VHF/UHF Yagi Antennas: Design, Build and Tune a Top Performer

AD6AE

Yagi designs proliferate the online video community - some may actually work. Some may be properly designed; few are properly tuned and rarely do they include actual test results. So, I ask how good is "It works great?" In this article, the design choice and method of construction are left up to the builder.

Many Yagi builds posted in online videos show nothing more than a low VSWR, then successfully hitting a repeater followed by jubilation. Ironically, in most cases, an HT with a whip can do the same. There are right and wrong ways to build and tune a Yagi for maximum performance without range testing and there's no better way to learn, than by using a known good design calculator then making and tuning your own. With that comes a feeling of accomplishment; pride in workmanship; skill development and a better understanding of how beam antennas actually work and behave.

Three common types of driven elements (DEs) may be used with equal results: Split dipole, folded dipole or half-folded dipole. Element shapes are usually round but may vary depending on design. Locations may vary slightly but tuning techniques remain the same. A reliable, easy to use 'Quick Yagi Designer' posted by K7MEM (SK), uses the same criteria that was developed by DL6WU who engineered a design that balances gain, bandwidth and higher detuning immunity.

When a stable design and correct tuning methods are followed, building materials can vary widely and still give near identical results. Links for two proven, easy to use design calculators that further include compensation for element length and shape, and different types of boom mounting options are: For a split, folded or half-folded dipole: VHF/UHF Yagi Antenna Quick Designer - K7MEM. For square, rectangular or flattened elements: (DL6WU Yagi-Uda antenna online calculator - 3G-aerial). Folded Dipole DE: Folded Dipole Design - K7MEM*. Half-folded dipole DE: VE3CVG Antenna Pages - Cheap Yagis (shows a clear half-folded DE illustration) for the following link. WA5VJB's designs are very tolerant of design and environmental variations: http://www.wa5vjb.com/references.html. His full article may be downloaded here: cheapyagi.pdf.

SUGGESTED GUIDELINES for BUILDING and TUNING

1. Decide on the center frequency for the antenna design, then approach it as a '***system***.'
2. The higher the frequency, the more precision that's required for layout and trimming.
3. Choose a design, boom and element materials, and mounting method.
4. Keep element lengths and locations on the boom to ±2 mm (≈3/32") for VHF and ±1 mm (≈1/16") for UHF.
5. Tune using a quality Antenna Analyzer or a NanoVNA set to display LogMag, R and X and calibrated to the extended reference plane when connected to a 2-3 meter long cable with a 61 mix 2-3 turn CM choke added at the end.

PROCEDURE

1. Cut elements and form the DE if folded; layout the element positions on the boom then mount ***only*** the DE; place the boom on a stand to elevate it 6-feet high, pointing straight up; trim the Driven Element for X≈0 (R will be close to 50Ω or, if using a folded or half-folded DE, 200Ω).
2. Permanently mount all elements ***EXCEPT*** the **Reflector, D1** and *optionally*, ***D2*** if wanting micro adjustments.
3. Temporarily, mount the Reflector, D1 and D2 in their respective locations (Gorilla black gaffer's tape works well).
4. Note that the resonant frequency has shifted well below the design frequency. **DO NOT** trim any elements! Due to mutual coupling of the elements, the antenna 'system' is capacitive; R ≈ 40-70Ω; |X|** ≈ 14; VSWR >2.
5. Remember that the antenna is a ***mutually dependent system*** and must be carefully tuned accordingly. Any single change will affect the others to a greater or lesser degree.
6. Moving the Reflector affects inductance = coarse adjustment. Moving D1 affects capacitance = fine adjustment. D2 affects capacitance = micro adjustment. For all three: Closer to the DE = more; further from the DE = less.
7. With the analyzer connected and the antenna mounted and pointing skyward, alternate changing the Reflector first then D1 in small increments while observing R and X; repeat to zero in. **Targets:** R ≈ 50; |X| ≈ 0. **Note** that once the VSWR lands at ≤ 1.2, making further adjustments using D2 becomes unnecessary.
8. Mark the new locations for R, D1 and D2 and permanently attach them. Note that different heights and surroundings will impact the 'isolated' readings somewhat. That's normal and of little concern.

*K7MEM Folded Dipole Design link: There is no ‘calculate’ button per se. After entering the values, click anywhere on the page for it to update the “L” in the equation. **|X|, depending on the analyzer, is X absolute meaning ignore the sign if one is present. A VNA will display the sign. What you’re looking for is a reading close to X=0.