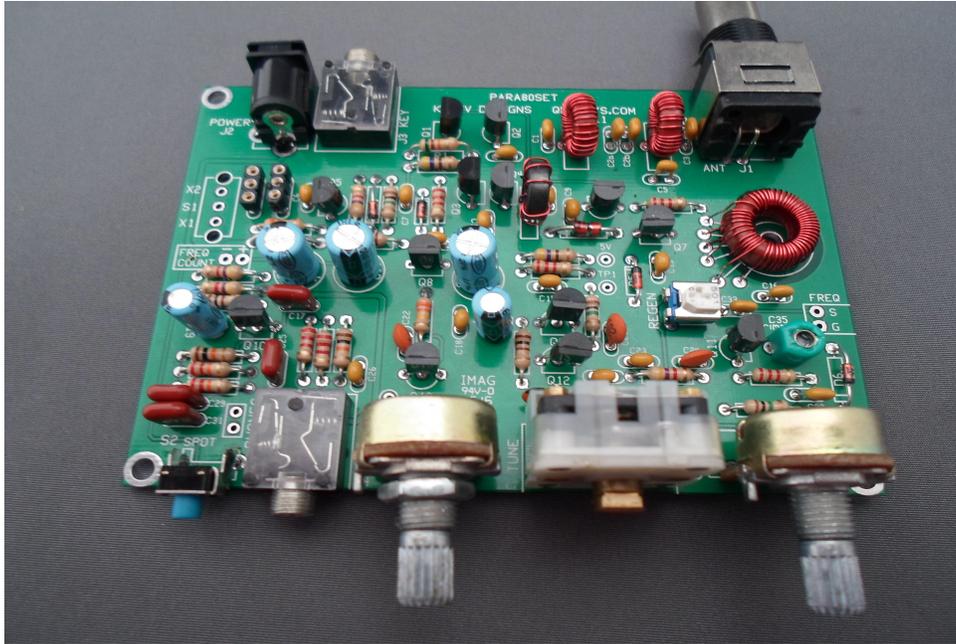


THE PARA40SET

A 40 meter version of the para80set

Designed by Steve, KD1JV -- Distributed by the QRP Guys



The "Para40set" is a 40 meter version of the "Para80set", which is an updated version of the MAS80, which originally designed by Steve, KD1JV for the M.A.S. design contest (minimum art session), a contest started by Dr. Harmut "Hal" Weber, DJ7ST. (Now a SK). The idea behind this contest is to encourage Hams to build and operate a rig using a minimal number of parts. Steve has made some improvements and modifications and the result is the Para80set. It is named to commemorate the "Paraset" clandestine vacuum tube transceiver that was parachuted behind enemy lines to Allied resistance groups in northern Europe, and Scandinavia during WW II.

Like the original "Paraset", this modern version incorporates a sensitive regenerative receiver and a 3 watt, crystal controlled CW transmitter, but with solid state components. Improvements over the original MAS80 design include a more efficient transmitter and a "spot" switch to locate the transmit frequency in the receiver, along with a 2 crystal switch option. Some component values have been tweaked to reduce the number of different part values used and provide better high frequency roll off of the audio.

Specifications:

Supply voltage range: 12V to 13.8V

Receiver:

Current: ~ 20 ma
Sensitivity: ~ 0.5 uV MDS
Main tuning range: ~ 270 kHz
Fine tuning range: ~ 30 kHz

Transmitter:

Power output: ~ 3.5 watts at 13.8V
Current: ~ 460 ma at 3.5W, 13.8V
Spurious outputs – 50 dBc or better.

First, familiarize yourself with the parts and check for all the components. If a part is missing, please contact us and we will send one. You must use qrpguys.parts@gmail.com to request a part.

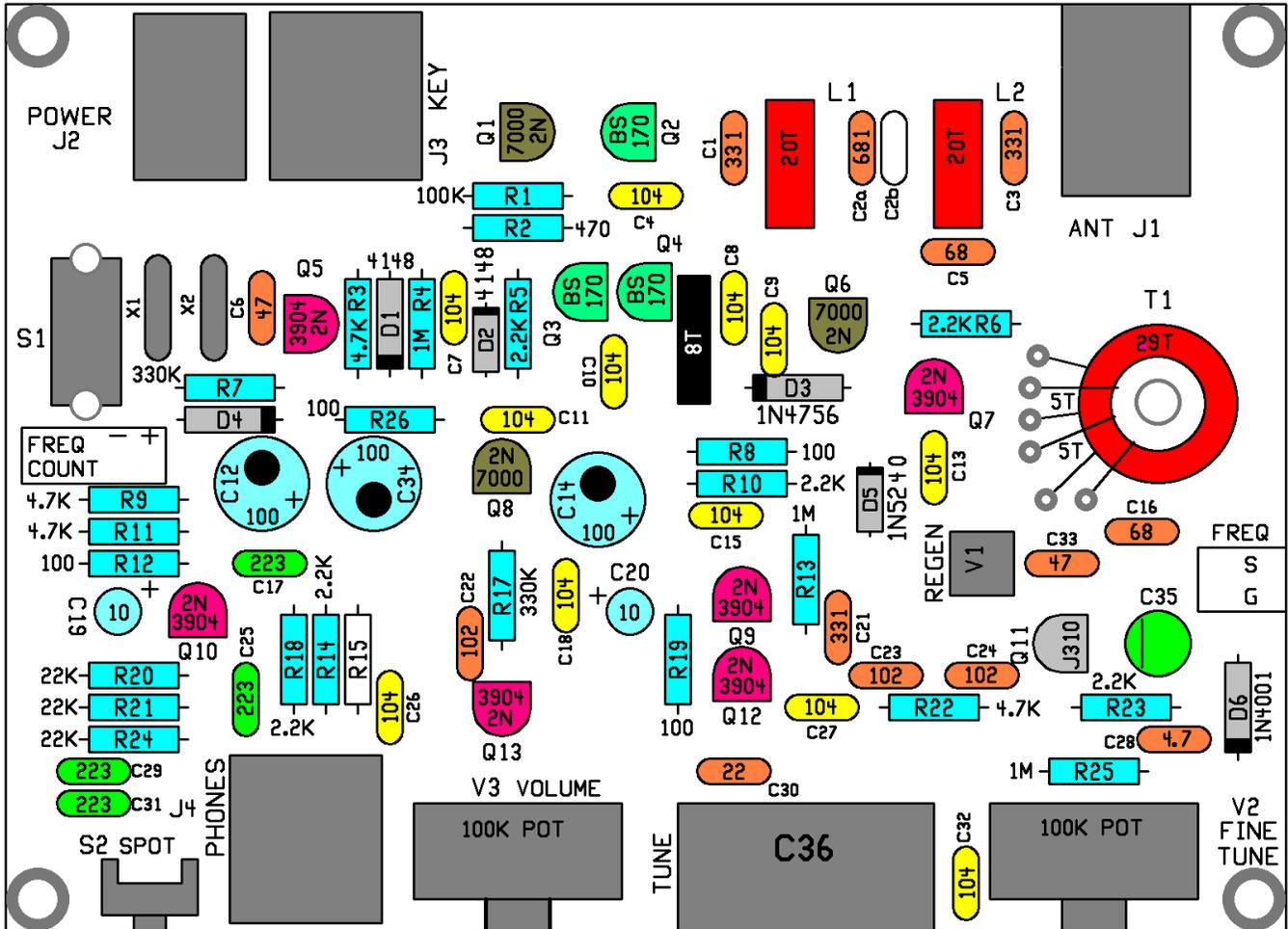
Assembly:

I recommend building up boards in "layers", starting with the lowest profile parts. This means starting with the resistors and diodes, then the small capacitors, then the transistors, then everything else. Experienced builders will only need to print out the layout diagram to build up the board, but a part-by-part assembly table is also included. You can start by sorting the parts into types and verifying the quantity against the parts list below. Just be sure not to loose any in the process!

QTY	Value	Identifier	QTY	Value	identifier
4	100 ohms	BRN/BLK/BRN/GLD	2	1N4001	1A silicon rectifier diode
1	470 ohms	YEL/VOL/BRN/GLD	2	1N4148	Small signal diode
6	2.2 K	RED/RED/RED/GLD	1	1N5240B	500 mw 10 V Zener diode
4	4.7 K	YEL/VOL/RED/GLD	1	1N4756A	1W, 47V Zener diode
3	22 K	RED/RED/ORG/GLD	1	J-310	N-JFET
1	100 K	BRN/BLK/YEL/GLD	3	BS170	TO-92 N MOSFET
2	330 K	ORG/ORG/YEL/GLD	3	2N7000	TO-92 N MOSFET
3	1 meg	BRN/BLK/GRN/GLD	6	2N3904	TO-92 NPN
			1	7.030 MHz	Crystal
1	4.7 pfd	4.7 disk			
1	22 pfd	22 COG/NPO	1	FT37-43	Ferrite core
2	47 pfd	47 COG/NPO			
2	68 pfd	68 COG/NPO	2	T37-2	Red iron powder core
3	330 pfd	331 COG/NPO			
1	680 pfd	681 COG/NPO	1	T50-2	Red iron powder core
3	.001 uF	102 disk	1	500 ohm	6mm trimmer resistor
4	0.022 uF	223 film	2	100 K	16 mm Log tapper pots.
13	0.1 uF	104 X7R MMLC	2	Phone jack	3.5mm board mount
2	10 uF/16V	10 electrolytic	1	DC jack	2.1 mm
3	100 uF/16V	100 electrolytic	1	BNC jack	PC mount
1	40 pfd	trimmer cap.	1	SPDT slide	Slide switch
			1	PB switch	6mm RT angle TACTILE
1	Tuning cap	Poly variable	1	7 feet	#28 magnet wire
1	Tuning cap shaft	hardware	4	Bumper	feet
			1	pcb	Circuit board

Layout Diagram: color

Print out this layout diagram for reference while building.

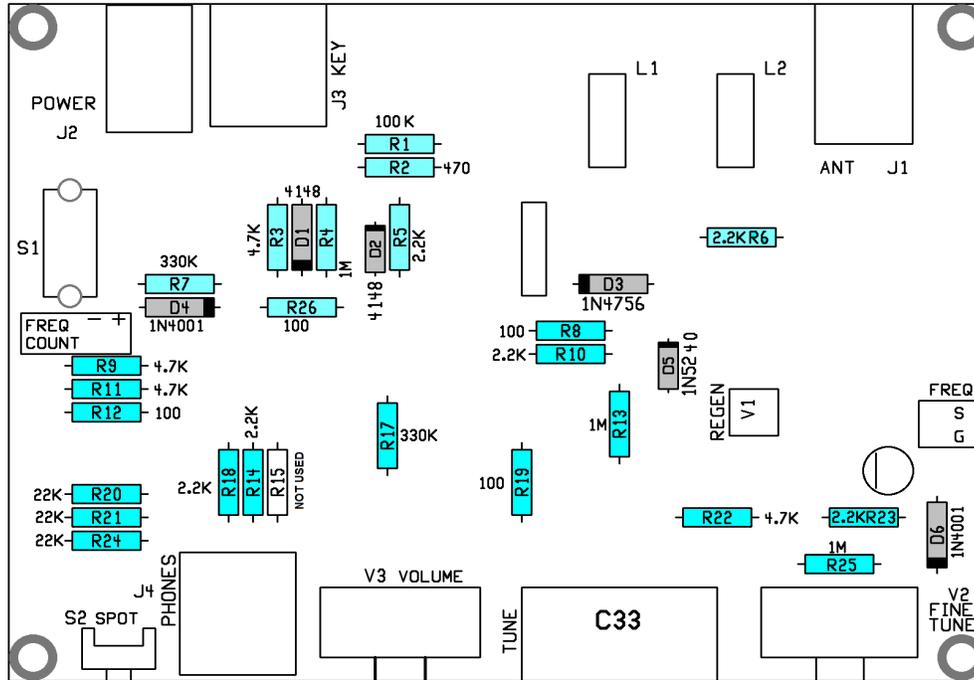


Resistors and diodes:

Parts are numbered on the board from upper left corner, left to right and zig-zag towards the bottom (front edge) of the board.

Look out for resistors with similar color codes which only vary by the 3d zero multiplier band, such as 2.2K vs 22K, 470 ohm vs 4.7K or 47 K and the like.

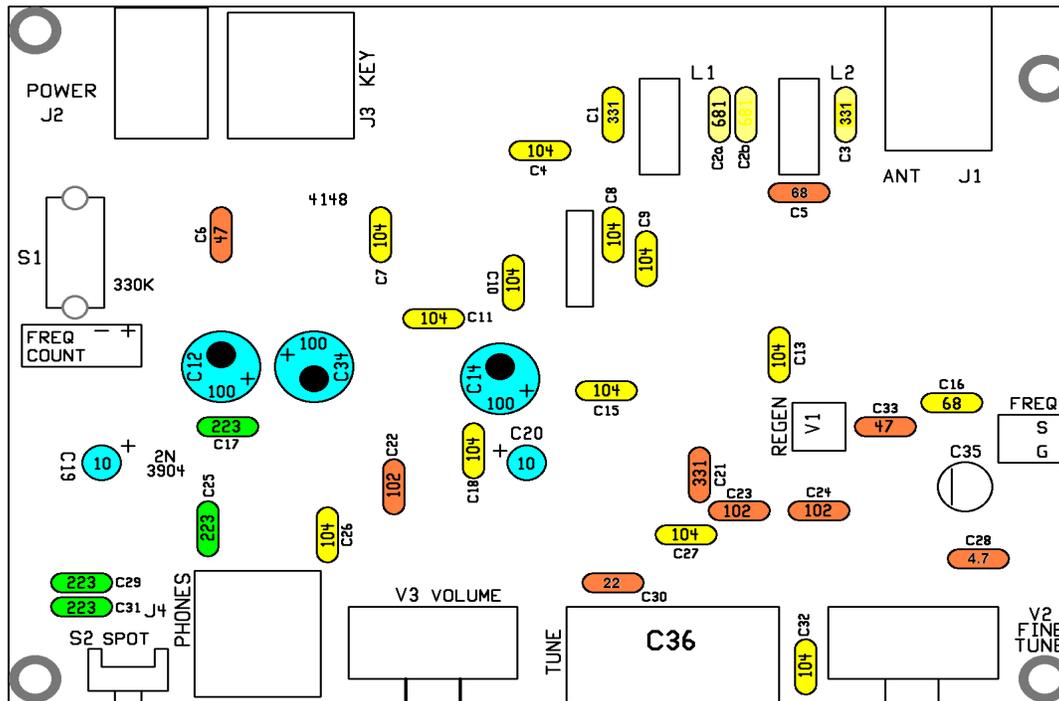
Be careful not to mix up D5 (a zener) with D1 and D2 (small signal silicon) diodes, since they are both in similar glass packages.



R1	100 K	BRN/BLK/YEL/GLD	R2	470 OHM	YEL/VOL/BRN/GLD
R3	4.7 K	YEL/VOL/RED/GLD	R4	1 M	BRN/BLK/GRN/GLD
R5	2.2 K	RED/RED/RED/GLD	R6	2.2 K	RED/RED/RED/GLD
R7	330 K	ORG/ORG/YEL/GLD	R8	100 OHM	BRN/BLK/BRN/GLD
R9	4.7 K	YEL/VOL/RED/GLD	R10	2.2 K	RED/RED/RED/GLD
R11	4.7 K	YEL/VOL/RED/GLD	R12	100 OHM	BRN/BLK/BRN/GLD
R13	1 M	BRN/BLK/GRN/GLD	R14	2.2 K	RED/RED/RED/GLD
R15		Not used, leave blank	R16	DELETED	Location
R17	330 K	ORG/ORG/YEL/GLD	R18	2.2 K	RED/RED/RED/GLD
R19	100 OHM	BRN/BLK/BRN/GLD	R20	22 K	RED/RED/ORG/GLD
R21	22 K	RED/RED/ORG/GLD	R22	4.7 K	YEL/VOL/RED/GLD
R23	2.2 K	RED/RED/RED/GLD	R24	22 K	RED/RED/ORG/GLD
R25	1 M	BRN/BLK/GRN/GLD	R26	100 OHM	BRN/BLK/BRN/GLD
D1	1N4148	Small glass	D2	1N4148	Small, glass
D3	1N4756A	Large, glass	D4	1N4001	Large, black plastic 1A, 50V
D5	1N5240B	Small, glass – don't mix up with 4148 diodes!	D6	1N4001	Large, black plastic

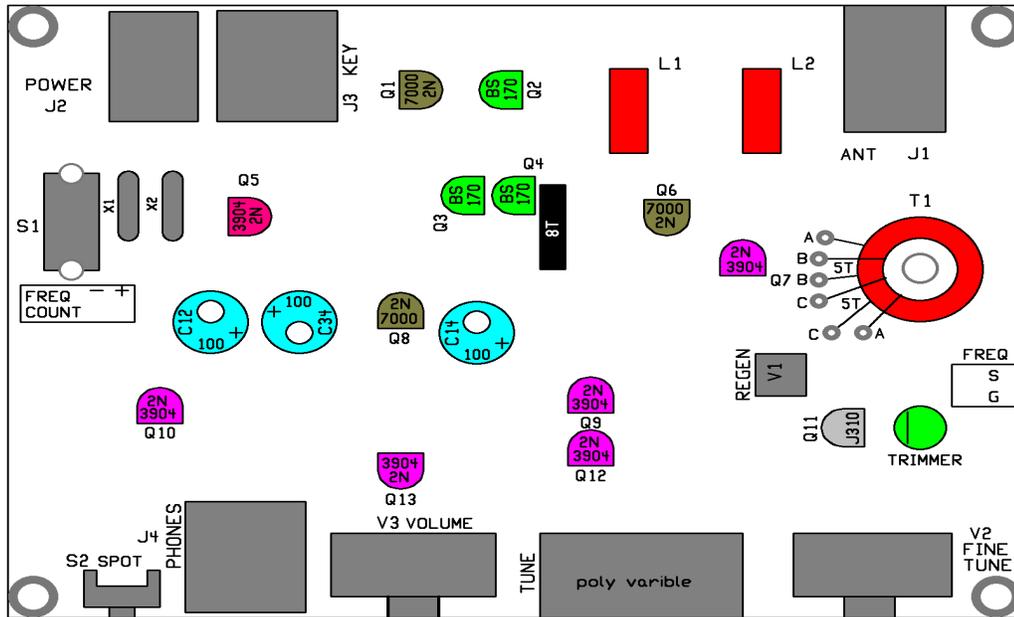
Capacitors:

All the 0.1 uF (104) caps are highlighted in yellow, since these are the most numerous value. The 0.022 uF caps are highlighted in green, as these are film caps. All other values are in light blue. Install the electrolytic caps last. Be sure to observe polarity. The plus end is the long lead. The negative lead pad is circled on the silk screen and highlighted in black below for the 100 uF caps.



C1	331	330 pfd, C0G	C2a	681	680 pfd, C0G
C3	331	330 pfd, C0G	C4	104	0.1 ufd X7R
C5	68	68 pfd, C0G/NPO	C6	47	47 pfd C0G/NPO
C7	104	0.1 ufd X7R	C8	104	0.1 ufd X7R
C9	104	0.1 ufd X7R	C10	104	0.1 ufd X7R
C11	104	0.1 ufd X7R	C12	100	100 ufd 16V electrolytic
C13	104	0.1 ufd X7R	C14	100	100 ufd 16V electrolytic
C15	104	0.1 ufd X7R	C16	68	68 pfd C0G/NPO
C17	223	0.022 ufd film	C18	104	0.1 ufd X7R
C19	10	10 ufd / 16V electrolytic	C20	10	10 ufd / 16V electrolytic
C21	331	330 pfd disk	C22	102	0.001 ufd disk
C23	102	0.001 ufd disk	C24	102	0.001 ufd disk
C25	223	0.022 ufd film	C26	104	0.1 ufd X7R
C27	104	0.1 ufd X7R	C28	4.7	4.7 pfd C0G/NPO
C29	223	0.022 ufd film	C30	22	22 pfd C0G/NPO
C31	223	0.022 ufd film	C32	104	0.1 ufd X7R
C33	47	47 pfd C0G/NPO	C34	100	100 ufd 16V electrolytic

Remaining parts:



Note: due to the close spacing of the variable resistors and tuning cap, you might want to mount the pots to the bottom of the board, although that will make the controls work “backwards” and require a taller box to give clearance to the knobs. Or they could be mounted off the board and the connections jumpered to the board.

Q1	2N7000	
Q2	BS170	
Q3	BS170	
Q4	BS170	
Q5	2N3904	
Q6	2N7000	
Q7	2N3904	
Q8	2N7000	
Q9	2N3904	
Q10	2N3904	
Q11	J310	
Q12	2N3904	
Q13	2N3904	
J3/4	PHONE JACK	
J2	DC POWER	
J1	BNC JACK	
S1	SPDT	SLIDE SWITCH
S2	PUSH BUTTON	RIGHT ANGLE TACKLE SWITH
X1	7.030 MHz	CRYSTAL or 3 pin SIP socket
V1	501	500 OHM TRIMMER RESISTOR
V2/3	100 K	16mm Log potentiometer
C36	VARIABLE	Tuning cap
C35	Trimmer cap	

Addendum

There are two style poly-varicon capacitors that may come with your kit. Both styles are detailed below and latest variety needs a slight modification.

Poly-varicon installation to kits ordered before 01/20/18

- [] Prior to installing the poly-varicon variable capacitors the leads must be re-routed through the snap-on cover. The pictures below show the “as received” and “modified” condition. Carefully pry off the cover, bend the leads to the rear, feed them through the cover and snap it back on. There is a small tab, opposite the side with the leads, on the cover that matches the body of the poly-varicon for the cover to fit properly.

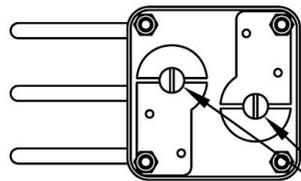


As received



Modified

- [] Adjust the two trimmer caps on the back of each poly-varicon to their *minimum* value as shown below.



ADJUST FOR
MINIMUM ENGAGEMENT
(LOWEST VALUE)

- [] Install the two polyvaricon capacitors on the inside of the front panel. Carefully feed the three leads through the board and secure the capacitors with the two short metric Phillips screws from the outside. Solder and clip the leads flush. Install the nylon spacers, long metric screws, and knobs as shown in the figure below.

Poly-varicon installation to kits ordered after 01/20/18



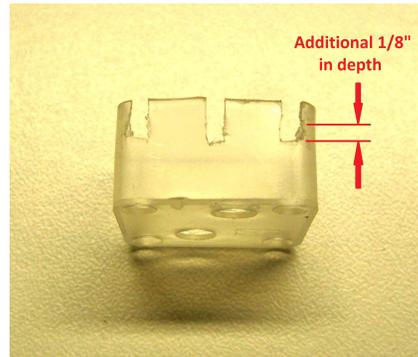
As received



Modified

The polyvaricons as received, need a modification to allow the leads to reach the bottom of the device so it can be soldered to the pcb. If bent without modifying the cover, all the leads will not reach. Shown above is the un-modified polyvaricon as received.

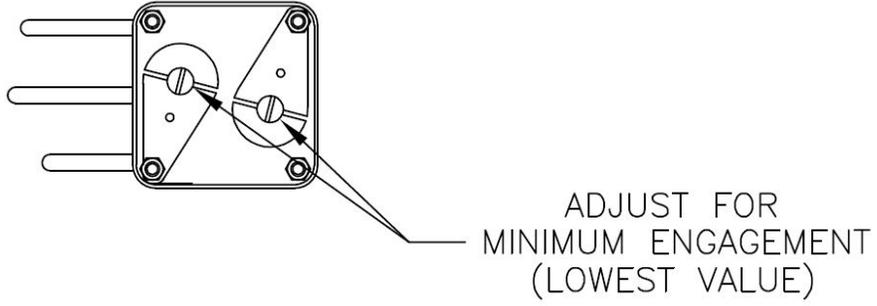
Carefully unsnap the protective cover. Deepen all three slots for the connection tabs by ~1/8" with an Exacto knife as shown on the right. Snap the cover back on, and run the leads on the outside of the cover.



Shown below the modified cover is snapped back on and the leads are bent to the bottom. It is now ready for installation. As you can see, one of the leads is shorter than the others and may need to be soldered on the top of the board. This is not a problem with plated through holes.



- [] Adjust the two trimmer caps on the back of each poly-varicon to their *minimum* value as shown below.



Toroids:

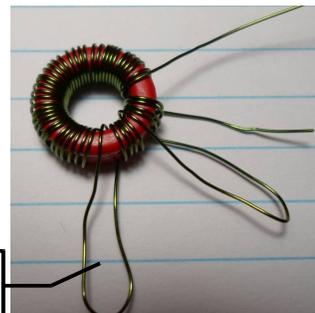
The toroid cores should be wound with the wire fairly tight and flush to the body of the core. Loops which extend much beyond the outside edge of the core need to be avoided. The recommended wire lengths in the table include a 1" start and stop wire length. If you run out of wire, your winding the core too loosely. A loosely wound core will not have the required inductance and will affect the tuning window, stability and power output. Note: When installing L3, you'll need to give it a "half twist" after soldering the leads to make it fit between Q4 and the cap on the other side, so leave a little slack in the leads.

L1	T37-2 (red)	17" #28 magnet wire, 20 turns Evenly space the turns around the core.
L2	T37-2 (red)	17" #28 magnet wire, 20 turns Evenly space the turns around the core.
L3	FT-37-43 (black)	6" #28 magnet wire, 8 turns

Winding the receiver input transformer, T1:

The receiver input has three windings, the input coupling, the receiver tuned circuit inductor and the feedback winding. The tuned circuit inductor winding and the feedback winding require to have a specific phase relationship for the detector to oscillate and produce audio output. Winding the core as explained below will ensure the proper phase relationship when mounted to the board. A piece of double sided foam tape or a nylon screw and fiber washer can be used to secure the T1 core to the board to reduce microphonics and improve stability.

- Cut a length of #28 magnet wire to 40"
- Wind the initial 29 turns for the detector input.
- Make a hairpin about 1" long and continue to wind an additional 5 turns.
- Break out another 1" hairpin and wind 5 more turns.
- All these turns will just fit around the core with little space to spare.
- Now snip the center of the hairpin turn to separate the three windings.
- Tin the leads and install into the board, making sure you don't cross winding leads.
- Once the toroids are installed, assembly is complete.
- Be sure to carefully inspect your solder joints before power up the board.



Test and operation:

A common 13.8V supply is recommended. So is adding a 1A fuse. Since the board it's self isn't fused, using a fused supply cable will prevent any possible damage to the supply or board if something went wrong with the assembly or soldering and a short develops.

Warning: The common on the headphone jack is "hot" and connected to the input supply directly through the headphones. Therefore, a short here to ground could burn out the headphones.

- Plug in a set of headphones
- Connect BNC jack to an appropriate antenna
- Plug in a DC power cable
- Using a small blade screwdriver, adjust the REGEN control pot fully counter clock wise.
- Turn on the power supply
- Check for +10 V at the pad labeled "TP3" If this is not about 10V, then you have a 1N4148 diode there instead of the zener.
- Check for about 1.8 V at TP1 and 13.0 V at TP2 (this assumes a 13.8V power supply)
- Turn the REGEN control slowly clockwise. You should start to hear band noise at about ¼ turn. This is when the detector starts to oscillate. Advance the control a little more to ensure reliable start up. If your using a frequency counter adjust for a stable reading on the display.
- Set the main tuning variable capacitor and fine tuning control fully counter clockwise.
- Use the C35 trimmer cap to set the frequency of the detector to about 7.000 MHz. This adjustment is a bit touchy. Since the detector is an oscillator, a near-by receiver can be used to set the cap. Tune your receiver to 7.00 MHz and adjust the trimmer until you hear the signal. You'll probably need to use a short piece of coax to the receiver antenna input with a short clip lead antenna placed near the Para40set board to hear the signal from the regen detector. A frequency counter can also be use, but it will likely load down the tuned circuit a little so unless the counter will be part of the final assembly, using the no connection receiver technique is best.

Transmitter testing:

- Connect a QRP power meter and 50 ohm dummy load to BNC jack
- Plug in a straight key into key jack.
- Power up board with 13.8 volts
- Key the transmitter.
- Power output should be about 2.5 to 3 watts. The power will sag a little if keyed for more than a few seconds. Note that the way the turns are spaced on L1 can have a significant impact on power output. If power output seems too much, "scrunch" some of the turns closer together
- Side tone should be audible in the headphones.

Tuning:

There is a "Main" or coarse tuning (the poly variable cap) and a "fine" tuning control (the pot to the right of the tuning cap). The main tuning covers pretty much the full band and since it spans the range in just a 180 degree turn of the knob, it's too touchy for picking out a specific signal. So, use the main tuning control to set the general area of the band you want to listen to and then use the fine tuning control tune around that area.

SPOT switch:

The spot switch allows finding your transmit frequency in the receiver. Simply push the switch and tune the receiver until you hear the tone you like and side band with the least QRM.

Adding a frequency readout dial.

A frequency counter can be added for a direct readout of the receiver frequency. The pads labeled "S" (signal) and "G" (ground) in the box labeled "FREQ" on the right side of the board connect to the counters signal input. The Pads labeled "+" (plus power) and "-" (ground) in the box labeled "FREQ COUNT" supply power to the counter board. This supply is isolated from the rest of the circuits on the board via a 100 ohm resistor and 100 ufd electrolytic capacitor. This keeps power supply noise from the counter out of the receiver.

Note that the counter can also radiate a fair amount of noise which can be picked up by the transmitter low pass filter coils and the receiver input coil. Therefore, try to mount the counter as far away from the coils as possible or add some shielding behind the counter board.

A suitable counter is available from the QRP Guys, QRPKITS.com or from China sourced from ebay.

Adding a speaker:

The headphone jack has switched contacts, so it would be possible to wire up a small 32 ohm speaker. There should be sufficient volume for most signals. Make sure it's a 32 ohm type, an 8 ohm will be too much of a load. Connect the speaker leads to the two pads to the left of the headphone jack.

Supply voltage:

The Para40set is designed to be powered by 13.8 volts. It will work reliably down to 12 volts with reduced power output. Power output can be improved by removing a turn from L1, making it 19 turns instead of 20.

Excessive SWR:

High SWR can cause the BS170 PA to draw excessive current and therefore damage them. When using an antenna tuner to find best match, it is recommended to use a resistive SWR bridge.

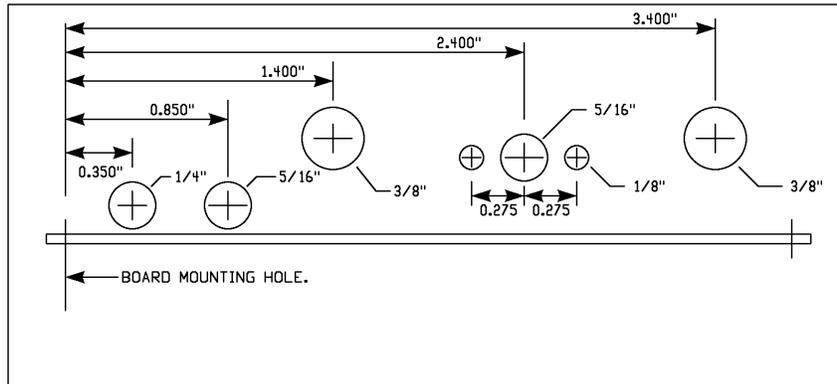
Trouble shooting:

Any trouble getting the rig to work will inevitably be tracked down to an assembly error, the most common of which are soldering issues. A close visual inspection of your soldering will likely find the problem area. Having miss placed parts is less likely, but a possibility, especially the mixing up of resistors with similar color codes. Voltages at critical points are noted on the schematic. Using your voltmeter to verify these voltages can help pin point the problem area. Minor variations from the voltages noted on the schematic are normal due to parts tolerances, voltmeter loading and calibration.

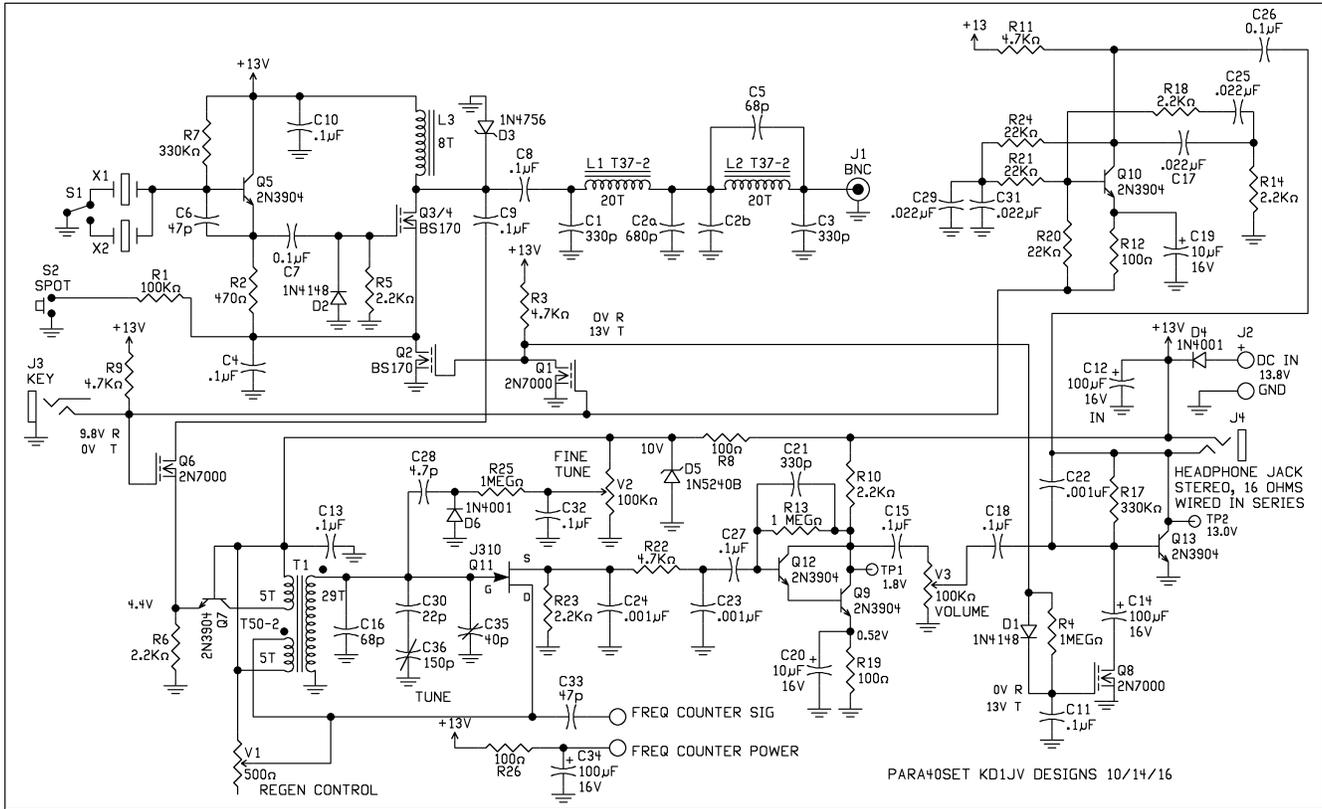
Packaging the board:

The simplest way to make an enclosure for the board would be a "L" shape, made of PCB material or aluminum. Just remember that the exposed mounting sleeve of the headphone jack is "live" with the DC supply so make sure it has good clearance from a conductive front panel. A front panel drill drawing is shown below. To fully enclose the board, a cover could be made of some thin hobby wood which would make for a nice looking package. The diagram below should print out to actual size so it can be used as a drill template, but be sure to double check the dimensions first to make sure. The height of the panel below the board will depend on what you use for board spacers. I would use at least an inch.

Three different case designs are also available on the QPRGUYS web site.



Schematic:



PCB track layout:

