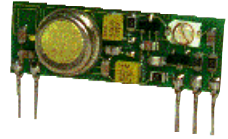




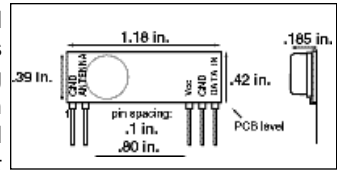
HIGH PERFORMANCE  
RF MODULE  
TXM-418/433-RM



## RM SERIES TRANSMITTER MODULE DATA GUIDE

### DESCRIPTION:

The LINX TXM-XXX-RM Series is an advanced ultra-compact SAW-based transmitter module. When paired with a Linx Technologies RM Series receiver, the units create a highly reliable link capable of transferring analogue or high-speed digital data at distances in excess of 500 ft. Like all Linx modules, the RM Series needs no production tuning or adjustment and requires no external RF components (except an antenna). Observing simple design rules, the module is easily integrated even by engineers lacking previous RF experience.



*Physical Outline*

### FEATURE HIGHLIGHTS:

- Compact SIP-style mounting
- No production tuning or setup
- Direct analog or digital input
- Precision SAW-stabilized FM/FSK modulation
- Supports high data rates (up to 10 Kbps)
- Wide supply range (5.9-9 vDC)
- Low power consumption (6mA Typical)
- Wide operating temperature range

### APPLICATIONS INCLUDE:

- Remote Control / Access Control
- Remote Monitoring / Telemetry
- Medical Alert
- Remote Industrial Process Monitoring
- Periodic Data Transfer
- Lighting Control
- Garage/Gate Openers
- Security / Fire Alarms
- Wire Elimination

### ORDERING INFORMATION

PART #	DESCRIPTION
MDEV-418-RM	Evaluation Kit 418 MHz
TXM-418-RM-**	Transmitter 418 MHz
RXM-418-RM-**	Receiver 418 MHz
MDEV-433-RM	Evaluation Kit 433 MHz
TXM-433-RM-**	Transmitter 433 MHz
RXM-433-RM-**	Receiver 433 MHz

\*\* Insert TB for Tube Packaging

## MODULE DESCRIPTION

The RM Series is a SAW-(Surface Acoustic Wave) based transmitter designed to be utilized in combination with a matching RM Series receiver. By adding a simple antenna, the pair can transfer serial data at distances well in excess of 500 feet. The range of the RF link is widely variable and depends upon many factors including the type of antenna employed and the operating environment. The 500 ft. quoted range is a conservative operating distance over open ground using 1/4-whip antennae at both ends of the link at 5 feet above the ground. Use of a less efficient antenna or adverse environmental factors such as interference, obstacles, or multipath can substantially reduce the link's reliable working range. Slowing the data rate or utilizing a directional antenna (especially on the receiver) can provide increased performance but may not comply with licensing requirements. It is recommended that your individual application be reviewed with Linx prior to entering production or seeking approvals.

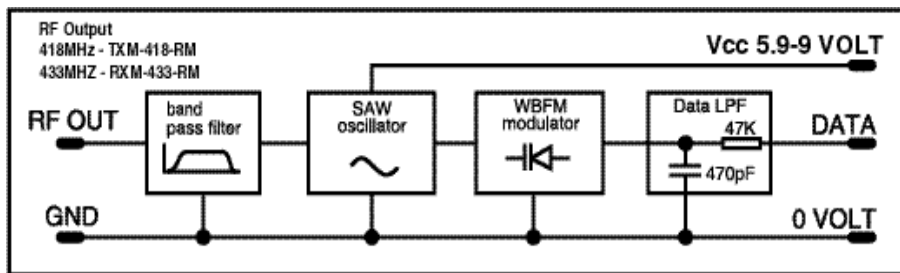


figure 1: LINX-TX block diagram

## THE SAW BASED DESIGN ADVANTAGE

The SAW (Surface Acoustic Wave) device provides a highly accurate frequency source with excellent immunity to frequency shift due to age or temperature. By using a SAW to insure accurate frequency control on the transmitter module the receiver's pass opening can be quite narrow, resulting in outstanding sensitivity and greater immunity to interfering signals. In order to frequency modulate this carrier the SAW is externally pulled to obtain the necessary deviation.

By employing a SAW on both the RM transmitter and receiver the units provide an excellent performance rivaling far more complex and costly systems. The SAW device, in combination with advanced design and manufacturing techniques, has made it possible to dramatically reduce the size and cost of an RF link while enhancing its performance. The end user benefits from improved product range and reliability and the OEM manufacturer from lower cost and simpler manufacturing procedures.

## PHYSICAL PACKAGING

The transmitter is packaged as a hybrid SIP module with five pins spaced 0.1 in. on center. The SIP package allows easy accommodation of both horizontal and vertical mounting requirements into a highly compact package. Its leaded design allows for easy prototyping and simple integration into through-hole and surface-mount designs. If the module will be bent and laid flush on the circuit board, a pad of silicon or other adhesive should be used to hold it in place.

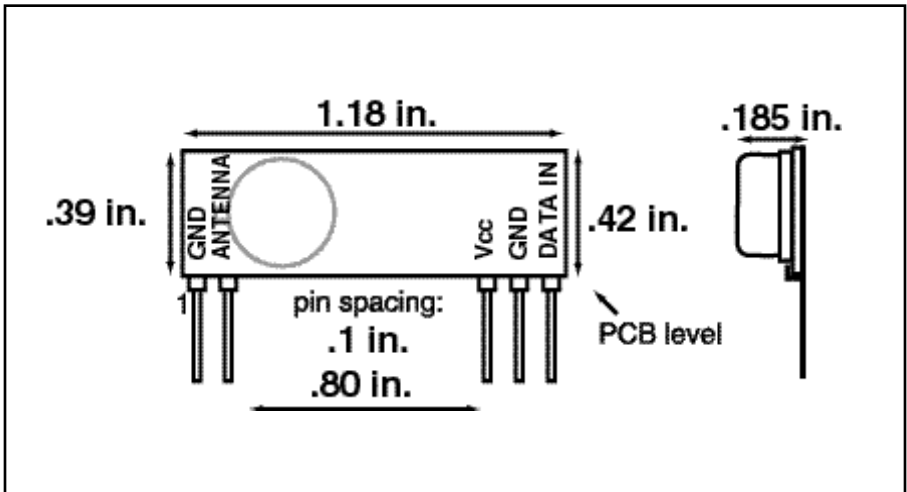


figure 2: Mechanical dimensions

## PIN DESCRIPTION

- Pin 1** GND      Connect to common ground-plane.
- Pin 2** RF OUT    For connection to external antenna. Output impedance is 50Ω.
- Pin 3** Vcc        Positive supply pin, supply voltages from +5.9 to +9 volts may be used.
- Pin 4** GND        Connect to common ground-plane.
- Pin 5** DATA IN    Analog or digital input. Should be driven by the same supply voltage as the module. Usually interfaced with a CMOS logic level device. Should never exceed Vcc.

## WHAT EXTERNAL COMPONENTS ARE REQUIRED ?

The RM Series transmitter requires only a supply voltage, an external antenna and analog or digital input. Production adjustment or tuning is not required.

# PERFORMANCE DATA – RM SERIES TRANSMITTER

## Performance Data Parameters:

Ambient temperature: 20°C  
 Supply voltage: +8 volts, unless noted otherwise  
 Test circuit: configured as shown in figure 3

Parameter		Min.	Typical	Max	Measure	Notes
Operating supply range (Vcc)		5.9	6.0	9.0	Volts	–
Supply current	Vcc = 6.0V	3.0	6.0	10.0	mA	–
	Vcc = 9.0V	5.0	10.0	17.0	mA	–
Field strength of fundamental	Vcc = 6.0V	-4	-1	+4	dBm	1
Transmit frequency	RM Modules are available in 418 & 433.92 MHz					
Initial frequency accuracy		-80	–	+80	KHz	–
Overall frequency accuracy		-95	–	95	KHz	2
Spurious radiation	Capable of meeting FCC Part 15					
FM deviation (+/-)		15	25	40	KHz	3
Modulation Bandwidth (-3dB) analog		DC	–	10	KHz	3
Digital data rate		100	–	10,000	BPS	4
Data input voltage	0vDC to Vcc					
Max. data rate	<=5Kbps					

### Notes:

- 1 Into 50Ω load.
- 2 Supply 5.9 to 9 volt, temp -10° to +55° C.
- 3 2 KHz square wave, 0 to Vcc.
- 4 High or low pulse.

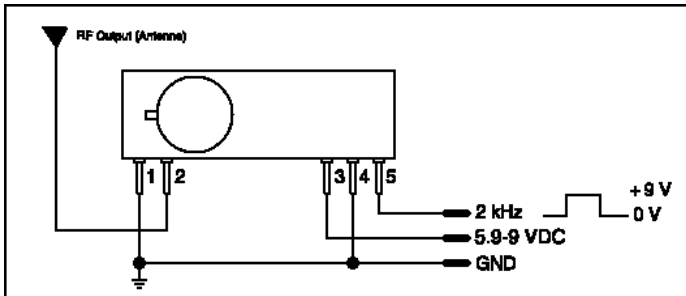


figure 3: LINX RM Series test circuit

## Absolute Maximum Ratings:

Supply voltage Vcc	pin 3	-0.7 to +12 volts
Modulation input	pin 5	-0.7 to +12 volts
Operating temperature		-10°C to +55°C
Storage temperature		-40°C to +100°C

**\*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.

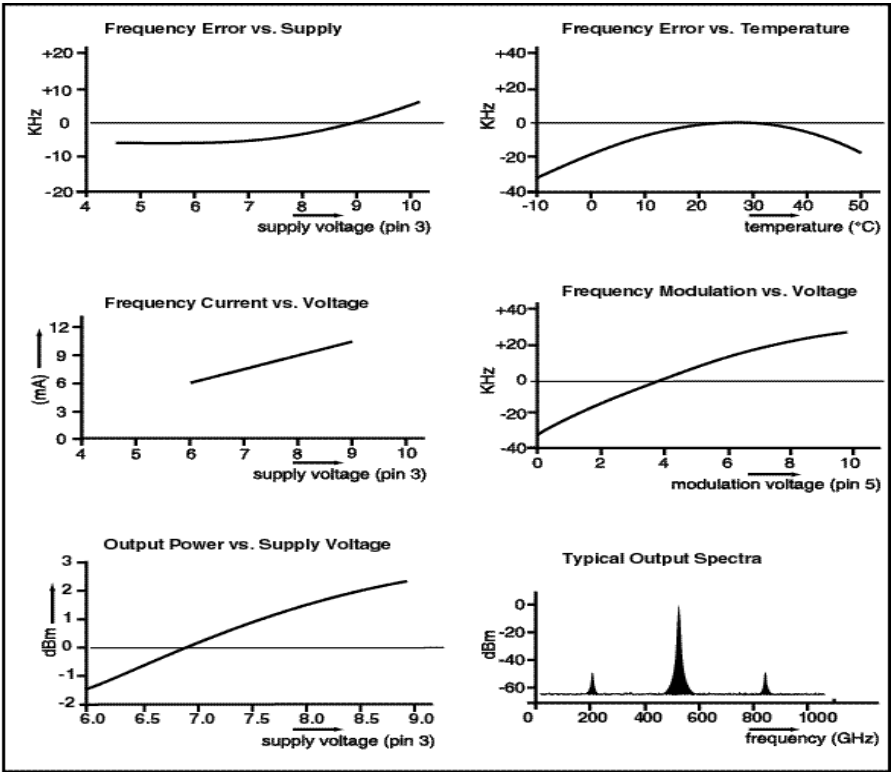


figure 4: Typical performance curves

## POWER SUPPLY REQUIREMENTS

The transmitter module requires a clean, well-regulated voltage. While it is preferable to power the unit from a battery, the unit can also be powered from a power supply as long as noise and 'hash' is less than 20mV. A  $10\mu\text{F}$  capacitor to ground on pin 5 (Vcc) and a  $10\Omega$  series resistor will help in cases where the quality of supply power is poor.

The module is not reverse polarity protected. Reverse supply voltages will cause permanent damage. External polarity protection is recommended.

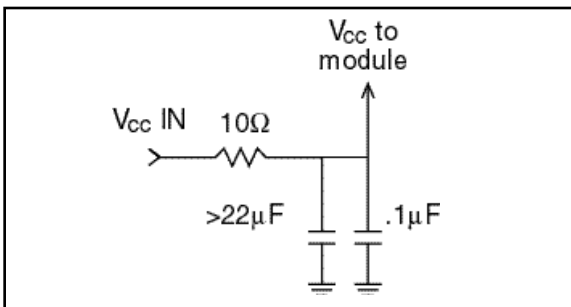
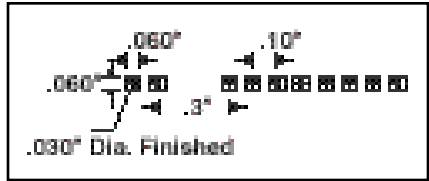


Figure 5: Suggested supply filter

# BOARD LAYOUT CONSIDERATIONS

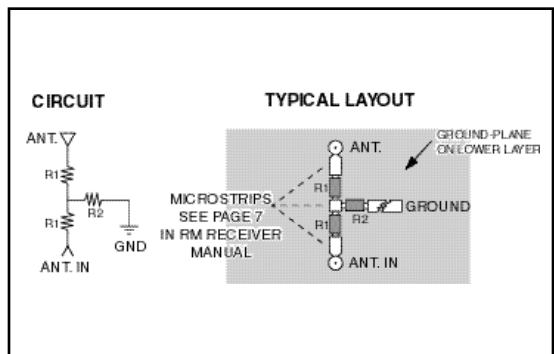
If you are at all familiar with RF devices you may be concerned about specialized layout requirements. Fortunately, because of the care taken in design, integrating an RM transmitter into your design is very straightforward. By adhering carefully to a few basic design and layout rules, you can enjoy a trouble-free path to RF success.

Figure 6 shows the suggested PCB footprint for the RM transmitter.



- 1) A ground-plane (as large as possible) should be placed directly under the RM transmitter. This ground-plane can also be critical to the performance of your antenna. *figure 6: Recommended PCB footprint*
- 2) The RM transmitter should, as much as reasonably possible, be isolated from all other components on your PCB. Specifically, high-frequency circuitry such as crystal oscillators should be kept as far away as possible from the transmitter.
- 3) The module may be mounted vertically or bent horizontal to the product's PCB. If the transmitter is to be mounted parallel to the board, it should be bent over so that the side without components is closest to the PC board and the component side is facing away from the PC board.
- 4) No conductive items should be placed within .25 in. of the module's component side to prevent detuning.
- 5) The trace from the transmitter to the antenna should be kept as short as possible. A simple trace is suitable for runs up to 1/4 inch for antennas with wide bandwidth characteristics. For longer runs or to avoid detuning a high-Q narrow bandwidth antenna such as a helical, use a 50-ohm coax or 50-ohm microstrip transmission line as shown in figure 7.

Depending on the type antenna being used, the output power of the RM module may be significantly higher than FCC regulations allow. The output power of the module is intentionally set high since many designers pair the module with an inefficient antenna in order to realize cost or space savings. Since attenuation is commonly



*figure 7: Microstrip transmission line*

required a designer may want to place locating pads in-line with the antenna trace as shown. In the event that a T-pad is required the antenna trace can be cut and the pads populated. For further details on T-pads please refer to Linx application note #00150.

# MODULATION REQUIREMENTS

The RM transmitter has a DC to 10 KHz modulation bandwidth and will accept direct analog (AFSK) or digital data. A modulation lowpass filter (10 KHz @ -6 dB, 1st order) is used internally.

Digital data is normally input to pin 5 in a serial stream at CMOS logic levels such as those from a microprocessor or encoder IC. The maximum data rate is 10Kbps. The pin should always be driven with a voltage common to the supply voltage present at pin 3 (Vcc). Under no condition should the voltage at the data pin be allowed to exceed the supply voltage (Vcc).

# DATA CODING

Once a reliable RF link has been established, the challenge becomes how to most effectively transfer data across it. Since the transmit and receive modules have no internal digital coding/decoding, a user has tremendous flexibility to send many types of analog and digital data. It is important to understand, however, that some intelligent transmission structure must be used. This is true for several reasons. The first and most significant is that there must be some way to distinguish an intended transmission from interferers and ambient noise. In addition, it is generally not possible to hold DC levels across an RF link, therefore, transitions must take place at minimum intervals.

It is, of course, a simple task to also accomplish application-specific data encoding and transfer using a microprocessor. Inexpensive micros such as the Microchip PIC series make an excellent choice for this task.

If you do not have a microprocessor on-board your product and you want to send control signals such as a key press, switch closing, or low-rate data, consider using an encoder and decoder IC chipset. These chips take care of all encoding, error checking, and decoding functions and are available from Linx. An example of such an application is shown below.

# BASIC REMOTE CONTROL EXAMPLE

This is an example of a basic remote control design utilizing a Holtek encoder/decoder IC. When a key is pressed at the transmitter, a corresponding pin at the receiver goes high. This basic circuit can be easily modified to suit a broad range of applications, and clearly demonstrates the ease of using and interfacing the Linx modules.

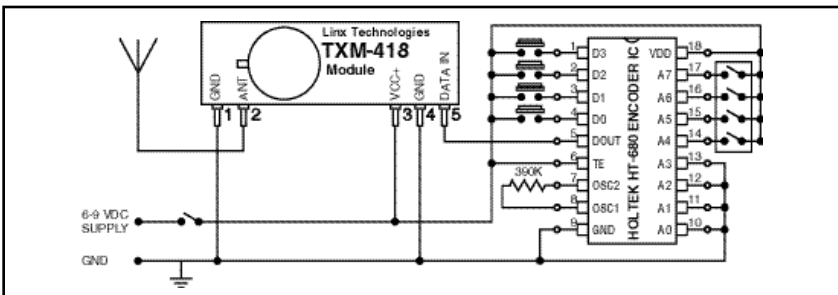


figure 8: Basic wireless encoder circuit

# ANTENNA CONSIDERATIONS

The range of the RF link is widely variable and depends upon the type of antenna employed and the operating environment. Proper design and matching of an antenna is a complex task requiring sophisticated test equipment and a strong background in principles of RF propagation. While adequate antenna performance can often be obtained by trial and error methods, you may also want to consider utilizing a premade antenna from Linx. Our low-cost antenna line is designed to ensure maximum performance and Part 15 compliance.

It is usually best to utilize a basic quarter-wave whip for your initial concept evaluation. This can easily be made from a piece of wire as shown on the next page. Once the prototype product is operating satisfactorily, a production antenna should be selected to meet the cost, size and cosmetic requirements of the product. It is important to recognize that the antenna plays a significant role in determining the performance and legality of your end product. In order to gain a better understanding of the considerations involved in the design and selection of antennas, please review Linx applications note #00500 "Antennas: Design, Application, Performance".

**The following notes should help in achieving optimum 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 ground-plane. 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.
3. It is always a good practice to include a T-attenuation pad as described under "Board Layout Considerations". This allows your product's output power to be adjusted for certification purposes without change or compromise to the antenna.
4. 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 ground-planes. In many cases, the space around the antenna is as important as the antenna itself.
5. In many antenna designs, particularly 1/4-wave whips, the ground-plane acts as a counterpoise, forming, in essence, a 1/2-wave dipole. For this reason adequate ground-plane area is essential. As a general rule the ground-plane to be used as counterpoise should have a surface area  $\geq$  the overall length of the 1/4-wave radiating element.
6. Remove the antenna as far as possible from potential internal interference sources. 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 ground-plane under all potential sources of noise. Shield noisy board areas whenever practical.
7. In some applications it is advantageous to place the transmitter 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.

## Antenna Selection Chart

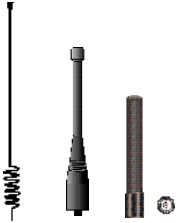
PARAMETER	LOOP	HELICAL	WHIP
Ultimate performance	●	●●	●●●
Ease of design setup	●	●●	●●●
Size	●●	●●●	●
Immunity to proximity effects	●●●	●●	●
	●=FAIR	●●=GOOD	●●●=EXCELLENT



# COMMON ANTENNA STYLES

There are literally hundreds of antennas styles that can be successfully employed with the RM Series. Following is a brief discussion of the three styles most commonly utilized in compact RF designs. Additional antenna information can be found in Linx application notes #00500, #00100, #00126 and #00140.

## Whip Style



1/4 wave wire lengths for RM frequencies:

418MHz = 6.7"

433MHz = 6.5"

A whip-style monopole antenna provides outstanding overall performance and stability. A low-cost whip can be easily fabricated from wire or rod, but most product designers opt for the improved 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 1/4-wave antenna is normally employed. Its size and natural radiation resistance make it well matched to Linx modules. The proper length for a 1/4-wave antenna can be easily found using the formula below. It is also possible to reduce the overall height of the antenna by using a helical winding. This decreases the antenna's bandwidth but is an excellent way to minimize the antenna's physical size for compact applications.

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

Where:

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

## Helical Style



A helical antenna is precisely formed from wire or rod. A helical antenna is a good choice for low-cost products requiring average range performance and internal concealment. A helical can detune badly in proximity to other objects and its bandwidth is quite narrow 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. There are a variety of shapes and layout styles which can be utilized. The element can be made self-resonant or externally resonated with discrete components. 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 substantial instability in the RF stages.

Linx offers a low-cost planar antenna called the "SPLATCH" which is an excellent alternative to the sometimes problematic PCB trace style. This tiny antenna mounts directly to a product's PCB and requires no testing or tuning. Its design is stable even in compact applications and it provides excellent performance in light of its compact size.

# LEGAL CONSIDERATIONS

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***NOTE: RM 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 operation 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 approvals necessary 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](http://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 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](mailto:labinfo@fcc.gov)

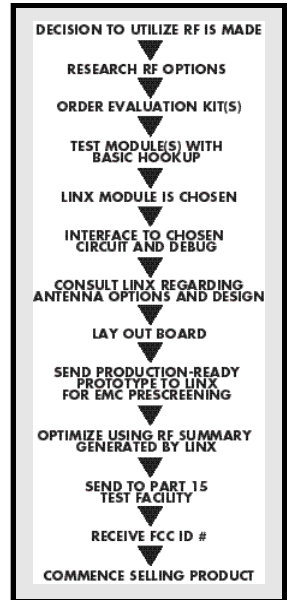
International approvals are slightly more complex, although many modules are designed to allow all international standards to be met. If you are considering the export of your product abroad, you should contact Linx Technologies to determine the specific suitability of the module to your application.

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 wireless capabilities 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 Linx RF modules the design and approval process will be greatly simplified. It is important, however, to have an objective view of the steps necessary to insure 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.

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, but you may even find the process enjoyable.



TYPICAL STEPS FOR IMPLEMENTING RF

## 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.

NOTE #	LINX APPLICATION NOTE TITLE
00500	Antennas: Design, Application, Performance
00130	Modulation techniques for low-cost RF data links
00125	Considerations for operation in the 260 Mhz to 470 Mhz band
00100	RF 101: Information for the RF challenged
00110	Understanding the performance specifications of receivers
00140	The FCC Road: Part 15 from concept to approval
00150	Use and design of T-Attenuation Pads



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## **Disclaimer**

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