

"The Survivor"

A 80 meter QRP SSB transceiver



- ~10 watts pep @ 13.8V
- 0.2 uV receiver sensitivity
- Up to 350 kHz tuning range
- 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. This much range is a bit touchy to tune in a signal, so main tuning is augmented by a fine tuning control. 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

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 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:

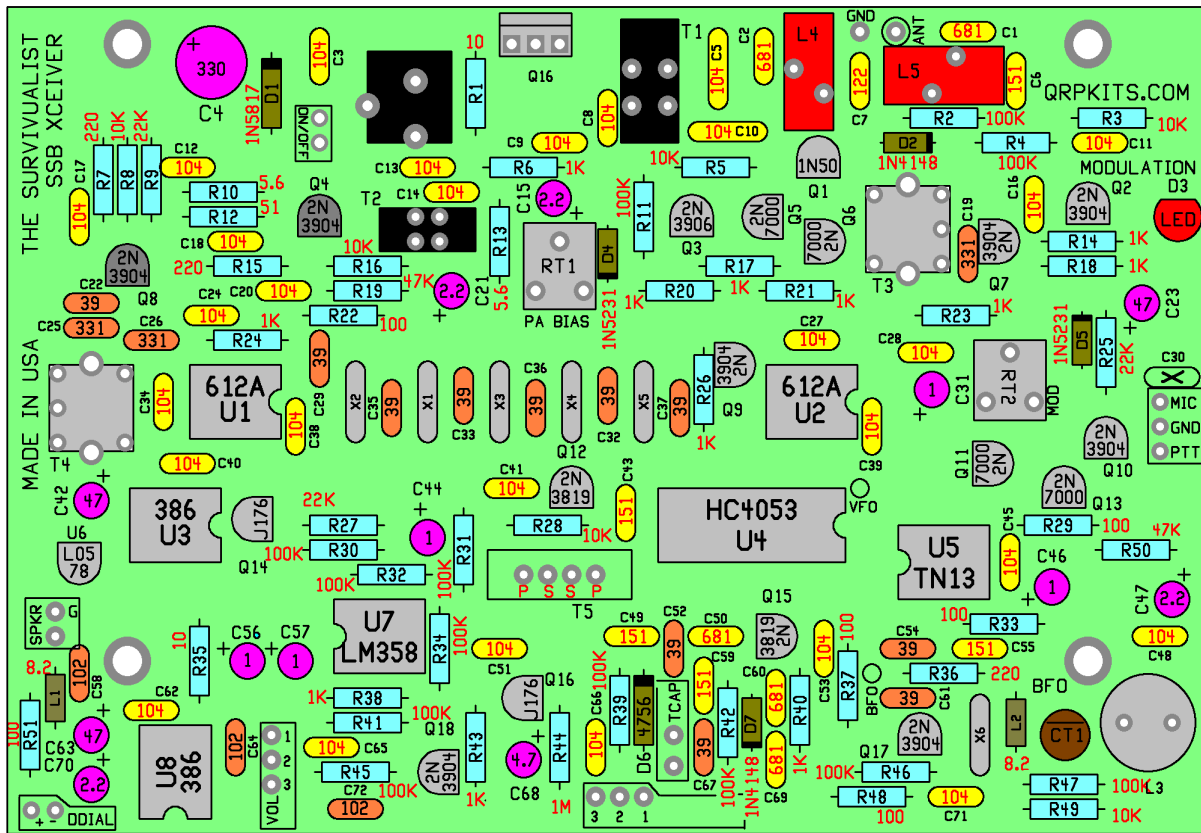
1. A *very short* push and release of the PTT switch on the microphone, < 1/2 second.
2. A "beep" will sound in the audio output, announcing the tune mode is now active.
3. Using the PTT will now activate a 600 Hz tone which is injected into the microphone circuit to modulate the rig. The tone is also 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:

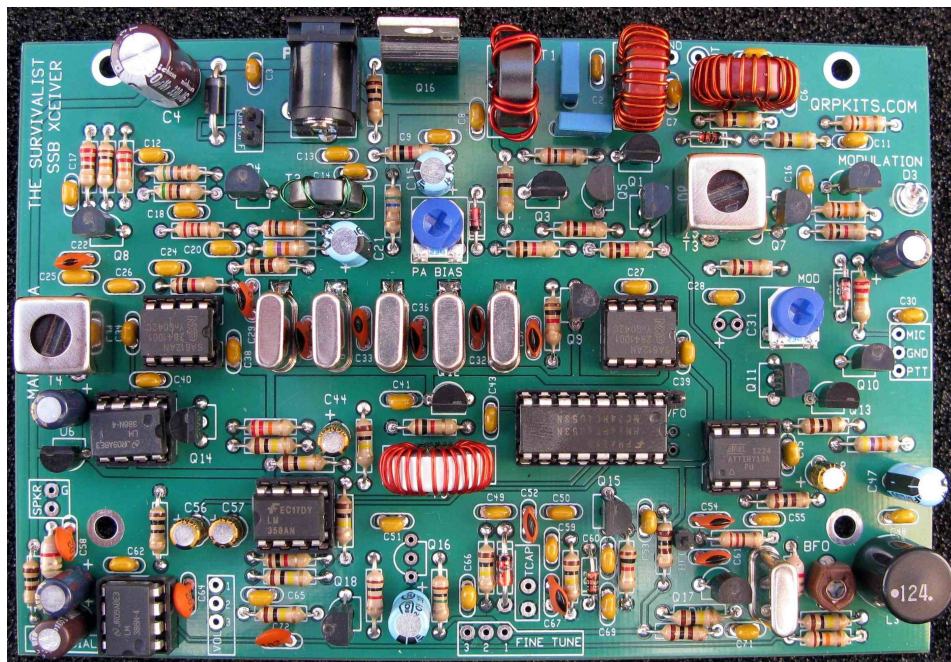
The Survivalist can be operated in CW mode thanks to the Tune mode and microprocessor control of the T/R sequencing in the transceiver. The difference between CW and Tune mode is that in CW mode, the transceiver must respond to quick changes in the state of the PTT switch and stay in the CW mode. Once 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.



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



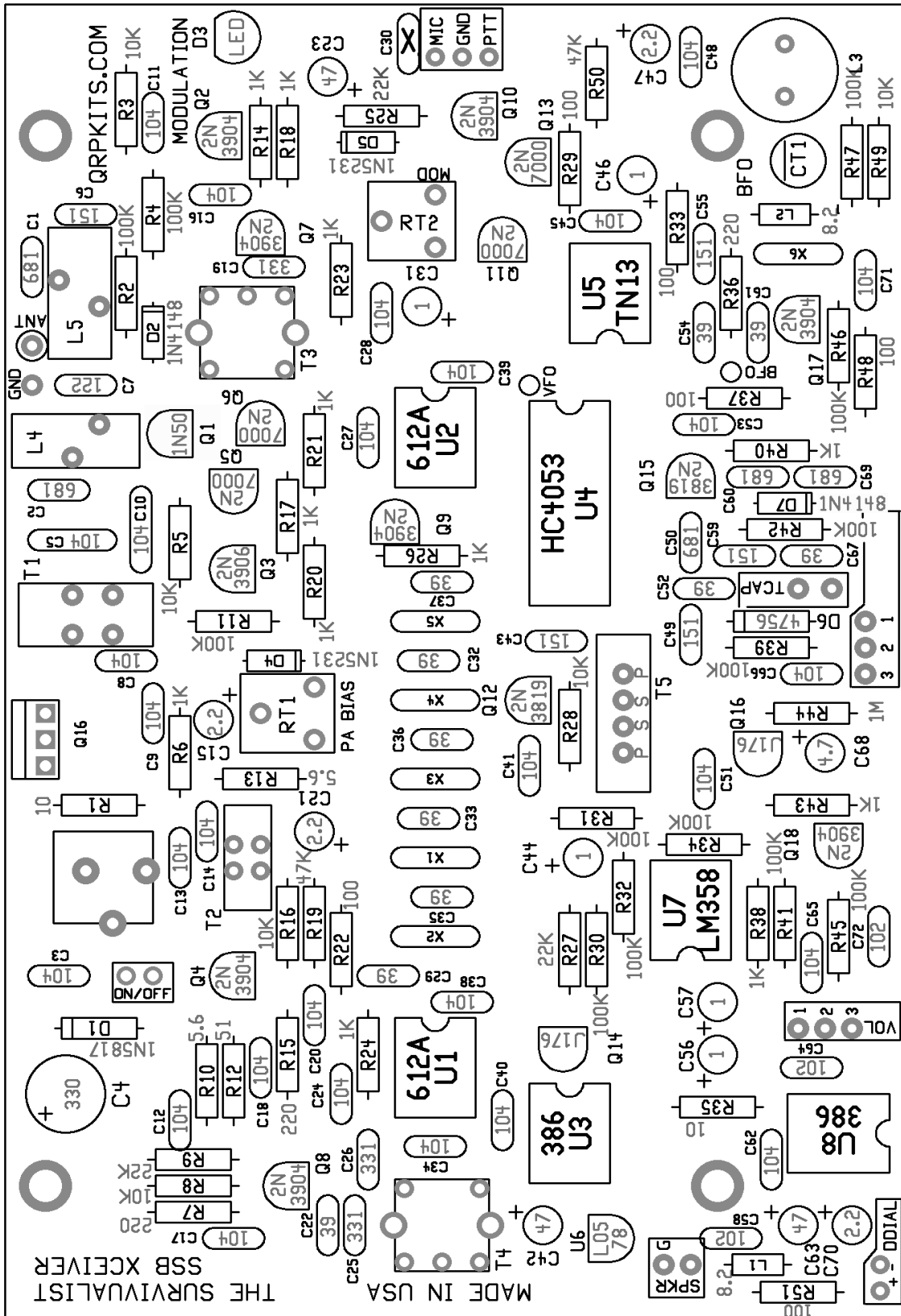
Picture 1, mostly assembled board

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	
3	220 ohms	RED/RED/BRN/GLD	
12	1 K	BRN/BLK/RED/GLD	
6	10 K	BRN/BLK/ORG/GLD	
3	22 K	RED/RED/ORG/GLD	
2	47 K	YEL/VOL/ORG/GLD	
13	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	
2	8.2 uHy	GRY/RED/GLD/GLD - RFC	
1	120 mHy	124 Larger black cylinder	
2	10.7 IF cans		
1	Poly-variable	Tuning cap	
1	70 pfd	Brown trimmer cap	
11	39 pfd	39 NPO disk	
5	150 pfd	151 C0G MLCC	
3	330 pfd	331 disk or MLCC	
5	680 pfd 100V	681 C0G MLCC	
3	0.001 uFd	102 disk	
1	1200 pfd 100V	122 mono 100V C0G	
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	4.7uFd/25V	Alum electrolytic	
3	47 uFd/16V	Alum electrolytic	
1	330 ufd/16V	Alum electrolytic	
1	RED LED T1		
2	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	
4	2N7000	MOSFET TO-92	
1	FQN1N50CTA	500V 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	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	
6	8 pin DIP socket		
1	16 pin DIP socket		
6	9.000 MHz, series	HU-49US crystal matched	
1	FT50-42	Black, Ferrite core, large	
1	FT37-42	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	
1	5 feet	Insulated hook up wire, #24	
1	5 feet	#24 magnet wire	
1	2 feet	#28 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.

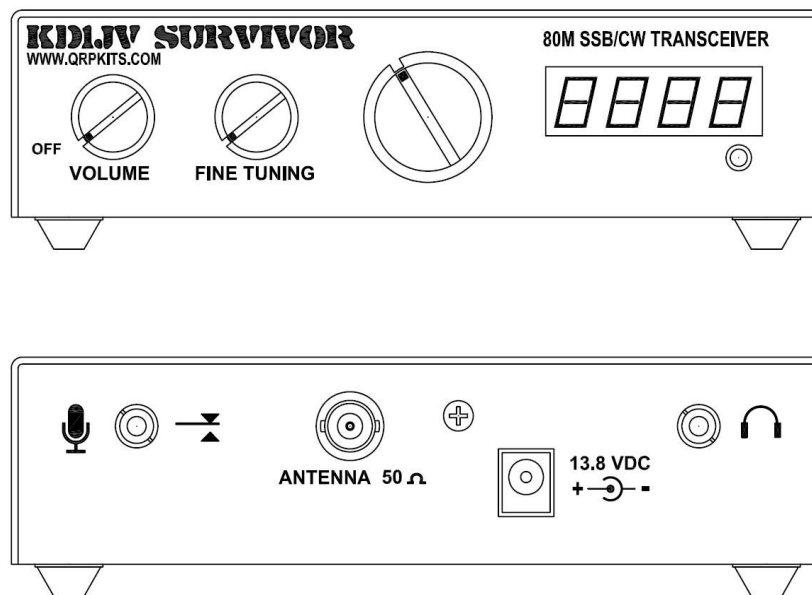
Cabinet prep:

- 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.

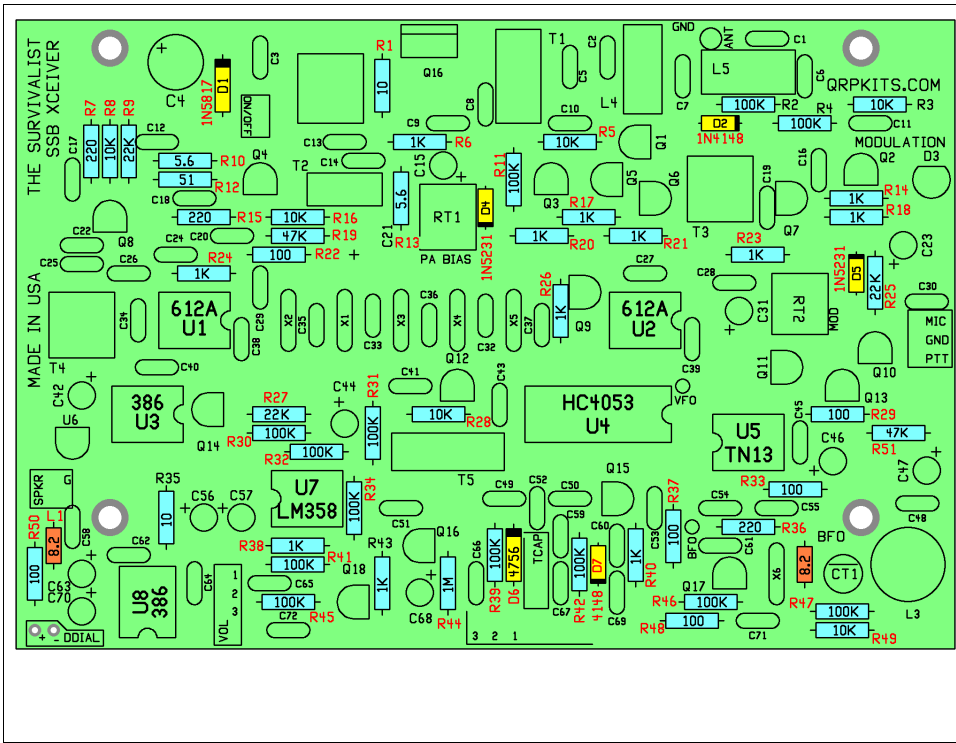
The decals are applied the same as model decals. Cut around each group of text or symbols you wish to apply. It doesn't have to be perfect as the background film is transparent. Apply the decals before you mount anything to the chassis. Use the above picture to get the correct spacing around the holes 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 maybe required. Observe polarity as indicated by black line on one end of the part and diagram.

Parts are numbered on the board from left to right, top to bottom in diagonal rows.

Sorting the resistors into their various values before hand will speed up assembly.

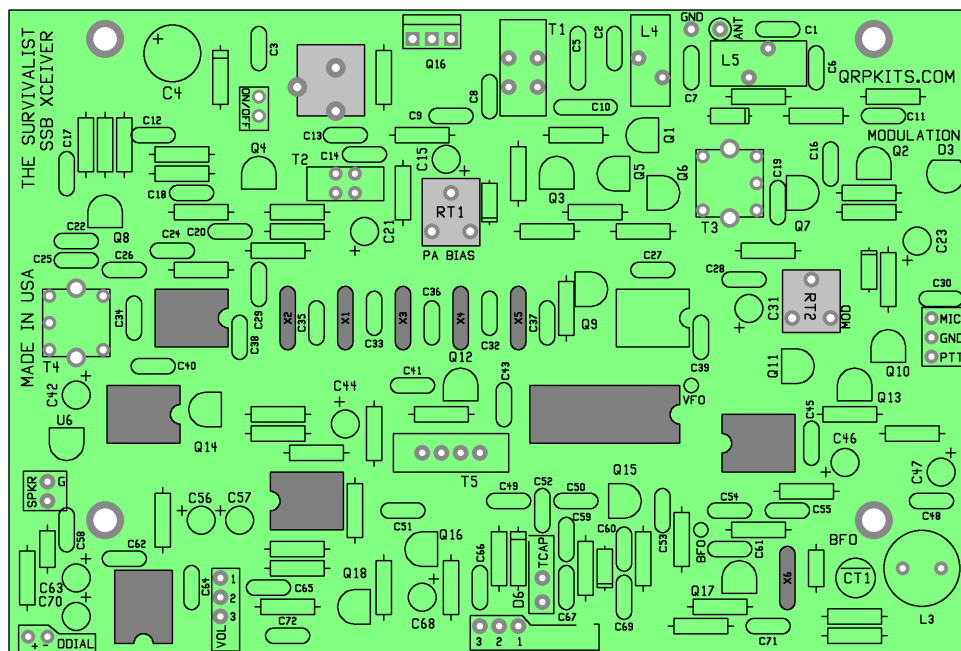
You may want to install all the resistors of one value at a time instead of sequential locations.

- BLK = Black = 0
- BRN = Brown = 1
- RED = Red = 2
- ORG = Orange = 3
- YEL = Yellow = 4
- GRN = Green = 5
- BLU = Blue = 6
- VOL = Violet = 7
- GRY = Gray = 8
- WHT = White = 9

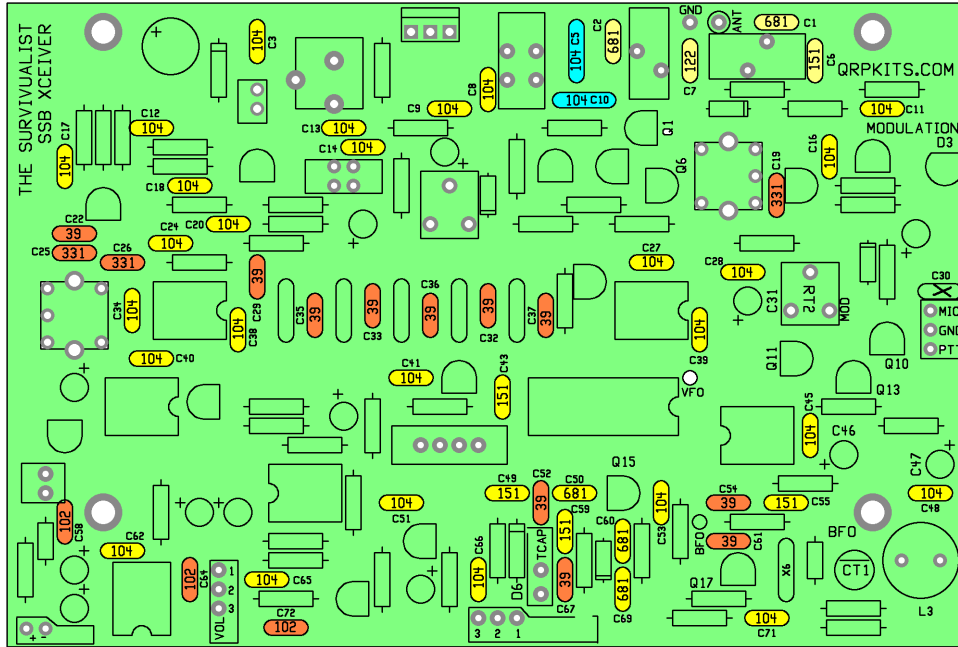
√	LOC	Value	Color code	√	LOC	Value	Color code	√	LOC	Value	Color code
	R1	10	BRN/BLK/BLK/GLD		R2	100K	BRN/BLK/YEL/GLD		R3	10K	BRN/BLK/ORG/GLD
	R4	100K	BRN/BLK/YEL/GLD		R5	10K	BRN/BLK/ORG/GLD		R6	1K	BRN/BLK/RED/GLD
	R7	220	RED/RED/BRN/GLD		R8	10K	BRN/BLK/ORG/GLD		R9	22K	RED/RED/ORG/GLD
	R10	5.6	GRN/BLU/GLD/GLD		R11	100K	BRN/BLK/YEL/GLD		R12	51	GRN/BRN/BLK/GLD
	R13	5.6	GRN/BLU/GLD/GLD		R14	1K	BRN/BLK/RED/GLD		R15	220	RED/RED/BRN/GLD
	R16	10K	BRN/BLK/ORG/GLD		R17	1K	BRN/BLK/RED/GLD		R18	1K	BRN/BLK/RED/GLD
	R19	47K	YEL/VOL/ORG/GLD		R20	1K	BRN/BLK/RED/GLD		R21	1K	BRN/BLK/RED/GLD
	R22	100	BRN/BLK/BRN/GLD		R23	1K	BRN/BLK/RED/GLD		R24	1K	BRN/BLK/RED/GLD
	R25	22K	RED/RED/ORG/GLD		R26	1K	BRN/BLK/RED/GLD		R27	22K	RED/RED/ORG/GLD
	R28	10K	BRN/BLK/ORG/GLD		R29	100	BRN/BLK/BRN/GLD		R30	100K	BRN/BLK/YEL/GLD
	R31	100K	BRN/BLK/YEL/GLD		R32	100K	BRN/BLK/YEL/GLD		R33	100	BRN/BLK/BRN/GLD
	R34	100K	BRN/BLK/YEL/GLD		R35	10	BRN/BLK/BLK/GLD		R36	220	RED/RED/BRN/GLD
	R37	100	BRN/BLK/BRN/GLD		R38	1K	BRN/BLK/RED/GLD		R39	100K	BRN/BLK/YEL/GLD
	R40	1K	BRN/BLK/RED/GLD		R41	100K	BRN/BLK/YEL/GLD		R42	100K	BRN/BLK/YEL/GLD
	R43	1K	BRN/BLK/RED/GLD		R44	1 M	BRN/BLK/GRN/GLD		R45	100K	BRN/BLK/YEL/GLD
	R46	100K	BRN/BLK/YEL/GLD		R47	100K	BRN/BLK/YEL/GLD		R48	100	BRN/BLK/BRN/GLD
	R49	10K	BRN/BLK/ORG/GLD		R50	47K	YRL/VOL/ORG/GLD		R51	100	BRN/BLK/BRN/GLD
	D1		1N5817		D2		1N4148		D3		Install later (LED)
	D4		1N5231B		D5		1N5231B		D6		1N4756B
	D7		1N4148								
	L1	8.2 u	GRY/RED/GLD/GLD		L2	2.2u	RED/RED/GLD/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.
 - Solder end of X1 through X5 to solder pad at the top of can. NOTE: leaving a gap between the crystal case and the board can allow solder to flow under the case and short out the lead.
- 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.



Ceramic capacitors

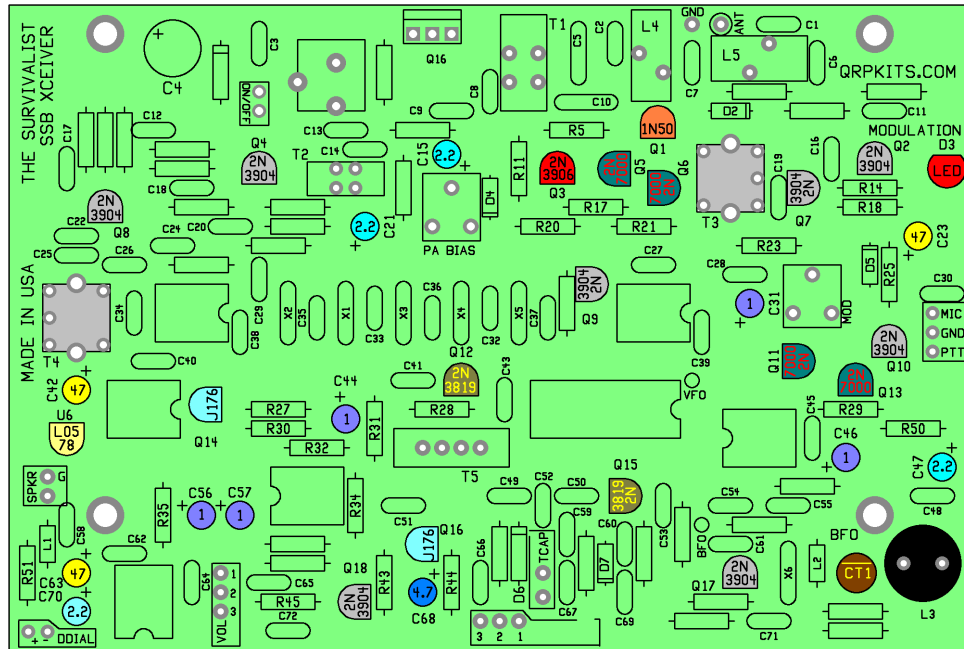


Electrolytic caps are installed later, their values are left blank on the chart below.

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.

√	LOC	Value	code/type	√	LOC	Value	code/type	√	LOC	Value	code/type
	C1	680 p	681 MLCC COG		C2	680 p	681 MLCC COG		C3	0.1 u	104 MLCC X7R
	C4		-----		C5	0.1 u	104 FILM, BOX blue		C6	150 p	151 MLCC COG
	C7	1200p	122 MLCC COG		C8	0.1 u	104 MLCC		C9	0.1 u	104 MLCC
	C10	0.1 u	104 FILM BOX blue		C11	0.1 u	104 MLCC		C12	0.1 u	104 MLCC
	C13	0.1 u	104 MLCC		C14	0.1 u	104 MLCC		C15		-----
	C16	0.1 u	104 MLCC		C17	0.1 u	104 MLCC		C18	0.1 u	104 MLCC
	C19	330 p	331 DISK		C20	0.1 u	104 MLCC		C21		-----
	C22	39 p	39 DISK		C23		-----		C24	0.1 u	104 MLCC
	C25	330 p	331 DISK or MLCC		C26	330 p	331 DISK or MLCC		C27	0.1 u	104 MLCC
	C28	0.1 u	104 MLCC		C29	39 p	39 DISK		C30		NOT USED
	C31		-----		C32	39 p	39 DISK		C33	39 p	39 DISK
	C34	0.1 u	104 MLCC		C35	39 p	39 DISK		C36	39 p	39 DISK
	C37	39 p	39 DISK		C38	0.1 u	104 MLCC		C39	0.1 u	104 MLCC
	C40	0.1 u	104 MLCC		C41	0.1 u	104 MLCC		C42		-----
	C43	150 p	151 MLCC COG		C44		-----		C45	0.1 u	104 MLCC
	C46		-----		C47		-----		C48	0.1 u	104 MLCC
	C49	150 p	151 MLCC COG		C50	680 p	681 MLCC		C51	0.1 u	104 MLCC
	C52	39 p	39 DISK		C53	0.1 u	104 MLCC		C54	39 p	39 DISK
	C55	150 p	151 MLCC COG		C56		-----		C57		-----
	C58	1000p	102 DISK		C59	150 p	151 MLCC COG		C60	680 p	681 MLCC
	C61	39 p	39 DISK		C62	0.1 u	104 MLCC		C63		-----
	C64	1000p	102 DISK		C65	0.1 u	104 MLCC		C66	0.1 u	104 MLCC
	C67	39 p	39 DISK		C68		-----		C69	680 p	681 MLCC
	C70		-----		C71	0.1 u	104 MLCC		C72	1000p	102 DISK

TO-92 transistors and odds and ends:



√	location	value	
	Q1	1N50	1 place , orange
	Q2, 4, 7, 8, 9, 10, 17, 18	2N3904	8 places, gray
	Q3	2N3906	1 place, red
	Q5, 6, 11, 13	2N7000	4 places, teal
	Q12, 15	2N3819	2 places, olive
	Q14, Q16	J-176	2 places, light blue (Q16 number was accidentally duplicated at top of board for IFR510B)
	U6	78L05	Pale yellow
	C31, 44, 46, 56, 57	1 ufd/ 50 V	Aluminum Electrolytic – Long lead is Plus
	C15, 21, 47, 70	2.2 ufd / 25V	Aluminum Electrolytic – Long lead is Plus
	C68	4.7 ufd / 25 or 16V	Aluminum Electrolytic – Long lead is Plus
	C23, 42, 63	47 ufd / 16V	Aluminum Electrolytic – Long lead is Plus
	C4	330 ufd / 16V	Aluminum Electrolytic – Long lead is Plus
	T3, T4	IF can	
	CT1	Brown trimmer cap	Flat side of cap goes towards line on board.
	L3	120 mHy inductor	Large black cylinder “124” marked on top.
	D3	Red LED	Long lead goes into hole on round side of outline.

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.

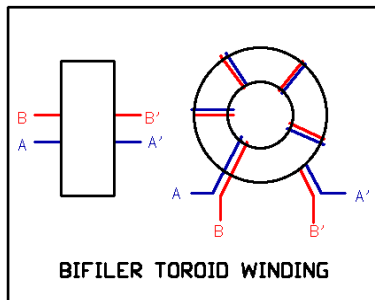
Coils shown left to right: VFO coil, Bi-filer T1, LPF coil L4



Picture 3, tinned wires

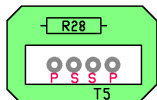
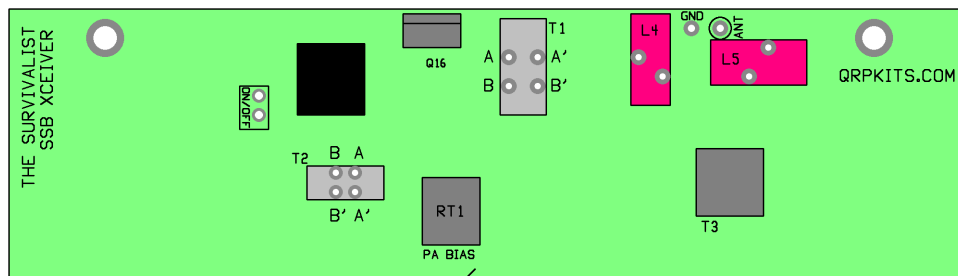
Picture 3 shows how the wire ends need to be trimmed back and tinned before the coil is inserted into the board. Putting a little blob of solder on the tip of your iron and then gently rubbing it against the wire will melt through the insulation and tin the wire.

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. A common mistake is to tin the wire, but not close enough to core, so when mounted, the insulated part of the wire is in the hole and not soldered to, while the tinned part is actually snapped off.



- L4, L5 T5-2 core (large, red) 22 turns, # 24 wire. (14") Evenly space turns around core, leaving small gap at wire ends
- T1 – FT50-42 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 right.
- T2 – FT37-42 core (small, black) 5 turns, #28 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.



- T5 – T50-7 core (large, white). Wind 21 turns #24 wire. (14") This is the primary winding. Next wind 8 turns of #28 wire (6") in gap in between #24 wire ends. This is the secondary winding.
- Install T5 the primary winding (21 turns) in the pads labeled "P" and the secondary (8 turns) into the holes labeled "S".

Chassis wiring:

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 real panel are routed along the side of the board, rather than above and across it.

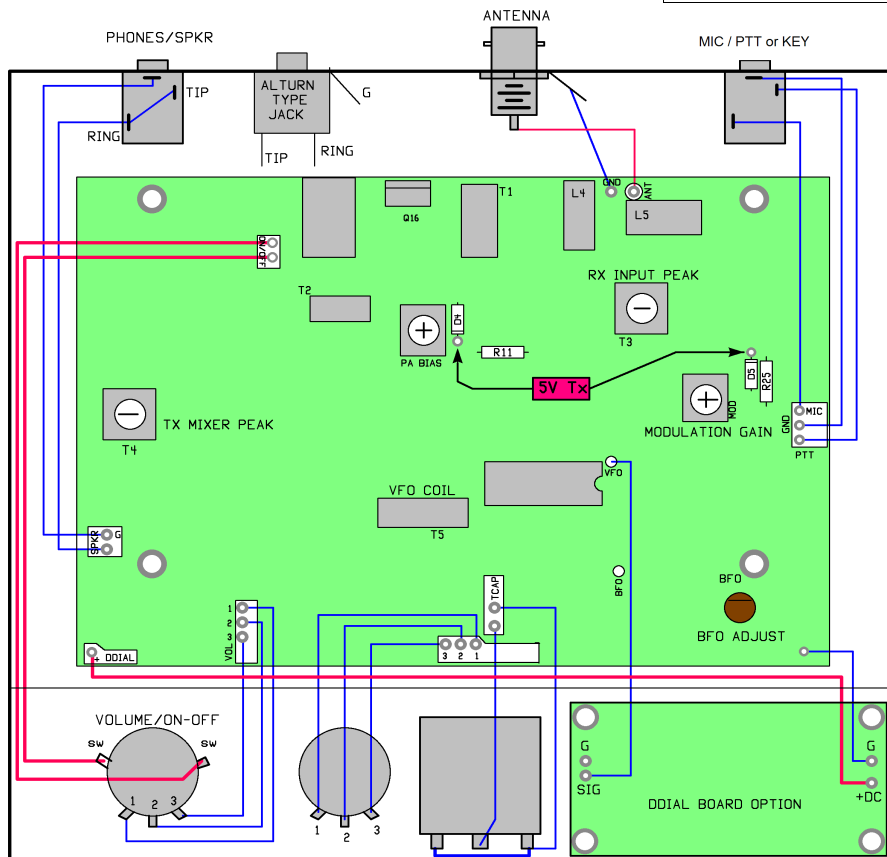
- Mount the front panel parts first. Tuning cap, RIT and Volume control and Digital Dial. Bend or remove anti-rotation tabs on pots.
- The BNC antenna jack wires from the board should be soldered to the board before the board is mounted into the case.
- You can cut the rest of the wires to length and solder them to the board outside 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.
- A ground wire isn't required to the Digital Dial as the cabinet acts as the return path, but one can be added between the two boards at the "G" pad near L3.



Picture 4, chassis wiring

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	1 wire	6"
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: Jumping the two outer tabs on the tuning cap results in the maximum tuning range.



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.

Testing and alignment:

- Since the rig does not have its own internal power fuse, 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 1 amp. If there happens to be a problem during testing, this will prevent damage to the board and/or your power supply.

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. Attach a frequency counter to the test point "VFO"
 4. The frequency should be between 5 and 5.35 MHz depending on the setting of the tuning capacitor.
 5. With both the tuning capacitor and RIT control tuned fully counter clockwise, the VFO frequency should be slightly above 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, T5. Moving turns closer together will lower the frequency. If the frequency is already too low, you will have to remove a turn from the coil to increase the frequency.
 7. Move the frequency counter to the "BFO" test point and verify a frequency slightly above 9.000 MHz.
- You can 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. Adjust BFO trimmer with small slotted screw driver for most natural sounding voice or band noise. 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.
 5. Peak the receiver input transformer, T3. It should peak with about a ½ to full clockwise turn of the slug.
 - If you are using the Digital Dial, it can now be set up for direct frequency reading of the operating frequency
 1. Connect the frequency input wire to the "BFO" pad on the main board.
 2. Tap a short across the "OFFSET SW" pads on the back of the DDial board. The display will change to read "Lo --"
 3. Click the front panel switch three times to select the "Lo C" mode.
 4. Click and hold closed the front panel switch until the display changes back to numeric characters (should be all zeros).
 5. Move the frequency input wire from the "BFO" pad to the "VFO" pad.
 6. The dial is now showing the operating frequency.

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 Q16:

- With the board mounted in the case, install the IRF510B MOSFET at the Q16 location.
- Line up the screw holes and attach with #4 nylon screw and nut.
- Push the body of Q16 up against the back of the cabinet to slightly kink the leads and ensure it is flush to the case.
- Top solder the three leads to the pads.
- Remove board from case and trim back leads on Q16
- Re-install the board into the case
- Attach Q16 to cabinet with mica insulator and nylon screw.

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

Transmitter adjustments:

- Connect power meter if available and dummy load to antenna jack.
 - Connect amp meter in series with power supply lead, 2 A scale.
 - 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.
 - Note the current being drawn from the power supply with the amp meter.
 - Slowly turn the "PA BIAS" trimmer resistor clockwise, while watching the amp meter.
 - Stop adjusting the BIAS as soon as the current starts to increase.
 - Back off on the BIAS just enough to put it below the threshold of current increase.
 - **Any higher bias can run the risk of PA oscillations with non-resistive loads.**
-
- Turn the "MODULATION GAIN" trimmer resistor clockwise to about mid position.
 - 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 insert an audio tone as long as the PTT is pushed.
 - Adjust T4 for best power output as indicated by the power meter or brightness of the LED mounted on the board. Typically, this will be about a ½ to full turn clockwise of the slug in T4.
 - Exit TUNE mode by doing a 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.

- 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.

You should now be able to attempt your first QSO with the new rig!

Tuning range options:

When full tuning range is used, (both capacitor sections of main tuning cap in parallel) full power output will not be obtained over the full tuning range, due to the bandwidth of the transmitter tuned circuit, T4. This is why T4 should be peaked at the center of the tuning range.

Tuning range can be reduced if desired by using only one of the capacitor sections. Reducing tuning range will make tuning less "touchy" and provide more consistent power output over the tuning range. Tweak the spacing of the turns on the VFO coil T5 to set the tuning range in your desired section of the band.

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.

Since the supply for the mic is 5.1 volts, using a 5V element isn't going to work.

Dynamic microphones elements are not directly compatible. Older CB set often used a Dynamic mic. Dynamics have a low impedance and low output voltage, therefore an external preamp will be required. In addition, a 2.2K resistor needs to be placed between the mic input and ground to bias Q10 to the proper voltage. A DC blocking cap may also be required, but this is usually included in the preamp output.

Crystal mics would also need special treatment, but these are so rare these days it's unlikely you would use one.

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. 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

U3 LM386	Pin	Voltage	Pin	voltage
	1	1.25	8	1.25
	2	0.0	7	2.45
	3	0.0	6	5.00
	4	0.0	5	2.38

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

U7 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

U8 LM386	Pin	Voltage	Pin	voltage
	1	1.40	8	1.40
	2	0.0	7	6.6
	3	0.0	6	6.7
	4	0.0	5	13.5

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	13.5 / 0	0 / 0
Q2	2N3904	0 / 0	0 / 0	0 / 5.1
Q3	2N3906	13.5 / 13.5	13.4 / 12.7	0 / 13.4
Q4	2N3904	0 / 1.0	0 / 1.7	13.5 / 13.5
Q5	2N7000	0 / 0	0 / 13.5	13.5 / 0
Q6	2N7000	0 / 0	0 / 5	13.4 / 0
Q7	2N3904	0 / 0	0 / 0.7	0 / 0
Q8	2N3904	0 / 2.1	0 / 2.8	0 / 10.3
Q9	2N3904	3.1 / 3.1	3.8 / 3.8	5 / 5
Q10	2N3904	0 / 0.75	0 / 1.4	0 / 5.1
Q11	2N7000	0 / 0	0 / 0	0 / 0.75
Q12	2N3819	2.7 / 2.7	0 / 0	5 / 5
Q13	2N7000	0 / 0	0 / 0	0 / 1.4
Q14	J-176	0 / 0	5 / 5	0 / 0
Q15	2N3819	1.5 / 1.5	-0.7 / -0.7	4.8 / 4.8
Q16	J-176	0 / 0	5 / 5	2.5 / 2.5
Q17	2N3904	1 / 1	1.7 / 1.7	4.5 / 4.5
Q18	2N3904	0 / 0	0 / 0	5 / 5
Q16	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 help 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, U1, is differentially coupled to a LM386 audio amp, U3. This provides an additional 6 dB of gain over single ended coupling and helps eliminate any common mode signals on the output of the mixer. The '386 provides a voltage gain of 20 with a minimum of external parts. A "P" channel J-fet is connected across the input pins to provide AGC action, more on this later.

The output of the first audio gain stage (U3) drives a pair of non-inverting amplifiers (U7) through a 100 K resistor. One of the amplifiers has a modest voltage gain of 4.5, while the other has a much higher gain of 100. The output of the low gain stage (U7a) is the receiver audio.

The high gain stage is used to drive the AGC circuits, which is comprised of Q18, Q16 and Q14. The way this works is Q16 and Q14 are normally turned off by a positive voltage on their gates 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 U7b starts to exceed 500 mV, Q18 starts to turn on. That reduces the gate voltage on Q14 and Q16, allowing them to start turning on. Q14 shunts the signal between the input pins of U3 while Q16 shunts the signal to ground, using the 100K resistor R31 as a dropping resistor element.

The gain of U7b is such that AGC action keeps the output signal on U7a to be no more than about 50 mV peak. R44, a 1 meg ohm resistor and C68, a 4.7 ufd cap sets the AGC time constant. R43, a 1 K resistor between the time constant and the controlling transistor Q8 slows down the attack time. Without the limiting resistor, the AGC can overshoot, causing a loss of audio until C68 can charge up again.

Originally, only the Q16 shunt to ground was used for AGC. While this was enough to limit the signal to 50 mV, very strong signals would cause U3 to saturate and clip, causing a distorted signal. Adding Q14 to reduce the input signal to U3 eliminated this problem.

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:

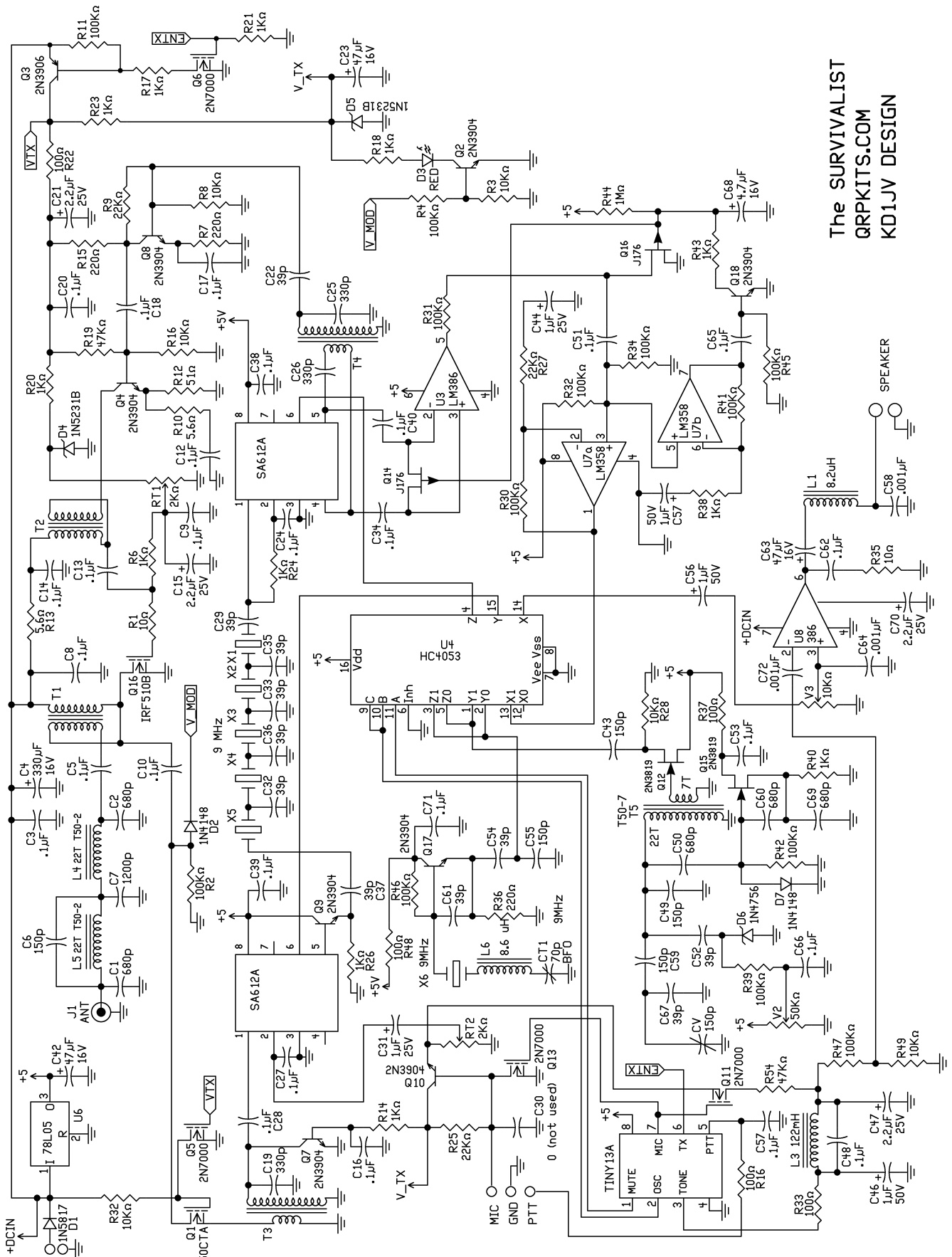
1. The audio is muted
2. The VFO and BFO oscillators are switched between the two mixers. The product detector (U1) is now the balanced modulator while the Receiver input mixer (U2) is now the transmit mixer.
3. The transmitter amplifiers are enabled by turning Q3 on via Q6. This also actives the QSK switch Q1, disconnecting the antenna to T3, the input tuned circuit. Q7 is also turned on, shorting the output side of T2 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.
4. The Microphone buffer transistor, Q10, is turned on by releasing the ground on the base via Q11.

Now, when you speak into the microphone, the audio is mixed with the 9 MHz BFO signal, which produces a double sideband signal, 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 U1 with the VFO to produce the desired operating frequency in the 75 Meter band. The desired mixer product is selected by the tuned circuit T4 and then amplified by Q8 and Q4 to a suitable level to drive the power output MOSFET Q16 (which should have been labeled Q19).

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 R33, C46, L3 and C47 to remove harmonics and generate a nice sin wave to modulate the transmitter. C48 across L2 blocks the second harmonic, which would otherwise take a second filter section to effectively remove. When the tone is being generated, Q13 is turned on which turns off the microphone so ambient noise isn't picked up by the mic. Q11 is also turned on, connecting the tone to the modulation level control.



The SURVIVALIST
QRPKITS.COM
KD1JV DESIGN

SPEAKER

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

