The Classic Rain-Gutter Loop Antenna – Is it any Good?

A simple technical look at an HF horizontal loop of
wire strung around your house at rain-gutter height, plus.
some novel loop disguise techniques.

By John Portune W6NBC

Compromise disguise antennas are no strangers to hams, especially on HF. But which ones are worth the effort? We often just put them up and hope for the best. But when I moved to a CC&R restrictive mobile home park recently, I wanted better answers, particularly for the classic rain-gutter loop, Figure 1. I couldn't put up more of an HF antenna without the neighbors noticing. But was it any good, or only little more than a dummy load?

Figure 1: Classic rain-gutter-height loop, elevated on standoffs
(stylized for emphasis)

To find out, I challenged the rain-gutter loop with EZNEC antenna modeling software. This required best-case and worst-caswe models to encompass most house variables: (1) two loop heights, (2) two house types and (3) several bands. These would place most houses somewhere within these limits. Loop heights were: 10 ft. (rain-gutter height) and 25 ft. (a more conventional loop height). House types were: all wood (best case) and stucco/chicken wire (worst case). Bands were: 40M, 20M and 10M.

Why didn't I include 80M and 160M? Well, I did at first, but right up front, EZNEC revealed something very important about horizontal loops – Rule of Thumb 1.

RULE OF THUMB 1
To be efficient, a closed loop must have a perimeter greater than one wavelength (1λ) on the lowest band in use.

Still, by comparing all these EZNEC simulations, I soon had encouraging results. A rain-gutter loop indeed can be effective. What's more, it can be made almost invisible to the neighbors. Later we'll look at some novel disguise techniques.

My Loop

My loop's perimeter is 152 ft, which is less than 1λ on 80M. But it is greater than 1λ on 40M and above. If I could have put up a larger loop, I would have been able to include data for the lower bands.

Does this mean, however, that I can't use my loop on the bands below 40M? Of course I can. My tuner will tune up almost anything. I just don't expect high efficiency. I could have achieved a larger loop by running some of it to nearby trees or to outboard poles at the back of my house.

My loop is rectangular,10 ft. high and mounted on plastic standoffs one foot above the edge of a 52 x 24 ft. shallow-peaked composition-shingle roof. This configuration is relatively typical of a small one-storey bungalow. Bigger houses fare better. Further, my mobile home is of all-wood construction.

Yes, there are electrical wires, air conditioning ducts, metal flashings and two small aluminum car-port tops near my loop. Some of these were difficult to model, but in tentative EZNEC runs, again right up front, another rule of thumb became clear – Rule of Thumb 2.

RULE OF THUMB 2
Metal objects near an antenna are commonly non-resonant. Therefore, they do not reduce the efficiency of an antenna, they only alter its radiation pattern

Being non-resonant, nearby metal objects normally do not absorb much energy. They mainly reflect it, thereby only changing the radiation pattern. But they do not lower the efficiency of the antenna to any significant degree.

Hence, my loop still radiates efficiently, only in slightly different directions, despite the nearby metal objects.

The EZNEC Model

To simulate my all-wood house, I used just the loop (red line) of Figure 2. For a stucco house, I added the non-grounded wire frame (black lines) to simulate embedded chicken wire. It's also valid for a house with metal siding or a metal-skinned mobile home. In all cases the simulations were over average soil.

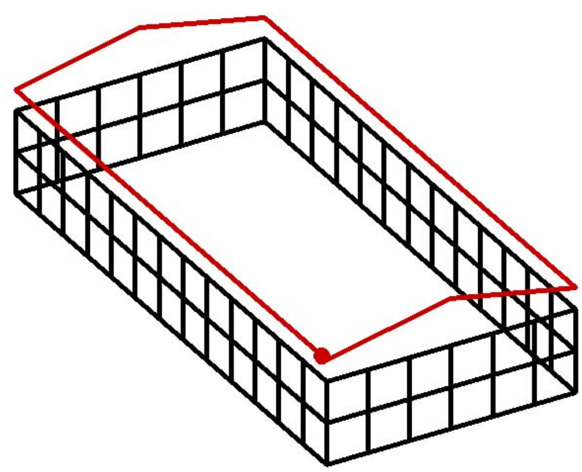

Figure 2: EZNEC model of the loop (red), at10 ft. and wire frame (black) over average soil to simulate chicken wire in stucco. The feed point (small dot at the lower left) may be anywhere on the loop.

