Antenna of the Month

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Inverted L

Long wavelengths mean long antennas, and when you're trying to put up something for 80 or 160 meters, you can quickly run out of real estate and altitude. A popular and effective solution is the inverted L. It's simply a vertical with the top bent over and running roughly horizontally. The vertical part does most of the work since high current is present nearer the base. The horizontal part can be thought of as more of a loading or matching device if it doesn't dominate the overall length. Unless you have a *very* tall tower to support a high dipole, a vertical antenna of some sort will typically be your best bet for DX performance on these low bands.

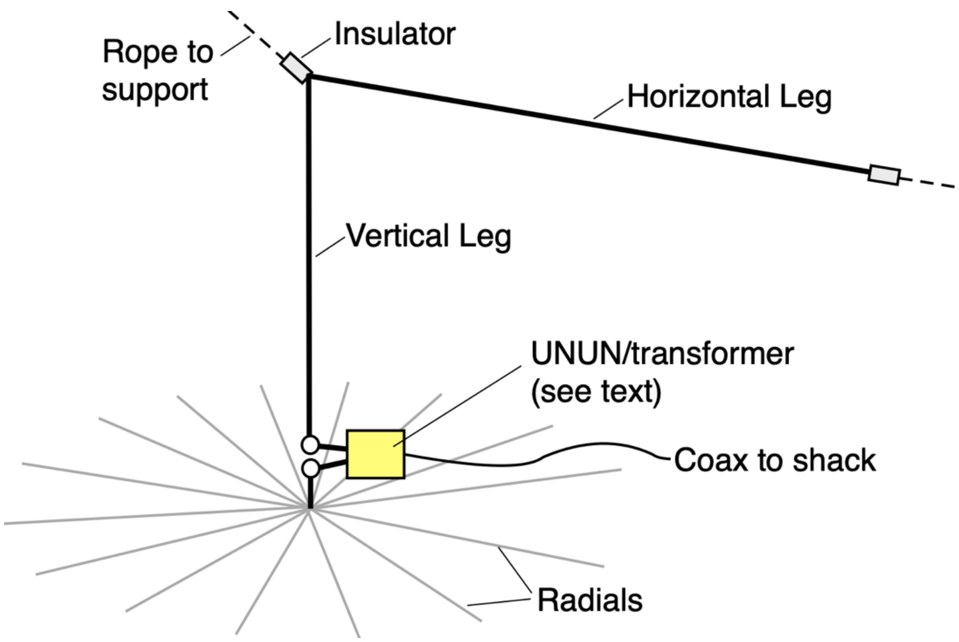

Figure 1. Typical inverted L construction.

Like any vertical (monopole), this antenna requires a ground radial system. It can consist of a large number of radials on or slightly under the ground, or a modest number of elevated radials. For ground radials, generally more is better; 32 is a good target. One thing about them is that they are non-resonant so length is not very critical. Elevated radials *are* resonant and will directly affect antenna tuning, but you can get by with just a few. For best performance, elevated radials should be up about 8 feet on 80 m and almost twice that on 160 m. See the *ARRL Antenna Handbook* for in-depth advice on design tradeoffs for any kind of radial system.

Our reference antenna is a wire vertical, 66 ft tall and with 32 shallow-buried radials 45 ft long. The inverted Ls use the same radial system. I varied the length of the vertical portion of the L, choosing 20 and 30 ft for comparison. The remainder of the wire ran horizontally, 46 and 38 ft, respectively.

Figure 2 compares the SWR. A properly-installed vertical ends up around 42 ohms at resonance, a good match to our regular coax. Inverted L antennas are always a lower impedance as are all shortened verticals. In this case it's usually around 20 ohms, and that's what my simulation shows. The shorter the vertical segment, the lower the impedance. For a better match, some guys add a transformer or some other matching network at the feedpoint. Note: You should always place a common-mode choke at the feedpoint of any of these antennas. (In this case, it's sometimes called an UNUN for unbalanced to unbalanced, but really, it's just a choke.) That will prevent the outside of your coax from becoming another radial with unknown properties.

A good radial system is extremely important. If it's inadequate, there will be excessive loss due to current flowing through the lossy Earth rather than copper wires. Curiously, this loss can actually *improve* your SWR! That's because the added loss appears in series with the antenna's radiation resistance. If your inverted L looks like 50 ohms, you probably have upwards of 25 ohms of loss in your radial system and literally half your power is being dissipated there. So don't be fooled: *SWR is not a direct indicator of antenna performance*.

