PG-FLEX 8 CHANNEL REMOTE TERMINAL

LOOP START/GROUND START POTS UNIT

Model	List Number	Part Number
FRC-754	4	150-1354-04

PAIRGAIN TECHNOLOGIES, INC.
ENGINEERING SERVICES TECHNICAL PRACTICE

SECTION 363-754-104-01

PAIRGAIN

Revision History of This Practice

Revision	Release Date	Revisions Made
01	June 22, 1998	Initial Release

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.

TABLE OF CONTENTS

PRODUCT OVERVIEW

This section provides a product description, and defines the features and specifications for the PairGain® PG-Flex™ FRC-754 List 4 Remote Terminal (RT) Channel Unit.

Description and Features

The FRC-754 List 4 channel unit provides eight loop start or ground start Plain Old Telephone Service (POTS) interfaces between a PG-Flex RT and subscribers. The FRC-754 List 4 uses A-Law pulse code modulation (PCM) encoding. For subscriber circuit testing, the FRC-754 List 4 provides metallic access to the subscriber line connection through an optional metallic bypass pair.

Features of the PG-Flex FRC-754 List 4 channel unit are:

- eight loop start or ground start POTS subscriber interfaces
- 64 kbps A-Law PCM encoding
- meter tones (12 kHz, 16 kHz)
- front panel ACTIVE LEDs indicate on-hook (idle), ringing, metallic access, and off-hook condition for each channel
- front panel FAULT LED indicator simplifies troubleshooting
- Pair Gain Test Controller (PGTC) compatibility
- Custom Local Area Signaling Services (CLASS) support (such as, caller ID)
- line-side answer supervision support (reverse battery)
- forward disconnect
- distinctive ringing
- application of ringing voltage
- detection of loop off-hook, ground start seizure, and Ring-Trip conditions

Front Panel

The FRC-754 List 4 front panel (Figure 1) includes green status LEDs for each line indicating on-hook (idle), ringing, and off-hook conditions, as well as a red LED indicating a fault condition on the channel unit. Table 1 lists the FRC-754 List 4 front panel LED states and functions, and describes the labels.

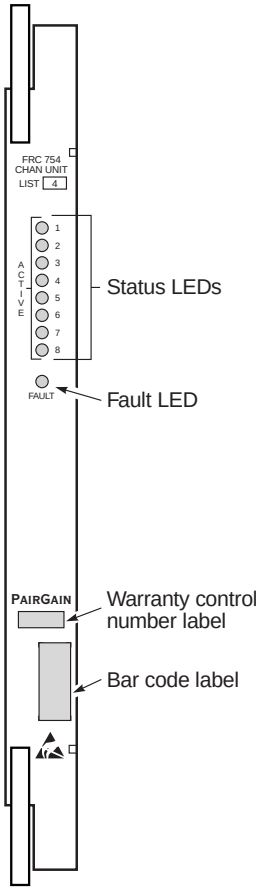

Figure 1. *FRC-754 List 4 Front Panel*

Table 1. *FRC-754 List 4 Front Panel LEDs and Labels*

LED and Labels	Function
ACTIVE (1 through 8)	Solid green: Channel is off hook. Fast flashing green: Channel is in test access mode. Slow flashing green: LED follows the ring signal. Off: Channel is on hook (idle).
FAULT	Red: Fault detected by the unit. See Table 10 on page 10 for troubleshooting procedures. Off: No faults detected.
Warranty Control Number Label	Indicates the beginning year and month of the equipment warranty. Also indicates the unit revision number. For example, a warranty control number of “71203” indicates a warranty beginning 1997 (7), in December (12), and the revision is “03.”
Bar Code Label	Contains the serial number and part number of the equipment in both bar code and text formats.

