The ATS-4 (rev b)

5 band CW
PSK31 mode capable

Manual for Rev B Assembly only
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Construction:

The first thing to do is to read through all the assembly steps and look at all the pictures and diagrams, so that you know what the assembly order is and what it is suppose to look like when done.

Band selection options

Option 1 – Build for either the 17 meter *OR* the 15 meter band as the upper frequency band.

Option 2 – Eliminate 80 meters and include both 17 and 15 meters.

For option 1, the only difference between building for 17 instead of 15 is the value of a resistor in the band selection voltage divider and the number of turns used in the transmitter low pass filter.

For option 2, the band specific parts all move over to the left one position, so that 40M in now in the 80M position and so on. Do not install 17 or 15 meter parts in the 80M switch position or stability problems will occur! The main problem with this option is the labeling on the front cover for band selection is no longer valid. This option is included because many Hams do not have an 80 M antenna and the length of wire needed for 80M portable work is a bit unwieldy. For strictly portable use, having both 17 and 15 meters is likely a better choice than 80 and either 17 or 15.

NOTE: The extra filter parts needed to build both the 17 and 15 meter bands will be available from KD1JV for $5.00.

Keeping track of the small parts:

The best way to keep track of the small parts and not to lose any is to open the parts packages over a large soup bowl and dump the contents of the package into it.

Replacing missing or lost parts:

I have been know to forget to put a part into the kit on occasion. However, it is more common to have a chip resistor or cap get away from you, never to be seen again happens from time to time. These parts are easy to replace, just send me an email and will mail what you need to you. I have limited supplies of the semiconductors, especially the DDS chip and display, so try not to damage those! I will need to charge you to replace either of those.

Parts packaging organization and where the heck is the circuit board?:

The Circuit board is inside the case, along with the display and backlight module. The rest of the parts are grouped in the sealed plastic envelopes more or less according to type of part. All the hardware is in one section, chip resistors and caps in another, etc. Most of the parts you need for a given assembly step will all be in the same group of parts.

Tools:

In addition to your normal hand tools, a pair of reasonably fine tipped tweezers for handling the parts is needed. An alternative to using tweezers (which can on occasion make a part go flying, never to be seen again) is a tooth pick or chop stick with a little bee's wax on the tip. The bee's wax makes the end sticky so you can pick up the part and hold it in place. (You will need a second tool to release the part from the toothpick, like the tip of a hobby knife) Most builders require a magnifying glass or visor to see and read the part numbers on the parts. You will also need some magnification to inspect the solder connections. Finally, you will need some solder wick to remove solder bridges between IC pins which are inevitable, especially between the pins of the DDS chip U5

You will need a soldering iron with a small tip. A 1/16” chisel tip is good. Conical tips don't work as well, as they have less contact with the end of the parts and the solder pads. Low wattage is not a requirement and can do more harm than good, as it takes longer to get a joint hot enough to melt the solder.

Since most, if not all the semiconductors are static sensitive, building in a static free environment is important. Wearing cotton clothes and using a wood top work bench usually satisfies this requirement. Many builders like to use a large cookie sheet with raised edges to work on. This not only keeps static at bay, the raised edges makes it less likely to loose parts.

Hand soldering vs using solder paste:

It is quite possible to build the rig using hand soldering. Sufficient small diameter solder is supplied for this purpose. PLEASE DO NOT USE LIQUID FLUX! It can not be easily cleaned out from under parts and can cause no end of odd problems due to leakage around high impedance nodes.

Using solder paste results in a much neater looking final product, is easier and is often more reliable than hand soldering. A video compatible with Windows media player illustrating both techniques is included on this CD.

When using solder paste, preheating the board with a hot plate is recommended. Because of the size and thickness of the board, just using an embossing heat gun takes too long to get up to temperature. It is generally best to install all the parts before melting the solder. This reduces the heating and cooling cycle to just one or two. One must be careful not to nudge parts once they have been placed, so it is best to work top down and from one corner inwards. If you don't want to place all the parts at once, put the board into a seal-able plastic container and leave in the refrigerator until you can get back to it. But don't leave it there too long or the flux in the solder will eventually dry out.

Solder paste is available in small quantities from Cash Olsen, KD5SSJ for $5.00 plus postage. See http://kd5ssj.com/solderpaste

Chip capacitors:

Chip capacitors are not marked with their value, so their part carries are color coded to indicate the value. So that you don't mix up values, it is best to place all the caps of a given value at one time before starting on another value. This may not be advisable when using solder paste, so only remove them one at a time from the carrier instead of all at once.

The order of parts placement:

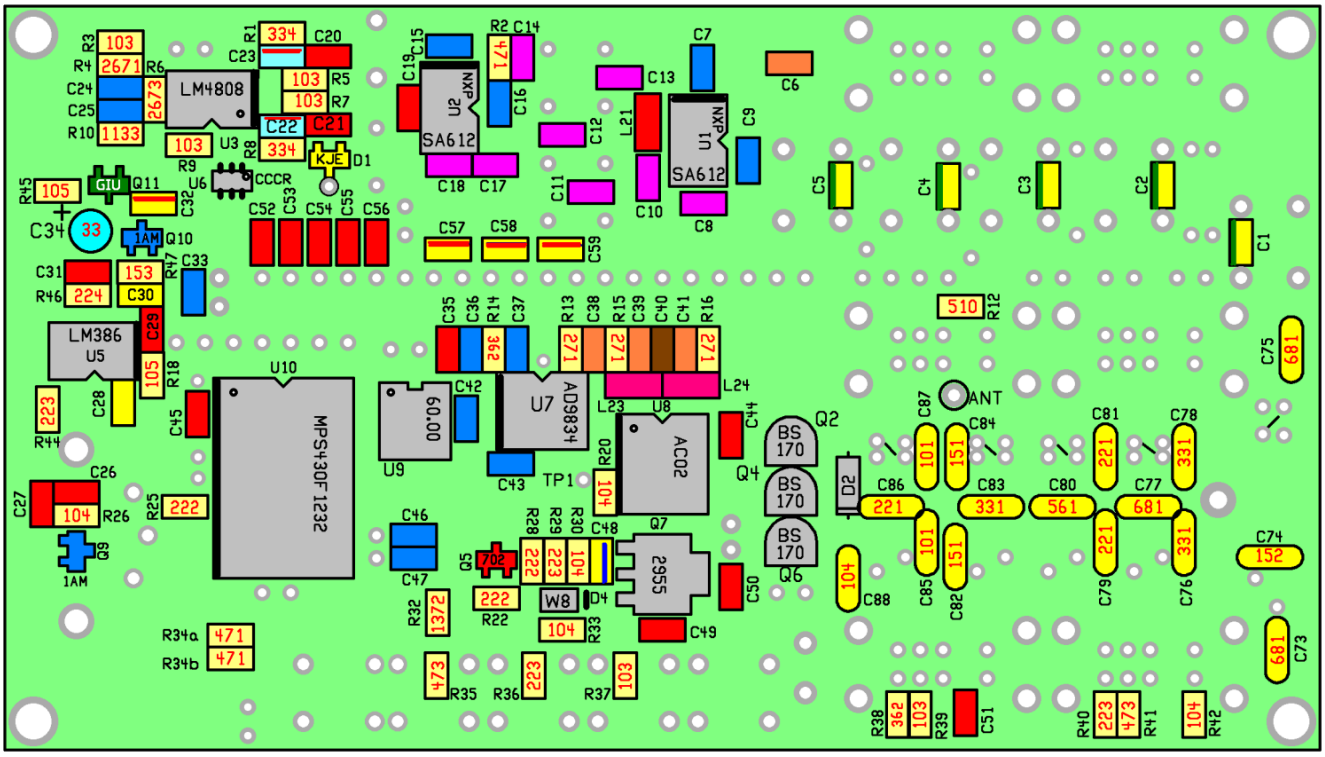
The semiconductors will go on first, as in some cases getting to the leads when hand soldering can be obstructed by other near-by parts. Then we will do the capacitors, and then the resistors. The “busy” bottom side of the board will be done first, then the top side. Once all the SMT parts have been mounted, we can start with the through hole parts.

Placement diagrams:

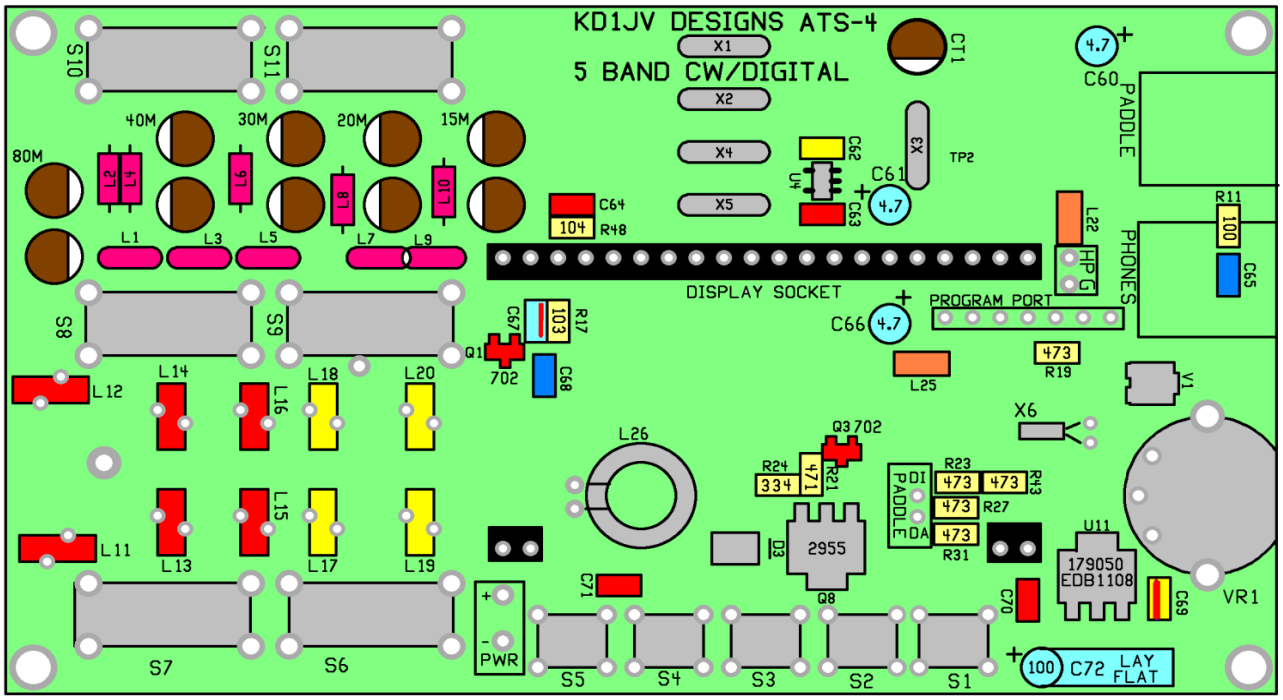
The placement diagrams are color coded with the color corresponding to the color marked on the part, if any. Resistors are marked with their value, as shown on the part and are highlighted in pale yellow. The two composite placement diagrams should be printed out for easy reference. Placement diagrams showing just the parts to be installed at that time are used for IC, capacitor, resistor, etc., so that the diagram is less “busy” and just the parts being placed at that time are more obvious.

Parts placement diagrams

This page should be printed out for easy reference while doing the assembly.
Bottom side parts placement:



Parts placement for top side of board:



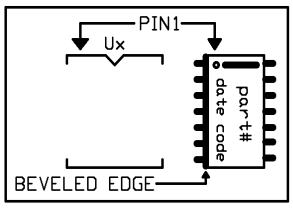
Parts inventory list:

Quantity	value	color/type		Quantity	Value	Code / color	Description
1	10 ohms	100 0805 resistor		1	LM4808		SOIC-8 audio amp
1	51 ohms	510 0805 resistor		2	SA612A		SOIC-8 mixer/oscillator
3	270 ohms	271 0805 resistor		1	LM386		SOIC-8 Audio amplifier
4	470 ohm	471 0805 resistor		1	74LVC1G3157	CC5R	SOT-23-6 SPDT analog switch
1	1K	102 0805 resistor		1	74AC02		SOIC-14 quad OR gate
3	2.2 K	222 0805 resistor		1	AD9843BRUZ		TSSOP-20 DDS
2	3.6 K	362 0805 resistor		1	MSP430F1232DW		SOIC-28 microprocessor
7	10 K	103 0805 resistor		1	TC1014-3.3V	A5CE (Orange)	SOT-23-5 3.3V LDO reg
1	15 K	153 0805 resistor					
4	22 K	223 0805 resistor		1	MCP1709-5002E/DB	1709050	SOT-223 5.0V 50 ma LDO reg
7	47 K	473 0805 resistor		2	MMBT3094	1AM (Blue)	SOT-23 NPN transistor
6	100 K	104 0805 resistor		1	SS12	S2	1A / 20V Schottky diode
1	220K	224 0805 resistor		1	BZT52C5V1-7-F	W8	5.1 V Zener diode
3	330 K	334 0805 resistor		1	BZX85C47		47V 1W zener diode
2	1 MEG	105 0805 resistor		1	BV99	KJE Yellow	SOT-23 dual silicon diode, series
1	2.67 K 1%	2671 0805 resistor		3	2N7002	702 (Red)	SOT-23 N Channel MOSFET
1	13.7 K 1%	1372 0805 resistor		1	MMBE5461	GIU (Green)	SOT-23 P Channel J-FET
1	113 K 1%	1133 0805 resistor		2	NDT2955	2955	SOT-233 P channel MOSFET
1	267 K 1%	2673 0805 resistor		3	BS170	BS170	TO-92 N channel MOSFET
1	10K	3mm smt trimmer		1	60.000 MHZ	60.00 CTS	5x7mm 60.000 MHz clock oscillator
5	3.3 pfd	Yellow/Green stripe		1	32.768 kHz		Watch crystal small cylinder
4	22 pfd	Orange		5	4.9512 MHz		HC49US matched set to 10 Hz
1	47 pfd	Brown		1	0.1 ufd 50V	104	0.1” LS X7R ceramic cap
8	100 pdf	Violet		3	4.7 ufd/16V		5 mm aluminum electrolytic
3	470 pdf	Light Blue/Red stripe		1	33 ufd / 16V		5mm
2	.001 ufd	Yellow		1	100 ufd /16V		7 mm
15	.01 ufd	Blue		1	EADOGM132E-5		LCD graphics module
1	.022 ufd	Yellow/Blue stripe		1	EALED55X31-G		Green/amber LED back light module
22	.1 ufd	Red		1	40 pin 0.6” DIP	IC Socket	
5	1.0 ufd	Yellow/Red stripe		1	17mm 50K audio		Thumb wheel pot
3	10 uhy	Orange 1206 RFC		1	Knob and screw	For above	
2	3.9 uhy	Red 1206 RFC		4	6mm x 17mm		TACT switch, red handle
	Filter parts:			1	6 mm x 14 mm		TACT switch
2	39 uhy	RFC		2	3.5 mm stereo	Phone jack	With nut, panel mount
4	10 uHy	RFC		1	1.8 mm coaxial	Power jack	
2	6.8 uhy	RFC		1	1.8 mm	Power plug	Mouser P/N 171-3219-EX
2	3.9 uHy	RFC		1	RCA phone jack		
11	60 pfd	Brown trimmer cap		6	DP3T switch		Slide switch
1	15 pfd	C0G ceramic cap		4	# 4-0.25”		Machine screw
1	22 pfd	C0G ceramic (22)		4	# 4 -0.625”		Machine screw
1	47 pfd	C0G ceramic (47)		4	#4 1/4” spacer		Hex threaded

1	68 pfd	C0G ceramic (68)		4	#4 3/8” spacer		Hex Threaded
3	100 pfd	C0G ceramic (101)		4	# 4 fiber washer		
2	151 pfd	C0G ceramic (151)		6	T30-2	Red core	
3	220 pfd	C0G ceramic (221)		4	T30-6	Yellow core	
3	330 pfd	C0G ceramic (331)		1	FT37-43	Black ferrite core	
1	560 pfd	C0G Ceramic (561)		4	wire	#30 magnet	#22, #24, #26 Teflon insulated
3	680 pfd	C0G ceramic (681)		8	#4 lock washer		
1	1500 pfd	C0G ceramic (152)		1	Clear display	window	
				1	Felt cloth		
				1	case		

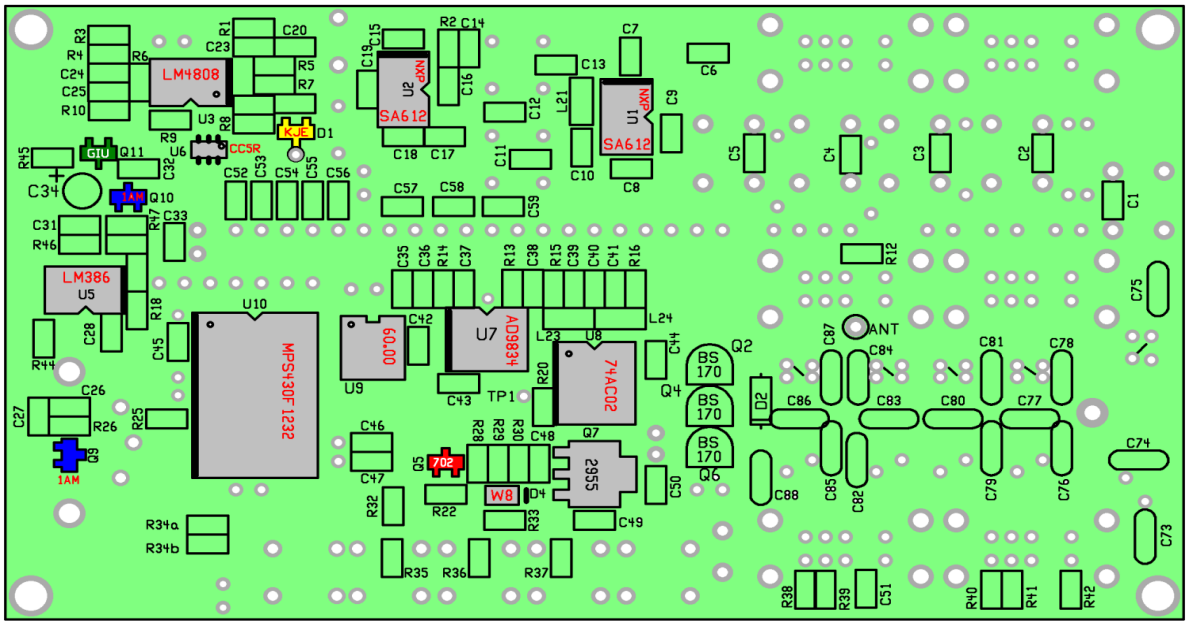
Semiconductor placement:

Finding the Pin 1 corner of the IC's.



The Pin 1 corner can be identified in several ways. Some of the chips have a dot in the upper left corner, which corresponds to the dot in the placement diagram. In some case, the manufactures logo will be located on the pin 1 edge of the package. In all cases, there will be a slightly beveled edge on the Pin 1 side of the chip, indicated by the line near the outside edge of the outline shown on the placement diagram. If the chip is orientated so that the lettering reads properly left to right, top to bottom, pin 1 is always the lower left corner.

Chip markings: Because of the size of the parts, the full part number sometimes is not shown on the part, instead a code is used. In addition, often there is a date code which will change depending on when the parts are bought, so these are not shown. Semiconductors are shown highlighted in gray or with the color code used on the carrier.



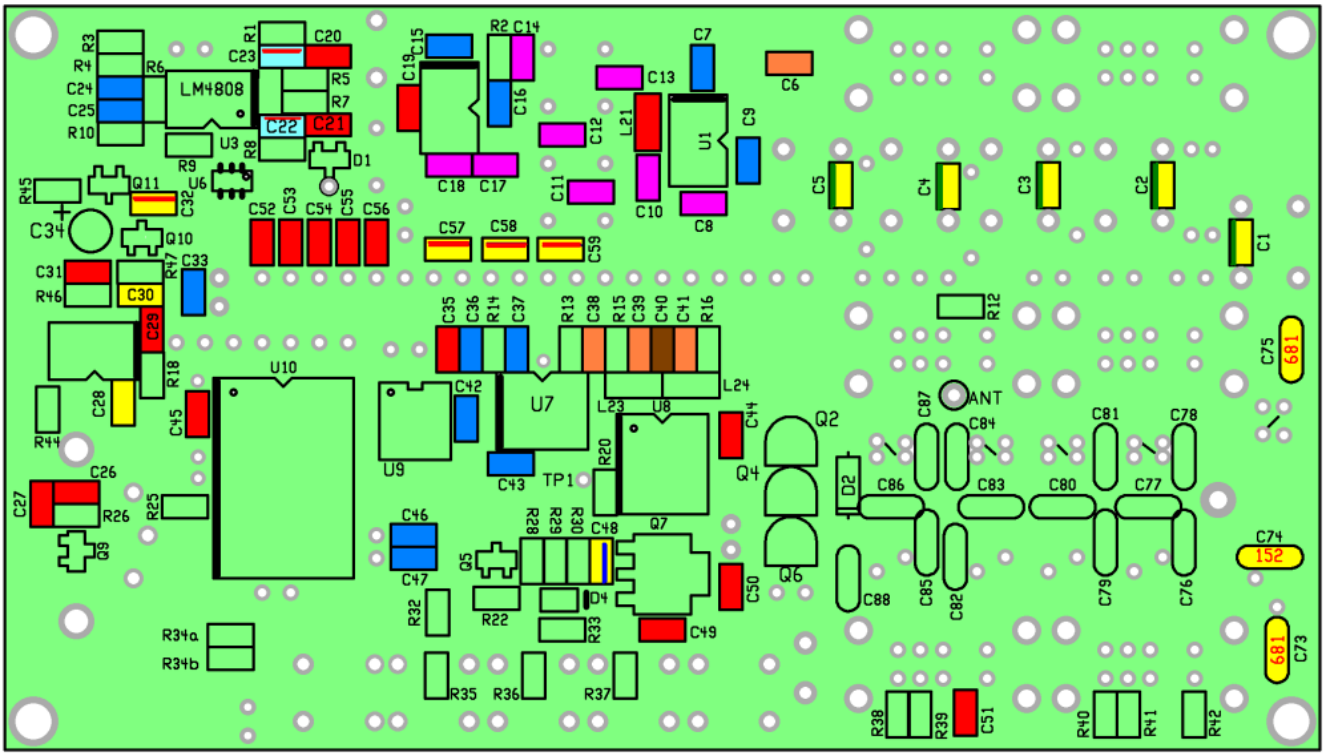
Location	Part marking/color	Package type	
U1/U2	SA612A	SOIC-8	Mixer/Oscillator The pin 1 end is less than obvious. Look for “NXP” in one corner and this will be the pin 1 end.
U3	LM4808	SOIC-8	Dual op amp
U5	LM386	SOIC-8	Audio amp
U6	CC5R	SOT-23-5	Look carefully for the dot in the corner of the chip
U7	AD9834	TSSOP-20	The pins on this chip can break off easy, try not to bend them to the sides!
U8	74AC02	SOIC-14	Quad OR gate
U10	MPS430F1232	SOIC-28	Processor
Q5	RED (702)	SOT-23	2N7002 MOSFET
Q9, Q10	Blue (1AM)	SOT-23	MMBT3904 NPN transistor
Q11	Green (GIU)	SOT-23	P channel J-FET
Q7	NDT2955	SOT-223	NDT2955 P channel MOSFET (do not mix up with 5V regulator, which is loose in parts bag. There are two mosfets, packaged in a parts carrier strip.
D1	Yellow (KJE)	SOT-23	BAV99 dual silicon diode
D4	W8	Tiny!	This part is located to the left of Q7. Carefully note the line on one end of the part and face towards the line on the board to the left of the D4 label.
U9	60.00 (silver rect)	5x7 mm clock	Note pin 1 dot on case. Make sure solder wicks up into the pad cups.

Check for and remove any solder bridges between pins on the ICs after soldering.

Capacitor placement, bottom side:

Pay careful attention to where each capacitor goes. Since the values of the caps are not marked on the part, if you place the wrong value somewhere, it will be next to impossible to find later.

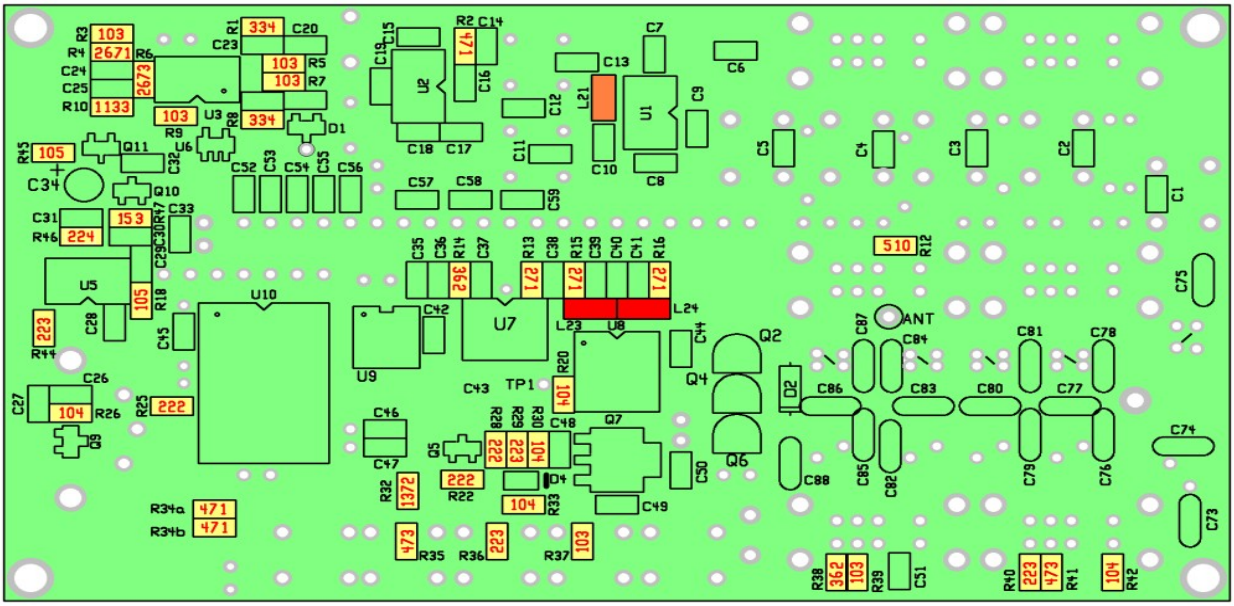
Note: Several caps are used on the other side of the board. Snip these off the carrier strips (make sure you preserve the color coding) and put aside (in a safe place) for now. 4 –Red, 2 – Blue, 1 – Yellow, 1 – Light blue/red strip, 1 – Yellow/red strip



COLOR	Designation	Number of locations	Value
Yellow Green Stripe	C1, 2, 3, 4, 5	5	3.3 pfd
Orange	C6, 38, 39, 41 (be careful not to put in any RED locations!)	4	22 pfd
Brown	C40	1	47 pfd
Violet	C8, 10, 11, 12, 13, 14, 17, 18	8	100 pfd
Light Blue/ Red stripe	C22, 23	2	470 pfd
Yellow	C28, 30	2	0.001 uF
BLUE	C7, 9, 16, 15, 24, 25, 33, 36, 37, 42, 43, 46, 47	13	0.01 uF
Yellow Blue Stripe	C48	1	0.022 uF
RED	C19, 20, 21, 26, 27, 29, 31, 35, 44, 45, 49, 50, 51, 52, 53, 54, 55, 56	18	0.1 uF
YELLOW RED Stripe	C 32, 57, 58, 59	4	1.0 uF

