N0GW Barn Verticals

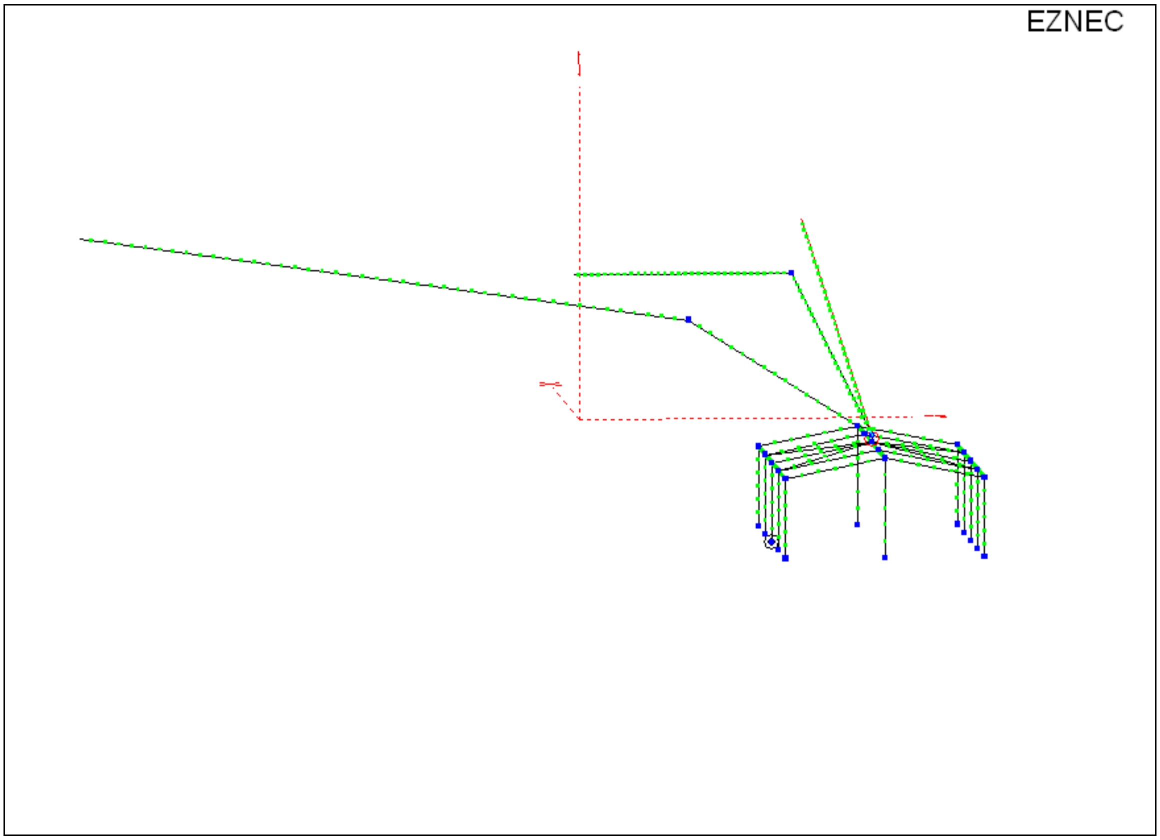
This antenna scheme is an example of operating multiple vertical antennas from a single feed point. It is an antenna system that I have been successfully using for over a year now. It consists of three independent quarter wave wires hung over tree limbs and fed from a single coax connection at the middle of my barn roof.

There was not a lot of thought put into this design. I have been using multiband antennas consisting of paralleled dipoles connected to a single coax feedline for over 30 years now. Tossing quarter wave wires over tree the trees near the barn and connecting them to a common feed point was a natural extension of that scheme.

I did not bother calculating precise wire lengths when I installed them. I just cut them a bit long to start with. I trimmed each of them, a little at a time, until the SWR minimum points were where I wanted them. As a result, I really don't know exactly how long each wire is anymore. That really doesn't matter though. What counts is where the wires resonate, not their precise lengths.

Paralleling wires for different ham bands works fairly well but it is not a magic bullet by any means. Obviously there is some, but fortunately small, interaction between the wires. This primarily shows up as a shift in resonant frequency of a wire between paralleled and not paralleled. Once a wire is resonated in a paralleled configuration, minor adjustment of wire lengths shows little interaction between bands.

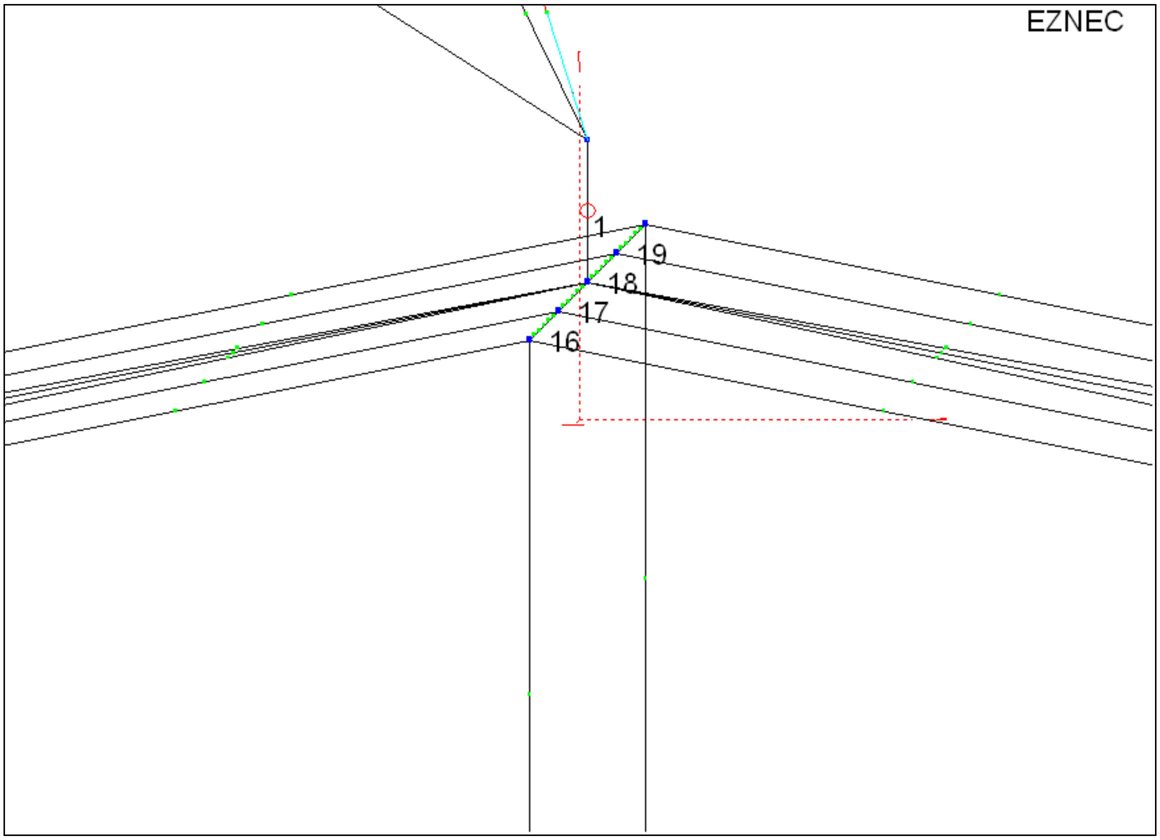
Also, when the antenna wires are physically parallel, mimicking an open wire transmission line, there is anti-resonance a bit below the shorter wire's resonant frequency. That causes the SWR to rise rapidly below the bottom of the shorter wire's operating band. This effect is less noticeable or absent from antennas like my barn verticals because the wires are not physically paralleled as they leave the feed point.



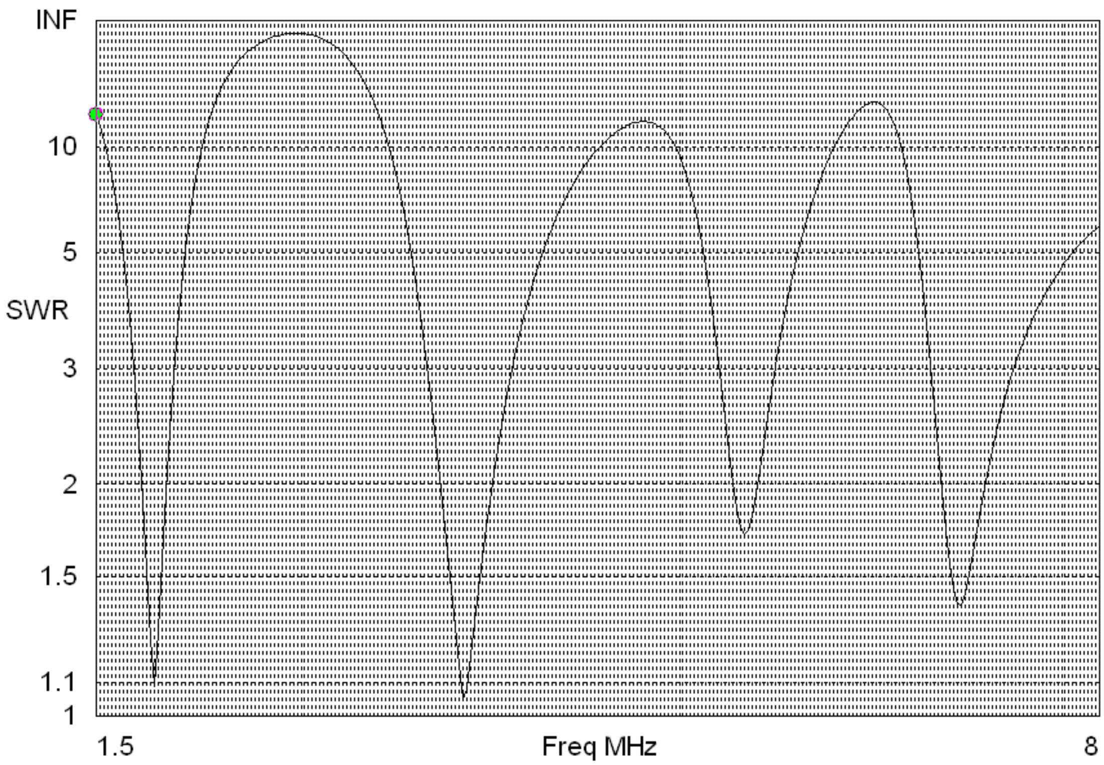
The graphic above shows the EZNEC definition I made for this antenna installation. As you can see, my barn is modeled as a wire frame with of the vertical lines, representing the sides of the barn, connected to ground.

Some versions of the NEC antenna analysis engine allow flat plates to be defined. That allows structures such as this barn, ships, airplanes, and other metal structures to be modeled fairly accurately and simply. The version of EZNEC I have does not have that capability so I use used the technique of simulating the building using individual wires. This usually works well enough as long as the lengths of the wires in the frame are a small fraction of a wavelength. The number of wires and their lengths in this model is probably adequate up through 40 meters or so.

The weird angles of the wire coming off the top of the barn are my approximation of how the real wires drape over tree limbs. I just eyeballed their configuration from the ground and adjusted the definition to (sort of) match.



The graphic above shows how the feed point is modeled. I defined a single one foot long vertical wire with its bottom end connected to the center of the roof. I then instructed EZNEC to install an RF source in the middle of that short wire. The three quarter wave wires then connect to the top end of this wire. This is a common way of modeling multiple wires fed from a single source.



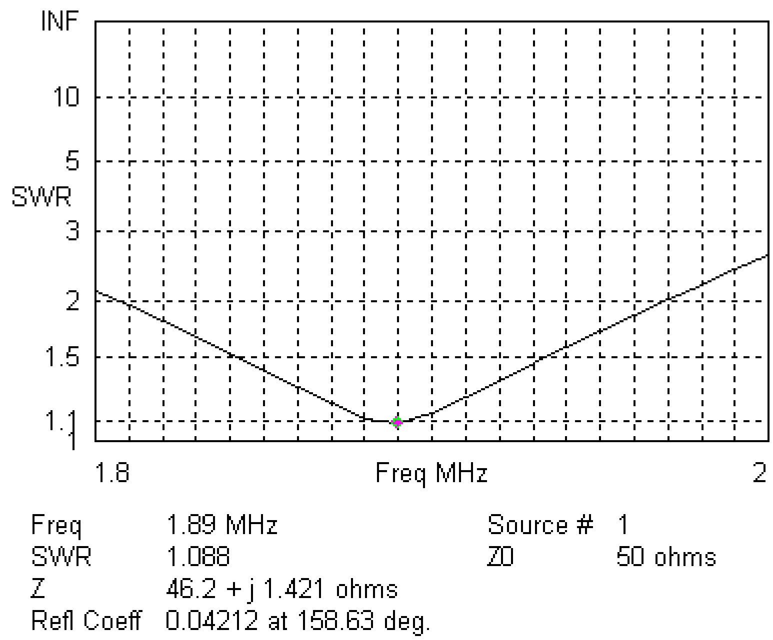
The SWR plot above is EZNEC's estimation for the entire range of 1.5 MHz through 8 MHz. The SWR dips occur at 1.9 MHz, 3.8MHz, 5.6 MHz and 7.2 MHz. The SWR dips in 160 meters, 75 meters, and 40 meters are from the three wires attached to the common feed point. The 5.6 MHz dip is the third harmonic of the 1.9 MHz wire.

There is a bit of a cheat factor built into the above plot. Remember from my opening comments that I don't know the actual element wire lengths. I trimmed them to resonate where I wanted resonance. I suppose I could have measured and added up the lengths of all the little pieces of wire I cut off and subtracted the result from the starting wire length. I didn't really care that much at the time though. I was interested in efficient radiation, not documentation.

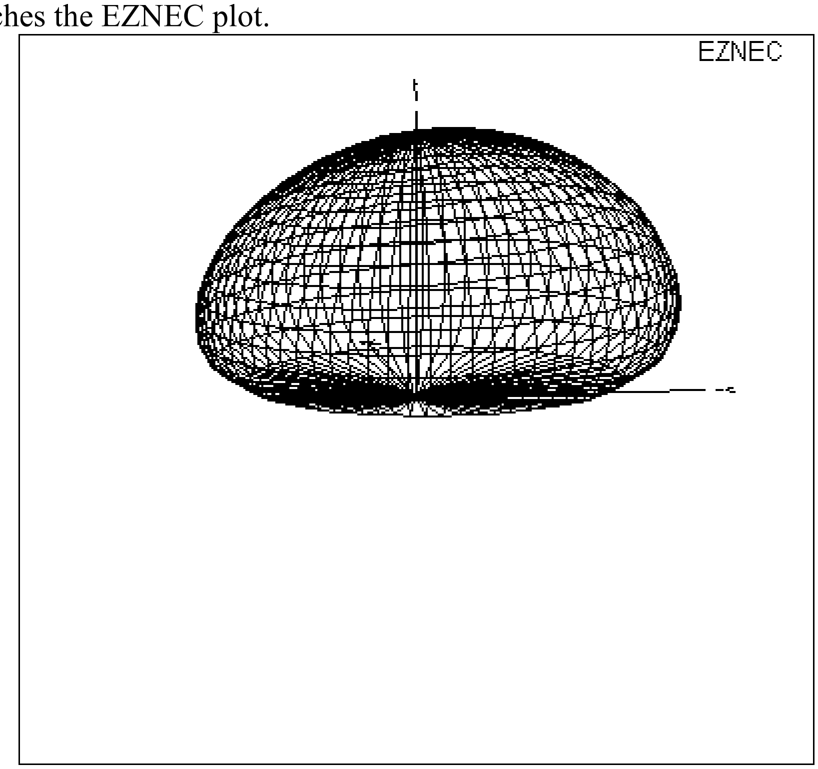
I performed essentially the same process on the wires in this EZNEC model. I adjusted their lengths to produce resonance where my SWR bridge shows resonance on the real antenna. Is this method of setting wire lengths accurate enough for this analysis? Probably. I am not able to precisely model the antenna wires, trees, buildings, and the surrounding ground. The final lengths for the quarter wave wires are close to theoretical resonant lengths so my guess is that the current distribution and wire interaction is very close to what occurs in my real antenna.

The wire lengths worked out to be:

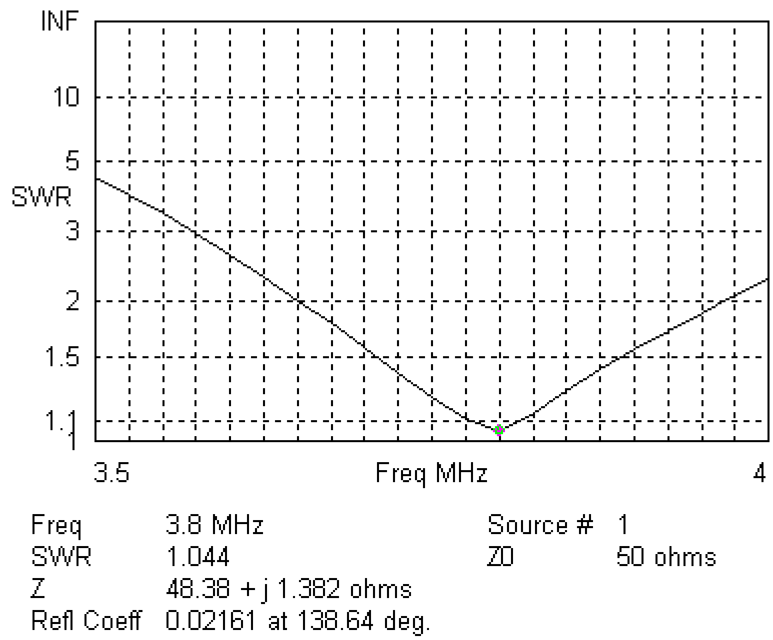
- 160 - 124 feet, 8 inches
- 75 - 61 feet, 10 inches
- 40 - 33 feet, 11 inches



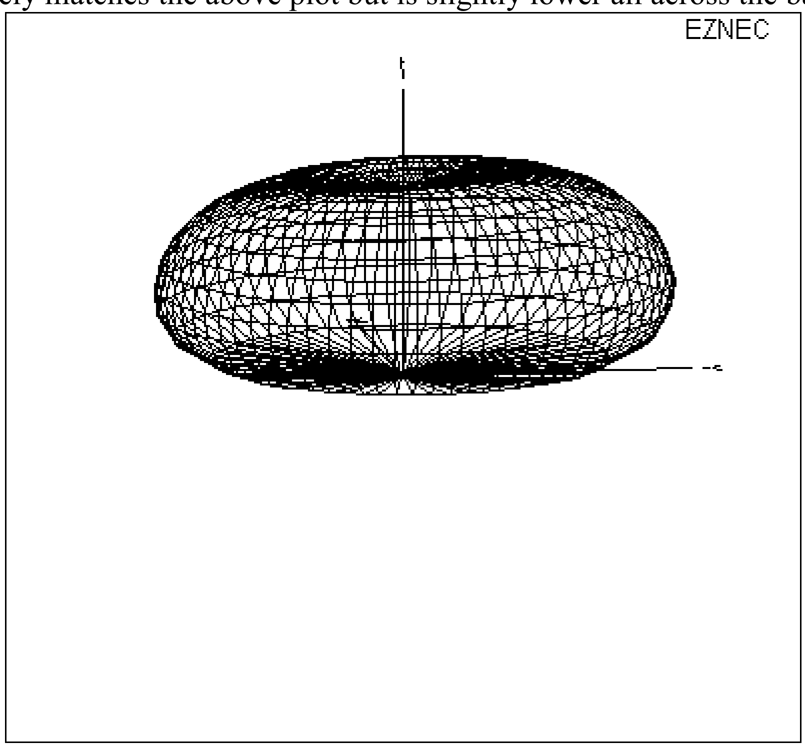
The SWR plot above shows more detail for the 160-meter band. It was a surprise how low the SWR is at resonance and how broad the SWR curve is. My guess is that this is a result of ground losses. My biggest surprise was that a plot made with my SWR bridge exactly matches the EZNEC plot.



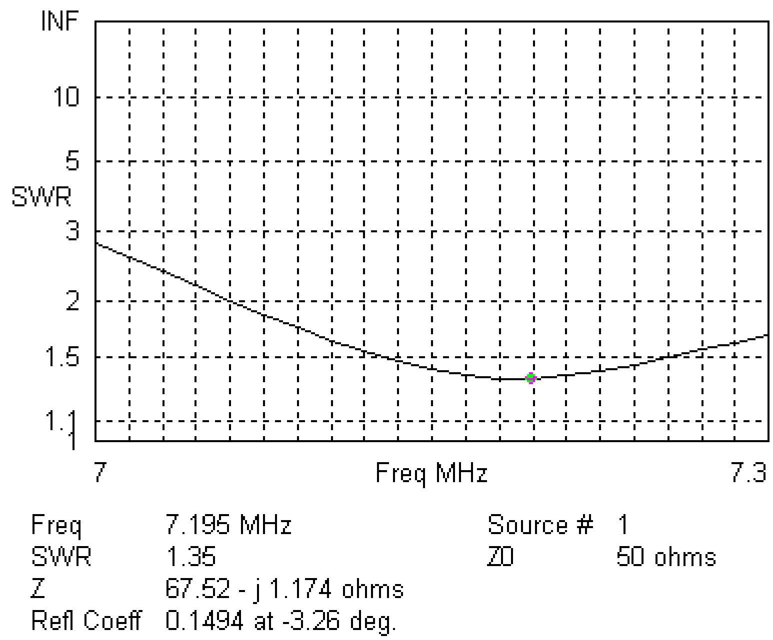
The graphic above is what EZNEC thinks the radiation pattern should be on 160 meters. Notice that because of the slope of the wire, there is no overhead null as would be found on a pure vertical antenna. EZNEC shows the gain of this antenna as –2.94 dBi.



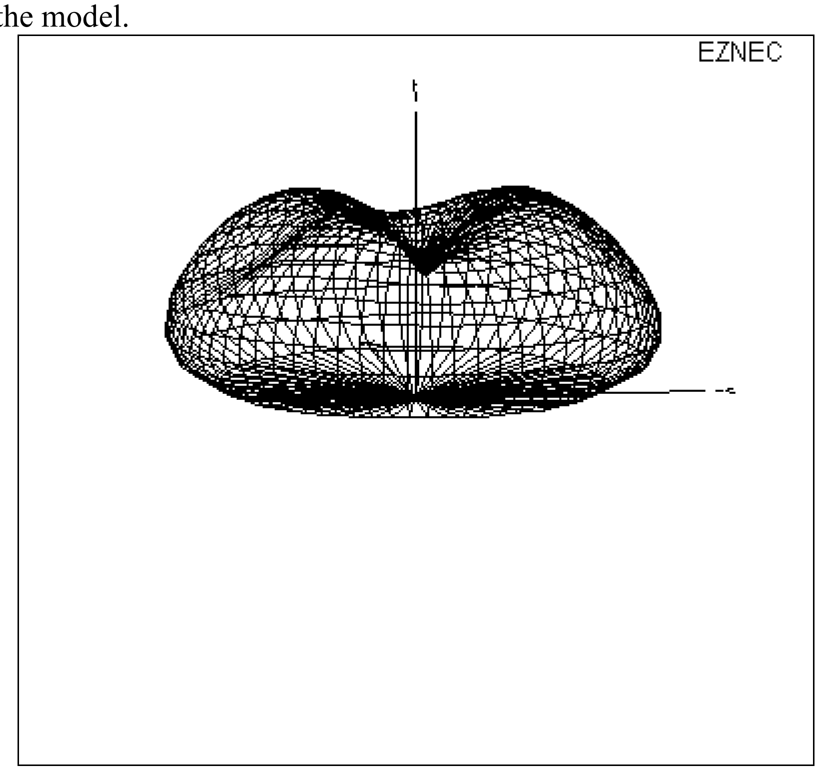
The SWR plot above shows EZNEC's guess for 75 meters. The plot taken with my SWR bridge is closely matches the above plot but is slightly lower all across the band.



The 3 dimensional radiation plot above for 75 meters shows a typical Inverted-L pattern. There is a little bit of a null overhead. The slope of the vertical wire and the horizontal tail fill in so a perfect null is not produced. EZNEC shows the gain as 0.57 dBi.



The EZNEC SWR plot for 40 meters is fairly broad. The plot using my SWR bridge showed the same broad band characteristic but lower across the band. I have no explanation for this. By rights, this should be a very efficient radiator. The 1500 square foot metal roof should be a very good counterpoise. As such, the vertical wire should act close to the same as a wire on a perfect ground plane. Either the model is inadequate for testing at this frequency or there is something funky about the physical installation that varies from the model.



The graphic above is of the 40-meter radiation pattern. EZNEC indicates the gain at this frequency is 0.12 dBi. Some interaction with the 160-meter and/or the 75-meter wire is visible. Notice pattern has dips and bumps that would not be present with a lone quarter wave wire tilted slightly off vertical.

How well does this antenna work? It works pretty well for such a quick and dirty setup. 160-meter performance is adequate for solid rag-chewing throughout the Midwest. 75-meter performance is quite good typically outperforming a dipole at 40 feet by several dB.

The performance on 40 meters is unimpressive at best. My 40-meter Inverted-V 50 feet above the ground outperforms this antenna in all but the most unusual situations. There have been some rare times when New Zealand stations are coming through in the early evening are good copy on the vertical but not on the Inverted-V. I've not been able to break the ZL stations using the vertical but then they are chatting with each other, not listening for weak DX.

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