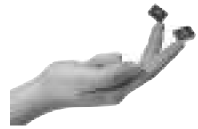
TXM-315-LC
TXM-418-LC
TXM-433-LC

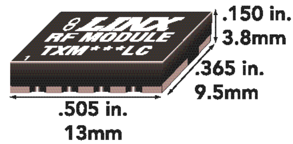


WIRELESS MADE SIMPLE

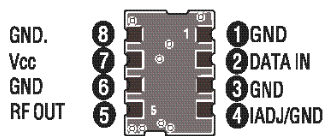
# LC SERIES TRANSMITTER MODULE DATA GUIDE

## DESCRIPTION:

The LC Series is ideally suited for volume use in OEM applications such as remote control, security, identification, and periodic data transfer. Packaged in a compact SMD package, the LC transmitter utilizes a highly optimized SAW architecture to achieve an unmatched blend of performance, size, efficiency and cost. When paired with a matching LC series receiver, a highly reliable wireless link is formed, capable of transferring serial data at distances in excess of 300 Feet. No external RF components, except an antenna, are required, making design integration straightforward, even for engineers lacking previous RF experience.




PHYSICAL DIMENSIONS




PINOUTS (BOTTOM VIEW)

## FEATURES:

- Low Cost
- No External RF Components Required
- Ultra-low Power Consumption
- Compact Surface-Mount Package
- Stable SAW-based Architecture
- Supports Data Rates to 5,000 bps
- Wide Supply Range (2.7-5.2 VDC)
- Direct Serial Interface
- Low Harmonics
- 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-***-LC | Basic Evaluation Kit |
| MDEV-***-LC | Master Development Kit |
| TXM-315-LC | Transmitter 315 MHZ |
| TXM-418-LC | Transmitter 418 MHZ |
| TXM-433-LC | Transmitter 433 MHZ |
| RXM-315-LC | Receiver 315 MHZ |
| RXM-418-LC | Receiver 418 MHZ |
| RXM-433-LC | Receiver 433 MHZ |

*NOTE*: For reflow compatible versions, add **-R** to the end of the part number.

*** Insert Frequency

LC Transmitters are supplied in tube packaging - 50 pcs. per tube.

Revised 2/1/00

# PERFORMANCE DATA– TXM-***-LC

## ABOUT THESE MEASUREMENTS

The performance parameters listed below are based on module operation at 25°C from a 3.3Vdc supply unless otherwise noted. Figure 1 at the right illustrates the connections necessary for testing and operation. It is recommended that all ground pins be connected to the groundplane.

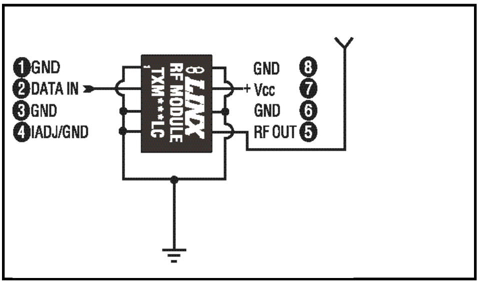



*figure 1: Test/Basic application circuit*

| Parameters LCTX 433,418, 315MHz | Designation | Min. | Typical | Max. | Units | Notes |
|---|---|---|---|---|---|---|
| Operating Voltage Range | $V_{CC}$ | 2.7 | – | 5.2 | Volts | – |
| Current Continuous | $I_{CC}$ | – | 3.0 | 6.0 | mA | 1, 5 |
| Current Average | $I_{CA}$ | – | 1.5 | – | mA | 2, 5 |
| Current In Sleep | $I_{SLP}$ | – | – | 1.5 | µA | 3 |
| Data Input Low | $V_{IL}$ | 0 | – | 0.4 | Volts | – |
| Data Input High | $V_{IH}$ | 2.5 | – | $V_{CC}$ | Volts | – |
| Oscillator Start-up Time | $T_{OSU}$ | – | – | 80 | µS | 4 |
| Oscillator Ring-down Time | $T_{ORD}$ | – | – | 100 | nSec | 4 |
| Output Power | $P_O$ | -4 | 0 | +4 | dBm | 4 |

| Parameter LCTX 315MHz | Designation | Min. | Typical | Max. | Units | Notes |
|---|---|---|---|---|---|---|
| Frequency of Carrier | $F_C$ | 314.93 | 315.0 | 315.07 | MHz | – |
| Harmonic Emissions | $P_H$ | – | – | -40 | dBc | 4 |

| Parameter LCTX 418MHz | Designation | Min. | Typical | Max. | Units | Notes |
|---|---|---|---|---|---|---|
| Frequency of Carrier | $F_C$ | 417.96 | 418.02 | 418.08 | MHz | – |
| Harmonic Emissions | $P_H$ | – | – | -40 | dBc | 4 |

| Parameter LCTX 433MHz | Designation | Min. | Typical | Max. | Units | Notes |
|---|---|---|---|---|---|---|
| Frequency of Carrier | $F_C$ | 433.87 | 433.92 | 433.97 | MHz | – |
| Harmonic Emissions | $P_H$ | – | – | -45 | dBc | 4 |

## Notes:

1. Current draw with data pin held continuously high.
2. Current draw with 50% mark/space ratio.
3. Current draw with data pin low.
4. RF out connected to 50Ω load.
5, Iadj (pin 4) through 430Ω resistor.

**Absolute Maximum Ratings:**

| | | | |
|---|---|---|---|
| Supply voltage $V_{CC}$, using pin 7 | -0.3 | to | +6 VDC |
| Operating temperature | -30°C | to | +70°C |
| Storage temperature | -45°C | to | +85°C |
| Soldering temperature | +225°C for 10 sec. | | |
| Any input or output pin | -0.3 | to | $V_{CC}$ |

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

## TYPICAL PERFORMANCE GRAPHS

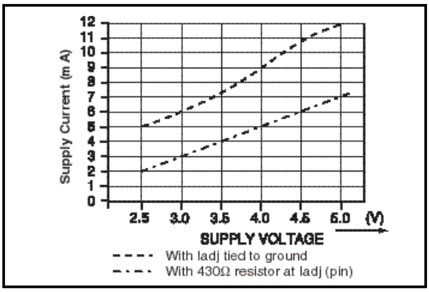



*figure 2: Consumption vs. Supply Voltage*

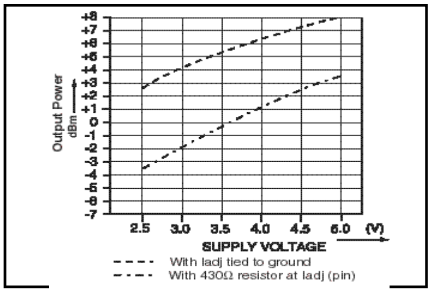



*figure 3: Typical RF power into 50Ω*

*figure 4: Typical Oscillator Turn-On Time*

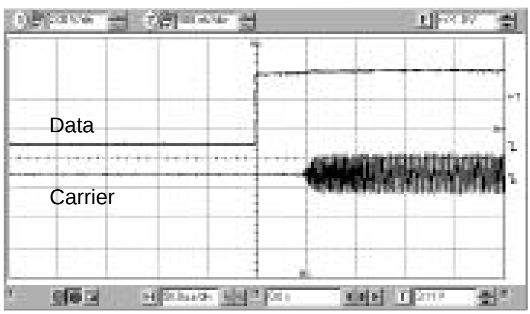
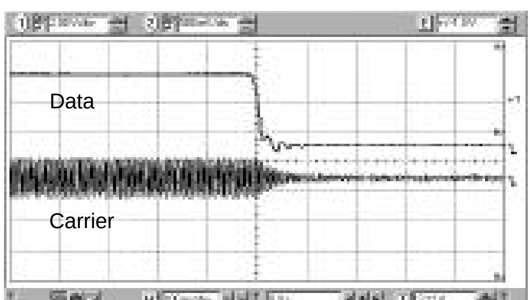



*figure 5: Typical Oscillator Turn-Off Time*



## PRODUCTION GUIDELINES

The LC modules are packaged in a hybrid SMD package which has been designed to support hand- or automated-assembly techniques. Since LC devices contain discrete components internally, the assembly procedures are critical to insuring the reliable function of the LC product.The following procedures should be reviewed with and practiced by all assembly personnel.

