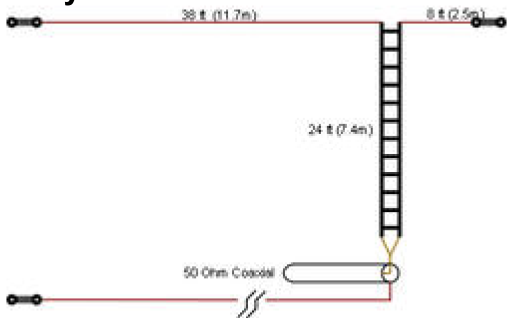
G7FEK antenna revisited

I recently came across a simple antenna design produced by Mike, G7FEK

An Ideal replacement for your 1/2 sized G5RV or Windom 40



Designed specifically for small gardens, it is an ideal replacement for those half size antennas such as the 1/2 size G5RV and Windom 40 (51 ft and 66 ft long respectively). This smaller antenna will give six bands, including **80 meters** as a resonant band with a full size 1/4 wave element. On this antenna, tuning on 80 is not an issue and it will easily outperform the 1/2 sized antennas by 10's of dB on this band.

- Only 46 ft long x 24 ft high
- Multiband operation **including 80 meters** without traps
- Low angle of radiation is dominant on most bands (ideal for DX)
- Enough High angle for short skip on 80m (local contacts)
- Coax fed for convenience
- Low visual impact
- Ideal DX antenna for portable working

Details can be found at

http://www.g7fek.co.uk/news.php?page=G7FEK_Limited_space_anten_29507&embed=yes

A more in depth document explaining the construction can be found here.

http://www.g7fek.co.uk/software/G7FEK%20antenna.pdf

Another detailed analysis can be found here

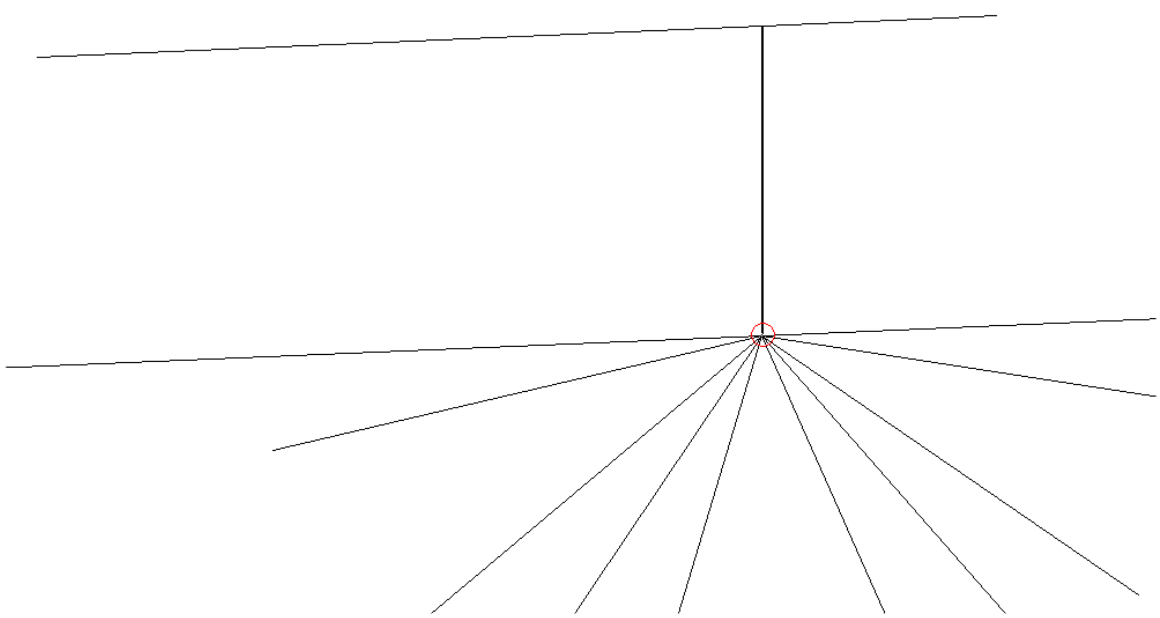
http://www.rsars.org.uk/ELIBRARY/ANTENNAS%20DOCS/G7FEK%20LIMITED%20SPACE%

I was intrigued by the concept because the 450 ohm ladder line was being used as two parallel Wires. These formed the vertical sections of two back to back, inverted L antennas for 80m & 40m. The wires at the bottom section of the 450 ohm feed line are connected together to provide a common feed point. Which is fed against a counterpoise wire and the outer screen of the coaxial cable.

