

# "The Survivor"

## A 80 meter QRP SSB transceiver



- Up to 10 watts pep @ 13.8V
- 0.2 uV receiver sensitivity
- Up to 350 kHz receiver tuning range
- 200 Hz warm up drift. (stable room temperature)
- 8 ohm 500 mw speaker output.
- "Tune" and CW modes
- 50 ma Rx current (with optional Digital Dial)
- small size 6" x 4" x 1.5", 11.5oz.
- 13.8V at 2A min recommended power supply

### Operation:

**Controls:** Controls consist of Volume, Fine and Main (course) tuning.

### Volume:

Set the volume control to a comfortable listening level. The AGC will hold the audio level to this volume for all but the weakest signals. The AGC has a slightly delayed response to keep it from overshooting when a large signal appears. This results in a momentary "thump". Without the slight delay, all audio would be lost until the AGC could recover from overshooting, which could take several seconds.

### Main tuning:

Main tuning has about a 350 kHz range in a single turn of the knob. NOTE: Tuning is "backwards". Turning the tuning knob clockwise decreases frequency.

### Fine tuning:

The fine tuning control has about a 30 kHz range, allowing you to tune between several near-by stations and to compensate for any minor drift the VFO has during operation.

**Microphone:** An "electret" microphone element is required. The rig supplies the power needed for the mic. A suitable, low cost microphone is available from [www.QRPKITS.com](http://www.QRPKITS.com)

### Push To Talk (PTT):

Transmitting is initiated by pushing the PTT button on the microphone and then talking (duh). The PTT switch is also used to activate "tune" and "CW" modes.

### Tune up mode:

Most 75/80 meter antennas have a fairly narrow bandwidth so therefore require an antenna tuner which needs to be readjusted every so often as you move up or down the band. Since a steady carrier works better than whistling into the mike to get a signal, a steady carrier or "tune mode" is built into the rig.

Tune mode is activated by:

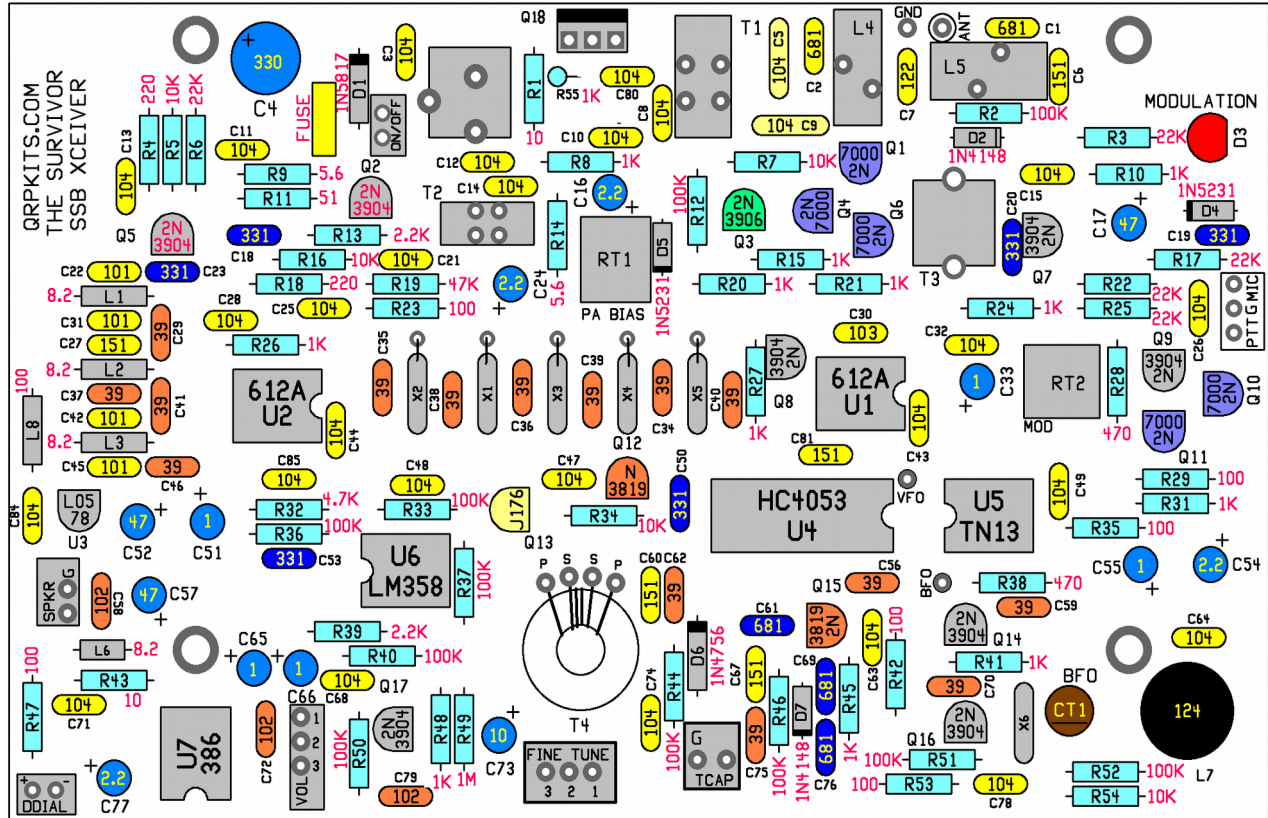
1. A *very short* push and release of the PTT switch on the microphone, < 1/2 second.
2. A "beep" will sound in the audio output, announcing the tune mode is now active.
3. Using the PTT will now activate a 600 Hz tone which is injected into the microphone circuit to modulate the rig. The tone is also heard in the speaker when the rig is transmitting. Transmit power is typically about 5 watts in tune mode, but will vary depending on the microphone gain setting.
4. To exit Tune mode, perform another *very short* push and release the PTT switch.
5. A double beep will sound in the audio output to announce the tune mode is no longer active.

### CW [Morse] mode:

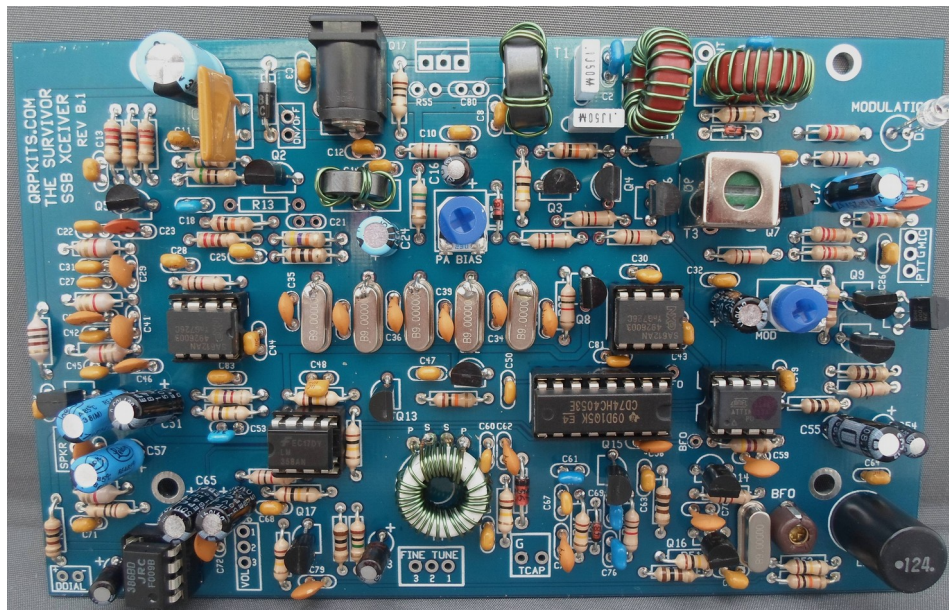
The Survivalist can be operated in CW mode thanks to the Tune mode and microprocessor control of the T/R sequencing in the transceiver. The difference between CW and Tune mode is that in CW mode, the transceiver must respond to quick changes in the state of the PTT switch and stay in the CW mode. Once enabled, CW mode can only be cleared by turning the rig off, then back on again.

CW mode is enabled by keying the character "H" with the PTT at between 5 and 20 wpm. This allows activating CW mode with either a straight key or external paddle. There will be no annunciating side tone until CW mode is enabled, so you have to mentally count the key taps to enter the mode. If not enough pulses are detected, the rig may enter Tune mode instead of CW mode. There just has to be four on/off pulses detected in less than 1/2 second to enter CW mode. When CW mode is detected and enabled, the audio output will announce "CW". The Survivalist will now operate as a CW transceiver, allowing for cross mode communication in the phone band.

# Parts placement diagram, color coded.



The picture below illustrates how a well constructed board should look like.

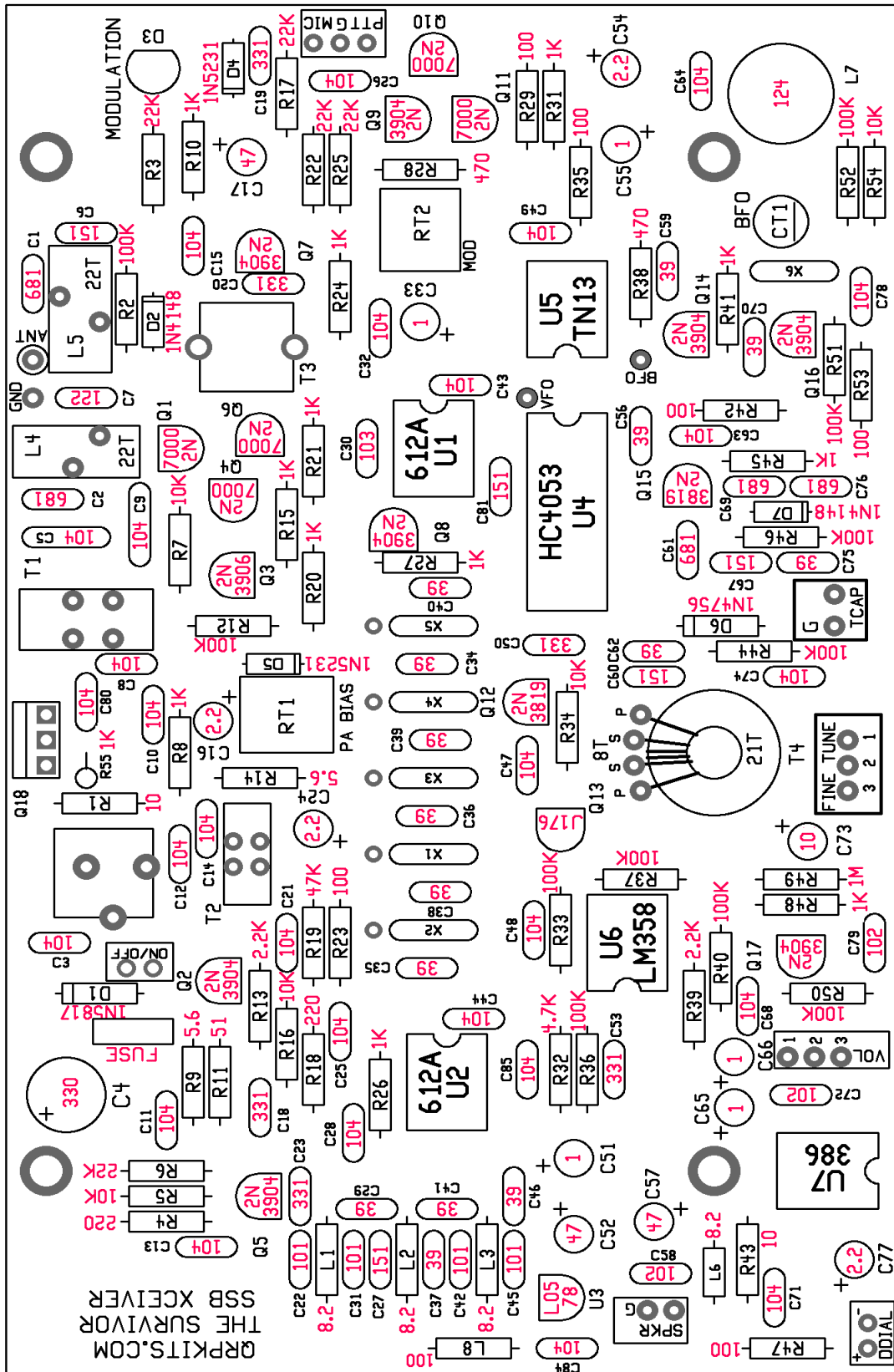


Parts list:

QTY	VALUE	Markings/type	
2	5.6 ohms	GRN/BLU/GLD/GLD	All resistors are 1/4w, 5% CARBON FILM
2	10 ohms	BRN/BLK/BLK/GLD	
1	51 ohms	GRN/BRN/BLK/GLD	this value is easy to mix up with 1 Meg - same colors, reverse order.
6	100 ohms	BRN/BLK/BRN/GLD	
2	220 ohms	RED/RED/BRN/GLD	
2	470 ohms	YEL/VOL/BRN/GLD	
13	1 K	BRN/BLK/RED/GLD	
2	2.2K	RED/RED/RED/GLD	
1	4.7K	YEL/VOL/RED/GLD	This value can be mixed up with 47 K.
5	10 K	BRN/BLK/ORG/GLD	
5	22 K	RED/RED/ORG/GLD	
1	47 K	YEL/VOL/ORG/GLD	
11	100 K	BRN/BLK/YEL/GLD	
1	1MEG	BRN/BLK/GRN/GLD	
2	2 K trimmer	6mm	
1	10 K	Panel mount with switch	
1	50 K or 100 K	Panel mount control, 12 mm	
4	8.2 uHy	GRY/RED/GLD/GLD - RFC	RFC's look like a resistor, but are shorter and fater.
1	100 uHy	BRN/BLK/BRN/GLD - RFC	
1	120 mHy	124 Larger black cylinder	
1	10.7 IF can		
1	Poly-variable	Tuning cap	
1	70 pfd	Brown trimmer cap	
15	39 pfd	39 NPO disk	
4	100 pfd	101 COG MLCC	
5	150 pfd	151 COG MLCC	
6	330 pfd	331 disk or MLCC	
5	680 pfd 100V	681 COG MLCC	
3	0.001 uFd	102 disk or MLCC	
1	1200 pfd 100V	122 100V COG	
1	0.01 ufd	103 X7R 50V MLCC	
27	0.1 uFd	104 X7R 50V MLCC	
2	0.1 uFd 100V	104 FILM, BOX	
5	1 ufd / 50V	ALUM Electrolytic	
4	2.2 ufd /50V	Alum electrolytic	
1	10 ufd /25V	Alum electrolytic	
3	47 uFd/16V	Alum electrolytic	
1	330 ufd/16V	Alum electrolytic	
1	RED LED T1		
1	J-176	P-channel j-fet TO-92	
1	2N3906	PNP TO-92	
2	2N3819	N-channel j-fet TO-92	
8	2N3904	NPN TO-92	

	5	2N7000	MOSFET TO-92	
	1	IRF510PBF	Power mosfet TO-220	
	1	78L05	5V, 100 ma regulator	
	2	1N4148	SS diode	
	2	1N5231B	5.1V zener	
	1	1N4756B	47 V 1W zener	
	1	1N5817	1A shottky diode	
	2	SA612A or SA602	8 pin DIP mixer/osc	
	1	LM358N	8 pin DIP dual op amp	
	2	LM386N	8 pin DIP Audio amp	
	1	74HC4053N	16 pin DIP multiplexer	
	1	ATTINY13A	8 pin DIP Atmel processor	Programmed
	5	8 pin DIP socket		
	1	16 pin DIP socket		
	1	FUSE 2.5A PTC	652-MFR250-0-010-LF	
	6	9.000 MHz, series	HU-49US crystal matched	
	1	FT50-42	Black, Ferrite core, large	
	1	FT37-43	Black, ferrite core, small	
	2	T50-2	Red powered iron core	
	1	T50-7	White powered iron core	
	1	2.1 mm	Power Jack, PC mount	
	2	Stereo panel jack		
	1	BNC panel jack		
	1	TO-220 insulator	Mica	
	1	#4, 1/2" Nylon screw		
	1	#4 nut for above		
	1	Main PCB		
	1	Case, top		
	1	Case, bottom		
	1	Red film		
	2	Small knob		
	1	Large knob		
	1	Tilt stand bale		
	2	Bale mounting blocks		
	4	Rubber feet		
	7	# 4-40 1/4" pan head	screws	
	2	# 4-40 1/4" flat head	screws	
	3	2 feet	Insulated hook up wire, #24	Black - Green - Red wires.
	1	5 feet	#24 magnet wire	

Print this large, ink jet printer friendly parts placement and value diagram for easy reference during assembly. Experienced builders will likely only need this diagram to stuff most of the board, but review the assembly instructions for any notes.



### Assembly tips:

- Presort the various parts and place similar types in small paper picnic bowls. Resistors in one, capacitors in another, and so on. This will not only speed assembly, but will also help keep parts from getting lost. If you like, you can also cross check the parts against the parts list as you do this to make sure you have them all.
- Be sure to print out the black and white parts placement diagram as this will be easier to reference most of the time. You really don't have to print out the whole manual if you have a laptop or equivalent on your workbench to view this.
- Hopefully you already know how to solder and don't need to be told to heat both the component lead and the solder pad with the tip of the soldering iron. Be stingy with the solder. You don't need much, only enough to fill up the hole. Using 0.020" diameter solder allows better control than the more common 0.032".
- The circuit board is assembled in the order of parts height. Low profile parts starting with resistors are installed first, the progressively taller parts are added.
- Q16, the transmitter output transistor will be the very last part mounted and only after the board has been wired into the case and tested.
- If you bought the Digital Dial option, it would be a good idea to build and calibrate this first. The Digital Dial can be used to adjust the VFO coil to put the tuning into the proper range.

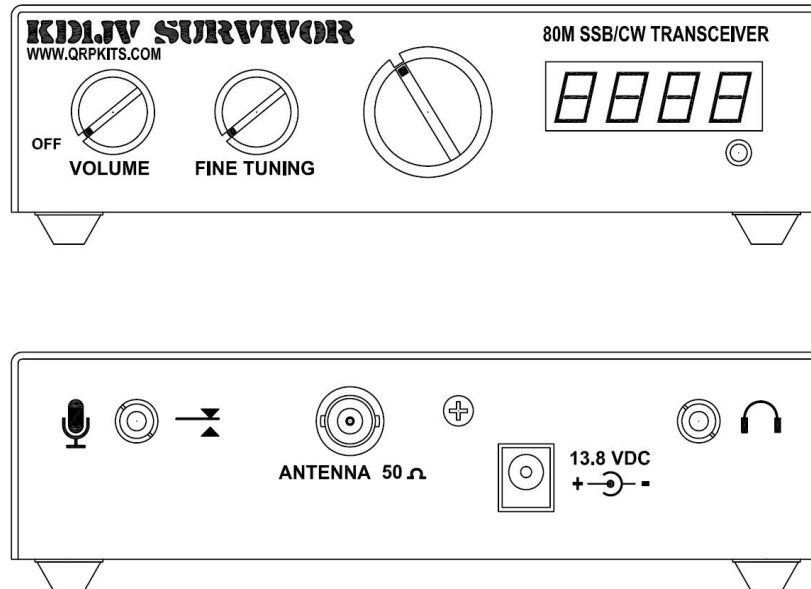
### Cabinet prep:

- There is a "Modulation" indicator LED on the board, which you might want to bring out to the front panel. This would require drilling a small hole someplace on the front, which would best be done now.
- If desired, paint the cabinet.
- Tape the red film over the display cutout on the front panel. If you'll be using the optional Digital Dial, snip the corner of the film to uncover the switch hole.
- Attach the tilt bail to the bottom of the case and add the four rubber feet bumpers.
- Attach the decals as described below.

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

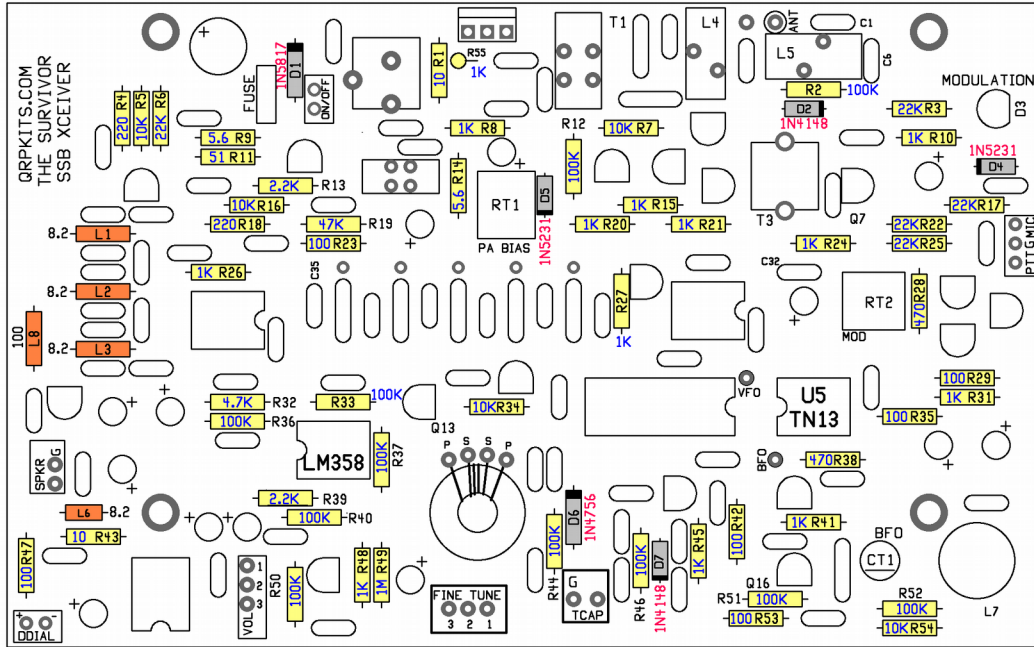
**Thoroughly clean the surface of the panel to remove any oils or contamination. We have found that moving the decals into position on bare aluminum chassis is difficult, due to the brushed surface, so we advise pre-coating the chassis with the Krylon clear before applying the decals, and then, after as well.**

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



# Resistor, RFC and Diode placement

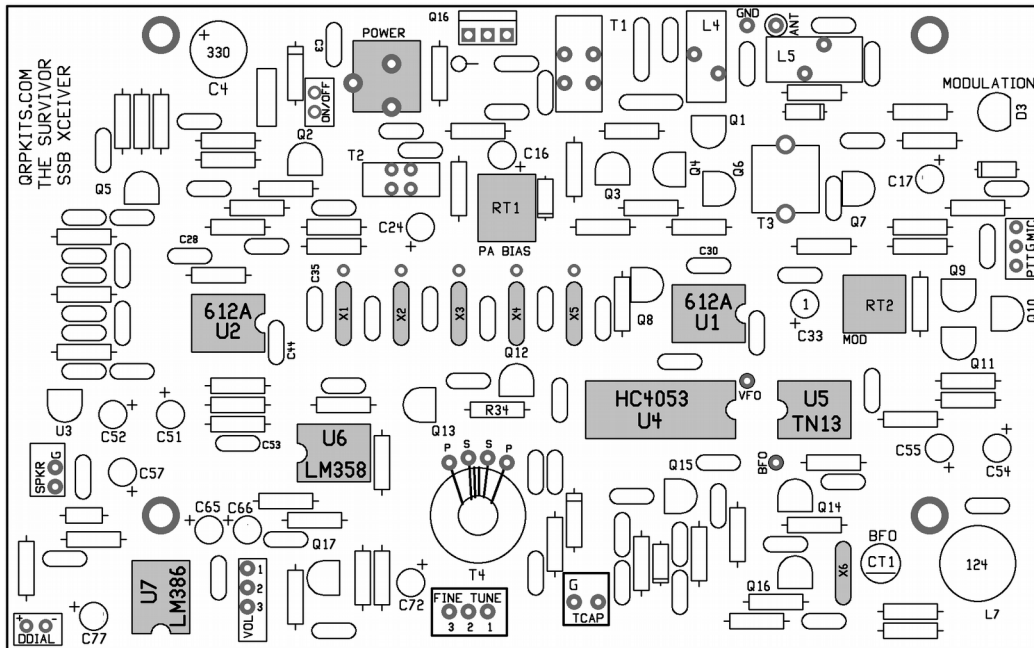
- Caution: The 1N4148 and 1N5231 diodes look identical, read the numbers carefully on the side of the part. A magnifying glass may be required. Observe polarity as indicated by black line on one end of the part and diagram.
- Sorting the resistors into their various values before hand will speed up assembly.
- Install all the resistors of one value at a time. The location/value table is set up for this.
- Parts are numbered on the board from left to right, top to bottom in diagonal rows.



√	LOC	Value	Color code	√	LOC	Value	Color code	√	LOC	Value	Color code
	R9	5.6	GRN/BLU/GLD/GLD		R20	1K			R3	22K	RED/RED/ORG/GLD
	R14	5.6			R21	1K			R6	22K	
	R1	10	BRN/BLK/BLK/GLD		R24	1K			R17	22K	
	R43	10			R26	1K			R22	22K	
	R11	51	GRN/BRN/BLK/GLD		R27	1K			R25	22K	
	R23	100	BRN/BLK/BRN/GLD		R31	1K			R19	47K	YRL/VOL/ORG/GLD
	R29	100			R41	1K			R2	100K	BRN/BLK/YEL/GLD
	R35	100			R45	1K			R12	100K	
	R42	100			R48	1K			R33	100K	
	R47	100			R55	1K			R36	100K	
	R53	100			R13	2.2K	YEL/VOL/RED/GLD		R37	100K	
	R4	220	RED/RED/BRN/GLD		R39	2.2K			R40	100K	
	R18	220			R32	4.7K	YEL/VOL/RED/GLD		R44	100K	
	R28	470	YEL/VOL/BRN/GLD		R5	10K	BRN/BLK/ORG/GLD		R46	100K	
	R38	470			R7	10K			R50	100K	
	R8	1K	BRN/BLK/RED/GLD		R16	10K			R51	100K	
	R10	1K			R34	10K			R52	100K	
	R15	1K	BRN/BLK/RED/GLD		R54	10K			R49	1 M	BRN/BLK/GRN/GLD
	D1		1N5817		D2		1N4148		D3		Install later (LED)
	D4		1N5231B		D5		1N5231B		D6		1N4756B
	D7		1N4148								
	L1/2/3/6	8.2 u	GRY/RED/GLD/GLD		L8	100 u	BRN/BLK/BRN/GLD				

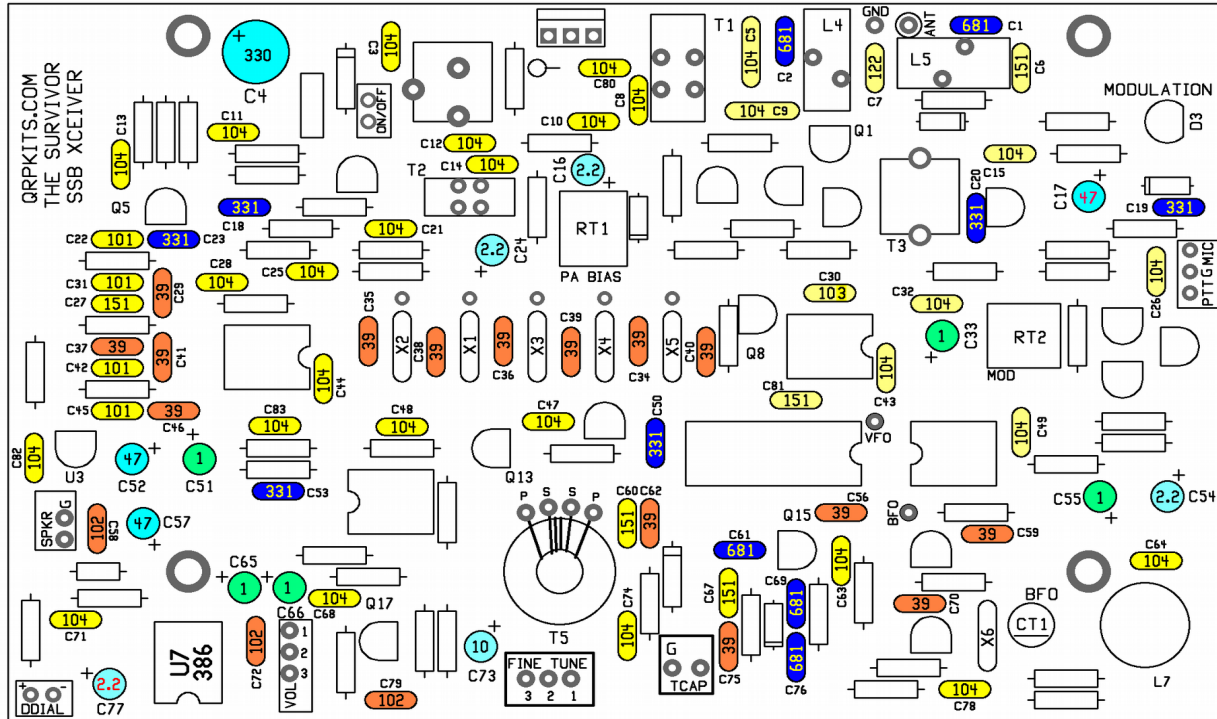
## Sockets, crystals, trimmer resistors and DC power connector:

- Parts to be installed are highlighted in gray in diagram below.
- Install crystals. Push flush to board.
  - Use resistor lead clippings to solder top edge of X1 through X5 to the solder pad next to the top of can.
- Install the IC sockets.
  - The notch on one end of the socket should be at the same end of the part outline which also has the notch. Note that not all the sockets face the same direction.
  - Make sure all the pins are sticking through the holes in the board before you start to solder. Sometimes a pin will fold over under the socket as it is inserted. If this happens and is not noticed, it can be very difficult to remove the socket to fix once you start soldering.
- Install the two trimmer resistors. They will go in easier if you first flatten out the kink in the leads with your pliers.
- Install the DC power jack.





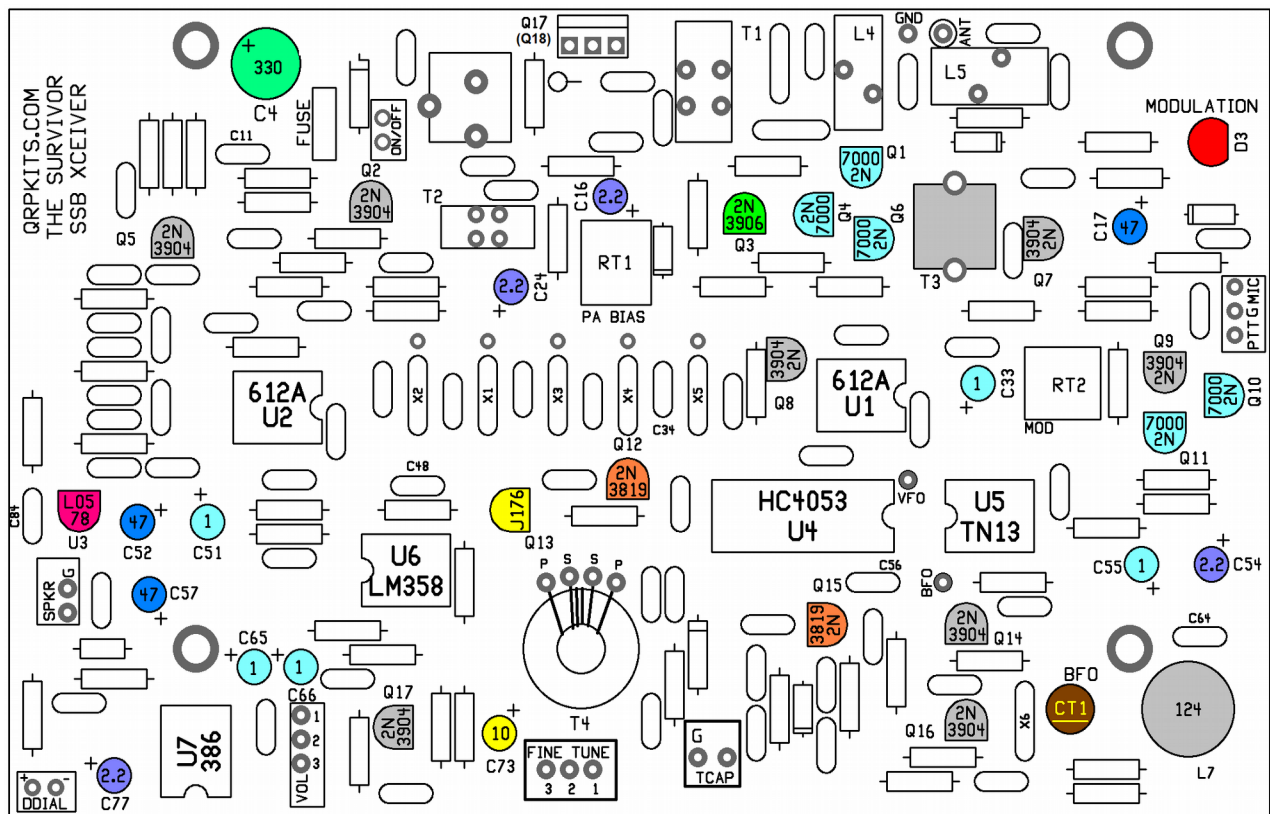
# Capacitors



The numbers on the small MLCC (Multilayer Ceramic Capacitors) can be hard to read. A magnifying glass is recommended. You don't want to mix up the values, as that could lead to problems not easily found. As with the resistors, sort the caps by value and type and install all the same value/type in batches. Since there are a lot of 0.1uF caps (104), install these first. Some caps may need to have their leads reformed to fit into the hole spacing properly. Electrolytic caps are installed after the small caps.

✓	LOC	Value	code/type	✓	LOC	Value	code/type	✓	LOC	Value	code/type			
	C3	0.1 u	104 MLCC		C63	0.1 u	104 MLCC		C61	680 p	681 MLCC			
	C8	0.1 u	104 MLCC		C64	0.1 u	104 MLCC		C69	680 p	681 MLCC COG	C29	39 p	39 DISK
	C10	0.1 u	104 MLCC		C68	0.1 u	104 MLCC		C76	680 p	681 MLCC	C34	39 p	39 DISK
	C11	0.1 u	104 MLCC		C71	0.1 u	104 MLCC		C18	330 p	331 DISK	C35	39 p	39 DISK
	C12	0.1 u	104 MLCC		C74	0.1 u	104 MLCC		C19	330 p	331 DISK or MLCC	C36	39 p	39 DISK
	C13	0.1 u	104 MLCC		C78	0.1 u	104 MLCC		C20	330 p	331 DISK or MLCC	C37	39 p	39 DISK
	C14	0.1 u	104 MLCC		C80	0.1 u	104 MLCC		C23	330 p	331 DISK or MLCC	C38	39 p	39 DISK
	C15	0.1 u	104 MLCC		C82	0.1 u	104 MLCC		C50	330 p	331 DISK or MLCC	C39	39 p	39 DISK
	C21	0.1 u	104 MLCC		C83	0.1 u	104 MLCC		C53	330 p	331 DISK or MLCC	C40	39 p	39 DISK
	C25	0.1 u	104 MLCC		C5	0.1 u	104 FILM, BOX		C6	150 p	151 MLCC COG	C41	39 p	39 DISK
	C26	0.1 u	104 MLCC		C9	0.1 u	104 FILM, BOX		C27	150 p	151 MLCC COG	C46	39 p	39 DISK
	C28	0.1 u	104 MLCC		C30	0.01 u	103 MLCC		C60	150 p	151 MLCC COG	C56	39 p	39 DISK
	C32	0.1 u	104 MLCC		C7	1200p	122 MLCC COG		C67	150 p	151 MLCC COG	C59	39 p	39 DISK
	C43	0.1 u	104 MLCC		C58	1000p	102 DISK		C81	150 p	151 MLCC COG	C62	39 p	39 DISK
	C44	0.1 u	104 MLCC		C72	1000p	102 DISK		C22	100 p	101 MLCC COG	C70	39 p	39 DISK
	C47	0.1 u	104 MLCC		C79	1000p	102 DISK		C31	100 p	101 MLCC COG	C75	39 p	39 DISK
	C48	0.1 u	104 MLCC		C1	680 p	681 MLCC		C42	100 p	101 MLCC COG			
	C49	0.1 u	104 MLCC		C2	680 p	681 MLCC COG		C45	100 p	101 MLCC COG			

## TO-92 transistors and remaining parts:



√	location	value	
	Q2, 5, 7, 8, 9, 14, 16, 17	2N3904	8 places
	Q3	2N3906	1 place
	Q1, 4, 6, 10, 11	2N7000	5 places
	Q12, 15	2N3819	2 places
	Q13	J-176	1place
	U3	78L05	1 place
	C33, 51, 55, 65, 66	1 ufd/ 50 V	Aluminum Electrolytic – Long lead is Plus
	C16, 24, 54, 77	2.2 ufd / 25V	Aluminum Electrolytic – Long lead is Plus
	C73	10 ufd /25V	Aluminum Electrolytic – Long lead is Plus
	C17, 52, 57	47 ufd / 16V	Aluminum Electrolytic – Long lead is Plus
	C4	330 ufd / 16V	Aluminum Electrolytic – Long lead is Plus
	T3	IF can	
	CT1	Brown trimmer cap	Flat side of cap goes towards line on board.
	L7	120 mHy inductor	Large black cylinder “124” marked on top.
	D3	Red LED	Long lead goes into hole on round side of outline.
	FUSE	R250010	Thin, yellow square

## Toroidal coils:

Now the fun part – winding the toroidal coils.



Picture 2, wound toroids

Picture 2 shows properly wound coils. Note how the wire is made to conform closely to the core. Winding the wire loosely around the core is not only sloppy, but will not work properly. However, you don't want the wire to be too tight, just snug.

Before winding the wire on the white core used for the VFO, it helps to stretch the wire slightly by grabbing both ends with pliers and giving them a little tug.

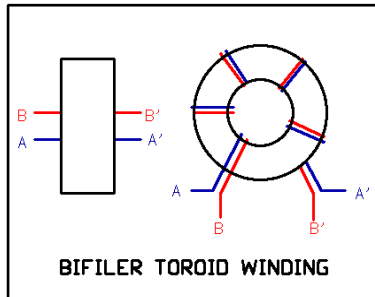
Coils shown left to right: VFO coil, Bi-filer T1, LPF coil L4



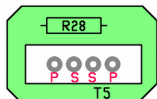
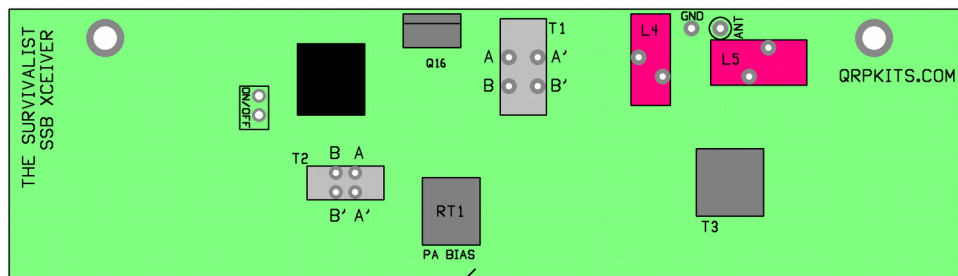
Picture 3, tinned wires

Picture 3 shows how the wire ends need to be trimmed back and tinned before the coil is inserted into the board. Putting a little blob of solder on the tip of your iron and then gently rubbing it against the wire will melt through the insulation and tin the wire.

Trying to solder to the wire after it has been inserted into the board holes without tinning will not work, as the pad and connecting tracks will wick away too much heat. Using enough heat to melt through the insulation in that case can damage the board. **When tining the leads for T2, make sure the insulation doesn't melt too far up the wire, as the two windings could short together.**



- L4, L5 T50-2 core (large, red) 22 turns, # 24 wire. (16") Evenly space turns around core, leaving small gap at wire ends
  - T1 – FT50-43 core, (large, black) 5 turns, # 24 wire, bi-filer. (8") Fold wire in half and lightly twist together. After winding, snip wire where folded to separate ends. Use ohm meter to identify the common ends of the two wires. Arrange the common ends to be opposite each other on the core as shown in the diagram to the left..
  - T2 – FT37-43 core (small, black) 5 turns, #24 wire, bi-filer. (6") As with T1, fold wire in half and wind 5 turns. Identify wire ends and arrange opposite each other as with T1.
  - The wires on T1 and T2 are now orientated properly and are symmetrical in respect to the pad locations on the board. If the wire ends are not properly located, the transmitter will not work.
  - Install L4, L5, T1 and T2 as shown in placement diagram below. Before placing T1 and T2, double check that the wires going in to the A-A' pads have continuity with an ohm meter, indicating they are the ends of the same wire.



- T4 – T50-7 core (large, white). Wind 21 turns #24 wire. (15") This is the primary winding. Next wind 8 turns (6") in the gap between the primary turns. This is the secondary winding. Make the windings are snug to the core for stability, but still loose enough you can move them slightly to adjust the spacing.
- Install the T4 primary winding (outside wires) in the pads labeled "P" and the secondary (inside wires) into the holes labeled "S".

## Chassis wiring:

Do a careful visual inspection of the solder connections on the board. Look for missing solder connections or places where solder is on the part lead but not on the corresponding pad. Both of these are common problems and you want to find them now, not after the board is all wired into the chassis.

Picture 4 shown below shows how the board to chassis wiring should look like. Note that the wires are made long enough so that there is some slack, but not so long as to be sloppy. Except for the antenna connections, the wires connecting to the rear panel are routed along the side of the board, rather than above and across it. Wires for the ON/OFF switch are run under the board to keep them out of the way.

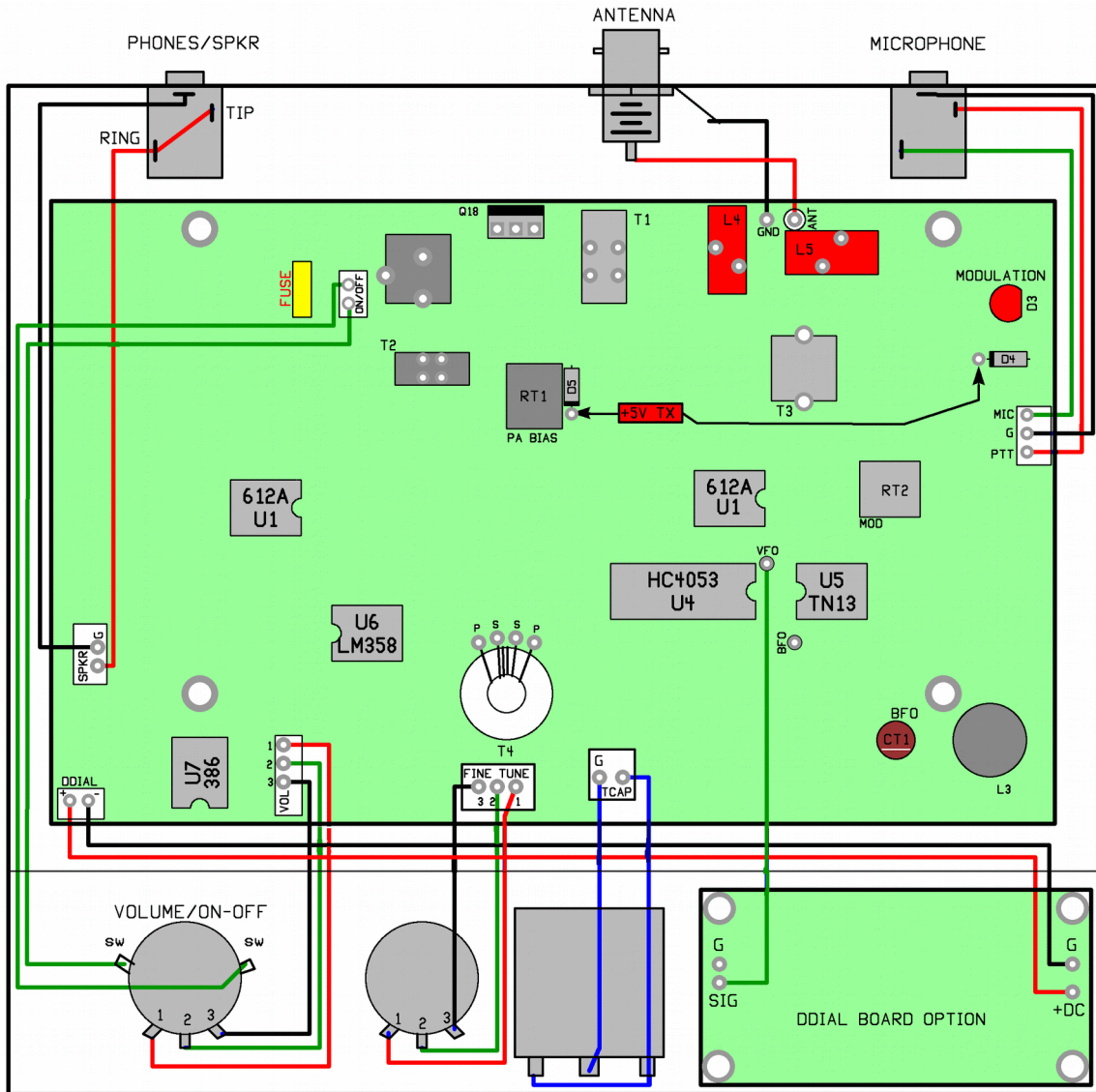
Part to connect	# of wires	Length
Volume	3 wires	2"
RIT control	3 wires	2.5"
Tuning cap	2 wires	1.5" #24 magnet
DDial pwr	2 wires	6" (black/red)
DDial	Freq input	1.75"
DC pwr	2 wires	5" (on/off switch on vol)
Speaker jack	2 wires	4"
Mic jack	3 wires	3"
Antenna	2 wires	1.5"

Note: Jumpering the two outer tabs on the tuning cap results in the maximum tuning range.

- Mount the front panel parts first. Tuning cap, RIT and Volume control and Digital Dial. Bend or remove anti-rotation tabs on pots.
- The BNC antenna jack wires from the board should be soldered to the board before the board is mounted into the case.
- You can cut the rest of the wires to length and solder them to the board outside of the case, or you can mount the board into the case and solder the wires on to the board from the top.
- Wire up the front panel controls. Use the #24 magnet wire between the board and tuning cap.
- Install the rear panel jacks and wire them up.
- The microphone jack is shown wired so PTT is tip and mic element is ring. This allows using straight key or keyer with standard mono phone plug attached.
- Don't solder the wire for the Digital Dial input signal to the main board yet, as you need to first use it at the BFO test point to measure the BFO frequency.



Picture 4, chassis wiring



## Testing and alignment:

- A board mounted PTC resettable fuse is used to protect a power supply and connecting wires if there is a short circuit on the supply lines, but it is a good idea to use a power cord with an in-line fuse or a current limited power supply which can be set to 2 amps. If there happens to be a problem during testing, this will prevent damage to the board and/or your power supply.
- Turn the two trimmer pots fully counter-clockwise before applying power to the board.

### The first test is to check operation of the VFO and BFO:

This can be done with an external frequency counter, the digital dial or a general coverage shortwave receiver with external antenna jack and BFO. If none of these are available, you will have to assume the frequency range is about right and check it later with an 80 meter ham band receiver.

1. Apply power to the board and turn on.
  2. If you have the Digital Dial installed, it should come on.
  3. Connect the Digital Dial input or a frequency counter to the test point "VFO"
  4. Set the Main tuning and RIT controls fully counter-clockwise.
  5. The VFO frequency should be about 5.000 MHz. 5.000 MHz corresponds to an operating frequency of 4.00 MHz. (9 – 5)
  6. The VFO frequency is "tweaked" by adjusting the spacing of the turns on the VFO coil, T4. Moving turns closer together will lower the frequency and spacing them farther apart will increase the frequency. Adjust the spacing so that the frequency is slightly above 5.000 MHz. The trimmer caps on the back of the main tuning cap can also be used for fine tuning the frequency.
  7. Since the tuning range is not quite the full band, if you would like to operate on a lower part of the band you might have to remove a turn from the T4 primary. (20 turns instead of 21). The higher the VFO frequency, the lower the operating frequency, since  $OP\ freq = IF - VFO$ .
  8. Move the frequency counter to the "BFO" test point and verify a frequency about 9.000 MHz.. Using a small slotted screwdriver, adjust the BFO trimmer (CT1) to 9.003,300 MHz.
  9. Remove power.
- Now install all the IC's into the sockets. Pay attention to the orientation, as they don't all face the same direction. The dot or notch on the part indicates the Pin 1 end and corresponds to the notch in the socket.
    1. Connect an antenna and speaker or headphones to rear panel jacks
    2. Connect power cable and turn on.
    3. Turn up the volume and you should start to hear band noise or signals when you tune around. (depends on time of day)
    4. Set the receive frequency to about the center of the tuning range and peak T3 for best signal or maximum band noise. Input tuning is relatively sharp, so if you have a favorite segment of the band to operate at, peak it there.
    5. If needed, tweak the BFO trimmer for the most natural sounding voice. You could also connect the audio output of the rig to your PC running a PSK program like Digipan. The waterfall will give you a visual indication of the bandwidth of the receiver audio.
  - If you are using the Digital Dial, it can now be set up for direct reading of the operating frequency
    1. Connect the frequency input wire to the "BFO" pad on the main board.
    2. Momentarily tap a short across the "OFFSET SW" pads on the back of the DDial board.
    3. The display will change to read "Lo --"
    4. Momentarily "click" the front panel switch three times to select the "Lo C" mode.
    5. Hold closed the front panel switch until the display changes back to numeric characters (all zeros or 7717).
    6. Move the frequency input wire from the "BFO" pad to the "VFO" pad and solder in place.
    7. The dial is now showing the operating frequency.
    8. Once the VFO frequency has been set, you might want to secure the toroid to the board with a dab of hot glue or melt some wax over it to stabilize it.

### Transmitter testing:

- Set PA BIAS and MOD controls (VR1 and VR2) to full counter clockwise. They come set from the factory at full clockwise.
- Turn rig on.
- Ground PTT input using microphone, straight key or jumper. [TIP] is PTT if wired as shown in diagram.
- **Check for 5 volts at Anode (banded) end of D4 and D5. (reference wiring diagram for location) This is very important!**
- If you do not measure 5V at D4 and D5, you have one or both zeners misplaced and are in one of the 1N4148 locations. You will now have to determine if the correct diode ended up in location D2 or D7 by trial and error. You have a 50-50 chance of picking the right one first off. Unless of course, both need to be swapped.
- If you measure 5 volts at D4 and D5, it is now safe to install the Power Output transistor, Q16 (this of course, is the Q16 next to the power jack at the rear of the board)

### Installing Q17 (Q18):

- With the board mounted in the case, place the IRF510B MOSFET in the Q17 location to the right of the power jack. Yes, the board says Q17 but it should have been Q18.
- Slip the mica insulator between the metal tab and the cabinet. Line up the screw holes and secure loosely with nylon screw and washer.

**Failure to use mica insulator and nylon screw to attach Q16 will result in a short circuit on DC input.**

- Push the body of Q18 up against the back of the cabinet to slightly kink the leads and ensure it is flush to the case. Tighten the mounting screw. Use an Ohm meter to verify the metal tab **IS NOT** shorted to the case.
- Solder the of the leads to the pads from the top side of the board. Be careful not to melt the RT1 trimmer knob while doing so!
- Remove board from case, solder and trim the remaining leads.
- Re-install the board into the case

### Transmitter adjustments:

- Connect a power meter (if available) and dummy load to antenna jack.
- Connect an amp meter in series with power supply lead, 2 A or larger full scale. (some meters do 10A, some 20A)
- Re-apply power to the rig.
- Set the Main tuning to about the center of the tuning range.
- Key the microphone (or ground PTT) to enable transmitter.
- Write down the current being drawn from the power supply with the amp meter. With a 13.8V supply, it should measure about 100 ma.
- While watching the amp meter, slowly turn the "PA BIAS" trimmer resistor clockwise. Keep turning until the current increases by 20 to 30 ma. This should occur at about the "2 o'clock" position. Increasing above 50 ma can cause the PA to go into oscillation. This of course, has to be avoided. If the current suddenly shoots up, then oscillation has occurred. Back off the setting.
- Activate "TUNE" mode by a short push and release of the PTT switch. (On time less than ½ second)
- A "Beep" should be heard in the speaker. If not, try again.
- Pushing and holding closed the PTT switch will now key the transmitter and create a CW signal. Turn the "MODULATION GAIN" [MOD] trimmer resistor clockwise and watch for power output. Increase setting until power output stops going up, which should be about 1/3 to ½ rotation. Power output should be between 10 and 12 watts.
- Exit TUNE mode by doing another short push and release of the PTT switch. A double beep should sound in the speaker indicating the mode has been released.

### Setting Modulation level:

Modulation level is ideally set using an oscilloscope so that you can view the modulation envelope. However, the on board modulation LED will give you a good idea. A low frequency Scope and be connected to the R3/D3 junction (a bypass cap added here might be needed) to

monitor modulation waveform. Simple DSO (Digital Storage Oscilloscope) kits are available from China for not a lot of money and can be handy to have. DSO 038 is a popular model. Try Banggood.com for all your Chinese bargains.

- Speaking "TEST" into the microphone should make the Modulation indicator LED flash bright and then flicker. If the LED remains bright and does not seem to "follow" your voice, the gain is too high. Conversely, if it barely comes on, the gain is too low.
- Good modulation should occur with the trimmer set about mid way with a normal speaking voice, directly into the mic.
- PEP (Peak Envelope Power) is about 3X the average power shown on a typical RF power meter. Avoid turning up the mic gain to produce a higher average power, as all your doing is "flat topping" which distorts your audio and causes splatter.

With that, you should now be able to attempt your first QSO with the new rig!

**Microphone options:**

The Survivor rig is designed to use a Electret microphone element, which are commonly used in CB mics, cordless phones and hands free microphones for cell phones. Electrets elements have a range of voltages needed to operate. Some work with as little as 1.5 volts and others need as much as 5. This rig is designed to use a 3V element, which is one of the more common operating voltages.

Dynamic and crystal microphones elements are not directly compatible.



**Trouble shooting.**

999 out of a 1000 times, the reason a newly built kit doesn't work right away is due to assembly errors. Parts can be damaged due to handling and some of the semi-conductors can be susceptible to ESD (Electric Static Discharge), but this is rare. Therefore, a close visual inspection will often be all you need to find the problem.

Look for:

- Bad soldering – missing connections and solder shorts. Bad connections to the magnet wire on the coils is a common problem. Check for continuity.
- Miss placed parts – IC's in the wrong socket or facing the wrong way, transistors in the place and so on.
- It can be sometimes difficult to read the number on the little multilayer ceramic caps and therefore easy to get them in the wrong place. Having a 0.1 ufd by-pass cap where a picofarad part should be and visa-versa will definitely cause something not to work.

If something doesn't pop right out at you, some actual trouble shooting to identify the problem area is required. Knowing where to look for a problem is half the battle. For this you need to do a process of elimination. Finding out what does work can lead to finding what doesn't work and then to the solution. For this some test equipment is needed. A voltmeter is need to start and having an Oscilloscope with which to trace and measure the RF signals is a big plus. Most of you will likely only have the voltmeter to use. The voltage tables below can help locate a problem area. Voltages can vary by 10% due to variations in voltmeters and the actual 5V regulator voltage. Some of the transistors will have RF signals on them which can affect the DC voltage reading depending on how your voltmeter reacts to the RF signal. You only have to worry if voltages aren't even close.

**Voltages measured with 13.8V DC supply connected.**

U1, U2 SA 612	Pin	Voltage	Pin	voltage
	1	1.38	8	5.00
	2	1.38	7	4.16
	3	0	6	4.93
	4	3.84	5	3.84

U5 TINY13A	Pin	Voltage	Pin	voltage
Rx / Tx	1	4 / 0	8	5.00
	2	5 / 0	7	0 / 0
	3	0 or 5	6	0 / 5
	4	0.00	5	5 / 0

U6 LM358	Pin	Voltage	Pin	voltage
	1	2.50	8	5.00
	2	2.50	7	2.50
	3	2.50	6	2.50
	4	0.0	5	2.50

U7 LM386	Pin	Voltage	Pin	voltage
	1	1.40	8	1.40
	2	0.0	7	6.6
	3	0.0	6	13.5
	4	0.0	5	6.5

U4 74HC4053	Pin	Voltage	Pin	Voltage
	1	4.93	16	5.0
	2	4.93	15	4.93
	3	4.93	14	2.5
	4	4.93	13	2.5
	5	4.93	12	0
	6	0.0	11	4.0 / 0
	7	0.0	10	4.96 / 0
	8	0.0	9	4.96 / 0

RED = Tx mode voltages

		E (S)	B (G)	C (D)
Q1	1N50CTA	0 / 0	13.4 / 0	0 / 0
Q2	2N3904	0 / 0.75	0 / 1.4	13.5 / 13.5
Q3	2N3906	13.5 / 13.5	13.4 / 12.7	0 / 13.4
Q4	2N7000	0 / 0	0 / 13.5	13.5 / 0
Q5	2N3904	0 / 2.1	0 / 2.8	0 / 10.3
Q6	2N7000	0 / 0	0 / 5	13.4 / 0
Q7	2N3904	0 / 0	0 / 0.7	0 / 0
Q8	2N3904	3.1 / 3.1	3.8 / 3.8	5 / 5
Q9	2N3904	0 / 1.65	0 / 2.25	0 / 5.1
Q10	2N7000	0 / 0	5 / 0	0 / 1.9
Q11	2N7000	0 / 0	0 / 0	0 / 0.75
Q12	2N3819	3.6 / 3.6	0 / 0	5 / 5
Q13	J-176	0 / 0	5 / 5	0 / 0
Q14	2N3904	2.0	2.6	4.4
Q15	2N3819	0.9 / 0.9	-0.7 / -0.7	4.8 / 4.8
Q16	2N3904	2.6 / 2.6	3.2 / 3.2	4.4 / 4.4
Q17	2N3904	0 / 0	0 / 0	5 / 5
Q18	IFR510B	0 / 0	0 / ~2.5	13.5 / 13.5

## Theory of operation:

### The receiver:

The core of the receiver is comprised of two SA612 active mixers, with a 5 crystal ladder filter between them for selectivity. An analog switch routes the VFO and BFO to the appropriate mixer as needed for either receive or transmit.

During receive, the first mixer, U2, combines the input signal with the Local Oscillator (VFO) to produce an IF frequency of 9 MHz. An emitter follower, Q9, buffers the output of the mixer to provide the crystal filter with a resistive load. This helps reduce ripples in the filter response as seen on the output side.

The output of the crystal filter is also terminated with a resistive load and drives the input of the second mixer, U1 which is acting as the product detector. A 9 MHz crystal oscillator provides the BFO frequency which mixes the 9 MHz IF down to audio.

The output of the product detector, U2, drives a pair of non-inverting amplifiers (U6) through a two 0.1 ufd caps wired in series. One of the amplifiers has a voltage gain of 20, while the other has a much higher gain of 100. The output of the low gain stage (U6a) is the receiver audio.

The high gain stage is used to drive the AGC circuits, which is comprised of Q17 and Q16. The way this works is Q16 is normally turned off by a positive voltage on the gate when there is no input signal, allowing the full amplification of the audio signal by U3 and U7a. When the audio signal on the output of U6b starts to exceed 500 mV, Q17 starts to turn on. That reduces the gate voltage on Q16, allowing it to start turning on. Q16 shunts the signal between C83 and C48 to ground to reduce the amplitude. The signal attenuation is done at the juncture of two caps so that changing DC voltages don't produce thumps.

The gain of U7b is such that AGC action keeps the output signal on U7a to be no more than about 50 mV peak. R49, a 1 meg ohm resistor and C73, a 2.2 ufd cap sets the AGC time constant. R48, a 100 resistor between the time constant and the controlling transistor Q17 slows down the attack time. Without the limiting resistor, the AGC can overshoot, causing a loss of audio until C73 can charge up again.

The audio signal from U7a is routed through one of the analog switches in U4, the 74HC4053, to provide muting during transmit. The output of the switch drives the volume control and then the final audio power amp, U8 which is also a LM386. By putting the AGC action before the volume control, audio level is consistent and is only varied by the volume control.

### The Transmitter:

A small microprocessor, U5, controls the transmit / receive switching. Not only does it simplify T/R control and timing, it allowed adding the Tune mode and CW mode features which would have been more complex to do in a strictly analog fashion.

When the PTT input goes low, (grounded), the following sequence of events happen:

1. The audio is muted
2. The VFO and BFO oscillators are switched between the two mixers. The product detector (U2) is now the transmit mixer while the Receiver input mixer (U1) is now the balanced modulator.
3. The transmitter amplifiers are enabled by turning Q3 on via Q6. This also activates the QSK switch Q1, disconnecting the antenna to T3, the input tuned circuit. Q7 is also turned on, shorting the output side of T3 so that any transmit signal which might leak past Q1 is shorted to ground before it can upset the operation of the mixer, which is now being used as the balanced modulator. Any small mixer products which might be produced by the transmit signal leaking into the mixer will be filtered out by the crystal IF filter.
4. The Microphone buffer transistor, Q9, is turned on by releasing the ground on the base via Q11. It takes very little signal to unbalance the mixer and an Electric microphone element produced more than sufficient amplitude that no amplification is needed.

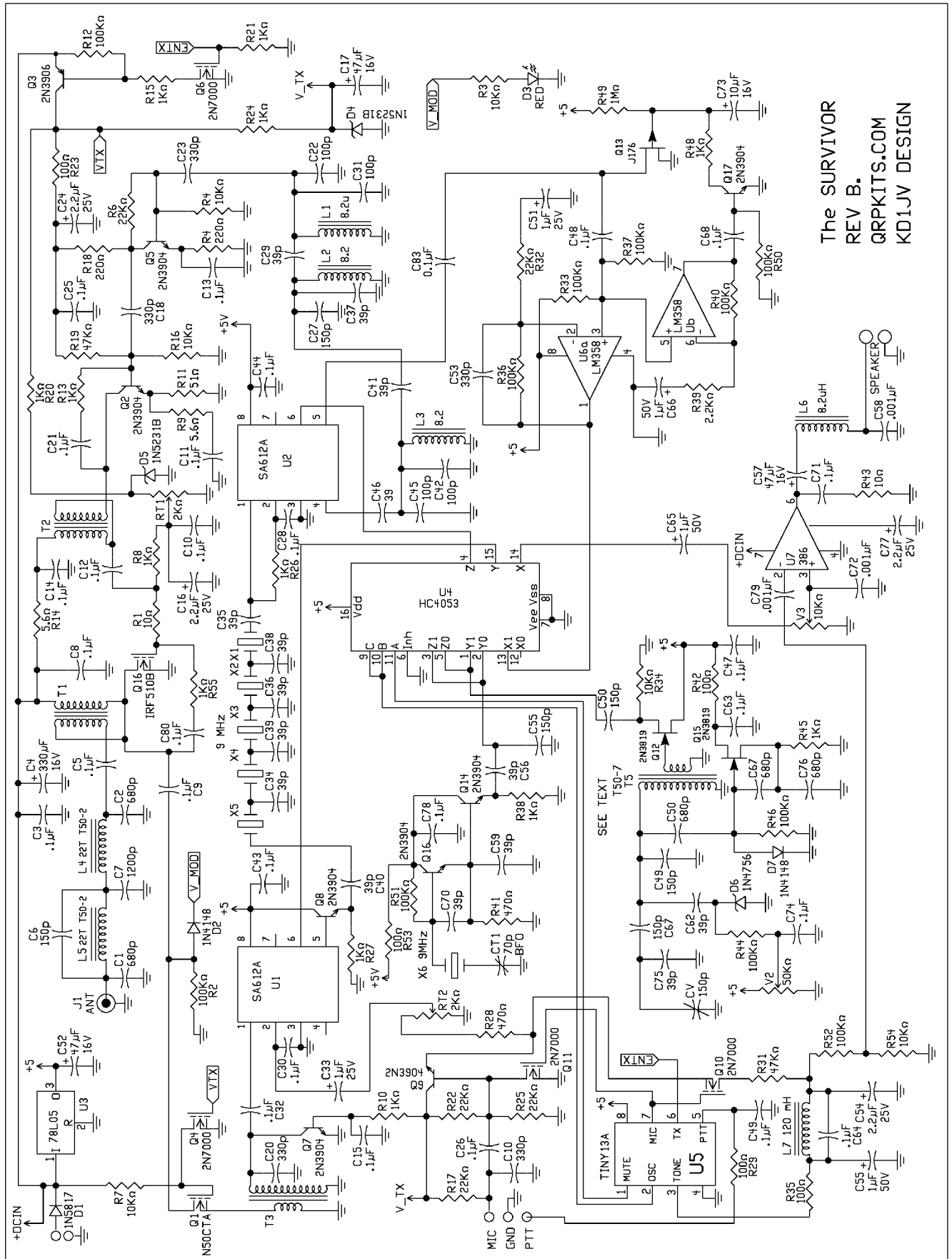
Now, when you speak into the microphone, the audio is mixed with the 9 MHz BFO signal, which produces a double sideband signal at 9 MHz +/- the audio frequency on the mixer output. The crystal filter removes the upper side band (9 MHz + the audio frequencies), leaving only the desired lower sideband signal.

The resulting 9 MHz LSB signal is then mixed in U2 with the VFO to produce the desired operating frequency in the 75 Meter band. A three element, capacitor coupled band pass filter eliminates undesired mixer products. The bandpass filter is wide enough to allow full power output across the tuning range.

The signal is then amplified by Q5 and Q4 to a suitable level to drive the power output MOSFET Q18. Negative feedback is applied to the driver, Q4 and the PA, Q18 to improve stability and linearity. A 5.1V zener regulates the bias voltage supply. Trimmer RT1 sets the actual gate voltage, applied to the gate of Q18 through a 1K resistor.

### Tune and CW mode:

In order to produce a single frequency output from the transmitter, an appropriate 600 Hz tone is injected into the microphone circuit. The tone is generated by the TINY13A microprocessor and is of course a square wave. The square wave is filtered through a low pass filter comprised of R35, C55, L7 and C54 to remove harmonics and generate a nice sin wave to modulate the transmitter. C64 across L7 blocks the second harmonic. When the tone is being generated, Q11 is turned on which turns off the microphone so ambient noise isn't picked up by the mic. Q10 is also turned on which connects the tone to the modulation level control.



Board layout. "Floating" pads are grounds to the ground plain which is not shown so that tracks on both sides of the board can be clearly seen.

