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QRP-France with a "Junk Box Shorty Forty" Antenna

Just when you think you've seen them all, along comes a small, portable, resonant antenna. Whether for portable use or simple experimentation, the Shorty is sure to please!

As an on-and-off ham for many years with the good fortune to travel France on business, I was especially happy to note our country's participation in the CEPT reciprocal licensing program. CEPT makes it possible for US hams to take their gear to more exotic locations without a lot of planning and paperwork. (Hams who live in exotic locations are also free to operate in more mundane regions—a distinct disadvantage of living in paradise.) When a recent *ARRLWeb* story described how easy it now is to operate in many European countries, I was a little nervous—but excited enough to think about giving it a try. Could I pull enough stuff together to make a go of it? Most importantly, could I make an effective antenna that would fit into my suitcase?

With a weeklong business trip to France less than a week away, I committed to operating as F/KF8JW/P during the evening hours from the balcony of my hotel room. The challenge was to take enough gear to succeed without overwhelming the purpose of the trip (business).

To travel light, 40-meter QRP with my tiny Norcal 40A transceiver seemed like the best bet. Two watts of CW should be plenty if I could come up with a reasonable antenna.

To coexist peacefully with the other items in my suitcase, my entire station had to fit into a space of about 12 × 6 × 4 inches. The antenna would have to be dropped (spooled) from an open window or hung from a tree. It would have to tune effortlessly and be relatively easy to handle. And, because I am familiar with one of the hotels on my itinerary, I knew a full-size dipole would be way too big for the space available.

A quick look in *The ARRL Antenna Book* turned up a curious antenna dubbed the "Shorty Forty," a "short" antenna originally conceived by Jack Sobel, WØSVM.[1] There weren't many construction details, especially concerning the feed line attachment, and being pressed for a quick solution, I chose to build a modified version of the "Shorty Forty" that I call the "Junk Box Shorty Forty" to honor the original.

Starting at the last minute, I was forced to use only junk box components. I later replaced the feed line with a section of RadioShack TV twin lead (#15-1153), which set me back less than $4.

The design is essentially a loaded, shortened dipole with a pair of loading coils positioned on either side of the feed point. Actually, the coils form a single center-fed coil, and the dipole elements trail out on either side. The coil is continuous and is actually three coils wound together on the same form. I added a few turns between the feed points to make a lumped hairpin-type match, which allowed me to make the overall length even shorter. This has been described as a *helical hairpin match*.[2]

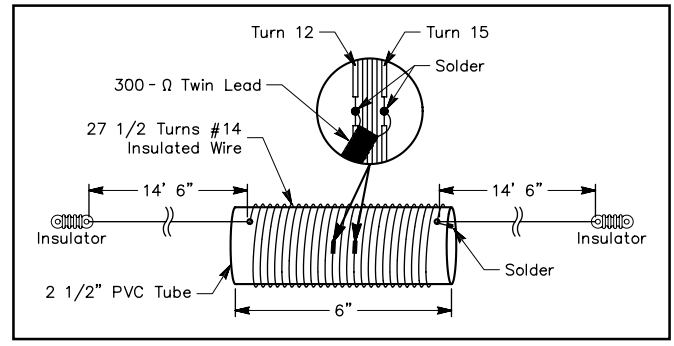

Figure 1—Construction diagram of the Junk Box Shorty Forty. At the center of the dipole is a 6-inch long, 2½-inch wide PVC tube. Wind 27½ turns of #14 insulated wire on the tube, beginning at either of the two anchor holes (the legs of the dipole solder to the coil through these holes). Connect 32 feet 300-Ω twinlead feed line to the center of the coil at the turns 12 and 15 as shown. Connect the other end of the feed line to a 4:1 balun. You may also need to use an antenna tuner depending on where you set up the antenna.

I used a 2½-inch piece of schedule 40 PVC pipe (5 inches long), drilled holes for string attachments and wound 27½ turns of #14 solid copper wire harvested from a piece of Romex house wire (see Figure 1). Romex is a trade name for standard house wiring. Any solid #12 or #14 wire will do. 12¼ turns are used in each loading coil, and three turns make up the matching section. The pipe cuts easily with a hacksaw, and drilling two holes near the ends is relatively easy. Mine are ¼-inch thru holes about ⅜-inch in from the ends of the pipe. The precise diameter of these holes isn't important.

I wound the coil by attaching one end of the insulated black wire (pulled apart from the house wire, insulation intact) to a nail

[1]Notes appear on page 68.

The Junk Box Shorty Forty—with the yellow and black dipole elements wound onto the loading coil—packed for transport. Note the twin lead connection to the middle, with two full turns between feed points. The 4:1 balun is visible as well.

A close-up view of the feed line/coil connection.

at the far end of the basement. I walked toward the fixed end and applied fairly high tension. Once wound, each end was threaded through the holes in the ends of the pipe to hold everything together. (By the way, the coil's hollow center later proved to be a good storage place for string and other station accessories.)

The Theory

The coil has an inductance of about 31 µH. A reference coil listed in the *Antenna Book* (34 turns of #12 wire on $2^1/_2$-inch form $4^1/_4$ inches long) has an inductance of 40 µH. About 3 µH are used in the balun/helical hairpin stub portion.

The antenna's input impedance is a good match for 300-Ω TV twin lead or 450-Ω ladder line. I used twin lead because of the power levels involved and its compact size. Besides—I had some on hand!

I used some scrap #24 solid wire for the dipole elements. I cut two pieces (yellow and the black), each about $14^1/_2$ feet long, leaving the insulation on. This stuff is just about invisible when it's 15 feet up in the air. I was confident that I wouldn't attract a lot of attention with my antenna. Loops for attaching the support strings were made by simply folding the dipole wires back on themselves for $1^1/_2$ inches or so, winding the ends with at least four twists.

Transmission Lines and Matching

Despite plenty of planning, the feed line "just happened."

The *Antenna Book* called for 50-Ω coax *without* a helical hairpin match. My available suitcase space wouldn't allow for standard coax (RG-58), and I wasn't comfortable using higher-loss RG-174 mini coax. Zip cord, featured in another section of the book, was interesting, but I didn't have any on hand and the twin lead was lightweight and potentially less bulky.

I even thought about making custom ladder line from two-inch-wide packing tape and another pair of #24 insulated wires. A check of the *ARRL Handbook* for equations and another trip to the basement and I was set. All I needed was to build a quick assembly fixture and somehow tape it all together.

Before I had assembled all necessary supplies, however, I found a hunk of old TV twin lead and, being late, I substituted it with a solemn promise to make the real stuff in the morning.

The coil wasn't fully wound, so I calculated the lumped inductance needed to match the antenna to 300 Ω. I initially used 39 feet of 300-Ω RadioShack heavy-duty TV twin lead, but now I have about 32 feet of the light-duty stuff attached.

I calculated the required hairpin match based on an equation in *The ARRL Antenna Book* and attached the twin lead to two parts of the loading coil, near the center, separated by three turns. The total turns are $27^1/_2$, with $12^1/_4$ turns for each dipole loading coil, with three full turns in the middle of the coil for the two feed point attachments (straddling two full turns).

According to *The Antenna Book*, when using a helical hairpin, the radiation resistance must be lower than the line (Z_0) so a match can be produced by trimming the antenna to make it capacitive. Then, by using a shunt inductor across the antenna terminals, the antenna can be resonated while simultaneously increasing the impedance to a value equal to the line Z_0. The match is then sized to exhibit the desired inductive reactance.[3]

Rather than building a more traditional stub match, I inserted a lumped sum inductance in the form of a few extra turns across the antenna terminals—a helical hairpin stub. This avoids the bulk of traditional hairpin stubs and keeps the circuit wound on the coil form (PVC pipe). This method works because the radiation resistance of the antenna is much lower than that of the 300-Ω twin lead.

Typically, an electrically short dipole has an input impedance of approximately $Z_{in} = 20\pi \times 2(L/\lambda) \times 2$ (assuming a triangular current distribution). For the Junk Box Shorty Forty (without loading coils and matching unit), that works out to about $Z_{in} = 11.4\ \Omega$ at 7.05 MHz.[4]

With a Z_{in} well below that of the 300-Ω Z_0 of the transmission line, the dipole loading coils and the helical hairpin work together to match the antenna to the feed line.

Each loading coil in the dipole legs add about $X_L = j618\ \Omega$ based on equations originally described by Jerry Hall, K1TD, in September 1974 *QST*.[5] Loading coil losses are kept to a minimum by reducing the total inductance required. This can be accomplished by positioning the inductors at the center, using #24 (small diameter) wire for the dipole elements and by using a matching section.

Rearranging the equation, $L = (X_L/2 \times \pi \times f)$, with f = 7.050 MHz, yields an inductance of 14 µH which, at 1.14 µH per turn, requires 12.25 turns. Two 12.25-turn inductors plus a three-turn matching section (about 3 µH) equals $27^1/_2$ turns

and about 31 µH of total inductance (as a single inductor).

To balance, the antenna must be made even shorter to provide more capacitive reactance (which helped achieve my goal of a *shorter* short antenna). The capacitive reactance can be estimated from available graphs at around –450 Ω for the final dipole element length.[6]

The twin lead (300 Ω), assuming a good impedance match at the antenna, transfers power effectively. When compared to RG-174 mini coax, which has a loss of about 3.2 dB per 100 feet, the TV twin lead wastes much less power.

Building the antenna actually took only about an hour. I first hung the antenna inside the house (it was a bitterly cold winter evening in northeast Ohio), much to the dismay of my formerly sleeping wife. I listened to several QSOs on 40 meters before I abandoned my disruptive testing in favor of future daylight work.

Putting Theories into Practice

The next morning was cold and snowy—perfect antenna weather! With the limitations of the weather, all reasonable chances of elevating the antenna (simulating a hotel balcony) disappeared. I had to run the dipole between the house and the children's swing set. After several pruning sessions I actually had a resonant antenna—even though it was only 5 feet off the ground. I obtained a 2:1 SWR bandwidth of 7.030 to 7.140 MHz, covering enough of the CW subband to be useful.

Starting with longer dipole elements, several feet were removed, resulting in final leg lengths of 14 feet 6 inches. The hairpin and twin lead provided a reasonable match and my portable balun/antenna tuner brought the SWR down to 1:1 at the transmitter.

A similar setup was used by Joe Everhart to match his NJQRP Squirt antenna, featured in April 2001 *QST*. I have experimented with several other feed arrangements, but I prefer the 300-Ω twin lead because it's easy to use and store.

After putting the children to bed, I set out into the cold, ran the twin lead under the kitchen door and set up a practice station on the kitchen table. Friday evening contests and QSO parties were in full swing.

I worked my way up the band making contest contacts. Finally I found Titus, KD4WQT, in Durham, North Carolina, and we embarked on a wonderful QSO. He gave my Norcal 40A an RST of 579. Considering that the antenna was only five feet above the ground, I was pleased and confident that I had an antenna I could successfully use in Europe.

Packing for the trip was simple. I wrapped everything around itself and wrapped it again in a layer of bubble wrap. The balun/tuner fit inside the PVC pipe. I'm sure I could have made everything more compact, but with less than a week to prepare, I was pleased.

Viva La Dipole!

The trip to France was uneventful, but lengthy. We left the US Sunday afternoon, arriving in southwestern France Monday afternoon. After checking into our hotel, I sank into my pillow for some much-needed rest. I woke up late in the evening and couldn't sleep, so I set up the station. From my window I could reach the terrace garden lamppost to anchor my antenna.

W1AW was a welcome sound from the United States! I copied part of the 20-WPM code-practice transmission while I was getting started. Most of the stations were on earlier in the evening, so working ops in Europe on 40 meters was going to take some improvisation.

After considering alternatives and the time I'd have available for fooling with antennas, I actually rigged the antenna *indoors* and set up my station in another room. It received well, but I really wondered how it would transmit.

Success! Everything fits on a 1-square-foot tile on the kitchen floor. The key is mounted to the pine board, which protects the hardware against travel damage. A small tuner is (at the upper left) hidden under the rest of the station.

Running 2 W to an indoor antenna is a worst-case scenario, to be sure. It meant my chances of success were near zero, but I set up my tiny station and forged ahead.

After a few minutes, F6ICW returned, finding my response to his CQ. I was elated and surprised that we held a 10-minute QSO from his QTH near Paris. I'm sure Bernard struggled to copy, sending a generous 359 report, but I was nonetheless thrilled.

A few more hours working the key were difficult, but fruitful. Friday evening I started the QSO parade with Denis, F/SOØDWK, in Paris, who was also traveling. Denis struggled to copy the weak signal from an "Indoor Shorty," but with the hotel empty at the start of the weekend, it was only a few hours before I could move the antenna outdoors again and really cut loose.

Outdoors, the antenna performed as expected (that is, much better!).

In Closing

If your travel budget is a little bruised, you certainly don't have to schedule an overseas trip to take advantage of the "Shorty." The antenna works well in a variety of unusual antenna locations, it's easy to build and packs away conveniently. It even works indoors in a pinch.

I had a great time building it. If you can plan your own CEPT adventure, consider taking along your own Junk Box Shorty Forty.

Notes

[1]*1988 ARRL Antenna Book*, Equation 1, p 6-7.
[2]*1988 ARRL Antenna Book*, Section 26-20.
[3]*1988 ARRL Antenna Book*, Section 26-9, "Combined Balun and Matching Stub."
[4]Warren L. Stutzman and Gary A. Thiele, *Antenna Theory and Design.* Published by John Wiley and Sons, 1981, pp 198-200.
[5]*1988 ARRL Antenna Book*, Section 6-6.
[6]Warren L. Stutzman and Gary A. Thiele, *Antenna Theory and Design.* Published by John Wiley and Sons, 1981, pp 198-200.

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