My Conclusions

So what did the EZNEC data show me? Figure 3 is the raw data of the gain of the main lobe in dBi. Compare apples with apples.

	wood		stucco	
	10 ft	25 ft	10 ft	25 ft
40M	9.5 dBi	7.6 dBi	4 dBi	7.3 dBi
20M	8 dBi	6.7 dBi	6.1 dBi	7.4 dBi
10M	10.1 dBi	12.5 dBi	9 dBi	12.5 dBi

Figure 3: Raw EZNEC main lobe gain data for (1) loop height, (2) house type and (3) band.

	10 ft	25 ft
40M	-5.5 dB	-0.3 dB
20M	1.3 dB	-0.7 dB
10M	-2.4 dB	0 dB

Figure 4: Difference in dB between the best-case (wood) and worst-case (stucco) houses of Figure 3.

The main point of this article best stands out in Figure 4. To me it shows that a roof-line loop is not a dummy load. Note, that except for a stucco house on 40M, all the gains of a roof-line loop are less than 3dB down. The significance of this is that a 3 dB loss in radiated power shows up in a QSO as only a single S-point at the receiving end. In contrast, a 9dB gain linear amplifier can make three S-points of difference, far more than the rain-gutter loop in the worst case. To me then, this EZNEC data does not suggest that a roof-top loop can't "get out."

NOTE: the improved gain at the lower height of 10 ft. on 20M is valid, and is due to a wider beam width of the main radiation lobe.

Larger Houses

Then for a more comprehensive view of roof-top loops, I did several EZNEC simulations on houses larger than mine. I do not include the data here, but another rule of thumb for rain-gutter loops is worth mentioning.

RULE OF THUMB 3
The larger the house and loop, the less the difference

For example if you have a two-storey house, a rain-gutter loop will have less loss. Or, if you have an attached garage or a bigger one-storey house, there will be less loss as well. What's more, the difference between stucco and wood diminishes as the house and loop get larger.

Mechanical Details and Disguise Techniques

During construction, two issues stood out: (1) Standoff material, and (2) Wire type.

I felt it best, merely by intuition, not to lay the wire directly on the roof, or to put it directly in plastic rain gutters. I was concerned about dielectric loss and moisture. I didn't test these assumptions by field strength tests, so being cautious, I decided to mount the loop on 1 ft. plastic standoffs. If any reader can confirm or deny this, with meaningful data, I would appreciate hearing from you.

However, no matter what material I initially considered for the standoffs –such as most hams' favorite, white PVC water pipe – it would have been an eyesore on the roof. Happily over coffee one morning, a good ham buddy Dave, AB6DU, made a great suggestion. He said, "Why don't you just hide the standoffs in plain view?" His reasoned, "Don't use standoffs that look out of place; make them look like they belong on a roof. Then then neighbors won't notice them.

Makw them look like vent pipes, ventilators, water heater flues or furnace exhausts, not antenna standoffs. Nobody ever notices this normal roof-top clutter, even though they are in plain view. Take a survey for yourself and you'll see just how much "stuff" is up there that you never notice. However, roof-edge white PVC water-pipe standoffs will immediately be noticed.

Figure 5 shows one of my fake vent pipes, with the wire of the loop highly emphasized for clarity. They're made from 1 ft. lengths of 2 in. black ABS DWV pipe, cut off at an angle to match the slope of my roof, and glued to a 4 in. ABS DWV test cap. I attached them directly to the roof shingles with silicone sealant to avoid leaks. Or you can slip 2 in pipe over a real 1 ½ in. vent pipe. Further, I set the standoffs one foot back so that they would look like they come from inside the house.

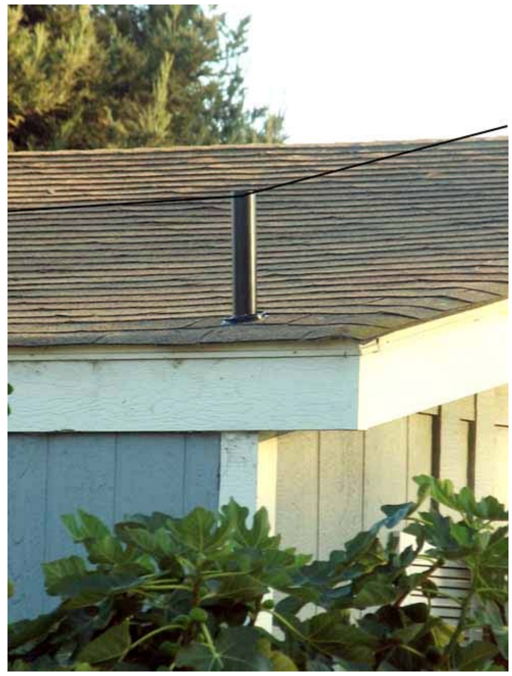

Figure 5: 1 ft. 2 in. ABS DWV plastic pipe standoff glued to a 4 in test cap and attached to the roof with silicone sealant. Neighbors think it’s a vent pipe. Loop wire is emphasized for clarity.

More Disguise

Figures 6a and 6b show an even sneakier piece of disguise witchery. It is a full-blown false RF transparent fireplace chimney. Santa was sharp enough last Christmas to notice my ruse. Building supply outlets and many hardware stores sell 4 ft. lengths of heavy cardboard tubes up to 12 inches in diameter, used to pour concrete posts. I added a removable false vent cap, made from two plastic (melamine) dinner plates and some plastic mesh harvested from an old baby gate (invisible to RF). The whole assembly is glued together with clear silicone sealant.

An added bonus with a fake fireplace chimney is that it can also hide VHF/UHF verticals. I have two false chimneys on my house. One hides a 2m/70cm vertical and the other a 137 MHz quadrafilar helix for weather satellite reception.

To make the cap removable, I cut a short 8 in. section from the original 48 in. cardboard tube. Then I cut a 1 in. wide slot longitudinally in this short piece and glued its edges together, in order to reduce its diameter, so that it would fit inside the main tube. I then glued the smaller tube section to the bottom of the false cap. The whole cap assembly now slips securely into the main tube. Making the cap removable makes it easy to install a optional antenna.

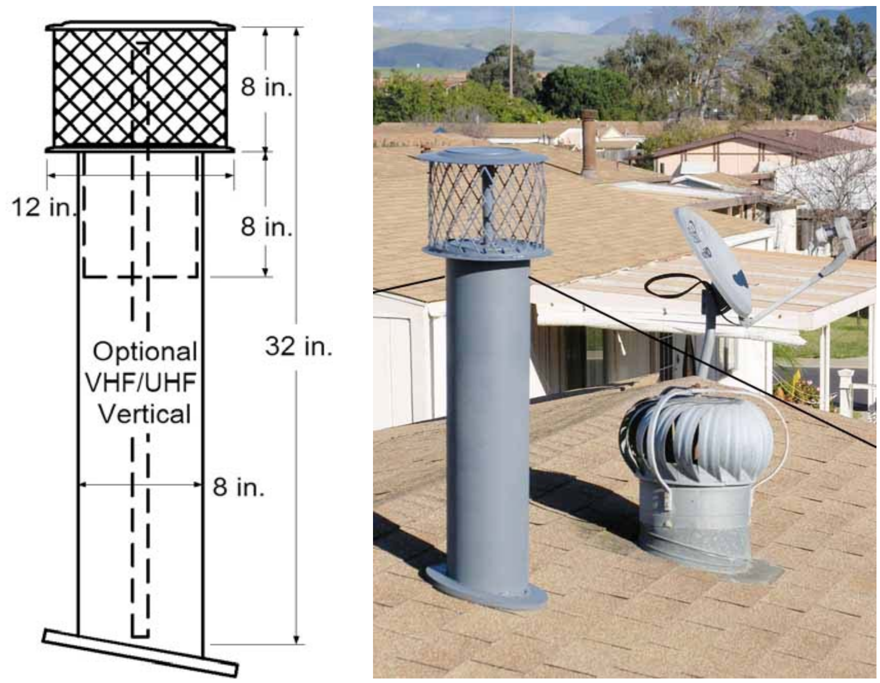

Figure 6a & 6b: 1 Fake fireplace chimney on my roof (see article). It supports part of loop and disguises a VHF/UHF vertical. It looks like it belongs on my roof. The loop wire is emphasized for clarity.

I then attached the false chimney to a circle of plywood for gluing to the roof. I painted all the chimney pieces, during assembly, with several heavy coats of low-gloss gray enamel.

The Antenna Wire

The final piece of disguise magic is to use very fine wire for the loop. Neighbors with good eyes may see it, but they again won't likely think it's an antenna. And don't worry, very fine wire is not a problem RF-wise. The loop is intentionally non-resonant on any ham band. Consequently its impedance is high making conductor loss is insignificant. Hence it can handle high power.

Mechanical strength is, however, a concern with very fine wire. Plain copper wire, under roughly 22 AWG, will sag in wind and ice. Fortunately there is an excellent alternate: Poly Stealth by Davis RF. See Figure 7. It is sold by a number of internet dealers.

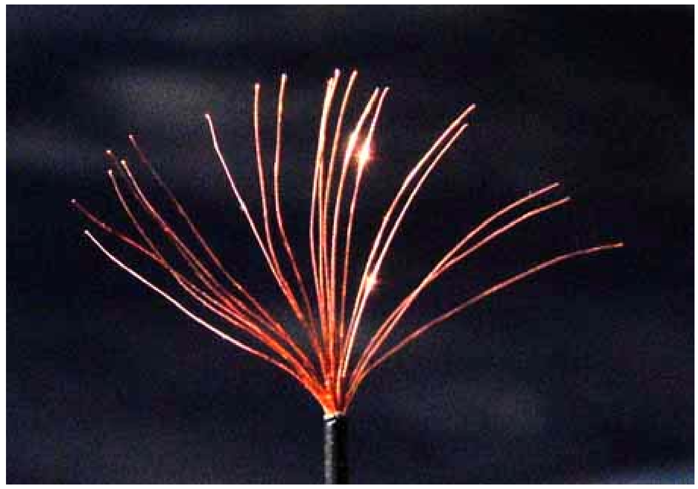

Figure 7: Davis RF 26 AWG Poly Stealth antenna wire. Multi-stranded copper-clad steel wire with a weather-resistant black polyethylene jacket. Tensile strength, 50 lbs.

Poly Stealth is surprisingly strong, non-stretching, multi-stranded copper-clad steel wire, covered with black weather resistant polyethylene insulation. It comes in several sizes, but the smallest size, 26 AVG, is very satisfactory for a rooftop loop. It has a tensile strength of 50 pounds, more than enough to tolerate wind and ice loading, in spans up to roughly 25 ft. You can cut a small horizontal slot or groove at the top of the fake vent pipes to secure the wire or simply glue it on with silicone sealant.

How to Feed the Loop

The loop requires a tuner, hence it needs a non-resonant perimeter. That is, its total length should not be an odd multiple of a quarter wavelength on any band. This lets the tuner work efficiently. Odd multiples of a quarter wavelength present a low impedance, causing some tuners to exhibit high currents or arcing, even if they do achieve a match. Automatic tuners often won't even tune quarter-wavelength resonant lengths.

So before installing my loop, I made an estimate of its rough length and did a little work with a calculator to see if the perimeter would be an odd multiple of a quarter wavelength on any ham band. This let me position the standoffs to accommodate the non-resonant perimeter. If some bands still won't tune, simply insert a small coil in the loop, supported by one of the standoffs.

Lastly, do not use coax to feed the loop; use open-wire feedline. The SWR is too high for coax. Losses would be excessive. Both 450 Ohm slotted line and 300 Ohm TV ribbon cable work fine. I opted for 300 Ohm TV ribbon. It is less visible and handles my full-gallon linear just fine.

NOTE: use one of the standoffs to support attachment of the feed line. Do not hang it directly from the loop. It is, however, okay to feed the loop at any location. It won't make any meaningful difference to the radiation pattern, especially on the lower HF bands. I feed mine at a corner, simply because that's where my rig is, though with open-wire line, it needn't be close to the feed point.

However, do use a balun: 4:1 or 9:1. Place it at the bottom of the open-wire line, not at the loop. It is okay to use a short coax pigtail to connect the balun to an unbalanced jack on your tuner. But keep it very short and make it from low-loss coax. I recommend LMR-400. But RG-8 and RG-213 are satisfactory. Some tuners have an open-wire output. If so, don't use any coax between the tuner and the loop. You can satisfactorily pass open-wire line through a wall in PVC pipe with caps for insulation, varmints and weatherproofing.

Parting Thoughts

No, I don't expect miracles from my gutter-height loop. Tall towers, big beams and high-mounted wire antennas certainly work better, but less than I expected. I reason, if QRP can be popular and an active part of ham radio, then a low roof-top loop is also quite practical. Remember, a rain-gutter loop with an amplifier is the equal of a big beam and a barefoot transceiver. Roof-top loops are far from being dummy loads. Best of all, the neighbors won't even notice them.

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