Sky Loop

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Disclaimer

This document describes how I installed my sky loop antenna system. I take responsibility for my installation. I make no claims about how safe this system is. If you use any of these ideas, you must take responsibility for your own installation.

Overview

This document describes the Sky Loop that is my one and only HF antenna system. For my situation (both environmental and operating interests) it is the “ideal” antenna system for me.

From Investigation to Implementation

When I got my Ham license, I immediately started to investigate and plan for my HF antenna system implementation. I spent countless hours reading articles, watching YouTubes, making notes, talking to other Hams, etc.

Much is made about resonant antennas. Indeed, resonance is one of the fundamentals in antenna theory. However, here is a very interesting quote that I came across in the ***ARRL Antenna Book 24th Edition****:*

> Is Resonance Required?
> An antenna need not be resonant in order to be an effective radiator. There is in fact nothing magic about having a resonant antenna, provided of course that you can devise some efficient means to feed the antenna. Many amateurs use non-resonant (even random-length) antennas fed with open-wire transmission lines and antenna tuners. They radiate signals just as well as those using coaxial cable and resonant antennas and as a bonus can usually be used on multiple frequency bands. It is important to consider an antenna and its feed line as a ***system*** in which all losses should be kept to a minimum. (emphasis added)

Putting it more succinctly, from https://kv5r.com/ham-radio/2018-projects/80-meter-doublet/:

> “And NO, an antenna does NOT need to be resonant to be efficient. Unless you feed it with coax.”

During my investigation I ran across these videos:
Tim G5TM - The Doublet Antenna & Ladderline
This is the first video I watched that introduced me to the doublet antenna. A doublet is essentially a center-fed dipole, fed with ladder line, going thru a tuner. The low loss of ladder line was really an eye-opener for me. In addition, a single antenna wire could be used on ALL bands instead of just one or a couple of bands (the lowest band you can work is dependent on how long the wire is that you can put up).

Kevin Laughlin - The Doublet. An old but good multi-band single dipole antenna. Part 1

Keving Laughlin - The Doublet antenna, QSOs and observations.
(this is actually Part 2 of the previous video)

These videos really got me to thinking.

All-band Vs. Multi-band Antennas

I'd like to make a distinction between 2 terms that are frequently confused with each other. These terms are:
multi-band
all-band

Multi-band simply means "multiple bands"; an antenna that works on more than one band.

All-band means the antenna works on **all** bands (within a specified range).

For example, a ***10-40M multi-band antenna*** can work on 10,15,20 & 40M. This design takes advantage of the harmonic relationships of multiple bands. However, it does not necessarily work well (or at all) on non-harmonic bands such as 12, 17 & 30M (unless you add complicated and lossy components).

A ***10-40M all-band antenna*** works on **all** bands from 10 to 40M (10, 12, 15, 17, 20, 30 & 40M).

So, be cautious about this terminology. For example, someone might mention they have an "all-band" antenna that covers 10-80M. What they might actually be saying is that it works on 10/15/20/40/80M. This is a multi-band antenna and doesn't work well (if at all) on 12/17/30/60M.

