

# The Clothesline Antenna

Dry your laundry or work DX. Could this be the first dual-purpose antenna?

**E**very once in a while, you run across an idea that seems so simple, so obvious, you can't believe it hasn't been done before. Surely (you say to yourself), you're not the first person in the universe to have thought of this...

That's the case with the Clothesline antenna and me. While mulling over a variety of ideas for an antenna suited to my apartment, I started drawing some graphs of sine waves at various frequencies. One thing led to another and I wound up with a terrific solution for my antenna needs—and it was one that I haven't found any references to anywhere. As far as I'm concerned, I've invented the Clothesline. Still, I'm not going to be surprised if someone shows me that it's been done before!

But even if this antenna design has been around since hydrogen, it may still be new to you. And even if you have seen something similar to the Clothesline, this design may be worth a second look. For hams in a variety of situations, this could be just what the doctor ordered to cure your DX dilemma.

## What It Is ... And Isn't

I will tell you what the Clothesline is, but first I'll tell you what it is not. The Clothesline isn't some dubious trick for loading up an actual clothesline with 12 cubits of RG-213 looped four turns to the foot around your washing machine. This is an antenna, it works all the HF bands, and it gets great results. It doesn't need a tuner because it's dead-on resonant on the 160, 80, 40, 20, 15 and 10 meter bands. A tiny tweak will bring in 12 and 17 meters, too.

It's remarkably easy to build. There are no traps, no stubs, no loading coils, no variable or fixed capacitors, no screws, no clamps, and you don't have to drill anything. This antenna is so simple to put up, it hurts. The Clothesline consists of little more than a piece of wire, a center insulator, some feed line, and a couple of \$2 hardware-store fittings.

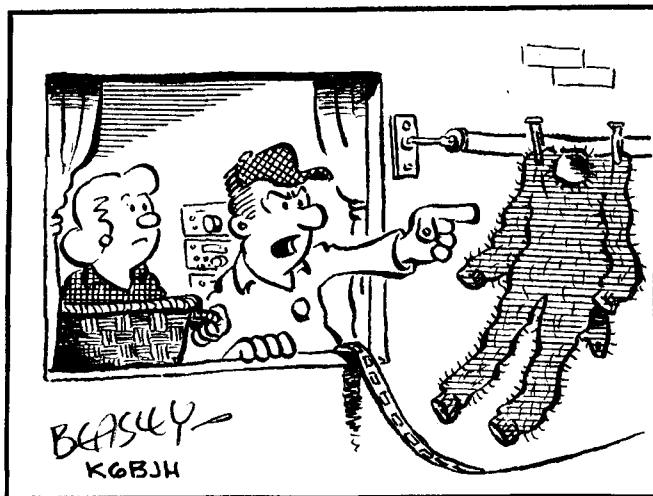
Too good to be true, you say? What's the catch, you ask?

Well, you *do* have to adjust this antenna for most band changes. But before you get too excited by the word "adjust," I'm not talking about unwrapping yards of black tape to get at a loading coil, or tweaking the bare shaft (whoops, hot side—sorry!) of a 50-year-old fleamarket variable capacitor. No, the Clothesline makes band changes a piece of cake. When you see how easy it is, you're going to chuckle!

## The Concept

The easiest way to explain how the Clothesline works is to lead you through the simple reasoning I used to come up with the thing. I started with a drawing like the one in Figure 1. It shows a simple dipole for 80 meters. It's 132 feet long and fed in the middle with coax. Next I drew the graph of the voltage distribution along the antenna (at its fundamental resonant frequency). Note the voltage is at a maximum (with reference to ground) at the antenna ends. That's important for any dipole radiator. The ends of the antenna have to correspond to the high voltage points of the curve.

I already knew that the curve the voltage wave describes is a quarter of a full cycle—a quarter wavelength—on each half of the antenna. And that the distance between the two places where the voltage is highest, or in other words, from one end of the antenna



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to the other, is  $\frac{1}{4}$  plus  $\frac{1}{4}$ —a half wavelength. That's why they call it a half-wave dipole.

I also understood why the feed point is in the middle. It's located precisely where the voltage curve is lowest with respect to ground. To me, an antenna is just like a transformer—it transforms the low impedance coming out of the coax up to the impedance needed to couple to the cosmos. Come in low, go out high. So much for the plain dipole.

I then dropped a 7-MHz voltage curve over the original 3.5 MHz length (see Figure 2). Because the new frequency is a whole multiple of our original frequency ( $3.5 \text{ MHz} \times 2 = 7 \text{ MHz}$ ), there is still a whole number of half wavelengths from one end to the other, so the voltage peaks are still at the ends. This means this same length of wire will resonate at 7 MHz, which means it will radiate perfectly well at this frequency too.

