RXM-315-LR
RXM-418-LR
RXM-433-LR

WIRELESS MADE SIMPLE

LR SERIES RECEIVER MODULE DATA GUIDE

DESCRIPTION

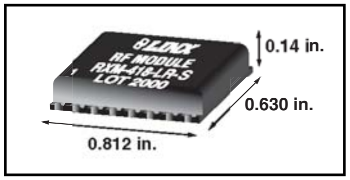


Figure 1: *Physical Dimensions*

The LR Receiver is ideal for the wireless transfer of serial data, control, or command information in the favorable 260-470MHz band. The receiver's advanced synthesized superhet architecture achieves an outstanding typical sensitivity of -112dBm, which provides a 5-10 times improvement in range over previous solutions. When paired with a compatible Linx transmitter, a reliable wireless link is formed, capable of transferring data at rates of up to 10,000bps at distances in excess of 3,000 feet. Applications operating at short distances, or lower data rates will also benefit from increased link reliability and superior noise immunity. Housed in a tiny reflow compatible SMD package, the LR Receiver module is footprint compatible with the popular LC-S Receiver, allowing existing users an instant path to improved range and lower cost. No external components are required (except an antenna), allowing for easy integration, even by engineers without previous RF experience.

FEATURES

- Long-Range
- Low-Cost
- PLL Synthesized Architecture
- Direct Serial Interface
- Data Rates to 10,000 bps
- Qualified Data Output
- No External Components Needed
- Low Power Consumption
- Wide Supply Range (2.7 - 5.2VDC)
- Compact Surface-mount Package
- Wide Temperature Range
- RSSI and Power-Down Functions
- No Production Tuning

APPLICATIONS INCLUDE

- Remote Control
- Keyless Entry
- Garage / Gate Openers
- Lighting Control
- Medical Monitoring / Call Systems
- Remote Industrial Monitoring
- Periodic Data Transfer
- Home / Industrial Automation
- Fire / Security Alarms
- Remote Status / Position Sensing
- Long-Range RFID
- Wire Elimination

ORDERING INFORMATION

PART #	DESCRIPTION
EVAL-***-LR	Basic Evaluation Kit
MDEV-***-LR	Master Development Kit
TXM-315-LR	Transmitter 315 MHz
TXM-418-LR	Transmitter 418 MHz
TXM-433-LR	Transmitter 433 MHz
RXM-315-LR	Receiver 315 MHz
RXM-418-LR	Receiver 418 MHz
RXM-433-LR	Receiver 433 MHz

*** Insert Frequency
Receivers are supplied in tubes of 40 pcs.

Revised 11/26/03

RECEIVER SPECIFICATIONS

Parameter	Designation	Min.	Typical	Max.	Units	Notes
POWER SUPPLY						
Operating Voltage	V_{CC}	2.7	3.0	3.6	V_{DC}	–
With Dropping Resistor		4.3	5.0	5.2	VDC	1,5
Supply Current	I_{CC}	4.0	5.2	7.0	mA	–
Power-down Current	I_{PDN}	20	28	35	µA	5
RECEIVER SECTION						
Receive Frequency Range	F_C					
RXM-315-LR		–	315	–	MHz	–
RXM-418-LR		–	418	–	MHz	–
RXM-433-LR		–	433.92	–	MHz	–
Center Frequency Accuracy	–	-50	–	+50	kHz	–
LO Feedthrough	–	–	-80	–	dBm	2,5
IF	–	–	10.7	–	MHz	5
Noise Bandwidth	N_{3DB}	–	280	–	kHz	–
Data Rate	–	100	–	10,000	bps	–
Data Output						
Logic Low	–	–	0.0	–	VDC	3
Logic High	–	–	3.0	–	VDC	3
Receiver Sensitivity	–	-106	-112	-118	dBm	4
RSSI / Analog:						
Dynamic Range	–	–	80	–	dB	5
Analog Bandwidth	–	50	–	5000	Hz	5
Gain	–	–	16	–	mV/dB	5
Voltage/No Carrier	–	–	1.5	–	V	5
ANTENNA PORT						
RF Input Impedance	R_{IN}	–	50	–	Ω	5
TIMING						
Receiver Turn-On Time:						
Via V_{CC}	–	3.0	7	10.0	mSec	5, 6
Via PDN	–	0.04	0.25	0.5	mSec	5, 6
Max Time Between Transitions	–	–	10	–	mSec	5
ENVIRONMENTAL						
Operating Temperature Range	–	-40	–	+70	°C	5

Table 1: *LR Series Receiver Specifications*

Notes

1. The LR can utilize a 4.3 - 5.2VDC supply provided a 330 ohm resistor is placed in series with V_{CC}.
2. Into a 50 ohm load.
3. When operating from a 5 volt source it is important to consider that the output will swing to well less than 5 volts as a result of the required dropping resistor. Please verify that the minimum voltage will meet the high threshold requirement of the device to which data is being sent.
4. For BER of 10^{-5} at 1200bps.
5. Characterized, but not tested.
6. Time to valid data output.

PERFORMANCE DATA

These performance parameters are based on module operation at 25°C from a 3.0VDC supply unless otherwise noted. Figure 2 at the right illustrates the connections necessary for testing and operation. It is recommended all ground pins be connected to the groundplane. The pins marked NC have no electrical connection.

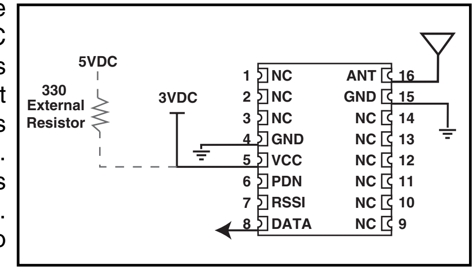


Figure 2: *Test/Basic Application Circuit*

ABSOLUTE MAXIMUM RATINGS

Supply voltage V_{CC}	-0.3	to	+3.6	VDC
Supply voltage V_{CC}, using resistor	-0.3	to	+5.2	VDC
Operating temperature	-30°C	to	+70°C	
Storage temperature	-45°C	to	+85°C	
Soldering temperature	+225°C for 10 seconds			
RF input, Pin 16	0 dBm			
Any input or output Pin	-0.3	to	+3.6	VDC

***NOTE* Exceeding any of the limits of this section may lead to permanent damage to the device. Furthermore, extended operation at these maximum ratings may reduce the life of this device.**

TYPICAL PERFORMANCE GRAPHS

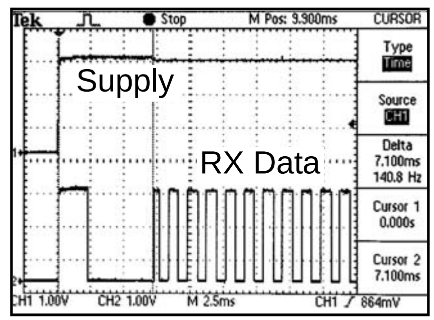


Figure 3: *Turn-On Time From V_{CC}*

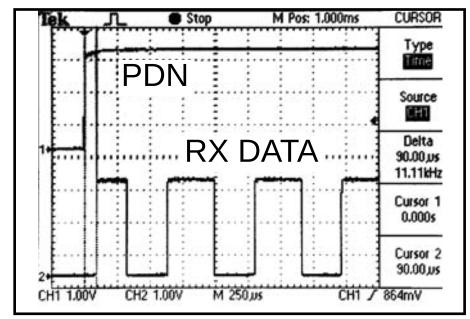


Figure 4: *Turn-On Time From PDN*

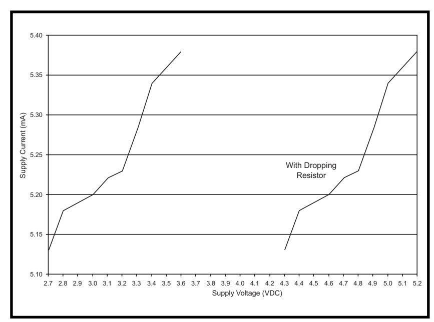


Figure 5: *Consumption VS Supply*

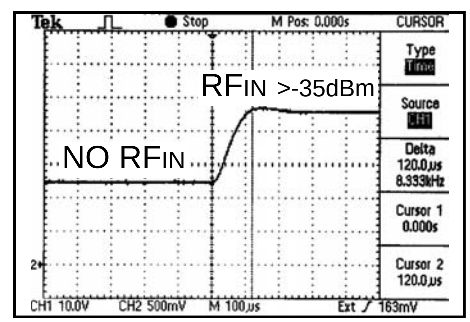


Figure 6: *RSSI Response Time*

PHYSICAL PACKAGING

The receiver is packaged as a hybrid SMD module with sixteen pins spaced 0.100" on center.

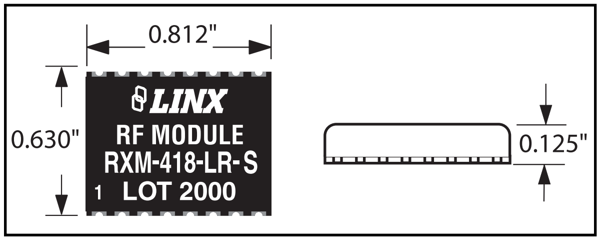


Figure 7: *LR Series Receiver Package Dimensions*

PIN DESCRIPTIONS

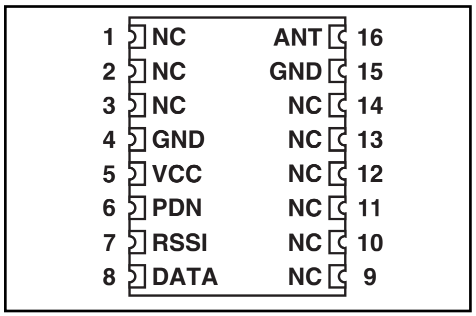


Figure 8: *LR Series Receiver Pinout (Top View)*

Pin Number	Name	Description
1 - 3	N/C	No Connection
4	GND	Analog Ground
5	V_{CC}	Supply Voltage
6	PDN	Power Down
7	RSSI	Received Signal Strength Indicator
8	DATA	Digital Data Output
9 - 14	N/C	No Connection
15	GND	Analog Ground
16	RF IN	50-ohm RF Input

RECEIVER DESCRIPTION

The LR receiver is a low-cost, high-performance synthesized AM/OOK receiver, capable of receiving serial data at up to 10,000 bits/second. Its exceptional sensitivity results in outstanding range performance. The LR's compact surface-mount package is friendly to automated or hand production. LR Series modules are capable of meeting the regulatory requirements of many domestic and international applications.

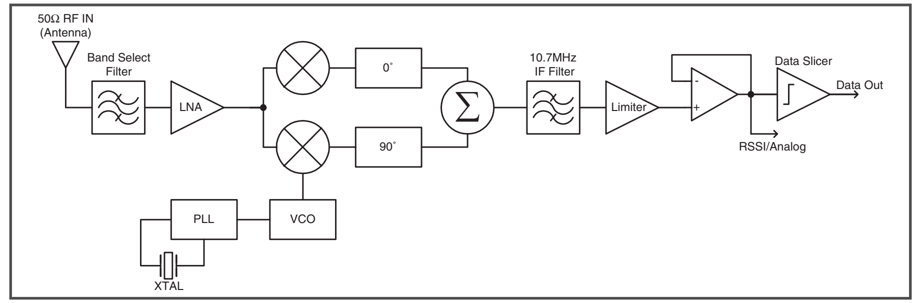


Figure 9: *LR Series Receiver Block Diagram*

THEORY OF OPERATION

The LR receiver is designed to recover data sent by an AM or Carrier-Present Carrier-Absent (CPCA) transmitter also referred to as CW or On-Off Keying (OOK). This type of modulation represents a logic low '0' by the absence of a carrier and a logic high '1' by the presence of a carrier. This modulation method affords numerous benefits. The two most important are: 1) cost-effectiveness due to design simplicity and 2) higher allowable output power and thus greater range in countries (such as the US) that average output power measurements over time. Please refer to Linx application note #00130 for a further discussion of modulation techniques.

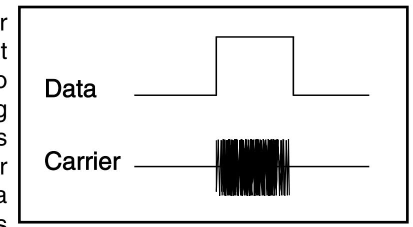


Figure 10: *CPCA (AM) Modulation*

The LR receiver utilizes an advanced single-conversion superheterodyne architecture. Transmitted signals enter the module through a 50-ohm RF port intended for single ended connection to an external antenna. RF signals entering the antenna are bandpass filtered and then amplified by an NMOS cascode Low Noise Amplifier (LNA). The filtered, amplified signal is then down-converted to a 10.7MHz Intermediate Frequency (IF) by mixing it with a low-side Local Oscillator (LO). The LO frequency is generated by a Voltage Controlled Oscillator (VCO) locked by a Phase-Locked Loop (PLL) frequency synthesizer that utilizes a precision crystal reference. The mixer stage incorporates a pair of double balanced mixers and a unique image rejection circuit. This circuit, along with the high IF frequency and ceramic IF filters, reduces susceptibility to interference. The IF frequency is further amplified, filtered, and demodulated to recover the baseband signal originally transmitted. The baseband signal is squared by a data slicer and output to the data pin. The architecture and quality of the components utilized in the LR module enable it to outperform many far more expensive receiver products.

PRODUCTION GUIDELINES

The LR modules are packaged in a hybrid SMD package that supports hand or automated assembly techniques. Since LR modules contain discrete components internally, the assembly procedures are critical to ensuring the reliable function of the LR product. The following procedures should be reviewed with and practiced by all assembly personnel.

PAD LAYOUT

The following pad layout diagram is designed to facilitate both hand and automated assembly .

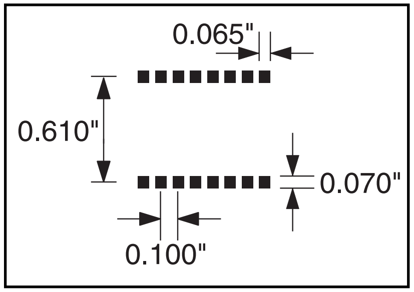


Figure 11: *LR-RX Pad Layout*

RECEIVER HAND ASSEMBLY

The LR receiver's primary mounting surface is sixteen pads located on the bottom of the module. Since these pads are inaccessible during mounting, castellations that run up the side of the module have been provided to facilitate solder wicking to the module's underside. This allows for very quick hand soldering for prototyping and small volume production.

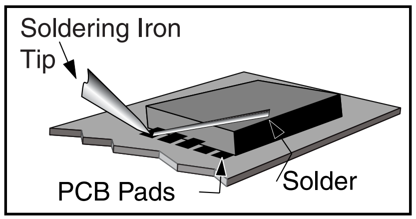


Figure 12: *LR-RX Soldering Technique*

If the recommended pad guidelines have been followed, the pads will protrude slightly past the edge of the module. Use a fine soldering tip to heat the board pad and the castellation, then introduce solder to the pad at the module's edge. The solder will wick underneath the module providing reliable attachment. Tack one module corner first and then work around the device taking care not to exceed the times listed below.

Absolute Maximum Solder Times

Hand-Solder Temp. TX +225°C for 10 Seconds
Hand-Solder Temp. RX +225°C for 10 Seconds
Recommended Solder Melting Point +180°C
Reflow Oven: +220°C Max. (See adjoining diagram)

AUTOMATED ASSEMBLY

For high-volume assembly most users will want to auto-place the modules. The modules have been designed to maintain compatibility with reflow processing techniques, however, due to the their hybrid nature certain aspects of the assembly process are far more critical than for other component types.

Following are brief discussions of the three primary areas where caution must be observed.

Reflow Temperature Profile

The single most critical stage in the automated assembly process is the reflow process. The reflow profile below should be closely followed since excessive temperatures or transport times during reflow will irreparably damage the modules. Assembly personnel will need to pay careful attention to the oven's profile to ensure that it meets the requirements necessary to successfully reflow all components while still meeting the limits mandated by the modules themselves.

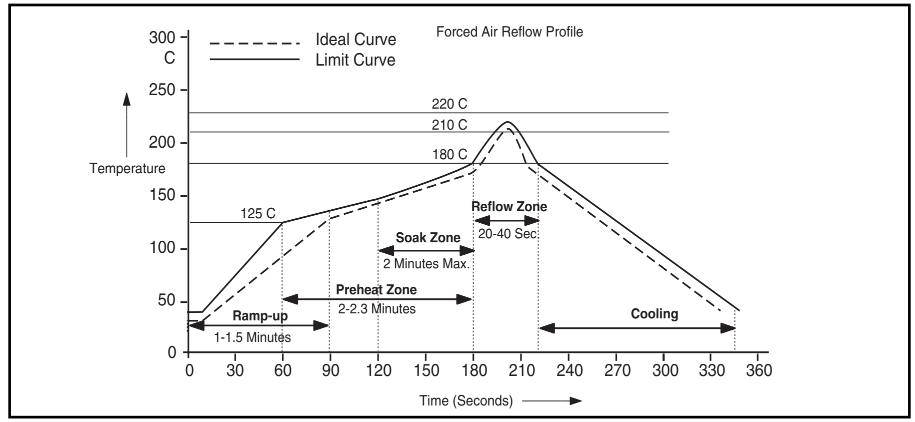


Figure 13: *Required Reflow Profile*

Shock During Reflow Transport

Since some internal module components may reflow along with the components placed on the board being assembled, it is imperative that the modules not be subjected to shock or vibration during the time solder is liquid.

Washability

The modules are wash resistant, but are not hermetically sealed. Linx recommends wash-free manufacturing, however, the modules can be subjected to a wash cycle provided that a drying time is allowed prior to applying electrical power to the modules. The drying time should be sufficient to allow any moisture that may have migrated into the module to evaporate, thus eliminating the potential for shorting damage during power-up or testing. If the wash contains contaminants, the receiver performance may be adversely affected, even after drying.

POWER SUPPLY REQUIREMENTS

The LR receiver module does not have an internal voltage regulator, therefore it requires a clean, well-regulated power source. While it is preferable to power the unit from a battery, the unit can also be operated from a power supply as long as noise and 'hash' are less than 20mV. Power supply noise will manifest itself as AM and FM noise and can significantly affect the receiver sensitivity, therefore, providing a clean power supply for the module should be a high design priority.

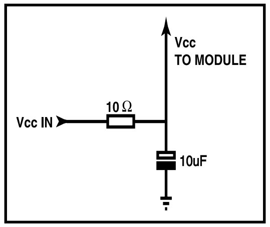


Figure 14: *Supply Filter*

A 10Ω resistor in series with the supply followed by a 10μF tantalum capacitor from V_{CC} to ground will help in cases where the quality of supply power is poor. Note that operation from 4.3 to 5.2 volts requires the use of an external 330Ω resistor placed in-line with the supply to prevent V_{CC} from exceeding 3.6 volts.

USING THE PDN PIN

The receiver's Power Down (PDN) pin can be used to power the receiver down without the need for an external switch. The PDN pin has an internal pull-up, so when the PDN pin is held high or simply left floating the module will be active.

When the PDN pin is pulled to ground the receiver will enter into a low-current (<40μA) power-down mode. During this time the receiver is off and cannot perform any function. It may be useful to note that the startup time coming out of power-down will be slightly less than when applying Vcc.

The PDN pin allows easy control of the receiver state from external components such as a microcontroller. By periodically activating the receiver, checking for data, then powering down, the receiver's average current consumption can be greatly reduced, saving power in battery operated applications.

Note: The voltage on the PDN pin should not exceed 3.6V. When using with a higher voltage control source, such as a 5V microcontroller, an open collector line should be used if available. As an alternative, a diode may be placed in series with the control line. Either of these methods will prevent damage to the module by preventing 5V from being placed on the PDN pin while still allowing the line to be pulled to ground.

USING THE RSSI PIN

The receiver's Received Signal Strength Indicator (RSSI) pin serves a variety of uses. This pin has a dynamic range of 80dB (typical) and outputs a voltage proportional to the incoming signal strength. A graph of the RSSI pin's characteristics appears on Page 4 of this manual. It should be realized that the RSSI levels and dynamic range will vary slightly from part to part. It is also important to remember that RSSI output indicates the strength of any in-band RF energy and not necessarily just that from the intended transmitter, therefore, it should be used only to qualify the level and presence of a signal.

The RSSI output can be utilized during testing or even as a product feature to assess interference and channel quality by looking at the RSSI level with all intended transmitters shut off. The RSSI output can also be used in direction-finding applications although there are many potential perils to consider in such systems. Finally, the RSSI pin can be used to save system power by "waking up" external circuitry when a transmission is received or crosses a certain threshold. The RSSI output feature adds tremendous versatility for the creative designer.

THE DATA OUTPUT

A CMOS-compatible data output is available on Pin 8. This output is normally used to directly drive a digital decoder IC or a microprocessor that is performing the data decoding. The receiver's output is internally qualified, meaning that it will only transition when valid data is present. In instances where no carrier is present the output will remain low. Likewise, when the carrier is detected the output will go high.

The data output line can be directly connected to a digital IC or microprocessor that will register the data and perform some function. In addition, the module can be connected to an RS232 level converter chip, like the MAX232, or to a Linx USB module for interfacing with a PC. The LR Series modules can also be used with standard UARTs. Since a UART utilizes high marking to indicate the absence of data, a designer using a UART may wish to insert a logic inverter between the data output of the LR receiver and the UART.

RECEIVING DATA

Once a reliable RF link has been established, the challenge becomes how to effectively transfer data across it. While a properly designed RF link provides reliable data transfer under most conditions, there are still distinct differences from a wired link that must be addressed. Since the LR modules do not incorporate internal coding/decoding, a user has tremendous flexibility in how data is handled.

It is always important to separate what type of transmissions are technically possible from those that are legally allowable in the country of intended operation. You may wish to review application notes #00125 and #00140 along with Part 15 Section 231 for further details on acceptable transmission content.

If you want to transfer simple control or status signals such as button presses or switch closures, and your product does not have a microprocessor on board or you wish to avoid protocol development, consider using an encoder and decoder IC set. These chips are available from a wide range of manufacturers including Linx, Microchip, Holtek, and Motorola. These chips take care of all encoding and decoding functions and generally provide a number of data pins to which switches can be directly connected. In addition, address bits are usually provided for security and to allow the addressing of multiple receivers independently. These ICs are an excellent way to bring basic remote control/status products quickly and inexpensively to market. Additionally, it is a simple task to interface with inexpensive microprocessors such as the Microchip PIC or one of many IR, remote control, DTMF, and modem IC's.

While the LR is ideally suited to the long range transfer of control and command information it can also be used with great success for the transfer of true variable data such as temperature, pressure, or sensor data. However, the 260 - 470MHz band in which the receiver operates is tightly regulated by Part 15 Section 231. Many types of transmissions, especially those involving automatic transmissions or variable data are required to be periodic. A careful review of these requirements should be made prior to development. Application Note #00125 discusses these requirements in more detail.

Another area of consideration is that of data structure or protocol. If you are not familiar with the considerations for sending serial data in a wireless environment you will want to review Linx application note #00232.

PROTOCOL GUIDELINES

While many RF solutions impose data formatting and balancing requirements, the LR Series does not encode or packetize the signal content in any manner. Naturally the received signal will be affected by such factors as noise, edge jitter, and interference but it is not purposefully manipulated or altered by the modules. This gives the designer tremendous flexibility for protocol design and interface.

Despite this transparency and ease of use it must be recognized that there are distinct differences between a wired and a wireless environment. Issues such as interference and contention must be understood and allowed for in the design process. To learn more about protocol considerations for the LR series we suggest you read Linx application note #00232.

Errors from interference or changing signal conditions can cause corruption of the data packet, so it is generally wise to structure the data being sent into small packets. This allows errors to be managed without affecting large amounts of data. A simple checksum or CRC could be used for basic error detection Once an error is detected the protocol designer may wish to simply discard the corrupt data or implement a more sophisticated scheme to correct it.

INTERFERENCE CONSIDERATIONS

The RF spectrum is crowded and the potential for conflict with other unwanted sources of RF is very real. While all RF products are at risk from interference its effects can be minimized by better understanding its characteristics.

Interference may come from internal or external sources. The designer's first responsibility is to eliminate interference from sources under their control. This means paying careful attention to layout, grounding, filtering and bypassing in order to eliminate all radiated and conducted interference paths. For many products this is straightforward, however, products containing components such as switching power supplies, motors, crystals, and other potential sources of noise must be approached with care. Comparing your own design with a Linx evaluation board can help to determine if and at what level design-specific interference is present.

External interference can manifest itself in a variety of ways. Low-level interference will produce noise and hashing on the output and reduce the link's overall range.

High-level interference is caused by products sharing the same frequency in proximity or from near-band high-power devices. It can even come from your own products if more than one transmitter is active in proximity. It is always important to remember that only one transmitter at a time can occupy a frequency regardless of the coding of the transmitted signal. In most instances, this type of interference is less common than those mentioned previously, but in severe cases it can prevent all useful function of the affected device.

Although technically it is not interference, multipath is also a factor to be understood. Multipath is a term used to refer to the signal cancellation effects that occur when RF waves arrive at the receiver in different phase relationships. This effect is a particularly significant factor in interior environments where objects provide many different signal reflection paths. Multipath cancellation results in lowered signal levels at the receiver and, thus, shorter useful distances for the link.

TYPICAL APPLICATIONS

Figure 15 shows a circuit using the Linx LICAL-DEC-LS001 decoder chip. This chip works with the LICAL-ENC-LS001 encoder chip to provide simple remote control capabilities. The decoder will detect the transmission from the encoder, check for errors, and if everything is correct, the encoder's inputs will be replicated on the decoder's outputs. This makes registering keypresses very simple.

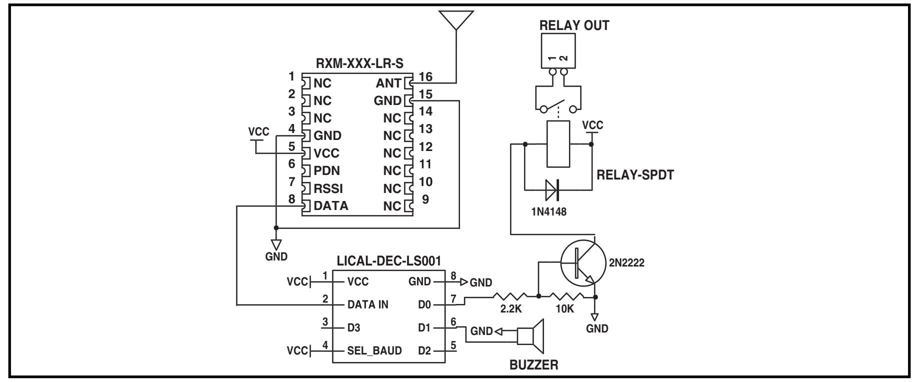


Figure 15: LR Receiver and LS Decoder

Figure 16 shows a typical RS232 circuit using the LR receiver and a Maxim MAX232 chip. The LR will output a serial data stream and the MAX232 will convert that to RS232 compliant signals.

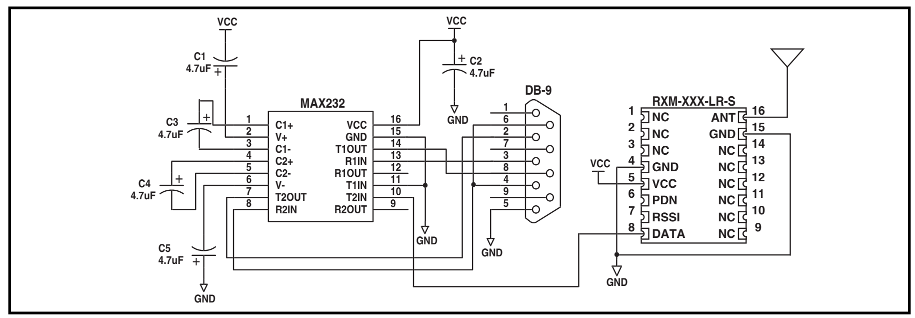


Figure 16: LR Receiver and MAX232 IC

Figure 17 shows an example of using the LR receiver with a Linx SDM-USB-QS-S USB module. The LR will output a serial data stream and the USB module will convert that to low speed USB compliant signals.

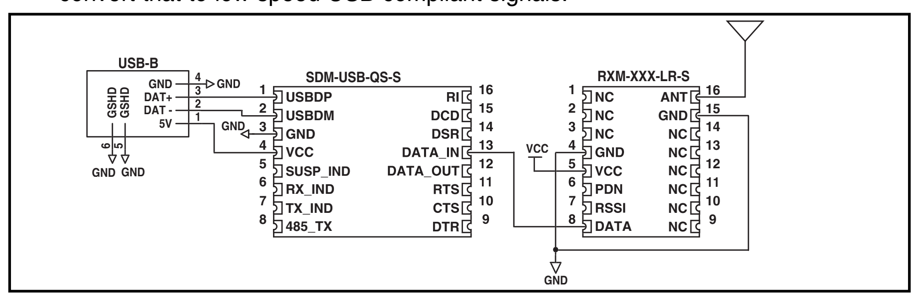


Figure 17: LR Receiver and Linx USB Module

BOARD LAYOUT CONSIDERATIONS

If you are at all familiar with RF devices you may be concerned about specialized board layout requirements. Fortunately, because of the care taken by Linx in designing the LR series, integrating an LR receiver is very straightforward. Despite this ease of application it is still necessary to maintain respect for the RF stage and exercise appropriate care in layout and application in order to maximize performance and ensure reliable operation. The antenna can also be influenced by layout choices. Please review this manual in its entirety prior to beginning your design. By adhering to good layout principles and observing some basic design rules you well along on the path to RF success.

Figure 18 shows the suggested PCB footprint for the LR Series receiver. The actual pad dimensions are shown on page 6. A groundplane (as large as possible) should be placed on a lower layer of your PC board opposite the LR receiver. This groundplane can also be critical to the performance of your antenna, which will be discussed later in the manual.

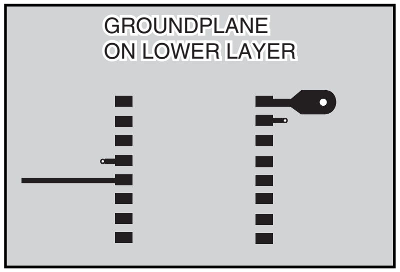


Figure 18: *Suggested PCB Layout*

During prototyping, the module should be soldered to a properly laid-out circuit board. The use of prototyping or "perf" boards is strongly discouraged.

No conductive items should be placed within 0.15in. of the module's top or sides.

Do not route PCB traces directly under the module. The underside of the module has numerous signal-bearing traces and vias which could short or couple to traces on the product's circuit board.

AM/OOK receivers are particularly subject to noise. The LR receiver module should, as much as reasonably possible, be isolated from other components on your PCB, especially high-frequency circuitry such as crystal oscillators, switching power supplies and high-speed bus lines. Make sure internal wiring is routed away from the module and antenna, and is secured to prevent displacement.

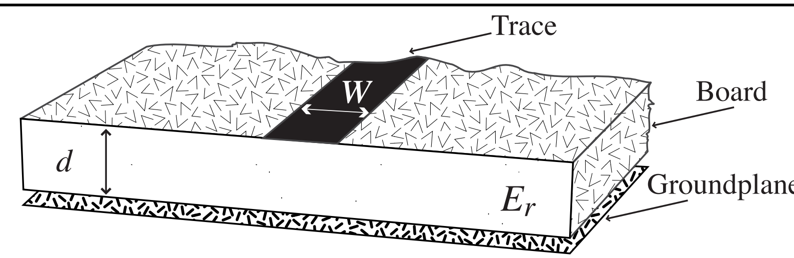
The power-supply filter components should be placed close to the module's Vcc line.

The trace from the module to the antenna should be kept as short as possible. A simple trace is suitable for runs up to 1/8 inch for antennas with wide bandwidth characteristics. For longer runs or to avoid detuning narrow bandwidth antennas, such as a helical, use a 50-ohm coax or 50-ohm microstrip transmission line as described in the following section.

In some instances, a designer may wish to encapsulate or "pot" the product. Many Linx customers have done this successfully; however, there are a wide variety of potting compounds with varying dielectric properties. Since such compounds can considerably impact RF performance it is the responsibility of the designer to carefully evaluate and qualify the impact and suitability of such materials.

MICROSTRIP DETAILS

A transmission line is a medium whereby RF energy is transferred from one place to another with minimal loss. This is a critical factor, especially in high-frequency products like the LR, because the trace leading to the module's antenna can effectively contribute to the length of the antenna, changing its resonant bandwidth. In order to minimize loss and detuning, some form of transmission line between the antenna and the module should be used, unless the antenna connection can be made very close proximity, <1/8in. from the module. One common form of transmission line is a coax cable, another is the Microstrip. This term refers to a PCB trace running over a groundplane that is designed to serve as a transmission line between the module and the antenna. The width is based on the desired characteristic impedance of the line, the thickness of the PCB, and the dielectric constant of the board material. For standard 0.062in thick FR-4 board material, the trace width would be 111 mils. The correct trace width can be calculated for other widths and materials using the information below. Handy software for calculating microstrip lines is also available on the Linx website (www.linxtechnologies.com).



$$E_e = \frac{E_r+1}{2} + \frac{E_r-1}{2} \cdot \frac{1}{\sqrt{1+12d/W}}$$

$$Z_0 = \begin{cases} \dfrac{60}{\sqrt{E_e}} \cdot ln\left(\dfrac{8d}{W} + \dfrac{W}{4d}\right) & \text{For } \dfrac{W}{d} \le 1 \\ \dfrac{120\pi}{\sqrt{E_e} \cdot \left(\dfrac{W}{d} + 1.393 + 0.667 \cdot ln\left(\dfrac{W}{d} + 1.444\right)\right)} & \text{For } \dfrac{W}{d} \ge 1 \end{cases}$$

E_r = Dielectric constant of PCB material

Figure 19: *Microstrip Formulas (Er = dielectric constant of PC board material)*

Dielectric Constant	Width/Height (W/d)	Effective Dielectric Constant	Characteristic Impedance
4.8	1.8	3.59	50.0
4	2	3.07	51.0
2.55	3	2.12	48.0

GENERAL ANTENNA RULES

The following general rules should help in maximizing antenna performance:

1. Proximity to objects such as a user's hand or body, or metal objects will cause an antenna to detune. For this reason the antenna shaft and tip should be positioned as far away from such objects as possible.
2. Optimum performance will be obtained from a 1/4- or 1/2-wave straight whip mounted at a right angle to the groundplane. In many cases this isn't desirable for practical or ergonomic reasons, thus, an alternative antenna style such as a helical, loop, patch, or base-loaded whip may be utilized and the corresponding sacrifice in performance accepted.

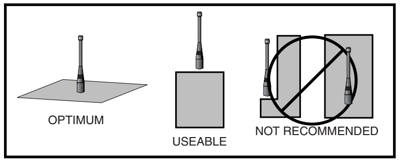


Figure 20: *Groundplane Orientation*

3. If an internal antenna is to be used, keep it away from other metal components, particularly large items like transformers, batteries, and PCB tracks and groundplanes. In many cases, the space around the antenna is as important as the antenna itself. Objects in close proximity to the antenna can cause direct detuning, while those farther away will alter the antenna's symmetry.
4. In many antenna designs, particularly 1/4-wave whips, the groundplane acts as a counterpoise, forming, in essence, a 1/2-wave dipole. For this reason adequate groundplane area is essential. The groundplane can be a metal case or ground-fill areas on a circuit board. Ideally, it should have a surface area $\geq$ the overall length of the 1/4-wave radiating element. This is often not practical due to size and configuration constraints. In these instances a designer must make the best use of the area available to create as much groundplane in proximity to the base of the antenna as possible. When the antenna is remotely located or the antenna is not in close proximity to a circuit board plane or grounded metal case or a small metal plate may be fabricated to maximize antenna performance.

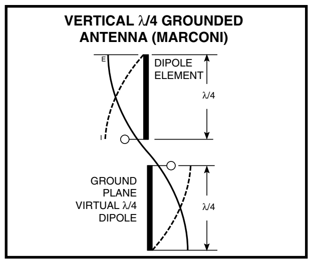


Figure 21: *Dipole Antenna*

5. Remove the antenna as far as possible from potential interference sources. Any frequency of sufficient amplitude to enter the receiver's front end will reduce system range and can even prevent reception entirely. Switching power supplies, oscillators, even relays can also be significant sources of potential interference. The single best weapon against such problems is attention to placement and layout. Filter the module's power supply with a high-frequency bypass capacitor. Place adequate groundplane under potential sources of noise. Shield noisy board areas whenever practical.
6. In some applications it is advantageous to place the module and its antenna away from the main equipment. This avoids interference problems and allows the antenna to be oriented for optimum RF performance. Always use 50Ω coax, such as RG-174, for the remote feed.

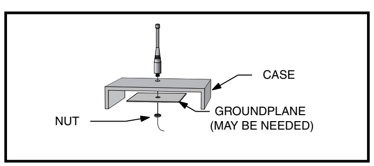


Figure 22: *Remote Groundplane*

RECEIVER ANTENNA CONSIDERATIONS

The choice of antennas is a critical and often overlooked design consideration. The range, performance, and legality of an RF link is vitally dependent upon the antenna. While adequate antenna performance can often be obtained by trial and error methods, antenna design and matching is a complex task. A professionally designed antenna, such as those offered by Linx, will help ensure maximum performance and Part 15 compliance.

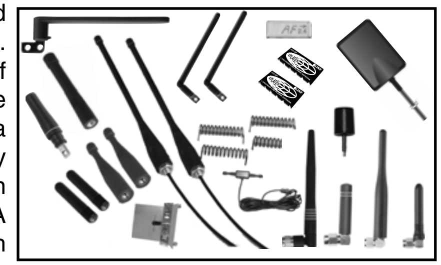


Figure 23: *Linx Antennas*

A receiver antenna should be optimized for the frequency or band in which the receiver operates and minimize the reception of off-frequency signals. The efficiency of the receiver's antenna is critical to maximizing range-performance. Unlike the transmitter antenna, where legal operation may mandate attenuation or a reduction in antenna efficiency, the receiver's antenna should be optimized as much as is practical.

It is usually best to utilize a basic quarter-wave whip until your prototype product is operating satisfactorily. Then other antennas can be evaluated based on the the cost, size and cosmetic requirements of the product. You may also wish to review application note #00500 "Antennas: Design, Application, Performance".

ANTENNA SHARING

In cases where a transmitter and receiver module are combined to form a transceiver it is often advantageous to share a single antenna. To accomplish this an antenna switch must be used to provide isolation between the modules so that the full transmitter output power is not put on the sensitive front end of the receiver. There is a wide variety of antenna switches available which are cost-effective and straight-forward to use. Among the most popular are switches from Alpha and NEC.

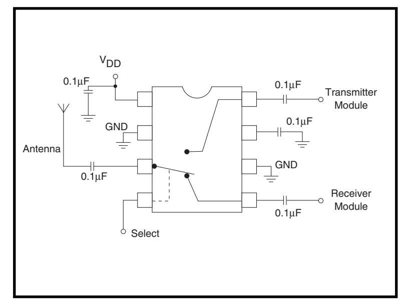


Figure 24: *Typical Antenna Switch*

Look for an antenna switch that has high isolation and low loss at the desired frequency of operation. Generally, the TX or RX status of a switch will be controlled by a product's microprocessor, but selection may also be made manually by the user. In some cases where the characteristics of the TX and RX antennas need to be different or switch losses are unacceptable it may be more appropriate to utilize two discrete antennas.

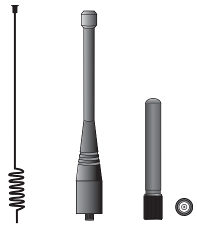
CONNECTOR OPTIONS

The FCC requires that antennas designed for use on Part 15 products be either permanently attached or utilize a unique and proprietary connector not available to the general public. In cases where the antenna needs to be removable, Linx offers a full line of connectors designed to comply with these requirements.

COMMON ANTENNA STYLES

There are literally hundreds of antenna styles and variations that can be employed with the LR receiver. Following is a brief discussion of the styles most commonly utilized. Additional antenna information can be found in Linx application notes #00500, #00100, #00125 and #00140. Linx also offers a broad line of antennas and connectors which offer outstanding performance and cost-effectiveness.

Whip Style



1/4-wave wire lengths for LC frequencies:
315Mhz=8.9"
418Mhz=6.7"
433Mhz=6.5"

A whip-style antenna provides outstanding overall performance and stability. A low-cost whip is can be easily fabricated from a wire or rod, but most designers opt for the consistent performance and cosmetic appeal of a professionally made model. To meet this need, Linx offers a wide variety of straight and reduced height whip-style antennas in permanent and connectorized mounting styles.

The wavelength of the operational frequency determines an antenna's overall length. Since a full wavelength is often quite long, a partial 1/2- or 1/4-wave antenna is normally employed. Its size and natural radiation resistance make it well matched to Linx modules. The proper length for a straight 1/4-wave can be easily determined using the formula below. It is also possible to reduce the overall height of the antenna by using a helical winding. This reduces the antenna's bandwidth, but is a great way to minimize the antenna's physical size for compact applications. This also means that the physical appearance is not always an indicator of the antenna's frequency.

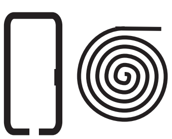
$$L = \frac{234}{F_{MHz}}$$

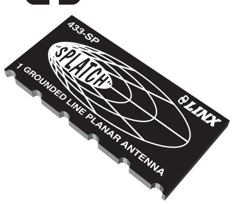
Where:
L=length in feet of quarter-wave length
F=operating frequency in megahertz

Specialty Styles

Linx offers a wide variety of specialized antenna styles and variations. Many of these styles utilize helical elements to reduce the overall antenna size while maintaining reasonable performance. A helical antenna's bandwidth is often quite narrow and the antenna can detune in proximity to other objects, so care must be exercised in layout and placement.

Loop Style





A loop- or trace-style antenna is normally printed directly on a product's PCB. This makes it the most cost-effective of antenna styles. The element can be made self-resonant or externally resonated with discrete components but its actual layout is usually product specific. Despite its cost advantages, PCB antenna styles are generally inefficient and useful only for short-range applications. Loop-style antennas are also very sensitive to changes in layout or substrate dielectric which can introduce consistency issues into the production process. In addition, printed styles initially are difficult to engineer, requiring the use of expensive equipment including a network analyzer. An improperly designed loop will have a high SWR at the desired frequency which can introduce instability in the RF stages.

Linx offers low-cost planar and chip antennas which mount directly to a product's PCB. These tiny antennas do not require testing and provide excellent performance in light of their compact size. They offer a preferable alternative to the often problematic "printed" antenna.

ON-LINE RESOURCES

LINX TECHNOLOGIES

www.linxtechnologies.com

- **Latest News**
- **Data Guides**
- **Application Notes**
- **Knowledge Base**
- **Software Updates**

If you have questions regarding any Linx product and have Internet access, make www.linxtechnologies.com your first stop. Our website is organized in an intuitive format to give you the answers you need in record time. Day or night, the Linx website gives you instant access to the latest information regarding the products and services of Linx. It's all here: manual and software updates, application notes, a comprehensive knowledge base, FCC information and much more. Be sure to visit often!

ANTENNA FACTOR

www.antennafactor.com

The Antenna Factor division of Linx offers a diverse array of antenna styles, many of which are optimized for use with our RF modules. From innovative embeddable antennas to low-cost whips, domes to yagi's, and even GPS, Antenna Factor likely offers or can design an antenna to meet your requirements.

CONNECTOR CITY
THE VALUE OF CONNECTIONS

www.connectorcity.com

Through its Connector City division, Linx offers a wide selection of high-quality RF connectors, including FCC-compliant types such as RP-SMAs that are an ideal match for our modules and antennas. Connector City focuses on high-volume OEM requirements, which allows standard and custom RF connectors to be offered at a remarkably low cost.

LEGAL CONSIDERATIONS

NOTE: LR Series modules are designed as component devices which require external components to function. The modules are intended to allow for full Part 15 compliance, however, they are not approved by the FCC or any other agency worldwide. The purchaser understands that approvals may be required prior to the sale or operation of the device, and agrees to utilize the component in keeping with all laws governing its use in the country of operation.

When working with RF, a clear distinction must be made between what is technically possible and what is legally acceptable in the country where operation is intended. Many manufacturers have avoided incorporating RF into their products as a result of uncertainty and even fear of the approval and certification process. Here at Linx our desire is not only to expedite the design process, but also to assist you in achieving a clear idea of what is involved in obtaining the necessary approvals to legally market your completed product.

In the United States the approval process is actually quite straightforward. The regulations governing RF devices and the enforcement of them are the responsibility of the Federal Communications Commission. The regulations are contained in the Code of Federal Regulations (CFR), Title 47. Title 47 is made up of numerous volumes, however, all regulations applicable to this module are contained in volume 0-19. It is strongly recommended that a copy be obtained from the Government Printing Office in Washington, or from your local government book store. Excerpts of applicable sections are included with Linx evaluation kits or may be obtained from the Linx Technologies web site (www.linxtechnologies.com). In brief, these rules require that any device which intentionally radiates RF energy be approved, that is, tested, for compliance and issued a unique identification number. This is a relatively painless process. Linx offers full EMC pre-compliance testing in our HP/Emco-equipped test center. Final compliance testing is then performed by one of the many independent testing laboratories across the country. Many labs can also provide other certifications the product may require at the same time, such as UL, CLASS A/B, etc. Once your completed product has passed, you will be issued an ID number which is then clearly placed on each product manufactured.

Questions regarding interpretations of the Part 2 and Part 15 rules or measurement procedures used to test intentional radiators, such as the LR modules, for compliance with the Part 15 technical standards, should be addressed to:

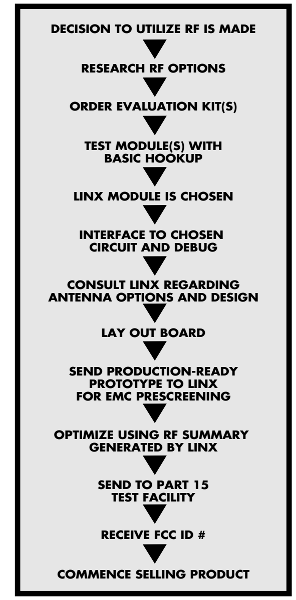
Federal Communications Commission
Equipment Authorization Division
Customer Service Branch, MS 1300F2
7435 Oakland Mills Road
Columbia, MD 21046
Tel: (301) 725-1585 / Fax: (301) 344-2050 E-Mail: labinfo@fcc.gov

International approvals are slightly more complex, although many modules are designed to allow all international standards to be met. If you are considering the export of your product abroad, you should contact Linx Technologies to determine the specific suitability of the module to your application.

All Linx modules are designed with the approval process in mind and thus much of the frustration that is typically experienced with a discrete design is eliminated. Approval is still dependent on many factors such as the choice of antennas, correct use of the frequency selected, and physical packaging. While some extra cost and design effort are required to address these issues, the additional usefulness and profitability added to a product by RF makes the effort more than worthwhile.

ACHIEVING A SUCCESSFUL RF IMPLEMENTATION

Adding an RF stage brings an exciting new dimension to any product. It also means that additional effort and commitment will be needed to bring the product successfully to market. By utilizing premade RF modules, such as the LR series, the design and approval process will be greatly simplified. It is still important, however, to have an objective view of the steps necessary to ensure a successful RF integration. Since the capabilities of each customer vary widely it is difficult to recommend one particular design path, but most projects follow steps similar to those shown at the right.



TYPICAL STEPS FOR IMPLEMENTING RF

In reviewing this sample design path you may notice that Linx offers a variety of services, such as antenna design and FCC prequalification, that are unusual for a high-volume component manufacturer. These services, along with an exceptional level of technical support, are offered because we recognize that RF is a complex science requiring the highest caliber of products and support. “Wireless Made Simple” is more than just a motto, it’s our commitment. By choosing Linx as your RF partner and taking advantage of the resources we offer, you will not only survive implementing RF, you may even find the process enjoyable.

HELPFUL APPLICATION NOTES FROM LINX

It is not the intention of this manual to address in depth many of the issues that should be considered to ensure that the modules function correctly and deliver the maximum possible performance. As you proceed with your design you may wish to obtain one or more of the following application notes, which address in depth key areas of RF design and application of Linx products.These applications notes are available on-line at www.linxtechnologies.com or by contacting the Linx literature department.

NOTE #	LINX APPLICATION NOTE TITLE
00100	RF 101: Information For The RF Challenged
00125	Considerations For Operation In The 260MHz to 470MHz Band
00130	Modulation Techniques For Low-Cost RF Data Links
00140	The FCC Road: Part 15 From Concept To Approval
00150	Use And Design Of T-Attenuation Pads
00232	General Considerations For Sending Data With The LC Series
00500	Antennas: Design, Application, And Performance

U.S. CORPORATE HEADQUARTERS:

LINX TECHNOLOGIES, INC.
575 S.E. ASHLEY PLACE
GRANTS PASS, OR 97526

Phone: (541) 471-6256
FAX: (541) 471-6251
http://www.linxtechnologies.com

Disclaimer

Linx Technologies is continually striving to improve the quality and function of its products. For this reason, we reserve the right to make changes without notice. The information contained in this Data Sheet is believed to be accurate as of the time of publication. Specifications are based on representative lot samples. Values may vary from lot to lot and are not guaranteed. Linx Technologies makes no guarantee, warranty, or representation regarding the suitability of any product for use in a specific application. None of these devices is intended for use in applications of a critical nature where the safety of life or property is at risk. The user assumes full liability for the use of product in such applications. Under no conditions will Linx Technologies be responsible for losses arising from the use or failure of the device in any application, other than the repair, replacement, or refund limited to the original product purchase price. Some devices described in this publication are patented. Under no circumstances shall any user be conveyed any license or right to the use or ownership of these patents.