Use Your Tower as a Dual-Band DX Antenna for 75/80 and 160 Meters

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and
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http://tinyurl.com/N9NB-QST

Dayton Hamvention
Antenna Forum by K3LR
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Outline of Talk

• Motivation for this Antenna

• Basic Concepts of a Dual Band vertical antenna

• Computer Modeling and Novel Design

• Construction of Antenna

• Tuning and real-world implementation

• Results and Conclusion
Motivation for this Antenna

N9NB in Riner VA is on a ridge – a very windy
Motivation for this Antenna
Motivation for this Antenna

• Very windy! The 160 m Inverted-L tied to tree came down often

• ~ 250’ - 300’ ground slope from JA to EU

• Two towers and trees only 65’ – 80’ tall

• 80 m and 160 m dipoles did not perform well– too low?

• 30 ground radials (~ 50’ each) installed for eventual vertical use.

• Needed a low-maintenance, low-profile performer
Motivation for this Antenna

Past 160 m solutions motivated me to solve the wind and performance problems at the N9NB ridge top location:

- A low-profile 160 m antenna in college for my apartment:  

- K9RS achieved gain using a parasitic tower on his 4-square:  
  R. Sokola, T. S. Rappaport, “Multi-element low band vertical arrays – approaches for small and other lots, ” 2008 Dayton Antenna Forum
One day at lunch in Austin, Texas in November 2017

- W5JAW had modeled N3BB’s tower for a 160 m shunt fed vertical
- I had been trying to figure out a single-feed dual band vertical for years
  - Investigated parasitic 80 m verticals next to 160 m but always 1 - 3 dB loss
- Inspiration struck as W5JAW and I tried different EZNEC concepts
- For 160 m shunt feed, a parallel wire located a few feet away can work on 80m
  - Much lower impedance (about 12 ohms)
  - Only 0.2- 0.5 dB loss from modeled ideal vertical performance, need 1:4 unun
Basic Concepts of Multi-Band Antenna

- Single feedline for multiple bands is convenient and cost-efficient
- Some multi-band dipoles do not require any traps or tuners or switches
- Resonance for one band should not be “bothered” by the other bands
- I had been using a single feed dual band dipole for 80/160 m at N9NB
- 80 m dipole is electrically short, high Z (cap) in parallel to 160 m feed
- 160 m dipole has high Z (resistive) in parallel to 80 m feed
Basic Concepts of Fan Dipole Antenna
• **First step**: Find resonance of tower – used EZNEC for base current feed

• Once we knew the tower could be shunt fed, 160 m was solved (ON4UN)

• **Second step**: Found proper spacing and length of parallel 80 m vertical wire

• **Third step**: Realized 80 m vertical used a 12-15 ohm feed impedance (1:4)

• Single feed with standard 1:4 Unun (80 m) and parallel “hot center” for 160 m

• **Fourth step**: Realized sensitivity at base of tower on 80 m – can tune 75/80!

• **Fifth step**: Build a single vertical and a 2 el phased array – have fun!
Current source (f)

80 m vertical

160 m shunt
Construction of the antenna

W5JAW Center Tapped Toroid Coil Solution for insulated driven element at N3BB

Use this if You have a Yagi with insulated driven element

Insulated driven element at top of tower must be center shunted to tower to prevent 160/80 m currents on balun/coax (do this for all top yagis)

Hi Z center-tapped toroid coil shunts the driven elements to tower, bringing all currents onto tower and not on yagi balun or yagi coax.
Construction of the antenna

- Center-tapped toroid coil w/balun: grounds insulated driven element
- W5JAW’s solution eliminates 160 m currents on top yagi balun/coax

Added center tapped toroid in parallel with stock yagi balun: the center tap shunts insulated driven elements to tower.

Windings of center-tapped toroid goes across insulated top yagi driven elements, use this idea for all driven elements at top of your tower.

Core: stack of two Amidon FT-114A-61 cores w/ties. Currents in two halves of driven elements are equal and in phase, giving Zero vector sum flux in the toroid core, and Low Z to the center tap. End to end Z diff. for feed line is 4KΩ, no impact on 14-30 MHz SWR.
**Construction of the antenna**

- Antenna parts cost less than $125 for a dual band 80/160 m vertical

<table>
<thead>
<tr>
<th>Qty</th>
<th>Component</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>JBX666 junction box</td>
<td>Manufactured by Kraloy, available at many electrical supply stores</td>
</tr>
<tr>
<td>1</td>
<td>5% × 6¾ × ¼ inch Plexiglas, Lexan, or perf board</td>
<td>To mount the capacitors in the junction box</td>
</tr>
<tr>
<td>2</td>
<td>20-foot pieces of ¾-inch schedule 40 PVC waterpipe</td>
<td>These are cut into three equal lengths of 6.66 feet at the store for</td>
</tr>
<tr>
<td></td>
<td></td>
<td>easy transport in a car</td>
</tr>
<tr>
<td>12</td>
<td>½-inch stainless-steel hose clamps</td>
<td>For mounting PVC spacer pipes to horizontal tower legs</td>
</tr>
<tr>
<td>1</td>
<td>Variable capacitor, 1 – 130 pF, 5 kV</td>
<td>Rating for legal limit</td>
</tr>
<tr>
<td>1</td>
<td>Doorknob capacitor, 180 pF, 5 kV</td>
<td>Rating for legal limit, available from Surplus Sales, Omaha, NE</td>
</tr>
<tr>
<td>1</td>
<td>Model 1435 1:4 unun with added hot center tap</td>
<td>Available from Balun Designs, Denton, TX</td>
</tr>
<tr>
<td>—</td>
<td>Assorted #12 AWG wire and lugs for vertical wires</td>
<td>To enable connections shown in Figures 3 and 4</td>
</tr>
</tbody>
</table>

