PAIRGAIN TECHNOLOGIES HIGAIN-2™ LINE UNIT
MODEL HLU-611 Issue 1
List 3 PairGain #150-1217-03 CLEI Code: T1L1JJK3AA

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

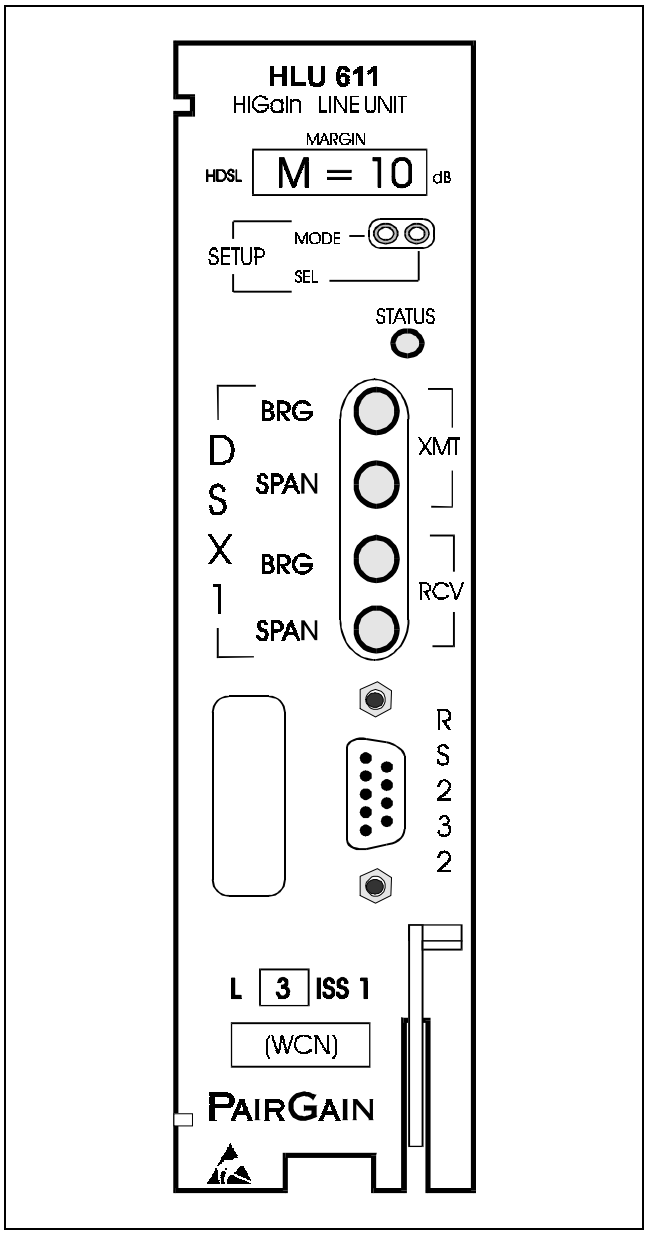

Figure 1. HLU-611 Front Panel. The PairGain HLU-611 is the Central Office side of a single pair repeaterless T1 transmission system.

A. PRODUCT OVERVIEW

1. DESCRIPTION AND FEATURES

1.01 PairGain's HiGain-2 Line Unit Model HLU-611 Issue 1, List 3 Figure 1, is the Central Office side of a single pair repeaterless T1 transmission system. When used in conjunction with an HRU-612 HiGain-2 Remote Unit, the system provides 1.544 Mb/s transmission on 1 unconditioned copper pair over the cable ranges shown in Table 1. The HiGain-2 system uses VHDSL (Very High-bit-rate Digital Subscriber Line) transmission technology. HiGain-2 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 14, 1995

a) Initial release.

1.03 HLU-611, List 3 features:

- Selectable DSX-1 Pre-equalizer
- -170 Vdc Line Power for HRU-612
- Front Panel VHDSL S/N Margin Display
- Selectable Loopback activation codes
- RS-232 maintenance port
- Non-volatile front-panel operator setup
- Front Panel DS1 splitting & brdg access
- Lightning and power cross protection on VHDSL interfaces
- 1568 kb/s full-duplex 2B1Q VHDSL Transmission on pair
- Front panel status indicating LED.
- On / Off front-panel display power cycling.
- DS1 LOS detector (125 consecutive zeros).
- Margin threshold alarm.
- Smart-jack AIS option.
- Easy return to factory default user settings.
- Circuit ID option

2. APPLICATIONS

2.01 HiGain-2 provides a cost-effective, easy to deploy method for delivering T1 high Capacity Digital Service (HCDS) over 1 metallic pair. The fiber-like quality service is deployed over 1 unconditioned, non-loaded copper pair. Conventional in-line T1 repeaters are not required. Cable pair conditioning, pair separation and bridged tap removal, are not required.

2.02 The general guidelines on which the range deployment rules in Table 1 are based require that each HiGain-2 loop have less than 35 dB of loss at the 2B1Q line rate of 392 kHz, with 135 ohm driving and terminating impedances, adherence to this rule will result in an operating margin of at least 6 dB. The HiGain-2 system operates with any number of other T1, POTS, Digital Data Service (DDS) or other HiGain-2 Systems sharing the same cable binder group. HiGain-2 systems can be used with customers requiring DS1 service on a temporary or permanent basis. HiGain-2 also provides a means of quickly deploying service in advance of fiber-optic transmission systems. With HiGain-2, service can be provided within hours. Fiber optic systems can be installed at a leisurely pace and cut-over from HiGain-2 when convenient to do so. The HiGain-2 system can then be easily removed and utilized elsewhere.

TABLE 1. HIGAIN-2 VHDSL LOOP LIMITS

Cable Gauge	Loss @ 392 kHz dB/kft	Ohms per kft	Maximum Loop For 35 dB Loss	Ohms @ Maximum Loop Length
26/0.4 mm	4.97	83.3	7.0 kft / 2.13 km	583
24/051mm	3.87	51.9	9 kft / 2.74 km	467
22/0.61mm	3.01	32.4	12 kft / 3.66 km	389
19/0.91mm	2.17	16.1	16 kft / 4.87 km	258

3. SPECIFICATIONS

VHDSL Line Code
1568 kb/s 2B1Q.

VHDSL Output
+13.5 dBm +/- 0.5 dB @ 135 ohms .

VHDSL Line Impedance
135 ohms.

Maximum Provisioning Loss
35 dB @ 392 kHz, 135 ohms.

Line Clock Rate
Internal Stratum 4 clock.

VHDSL Startup Time
30 seconds typ., 60 seconds max.

One-way DS1 Delay
<220 microseconds.

DSX-1 Line Impedance
100 ohms.

DSX-1 Pulse Output
12V pk-pk for EXTERNAL equalizer or pre-equalized for 0-655 feet of ABAM.

DSX-1 Input Level
+1.5 to -7.5 dB_{DSX}.

DS1 Line Rate
1.544 Mb/s +/- 200 bits/sec.

DS1 Line Format
AMI, B8ZS or ZBTSI.

DS1 Frame Format
ESF, SF or unframed.

Power Consumption
14 watts typ.; 18 watts max.

Heat Dissipation
6 watts typ.; 8 watts max.

Fusing
Internal;connected to “FUSEALARM” output on pin 32.

Span Voltage
-170 Vdc max.

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

Electrical Protection
Secondary surge protection on DS1 & VHDSL ports. Power cross protection on VHDSL port.

Operating Temperature & Humidity
0 to 50º Celsius, 5 to 95% (non-condensing)

Mounting
AT&T 220 type or equivalent.

Dimensions
5.9”Hx1.4”Wx10”D.

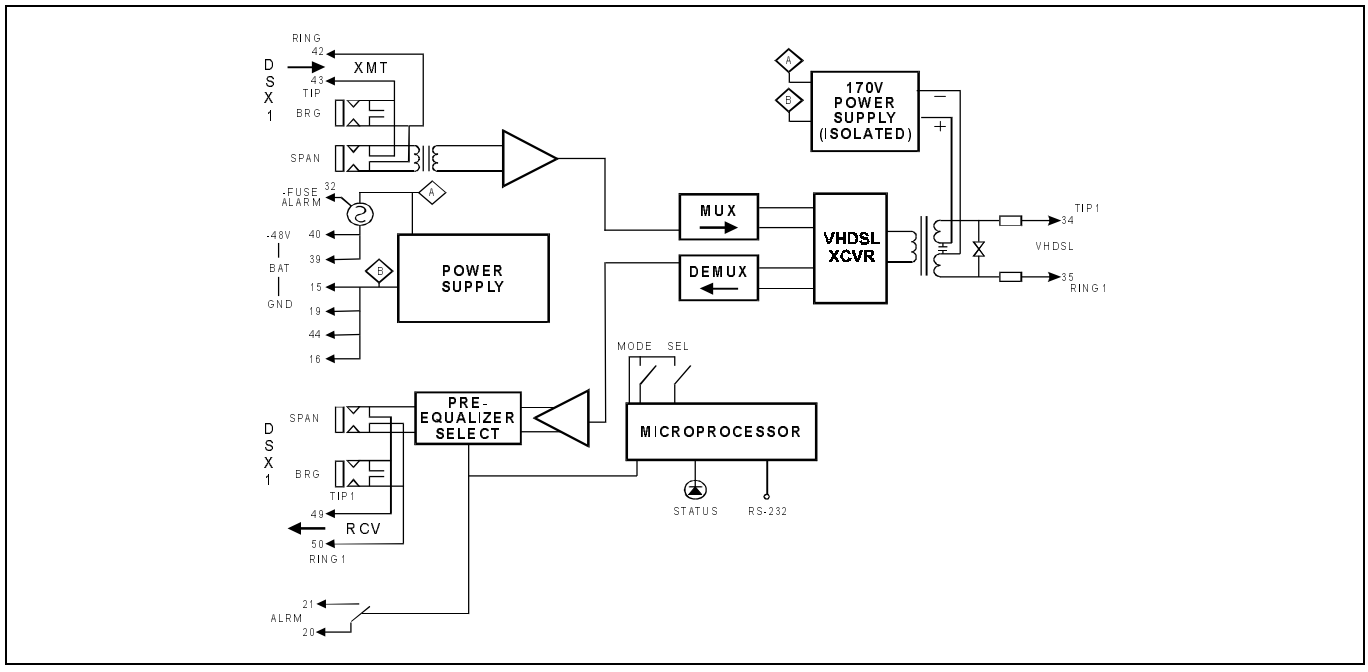

Figure 2. HLU-611 Block Diagram.

4. CERTIFICATION

4.01 FCC compliance: The HLU-611 has been tested and found to comply with the limits for a 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 contacting 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. FUNCTIONAL OPERATION

7.01 HiGain-2 utilizes PairGain's 2B1Q VHDSL transceiver systems to establish one full-duplex 1568 kb/s data channels between the HLU-611 and a remotely mounted HRU-612 HiGain-2 Remote Unit.

7.02 A block diagram of the HLU-611 is shown in Figure 2. The HiGain-2 HLU-611 receives a 1.544 Mb/s DS1 data stream from the DSX-1 digital cross connect interface. The HLU contains a DS1 frame synchronizer controlled by an 8-bit micro controller that determines the type of framing on the DS1 stream and synchronizes to it. The HLU-611 recognizes SF(including D4) or ESF framing. When the data is unframed, the HLU-611 arbitrarily defines a frame bit.

7.03 The HLU-611 contains a demultiplexer that generates a 1568 kb/s data stream. The data stream contains VHDSL frames that are nominally 9408 bits (6 milliseconds) in length. The VHDSL frames contains a 14 bit Frame Sync Word (FSW), 6 bit Cyclic Redundancy Check (CRC), 21 bit operations channel and DS1 payload.

7.04 The formatted VHDSL channel is passed to the VHDSL transceiver which converts it to a 2B1Q format on the VHDSL line. The 2B1Q line code is designed to operate in a full-duplex mode on one unconditioned pair. The transceiver's echo canceler and adaptive equalizer receive the signal from the remote end in the presence of impairments and noise on the copper pair.

7.05 The received VHDSL channel is processed by the transceiver and then passed on to the HLU-611 multiplexer module. The multiplexer provides frame synchronization for the VHDSL channel. The multiplexer and VHDSL transceiver work under control of the HLU-611 micro controller and compensate for data inversions caused by tip-ring reversals. By synchronizing to the FSW of the VHDSL channel, the multiplexer can reconstruct the original 1.544 Mb/s DS1 stream from the VHDSL channel. The CRC fields on the VHDSL streams allow the HLU-611 to determine if errors are present on the channel due to excessive impairments on the VHDSL pairs or due to excessive impulse or crosstalk noise.

7.06 The multiplexer removes data link messages from the VHDSL channel and passes them to the micro controller. This mechanism allows operations messages and status to be exchanged between the HLU-611 and the HRU-612 remote unit.

7.07 The reconstructed VHDSL data channel is buffered in a first-in-first-out buffer (FIFO) within the multiplexer. A frequency synthesizer in conjunction with the FIFO regulates the output bit rate and reconstructs the DS1 clock at the exact rate received from the remote end. The HiGain-2 system operates at DS1 rates of 1.544 Mbs with up to ±200 bits/second of offset.

7.08 A DSX-1 interface driver converts the DS1 channel to an AMI or B8ZS format. The DSX-1 equalizer is programmable to 5 different lengths as determined by the distance between the HLU and the DSX-1 interface. This provides CB-119 compliant pulses at the DSX-1 interface over a range of 0-655 feet of ABAM cable.

7.09 The HLU-611 contains 2 separate power converters. The main power supply converts -48V local battery to logic power for the HLU-611 circuits. The line power supply converts the -48V battery to a -170 Vdc feed that provides loop power feed on the cable pair to the HRU Unit. The line power supply can be turned on or off by the micro controller and is automatically shut down in the presence of line short circuits or micro controller failure.

7.10 The three most important power demands of an HLU-611 on the shelf power supply are its maximum power consumption, its maximum power dissipation and its maximum current drain. These three parameters for the HLU-611, on a per slot and per shelf basis, are as follows:

Maximum Power Dissipation:

- Per Slot = 7.0 Watts
- Per Shelf =91 Watts

Maximum Power consumption:

- Per Slot = 16 Watts
- Per Shelf =208 watts

Maximum Current Drain:

- Per Slot = 0.376 Amps
- Per Shelf =4.9 Amps.

Note that the worse case conditions under which these parameters were measured include a 7,500 ft. # 26 AWG loop, 60 mA. of CPE current, a fully loaded 13 slot shelf, and a 42.5 V shelf battery voltage.

7.11 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/sq. ft.

7.12 In Central Office locations, the maximum power dissipation for open faced, natural convection cooled mountings is limited to 120 W / sq. ft. per Section 4.2.3 of the NEBS standard TR-NWT-000063. The footprint of a 13 slot 23 " HLU-611 shelf is 7.024 sq. ft. Thus the maximum bay dissipation is limited to 840 Watts. At 91 watts per shelf, this limits the number of fully loaded HLU-611 shelves to 9 per bay. Note that this is a worse case situation in that it assumes the entire Central Office is subjected to the maximum power density. Conditions other than these worse case ones would permit increasing the number of shelves per bay without jeopardizing the C.O.'s thermal integrity.

7.13 The thermal loading limitations imposed when using the HLU-611 in CEVs or other enclosures are determined by applying the HLU-611's power parameters to the manufacturer's requirements for each specific housing.

7.14 The Maximum Power Consumption is the total power that the HLU-611 consumes or draws from its -48 V shelf power source. This parameter is needed when the 611 is located remote to its serving C.O. It determines the battery capacity required to maintain an 8 hour stand-by battery reserve for emergency situations. It thus limits the maximum number of plugs per remote enclosure. Use the above data to perform this analysis on a case by case basis.

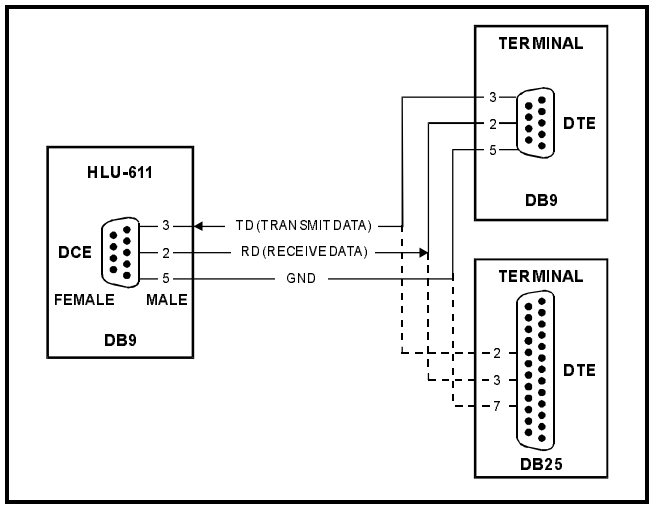

Figure 3. DB-9 Pin-outs.

7.15 The Maximum Current Drain is the maximum current drawn from the shelf power supply when it is at its minimum voltage (42.5 V). This determines the shelf fusing requirements. HLU-611 shelves are normally fused at 10 amps. A fully loaded shelf of 13 HLU-611s draws 4.9 amps in the worst case. This is well within the 10 amp fuse limit.

7.16 A 9-pin (RS-232) DB-9 connector (see Figure 3), is provided on the front panel. This connector provides access to HiGain-2's maintenance, provisioning and performance monitoring interface. A very basic interface is available via a 'dumb terminal'. Figures 7 through 13 show the menu selections that are available from the terminal. The port is configured as DCE with 8 data bits, 1 stop bit and no parity. Striking the SPACE bar several times invokes autobaud from 1200 to 9600 b/s.

7.17 The normally open alarm contacts available across pins 20 & 21 comprise the HLU-611's minor alarm output. These alarm contacts close for any of the following alarm conditions. Note that the front panel message which accompanies each alarm condition is shown in bold letters before each alarm condition. Since more than one alarm condition can exist at any given time but only one message can be displayed, the alarms are listed in their order of priorities. Only the highest priority alarm is displayed if more than one alarm condition exists.

1) **ALRM LOSW:** The VHDSL loop loses sync.
2) **ALRM LLOS:** Loss of the HLU T1 input signal.
3) **ALRM RLOS:** Loss of HRU T1 input signal
4) **ALRM HES:** VHDSL Loop has exceeded the 24 hour user-selected Errored-Seconds (CRC) threshold
5) **ALRM DS1:** The total number of bipolar violations (BPV) at the HLU and HRU T1 input have exceeded the 24 hour user-selected threshold.
6) **ALM MAL**: The margin on the VHDSL Loop has dropped below the minimum threshold value set by the dumb terminal MARGIN ALARM THRES; as described in Section 8.

The HLU 611's STATUS LED flashes RED for the duration of a minor alarm condition. Alarms 4 & 5 can be inhibited by selecting NONE for the ESAL

system option. See Section 8 for System Settings information. The MAL1 alarm can be disabled by setting the margin alarm threshold to 0. All six alarms can be inhibited by selecting DIS (disable) for the ALM system option. The MNALRM can be retired by executing the ACO option. This is accomplished by depressing the SEL button on the front panel. This turns the alarm off and replaces the ALRM message by the ACO message. The second part of the ALRM message, which defines the cause of the alarm, remains. Both messages remain until the alarm condition clears or another alarm occurs. Disabling the ALM also retires an ACO condition.

