



FCC Part 15 ISM Regulations

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Overview

This document is to describe the FCC part 15 regulatory requirements for license-free 902-928MHz ISM transmitters. Refer to these rules for the current requirements.

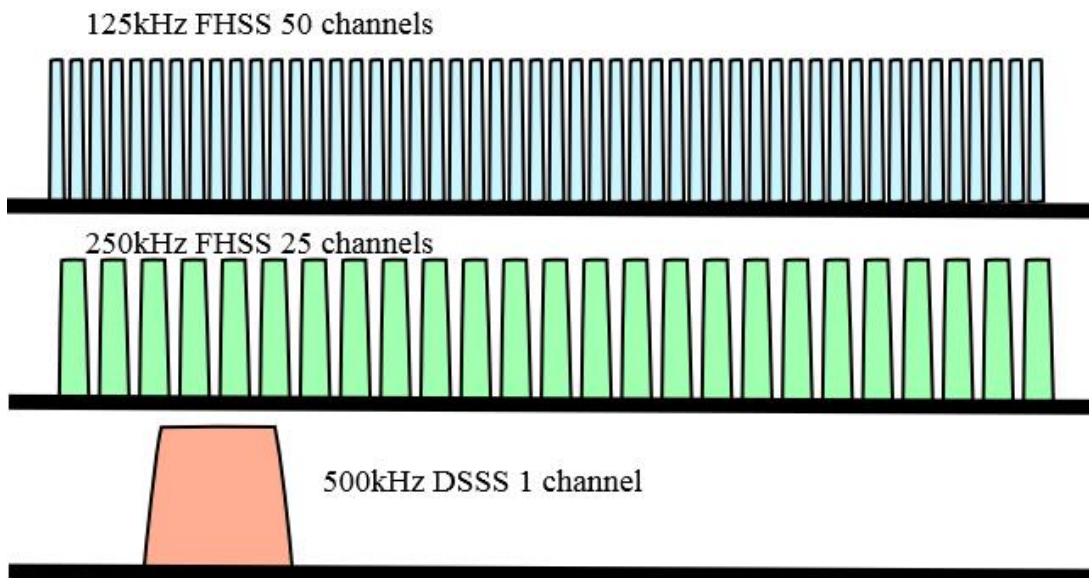
The code of Federal Regulations, Title 47 Part 15 describe the specifics of the regulations that apply to data radio transmitters in this ISM (Industrial, Scientific, and Medical) band that utilize spread spectrum techniques. 915 MHz is the center frequency of the band. The FCC regulations allow 50 mV/m electrical field strength, at a distance of 3 meters from the transmitting antenna.

Operation in this band

The primary requirements of operating in the ISM base are:

1. The device must not cause harmful interference.
2. Devices must accept interference from other devices, and there is no guarantee of the availability of a radio channel for communications.

Part 15.247 covers the restrictions on an intentional radiator utilizing **Frequency Hopping Spread Spectrum** or **Digital Modulation Techniques**.



Frequency Hopping

Frequency Hopping Spread Spectrum (FHSS) must meet certain power and bandwidth restrictions, as described below. There are many other spurious regulations but these are the primary emission regulations:

1. Channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.
2. **<250kHz Wide Channels:** If the channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy shall not be greater than 400mS within a 20 second period.
3. **>=250kHz Wide Channels:** If the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy shall not be greater than 400mS seconds within a 10 second period.
4. Each hopping frequency must be used equally by each transmitter.
5. Receivers shall have bandwidths that match the transmitters and shall shift frequencies in synchronization with the transmitted signals.
6. The maximum 20 dB bandwidth of the hopping channel is 500 kHz.
7. The maximum transmit power is:
 - a. 1.0 watt for systems employing at least 50 hopping channels
 - b. 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels
8. Antenna gains can be up to 6dBi, which is about 4.8dB dipole gain.
 - a. If the transmitting gain is greater than 6 dBi, the conducted output power from the intentional radiator shall be reduced the number of dB that the antenna gain exceeds 6dBi by.

Direct Sequence Spread Spectrum

Direct sequence spread spectrum is a type of digital modulation that spreads the data transmissions over a wide spectrum.

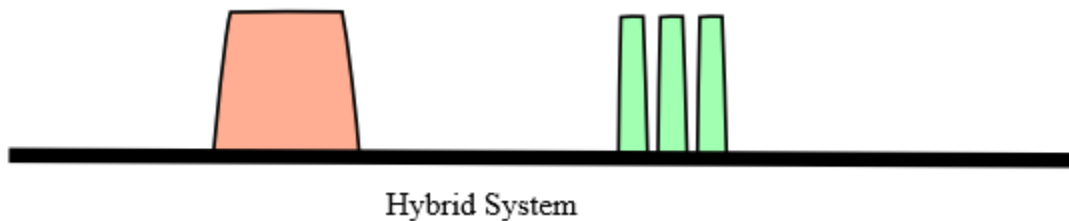
1. The minimum 6dB transmit power bandwidth is 500 kHz.
2. The maximum transmit power is 1 watt (30dBm) and the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz bandwidth.
3. Antenna gains can be up to 6dBi, which is about 4.8dB dipole gain.
 - b. If the transmitting gain is greater than 6dBi, the conducted output power from the intentional radiator shall be reduced the number of dB that the antenna gain exceeds 6dBi by.
4. To ensure that the power spectral density requirements are met, the data being transmitted is encoded with a pseudorandom bit pattern called a PN sequence.

Hybrid Systems

FCC part 15.247 (f) defines another type of operation which is a hybrid combination of frequency hopping and direct sequence. This allows a system to use a smaller number of hopping channels which can help reduce power consumption and system latency.

1. When frequency hopping and direct sequence turned off, a device must have an average time of occupancy on any frequency less than or equal to 400ms within a time period of $0.4 \times$ number of channels. There is no minimum number of hopping channels with a hybrid system
2. The operation of the hybrid system, with the frequency hopping operation turned off, shall comply with the power density requirements of Direct Sequence.

For example, in an 8 channel hybrid system, the dwell time in frequency hopping mode must not exceed 3.2 seconds ($400 \text{ ms} \times 8$). The power spectral density must not exceed +8dBm in any 3kHz bandwidth.



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Spread Spectrum

The FCC in the USA and other country's regulatory authorities require radio transmitters to widely spread their radio frequency (RF) power across a band. In the USA, it is FCC regulation 15.247 that specifies this. Here is a link to a summary of the spread spectrum requirements for license-free wireless. AN203.

LoRa Technology

Raveon is one of the may early implementers of LoRa technology in the USA, and one of the first to get a full-power LoRa device FCC certified. LoRa is a radio modulation technique and protocol that enables a device to have unprecedented long-range communications.

Use of the ISM Band

Often systems IN the U.S. are setup for monitoring and collecting highway tolls use the 915-MHz band. In other countries 800MHz and 900Mhz bands are often used.

Home weather stations, automated meter reading, industrial monitoring and home security use this technology. RFID tags for monitoring and recording the movements of pharmaceuticals in the distribution chain also use this band.