Build a Space-Efficient Dipole Antenna for 40, 80 and 160 Meters

A new trap design, using only RG-58 and PVC pipe, yields better space efficiency than conventional coaxial traps.

By A. C. Buxton, W8NX
2225 Woodpark Rd
Akron, OH 44333

These days more than ever before, many hams who want to work the low bands need an effective antenna that fits on a small lot. I'll show you how to build a shortened dipole for 160, 80 and 40 meters using improved coaxial-cable traps that I call Super Traps. The antenna, which covers the three ham bands below 7.3 MHz, is about the same length as a full-size 80-meter dipole. If you install the antenna as an inverted **V** with a 90° included angle, the baseline length is 88 feet. The antenna uses traps that are easily constructed, rugged and weatherproof. They use no exposed capacitors or inductors.

You can feed the antenna directly with balanced 75-Ω line or via a 1:1 balun with either 50- or 75-Ω coaxial cable. Feed-line length is not critical. The antenna resonates at 1.865, 3.825 and 7.225 MHz. I installed such an antenna on my lot as an inverted **V**, with the apex 38 feet high and the ends at about 15 feet.

As part of this project, I developed a BASIC-language computer program[1] for trap design; a listing is available from the ARRL.[2] You can use this program to design these traps for frequencies of your choice, but you don't need a computer to make the antenna described here.

Fig 1 shows the antenna layout. The antenna is made of #14 stranded wire and two pairs of coaxial traps. Construction is conventional in most respects, except for the high inductance-to-capacitance (L/C) ratio that results from the unique trap construction. Two recent *QST* articles give tips on dipole construction and feeding.[3,4]

[1]Notes appear on page 36.

The traps use two-layer windings of the core (dielectric and center conductor) of RG-58 coaxial cable. Coaxial cable with flexible, rugged stranded-wire center conductors is preferable to that with a more brittle solid-wire center conductor. Fig 2 shows the traps. The 3.8-MHz trap is shown with the weatherproofing cover of electrical tape removed to show the construction details.

Precautions and Trap Specifications

With this trap-winding configuration, there are two thicknesses of core dielectric material between adjacent turns, which doubles the breakdown voltage of the traps. The transformer action of the two windings gives a second doubling of the trap-voltage rating. Thus, the trap voltage rating is 5.6 kV (four times RG-58's 1.4-kV rating). Conventional coaxial-cable traps made of RG-58 have a rating of 2.8 kV.

The 7-MHz traps have 33 μH of inductance and 15 pF of capacitance, and the 3.8-MHz traps have 74 μH of inductance and 24 pF of capacitance. The trap Qs are over 170 at their design frequencies, as measured on a Boonton Q meter.

These traps are suitable for operation at the 1-kW power level. When making the traps, *do not* use RG-8X or any other foam-dielectric cable. Winding such cables on small-diameter forms causes the center conductor to migrate through the dielectric toward the inside, decreasing the breakdown rating and compromising trap performance. The core diameter also differs from that of RG-58.

Construction

Although these traps are similar in many ways to other coaxial-cable traps, the shield winding of the common coax-cable trap has been replaced by an outer winding that fits snugly into the grooves formed by the inner layer. Capacitance is reduced to 7.1 pF per foot, compared to 28.5 pF per foot with conventional coax traps made from RG-58. Trap reactance can be up to four times greater than that provided by conventional coax-cable traps.

The coil forms are cut from PVC pipe available at plumbing-supply stores. The 7-MHz trap form is made from 2-inch-ID pipe with an outer diameter of 2.375 inches. The 3.8-MHz trap form is made from 3-inch pipe with an outer diameter of 3.5 inches. The 7-MHz trap uses a 12.3-turn inner winding and an 11.4-turn outer winding. The 3.8-MHz trap uses a 14.3-turn inner winding and a 13.4-turn outer winding. All turns are closewound. The inner-trap frequency is 7.17 MHz and the outer-trap frequency is 3.85 MHz.

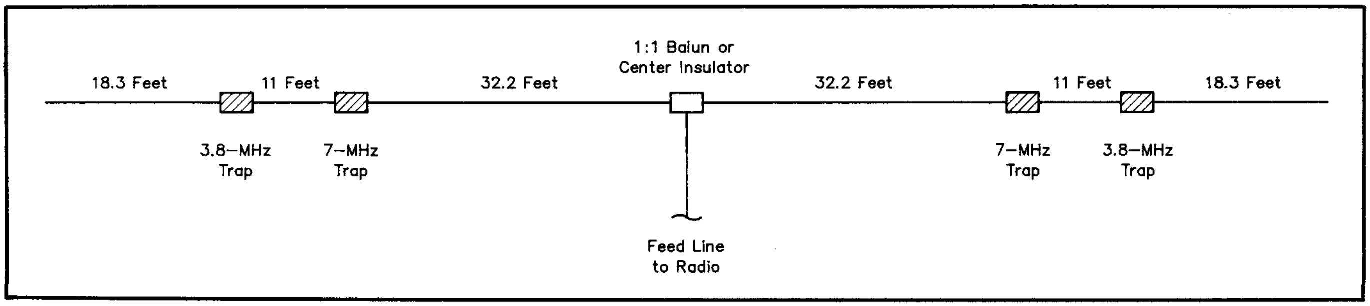

Fig 1—The shortened dipole resonates in the SSB portions of the 40, 80 and 160-meter bands. The antenna is 124 feet long.

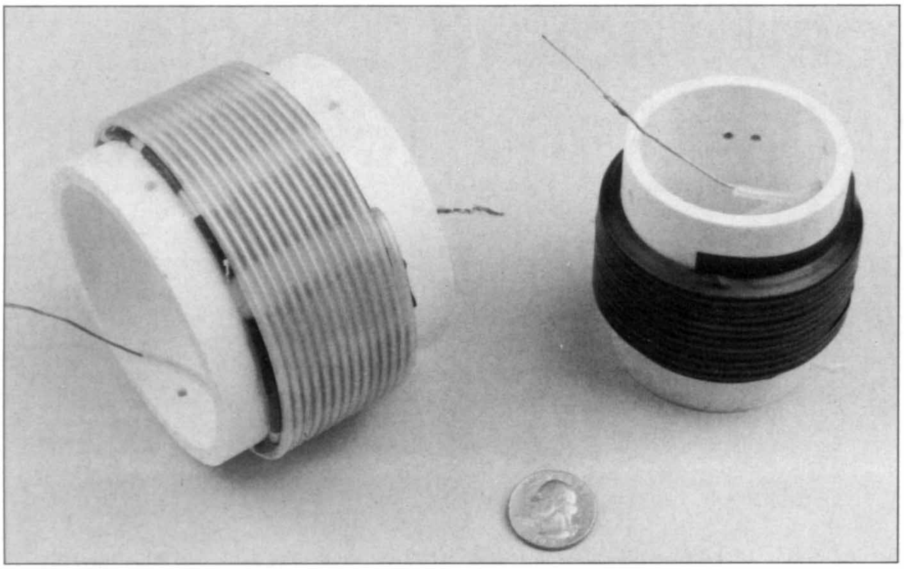

Fig 2—The improved coaxial-cable traps use two layered windings to provide an unusually high inductance-to-capacitance ratio, higher Q, and twice the breakdown voltage of single-layer traps. The 3.8-MHz trap is shown without its protective electrical-tape wrap to show the details of trap construction. This construction method makes for simple, lightweight, rugged and weatherproof traps.

If you are unable to get PVC forms of exactly the same diameters as those called for here, compensate for the effect of form-size differences by taking advantage of the fact that the number of turns varies inversely with the form diameter. Thus, if the form diameter you use is, say, 5% larger than mine, reduce the number of turns by 5%. If necessary, add or remove fractions of a turn at the end of the outer winding. If you have a computer, you can use the BASIC program[5] to calculate the exact number of turns for other form diameters. Stay as close as you can to the prescribed diameters because too much deviation changes the loading effect of the traps. A small change in trap loading may require a change in the lengths of the tip segments beyond the traps.

Use a #30 (0.128-inch diameter) drill for the feed-through holes in the PVC coil forms. The start and end holes of the 7-MHz traps are spaced 1.44 inches center to center, measured parallel to the trap center line. The holes in the 3.8-MHz traps are 1.66 inches apart. Wind the traps with a single length of coax core. The unspliced lengths are 17.55 feet for the 7-MHz traps and 28.45 feet for the 3.8-MHz traps. These lengths include the trap pigtails and a few inches for fine tuning.

