Multiband Loaded Coil Vertical Antenna

60m / 40m / 30m / 20m

Version 1.0 - 01/09/2021

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Based on information from Tommy SA2CLC in his YouTube Video
https://www.youtube.com/watch?v=-jBY1lX0aCg

Attribution

I feel it is only fair that attribution should always be given where original published work has been used for the basis of a project or design.

First of all, the design and body of this work is attributed to Tommy **SA2CLC.** It is Tommy's 3D STL file that I have used in this document. It is Tommy's general directions that have been followed by me in this document. Tommy has also followed fair attribution in his Video by recognizing the work that he based his design on, which was with inspiration from an **OK1CDJ** design.

What do I bring to the table with this document? Adding a little more detail to the build and parts to make it easier to Ham Radio newcomers, as well as newcomers to building your own Antenna's. I also talk about the practicality of the design, it's benefits over and standard End Fed Wire and an antenna tuner, why certain materials have been used and what should not be used.

Introduction

I came across Tommy's design while I was looking for antenna that I could erect in the backyard. I already had a 15m resonant Dipole, which, with my radio's Antenna tuner, I can tune it to work on other bands, but the one band I wanted it to work on was the 40m band, and to be fair, that's too much to ask of the Antenna Tuner and 15m Dipole (at least in terms of efficiency).

Furthermore, I have built a couple of 40m CW Transceivers (which I would prefer to use without an Antenna tuner) and would like to partake in some of the other homebrew equipment which is plentiful for the 40m band.

The next issue I have is in terms of Australian Local Planning laws which limits the height of an Antenna Structure to 6m from the ground level. Yes, I can apply to get local government approval for a higher structure, but honestly not worth the time and money.

If, and when the upward swing of the Solar Cycle kicks in, in the next few years, I will spend a fair bit of time working on 10m and 15m antennas. In the meantime, on the HF bands, the only real choice I have is using 40m or 80m bands. Typically, the 80m antenna is almost impossible in this back yard, so the 40m is a good compromise.

I would love to buy (or build) an antenna like the DX Commander, but the antenna length of 10-12m would mean applying for local government approval.

So, my main interest as I mentioned above is the 40m band, and if I can cover that entirely, this Antenna would suit my needs.

One of the other needs, is that even if this Antenna is not the one for home, and I find a better solution down the track, I want this Antenna to be useful and portable for possible SOTA / VKFF (VK POTA equivalent) trips

So that's why I decided on Tommy's design, and that is what this document is all about.

So thank you Tommy (SA2CLC) for providing your design and access to your 3D Print file.

Tools

I tossed up whether to mention it, but I think it is necessary. Using the right tools to do the job will make your life a lot easier. Note, I say the right tools, and not necessarily the most expensive or the best tools.

For most of us our hobby has a finite end to the finances, so you need to be prudent on the gear that you purchase. It would be nice to go out and spend $1000+ on all the tools that you want, but for many of us this is not possible. But the following are important;

- **Temperature Controlled Soldering Iron (and or station)** - In Amateur Radio, you are going to work with a variety of components, particularly items such as SO239 Sockets or Enamelled Copper wire, and then back down to heat sensitive semiconductors. A good temperature-controlled iron just makes a lot of sense.

- **Multimeter** – Just put a little bit of money into this, as a good multimeter will last you years, and may be one of the most useful tools you will own.

- **Good set of pliers and Diag pliers/Diagonal Cutters/Side Cutters** - Just don't go for the cheapest, put a little bit of money into some decent ones, you will learn to appreciate them. For the Steel wire, I recommend a heavy duty set of pliers/cutters. The last you want is to damage/blunt your small side cutters trying to cut steel wire.

Other useful tools that reduce frustration.

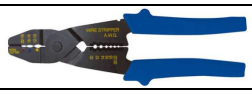
- **Soldering Helping Hand with Magnifier and LED Lighting** - Now I will be honest and state that my eyesight is nothing like it used to be, so I find the magnifier really helpful, and the ability for this thing to hold a board or even just a wire, just makes it easier. Whether you are old or young, good eyesight or not, a good light source and a good magnifying glass will make identifying issues or faults that so much easier.

- **Powered Rotary Tool with flexible Shaft (e.g. Dremel or similar) -** There is nothing I have found that has been more useful in the workshop than the Rotary tool. With a range of engraving, polishing, cutting, cleaning, sanding, carving and drilling tools, it becomes indispensable in the workshop now. With the ability to control the speed, even delicate work whilst parts are in place, can be completed without applying too much force and is invaluable for 3D Printing part cleanup.

Bill of Materials (BOM)

You are going to need the following parts :

Table 1

Qty	Part	Picture	Comment
1	Telescopic Squid Pole (5m or 6m)		Read the Part Consideration Notes
1	Squid Pole Holder		
1	3D Printer – Ender 3 or Pro		Read the Part Consideration Notes
1	PETG or PLA Filament		Read the Part Consideration Notes
1	Crimping Tool		
2	Banana Plug (Black)		Read the Part Consideration Notes
1	Banana Plug (Red)		Read the Part Consideration Notes
3	Banana Socket 4mm (Red)		Read the Part Consideration Notes
7m	Galvanized Steel Fence Wire 1.25mm		Sometimes called Tie Wire – see Notes
4	Electrical Terminal (Coil Top)		6.3mm Circular Hole (Blue)
1	Electrical Terminal (Coil Bottom)		5mm Circular Hole (Red)
1	M4 Bolt (20mm)		
2	M4 Nut		
4	10mm (length) Self tapper		3mm is what I had available as a self tapper and that worked well.
1	SO239 Square Panel Mount		
16+m	Antenna / Radial Wire	Insulated wire	Read the Part Consideration Notes
1	Alligator Clip or Test Hook Clip		Read the Part Consideration Notes
	Optional		
3m	Silicone Tape Self-fusing		Read the Part Consideration Notes
6	Hose Clamps		For permanent setup

Parts Considerations

Telescopic Squid Pole
One clear sentence – not all Squid Poles are created equal – buyer beware.
I personally deal with a company called Haverford in Australia. Their reviews speak for themselves, and I can attest to their service and product. To top it off, they have an additional range of Squid Poles
https://haverford.com.au/collections/telescopic-squid-poles
that are marked as **Multipurpose**. My understanding is that they are a little thicker at the top and topped off with a rubber stopper. They have them in all different sizes including 5m and 6m through to 10m.

Squid Pole Holder
You will need something to stabilize the pole. Most Fishing/Sport stores have Squid Pole Holders. I probably would not look at these for a permanent Antenna in the back yard (unless you guy it well), but even while you get it setup and tested, for <$10 it will support your squid pole in light winds, and could be used for portable operation.

PLA or PETG Filament
Now Tommy is very clear that he has used PETG for filament choice. The reason for PETG is that there is a possibility that this Coil Former will be

1) Used in direct sunlight
2) Stored in the car if being used for SOTA/POTA/VKFF use

If you use PLA, the most likely failure of the Coil Former (Deforming / melting) will be leaving the Coil Former in the car on a very hot day. If the likelihood of this is high then you are best printing in PETG.

If you are just leaving it in the yard, where the sun will hit it, but still has airflow, then you can at least try it in PLA (if that is all you can print in). Worst case, you may need to reprint a Coil Former, and all the parts are reusable, so no harm, no foul. Just remember, PLA has a much lower melting point than PETG or ABS

Electrical Ring Terminal (Coil Top)
You are going to need to use Crimped Electrical Ring Terminals at both ends of the coil. The only difference is that the one at the Coil Top (working on the basis that the SO239 connection is at the base of the Coil Former), needs to have a hole of 6.3mm (as it needs to sit under the Banana Socket flange.

Electrical Ring Terminal (Coil Bottom)
Same as the Coil Top, but the hold size is 3mm, as It will be held in place by the M6 bolt and nuts. You will need two of these, as one is on the outside, and one is on the inside (both on the M6 Bolt. The inside terminal will have a wire connected which will connect the centre pin of the SO239 Socket.

Banana Plugs
When I set this up initially, I used the standard low cost plugs and these work great if this is all you have, however one thing I found is the need for additional radials and how to attach these. So I look at an alternative method which is using PiggyBack Banana plugs. This means I can have a radial wire attached to each one and quickly plug or unplug the radial as I needed. The other benefit or of these slightly more expensive plugs is that it supports the wire in the body of the plug (strain relief for the wire), and the wire is actually soldered which naturally is a better method

Banana Socket 4mm
Now, this requires a little explaining, as its not clear on the Video. The sockets that he appears to have used, are 4mm Panel Mount Socket, the most basic socket. Don't go for the gold coloured knurled sockets, as the only part that is being used is the metal internal piece and the nuts and the solder tab.
My local electronics store has them listed as this
https://www.jaycar.com.au/red-4mm-panel-mount-socket/p/PS0406
They are very common and I suspect that your local store should have the same things
The internal size is 4mm, the external size of the metal piece is 6mm. Don't worry what the colour is, as you will not be using the coloured plastic pieces. We need three, one for the wire vertical connection, and the other two for the radials.

Galvanised Steel Fence Wire 1.25mm (17 Gauge)
Tommy's original request was to use Aluminium Fencing wire. Whilst it is available in Australia, it does not appear to be readily available (e.g. have to order – cannot pickup from a Store). So I made the choice to go for Galvanised Steel Fence Wire (Actually called Tie Wire), which is readily available. I also dropped down the gauge, to what Tommy appears to suggest in his Youtube comments to others.

At this gauge it also made it more malleable and had no major issues winding it onto the Coil former. Being Galvanised, it probably offers some protection from the Elements.

Silicone Tape Self Fusing (optional)
Now finally this is optional, but it is one of the best products that I have used several times over. In some cases I have used it in place of Heat-Shrink on external antennas. But in this case, I have used it as a temporary restraint on the top and bottom of the coil to stop the coil from unravellling, whilst I terminated the coil ends with crimped terminals, and fastened them. I have even left it for days (as my wrist was sore after winding the coil). Unlike normal tape, this has no sticky residue left, and actually creates a large amount of friction on what it is covering, and is waterproof.

Antenna/Radial Wire
This insulated wire can be the gauge that you need for the power you are going to put through this antenna. For me personally, I won't be putting any more than 20W through this antenna, and in many cases much less. So a 16 gauge insulated wire will do me. It's a case of balancing the weight of the wire on the telescopic pole. The stronger the pole, the heavier weight that you can put on it.

The same wire can be used for your radial wires. I used two 5m lengths for the radials and one 6m length for the Antenna as a starter, but if you are wanting to be ahead, you may like to have more lengths on hand (as you read under the testing section).

Alligator Clip or Test Hook Clip
Finally, another important part that you may want to spend some time on deciding what to use. Yes the coil is tightly wound (spacing wise), and whilst it will work, the trusty alligator clip will work, but it moves and makes contact with the wire above or below unless you support it well. You may have a source of alligator clips that get round this issue with fine tips (but these are not readily found in your local hardware or electronics retail shop).

After a couple of goes, I switched over to some Spring Test Hook Clip, and this made a huge difference, being able to place anywhere, and once placed, due to the spring, stayed in place and in most cases horizontal. The only thing I had to do was to remember to press it in, turn 45 degrees before pulling out.

I have had a look around and it appears that you can get these hooks with a larger gauge hook, but as I don't expect to use this antenna above 10-20W anytime soon, these will suit me fine.

IMPORTANT : In all your replacement choices, you need to consider the power you will be running through this Antenna. All of my choices and information in this document were based on using it at 10-20W.

Coil former alternatives

Using a 3D Printer
Now, one of the simplest ways to build your former is with a 3D printer. If you plan to keep experimenting in Amateur radio, it is one of the best tools/aids that you could spend your money on.

They are fast becoming, or have become the staple tool of most Ham Radio experimenters. If you have not got one at the moment, I won't say it is a quick and simple learning curve, but the time invested in it is definitely repaid.

Once you have learnt to use it, printing custom cases, coil formers, vertical antenna guy plates, antenna wire organisers, etc., things that you cannot commonly get at your local stores. With the numerous websites with ready to print 3D parts, you don't even need to go near CAD software (but you can if you want).

With the ENDER 3D PRO or similar, being less than $US200 or around the $AUD260 mark, it is relatively cheap

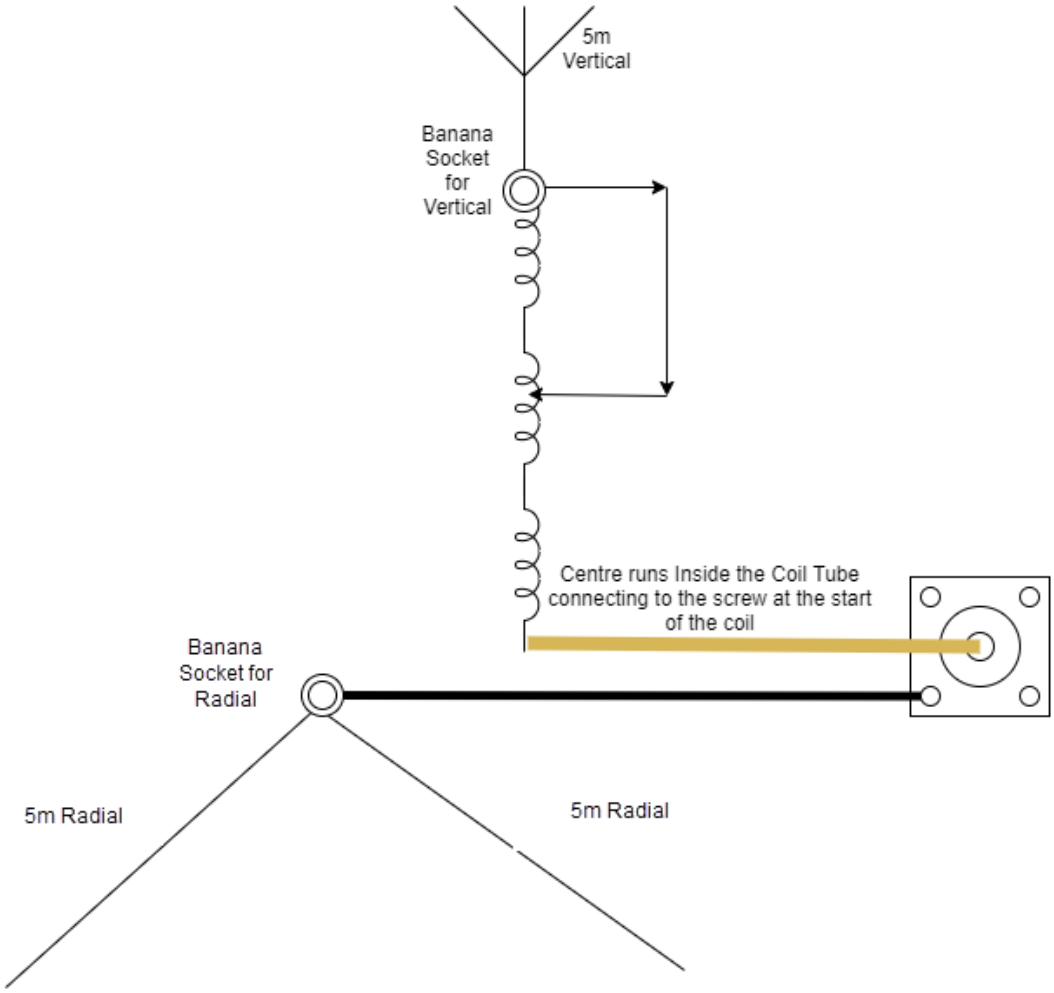
Now you might not want to delve into 3D printing, and that is understandable, particularly if your interest is in this one project, so I recommend finding someone with a printer. One common place is your local Maker Hub (almost every city has one), as this is one of the key tools that they have for use, and you may find the members there may offer to print one on their home 3D printer for a small price.

What Else Can you use (no access to 3D Printer)?
A couple of methods come to mind

1) Obtain a 60mm (OD) PVC or similar pipe, and glue gun. You may want to possibly locate some aluminium fence wire (allowing it to be a bit more malleable) or possibly some copper wire (just remember copper in the elements will not last long), or you could use some insulated wire and create some taps as you go). You will probably need to score the pipe so that the wire will main separated. This can be achieved on a pipe of this size with a Dremel style tool and a steady hand.

2) One more thing that can be tried is again selecting a more malleable wire, and create an air coil, using plastic on four sides of the coil. I have done one a few years ago, and wound it onto a 60mm former and left it over a week. It held its form quite well, I then used some plastic I bought from the hardware (originally I tried Perspex, but it was too brittle and hard to work with. I ended up with some plastic paint stirrers, created all the grooves to hold the wire, and placed four of them on the coil and then used the Glue Gun to keep them in place.

Circuit Diagram



The circuit diagram is relatively straight forward, but it makes it easier as you are visualizing the connections.

If we work through it, we have a Banana Socket, connected to the Earth plate of the SO239. There are holes at the base of the Coil Former (Tube) for two banana sockets, which will allow you to have a radial coming from either side of the former, reducing the number of wires connected to each banana plug.

Next, we have the centre of the SO239 socket, connected to the base of the coil (internally in the former), and externally on the former, we have the Electrical Ring Terminal connection connected to the start of the coil. So these are joined together by the M6 Bolt and Nuts (that passes through the wall of the former)

The Coil runs up the former, until it is terminated at the top of the coil, again with an Electrical Ring terminal underneath the Banana Socket.

Then into the Banana Socket, the 5m vertical antenna wire (with Banana Plug on one end) plugs into the socket at the top of the coil).

And finally soldered to a tab (located under the banana socket), is a wire with an alligator clip attached that we connect somewhere on the Coil. With this wire, we are varying the tap location on the coil.

Other Critical Design Details

As this document was prepared using the materials that I have used, I have provided the details below in case they change (and probably do) from the original details provided by Tommy SA2CLC.

You may need them if you decide to experiment or confirm design formulas (which is a great way to learn more). However, his Coil Former is used as he designed it.

Coil Details

	Metric	**Imperial**	**Comment**
Ant. Vertical Length	**5.40m**	17.716ft	If you use the full 6m of pole
Ant. Vertical Length	**4.40m**	14.435ft	If you stay with the original design
Coil Dist from Base	**0.6m**	1.96ft	Measured from base to middle of coil
Coil Diameter	**60mm**	2.3622”	
Coil Radius	**30mm**	1.1811”	
Coil Length	**80mm**	3.1496”	
Coil Wire Diameter	**1.25mm**	0.0492”	Between 16 and 17 Gauge – select 16
Coil Turns			29

Build Instructions

1) First, make sure your workspace is clean and organized. There is nothing worse than trying to start with the remnants of your last project sitting on the bench.

2) Now we will 3D print the Coil Former. The STL (Loading_coil.stl) for this was obtained from https://www.thingiverse.com/thing:4525375 . The main things to note, is that it loads with the print on its side, you need to re-orientate it (under your printing software) so that it is on its base, otherwise you are going to have a hard time printing (due to not sticking to the plate). Also, I found that due to the height/weight, that a brim provided some confidence that it was on a stable base.

3) Once this is finished, now print the two mounts. The STL (Pole_mount.stl) is available from the same location as the loading coil. You will find that it is only one in the STL, and you are going to need two, so you should duplicate it in your printing software (most have a copy or duplicate function), and print both at the same time.

4) Now before you start winding the Coil, to save you frustration later, grab the solder lug (with a 4mm inside diameter hole), and solder a reasonable gauge wire to the lug. The reason for this is that this lug needs to go on the screw that we want to form the anchor of the coil, and the last thing we want to do with a fully wound coil is playing around with undoing the bolt to get the lug on later. This lug is connected to the bolt on the inside of the former. Just leave the wire through the SO239 mount hole and we will connect it later.

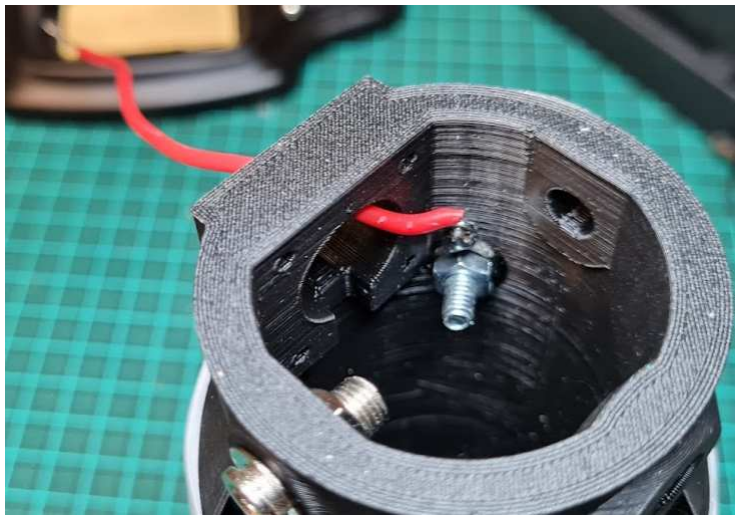


Figure 1 - The bottom of the former showing bolt

5) The first step you should do is to take the start of your fence wire and terminate it with a 5mm Electrical Ring Terminal.

6) Now put your M4 Bolt through the 5mm Electrical Ring terminal, then through the hole (the only hole that looks like it suits that size). You may have to screw it through. Once the bolt reaches inside of the former, you now want to put the solder lug on, and finally tighten it all up with a nut.

   As you can see from the figure 2 below, you should orientate the Electrical Ring terminal body, opposing the direction that you will be winding the coil.

7) We are now going to commence winding the coil. Keep the tension as you wind. If you let go, it will come un-done and you start again. My advice is wind about 10 turns, grab some help from someone to hold the wire to keep the tension on, and use the optional Silicon tape on the bottom 10 turns, to hold it in place. Now complete the rest of the turns until you reach the end, and when you reach the end, cut off the wire + 100mm, pushing the extra 100mm through one of the large holes and bend it on itself (just as a temporary thing), to stop the coil uncoiling.

8) Once you have done, this put some more silicone tape at the top, again to hold your coil in place until you have time to properly terminate and fasten the coil. In fact, with that tape in place, you can leave it for days until you feel that you want to move on (as your wrist will be sore).

9) Now work out where you need to cut the Fencing wire to perfectly match up (after crimping a 5mm Ring terminal) so that it will sit under the top banana socket, which will hold the coil in tension. This is where the silicone tape really proves its value, as you play with the ends of the coil and the tape holds it all together.

10) But before you place the 5mm ring terminal under the banana socket, you also need to crimp a reasonable gauge insulated wire to the 6mm (Blue) ring terminal. This wire will be our coil tap, so make it long enough to be able to tap at the bottom of the coil. The other end of this wire will eventually have a alligator (or similar) clip at the end of it. So, both Ring terminals will sit under the Banana Socket as shown below.

At this point, you have completed the most painful part of this build. If you have failed and everything is coming apart at the seams, the best part is that you can start again. Everything is basically re-usuable. Even if you are not happy with the neatness of your coil wind, you can re-do this later, without going right back to the start.

Just a couple of notes and observations for those with some questions so far.

- Yes 1.25mm steel wire is large enough to be crimped (without doubling over the steel wire) in both the RED and BLUE Electrical terminals and hold fast if crimped with reasonable force.

- Yes, that silicon tape is invaluable for me, once again, as it held the coil in place, particularly as adjustments were made, changes to methodology. I left it on there until the very end.

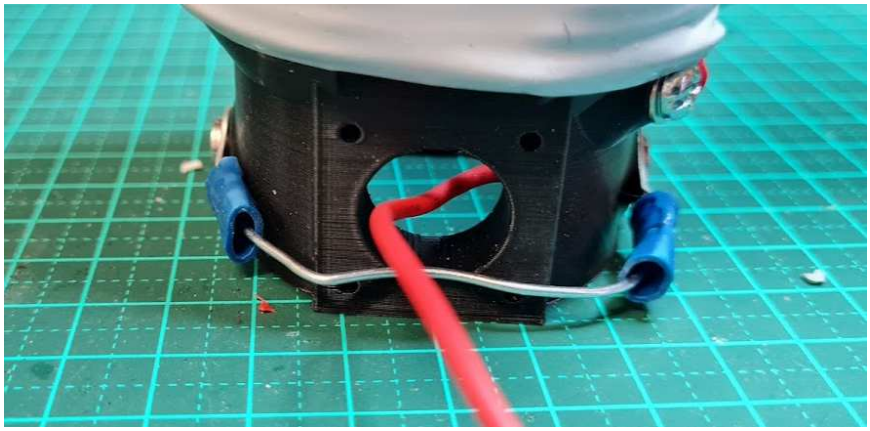
- You will note that the top Electrical terminal is not installed opposing the coil winding (as we did on the bottom). Well actually I did, but found that I cut 3mm to short. So I decided to cut the wire back, measuring a little more accurately, and install it in-line with coil winding. With the top one, it can be done this way.

