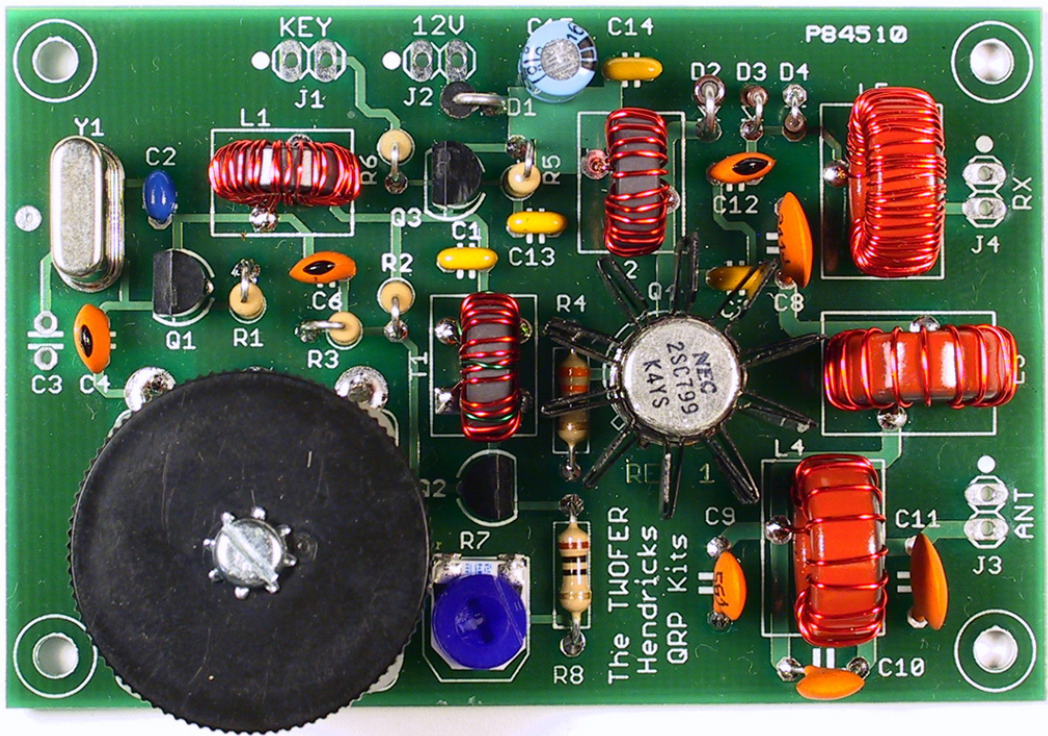


# Hendricks QRP Kits

## The Twofer

### Rev 1

11-15-06



## 1. Description

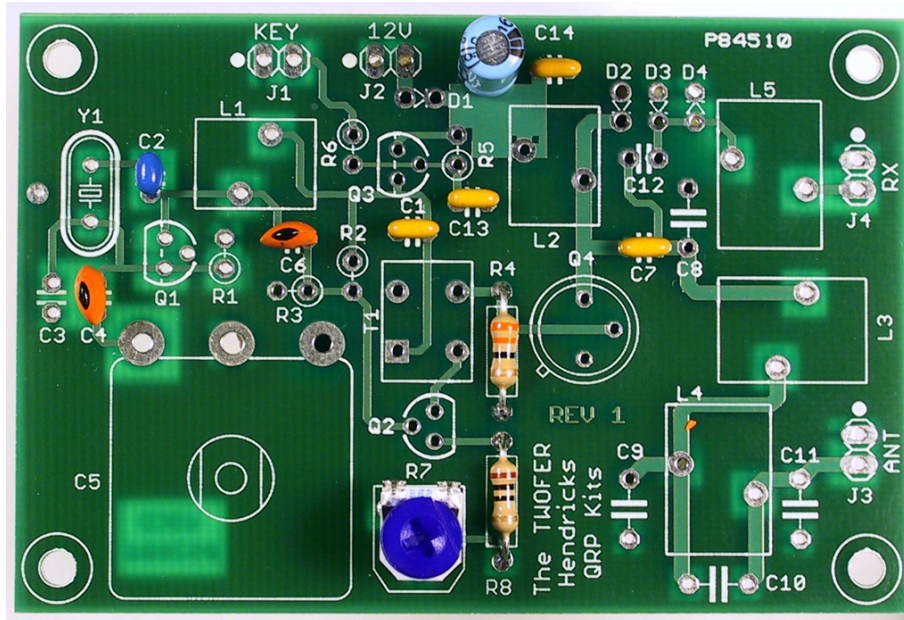
The Twofer is a classic QRP transmitter that's easy to assemble and operate. It uses a JFET VXO (variable crystal oscillator), driver stage and PA stage that's capable of producing over 2 Watts. The VXO range depends on the operating band, but provisions are incorporated for experimentation. The kit is available in 40m, 30m and 20m 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. **Note:** The schematic and parts list specify a 2SC799 transistor for Q4. A 2N3553 may be substituted. They are identical in performance and pinout.

- 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 0.1uF (104) at C1, C7, C13 and C14.
  - 0.01uF (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.



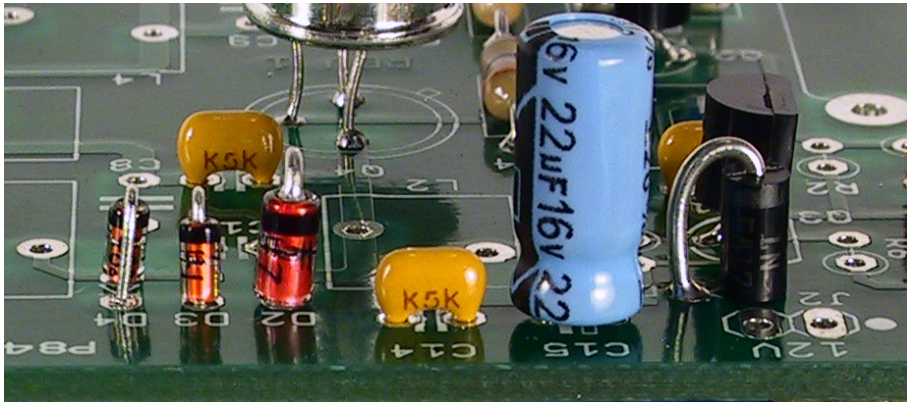
**Figure 1 Capacitor and Resistor Installation**

- 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. If the 2SC799 was supplied with the kit, remove the mounting flange. Save this and the insulating bushings for other projects. Install:
  - MPF102 at Q1.
  - 2N3906 at Q3.
  - 2N2222 at Q2.
  - 2SC799 or 2N3553 at Q4. Leave a 3/16" gap between the bottom of the transistor and the board.



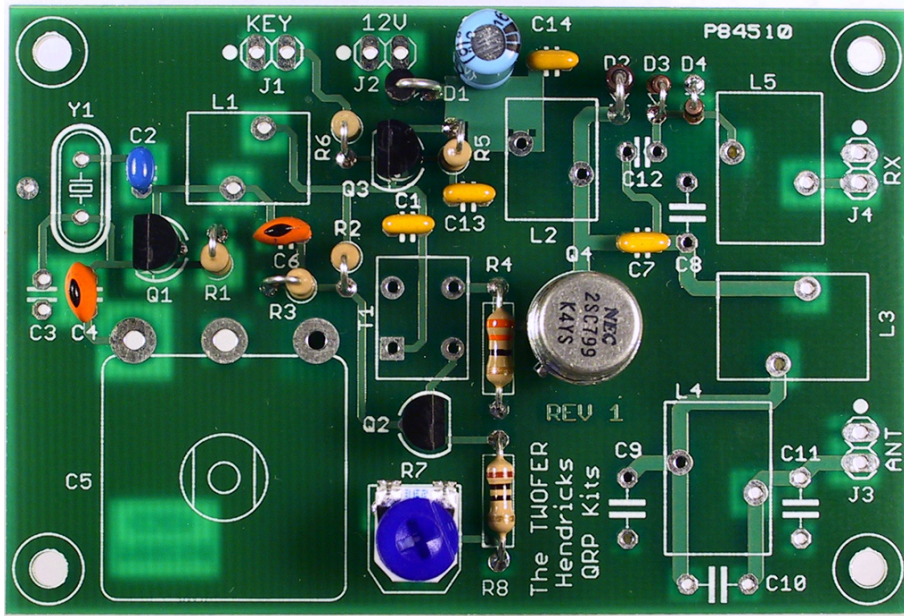


- The diodes are installed with the cathode lead inserted into the hole pointed to by the arrow on the board silkscreen. Figure 4 shows the correct diode orientation. Install:
  - 1N5817 at D1.
  - 1N4752 at D2.
  - 1N4148 at D3.
  - 1N4148 at D4.



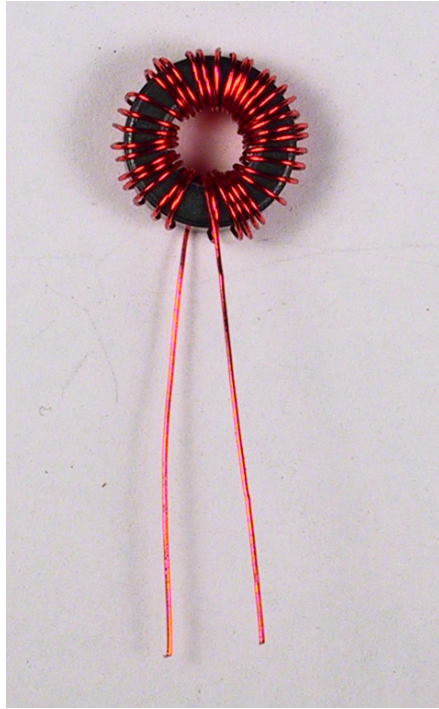
**Figure 4 Diode Installation**

- 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.

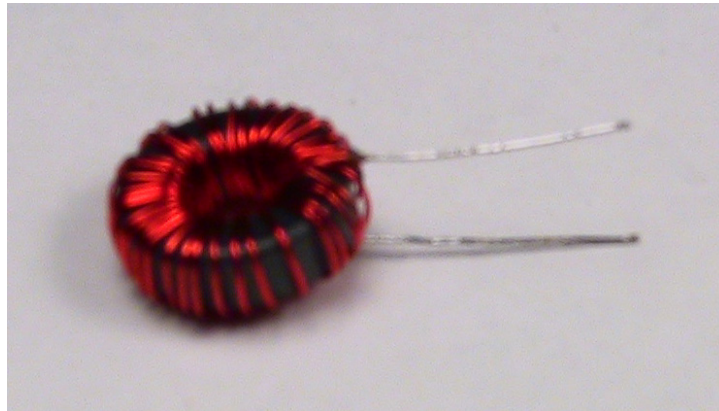


**Figure 5 Resistor Installation**

- Winding L1. Locate the FT37-43 toroid. It is the shiny one with a dot of paint.
  - Measure 20" of the thinner, 30AWG 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.



**Figure 6 Completed L1 before tinning**

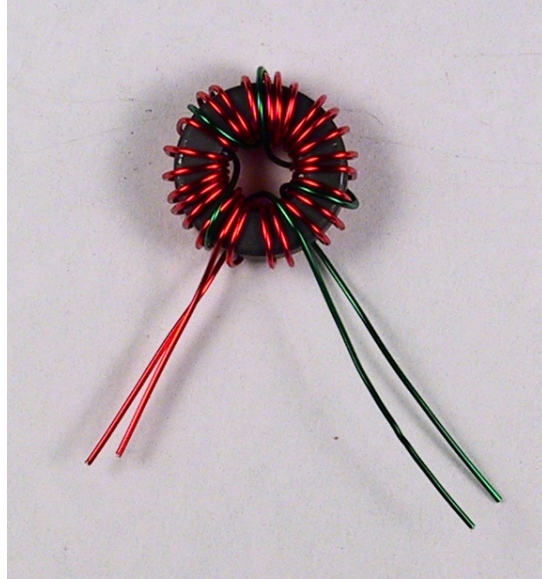


**Figure 7 Tinned Inductor Leads**

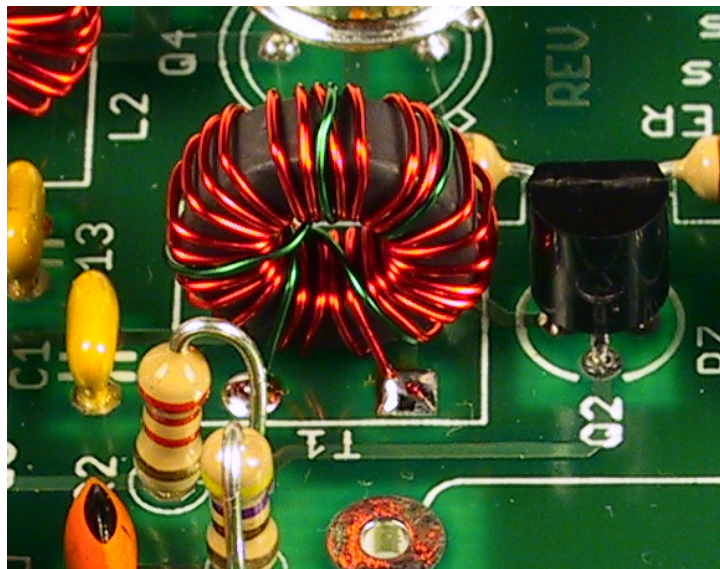
- Winding L2. Locate one of the FT37-61 toroids. It is dull without a paint dot.
- Measure 12" of the heavier, 26AWG FIXME wire and cut.
- Wind 21 turns of wire around the toroid. Again, leave 1" at the start of winding..

- 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 14" of the larger diameter Red 26AWG wire and cut.
  - Wind 25 evenly spaced turns around the toroid.
  - Measure 5" of the Green 26 AWG 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.



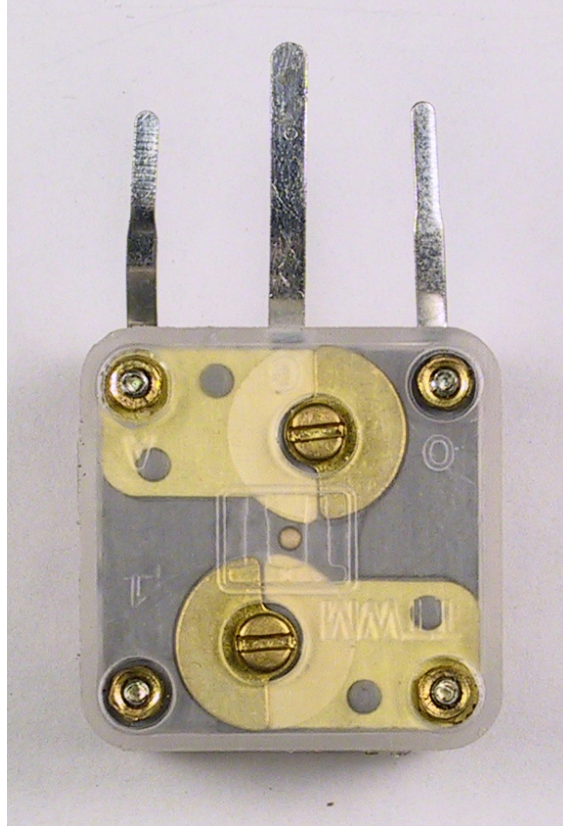


**Figure 8 Correct T1 Lead Dress**



**Figure 9 T1 Installation**

- ❑ Locate the polyvaricon. Using a small screwdriver, adjust the two trimmers on the bottom so they are fully unmeshed. You should see a “full moon” brass colored disk in this condition, as shown in Figure 10.



**Figure 10 Minimum Trimmer Setting**

- Bend the leads of the polyvaricon away from the shaft and install it at C5. The cap should rest flat against the PC board. You can use double-sided tape or a dab of glue to secure it. Solder all three leads and trim.
- Turn the shaft of C5 fully counter clockwise.
- This completes assembly of the general portion of the Twofer. Take a few minutes to inspect your work before continuing.

### 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

- 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 17" of the heavier 26AWG 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 38" of the 30AWG 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 12" of the heavier 26AWG 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 28" of the 30AWG 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 12" of the heavier 26AWG 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 24" of the 30AWG 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 10" of the heavier 26AWG 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 30AWG 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

- 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 10" of the heavier 26AWG 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 18" of the 30AWG 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 10" of the heavier 26AWG 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 16" of the 30AWG wire.
  - Wind 24 evenly spaced turns around the toroid.
  - Trim and tin the leads as before.
  - Install the finished coil at L5



## 4. Final 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.
- Carefully press the top hat heatsink onto Q4.
- Install the thumbwheel knob on C5.

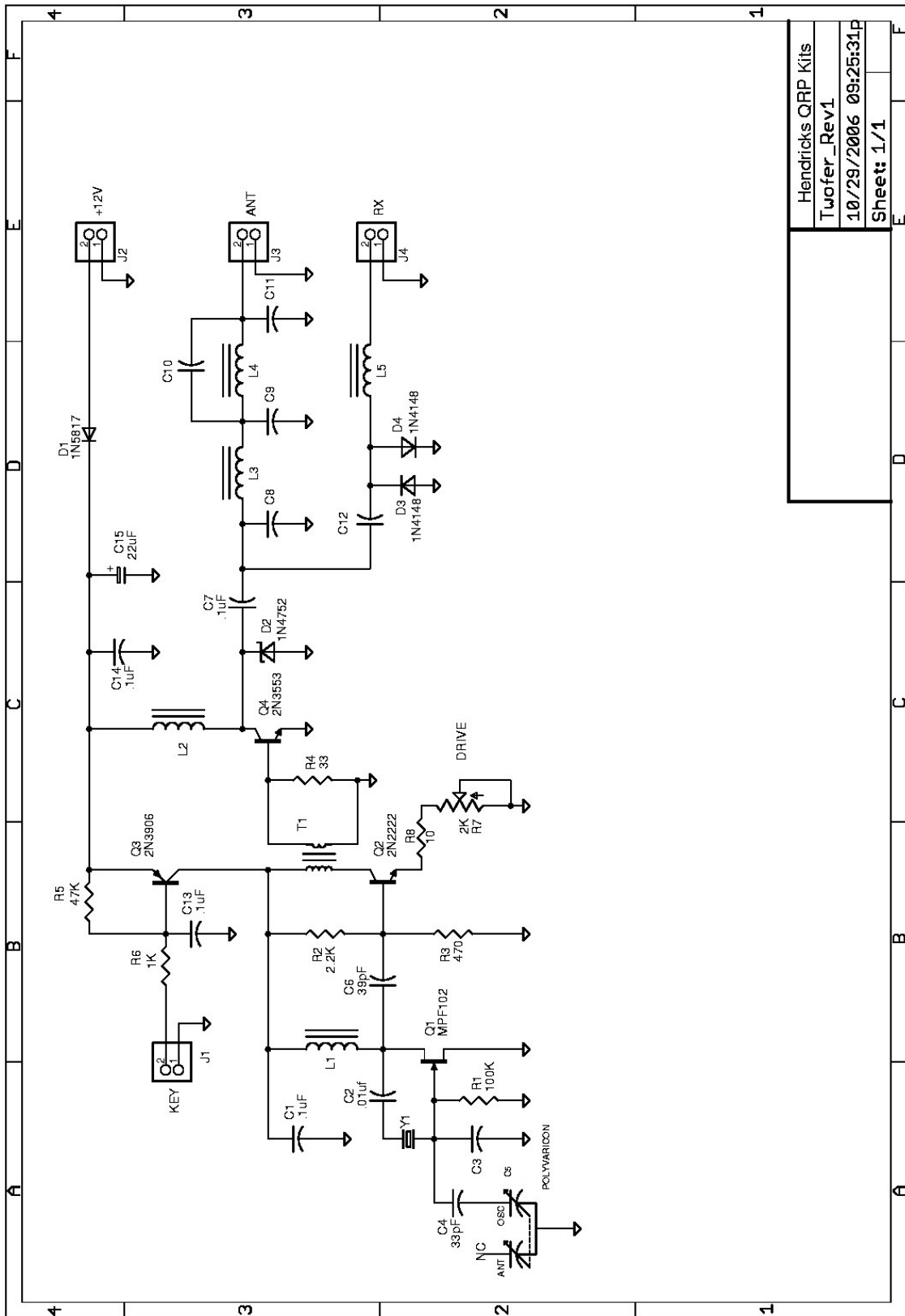
## 5. Testing

- Note that 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 2 Watts. 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.
- Measure the VXO range. This is highly dependent on the operating band. Lower bands tend to have a smaller spread. C3 is not part of the basic kit, but you can experiment with different values to adjust the frequency range to your particular interests.

## 6. Operation

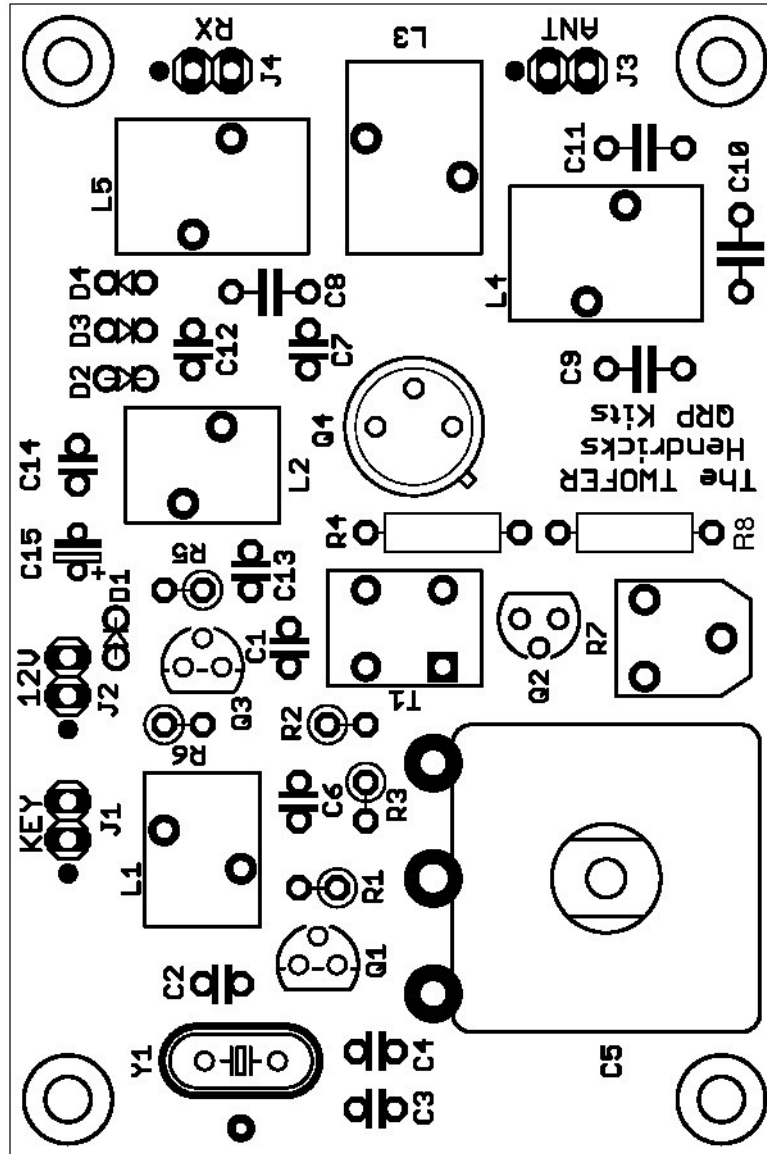
The Twofer has four basic connections: Power, Key, Antenna and Receiver. The power supply voltage is nominally 12 volts and can be supplied from a battery or AC power supply. The transmitter can draw upwards of ½ Amp when keyed, so a suitable supply is necessary. The Key input at J1 is compatible with 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



Hendricks QRP Kits
Twofer_Rev1
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# Appendix B – Component Layout





## Appendix C – General Parts List

Reference Designator	Value	Description
C1	0.1uF	Mono ceramic capacitor
C2	0.01uF	Mono ceramic capacitor
C3	N/A	Not Used
C4	33pF	NP0 cap
C5	Variable	Polyvaricon
C6	39pF	NP0 cap
C7	0.1uF	Mono ceramic capacitor
C13	0.1uF	Mono ceramic capacitor
C14	0.1uF	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	Toroid choke
L2	21T – FT37-61	Toroid choke
Q1	MPF102	JFET
Q2	2N2222	NPN
Q3	2N3906	PNP
Q4	2SC799/2N3553	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	Toroid transformer
N/A	N/A	Top hat heatsink – style may vary
N/A	N/A	C5 turning knob

## 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

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

## 15m

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

## 10m

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