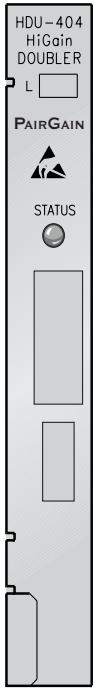
HiGain Micro Doubler Unit

Model	List Number	Part Number	CLEI Code
HDU-404	2	150-1558-02	T1R6AFDC



PairGain Technologies, Inc.
Engineering Services Technical Practice
Section 150-404-102-04

PairGain

Revision History of This Practice

Revision	Release Date	Revisions Made
01	September 9, 1998	Initial Release
02	December 22, 1998	Added front panel status LED to Table 4.
03	February 10, 1999	Updated CLEI Code
04	June 23, 1999	Added PG-Flex applications and expanded the thermal deployment rules.

USING THIS TECHNICAL PRACTICE

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

Notes contain information about special circumstances.

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

The Electrostatic Discharge (ESD) Susceptibility symbol indicates that a device or assembly is susceptible to damage from electrostatic discharge.

DOCUMENTATION

If you have comments on this PairGain document, send an email to *technical_publications@pairgain.com.* Type the product name and the section number of the document in the subject area of the email message.

UNPACK AND INSPECT YOUR SHIPMENT

Upon receipt of the equipment:

1 Unpack the container and visually inspect the product for signs of damage. If the equipment has been damaged in transit, immediately report the extent of the damage to the transportation company and to your sales representative. (If you must store the equipment for a prolonged period, store it in the original container.)

2 Verify the contents using the packing list to ensure complete and accurate shipment.

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OVERVIEW

The PairGain® HiGain® HDU-404 List 2 is a low-power micro doubler unit that extends the range of a HiGain repeaterless T1 transmission system. The doubler units are installed between any doubler-compatible HiGain Line Unit (HLU) and a HiGain Doubler Unit (HDU) or HiGain Remote Unit (HRU). Each doubler allows 1.544 Mbps transmission over an additional Carrier Service Area (CSA) range.

Each CSA span encompasses approximately 12,000 feet (3.657 km) of 24 American Wire Gauge (AWG) or 9,000 feet (2.743 km) of 26 AWG loops. The HDU-404 List 1 and List 2 are identical except that:

- The List 1 is only compatible with the HiGain product line.
- The List 2 is compatible with both PairGain's HiGain and PG-Flex product lines.

Refer to "PG-Flex Applications" on page 6 for more information regarding the PG-Flex doubler applications.

FEATURES

- The unit occupies one 200 Mechanics slot (half the width of a 400 mechanic slot)
- Powered by any doubler-compatible HiGain or PG-Flex line unit
- Front-panel status display Light Emitting Diodes (LED)
- Lightning and power-cross protection on both sides of the High bit-rate Digital Subscriber Line (HDSL) interface
- Extremely low power dissipation
- Extremely low latency
- Can be used in four-span line-powered circuits (three doublers and one remote) or five-span locally-powered circuits (four doublers and one remote)
- Compatible with PG-Flex List 3x line units in configurations with up to three spans

- Complies with the applicable requirements of Network Equipment Building System (NEBS) Generic Equipment requirements of GR 1089 CORE and GR 63 CORE compliance
- Minimal wander and jitter

COMPATIBILITY

The HDU-404 List 2 is compatible with the following PairGain outdoor enclosures:

- HRE-450 List 5, single slot unit
- HRE-423, 3-slot unit
- HRE-454, 4-slot unit

PRODUCT DESCRIPTION

The open-framed cover reduces thermal stress and improves reliability by allowing air to freely circulate over all components. Figure 1 on page 3 shows the HDU-404 front panel and Table 1 on page 3 describes the doubler unit components and labels.

