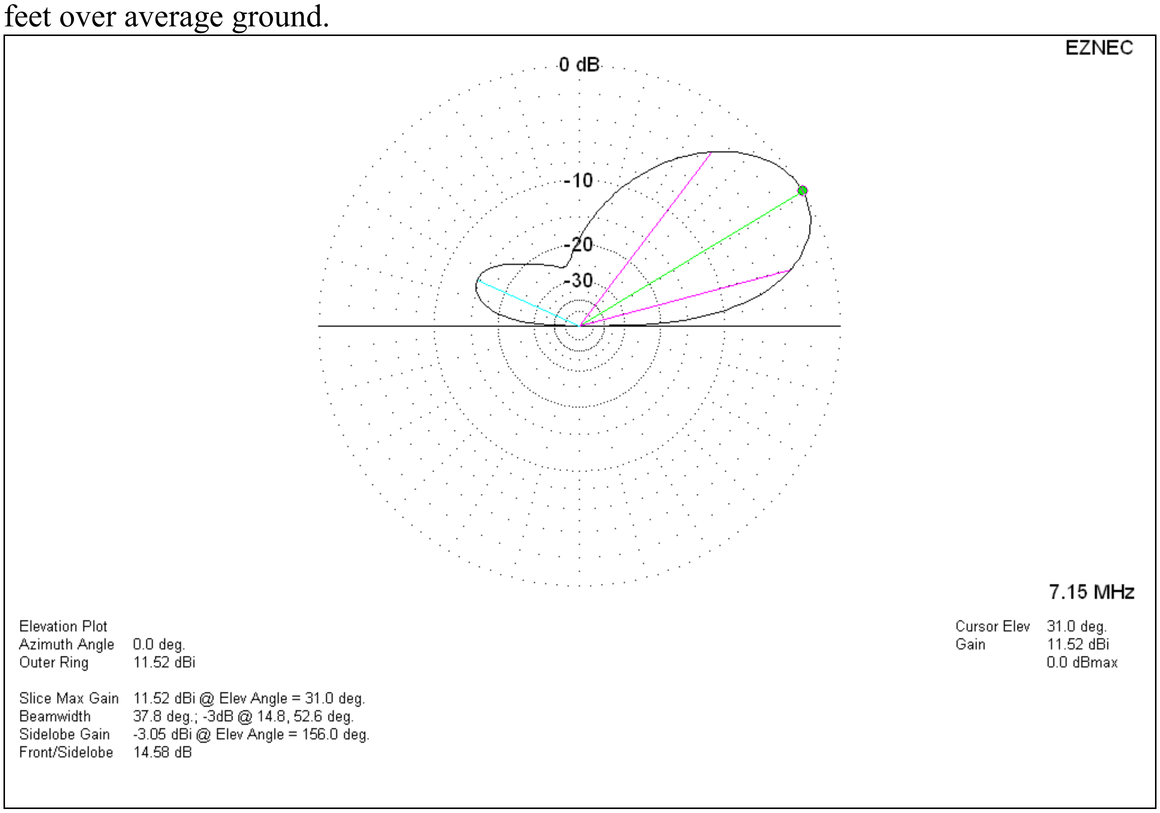
The 3-6-9 Wire Yagi – An Alternative Yagi Tuning Scheme

There have been numerous articles discussing schemes for tuning and feeding Yagi antennas. There is one scheme that I have yet to see mentioned. Jim Boyden, AB0GE, employed it in the three element 3-6-9 40 Meter Wire Yagi he developed. This antenna that was popular during the last sunspot lull.

Traditional yagi designs typically provide high forward gain and high front-to-back at the expense of operating bandwidth and feed impedance. What is unique about the 3-6-9 wire yagi design is that it provides low SWR, gain, and good front-to-back ratio across the entire 40 Meter band without the use of tricky feed schemes. Its efficiency is approximately the same as an ordinary half wave wire dipole antenna.

The 3-6-9 40 Meter Wire Yagi is a simple 3-element yagi made with ordinary antenna wire. The original design started with a 66-foot long dipole for 40 meters. Jim added a 69-foot long reflector wire a quarter wave behind the dipole and a 63-foot long director wire a quarter wave in front of it. Adding and subtracting 5% of the original 66-foot length driven element produced the 69-foot and 63-foot length values. Notice that the element lengths, front to back are 63, 66, and 69 feet long, from which the 3-6-9 part of the antenna's name was derived. The interesting point is that this simple design actually works.

Below is an EZNEC plot of the radiation pattern of the 3-6-9 with #12 copper wire at 50 feet over average ground.

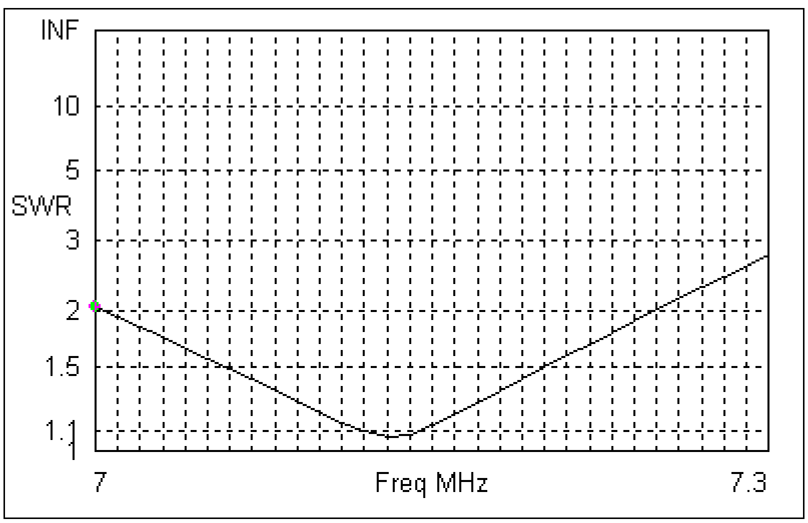


Keep in mind that the pattern above is for the original wire lengths and spacing. The optimum spacing for front-to-back ratio is actually a little less than a quarter wave, about 27 feet spacing for 40 meters.

EZNEC calculated the following values for the original design wire lengths and spacing:

7.00 Mhz: 11.29 dBi gain, 13.92 dB F/B
7.15 Mhz: 11.52 dBi gain, 14.58 dB F/B
7.30 Mhz: 11.44 dBi gain, 9.08 dB F/B

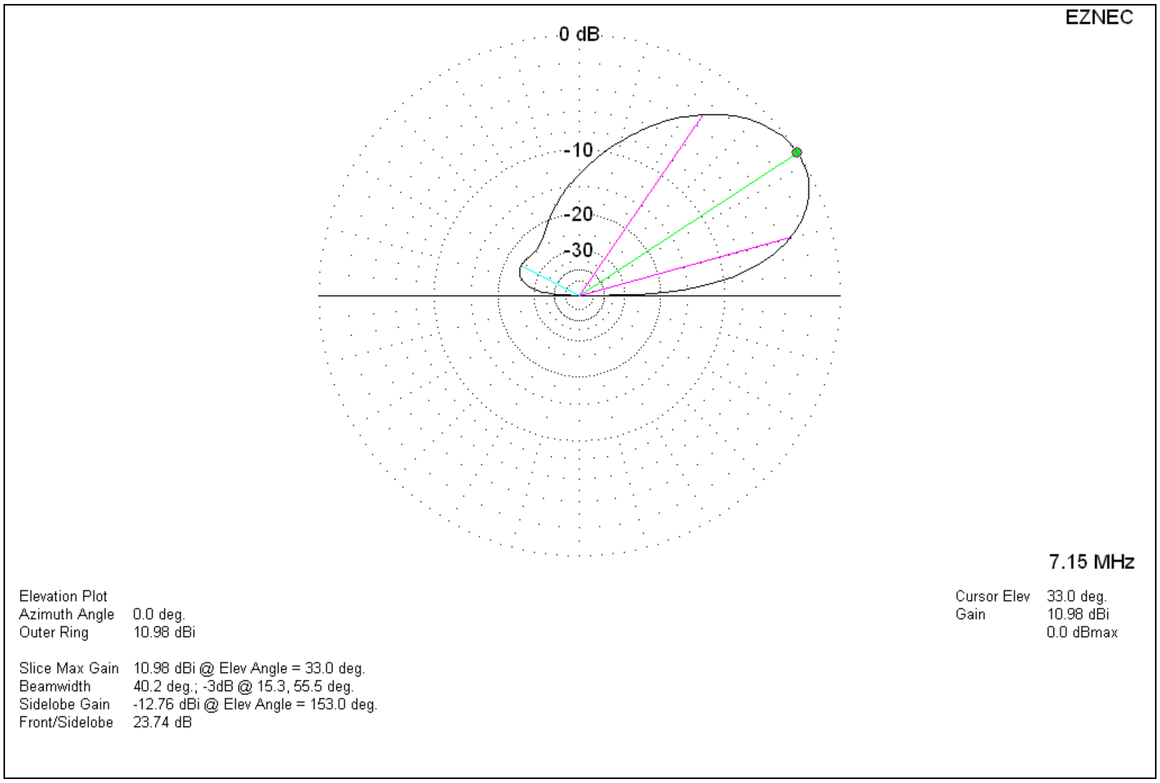
The EZNEC SWR plot below shows the broadband nature of the antenna. Note again that this plot is for the original design. The SWR dip can be adjusted up or down in frequency with out effecting gain or front-to-back ratio by adjusting the driven element length. Interestingly, decreasing the element spacing actually improves the 2:1 SWR bandwidth.

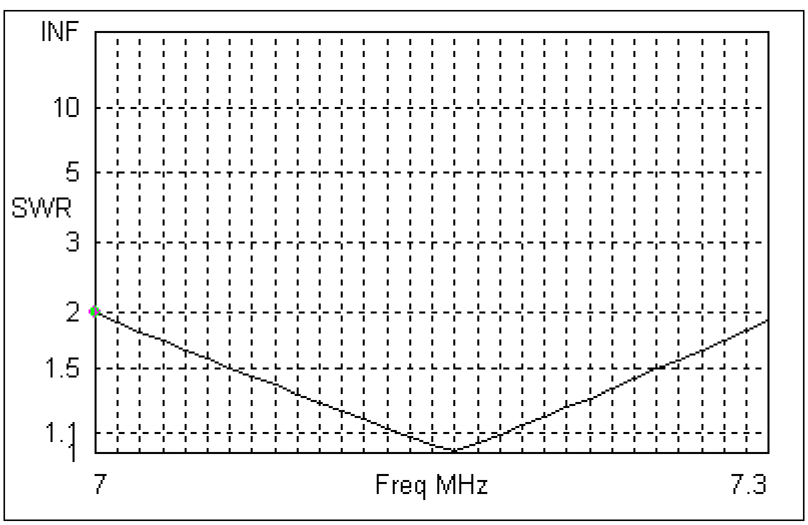


While examining variations on this antenna with EZNEC, I discovered that it is possible to find a combination of element lengths that will provide broadband 50 Ohm feed operation at essentially any equal element spacing value. Most interesting was that it was possible to achieve even better SWR bandwidth with closer spacing. With careful adjustment of director and driven element lengths, spacing down to and below 1/10 wavelength can provide good SWR bandwidth.

The design procedure for producing 3-6-9 type operation was to choose an element spacing and reflector wire length. The director wire length was then adjusted to achieve 50 Ohm feed impedance while keeping the driven element resonant on the antenna's chosen center frequency. It was fascinating to discover that almost any reflector length, from roughly 0.5 wavelengths to several percent longer could be made to work. Gain and F/B tended to peak broadly at the shortest reflector length that would still allow 50 ohm feed impedance on the antenna's center operating frequency. Gain and F/B also peaked at spacing values around a quarter wave or a few percent less. Front-to-back and gain vary slowly across the antenna's operating bandwidth.

As an example, retaining the original 69 foot reflector length, adjusting element spacing for best F/B, and retaining 50 ohm feed at 7.15 MHz, the following antenna pattern and SWR plot was produced:





Reflector and director spacing was set to 27 feet from the driven element. Director length was 62 feet. Driven element length was 66.4 feet. Reflector length was 69 feet. Antenna height was set to 50 feet above EZNEC's average Real/High Accuracy ground conditions. Keep in mind that wire losses are taken into account in the above plots. The above plots were produced assuming #12 copper wire with 63, 66, and 69 segments respectively. Wire loss is very low with this design.

EZNEC calculated the following values for this set of wire lengths and spacing:

7.00 Mhz: 10.81 dBi gain, 12.35 dB F/B
7.15 Mhz: 10.98 dBi gain, 23.74 dB F/B
7.30 Mhz: 11.15 dBi gain, 15.65 dB F/B

The 3-6-9 40 Meter Wire Yagi has proven itself in the past. It works well at heights down to a quarter wave above ground or so. It scales well to other bands. It is worth looking at as a modest size and modest cost beam antenna. Most important thought, it demonstrates that extremely narrow operating bandwidth is not an inherent characteristic of the yagi antenna.

N0GW
Gary Wescom