The KD1JV Tri-Bander CW transceiver

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Specifications:

- Any three ham bands, 80, 60, 40, 30, 20, 17 or 15 meters - choose band mix at time of order.
- 5 watts output on all bands with 13.8V supply
- Built in Iambic B mode keyer with 5 to 40 wpm code speed and two 63 character message memories.
- Receiver sensitivity, 0.2 uV MSD
- DDS VFO for rock steady stability with 50 Hz and 200 Hz tuning rates
- Easy to read four digit LED display with leading zero suppression.
- Rotary knob tuning
- RIT (receive incremental tuning)
- Four IF crystals for excellent selectivity and opposite side band rejection
- 600 Hz audio filter
- Audio derived AGC
- Small size, 6” wide, 1.5” tall and 4” deep.
- Light weight, 12 ounces.
- Modest supply current requirements, 90 ma on receive (no signal) and 600 to 800 ma on transmit at 5W out (current depends on band, higher bands draw more current)
- Supply range : 13.8 V max, 10 V min.

Operation:

Power on/off:

Power switch is part of volume control.

Band selection:

One of the three available bands are selected with a three position toggle switch (on-off-on).

- When a band is selected, the display will indicate the band in meters for a second. (80 for 80 meters, 40 for 40 meters, and so on)
- When a band is first selected after the rig is powered up, the default start up frequency (QRP calling freq for that band) is loaded. Subsequently, the last used frequency is loaded when switching between bands. This can be useful in contest situations.
- Frequency is displayed as 100 kHz, 10 kHz, 1 kHz and .1 kHz (100 Hz). MHz digits are not displayed as you should know which band your on.

Tuning:

Operating Frequency is tuned using a mechanical rotary encoder. Tuning steps are 50 Hz in slow tuning rate and 200 Hz in fast tuning rate. The 50 Hz rate is selected on power up.

- To change tuning rate: Push and hold the tuning knob to activate the built in switch. Hold closed until the Morse letter "F" (for FAST) or "S" (for SLOW) annunciates (1 second), then release.
- Since the slow tuning rate is 50 Hz and the display only shows 100 Hz digits, the display will change on every other click of the tuning encoder.

Tuning Limits:

Tuning is limited to be within the bounds of the selected band. This includes the phone segments, but reception of SSB is usually not possible due to receiving on the wrong sideband, the narrow IF and audio filters used in the rig.

RIT:

Receive integral tuning (RIT) allows changing the receive frequency up to +/- 9.9 kHz from the transmit frequency. When RIT is activated, the display will change to show the difference between the current transmit frequency and the new receive frequency.

Normally, RIT is used to fine tune in a station which is not quite on your frequency, but can also be used when a DX or contest station is operating "Split" and listening off their transmit frequency. When RIT is active, it is possible to toggle back to your transmit frequency to check if it is still clear or if some one is calling you there. While in this mode, you can not tune, but you can transmit.

- Turning RIT on and off : short push of the Tuning knob Display will change to RIT mode : [r 0.0]
- Toggle back to transmit frequency : click the <MENU> switch. Display will change to : [r = 0.0]

60 meter operation:

If the 60 meter band is installed, operation on this band is somewhat different then "normal". The 60 meter band consists of five channels and CW operation is allowed only at the center frequency of each channel. Therefore, the transmit frequency is fixed and can not be tuned on this band. However, the receiver frequency can be tuned +/- 900 Hz in case the beat note of another station doesn't quite match and needs to be "tweaked". Tuning rate is set at 50 Hz with RIT effectively always enabled.

60 meter display: When 60 meters is selected the display will show the channel number selected and the receiver offset frequency in 100 Hz increments. [C1 .0] A minus sign will appear if you tune below the channel center frequency.

Channel selection: Advance through the channels by pushing on the tuning knob. The next channel after 5 will roll over back to channel 1. Convention is to start on Channel 1 to find an open channel.

Menu switch: This works as usual.

60 Meter channel frequencies:

Channel 1 : 5.3320 MHz USA only
Channel 2 : 5.3480 MHz USA only
Channel 3 : 5.3585 MHz USA only
Channel 4 : 5.3730 MHz USA only
Channel 5 : 5.4050 MHz International

60 Meters is a shared band with Homeland Security and other government agencies. There could be voice or digital mode operation on these channels and they have priority. Please listen before transmitting to ensure the channel is clear or QRT if other signals appear while operating.

Keyer operation:

The Tri-bander includes a built in Iambic "B" mode keyer with a speed range of 5 to 40 wpm. Keyer operation is controlled by the push button switch located under the display 100's digit and will be referred to as "the MENU Switch"

Changing Keyer speed:

To active speed change, click and release the keyer switch (short click). After a short pause, (a delay to allow sending keyer message), the display will now indicate the current code speed as [C x.x]. Use the paddle to change speed. Dot = down, Dot = down. Pausing for a second will automatically exit the change speed mode and revert to normal operation.

Message memories:

Two message memories are available. Each message length can be up to 63 characters, including word spaces.

Storing a message:

Click and hold closed the <MENU> switch until the Morse letter "M" is enunciated by the side tone. The display will blank with dashes [- - -. -]when the switch is released to indicate your in this mode.

1. Start entering in your message via the paddle. Letter and word spaces are automatically inserted when the applicable pause is detected. The pause length is the "ideal" spacing of 3 dots for a letter and 7 dots for a word. Since many people don't pause long enough between letters and words in normal on air sending, the best way to insure a space is inserted is to pause a little longer than your used to for letters and much longer for words. A little practice will likely be needed to master the timing.

2. Once you have completed entering your message, click the keyer switch. The message you just entered will be repeated via the side tone so you can check to see how it sounds and if you made any mistakes.

3. If a mistake was made: Restart the procedure by clicking the keyer switch again. The letters "EM" will be enunciated by the side tone.

4. To store the message: Tap either the Dot or Dash paddle. Dot will store into message 1 location and Dash to message 2 location. The letters "MS" (message stored) will be enunciated by the side tone. Once a message stored, normal operation of the rig is restored.

To send a stored message:

Click the <MENU> switch and then quickly tap either the dot or dash paddle.

Message pause and stop.

- To *pause* a message, close the DOT paddle. If a character is being sent when the paddle is closed, the pause will start when that character has finished sending.

- To *stop* a message, close the DASH paddle. Again, if a character is being set when the paddle is closed, it will finish sending.

Straight key mode:

Straight key mode is activated if the Dash input is grounded when you turn on the rig. This automatically happens if a monaural phone plug (normally used with a straight key) is inserted into the stereo paddle jack.

Tune up mode:

It is sometimes handy to be able to temporarily key the transmitter on and off manually with the paddle for measuring power output or allowing an autotuner to do its thing (though this is not recommended).

This mode is activated by clicking and holding the <MENU> switch closed for 2 seconds. The letter "T" will be first enunciated and then display will change to a character which sort of looks like a "t" when the switch is released and tune mode becomes active.

The transmitter can now be keyed on and off with the paddle. When done, exit back to normal operation by clicking the <MENU> switch again.

AGC action:

The audio derived AGC is designed to keep strong signals from being excessively loud, but can result in thumping. If this is noticed, turn the volume down to a point below which the AGC kicks in.

Speaker or headphones:

There is sufficient audio output power to drive a small 8 ohm speaker. Care should be taken when using headphones to keep the volume turned now when tuning around the band. Although the audio AGC action will limit the volume of strong stations, this can still be too much when using headphones.

Power supply voltages and fusing:

Power supply voltage to the Tri-bander should be between 10 to 13.8 volts.

A PTC resettable fuse is included on the circuit board in case something shorts out. This will prevent the power supply wires from melting if you have the rig connected to a high current capacity supply which isn't otherwise protected and somehow a short develops inside the rig. However, the PTC is slow to respond and can take several seconds if the current isn't real big. It's still better then nothing but it's a good idea to have a 1A fast blow fuse in line with your power cable.

High SWR warning: The BS170 MOSFET final amplifier has proven to be very robust, but it can still be damaged if connected to a highly reactive load, such as a very poorly matched antenna feed line. The use of a resistive SWR bridge such as our Easy SWR Indicator will prevent any possible damage when trying to match an unknown antenna.

Circuit description:

Microprocessor controller and DDS VFO:

The heart of the rig is the microprocessor controller and DDS VFO. An Atmel MEGA48 processor is used for the controller. The MEGA48 controls the DDS VFO, drives the frequency display, implements the keyer functions, controls transmit and receive switching and produces the side tone. An Analog Devices AD9834 DDS chip is used for the VFO. Using a 60 MHz clock, direct frequency output to 21 MHz is possible.

Receiver:

The receiver is a classic SA612 circuit, widely used in QRP rigs. The 1st mixer input is double tuned for good image and out of band signal rejection. A four crystal IF filter using matched crystals provides good selectivity and opposite side band rejection. The use of four crystals and low profile HU-49US crystals results in noticeably better performance than three crystal filters using the tall, HU-49U crystals.

