

20 meter vertical half-wave dipole with inverted-vee lower element Tom Pierce K8EBR 9-13-2023

When asked I usually describe this single band antenna as a vertical dipole or an inverted Y while others prefer see it as a vertical ground plane with droopy radials. All are correct. This antenna has worked out well for me as a good DX radiator on 20 meters. It is a straightforward 16 gauge copper wire antenna that has a 50 ohm balanced input, fed with coax, and requires less real estate than a horizontal dipole and uses no ground plane. This antenna exhibits a generated field that is best described as a low angle horizontal toroid radiation profile and is quite efficient when carefully tuned. My antenna hangs from a Nylon cord strung between two tree tops but there are certainly other ways to support it. Interestingly, its height above the ground does not seem to play a large role in its performance requiring a minimum of about 50 ft. total height or just enough for safety. Both the antenna upper vertical element and the two lower elements are a quarter-wave long. The lower pair is cut to be a few inches longer than the upper element; the length difference is due to ground proximity which is confirmed by 4NEC2 simulation. The overall height of this configuration is 43% of a wavelength or 30 feet total.

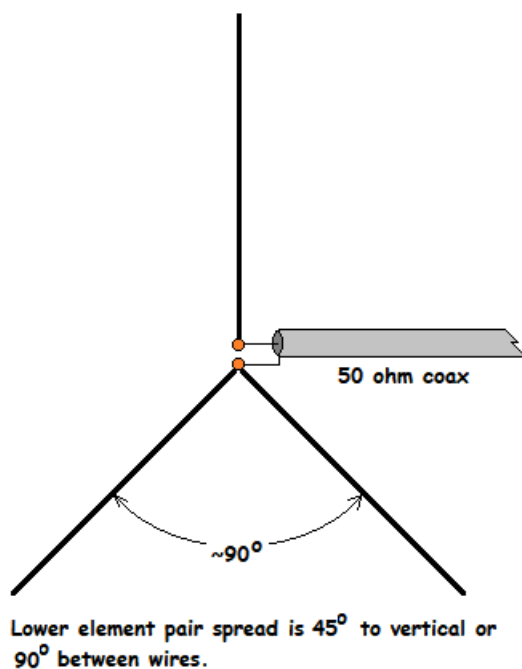


Figure 1 Vertical dipole Configuration

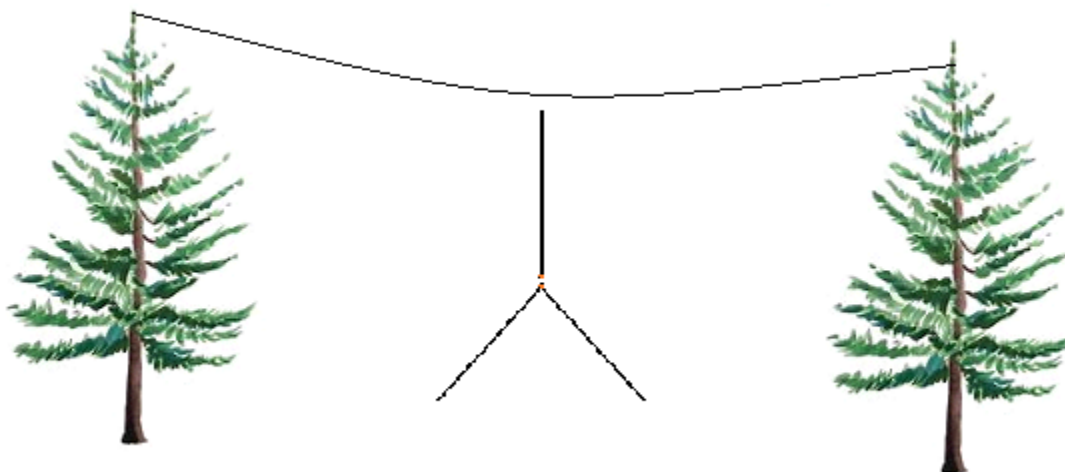


Figure 2 Antenna Suspension Arrangement

Since my QTH is heavily wooded this dipole has other trees within its reactive near-field boundary as well as within its radiated near-field boundary (approx. 12 ft. and 25 ft. radius respectively) but these obstructions do not seem to increase RF losses enough to present a noticeable problem. The lower element pair uses a Dacron paracord for tie-down holding each lower element tip to a staked ground point. A third paracord is used to limit the lower conductor pair spread in order to maintain their 45° angle; this angle maintains the antenna input impedance at 50 ohms.

