

TTAB

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE  
BEFORE THE TRADEMARK TRIAL AND APPEAL BOARD**

In the Matter of Trademark Application, Serial No. 76/417,545 Published in the Official Gazette on April 8, 2003.

Linx Technologies, Inc. )  
 )  
 Opposer )  
 )  
 v. )  
 )  
 Recoton Audio Corporation )  
 )  
 Applicant )

Opposition No. \_\_\_\_\_

Assistant Commissioner for Trademarks  
2900 Crystal Drive  
Arlington, VA 22202-3513

06-11-2003  
U.S. Patent & TMO/c/TM Mail Rcpt Dt. #71

**NOTICE OF OPPOSITION**

This Notice of Opposition is timely filed under a 1 month extension approved on May 8, 2003, ESTTA Tracking Number ESTTA 1645, and 37 C.F.R. §1.6(a)(1), next business day.

Linx Technologies, Inc., an Oregon Corporation, located at 575 SE Ashley Place, Grants Pass, Oregon 97526, believes that it will be damaged by the registration of the mark LINX, Serial Number 76/417,545, and hereby opposes registration of the same.

As grounds of opposition, it is alleged that:

1. Applicant's mark, LINX and design, Serial Number 76/417,545, is being applied for in class 9 in connection with "home and mobile **audio** and video equipment, namely electronic devices incorporating the technology for converting any headphone system to a **wireless system**", date of First Use In Commerce of June 1, 2000.

06/24/2003 KGIBBONS 00000059 500393 76417545

01 FC:6403 100.00 DA

2. Opposer's mark LINX, Serial Number 76/390,815, is being applied for in class 9 in connection with "wireless radio frequency modules, integrated circuits, **completed wireless products**, namely, radio frequency remote control transmitters and receivers, radio frequency connectors and antennas used for consumer, medical, industrial and commercial applications," date of First Use In Commerce of September 1, 1996.

3. Opposer uses the LINX word mark in connection with advertising its wireless radio frequency modules, integrated circuits, completed wireless products, namely, radio frequency remote control transmitters and receivers, radio frequency connectors and antennas used for consumer, medical, industrial and commercial applications, including wireless data transfer, **audio**/analog signal transfer, process monitoring, home/industrial automation, keyless entry, remote control, fire/security alarms, wireless networks, remote status sensing, telemetry, RS-232/485 data links, MIDI links, and voice links/intercoms. See Exhibit A.

4. Opposer has continuously engaged in the business of selling original equipment manufacturer (OEM) and consumer-targeted products listed above, since well before the date of First Use In Commerce of June 1, 2000 claimed by Applicant.

5. Opposer has, since at least September 1, 1996, continuously used the LINX word mark in connection with wireless radio frequency modules, integrated circuits, completed wireless products, namely, radio frequency remote control transmitters and receivers, radio frequency connectors and antennas used for consumer, medical, industrial and commercial applications, including wireless data transfer, audio/analog signal transfer, process monitoring, home/industrial automation, keyless entry, remote control, fire/security alarms, wireless networks, remote status sensing, telemetry, RS-232/485 data links, MIDI links, and voice links/intercoms.

6. Opposer has, since well before Applicant's First Use In Commerce claim, advertised, marketed and promoted the LINX mark in a variety of ways, including, but not limited to, use on Opposer's website, in brochures, on the actual product, at trade shows, in magazines and trade journals. See Exhibit A and B.

7. As a result of such continuous use, advertisement, and promotion of the LINX mark, Opposer's use of the mark clearly distinguishes its goods from that of others.

8. Applicant's proposed use of the mark LINX to denote home and mobile audio and video equipment, namely electronic devices incorporating the technology for converting any headphone system to a **wireless system**, is closely related to the goods offered by the Opposer under the LINX mark, which is likely to cause confusion, mistake or deceive as to the source of origin of Applicant's goods.

9. Applicant's LINX mark and design, is closely related to Opposer's LINX word mark due to the prominence of the word LINX, and the similarity of the goods. Opposer believes that this will falsely suggest a connection or association of Applicant with the Opposer and that prospective and actual consumers of the goods provided by the Applicant will likely believe that such goods emanate from or are in some way associated or affiliated with Opposer. As such, Opposer believes it will be damaged by Applicant's registration in the following ways:

- a) Any confusion in products with similar names would mislead consumers and dealers and could damage the reputation of Opposer and its products.
- b) Opposer's products represent the latest in wireless technology and Opposer has been promoting and perfecting the LINX products since 1994. OEM and consumer perceptions of the LINX product would be damaged if they purchased the Applicant's

product and the products did not perform to level they expected if they had purchased Opposer's product.

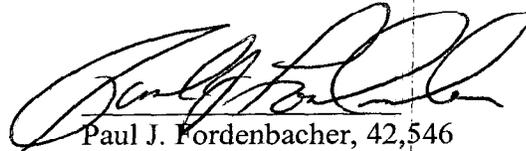
c) Opposer solicits OEM and user input on product performance, comfort, and safety. Opposer's reputation would be damaged if OEM and user were to become confused by the Applicant's and Opposer's products, and thus not receive appropriate feedback on their product.

10. For the foregoing reasons, Opposer believes that registration of LINX and design by the Applicant will seriously damage the Opposer.

WHEREFORE, Opposer believes it will be damaged by registration of the mark sought to be registered by Applicant and prays that such registration be denied.

DATED: June 9, 2003

Respectfully submitted,



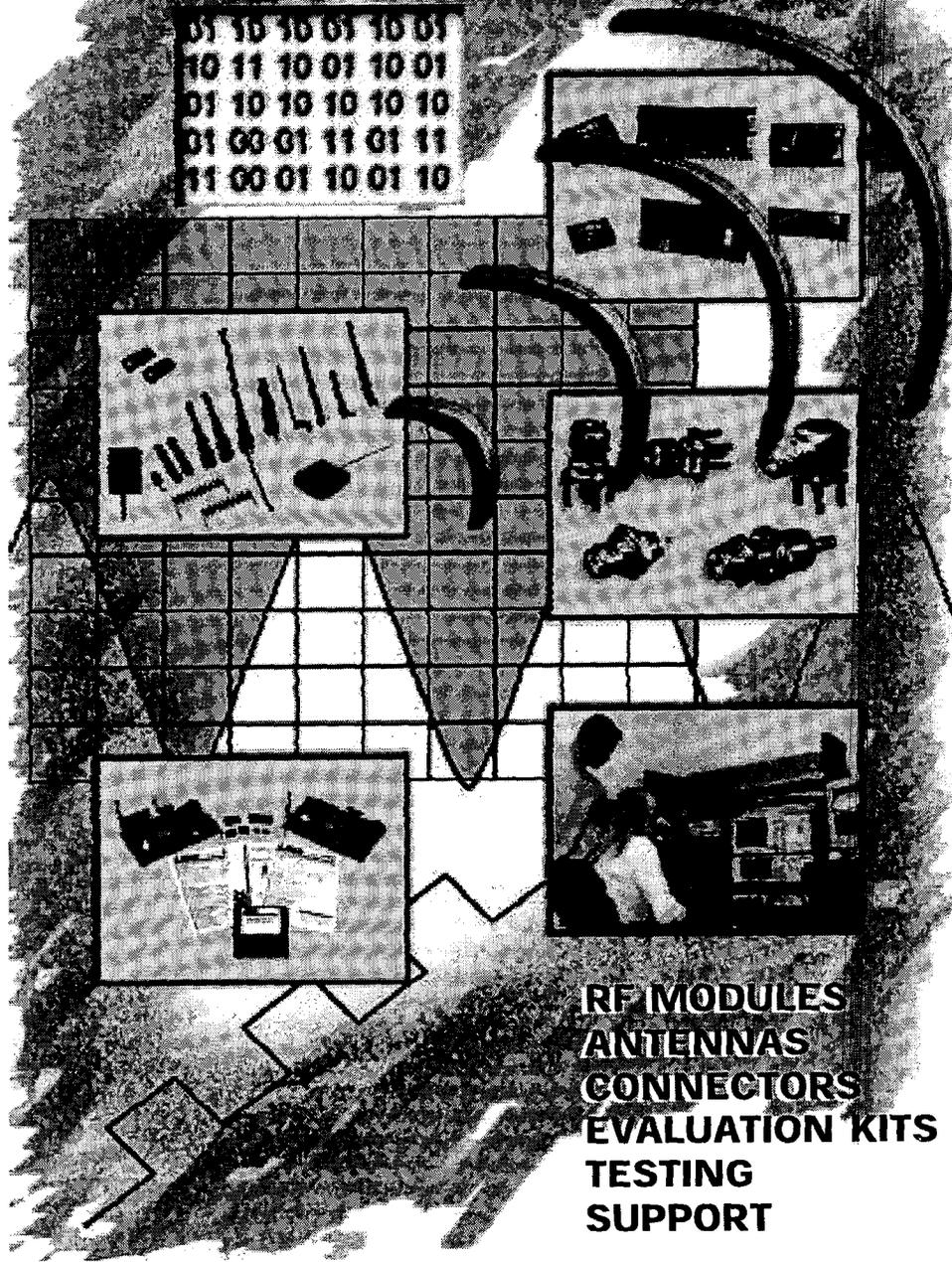
Paul J. Fordenbacher, 42,546  
Of Attorneys for Opposer

Exhibit A



# Product Overview Guide

Quarter 2, 2003



# Table of Contents

<b>RF MODULES</b>	<b>1</b>
<b>RF AMPLIFIERS</b>	<b>2</b>
<b>EVALUATION SYSTEMS</b>	<b>3</b>
<b>PRECERTIFIED OEM PRODUCTS</b>	<b>4</b>
<b>ANTENNAS</b>	<b>5</b>
<b>CONNECTORS</b>	<b>6</b>
<b>SERVICES</b>	<b>7</b>
<b>APPLICATIONS LITERATURE</b>	<b>8</b>
<b>SALES POLICIES</b>	<b>9</b>



# LC SERIES TRANSMITTER MODULES

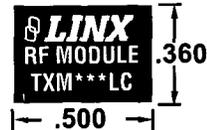


## Description:

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

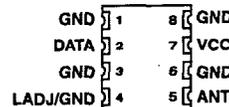
### TOP VIEW



### SIDE VIEW



### TOP VIEW



## PINOUTS

## 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
TXM-***-LC	LC Transmitter
EVAL-***-LC-P	LC Basic Evaluation System
MDEV-***-LC-P	LC Master Development System

\*\*\* = Frequency 315, 418, 433.92 MHz

LC Modules are supplied in tubes.



## ES-SERIES RF MODULES



### Description:

Housed in a tiny SMD package, the ES utilizes an advanced FM/FSK-based synthesized architecture to provide superior performance and noise immunity when compared to AM/OOK solutions. An outstanding 56Kbps maximum data rate and wide-range analog capability make the ES-Series equally at home with digital data or analog sources such as audio. A host of useful features including RSSI, PDN, audio reference, LVL ADJ, low voltage detect, and a microprocessor clock source are provided. ES series components will be available in a wide range of frequencies. The first model operates at 916.48MHz which in North America allows an unlimited variety of applications including data links, audio links, process and status control, home and industrial automation, security, remote control/command, and monitoring. Like all Linx modules, the ES Series requires no tuning or external RF components (except an antenna).

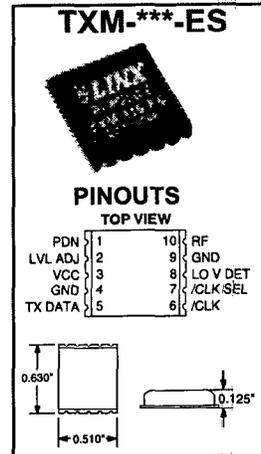
### Applications Include:

- Wireless Data Transfer
- Audio/Analog Signal Transfer
- Process Monitoring
- Home/Industrial Automation
- Keyless Entry
- Remote Control
- Fire/Security Alarms
- Wireless Networks
- Remote Status Sensing
- Telemetry
- RS-232/485 Data Links
- MIDI Links
- Voice Links/Intercoms

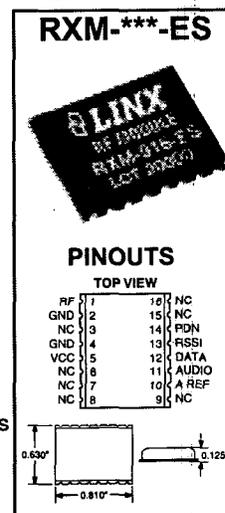
### Features:

- Ultra-compact SMD package
- FM/FSK modulation for performance/noise immunity
- Precision-frequency synthesized architecture
- Excellent sensitivity for outstanding range performance
- Very low current for long life in battery-powered applications
- Direct interface to analog and digital sources
- High data rate - 56,000 bps max.
- Wide-range analog capability including audio 20Hz-28KHz
- No tuning or external RF components required (except antenna)
- User powerdown input
- RSSI signal strength output
- Low-voltage detect and microprocessor clock output on TX
- Cost-effective: low cost vs. performance

### TRANSMITTER PHYSICAL DIMENSIONS



### RECEIVER PHYSICAL DIMENSIONS





# LC SERIES RECEIVER MODULES

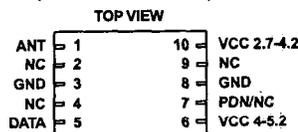
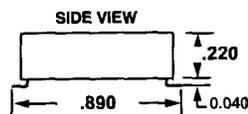
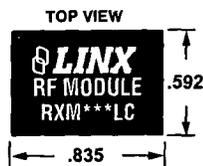


## P-STYLE (PINNED SMD VERSION)

### Description:

The LC Series is ideally suited for volume use in OEM applications such as remote control, security, identification, and periodic data transfer. Available in 2 styles of compact SMD packages, the LC receiver utilizes a highly optimized SAW architecture to achieve an unmatched blend of performance, size, efficiency and cost. When paired with a matching LC-Series transmitter, 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



### Features:

- Low Cost
- No External RF Components Required
- Low Power Consumption
- Compact "L" Leg Surface-Mount Package
- Stable SAW-Based Architecture
- Outstanding Sensitivity
- Supports Data Rates to 5,000 bps
- Wide Supply Range (2.7-5.2 VDC)
- Qualified Data Output
- Direct Serial Interface
- 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

### PINOUTS

### ORDERING INFORMATION

PART #	DESCRIPTION
RXM-***-LC-P	LC Receiver (Pinned SMD)
EVAL-***-LC-P	LC Basic Evaluation System
MDEV-***-LC-P	LC Master Development System
*** = Frequency 315, 418, 433.92 MHz	
LC Modules are supplied in tubes.	



# LC SERIES RECEIVER MODULES

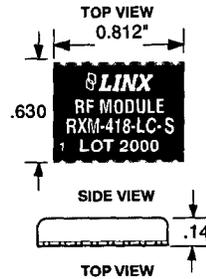


## ULTRA-COMPACT S-STYLE (TRUE SMD VERSION)

### Description:

The LC Series is ideally suited for volume use in OEM applications such as remote control, security, identification, and periodic data transfer. Available in 2 styles of compact SMD packages, the LC receiver utilizes a highly optimized SAW architecture to achieve an unmatched blend of performance, size, efficiency and cost. When paired with a matching LC-Series transmitter, 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.

### PHYSICAL DIMENSIONS



TOP VIEW

1	NC	ANT	18
2	NC	GND	15
3	NC	NC	14
4	GND	NC	13
5	VCC	NC	12
6	PDN	NC	11
7	NC	NC	10
8	DATA	NC	9

### PINOUTS

### Features:

- Low Cost
- No External RF Components Required
- Low Power Consumption
- Compact True Surface-Mount Package
- Stable SAW-Based Architecture
- Outstanding Sensitivity
- Supports Data Rates to 5,000 bps
- Direct Serial Interface
- 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
- Wire Elimination
- Long-Range RFID

### ORDERING INFORMATION

PART #	DESCRIPTION
RXM-***-LC-S	LC Receiver (SMD)
EVAL-***-LC-S	LC-S Basic Evaluation System
*** = Frequency 315, 418, 433.92 MHz	
LC Modules are supplied in tubes.	

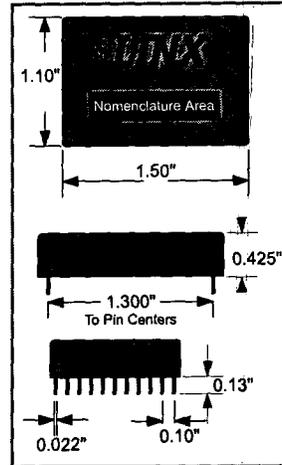


## SC SERIES TRANSCIVER MODULE



### Description:

The TR-\*\*\*-SC-P transceiver module is designed for the cost-effective, bi-directional transfer of wireless information. The transceiver utilizes an advanced synthesized superhet architecture and has direct interface for analog or digital information, fully qualified UART-compatible data output, RSSI, low power consumption, wide operational voltage, on-board TX/RX switch, SAW front-end filter, and many other useful features. Fast turnaround times, along with the support for data rates to 33.6Kbps, make the transceiver suitable for a wide range of applications. Housed in a compact through-hole package, the transceiver requires no tuning or external RF components (except antenna), allowing for straightforward application, even by engineers lacking previous RF experience.



### Features:

- Precision Crystal-Controlled Synthesized Architecture
- Transparent Serial Input
- UART-Compatible Data Output
- Built-In Data Squelching
- High Data-Rate: 33,600bps
- Analog Capable, Including Audio
- Single-Antenna-Ready (No TX/RX Switch Required)
- FCC-Compatible
- Differential LO Dramatically Reduces Unintended Radiation
- Output Power Can Be Programmed With An External Resistor
- Good Sensitivity (-94dBm Typical at 10<sup>-5</sup> BER)
- SAW Filter on 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 13 VDC)
- Very Low Power Consumption (as Low as 12mA)
- Power-Down Mode – 50µA Max (VCC @ 5V)

### PHYSICAL DIMENSIONS

GND	1	20	GND
RX DATA	2	19	GND
AUDIO	3	18	GND
RSSI	4	17	GND
PDM	5	16	GND
NC	6	15	GND
RXEN	7	14	LV/LADJ
TXEN	8	13	GND
TXDATA	9	12	ANT
VIN	10	11	GND

### PINOUTS

Viewed from top

### Applications

- Wireless Data Transfer
- Audio/Analog Signal Transfer
- Process Monitoring
- Home/Industrial Automation
- Remote Control
- Wireless Networks
- Telemetry
- RS-232/485 Data Links
- Voice Links/Intercoms

### ORDERING INFORMATION

PART #	DESCRIPTION
TR-***-SC-P	SC Transceiver
EVAL-***-SC-P	SC Evaluation System
MDEV-***-SC-P	SC Master Development System
***= 433.92, 906.37, 909.37, 916.48 MHz	

## PERFORMANCE DATA TR-\*\*\*-SC

### 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
Center Frequency	Fc		Model Dependent		MHz	
Fc Tolerance		-50		+50	KHz	1
Output Power	Po	-3	-0	+4	dBm	2,3
Output-Power Control Range			15		dB	2,4,8
Harmonic Emissions	Ph		-43		dBc	
Spurious Emissions		Compatible with FCC Part 15				
Frequency Deviation		90	110	130	KHz	5
Data Rate		300		33,600	Bps	8
Audio Modulation Bandwidth		.15		17	KHz	7,8
Modulation Voltage						
Digital (Mark)		3	5	5.2	VDC	9
Digital (Space)		0	0		VDC	
Analog		0		3	Vp-p	10
<b>RECEIVE SECTION</b>						
Receive Frequency	Flo		Model Dependent		MHz	
Flo Tolerance		-50		+50	KHz	
Local Oscillator Feedthru			-65	-50	dBm	2
Spurious Emissions		Compatible with FCC Part 15				
Receive Sensitivity		-90	-94	-100	dBm	6
Data Rate		300		33,600	Bps	8
Required Transition Interval				3.5	ms	8,14
Audio Bandwidth		.15		17	KHz	7,8
Audio Level			180		mVp-p	8
RSSI DC Output Range			.7 to 2.5		V	8
RSSI Gain	Grssi		27		mV/dB	8
RSSI Dynamic Range			65		dB	8
<b>ANTENNA PORT</b>						
Designed for match			50		ohms	8
<b>TIMING</b>						
Power-on to Valid Receive			6	8	ms	8, 9,11
Power-on to Valid Transmit			3	5	ms	8, 9,11
RX to Valid TX Switching			3	5	ms	8,9,12
TX to Valid RX Switching			4	6	ms	8,9,13
<b>POWER SUPPLY</b>						
Operating Voltage	VCC (pin 10)	2.7		13	VDC	
Current Consumption	Icc					
TX Mode		12		29	mA	
RX Mode		10	13	15	mA	
Sleep Mode			50		uA	8
<b>ENVIRONMENTAL</b>						
Operational Temp.		0		70	°C	

RF MODULES 1

#### NOTES:

- Center frequency measured while modulated with a 0-5V square wave.
- Into a 50-ohm load
- LVLADJ open
- Maximum power when LVLADJ open, minimum power when LVLADJ grounded
- TXDATA pin modulated with a 0-5V square wave.
- For 10<sup>-6</sup> BER at 9,600 baud
- The audio bandwidth is wide to accommodate the needs of the data slicer. In audio applications, audio quality may be improved by using a low-pass filter rolling off at the maximum frequency of interest.
- These parameters are only characterized and not tested.
- The SC is optimized for 0-5V modulation when sending digital data. 0-3V modulation is possible but will slightly reduce system sensitivity and increase settling times.
- Analog signals including audio should be AC-coupled. Signals in excess of 3V will cause distortion.
- Time to transmitter or receiver readiness from the application of power to VIN or PDN going high
- Time from the TXEN going high and RXEN going low to the transmitter being ready to transmit data
- Time from the RXEN going high and TXEN going low to valid receiver data output
- Maximum time without a data transition

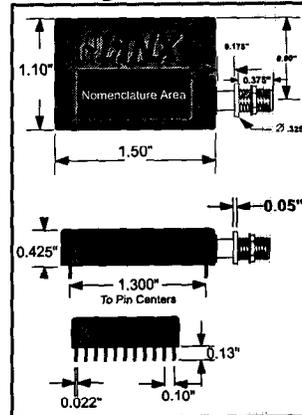


## SC SERIES PRECERTIFIED TRANSCEIVER MODULE

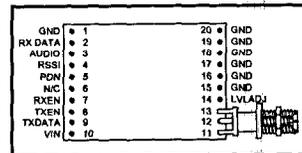


### Description:

The PA version of Linx popular SC Series greatly reduces the time and expense of making a product wireless. That is because it is pre-approved by the FCC when used with the appropriate proprietary antennas. The transceiver is designed for the cost-effective, bi-directional transfer of analog & digital information. Housed in a compact through-hole package, it utilizes an advanced synthesized superhet architecture and has direct interface for analog or digital information, fully qualified UART-compatible data output, RSSI, low power consumption, wide operational voltage, on-board TX/RX switch, SAW front-end filter, and many other useful features. Fast turnaround times, along with the support for data rates to 33.6Kbps, make the transceiver suitable for a wide range of applications. The transceiver requires no tuning or external RF components, except an antenna, making integration straightforward.



PHYSICAL DIMENSIONS



PINOUTS

Viewed from top

### Features:

- FCC-Precertified For Immediate Integration
- Precision Crystal-Controlled Synthesized Architecture
- Transparent Serial Input
- UART-Compatible Data Output
- Built-In Data Squelching
- High Data Rate: 33,600bps
- Can Transmit Intercom-Quality Audio
- Single Antenna Ready (No TX/RX Switch Required)
- Differential LO Dramatically Reduces Unintended Radiation
- Output Power Can Be Programmed With An External Resistor
- Good Sensitivity (-94dBm Typical at 10<sup>-5</sup> BER)
- SAW Filter on 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 13VDC)
- Very Low Power Consumption (as Low as 12mA)
- Power-Down Mode – 50µA Max (VCC @ 5V)

### Applications Include:

- Wireless Data Transfer
- Audio/Analog Signal Transfer
- Process Monitoring
- Home/Industrial Automation
- Remote Control
- Wireless Networks
- Telemetry
- RS-232/485 Data Links
- Voice Links/Intercoms

### ORDERING INFORMATION

PART #	DESCRIPTION
TR-916-SC-PA	SC Transceiver
EVAL-916-SC-PA	SC Evaluation System
MDEV-916-SC-PA	SC Master Development System

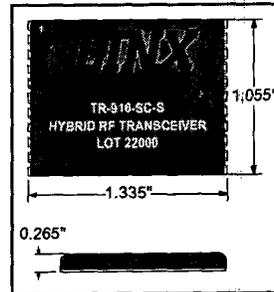


## SC SERIES SMT TRANSCEIVER MODULE



### Description:

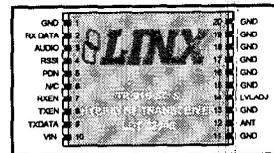
The TR-\*\*\*-SC-S transceiver module is designed for the cost-effective, bi-directional transfer of wireless information. The transceiver utilizes an advanced synthesized superhet architecture and has direct interface for analog or digital information, UART-compatible data output, RSSI, low power consumption, wide operational voltage, on-board TX/RX switch, SAW front-end filter, and many other useful features. Fast turnaround times, along with the support for data rates to 33.6Kbps, make the transceiver suitable for a wide range of applications. Housed in a compact SMT package, the transceiver requires no tuning or external RF components (except antenna), allowing for straightforward application, even by engineers lacking previous RF experience.



PHYSICAL DIMENSIONS

### Features:

- Direct Interface For Analog or Digital Information
- Precision Crystal-Controlled Synthesized Architecture
- Transparent Serial Input
- UART-Compatible Data Output
- Built-In Data Squelching
- High Data-Rate: Up To 33,600bps
- Wide-Range Analog Capability Including Audio
- Single-Antenna-Ready (No TX/RX Switch Required)
- Output Power And Harmonics Are Compatible With FCC Regulations
- Differential LO Dramatically Reduces Unintended Radiation
- Output Power Can Be Programmed With an External Resistor
- Good Sensitivity (-95dBm typical at  $10^{-5}$  BER)
- SAW Filter on Front End For Superior Out-of-Band Rejection
- Received Signal Strength Indication
- Fast Start-Up And Turnaround Times
- Wide Input-Voltage Range (2.7 to 13VDC)
- Very Low Power Consumption (as Low as 12mA)
- Power-Down Mode – 50µA max (VCC @ 5V)



### PINOUTS

Viewed from Top

### Applications Include:

- Wireless Data Transfer
- Audio/Analog Signal Transfer
- Process Monitoring
- Home/Industrial Automation
- Remote Control
- Wireless Networks
- Telemetry
- RS-232/485 Data Links
- Voice Links/Intercoms

### ORDERING INFORMATION

PART #	DESCRIPTION
TR-916-SC-S	SC Transceiver
EVAL-916-SC-S	SC Evaluation System
MDEV-916-SC-S	SC Master Development System



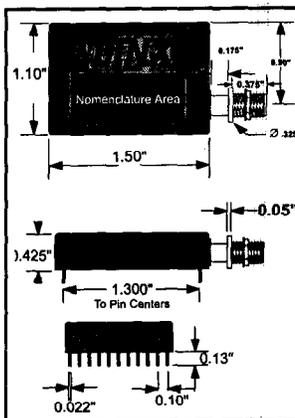
## MC SERIES PRECERTIFIED TRANSCEIVER MODULE



### 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 TR-900-MC-PA transceiver module is designed for the high-performance bi-directional transfer of wireless data. The transceiver features 100 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.

### PHYSICAL DIMENSIONS

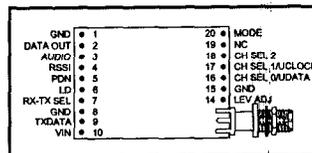


### Features:

- FCC-precertified for immediate integration
- Precision VCXO synthesized architecture
- 8 parallel or 100 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<sup>-5</sup> BER)
- SAW front end for superior out-of-band rejection
- RSSI (Received signal strength indication)
- Fast start-up and turnaround times
- Wide input-voltage range (2.7 to 12 VDC)
- Very low power consumption (as low as 12 mA)
- Power-down mode

### Applications Include:

- 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



### PINOUTS

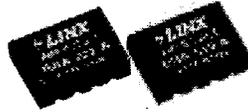
Viewed from top

### ORDERING INFORMATION

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

## RF AMPLIFIERS 2

### *More Power To You*



Linx offers compact, low-cost RF amplifier modules which are ideally suited to a variety of amplification and buffering applications. The broad bandwidth and gain flatness of the modules allow them to be used over a wide range of frequencies and applications, including extending the range of Linx's own RF modules (when legally appropriate).

**\*IMPORTANT NOTE\***

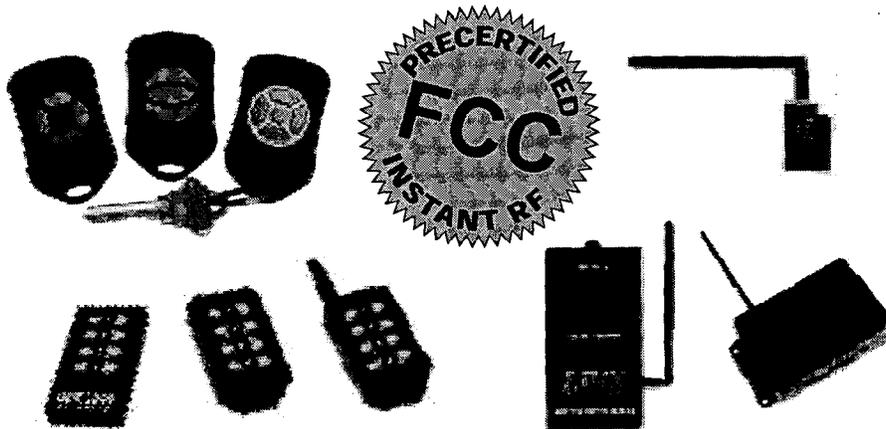
Use of these modules may result in the amplification of signals to a level which may be unacceptable for legal or technical reasons. It is the responsibility of the user to determine and adhere to the appropriate guidelines for the proposed application.

### **RF AMPLIFIERS**

<b>PART#</b>	<b>DESCRIPTION</b>	<b>PG.</b>
BBA-322-A	High-Gain RF Amp	38
BBA-519-A	High-Power RF Amp	38

## PRECERTIFIED OEM PRODUCTS 4

### Instant RF For Your Application



The Linx OEM-configurable RF product line greatly reduces the cost and time required to bring a wireless product to market. The line features a variety of low-cost generic command and control modules which can be customized to meet specific OEM labeling requirements. Since these products have received prior FCC approval, the time and expense of bringing a product to market is significantly reduced. Available in frequencies from 315-433MHz, the modules are divided into two classes: command and function modules.

Command modules include complete handheld and keyfob transmitters capable of sending multiple commands to an unlimited number of function modules. The command module's transmissions may be received by a compatible Linx RF module incorporated in a user's discrete circuit or by a Linx function module. Function modules contain a receiver and decoder to interpret the signal sent by the command module and then perform switching and control functions. The command module's transmissions may also be received by the Linx LC or KH family of RF modules.

#### COMMAND MODULES

PART#	DESCRIPTION	PG.
CMD-KEYx-***-xxx	Keyfob Transmitter	50
CMD-HHTX-***-xxx	8-Button Handheld Transmitter	51
CMD-HHLR-***-xxx	Long-Range OEM Handheld Transmitter	52
CMD-HHCP-***-xxx	Compact OEM Handheld Transmitter	53

#### FUNCTION MODULES

PART#	DESCRIPTION	PG.
FCTN-DEC1-***	OEM Decoder Module	54
FCTN-WALL-***	AC Function Module	55
FCTN-RLY-***	Relay Module	56

\*\*\* See Order Info for available frequencies



**PRECERTIFIED OEM  
RF PRODUCTS**

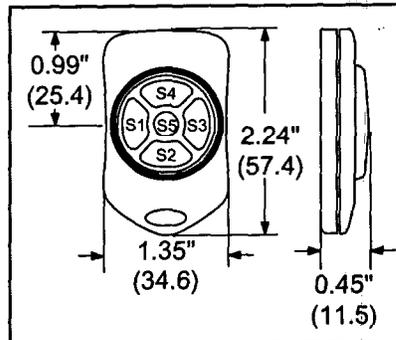


**KEYFOB TRANSMITTER**

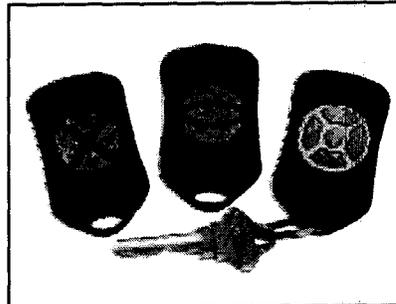


**Description:**

The Linx CMD-KEYx-\*\*\*-xxx remote command keyfob is ideal for general-purpose remote control and command applications. The unit has been pre-certified for FCC Part-15 compliance which reduces costs and time to product introduction. Available in 315, 418 or 433.92 MHz (418MHz standard), this stylish and compact remote is capable of 100+ ft. transmission range. The unit can be configured with 1-5 buttons and the keypad and labeling can be customized to meet specific customer requirements. Selectable addressing provides security and allows for 1024 distinct transmitter-receiver relationships. The transmission can be decoded using a matching Linx function module, a KH-Series receiver/decoder module or a Linx LC-Series receiver paired with a decoder IC or microcontroller. The unit operates from a 3-volt lithium cell.



**Physical Dimensions**



**OEM Configurations**

With a one-time NRE and minimum order, Linx can configure the keypad and label areas to meet your specific requirements. Contact Linx for details.

**Applications Include:**

- Remote Control / Command
- Keyless Entry
- Garage / Gate Openers
- Lighting Control
- Security / Call Systems
- Home / Industrial Automation
- Wire Elimination

**ORDERING INFORMATION**

PART #	DESCRIPTION
CMD-KEYx-***-xxx	Keyfob Transmitter
*** = 315, 418 (Standard), 433.92 MHz	
x = Number of buttons from 1 to 5	
xxx = Color <i>Leave blank for standard Black</i>	
CGY = Gray	CBL = Blue
CRE = Red	CPU = Purple



**PRECERTIFIED OEM  
RF PRODUCTS**

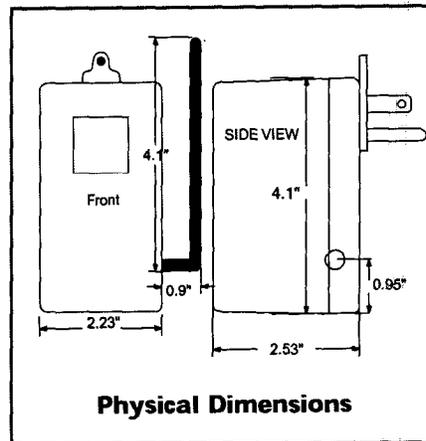
## AC FUNCTION MODULE

### Description:

The module plugs directly into a wall receptacle and is capable of switching devices at loads up to 1800 watts (15 amps) or 1 HP @ 120VAC. Devices connect via a standard NEMA 5-15 North American power plug. Labeling can be modified to meet specific customer requirements. The antenna rotates to a variety of positions to allow for maximum range when plugged into a power strip or floor outlet. The unit is pre-approved as a Class-B device to allow immediate integration and sale in most OEM products.

### Applications include:

- Lighting Control
- Remote Activation
- Home / Industrial Automation
- Process Control
- Security



**OEM PRODUCTS 4**

### OEM Configurations



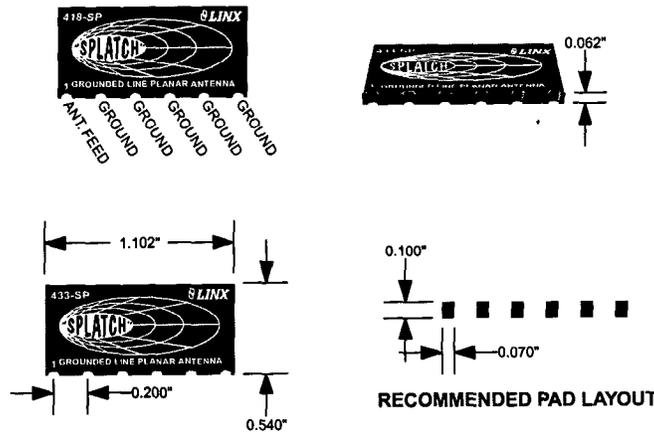
With a one-time NRE and minimum order, Linx can configure the label areas to meet your specific requirements. Contact Linx for details.

ORDERING INFORMATION	
PART #	DESCRIPTION
FCTN-WALL-***	AC Function Module
*** = 315, 418 (Standard), 433.92 MHz	



**SP-SERIES ANTENNA**

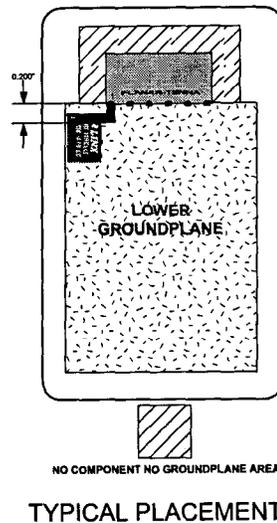
The Splat uses a grounded-line technique to achieve outstanding performance from a tiny surface-mount element. This unique antenna is designed for hand or reflow mounting directly to a product's circuit board. Its low cost makes it ideal for volume application. Unlike many compact antennas, the Splat exhibits good proximity performance, making it an appropriate choice for hand-held applications such as remote controls, pagers, and alert devices. Typical performance is below that of many external antennas but the Splat is an excellent choice when cosmetic or mechanical issues dictate the use of an internal antenna.



**Features:**

- Ideal for concealed/internal mounting
- Direct PCB attachment
- Ultra-compact package
- Very low cost
- Suitable for hand or reflow assembly
- Resistant to proximity effect
- Perfect for compact portable devices

ORDERING INFORMATION	
PART #	DESCRIPTION
ANT-***-SP	Splat Planar Antenna
***= 315, 418, 433, 868, 916 MHz	

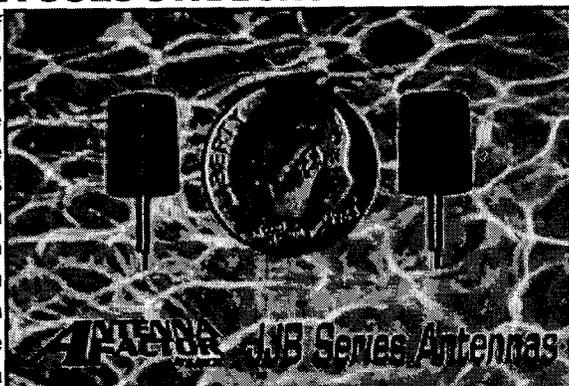


## HOT NEWS

April 2, 2003

### COMPACT ANTENNA GOES STRAIGHT

The Antenna Factor division of Linx Technologies is pleased to announce that its popular JJB-Series antenna is now available in a vertical-mount style. The tiny JJB-Series antenna packs near the performance of a conventional monopole into an incredibly compact 7mm diameter package. The antenna features a through-hole feedline which attaches directly to a user's PCB. JJB antennas are



ideal for internal or external mounting in any OEM application requiring a compact, low-cost antenna solution. The 1/4-wave antennas are designed for 50-ohm systems and exhibit a VSWR of <1.9. Frequencies of 900MHz to 2.4Ghz are available (916MHz standard). JJB-ST antennas are priced from .98¢ @ 1,000 pcs. and will be available in May of 2003..

[More Information](#)

February 25, 2003

### LOW-COST PLANAR ANTENNA NOW AVAILABLE FOR U.S. AND EUROPEAN BANDS

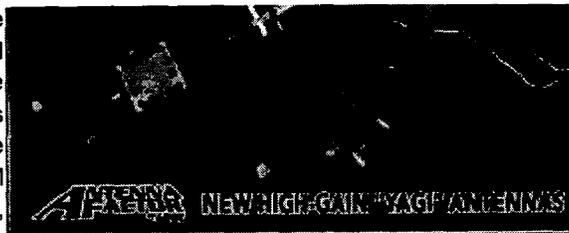
Designers of compact wireless products often find their antenna options and performance limited by size, cost and cosmetic constraints. Affectionately dubbed the "Splatch", a revolutionary planar antenna from Antenna Factor has changed all that. Now this low-cost antenna is available in standard or custom frequencies from 300Mhz to 900MHz to meet worldwide



frequency allocations. By utilizing a proprietary grounded-line technique, the "Splatch" extracts outstanding performance from a tiny surface-mount element. Unlike many compact antennas, the "Splatch" is highly immune to proximity effects, making it ideally suited to hand-held applications such as remote controls, pagers, and alert devices. Its stable design allows excellent performance to be obtained even by engineers lacking previous RF experience. The antenna's SMD package is appropriate for reflow or hand attachment. The antenna measures 1.1"L x .5"W x .062"H and exhibits a 50-ohm characteristic impedance and a VSWR of less than 1.9. The antenna costs less than \$1.00 in production quantities.

[More Information](#)

designed for long-distance directional communication and can greatly enhance the performance of RF links. As with all Linx products the antennas are priced to appeal to volume OEM applications, but that doesn't mean any sacrifice in quality. Made of stainless steel and featuring sturdy mast mounts these rugged antennas are constructed to withstand the stress of long-term use. All antennas are designed for 50-ohm system matches and a maximum input of 100W. Antenna gain ranges from 9.5 to 13 dBi with a bandwidth of 23-80 MHz depending on the model.



[More Info](#)

June 21, 2001

## LINX ANNOUNCES SURFACE MOUNT SC DRAMATIC SIZE REDUCTION IN POPULAR TRANSCEIVER SERIES

Linx Technologies is pleased to announce that its popular SC series transceiver module is now available in a low-profile SMD package. The TR-XXX-SC-S transceiver module utilizes an advanced synthesized superhet architecture and features a direct interface for analog or digital information. Extremely fast settling and turnaround times, along with the ability to accommodate analog signals including audio or serial data at rates up to 33.6kbps, make the transceiver ideally suited for a wide range of half-duplex bi-directional communication requirements.



Housed in a compact SMD package, the transceiver requires no tuning or external RF components (except antenna). This allows for straightforward integration, even by engineers lacking previous RF experience. The SC series is currently available in a 916MHz version with other frequencies soon to follow. Transceivers will be available third quarter and are priced at \$29.10 (1,000 pcs.)

[SCS Data Manual](#) (Acrobat PDF, 365K)

June 20, 2001

## DUAL-BAND BREAKTHROUGH

A breakthrough in dual-band antenna technology, the CELNSAT antenna combines a wide-band ISM or Cell-band antenna with a high-efficiency, amplified GPS antenna. Housed in a weather-tight, tamper-resistant dome, the CELNSAT is ideal for mounting on devices such as vehicles, vending machines, or equipment housings.



[DBD Data Sheet](#)

are ideally suited for volume use in OEM applications such as remote control/command and keyless entry. The KH modules combine an optimized RF link with an on-board encoder or decoder. A pair of modules are capable of transferring the status of up to 8 parallel inputs and 59,049 addresses over distances in excess of 300 feet.



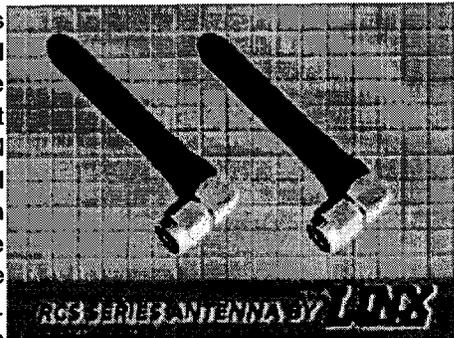
The development system features fully assembled evaluation boards which allow for visual and audible testing of the KH module's performance in various environments. An on-board prototyping area is also provided to allow rapid product development. Antennas, extra KH modules, and full documentation are also included. The kits are available for immediate delivery.

[More Information](#)

October 11, 2000

## TINY ANTENNAS DELIVER IMPRESSIVE PERFORMANCE

The new RCS Antenna Series from Linx is ideally suited to the size, cosmetic, and performance requirements of leading-edge wireless products. These ultra-compact antennas utilize a precision helical element to dramatically reduce the overall antenna size while providing in-bandwidth performance comparable to a full-size whip. Two models provide coverage of the popular 902-928MHz and 2.4 GHz bands. Despite their diminutive size these antennas are designed to resist shock and abuse. The antennas attach via an FCC-compliant right-angle gold-plated RP-SMA type connection. Other connection styles are available by special order. Complete information may be obtained by contacting Antenna Factor at (800) 489-1634.



Our ["Whip"-Style Product Selector](#) offers more details.

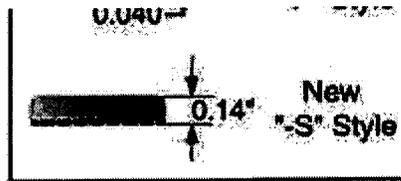
September 30, 2000

## LINX INTRODUCES TRUE SMD PACKAGE AND PERFORMANCE IMPROVEMENTS FOR ITS LC SERIES RECEIVER

Building on the success of the popular LC series receiver, Linx is pleased to introduce a second version of the part which features enhanced performance, reduced size and lower cost. The original receiver, which features gullwing mounting pins, will continue in full production and is now designated by the addition of a -P on the end of its part number. The new receiver is designated by a -S and features true SMD pads and castellations similar to those present on the LX transmitter series. The new package allows for easier hand and reflow



assembly and substantially reduces the component height. In addition, because the module is more closely coupled to the user's board, overall sensitivity is improved, yielding slightly better range performance. The module does NOT share the original device's footprint.



Package Height Comparison

When paired with an LC- or KH-series transmitter, the modules provide a complete and cost-effective solution for the transfer of serial control and command information over distances in excess of 350 feet. No external RF components are required (except an antenna), allowing for easy design integration even by engineers without prior RF experience. Volume shipments of the -S part will begin in November. A full design guide is presently available.

For a closer look, download the [RX-XXX-LC-S manual](#) (352K) manual.

August 1, 2000

## LINX ANNOUNCES KH SERIES MODULES NEW RF MODULES INTEGRATE ON-BOARD ENCODER/DECODER STAGES

The new KH series from Linx Technologies is ideally suited for OEM applications such as remote control/command, security, and automation. Packaged in a compact reflow-compatible SMD package, the modules combine a highly optimized RF stage with a parallel encoder/decoder. The transmitter module accepts up to eight parallel inputs allowing direct connection of switches, contacts, or microprocessor control lines. The receiver provides eight logic-level outputs for connection of devices under control such as relays, motors, indicators, or microprocessor lines. Ten tri-state address lines are also provided to allow for security and the creation of 59,049 unique transmitter/receiver relationships. When paired with a suitable antenna the modules form a reliable wireless connection capable of operation at distances in excess of 300 feet. No additional RF components except an antenna are required; thus design and manufacturing costs are greatly reduced. The modules are also individually compatible with a complete family of FCC pre-certified OEM products offered which include keyfob and handheld transmitters, relay and AC control modules. The KH series modules will be available in late 4th quarter.

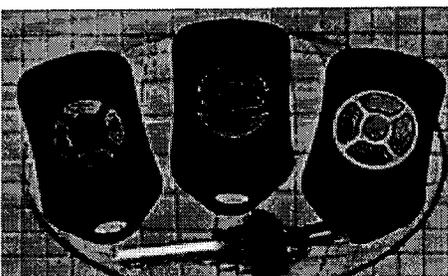


For a closer look, download the [Receiver](#) (399K) or [Transmitter](#) (426K) manuals.

July 13, 2000

## LINX ANNOUNCES AVAILABILITY OF KEYFOB TRANSMITTER MODULES

These ultra-compact keyfobs are ideally suited to a wide range of OEM remote control and command applications. Inside their futuristically styled package, a highly accurate SAW-based transmitter and line planar antenna combine to deliver outstanding range performance and reliability. Multiple transmitter frequencies are available and have been pre-certified



are available and have been programmed by the FCC to reduce the time and cost of product introduction. The fobs generate a secure encoded transmission which can be received and decoded using a variety of receiver products including Linx's own LC or KH series RF receiver modules. The units operate from a standard 3-volt lithium cell which provides several years of use under normal operating conditions. Available in 1 to 5 button configurations, labeling of the keypad, housing, and button-styles can be customized to meet the needs of OEM users.

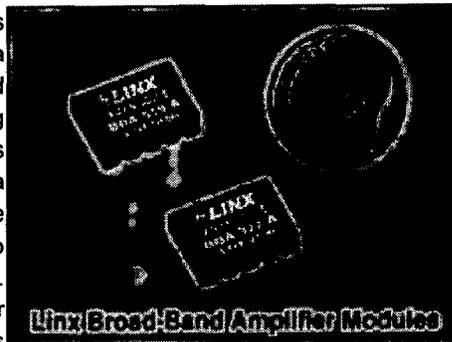
[View the PDF file](#) for a closer look. (332K)

**April 14, 2000**

## **GAIN TO GO**

### **LINX INTRODUCES HIGH-PERFORMANCE LOW-COST BROADBAND AMP MODULES**

The new BBA series of broadband amps from Linx Technologies are ideal for a wide variety of RF amplification and buffering requirements including extending the range of Linx's own RF modules (where legally appropriate). Housed in a tiny SMD package, the hybrid amps are completely self-contained and require no external RF components for operation. The I/O's are pre-matched to 50 Ohms for ease of integration. BBA series amps incorporate a GAHBT gain stage which yields exceptional performance. Two models are planned for introduction in June of 2000. The BBA-322 is a 3-volt device which features DC to 3GHz operation with 20dB of small signal gain, up to a +11dBm output power and a noise figure of <3.9dB. The BBA-519 is the higher-power 5-volt device capable of operating from DC-4GHz and providing a gain of 16dB up to an output of +18 dBm.



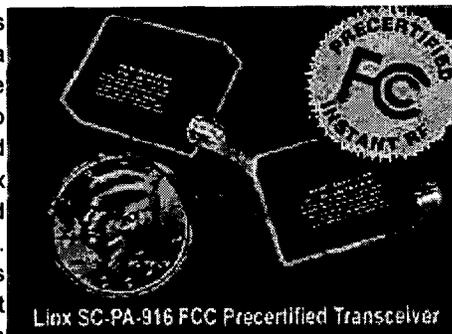
A [PDF Data Guide](#) (61K) and [Manual](#) (105K, updated 3/27/01) are available.

**Legal Disclaimer:** When combined with certain RF sources, these devices are capable of generating power levels in excess of those allowed for many areas and applications. It is the users responsibility to insure that the devices are used in a manner legally appropriate for the application and area of use. User is advised that use in any other manner may adversely affect other legally operating products and result in substantial fines or penalties as dictated by regulatory agencies.

**March 6, 2000**

## **LINX TECHNOLOGIES RECEIVES FCC MODULAR APPROVAL**

Linx Technologies shocked the wireless component industry by obtaining a Modular Grant of Authorization from the FCC for its new SC-PA series. Believed to be the first such approval for a OEM hybrid component, the Grant will save Linx customers thousands of dollars and untold delays bringing their products to market. Linx Technologies' corporate motto is "Wireless Made Simple" and in this case it certainly looks like Linx has lived up to its billing.



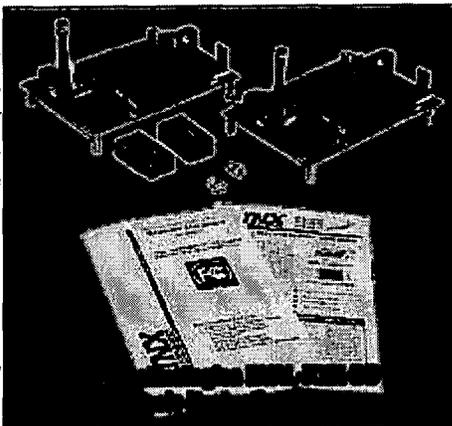
support area to its website for further information on our products.

December 17, 1999

## **LINX ANNOUNCES TWO EVALUATION PLATFORMS FOR NEW SC TRANSCEIVER**

### **NEW TRANSCEIVER EVALUATION PLATFORMS SPEED WIRELESS IMPLEMENTATION**

Linx Technologies is pleased to announce the availability of two evaluation/development platforms for its new SC series of low-cost transceiver modules. The development kits gives prospective users a chance to fully explore the SC series modules, which are capable of bi-directional communication of digital or analog information over distances in excess of 400'. The kits contain all the tools necessary to cost-effectively add half-duplex wireless capabilities to any product.



The "BASIC EVAL-XXX-SC" kit provides a cost-effective way to evaluate the SC series performance and begin integrating it into OEM products. The kit features an on-board encoder /decoder chipset which provides a known data structure. Relay and buzzer outputs assist in quickly testing for range and interference in anticipated use environments. Once development begins, a convenient prototyping area with breakout headers and regulated power supply allows for rapid testing and interface. Finally, when development is complete, the kit will continue to serve as a valuable benchmark to compare the performance of the designer's final product. The kit includes 2 SC series modules, 2 pre-assembled evaluation boards, 2 antennas, 2 connectors, batteries and complete documentation. The EVAL-XXX-SC kit is priced at \$199.

[Download the PDF file](#) for a closer look. (204K)

December 15, 1999

## **LINX WINS SECOND PRODUCT OF THE YEAR AWARD!!**

Linx Technologies, Inc. is pleased to announce that its popular LC-Series receiver and transmitter pair has been named a "PRODUCT OF THE YEAR" by EE Product News, a leading trade journal. This is the second award of this caliber for Linx who earlier in the year received a similar award for its HP-Series RF modules from Wireless Design and Development magazine. Linx's award was publicly announced by EEPN in its December '99 issue.



[More Information](#)

October 8, 1999

## NEW SC SERIES TRANSCEIVER!!

The TR-XXX-SC transceiver module is designed for cost-effective, high-performance bi-directional transfer of wireless information. The Transceiver utilizes an advanced synthesized superhet architecture and has direct interface for analog or digital information. Features include: fully qualified UART compatible data output, RSSI, low-power consumption, wide operational voltage, on-board TX/RX switch, SAW front end



filter, and many others. Extremely fast settling and turnaround times, along with the ability to accommodate data rates up to 33.6Kbps make the transceiver ideally suited for a wide range of bi-directional communication requirements. Housed in a compact through-hole package, the transceiver is fully integrated and requires no tuning or external RF components (except an antenna) allowing for straightforward application, even by engineers lacking previous RF experience. The 916 MHz model will be available in December, with additional frequencies to be added in early 2000.

[Download the PDF file](#) for a closer look. (77K)

**March 1, 2001:** THE NEW MANUAL HAS ARRIVED. Take a look.

September 21, 1999

## 003 EDGE-MOUNT CONNECTORS NOW AVAILABLE FOR .031-THICK PCB'S

The CONREVSMA003 board-edge RP-SMA antenna connector is now in stock for .031-thick PCB's. This connector mates with a variety of Linx antennas and cable-end connectors and meets Part 15 requirements.



[View the Connectors](#) (157K)

June 29, 1999

## LOW-COST INTERNAL PLANAR ANTENNA NOW AVAILABLE FOR THE POPULAR 902-928 MHZ BAND

The Antenna Factor division of Linx Technologies is pleased to announce that its popular "Splatch" planar antenna is now available in a model covering the 902-928 MHz band. The "Splatch" utilizes a proprietary grounded-line technique to extract outstanding performance from a tiny surface-mount element. The "Splatch" is designed for direct PCB mounting which eliminates the mechanical and cosmetic concerns of traditional external antennas.



The stable grounded-line design results in excellent pattern and polarization characteristics and minimizes proximity detuning. These properties make the "Splatch" an ideal choice for compact applications such as remote controls, pagers, and alert devices. The antenna measures 1.1"L x .5"W x .062"H and exhibits a 50-ohm characteristic impedance and a VSWR of less than 1.9. The antennas low cost, (less than \$1.00 in production quantities) makes it ideally suited to volume OEM

# Exhibit B

Integrated Applications of Wireless Communications and Embedded Systems

A Selected Paper

For

NAIT 2002 Annual Convention  
Nov 6 – Nov 9, 2002  
Panama City Beach, Florida

Title:

Integrated Applications of Wireless Communications and Embedded  
Systems

By:

Dr. Steve C. Hsiung  
And  
Dr. Ward P. Belliston

Department of  
Industrial Technology & Education  
6000 Old Main Hill  
Utah State University  
Logan, UT 84322-6000  
Phone: (435)797-7559  
Fax: (435)797-2567

Email: [shsiung@cc.usu.edu](mailto:shsiung@cc.usu.edu)  
Email: [ward@cc.usu.edu](mailto:ward@cc.usu.edu)

## **Introduction**

Wireless communication has several advantages over traditional wired transmission. Adding wireless features to an embedded control system makes the system very attractive to many applications. Providing the integrated application of these two systems reflects the new technology development and required curriculum development that is needed in bridging the gap between academic curricula and industry. It also attracts students' interest to this field.

Wireless communication has become an increasing trend in recent technology development. Due to the advancement of communication circuits, it seems many applications are headed toward wireless technology for needed signal transmission and receiving. This article is about an embedded system that uses a microcontroller in an independent control application that sends/receives data wirelessly. The goal is to use the least amount of electronic components to achieve the most complex circuits at the lowest cost in a system development. Integration of both wireless communication and embedded system uses technology advancements and takes full advantages of both systems in an applied application.

## **Available Wireless Communications**

Low-Power, non licensed transmitters operate on a variety of frequencies and use very little power, most often less than a milliwatt. They are "non-licensed" because their operators are not required to obtain a license from the Federal Communications Commission (FCC) to use them. However, they must share these frequencies with licensed transmitters and are prohibited from causing interference to licensed transmitters [3].

The FCC has rules to limit what is referred to as harmful interference to licensed transmitters by low-power, non licensed transmitters. The FCC's regulations are most restrictive on products that are most likely to cause harmful interference, and less restrictive on those products that are least likely to cause interference. Detailed information concerning low-power, non licensed products are contained in the FCC regulations themselves, and can be found in Part 15 of Title 47 of the Code of Federal Regulations [3].

Part 15.23 of the Code of Federal regulations states that hobbyist, inventors and other parties that design and build part 15 transmitters with no intention of ever marketing them may construct and operate up to five such transmitters for their own personal use without having to obtain FCC equipment authorizations [3]. The manufacturers of the transmitters discussed in this article have intended to comply with the FCC regulations as far as emissions are concerned. The transmitters should not exceed the emission limits of the regulations. Table 1, which has the title of "Part 15 Permitted Frequency Allocations", shows the frequency bands used between 38.25 MHz and 3.26 GHz, and the emission limits for any type of use for a transmitter. The radiated energy is measured in list of the actual frequencies, emission limits and their uses. There are other applications such as cordless telephones, intermittent control signals, periodic transmissions, etc. which are not included in Table 1. Some of the most common frequencies are within the bands of 385-322 MHz, 410-470 MHz, and 902-928 MHz.

## Integrated Applications of Wireless Communications and Embedded Systems

Frequency Band	Type of Use	Emission Limit
38.25-40.66 MHz	Any	100 uV/m @ 3m
40.66-40.7 MHz	Any	1,000 uV/m @ 3 m
40.7-49.82 MHz	Any	100 uV/m @ 3 m
49.82-49.9 MHz	Any	10,000 uV/m @ 3 m
49.9-54 MHz	Any	100 uV/m @ 3 m
72-73 MHz	Any	100 uV/m @ 3 m
74.6-74.8 MHz	Any	100 uV/m @ 3 m
75.2-76 MHz	Any	100 uV/m @ 3 m
88-108 MHz	Any	150 uV/m @ 3 m
121.94-123 MHz	Any	150 uV/m @ 3 m
138-149.9 MHz	Any	150 uV/m @ 3 m
150.05-156.52475 MHz	Any	150 uV/m @ 3 m
156.52525-156.7 MHz	Any	150 uV/m @ 3 m
156.9-162.0125 MHz	Any	150 uV/m @ 3 m
167.17-167.72 MHz	Any	150 uV/m @ 3 m
173.2-174 MHz	Any	150 uV/m @ 3 m
216-240 MHz	Any	200 uV/m @ 3 m
285-322 MHz	Any	200 uV/m @ 3 m
335.4-399.9 MHz	Any	200 uV/m @ 3 m
410-470 MHz	Any	200 uV/m @ 3 m
806-902 MHz	Any	200 uV/m @ 3 m
902-928 MHz	Any	50,000 uV/m @ 3 m
928-960 MHz	Any	200 uV/m @ 3 m
1.24-1.3 GHz	Any	500 uV/m @ 3 m
1.427-1.435 GHz	Any	500 uV/m @ 3 m
1.6265-1.6455 GHz	Any	500 uV/m @ 3 m
1.6465-1.66 GHz	Any	500 uV/m @ 3 m
1.71-1.7188 GHz	Any	500 uV/m @ 3 m
1.7222-2.2 GHz	Any	500 uV/m @ 3 m
2.3-2.31 GHz	Any	500 uV/m @ 3 m
2.39-2.4 GHz	Any	500 uV/m @ 3 m
2.4-2.4835 GHz	Spread Spectrum Transmitters	1 Watt Output Power
2.4-2.4835 GHz	Any	50,000 uV/m @ 3 m
2.5-2.655 GHz	Any	500 uV/m @ 3 m
2.9-3.26 GHz	Any	500 uV/m @ 3 m

Table 1 Part 15 Permitted Frequency Allocation

### Our Choice of Wireless Communications

There are a number of manufacturers who produce wireless transmitters and receivers. Table 2, 3, & 4 summarizes some of these products. Choosing the best wireless communication module is based on the cost, communication range, operating function complexity, and target applications. We chose three manufacturers modules for potential applications in combining embedded system controls, communication circuit, and senior project courses which can be found in the mentioned tables.

Part #	Freq.	Vcc	Icc	Modulation	Baud Rate	Audio	Range	Price	Maker
RCT-433-AS	433.92 MHz	2-12 Vdc	5 ma@3V	ASK/OOK	4800	No	100-300 ft.	\$4.90	Radiotronix
TXE-315-KH	315 MHz	2.7-5.2 Vdc	3 ma		4800	No		\$9.98	LINX
TXM-315-LC	315 MHz	2.7-5.2 Vdc	3 ma		4800	No		\$6.90	LINX
TXLC-434	433.92 MHz			CPCA	5000	No	300 ft.	\$14.95	Reynolds Electronics
TM1V	418 MHz	5 Vdc		On-Off and Pulse	4800	No	300 ft.	\$16.40	GLOLAB
TLP-434	433.92 MHz	2-12 Vdc	5 ma	ASK	3000	No			Reynolds, LAIPAC Technology
TRF4900P W	850-950 MHz	2.2-3.6 Vdc	58 ma	FM/FSK	20 MHz Clock			\$4.75	Texas Instruments
TH7107EF F	315/433 MHz			FSK/FM/ASK				\$11.29	Melexis

Table 2 Available Transmitter Products

## Integrated Applications of Wireless Communications and Embedded Systems

Part #	Freq.	Vcc	Icc	Modulation	Baud Rate	Audio	Distance	Price	Maker
RCR-433-RP	433.92 MHz	5 Vdc	4.5 ma	ASK/OOK	4800	Yes	100-300 ft.	\$5.50	Radiotronix
RCR-433-HP	433.92 MHz	5 Vdc	4.5 ma	ASK/OOK	4800	No	300-800 ft.	\$13.80	Radiotronix
RXM-315-LC	315 MHz	2.7-4.2 Vdc	6 ma		5000	No		\$13.79	LINX
RXD-315-KH	315 MHz	2.7-4.2 Vdc	7 ma		4800	No		\$15.93	LINX
RXLC-434	433.92 MHz	2.7-5.2 Vdc		CPCA	5000	No	300 ft.	\$22.95	Reynolds Electronics
RM1V	418 MHz	5 Vdc		On-Off and Pulse	4800	No	300 ft.	\$23.75	GLOLAB
RLP-4334	433.92 MHz	4.5-5.5 Vdc		ASK	3000	No			Reynolds, Laipac Technologies
TH71101ENE	315/433 MHz	5 Vdc		FSK/FM/ASK				\$15.58	Melexis

**Table 3 Available Receiver Products**

Part #	Freq.	Vcc	Icc	Modulation	Baud Rate	Audio	Applications	Price	Maker
EWM-900-FDTC-BS	902-928 MHz	3 Vdc	35ma Rx 25ma Tx	FM/FSK	19.2K	Yes	Full-Duplex Data & Audio 500-1000 ft.	\$69.00	Radiotronix
EWM-900-FDTC-HS	902-928 MHz	3 Vdc	35ma Rx 25ma Tx	FM/FSK	19.2K	Yes	Full-Duplex Data & Audio 500-1000 ft.	\$69.00	Radiotronix

**Table 4 Available Transceiver Products**

The following are the chosen modules designed for digital bits/bytes communication. We used them in an integrated system with embedded microcontroller applications.

### Choice #1

The first one is made by Radiotronix that has separate module for transmitter and receiver. The followings are the feature and application circuit for each module:

Transmitter: Radiotronix, RCT-433-AS [5]

Size: 0.25" \* 0.4"

Speed: 4800 Baud with ASK/OOK Modulation

Range: 100 – 300 ft.

Frequency: 433.92 MHz

Channel: 1

Price: \$4.90

Microcontroller Interfacing:

Tx Data In → One of the Microcontroller Output Lines

Application Circuit: Figure 1.

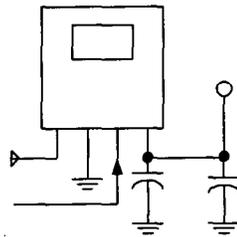


Figure 1 Radiotroinx RCT-433-AS Transmitter Circuit

Receiver: Radiotronix, RCR-433-RP [4]  
 Size: 1.76" \* 0.43"  
 Speed: 4800 Baud with ASK/OOK Modulation  
 Range: 100 – 300 ft.  
 Frequency: 433.92 MHz  
 Channel: 1  
 Price: \$5.50  
 Microcontroller Interfacing:  
     Rx Data Out → One of the Microcontroller Input Lines  
 Application Circuit: Figure 2.

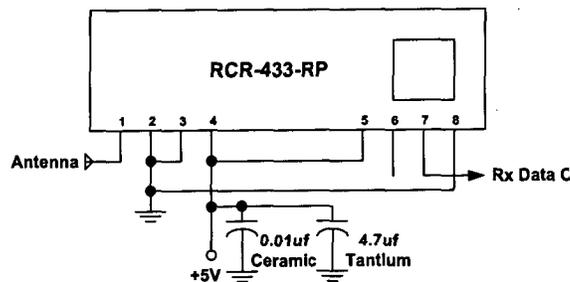


Figure 2 Radiotroinx RCT-433-AS Receiver Ci

These modules are the lowest in cost. To use these as a full pairs of these transmitter and receiver modules is needed. A bit based used on the bits/bytes communication between microcontroller and modules. A simple algorithm as presented in Figure 3 is implemented method.

### Choice #2

The second one is made by Linx Technology that also has a transmitter and receiver. The following are the feature and application module:

Transmitter: Linx, TXM-315-LC [8]  
 Size: 0.5" \* 0.36"  
 Speed: 5000 Baud  
 Range: > 300 ft.  
 Frequency: 315 MHz

Integrated Applications of Wireless Communications and Embedded Systems

Channel: 1  
 Price: \$6.90  
 Microcontroller Interfacing:  
 Tx Data In → One of the Microcontroller Output Lines  
 Application Circuit: Figure 4.

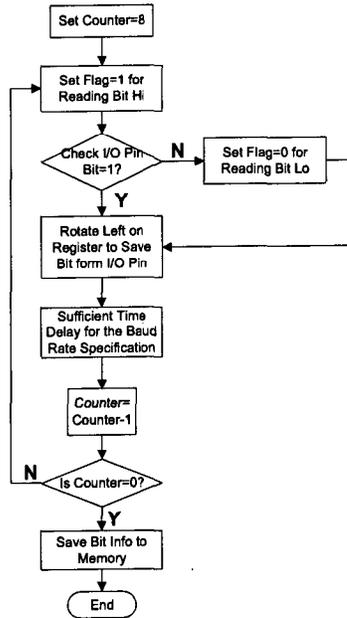


Figure 3 Bit Banging Flow Chart

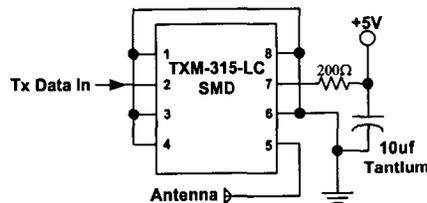


Figure 4 Linx TXM-315-LC Transmitter Circuit

Receiver: Linx, RXM-315-LC-S [6]  
 Size: 0.812" \* 0.631"  
 Speed: 5000 Baud  
 Range: > 300 ft.  
 Frequency: 315 MHz  
 Channel: 1  
 Price: \$13.79  
 Microcontroller Interfacing:  
 Rx Data Out → One of the Microcontroller Input Lines  
 Application Circuit: Figure 5.

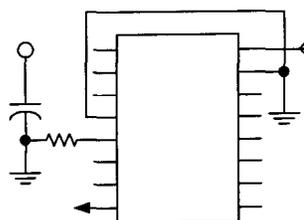


Figure 5 Linx RXM-315-LC-S Receiver Circuit

These modules are moderate in cost. To use these as a full duplex protocol, two pairs of these transmitter and receiver modules is also needed. A bit banging method is used on the bits/bytes communication between microcontroller and transmitter/receiver modules. The same algorithm in the bit banging method as in Choice #1 is implemented.

### Choice #3

The third one is also made by Radiotrix that is a single module of full-duplex audio/data transceiver. The followings are the feature and application circuit:

#### Transmitter/Receiver:

Radiotrix, EWM-900-FDTC [2]  
 Size: 1.22" \* 0.82"  
 Speed: 19.2K Baud  
 Range: 500 - 1000 ft.  
 Frequency: 902-928 MHz  
 Channel: 56  
 Price: \$69.00

#### Microcontroller Interfacing:

Tx Data In	→ One of Microcontroller Output Lines
Rx Data Out	→ One of Microcontroller Input Lines
Interface Latch Enable	→ One of the Microcontroller Output Lines
Interface Data	→ Microcontroller's SPI Data (MOSI) Line
Interface Clock	→ Microcontroller's SPI Clock (SCLK) Line

Application Circuit: Figure 6.

This module is one of the highest in cost but it has functionality in full duplex. So, only one pair of this module is need in-between parties. There are three signal wires for configuration of frequency, channel, and transmit/receive mode. The best interface control of this device is SPI (Serial Peripheral Interface). The SCLK, a clock signal of the SPI is connected to Interface Clock line. The Data\_Out (Master Out Slave In, MOSI), an output data signal of the SPI is connected to Interface Data line. Since the transceiver module interface signal requires a form of 24 bits in sequence, one of I/O lines of the microcontroller to the Interface Latch Enable line is the best fit for this 3 bytes chain interface. The standard SPI is framed in one byte at a time or per transition. Therefore, a single I/O line and using SPI routine three times is required to configure this module for any desirable communication between parties.

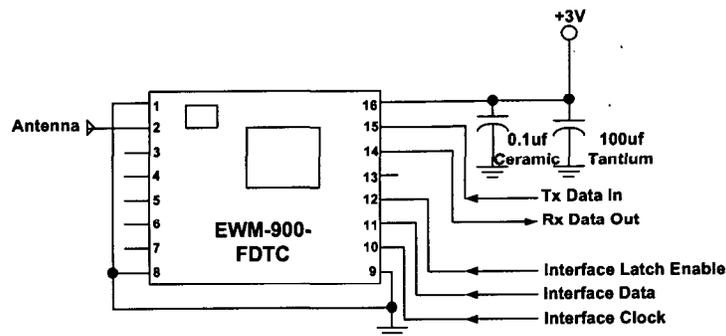


Figure 6 Radiotronix EWM-900-FDTC Transceiver Circuit

### Integration of Wireless and Microcontroller Applications

There are applications in using extra decoder through a DIP switch setting to change appropriate address to a specific pair of transmitter and receiver, such as the garage door openers. These are limited to the hardware settings and available addresses. The duplication of available addresses poses a security concern. Using software control of protocols has the advantages in flexibility, security, and low cost.

Speaking of the protocols is just a matter of imagination of different rules in sending and receiving series of bits/bytes. Normally, there is a Start byte, Acknowledge (ACK) byte, Address byte, Command byte, Control Data byte, and Stop byte [7]. It depends on the definition of all the different bytes. One byte of data can have 254 different variations that exclude all 0's (0X00 or \$00) and all 1's (0X00 or \$FF). So, if we define one byte each for Start, Stop, and ACK. This will leave 251 bytes for Address and Command bytes. If we only use two bytes for command Read and Write. This will give us 249 bytes of different Address that means a total of 249 devices.

For example:

- Start byte = 0X01 or \$01
- Stop Byte = 0X02 or \$02
- ACK Byte = 0X03 or \$03
- Command Byte Read = 0X04 or \$04
- Command Byte Write = 0X05 or \$05
- Address Byte = Range from 0X06 or \$06 to 0XFE or \$FE
- Control Data Byte = Range from 0X00 or \$00 to 0XFF or \$FF

We can even integrate the Read/Write option into one bit in the address byte. Normally, this Read/Write bit is the last bit in the address byte where bit 7 = "0" means Write and bit 7 = "1" means Read. Using this strategy will limit available address bits to 7 bits and the total available addresses become  $2^7$  that will provide 128 different devices. But this definition will provide 256 different command bytes for any specific application in mind.

For example:

- Start byte = 0X01 or \$01
- Stop Byte = 0X02 or \$02

ACK Byte = 0X03 or \$03

Address Byte = Range from 0X80/0X80 (Read) to 0XFF/\$FF (Read) or Range from \$00/\$00 (Write) to 0X7F/\$7F (Write) = A Total of 128 Different Addresses for Read and 128 Different Addresses for Write

Command Byte = 0X00 or \$00 – 0XFF or \$FF = A Total of 256 Different Commands

Control Data Byte = 0X00 or \$00 – 0XFF or \$FF

**Protocol Rules:**

1. Start and Stop byte can only be sent by a transmitter.
2. The receiver has to send an ACK byte when its address is called by a transmitter.
3. The addressed receiver has to send an ACK byte after every byte following the address byte.
4. There should be a defined time out period (about 25 ms): Any byte sent by a transmitter shall expect an ACK byte from a receiver. There is a timeout period for the receiver to respond an ACK byte. If there is no ACK byte from a receiver the transmitter shall terminate the communication by sending a Stop byte.
5. Anything after timeout period shall consider there is a transition error. A new or a repeated communication can start or initiate from a transmitter again.

Using either one of the above mentioned protocol and following the rules in software driven embedded control system, the cost and security of this system will become a very attractive implementation.

If we use the Choice #3 modules, there are 56 different channels of different frequencies. Imagine using 56 different frequencies on a randomly selected basis and combining with different command bytes and implemented in a comprehensive software controlled embedded system; this makes the hacking on a security sensitive application a very difficult task.

We can elaborate the protocol further by using CRC-8 to improve the integrity of the wireless communication. CRC-8 is called 8-bit Cyclic Redundancy Check that uses polynomial  $C(X) = X^8 + X^2 + X^1 + 1$  to calculate each byte stream as a FCS (Frame Check Sequence) [1]. The way it works is that each transmitter will send an additional byte as a CRC-8 byte and the receiver will have to calculate its own CRC-8 byte after receiving the entire byte stream. The receiver needs to verify the received CRC-8 byte and calculated CRC-8 byte; both bytes have to be identical to be considered as a valid transmission. If it is not, then the communication is treated as a failure. The way the receiver signals this CRC-8 byte mismatch is by not sending an ACK byte at the end which causes a time out. Another communication has to reestablish and everything has to start over again. This protocol implementation has the advantage of providing cleaner communication and eliminates most errors but it also brings a heavy load on software coding and microcontroller execution time.

### **The Potential Applications of Integrated System**

Wireless communication is the increasing trends in various industrial/commercial products. There is also increasing concern on the security issues related to wireless products. The integrated system of wireless communication and embedded system using smart protocol design makes the security concern easy and broadens the applications in various areas. The following are some of the many applications to be easily pointed out:

- |                                |                                     |
|--------------------------------|-------------------------------------|
| 1. Building and Home security  | 2. Cordless Phones                  |
| 3. Garage Door Opener          | 4. Baby Monitor                     |
| 5. Medical Monitoring          | 6. Remote Industrial Monitoring     |
| 7. Periodic Data Transfer      | 8. Remote Keyless Entry             |
| 9. Remote Lighting Control     | 10. On-Site Paging                  |
| 11. Inventory Control          | 12. Automated Utility Meter Reading |
| 13. Home/Industrial Automation | 14. Fire/Security Alarms            |
| 15. Wireless Headsets          | 16. Vending Machines                |
| 17. Biotelemetry               | 18. Pagers                          |
| 19. Remote Data Logger         | 20. Etc.                            |

### **Conclusion**

Wireless communication has been widely used for decades. The current advancements in technology have made wireless application even more attractive and made our daily life heavily dependent on it. Also, these technologies make it possible to put complex circuits into a single integrated circuit. The application of an embedded system is aimed at using a simplified version of a microcomputer, called a microcontroller, in a system design with minimum support of external components. A close look at the new products available in the market today reveals the growing trend in the integration of systems. The security issues associated with wireless communication can be compensated with embedded systems using smart software protocols. The merging of these systems is a major focus in newly developed industry products. The reflection of the current developments in technology, with regard to computer/electronic technology curricula and project implementations, is crucial to the success of the program and the enrolled students.

### **Definition of Terms**

1. OOK (On-Off Keying): In this type of transmitter, the main oscillator is turned off when a zero is being transmitted and it is turned on when a one is being transmitted. The benefits of an OOK transmitter are that the current consumption becomes a function of the ratio between 1's and 0's in the data stream and it achieves better modulation depth than an ASK transmitter. The OOK data rate is limited by the start-up time of the oscillator. The start-up time of the oscillator determines the maximum data rate that the transmitter can send.
2. ASK (Amplitude Shift Keying): In this type of transmitter, the output amplifier's gain is varied; a lower gain for a 0 and a higher gain for a 1. Thus, a 1 causes a higher output power. The difference between OOK and ASK is that the oscillator is always on in an ASK system. Because the oscillator does not have to restart each time the

data input pin transitions from a 0 to a 1, the ASK transmitter can send much higher data rates. However, ASK transmitters are more expensive to build, use more current, and are less immune to noise than OOK transmitters.

3. FM (Frequency Modulation): Modulation in which the instantaneous frequency of a sine wave carrier is caused to depart from the center frequency by an amount proportional to the instantaneous value of the modulating signal. In FM, the carrier frequency is called the center frequency.
4. FSK (Frequency-Shift Keying): Frequency modulation in which the modulating signal shifts the output frequency between predetermined values. Usually, the instantaneous frequency is shifted between two discrete values termed the "mark" and "space" frequencies. A "mark" corresponding to a logic 1 and a "space" corresponding to a logic 0.
5. RFID (Radio Frequency Identification): A basic RFID system consists of an antenna or coil, a transceiver (with decoder), and a transponder (RF tag) electronically programmed with unique information.
6. NRZ (Non-Return To Zero): Non-Return to zero encoding is commonly used in slow speed communications interfaces for both synchronous and asynchronous transmission. Using NRZ, a logic 1 bit is sent as a high value and a logic 0 bit is sent as a low value. A problem arises when using NRZ to encode a synchronous link which may have long runs of consecutive bits with the same value. For example, during long "runs" of 0's there are no observable bit boundaries making it difficult for the receiver to distinguish one 0 from another.
7. SAW (Surface Acoustic Wave): A fundamental frequency device that resonates at frequencies much higher than crystals
8. CPCA: Carrier-Present, Carrier Absent
9. VSWR (Voltage Standing Wave Ratio): The ratio of the maximum to minimum voltage in standing wave pattern. It varies from 1 to (plus) infinite.

#### **Bibliography**

- [1] CRC-8 Implementation White Paper (1999), USAR System Inc., [www.semtech.com](http://www.semtech.com)
- [2] EWM-900-FDTC Radiotronics Data Sheet (2002), 1141 SE Grand Suite 118, Oklahoma City, OK 73129, [www.radiotronics.com](http://www.radiotronics.com)
- [3] Federal Communications Commission Code of Federal Regulations Part 15.23 Title 47 (1997), Customer Service Branch, MS 1300F2, 7435 Oakland Mills Road, Columbia, MD 21046, [www.fcc.gov](http://www.fcc.gov)

Integrated Applications of Wireless Communications and Embedded Systems

- [4] RCR-433-RP Radiotronix Data Sheet (2001), 1141 SE Grand Suite 118, Oklahoma City, OK 73129, [www.radiotronix.com](http://www.radiotronix.com)
- [5] RCT-433-AS Radiotronix Data Sheet (2001), 1141 SE Grand Suite 118, Oklahoma City, OK 73129, [www.radiotronix.com](http://www.radiotronix.com)
- [6] RXM-315-LC-S, Linx Technologies Data Sheet (2001), 575 SE Ashley Place, Grants Pass, OR 97526, [www.linxtechnologies.com](http://www.linxtechnologies.com)
- [7] System Management Bus (SMBus) Specification (2000), Revision 2.0, Smart Battery System Specifications, [www.sbs-forum.org](http://www.sbs-forum.org) , Email: [battery@sbs-forum.org](mailto:battery@sbs-forum.org) or [questions@sbs-forum.org](mailto:questions@sbs-forum.org)
- [8] TXM-315-LC Linx Technologies Data Sheet (2001), 575 SE Ashley Pl., Grants Pass, OR 97526, [www.linxtechnologies.com](http://www.linxtechnologies.com)

Exhibit C

**Linx Technologies** -- Products - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address [http://www.linxtechnologies.com/docs/f\\_prod.html](http://www.linxtechnologies.com/docs/f_prod.html) Go Links

**LINX TECHNOLOGIES**

Return to Main | 516 571 5216 | 800 756 6411

RF MODULES | OEM PRODUCTS | EVAL KITS | ANTENNAS | CONNECTORS

Search Linx

Powered By

**LINX PRODUCTS**

Looking for an overview of all Linx RF modules? Our latest product guide summarizes our current products as well as some exciting upcoming new ones. [Download here](#) if you have lots of patience or contact our literature department for a hard copy.

**RF MODULES**

Linx RF modules allow engineers of all skill levels to quickly and cost-effectively add wireless capabilities to virtually any product. Check in here for detailed information on all of our modules.

**OEM PRODUCTS**

Done

Start | Inbox... | C:\Docu... | Microsoft... | Linx Tec... | MANAGE... | Internet

4:53 PM



**SCHWABE, WILLIAMSON & WYATT, P.C.**  
ATTORNEYS AT LAW

PACWEST CENTER, SUITES 1600-1900 • 1211 SOUTHWEST FIFTH AVENUE • PORTLAND, OREGON 97204-3795  
TELEPHONE: 503.222.9981 • FAX: 503.796.2900 • www.schwabe.com

PAUL J. FORDENBACHER  
Minnesota and US Patent and  
Trademark Office  
Direct Line: (503) 796-2767  
E-Mail: pfordenbacher@schwabe.com

June 9, 2003

Assistant Commissioner for Trademarks  
2900 Crystal Drive  
Arlington, VA 22202-3513

Re: Notice of Opposition  
Mark: LINX  
Serial No. 76/417,545  
Applicant: Recoton Audio Corporation  
Opposer: Linx Technologies, Inc.  
Our File No. 079883-131655

06-11-2003  
U.S. Patent & TMOfr/TM Mail RcptDt. #71

Dear Assistant Commissioner:

Enclosed for filing in the above referenced matter are the following:

- The original and one copy of the Notice of Opposition
- Exhibits A through C;
- A self-addressed, postage paid postcard to be date stamped acknowledging the receipt of these items.

Please charge our deposit account #500393 for the \$300 filing fee.

Best regards,

Paul J. Fordenbacher

**Certificate of Express Mail Under 37 CFR 1.10**

"Express Mail" mailing label number: EV069126867US

Date of Deposit: June 9, 2003

I hereby certify that this paper and fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Trademarks, 2900 Crystal Drive, Arlington, VA 22202

Rachel L. Bradfute  
(Typed or printed name of person  
mailing paper & fee)

  
Signature of person mailing  
paper & fee)