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.

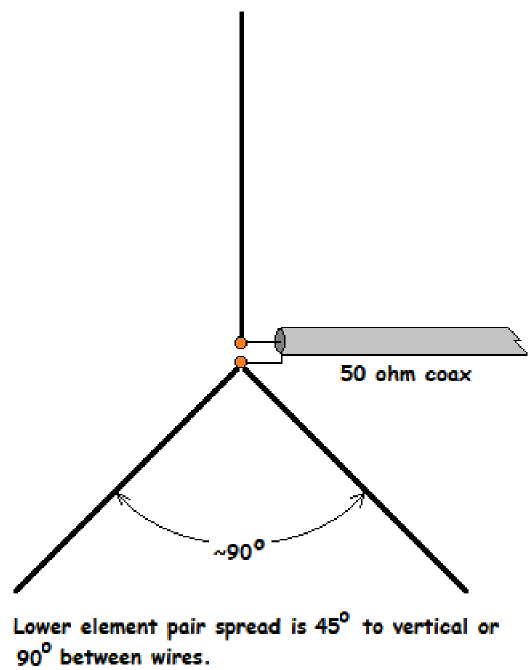


Figure 1 Vertical dipole Configuration

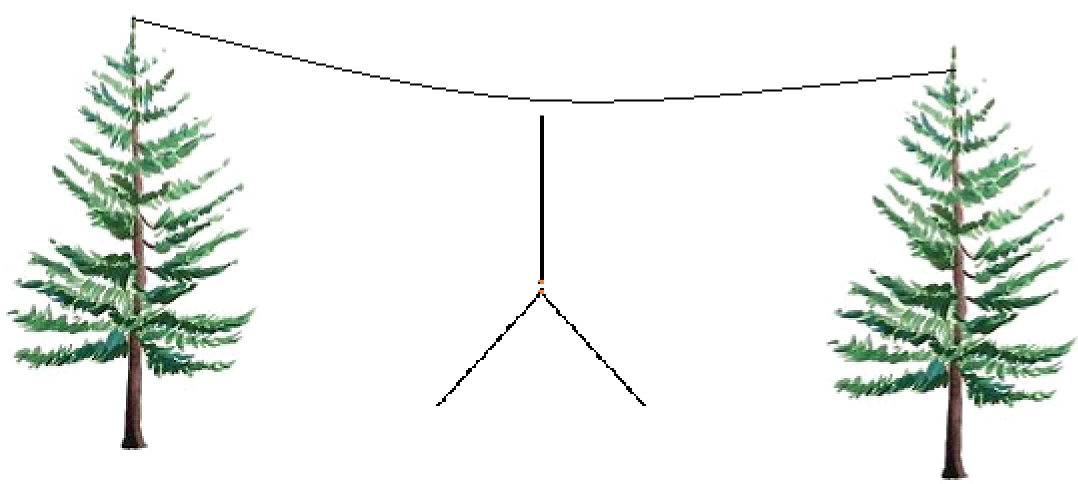


Figure 2   Antenna Suspension Arrangement

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 45º 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:

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

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

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 90º 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

