

Firefly SDR TH

Through hole version of the Firefly SDR

Hendricks QRP Kits

Software Defined Receiver for 30m and 20m
With 3w CW Transmitter

by Dan Tayloe, N7VE

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Specifications

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

SDR Receiver

Tuning range: 30m:10.120 MHz +/- 24 KHz ; **20m:** 14.065 +/- 24 KHz using free software packages such as PowerSDR and Rocky

Curent Drain: Approximately 28 ma @ 12v.

Supply voltage range: 9 to 13.8v

Receiver bandwidth: Wideband SDR receiver ~ 3 db down at +/- 24 KHz. Audio selectivity via PC software.

MDS receiver sensitivity: Dependent on the PC sound card used. 30m measured: **-127/-128 dbm** in 500 Hz using a Presonus Firebox and PowerSDR software.

Third order distortion dynamic range (IP3DR): **93 db**

Blocking Dynamic Range (BDR): **~100 db**

Transmitter

Power Output

- 3 to 3.5w at 12v

Note: TX designed for CW type transmit duty cycle, finals rated to 2.4w power dissipation. Prolonged key down operation is not advised.

TX tuning range

- **30m:** 10.108 to 10.119 KHz, 11 KHz range with 10.120 MHz crystals;
- **20m:** 14.049 to 14.065 KHz, 16 KHz range with 14.065 MHz crystals;

Note: Exact low end TX tuning range will vary from crystal pair to crystal pair

TX harmonic output

- All output harmonics less than -50 dBc

Note to the Reader

In the interest of “time to market”, I am shamelessly lifting the following few sections kit building sections from the NC2030 manual. Please ignore the references to the NC2030 – Dan, N7VE

Building the Kit

Things you will need

Jacks, pots, switches, and push buttons, and a case specifically:

- **Five 1/8” stereo jacks** (I/Q audio output, Monitor speaker output, Paddle inputs, Audio input from PC, mute signal output)
 - **One small push button switch**, normally open (programming button for the keyer)
 - **One sub-miniature SPST switch** (used for spotting the TX VXO on frequency)
 - **One 100K linear panel mounted pot** (keyer speed pot)
 - **One 10K linear panel mounted pot** (used to tune the TX VXO frequency)
 - **One antenna jack**
 - **One rear 12v power connector**
 - **One case.** Dimensions should be at least 5” in depth, 3.5” wide and 1 3/8” tall. The case should be metal to provide shielding on the TX VXO from the radiated antenna signal.
-
- One 1/4w resistor for testing, 10K to 100K (47K recommended)
 - 9v battery clip (for temporary power connection for testing)
 - Fresh 9v battery (for a low current power source for testing)
 - Clear nail polish (“Sally Hansen Diamond Strength” highly recommended for hardness. Source: Ulta)
 - Tweezers
 - Solder sucker (highly recommended) or solder wick
 - Temperature control soldering iron with a fine tip
 - 8 pin socket for the keyer chip (optional)
 - Magnifying headpiece and/or magnifying glass. 3.5 power reading glasses may work also. Try them on and check for focus at a 6 to 8” operating distance.
 - Cookie sheet (highly recommended for building on top of in order to catch stray parts)

An important note: SDR radios have traditionally had a number of complaints concerning performance problems related to intermittent connections in the low level audio jacks. The use of good connectors and gold plated audio cables plugs have proved to be helpful in obtaining consistent day to day receiver performance. Cheap audio jacks and cheap audio cables provide for a good low cost starting point, but can be problematic in the long run.

Good shielded audio cables between the receiver low level I/Q audio output and the input to the computer sound card is very helpful in keeping out spurious signals. Given a choice, make this cable as short as possible.

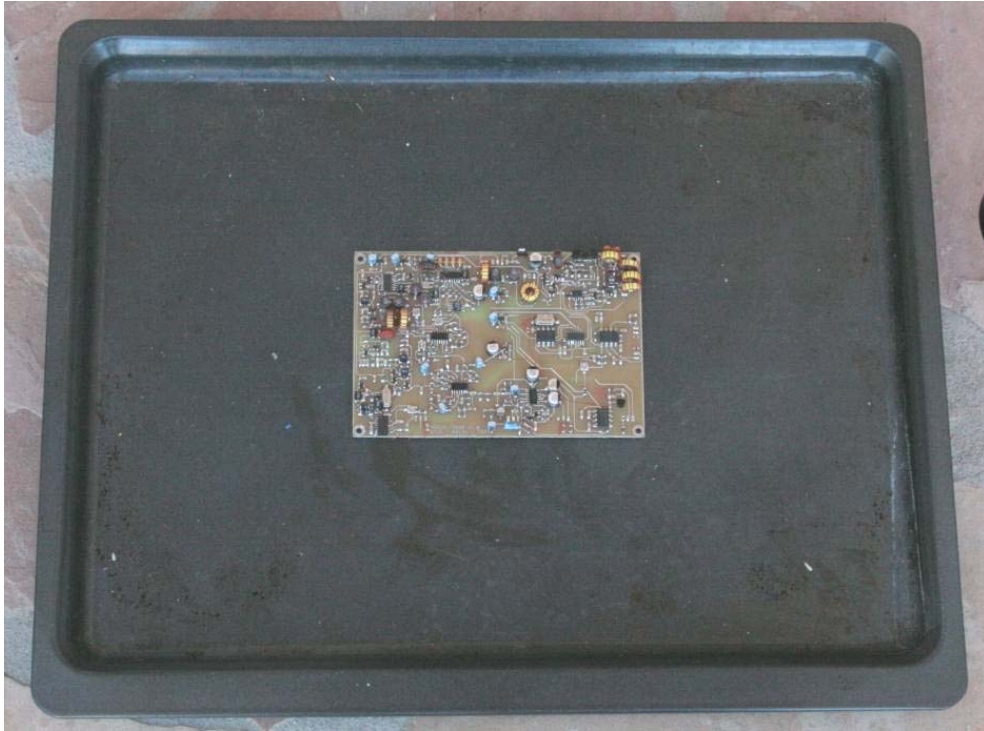


Figure 1. Working over an oversized cookie sheet is highly recommended to catch stray parts



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



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



Figure 4. Headband Magnifiers. "Mag-eyes" from JoAnn Fabrics

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

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

Parts List



Figure 5. Package as it arrives from Hendricks QRP Kits

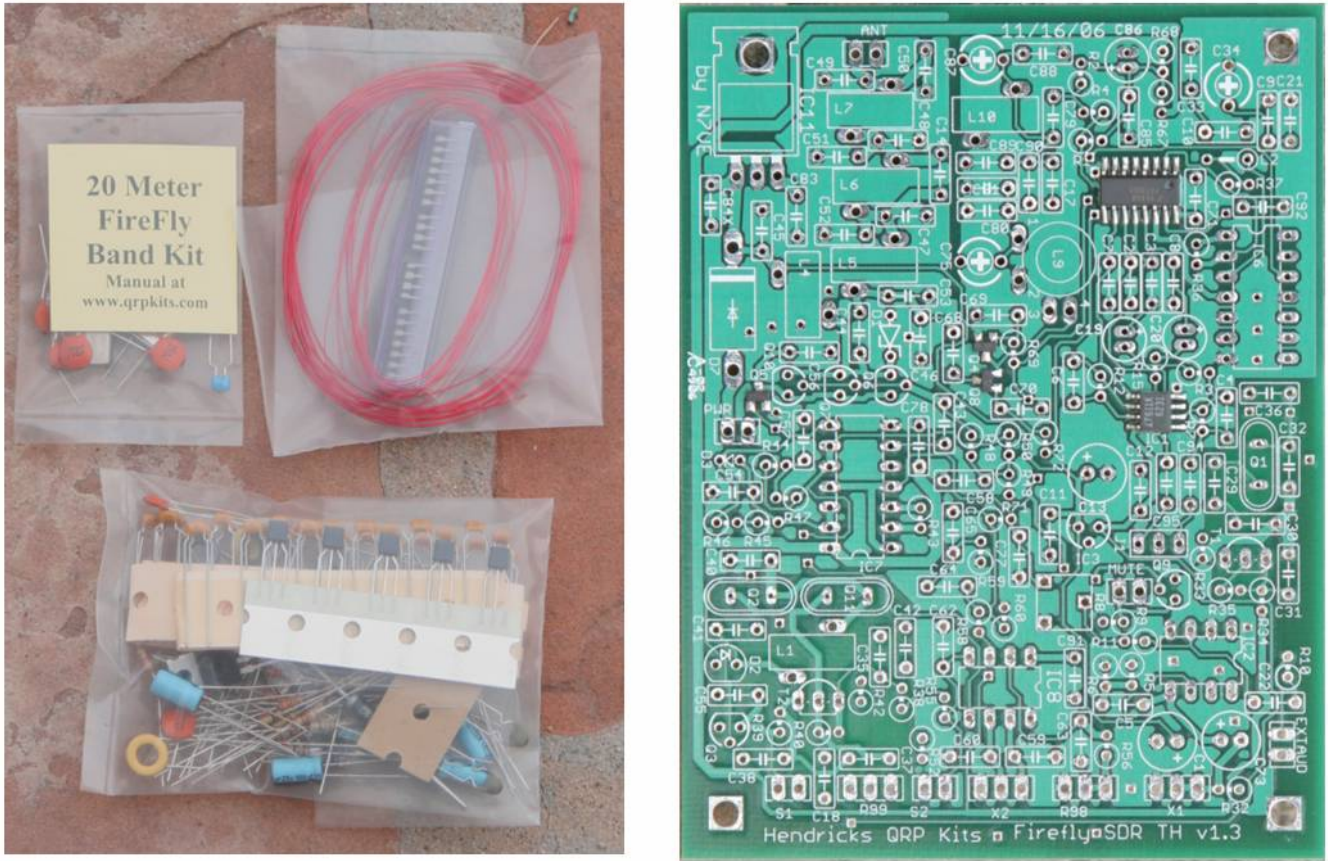


Figure 6. Internal contents of the box – Three parts packs plus the PC board

The bare board comes with five pre-mounted surface mounted parts listed below:

QTY	Part
1	LT6231CS8
2	BSS123
1	NDS335N
1	74CBT3253D

Figure 7. List of pre-mounted parts

The parts are broken into band specific and common parts. Here are lists of both:

30m List		20m List	
2	100 pf	1	2.2 pf
1	150 pf	1	100 pf
5	180 pf	1	120 pf
1	2.2 pf	4	150 pf
1	22 pf	1	27 pf
3	4.7 pf	1	33 pf
2	47 pf	2	330 pf
2	470 pf	2	4.7 pf
1	10 uH choke	1	47 pf
3	10.120 MHz xtal	2	68 pf
		1	4.7 uH choke
		3	14.065 MHz xtal

Figure 8. Inventory of band specific parts included in the kit

Qty	Value	Qty	Value
11	0.01 uf	6	T37-6
28	0.1 uf	1	FT37-43
3	100 uf		
2	150 pf	5	BS170
1	22 pf	2	BSS123
3	22 uf	1	NDS335N
1	47 pf	2	SS9018
1	5 pf		
2	50 pf	3	18
		2	100
1	1N5262B 51v zener	2	300
1	MV209	5	100K
1	1N4148	7	1k
1	SB320	10	3.3K
		2	33K
1	LT6231CS8	2	47K
1	LM386-N4	5	75K
1	78I06	3	8.2K
1	74AHC04N		
1	74AC00N	1	5K trim pot
1	12F629		
1	74CBT3253D		
1	7805T		

Figure 9. Parts common to all bands

Tools and Construction Hints

In building this transceiver myself and creating the manual, I have had some problems. These fall into several different categories:

- 1) IC pins not truly soldered
- 2) ICs mounted backwards
- 3) Resistors and capacitors not soldered to the right set of pads
- 4) Not all parts were installed
- 5) Bad resistor (part was open)
- 6) Leads not totally stripped on the toroid cores

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

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

You may find that the components in the pictures may be slightly different from what is in your kit. This may be partially due to the fact that the pictures are of the 20m version.

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

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

I find that this radio can be built in about six hours. One good Saturday should do it.

Bare PC Board Pictures

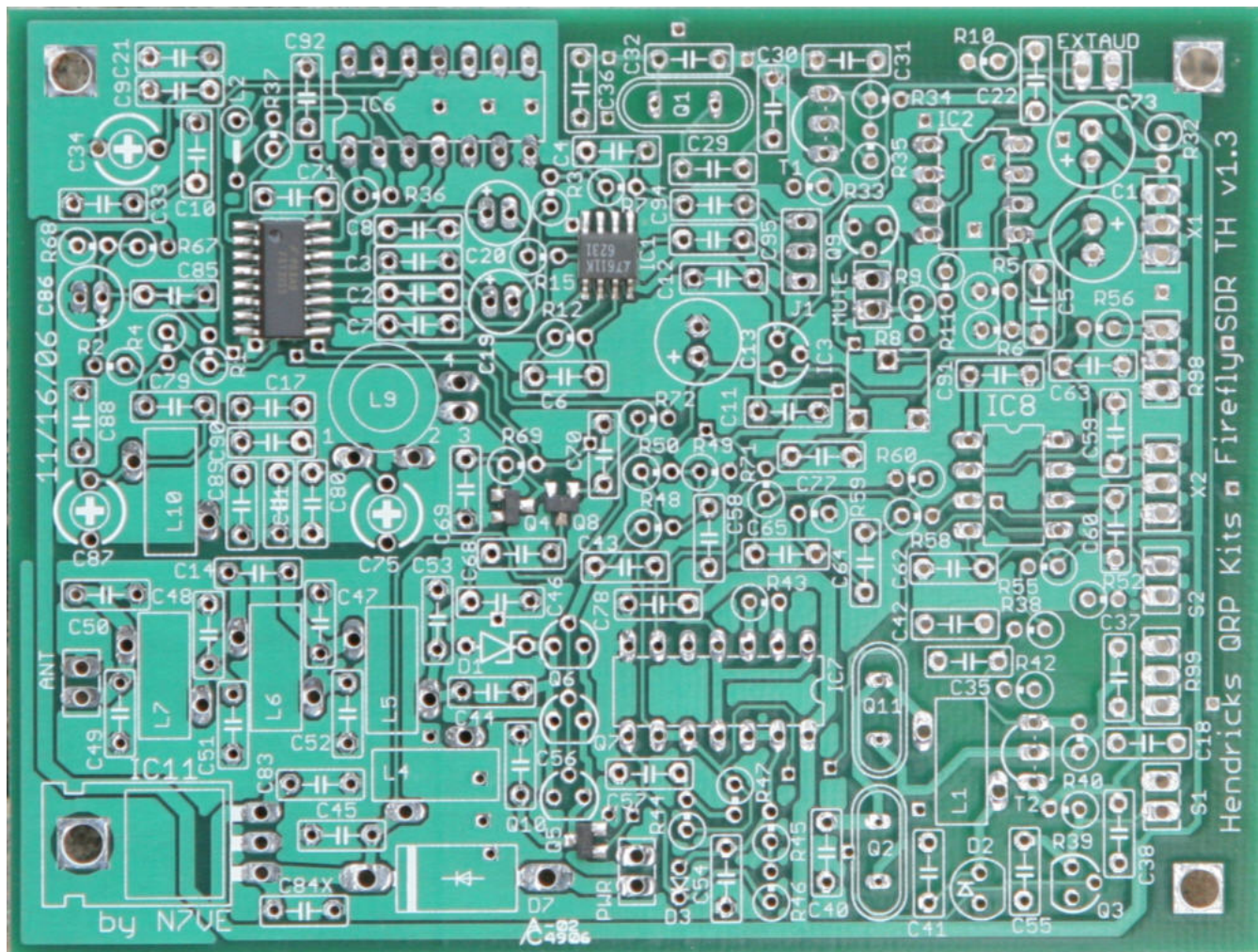


Figure 10. Top side view of the Firefly SDR TH board

Power Connections and 5 and 6v Regulators

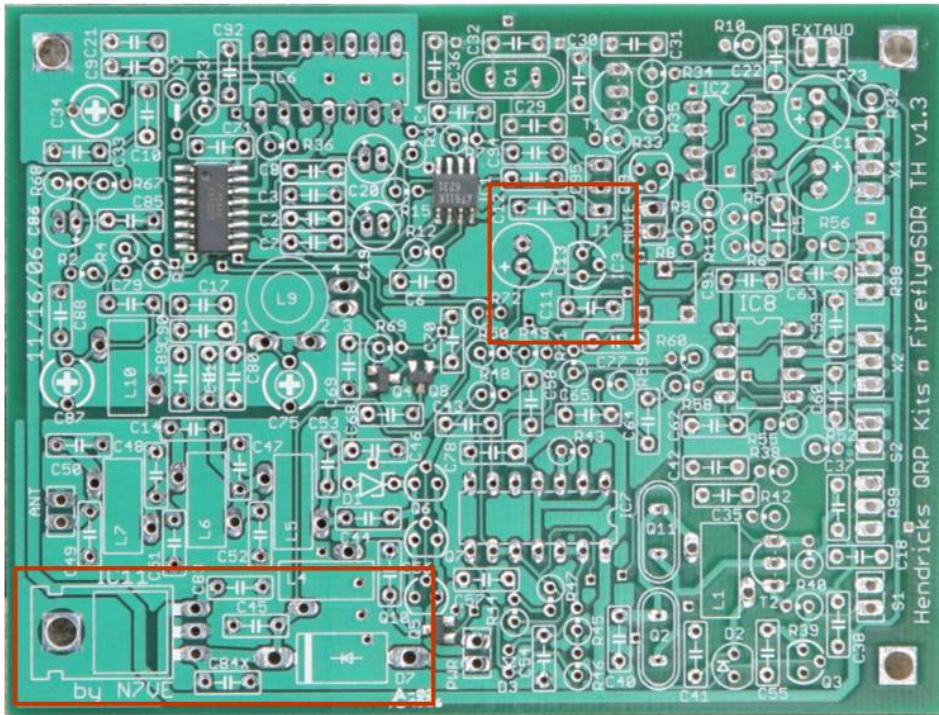


Figure 11. 5v, 6v Regulator and 12v input areas highlighted

I suggest using a 9v battery clip to temporarily supply power to the board. This is a low current, temporary power connection that protects the board in case of a problem. ***The 9v battery clip is not supplied.***

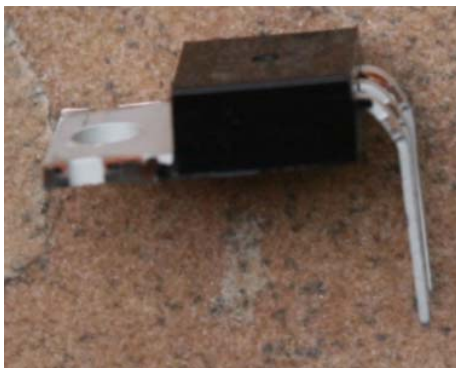


Figure 12. Lead forming of the LM78M05 5v regulator before installation

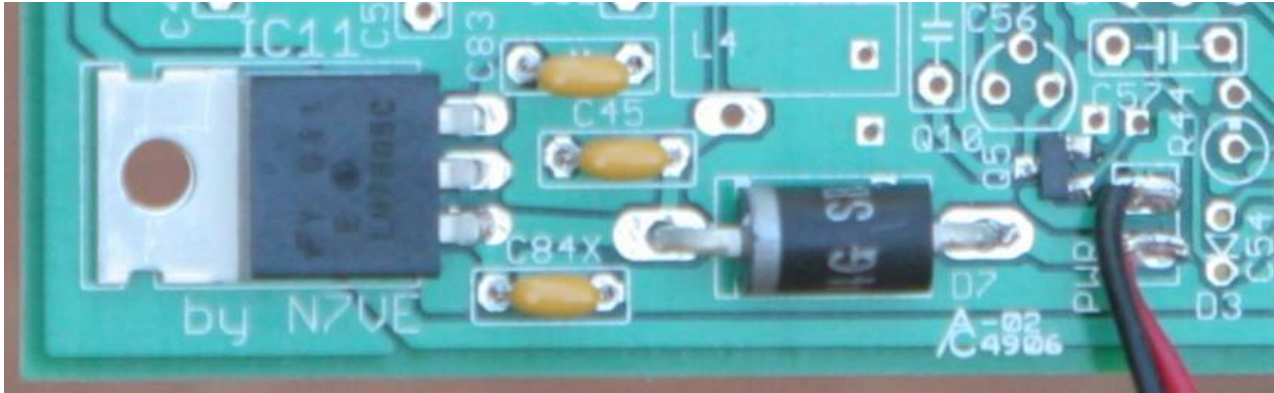


Figure 13. 5v regulator, protection diode, and 9v temporary connection. Note D7 diode polarization!

Install IC11 (LM78M05). **Make sure hole of the regulator matches up with the mounting hole on the board!**

Install 0.1 uf caps (marked “104”). C11 and C12

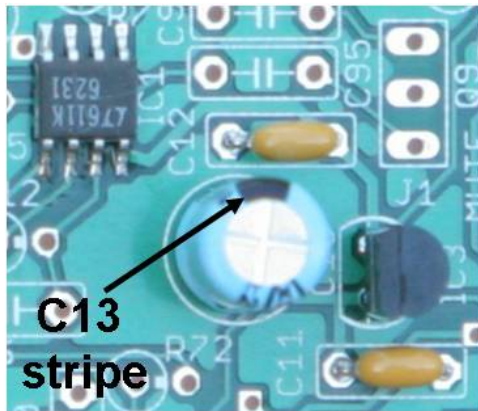


Figure 14. 6v regulator installed. Note IC3 flat side orientation and C13 stripe orientation.

Install IC3 (LM78L06), D7 SB320. **Double check the polarity against the above picture! Check the diode band polarity, and match the flat side of T3 against the flat side outline on the board.**

Install 0.1 uf caps (marked “104”). C83, C84x and C45

Install C13, 100uF polarized capacitor. This is a polarized capacitor, ***so make sure it is installed with the correct polarization.*** The black stripe on the top of the cap is the negative side of the capacitor. The non-striped side matches with the “+” symbol marked on the board. **Double check against the orientation on the board.**

5 and 6v Regulator Tests

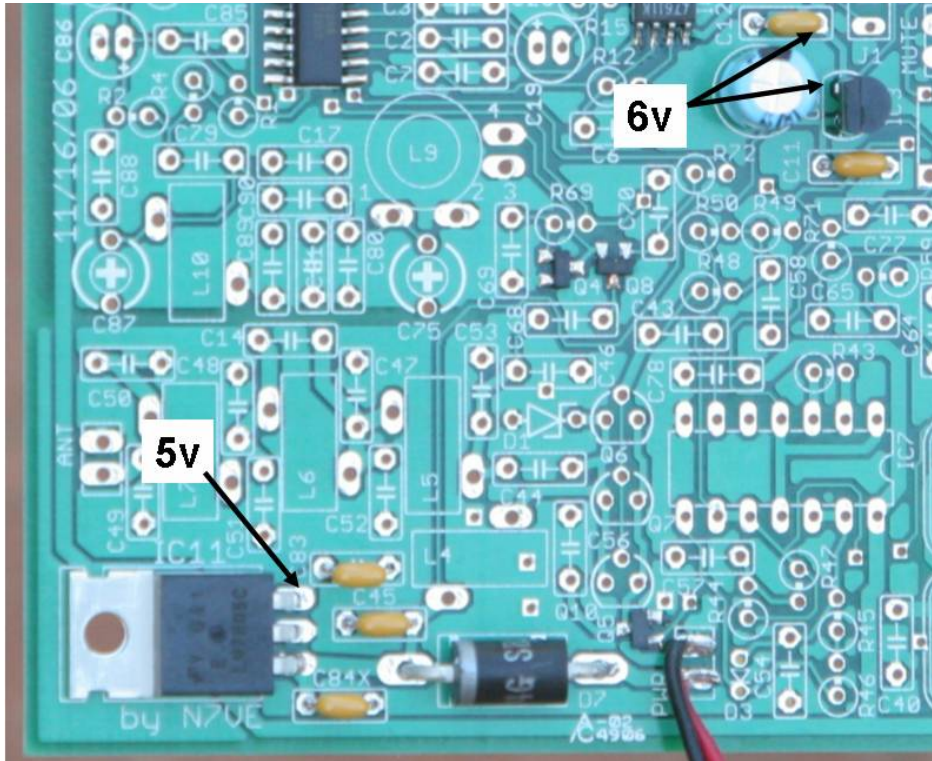


Figure 15. 5v and 6v regulator output test points

The drain on the 9v battery should be **about 10 ma**. The current drain can be tested by connecting the 9v battery by one terminal only, then connecting a voltmeter between the remaining battery terminal and remaining 9v battery clip terminal.

The input voltage to the board is diode protected. Thus you will not damage the board by hooking the battery up backwards.

The tab of the 5v regulator makes a good ground connection point. All four corner mounting hole are grounded on this board and also make good ground test points. All voltage measurements should use one of these grounding points.

Measure and verify the 5v and 6v outputs as shown above. However, if the current drain is right, it is highly likely that all is well.

It should be noted that the idle current of the regulators vary quite a bit from device to device and that the total current drain at this point could be different by several ma.

At this time, remove the 9v battery connection.

Sidetone monitor Amplifier

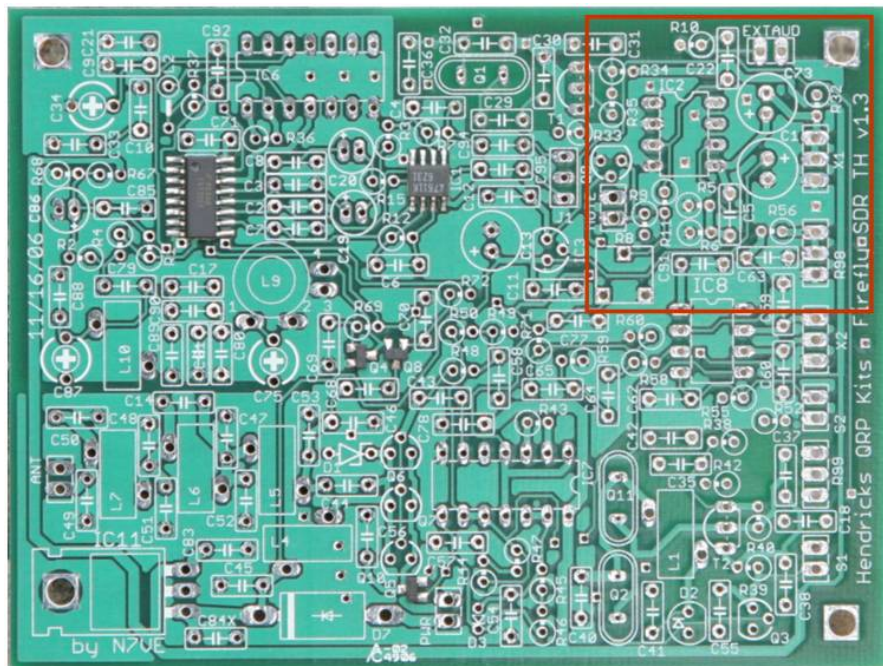


Figure 16. Parts location of the CW side tone monitor amplifier

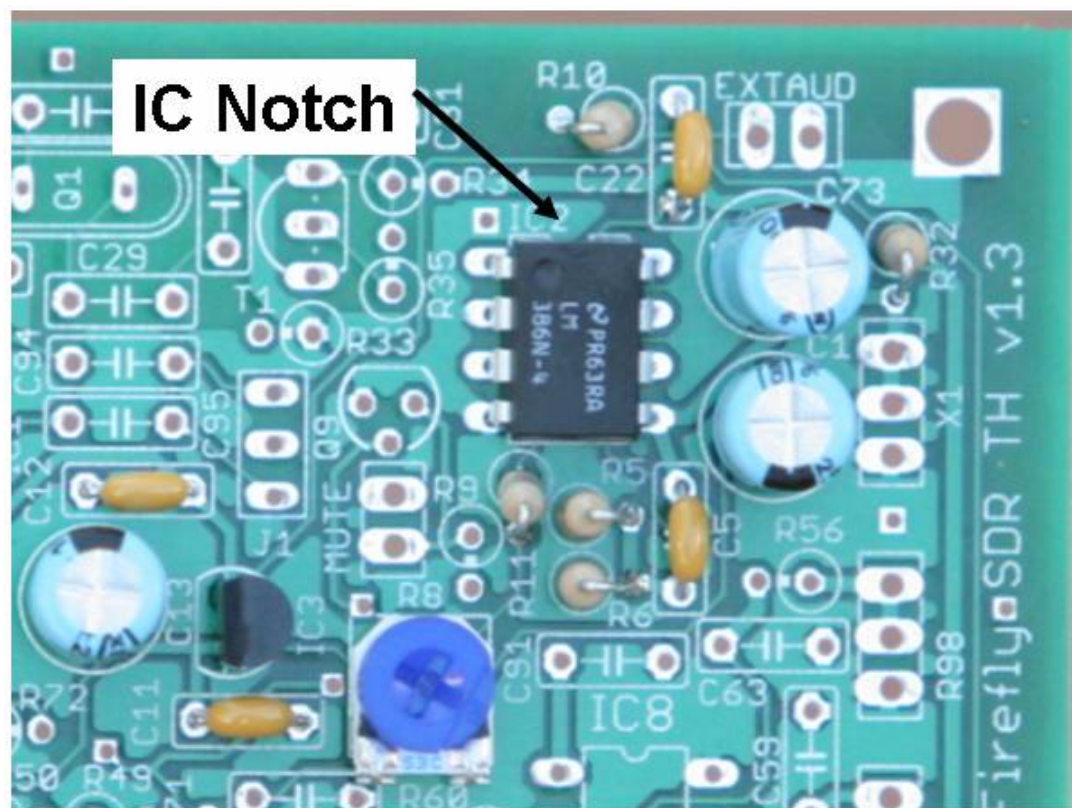


Figure 17. Side tone monitor amp. Note IC2 polarity and black stripes on C1 and C73.

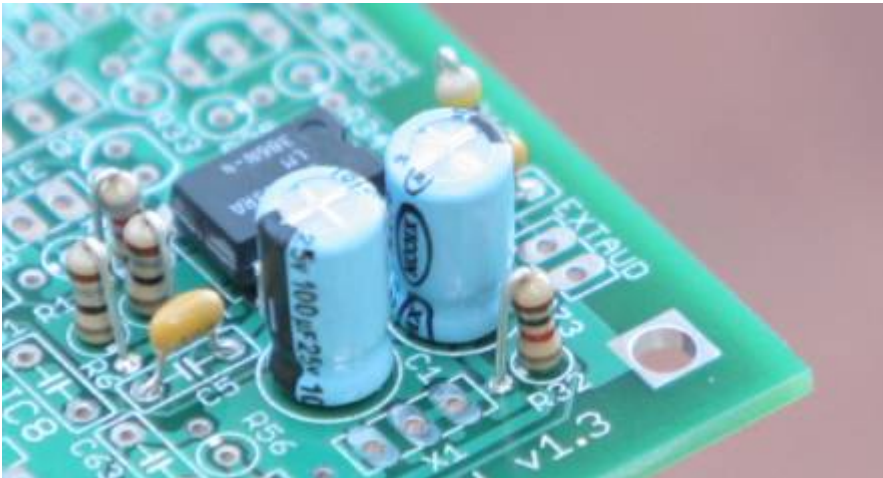


Figure 18. Note that all resistors are installed vertically as shown above, fat end on the marked circle area.

Install the following parts in the following order:

- Install IC2 (LM386-4). ***Double check the orientation of the IC before soldering it in. Solder one pin, double check the orientation with the picture above, and then solder the rest of the pins.***
- Install C1 & C73 100 uf large blue electrolytic cap. ***Double check the polarity of the black stripe against the photos above.***
- Install R8 (5K trim resistor). ***Don't forget to solder down the trim resistor!*** It snaps in place well and is easy to forget!
- Install R5 and R6 (18 ohm – brown-grey-black-gold), R11 (8.2K – grey-red-red-gold) R32 (1K marked brown-black-red-gold) and R10 (47K- yellow-violet-orange-gold)
- Install C5 & C22 (0.1 uf – marked 104)
- Install Q9 (BS170), R9 (3.3K- orange-orange-red-gold). These two parts are not shown as installed in the pictures above, but were added to this section after the pictures were taken.

CW Side Tone Monitor Amplifier Test

This will be tested more completely after the next section. The easiest test is to check the board current draw when connected to the 9v battery. At this point the current drain is in the 15 ma range.

Keyer Circuit

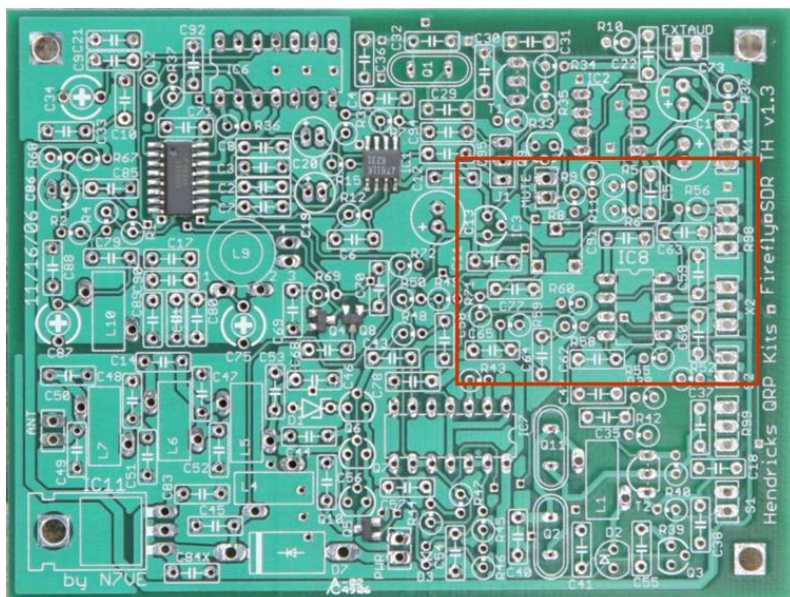


Figure 19. Location of keyer circuitry

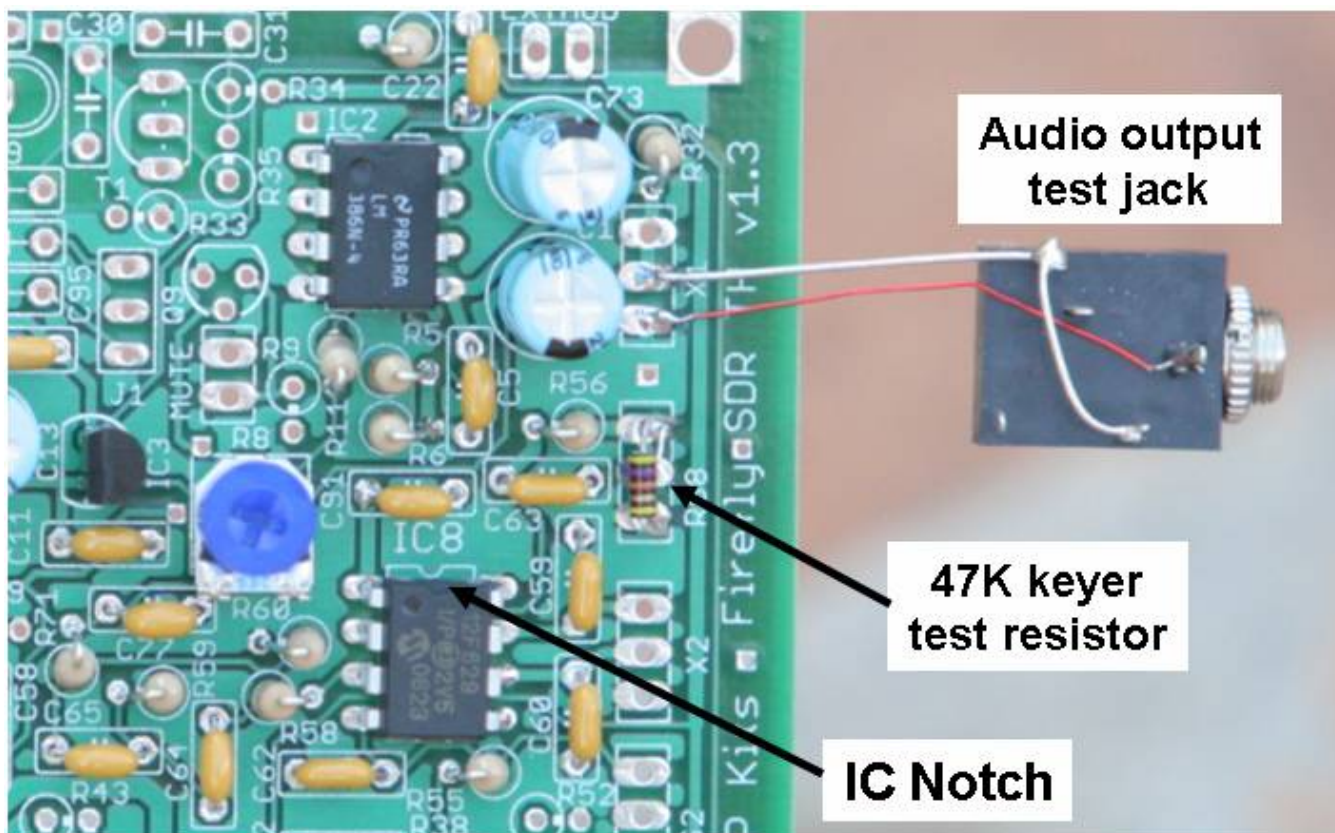


Figure 20. Keyer Section. IC8 Notch is at the top end. 47K keyer test resistor shown with audio test jack.

Install IC8 (12F629). **Note the IC8 notch orientation in the above picture before soldering! Solder one pin, double check the orientation with the picture above, and then solder the rest of the pins.**

Install 0.01 uf capacitors (marked “103”): C59, C60, C62, and C63.

Install 0.1 uf capacitors (marked “104”): C91, C64, C65, and C77

Install 3.3K resistors: R59, R60, and R71 (marked orange-orange-red-gold)

Install 1K resistors: R56, R58 (marked brown-black-red-gold). R56 is hard to find. It is right below the two large blue 100 uf caps in the side tone amplifier.

Install 8.2K resistors: R55 (marked grey-red-red-gold)

For temporary testing purposes connect a resistor somewhere in the 10K to 100 K range as shown above across the connections for the CW speed pot R98. I used a 47K resistor (not included) because that is what I had closest to hand. This will allow the keyer chip to send “**FB**” out of the side tone speaker monitor output when the board is powered up. Alternatively you could hook up the cw speed pot temporarily.

Keyer and CW Side Tone Monitor Amplifier Test

Connect the 9v battery. If no monitor side tone external speaker is connected, the board current draw when connected to the 9v battery will start at ~ 16 ma, then quickly drop back to 15 ma. The 1 ma difference is the keyer chip turning on and sending “FB”. The keyer chip will then turn off when done, reducing the current back down to 15 ma.

The sidetone volume trimmer R8 is turned all the way down from the factory. You will need to turn it up (half way?) to get any side tone volume.

A further and more complete test is to connect an external speaker (or set of headphones) to the CW side tone monitor output, X1. The picture above shows a headphone output connected temporarily across X1. R8 is the volume control for this CW side tone output, and the output is quite loud. Set R8 to a comfortable listening level.

With a speaker attached, the current drain increased to 20+ ma (I have seen 54 ma!) when the board is first powered up and the “FB” is sent. The current then dropped back to 15 ma. The high current value will depend on your exact R8 volume setting and the impedance of the external speaker.

Note: The CW Keyer may not reset properly if the voltage is removed from the rig for only a few seconds. ***If the chip does not reset properly, it will not send the sign on messages on power up.*** If you power off the rig and want to power it back on immediately, you may need to ***press the Keyer push button*** to make sure the processor burns up all stray charge and thus get reset properly before turning the rig back on.

The operating instructions for the keyer are at the end of this manual. The keyer has several memories, a beacon mode, and a straight key mode where if a straight key is plugged in on power up (or if a paddle lever is held on power up), the keyer will disable itself and assume an external straight key is being used. The straight key mode is determined each time the keyer (i.e., the transceiver) is turned on.

Note: When straight key mode is used, the keyer speed *must be set to maximum* for the keyer to work properly!

Disconnect the 9v battery supply.

Receiver Side Local Oscillator

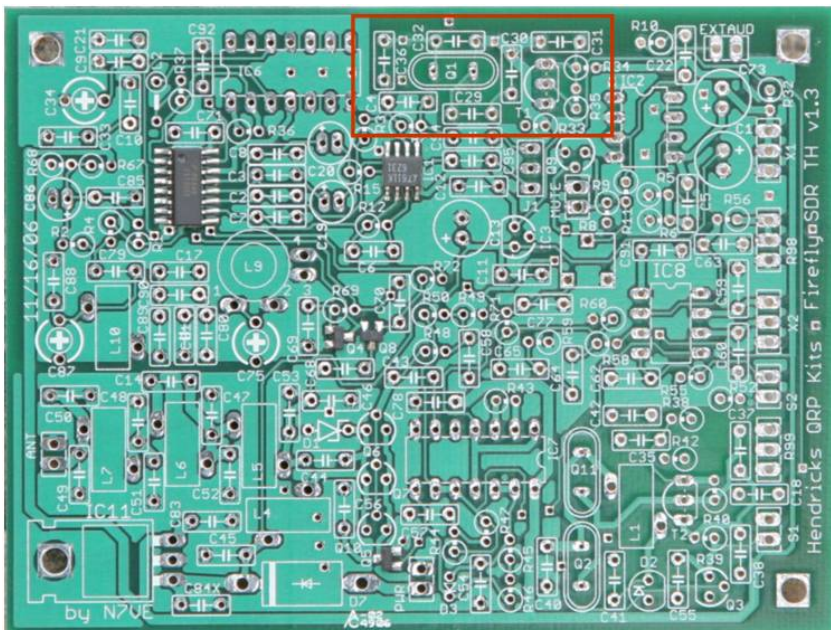


Figure 21. Location of the receiver crystal oscillator circuitry

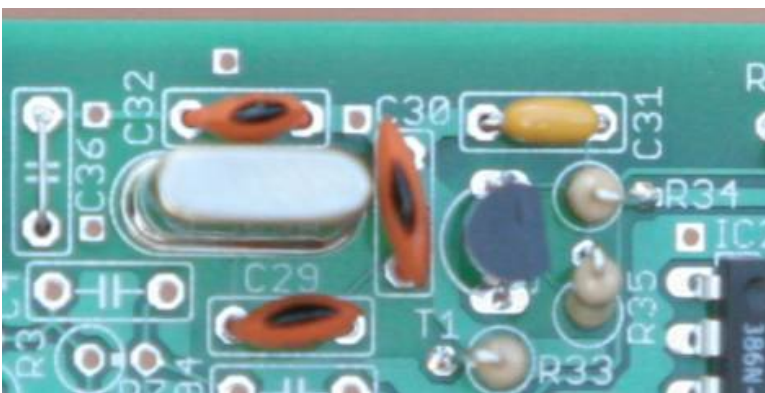


Figure 22. Receiver LO parts mounted

Install 0.1 uf (marked “104”) capacitor: C31

Install 100K resistors: R35 (marked brown-black-yellow-gold)

Install capacitors: C36 (place a short wire across this point), C32 (47 pf disc cap marked “47”)

Install 3.3K resistors: R34 (marked orange-orange-red-gold)

Install 1K resistors: R33 (marked brown-black-red-gold)

Install SS9018: T1. *Make sure the flat side of T1 matches the flat side silk screen marking on the board.*

30m specific parts

Install caps C30 (180 pf disc cap marked “181”) & C29 (100 pf disc cap marked “101”)
Install Q1 10.120 MHz crystal.

20m specific parts

Install caps C30 (150 pf disc cap marked “151”) & C29 (68 pf disc cap marked “68”)
Install Q1 14.065 MHz crystal.

Receiver Side Local Oscillator Test

Connect the 9v battery. After the keyer finishes sending “FB”, the board current draw when connected to the 9v battery will be in the 16 ma range, about 1 ma higher than in the previous current test.

A second test is to listen for the oscillator at either 10.120 (30m) or 14.065 MHz (20) on another receiver. If you have scope, you will see ~2v pk-pk of RF sine wave on the jumper at C36.

Disconnect the 9v battery supply.

90 Degree Phasing Section and LO Buffer

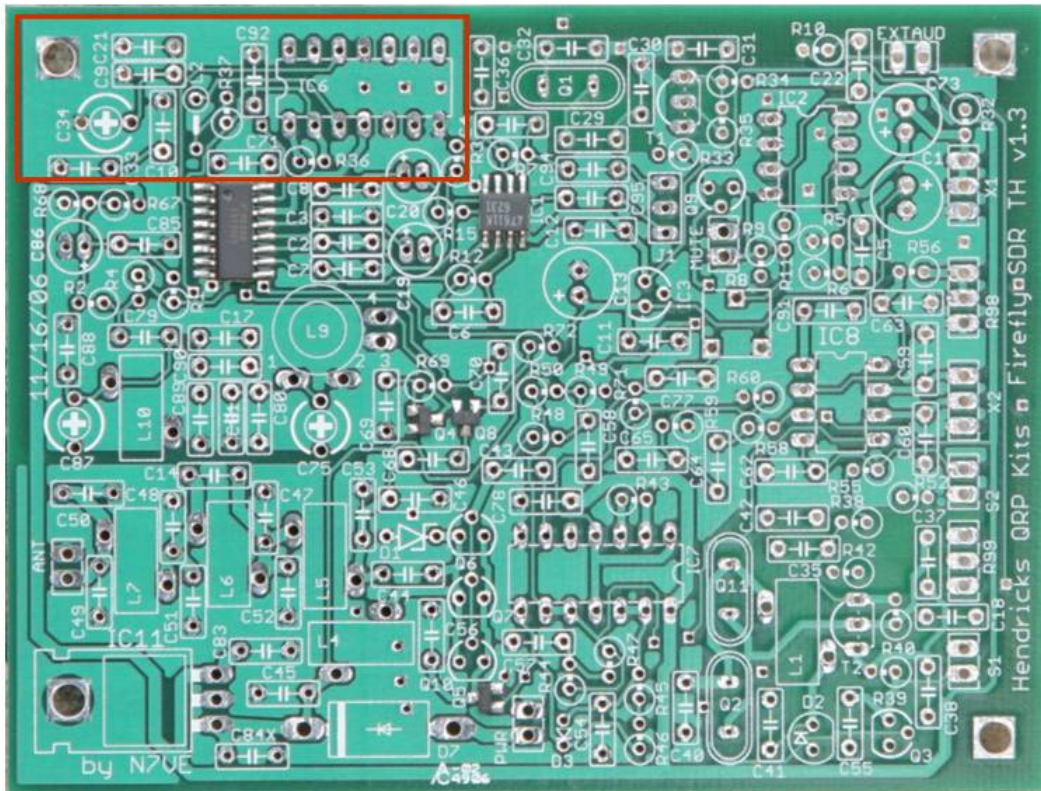


Figure 23. Location of the receiver crystal oscillator circuitry

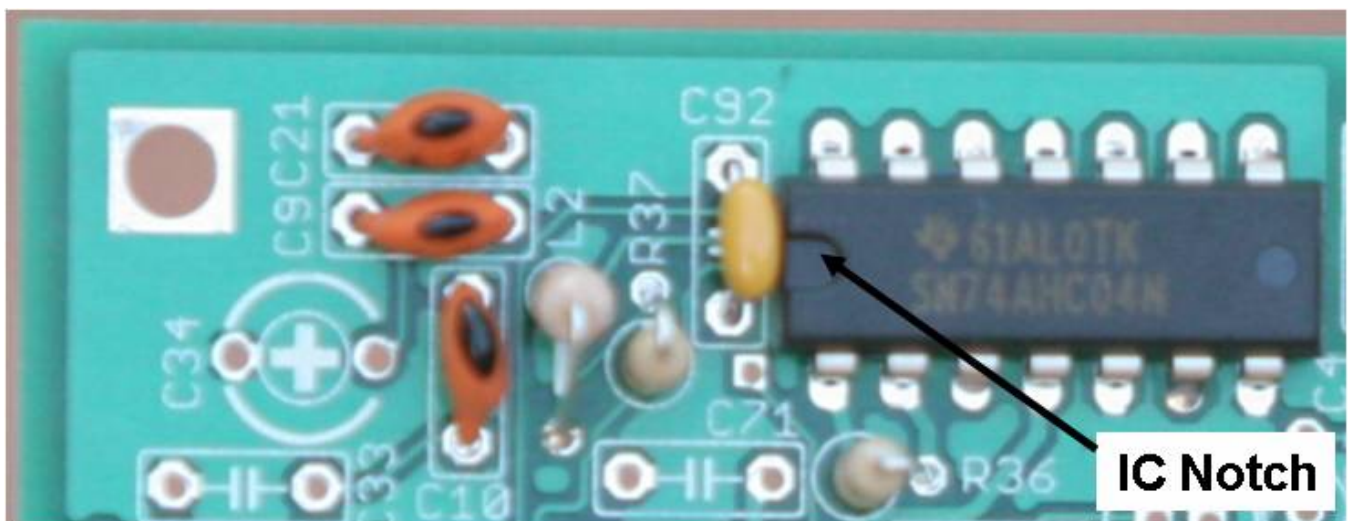


Figure 24. Receiver LO section. Note the notch location on IC6. Note L2 is mounted on end like the resistors.

Install □ IC6 (74AHC04): **Caution! Install with the polarity as shown above! Solder one pin, double check the orientation with the picture above, and then solder the rest of the pins.**

Install resistor: □ R36 (100K marked brown-black-yellow-gold)

Install capacitors: □ C92 (0.1 uf – marked “104”)

Install 1K resistor: □ R37 (marked brown-black-red-gold)

30m specific parts

Install Caps- □ C10 (22 pf disk cap marked “22”), □ C9 & □ C21 (4.7 pf disk cap marked “4.7”)

Install inductor - □ L2, 10 uH molded choke. This looks like a fat resistor in the band specific parts package. Brown-black-black-gold. *Note the inductor is installed standing on end.*

20m specific parts

Install caps □ C10 (27 pf disk cap marked “27”), □ C9 (2.2 pf disk cap marked “2.2”), □ C21 (4.7 pf disk cap marked “4.7”)

Install inductor - □ L2, 4.7 uH molded choke. This looks like a fat resistor in the band specific parts package. Yellow-violet-gold-gold. *Note the inductor is installed standing on end.*

90 Degree Phasing Section and LO Buffer Tests

Connect the 9v battery. After the keyer finishes sending “FB”, the board current draw when connected to the 9v battery will be in the 24 ma range.

Disconnect the 9v battery supply.

Detector Circuit

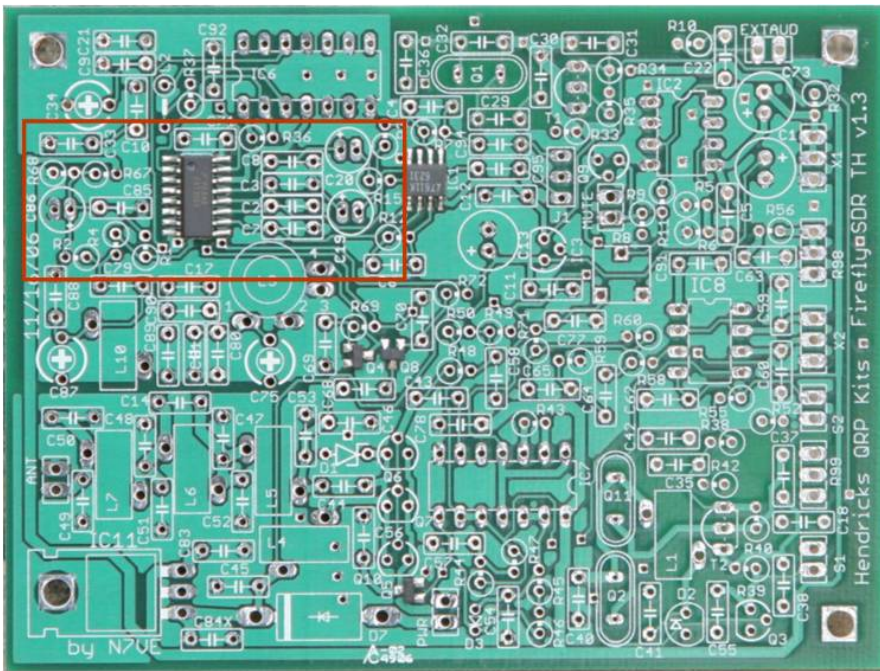


Figure 25. Location of the detector circuit

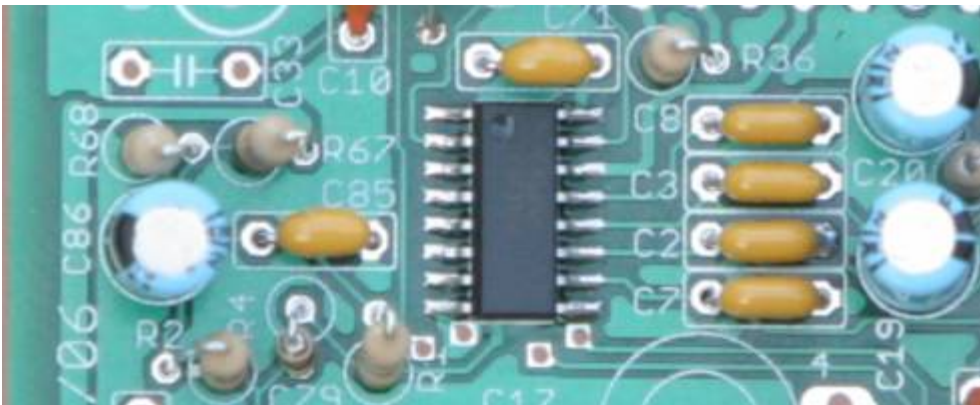


Figure 26. View of installed detector. Make sure C19, C20 and C86 are installed as shown

Install resistors: □ R4 (18 ohms –brown-grey-black-gold), □ R1 and □ R2 (300 ohms - marked orange-black-brown-gold)

Install 0.1 uf (marked “104”) capacitors: □ C71, □ C85

Install 0.01 uf (marked “103”) capacitors: □ C2, □ C3, □ C7, & □ C8

Install capacitor: □ C19, □ C20, and □ C86 22 uf. **Caution! Install with black stripe as shown above!**

Install resistors: □ R67 & □ R68 (3.3K – orange-orange-red-gold)

Detector Circuit Tests

No tests at this time. The pre-installed IC1 will disturb any measurements in this stage until the pre-amp stage is completed in the next section.

Receiver Audio Preamp

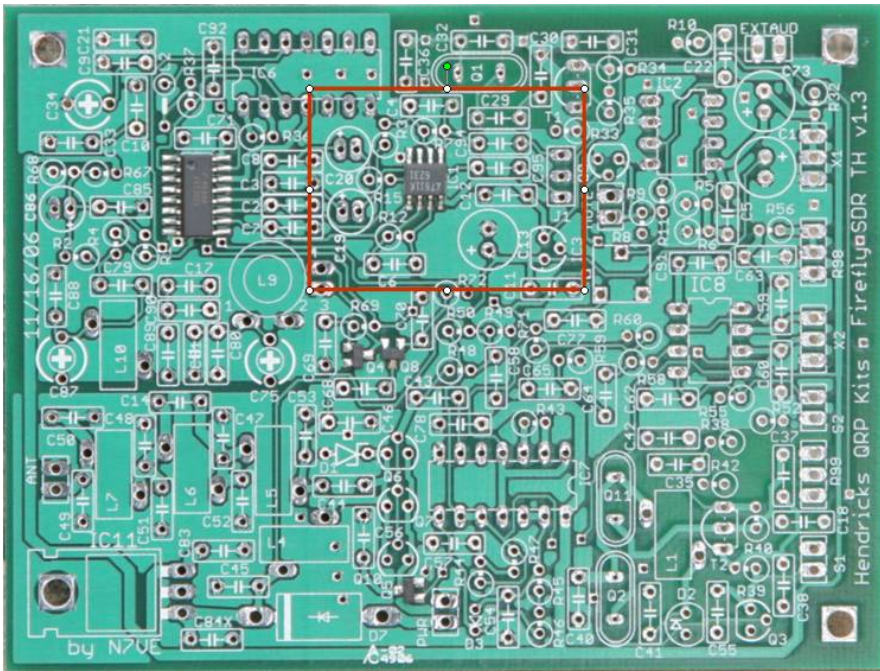


Figure 27. Top placement of receiver audio preamp stage

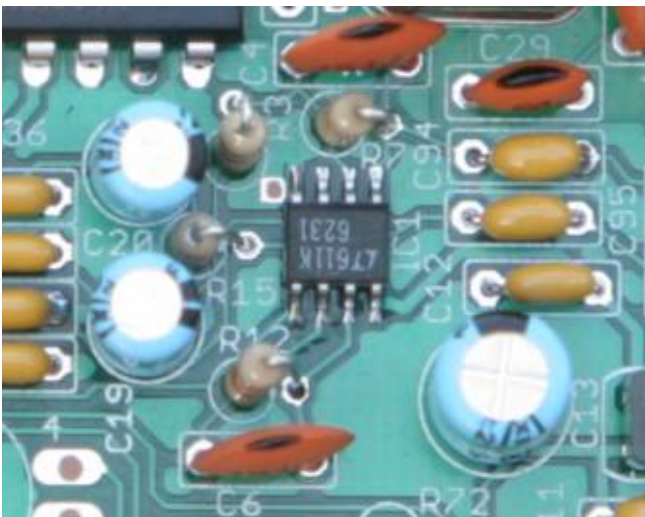


Figure 28. Close up of the parts in the audio preamp stage.

Install capacitors: C4, C6 (150 pf disc caps marked “151”)

Install capacitors: C94, C95 (0.1 uf – marked “104”)

Install resistors: R3, R15 (100 ohms – marked brown-black-brown-gold)

Install resistors: R7, R12 (33k ohm – marked orange-orange-orange-gold)

Receiver Audio Preamp and Detector Tests

Connect the 9v battery. After the keyer finishes sending “FB”, the board current draw when connected to the 9v battery will be in the 27 to 28 ma range.

Measure the voltage at either end of R4 in the detection circuit. Again, the ground reference for this test is the tab of the large 78M05 voltage regulator. The measured voltage should be in the 2.5v range. This test makes sure that the input voltage divider works.

Measure the voltage across the four detection caps C2, C3, C7, and C8. If the detector is running correctly, the voltage at each of these points should be the same as seen across R4 above, 2.5v.

Measure the voltage at the IC1 end of C94 and C95. Again, the ground reference for this test is the tab of the large 78M05 voltage regulator or one of the four corner mounting holes. The measured voltage should be close to 2.5v.

Disconnect the 9v battery supply.

Receiver Front End and T/R Switch

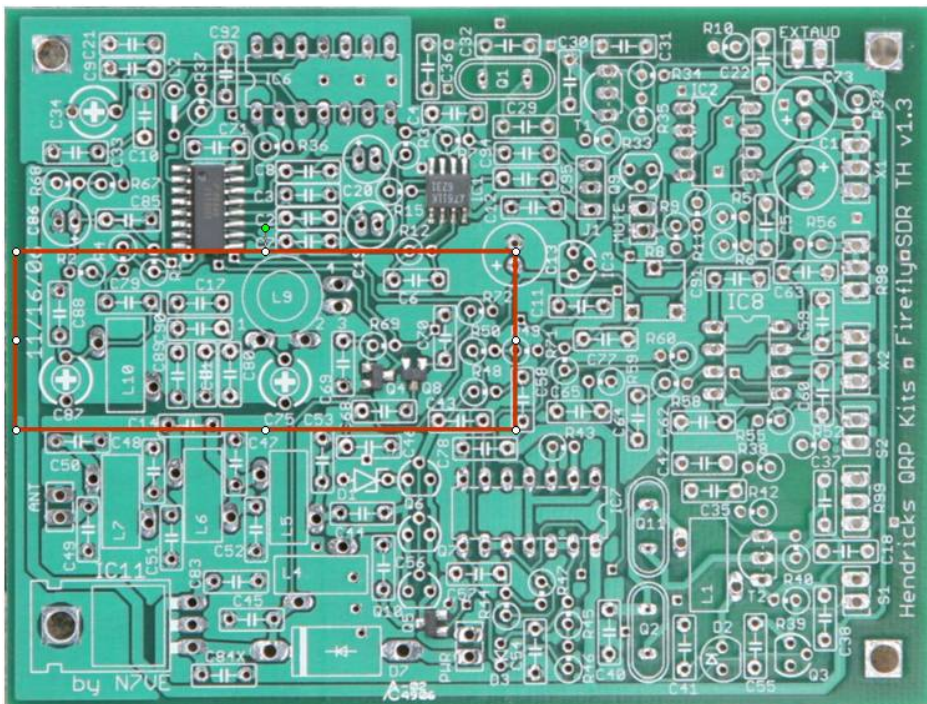


Figure 29. Top placement of receiver front end and T/R switch



Figure 30. Close up of receiver front end and T/R switch

Install capacitors: □ C68 (0.1 uf – marked “104”)

Install capacitors: □ C69 & □ C70 (0.01 uf - marked “103”)

Install resistor: □ R69 and □ R72 (3.3K – orange-orange-red-gold)

Install trimmer caps: □ C87, □ C75 50 pf trim cap. **Caution! Install flat side of trim caps as shown. These caps must have the right orientation or it will affect tune up (flat side hot end, rounded ground end).**

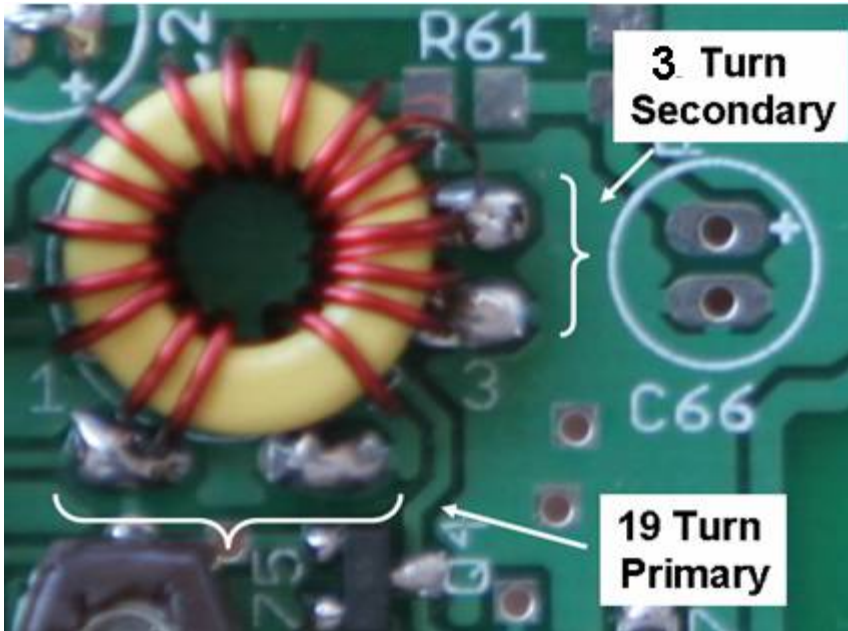


Figure 31. Close up of input receiver filter inductor L9. 30m values shown. For other bands see text.

The wire used in this kit is especially designed to be easy to strip using heat. Place some excess solder on the tip of your soldering iron (“solder blob”). Place the end of the cut wire into the blob, and the insulation will burn off. Work the iron down the wire to strip off as much insulation as needed, refreshing the solder blob as needed.

30m specific parts

Install caps: □ C80 (180 pf disc cap marked “181”), □ C79 (47 pf disc cap marked “47”)

Install caps: □ C89 (150 pf disc cap marked “151”), □ C90 (4.7 pf disc cap marked “4.7”), □ C17 (2.2 pf disc cap marked “2.2”)

Install □ L9 - T37-6 yellow core, 19T # 26 primary, 3T #32 secondary. Use 10” of #26 wire (the larger diameter wire supplied in the kit) for the primary, 4” of #32 (the very fine diameter wire supplied) for the secondary.

Install □ L10 - T37-6 yellow core, 18T # 26. Use 10” of #26 wire (the larger diameter wire supplied in the kit) for the primary.

20m specific parts

Install caps: C80 (120 pf disc cap marked “121”), C79 (33 pf disc cap marked “33”)

Install caps: C89 (100 pf disc cap marked “101”), C90 (4.7 pf disc cap marked “4.7”)

Install L9 - T37-6 yellow core, 16T # 26 primary, 3T #32 secondary. Use 10” of #26 wire (the larger diameter wire supplied in the kit) for the primary, 4” of #32 (the very fine diameter wire supplied) for the secondary.

Install L10 - T37-6 yellow core, 15T # 26. Use 10” of #26 wire (the larger diameter wire supplied in the kit) for the primary.

Receiver Front End and T/R Tests

Connect the 9v battery. After the keyer finishes sending “FB”, the board current draw when connected to the 9v battery will be in the 27 ma range. The current drain should not have changed from the current drain measured in the previous section.

.There is not much that can be tested in this stage at this point. The drivers for the T/R switching transistors will not be installed until later. In past projects, there have been a lot of problems with the enamel wire on the inductors not being properly stripped before the inductors are installed. One simple test is to place an ohm meter across the PC board pads of L9 (two pads) and L10 (four pads) to ground (the tab of the 5v regulator) to make sure the inductor leads had been properly stripped and installed.

Disconnect the 9v battery supply.

Transmitter VXO

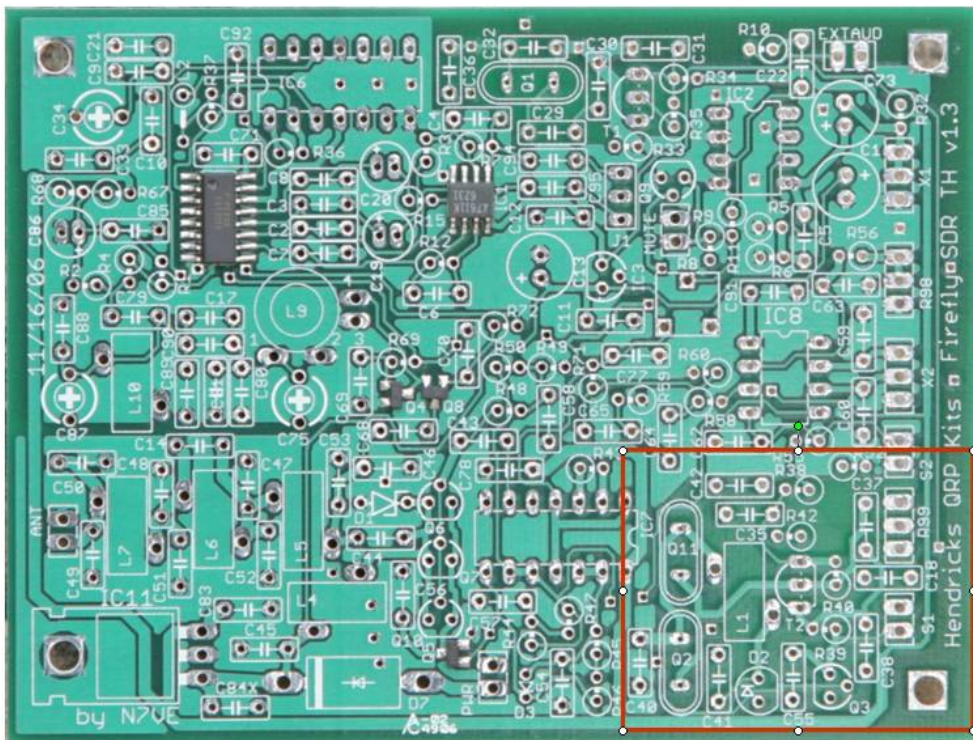


Figure 32. Location of the transmitter VXO

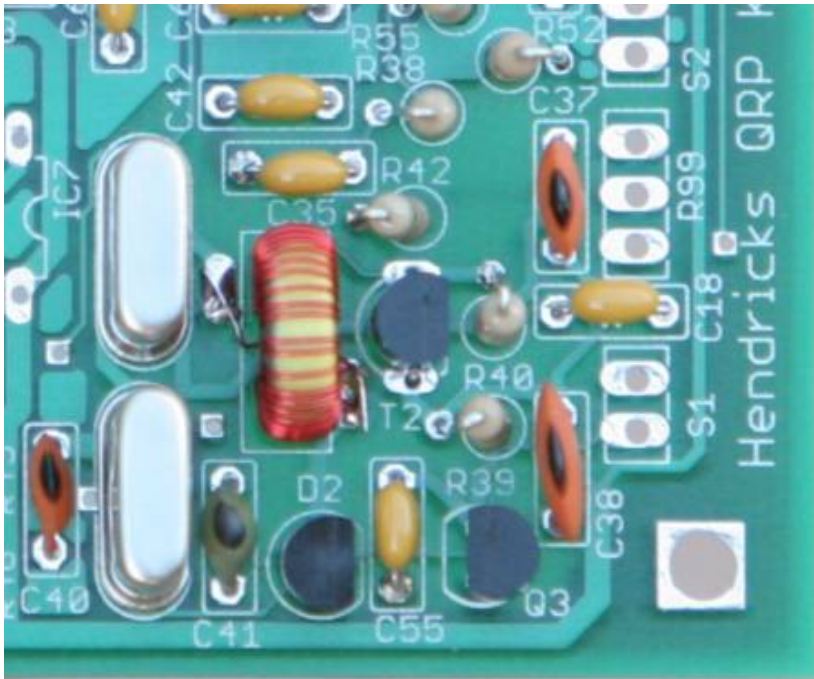


Figure 33. Close up of installed transmitter VXO parts

Install transistors: T2 (SS9018), Q3 (BS170) **Caution! Install with the polarity as shown above!**
The flat side of T2 and Q3 match the flat side on the silkscreen outline.

Install capacitors: C18, C35, C55 & C42 (0.1 uf – marked “104”), C40 (22 pf disc cap marked “22”), C41 (5 pf disc cap marked “5”)

Install resistors: R39 & R52 (1K – brown-black-red-gold), R40 and R42 (100K – brown-black-yellow-gold), R38 (3.3K – orange-orange-red-gold)

Install varicap tuning diode: D2 (MV209). **Caution! Install with the polarity as shown above!** **The flat side of D2 matches the flat side on the silkscreen outline.**

Note: L1 below needs to be wound with the turns snug to the core. Do not use too much tension as the fine wire will break. However, the windings snug against the core is done as a precaution to improve temperature stability of the VXO.

30m specific parts

Install capacitors: C37 (100 pf disk marked “101”), C38 (180 pf disk marked “181”)

Install inductor: L1 - T37-6 yellow core, 56T #32. Use the #32 wire (the very fine diameter wire supplied).

Install crystals: Q2, Q11 (10.120 MHz)

20m specific parts

Bottom side – Install capacitors: C37 (68 pf disk marked “68”), C38 (150 pf disk marked “151”)

Install inductor: L1 - T37-6 yellow core, 40T #32. Use the #32 wire (the very fine diameter wire supplied).

Install crystals: Q2, Q11 (14.065 MHz)

Note: L1 needs to be coated with clear fingernail polish to both seal the windings to the core and seal the core to the board. Not all clear fingernail polishes dry hard. My wife recommends Sally Hansen Diamond Strength (source: Ulta). It seems to work very well. Sealing windings to the core improves the temperature stability of this oscillator.

Transmitter VXO Tests

Connect the 9v battery. After the keyer finishes sending “FB”, the board current draw when connected to the 9v battery will be in the 27 ma range. The current drain should not have changed from the current drain measured in the previous section. Shorting S1 (TX VXO spot switch) should see the current drain increase by another 1 ma.

At this point in time, there will be no voltage across D2, the varactor tuning diode, so the VXO will be tuned to a very low frequency. Thus you can verify that the VXO is oscillating by listening for the

transmit VXO as the jumper header S1 is shorted. On the 30m version, the VXO frequency might end up being lower than 10.1 MHz.

If you have a scope, at the C41 – D2 junction (the board edge side of C41), you should see ~2v pk-pk of VXO RF when the spot switch S1 is shorted.

Disconnect the 9v battery supply.

Transmitter Buffer Circuit

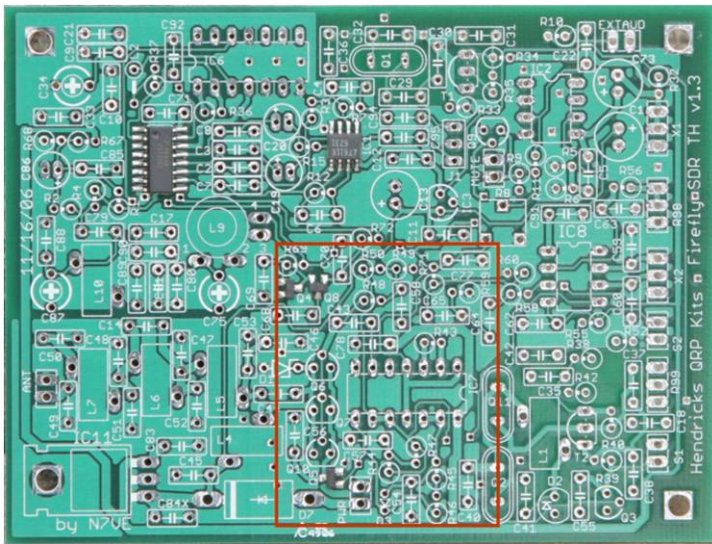


Figure 34. Location of the TX Buffer circuit

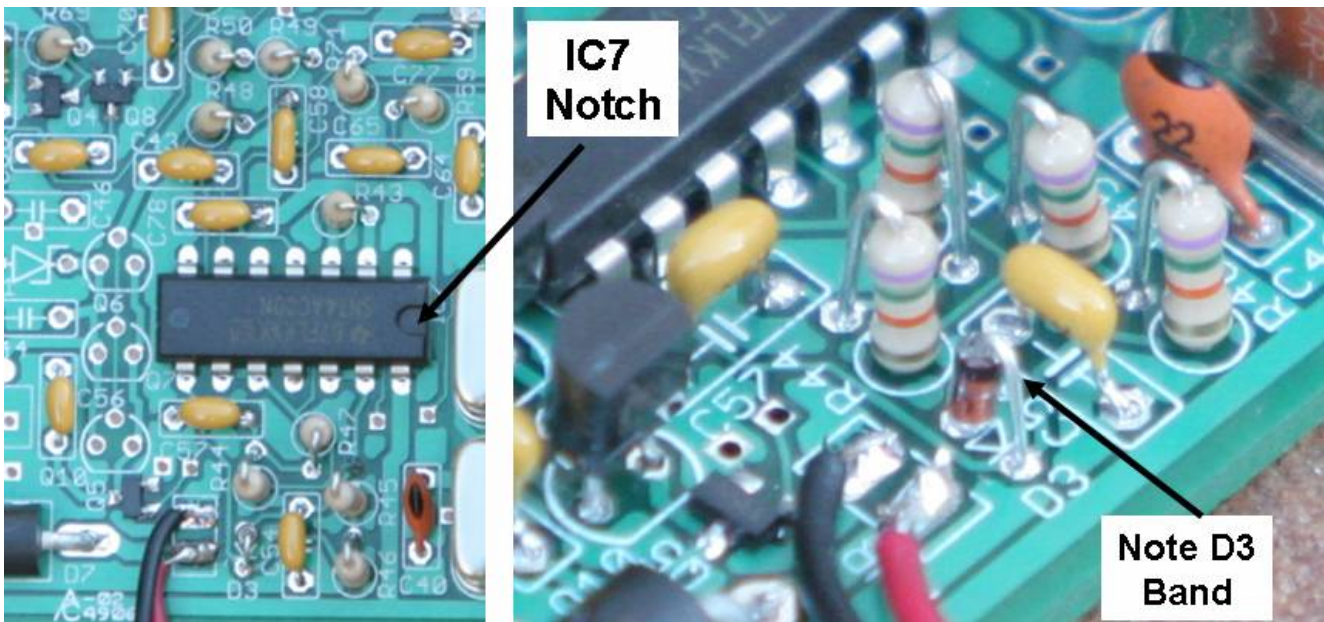


Figure 35. TX buffer parts installed. IC7 notch location, close up of D3 orientation shown.

Install IC: □ IC7 (74AC00) **Caution! Install with the polarity as shown above! I have hooked this up backwards and it fries the IC! Solder one pin, double check the orientation with the picture above, and then solder the rest of the pins.**

Install resistor: □ R43 (100K – brown-black-yellow-gold), □ R50 (47K ohm – yellow-violet-orange-gold), □ R48 (8.2K ohm – grey-red-red-gold)

Install resistors: □ R45, □ R46, □ R44, □ R47, □ R49 (75K ohm – violet-green-orange-gold)

Install diode: □ D3 (1N4148). **Caution! There are two glass diodes, one is a Zener diode! The slightly thinner one is marked “41 48”. Use this one! Double check!**

Install capacitors: □ C54, □ C78, □ C43, □ C56, □ C57 (0.1 uf – marked “104”)

Install capacitors: □ C58 (0.01 uf – marked “103”)

Transmitter Buffer and T/R Switch Tests

Connect the 9v battery. After the keyer finishes sending “FB”, the board current draw when connected to the 9v battery will be in the 27-28 ma range. The buffer stage draws basically no additional current when not transmitting.

If you can send dot-dash five times in a row (both paddles closed), this will cause the keyer to go into “key down” and the current draw increases to ~108 ma.

At this point, the drivers for the T/R switch have been put into place so that the T/R switch can now be tested. Refer to the figure below:

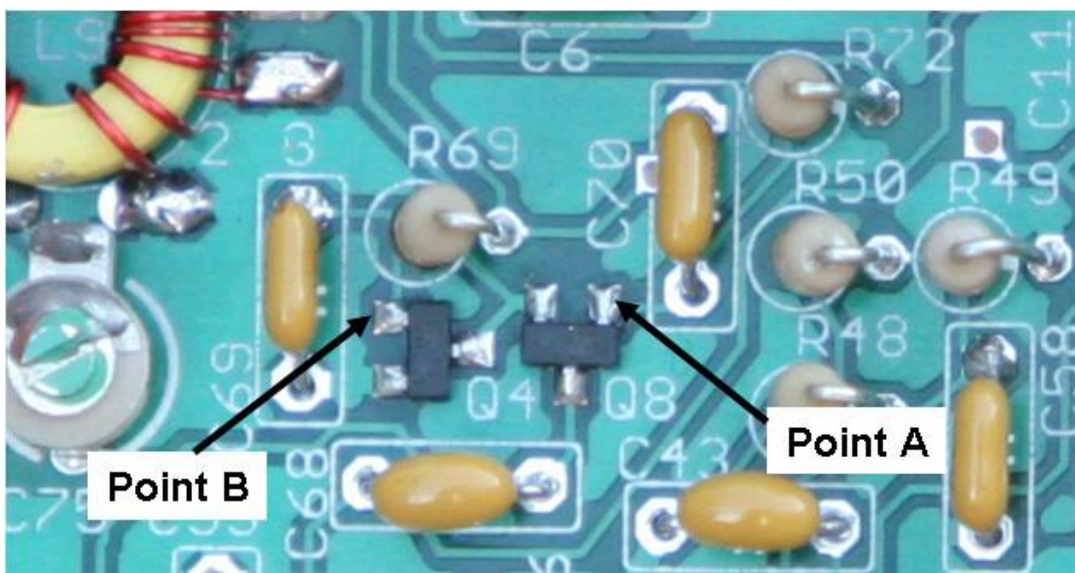


Figure 36. Test points for the T/R switch in the receiver front end

With the board powered up in receive mode, **point A should be 5v**, and **point B should be 0v** or at least less than 1v. When in transmit mode, these readings should flip: point A 1v or less and point B at 5v. The T/R transition can be tested by shorting the keyer paddle inputs as shown in the diagram below:

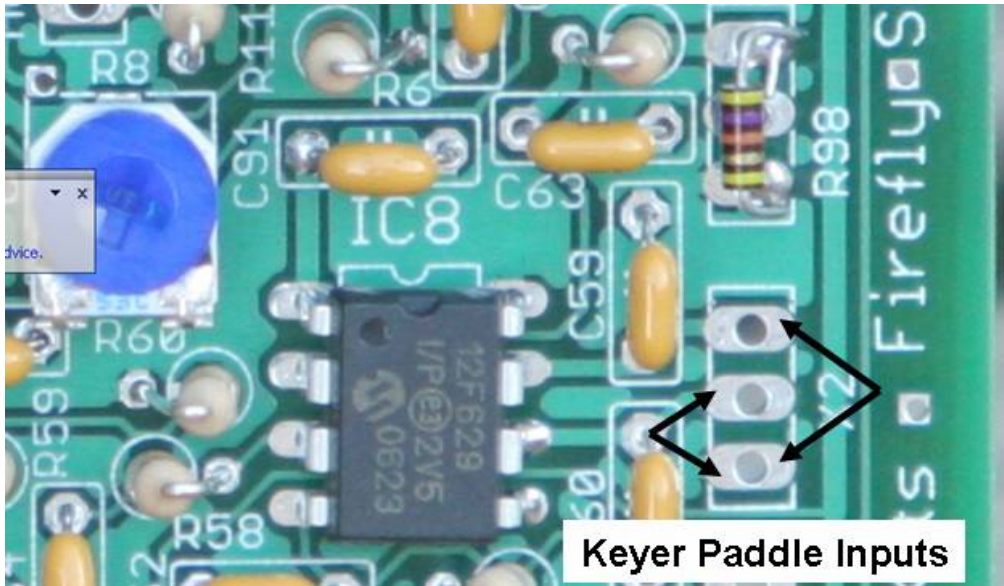


Figure 37. Location of keyer paddle inputs to test the T/R switch

I typically use my pointed tweezers to temporarily short the paddle inputs for a quick test.

Disconnect the 9v battery supply.

Transmitter PA Circuit

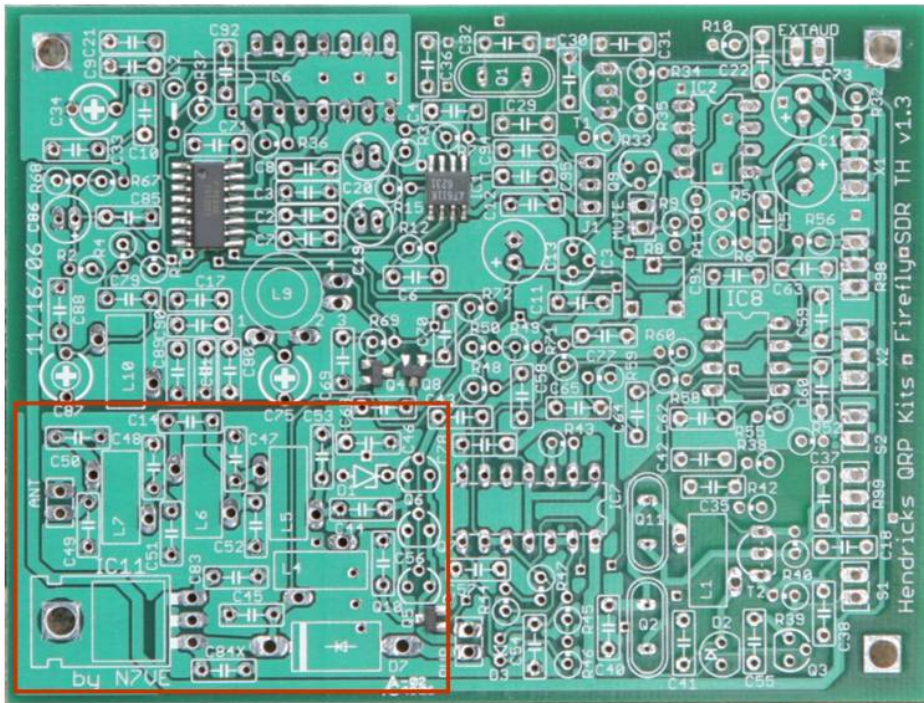


Figure 38. View of the PA circuit

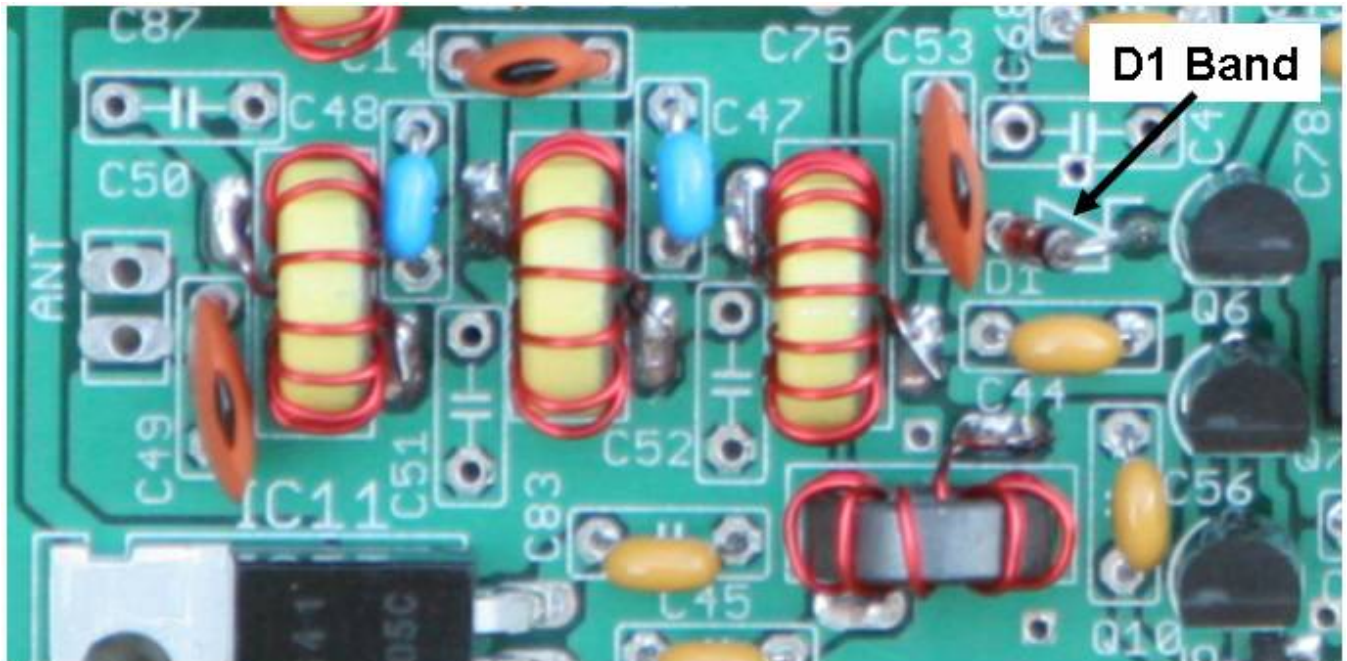


Figure 39. View of the PA circuit. Note band orientation of D1.

Install diode: D1 (1N5262B 51v Zener Diode – Glass diode). *Double check band orientation (see above)! Double check this is not a 1N4148! Stand diode up on end like the resistors.*

Install transistors: Q6, Q7, and Q10 (BS170). *Double check flat side transistor orientation in above figures!*

Install capacitors: C44 (0.1 uf – marked “104”), C14 (47 pf – marked “47”)

30m specific parts

Install capacitor: C47 & C48 (470 pf disk “471”), C49 & C53 (180 pf disk “181”)

Note: make sure the windings on the following inductor are evenly spaced over the entire core!

Install inductors: L5 & L7 - T37-6 (yellow core) 16T #26 - 10” of wire

Install inductors: L6 - T37-6 (yellow core) 18T #26 - 10” of wire

Install inductors: L4 - FT37-43 (dark core) 10T #26 - 10” of wire

20m specific parts

Install capacitor: C47 & C48 (330 pf – “331”), C53 & C49 (150 pf – “151”), C14 (47 pf disc cap - “47”)

Note: make sure the windings on the following inductor are evenly spaced over the entire core!

Install inductors: L5 & L7 - T37-6 (yellow core) 13T #26 - 10” of wire

Install inductors: L6 - T37-6 (yellow core) 14T #26 - 10” of wire

Install inductors: L4 - FT37-43 (dark core) 8T #26 - 10” of wire

Transmitter PA Tests

Connect the 9v battery. After the keyer finishes sending “FB”, the board current draw when connected to the 9v battery will be in the 33 to 35 ma range.

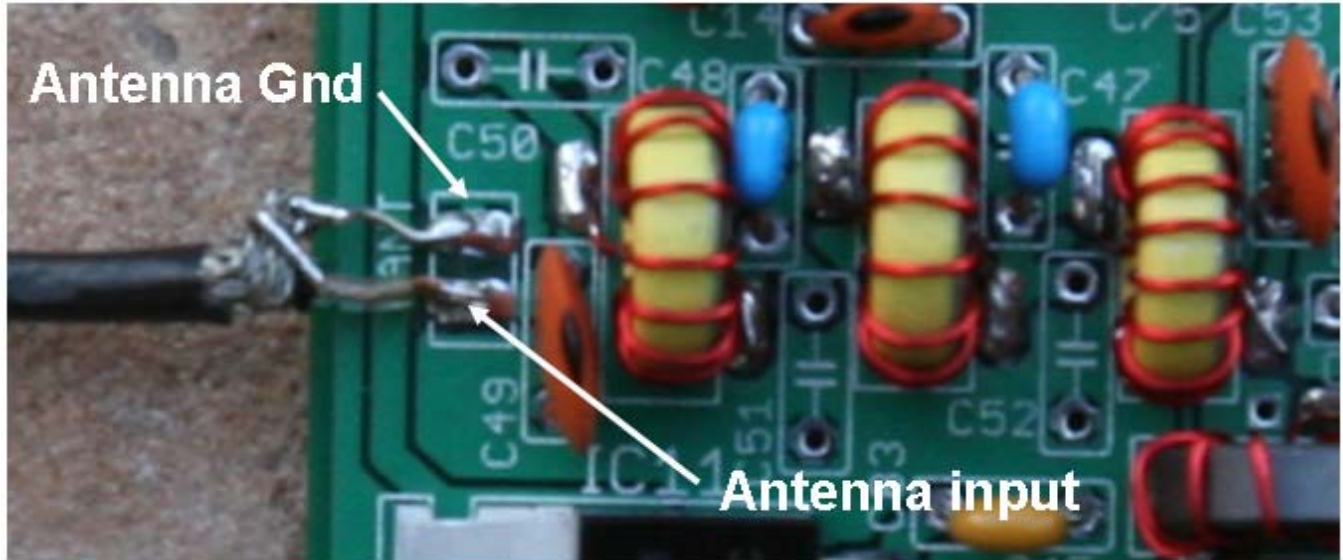


Figure 40. Antenna coax connection to transceiver. Upper connection is ground, lower is antenna.

Connect a coax to the board and connect the transceiver to a 50 ohm load. Switch the 9v battery for a more stout 12v power source. Keying the transmitter as in the previous section should produce a 3w to 3.5w output.

Board Connections

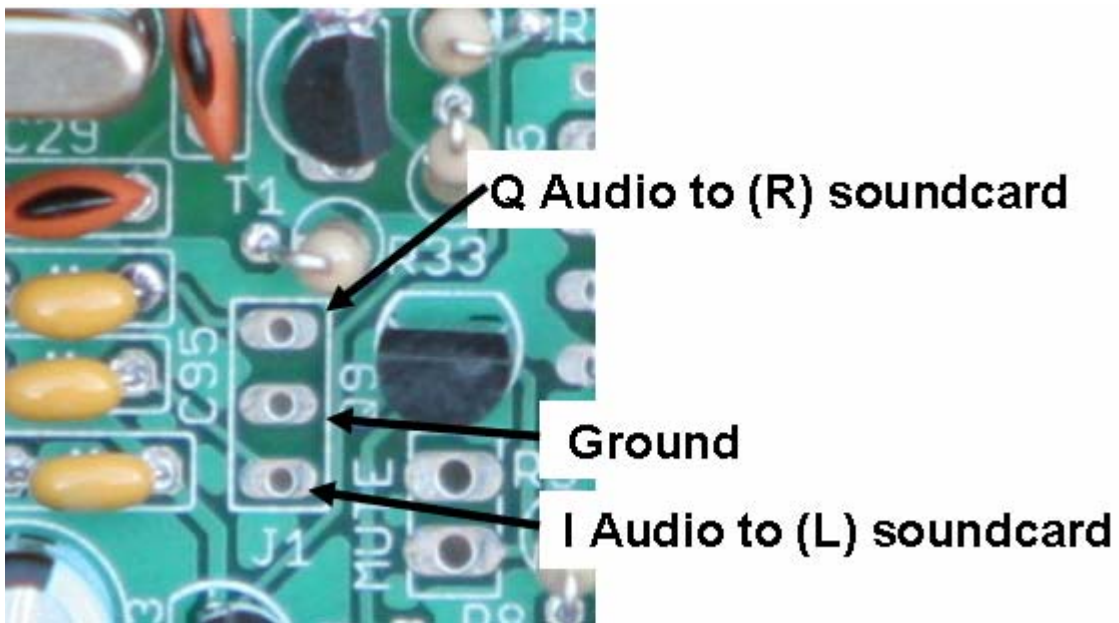


Figure 41. Connections for J1, I/Q (R/L) audio output to the PC sound card input

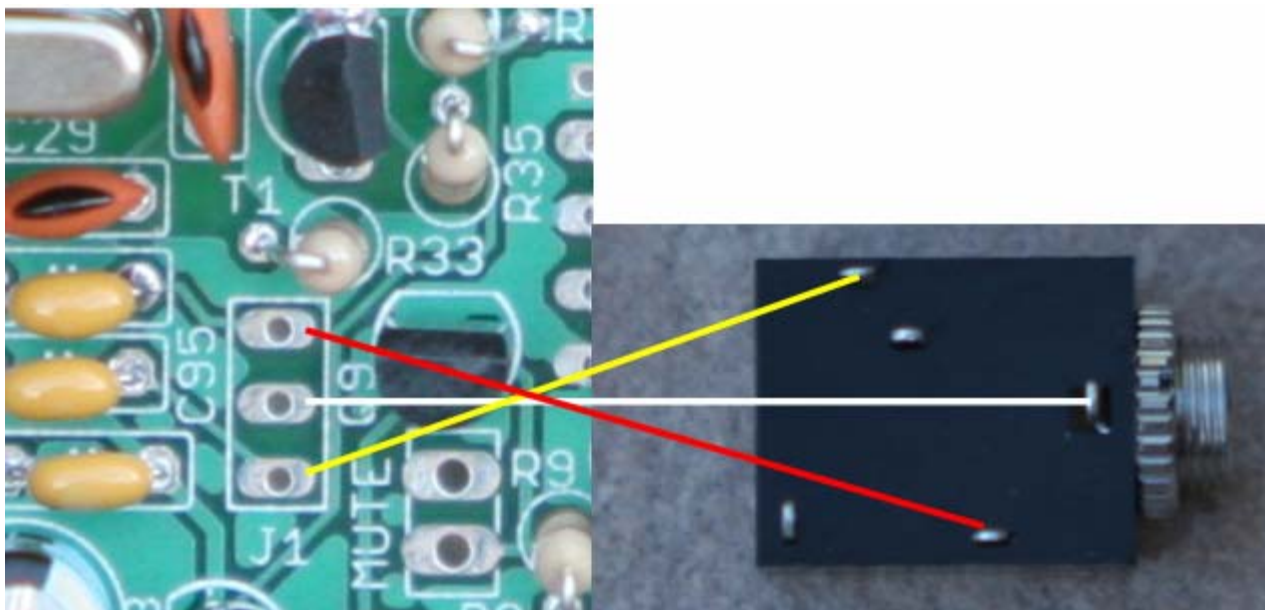


Figure 42. Connections of the I/Q audio output to its audio jack

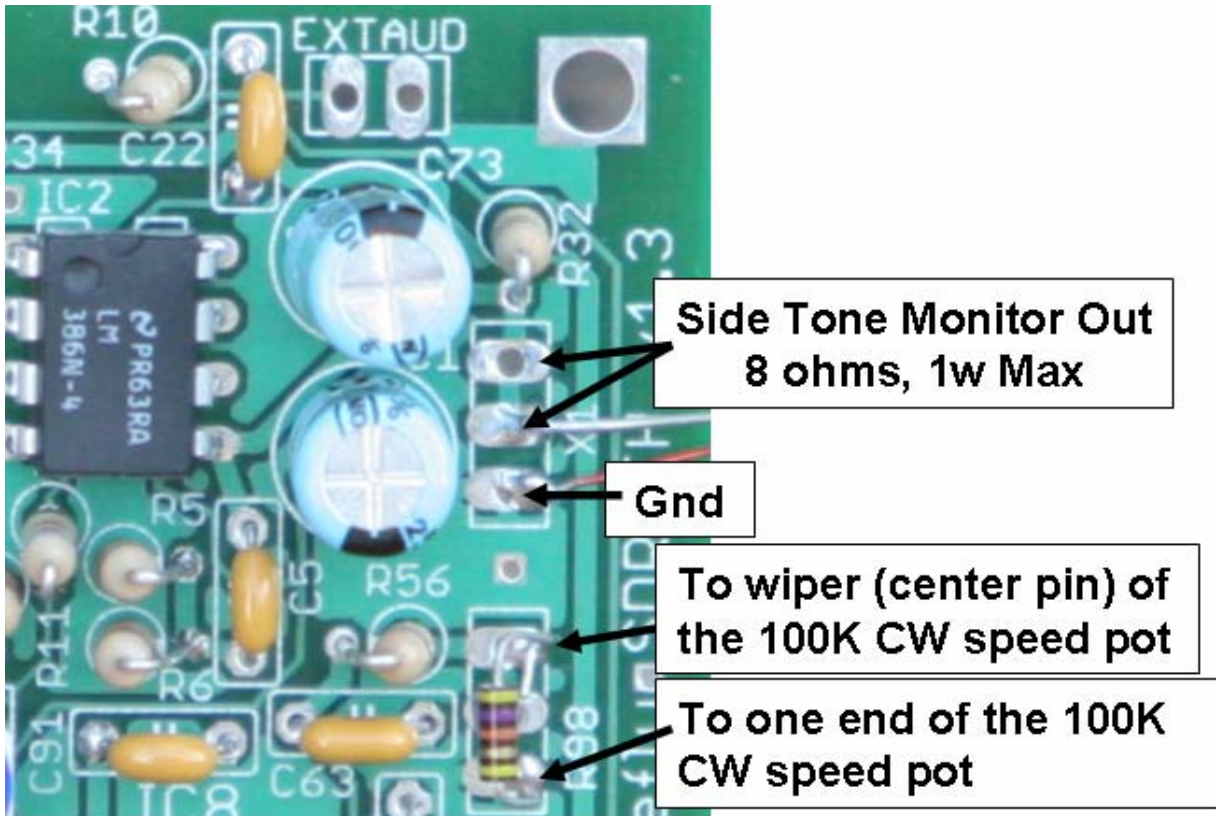


Figure 43. Connections for X1 and R98, CW side tone monitor speaker and 100K CW speed pot.

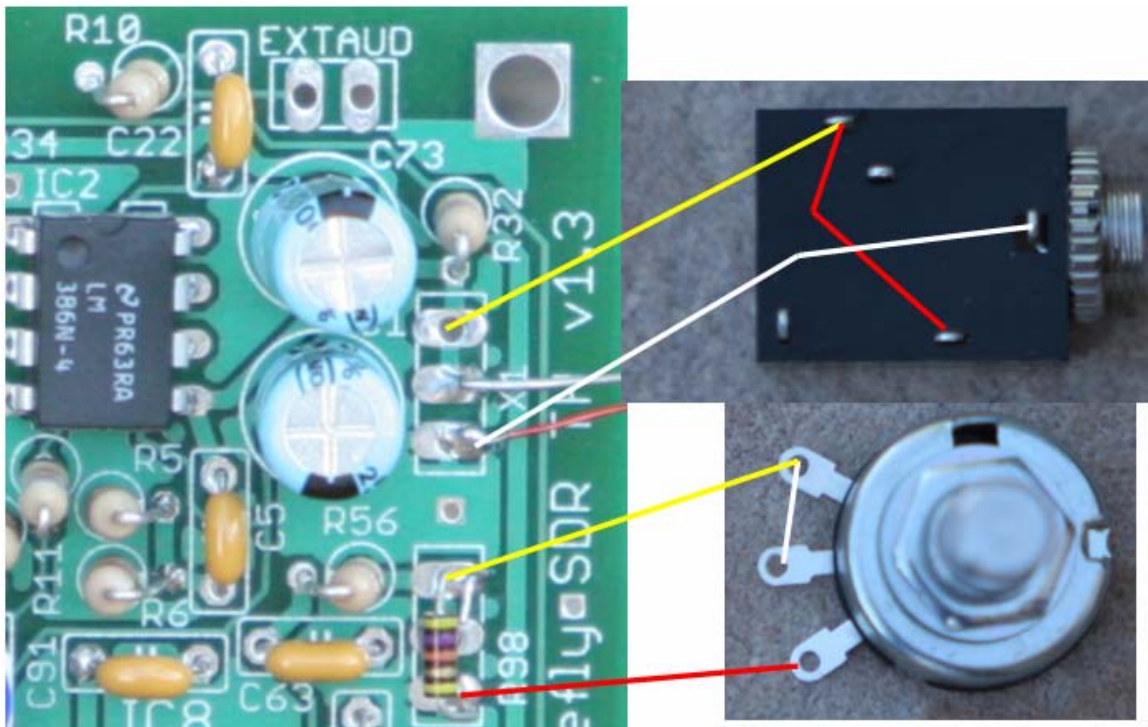


Figure 44. Connections to CW mon speaker jack, CW speed pot. Remove temporary resistor across R98.

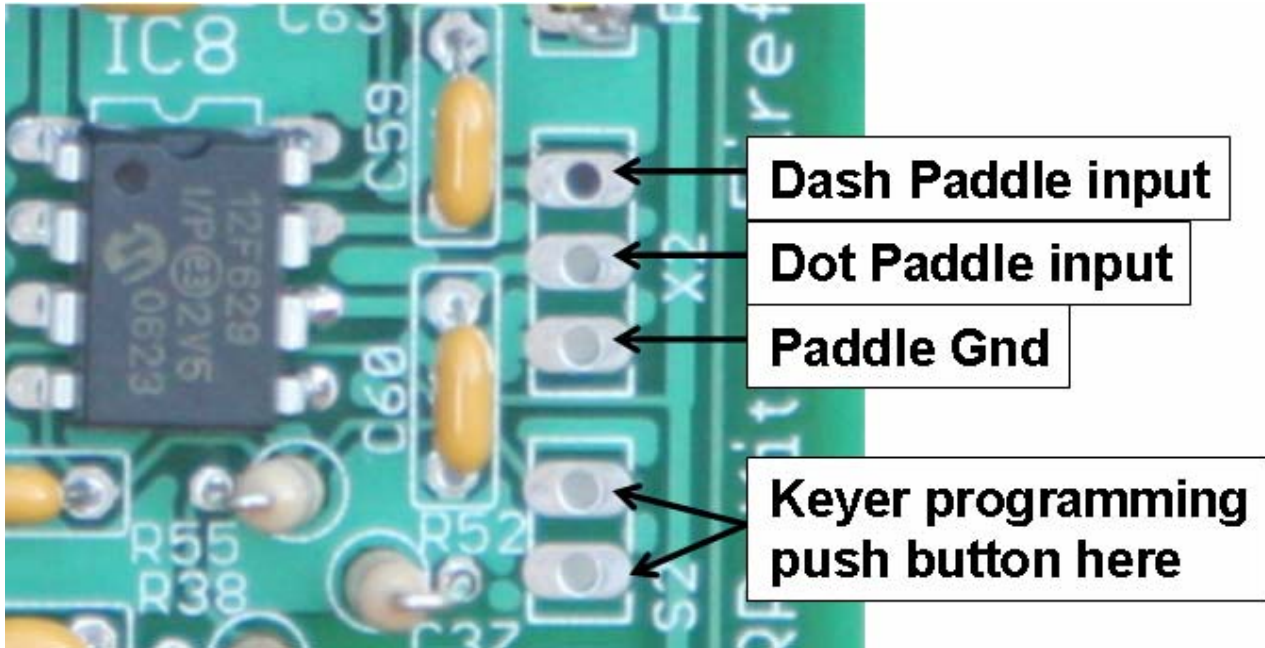


Figure 45. Connections for keyer paddle inputs (X2) and for keyer programming push button switch (S2)

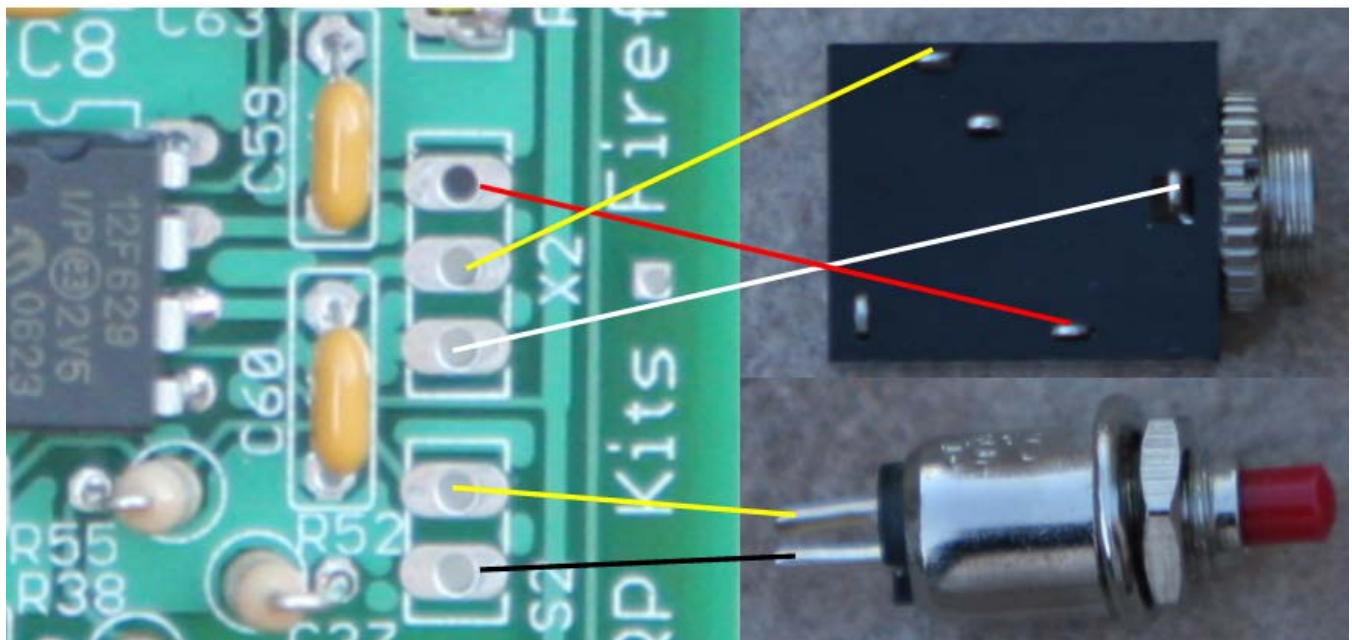


Figure 46. Visualization of paddle jack and keyer programming switch connections

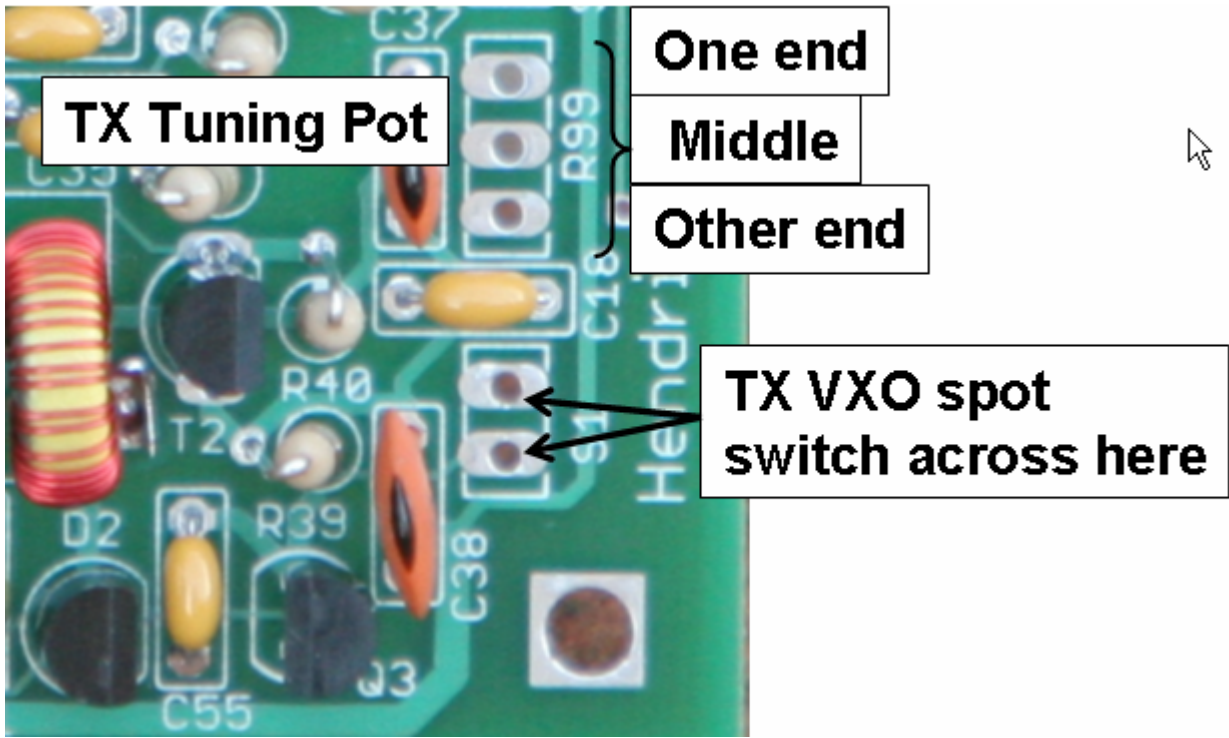


Figure 47. Connections for TX spot switch (S1) and TX VXO 10K tuning pot (R99).

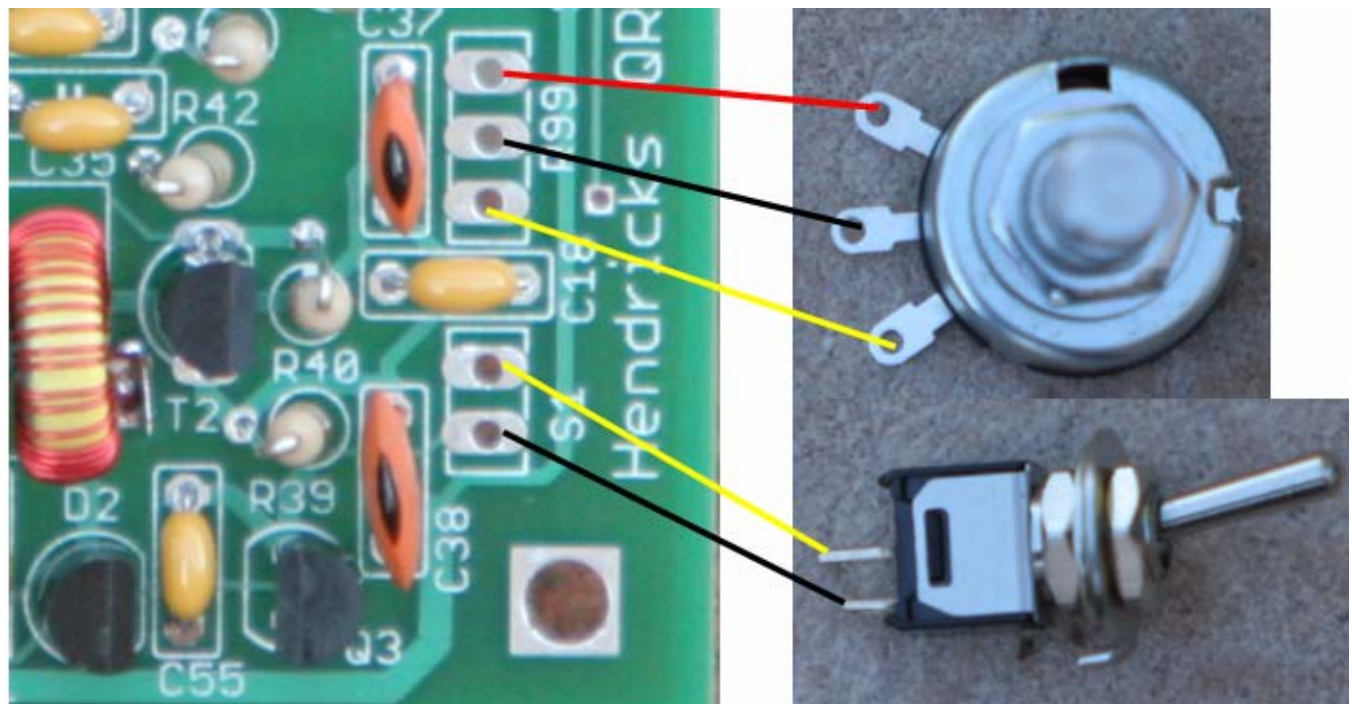


Figure 48. Visualization of TX tuning pot and VXO spot switch connections. Switch shown "Spot On".

One option of the kit is to take the PC audio output (SDR radio signal outputs) and feed it back into the CW side tone monitor amplifier. This allows the PC SDR receiver output and the TX side tone to be mixed together to create a single signal for use with headphones. The connections are shown below:

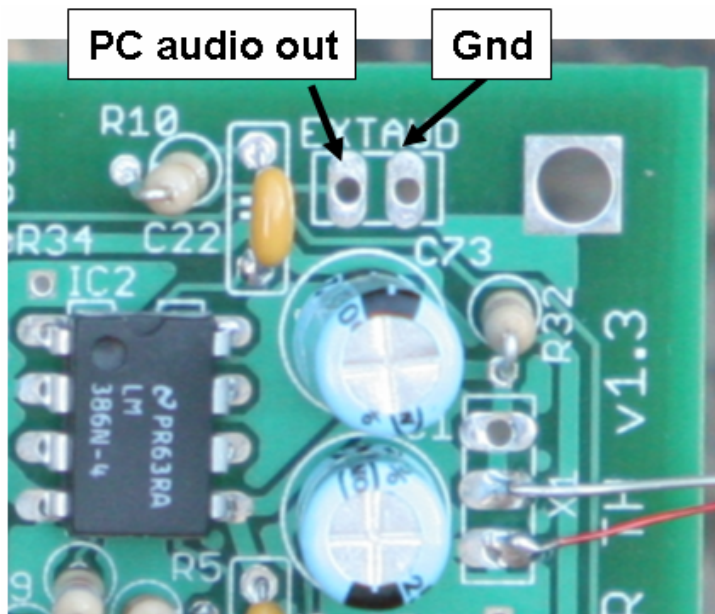


Figure 49. Ext Audio connector. Connection to PC audio output.

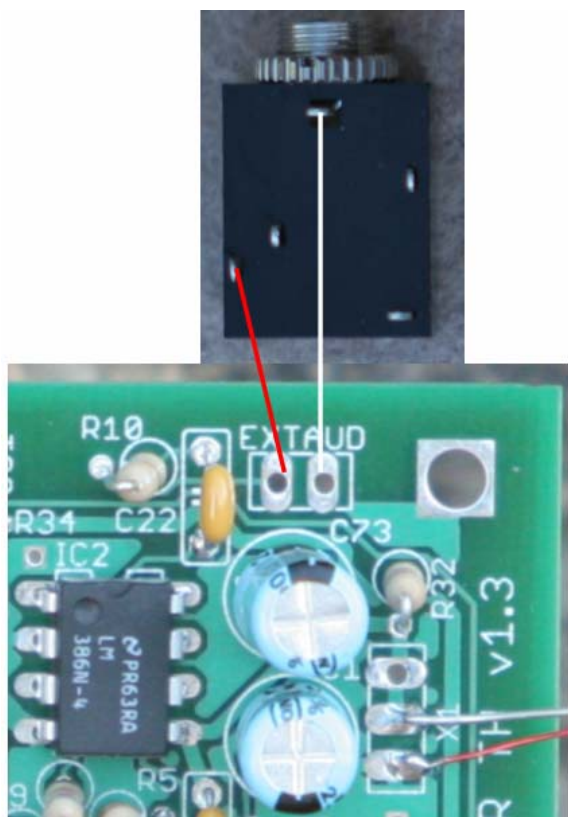


Figure 50. Visualization of the optional connection to the PC audio output. Mono input only.

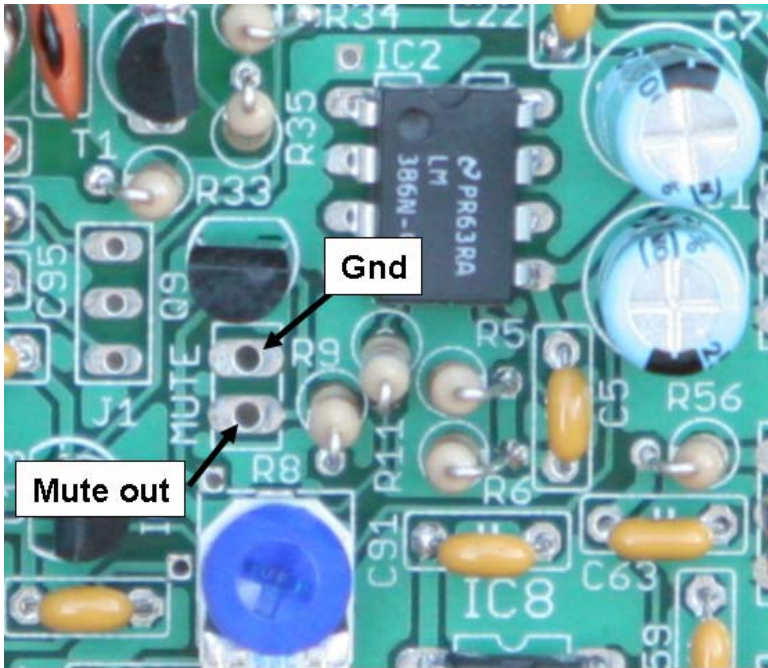


Figure 51. Optional mute output signal (0v = mute, 5v = normal).

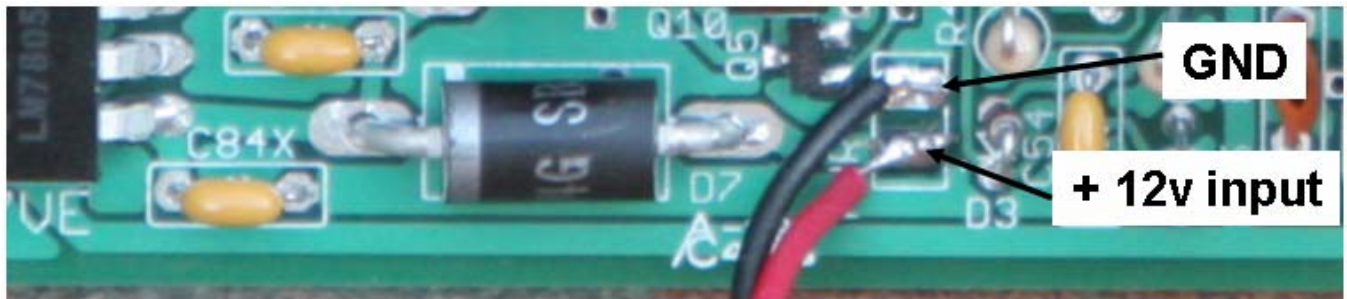


Figure 52. Connections for 12v to the board

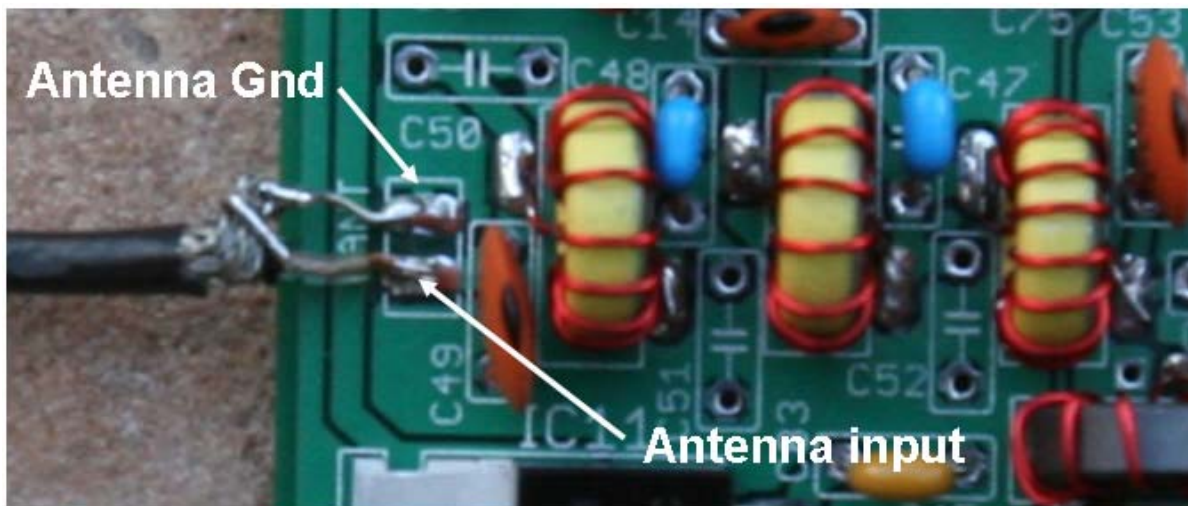


Figure 53. Antenna Connections

System Connection Block Diagram



Figure 54. External connections from a case view

The above picture shows the transceiver mounted in a case in a configuration that does not mix the PC audio back into the CW side tone amplifier. Thus, in the above configuration, the SDR receiver output comes out of the PC speakers (not shown above), and the cw sidetone comes out of the separate cw side tone monitor speaker.

This configuration is shown in pictorial representation in the following diagram:

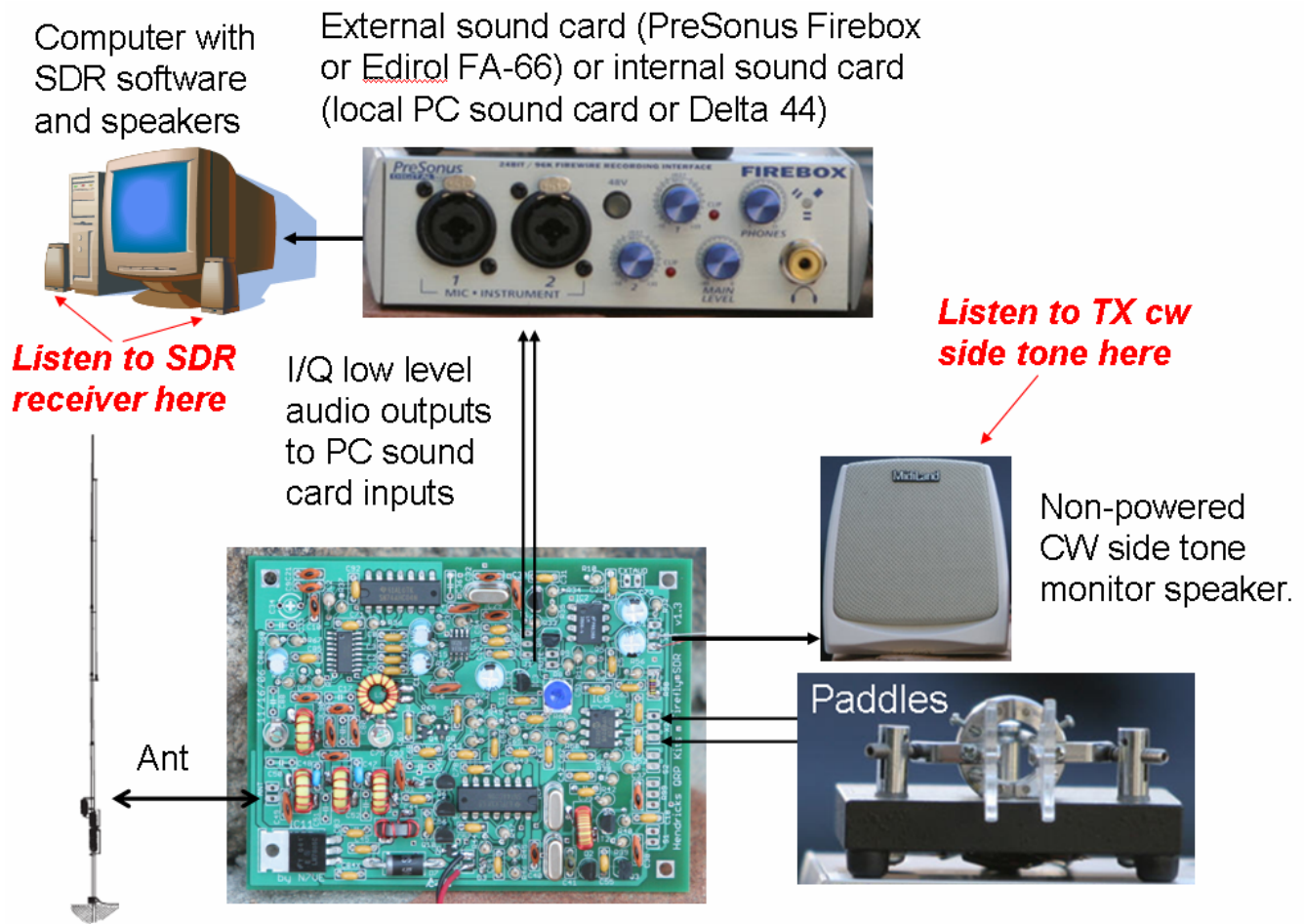


Figure 55. Diagram of the major external interfaces of the Firefly SDR, less front panel controls.

Another option is to mix the PC SDR receiver output back into the CW side tone amplifier so that the receiver output and TX side tone appear on the same output. When using this configuration, the PC output volume must be adjusted so that the PC audio appears at the proper level in the output. Likewise, the TX sidetone level must be adjusted via the trim pot R8. These two adjustments may interact to a small degree.

The diagram for the combined receiver/sidetone connection is shown below:

External sound card (PreSonus Firebox or Edirol FA-66) or internal sound card (local PC sound card or Delta 44)

Computer with SDR software



Listen to RX, TX side tone here (headphones?)

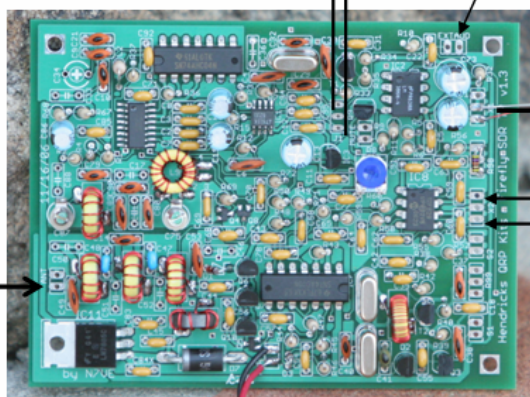
I/Q low level audio outputs to PC sound card inputs

PC audio output sent to Extaud input

Non-powered CW side tone monitor speaker.



Ant



Paddles

Figure 56. System view of combined RX/TX sidetone configuration

Mounting into a case

Transmitter section to the rear side of the case, CW sidetone monitor speaker outputs to the front. ***The holes in the board (and in the 78M05 5v regulator) are sized for 4-40 hardware.*** I recommend using either one thick nut as a spacer between the case and the board (as shown below) or two regular nuts.

Do not use over size nuts! Before mounting, make sure the nuts used are not so wide as to short out any traces to ground on either the top or bottom side of the board.

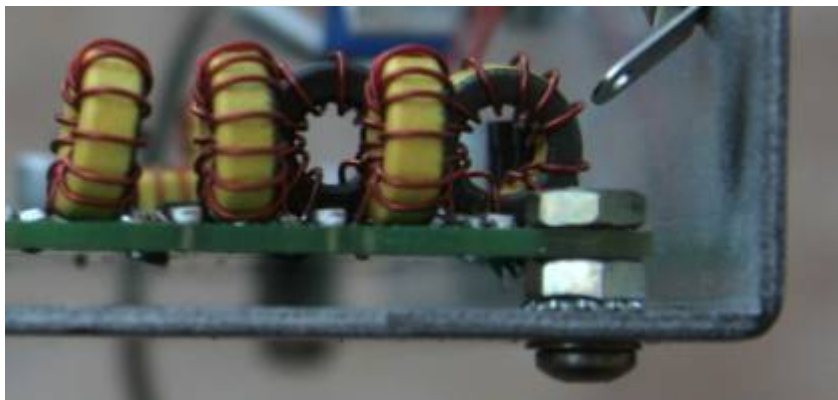


Figure 57. Mount all four corners of the main board using the mounting hardware as shown.

The board is 3.2" x 4.2". The antenna jack should be placed as close as possible to the rear of the case, while the other connections such as TX VXO tuning, cw speed, etc, should be placed near the front. ***A minimum case length of 5" is recommended in order to provide some space for front mounted jacks and pots. The case should be at least 3.25" wide. The case should be at least 1 3/8" high in order to allow room on the front panel for a larger tuning knob.***



Figure 58. Homebrew case fashioned out of double sided PC board, 5" x 3.5" x 1.375".

A Note on PC Sound Cards

The SDR receiver front end puts out very low level audio signals in the 0 to 24 KHz range that is converted into digital form by the sound card of a computer. It is good to keep in mind that the sensitivity of the SDR receiver relates directly to the performance of the sound card A/D converter. Generic PC sound cards use 16 bit A/D converters. All A/D converters have a maximum input voltage of around 2 to 5v. The performance of 16 bit converters are typically roughly 80 db of dynamic range. Pro sound cards use 24 bit converters which are in the 98 to 122 db. The currently affordable high end 24 bit cards are in the 108 to 112 db of dynamic range, which is 30 db more sensitivity than the 16 bit card. The very high end 122 db A/D parts currently exist, are being designed into a sound card that should be available in a few months by the HPSDR group and TAPR.

The point of all of this is that the large signal dynamic range and the receiver sensitivity is a function of the quality of the A/D converters. The 16 bit sound card in most PCs will not allow the full receiver performance to be realized. However, it will allow the user to get on the air, make contacts, and give SDR receivers a trial spin before moving on to a better sound card.

The current higher end sound cards are the Delta-44 (\$150, designed for a desktop PC) and the Edirol FA-66 (\$350, designed for a firewire interface to a laptop). Flex Radio carries these sound cards:

<http://www.flex-radio.com/>

It needs to be noted that most laptops are reported not to have stereo sound card inputs, but rather mono inputs. If the receiver is connected to a mono input, the SDR software will work, but will be unable to determine the difference between a signal 1 KHz higher from the center 10.120 MHz from that 1 KHz lower than 10.120 MHz. Thus signals that appear at 10.114 MHz (10.120 – 6 KHz) could really be a signal at 10.126 MHz (10.120 + 6 KHz). The use of the both the I/Q outputs from the receiver allows the SDR software to determine which side of 10.120 MHz the signal belongs to and to null the image.

Pre-Loading of SDR software on the PC

In order to tune up the receiver, the I/Q audio output must be connected to the sound card input of a PC and a SDR software package must be installed and verified. There are several SDR software packages that are very popular, “Rocky” and “PowerSDR”. Both are free and are available on line.

Of the two, I think that PowerSDR that has seen the most development activity, and is what I recommend. Remember that since the vast majority of the receiver functionality is in software, improvements to SDR software is like getting receiver hardware upgrade for free. For example, PowerSDR just release a beta version that allows two receivers to be run at the same time, one in the right speaker, the other in the left. This allows one to listen to both sides of a DX pile up when operating a split, or allows to monitor a station you want to work while you tune around elsewhere in the band.

Both Rocky and PowerSDR are set up to work with softrock receiver. The receiver portion of this rig is softrock compatible. Any SDR software that can run a softrock receiver can be used for the receiver side of the Firefly SDR.

Rocky: <http://www.dxatlas.com/rocky/>

This page for Rocky gives the setup instructions for the Rocky software package.

PowerSDR: <http://www.flex-radio.com/testdrive.htm>

This gives a link for you to get the PowerSDR software up and running on your computer. If you have any question on whether or not your computer is fast enough to run SDR software, I would suggest running this and checking the CPU meter on your computer. One of the features of both Rocky and PowerSDR is that it allows you to run a prerecorded sound file. Note that playing a prerecorded sound file exercises the full receiver functionality since the receiver cannot tell the difference between sound samples from the sound card from sound samples played from a file. If the sound samples work, your computer will work.

<http://www.flex-radio.com/downloads.htm#PowerSDR> This link includes one sound file. Use this for a test drive of both Rocky and PowerSDR.

There is no reason why you cannot install both packages on your computer and try them both out.

The computer requirements vary widely from computer to computer. In general, any computer with a video on the mother board will have much worse performance than a computer with dedicated video card. It is much cheaper for a computer manufacturer to use an integrated video chip set on the motherboard (almost all laptops are this way, as well as the low end desktops), but the video memory, which is used all the time for refreshing the display, is shared with the computer, thus the computer runs slow compared to the same computer with a dedicated video card.

The suggestions that I have seen recommend at least a 1 GHz PC. This should get you going for the standard +/- 24 KHz (48 kbps sampling rate) receiver reception range. There are sound cards available that also support 96 Kbps sampling (+/- 48 KHz receiver tuning range) and even 192 Kbps (+/- 96 KHz receiver tuning range). Flex Radio recommends a 3 GHz PC when sampling at 192 Kbps.

Keep in mind that the +/- 24 KHz tuning range of the receiver exceeds the tuning range of the VXO transmitter, so this does not really concern this kit. However, if you are looking to get a new computer, the 3 GHz rate would be one to keep in mind.

Notes on loading PowerSDR

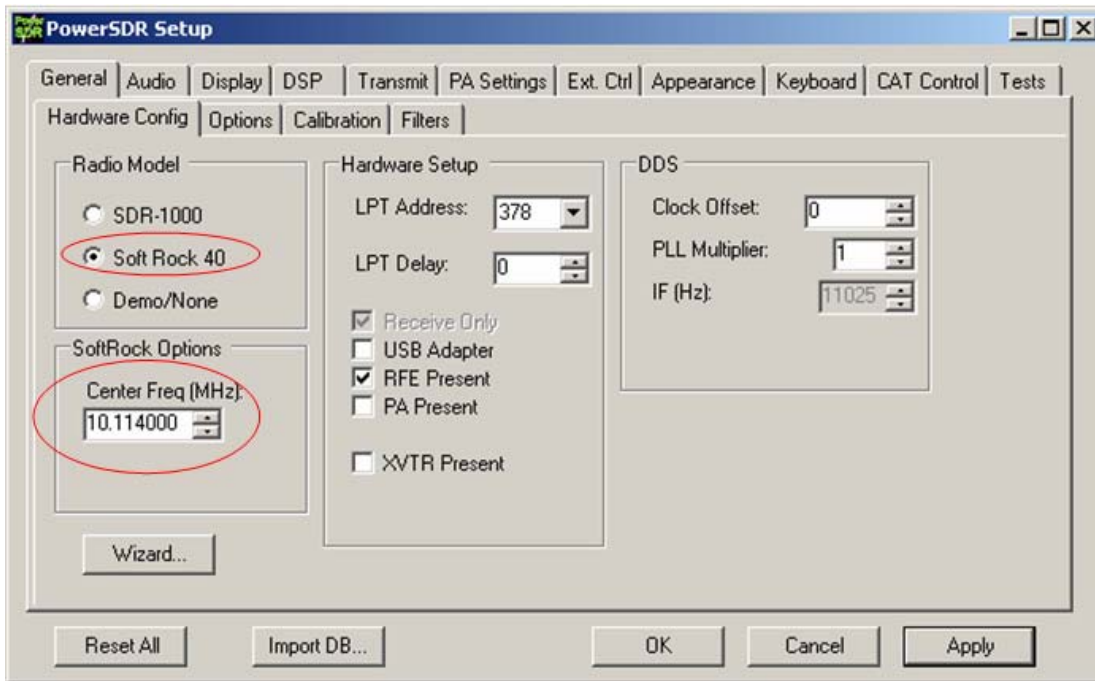


Figure 59. Select the setup tab to get to this window. Select SoftRock, and set the center frequency.

The nominal center frequencies are 10.114, 14.058, or 18.095 MHz. If you are using a signal source of a known signal level (like the KX1/KX2 generators), select the calibration tab above.

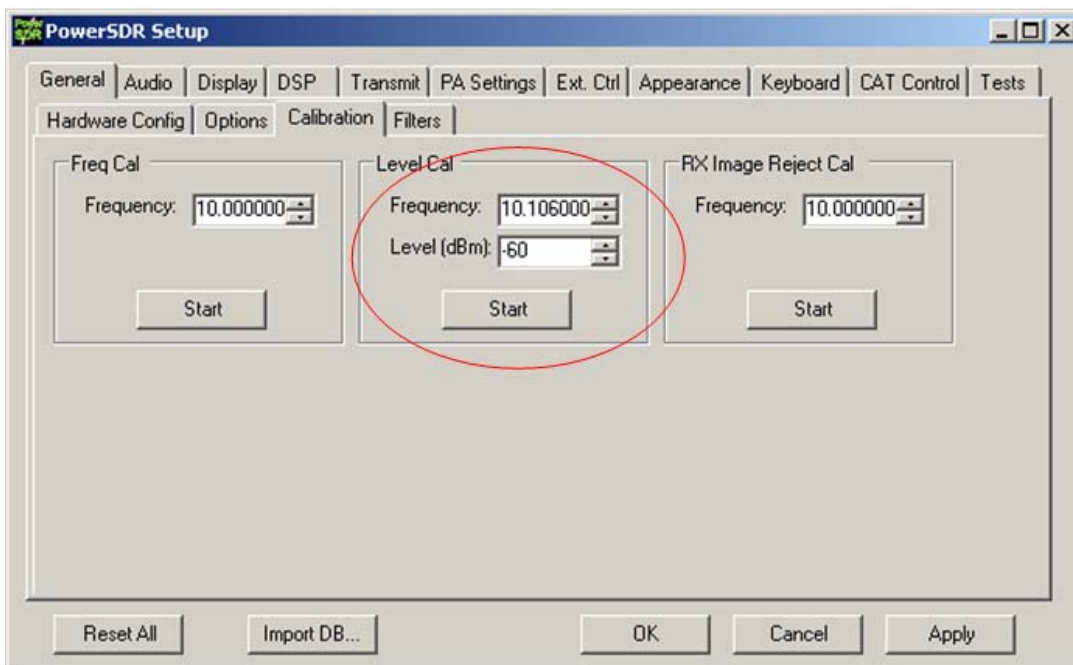


Figure 60. Sheet used to calibrate the signal strength readings in Power SDR

Enter the frequency of the test signal, its input signal strength, then click start.

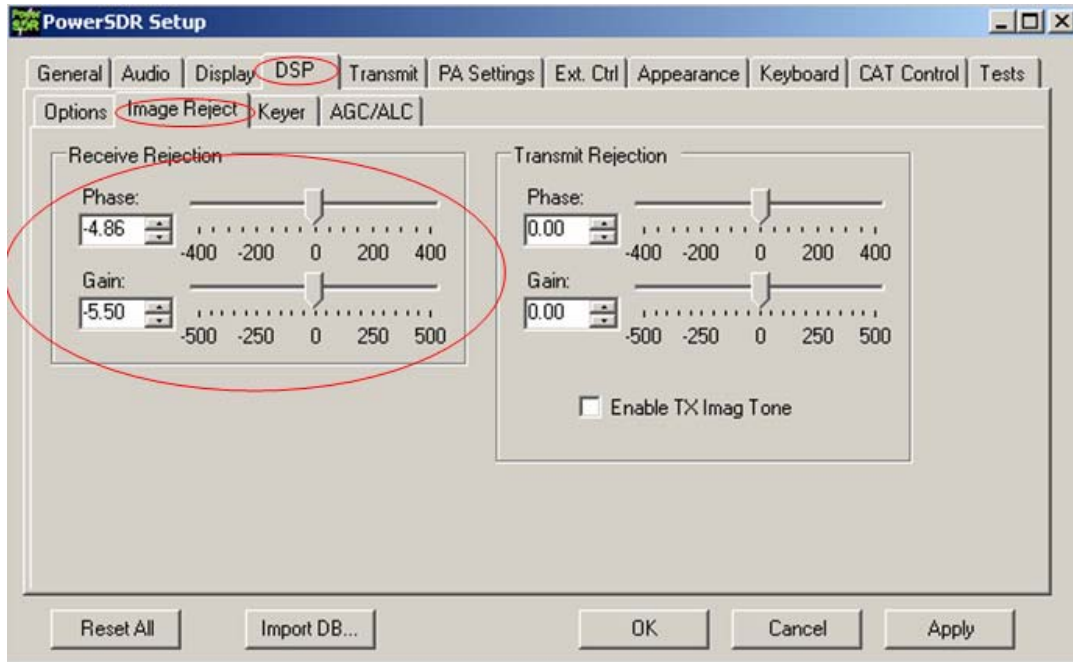


Figure 61. DSP/Image Reject tab used to null opposite sideband signal

This is the tab that is used to fine tune the image rejection response. Course tune using the sliders, then fine tune with the up arrow/down arrow on the box. Ideally, the rejection should be nulled using a signal ~ 5 KHz lower than the center frequency (10.114, 14.058, 18.095 MHz).

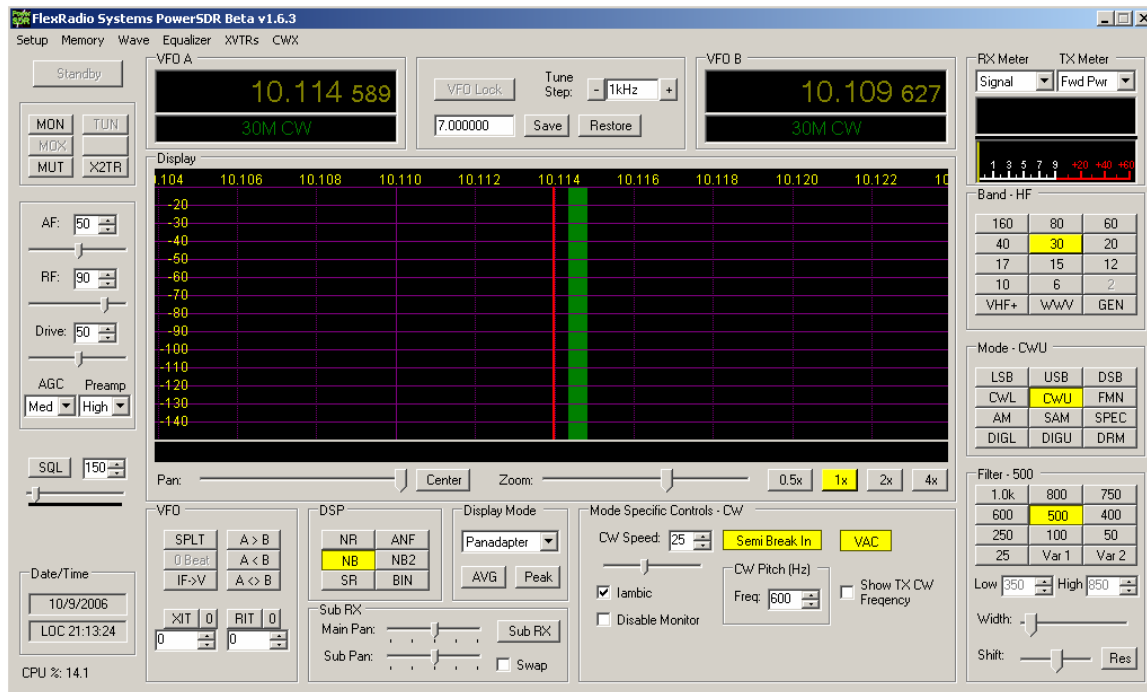


Figure 62. Generic settings – NB on, 500 Hz filter, CWU, proper band selected (30m here)

The most important point here is to click on “NB” to enable the noise blanker. Also note that the receiver will not turn on until the “Standby” button in the upper left is clicked (off as shown).

SDR Receiver Resources

If you have problems with the above packages, there are two user groups that have very knowledgeable folks that can probably help.

<http://groups.yahoo.com/group/softrock40/>

This is the softrock receiver group. Since the receiver used here looks like a softrock receiver (i.e., I/Q audio into a sound card), this group is a very good resource for hardware and software issue.

<http://mail.flex-radio.biz/pipermail/flexradio> flex-radio.biz/

This is the group for the PowerSDR software. If you use this package, you should probably monitor this group for software upgrades. Although this group is primarily focused on the Flex Radio SDR-1000, since their software is compatible with the softrock, it is also compatible with the receiver side of the Firefly SDR.

Receiver Tune Up

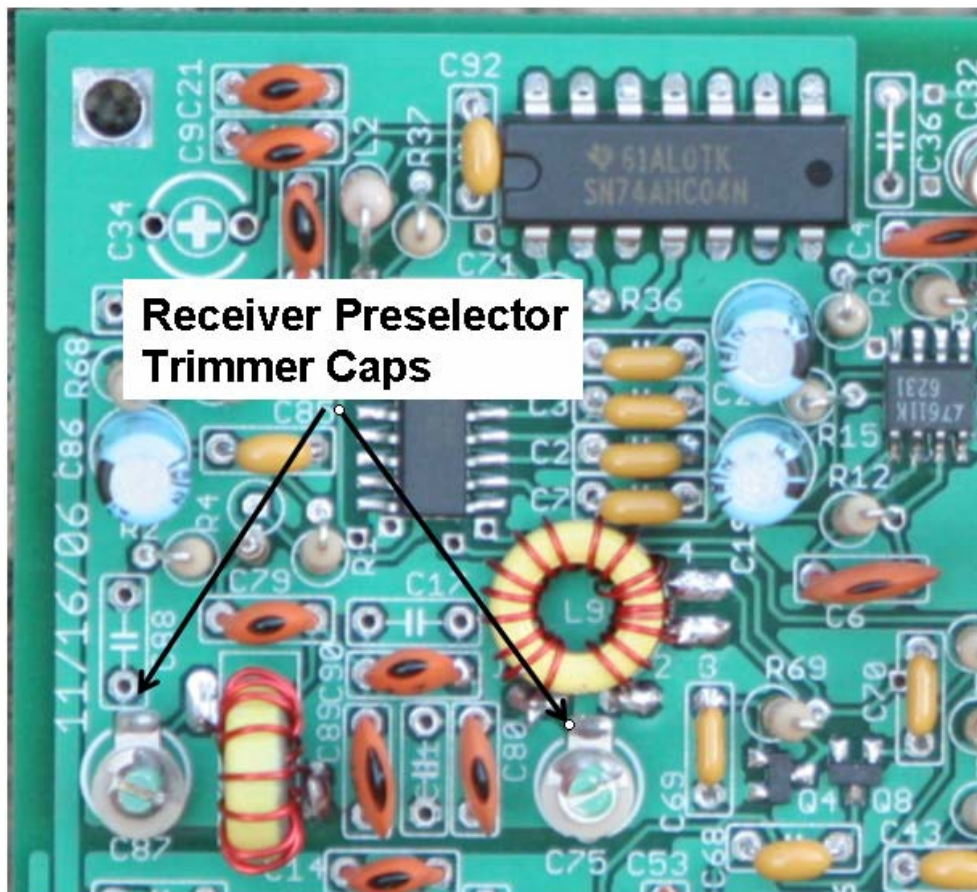


Figure 63. Adjustment points for tuning up the receiver.

The adjustment is very straight forward. First a strong, steady signal source is required. Some examples of signal sources are:

- A RF signal generator. For this purpose, a setting of -50 dbm is ideal.
- A crystal oscillator loosely coupled into the front end (1 to 2 pf in series). QRP crystals are available from a number of sources including Norcal.
- A marker generator such as the one available from Norcal.
- A QRP transmitter transmitting at minimum power into a dummy load produced a very strong signal that can be readily picked up using a 1 inch “sniffer” stub of wire connected to the antenna port of the NC2030. **DO NOT TRANSMIT DIRECTLY INTO THE FRONT END OF THE RECEIVER!**
- Over the air signals can be used, but these are usually neither strong nor consistent.

All that is needed is to peak both receiver pre-selector trim caps. With the receiver connected to the PC and with the SDR sound card connected, the receiver center frequency is roughly 10.120 MHz for 30m

and 14.065 MHz for 20m. This center frequency can be applied to the set up portion of the SDR software.

With one of the above signals applied to the input, the receiver Preselector trim caps are adjusted for best received signal strength. Alternating back and forth between the two caps quickly peaks the receiver front end.

The next step is to look at the tune up signal and its mirror image on the far side of 10.120 MHz. For example, if the target signal is 10.116 MHz, there will be an image of this signal at 10.124 MHz. First check to see which signal is smaller. There should be some small opposite sideband suppression at this point. If the 10.116 signal is larger, all is well. If on the other hand if the signal at 10.124 MHz is larger, then the I and the Q signals audio output are backwards and need to be reversed.

If all is well, the opposite sideband image should be nulled out as much as possible using software. Rocky is especially good at this as it automatically starts to try to null out images of strong signals. I like PowerSDR better, and there are amplitude and phase adjustments (see the PowerSDR notes later) that allow the signal to be nulled out to nothing. Nulling is a combination of doing rough nulling using the slider controls, then fine nulling using the + and – value adjustments. I suggest reading the PowerSDR manual to find out how to set up the software to run in a “softrock” compatible mode, how to set the softrock fixed frequency, and how to calibrate the signal strength when using a calibrated signal source such as the XG1 and XG2 from Elecraft.

Operating the Firefly SDR

I am not sure what to say here. There is a manual on the Flex Radio web site that describes how to tune using the SDR software. First I suggest practicing tuning in signals on the band. My favorite two tuning modes are point and click & drag and drop. Using point and click, placing the cursor in the spectrum window and right clicking on the mouse will turn on cross hairs. Right clicking will toggle this cross hair mode on and off. With the cross hairs on, left clicking on a signal will place it in the middle of the receiver passband. With drag and drop, you can use the left mouse button to “drag” a signal into the middle of the receiver passband.

When you get to the point of wanting to answer a signal on the air, turn the “spot” switch on and you will be able to see the transmit signal as you turn the TX tune knob. Tune the TX spot signal and you will be able to visually place it right on top of the signal you are listening to. At that point, the transmitter is set up and ready to go. Turn off the TX spot switch and use the keyer paddles to communicate with the other end.

The monitor speaker output provides up to 1w of audio power. Thus, an amplified speaker is not needed. The on board 5K trimmer resistor (R8) in the keyer/cw sidetone monitor amplifier section is the volume control for the output level of this output. Set the volume to a comfortable level. There is no transmit connection into the SDR software, so the SDR receiver is still “on” during transmit even though the actual receiver hardware is turned off during transmit. Thus the SDR receiver produces anomalous audio output during transmit, it sounds kind of like a “thump”, so the CW sidetone output on the

separate side tone monitor speaker is used to overcome the noise of the SDR receiver during the transmit period.

On PowerSDR, * (“star” key) can be used to mute the audio. Once the receiver has been muted once, from that point onwards the space bar can be used to toggle the mute on and off. The use of the space bar in to toggle the mute on and off is is an oddity of the Windows operating system and is not something PowerSDR does.

Note that you have ***two speaker outputs***, one set from the PC that carries the ***SDR receiver output***, and a separate speaker output for ***cw side tone***. The Extaud input jack can be used to mix the PC audio output with the internal TX side tone signal to produce a combined audio output suitable for listening with headphones.

The Firefly SDR has a built in keyer, complete with a memory function. The instruction on using the keyer and all of its functions are at the end of this document. If you never want to bother with the memory functions, or the beacon mode, or changing the keyer side tone frequency, just plug in a paddle and go. The only thing you really need to know is how to use the cw speed control on the front panel.

The keyer has a straight key mode where a straight key (or an external keyer) can be plugged into the transceiver. When the transceiver is turned on, the keyer chip looks to see if one side of the paddle is grounded (like what would happen with a mono straight key plug), and the keyer will enter straight key mode. If you want to use paddles again, simple power off the rig and turn it on again to clear out straight key mode. ***Note: when using straight key mode, turn the keyer speed to the fastest speed or the external keying may not work correctly at high external keying speeds.***

The keyer also has a handy “tune” mode. Hold both the dot and dash paddles closed for five alternating dots and dashes and the transmitter will go into a steady transmit. Pressing either paddle will cancel the tune mode.

Read the keyer operating section. There are lots of neat things that this keyer can do.

Firefly SDR Customizations and Optimizations

The gain of the audio pre-amplifiers is currently set by the resistors R7 and R12 (33K). The input impedance is essentially 300 ohms, so the gain of the op-amp is $33000/300 = 110x$. In addition, the fact that the op-amp is operated in a differential mode, thus there is a hidden additional 2x gain for a total of 220x.

This translates to a db gain of $20 \cdot \log_{10}(220) = 46.8$ db. This amount of gain was used in order to maximize the sensitivity of the receiver. As it is, the noise floor of my Presonus Firebox increases by only 2 db as I power up the receiver. The current 3 db rise, 500 Hz sensitivity is around -127 to -128 dbm when measured using the Firebox “sound card”.

However, on 30m this sensitivity level is excessive. The SDR software measures the 20m background noise at about -100 dbm at my suburban location. From a receiver performance perspective, it is good to have the receiver noise floor 10 to 15 db lower than the band noise. Thus, for my and my band conditions at my location using my 500 ft loop antenna, I have roughly 12 db too much gain in my receiver front end.

This excess gain will vary significantly from sound card to sound card. Thus, for your sound card, the background noise of the receiver in a 500 Hz bandwidth can be measured with the receiver connected to a 50 ohm dummy load. This noise level can be compared to the band noise on 30m under good band conditions to see the difference. If your sound card is less sensitive, and the difference is less than 15 db, there is no reason to change anything.

However, if like me, you see a difference significantly larger than 15 db, it may be worth while to reduce the gain of the receiver. One way to do this is to reduce the gain of the receiver op-amp by reducing the 33K feedback resistors. The problem with this method is that the 150 pf caps across the 33K resistors need to be increased as much as the 33K resistors are reduced. Reducing the receiver gain by 12 db (4x) would involve reducing the 33K resistors to 8.2K while increasing the 150 pf caps to roughly 600 pf. A close value would be 560 pf. The caps used are not critical, but help reduce the size of signals far from the receiver intended bandpass. They have been selected for a receiver bandwidth of +/-24 KHz, which is larger than the TX tuning range.

Another method is to change the attenuator in the front end of the receiver. This affects resistors R1 & R2 (300 ohms) and R4 (18 ohms). The input attenuator is currently 3 db. The extra attenuation would serve to further decouple the receiver pre-selector filter from the detector input, allowing for a flatter, more uniform wideband image rejection response.

Below is a list of resistor values for different attenuator values:

Attenuation	R1 & R2	R4		Attenuation	R1 & R2	R4
3	300	18		9	107	63
4	220	24		10	98	72
5	182	31		15	73	139
6	153	38		20	62	252
7	133	46		25	57	452
8	118	54		30	54	805

Figure 64. Pi Attenuator values – 3 db to 30 db

If you want to change to a higher value of attenuator, R1, R2 and R4 can be readily replaced.

There are two other customizations that can be done. First, the tuning range is fairly non-linear. The tuning range can be made more linear by adding a 4.7K resistor across the VXO tuning pot (R99) as shown below:

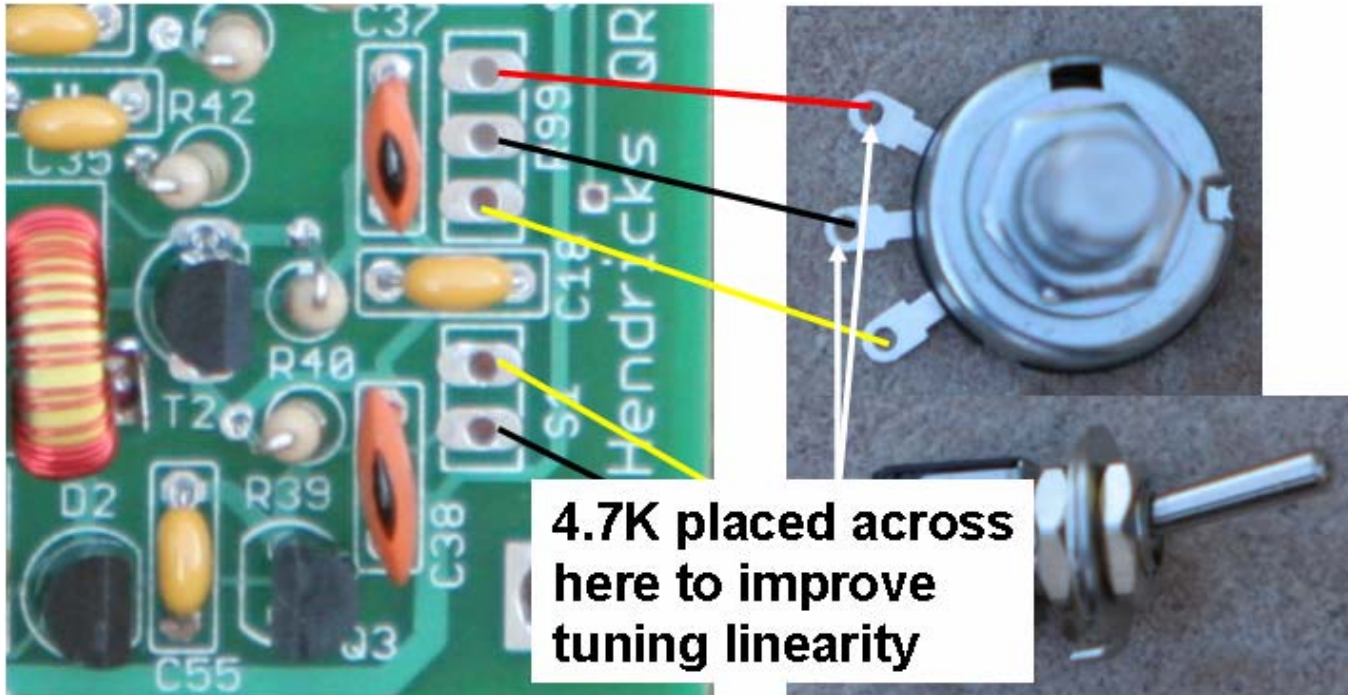


Figure 65. Tx VXO tuning linearity improved by using an external 4.7K resistor

A second customization is to add a small 5k trim pot to one end of R99 is the bottom end of the tuning range goes below 10.100 MHz with your crystals. In my v1.0 board, the bottom end of the tuning range was 10.092 KHz. The v1.1 board bottom end range was 10.102 MHz. This difference in tuning range is primarily due to the differences in crystals between the two boards. If the bottom end of the tuning range is significantly below 10.100 MHz, then it would be advantageous to add a small trim pot between R52 and its connection to R99, the TX VXO tuning pot. This trim pot can then be adjusted so that the bottom end of the TX VXO stops at 10.100 MHz with the spot switch turned on. This will allow the entire tuning range of R99 to tune useful coverage range, making the TX VXO easier to tune.

Appendix A. Parts List

Ref	Value	Ref	Value	Ref	Value
C1	100 uf	C73	100 uf	R4	18
C2	0.01 uf	C77	0.1 uf	R5	18
C3	0.01 uf	C78	0.1 uf	R6	18
C4	150 pf	C83	0.1 uf	R7	33K
C5	0.1 uf	C84X	0.1 uf	R8	5K trim pot
C6	150 pf	C85	0.1 uf	R9	3.3K
C7	0.01 uf	C86	22 uf	R10	47K
C8	0.01 uf	C91	0.1 uf	R11	8.2K
C11	0.1 uf	C92	0.1 uf	R12	33K
C12	0.1 uf	C94	0.1 uf	R15	100
C13	100 uf	C95	0.1 uf	R32	1k
C14	47 pf			R33	1k
C18	0.1 uf	D1	51v 0.5w	R34	3.3K
C19	22 uf	D2	MV209	R35	100K
C20	22 uf	D3	1N4148	R36	100K
C22	0.1 uf	D7	SB320	R37	1k
C31	0.1 uf			R38	3.3K
C32	47 pf	IC1	LM833D	R39	1k
C35	0.1 uf	IC2	LM386-N4	R40	100K
C36	5 pf	IC3	78106	R42	100K
C40	22 pf	IC6	74AHC04N	R43	100K
C41	5 pf	IC7	74AC00N	R44	75K
C42	0.1 uf	IC8	12F629 keyer	R45	75K
C43	0.1 uf	IC9	74CBT3253D	R46	75K
C44	0.1 uf	IC11	7805T	R47	75K
C45	0.1 uf			R48	8.2K
C54	0.1 uf	Q3	BS170	R49	75K
C55	0.1 uf	Q4	BSS123	R50	47K
C56	0.1 uf	Q5	NDS335N	R52	1k
C57	0.1 uf	Q6	BS170	R55	8.2k
C58	0.01 uf	Q7	BS170	R56	1k
C59	0.01 uf	Q8	BSS123	R58	1k
C60	0.01 uf	Q9	BS170	R59	3.3k
C62	0.01 uf	Q10	BS170	R60	3.3k
C63	0.01 uf			R67	3.3K
C64	0.1 uf	T1	SS9018	R68	3.3K
C65	0.1 uf	T2	SS9018	R69	3.3K
C68	0.1 uf			R71	3.3k
C69	0.01 uf	R1	300	R72	3.3K
C70	0.01 uf	R2	300	R98	100K
C71	0.1 uf	R3	100	R99	10k

Figure 66. Common, non-band specific parts

Part	30m	20m
L1 - T37-6	56T #32	40T #32
L2 molded choke	10 uH	4.7 uH
L4 - FT37-43	10T #26	8T #26
L5 - T37-6	16T #26	13T #26
L6 - T37-6	18T #26	14T #26
L7 - T37-6	16T #26	13T #26
L9 - T37-6	19T #26 & 3T #32	16T #26 & 3T #32
L10 - T37-6	18T #26	15T #26

Figure 67. Band specific inductors

Part	Value	
	30m	20m
C9	4.7 pf	2.2 pf
C10	22 pf	27 pf
C14	47 pf	47 pf
C17	2.2 pf	n/a
C21	4.7 pf	4.7 pf
C29	100 pf	68 pf
C30	180 pf	150 pf
C37	100 pf	68 pf
C38	180 pf	150 pf
C47	470 pf	330 pf

Part	Value	
	30m	20m
C48	470 pf	330 pf
C49	180 pf	150 pf
C53	180 pf	150 pf
C79	47 pf	33 pf
C81	180 pf	120 pf
C89	150 pf	100 pf
C90	4.7 pf	4.7 pf
Q1	10.120 MHz	14.065 MHz
Q2	10.120 MHz	14.065 MHz
Q11	10.120 MHz	14.065 MHz

Figure 68. Band specific parts

Appendix B. Keyer Instructions

Operation:

General notes on using the dit, dah and mem switch to control the keyer: The switch on pin 4 of the keyer chip will be referred to as the mem switch. Multiple functions result from multiple switch-press combinations (mem alone, mem+dit, mem+dah, mem+both dit and dah). Also, the switches can be pressed and released (PAR) OR pressed and held for two seconds (PAH). This doubles the number of combinations of the three control switches.

Generally, PAR is used for actions: send the code speed or send a memory. PAH is used for settings: change the code speed (no pot) or record a memory or change the iambic mode.

4 menus are used for setting various options - they are activated by a PAH of the mem switch alone or plus a simulpress of dit or dah or both. The menu selections are made by pressing either the dit or dah switches - you will then normally hear a corresponding dit or dah via the sidetone, the selection will be made and you are then returned back to normal keyer mode. In general, the operator can skip a menu item by a PAR of the mem switch.

Note that the keyer sidetone will be lower in pitch (about 270 Hz) for keyer commands such as the menu prompts. The normal sidetone pitch for routine sending defaults higher at about 580 Hz and can be changed with the SS menu command.

keys used	PAR (press and release)	PAH (press and hold)
mem switch	send memory 3	record memory 3, O?, also beacon items: BE and BA
mem + dit	send speed	paddle set of speed, pot options, main menu
mem + dah	send memory 2	record memory 2: M?
mem + both	send memory 1	record memory 1: T?

Figure 69. A Function Table of the Keypress Combinations

Powerup:

After powerup the keyer will send an FB through the sidetone to signal correct operation. If either the dit or dah input is pressed during powerup the opposite paddle input will act as a straight key. An easy way to do this is to plug in a mono plug from the external key or keyer cable into the stereo paddle jack of the NC2030. The ring contact of the paddle jack will then be grounded.

Speed Readout:

The speed (in WPM) will be played through the sidetone if the mem switch is simulpressed with the dit switch and then both are released. I normally press the mem switch first and hold it, press the dit switch and finally release both.

Speed Control and Menu:

Initially the keyer will powerup at a default speed of 16 WPM in paddle speed set mode. The speed can be adjusted by pressing and holding the mem switch along with the dit switch. Usually I press and hold

{PAH} the mem switch and then tap the dit switch. After 2 seconds, the keyer will send an S (for speed set). Press the mem switch to advance to the next menu item without changing the speed. Or, pressing the dit switch will increase the speed by 1 WPM and send a dit. Pressing the dah switch will decrease the speed by 1 WPM and send a dah. You can continuously adjust the speed by holding either switch but note that if you run the keyer "off the scale" at either 8 or 49 WPM, the keyer will "wrap around" to the opposite speed extreme. Exit the speed adjust routine by pressing and releasing the mem switch.

If the pot circuitry is connected AND the P menu is invoked to turn on the pot speed control the speed can be adjusted by turning the pot. Maximum possible speed is 49 WPM, minimum possible speed is 8 WPM. Note that the minimum speed can be affected by component tolerances on the speed pot and the capacitor - see the pot calibration menu item if an 8 WPM minimum speed is required. The pot position is read continuously when the keyer is sending code, just before each dit, dah or space is sent. This allows the operator to adjust the code speed even in the middle of a memory send or record.

	Menu item	pressing a dit:	pressing a dah:
S	Speed set from paddle	increases speed by 1 WPM	decreases speed by 1 WPM
P	Pot / paddle speed control	selects pot speed control	selects paddle speed control
C	Calibrate pot speed control	enters the calibration routine	restores default pot calibration
B	Bug / straight key mode	enables bug mode (dah = key)	disables bug mode (default)
A	iambic mode A or B	enables iambic mode A	enables mode B (default)
R	Reverse paddle mode	reverse dit and dah switches	return dit and dah to normal
AU	Autospace on / off	turns on character autospace	turns off autospace (default)

Figure 70. Mem + dit menu (PAR mem to advance to the next menu item)

P - Select Pot or Paddle speed control:

Allows the keyer to be switched between pot or paddle speed control. The keyer defaults to paddle speed control.

C - Calibrating the Pot speed control:

Due to the variation in capacitors and pots it is likely that the minimum setting of the pot will result in a minimum speed higher than 8 WPM. This menu item will compensate and store an updated calibration value. Before entering the menu, be sure to turn the pot to the minimum speed. Then press the dit to go into the calibration routine - then one or more dits will be sent after a short delay and the keyer will exit from the menu. If the pot calibration is run with the pot not set at the minimum, rerun the cal with the pot correctly set. Pressing a Dah will restore the default powerup calibration value.

B - Bug / Straight-key mode:

Dits are sent normally but dahs are sent like a straight key.

A - Iambic mode A or B:

The A mentioned above signifies the mode A/B select menu item. The iambic mode of the keyer can be set to either mode using this routine. Check the JHP web site for an Acrobat (.pdf) file which explains the difference between the A and B keying modes.

R - Reverse paddle mode:

Reverses the dit and dah switches (easier than resoldering a jack). Remember that the pot speed control will be changed to the dit paddle which means that pot speed control changes while the dit is pressed will be ignored until the dit is released.

AU - AUtospace on/off:

The autospace feature inserts a character space (1 dah in length) automatically if the operator has not pressed a paddle switch 1 dit space after the last dit/dah sent. This feature is always on in the memory record routines (needed for the recording process).

Recording Memory 2:

A memory of up to 40 characters long can be recorded. The memory 2 record menu is entered by simulpressing the memory and the dah keys and holding them for 2 seconds. I usually PAH the mem switch and then tap the dah key.

	Menu item	Pressing a dit:	Pressing a Dah
SS?	Sidetone Set	Lowers sidetone	Raises sidetone
M?	Record memory	records a dit	records a dah

Figure 71. Mem + dah menu (PAR mem to exit)

SS? - Sidetone Set:

Press either a dit or dah to enter the SS menu and turn on the sidetone. A dit PAR (or PAH) will decrease the sidetone frequency, a dah PAR (or PAH) will increase the sidetone frequency. The sidetone will "wraparound" at the high (about 1700 Hz) and low (about 320 Hz) frequency limits. When the sidetone is at the desired frequency a PAR of the mem switch will exit the menu and store the new sidetone frequency in EEPROM. The SS menu item affects only the normal sidetone, the command sidetone is unchanged.

M? - Record Memory 2:

The memory is recorded by sending normally. Note that the keyer output is off during the recording and that the lower command sidetone is used. When complete, PAR the mem switch. The routine will be exited automatically after the 40th character is sent. The memory is saved in flash memory which means that it will still be there even if power is removed. If this menu item is entered by mistake, PAR the mem switch to exit without changing the memory.

Playing Memory 2:

Play memory 2 by simulpressing and releasing the memory and the dah keys. I usually PAH the mem switch and then tap the dah switch - the memory starts to play after the mem switch is released. A tap of either the dit or dah switch will stop the message play.

	Menu item	pressing a dit:	pressing a dah:
BE	BEacon mode	starts the beacon going	Exits the menu
O?	Record memory 3	records a dit	records a dah
BA	Beacon Alternate mode	selects alternate beacon sends of mem 1 and mem 2	selects send of mem 1 only (default)
ST	SideTone on/off	turns off the sidetone	turns the sidetone on (default)

Figure 72. Mem switch menu (PAR mem to advance to the next menu item)

BE - Beacon Mode:

Beacon mode will send the contents of mem 1 continuously. Start the beacon by pressing the dit switch - the beacon starts to play. Exit beacon mode by tapping the dit or dah switch.

O? - Record Memory 3:

The memory is recorded by sending normally. Note that the keyer output is off during the recording and that the lower command sidetone is used. When complete, PAR the mem switch. The routine will be exited automatically after the 40th character is sent. The memory is saved in flash memory which means that it will still be there even if power is removed. If this menu item is entered by mistake, PAR the mem switch to exit without changing the memory.

Playing Memory 3:

Play memory 3 with a PAR of the memory switch. - the memory starts to play after the mem switch is released. A tap of either the dit or dah switch will stop the message play.

BA - Beacon Alternate between mem 1 and mem 2 mode:

This routine selects/deselects alternating the beacon play between memory 1 and memory 2.

ST - SideTone on/off:

Since most rigs have a built-in sidetone, it is handy to be able to silence the NorCal Keyer sidetone, especially when the tone is injected into the rig audio. Note that the sidetone will still be engaged during any menu or recording entry even if it has been turned off.

	Menu item	pressing a dit:	pressing a dah:
T?	Record memory 1	records a dit	records a dah

Figure 73. Mem + both menu (PAR mem to exit)

T? - Record Memory 1:

Enter record mode for memory 1 with a PAH of the mem switch and both paddle switches for 2 seconds. Hold the mem switch down, then squeeze both paddle switches simultaneously (they both must be down at the same time), then release the paddle, keep holding the mem switch until after 2 seconds the keyer will send **T?**. Memory 1 can now be recorded. Start sending your message. when complete, press the mem key. The memory is 40 characters long - recording will terminate automatically after the 40th character. If this menu item is entered accidentally, just PAR the mem switch to exit without recording.

Playing Memory 1:

First, hold the mem switch down, next, squeeze both paddle switches (they both must be down at the same time) then release the paddle and finally release the mem switch before 2 seconds elapse. The memory will start to play right after the mem switch release.

Notes:

To perform a full keyer reset (parameters to their default values, memories untouched):

- 1) remove power to the keyer
- 2) press and hold the mem switch
- 3) powerup the keyer keeping the switch depressed until the FB is sent.

One unique feature of the NorCal Keyer is 5 ditdah tune mode. If both paddles are held for at least 5 ditdahs and then released, the keyer will enter tune mode (key down, sidetone on). To exit, tap either the dit or dah. Thanks to Lew Paceley, N5ZE, for inventing this mode.