7.18 Pin 32, FUSEALARM, is driven to -48 V and the front panel STATUS LED turns red whenever the on board fuse opens.

7.19 The HLU-611's front panel tri-color STATUS LED has the following states:

- GREEN - Normal Operation
- FLASHING GREEN - VHDSL Acquisition
- FLASHING RED - Minor Alarm (For conditions see Paragraph 7.17)
- RED - FUSEALRM
- YELLOW - Self Test in process or an HLU loopback in effect (CREM or NLOC).
- FLASHING YELLOW - The HLU is in an ARMED state.

7.20 Depressing both the MODE and SEL pushbuttons on the front panel for at least 3 seconds initiates a MANUAL loopback session. This session allows the user to SEL one of four HiGain loopbacks. The message, MAN LPBK, appears on the front panel display followed by the message NRE?. If the SEL button is now depressed, an NREM loopback is executed and the message changes from NRE? to NREM. If the MODE button is depressed instead of the SEL button, NRE? is replaced by NLO?. This now allows an NLOC loopback to be executed with the SEL button. Depressing the MODE button two more times yields the CLO? (CLOC) and CRE? (CREM) customer loopback options. This interactive button procedure permits any of the four HiGain loopback to be executed. Once a loopback is executed, it can be terminated and the next loopback option presented by depressing the MODE button. If neither button is depressed for a period of 30 seconds, this manual loopback session terminates and the normal margin displays reappear. If this time-out occurs with an active loopback in effect, the appropriate loopback message appears in addition to the loop margin messages. Once the manual loopback session terminates, the loopback remains in effect until it times-out in accordance with the user LBTO setting. It can also be terminated by re-entering the manual loopback mode and selecting another loopback. Only 1 loopback can exist at any given time. Depressing both buttons, again for 3 seconds, terminates any active loopback, ends the MANUAL loopback session and returns the display to normal. Note that the loopbacks can be also initiated from the RS-232 maintenance port by choosing the LOOPBACK MODE, option "D" from the MAIN MENU. This displays the Loopback Menu, shown in Figure 14, from which any of the four loopbacks can be initiated.

8. OPTIONS

8.01 The HLU-611 contains a non-volatile RAM which stores the system option settings. No dip-switches or jumpers are required to set the HLU-611 configuration. The options are set via pushbuttons on the front panel, through the RS-232 interface, or from the NMA interface and are retained if shelf power is lost or if the HLU-611 is unplugged. Table 2 lists the HLU-611 option settings. Note that only those options enclosed by quotes can be set by the front panel buttons. All 14 options can be set via the front panel RS-232 maintenance part. Figure 8 illustrates the same options on the HLU-611 set-up menu.

8.02 The SETUP (MODE and SEL) momentary pushbuttons are used to set the options from the front panel. To initiate an OPTION SETTING mode, depress the MODE button for 1 second and release. The message displayed on the front panel alternates between the system parameter and its current setting. Depressing the SEL button steps the display through all possible settings (one at a time) of the MODE (parameter) being displayed. After the desired setting has been chosen, depress MODE. This does two things. First it updates the current displayed mode to the setting chosen. It then selects the next configurable parameter. After the last parameter has been selected, the displays shows CONF/NO. If the MODE button is now depressed, none of the changed parameters are installed. If the SEL button

is depressed, a YES message is displayed and the chosen changes are installed. In either case the display returns to its normal mode. The display also returns to its normal mode, without installing any new changes, if neither button is depressed for 30 seconds.

8.03 All 14 user options can be set to their default values by depressing the SEL button for 6 seconds. When released, the message: "DFLT NO" appears. To install the default values depress the SEL button again. The "YES" will follow indicating that the default values are now in effect. To terminate this DFLT mode without reverting the options to their default values, depress the MODE button or do nothing for 30 seconds. The latter returns the display to its normal state.

8.04 Depressing the MODE button for 3 or more seconds causes the display to scroll through the HLU's software version number, its List #, the type of frame pattern being received from the DSX-1, the line code setting of the HLU and all 11 option settings. See Table 9 for these additional messages.

8.05 The following three user options must be set with a dumb or smart terminal: CIRCUIT ID, DS0 BLOCKING and MARGIN ALARM THRESHOLD.

8.06 The CIRCUIT ID option is set by choosing the "I" option from the dumb terminal's main menu shown in Figure 6. The message "enter circuit ID #: 24 characters max" follows the "I" selection hit the return key after entering the chosen set of alpha-numeric ID characters. Then chose "C" to confirm. Note if more than 24 characters are entered, en error message appears. Simply delete the excess characters and then hit the return key once again. The ID appears in all HLU screens as shown in Figures 6 through 13. The ID does not appear on the HRU screens when the maintenance port is accessed at the remote unit. Note that the Circuit ID is not set to its default (all blanks) setting when the DFLT setting option is utilized.

8.07 To set the DS0 BLOCKING option first select the SYSTEMS SETTINGS ("D" choice) from the main menu. The menu shown in Figure 8 appears. Now enter the letter "B" shown in parenthesis of the DS0 blocking selection. The DS0 channels are blocked or unblocked by entering each channel's number. Multiple channels can be selected by inserting a space between each entry. After all the new settings have been made, enter "E" for exit and then "C" for confirm. The new choices are now installed. If DS0 blocking is invoked in a HiGain-2 system that has an earlier HRU that does not support the blocking option, blocking will only occur at the DS1 output of the HLU. The HRU's DS1 output will not be blocked. Also, all blocked channels are opened for all HiGain-2 loopback tests. This allows the standard full bandwidth T1 loopback tests to be performed.

8.08 To set the MARGIN ALARM THRESHOLD select "G" from the system settings menu. Enter the desired minimum acceptable alarm threshold from the 0 to 15 dB range. This causes a minor alarm to occur (see Paragraph 7.17) if the margin on the VHDSL loop drops below the selected threshold value. Since the margin can never drop below 0, choosing "0" for the margin threshold turns the margin alarm off.

8.09 The other dumb terminal system settings are set in a similar manner. Simply enter the letter in parenthesis of the parameter to be changed. Each entry of this letter scrolls the parameter to its next value, hit the enter key after each selection is madeAfter all selections have been made, enter "E" and then "C" to the resulting Confirm message. This activates the new choices and returns control to the main menu.

8.10 The SELF-TEST mode that occurs when the VHDSL loop is not in sync includes the input DS1 transceiver chip in the self test procedure. This process can cause the AIS pattern, that is normally transmitted from the HLU during these out of sync intervals, to exhibit occasional BPVs.

9. LOOPBACKS

9.01 HiGain-2 has a family of loopback options. The most important of these is the Smart-Jack loopback which enables the HRU-612 to respond to the standard 2/3 in 5 Smart-Jack in-band loopback codes. This option can be enabled or disabled from either the front panel settings or the dumb terminal system settings menu.

9.02 In addition to the Smart-Jack loopback, HiGain-2 can be configured for one of five special in-band loopback command sequences. These are selected from the SPLB user option shown in Table 2 and Figure 8. The loopback locations are shown in Figure 5.

9.03 GNLB is the HiGain-2 Generic loopback code. The GNLB allows 4 in 7 or 6 in 7 in-band codes to loop-up the HLU (NLOC or CREM respectively) and 3 in 7 or 4 in 7 in-band codes to loop-up the HRU (NREM or CLOC respectively). NLOC & NREM are issued from the HLU DS1 interface. CLOC & CREM are issued from the HRU DS1 interface. All looped states are terminated (looped-down) with the 3 in 5 loop-down code. All commands must be present for 5 seconds before HiGain-2 responds. Table 3 lists the test procedures that apply when using the GNLB mode.

TABLE 2. SYSTEM OPTION SETTINGS

MODE	*CHOICE*	*DESCRIPTION*
"EQL"	EXT*	Replaces the internal equalizer with a 12 Vpk-pk drive source for an external equalizer.
	0	Sets the Equalizer to DSX-1 for 0-133 feet.
	133	Sets the Equalizer to DSX-1 for 133-266 feet.
	266	Sets the Equalizer to DSX-1 for 266-399 feet.
	399	Sets the Equalizer to DSX-1 for 399-533 feet.
	533	Sets the Equalizer to DSX-1 for 533-655 feet.
LBPK	DIS	Configures the HiGain system to ignore all in-band Smart-Jack loopback commands.
	ENA*	Enables the HiGain system to recognize all in-band Smart-Jack loopback commands.
SPLB	GNLB	Configures the HiGain system to respond to the generic (3/4 in 7) in-band loopback codes.
	A1LB & A2LB*	Configures the HiGain system to respond to the Teltrend addressable repeater in-band loopback codes.
	A3LB	Configures the HiGain system to respond to the Wescom addressable repeater in-band loopback codes.
	A4LB	Configures the HiGain system to respond to the Wescom Mod 1 addressable repeater in-band loopback codes.
	A5LB	Configures the HiGain system to respond to the Teltrend Mod 1 addressable repeater in-band loopback codes.
PWRF	DIS	Disables powering to the HRU-612.
	ENA*	Enables powering to the HRU-612.
ZBTS	ON	Tells the HiGain system that the ESF frame is operating in its Zero Byte Time Slot Interface (ZBTSI) mode.
	OFF*	Tells the HiGain system that the ESF frame is operating in its normal non-ZBTSI mode.
ESAL	17	Creates a minor alarm condition which flashes the red STATUS LED when 17 Errored Seconds (ES) (17 HDSL CRC errors on either HDSL loop or a total of 17 BPV and FERR occur within a 24-hour period.
	170	Creates a minor alarm condition which flashes the red STATUS LED when 170 ES (170 HDSL cyclic redundancy check (CRC) errors on either HDSL loop or a total of 170 BPV and FERR) occur within a 24-hour period.
	NONE*	Prevents generation of a minor alarm due to excessive Errored Seconds.
"LBTO"	NONE	Disables automatic time-out cancellation of all loopbacks.
	20	Sets automatic cancellation of all loopbacks to 20 minutes after initiation.
	60	Sets automatic cancellation of all loopback to 60 minutes after initiation.
	120*	Sets automatic cancellation of all loopback to 120 minutes after initiation.
ALM	DIS*	Opens the Alarm relay contacts if closed, and prevents another relay alarm closure from occuring.
	ENA	Enables activation of the minor alarm relay when a minor alarm condition occurs.

Table continued on next page

TABLE 2. SYSTEM OPTION SETTINGS (CONTINUED)

MODE	***CHOICE***	***DESCRIPTION***
"LNCD"	B8ZS	Places both the HLU-611 & HRU-612 into their B8ZS modes.
	AMI*	Places both the HLU-611 & HRU-612 into their AMI modes.
"FRMG"	AUTO*	Configures the HiGain system to operate in an auto-framing (AUTO) mode in which it continuously searches the input T1 bit stream for a valid SF or ESF frame pattern. This feature is required for fractional T1 applications (DS0 blocking) where it insures proper channel time slot alignment. While the HiGain system can also process unframed data in this AUTO mode, it is recommended that the unframed (UNFR) mode be used for all unframed applications. Using the AUTO mode for unframed applications runs the risk of detecting "pseudo-valid" frame sequences, which can affect the data integrity.
	UNFR	Configures the HiGain system to operate in an unframed mode. This mode disables the auto framing process and forces the HiGain system to function as a transparent bit pipe.
HAIS	DIS*	Prevents a margin alarm from generating an AIS pattern at either TI interface. Causes the HiGain system to transmit the AIS signal at both the HLU-611 & HRU-612 T1 output ports when both of the HDSL loops are not in sync (LOSW).
	1LP	Enables a margin alarm to initiate an AIS condition at each T1 output. Causes the HiGain system to transmit the AIS signal at both the HLU-611 & HRU-612 T1 output ports when either of the two HDSL loops is not in sync (LOSW) or if a MARgin alarm occurs.
SAIS	ENA*	Causes the HRU-612 to transmit the AIS signal towards the Network Interface (NI) when in NREM or Smart-Jack loopback.
	DIS	Causes the HRU-612 to transmit the signal from the network towards the NI and opens and terminates the HRU-612 RCV NI port when an HRU NREM or Smart-Jack loopback is executed. The AIS signal is off.
CONF	YES	Confirms that all eleven (listed above) operating modes are to be updated to their current choices.
	NO*	Prevents the most recently selected operating mode choices form being updated. They remain as they were before the system option settings procedure was entered.
MARgin Alrm Trsh	0 to 15 dB 4 dB*	The Margin Alarm Threshold can only be set via the RS-232 maintenance port. It determines the minimum allowable margin below which a minor alarm can occur. (Default value)
DS0	BLK	The DS0 blocking option can only be set via the RS-232 maintenance port with a terminal. The 4-Character HLU-611 front panel only displays the status of the blocking option. BLK indicates at least one channel is blocked.
	NONE*	NONE indicates no channels are blocked.
"xxxx"	Panel Set	Only these options can be set by the front panel. All of the options can only be set from the RS-232 maintenance port.

*Indicates HLU-611 factory settings. HiGain can be set to these default settings by pressing the SEL button for 6 seconds and then selecting the YES response to the resulting DFLT message.

9.04 The A1LB loopback selection (Table 4) complies with that proposed for VHDSL systems in the T1E1.4/92 recommendation with the following additions:

1) Query loopback
2) IOR powerdown
3) Three loopback time-out choices
4) Initiation from either end
5) Repeating bit error signatures
6) Alternate Query loopback

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

9.05 A2LB through A5LB are four special addressable repeater loopback functions which are supported by the List 6 version of HiGain-2. These loopbacks provide HiGain-2 with sophisticated maintenance and trouble shooting tools. Tables 5 thru 8 list the details of these Special Loopback (SPLB) functions. A2LB & A5LB are patterned after the Teltrend addressable T1 repeater loopbacks. A3LB & A4LB are patterned after the Wescom addressable T1 repeater loopbacks. All four SPLBs have been enhanced to handle the specific requirements of the following HiGain-2 customers:

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

9.06 A5LB differs from A2LB in that A5LB does not block the arming (3 in 5) code from exiting the HLU into the network. A2LB can be configured to either block this arming code after 2 seconds, and replace it with the AIS code, or to unblock it by executing the FAR-END ACTIVATE code. Since A5LB never blocks the arming code from exiting the HLU, it does not need this FAR-END ACTIVATE code. A3LB differs from A4LB in that A3LB supports the additional 1 in 6 smart jack loopback command. Refer to the PairGain HiGain-2 Intelligent Repeater Application Note # 910 Part # 325-910-100 for more SPLB details.

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

9.08 HiGain-2 may take longer than normal to respond to inband loopback commands when its framing mode is set to UNFR and the inband commands are sent in either an SF or ESF mode. The frame bits override the command bits and cause errors in the command sequence. These errors cause HiGain-2 to reject some sequences. This can extend the detection interval.

C. INSTALLATION AND TEST

10. INSTALLATION

10.01 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.

10.02 The HLU-611 is designed to mount in a 220-type ORB shelf or equivalent SXSS, Kentrox T-Term and Wescom 342-30 shelves. The HLU-611 slot pin-outs are shown in Figure 4.

CAUTION

The ALM option must be disabled (DIS) when using the Kentrox 220 T-Term shelf. This is required to resolve a conflict between the HLU alarm relay output and the Kentrox external equalizer output. Both use the same pins, 20 and 21.

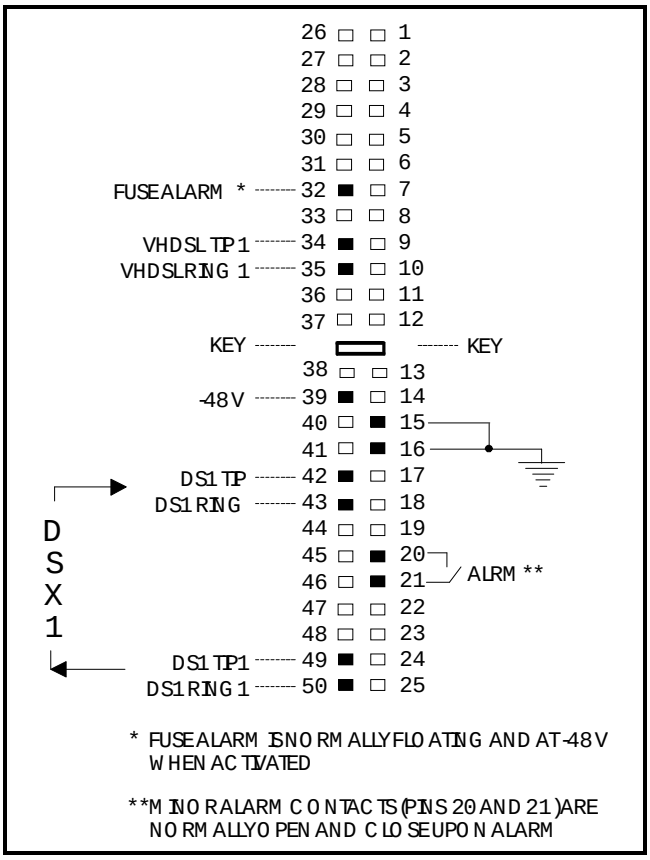

Figure 4. HLU-611 Pin-outs.

CAUTION

The HLU-611 is incompatible with the newer Kentrox 224 shelves when these shelves are optioned to connect their -V line (which is normally -48V to -130V). The -V line connects to pin 40. The HLU-231 connects pin 40 to 39 and pin 39 to -48V, which causes the conflict.

11. TESTING

11.01 Tables 3 through 8 provide step by step test procedures for the HLU-611 Unit as a function of the loopback option selected. These procedures allow verification of the integrity of the VHDSL channel to the HRU-612 remote unit as well as the DS1 channels to the customer and the local DSX-1 interface.

11.02 The HLU's 4 character front panel display has many useful system diagnostic messages. They are listed in Table 9. This display turns on when power is initially applied to the 611. In order to conserve power, it only remains on for 5 minutes if neither the MODE nor SEL buttons are depressed. The use of either button restarts the 5 minute power-control timer.

11.03 If trouble is encountered on the DSX-1 interface, verify that the hit is making a positive connection with the mounting assembly's connector. Also, verify that the pre-equalizer is properly set. All installations should be set to the largest value that does not exceed the distance from the DSX-1 to the shelf

11.04 The transmit and receive T1 DSX-1 ports have splitting access and bridging miniature 210 jacks as shown in Figure 2. Connecting one cable between the two BDG jacks and another between the two SPAN jacks splits the XMT and RCV and creates metallic loopbacks towards both the DSX-1 and the HLU.

11.05 Figure 7 shows the HLU status screen. It contains useful information on the VHDSL loops and the DS1 input. Figures 11, 12 & 13 show the performance data & alarm history screens. All the performance data shown in Figures 8 , 11 & 12 can be cleared to zero by selecting the (C)lear option from the HLU Status Screen shown in Figure 7. Note that since the HLU is considered the master module, this clears **all** performance data screens at both the HLU & the HRU. Clearing the data from the HRU only clears performance data at the HRU. It does not clear it at the HLU.