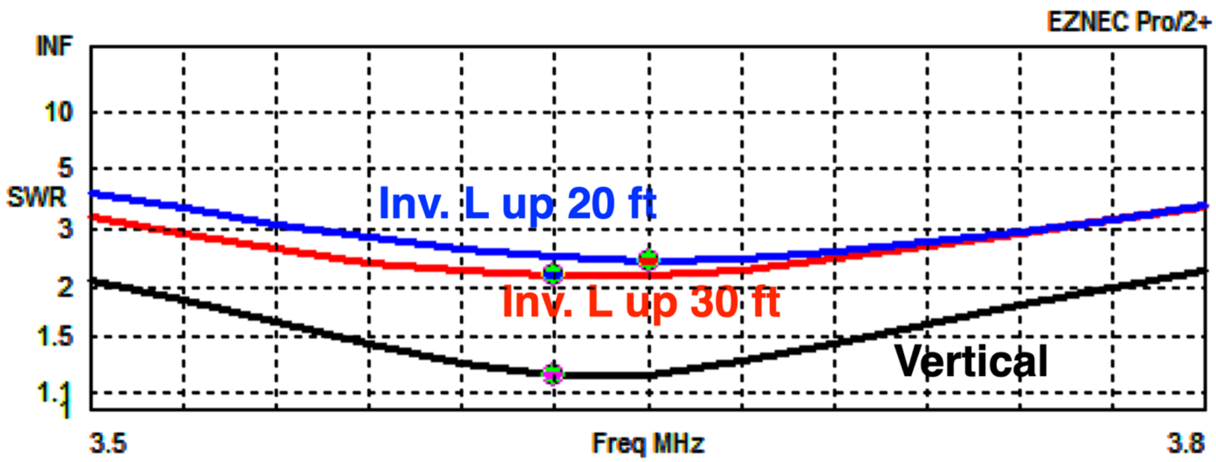

Figure 2. SWR comparison over average ground conditions. An inverted L at resonance is typically around 20 ohms with a good radial system.

Looking at the pattern in azimuth, it's going to be omnidirectional with a slight bias in the pattern away from the horizontal wire's direction. For the 20 ft vertical case, it's about 3 dB. The better news is that the elevation pattern (Fig. 3) is very good compared to the baseline vertical with excellent low-angle radiation. "Forward" gain is nearly identical, with only the small decrease off the back. Also the horizontal wire gives you some radiation straight up which can be useful for shorter-distance QSOs.

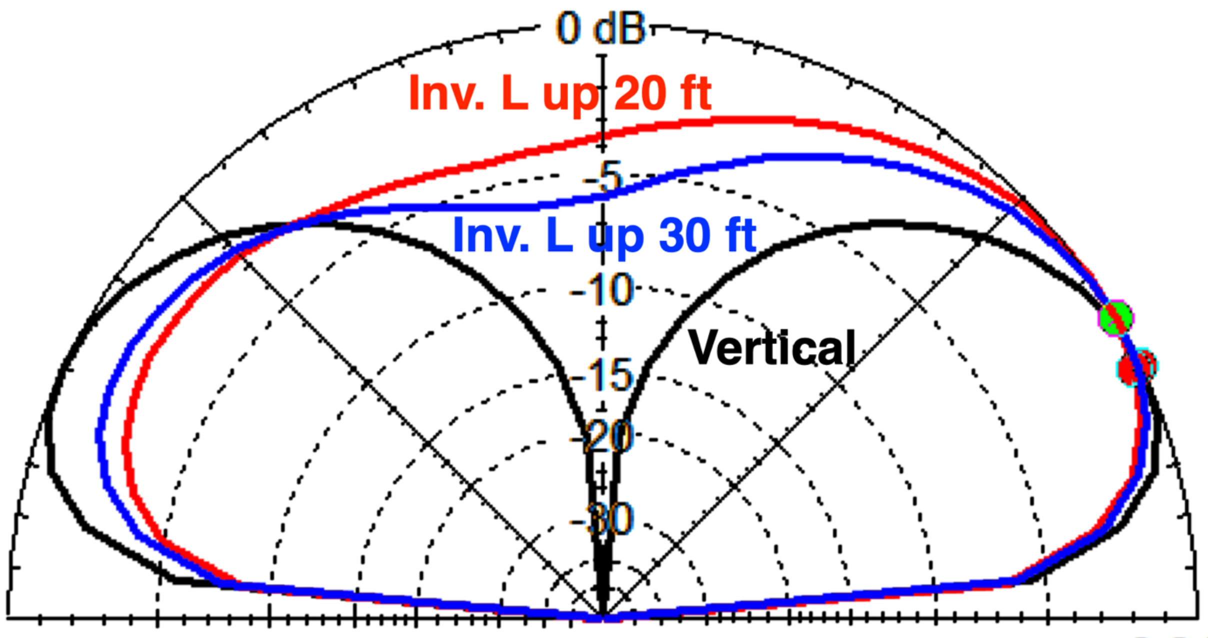

Figure 3. Comparison of elevation patterns. Outer ring is 0.0 dBi.

The last simulation I did was with four elevated radials. Elevated radials often provide higher total efficiency than ground radials. Rudy, N6LF, has written on this extensively [Ref 1]. The elevation pattern has a bit more energy at higher takeoff angles, and a greater front-to-back ratio, on the order of 5 dB, but it's still excellent at low angles. The other difference is that the impedance is even lower, on the order of 12 ohms. A 4:1 impedance transformer would be a good idea here. As I mentioned, elevated radials are resonant and tuning is required. Adjusting the relative length of the vertical-horizontal wire vs. the radial length can walk the impedance around a bit for a better match but it will still be pretty low. For instance, shortening the radials by 10% increased the impedance to about 18 ohms.

In conclusion, the inverted L is a well-respected antenna for low band DXing when space is limited, especially if you can lay down a good radial field. Don't be afraid to route the horizontal wire to fit your property. It can slope downward and bend in odd directions without seriously degrading performance.

References

Rudy Severns, N6LF. All of his classic articles are available online. https://rudys.typepad.com/