In Search of the Perfect Stealth Antenna

By: Clay Abrams K6AEP (rev 4 - 4/11/11)

When I first move to the community which I now live I knew of many restriction which include Amateur Radio Antenna. At the time I did not consider this as very important in my future life style goals. After living in this community for over 11 years, I gradually became interested once again in HF Amateur Radio Communications.

My first purchase was an Icom 718 Transceiver and AH-3 antenna tuner. This tuner allowed me to automatically tune random pieces of wire and use them as antenna's. My first attempts were rather poor choices. I finally experimentally decided a random wire length of 74 was best for the AH-3. I tried various grounding schemes and antenna location. My location choice was to place the antenna under the eves of the house.

I struggled with this configuration for a number of years. I found antennas would load OK with the AH-3, but for some reason my radiation was poor. For some reason the noise level was extremely high and I could not work out. I would call station and my returned signal report was poor at best. Most times I could not even be heard.

After using this antenna configuration for a couple of years, I read about a End Fed ½ wave antenna called a PAR. Everyone raved about this antenna on amateur forums. I decided to try a 20 meter version, which was 33 feet in length. I was able to string this antenna between two trees in the rear of my property. The results were astounding. Immediately I worked everyone and got great signal reports. The PAR antenna came with a small black module and 33 feet of wire. How did this antenna work? Not a clue in it's documentation on the technical design of this antenna. It's price was reasonable, so why should I be interested so much in it's design. However I was. Also the noise level was many db below what I received with the AH-3. How could this be?
http://www.parelectronics.com/end-fedz.php

The PAR specs said this antennas was for single band operation only, I did not ever try using it on another band. Conditions were bad a few years ago, and I wanted to try operation on 40 meters. I additionally bought a 40 meter PAR and was extremely happy with my results. I mounted this under the eves of my home.

I became very interested in PSK-31 on 20 meters. This one of the best modes one can work with low power like my Icom 718. In 2010 band conditions started to improve. Also the QRM started to get worse. All PSK31 operation seemed to be around 14.071 – 14.072 Mhz. The QRM was getting very bad and front end overload with the Icom 718 made the rig almost unusable at time. Especially if a local got on the air, I had to shutdown down due to front end overload.

Something had to be done. Now was time to get serious if I wanted to enjoy my hobby more.

A New Transceiver Upgrade

I read all I could about a new Kenwood rig released in the spring of 2010 the TS-590s. The TS-590s had been getting very good reviews in many Ham Radio Publications. It's specifications were also excellent. After searching the Web for a few months looking at review of all ham equipment I decided to purchase a new TS-590s. After shock of buying the most expensive piece of ham radio hardware I have very bought, it's performance lived up to all my expectations.

All my problems of front end overload and narrow selectivity of signals my receive and transmit issues were resolved. Using a rig like this is a culture shock. It is so complex and has so many features it can be difficult to use. I decided to write my own control software. That's another another on going project. I am not sure how successful I will be due to the rig's complexity.

Back to antenna's, I next decided to learn more end fed antenna's at look at other options other than a PAR. My first investigation was multi band wire antenna like a G5RV or a dipole. The G5RV was not a choice due to it's physical size and feed line. I read about a Buxomm 401OCD and 8010CD dipoles. I decided to purchase a 4010CD and see how it worked.

http://www.packetradio.com/catalog/index.php?main_page=product_info&products_id=1770

After installing a 4010CD I realized I made a big mistake. It would not load on 40 meters and it's on air performance was below what I receive from the PAR. However, it had one advantage of low background noise.

Again I started my quest to find a better choice. I finally started to become aware of unbalanced Balun's. What they did was to take an unbalanced 52 ohm feed line and feed a high impedance unbalanced antenna. The had a special name of a UnUn Balun. Could this be the answer to the perfect stealth antenna?

The UnUn Balun

I found dozens of antenna's designs on the Web using various forms of UnUn Baluns. Seems like many hams are experimenting in this arena.

I found an easy way out would be possible to purchase a UnUn Balun with a 52 ohm to 450 Ohm or 9:1 matching ratio. A group of hams had a club project in Hawaii (EARC) . They sold a small box as kit form or completely assembled for $39. They said they have sold this box to many hams all over the world, who were happy with the results. I decided to purchase one.

http://cgi.ebay.com/ws/eBayISAPI.dll?ViewItem&item=260701825106

It arrived in a little over a weeks. I replaced the PAR 40 meter balun with the EARC balun and use the 66 ft wire. I was able to tune more bands with the EARC and achieve excellent results. What can I say, it worked as advertised. The EARC came with 36 ft of antenna wire.

After looking at the design, it looked so easy to construct. I felt I might be able to do better. The EARC design did work on most bands with a 66 ft wire. However I could not load 1.8 Mhz, 3.5 Mhz and 50 Mhz. This was not a huge problem for me. However, many UnUn Blaun design said they would cover these frequencies. The construction of UnUn seemed to be so simple, why pay someone $40+ to do it for you when you can build one in a couple of hours.

The first step was to buy the material from Amidon. https://www.amidoncorp.com/

The Construction Phase

I decide to purchase three different Toroid Powered Iron Core mixes from Amidon. Most of the designs I found on the Web were for type -2 cores. Some folks said this core was good for low frequencies. Some said a type core -26 was a best choice. I decided to purchase -2, -40 and -52. I applied common sense to my choices. I knew type 40 and 52 must be newer blends, they had to be better? Since there was little or no specific specifications and the toroid prices were so low ($2+) how could I go wrong. Next was the core size. A type T-130 is a little larger than 1 inch and will dissipate 300 watts of power. This seemed like a good choice, since I was running 100 watts max. I found out later that the -40 material was an enhanced version of -26 type material.

My first trial was to build a simple design using two windings on a single core. I found a design on the web which the author used 44 turns of #18 wire secondary and 5 turns #18 primary. I built this into a $6 plastic electricians junction plastic box I found in Home Depot. I wound this wire on a -2 type coil. The results were a disaster. It did not work and the SWR was too high on all bands.

My next rial was to use a design by M0UKD. This design uses three wires. I purchased a three wire set of wire spools from Radio Shack of #18 wire. They were Red, Green and Black wires. I thought this might be a convenient way to keep track of the wires once wound on the toroid. I decided to use a -40 toroid. The wire length was 2 feet (3 each) and with 11 turns on the toroid. Since the Hawaii EARC design seemed to use a similar concept.

I found that the wire size with the thick insulation made feeding the wire around the toroid a bit difficult to string. The entire process took a little over an hour after the box was constructed. I followed the M0UKD design. After construction I tested the design by placing a 470 Ohm 25 watt resistor on the antenna terminal and testing the SWR using a MFJ 949E tuner, running 10 watts.

I also decided to revisit multi band operation using my PAR 20 meter antenna. I have this antenna between two trees in the back of my property. Much to my surprise the 20 meter was able to load and was usable on a number of bands, with good results.

Some Test Results

The following pages have pictures of the basic UnUn Design and some test results.

Table 1 shows the SWR for the Buxcomm Dipole Antenna about 20 feet off the ground

Table 2 shows the SWR using the EARC Hawaii UnUn Balum 66 foot wire end fed PAR antenna wire

Table 3 shows the test results using a type T130 - 40 toroid material and the M0UKD design and a 470 Ohm 470 25 watt resistor as a dummy load.

Table-4 shows using the Radio Shack #18 wire T130 - 40 core. After extensive testing at 100 Watts output this balun died in a smoke test. The wiring became so hot windings melted together. It was not hot enough to melt solder connection, but the wire insulation was melted enough to short out windings.

Table-5 shows some test results using #18 Solid Copper Enamel wire on T130 - 40 core. This design has not failed after a similar test as with the Radio Shack Wire. Good results have been achieved from 1.8 Mhz to 28 Mhz. An Antenna tuner must be used. The TS-590s has two built in antenna tuners which will tune a SWR up to 1.3:1.

Table-6 shows the results using a 20 meter PAR (out of the box) antenna. I found the antenna was usable on most bands above 7 Mhz. The on air results seemed to compare with the 66 ft wire. I was able to switch rapidly between the antennas using the TS-590s built in tuner for these tests. One advantage was that this antenna is more in the open with less near by objects. Signal noise is at times somewhat less.

Table-7 displays the test results using #18 Solid Copper Enamel wire on T130 – 52 core. This design seemed to be slightly better than the -40 core material at higher frequencies. The 1.8 Mhz SWR was considerably higher than the -40 material.

Table-8 shows the SWR for -2 material, which is the highest recommended by most amateurs. The low frequency end 1.8 Mhz had a higher SWR than the -40 0r -52 material.

Table-9 and 10 show the SWR and RF feedback results of 36 and 74 feet wire antennas.

Some On The Air Results

Stealth antenna communication can sometimes take patience to make contacts. You are at a disadvantage compared to more fortunate hams who have unlimited space for large antenna farms. Your choice of bands and communication mode can make a huge difference. For example 20 meter SSB is chosen by “fat cats” with lots of resources, like power amps and antenna farms. Many of those large signals heard on these modes and bands are unreachable by users with more modest stations.

I have found PSK31 operation using a Stealth Antenna ideal mode of operation. Most operation on PSK31 is under 100 watts of power. So if your power and antenna's are modest this is the mode for you. During a CW or SSB contests KW's and huge antenna arrays and high power are typically used.

I have found on PSK31 using a well matched UnUn 9:1 Balun fed antenna or a PAR antenna I can work almost anyone I can hear, and get excellent results. My antenna heights are about 20 feet max. I believe a vertical with a good ground system will perform better on DX contacts. However making a Stealth Vertical can be an expensive elaborate construction process. A low cost UnUn Wire antenna can be constructed for under $20 and provide excellent performance. An antenna like this can also be almost totally hidden from the view of non welcome visitors who may not approve or be tolerant of ham radio operation.

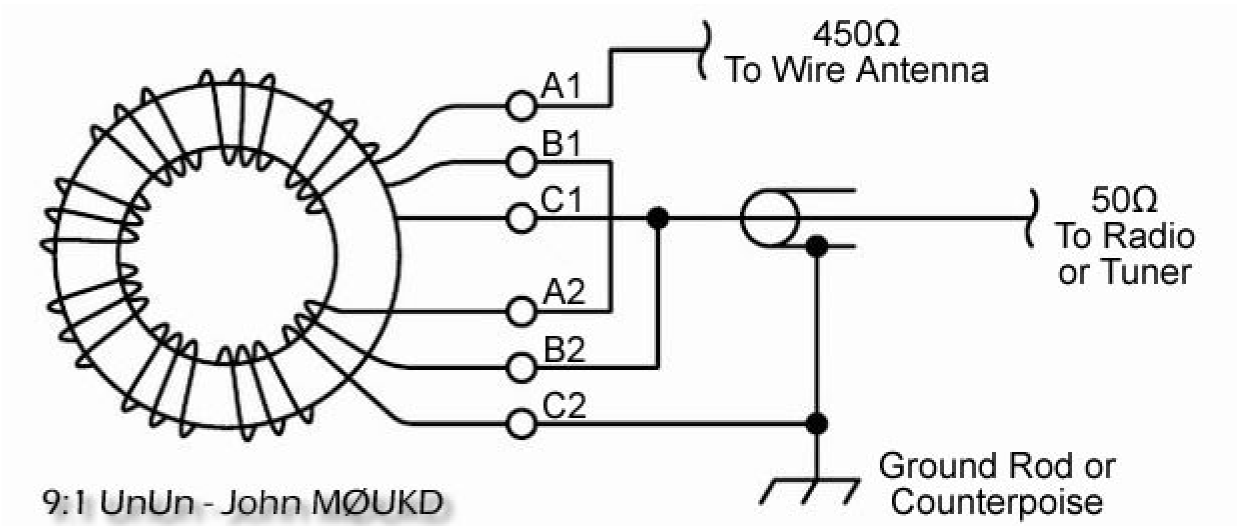
On PSK31 I been successful to work Europe, the tip of South America and all over the Far East with excellent reports and many positive comments on my signal. I also had excellent reports using JT65A mode of transmission.

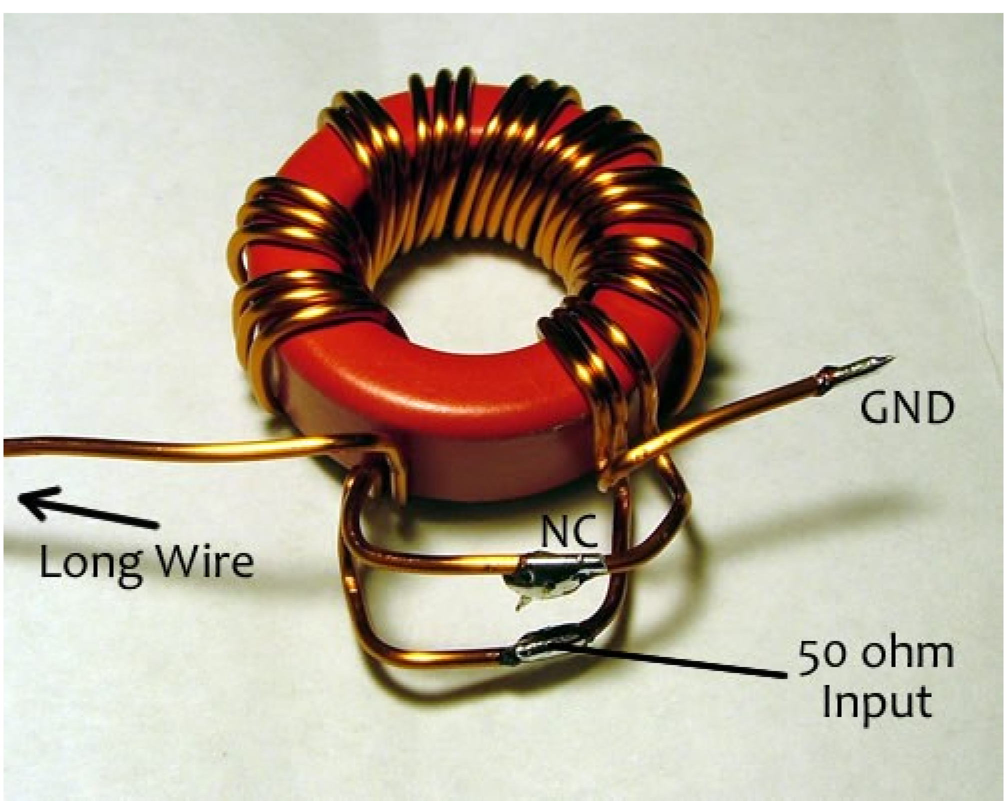
My test results seems to show that Powered Iron Core material of -26 or -40 was the optimum for all HF Ham Radio Bands. Adding a good electrical ground at the UnUn balun did not seem to make any difference in SWR or loading. I did not try adding a counterpoise wire.

Stealth antenna length can be chosen to provide lower SWR's on your favorite bands. Three antenna lengths were tested 36, 66 and 74 feel lengths of wire. Table 9 and 10 contain the 36 and 74 ft length results. The 36 ft length did have low SWR on all bands however, it's location was very low to the grounds and in a very poor location which accounted for higher RF feedback in the ham shack. The 66 and 74 feet SWR results were more reasonable. I chose 66 ft length wire as my optimum length because of low SWR and less RF feedback on the bands I mostly work.

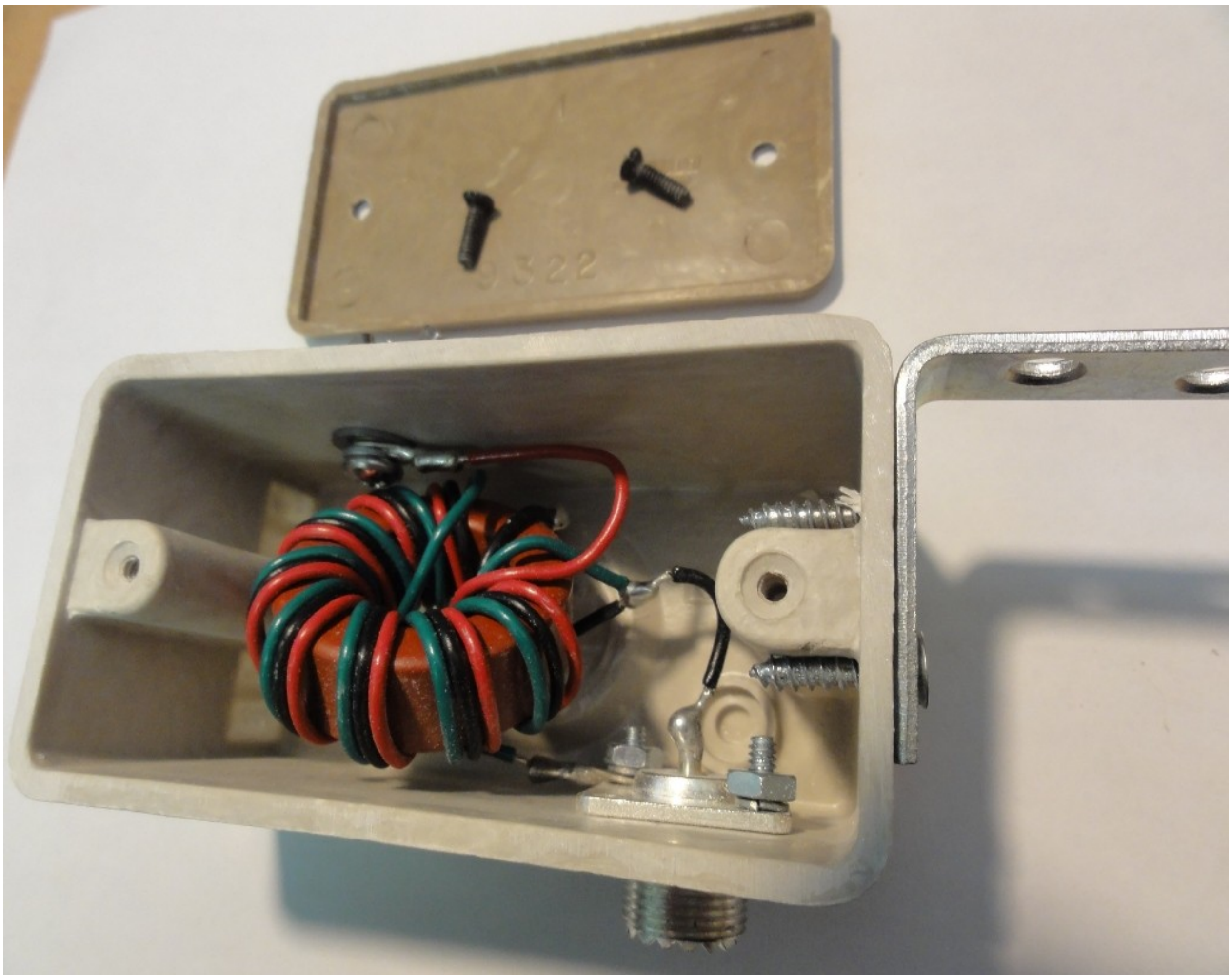
Clay K6AEP

UnUn Design by M0UKD

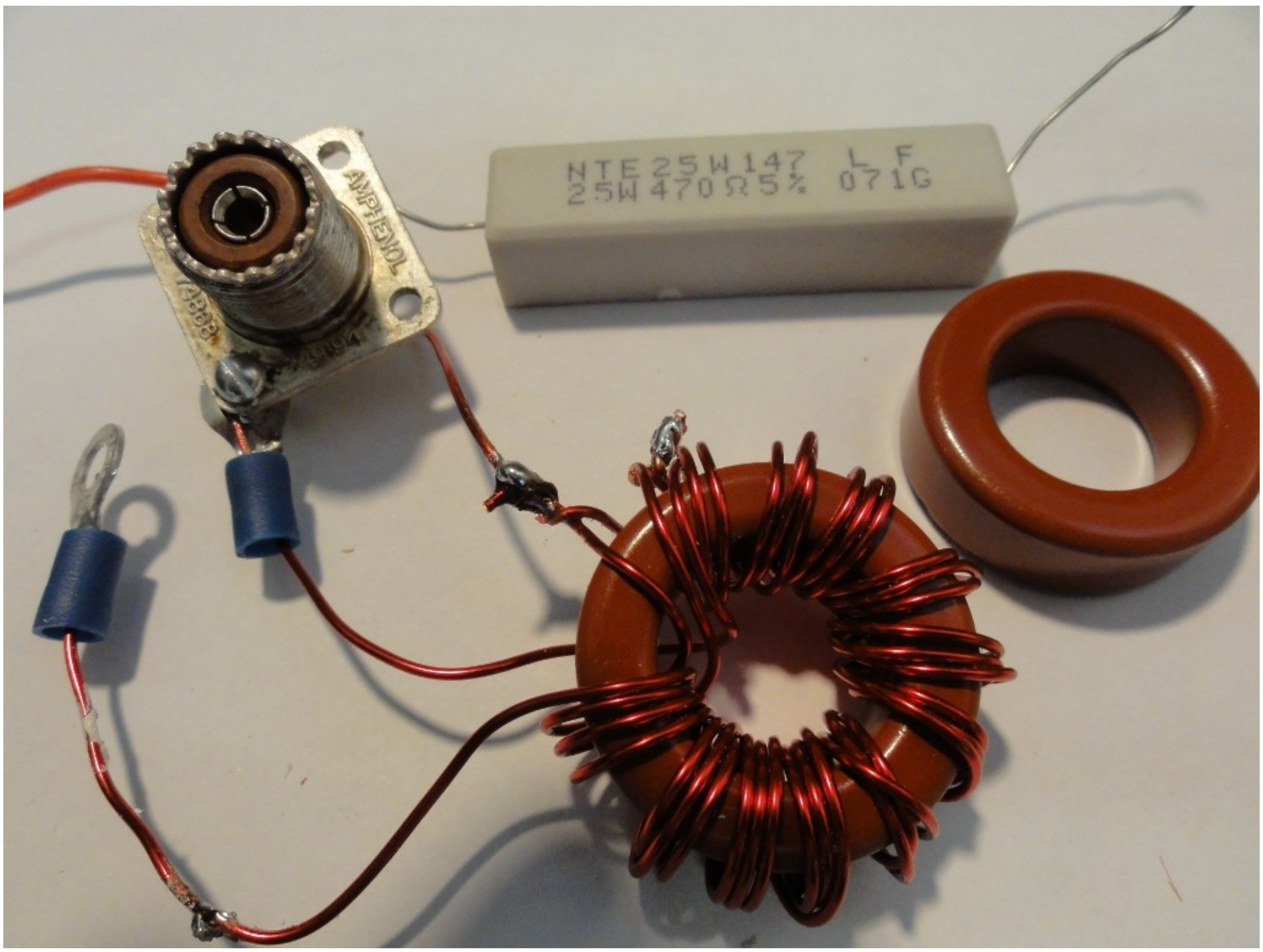




EARC Box



K6AEP - Design – Type T130-2



Test Results

1. Buxcom 4010cd Dipole center fed 33 feet - Coax 100 feet RG8

1.8 Mhz - SWR error could not load
3.8 Mhz - SWR error could not load
7.2 hz - SWR error could not load
10.14 Mhz - 1.125:1
14.07 Mhz - 1.3:1
18.1 Mhz - 1:5:1
21.07 Mhz - 1.4:1
24.91 Mhz - 1.3:1
28.5 Mhz - 1.2:1
50.5 Mhz - 1.2:1

2. EARC Hawaii UnUn Balum 66 foot wire end fed - Coax RG8 about 15 feet

1.8 Mhz - SWR error could not load
3.8 Mhz - SWR error could not load
7.035 Mhz - MFJ Ant tuner 1.2:1 - Without MFJ 949 SWR error
10.14 Mhz - 1.1:1
14.070 Mhz - 1.8:1
18.10 Mhz - 1.1:1 High RF feedback high power (10w OK)
21.07 Mhz - 1.2:1
24.920 Mhz - 1.0:1 High RF feedback high power (10w OK)
28.12 Mhz - 1.2:1
50.00 Mhz Would not tune

3. UnUn K0UKD design - #18 wire - On a type 40 Iron core toroid – 470 Dummy Ohm load

1.8 Mhz - 1.1:1
3.8 Mhz - 1.1:1
7.2 Mhz - 1.1:1
10.14 Mhz - 1.1:1
14.1 Mhz - 1.1:1
18.1 Mhz – 1.1:1
21.07 Mhz - 1.1:1
24.91 Mhz - 1.1:1
28.5 Mhz - 1.1:1
50.5 Mhz - 1.2:1

4. UnUn K0UKD design - #18 Wire - On a type 40 Iron core toroid - 66 ft wire
Wire used was Radio Shack #18 tri color - Failed after 1 hour - Insulation Melted

1.8 Mhz - 1.8:1
3.8 Mhz - 1.8:1 High RF feedback high power (10w OK)
7.035 Mhz - 1.2:1
10.14 Mhz - 1.1:1 High RF feedback high power (10w OK)
14.070 Mhz - 1.2:1
18.10 Mhz - 1.3:1 Some RF feedback high power (10w OK)
21.07 Mhz - 1.15:1
24.920 Mhz - 1.3:1 High RF feedback high power (10w OK)
28.12 Mhz - 1.1.5:1
50.00 Mhz 1.2:1

5. UnUn K0UKD design - #18 Wire (Solid Copper Enamel) - On a type 40 Iron core toroid - 66 ft wire

1.8 Mhz - 1.15:1
3.8 Mhz - 1.9:1 High RF feedback high power (10w OK)
7.035 Mhz - 1.2:1
10.14 Mhz - 1.1:1 High RF feedback high power (10w OK)
14.070 Mhz - 1.2:1
18.10 Mhz - 1.5:1 Unusable due RF feedback high power (10w OK)
21.07 Mhz - 1.15:1
24.920 Mhz - 1.3:1 High RF feedback high power (10w OK)
28.12 Mhz - 1.15:1
50.00 Mhz 1.2:1

6. PAR 20 Meter end fed antenna – Wire length 33 ft – Coax 100 feet – RG8

1.8 Mhz - SWR error could not load
3.8 Mhz - SWR error could not load
7.0 Mhz - 1.5:1
7.1 Mhz - 1.5:1
7.2 Mhz - 1.5:1
10.14 Mhz – SWR error could not lo
14.07 Mhz 1.1:1 all over band
18.1 Mhz 1.3:1
21.07 Mhz 1.3:1
24.91 Mhz 1.3:1
28.5 Mhz 1.5:1
50.05 Mhz 1.15:1

7. UnUn K0UKD design - #18 wire - Solid Copper Enamel on a type 52 Iron core toroid - 66 FT wire

1.8 Mhz - 1.25:1
3.8 Mhz - 1.3:1 High RF feedback high power (10w OK)
7.2 hz - 1.3:1
10.14 Mhz - 1.2:1 High RF feedback high power (10w OK)
14.1 Mhz - 1.6:1
18.1 Mhz - 1.6:1 Very High RF feedback high power (10w OK)
21.07 Mhz - 1.2:1
24.91 Mhz - 1.2:1 High RF feedback high power (10w OK)
28.5 Mhz - 1.2:1
50.5 Mhz - 1.0:1

8. UnUn K0UKD design - #18 wire - On a type 2 Iron core toroid - 470 Ohm load

1.8 Mhz - 1.7:1
3.8 Mhz - 1.2:1
7.2 hz - 1.1:1
10.14 Mhz - 1.05:1
14.1 Mhz - 1.0:1
18.1 Mhz - 1.0:1
21.07 Mhz - 1.1:1
24.91 Mhz - 1.2:1
28.5 Mhz - 1.3:1
50.5 Mhz - 1.0:1

9. UnUn K0UKD design - #18 wire - On a type 40 - 74 ft wire - Added 8 feet 66 ft antenna.

1.8 Mhz - 1.2:1
3.5 Mhz - 1.9:1 High RF feedback high power (10w OK)
7.2 hz - 1.05:1 High RF feedback high power (10w OK)
10.14 Mhz - 1.25:1 High RF feedback high power (10w OK)
14.1 Mhz - 1.25:1
18.1 Mhz - 1.2:1
21.07 Mhz - 1.3:1
24.91 Mhz - 1.1:1
28.5 Mhz - 1.25:1 High RF feedback high power (10w OK)
50.5 Mhz - 1.0:1

10. UnUn K0UKD design - #18 wire - On a type 52 - 36 ft wire - Low elevation close to ham shack.

1.8 Mhz - 1.1.5:1
3.5 Mhz - 1.1:1 RF feedback high power (10w OK)
7.2 hz - 1.15:1 High RF feedback high power (10w OK)
10.14 Mhz - 1.15:1 Some RF feedback high power (10w OK)
14.1 Mhz - 1.1:1
18.1 Mhz - 1.2:1 High RF feedback high power (10w OK)
21.07 Mhz - 1.3:1 RF feedback high power (10w OK)
24.91 Mhz - 1.2:1 Some RF feedback high power (10w OK)
28.5 Mhz - 1.2:1 Some RF feedback high power (10w OK)
50.5 Mhz - 1.0:1