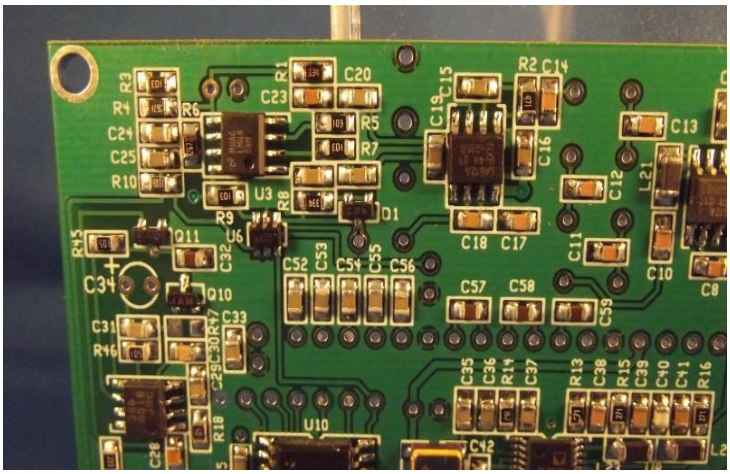
Resistor, bottom side:

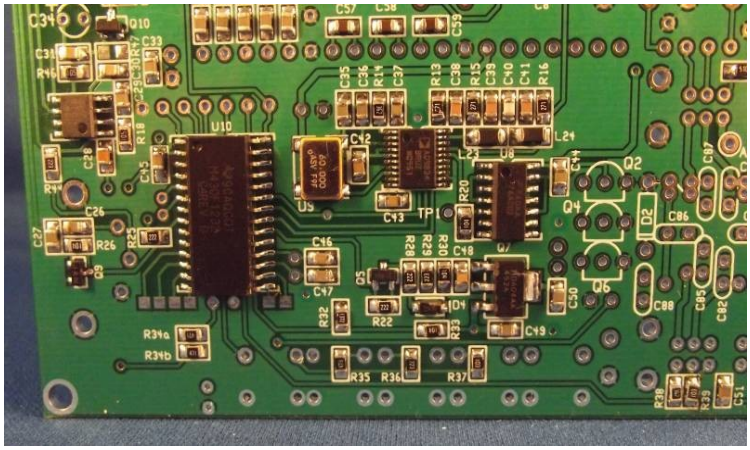
Resistor codes – there are two types of resistors used, 5% and 1%. 5% use a 3 digit code, the first two digits being the most significant digits and the last the zero multiplier. Therefore, a 10 ohm resistor is marked 100 and a 100 ohm resistor 101, 1 K ohm 102, and so on. 1% resistors use a four digit code, as they have more value steps than 5%. Again, the last digit is the zero multiplier. Therefore a 2.67 K ohm resistor is marked 267. Resistors are highlighted in pale yellow to make them stand out from the background. There are also three inductors to be placed in this step. These are color coded orange and pink, are larger than the resistors and have a solid black body.
NOTE: when building for 17M, change R38 value to 1K, 102 resistor.



Value marking	Location designation	# of places	value	
510	R12	1	51 ohms	
271	R13, 15, 16	3	270 ohms	
471	R2, 34a, 34b	3	470 ohms	
222	R22, 25, 28	3	2.2 K	
362	R14, R38	2	3.6 K	Note: make R38 1K (102) for 17 meter band
103	R3, 5, 7, 9, 37, 39	6	10 K	
153	R47	1	15K	
223	R29, 36, 40,44	4	22 K	
473	R35, 41	2	47 K	
104	R20, 26, 30, 33, 42	5	100 K	
224	R46	1	220K	
334	R1, R8	2	330 K	
105	R18, R45	2	1 MEG	
2671	R4	1	2.74 K 1%	
1372	R32	1	13.7 K 1%	
1133	R10	1	113 K 1%	
2673	R6	1	267 K 1%	
Orange	L21	1	10 uhy inductors	Back, 1206 size
Red	L23, L24	2	3.9 uhy inductors	Black, 1206 size

The board should now look like the photos below.



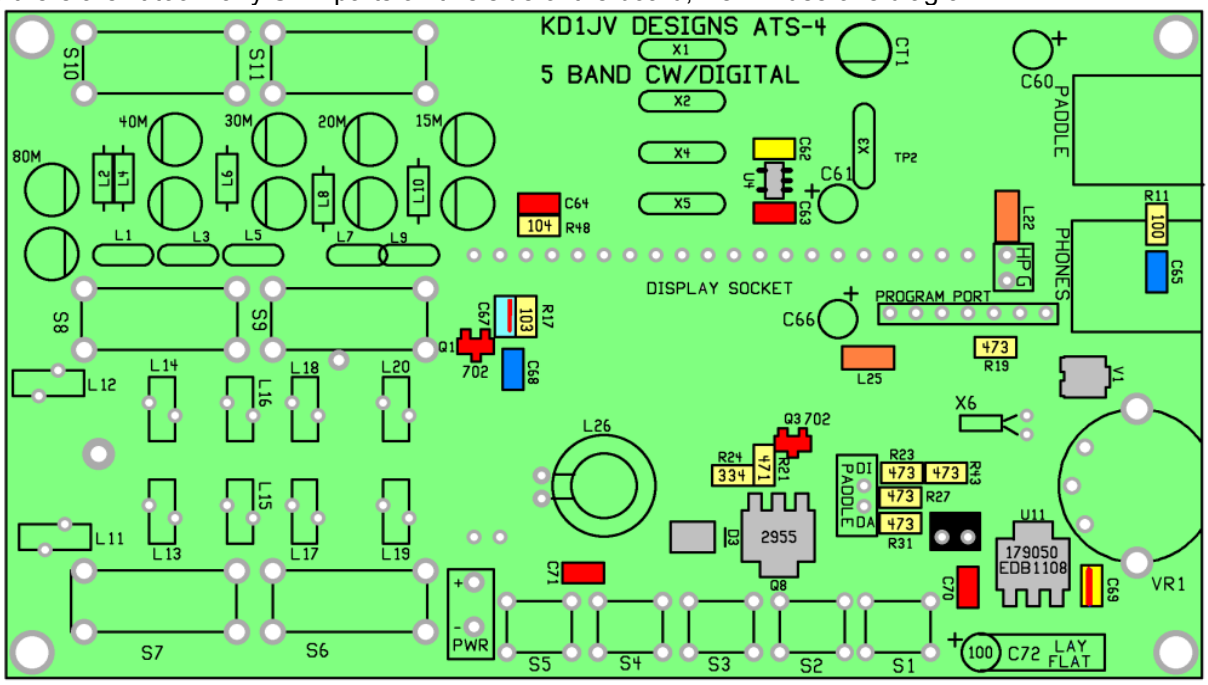


Since the number one reason a kit does not work the very first time power is applied is due to soldering issues, it is well worth it to spend time now carefully inspecting your soldering. Finding and correcting these problems now will save you much time and frustration trying to find them later. Use a magnifying glass to inspect the connections to each part and IC lead. There are several things to look for.

1. Missing solder connections. It is not uncommon to forget to solder both ends of a chip resistor or cap. Often the unsoldered end will make contact with the board – for a while and later become intermittent. You may have also missed soldering some IC pins – maybe even a full row on one side of the chip.
2. Solder did not flow onto the end of the part or onto the solder pad.
3. Bad or intermittent connections to one or more of the clock oscillator solder terminals is a common problem.
4. If using solder paste, make sure all the connections turn shiny silver. If any remained dull gray, not enough heat was used there and can be fixed with a touch of your soldering iron.
5. Shorts between IC leads. The DDS chip is most prone to this and bears careful inspection.

Top side SMT parts:

Since there aren't too many SMT parts on this side of the board, we will use one diagram.

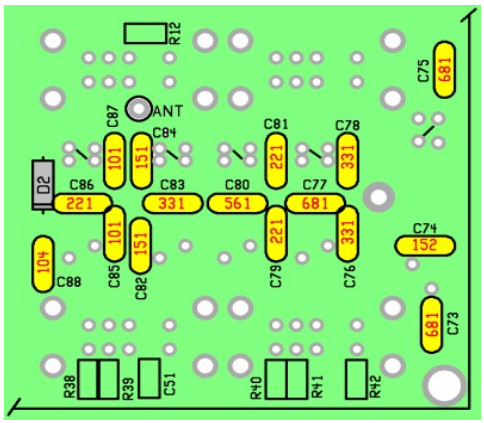


Color	Location	Markings	value	
	U11	179050	5.0V reg	SOT-223 IC Do not mix up with the 2955 mosfets!
	U4	Orange	3.3 V reg	SOT-23-5 This is the only part of this package type with 5 leads.
Red	Q1, 3	702	2N7002	SOT-23 MOSFET
	Q8	2955		SOT-223 P-Channel MOSFET
	D3	S2	diode	Note polarity line!
Orange	L22, L25	Black 1206	10 uHy	Inductor
BLUE	C65, C68		0.01 uF	Capacitors (2 place)
RED	C 63, 64, 70, 71		0.1 uF	Capacitor (4 Places)
Light Blue/red stripe	C67		470 pfd	Capacitor (1 place)
Yellow	C62		1000 pfd	Capacitor (1 place)
Yellow/red stripe	C69		1 ufd	Capacitor (1 place)
	R21	471	470 ohms	Resistor (1 place)
	R17	103	10 K	Resistor (1 place)
	R19, 23, 27, 31, 43,	473	47 K	Resistor (5 places)
	R48	104	100 K	Resistor (1 place)
	R24	334	330 K	Resistor (1 place)
	V2		10K	Trimmer resistor – this can be a bit tricky to solder in by hand. Solder the wiper first (single lead on one side of part), then the two connections on the other side.

Through hole components:

Low Pass Filter capacitors: *(in bag with toroids cores)*

These all go onto the **bottom side** if the board. We might as well also mount D2 at this stage, since its in the same area. (D2 and C88 are packaged with the other through hole parts in another bag.)



