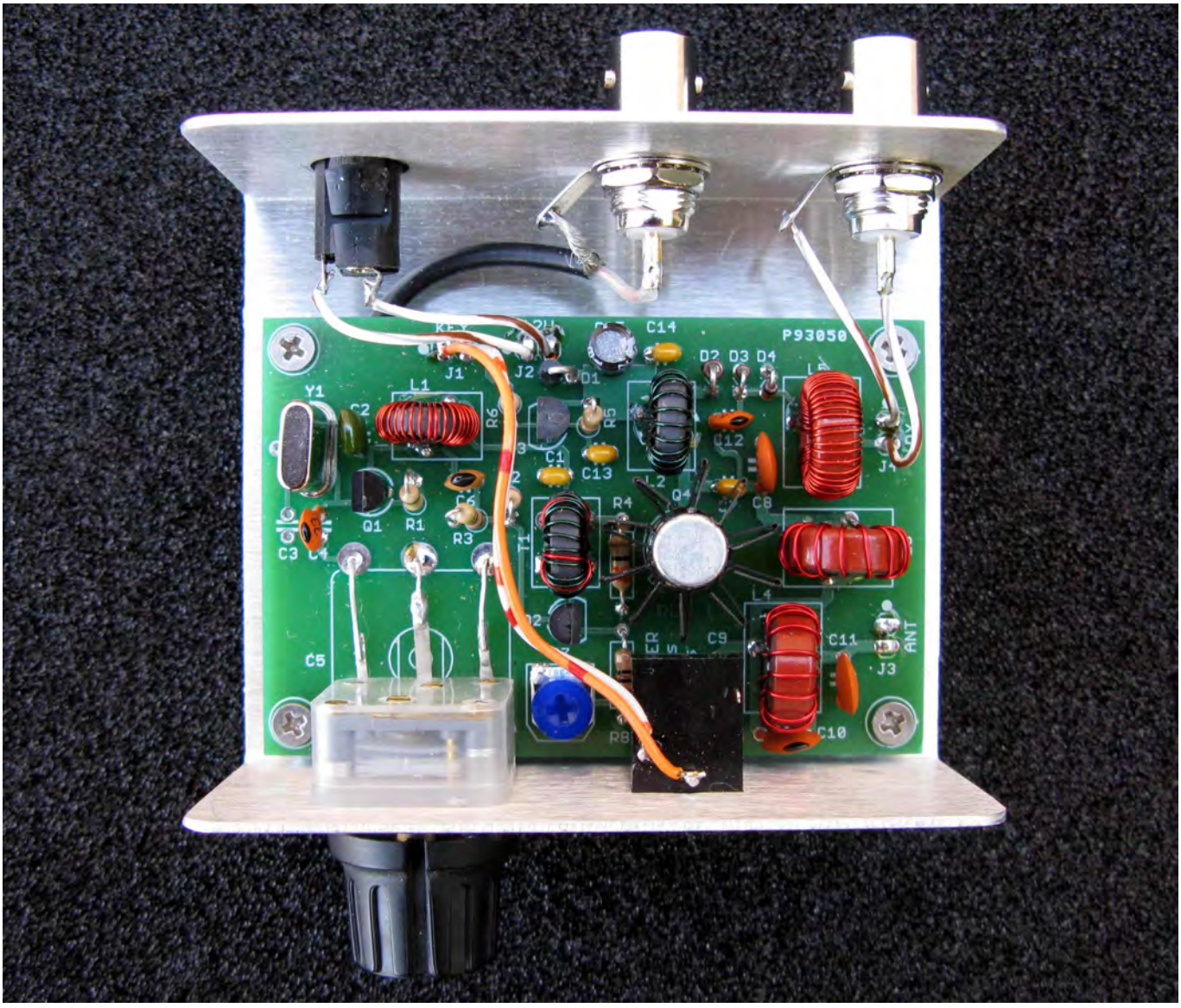
Hendricks QRP Kits
The Twofer
Rev. 01/06/12



1. Description

The Twofer is a classic QRP transmitter that's easy to assemble and operate. It uses a JFET VXO (variable crystal oscillator), driver stage and PA stage that's capable of producing 1 Watt. The VXO range depends on the operating band, but provisions are incorporated for experimentation. The kit is available in 40m, 30m, 20m, and 10m versions. Additional information is provided for experimentation on other bands.

2. Basic Assembly

The Twofer is available for several bands, but uses many common components. We will start installing the general components and get into specific band assembly in the following section.

The first step is to inventory all the parts against the Parts List found in Appendices C and D. Every care was taken to ensure a complete kit. If you discover a component is missing, contact Doug at Hendricks QRP Kits and it will be shipped as fast as possible.

- ❑ Refer to Figure 1. You can solder the leads of each component as you insert it, or insert several parts and then solder and trim the leads. Install:
  - ❑ Four .1uF (104) at C1, C7, C13 and C14.
  - ❑ .01uF (103) at C2. You may need to straighten the leads to permit easy insertion.
  - ❑ 33pF (33) at C4.
  - ❑ 39pF (39) at C6.
  - ❑ 22uF at C15. Note the polarity: The long lead is inserted into the hole marked with the + sign. The negative band on the cap is closest to C14.
  - ❑ 33 Ohm resistor (Orange-Orange-Black-Gold) at R4.
  - ❑ 10 Ohm resistor (Brown-Black-Black-Gold) at R8.
  - ❑ 2K trim pot at R7. Turn the shaft fully counter-clockwise.

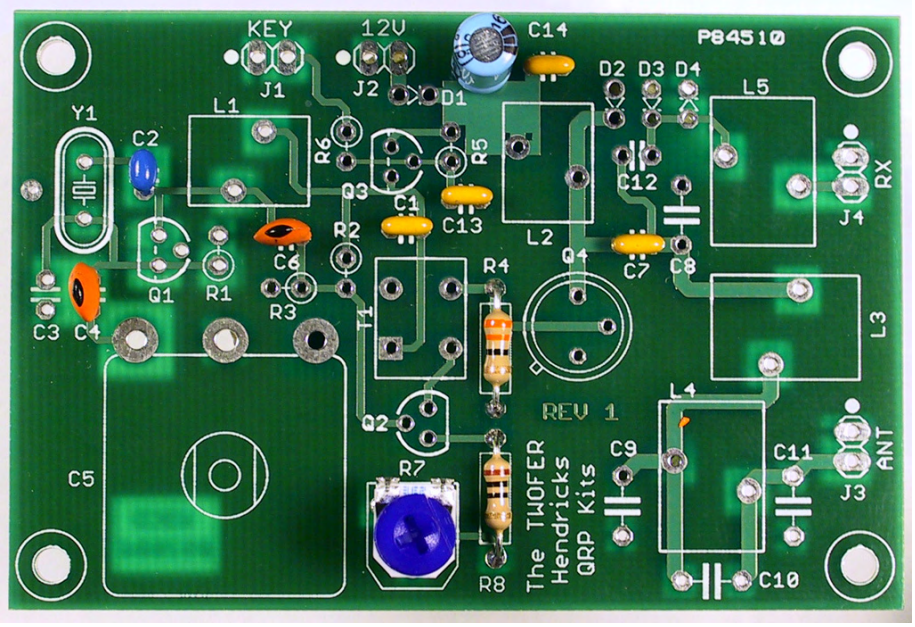


Figure 1 Capacitor and Resistor Installation

- ❑ Refer to Figure 2 for transistor installation. Pay close attention to the orientation of Q1, Q2 and Q3. The board silkscreen shows the proper alignment. These devices will require slight lead bending for proper fit.