But I noticed right away that something had changed from our earlier situation—the point where the voltage minimum crossed ground was no longer in the middle. There were now two such

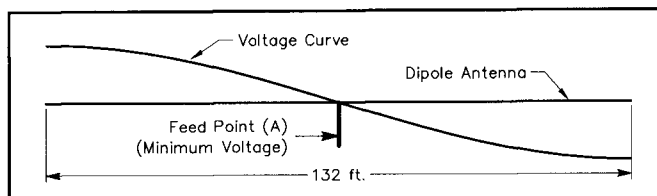
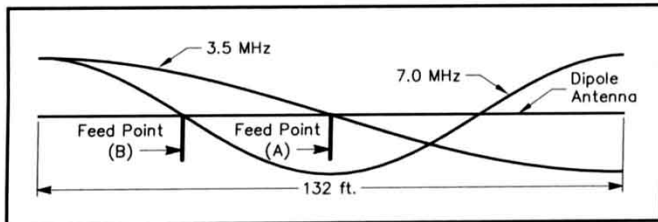


Figure 1—The voltage distribution along an 80-meter dipole antenna. Note that the voltage is at maximum (with respect to ground) at the ends of the antenna.



**Figure 2—Take the 80-meter dipole shown in Figure 1 and overlay the voltage distribution for a 7-MHz signal. Note how the 7-MHz feed point (B) has shifted to the left of the 3.5-MHz feed point (A).**

points, neither of them anywhere near the middle. So the antenna was resonant—the voltage peaks were at the ends—but my original feed point was now useless! Alright, I reasoned. If I shift the feed line to the new minimum I'll have the perfect setup—high voltage at the ends, low voltage at the feed point. Look out DX, here I come!

I thought about how far I'd moved the feed point. Looking at the curve, you can see that from (A) to (B) is a quarter wavelength at the new frequency, right? We doubled the frequency, which means we cut the old wavelength in half. So what used to be a quarter wave at the old frequency—from the middle to one end—will be twice that, or one-half wavelength, at the new frequency. And I wanted to get the feed point over to the new location at point (B), so I move it half that half—a quarter wavelength—over to the new minimum at (B).

I also realized that I'd added a quarter wave to the right half of the antenna, making the right-hand side  $\frac{1}{2}$  plus  $\frac{1}{4}$  wavelengths, or a total of  $\frac{3}{4}$  wavelengths long. Since  $\frac{3}{4}$  on the right plus  $\frac{1}{4}$  on the left equals 1, I now had a full-wavelength antenna with some gain compared to a dipole, fed one-quarter wavelength from one end.

I kept going. I doubled the frequency again, and the same thing happened. The voltage peaks would stay at the ends, but I'd see the feed point moving further to the left by one-quarter wavelength at

the new frequency for each time I doubled frequency.

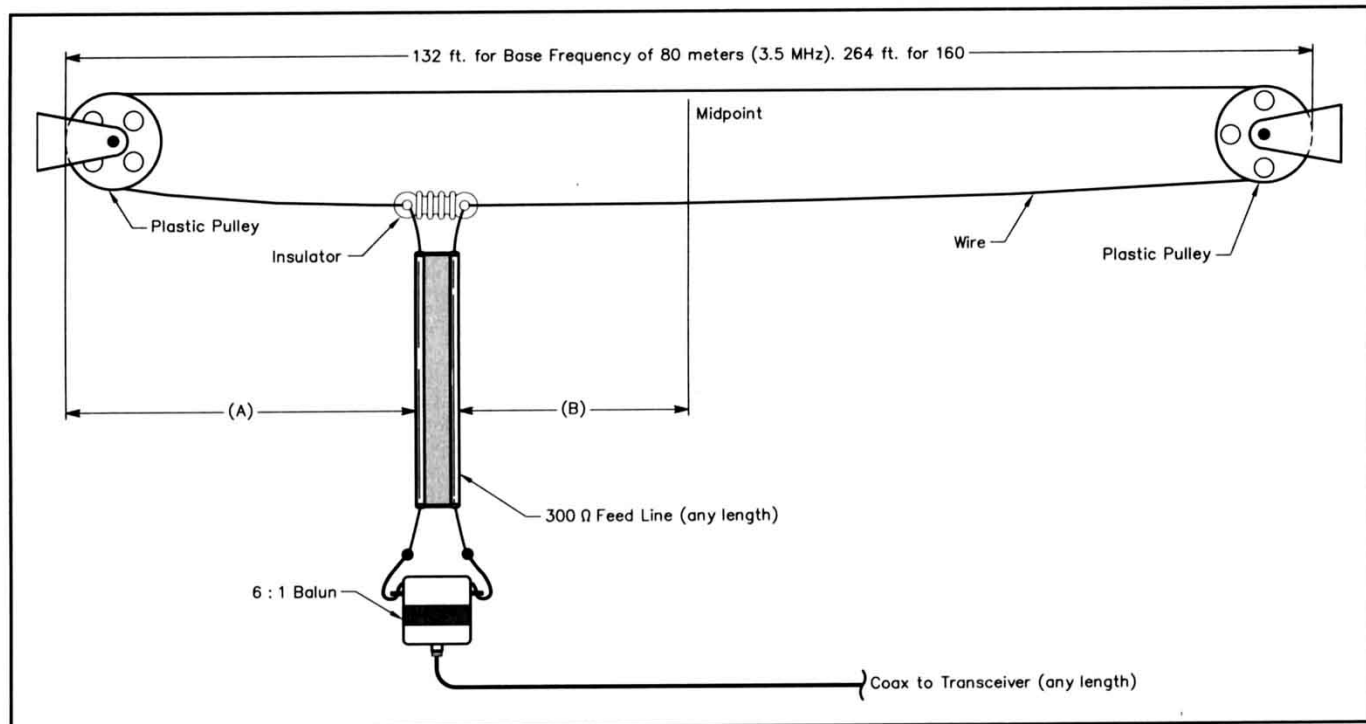
I tried it for other multiples—by 3, 5, 6, 7 and so on. Just as I expected, I always wound up with some whole number of half waves, and voltage peaks at the ends. All I ever had to do was to move the feed point to the new quarter-wave point of the antenna. And for that matter, for any band other than 80, I had a choice of feed points. Each higher-band antenna had more than one voltage minimum point in its length, and I could feed at any one!

Now I drew a bunch of these curves like the ones shown in Figure 2 for 80, 40, 20, 15 and 10 meters. I dropped reference lines down from each voltage minimum to show where the feed points would lie along this single piece of wire, depending on the frequency. Because there are multiple feed points for each of the higher bands, I could see that any time I want to change frequency, I would just shift to the closest feed point for the next frequency, and away we go!

But so what? How was I going to make a simple antenna with all these feed points? For that matter, what was simple about an antenna with all these feed points anyway? The answer was, "nothing." What about a *single* feed point that somehow travels or slides along the antenna to anywhere I want it to go? Could I make that happen? I was looking out the window at my 40-meter folded dipole when I came up with the answer.

Other than the fact that it's fed with 300- $\Omega$  line rather than coax, the folded dipole is almost identical to the standard dipole. It resonates over the same lengths at the same frequencies, so my marvelous (but yet to be invented) multi-band, sliding feed-point antenna would be just as comfortable with a folded dipole 132 feet long as it would be with a plain dipole. But what about the sliding feed point?

What would happen with my folded dipole if I just grabbed the feed line and tried to slide it along toward one end? It hit me: If the endpoints were run over pulleys the feed point would effectively slide! It would just run along the bottom of the antenna to anywhere you cared to put it. As far as the electrical nature of the antenna is concerned, absolutely nothing has changed—except the position of the feed point! And there it was—the birth of the multi-band, sliding feed-point antenna, otherwise known as the



**Figure 3—The Clothesline antenna. Just set (A) or (B) to equal a quarter wavelength at your operating frequency. As long as it is a multiple of your base frequency (most HF ham bands are), your antenna is tuned. You can measure out your favorite bands, peak them by observing the SWR, and put color marks or tags on the bottom wire. Roll up to the mark and you're ready to couple to the cosmos!**

Clothesline! See Figure 3.

But wait a minute, I thought. It's a clothesline. It can't possibly work. It's too simple!

Yet no amount of poking about on paper could find fault with it. Still very skeptical, I strung up a miniature version (for 10 and 20 meters) running down my hallway. It worked! It loaded like a breeze, with the feed about 8 feet from the end on 10 meters and about 16 feet from the end on 20 meters, just where those graphs said it should. I bought some decent wire, a couple of plastic pulleys, 75 feet of 300- $\Omega$  twin lead, and threw one up on the roof to cover 40 through 10 (66 feet is all the horizontal space I have up there). Within a couple of days I had racked up dozens of DX contacts on every band. Most remarkable was the apparent gain on the higher bands. I consistently surprised other stations (and myself) with my signal strength, usually trading equal signal reports and getting lush praise from guys running far greater power and fancier antennas. xMy 100 W and a Clothesline are reaching the world!

