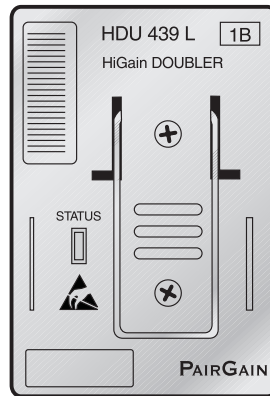
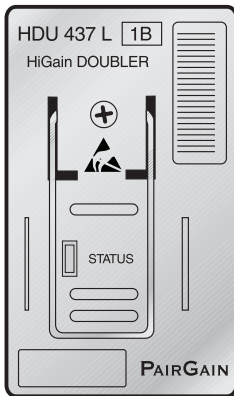

HIGAIN MINI DOUBLERS

| Model | List Number | Part Number | CLEI Code |
|---------|-------------|-------------|------------|
| HDU-437 | 1B | 150-1502-12 | T1R5A70EAA |
| HDU-439 | 1B | 150-1268-12 | T1R5A60EAA |
| HCC-239 | 1 | 150-1550-01 | |



PAIRGAIN TECHNOLOGIES, INC.
ENGINEERING SERVICES TECHNICAL PRACTICE



SECTION 150-439-112-03

Revision History of This Practice

| Revision | Release Date | Revisions Made |
|----------|-------------------|--|
| 01 | December 19, 1997 | Initial release |
| 02 | October 26, 1998 | Added references to new HCC-239 List 1 and added reference to AT&T 819 Cabinet |
| 03 | March 1, 1999 | Updated capacity tables |

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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.

If you have comments or questions about this Technical Practice, you can send email to *technical_publications@pairgain.com*. Type the product name and section number of the document in the subject area of the email message.

UNPACK AND INSPECT YOUR SHIPMENT

When you receive the equipment, inspect it 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 PairGain.

Your shipment should consist of:

- one of the following doubler units
 - HDU-437 List 1B
 - HDU-439 List 1B with one HCC-239 List 1
- this Technical Practice (150-439-100-03)

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OVERVIEW

The PairGain[®] HiGain[®] Mini Doubler HDU-437 List 1B and HDU-439 List 1B are low-power doubler units in mini-repeater packages. Each extends the range of a HiGain repeaterless T1 transmission system.

The HDU-437 and HDU-439 extend the delivery of T1 High-Capacity Digital Service (HCDS) to customers over metallic cable pairs. The HDU-437 and HDU-439 are installed between any doubler-compatible HLU and any other HDU or HiGain Remote Unit (HRU).

The HDU-437 and HDU-439 allow 1.544 Mbps transmission over twice the normal Carrier Service Area (CSA) range to 24,000 feet (7.315 km) of 24 American Wire Gauge (AWG) or 18,000 feet (5.486 km) of 26 AWG copper loops. Two doubler units can triple the CSA range to 36,000 feet (10.97 km) of 24 AWG loops or to 27,000 feet (8.22 km) of 26 AWG loops.

The HiGain Cut-through Card HCC-239 is shipped with the HDU-439. The HDU-439 mounts into two adjacent slots of a standard 239 mini-T1 repeater apparatus case and blocks one slot. The HCC-239 allows pair cut-through on the blocked repeater slot. The HDU-437 doubler units occupy one slot of the original Digital Data System (DDS) or Integrated Services Digital Network (ISDN) repeater apparatus case—these slots are about twice the width of a 239 T1 repeater. All HiGain modules comply with the applicable requirements of Network Equipment Building System (NEBS) generic equipment requirements TR-TSY-000063 and Transport System Generic Requirements TSGR TR-TSY-000499.



The HDU-437 List 1B and HDU-439 List 1B mini doubler units can be used in two-doubler circuits with older HDU-451 doubler units.

FEATURES

HDU-437 and HDU-439 HiGain Mini Doubler features include (Figure 1 on page 4):

- front-panel Light Emitting Diode (LED) status display
- lightning and power cross-protection on all four High-bit-rate Digital Subscriber Line (HDSL) interface ports
- remote power capability from any doubler-compatible HiGain Line Unit (HLU)
- low power dissipation
- ground fault detection

THREE-SPAN, LINE-POWERING APPLICATIONS

Most applications requiring two HiGain mini doubler units must use a locally-powered HRU. However, the unique low-power property of the HiGain mini doubler units allows some specific two-doubler unit circuits to line-power all three spans, including the HRU.

The required equipment for three-span line-powering operation is:

- HLU-231 List 8x (part number 150-1111-8x)
- HLU-319 List 5x (part number 150-1140-5x)
- HLU-388 List 5x (part number 150-1141-5x)
- HLU-231 List 7D or List 7E (part number 150-1111-74 and 150-1111-75)
- HLU-231 List 7B (part number 150-1111-72)
- HLU-431 List 1D or List 1E (part number 150-1504-14 and 150-1504-15)
- HDU-439 (part number 150-1268-12) or HDU-437 (part number 150-1502-12)
- HRU-402 List 1 (part number 150-1592-01)
- HRU-412:

- List 8 (part number 150-1103-08)
- List 8A (part number 150-1103-81)
- List 6 (part number 150-1103-06), Configuration 22 (or greater)
- List 7 (part number 150-1103-07), Configuration 16 (or greater)
- List 7A (part number 150-1103-71)



The HRU-412 must have the 60 mA Customer Premised Equipment (CPE) current option set to 0 when used in three-span line-powered circuits.

