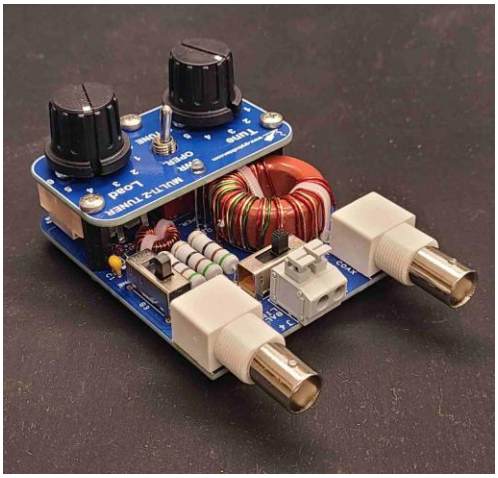
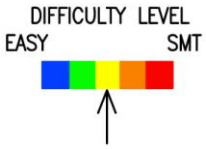
QRPBuilder Universal Multi-Z Tuner Assembly Manual





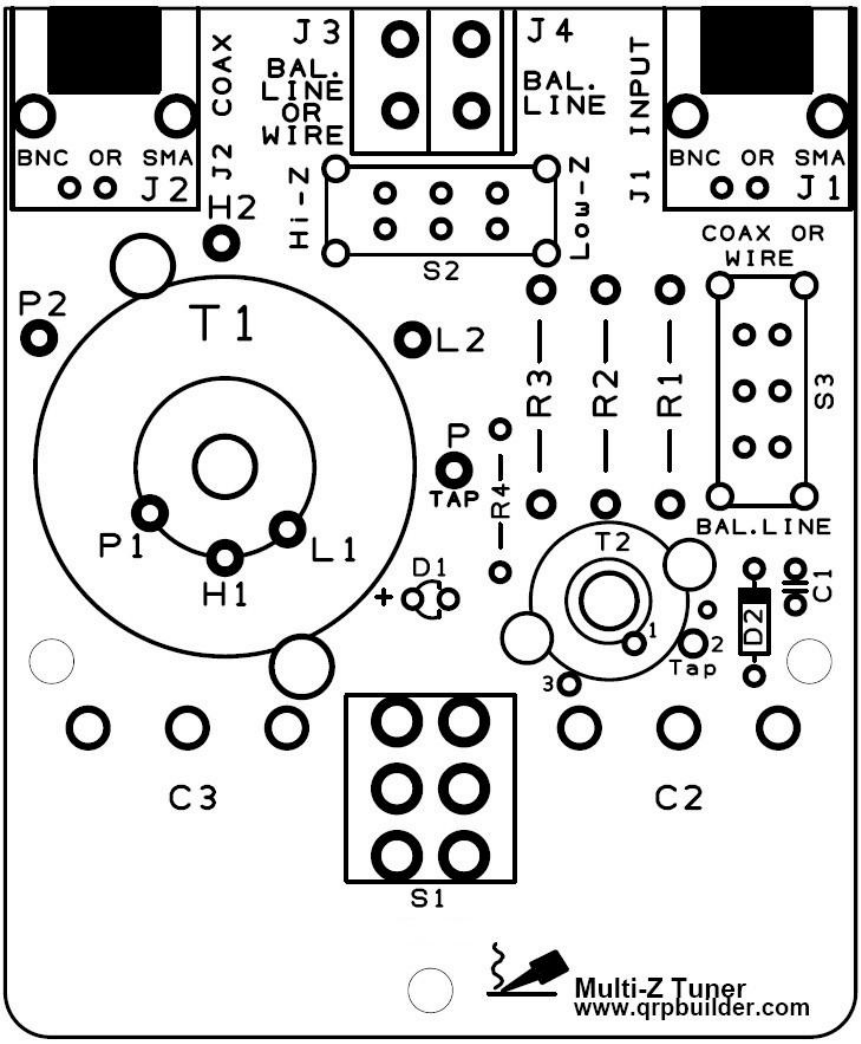
First, familiarize yourself with the parts and check for all the components. If a part is missing, please contact us and we will send one. To request a part, please use grpbuilder@gmail.com.

Please read the assembly instructions carefully before starting.