My past experiences of antennas using 450 ohm or 300 ohm feed line in this way has been mixed. The problem is that the spacing between the wire pairs is very small, which results in a great deal of coupling between the wires. Almost to the extent that they could be considered to appear to be a single wire. If the spacing is increased slightly this effect begins to diminish and at spacing's of greater than about 150mm the coupling is becoming negligible.

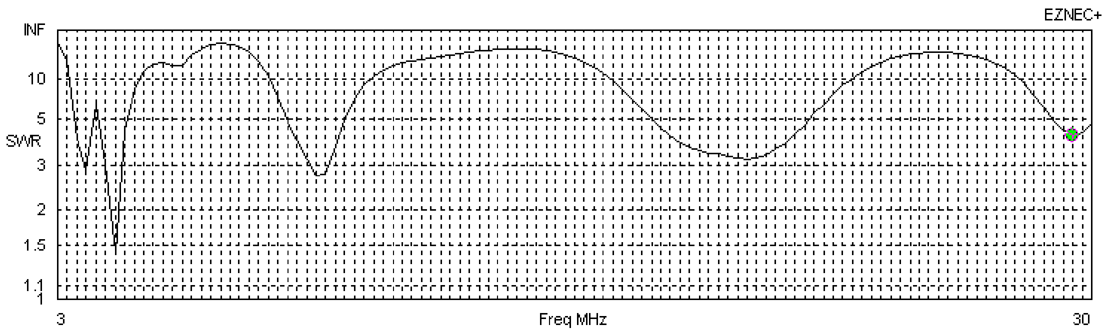
My initial conclusion that the antenna was basically just a single wire fed Windom (an antenna which I had previously tried). So I produced a model using EZNEC which I based on a previous model of a ZS6BKW (G5RV variant) antenna I already had, complete with 450 ohm feed line. So it was relatively easy to modify this to look like the G7FEK.

I deliberately kept the radial system I had already got installed for my ZS6BKW in my model as I hoped to be able to perform some A/B tests at a later stage.



However on inspecting the model it became immediately apparent that it was not a single wire fed Windom and that it was indeed two back to back inverted L's which were closely coupled by means of the twin feedline, exactly as described by Mike, G7FEK.

This interaction presented some difficulties when I tried to get the EZNEC SWR plot to fit any particular amateur bands. Any small changes to wire lengths made huge differences to the whole plot. The SWR plot below shows my initial attempt using the dimensions given by G7FEK.



In order to try and make it easier to adjust each section I removed some wires from the model in order to determine which wire was responsible for each dip in the SWR curve, and what the various interactions between wires were caused by. This turned out to be a real nightmare to try and optimise, as there are just too many variables to adjust, and too many interactions between the various parts. It seemed that in a practical implementation you could get a low SWR on the 3.6 & 7 MHz bands relatively easily by adjusting the length of the two top sections. But obtaining a low SWR on the other bands seemed to rely on having a large amount of luck (or having a good antenna analyser and a great deal of spare time).

I also realised that the radial system was also interacting quite badly with the SWR curve. So I removed the modelled earth radials and simple replaced them with a connection to the NEC ground via a 30 ohm resistor. This produced much more stable results and I could now see the two primary resonances of the twin inverted L sections, although there was still some interaction.

At this stage I decided to remodel the 450 ohm ladder line, by opening out the top end of the ladder line between 0.5 to 2m wide (so that it formed a long V shape). I thought that this would be relatively easy to implement in real life by using a short length of fishing line to 'join' the top ends of the V together. It would also be possible to make the whole antenna from wire, which would be cheaper and visually much less obtrusive than using 450 ohm ladder line.

Making this change immediately reduced the interaction between the main parts of the antenna and made it much easier to optimise the length of each inverted L section. The longer one was tuned to 3.6MHz and the shorter one tuned to 7.1MHz. I finally settled on a 1m spacing as being the most practical to implement.

The next step was to try and emulate the counterpoise wires described by G7FEK which he ran underneath the flat top section of the antenna.

I decided that the most likely scenario would be to run the wires along a garden boundary fence (as was the case with my ZS6BKW) so I added some raised counterpoise wires at 2m above ground level, whilst still retaining the NEC ground connection via a 50 ohm series resistor

In order to achieve this I had to raise the overall height of the antenna by 2m, but I felt that having the horizontal top section at 10m above ground would be typical of many instillations.

I also experimented with changes in the value of the resistor I had connected in series with the ground wire. As mentioned in the G7FEK document a good SWR figure at 3.6 & 7.1MHz was dependent upon having some degree of ground resistance, but providing it was between about 10 and 40 ohms the match was reasonably good. As this is typical value of resistance achieved with a modest small radial system, it seemed to concur with G7FEK's observations.

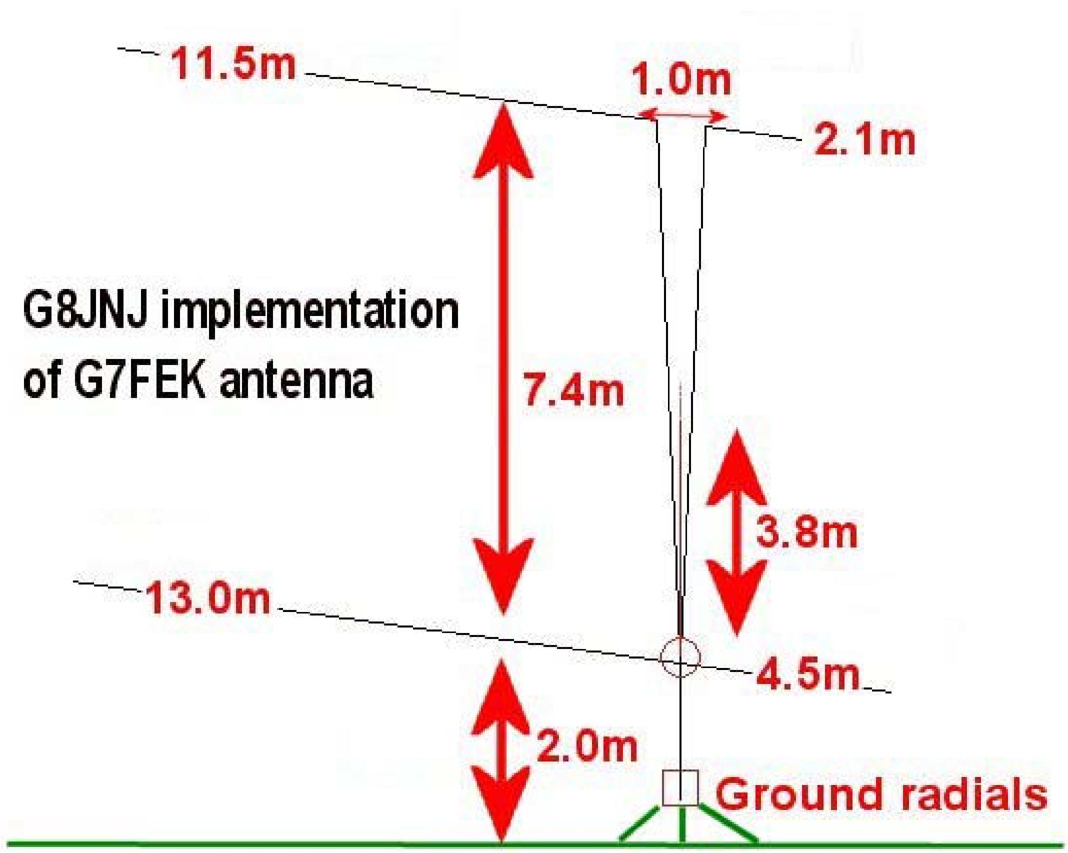
These changes further improved the SWR curve, and after a few more iterations of counterpoise wire lengths, I was able to get something close to the SWR curve as shown by G7FEK, except on 21MHz.

To resolve this I followed G7FEK's suggestion of adding an additional wire about 4m long, which I tuned to 21MHz, but I placed it in the centre of the V feed, as in practice it would be quite easy to support this additional vertical wire with another section of fishing line.

Here’s the final arrangement.

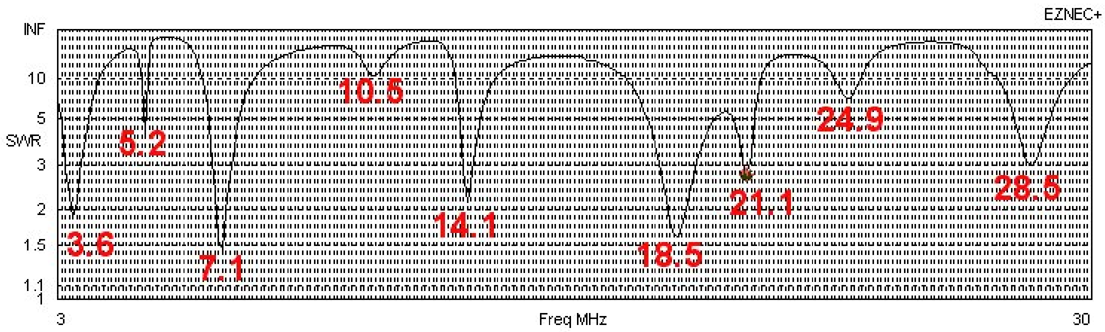
The resistor emulating the ground resistance of the radial system is shown as a small square, and the 50 ohm feed point is shown as a circle. The coax cable inner goes to the bottom of the V and vertical wire.

The coax screen connects to the counterpoise wires at 2m above ground and the radial system at ground level. This can either be via a connection directly to the screen of the coax at ground level, or by a separate 2m long wire or strap. The radial system should consist of at the very least of one ground spike. Ideally it would be a minimum of 4 to 8 buried radial wires (beyond this number it’s a lot more work with not much return) of about 10 to 15m long. If the radials are shorter than 10m need to bury more of them.



After a few more adjustments I even managed to achieve some small improvements in SWR on 5MHz and 10.5MHz, and although some of the dips were not quite spot on the required frequencies they were close enough as a starting point.

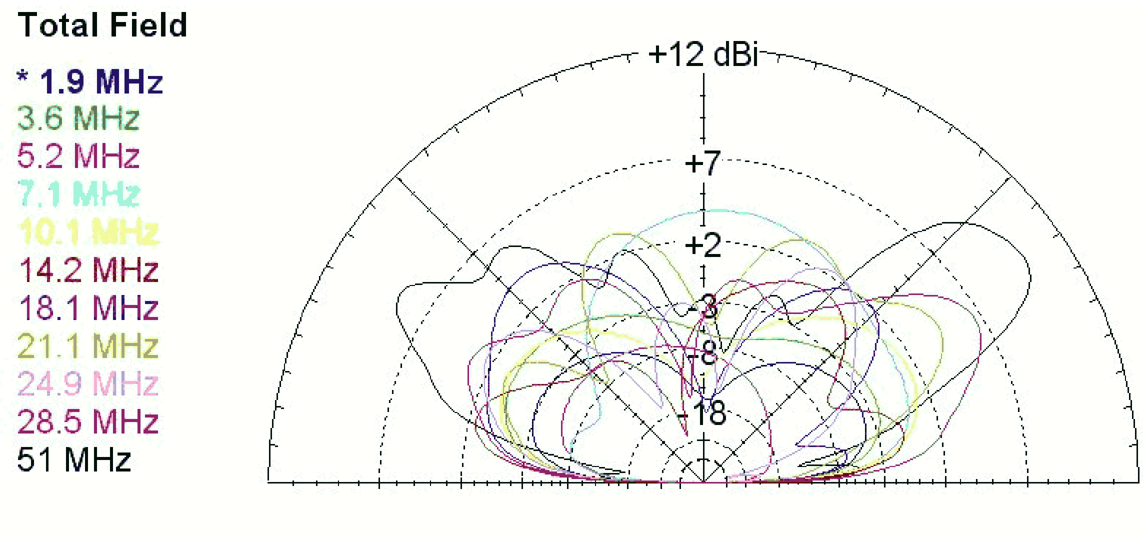
In most cases the SWR is less than 10:1 which will keep coax mismatch losses down to an acceptable level. However some form of matching unit is still be required to reduce the SWR to a low enough value for use with modern solid state transceivers.



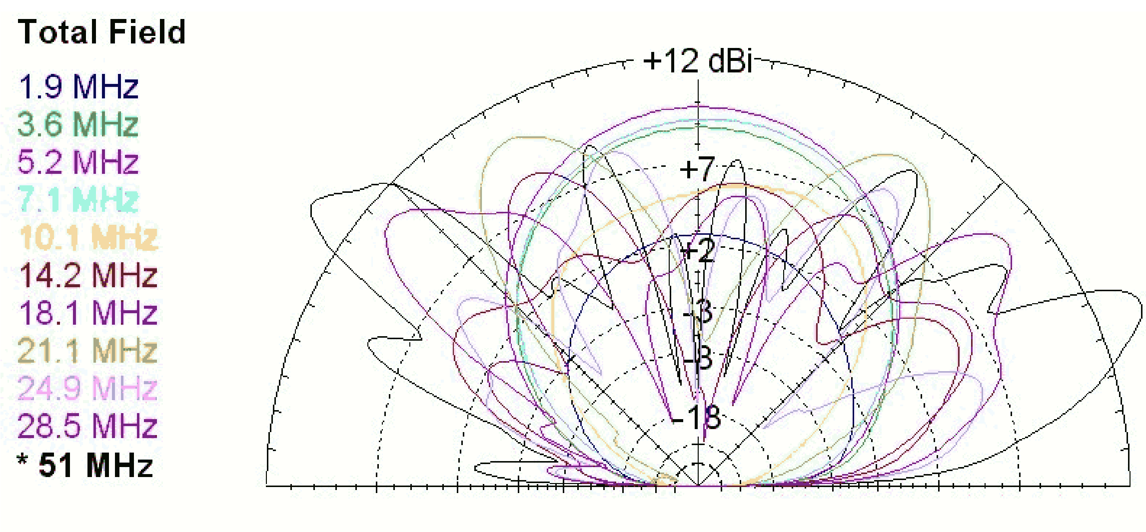
Note that this SWR plot is derived from the model. An actual antenna will not follow this curve exactly, due to variation in construction, ground terrain and surrounding structures. So some experimentation will be required if you decide to build the antenna. I find that with multiband antennas such as this, an antenna analyser is almost certainly required so that you can instantly see the effect t of any changes you make.

I'd suggest building it in stages. Get the 3.6 & 7.1MHz horizontal sections working first by feeding them against the ground radials. Then add the counterpoise wires and try to get the 14.1 and 28.5MHz dips in the right places. Finally add the vertical wire for 21.1MHz. Hopefully by following this order you should only have to make a few final adjustments to achieve a similar SWR response curve.

The elevation pattern of the G7KEK antenna looks like this



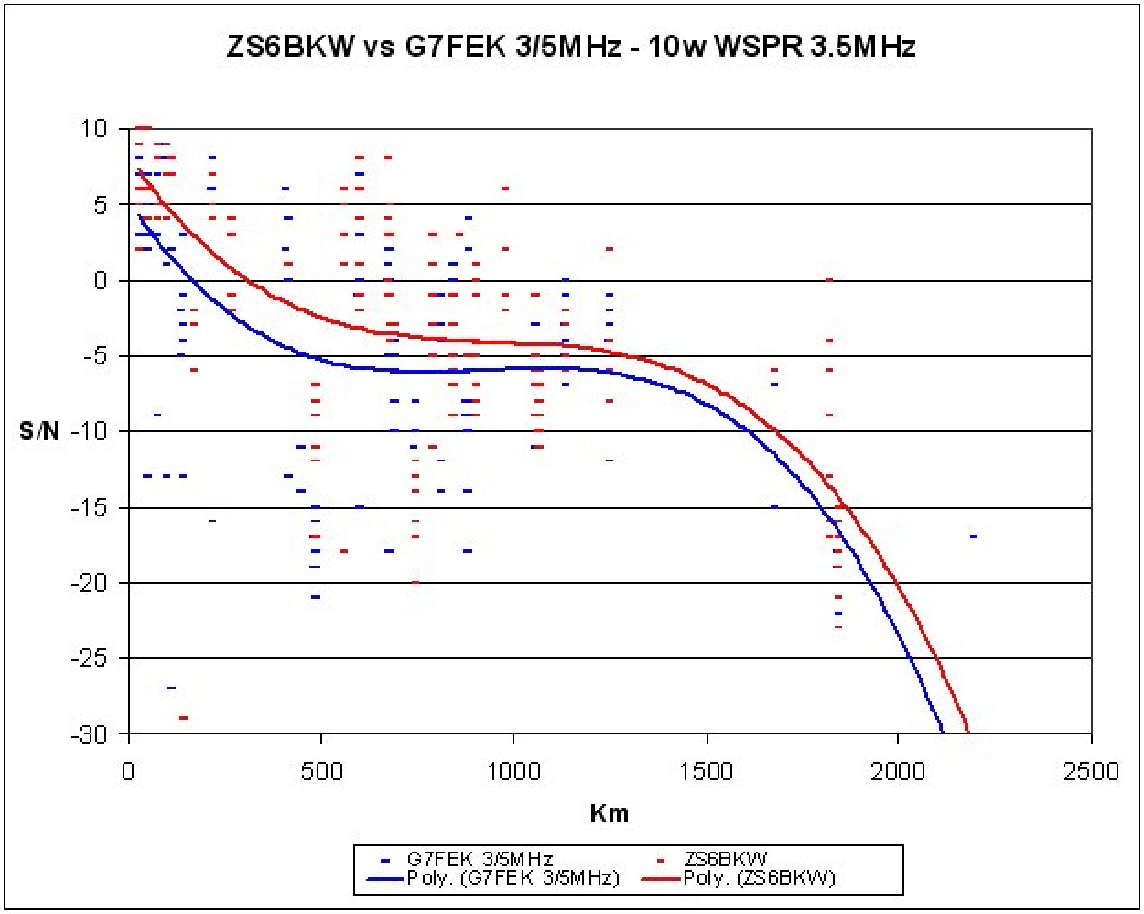
And here's my ZS6BKW (G5RV variant) elevation pattern for comparison purposes.



The performance is not too bad. The G7FEK has less gain at high angles, so is not quite so good at providing NVIS coverage. At low angles it's only a few dB down on the ZS6BKW so it should offer similar performance in a slightly smaller space.

As a quick test I ran WPSR for a short period one evening around dusk with my antenna configured first as a ZS6BK doublet, then as a G7FEK. It wasn't quite the correct dimensions for the G7FEK as the two L sections were resonant on 3MHz and 5MHz. However the auto-atu matched it OK, so I was at least able to get a rough idea of the likely antenna performance.

The graph shows the received Signal to Noise ratio of my transmissions as reported by other stations at varying distances from a few tens of Km, out to just over two thousand Km.



As you can see the ZS6BKW provides about 3dB more NVIS performance out to about 1000Km.

After this point the ZS6BKW low angle radiation becomes similar to that of the G7FEK and the difference between the two is negligible.

This initial test was very encouraging; the next step is to build a properly dimensioned version of the antenna.

All comments and suggestions on this note would be gratefully received.

www.g8jnj.webs.com