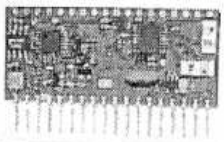
LINX TECHNOLOGIES
WIRELESS MADE SIMPLE

HIGH PERFORMANCE RF MODULE
RXM-900-HP



HP SERIES RECEIVER MODULE DESIGN GUIDE

DESCRIPTION:

The HP series receiver module is designed for the cost-effective, high-performance wireless transfer of analog or digital data, in the popular 902-928MHz band. The receiver offers eight selectable channels and, when paired with an HP series transmitter, is capable of receiving analog and digital information for distances up to 1/4 mile. To assure optimum performance under all field conditions the receiver employs an advanced microprocessor-controlled synthesized architecture. Like all Linx modules, the HP series requires no tuning and in most cases no external RF components *(except an antenna)*, making integration straightforward even for engineers lacking previous RF experience.

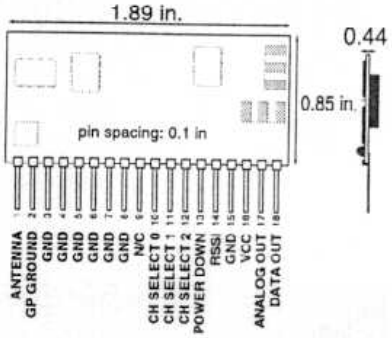


Figure 1: Physical Package

FEATURES:

- 8 Binary Selectable Reception Frequencies
- Exceptional Sensitivity (-95dBm @ 10^{-5} BER typical)
- High Serial Data Rate (50Kbps max.)
- Direct Serial Interface
- Fully Qualified Data Output
- Wide-Range Audio-Capable Analog Output (50Hz-25KHz)
- Cost-Effective
- No External RF Components Required (Except Antenna)
- Manufacturing-Friendly SIP-Style Packaging
- Precision-Synthesized Frequency Reference
- Wide Supply Range (2.7-16V DC)
- Receive Signal Strength (RSSI) and Powerdown Pins
- No Production Tuning

APPLICATIONS INCLUDE:

- Continuous Data Transfer
- Home/Industrial Automation
- Wireless Networking
- Remote Control
- Remote Access
- Remote Monitoring/Telemetry
- Fire/Security Alarms
- Long-Range RFID
- High-Quality Wireless Audio
- Analog Signal Transfer
- General Wire Elimination

1-800-736-6677

ORDERING INFORMATION

PART #	DESCRIPTION
MDEV-900-HP	Evaluation Kit 900 MHz
TXM-900-HP	Transmitter 900 MHz
RXM-900-HP	Receiver 900 MHz

2-8-99

Revised 9/10/98

SPECIFICATIONS

ABOUT THESE MEASUREMENTS

The performance parameters listed below are based on module operation at 25°C from a 5VDC supply unless otherwise noted. It is recommended all ground pins be connected to the ground-plane. The pin marked N/C has no physical connection and is designed only to add support.

Parameter	Designation	Min.	Typical	Max.	Units	Notes
Input Voltage	V_{CC}	2.7	–	16.0	Volts	–
Supply Current	I_{CC}	18	21	24	mA	1
Sleep Current	I_{SLP}	–	–	50	µA	–
Data output:						
Logic low	V_{DOL}	GND	–	0.5	VDC	–
Logic high	V_{DOH}	2.7	–	3.0	VDC	–
RF input impedance	R_{IN}	–	50	–	Ohms	–
Receive frequency	F_C	903.37	–	921.37	MHz	2
Noise Bandwidth	N_{3DB}	–	280	–	KHz	–
Data Bandwidth		300	–	50,000	Bps	–
Audio Bandwidth		50	–	25,000	Hz	–
Sensitivity		-92	-95	-100	dBm	3
DC Modulation Sensitivity		-88	–	–	dBm	4
RSSI:						
Dynamic Range		60	70	80	dB	–
Gain	G_{RSSI}	–	12	–	mV/dB	–
Voltage/No Carrier		–	–	800	mV	–
Spurious Emmissions		–	–	-45	dBm	–
Interference Rejection:						
Half F_C Spurious		–	60	–	dB	–
$F_C \pm 1$MHz		–	20	–	dB	–

Figure 2: Specifications table

Notes:

1. Over full operating voltage
2. Depends on CS0 - CS2 voltage levels
3. For 10^{-5} BER @ 9600 bps
4. Minimum input power level to ensure that data output can hold a DC level

Absolute Maximum Ratings:

Supply voltage Vcc	-0.3	to	18 VDC
Operating temperature	0°C	to	+70°C
Storage temperature	-45°C	to	+85°C
Soldering temperature	+260°C for 15 sec.		
RF input, pin 1	0 dBm		

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

Figure 3: Maximum ratings table

TYPICAL PERFORMANCE GRAPHS

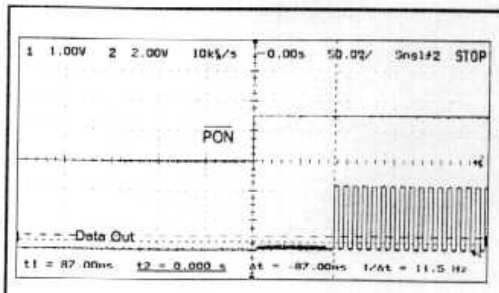


Figure 4: Receiver Turn-on Time

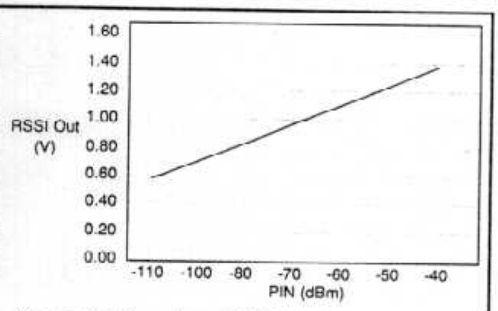


Figure 5: Receiver RSSI

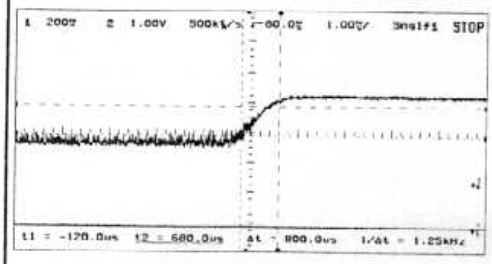


Figure 6: RSSI Response Time

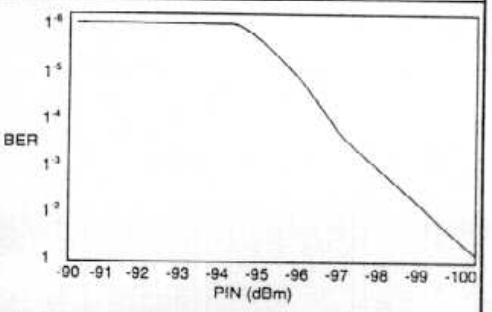


Figure 7: BER vs. Input Power (typical)

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.

PHYSICAL PACKAGING

The receiver is packaged as a hybrid through-hole SIP-style module with 18 pins spaced at .1" intervals. Baseband components occupy the rear of the board while high-frequency components are grouped on the front. Pin 1 is on the far left of the board when viewed from the front.

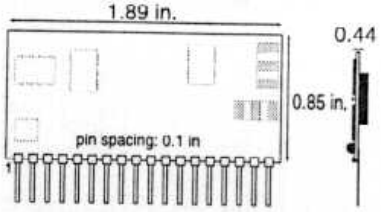


Figure 8: Physical package

PRODUCTION CONSIDERATIONS

The SIP module may be installed using hand- or wave-solder techniques. The module should not be subjected to reflow. If the module is subject to production wash cycles, adequate drying time should be allowed prior to power-up. If the wash cycle introduces contaminants, the module's performance may be adversely affected.

THEORY OF OPERATION

The HP-RXM is a high-performance, eight-channel, dual-conversion superhet FM receiver capable of receiving analog or digital data.

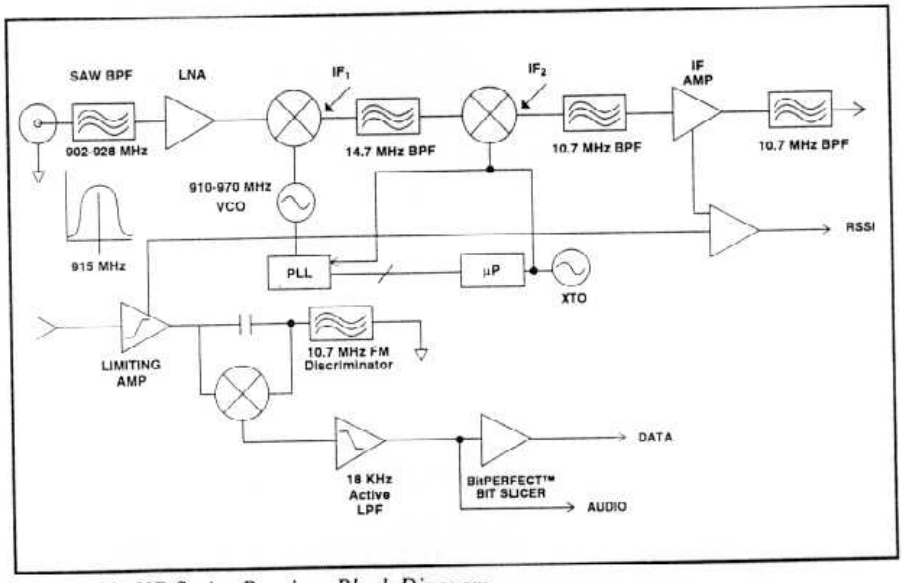


Figure 10: HP Series Receiver Block Diagram

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 HP operates. While FSK modulation is not the most bandwidth-efficient manner of modulating digital data, it is an excellent choice for reliable, low-cost, low-power RF products such as the HP series.

To transmit analog information the module employs FM modulation. In this mode, simple to complex waveforms can be introduced at the transmitter's data pin and recovered with minimal distortion at the receiver's analog output pin.

The user-supplied antenna is connected at pin 1 (see Figure 1). The HP-RXM RF port is matched to 50 ohms to support interface to commonly available antennas such as those manufactured by Linx.

The RF signal coming in from the antenna is filtered by a SAW (surface acoustic wave) filter. The purpose of the SAW BPF is to attenuate unwanted RF energy (i.e., not in the 902-928 MHz band) that is present at the antenna. A SAW device provides significantly steeper roll-off and higher out-of-band attenuation than other filter types such as an LC bandpass.

Once filtered by the SAW, the signal is then amplified by a Low-Noise Amplifier (LNA) to increase the receiver sensitivity and lower the overall noise figure of the receiver. After the LNA, the signal is mixed with a synthesized local oscillator to perform the first frequency conversion.

The first IF frequency is 14.7 MHz. This frequency is achieved by setting the synthesizer frequency to a value that is 14.7 MHz higher than the incoming RF energy from the antenna. The 14.7 MHz IF frequency works out nicely as it inherently eliminates the low image for the second conversion to 10.7 MHz, thus eliminating the possibility of an in-band image from an unwanted source.

A high-performance IF receiver strip is used to perform the second conversion and the FM demodulation. The IF strip takes the 14.7 MHz frequency from the first conversion, mixes it with a high-precision 4.0 MHz crystal oscillator-generated frequency to produce the second IF of 10.7 MHz, and amplifies it in preparation for FM demodulation.

FM demodulation is achieved with an on-board gilbert multiplier. The output of the IF strip is a demodulated waveform that, after filtering, very closely resembles the original waveform used to modulate the transmitter.

A high-performance, active low-pass filter cleans up the audio signal, removing all of the unwanted noise from the FM demodulation process. The output of this filter is provided to the audio output pin and to the BitPERFECT bit slicer, which uses proprietary methods to support a wide dynamic range of modulation rates (300 bps to 50Kbps) with no prerequisites for waveform duty cycle.

An on-board micro-controller is used to manage receiver functions and to provide a simple interface to external circuitry. The micro-controller performs the following functions:

- FREQUENCY SYNTHESIZER PROGRAMMING: The micro-controller reads the three-channel select input lines and programs the frequency synthesizer registers to the proper values for a given channel. This frees the user from complex programming requirements and allows for manual channel selection via switches in product designs where a microprocessor is not used.

- BASEBAND DATA QUALIFICATION: The micro-controller monitors the signal quality and squelches the data output when the signal is not strong enough for accurate data detection. This prevents noise on the data output pin during low-signal or no-signal conditions.

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 layout of the module's PCB, integrating an HP series receiver 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.

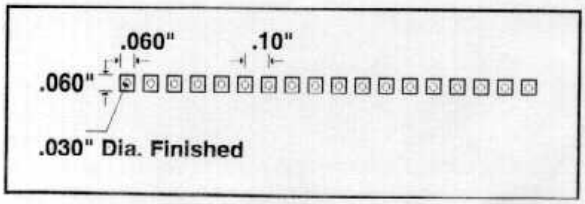


Figure 11: Suggested PCB Footprint

Figure 11 shows the suggested PCB footprint for the HP series receiver.

A ground-plane (as large as possible) should be placed directly under the HP receiver. This ground-plane can also be critical to the performance of your antenna.

NOTE: READ THIS IF YOU ARE GOING TO PERIODICALLY POWER-DOWN RECEIVER!!

A common method of reducing receiver power consumption is to turn the receiver off via the PDN pin for some time interval and wake the receiver periodically to check for the presence of a transmitted signal. In order to implement this method with an HP receiver successfully, there are some timing requirements the user must observe when powering up the receiver to check for channel activity.

At power-up the receiver's on-board microprocessor will begin its start-up routine as detailed previously. A 95 mSec time period must be allotted to allow this routine to be completed. After 95 mSec, the data and RSSI circuits are fully qualified and reliable.

The off-period is determined by the discharge rate of the internal bypass capacitors. The capacitors must fully discharge to ensure that subsequent power-ups will reliably restart the microprocessor. This minimum time should be no less than 300 mSec. If the user is finding that the transmitter is not reliable starting up after power-up, this time should be increased.

CHANNEL SELECTION

The HP receiver module features eight user-selectable channels. The channel of operation is determined by the state of pins CS0-CS2. Figure 15 shows a channel-selection table based on the pins' states. The on-board microprocessor performs all PLL loading functions. This frees the user from complex programming requirements and allows for manual channel selection via switches in product designs where a microprocessor is not used.

CS2	CS1	CS0	Channel	Frequency
0	0	0	0	903.37
0	0	1	1	906.37
0	1	0	2	907.87
0	1	1	3	909.37
1	0	0	4	912.37
1	0	1	5	915.37
1	1	0	6	919.87
1	1	1	7	921.37

Figure 15: Channel-Selection Table

ANALOG OUTPUT

The analog output is derived after amplification in the BitPERFECT bit slicer. The analog output is valid from 50 Hz to 25 KHz, providing an AC signal of about 1V peak-to-peak. This output should not be used to drive a low-impedance load such as a speaker. In applications requiring direct drive into a speaker, such as the transmission of audio, a simple op-amp circuit like the one shown in Figure 16 can be used. In this circuit, the op-amp is used to act as an impedance converter.

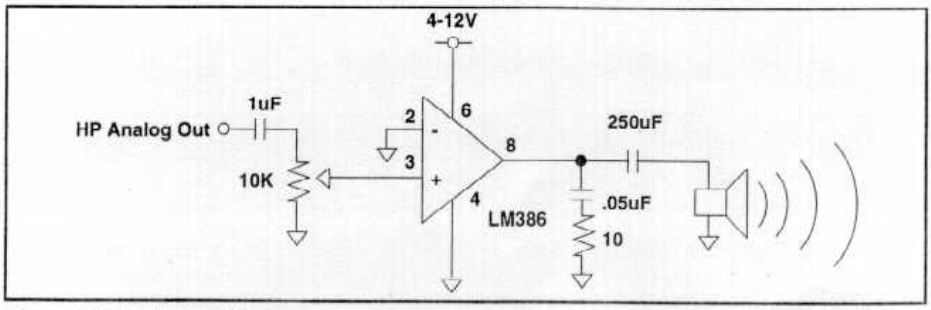


Figure 16: Audio Amplifier

LEGAL CONSIDERATIONS

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

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

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

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

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

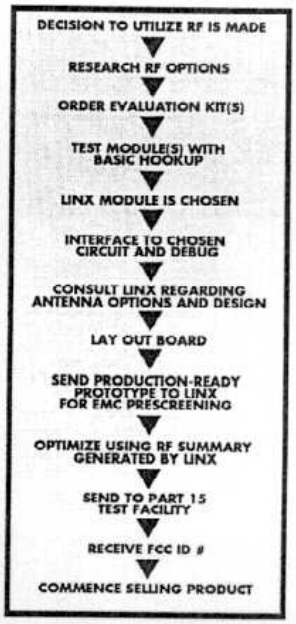
International approvals are slightly more complex, although many modules are designed to allow all international standards to be met. If you are considering the export of your product abroad, you should contact Linx Technologies to determine the specific suitability of the module to your application.

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

SURVIVING AN RF IMPLEMENTATION

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

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



TYPICAL STEPS FOR IMPLEMENTING RF

HELPFUL APPLICATION NOTES FROM LINX

It is not the intention of this manual to address in depth many of the issues that should be considered to ensure that the modules function correctly and deliver the maximum possible performance. As you proceed with your design you may wish to obtain one or more of the following application notes, which address in depth key areas of RF design and application of Linx products.

NOTE #	LINX APPLICATION NOTE TITLE
00500	Antennas: Design, Application, Performance
00130	Modulation techniques for low-cost RF data links
00126	Considerations for operation in the 902 Mhz to 928 Mhz band
00128	Considerations for multi-channel RF environments
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
00110	Understanding the performance specifications of receivers

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