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A 20 Meter Sleeve Dipole Without the Sleeve

Here is a variation on the sleeve dipole for antenna experimenters to try.

Many *QEX* readers are familiar with the sleeve dipole concept, although it is likely few readers have built one. As shown in Figure 1, part A, the coaxial feed line going to the center of the dipole is routed through a quarter-wave conducting sleeve. The dipole sinusoidal RF current distribution is impressed on the sleeve and a quarter-wave wire forming the second half of the dipole. This geometry permits convenient feeding of the dipole from one end. Note that the electric field, E, at the ends of a dipole are maximum, so care must be taken with this high voltage feed point.

Despite the convenient geometry, a sleeve dipole is not all that convenient to construct, since it entails the tedious job of dressing a copper braid over a long piece of coax.

In this article I present a sleeve dipole equivalent antenna, minus the sleeve.

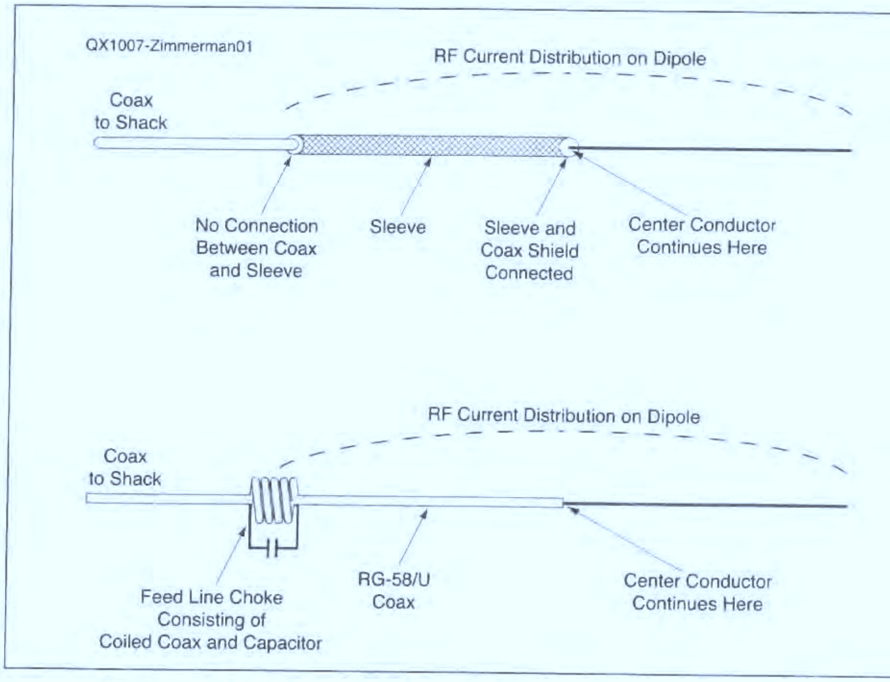


Figure 1 — Construction of a sleeve dipole (A) and the choke dipole (B).

Concept

The feed end of the sleeve forms one end of the dipole RF current distribution. Radio frequency current cannot bridge the sleeve/coax gap, as the gap represents a very high RF impedance. I propose replacing the sleeve and high impedance gap with a high impedance current choke, as shown in Figure 1, Part B. The sinusoidal dipole current then may be impressed on the exterior surface of the coaxial shield and the same quarter-wave wire as before.

Modeling

To make an effective current choke, I wound the coaxial cable to form a coil, and bridged it with an air variable capacitor to form a high impedance parallel LC network. For such a choke, we need to have some idea of the effective inductance and capacitance of the dipole itself. That is to say, we need to know the equivalent circuit model of a resonant dipole antenna.

For this equivalent circuit, I first turned to *EZNEC* and modeled a half-wave dipole in free space for 14.200 MHz.[1] I used a ¼ inch wire diameter to represent RG-58/U coax. A length of 10.181 meters provides the resistance and reactance values shown in Figure 2A and B. If this impedance, $Z = R + jX$, is plotted on a Smith Chart (Figure 3), we see the locus is very nearly the real 72 Ω circle. Well, not quite: the entire circle is rotated clockwise around the origin, as if bridged by a stray capacitance. Accordingly, I tested the candidate circuit model shown in Figure 4 with the impedance data in Figure 2A and B. The resulting component values R_{series}, L_{series}, C_{series}, and C_{stray} given in the Figure 4 caption reproduce the dipole impedance exactly (to within 0.01 Ω for the antenna R and X) between 13.9 and 14.4 MHz.

For readers interested in using this model for another amateur band at frequency f (MHz), the inductor and two capacitors may

[1]Notes appear on page 38.

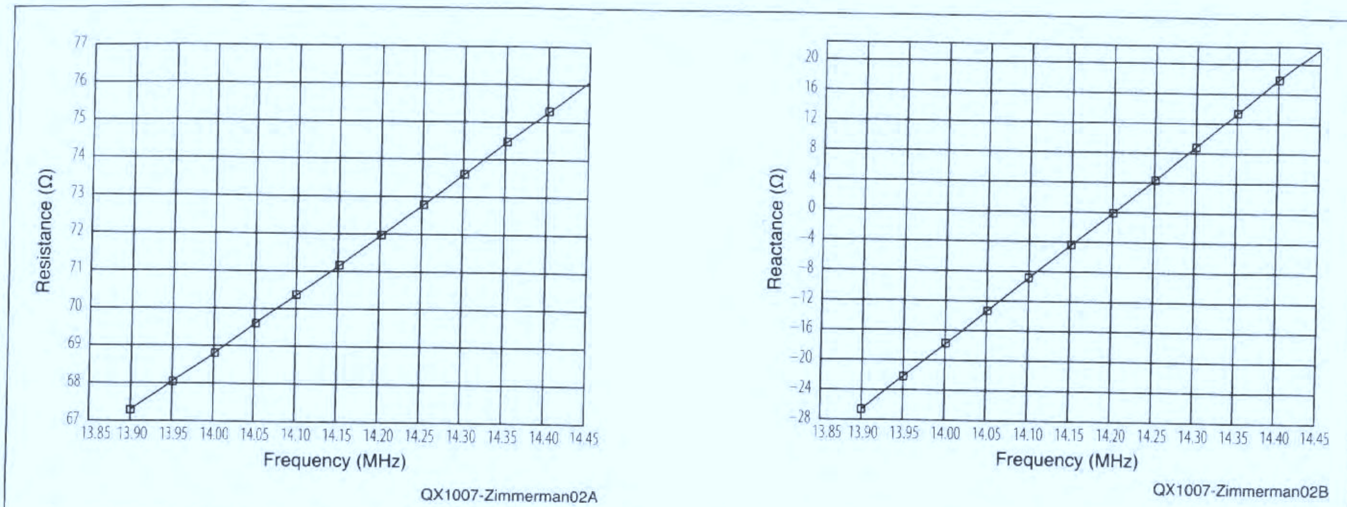


Figure 2 — Part A gives the resistance of the dipole as modeled on *EZNEC* for 14.200 MHz. The modeled reactance is shown at Part B.

be scaled by the ratio = 14.200 / f (MHz). Of course there is no need to scale the resistance, R_{series}; it remains the same independent of the dipole frequency.

