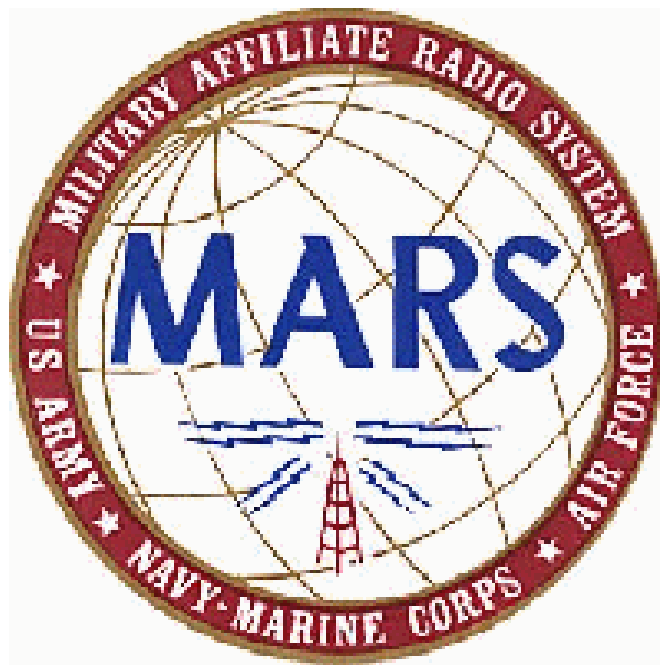


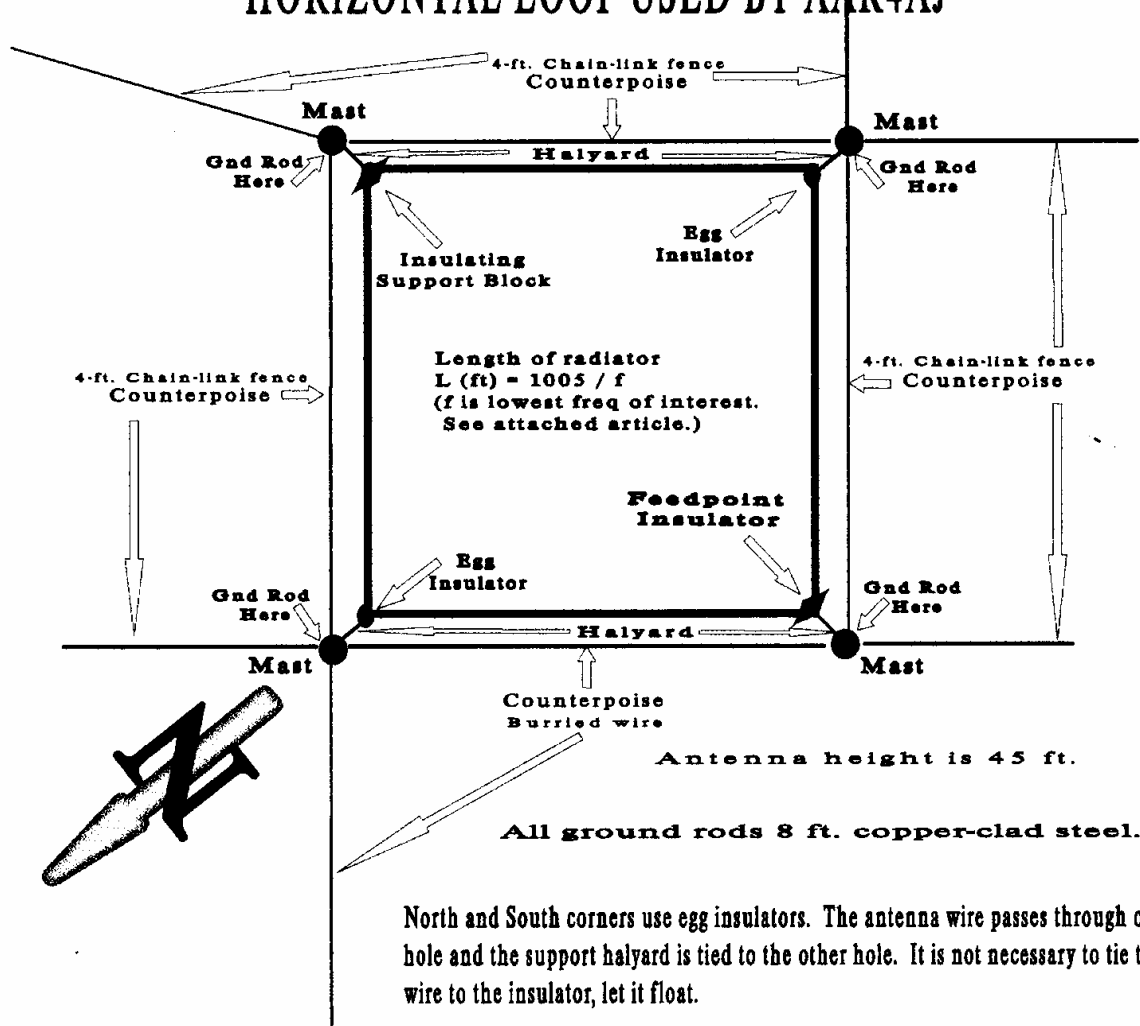
Army MARS



A HORIZONTAL LOOP ANTENNA

**A broadband antenna for 1.8 to 30 MHz, its construction
and use.**

HORIZONTAL LOOP USED BY AAR4AJ



See attached article for a discussion of the insulator used in the east corner of this antenna.

Antenna wire used: MILSPEC 14 AWG stranded high-tensile strength tactical antenna wire. Since this antenna does not need to be stretched tight, any 12 AWG or above home wire, bare, solid, stranded, insulated, etc. it OK. Some droop is acceptable and should cause no problems in tuning the antenna.

Masts are Mil surplus fiberglass push-up 40 ft. masts. Anything will work for masts. Antenna height should be a minimum of 20 ft. above counterpoise and maximum of 42 feet above counterpoise.

For discussion of feedline used at this station, see attached article for discussion.

A HORIZONTAL LOOP AS BUILT BY AAR4AJ/KM4QQ

by

Edward Butorajac, AAR4AJ

In the spring of 1989, the author re-entered amateur radio after a 21 year hiatus from his beloved hobby. Faced with a relatively small lot and a desire to be able to operate on all the MF and HF amateur bands, a search for an ideal antenna began. A half-wave dipole was tried, stretched between trees in the neighbor's yards on both sides of me. They were gracious enough to allow me this privilege, and I was grateful for their indulgence. I also had a 40, 20, 15, 10-meter spider dipole array up. The spider dipole worked well. 80 and 75 meters was another story!

The antenna tuned just fine across the entire width of the band with the help of a tuner. The problem was the terrifically high noise levels I was experiencing. Not only atmospherics, but ac line noise. I could hear every microwave oven in the area, most of the attic exhaust fans and other assorted appliances. In the evenings, a noise level of around 40 dB over S-9 was not uncommon.

A friend, Rick Redman, N4CYC, thought he had the answer to my problems. One afternoon while visiting, he asked me to get a tape measure out, and we measured the size of the back yard. (The wife does not want antennas in the front yard!) Rick did a couple short calculations and decided the yard was just the right size for a horizontal loop. I scrounged up four masts that would allow a height of about 20 feet. Some old surplus antenna halyards, a few insulators, some wire and a bit of coax and the deed was done.

The frequency used to cut the length of the antenna wire was 3.505 MHz. The length of the wire came out to 286 ft., 9 in. Dividing this figure by 4 gave something under 72 ft. per side of the square. This fit just fine inside a yard that was 75 ft. square. The yard also has a 4 ft.-high chain link fence around three sides of it. The fence would act as a counterpoise, and it was just a bit outside the perimeter of the antenna. This I figured would work as an advantage. (Note, I do not know how the antenna might perform with a different counterpoise, this is one experiment I did not try.)

Transmission Line Experiments

I was not sure how I wanted to feed the antenna. I know the impedance of a full-wave loop is somewhere in the area of 100 to 125 Ohms. If my MFJ antenna analyzer can be believed, it was somewhere near 100 Ohms. I fed the antenna with 50-Ohm coax and used it for about 6 months making careful notes of signal strengths, receive signal levels, etc. I was happy with the loop at this point, but was not sure I was getting the most I could from it. I had other configurations I wanted to try. Of course, if one subscribes to the "Conjugate Match Theory", and there is mathematical (or Mathemagical, depending on your stand on the subject,) proof to back this theory up, the 50-Ohm coax should work as-well-as any other feedline configuration. But. . . .

Next, RG-62A/U, a 93-Ohm coax was tried and again careful comparison notes were compiled. This didn't seem to be any improvement, and was only used for a period of

3 months. Next I tried 450-Ohm ladder line. Over a period of 6 months, carefully noting the results, I noted a bit of signal strength increases in all three major areas: receive signal reports, the reports received from other stations and noise in the receiver (both atmospheric and man-made.) *Also noted was a tendency for static build-up on the antenna and the characteristic static popping and receiver overload when a storm front moved into the area, necessitating disconnecting the antenna.*

Note that mention is made of noise for only the second time when I was using the ladder line. When using coax as a transmission line, I noted a difference of approximately 6 – 8 dB lower atmospheric noise. Also, in relation to the dipole I started with (and with which I was plagued by severe noise) the ac line-type noises were altogether gone! This meant I did not have to go and find each source of interference and bargain with the neighbors to get a quiet RF spectrum in which to work. My antenna did the job for me! If the loop had nothing else going for it, the reduction of the noise was enough to insure continued use of the horizontal loop as the primary antenna at this station.

Final Feedline Configuration

The last configuration tried was the coaxial feedline with a quarter-wave matching section. The matching section was designed for a frequency of 3.975 MHz. There are several reasons for this. First, in Georgia, this is one of the most used frequencies for emergency communications. Second, it is near the top of the band, and since MARS had become a part of the operating interests here, placed the MARS frequencies just outside the band within reach. Third, another frequency of a net often frequented is just above 3.9 MHz, and this only needed a slight bit of touchup with the internal tuner on the transceiver. Also, it allowed tuning of the CW frequencies of 80 meters with little difficulty.

160-meter operation with the 80-meter loop

I tried using the loop on 160-meters, and was very disappointed in the results. Signal reports were very poor. I had hoped for better. Then a big light shown, and suddenly the thought struck: A full-wave 80-meter antenna is a half-wave 160-meter antenna! Enter the insulator block in the corner opposite the feed corner of the antenna. When the antenna is being used as an 80—meter loop, there is a jumper placed across this insulator. During the winter (which is a low lightning and static field period), the loop can have the jumper removed for 160 meter operation. During the summer, there is little operation on the top band because of high atmospheric disturbance levels and ionospheric absorption levels, and a low power station does not have much of a chance to talk to many stations outside of locals, of which there are few on 160 in this area. Of course, the insulator block can be eliminated and replaced with an egg insulator like the north and south corners of the antenna if no 160 meter operation (or MARS frequency operation between 2 and 3.5 MHz) is anticipated.

Broadband Frequency Coverage with Coaxial Feedline

While use of many types of antennas over a broad range of frequencies is simplified by use of open-wire or ladder line feeders, there seems to be no real problem here using the loop with a coaxial feedline as described in the last paragraph. There is a bit of problem tuning some frequencies from between 24 and 30 MHz. This should be correctable by changing the length of the coax between the tuner and the quarter-wave stub, or the length of coax between the radio and tuner. Since there is so little operation done at this station in that range, this has not been done yet.

Counterpoise

This is the secret to the loop antenna. If a loop is to operate efficiently, regardless of feedline used, it must have a good counterpoise. I do not believe it is possible to have too much counterpoise. Referring to the diagram, one can easily see there is chain-link fencing around three sides of the antenna. Also a wire was installed to go under the fourth side of the antenna. Since the masts are in the corners of the fence, these points were convenient points to drive 8-ft. ground rods. Copper wire was woven through the top of the chain link fence to insure a good counterpoise field. The fence and the woven wire was all grounded. Of course, the neighbor's fences also became a part of the system. (A plus when living in a sub-division with a lot of fences.)

Other improvements

The only other major improvement was to use heavier coax, (RG-213 and RG-11 instead of RG-58 and RG-59) and increasing the height of the antenna from 20 ft. to 45 ft. As you can imagine, each of these improvements helped performance.

Quarter-wave Matching Stub

The formula for calculating length of the matching stub is: $L_{(ft)} = 246 \times Vf / f_{(MHz)}$. Vf is the velocity factor for the coax cable used to make the stub. For RG-11/U or RG-59/U it is 0.66. Check a table of coaxial specs for the velocity factor of the cable you are using. The stub is connected directly to the antenna on one end, and should be terminated in a PL-259 connector, or other suitable connector. Connect any length of 50-Ohm coax to the end of the stub to connect the antenna to the station. Use the shortest run possible to keep line loss at a minimum.

Lightning Hazard

As mentioned above, when using coax there is a lot less noise than when using open-wire or ladder line feedline. This is probably because of the antenna being at ground potential. As long as your antenna is connected to your station, and the station is properly grounded, the antenna is at ground potential. As long as the antenna has the jumper in place (if one was installed), the entire length of the antenna

is at the same ground potential. This makes it impossible for static charges to build on the antenna (or more correctly between an insulated portion of the antenna and ground). As such, static discharge can not occur, putting your station equipment at risk. In fact, the loop antenna is never disconnected from the author's station. Operation during local electrical storms has never posed a problem. The station has endured many severe storms without damage. I do not think anything will survive a direct hit, but if antennas are properly installed and kept at ground potential, risk is greatly reduced. The pine (and other) trees around the neighborhood are much higher than the antennas here. This also affords a measure of protection. Neighbors in adjacent properties have suffered lightning damage to their houses and trees. None has occurred on this property. Luck you say? Maybe, but sound lightning avoidance engineering has played a big part. That is a subject for another article.

Edward (Ed) Butorajac can be reached for comments and clarification of anything covered here at km4gg@arrl.net, or by snail mail at 3604 San Sebastian Dr., Hephzibah, GA 30815-6528. Ed entered amateur radio in the late 50's, joined the Army in 1962, and while overseas allowed his amateur licenses to laps. After retirement from military service, again the radio bug bit and again a license was obtained in the spring of 1989. A year later upgrading to extra class and joining MARS brought him to where he is today. Having served in the field of electronics as a technician and supervisor, and since retirement as a technician for a government contractor has kept him in the forefront of technology in the communications-electronics field. Antenna systems design and lightning damage avoidance are a couple of the areas of interest in which his interests are strong, and has been one of the communications and electronic fields in which he has provided service over the past 40 years.