### How to Build and Use the Clothesline

Measure out enough wire for twice the lowest frequency. If this happens to be 80 meters, you'll need  $2 \times 132$  feet (plus a bit for trimming). String it up like a clothesline, using nylon or rope leaders to attach the plastic pulleys to their supports. Just make sure that all the wire is used, so that the antenna is full-length. You can use long leaders if you want to hang one end off a distant support. Run each end of the wire through the pulleys top-to-bottom, attach the two ends to a center insulator and hook up your feed line. That's it!

If you're building a version for 80 or 160 meters, you'll want to install a third little pulley to ride along the top run, attached by a short piece of cord to the center insulator, to help keep the top and bottom runs of the antenna roughly parallel. Build it for 40 as the lowest frequency and you won't even need this little extra.

There is a full set of feed points between the middle of the antenna and half-way out to either end, so if you want to keep the feed line short, you can cut it to provide just enough slack to move within this range. Alternatively, because different feed points for the same frequency can affect the gain pattern, you may want the flexibility of having a choice of feed points for each frequency, and decide to leave more line slack. Losses in twin lead are so much lower than in regular coax, you can use all you want (within reason). Do be careful to stand it off from any metal it encounters on the way into the shack.

Inside, the simplest way to match the twin lead to your rig is with a balun. I use a 6:1 balun to get the impedance down to the 50  $\Omega$  my radio likes. A 4:1 balun works fine too, though the 6:1 usually presents a better match. Both baluns are sold by a number of QST advertisers. Ditto for the 300- $\Omega$  twin lead.

Speaking of the shack, if yours is on an upper level at your home, consider setting the Clothesline up with one end near a shack window. You'll be able to reach out, retune (that is, haul in the line), then go back to your rig to check your SWR meter.

If you don't have this luxury, don't sweat it. I calibrated my Clothesline by setting my rig on tune-up power for each band, and going up to the roof of my apartment building to peak the antenna with a field-strength meter. I confirmed each setting by checking the SWR back in the shack. On every band I tuned for, it was well below 1.5:1. As I found each feed-point setting, I marked them with various colored indelible markers for each band. Now when I want to change bands, I just go up to the apartment roof, run the Clothesline out to the right color, and I'm tuned! It takes seconds.

I can imagine other settings where you'd run the Clothesline right outside a window, out to some convenient support. Or vertical, up or down the side of a building, a tree, or a flagpole (tie a flag to it, if you like). If you're camped out in suburbia with difficult, anti-antenna neighbors, a detachable feed line using alligator clips makes it the perfect disguised antenna. Who's going to suspect a clothesline? You could even use it during the day to... wait for it... *dry clothes!* You could even make it out of your standard, garden-variety hardware-store clothesline kit—plastic

pulleys, vinyl-covered wire, the works. This makes the Clothesline the only ham antenna kit I know of that you can buy complete (minus the feed line) from your local hardware store. (In a perfect world, your local hardware store would stock twin lead.) Yes, I know I said at the beginning that this wasn't a trick for loading up a real clothesline and I've been true to my word. This is an antenna that happens to *look* like a clothesline.

I mentioned covering 17 and 12 meters. If you cut the original length to resonate just a little up from the bottom of 80, at 3.615 MHz, the fifth harmonic is smack dab on 17 meters. Cut it to 3.55 MHz and harmonic number seven is on 12 meters. In fact, these are such minor variations that you can surely find a convenient center frequency on 80 that'll put you right where you want to be on all bands. Though you don't need it, a tuner (either in or out-board) can get you right down to zero reflected power. Remember, feeding with twin lead or other balanced lines keeps your losses way down, so a little elevated SWR at the band edges is no big deal.

I'm now thinking about some kind of motor drive that'll permit me to tune up from inside the shack. My first reaction to this idea was, if I'm going to get into motor drives and the like, is that any simpler than a beam? I now think the answer is "yes." The drive would be simpler, in that I wouldn't need any position feedback—all I need to do is watch my reflected power meter to know when I've hit resonance. It doesn't need a whole lot of travel because a full range of feed points is available over just a quarter-length of the antenna. As well, few beams are all-band. And since the antenna you can put up is always simpler than the antenna you can't, for those of us in apartment settings where a beam or other, more complex antenna systems are out of the question, a motorized Clothesline might well be worth the effort. I've got a sneaking suspicion that, somewhere out there, there's a cheap, off-the-shelf drive unit with "Clothesline" written all over it!

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