Antenna Workshop

In one of his last articles, the late Joe Carr K4IPV expains that there is an antenna suited for use on the lower h.f. bands-and it will fit in most gardens!

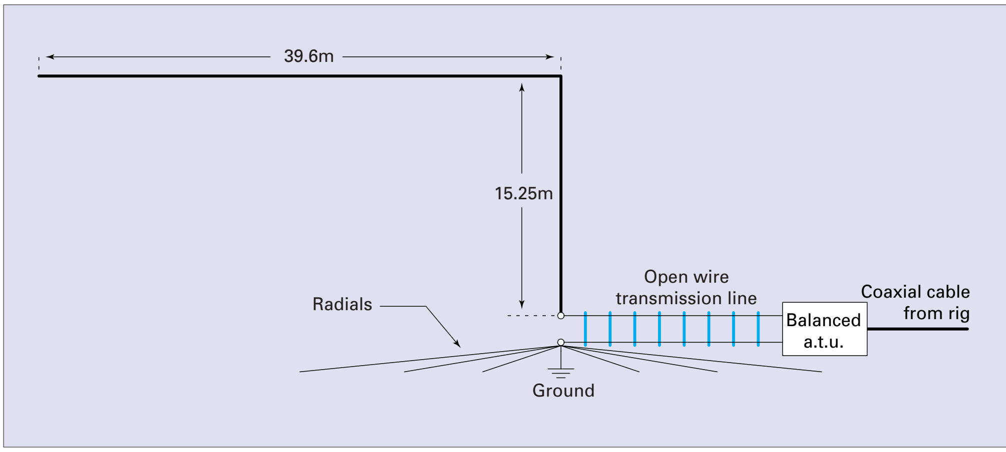

Fig. 1: This design for 1.820MHz could fit in many gardens, but is easily scaled for higher bands. See text for more detail.

Antennas for the 1.8, 3.5 and even the 7MHz bands tend to be problematical for a lot of Amateurs. Why? Because antennas for those bands require space that most Amateurs lack. For example, at the 1.8MHz band the half wavelength dipole is 79m long!

I don't have around 80m of space, and I doubt that most other Amateurs do either. Even for the 7MHz band, the full sized half wavelength antenna is nearly 20m long, which is often still too long for many gardens.

The answer for many Amateurs with small gardens would seem to be any form of Inverted-L antennas. There seems to be at least two types - well maybe just two and a half types if you insist!

First Type

The first type of Inverted-L antenna that I'm about to describe is approximately $3\lambda/8$ long. The antenna shown in **Fig. 1**, is for the 1.8MHz band, designed for 1.820MHz. Antennas for 3.5 and 7MHz can be made by frequency scaling the dimensions. That is, multiply the dimensions by $1.82/f(\text{MHz})$, where f is the new design frequency.

For example, to scale the dimensions for 3.75MHz, multiply by 1.82/3.75 = 0.485. This means the horizontal section would be 19.21m and the vertical section is 7.4m. The antenna is fed by any length of 600Ω twin feed transmission line and an antenna tuning unit (a.t.u.). The high impedance at the bottom of the antenna is transformed, by the open wire feeder and a.t.u. to an impedance that your transmitter can handle.

Because this antenna has a high feed-point impedance, be careful of the type of a.t.u. that has a limited range line impedances. You need a good a.t.u. to match high impedance values to the output impedance of your rig (probably 50Ω). There is an advantage to use an older rig with a vacuum tube (valved) final power amplifier.

The inverted-L antenna requires a good ground system to work properly. For many Amateurs that means one or more long ground rod directly underneath the vertical section, leaving only a short length for connection to one side of the antenna feedline.

In other cases, good grounding means a radial system. If the radials are buried, then they don't have to be resonant (although the wire should be bare!), although they should be as long as possible and trenched into the earth with a spade or shovel, but do not leave them on the surface (far too easy to trip up over).

The number of radials is simple: the more the better. In truth, about four radials seems a reasonable compromise, though above sixteen the return in extra far-field strength is minimal.

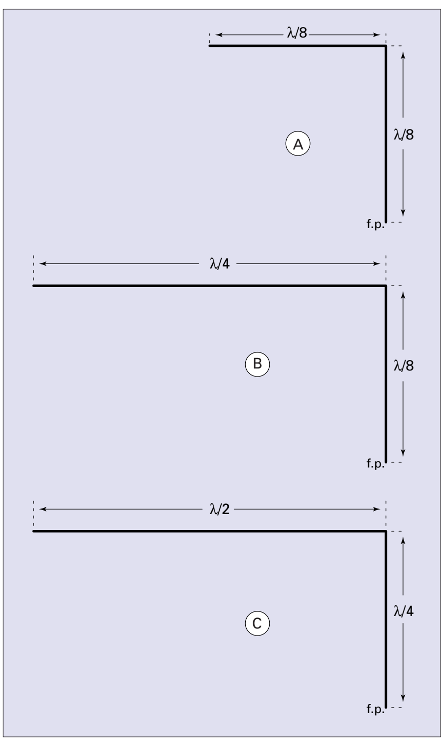

Fig. 2: Shown here are three variants of the 'second' type of Inverted L antenna, that Joe says are really versions of the type shown in Fig 1. See text for more detail.

Second Type

The second type of inverted-L antenna is actually a variation on the theme of the first. I feel there are three varieties. The type shown in **Fig. 2a** is $\lambda/8$ long for both vertical and horizontal legs. The type in **Fig. 2b** is $\lambda/4$ long on the horizontal segment and $\lambda/8$ long on the vertical. The type in **Fig. 2c** is $\lambda/2$ long on the horizontal segment and $\lambda/4$ long on the vertical.

Computer modelling of the type 2 antenna (Fig. 2b) showed that it had a gain of 1.5dBi (decibels over isotropic). Given that a dipole has a gain of about 2dBi, this antenna has a gain slightly less than a dipole in the horizontal aspect. The pattern peaked perpendicular to the horizontal line of the antenna.

The nice thing about this antenna is the 'free' band that one gets. For example, you can build an antenna for either the 1.8 and 3.5MHz, or for the 3.5 and 7MHz bands. The antenna has one current node at the lower frequency and two at the higher frequency.

The simplified diagram of **Fig. 3** shows the antenna impedance matching scheme for all three antenna types presented in this article. The transformer is bifilliar wound, although with slightly different numbers of turns, on an FT-240-61, FT-240-43, or FT-200-2 core, or equivalent.

The primary winding is 16 turns 2mm (14s.w.g.) enamelled wire, and the secondary is 10 turns of the same wire. The secondary is tapped at the eighth turn from the feedline end. A series capacitor is needed on 3.5 and 1.8MHz, but rarely on 7MHz.

High Voltage

The capacitors can be a combination of high voltage, high current disk ceramic or similar capacitors, or they can be a single transmitting quality variable capacitor if some means is provided of varying the capacitance. In any event, the purpose of the capacitor is to cancel a significant amount of inductive reactance that appears in the impedance of about 100Ω (resistive).

After the correct amount of capacitive reactance is determined, perhaps by using a variable capacitor and then measuring its capacitance at the setting that drops the v.s.w.r. to minimum, a combination of several parallel disk ceramic capacitors can be substituted into the circuit. The correct capacitor is selected by a switch or relay (S1).

The important thing to remember is the voltage rating of the capacitors. For a 100W transceiver a voltage rating of about 1kV working is sufficient, but for higher power levels use 4kV working units instead. The capacitors also have to handle fairly high currents (1A at 100W and 4A at 1,500W), so select the units carefully.

Feedline v.s.w.r. can be handled by using a Q-matching section. By using quarter wavelength of 75Ω coaxial cable between the antenna tuner and the 50Ω coaxial cable to the transmitter, one can reduce the 100Ω feed-point impedance to a manageable v.s.w.r. Of course, this approach must be repeated on each band of operation, because the quarter-wave 'Q-section' is inherently frequency dependent.

Operation on 1.8MHz might require an inductor in series with the antenna. Try an 18μH adjustable or roller inductor for use in this type of situation. This coil is used with the capacitors bypassed.

Third Version

The third version of the inverted-L antenna shown here is intended for use where you have vertical height, but lack the space to put in a full size antenna and/or a system of radials. All of the methods at making a compromise antenna (e.g. inductors in the radiators) tend to narrow band the antenna by raising its *Q*. The antenna shown in **Fig. 4** doesn't suffer the indignity of a narrower bandwidth. In addition, the antenna has both high angle and low angle of radiation.

The antenna shown in Fig. 4 is a ½ dipole with one radiator element vertical and the other horizontal. The feed-point of the 'bent-L' antenna, like all λ/2 dipoles, is in the centre, is closer to 50Ω than 73Ω because of coupling between the elements. The antenna has an s.w.r. of less than 3:1 across the 3.5MHz band, and less than 1.8:1 across the 7MHz band.

In tests conducted by **W2KK** back in the 1970s, a bent-L dipole performed a little down on a simple dipole at around -2dBd. However, the inverted-L antenna beat a λ/4 vertical monopole without radials (-10dBd), a λ/4 vertical with radials (-8dBd), an inverted-V (-3dBd) and a λ/2 vertical (-15dBd) antenna types.

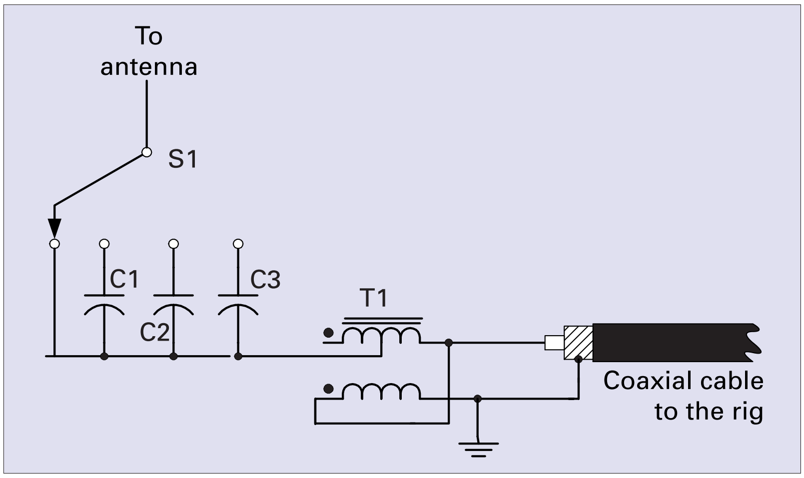

Fig. 3: A simple antenna tuning unit uses series capacitors to tune the antenna inductance to the centre of the band of interest. Each capacitance value is chosen to give a low s.w.r. then replaced with fixed value, high voltage compents. See text for more detail.

In my view, these tests fail to take into account angle of radiation, but they are none the less significant. The gain of the antenna is slightly less than that of the regular horizontal or vertical dipole, but not so much that you would notice it.

The length of the elements is slightly less than the lengths of ordinary half wavelength dipoles. Each element (vertical and horizontal) is found from the formula: 132/*f*, where: the element length is in metres and the frequency in megahertz.

If the layout of your property doesn't allow the antenna to be run in straight lines, then bend one or both elements as needed. The overall length of the resultant antenna should still be (132/*f*)m, even though the elements are not particularly straight.

Bending the upper section results in lower gain most of the time, because it distorts the pattern of the antenna considerably. This principal is little understood amongst antenna builders: if the result is inability to operate at all, go for a compensation antenna and accept the results, it's better than not being able to operate at all.

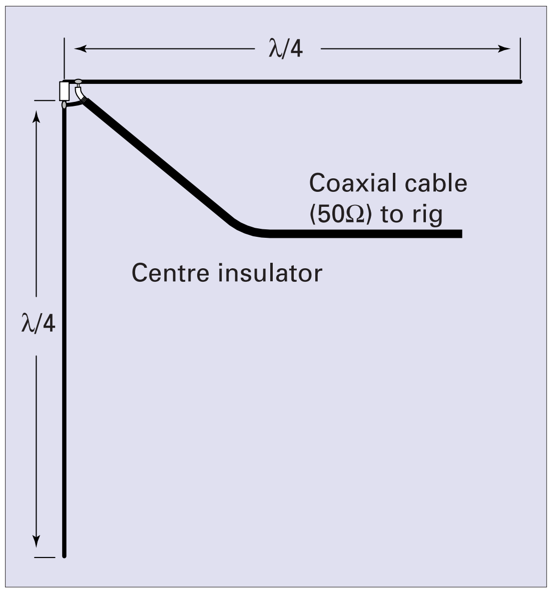

Fig. 4: The final type of Inverted L, like a dipole is fed at ites centre point rather than at the lowest point. Cut for the band of interest, it matches quite well to a 50Ω coaxial line. See text for more detail.

Splendid Antenna

I've come to the conclusion that the Inverted-L antenna is a splendid antenna for those who want to work the 1.8, 3.5 and 7MHz amateur radio bands, but lack the garden space to do so. The antenna is a compromise to be sure, so they typically have less gain than a standard half wavelength dipole antenna.

The reduced gain of this antenna is essentially a non-issue when the result of not using such an antenna is...radio silence! *PW*