By Rich Wadsworth, KF6QKI

A Portable Twin-Lead 20-Meter Dipole

With its relatively low loss and no need for a tuner, this resonant portable dipole for 14.060 MHz is perfect for portable QRP.

My first attempt at a portable dipole was using 20 AWG speaker wire, with the leads simply pulled apart for the length required for a $^{1}/_{2}$ wavelength top and the rest used for the feed line. The simplicity of no connections, no tuner and minimal bulk was compelling. And it worked (I made contacts)!

Jim Duffey's antenna presentation at the 1999 PacifiCon QRP Symposium made me rethink that. The loss in the feed line can be substantial, especially at the higher frequencies, if the choice in feed line is not made rationally. Since a dipole's standard height is a half wavelength, I calculated those losses for 33 feet of coaxial feed line at 14 MHz. RG-174 will lose about 1.5 dB in 33 feet, RG-58 about 0.5 dB, RG-8X about 0.4 dB. RG-8 is too bulky for portable use, but has about 0.25 dB loss. For comparison, *The ARRL Antenna Book* shows No. 18 AWG zip cord (similar to my speaker wire) to have about 3.8 dB loss per 100 feet at 14 MHz, or around 1.3 dB for that 33 feet length. Note that mini-coax or zip cord has about 1 dB more loss than RG-58. Are you willing to give up that much of your QRP power and your hearing ability? I decided to limit antenna losses in my system to a half dB, which means I draw the line at RG-58 or equivalent loss.

TV Twin Lead

It is generally accepted that 300 ohm ribbon line has much less loss than RG-58. Some authors have stated that TV twin lead has similar loss as RG-58, which is acceptable to me. A coil of twin-lead is less bulky and lighter than the same length of RG-58. These qualities led me to experiment with it. One problem is that its 300 ohm impedance normally requires a tuner or 4:1 balun at the rig end.

But, since I want approximately a half wavelength of feed line anyway, I decided to experiment with the concept of making it an exact electrical half wavelength long. Any feed line will reflect the impedance of its load at points along the feed line that are multiples of a half wavelength. Since a dipole pitched as a flat-top or inverted V has an impedance of 50 to 70 ohms, a feed line that is an electrical half wave long will also measure 50 to 70 ohms at the transceiver end, eliminating the need for a tuner or 4:1 balun.

To determine the electrical length of a wire, you must adjust for the velocity factor (VF), the ratio of the speed of the signal in the wire compared to the speed of light in free space. For twin lead, it is 0.82. This means the signal will travel at 0.82 times the speed of light, so it will only go 82% as far in one cycle as one

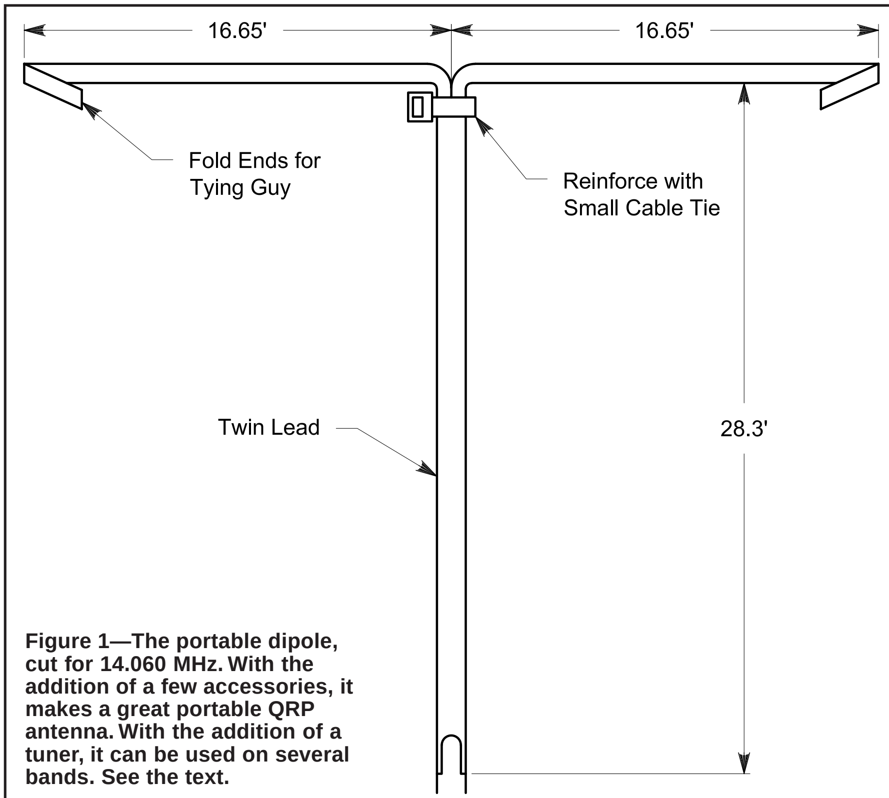

Figure 1—The portable dipole, cut for 14.060 MHz. With the addition of a few accessories, it makes a great portable QRP antenna. With the addition of a tuner, it can be used on several bands. See the text.

would normally compute using the formula 984/f(MHz). I put a 50 ohm dummy load on one end of a 49 ft length of twin lead and used an MFJ 259B antenna analyzer to measure the resonant frequency, which was 8.10 MHz. The 2:1 SWR bandwidth measured 7.76 to 8.47 MHz, or about 4.4% from 8.10 MHz.

The theoretical $^{1}/_{2}$ wavelength would be 492/8.1 MHz, or 60.7 feet, so the VF is 49/60.7=0.81, close to the 0.82 that is published. A $^{1}/_{2}$ wave for 14.06 MHz would therefore be 492×0.81/14.06 or 28.3 feet. I cut a piece that length, soldered a 51 ohm resistor between the leads at one end, and hoisted that end up in the air. I then measured the SWR with the 259B set for 14.060 MHz and found it to be 1:1. I used the above-measured 2:1 bandwidth variation of 4.4% to calculate that the feed line could vary in length between 27.1 and 29.5 feet for a 2:1 maximum SWR.

Now comes the fun part. With another length of twin lead, I cut the web between the wires, creating 17 ft legs, and left 28.3 feet of feed line. I hung it 30 feet high, tested, and trimmed the legs until the 259B measured 1:1 SWR. The leg length ended up at 16.75 feet. (Note: The VF determined above only applies to the feed line portion of the antenna.) There is no soldering and no special connections at the antenna feed point. I left the ends of the legs an inch longer to have something to tie to for hanging. I reinforced the antenna end of the uncut twin lead with a nylon pull tie, with another pull tie looped through it to tie a string to it for using as an inverted V. To connect the feed line to the transceiver, I used a binding post-BNC adaptor that is available from Ocean State.[1] My original intention of leaving the feed line free of a permanent connector was to allow connection to an Emtech ZM-2 balanced antenna binding post connectors. Since then I have permanently attached a short stub of RG-58 with a BNC, because I plan to either use it with my single band 20 meter Wilderness Radio SST, or with an Elecraft K1 or K2 with built-in tuner. I did this by connecting the shield to one side of the twin lead and the center conductor to the other side—no balun was used between the coax and twin lead.

After a year or so of use and further field testing, including different heights and V angles, I further trimmed the legs to a length of 16.65 feet. I found that the lowest SWR was usually obtained with the V as close to 90 degrees as I could determine visually.

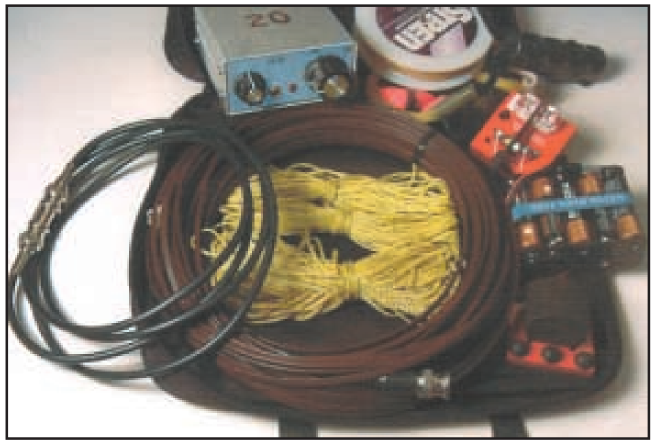

Figure 2—The author's portable station, including twin-lead dipole, 20-meter Wilderness Radio SST transceiver and support line. It all fits in the 8″×10½″×2″ Compaq notebook computer case.

Also, I found that the resonant frequency (or at least the frequency at which SWR was at a minimum) is lower if the antenna is closer to the ground, and vice-versa. For example, with the top of the V at 22 feet, the lowest SWR was measured at around 13.9 MHz, and with the top of the V at 31 feet, SWR was lowest at around 14.1 MHz. In both cases, SWR at 14.060 did not exceed 1.3:1.

I used Radio Shack 22 AWG twin lead that is available in 50 ft rolls. To have no solder connections, you need at least 45 feet. When I cut the twin lead to make the legs, I just cut the "web" down the middle and didn't try to cut it out from between the wires. It helps make the whole thing roll up into a coil, and the legs don't tangle when it's unrolled, since they're a little stiff. It turned out that the entire antenna is lighter than a 25 ft roll of RG-58. This antenna can be scaled up or down for other frequencies also. An even lower loss version can be made with 20 AWG 300 ohm "window" line, though the VF of that line is different and should be measured before construction.

How High?

Wait, you say—"After all that talk about having it a half wave up, you only have it up 28 feet." A 6 or 12 ft RG-58 jumper, available with BNC connectors from RadioShack, can be used to get it higher if the right branch is available. Since impedance at the feed point is 50 to 70 ohms, 50 ohm coax can be used to extend the feed line. I have used it in the field a few times as an inverted V, at various heights and leg angles, and used an SWR meter to double-check its consistency in different situations. SWR never exceeded 1.5:1, so I feel safe leaving the tuner home. For backpacking, I leave the SWR meter home, too!

And there's a bonus: Since it has a balanced feed line, it *can* be used with little loss as a multi-band antenna, with a tuner, from 10 to 40 meters. I quote John Heyes, G3BDQ, from *Practical Wire Antennas*, page 18: "Even when the top of the doublet antenna is a quarter-wave-length long, the antenna will still be an effective radiator." Heyes used an antenna with a 30 ft top length about 25 ft off the ground on 40 meters and received consistently good reports from all Europe and even the USA (from England). It will not perform as well at 40 meters as at 20 meters, however, though 10 through 20 meters should be excellent.

Testing, Testing

To test this theory, I recently worked some of Washington State's Salmon Run contesters and worked many Washington hams and an Ohio and a Texas station on 15 and 20 meters, with the antenna up 22 feet on a tripod-mounted SD20 fishing pole, using 10 W from an Elecraft K2 from central California. The K2 tuner was used to tune the antenna on 15 meters. Signal reports were from 549 to 599. Unfortunately, this was a daytime experiment and 40 meters was limited to local traffic.

At the 2001 Freeze Your Buns Off QRP contest, it was hung at 30 feet and compared to a 66 ft doublet up 50 feet on 10, 15 and 20 meters, using a K2 S-meter. There was little if any difference. At the 2001 Flight of the Bumblebees QRP contest I compared it, at 20 meters, to a resonant wire groundplane antenna with each antenna top at 20 feet and found it to consistently outperform the groundplane. I have concluded through these informal experiments that a resonant inverted V, when raised at a height close to or exceeding a half wavelength, produces the most "bang for your buck" and that extra length or height beyond that yields diminishing returns.

A ham since 1998, Rich Wadsworth, KF6QKI, is a civil engineer in private practice as a consultant. Since earning his license, he reports, that he has become obsessed with kits and homebrewing. You can reach Rich at 320 Eureka Canyon Rd, Watsonville, CA 95076; **richwads@compuserve.com**. QST

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