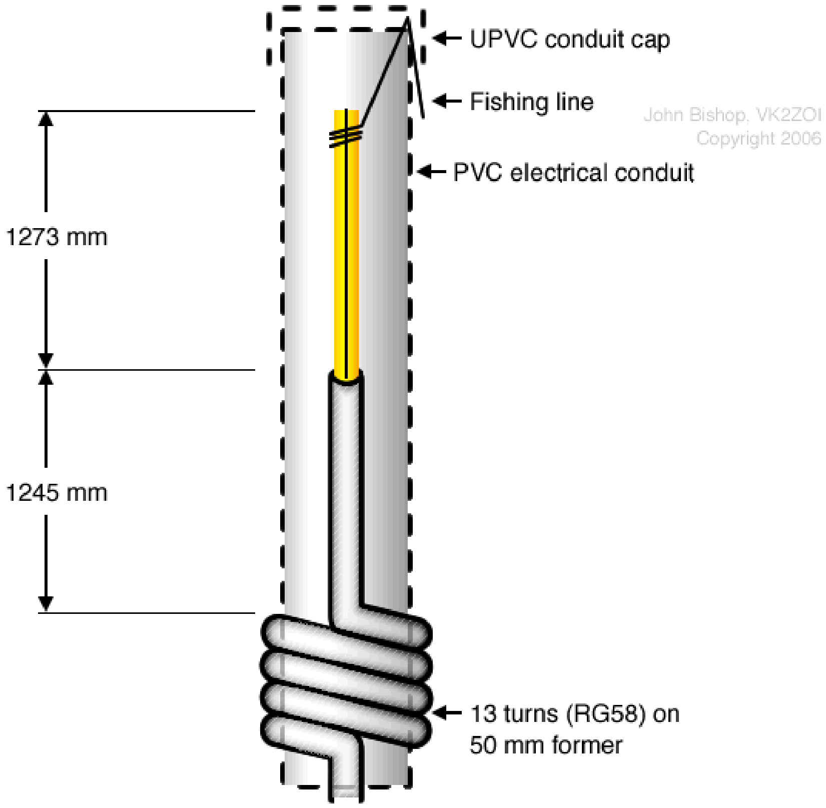
My 6 Meter Flowerpot Antenna

Design Inspiration

To those who have gone before, I follow in your footsteps and try to add a little more to the understainding of the flowerpot antenna tradition.



VK2ZOI Flower Pot Antennas for 6 & 2 metres by John Morrissey VK3ZRX:
http://vic.wicen.org.au/pipermail/wicenvic_vic.wicen.org.au/attachments/20170903/ac6842c5/attachment-0003.pdf

SOTA – 6m 52 MHz Coaxial Dipole Antenna by Andrew VK1AD - 16/08/2015:
https://vk1nam.wordpress.com/2015/08/16/sota-6m-coaxial-dipole-antenna/

The Coaxil Dipole Design was further developed as the Flowerpot Antenna by John Bishop (VK2ZOI).
See https://vk2zoi.com/flower-pots/

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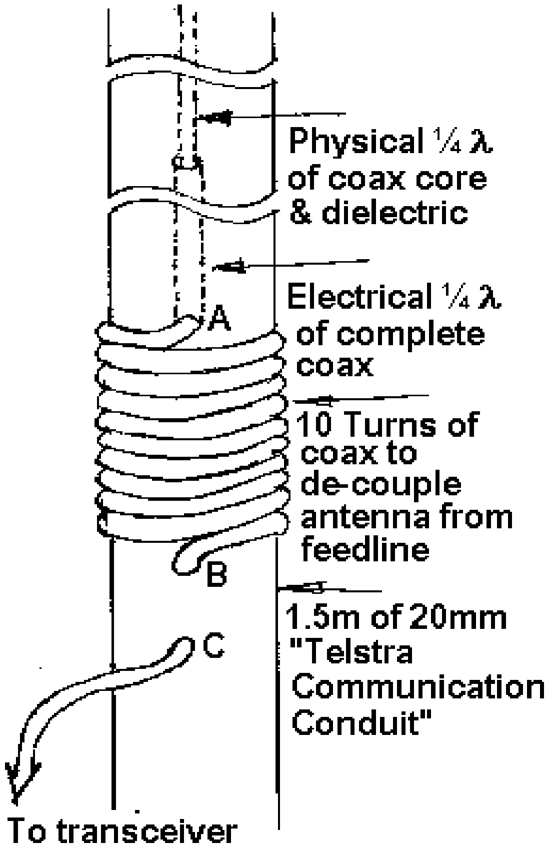
Design Theory

Design Ojective:

The design objective is to produce a vertical antenna for the six meter band, centered on 52Mhz with a 50 Ohm reactance and reasonable performance from materials I have available at home.

This image of a 2 meter flowerpot shows the two quarter wave sections.

An Inexpensive Vertical Antenna for 2m by Mark A. Dods VK3XMU (Now VK3ZR):
Source: http://www.vic.wicen.org.au/?page_id=1353



The Design Principle:
This design uses a single length of coax to form a choke and two 1/4 wave radiating elements forming a single 1/2 wave centeJohn Bishop (VK2ZOI)r fed vertical dipole. The asumption is that the upper quater wave radiates from the core on the coaxial cable and the lower section radiates from the shield.

This antenna works due to the skin effect. The RF travels out the quarter wave radiator section of the coaxial cable on the inside of the shield. When it hits the end of the shield it travels back on the outside forming the "other half" of the dipole. The RF is stopped by the choke wound into the feedline.

The Western Carolina Amateur Radio Society-Smoketest-August-2005:

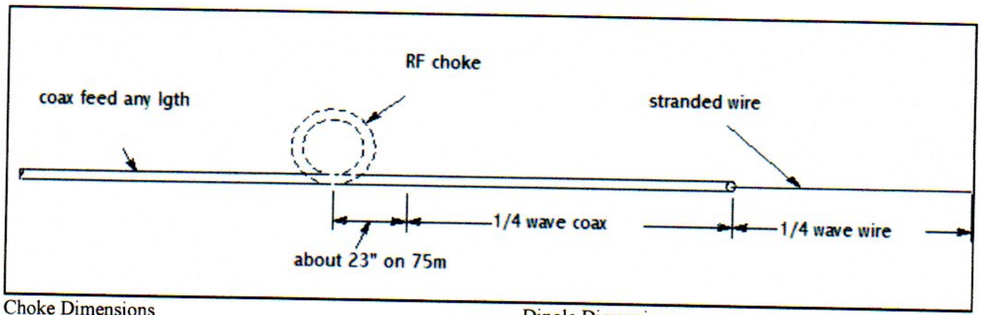
Quick Easy portable HF antenna

Do you want an HF antenna that is both easy to build and very portable? One that can be strung up quickly? While looking at an older copy of the ARRL Radio Handbook, I came across a "Resonant Feedline Dipole" that is made out of one piece of coax and a piece of stranded wire. I made one cut for 75m out of RG-58a/u and have tried it a couple different times with good success. The first time was camping (near Bryson City) where it was strung through the trees and bushes about 5 feet off the ground. The second time was at WCARS Field Day (Asheville) where I strung it as a "sloper" up over and down a tree. About 70% was sloping and the remainder vertical. During FD I made contacts both locally, across NC to the coast and regionally with good signal reports.

The antenna consists of a coax feedline, a choke wound into the feedline, a 1/4-wave section of coax, and finally a 1/4-wavelength section of stranded wire soldered to the center conductor ONLY of the coax. While the original article said to use a 1/4-wave length feedline, several "experts" have said any length will work. I used the 1/2 wavelength feedline because I made it before further discussions. I plan to cut off most the feedline and put in coax fittings so I can use whatever length coax feedline I need at the time. The diagram shows the form of the antenna and the tables the dimensions.

In simple terms this antenna works due to skin effect. RF travels out the 1/4 wavelength radiator section of coax on the inside of the shield. When it "hits" the end of the shield it simply comes back on the outside thus forming the "other half" of the dipole. The RF is stopped by the choke wound into the feedline.

Dick, K8SKX



Choke Dimensions

Freq	RG-213, RG-8	RG-58
3.5	22 ft, 8 turns	20 ft, 6-8 turns
7	22 ft, 10 turns	15 ft, 6 turns
10	12 ft, 10 turns	10 ft, 7 turns
14	10 ft, 4 turns	8 ft, 8 turns
21	8 ft, 6-8 turns	6 ft, 8 turns
28	6 ft, 6-8 turns	4 ft, 6-8 turns

Dipole Dimensions

Freq mHz	Overall length	Leg Length
28.4	16' 6"	8' 3"
21.1	22' 2"	11' 1"
18.1	25' 10"	12' 11"
14.1	33' 2"	16' 7"
10.1	46' 4"	23' 2"
7.1	65' 10"	32' 11"
3.6	130' 0"	65'

Note: based on 1997 ARRL Handbook page 20.17

From WCARS Smoketest August 2005

Source: WCARS Smoketest August 2005

The Quarter Wave Dipole:

The radiating elements act as a centre fed quarter wave dipole. The quarter Wave lenght can be calculated as (300 x 10^6 / 52 Mhz x 0.95 x 0.25) = 1370mm.
where:John Bishop (VK2ZOI)
Speed of light = 300 x 10^6
Velocity Factor = 0.95
Centre Frequency = 52 MHz
Quarter Wave Lehgth = 0.25

The Unknown Correction Factor:

The big question is; What are the correct velocity factors for the upper and lower quarter wave sections? Given the construction method, the stripped upper consisting of core wire and diaelectric and unstripped lower consisting of a section of complete coaxial cable, and PVC couduit that acts as a radome, all have an dielectric effect.

De-Coupling:

The purpose of the Radio Fequency Choke is to de-couple the antenna from the feedline in order to prevent common mode currents reaching the transceiver. My understaining is that to achieve maxiumium "chocking" the coil should be designed to have maximium resonance at the centre frequency. However, John VK2ZOI in hte section on "Scaling to Other Frequencies" states, "The choke needs to be resonant about 5 to 6% below the desired operating frequency."John VK2ZOI in the section on "Scaling to Other Frequencies" states, "The choke needs to be resonant about 5 to 6% below the desired operating frequency."Frustratingly, no explanation is given for this adjustment.

He gives us the following table:

RG58 Co-ax Self Resonant Frequency (MHz)

RG58 Co-ax Self Resonant Frequency (MHz)			
Coil Turns	**PVC Conduit Former Diameter**		
	25mm	**32mm**	**50mm**
4	-	160	-

5	150	136	85
8	142	106	65
9	135	100	60
10	129	95	57
12	117	84	52
15	105	75	47

Source: http://vk2zoi.com/articles/half-wave-flower-pot/

The Velocity Factor:

The upper and lower section of the dipole are slightly different lengths, preseumable due to the differing velocity factors as a result of having or not having the outer protective layer.

In my attempt to understand the correction factor (velocity factor?) used to determeine the length of the upper spripped section and the lower unstripped section for each centre ferquency, I have compiled this survey of website professing expertise in the flowerpot contruction method.

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Survey of Constructed Flowepot Antennas

Theory is a good way to understand how an antenna should be built, however how they are actually built is the real test. So I gathered as many measurtements of dipole actually used by constructors. Unfortunalty, most constructors who published, did not alway quote their measuremnts. This is the results of what I could track down. A big thanks to those who published details.

No	Author	Band	Freq	¼λ	Upper	Up VF	Lower	Lo VF	Up + Lo	½λ	VF	%OCF	Notes
1	John VK2ZOI	2m	146.000	514	457	0.889	447	0.870	904	1027	0.880	50.55	
2	Mark VK3ZR	2m	146.000	514	530	1.031	351	0.683	881	1027	0.858	60.16	Inconsistent. See page link
3	Andrew VK1AD	2m	146.200	513	460	0.897	450	0.877	910	1026	0.887	50.55	
4	Andrew VK1AD	6m	52.000	1442	1315	0.912	1255	0.870	2570	2885	0.891	51.17	No conduit used so 3% (38 mm) added
5	John VK2ZOI	6m	52.700	1423	1273	0.895	1245	0.875	2518	2846	0.885	50.56	Freq interpolated from graph
6	Michael VK4MWL	6m	52.535	1401	1300	0.928	1250	0.892	2550	2802	0.910	50.980	No Conduit - In Free Air

3

What can we learn from this small dataset?

- The overall Correction Factor for Velocity Factor or End Effect on the half wavelength is probably 0.88 to 0.885 for flowerpots in grey conduit and about 0.89 for flowerpots hanging in free air.
- The %OCF which is the Upper ¼λ as a percentage of the ½λ is about 44.7 percent enclosed the grey conduit and 45.6 percent in free air.

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Forum Discussion

This forum has some interesing insights into the theory behind the Flowerpot Design.

https://reflector.sota.org.uk/t/flowerpot-antenna-u-k-dimensions/24046/5

Andrew VK1DA/VK2UH - The End Effect:

The wavelength is calculated from the formula L = 300/f where f is in Megahertz and L is in metres. Each part of the antenna is approximately a quarter wavelength, but reduced due to the end effect of a wire antenna with an open end. Subtract 5% for end effect.

According to The Fundamentals of Single Sideband, published by Collins Radio,

"Resonance occurs when [a dipole antenna's] length is a half wave length or multiples thereof. A practical rectilinear conductor will resonate when it is slightly less than a half-wave in length due to the end effect. End effect is due to a decrease in inductance and an increase in capacitance near the end of the conductor, which effectively lengthens the antenna. End effect increases with frequency and varies with different installations. In the high-frequency region, experience shows that the length of a half-wave radiator is in the order of 5% less than the length of a half-wave in free space. The greater the diameter of the conductor, the greater the difference between its electrical and physical length." Source: http://collinsradio.org/archives/ssb_fundamentals/Fundamentals%20of%20Single%20Side%20Band-one-file.pdf

David G0EVV Half Wave with Offset Matching:

The clever bit is the choke, this in not just any choke, this is a self resonant choke. That is to say its inductance and inter-turn capacitance is parallel resonant at 145.5 megs. I use RG174 for my flowerpots and that includes the choke. I find that 8.5 turns close wound on on a 22mm dia plumbing fitting is just right. To get the correct dimensions, make a coil, as per above then cut off the tails. Then use an aerial analyser with 1 turn coupling loop and look for resonance. It should be 145 ±1MHz. if high, try with a another 1/4 turn etc.

The distance from the top of the coil to the tip should be 1/2 an electrical wavelength, allowing for end effects and the tube dielectric. I use glass fibre fishing rods to mount it in. The offset "feedpoint" is to provide 50 Ohms impedance. Resonance is affected by the tube dielectric. So it must be set up inside the tube.

You will find the feeder is dead as far as RF is concerned, when you touch it the VSWR does not change, the choke is doing its job.

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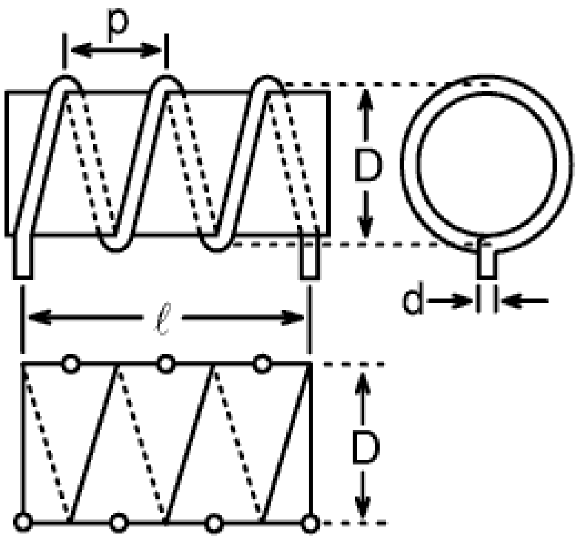
Choke Design

http://hamwaves.com/antennas/inductance.html

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QOIL™ — https://hamwaves.com/qoil/ — v20181217
  Coil design 2021-01-09 23:55

INPUT
  mean diameter of the coil    D = 52 mm
  number of turns              N = 13
  length of the coil           ℓ = 63 mm
  wire or tubing diameter      d = 4 mm
  design frequency             f = 52 MHz
  The (plating) material is annealed copper.

INTERMEDIATE RESULTS
  winding pitch                p = 4.85 mm
  physical conductor length    ℓ_w_phys = 2124.7 mm
  effective pitch angle        ψ = 1.76°

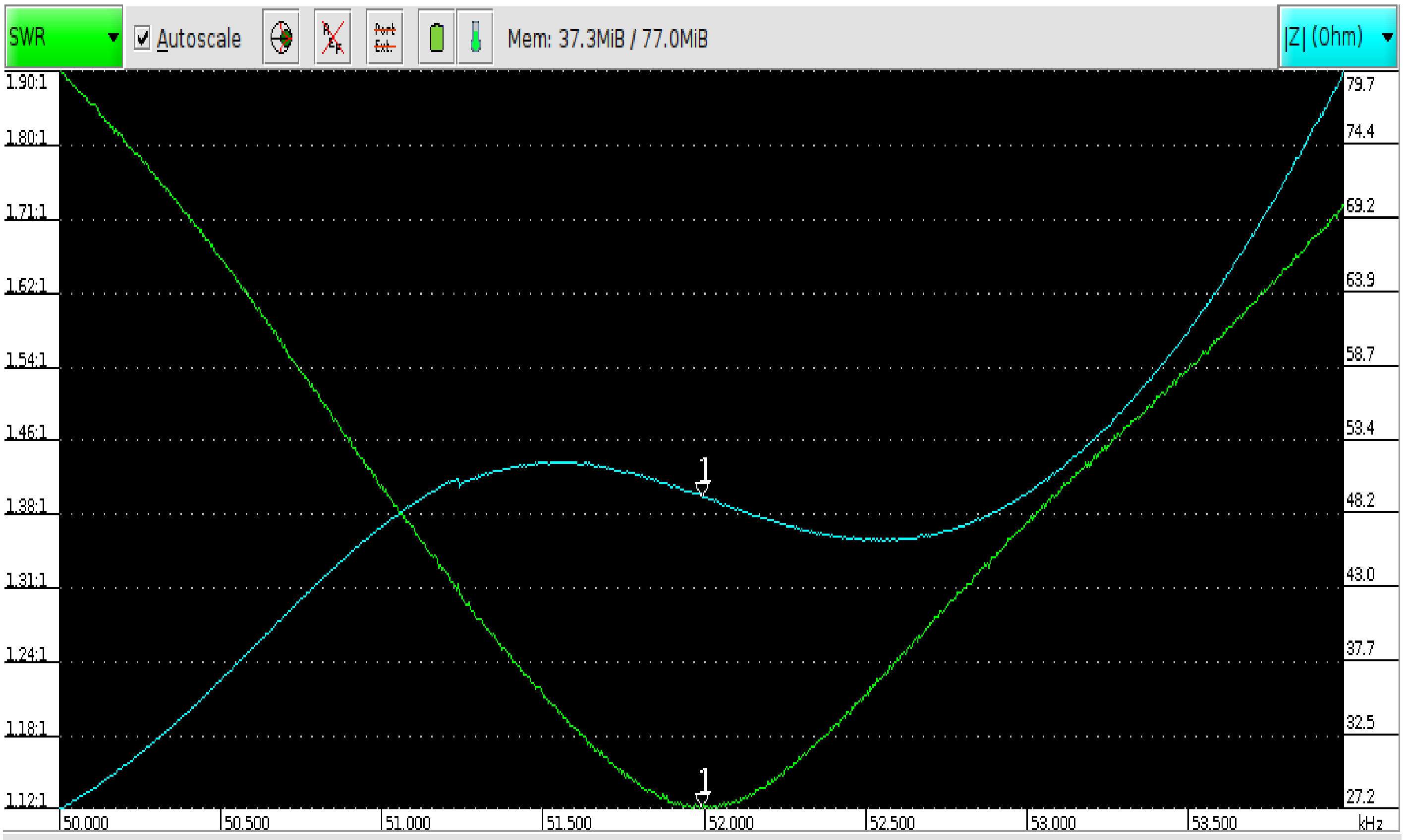
RESULTS
  Effective equivalent circuitλ
    effective series inductance @ design frequency          L_eff_s = 1572.010 µH
    effective series reactance @ design frequency           X_eff_s = 513615.9 Ω
    effective series AC resistance @ design frequency       R_eff_s = 0.943 Ω
    effective unloaded quality factor @ design frequency    Q_eff = 544855
  Lumped circuit equivalent
    f-independent series inductance; geometrical formula    L_s = 4.645 µH
    series AC resistance @ design frequency                 R_s = 0.000 Ω
    parallel stray capacitance @ design frequency           C_p = 2.0 pF
  Self-resonant frequency                                   f_res = 52.038 MHz
```

For further references see:
Short Tutorial: RF Choke vs. Inductor:
https://passive-components.eu/short-tutorial-rf-choke-vs-inductor/

Wikipedia - Choke (electronics):
https://en.wikipedia.org/wiki/Choke_(electronics)#Radio_frequency_choke [Top][Home]

VNA Analysis

This first VNA results:



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Tuning adjustments

- Cut the antenna long and pruned it to a match.
- Uncoil the choke and push a bit more coax up inside the tube, then rewind the coil.
- Place the coil in series with a noise source and plug it into my VHF/UHF spectrum analyser.
  This gives a clear picture of the "trap" function at resonance.
  Any close objects or body parts will pull the tuning.
  The trap is quite low Q however, so this is probably not of huge consequence.

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ref

Alan Yates - VK2ZOI Flower-Pot Antenna - 2007-01-14:
http://www.vk2zay.net/article/99

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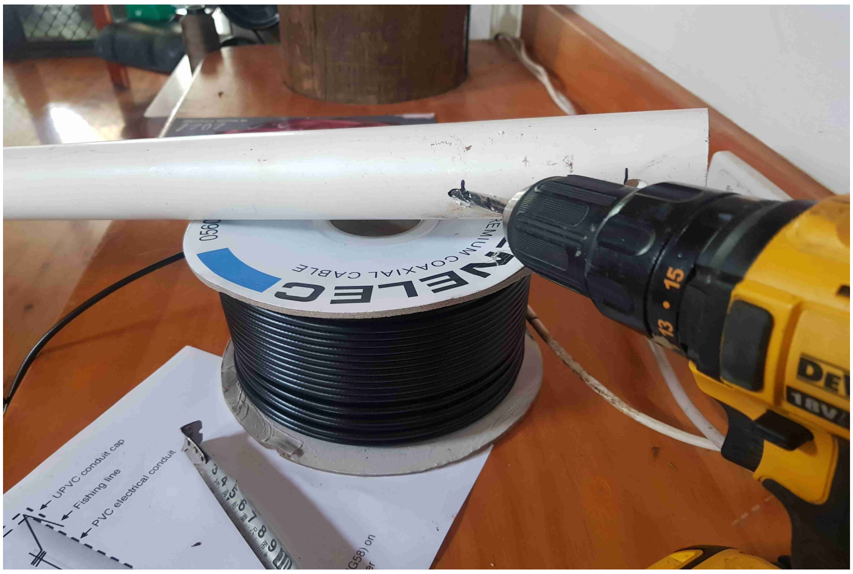
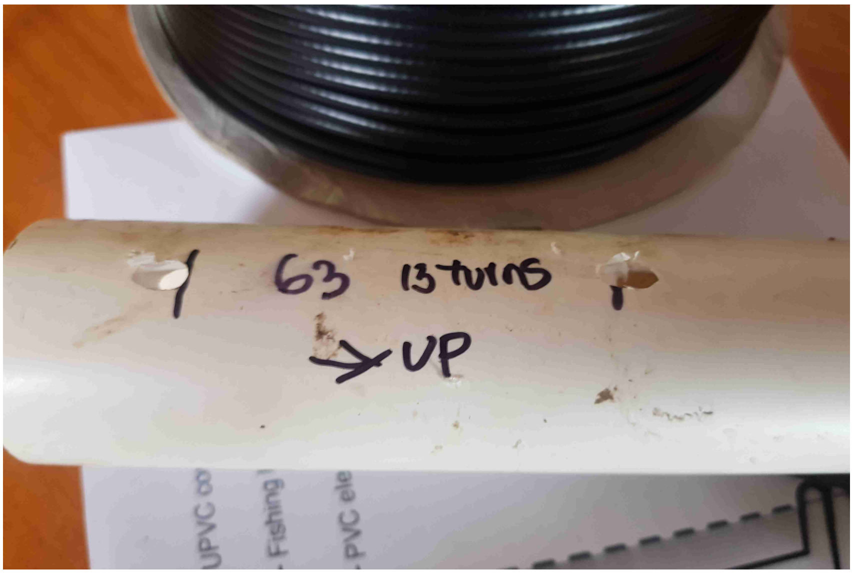
My Construction Photos

Conduits for the antenna:

Choke Former:



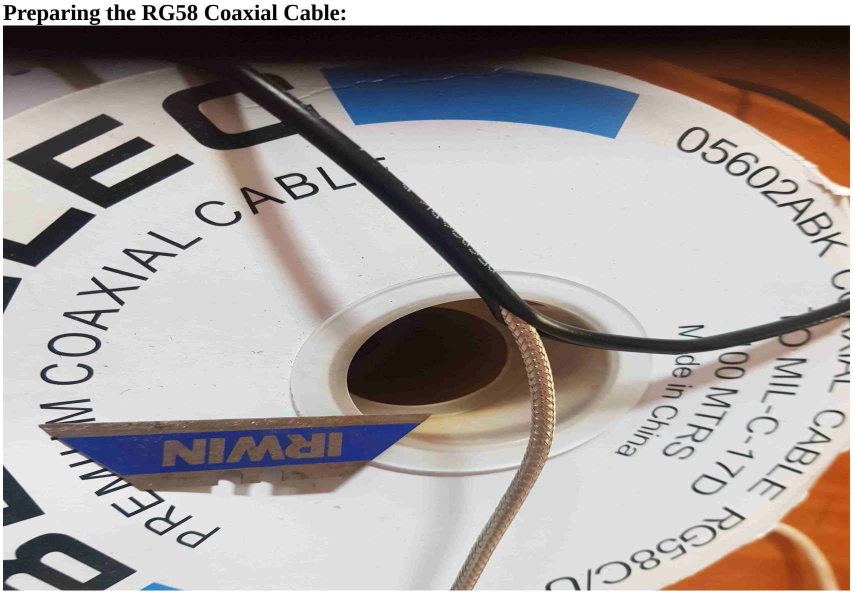


Choke Windings:


PREMIUM CO
100 MTRS
TO MIL-C-17D

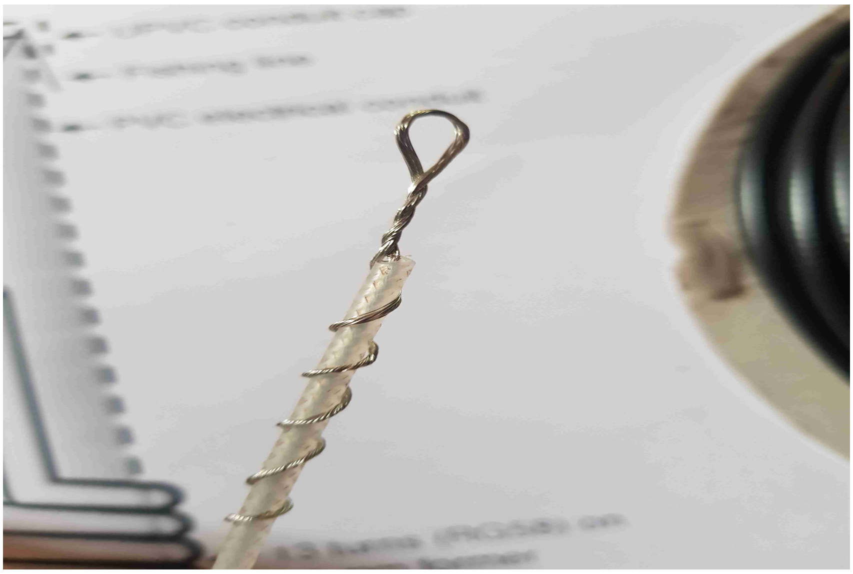

PREMIUM COAXIAL
RG58C/U
100 MTRS
Made in Chi
MIL-C-17D

Preparing the RG58 Coaxial Cable:



Top Section:

The top 100mm is stipped and twisted back to allow for lengthing the antenna in case the frequency is to high.



Steel Base:

Antenna Mount on Roof:

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