The Cookie-Can Antenna – Is it Any Good?

Every ham likely has made a 2 meter antenna from a discarded cookie can or a pizza pan. But how well do these perform? A close look at this familiar "make-shift" antenna may surprise you.

By John Portune W6NBC

The whip was a piece of coat hanger soldered into a banana jack, or a 19 in. spike on a magnetic mount, but at the bottom was grandma's Christmas fruit cake can. Every ham knows this antenna. But who has ever seriously looked technically into this familiar "kluge?" Most of us just threw one together in a pinch, believing that the ground plane was probably too small? But is there a way to rescue the cookie-can portable?

The evidence presented here, taken mostly from EZNEC computer modeling but also from field testing may surprise you. It did me. There is a "right way." So don't toss out that empty Scottish shortbread tin. You will also need this if you ever use a magnetic mobile whip indoors, perhaps on a curtain rod or stuck on top of your radio or refrigerator.

A Friendly War

A good ham buddy, Ernie W6ND goaded me into this. His passion is country engineering. He loves bailing wire, wooden dowels and of course liberal amounts of PVC pipe. He says, "I'll never let efficiency into my shack. I just make things and try them."

So he and I are constantly "at war" over his "back-woods" designs – in fun, of course. The latest skirmish was a 2 meter cookie-can portable made for a mutual shut-in ham friend from a 7½ in. cookie can, Figure 1. I "let him have it" with the classic ham squelch, "The ground plane is too small." This time, though, I had to eat crow. After seriously looking at cookie-can portables with EZNEC antenna modeling software and doing some live field tests, I discovered that they are not all kluges. You just need to know how to configure them.

An EZNEC Model

So thinking that I could defeat Ernie with technical bluster, I organized my frontal attack around an EZNEC wire-frame model of his antenna, Figure 2. EZNEC is a popular antenna modeling software, a big favorite of mine.

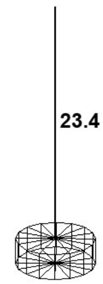

Figure 1: Ernie’s 7½ in. cookie-can portable
Figure 2: EZNEC wire-frame model. Whip diameter 0.1 in.

Actually, to gather the comprehensive data here, I made seven models: for 2.5, 5, 7½, 10, 20, 40 and 80 in. cans, all 2 in. thick. Some were theoretical. Grandma wasn’t that generous with her chocolate chip cookies. I modeled them all at 146 MHz, 2½ feet (picnic table height) over average soil, for a wave angle of 15 degrees, and with a whip diameter of 0.1 in. I added an eighth model as a reference, a half wavelength vertical with no can.

I was now ready to show Ernie that his 7½ in. cookie can antenna doesn’t work well. Was I in for a surprise? Figure 3, 4 and 6 blew me out of the water. All three figures use the same EZNEC data from the modeling. Begin by noticing the whip length predicted for each can.

CAN dia. in.	ANT len. In.	GAIN dBi	Z Ohms	SWR
Vertical dipole	38.5	1.66	72-j4	1.5 : 1
2.5	29.1	1.61	89-j13	1.8 : 1
5	25.5	1.51	49+/-j0	1.0 : 1
Ernie’s, 7.5	23.7	1.27	38+j2	1.3 : 1
10	22.3	1.02	35+j4	1.5 : 1
20	20.5	0.89	29+j5	1.7 : 1
40	19.2	0.64	29+j5	1.7 : 1
80	19.1	0.14	64-j7	1.3 : 1

Figure 3: Can size vs. spike length, antenna gain,
feed point impedance and SWR as computed by EZNEC.
Whip diameter 0.1 in.

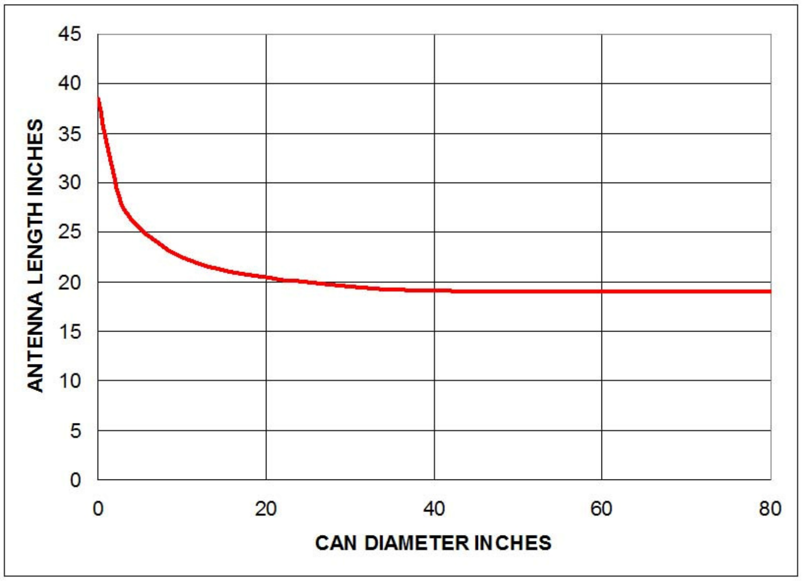

Figure 4: Whip length to achieve resonance

The data made it clear to me that an efficient cookie-can portable MUST HAVE A LONGER WHIP if you make the can smaller. It's the same if you put the whip on any surface smaller than half a wavelength in extent (40 in). Don't just plunk down a 19 in. spike and leave it there. You RV'ers with smooth-sided motor homes, pay close attention here. You can actually use quite a small metal plate underneath the whip on top of your rig and still get good performance. You must, however, increase the whip length.

Few hams, however, seem to grasp this principle. Most just assume that 19 in. is the only length a 2 meter whip should ever be, no matter where it is mounted. But making it the right length is the key to success with a cookie-can portable. To further illustrate this, notice Figures 4. Suppose you were to shrink the can down to nothing. How long would the whip would you make the whip – still 19 in.? No! You must lengthen it to 38 in. This is no surprise, the quarter wavelength whip has become a full half wavelength dipole.

Figure 5 further shows the gain of a cookie-can antenna with the correct whip length. Interestingly, it actually improves slightly for smaller cans. This is because the radiating part of the antenna is longer. The difference though is minor, just over one dB. BUT if you don't increase the whip length, the performance will degrade. I have even seen hams put a 19 in. spike on a wooden bookshelf or on a smooth-sided motor home with no metal plate or ground plane.

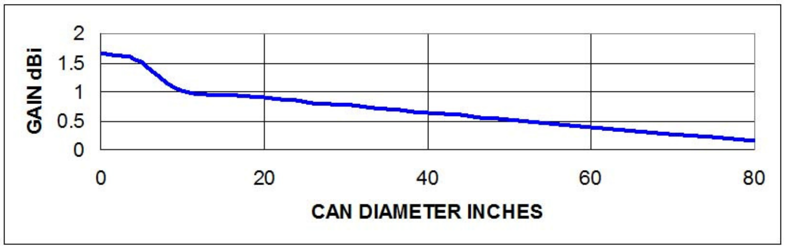

Figure 5: Gain vs. can size at a 15 degree
wave angle, with whips of the correct length.

Why This Works

You may still be thinking, “I don’t believe this; you can’t make the ground plane small” No so! The reason is this. A can less than 40 inches in diameter (half a wavelength) is actually no longer a ground. Ground plane rules don’t apply for small cans. The can is now a capacitive hat. It has become end loading for a shortened half wavelength dipole rather than a reflective surface to provide a virtual image of the spike.

The way I implement a 2 meter cookie-can antenna is this. I first replace the 19 in. whip with something quite a lot longer. Or I just temporarily twist or solder some solid wire onto the top of the whip. Then I begin trimming in small increments, using an antenna analyzer to achieve a low SWR. Once the whip and the can are on frequency they will radiate well.

Also while tuning, be sure to use a choke balun. If you don’t, the feed coax will disturb your adjustment. I usually just wind a foot or so of the coax into a small multi-turn bundle near the can. Or I use ferrite beads. Also keep metal objects away from the antenna, such as the supports for your work bench.

A Coffee-can Portable

Well then, after recovering from Ernie’s gentle scorn, I reasoned, “Shouldn’t I now be able to make an effective portable from any can?” Figure 6 shows what I “brewed up” from a coffee can and a magnetic mount – no pun intended.

Again, I first replaced the original 19 in. whip with 30 in. of #10 AWG solid copper wire, an adequate length for trimming. Then on a wooden TV tray, 2½ feet off the ground, and with an MFJ 259B antenna analyzer, I shortened the whip in small increments until I reached the 2 meter band. The top is now 25 in above the coffee can – a full six inches longer. Since then I have replaced the copper wire with a stainless steel whip of the same length.

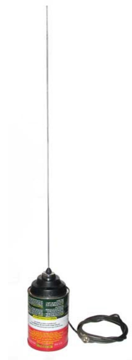

Figure 6: Coffee-can 2 meter portable antenna
using a mag-mount and a 25 in. whip.

A Deluxe Version

For a fancier version I made a cookie can portable from a 10 in. can, a UHF plug and jack and a small telescopic whip from a portable broadcast receiver. See Figure 7. It is my “use anywhere” antenna. I keep it in my RV. Further, I cut a slot in the side of the bottom of the can to allow the coax to be rolled up and put inside along with the whip, when the antenna is not in use.

On a large metal surface I simply set the whip to 19 in. On a non-metalic surface it needs to be extended to roughly 22 in. On other surfaces, the length is in between. Again, I use an SWR bridge or antenna analyzer to make the adjustment, though with experience, I can usually guess the length pretty well.

Figure 7: 10 in. cookie can with telescopic whip in a UHF
connector. Whip and coax are put inside the can for storage.

Another option is to use a mag-mount directly on top of a rig with a steel case, Figure 8. Just like on a cookie can, the length of the whip is easily tuned to a proper length. This is in fact true for any metal surface.

Figure 8: A magnetic mount and spike placed directly on top of a rig.

Proof of Concept

However, to be sure that I wasn't just fooling myself with antenna modeling software, I decided to perform field tests. I have a 2M FM receiver, calibrated in dBm at the input. I connected it to a half wavelength vertical coaxial dipole at 20 ft. The test transmitter was a low-power T-hunt transmitter with a 20 dB (power) pad to insure a 50 Ohms source. It also kept the input signal below receiver saturation. The receiver was roughly 200 yards away from the transmitter, again on the wooden TV tray.

I chose the coffee-can-mag-mount antenna for the tests. A cookie can antenna would have been very similar. It was configured in three ways: with (1) with only the original 19 in. spike, (2) with the re-tuned 25 in. spike, and (3) with the original 19 in. spike, but this time with 4 added drooping radials of 10 AWG solid copper wire. The latter was an improvise ground plane antenna. It has essentially the same radiation pattern and gain as a vertical half wavelength dipole or a J-pole. I pruned the radials to bring the whole antenna to tune. The radials are roughly 21 in. See Figure 9.

Figure 9: Coffee Can Antenna with 19 in. spike and 4 drooping 21 in. radials

Figure 10 compares the three. As you can see, both the ground plane antenna and the coffee can with the correct length spike were close, within ½ dB. The coffee can with the original 19 in. spike was 1½ dB weaker. Lengthening and re-tuning definitely restores the performance.

Antenna	Spike	Signal at RX
Can	19 in.	-78 dBm
Can	25 in.	-78.5 dBm
Can+Radials	19 in.	-80 dBm

Figure 10: Field test results

What About Matching?

Matching was a surprise, however. The SWR actually changed little when I lengthened the whip on a smaller can. For example, the feed points in these simulations was dictated by the base mount. They were all at the bottom of the whip, just above the can. Even so, the SWR changed little. In fact, the smaller cans had better SWR. The reason, I believe, is this. As the whip gets longer, the feed point essentially moves away from the electrical center of the antenna. This raises the feed impedance, thereby compensating for the change of length.

Never again will I think of grandma's cookie can as a ground plane, that is, unless it is larger than 40 inches in diameter. (I wonder how many cookies such a can would actually hold?) A smaller can becomes a capacitive hat. Further, I now know that I must lengthen the whip on a small can or surface and bring it to resonance to restore good performance.

I will be pleased to correspond or receive photos of any variations of these principles you may try: jportune@aol.com. 1095 W. McCoy Lane #99, Santa Maria, CA 93455.