- Remember these circle terminals can be set at an angle to take up a little slack if required.

- Where you connect a stranded wire to a Electrical terminal with crimping, bend the wire back over the insulation, and insert this into the terminal to be crimped.

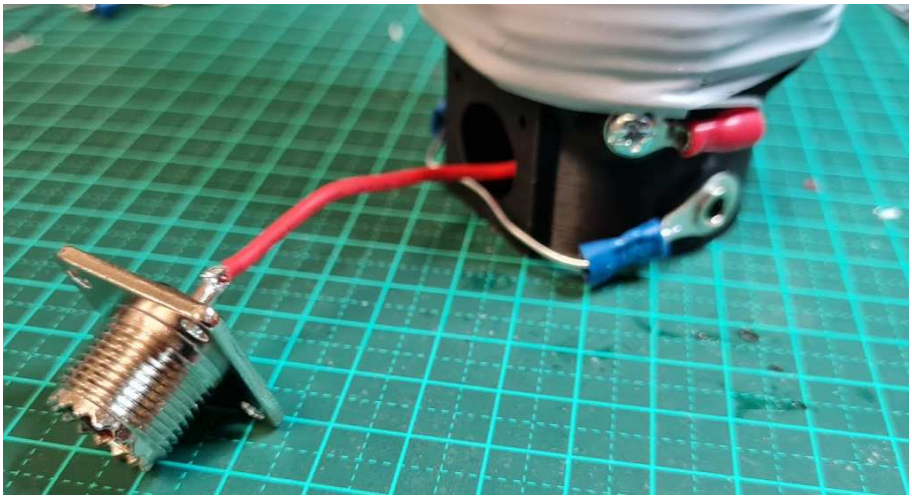
Now we can finally complete the last parts of the Coil, predominately the base of the Coil.

11) Cut off a piece of Steel Fencing wire and terminate both ends with a 6mm electrical terminal circle. Now what we are trying to do is make a connection from one side of the coil former to the other side, whilst running the steel wire under the SO239 plate.

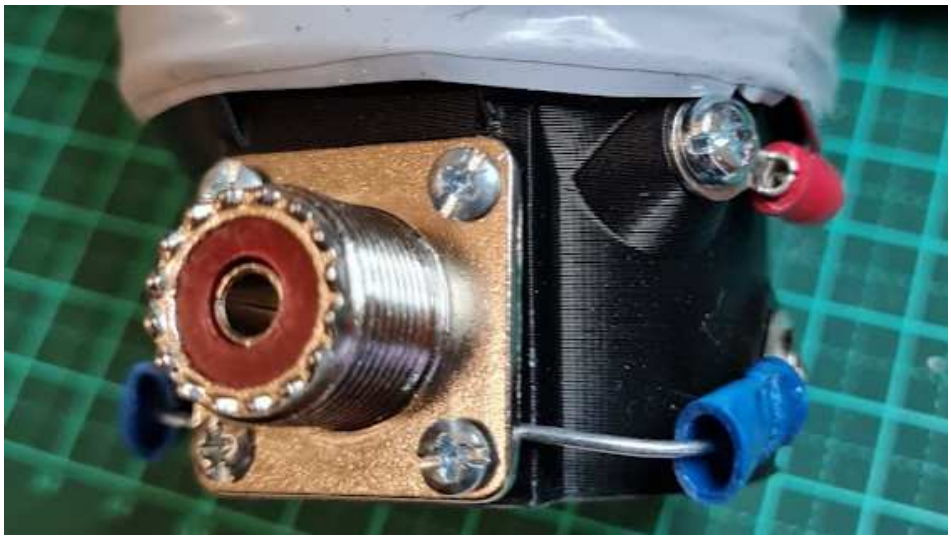


It does not need to be exact as the SO239 plate will hold the steel wire and everything in place when we mount the SO239. Main thing to make sure is that it is not super tight, as it needs to go close to the bottom screws (just inside them).

12) Now we need to cut the red wire a little shorter for neatness and pre-tin the and of the wire. However don't make it too short that you are awkwardly trying to solder at an angle. A good solder connection is better than trying to be perfect. We now need to solder that to the middle connection of the SO239



13) Now we are going to mount the SO239 onto the bottom of the coil trapping the steel wire under the plate, but away from the centre connection. I actually had the self tapping screws in my toolbox already, and they worked quite well.



So now we have the coil built, take the time to tighten up all the nuts and we will then move onto the final build items.

Completing the Build

14) Now make up your Antenna connection using a 5-6m piece of wire. Now connect it to the Banana Plug. What do you mean there is nothing to solder or attach to?? If you have the low end plugs (which are perfectly fine), the main thing is that there is no place to solder to, and can leave you perplexed. To connect the wire, strip it and leave at least 10mm of uninsulated wire (twisted, but not tinned), and feed it to where the metal part of the banana plug screws in. Basically we poke it out the bottom, just, and then screw in the metal piece and the wire gets caught up in the screw threads and it is quite solid in terms of a connection.

    Just a suggestion, my two radial wires, I put a black banana plug on, and the antenna wire, I used a red banana plug on. This makes it easier to identify if I trim either of the wires, so that they go back to the same connection.

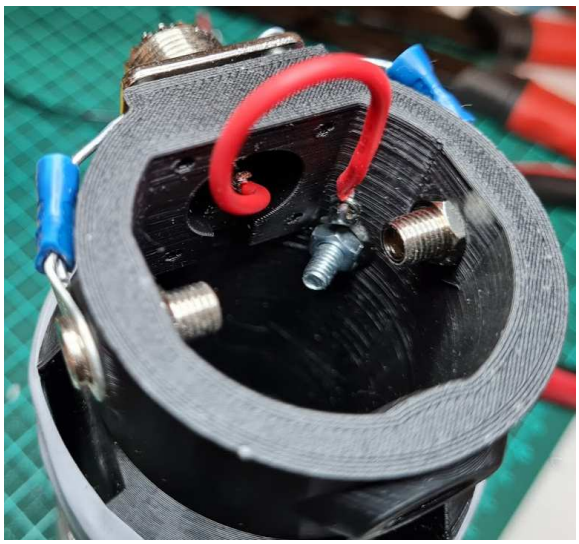
15) Same now goes for the Radial, and my recommendation is to make two of these of 5m length and plug into either side of the coil former at the bottom (both are connected to the same “earth”).

16) Solder or Screw (if yours has a screw) an Alligator Clip to the Coil Fly (Tap) Wire

17) Install the two Pole Mount clips you printed earlier.

18) At This point if you have followed the suggestion, you can now remove Silicon Tape, as we should be finished working on the coil. Take the time to make sure the coil is sitting in the thread still, and make sure each turn is separated on the coil.

Other Photos for your reference



Offline Testing of your Build

I appreciate this is something that you may not do often, but it can save a lot of trouble and dis-satisfaction

1) With a multimeter, check the continuity of the coil, by placing the one probe on the Centre of the SO239 and the other probe on the banana Socket at the top of the coil. This should show a connection or short.

2) Again, with a multimeter, with on probe on the thread of the SO239, and the other probe on the banana socket at the base of the Coil Former, you should get a short or continuity. Check the other banana socket round the other side, and you should get the same thing.

3) Strip off a couple of millimeters of the Antenna wire and the radials. With the multimeter, check for continuity from the Banana Plug to the end of the wire (particularly we are checking that the Banana plug is making contact with the wire, but your wire could have a break in it, so this checks this as this could have a major impact on whether your antenna works.

These are simple tests, but done now, you can focus your fault finding skills on more important areas, knowing that the basics have been checked.

It counters the issue that almost all of us fall into at one time or another when building technical projects, which is that we start fault finding actually looking for a hard to locate issue, when it was a basic fault that was not considered. I have even seen projects abandoned because people did not go back to basics, and ended up being a simple fault. (if you want a real live example of this, read all about the issue with Antenna in its first real test a little later in this document)

Setup of your Antenna

1) Setup your Squid Pole Holder in the ground. As I mentioned, for a temporary setup, it will do the job quite well (holding the pole up), but if you are intending to make this a permanent installation, I would look to implement a more permanent installation, which may include guy wires (another use for a 3d printer to create the guy wire plates), and a more supportive base.

2) Insert your Telescopic Squid Pole and check that the Squid Pole Holder will support the pole (just in case the ground is wet and won't hold it).

3) Attach your Antenna Wire to the tip of the Telescopic Pole, and commence extending the pole (giving a slight upward and round twist to affix the telescopic section), until you have reached your desired height. If this is going to be a permanent setup, you may want to use hose clamps to secure each section from un-telescoping.

4) Attach the Coil to the Telescopic Pole roughly 300mm from the ground with Cable Ties to hold it against the pole

5) Plug your Antenna wire Banana plug into the socket at the top of the coil

6) Plug your two radials into the bottom banana sockets and spread them out straight along the ground for 5m

7) Finally plug a RG58 patch cable or similar, into the SO239 at the base of the Coil and the other end will connect to your rig. However, if you have the capability and the equipment, I strongly recommend performing some tests with an Antenna Analyzer such as the SARK100 or the NanoVNA products, so that you can test your antenna on the various bands and work out the best locations for the coil taps. If you are member of a local Amateur Radio Club, you may find that they have a couple of models that are loaned out short term to members. No harm in asking, and it might start something brewing.

Initial Tests

My initial setup was to attach the Vertical wire and the two radial wires. Again, with the Antenna all constructed, I completed a quick check for shorted or open connections. All looked good. I would have started the normal process of connecting an Antenna Analyser or NanoVNA device and performing some basic checks, but with only a couple of hours of daylight left, and I had not charged the NanoVNA, I was not able to perform the normal checks.

So, my initial setup was with the following

- Vertical Antenna Wire of 6m in Length
- Two Radials of 5m in length (Separated by 180 degrees)

So, with the time I had left, I decided to perform a non-scientific test and have a listen to the bands, particularly the 40m Band. I realized that we were moving into the “Gray-Line”, but that is the most common time I have been listening for a while now on the 40m band.

The big thing I noticed was a lot more abundance of QSO’s (particular ones that I could now hear both sides of the conversation). So, impressed with that improvement, I thought I would again do a non-scientific test of the loading coil, I had the radio up loud, and commenced moving the fly lead onto various taps of the coil (and also in accordance with my expectations where the tap for the 40m would be), until I could clearly hear a large difference in the quality/loudness of the transmissions. Based on the difference I heard with each of the changes, it appears that the antenna and loaded coil was definitely working.

Anyhow, after that, it provided me with enough interest that this project will have a good outcome and well worth spending a lot more time. Likewise, I was just as excited with the antenna pack down time. This was completed in less that 3-4 minutes, with Telescopic Pole packed, antenna wire and radial wires rolled up neatly, Antenna Ground holder removed. This is really looking good for field work as well.

My next set of tests will be done with Antenna Analyzer or similar (NanoVNA etc).

Further Testing - Take your Time

After all the work that you have done in getting this Antenna setup, you are probably busting to put it to use. But I am going to recommend that you take the time to understand this Antenna design if you haven't done a similar Antenna before.

If you have NanoVNA device (or an analyzer which will connect to a computer), then take the time to set it up. I have a computer that is setup just for measurements / test instruments. I setup the Antenna a short distance from the Shack with a long enough coax and set several hours aside to perform some tests and measurements. Using something like NanoVNASaver, allowed me to conduct the tests from a PC (or Laptop), saves my eyesight from staring at the NanoVNA device, and allowed a documented structured test, with recorded results.

Calibrate Your NanoVNA or Antenna Analyzer

I raise this subject, as I have forgotten to calibrate it before, and I am sure I will do it again, and I am sure that I am not the only one. If you don't use your NanoVNA that often, each time you pull it out, you should recalibrate it just like any other sensitive instruments.

Particularly if you live in an area that has a reasonable range of temperatures for the year (where I am, Minus 8 degree Celsius through to occasionally 44 degree Celsius), you should recalibrate each time you pull it. It takes seconds.

It can make a difference, and there is nothing worse than realizing you have wasted an hour or two (or more) chasing a rabbit down a hole just because your measurements were out due to one thing you forgot to do.
https://www.youtube.com/watch?v=x-tbvAbh9jk

Testing and Coil Tap Settings

Now before I started, I decided to focus on the 40m band with this Antenna. As you can imagine, the other bands are going to be basically the same exercise, but focusing on one first, will confirm everything is working the way it should and as expected (e.g. if selecting different taps on the coil, did not have the desired and expected effect, then I know that something is not working correctly).

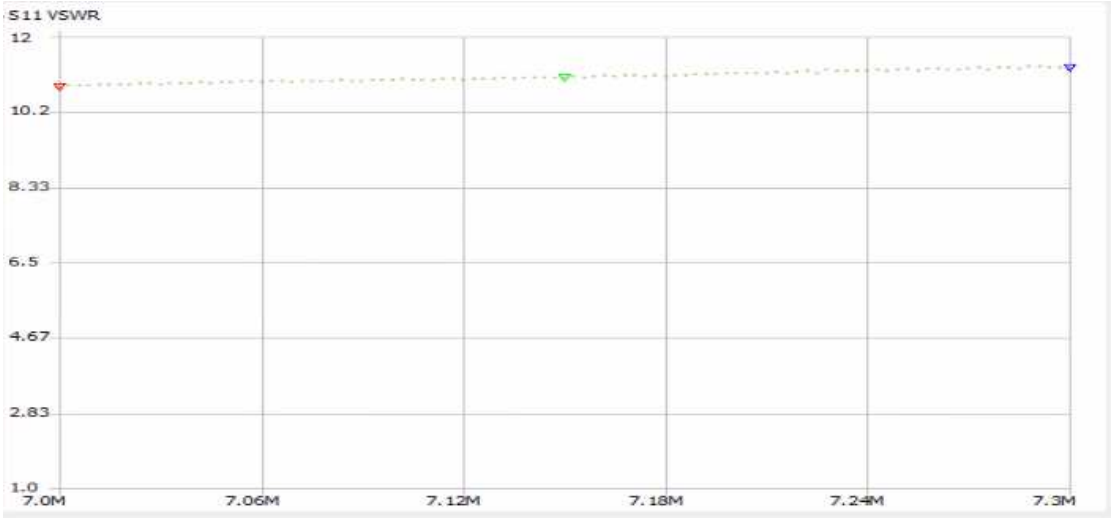
40m Testing and Results

For these tests, I set the NANOVNA sweep control, starting at 7.0Mhz and stopping at 7.3 Mhz, particularly as I am looking for a setting that can be used for the entire 40m band (at least in VK).

Now for this sweep, I picked a coil tap based on my initial tests (the one where I picked it based on “loudest” tap), and performed a sweep.

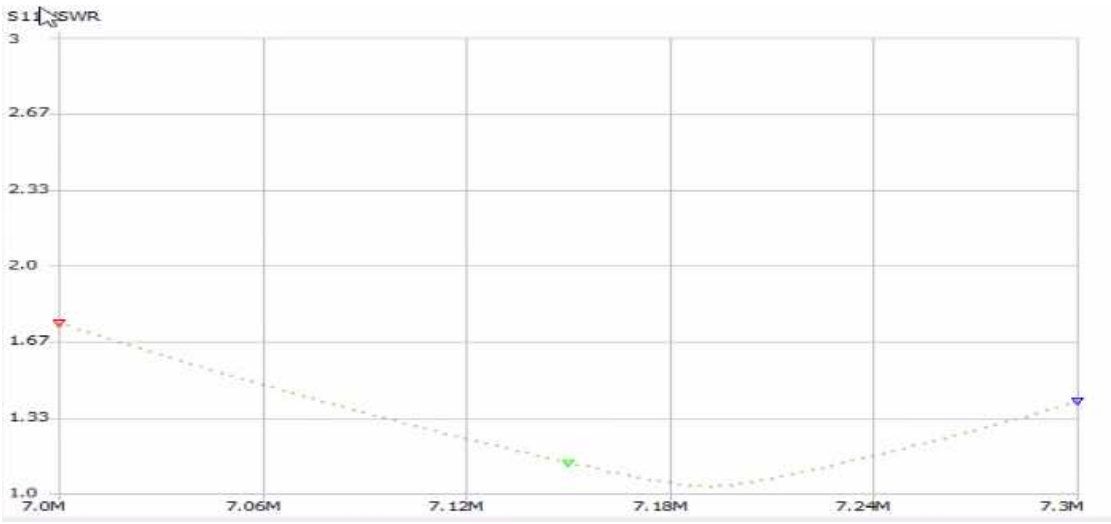
However, as I was interested in looking at the effect of the radials, I did not install an radials for my first initial test. As I mention in this document, every opportunity should be used to learn and explore, and as I mention, even if this Antenna does not fulfil my needs, it has not been wasted, as the knowledge that I gain is far more valuable than the costs involved.

This was the first result



Kind of what I expected, as at best (with the loading coil), we have a ¼ wave Antenna, with no grounding. We need the radials to provide the grounding.

So I installed the Radials – expecting some improvement and was quite surprised



Quite an improvement, and shows how important the radials are to the antenna design.
We now had a SWR or 1.031:1 at 7.19Mhz (almost the middle of the band and 1.67:1 at the top end of the band and 1.4 at the bottom end of the band – figures I could live with for the moment.

As a quick test, I setup the RTL-SDR to a clear frequency, the same with the transceiver and performed a quick test transmission – sounded good – happy to proceed. As it happened, there was a local competition that had started already as I made this successful check, so I quickly read the competition rules and requirements, left the Antenna as it was, and turned on the transceiver again, and actually found someone (actually a local ham) calling CQ Contest right in the middle of the band. There was a fair amount of QRM, including someone that was woefully off frequency underneath the local ham. I responded to the contest call and what a failure!!, actually more of train wreck.

My initial call was responded to, but I noticed that the QRM (or what I thought was the QRM) got a lot worse, I was struggling to hear him, and likewise he was starting to have troubles with hearing me, then the rig stopped transmitting, right in the middle of the exchange. If you can imagine a deer in the headlights (that was me), trying to work out what was going on. I had not passed the exchange he needed to complete a successful contact, so to a certain degree, I felt a gutted, having let a fellow ham down. A few minutes later, I was still in splatter diagnostics mode. I needed to walk away for a few minutes.

Glad I did, as I came back with a clear head. I took the radio down a bit in the band (away from the contest and made another test call). This time, watching the screen, I saw the SWR Threshold limit warning on the radio (I was not in front of the rig entering contest logs). I now have a likely cause. I put the NanoVNA on the Antenna again – showing a SWR of 10 : 1 – now there was the first reason, I have the SWR limit on the rig set at 2:1, so naturally the rigs software had folded back the power that was transmitted (and probably saved my finals).

I have never tested what it does (SWL Limiter), but I assume with a 10:1 the power was almost shutdown to nothing. Finally I felt I was getting somewhere, now to find the root cause, which meant taking a look at the antenna. First check was the vertical element, that looked fine, now the radials, they looked good, still laying loosely on the ground, and then I checked the banana plug that these radials attached to…..

Bingo!!!!! There was the one radial wire swinging the breeze (literally), and one radial still had a few strands connected. After thinking about it, it appears that I stepped on one of the radial wires after the last testing, and this has caused this issue. I also note that this one of the cheaper banana plugs with no soldered conection. I located my pre-made radials with the better quality plugs (and strain relief), and completed the NanoVNA test again. Very impressed with the reproductability of the good results, placing the radials in almost the same locations as the last, and the curve and the numbers were basically identical.

Now for the next few hours, I just listened around the band, particularly taking note of distant 400km – 800km stations, and how much easier it was to pull them out of the muck over my previous ATU tuned 15m dipole. I won't say that they came in booming but with judcious use of the rigs controls, I could now probably carry a conversation. Periodically, I would tune back to the original contest operator call I failed to respond to earlier in the day, waiting for his calls to slow down, and they did. I responded to his CQ once again and he reported an RS of 59, we completed the correct exchange, and I apologised for the earlier failure of the Antenna.

So what did we learn from this real life test (as I said, everything is a learning exercise)

- Radials are ever so important to a vertical antenna (or at least this type).
- Sometimes a few extra dollars on parts, may make all the difference (better quality banana plugs).
- When you feel you have a train wreck – walk away and come back with a clear head.
- So far, as an antenna for a compromised location, I am quite satisfied with it.

A few weeks later, I did further testing on 40m and whilst I have not documented everything I have done (several hours of testing), I will note some dot points of my results.

- In all my testing, I found that I could reproduce almost everytime the original SWR readings I got above, as long as I followed exactly what I did in terms of placement of radials, height of antenna, placement of antenna etc.

- I tried with the two radials raised 40cm off the ground. The result was not an improvement. In fact whilst I was able to achieve the same or slightly less favourable SWR, the dip was sharper, meaning that the SWR at the edges of the band were considerably higher. So with design, the elevated radials were not useful, in fact I found laying them firmly on the ground, resulted in the broader dip

30m Testing and Results

Appears that this Vertical can be used on the 30m band with reasonable SWR

1.25:1 through to 1.28:1 throughout the 30m band

20m Testing and Results

The original antenna designer & author states that he can short the Coil (just move the clip up to the top of the coil), and trim the vertical wire and he could achieve resonance on 20m as well. This is highly likely, as the length of wire for a quarterwave vertical is a touch over 5m and our fibreglass pole is 6m, but I never got to test this as currently in COVID lockdown and cannot easily obtain some more wire. As well as that, 20m is not available to me. But I will update this document as soon as I obtain the additional wire and test the SWR.

60m Testing and Results

In the full gammut of tests that I ran, I did not note it or capture screenshots, but I can confirm that the antenna is resonant on 60m. I did not realise until after my tests why the frequency rang a bell. The main reason is that this frequency is not available to us in Australia.

Musings on this Antenna Design and Build.

First of all, Tommy **SA2CLC** has done a great job of creating his design of the coil former and providing the details of his Antenna build.

Actually, what it provides is not just another Antenna design to try (and it does that), but it gives you an opportunity to learn a particular area of Antenna Design. From this design, you can learn about

- Vertical Antenna's
- Loaded Coil Antenna's
- Radials and their impact on Shortened Antenna's
- Inductance
- Loaded Coil vs Antenna Tuner

And if this antenna does not suit you, or you have learnt its limits, almost everything is reusable. Your Telescopic pole could be the other end of your dipole, or it becomes the basis of your inverted V. The coil may be able to be used on another design, just work out what inductance you need, confirm the windings, and the radius, there is a good chance it can be re-used.

That's what Amateur radio is all about. Designing, building, modifying, learning. Yes, it's great to buy things off the shelf, my HF radio is off the shelf, but just about everything else is home brew, which includes a QRP antenna tuner, 1W CW Transmitted, 3W CW Transmitter, all of my Antenna's. It is that learning that stays with you for life. I know after being out of Amateur radio for 30+ years, got back into it and no word of a lie, everything I learnt back then, just comes flooding back.

Now, Tommy provided everything need to build his Antenna when you piece together information from his Youtube Video, his design description page on Thingiverse, and finally his comments below his Youtube video. However, I do recognise each of us is different, and some prefer it laid out easy to follow, while others enjoy the thrill of the hunt. Regardless, they are enjoying building and trying something new, learning something new. So hopefully these instructions will help you in your learning.

Even when you have built it, and have experienced it, take the time to look up the dot points I laid out about, and learn more about what you have build and why it works, and what impacts how it works.

Who am I??

My name is Bob Fryer, callsign VK1ERF from Australia, a guy that took almost 35 years to get his basic Ham licence. Well, it reads bad, but it is not that bad. I had a strong interest in Electronics and Radio in my teenage years, I did my initial Ham exams 35 years ago and failed on the CW portion and never completed the process (as life changed). In 2021 as part of the Covid-19 pastimes, working on Lora-WAN devices, I found it interweaved with Amateur Radio, so I decided it was time to get my Ham Licence, which I did.

Whilst I have only just obtained my Ham licence, I started my journey in Electronics in the late 1970's and was heavily involved until the late 1980's. My career direction changed and I took a break until 2010, when I became involved in Digital Electronics again and marveling at the changes since the 80's. In the last year or so, I have re-ignited my interest in RF, and all that I learnt back in the 80's, is coming back in droves, with primary interests in Antenna's, and a renewed interest in QRP & CW (funny how they take CW out of the exam and now more people are are interested in it)

I hope these instructions are useful to someone else.

73's
Bob