The output of the product detector, U2 is first amplified by a differential input amplifier, U3b. The second section of U3a is used as an audio band pass filter with a pass band centered at 600 Hz. This audio filter, in addition to removing high frequency hiss, adds some gain. The audio is muted during transmit by the series connected N-channel JFET Q5.

U8, a LM386 audio amp provides final gain. In addition to headphones, it is able to drive a small, 8 ohm speaker. An audio AGC circuit is built around the audio amp to limit the output volume to help protect your ears if the volume is turned all the way up and you tune across a strong station. The output level is limited to 800 mv p-p or about 10 mw rms.

AGC Circuit: The audio output of U8 is coupled to base of Q9, a 2N3906 PNP transistor. Q9 has a little bias voltage of about 400 mv applied to it via the resistor divider R19/R17. This allows AGC action to start when the audio level from U8 starts to exceed 400 mv instead of 600 mv, the normal turn on voltage for a silicon transistor. Q7 is a N-Channel MOSFET and is used to attenuate the audio signal going into U8 from the volume control. A 22K resistor, R15 is in series with the volume control wiper and the input to U8 so that Q7 has a dropping resistor to work against if the volume control is turned all the way up.

As the audio output level of U8 starts to exceed 400 mv, Q9 starts to turn on, applying voltage the voltage at Q7's gate and thereby starting to turn Q7 on and attenuate the input signal to the amplifier. The gate voltage of Q7 will find a level at which it will keep the output voltage of U8 at 400 mv peak. C41 at Q7's gate holds the AGC voltage steady.

Transmitter:

The transmitter is as simple as it can get. The AD9834 DDS chip includes a built in comparator, which when enabled during transmit, directly produces a square wave output. This is then buffered by three OR gates in parallel, using a high speed 74AC02 logic chip, which in turn drives three BS-170 MOSFET's in parallel.

The square wave drive to the MOSFETs produces fast turn on and turn off times. This, combined with the low "ON" resistance and impedance matching achieved by the Low Pass output filter, results in a reasonably high PA efficiency of about 75%. This makes it possible to produce 5 watts of output power using three plastic TO-92 devices with no heat sinking. Something not easily achieved with a traditional analog amplifier chain using bi-polar transistors. The use of a high speed logic gate to drive the PA also results in a constant

drive level, independent of frequency, allowing a full 5 watt output on the higher bands with out complicated frequency compensation or drive adjustment controls.

The PA is keyed on and off with a P-channel MOSFET. A 0.01 ufd cap between the Gate and Drain output produces a 5 ms rise and fall time to the keyed voltage for key click suppression. The use of a MOSFET here instead of a PNP transistor results in less voltage drop, easier control of the rise and fall times due to the high impedance gate input.

Parts List

	QTY	VALUE	Markings/type			QTY	VALUE	Markings/type
	1	10 ohms	BRN/BLK/BLK/GLD			3	BS-170	MOSFET TO-92
	1	51 OHMS	GRN/BRN/BLK/GLD			1	2N3819	N-channel j-fet TO-92
	3	470 OHMS	YEL/VOL/BRN/GLD			1	2N3906	pnp TO-92
	8	2.2 K	RED/RED/RED/GLD			4	2N7000	MOSFET TO-92
	4	10 K	BRN/BLK/ORG/GLD			1	FQPFxxP06	P-CHN MOSFET TO-220F
	3	22 K	RED/RED/ORG/GLD			2	78L05	5V, 100 ma regulator
	1	33 K	ORG/ORG/ORG/GLD			5	1N4148	SS diode
	2	47 K	YEL/VOL/ORG/GLD			1	1N4756B	47 V 1W zener
	5	100 K	BRN/BLK/YEL/GLD			1	1N5817	1A shottky diode
	3	470 K	YEL/VOL/YEL/GLD			2	SA612A	8 pin DIP mixer/osc
	4	1MEG	BRN/BLK/GRN/GLD			1	LM358N	8 pin DIP dual op amp
						1	LM386	8 pin DIP Audio amp
	1	10 K	Volume with switch			1	74AC02N	14 pin DIP quad OR gate
	1	PTC Resetable fuse	RUEF090 .9A hold, 1.8A trip			1	ATMEGA 48	28 pin DIP microprocessor
	2	10 uHy	BRN/BLK/BLK/GLD - RFC			1	4 digit led	Multiplex display
						1	DDS Module W/SIP pins	
	1	30 pfd	Green trimmer cap			5	4.91520 MHz	HU-49US crystal matched
	1	22 pfd NPO	22			4	DPDT DIP relay	EA2-5NJ
	7	100 pfd NPO	101			1	6 mm x 13 mm	TACK switch
	2	470 pfd NPO	471			1	2.5 mm	Power Jack, PC mount
	8	0.001 uFd	102			1	16 pin, right angle	SIP pin strip
	3	0.01 uFd	103 Film			1	Rotary Encoder w/sw	
	20	0.1 uFd	104 MONO			1	FT37-43	Black, ferrite toroid core
						1	DPDT toggle	Center off (on-off-on)
	2	1 uFd/50V	Alum electrolytic			2	Stereo panel jack	
	4	47 uFd/16V	Alum electrolytic			1	BNC panel jack	
	1	220 ufd/16V	Alum electrolytic					
						1	Front panel	Small circuit board
						1	Main PCB	Large circuit board
	4	8 pin DIP socket				1	Case, top	
	1	14 pin DIP socket				1	Case, bottom	
	1	28 pin DIP socket	0.3” width			1	Red film	
						1	Tilt stand bail	
	1	5 feet	Insulated hook up wire, #24			2	Bail mounting blocks	
	1	1 foot	#28 magnet wire			7	# 4-40 1/4” pan head	screws
	1	Small knob				2	# 4-40 1/4” flat head	screws
	1	Large knob						

Assembly Instructions:

The quickest and easiest way to build the rig is in “layers”. The lowest profile parts are installed first, such as resistors and diodes, then higher profile parts such as capacitors and so on.

Once the board is populated with all the parts, testing will be done by inserting the various Integrated Circuit chips one at a time and testing the associated stages they are used with.

Before you start assembly, it is helpful to sort the parts into types and values.

Using a number of paper or plastic picnic bowls to sort the parts into is a good idea to keep parts from getting lost on the bench.

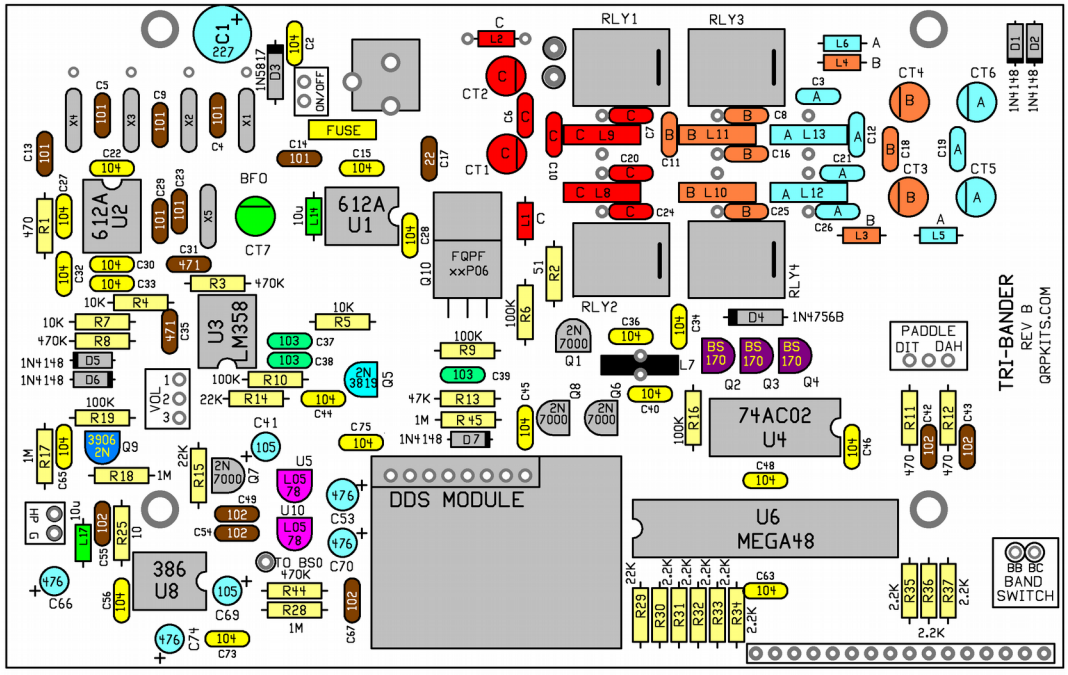
If you lose, damage or are missing a part, send a message to: grpkits.com@gmail.com for a replacement.

Please specify the part type and value. For example, instead of saying you need R22, say you need a 1K resistor. Otherwise, we will have to look up the parts list for the kit and figure out what R22 is and that can delay getting you that part.

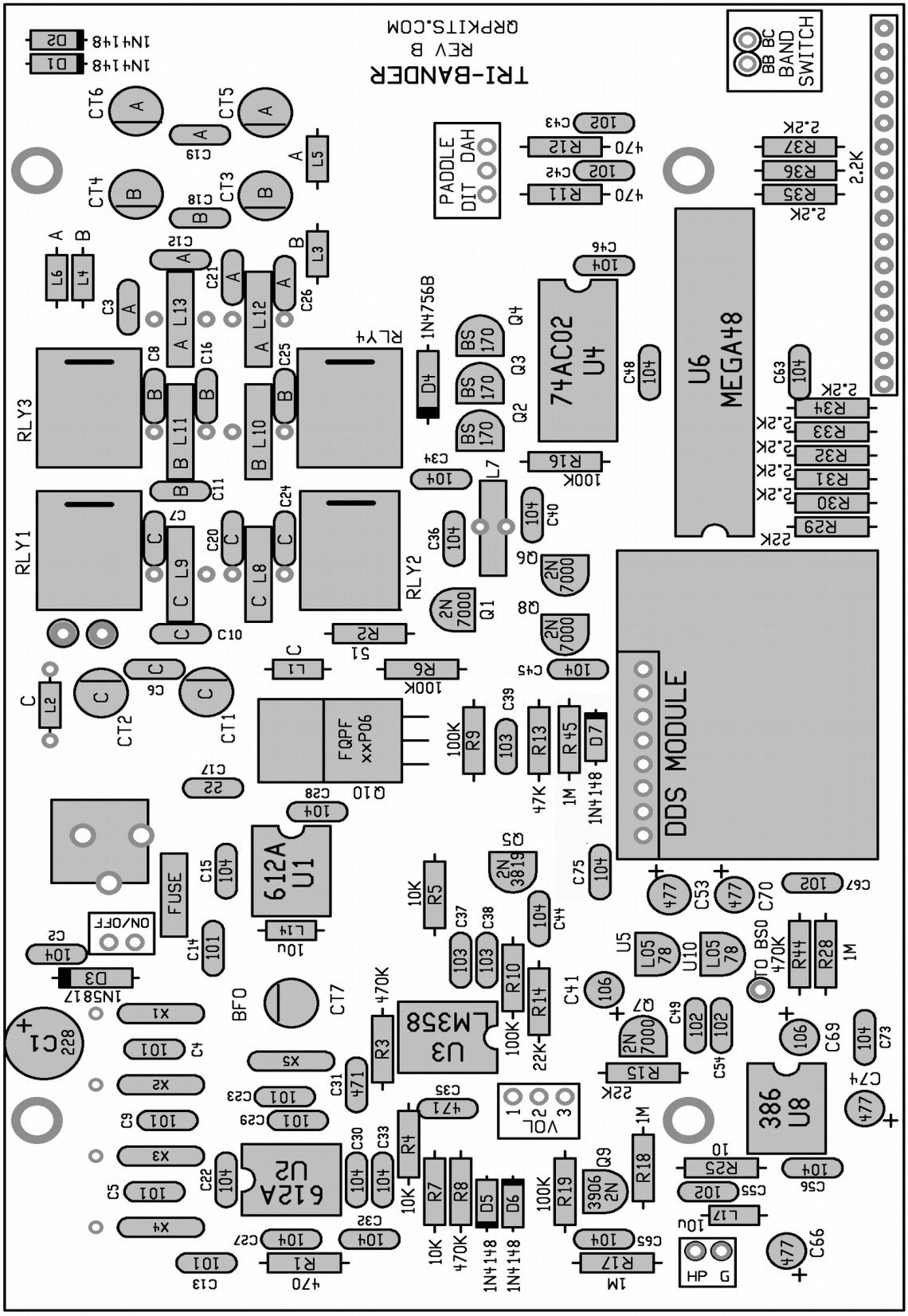
In general, parts are numbered on the board in rows, starting with the lowest part number in the upper left corner of the board (this is the back end), and then run left to right and then zig-zag down the board to the front end. Parts will be inserted in that order. Part values are labeled on the parts placement diagram for easy reference.

There are two placement diagrams included. The first is in color, which makes the various parts types stand out better, but would use a lot of ink to print out.

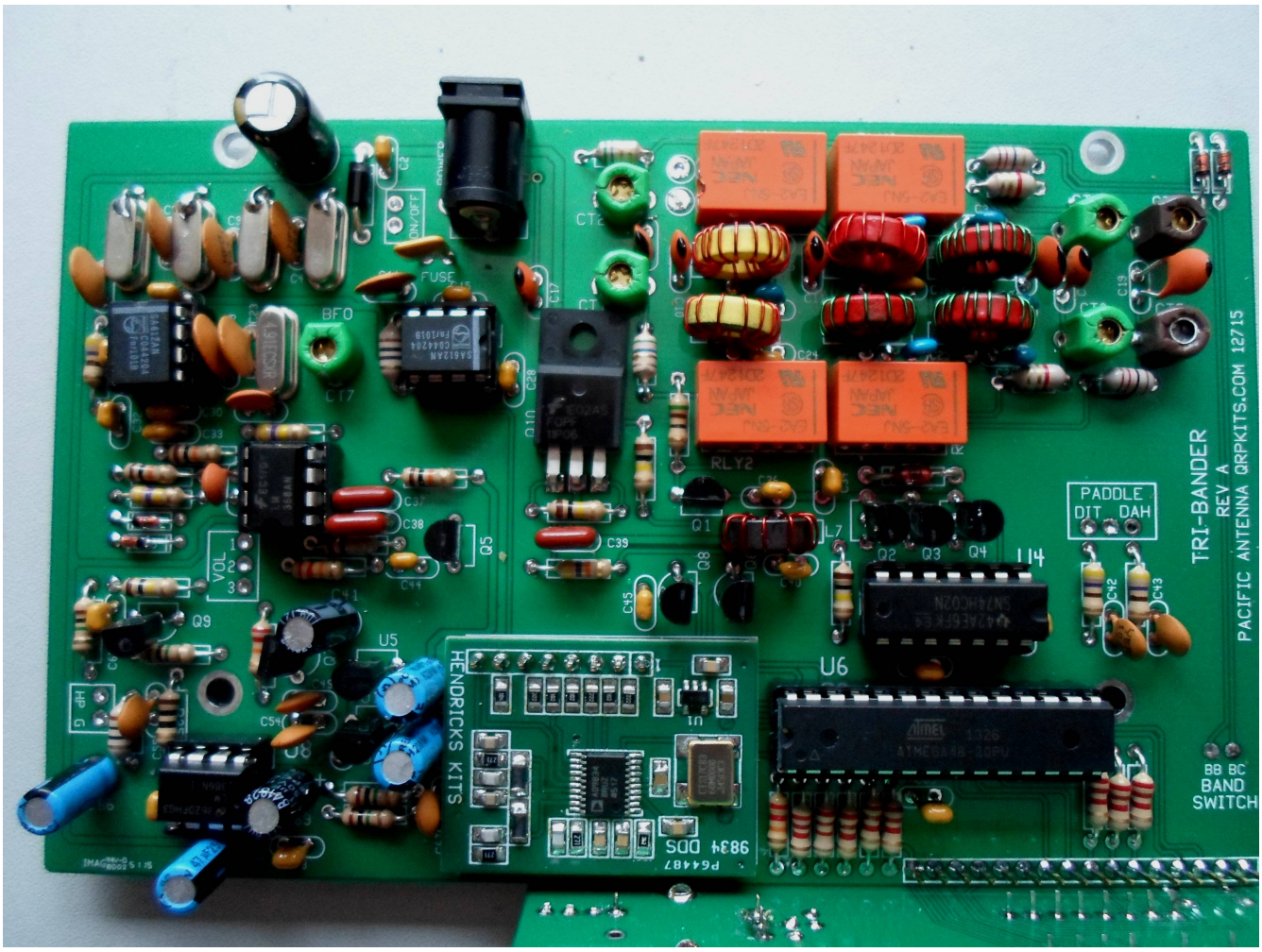
A second, ink jet friendly diagram is also included. At least one of these diagrams should be printed out for easy reference as you build up the board. Note that the band specific parts have no value labeled. See band table for values later in manual.



Ink jet friendly diagram:



Completed board



Note, R45 and D7 are missing from this photo, as they were later added.

Cabinet preparation:

Before starting on the board assembly, the cabinet should be prepared first. This way, it will be ready to go when you finish building the board.

1. Clean the cabinet.
2. (optional) paint the cabinet.
3. Apply decals.
    - When labeling the band select switch, note that the center position should be the lowest frequency band.
4. Attach tilt stand bail to bottom of cabinet.
5. Attach Red film over display cutout. Holes to clear the mounting stand offs and for switch can be made with a 1/4" dia paper punch. Tape in place.

Decal instructions:

The decals are applied in the same manor 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.