Specifications

Electrical Characteristics

Analog Impedance	600 Ω
Subscriber Drop	960 Ω (including 430 Ω for the handset)
DC Loop Current	≥ 23 mA
Ringer Output	40 V RMS, 3 lines simultaneously, 5 REN each
End-to-End Loss	-2.5 dB ± 1.0 dB at 1004 Hz
Lightning Protection	Meets all requirements (GR-CORE-1089, Section 4)

Environmental

Operating Elevation	–200 ft. to 13,000 ft. (–60 m to 4000 m)
Temperature and Humidity	–40° F to +150° F (–40° C to +65° C) 5% to 95% (non condensing)

Physical

Weight	0.6 lb (0.3 kg)
Dimensions	
Height	12.00 in. (30.5 cm)
Width	1.00 in. (2.5 cm)
Depth	4.50 in. (11.4 cm)

Operational Capabilities

The FRC-754 List 4 channel unit provides eight loop start or ground start POTS interfaces between the RT and subscribers, and performs the following functions:

- 64 kbps A-Law PCM encoding
- applies ringing voltage
- generates forward disconnect
- generates 12 kHz or 16 kHz meter tones
- detects an off-hook or ring-trip condition
- connects a subscriber loop to a metallic bypass pair
- protects against secondary surges

The subscriber line battery is supplied by a constant current supply. It is sufficient to operate a telephone set over the indicated loop length. The battery feed can be disconnected and the loop opened to release subscriber equipment when a forward disconnect signal is received from the FLC-704 List 4 COT line unit. The battery feed polarity can also be reversed as a physical signal of far end supervision.

Circuit Operation

The following paragraphs define the FRC-754 List 4 circuit operation when using loop start for subscriber lines or ground start for PBX lines. Each FRC-754 List 4 circuit has an associated LED that indicates when the line is off-hook, idle, ringing, or under test (see Table 1 on page 2).

Loop Start Operation

The following section summarizes the loop start sequences for on-hook (idle), subscriber inititated outgoing calls, subscriber received incoming calls, and busy conditions.

On-hook (Idle) Condition. Loop start idle condition is a Ring-lead negative and Tip-lead positive from the CO with the same condition out of the RT toward the subscriber (see Table 2 for circuit interactions).

Table 2. *Circuit Interactions for an Idle Condition (Loop Start)*

Operation	CO Switch	FRC-754 List 4 COCU	FRL-754 List 4 RTCU	Subscriber
Circuit Idle	No ringing ⇐	⇒ On-hook	No ringing ⇐	⇒ On-hook

Subscriber Initiated Outgoing Call. The following occurs when the calling line goes off-hook (see Table 2 on page 4 for circuit interactions):

- loop current flows and is detected by the FRC-754 List 4 channel unit
- FLC-704 receives an off-hook signal from the RT
- FLC-704 generates an off-hook condition to the CO switch
- CO sends dial tone
- FRC-754 passes a dial pulse or Dual Tone Multi Frequency (DTMF) signal through the FLC-704 from the subscriber and forwards these to the CO

Table 3. *Circuit Interactions When a Subscriber Initiates an Outgoing Call (Loop Start)*

Operation	CO Switch	FRC-754 List 4 COCU	FRL-754 List 4 RTCU	Subscriber
CO Idle	No ringing	⇒	No ringing	⇒
Subscriber goes off-hook	⇐	Off-hook	⇐	Off-hook
CO returns dialtone	Dialtone	⇒	Dialtone	⇒
Subscriber Dials	⇐	DP or DTMF	⇐	DP or DTMF

Subscriber Receives Incoming Call. The following occurs for an incoming call (see Table 4 for circuit interactions):

- FLC-704 detects a ringing signal from the CO
- FLC-704 signals the FRC-754 which then connects ringing to the subscriber
- subscriber line goes off-hook and the FRC-754, through the FLC-704, provides an off-hook condition to the CO switch

Table 4. *Circuit Interactions When a Subscriber Receives an Incoming Call (Loop Start)*

Operation	CO Switch	FRC-754 List 4 COCU	FRL-754 List 4 RTCU	Subscriber
Subscriber Idle	⇐	On-hook	⇐	On-hook
CO generates ringing	Ringing	⇒	Ringing	⇒
Subscriber goes off-hook	⇐	Off-hook	⇐	Off-hook
Ring trip	No ringing	⇒	No ringing	⇒

Busy Condition. Loop start busy condition at the RT is a Ring lead negative and a Tip lead positive with loop current flowing. The same conditions occurs at the CO (see Table 5 for circuit interactions).

