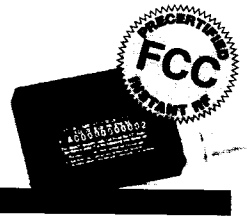
LINX TECHNOLOGIES
WIRELESS MADE SIMPLE

MULTI-CHANNEL
HIGH-PERFORMANCE
MC-PA SERIES
RF TRANSCEIVER

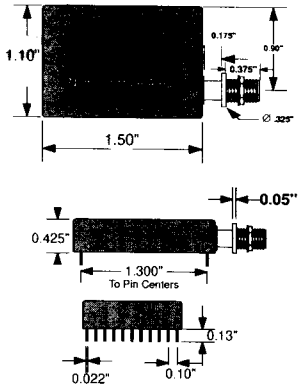


MC-PA SERIES TRANSCEIVER MODULE DESIGN GUIDE

Description

The PA version of Linx's popular MC Series greatly reduces the time and expense of making a product wireless. This is because the transceiver module is pre-approved by the FCC when used with the appropriate proprietary antennas. The TC-900-MC-PA transceiver module is designed for the high-performance bi-directional transfer of wireless data. The transceiver features 250 selectable channels and is capable of transmitting serial data at rates up to 150Kbps. Manual or serial channel selection modes are available. Utilizing an advanced synthesized superhet architecture, the module provides a direct serial data interface, fully qualified UART-compatible data output, RSSI, very low power consumption, wide operational voltage, on-board TX/RX switch, SAW front-end filter, and many other useful features. The open serial interface and fast turnaround times eliminate the code balancing, packetizing and latency issues found in other products. Housed in a compact through-hole package, the transceiver requires no tuning or external RF components (except antenna), allowing for straightforward application.

Package Outline



Features

- FCC precertified for immediate integration
- Precision VCXO synthesized architecture
- 8 Parallel or 250 Serially selectable channels
- High data-rate: 2,400-150,000bps
- Transparent logic-level serial input
- UART-compatible data output
- Qualified data output
- Single antenna (No TX/RX switch required)
- FCC compatible output power and harmonics
- Differential LO for low unintended radiation
- TX power programmable with external resistor
- Excellent sensitivity (-93dBm typical at 10-5 BER)
- SAW front-end for superior out-of-band rejection
- RSSI (Received signal strength indication)
- Fast start-up and turnaround time
- Wide input-voltage range (2.7 to 12 VDC)
- Very low power consumption (as low as 12 mA)
- Power-down mode

Applications

- Small Area Networks
- Wireless RS:232/485 Modems
- General Data Transfer
- Compressed Digital Audio/Video
- Remote Control W/ Confirmation
- Telemetry
- Data Collection
- Home/Industrial Automation
- Long-Range RFID
- Robotics
- Wire Elimination

ORDERING INFORMATION

PART #	DESCRIPTION
TC-900-MC-P	MC Series Transceiver DIP Pkg.
TC-900-MC-PA	MC Series Transceiver DIP Pkg. FCC Preapproved
MDEV-900-MC-PA	Master Development System

☐ Not covered in this manual

Revised 10/2/00

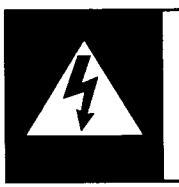
PERFORMANCE DATA TC-900-MC-PA

ABOUT THESE MEASUREMENTS

The performance parameters listed below are based on module operation at 25°C from a 5VDC supply unless otherwise noted.