Potential circuits for three-span line powering must meet the following deployment rules:

- 1 The total loop resistance of all three spans must not exceed 2000 Ω .
- 2 The total loop insertion loss at the HDSL line rate of 196 kHz must not exceed 105 dB. This results from the normal loss limit of 35 dB for each of the three spans.



The spans refer to the cable pairs between HiGain modules.

For more detailed information on loop resistance and insertion loss, please see [“Appendix B - Loop Resistance and Insertion Loss”](#) on page 18.

FRONT PANEL DESCRIPTION

Figure 1 shows the HDU-437 1B and HDU-439 List 1B front panel and Table 1 describes the doubler unit components.

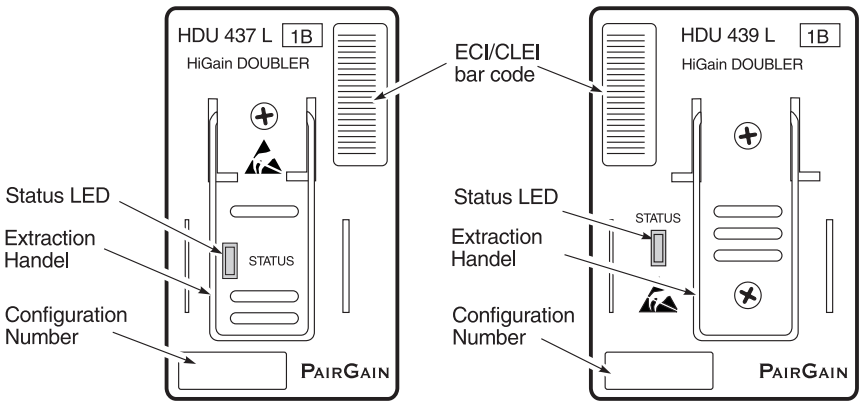


Figure 1. HDU-437 List 1B and HDU-439 List 1B Front Panels

Table 1. Front Panel Components and Labels

| Name | Function |
|-------------------------|---|
| ECI/CLEI Bar Code Label | Contains Equipment Catalog Item (ECI) bar code number and human-readable Common Language Equipment Identified (CLEI) code number. |
| Status LED | Indicates operational status of doubler. |
| Extraction Handle | For removing the HDU from the enclosure. |
| Configuration Number | Contains either a stand-alone 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 |

COMPATIBILITY

The HDU-437 List 1B and the HDU-439 List 1B are compatible with the following PairGain outdoor enclosures:

- HRE-500, single-slot unit
- HRE-458, 10-slot unit
- HRE-504, 4-slot unit
- HRE-506, 6-slot unit
- HRE-819 (see [page 25](#))

THERMAL CONSTRAINTS

The HDU-437 and HDU-439 doubler units can be housed in a variety of outdoor apparatus cases. The capacity of the doubler units in several of these standard enclosures is listed in “[Appendix E - Abbreviations](#)” on [page 31](#). The number of doubler units that can be plugged into each enclosure is limited by mandatory thermal constraints. The constraints are imposed to avoid overheating that may result in damage to the doubler units.



You must observe thermal constraints for reliable service under worst-case conditions. Consult PairGain when using the enclosures in environments that are more hostile than those allowed by the constraints or when using unlisted enclosures.

FUNCTIONAL DESCRIPTION

HiGain uses PairGain's Two-Binary, One-Quaternary (2B1Q) HDSL transceiver systems to establish two, full-duplex, 784 kbps data channels between the line units and the remote units. Each HDU-437 and HDU-439 increases the maximum range of a new doubler circuit by approximately 12,000 feet (3.66 km) for 24 AWG cable or 9,000 feet (2.74 km) for 26 AWG cable.

BLOCK DIAGRAM

A block diagram of the HDU-437 and HDU-439 with pinouts is shown in [Figure 2](#). The HDU-437 and HDU-439 power supplies use the 200 Vdc power feed voltage received on the HDSL pair to produce the +5 Vdc and -5 Vdc required by the HDU-437 and HDU-439 electronics. The power feed continues through the HDSL output pair to a second doubler or to the HRU.

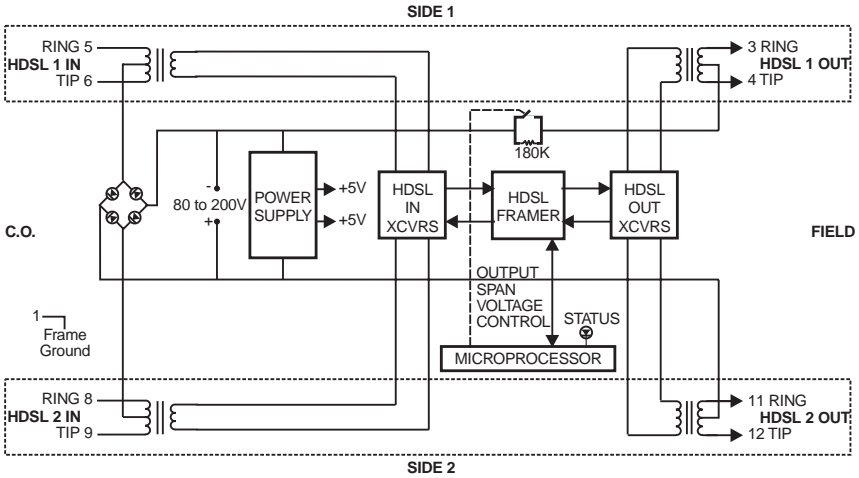


Figure 2. Mini Doubler Block Diagram

FAULT ISOLATION

In line with PairGain's continuing efforts to provide equipment that fully complies with new industry standards, the List 1B doublers have been enhanced from the List 1 units with a special ground fault-detecting circuit that meets the requirements described in Paragraph R7-1, Section 7.2.1 of GR-1089-CORE, Issue 2, December, 1997.