Table 5. *Circuit Interactions for a Busy Condition (Loop Start)*

Operation	CO Switch	FRC-754 List 4 COCU	FRL-754 List 4 RTCU	Subscriber
Circuit busy	No ringing	⇒	No ringing	⇒
	⇐	Off-hook	⇐	Off-hook

Ground Start Operation

The following section summarizes the ground start sequences for on-hook (idle), subscriber inititated outgoing calls, subscriber received incoming calls, and busy conditions.

Idle Condition. Ground start idle condition is a Tip-lead open and Ring-lead negative from the CO and Tip lead open and Ring-lead negative at the RT (see Table 6 for circuit interactions).

Table 6. *Circuit Interactions for an Idle Condition (Ground Start)*

Operation	CO Switch	FRC-754 List 4 COCU	FRL-754 List 4 RTCU	Subscriber
Circuit Idle	Tip - no ground No ringing ⇐	⇒ Ring - no ground On-hook	Tip - no ground No ringing ⇐	⇒ Ring - no ground On-hook

Subscriber Initiates Outgoing Call. The following occurs when a PBX requests service for an outgoing call (see Table 7 for circuit interactions):

- PBX grounds Ring lead at the RT
- FRC-754 signals the FLC-704
- FLC-704 operates a Ring-ground relay that requests dial tone from the CO (this makes the circuit busy, or seizes it, for outgoing calls, and blocks any incoming calls prior to the PBX dialing (that is, it prevents glare where incoming and outgoing calls may occur simultaneously on the same line). Glare occurs when both ends of a telephone line or trunk are seized at the same time.
- CO sends dial tone and grounds the Tip to signal the PBX to begin dialing
- FLC-704 detects Tip-ground, closes the loop between Tip and Ring, and signals the FRC-754 to send Tip ground to the PBX
- PBX removes the original Ring-ground condition and completes the loop (Tip and Ring)

Table 7. *Circuit Conditions When a Subscriber Initiates an Outgoing Call (Ground Start)*

Operation	CO Switch	FRC-754 List 4 COCU	FRL-754 List 4 RTCU	Subscriber
CO Idle	Tip - No ground No ringing	⇒	Tip - No ground No ringing	⇒
Subscriber requests dialtone	⇐	Ring - ground On-hook	⇐	Ring - ground On-hook
CO returns dialtone	Tip - ground Dialtone	⇒	Tip - ground Dialtone	⇒
Subscriber Dials	⇐	Ring - no ground Off-hook DP or DTMF	⇐	Ring - no ground Off-hook DP or DTMF

Subscriber Receives Incoming Call. The following occurs for an incoming call (see Table 8 for circuit interactions):

- FLC-704 detects a ringing signal from the CO, along with Tip-ground
- FLC-704 signal the FRC-754 to connect Tip-ground and ringing to the PBX
- PBX goes off-hook and the FRC-754, through the FLC-704 closes the loop between Tip and Ring, the CO disconnects ringing and establishes an audio path

Table 8. *Circuit Conditions When a Subscriber Receives an Incoming Call (Ground Start)*

Operation	CO Switch	FRC-754 List 4 COCU	FRL-754 List 4 RTCU	Subscriber
Subscriber Idle	⇐	Ring - no ground On-hook	⇐	Ring - no ground On-hook
CO seizes loop	Tip - ground No Ringing	⇒	Tip - ground No Ringing	⇒
CO generates ringing	Tip -ground Ringing	⇒	Tip -ground Ringing	⇒
Subscriber goes off-hook	⇐	Ring - no ground Off-hook	⇐	Ring - no ground Off-hook
Ring trip	Tip - ground No ringing	⇒	Tip - ground No ringing	⇒

Busy Condition. Ground start busy condition at the RT is a Ring lead negative and a Tip lead positive with loop current flowing. The same conditions occurs at the CO (see Table 9 for circuit interactions).

Table 9. *Circuit Conditions for a Busy Condition (Ground Start)*

Operation	CO Switch	FRC-754 List 4 COCU	FRL-754 List 4 RTCU	Subscriber
Circuit busy	Tip - ground No ringing	⇒	Tip - ground No ringing	⇒
	⇐	Ring - no ground Off-hook	⇐	Ring - no ground Off-hook

CLASS Features

PG-Flex supports on-hook transmission of analog signals. When Call ID (a CLASS feature) is activated, the CO generates analog signalling toward the PBX between the first and second bursts of the ringing signal.

Forward Disconnect

The forward-disconnect function releases a called line that was left on hold or an answering set that requires a loop open to be able to turn off.

INSTALLATION AND TEST

Unpacking

Upon receipt of the equipment:

1 Unpack each container and 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. Order replacement equipment if necessary.

2 Check the contents versus the packing list to ensure complete and accurate shipment. If the shipment is short or irregular, contact PairGain as described in "Product Support" on page 11. If you must store the equipment for a prolonged period, store the equipment in its original container.

Observe normal electrostatic discharge precautions when handling electronic equipment. Do not hold electronic plugs by their connector edges. Do not touch components or circuitry.

Installing

Observe normal electrostatic discharge precautions when handling electronic equipment. Do not hold electronic plugs by their connector edges. Do not touch components or circuitry.

1 Insert each FRC-754 List 4 into the FRE-765 RT enclosure, then see if all LEDs on the channel unit:

- turn ON for approximately 2 seconds
- scan from top to bottom
- flash all ON, then OFF

If the LEDs do not follow the above sequence, see Table 10 on page 10.

2 After the system has powered up, established HDSL synchronized communications, and no calls are in progress, verify that the channel unit front panel indicators ACTIVE 1 through ACTIVE 8 and FAULT LEDs are all off.

Use List 3 of higher PG-Flex CO and RT line units when activating the ground start feature.

To reduce power at the RT, the FRC-754 LEDs turn off after a two minute time-out period. Press and hold the ACO button on the RT line unit for two seconds to turn on the LEDs for another two minutes.

Provisioning

Provision the FRC-754 List 4 using the appropriate line unit technical practice. For each channel provisioned, select the loop start of ground start option.

Verify Installation

After the PG-Flex system is powered up and HDSL communication is synchronized:

1 Verify that the front panel ACTIVE indicators are all OFF and the FAULT indicator is OFF (no calls are in progress).

2 Test the loop start circuits, as follows:

- Place an outgoing call for each subscriber circuit provisioned, and verify that the ACTIVE LED tracks the progress of the call (refer to Table 1 on page 2 for front panel indications)
- Place an incoming call to each subscriber circuit provisioned, and verify that the ACTIVE LED tracks the progress of the call (refer to Table 1 on page 2 for front panel indications)

3 Test the ground start circuits, as follows:

- Place an outgoing call for each subscriber circuit provisioned, and verify that the ACTIVE LED tracks the progress of the call (refer to Table 1 on page 2 for front panel indications)
- Place an incoming call to each subscriber circuit provisioned, and verify that the ACTIVE LED tracks the progress of the call (refer to Table 1 on page 2 for front panel indications)

Troubleshooting

Table 10 provides troubleshooting procedures based on indications displayed by the front panel indicators of the FRC-754 List 4 channel unit.