TRANSMIT SECTION Parameter	Designation	Min	Typ	Max	Units	Notes
Frequency Range	Fr	902.5		927.5	MHz	
Fc Tolerance		-50		+50	KHz	
Output Power	Po	Preset for Part-15 Compliance				
Harmonic Emissions	Ph		-43		dBc	
Spurious Emissions	compatible with FCC part 15					
Frequency Deviation		80	100	135	KHz	
Data Rate		2,400		150,000	Bps	
Modulation Voltage						
Digital		0	3	5	VDC	
RECEIVE SECTION						
LO Frequency	Flo		SEE TABLE 1		MHz	
Flo Tolerance		-50		+50	KHz	
Local Oscillator Feedthru			-50		dBm	1
Spurious Emissions	compatible with FCC part 15					
Receive Sensitivity		-90	-93	-100	dBm	
DC Modulation Sensitivity			-86		dBm	5
Data Rate		100		150,000	Bps	
Data Output Level			VCC-.7	VCC	mVp-p	
RSSI DC Output Range			.5 to 2.5		V	6
RSSI Gain	Grssi		25		mV/dB	6
RSSI Dynamic Range			80		dB	6
ANTENNA PORT						
Input Impedance			50		ohms	6
Input VSWR			1.5:1			6
TIMING						
Power-on to Valid Receive			6		ms	6, 7
Power-on to Valid Transmit			4		ms	6, 7
RX to Valid TX Switching			2.5		ms	6
TX to Valid RX Switching			3.8		ms	6
Minimum Off-Time			10		ms	6
POWER SUPPLY						
Operating Voltage	VCC (pin 10)	2.7		16	VDC	
Current Consumption	Icc					
TX Mode			12		mA	
TX Mode			20	23	mA	
RX Mode			13	15	mA	
Sleep Mode			???		uA	11
ENVIRONMENTAL						
Operational Temp.		-10		+85	°C	

NOTES:
1) Into a 50-ohm load
2) Pin 9 is modulated with a 3V square wave
3) For 10^{-5} BER at 9,600 baud
4) Minimum input power level to ensure that the output will hold a DC level
5) These parameters are only characterized and not tested
6) Measured from rising edge on /PDN
7) Measured from rising edge of carrier modulation on transmit side to valid data on receive side
8) VCC on pin 10 is 5V



CAUTION

This product incorporates numerous static-sensitive components. Always wear an ESD wrist strap and observe proper ESD handling procedures when working with this device. Failure to observe this precaution may result in module damage or failure.

TYPICAL PERFORMANCE GRAPHS

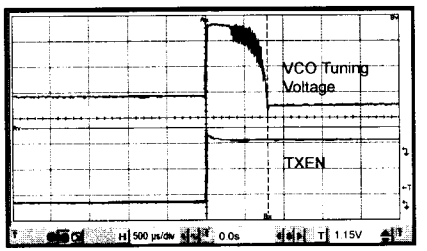


Figure 1: TXEN to PLL lock timing

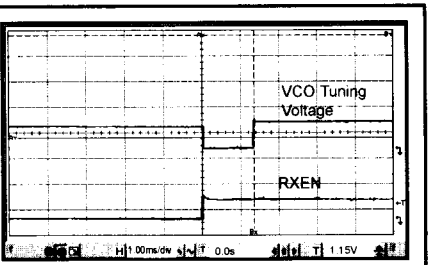


Figure 2: RXEN to PLL lock tuning

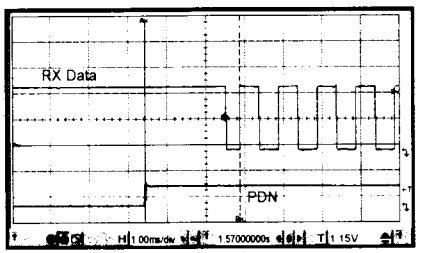


Figure 3: PDN to valid RX data

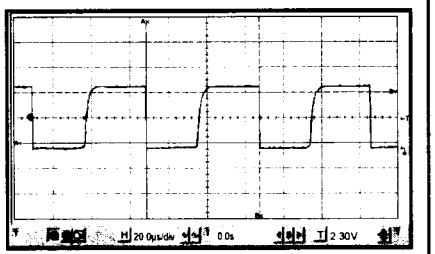


Figure 4: Receive Bit Symmetry @36.8Kbps

PIN DESCRIPTION

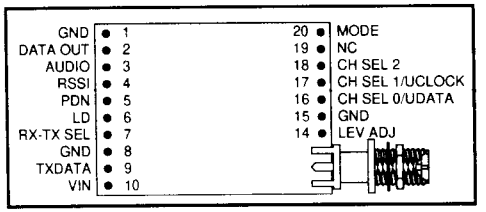


Figure 5: MC Series Pinouts (viewed looking down on top cover)

PIN#	PIN TITLE	EQUIVALENT CIRCUIT	DESCRIPTION
1, 8, 11, 13, 15	Ground		MODULE GROUNDS Tie to common groundplane
2	RXDATA	V_{CC} 5.1K VREG Data Out	RECOVERED DATA OUTPUT
3, 19	N/C		NO CONNECTION
4	RSSI	V_{CC} 51K .033uF	RECEIVED SIGNAL STRENGTH INDICATOR
5	PDN	V_{IN} 120K PDN	POWER DOWN Logic low powers down the transceiver
6	LOCKDET	LD	LOCK DETECT Indicates PLL lock Use as CTS in TX
7	RX/TX SELECT	RX/TX SELECT 10K	RX/TX SWITCH Open, or internally pulled high for RX pull low for TX
9	DATA IN	DATA IN 28K 10K	SERIAL DATA INPUT
10	VIN		SUPPLY VOLTAGE 2.7-12VDC
12	ANT	ANT 50Ω	50Ω ANTENNA PORT TX/RX switched inside module
14	LEV ADJ	LEV ADJ 4Ω 400	LEVEL ADJUST Open for maximum power Insert resistor to lower over 20db range
16	CH SEL0/UDATA	CH SEL 0 10K	CHANNEL SELECT 0 / USER DATA Binary channel select 0 in parallel mode User data in serial mode
17	CH SEL1/UCLOCK	CH SEL 1 10K	CHANNEL SELECT 1 / USER CLOCK Binary channel select 1 in parallel mode User clock in serial mode
18	CH SEL 2	CH SEL 2 10K	CHANNEL SELECT 2 Binary channel select 2 in parallel mode Not used in serial mode
20	MODE	MODE 10K	MODE SELECT Internally pulled up Leave open or high for serial channel mode Ground for parallel selection

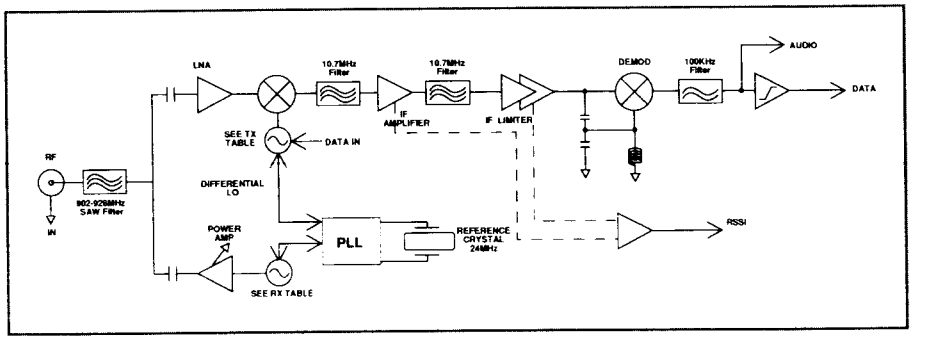


Figure 6: MC Series Block Diagram

DESCRIPTION

The TC-900-MC-PA module is a multi-channel, half-duplex transceiver designed for the transmission of digital data wirelessly at distances of <500 feet outside and <200 feet inside. No external components (excluding an antenna) are required. The module incorporates on-board switch allowing the use of a single antenna. Linx offers a wide selection of antennas designed for use with the transceiver module. The PA version has been pre-certified by the FCC which greatly reduces the time to market and cost of product introduction.

The transceiver is half-duplex. Therefore, it can only be operated in one mode at a time: either transmit mode or receive mode. When transmitting, the receiver is powered down. Likewise, the transmitter is powered down in receive mode.

The TC-900-MC-PA incorporates a precision Low-Dropout Regulator on-board which allows the module to operate over an input voltage range of 2.7 to 16 volts DC. An on-board micro-controller reads the channel-selection lines and programs the PLL to the desired channel frequency. The MC-PA allows parallel selection from eight channels. For greater flexibility the MC-PA features a serial mode for selection from 250 channels. In this mode the desired channel is programmed via a single eight-bit word.The micro-controller also monitors the status of the PLL and indicates when the transmitter is stable and ready to transmit data by raising the Lock Detect (LD) line high.

TRANSMITTER OPERATION

The transmit section of the transceiver is capable of producing up to 1mW of output power while maintaining harmonics and spurious emissions within legal limits.

The transmitter is comprised of an LO and crystal-controlled frequency synthesizer. The frequency synthesizer phase locks the LO to a precision crystal to achieve a high-Q, low phase-noise oscillator. An accurate 24.00MHz VCXO (voltage-controlled crystal oscillator) serves as the frequency reference for the transmitter. The modulated 24.00MHz reference frequency is applied to the Phase-Locked Loop (PLL). The PLL, combined with a 902-928MHz VCO, forms a stable frequency synthesizer that can be programmed to oscillate at the desired transmit frequency.

An on-board micro-controller reads the channel-selection lines and programs the

PLL to the desired channel frequency. The micro-controller also monitors the status of the PLL and indicates when the transmitter is stable and ready to transmit data by raising the Lock Detect (LD) line high. The transceiver's LD output is often used as a clear-to-send (CTS) indication so that data transmission can begin instantly upon PLL lock.

Digital information is modulated at the transmitter using FSK (frequency shift keying), the binary form of frequency modulation. FSK offers significant advantages over AM-based modulation methods, i.e., increased noise immunity and the ability of the receiver to "capture" in the presence of multiple signals. These advantages will be particularly appreciated in crowded bands like those in which the MC-PA operates.

The transmit power amplifier is fixed for FCC complience and cannot be adjusted.

The output of the transmitter's power amplifier is connected to a Surface Acoustic Filter (SAW) which is used to suppress harmonic emissions. All harmonic specifications are based on a 50-ohm load. The module incorporates an on-board switch allowing the use of a single antenna. Linx offers a wide selection of antennas designed for use with the transceiver module. It is important to note that the module must be used with the correct, preapproved antenna in order to maintain its pre-certified status.

RECEIVER OPERATION

The receive section of the transceiver is a single conversion superhet configuration, with an IF of 10.7 MHz. The receiver combines outstanding sensitivity and remarkably low power consumption.

The incoming RF signal is filtered by Surface Acoustic Filter (SAW) which is used to attenuate unwanted out of band energy. A SAW filter provides significantly steeper roll-off and higher out-of-band attenuation than many other filter types.

Once filtered, the signal is amplified by a Low-Noise Amplifier (LNA) which increases the receiver sensitivity and results in a low overall noise figure. After the LNA the signal is introduced to a mixer where it is combined with a high-side local oscillator frequency generated by the synthesized 24.00MHz VCXO (voltage-controlled crystal oscillator) which serves as the frequency reference for the transmitter.

After the mixer, the 10.7 MHz by-product is passed through additional filtering and gain stages. A quadrature demodulator is used to recover the baseband signal from the carrier. After demodulation the low-level baseband signal is filtered, then fed to a proprietary high-performance data slicer. The data slicer is capable of recreating squared waveforms within a 1200Hz to 75kHz analog bandwidth, giving a data-rate bandwidth of 2400bps to 150kBps. The slicer assures fast and square edge transitions and restores much of the symmetry of the original data. In addition, the slicer restores the data to its original phase and qualifies the data output by comparison of the RSSI level with a factory-preset squelch threshold. When the transmitter is on but not being modulated, or when the received signal strength is too low to ensure proper demodulation, the data output is squelched to a continuous high state. This ensures compatibility with

common serial UART's which expect to see a high-to-low transition as a start sequence. The final data output is a remarkably accurate recreation of the original data suitable for direct interface with a wide variety of external devices.

TIMING CONSIDERATIONS

There are several important timing parameters listed under the "Performance Specifications" section of this document. It is important to consider when designing Start-Up time and RX-to-TX time. The value for each is Please make sure that you have a current data sheet prior to designing with the Transceiver.

The TX start-up time is measured as the time from the /PDN pin going high to the transmitter being ready to transmit data.

The RX start-up time is measured as the time from the /PDN pin going high to the receiver's data output being valid.

The RX-to-TX time is measured as the time from the RX/TX select line going high to the transmitter being ready to transmit data.

The TX-to-RX time is measured as the time from the RX/TX select line going low to the receiver's data output being valid.

Parameter	Description	Min.	Max.
T_1	TX initial startup time		5 mSec
T_2	Max time between data output transitions		33 mSec
T_3	TX Channel Change Time (Time to Valid Data)		10 mSec
	TX to RX time		
T_4	RX initial startup time		12 mSec
	RX Settling time		
TX	Channel Change Time (Time to Valid Data)		10 mSec
	RX to TX time		
T_5	Min. Off Time	1 mSec	

POWER CONSIDERATIONS

The transceiver has an on-board voltage regulator that regulates the internal VCC to 3.0V. This allows a wide operating voltage range of 2.7V to 16V. At 2.7V, the internal regulator acts as a saturated switch, directly passing voltage through to the internal electronics. The /PDN pin can be used to put the transceiver into a low-current sleep mode (<50uA).

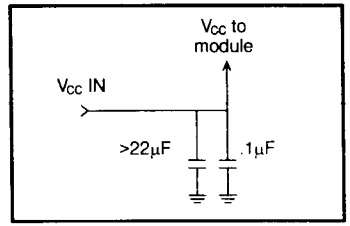


Figure 7: Suggested supply filter

The user must provide a clean source of power to the receiver to ensure proper operation. In an FM receiver, power-supply noise will manifest itself as AM and FM noise in the receiver circuitry, reducing the overall sensitivity of the receiver. Providing a good power supply for the module is a designer's first line of defense in the battle for receiver sensitivity. The module's power-supply line should have bypass capacitors configured, as shown in figure 7, in near proximity to the module. The designer should check the incoming supply for system noise as additional filtering may be required.

CHANNEL SELECTION

The MC-PA has an on-board microcontroller which serves to greatly simplify the channel-selection process by eliminating the traditionally complex ritual of calculating and programming the synthesizer's many counter and control registers. Instead, the MC-PA allows channel selection in the two convenient formats described below. *IMPORTANT NOTE: The mode selected at power-up remains in effect regardless of changes in the mode status line. If both parallel and serial modes are to be alternately used in the same device, supply must be cycled in order for the mode change to be recognized.

Parallel Mode

When the mode select line is grounded at power-up the transceiver will allow parallel selection of eight channels. The Mode line may be permanently wired high or controlled by external logic if both Parallel and Serial channel selection modes are to be used.The channel of operation is determined by the state of pins CS0-CS2. Figure 17 shows a channel-selection table based on the pins' states. This mode allows for manual channel selection via switches in product designs where a microprocessor is not used. The eight channels selected in this mode correspond with the frequencies of Linx' popular HP-series for use in mixed module environments.

Serial Mode

The serial selection mode is entered by assuring that the Mode line is high at transceiver power-up. In this mode CS0 becomes a user data line and CS1 becomes a user clock line. Together these two lines form a simple synchronous interface which allows the direct selection of 250 channels via an external microprocessor. A synchronous data transfer protocol was chosen because of its ease of interface and flexibility. The synchronous method chosen by Linx is unique but quite similar to the I2C standard. Two pins (CLOCK and DATA) are controlled externally to transfer a single eight-bit word containing the desired channel number. Each bit is delimited for transfer by a pulse on a separate clock line. Because each data bit is associated with a clock bit the module will, within the specified limits, correctly recognize a bit regardless of the clock rate or asymmetry. User information can be transferred from near DC to very high data rates and the rate can vary across those limits throughout the data transfer process.

Channel selection is accomplished by a frame sequence followed by an eight-bit number from 0-250 representing the desired channel as shown in the adjoining diagrams.

In order to delimit the data and assure the most robust interface, a packet must be started with a framing sequence in order to be considered valid.

Both the data and clock pins are internally pulled high on the module. The framing sequence consists simply of externally pulling both the clock and data pins low then returning the clock line high. This prepares the module to accept an eight-bit word synchronously, LSB first. Data bits are transferred by taking the DATA pin high or low to represent the bit being sent and then pulling the CLOCK line low. Data is transferred on the FALLING edge. The CLOCK line is then restored high to prepare for the next bit's transfer. When eight bits have been received by the modules on-board processor the data is automatically latched and read. The auto-latch feature is designed to minimize the number of external I/O lines and programming requirements. Application note #155 (Serial Loading Techniques for the MC- Series) provides further details of interface and includes sample code for the popular PIC microcontroller.

It is important to note that the module has several modes designed to handle loading errors and assist the designer in troubleshooting. When an error such as an absent or improper load occurs, the module will automatically go to a preset frequency. By using a spectrum analyzer on any HP series receiver module the error type can be identified. It is important to note that the module will always be active on some frequency anytime it is powered on whether loaded externally or not. This is to allow troubleshooting and insure FCC compliance.

If you are unfamiliar with utilizing a microprocessor for synchronous data transfer, you may wish to review the following software which demonstrates a simple synchronous serial transfer routine for the popular Microchip PIC processor.

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 by Linx in the internal design of the module, integration 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.

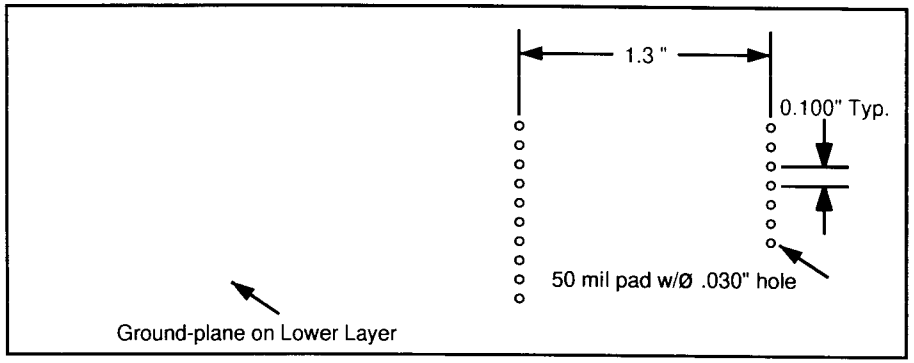


Figure 8: Recommended PCB layout

Figure 8 shows the suggested PCB footprint for the MC-PA Series transceiver.

The module should, as much as reasonably possible, be isolated from other components on your PCB. Specifically, high-frequency circuitry such as crystal oscillators should be kept as far away as possible from the module. Avoid running noise bearing traces under the module or in the vicinity of the antenna.

A groundplane (as large as possible) should be placed under the Transceiver. This groundplane can also be critical to the performance of your antenna. In most cases the module will be used with a 1/4-wave antenna. The groundplane serves as the antenna's counterpoise, forming, in essence, a half-wave dipole.

Since the MC-PA is designed to utilize antennas which attach directly, the orientation of the module on the product's PCB is important. Several possible orientations are shown below.

The optimum orientation for the antenna would be centered on the edge of the groundplane, shown in figure 9-A.

Position shown in figure 9-B is **NOT** recommended.

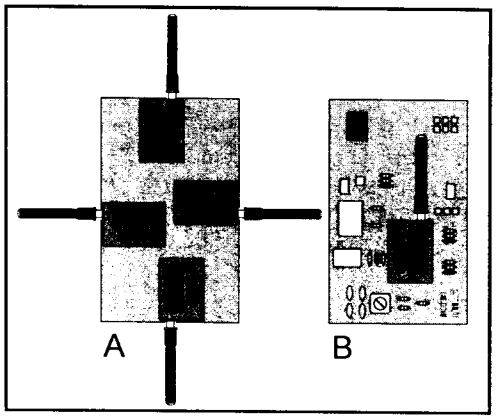


Figure 9: Groundplane orientation

ANTENNA CONSIDERATIONS

The MC-PA series transceivers feature a unique RP-SMA antenna connector. This connector is designed to allow the convenience and flexibility of a detachable antenna while maintaining compliance with FCC guidelines.

Linx and other manufacturers sell a variety of antenna styles and connectors designed to mate with the module's RP-SMA connection. It is important to note, however, that the module must be used with the appropriate Linx antennas in order to retain its pre-approved status. Other antennas may be used; however, recertification would be necessary prior to offering the product for sale. The antennas pictured below illustrate styles that would be commonly employed. Please contact Linx or visit www.linxtechnologies.com for the most current information on compliant antenna styles.

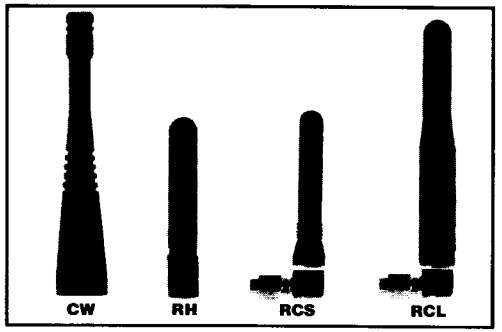


Figure 10: Compatible Linx Antenna Styles

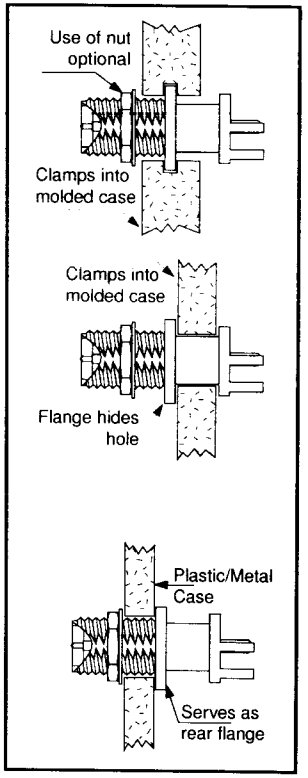


Figure 11: Mounting Options

A SYSTEM'S DESIGN APPROACH

To properly apply the transceiver, the designer must take a "systems" view of the communications link.

In this communication system, there are a transmitter, an antenna, free space, an antenna, and a receiver. At every point in this system, there are timing and data corruption issues that must be fully understood and accounted for.

It is important to note that the TC-900-MC-PA does not encode or packetize the data in any manner. This transparency eliminates the issues of variable latency common to traditional radio modems and gives the designer tremendous flexibility in the structure of protocol. A drawback to this approach is that the performance and reliability of the link is in part determined by the quality of external software and hardware. It is critical that all project engineers have a full understanding and respect for the differences that exist between a wired and a wireless environment. The following section briefly outlines the typical flow of

events in a link incorporating MC series modules. There are many alternative methodologies but it is intended to illustrate some of the considerations previously mentioned.

The MC series is a half-duplex transceiver. This means that the transceiver itself can only act as a transmitter or a receiver at any given time, but never both. When designing with a half-duplex transceiver it is important to allow for the timing requirements when shifting between transmit and receive modes. In a typical system, the operation will be as follows:

1) Switch to transmit mode

The transceiver is placed in transmit mode by bringing RX/TX line high or leaving it floating. The PDN pin must be open or pulled to VCC. Once the transceiver is placed in transmit mode, it will start the VCXO (voltage controlled crystal oscillator) and begin trying to phase-lock the main carrier to the VCXO.

2) Wait for transmitter to stabilize

This step is necessary to allow the transmitter time to stabilize. Lock will be indicated by the lock detect (LD) pin after which time the transmitter is ready to begin sending data. If the LD pin is not utilized the designer must allow the maximum lock time listed elsewhere in this document.

3) Transmit a packet

Packets should be transmitted so that there is no space between bytes. The following packet format should be followed:

[uart sync byte] [start byte] [packet data]

The UART sync byte is used to ensure that the start-bit for the start byte will be accurately detected. It is a single byte with a value of 0FF hex.

The start byte indicates the beginning of the packet. The detection of the start byte would be performed by the computer or microcontroller connected to the transceiver.

4) Switch to receive mode

The transceiver is placed in receive mode by pulling the RX/TX line low. The PDN pin must be open or pulled to VCC. Once the transceiver is placed in receive mode, it will start the crystal oscillator and begin trying to phase-lock the LO to the crystal.

5) Wait for receiver to stabilize

This step is necessary to allow the receiver time to stabilize. When the LO is phase-locked and the data slicer stable, the transceiver is ready to receive valid data.

6) Receive a packet

The pre-amble serves to set up the data slicer, but can confuse the UART. The UART interprets the start-bit of a byte as a 1-0 transition. When the incoming data is 101010... it is hard to know which 1-0 transition actually marks the start bit. This problem is solved by the UART Sync Byte. It will cause the bit pattern to look like this:

...010101 0111111111. The space indicates the beginning of the UART Sync byte. If the UART were to interpret the last 1-0 transition as a start-bit, it would receive the following byte: 1011111111. The remaining 1's would be ignored and the start-bit of the start byte would be correctly recognized.

The start byte is used by the receiving computer or microcontroller to detect the beginning of a valid packet. In reality, there may actually be two start bytes. In any case, the start byte should be chosen so that it does not appear in the data stream. Otherwise, a receiver may "wake up" in the middle of a packet and interpret data in the packet as a valid start byte. There are other, more complicated ways to organize the protocol if this restriction cannot be met.

There is a possibility of bursting errors corrupting the data packet, so we recommend that some form of error checking be embedded in the data packet. A simple checksum or CRC could be used.

When used for half-duplex communications, the microcontroller will basically run through the steps in order and then return back to step 1, flipping back and forth between transmit and receive modes. In this case, the designer must take into account the timing considerations of both the transmitting and receiving sides. The preceding flow description is very simplistic and is intended for illustration purposes only. The systems designer should carefully think through protocol issues to ensure reliability under field conditions.

LEGAL CONSIDERATIONS

The TC-900-MC-PA module has been previously tested and received certification as a modular product from the FCC. No further testing of the module is necessary when compliant antennas are employed. The pre-certified status of the module is valid only if all of the following are observed:

- No modifications to the module may be made.
- The module must utilize Linx antennas which have been previously tested with the module and approved for FCC compliance.
- The pre-certified status applies only to the RF module. The user must determine if additional certification or testing is required for peripheral circuitry.
- If the transceiver's own label is not visible when installed inside another device then the device must display an external label referring to the enclosed module. The exterior label should appear as follows:

> This device contains
> a previously certified
> RF Transceiver module
> FCC ID:OJM-TC-900-MC

The product's instruction manual must display the following statement:

INSTRUCTION TO THE USER

This equipment contains an RF module which has been previously tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

Reorient or relocate the receiving antenna.

Increase the separation between the equipment and receiver.

Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

Consult the dealer or an experienced radio/TV technician for help.

This equipment has been certified to comply with the limits for a Class B computing device, pursuant to FCC Rules. In order to maintain compliance with FCC regulations, shielded cables must be used with this equipment. Operation with non-approved equipment or unshielded cables is likely to result in interference to radio and TV reception. The user is cautioned that changes and modifications made to the equipment without the approval of manufacturer could void the user's authority to operate this equipment.

NOTE: MC-PA Series Modules are pre-approved by the FCC for operation within the United States; however, they are not approved by other agencies worldwide. The purchaser should understands that additional approvals may be required prior to the sale or operation of the device, and agrees to utilize the component in keeping with all applicable laws in the country of operation.

Questions regarding domestic rules 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

ACHIEVING A SUCCESSFUL RF IMPLEMENTATION

Adding wireless capabilities brings an exciting new dimension to any product. By utilizing Linx pre-certified RF modules the cost, effort, and time necessary to bring your product to market will be greatly reduced. 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.

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**
00126	**Considerations for operation in the 902 Mhz to 928 Mhz band**
00100	**RF 101: Information for the RF challenged**
00140	**The FCC Road: Part 15 from concept to approval**
00150	**Use and design of T-Attenuation Pads**
00102	**RS-232 A brief overview**
00161	**Considerations for sending data with the SC Series***

* =Not available at the time of this printing

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