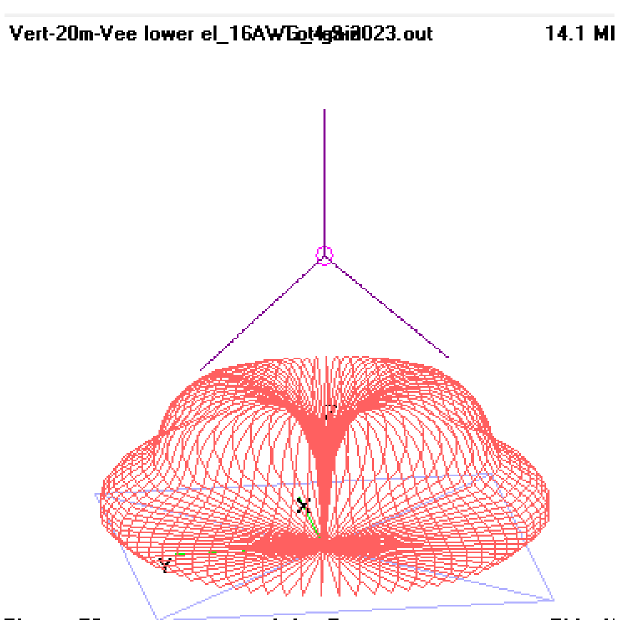


Figure 5 Radiated field profile

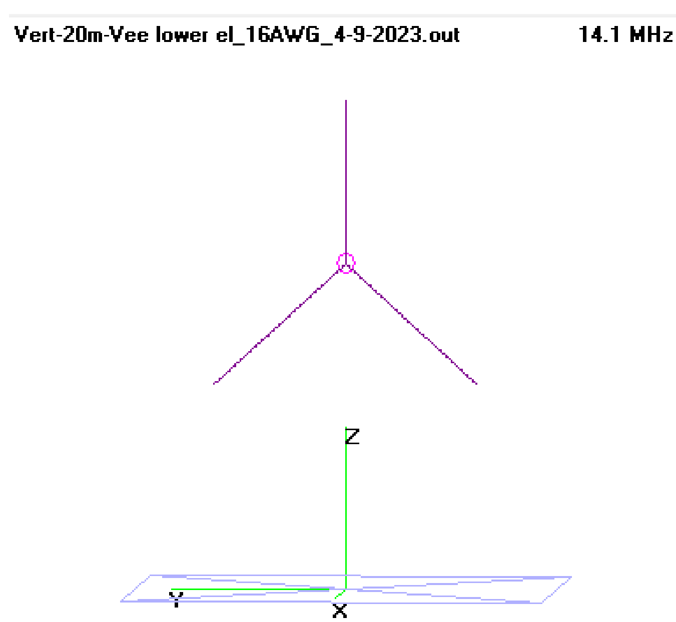


Figure 6 Antenna configuration

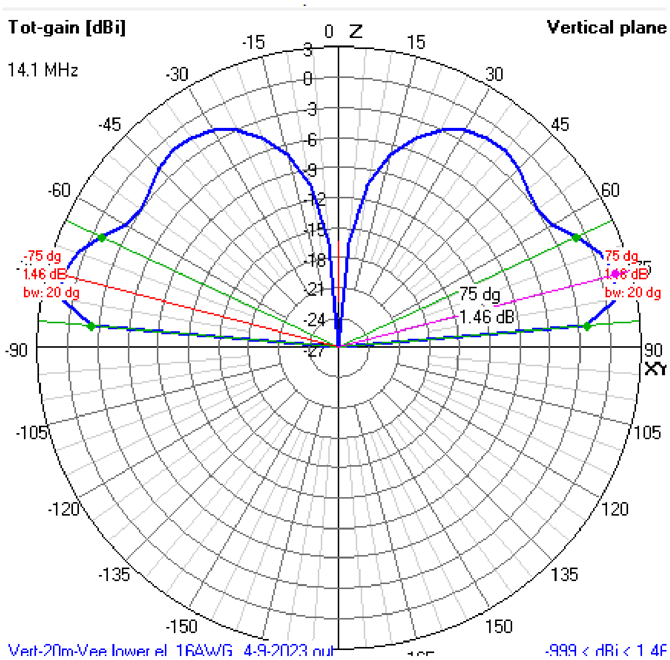


Figure 8 Gain plot vertical plane

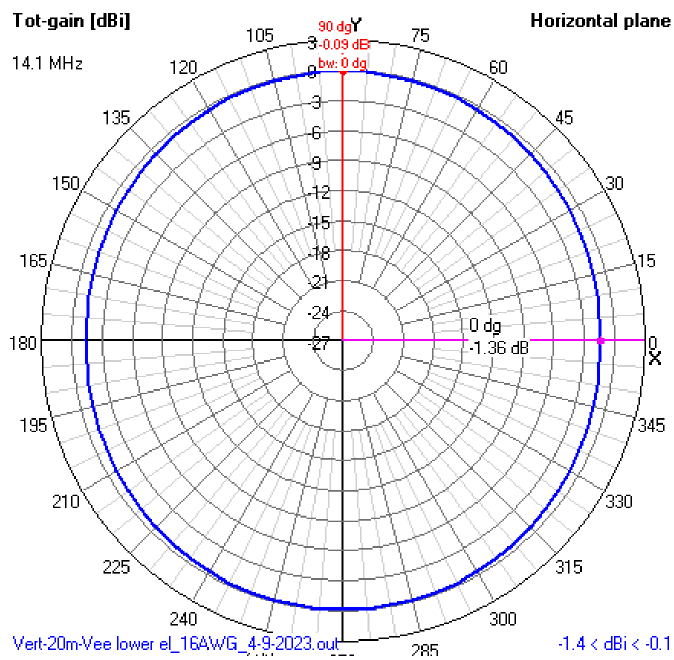


Figure 9 Gain plot horizontal plane

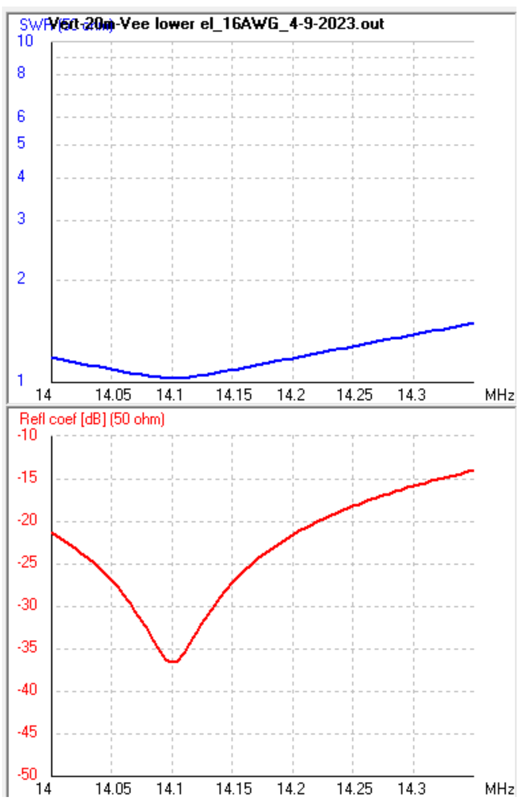


Figure 10 SWR and Reflection Coefficient

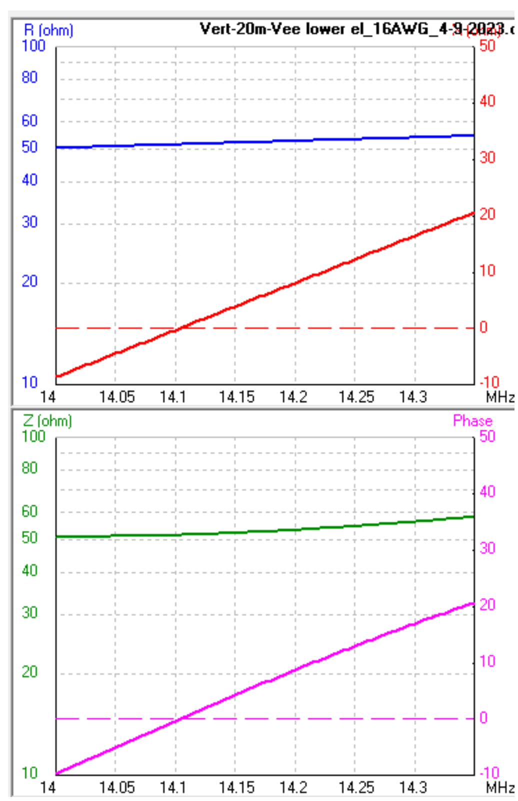
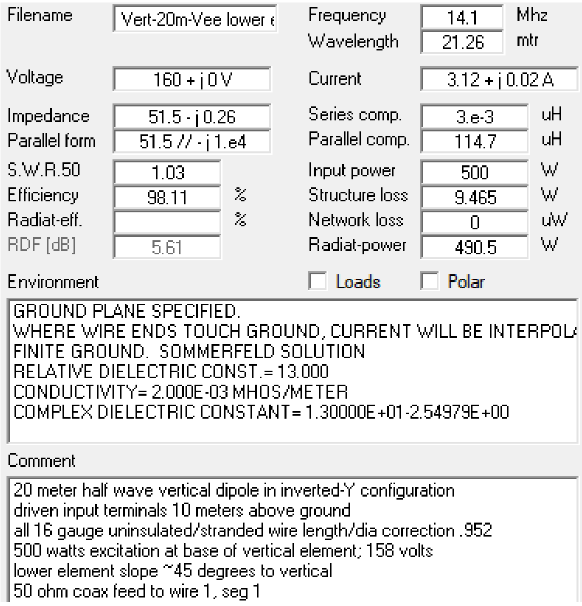