Use the picture on the first page as a guide for where the decals go.

Be sure to get the correct spacing away from the holes, 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. Use dish washing liquid soap and water (rise well), denatured alcohol or paint thinner.

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. (Unless you have elected to paint the chassis first).

1. Trim around the decal.

2. 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.

3. 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.

4. 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.

5. 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.

6. Allow to set overnight, or speed drying by placing near a fan for a few of hours.

7. When dry, spray two **light** coats of a clear matte finish such as Krylon clear to seal and protect the decals.

8. Allow time for each coat to dry between coats.

- All decals come with two complete sets, in case you run into problems.

Part by part placement guide: Resistors

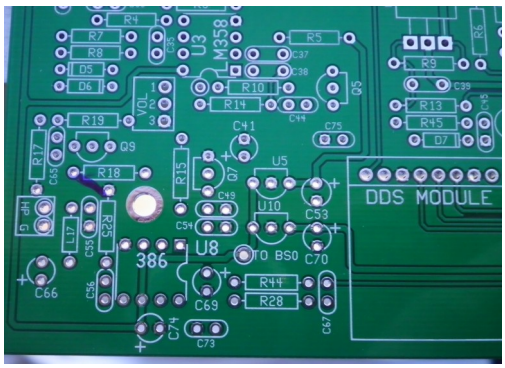
Read the color codes carefully as several values only differ by the zero multiplier band and can be easily confused with values with similar color coding. Some location designations have been eliminated so are not listed.

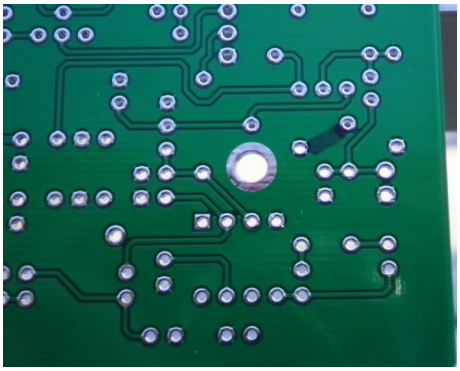
√	location	Value	Color code		√	Location	Value	Color code
	R1	470 Ω	YEL/VOL/BRN/GLD			R17	1 MEG	BRN/BLK/GRN/GLD
	R2	51 Ω	GRN/BRN/BLK/GLD			R18	1 MEG	BRN/BLK/GRN/GLD
	R3	470 K	YEL/VOL/YEL/GLD			R19	1000 K	BRN/BLK/YEL/GLD
	R4	10 K	BRN/BLK/ORG/GLD			R25	10	BRN/BLK/BLK/GLD
	R5	10 K	BRN/BLK/ORG/GLD			R28	1 MEG	BRN/BLK/GRN/GLD
	R6	100 K	BRN/BLK/YEL/GLD			R29	22 K	RED/RED/ORG/GLD
	R7	10 K	BRN/BLK/ORG/GLD			R30	2.2 K	RED/RED/RED/GLD
	R8	470 K	YEL/VOL/YEL/GLD			R31	2.2 K	RED/RED/RED/GLD
	R9	100 K	BRN/BLK/YEL/GLD			R32	2.2 K	RED/RED/RED/GLD
	R10	100 K	BRN/BLK/YEL/GLD			R33	2.2 K	RED/RED/RED/GLD
	R11	470 Ω	YEL/VOL/BRN/GLD			R34	2.2 K	RED/RED/RED/GLD
	R12	470 Ω	YEL/VOL/BRN/GLD			R35	2.2 K	RED/RED/RED/GLD
	R13	47 K	YEL/VOL/ORG/GLD			R36	2.2 K	RED/RED/RED/GLD
	R14	22 K	RED/RED/ORG/GLD			R37	2.2 K	RED/RED/RED/GLD
	R15	22 K	RED/RED/ORG/GLD			R44	470 K	YEL/VOL/YEL/GLD
	R16	100 K	BRN/BLK/YEL/GLD			R45	1 MEG	BRN/BLK/GRN/GLD

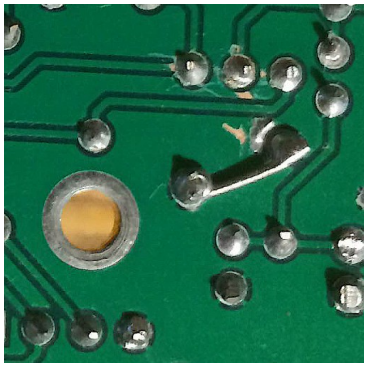
Note: On all Rev_A.1 main boards: When installing the resistors, you will need to add a jumper between one of the pads of R18 and R25. This is to provide proper grounding in the audio circuits. These two resistors are located in the lower left corner of the board. As shown in the photos below

This can most easily be accomplished by using part of the excess resistor lead from either R18 or R15 during their installation. It should be done after the leads are put through the board on both resistors. Otherwise, the solder might plug the hole for the resistor leads to go through the board.

The simplest is to first solder in R18 and R25 and then bend one of the leads over to contact the pad on the other resistor.
The pads to be used can be seen when holding the board facing you so that the text is oriented correctly. When viewed from above the board in this orientation, the pads to connect are the left side pad of R18 to the upper pad of R25 located adjacent to the mounting hole for the board as shown int eh photos below. In the first two the location is marked and in the last, a jumper is installed.







Jumper location shown on front of board **Jumper location shown on back** **Jumper installed**

If you have any questions regarding installing the jumper, please contact us at grpkits.com@gmail.com

Molded inductors

There are two (2) molded inductors (RFC) to install. These look like resistors but are a little shorter and fatter. Like resistors, the value is also color coded on the body of the part.

- Install L14/L17 – 10 uhy BRN/BLK/BLK/GLD

Diodes: Be sure to observe proper polarity. Band near end of part goes towards line on part outline.

- Install D1, D2, D5, D6, D7 – 1N4148 small glass body
- Install D3 – 1N5817 large plastic body.
- Install D4 – 1N4756A large glass body

Crystals:

The crystals are now installed, the locations are shown filled in with light gray. All the crystals are matched and the same frequency, so it doesn't matter which ones go where.

- Install X1 to X5
- Solder a resistor lead clipping to the pad located just above the X1 to X4 crystal tack solder it to the top of the crystal can to ground it.

IC sockets:

- IC sockets are now installed. **Make sure notch in socket is aligned with notch on part outline on board.**
- Before soldering, make sure they are flush to the board and that all the pins are sticking out of the holes on the bottom of the board. If a pin gets bent over as you are inserting the socket, this will be difficult to fix later.
- U1, U2, U3, U8 – 8 pin socket
- U4 – 14 pin socket
- U6 – 28 pin socket

Capacitors:

There are four types of capacitors used.

- Some caps may have lead spacing too wide for the board holes. Please take a few minutes to "unkink" the formed leads (typically the DISK caps) and straighten them out so the cap sits properly to the board.
- Multi-layer (MONO) caps, which are generally yellow and rectangular is shape.
- NPO type disks will have a black dot on the top edge of the cap. Note. Some of the ceramic disk caps will have lead spacing wider then the hole spacing on the board. In this case, use your needle nose pliers to kink both leads inward slightly to match the board hole spacing.
- Film capacitors. These will be green in color.
- Aluminum Electrolytic. These are round cylinders and have polarity. They must be installed with the correct polarity. Electrolytic caps inserted with the wrong polarity across the DC supply can heat up and explode! The negative lead is marked with a black stripe and the positive lead is always the longer lead.

Capacitor value markings:

The capacitor value is marked on the part with a two or three digit number and is read in picofards. The third digit is the zero multiplier. Values of less than 100 pfd generally show only two digits, but sometimes three. Therefore, if a part is marked 470, that means it is a 47 pfd cap and not a 470 pfd cap. A 470 pfd cap would be marked 471. Mono caps also often have letters printed on the part. These letters indicate the type or tolerance and can be disregarded.

NOTE: Electrolytic and band specific values which will be added later are not listed. Some numbers are no longer used.

√	location	value	type	√	location	value	type
	C2	0.1 ufd (104)	MONO, YELLOW		C36	0.1 ufd (104)	MONO, YELLOW
	C4	100 pfd (101)	NPO DISK, BROWN		C37	0.01 ufd (103)	FILM, RED box
	C5	100 pfd (101)	NPO DISK, BROWN		C38	0.01 ufd (103)	FILM, RED box
	C9	100 pfd (101)	NPO DISK, BROWN		C39	0.01 ufd (103)	FILM, RED box
	C13	100 pfd (101)	NPO DISK, BROWN		C40	0.1 ufd (104)	MONO, YELLOW
	C14	100 pfd (101)	NPO DISK, BROWN		C42	.001 ufd (102)	DISK, BROWN
	C15	0.1 ufd (104)	MONO, YELLOW		C43	.001 ufd (102)	DISK, BROWN
	C17	22 pfd (22)	DISK or MONO		C44	0.1 ufd (104)	MONO, YELLOW
	C22	0.1 ufd (104)	MONO, YELLOW		C45	0.1 ufd (104)	MONO, YELLOW
	C23	100 pfd (101)	NPO DISK, BROWN		C46	0.1 ufd (104)	MONO, YELLOW
	C27	0.1 ufd (104)	MONO, YELLOW		C48	0.1 ufd (104)	MONO, YELLOW
	C28	0.1 ufd (104)	MONO, YELLOW		C49	.001 ufd (102)	DISK, BROWN

	C29	100 pfd (101)	MONO, YELLOW		C54	.001 ufd (102)	DISK, BROWN
	C30	0.1 ufd (104)	MONO, YELLOW		C55	.001 ufd (102)	DISK, BROWN
	C31	470 pfd (471)	DISK, BROWN		C56	0.1 ufd (104)	MONO, YELLOW
	C32	0.1 ufd (104)	MONO, YELLOW		C63	0.1 ufd (104)	MONO, YELLOW
	C33	0.1 ufd (104)	MONO, YELLOW		C65	0.1 ufd (104)	MONO, YELLOW
	C34	0.1 ufd (104)	MONO, YELLOW		C67	.001 ufd (102)	DISK, BROWN
	C35	470 pfd (471)	DISK, BROWN		C73, C75	0.1 ufd (104)	MONO, YELLOW

- Trimmer capacitor CT 7 – Green trimmer. Make sure the flat side of the part is facing the line drawn in the circle outline on the board.

Transistors:

Be sure to properly ready the part number on the three legged transistors so they go in the proper place. A magnifying glass maybe helpful for this. When installing the part, look out of thin shavings of the plating on the leads which might come off as you push the legs into the holes. These can cause shorts between the leads. Space the package about 1/8" above the board – no not push real close to the board. Also, be sure to orientate the flat side of the package with the flat side of the part outline. Note that the leads of some the parts will have to be reformed to match the pad pattern on the board.

□ Install Q2, Q3, Q4 – BS170 mosfets – these are static sensitive!
□ Install Q1, Q6, Q7, Q8 – 2N7000 mosfets – these are also static sensitive.
□ Install Q9 – 2N3906 PNP
□ Install Q5 – 2N3819 j-fet
□ Install U5/U10 – 78L05 5V regulator
□ Install Q10, FQPFxxP06 – bend leads 90 degrees to body and mount flush to board. (xx is number which designates the parts current rating. Typically this number is "11".

- Now install all the Electrolytic capacitors. Be sure to observe proper polarity. **Long lead is plus side**. Black stripe on the body of the can indicates negative side. C1 can explode if installed backwards!

□ C1 - 220 ufd /16V (227 on the digram)
□ C41, C69 - 1 ufd /50V (105 on the diagram)
□ C53, C66, C70, C74 - 47 ufd /16V or 25V (476 on the diagram)

- DC PTC fuse, power jack and relays.

□ PTC fuse, yellow rectangle, 0.3" x 0.5" marked RUFE090 Locate behind DC power jack.
□ Install DC power jack
□ Install the four (4) relays, RLY1, RLY2, RYL3 and RYL4. Note the line on one end of the relay and match this with the line at the right end of the relay outline. Be sure to double check before soldering. If you get it in backwards, it's real hard to remove.

Initial test

Before we go any farther now is a good time to do the initial board test to see if the power supply circuits are working properly.

1. Solder a temporary jumper between the pads labeled "ON/OFF" near the power jack.
2. Using the power plug, connect up a 9V or greater power supply and turn it on.
3. Check for the presence of the 5V analog and digital regulator outputs.
    1. The analog 5V can be found at pin 8 of the U1 or U2 socket.
    2. The digital 5V can be found on pin 14 of the U4 socket.
4. If you fail these tests, figure out why.

Install L7 now

- Wind and install L7 – 10 turns #28 magnet wire on FT37-43 core (black)

DDS Module:

- Solder the 8 pin SIP pin strip to the main circuit board. Short pins down into main board, long pins up.
- Place the DDS module on the pins and solder in place.

NOTE: you might want to hold off soldering the module in to place until after you confirm it is working properly. A piece of cardboard can be used under the module to angle it up tight against the SIP pins to make a friction connection for testing.

Band specific parts:

Part locations are listed in table for band A, then band B and then Band C. The lowest frequency band should be made band A and the highest frequency band C. For example, band A could be 80 meters, while band C would be 15 meters, but not the other way around. This ensures the highest frequency band has the shortest track lengths.

On the color parts layout, band A parts are shown highlighted in light Blue, band B parts in Orange and band C parts in Red.

- Be sure to count the turns on the low pass filter coils, L8 through L13 correctly. Each time the wire passes through the center of the core, this is one turn. Having one extra turn, which is a common mistake, will result in reduced power output. Also the turns should be reasonably tight to the core. Sloppy winding can result in reduced performance. Evenly space the turns around the core.
-

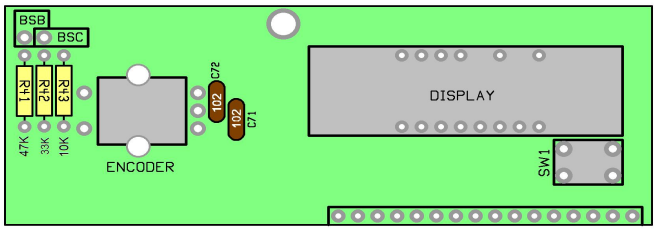
80			Value	Type		**40**			Value	Type
A				Will always be band A		**A**	**B**	**C**		
C12			100 pfd	101 NPO Disk		C12	C11	C10	68 pfd	NPO disk
C3			680 pfd	681 mono C0G		C3,	C8	C7	330 pfd (331)	C0G
C21			1500 pfd	152 mono C0G		C21	C16	C20	680 pfd (681)	C0G
C26			680 pfd	681 mono C0G		C26	C25	C24	330 pfd (331)	C0G
C19			15 pfd	15 NPO Disk		C19	C18	C6	10 pfd	NPO disk
CT5/6			70 pfd	Brown trimmer		CT5/6	CT3/4	CT1/2	70 pfd trimmer	Brown
L12			24 turns	#30 wire T37-2 Red		L12	L10	L8	18 turns	#28 wire T37-2 Red
L13			29 turns	#30 wire T37-2 Red		L13	L11	L9	20 turns	#28 wire T37-2 Red
L5/6			39 uHy	ORG/WHT/BLK/GLD		L5/6	L3/4	L1/2	12 uHy	BRN/RED/BLK/GLD

30			Value	Type		**20**			Value	Type
A	**B**	**C**				**A**	**B**	**C**		
C12	C11	C10	47 pfd	47 NPO Disk		C12	C11	C10	33 pfd	33 NPO Disk
C3	C8	C7	220 pfd	221 mono C0G		C3,	C8	C7	150	151 mono C0G
C21	C16	C20	560 pfd	561 mono C0G		C21	C16	C20	330	331 mono C0G
C26	C25	C24	220 pfd	221 mono C0G		C26	C25	C24	150	151 mono C0G
C19	C18	C6	4.7 pfd	4.7 NPO Disk		C19	C18	C6	2.2 pfd	2.2 NPO Disk
CT5/6	CT3/4	CT1/2	30 pfd	Green trimmer		CT5/6	CT3/4	CT1/2	30 pfd	Green trimmer
L12	L10	L8	13 turns	#28 wire T37-2 Red		L12	L10	L8	14 turns	# 28 wire T37-6 Yellow
L13	L11	L9	17 turns	#28 wire T37-2 Red		L13	L11	L9	18 turns	#28 wire T37-6 Yellow
L5/6	L3/4	L1/2	8.2 uHy	GRY/RED/GLD/GLD		L5/6	L3/4	L1/2	4.7 uHy	YEL/VIO/GLD/GLD

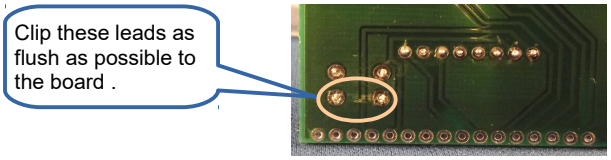
17			Value	Type		**15**			Value	Type
A	**B**	**C**				**A**	**B**	**C**		
C12	C11	C10	15 pfd	15 NPO disk		C12	C11	C10	15 pfd	15 NPO disk
C3	C8	C7	47 pfd	47 mono C0G		C3,	C8	C7	47 pfd	47 mono C0G
C21	C16	C20	220 pfd	221 mono C0G		C21	C16	C20	220 pfd	221 mono C0G
C26	C25	C24	100 pfd	101 mono C0G		C26	C25	C24	100 pfd	101 mono C0G
C19	C18	C6	2.2 pdf	2.2 NPO Disk		C19	C18	C6	2.2 pfd	2.2 NPO Disk
CT5/6	CT3/4	CT1/2	30 pfd	Green trimmer		CT5/6	CT3/4	CT1/2	30 pfd	Green trimmer
L12	L10	L8	13 turns	# 28 wire T37-6 Yellow		L12	L10	L8	11 turns	#28 wire T37-6 yellow
L13	L11	L9	16 turns	# 28 wire T37-6 Yellow		L13	L11	L9	14 turns	#28 wire T37-6 yellow
L5/6	L3/4	L1/2	3.3 uHy	ORG/ORG/GLD/GLD		L5/6	L3/4	L1/2	3.3 uHy	ORG/ORG/GLD/GLD

60 Meter		value	Type
A	B		
C12	C11	150 pfd	151 mono C0G
C3	C8	680 pfd	681 mono C0G
C21	C16	1200 pfd	122 mono C0G
C26	C25	680 pfd	681 mono C0G
C19	C18	4.7 pfd	4.7 NPO Disk
CT5/6	CT3/4	70 pfd	Brown trimmer
L12	L10	20 turns	#28 wire T37-2 Red
L13	L11	20 turns	#28 wire T37-2 Red
L5/6	L3/4	22 uHy	RED/RED/BLK/GLD

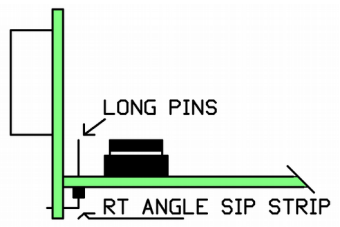
Front panel board assembly:

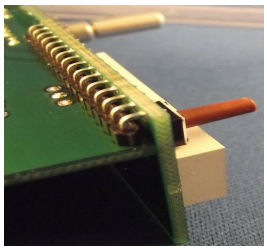


- R41, 47 K (YEL/VOL/ORG/GLD)
- R42, 33 K (ORG/ORG/ORG/GLD)
- R43, 10 K (BRN/BLK/ORG/GLD)
- C72, 102 disk
- C71, 102 Disk
- LED display module. This can only go in one way so there is no risk of it being up side down. Be sure to make sure it is square to the board as there is enough wiggle room on the pads it can be cocked a little. .
- Encoder.
- Tactile PB Switch. This can also go in only one way. NOTE: **Clip leads along bottom side of switch (just above the holes for the SIP pins) flush to the board and solder pins from front side of board.**



Mating Front panel board to Main board:





1. Insert long leads of SIP pin strip up through bottom side of main board. Make sure it is seated against the board along it's length.
2. Solder the pins and clip off the excess pin length
3. Attach front panel board to pins. Very little of the pins will stick through the pads on the front panel board. Solder one pin on the end of the strip from the back side of the board.
4. Make sure front panel board is pushed tight up against edge of main board and is at an exact right (90 degree) angle to the main board. It's a good idea to test fit the boards into the case to make sure. The board has to be angled into the case. Be careful of the push button switch that is goes into the hole under the display window.
5. Solder the rest of the pins.

Board mounting into cabinet and wiring: (see photo next page for suggested wire routing)

- Although you can top solder the wires with the board already in the cabinet bottom, it's easier to cut and attach the wires to the board before you put the board in the bottom piece.
- Cut the hook up wire to the lengths listed in the table and solder to the appropriate places on the board.
- Mount the volume control to the cabinet with the terminals facing “UP” This has to be done before installing the board.
- The board is now inserted into bottom section of the case by angling it in, making sure the shaft for the tuning encoder and Keyer PSB switch are lined up with their respective holes.
- Once the board is in place, the headphone, paddle and antenna jacks can be installed and wired up.
- Now wire up the volume control.
- Finish up by wiring the band select toggle switch. This is easiest to do before mounting the switch to the panel.

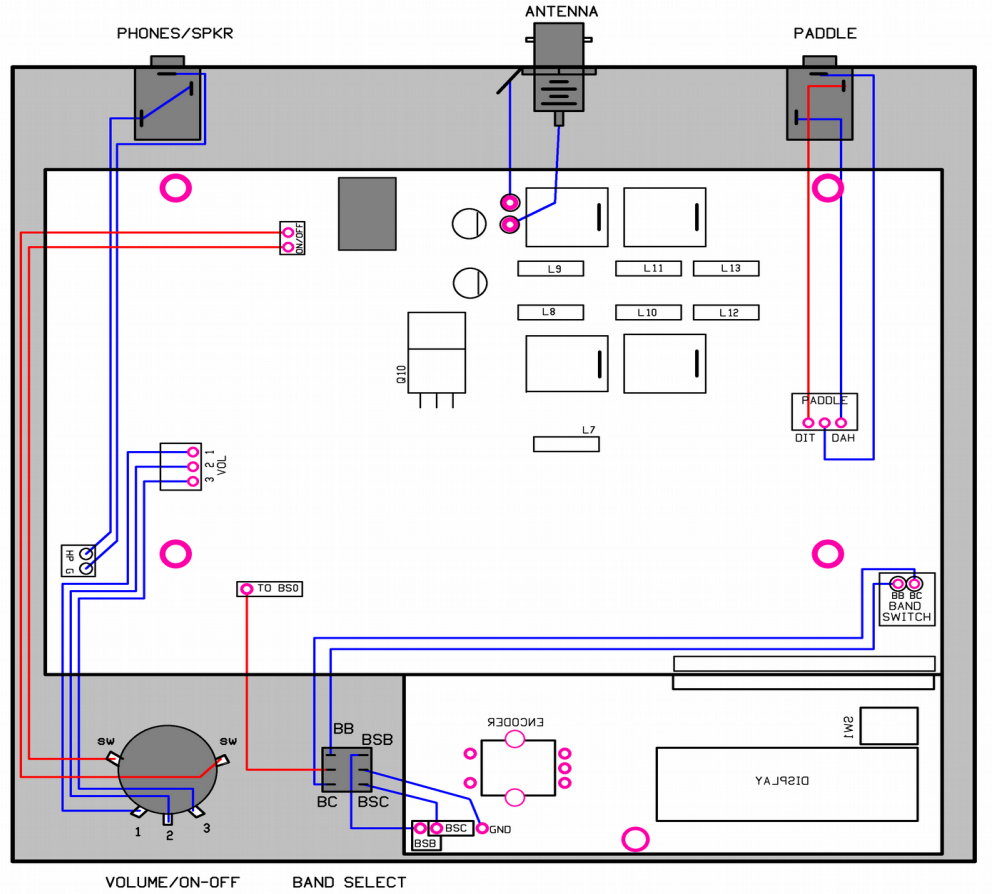
NOTE: You need to be careful when wiring up the toggle switch to match the relay and resistor selections to the same side of the switch and to match the decals you put of the front panel.

For example, say you have a 40, 30 and 20 band selection and you labeled the panel 30-40-20.

With the toggle to the left, the center pin will be connected to the pin on the right at the back of the switch, opposite the direction of the switch handle.

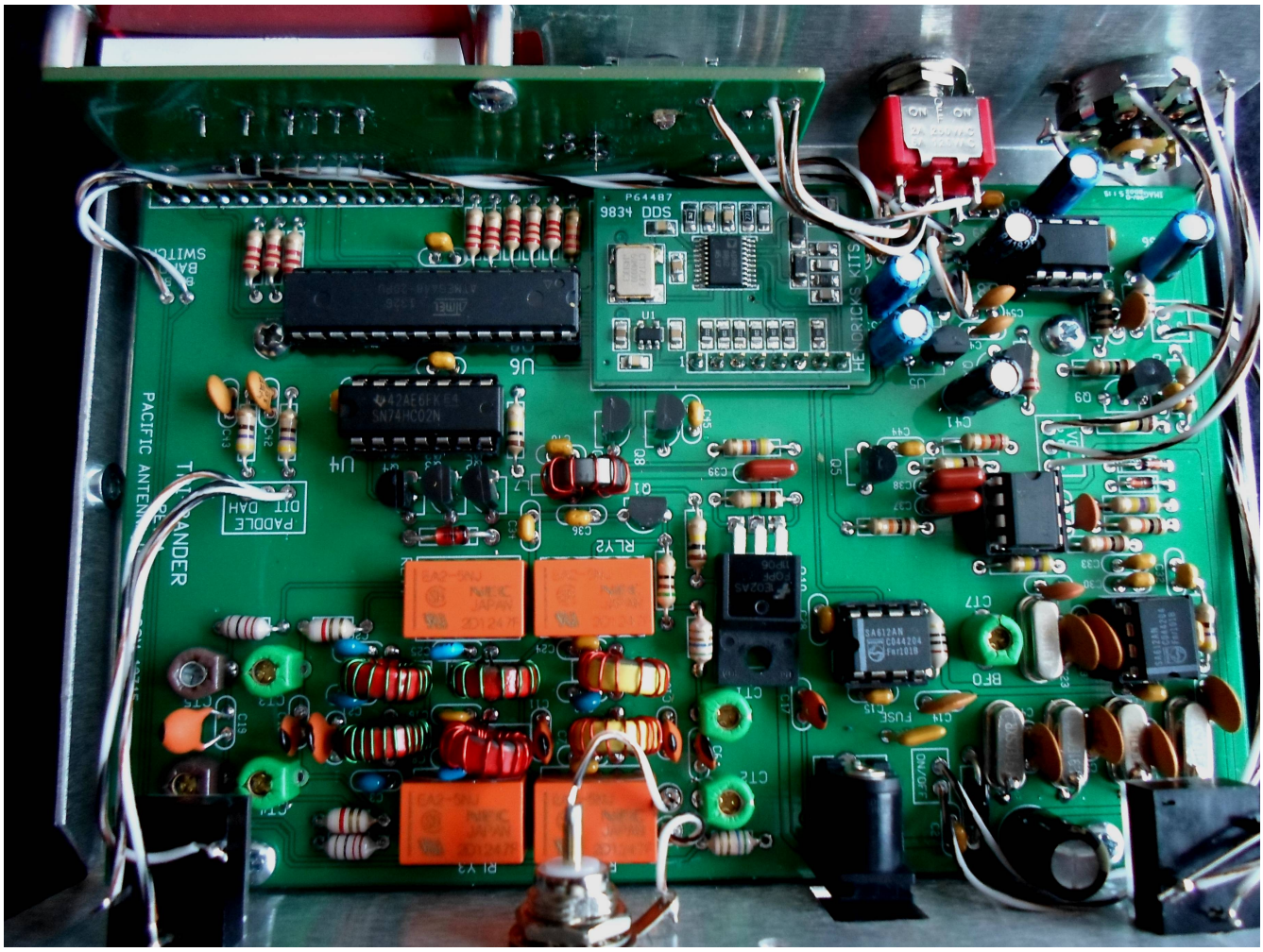
Therefore, you will want to wire the connections to band “B” to the terminals on the right side of the switch.

On/Off	2 wires, 6” long
VOL 1,2,3	3 wires, 2.5” long
Relay BB/BC	2 wires, 5.5” long
Band SW BSB/BSC	3 wires, 1.5” long
Band SW BS0	1 wire, 1.5” long
Phones/Spkr	2 wires, 3.5” long
Paddle	3 wires, 2.5” long
ANTENNA (BNC jack)	2 wires, 1” long



NOTE: band select switch shown mounted so toggle is vertical (up and down).

Assembled board, wired into case:



Note how wires “float” above the board.

Power up and test:

1. Insert the ATMEGA-48 chip into U6 socket. Just in case you put the socket in backwards, verify chip direction with parts layout diagram.
2. Insert LM386 chip into U8 socket
3. Insert the 74AC02 chip into the U4 socket
4. Connect power cable to power supply, plug into power jack on rig.
5. Plug a paddle into the paddle jack.
6. Plug speaker or headphones into headphone jack
7. Apply power to rig and turn on.
8. The display should now come on and read [bA8.0]

- You must now program the processor so it knows which frequency (in meters) you have selected for band A, B and C. bA80 shown on the display indicates band A is currently set to 80 meters.

1. Change the band setting by tapping the DOT paddle. This will advance the setting from 80 to 60, 60 to 40 and so on. The display will change accordingly and a beep will sound. [bA8.0], [bA6.0] and so on. After 15 meters, the selection will roll over back to 80 meters. This is done in case you go past the band you wanted, as there is no "decrement" switch.
2. Once the proper band setting is selected, advance to the next band to be set by clicking the keyer switch located under the display. The next higher frequency band will automatically be selected and displayed.
3. Select the band setting for the B band
4. Click keyer switch to advance to C band.
5. Select the band C band
6. Click the keyer switch to finish. The rig will reset to it's normal operation.

- If a mistake is made or at some point you what to change the filters on one of the band positions to operate on a different band, the band select mode can be enabled by holding closed the DASH paddle and the KEYER switch while turning power to the rig on.

Receiver testing and BFO adjustment:

1. Disconnect power from rig
2. Insert SA162A chips into U1 and U2 sockets
3. Insert LM358 into U3 socket.
4. Insert LM386 into U8 socket.

- Hold closed the DOT paddle and KEYER switch while turning power to the rig on.
- The rig will now be in a calibration mode and the display will show [CAL.r]
- If an accurate frequency counter is available, the DDS reference frequency can now be calibrated. Since the typical frequency error is usually 50 Hz or less, the calibration can be skipped by going to step 4 if a suitable frequency counter is not available.

    1. DDS frequency can be found at the pad labeled "DDS" to the left of U4 and is a 3.3V square wave.
    2. The DDS frequency is calibrated to exactly 10.000,000 MHz
    3. Use the Dot and Dash paddles to tune the DDS frequency up or down as required to set the frequency to 10.000,000 MHz.
    4. Finish by clicking the KEYER switch. This will advance to the offset/BFO adjust mode. The display will now show [CAL.o]

- If an Oscilloscope is available (it can be audio PC based 'Scope) the IF offset frequency can be set in addition to the BFO frequency. If a 'Scope is not available, the BFO trimmer will have to be set by ear. (skip to step 6)
    1. Connect the 'Scope to pin 7 of U3 (output of 1st audio stage, pad to the left of R10).
    2. Preset BFO trimmer (CT7) about ¼ turn.
    3. Using the paddle, tune LO frequency up and down, noting the point at which the signal amplitude starts to drop off.
    4. Tune the LO frequency be more or less centered in the pass band of the IF filter.
    5. Move the 'Scope to pin 1 of U3 (or top of volume control)
    6. Adjust BFO trimmer to peak signal in pass band of Audio Filter. If a 'Scope is not available, peak by ear, keeping volume control turned down so that AGC is not engaged.
    7. Once adjustments are finished, click the KEYER switch again to store these values and rest the rig.

- NOTE: When entering the Calibration mode, the default frequency values for reference and IF offset are loaded. This is done in case the values now stored in EEPROM become corrupted. Therefore, it is not possible to "test" the calibration by re-entering the calibration mode. If you wish to test the calibration, measure the transmit frequency on the highest band you have chosen to install into the rig, before and after calibration.
- If you haven't already soldered the DDS module in place to the SIP pins, you can do so now as it is working properly.
- If you were able to set the BFO trimmer, everything up to the 1st mixer is working correctly.
- You can now connect up an antenna (or signal generator) and peak the receiver input trimmer caps for each band. Peak for band noise or signal strength. The receiver will be quite deaf until the trimmers are properly peaked.
- Be sure to reduce the volume as you get a better peak or the AGC will prevent finding the best peak of the tuning caps.

Transmitter testing:

1. Connect a QRP RF power meter and dummy load to antenna jack.

2. Plug a straight key into the paddle jack or close the Dash paddle when turning on power so transmitter can be keyed on and off.

3. Check power output on all three bands. Using a 13.8 volt supply, the power output should be about 5 watts.

   Power output can be tweaked to some extent by changing the spacing of the turns on the low pass filter cores. With a little experimentation, it should be possible to achieve 5 watts output on each band.

   - Coils L8, L10 and L12 will have the most effect on power output. These are the inductors which follow the PA FETS, and influence the matching between the PA and load. When the turns on L8. L10 and L12 are most evenly spaced around the core, this will result in the maximum power output. Moving the turns closer together will reduce power output.

   - The inductors L9, L11 and L13 also have some effect on power output. These work opposite of the input side inductors, moving the turns closer together reduces power output.

   - If you have little or no power output and can not peak the receiver input with the trimmer caps, you probably have the wires from the band selector switch to the relays reversed and have the wrong filters selected for that band. Pretty easy to get it wrong.

Trouble shooting guide:

In most cases, any problems with the getting the rig to work will be tracked down to soldering problems or miss placed parts.

A close visual inspection of the board is often enough to find soldering problems or the miss-placed parts.

Soldering problems

These fall into four groups:

1. Missing solder connections

2. Solder bridges between closely spaced pads which should not be connected together.

3. Solder which stuck to the part lead but did not flow into the solder pad on the board. This is often caused by not using enough heat or not placing the iron tip on both the lead and the solder pad.

4. Not making connection to the wires on the toroid coils. Even if you pre-tined the magnet wire, you may have pulled it past the tinning when inserting the wires into the board and are not making a connection. Buzz out the connection to ensure continuity.

Miss-placed parts:

The most common error here is not reading the resistor color code correctly.

Some values have identical colors, but in a different order.

It is easy to mistake a 51 ohm resistor (Green/Brown/Black) for a 1 Meg resistor (Brown/Black/Green)

Trouble shooting technique:

The trick to trouble shooting is being able to narrow down the area to look at to find the problem. Just using a DVM will be sufficient for basic trouble shooting. For more difficult cases, an Oscilloscope and signal generator may be needed to track signals through the circuits.

In any case, one should first determine which parts of the circuit are working properly and this will lead you to what is not.

If the rig is completely dead, the problem is likely with the power supply and could very well be a short to ground somewhere on the 5 volt supply feeding most of the IC's.

