

Add 6 Meters to Your Triband Trap Yagi

This approach is almost painless, stealthy and gets the job done.

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Back in the 1950s, HF transceivers were just starting to replace separate receivers and transmitters and our DX bands were 20, 15 and 10 meters. The triband trap Yagi became a very popular antenna for those who wanted to work DX but couldn't swing separate monoband Yagis for each band. Many amateurs also operated on 6 meters in those days, but the equipment was usually separate from the HF gear — the focus of VHF specialists, in many cases.

Fast forward to 2011 and almost all current “HF” transceivers also cover MF (160 meters) and VHF (at least to 6 meters), with similar performance, power and features as on the HF bands. A look on the towers of many amateurs will yield a view of the same type (or even the same) trap tribander from the '50s.

That Was the Situation at W1ZR

In my case, the triband Yagi was a relic from the '80s I obtained for a price too good to pass up. I didn't actually have a tower to put it on, and after getting the neighborhood acclimated to the driven element tied to the top of my chimney for a few years, I took the plunge and sunk a pipe mast next to the chimney, put on a rotator, and — one piece at a time — the Yagi grew in place of the solo driven element.

During the same period, I retired my old 160-10 meter transceiver to replace it with a modern unit that covered 160 through 6 meters. Now my radio had outpaced my antenna farm. I could operate 6 meters using my 100 foot center fed Zepp, but I had nulls every few degrees all the way around — something had to be done.

The Mast Thickens

My challenges were twofold. First, because my rotator was mounted on top of a mast, rather than inside a tower, I had to derate the rotator's wind load capability by 50%, and avoid any bending moments resulting from loads above the rotator. That put the tribander right above the rotator. To add 6 meters, my first thought was to investigate the low wind load Moxon we reviewed in 2004, secured a few feet above the tribander.¹ Unfortunately, my modeling indicated that installing them just a few feet apart would result in significant degradation of the gain and pattern of both



antennas — back to the drawing board.

I had been very pleased with the results of my 40 and 20 meter skeleton sleeve dipole described in a recent *QST* article — could I use the same technique to add 6 meters to my Yagi?² *EZNEC* modeling indicated that it could indeed work — and work very well.³

This gave me two significant advantages:

- I had sidestepped the wind loading and bending moment concerns. The added elements were right above the rotator and the thin elements were largely in the shadow of the tribander's elements or boom, depending on relative wind direction.

- Perhaps even better — I did not need an additional feed line. The HF feed line, going to the split driven element, would also feed power to the 6 meter Yagi. This occurs through parasitic coupling, so no connection to the tribander is required.

The Details

Before I proceed, I should give credit where due. Following publication of my two band “skeleton sleeve” dipole article, I found that the parasitic coupling to a single element was presented in an antenna article in *The ARRL Antenna Compendium, Volume 5* by Gary Breed, K9AY, also the developer of the low frequency receiving loop that bears his call letters.⁴ Gary called it a *coupled resonator* antenna — perhaps more descriptive a name. There's nothing new under the sun — it would seem.

Design Approach

The usual issue with Yagi design is that

there are many variables as well as many objectives. The primary variables are element length and spacing while the objectives are generally forward gain, front-to-back ratio (F/B) and bandwidth. They tend to fight each other to some extent, and others may find different combinations that are better in one respect or another.

My goal was to achieve reasonable Yagi performance with elements comfortably between those of the tribander. Using *EZNEC* modeling, I was able to find a set of dimensions that were predicted to work well starting from the National Bureau of Standards (NBS) baseline of 0.2λ parasitic element spacing.⁵ The modeled forward gain was within about 1 dB of a similarly sized three element Yagi in the same space but without the tribander — not a bad trade, in my view.

The loss in a mismatched transmission line is a particular problem at VHF, so it is important to match to whatever impedance the Yagi offers. In a traditional VHF Yagi, the low impedance is generally transformed to a matched value through an adjustable matching arrangement. For the coupled resonator with no direct connection this is accomplished, as predicted by Breed's formula, by adjusting the spacing between the HF driven element and our coupled resonator. I found that adjusting the center-to-center spacing from about 4 inches (the minimum possible with the mounting hardware) to the 10 inches shown, I could increase the impedance of a single element coupled resonator from 45 to 120 Ω . The same adjustments resulted in a reduction of element resonant frequency

¹Notes appear at end of article.

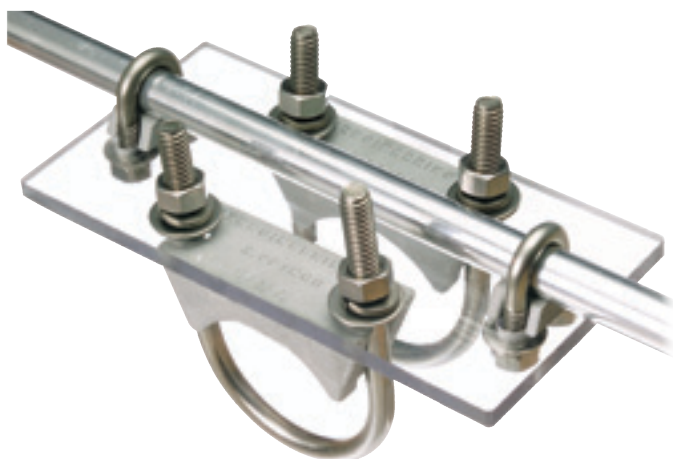


Figure 1 — I used the DX Engineering (www.dxengineering.com) stainless steel saddle clamps, as well as their telescoping aluminum tubing and stainless element clamps. Lower cost non-stainless hardware could be used if the budget is tight.

from 50.2 to 49.2, so retrimming is required. By using the 10 inch spacing for the three element case, the low impedance of the Yagi configuration was transformed to close to the desired 50 Ω (see Table 1).

A Few Caveats

This project was initiated on a trap tribander with a split dipole feed. Although this is the arrangement of many such Yagis, other configurations will be encountered. Some may include a shunt transmission line section across the feed or other matching arrange-

ments. They may also work but I haven't tried them. If you're not sure, try it with just the driven element before you commit to the whole project.

Elements

For elements, I selected aluminum tubing in diameters of $\frac{1}{2}$ and $\frac{3}{8}$ inches and a wall thickness of 0.058 inches. These telescope nicely. For the center of each element, I used a 3 foot section of $\frac{1}{2}$ inch tubing with the ends slit and compressed on the smaller section on each side using stainless hose type clamps of the appropriate size. I obtained my tubing and clamps from DX Engineering, which offers the tubing in 3 foot and 6 foot lengths. The 3 foot, $\frac{1}{2}$ inch tubing is available with one end pre-slit for a slight additional charge, and they may offer it with both ends slit by the time you read this. I had reasonable luck slitting the other end using either a band saw or a hacksaw with the tubing in a vise. The outer $\frac{3}{8}$ inch sections were made from 6 foot lengths, two required per element — each cut to 4 feet 4 inches long.

**Table 1
Measured SWR at Antenna**

Frequency	SWR
50.0	1.2
50.1	1.1
50.2	1.1
50.3	1.2
50.4	1.6

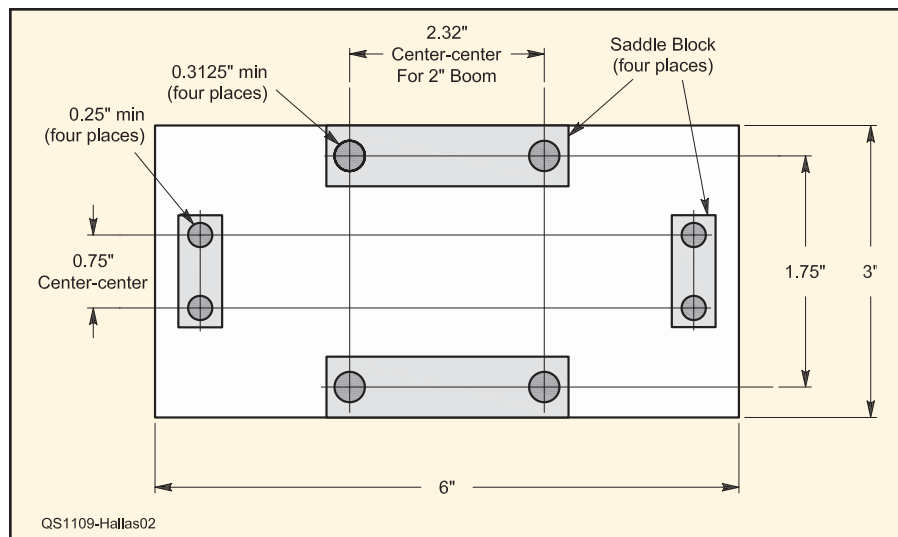


Figure 2 — Dimensions of the construction lines and hole locations for the 3 x 6 inch pieces made from the McMaster-Carr polycarbonate sample pack. The dimensions assume a 2 inch boom and $\frac{1}{2}$ inch inner element section. For a different size boom, obtain correctly sized saddle clamps and lay out accordingly.

Element Mounting

I chose to mount the elements insulated from the boom to avoid having to make the required correction for all metal construction. I used a 3 x 6 inch piece of $\frac{1}{4}$ inch polycarbonate for each insulator. I would guess other materials could be used, but polycarbonate comes highly recommended and was readily available.^{6,7}

To mount the insulator to the boom, and to the elements, I choose stainless steel saddle clamps also from DX Engineering. These clamps are very nicely constructed (see Figure 1). Although they are more expensive than the hardware store variety, I thought they were worth it. For those on a tight budget, less expensive clamps may work fine for many years, but will make for tougher disassembly.

Once you have the clamps selected, carefully lay out the insulator for drilling. Figure 2 indicates the construction lines that I laid on the handy paper that came applied to the McMaster-Carr polycarbonate. It is important that the holes be lined up quite closely. If the clamps for one side or the other aren't parallel, the tubing may bind. If misaligned, the 6 meter elements will not be parallel to the HF elements.

If your shop gear and skills are up there with Barry Shackelford, W6YE, you could make the holes just a bit larger than the U bolts. For me, using a hand drill and a vise, I found I had to open them up just a bit with a rotary grinding tool.

Mounting the Elements

Figure 3 shows the dimensions of the 6 meter elements on the Yagi. Note that I have referenced them all to the center of the HF driven element. This should allow for some differences between tribanders. For the record, my tribander is a Wilson Electronics SY33. This looks a lot like the very popular Mosely TA-33, but has slightly wider element spacing.

Table 2 provides a summary of dimensions for the NBS 0.2 λ spacing case that I used. In case your tribander has a shorter boom, I have also included dimensions for a version with 0.2 λ reflector spacing and 0.15 λ director spacing. EZNEC modeling predicts that this version has about 0.5 dB less gain than the larger version. I haven't actually tried the shorter version.

Performance

Modeling is fine, but on-air measurements remove any guesswork. I made measurements of W1AW (50 air miles away) code practice on 20, 15 and 10 meters before and after adding the 6 meter elements and found no difference. I asked W1AW Station Manager Joe Carcia to put a signal on a clear 6 meter frequency. I was very pleased; gain was at least as good as EZNEC predicted (see Figure 4). My F/B was not as good, perhaps due to reflections from multiple antennas.

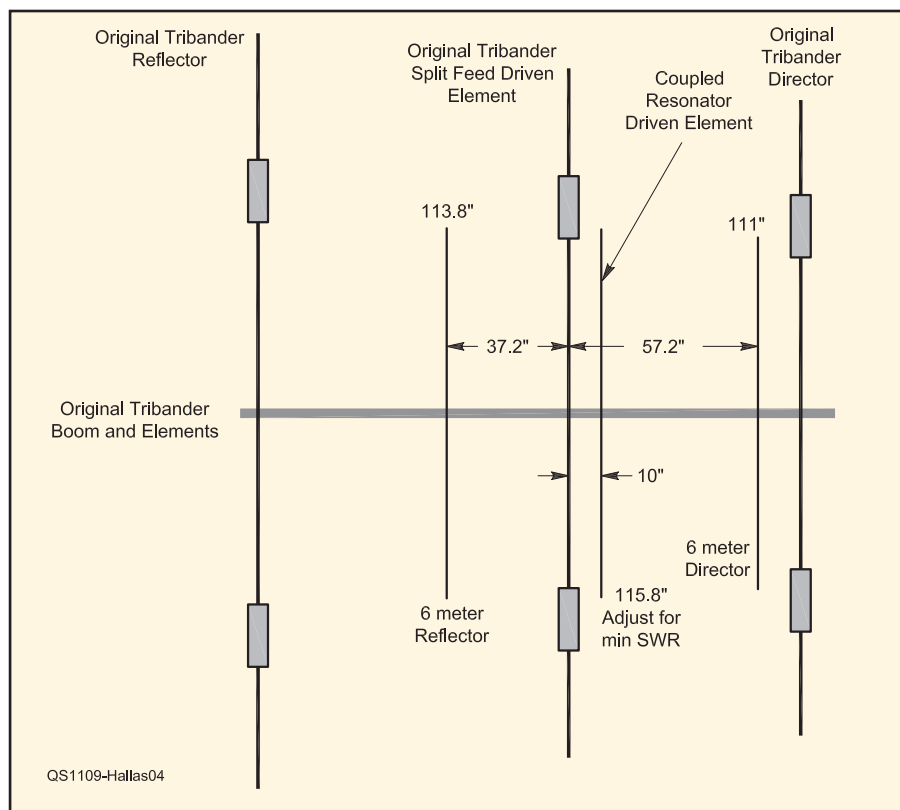


Figure 3 — Dimensions of the elements and spacings referenced to the center of the tribander driven element. The element length shown, assume insulated elements, ½ inch diameter, 3 feet long center element sections, the remainder ⅜ inch telescoped aluminum.

Table 2

6 Meter Element Dimensions (inches)

Reference is center of triband Yagi driven element.

Element	Element Length	Each 0.375 inch End-Section Length	Distance (c-c) to Reference
<i>Single Element Rotatable Dipole</i>			
Driven Element	113.5	38.75	5
<i>Three Element Yagi — NBS Version (0.2 λ Spacing)</i>			
Reflector	113.8	38.9	37.2
Driven Element	115.5	39.75	10
Director	111	37.5	57.2
<i>Three Element Yagi — Compact Version (0.2 λ Reflector Spacing, 0.15 λ Director Spacing)</i>			
Reflector	114.0	39.0	37.2
Driven Element	115.2	39.6	8
Director	111.2	37.6	45.6

After adjustment of the driven element length, the SWR was also quite close to the predicted values. I also made use of near (N2GHR/B at 24 miles) and distant (NL7XM/B, 108 miles and K2ZD/B, 118 miles) beacons to verify sensitivity and pattern as I made adjustments — thanks for having those signals out there!

A Few Observations and Suggestions

While this design was focused on the three element Yagi and tribander shown, other arrangements are equally feasible. In particular, the single coupled resonator element is a

natural for those using a rotatable multiband, or single band, dipole. For that case, a center-to-center spacing of about 5 inches should give a good match.

I think a two element 6 meter Yagi with driven element and director would also perhaps work well, just down about 1 dB in forward gain from mine, but with less F/B.

Make sure you carefully look over your antenna system before you fire up on 6 meters. If your tribander has been there since the '50s, chances are good that there is a low-pass filter in the line that cuts off at 30 MHz. Don't ask me how I know that it

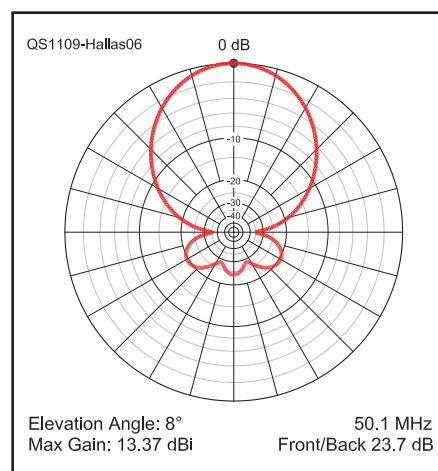


Figure 4 — EZNEC model results showing azimuth pattern including front-to-back ratio.

needs to come out! Similarly, while my coax surge arrestors are rated into the VHF range, not all are. Check yours and see before you push power down the line.

I also noticed that the usual cable run from the transceiver through my bypassed HF only amplifier and bypassed high power HF tuner changed the SWR significantly and added a bit of loss, even with everything “bypassed.” No doubt this was due to wire lengths in the equipment — they weren't designed to pass 6 meter signals, after all. Make sure you make all measurements and adjustments directly at the coax to the antenna with no HF gear in the line.

Notes

- ¹C. Greene, K1JX, “Short Takes — Par Electronics SM-50 6-Meter Stressed Moxon Antenna,” *QST*, Mar 2004, p 66.
- ²J. Hallas, W1ZR, “Getting on the Air — A Folded Skeleton Sleeve Dipole for 40 and 20 Meters,” *QST*, May 2011, pp 58-60.
- ³Several versions of EZNEC antenna modeling software are available from developer Roy Lewallen, W7EL, at www.ez nec.com.
- ⁴G. Breed, K9AY, “The Coupled-Resonator Principle: A Flexible Method for Multiband Antennas,” *The ARRL Antenna Compendium*, Vol 5, pp 109-112. Available from your ARRL dealer or the ARRL Bookstore, ARRL order no. 5625. Telephone 860-594-0355, or toll-free in the US 888-277-5289; www.arrrl.org/shop/; pubsales@arrrl.org.
- ⁵P. Viezbicke, *Yagi Antenna Design*, NBS Technical Note 688, Time and Frequency Division, Institute for Basic Standards, National Bureau of Standards (now NIST), Boulder, Colorado 80302, 1976.
- ⁶J. Wonoski, N1KHB, “An Ideal Plastic for Amateur Radio Projects,” *QST*, Oct 2009, pp 42-44.
- ⁷McMaster-Carr offers a “polycarbonate sample pack,” consisting of a single 6 × 6 inch sheet at ¼ inch thickness for \$2.65. Cut in half, this makes two element insulators. Two sheets provide enough for three, plus one to help you remember to measure twice and cut once. See www.mcmaster.com/#polycarbonate-sheets/=b25b3e.

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