Strip the jacket from the coax. This is easily done using a wood vise with wide jaws to hold the cable while cutting the jacket longitudinally with a sharp knife or razor. The coax outer conductor (braid) is best removed by pushing (not pulling) it off.

Use electrical tape to keep the turns of the inner-layer winding closely spaced during the winding process. This counteracts the tendency of the tension in the outer-layer winding to spread the inner-layer turns. Stick the tape strips directly to the coil form before winding and then tightly loop them over and around the inner layer before winding the outer layer. Use six or more tape strips for each trap.

If possible, check the resonant frequencies of your traps with a dip meter. Try to maintain an accuracy of 50 kHz or better.

For low-noise reception, erect the antenna as close to horizontal as possible. If you let the ends of the antenna droop toward the ground, as I have done with my inverted-**V** installation, you may have to accept a somewhat higher noise level in the interest of structural simplicity and reduced baseline length. Some feel that the inverted-**V** configuration is better for DXing than a horizontal dipole at the same height. For an inverted **V** with a 90° included angle (legs that slope downward at 45°), you'll need a minimum apex height of about 55 feet and a baseline length of 88 feet. Get the apex as high as you can and keep the ends at least 10 feet above the ground for safety.

Configuration and Performance Trade-Offs

You seldom get something for nothing. This antenna proves no exception to that rule. As with all trap dipoles, this one has less-than-ideal bandwidth due to the loading effect of the traps. This is the price paid for multiband coverage and physical shortening. This antenna covers 65 kHz of 160 meters, 75 kHz of 80 meters and the entire 40-meter band with SWRs under 2:1. The bandwidth limitations on 160 and 80 meters can be largely offset with an antenna tuner.

It is also important to recognize that the traps are used in low-current portions of the antenna, minimizing I^2R trap losses. A relatively high radiation resistance is therefore also retained.

Good luck with your low-band antennas!

Al Buxton was first licensed in 1937 as W7GLC. He has had careers in both industry and academia. He spent 21 years with Goodyear Aerospace Corp, 6 years with Tulane University and 11 years with the University of Akron (Ohio). He is a registered professional electrical engineer in Ohio and earned BS and MS degrees in electrical engineering from Tulane University. While in industry he worked in the fields of automatic controls, computers, radar and antenna development. He retired as Associate Professor Emeritus from the University of Akron.

In retirement, Al is active in Amateur Radio and computer application studies in antenna development. He's writing a series of articles on transmission lines, antenna traps and trap-dipole antennas.

Notes

[1]I wrote the program in GWBASIC 3.2. It uses generic BASIC commands and can be easily converted for use with computers other than IBM PCs and compatibles.

[2]For a copy of the BASIC program, send a business-size SASE to the ARRL Technical Department Secretary, 225 Main St, Newington, CT 06111-1494. Request the July 1992 *QST* BUXTON BASIC PROGRAM listing.

[3]J. Healy, "Antenna Here is a Dipole," *QST*, Jun 1991, pp 23-26.

[4]J. Healy, "Feeding Dipole Antennas," *QST*, Jul 1991, pp 22-24.

[5]See note 2.

Strays

WWII MERCHANT MARINE REUNION

☐ The 1992 reunion of the Gallups Island Radio Association (GIRA) will be held at the Ramada Renaissance Hotel in Long Beach, California, August 28-30. The GIRA is composed of Merchant Marine radio operators who graduated from the US Maritime Service radio school on Gallups Island in Boston Harbor during 1940-45. Many of the Gallups Island students were recruited from an article in April 1941 *QST* and a followup article in 1942 entitled "Gallups Island Revisited." Bob Clough, K6RS, Director Region 9 GIRA, 1324 Buckingham Dr, Thousand Oaks, CA 91360.

I would like to get in touch with...

☐ anyone who has used an AEA PK-232MBX with a Tandy 1000TX computer. Michael Kramer, WA2HZM, RD 1 Box 417A, Pine Plains, NY 12567.

☐ anyone who worked for the OWI while I was an engineer at Honolulu station KRHO during WWII. Rex Lawman, N5XLB, 1804 Mill Creek, N Little Rock, AR 72116.