

A Horizontal Loop Antenna for Shortwave Listening and Amateur Radio Use

Overview: There is need for an antenna design which meets the following criteria- easily constructed with home tools; made from locally-available, non-specialty materials (as much as practical); reasonable for single-person deployment; unobtrusive/low-observable; omnidirectional; effective for a wide range of frequencies; durable under different weather conditions; and most importantly good performance. The horizontal loop antenna meets these criteria and performs very well. I will show you how to construct and use one from materials you have available locally, with tools you should already have.

Basic Specifications:

Size: Varies with frequency range, the model I will show is approximately 287 feet of wire, arranged in a square shape, so about 72 feet per side, plus room to hang the antenna. I will also discuss smaller models for space-limited applications.

Cost: \$0-\$100- If you have some or all of the materials already on hand, or adapt what you have, the cost will be minimal. If you need or want to buy everything, the price varies considerably, most of the cost will be the wire itself.

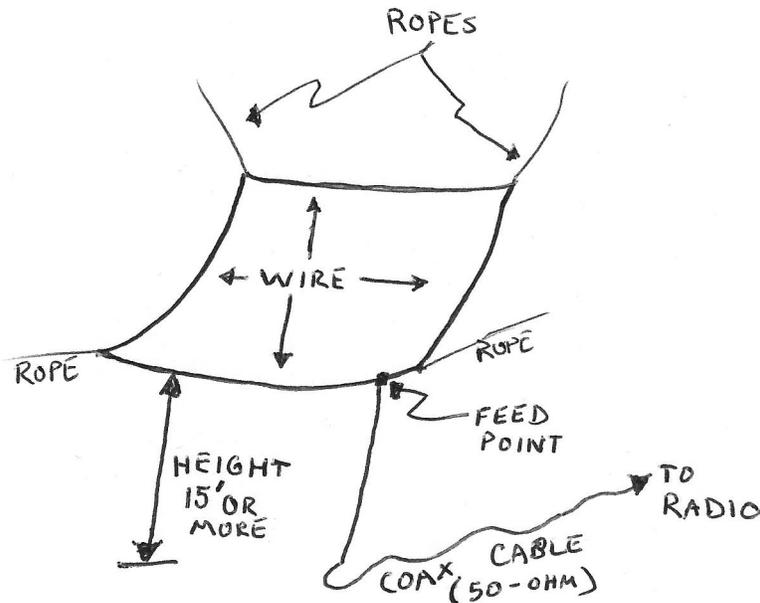
Performance: This antenna will be suitable for transmitting (with an appropriate tuner) from 3.5 MHz to 54 MHz; and for receiving over a much greater range for shortwave broadcasts. The design of this antenna tends to pick up less atmospheric/electrical noise, so your reception will be quieter and more readable. It is also omnidirectional, which will allow you to receive broadcasts from any direction without moving or altering the antenna.

NOTE: I will not delve into very technical aspects of antenna design, as there are many texts out there available which will do a better job of it. Much of the information on antennas that is available on the internet is clouded with rumors, ignorance, and bias. Antennas work on the principles of physics, there is no secret way to improve performance short of working within these principles. All antennas are a compromise of some sort, I personally feel that for the application we're discussing, the horizontal loop best fits the need.

Now, let's get started with an overview and the materials and tools needed.

FIRST, though, we will talk about safety- you will be hanging wire in the air, which involves several safety concerns. ALWAYS ALWAYS ALWAYS be aware of your surroundings when working with antennas- electrical wires, falling tree limbs, and falls can kill you or your loved ones. NEVER try to erect any antenna remotely close to any utility lines, poles, lights, or commercial installations. Ensure that your antenna is PROPERLY protected against lightning strikes and that you provide a proper ground for your station and antennas. If you are uncomfortable or have questions, please contact me and we will help you or try to find someone local to you who can help. I assume no responsibility for the use or misuse of this document, you are responsible for your own safety. Now that the "lawyer talk" is out of the way, let's make some antennas!