When used with HLUs with similar ground fault-detective circuit, ground faults occurring at any point along any span on any wire are immediately detected. This condition shuts the HiGain circuit down. The line unit periodically tries to apply power to the first span to determine whether the fault condition is still present. As long as the fault condition exists, the power cycling and ground fault protection continues. The operation of the ground fault circuit requires that the doubler enclosure be connected to the earth ground. Circuits containing both the new List B and older doublers also support this new ground fault detecting feature, provided the doubler nearest the HLU is a List B unit.

The presence of this new circuit causes the HDSL span-powering voltage levels to be shifted up to 100 volts more positive than their value in non-List B doubler circuits. The actual shift depends on loop length, number of doublers, HRU powering option, and the setting of HLU Bipolar/Unipolar switch. The List B doublers are backward-compatible with all versions of HLUs. [Table 2 on page 8](#) describes the conditions found during fault isolation.

Table 2. Fault Isolation Guide

| Problem | Solution |
|---|--|
| Status LED does not light | <ol style="list-style-type: none">1 Verify that the HLU is installed and operational in the Central Office (CO).2 Verify proper cabling between the doubler enclosure and the CO.3 Measure 100 Vdc to 200 Vdc between pins 5 or 6 and 8 or 9. This voltage peaks every 15 seconds as the HLU powers up. If less than 130 Vdc is present, check the cabling or the HLU. Only the line units mentioned in this practice can be used to power doublers. Other HLU versions can seem to work but do not provide reliable operation and should not be used. |
| HDSL LED continues to flash green once per second | Synchronization is being attempted with the upstream unit. |
| HDU-437 or HDU-439 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. |

INSTALLATION

This section describes the installation procedures for the HDU-437 and the HDU-439.

INSTALLING THE MINI DOUBLER

To install the HDU-437 and HDU-439 in an enclosure, perform the following steps and refer to the enclosure installation manual for information about cabling, proper connections, grounding, and line and local power.



This product has static-sensitive components. Follow proper ESD guidelines when handling this product, such as using an ESD wrist strap connected to electrical ground.

- 1 Slide the doubler into the card guides for the desired slot (see [Figure 3 on page 10](#)).
- 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.

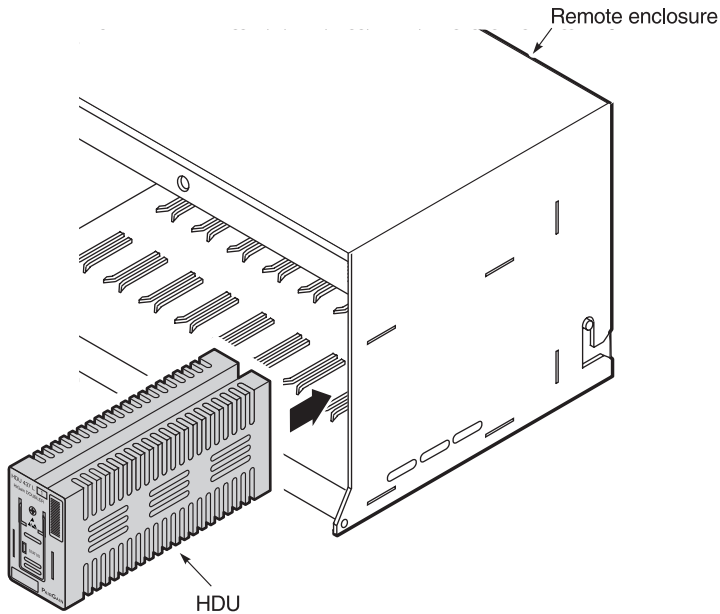


Figure 3. *Installing the HDU-437 and HDU-439 in a Remote Enclosure*



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 PairGain technical practice.

Once the HDU 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. Refer to the section titled [“Alarms” on page 13](#) for more details on LED operation.



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

INSTALLING AND REMOVING THE CUT-THROUGH CARD

When the dual-slot HDU-439 is inserted into a T1 enclosure, it blocks access to the adjacent slot. In order to cut through the IN (central office side) pairs to the OUT (field side) pairs of the blocked repeater slot for downstream access, a HiGain Cut-through Card, HCC-239, is included with all HDU-439 List 1B doubler units. A block diagram of the HCC-239 is shown in [Figure 4](#).



Additional packages of 25 HCC-239s (PairGain part number 150-1550-01) are also available if this cut-through feature is needed in other doubler installations.

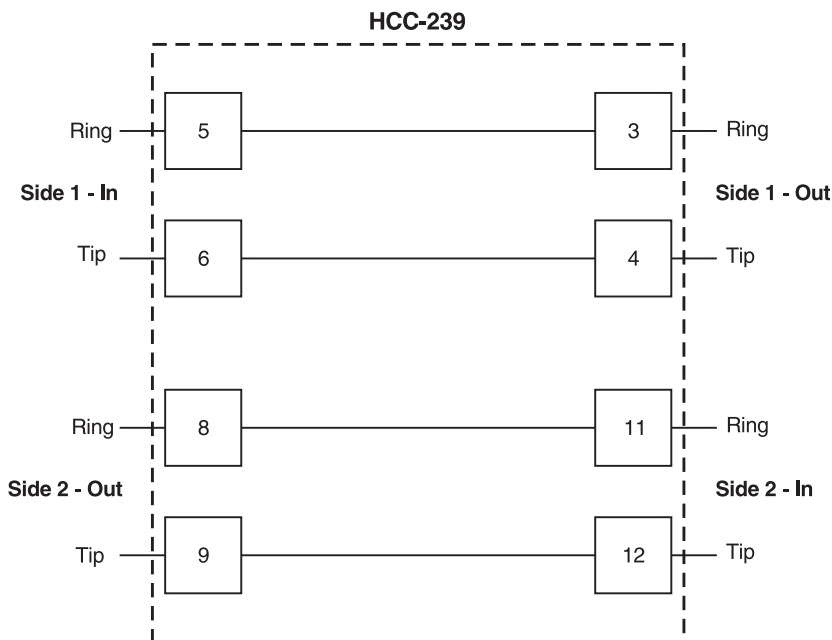


Figure 4. HCC-239 Card Block Diagram

A special insertion tool (the HCT-239, PairGain part number 150-1595-01) simplifies the HCC-239 installation and may be purchased from PairGain (see [Figure 5](#)).

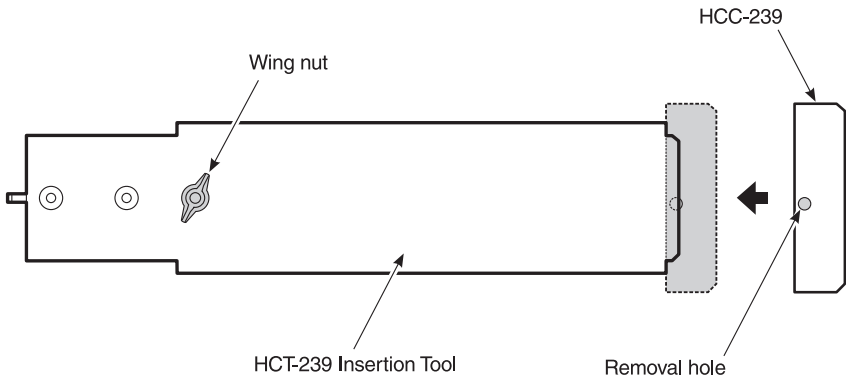


Figure 5. *HCT-239 Insertion Tool*

To install the HCC-239 using the HCT-239 insertion tool or long-nose pliers:

- 1 Loosen the wing nut on the HCT-239 insertion tool.
- 2 Slide the non-connector edge of the card into the tapered edge of the insertion tool. (The HCC-239 card is symmetric, so the orientation is irrelevant and the card cannot be plugged in backward.)
- 3 Tighten the wing nut to firmly grip the card.
- 4 Hold the tool near the end, and insert the card into the blocked slot cavity.
- 5 Carefully align the edge of the card with the slot-edge connector.
- 6 Push the card into the connector until it is firmly seated.
- 7 Loosen the wing nut and remove the tool.

To remove the HCC-239 card from the slot, proceed as follows:

- 1 Grip the end of the tool and insert the tool into the slot cavity containing the HCC-239 card.
- 2 Carefully insert the tool hook into the removal hole in the card.
- 3 Align the hook along the open side of the card-edge connector.
- 4 Apply steady outward pressure, and gently remove the HCC-239.

TROUBLESHOOTING

This section describes different status LED alarms and the operation of loopbacks in HiGain systems.

ALARMS

[Table 3](#) describes the HDU-437 and HDU-439 front panel tri-color status LED alarms.

Table 3. *Front Panel Status Indicator*

| Status LED | Description |
|--|--|
| Flashing green once per second | Synchronization is being attempted between the HDU and the upstream (network) module. |
| Flashing green more than once per second | Synchronization is being attempted between the HDU and the downstream (customer) module. |
| Solid green | HDSL frame synchronization has been achieved between the HDU and both the upstream and downstream modules. |
| Flashing red once per second | HDSL Cyclic Redundancy Check (CRC) error has occurred between the HDU and the upstream module. See the “Appendix A - Specifications” on page 16. |

Table 3. *Front Panel Status Indicator (Cont.)*

| Status LED | Description |
|---|--|
| Flashing red more than once per second | An HDSL CRC error has occurred between the HDU and the downstream module. See “Fault Isolation” on page 7 . |
| Flashing yellow once per second | A Network Doubler Unit (NDU) loopback is in effect in the HDU toward the network. This tests the integrity of the upstream span. |
| Flashing yellow more than once per second | A CDU (HDU to Customer) loopback is in effect in the HDU towards the customer. This tests the integrity of the downstream span. |

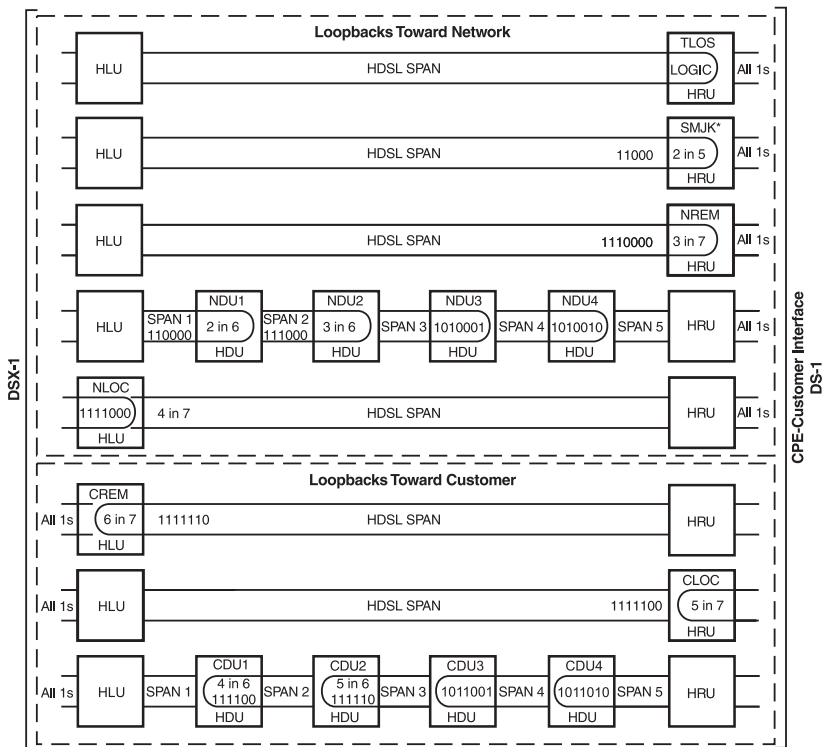
LOOPBACK OPERATION IN HIGAIN SYSTEMS

The complete family of loopbacks that a HiGain system can execute is shown in [Figure 6 on page 15](#). Four of these loopbacks, NDU1, NDU2, CDU1, and CDU2, occur in the doubler. The loopbacks can be initiated from the HLU RS-232 craft port, the HLU front-panel buttons, or from a family of Special Loopback (SPLP) in-band commands.

The loopback command set is listed in [Table 4](#). For more information about other doubler loopback commands, see the appropriate HLU technical practices.

Table 4. *Loopback Command Set*

| Command Set | Loopback |
|-----------------|----------|
| 110000 (2-in-6) | NDU1 |
| 111000 (3-in-6) | NDU2 |
| 111100 (4-in-6) | CDU1 |
| 111110 (5-in-6) | CDU2 |



The SmartJack loopback is a metallic loopback in the HRU-412, List 6, 7, and 8. It is a logic loopback in all lower HRU list numbers. Set the SAIS option to ENA to send the all ones pattern (AIS) to the CI during SmartJack loopback. Use the 3-in-5 code to loop down.

Figure 6. HiGain Loopbacks

For more information about other doubler loopback commands, see the practice for the HLU being used with the doubler (documents can be requested at: technical_publications@pairgain.com).

APPENDIX A - SPECIFICATIONS

Appendix A lists the specifications for the HDU-437 and HDU-439.

HDSL

| | |
|----------------------------------|--|
| Line code | 784 kbps, 2B1Q full duplex |
| Output | +13 dBm |
| Line impedance | 135 Ω |
| Resistive signature input/output | 25 Ω |
| Start-up time (per span) | 15 seconds (typical), 30 seconds (maximum) |

Line clock rate Internal Stratum 4 clock

Maximum power consumption 5.5W

Maximum provisioning loss 35 dB @ 196 kHz, 135 Ω

Mounting

HDU-437 Single slot of original DDS/IDSN repeater mechanics

HDU-439 Dual 239 T1 mechanics

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-437

Single slot of original DDS/IDSN repeater mechanics

| | |
|--------|--------------------|
| Height | 2.6 inch (6.6 cm) |
| Width | 1.45 inch (3.7 cm) |
| Depth | 6.5 inch (16.5 cm) |
| Weight | 1.8 lb (0.8165 kg) |

HDU-439

Dual 239 T1 mechanics

| | |
|--------|--------------------|
| Height | 2.6 inch (6.6 cm) |
| Width | 1.65 inch (4.2 cm) |
| Depth | 6.5 inch (16.5 cm) |
| Weight | 1.8 lb (0.8165 kg) |

APPENDIX B - LOOP RESISTANCE AND INSERTION LOSS

Use the data in [Table 5 on page 19](#) to calculate the total loop resistance and loop insertion loss for the specific length and gauge of each section of each span. The doublers are placed according to the standard rules that allow a maximum span loss of 35 dB @ 196 kHz. In order to achieve optimum performance, the electrical length (196 kHz loss) of all doubler spans should be as close as possible to being equal. This usually results in the highest operating system margin.



The longer three-span line-powered loops may take additional time (as much as 3 minutes) for all three spans to turn up and acquire HDSL synchronization from a cold start.

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

- 1 Place the enclosures at the electrical limits, 35 dB, of each span. This would place the first doubler at the 35 dB location and the second at 70 dB. This allows the maximum circuit range of 105 dB to be realized, if the third span to the most distant remote unit is also 35 dB.
- 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.
- 3 This rule minimizes the power consumption and dissipation of the HLU that provides the doubler power. Rule 3 requires Span 1 to be a minimum and Span 3 to be a maximum. This choice minimizes the I^2R loss in the cable pairs, and reduces the thermal stress on the HLU.

These HiGain mini doublers operate with any number of other T1, Plain Old Telephone System (POTS), DDS, or other HiGain systems sharing the same cable binder group.

Table 5 shows a list of HDSL signal cable losses for various cable gauges at 196 kHz and 135 Ω . **Table 5** applies to the HDSL cable pairs between the HLU and the HDU as well as between the HDU and the HRU.

Table 5. HDSL Signal Cable Loss

| Cable gauge | Ohms per thousand feet (0.3048 km) | Loss @ 196 kHz (dB/thousand feet)^(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 C - THERMAL CONSTRAINTS

The number of doubler units used in any of the enclosures depends on the maximum outside ambient temperature. The capacities listed in [Table 6 on page 21](#), [Table 7 on page 22](#), and [Table 8 on page 26](#) (for both indoor and outdoor enclosures) are based on a maximum outside temperature of +115 °F (+46.1 °C). These requirements comply with Section 10.2.1.3 of TA-NWT-001210. The Section requires HDSL equipment placed in outdoor cabinets to operate in a temperature, outside the housing, of -40 °F (-40 °C) with no solar load and +115 °F (+46.1 °C) with maximum solar load and maximum power dissipation. Full solar load is equal to the maximum sunlight exposure as defined in TR-TSY-000057.

The capacities listed for the indoor enclosures in [Table 6](#) assume no solar load. The capacities listed for the outdoor enclosures in [Table 7](#) and [Table 8](#) assume a full solar load as described above. In order to reduce thermal stress, the “Recommended Slot Assignment for Maximum Capacity” column assigns slots according to the following two rules:

- Always leave at least one empty slot between adjacent doublers.
- Allow as much room as possible between doublers.

Slot assignments that differ from those recommended in the tables are allowed, so long as the above two rules are applied.

The doubler capacity numbers listed for each outdoor enclosure must be reduced by one for each additional +10 °F (+5.5 °C) rise (or any fraction thereof) in outside ambient temperature above +115 °F (+46.1 °C). The doubler capacity number for any application can be increased by one for those applications having no solar load to bear (not exposed to direct sunlight, as in manholes). The capacities for the HRE-819, ADC Radiator, and HRE-458 can be increased by two for applications without solar load. However, any increase in capacity is still subject to the above rule (1) that requires at least one empty slot between adjacent doubler units in all applications.

Table 6. Indoor Enclosure Capacities for the HDU-439 without Solar Load

| Vendor | Description | Model Number | HDU-439 Doubler Capacity | 239 T1 Repeater Capacity | Recommended Slot Assignment for Maximum Capacity |
|---------|------------------------|-------------------------|--------------------------|--------------------------|--|
| Charles | Indoor wall mount | CiAC2300 ^(a) | 3 | 7 | 1, 3, 5 |
| | | CiAC2002 ^(a) | 1 | 2 | 1 |
| SPC | Indoor rack/wall mount | 4400-09 | 4 | 9 | 1, 3, 5, 7 or 2, 4, 6, 8 |

(a) Requires removing the metal slot separator.

For example, if the solar load is removed from the SPC 7430-8 T1 slot enclosure, whose capacity is two doubler units with solar load, capacity is increased to three doubler units. But this would necessitate placing two doublers side by side, with no empty slot between them. This violates the adjacency rule and thus forbids this shelf configuration. The empty slot requirement can be waived by reducing the otherwise allowed capacity by one for every two doubler units that do not have an empty slot between them. For instance, if the application allows for seven doublers, but two are directly adjacent with no empty slot between them, then the total capacity must be reduced to six.

Standard T1 and DDS repeaters can be installed in the same apparatus case with the doubler unit. If this method is used, the maximum number of doubler units that can occupy the same case with the standard repeaters must be reduced by one for every four T1 repeaters (or fractions thereof) installed and by one for every single DDS/ISDN repeater installed. For optimal performance, T1 and DDS repeaters located with doubler units in outdoor enclosures should be placed in slots that are not adjacent to the doubler units.

**Table 7. Outdoor Enclosure Capacities for the HDU-439
with Full Solar Load**

| Vendor | Description | Model No. | HDU-439 Doublers Capacity | 231 T1 Repeater Capacity | Recommended Slot Assignment for Maximum Capacity^(a) |
|---------------|-----------------------------------|------------------|--|---|---|
| PairGain | Outdoor canister, pole/wall mount | HRE-458 | 6 | 10 | 1, 4, 5, 8, 9, 10 |
| | Outdoor canister, pole/wall mount | HRE-504 | 2 | 4 | 1 and 4 or 2 and 3 |
| | Outdoor canister, pole/wall mount | HRE-506 | 4 | 6 | 1, 2, 5, 6 |
| | Outdoor canister, pole/wall mount | HRE-500 | 1 | 1 | NA |
| | Outdoor dual chamber | HRE-819 | 10 | 12 | 1, 2, 3, 4, 6, 7, 8, 9, 10, 12, |
| KEPTEL | Outdoor single chamber | RF 809 | 4 | 12 | 1, 5, 8, 12 |
| | Outdoor dual chamber | RF 819 | 10 | 12 | 1, 2, 3, 4, 6, 7, 8, 9, 10, 12 |

Table 7. Outdoor Enclosure Capacities for the HDU-439 with Full Solar Load (Cont.)

| Vendor | Description | Model No. | HDU-439 Doubler Capacity | 231 T1 Repeater Capacity | Recommended Slot Assignment for Maximum Capacity ^(a) |
|----------------|-----------------------------------|-------------------------|---|--------------------------|---|
| AT&T | Outdoor 841 cabinet | 27A, B, C or D shelf | 8 per shelf; 32 total | 25 per shelf/100 total | 1, 4, 10, 13, 17, 20, 22, 25 |
| | Outdoor dual chamber | 819 | 4 per chamber (8 total, mounted horizontally) | 25 | 1, 5, 11, 14, 15, 18, 22, 25 |
| | | | 3 per chamber (6 total mounted vertically) | 25 | 1, 5, 11, 15, 18, 22 |
| Alcatel | Outdoor canister, pole/wall mount | 621204 | 3 | 12 | 1, 5, 9 |
| | | 621205 | 3 | 25 | 1, 5, 15 |
| | | 621206 | 5 | 50 | 1, 5, 9, 13, 17 |
| Charles | Outdoor canister, pole/wall mount | CiAC4306 ^(b) | 2 | 6 | 1 or 5 |
| | | CiAC3300 | 1 | 3 | 1 or 2 |
| | | CiAC5312 | 3 | 12 | 1, 5, 9 |
| | | CiAC5325 | 3 | 25 | 4, 8, 12 |
| | | CiAC5350 | 5 | 50 | 4, 8, 12, 16, 23 |
| Sierra Sunrise | Outdoor canister, pole/wall mount | 3011 | 2 | 6 | 3, 6 |
| | | 3021 | 1 | 5 | 3 |
| SPC | Outdoor canister, pole/wall mount | 7130-08FP | 2 | 8 | 4, 6 |
| | | 7130-12FP | 3 | 12 | 1, 4, 11 |
| | | 7130-25FP | 4 | 25 | 1, 7, 15, 24 |

(a) Slot numbers refer to the slots into which a doubler unit may be inserted to access its four network cable pairs.

(b) Requires removing the metal slot separator.

The nonsymmetrical dimensions of the AT&T 819 cause the capacity to be subject to mounting orientation. Mounting the AT&T 819 vertically increases the internal heat load due to the self-heating “chimney effect” created by each double unit adding heat to the unit above it. Mounting the AT&T 819 horizontally reduces the chimney effect. The capacity of PairGain’s HRE-819 and KEPTEL RF 819, on the other hand, is based upon a modified design that makes it independent of mounting orientation.

The AT&T 819 has two individual, isolated chambers (see Figure 7). Slots 1 through 14 are in one chamber. Slots 15 through 25, along with the PRES, FIL, CAP, and COIL slots are in the other chamber.

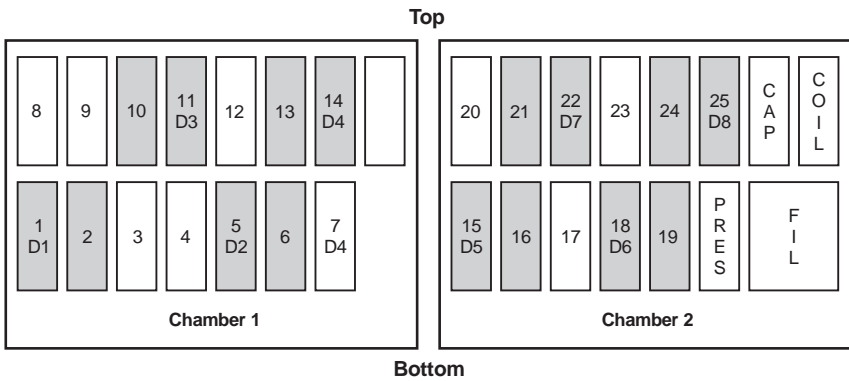


Figure 7. AT&T 819 Enclosure, HDU-439 Slot Locations D1 through D8 for Full Solar Local Horizontal Mount



Slot 7 of the AT&T 819 cannot be used for the HDU-439 doubler because of mechanical interference between the doubler unit cover and a mounting screw in the cavity adjacent to slot 7.

The PairGain HRE-819 and KEPTEL's RF 819 also have individual isolated chambers as shown in [Figure 8](#), however, it only has 12 active slots due to heat limitations and cable stub pair capacity. Slots 1 through 6 are in one chamber. Slots 7 through 12 along with the PRES slots are in the other chamber. The FIL, CAP and COIL slots are not supported.

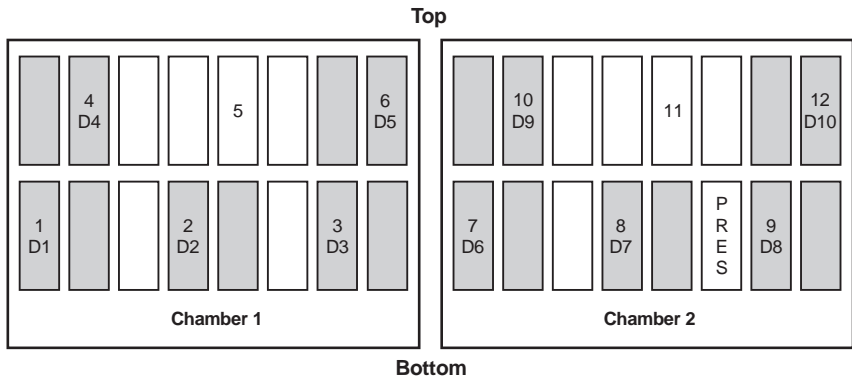


Figure 8. HRE-819 Enclosure, HDU-439 Slot Locations D1 through D10 for Full Solar Local



Applications without solar load can populate empty slots 5 and 11 shown in [Figure 8](#).

