Interference and Noise at 915 MHz

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The 902 - 928 MHz ISM (Industrial, Scientific, and Medical) band is shared with a wide variety of devices that can interfere with LoRa mesh operation. Understanding who shares this band, how their signals manifest, and how to identify and mitigate interference is essential for reliable mesh network operation.

The 902 - 928 MHz ISM Band Landscape

LoRa mesh operates in this band under FCC Part 15.247 (digitally-modulated / spread-spectrum systems, up to 1 W conducted). Part 15.249 is a separate, much-lower-power regime (field-strength limited to roughly well under 1 mW EIRP) that LoRa mesh nodes do not and cannot use at the 17 - 30 dBm power levels described on this page. It shares this spectrum with many other systems:

Technology	Frequency Range	Modulation	Typical Power	Interference Risk
LoRa (US915 plan)	902 - 928 MHz, 64 uplink channels grouped into 8 sub-bands + 8 downlink	CSS (chirp spread spectrum)	17 - 30 dBm	N/A (desired signal)
Zigbee 900 MHz	902 - 928 MHz	DSSS	0 - 10 dBm	Low; different modulation
Z-Wave (North America)	908.42 MHz / 916 MHz	FSK/GFSK	0 - 14 dBm	Low to moderate; narrow channels in LoRa band
FHSS devices (phones, security systems)	902 - 928 MHz, frequency hopping	FHSS/FSK	Varies	Moderate; wideband hopping
900 MHz cordless phones (older)	902 - 928 MHz	FHSS or analog FM	100 mW	Moderate; common in homes
Baby monitors (900 MHz type)	902 - 928 MHz	FM/FHSS	10 - 100 mW	Moderate locally

Technology	Frequency Range	Modulation	Typical Power	Interference Risk
ISM telemetry (AMR meters, SCADA)	902 - 928 MHz	FSK/OOK	Up to 1 W conducted (same 15.247 limit as LoRa)	Low to high; site-dependent
WiFi 802.11ah (HaLow)	902 - 928 MHz	OFDM	Typically <30 dBm	Emerging; not yet widespread
Cellular Band 8 uplink	880 - 915 MHz	LTE/WCDMA	Up to 2W	Adjacent band; high-power cellular near tower can cause blocking
Cellular Band 8 downlink	925 - 960 MHz	LTE/WCDMA	Up to 43 dBm tower	Adjacent band; strong tower signal can cause receiver desensitization

Note that the co-band Part 15 devices above (such as AMR/SCADA telemetry) are bound by the same 15.247 limit of 1 W conducted as LoRa; none are licensed to exceed it.

How LoRa Handles Interference

LoRa's CSS modulation has inherent interference rejection properties. The chirp spread spectrum processing gain allows LoRa to decode signals below the noise floor, but the margin is spreading-factor dependent: the demodulation SNR limit ranges from about -7.5 dB at SF7 to about -20 dB at SF12. Only the highest spreading factors approach 20 dB below the noise floor. However, strong narrowband interferers can still cause problems:

- **Blocking/desensitization:** A strong signal anywhere near 915 MHz can saturate the LoRa radio's LNA or ADC, raising the effective noise floor and degrading sensitivity to all LoRa signals. This is the most common form of interference damage.
- **Intermodulation:** Two strong interferers at frequencies f_1 and f_2 can produce intermodulation products at $2f_1 - f_2$ and $2f_2 - f_1$ that fall on LoRa channels.
- **Direct channel co-channel interference:** This depends on how many other users land on your specific narrow LoRa channel (125/250/500 kHz), not on the total 26 MHz band width. Because Meshtastic/LoRa mesh nodes typically share a small number of common channels, co-channel collisions among mesh users are in fact common in dense deployments.

Identifying Interference

Symptoms of interference in a LoRa mesh network:

- SNR (signal-to-noise ratio) readings consistently lower than expected given link budget calculations

- Elevated RSSI on channels with no active transmissions ("noise floor rise")
- Time-of-day correlation with interference events (e.g., worse during business hours when nearby office equipment is active)
- Geographic correlation - nodes near specific buildings, industrial sites, or utility infrastructure experience worse performance
- Intermittent packet loss despite strong RSSI - suggests bursty interferers like FHSS devices occasionally hitting LoRa channels

Tools for characterizing interference:

- **LoRa channel activity detection (CAD):** Built into SX1276/SX1262; CAD detects LoRa activity on the currently-tuned channel and returns a busy/available status - it is not a spectrum scanner. To survey multiple channels, scan them sequentially or use an SDR.
- **RTL-SDR + SDR#/GQRX:** A $25 RTL-SDR dongle can display the entire 902 - 928 MHz spectrum in real time, revealing the presence, frequency, and character of interferers
- **HackRF / Airspy:** Higher-end SDR for more detailed analysis; can capture wideband spectral views and decode modulations

Mitigation Strategies

Channel Plan Management

LoRaWAN US915 defines 64 uplink channels at 125 kHz (200 kHz spacing, 902.3 - 914.9 MHz) grouped into 8 sub-bands, plus 8 uplink channels at 500 kHz, and 8 downlink channels at 500 kHz (923.3 - 927.5 MHz). Note that Meshtastic does not use LoRaWAN channelization - it uses single configurable frequencies - so this LoRaWAN detail is tangential to most mesh users. Meshtastic and other mesh firmware may allow channel selection. If interference is identified on specific channels, reprogram nodes to avoid those frequencies. For 915 MHz LoRa in the US, the upper portion of the band (916 - 928 MHz) is less heavily used by legacy FHSS devices and may have lower ambient interference.

Antenna Selection and Placement

Directional antennas inherently reject interference from outside their main beam. The 12 dBi Yagi described on the Directional Antennas page, aimed at a target node, has substantial front-to-back rejection (typically 15 - 25 dB), meaning interferers behind the antenna are attenuated by that amount. For fixed infrastructure links experiencing interference from a known direction, switching from omni to directional can provide dramatic improvement.

Physical Separation and Height

Interference from consumer devices (baby monitors, cordless phones) drops off rapidly with distance due to their low power and proximity effects. Raising the antenna above the local RF clutter level (above rooftops, not at window height) can substantially improve SNR - often several

dB to more than 10 dB depending on the site - by placing the antenna in a "quieter" RF environment.

Filtering

Band-pass filters for 902 - 928 MHz can be installed between the antenna and the LoRa radio to reject out-of-band energy (especially cellular downlink at 925 - 960 MHz) that might cause blocking. Mini-Circuits, Johanson Technology, and similar vendors offer suitable filters:

- Look for a passband of 902 - 928 MHz with at least 40 dB rejection outside the band
- Insertion loss within passband should be under 2 dB
- Rate the filter's power handling for your maximum *conducted* transmit power (up to 1 W / 30 dBm under 15.247), not EIRP. The filter sits before the antenna, so it sees conducted power only; antenna gain (and thus EIRP) occurs after it.

Note that filtering is only effective against out-of-band interference. In-band interference (e.g., another user in the 902 - 928 MHz band) cannot be filtered without also removing the desired LoRa signal.

Firmware-Level Mitigation

- **Lower the hop timing aggressiveness:** Reducing retransmission aggressiveness in meshing firmware reduces the probability that any given packet collides with a bursty interferer
- **Use higher spreading factors:** SF11 and SF12 provide more interference rejection (processing gain) at the cost of reduced throughput
- **Enable Listen-Before-Talk (LBT):** Some LoRa firmware supports carrier sense before transmitting, reducing collisions with other ISM band users

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