Construction of the antenna

• Gamma Match capacitor construction
Construction of the antenna
Tuning and Implementation

- First: Tune 160 M Gamma match height and Cap with 80 m/unun connected
- Second: Determine 80 m wire height and spacing, special care for base spacing
- Third: using PVC pipe as a core, a tight coil lowers 80 m resonant freq.
- Fourth: Moving 80 m wire closer to tower and uncoiling raises the freq.
Tuning and Implementation

- SWR is excellent over 100 kHz range on both bands
- Easy to move between 3525 and 3725 kHz resonance with coil base and tie rope
- No tuners, traps, or moving parts!

**Table 2**
Measured SWR, 160-meter band

<table>
<thead>
<tr>
<th>Freq., kHz</th>
<th>SWR</th>
</tr>
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<tbody>
<tr>
<td>1,800</td>
<td>1.4</td>
</tr>
<tr>
<td>1,825</td>
<td>1.1</td>
</tr>
<tr>
<td>1,850</td>
<td>1.2</td>
</tr>
<tr>
<td>1,875</td>
<td>1.6</td>
</tr>
<tr>
<td>1,900</td>
<td>2.1</td>
</tr>
</tbody>
</table>

**Table 3**
Measured SWR, 80-meter band

<table>
<thead>
<tr>
<th>Freq., kHz</th>
<th>SWR</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,500</td>
<td>1.4</td>
</tr>
<tr>
<td>3,525</td>
<td>1.2</td>
</tr>
<tr>
<td>3,550</td>
<td>1.1</td>
</tr>
<tr>
<td>3,575</td>
<td>1.3</td>
</tr>
<tr>
<td>3,590</td>
<td>1.5</td>
</tr>
<tr>
<td>3,600</td>
<td>1.9</td>
</tr>
</tbody>
</table>

Graphics Courtesy QST Magazine
T.S. Rappaport, J. Parnell, “Use your tower as a dual band, low band DX antenna, QST, May 2019, pp. 41-45
Practical Implementation (no EZNEC)

- **First step:** ON4UN: estimate or measure your tower resonance for 160 shunt

- **Second step:** If insulated top yagi(s), install parallel center-tap toroid(s) to ensure proper vertical performance, and protect hi-band yagi(s) balun/coax

- **Third step:** Install single band 160 m shunt fed vertical to validate performance

- **Fourth step:** Install single coax w/1:4 Unun, 80 m wire 3’ from tower || 160 shunt

- **Fifth step:** Experiment with length of 80 m wire and spacing from tower, and spacing length (and coil of wire) at base of tower on 80 m – can tune 75/80

- **Sixth step:** Confirm both 160 and 80/75 provide resonance, HAVE FUN!
• For a Two Element dual-band phased array, use two identical vertical towers

• Identical 125’ coax runs to each of the two towers – equal phase feeds

• Using a stack match in shack, I can select N, S, or BOTH

• N drives the N vertical for gain to the N-NW using the south tower as reflector

• S drives the S vertical for gain to the S-SE using the north tower as reflector

• Exploits parasitic reflector as in K9RS 4-square (2008 Dayton Antenna forum)

• BOTH drives each vertical: broadside 2 element phased array to NE and SW
Tuning and Implementation

- 2 Element Phased Array gain > single element: 1.1 dB (160) and 3.8 dB (80)
- 2 Element design: Half wave spacing on 80 m, Quarter wave spacing on 160 m

Best elevation angle depends on ground cond. (EZNEC and ON4UN): Model shows 24 deg. for 160 m and 25 deg. for 80 m. More radials will improve single element gains!
Does it work?? I consistently break pile ups and work what is heard w/LP

- #3 World Low Power Stew Perry Top Band Challenge December 2018
  - (Low Power World QSO leader, did not use any RX antenna other than the vertical!)

- #1 US Low Power 2019 ARRL CW DX (preliminary)

- #1 North America Low Power 2019 Russian DX Contest (preliminary)

- #1 North America Low Power 2019 CQWPX SSB (preliminary)

YES! IT WORKS !!! ……BUT WAIT, there’s MORE……
• Amazingly, the antenna tunes well on almost every band: 160-6 m!

• EVEN WARC BANDS and 6 m without a tuner! Who would have guessed?

• Discovered by remote operation with limited antennas connected

• Worst VSWR was 5:1 on 40 m and 15 m, other bands did not need a tuner!

• Unexpected benefit! No telling what the patterns are – but I can work DX!
CONCLUSION:

• I no longer use dipoles. The tower verticals are my only 80/160 m TX Ants.

• These verticals are easy to make, easy to maintain, and really work well!

• They require no tuners, traps or switches for dual band 80/160 m operation

• Adding more ground radials will improve the gain even more

• TRY IT, YOU’LL LIKE IT!
THANK YOU!

73
de
N9NB and W5JAW

Use this QR Code for a preprint of May 2019 QST article about this antenna: http://tinyurl.com/N9NB-QST