Table 8. Outdoor Enclosure Capacities for the HDU-437 with Full Solar Load

| Vendor | Description | Model Number | HDU-437 Doublers Capacity | DDS Repeater Capacity | Recommended Slot Assignment for Maximum Capacity |
|-------------------|--|-------------------------------|--|--------------------------------------|---|
| SPC | Outdoor canister, pole/wall mount | 7130-0656 | 2 | 6 | 1, 6 or 3, 4 |
| | | 7130-0856 | 3 | 8 | 1, 4, 6 |
| | | 7130-1656 | 4 | 16 | 4, 7, 10, 13 or 1, 6, 11, 16 |
| Adtran | Outdoor canister, pole/wall mount | LRH30AV or LRH30FV | 1 | 2 | 1 or 2 |
| | | LRH 11-30AD or LRH 11-30FD | 2 | 4 | 1 and 4 or 2 and 3 |
| Sierra Sunrise | Outdoor canister, pole/wall mount | 3011 | 2 | 3 | 3, 6 |
| | | 3021 | 2 | 2 | 4, 6 |
| ADC Radiator | Outdoor canister, pole/wall mount | SPX-HRXC-30- B1-PG | 6 | 8 | 2, 3, 4, 6, 7, 8 |

There are 15 different models of the HRE-819. The HDU-439 is compatible only with the following four models:

- 819 A1
- 819 A2
- 819 B1
- 819 B2

The HDU-439 is not compatible with the older 818 T1 repeater apparatus case because the 818 has a shallow cover, which cannot accommodate the HDU-439 length.

However, the 818 case can be used if the shallow cover is replaced by the deeper cover of the 819 apparatus case. The doubler unit capacity deployment rules can be summarized as follows:

- 1 Use [Table 6 on page 21](#) for indoor enclosures.
- 2 Use [Table 7 on page 22](#) and [Table 8 on page 26](#) for outdoor enclosures with Full Solar Load for ambient temperatures up to 115 °F maximum.
- 3 Increase the [Table 7](#) and [Table 8](#) capacities by one for non-solar load (shaded or manhole) applications. The capacities for the HRE-819, ADC Radiator, and HRE-458 can be increased by two for applications without solar load.
- 4 Increase the [Table 7](#) and [Table 8](#) capacities by one for each full 10 °F reduction in ambient temperature below 115 °F.
- 5 Decrease the [Table 7](#) and [Table 8](#) capacities by one for each 10 °F increase, or fraction thereof, in ambient temperatures above 115 °F.
- 6 Decrease any outdoor capacity by one for every four T1 repeaters, or fraction thereof, that are installed with the doublers.
- 7 Decrease any outdoor capacity by one for every DDS or ISDN repeater that is installed with the doublers.
- 8 For all outdoor applications, decrease the capacity by one for every two adjacent doublers that are not separated by at least one empty slot.



Always provide as many empty slots between doublers as possible.

APPENDIX D - PRODUCT SUPPORT

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

TECHNICAL SUPPORT

Technical assistance is available 24 hours a day, 7 days a week by contacting PairGain Customer Service 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 (8:00 AM to 5:00 PM, Pacific Time, Monday through Friday, excluding holidays), technical assistance calls are normally answered directly by a Customer Service Engineer. At other times, a request for technical assistance is handled by an on-duty Customer Service Engineer through a callback process. This process normally results in a callback within 30 minutes of initiating the request.

BBS

In addition, PairGain maintains an online Bulletin Board System (BBS) for obtaining current information on PairGain products, product troubleshooting tips and aids, helpful utilities, and for posting requests or questions. This system is available 24-hours a day by calling (714) 730-2800. You can access the BBS if you have a Hayes-compatible modem with a 2400 to 28,800 baud rate. The following setup format is required: 8 Data Bits, No Parity, 1 Stop Bit.

WORLD WIDE WEB

PairGain product and company information can be found at <http://www.pairgain.com> using any Web browser.

For firmware updates, click the “Firmware” icon on the PairGain home page, type your password and select the type of firmware you wish to upgrade.

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

If there is another reason for returning the equipment, please let us know so we can determine how best to help you.

- 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)**

APPENDIX E - ABBREVIATIONS

Appendix contains information on abbreviations and definitions for the HDU-437 List 1B and HDU-439 List 1B.

| | | | |
|-------------|--|-------------|---|
| 2B1Q | Two-Binary, One-Quaternary | HLU | HiGain Line Unit |
| AWG | American Wire Gauge | HRE | HiGain Remote Enclosure |
| BBS | Bulletin Board System | HRU | HiGain Remote Unit |
| CDU | HDU to Customer loopback | ISDN | Integrated Services Digital Network |
| CLEI | Common Language Equipment Identified | Kbps | Kilo (thousand) Bits Per Second, sometimes written Kb/s |
| CPE | Customer Premises Equipment | LED | Light Emitting Diode |
| CRC | Cyclic Redundancy Check | Loop | A length of twisted-pair copper wire connecting the local unit of an HDSL circuit to the remote unit. |
| CSA | Carrier Serving Area/Customer Service Area | MBPS | Mega (million) Bits Per Second, sometimes written Mb/s |
| DDS | Digital Data Service | NDU | HDU to Network Loopback |
| ECI | Equipment Catalog Item | NEBS | Network Equipment Building System |
| ESD | Electrostatic Discharge | POTS | Plain Old Telephone Service |
| HCC | HiGain Cut-through Card | RMA | Return Material Authorization |
| HCDS | High Capacity Digital Service | SPLB | Special Loopback |
| HDSL | High bit-rate Digital Subscriber Line | WCN | Warranty Control Number |
| HDU | HiGain Doubler Unit | | |

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.

UL LISTING

The HDU-437 List 1B and HDU-439 List 1B are listed with the Underwriter Laboratory.

Use caution when installing or modifying telephone lines. Dangerous voltages may be present. Do not install telephone wiring during a lightning storm. Always disconnect telephone lines and power connections from wall outlets before servicing or disassembling this equipment.

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

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