Parts List

1 – Multi-Z Tuner base pcb
1 – Multi-Z Tuner top pcb
1 – S1 - Toggle switch - DPDT
2 – S2, S3 - Slide switch – DPDT
1 – C1 - .1uF MLCC capacitor, marked 104
2 – C2, C3 - Polyvaricon, w/shaft and hardware
1 – D1 - Red LED w/clear lens
1 – D2 - 1N4148 signal diode, sm. glass, w/black band on one end
3 – R1, R2, R3 - 51 ohm 2W power resistor (green-brown-black-gold)
1 – R4 - 470 ohm resistor (yellow-violet-brown-gold)
1 – L1, FT37-43 toroid core (black)
1 – T1, T106-2 toroid core (red)
1 – 24” of 26AWG magnet wire
1 – 36” of red 22AWG magnet wire
1 – 24” of natural 22AWG magnet wire
1 – 18” of green 22AWG magnet wire
2 – Ø20mm control knob
2 - BNC pcb female horizontal connector
2 – SMA pcb female horizontal connector
1 – 2 position, pushbutton terminal block
3 – M3 plastic hex standoff
6 - M3 x 6mm long. S.S. Phillips screw
4 – Round self-adhesive rubber foot
4 – 1/8” plastic cable ties

Refer to the graphic below and the silk screening for the placement of the components.



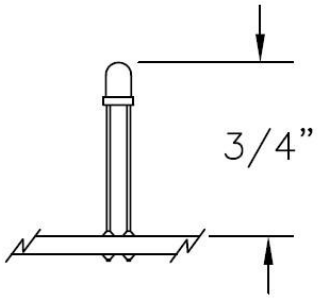
[ ] Install C1, .1uF MLCC capacitor, marked 104.

[ ] Install D2, 1N4148 signal diode, observing the black polarity band (cathode) matching the silkscreen band.

[ ] Install R4, 470 ohm resistor (yellow-violet-brown-gold)

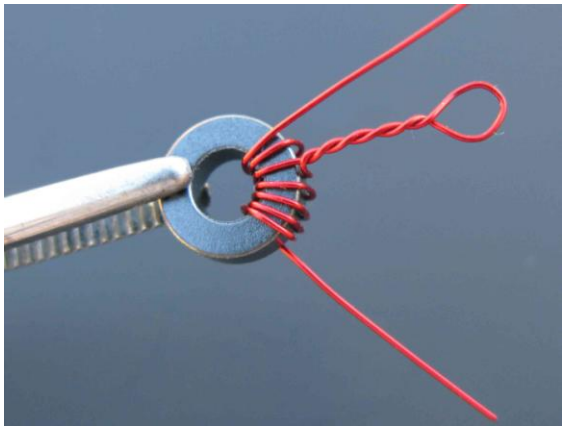
[ ] Install R1 – R3, 51 ohm, 2W, power resistors (green-brown-black-gold), or value is printed on the component. Mount them about 1/16” off the surface of the board to allow for air circulation.

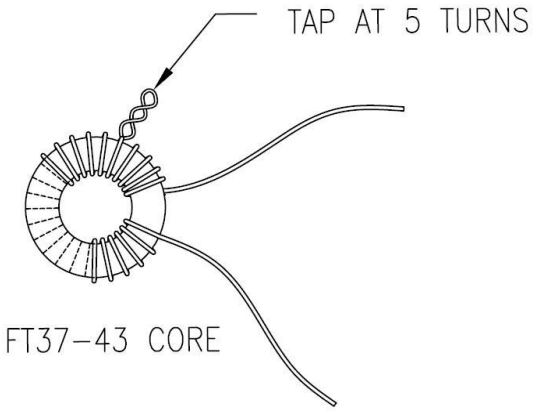
[ ] Install D1, the clear lens red LED measuring 3/4” from the top of the board to the top of the led. The long lead is positive and must be installed with the correct polarity as marked on the pcb.



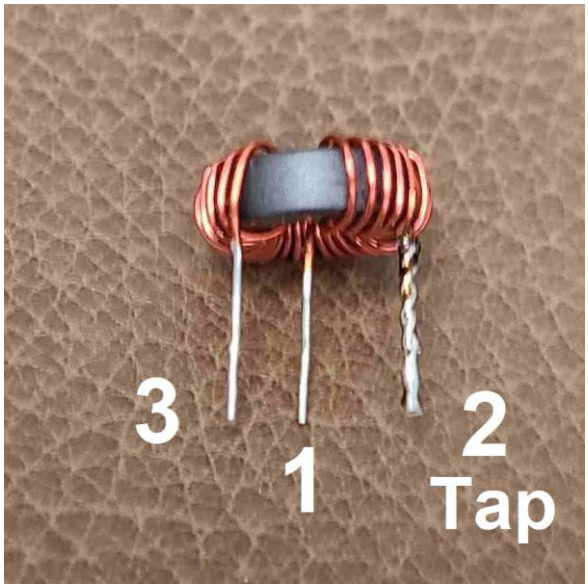
[ ] For T2, use the FT37-43 (black) core and the 24” of the thinner supplied 26awg magnet wire. You are winding a total of **25** turns, with a tap at **5** turns from the beginning of winding Remember, every time the wire goes through the center of the core, it counts as one turn. The picture and figure below shows the beginning of winding and the twisted technique for the tap. The total of 25 turns will completely fill the toroid.

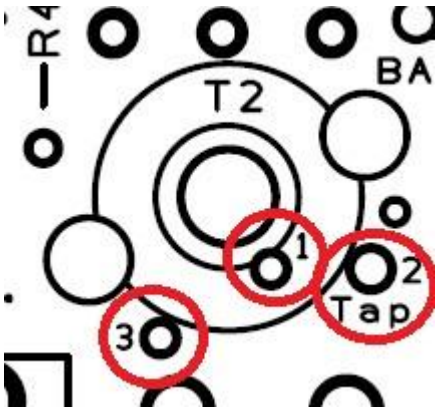
Note: *Now is a good time to mention a good way for counting the turns on small toroids. Many times on toroids with a lot of turns, you lose track going around. A good trick is to take a digital picture of it and blow it up on your computer screen. Counting is clearly a lot easier. Never cut until you verify the turn count. Too many turns is easy to fix, too few leaves only one option..*



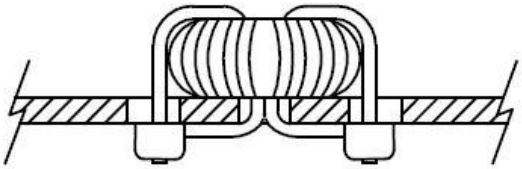


[ ] Bend the leads straight down, trim to 1/2” long, and tin the leads prior to soldering them to the backside of the board. The magnet wire supplied Is Thermaleze® brand and will tin with a hot soldering iron. Always tin the leads before trying to solder them in place and you will greatly eliminate any continuity problems. When installing do not pull the wires past where you have tinned them.





[ ] Solder T2 where indicated on the PCB, and centered on the silkscreen. You will notice the tap hole is indicated, and is slightly larger in diameter to accept the double twisted wire. Install the toroid flush with the top of the board. Do not elevate it off the board. You will be securing it with two tyraps as shown below.



[ ] Decide if you want to use BNC or SMA connectors and install J1,2, either the BNC female connector flush with the top of the board, and solder the two locating pins and two electrical connections or solder the SMA female connectors to the board edge.

[ ] Install S1, DPDT toggle switch. Solder one lug and check for squareness. Finish soldering the five remaining lugs. Discard the nuts and washers.

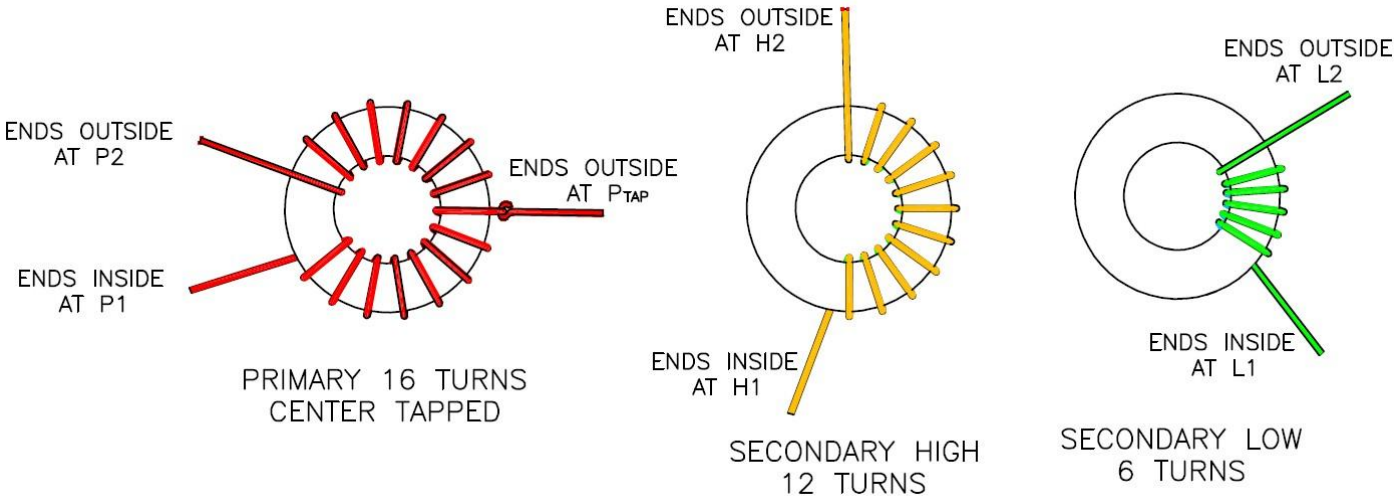
[ ] Install S2,3, DPDT switches where indicated, soldering all four corners and the electrical pins.

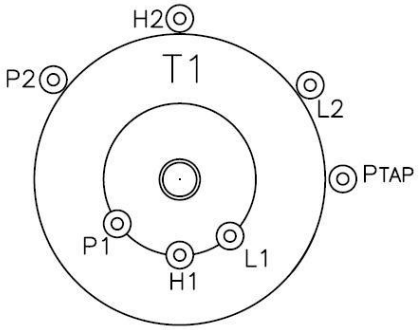
T1 preparation and installation

The next item to make and install is T1. Take your time and wind T1 carefully. It is difficult re-do. Make it look like the illustrations.

This T106-2 toroid has a 16 turn center tapped primary, a 12 turn secondary, and another 6 turn secondary. We have supplied three different colors of 22awg magnet wire to help you differentiate the windings. Proper winding of the transformer will result in the three different windings ending up at the correct positions on the PCB. The two secondary windings are on top of the primary winding. The graphic below shows the separate windings and how they are positioned on the T160-2 toroid. Please study the following figures and understand the process before you try winding the transformer.

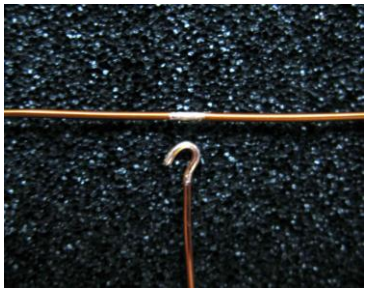
If a winding does not end up as shown below or is not wound in the same direction as shown below, the tuner will not work properly. Note that the ends of the windings must be over or under the core as shown below.

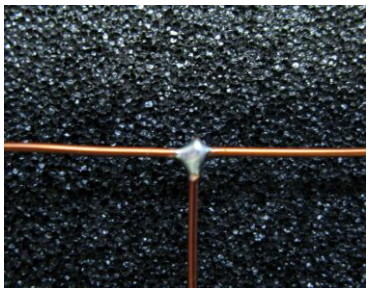




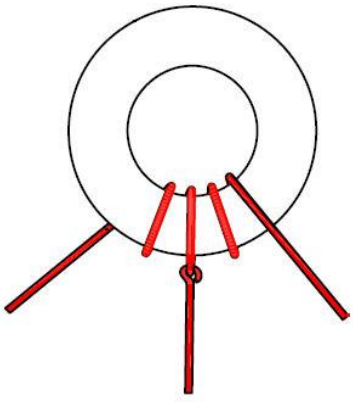
The seven pad positions for T1

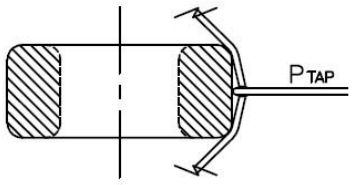
[ ] Prepare the primary wire as shown in the figure below. Cut 30” of the supplied **RED** 22awg wire and a 2” piece. Strip the insulation off of the 2” piece for 1/4” and make a small loop that will attach to the center of the 30” long section. On the 30” piece measure to the center (15”) and strip off the enamel insulation for 1/8” inch and solder the loop to the center. See photos below.

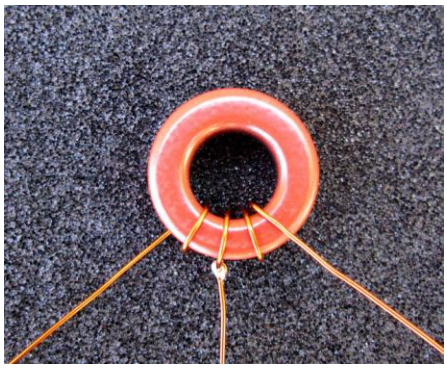


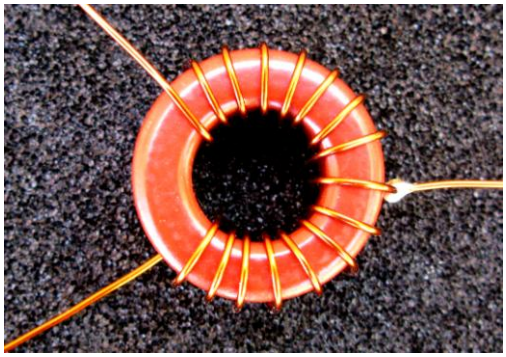


[ ] Start winding by positioning the tap halfway up the outside of the core and pass the right side winding **up** thru the center of the core and the left side winding **down** thru the center of the core. Wind a couple of turns in each direction and compare it to the graphic and picture below. All three windings will be done with this method. If it doesn’t look like this, stop and correct it. Wind a total of 16 turns, eight in each direction. Every time the wire passes through the core, counts as one turn



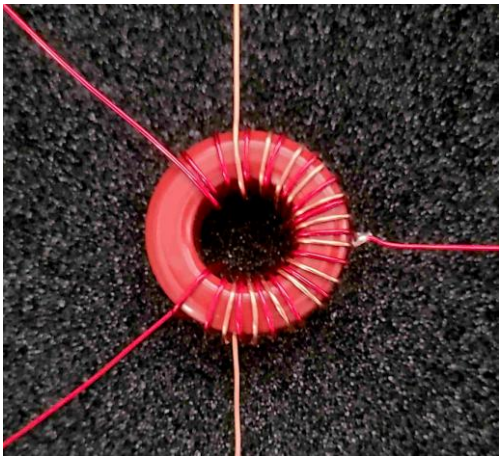






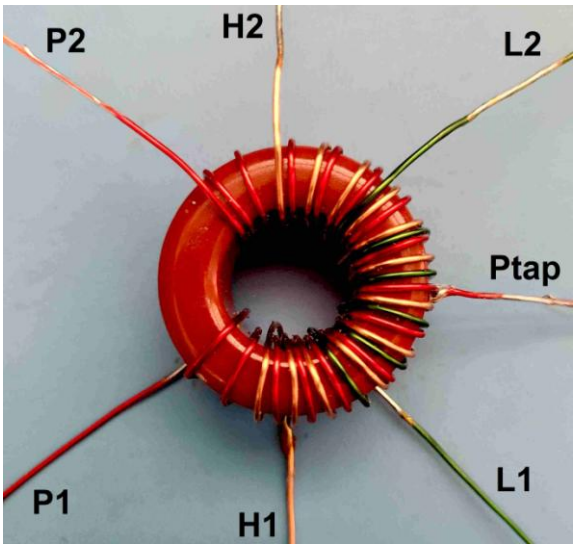
Completed primary winding, 16 turns

[ ] Cut a **NATURAL** color piece of the 22awg wire 22” long, mark the center at 11” with a marker And start with the center of the wire along one side of the tap, on the outside, and wind 6 turns In each direction. Wind the right side **up** thru the center and the left side **down** thru the center of the core. Space your winding out so that they end up 180º apart centered on the primary tap as shown below.



12 turn secondary added

[ ] Cut a **GREEN** color piece of the 22awg wire 13” long, mark the center at 6.5” with a marker and Start with the center of the wire along one side of the tap, on the outside, and wind 3 turns in each direction for a total of 6 turns. Wind the right side **up** thru the center and the left side **down** thru the center of the core. Space leads so that they end up ~90º apart centered on the primary tap as shown below.



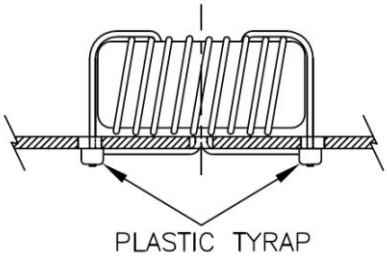
In the picture above, all the leads (P2, H2, L2) shown above the center tap should exit the core over the top of the toroid and all the leads (P1, H1, L1) below the center tap should exit under the toroid. When all these leads are bent down, they will line up with the lettered pads on the PCB. The leads P1, P2, and Ptap will be the red wire. H1 and H2 will be the natural color wire. L1 and L2 will be the green wire.

[ ] When you are satisfied you have followed these instructions you may bend the leads down, strip the enamel, and tin the leads. **P1**, **H1**, and **L1** pass through the PCB on the inner diameter of the toroid. **P2**, **H2**, **L3**, and **Ptap** pass through the PCB on the outer diameter of the toroid.

Note: Do not trim all the leads the same length. It is difficult to align 7 leads simultaneously. Trimming them different lengths make insertion much easier. Before soldering, if you lose absolute confidence in the name of the leads, verify their identity with an ohmmeter before proceeding. Also, be careful not to pull the leads through the holes past where you have stripped and tinned the insulation.

[ ] Position the toroid flush with the top of the board, solder, and trim the leads flush.

[ ] Secure toroid to the pcb with two tyraps as shown below.

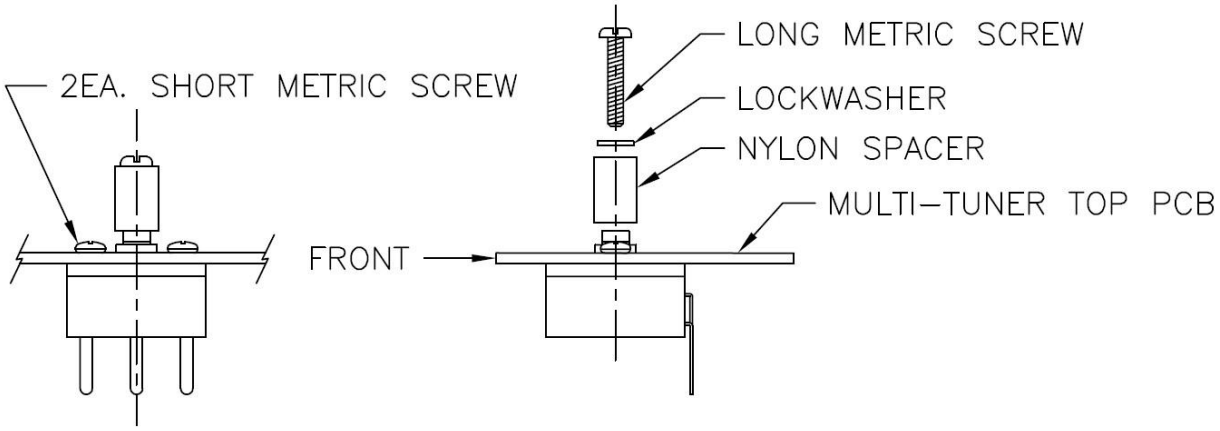


Polyvaricon installation

[ ] Adjust the two trimmer caps on the back of each polyvaricon to their *minimum* value as shown below.

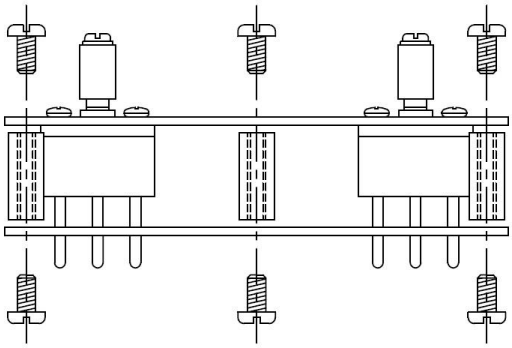
Set for minimum engagement

[ ] Install the two polyvaricon capacitors to the Multi-Z Tuner top pcb using the hardware shown below. The leads of the polyvaricon will install to the rear of the pcb.



[ ] Refer to the graphic below and install the three plastic hex standoffs to the base pcb using three of the M3 x 6mm screws from the bottom.

[ ] Install the top board/polyvaricon assembly onto the three standoffs. Route the polyvaricon leads through the base pcb holes, and align the led and toggle switch to protrude through the holes in the top board. The switch and LED are not shown for clarity. Secure the top with the three remaining M3 x 6mm screws.



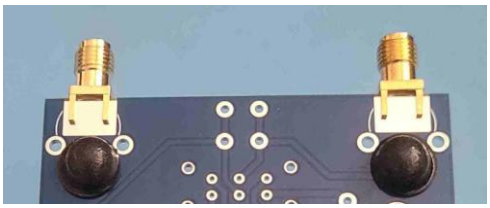
[ ] Solder the six polyvaricon leads and trim flush with the bottom of the base pcb.

[ ] Install the instrument knobs.

The instrument knobs are inspected 100% for the small shaft set screw to be present, however in shipment, they can vibrate out of position. Carefully check the contents of the sealed pouch if yours is not in the knob.

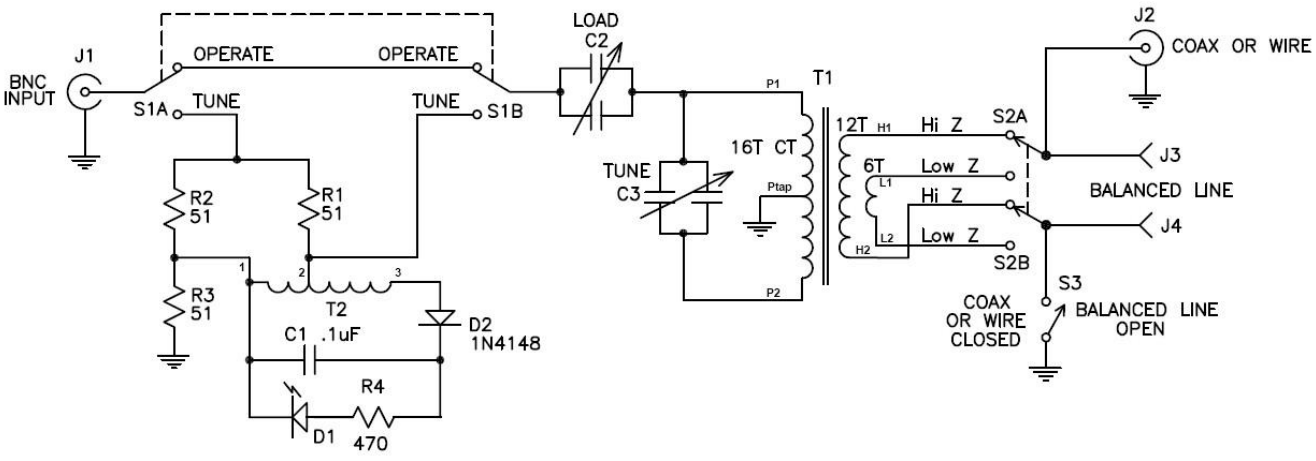
[ ] Apply the self adhesive rubber feet to the bottom of the tuner at the four places indicated by the silk screened circles.

If you chose SMA connectors, place the rear bumpers as shown below.



This completes the assembly.

Schematic:



The QRPBuilder Universal Multi-Z Tuner can be used with a wide variety of Hi-Z and Low-Z impedance antennas and feed lines. Matching the Hi-Z/Low-Z switch to your antenna type, reduces the load on the tuner and improves the efficiency.

Examples include:

Hi-Z antennas

E.F.H W. antennas
Random wire/Long wire antennas
Folded Dipole antennas

Low-Z Antennas

Half Wave center fed dipole antennas
Inverted Vee antennas
Quarter Wave Vertical antennas
NVIS dipole antennas

The basic feed lines are accepted, Coax (unbalanced) 50Ω and Parallel-Conductor line (balanced) 400-600Ω.

Tuner usage

The tuner is rated at 5W CW, 10 watts PEP max. and incorporates the N7VE LED absorption bridge circuit for sensing SWR. In the TUNE position, you cannot damage your transmitter caused by a high SWR. The worst your transmitter is looking at is a maximum of 2:1 SWR in the TUNE position. The LED is only showing reflected power. At full brilliance your SWR is 4:1 or greater, at half brilliance your SWR is approximately 2:1, and the LED will completely extinguish at 1:1. *Tip from Dan…If your led does not completely go out at 1:1 there may be a little too much gain on L1, the indicator transformer. Just reduce the turns on the side of the tap with the most turns, one or two turns.*

Adjusting for a wire antenna match

With your transmitter and antenna connected to the tuner, set the tune/operate to the tune position. Set the adjustment knobs to the center position. Note: Tune mode, maximum continuous power Input – 5W.

Place the HI/Low impedance switch in the Hi position. The Hi impedance setting provides the most efficient coupling and operation. Briefly key your transmitter and attempt to adjust the knobs to dim the LED. Continue adjusting back and forth until the LED is out or is as dim as possible. If the adjustments do not produce adequate dimming of the LED switch to the Low impedance position and repeat the adjustment process. Note: Under some conditions of match adjustment the LED will not go completely out. Your antenna will be tuned for proper operation even if the LED does not dim completely out. Switch the tune/operate switch to the operate position.

Use all the normal cautions throwing wires up in the air near power lines.

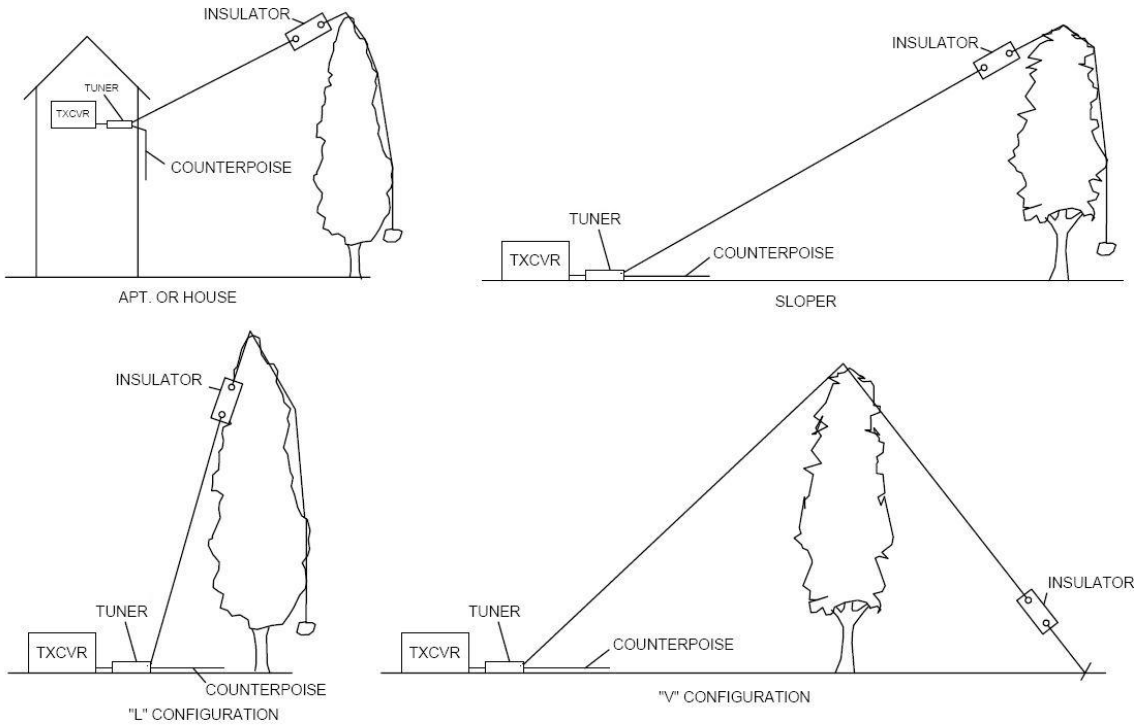
If you use a counterpoise wire, connect it to J4 (ground), with S2 in the “WIRE” position and lay it out in a straight line, 180º from the antenna wire when possible. Any length that is non-resonant to your frequency is best. I usually use 10ft. or 20ft.

Additionally, after the antenna is tuned up, keeping the bridge in the circuit, “Tune” position, will reduce the power by a factor of four to a matched antenna. This can occasionally be useful when trying to bring a 3w QRP transmitter to under the 1w level for certain sub-one watt contest multipliers.

Even with low power, many antennas can produce feed line radiation causing false, erratic swr readings, and poor performance. To eliminate feed line radiation, use a choke or 1:1 balun. Install at the end of your coax, where it connects to the antenna.

Feed line radiation refers to the phenomenon where the transmission line connected to an antenna radiates energy, which can cause interference and affect the performance of the antenna system. This radiation can occur at any power level when the feed line becomes part of the radiating system. It is important to minimize feed line radiation to ensure efficient transmission and reception. Techniques such as using a 1:1 balun or feed line choke can help minimize this effect.

This is an example of a simple feed line choke using a few turns of RG174 coax through a clamp-on ferrite.



Notes: