RF Connectors for LoRa Hardware

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RF connector incompatibility is one of the most common and frustrating problems when assembling LoRa mesh hardware. Knowing which connectors are standard on which hardware and understanding adapter losses will save hours of troubleshooting and return shipping.

The Principal Connector Families

SMA (SubMiniature version A)

SMA connectors are the workhorses of small-form RF hardware. They are threaded (10-32 thread) and rated to 18 GHz in standard form. Power handling is frequency-dependent: a standard SMA handles roughly 100 W at HF, derating sharply with frequency to only a few watts near 18 GHz. (At LoRa's sub-1 W transmit power this is academic; for genuinely high-power runs use N-type or larger.) Two variants cause constant confusion:

Type	Center Pin on Male	Center Pin on Female	Notes
SMA (standard)	Pin protrudes	Socket (receptacle)	Used on most professional RF equipment and high-quality antennas

Type	Center Pin on Male	Center Pin on Female	Notes
RP-SMA (Reverse Polarity)	Socket (receptacle)	Pin protrudes	An industry convention WiFi vendors adopted to comply with FCC 47 CFR 15.203, which requires a unique (non-standard) antenna coupling so the public cannot easily fit unauthorized antennas. The FCC does not mandate RP-SMA specifically — only a non-standard coupling; RP-SMA is one common way to meet that requirement. Extremely common on consumer WiFi and found on some consumer LoRa hardware.

Critical: Standard SMA and RP-SMA are physically intermateable - the threads engage and the connector tightens - but they do NOT make electrical contact. You will have a physically connected but RF-dead assembly. Always verify polarity before tightening.

Which LoRa Hardware Uses Which?

Hardware	Connector
RAK WisBlock (RAK4631, RAK19007)	U.FL / IPEX on module; SMA via the supplied IPEX-to-SMA pigtail (not a fixed enclosure connector)
Lilygo T-Beam (most versions)	SMA female (standard)
Heltec WiFi LoRa 32 v2/v3	Varies by revision: U.FL / IPEX on PCB on some boards, board-mounted SMA on others. Verify your specific board.
Meshtastic / LilyGo T-Echo	U.FL on PCB
Seeed WIO-E5 module	U.FL on module
Dragino LPS8 gateway (indoor)	SMA female
RAK Wisgate Edge (commercial gateway)	N-female (standard)
TTGO LoRa32 v2	U.FL with bundled SMA pigtail
Adafruit Feather M0 RFM95W	U.FL; use an SMA edge-launch or U.FL pigtail

Note: Connector types can vary by hardware revision. Always verify on the actual unit or current product page before ordering cables and adapters.

N-Type Connector

The N-type is a larger, weatherproof threaded connector rated to 11 GHz (standard) or 18 GHz (precision). It is the connector of choice for any serious outdoor installation - towers, rooftop

gateways, commercial deployments. N-type connectors have excellent weatherproofing when properly assembled, low contact resistance, and are designed for repeated mating cycles.

- **Used on:** Commercial gateways (Dragino, RAK Wisgate, Kerlink, MultiTech), tower-mount antennas, LMR-400 and larger cable installations
- **Loss:** Typically 0.05 - 0.1 dB per connector pair at 915 MHz
- **Availability:** Widely available; both solder and crimp versions for all major coax types

U.FL / IPEX / MHF1 Connector

U.FL (the Hirose trade name) or IPEX/MHF1 (equivalent generic and Amphenol variants) are ultra-miniature snap-lock coaxial connectors used on PCBs to connect the RF IC to an external antenna pigtail. They are rated to only about 30 mating cycles, so they are not designed for repeated disconnection.

- **Used on:** Almost all LoRa and GPS modules mounted on PCBs - Heltec, RAK module cores, TTGO, and most other SoC-level boards
- **Important:** Extremely fragile and rated for only ~30 mating cycles; do not repeatedly disconnect/reconnect. Lock in place and leave. If you need a permanent connection, solder a small bead of hot glue after mating to prevent accidental disconnection.
- **Pigtails:** Use only U.FL-to-SMA (or RP-SMA) pigtails made with RG-178 or similar micro-coax. The connector at the board end is U.FL female (socket on pigtail). The connector at the panel end should match your application (SMA, N, etc.)
- **Loss:** The U.FL connector itself adds only ~0.05 - 0.1 dB at 915 MHz; a typical U.FL pigtail (connector + thin coax) adds ~0.2 - 0.5 dB total, most of which is the thin pigtail coax.

Adapter Losses

Each adapter in the RF path adds loss and a potential failure point. Typical losses at 915 MHz:

Adapter Type	Typical Loss at 915 MHz	Notes
SMA(M) to SMA(F) barrel	0.1 - 0.2 dB	Use only when necessary; prefer direct cable
SMA to N-type	0.1 - 0.3 dB	Acceptable for indoor patch panels; not preferred outdoors
RP-SMA to SMA	0.1 - 0.2 dB	Common necessity when mixing hardware
U.FL to SMA pigtail	0.2 - 0.5 dB	U.FL connector + cable loss; unavoidable for PCB boards
PL-259/SO-239 (UHF)	0.3 - 0.8 dB	Not designed for 915 MHz; avoid entirely

Quality Matters

A cheap SMA connector or adapter purchased in a $3 bag of 20 pieces is not equivalent to a $5 Amphenol or TE Connectivity connector. Differences include:

- Contact resistance: quality connectors use silver or gold plating; cheap ones use brass or tin that oxidizes
- Dimensional tolerances: loose tolerances cause intermittent contact at vibration or thermal cycling
- Dielectric quality: cheap connectors use low-grade PTFE substitutes that absorb moisture
- Thread quality: soft aluminum threads strip after a few matings

For outdoor permanent installations, spend the money on proper connectors. For bench development, economy connectors are acceptable. Never use economy connectors in a deployed outdoor node.

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