Comments on the WD8DSB Terminated Bow-Tie RX Antenna

Rudy Severns N6LF

A typical terminated loop receiving antenna is shown in figure 1. The horizontal length is 54' and the vertical length is 24' which corresponds to the dimensions of one version of Don's (WD8DSB) antenna. The bottom wire is 8' above ground.

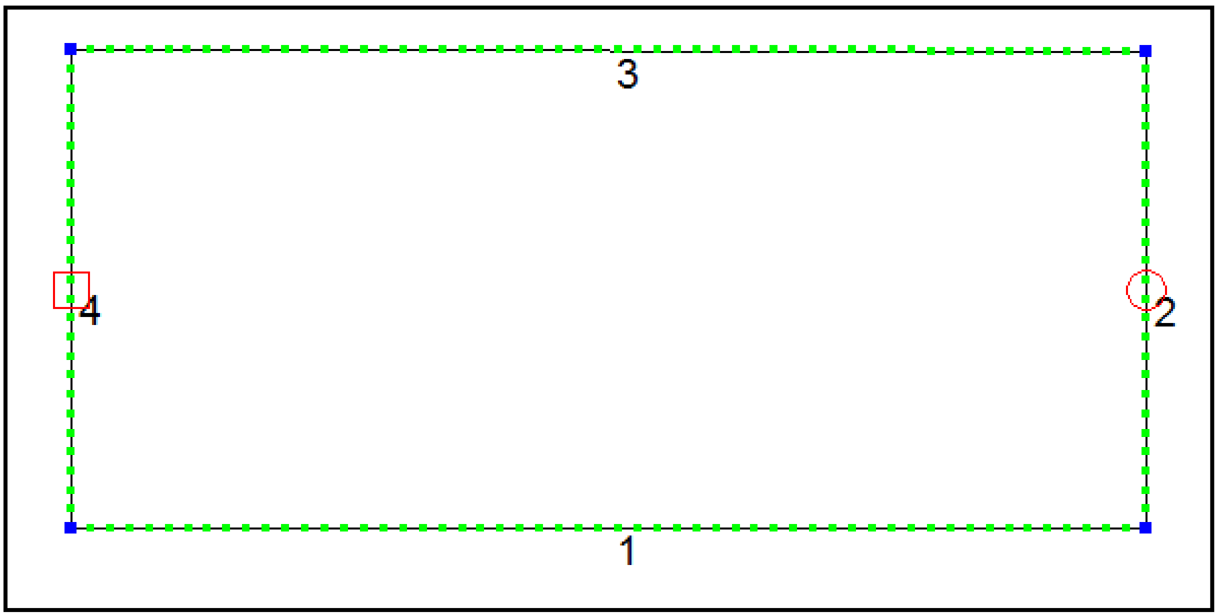

Figure 1 - Typical terminated loop rx antenna.

The source (circle) is placed at the center of wire 2 and the load (square,≈1kΩ) is located at the middle of wire 4.

The elevation pattern and azimuthal pattern at 25^{o} are superimposed in figure 2. At 1.8 MHz, RDF=7.7 and the peak gain is -21 dB.

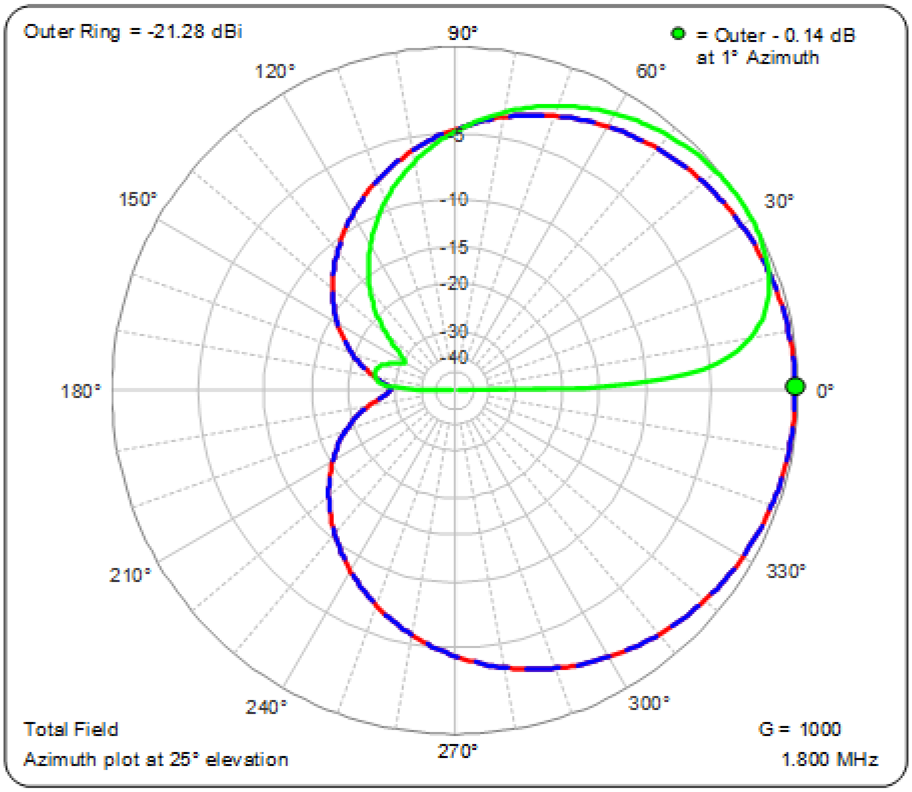

Figure 2 - Radiation patterns.

Don, WD8DSB has explored twisting the antenna in figure 1 into a "bow-tie" as shown in figure 3. Note: wires 1 and 3 are not connected at the center, wire insulation or a small separation are adequate.

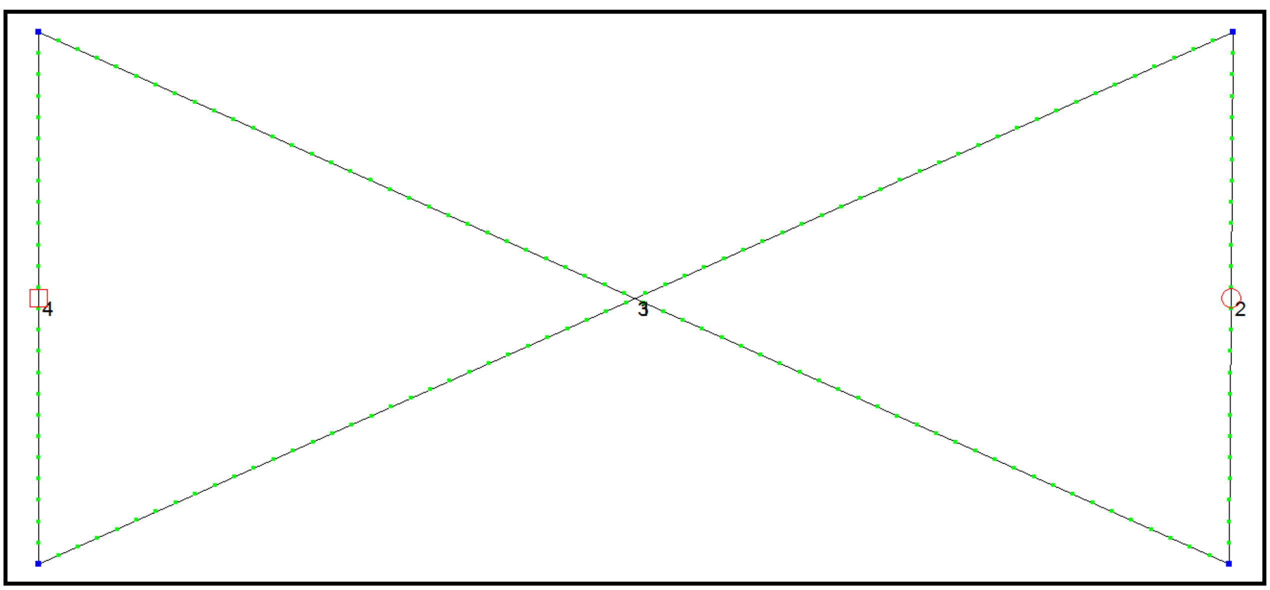

Figure 3 - WD8DSB Bow-Tie.

The patterns for the bow-tie are shown in figure 4. The RDF=9.7 and the peak gain is -33 dB.