Choke Construction

A good starting point for choke design is to use inductor and capacitor values approximately equal to those in the dipole itself. For my 20 meter inductor, I chose a target value of 7 μH. The resonating capacitor for 7 μH and 14.200 MHz is 24 pF. Using the *ARRL Single-Layer Coil Winding Calculator*, I chose 10 turns of coax on a 3 inch diameter mandrel with a total coil length of 2.0 inches.[2] After winding the coil of coax, I bared a ¾ inch segment of coax braid on each end of the coil. Then, using a soldering gun (260 W), I bridged the coil with a 10-100 pF air variable capacitor, as shown in Figure 5. My coil form was a plastic drink bottle. You can see strips of duct tape holding the coax coil turns in place.

To be sure the choke had sufficient impedance to keep RF current off the feed line, I tested the choke with an AEA Bravo VIA impedance analyzer, using 1 inch test leads. The resulting series impedance of the parallel tank is 1000 Ω, which was deemed satisfactory for 100 W operation. The data is shown in Figure 6.

The total length for the resonant dipole, from *EZNEC*, is 10.181 meters, half of which is RG-58/U coax and half of which is AWG No. 12 copper wire. The dipole center connection of the coaxial cable center conductor to the No. 12 wire is shown in Figure 7.

My backyard is small, and I had to install the dipole in a sloping manner. My installation is shown in Figure 8. The choke is on top of the bamboo pole at the left, and the No.

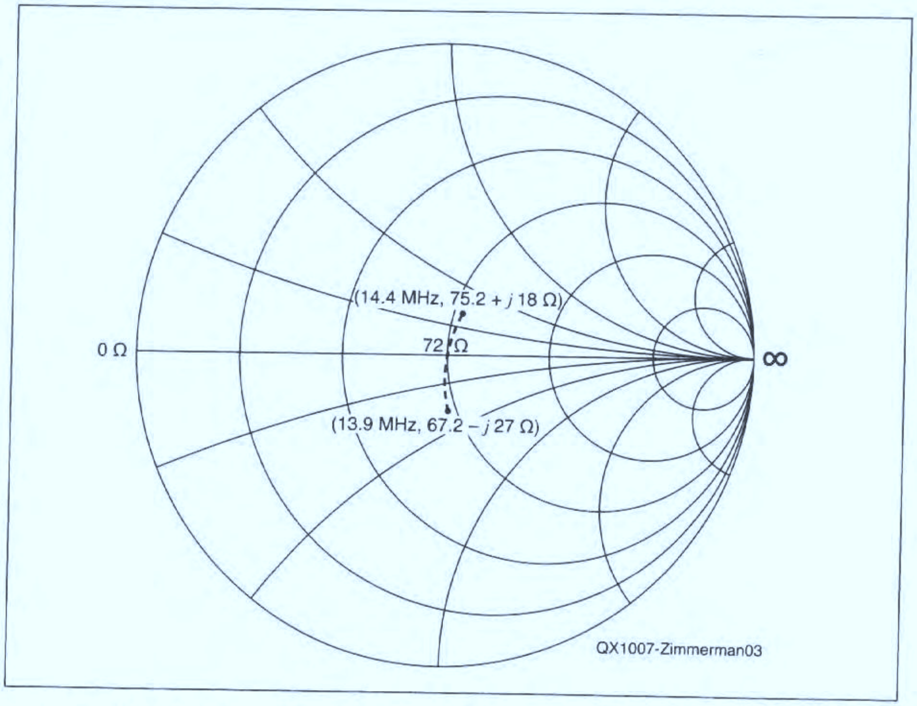


Figure 3 — Smith Chart with 72 Ω resistance at the center. The modeled dipole impedance is slightly shifted from the 72 Ω circle.

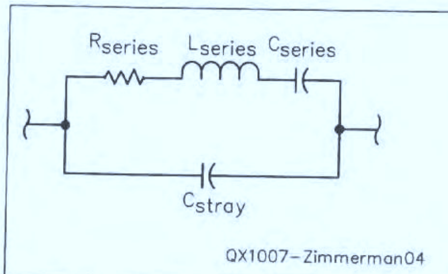


Figure 4 — This is the proposed circuit model of a resonant dipole antenna. For 14.200 MHz the values are: R_{series} = 71.4062 Ω, L_{series} = 7.2081 μH, C_{series} = 17.5906 pF, C_{stray} = 14.0387 pF.

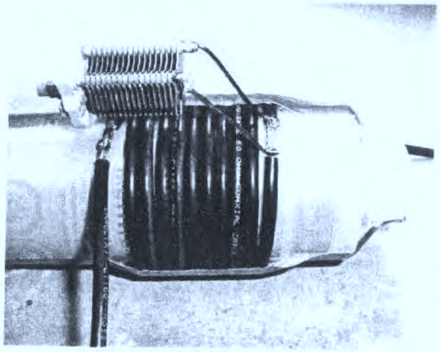


Figure 5 — This photo shows the 1000 Ω impedance current choke for 14.200 MHz.

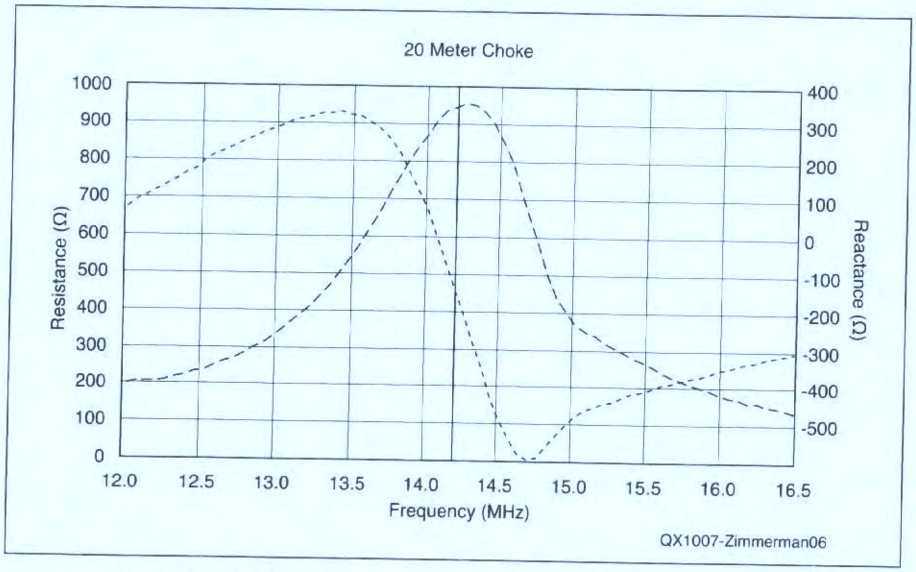


Figure 6 — Here is the measured plot of R and X for the current choke.

12 wire is supported at the right on a 9 meter push-up mast.

TUNE-UP

The dipole initially resonated at 14.350 MHz with an SWR of 1.46:1. The passband is primarily dependent on the dipole length, and less so on the choke tuning. I lowered the choke briefly, and slightly increased the capacitance; this brought the antenna center frequency to 14.250 MHz as shown in Figure 9. After tune-up, the choke (or at least the variable capacitor) should be protected in a weather-proof plastic box; do not use a metal box, as there is high RF voltage across the choke.

You may want to measure the capacitance value after the antenna is adjusted for the best operation, and replace the variable capacitor with a fixed-value unit. You could also just build the antenna using a fixed value capacitor in the range of about 25 to 35 pF. Be sure to choose one that can handle the high voltage point at the end of the antenna.

