

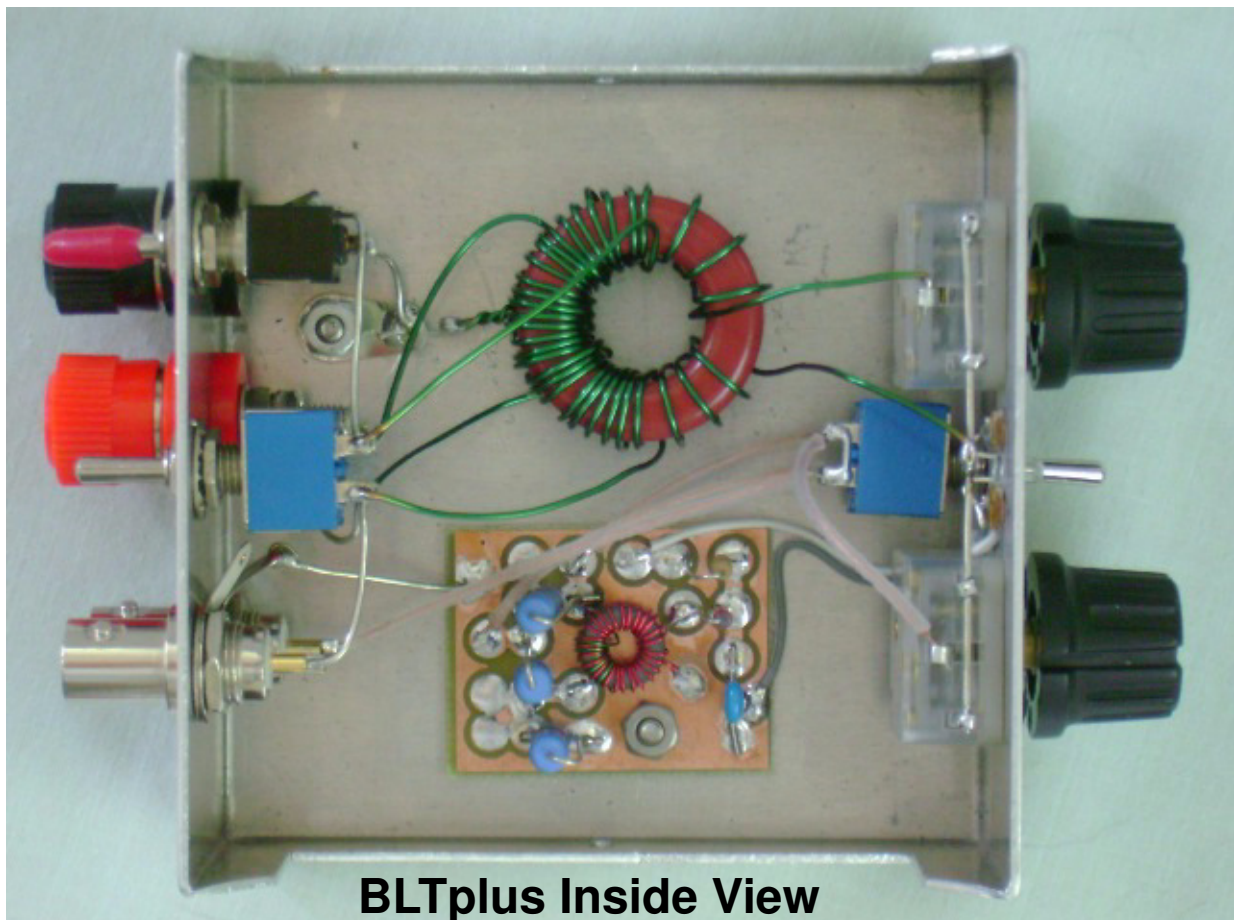
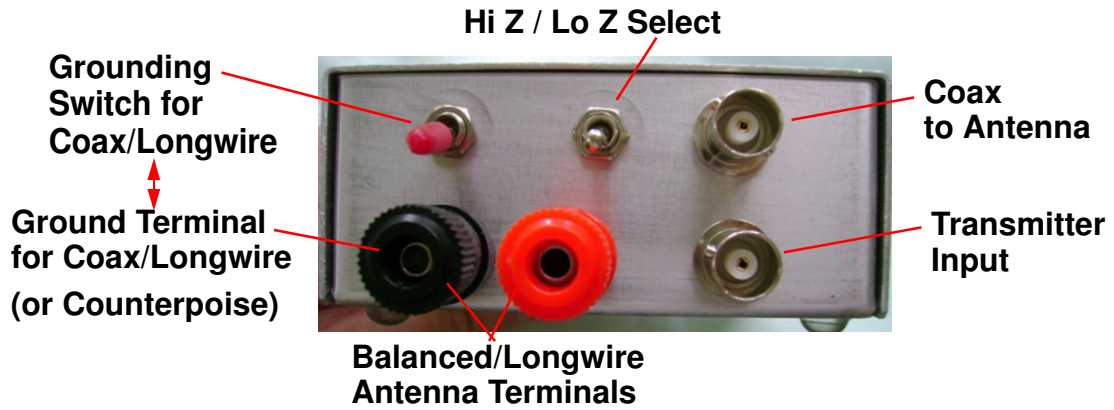
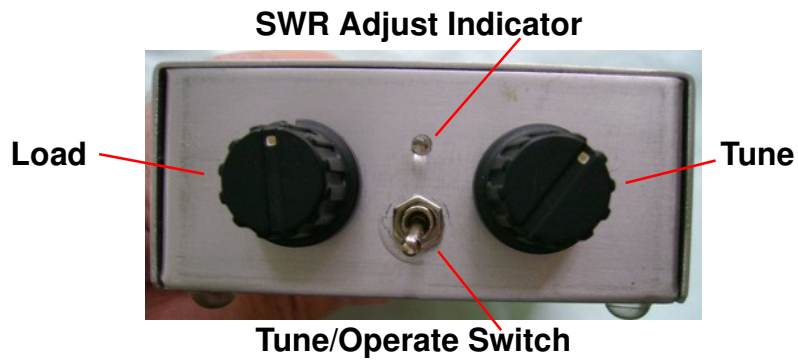
Hendricks QRP Kits

Affordable QRP kits at exceptional value

BLTplus



Assembly and Operation Guide



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Manual prepared by W5USJ

Hendricks QRPKits BLTplus

Hendricks QRPkits BLTplus is the second generation of the popular NorCal/Hendricks BLT kit. New features include:

- Revised prepunched enclosure
- Coax/longwire ground switch and additional BNC connector
- Larger stronger balanced line/long wire binding posts

Background

The following is an updated version of the background section written by Doug Hendricks for the original NorCal BLT manual.

NorCal's original BLT was designed by Charlie Lofgren, W6JJZ who is renowned in the QRP world as a z-match tuner expert. Charlie has built all the tuners used by the Zuni Loop QRP Expeditionary Force for years. They all swear by them.

The original tuner was a balanced line tuner only, and would not work with coax feedlines unless modified as shown in the mods section of the original manual. It worked great with open wire feeder, ladder line, zip cord and even computer ribbon cable. As long as you used balanced line as a feedline, the BLT would work.

Charlie designed the tuner to work specifically with the polyvaricon variable capacitors that used to be sold by Mouser. I asked him to design it at first because I wanted a simple tuner for a presentation that I was doing at the Ft. Smith QRP Group Forum, ArkiCon 2000. It turned out so well that everyone who saw it wanted one. Thus the NorCal W6JJZ BLT kit was born. I would like to thank Charlie for his efforts on behalf of NorCal. This one is going to be a classic.

The design is for a classic Z-Match using inductive coupling with L1, L2 and L3 wound on a single T106-2 toroid. L2 or L3 is switched in and out of the circuit by switch 2 located on the back panel of the tuner. The "high" and "low" positions on the switch for the output links may need clarification. The positions are for "high" and "low" in terms of impedance not frequency. For a given band and antenna try the High Z link first and use the Low Z link only if a match can't be found with the high link. (Often either link will allow a match. In these instances, the High Z link produces better efficiency as a result of loading the tank circuit more heavily.) [Better coupling]

The circuit also includes the famous N7VE LED SWR indicator circuit. Dan Tayloe invented this several years ago and it has proven a great addition to the QRP fraternity. This allows us to have an indication of lowest SWR on the

tuner (indicated by the dimming of LED going out at minimum SWR).

The circuit also includes an absorptive bridge which means that your transmitter sees a 50 Ohm load as you are tuning up. This will help to save your final transistors! This tuner is rated at 5 Watts. I doubt if the polyvaricon caps will take the 100 Watts of your big rig! Now, lets get started to build the kit. First of all, you will need the following tools: 25 – 30 Watt soldering iron, drill, 1/8" bit, small Phillips screw driver, small blade screw driver, pliers, diagonal cutting pliers, needle nose pliers and about 4 feet of #24 solid insulated hookup wire. A Volt/Ohm meter is helpful also. Please read the manual in its entirety before you start building. You may want to print out the schematic, parts layout, parts list [LOM] and wiring diagram.

Note: Update meters to include Digital Multi Meters (DMMs).

Parts Inventory

Before starting the assembly, inventory the parts and verify that you have the parts described in the following list of materials (LOM).

List of Material

C1 – 0.1uF Ceramic
C2, C3 – 150/60 pF Dual Polyvaricons
D1 – 1N34A
D2 – LED Super Bright, Red, Clear
R1, R2, R3 – 51 Ohm, 5%, 1 Watt — Green Brown Black Gold
R4, 470 Ohm, 5%, 1/4 Watt — Yellow Violet Brown Gold
SW1, SW2 – DPDT Toggle On/On
SW3 – SPDT used as On/Off or SPST On/Off
J1, J2 – BNC Jacks, Single Hole Mounting
J3, J4 – Red and Black Binding Posts
T1 – 5t Primary, 25t Secondary Wound on FT37-61 Toroid
T2 – 16t Primary Center Tapped, 12t Secondary 1, 6t Secondary 2
Wound on T106-2 Toroid
4ea – 3x2.6mm Pan Head Screws
2ea – 12x2.6mm Pan Head Screws
2ea – 1/4 x 3/8 Nylon Bushings
18 inches – #26 Red Wire
18 inches – #26 Green Wire
6 feet – #22 Green Wire
2ea – Black Knobs
1 – #4 Internal Tooth Solder Lug
2ea – 4/40 x 1/4 Panhead Screws
2ea – 4/40 Nuts
4ea – Bumpers/Feet
Prepunched Enclosure
Panel Decals

Additional materials needed for assembly:

12 inches – #22 Bare Hookup Wire
3 feet – #22 Insulated Hookup Wire
A/R – Solder

Note: Some supplied parts may vary from those shown in the pictures but will work the same

Prepare Enclosure

Steps included in this section are not required to build the kit. However, cleaning up the machine shop residue on the enclosure and the tooling marks will produce a more attractive finished kit.

Degrease Enclosure

Machine shop processing residue can be remove most simply by washing the enclosure with a mild detergent. Dishwashing liquid will work fine. Dry thoroughly.

Tooling Mark Cleanup

Punching and forming from the machining process leaves die marks in the aluminum surfaces. Light sanding will remove them and produce a cleaner look.

Brushed Finish

Use a 100 grit wet/dry sandpaper for a coarser finish that resembles a brushed aluminum appearance.

Satin Finish

Use a 200 grit wet/dry sandpaper for a finer finish that resembles a satin aluminum appearance. You might want to choose a satin finish if you also want to paint the enclosure.

Clean the sanding residue from the enclosure surfaces when you finish.

Painting

Once the surfaces of the enclosure are prepared and cleaned, you can apply paint of your choice. If you decide the leave the aluminum unpainted, you still may want to keep it looking nice. A clear coat of a satin finish could be applied to prevent fingerprinting and oxidation.

Labeling

If you choose to label the tuner, consider the method you would like to use before starting the parts assembly. Full panel labels or individual stick-on labels will require a different approach.

Layout and Drill Holes

Why aren't these holes pre drilled? Well, it would have required an expensive major tooling change for the punches. Most kit builders have the tools necessary to drill a couple of small holes. So it seemed reasonable to have the kit builder take care of this part of the enclosure fabrication.

Locate and drill two 1/8 inch diameter holes as shown in Figure 1 below. One for the ground lug and one to mount the SWR bridge PCB.

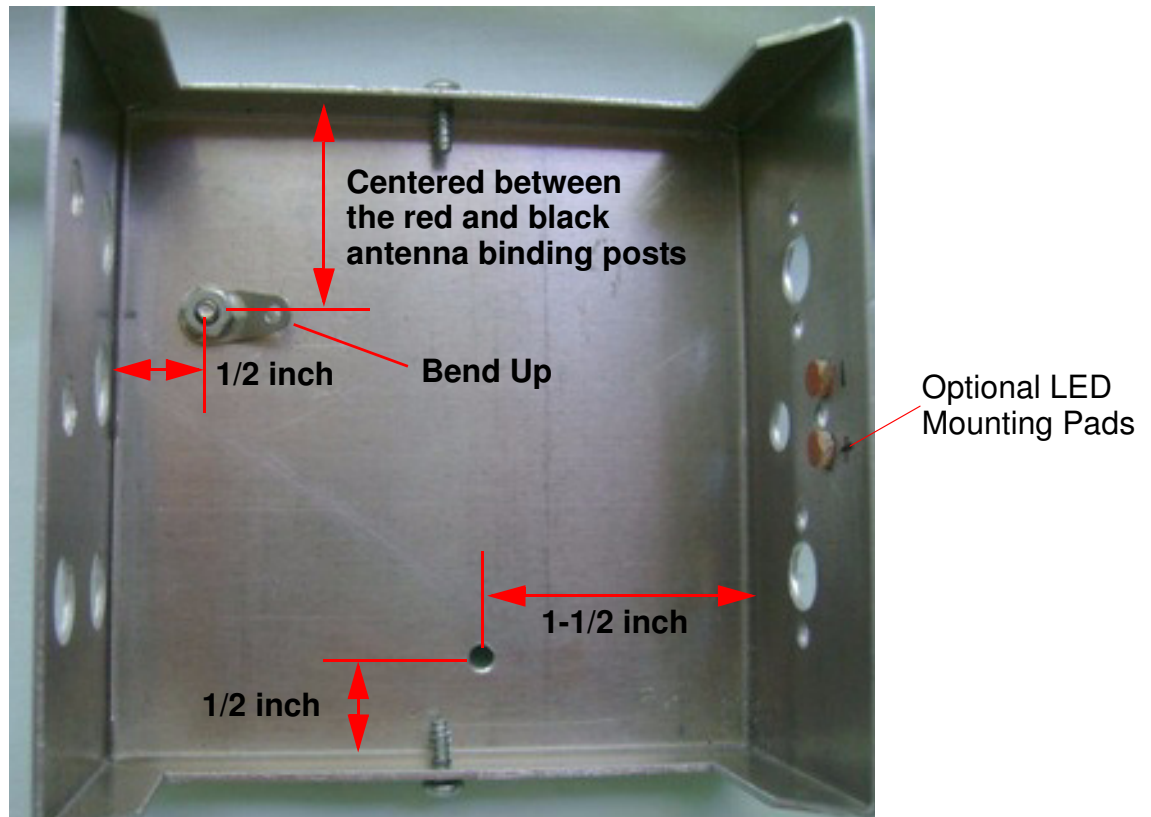


Figure 1 Layout and Drill Holes

Note: The cover screws are shown in place to ensure clearance with parts mounted inside when the cover is attached.

Attach Ground Lug

Using a 1/4 inch 4-40 screw, 4/40 nut and internal tooth ground lug, install and orient as shown in Figure 1 above.

Affix Feet/Bumpers

Affix a foot/bumper at each of the four corners of the enclosure bottom.

Affix Optional LED Mounting Pads

Using two small PCB pads and a dab of jelled super glue, affix the pads adjacent to the LED mounting hole as shown in Figure 2 below.

Position the pads slightly above the center line of the LED mounting hole.

Round punched pads are not required. You can clip small squares or rectangles from a larger PCB. Observe the clearance requirements in any case.

Polarity is marked for convenience when the wiring is connected.

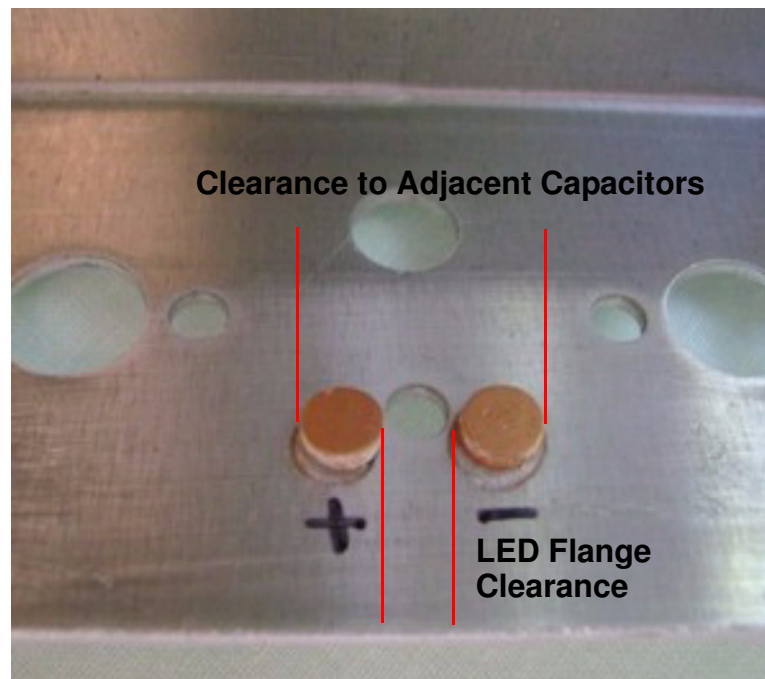


Figure 2 LED Solder Pads

Note: If you choose to wire direct to the LED, the steps to attach wires to the SWR bridge PCB will be found on page 17 of this manual.

Assemble Back Panel

Assemble the lower row of parts on the back panel starting with the black binding post. Note the orientation of the solder lugs.

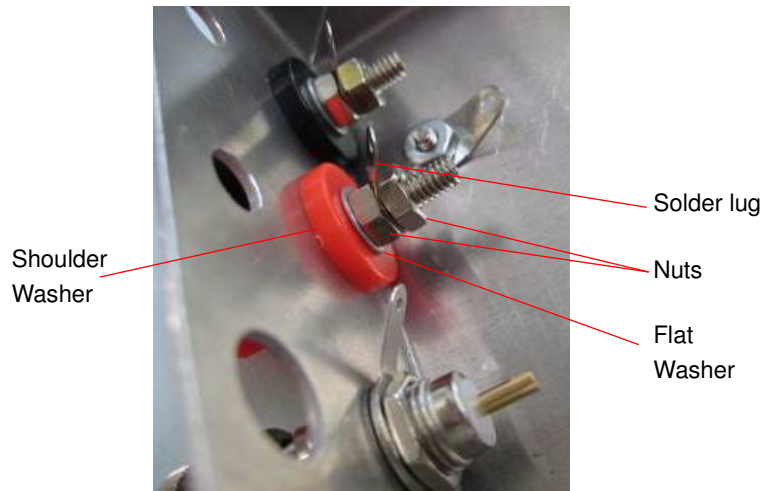


Figure 3 Backpanel Assembly

The assembly sequence used here will facilitate tool use and wiring.

Start the assembly with the black binding post. Then the red post and finally the lower coax connector. Also see Figure 4 below.

Black Post – disassemble the parts then reassemble in reverse order except for the two nuts and solder lug. Place the solder lug between the two nuts. Orient the solder lug about 45 degrees toward the outside of the enclosure.

Red Post – same procedure except orient the solder lug about 45 degrees in the opposite direction.

BNC connector – assemble with the lock washer next to the panel under the solder lug to ensure a good ground. Orient the solder lug toward the red post. It helps to use a BNC connector as a holding tool during the assembly.

DPDT switch – Assemble the top row starting with the middle DPDT switch. Adjust the position of the nuts and lock washer such that there are about two threads showing when the nuts are tightened.

SPST (or SPDT) switch – assemble in a similar fashion.

BNC connector – assemble in a similar fashion to the lower connector. Orient the solder lug toward the DPDT switch.

Wire and Solder Back Panel

Using short lengths of bare hookup wire, connect the binding posts, switches, coax connector and ground terminal as shown in Figure 4 below and the wiring diagram on page 28.

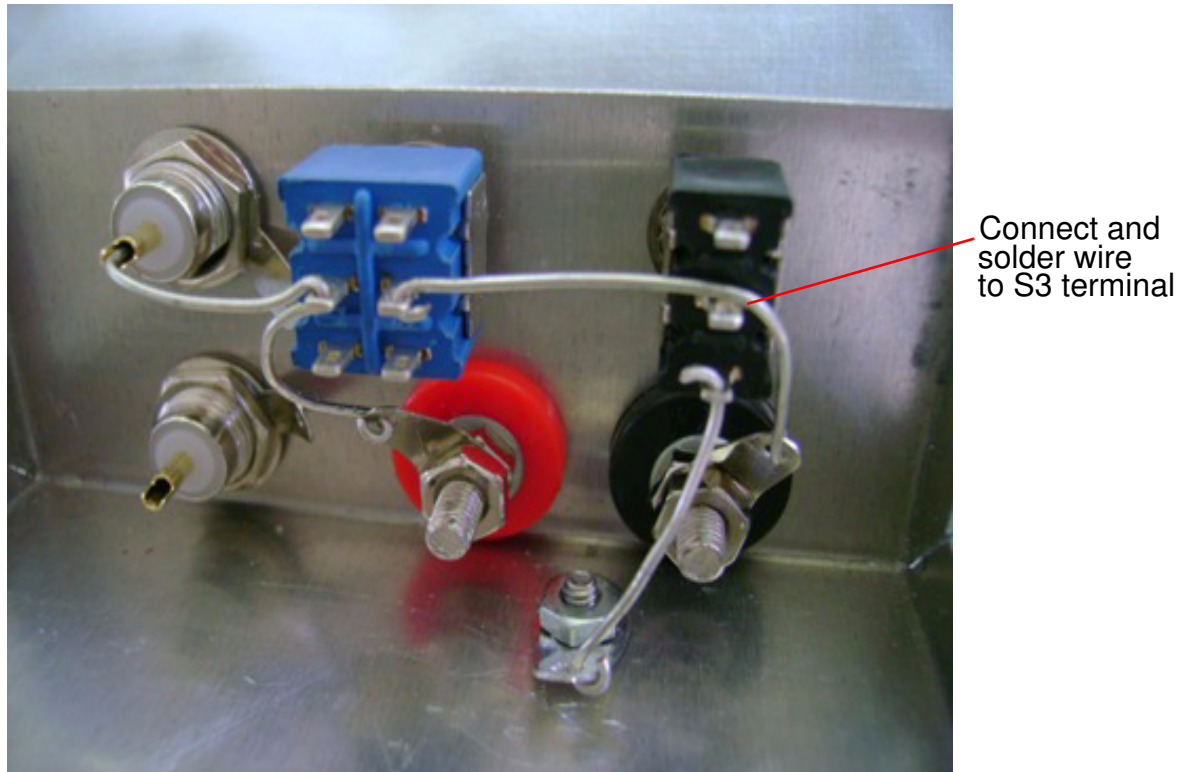


Figure 4 Backpanel Prewiring

Solder the connections to the binding posts, switches and coax connector. Leave the ground terminal until transformer T2 is connected later.

Assemble SWR Bridge PCB

Steps described in this manual section will prepare the SWR bridge components for assembly on the PCB.

Prepare Components for Assembly

Figure 5 below shows the components used on the SWR bridge PCB. The cathode, banded end of diode D1, is formed with the short lead next to the band end.

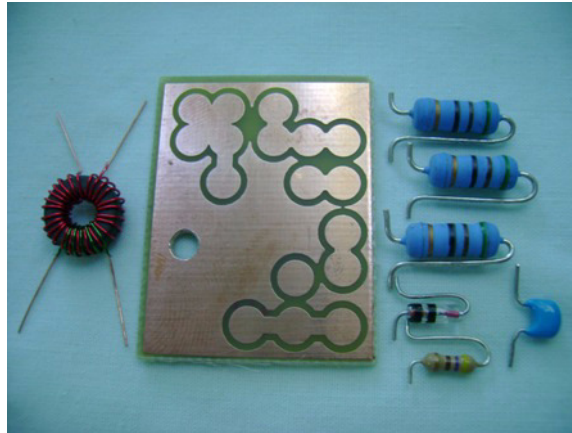


Figure 5 Prepared Components

Drill Mounting Hole – Layout and drill a 1/8 inch diameter hole as shown in Figure 6 below.

Tin PCB Pads – Tin the pads prior to component assembly as shown in Figure 6 below.

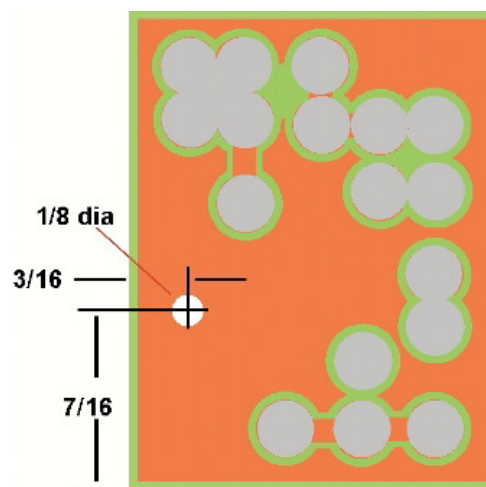


Figure 6 Mounting Hole and Tinned Pads

Wind Transformer T1

Winding SWR bridge transformer is similar to winding a bobbin. Start either clockwise or counter clockwise. It doesn't matter but make both windings the same. Hold the first couple of turns in place with thumb and forefinger to keep them in place. Form the turns snugly against the toroid core. Do not pull the wire too tight as you may damage or break it.

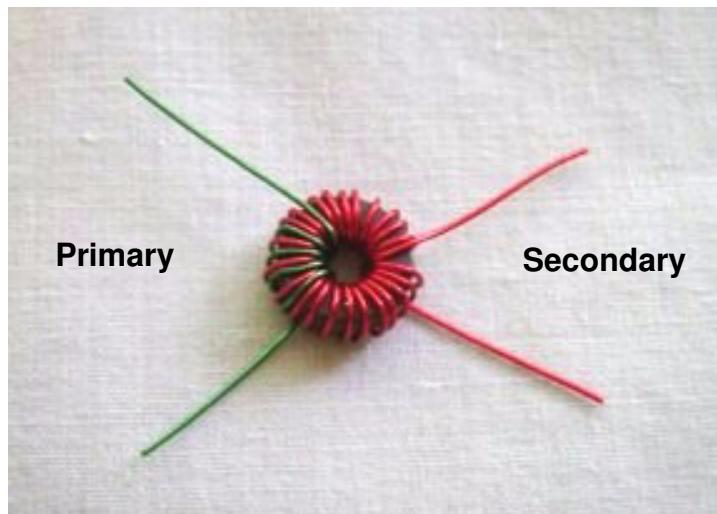


Figure 7 SWR Bridge Transformer T1

Using 14 inches of red #26 gauge wire, wind 25 turns on the FT37-61 toroid. Leave about 3/4 inch of wire.

Using 4 inches of green #26 gauge wire, wind 5 turns centered about the middle of the secondary winding.

Strip and Tin T1 Wires

Strip the insulation from the T1 wires to within about 1/8 inch of the core.

You can strip the wires by carefully scraping off the insulation with a pocket knife. Be careful that you don't nick the wires as this may cause them to break.

Or you can burn off the insulation with a match or lighter and use some fine grit sandpaper to clean off the residue.

Or, you can use a hot soldering iron. Start at the very tip of the wire and heat the insulation under a ball of solder until it melts. Then move back along the wire feeding solder into the ball over the length to be tinned.

Assemble Bridge PCB Components

Assemble the prepared parts on the SWR bridge to the "Pittsburg" PCB pads and ground plane as shown in Figure 8 below.

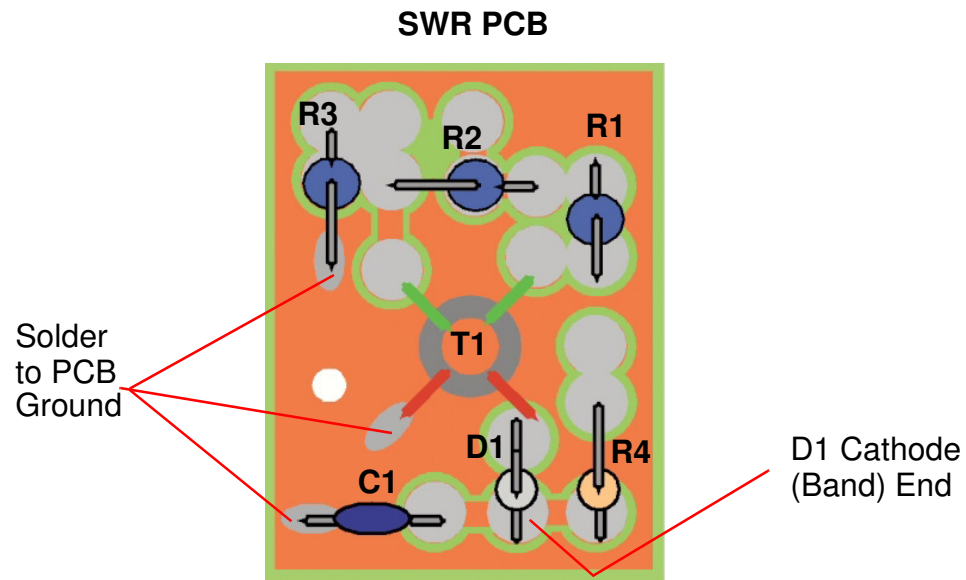


Figure 8 SWR Bridge PCB Assembly

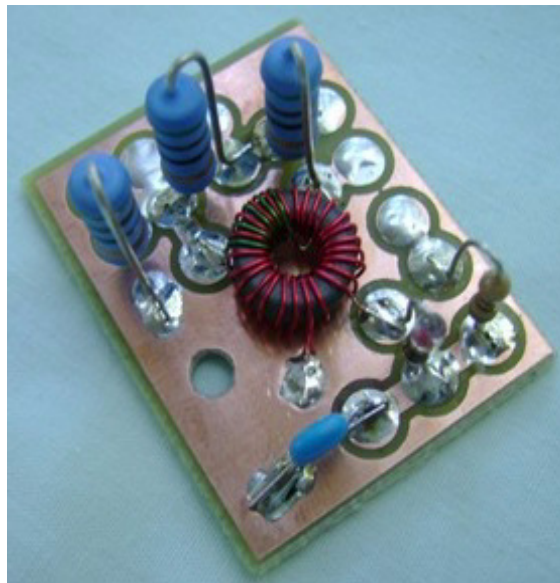


Figure 9 Assembled SWR Bridge PCB

Attach SWR Bridge PCB

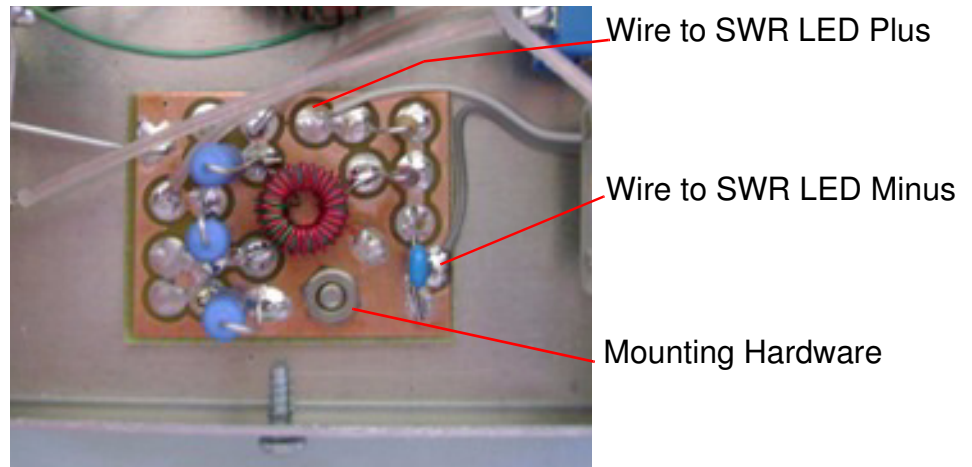


Figure 10 Mounting the SWR Bridge PCB

Using a 4-40 nut and 4-40 x 1/4 binding head screw fasten the SWR PCB to the enclosure.

Solder a bare hookup wire from the SWR bridge PCB to the solder lug on the bottom BNC connector. See Figure 11.

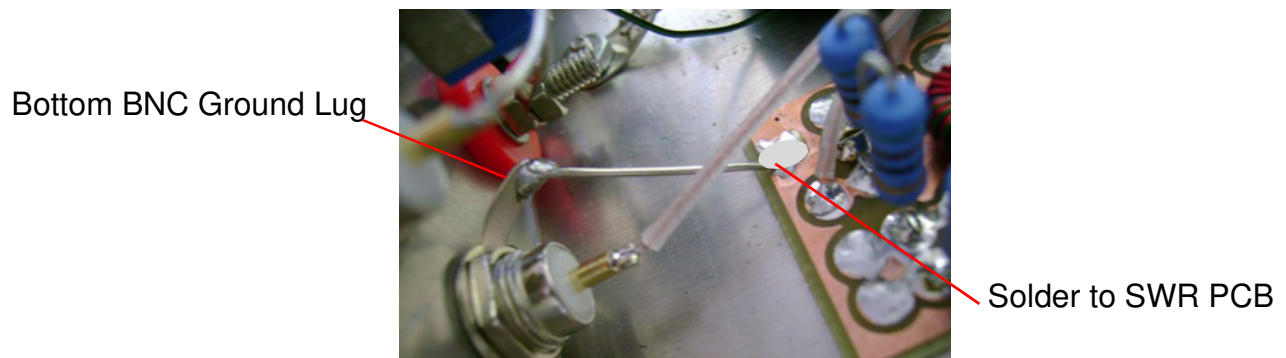


Figure 11 SWR PCB Ground Wire

Prepare LED for Assembly

Note: Form the LED leads carefully to prevent breakage.

Illustration is oversize to better show details.

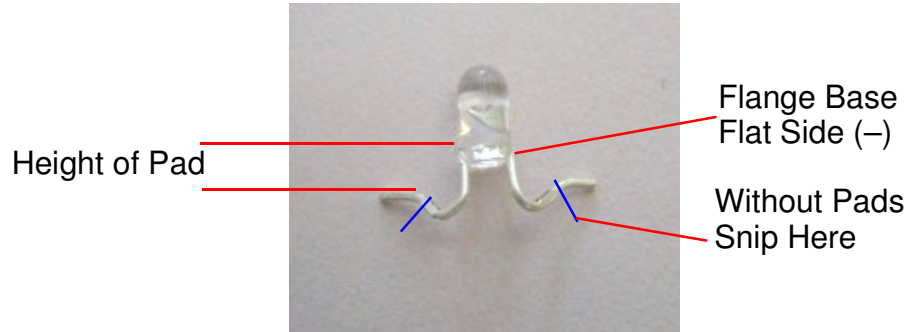


Figure 12 Forming LED Leads

Attach LED to Front Panel

Two methods of mounting the LED to the front panel are shown in Figure 13 below.

Method one uses the optional mounting (Manhattan) pads. Connect wires to the pads. Observe polarity.

Method two mounts the LED in the panel with a dab of jelled super glue to hold it in place. Connect wires directly to the leads of the LED. Observe polarity.

Note: The LED minus lead may also be the short lead.

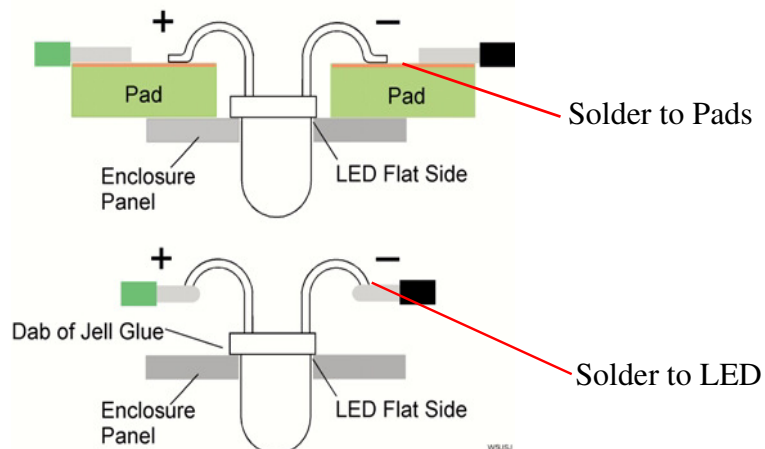


Figure 13 LED Mounting Methods

Connect the LED Wires

Refer to the wiring diagram on page 28 at the end of this manual

Using 2 lengths of hookup wire 2-1/2 inches long, strip the ends to about 3/16 inch.

Tack-solder one wire from the plus side of the LED to the pad on the SWR PCB at the end of R4.

Tack-solder the other wire from the minus side of the LED to a point on the SWR PCB next to capacitor C1.

Dress the wires such that they will clear the switch and capacitor C2 to be mounted later.

Note: The wires used in the pictures are the white and gray pair from computer ribbon cable. This light-gauge wire is OK to use with a DC circuit and, as in this case, there is very little current flow.

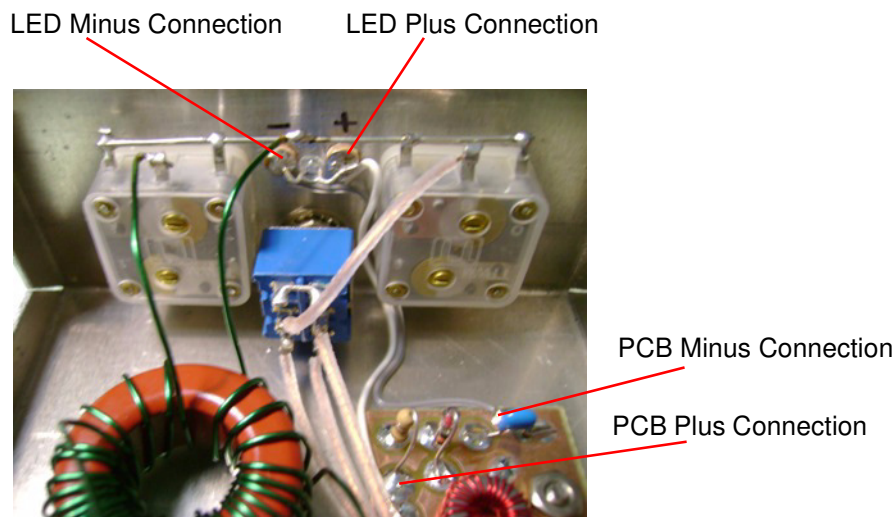


Figure 14 Wiring to LED

Assemble Front Panel

In this section, variable capacitors C2 and C3 are prepared for assembly onto the enclosure front panel. Next, they are mounted and wired.

Prepare Capacitors for Assembly

Using a 12 x 2.6mm screw attach a nylon spacer to each capacitor as shown in Figure 15 below.

Note: to prevent damage do not force the capacitor shaft against the stops when tightening the screw.

Set the trimmer capacitors to minimum as shown in Figure 15 below

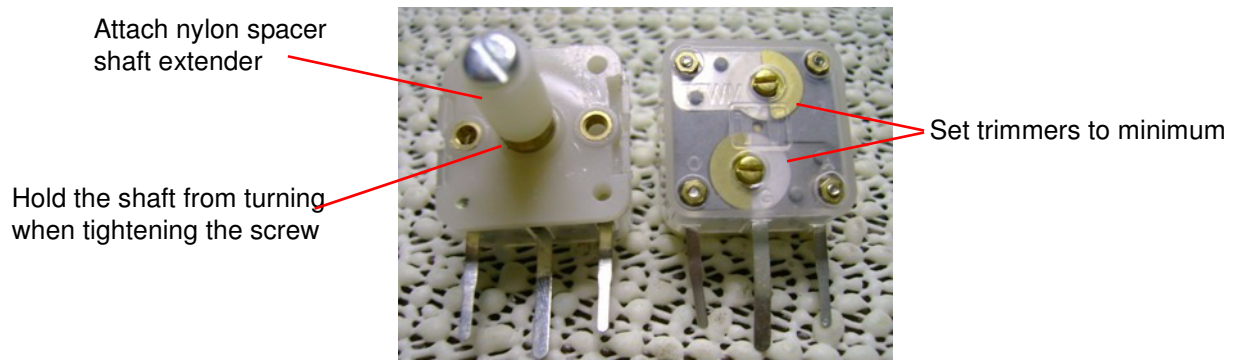


Figure 15 Preparing Capacitors

Using two 3 x 2.6mm screws attach the capacitors to the front panel. Be sure to use the washers or the screws may hit the capacitor plates. Orient the capacitors with the terminals up.

Wire Capacitors C2 and C3

Trim the capacitor terminal length to about 5/16 inch and carefully form a U bend.

Using a length of bare wire carefully crimp the four rear terminals around the wire, solder and trim off any excess. See Figure 16 below



Figure 16 Wiring Capacitors

The two front terminals will be connected during the final wiring process.

Pre Wire the Tune/Operate Switch

Refer to the wiring diagram on page 28 for a wiring and connection visual aid.

Prepare Switch Hookup Wires

Using a wire clipped from a component, connect and solder a jumper between switch terminals C and F. See Figure 17 below.

Using hookup wire, cut 4 wires to length and strip 3/16 inch according to the following cut list (switch terminal and minimum length).

A – 1-1/2 inches

B – 2-1/8 inches

D – 2-1/4 inches

E – 2-1/2 inches

Connect each wire to the proper switch terminal and solder as shown in Figure 17 below.

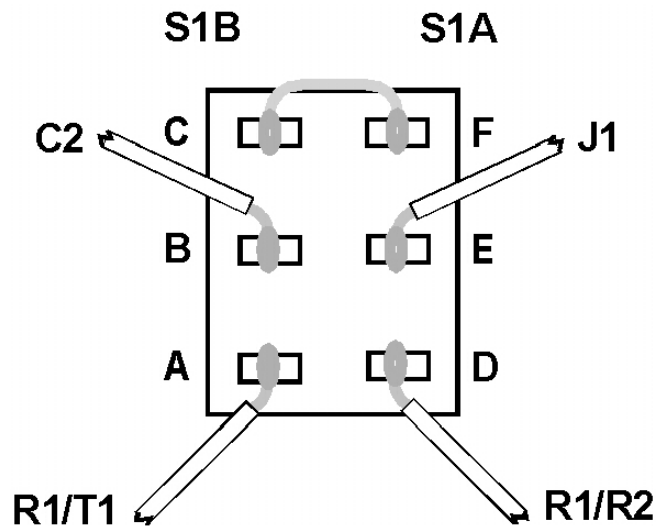


Figure 17 Switch Terminal Wiring

Assemble Switch and Connect Wires

Attach the switch to the front panel – observe orientation. The C/F jumper will be adjacent to the LED.

Using the wiring diagram as a guide attach and solder the wires from the switch to the SWR PCB, J1 and C1.

Wind Output Transformer T2

BLTplus output transformer, T2, consists of a center tapped primary winding, L1, and two secondary windings, L2 and L3. The appendix section, page 26, includes a drawing that provides information to facilitate the winding process.

Referring to the drawing, the winding steps are:

- Choose which center tap option will work best for you
- Choose which of the winding connection methods you'd like to use
- Form the center tap for winding L1 and...
- Wind the 16-turn primary L1 on the toroid
- Wind the 12-turn secondary L2 on the toroid
- Wind the 6-turn secondary L3 on the toroid

If you choose to make connections to the transformer with hookup wire the additional steps are:

- Cut the transformer leads down to about 1/2 inch and strip 3/8 inch
- Form a loop at each wire end and connect a 2-inch length of hookup wire

Your finished transformer should resemble the illustrations on the drawings.

Connecting Transformer T2

Refer to the wiring diagram drawing in the appendix section, page 28, and the inside view of the BLTplus on page 2.

You may find it useful to put a temporary spacer about 1/4 inch thick under the toroid to position it away from the enclosure.

- Position the wound toroid and route the leads as shown in the pictures.
- Place the wires in the position they will be when attached and cut them to length. Leave enough slack for connection and soldering.
- Strip about 1/4 inch of insulation from the end of each wire.
- Connect secondary wires L3c and L3c' to the bottom terminals of S2
- Connect secondary wires L2b and L2b' to the top terminals of S2
- Connect primary wire L1a' to the center lug of C3
- Connect primary wire L1a to the center of the wire between C2 and C3

Final Assembly Checkout

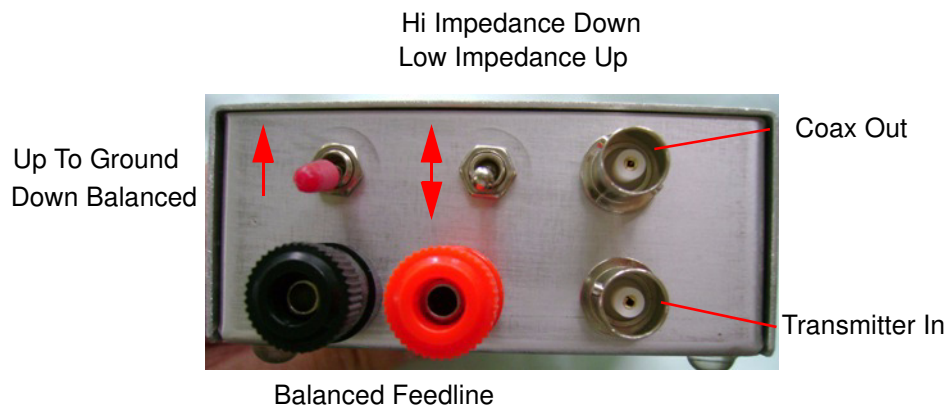
Inspect carefully for good solder connections and ensure that there are no shorts, incorrect or missing connections. Use the wiring diagram and schematic from the appendix section page 28 as a guide. Also, compare the wired assembly to the schematic on page 27.

BLTplus Operation

BLTplus is designed to "tune" or match your transmitter to typical antenna systems for the 40, 30, and 20 meter amateur bands. Under ideal conditions, where the impedances and SWR are not at extremes, you may be able to adjust for a match on higher frequency bands.

Antenna Connections

Connections for various types of antennas are shown in Figure 18 below and described in the following text.



Switch positions are correct when wired as described in this manual

Figure 18 Back Panel Connections

Connect your transmitter output to the transmitter in BNC jack. Depending on the type of antenna you will be using select the connections and settings as follows:

Note: The grounding switch connects the black binding post to the BLTplus chassis ground. A physical ground (earthed) connection may also be used when conditions require one.

- Connect balanced feedline to the red and black binding posts. Leave the grounding switch in the down position.
- Connect end fed longwires to the red binding post terminal. Connect a counterpoise wire to the black binding post. Place the grounding switch in the up position.
- Connect coax to the coax out jack. Place the grounding switch in the up position.

Adjusting for a 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, BLTplus maximum power Input – 5 Watts

Place the HI/Low impedance 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.

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 is not completely dim.

Switch the tune/operate switch to the operate position. Work those DX stations.



Figure 19 Tuner Controls

Experiment and Customize

BLTplus may not work effectively with some antenna systems. You may find it useful to adjust the turns on T2 to provide effective tuning. An excellent resource for experimenting and customizing is the BLT paper by Carey Fuller, NX0R. His paper, in PDF format, can be downloaded from the QRPkits.com website on the BLT page. http://www.qrpkits.com/norcal_blt.htm

Steve, KD1JV, made some mods to the PFR-3 BLT specifically for a 44 foot EDZ using about 50 feet of 450 Ohm window line.

L1= 11t CT at 5/1/2, L2=6t, L3=2t, L2 and L3 centered around the CT.

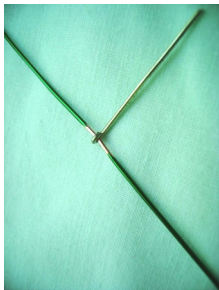
Appendix

Supplements to help build and operate the BLTplus.

- Output transformer T2 winding information
- BLTplus Schematic
- BLTplus wiring diagram

T2 Center Tap Forming Options

Method 1



Cut wire 28 inches long

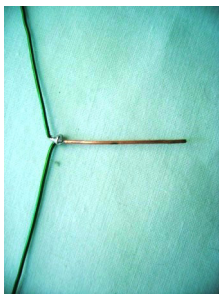
Find the center (14 inches)

Carefully strip about 1/2 inch of insulation from the center (1/4 inch each side).

Attach and solder a 1 inch length of bare wire at the center.

NOTE: Wire lengths for the three methods shown above are for connection ver. 1 shown below

Method 2



Cut wires 15 inches and 14 inches long.

Strip about 1 inch of

insulation from the end of the 15 inch length. Strip 1/4 inch from the 14 inch length.

Form a small J-hook at the bare end of the 14 in. wire.

Attach the J-hook end to the point where the insulated and bare wire meet. Solder.

Method 3



Cut wire 30 inches long

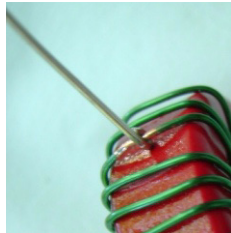
Find the center (15 inches)

Carefully strip about 1-1/2 inches of insulation from the center (3/4 inch each side).

At the center location, bend the wires tightly together.

Hold the wires firmly with pliers at 3/4 inch from the bend. Twist 2 turns.

Winding the Primary



Start the primary winding by positioning the center tap in the center of the toroid. Hold firmly and wind a couple of turns in each direction.

These first windings will hold the wire on the core.

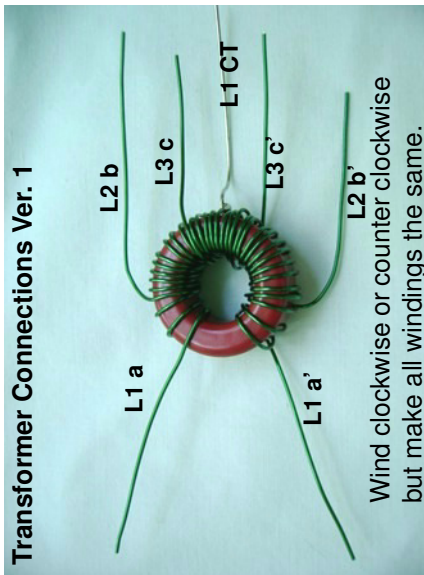
Continue the winding for a total of 8 turns in each direction. Space evenly around the toroid.

Each pass through the middle is 1 turn.

You may find it easier to form the wire against the core by pushing the wire down through the middle.



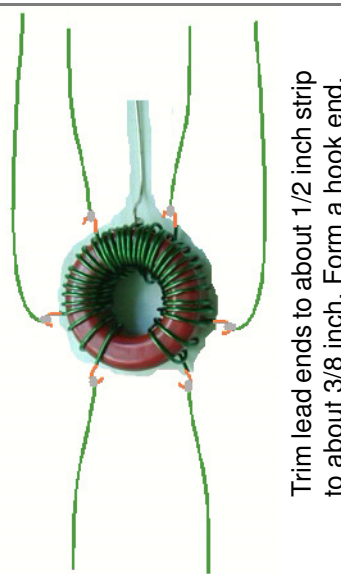
Transformer Connections Ver. 1



Wind clockwise or counter clockwise but make all windings the same.

Transformer Connections Ver. 2

Note: Use 3 inches less wire for this version



Trim lead ends to about 1/2 inch strip to about 3/8 inch. Form a hook end.

Continue Winding Secondaries:

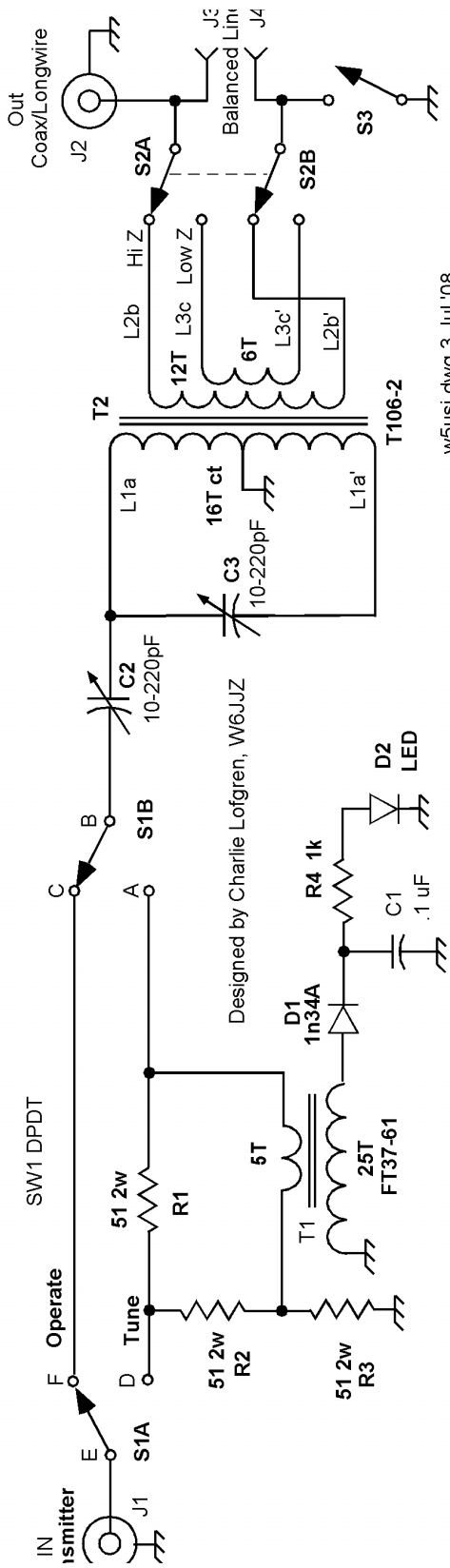
Find the center of each wire length as the starting point for L2 and L3.

Using a 22 inch length of wire, start L2 at the middle next to the center tap and wind 6 turns each side within the turns of the primary winding.

Using a 13 inch length of wire, start L3 at the middle next to the center tap and wind 3 turn in each direction.

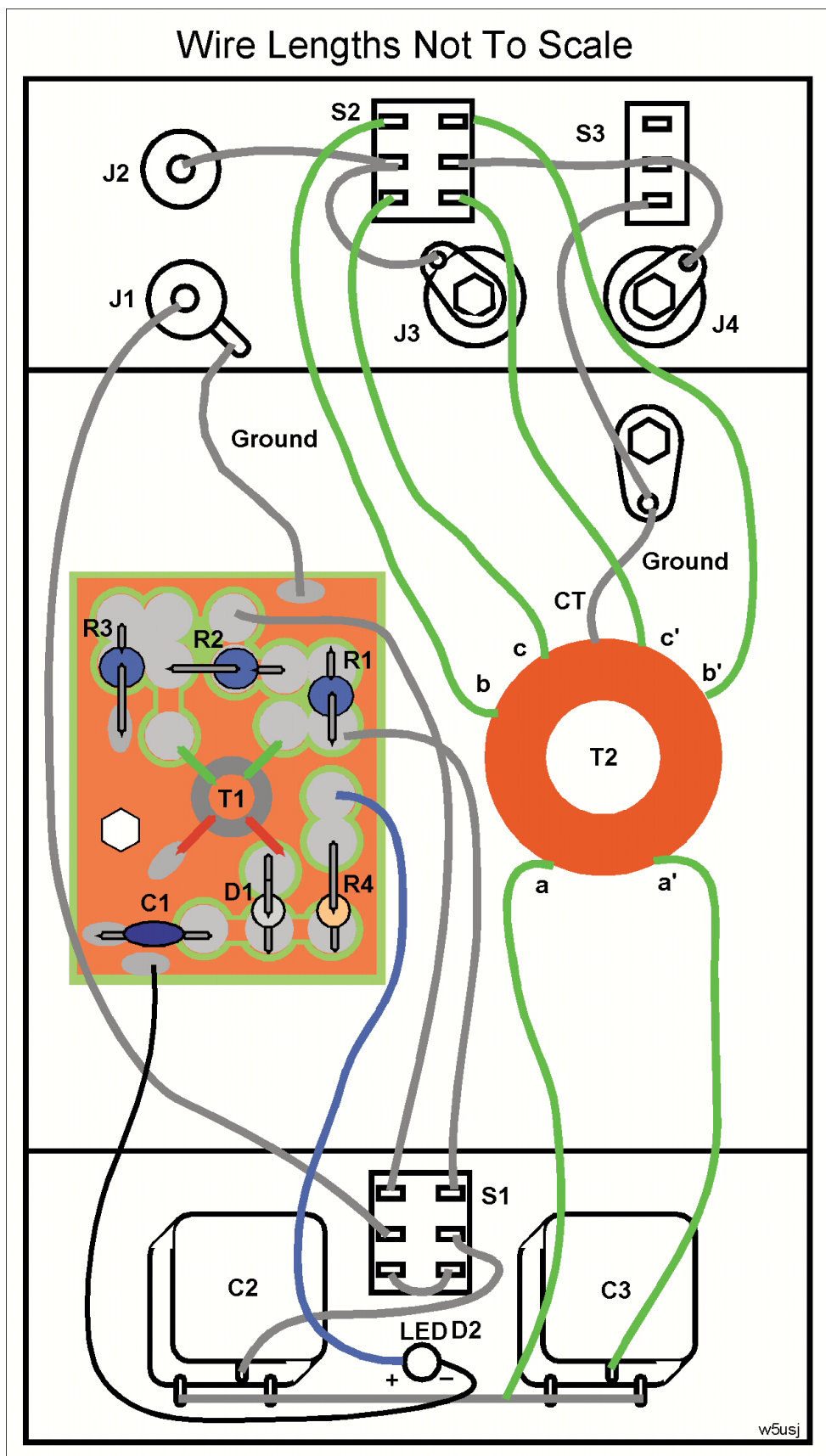
Winding Transformer T2

QRP Kits BLT Plus



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BLTplus Schematic



BLTplus Wiring Diagram

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