

## **LinkNet™ LNKF100 RF MODULES**

*User, Installation, Operation,  
and Maintenance Manual*

D044-13432 Rev A

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This Powerwave product is intended only for installation in a RESTRICTED ACCESS LOCATION and is designed to operate within the Normal Operating (typical operating) ranges or conditions specified in this document. Operation of this equipment beyond the specified ranges in this document may cause:

1. Spurious emissions that violate regulatory requirements.
2. The equipment to be automatically removed from service when maximum thresholds are exceeded.
3. The equipment to not perform in accordance with its specifications.

It is the Operator's responsibility to ensure this equipment is properly installed and operated within Powerwave operating specifications to obtain proper performance from the equipment and to comply with regulatory requirements.



### ***Warnings, Cautions, and Notes***

Warnings, cautions, and notes are found throughout this manual where applicable. The associated icons are used to quickly identify a potential condition that could result in the consequences described below if precautions are not taken. Notes clarify and provide additional information to assist the user.

**Warning**

This warning symbol means danger. You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical and RF circuitry and be familiar with standard practices for preventing accidents.

**Caution**

This caution symbol means *reader be careful*. In this situation, the user might do something that could result in equipment damage or loss of data.

**Note**

This note symbol means *reader take note*. Notes contain helpful suggestions or references to material not covered in the document. Procedures are not contained in notes.

**Revision Record**

Revision Letter	Date of Change	Reason for Change
A	Dec 2005	Initial Release

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# Chapter 1

## Theory of Operation

### 1 Introduction

This manual contains information and procedures for installation, operation, maintenance, and troubleshooting of the LNKF100 Modules. The manual is organized into the following chapters:

<b>Chapter 1</b>	Theory of Operation	<b>Chapter 3</b>	Antenna Installation
<b>Chapter 2</b>	Operation	<b>Chapter 4</b>	Return for Service

#### 1.1 Overview

A LinkNet FM Module is a radio repeater that simultaneously receives and transmits a single narrow band radio channel. The normal application of a LinkNet FM Module is as an on-frequency repeater where the input and output are on exactly the same frequency. It can also be used as a frequency translating repeater where the input and output can be set to any frequency in the specified band (see Table 1 for details).

The LinkNet FM Module accomplishes its repeater function without store and forward circuitry, or expensive conventional simulcasting techniques. The fact that the same frequency can be retransmitted by a LinkNet FM Module means that additional frequency allocations are not required in situations where an existing radio coverage pattern needs to be extended. The most common LinkNet FM Module applications are the extension of above ground signals into buildings, tunnels, vehicles or the extension of radio coverage patterns into outdoor shaded areas such as deep valleys.

From an applications standpoint, a LinkNet FM Module is very similar to a regular two-way radio repeater. LinkNet FM Modules can be combined using regular two-way radio multicoupling or duplexing equipment and have input and output signal characteristics to those of regular transmitters and receivers. The one special consideration in LinkNet FM Module systems is that of input to output antenna isolation. This must be carefully engineered for each installation.

LinkNet FM Modules are designed for indoor use only and are intended for mounting in a standard EIA 19 inch rack. The Modular design of LinkNet FM Module circuitry allows for easy servicing, stocking of spares, adaptability and upgrade ability.

#### 1.2 Models

Table 1 LNKF100 Module Family

LNKF100 MODULE FAMILY		
MODEL	TYPE	FREQUENCY
LNKF100-A1	25 KHz FM Channels	136-157 MHz (FM)
LNKF100-A2	12.5 KHz FM Channels	136-157 MHz (FM)
LNKF100-B1	25 KHz FM Channels	155-174 MHz (FM)
LNKF100-B2	12.5 KHz FM Channels	155-174 MHz (FM)

### 1.3 Block Diagram

LNKF100 RF Module:

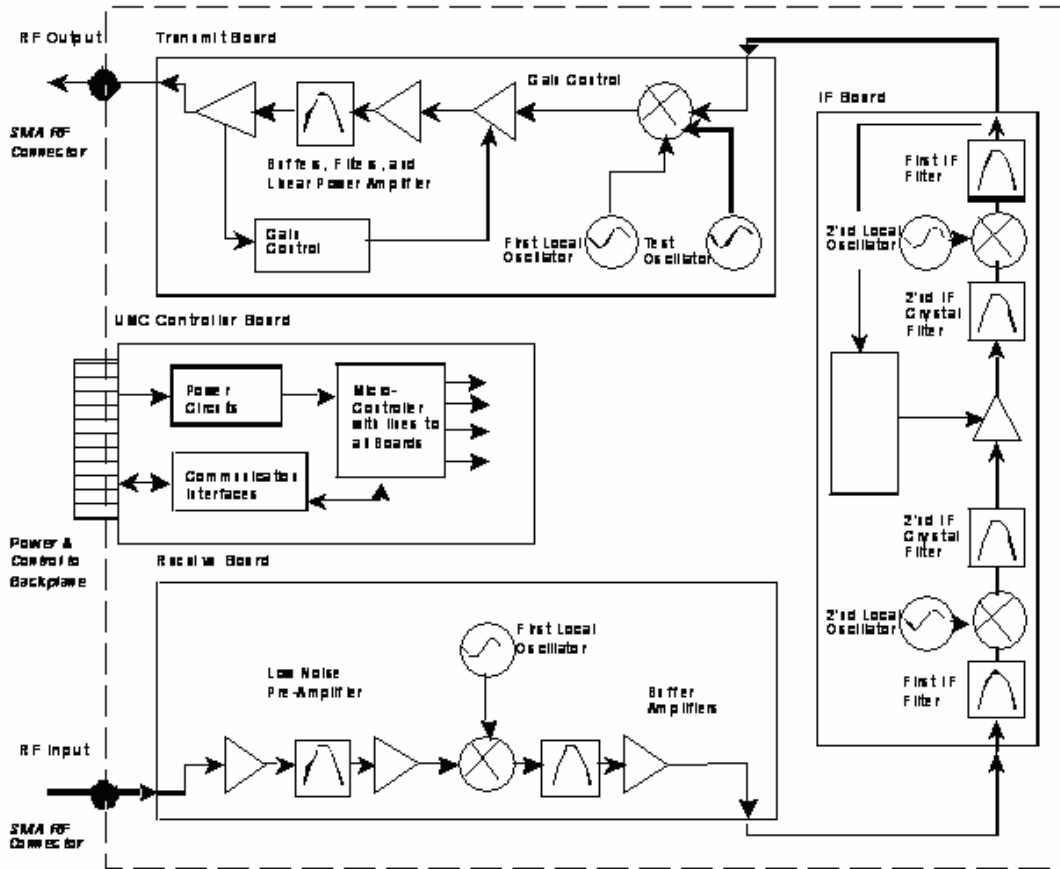


Figure 1-1 Block Diagram LNKF100 RF Module



## 1.4 Module Specifications

**Table 2 LNKF100 Module Specifications**

Frequency Bands	See Model Chart
Modulation & Channel Spacing	Narrowband FM 25 or 12.5 KHz as per Model Chart
RF Frequency Stability	Tracks Input Signal Exactly
Max. RF Output Power	37 dBm
RF Output Power Range	+20dBm to +37dBm
RF Output Power Variation vs. Input (over -90 to -30 dBm)	+/- 1 dB
Input Dynamic Range	-110 to -30 dBm
Input Sensitivity Adjust Range	-110 to -50 dBm
Input Hysteresis	1 to 10 dB
Adjacent Channel Selectivity	60 dB minimum for 25 KHz modules 55 dB minimum for 12.5 KHz modules
Transmit Duty Cycle	Continuous
Transmit Spurious	-13 dBm max for 25 KHz modules -20 dBm max for 12.5 KHz modules
Receive Conducted Spurious	-57 dBm max
Audio Distortion & Noise	<4% increase for 25 KHz modules <5% increase for 12.5 KHz modules
Transmit Key-Up & Key-Down Times	<2 mS Key-Up, <1 mS Key-Down
Group Delay	<120 usec for 25 KHz, <160 usec for 12.5 KHz
RF Connectors	SMA (50Ω) Connectors
Module Power Supply Requirements	45 Watts maximum
Connections	Edge Connector & 2 SMA RF Connectors, DB-15 Connector on back of Card-Cage provides per-Module Fault Relay, Interconnect to other Modules, & RS-232 Connection
Front Panel Indicators	Operating, Stand by, Fault, Program Mode, Receive, Transmit
Configuration Options	RF Modules may be configured either via the optional Gateway Module, or via a PC and an RS-232 Connection via the Card-Cage.
Operating Temperature Range	-10 to +50°C; consult manual <b>DCM000000008</b> for cooling requirements
Operating Humidity Range	10 to 90% RH, Non-Condensing
Size & Weight	9.11" High, 2.00" Wide, 14.00" Deep, 10 lbs, 4.5 kg Max
FCC Identifier	
Industry Canada Certification	

Also consult the main LinkNet™ Manual DCM000000008.

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# Chapter 2 Operation

## 2 Introduction

This chapter contains information for the standard operation of the LNKF100 Modules.

### 2.1 Software Set-Up

The LNKF100 module is shipped with the following factory set options:

**Table 3 LNKF100 Factory Set Options**

OPTION	RANGE OF VALUES	DEFAULT VALUE
Frequency	See Model Chart	Order Specific
Receive Threshold	-110 to -50 dB	-95 dB
Receive Hysteresis	1 to 10 dB	3.0 dB
Time Out	1 to 600 Seconds, or none	None
Module Enabled	On / Off	On
Transmit Power Level	20 to 37 dBm	Order Specific

Default values may be changed when an order is placed. Check your order confirmation (shipped with modules) for customized values.

### 2.2 Configuration

In line with the versatility of the LinkNet™ Platform, it is possible to reconfigure the LNKF100 module in the field, either with a Personal Computer (PC) or via the optional Control Module. To use a PC it is necessary to have a Powerwave CAB000000057 control cable to connect between the appropriate module's DB15 connector on the back of the card-cage and the standard DB9 RS232 connector on the PC. On the PC a terminal emulation program such as *HyperTerminal* is used to communicate to the LinkNet Module. The settings are 9600 baud, 8 bits, no parity, and 1 stop bit. Commands are one or two words followed by pressing *Return*. Commands may be given in upper or lower-case. Available commands are:

- ACCESS USER:** Required as a simple password to gain access to customer settable parameters and diagnostics. This will time-out after 10 minutes, and may have to be re-typed.
- HELP or ?:** Displays a list of available commands.
- LIST:** Displays current settings and status faults, etc.
- VER:** Display the current version of software.
- ENABLE 1 or 0:** Enables or disables the module.
- TXFREQ #####:** Displays or sets the current transmit frequency (in Hertz).
- RXFREQ #####:** Displays or sets the current receive frequency (in Hertz).
- TXPOWER ##:** Displays or sets the transmit power level (in tenths of a dBm).
- RXTHRESH -####:** Displays or sets the receive threshold level (in tenths of a dBm).
- RXHYSYTER ##:** Displays or sets the receive hysteresis (in tenths of a dB).
- TIMEOUT ####:** Displays or sets the timeout-timer value (in Seconds).  
Enter 0 for no timeout.
- TESTOSC 1 or 0:** Enables or disables the test oscillator.

Please consult Powerwave Technologies Inc. for further support.

## 2.3 Power On Self Test (POST)

Each module automatically performs a self-diagnostics when inserted into the system card-cage. These tests determine that the unit is correctly installed in the card-cage and not damaged in transit.

- All six of the LED's on the front panel will flash 3 times
- If the LED's do NOT flash three times, then remove the module, check the power source, and re-insert the module, (See Installation Instructions).
- If the card is "OK" the LED's will continue normally (See Normal Operation).
- If there is a fault, then the Red Fault LED will remain on. If this occurs, contact Powerwave Technologies Inc.

**Note!** The Power On Self Test is *Not* an RF test, it only verifies that there is power to the unit and that the logical circuitry is functioning.

## 2.4 Fault Indications

Each module continuously performs internal diagnostics. If a problem is detected it will activate its Red Fault LED and Fault Relay. Faults detected include:

- Over Temperature
- High VSWR
- Loss of Lock
- Misc. Internal Faults

Detailed faults are detected by the optional gateway module. Details may also be determined via the module's control port connector and an RS232 connected Terminal Emulator using the **LIST** command.

## 2.5 Normal Operation



The LNKF100 Module has six LED's on the faceplate:

**OPERATING** - LED will flash GREEN when RF Data is present and unit is operating normally.

**STANDBY** – Under the control of the Control Module, the LNKF100 Module has the ability to act as a duplex transmitter, sitting perpetually in stand by mode waiting for the primary transmitter to fail. This LED should be constant Amber. If a fault should occur with the primary module, the “Stand by” unit will immediately become the primary unit, at which time the stand by LED will be turned off and the LED's will show an operating module.

**TRANSMIT** – Green when a signal is being transmitted.

**RECEIVE** – Green when a signal is being received.

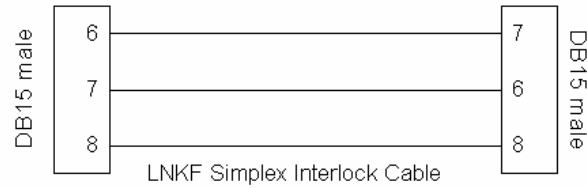
**PROGRAM** – Constant Amber when the unit is being re-programmed by the controller module. This will signify that the unit is powered on but unavailable for use.

**FAULT** – Constant Red if the internal diagnostics for the module detects a problem.

**Figure 2-1 LNKF100 Faceplate**

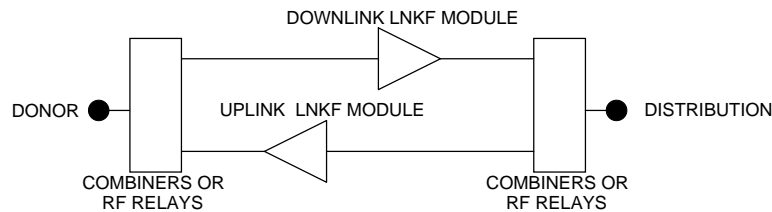
## 2.6 Simplex Operation

- For back-to-back Simplex operation, the LinkNet Modules to be used MUST be interconnected as shown:



**Figure 2-2 LNKF100 Simplex Interconnection**

- This connection is made using a custom male DB15 to male DB15 cable as shown above interconnected between the two LNKF modules. This cable is plugged into the two module's control ports (see DCM000000008 "Control Connections") on the back of the chassis they are installed in.
- The RF connections are made using either combiners or RF Relays:



**Figure 2-3 LNKF100 RF Connection**

- The specific details are determined by the system design, and must provide enough RF isolation between the two modules.

