Comparing a Good Vertical and a Good Dipole

By Jim Brown K9YC

The question is often asked – should I use a vertical or a dipole? In my experience, there's no one answer, but there are some important factors that contribute to the answer.

- What is are the electrical heights of the two antennas?
- What are the ground losses?
- What does terrain contribute?
- What happens to the predominant ground reflection?

When studying these plots, remember that these are very good verticals with good radial systems, over average earth. A poor vertical (short, poor radial system) may be 6-10 dB worse, a good one (looking at sea water) may be 6 dB better (but sea water will also improve the dipole).

Electrically Low Dipoles I have two antennas for 160M. The vertical is a top-loaded "Tee" configuration, with an 86 foot vertical wire (0.17λ) and a 132 ft horizontal section suspended between two trees. The antenna is roughly 3/8λ electrically (thanks to the top loading), and is tuned to resonance (and a 50 ohm match) with a series capacitance of 340 pF. The dipole is at roughly 110 ft, also suspended between some tall trees, and is broadside to about 60/240 degrees azimuth.

We've probably all seen the polar plots for various antennas in textbooks, as well as those produced by NEC. It's easy to draw some inaccurate conclusions if you're not careful, so let's take a closer look. Fig 1 shows the vertical patterns for these two antennas computed by NEC. The plot makes it obvious that a dipole at 110 ft on 160M is still a fairly low dipole! This comparison is also representative of performance on 80M of a quarter wave vertical and a dipole at 55 ft, and on 40M for a quarter wave vertical and a dipole at 28 ft.

At first glance, the difference between the two antennas is that the dipole seems to have a lot stronger field, but that it is going to relatively high angles. The problem with the polar plot of the data is that it isn't terribly obvious how much difference there is between the two antennas at low angles.

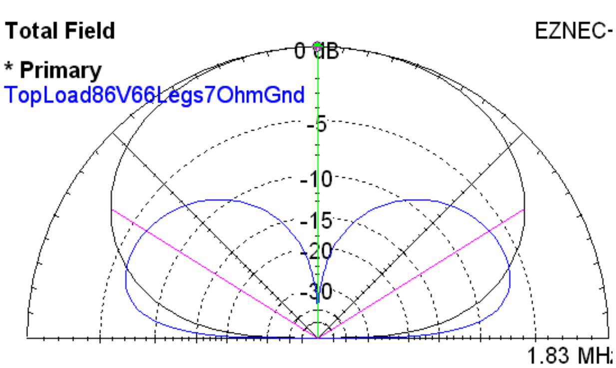

Fig 1 – Polar Plot

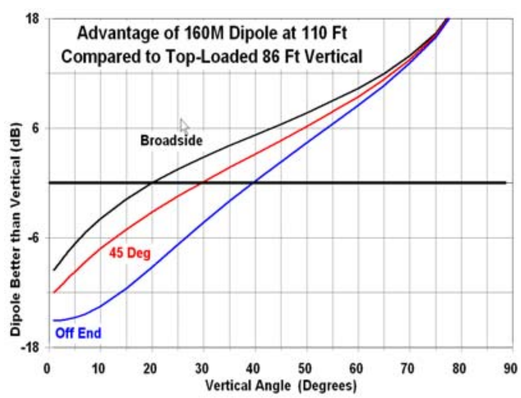

Fig 2 – Rectangular Plot

The late Dick Heyser taught us that different ways of looking at data is instructive. Fig 2, a replot of the same computation in rectangular form, makes it clear that below about 10 degrees, the vertical is nearly a half S-unit better on-axis of the dipole, a full S-unit better at 45 degrees to the dipole, and at least two S-units better off the end of the dipole.

Ah, some say – but the vertical doesn't do nearly as well at the high angles that support short distance propagation. Yes, that's true – but:

1) Don't forget inverse square law – field strength falls as the square of the distance, so stations at 800 miles are 6 dB closer than stations at 1,600 miles and 9 dB closer than stations at 2,300 miles! You don't need as much signal to work those closer stations.
2) Don't forget ground wave propagation over short distances.

I'm set up so that I can instantly switch between two transmitting antennas (and two reversible Beverages). I've learned a lot by switching between these antennas both on transmit and receive.

- In the hours before sunset, 1 kW to the vertical will work consistently work stations in WA and CO from my QTH south of San Francisco (800 and 1,000 miles respectively), while the dipole won't even get a QRZ? The advantage of the vertical during these winter daylight hours is at least 6 dB, and seems to persist for at least an hour or two past sunset. I can't say what happens after sunrise – most topbanders QRT soon after sunrise after operating through the wee hours.
- Well past sunset and well before sunrise, it's often a toss-up as to which antenna will be better over any distant path. I'll often do alternating CQ's on the two antennas, and when I want to call another station, I'll often switch between the two antennas to see which hears him better and use that antenna to call. It all comes down to what vertical angle supports propagation to the distant station, and the vertical pattern of the antenna system he's using.

Fig 3, at right, shows the results of comparing the NEC model for my 80M dipoles at 110 ft with a 71 ft vertical over the same radial system on 80 meters. Since I have two 80M dipoles at right angles, I mostly care about what happens between broadside and 45 off axis. While the 80M vertical still has an advantage at low angles, it's s a smaller advantage and over a smaller vertical angle. Is it worth adding a fan element to my 160M vertical? Yes, because it's not a lot of effort to do so – but it's a lot less useful than on 160M.

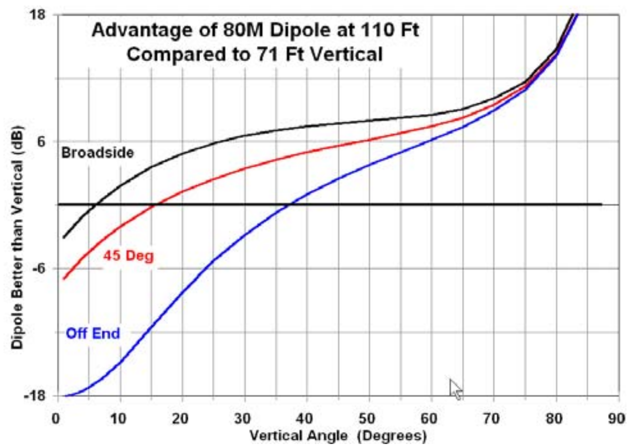

Fig 3 – 80M Comparison

Electrically High Dipoles It's a very different story if the dipole is electrically high. Fig 4 and 5 are the computed vertical patterns of horizontal and vertical dipoles for 40M. The horizontal dipole is at 118 ft; the vertical dipole pattern is computed for the top of the antenna at three heights. The three inner curves are the vertical dipole, the outer curve is horizontal dipole.

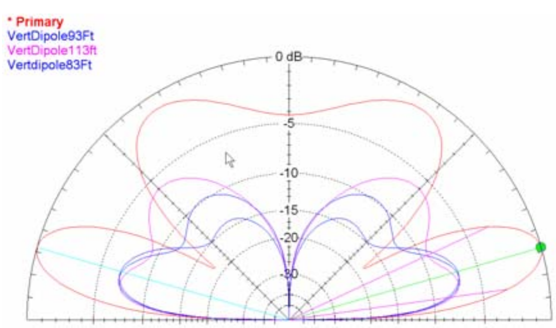

Fig 4 – Broadside to the Horizontal Dipole

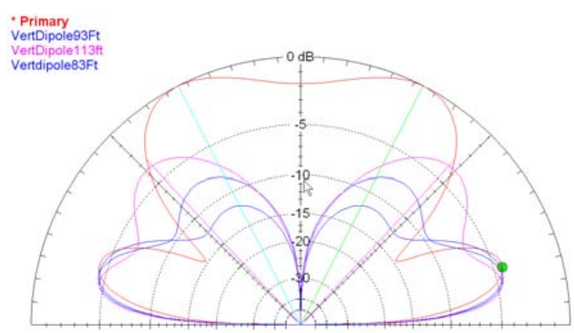

Fig 5 – 60° off Axis of Horizontal Dipole

Figs 4 and 5 make it clear that the horizontal dipole is clearly better within 60 degrees of broadside at both low and high angles!

What about a beam? Add 2-4dB to the on-axis advantage of the dipole (contrary to what you might read on the manufacturer's data sheet, it takes a serious monoband beam to provide more than about 5dB gain over a dipole).