GENERAL

an1200 26 lora and fcc part 15 247 measurement guidance

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Understanding the AN1200 26 LoRa Measurement Guidance and FCC Part /15.247

In the rapidly expanding world of low power wide area networks (LPWANs), LoRa has become a dominant technology for Internet of Things (IoT) deployments. Whether you're a developer building a new sensor node, a compliance engineer preparing a product for market, or a regulatory specialist ensuring adherence to U.S. rules, a clear grasp of the **AN1200 26 LoRa and FCC Part /15.247 measurement guidance** is essential. This guide delves into the intricacies of the FCC's emission limits for sub GHz devices, the specific requirements outlined in AN1200 26, and the practical steps you need to take to achieve compliance.

Why Measurement Matters for LoRa Devices

LoRa operates in the 915 /MHz band in the United States, a frequency range that is shared by a variety of devices such as wireless microphones, cordless phones, and industrial sensors. Because of this shared environment, the FCC imposes strict limits on the amount of radio frequency (RF) energy a device can radiate. These limits are defined in **Part /15.247** of the FCC rules, which specifies the maximum power spectral density (PSD) for sub GHz devices. Failure to meet these limits can result in interference with other users, fines, or product recalls.

To prove compliance, manufacturers must perform **measurement tests** that verify the device's PSD remains below the regulatory threshold across its operating bandwidth. The **AN1200 26 LoRa Measurement Guidance** is the FCC's official document that explains how to conduct these tests correctly, what equipment to use, and how to interpret the results.

What Is AN1200 26?

AN1200 26 is the FCC's *Application Note* that provides detailed guidance for measuring and evaluating the emissions of sub GHz devices, specifically those using LoRa modulation. It builds on earlier documents such as AN1200 22 and AN1200 25, focusing on the unique characteristics of LoRa, which include chirp spread spectrum modulation and variable bandwidths.

Key objectives of AN1200 26 include:

- Clarifying the measurement setup for LoRa devices in the 902–928 /MHz band.
- Defining the acceptable PSD thresholds based on the device's transmit power and bandwidth.
- Providing step by step procedures for capturing the spectrum and calculating the average PSD.
- Offering guidance on handling edge cases, such as devices that use multiple spreading factors or dynamic power control.

Because LoRa devices can operate over a wide range of bandwidths—from 125 kHz up to 500 kHz—the guidance must account for how these bandwidths affect the PSD calculation.

FCC Part /15.247: The Regulatory Landscape

Part /15.247 is part of the FCC's Part /15 rules, which govern unlicensed radio communications. Section /15.247 specifically addresses **sub GHz devices operating in the 902–928 /MHz band**. The main regulatory requirement is

that the **power spectral density (PSD)** of the transmitted signal must not exceed a certain threshold, usually expressed in dBm/Hz.

For most LoRa devices, the PSD limit is set at **" 41.6 /dBm/Hz** for the 915 /MHz band. However, the FCC allows a **+2 /dBm** "safety margin" for devices that use multiple spreading factors or have variable transmit power. This means that a device's measured PSD should be at least 2 /dB below the regulatory limit to be considered compliant.

In addition to PSD limits, Part /15.247 also specifies:

- Allowed bandwidths and center frequencies for sub GHz devices.
- Maximum transmit power levels for different device classes.
- Procedures for measurement and testing, including the use of spectrum analyzers, antennas, and test environments.

Understanding these requirements is the first step in ensuring that your LoRa device meets FCC standards.

Measurement Setup: Equipment and Environment

Accurate measurement hinges on a well configured test environment and the right tools. Below is a detailed checklist of the equipment and setup you'll need to perform a compliant LoRa measurement.

1. Spectrum Analyzer

The core of the measurement is a high quality spectrum analyzer capable of:

- Operating in the 902–928 /MHz band.
- Providing a resolution bandwidth (RBW) of at least 3 /kHz.
- Having an average detector for PSD calculations.
- Supporting a measurement bandwidth that covers the full LoRa spread spectrum.

Examples include the Tektronix RSA3000 series or the Rohde & Schwarz FSH series.

2. Antenna

Use a standard **dipole antenna** or a **whip antenna** with a known gain (typically 0 /dBi) that is well matched to the 915 /MHz band. The antenna should be positioned in free space or on a **metamaterial antenna stand** to minimize reflections.

3. Power Supply and Control

To evaluate the device at its nominal operating power, supply it with a stable **regulated power source**. If your LoRa module supports dynamic power control, ensure you can set it to the maximum transmit power for the test.

4. Test Environment

Perform the measurement in an **anechoic chamber** or a **large open field** to avoid multipath interference. If an anechoic chamber is unavailable, use a Faraday cage and maintain a minimum distance of 3 meters between the device and the antenna.

5. Calibration

Before starting, calibrate the spectrum analyzer's **frequency accuracy** and **gain calibration** using a **calibration tone** at 915 /MHz. This ensures that the measured PSD values are accurate.

Step by Step Measurement Procedure

Below is a practical, step by step guide to measuring your LoRa device in compliance with AN1200 26 and FCC Part /15.247.

1. Prepare the Device\n\nConfigure the LoRa module to operate at the highest transmit power allowed by the FCC.
2. Select the widest bandwidth (500 /kHz) if the device supports multiple bandwidths; otherwise, use the maximum bandwidth available.
3. Set the spreading factor to the lowest (SF /7) for maximum data rate, or to the highest (SF /12) to test worst case PSD.

- Mount the antenna on a stand at least 1.5 /meters above the ground.
- Align the antenna so that its boresight points directly at the device.

- Set the center frequency to 915 /MHz.
- Choose a resolution bandwidth (RBW) of 3 /kHz to capture the LoRa chirp accurately.
- Set the video bandwidth (VBW) to the same value as the RBW for real time averaging.
- Select the average detector mode.

- Start the LoRa transmission from the device.
- Record the spectrum trace for a period of at least 10 /seconds to capture multiple chirps.
- Use the spectrum analyzer's PSD calculation feature to compute the average power spectral density.

- Verify that the maximum PSD value across the bandwidth does not exceed the regulatory limit minus the safety margin (" 41.6 /dBm/Hz – 2 /dB = " 43.6 /dBm/Hz).
- If the device uses multiple spreading factors, repeat the test for each SF.

- Save the spectrum trace and PSD data in PDF or CSV format.
- Include details such as test date, equipment used, device configuration, and test environment.

Important Tips

- When measuring devices that support dynamic power control, test at the maximum power setting to ensure compliance under worst case conditions.
- For devices that use multiple bandwidths, perform separate measurements for each bandwidth and document all results.
- Always include a margin of error in your documentation to account for measurement uncertainties.

Calculating Power Spectral Density (PSD)

PSD is a key metric that determines whether a device complies with FCC limits. It is calculated by dividing the average power of the transmitted signal by the bandwidth of the signal. The FCC's Part /15.247 specifies that the PSD must be measured in **dBm/Hz**.

Formula

PSD (dBm/Hz) = 10 × log10(Power (mW) / Bandwidth (Hz))

Where **Power (mW)** is the average power over the measurement period and **Bandwidth (Hz)**is the instantaneous bandwidth of the LoRa chirp.

Example Calculation

- Measured average power: 10 /mW (10 /dBm)
- Bandwidth: 500 /kHz
- PSD = 10 × log10(10 /mW / 500 /000 /Hz) = 10 × log10(2 /× /10 { u) "H –46.99 /dBm/Hz

In this example, the PSD is well below the regulatory threshold of " 43.6 /dBm/Hz, indicating compliance.

Common Pitfalls and How to Avoid Them

Even experienced engineers can fall into traps when measuring LoRa devices. Below are some of the most common mistakes and how to prevent them.

1. Using the Wrong Resolution Bandwidth

If the RBW is too wide, the analyzer may smooth out peaks, leading to an underestimation of PSD. Conversely, too narrow an RBW can increase noise floor and produce false positives. Stick to the recommended 3 kHz RBW unless your device's bandwidth requires a different setting.

2. Neglecting the Antenna Gain

Failing to account for antenna gain can skew PSD values. Always use an antenna with a known gain (usually 0 dBi) or apply the gain correction factor in your calculations.

3. Measuring in a Reflective Environment

Multipath reflections can artificially inflate the measured PSD. Use an anechoic chamber or ensure a minimum distance of 3 /meters from the device to the antenna.

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