Install:

- ❑ MPF102 at Q1.
- ❑ 2N3906 at Q3.
- ❑ 2N2222 at Q2.
- ❑ 2N2219A at Q4. Leave a 3/16” gap between the bottom of the transistor and the board.

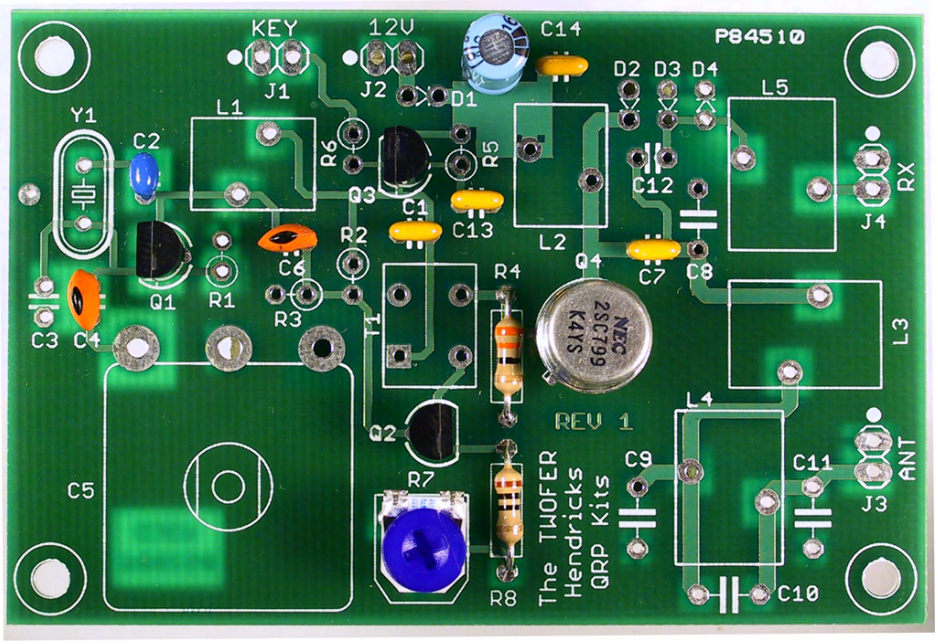


Figure 2 Transistor Installation

- ❑ Bend the cathode lead (striped end of the diode) of D1, D2, D3 and D4 as shown in Figure 3. **Striped end at the top.**

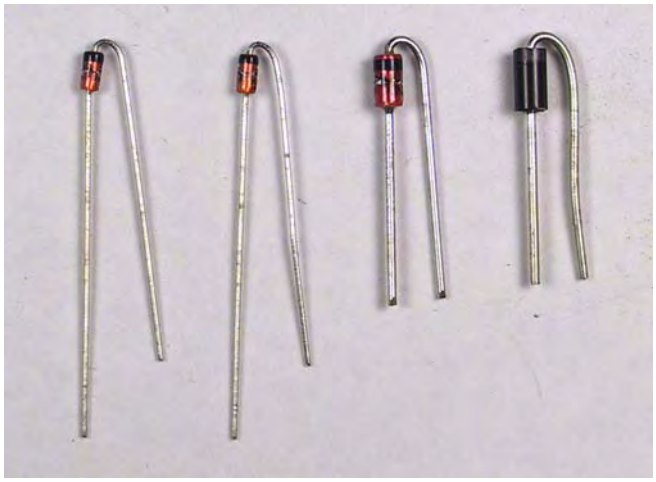
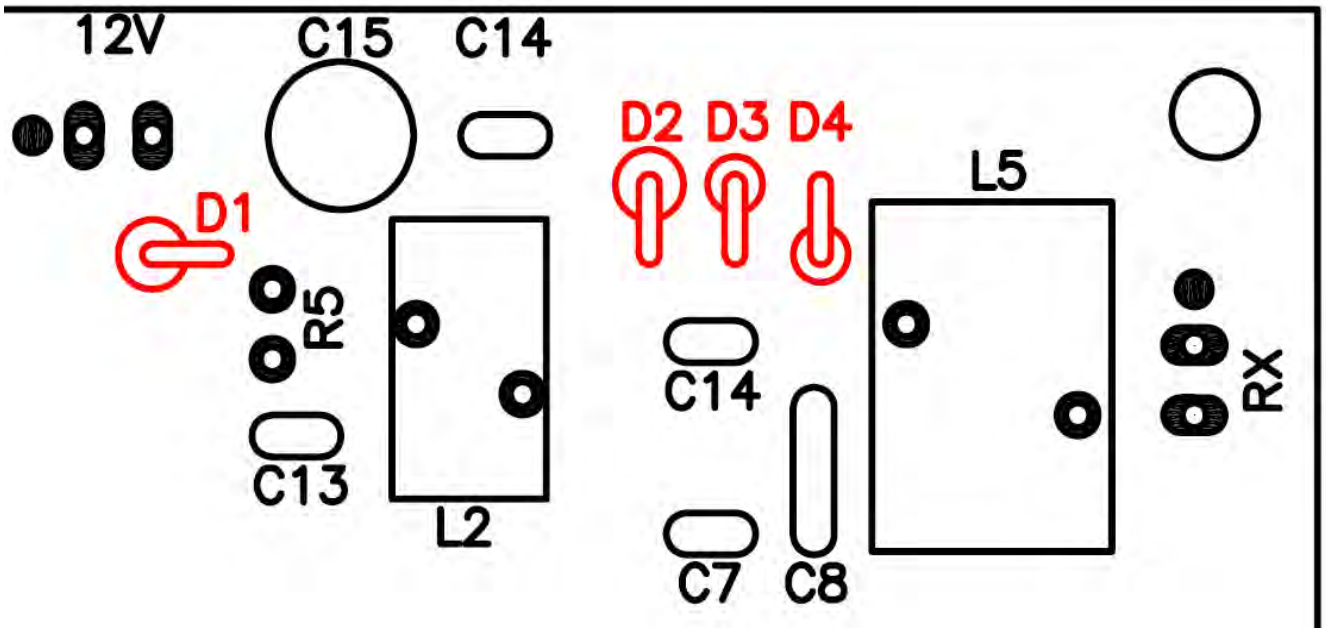


Figure 3 Diode Lead Forming

- ❑ The diodes are installed with the cathode lead inserted into the hole pointed to by the arrow on the board silkscreen. Figure 4 shows the correct diode orientation. Install:
  - ❑ 1N5817 at D1.
  - ❑ 1N4752 at D2.
  - ❑ 1N4148 at D3.
  - ❑ 1N4148 at D4.

Figure 4 Diode Installation Guide



- ❑ The remaining five resistors are installed next. Bend one lead of each resistor as you did with the diodes. Figure 5 shows the board after resistor placement. Install them as follows:
  - ❑ 100K (Brown-Black-Yellow-Gold) at R1.
  - ❑ 2.2K (Red-Red-Red-Gold) at R2.
  - ❑ 470 Ohm (Yellow-Violet-Brown-Gold) at R3.
  - ❑ 47K (Yellow-Violet-Orange-Gold) at R5.
  - ❑ 1K (Brown-Black-Red-Gold) at R6.

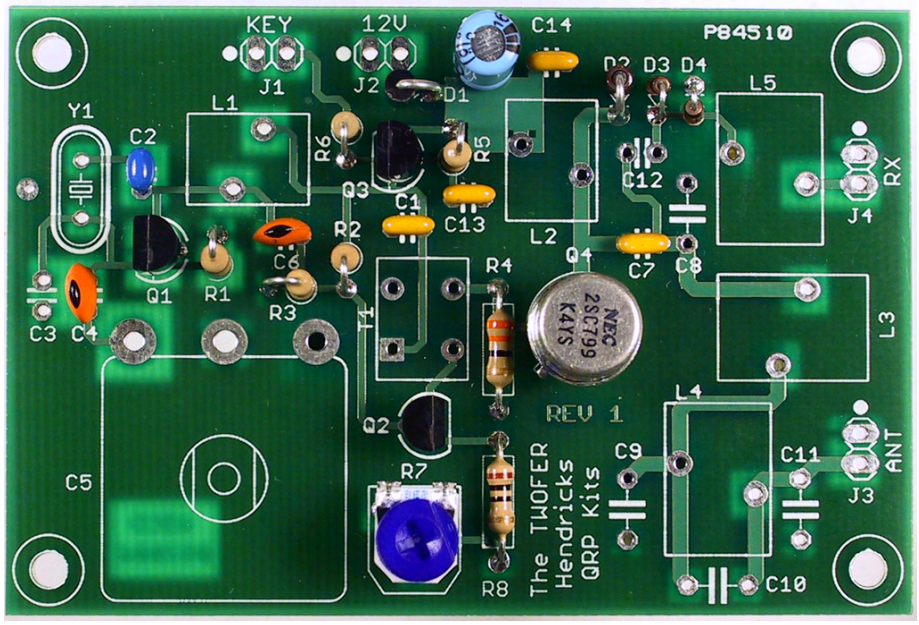
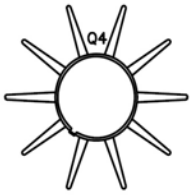


Figure 5 Resistor Installation

- ❑ Winding L1. Locate the FT37-43 toroid. It is the black one with a dot of paint.
  - ❑ Measure 22” of the, Red magnet wire and cut.
  - ❑ Wind 36 turns of wire around the toroid. Leave 1” of wire at the start. Each pass through the center counts as 1 turn. Figure 6 shows the completed inductor.
  - ❑ Trim the leads to 1/2”. Tin them using a soldering iron and solder, as shown in Figure 7. Make sure the varnish is removed all the way up to the edge of the toroid.
  - ❑ Install the completed inductor at L1.
  - ❑ Make sure the inductor was soldered properly by measuring the resistance across the pads: it should be less than 2 Ohms. If it is greater, then the varnish was not completely removed. Try reheating the solder and measure again. If this doesn’t help, remove L1 and re-tin the leads.



  - ❑ Now is a good time to put the heatsink on Q4. The fins will need to be bent slightly, when you install the toroids and transformer.

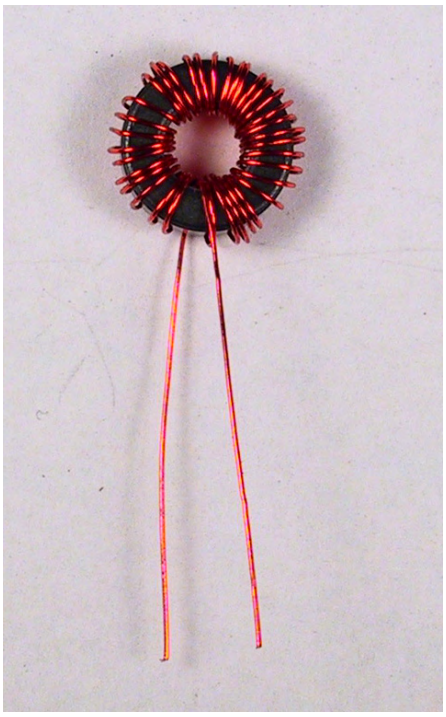


Figure 6 Completed L1 before tinning

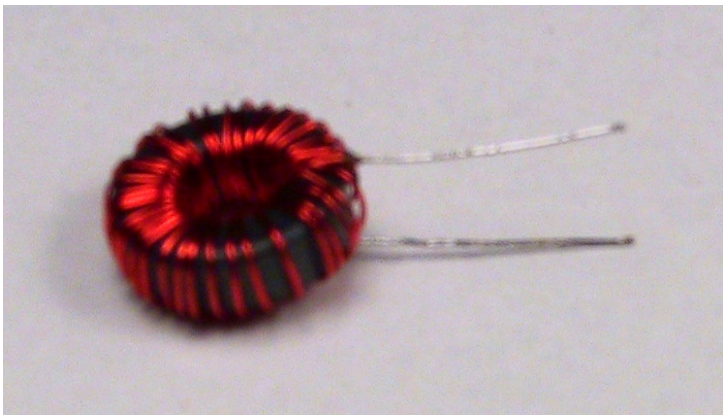


Figure 7 Tinned Inductor Leads

- ❑ Winding L2. Locate one of the FT37-61 toroids. It is dull without a paint dot.
    - ❑ Measure 14” of the, Red magnet wire and cut.
    - ❑ Wind 21 turns of wire around the toroid. Again, leave 1” at the start of winding..

- ❑ Cut the excess lead length to 1/2” and tin as before.
- ❑ Install the completed inductor at L2.
- ❑ Measure the resistance across the L2 pads: it should be less than 1 Ohm.

❑ Winding T1. Locate the remaining FT37-61 toroid.

- ❑ Before you start winding, refer to Figure 8 to see how the leads should be dressed.
- ❑ Measure 16” of the Red magnet wire and cut.
- ❑ Wind 25 evenly spaced turns around the toroid.
- ❑ Measure 7” of the Green magnet wire and cut.
- ❑ Wind 5 evenly spaced turns on top of the previous winding.
- ❑ Tin the leads.
- ❑ Refer to Figure 9 and insert the Red leads into the pads closest to Q2.
- ❑ Insert the Green leads into the pads closest to C1.
- ❑ Gently tug on all four leads to seat the inductor against the board and solder.
- ❑ Measure the resistance across the Red lead pads: it should be less than 1 Ohm.
- ❑ Measure the resistance across the Green lead pads. Likewise, it should be less than 1 Ohm.
- ❑ Correct any high resistance connections before proceeding.

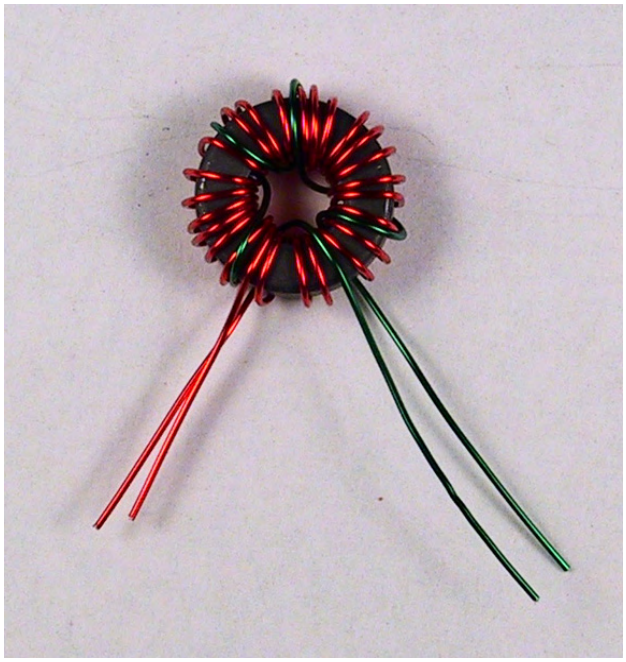


Figure 8 Correct T1 Lead Dressing

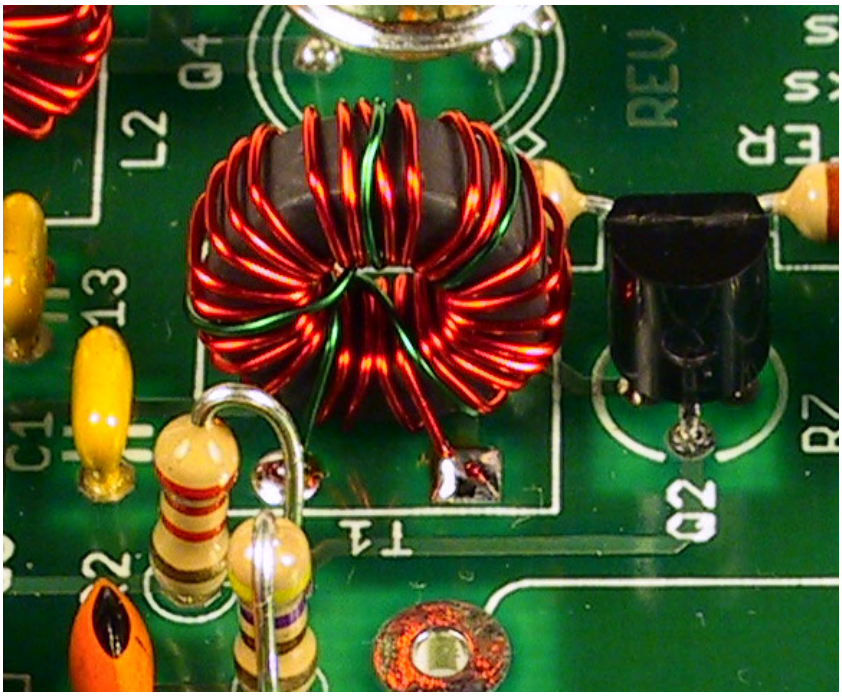


Figure 9 T1 Installation

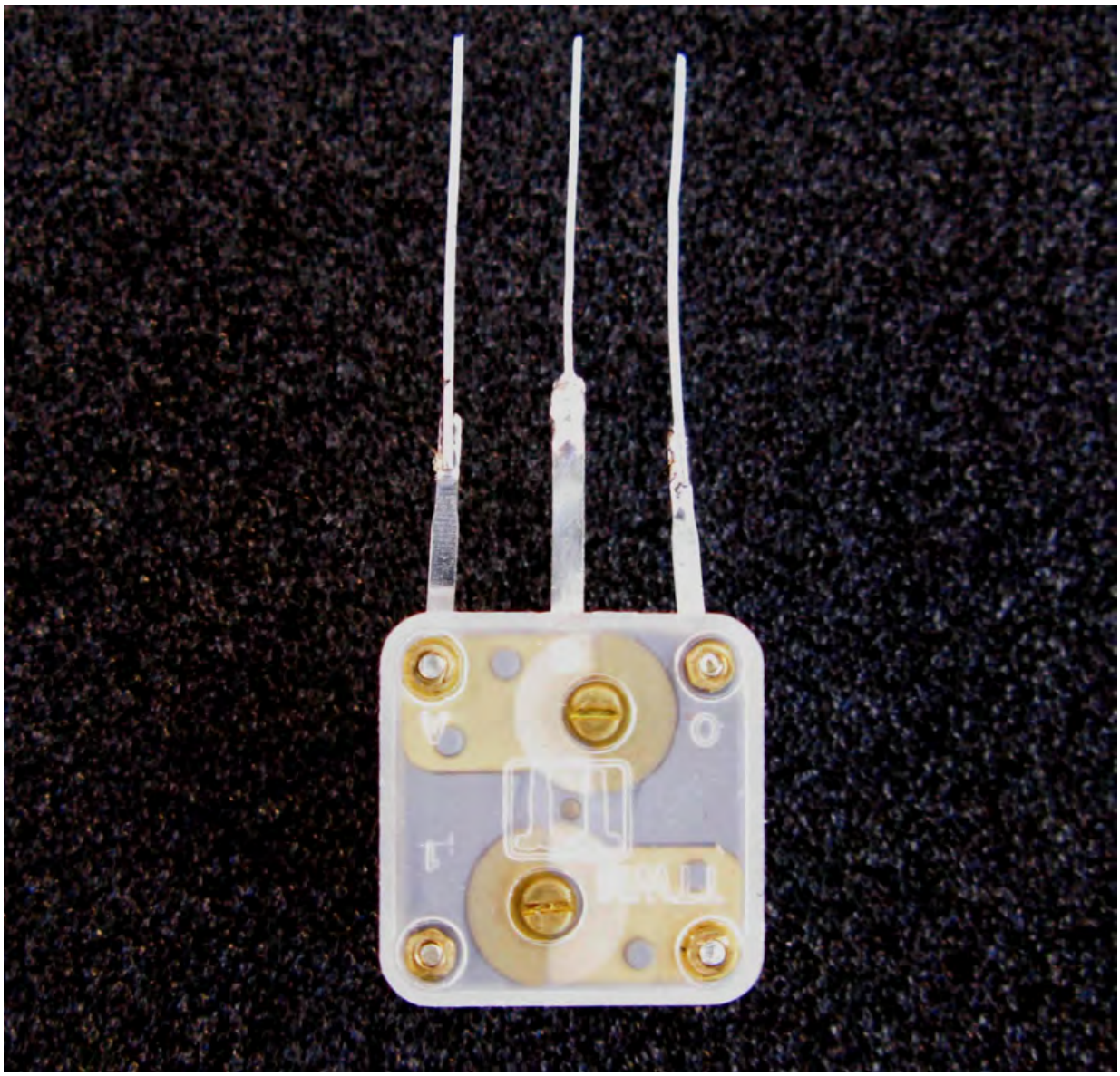


Figure 10 Poly-varicon preparation

- ❑ Extend the leads of the poly-varicon with some trimmed component leads.

- ❑ On the backside set the trimmers to the minimum capacitance. You should see a "full moon" brass colored disk in this condition, as shown in Fig. 10.

3. Band Specific Assembly

The Twofer is currently available in 40m, 30m and 20m versions. In addition to these bands, instructions are provided below for 80m, 15m and 10m if you want to experiment. Follow the appropriate instructions below for your kit.

3.1 80m (Reference only)

- ❑ Install the following capacitors:
  - ❑ 1200pF (122) at C8
  - ❑ 2000pf (202) at C9
  - ❑ 180pF (181) at C10
  - ❑ 1200pF (122) at C11
  - ❑ 91pf (91) at C12

- ❑ Winding L3. Locate one of the Red T50-2 toroids
  - ❑ Measure and cut 19”of the Red magnet wire.
  - ❑ Wind 22 evenly spaced turns around the toroid.
  - ❑ Trim and tin the leads as before.
  - ❑ Install the finished coil at L3

- ❑ Winding L4. Follow the steps for L3 and install it at L4.

- ❑ Winding L5. Locate the remaining Red T50-2 toroid.
  - ❑ Measure and cut 40” of the Red magnet wire.
  - ❑ Wind 67 evenly spaced turns around the toroid.
  - ❑ Trim and tin the leads as before.
  - ❑ Install the finished coil at L5

3.2 40m

- ❑ Install the following capacitors:
    - ❑ 240pF (241) at C8
    - ❑ 560pf (561) at C9
    - ❑ 120pF (121) at C10
    - ❑ 240pF (241) at C11
    - ❑ 47pf (47) at C12

- ❑ Winding L3. Locate one of the Red T50-2 toroids
    - ❑ Measure and cut 14” of the heavier Red magnet wire.
    - ❑ Wind 15 evenly spaced turns around the toroid.
    - ❑ Trim and tin the leads as before.
    - ❑ Install the finished coil at L3

- ❑ Winding L4. Follow the steps for L3 and install it at L4.

- ❑ Winding L5. Locate the remaining Red T50-2 toroid.
    - ❑ Measure and cut 30” of the Red magnet wire.
    - ❑ Wind 45 evenly spaced turns around the toroid.
    - ❑ Trim and tin the leads as before.
    - ❑ Install the finished coil at L5

3.3 30m

- ❑ Install the following capacitors:
    - ❑ 470pF (471) at C8
    - ❑ 680pf (681) at C9
    - ❑ 56pF (56) at C10
    - ❑ 470pF (471) at C11
    - ❑ 30pf (30) at C12

- ❑ Winding L3. Locate one of the Red T50-2 toroids
    - ❑ Measure and cut 14” of the heavier Red magnet wire.
    - ❑ Wind 13 evenly spaced turns around the toroid.
    - ❑ Trim and tin the leads as before.
    - ❑ Install the finished coil at L3

- ❑ Winding L4. Follow the steps for L3 and install it at L4.

- ❑ Winding L5. Locate the remaining Red T50-2 toroid.
    - ❑ Measure and cut 26” of the Red magnet wire.
    - ❑ Wind 40 evenly spaced turns around the toroid.
    - ❑ Trim and tin the leads as before.
    - ❑ Install the finished coil at L5

3.4 20m

- ❑ Install the following capacitors:
    - ❑ 270pF (271) at C8
    - ❑ 560pf (561) at C9
    - ❑ 56pF (56) at C10
    - ❑ 270pF (271) at C11
    - ❑ 22pf (22) at C12

- ❑ Winding L3. Locate one of the Red T50-2 toroids
    - ❑ Measure and cut 12” of the Red magnet wire.
    - ❑ Wind 10 evenly spaced turns around the toroid.
    - ❑ Trim and tin the leads as before.
    - ❑ Install the finished coil at L3

- ❑ Winding L4. Follow the steps for L3 and install it at L4.

- ❑ Winding L5. Locate the remaining Red T50-2 toroid.
    - ❑ Measure and cut 21” of the Red magnet wire.
    - ❑ Wind 34 evenly spaced turns around the toroid.
    - ❑ Trim and tin the leads as before.
    - ❑ Install the finished coil at L5

3.5 15m (Reference only)

- ❑ Install the following capacitors:
    - ❑ 220pF (221) at C8
    - ❑ 360pf (361) at C9
    - ❑ 27pF (27) at C10
    - ❑ 220pF (221) at C11
    - ❑ 15pf (15) at C12

- ❑ Winding L3. Locate one of the Red T50-2 toroids
    - ❑ Measure and cut 12” of the Red magnet wire.
    - ❑ Wind 9 evenly spaced turns around the toroid.
    - ❑ Trim and tin the leads as before.
    - ❑ Install the finished coil at L3

- ❑ Winding L4. Follow the steps for L3 and install it at L4.

- ❑ Winding L5. Locate the remaining Red T50-2 toroid.
    - ❑ Measure and cut 20” of the Red magnet wire.
    - ❑ Wind 28 evenly spaced turns around the toroid.
    - ❑ Trim and tin the leads as before.
    - ❑ Install the finished coil at L5

3.6 10m

- ❑ Install the following capacitors:
    - ❑ 180pF (181) at C8
    - ❑ 270pf (271) at C9
    - ❑ 15pF (15) at C10
    - ❑ 180pF (181) at C11
    - ❑ 10pf (10) at C12

- ❑ Winding L3. Locate one of the Red T50-2 toroids
    - ❑ Measure and cut 12” of theRed magnet wire.
    - ❑ Wind 8 evenly spaced turns around the toroid.
    - ❑ Trim and tin the leads as before.
    - ❑ Install the finished coil at L3

- ❑ Winding L4. Follow the steps for L3 and install it at L4.

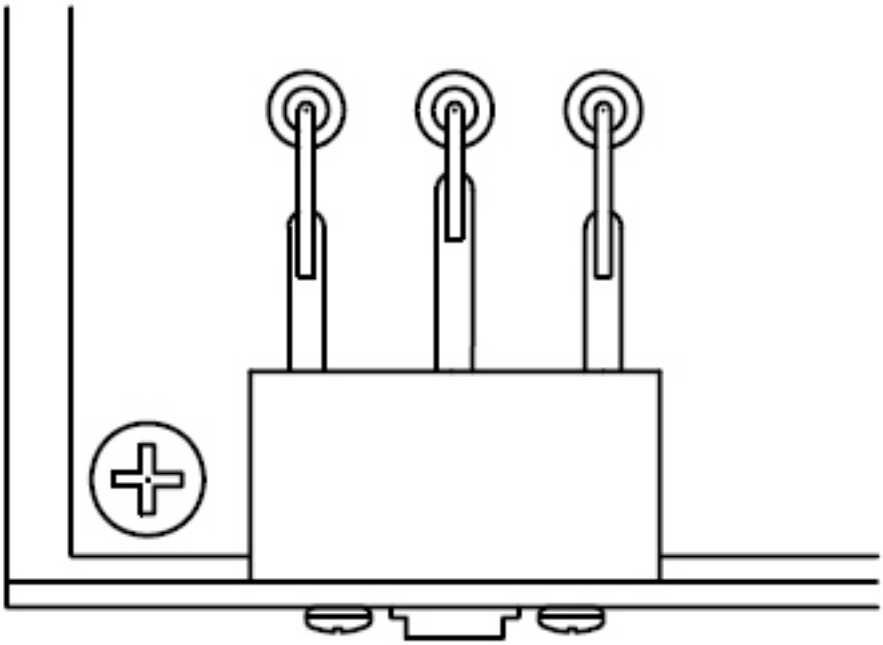
- ❑ Winding L5. Locate the remaining Red T50-2 toroid.
    - ❑ Measure and cut 18” of the Red magnet wire.
    - ❑ Wind 24 evenly spaced turns around the toroid.
    - ❑ Trim and tin the leads as before.
    - ❑ Install the finished coil at L5

4. Final Board Assembly

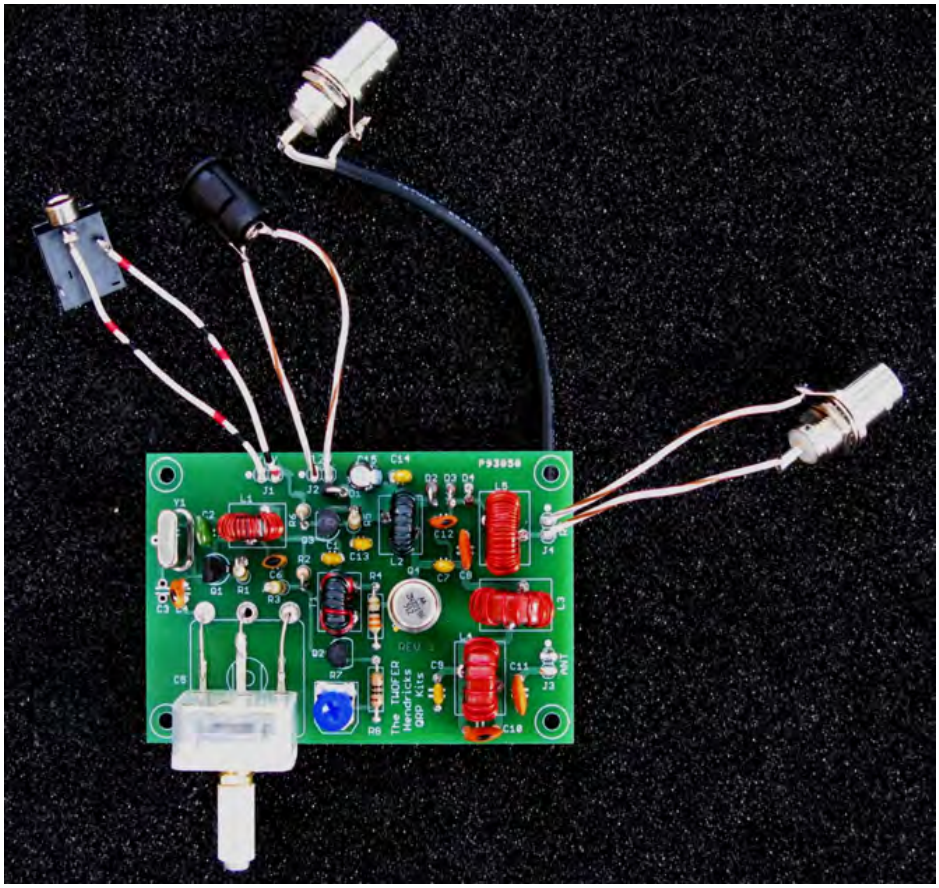
- ❑ Check the continuity across the bottom pads of L3, 4, and 5. The resistance should be less than 1 Ohm in all cases.

- ❑ Install the crystal at Y1.

- ❑ Mount the PCB in the chassis, pre-mount the polyvaricon in it's installed position. Trim and solder the extended poly-varicon leads to the three pads. as shown below.



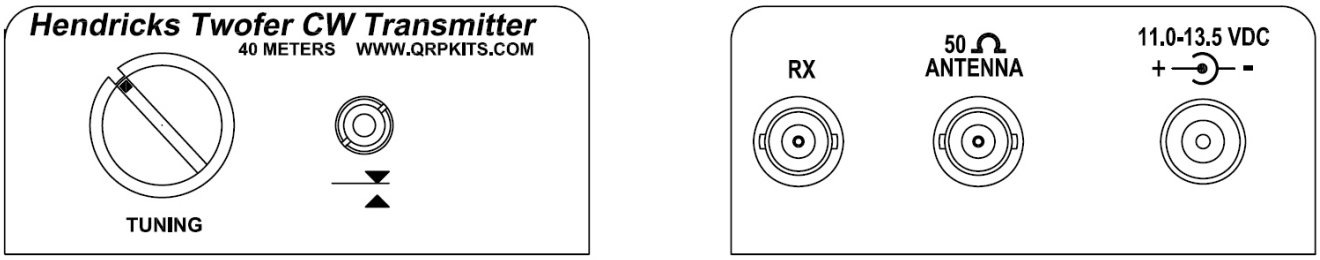
5. Testing



- ❑ Remove the board from the chassis, after the poly-varicon installation.
- ❑ Strip, tin, and solder the short piece of RG-174 to the underside of the board, at the ANT pads. Be sure to solder the shield to the pad marked with the white dot, signifying the ground side of the connection.
- ❑ Strip, tin, and solder 3" pieces of the hook-up wire to the KEY, 12V, and RX pads, on the top side of the board.
- ❑ Strip, tin, and solder the end of the RG-174 to the BNC connector, and solder the other BNC to the RX leads.
- ❑ Solder the power connector and 1/8" stereo jack to the appropiate leads.
- ❑ Note the the ground terminal of all four connectors is identified by a white dot on the silkscreen.
- ❑ Make sure R7 and C5 are turned fully counter-clockwise.
- ❑ Connect a key to J1.
- ❑ Attach a 50 Ohm dummy load to J3. Some means of monitoring the output is necessary. A calibrated oscilloscope or QRP wattmeter is ideal
- ❑ Connect a 12V, 1 Amp power supply to J2.
- ❑ Key the Twofer for several seconds at a time and adjust R7 until the output power measures 1 Watt. Depending on the band and supply voltage, you may be able to advance R7 to achieve a slightly higher output. Stop adjusting when no further power increase is observed.

6. Chassis preparation:

Hendricks Twofer Decal Installation

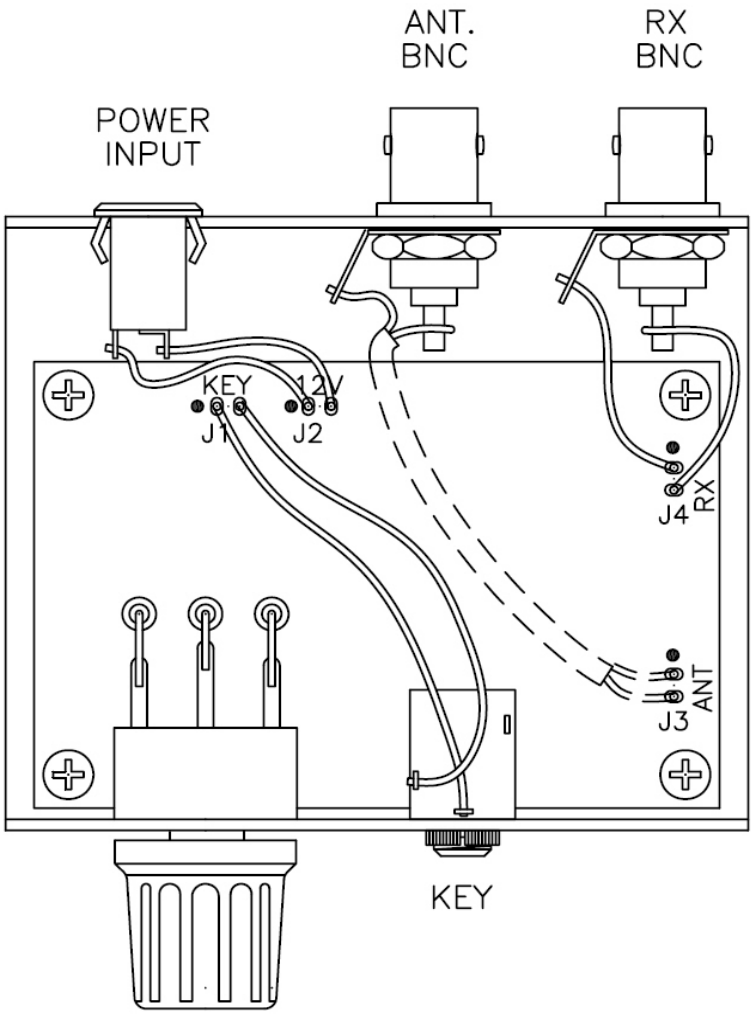


Thoroughly clean the surface of the panel to remove any oils or contamination. If you do not paint your case, we have found that moving the decals into position on a bare aluminum chassis is more difficult, due to the brushed surface, so we advise pre-coating the chassis with a light coating of the Krylon clear before applying the decals.

The decals are applied the same as model decals. Cut around each group of text you wish to apply. It doesn't have to be perfect as the background film is transparent. Apply the decals before you mount anything to the chassis. Use the above picture to get the correct spacing around the holes, as it is very easy to do a great decal installation and have a portion covered up with a knob.

Trim around the decal. After trimming, place the decal in a bowl of lukewarm water, with a small drop of dish soap to reduce the surface tension, for 10-15 seconds. Using tweezers, handle carefully to avoid tearing. Start to slide the decal off to the side of the backing paper, and place the unsupported edge of the decal close to the final location. Hold the edge of the decal against the panel, with your finger, and slide the paper out from under the decal. You can slide the decal around to the right position, as it will float slightly on the film of water. Use a knife point or something sharp to do this. When in position, hold the edge of the decal with your finger and gently squeegee excess water out from under the decal with a tissue or paper towel. Work from the center, to both sides. Remove any bubbles by blotting or wiping gently to the sides. Do this for each decal, and take your time. Allow to set overnight, or speed drying by placing near a fan for a few of hours. When dry, spray two **light** coats of matte finish, Krylon, clear to seal and protect the decals, and allow the spray to dry in between coats. All decals come with two complete sets, in case you mess one up.

7. Chassis wiring

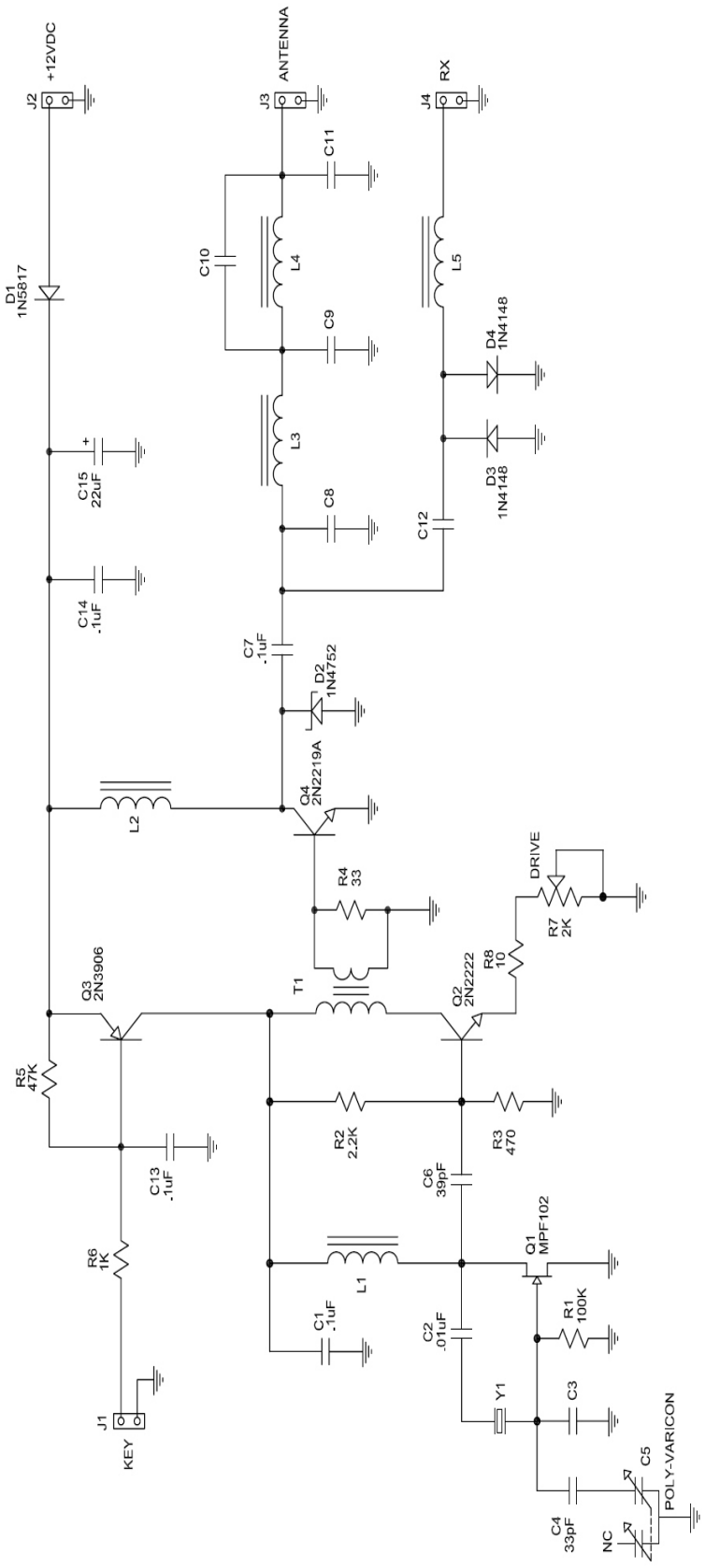


- ❑ You can now mount the PCB, with the four 4-40 screws, and secure the poly-varicon with the two small screws supplied.
- ❑ Unsolder the connectors temporarily used for testing, mount the stereo jack, power connector and the two BNC connectors with the ground tabs as shown.
- ❑ Route and solder the wires from the PCB to the connections as shown.
- ❑ Complete the assembly by mounting the poly-varicon shaft, knob, and four rubber feet on the underside corners of the chassis.

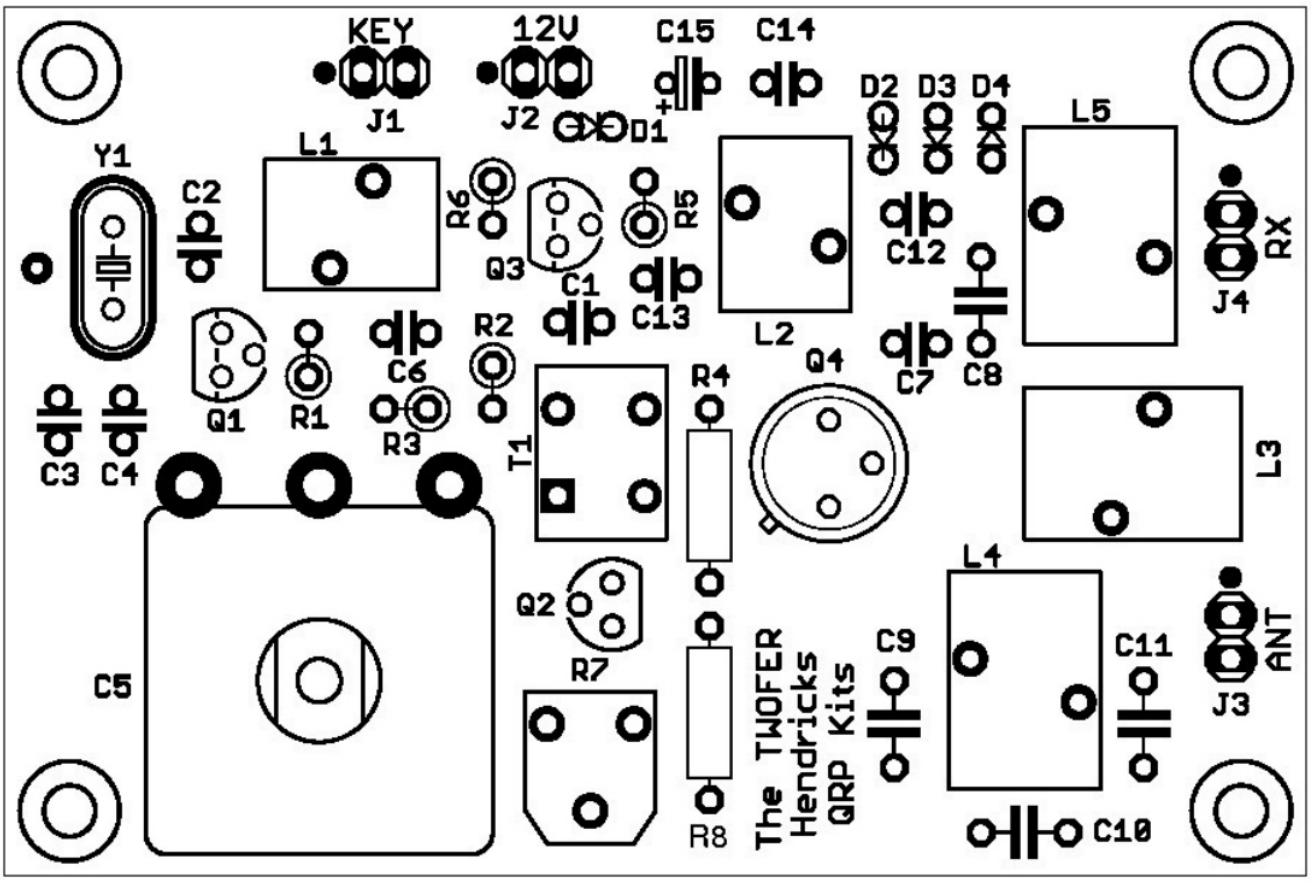
8. Operation

The Twofer has four basic connections: Power, Key, Antenna and Receiver. The power supply voltage is nominally 12 volts and can be supplied from a battery or AC power supply. The transmitter can draw upwards of ½ Amp when keyed, so a suitable supply is necessary. The Key input at J1 is compatible with most keyers. Ground this input to transmit. A 50 Ohm load is required at J3, the antenna connection. D2 protects the output transistor against high SWR conditions. A 50 ohm antenna connection for a separate receiver is provided at J4. During transmit, a small amount of RF is present so you can monitor your keying.

Appendix A - Schematic



Appendix B - Component Layout



Appendix C – General Parts List

Reference Designator	Value	Description
C1	.1uF	Mono ceramic capacitor
C2	.01uF	Mylar capacitor (green)
C3	N/A	Not Used
C4	33pF	NP0 cap
C5	Variable	Poly-varicon w/mounting and shaft hardware
C6	39pF	NP0 cap
C7	.1uF	Mono ceramic capacitor
C13	.1uF	Mono ceramic capacitor
C14	.1uF	Mono ceramic capacitor
C15	22uF	Electrolytic capacitor
D1	1N5817	Schottky diode
D2	1N4752	Zener diode
D3	1N4148	Signal diode
D4	1N4148	Signal Diode
L1	36T – FT37-43 Black core w/paint dot	Toroid choke
L2	21T – FT37-61 Black core	Toroid choke
Q1	MPF102	JFET
Q2	2N2222	NPN
Q3	2N3906	PNP
Q4	2N2219A, 2N3553, or 2SC799	NPN
R1	100k	1/4W Resistor
R2	2.2k	1/4W Resistor
R3	470	1/4W Resistor
R4	33	1/4W Resistor
R5	47k	1/4W Resistor
R6	1k	1/4W Resistor
R7	2k	Trimpot
R8	10	1/4W Resistor
T1	25T/5T-FT37-61 Black core	Toroid transformer

Qty.	Description
1	Chassis
1	DC power jack
2	BNC chassis female
1	Decal Set
1	1/8" stereo jack
1 Lot	Red and Green magnet wire
4	4-40 x .25" philips head screw
4	Rubber feet
18"	Hook-up wire
6"	RG-174 coax
1	Med. knob
1	Printed circuit board
1	Transistor heatsink

Appendix D - Band Specific Parts

80m

Reference Designator	Value
C8	1200pF
C9	2000pF
C10	180pF
C11	1200pF
C12	91pF
L3	22T – T50-2
L4	22T – T50-2
L5	67T – T50-2

40m

Reference Designator	Value
C8	240pF
C9	560pF
C10	120pF
C11	240pF
C12	47pF
L3	15T – T50-2
L4	15T – T50-2
L5	45T – T50-2

30m

Reference Designator	Value
C8	470pF
C9	680pF
C10	56pF
C11	470pF
C12	30pF
L3	13T – T50-2
L4	13T – T50-2
L5	40T – T50-2

20m

Reference Designator	Value
C8	270pF
C9	560pF
C10	56pF
C11	270pF
C12	22pF
L3	10T – T50-2
L4	10T – T50-2
L5	34T – T50-2

15m

Reference Designator	Value
C8	220pF
C9	360pF
C10	27pF
C11	220pF
C12	15pF
L3	9T – T50-2
L4	9T – T50-2
L5	28T – T50-2

10m

Reference Designator	Value
C8	180pF
C9	270pF
C10	15pF
C11	180pF
C12	10pF
L3	8T – T50-2
L4	8T – T50-2
L5	24T – T50-2