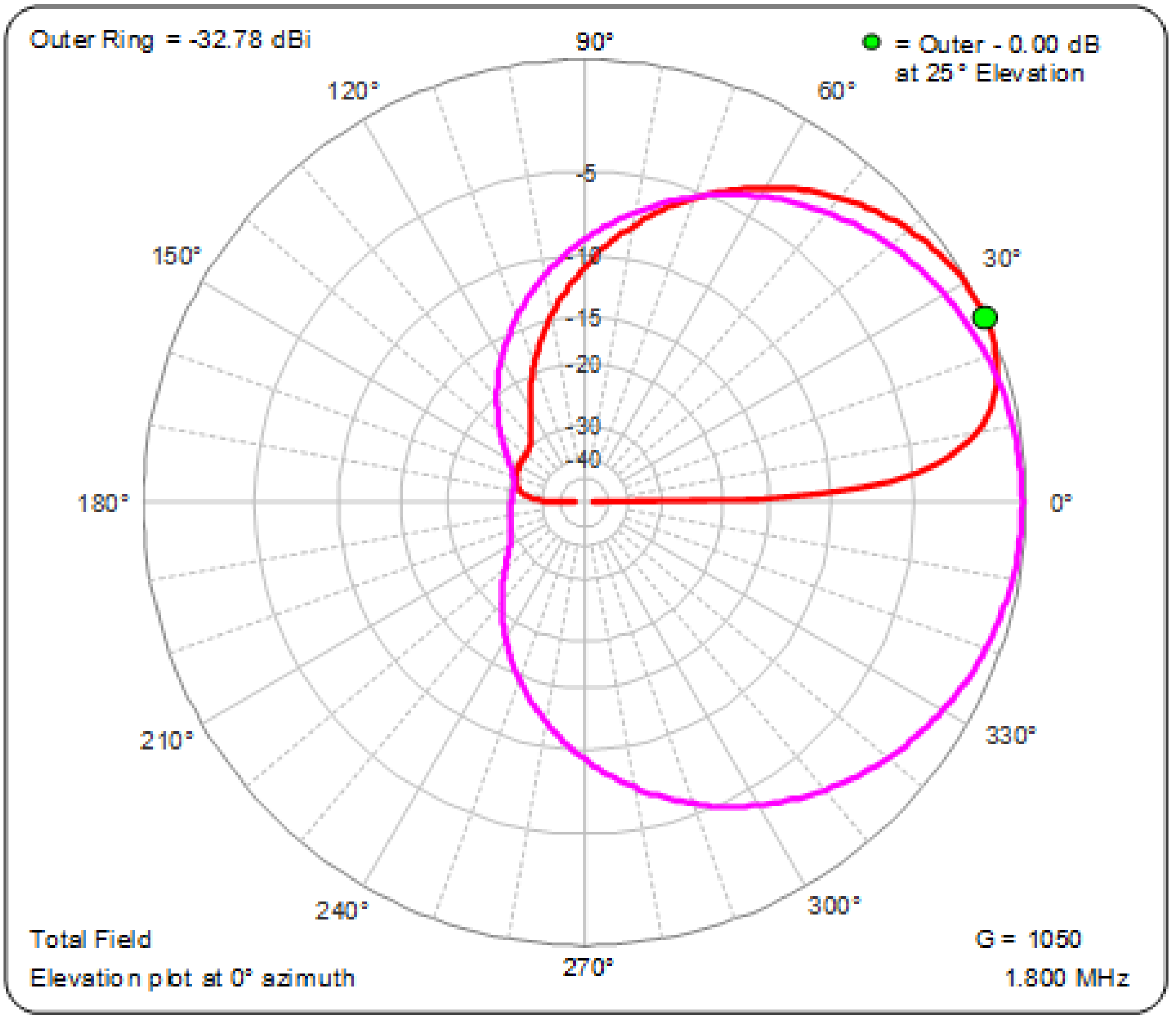

Figure 4 - WD8DSB patterns.

Adding the twist increases the RDF from 7.7 to 9.7 and reduces the peak gain from -21 dB to -33 dB. Figures 4 and 5 compare the patterns between the two antennas.

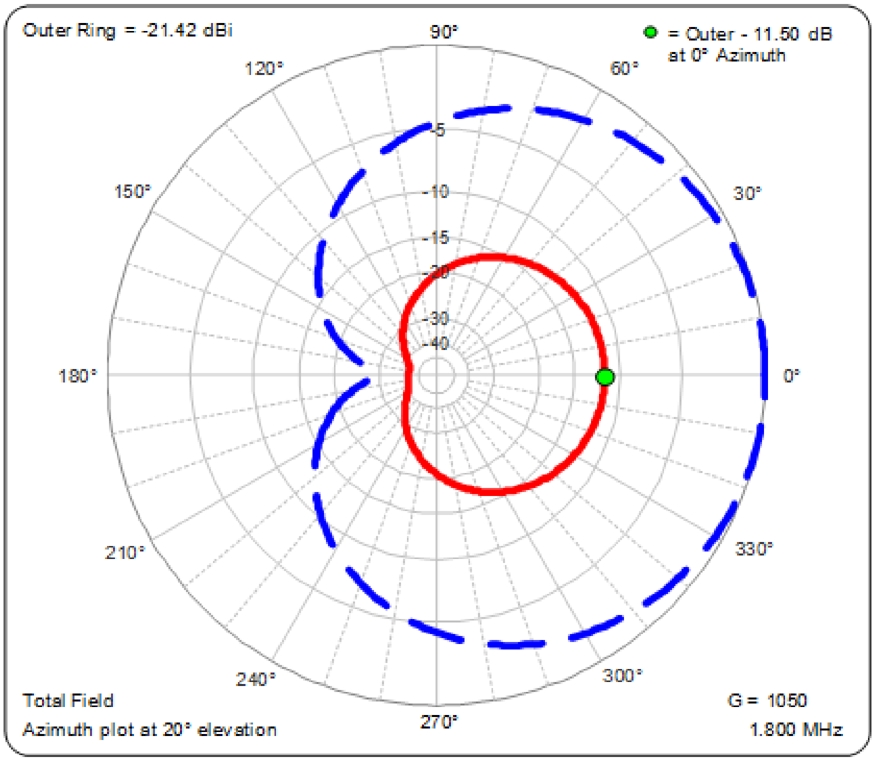

Figure 5 - Azimuthal pattern at 20^{o} elevation.

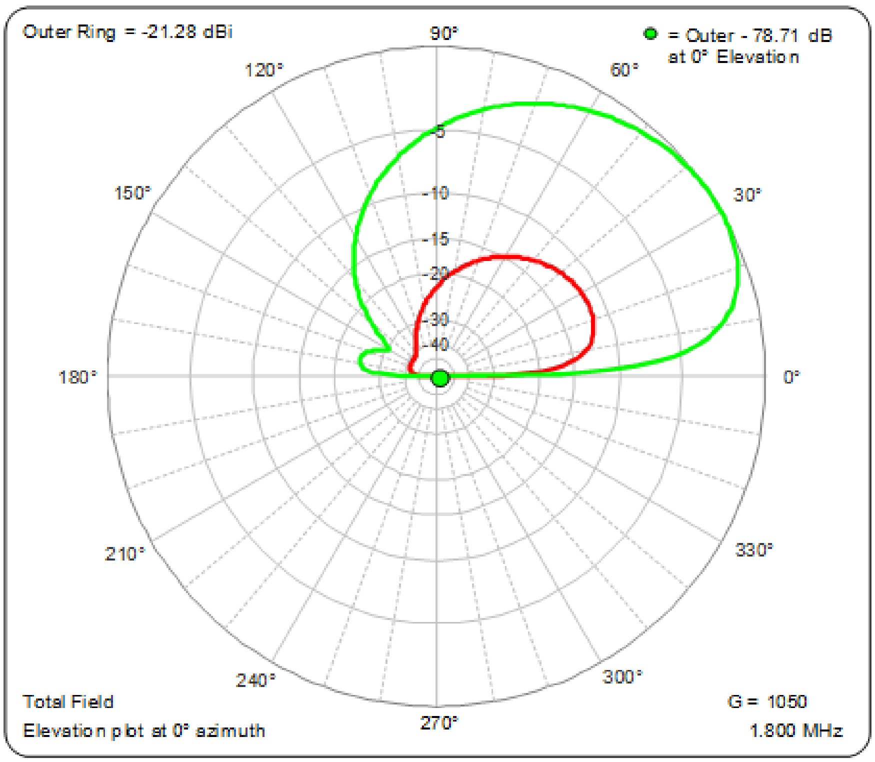

Figure 6 - Elevation patterns.

The difference between the antennas (figures 1&3) is the 180^o relative phase shift between the currents in wires 2 and 4. The improvement in RDF and reduction in gain with the introduction of a 180^o phase shift is very similar to the behavior seen in the DK6ED double loop antenna shown in figure 7.

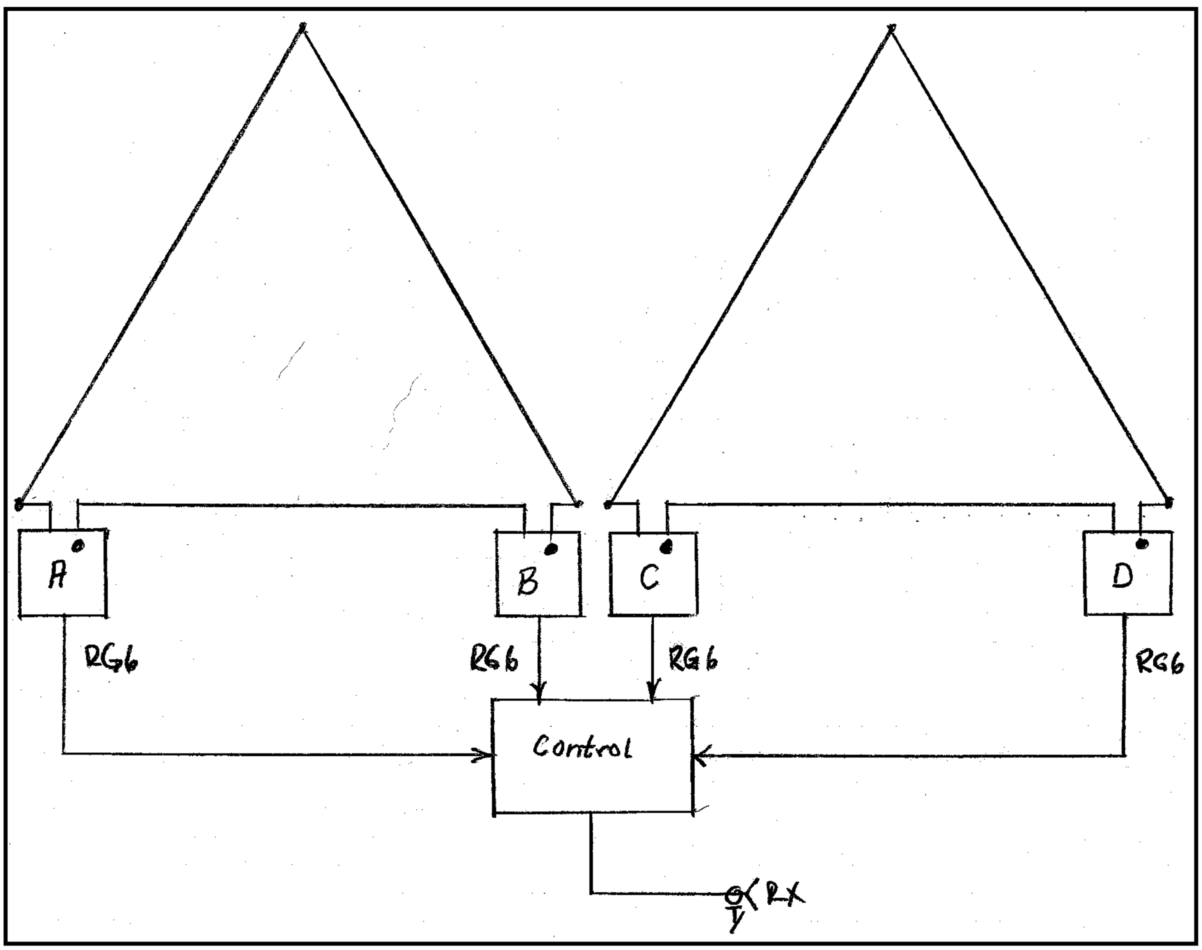

Figure 7 - DK6ED loop antenna.

The equivalent pattern to figure 5 is shown in figure 8.

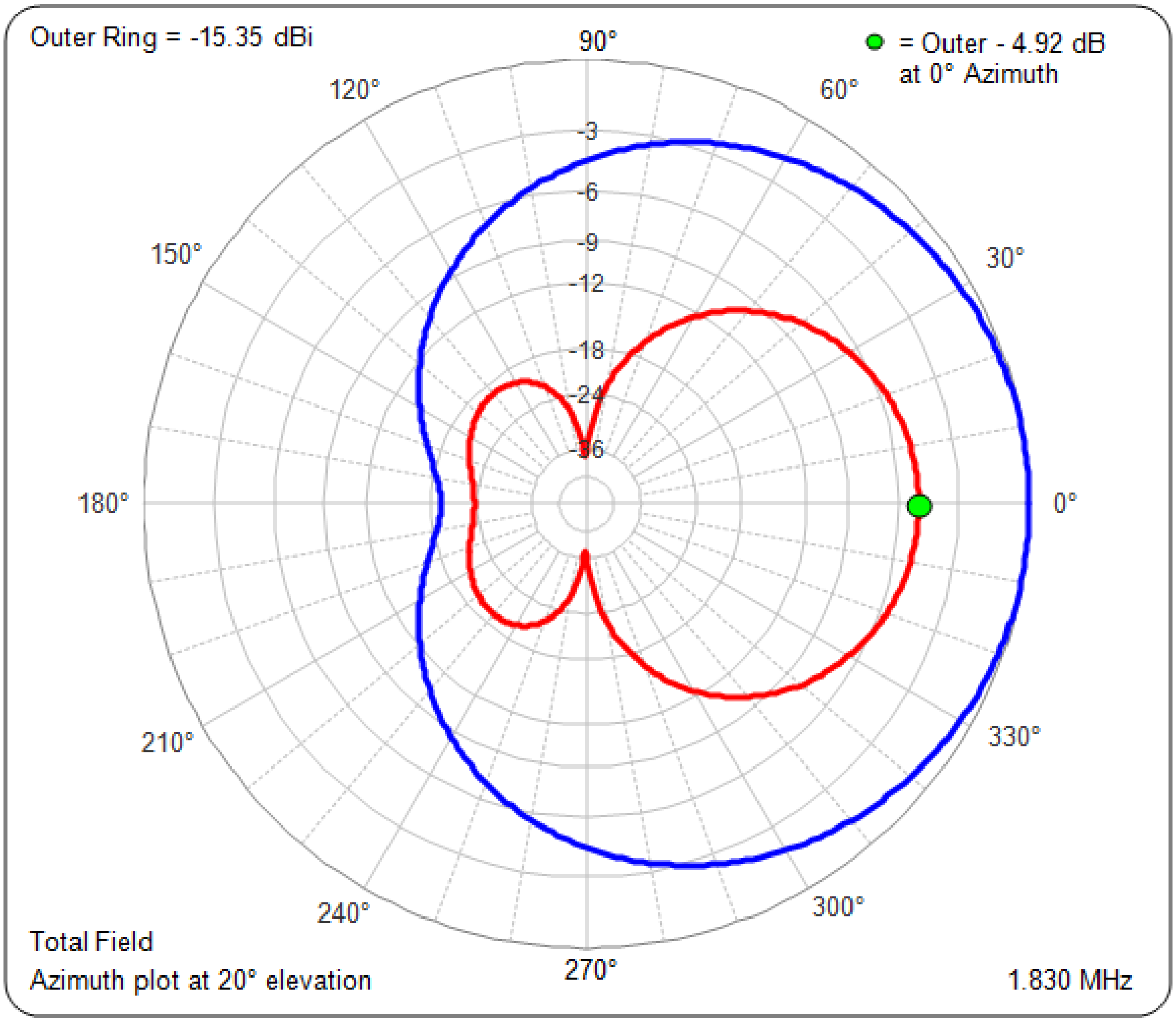

Figure 8 - Pattern comparison for the DK6ED antenna.

The outer pattern is for the two loops in phase and the smaller inner pattern is for the loops drive 180° out of phase. Again we see improvement in the pattern, RDF increases from 7.5 to 11.5 and the gain falls from -15 dB to -20 dB.

This isn't quite a fair comparison because the loop geometry and the physical dimensions are quite different between figures 3 and 7. What we can do is divide figure 1 into two loops, keeping the height a 24' and the width at 54' and insert two sources and two loads as shown in figure 9.

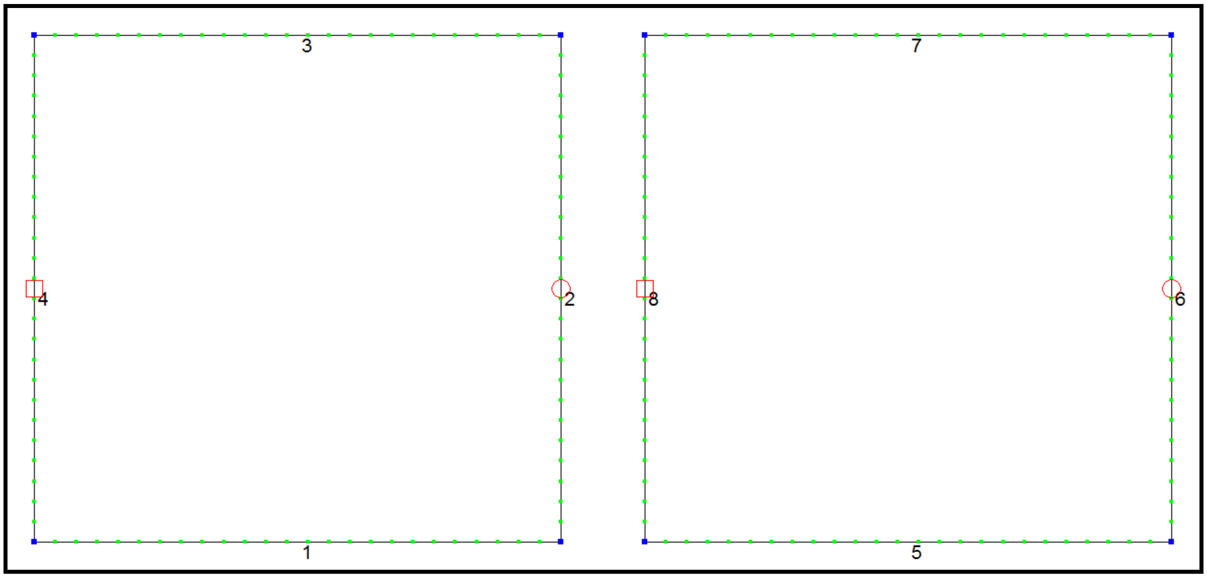

Figure 9 - DK6ED with 54'X24 dimensions.

This antenna has the patterns shown in figure 10, where RDF=11.4.

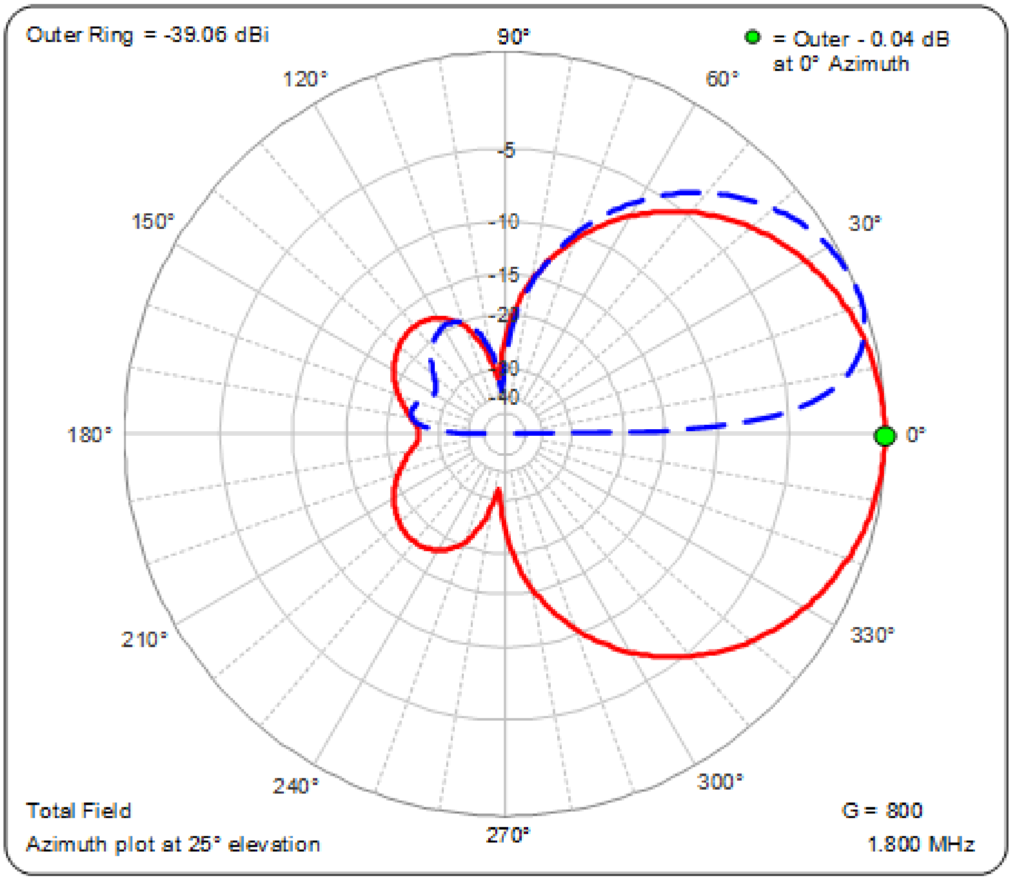

Figure 10 - Scaled DK6ED patterns.

The gain shown, -39 dB, is low by 3 dB because it's only for one source. Combining the output from the two sources adds +3 dB. The gain is then -36 dB which is within three dB of the WS8DSB antenna. The pattern however, is substantially better. Don pointed out to me that a preamp can easily compensate for the lower gains so they are not a serious concern.

I would add a further comment on that. Preamps are frequently used in voltage probe antenna arrays but because of the very high source impedances it's not easy to install a filter between the antenna and the preamp to eliminate interference and overloading from local BC stations, the transmit antenna, etc. The family of resistively terminated loop antennas have well defined resistive feedpoint impedances, dominated by the termination resistance, usually in the vicinity of 1KΩ. A simple 4:1 turns ratio transformer (16:1 impedance transformation!) can be used at the feedpoint to transform the impedance to something resembling 50-75Ω. This impedance level allows insertion of normal filters in the line between the antenna and the preamp. In addition the preamp can be inside the shack, not out in the wx. In fact with properly terminated transmission lines one can also play games with line length and phasing.

As shown in figure 7 the sources and loads can be placed in the bottom horizontal wires with very little effect on the pattern. It is very convenient to have these points within reach. This works fine for the simple rectangular/triangular geometries but cannot be done in the WD8DSB antenna. As pointed out by Don, shifting the feed and/or termination locations affects the pattern. The typical single loop like that shown in figure 1 and the DK6ED antennas on the other hand, are very insensitive to variations in the loop shape, feed points and/or termination points.

To make the WD8DSB antenna reversible two cables to the feed/termination points are needed. The DK6ED version needs four cables but in exchange for this additional complexity with the four cables you can have six different patterns[1] instead of two which can be very handy.

WD8DSB mentions the Double Half-Delta rx antenna by Wallner, AA7JV, which also exploits the 180^{o} phase shift to improve the pattern. I had a discussion with Don on some of my comments and he generously pointed out that since writing up his notes he'd discovered that a bow-tie rx antenna had been developed earlier by Mark, WA1ION, for reception in the BC band. With so many good people looking for new variations in rx antennas it's not surprising that there will be duplication. You can almost bet on it! The real problem is that good ideas often don't get circulated as they should. To see that in the context of terminated loops just look up U.S. patent 2,247,743 by H.H. Beverage! The bad ideas however, seem to fly through the ether all on their own with no assistance!

Final comment

Besides the interesting and useful variation the bow-tie represents, to me the most important point coming from a comparison of these antennas is the central roll played by 180^o phase shifts to improve the RDF. In all cases a loss of gain is the price paid for the improvement but easily fixed with a filter and preamp.

Reference

[1] R. Severns, N6LF, A Receiving Array for 160m Through 2200m, QEX Sept/Oct 2016, pp. 22-29