



## Build a 2 Meter DDRR for Mobile

### By W5GVE

This is a story of an antenna and its modification over time into "better" forms. Part of the improvement was by design, and part was just plain good luck. When you are working closely with an antenna, unless you keep very detailed records, it is difficult to discern which is which after the fact.

### PURPOSE

The original objective was to build an antenna for 2 meters FM (146-148 MHz), vertically polarized, and omni-directional. The world is already full of such antennas; why something new? The truth is that I needed a short antenna that wouldn't scrape against the low-hanging trees of the desert where shade is precious, or against the 7 1/2 foot ceiling of the multi-story parking garages in the cities I occasionally visit.

Many years ago, I was intrigued by the DDRR antenna. It originally was a quarter wavelength radiator sprouting up from a ground plane, taking a sharp turn to the horizontal and coming around in a circle to almost meet itself where it sprouted. Sort of an open loop parallel to the ground with one end connected to the ground. This obviously horizontal antenna behaved in an outrageous fashion—*it radiated vertically!* There's no free lunch however and, as originally described, it worked about half as well as a full-sized quarter wave vertical wire. But, if you could stand the tariff, it *was* low to the ground—1/10<sup>th</sup> as tall as the vertical.

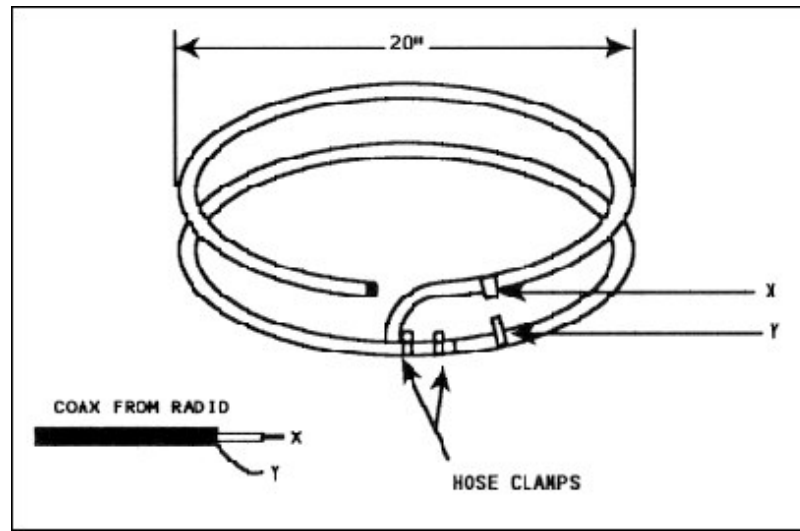
I stood it as long as I could and finally built one for the Citizen's Band (27.5 MHz). This was years ago, and as I recall, the mobile CB-DDRR was three feet in diameter, six inches tall and looked like a pair of hula hoops. It was built of 1/2" aluminum cable-TV trunk cable held together at crucial points with automotive hose clamps. And, it worked! At least *until my wife saw it*, and said she could not be seen dead driving around town under it! So, DDRRing went dormant for a decade.

In subsequent years, more articles appeared on the DDRR in its quarter-wave version, and later, a half-wave model. I didn't try either and pretty well believed what I was reading. As the need for the 2M low profile antenna grew, my mind turned to the 1/4 wave DDRR, through the 1/2 wave DDRR and ended on the great idea of maybe a 3/4 wave DDRR!

A 3/4 wave edition would not be any taller than a plain vanilla (1/4 wave) DDRR, and would have much greater capture area. It seemed like the perfect solution. If it looks weird, so what? My wife has her own car now. All systems were GO, so I began. Not having a whole lot of imagination, I began by resurrecting the concept of the CB-DDRR, 1/2" aluminum TV cable and all.

At 147 MHz, a wavelength is quite close to 80" and 3/4 wavelength is 60". The diameter of a 3/4 wavelength DDRR is 20". I arbitrarily decided that 3" in height (center to center) would probably be tall enough to help capture incoming wave fronts, and it *did* resemble the old CB version.

Figure 1



### WORKED LIKE WOW!

For testing purposes, I taped it to the roof of my little Chevrolet station wagon. Wow, did it ever work! I compared it to the 5/8 wave vertical magnetic mount whip on the other end of the station wagon roof, and the 3/4 wave DDRR equaled or exceeded the commercial whip. One little problem. It had a great gain off one section of the antenna, average elsewhere, and a tiny area of a slight null. Further tests showed it had a substantial amount of horizontally polarized radiation in addition to the desired vertical radiation. What was going on? The Mark I version has problems!

### DIRECTIVITY

I believe the 3/4 wave DDRR showed directional characteristics because its physical structure is about 1/4 wavelength in diameter. Current on exactly opposite points of the radiator's circumference are 3/8 wave (30") out of phase, electrically, but are 1/4 wave apart (20") physically. I did not have the means to work this out theoretically, but it seems reasonable that this physical configuration would simulate radiation patterns of discrete radiators phased and separated in this manner. I decided this was the kind of a problem that could not be overcome. It could be developed if, some day, I want to build a directional vertical low-height radiator. Maybe some day.

### POLARIZATION

The method of feeding the antenna was the same as I used years ago on the CB-DDRR. Since the DDRR can be looked upon as a section of parallel conductor feedline, with one side joined to a ground plane, one end is effectively shorted and presumably at a very low impedance point, and the other end is at a very high impedance, it seemed reasonable that at some point near the low end there are a pair of points at 50 ohm—just right for direct coax feed. It worked on the CB-DDRR and I figured it would work on the 2M version too.

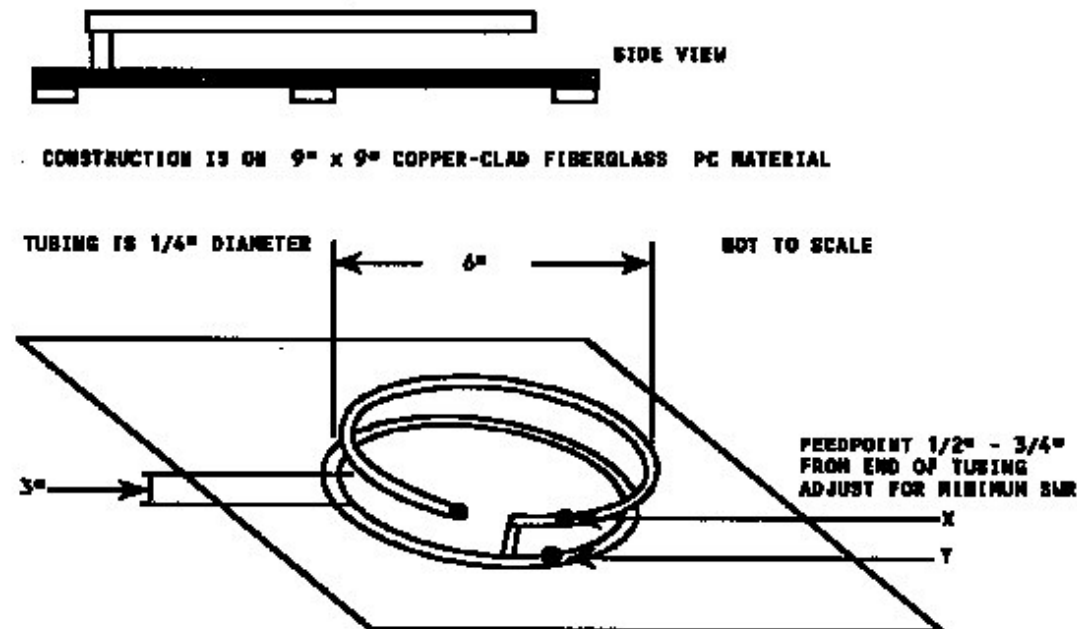
A straight transmission line antenna, laid out horizontally, would radiate horizontally polarized energy. But when the same antenna is curled up into a loop, about 1/2 wavelength in diameter, it radiates vertically polarized energy. In order to get a good match (50 ohms, with low reflected power) I had to skew the feed points slightly. That is, the center conductor of the coax was connected to the upper line at a point NOT directly over the point where the coax braid is connected.

## TOO MUCH SKEW?

I believe the skewing of the feed points resulted in the mostly vertical, but partly horizontally polarized radiation. Again, this is an area for further eXperimentation, since I did not pursue it at this time. So much for the 3/4 wavelength DDRR.

Considering the phasing problem that gave me the unwanted directivity, I concluded that some of this could be expected with a 1/2 wavelength. So, I decided to do a plain old 1/4 wavelength DDRR, but by using some of the information about transmission line radiators I had picked up in the intervening years since the CB-DDRR, mainly the work of *Ted Hart, W5QJR*. The better the conductivity of the radiator, the better the antenna. That rules out aluminum tubing and hose clamps.

Figure 2



## SOME SUCCESS

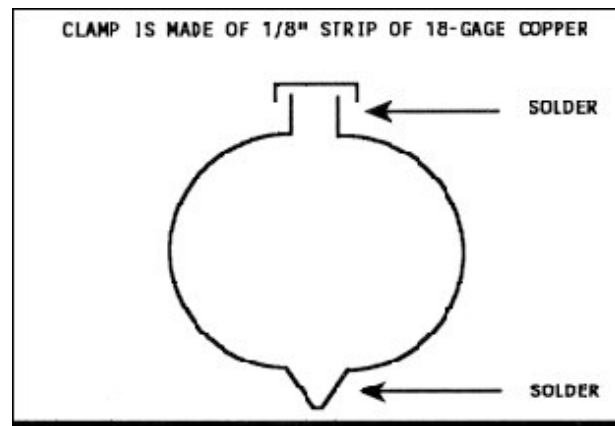
I decided to begin with a 1/4" diameter copper tubing, formed into two 6" diameter loops, separated 3". One loop is tack-soldered at 3" intervals to a 9" square of copper-clad fiberglass printed circuit board stock. The coax braid is soldered with no length to the circuit board. The center conductor is taken up 3" and soldered to the free loop about 2" from the shorted end. Matching is accomplished by three methods: adjustments of the tap on the free loop; trimming the free end of the loop (raising frequency of resonance); and bending the free end of the loop up or down (raising and lowering, respectively, the frequency of resonance). The results? Equal to the 5/8 mag-mounted vertical whip! The Mark II is a success. Now to improve on this!

## THE NEXT VERSION

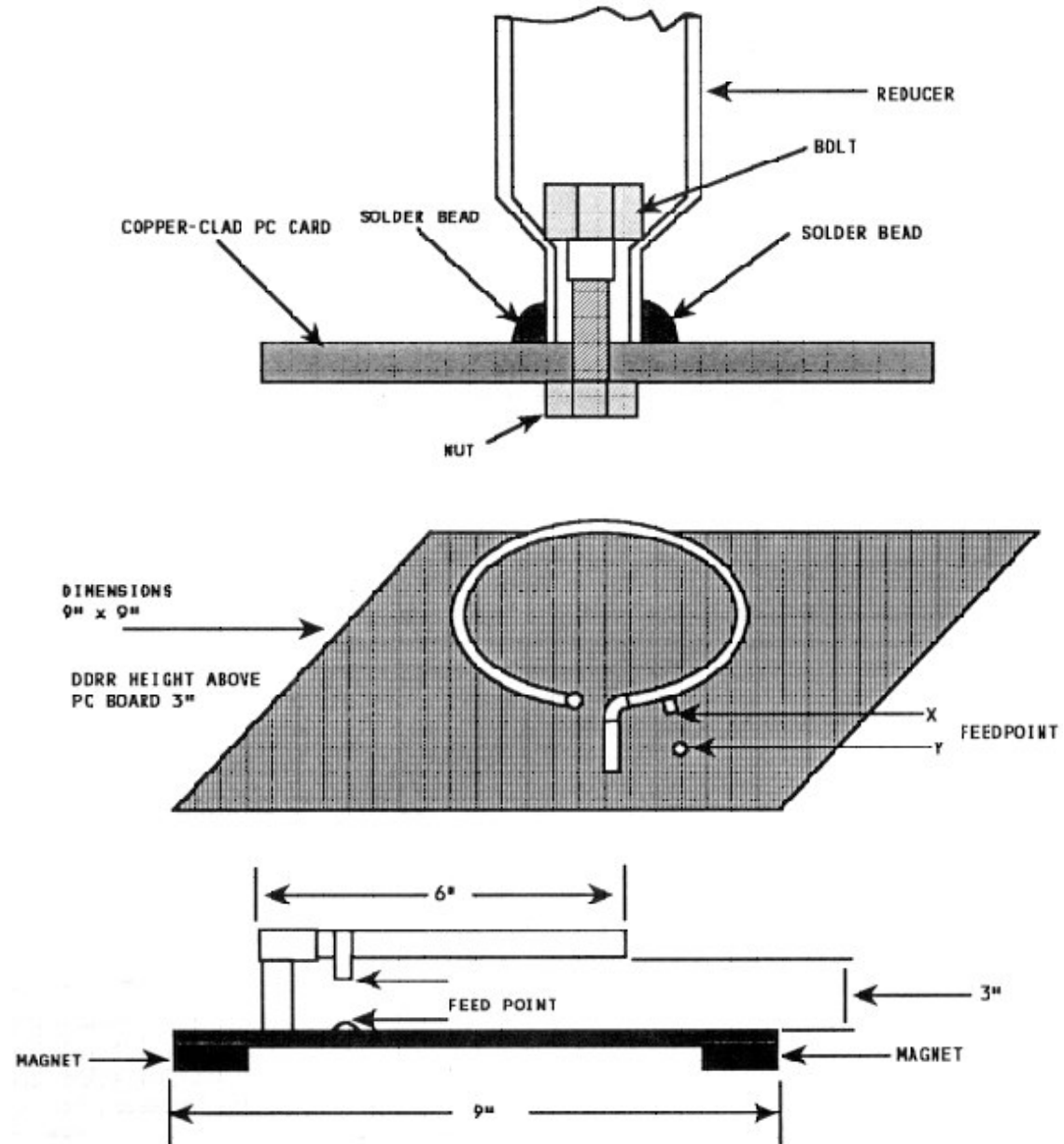
The Mark III version was also begun on a 9" square of circuit board material. It has great surface conductivity, is stiffer than solid sheet copper, can be soldered readily, and can be attached to a magnet for car-roof mounting. Instead of a double loop of 1/4" copper tubing, the Mark III uses a single 20" long loop of 5/8" copper tubing, a 5/8" copper "L", and a 2" piece of 5/8" tubing to space the loop over the ground plane. Matching is the same as the Mark II's, with the exception of soldering to the loop. I had to use a fancy homemade copper clamp—low resistance, moveable, and IT CAB be soldered!

Once the best tap point has been determined, drill a small hole at the point. Use a sheet metal screw and a copper tab to solder on the coax center connector. The adjustments for best match are limited to two: trimming the end of the loop with a tubing cutter and moving the feed tap. This is a high-Q device, and moving the feed tap has a very large influence on the resonant frequency, as well as feed point impedance. Performance? Equals or exceeds the 5/8 wave vertical whip in all respects. Being fairly high Q, it has a useful bandwidth, a little narrower than the whip—about 2 1/2 MHz.

**Figure 3**



**Figure 4**



### SPECIAL CONSTRUCTION DETAIL

Fixing the butt of the free loop of the Mark III to the ground plane took some real effort. I finally solved the physical problems by clamping a bolt inside the 2" vertical piece of 5/8" tubing in the jaws of a vise and clamping the tubing again below the bolt head to form a shoulder against which the bolt can be pulled tightly, securing the loop to the ground plane. Gently solder the butt to the circuit board, flaming the tubing and not the PC board.

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Send mail to [webmaster@antennex.com](mailto:webmaster@antennex.com) with questions or comments.

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