Building a Collinear Vertical Antenna

This page covers two simple, easy-to-build omnidirectional verticals for 915 MHz - a J-pole and a 5/8-wave vertical - both a significant improvement over the stock rubber duck antennas included with most LoRa boards. (A true multi-element collinear, which stacks several half-wave sections in phase to reach ~3-6 dBd, is described conceptually below but is a more advanced build not detailed here.) The J-pole and 5/8-wave verticals below are straightforward to build with basic tools.

How a Collinear Works

A collinear antenna consists of multiple half-wave dipole elements stacked vertically and fed in phase. Each additional element increases the gain and makes the radiation pattern more disk-shaped (more horizontal, less toward sky/ground) - which is exactly what you want for a terrestrial mesh network. Note that the two single-element verticals built on this page (the J-pole and the 5/8-wave) are *not* multi-element collinears; they are simpler designs with dipole-class gain, included here as practical starting points.

Simple J-Pole Vertical for 915 MHz

The J-pole is one of the simplest omnidirectional verticals to build. It is an end-fed half-wave radiator fed through a quarter-wave parallel matching stub (the "J") - it is **not** a collinear. Its gain is essentially that of a half-wave dipole, about ~0 dBd (~2.15 dBi); the widely-repeated "~3 dBd J-pole" claim is a myth. Its real advantages are a clean omnidirectional pattern and an easy feed, not extra gain. A J-pole gives roughly 2-3 dB more than a basic quarter-wave ground plane, not 3.5 dBd.

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915 MHz J-Pole dimensions:
Radiator: 163 mm (6.42") - connects to matching section
Matching section: ~82 mm (3.23") - quarter-wave parallel stub (half the radiator length)
Shorting bar: 40 mm (1.57") - connects bottom of radiator to top of short arm
Feed point: 37-42mm from bottom of matching section (tune for min SWR)

Material: 3/32" or 1/8" brass rod, or stiff copper wire (14 AWG solid)
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Tuning the feedpoint: attach the coax at about 40 mm up from the bottom of the matching stub, sweep SWR with a NanoVNA (see the Testing & Tuning pages), and slide the tap a few millimetres up or down toward the lowest SWR at 915 MHz. The exact feed position depends on conductor diameter, so expect to fine-tune. These dimensions are a starting point - verify against a 915 MHz J-pole/Slim Jim calculator and tune with a NanoVNA.

5/8 Wave Vertical

A 5/8 wavelength vertical with a ground plane offers roughly 3 dB of gain over a quarter-wave whip - that is about 1-1.5 dBd (~3 dBi) over a dipole, **not** 3 dBd. Its main benefit is a lower takeoff angle than a quarter-wave, which is excellent for long-range terrestrial links:

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5/8 wave vertical at 915 MHz:
Vertical element: 203 mm (7.99") nominal; trim ~5% shorter for end effect, tune with a NanoVNA
Ground plane radials: 4x at ~82 mm (quarter-wave), angled 45 degrees downward
Feedpoint: SMA or N connector at base
Impedance: a 5/8-wave element is NOT naturally 50 ohms - it presents
  capacitive reactance and generally needs a base matching/loading coil.
  (Drooping radials alone match a quarter-wave, not a 5/8-wave.)
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Weatherproofing a DIY Antenna

Any antenna installed outdoors needs weatherproofing to survive years of exposure. Any DIY antenna installed outdoors must also be grounded and surge-protected (see Grounding and Lightning Protection) and kept well clear of overhead power lines during and after installation; solder in a well-ventilated area.

- **UV protection:** Coat metal elements with cold galvanizing compound or clear lacquer spray. Aluminum naturally oxidizes to a protective oxide layer against bulk corrosion, but that oxide raises contact resistance at joints and connectors, so bare aluminum joints still need protection; copper and brass oxidize to patina that increases resistance - coat with lacquer.
- **Connector protection:** Wrap SMA/N connector base with self-amalgamating tape (silicone rubber tape that bonds to itself). Apply starting from the cable, overlapping onto the connector, then back. Provides a reliable weatherproof seal.
- **Mounting:** Stainless steel hardware is the practical choice; it is only moderately compatible with aluminum, so in coastal or salty environments use anti-seize or dielectric isolation to limit galvanic corrosion. Coat any carbon steel hardware with cold galvanizing compound.

- **Housing:** For clean installations, insert the antenna inside a length of PVC pipe (Schedule 40, 3/4" inside diameter for most quarter-wave to collinear antennas). PVC is RF-transparent at 915 MHz with minimal loss.

Gain Comparison: Antennas for 915 MHz

Gains below are given in both dBd (relative to a half-wave dipole) and dBi (relative to an isotropic source). Convert with **dBi = dBd + 2.15**.

Antenna Type	Gain (dBd / dBi)	Pattern	Build Difficulty	Best Use
Stock rubber duck	-3 to 0 dBd / -0.85 to 2.15 dBi	Omnidirectional	None (included)	Portable/indoor only
Quarter-wave with radials	~0 dBd / ~2 dBi	Omnidirectional	Easy	Basic outdoor fixed
J-Pole (end-fed half-wave)	~0 dBd / ~2.15 dBi	Omnidirectional	Easy	Home repeater
5/8 wave vertical	~1 dBd / ~3 dBi (≈3 dB over a quarter-wave whip)	Omni, low angle	Medium	Long-range omni
5-element yagi	~7-8 dBd / ~9-10 dBi	Directional ~55°	Medium	Point-to-point link
Commercial 5 dBi fiberglass	~3 dBd / 5 dBi	Omnidirectional	None (buy)	Outdoor repeater

Note: antennas above 6 dBi require a dB-for-dB reduction of conducted power under FCC 15.247(b)(4)(i) in the 902-928 MHz band - see the FCC Regulations and EIRP Reference page.

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