Location	markings	value	type
C74	152	1500 pfd	C0G
C73, 75, 77	681	680 pfd	C0G
C80	561	560 pfd	C0G
C76, 78, 83	331	330 pfd	C0G
C79, 81, 86	221	220 pfd	C0G
C82, 84	151	150 pfd	C0G
C85, 87	101	100 pfd	C0G
C88	104	0.1 ufd	C0G

D2 – glass diode, observe polarity. Zener, 47V

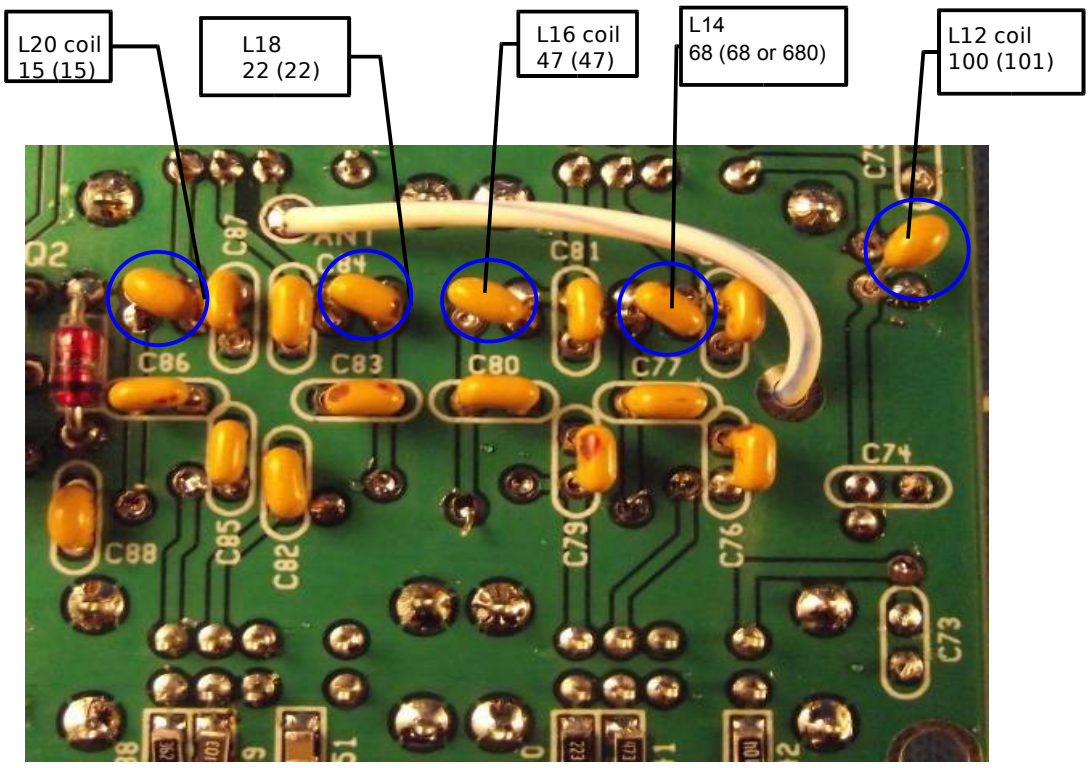
C88 and D2 are in the bag with the other through hole parts.

The 680 p caps are on a strip of three, don't mix up with the single 68 p cap used later.

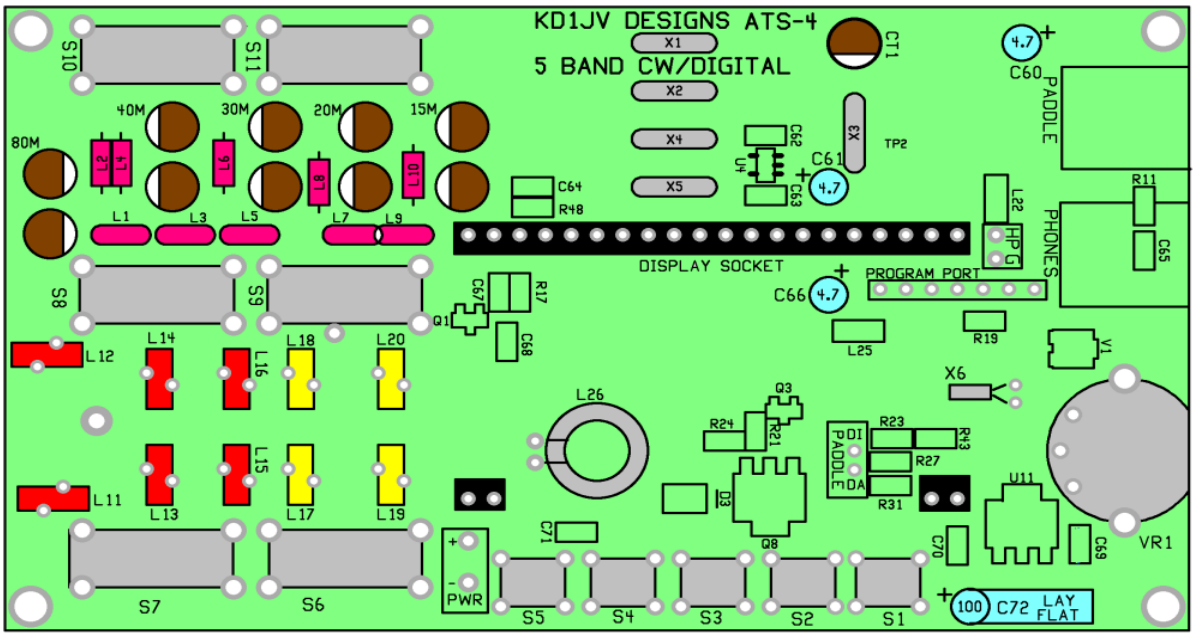
Second harmonic trap capacitors:

These caps are not labeled on the board. These mount in the "extra" holes for L12,14,16,18 and 20. These two holes - top left, bottom right - are used for mounting the second harmonic trap caps.

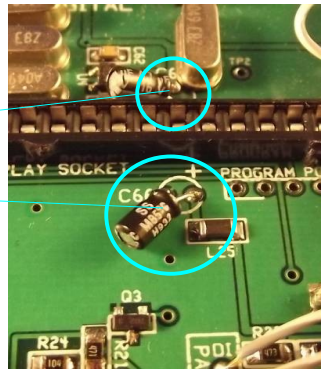
L20 coil = 15 pfd (15 or 150) - L18 cap = 22 pfd (22 or 220) - L16 cap = 47 pfd (47 or 470) - L14 cap = 68 pdf (68 or 680) - L12 cap = 100 pdf (101)



Through hole parts mounting continued:



Location	value/type	Notes
X1, 2, 3, 4, 5	HC-49US	Push flush to board and tack solder edge of X1-X4 to solder pads.
C60, 61, 66	4.7 ufd	The + lead of C61 might short to X3 can, angle cap to prevent this. C66 needs to be laid flat to board, angle to side to avoid L25.
C72	100 ufd	Lay flat to board
X6	32768 Hz xtal	Small cylinder, tack solder side to solder pad.
VR1	50K thumb wheel	Volume control
CT1	Brown trimmer	Note flat end of cap goes towards line.

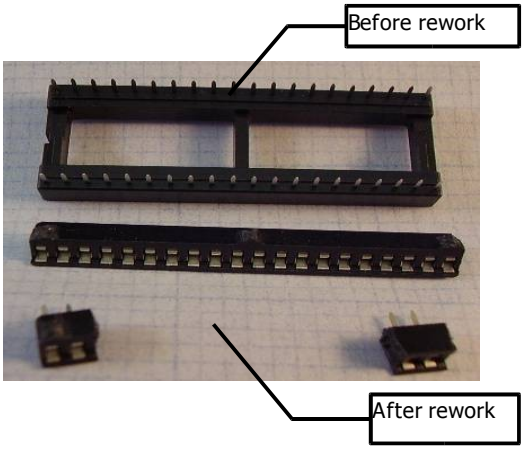


- Slide and push button switches will be installed later, as these will get in the way for installing the BPF toroids.
- The left over 33 ufd cap will go on the bottom of the board, later

Display socket:

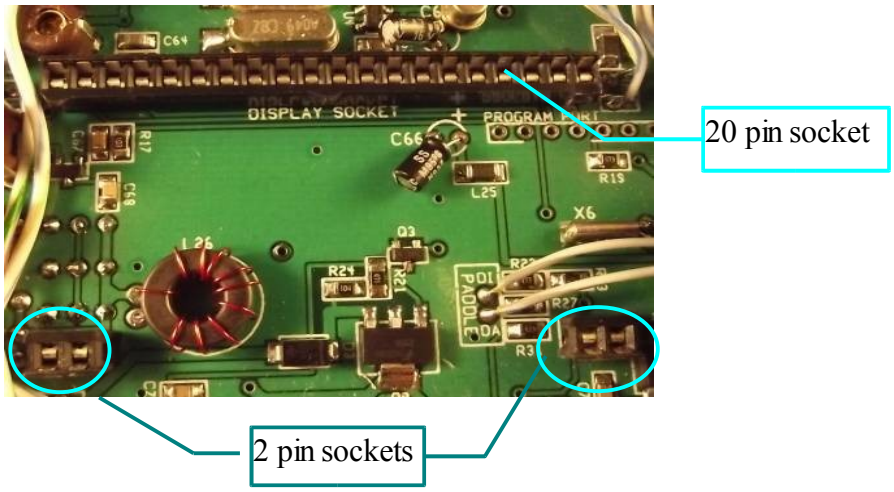
The next part to be mounted is the display socket. It is made from a 40 pin DIP IC socket, which you will find packaged with the display in the bubble package. We need one row of 20 pins and two, 2 pin sockets. Use your wire side cutters to snip off the plastic bars between the two rows of pins of the socket. Clean up the plastic snubs on the side of one the 20 pin strips of pins with your hobby knife.