The Big Picture



Overview of Loop

The Horizontal Loop Antenna is one full wavelength at the lowest frequency used. The formula for calculating length is:

$$1,005/f=L$$

In other words, take 1,005; divide it by the lowest frequency in megahertz (MHz)- this result is the length in feet. The antenna I'm making here is for 3.5 MHz (80 meter band), so 1,005 divided by 3.5 equals 287.143 or so. The length of the wire is not absolutely critical, a few inches either way will have little effect on performance. Another popular size is for the 40-meter band (7 MHz). The best part of this antenna is that when transmitting, the antenna loads well at EVERY harmonic- the 3.5 MHz antenna will also perform well at 7, 10.5, 14, 17.5, etc. up to a certain point where performance starts to degrade. Luckily for us, most of those harmonics fall within other Amateur bands. For receiving, it should perform very well at all broadcast frequencies.

There are tales on the internet and amongst Hams that this antenna is a "cloudwarmer", in other words, the radio energy goes straight up and "warms the clouds". For long-range HF communication, a low angle of radiation is desirable. However, this is true to some extent at the primary frequency, but at each harmonic, the angle of radiation gets lower, and there is actually some "gain" to be had at the higher harmonics. Height above ground and the type of ground will also affect this. Again, for reception only, this will not matter nearly as much as for transmitting.

A dipole antenna is a bit simpler, but for 2 more supports, and a bit more wire, this design is no more complex to build, and performs much better overall. I will not discuss directional antennas here (Yagi, Log Periodic, etc) as they are far too complex to design and build for most people.

They also require a support structure of some type and a means to “aim” the array, such as a rotor. They are also much more visible, and prone to damage from ice or tree limbs.

This antenna is fed with coaxial cable (coax) of 50-ohm impedance. This cable is available either through radio equipment dealers or online. It is also available in many sizes and grades, which can be confusing. For the shortwave listener or Amateur HF operator, a good cable to use is called “RG-8x”. Unless you are transmitting using an amplifier, or working at VHF frequencies, this cable is more than sufficient for runs up to 150'. The cable will need to have PL-259 (aka UHF) connectors installed, if you don't have experience with this, either buy the cable with connectors pre-installed or find an experienced ham to help you. This is the point that ruins many antenna installations- improperly installed connections- so ask for help if you need to. I strongly recommend against buying the cheapest cable you can find, especially at a certain large electronics retailer. They sell very poor-quality cable with poorly-crimped fittings at a premium price. You will need enough cable to safely get from your radio to the antenna, figuring in the height of the feedpoint. You can always use a bit extra for other projects, so don't skimp on this step.

Several designs on the internet for this type of antenna insist on using balanced feedline, or “ladder line”. In my opinion, this is unnecessarily complicated and I have never had problems using coax to feed the antenna directly. Ladder line is also much more “finicky” about installation, and needs a balanced-line tuner to transmit.

Materials for Construction

I will discuss each of these afterwards, plus ideas for substitutions/improvisation. For now, just a list.

290' of wire (14AWG stranded black insulation from home center) (usually comes in 500' spool)

Support rope- try to get at least 400' of rope with a few hundred pounds breaking strength. 550 or paracord is great for this.

Corner insulators- 4, can be purchased at a farm store as “egg” insulators for electric fencing, black plastic or ceramic.

Feedpoint- you will need either a short piece (14”-18”) of coax with a PL-259 connector on each end, plus a “dogbone” support or other material (basic method) OR construct a feedpoint based on an SO-239 chassis-mount connector (better method). I will discuss this in detail below.

Coax- discussed above, RG-8x is a good compromise between performance, cost, and weight/size.

Solder- Rosin-core electrical solder. DO NOT use acid-core solder made for plumbing!

Electrical tape- use the good stuff- Scotch 33 or better- this will be out in the weather and you need to protect your connections.

Clear silicone- use “aquarium safe” silicone from the pet store. Normal silicone caulk will cause corrosion on electrical connections. You can also get putty in the electrical section of the home store, this will need to be covered with tape, but works very well on coax connections. Both are helpful, but the silicone is needed to seal the coax and feedpoint.

Hardware- Eye bolts to hang, washers, nuts, connectors- this will depend on the design used and what you have available. One of the best parts of building antennas is improvisation.

Tools Needed

Wire Cutters/Strippers

Soldering Iron/Gun

Utility Knife

Screwdrivers

Long Measuring Tape (100' is great if you have one)

If you build it, they will come in...

I will not get into great detail about the construction, I will show the different processes and applications in the accompanying video. The most complicated part of this antenna is the feedpoint, but once you've figured that out, you can make most wire antennas with little additional skill. Instead of a step-by-step, I will outline the goals of each step and let you improvise the method according to your own skill and materials on-hand. Contact me with any specific questions or issues.

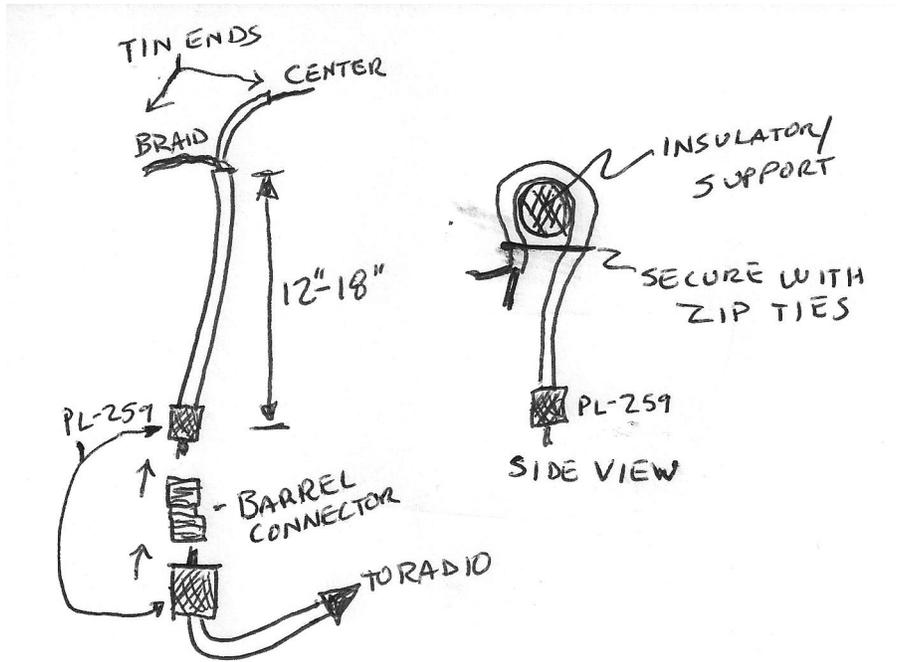
Feed Point:

This is the part that sticks many people, and influences them to go out and spend a good deal of money on pre-made feedpoint insulators. You can certainly do so, I can recommend several of the best types if you contact me. As to building one, there are as many methods as builders, the goals remain the same. The coax feedline has 2 conductors, a center and the braid. In this application, they are not critical which gets connected where. The loop of wire once cut for length will have 2 ends- one will connect to the center conductor, the other to the braid. The goals for this are a mechanically-sound connection and support for both the tension on the wire, and the weight of the feedline hanging down. This is also the transition between wire and coax, so the feedpoint should have an easy and removable means to connect it to a standard coax connector. I will show you two basic methods.

Method One- cut coax with support:

This method is perhaps the simplest to construct, but will also not last nearly as long. The basic concept is to take a short piece of coax with an installed PL-259, strip the cut end back to expose a piece of each conductor (see video), and attach it to both the antenna element and a means of physical support. The exposed cable ends must be completely sealed, as the braid of coax will "wick" water many feet inside the jacket and ruin your cable. The benefits are that other than the coax and connector, everything else in the design can be made from what you have. I have used many different things for center insulators, plastic, wood, ceramic, any non-conductive weather-resistant material will work.

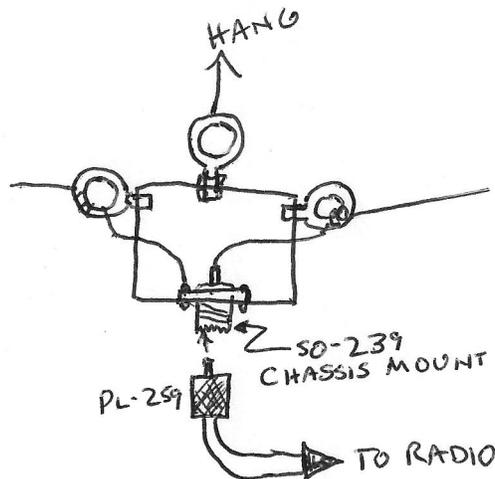
Method One- sketch- (excuse the smears and sloppy drawing)



On the left, the coax piece is stripped back and the ends are tinned with solder. On the right, the coax is wrapped over or through the support/insulator. Notice that the cut end points down, this will help water to drip off instead of running into the cable. See video for more details.

Method Two- fabricated feedpoint/support

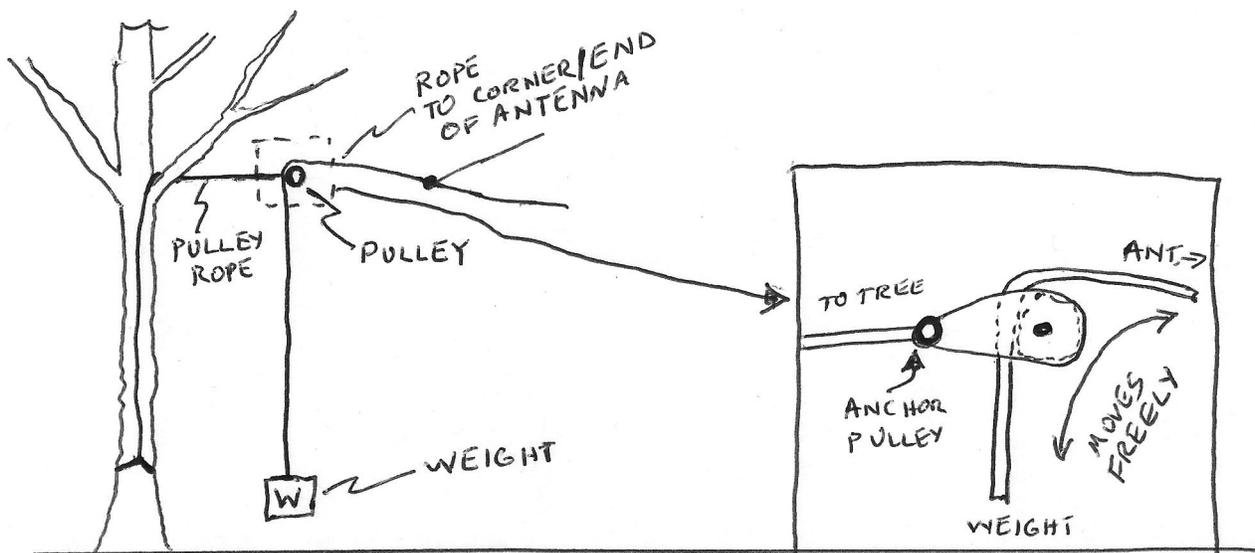
This method is a bit more complicated, but will result in a stronger and more weatherproof connecton. The basic idea is to have a box or enclosure (can be round, such as PVC fittings) with support attachments on the sides and top, and an SO-239 female connector on the bottom to directly attach coax. This eliminates the need for a barrel connector and makes weatherproofing much easier. Same theory, braid to one side, and center conductor to the other. All connections should be soldered and protected from corrosion.



Hang 'Em High!

Hanging wire antennas is just “one of those things”... everyone has a different way of doing it. I have several criteria for hanging antennas, foremost of those is safety. Some folks use slingshots with lead weights, bows and arrows, even pneumatic launchers. All of these methods use a dangerous projectile which is only constrained by your leader from flying off and hurting someone or damaging property. Unless you're in the wilderness, none of these has an acceptable safety factor. The method that I use most often now is a slingshot designed to launch tennis balls, marketed as a dog toy. These can be purchased for around \$25. You can simply throw the weight, but it takes some practice and will not get your antenna as high as it should be. For a one-time shortwave listening antenna, this might be OK, but higher is better, this antenna will perform best when hung 40 feet or more above the ground. Again, it is a forgiving design, not everyone has 4 trees of sufficient height in a perfect square, so do the best you can. The goal is to keep the antenna enclosing the maximum space (a circle would actually be best, but would require too many supports), and as level over the ground as possible.

At least 3 of the corners should be rigged to “float”, meaning that the corner insulators can slide along the wire. This gives you some slack for the antenna to move when the wind blows the trees around. The best way to counteract this is with pulleys and weights, but such a setup is only critical to a dipole antenna with only 2 supports- any opposing movement of the end supports would stretch and possibly break the antenna. I have a sketch to illustrate how this works:



The weight should be made of something that allows you to add/subtract weight, but also be covered to keep rain and ice from building up inside. I have had great success with the jugs that cat litter comes in, painting them a non-obtrusive color and putting enough small rocks inside, then replacing the cap. How much weight you need will depend on the length of the antenna- it should be enough to keep the wire taught without stressing it too much.

With “floating” corners on the loop, I have had an 8” tree limb pull a corner of the antenna all the way to the ground after a storm. The wire was unbroken, two corner ropes pulled the knots out and had to be re-hung, but nothing on the antenna was permanently damaged. Antennas are not “forever”, they will need periodic maintenance and repair. An annual inspection and lowering/repair perhaps every 3 years or so. Now, a bit more about hanging technique.

For the Dogs...

The tennis ball slingshot that I use will launch a properly-weighted tennis ball with a messenger line over the top of most trees. I use common "mason line" for launching, it is a good balance between weight, cost, and strength. The best way to control this line is to feed it into a large can or bucket, which will prevent most tangles. See the video for more details. One safety note- if you are going to throw a weight by hand, or when pulling on the mason line, wear gloves! The line will give you some deep burns if it slides across your bare skin.

To weight a tennis ball, cut a 2" or so slice in the ball with a sharp utility knife. You should be able to then squeeze the ball and open the cut, like an old change purse. The weight can be small screws or nuts, I use about 2 ounces of BB's poured in. 2-4 ounces of weight is a good amount, too heavy- it won't go high enough; too light- won't pull the line down through the tree.

To use the ball in the slingshot, I poke 2 holes in the ball and thread a loop of mason line through, usually doubled. See the video for a good way to tie the ball on without having to cut the line every throw.

Once your mason line is up and over the tree, you can tie your support rope on the end and pull it back up through. Use good knots and heat fuse all cut ends to prevent fraying.

Also, don't forget to attach and seal your coax before you haul the antenna up!

Weatherproofing Connections

All connections MUST be protected from water! Coax cable will wick water 20 feet into the cable if it's allowed access. This completely and permanently ruins that section of cable. PL-259 connectors are NOT waterproof, or even water-resistant. Use sealing putty and/or high-quality electrical tape to seal the connectors. See the video for more, or check out some online sources.

Final Notes:

The loop antenna should perform admirably if hung reasonably well (as much in a square as possible) and high enough off the ground. $\frac{1}{4}$ wavelength is a good height for most wire antennas. This means an 80-meter antenna should be (gasp!) 20 meters off the ground.

If you have any further questions after reading this and watching the video, please contact me and we'll try to help you out.

Even if you're not an Amateur Radio operator, and never plan on being one, this antenna is a good design because a neighbor, friend, or compatriot can use the antenna for important disaster communications from your location if it's ever needed.

Thanks,

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