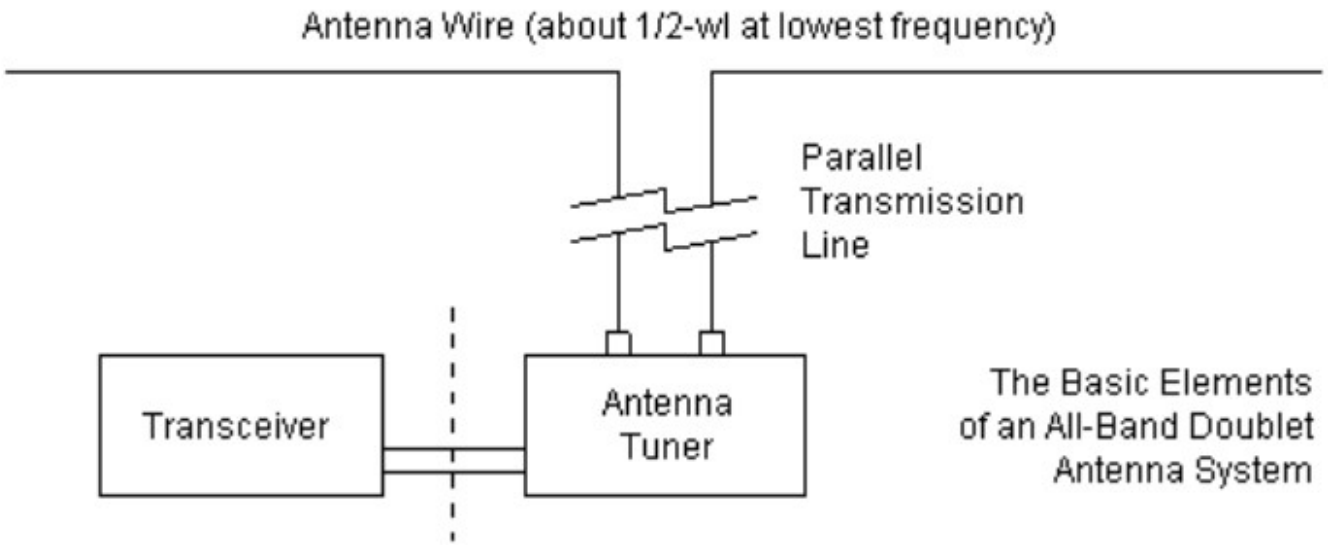
So, in additional to having the most efficient (I.e, minimal loss) system possible I decided that I wanted **all** the bands (within a specified range), not just some of the bands.

All Band Doublet System

When I ran across the concept of the doublet, I got a feeling that this was close to, or exactly, the direction to go for myself.

Here is a reference that is very useful:

[All-Band Doublet - L. B. Cebik - W4RNL]



Characteristics

Antenna: non-Resonant dipole. Exact length is not important.
Feedline: parallel feedline (PFL)
Matchbox (AKA tuner): required

Advantages (compared to a traditional dipole)

> All band coverage in a single antenna system
(the lowest covered band is based on the length of the antenna)
> Not limited to only harmonic bands
> Far less power loss than coaxial feedline (CFL)

Disadvantages (compared to a traditional dipole)

The biggest challenge is that feedline routing is more particular for PFLs than for CFLs. However, with proper planning this is not as big of a deal as many Hams claim that it is.

Notes

> The usual impacts of antenna height apply. e.g., For example, if the antenna is 40' AGL, your 80M and 40M coverages are going to be more NVIS than DX.

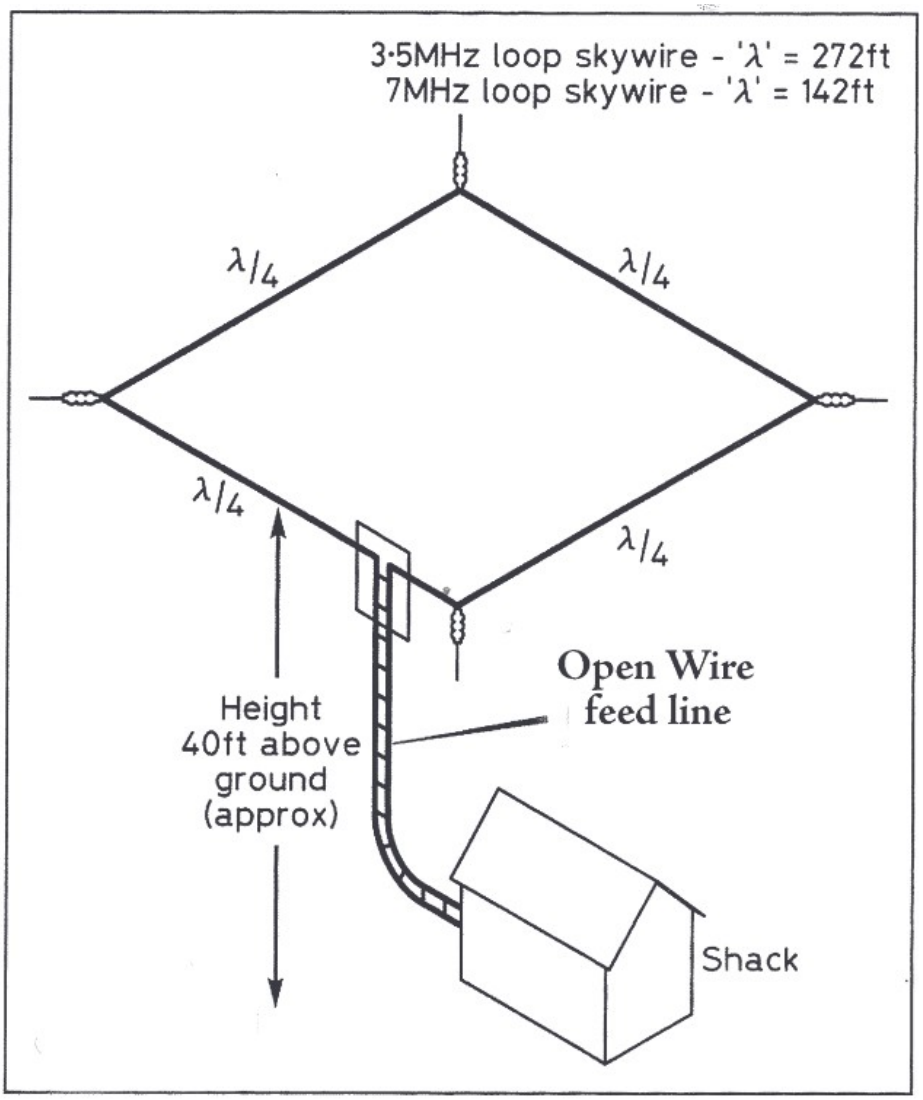
> Feedline loss comparison. From this table, you can see why I decided to go with PFL:

HF Feed Line Loss / 100' - 100 Watts Output												
	3.5MHz			7MHz			14MHz			28MHz		
	loss db	Loss (%)	Power Out (Watts)	loss db	Loss (%)	Power Out (Watts)	loss db	Loss (%)	Power Out (Watts)	loss db	Loss (%)	Power Out (Watts)
Coax												
RG58 ($.49/ft)	0.7	15	85.1	1.0	21	78.8	1.5	29	71.1	2.1	39	61.3
RG8X ($.65/ft)	0.6	12	87.9	0.8	17	83.1	1.2	23	76.6	1.7	32	68.0
RG213 ($1.85/ft)	0.4	9	91.4	0.6	12	88.0	0.8	17	83.3	1.1	23	77.0
DX 400Max ($1.45/ft)	0.2	6	94.5	0.3	8	92.4	0.5	11	89.4	0.7	15	85.3
7/8" Heliax ($6/ft)	0.1	2	98.4	0.1	2	97.4	0.1	3	96.8	0.2	5	95.4
Parallel Line												
450Ω Window Line ($1.18/ft)	0.1	1	98.7	0.1	2	98.2	0.1	3	97.4	0.2	4	96.3
600Ω Ladder Line ($.48/ft)	0	1	99.1	0.1	1	98.7	0.1	2	98.2	0.1	3	97.5

I really got focused on this part of the antenna system. If my transmitter is putting out 100W I want as much of that getting to the antenna as possible!

All Band Sky Loop

Having been convinced of the advantages of an all band doublet antenna system, I came across the sky loop. Here is one conceptual sketch:



The illustration above does not show a matchbox but it is definitely required (assume the matchbox is inside the shack).

This system incorporates the advantages of the doublet. However, the length of the antenna wire is a full wavelength (on the lowest band you want to operate on). There are versions of this that use CFL instead of PFL, but I was committed to using PFL to reduce power loss as much as possible.

The additional benefit of the sky loop is that it is **more omnidirectional** than the doublet. The disadvantage is that it requires more real estate to put up (which I happen to have).

I put up this system in the summer of 2021 at my home QTH. I have been very pleased with this system and have no plans to change it. For my home QTH environment and operating criteria this is my “best” antenna.

I have not had any problems with the sky loop. The installation method that I used allows the sky loop to flex with the wind and prevents it from breaking under a strain.

Nor, have I encountered one of the commonly mentioned “problems” with PFL’s, that of moisture having an impact on tuning/SWR. I just haven’t had that problem. Perhaps, one of

the reasons is that I live in a dryer climate than many others (Colorado). However, we do get our share of rain, snow and ice and I've had no problems.

Details

Matchbox

There are a lot of matchboxes (AKA tuners) on the market that ***claim*** they work well with PFL's or balanced lines. I can tell you that at least some of the claims are **not** true.

It is imperative that you get a matchbox specifically designed for PFL's. One of the key components for a PFL matchbox is a 1:1 balun. Many (if not most) matchboxes use 4:1 baluns. This is simply the **wrong balun** to use for a PFL matchbox. That doesn't mean that a matchbox with a 4:1 won't work at all. It means that it likely won't work as well.

The matchbox that I am successfully using is an MFJ-974HB.

I helped a Ham friend put up a doublet. He got a "good deal" from a Ham friend on a tuner that claimed to work well with PFL's. There were several bands that he could not tune at all. I took my MFJ-974HB to his QTH and used it instead of the matchbox he had and it successfully tuned **all** bands from 6-80M. Getting the right matchbox **does** make a difference!

Sky Loop

Here is the antenna wire I got:
https://www.dxengineering.com/search/part-type/wire?fr=part-type&SortBy=BestKeywordMatch&SortOrder=Ascending&keyword=dxe-antw-500

Ladder Line

Here's a link for making the ladder line that is the method I used:
http://www.w1aex.com/owl/owl.html
This article has a link to the insulators this person used (Fi-Shock). Here is the specific link:
https://www.zarebasystems.com/zareba-4-inch-fin-tube-insulator-ht4fti25
This is 25 insulators per package for $7.99

Here's a link to Tractor Supply, 25 pack for $2.49.
https://www.tractorsupply.com/tsc/product/zareba-4-in-fin-tube-insulator-pack-of-25?cm_vc=-10005
I put my insulators 1' apart. You'll have to call to see if a store carries them in stock. I had to order mine and pick them up at the store.

Notes

Here is an excellent reference on ladder line.

> Ladder line length is a consideration to keep in mind. Do some research to understand this aspect.

> When running ladder line parallel to any metal, you should space the ladder line away from it, 1-2 widths of the ladder line. You **can** run ladder line thru metal siding without impact. Make sure it's perpendicular to the siding and that you run it inside some kind of plastic tube (e.g. PVC, PEX, etc.).

Surge Protection and Grounding

Do proper research on grounding your antenna and surge protection and take responsibility for your own installation.

I got this Surge Protector:
https://www.dxengineering.com/parts/dxe-llsp

I also splurged and got replacement parts to keep on hand just in case the surge protector gets zapped:
https://www.dxengineering.com/parts/dxe-llsp-rp
(It's also possible that they will stop making this particular surge protector, so replacement parts might be impossible to get in the future)

For my installation, I ran 8 ga copper wire into my basement and connected to the grounding bus bar next to my main breaker box. This feeds to the UFER ground that I have for my house.

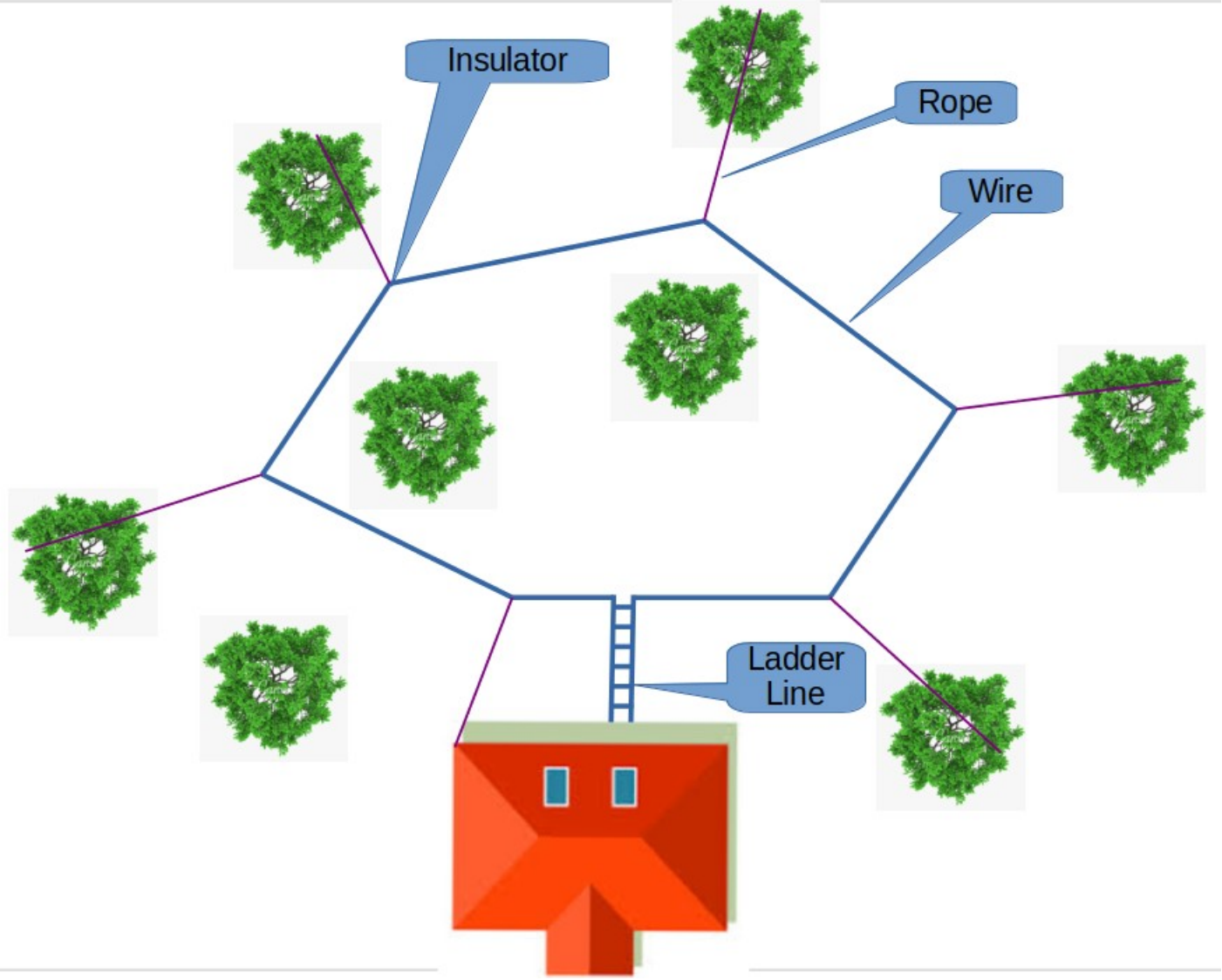
Rope

Here's the rope I bought:
https://www.dxengineering.com/parts/syn-dbr-187-500

Vertex Insulators

Here are the insulators I used at each vertex of the sky loop:
https://www.tractorsupply.com/tsc/product/american-farmworks-jumbo-black-corner-electric-fence-insulators

Some Installation Details



> Lay out the antenna wire

I began by laying the 300’ of wire out on the ground running it between trees. The goal is to suspend the wire in between trees by attaching a rope (thru an insulator) at each bend (vertex) and running the rope to the tree.

> Slide the vertex insulators over the line and position them where they should be.

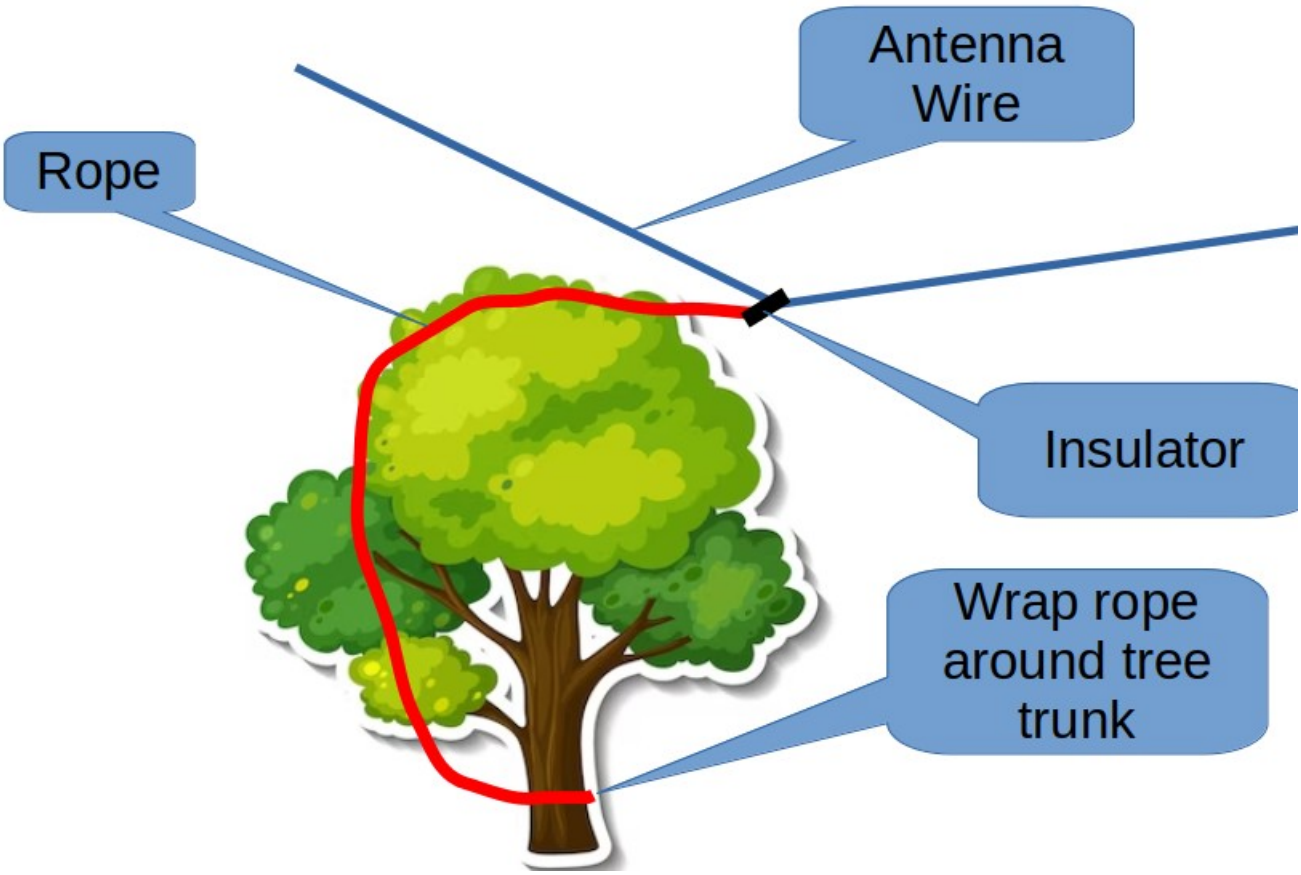
> Connect the ladder line

You need to make up the ladder line ahead of time and come up with how you’re going to attach it to the antenna wire.

I used a piece of PVC pipe and wrapped it as shown in Photo 1 for strain relief. It is recommended to crimp the ladder line connections to the antenna wire rather than solder them.

> Hoist the antenna up into the trees and fasten

I used a slingshot and fishing line to get the rope up and over the branches in the trees. There are lots of videos and instructions out there on how to do this.
I subsequently helped a Ham put up a sky loop (Jul, 2023) and was having a lot more trouble getting the ropes up into the trees. Another Ham who came to help brought along an arborist throw line rope. Using this rope was a huge improvement over the slingshot/fishing line method. I listed a link in the References section posted by a POTA enthusiast.



Note that the rope attached to the insulator is simply running over top of branches and back down towards the ground. I tied off the rope around tree trunk.

The branches (and consequently the rope and wire antenna) flex in the wind. That means the wire antenna is also moving a bit when it's windy. That doesn't affect the performance of the antenna. This allows the system to flex and not break since it's not under under a high strain.

I periodically inspect the sky loop and if it seems to be sagging a bit I just pull the slack out by pulling on the rope(s) and tying them off again on the tree trunk.

> Run the ladder line to the house

I drove a T post into the ground and attached a 10' tall piece of wood to it with a "T" on top. I attached the ladder line to the "T" with zip ties. From there it runs horizontally to the house (Photo 2).

> Weather Proof Disconnect Box

I purchased this weather proof enclosure from Amazon:

https://www.amazon.com/Outdoor-Electrical-Junction-Mounting-Plate/dp/B09FR9Z2DW/ref=sr_1_47?sr=8-47

This contains a disconnect (knife) switch and surge protector (Photo 3). You can also see the grounding wire.

This same box also houses a disconnect switch and surge protector for my VHF/UHF antenna.

When I am concerned about lightning, it is quick and easy to step outside and disconnect the antennas in this box.

> Complete running the ladder line into the shack

I then complete the ladder line run around the house allowing it to lay against the siding. The siding is not metal, so it's fine to do that.

I drilled two holes thru the house wall, inserted plastic tubes and ran the ladder line thru the tubes and into the shack on the other side of the wall. I then caulked around the outside tubes. (Photo 4)

CAUTION: Make sure there is no electrical wiring in the wall where you are coming thru!!!

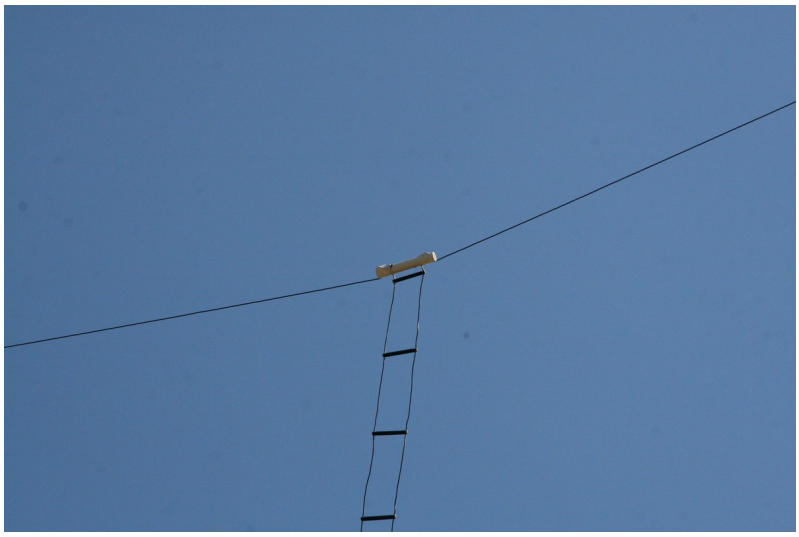


Photo 1

Photo 2

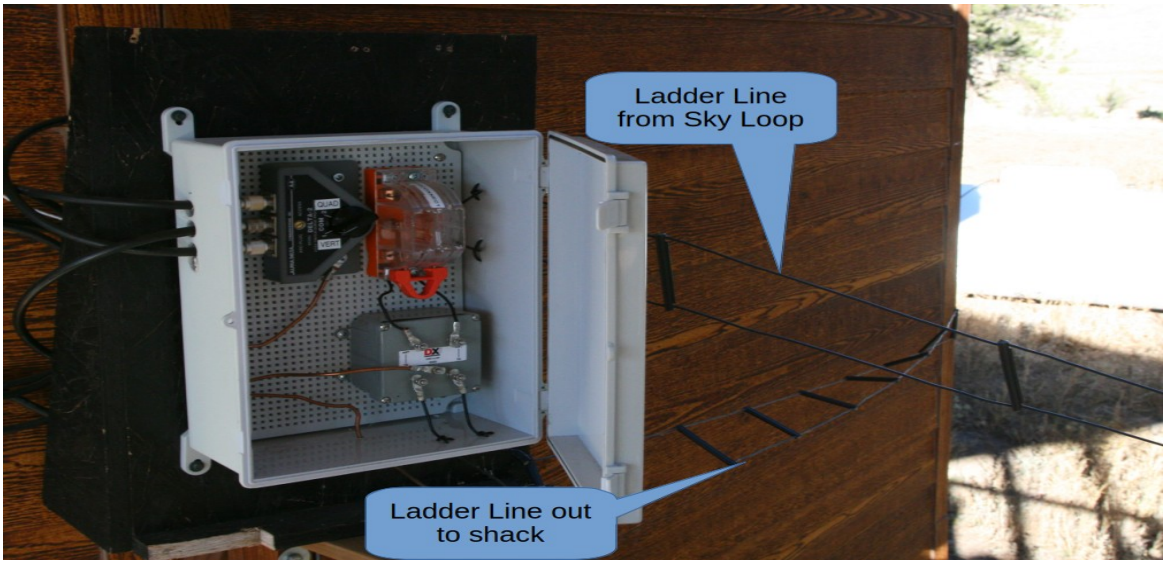


Photo 3

Photo 4

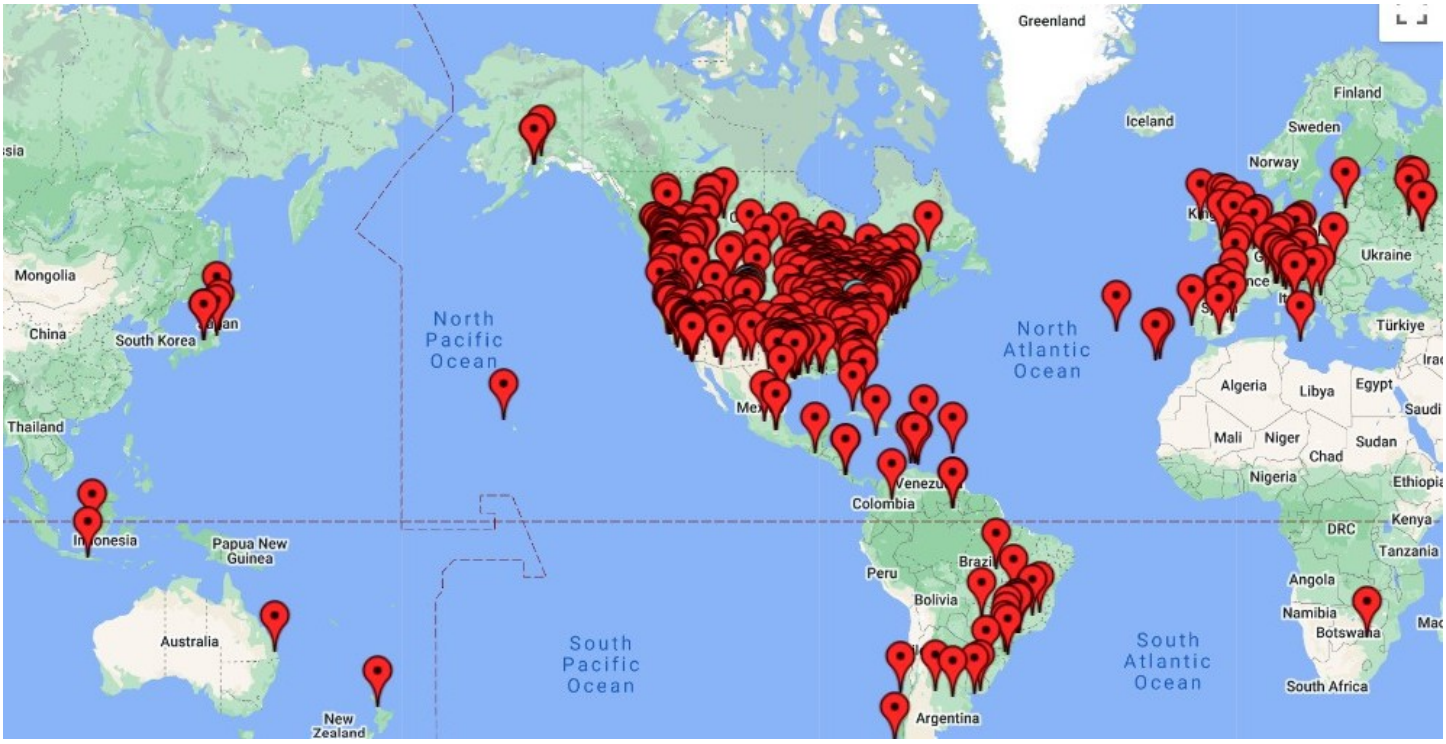
Directionality (Radiation Pattern)

So how does it work? I'm very happy with the results. I can tune **all** bands from 6 to 80 meters to 1:1 SWR.

Keep in mind that we do almost all of our operating using voice (AM/SSB/FM) and running barefoot (100W).

Also, note that we don't spend a huge amount of time on the air. Ham radio is only one part of our lives.

Here is a plot of contacts made to date:



The radiation pattern appears to be relatively omnidirectional. Ham population in various areas is always a factor.

RF in the Shack

We have had absolutely no issues with RF in the shack!

I would assert that if a person is having RF problems in the shack with a properly implemented doublet/sky loop antenna system the RF is coming from somewhere else, not from the antenna system.

What Would I Do Differently?

After using this system since 2021, I can't honestly think of a single thing that I would change.

We’re not contest-ers. We don’t do digital (although we know how). And we’re very pleased with NVIS performance on 80/40M for local emergency communications capability. In fact my XYL (Laurie, KØLTH) is a net control operator for a weekly 80M ARES Colorado state net and our station is consistently in the top strongest stations on the net. (Yes, we have data to back up that claim)

References

A Dozen Ways to See and Love Your Feeders - Cebik

KV5R.COM Ladder Line

KV5R.COM 80-Meter Doublet

Skywire Loop Antenna

A FIELD ANTENNA’S BEST FRIEND: THE AMAZING ARBORIST THROW LINE.