## PAD LAYOUT

The following pad layout diagrams are designed to facilitate both hand and automated assembly.


*figure 6: Suggested Pad Layout*

## TRANSMITTER HAND ASSEMBLY

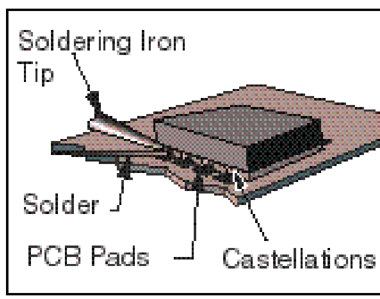



*Figure 7: LC-TX Soldering Technique*

The LC transmitter's primary mounting surface is eight 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. If the recommended pad placement (Rev.2) has been followed, the pad on the board will extend slightly past the edge of the module. For best soldering results, Linx suggests the use of a water-soluble flux-core solder such as Kester Cat. 24-6337-6403. Touch both the PCB pad and the module castellation with a fine soldering tip. Tack one module corner first, then work around the remaining attachment points using care not to exceed the solder times listed below.

# Absolute Maximum Solder Times

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

## TRANSMITTER AUTOMATED ASSEMBLY

For high-volume assembly most users will want to auto-place the modules. The modules have been designed to maintain compatibility with most pick-and-place equipment; however, due to the module's hybrid nature certain aspects of the automated assembly process are far more critical than for other component types.

***NOTICE***

Only modules with an "R" at the end of the part number (i.e., TXM-418-LC-R) are suitable for reflow processing. Modules not bearing this designation may be irreparably damaged by reflow temperatures.

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 insure that it meets the requirements necessary to successfully reflow all components while still meeting the limits mandated by the modules themselves.

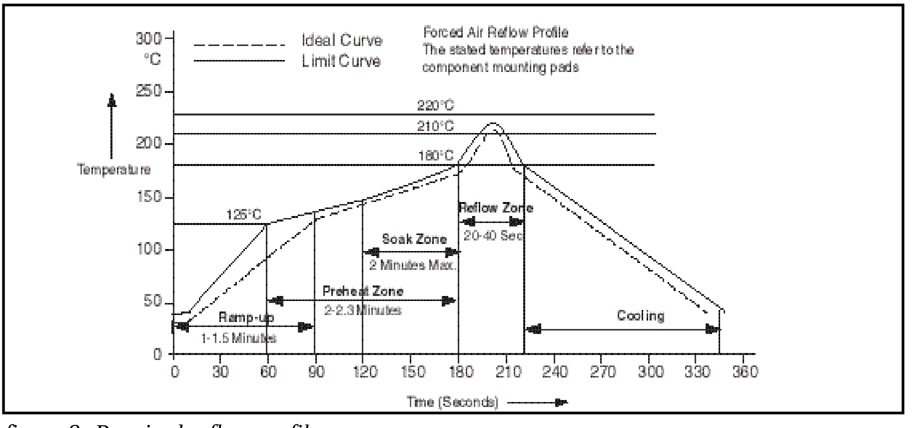



*figure 8: Required reflow profile*

### 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 module not be subjected to shock or vibration during the time solder is liquidus.

### Washability

The modules are wash resistant, but are not hermetically sealed.They may be subject to a standard wash cycle;however, a twenty-four-hour drying time should be allowed before applying electrical power to the modules. This will allow any moisture that has migrated into the module to evaporate, thus eliminating the potential for shorting during power-up or testing.

## PHYSICAL PACKAGING

The transmitter is packaged as a hybrid SMD module with eight pads spaced 0.100" apart on center. The SMD package is equipped with castellations which allow for side introduction of solder. This simplifies prototyping or hand assembly while maintaining compatibility with automated pick-and-place equipment. Modules are available in tube or tape-and-reel packaging (see page 1 for ordering information).

## PIN DESCRIPTIONS:

**Pin 1 GROUND**

Connect to quiet ground or groundplane.

**Pin 2 DATA IN**

Serial data input pin.TTL and CMOS compatible.

**Pin 3 GROUND**

Connect to quiet ground or groundplane.

**Pin 4 IADJ/GND**

Connect to ground for 3V operation. Connect to ground through 430 Ohm resistor for 5V operation. (see graph on page 3)

**Pin 5 RF OUT**

Connect to 50Ω matched antenna.

**Pin 6 GROUND**

Connect to quiet ground or groundplane.

**Pin 7 POSITIVE SUPPLY (**Vcc **2.7-6 VDC)**

The supply must be clean (<20 mV pp), stable and free of high-frequency noise. A supply filter is recommended unless the module is operated from its own regulated supply or battery.

**Pin 8 GROUND**

Connect to quiet ground or groundplane.

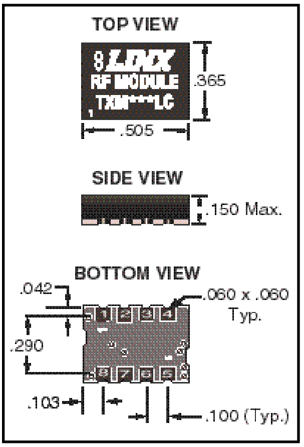



*figure 9: LC -TXM Physical Package*

## POWER SUPPLY REQUIREMENTS

The transmitter module 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 kept to less than 20 mV. A 10Ω resistor in series with the supply followed by a 10µF tantalum capacitor from Vcc to ground as shown at the right will help in cases where the quality of supply power is poor.

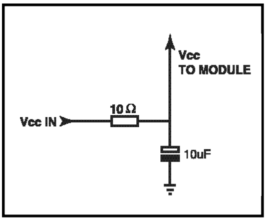



*figure 10: Supply Filter*

## MODULE DESCRIPTION

The LC-TXM is a low-cost, high-performance SAW-(Surface Acoustic Wave) based CPCA (Carrier-Present Carrier-Absent) transmitter capable of sending serial data at up to 5,000 bits/second. With proper code balance the CPCA modulation method enables the transmitter to be legally operated at higher output power levels than continuous carrier modulation methods such as FSK. The LC's compact surface-mount package integrates easily into existing designs and is also friendly to prototype and hand production. The LC's ultralow power consumption makes it ideally suited for products powered from a battery. When combined with a Linx LC series receiver a highly reliable RF link capable of transferring digital data over line-of-sight distances in excess of 300 feet (90M) is formed.

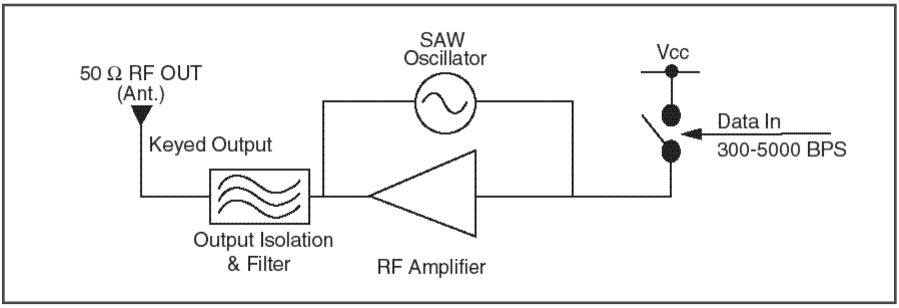



*figure 11: LC Series Transmitter Block Diagram*

## THEORY OF OPERATION

The LC-TXM transmits data using CPCA (Carrier-Present Carrier-Absent) modulation.This type of AM modulation is often referred to by other designations including CW and OOK. As the CPCA designation suggests, 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. Three of the most important are: 1) Cost-effectiveness due to design simplicity. 2) No minimum data rate or mark/space ratio requirement. 3) Higher output power and thus greater range in countries (such as the US) where output power measurements are averaged over time. Please refer to Linx application note #00130 for a further discussion of modulation techniques including CPCA.

The LC-TXM is based on a simple but highly optimized architecture which achieves a high fundamental output power with low harmonic content. This insures that most approval standards can be met without external filter components. The LC transmitter is exceptionally stable over time, temperature, and physical shock as a result of the precision SAW (Surface Acoustic Wave) device that is incorporated as its frequency reference. Due to this accuracy and the high Q of the SAW device most of the output power is concentrated in a narrow bandwidth. This allows the receiver's pass opening to be quite narrow, thus increasing sensitivity and reducing susceptibility to near-band interference. The quality of components and overall architecture utilized in the LC series is highly unusual in a low-cost RF device and is one of the primary reasons the LC transmitter is able to outperform even far more expensive products.

## THE DATA INPUT

A CMOS/TTL level data input is provided on pin 2.This pin is normally supplied with a serial bitstream input directly from a microprocessor, encoder, or UART. During standby or the input of a logic low, the carrier is fully suppressed and the transmitter consumes less than 2µA of current. During a logic high the transmitter generates a carrier to indicate to the receiver the presence of a logic 1. The applied data should not exceed a rate of 5,000 bits/sec. The data input pin should always be driven with a voltage common to the supply voltage present at pin 7 (Vcc). Under no condition should the data pin be allowed to exceed the supply voltage (Vcc).

## TRANSMITTING 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 LC modules do not incorporate internal coding/decoding, a user has tremendous flexibility in how data is formatted and sent.

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 Sec. 231 for further details on acceptable transmission content.

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 (Considerations for sending data with the LC series).This application note details important issues such as the effect of start-up times, pulse stretching and shortening and the relationship between data and output power in a CPCA-based transmitter. These issues should be clearly understood prior to commencing a significant design effort.

If you want to send simple control or status signals such as button presses or switch closures, and you do not have a microprocessor on board your product 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:Microchip (Keeloq), Holtek, and Motorola.These chips take care of all encoding, error checking, 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 IC's 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.

On the following page you will find an example of a basic remote control transmitter utilizing a encoder chip from Holtek. When a key is pressed at the transmitter, a corresponding pin at the receiver goes high. A schematic for the receiver/decoder circuit may be found in the LC receiver guide. These circuits can be easily modified and clearly demonstrate the ease of using the Linx LC modules for remote control applications.

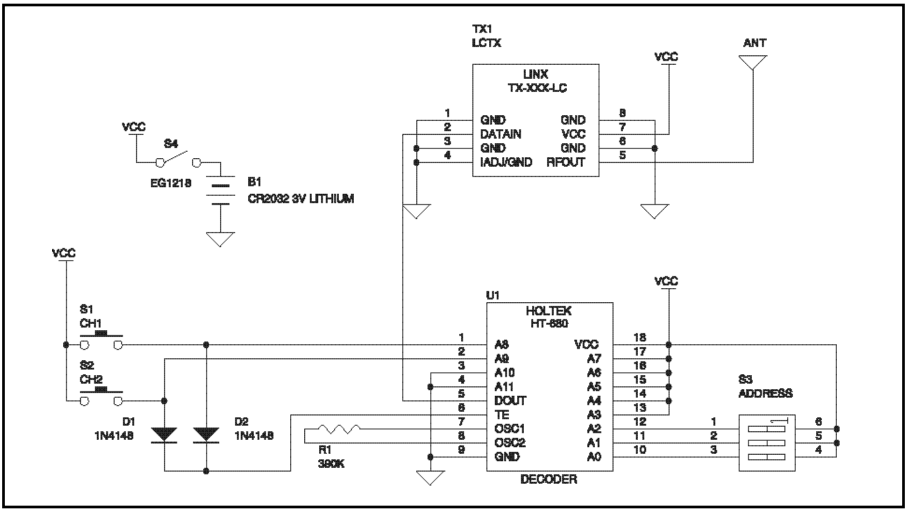


*figure 12: Basic Remote Control Transmitter Circuit*

***Notes:***

1) DIP Switch used to set ID code. A 3-position switch was chosen for this example but all or none of the address bits may be used.Settings of the Receiver and Transmitter must match for signal to be recognized.

## 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 LC series, integrating an LC transmitter is very straightforward. This ease of application results from the advanced multi-layer construction of the module. By adhering to the following layout principles and observing a few basic design rules, you can enjoy a straightforward path to RF success.

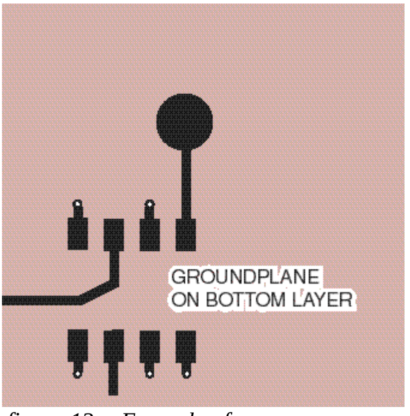
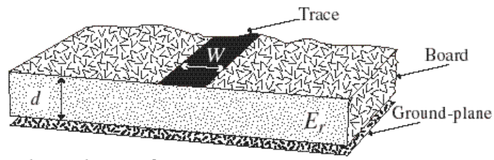



*figure 13: Example of proper groundplane*

1. No conductive items should be placed within .15" of the module's top or sides.
2. A groundplane should be placed under the module as shown. It will generally be placed on the bottom layer. The amount of overall plane area is also critical for the correct function of many antenna styles and is covered in the next section.
3. Observe appropriate layout practice between the module and its antenna. A simple trace may suffice for runs of less than .25" but longer distances should be covered using 50Ω coax or a 50Ω microstrip transmission line. This is because the trace leading to the module can effectively contribute to the length of the antenna thus lowering its resonant bandwidth. In order to

minimize loss and detuning, a microstrip transmission line is commonly utilized.The term microstrip refers to a PCB trace running over a groundplane, the width of which has been calculated to serve as a 50Ω transmission line between the module and antenna. This effectively removes the trace as a source of detuning.

The correct trace width can be easily calculated using the information below.The width is based on the desired characteristic impedance, the thickness of the PCB, and its dielectric constant. The correct trace width can be easily calculated using the information below.




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

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

*figure 14: 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 |

4. Depending on the type antenna being used and duty cycle of incoming data, the output power of the LC 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 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.

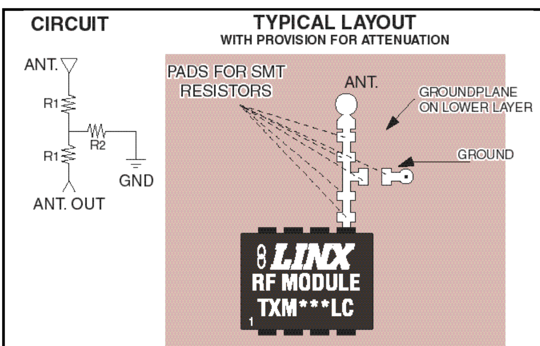



*figure 15: Attenuation pad layout*

# ANTENNA CONSIDERATIONS

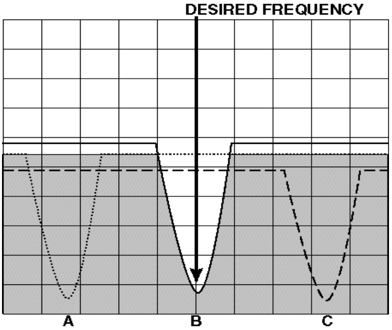
The choice of antennas is one of the most critical and often overlooked design considerations. The range, performance, and legality of an RF link is critically dependent upon the type of antenna employed. Proper design and matching of an antenna is a complex task requiring sophisticated test equipment 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 professionally designed antenna such as those offered by Linx. Our low-cost antenna line is designed to ensure maximum performance and compliance with Part 15-attachment requirements. The purpose of the following sections is to give you a basic idea of some of the considerations involved in the design and selection of antennas. For a more comprehensive discussion please review Linx applications note #00500 “Antennas: Design, Application, Performance”.

## THE TRANSMITTER ANTENNA

The transmitter antenna allows RF energy to be efficiently radiated from the output stage into free space. In modular designs such as the LC, a transmitter’s output power is often slightly higher than the legal limit.This allows a designer to utilize an inefficient antenna in order to achieve full legal power while meeting size, cost, or cosmetic objectives. For this reason a transmitter's antenna can generally be less efficient than the antenna used on the receiver.

It is usually best to utilize a basic 1/4-wave whip for your initial concept evaluation. Once the prototype product is operating satisfactorily, a production antenna should be selected to meet the cost, size and cosmetic requirements of the product.

Maximum antenna efficiency is always obtained when the antenna is at resonance. If the antenna is too short, capacitive reactance is present;if it is too long, inductive reactance will be present. The indicator of resonance is the minimum point in the VSWR curve. You will see from the following example that antenna (A) is resonant at too low a frequency, indicating excessive length, while antenna (C) is resonant at too high a frequency, indicating the antenna is too short.Antenna (B), however, is “just right.”




Antenna resonance should not be confused with antenna impedance. The difference between resonance and impedance is most easily understood by considering the value of VSWR at its lowest point.The lowest point of VSWR indicates the antenna is resonant, but the value of that low point is determined by the quality of the match between the antenna, the transmission line, and the device to which it is attached.

To fully appreciate the importance of an antenna that is both resonant and matched consider that an antenna with a VSWR of 1.5 will effectively transmit approximately 95% of its power while an antenna with a VSWR of 10 will only transmit about 30%.

## GUIDELINES FOR 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 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.

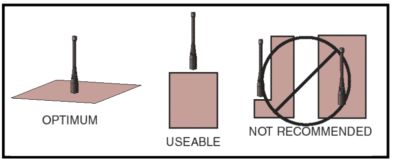
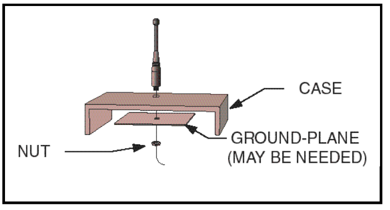



*figure 16: Groundplane orientation*

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.

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, the groundplane to be used as counterpoise should have a surface area ≥ the overall length of the 1/4-wave radiating element; however, Linx recognizes that this is impossible for most compact designs, so all Linx antennas are characterized using a 4.5" X 4.5" groundplane with the antenna centered and oriented at a 90° angle. Such an orientation 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. In instances where the antenna is remotely located or the antenna is not in close proximity to a circuit board plane or grounded metal case, a small metal plate may be fabricated to maximize antenna performance.




5. Remove the antenna as far as possible from potential interference sources. There are many possible sources of internally generated interference. Switching power supplies, oscillators, even relays can also be significant sources of potential interference. Remember, 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 all potential sources of noise. Shield noisy board areas whenever practical.

6. 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.

# COMMON ANTENNA STYLES

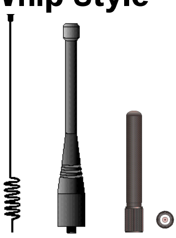
From a coat hanger to a tuned Yagi, there are literally hundreds of antenna styles and variations that can be employed. Following is a brief discussion of the three styles most commonly utilized in compact RF designs. The selection chart broadly categorizes key areas of antenna performance. In reviewing this section it is important to recognize that each antenna style will produce widely varying results based on the specific design execution and optimization. Additional antenna information can be found in Linx application notes #00500, #00100, #00125 and #00140.

## LC Antenna Selection Chart

| *PARAMETER* | *LOOP* | *HELICAL* | *WHIP* |
|---|---|---|---|
| **Ultimate performance** | ● | ●● | ●●● |
| **Ease of design setup** | ● | ●● | ●●● |
| **Size** | ●● | ●●● | ● |
| **Immunity to proximity effects** | ●●● | ●● | ● |
| **Range (open ground to similar antenna)** | **100 ft.** | **200 ft.** | **300+ ft.** |

**●=FAIR ●●=GOOD ●●●=EXCELLENT**

## Whip Style



1/4-wave wire lengths for LCfrequencies:

**315Mhz=8.9"**
**418Mhz=6.7"**
**433Mhz=6.5"**

A whip-style antenna provides exceptional performance and is easy to integrate. A low-cost whip is generally made of a wire or rod while more expensive whip designs are encapsulated in rubber or plastic to improve appearance and minimize the potential for damage to the antenna element. A whip is often combined with a helical winding to reduce the overall length. This technique is commonly referred to as “base loading”. The wavelength of the frequency to be received or transmitted determines an antenna’s length.Since a full-wave antenna is quite long, a partial wavelength antenna such as a 1/2- or 1/4-wave is generally used. For testing, or even production, a whip can be easily made from a piece of solid conductor wire cut to the appropriate length. Length for a 1/2-wave is easily determined using the following formula.The resultant length may be divided in half for a 1/4-wave.

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

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

## Helical Style

A helical is a wire coil usually wound from steel, copper or brass. This antenna is very efficient given its small size. The helical is an excellent choice for products requiring good range performance and a concealed internal antenna element. Care must be exercised in placement, however, as a helical detunes badly when located in proximity with other conductive objects. Because a helical has a high Q factor its bandwidth is very narrow and inter-coil spacing has a pronounced effect on antenna performance. For this reason, is it usually best to utilize a pre-made helical which has been professionally optimized to achieve maximum performance.

## Loop Style

A loop or track-style antenna is usually printed directly on the PCB making it the most cost-effective of antenna styles. There are many different styles and shapes of loops which can be utilized, including spirals and rectangles. A loop has excellent immunity to proximity detuning (e.g., a user’s body) and is easily concealed inside products which have a plastic case. Despite these advantages, a loop is difficult to match and tune without expensive RF test equipment.An improperly designed loop will have a very high SWR and may induce harmonics. For this reason a helical or whip style is usually a better choice for applications requiring maximum range performance.

# LEGAL CONSIDERATIONS

***NOTE: LC 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 necessary approvals to market your completed product legally.

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 LC 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

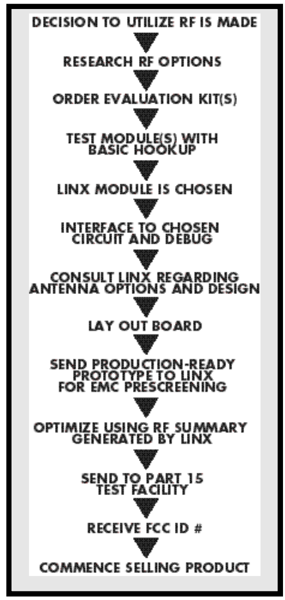
International approvals are slightly more complex, although many modules are designed to allow all international standards to be met. If you are considering the export of your product abroad, you should contact Linx Technologies to determine the specific suitability of the module to your application.

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.

## SURVIVING AN 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 LC 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 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, 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 |
|---|---|
| 00232 | General considerations for sending data with the LC Series |
| 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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**http://www.linxtechnologies.com**

## Disclaimer

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