All-band Flagpole Vertical

This free-standing 22 ft. flagpole antenna is a CC&R-
proof, no-radial, easy-to-tilt-over, multi-band HF vertical

By John Portune W6NBC

What ham hasn't looked at a flagpole and said, "That would make a great antenna; the neighbors wouldn't have a clue." Yet great as this may sound, home-brewing an efficient well-disguised RF flagpole antenna is challenging.

Figure 1: My stealthy multi-band flagpole antenna

To be effective both as an antenna, but also be stealthy and RF flag-flier (Figure 1) needs to be: (1) a plain pole without extra hardware visible to the neighbors – radials, stubs, loading coils, or capacity hats, (2) able to work multi-bands (2) free standing and (5) easy to tilt over. Sound difficult? Not so. This home-brew flagpole antenna accomplishes all these?

Physical Configuration

The building material is surplus military camo-pole sections. These, convenient, easy-to-stack, 48 in. aluminum or fiberglass pole sections, made of heavy-wall 1¾ in. OD tubing, are designed to support large military camouflage nets. What's more, they're readily-available on the Internet; mine came from armysurplus.com. I used seven – five aluminum and two fiberglass, all painted "flagpole white." Refer to Figure 2.

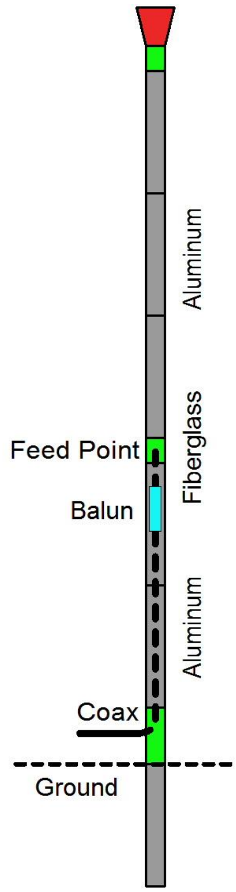

Figure 2: Mechanical Configuration

As ground support for the antenna, I buried a single aluminum section directly in the soil,. Only the short section connector is above ground. Next above ground is a 15¼ in. length of a fiberglass section cut from the top, including the connector. This shortened piece is the ground insulator. Next are two full-sized aluminum sections which constitute the lower half of a center-fed vertical dipole.

Above these is a 10¼ in. cut-off fiberglass section. It's the feed point of the antenna. I put stainless steel hose clamps at the cut-off ends to keep the fiberglass from splitting. Then above the feed point is the upper half of the dipole, three additional aluminum sections. With two aluminum section at the bottom and three on top, the feed point is slightly off center. This raises the feed impedance for a better match to the coax.

Lastly you can add decoration to the top and/or a solar-powered garden-path light with a red filter. Use a third cut-off fiberglass section for this. My neighbors love the red light. There’s also a rope pully at the top and a rope cleat near the bottom. These have little RF effect on the antenna.

Why a Plain Pole?

Getting to the electrical design of the antenna, I reasoned that in front of a small mobile home, near the street, a quarter-wavelength (λ/4) vertical with radials, stubs, loading coils and/or a capacitive top hat isn’t stealthy enough. The extra hardware would be a dead giveaway to neighbors that it’s not just a flagpole. But to make “just” a plain pole work well without radials and work multiple bands, takes some doing.

To do so, I first had to eliminate radials. The best way is to choose a half-wavelength (λ/2) center-fed design, as opposed to a base-fed with radials λ/4 configuration. At ground level, a λ/2 no-radial vertical competes very favorably with a λ/4 vertical with radials. Both have low-angle radiation.

Further for neighbor friendliness, I ran the coax up through the inside of the lower half of the dipole. Again see Figure 2. The coax enters through a slot cut in the fiberglass ground insulator. I compared both side feed and up through the antenna feed in my initial design phase and noticed little difference.

Figure 3 details the feed point, including a 1:1 current choke balun inside the pole to decouple the coax. A reasonably-priced, full-power, ferrite-torroid balun kit is available from Hexkit.com. You can include a connector above the balun, or just install balun and terminals directly on the end of the coax. I needed the connector to be able to calibrate my vector network analyzer right at the feed point.

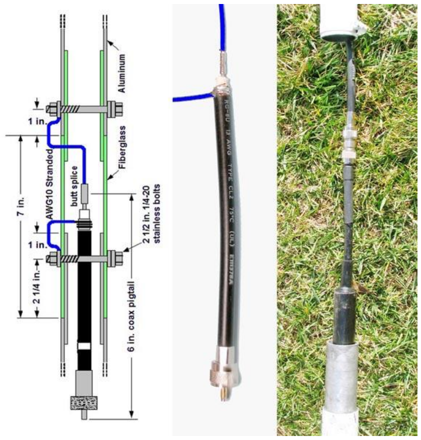

Figure 3: (L) feed point detail (C) Dipole terminal pigtail (R) Top of balun and connector

Multi-band Operation

Next, how could I make a plain pole work multi-band? Simple, remote all tuning and matching to an automatic antenna tuner, 25 ft. down the coax in my shack. Put no matching in the antenna itself. This turns out to be the only truly practical way to eliminate loading coils, stubs and capacity hats on a plain pole.

“But isn’t that’s a bad idea,” you may be thinking? “Won’t unmatched coax and a tuner some distance from the antenna introduce high losses?” Yes, there will be SOME. But the meaningful question is, how much? I wanted hard figures, not common ham wisdom. And after working up hard figures, I was pleased to discover that the loss is much less than common ham wisdom might suggest. Efficient operation with no tuning or matching in the antenna is quite practicable.

Apart from the type of coax, loss in coax depends on three factors: (1) Coax Length (2) Operating frequency and (3) SWR. My length of (25 ft.) and my operating frequencies (the HF ham bands) were already known. To complete my loss picture with hard figures, I needed to measure the SWR my flagpole would present on each band. I obtained this data by performing an HF ham band SWR sweep with an SDRKit VNWA 3e Vector Network Analyzer, calibrated to read as if it were right at the feed point. Figure 4 shows the result.

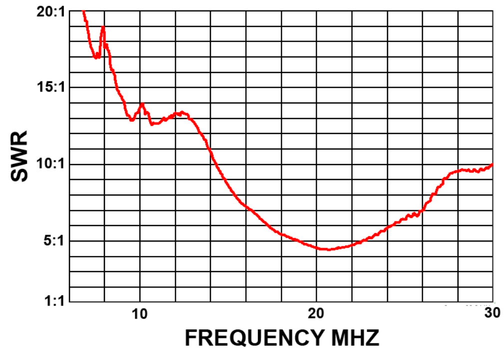

Figure 4: SWR vs. Frequency sweep at the feed point of the flagpole

Then finally to get hard loss figures, I entered the SWR data, 25 ft. and LMR400, into a handy little coax loss calculator I downloaded from the Internet. You can find it now on my Web Site; w6nbc.com/coaxloss.html. What % of my TX power reached the flagpole at the end of 25 ft. of LMR400 at is plotted in Figure 4. The red line show the amount of loss needed to give a drop of one S-point at the receiving station.

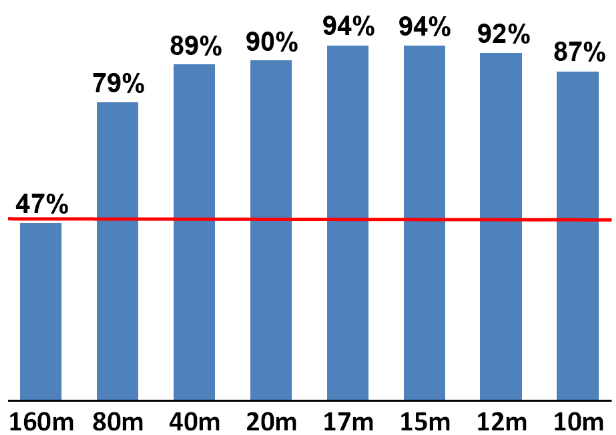

Figure 5: Percent TX Power arriving at the flagpole, at the end of 25 ft. of LMR-400, by band,..

These hard facts of an auto-tuner in my shake and 25 ft. of LMR-400, center-feeding a plain 22 ft. flagpole, are totally acceptable to me. Even on 160 meters, there will only be the loss of one S-point at the receiving station due to the coax and remote tuner. Remember: a loss of 50% TX power represents a loss of 6dB received signal Voltage, or one S-point.

SIDE NOTE: Don't look for an SWR dip at the end of the feed line with an antenna analyzer, such as a MFJ-259. The SWR will only be low on the rig side of the tuner.

How Much Power?

Again let's look at the simple math. In 50 Ohm coax carrying 577 RMS Watts (1500 W PEP), at 1:1 SWR, the voltage is 170 Volts and the current 3.4 Amps. (E^2 / 50 Ohms = 577 WA, I^2 x 50 Ohms = 577 W). At an SWR of 10:1 the current and voltage will be 5 times greater in places. But these are still is well within the published limits of LMR-400. My flagpole easily handles my cherished old Heatkit SB-220 on 40m through 10m.

Free Standing

As mentioned above, to support my flagpole I buried a single full-length aluminum pole section directly in the soil. Concrete is not required.. Only the reduced tip remains above ground. This support easily handles my 22 ft, pole in a stiff breeze, flying two 3 ft. by 5 ft. flags. To make the ground hole, I constructed a garden-hose water drill from a 5 ft. length of ¾ in. ABS pipe and a garden-hose fitting. I went down a little more than 4 ft. to allow for a handful of gravel as a firm base.

Tilt-Over

Also, a hinge at the base is not needed. I can easily pick up the whole the antenna for tilt-over. The bottom-joint and all pole joints, need to be kept liberally lubricated with silicon grease. It's sold in auto parts stores as Dielectric Tune-up grease. It is not necessary to bolt the joints together. Capacitive coupling at the pole section interconnects adequately provides a good RF connection, even with the silicon grease,

Finally, for safe alignment when tipping, I inserted a two foot length of heavy 1 3/8 in. bendable neoprene tubing into the top end of the buried section. Many hardware stores carry this tubing. Some additional gravel in the buried pipe keeps the neoprene tubing in place.

Admittedly this is a somewhat unconventional approach to vertical antenna design, but it keeps my neighbors happy and is well within the limits of good ham practice. Best of all, it is very convenient to use. I just push the tune button on my rig and I am hauling in the DX, and my neighbors are happy.