# Chapter 3

## Antenna Installation

### 3 Introduction

This chapter contains antenna installation and warning information for the LNKF100 Modules.

#### 3.1 Antenna Installation

- All antenna installation to be performed by qualified technical personnel only.
- Antenna installation instructions and locations below are for the purpose of satisfying FCC RF Exposure Compliance requirements.

**Note!** If multiple LinkNet™ Modules are used, the Instructions below apply to the composite power output of all Modules when transmitting simultaneously.

- The *Roof Top Antenna or Antennae* for linking to the *Donor Site(s)* is/are directional (high gain) Antennae, fixed-mounted physically on the side or top of a building, or on a tower. The Antenna Gain must be no more than 20 dBi.

**Note!** If multiple LinkNet™ Modules are used with output combiners into any one Antenna, and/or multiple Antennae are used on one Roof Top, then the sum of composite powers into all Roof Top Antennae must not exceed 20 Watts maximum.

- The *Roof Top Antennae* location should be such that only qualified technical personnel can access it, and that under normal operating conditions no other person can touch the antenna, or approach within 10 meters of the antenna.
- The *In-Building Antenna* connection is via a coaxial cable distribution system with signal taps at various points connected to the fixed-mounted *Indoor Antennae*. The *Indoor Antennae* are simple 1/4 wavelength (0 dB Gain) types. They are used with Powerwave Technologies' 12, 16, or 20 dB cable taps. As such the maximum EIRP will be at the first tapped antenna, which will be 12 dB below the maximum signal level of the LinkNet™ (+40 dBm); +28 dBm, or 0.63 Watts EIRP. These antennae are to be installed such that no person can touch the antenna, or approach within 0.2 Meters.

**Note!** If multiple LinkNet™ Modules are used with output combiners, then the composite power output of all Modules transmitting simultaneously must meet this maximum EIRP requirement.

Please consult Powerwave Technologies Inc. for assistance as required.



### **ANTENNA INSTALLATION CAUTION**

ALL ANTENNA INSTALLATION IS TO BE PERFORMED BY QUALIFIED TECHNICAL PERSONNEL ONLY.

ANTENNA INSTALLATION INSTRUCTIONS AND LOCATIONS ARE FOR THE PURPOSE OF SATISFYING FCC RF EXPOSURE COMPLIANCE REQUIREMENTS, AND ARE NOT OPTIONAL.

ALL ROOF TOP ANTENNA INSTALLATION MUST BE SUCH THAT NO PERSON CAN TOUCH THE ANTENNA, OR APPROACH CLOSER THAN 10 METERS.

ALL IN-BUILDING ANTENNAE INSTALLATIONS MUST BE SUCH THAT NO PERSON CAN TOUCH THE ANTENNAE, OR APPROACH CLOSER THAN 0.2 METERS.

## **3.2 FCC Information to Users**

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



### **CAUTION**

CHANGES OR MODIFICATIONS NOT EXPRESSLY APPROVED BY POWERWAVE TECHNOLOGIES INC. COULD VOID THE USER'S AUTHORITY TO OPERATE THE EQUIPMENT.



# **Chapter 4**

## **Return for Service**

### **4 Introduction**

This chapter contains return for service and parts and accessories information for the LNKF100 Modules.

#### **4.1 Return For Service Procedure**

When returning products to Powerwave Technologies Inc., the following procedures will ensure optimum response.

##### **4.1.1 Obtaining An RMA**

A Return Material Authorization (RMA) number must be obtained prior to returning equipment to the factor for service. Please contact our Repair Department at +1 (714) 466-1000 to obtain this number, or FAX your request to +1 (714) 466-5816 or <mailto:RMA@PWAV.COM>. Failure to obtain this RMA number may result in delays in receiving repair service.

##### **4.1.2 Repackaging For Shipment**

To ensure safe shipment of the amplifier, it is recommended that the original package designed for shipping the amplifier be reused. If it is not available, contact Powerwave Technologies Inc. Customer Service Department for packing materials.

#### **4.2 Parts and Accessories**

Parts and Accessories for the LNKF100 Modules may be purchased by contacting Powerwave Technologies Inc. at 1-888-PWR-WAVE. When ordering a replacement part, please provide model number, serial number and software version number.