A Wideband 80-Meter Dipole

This worthy antenna is so simple and inexpensive you'll want more than one!

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The 500-kHz width of the 80-meter band makes it by far the widest HF amateur band on a percentage basis—13% of the center frequency. Over the years, a legion of articles have described antennas that purported to provide an SWR of less than 2:1 over the whole band. Some did, some didn't. With my two transceivers—a Drake TR-7 and Yzaesu FT-757GX—even a 2:1 SWR isn't low enough because the rigs automatically begin to reduce output power before a 2:1 SWR is reached. I suspect this is not an uncommon occurrence with other rigs (not equipped with built-in automatic antenna tuners) as well.

What's really needed is an antenna that provides an SWR below 1.6 or 1.7:1 over the entire band. It'd be really convenient to jump from one end of the band to the other without having to think about retuning the antenna tuner or rig, or buying an automatic antenna tuner. Such a requirement makes antenna design tough!

The following is a description of an antenna that meets the need. This one has been built—and it works great with no noticeable SWR degradation caused by rain, snow, wind or other weather elements. Surprisingly, it's a simple wire antenna that's only as long as a standard dipole.

Earlier Antennas

My idea has its roots in two well-known antennas: the open-sleeve dipole[1,2,3] and the folded dipole.[4] With an open-sleeve dipole, additional conductors are added in close proximity to—but not connected to—a common single-wire dipole, as shown in Figure 1. In addition to the fundamental resonance of the simple dipole, the added conductors create new resonances. This effect can be used to multiband or broadband an antenna—and it's an idea that's been around since WW II.

A folded dipole's bandwidth is greater than a single-wire dipole made of the same wire size. Although the bandwidth attainable with a folded dipole is better, by itself, it's still not good enough for our needs. Figure 2 shows the typical SWR plot for a folded dipole, using 12-inch element spacing, #14 wire and centered on 3.750 MHz. This antenna's 2:1 SWR bandwidth is approximately 375 kHz. You can improve things a bit by using greater element spacing, but then the weight and length of the spacers gets to be a hassle and you still won't have sufficient bandwidth.

Antenna Height

One common problem with any 80-meter antenna is installing it high enough to do some good. Because the current maximum is at the center of the dipole, it's important to keep that part of the antenna as high as possible. For most installations, 70 feet is pretty high, but at 80 meters, 70 feet is only one quarter of a wavelength.

A dipole's radiation angle is largely determined by the height of its center. If the antenna is strung between two supports, there's bound to be some sag, height is lost and the radiation angle raised. Weight of any sort—baluns, long lengths of coax, matching networks, etc, particularly near the antenna's center—contribute to sag. The resultant high-angle radiation is great for local QSOs, but bad news for DXing.

If I can't provide support for the antenna center, I prefer to use lightweight transmitting twinlead (weighing in at 2.4 lb/100 ft versus the 9.4 lb/100 ft of RG-8 coax), with the balun at ground level. The 450-Ω ladder line is quite efficient, relatively light and costs about 16 cents a foot, much less than coax.

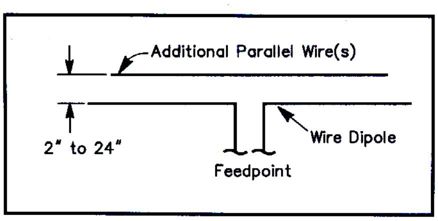

Figure 1—An open-sleeve dipole example.

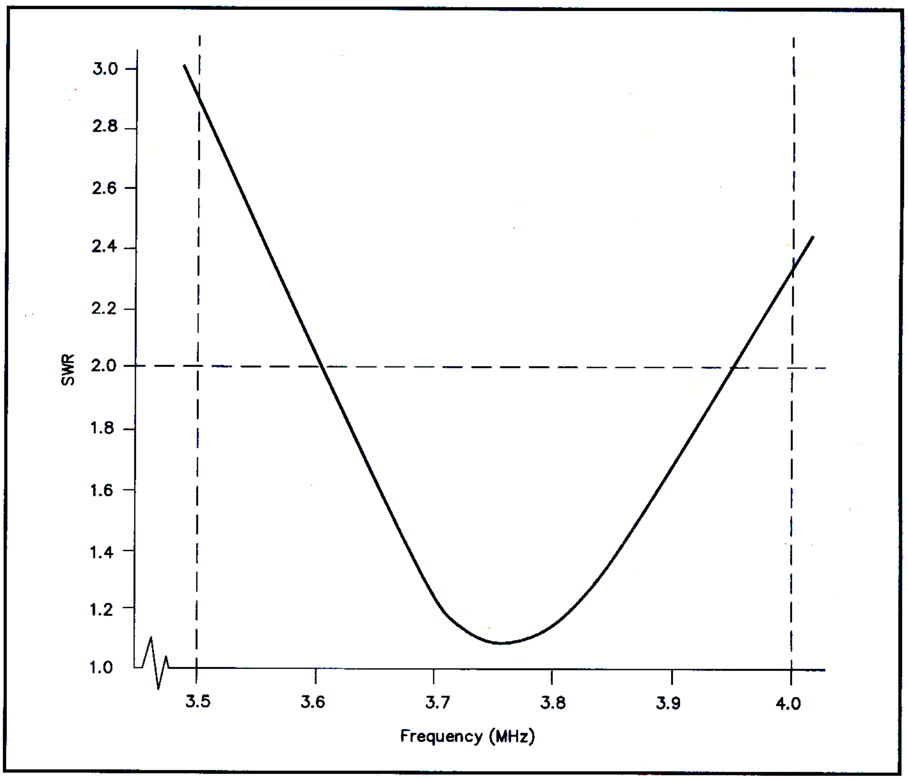

Figure 2—Typical SWR for a folded dipole resonant at 3.75 MHz.

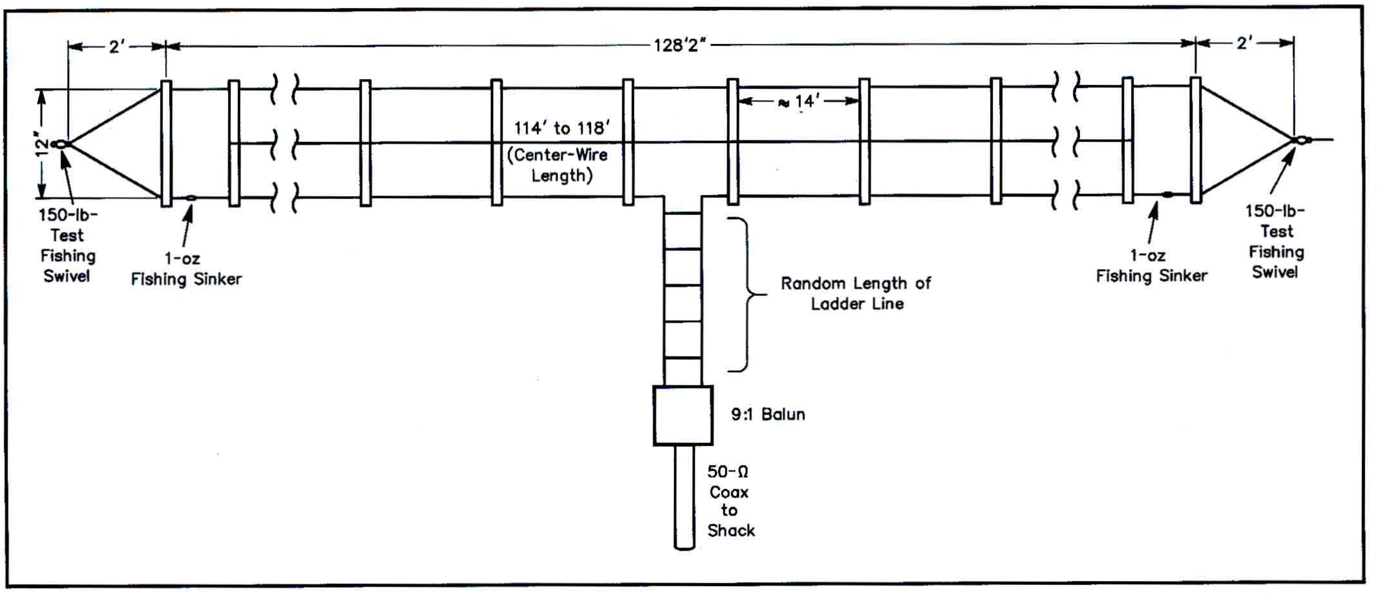

Figure 3—The open-sleeve folded dipole: simple and inexpensive. The antenna is fed with a random length of 450-Ω open-wire transmission line through a 9:1 balun.

The feed-point impedance of a folded dipole is about 300 Ω. Although 300-Ω ladder line is available, making the transition from 300 Ω to 50 Ω requires a 6:1 balun. Such baluns can be bought or made, but 4:1 or 9:1 baluns are much more common.

A Broadband 80-Meter Antenna

The antenna I came up with is shown in Figure 3. It's simply an open-sleeve version of the folded dipole. The resonator wire added midway between the two folded dipole elements is supported by the spacers already used for the folded dipole. That's all there is to it: a single wire down the middle of a folded dipole! One interesting result of adding the wire is that not only is the antenna very broadband, but by juggling the spacing and wire lengths a bit, Z_r is very close to 450 Ω, which fits in nicely with available transmission lines and a 9:1 balun. The transmission line operates with a very low SWR and can be of virtually any length.

A graph of the measured SWR for two lengths of the center wire (L_c) is shown in Figure 4. The measurements were made with considerable care, using Bird wattmeters. For L_c = 118 feet, the highest SWR is 1.5: 1, and is less than that over most of the band. For L_c = 114 feet, the worst-case SWR is 1.8:1, but the overall 2:1 bandwidth is extended to 800 kHz. This would be advantageous to MARS operators operating just above the upper band edge. Experimenting further, I shortened L_c to 112 feet, which pushed the 2:1 bandwidth up to nearly 1 MHz (3.3 to 4.25 MHz). For most hams, that may not be of great importance, but it's something to keep in mind.

Figure 3 shows the number and separation of the wire spacers. It's important to keep the spacers as light (and inexpensive!) as possible. The two spacers on each end have to be fairly stiff, so I used sections cut from solid fiberglass electric-fence wands.[5] The rest of the spreaders are made from half sections of ½-inch CPVC plastic pipe. They're about half the weight of the fiberglass wand spreaders. I could have used full sections of the CPVC pipe for the end spreaders but, for the same weight, they would have had more wind loading.

Summary

Modeling this antenna, which is essentially a transmission line, doesn't work very well on *MININEC*-based programs.[6] *NEC* programs such as *NecWires*[7] are needed, and even then, you have to use 50 to 100 segments per λ/2 for the final design. Using *NecWires*, the total computed loss was only 0.07 dB (1.6%) for #14 wire and 0.09 dB (2%) for #16. Combined with the very low loss of the open-wire transmission line, if a good three-core, 9:1 Guanella balun[8] is used, the overall efficiency will be quite good.

At best, these antennas will be close to the ground in terms of wavelengths. The

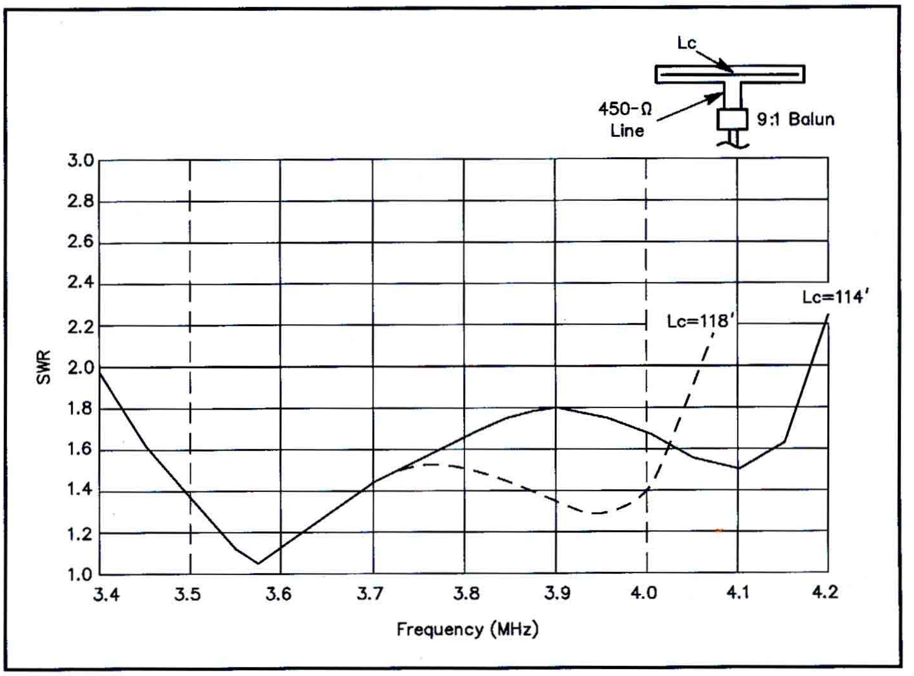

Figure 4—SWR curve of the open-sleeve dipole of Figure 3, showing curves for different lengths of the center wire (L_C).

ground effects are important and will affect the impedances and final dimensions. This antenna was modeled at a height of 70 feet over poor ground ($\epsilon_r = 13$, $\sigma = 2$ mS), which corresponds (more or less) to my location and support height. I only had to adjust the center wire a bit to get the predicted performance. At another location or antenna height, the final performance and dimensions may be different.

A folded dipole *loves* to rotate when being hoisted and it twists when the wind blows, which really upsets the SWR if the parallel wires short together. In Figure 3, I've included a couple of details that help reduce this problem. The ends of the dipole are not symmetrical. To aid in avoiding antenna twist, 1-oz fishing sinkers are added to the bottom wire on each end. I also use two heavy-duty (150-pound-capacity) fishing-line swivels at the antenna support points.

Performance isn't the only criterion for a good antenna. For most hams, cost is always a consideration. This design uses 380 feet of wire (a total cost of $34 at 9 cents per foot[9]) and about a buck's worth of 1/2-inch CPVC pipe. The CPVC can also be used for the center and end insulators. The 450-Ω open-wire transmission line costs 14 to 16 cents per foot (see Note 9), so add another $15 to the total. So, for $50, you've got everything but the balun and the lead-in coax. You've also got a darn good antenna.

Notes

[1]Roger Cox, WBØDGF, "The Open-Sleeve Antenna: Development of the Open-Sleeve Dipole and Open-Sleeve Monopole for H.F. and V.H.F. Amateur Applications," *CQ,* Aug 1983, pp 13-19.

[2]Gary Breed, K9AY, "Multi-Frequency Antenna Technique Uses Closely Coupled Resonators," *RF Design,* Nov 1994, pp 78-85.

[3]Bill Orr, W6SAI, "Radio FUNdamentals," The Open Sleeve Dipole, *CQ,* Feb 1995, pp 94-98.

[4]R. Dean Straw, N6BV, Ed, *The ARRL Antenna Book* (Newington: ARRL, 17th ed, 1994), p 2-32.

[5]These wands, which measure 3/8-inch in diameter and are 4 feet long, are available from farming supply stores and Sears.

[6]*ELNEC* is available from Roy Lewallen, W7EL, PO Box 6658, Beaverton, OR 97007. *AO 6.1* is available from Brian Beezley, K6STI, 3532 Linda Vista Dr, San Marcos, CA 92069, tel 619-599-4962.

[7]*NEC-Wires* is available from Brian Beezley, K6STI; see Note 6.

[8]Jerry Sevick, W2FMI, *Transmission Line Transformers* (Newington: ARRL, 2nd ed, 1990), p 9-28.

[9]Several *QST* advertisers offer 450-Ω open-wire transmission line. See the ads at the back of this issue.

Rudy Severns was first licensed as WN7WAG in 1953, became W7WAG the following year and got his Amateur Extra class license in 1959. An electrical engineer who received his BS from UCLA in 1966, Rudy is a senior member of the IEEE, an ARRL life member and presently works as an independent consultant for power electronics and power conversion design. QST