Figure 11 Input R+jX and Z w/phase



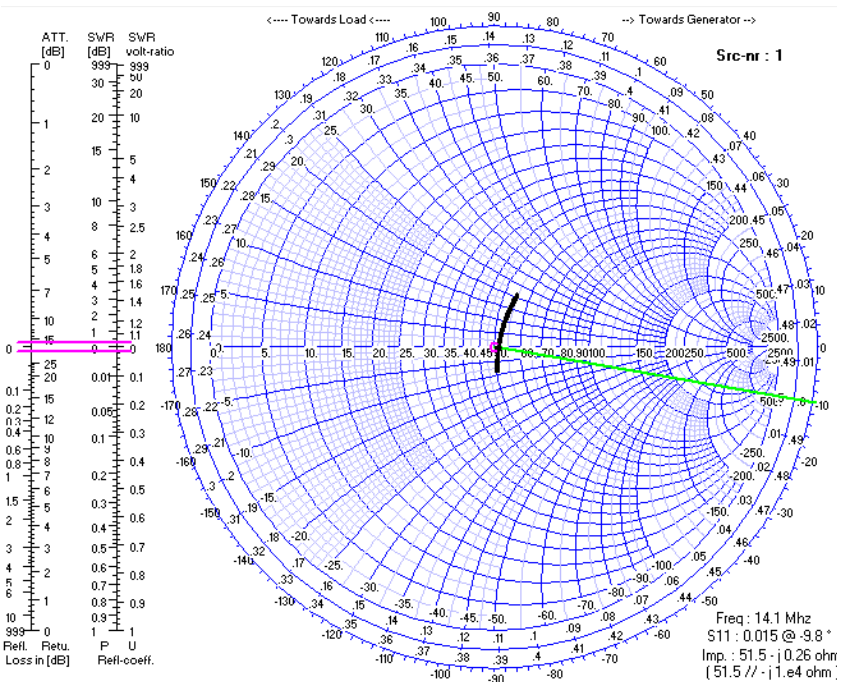


Figure 12 4NEC2 data listing

Figure 13 Antenna Smith chart

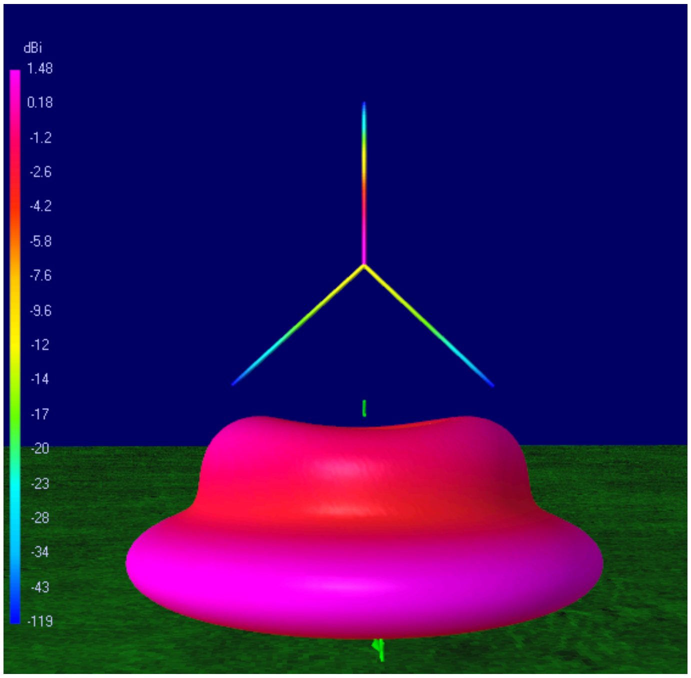


Figure 14 Gain 3D plot

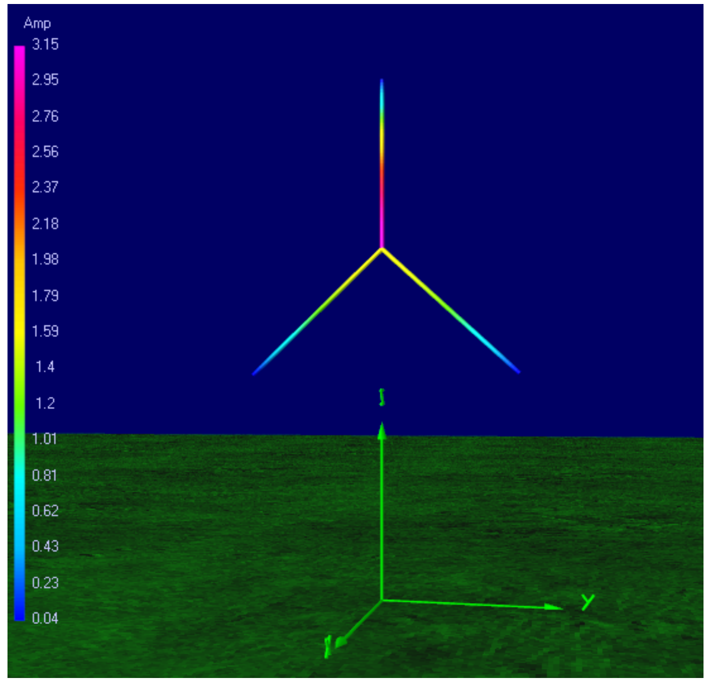
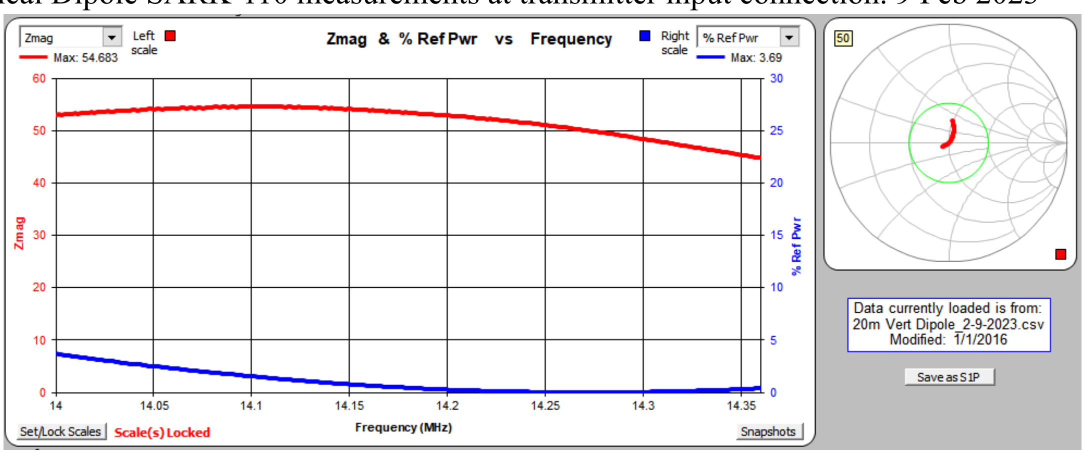
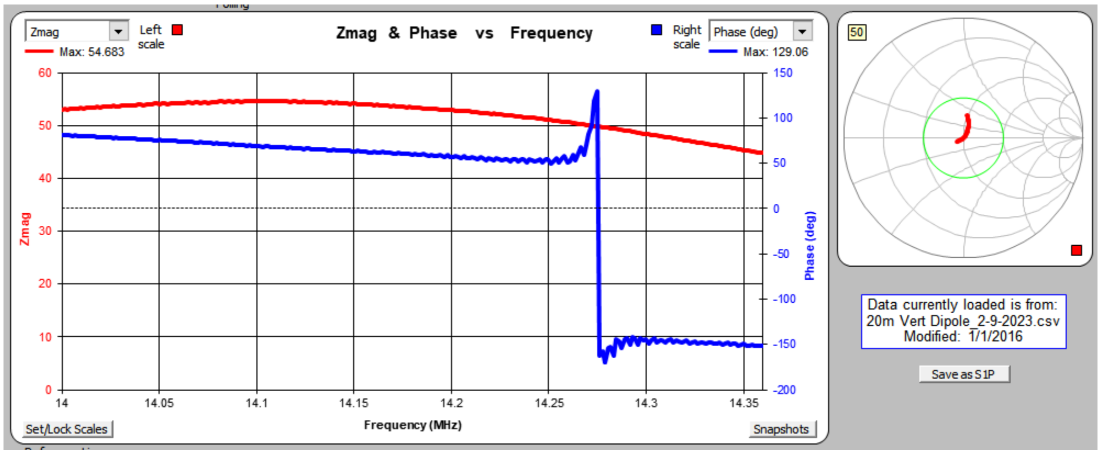
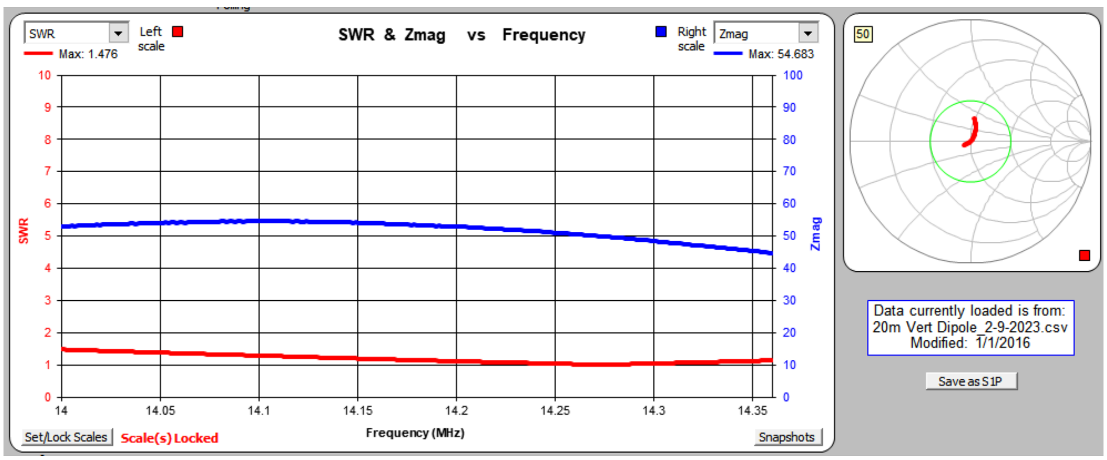


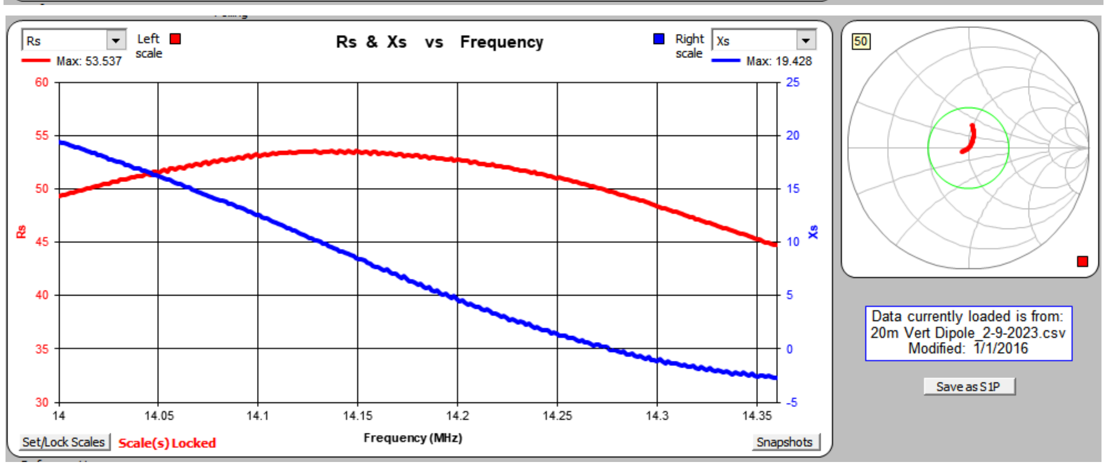
Figure 15 Element RF current plot

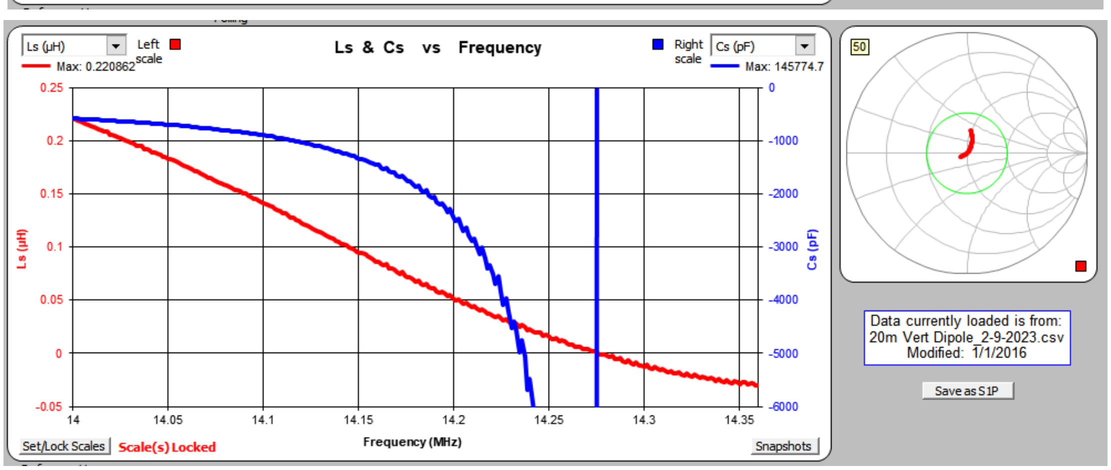
20 meter Vertical Dipole SARK-110 measurements at transmitter input connection. 9 Feb 2023

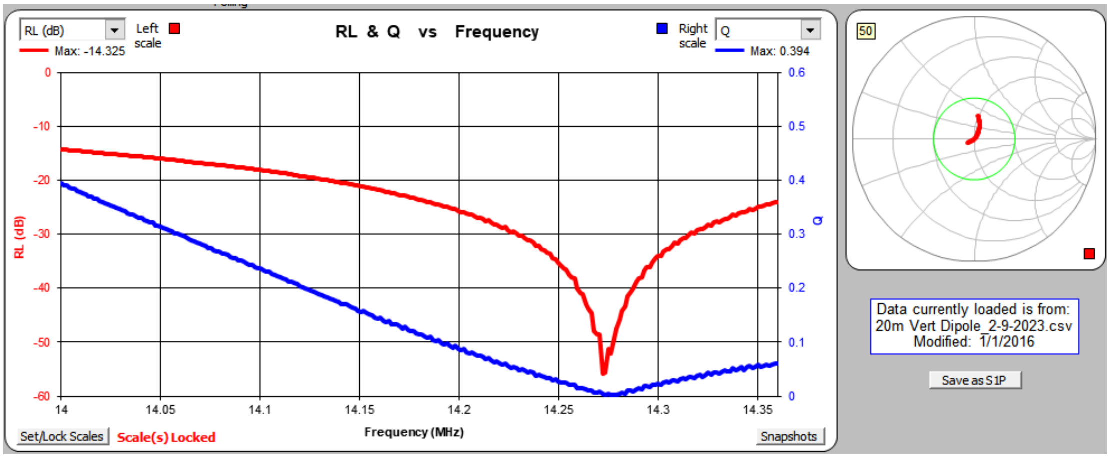


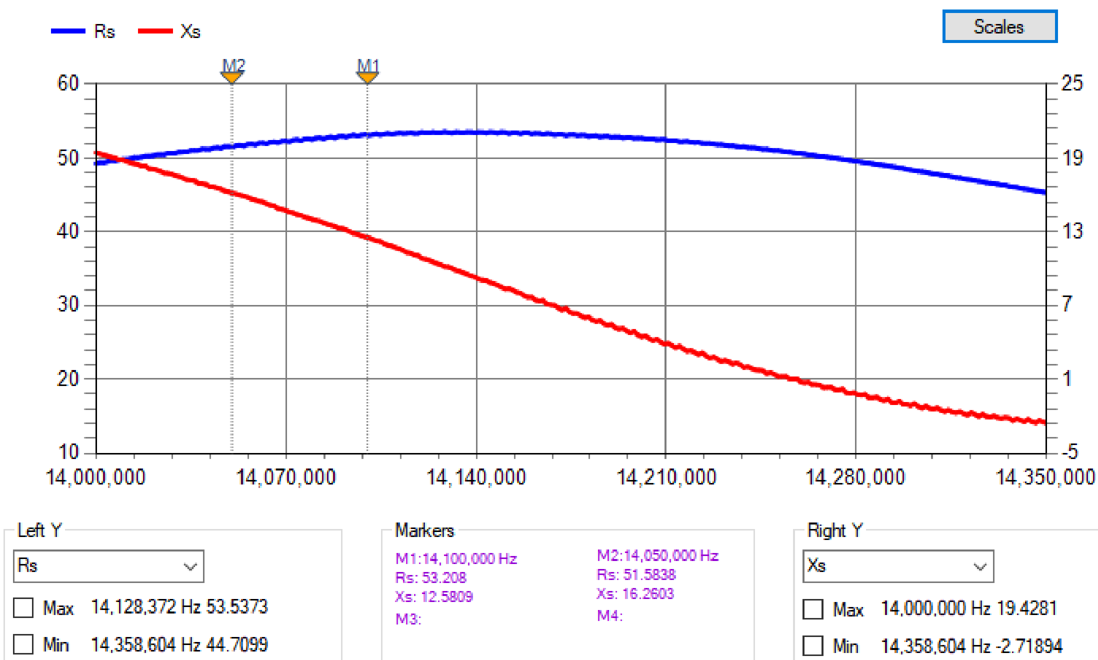

Zmag
Left scale
Max: 54.683
Zmag & Phase vs Frequency
Right scale
Phase (deg)
Max: 129.06
Zmag
Phase (deg)
Frequency (MHz)
Set/Lock Scales
Snapshots
50
Data currently loaded is from:
20m Vert Dipole_2-9-2023.csv
Modified: 1/1/2016
Save as S1P


SWR
Left scale
Max: 1.476
SWR & Zmag vs Frequency
Right scale
Zmag
Max: 54.683
SWR
Zmag
Frequency (MHz)
Set/Lock Scales
Scale(s) Locked
Snapshots
50
Data currently loaded is from:
20m Vert Dipole_2-9-2023.csv
Modified: 1/1/2016
Save as S1P


Rs
Left scale
Max: 53.537
Rs & Xs vs Frequency
Right scale
Xs
Max: 19.428
Rs
Xs
Frequency (MHz)
Set/Lock Scales
Scale(s) Locked
Snapshots
50
Data currently loaded is from:
20m Vert Dipole_2-9-2023.csv
Modified: 1/1/2016
Save as S1P


Ls (µH)
Left scale
Max: 0.220862
Ls & Cs vs Frequency
Right scale
Cs (pF)
Max: 145774.7
Ls (µH)
Cs (pF)
Frequency (MHz)
Set/Lock Scales
Scale(s) Locked
Snapshots
50
Data currently loaded is from:
20m Vert Dipole_2-9-2023.csv
Modified: 1/1/2016
Save as S1P


RL (dB)
Left scale
Max: -14.325
RL & Q vs Frequency
Right scale
Q
Max: 0.394
Frequency (MHz)
Set/Lock Scales
Scale(s) Locked
Snapshots
Data currently loaded from:
20m Vert Dipole_2-9-2023.csv
Modified: 1/1/2016
Save as S1P


Rs
Xs
Scales
M2
M1
Left Y
Rs
Max 14,128,372 Hz 53.5373
Min 14,358,604 Hz 44.7099
Markers
M1:14,100,000 Hz
Rs: 53.208
Xs: 12.5809
M3:
M2:14,050,000 Hz
Rs: 51.5838
Xs: 16.2603
M4:
Right Y
Xs
Max 14,000,000 Hz 19.4281
Min 14,358,604 Hz -2.71894