Considerations for Operation within the 260–470MHz Band

# Application Note AN-00125

## Introduction

This application note is designed to give the reader a basic understanding of the legal and technical considerations for operation of RF devices in the 260–470MHz band within the United States. The use of these frequency bands varies considerably worldwide, so it should be recognized that this application note is intended for designers utilizing Linx RF modules and planning to operate in the United States.

When working with RF, a clear distinction should always be made between what is technically possible and what is legally acceptable. Achieving a solution that meets technical objectives but cannot be legally sold or operated serves little use. As such, issues of legality should be given high priority.

## 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 260–470MHz band are contained in volume 0-19. It is strongly recommended that a copy be obtained and reviewed in its entirety. You can get a full copy of the code from your local government bookstore, the Government Printing office in Washington <http://bookstore.gpo.gov/> or the FCC website <http://wireless.fcc.gov/rules.html>.

## What Is Unlicensed Operation?

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 testing and/or certification. Indeed, both the transmitter and receiver must be tested by a qualified testing laboratory. However, once this has been done and any necessary approvals received, the end user of the product can then operate it without obtaining a license for its use.

## Receiver Procedure

The approval procedures for transmitters and receivers are quite different. The receiver is considered an unintentional radiator and is subject to authorization under the Declaration of Conformity process. This is a simple process in which an accredited laboratory tests the product to ensure that the equipment complies with FCC standards. The test results should be maintained within your files, but an FCC filing or submittal is not required unless specifically requested pursuant to Section 2.1076.

Following successful completion of this process, the end product should be labeled as prescribed by theFCC. Further information may be obtained at <http://fjallfoss.fcc.gov/oetcf/kdb/forms/FTSSearchResultPage.cfm?id=27980&switch=P>.

## Transmitter Procedure

The transmitter is an intentional radiator and subject to certification. Certification testing should be performed by a properly approved laboratory. In most cases you do not need to be present for testing and your chosen laboratory will prepare the filing paperwork. Certifications were once issued by the FCC directly, but now independent laboratories are allowed to issue certification though the Telecommunication Certification Body (TCB) program, which has streamlined the process.

Following successful testing, a report will be produced showing information about the testing and your device. A label displaying your FCC ID number along with FCC prescribed information will need to be placed on your certified product. You can obtain further information on labeling at the website listed in the preceding section.

The rules for transmitters operating in the 260–470MHz band are governed by Part 15.231. In some bands the FCC specifies only fundamental power, harmonic levels, and allowed bandwidth. However, in the case of the 260–470MHz band, the FCC also considers factors such as the intended application and transmission duration.

You will want to review the text of 15.231 in its entirety. (It has been included for your convenience.) When reviewing this section, it is critical to read paragraphs (A)–(D) as a unit, and recognize that paragraph (E) only applies if the rules of paragraph (A) cannot be met. Given the rules' complexity and application-dependent nature, they are best illustrated in Figure 1 on the following page.

FCC rules are subject to a case-by-case interpretation. If your application is not clearly in compliance or you are uncertain, contact the FCC at:

Federal Communications Commission
Office of Engineering and Technology
7435 Oakland Mills Road
Columbia, MD 21046
Phone: +1 301 362 3000
https://fjallfoss.fcc.gov/oetcf/kdb/forms/InquiryForm.cfm

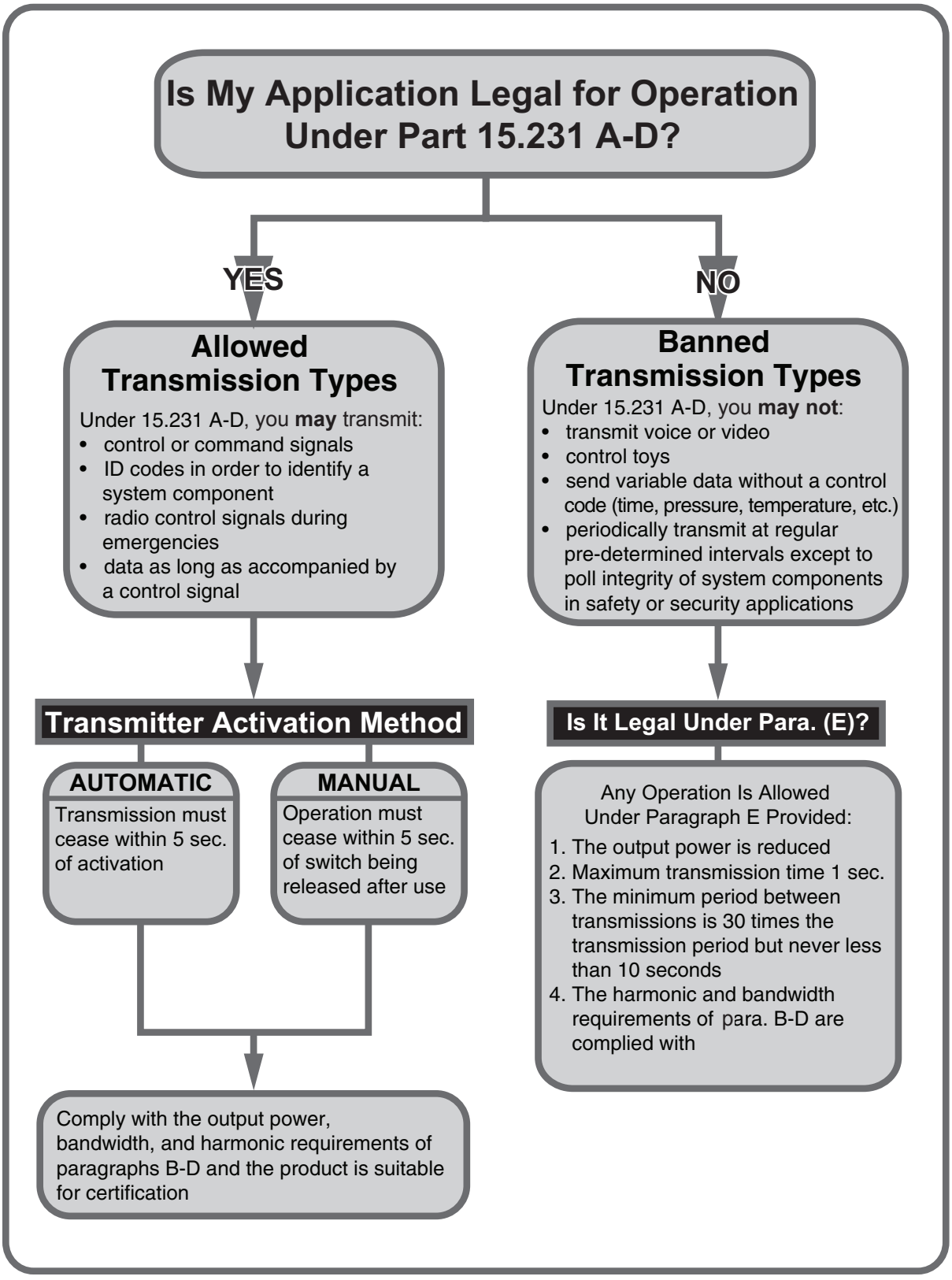


Figure 1: Is My Application Legal for Operation Under Part 15.231 A–D?

## Functional Requirements

Once you are certain your application is allowed in principle, you will want to focus on understanding the specific functional requirements that must be met in order for your product to receive certification.

## Determine and Comply with Allowed Output Power

The following table shows the relationship between the fundamental frequency of operation and the allowed output power. Since the output power is allowed to climb as the frequency increases, it might appear that selecting the highest frequency would give the best range performance. This is not the case, however, since free space attenuation increases proportional to frequency. Thus, the regulations equalize the bands propagation characteristics. Antenna size and efficiency should also be considered. Compact or reduced sized antennas will generally not be as efficient at the lower parts of the band.

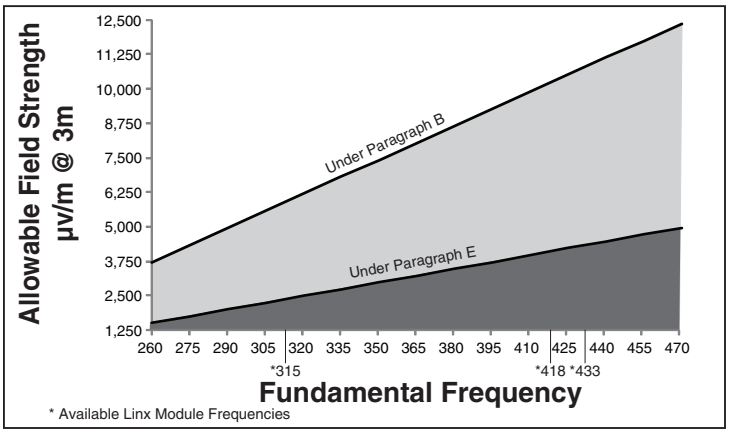


Figure 2: Allowed Output Power

It is always important to note that the RF level radiated into free space is dependent not only on raw output power, but also factors such as the type of antenna employed, circuit layout, and ground plane. Most transmitter modules, including those manufactured by Linx, are capable of producing non-compliant output levels. This extra power helps designers overcome inefficient antenna styles and allows them to take advantage of the FCC's averaging allowance when modulation techniques such as ASK/OOK are employed. If the module is matched to an efficient antenna, the output power may need to be reduced using the module's level adjust or an external attenuation pad. For further details, review Linx Application Note AN-00150.

In addition to fundamental output power restrictions, the FCC also regulates allowed harmonic levels and occupied bandwidth. Since this application note is oriented toward users of Linx products, little detail is needed on these points as Linx modules are designed to meet these requirements. It is important, however, to note that there are ways in which a user can adversely affect harmonic content including the use of a poorly matched or tuned antenna, supply/system noise, or layout or bypass issues.

While these considerations of legality may appear formidable, they generally are 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 can be nearly painless process.

Now that your application has hopefully survived the legal considerations outlined above, let's consider the actual technical issues of operation in these frequencies.

## Benefits of Operation within the 260–480MHz Band

First, it should be recognized that the unusual restrictions placed on the band by the FCC do more than just make a designer's life miserable. The random periodic nature of transmissions resulting from these restrictions helps to keep this set of frequencies clear of sustained interference. Other Part 15 bands are potentially crowded with continuous transmissions of voice, data, video, and even microwave ovens.

Second, longer transmission distances are achieved with less power. The free space propagation of frequencies in this range is significantly better than at higher frequencies, such as 900MHz or 2.4GHz. Therefore, lower output power is needed to attain any particular distance and power consumption is significantly reduced.

Third is cost-effectiveness. The components used at these frequencies are lower in cost than those designed for higher frequencies.

Fourth is international regulatory compatibility. Many countries worldwide have allocated frequencies within this band for similar uses. If your product will be sold abroad, this may allow for international compatibility.

## Common Frequencies within the Band and Their Uses

As you review Linx product offerings, you will notice three standard frequencies within the 260–470MHz band. These frequencies are 315, 418 and 433.92MHz.

- 315MHz is commonly used for gate/garage door openers, security and keyless entry systems.
- 418MHz is a very clean frequency in the US and also appropriate for operation in Canada.
- 433.92MHz is used throughout all of Europe. While it is allowable for use here in the US and Canada, interference from amateur radio, the nearby pager band, and active RFID tags may sometimes pose a problem.

## Summary

The 260–470MHz band is ideal for transmitting control, command or status signals. It should also be given consideration for control signals accompanied by data such as time, temperature or pressure.

## Appendix A—FCC CFR Section 15.231

**Periodic operation in the band 40.66–40.70MHz and above 70MHz.**
(a) The provisions of this section are restricted to periodic operation within the band 40.66–40.70MHz and above 70MHz. Except as shown in paragraph (e) of this section, the intentional radiator is restricted to the transmission of a control signal such as those used with alarm systems, door openers, remote switches, etc. Continuous transmissions, voice, video and the radio control of toys are not permitted. Data is permitted to be sent with a control signal. The following conditions shall be met to comply with the provisions for this periodic operation:

(1) A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

(2) A transmitter activated automatically shall cease transmission within 5 seconds after activation.

(3) Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds per hour.

(4) Intentional radiators which are employed for radio control purposes during emergencies involving fire, security, and safety of life, when activated to signal an alarm, may operate during the pendency of the alarm condition.

(5) Transmission of set-up information for security systems may exceed the transmission duration limits in paragraphs (a)(1) and (a)(2) of this section, provided such transmissions are under the control of a professional installer and do not exceed ten seconds after a manually operated switch is released or a transmitter is activated automatically. Such set-up information may include data.

(b) In addition to the provisions of Section 15.205, the field strength of emissions from intentional radiators operated under this section shall not exceed the following:

| Fundamental Frequency (MHz) | Field Strength of Fundamental (microvolts/meter) | Field Strength of Spurious Emissions (microvolts/meter) |
|---|---|---|
| 40.66–40.70 | 2,250 | 225 |
| 70–130 | 1,250 | 125 |
| 130–174 | 1,250 to 3,750** | 125 to 375** |
| 174–260 | 3,750 | 375 |
| 260–470 | 3,750 to 12,500** | 375 to 1,250** |
| Above 470 | 12,500 | 1,250 |

** linear interpolations

Figure 4

(1) The above field strength limits are specified at a distance of 3 meters. The tighter limits apply at the band edges.

(2) Intentional radiators operating under the provisions of this section shall demonstrate compliance with the limits on the field strength of emissions, as shown in the above table, based on the average value of the measured emissions. As an alternative, compliance with the limits in the above table may be based on the use of measurement instrumentation with a CISPR quasipeak detector. The specific method of measurement employed shall be specified in the application for equipment authorization. If average emission measurements are employed, the provisions in Section 15.35 for averaging pulsed emissions and for limiting peak emissions apply. Further, compliance with the provisions of Section 15.205 shall be demonstrated using the measurement instrumentation specified in that section.

(3) The limits on the field strength of the spurious emissions in the above table are based on the fundamental frequency of the intentional radiator. Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in this table or to the general limits shown in Section 15.209, whichever limit permits a higher field strength.

(c) The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70MHz and below 900MHz. For devices operating above 900MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20dB down from the modulated carrier.

(d) For devices operating within the frequency band 40.66–40.70MHz, the bandwidth of the emission shall be confined within the band edges and the frequency tolerance of the carrier shall be ±0.01%. This frequency tolerance shall be maintained for 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.

(e) Intentional radiators may operate at a periodic rate exceeding that specified in paragraph (a) of this section and may be employed for any type of operation, including operation prohibited in paragraph (a) of this section, provided the intentional radiator complies with the provisions of paragraphs (b) through (d) of this section, except the field strength table in paragraph (b) of this section is replaced by the following:

| Fundamental Frequency (MHz) | Field Strength of Fundamental (microvolts/meter) | Field Strength of Spurious Emissions (microvolts/meter) |
|---|---|---|
| 40.66–40.70 | 1,000 | 100 |
| 70–130 | 500 | 50 |
| 130–174 | 500 to 1,500** | 50 to 150** |
| 174–260 | 1,500 | 150 |
| 260–470 | 1,500 to 5,00** | 150 to 500** |
| Above 470 | 5,000 | 500 |

** linear interpolations

Figure 5

In addition, devices operated under the provisions of this paragraph shall be provided with a means for automatically limiting operation so that the duration of each transmission shall not be greater than one second and the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds.



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