Table 10. *FRC-754 List 4 Channel Unit Troubleshooting Procedures*

Indication	Problem	Action
FAULT LED ON	The FRC-754 processor has detected a fault.	Remove and reinsert the Channel Unit. If the FAULT LED does not extinguish, replace the Channel Unit.
Troubleshooting based on customer-originated trouble reports		
No Dial Tone, Can't Dial	• faulty RT or COT Channel Unit • facility short/open • CO switch problem • Tip/Ring reversed at CO	**1** Lift the subscriber pair at the network interface. If dial tone is present and you can place a call, refer the problem to the customer per local practice. **2** If you cannot hear a dial tone or cannot place a call at the network interface (with the subscriber pair lifted), check for a dial tone at the RT. If a dial tone is present, check the pair between the RT and the network interface. If no dial tone is present, replace the RT Channel Unit. **3** If the problem still exists, reinsert the original RT Channel Unit and replace the COT Channel Unit. Test for operation. **4** If the problem still exists, refer the problem to the CO switch.
Phone Doesn't Ring	• high-resistance subscriber line short • faulty RT or CO Channel Unit • loop length too long	**1** Lift the subscriber pair at the network interface. If ringing is present, refer the problem to the customer per local practice. **2** If ringing is not present, check for ringing at the RT. If ringing is present, check the pair between the RT and the network interface. If no ringing is present, replace the RT Channel Unit. If ringing is still not present, check a circuit on another Channel Unit. If ringing is still not present, replace the RT Line Unit. **3** If ringing is still not present at the RT, reinsert the original Channel Unit and Line Unit. Test for ringing at the COT. **4** Test for ringing into the COT from the CO switch. If no ringing is present, refer the trouble to the CO switch. If ringing is present, replace the COT Channel Unit. Test again for ringing at the network interface. If ringing is still not present, contact PairGain technical assistance per "Product Support" on page 11. **5** Verify the resistance of the copper loop between the RT Enclosure and the network interface is less than 530 Ω.
Phone Doesn't Stop Ringing	• faulty subscriber instrument • faulty RT Channel Unit • loop length too long	**1** Test for ring trip at the network interface. If the ringing is tripped, refer the trouble to the customer per local practice. **2** If the ringing is not tripped, test for tripping at the RT. If ring trip does occur, check the loop for excessive length. If ring trip does not occur, replace the RT Channel Unit. If ring trip still does not occur, contact PairGain technical assistance per "Product Support" on page 11. **3** Verify the resistance of the copper loop between the RT Enclosure and the network interface is less than 530 Ω.
Can't Hear, Can't Be Heard	• subscriber problem • faulty RT or COT Channel Unit	**1** Lift the subscriber line at the network interface and check the signal level. If correct, refer trouble to the customer per local practice. **2** If the level is too low, check the level at the RT. If the level is correct at the RT, check the pair between the RT and the network interface. If the level is too low at the RT, replace the RT Channel Unit. **3** If the level is still too low, reinsert the original RT Channel Unit. **4** Check the level at the COT coming from the CO switch. If it is correct, replace the COT Channel Unit. If it is not correct, refer the problem to the CO regarding the switch. **5** If the level is still not correct, reinsert the original COT Channel Unit. Contact PairGain technical assistance per "Product Support".

PRODUCT SUPPORT

This section contains product support and warranty information.

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

Fax: (714) 832-9924

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.

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) 730-2800. Transmission speeds up to 28.8 kbps are supported with a character format of 8-N-1.

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 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.

FCC Compliance

This unit complies with the limits for Class B 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 the appropriate instruction manual for the unit you are installing to get information on:

- Cabling
- Correct connections
- Grounding

Modifications

The FCC requires the user to be notified that any changes or modifications made to this device that are not expressly approved by PairGain Technologies, Inc. may void the user's authority to operate the equipment.

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

ABBREVIATIONS

2B1Q	2 binary bits encoded in one quaternary symbol
AWG	American Wire Gauge
CLASS	Custom Local Area Signaling Services
CO	Central Office
COT	Central Office Terminal
DS0	Digital Signal Level Zero (64 kb/s)
DTMF	Dual Tone Multi-Frequency
HDSL	High-bit-rate Digital Subscriber Line
MLT	Mechanized Loop Testing
PBX	Private Branch Exchange
PCM	Pulse Code Modulation
PGTC	Pair Gain Test Controller
POTS	Plain Old Telephone Service
RMA	Return Material Authorization
RT	Remote Terminal

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