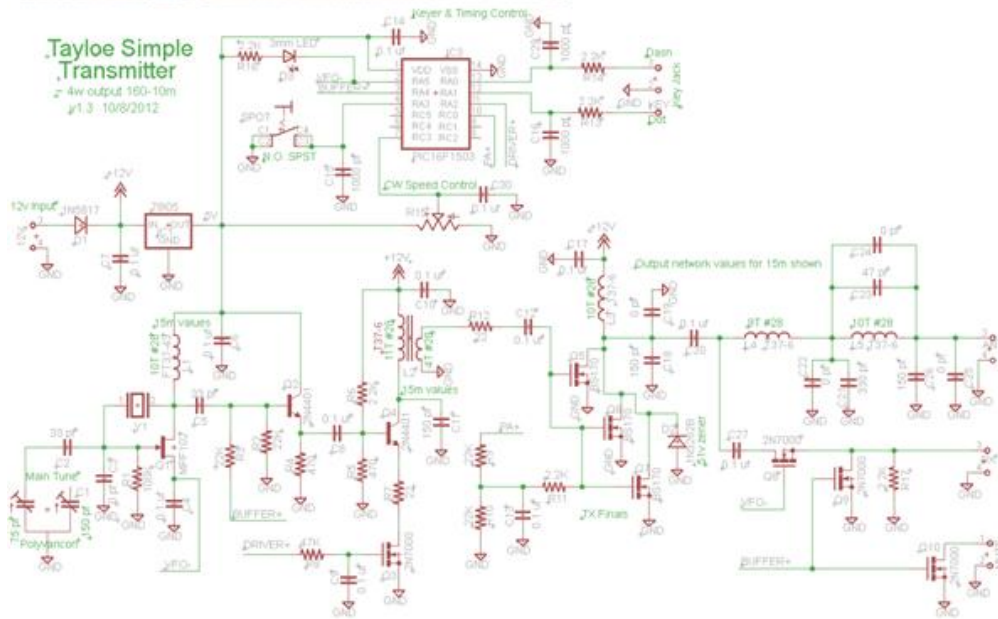
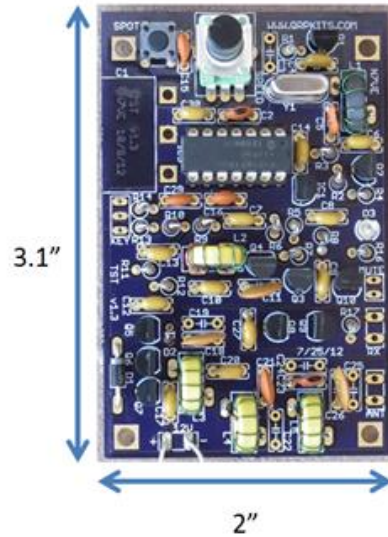


Hendricks QRP Kits



Taylor Simple Transmitter (TST)

4w Crystal CW Transmitter for 10-17m
With build in keyer and cw speed pot

by Dan Tayloe, N7VE

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Specifications and Features

As measured from current prototypes, some variance in performance is expected from unit to unit.

Transmitter

Power Output: ~4w into a 50 ohm load at 12v

TX power amplifier efficiency: ~70%. Finals stays cooler, transmitter draws less power.

Note: *TX designed for CW type transmit duty cycle. Prolonged key down operation is not advised.*

TX harmonic output suppression readily exceeds FCC specifications: >55 dB attenuation typical

Spot Switch: Turns on the oscillator and buffer so that you can find it with a receiver

Built In Keyer: Keyer chip included with adjustable cw speed pot

Straight Key mode: Power up with the jack “ring” shorted (mono plug) causes the keyer to enter straight key mode. This mode is useful with external memory keyers for beacon use, as well as normal straight keys or bugs.

Straight Key “dotting” mode: Staying key down for several seconds places the transmitter into “dotting” to protect the finals.

Built in receiver T/R switch with “mute” output: An external receiver can be hooked up directly to the transmitter “RX” output. “Mute” output provides an open collector shunt to ground during transmit.

Building the Kit

Things you will need

- Solder sucker (highly recommended) or solder wick
- Temperature control soldering iron with a fine tip
- *14 pin socket for the PIC16F1503 microcontroller (optional)*
- Magnifying headpiece and/or magnifying glass. 3.5 power reading glasses may work also. Try them on and check for focus at a 6 to 8" operating distance.
- Cookie sheet (highly recommended for building on top of in order to catch stray parts and most importantly to reduce **static discharge damage** to parts.

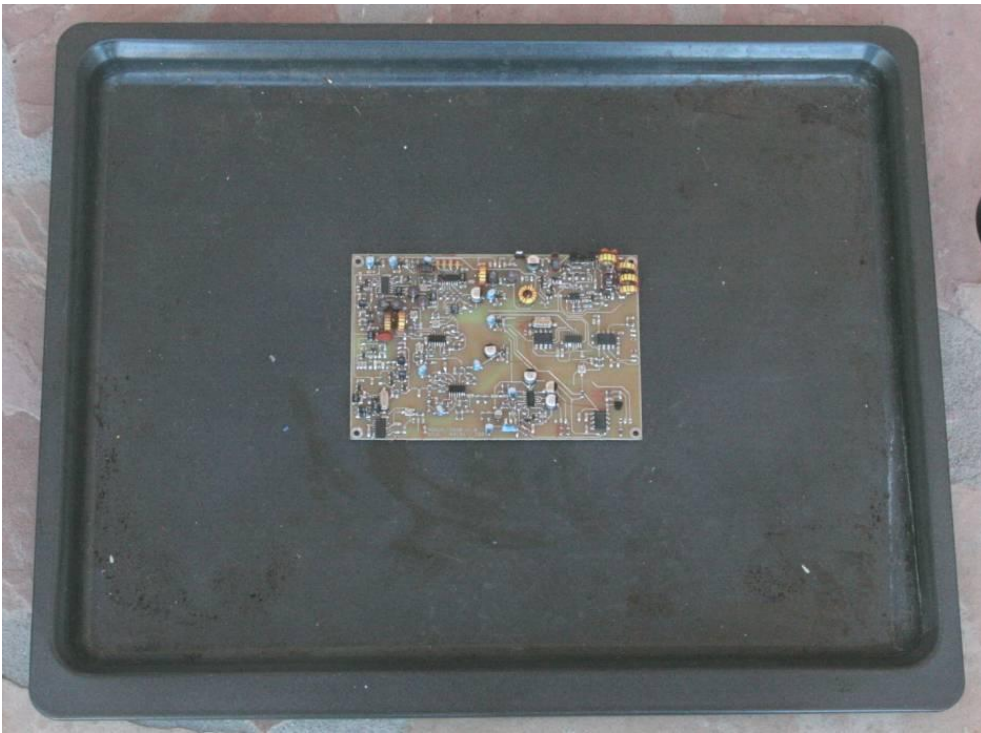


Figure 1. Working over an oversized cookie sheet is highly recommended



Figure 2. A temperature controlled soldering helps a lot. 750 degrees is recommended for non-lead tinned boards



Figure 3. A very pointed soldering iron tip is a big help for small components



Figure 4. Headband Magnifiers. “Mag-eyes” from JoAnn Fabrics

As far as magnification, I think that common reading glasses may be just as good. Try 3.5 or 3.25 magnification glasses. Try them on and check the focus distance. Ideal is a focus distance of about 8 inches.

I use the above Mag-eyes with my normal 1.5x reading glasses. I can gang both the reading glasses and the Mag-eyes together to get a really good, close up look at the parts. However, it does drive my eyes a bits nuts switching from no glasses to glasses, to Mag-eyes, to glasses plus Mag-eyes.

Parts List

Below is a list of the all parts that are included in the kit:

Table 1. Inventory of band generic parts

Capacitor list		
Quantity	Value	Devices
13	0.1 uF	C4, C6, C7, C8, C9, C10, C12, C13, C14, C17, C20, C27, C30
3	1000 pf	C15, C16, C29
2	33 pf	C2, C5
1	Main tuning Polyvaricon	C1

Diode, Transistors and IC list		
Quantity	Value	Devices
1	1N5817	D1
1	1N5262B 51v zener	D2
1	3mm water clear ultra bright LED	D3
1	78L05	IC1
1	PIC16F1503	IC3
1	2N5485	Q1
2	2N4401	Q2, Q4
3	BS170	Q5, Q6, Q7
4	2N7000	Q3, Q8, Q9, Q10

Resistor list		
Quantity	Value	Devices
2	22	R7, R12
2	470	R4, R5
6	2.2K	R6, R11, R13, R14, R16, R17
4	22K	R2, R3, R9, R10
1	47K	R8
1	100K	R1
1	100K PCB mount	Code Speed Pot

Inductor list		
Quantity	Value	Devices
4	T37-6	L2, L3, L4, L5
1	FT37-43	L1

Case hardware list		
Quantity	Value	Devices
1	CHASSIS	
4	4-40 x .25 Pan HEAD SCREW	
1	Medium NORCAL KNOB	
4	RUBBER FEET, 1/4" THICK	

Misc hardware list		
Quantity	Value	Notes
1	SPST_SWITCH - Spot	
1	1/8th stereo jack – Keyer paddles/Key input	
2	BNC antenna jack (with ground lug, lock washer, and nut)	
1	Panel Mount Power Jack	
2	Polyvaricon mounting screw	
1	Polyvaricon 1/4" nylon shaft	
1	Polyvaricon shaft screw	
1	8 inches red # 28 gauge wire	
1	5 feet green # 28 gauge wire	
1	12 inches hook up wire	
1	PC board	
1	<i>Optional:</i> 14 pin IC socket for PIC16F1503 processor	<i>User supplied</i>

Table 2. Band Specific Part Values

	C3	C11	C18	C19	C21	C22	C23	C24	C25	C26
10m	-	68 pF	68 pF	-	220 pf	-	33 pf	-	100 pf	33 pF
15m	-	150 pF	150 pF	-	330 pf	-	47 pf	-	-	150 pF
17m	-	180 pF	150 pF	-	220 pf	180 pf	56 pf	-	-	180 pF

	L1	L2	L3	L4	L5
10m	9T	10/4T	9T	9T	9T
15m	10T	11/4T	10T	9T	10T
17m	11T	12/4T	11T	10T	11T

Tools and Construction Hints

In building this transceiver as well as others, I have had some problems. These fall into several different categories:

- 1) ICs mounted backwards
- 2) Resistors and capacitors not soldered to the right set of pads
- 3) Diodes installed backwards
- 4) Not all parts were installed
- 5) Leads not totally stripped on the toroid cores

Please learn from my mistakes. Each time an IC is mounted, check the mounting polarity twice before soldering it in. I suggest checking the IC polarity, soldering down one corner pin, and then checking it one more time before finishing the job. I think the old saying is “measure twice, cut once.”

I have once been bit by not mounting all the parts. Double check the pictures against your kit to make sure things end up in the right place.

You may find that the components in the pictures may be slightly different from what is in your kit. Parts can change from order to order.

This manual has been set up to build a section, and then test it. The tests are normally quite simple. This should find most problems as we go from stage to stage rather than getting to the end and not knowing where to start.

I found building the transceiver over a large cookie sheet eliminated the problem of dropping parts and losing them. However, when doing the applied voltage tests, you should place a few sheets of clean paper under the boards to keep them from shorting out against the cookie sheet.

Some parts are static sensitive! Please take the suggestion to build over a conductive surface like a large cookie sheet and always touch the cookie sheet before touching any part after leaving and returning to work.

This transmitter can be built in about four hours.

Bare PC Board Pictures

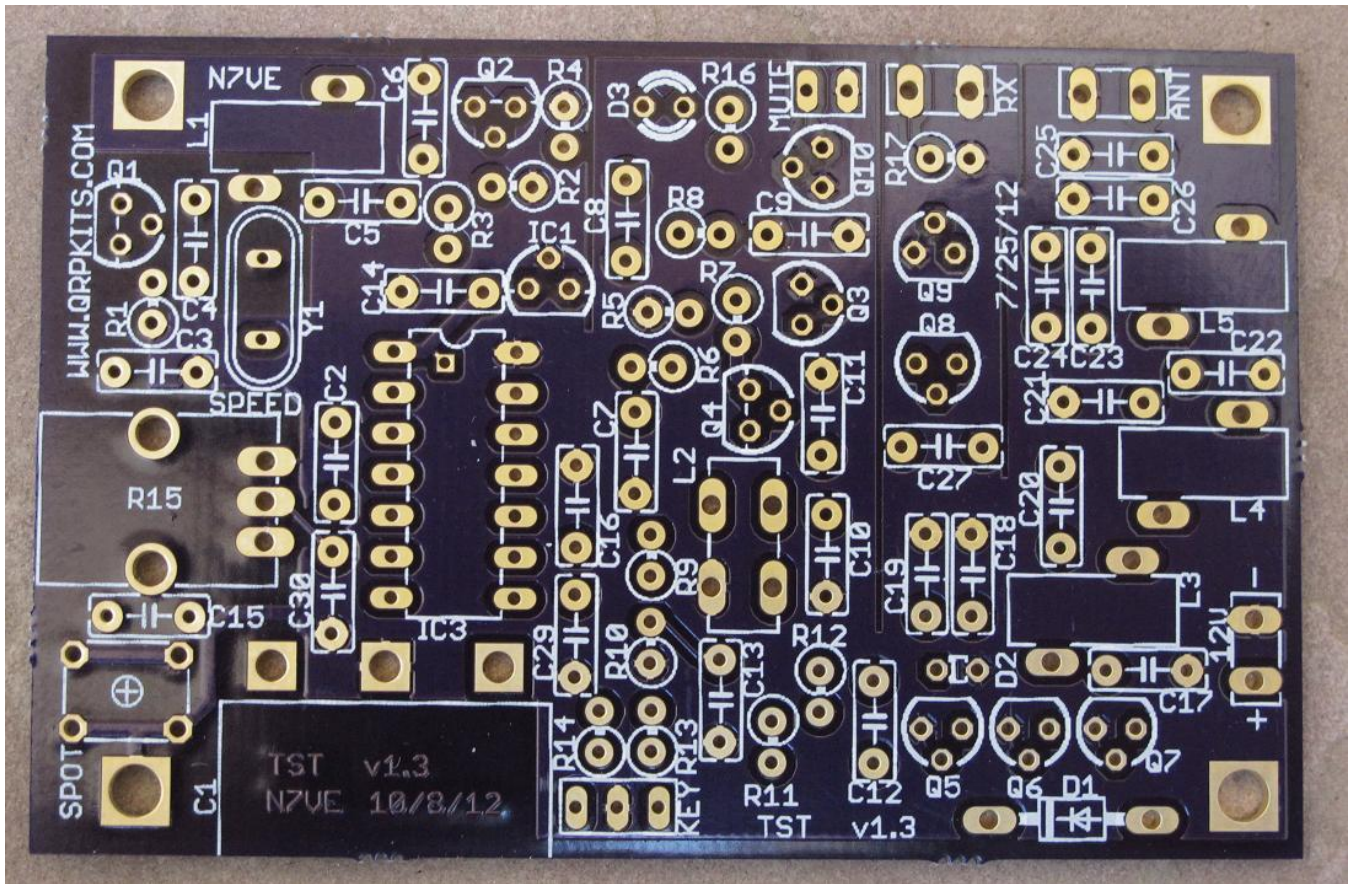


Figure 5. Top side view of the TST board

Installation of Miscellaneous Parts

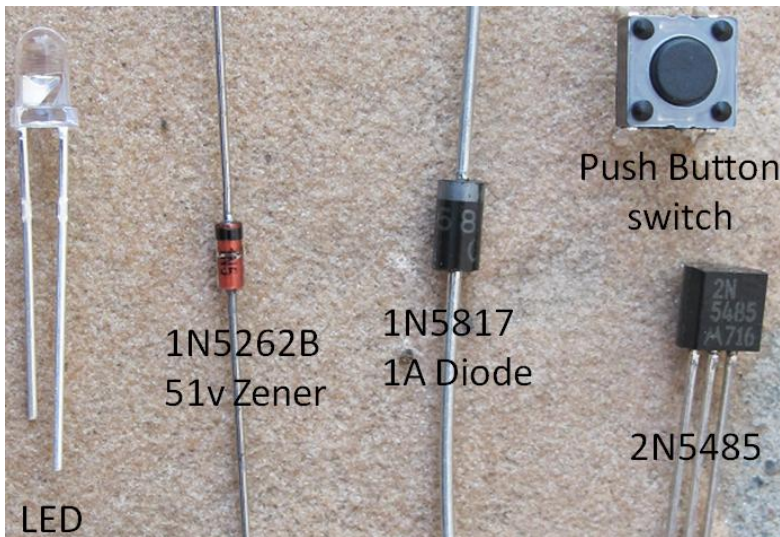


Figure 6. Misc parts to be mounted. Push button may have an extension shaft.

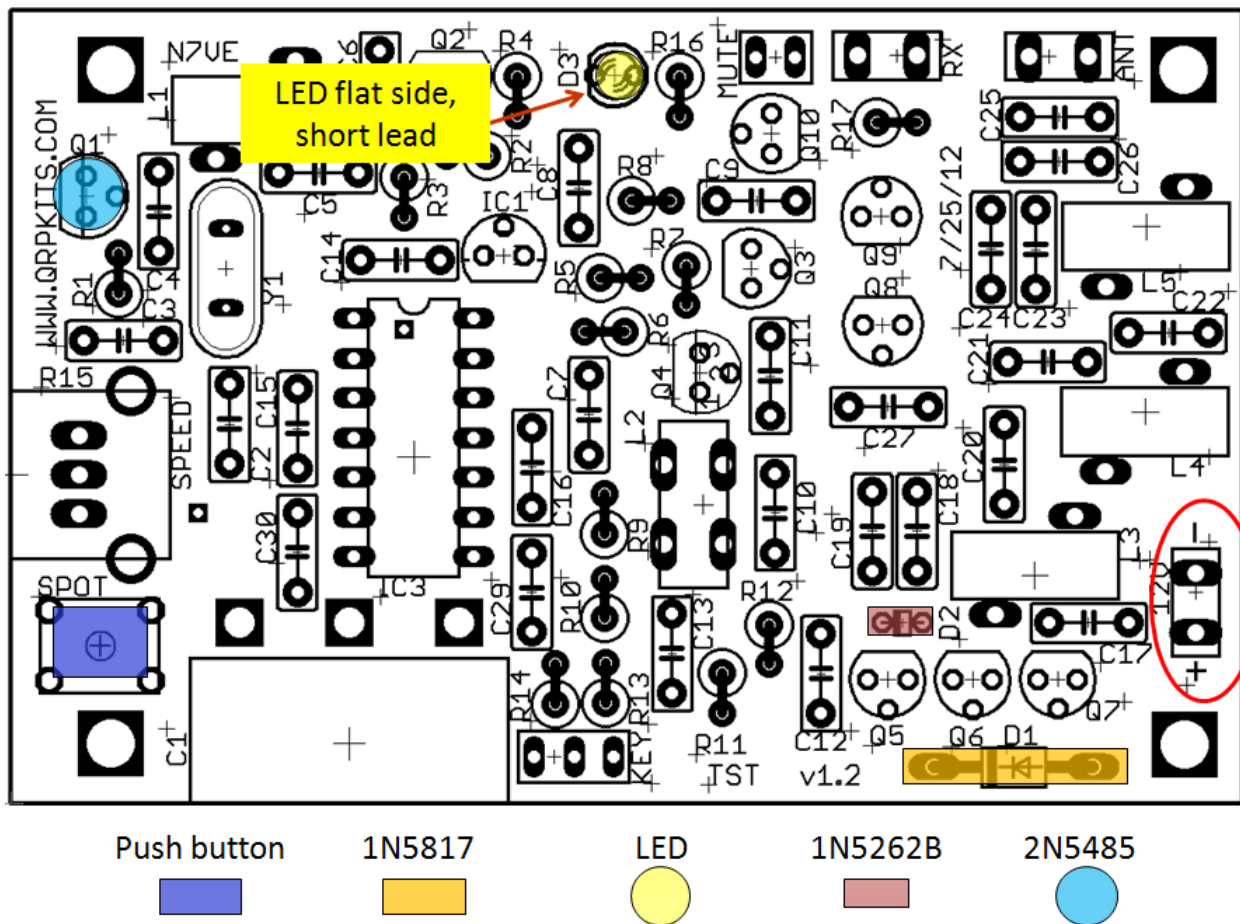


Figure 7. Parts location of misc parts

Install the following parts in the following order:



Figure 8. LED. Flat LED side matches the **short** lead side.

Install □ D3 (LED). *Looking closely, one side of the LED has a flat spot. The LED needs to be installed with the flat side oriented as shown above. TIP: The short lead on the LED is the side with the “flat” spot.* Make sure the LED is inserted as far as it will go into the board as we do not want excess lead length.

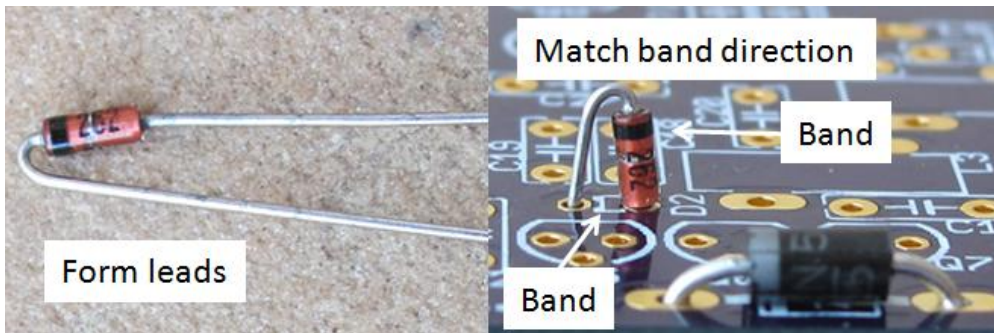


Figure 9. D2 details. Mount diode vertically with the white band on the board matching the band on the diode

Install □ D2 1N5262B 51v zener. See details above. This diode is mounted vertically (on end) with the banded end in the air. Make sure the banded end connects to the hole as shown on the D2 board markings. *There is only one part like this. Double check the polarity of the diode against the photos below.*

Install □ D1 1N5817 1A polarity protection diode. See details below. Make sure the banded end connects to the hole as shown on the D1 board markings. *Double check the polarity of the diode against the photos below. Use the trimmed as temporary leads for the input voltage as shown below.*

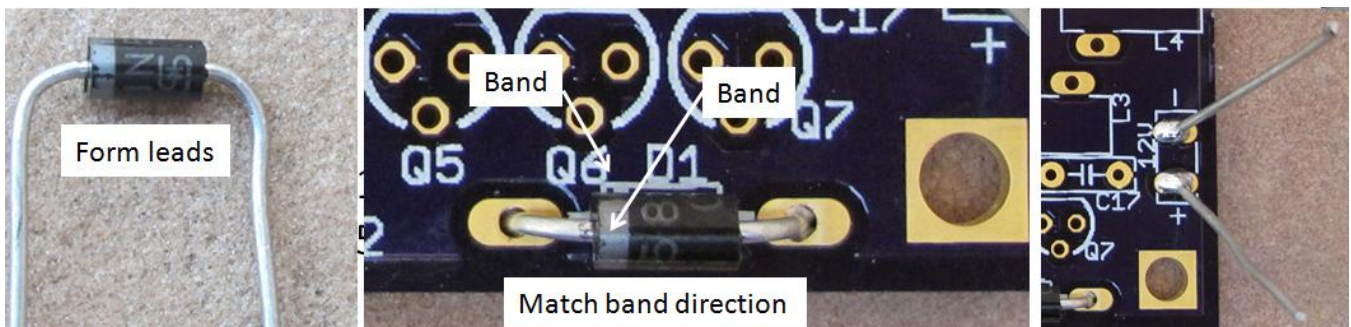


Figure 10. D1 details. Make sure to install in the proper orientation. Use trimmed leads for input voltage

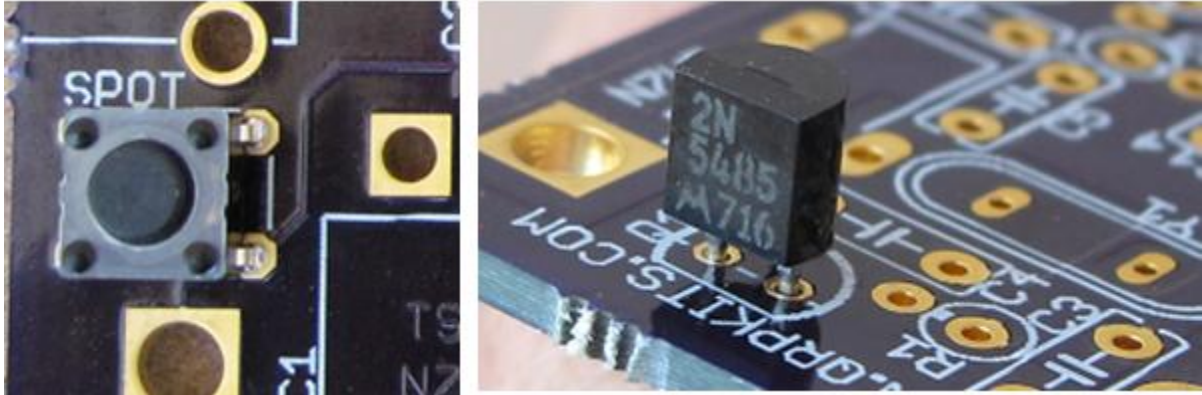


Figure 11. Spot Switch and Q1 Installed. Keep Q1 Leads Short!

Install 2N5485 □ Q1 – **Match flat side with board outline as shown above!** Keep the leads short on all devices – mount the transistor low to the board.

Install push button □ SPOT – Note that the push button may have a vertical extension shaft.

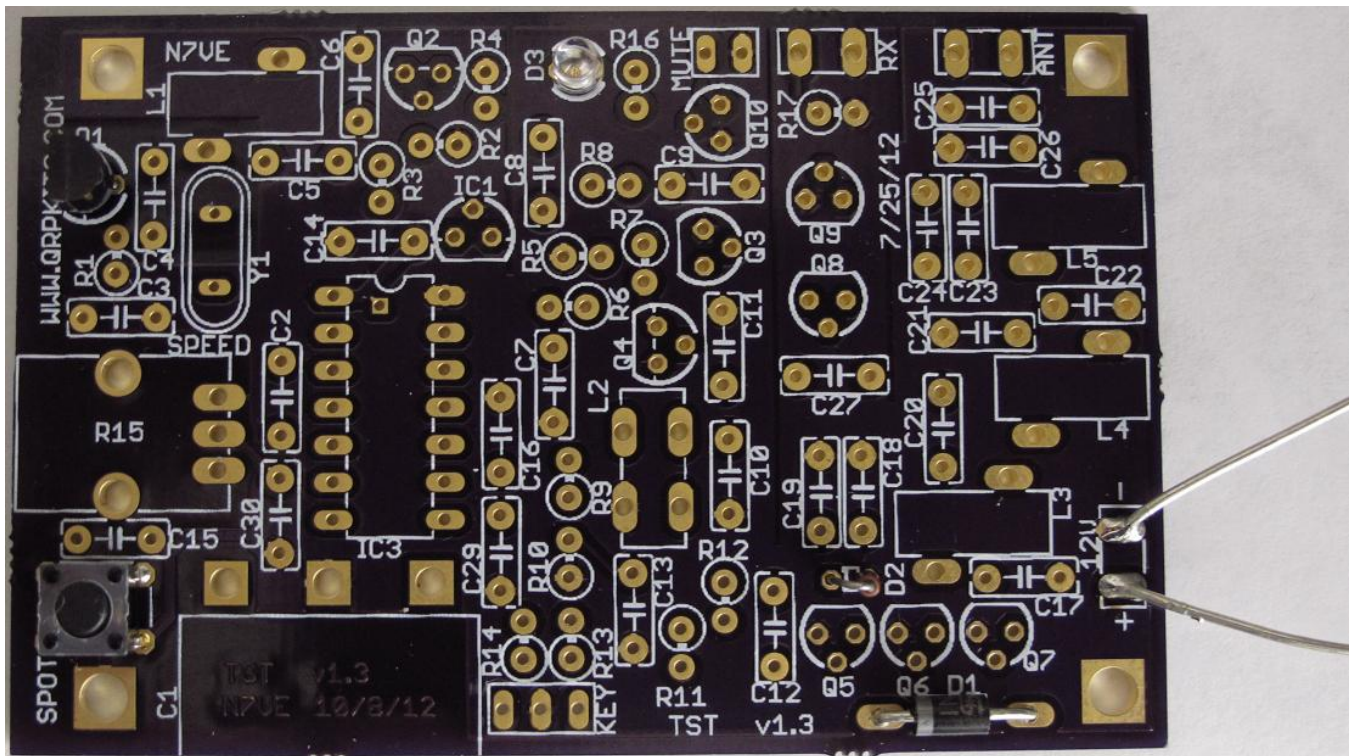


Figure 12. Misc parts shown mounted on PCB.

Installation of the Resistors

It is very easy to get resistors confused. 470 and 47K resistors and 22 ohm, 2.2K and 22K ohm resistors are easy to confuse. First start by sorting all the resistors into seven different piles, one pile for each resistor type. **You can use a volt-ohm meter to double check the resistor values as an additional precaution.**

The seven resistor types in this kit and their associated color codes are:

100K (brown – black – yellow) – 1 resistor total
47K (yellow – violet – orange) – 1 resistor total
22K (red – red – orange) – 4 resistors total
2.2K (red – red – red) – 6 resistors total
470 (yellow – violet – brown) – 2 resistors total
22 (red – red – black) – 2 resistors total

All resistors are mounted vertically. The base of the resistor is mounted on the circle portion of PCB symbol, while the direction of the pad for the other lead is indicated by the square on the circle as shown below.

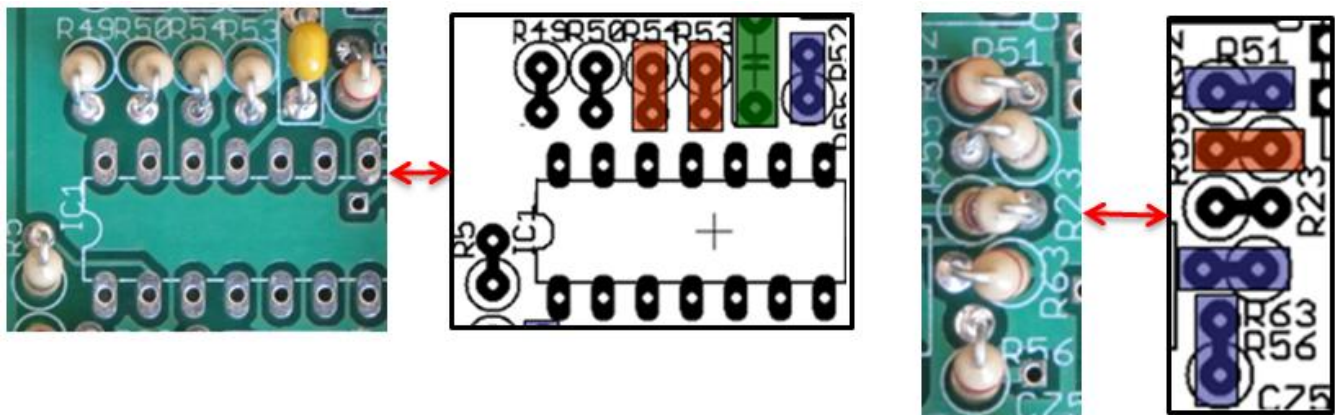


Figure 13. Overlay resistor orientation vs. PCB mounted part resistor orientation

Notice the “Rxx” designation on the overlay diagram and the placement of the real resistors on the board. Again, the resistor body goes on the circle, and the resistor lead goes in the direction of the small square on the circle. Note in particular R48 and R50 in the first drawing and the direction it indicates for the lead side of the resistor. Compare that with the mounted resistor in the photo. Like wise, in the second drawing, R56 at the bottom is pointed North-South (NS) while the other resistors above it are pointed East-West (EW).

The overlay has exaggerated the correct resistor installation direction by the use of a colored rectangle to indicate the proper orientation when a resistor is to be installed in a particular spot.

It is easy to place a resistor in the wrong spot. I suggest placing the resistor in the board, spreading the leads outward on the bottom to hold them into place, then double checking the parts placement a second time before soldering the resistors in place and trimming off their leads.

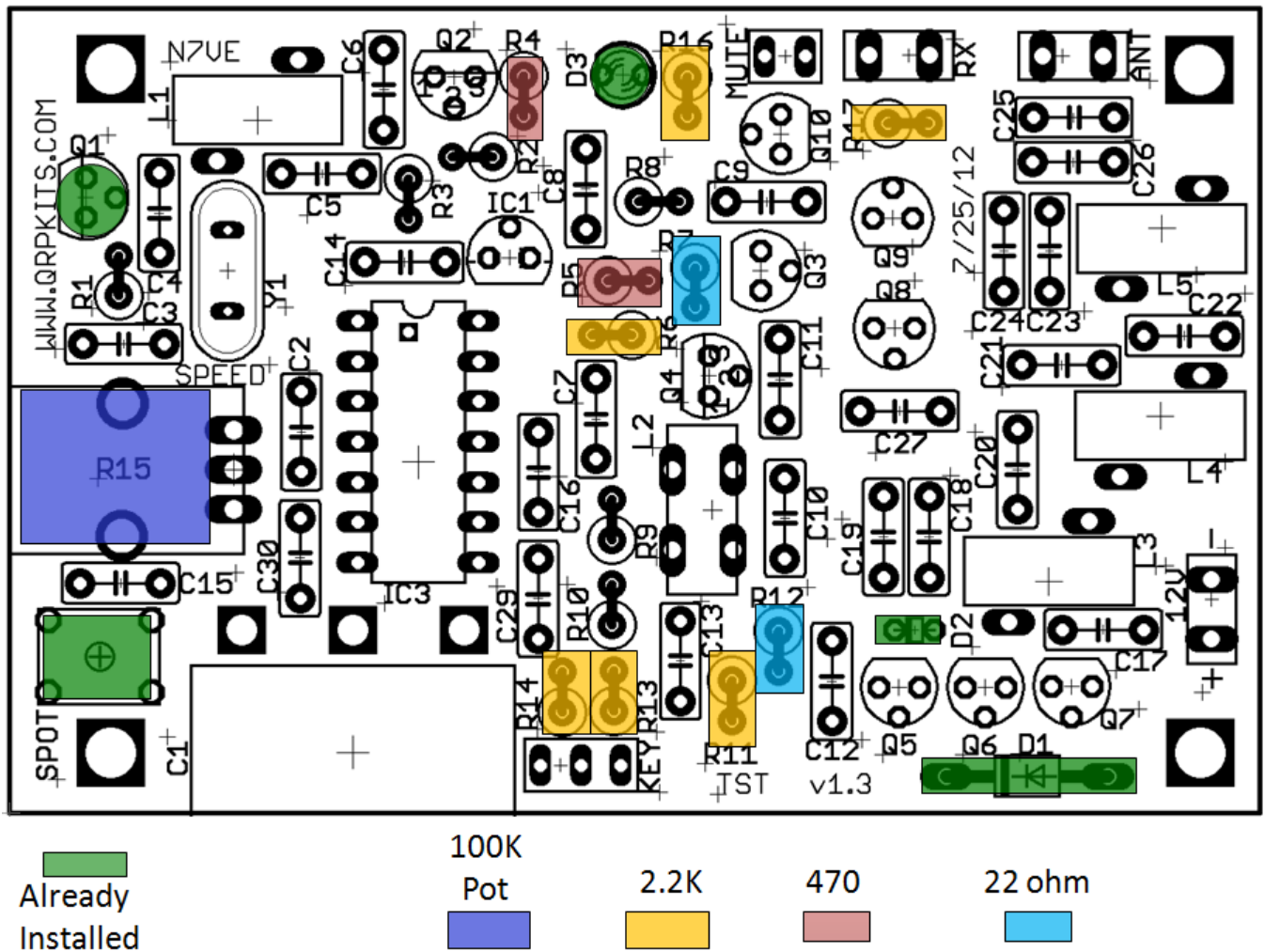


Figure 14. Installation locations of 22, 470, 2.2K and 100K cw speed pot resistors



Figure 15. Perform visual inspection to make sure all resistors are the same value

When installing resistors, it is very easy to mix up red-red-orange (22K), red-red-red (2.2K) or with red-red-black (22). I recommend gathering all resistors of the same type, *line them up in your fingers* and inspect them to make sure they are all exactly the same and that they are the right colors. See above.

If in doubt, double check the resistance value with an ohm meter.

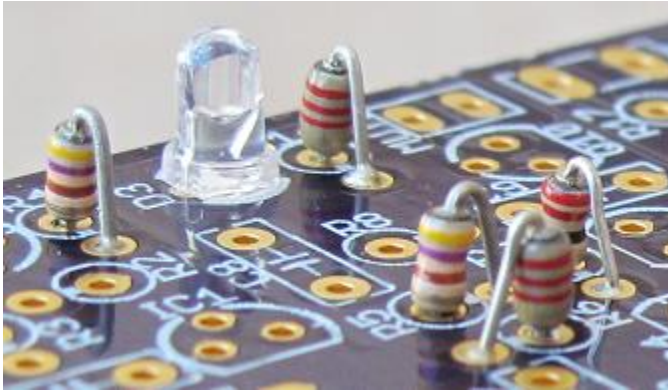


Figure 16. Resistors are mounted vertically, with short leads, body on the circle, close to the PCB

As the parts are installed, it is recommended to both *check the box* below and *cross off the part on the picture* above. Install the following parts in the following order:

Install 2.2K resistors (marked red – red – red). R6, R11, R13, R14, R16, R17 *Make sure R13, R14 are N-S, not E-W*

Install 22 ohm resistors (marked red – red – black). R7, R12

Install 470 resistors (marked yellow-violet-brown). R4, R5

Install 100K cw speed pot as shown below: R15

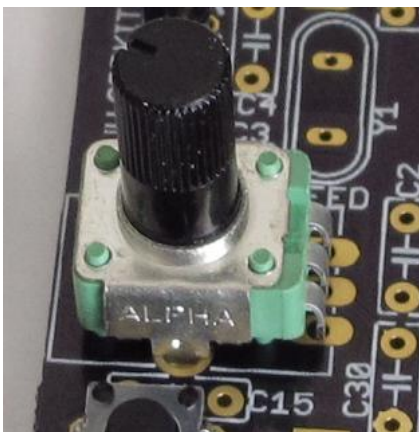


Figure 17. CW speed pot installed

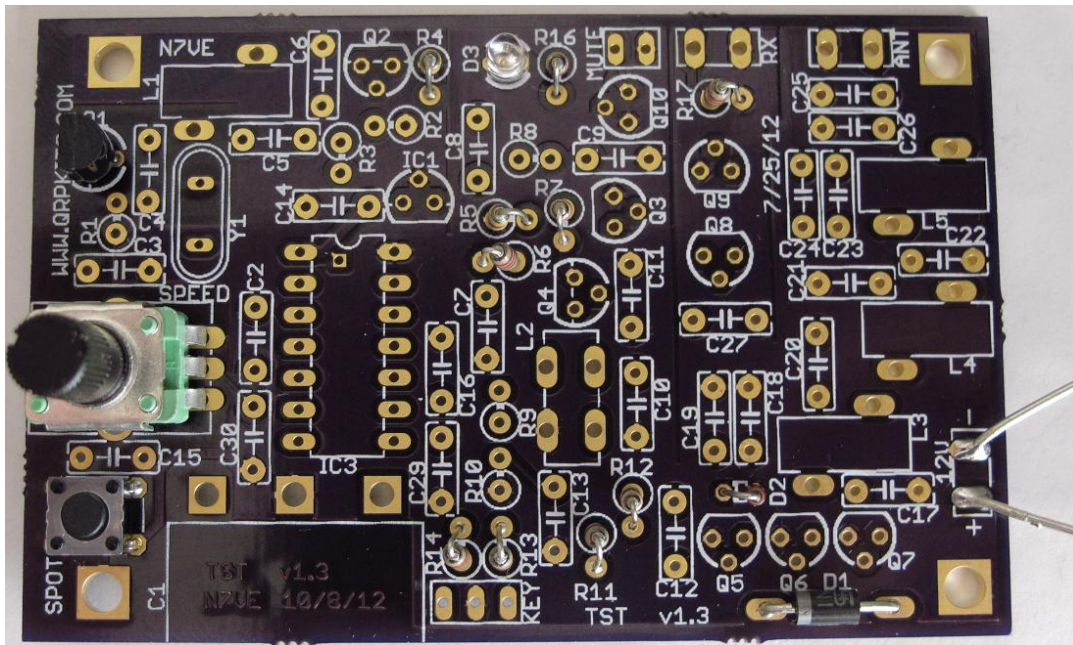


Figure 18. Board with 22, 470, 2.2K resistors and cw speed pot installed

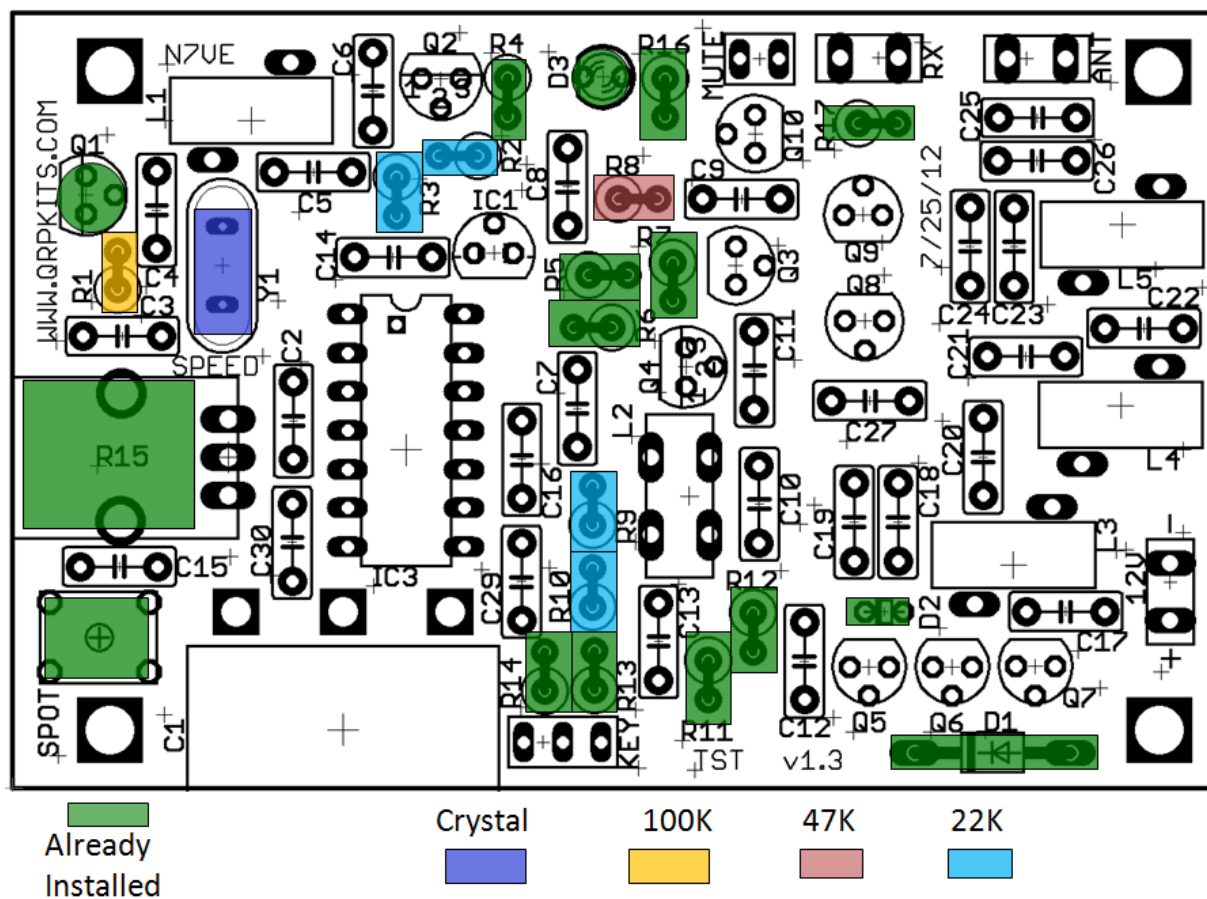
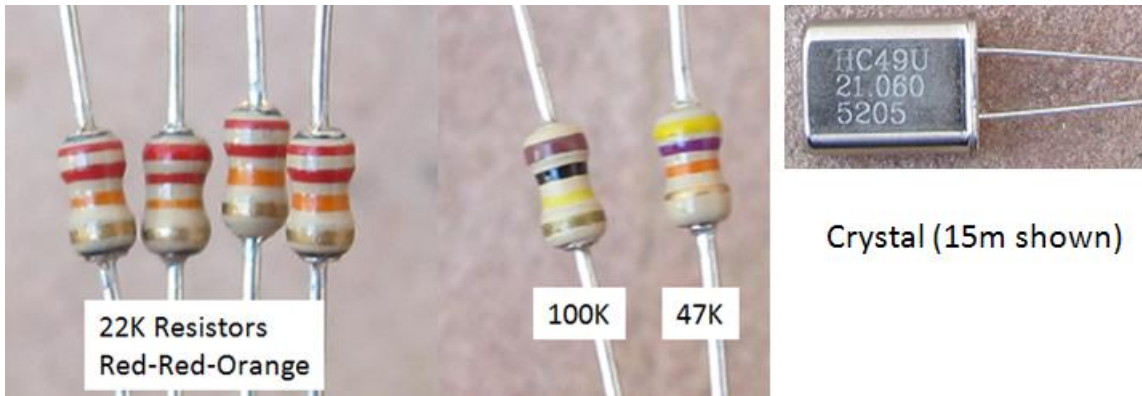


Figure 19. Placement of 22K, 47K, 100K and Crystal on Board



Crystal (15m shown)

Figure 20. Parts installed this step. Hold all 22K resistors together and double check they match

As the parts are installed, it is recommended to both *check the box* below and *cross off the part on the picture* above. Install the following parts in the following order:

Install 100K resistor (marked brown – black – yellow). R1

Install 47K ohm resistors (marked yellow – violet – orange). R8

Install 22K resistors (marked red – red – orange). R2, R3, R9, R10

Install the crystal. Y1

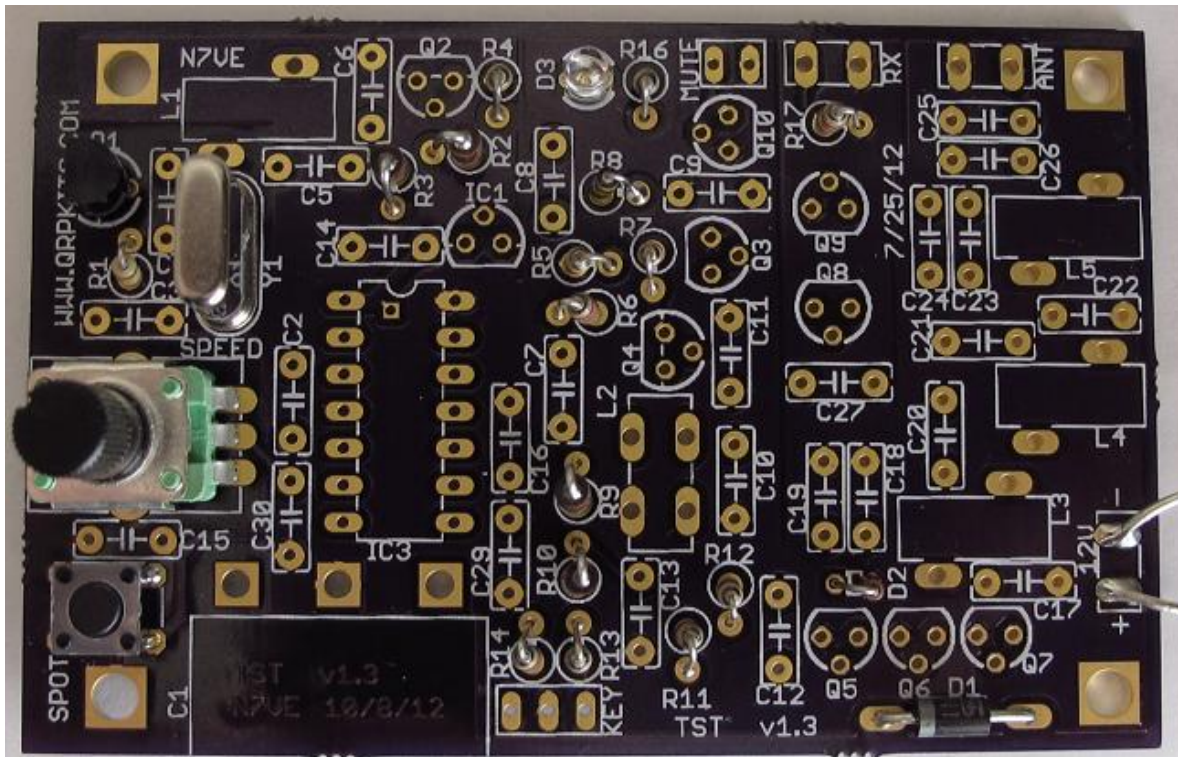


Figure 21. Board with 4.7K, 22K, 47K, 100K resistors and crystal installed

Installation of the Capacitors and ICs

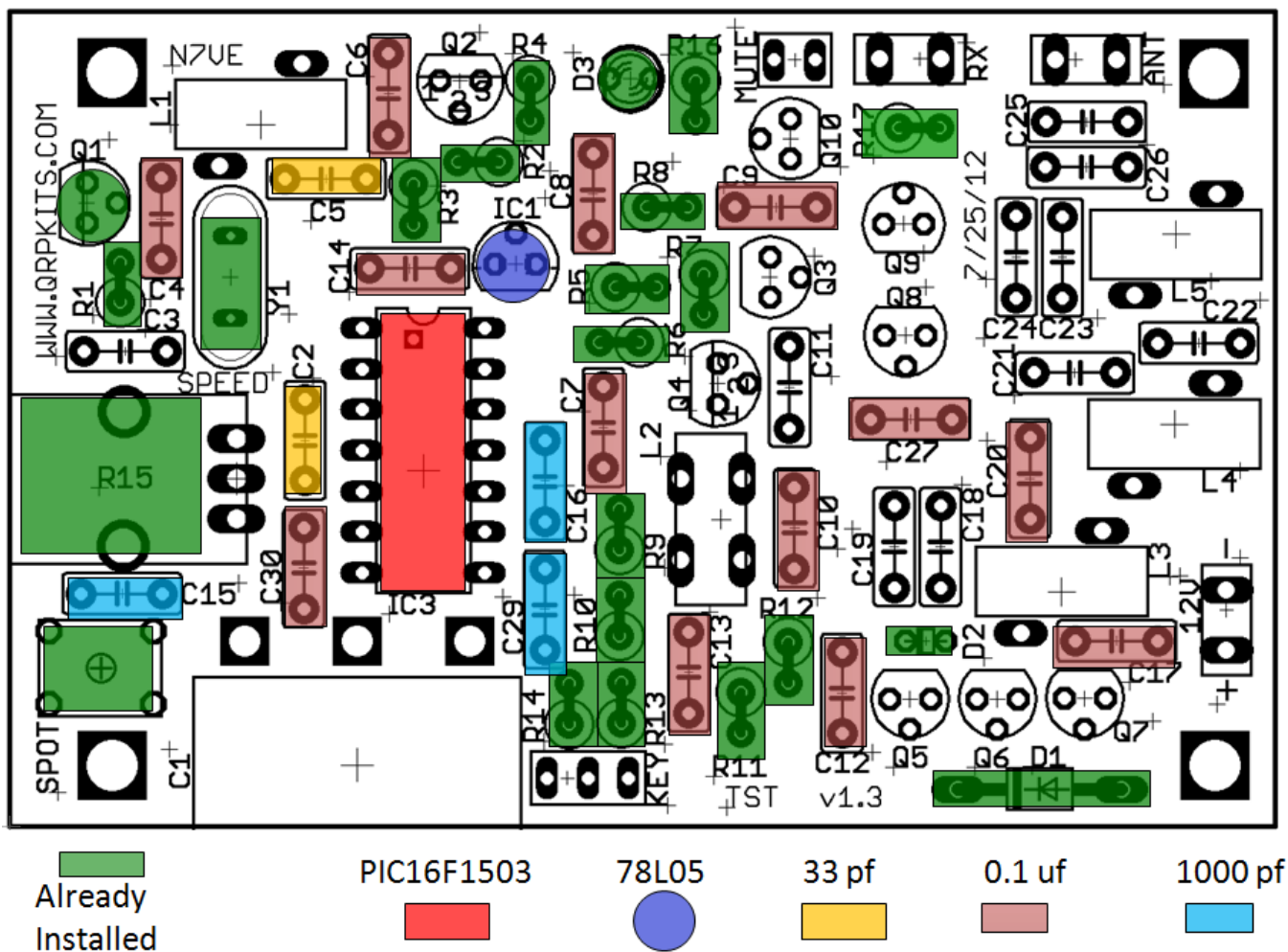


Figure 22. Installation location of the 33 pf, 1000 pf, and 0.1 uF caps, plus 78L05 and PIC16F1503 ICs



Figure 23. Picture of parts: 78L05 and PIC16F1503 plus 0.1 uf (104), 1000 pf (102), and 33 pf caps

As the parts are installed, it is recommended to both **check the box** below and **cross off the part on the picture** above. Install the following parts in the following order:

- Install 33 pf caps (marked “33”) C2, C5
- Install 1000 pf caps (marked “102”) C15, C16, C29
- Install 0.1 uf caps (Marked “104”) C4, C6, C7, C8, C9, C10, C12, C13, C14, C17, C20, C27, C30

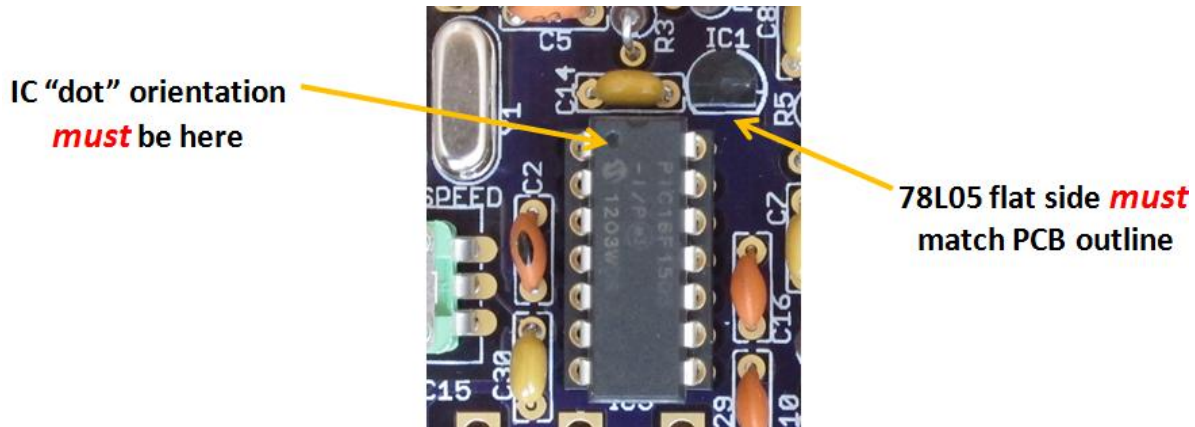


Figure 24. 78L05 and PIC16F1503 mounting orientation. *Optional 14 pin socket shown*

- Install PIC16F1503 IC3 ***Must use IC “dot” orientation shown above!***
- Install 78L05 5v regulator IC1 ***Make sure flat side lines up with PCB outline as above***

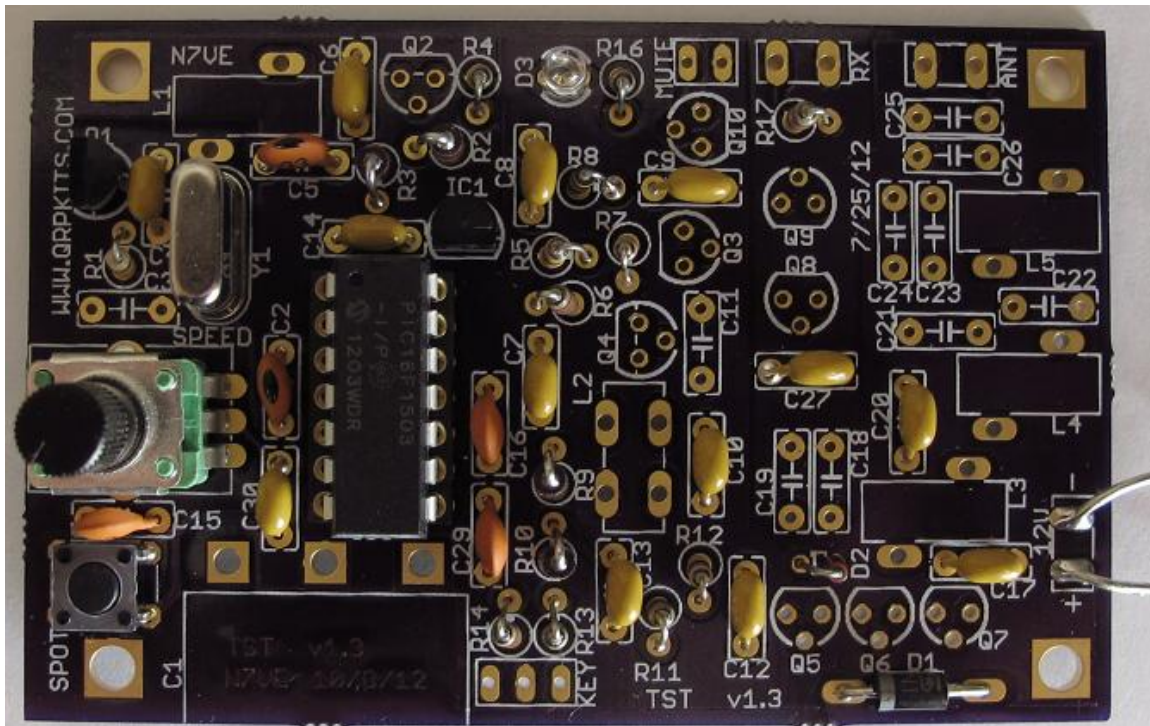


Figure 25. Parts mounted with 33 pf, 1000 pf and 0.1 uF capacitors, plus PIC16F1503 uP and 78L05 5v regulator

First tests

- 1) Connect 12v to the 12v input leads. □ The LED should blink three times and then stop.
- 2) Press the “spot” switch near the CW speed pot. □ The LED should come on and stay on
- 3) Press the “spot” switch again. □ The LED should go out and stay out
- 4) Take a spare wire lead, bend it into a “U” shape and place it between the center pad and the right pad of the “key” input as shown below. □ The LED should start blinking

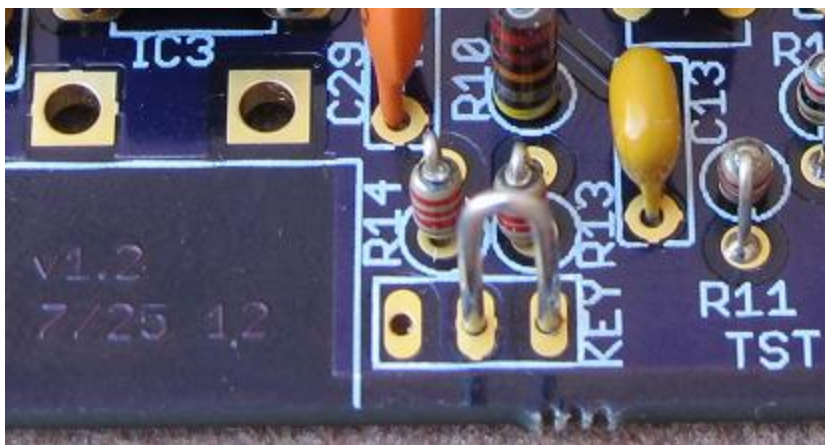


Figure 26. Keyer test using a "U" shaped shorting wire

- 5) With the spare wire still in place from (4) above, vary the cw speed pot. The LED should vary its blinking speed with the pot setting.

Pressing the “spot” switch turns on the crystal oscillator and its buffer so you can listen to where it will be transmitting in your receiver. Pressing the “spot” switch toggles the crystal oscillator on and off.

The Key input will accept either a keyer paddle or a straight key. The use of a mono straight key in the stereo paddle input will short out the left most KEY pad (jack “ring” input). On power up this is used to determine that “straight key mode” is active.

Notice that the LED indicates either that “Spot” is on or that the transmitter is keyed.

- 6) Disconnect the 12v power. Reconnect the power with a voltmeter set to read current connected in series with the board. After the LED blinks three times, the current drain should be roughly 7 to 8 ma.
- 7) With the “spot” turned on, the current drain should be 9 to 10 ma range.

At this point the keyer/timing processor and its inputs (CW speed, Spot and Key) are all working.

Installation of VXO and buffer inductors, and all remaining transistors

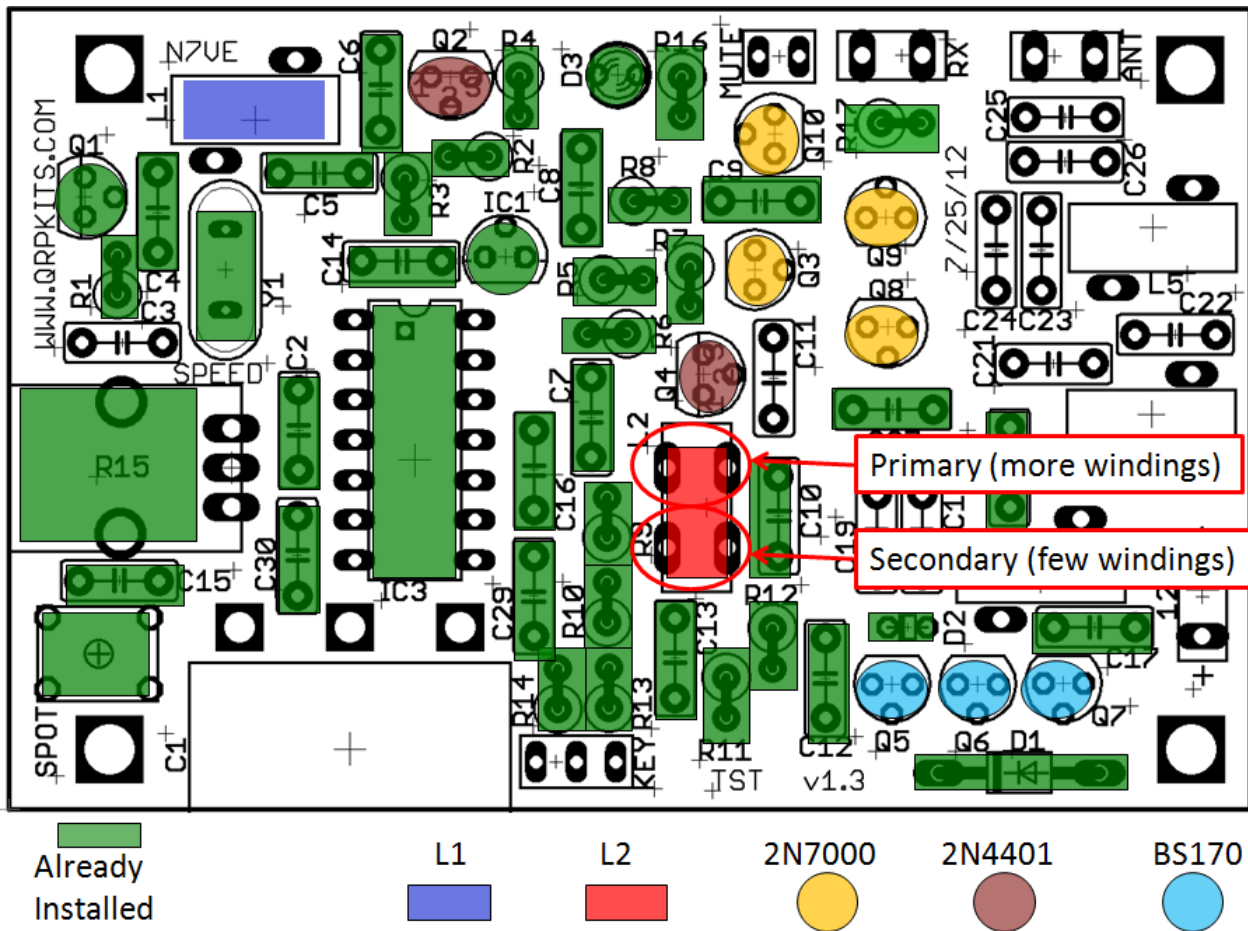


Figure 27. Locations shown for all transistors, VXO inductor, PA driver transformer

- Install 2N7000 transistors □ Q3, □ Q8, □ Q9, □ Q10 ***Keep all transistors low to the PCB with short leads as shown below. Transistor flat side must match PCB layout!***

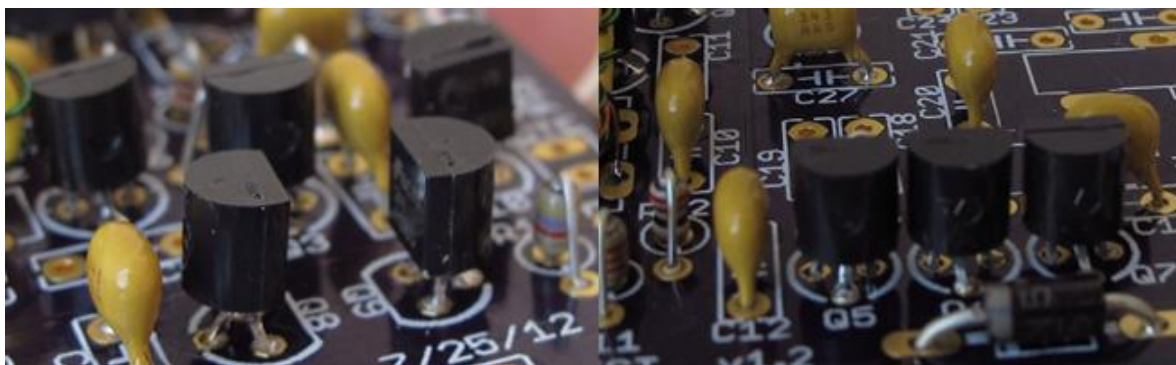


Figure 28. Keep all transistors close to the PCB (**short leads!**)

- Install 2NBS170 transistors □ Q5, □ Q6, □ Q7 **Keep all transistors low to the PCB with short leads as shown above. Transistor flat side must match PCB layout!**
- The PCB is part of the heat sink for these transistors, so keeping the leads short help keep the transistors cool and minimizes stray inductance (bad!).
- Install 2N4401 transistors □ Q2, □ Q4 **Keep all transistors low to the PCB with short leads as shown above. Transistor flat side must match PCB layout!**

Instructions for winding inductors

The first inductor to be wound will be L1. The toroid core (FT37-43) is different from the other four cores in that **only it has no color**. There are two characteristics of the four inductors being wound for this kit:

- 1) It is very important to use the **right number of turns!**
- 2) In order for the inductor to **sit properly** on the board, **it must be wound a certain way.**

We will wind and install L1 first and will illustrate how to count the number of turns and to show how to wind it in the right way.

Cut 10” of green # 28 gauge wire. The number of turns used depends on the band the kit is being built for. This much match the frequency on the crystal.

10m (28 MHz) – 9 turns
 15m (21 MHz) – 10 turns
 17m (18 MHz) – 11 turns

The first turn is placed through the core from the bottom. Hold the short end on the bottom, with the long end of the wire out the top of the core as shown below:

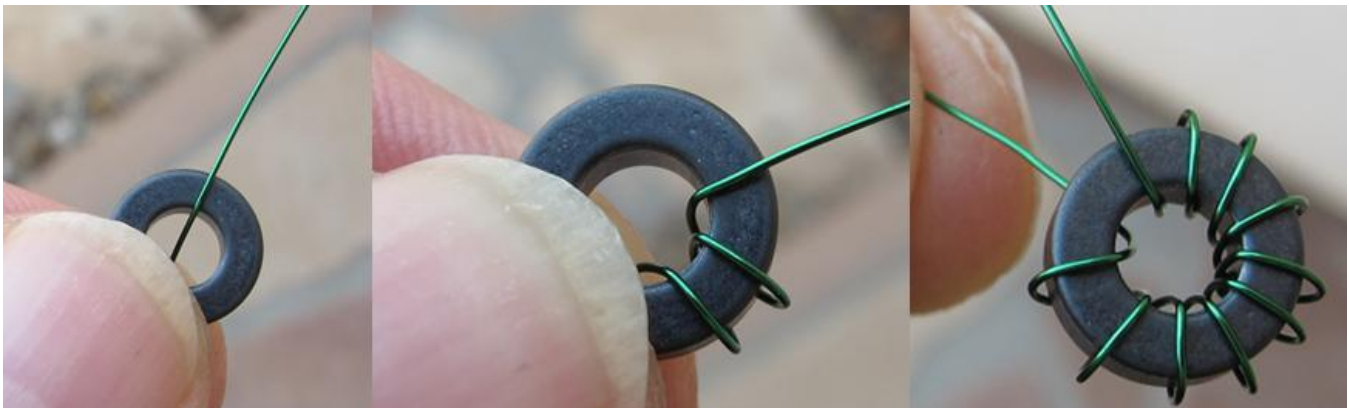


Figure 29. First turn. 3 turns shown winding counter-clockwise. Finished 10 turn coil shown.

Above shows the winding sequence for a 10 turn coil (15m). On the “3 turn” picture, you can count 3 turns on the inside of the coil, but only two on the outside. **It is the inside turns that counts!** I

always double check by **counting the outside turns and add 1**. **Add turns to the coil counter-clockwise with each new turn coming in from the bottom side**. Look closely at the 10 turn picture and you can count **10** turns on the **inside** of the core and **9** turns on the **outside**. $9 + 1 = 10$.

Double check all the coils you wind for the right number of turns!

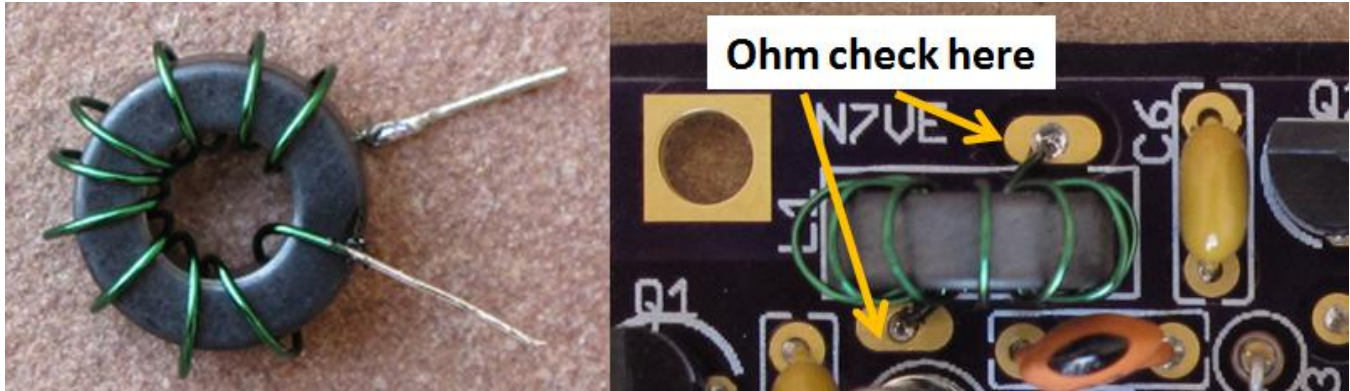


Figure 30. 10 turn (15m) coil shown trimmed and stripped right up to the edge of the core. Ohm check points.

Next the leads need to be trimmed and stripped. The enamel wire used in this kit is special in that it strips more easily than normal with heat. I simply use a blob of solder on the end of the iron and start from the cut end of the wire, burning off insulation and working towards the core edge. The burnt enamel fowls the solder, so I keep adding fresh solder as I go.

Install L1 – double check for the right number of turns for the band used. (10m 9 turns, 15m 10 turns, 17m 11 turns)

If the coil was been wound as described above, it will sit in the rectangle outline. If it was wound wrong, it will want to sit sideways, 90 degrees off.

Check L1 to make sure it has good solder contact: Use an ohm meter and make sure there is a short (i.e., L1 – zero ohms) between the two pads L1 is connected to. It is not unusual to have problems cleaning the enamel off the wire. If it is not stripped properly, there will be no connection between the two pads.

Next, wind L2 which is a two winding transformer. This uses a yellow T37-6 core and a 10” piece of green #28 enamel wire. The primary side is band specific:

10m (28 MHz) – 10 turns

15m (21 MHz) – 11 turns

17m (18 MHz) – 12 turns

The exact number of turns is very important! Please verify the right number of turns. In all cases, the secondary is **four turns** of red #28 enamel wire. The construction of L2 is shown below. The four turns of the secondary winding is wrapped **in between** the windings of the secondary as shown.



Figure 31. L2 transformer. 11T (15m) green primary, 4T red secondary

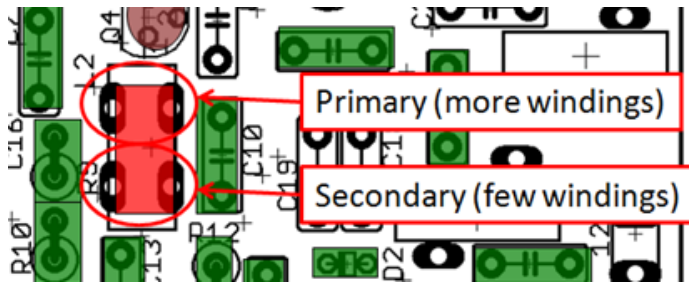


Figure 32. Primary and secondary winding connections of L2 to the board shown.

□ Install L2 – double check for the right number of turns for the band used. (10m 10 turns, 15m 11 turns, 17m 12 turns) Make sure to strip the leads up to the edge of the core as was done with L1.

□ Check L2 to make sure it has good solder contact: Use an ohm meter and make sure there is a short (i.e., L1 – zero ohms) between the two primary winding pads, and also check between the two secondary winding pads.

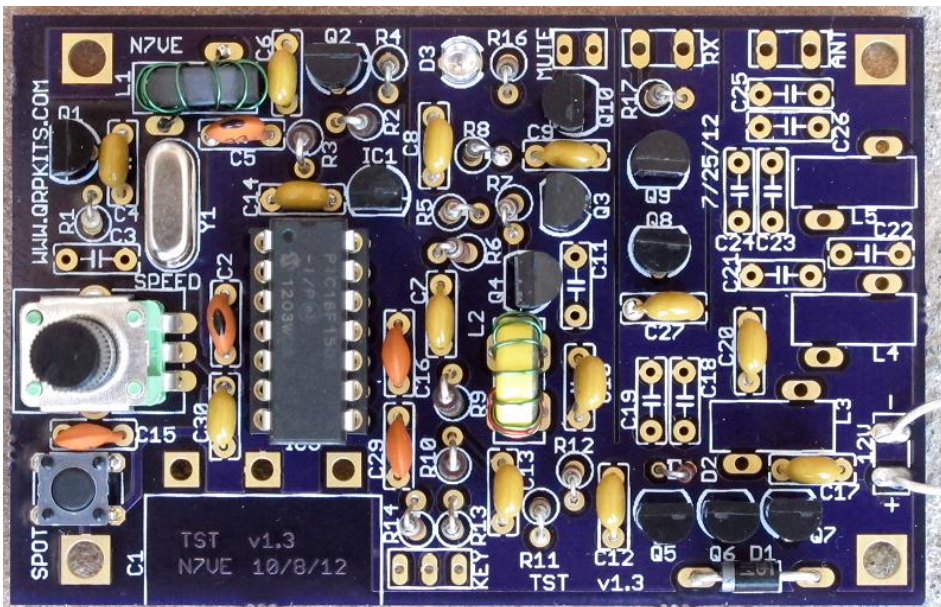


Figure 33. Board with all transistors installed and inductors L1 and L2.

Second tests

- Connect 12v to the input voltage and check the current drain. It should be around 7 to 8 ma.
- Turn on “Spot”. The current should increase to 17 to 18 ma.

Installation of Transmitter Low Pass Filter and PA Driver Cap

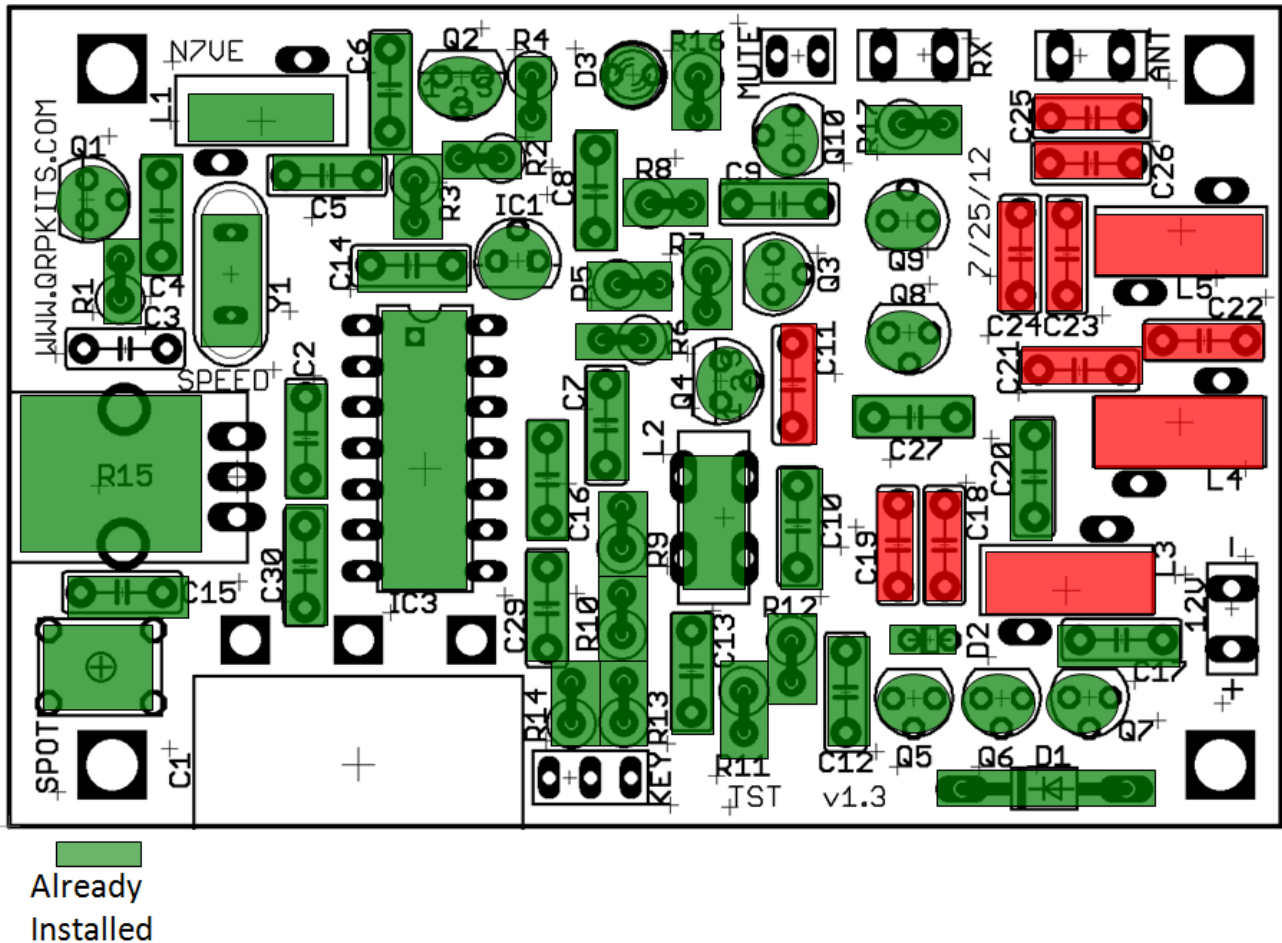


Figure 34. Parts placement for TX Low Pass Filter and PA Driver Cap

Wind L3, L4 and L5 as described for L1 (counter clockwise from the start, each turn coming in from the bottom). Each coil uses 10” of green #28 enamel wire and a yellow T37-6 toroid core.

- | | | |
|------------------|---------------|--------------|
| L3: 10m 9 turns; | 15m 10 turns; | 17m 11 turns |
| L4: 10m 9 turns; | 15m 9 turns; | 17m 10 turns |
| L5: 10m 9 turns; | 15m 10 turns; | 17m 11 turns |



Figure 35. Example of 15m coil set L3 (10T), L4 (9T), L5 (10T)

Above is an example of the 15m coil set for L3, L4, L5. Verify that counting the outside turns + 1 is the same as counting the number of times the wire passes through the inside edge of the coils.

*It is **extremely important that the number of turns on these three inductors are right as this is a resonant, high efficiency, output network.***

Install L3, L4, and L5 and check across the pads for each inductor that there is zero ohms. This makes sure the enamel was properly removed and that the inductors are properly soldered in place.

Install capacitors specific to the correct band:

10m:

Install 100 pf capacitor (marked “101”) C25

Install 68 pf capacitors (marked “68”) C11, C18

Install 220 pf capacitor (marked “221”) C21

Install 33 pf capacitors (marked “33”) C23, C26

Capacitors not used: C3, C24, C19, C22

15m:

Install 150 pf capacitors (marked “151”) C11, C18, and C26

Install 330 pf capacitor (marked “331”) C21

Install 47 pf capacitor (marked “47”) C23

Capacitors not used: C3, C24, C25, C19, C22

17m:

Install 150 pf capacitor (marked “151”) □ C18

Install 180 pf capacitors (marked “181”) □ C11, □ C22, □ C26

Install 220 pf capacitor (marked “221”) □ C21

Install 56 pf capacitor (marked “56”) □ C23

Capacitors not used: C3, C24, C25, C19

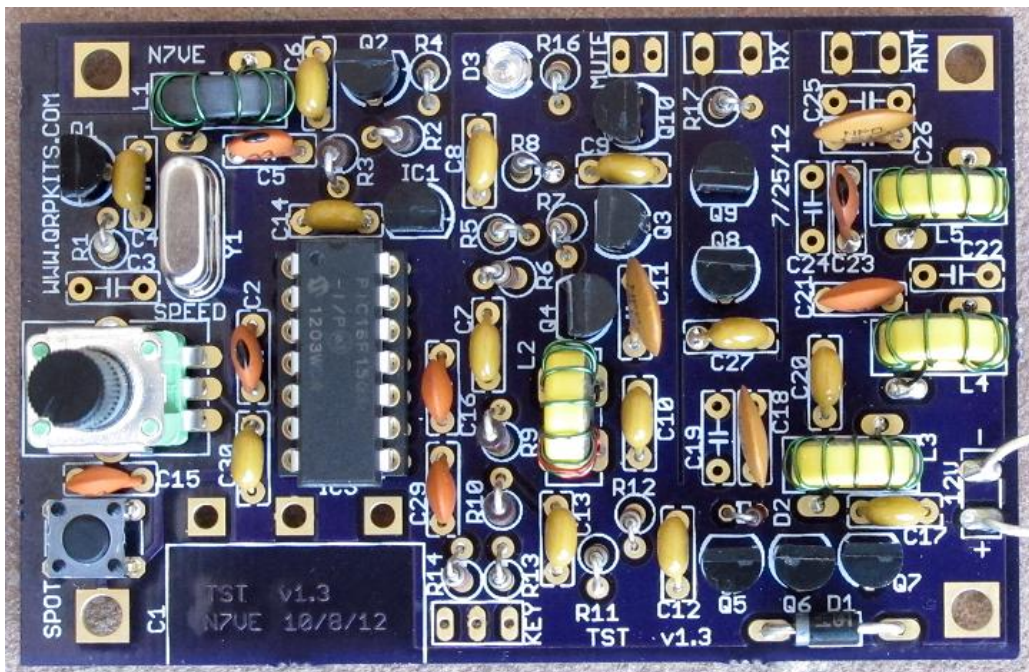


Figure 36. Completed transmitter board (except for main tune capacitor C1) – 15m version shown

Installation of Transmitter into case and mounting of C1 (main tune cap)



Figure 37. Completed kit in case (less connections to rear 12v power jack)

Installation into Chassis

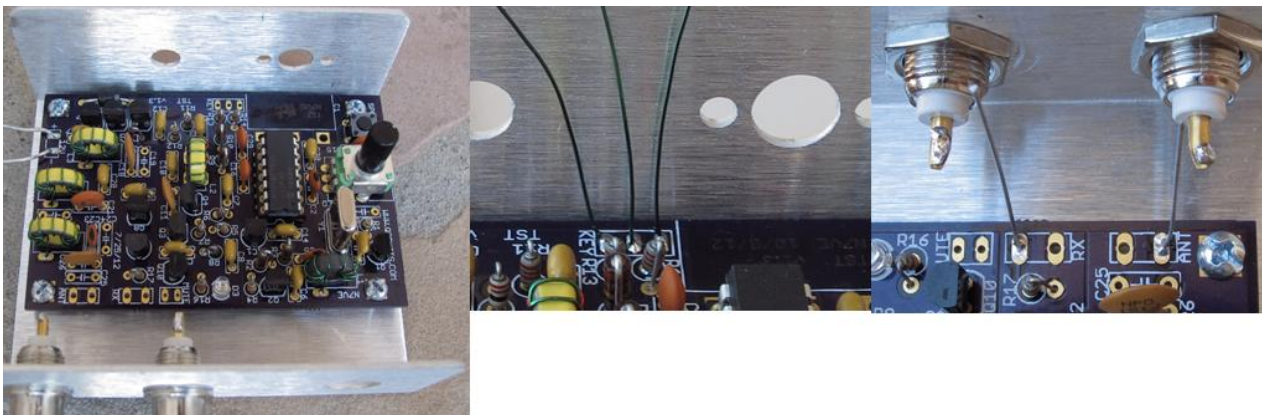


Figure 38. Mount PCB in the frame using four 4-40 screws. Add keyer leads, antenna leads

Before adding C1, it is easier at this point of time to add leads for the keyer jack. Add three 3” leads for the keyer jack. Also add antenna leads using two resistor lead scraps. All of these leads can be mounted from the top side of the board. Just make sure that the leads are not long enough to short against the chassis. Look at the bottom side of the PCB and make sure that is the case

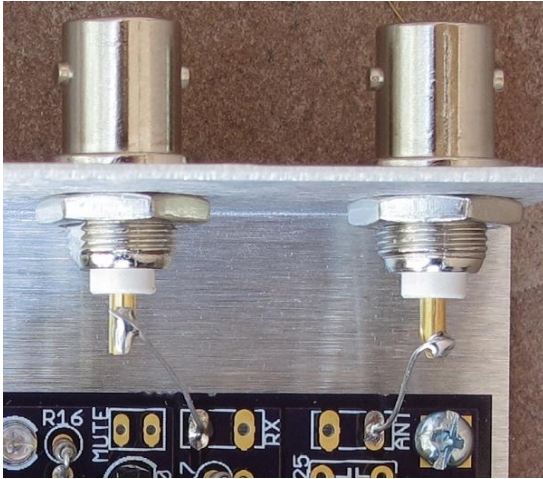


Figure 39. Transmitter antenna connection (ANT) and external receiver (RX) connection

It is very important to hook up the external RX and transmitter ANT connection as shown above. Each of these two connections have a ground side and a “RF hot” side. The RX connection in particular may be backwards from what is expected. I find the washer works better on the *outside of the case* rather than under the nut on the inside of the case. A ground lug is provided for these antenna connections, but is really not needed as the chassis standoff in that corner provides an adequate ground connection to both antennas.



Figure 40. Polyvaricon with short leads. Leads extended with resistor leads. Form and clip leads.

As can be seen in the figure above, the leads of the polyvaricon need to be bent to the rear of the variable capacitor as the mounting holes for the leads need to go into pads behind the body of the capacitor.

Some polyvaricons have longer leads than others. Those with longer leads can be used “as is”, while those with shorter leads need to have their leads extended. See the diagram below.



Figure 41 Mounting of C1. Mount C1 on the front panel first, then solder the leads from the top side.



Figure 42. Visualization of rear panel 12v power jack. Power and ground connections shown. Hookup wire used.

The power and ground connections should be routed around the *edge of the board (right side, rear edge)* rather than running the leads under the board. This is in an attempt to keep it away from the transmitter section and to make sure output RF does not feedback to an earlier stage and cause problems.

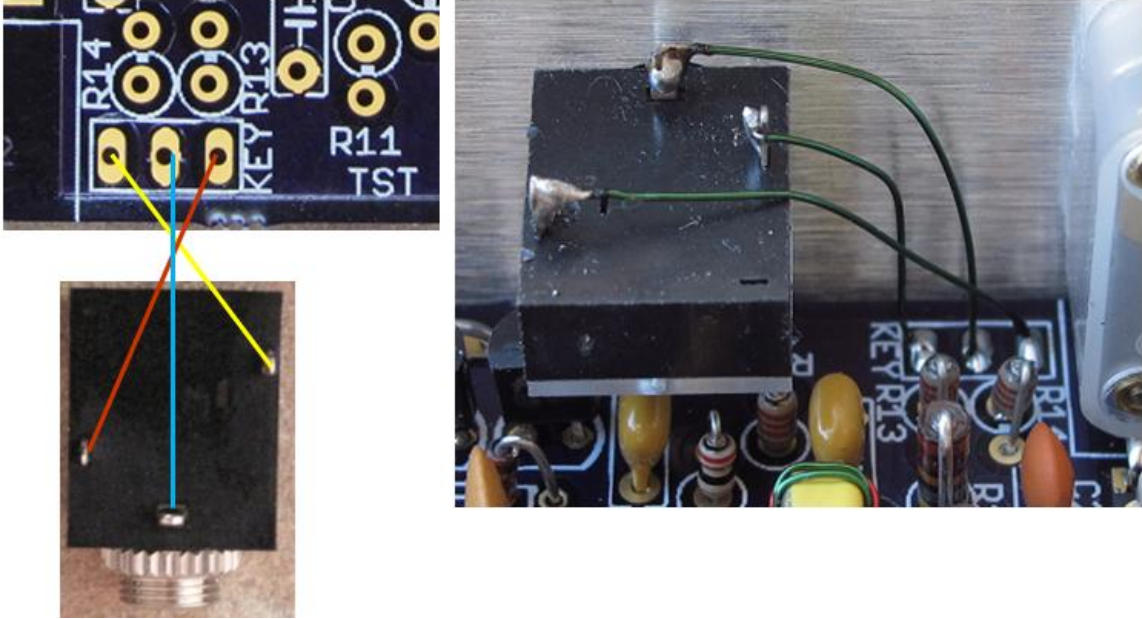


Figure 43. Visualization of the front panel keyer jack connections.

At this point in time, the kit is done.

Transmitter Operation and Features

The transmitter outputs ~4w (12v input) to the “ANT” jack.

Built in T/R switch for an external receiver

The board has a built in T/R switch to allow the connection of an external receiver via the “RX” jack. When the transmitter is not active, the external receiver (“RX”) is automatically connected to the ANT jack via the on board T/R switch. When transmitting, ~0.05v pk-pk RF appears across the RX output with no load on the RX output.

Mute output

A “Mute” output is also provided. This is simply a transistor open drain output (60v max) that shorts to ground on transmit.

“Spot” mode

The spot button is used to toggle the crystal oscillator and its buffer on and off. When “spot” is on, the LED is light up to indicate that “spot” is on. Press the SPOT button once to turn it on, press it again to turn it off. Spot allows the user to find out where the transmitter will be transmitting by listening in the receiver for the oscillator.

Built in keyer with cw speed pot

The kit has a built in keyer with cw speed control. A LED was provided so that you can visually watch the rig being keyed as there is no audio side tone output other than listening to the transmitter with the external receiver.

Straight Key mode

When the transmitter is powered up, it looks for a short to ground on the “ring” input of the keyer jack. If this is the case, the transmitter disables the keyer and goes into “straight key mode”. This mode allows the use of either a bug, straight key, or an external memory keyer (beacons?) for sending cw.

Dotting mode during “straight key mode”

The finals are not rated for 100% duty cycle. If the transmitter is keyed continuously for several seconds, the transmitter will send a string of dots to keep the transmitter finals from over heating.

Taylor Simple Transmitter

4w output 160-10m
#1.3 10/8/2012

