A simple home-brew project for the first-time builder.

A QRP random wire tuner unit.

By Matt Erickson, KK5DR

This project should be well within the abilities of most hams who wish to try it. I built this unit with low power portable field operations in mind, so, small size was the important factor in its design. When you are out at the camp site with your little QRP transceiver you may not have a resonate antenna for each of the bands you wish to operate on. A random wire is the most convenient and versatile antenna to use in such a temporary set up. A tall tree and a length of wire and your on the air. With nearly all random wire installations a matching/tuner unit is required to match the feed impedance to the 50 ohms the transmitter likes to operate into. The simplest of these tuners is the simple LC type network.

This project can be done in a weekend or two, depending on the builders focus and available time to work on it.

I hope the first time builder finds it enjoyable and also a big confidence builder that will encourage them to move up to bigger and more complex projects in the world of home-brewing.

Some of the parts required for this project are;

Enclosure: which can be any metal box you can find that is large enough to fit the internal parts you plan to use. However, a metal box is not an absolute requirement if you can not acquire one, you may use an old

home-brewers building method of using a wood board to build your tuner. Since this is a low power project (50 watts or less) a metal box is not required for shielding. I would not recommend the use of an unshielded box or board when building this type of tuner if it is to be used at power levels above 50 watts input. The higher power level requires a good shield to protect against RF feed-back and RF field exposure to the operator. For my box I used a ready made unit by Eagle, sold by Mouser, PN 40UB103, $10.32 each. There are a number of sources for enclosures, each is dependent on the users design requirements and wishes. Be sure you choose a properly sized enclosure which is usually determined by the internal parts, so selecting the internal parts first would be the way to start. When you have all the internal parts collected lay them out on a table and adjust then to sit like you plan them to be in the box. Be sure to allow enough spacing around each to prevent shorting and spacing for wiring. when you have done this, measure the length, width and height plus the extra space needed. With these dimensions you are ready to hunt for an enclosure that comes closest to your required size and style.

Variable capacitor: I planed to cover all bands from 160-10 meters with my tuner, so a total of 1000pF would be required, however, a variable cap of this size would have far too much capacitance to tune properly on 10m. A way around this issue is to use a smaller capacitance tuning cap and then switch in more and more fixed caps as the frequency of operation goes down. Spacing of the cap plates should be enough to withstand 500V, so the spacing could be as little as 1/64th/.0156" = .396mm, but 1/32nd/.0312" = .792mm is OK. The fixed caps that will be switched in, should be rated at 500V too. Small silvered-mica caps are the preferred type. My tuning cap is a 200pF constant curve type. It has a minimum capacitance of 11pF, so it should tune 10m nicely.

Inductor: The maximum inductance for 160m operation should be about 33-28µH. This can be had by a very small O.D. air coil, or by using a toroid inductor to keep the overall size very compact. I used a yellow mix toroid (2-50MHz) with an I.D. of about 3/4". Getting the inductance level right is a bit of trial and error. You will need an LCR meter to measure the inductance each time you try a configuration. I tried several cores and numbers of turns until I found a combination that works for me. Once you have a coil that has the correct maximum inductance, it will be tapped ever other turn to the switch which is then connected to the circuit.

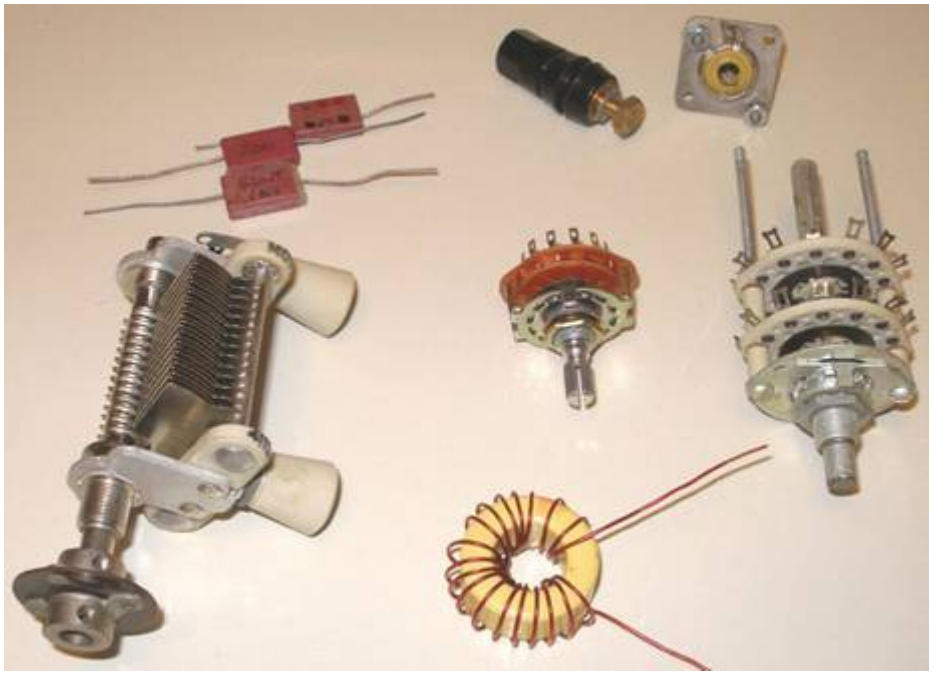
Rotary switches: I prefer 12 position rotary switches for tapping the inductor and fixed caps. These are small and can be had cheap from various electronic suppliers. You will need two.

Input coaxial port: You need one SO-239 or BNC bulkhead type connector for the RF input port.

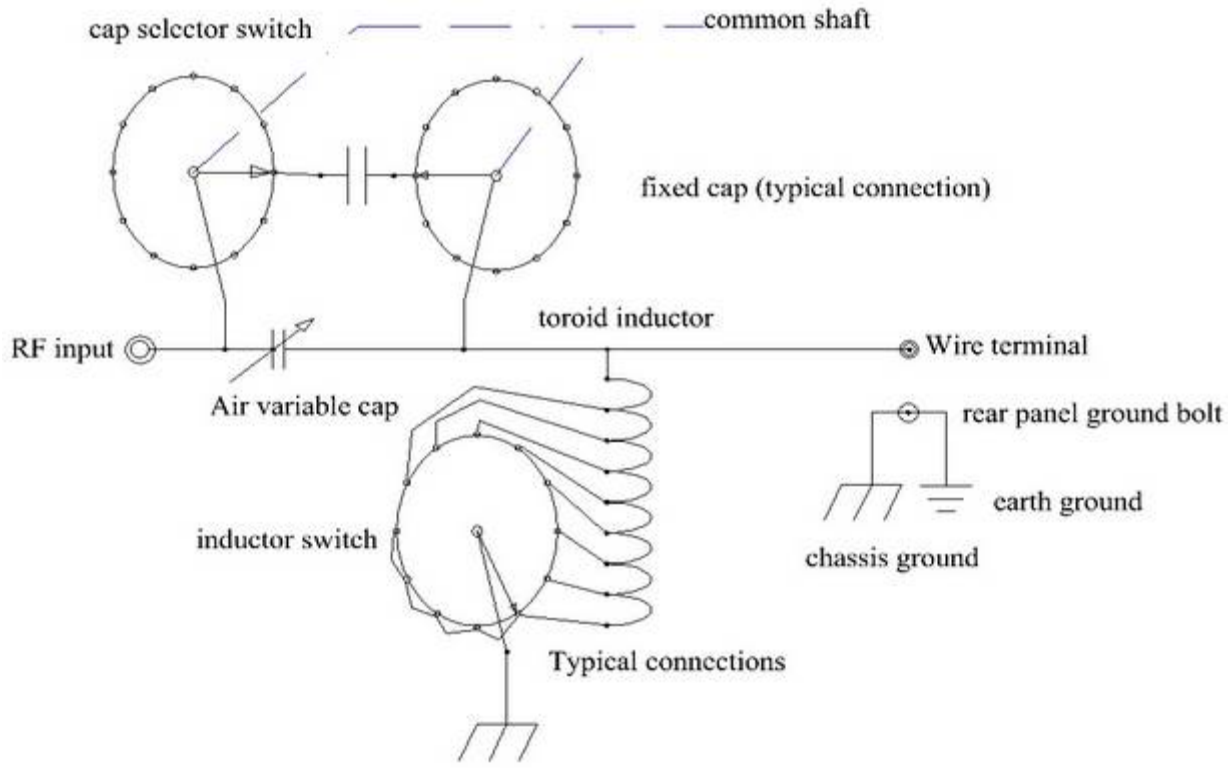
RF output port: A ceramic feed-through insulator or and small plastic type wire terminal can be used. Again, they must be able to handle 500V and not arc over.

Knobs: Here is where the builder can either be a good parts scrounger or you can just purchase a matched set of new knobs. The size and style of knobs you use is up to you and can vary widely. I suggest using a reduction type knob with calibration marks for the capacitor tuning control. This will make tuning much easier and repeatable.

The photo below shows some of the parts I have selected for this project.

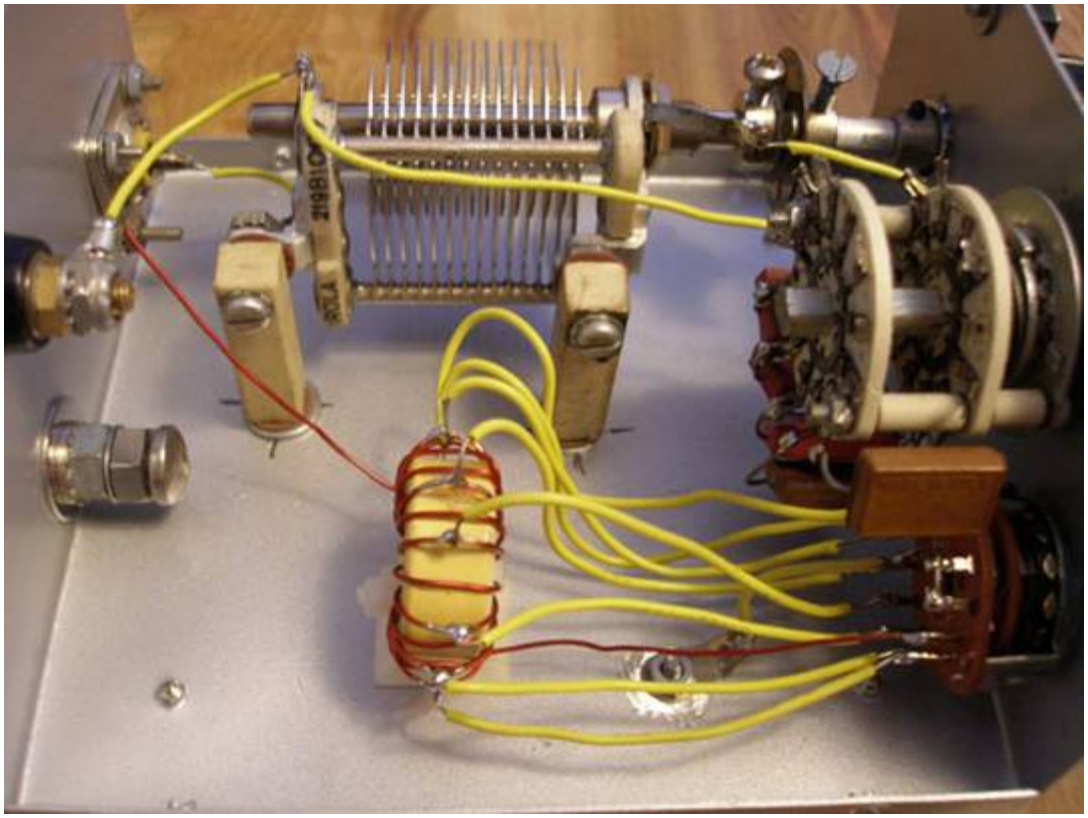


I chose a tuner design that is the simplest and has the widest matching range. This is a series C, shunt L type, seen below in the schematic.



You will notice that not all the connections are shown on the switches in the schematic. Not all the switch positions are used so I only displayed the typical connections. Wire size of 18 to 24ga. should be fine for the power level this tuner will operate on. On the higher frequency bands the air variable cap alone should be

enough for tuning, all fixed caps are disconnected. You will notice in the parts photo above that there are some insulators. These are required to isolate the tuning cap from the chassis. The shaft must be insulated as well. The fixed caps must be insulated from the chassis. I used a two bank ceramic switch for the fixed cap switch, this is because the cap has the highest RF voltage impressed on this part of the circuit, so this switch can withstand these higher voltages, it also helps to isolate the fixed caps out of the tuning circuit so stray capacitance is minimized. The inductor is connected to chassis ground through the selector switch. Each tap from the top to the bottom are for decreasing frequency operation.



The photo above shows the finished tuner internal arrangement and wiring.

The photo above shows the front control panel of the tuner. The large calibrated knob on the right is the variable tuning capacitor control with reduction drive. The knob in the middle is the selector switch for adding or removing fixed capacitors in the circuit. The position marked "out" removes all fixed caps from the circuit. The knob on the left side is the inductor tap switch, for selecting the desired tap point on the inductor and shunting it to ground.

The simple rear connection panel is shown in the photo above.

I used a felt tip pen to mark the panels. You can make more complex and expensive markings if you wish.

Now that you have built it, take it out into the field and try it! I suggest that you use an SWR analyzer to set it, then connect your QRP HF radio to it, and have some fun.

Things to remember when using this tuner;

Never put more than 50 watts into it!

Use the least amount of capacitance and inductance on 10 meters, and increase them as you go lower in frequency.

Use an SWR analyzer or outboard low power SWR bridge to aid in quick tuning.

Use at least 30 feet of wire for the radiator and the ground counterpoise. Several ground wires will make the radiation more effective.

Have fun building and using your little QRP tuner, but it might even help you when nothing else is working and you need to get on the air.

73 de Matt KK5DR