

Building a 915 MHz Yagi Antenna

A yagi antenna provides significant directional gain for point-to-point links - ideal for connecting two backbone nodes across a valley, mountain, or city. Building your own 915 MHz yagi is a rewarding project that costs \$10-20 in materials vs. \$50-150 for a commercial equivalent.

Yagi Design Fundamentals

A yagi consists of three element types mounted on a boom:

- **Reflector** - Behind the dipole; slightly longer than a half-wavelength; increases gain in forward direction
- **Driven element (dipole)** - The active element connected to the feedline
- **Directors** - In front of the dipole; slightly shorter than a half-wavelength; focus the beam forward

At 915 MHz, a half-wavelength in free space is approximately 164 mm (6.4 inches). Note that a real resonant element is about 5% shorter than the free-space half-wave due to end effect, so a driven dipole element typically cuts to around 155 mm rather than the full 164 mm. Each element is cut to a specific length and spaced precisely on the boom, then tuned with a NanoVNA.

5-Element Yagi Plans for 915 MHz

A typical 5-element yagi provides approximately 9-10 dBi (roughly 7-8 dBd) gain with a tight forward beam. Reaching 12 dBi generally requires 7-8 elements. With clear line of sight, a full Fresnel zone, adequate height, and a matching antenna on the far end, such a yagi can support links of 10 km or more; the realistic range depends on transmit power, terrain, and spreading factor as much as on antenna gain, so treat long-range figures as best-case line-of-sight, not routine.

FCC compliance note: A yagi above 6 dBi exceeds the 6 dBi reference gain in FCC 15.247(b)(4)(i). When used at 902-928 MHz, conducted transmit power must be reduced dB-for-dB for every dB of antenna gain above 6 dBi (for example, a 10 dBi antenna requires conducted power no greater than 26 dBm). The EIRP ceiling of about 36 dBm (4 W) is a derived limit (30 dBm

conducted + 6 dBi), not a bonus you add gain on top of, and there is no relaxed point-to-point antenna allowance at 915 MHz.

Element dimensions (915 MHz, 5-element, nominal - tune with a NanoVNA):

Reflector: 178 mm (7.01")

Driven element: 163 mm (6.42") - center-fed dipole (trim toward ~155 mm for resonance)

Director 1: 151 mm (5.94")

Director 2: 147 mm (5.79")

Director 3: 144 mm (5.67")

Spacing from reflector:

Driven element: 49 mm (1.93")

Director 1: 115 mm (4.53")

Director 2: 210 mm (8.27")

Director 3: 330 mm (13.0")

Materials

- **Elements:** 3/16" (4.8mm) aluminum rod or welding rod. Available at hardware stores.
- **Boom:** 1/2" (12mm) square aluminum extrusion, 400mm long. Also available as wooden dowel (slightly less rigid but fine for hobby use).
- **Driven element:** Built as a split (center-fed) dipole fed through a gamma match or 50-ohm hairpin match - see the construction steps below.
- **Feedline:** Use RG-174 or LMR-195 only for a short (under ~1 m) pigtail, since RG-174 loses roughly 1 dB per metre (~30 dB per 100 ft) at 915 MHz. For any real cable run, use low-loss LMR-240 or LMR-400-class coax. SMA connector at the antenna end.
- **Hardware:** 1/4-20 stainless bolts and nylon locknuts to mount elements to boom.

Construction Steps

1. Cut all elements to specified lengths using a hacksaw or pipe cutter. Deburr ends.
2. Mark boom at element spacing positions.
3. Drill 3/16" holes through boom at each position.
4. Thread the reflector and directors through their boom holes and secure with nylon locknuts (finger-tight then 1/4 turn more). These are single, continuous rods.
5. Build the driven element as a split dipole: instead of one continuous rod, use two collinear half-elements (each about a quarter-wavelength, ~38 mm) mounted on an insulating block at the boom center, with a small gap (~3-5 mm) between their inner ends.

6. Feed it with one of these matches:

- **Direct/gap feed (simplest):** Solder the coax center conductor to one half-element and the coax shield to the other half-element across the center gap. A bare split dipole presents roughly 50-70 ohms, close enough to test; add a current balun (a few turns of the coax through a ferrite at the feed point) to keep RF off the coax shield.
- **Gamma match (for a continuous-rod driven element):** If you prefer one solid driven rod grounded to the boom at its center, run a parallel gamma rod (about 1/10 the driven-element length) spaced ~10-15 mm alongside one half, connect the coax center to the gamma rod through a small series capacitor (a few pF, often a short coax-sleeve trombone), and bond the coax shield to the driven element at center. Adjust the gamma rod length, spacing, and capacitance for lowest SWR.

7. Weatherproof the feed point and connector after tuning.

Testing Your Yagi

After construction, verify performance:

- Use a NanoVNA to check SWR at 915 MHz. Target: SWR less than 2:1, ideally below 1.5:1. Adjust the match (and trim the driven element toward resonance) as needed.
- Compare RSSI at a fixed test point vs. a reference omni - the yagi should show roughly 6-10 dB improvement in its forward direction. Measured improvement varies with the environment, multipath, and reference antenna, so this is a typical figure, not a guarantee.
- Note the half-power beamwidth: a 5-element yagi has roughly 55 degree horizontal beamwidth. For best performance, aim within about +/-15 degrees (roughly half the half-power beamwidth) of the far station.

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