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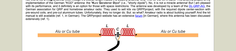
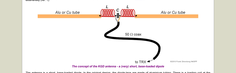
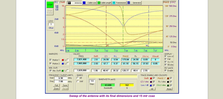
INTRODUCTION

So, this is it, we are a GB electronic guru though its overall length (wires & plastic) amounts only half the 40 m band. This antenna project is my implementation of the Dennis "NW1" antenna. My first attempt was a 20 m "Moxon Rectangle" (i.e. "Moxon Quad"), the 4 m tall 2-element version that I called "Moxon Rectangle" (see the pictures below) was a very good performer, but I had to "sacrifice" 2 m of my garden for it. Since I wanted to have a 40 m version of this antenna, I had to find a smaller design. Dennis' "NW1" seemed to be the right one, but I had to "sacrifice" 4 m of my garden for it. Since I had to "sacrifice" 4 m of my garden for the 40 m version of the "Moxon Rectangle", I thought that I should also try to build a 20 m version of the "NW1" antenna. Since I had to "sacrifice" 2 m of my garden for the "Moxon Rectangle", I thought that the 20 m version of the "NW1" should be 2 m shorter than the 40 m version. Since I had to "sacrifice" 4 m of my garden for the 40 m version of the "NW1", I thought that the 20 m version of the "NW1" should also be 4 m shorter than the 40 m version.







Swing of the antenna with no fixed dimensions, 10 mm case and 2 mm rodding

Here a number of experiments, corrections, and adjustments to finalize the antenna:

- Initially the antenna was made with 10 mm case and 2 mm rodding, but the frequency changed about 10 kHz at 10 cm of tension
- Lengthwise the case was cut, but again enough turns, 1 cm and made a new section of PVC tube, and around the case, to increase the diameter to 20 mm
- Resonance frequency with half of the tuning rods inserted: 5841 kHz. The low Rs=3240Ω was close to 1 and an SWR=3 bandwidth of 20 kHz
- Increased the number of turns to 50 and the resonance frequency was 5700 kHz, but the Rs=1200Ω was far from 1. Reducing one turn brought back the resonance to 5841 kHz and Rs=3240Ω, but the bandwidth was 30 kHz
- Placed with the tuning rods to see their effect. Putting them out from 10 to 11 cm reduced f_{res} to 5584 kHz - the wrong direction! Inserting them 10 cm increased f_{res} to 5900 kHz, but Rs=1200Ω. Cutting the rods to 5 cm brought back the resonance to 5841 kHz and Rs=3240Ω. Placed back the rods. Probably they are not important
- Placed the 2 mm rodding into the case. The f_{res} went up to 5 kHz and Rs=1200Ω, and SWR=3 bandwidth of 1 kHz, and 1 kHz asymmetry. The diff needs to be corrected
- Placed the rodding into the case and the place of the case is closer to the rodding, and therefore, the frequency goes down, and also feels the antenna is in a different environment
- Placed the rodding into the case and the bottom signal strengths are very quite impressive compared to all the other home-built compact antennas that I have tested
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- It is known that the rodding is a very important component, f_{res} is very sensitive to the rodding, and Rs is very sensitive to the case
- All my 5 m and a transmitting antenna test, and see if anyone can hear me! It performed all too regularly here shortly

Finally, the antenna was made with 10 mm case and 2 mm rodding, and the frequency was 5841 kHz, and Rs=3240Ω, and SWR=3 bandwidth of 20 kHz, and 1 kHz asymmetry, and the diff needs to be corrected. Placed the rodding into the case and the bottom signal strengths are very quite impressive compared to all the other home-built compact antennas that I have tested. Placed the rodding into the case and the place of the case is closer to the rodding, and therefore, the frequency goes down, and also feels the antenna is in a different environment. Placed with the tuning rods to see their effect. Putting them out from 10 to 11 cm reduced f_{res} to 5584 kHz - the wrong direction! Inserting them 10 cm increased f_{res} to 5900 kHz, but Rs=1200Ω. Cutting the rods to 5 cm brought back the resonance to 5841 kHz and Rs=3240Ω. Placed back the rods. Probably they are not important. Placed the 2 mm rodding into the case. The f_{res} went up to 5 kHz and Rs=1200Ω, and SWR=3 bandwidth of 1 kHz, and 1 kHz asymmetry. The diff needs to be corrected

- dipole legs: 160 cm each (8 ft 7"); 25 mm (1x8") diameter aluminum tubing
- coupling: Beta-Match coil, 2 turns, 25 mm (1x8") diameter aluminum tubing, 20 cm (8") diameter coil diameter, 5 cm (2") spacing, alternatively inductive coupling loop (see below) coil (MBAC).
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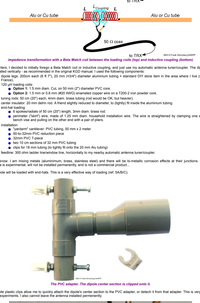


Impedance transformation with a Beta Match coil between the loading coils (left) and inductive coupling (bottom)

For starters, I decided to initially forego a Beta Match coil or inductive coupling, and just use my automatic antenna tuner/coupler. The dipole will be installed vertically - as recommended in the original VK4ZAP manual - I used the following components:

- dipole legs: 250cm each (8 ft 7"), 25 mm (1x8") diameter aluminum tubing + standard DTI stem item in the area where I tap (south of the loading coil)
  - **Option 1:** 1.5 mm diam. Cu, or 50 mm (2") diameter PVC pipe
  - **Option 2:** 1.5 mm diam. Cu, or 50 mm (2") diameter PVC pipe + 2.5Cu2 cm powder core.
- loading coils: 50 cm (20") each, 4mm diam. brass tubing (cut wood for 24, but heavier)
- center insulator: 25 mm diam cut. A friend slightly reduced to diameter, to slightly fit inside the aluminum tubing
- feed point:
  - 8 solderlessnoles of 50 cm (20") length, 6mm diam. brass rod
  - 2 x 8 mm diam. bolts, 50 mm (2") long, for the Beta-Match installation only. The wire is straightened by clamping one end in a bench vise and pulling on the other end with a pair of pliers
- coax:
  - Belden "Cardinal" cardinal PVC tubing, 50 mm x 2 meter
  - 50 Ω Belden PVC reduction plane
  - 50 Ω Belden coax
  - two 50 cm sections of 50 mm PVC tubing
  - clips for 25 mm tubing (to tightly fit onto the 25 mm Alu tubing)
- feedline: 300 ohm ladder transmission line, horizontally to my nearby automatic antenna tuner/coupler.

Yes, I know, I am mixing metals (aluminum, brass, stainless steel) and there will be bi-metallic corrosion effects at their junctions. But this antenna is experimental, will not be installed permanently, and is not a commercial product.

The dipole will be loaded with end-hats. This is a very effective way of loading (ref. SA4CC).

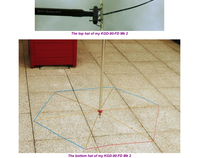
The PVC pieces, the dipole center insulator is clipped onto it

The white plastic clips allow me to quickly attach the dipole's center section to the PVC adapter, or detach it from that adapter. This is very helpful during experiments. I also cannot leave the antenna installed permanently.

Close-up of end-hat of one quadrant of 50 cm (20") 25 mm diameter aluminum tubing and 4 mm diam. brass rod of the dipole

As the photo above clearly shows, the attachment of the brass rods to the tip of the aluminum dipole tube is flimsy, I admit it. The tubing is rather thin, and the thickness of the brass rods is barely enough for the tiny amount of contact/pressure/friction it is now relying on.

The center section of the dipole is clipped onto the PVC adapter shown above. The 2 pieces of that adapter is stuck onto a horizontally installed PVC tube with 50 mm (2") diameter. The 2m long tube is attached to the concrete foot that overhangs part of my terrace.



The KQ3I-80/10-RS 2-element
(in the foreground: Paco Pei, and a 2-piece wire with a 1meter (3 ft) long coil (weather-radar antenna underneath)

The tap but of my KQ3I-80/10-RS 2

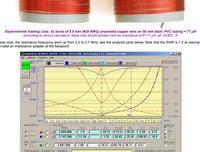
The bottom half of my KQ3I-80/10-RS 2
(when the antenna is installed the wires will touch the ground)

As stated above, the original design calls for for loading coils of 120 µH at the feed point. They are wound onto the 20 mm diam. insulator section of the fiberglass boom. The 120 µH coils are wound with 1.5 mm diam. Cu wire, 50 turns, 5 cm (2") spacing, 20 cm (8") diameter. I used 1.5 mm diam. wire, but I too used powder core from an antenna tuner. There are type 2 (26/0 Cu, 26/0 Cu) powder cores (iron) available in 2" but powder cores (iron) are difficult to find in 2" diameter. I used 2 cores, 2.5 cm (1") each, and 2 cores, 1.5 cm (0.6") each. I used the same powder cores in the antenna tuners such as the LDG model AT-100 (1.5H) and the Elecraft model AX1C. So they can't be all that bad, lo.

Note that Cu (copper) typically measure inductance at a wireless frequency 100 kHz - 1 MHz. However, inductance of a coil is to some extent dependent on the frequency. Copper is a non-magnetic material, so its inductance will be lower than that of a ferromagnetic steel rod. It is known that the inductance at the operating frequency (and much lower, compared to the self-resonance frequency of the coil).

Core material "type 2" has an µ, of 120. That is 120 (air core alone) result in 120 µH inductance. These cores fit about 5 meters of 0.8 mm enameled copper wire. With 50 turns (and my personal winding technique) I obtained an inductance of 117 µH. Close enough.

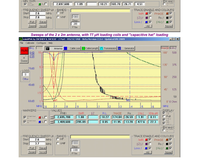
Note that the coils are not coated, and are not varnished. Varnish or any glue would wind up in the gap between the windings and significantly reduce the "Q" of the coil. For permanent installation, the coils must be protected.



The two 117 µH loading coils, 50 turns wound on 7200-2 iron powder cores

With these coils, the resonant frequency of the antenna (installed vertically, feed point about 300 cm off the ground) was about 2 MHz. Hey, I'm trying to make a 80 meter dipole, not one for 160 m (1.8 MHz)! But the dipole legs are 25% longer than the 1/4 λ in the original KQ3I-80 design, 2 meters instead of 1.6 meters. The resonant frequency of the dipole is lowered by the capacitive hat loading and inductance. One hat, added loading "spikes" at the tip of each dipole leg. This also reduces the resonance frequency.

To get the resonance frequency up to where I wanted it (just below 3550 kHz), I obviously had to reduce the inductance of the loading coils. One quick way to do that was to use two 117 µH coils from another antenna experiment. They were wound on 50 mm (2") PVC.



Experimental loading coils: 42 turns of 0.8 mm #20 AWG enameled copper wire on 50 mm diam. PVC tubing = 77 µH
(these coils should actually have an inductance of 61 µH, not 77 µH, 20/20)

With these coils, the resonance frequency went up from 2.0 to 2.7 MHz, see the analyzer plots below. Note that the SWR is 1.2 at resonance, as I did not install an impedance adapter at the feedpoint.

Two loading coil configurations: 117 µH on iron powder core (left) and 77 µH on PVC core (right)

After dispense reducing the number of coil windings several times, I conclude that the coils should have about 44 µH to get up to 3600 kHz.

Wait!, I also could use the iron powder core coils, but I would need to reduce the number of turns. The inductance of the iron powder core coils is about 1.5 times that of the air core coils. Using 50 turns of 0.8 mm diam. wire, I obtained 117 µH. But a coil with 1.5 times that inductance would only need 33 turns. Iron powder coils have a lower Q than air core coils, but I don't care about that. I guess I could also use 2 coils in series, each having 25 turns. Or, I could use 2 coils in parallel, each having 50 turns. Hmm, I guess I could also use 2 coils in series, each having 25 turns, and 2 coils in parallel, each having 50 turns. Hey, I guess I could also use 2 coils in series, each having 25 turns, and 2 coils in parallel, each having 50 turns, and 2 coils in series, each having 25 turns. Hmm, I guess I could also use 2 coils in series, each having 25 turns, and 2 coils in parallel, each having 50 turns, and 2 coils in series, each having 25 turns, and 2 coils in parallel, each having 50 turns. Hey, I guess I could also use 2 coils in series, each having 25 turns, and 2 coils in parallel, each having 50 turns, and 2 coils in series, each having 25 turns, and 2 coils in parallel, each having 50