Antennas

Getting a quart antenna into a pint pot garden


PHOTO 1: The elevated radial system being tested with a Hustler 6BTV antenna.

SMALL SPACE, BIG PROBLEM. The most frequently asked questions I receive in my e-mail, or raised at when I give talks on antennas, is the subject of making or selecting a suitable HF antenna for a restricted QTH. The situation is worse for the lower HF bands where the efficiency of the antenna falls dramatically if you try to make it too small. A half wave dipole for 3.6MHz is 130ft (40m) long and most modern QTHs do not have anything like that sort of space.

A BACKYARD ANTENNA. What I am about to propose, as a possible solution to antennas in QTHs with very little space, is based on an antenna I made many years ago for an amateur friend. He wanted an antenna for the 80m band but lived in a small two-up two-down house with nothing more than a back yard that was about 18ft (5.5m) square. Furthermore, it was paved, with no provision for an earth connection. The only redeeming feature was concrete washing line pole in the far corner of the yard.

I made a scaffold pole extension to the clothes post for a mast. The chimney was pressed into service as an additional support. The objective was to get as much wire into the restricted space as possible, with the area of greatest current as high as possible. The length of the wire element was not measured, just made to fit the space. It resulted in an open loop structure as shown in **Figure 1**. To my recollection the whole structure was about 16ft (4.9m) square. The antenna was fed in the centre and matched to the rig using an ATU in the shack.

Surprisingly, we were able to work stations around the UK on 80m SSB using a QRP rig. Theoretically, the performance of this antenna is very poor. According to EZNEC, the feed point has a feed resistance of about 3Ω and a reactance greater than –j1000, which should have put it outside the impedance matching range of any normal ATU. No doubt matching efficiency was also poor and the feedline loss was high.

I recently used an EZNEC model in an attempt to improve the performance of this antenna. I started with the introduction of a couple of loading coils. A value of 70μH brought the structure into near resonance with a feed impedance of R13 +j20, which is a lot more manageable as far as matching is concerned. A 70μH coil can be made by winding 75 turns of 18SWG wire on a 1.6in (40mm) diameter section of plastic waste pipe. This value is not critical because the antenna is tuned with an ATU.

The model predicted a gain of –6dBi; probably due to the current in the lower section of the open loop cancelling the radiation from the upper section. (To put this into perspective, a good quality 80m mobile antenna has a gain of around –10 to –12dBi.) The gain can be improved by routing the end sections away from each other.

The model also predicts that the antenna will work on other bands but, for some bands, such as 7MHz, the coil may have to be shorted out using jumper wires. The required accessibility of these coils is the reason why they are placed fairly close to the ends of the elements, which are close to the ground.

This antenna does not have to be a true square or even orientated in the vertical position. It can be made so that the square is sloping or lopsided. The most important consideration is to make it as large as your small QTH will allow. The chances are that if you can make it larger than shown in Figure 1, the antenna will work without loading coils on 80m. The antenna is fed with 300Ω balanced line feeder because it has a lower loss than coax with high values of SWR. The ribbon feeder is connected straight to a short length of RG213 via a 1:1 balun.

The shack end of the coax feeder is connected to the coax connector on the ATU. Do not take the twin feeder straight to the balanced feeder connections of the ATU because this routes the connections via a 4:1 transformer found in most ATUs. This will worsen the impedance matching ratio. Because the antenna is electrically small, the feeder will be in close proximity to the radiating elements. This will probably cause common mode currents on the feeder and a 1:1 current choke will be useful in minimising these.

VERTICAL ANTENNAS. For small spaces, vertical antennas appear to be an attractive option. They can generate low takeoff angles of radiation, which means long skip distances. However, there can be problems with installing verticals. The instructions with some commercial verticals allege that you can use them without radials. With the exception of the vertical dipole, a dipole on its end, a vertical antenna is only half an antenna, the radial and the ground is the other half.

ELEVATED RADIALS. You can use resonant elevated radials with a feed point at least 5ft (1.5m) above the ground. With this you need at least two tuned radials per band, and they must not touch the ground. For a small number of radials, the higher you can get the feed point (and radials) the better.

Walter Blanchard, G3JKV tested a Hustler 6BTV on behalf of the Dorking Amateur Radio Club using this approach. The instructions stated that Hustler antennas will work with just a simple earth rod but will perform better with radials. To test this out, G3JKV mounted the antenna it on a tilt-over swivel so it could be lowered for easily for adjustment. The swivel point was about 5ft above ground. The aluminium ground pole was 2in diameter and sunk 5ft (1.5m) into the ground, giving a 10ft (3m) total length. It would not work properly using just the ground pole for earth, which may have been the result of a poor sandy earth. It would not resonate anywhere near the ham bands and where it did resonate the SWR was very high.

Various radials were tried. All the radials were attached at approximately the swivel point. The antenna worked well provided 3 or 4 radials were used, but fewer radials resulted in a reduced performance. Radials spaced out equally around 360° (about every 20°) gave the best results.

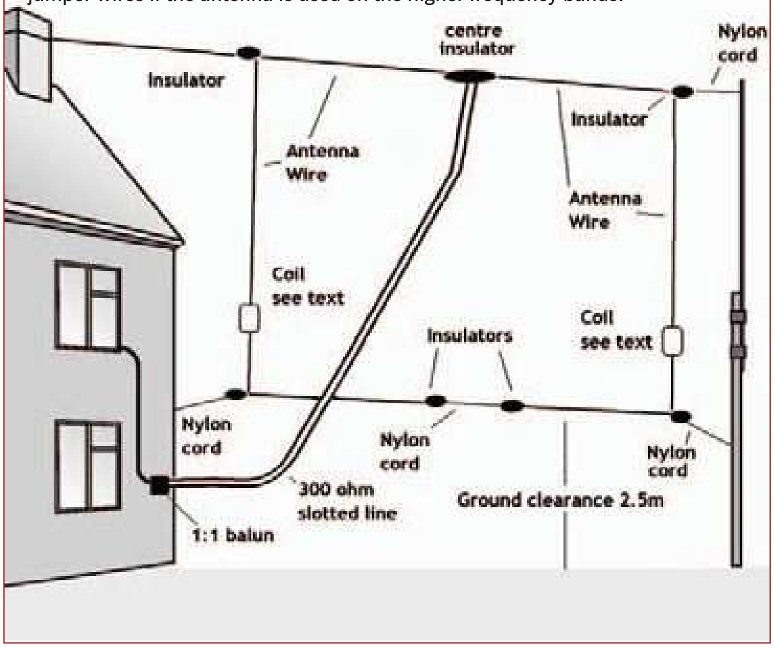
After many experimental antenna and radial adjustments a SWR 1.2:1 or less on every band was achieved. However, to get this sort of performance, a cat's cradle of radial wires and sticks was required. With three radials per band, nearly 500ft (150m) of wire was used, all up on sticks at head height around the garden – and that made the garden unusable. Hustler recommends 14SWG or larger gauge copper wire. G3JKV priced the radial wire material on the web at over £200, which is nearly as much as the aerial.

G3JKV goes on to say that this vertical definitely picked up more local noise than his 40ft (12m) high horizontal dipoles. WSPR **[1]** worked and heard a lot more DX using the wire dipoles than this vertical. Averaging over a large number of different stations and bands using WSPR showed the dipoles had something like a 10dB advantage.

If you haven't got 40ft (12m) high dipoles then a vertical may still be the way to go. It has a low visual impact and has a low angle of radiation provided that they are in the clear of other metal objects and as far away as possible from house electrical wiring.

If you can settle for a single band antenna, the radial problem is nowhere near as acute. My first DX in the late 1950s was working all around South America on 15m using a vertical with four sloping radials. The base was around 12ft high and, as I recall, it was a very simple antenna to construct.

FIGURE 1: Suggested layout of a compact 80m plus other bands antenna. The RF voltages at the ends of the antenna are high during transmit so they should be high enough to avoid accidental contact. The loading coils can be provided with jumper wires if the antenna is used on the higher frequency bands.



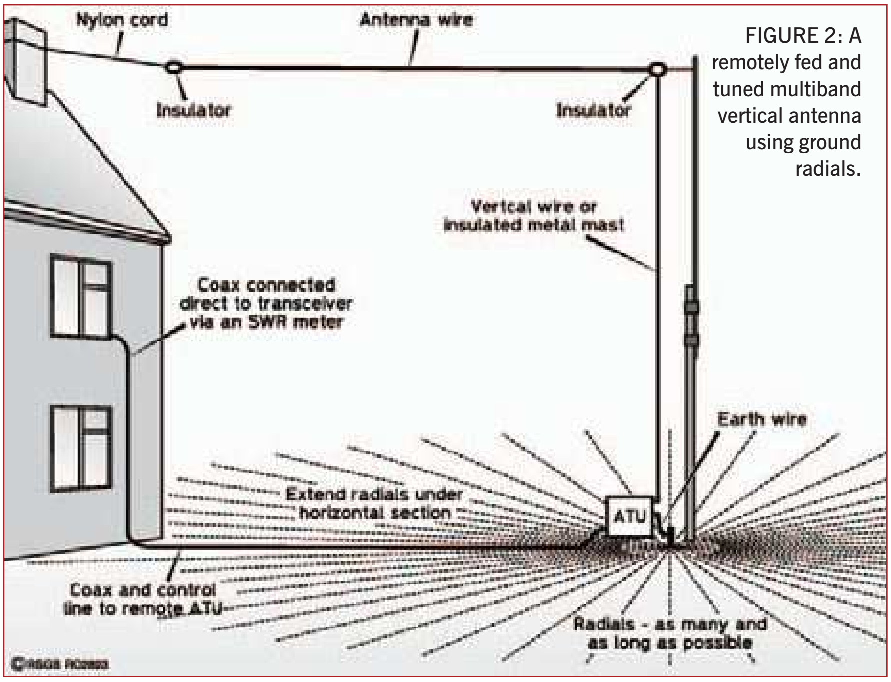


FIGURE 2: A remotely fed and tuned multiband vertical antenna using ground radials.

GROUND RADIALS. Most lower HF band DXers use vertical antennas, usually in some sort of multiple antenna gain configuration such as a four square. These antennas are normally ground mounted, that is to say the feed point is just above the ground, with lots of radials on (or slightly under) the soil.

For a ground-mounted vertical mounted over average soil, you will need at least 16 radials, 30ft (9m) long for frequencies 3.5MHz and above. That is 480ft (144m) of wire. More and longer is better, especially for 40/80m operation. John Stanley, K4ERO, notes **[2]** that if you have the luxury of laying down 120 radials, 33m (108ft) long, the same antenna will have 3dB extra gain compared with the 16 radial model described previously. The downside is that it will take around 13,000ft (4000m) of wire – yes, two and a half miles! Small diameter wire can be used for these radials because there are so many of them to share the return currents. They are also in parallel with the ground currents in the earth.

Ground radials need not be resonant. This is a misconception based on elevated or ground plane type elements. They are different from the elevated ground plane radials in this regard since ground radials supplement ground currents and do not try to replace them entirely. Elevated ground plane radials, especially if few in number, need to be bit longer than 1/4 wave at the operating frequency.

What you absolutely have to avoid with ground radials is to put the feed point a short distance in the air, then run radials down and along the ground.

Ground radials do not actually need to be much longer than the antenna is tall. A shortened antenna with loading coils will have a more compact near field where the majority of the antenna field is. The ground needs only reach out as far as the near field extends. Field intensity drops off with the square of the distance from the base of the antenna.

Keen lower HF band DXers invest a lot of time and effort in building a good ground radial system, particularly with a multi element vertical where a radial system is required for each vertical element.

A practical remotely tuned multiband antenna used with an automatic ATU is shown in **Figure 2**. If we assume the vertical and horizontal sections of the antenna are each 25ft (7.6m), this will make a near quarter wave antenna on 80m and a half wave on 40m. If you want the antenna for 40m and above the total length of the antenna can be shortened and the lengths of the radials can be halved.

REFERENCES

[1] I hope to describe a method of testing antennas using WSPR in next month's Antennas.
[2] 'Optimum Ground systems for Vertical Antennas', John Stanley, K4ERO, *QST* December 1976