TABLE 3. HLU-611 TEST PROCEDURES FOR GNLB OPTION

Step	Action
1	Have the C.O. tester send the HRU (3 in 7) in-band loop-up for 5 seconds. Observe that the HLU displays the “NREM” message indicating an HRU loopback is in effect (see Figure 5).
2	Have the C.O. tester transmit a T1 test signal into the HLU and verify that the returned (looped) signal is error free.
3	If the above test fails, have the C.O. tester transmit the (3 in 5) in-band loop-down code. Verify that the HLU display returns to normal.
4	Have the C.O. tester send the HLU (4 in 7) in-band loop-up for 5 seconds. Observe that the HLU displays the “NLOC” message indicating an HLU loopback is in effect.
5	Repeat step “2”. If the test passes, the problem is in the cable pair or the HRU. If it fails, the problem is in the C.O. equipment
6	The NREM and NLOC loopbacks can also be initiated from the front panel of the HLU with the MODE and SEL pushbuttons. See Paragraph 7.20 for details.
7	The HLU can be looped-up from the remote location (CREM) by issuing the 6 in 7 command at the HRU’s DS1 input port.
8	The HRU can be looped-up from the remote location (CLOC) by issuing the 5 in 7 command at the HRU’s DS1 input port.

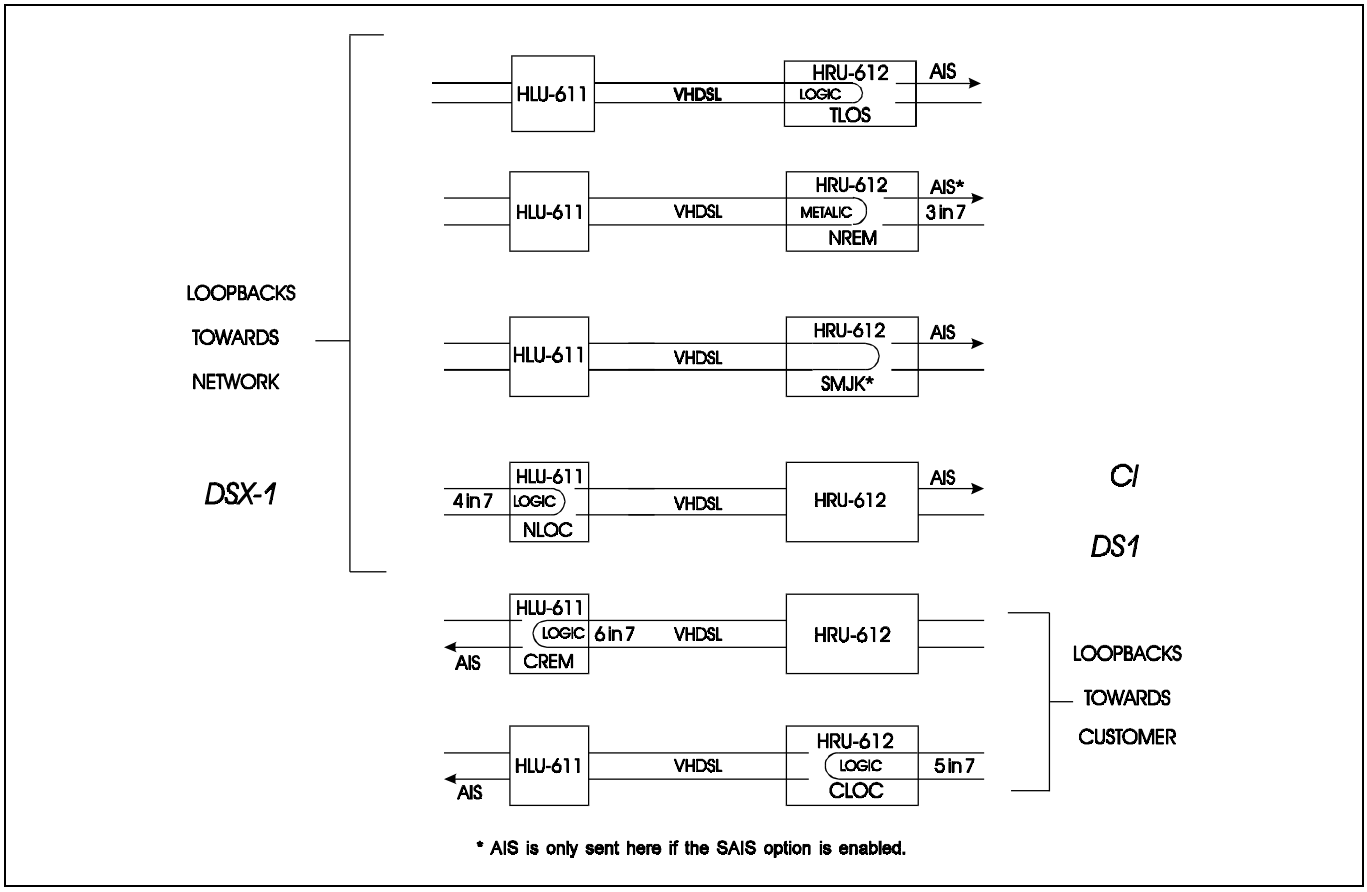

Figure 5. HLU-611 Loopback Configurations.

TABLE 4. HLU-611 TEST PROCEDURES FOR A1LB OPTION

Step	Action
1	Send into the HLU the inband ARMING and NIU (Network Interface Hit) LPBK code 11000 for at least 5 seconds, or at least 4 repetitions of the 16-bit ESF Data Link ARMING code 0001 0010 1111 1111.
2	Monitor the output of the HLU-611 for the return of the pattern. Return of pattern indicates that either the HRU has looped-up (If the SMART-JACK LOOPBACK option is ENABLED) or that an external NIU has looped up (If the SMART-JACK LOOPBACK option is DISABLED) and that the HLU and HRU units have been ARMED. Verify that the HLU display intermittently indicates 'ARM and also "SMJK" if the HRU is in loopback.. Also verify, if possible, that the LOOPBACK LED of the HRU-612 is flashing, indicating that the HRU is armed or that it is on solid, indicating that it is both armed and in loopback.
3	Once armed the HLU can be looped back (NLOC in Figure 5) by sending IOR (Intelligent Office Repeater) LPBK activation code 1101 0011 1101 0011 for at least 5 seconds. The tester observes the following activation response: • 2 seconds of AIS (all ones), followed by: • 5 seconds of returning data pattern, followed by: • 231 logic errors (including the frame bits) occur in the returned pattern(20 errors if ILR-2 were sent), followed by: • normal looped data. Note that this error pattern will repeat every 20 seconds as long as the IOR loopback pattern is • being sent. This same 20 second repeat scenario also applies to ILR, Time-Out Override and Query commands. The HiGain-2 Line Hit is now in Logic Loopback (NLOC of Figure 5). The display on the HLU-611 periodically shows NLOC (network local loop) and ARM (the HLU is still armed) in addition to the margin displays. The Loopback Time-out option, which is user settable to NONE, 20, 60 or 120 minutes, determines the duration of this loopback unless it is overridden by the TIME-OUT OVERRIDE command or a loop down command is sent. If the Time-out Override code 1101 0101 1101 0110 is received, the "activation sequence" described in "3" above is repeated and the automatic timed expiration of the loopback is inhibited. If this Time-out Override is sent, then the only way to loop the HLU down is to issue the IR (Intelligent Repeater) LPDN (loopdown) code 1001 0011 1001 0011 or to issue the NIU (Network Interface Hit) LPDN and Disarm code 11100. The automatic time-out timer is restored during subsequent loopback sessions.
4	Upon completion, the tester sends IOR LPDN code 1001 0011 1001 0011 to loop-down the HiGain-2 Line Hit. The unit remains ARMED however, as indicated by the ARM message on the HLU-611 and the flashing of the HRU-612's LOOPBACK LED.

Table continued on next page

TABLE 4. HLU-611 TEST PROCEDURES FOR A1LB OPTION (CONTINUED)

Step	Action
5	Using the following codes, a NETWORK tester can activate loopbacks NLOC or NREM or SMJK (if enabled) shown in Figure 5. A CUSTOMER tester can activate loopbacks CLOC or CREM.

Addressable 1 (A1LB) Repeater Loopback Commands

ARMING or NIU LPBK (inband)	Arming code	11000 11000..
ARMING or NIU LPBK (ESF Data Link)	Arming code	1111(F)*1111(F)0100(4)1000(8)
IR LPDN or DISARM (inband)	Disarming code	11100 11100..
DISARM (ESF Data Link)	Disarming code	1111(F)1111(F)0010(2)0100(4)
IOR LPBK (NLOC & CREM 231 errors)	HLU Loop up	1101(D)0011(3)1101(D)0011(3)
ILR-2 LPBK (NREM & NLOC 20 bit errors)	HRU Loop up	1100(C)0111(7)0100(4)0010(2)
IR LPDN	Loop down (HLU or HRU)	1001(9)0011(3)1001(9)0011(3)
IR QUERY LPBK	Query loopback	1101(D)0101(5)1101(D)0101(5)
IR ALTERNATE QUERY LPBK	Alternate Query loopback	1101(D)0101(5)1110(E)1010(A)
TIME-OUT OVERRIDE	Loopback Time-out Override	1101(D)0101(5)1101(D)0110(6)
FAR END NIU ACTIVATE	Unblock AIS & pass 2 in 5	1100(C)0101(5)0101(5)0100(4)
IOR POWER DOWN (HLU)	Removes VHDSL line power	0110(6)0111(7)0110(6)0111(7)

Note: the left most bit arrives first in all 8 sequences. The detection algorithm functions reliably with a random 10E-3 bit error ratio (BER) on the facility. The IOR POWER DOWN code must remain present for the duration of the power down mode. When this code is removed, HiGain-2 returns to its normal unlooped and unarmed state.* This is the HEX number for the 4 bit group.

6	After testing is complete, send the universal loopdown [IR (Intelligent Repeater) LPDN] code if the system is to loopdown but remain ARMED. Send the disarm code 11100 if all the equipment is to be looped down, disarmed and returned to normal operation. Note that the ARMED mode has an automatic time-out of 120 minutes.
7	The NREM and NLOC loopbacks can also be initiated from the front panel of the HLU with the MODE and SEL pushbuttons. See Paragraph 7.20 for details.

TABLE 5. HLU-611 TEST PROCEDURES FOR A2LB OPTION

Step	Action
1	Send into the HLU the inband ARMING and NIU (Network Interface Hit) LPBK code 11000 for at least 5 seconds, or at least 4 repetitions of the 16-bit ESF Data Link ARMING code 0001 0010 1111 1111.
2	Monitor the output of the HLU-611 for the return of the pattern. Return of pattern indicates that either the HRU has looped-up (If the SMART-JACK LOOPBACK option is ENABLED) or that an external NIU has looped up (If the SMART-JACK LOOPBACK option is DISABLED) and that the HLU and HRU units have been ARMED. Verify that the HLU display intermittently indicates 'ARM and also "SMJK" if the HRU is in loopback.. Also verify, if possible, that the LOOPBACK LED of the HRU-612 is flashing, indicating that the HRU is armed or that it is on solid, indicating that it is both armed and in loopback.
3	Once armed the HLU can be looped back (NLOC in Figure 5) by sending IOR (Intelligent Office Repeater) LPBK activation code 1101 0011 1101 0011 for at least 5 seconds. The tester observes the following activation response: • 2 seconds of AIS (all ones), followed by: • 5 seconds of returning data pattern, followed by: • 231 logic errors (including the frame bits) occur in the returned pattern(20 errors if ILR-2 were sent), followed by: • normal looped data. Note that this error pattern will repeat every 20 seconds as long as the IOR loopback pattern is • being sent. This same 20 second repeat scenario also applies to ILR, Time-Out Override and Query commands. The HiGain-2 Line Hit is now in Logic Loopback (NLOC of Figure 5). The display on the HLU-611 periodically shows NLOC (network local loop) and ARM (the HLU is still armed) in addition to the margin displays. The Loopback Time-out option, which is user settable to NONE, 20, 60 or 120 minutes, determines the duration of this loopback unless it is overridden by the TIME-OUT OVERRIDE command or a loop down command is sent. If the Time-out Override code 1101 0101 1101 0110 is received, the "activation sequence" described in "3" above is repeated and the automatic timed expiration of the loopback is inhibited. If this Time-out Override is sent, then the only way to loop the HLU down is to issue the IR (Intelligent Repeater) LPDN (loopdown) code 1001 0011 1001 0011 or to issue the NIU (Network Interface Hit) LPDN and Disarm code 11100. The automatic time-out timer is restored during subsequent loopback sessions.
4	Upon completion, the tester sends IOR LPDN code 1001 0011 1001 0011 to loop-down the HiGain-2 Line Hit. The unit remains ARMED however, as indicated by the ARM message on the HLU-611 and the flashing of the HRU-612's LOOPBACK LED.

Table continued on next page

TABLE 5. HLU-611 TEST PROCEDURES FOR A2LB OPTION (CONTINUED)

Step	Action
5	Using the following codes, a NETWORK tester can activate loopbacks NLOC or NREM or SMJK (if enabled) shown in Figure 5. A CUSTOMER tester can activate loopbacks CLOC or CREM.

Addressable 2 (A2LB) Repeater Loopback Commands

ARMING or NIU LPBK (inband)	Arming code	11000 11000..
ARMING or NIU LPBK (ESF Data Link)	Arming code	1111(F)*1111(F)0100(4)1000(8)
IR LPDN or DISARM (inband)	Disarming code	11100 11100..
DISARM (ESF Data Link)	Disarming code	1111(F)1111(F)0010(2)0100(4)
IOR LPBK (NLOC & CREM 231 errors)	HLU Loop up	1101(D)0011(3)1101(D)0011(3)
ILR-2 LPBK (NREM & NLOC 20 bit errors)	HRU Loop up	1100(C)0111(7)0100(4)0010(2)
IR LPDN	Loop down (HLU or HRU)	1001(9)0011(3)1001(9)0011(3)
IR QUERY LPBK	Query loopback	1101(D)0101(5)1101(D)0101(5)
IR ALTERNATE QUERY LPBK	Alternate Query loopback	1101(D)0101(5)1110(E)1010(A)
TIME-OUT OVERRIDE	Loopback Time-out Override	1101(D)0101(5)1101(D)0110(6)
FAR END NIU ACTIVATE	Unblock AIS & pass 2 in 5	1100(C)0101(5)0101(5)0100(4)
IOR POWER DOWN (HLU)	Removes VHDSL line power	0110(6)0111(7)0110(6)0111(7)

Note: the left most bit arrives first in all 8 sequences. The detection algorithm functions reliably with a random 10E-3 bit error ratio (BER) on the facility. The IOR POWER DOWN code must remain present for the duration of the power down mode. When this code is removed, HiGain-2 returns to its normal unlooped and unarmed state. * This is the HEX number for the 4 bit group.

6	After testing is complete, send the universal loopdown [IR (Intelligent Repeater) LPDN] code if the system is to loopdown but remain ARMED. Send the disarm code 11100 if all the equipment is to be looped down, disarmed and returned to normal operation. Note that the ARMED mode has an automatic time-out of 120 minutes.
7	The NREM and NLOC loopbacks can also be initiated from the front panel of the HLU with the MODE and SEL pushbuttons. See Paragraph 7.20 for details.

TABLE 6. HLU-611 TEST PROCEDURES FOR A3LB OPTION

Step	Action
1	The HiGain-2 Line Hit can be looped back (NLOC in Figure 5) by sending the (Addressable Office Repeater) LPBK activation code 1111(F) 1111(F) 0001(1) 1110(E) for at least 5 seconds. This causes the HLU to enter its NLOC state shown in Figure 5. The display on the HLU-611 alternates between NLOC (network local loop) and the margin displays. The Loopback Time-out option, which is user settable to NONE, 20, 60 or 120 minutes, determines the duration of this loopback unless it is overridden by the reception of a second identical 16 bit loopup command before the timer expires. When this time-out override state exists, the only way to loop the HLU down is to issue one of the three loopdown commands listed in Step 2. The automatic time-out mode is restored during subsequent loopback sessions.
2	The following list summarizes the codes required to execute all the HiGain-2 loopbacks shown in Figure 5. Note that all code sequences must be present for at least 5 seconds. LU=LOOPUP, LD =LOOPDOWN, NI = NETWORK INTERFACE, CI = CUSTOMER INTERFACE. **Addressable 3 (A3LB) Repeater Loopback Commands** POSITION — NAME — CODE HLU-611 LU FROM NI — NLOC — 1111(F)*1111(F)0001(1)1110(E) HLU-611 LU FROM CI — CREM — 0011(3)1111(F)0001(1)1110(E) HRU-612 LU FROM NI — NREM — 1111(F)1111(F)0000(0)0010(2) HRU-612 LU FROM CI — CLOC — 0011(3)1111(F)0000(0)0010(2) HRU-612 LU FROM NI — SMJK — 11000 11000 11000.. HRU-612 LU FROM NI — SMJK — 100000 100000 100000.. HRU-612 LU FROM NI (ESF-DL) — SMJK — 1111(F)1111(F)0100(4)1000(8) HLU & HRU LD FROM NI OR CI — 11100 11100 11100.... HLU & HRU LD FROM NI OR CI — 100 100 100 ... HLU & HRU LD FROM NI OR CI(ESF-DL) — 1111(F)1111(F)0010(2)0100(4) Note: the left most bit arrives first in all sequences. The detection algorithm functions reliably with a random 10E-3 bit error ratio (BER) on the facility. * This is the HEX number for the 4 bit group.
3	The NREM and NLOC loopbacks can also be initiated from the front panel of the HLU with the MODE and SEL pushbuttons. See Paragraph 7.20 for details.

TABLE 7. HLU-611 TEST PROCEDURES FOR A4LB OPTION

Step	Action
1	The HiGain-2 Line Hit can be looped back (NLOC in Figure 5) by sending the (Addressable Office Repeater) LPBK activation code 1111(F) 1111(F) 0001(1) 1110(E) for at least 5 seconds. This causes the HLU to enter its NLOC state shown in Figure 5. The display on the HLU-611 alternates between NLOC (network local loop) and the margin displays. The Loopback Time-out option, which is user settable to NONE, 20, 60 or 120 minutes, determines the duration of this loopback unless it is overridden by the reception of a second identical 16 bit loopup command before the timer expires. When this time-out override state exists, the only way to loop the HLU down is to issue one of the three loopdown commands listed in Step 2. The automatic time-out mode is restored during subsequent loopback sessions.
2	The following list summarizes the codes required to execute all the HiGain-2 loopbacks shown in Figure 5. Note that all code sequences must be present for at least 5 seconds. LU=LOOPUP, LD =LOOPDOWN, NI = NETWORK INTERFACE, CI = CUSTOMER INTERFACE. **Addressable 4 (A4LB) Repeater Loopback Commands** POSITION — NAME — CODE HLU-611 LU FROM NI — NLOC — 1111(F)*1111(F)0001(1)1110(E) HLU-611 LU FROM CI — CREM — 0011(3)1111(F)0001(1)1110(E) HRU-612 LU FROM NI — NREM — 1111(F)1111(F)0000(0)0010(2) HRU-612 LU FROM CI — CLOC — 0011(3)1111(F)0000(0)0010(2) HRU-612 LU FROM NI — SMJK — 11000 11000 11000.. HRU-612 LU FROM NI (ESF-DL) — SMJK — 1111(F)1111(F)0100(4)1000(8) HLU & HRU LD FROM NI OR CI — 11100 11100 11100.... HLU & HRU LD FROM NI OR CI — 100 100 100 ... HLU & HRU LD FROM NI OR CI(ESF-DL) — 1111(F)1111(F)0010(2)0100(4) Note: the left most bit arrives first in all sequences. The detection algorithm functions reliably with a random 10E-3 bit error ratio (BER) on the facility.
3.	The NREM and NLOC loopbacks can also be initiated from the front panel of the HLU with the MODE and SEL pushbuttons. See Paragraph 7.20 for details.* This is the HEX number for the 4 bit group

TABLE 8. HLU-611 TEST PROCEDURES FOR A5LB OPTION

Step	Action
1	Send into the HLU the inband ARMING and NIU (Network Interface Hit) LPBK code 11000 for at least 5 seconds, or at least 4 repetitions of the 16-bit ESF Data Link ARMING code 0001 0010 11111111.
2	Monitor the output of the HLU-611 for the return of the pattern. Return of pattern indicates that either the HRU has looped-up (If the SMART-JACK LOOPBACK option is ENABLED) or that an external NIU has looped up (If the SMART-JACK LOOPBACK option is DISABLED) and that the HLU and HRU units have been ARMED. Verify that the HLU display intermittently indicates 'ARM and also "SMJK" if the HRU is in loopback.. Also verify, if possible, that the LOOPBACK LED of the HRU-612 is flashing, indicating that the HRU is armed or that it is on solid, indicating that it is both armed and in loopback.
3	Once armed the HLU can be looped back (NLOC in Figure 5) by sending IOR (Intelligent Office Repeater) LPBK activation code 1101 0011 1101 0011 for at least 5 seconds. The tester observes the following activation response: • 2 seconds of AIS (all ones), followed by: • 5 seconds of returning data pattern, followed by: • 231 logic errors (including the frame bits) occur in the returned pattern(20 errors if ILR-2 were sent), followed by: • normal looped data. Note that this error pattern will repeat every 20 seconds as long as the IOR loopback pattern is • being sent. This same 20 second repeat scenario also applies to ILR, Time-Out Override and Query commands. The HiGain-2 Line Hit is now in Logic Loopback (NLOC of Figure 5). The display on the HLU-611 periodically shows NLOC (network local loop) and ARM (the HLU is still armed) in addition to the margin displays. The Loopback Time-out option, which is user settable to NONE, 20, 60 or 120 minutes, determines the duration of this loopback unless it is overridden by the TIME-OUT OVERRIDE command or a loop down command is sent. If the Time-out Override code 1101 0101 1101 0110 is received, the "activation sequence" described in "3" above is repeated and the automatic timed expiration of the loopback is inhibited. If this Time-out Override is sent, then the only way to loop the HLU down is to issue the IR (Intelligent Repeater) LPDN (loopdown) code 1001 0011 1001 0011 or to issue the NIU (Network Interface Hit) LPDN and Disarm code 11100. The automatic time-out timer is restored during subsequent loopback sessions.

Table continued on next page

TABLE 8. HLU-611 TEST PROCEDURES FOR A5LB OPTION (CONTINUED)

Step	Action
5	Using the following codes, a NETWORK tester can activate loopbacks NLOC or NREM or SMJK (if enabled) shown in Figure 5. A CUSTOMER tester can activate loopbacks CLOC or CREM.

Addressable 5 (A5LB) Repeater Loopback Commands

ARMING or NIU LPBK (inband)	Arming code	11000 11000..
ARMING or NIU LPBK (ESF Data Link)	Arming code	1111(F)*1111(F)0100(4)1000(8)
IR LPDN or DISARM (inband)	Disarming code	11100 11100..
DISARM (ESF Data Link)	Disarming code	1111(F)1111(F)0010(2)0100(4)
IOR LPBK (NLOC & CREM 231 errors)	HLU Loop up	1101(D)0011(3)1101(D)0011(3)
ILR-2 LPBK (NREM & NLOC 20 bit errors)	HRU Loop up	1100(C)0111(7)0100(4)0010(2)
IR LPDN	Loop down (HLU or HRU)	1001(9)0011(3)1001(9)0011(3)
IR QUERY LPBK	Query loopback	1101(D)0101(5)1101(D)0101(5)
IR ALTERNATE QUERY LPBK	Alternate Query loopback	1101(D)0101(5)1110(E)1010(A)
TIME-OUT OVERRIDE	Loopback Time-out Override	1101(D)0101(5)1101(D)0110(6)
IOR POWER DOWN (HLU)	Removes VHDSL line power	0110(6)0111(7)0110(6)0111(7)

Note: the left most bit arrives first in all 8 sequences. The detection algorithm functions reliably with a random 10E-3 bit error ratio (BER) on the facility. The IOR POWER DOWN code must remain present for the duration of the power down mode. When this code is removed, HiGain-2 returns to its normal unlooped and unarmed state.* This is the HEX number for the 4 bit group.

6	After testing is complete, send the universal loopdown [IR (Intelligent Repeater) LPDN] code if the system is to loopdown but remain ARMED. Send the disarm code 11100 if all the equipment is to be looped down, disarmed and returned to normal operation. Note that the ARMED mode has an automatic time-out of 120 minutes.
7	The NREM and NLOC loopbacks can also be initiated from the front panel of the HLU with the MODE and SEL pushbuttons. See Paragraph 7.20 for details.

TABLE 9. HLU 4 CHARACTER FRONT PANEL MESSAGES

Message	Full Name	Description
CREM	Customer Remote Loopback	Signal from customer is looped back to customer at HLU-611
NLOC	Network Local Loopback	DSX signal is looped back to DSX at HLU
CLOC	Customer Local Loopback	Signal from Customer is looped back to customer at HRU-612
NREM	Network Remote Loopback	DSX signal is looped back to DSX at HRU
SMJK	Remote Smartjack Loopback	Signal from DSX is looped back at HRU by the HRU smartjack module.
TLOS	Transmit Loss Of Signal	HRU is in a logic loopback state caused by a loss of its T1 input from the NI, if enabled via SAIS option.
FERR	Framing Bit Error Occurred	Framing bit error occurred at HLU T1 input
LBPV	Local Bipolar Violation	A bipolar violation has been received at the T1 input to the HLU-611.
SIG	Signal	The HLU & HRU transceivers are trying to establish contact with each other.
ACQ	Acquire	The HLU & HRU multiplexers are trying to establish synchronization over each loop.
HES	VHDSL CRC Error	VHDSL CRC error.
ARM	HiGain-2 System ARMED	Armed to respond to Intelligent Repeater Loop Codes
ACO	Alarm CutOff	A MNRALM has occurred, and been retired to an ACO condition, by depressing the SEL button on the HLU front panel.
SELF TEST	Self Test	The HLU is in a self test mode. This occurs every power ON/OFF cycle.
ALRM	Alarm Condition Exists	A minor alarm condition is in effect.
M=X	VHDSL Loop Margin	Indicates the power of the received VHDSL signal relative to noise. Any value of ‘06’ or greater is adequate for reliable system operation.

Table continued on next page

TABLE 9. HLU 4 CHARACTER FRONT PANEL MESSAGES (CONTINUED)

Message	Full Name	Description
PWR FEED SHRT	Power Feed Short	Indicates a short across the VHDSL pair
PWR FEED OPEN	Power Feed Open	Indicates an open circuit in the T&R of the VHDSL pair.
PWR FEED OFF	Power Feed Off	VHDSL span power has been turned off by setting the PWFD option to DIS.
BAD RT?	No response from HRU	The HLU does not receive any response from the HRU. Thus the HRU's integrity is questionable.
VER	HLU Software Version #	This is displayed during the System Settings review mode. Depress the Mode button for 3 seconds.
LIST 0xL	HLU's List #	Displayed during System Settings review mode defined above.
FRM	Frame:SF,ESF,UNFR,NONE	Defines the type of frame pattern being received from the DSX-1. Displayed during System Settings mode defined above.
CODE	Line Code: AMI, B8ZS	This is the line code that the HLU is set to receive and transmit at its DSX-1 interface. Displayed during System Settings mode defined above.
LOSW	Loss of Sync Word	Indicates that the VHDSL loops has lost sync. Causes a minor alarm.
LLOS	Local Loss of Signal	Indicates that no signal is detected at the T1 input to the HLU. Causes a minor alarm.
RLOS	Remote Loss of Signal	Indicates that no signal is detected at the T1 input to the HRU. Causes a minor alarm.
DS1	DS1 BPV errors	Indicates that the number of BPVs at the HLU and HRU DS1 inputs that have exceeded the 24 hour ES threshold. Causes a minor alarm
DS0	DS0 Blocked Channels	Indicates status of DS0 blocked channels. NONE indicates no channels are blocked. BLK indicates some channels are blocked.
MAL	Margin Alarm	The margin on the VHDSL loop has drooped below the threshold (0 to 15 dB) set by the user.

```
HI-GAIN HLU-611   MAINTENANCE TERMINAL MAIN MENU   (ver V1.4L-0003)
                        CIRCUIT ID#: HLU611/HRU612

                    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 #
```

Figure 6. HLU-611 Maintenance Menu Main Menu.

```
                              SPAN STATUS
                    (HLU/ver1.4-0003:HRU/ver1.0-0002)
TIME: 14:51:31
DATE: 06/27/95                      CIRCUIT ID#: HLU611/HRU612

ALARMS:   NONE
LOOPBACK: OFF
                    HLU                       HRU
                    HDSL                      HDSL
                 cur/min/max               cur/min/max
MARGIN:            20/19/21                  20/19/20 dB
PULSE ATTN:           00                        00    dB
PPM OFFSET:           00                        -08   ppm
24 HOUR ES:        00000                     00000  seconds
24 HOUR UAS:       00000                     00000  seconds

                                  DS1 STATUS
                               HLU                    HRU
24 HOUR BPV Seconds:        00000                  00000
24 HOUR UAS Count:          00000                  00000
Frame type:                   SF                     SF
Code type:                   AMI                    AMI

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

Figure 7. HLU-611 View Span Status Display.

```
                                SYSTEM SETTINGS

      TIME: 14:53:00
      DATE: 06/27/95                    CIRCUIT ID#: HLU611/HRU612

      E(Q)UALIZATION:     0
      SMART-JACK (L)B:    ENABLE
      (S)PECIAL LPBK:     A2LB
      (P)OWER:            ENABLE
      (Z)BTSI:            OFF
      ES ALARM TH(R)ES:   NONE
      LOOPBACK (T)IMEOUT: 120
      (A)LARM:            DISABLE
      (D)S1 LINE CODE:    AMI
      (F)RAMING:          AUTO
      AIS ON (H)DSL ALRM: DISABLE
      AIS ON S(M)JK/NREM: ENABLE
      MAR(G)IN ALM THRES: 4
      DSO (B)LOCKING: xx - Blocked Channels
      01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

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

Figure 8. HLU-611 System Settings Menu.

```
                                  SET CLOCK

        TIME: 14:54:16
        DATE: 06/27/95
        CIRCUIT ID#: HLU611/HRU612


        Format: HH:MM
                MM/DD/YY









        NEW TIME:

        NEW DATE:



        (U)PDATE REMOTE?
```

Figure 9. HLU-611 Set Clock Menu.

```
Date: 06/27/95            PERFORMANCE DATA
CIRCUIT ID#: HLU611/HRU612
                    ERRORED SECONDS/UNAVAILABLE SECONDS

                  DS1                 HDSL
              HLU       HRU       HLU       HRU
11:00     000/000   000/000   000/000   000/000
11:15     000/000   000/000   000/000   000/000
11:30     000/000   000/000   000/000   000/000
11:45     000/000   000/000   000/000   000/000
12:00     000/000   000/000   000/000   000/000
12:15     000/000   000/000   000/000   000/000
12:30     000/000   000/000   000/000   000/000
12:45     000/000   000/000   000/000   000/000
13:00     000/000   000/000   000/000   000/000
13:15     000/000   000/000   000/000   000/000
13:30     000/000   000/000   000/000   000/000
13:45     000/000   000/000   000/000   000/000
14:00     000/000   000/000   000/000   000/000
14:15     000/000   000/000   000/000   000/000
14:30     000/000   000/000   000/000   000/000
14:45     000/000   000/000   000/000   000/000

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

Figure 10. HLU-611 View Performance Data Display.

```
Time: 14:58:48                    7 DAY HISTORY
CIRCUIT ID#: HLU611/HRU612

                        ERRORED SECONDS/UNAVAILABLE SECONDS

                 DS1                       HDSL
             HLU           HRU         HLU           HRU
06/20    00000/00000 00000/00000 00000/00000 00000/00000
06/21    00000/00000 00000/00000 00000/00000 00000/00000
06/22    00000/00000 00000/00000 00000/00000 00000/00000
06/23    00000/00000 00000/00000 00000/00000 00000/00000
06/24    00000/00000 00000/00000 00000/00000 00000/00000
06/25    00000/00000 00000/00000 00000/00000 00000/00000
06/26    00000/00000 00000/00000 00000/00000 00000/00000
current  00000/00000 00000/00000 00000/00000 00000/00000

                                    (E)xit
```

Figure 11. HLU-611 View Performance History Display.

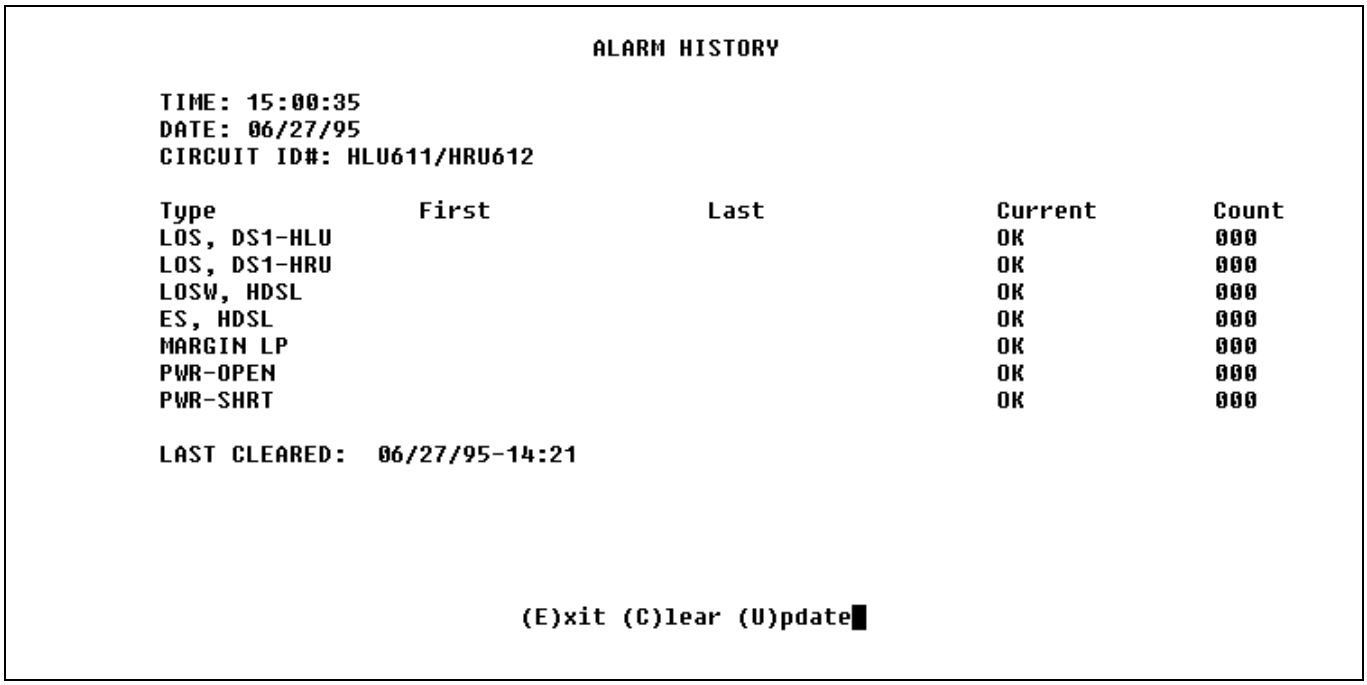

Figure 12. HLU-611 View Alarm History Display

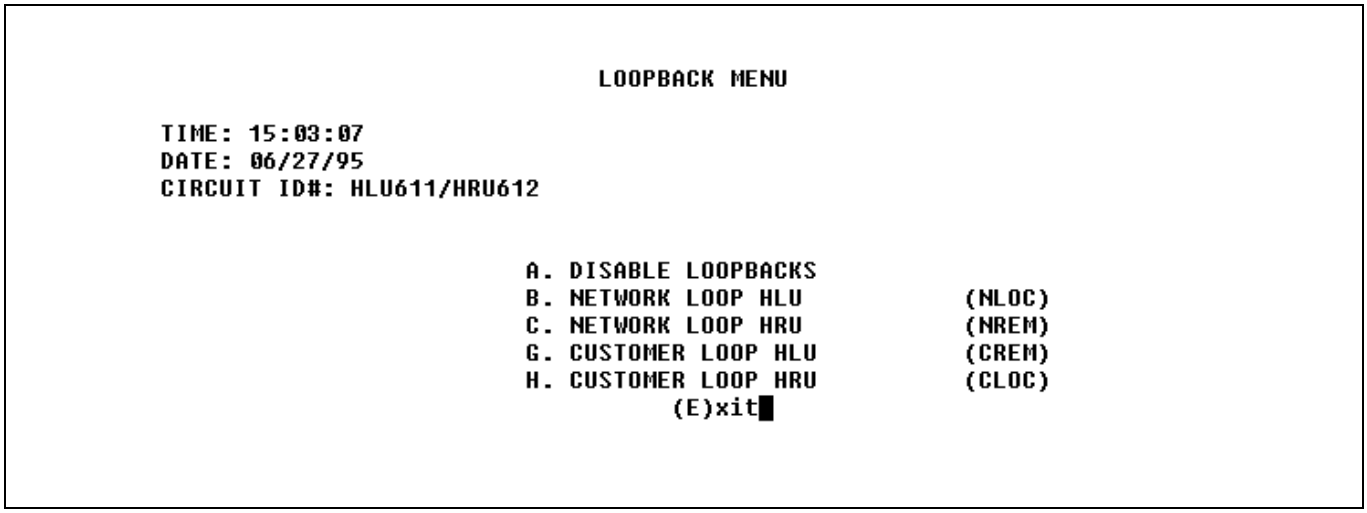

Figure 13. HLU-611 Loopback Menu