Summary

Initial tests were made at 25 W PEP. I checked into the Maritime Mobile Net on 14.300 MHz, with net control W4YKY in southern Georgia. Carl came right back with a 59+10 dB report and said, "Don't change anything!"

There is no evidence of RF in the shack. The rig works stably, and I can grip the cable with my hands and observe no SWR change.

The choke dipole is convenient for city apartment dwellers, or anyone who may prefer an "end fed" antenna arrangement. Performance at the 100 W level has been pleasing. I easily keep regular schedules with WP4G in San Juan, Puerto Rico. I wish to recommend this design to other readers.

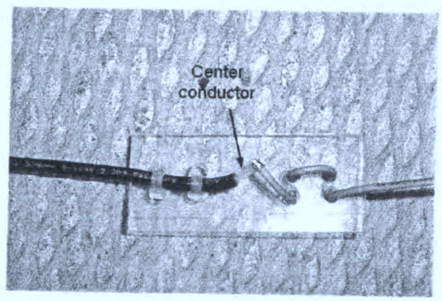


Figure 7 — This is the center feed point of my choke dipole.

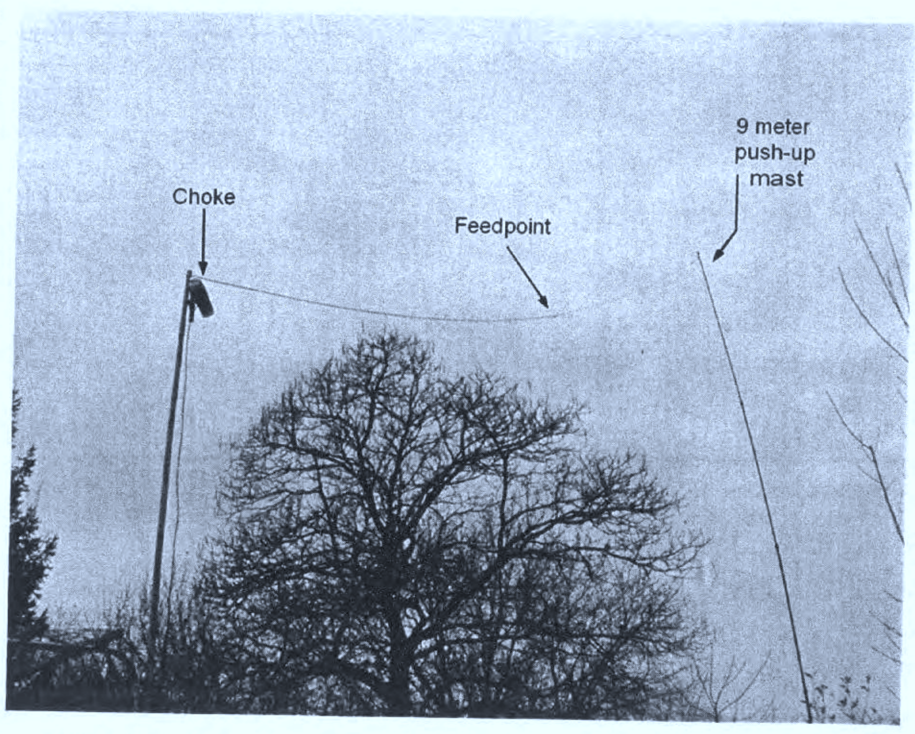


Figure 8 — The sloping dipole in my backyard. The push-up mast is 9 meters high.

Robert K. Zimmerman, Jr. was born in 1951 in Dupo, Illinois. He graduated from Southern Illinois University, Edwardsville, with BS and MS degrees in physics (1973, 1975) and then attended the University of Illinois, Urbana-Champaign, where he was awarded the MSEE degree in 1980. He has spent his entire career in radio science, working for Cornell University (Arecibo Observatory), NASA Goddard Spaceflight Center, Los Alamos National Laboratory (accelerator division), and most recently as a radar engineer on Kwajalein Atoll. He is presently involved in microwave antenna research at McMaster University, Hamilton, Ontario. An ARRL Life Member, Bob has been licensed as WN9PXG (1965), WA9ZSF, NP4B, V73BZ, and now as VE3RKZ. He is active primarily on 40 m and 23 cm.

Notes

[1]The author's *EZNEC* antenna model files for this antenna are available for download from the ARRL *QEX* Web site. Go to **www.arrl.org/qexfiles** and look for the file **7x10_Zimmerman.zip**.

[2]The *ARRL L-C-F and Single Layer Coil Winding Calculator* is available from your local ARRL dealer, or from the ARRL Bookstore. ARRL Order No. 9123, $12.95. Telephone toll free in the US 888-277-5289 or call 860-594-0355, fax 860-594-0303; **www.arrl.org/shop**; **pubsales@arrl.org**.

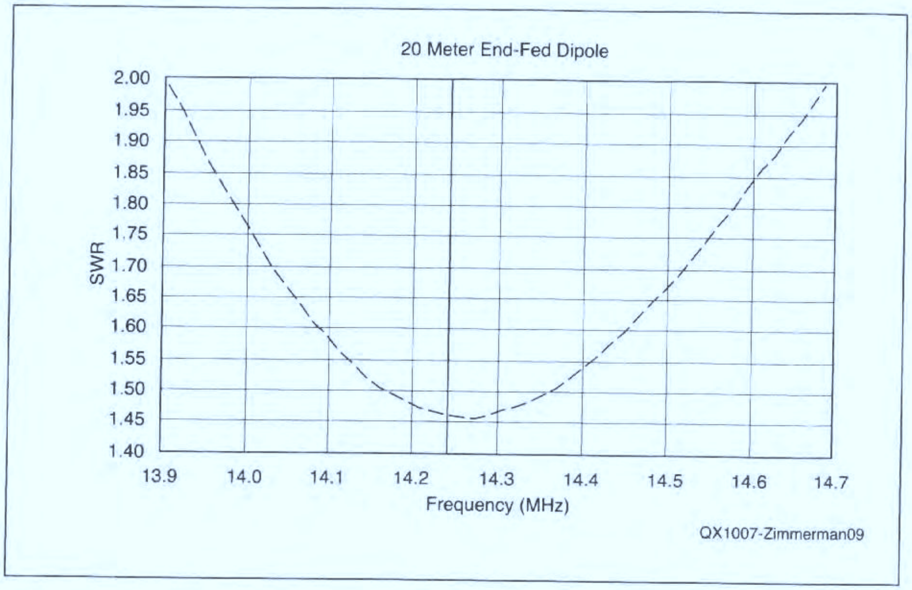


Figure 9 — The measured SWR plot of my finished choke dipole, after adjustment.

QEX

End-Fed Dipole *Lite*: Taking Kurt's Design to the Field

By Richard Fisher, KI6SN

Krusty Ol' Kurt N. Sterba's *Aerials* column in the August edition of ***WorldRadio Online*** sure got the attention of this trail-friendly radio enthusiast.

"What we have here is a coax-fed dipole, except that we don't have the coax hanging down from the center . . . Instead the feedline coax comes from one end of the antenna. Simple but elegant."

A dipole that is fed to the transceiver or tuner at one end and needing only one support at the other? Backpackers have got to like that. What could be more perfect for the trail?

Kurt went on to explain how he had been inspired by a design by James E. Taylor, W2OZH, published in 1991. After making critical refinements and improvements, Kurt would go on to come up with an end-fed dipole design of his own.

Taylor's "Resonant Feed-Line Dipole" employs a quarter-wavelength of wire and a quarter-wavelength of coaxial cable to form a half-wave dipole that's fed at one end. Mr. Sterba took a good idea and made it even better.

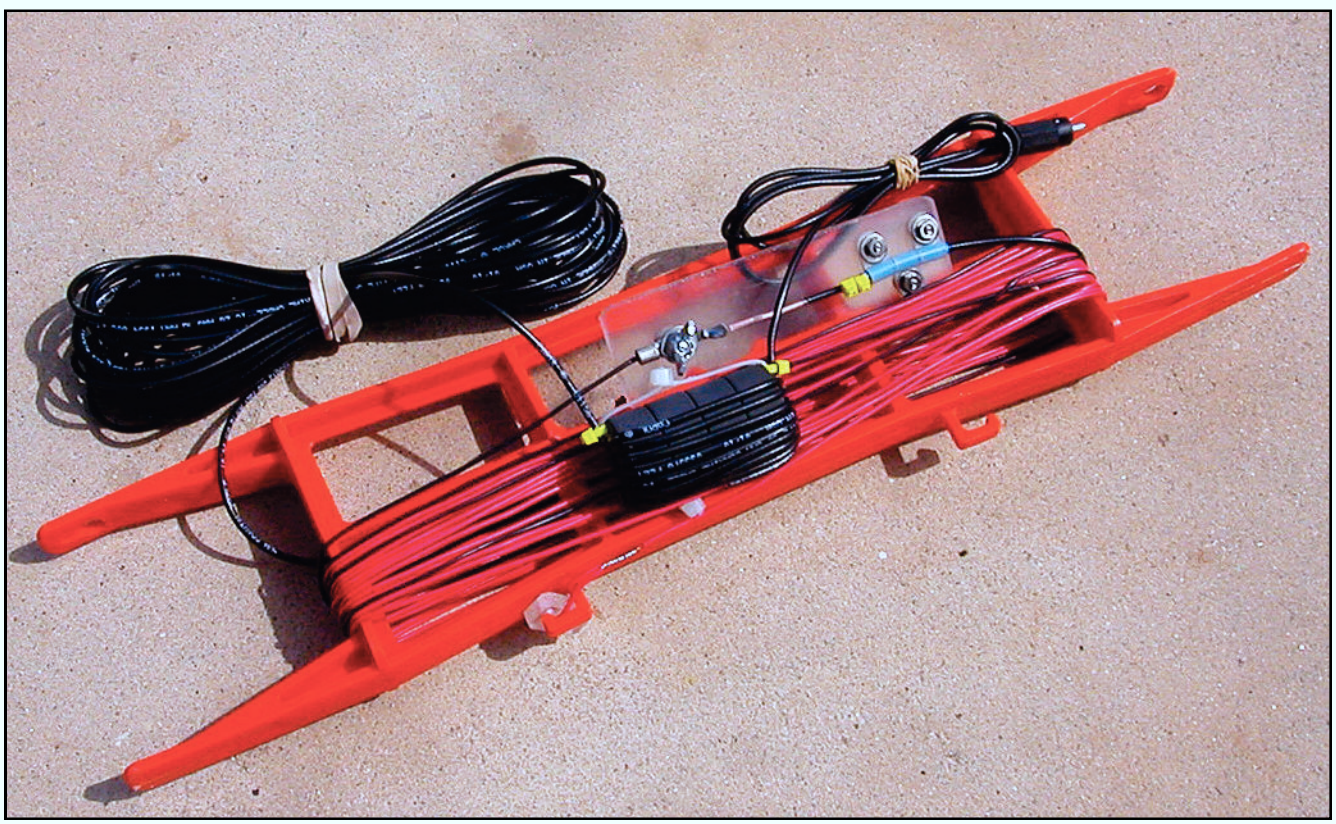
The theory behind this remarkable design is detailed in Kurt's August column. <http://worldradiomagazine.com/wro_issues/2010/WRO_08_2010.pdf> If you haven't read it, please do so – it'll make what follows so much easier to understand.

Theory Into Practice

One of the antenna's secret weapons is an RF choke positioned one-quarter wavelength down the coaxial cable from the dipole's center point. It's what establishes the resonant part of the coax, leaving a non-resonant length of 50-ohm RG-58 to connect to your transceiver or tuner.

Instead of employing W2OZH's six-inch-diameter air-wound coil choke, though, Kurt opted to use a much smaller coil for a 20-meter version with 10-turns of coax wound through two F240-61 stacked toroids. Much more efficient and reliable.

Unfortunately, the F240-61s are rather large ferrites to accommodate heavy duty RG-58 coax. That combination can



All wound up and ready to go, the trail-friendly version of Kurt N. Sterba's End-Fed Dipole Lite fits easily in a backpack and won't weigh you down on the trail. *(Photos courtesy of KI6SN)*

Stacked F114-61A toroids are one of the secret weapons of the trail-friendly End Fed Dipole Lite. Nylon wire ties hold the ferrite cores and coax in place.

weigh down a hiker in a real hurry.

Is there a way to duplicate this antenna in a trail-friendly configuration – light and durable with a small backpack "footprint?" Once again Kurt came through, describing an end-fed dipole "using RG-174U (50 ohm) cable and a toroid core choke just adequate for (a) five or 10-watt transmitter. RG-174U is a tenth-of-an-inch outer diameter."

In addition to much lighter coax, this trail-friendly design replaces the large F240-61 toroids with much smaller and lighter F114A-61s. The antenna measurements and choke requirements for this tidier version are the same as for the home-based higher power version.

With an *end-fed dipole lite,* though, we would really be in T-FR business.

Gathering the Pieces

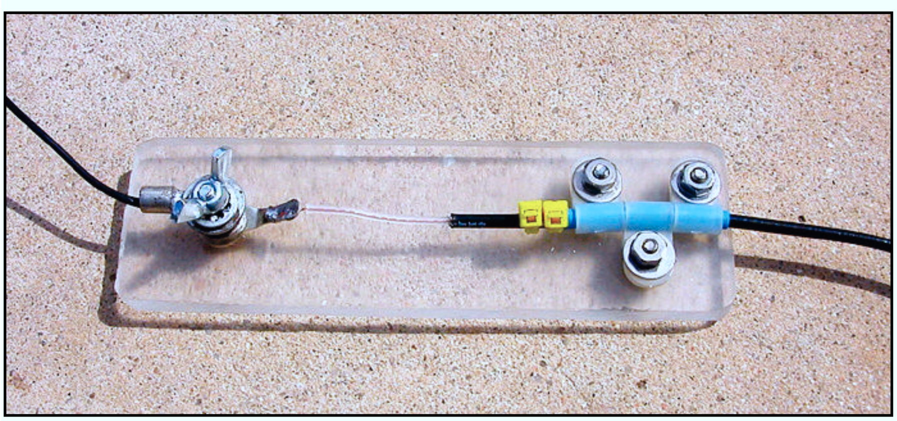
The parts list for the KI6SN trail-friendly 40-meter version of Kurt's design is pretty spartan: 40-feet of RG-174U, four F114-61A toroids, about 35-feet of No. 22 stranded hook-up wire, a couple of pieces of one-quarter-inch Plexiglass, nylon wire ties, and a handful of nuts-bolts-and-washers. You'll need some elbow grease, as well.

Several parts houses carry F114-61A toroids. I got mine from Palomar Engineers in Escondido, California. <http://www.palomar-engineers.com/> They're pretty inexpensive and shipped overnight.

The RG-174U was found locally, but this lightweight coax is carried by many distributors and is readily found on the Internet.

The hook-up wire came right from RadioShack (RS 278-1224). There are three 25-foot-long rolls of the stranded wire in the package, so you'll have to splice two rolls together to get the necessary length for a 40-meter quarter-wave wire. *No big deal.*

The Plexiglass for the dipole's center connection point – one-quarter inch thick and shaped rectangularly to 4.75-by-1.25



Quarter-inch thick Plexiglass was used to secure the center point of the KI6SN trail-friendly version of Kurt's End-Fed Dipole Lite. The 40-meter single wire portion of the antenna can be easily changed for other bands by removing the wing nut, left, and attaching a quarter-wave wire for another band.

inches – can be found along with the other assorted hardware needed at most home improvement stores.

Let's Go . . .

OK, time to get building. I was shooting for a resonant frequency of 7.040 MHz – a popular T-FR hangout on 40 meters. A half-wave at that frequency is: 468/7.040, or 66.48 feet. Divide that by two to get a quarter-wave and you'll have 33.24 feet. That's about 33-feet, 3-inches – our magic number for both the quarter-wave resonant portion of the RG-174U and for the quarter-wave single wire. We'd have several feet of non-resonant coax beyond the choke point to connect to the transceiver or tuner, but we'll get into that later.

We started by stacking the four toroids atop one another and cinching them with nylon wire ties. Next, the "center" connection point of the RG-174U was prepared by carefully cutting the coax's black outer plastic insulation with a knife and exposing about 1.5 inches of the coax's braid. We next cut away the outer braid with a small pair of scissors, leaving just the insulated center conductor. After stripping away a bit of the center conductor insulation, we added a solder lug to the end of the inner conductor. At the center point of the antenna, the coax's outer braid isn't connected to anything.

The total exposed portion of the insulated center conductor (center conductor plus solder lug) is two inches from where the braid ends.

Next, we soldered together the ends of two rolls of the 25-foot-long stranded No. 22 wire. Since there are two inches of coax center conductor exposed at the Plexiglass insulator, we'd have to subtract two inches from the quarter wave measurement for the single wire (that's 33-feet, 3-inches minus 2-inches, or 33-feet, 1-inch). That's how long the single wire would need to be.

We'd need to factor in the length of a solder lug on one end of the single wire and a loop of the wire through a small Plexiglass insulator at the other end. Then: Measure twice. Cut once.

Time to make the Plexiglass center connection point. After cutting and shaping the plastic, we drilled four holes:

- One for a bolt-washers-wing nut combination that would be the connection point between the RG-174U center conductor and the single wire part of the antenna.
- Three other holes would accom-

The Plexiglass center piece is the connection point for the RG-174U coax and No. 22 stranded hook-up wire in the trail-friendly End-Fed Dipole Lite.

A piece of string was used at the RF choke point of the RG-174U coax to tie-off the EFD about four-feet above the ground. Non-resonant coax leading from the bottom of the toroid stack goes to the transceiver or tuner.

modate nuts, bolts and washers to mount three small plastic cable clamps to keep the RG-174U firmly in place on the Plexiglass.

Finally, it was time to measure one-quarter wave of coax to determine the point at which to slide the toroid stack into place to make the RF choke.

We precisely measured from the braid ending point on the Plexiglass down the coaxial line 33-feet, 3-inches. At that point we wound 10-turns of the RG-174U through the toroid stack and secured the lash-up with a couple of small, yellow nylon wire ties. The coax length that was left over would be used to reach the feed point at the transceiver or tuner.

With this end-fed dipole, the coax is connected at the transceiver or tuner just as you would any conventional center-fed dipole.

I wanted to be able to make this a multi-band field antenna, so the single quarter-wave wire is connected to the coax inner conductor on the Plexiglass using a wing nut. Just disconnect the 40-meter wire, put on, say, a 20-meter wire and reposition the toroids along the coaxial line at one-quarter wave for 14 MHz. You're good to go. *Pretty cool.*

But Will It Work?

After soldering an RCA-style plug to the end of the coax for the transceiver/tuner feed point, it was time to take Kurt's trail-friendly End Fed Dipole Lite to the field for a smoke test. To make things easy to handle, we wrapped the entire antenna on an orange plastic wire/rope organizer from the hardware store. It would fit nicely in our backpack and unfurled easily.

In the back yard, the single wire end of the dipole – with insulator – was hoisted about 20-feet into a tree. The coaxial end was tied-off at the RF choke point about four feet above ground. The remainder of the coax was fed through a tuner to a NorCal-40A QRP transceiver powered by a 12-volt gel-cel battery.

Running a little less than one-watt, the end-fed dipole tuned up beautifully – no problem achieving a 1:1 SWR. It was mid-afternoon on a Friday. Forty meters was pretty noisy and void of signals. *Let's hope for the best.*

Eureka!

After a couple of CQs, we hooked up with Bill Ferrell, WB6CRM, several hundred miles away in West Sacramento, California. *Wow, it's working – even under these lousy conditions and at less than one watt output.*

Next, Brian Hunt, KØDTJ, came back from Half Moon Bay up the California coast. We chatted solidly for about a half hour, despite the QRN (static) and QSB (fading). His Elecraft K3, inverted V antenna and operating skills did a great job pulling me through. He is several hundred miles from me, as well.

It was proof positive this antenna *really works*. Perfect for the trail and what fun to use.

For any dipole fan who wants to try a no-nonsense antenna that's easy to build, carry and put up and take down in the field, look no further. This trail-friendly version of Kurt's EFD is a beautiful performer.

Paul RaBu

RFD-1 and RFD-2: Resonant Feed-Line Dipoles

This unique design offers simplicity and general utility. In short, these are "reel" great antennas for the HF bands.

By James E. Taylor, W2OZH
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During several decades of operation on the 80-meter band, I have encountered a number of hams who need an antenna system that is efficient, simple to construct, and yet can be deployed easily in difficult locations. The resonant feed-line dipoles described here provide an excellent match to the transceiver without a separate antenna tuner. They are easily transported on plastic cord reels. The basic design is extensible to other bands—all of this without a dangling feed line to contend with!

Consider some realistic situations encountered by fellow hams in their efforts to get on 80 meters:

Scenario 1: You live on a small suburban lot with trees, but there is no way to stretch a straight 120-foot-long dipole with a feed line.

Scenario 2: Your small backyard ends at the edge of a steep decline. A radiator wire could be snaked through the trees, but running a separate feed line is out of the question.

Scenario 3: You live in a high-rise building and could secretly stretch a wire upward or downward, but there is no way to install a feed line.

Scenario 4: You're going on vacation to the mountains and you know that your cottage is nestled among hundred-foot-high pines. You can take along a bow and arrow and cord, but then what would you do?

In response to these problems, I began to search for a universal solution under the following ground rules. (1) No separate antenna tuner would be required, (2) the antenna could be deployed with no more difficulty than stringing up a length of coax, and (3) the antenna could be easily stored and unwound from a cord reel without a tangle of cable and wire.

Several years ago I used a 10-meter vertical linear coaxial sleeve antenna, as shown in Fig 1. A vertical dipole is constructed from a quarter-wave whip and a quarter wavelength of shielding braid. Its feed line passes through the braid, yielding a simplified geometry. Although this concept could be adapted to 80 meters, who wants to deal with 60 feet of shielding braid? The important lesson I learned was that the RF current has no trouble traveling up the inside of the coax and making a 180° turn to travel back on the outside of the braid!

Because this is true, perhaps we don't need the separate outer braid. Why not just use the outside of the coax itself? If we do this, however, how do we let the RF "know" when it should stop flowing and reflect back toward the center of the radiator, as it did when it came to the end of the added braid in the 10-meter vertical? The current on the outside of the coax shield is called "common-mode" current—there is no counteracting equal and opposite current as there is inside the coax. One design approach utilizes the primary function of a balun transformer: to place an unbalanced reactance in the path of this common-mode current without affecting the desired balanced transmission line currents. The development of this concept is discussed in the Appendix.

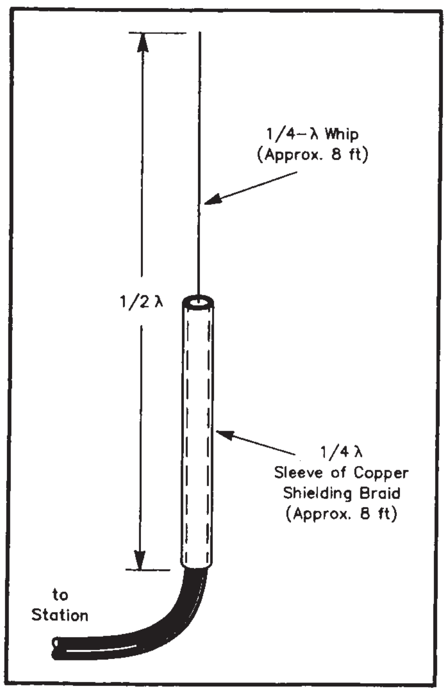

Fig 1—A vertical linear coaxial sleeve antenna for 10 meters.

The common-mode current on the coax shield is transformed by a quarter-wavelength stub to maximum near the transceiver. It was not surprising to note experimentally that a coil of a few turns placed at the fed end of the dipole decreases the resonant frequency of the system substantially (because of the added inductive reactance). However, an unexpected dividend of this is that, at the resonant frequency, an almost perfect impedance match to the 50-ohm source is realized! Now we have the design for our simplified antenna system! We can increase the resonant frequency by moving the coil along the cable away from the current maximum while retaining the perfect match. And at the same time we can decrease the common-mode current on this part of the line, because of the coil's inductive reactance. For the values chosen, the coil is near self-resonance from the distributed capacitance of the coil windings. The equivalent parallel-resonant circuit serves to increase the reactance at this point in the antenna, which assures a reflection when the RF reaches this virtual end of the dipole. To my knowledge, this configuration and method of resonating is unique and novel, and I refer to it as a T choke.

Construction, Installation and Adjustment

The simple arrangement of the resonant coaxial linear dipole is shown in Fig 2. The

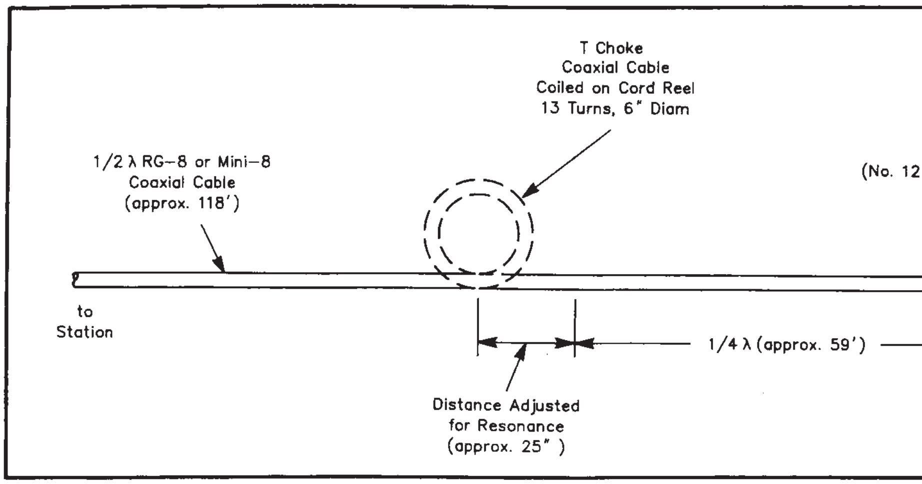

Fig 2—The RFD-1 (resonant feed-line dipole) antenna for 80 meters.

dimensions and test results are for a nominal frequency of 3.95 MHz. To dramatize the simplicity of the antenna, I list all required parts in Table 1.

The coaxial cable connector is assembled at the input end of the coax for connecting to the transceiver. The center conductor of the far end of the cable is connected to the antenna wire to form a hook and eye, and is securely soldered. This junction is potted in the center of a short length of PVC pipe to form a robust center insulator assembly. At the outset, 13 turns of cable can be wound on the cord reel at a point approximately 59 feet plus 25 inches from the center of the dipole. The 13 turns can then be taped in place on the reel with duct tape or equivalent. The remaining coax and wire can now be wound on the reel for ease of transporting. To avoid kinks when unwinding, secure the end of the wire and rotate the reel, keeping the wire and coax taut.

Ground losses are a great enemy of an HF antenna, especially at the lower frequencies, so place the dipole for 80 meters as far above the ground as possible! After installation, check the resonant frequency with a noise bridge or an SWR meter. If these construction details are followed, the resonant frequency should be approximately 3.95 MHz. If the resonance indication is indefinite or if the resistance is not close to 50 ohms, adjust the self-resonance of the coil by moving the turns slightly on the reel. This alters the inter-turn capacitance, permitting adjustment of the reflection of RF at the end of the dipole. During this adjustment, remember that the greatest effect is between the input and output turns, where the voltage difference is greatest. If you want to lower the resonant frequency of the antenna, remove the tape and rotate the reel to increase the 25-inch distance, thereby increasing the length of the dipole. This is done in a manner to retain the 13-turn coil—you are winding and unwinding equal lengths of cable. When the desired resonant frequency is attained, you are ready to operate! This is a broadband antenna, and not much adjustment is required.

Table 1
RFD-1 Parts List

- 1—118-foot length RG-8X (minifoam) coaxial cable
- 1—59-foot length no. 12 stranded or Copperweld wire
- 1—PL-259 male coaxial cable connector
- 1—10-inch-diameter cord reel (Doscocil model no. 32500 or equiv.)
- 1—3-inch length of ½-inch OD PVC pipe (for center insulator)
- 1—Epoxy potting compound (sufficient to fill pipe)

The 13 turns is mentioned only as a nominal coil size. I have used both 11-turn and 13-turn coils. Self-resonance can be adjusted as mentioned earlier. As the number of turns is increased, the initial 25-inch distance will be decreased. For example, in my test installation a change from 11 turns to 13 turns altered this distance required for resonance from 68 inches to 25 inches. A greater impedance at this point serves to improve the isolation of the dipole from ground.

The RFD-2 for Two-Band Operation

The preceding construction information is for an antenna dedicated to a single amateur band, the RFD-1. With a slightly different configuration, referred to as the RFD-2, the RFD-1 design can be extended to cover the 40-meter band without severing the coaxial cable. Conversion from 80 to 40 meters and back requires only a few minutes. The RFD-2 design allows you to change operation to 40 meters for a few days without permanently altering the 80-meter lengths. In other words, the total dimensions of the 80-meter coaxial feed-line dipole are retained but operation is adapted to 40 meters. This is done simply by winding coaxial cable on reels. This is readily achieved by altering the winding of the coax on the original reel and then adding a second coil near the far end of the dipole. Once the values have been established, this band change is accomplished simply.

The RFD-2, as it has evolved at W2OZH, is shown in Fig 3. Total dimensions are given in Fig 3A. The length of the feed line has been increased from that of the RFD-1 to 143 feet to make allowance for the cable used in the 13-turn coil. This assures an isolating stub which is approximately ¼ λ on 80 meters, and at the same time permits a stub length that is close to ¾ λ on 40 meters, thereby achieving the desired high impedance for isolation on both bands. Also, the no. 12 terminating antenna wire has been replaced by a length of coaxial cable—the outer jacket provides insulation so the coax can now be coiled to provide the desired dipole length on 40 meters.

As pointed out earlier, a self-resonant coil is used to assure a high coefficient of reflection at the fed end of the 80-meter dipole. For other bands it is necessary to calculate the approximate number of turns required to approach self-resonance. A suitable winding for 80 meters was determined to be 13 turns on a 6-inch diameter reel, so the numbers for other bands can be obtained by a simple scaling calculation. Details are given in the Appendix. For guidance in adapting the design for the other HF bands, the approximate number of turns for the terminating coils is shown in Table 2.

For wavelengths shorter than 40 meters it may be desirable to use a radiating section longer than ½ λ. The length either side of center can be any odd number of quarter wavelengths. For example, on 20 meters the radiator could be 3/2 λ (three quarter waves either side of center). Depending upon the antenna orientation, the additional radiation lobes may be advantageous. Also, the unused conductor lengths at the ends are less apt to cause trouble because of parasitic excitation from the main radiator.

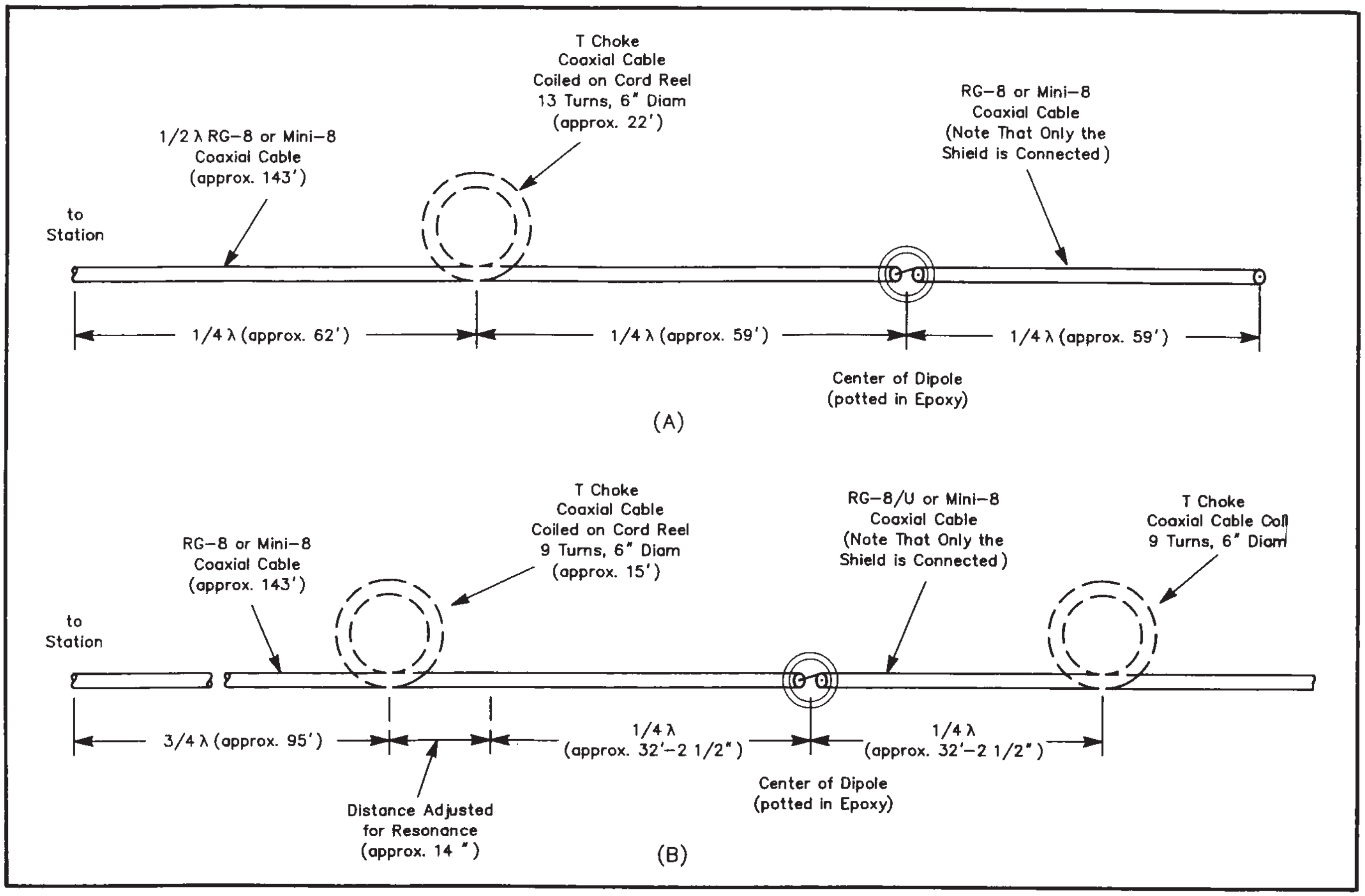

Fig 3—The RFD-2 antenna can be configured for either of two bands. Shown at A is the setup for 80 meters, and at B for 40 meters.

Arrangement and Construction

From Table 2, for the 40-meter band we need to reduce the resonant coil at the input end of the dipole to nine turns, and we need to move the coil along the coax to a point slightly more than 32 feet, 2¾ inches from the center. This is half the dipole length calculated for 7.26 MHz with an allowance for tuning adjustment, using the dipole-length approximation equation, $L = 468/f_{MHz}$. As with the RFD-1, this coil establishes the desired high impedance at the fed end of the dipole.

In addition, we need to establish a high impedance at the far end of the dipole because, in this case, the desired end of the 40-meter dipole does not coincide with the end of the conductor. This is because we want to retain the full length of the conductor measured for the 80-meter band, rather than cutting it. The desired high-impedance reflecting termination is achieved by use of a second, 9-turn, self-resonant coil of coax.

Fig 3B shows the RFD-2 configuration for 40 meters. A cord reel can be used for the second coil, although any suitable insulating 6-inch-diameter form can be used. I wound the coil in two layers using a 1-gallon windshield-washer-fluid bottle. After the windings had been properly adjusted, I taped them in place with duct tape, and slipped the coil off the form so it became self-supporting.

Table 2
Scaling of RFD-1 to Other Bands

Band	*Frequency*	*Turns*
160 m	1.90	19
80 m	3.95	13
40 m	7.26	9
30 m	10.12	8
20 m	14.29	7
17 m	18.14	6
15 m	21.38	6
12 m	24.96	5
10 m	28.65	5

As with the RFD-1, it is desirable to place the antenna as high above ground as possible to reduce ground losses and to help achieve low-angle radiation, if that is desired. The dipole does not have to be installed in a straight line, and if you can gain appreciably greater height by bending it, this may be a desirable compromise.

After the antenna with its two coils is erected, measure the resonant frequency using a noise bridge or an SWR meter. If the construction details have been followed, the resonant frequency should not be far from the nominal value of 7.26 MHz. The resonance point and the input resistance can be shifted moderately by both changing the 14-inch offset distance and changing the inter-turn spacing of the coils. The greatest effect is produced by changing the spacing between the input and the output turns (that is, between coil turns 1 and 9). This is because the voltage difference, and therefore the change in capacitive influence, is greatest there.

Results

My experience in developing antennas is that the good concepts really "want to work," and this antenna was no exception. Noise-bridge measurements with the RFD-1 indicated an input resistance at resonance of 49 ohms, and from a practical standpoint the SWR is 1:1. An H-field antenna probe was used to evaluate the power radiated at the center of the dipole compared with that at the current loop near the feed-point. The current ratio was 5.5 to 1, which corresponds to a power ratio of 30 to 1, or 15 decibels. This indicates that the coil is very effective in attenuating the common-mode current flowing back toward the feed point.

For the RFD-2 with the 40-meter dimensions shown in Fig 3B, the initial resonance point was within the 40-meter phone band and the SWR was essentially 1:1. Slight adjustment brought the resonant frequency up to the desired value, and the input resistance was very close to 50 ohms. A salient characteristic of the RFD antennas is the ease with which an impedance match is attained. It appears always to be easy to get a reflected power indication of zero. This is probably because the common-mode current on the shield of the coax is indistinguishable from the desired radiating current—in other words, the common mode is used rather than avoided.

Appendix

When the separate outer braid of the antenna shown in Fig 1 is removed, there must be some way to let the RF "know" when it should stop flowing on the shield of the coax and reflect back toward the center of the radiator. A balun box that I made up for another purpose is one approach: 30 turns of bifilar winding on an Amidon T-200-2 iron-powder toroidal core. The turns formula for such a balun transformer is

$$T = \sqrt{\frac{\text{desired L } (\mu H)}{A_L}}$$

where

T = no. of turns

A_L = inductance index (microhenries per 100 turns)

From this, the inductive reactance for unbalanced current is

$$X_L = 2\pi fL = \frac{2\pi fT^2A_L}{10^4}$$

At a frequency of 4 MHz, this 30-turn coil has an unbalanced reactance of only 270 ohms. We would need about ten of these in series to support the RF field at the end of a dipole antenna!

An alternative method involves placing a toroidal isolation transformer in the coaxial line at the fed end of the linear dipole. I actually wound such a transformer on two stacked T-200-2 cores, to provide a 1-kW power capability. This configuration worked, after a fashion, but the impedance match was less than desired, probably because of excessive capacitance between secondary and primary windings. However, before I took steps to control this, a simpler approach came to mind.

We need to isolate the transceiver from the fed end of the dipole, so why not cut the coaxial feed line to be a quarter wavelength long? (This length is measured in free-space, not in the line.) This serves to transform the high impedance of the fed end of the dipole to the low impedance at the grounded transceiver. Any unused portion of this approximate 60-foot length of coax can be wound in a coil and used for further isolation and, as it turns out, for tuning the system to resonance.

Scaling for a Second Band

For coverage of a second band, we would like to have the same inductive reactance that we had for the 80-meter coil. From handbooks, the inductance of a coil of assumed dimensions is

$$L = AN^2$$

where

A = a constant determined by the coil geometry

N = number of turns

Thus, we have for the reactance

$$X_L = 2\pi fL = 2\pi fAN^2$$

For equal reactances, we can calculate N_2, the new number of turns, at frequency f_2, from N_1, the known number of turns at frequency f_1, by the equation

$$N_2 = N_1 \sqrt{\frac{f_1}{f_2}}$$

Jim Taylor has been an active ham for "several decades." A retired Xerox research staff manager, Jim's numerous articles in ham journals have concentrated on 80-meter antennas for mobile and fixed applications. Two designs which have attracted some attention are "The 'Mobiloop'" (QST, Nov 1968, pp 18-19) and "An 80m Phased Array" (73, Mar 1975, pp 52-54, 56).

New Books

HAM STUFF

By Walt Garrett, NØMAL. Published by GAI Systems Press, PO Box 5832, St Louis, MO 63134. 1991. Softcover, 8½ × 11 inches, 392 pp. $19.95.

Reviewed By Brian Battles, WS1O

A well-known George Carlin comedy album is entitled *A Place for My Stuff.* If Carlin were a ham, this book would be where his stuff would indeed be listed. *Ham Stuff* is a reference volume that lists nearly every resource imaginable for ham radio information, products and services. (The author estimates he included 80% of the sources available, but I sure can't think of anything that's missing!)

The book is divided into 19 chapters in three main parts: Stuff to Do, Stuff to Buy and the Ham Stuff Directory. There are comprehensive entries for Amateur Radio organizations, museums, public service groups, transceiver and accessory manufacturers, maps, vacation and rental QTHs, Scouting, summer camps, license plates, publications, equipment, hamfests, scholarships, dealers, instruction, examinations, clothing, software, SWLing, equipment collecting, charts, jewelry, kits, modifications, antennas, bumper stickers, towers and just about anything else you can think of. It even lists ARRL officers, Directors and Section Managers as of March 1991.

There are no schematics, tables, charts or lengthy essays, though. *Ham Stuff* is a compendium of comprehensive listings that tells you where to obtain products, services or information. It's set in a pleasant typeface on large pages and is devoid of artwork, except for some manufacturers' logos in the equipment sections.

New Products

The ARRL and QST *in no way warrant products described under the New Products banner.*

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☐ The QSL Post Office will mail US QSL cards via First-Class mail to any US or Canadian destination (and Canadian cards to any US address), postage-free to the sending ham. Registered hams sign a form permitting the QSL Post Office to insert their cards in no. 10 envelopes with a circular entitled *Ham Radio Bulletin*, which contains advertising from Amateur Radio equipment manufacturers and vendors, news and hamfest listings. Registered hams may send groups of standard-size QSL cards as often as they wish. For information and rates, send a business-sized SASE to QSL Post Office, PO Box 28055, Lakewood, CO 80228.

MONOBAND YAGIS REDESIGNED

☐ Hy-Gain has updated two of its single-band Yagi antennas based on sophisticated "method of moment" computer modeling.

The older models 205BA-S and 155BA-S were changed and renamed the 205CA and 155CA, respectively, and feature enhanced front-to-back ratios. The 205CA, with a suggested retail price $762, has a new adjustable beta match with stainless steel hardware and a setting for the 17-meter band. The 155CA, with a suggested list price of $430, has standard settings for CW, mid and phone, and an optional setting for 12 meters. Telex Communications Inc, 9600 Aldrich Ave S, Minneapolis, MN 55420; tel 612-884-4051, fax 612-884-0043.