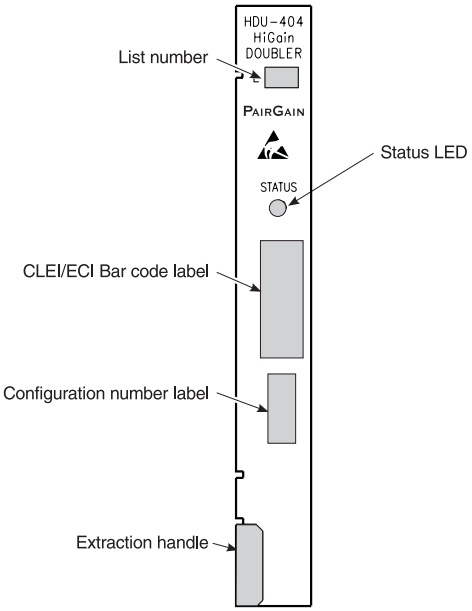


Figure 1. *HDU-404 Front Panel*

Table 1. *Front Panel Components and Labels*

Name	Function
List number	Indicates operational status of the model (see Table 2 on page 4).
Status LED	Indicates operational status of doubler.
CLEI/ECI Bar code label	Contains human-readable Common Language Equipment Identifier (CLEI) code number and Equipment Catalog Item (ECI) bar code number.
Configuration number	Contains either a two or three-digit configuration number or a five- or six-digit warranty configuration number as follows: Digit 1 - Last digit of shipment year Digits 2 and 3 - Shipment month Digits 4, 5, and 6 - Configuration number The configuration number can also be found on a small bar label, containing the Julian date code and part number, attached to the PC board or to the front panel.
Extraction handle	For removing the HDU from the enclosure.

The front panel of the HDU-404 contains a tri-color LED. The LED color and activity provides information on system functionality. Table 2 provides a list of all alarm indications in priority order.

Table 2. *Front Panel Status LED*

LED	Description
Flashing green about once per second	Indicates synchronization is being attempted between the HDU-404 and the upstream (network) module.
Flashing green rapidly	Indicates synchronization is being attempted between the HDU-404 and the downstream (customer) module.
Solid green	Indicates HDSL frame synchronization has been achieved between the HDU-404 and both the upstream and downstream modules.
Flashing red about once per second	Indicates an HDSL Cyclic Redundancy Check (CRC) error has occurred between the HDU-404 and the upstream module.
Flashing red rapidly	Indicates an HDSL CRC error has occurred between the HDU-404 and the downstream module.
Flashing yellow about once per second	Indicates a Network Doubler Unit (NDU) loopback exists in the HDU-404 towards the network. This tests the integrity of the upstream span.
Solid yellow	Indicates the HDSL margin is less than the margin threshold provisioned for the circuit.
Flashing yellow rapidly	Indicates a CDU (HDU-404 to Customer) loopback exists in the HDU-404 towards the customer. This tests the integrity of the downstream span.

HIGAIN DOUBLER APPLICATIONS

HiGain doublers operate with any number of other T1, Plain Old Telephone System (POTS), Digital Data Service (DDS), or other HiGain systems sharing the same cable binder group. The HDU-404 can be used in two-span to five-span circuits, depending on the models of the HLU and HRU being used with the doubler units and the power option chosen for the HRU. The number of doublers is equal to one less than the number of spans as shown in Figure 4 on page 14.

Table 3 lists the maximum number of HDU-404 doubler units that can be deployed according to the HLU and HRUs that are used.

Table 3. *HDU-404 Circuit Ranges*

HLU Model	Maximum Number of HDU-404 Doublers Per Circuit[a]			
	Line-Powered Remote		Locally-Powered Remote	
	I-CPE ON	I-CPE OFF	I-CPE ON	I-CPE OFF
HLU-388 List 2x, HLU-319 List 2x, HLU-231 List 3D, HLU-231 List 6D, HLU-232 List 1D HLU-231 List 7x, HLU-431 List 1x	1	2	2	2
HLU-231 List 8D, HLU-319 List 5D, HLU-388 List 5D HLU-231 List 8/List 8E, HLU-319 List 5/List 5E, HLU-388 List 5/List 5E	2	3 [b]	2	4[c]

(a) HRU-411 applications with Current-Customer Premises Equipment (*I*-CPE) on are limited to single HDU-404 doubler circuits. The HRU-412 is limited to applications with one and two doublers only.
(b) Requires HRU-402 or HRU-411.
(c) Requires HRU-402 List 1 or List 3.

Each span can take up to 30 seconds to acquire HDSL synchronization. The total time to acquire end-to-end synchronization increases with the number of spans.

PG-FLEX APPLICATIONS

Figure 2 shows a typical HDU-404 installation for the PG-Flex subscriber carrier system. For each doubler installed between the PG-Flex Central Office Terminal (COT) and Remote Terminal (RT), two auxiliary power pairs are required between the COT and RT. A maximum of two doublers may be installed in a PG-Flex system.

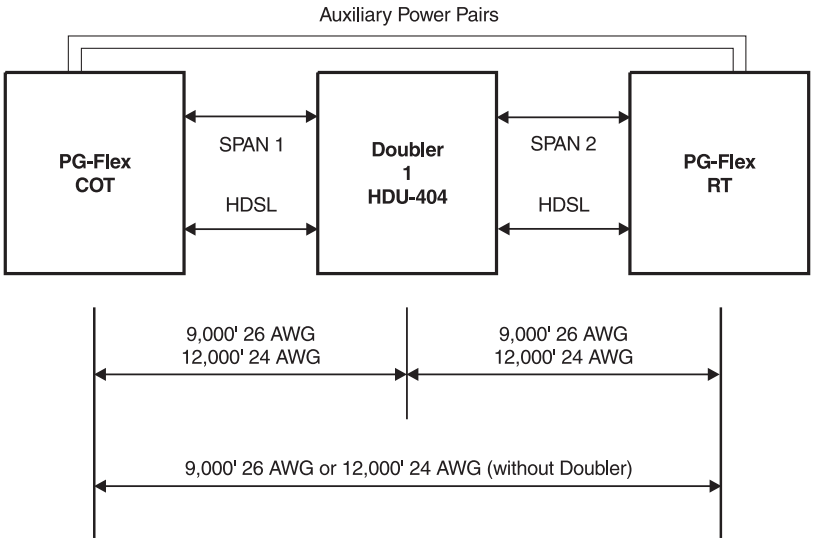


Figure 2. *Typical HDU Installation with PG-Flex*

With two doublers, four sets of auxiliary power pairs must be installed between the COT and the RT. These auxiliary power pairs must be the same wire gauge (or larger) as the pairs used for HDSL and power.

The PG-Flex system can operate with a number of other systems, sharing the same cable binder group, such as:

- T1 (1.544 Mbps capability)
- POTS
- DDS
- Other PG-Flex systems

With doublers, PG-Flex CO line units will put out ±125 V to ±130 V on the HDSL and auxiliary power pairs. At least ±75 V is required at the RT for ringer voltage and POTS loop current to meet specification.

Refer to the PG-Flex COT shelf, RT enclosure, and line unit practices for additional information on PG-Flex powering and auxiliary power pair requirements (see “Documentation” on page iii).

GENERAL INFORMATION

This section deals with information that deals with both HiGain and PG-Flex applications.

MICRO DOUBLER CAPACITY DEPLOYMENT RULES

The physical location of the doublers is driven by the following three deployment rules:

- **Rule 1.** Place the enclosures at the electrical limits, 35 dB, of each span. This places the first doubler at the 35 dB location and the second at 70 dB and so on. This allows the maximum circuit range to be realized.

Caution must be observed when pushing doubler spans to their 35 dB maximum range. Refer to PairGain's Technical Advisory #TA-015 on HiGain operating ranges and general deployment guidelines.

- **Rule 2.** If Rule 1 is not applicable, then try to make all spans the same electrical length (same 196 kHz loss). This minimizes the maximum span loss and assures maximum operating margin, resulting in optimal transmission performance on the HDSL cable pairs. If specific application constraints preclude using rule 2, or if two different circuit layout choices have the same maximum span loss, then use rule 3.
- **Rule 3.** This rule minimizes the power consumption and dissipation of the HLU that provides the doubler power. Rule 3 requires the spans closer to the HLU to be as short as possible and the spans farther from the HLU to be as long as possible. This choice minimizes the I^2R loss in the cable pairs, and reduces the thermal stress on the HLU.

Only those HRUs that have a local powering option can be used in local HRU-powered applications.

Table 4. *HDU-404 List 2 Deployment Rules for the HRE-423 and HRE-450 Enclosures*

Occupied Slots	Solar Load	Maximum Ambient Temperature
HRE-423		
1 2 3	Full	135 °F
1 2 3	None	140 °F
1 2	Full	145 °F
1 2	None	135 °F
2	Full	155 °F
2	None	160 °F
HRE-450		
1	Full	150 °F
1	None	160 °F

Full Solar Load = Maximum sunlight exposure per TR-TSY=000057. None = Inside, underground or fully shaded.

Table 5. *HDU-404 List 2 Deployment Rules for the HRE-454 Enclosure*

Occupied Slots	Solar Load	Maximum Ambient Temperature
1 2 3 4	Full	125 °F
1 2 3 4	None	130 °F
1 2 4	Full	135 °F
1 2 4	None	140 °F
2 4	Full	145 °F
2 4	None	150 °F
2	Full	155 °F
2	None	160 °F

Full Solar Load = Maximum sunlight exposure per TR-TSY-000057. None = Inside, underground or fully shaded.

DOUBLER ENCLOSURE CAPACITIES

Care must be taken when deploying the HDU-404 in sealed multislot outdoor enclosures, such as the PairGain 4-slot HRE-454 enclosure. These enclosures restrict the rate of heat transfer to the outside ambient. This effect can cause excessive heat build up if the deployment rules shown in Table 4 and Table 5 on page 9 are not followed.