Now take the other strip of pins and remove the third pin from one end. This is done by pushing the lead up from the bottom of the socket. Now snip off the two pins piece from the end and clean up the sides of the plastic housing with your knife. Do this a second time to make two, 2 pin sockets.



Installing the display socket:

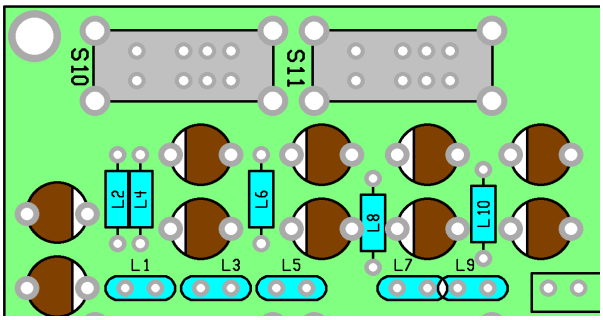
The display socket mounts to the top side of the board, as shown in the photo below. When mounting the sockets, they will tend to tilt over to the side slightly due to a rib along one side of the leads. Therefore, start by tack soldering one pin on the end of the row first, then make sure the socket is not tilted before soldering the rest of the pins.



Receiver input inductors and caps:

L1/L2	39 uhy	Orange/white/black/gold
L3/L4/L5/L6	10 uhy	Brown/black/black/gold
L7/L8	6.8 uhy	Blue/gray/gold/gold
L9/L10	3.9 uhy	Orange/white/gold/gold

- The color codes for 39 and 3.9 uhy look nearly the same, so be careful here!
- Note that L1/3/5/7/9 mount vertically



- Install the brown trimmer caps in locations shown in diagram. Flat side of trimmer will mount towards line on part outline.

The Toroid coils !

These are wound by passing a short end of the wire into core down from the top side and continue winding by passing the wire up from the bottom and winding in a counter clockwise direction. For lefties, do the reverse.

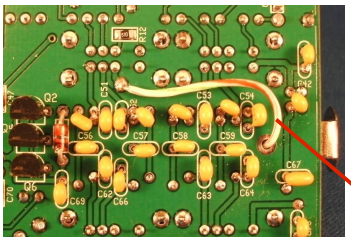
For these coils it is very important to get the correct number of turns. One turn to many or two few will seriously impact power output and spectral purity. Remember, each time the wire passing through the center of the core, that is one turn. #30 wire is used for these coils. This wire should be tinned before trying to solder the wire to the pads. Note that the L15 and L16 labels were duplicated for the 17/15 meter locations and obviously should have been labeled L17 and L18. Also note the difference in number of turns for L18 and L17 depending if your building for 17 or 15 meters. Besides the resistor value used in band select, this is the only difference between these two bands. Install the coils as you wind them so that they don't get mixed up.

80 Meters	L11, T30-2 (Red), 23 turns (12”)	L12, Red, 26 turns (13”)
40 Meters	L13, T30-2 (Red), 16 turns (8”)	L14, Red, 19 turns (10”)
30 Meters	L15, T30-2 (Red) 12 turns (7”)	L16, Red, 14 turns (7”)
20 Meters	L17, Yellow, 11 turns (6”)	L18, T30-6 (Yellow), 16 turns (7.5”)
17 Meters	L19, Yellow, 12 turns (6”)	L20, T30-6 (Yellow), 14 turns (7.5”)
15 Meters	L19, Yellow, 10 turns (6”)	L20, T30-6 (Yellow), 12 turns (6”)

- L26 – wind ten (10) turns on black FT37-43 core and install flat to board.

Wind coils with wire evenly spaced around core.

Antenna lead wire:



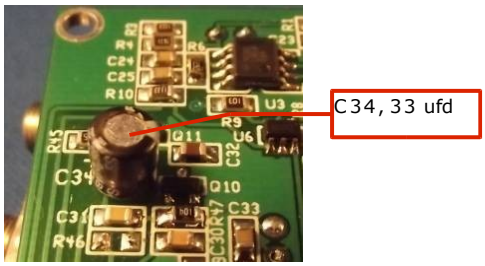
A wire used to connect the antenna connector to the board is now added.

This wire solders into the hole labeled “ANT” just below S9. It then comes up to the top of the board through the hole between the 80 meter coils as shown in photo. Use 3” of # 22 Teflon insulated stranded wire. Solder from the bottom side and make sure the end in the hole doesn't touch the switch body on the other side of the board.

- Install the six three position slide switches. (S6 to S11) Important! *Make sure the switches are square to the board before soldering more than one lead.* The switches can be mounted offset from the board slightly to allow more of the switch handle to stick up beyond the top of the case. If you do this, it will take some care to make sure the switch body stays square to the board.

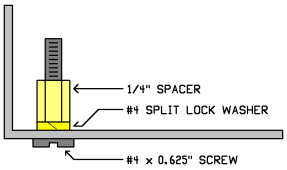
- Install S5. This switch has the shorter actuator arm
- Install S1, S2, S3, and S4. These have the longer actuator arms.
- Again, make sure these switches are seated firmly and square to the board.

- There should be one (1) 33 ufd electrolytic cap left to install. This goes on the bottom of the board at location C34 as shown in photo. Push flush to board.



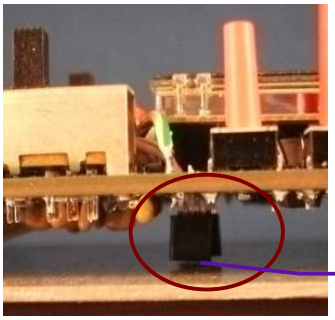
The last few details:

- Install board mounting screws and spacers:



Before the PA mosfets can be mounted, the bottom piece of the case must be prepared by inserting the four board mounting screws and threaded spacers. Insert a # 4 x 0.625" screw in the corner holes on the bottom case piece, add a split lock washer, then secure with the 1/4" long threaded hex spacer. Do this in each of the four corners.

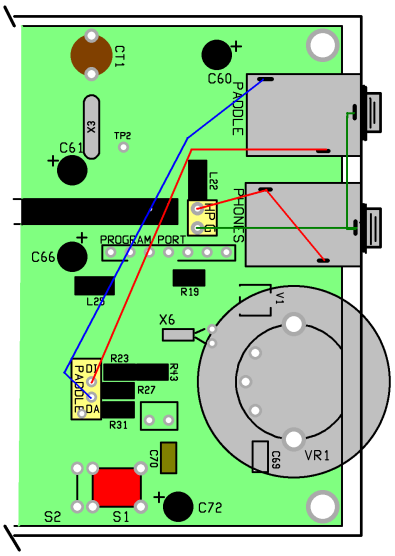
- Mounting of the PA mosfets:



The BS170 mosfets mount from the bottom side of the board. The top of the mosfets should be spaced so that they touch the bottom of the case, as this will provide some heat sinking. Install the BS170's, but don't solder in place yet, but kink a lead to the side so they don't fall out when the board is flipped over. Now insert the board onto the mounting screws in the bottom piece of the case and push down until the board rests on the spacers. Check to make sure the top of the mosfet packages are square to and touching the bottom of the case, then solder the leads from the top side of the board. Be careful with your iron as to not touch any of the switches or other plastic parts.

- With the board now mounted in the bottom section of the case, attach the knob to the thumb wheel pot. Check to see if the knob rubs against the cut out in the side of the case. It likely will and you will need to open up the cut out a little with a flat file.

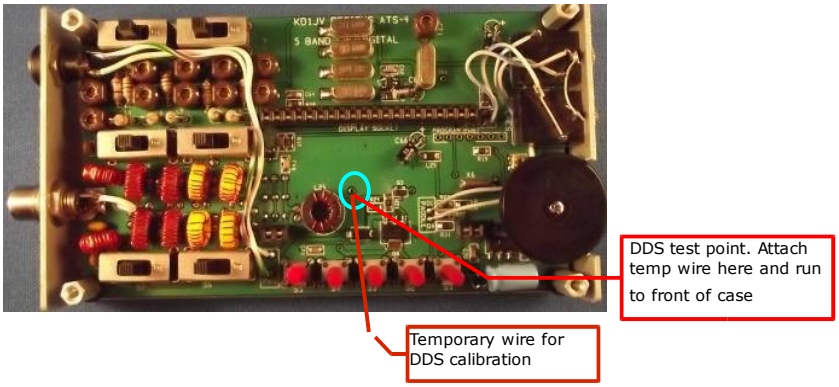
- Paddle and Headphone jack wiring:



Use the # 26 Teflon wire (white/blue stripe) for these connections. A separate ground wire is not used for the paddle jack and gets its ground using a wire jumper over from the headphone jack. Route the wires as shown in the photo.

Note that the ground wire for the headphone jack is the pad below the one labeled "HP". Solder the wires to the pins on the jacks as close to the body of the jack as possible and chip them short. Otherwise, they may short to the top cover.

See photo below for wire routing.



- Power jack and Antenna jack

3.5" lengths of Teflon wire are used to wire to the power jack (#24). The short lead on the jack is positive and the power connections on the board are between S6 and S5, just below one of the two pin display socket jack near the front of the board. Route the wires as shown in the photo. Face the positive lead of the power jack away from the band switch body.

The ground lug of the antenna jack is soldered to a ground pad on the board. This can be a little tricky to do, so you might want to do this with just a short piece of solid wire.

Note that the power wires and antenna lead will have to be disconnected from the jacks in order to remove the board from the case. Therefore, do not crimp the wire into the holes in the jacks, so they are easy to remove if needed.

Preparing the display for mounting:

- Before the back lighting module is placed on the pins on the bottom side of the display, a protective plastic film must be removed from the bottom of the display and the top of the back lighting module.
- The display is fragile, so handle carefully.

The back lighting module needs to be soldered to the bottom of the display. Only the two corner pins on the 20 pin row need to be soldered to support that end. Soldering more than these corner pins would make it very difficult to replace the back lighting module, should that ever be needed.

Each of the two pins on the bottom corners need to be soldered, as these make the connections to the LEDs in the back lighting module to the main board.

Solder the pins in these locations

WARNING: As noted above, the display is made of thin glass and fragile. Once plugged into the socket, it will be difficult to remove and utmost care most be taken doing so. To make removal of the display easier, it helps to first plug something else in and out of the IC socket several times, like a dip IC to take some of the tension out of the socket leafs.

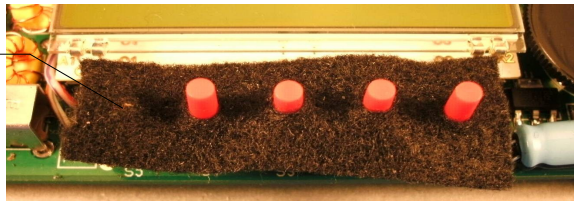
WARNING: When inserting the display into the socket, push only along the edges of the display. DO NOT push in the center of the display, or damage may occur – the glass may crack or squeeze the liquid crystals out of their proper locations to make a splotch.

Prepping the top cover of the case:

In this step, we add the clear plastic display window

- Remove the protective covering from both sides of the clear plastic window and clean up the edges.
- Place over the display cut out on the inside of the cover piece.
- Secure with a bead of silicon caulking around the edges. Although you could use tape for this, it is better to use the silicon caulking. The display should never get wet, so a good seal around the edges is advisable. Just be careful not to get any of the silicon stuff on the visible part of the window.
- A piece of felt cloth is used to cover the hole for the “ON” switch and to fill around the other push button switches to keep dust and dirt out of the inside of the rig. Poke holes or cut a slit with a sharp knife for the control switches to poke through. You will have to “work” the cloth a little to remove tension above the ON switch, so the felt does not keep the switch activated all the time.

Felt covers top of the ON switch, the other switches poke through it.



- The top section of the case attaches with four # 4, 1/4” screws into threaded stand offs attached to the screws from the bottom of the case. Some additional height is required and is done by first putting a #4 fiber washer, then a # 4 split washer on the end of the screw coming out through the board, then attaching the 3/8” threaded spacer.

- Finish by putting the four bumper feet on the bottom of the cabinet.

Testing and calibration:

The rig is now fully assembled and ready for its first power up test. For this, use a 9 volt transistor radio battery. If there is a problem, this type of battery likely can't supply enough current to do any serious damage. Wire up the battery to the power plug and plug it into the DC power jack. Most times, the rig will turn on when power is first applied. If not, push the ON button and the display should light up and numbers appear on the display.

Test the operation of the various switches to ensure these are all doing what they should to.

Calibration:

The DDS reference oscillator frequency can be calibrated. However, unless a very accurate frequency counter is available, this step can be skipped as the frequency error is typically very small. Errors of 100 Hz or less on the 15 meter band, and less on lower frequency bands, are typical.

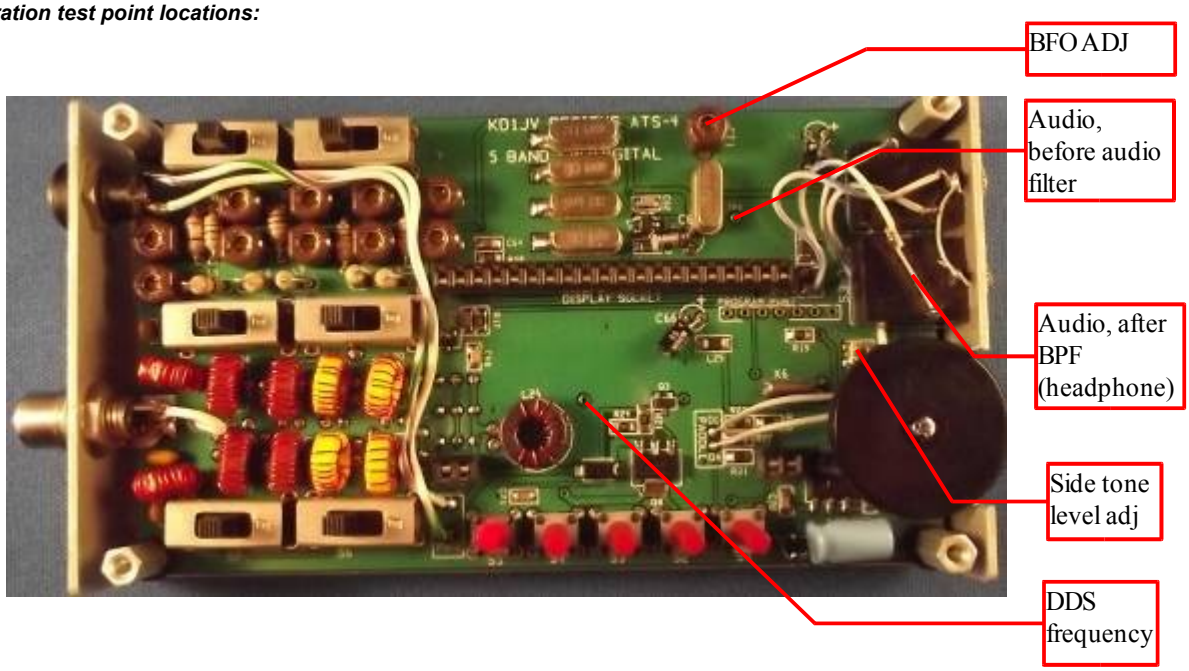
A more important calibration is the LO offset. Because crystals are matched to 10 Hz, there can be a spread of several 100 Hz in the center frequency of the filter, depending on the set of crystals you happen to get. Therefore, the default IF offset may not fall exactly at the optimum point in the filter for best sensitivity. Therefore, this frequency can be adjusted. This adjustment is best made with the aid of a Oscilloscope. If you do not have a 'Scope, a PC based one using a sound card will work, as you are dealing with audio frequencies at that point.

The most important calibration is that of the BFO frequency. This ensures you are transmitting and receiving on the same frequency.

The DDS frequency test point is located under the display. If you did not add a test point wire earlier, this can be added now.

NOTE: When the calibration routine is entered, the default values for reference and offset frequency are loaded. This is done because of the chance the numbers stored in programmable memory might have become corrupted and are no longer valid. By using the default values, we know for sure we are starting from a known, good point. Therefore, you can not “check” the calibration by re-entering the calibration mode. If you wish to check the calibration, first measure the transmit frequency of one of the high frequency bands were any error will be the largest, then check again after calibration.

Calibration test point locations:



Entering Calibration mode:

- Remove power or turn the power off (if not already off).
- Plug in a paddle to the paddle jack.
- Hold the DOT paddle closed and any one of the four control switches, (FN, SP, UP, DOWN)
- Turn power on. The message “CARF” should appear in the lower left corner of the display. The main freq line will be blank. The DDS chip is now producing a 10 MHz square wave on TP1, located just to the left of U6.
- Use the tune up and tune down switches to adjust the frequency to exactly 10.000,000 MHz.
- Once the frequency has been set, click the [FN] switch to advance to the offset and BFO calibration mode.

- NOTE: pre-adjust the BFO trimmer CT1 by turning it 90 degrees (¼ turn).
- The message in the lower left corner will now read “CAOS”. A frequency counter is also activated and appears on the lower display line to the right and will read 0000 Hz at first. This will show the BFO audio beat note frequency. The counter may continue to read zero until the BFO beat note is close to 600 Hz.
- The DDS is now producing the IF frequency which can be adjusted with the tuning switches to fall into the center of the pass band of the IF filter. This is ideally done with an Oscilloscope placed on the TP2 pad. Since this is an audio frequency, a virtual Scope using a PC sound card can be used.
- If you do not have a 'Scope, it is best to use the default values and skip to the BFO adjust step.

BFO frequency adjust:

- Using the counter display in the lower left corner of the display, set the BFO trimmer so the frequency is 625 Hz. This puts the audio beat note in the center of the audio band pass filter pass band and is the frequency used by the optional PSK decoder.
- Once the BFO frequency has been set, complete the calibration by clicking the [FN] switch. The rig will restart with the new calibrated numbers in place.
- Turn the power off to the rig using “OFF” function of the FN switch. (Click and hold closed for a few seconds until “OFF” is displayed in the lower left corner of the display, then release the switch)

Peaking the receiver input circuit:

The receiver will seem to be quite “deaf” until the input coils are peaked. This can be usually done using atmospheric noise or a strong signal, but on the quieter high frequency bands, you might need to use another rig as a signal source (unless you have a signal generator with adjustable output). Of course, if using another rig as a signal source, turn its power output down as low as it will go (if possible), and use a dummy load.

Peak the appropriate trimmers for each band.

Side tone level adjust:

The knob on the volume control will have to be removed to access the side tone level trimmer. Use small jewelers flat blade screw driver and adjust to desired side tone level.

Peaking transmitter power output:

The power output on all bands should be about 2.5 watts with a 9V supply and 4.5 to 5 watts with a 12 V supply. The exact power output can vary by +/- 10 or 20% simply by how the wire on the cores are spaced. This effect is more pronounced on 20 meters and above. You can simply live with what ever power out you happen to get, so long as it isn't too radically off what it should be. Or you can tweak the spacing of the turns on the cores to make the power output more or less consistent across all the bands. Power output will go down if the turns on the coils connected to the PA (L11, L13, L15, L17) are moved closer together and the power will go up when the turns on the antenna side coils (L12, L14, L16, L18) are moved closer together.

Assuming all has gone well, remove the temporary wire for the DDS calibration, put the display back in place, put the top cover in place and start operating the rig. Enjoy and good DX!

Troubleshooting:

Hopefully, the rig powered up and worked correctly the very first time you applied power to it. If it didn't we'll just have to try and figure out why.

The number one reason a rig like this doesn't work first time is due to soldering problems. There have been very few, if any of the ATS rigs sent back for me to fix that couldn't be fixed with just solder. So, this is the very first thing you need to look for. Try to avoid the “shotgun” approach of of re-soldering everything. Instead, try and identify the area where the trouble is and look closely there. There is a very good chance that most of the circuits are working okay.

A missing solder connection to one end of a chip capacitor, resistor or IC lead may not be apparent initially. Simple pressure can be making the connection and it is only after some time or stress on the board that the connection becomes intermittent.

Some possible problems and where to look:

No power!

- Check the wiring of the power jack to make sure [+] is on the center pin and connected to the proper pad on the main board.
- D3 maybe in backwards.
- Connections to Q8, Q3 and associated parts.

Power comes on, but turns right off

- Check Q3 and connection to pin 19 of the processor U10. Verify 3.3 volts on both sides of L25, which feeds power to U10. Check for 3.3V on pin 2 and ground on pin 4 of U9

Nothing shows up on the display:

- The 32.762 kHz oscillator must be working before the processor (U10) does much of anything. A damaged crystal or the connections back to U10 can cause this oscillator not to work.

No output from the DDS chip, U7

- Bad connection(s) on the reference clock oscillator chip (U9) is often the cause of no DDS output.
- A solder short or bad solder connection to the leads of U7 is the most likely cause. Also check the solder connections of all the associated passive parts. There will be a small DC bias voltage on the output filter (R16) if the chip is getting set up data from the processor, but is not getting the reference clock signal.

No audio:

- make sure connections to the headphone jack are not reversed. Connections to U5. Check for hum by placing a finger on the volume control. Track audio back through audio band pass filter and audio preamp stage in U3. All pins of U3 should measure about 2.5 volts, except the supply pin (pin 4) at 5 volts and the ground pin, (pin 11).

Audio but no signals from antenna:

- Make sure all the band select switches are in the proper position!
- Solder shorts on band select switch pins
- Just about anything from the antenna input to the product detector output.
- Make sure there is continuity through the low pass filter coils.
- Connections to QSK switch Q1 and coupling cap C68.

The transmitter:

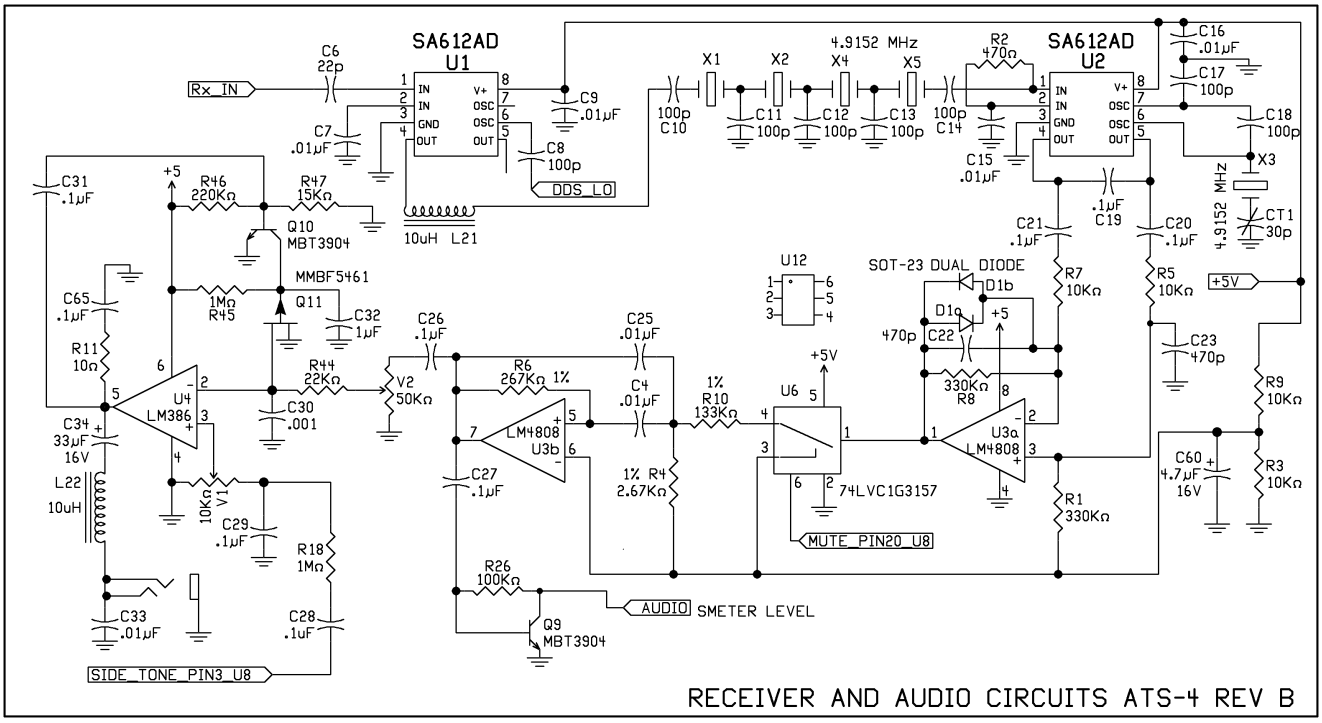
Any trouble here is likely in the voltage keying circuit of Q5, Q7 and associated parts. If D4 is in backwards, that could cause no output from Q7.

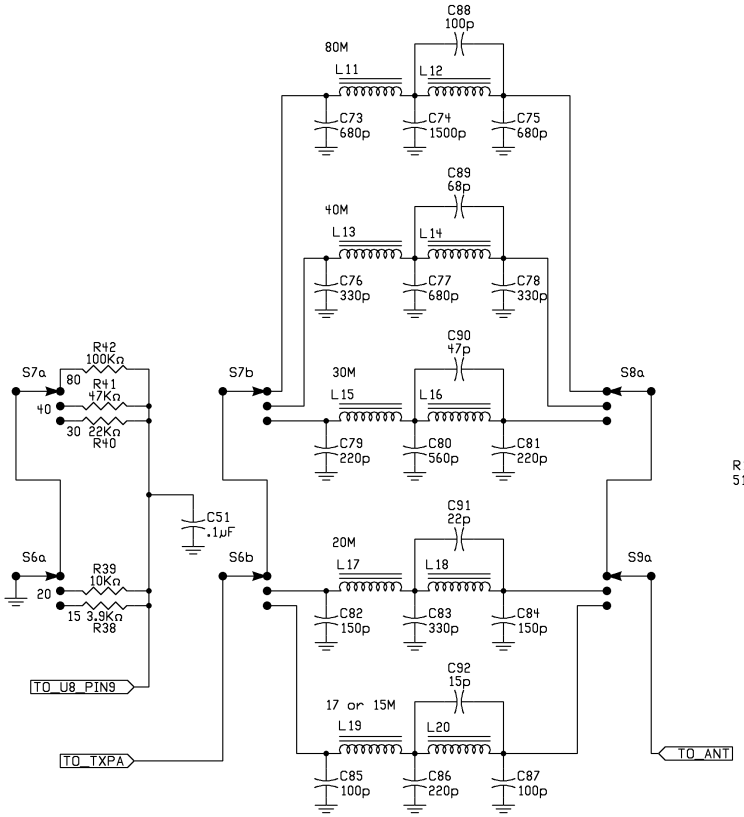
Low power output, some bands:

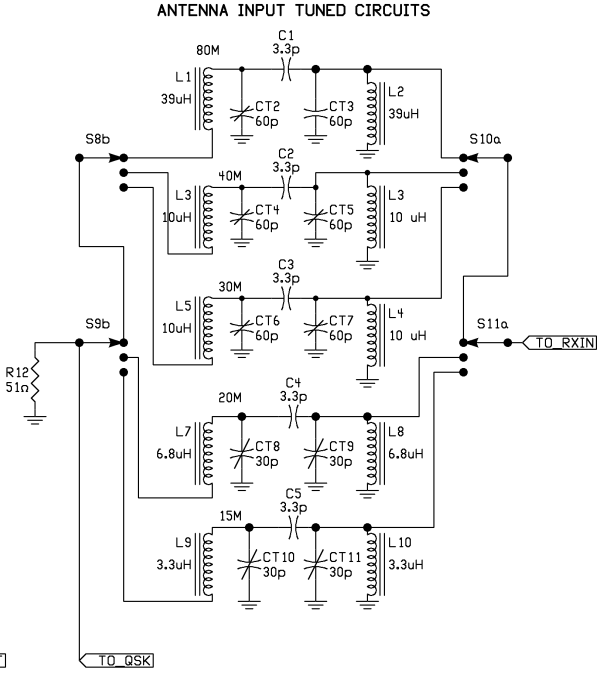
Having the wrong number of turns on the toroids is usually the cause of low power output. Also double check the connections for the second harmonic trap caps across the antenna side coil.

Schematics

Receiver section:







CPU – transmitter section: