# SUPER Tuna ][+

# Builder's Guide

**Ver2.3**

**Rex Harper  W1REX**

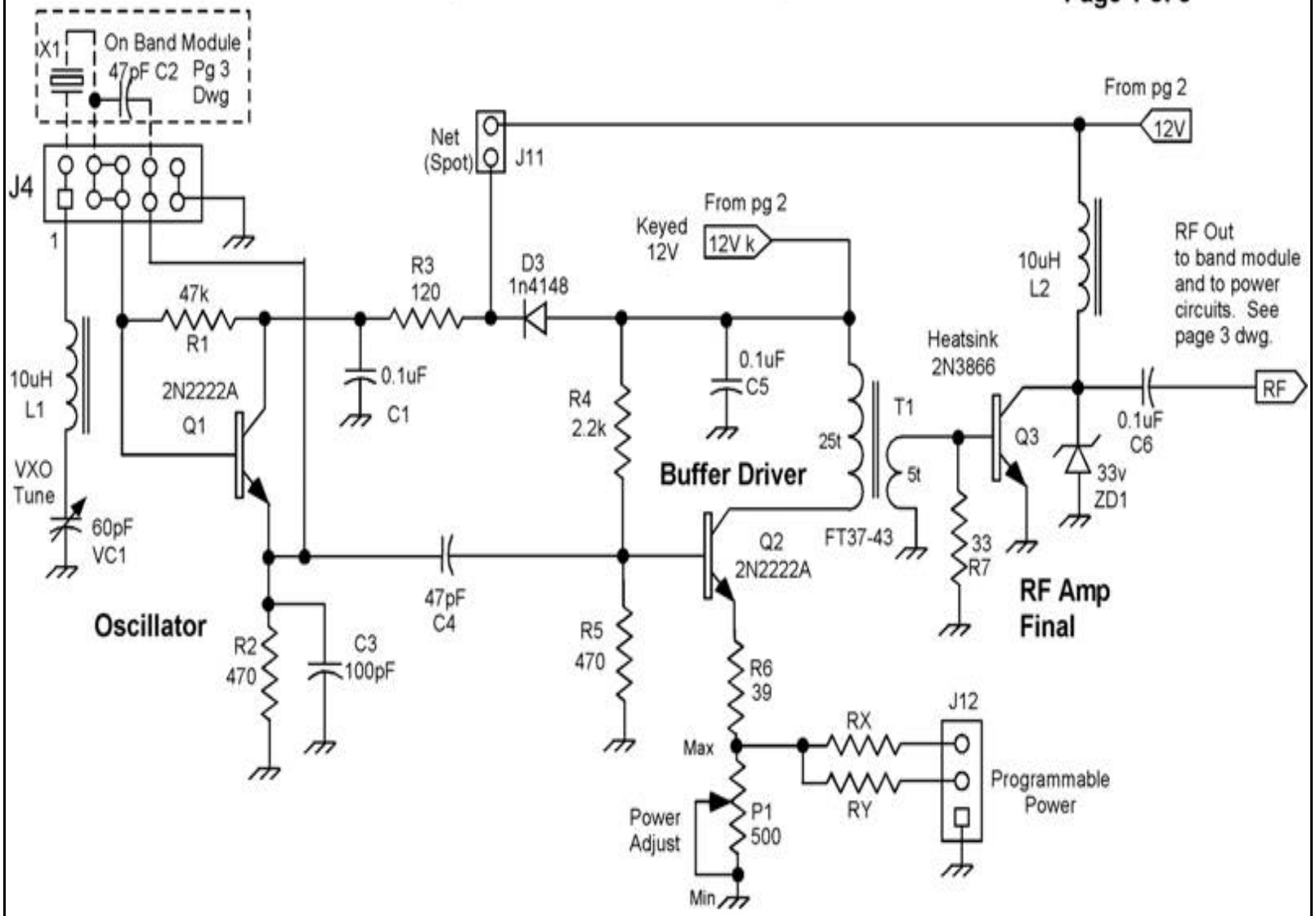
**3/25/2015**

# Super Tuna ][ + Schematic

W5USJ drawing - 27 Mar 2011

**Oscillator/Buffer/Amplifier** — J4 viewed from the top of the board

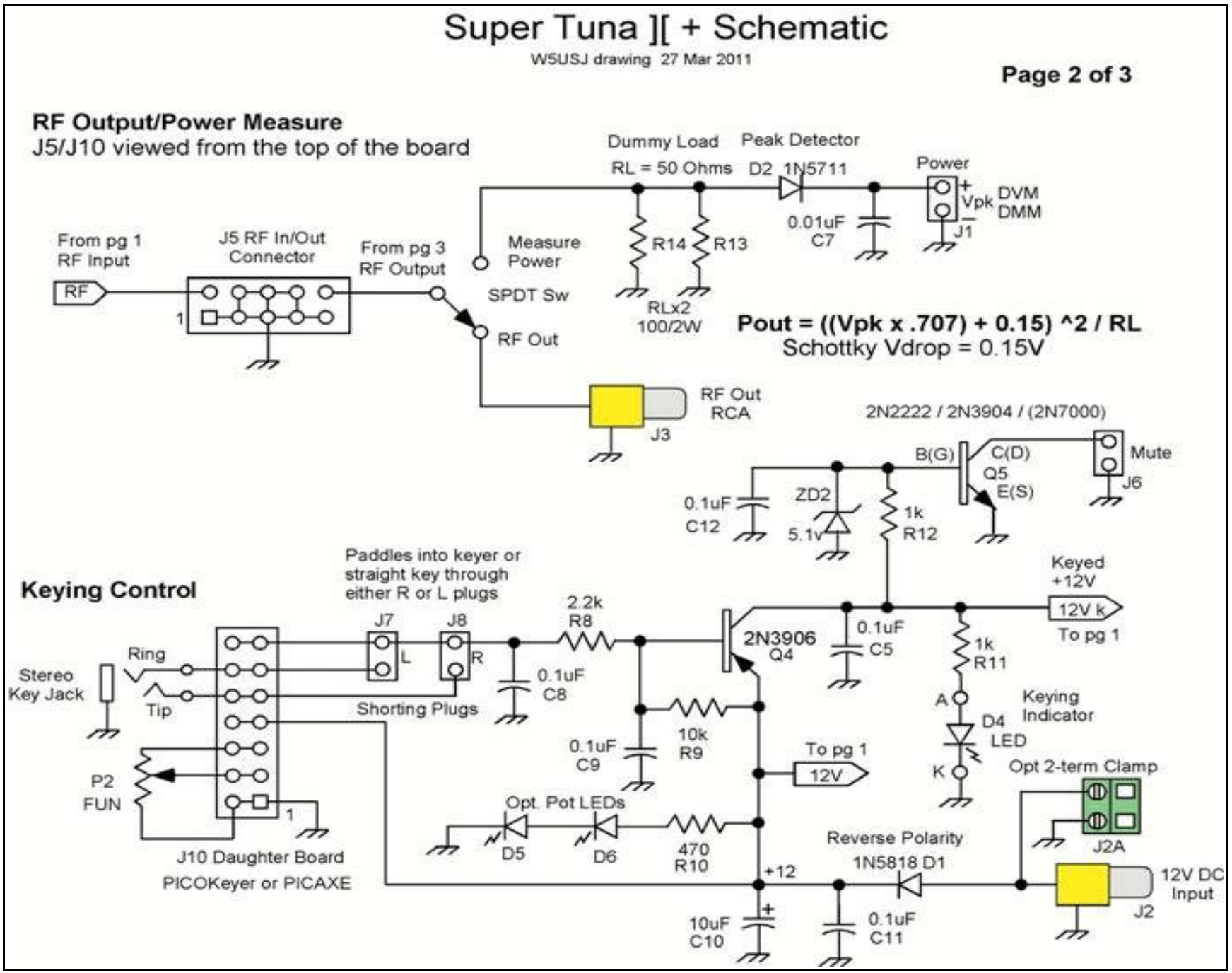




# Super Tuna ][ + Schematic

W5USJ drawing 27 Mar 2011



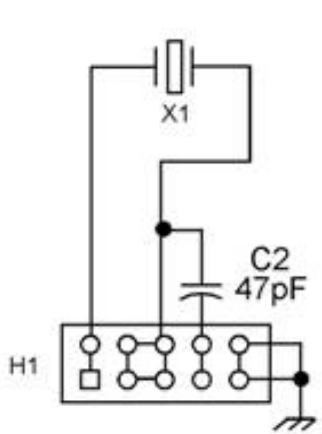


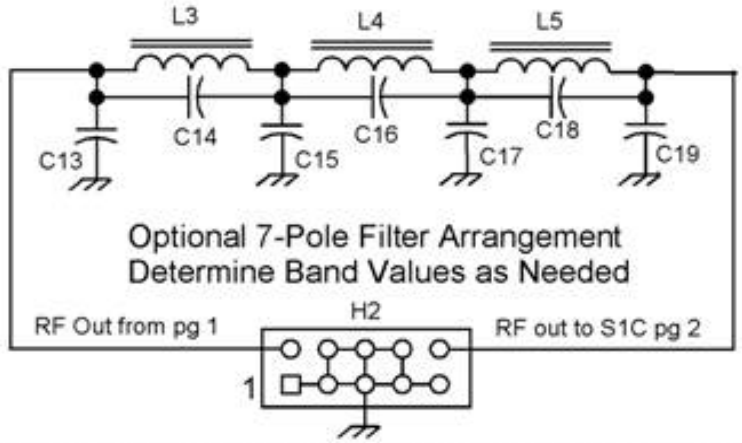
# Super Tuna ][ + Schematic

W5USJ drawing 27 Mar 2011



**Band Module** — H1/H2 viewed from the top of the board

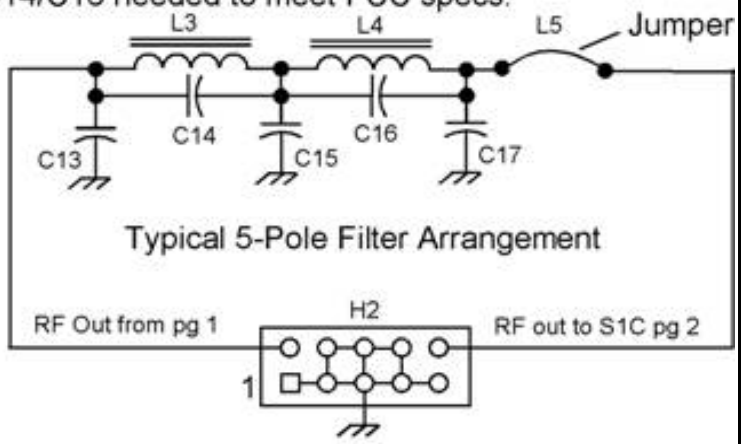



**5-Pole Filters:** All capacitors pF, Kemet 5% C0G or equiv.

| | |
|---|---|
| 80 | C13, 680 C14, 100 C15, 1200 C16, 220 C17, 680<br>L3/L4, 2.2uH 21t #22 T50-2 or 23t #24 T37-2 |
| 40 | C13, 330 C14, 47 C15, 680 C16, 150 C17, 330<br>L3, 1.2uH 15t #22 T50-2 or 17t #24 T37-2<br>L4, 0.85uH 13t #22 T50-2 or 15t #24 T37-2 |
| 30 | C13, 220 C14, 47 C15, 470 C16, 82 C17, 220<br>L3, 1.0uH 14t #22 T50-2 or 16t #24 T37-2<br>L4, 0.75uH 12t #22 T50-2 or 14t #24 T37-2 |
| 20 | C13, 220 C14, 27 C15, 470 C16, 68 C17, 220<br>L3, 0.525uH 11t #22 T50-6 or 12t #24 T37-2<br>L4, 0.475uH 10t #22 T50-6 or 11t #24 T37-2 |
| 10 | C13, 120 C14, NA C15, 270 C16, 39 C17, 120<br>L3, 0.270uH 10t #24 T25-6<br>L4, 0.200uH 8t #24 T25-2 (will be 217nH) |

C14/C16 needed to meet FCC specs.



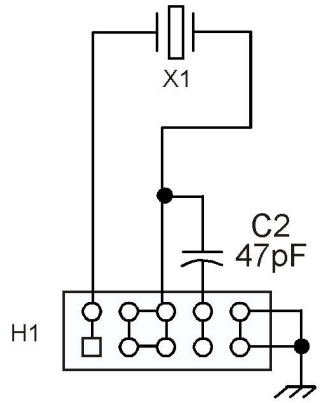
# Band Modules ST][ and ST][ + Schematics

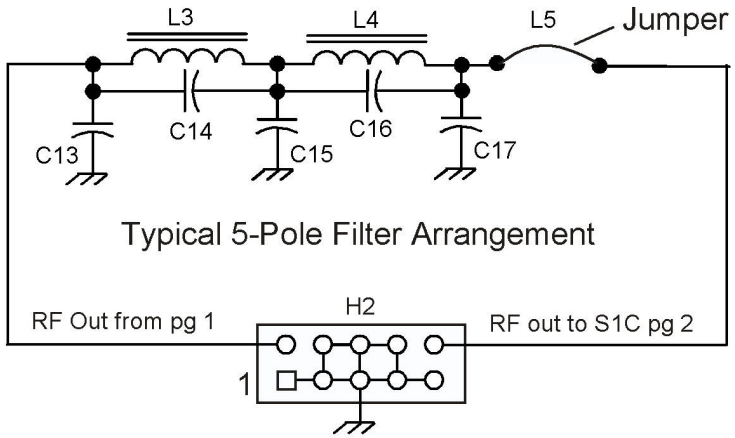
W5USJ drawing 14 Jun 2012

From Page 3 of 3 of the schematic drawings

**Band Module** — H1/H2 viewed from the top of the board

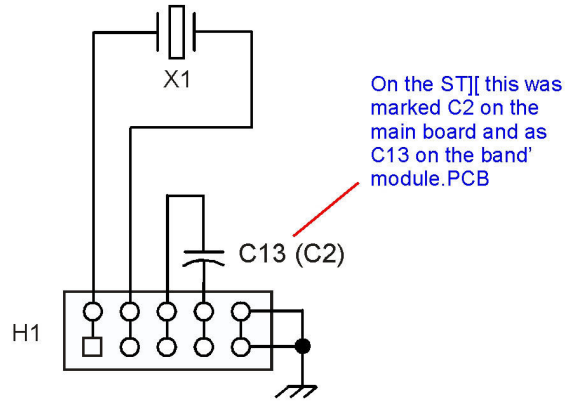
Super Tuna ][ +



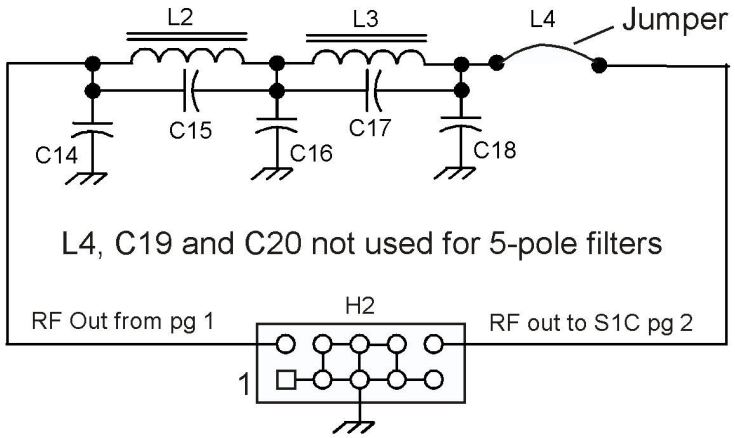




Old Version Band Module Part Number ID markings on the ST][ band module PCBs

Super Tuna ][




On the ST][ this was marked C2 on the main board and as C13 on the band' module.PCB



The first thing you should do is to familiarize yourself with what you are going to build. The previous 3 pages are schematics of the current version of the SUPER Tuna ][+ transmitter. Sheet one depicts the circuitry of the main oscillator/transmitter functions of the SUPER Tuna. Sheet  two shows the various ancillary circuits such as keying, power measurement and muting while the third sheet documents the circuitry and construction of ALL the band module options currently supported. The SUPER Tuna ][+ is new but the band modules are from the original SUPER Tuna ][. The ][+ schematics show a slightly different nomenclature for the components on the band modules. Sheet 4 details the nomenclature differences between the ][+ schematics and the actual ][ band module. You don't have to memorize the circuitry but you should have a basic knowledge of what's what and who is where? (On first base!)

The second thing that you need to do is break out all the parts, sort them and check that everything has been included in the can. I'm not a 100% perfect kitter! Every kit is kitted by hand and sometime VERY late at night (when everyone else is sleeping and aren't making demands for my time). So sometimes I forget a part or it bounces out of the cup right as I drop it in and I didn't see it bounce...what with only one eye open at that late hour. So check the parts and let me know if anything is missing.

The third thing that you should do is read completely through the guide, maybe a couple of times, so that you are familiar with all the steps and how the construction goes. Knowing whats going to happen a little later on helps you make better decisions earlier in the build.

# SPT][+
# Bill of Materials

**Resistors**
R1 = 47k
R2, R5, R10 = 470
R3 = 120
R4, R8 = 2.2K
R6 = 39
R7 = 33
R9 = 10K
R11, R12 = 1K
R13,R14 = 100 2W

**Potentiometers**
P1 = 500 or 1K ohm linear
P2 = 10K or 50K linear

**Capacitors**
C2, C4, C14 = 47
C3 = 100
C16 = 150pf
C13, C17 = 330pf
C15 = 680pf
C7 = .01
C1, C5, C6, C8,
C9, C11, C12 =.1uf
C10 = 10uf
VC1 = 60pf polyvaricon

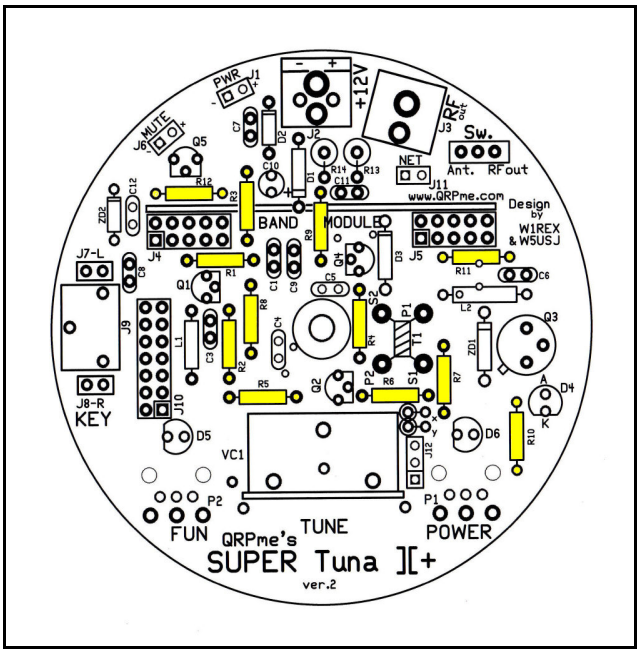
**Diodes**
D1 = 1N5818
D2 = 1N5711
D3 = 1N4148
D4 = LED – keying
LED Pots Optional **x2**
ZD1 = 33V 1W Zener
ZD2 = 5.1V Zener

**RF Chokes/Transformer**
L1, L2 = 10uh
T1 = FT37-43 (25t P & 5t S)
L3, L4 = T50-2 toroid

**Transistors**
Q1, Q2, Q5 = PN2222A
Q3 = 2N3866 (TO-5 house branded 4-247 CG9949 or similar)
Q4 = 2N3906

**Jacks/Connectors**
J1, J6, J7, J8, J11 = 2-pin st. male header
J2, J3 = RCA
J4, J5 = 10-pin header socket
J9 = Stereo phone jack
J10 = 14-pin header socket
J12 = 3-pin st. male header optional
3-pin Swiss pin socket (Q3 socket)
J7, J8 = .1" shorting plugs

**Other**
28ga. Magnet wire for 50 turns
PCB ST][+
PCB Polyvaricon Mounting
PCB Band Module
VC1 = Knob
Q3 = Heat sink
VC1 = 2.5 x 3mm screws **x2**
VC1 = $\frac{1}{4}$" x $\frac{1}{4}$" shaft ext.
VC1 = 2.5 x 8mm ext. screw
Sw = SPDT switch w/.1" spc
Can
1/8"x1.5" x32 screw & nut
7.030 Xtal

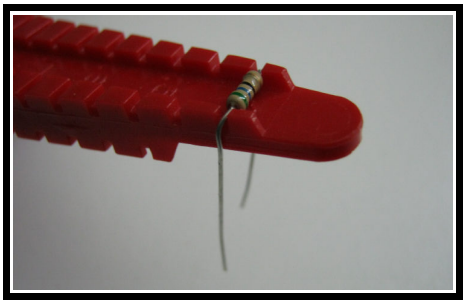



Install all the ¼ watt resistors flush to the surface of the board. Bend the leads with .4" spacing, insert them into the proper holes then spread the leads apart slightly where they exit the bottom of the board. The resistors should stay in place when you turn the board upside down. You can use the open can as a holder for the board while soldering. Place the board upside down on the top of the can and solder… Install the resistors in small batches, bending, soldering and clipping off the excess leads in comfortable batches until all of them are installed. Batching will make the build quicker.

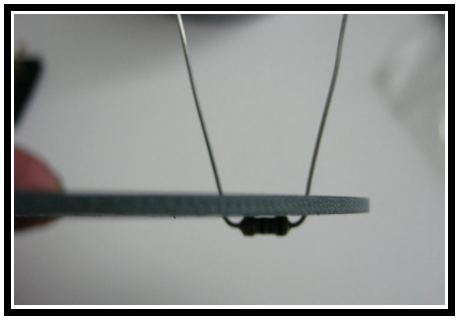
**Install:**

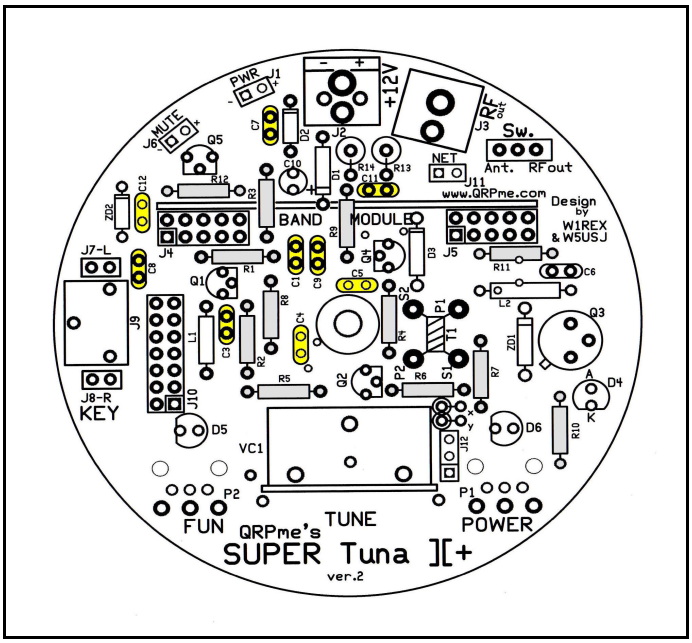
R1 = 47k ( yellow-violet-orange)
R2 = 470 (yellow-violet-brown)
R5 = 470 (yellow-violet-brown)
R10 = 470 (yellow-violet-brown)
R3 = 120 (black-red-brown)
R4 = 2.2K (red-red-red)
R8 = 2.2K (red-red-red)
R6 = 39 (orange-white-black)
R7 = 33 (orange-orange-black)
R9 = 10K (brown-black-orange)
R11 = 1K (brown-black-red)
R12 = 1K (brown-black-red)

**Lead Benders are handy!**



**Bend leads apart to hold..**



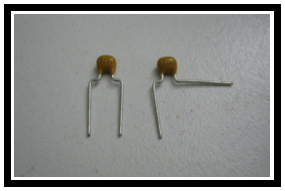


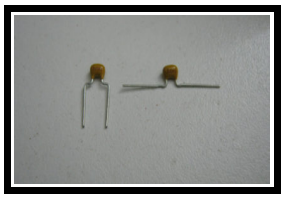

Install the small monolithic capacitors on the main board. Install them flush to the surface of the board. Again, bend the leads apart slightly where they exit the bottom of the board. Turn the board upside down on the top of the can and solder… All the cap pads have .1" spacing but some of the caps might have leads pre-bent at .2". You might have to re-bend them to .1". Make sure that you don't stress the cap where the lead enters the body of the cap. Install the capacitors in small batches, bending, soldering and clipping off the excess leads in comfortable batches until all of them are installed.

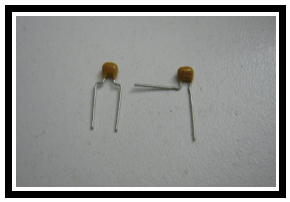
**Install:**

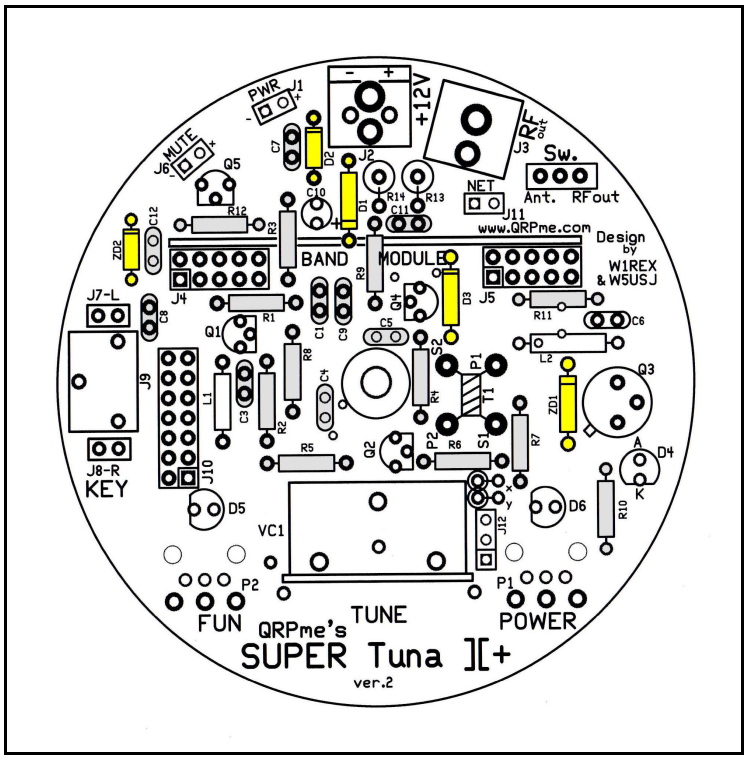
C4 = 47pf (marked 470)
C3 = 100pf (marked 101)
C7 = .01uf (marked 103)
C1 = .1uf (marked 104)
C5 = .1uf (marked 104)
C6 = .1uf (marked 104)
C8 = .1uf (marked 104)
C9 = .1uf (marked 104)
C11 = .1uf (marked 104)
C12 = .1uf (marked 104)

**Re-bend?**





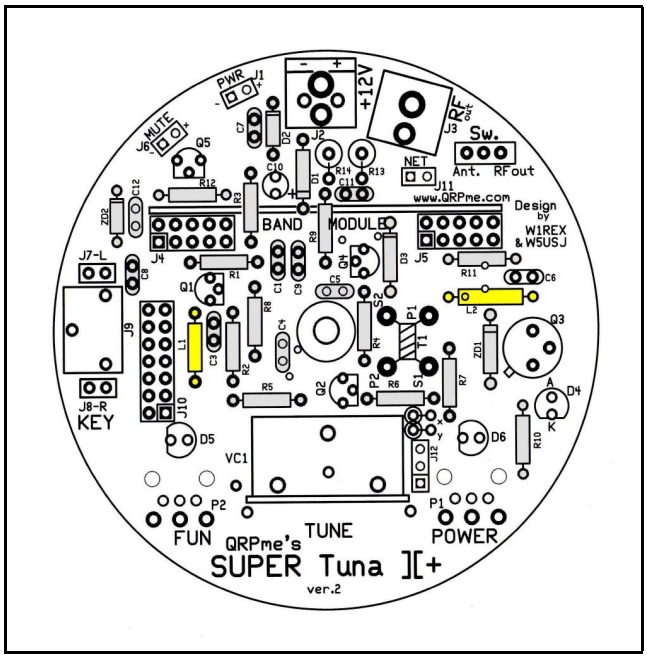





Now it is time to install the diodes. Diodes install the same way as resistors except for one thing: diodes have a POLARITY. The diode type is marked in teeny tiny lettering that I need to use either a magnifying glass or visor to read. There is also a solid stripe or band at one end of the body indicating the POLARITY. Orient the diodes with the band matching the band marker on the silk screen.

**Install:**

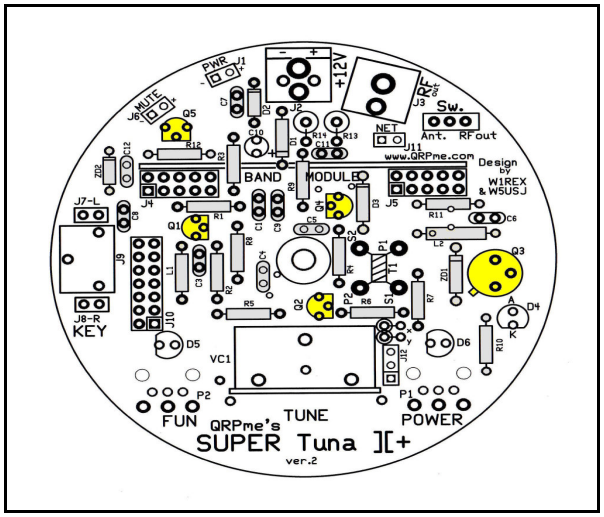
D1 = 1N5818 ( .4" spacing )
D2 = 1N5711 ( .3" spacing )
D3 = 1N4148 ( .4" spacing )
ZD1 = 33V 1W zener diode ( BZX85C33 or equivalent ) ( .4" spacing )
ZD2 = 5.1V zener diode ( 1N4733 or equivalent ) ( .3" spacing )




The inductors (or chokes) are next. They look very similar to resistors and have the same colors for marking their values. The two small chokes used on the SUPER Tuna][+ circuit are both 10uh chokes and are a little 'tubbier' than a resistor. Since you installed all the resistors already, the chokes should be pretty easy to find…

**Install:**

| | | |
|---|---|---|
| L1 = 10uh choke | (marked brown-black-black-gold) | ( .4" spacing ) |
| L2 = 10uh choke | (marked brown-black-black-gold) | ( .5" spacing ) |

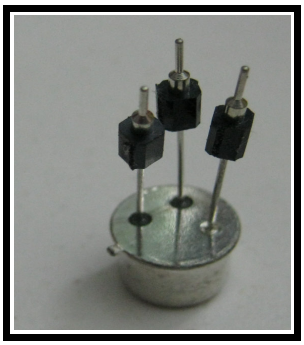


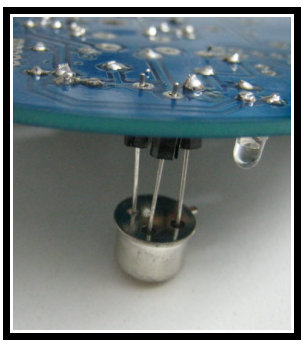

There are 5 transistors in the SUPER Tuna][+ circuit. Four transistors are soldered directly into the board while the power transistor, Q3, is installed into a make-shift socket. Transistors have POLARITY and should be oriented such that the flat face of the transistor matches the flat face on the silk screen marking. The transistor type is printed on the face for easy identification…in my case ONLY using a good light AND a magnifier!

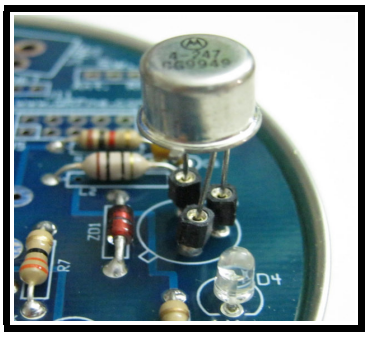
**Install:**

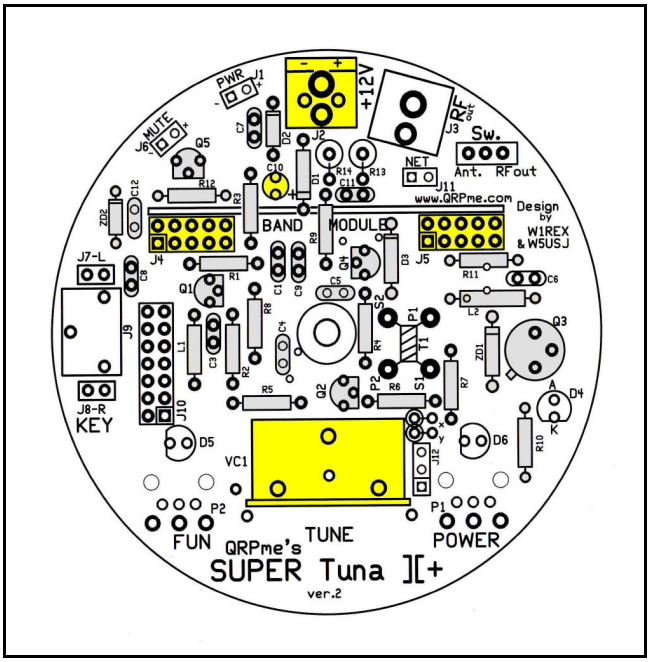
Q1 = PN2222A
Q2 = PN2222A
Q3 = 2N3866 (marked DG0001 or CG9949 (or similar) is a 'house' branded part)
Q4 = 2N3906
Q5 = PN2222A

Transistor Q3 is mounted in socket pins made from individual pins cut from a 3 or 8-pin SIP socket strip. Cut the 3 pins from the strip and carefully press them onto the leads of transistor Q3. Form the leads of the transistor and dry-fit them into the Q3 pads so that the socket pins are vertical to the board. Solder 1 pin when you are happy with the fit then the rest after a check. Remember that when you go to replace the transistor at a later date, it will be much easier to replace when the socket pins are oriented uniformly vertical for easy insertion of the new transistor.










Install some miscellaneous parts.

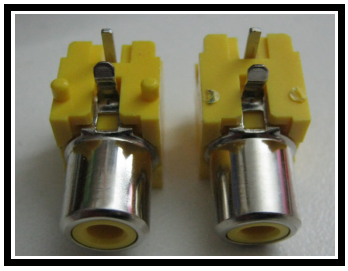
2x5x.1" header connectors at J4 & J5

power RCA connector

or optional 1x2 screw terminal block at +12V

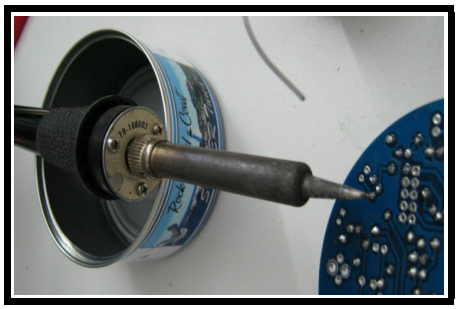
10uf at C10

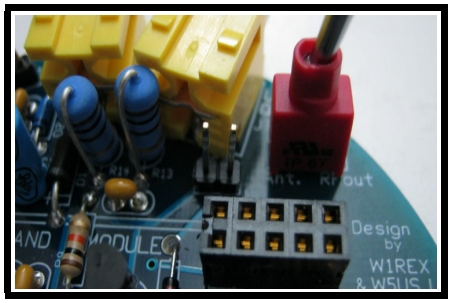
polyvaricon cap mounted to small mounting pcb at VC1



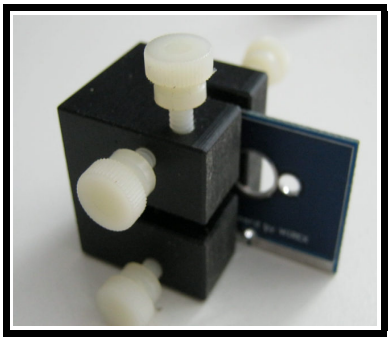
You might have to cut some tiny plastic feet off the RCA connectors.

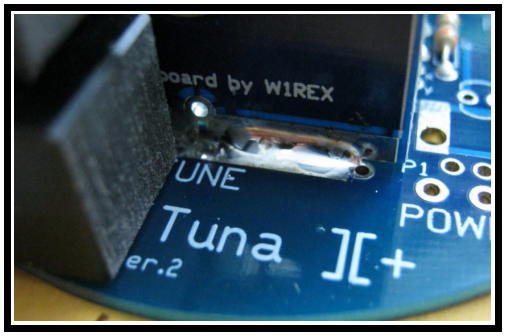
When installing components that easily fall out when you turn the board over for soldering, a helpful hint is to set the iron in the empty tuna can with a weight on the cord to hold it in place. Now you can hold the part in place AND board with one hand while adding the solder with your second hand. A bench-top vice is also a handy device for holding your soldering iron for those situations where you can really use a third hand. Solder only ONE pin of the header connectors, then inspect the top side for nice vertical placement of the header before soldering the rest of the connections.

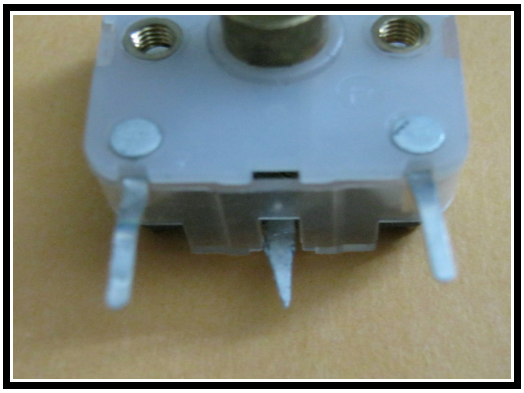




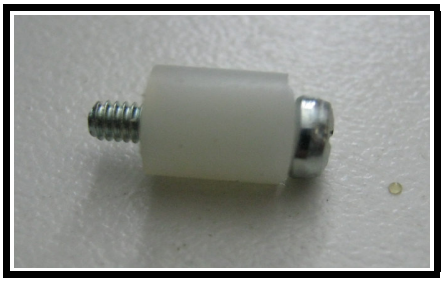
Install the polyvaricon mounting board at VC1. There are solder pads at the bottom of both sides. Take care to center the board left & right so that the potentiometers will fit later on. Of course, I use an SBSS tool to help solder the board square. The polyvaricon is mounted to the small printed circuit board using two small 2.5x3mm screws. The two front leads of the polyvaricon fit fine but the back lead needs to be thinner to fit the pad hole. Use some sharp side cutters to cut off the sides (a little only!) of the lead to thin it some. Dry fit the cap and trim the lead until it fits. Insert the leads into the pad holes and then mount the cap with the tiny screws. Solder the leads and trim the excess.

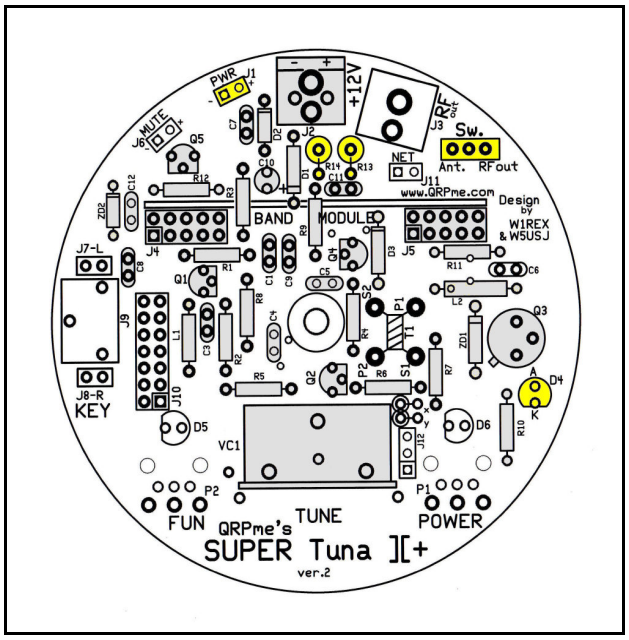





Tuning cap knob – Some polyvaricon caps have a shaft long enough to mount the supplied knob while others are VERY short. For those short shaft pots, you will have to mount a small extension shaft using the supplied 1/4" nylon spacer and 2.5mm x 8mm screw. Once installed on those short cap shafts, the knob can be mounted on the nylon spacer.



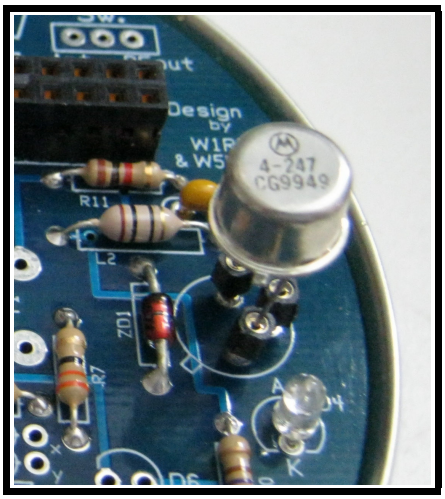


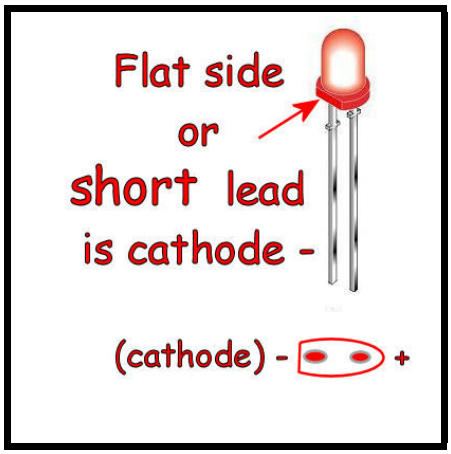

Now for some more miscellaneous parts:

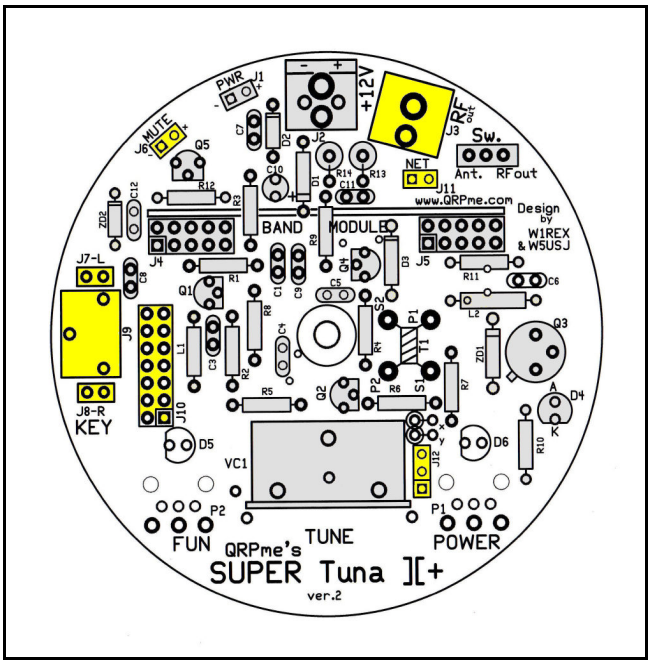
LED - keying indicator at D4
1x2x.1" male header at PWR
100ohm (brn-blk-brn) power resistors at R13 & R14
SPDT switch at Sw.

The power resistors are mounted vertically. The holes on the SPDT switch might be tight but persistent pressure and wiggling will coax the switch into the holes.

The silk screen POLARITY marking for the cathode (-) of an LED is a flat side of the LED circle. Orient the LED so that the flat (or shorter LED leg) side of the LED matches the the flat on the silk screen marking. If you don't have a flat side on the LED, the shorter of the 2 leads would be the lead to install in the hole associated with the flat end of the LED.



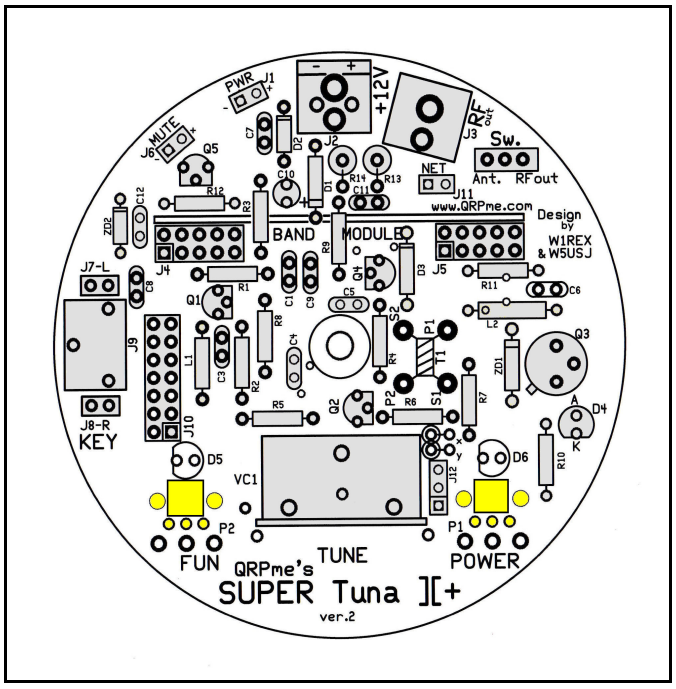



More miscellaneous connectors:

Stereo jack at J9
1x2x.1" male header at J7-L
1x2x.1" male header at J7-R
2x7x.1" male header at J10
1x2x.1" male header at MUTE
1x3x.1" male header at J12
1x2x.1" male header at NET
RCA jack at RF

male headers are shipped as individual headers or cut from 8 pin strips...

Those little 2 pin male headers are a bit tricky. I use the soldering iron in the can or bench top vice and very carefully hold the header in the hole using my fingernail, touching one pin only. Then I carefully solder the OTHER pin in, let cool and turn the board over to check the header fit. If it needs adjusting, hold it again and touch the iron to the SAME pin and try to align the header before removing the iron and letting it cool again. Recheck. If everything is OK, move on to the other headers. Once they are all on (with ONLY ONE pin soldered) then go back and solder the other pins. Working too long when soldering a header will cause the header's plastic to melt.




Install the two potentiometers at FUN and POWER. The FUN potentiometer is a 50K pot and the POWER potentiometer is a 1K potentiometer.

Before soldering the pots, please inspect the front foot pins. When the POT if fully inserted into the pad holes, the front frame 'foot' actually touches the pad for the optional front pots. You will need to modify either the frame 'foot' or the traces to the front pots to prevent the grounded frame from shorting to the front pot pads. There are 3 easy options:

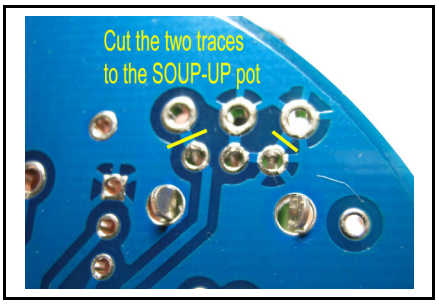
1. cut the traces from the optional front pot pads to the regular pot pads

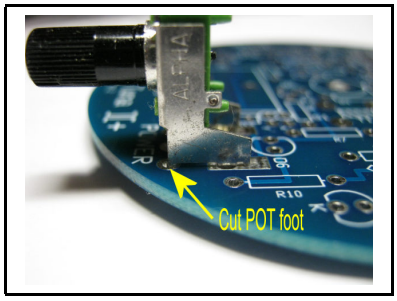
OR

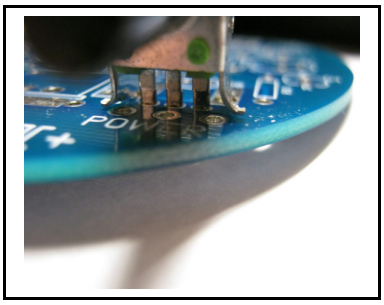
2. cut off the small frame feet on the front of the pot before inserting it into the pads

OR

3. bend the small frame feet outwards so they no longer touch the underlying pads

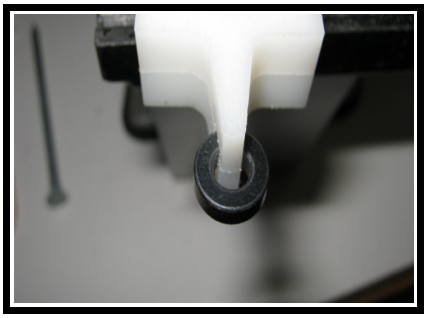


I prefer to cut the traces on the underside of the board thereby isolating the front pot pads. Now you can solder the front frame/feet to the top pads to provide added stability to the pots.

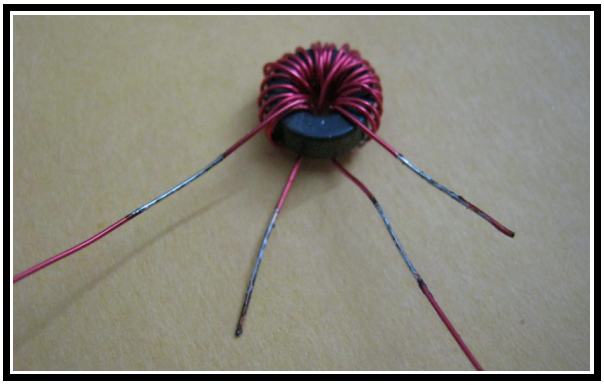
Now for what some people think is the hardest of all things to do in building QRP kits.....winding a transformer. It is easier if you have the right tool. I use the Toroid EZ tool to hold the toroid in position. Now I have 2 hands free to wind the toroid.

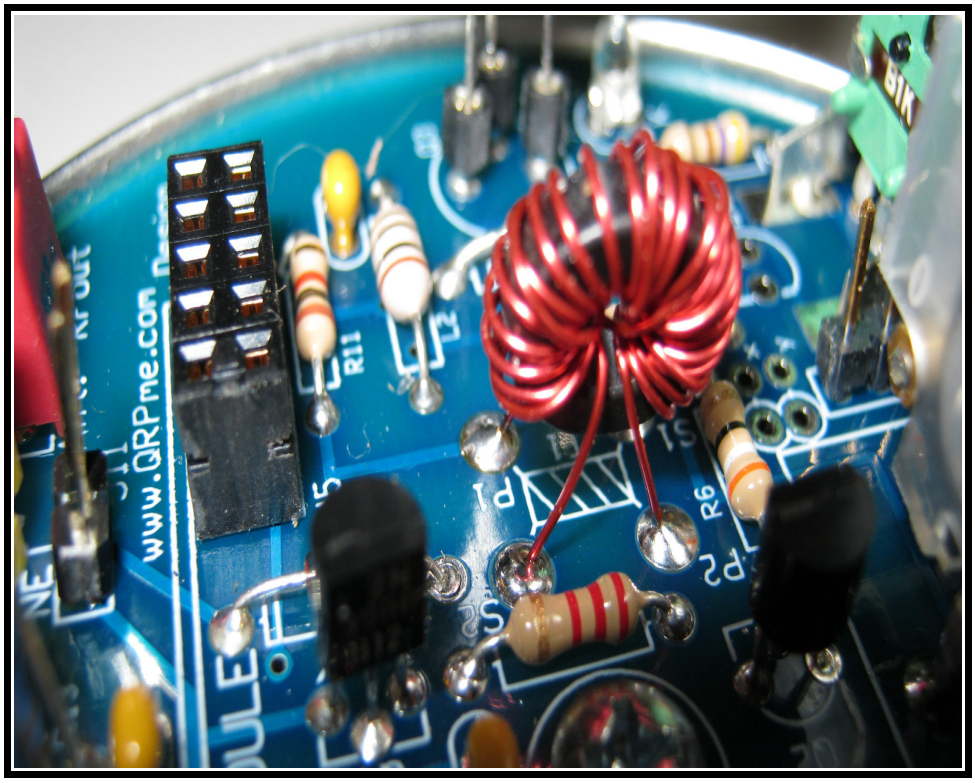


Ferrite Toroid .37" dia.
of type 43 ferrite material = FT37-43

Wind 25 turns of magnet wire on the FT37-43 (little black donut). Look at the location for mounting the toroid (T1) and imagine the toroid standing vertical in the rectangular outline screened on the pcb. Now look for the primary winding solder pads.... marked P1 & P2. On the SUPER Tuna, they are in the top right and bottom left quadrants. Note that the secondary windings (marked S1 & S2) are at the bottom right and top left... or exactly opposite. This means that when you go to wind the secondary windings, make sure you start from the opposite direction. If you started the primary winding by going DOWN thru the toroid, then start the secondary winding by coming UP thru the toroid. This will make it very straight forward when you mount the transformer. Make a mental note of which direction you started. Use about 270 degrees on the toroid to make the windings. Clip the leads off at about 1" beyond the toroid.

Now wind 5 turns of magnet wire over the 1st set of windings. Start from the opposite direction and cover the same 270 degrees with 5 evenly spaced turns. Clip the leads off at about 2" beyond the toroid. Any length will work as long as it is VERY noticeably longer than the lead length of the primary leads. That is how you can easily tell them apart later. 'Dry fit' the transformer and make note of the location on the leads where you will need to solder. Remove the transformer and melt insulation off the magnet wire using a soldering iron with a good glob of solder on it. "Dry fit' again. If everything looks right, then remove the transformer once more. I like to GENTLY scrape off any residue from the magnet wire with a Xacto blade before actually soldering it in position. I will then know that I've done everything to assure that the solder connection will be clean and tight.

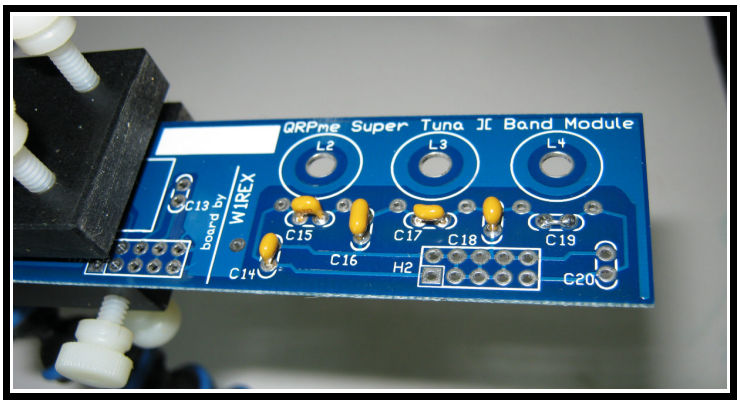




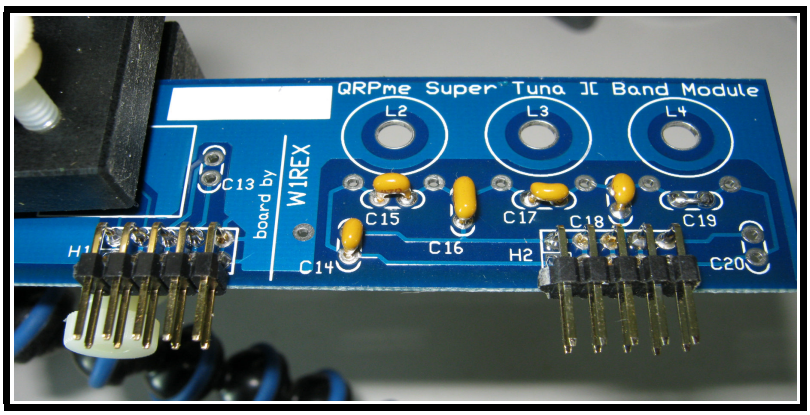

**Transformer T1 soldered into position.**

The SUPER Tuna board can now be mounted on the tuna can using the 1.5+" x #6 bolt and nut. Screw the bolt in from the top of the board and then down into the can. The nut will thread onto the bolt where it comes out of the bottom of the can. Don't over tighten the nut. It is used only to pinch the board and can together.

The one remaining thing to build is the band module board. The SUPER Tuna can be easily moved from band to band by simply swapping out the band module. The only components that need to change when moving the SUPER Tuna about the bands are the crystal and low pass filter. Hence, they a mounted on a small band module board for maximum flexibility.



I use the SBSS mounted in a Gorilla Pod camera tripod to hold the board for soldering AND taking pictures!



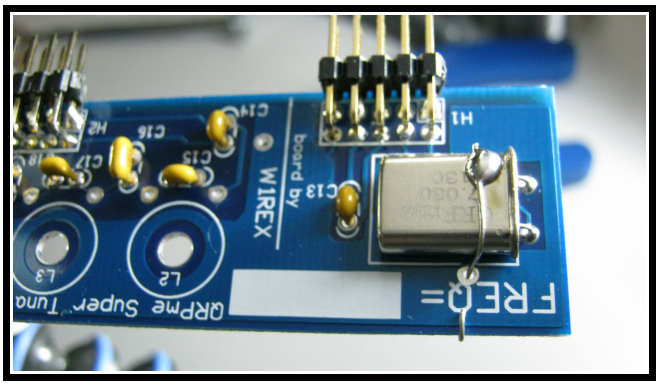

Install the 5 caps for the low pass filter and the two 2x5x.1" right angle male header plugs. For the 40m band module board:

C14 = 330pf marked 331
C15 = 47pf marked 470
C16 = 680pf marked 681
C17 = 150pf marked 151
C18 = 330pf marked 331

Swap the board around in the holder and ..

Install the oscillator cap C13

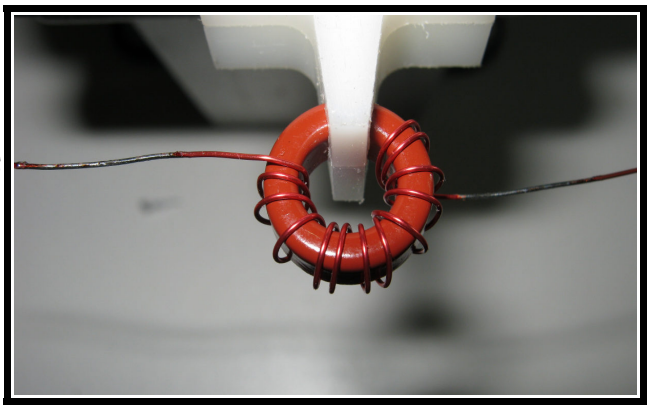
C13 = 47pf marked 470




Install the 40m crystal and then use a piece of cut component lead to ground the case to the pad just below (above in the picture) the Q in FREQ.

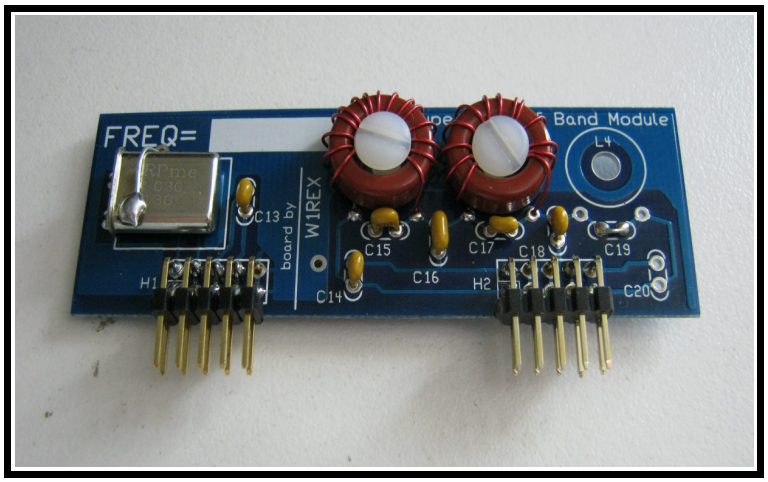
You could also install a 3 pin SIP socket (with center pin clipped off) in the crystal pads which would allow you to plug in various crystals in order to move about the band. This might be more desirable on 40m band modules where there are many available crystals for the 40m band. Of course, this mod would make the crystal a potential source of problems where the connection and mounting are both flimsy. LIGHTLY tinning the crystal leads would make them fit into the SIP sockets a little tighter. Don't tin them too much....

Now you get to have some more fun winding toroids. L2 and L3 on the band module are the same value. They are 2.2uH or 21 turns on T50-2 toroids or 23 turns on T37-2 toroids. Check the size of the supplied toroids:  3/8" diameter are T37s and 1/2" diameter toroids are T50s.



Wind the toroids, 'dry fit' them and prepare the magnet wire for soldering same as with the previous transformer. Install the toroids flat against the band module board and secure them to the board using the nylon screws. Now solder the wires and clip off the excess.

Use a clipped off component lead and solder in a jumper across either L4 or C19. This will bypass the 3rd filter section which is not required. The layout of the band module board is quite generic and will allow you to install filters from other sources...




## Completed 40m band module

Install the band module board into the header connectors on the main tuna board, You should now be ready to check out the operation of the transmitter. Switching the switch to Power will place a built in dummy load on the output of the transmitter. Applying power, you should be able to key the transmitter and follow the keying by watching the LED.  You can verify the power output by measuring to output voltage at the 2 pin male header marked PWR using a digital multimeter. You should get about 2 watts out of the SUPER Tuna which is about 20 volts.

You can now mount the heat sink onto transistor Q3. It is much easier if you take the transistor out of the socket and push it into the heat sink rather than attempt to push the head sink onto the transistor.... Reinstall the transistor/heat sink combo into socket Q3.


**Completed SUPER Tuna ][+ transmitter!**