

## Switchable Multi-Impedance Matching Transformer for HF Antenna Matching Phil Salas - AD5X

### Introduction

Generally, HF mobile antennas are significantly shorter than a quarter wavelength, especially for the lower frequency HF bands. And, HF base station antennas also tend to be electrically short for the 80 and 160 meter frequency bands. As you probably know, the radiation resistance drops quickly with antenna length (it is proportional to the length squared). Therefore, you need to somehow match this low radiation resistance (plus ground and other losses) up to 50 ohms. There are several ways you can do this. Base capacitive or inductive matching techniques are very popular. In my case, I wanted the flexibility of a switched broadband multi-tap transformer. Jerry Sevik, W2FMI, published an article in the April 1993 issue of CQ Magazine where he added one tap to a tri-filar wound transformer permitting impedance ratios of 1:9, 1:5.75, 1:4, 1:2.25, and 1:1.44. This design, along with a 2P6T rotary switch, gives us a highly flexible, multi-impedance matching transformer that can be mounted in a small box.

### Transformer Design

W2FMI used a 1.5 inch diameter ferrite core with a permeability of 250. I chose a FT114A-61 torroid which is 1.14 inches in diameter and has a permeability of 125. This transformer will easily handle a 100 watt transmitter. And even though the permeability is low, there are enough turns at the lower frequencies to give us adequate transformer impedances due to the lower radiation resistances I am trying to match at these lower frequencies. I chose the 1.14 inch diameter core so that it would fit into a small aluminum box. I used a Bud CU-3000A aluminum box (2-3/4" X 2-1/8" X 1-5/8") available from Mouser Electronics (Mouser 563-CU-3000A). To wind the transformer, first take one wire and create a center tap as shown in Figure 2. Then place three wires together (I held them together by placing heat shrink tubing on either side of the tap) and carefully wrap the wires around the torroid starting from the center tap. I.e., place the center tap on the torroid and wind five turns on either side of it. Each non-tapped wire consists of 14 inches of #16 enamel covered wire. The center tapped winding consists of 16 inches of the same enameled covered wire.

Finally, I wired up the circuit as shown in Figure 3 so that I could easily switch through all the various impedance options. A Mouser 2P-6T rotary switch (Mouser 10YX026) accomplishes the switching of all impedances as well as a bypass or 1:1 position. Everything mounts nicely in the box as shown in the photographs.

### Applications

This very flexible impedance transforming box is ideal for quickly determining custom transformers you may wish to build for specific applications. As an example, when I mounted an Outbacker Perth antenna on my Geo Metro, I quickly found that a 1.44 transformer gave me a good 50 ohm impedance match across the HF bands. This implies that the Perth impedance, along with associated losses, is around 35 ohms. Now, the Perth has internal transformer matching that should give close to a 50 ohm impedance so I was surprised at this. However, I went ahead and wound a custom 1.44 transformer and have had great results with it.

Now for the interesting part. When I recently mounted this same Outbacker Perth on my Ford Explorer, I found that the Perth did provide a 50 ohm match without an external transformer. This seem implied that the ground losses on the Explorer were much higher (15 ohms or so) than on the Geo Metro! I didn't expect this. I use a Hustler ball mount mounted right on the side of my Geo, and a well-grounded hatchback mount on the Explore. I changed to a ball mount on the side of my Explorer, and the impedance dropped back to what it was on the Geo Metro. So – for what it's worth, the ball mount works much better than the hatchback mount.

### Conclusion

That's all there is to it. The W2FMI design, with the appropriate switch wiring, gives you a very flexible impedance matching transformer for many HF antenna applications.

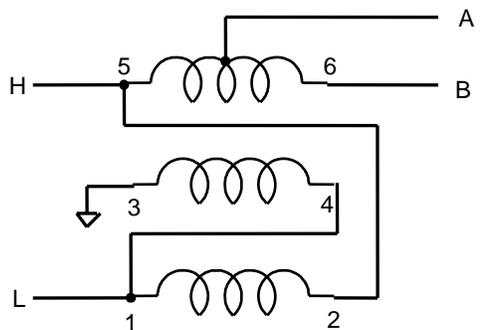


Figure 1 - Transformer Schematic

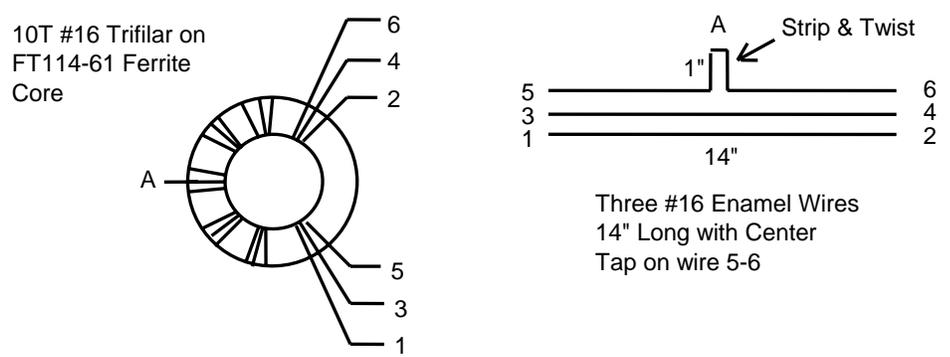


Figure 2 - Torroid Specifics

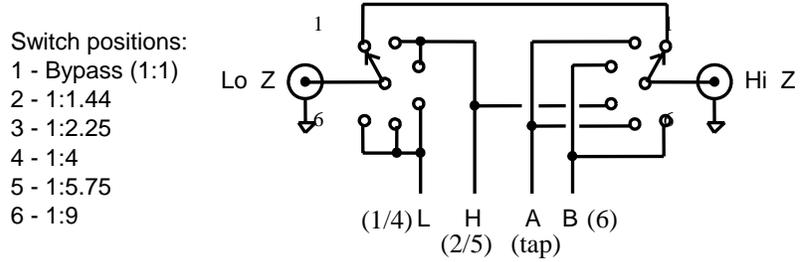


Figure 3 - Switch Box Wiring



Front View



Inside