My treetop-to-treetop suspension line was established using a homemade PVC pipe pneumatic spud launcher that has given me years of service. There are numerous spud launchers in the form of finished sling-shot type as well as DIY pneumatic types available, see list below.

<https://www.n1fd.org/2020/05/27/bigshot-slingshot/>
<https://www.wt4y.com/antenna-stuff/spud-launcher>
<https://www.dxzone.com/7-genius-diy-antenna-launcher-projects/>
<https://www.antennalaunchers.com/csv19/csv19asm.html>
<https://k4icy.com/launcher.html>

The antenna wire is 16 gauge stranded copper while the element ends use stainless wire thimbles and stainless U-bolt wire clamps sized for 16 gauge wire. When cutting wire leave a generous length folded back on the element wire to provide for tuning; there's nothing worse than the wire being cut too short to tune. Thimbles and clamps are inexpensive online from AliExpress.



Figure 3 Antenna Hardware, Clamps and Thimbles

A good antenna analyzer or a NanoVNA vector network analyzer really helps the cutting and tuning aspect of this project. I used a Sark-110 but a NanoVNA would have done the job more inexpensively.

This antenna works equally well on any band so long as its height can be supported. A length/dia corrected length quarter-wave wire element for any band or frequency may be calculated as follows:

$$\frac{\lambda}{4} \text{ length inches} = \frac{2803.2}{f_{\text{MHz}}}$$

$$\frac{\lambda}{4} \text{ length feet} = \frac{233.6}{f_{\text{MHz}}}$$

Keep in mind that the above equations includes a 5% correction. Without including this factor the antenna's sweet spot would have a slightly lower frequency by being electrically long and appearing inductive.

There are a large number of dipole center insulators available online but most are built on the assumption that they will be applied to a horizontal dipole. The problem when using such an insulator on a vertical dipole is that the coax connector is then rotated 90° to be on the side. The simple solution to this problem is to use a right angle coax connector adapter to connect the transmission line so that the coaxial cable then hangs straight and vertical.



The Budwig HQ-1 center insulator is a great way to build a dipole

Figure 4 Dipole center insulator w/coax adapter

<https://www.simplehamradioantennas.com/2021/05/build-dipole-antenna-center-insulator.html>

<https://www.jpole-antenna.com/2020/09/29/build-a-dipole-antenna-center-insulator/>

<https://www.youtube.com/watch?v=E5OqrvyjTgs>

Vert-20m-Vee lower el_16AWG_4-9-2023.out

14.1 MHz

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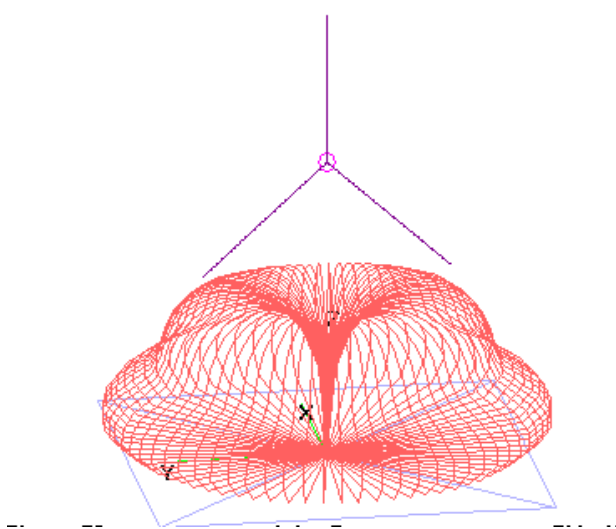


Figure 5 Radiated field profile

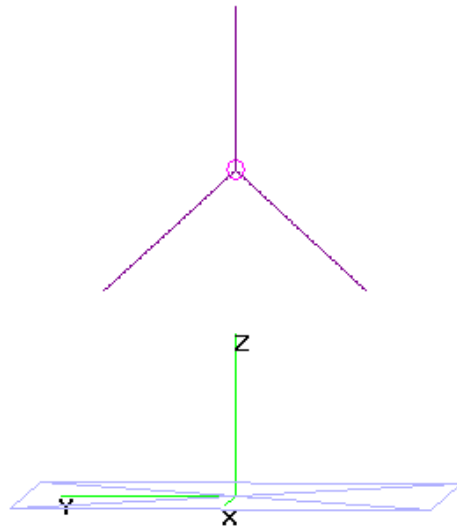


Figure 6 Antenna configuration

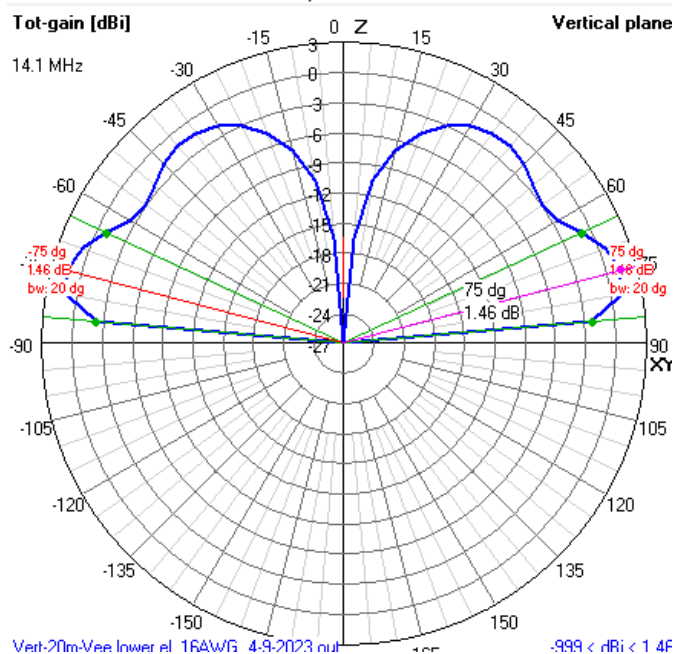


Figure 8 Gain plot vertical plane

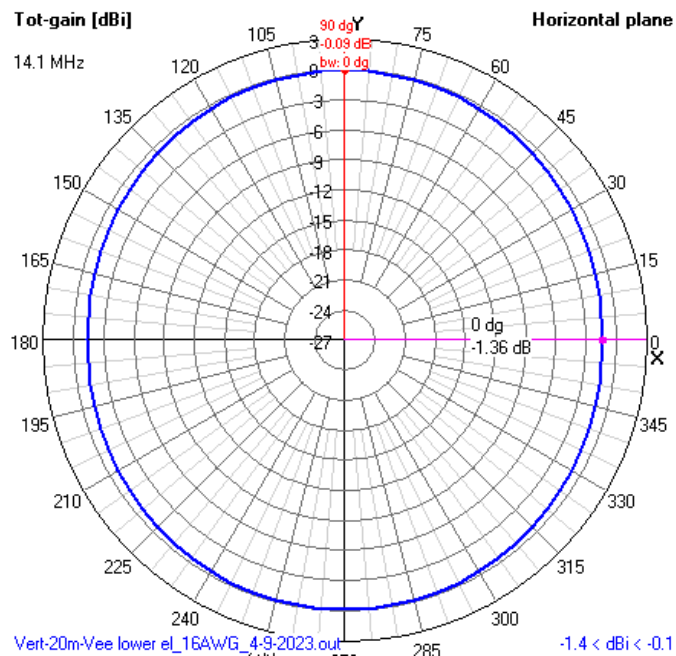


Figure 9 Gain plot horizontal plane

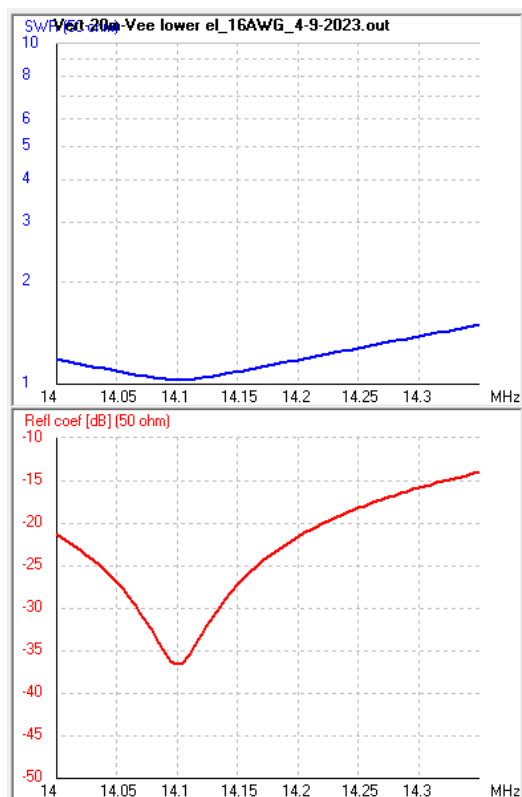


Figure 10 SWR and Reflection Coefficient

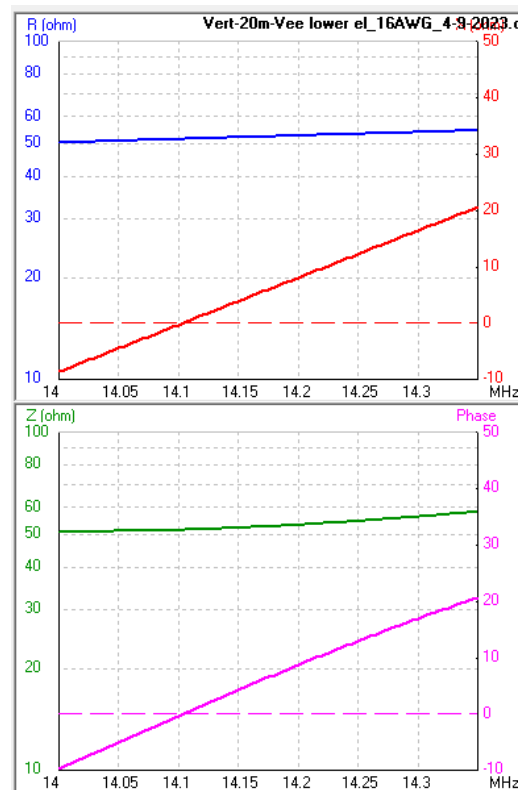


Figure 11 Input R+jX and Z w/phase

Filename	Vert-20m-Vee lower e	Frequency	14.1	Mhz
		Wavelength	21.26	mtr
Voltage	160 + j0 V	Current	3.12 + j0.02 A	
Impedance	51.5 - j0.26	Series comp.	3.e-3	uH
Parallel form	51.5 // -j1.e4	Parallel comp.	114.7	uH
S.W.R.50	1.03	Input power	500	W
Efficiency	98.11	Structure loss	9.465	W
Radiat-eff.		Network loss	0	uW
RDF [dB]	5.61	Radiat-power	490.5	W
Environment	☐ Loads ☐ Polar			
GROUND PLANE SPECIFIED. WHERE WIRE ENDS TOUCH GROUND, CURRENT WILL BE INTERPOLATED FINITE GROUND. SOMMERFELD SOLUTION RELATIVE DIELECTRIC CONST.= 13.000 CONDUCTIVITY= 2.000E-03 MHOS/METER COMPLEX DIELECTRIC CONSTANT= 1.30000E+01-2.54979E+00				
Comment 20 meter half wave vertical dipole in inverted-Y configuration driven input terminals 10 meters above ground all 16 gauge uninsulated/stranded wire length/dia correction .952 500 watts excitation at base of vertical element; 158 volts lower element slope ~45 degrees to vertical 50 ohm coax feed to wire 1, seg 1				

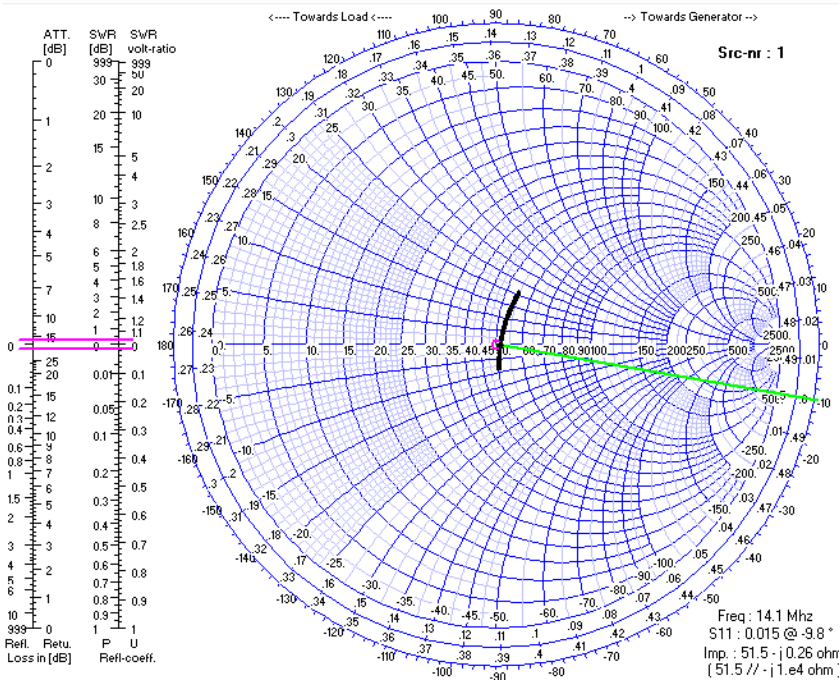


Figure 12 4NEC2 data listing

Figure 13 Antenna Smith chart

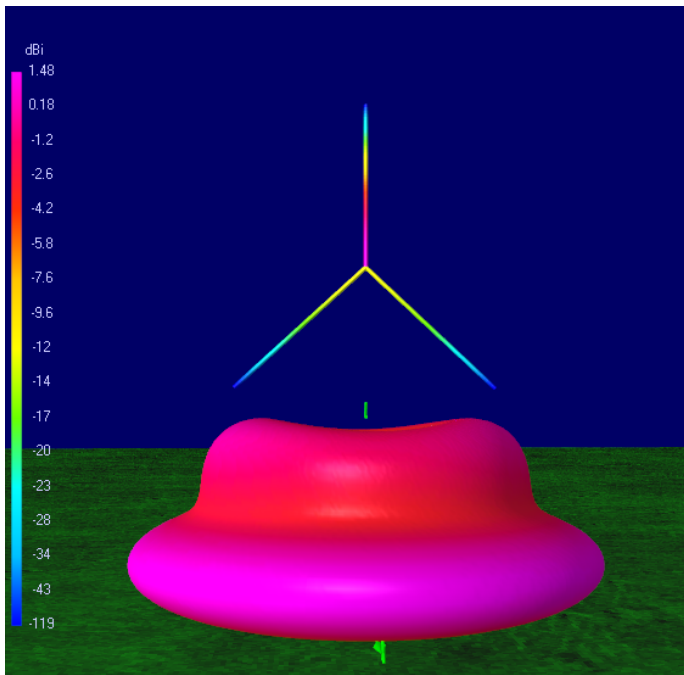


Figure 14 Gain 3D plot

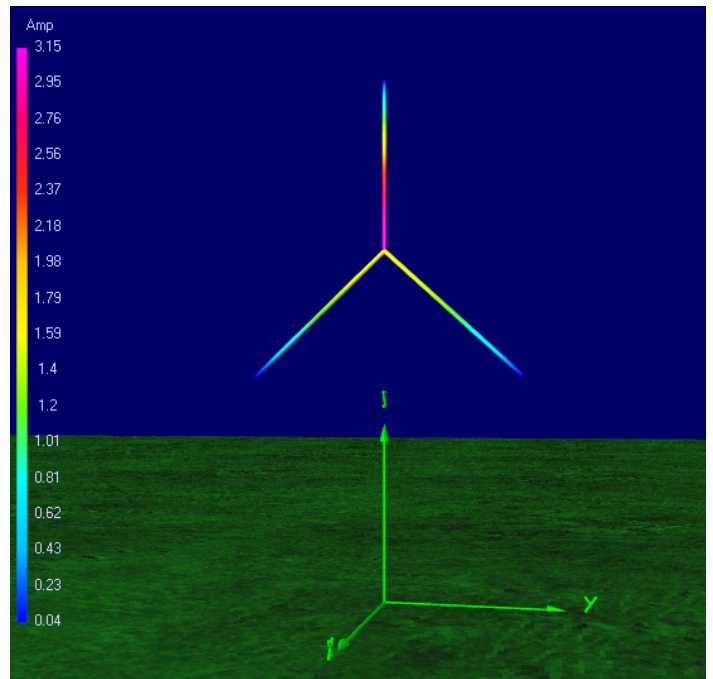


Figure 15 Element RF current plot

20 meter Vertical Dipole SARK-110 measurements at transmitter input connection. 9 Feb 2023