The tables show the limit of doublers that can be reliably housed in either the HRE-423 or HRE-454 enclosure as a function of solar exposure and maximum ambient temperature. The maximum ambient temperature refers to the outside air temperature. The occupied slots designate which slots (1, 2, 3 or 4) are occupied for each condition. For example, if the occupied slots for the HRE-423 are 1 and 3, the doublers are located in slots 1 and 3 with slot 2 empty. If the occupied slots for the HRE-454 are 2 and 4, the doublers are located in slots 2 and 4 with slots 1 and 3 empty. If other than the specific slot arrangements are used, then the next lower temperature deployment rule must be used.

For example, if slots 1 and 2 or 3 and 4 are used in the HRE-454, instead of slots 2 and 4, then use the deployment rules that apply when slots 1, 2 and 4 are occupied.

All of the applications in Table 4 and Table 5 on page 9 that exceed +115 ºF (+46.1 ºC) meet the requirements of Section 10.2.1.3 of TA-NWT-001210. HDSL equipment deployed in outside cabinets will operate in a temperature, ambient outside the housing, of -40 ºF (-40 ºC) with no solar load to +115 ºF (+46.1 ºC) with maximum solar load and maximum power dissipation.

The doubler may also be enclosed in the PairGain single-slot HRE-450 outdoor enclosure. The thermal limits for this configuration are also shown in Table 4 on page 9.

INSTALLATION

To install the HDU-404 in a remote enclosure, perform Step 1 and Step 2 on page 12 and refer to the appropriate installation manual for information about cabling, proper connections, grounding, and line and local power (see "Documentation" on page iii).

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

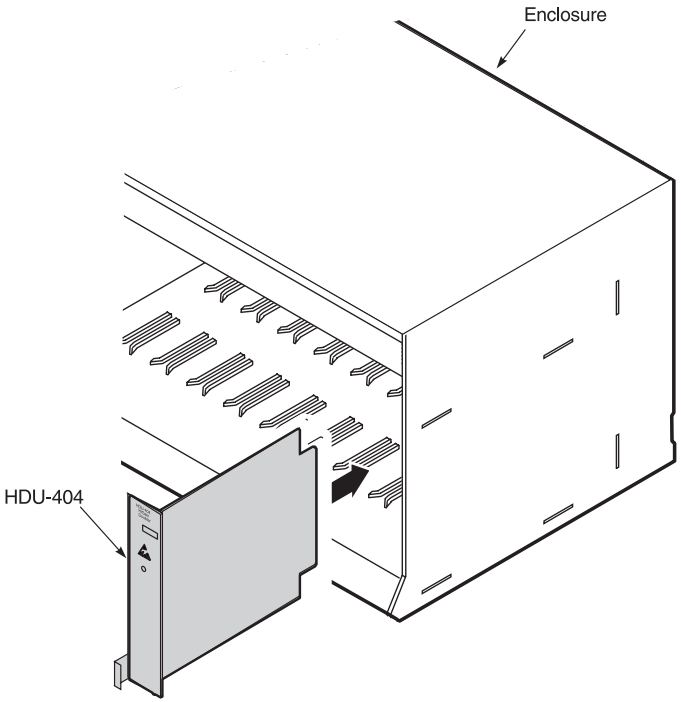


Figure 3. *Installing the HDU-404 in a Remote Enclosure*

To install the doubler unit, perform the following steps.

1 Slide the doubler into the card guides for the desired slot (see Figure 3 on page 11).

2 Push the unit into the enclosure until it is seated in the card-edge connector. The unit should snap into place, indicating that it is properly seated.

Some enclosures may require you to adjust the retaining bar located on the front of the enclosure in order for the doubler unit to be installed. Refer to the appropriate technical practice for the vendor's shelf.

Once the HDU-404 is installed in the enclosure, the front panel Status LED flashes green if power is applied from an upstream line unit. When the loops on both sides of the HDU synchronize, the LED constantly glows solid green.

LOOPBACK OPERATION IN HIGAIN SYSTEMS

Doubler loopbacks work only with HiGain systems. PG-Flex does not support doubler loopbacks.

When equipped with the HDU-404, a HiGain system can execute the types of loopbacks listed in Table 6 on page 13.

The loopbacks can be initiated from any of the following:

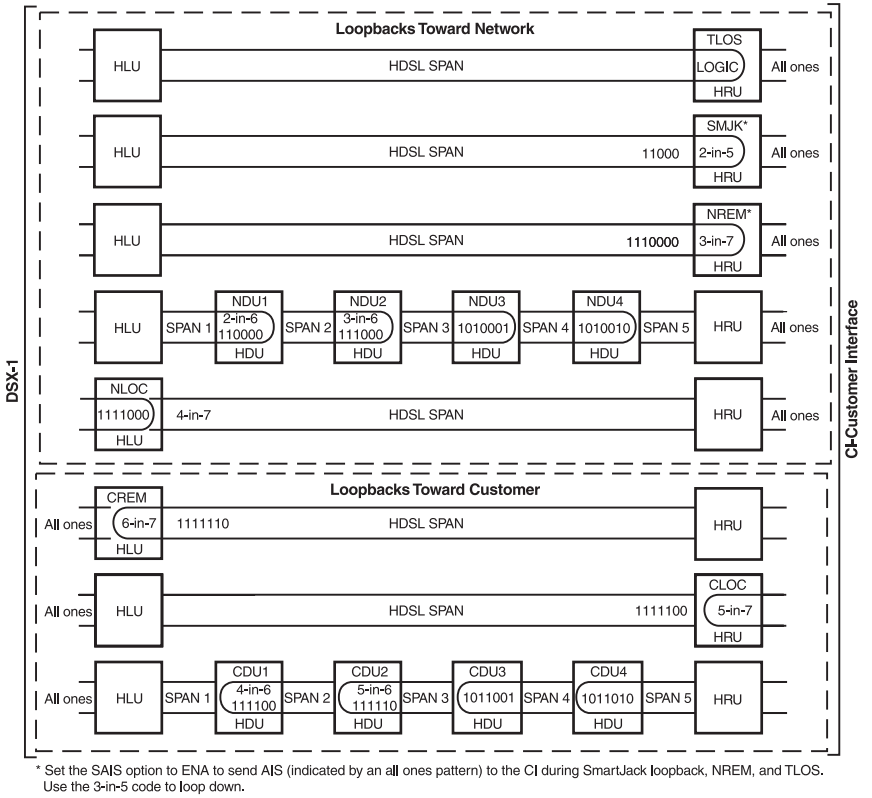
- The HLU craft port
- The HLU front-panel buttons
- A family of Special Loopback (SPLB) in-band commands initiated at the T1 input port at either the HLU or HRU
- The HRU craft port if remote provisioning is enabled from the HLU.

The commonly used SPLB generic command set for four-doubler loopbacks is listed in Table 6 on page 13. The commands are specific combinations of either 6 or 7 bits that continuously repeat. All NDU loopbacks are towards the network. All CDU loopbacks are towards the customer. Figure 4 on page 14 is a diagram of various HiGain loopback system configurations.

Table 6. *SPLB Generic Loopback Command Set*

Command Set	Loopback Command
NDU1	1 1 0 0 0 0 (2-in-6)
NDU2	1 1 1 0 0 0 (3-in-6)
NDU3	1 0 1 0 0 0 1
NDU4	1 0 1 0 0 1 0
CDU1	1 1 1 1 0 0 (4-in-6)
CDU2	1 1 1 1 1 0 (5-in-6)
CDU3	1 0 1 1 0 0 1
CDU4	1 0 1 1 0 1 0

Loopbacks NDU3, NDU4, CDU3 and CDU4 are only available when the HDU-404 is used with other HiGain circuit modules that include the HLU-231 List 8X; HLU-319 List 5X; and HLU 388 List 5X line units; and the HRU-402 and HRU-411 remote units.



* Set the SAIS option to ENA to send AIS (indicated by an all ones pattern) to the CI during SmartJack loopback, NREM, and TLOS. Use the 3-in-5 code to loop down.

Figure 4. *HiGain Loopbacks*

For more information about the SPLB doubler commands, see the appropriate HLU Technical Practice. Refer to "Documentation" on page iii.

APPENDIX A - FUNCTIONAL DESCRIPTION

HiGain uses the PairGain Two-Binary, One-Quaternary (2B1Q) HDSL transceiver system to establish two full-duplex, 784 kbps data channels between the HLU and the HRU units. Each HDU-404 increases the maximum range by approximately 12,000 feet (3.66 km) of 24 AWG or 9,000 feet (2.74 km) of 26 AWG per doubler.

A block diagram of the HDU-404 with pinouts is shown in Figure 5. The doubler unit power supply uses the HDSL simplexed line voltage to produce +5 Vdc and +3 Vdc required by the HDU-404 electronics. The power feed is passed on to the HDSL output pair to power the second doubler or a remote unit.

The maximum power dissipation of the doubler unit is 3.5 watts.

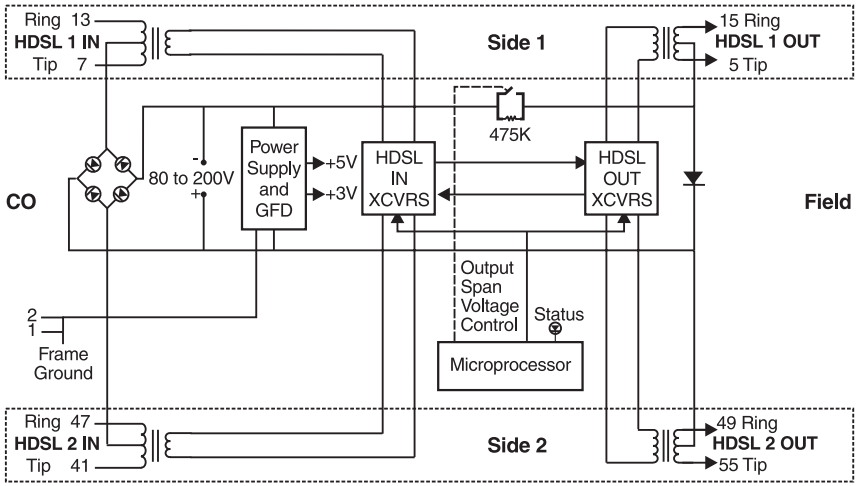


Figure 5. *Doubler Block Diagram*

Table 7 provides a guide for the loss that occurs when using various cable gauges at 196 kHz and 135 Ω. It applies to the HDSL cable pairs between the COT and the HDU, and between the HDU and the RT.

To achieve optimum performance, make the electrical length (196 kHz loss) of all HDU spans as close to equal as possible. This results in the highest operating loop margins. If it is not possible to make all spans equal, choose span lengths that reduce the total power consumption of the CPT that powers the HDU. Do this by minimizing the length of Span 1 and Span 2. Use Table 7 when you calculate the electrical length of each span.

The HDU-404 has a range of up to 35 dB loss at 196 kHz on each of the four HDSL loops. A list of HDSL signal cable losses for various cable gauges at 196 kHz and 135 Ω is provided in Table 7. (Table 7 shows the HDSL cable pairs between the HDU-404 and the HLU, as well as between another HDU or HRU.

Table 7. *HDSL Signal Insertion Loss*

Cable Gauge	Ω per Thousand ft (0.3048 km)	Loss @ 196 kHz (dB/Thousand ft)[a]
26 AWG/0.4 mm	83.3	3.880
24 AWG/0.51 mm	51.9	2.841
22 AWG/0.61 mm	32.4	2.177
19 AWG/0.91 mm	16.1	1.535

(a) Add 3 dB for each bridged tap and 1 dB for each cable gauge change.

APPENDIX B - SPECIFICATIONS

Appendix B lists the specifications for the HDU-404.

HDSL

Line Code	784 kbps, 2B1Q full duplex
Output	+13 dBm
Line Impedance	135 Ω
Resistive Signature Input/Output	25 Ω (maximum)
Start-up Time (per span)	15 seconds (typical), 30 seconds (maximum)

Line Clock Rate

Internal Stratum 4 clock

Power Consumption

3.1 W (nominal)

Maximum Provisioning Loss

35 dB @ 196 kHz, 135Ω

Wander and Jitter

Nominal - The absence of an HDSL framer from the HDU-404 reduces the Doubler Unit effect on a circuit's overall wander and jitter to second order insignificance when compared to the wander and jitter of other circuit modules.

Latency

80 microseconds (maximum either direction)

Mounting

Standard 400 or SLIM™ (half the width of a 400)

Electrical Protection

Secondary surge and power cross protection on all HDSL ports

Environmental

Operating Temperature	-40 °F (-40 °C) to +149 °F (+65 °C)
Operating Humidity (non-condensing)	5% to 95%
Operating Temperature in Outside Enclosures	Complies with Section 10.2.1.3 of TA-NWT-001210
Operating Elevation	200 feet (60.96 m) below sea level to 13,000 feet (3.96 km) above sea level

Dimensions and Weight

HDU-404 (200 Mechanics™)	
Height	5.6 inch (14.22 cm)
Width	0.7 inch (1.7 cm)
Depth	5.6 inch (14.22 cm)
Weight	1 lb, 2oz (1.76 kg)

APPENDIX C - GROUND FAULT

Appendix C describes ground fault detection and isolation.

GROUND FAULT DETECTION

The HDU-404 has a Ground Fault Detection (GFD) circuit as described in R7-1, Section 7.2.1 of GR-1089 CORE, Issue 1, Revision 1, December, 1996.

When used with HiGain line units, ground faults occurring at any point along any span are immediately detected. Ground fault conditions shut the HiGain HDSL power feed circuit down. The line unit periodically tries to apply HDSL power to the first span to determine whether the fault condition is still present. As long as the condition exists, the power cycling and ground fault protection continues. To discontinue the ground fault protection, locate and repair the fault in the cable.

Circuits containing both the HDU-404 and older doublers without a GFD circuit also support this new ground fault detecting feature, provided the doubler nearest the HLU is an HDU-404.

To operate properly, the ground fault circuit requires that the doubler enclosure ground plane is securely connected to earth ground.

HiGain Fault Isolation

Solutions for common problems that may occur with the HDU-404 are listed in Table 8.

Table 8. *HiGain Fault Isolation Guide*

Problem	Solution
LED does not light	**1** Verify that the HLU is installed and operational in the CO. **2** Verify proper cabling between the doubler enclosure and the CO. **3** Measure 100 to 200 Vdc between pins 5 or 6 and 8 or 9. This voltage peaks every 15 to 30 seconds as the HLU cycles between self test and line power. If less than 100 Vdc is present, check the cabling or the HLU. Only the line units mentioned in the "Applications" section can be used to power doublers (see Table 2). Other HLU models may not provide reliable operation and should not be used.
LED flashes green	Synchronization is being attempted with the upstream unit.
HDU-404 loses power	The HLU at the CO is not present. Measure the resistance of the HDSL input loop. Resistance should be normal loop resistance plus the 25 Ω signature of the HLU.
HDSL line power appears in very short bursts	A grounded pair is being detected by either the HLU or HDU-409 in Span 1. This causes the unit's GFD circuit to trigger which forces the HDSL line voltage off immediately after it cycles on. Remove the HLU and HDU-404 and check for cable ground faults in Span 1. The doubler's GFD circuit can easily be checked by grounding any of the loop connectors to the doubler. This forces the circuit down immediately. If the circuit stays up, either the GFD circuit is defective or the HDU-409 is not properly grounded.
HDU-404 shuts off after Span 1 comes up	A grounded pair is being detected by the HDU-404 in Span 2. Remove HDU-404 and check for ground fault in Span 2.

PG-FLEX FAULT ISOLATION

Solutions for common problems that may occur with the HDU-404 in PG-Flex applications are listed in Table 9.

Table 9. *PG-Flex Fault Isolation Guide*

Problem	Solution
LED does not light	**1** Verify that the PG-Flex COLU is installed and operational in the CO. **2** Verify proper cabling between the doubler enclosure and the CO. **3** Measure 150 Vdc between pins 5 or 6 and/or 9 of the HDU. This voltage peaks every two minutes during the HDSL startup cycle. If less than 100 Vdc is present, check the cabling between the doubler enclosure and PG-Flex COT shelf. Refer to the COLU practice and verify the COLU is operating properly.
LED flashes green	Synchronization is being attempted with the upstream unit.
HDU-404 loses power	**1** The COLU at the CO may not present or may not be operating properly. **2** Check the cabling between the doubler housing and the PG-Flex COT shelf. Measure the resistance of the HDSL input loop. Resistance should be normal loop resistance plus the 25 Ω signature of the COLU.
HDSL line power appears in very short bursts	With PG-Flex the GFD is in the COT line unit. Tip or ring ground faults between the COT and the doubler causes the power to turn on for a few seconds every two minutes. With the HDU-404 doubler, a ground fault after the doubler on Loop 2 has the same affect. On Loop 1, however, the DC power does not shut off because of a ground fault. When there is a ground fault on Loop 1, the doubler limits its output voltage to approximately -40 V. Pair 2 maintains the normal 130 V. This is enough voltage to power the doubler, but not the RT. Typically the HDSL Loop 1, after the doubler, will drop the resync periodically. Note that if the pairs are reversed, the polarity of the voltages are reversed. Remove the line units and doublers and check for cable faults.
HDU-404 shuts off after Span 1 comes up	A grounded pair is being detected by the COLU in Span 2. Remove HDU-404 and check for ground fault in Span 2.
LED continues to flash green once a second	Verify RT is installed and operational. Check for Ground Fault on Span 2 if HDSL line power is turning on and off every 10 seconds on the out span.

APPENDIX D - ABBREVIATIONS

Following are abbreviations and definitions used in this practice.

2B1Q	Two-Binary, One-Quaternary. Line coding used for HDSL.
AIS	Alarm Indicator Signal
AWG	American Wire Gauge--the standard used to describe wire size. The diameter of the wire increases as the gauge decreases: 26 AWG is 0.0157 feet (4 mm) in diameter, 24 AWG is 0.0201 feet (51 mm), and so on.
Bridged Tap	A pair of wires connected in parallel across a single line to form a "T" configuration.
Cable Binder Group	A group of 25 pairs of wires.
CDU	HDU to Customer loopback
CLEI	Common Language Equipment Identifier
CO	Central Office
CRC	Cyclic Redundancy Check
CSA	Carrier Serving Area/Customer Service Area
DDS	Digital Data Service
ECI	Equipment Catalog Item
ENA	Enable
GFD	Ground Fault Detection
HDSL	High bit-rate Digital Subscriber Line
HDU	HiGain Doubler Unit
HLU	HiGain Line Unit
HRE	HiGain Remote Enclosure
HRU	HiGain Remote Unit
ISDN	Integrated Services Digital Network

KBPS	Kilo (thousand) Bits Per Second, sometimes written Kb/s
LED	Light Emitting Diode
Loop	A length of twisted-pair copper wire connecting the local unit of an HDSL circuit to the remote unit.
MBPS	Mega (million) Bits Per Second, sometimes written Mb/s
NDU	HDU to Network Loopback
NEBS	Network Equipment Building System
POTS	Plain Old Telephone Service
RMA	Return Material Authorization
SPLB	Special Loopback

PRODUCT SUPPORT

The PairGain Customer Service Group provides expert pre-sales and post-sales support and training for all its products.

TECHNICAL SUPPORT

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

Telephone:	(800) 638-0031 or (714) 832-9922 The 800 telephone support line is toll-free in the U.S. and Canada.
Fax:	(714) 832-9924
Email	support@pairgain.com

During normal business hours (7:30 AM to 5:30 PM, Pacific Time, Monday through Friday, excluding holidays), technical assistance calls are normally answered directly by a Customer Service Engineer. At other times, a request for technical assistance is handled by an on-duty Customer Service Engineer through a callback process. This process normally results in a callback within 30 minutes of initiating the request.

WORLD WIDE WEB

PairGain product and company information can be found at *http://www. pairgain.com* using any Web browser. To download PairGain product manuals from the Customer Site portion of the web page, you need to provide a customer password. If you do not have a password, contact your PairGain sales representative.

RETURNS

To return equipment to PairGain:

1 Locate the number of the purchase order under which the equipment was purchased. You will need to provide this number to PairGain Customer Service to obtain a return authorization.

2 Call or write PairGain Customer Service to ask for a Return Material Authorization (RMA) number and any additional instructions. Use the telephone or fax number listed below:

- Telephone: (800) 370-9670
- Fax: (714) 730-2961

3 Include the following information, in writing, along with the equipment you are returning:

- Company name, address, and the name of a person PairGain can contact regarding this equipment.
- The purchase order number provided to Customer Service when the RMA number was requested.
- A description of the equipment, as well as the number of units that you are returning. Be sure to include the model and part number of each unit.
- The shipping address to which PairGain should return the repaired equipment.
- The reason for the return:
  - The equipment needs an ECO/ECN upgrade.
  - The equipment is defective.
  - If there is another reason for returning the equipment, please let us know so we can determine how best to help you.

If the equipment is defective, please tell us what you observed just before the equipment malfunctioned. Be as detailed in your description as possible.

4 Pack the equipment in a shipping carton.

5 Write PairGain's address and the Return Material Authorization Number you received from Customer Service clearly on the outside of the carton:

PairGain Technologies, Inc.
14352 Franklin Ave.
Tustin, CA 92780-7013

Attention: **CRF RMA (Number)**

FCC and warranty information can be found on the inside back cover of this manual.

CERTIFICATION AND WARRANTY

FCC COMPLIANCE

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

Refer to the installation section of this manual for guidance on: cabling, correct connections, grounding.

WARRANTY

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

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

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

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

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

MODIFICATIONS

Any changes or modifications made to this device that are not expressly approved by PairGain Technologies, Inc. may void the user's warranty.

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

Corporate Office
14402 Franklin Avenue
Tustin, CA 92780
Tel: (714) 832-9922
Fax: (714) 832-9924
For Technical Assistance:
(800) 638-0031

ISO 9001
DNV
DNV Certification, Inc.
Certificated Firm

PAIRGAIN