



AeroElectric Connection

Bob Nuckolls, K0DYH
Medicine Lodge, Kansas 67104

Rev A October 7, 2019

A quick study in effects of geometry on antenna performance

The first figure of this demonstration shows the performance plot of a skinny “spike” antenna over a 4-radial ground plane. This antenna’s connector mates with a miniVNA Tiny network analyzer. The calculated $\frac{1}{4}$ -wave frequency of this antenna is

6 inch / 0.03936 in per mm = 152.4 mm (1/4 wave in free space)

$X4 = 609.6 \text{ mm}$ or 0.6096 meters (full wave in free space)

$300 / .6096 = 492.1$ calculated center frequency.

From the data plot we see a measured center frequency (M3) of 494.7 MHz, a difference of about $\frac{1}{2}$ percent . . . excellent agreement.

Placing makers M1 and M2 at the 1.5:1 SWR points illustrates a bandwidth of 67.3 MHz. Note that the lowest SWR is 1.20:1

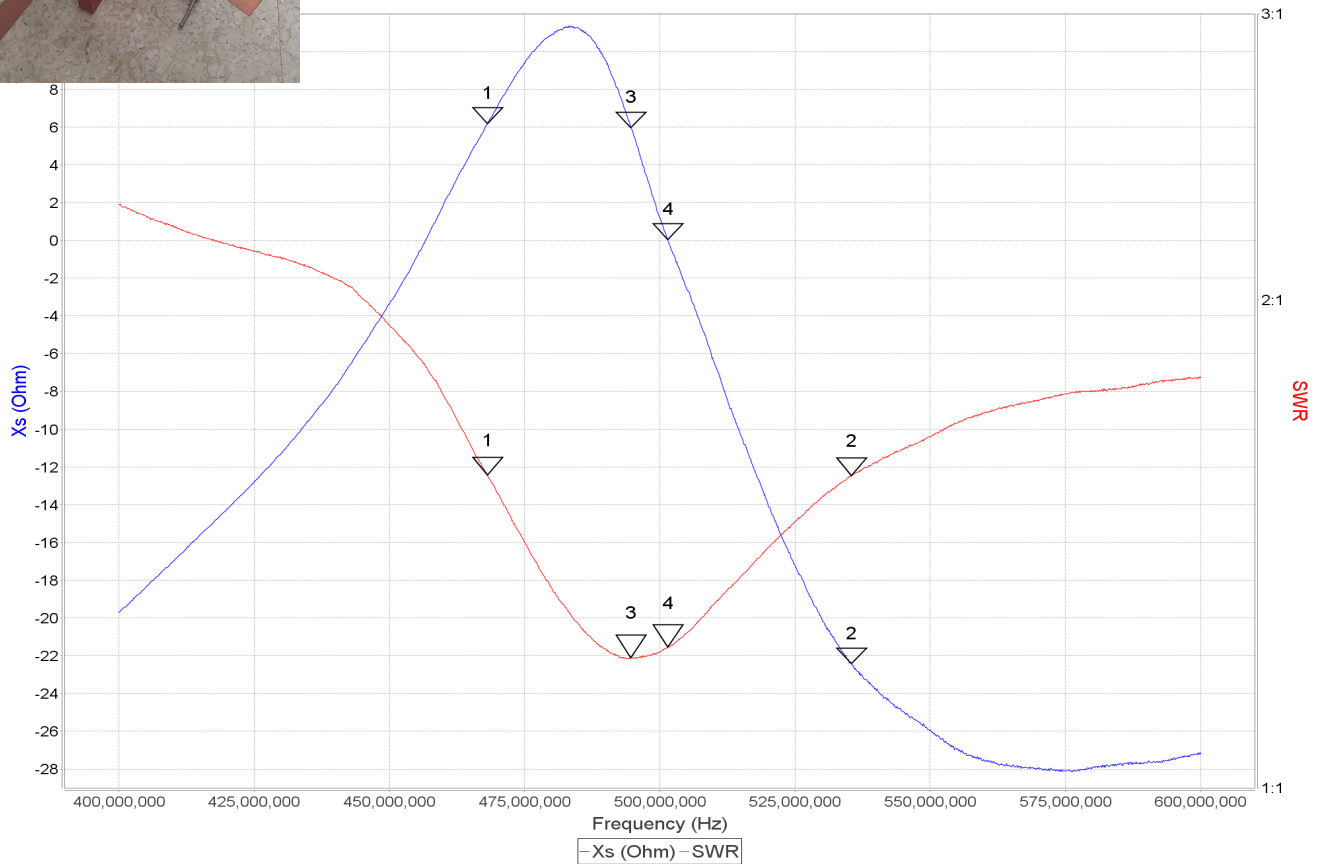
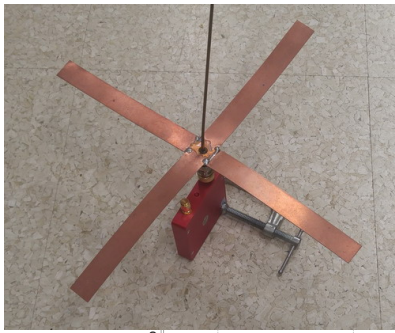
The second figure illustrates the effects of increasing the antenna’s radiator width to 0.5”. A performance sweep of this antenna shows a 1.5:1 SWR bandwidth of 104.7 MHz . . . much wider than the skinny spike illustrated above. Further, the lowest SWR drops to 1.04:1 . . . measurably lower than the skinny spike.

Note that the ‘center’ frequency is now spread over the range from M3 to M4 or about 481 MHz. This suggests that our wider ‘blade’ antenna needs to be shortened slightly to bring it back up to the original 484.7 MHz.

This experiment demonstrates the increasing bandwidth offered by a wider $\frac{1}{4}$ -wave element.

These effects are scalable. If we multiply all the frequencies cited above by 2.2, the new test values fall in the range of interest for the UHF frequencies utilized by ADSB, transponders, DME, etc. The data plotted in the second scan demonstrates that crafting a single, simple antenna with excellent performance over the full range of interest is possible and practical.

6" spike over ground plane

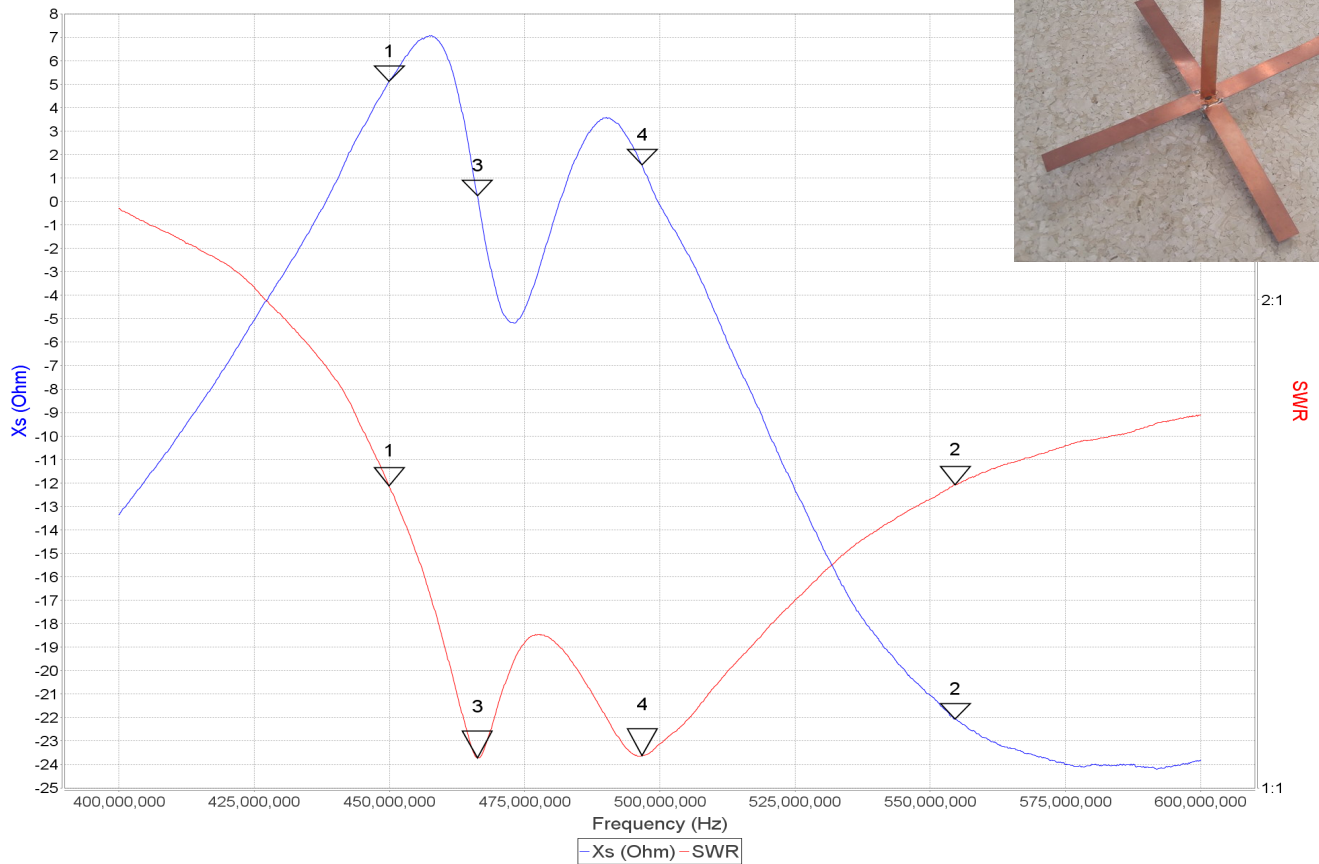


Marker	Freq. (Hz)	RL (dB)	RP (°)	Z ()	Rs ()	Xs ()	Theta	SWR
1	468,160,904	-13.21	155.81	33.5	32.9	6.2	10.6	1.56:1
2	535,424,954	-13.24	-55.59	63.5	59.4	-22.4	-20.7	1.56:1
1-2	67,264,050	0.02	211.40	30.0	26.5	28.6	0.0	---
3	494,682,158	-20.73	33.71	58.3	58.0	6.0	5.9	1.20:1
4	501,472,624	-20.04	0.22	61.0	61.0	0.0	0.0	1.22:1

Comment:

Date: 10/7/19 11:28 AM
 Mode: Reflection
 Analyser: miniVNA Tiny / mini radio solutions - miniVNA Tiny
 Scan
 Start: 400000000 / 400,000,000
 Stop: 599998480 / 599,998,480
 Samples: 1562
 Overscan: ?
 Calibration
 Samples: 1000
 Overscan: 2
 File: REFL_miniVNA Tiny.cal
 User: Bob
 Headline: {2} - {0,date,yyMMdd}_{0,time,HHmmss}

6" x 1/2" blade antenna over ground plane



Marker	Freq. (Hz)	RL (dB)	RP (°)	Z ()	Rs ()	Xs ()	Theta	SWR
1	449,967,580	-13.51	159.60	33.6	33.2	5.1	8.8	1.53:1
2	554,643,254	-13.48	-71.22	57.0	52.6	-22.1	-22.8	1.54:1
1-2	104,675,674	0.03	230.83	23.4	19.4	27.2	0.0	---
3	466,239,074	-33.40	173.28	47.9	47.9	0.2	0.3	1.04:1
4	496,732,110	-32.75	40.63	51.8	51.8	1.6	1.7	1.05:1

Comment:

Date: 10/7/19 11:51 AM
 Mode: Reflection
 Analyser: miniVNA Tiny / mini radio solutions - miniVNA Tiny
 Scan
 Start: 400000000 / 400,000,000
 Stop: 599998480 / 599,998,480
 Samples: 1562
 Overscan: ?
 Calibration
 Samples: 1000
 Overscan: 2
 File: REFL_miniVNA Tiny.cal
 User: Bob
 Headline: {2} - {0,date,yyMMdd}_{0,time,HHmmss}