If the display comes on, the microprocessor is working and if you get side tone when you use the paddle, or hear hiss when the volume control is turned all the way up, the audio amp is working.

If there is no side tone or hiss, the problem maybe a simple as the wiring to the speaker/headphone jack.

If you get audio, but can not hear any off air signals, the problem is more difficult to find as it could be anywhere between the antenna jack and the audio amp.

In this case having a signal generator and Oscilloscope are of great help in tracing the signal though the circuits.

Transmitter:

There is not a whole lot which can go wrong with the transmitter portion.

Check for PA keying voltage coming out of Q10, proper soldering of the toroid magnet wire.

Also make sure the proper filters are being selected with the band switch!

Voltage Tables:

The expected voltages listed in the tables below may be of help in diagnosing issues:

U4 74AC02 PA driver, Quad NOR gate

Pin#	Voltage	Pin#	Voltage
1	0	14	5V
2	0	13	0
3	5V	12	0
4	0V	11	5V
5	5V	10	5V
6	0	9	0
7	0	8	0

U1/U2 SA612A Mixers

Pin#	Voltage	Pin#	Voltage
1	1.4V	8	5V
2	1.4V	7	4.25V
3	0	6	4.96V
4	3.9V	5	3.9V

Pin1/2 signal in Pin 6 Osc in
Pin 4/5 signal out Pin 7 Osc out

DC Voltage on pins 6/7 maybe influenced by RF present on pins.

U3 LM358 audio preamp / BP filter

Pin#	Voltage	Pin#	Voltage
1	5V	8	DCIN
2	5V	7	5V
3	5V	6	5V
4	0 (GND)	5	5V

DCIN = board supply voltage, less diode drop.

U8 LM386 audio power amp

Pin#	Voltage	Pin#	Voltage
1	1.33V	8	1.34V
2	0	7	½ DCIN
3	0	6	DCIN
4	0 (GND)	5	½ DCIN

U6 MEGA48 Microprocessor

Volt	5V	0V	0V	0V	5V	0V	0V	5V	5V	5V	5V	DS	5/0	5/0
Pin#	28	27	26	25	24	23	22	21	20	19	18	17	16	15
Pin#	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Volt	0V	DS	DS	DS	DS	DS	5V	0V	DS	DS	DS	DS	DS	DS

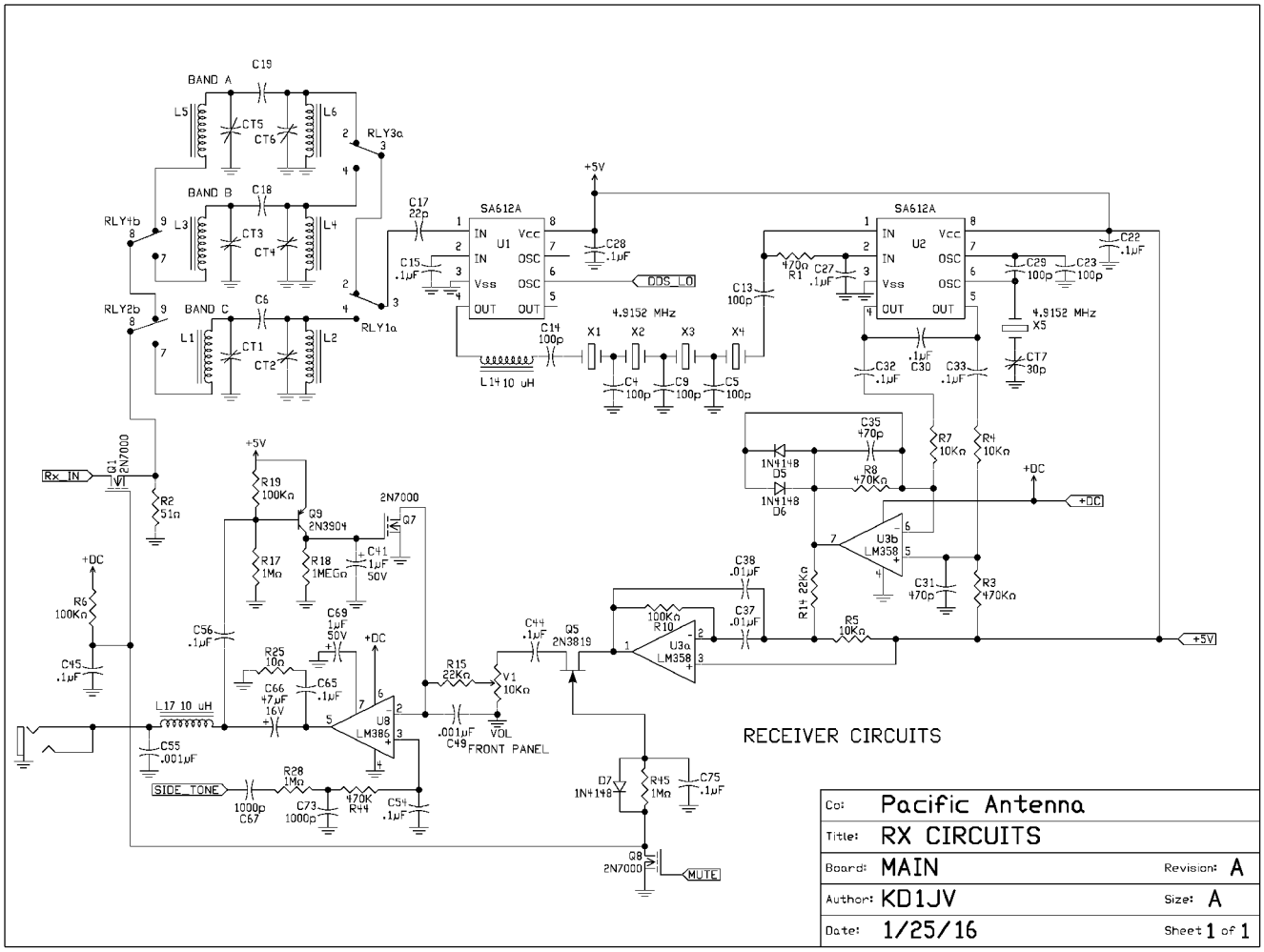
DS = Display segment or digit select voltage varies depending on digits displayed and duty cycle.

Pins 15/16 Tuning encoder inputs, voltage depends on position of encoder, may be high (5V) or low (0V)

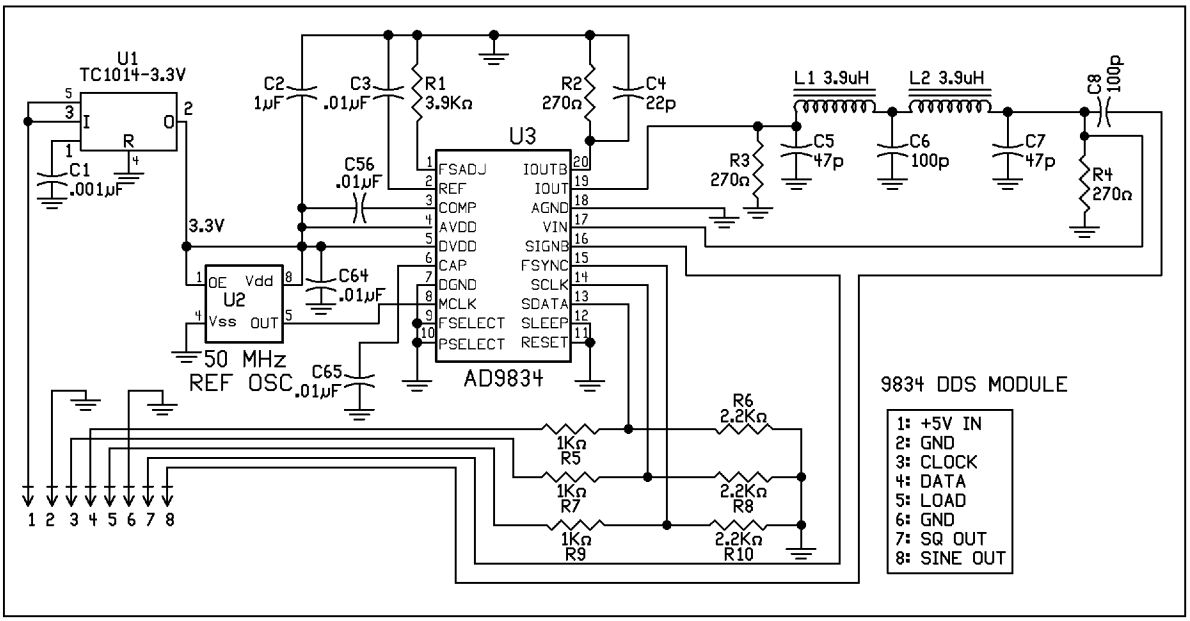
Note: These values may vary slightly due to component variations, etc but should be close to these values.

Schematics:

RX Circuits:



DDS Module:



MPU, DDS and TX Circuits: