APPLICATION NOTE AN-00126
Considerations For Operation Within the 902-928MHz Band

INTRODUCTION

This application note is designed to give the reader a basic understanding of the technical and legal issues that apply to the operation of RF devices in the 902MHz to 928MHz band. Since the allowed use of frequencies varies considerably worldwide, it should be recognized that this resource document is intended for designers planning to operate in the United States under the rules of CFR47 Part 15.

When working with RF, a clear distinction must always be made between what is technically possible and what is legally acceptable. Since consideration of technical issues serves little purpose if the chosen frequency cannot be legally used for your intended purpose, let us consider issues of legality first.

LEGAL CONSIDERATIONS

In the United States, the Federal Communications Commission (FCC) is responsible for the regulation of all RF devices. These 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 operation in the 902 to 928MHz band are contained in volume 0-19. It is strongly recommended that you obtain a full copy of the code from your local government bookstore, the Government Printing office in Washington (http://bookstore.gpo.gov/) or the FCC web site at:

http://wireless.fcc.gov/rules.html

WHAT IS UNLICENSED OPERATION?

Here in the United States, the FCC requires any device that intentionally radiates RF energy to be tested for compliance with FCC rules. Certain bands within the RF spectrum are available for “Unlicensed” operation. The term “Unlicensed” is often misunderstood. The manufacturer of a product designed for unlicensed operation is not exempt from the certification procedure. Indeed, both the transmitter and receiver must be tested by a qualified testing laboratory and an FCC ID number obtained before the product can be legally sold. Once this has been done, however, the end user of the product can operate it without obtaining a license for its use.

The frequencies from 902 to 928MHz are allocated for a wide variety of unlicensed applications. Under Part 15 and Part 18 a wide variety of narrow band, spread spectrum and Industrial/Scientific/Medical (ISM) devices are allowed legal operation. In most instances, users of modules manufactured by Linx will seek certification under Part 15.249.

WHAT MUST I DO TO BE UNLICENSED?

Part 15 requirements for many bands are somewhat obscure and difficult to interpret. Thankfully, the regulations of Part 15.249 are very straightforward.

Comply with allowed power output, harmonic and spurious requirements.

Devices operating under Part 15.249 are allowed a maximum fundamental field strength of 50,000 microvolts and harmonics of 500 microvolts measured at three meters. All spurious radiation shall be attenuated to the lesser of 50dB below the fundamental or to 200 microvolts below 960MHz or 500 microvolts above. Linx modules are inherently designed to meet these requirements, but it is important to note that external factors can affect the module’s compliance. The RF level radiated into free space is dependent not only on raw output power but also on the type of antenna employed. Most transmitter modules, including those manufactured by Linx, have an output level that is sufficient to produce a radiated RF level that is non-compliant. The transmitter is purposely set high because many designers may wish to utilize inefficient antenna styles for cost or cosmetic reasons. If the module is matched to a highly efficient antenna or one that exhibits gain characteristics, such as a full whip or yagi, the output power may need to be reduced externally by an attenuation pad. For further details, review Linx application note #00150.

On the other hand, a badly matched antenna can be equally damaging. Consider, for example, an antenna that has a high Standing Wave Ratio (SWR) at the fundamental frequency and a low SWR at a harmonic frequency. This misplaced antenna efficiency may cause the harmonic power to rise to an unacceptable level. Harmonics can

also be affected by noise present in the transmitter power supply. This noise can cause oscillator instability and subsequent spurs and harmonic events.

While these issues of legality may appear formidable, they are generally not. By choosing a correct operational frequency and using a pre-made RF module, a product designer's burden is greatly reduced. With proper attention to such basics as good layout, clean supply lines, and a properly matched antenna, RF success is a nearly painless process.

Now that you have a basic overview of legal issues, let us consider the actual technical issues of operation in these frequencies.

BENEFITS OF OPERATION WITHIN THE 902-928MHZ BAND

First is freedom. The band is free of the tight FCC restrictions that limit the applications for which other bands can be used. In the 902-928MHz band, virtually any analog or data signal can be sent without restrictions on content or duration.

Second, higher legal output power yields longer transmission distances than many other bands.

Third, the propagation of frequencies in the 900MHz range is better than at higher frequencies, such as 2.4GHz. Therefore, lower output power is needed to attain any particular distance. Since less output power is needed, transmitter power consumption is reduced.

Fourth is antenna compactness. A useful by-product of higher frequency is shorter wavelength. This allows a 1/4-wave antenna in the 900MHz range to be typically less than 3.25 inches in length, allowing for easy concealment in compact portable products.

DRAWBACKS TO THE 902-928MHZ BAND

First, the lack of restriction on the band has caused it to become increasingly popular and, thus, congested. Many products that transmit continuous data at high rates are now migrating to higher frequencies, but the popularity of the band makes it likely to remain crowded.

Second, higher level interferers. In addition to its allocation for narrow-band devices the 902-928MHz frequency range is also allocated for, and surrounded by, potentially higher-level interferers, such as spread spectrum devices. Linx modules employ a variety of techniques to minimize the possible impact to a user from such interference, including SAW filtration, uncommon frequency allocation, channel qualification and constant carrier modulation techniques.

Third is difficulty of export. Most countries outside the US do not allow similar operation in the 900MHz band, so it is usually impractical to export a device that operates in this range. Fortunately, nearby frequencies are being standardized in large market areas such as Europe. Linx will offer pin- and function-compatible products allowing accommodation of both domestic and export requirements with just a change of modules and antennas.

SUMMARY

The 902-928MHz band is ideal for instances where analog or digital signals prohibited in other bands need to be sent. In addition, it should also be given consideration for all applications where high performance analog or digital transmissions are required.

SECTION 15.249

Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz, 5725 - 5875 MHz, and 24.0 - 24.25 GHz.

(a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these

Fundamental Frequency	Field Strength of Fundamental (millivolts/meter)	Field Strength of Harmonics (microvolts/meter)
902 - 928MHz	2,250	225
2400 - 2483.5MHz	1,250	125
5725 - 5875MHz	1,250 to 3,750**	125 to 375**
24.0 - 24.25GHz	3,750	375

frequency bands shall comply with the following:

(b) Fixed, point-to-point operation as referred to in this paragraph shall be limited to systems employing a fixed transmitter transmitting to a fixed remote location. Point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information are not allowed. Fixed, point-to-point operation is permitted in the 24.05-24.25 GHz band subject to the following conditions:

(1) The field strength of emissions in this band shall not exceed 2500 millivolts/meter.

(2) The frequency tolerance of the carrier signal shall be maintained within + 0.001% of the operating frequency over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

(3) Antenna gain must be at least 33 dBi. Alternatively, the main lobe beamwidth must not exceed 3.5 degrees. The beamwidth limit shall apply to both the azimuth and elevation planes. At antenna gains over 33 dBi or beamwidths narrower than 3.5 degrees, power must be reduced to ensure that the field strength does not exceed 2500 millivolts/meter.

(c) Field strength limits are specified at a distance of 3 meters.

(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in Section 15.209, whichever is the lesser attenuation.

(e) As shown in Section 15.35(b), for frequencies above 1000 MHz, the above field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For point-to-point operation under paragraph (b) of this section, the peak field strength shall not exceed 2500 millivolts/meter at 3 meters along the antenna azimuth.

(f) Parties considering the manufacture, importation, marketing or operation of equipment under this section should also note the requirement in Section 15.37(d).