Dual Full-Wave Loop Antenna

By John Griggs,* W6KW

Achieving gain from an antenna at 7 and 3.5 MHz normally requires a rather large piece of real estate, a high tower or both. To obtain significantly improved performance over a dipole at these frequencies, and to do it inside an average city lot, is a goal worth pursuing! With this in mind I decided to replace my inverted-V dipoles on 7 and 3.5 MHz with a dual full-wave loop antenna, one inside the other.

I had noticed the strong signals on 7 MHz from Pat Kearins, W7UI (now a silent key), and from Carl Winter, W6OAW, on 3.9 MHz, and was interested to find that both were using full-wave loops. Both signals would pin my S-meter, and my QTH is well over 200 miles (km = miles × 1.613) from either station. The antenna at W7UI was a loop suspended by a very high supporting structure. This loop resembled a square, with one corner facing up, one facing the ground, and the other two corners pulled outward by guy wires.

My attention was attracted to a horizontal loop antenna used by another ham on 3.9 MHz that produced extremely strong signals. It was a square loop, 65 feet (meters = feet × 0.3048) on a side, with each leg parallel to the ground but only 14 feet high. Fed by a tuned line, it functioned well, but it was most effective for relatively short ranges, up to 200 miles or so.

Of more interest to me, however, was the 75-meter rectangular loop used at W6OAW. I learned that this was a dual antenna, i.e., a full-wave rectangular loop for 3.9 MHz suspended about 40 feet above ground, with another full-wave loop for 7 MHz inside the first, in the same plane. The 3.9-MHz loop is a closed circuit, whereas the 7-MHz loop is an open circuit. This permits operation on 10, 15 and 20 meters as well as 40 meters when used with open-wire feed line and a matching network. The outer loop is fed with coaxial cable.

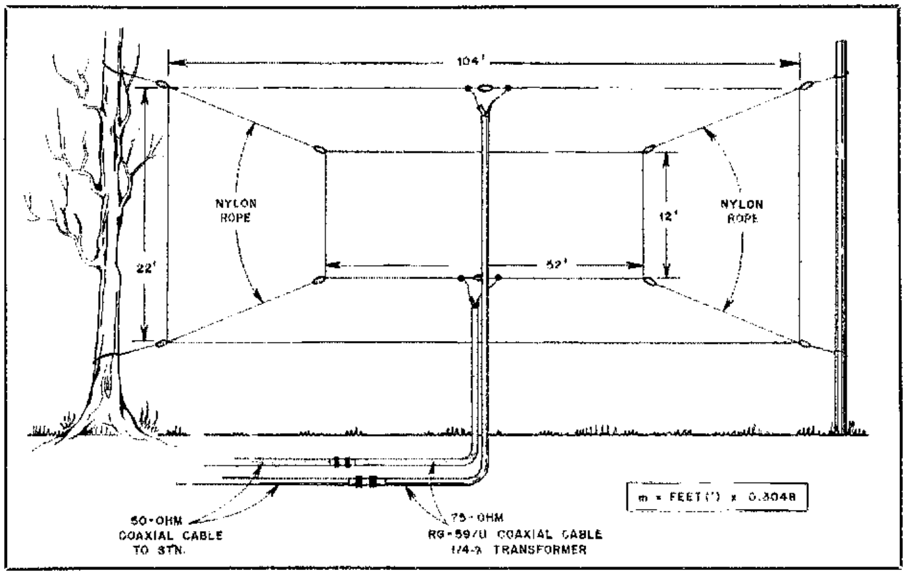

Fig. 1 — Dimensions for the dual full-wave loop antenna. Input impedance is on the order of 104 ohms. A quarter-wave matching section of RG-59/U is used to provide a match to 50 ohms.

Design Planning

In considering loop antennas for my lot, which is 75 feet wide by 125 feet deep, I found that I could use two 40-foot high pipe masts, 130 feet apart along a diagonal across my lot. I duplicated the W6OAW arrangement, except that I hung the antenna vertically and made both loops closed-circuit designs. I could use them only on the bands for which they were cut, 7.2 MHz and 3.8 MHz. Each is fed with a quarter-wave matching section of RG-59/U, which provides a 50-ohm match for the RG-8/U cables leading in to my operating position.

Construction

See Fig. 1 for construction details and dimensions. Matching the 104-ohm antenna impedance to the 50-ohm line impedance requires a quarter-wave coaxial line having a characteristic impedance of 72 ohms. The formula for a 1/4-wave section is:

$$\frac{246}{f(\text{MHz})} = \ell(\text{ft}) \qquad \text{(Eq.1)}$$

This result must be multiplied by the velocity factor of the coaxial cable, 0.66 for RG-59/U 73-ohm cable. The quarter-wave section was determined to be 42.7 feet for 3.8 MHz and 22.6 feet for 7.2 MHz. These connect to RG-8/U cables for a 50-ohm match to the transceiver.

The top section of the 3.8-MHz loop is fed at the center because of the length of the quarter-wave line, but the shorter matching section for the 7.2-MHz loop allows me to feed the bottom portion of that antenna.

The inner loop is supported from the corners of the outer loop by means of nylon rope and suitable insulators. It is best to use lightweight, high-quality insulators and wire no larger than no. 14 to reduce the weight of the array. Pulleys (and rope) will be required at the tops of the 40-foot poles and also at the 18-foot level. The fact that the bottom horizontal section of the antenna narrowly misses the top of my house roof seems to have no deleterious effect on its operation.

Measure the antenna sections carefully, and cut them to length. Pay particular attention to locate the feed point at the exact center of the horizontal wire sections. This provides horizontal polarization. Feeding the loop at the center of either vertical section will provide vertical polarization.

Tuning

If trimming is needed to resonate the antenna to your favorite operating frequency, cut or add equal length pieces at each vertical section. Do not shorten the sides to the point at which the top and bottom sections are less than 0.1 wavelength apart. Careful pruning of the horizontal sections would be required if such a problem develops.

Information given to me by those using this antenna seems to confirm my results. A typical comment is "Boy are you ever loud!" A gain of 1.8 dB over a dipole is claimed for this type of antenna. The principal difference appears to be a lower angle of radiation. While it is possible to work stations off the ends of the antenna, maximum radiation occurs broadside to the element. What I like about the antenna is the ability to hear weak stations. It is outstanding in this regard.

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