

Base Matching Assemblies for Short Antennas

Phil Salas – AD5X (ad5x@arrl.net)

Introduction

I've written several articles on portable and mobile antennas, including information on building mounts. And every time I build a new mount, I evolve the design. The short-antenna matching mounts described here are simple, and integrate three different types of base matching to suite your preferences – capacitive, inductive and transformer matching.

Antenna Matching

Short antennas have very low radiation resistance. Ground and coil losses become part of the load as well. Typically, radiation resistance is in the 1-4 ohm range, and coil losses are in the 3-5 ohm range for short (8-foot) antennas operating on 80-20 meters. And ground losses typically are in the 7-15 ohm range. A good rule of thumb is that you must match a 20-25 ohm load to your 50-ohm transmitter. If you have a good VSWR without some sort of base matching, you probably have high coil losses and/or ground losses!

There are several ways to match a short antenna. You can increase the antenna length a bit (making it inductive), and add shunt capacitive base matching. Or decrease antenna length a bit (making it capacitive) and add shunt inductive base matching. In either case, the amount of capacitance or inductance may need to change as you change bands. Finally, a broadband transformer may also be used to match antennas on different bands.

All of the described matching devices can be built either as a direct “in-line” unit, as for putting in series with a standard 3/8x24 threaded mount, or as a direct SO-239 interface matching unit. I show both types for the capacitive match, the SO-239 interface only for the inductive match, and the “in-line” only for the transformer match.

Base Matching Capacitor Mount

Capacitive matching is simple, and it can give you virtually a perfect match on all bands. Refer to Figure 1 for the schematic of the base capacitive matching device. With the 12-position switch used, you can use up to eleven capacitors in the matching bases described (you need one position for zero capacitance). Silver mica capacitors are available from Mouser Electronics (www.mouser.com) and Hosfelt Electronics (www.hosfelt.com). Some good values to use are: 47, 82, 120, 150, 180, 220, 330, 560, 680, 820 and 1200 pf of capacitive matching. These will give you all the values necessary to obtain an excellent match from 60-10 meters for most short antennas, and a 300-volt rating is more than adequate for a 100-watt transmitter. If you will be operating on 80 meters, you should add an 1800 pf capacitor and probably give up either the 150 pf or 180 pf capacitor. The capacitors have to be carefully mounted on the switch so that they will fit within the 1-1/4” PVC coupling with everything else (see photo “Switch & Caps”).

Figure 2 shows the physical design. This assembly passes the RF directly through it, and the capacitors are connected to a ground screw as shown in the figure. So as to leave plenty of room inside the mount for all the circuitry, cut the PVC plug and adapter internal collar lengths such that they only extend 1/4” into the 1-1/4” PVC coupler. Drill a

3/8" hole in one side for the rotary switch. You also need to drill a #8 clearance hole in a convenient location for the screw used as a ground connector. Finally, drill a 3/8" diameter hole in the 1-1/4" PVC plug to pass the 3/8x24 stainless steel bolt that will screw directly into a standard 3/8x24 antenna mount. I soldered directly to the stainless steel bolt head as shown. You can solder to stainless steel using either silver solder paste, or aluminum solder paste. I found that sometimes one works, and sometimes the other works. I guess it has something to do with the type of stainless steel the bolt is made of. Silver solder paste is available from Radio Shack or www.solder-it.com. I've only been able to find the aluminum solder paste at www.solder-it.com. A ground wire connects from the 3/8x24 stainless steel bolt to the brass ground screw and the common switch terminal. This matching unit is screwed directly into your ball mount, and the antenna is then screwed into the top of this device. A ground wire attaches from the ground stud on this unit to one of the ball mount mounting bolts. You can make this a permanent attachment to the ball mount ground, or just use a Radio Shack 270-349 alligator clip to connect to the bolt head. I've found that this clip will stay on the bolt head at high highway speeds. Refer to photos "Ball Mount Cap Front", "Ball Mount Cap Back", and "Ball Mount Cap Inside" for photos of the complete device. Notice that I included a 20K ohm 1-watt resistor in the capacitive match mount. This is used to bleed off static build-up on the antenna.

Figure 3 shows an alternative mount that has an SO-239 input. You can use this for ground mounting, or mounting on a bracket on a trailer hitch. This design can be used with all versions of the mounts if you desire a direct SO-239 input. Refer to photos "SO239 Cap Parts", "SO239 Cap Inside", and "SO239 Cap Outside". Drill a 5/8" diameter hole in the center of one side of the PVC coupler for the SO-239 connector, and a 3/8" hole in the opposite side for the switch. As seen in the photos, I hack-sawed two sides off a standard 4-hole mount SO-239, but later I started using standard 4-hole SO-239 connectors. Use either hot glue or epoxy to seal around the SO-239 connector. I also used a 3/8x16 ground bolt on this mount so I could easily add a ground spike for ground mounting if desired. The ground mounting spike is made from a 3/8x16x12" zinc plated hex head carriage bolt. Cut off the bolt head, and round the end with a file. Use a 3/8x16 zinc plated coupler to attach the 1-1/4" bolt to the 12" bolt as shown in Figure 4 and photo "Base & Shaft". Now you can either leave the spike off for mounting directly to a metal plate or trailer mount, or you can screw on the spike for ground mounting.

Remember – if you ground mount, you need to use radials. I use six 12-foot radials with 1-1/2" brass wood screws soldered on the outside ends. These screws are pushed into the ground to hold the radials in place.

Inductive Base Matching

I recently purchased a Little Tarheel screwdriver antenna, and the recommended matching was for a one-microhenry shunt inductor connected at the base of the antenna. The inductive match shown in Figure 5 and photos "L Front" and "L Side" is a base design which incorporates this matching inductor on the mount. I found that three turns of #18 enameled wire gave me a good match on all bands from 60-meters and above. Drill and tap a #8 thread into the upper 1/8NPT brass adapter so the upper antenna-end of

the coil attaches to a #8 brass screw that threads into the adapter as shown in the figure. I covered the enameled wire with clear epoxy, but this is probably not necessary. I used a direct SO-239 interface for this matching base mount, though an in-line ball-mount version could easily be built. Make sure to connect a common ground wire from the SO-239 to the 3/8x16 bolt head, and to the #8 brass ground screw as shown.

Transformer Matching

Assuming an 8-foot center loaded mobile antenna, with a coil Q of 250 and ground losses of 10 ohms, a summary of the total losses and VSWR for each band are given below:

<u>Frequency</u>	<u>Rr</u>	<u>Rl</u>	<u>Rg</u>	<u>Total</u>	<u>VSWR</u>	<u>VSWR w/2.25:1 xfmr</u>
3.8 MHz	1	11	10	22	2.3:1	1:1
7.2 MHz	3	6	10	19	2.6:1	1.2:1
10.1 MHz	6	4	10	20	2.5:1	1.1:1
14.2 MHz	12	3	10	25	2:1	1.1:1
18.1 MHz	15	1	10	26	1.9:1	1.2:1
21.3 MHz	20	1	10	31	1.6:1	1.4:1
24.9 MHz	28	1	10	39	1.3:1	1.75:1
28.4 MHz	36	0	10	46	1.1:1	2.1:1

As you can see, the unmatched VSWR is around 2:1 below 21 MHz, so a broadband 2.25:1 match can give a good match. Above 15 meters, the transformer match can just be removed. I built a transformer match as shown in Figures 6, 7 and 8. The FT-114A-61 core will handle a 100-watt transmitter. Photos “Xfmr”, “Xmatch Inside” and “xmatch Outside” give more details. This device is used exactly like the capacitive matching ball mount. I.e. it is screwed in series with the antenna and ball mount. Again, the ground wire is very important. Again, a direct SO-239 input version can be built if desired.

Summary

If you operate HF portable or mobile, you are generally stuck with an antenna much shorter than desired. Assuming your losses aren't too bad, your resonant impedance will be low, and so a match will be necessary. This article described improved base mounts with integral matching that are easy to build, and work well for the typical 100-watt rig.

Common Parts for all bases

<u>QTY</u>	<u>Description</u>	<u>Source</u>
1	1-1/4" PVC coupler	ACE/Home Depot
1	1-1/4" PVC plug	ACE
1	1-1/4-to-1/2 PVC adapter	ACE
1	1/2-to-1/8NPT brass adapter	ACE
1	#8 1/2" brass screw	ACE/Home Depot
1	#8 brass nut	A CE/Home Depot
1	#8 copper plated steel lockwasher	ACE
4	#6 ss sheet metal screws	ACE/Home Depot
1	3/8 ss lockwasher	ACE
1	SO-239 (optional-see text)	Mouser 523-83-1R-RFX

CMATCH Parts List

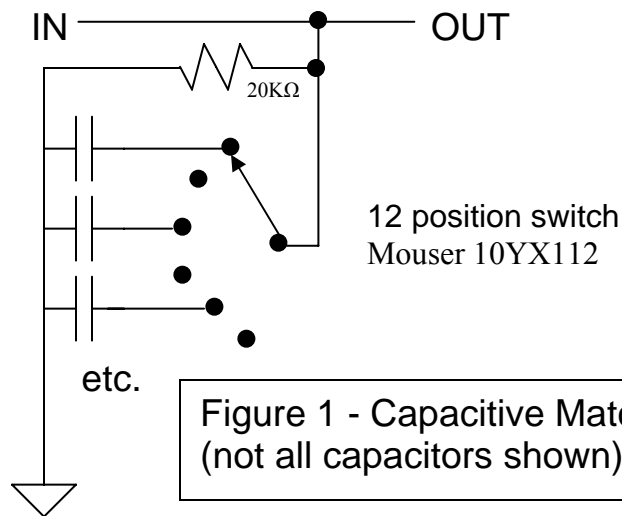
<u>QTY</u>	<u>Description</u>	<u>Source</u>
1	3/8x24x1-1/4" ss bolt	ACE
1	3/8x24 ss nut	ACE
1	12 pos rotary switch	Mouser 10YX112
7	mica capacitors, 300V min	Mouser Electronics

LMATCH Parts List

<u>QTY</u>	<u>Description</u>	<u>Source</u>
1	3/8x24x1-1/4" ss bolt	ACE
1	3/8x24 ss nut	ACE

XMATCH Parts List

<u>QTY</u>	<u>Description</u>	<u>Source</u>
1	3/8x24x1-1/4" ss bolt	ACE
1	3/8x24 ss nut	ACE
1	3/8 ss lockwasher	ACE
1	FT-114A-61 Ferrite Core	www.cwsbytemark.com
48"	#16 enameled wire	www.cwsbytemark.com



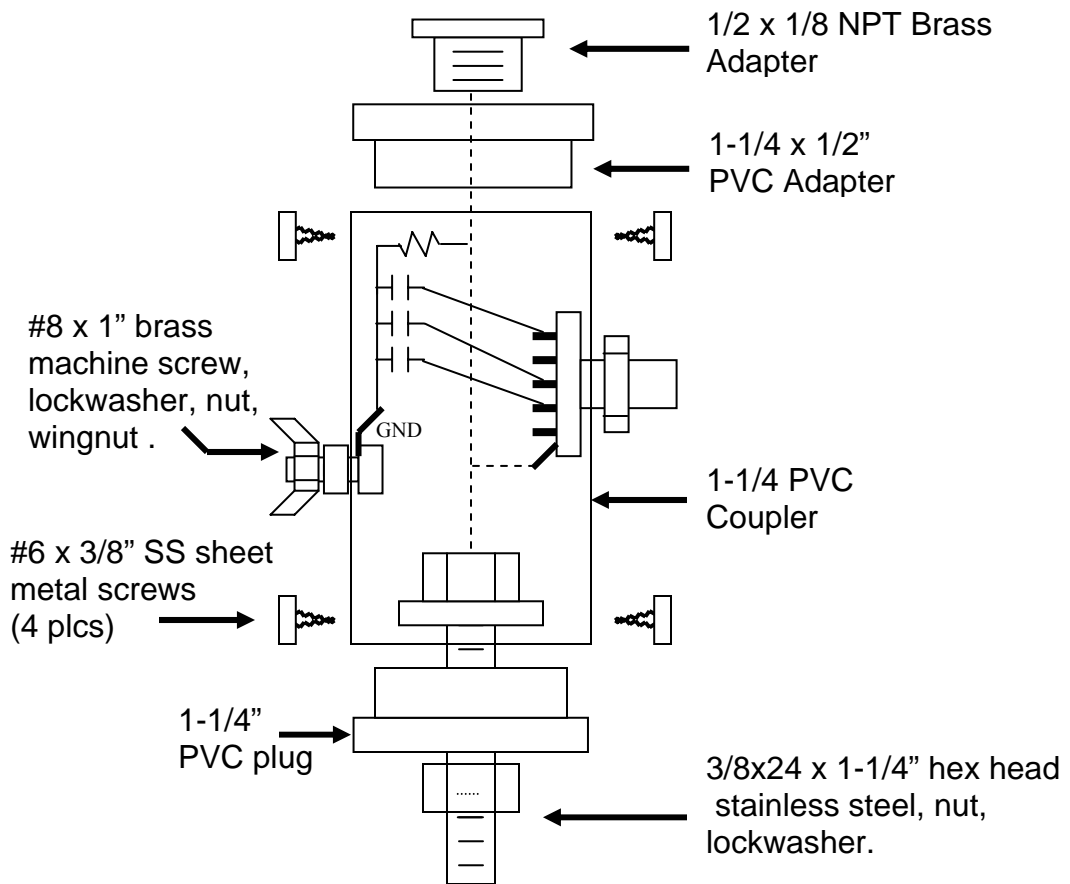


Figure 2 – Ball-Mount Capacitor Matching Assembly

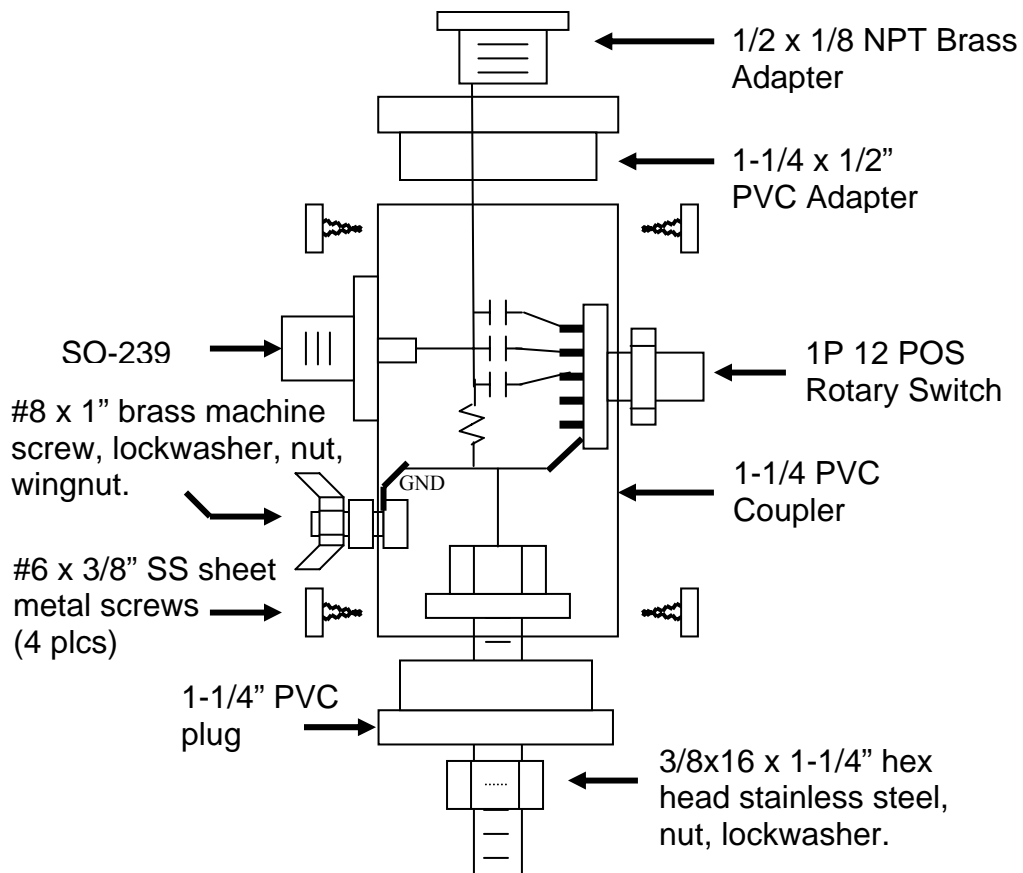


Figure 3 – Alternative Capacitor Matching Assembly

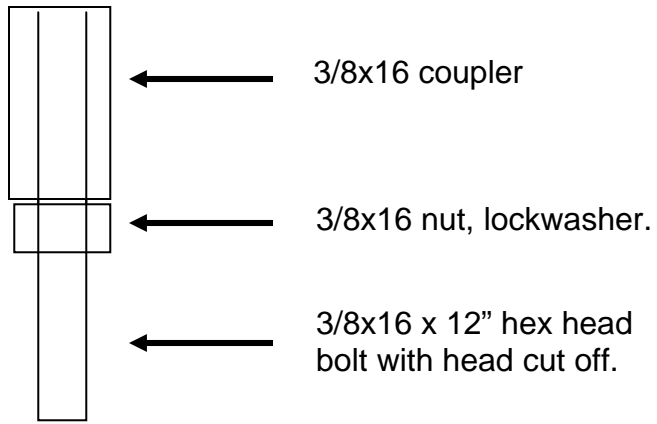


Figure 4 – Ground Mount “spike” Assembly

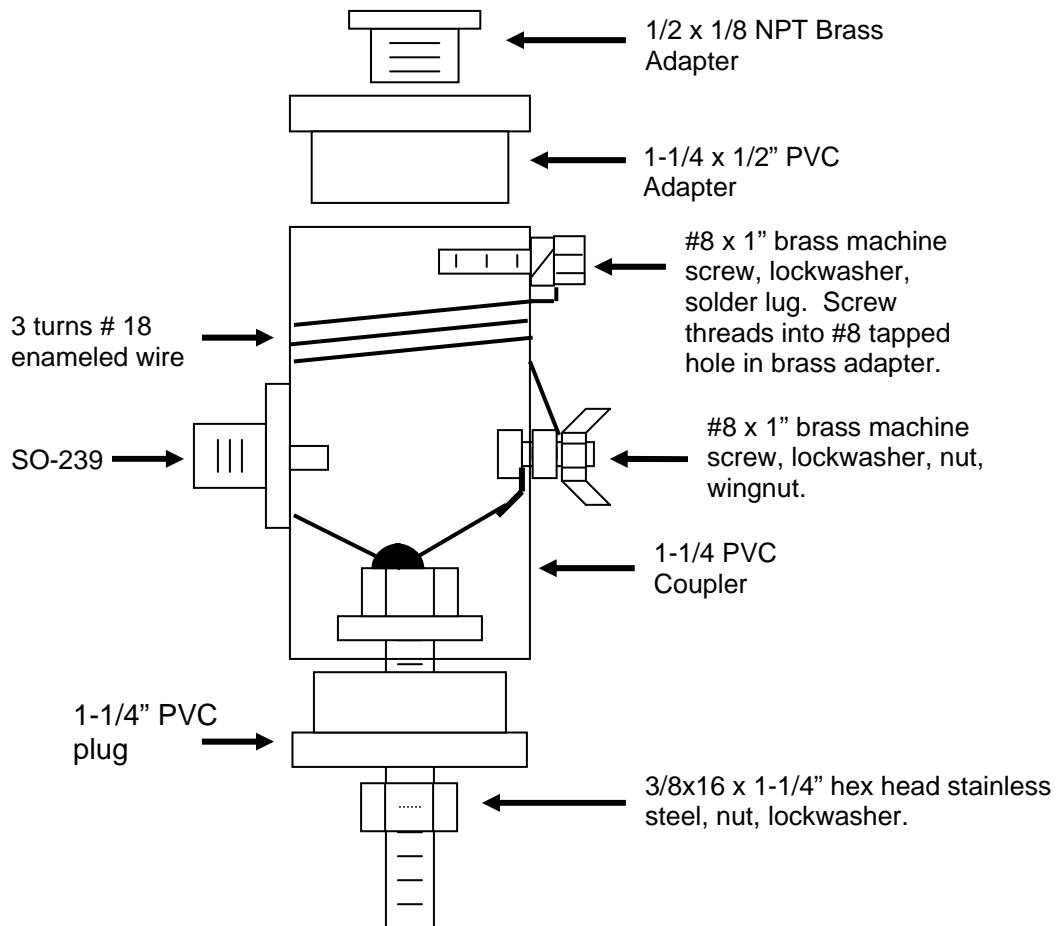


Figure 5 – Inductive Base Matching Assembly

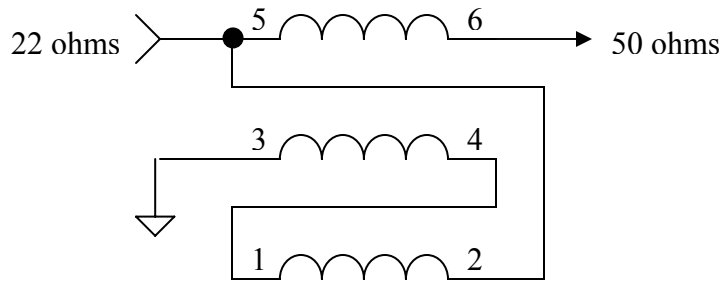


Figure 6 - 2.25:1 Broadband Matching Transformer.
6-turns tri-filar #16 enameled wires on FT-114A-61

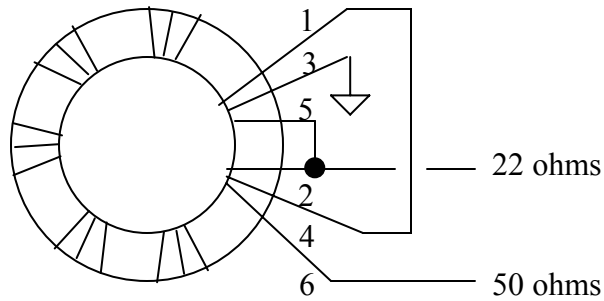


Figure 7 - 2.25:1 Matching Transformer Implementation

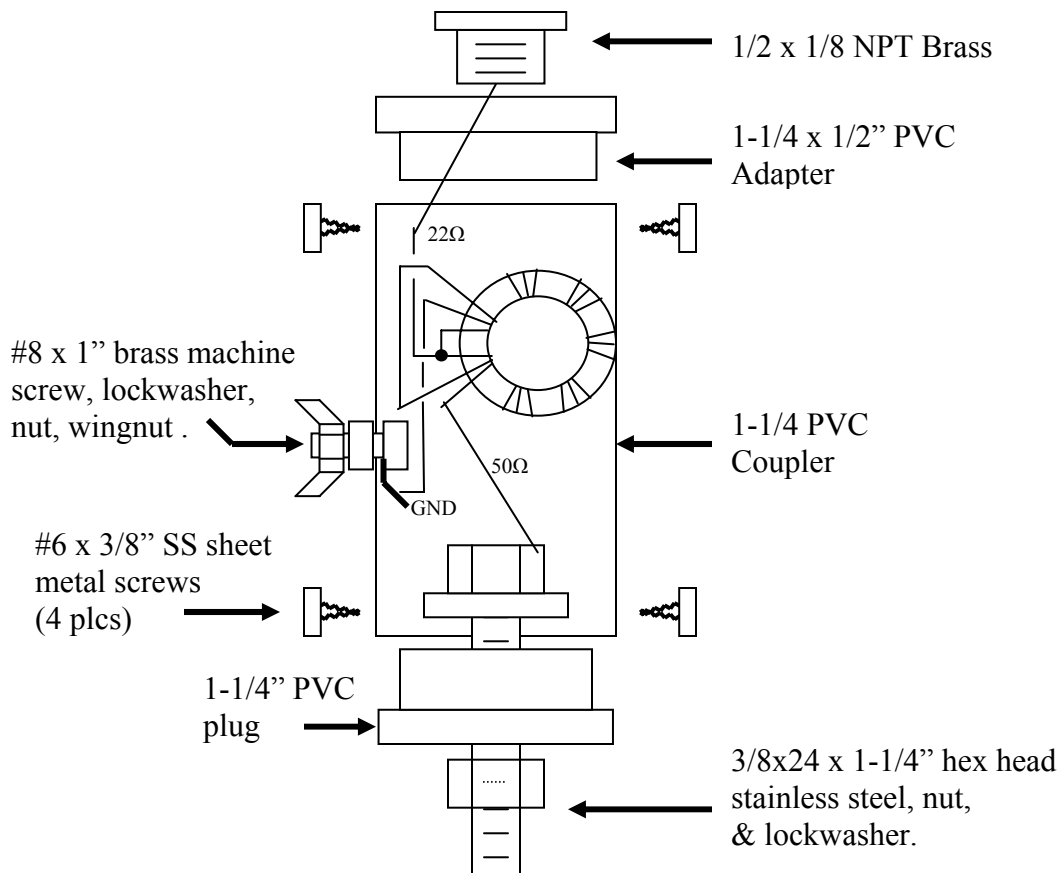


Figure 8 - XFMR Matching Assembly



Switch & Caps



Ball Mount Cap Front



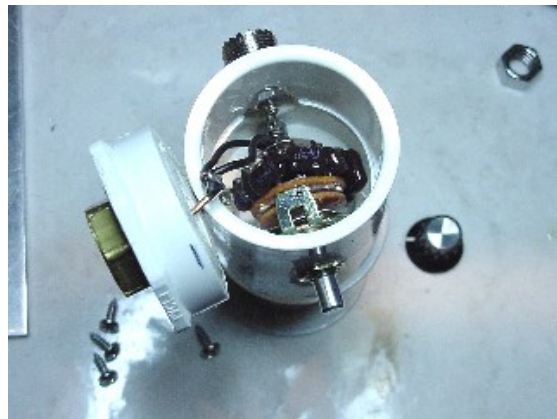
Ball Mount Cap Back



Ball Mount Cap Inside



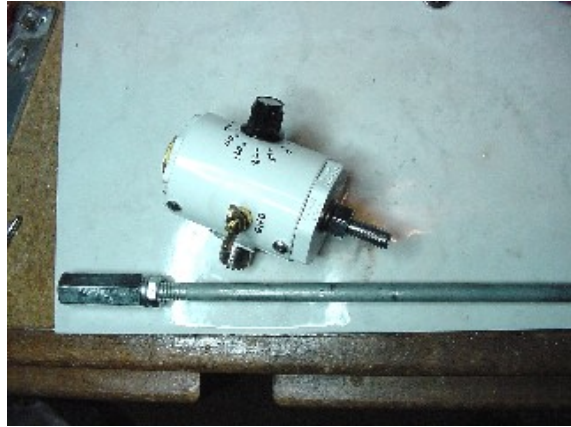
SO-239 Cap Parts



SO-239 Cap Inside



SO-239 Cap Outside



Base & Shaft



Front



L Side



Xmatch Inside



Xmatch Outside



Transformer