The Mountain Topper

Tri-bander
(revised 4-10-14)

A very small, very efficient, three band rig

By
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Specifications:
Three bands, choose 3 - 40M, 30M, 20M or 17M.
80M possible, but filter parts not supplied.

Receiver:

MDS: ~0.2 uV
Small signal band width ~ 500 Hz
Audio output limited to ~ 1200 mv p-p
Headphone output, 16 ohms min recommended.
Minimum current (no signal) ~40 ma

Transmitter:
2.5 watts @ 9 volt supply typical
Spurs -50 dBc or better

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Assembly:

- Your work area should be reasonably clean and uncluttered. Good lighting is a must.
- Empty the packets containing the parts into small paper bowls. This will ensure that they do not get lost. Some people like to do the assembly over a cookie sheet as the lip around the edge helps to keep parts from going far. The metal sheet also provides some measure of static control, especially if you ground it. A white sheet under your work area could help in finding a part which might get away from you.
- A very thin (0.015") solder is supplied for soldering the surface mounted parts. Very little solder is need for each connection. Ideally, you want a little convex fillet at the end of chip resistors and capacitors. Try not to end up will a ball of solder at the end of the part.
- Do not use liquid solder flux. It simply makes a mess and is difficult to clean off the board and get out from under parts. If not completely removed from the board, it can cause problems.
- Before placing a part, lightly tin one pad for where it will go. You can speed assembly by tining one pad at all the locations for which a particular value of part will go. There is no need for a low wattage soldering iron. It is best to have a hot tip which will let you get the job done quickly. You will need a small tip on the iron, 1/32" to 1/16" chisel or round is best.
- Most of the surface mount parts come in part carriers. To remove the part(s), hold the carrier close to the work surface and carefully peel back the clear plastic covering the part. This can be done with the tip of a sharp hobby knife such as a #11 Xacto blade or pointy tipped tweezers. Once you remove the clear plastic strip, dump the part out of the carrier and onto your work surface.
- If you use tweezers to handle the parts, be very careful you don't grab onto them too tightly. These little parts have a way of flying out from between the tips of the tweezers, never to be seen again. Apparently, they go into the twilight zone, along with all the pens, small parts and hardware which falls off the bench. They must go someplace since its never anywhere I can ever find them again!
- An alternative to using tweezers to handle the parts is to use a tooth pick or chop stick with the end rubbed into a little bees wax. The bees wax makes the end sticky so the part will stick to it. For the smaller IC's I grab them length wise with the tweezers.
- Tack the end of a part in its place by applying heat to the end of the part over the tined circuit board pad, while applying a little pressure to make sure it lays flat to the board. Be sure to heat both the pad and the end of the part. Generally, you will not have to add any additional solder to this connection. Then solder the other end of the part. If you don't do this right away and go onto tacking down some more parts, there is a good chance you will forget to go back and solder all the parts which require it.
- It is nearly impossible not to make solder shorts between pins on the DDS chip, due to the close pin spacing. Remove any shorts with solder wick.

Using solder paste:

Using solder paste is the ideal way to build the board. Small amounts of solder paste in an application syringe can be bought for about $5.00 from Cash Olson over the internet. Also needed is a warming plate to preheat the board to about 200 degrees and a low power heat gun. An "Embossing" heat gun is commonly used (found at craft stores), though a hair dryer on low setting might work. A soft air flow is required as to not to blow parts off the board.

For chip caps and resistors, a very small dab of solder paste is put on the pads and then the part placed over the pads. The parts will slide around very easily, so one must be careful not to nudge them. For IC's, placing the IC down first, then putting a bead of paste along the leads looks to be a better method then putting the paste on the pads first, then the IC.

The LED display should be hand soldered, along with all the through hole parts. Start with the side of the board with the most parts first (bottom in the case of the MTR).

Once all the parts have been placed, put the board on the warming plate and heat to about 200 degrees. Then slowly heat the top of the board with the hot air gun. When the solder paste reaches its melting point, you will see it liquefy and the parts snap into alignment to the pad. This is when the solder paste turns from a dull gray to shinny. Be on the look out for "tomb stoning" which is when a chip cap or resistor will stand up on one end. Once all the solder has reflowed, remove the power to the heating plate and let it cool down.

I have a youtube video showing how to solder SMT parts, both by hand and using solder paste. http://youtu.be/Ah5HEjDTHUo You may want to watch some of the other suggested videos on SMT soldering which are done a bit more professionally then mine.

Using the parts placement guides:

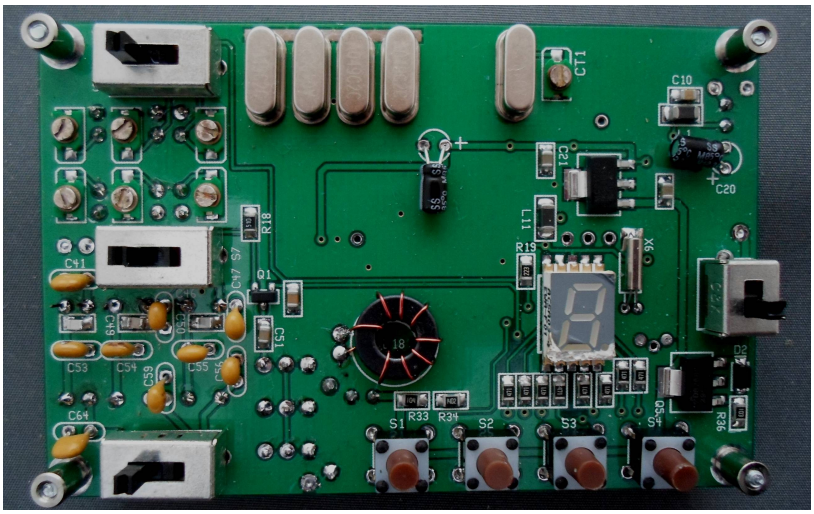
The parts placement guides on the following pages are color coded to show the location of the various types of parts. Parts to be installed are highlighted in various colors to help identify their locations. The guides are scaled so that the writing on them is easy to see on a computer monitor and come out crisper after the conversion to pdf. Unfortunately, if you print all these pages out, it will use up a bunch of your ink jet ink.

Some parts do not have values marked on them or are very hard to read. Capacitors are not marked so these have been color coded with a marker on the part carrier using the resistor color code to indicate their value in pfd.

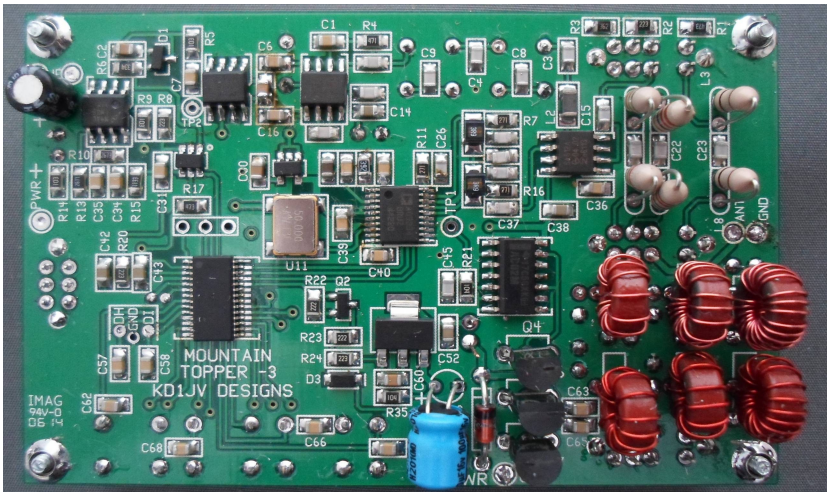
SOT-23 parts have numbers printed on them, but are very hard to read. Therefore, these parts are also color coded, but with a color sticker, as they come in plastic carriers. The color on the carrier matches the color shown on the placement guide diagram.

Resistors have their value printed on them, though it might take a magnifying glass to read the numbers. Therefore, individual values are not color coded.

Here's what the finished board should look like when your done:



I made the mistake of using hot air to attach the LED display and ended up melting the bottom edge. Therefore, if you use solder paste, hand solder the display.

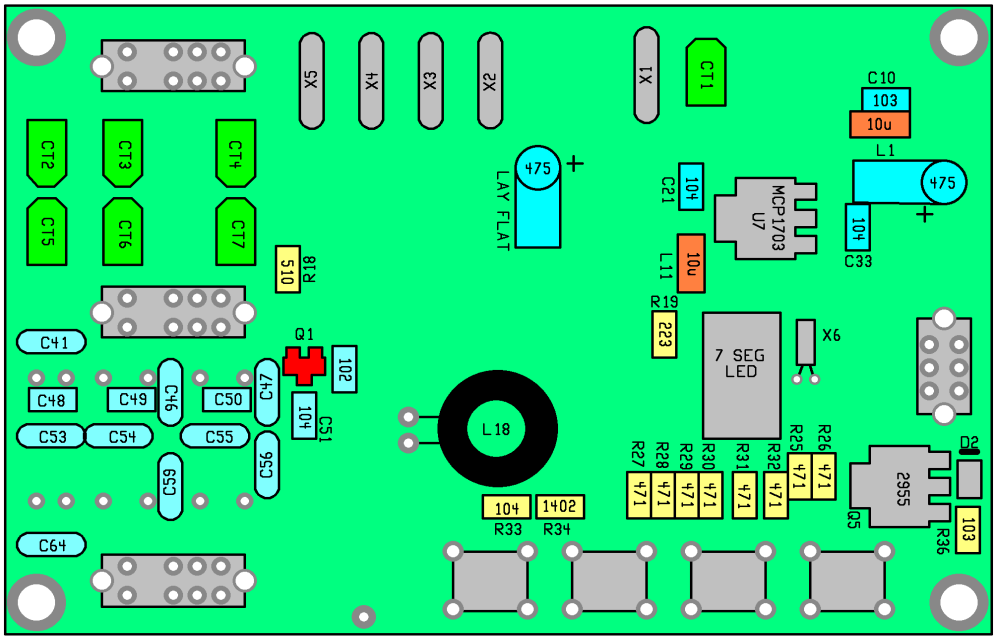


Component location diagrams

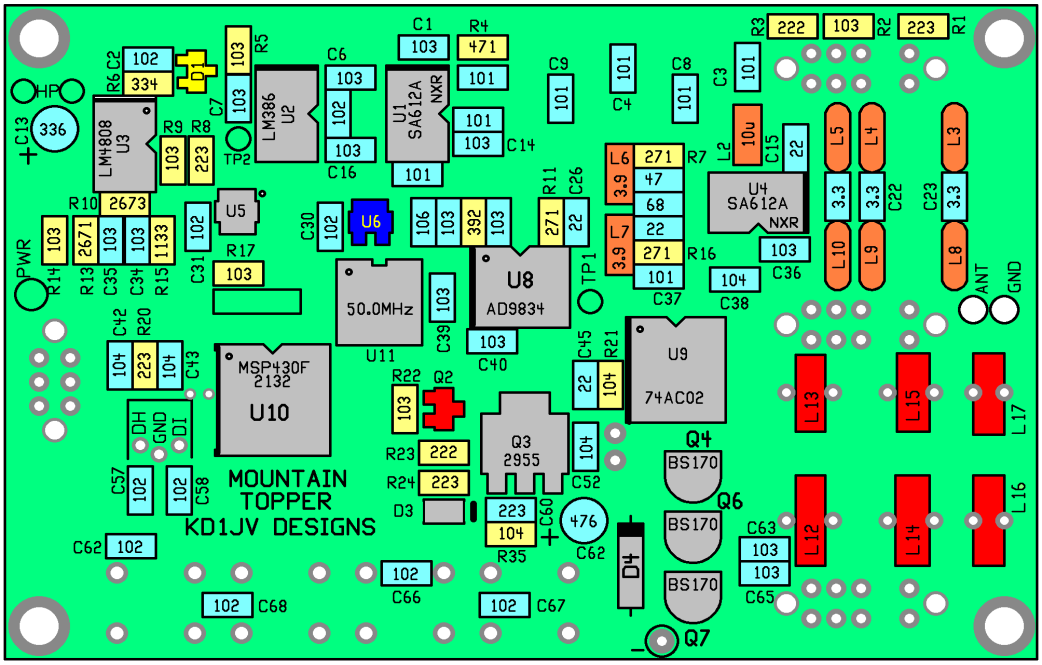
These diagrams show the overall part locations and values. This page can be printed out to help locate part locations.

Color highlighting is used to help identify component type, not value. Blue = capacitors, Yellow = resistors, Red and orange = inductors, gray = semiconductors or through hole parts.

Top Side:



Bottom Side:

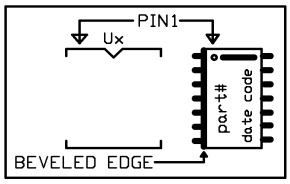


Parts list:

QTY	Value	Color code or value #	
1 or 2	51	510	The extra 51 or 270 resistor used to select 17M band option.
3 or 4	270	271	50-50 chance of getting the 51 or 270 resistor.
9	470	471	
2	2.2 K	222	
1	3.9 K	392	
7	10 K	103	
5	22 K	223	
3	100K	104	
1	330K	334	
1	2.67K	2671 1%	
1	14.0K	1402 1%	
1	113K	1133 1%	
1	267K	2673 1%	
7	30 p	Trimmer caps	
3	3.3 p	(3.3) GRN/GRN	
5	22 p	(22) RED/RED	
1	33p	(33) Org/Org/Blk	
2	47 p	(47) YEL/VOL	
2	68 p	(68) BLU/GRY	
8	100 p	(101) BRN/BLK/BRN	
11	1000p	(102) BRN/BLK/RED	I accidentally cut a bunch of strips of 10, so some kits have one of these caps loose.
15	0.01 u	(103) BRN/BLK/ORG	
1	0.022u	(223) RED/RED/ORG	
7	0.1 u	(104) BRN/BLK/YEL	
1	1 u	(106) BRN/BLK/BLU	
2	4.7 u	ELECTRO	
1	33 u	ELECTRO	
1	100 u	ELECTRO	
2	3.9 uH	RED	L3, L6 SMT 1206
3	10 uH	BLUE	L1, L2, L11 SMT 0805
2	22 uH	40M	RED/RED/BLK/GLD
2	12 uH	30M	BRN/RED/BLK/GLD
2	8.2 uH	20M	GRY/RED/GLD/GLD
2	100 p	(101) C0G	leaded
2	150 p	(151) C0G	
3	220 p	(221) C0G	
3	330 p	(331) C0G	
1	560 p	(561) C0G	
1	680 p	(681) C0G	

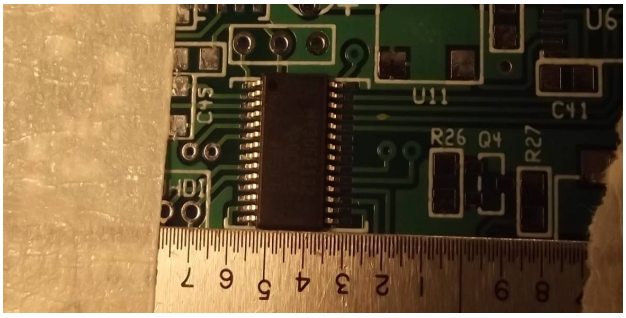
QTY	Part number	Color code or value #	location/description
2	SA612A		U1, U4 MIXER
1	LM4808M		U3 AUDIO AMP
1	TC1014-3.3VCT713	Blue A5xx (last two characters are date code	U6 3.3V REG
1	LM386M		U2 AUDIO AMP
1	AD9834BRUZ		U8 DDS
1	MCP1703-5002E/DB	MCP1703	U7 5V REG
1	74AC02M	AC02	U9 QUAD OR
1	SN74LVC1G3157DBV	CC5x	U5 ANG SWITCH
1	MSP430F2132IPW		U10 MPU
1	ASV-50-EJ-T	ASV 50.0	U11 50 MHz CLK
2	2N7002	RED [702]	Q1, Q2 MOSFET
2	NDT2955	2955	Q3, Q5 P-CH
3	BS170		Q4,6,7 MOSFET
1	BAV99	YEL [A7]	D1
2	BZT52C5V1-F	[W8]	D2, D3 5.1V zener
1	BZX85C47	GLASS	D4 47V zener
1	0.3” 7 SEG LED		DISPLAY
1	32.768 kHz	CYLINER	CRYSTAL
5	4.9152 MHz	HC-49/US	XTAL, MATCHED
1	DPDT	Slide switch	
3	DP3T	SLIDE	SWITCHES
4	6 X 4.3mm TACT	SWITCH	612-TL1105EF100Q
1	1.7mm X 4mm	DC JACK	163-4018-EX
1	1.7mm X 4mm	DC PLUG	171-3219-EX
2	3.5mm STEREO	JACKS	
4	0.187” # 2 SWAG	THREADED	SPACER
4	#2-32	SCREWS	
1	Red display filter film		
6	T-30-2	RED	IRON TOROID
1	FT37-43	BLACK	FERRITE TORIOD
1	8+ feet #28 MAGNET	WIRE	
1	1 feet HOOK UP	WIRE	
1	48” 0.015” SOLDER		
1	CIRCUIT BOARD		
4	Bumper feet		
1	3” solder wick		
1	Enclosure, top and bottom.		

Semiconductor placement

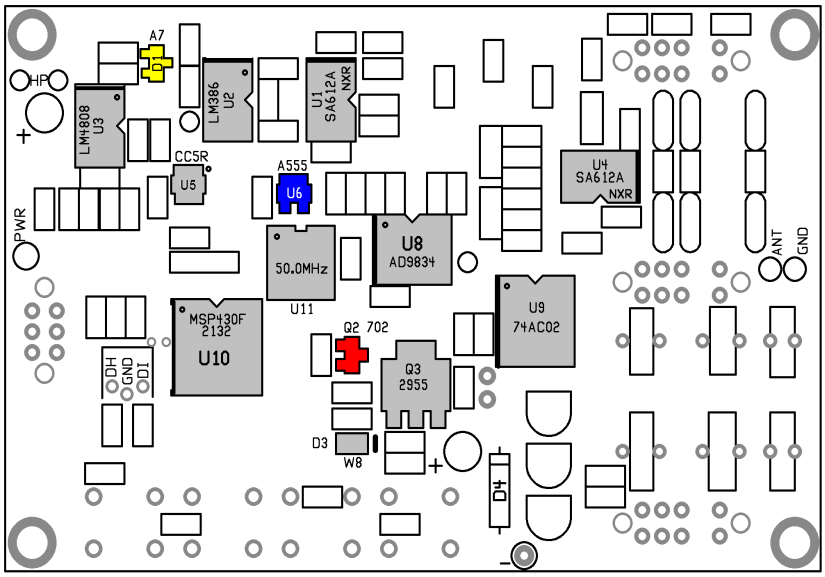


- Finding Pin 1. Some of the ICs used in this kit have a dot or indentation at the Pin 1 corner of the chip. For others, the Pin 1 locations isn't as obvious. The manufactures logo is sometimes used (as is the case for U1 and U3) or sometimes there is a line along the Pin 1 end of the chip. In all cases, there is a beveled or rounded edge along the side of the Pin 1 (left) side of the IC package. When the package is orientated vertically and the beveled edge is to the left, Pin 1 is always in the upper left corner as shown in the diagram.

- U1 and U4, (SA612) use the manufactures log (NXP) for the pin 1 corner designator.
- Before placing an IC or transistor, tin one of the corner pads and then tack that lead of the part down first. Before soldering any other pins, make sure all the leads are lined up on the pads. This is especially important for U8 and U10, where these isn't much room for error. (see hit below for an aid to lining up the leads with the pads) Then solder the lead on the opposite corner from the tacked lead to make sure the body doesn't move when you solder the rest of the leads.
- You will have to carefully check the number on the 8 pins IC's to tell them apart. Using a magnifying glass and tilting the part slightly to the light will aid in reading the a part number. The rest of the IC's are each in unique packages, so are easier to determine their locations.
- Tilting an IC to the light can make reading the part number easier.
- U5 and U6 are very similar. The way to tell them apart is the fact U5 has 6 leads and U6 has 5. To help tell them apart, the U6 part carrier has a Blue sticker on it. U5 has a faint dot which marks the pin 1 end, also the lettering “CC5R” will be upside down when installed correctly.
- There are several different SOT-23 devices, the packages they are in are each color coded to match the layout diagram.
- U11 is the rectangular box with the silver top. Be sure to get solder to flow into the little “U” shaped cups near each corner of the part. A number of builders have had trouble with this and not made solder connection to the pads under the part. A fine tipped iron is required here. Also, be careful of using too much solder and making a short to the metal top of the package.
- D3 has very faint line on one end to indicate the cathode end. Look carefully for this line and face it towards the line printed on the board.
- There maybe more numbers or letters on the semiconductor packages then indicated on the layout diagram. These are date or lot codes and can vary depending on when the parts are purchased. Therefore these are not used for part identification on the layout diagrams.
- CAUTION! There are three parts in SOT-223 packages, one of which is the 5V regulator, which goes on the top side of the board. *Do not mix up with the 2955 MOSFETS, Q2 and Q3*. The regulator is loose in the semiconductor parts bag, while the two MOSFETS are together in a parts carrier.
- HINT: Taping a straight edge, such as a thin metal ruler, across the board and lined up with the bottom outline of U8 or U10 (as the case maybe) will aid in keeping the part aligned with the pads. First do U8, then U10. After soldering the leads, clean up any solder shorts with the supplied solder wick. Be sure to only pull the wick parallel to the leads, not against the gain!



Bottom side semiconductors:



LOCATION	PART #	PACKAGE
U8	AD9834	TSSOP-20
U10	F2132	TSSOP-28
Q2	Red/702	SOT-23
D1	Yellow /A7	SOT-23
U1/U4	SA612A	SO-8
U2	LM386	S0-8
U3	LM4808	SO-8
U9	74AC02	SO-14
D3	-- W8	2 leads
U6	Blue/A5xx	SOT23-5
U5	---- CC5x	SOT-23-6
U11	50.00	silver
Q3	2955	SOT-223

Remember, Q3 is in parts carrier, not loose

The last letter on U5 is a date code.

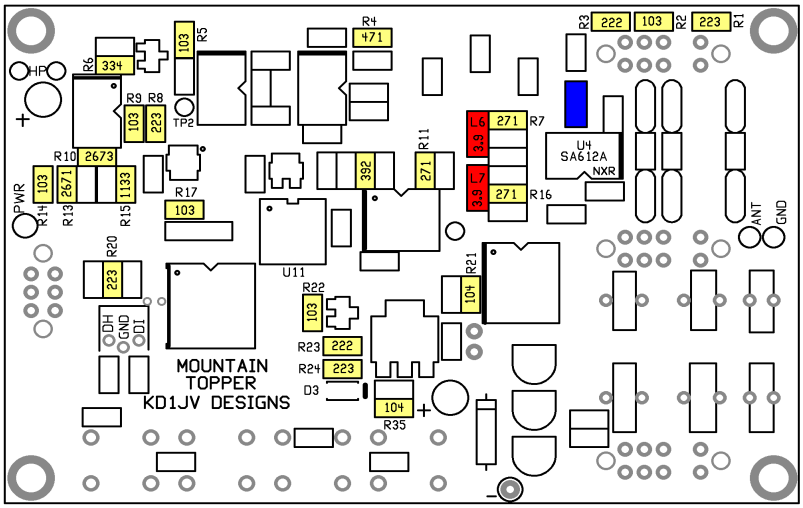
NOTE: The lettering on U5 and U6 will be “up side down” when viewed with this board ordination. Note the faint DOT indicating pin one on U5 and the corresponding dot on the board. Look very carefully for the line on the D3 diode indicating the cathode end.

Whether you use solder paste or hand solder, you will likely have shorts between the leads of U10 and U8. Use the supplied solder wick to remove the shorts. Place the wick over the leads and apply heat with your iron. Be sure to slide the wick off the pins along the leads, not across them.

U11: make sure you get the clock oscillator positioned correctly. Once soldered in place, it is very difficult to remove. Also make sure you solder it well. Not making good connections to the little solder tab cups on the side of the part has been a problem for some, likely due to have a soldering iron tip which is a little too big.

Resistors : Bottom

- Since part designation numbers for most parts are not printed on the board, you will need to use the diagram to locate where the part goes. Pay careful attention to where the part is located to be sure it doesn't go where a cap will go later.
- Resistor locations are highlighted in yellow. The number shown inside the outline is the same as marked on body of part. Note that several resistors have four numbers printed on them, these a 1% values. Resistors with three digits are 5%.
- Three inductors will also be installed with the resistors. These are packaged with the resistors, but are larger and have no numbers printed on them. There are two values used, so they are color coded. The two left over “orange” inductors will be used on the other side.
- There will be a number of resistors left over which go on the top side of the board. Put these aside in a safe place until needed.
- The “approximate location ” in the table will help locate the position of the resistor values on the board. upper/middle/lower is Y coordinates area while left/center/right is X coordinates.
- Resistors R1, R2 and R3 values depend on the band to be used see band value table below. The placement diagram shows the location and values for the typical 40/30/20 band line up. You might decided to make you band selection 40/20/17 or 30/20/17 etc. If you do an alternative band selection line up, you will need to keep track of which filter parts go into the corresponding band slots later in assembly.



Band select values: R1/R2/R3 R3 = highest frequency band. Your band combination values may vary from that shown on the diagram (40/30/20)

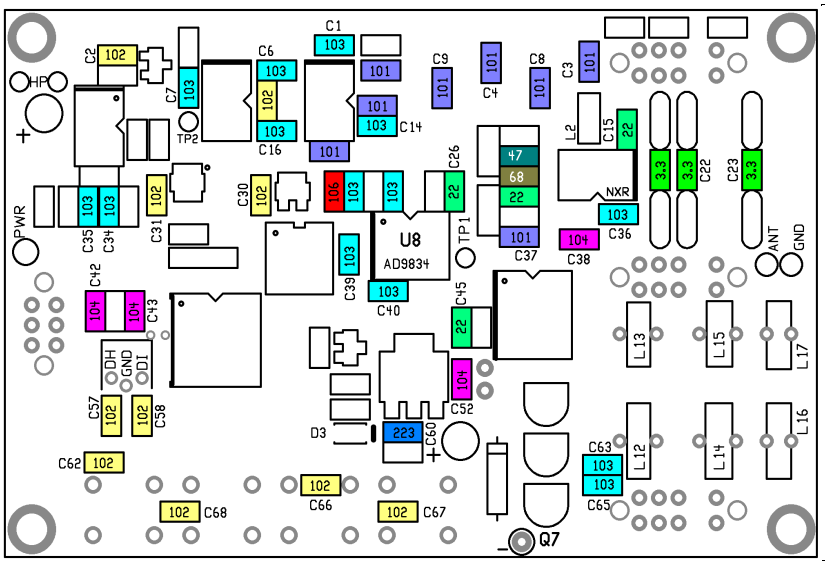
17M (R3)	51 ohm (510) [or 270 ohm {271} since I ran out of enough 51 ohm resistors at about 75 kits]
20M (R3)	2.2K (222)
30M (R2)	10K (103)
40M (R1)	22K (223)

Value	# places	Approximate location
471	1	R4, upper/center
271	3	R7/11/16 upper/center
222	2	R1 Upper right, R23 lower/center
392	1	upper/center
103	6	R2/5/9/14/17/22
223	4	R1/ R8/ R20/ R24 upper/center/lower left
104	2	R21/35 lower/center
334	1	R6 upper/left
NOTE		The next two values look alike – only the last digit is different.
2671	1	R13 upper/left
2673	1	R10 upper/left
1133	1	R15 upper/left
Blue	1	upper/right inductor.
Red	2	middle/right inductor.

Capacitors : Bottom

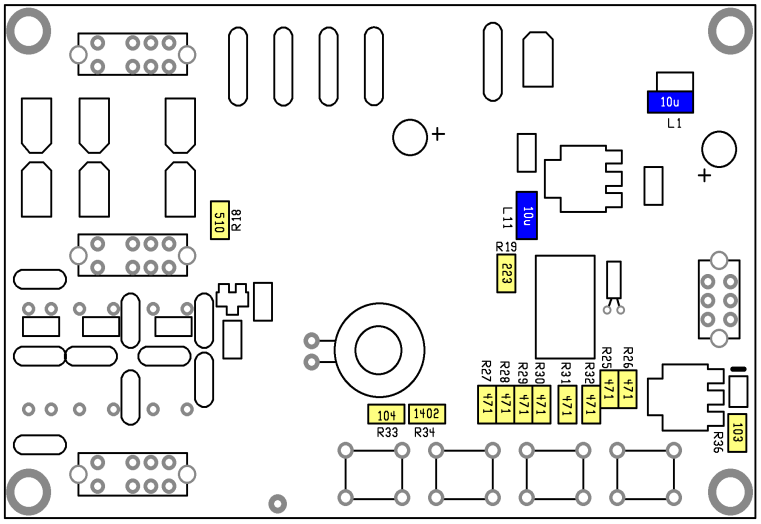
Capacitors are now numbered and color coded in a manor similar to through hole resistors so that their values are more easily identified. The “sprocket” side (the side with the holes) is the least significant digit. Therefore, a 0.1 ufd cap will be numbered “104” and color coded Brown, Black, Yellow.

The colors on the layout diagram no longer relate directly to the colors on the capacitors, but are used simply to make locating the location of caps with the same value easier. Match the value of the component written inside the outline to the appropriate value as indicated by the color code on the chip carrier. Two digit values (3.3/22/47) will have only two colors on the carrier.



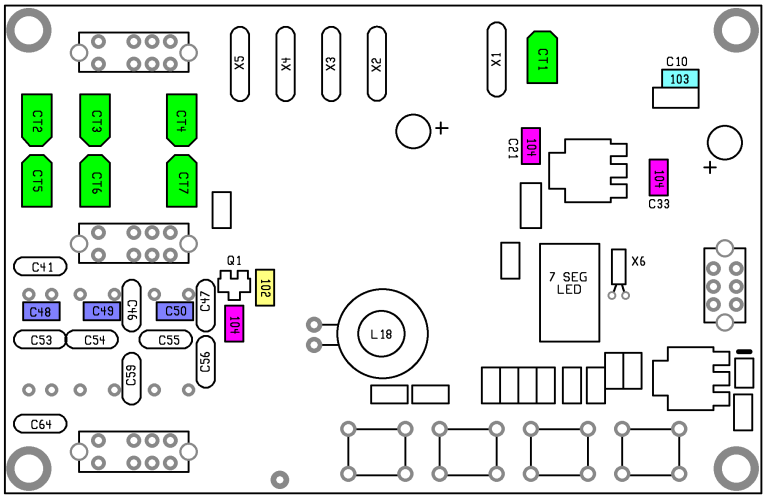
Value/highlight on diagram	Color code on part	# places
3.3 Green	GRN/GRN	3
22 pale green	RED/RED	3
47 teal	YEL/VOL	1
68 tanish	Blue / Gray	1
101 purple	BRN/BLK/BRN	8
102 yellow	BRN/BLK/RED	10
103 pale blue	BRN/BLK/ORG	14
223 blue	RED/RED/ORG	1
104 pinkish	BRN/BLK/YEL	4
106 red	BRN/BLK/BLUE	1

TOP RESISTORS:



Value	# places	location
510	1	R18
471	8	R25 to R32
103	1	R36
223	1	R19
1402	1	R34
104	1	R33
Blue	2 (10 uH inductor)	L1, L11

TOP CAPACITORS:



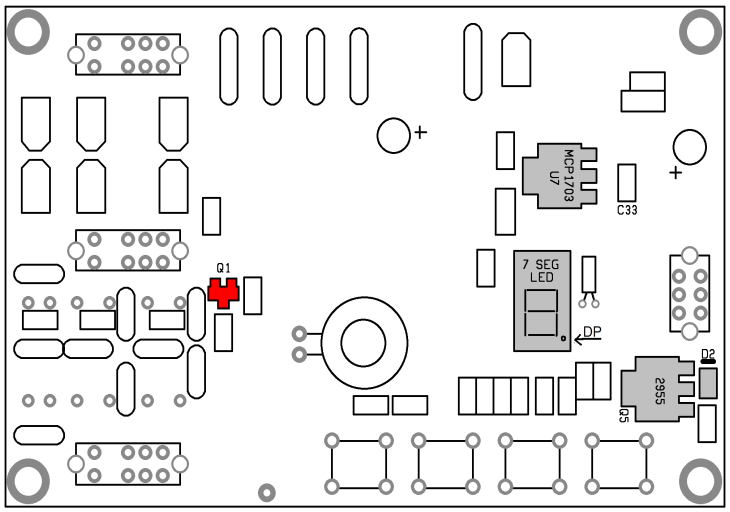
Value	Color code	# places
102 (yellow)	BRN/BLK/RED	1
103 (blue)	BRN/BLK/ORG	1
104 (purple)	BRN/BLK/YEL	3
CT1-7	Green trimmer	7

Note notched end of trimmer cap and match with outline on board. Otherwise adjustment screw will be “hot”.

Values for C48/C49/C50 depend on selected band for that switch position.

40 M (C48)	68	Blue/Gray
30 M (C49)	47	Yellow/Violet
20 M (C50	33	Orange/Orange/Black
17 M (C50)	22	Red/Red

TOP Semiconductors:

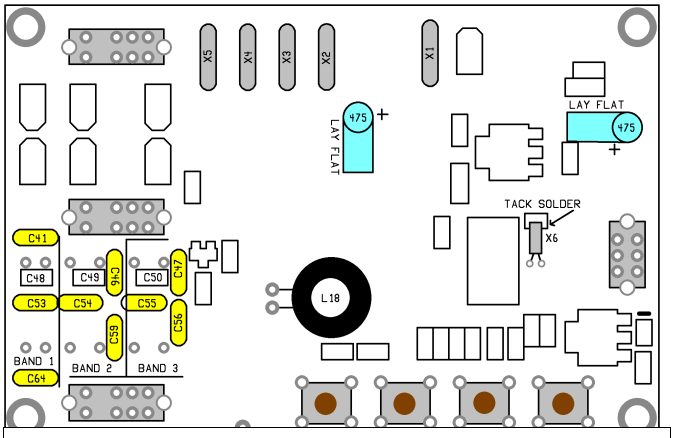


Value	location	
Red (702)	Q1	
---- tiny! W8	D2	Polarity!
MCP1703	U7	Don't confuse with Q6!
2955	Q5	SOT-233 mosfet
7 seg display Hand solder	LED Display	Make sure decimal point is in lower right hand corner. Once soldered in place, the display is nearly impossible to remove.

Through hole parts:

(use your normal solder {.02 or /.032} for most of these parts)

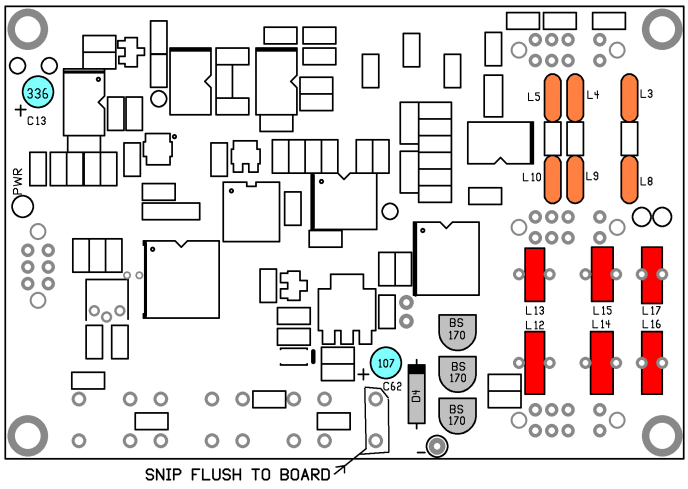
When removing these parts from the plastic bag, keep a look out for the small watch crystal which could easily get lost. The threaded spacers are in with the hardware.



Band	Location / value	Location / value
Band 1 - 40M	C41, C64 331 (330p)	C53 681 (680p)
Band 2 - 30M	C46, C59 221 (220p)	C54 561 (561p)
Band 3 - 20M	C56, C47 151 (150p)	C55 331 (330p)
Band 3 - 17M	C56, C47 101 (100p)	C55 221 (220p)

- X1 – X5. The cases of of X2,3, 4 and 5 should be tack soldered to the pad along the top edge of the board. Flow a little solder between X2 and X3, then again between X4 and X5.
- X6 – small cylinder crystal. Tack solder top of crystal to solder pad at the top of the crystal.
- Insert the four (4) threaded spacers into the corner holes . Insert from top side and solder on bottom. Only solder the in place the two on the left hand side of the board next to the band select switches. The two which are not soldered will be used later as stand offs so the board can be attached to the top of the case while testing and making adjustments.
- Slide switches. Four places. Three DP3T and one DPDT. Make sure they are seated flat to be board before soldering more then one lead.
- S1-4 TACT switches. These can only go in one way, so don't force them. The leads which go along the top and bottom are spaced a little farther apart.
- Electrolytic caps, 4.7 ufd, C17 and C20. Long lead is plus (+). These must be mounted laying down, flat to the board.
- Low pass filter band capacitors, see table.
- L18 – 8 turns (6“) on black T37-43 core. Wind now, but put aside and install later.

Bottom side through hole parts:



- C13 – 33 uFd electrolytic. Stand this off the board a little and tilt slightly for better access to the headphone jack wire solder pads.
- C62 – 100 uFd electrolytic – lay this part over, but snip the leads of the TACT switch real close to the board first so they don't nick the plastic wrap on the cap.
- D4 – large glass diode – 47V zener.
- Q7, Q8, Q9 - BS-170 TO-92
- L3/4/5 and L8/9/10 mount vertically see table for values.
- L12 to L17 See table below for number of turns to wind.

Band 1	Band 2	Band 3	40M	30M	20M	17M
L3, L8	L4, L9	L5,L10	22 uH Red/Red/BLK/GLD	12 uH BRN/RED/BLK/GLD	8.2 uH GRY/RED/GLD/GLD	8.2 uH GRY/RED/GLD/GLD
L16	L14	L12	T30-2 RED 18 turns 10”	T30-2 RED 13 turns 9”	T30-2 RED 12 turns 8”	T30-2 RED 11 turns 8”
L17	L15	L13	T30-2 RED 20 turns 12”	T30-2 RED 16 turns 10”	T30-2 RED 15 turns 10”	T30-2 RED 14 turns 10”

80 M values	L3, L8	L16	L17	C41/C64	C53	C48	R1
	39 uHy	23 turns, #30 T30-2	26 turns, #30 T30-2	680 pfd (C0G)	1500 pfd (C0G)	150 pfd	100K

Tack 33 pfd caps across L3, L8 to resonate on 80M with trimmer caps. Cap at L8 needs to go to ground, not across inductor.

Final board inspection:

The board should now be fully populated with the parts. Before wiring up the board to the jacks for testing, do a close inspection of all the solder connections with a magnifying glass. A few minutes inspecting your work and fixing any problems now will save a lot of time later.

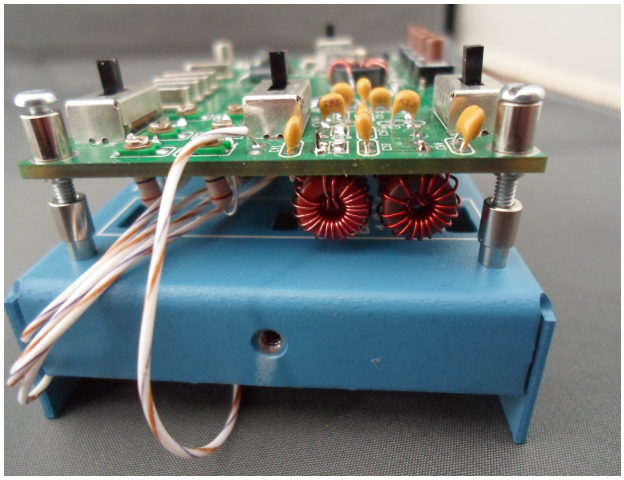
Cleaning the flux off with an electrical cleaner such as “CRC QD Electronic Cleaner”, available in the auto parts section of Walmart, makes inspection easier. An old toothbrush makes a good tool to scrub the board with. Alcohol does not do a good job of removing flux and can leave a white film which could cause trouble.

Make sure you removed any shorts between leads on the TSSOP parts (U8 and U8) along with U5 and U6. If you hand soldered, make sure you soldered both ends of the part. When tacking down one end of a number of parts of the same value, it can be easy to miss soldering the other end.

Jack Wiring:

Because the receiver input trimmers and BFO trimmer are on the top of the board, they need to be adjusted before the board in mounted inside the enclosure. The various jacks need to be wired to the board while the adjustments are being made and having them flop around loose can be a potential problem, as one of the bare terminals might short against something which could cause damage.

To avoid these problems, the board can be temperately mounted over the top of the enclosure.



- Mount the two board spacers which you did not solder to the board and mount them with the narrow end towards the case with the short #2 screws.
- Install the various jacks to the case.
- Attach the wires for connecting to the jacks to the board.
- Mount the board to the spacers on the top of the case using the long #2 screws. You will need to leave a little space between the spacers so that the toroids don't touch the top of the case, so first screw in the long screws int the board spacer most of way in, leaving just enough that a few threads will catch the spacers mounted to the case when the screw is all the way in.
- Now wire up the jacks. Use the shortest possible path from the board to the jacks, by routing the wire through the various holes in the top of the case. Use the supplied Teflon insulated stranded wire for power, power ground and antenna. Use left over magnet wire for the rest. Headphone and paddle grounds can be returned via the case ground.

Check out and Calibration:

Clean the board of any flux residue. This will help in inspecting all the solder connections. “Electrical Parts Cleaner”, available at most commercial electrical parts suppliers works well to remove flux. Denatured alcohol will also work. Avoid rubbing alcohol, as this leaves a white residue. Using your magnifier, inspect all the solder connections, looking in particular for any you might have missed making. Hopefully, you have all the ICs installed with the proper orientation and location, as this type of error is not easy to correct. Same goes with the caps, as it’s now difficult to verify their correct values.

WARNING! When powering the board outside the cabinet be sure to insulate the power jack terminals to prevent shorting to something on the board. If the raw DC should touch one of the paddle inputs, it will blow that processor port and will need to be replaced. Other damage could occur, depending on what you happen to bump the supply or ground to on the board. This is not a problem if you mount the board to the over the top of the enclosure as shown on the previous page.

- If you have already installed L18, remove it before doing the initial power up tests.

- Use an ohm meter to check for shorts across the DC in, +3.5 and +5 regulator outputs to ground.
- Find and eliminate short if one is detected.
- Wire up a 9V supply to the power plug (Use 9V battery or current limited supply set to 50 ma limiting) to start. This way, if there is a problem, its unlikely any damage will result from too much current being drawn.
- Plug a set of stereo headphones into the headphone jack.
- Plug in the power supply
- You should hear the power up message “4” “3” or “2” in the headphones and see a that number appear on the LED display. If you hear this message, you know the processor and audio amp are working fine.
- Check the voltage at TP1, it should be 0 volts. If not, check connections on R19.
- Check the voltage on the PA gates, Q7 to Q9. This voltage should be zero (0) volts. If it is not, check solder connections on U8 pins.
- Plug a paddle into the paddle jack and send some dits and dahs. You should of course, hear them in the headphones.
- Connect a voltmeter between ground and the Drain of Q5, the PA keying transistor. (Large metal tab is Drain).
- Send a string of Dahs and watch the voltmeter. The voltage reading should go to near the DC supply input voltage. It should then slowly decay to zero when you stop sending. This is the voltmeter discharging the .1 uF bypass cap. When using a very high impedance DVM to measure the voltage, it may take a LONG time for the voltage to decay. Check the soldering in the keying circuit if there is a problem.
- Remove power from the board.
- You can now install L18.

Reference Oscillator Frequency Calibration:

NOTE: Entering the calibration mode will rest the reference, offset and initial power on frequencies to their default values. This is done to ensure “known good values” are used in the off chance the stored values become corrupted.

The “ideal” reference frequency of 50.000,000 MHz is initially assumed to calculate the DDS VFO frequency. In practice, the reference oscillator has a +/- 20 ppm tolerance. This tolerance can cause an error between what the processor thinks the operating frequency is and what it really is. The error would be most noticeable on the higher bands, where the reference clock is less divided. Therefore, this calibration is provided to adjust the value of the reference frequency value used in the DDS frequency calculation to exactly match the actual oscillator frequency and therefore produce the expected operating frequency.

However, the typical error using the 20 ppm clock is small enough that if you don't have an accurate frequency counter, it is usually best to use the default values and “click past” this part of the calibration.

This calibration is most easily done with an accurate frequency counter. If you do not have access to one, but do have a rig with general coverage, good calibration and can tune to 10 MHz, then you can use that. If you can connect up a PSK program or other audio spectrum analyzer software which can show you the audio frequency of the signal from the rig's audio, this will help a lot. Set the rig to receive USB at 9.999,000 MHz. This will cause a 1 kHz beat note when a 10.000,000 MHz signal is received. The PSK waterfall can be used to show you when you have adjusted the DDS frequency to produce the exact 1 kHz beat note. A short pick up wire attached to a piece of coax going to the rigs antenna jack and placed near the TP1 test point should pick up plenty of signal. If you have no means of accurately measuring 10 MHz, skip through this procedure by clicking the **Fn** switch after step 6 and go directly to the LO cal procedure.

1. Click and hold closed both the **RIT** and **Tune UP** switches.
2. Apply power.
3. “CR” will be annunciated by the side tone. “C” and then “r” will appear on the LED display when calibration mode is enabled.
4. Release the switches.

5. Connect a frequency counter to DDS TP1.
6. Wait a minute or two for the oscillator to stabilize.
7. Using the tune up and tune down switches, adjust the frequency at TP1 to exactly 10.000,000 MHz.
8. Once the frequency is adjusted, click the **Fn** switch to store the new reference frequency.
9. The side tone will now announce “CO” A low pitched tone will be heard in the headphones. The display will change to “o”

NOTE: if you don't get any output from the DDS, often times this is due to a bad or missing solder connection to one of the reference oscillator pins. Also check the soldering to the DDS chip.

Local Oscillator frequency trim and BFO adjustment:

This is used to trim the LO frequency to exactly match the center response of the IF crystal filter. This will ensure the best sensitivity of the receiver. This adjustment is made with the help of an Oscilloscope. An audio spectrum analyzer program running on your PC would also work. A program of this type is located on the CD. If one isn’t available, skip to step 5 and peak the BFO trimmer by ear. You can solder a short wire to TP2 and one of the headphone jack pins to hang a clip lead onto.

NOTE: The default offset frequency comes out very close to ideal and likely will need no adjustment. The more important adjustment is setting the BFO trimmer so that the beat note peaks in the audio filter response.

BFO adjustment:

1. Connect a ‘Scope to the headphone jack. (2V / div, 1 ms / div sweep)
2. Preset the BFO trimmer cap (CT1) by giving it about a ¼ turn.
3. You should hear a pretty loud tone in the headphones.
4. Adjust the green BFO trimmer cap, CT1, and peak the audio signal at the headphone jack. This centers the beat note in the audio band pass filter.
5. You can monitor the signal at TP2 with a Scope and tune the LO for largest signal using the up and down tuning buttons.
6. If you tweak the LO frequency, be sure to go back to the headphone jack and reset the BFO frequency to peak in the audio filter.
7. Click the Fn button again to finish the calibration. The rig will reset and restart.

If the above calibrations worked, you know everything but the transmitter is working properly. You can now go onto the testing and adjusting the band filters. Otherwise, go to the trouble shooting guide on page 16 and track down the reason the receiver isn’t working.

Receiver input peaking:

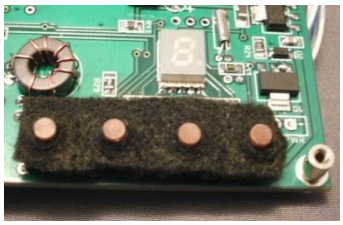
There are three sets of capacitor trimmers which have to be peaked, one set for each of the three bands. The two caps in vertical line with each other are for one of the three bands. CT2/CT5 are for 40, CT3/CT6 are for 30 and CT4/CT7 are for 20 or 17.

Attach an antenna or signal generator the antenna input and peak the trimmers for best signal or band noise. Note: the receive can seem to be quite “deaf” until the trimmers are peaked. 20M may not have enough atmospheric noise to be noticed, so finding a signal to peak or using a signal for an other transmitter maybe required.

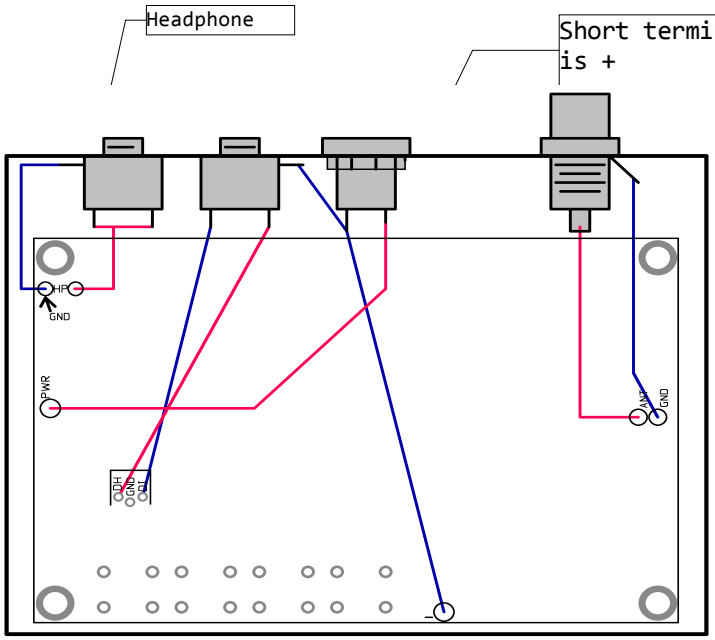
Transmitter test and output (low pass) filter adjustment:

- Connect a QRP watt meter and 50 ohm dummy load to the antenna jack
- Connect a 9.0 Volt supply. Other voltages can be used, but power out at 9.0 volts is the only known data point for sure.
- Use a straight key or keep the Dash paddle closed when turning power to the board on so it goes into straight key mode.
- Key the transmitter and check the power output. If using a 9.0 volt supply, the power should be close to 2.5 watts and between 4.5 and 5 watts with a 12.0 volt supply.
- Power out can be tweaked by adjusting the spacing of the turns on the LPF toroids. Typically, moving turns closer together on the coils on the PA side of the filter (L12/L14/16) will decrease power while spreading them apart (to be move evenly spaced around the core) will increase power. The power out on 40 and 30 will likely be a little on the high side with the turns evenly spaced.
- To achieve maximum PA efficiency, using an milliamp meter to monitor the current while making the filter adjustments can allow you to find the point where you get the most power out with the least amount of current.
- Once one band is done, switch to the others and make any adjustments if needed.

Final steps:



After testing and before you mount the board into the case and do the final wiring, poke holes in the black felt to line up with the PB switches and then trim the felt as shown to the left. This helps keep grit out of the case and makes it look a little better.



Jack wiring diagram. The wires will be much longer in order to mount the board to the top of the enclosure, cut the wires back to a more reasonable length when the board is mounted permanently into the enclosure.

Tape the red filter over the LED display viewing hole inside the case with some clear shipping tape.

<< Bottom, inside view.

After you do the final wiring, attach the bottom piece of the enclosure and attach the four bumper feet.

Troubleshooting:

With careful assembly, the MTR should power up and work great the first time power is applied. But we all know that sometimes doesn't happen and you'll have to figure out why.

In nearly all cases, any problem can be tracked down to soldering issues, usually missing connections. On occasion, the connection can look good as there is solder there, but it did not stick to the pad under the part. This kind of problem is a bit harder to find then the missing solder.

So, before you do anything else, spend a few minutes with a magnifying glass and a strong light and inspect the board, looking closely at all the solder connections. Inspecting the connections is easier if the board is cleaned of flux. CRC brand QD Electronic Cleaner, available in the automobile section of Wal-Mart does a good job of removing flux. Use an old (but clean) toothbrush to scrub the board. De-natured alcohol can also be used (do not use rubbing alcohol, it will leave a white film residue).

It also helps to know the general area to look for a problem. The chances are good most everything is working and there are only one or a couple of problems to find. It really helps to have a 'Scope and signal generator, but a DVM will usually point you in the right direction.

Possible specific problems:

- Dead!

Supply wired with correct polarity?
Connections to Q5. This part acts like a diode, but D2 and R36 bias the gate so the mosfet turns “on”, eliminating the diode drop.

Output from 5V and 3.3 V regulators? If not, check connections and for shorts to ground.

Connections to U10, the processor. Check power supply pins and X6 crystal connections. The processor will not do anything except set the ports direction and state unless the 32 kHz clock is running.

- Missing segments on LED display.

Check connections on R27 to R32, at the display and the processor leads.

- No receive

Could you hear and adjust the BFO beat note in Cal mode?

If so, everything pass the first mixer (U4) is working and you can concentrate on the input circuits. If no BFO note was heard, continue below:

DDS working?

If not, a common problem is often with the soldering of the reference oscillator. Make sure solder flowed into the little cups and you didn't use too much solder and short to the metal cover. Check the connections of all the parts in the area around the the DDS chip, U8.

Got Audio?

The audio is remarkably quiet, so until you hook up an antenna, you probably will not hear any noise. If you can hear side tone, then you know the problem is before the audio switch, U5 or a connection to it.

Mixers okay?

First, make sure they are in the correct way. The little “NXP” lettering marks the pin 1 corner of the chip. Check all the connections around these parts.

- No transmit:

Not a whole lot to go wrong here.

Keyed voltage getting to L18? Check Q2, Q3 and associated parts.
Check connections to U9 and L18
Check connections on output filter toroid.
Make sure filter values matches the band.

Voltage charts:

P1	1.4V	RFIN	P8	5.0V	V+
P2	1.4V	RFIN	P7	4.3V	OSC
P3	0V	GND	P6	4.9V	OSC
P4	3.9V	OUT	P5	3.9V	OUT

U1/U4 SA612 mixer oscillator

P1	2.5V	OUT	P8	5.0V	V+
P2	2.5V	-IN	P7	2.5V	OUT
P3	2.5V	+IN	P6	2.5V	-IN
P4	0V	GND	P5	2.5V	+IN

U3 LM4808 audio amp

P1	2.2V	Audio in	P6	3.5V	Control
P2	0V	GND	P5	5V	V+
P3	0V	ST in	P4	2.2V	Audio out

U5 Analog SPDT switch

P1		gain	P8		gain
P2	0V	-IN	P7		
P3	0V	+IN	P6	5.0V	V+
P4	0V	GND	P5	2.5V	OUT

U2 LM386 audio amp

P1	0V	TEST	P28	3.3V	MUTE
P2	3.3V	V+	P27	3.3V	DDS
P3	0V	ST out	P26	3.3V	DDS
P4	0V	GND	P25	0V	DDS
P5	2.7V	osc	P24	0V	Tx key
P6	1.7V	osc	P23	3.3V	Tune dn
P7	3.3V	reset	P22	3.3V	MENU
P8	3.3V	Tune up	P21	3.3V	RIT
P9	3.3V	Dash in	P20	0/3.3V	Band volt
P10	3.3V	Dot in	P19	.5 to 1.2	Batt V
P11	3.3V	7seg	P18	3.3V	QSK sw
P12	3.3V	7seg	P17	3.3V	7seg
P13	3.3V	7seg	P16	3.3V	7seg
P14	3.3V	7seg	P15	3.3V	7seg

U10 MPS430 MPU

P1	1.13V	FS ADJ	P20	.75V	IOUTB
P2	1.17V	REF out	P19	.37V	IOUT
P3	1.76V	COMP	P18	0V	AGND
P4	3.3V	AVDD	P17	.37V	CMPin
P5	3.3V	DVDD	P16	0V	CMPout
P6	2.4V	CAP	P15	3.3V	FSYNC
P7	0V	DGND	P14	3.3V	SCLK
P8	1.7V	40 MHz	P13	0V	SDATA
P9	0V	Fsel	P12	0V	SLEEP
P10	0V	Psel	P11	0V	RESET

U8 AD9843 DDS

Operation:

Basic operation:

Turning the rig on and off:

The slide switch to the right of the display turns the power on and off. There was suppose to be international on/off icons to label the switch, but somehow these got dropped from the silkscreen artwork and didn't get noticed. The decimal point on the LED will light to indicate power is on.

- When the rig is powered up, it checks the position of the band select switch and loads the initial values for that band. The display will flash a number to indicate the currently selected band (8, 4, 3, 2 or 7) and enunciate that number in Morse.
- The initial frequency operating frequency will be the QRP calling frequency for that band as shown in the table below. It is possible to change these default frequencies to another more to your liking later if you wish. Only three of these bands are actually available for use.

Band	Display/Morse	Initial frequency
40 M	4	7.030 MHz
30 M	3	10.118 MHz
20 M	2	14.060 MHz
17 M	7	18.0680 MHz

Band selection:

Three, DP3T switches are used to select one of the thee bands the rig has been built for.

- Make sure all three switches are in the same position, i.e., left, center or right. It would be a good idea to get into the habit of moving all the switches in sequence, like top to bottom.
- The switch near the top edge of the case tells the processor which band is selected. When the position of this switch is changed, the digit for the band selected will flash on the display.
- When changing bands after initial power up, the last used frequency for that band will be loaded.

Volume control:

There is none! Instead, an automatic level control is built into the rig. This circuit limits the audio output level to about 420 mV rms, which is about 10 mW into a 16 ohm load, typical for a pair of stereo ear buds connected in parallel. With sensitive ear buds, this can actually produce too much volume if your hearing is still good. In this case, an in line volume control can be added in series with your headphones.

Input attenuator:

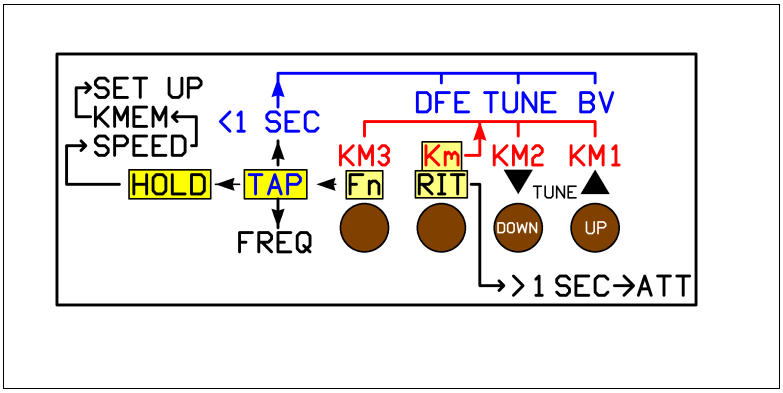
Volume can be reduced using the attenuator feature. This turns the QSK receiver input switch off, greatly reducing the sensitivity of the receiver.

- To enable, press and hold closed the <**RIT**> switch until “A” is enunciated by the side tone, (about 1 second after the “R” for RIT mode) and the letter “A” appears on the display.
- To disable, press and hold closed the <**RIT**> switch until “A” is enunciated by the side tone and the display blanks.

NOTE: If the attenuator is turned on when keyer beacon mode is enabled, it will be turned off. It will also be turned off if one of the menu functions is selected, such as keyer message entry, DFE or setting low voltage battery warning.

The attenuator will stay on when displaying frequency, battery voltage or in keyer speed setting mode. The “A” will be restored to the display when the function has completed. The attenuator will also stay on in RIT mode, but there will be no indication of this as the display will be used to display the RIT tuning delta. The attenuator mode indicating “A” will be restored to the display when RIT is exited.

Control switches:



- Four push button switches control the operation of the Mountain Topper.
- All switches have multiple functions. The primary function of each switch is labeled in BLACK in the switch function flow diagram shown to the right.
- Secondary functions are enabled by a short click (TAP) of either the <**Fn**> switch or the <**RIT**> switch, followed by clicking the switch for the desired function. This allows often used secondary functions to be quickly accessed.
- Additional functions are enabled by holding the **Fn** or **RIT** switch closed for longer then 1 second.
- You can right click on the image to print it out, then laminate it and tape to the bottom of the rig for reference.

Frequency tuning:

The operating frequency of the rig is controlled by the **TUNE UP** and **TUNE DOWN** buttons. These are labeled on the front panel with an up arrow and down arrow, respectively. "Clicking" the appropriate switch will increment or decrement the current frequency by 50 Hz. Holding one of the tune switches closed for longer than one (1) second will start an auto-tune mode. The frequency will now change in 100 Hz steps at a rate of about 10 steps a second as long as the switch is held closed. Tuning will revert back to normal one step, 50 Hz tuning when the switch is released. The 100 Hz / 10 steps a second tuning rate is a compromise between being able to scan the band at a reasonable rate, while not being so fast its easy to miss weak signals.

When tuning stops, after a short delay the current frequency will be displayed on the LED readout, one digit at a time.

Tuning limits:

The tuning range includes the entire band, though SSB reception is not possible since it will be received on the wrong sideband. A double beep will sound when the band edges are reached and tuning will stop there, preventing out of band transmission.

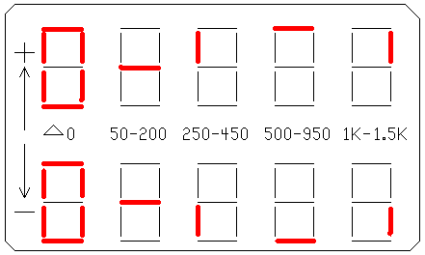
RIT:

The MTR has only RIT (Receive Incremental Tuning) and is limited to a tuning range of +/- 1500 Hz. When RIT mode is enabled, the LED display is used to give indications of where you are tuned in respect to the transmit frequency.

- **RIT is enabled** by clicking and holding closed the <**RIT**> switch closed until the letter "R" is annunciated in Morse by the side tone. There is a slight delay after closing the switch and the sending of the "R", as the RIT switch is also used to activate the transmission of keyer messages.

- **RIT is exited** by clicking and holding closed the <**RIT**> switch until "R" is annunciated. "X" will then be annunciated to indicate RIT has been exited. The display will blank and the original (Rx =Tx) operating frequency which was in use when RIT was activated will be restored. If the attenuator was on when RIT was activated, the letter A will be displayed again.

LED Display while in RIT mode:



While RIT is active, the display is used to show the approximate Rx frequency delta relative to the Tx frequency, as illustrated by the diagram.

- A [0] is displayed when Rx = Tx frequency. A side tone beep is also sounded when you tune back to the frequencies being equal.
- When you tune above or below the Tx frequency, but by less then 250 Hz, the display will show [-]
- When you tune beyond delta 250 Hz, LED segments above or below the center [-] segment will light, changing in a clock wise direction for above the Tx frequency and counter clock wise for below the Tx
- Between 250 and 450 Hz, the upper left or bottom left segment will light. The upper segment for above the Tx frequency and the bottom segment for below.

- Between 500 and 950Hz, the top or bottom segment will light.
- Above 1000 Hz, the upper right or bottom right segment will light.
- AT 1500 Hz, the tuning limit, a beep will sound in the side tone.

Toggling between the RIT Rx frequency and the RX = Tx frequency:

- Momentarily pushing the <**Fn**> button will toggle the receive frequency back to the transmit frequency to check if the frequency is still clear or if someone is calling you there.
- The top and center segments of the LED display will light, which is as close as we can get to making an equal sign: [=].
- While in Rx = Tx mode, you may transmit using the key or paddle, but no other functions will be available.
- Push the <**Fn**> button again to toggle back to the RIT frequency.

MENU:

The **Fn** switch is used to access, activate or escape from, the various functions and options available in the rig. The **Fn** switch is sometimes used alone and sometimes in conjunction with the other switches to activate a function. In all cases, how long the **Fn** switch is held closed will determine what function is to be activated.

Quick selections:

The DFE, Tune mode and battery voltage functions can be quickly accessed by using the <**Fn**> switch in conjunction with one of the three other switches.

- Click and release the <**Fn**>, then one of the other three switches clicked within 1/2 second to activate the desired function.
- <**RIT**> = DFE (direct frequency entry)
- <**Tune Down**> = Tune Mode
- <**Tune Up**> = Battery Voltage

DFE Mode:

"DFE" is annunciated when mode is activated a dash, [-], is displayed on LED

This mode allows you to enter a desired operating frequency using the paddle. This can be any frequency within the upper and lower band edges currently in use. Simply use the paddle to enter the frequency numbers in Morse, starting with the 100 kHz digit and ending with the 100 Hz digit (four numbers total). The LED display will display the number which has been entered and the side tone will sound a beep. If a number is miss sent, a "?" will be annunciated and that digit must be re-entered. When four digits have been entered, the new frequency will be read out via Morse and the display, then the rig will re-tune to that frequency. If the frequency entered is beyond the tuning limits, DFE mode will simply terminate and the frequency will remain where it was.

NOTE:

- DFE mode is not available if the rig is in Straight key mode.
- DFE mode is not available when RIT is active.
- DFE mode can be escaped by clicking the <**Fn**> switch at anytime before all 4 digits have been entered.
- Some "Cut numbers" can be used. These are "T" = 0, "A" = 1, "U" = 2 "V" = 3, "N" = 9.

Tune Mode:

"T" is annunciated when mode is activated, "t" (of sorts) is shown on display

NOTE: Tune mode is not available if the rig is in Straight key mode.

This mode allows you to toggle the transmitter on and off using the paddle. This makes it easier to adjust a small antenna tuner if two hands are required to operate it (One to hold it in place and one to turn knobs).

NOTE: If the supply voltage exceeds 10.0 volts, the power output is automatically reduced. This reduces the risk of PA FET damage if the SWR becomes excessive while adjusting an antenna tuner or checking SWR into an unknown load. Power output starts at a few 100 mw and it takes a few seconds for the power to ramp up to about 2 watts.

If full power output is desired, for say checking power output into a 50 ohm load (dummy or antenna) with a supply voltage greater then 10.0 Volts, put the rig into straight key mode by holding closed the Dash paddle while tuning power on. Reset to paddle mode when done by cycling the power off and back on again.

- If a constant carrier is not needed, it is better to send a string of Dots then use Tune mode for adjusting a tuner.
- Toggle transmitter on: Tap the LEFT (DOT) paddle.
- Toggle transmitter off: Tap RIGHT (DASH) paddle.

- Exit Tune mode: Click **Fn** switch, “E” annunciated.

Battery Voltage:

This mode reads the input voltage to the board and then displays it on the LED display and annunciated in Morse. The letter “B” is sent before the digits during Morse annunciate. A dash [-] is used to indicate the decimal point since the display decimal point is always on as a power on indicator.

Low battery voltage warning:

A low battery voltage warning can be programmed to advise you it's time to go QRT before you damage your battery. This is important if you are using Li-ion batteries. The letter “L” will be displayed on the LED readout when the battery voltage drops below the set point. The set point is entered using the User settings function described later.

Fn switch only selected functions:

- Frequency,
- Keyer code speed (S)
- keyer memory entry (M)
- User preference settings (P)

With the exception of Frequency, click and hold closed the Fn switch until the letter on the 7 segment display appears and the Morse letter identifying the desired function has been annunciated by the side tone, then release the switch. The switch must be released before the next letter in the Fn sequence is annunciated to select the desired function.

Frequency readout:

- Click and then release the <**Fn**> switch will activate the frequency readout.

The default mode of readout is both a numerical readout, sequenced one digit at a time on the LED display, and annunciated in Morse by the side tone. The 100 kHz, 10 kHz, 1 kHz and 100 Hz digits are indicated, in that order. MHz digits are implied by the band in which the rig is currently operating on. A dash [-] on the display and an “R” in Morse indicates the decimal point separating the 1 kHz digit from the 100 Hz digit. Zero's are sent as the cut number “T” in Morse. Therefore, a frequency such as 7.0400 will be sent as T4TRT in Morse and seen as 040-0 on the display. It is possible to set the rig to indicate the frequency only with the LED display.

S: Selecting Keyer code speed

“S” on the display

Keyer speed has a range of about 10 to 35 wpm. Initial power on speed is set to 20 wpm. Code speeds are selected in approximatively 1 wpm increment using the paddle.

- Click and hold closed the **Fn** switch until the letter “S” is annunciated and appears on the 7 segment display, then release the switch.
- This mode will automatically exit after 1 second if no action has taken place in that time.
- **Increase speed: Close DAH paddle or Tune up button .**
- **Decrease speed: Close the DIT paddle or tune down button.**

NOTE: If the rig is in Straight key mode, the Tune up and Tune down switches can used to change code speed. This allows changing the code speed used to send previously stored messages.

Saving the selected code speed to memory:

If you would like to save the current code speed to memory so that it will be loaded on power up as the default speed, this can be done in the “user preferences” function.

M: Keyer Memory entry:

“n” on the display – the closest we can get to “m” with 7 segments

There are three keyer memories available. Each message location an store up to 63 characters, which includes word spaces.

Upon releasing the <**Fn**> switch after the letter “M” has been annunciated, the receiver will mute and entry of the message via the paddle may begin.

- If keyer memory entry has been selected by mistake, clicking the <**Fn**> switch will exit this mode without disturbing the contents of the memory, provided the paddle has not yet been used.

Timing for determining letter and word spaces is automatic and is based on “ideal” timing. Since many of us have a hard time sending with ideal letter and word space timing, generally running letter groups and words together, segments on the LED will flash to let you know when a letter time out or word space time out has occurred. The upper left LED segment (f) will flash at the letter space interval and the upper right segment (b) will flash at the word space time out. Paying attention to the flashing lights will allow you to enter a message without timing mistakes.

Checking and storing the message:

- When you have finished keying in the messages, click the <**Fn**> switch.
- The message will then play back so you can check that they were entered correctly.
- If the playback is good and there are no mistakes,
  - Click <**Tune down**>, <**Tune up**> or <**Fn**>, to store the message in one of those three locations. A Morse “R” will acknowledge the switch press. It then takes a second or so to store the message and once done, the side tone will beep once and the rig will return to normal operation.
  - Click <**Km**> if you the message had mistakes and you want to re-enter it. “EM” (Enter Message) will be annunciated by the side tone.
- If you want to enter and store another message, the memory mode must be again selected using the **Fn** switch, as once a message is stored, the rig goes back to normal operation.

Sending messages:

- First, click the <**Km**> button, then within 1/2 second, click either the **<Tune Down>, <Tune Up> or <Fn>** switch to transmit the desired message.
- **Message 1** is sent by clicking the **<Tune Down>** switch within 1/2 of a second after releasing the Split switch.
- **Message 2** is sent by clicking the **<Tune Up>**_switch within 1/2 of a second after releasing the Split switch.
- **Message 3** is sent by clicking the **<Fn>** switch within 1/2 of a second after releasing the Split switch.

Message 1 can also be sent by tapping the **DAH** paddle
Message 2 can also be sent by tapping the **DIT** paddle

Message Pause and Stop :

After a message has started being transmitted, it maybe paused or stopped using the paddle.

Pause: Closing the DOT paddle will pause the message for as long as the paddle is held closed. Pause will start when a character being sent has finished sending.

Stop: Closing the DAH paddle will terminate the transmission of the message when a character currently being sent has been completed.

Beacon Mode:

Message #3 can be used as a beacon, typically used for calling CQ.

- To active the beacon, first press <**Km**>, then press and hold <**Fn**> for 1 second until the letter “b” appears on the LED display. Release the button and the message will start. The delay between message repeats is initially 3 seconds, but can be increased.
- The message can be terminated or paused with the paddle as the message is sending.
- Using the paddle during the pause before the message repeats will go directly to transmitting and terminate the message sending.
- Beacon can also be terminated by pushing the <**Fn**> switch during the pause between repeats.
- The delay between message repeats can be increased by 1 second increments during the pause by pushing the <**Tune up**> switch. An upper limit is not tested for so the delay could be made quite long. Be careful of this.
- The <**Tune down**> switch will decrement the delay by 1 second increments, but can not be reduced below the default 3 second initial delay time.

Messages in straight key mode:

If messages are in memory, they can be also used in straight key mode. In this case, they can only be activated by the front panel switches. Message pause is not available, but the message can be terminated by closing the key while the message is being sent.

P: Program user preferences

"P" on the display

This mode stores the current state of the rig into Flash memory to use as the default values on power up. The current operating frequencies for each band will become the power up frequencies, along with the current code speed. In addition, you can turn off the Morse annunciation for functions which also use the display for feedback.

- Push <**Fn**> to exit with no action taken.
- To store the current state of the rig, push the <**TUNE UP**> button.
- To turn Morse annunciation of frequency and battery voltage off or back on, push the <**RIT**> button.
- To enter a low battery warning set point voltage, push the <**TUNE DOWN**> button.

Low battery voltage warning set point: <Tune down>

This mode allows you to enter a voltage at which you would like to get a "low battery" warning. The letter "L" will be displayed on the LED display when the battery voltage drops below this set point. The low voltage warning will only clear if the supply voltage rises above the set point and power to the rig is cycled off, then on again.

The initial default value for the warning is 5.5 volts, the absolute minimum operating voltage for the rig.

NOTE: The voltage measurement is not calibrated, so the reading may be off by +/- 100 mV. Therefore, set the warning set point to a voltage some what higher then a critical cut off point to allow for some margin of error and additional operating time.

The DFE mode is used to enter the voltage via the paddle.

- After the <TUNE UP> switch is pressed the side tone will annunciate "E B V" (enter battery voltage)
- Enter four digits using the paddle, as in DFE mode. The voltage is entered as XX.XX volts.
- When the fourth digit is entered, the mode will terminate and go back to the switch scan.

Restoring default values:

If you wish to restore the original default power on frequencies, this can be done by holding the <**Fn**> switch closed while power is applied to the rig. These values can then be stored into memory with the above procedure. Calibration values are not affected. Calibration values can be restored using the calibration mode, which will also reset the initial power on frequencies.

Straight key mode:

Straight key mode is automatically detected and enabled when the rig is powered up when a monaural plug is in the paddle jack. The sleeve of the mono plug grounds the dash input, which enables straight key mode. Straight key mode also allows use of an external keyer if one so desires.

Operating voltages:

The MTR has been optimized for operation at 9 volts, with a minimum operating voltage of 6 volts and a maximum of 12.0 volts. Since power output is dependent on supply voltage, power output will vary from a low of about 900 mw at 6 V and up to about 5 watts at 12 volts.

NOTE: Since there is no fuse or current limiting in the rig, using a 1A in-line fuse in the power supply cord is highly recommended, especially if using a supply capable of large short circuit currents.

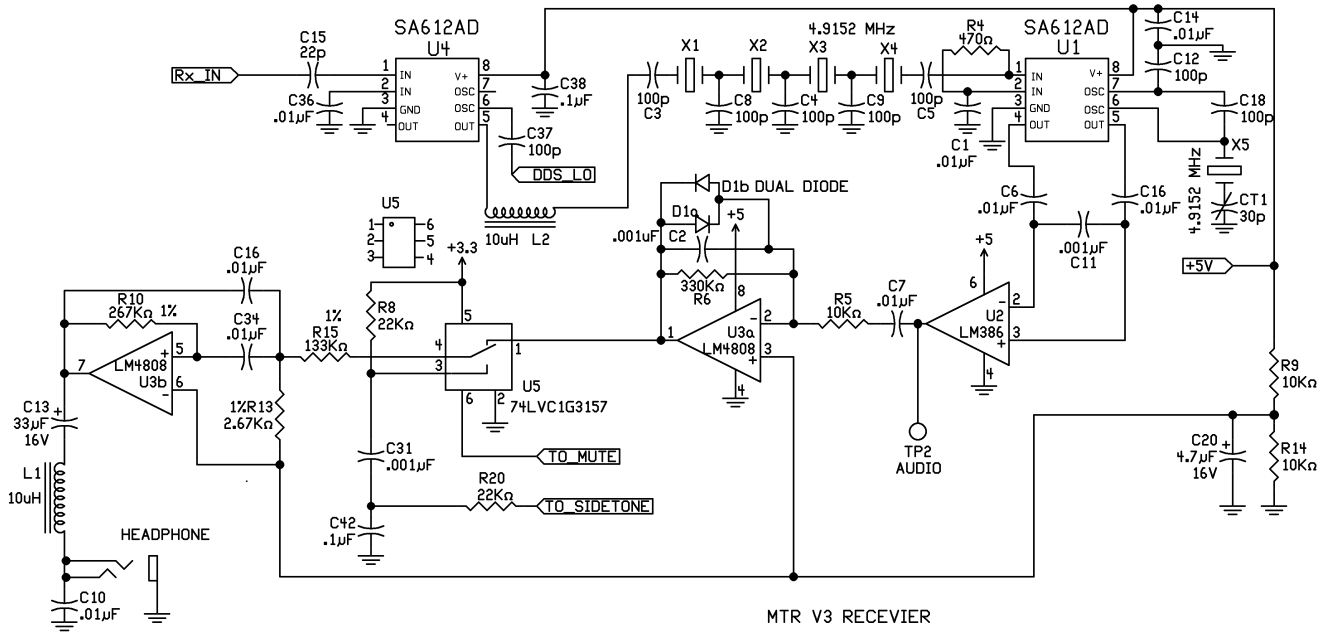
HIGH SWR CAUTION:

If operating the MTR with supply voltages greater than 9 volts, please ensure there is a low SWR load connected to the rig. High SWR conditions (especially those which are reactive) when operating above 3 watts output may cause the PA stage to become unstable or cause the PA FETS to be damaged. Be very careful when using a fully charged gell cell to power the rig!

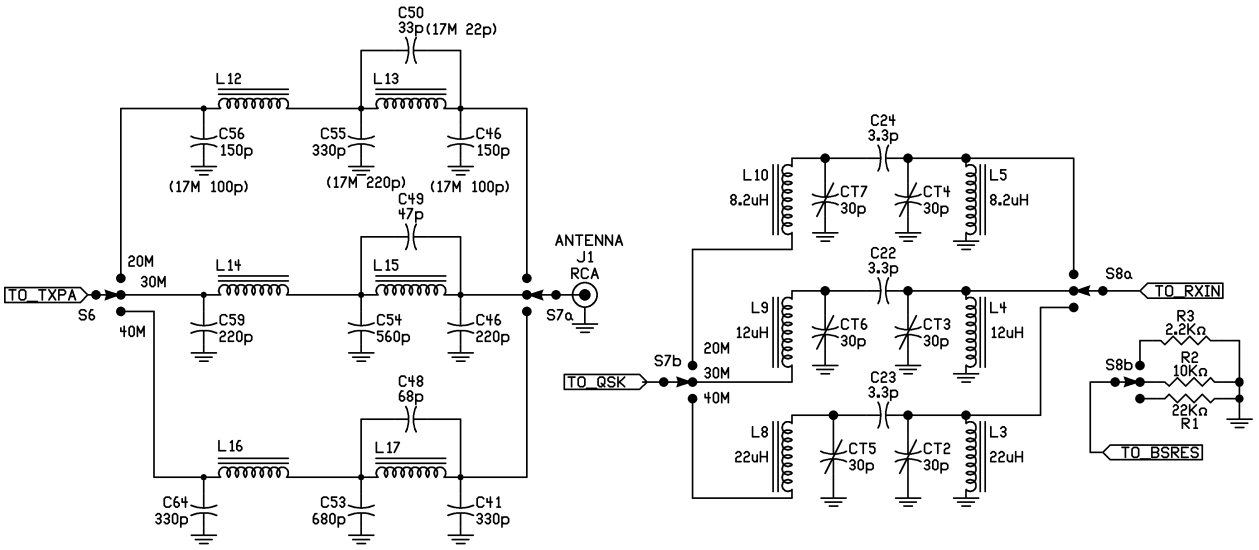
It is highly recommended that a resistive SWR bridge be used if an antenna tuner is needed to match the antenna.

Spare DC power plug: Mouser part number 171-3219-EX 1.7mm x 4.0 mm

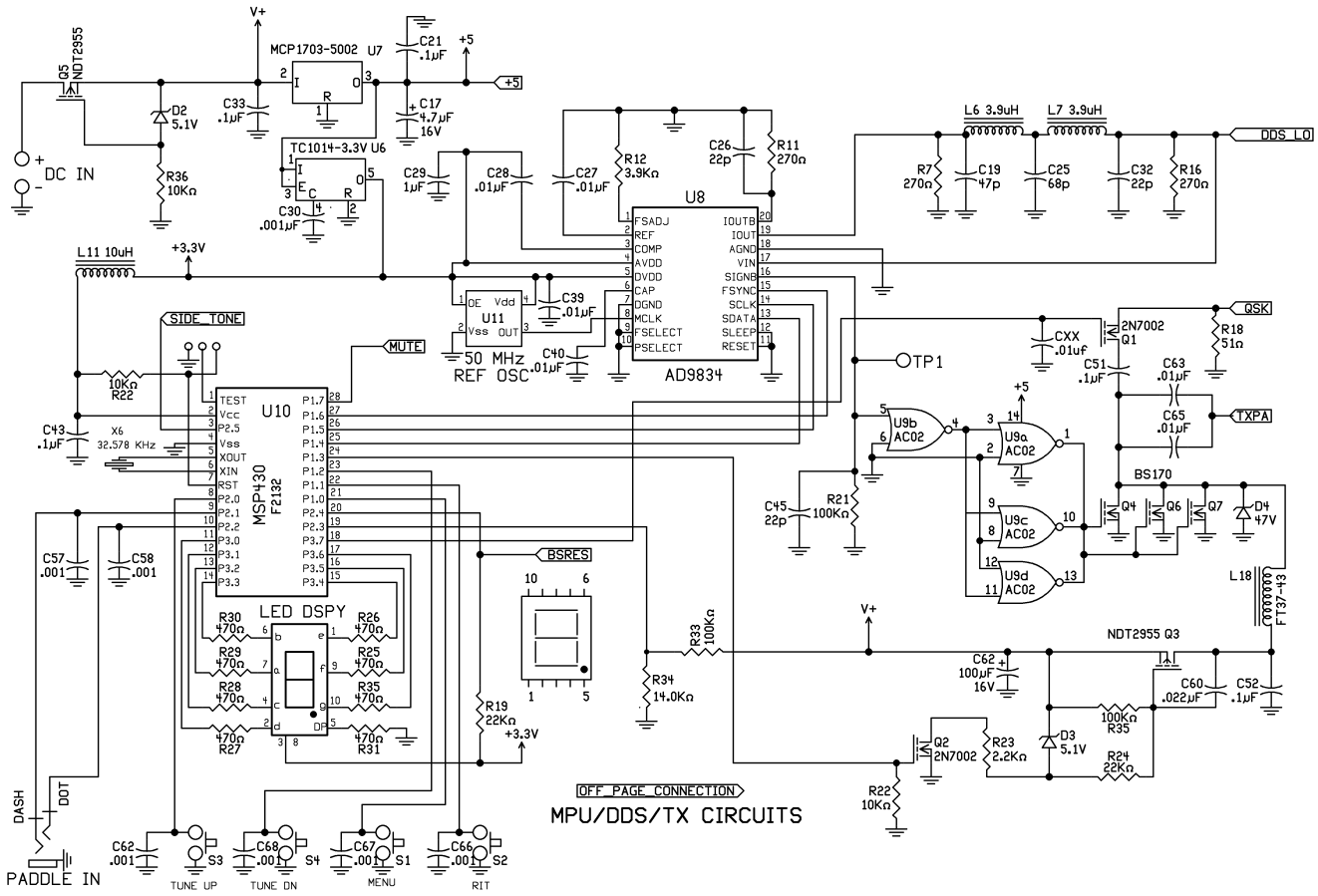
Schematics Receiver section:



MTR V3 RECEVIER

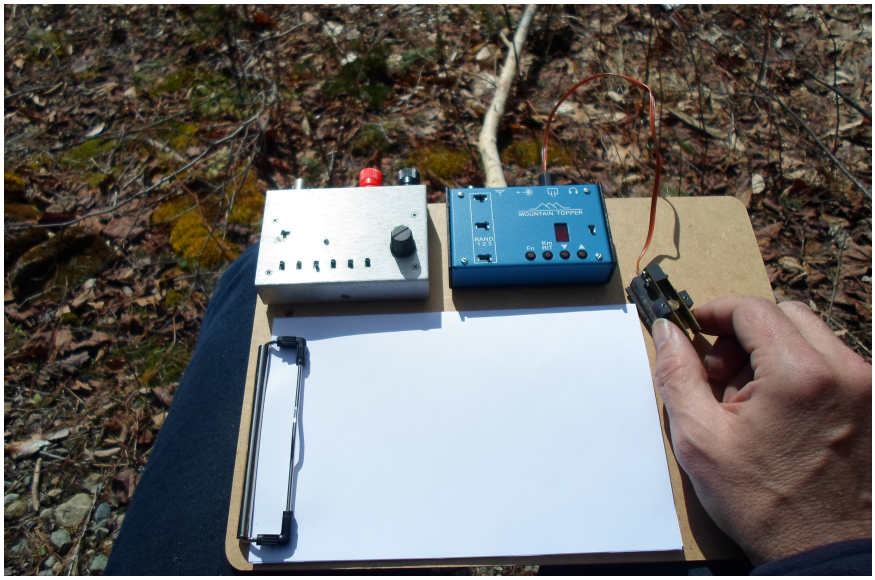


CPU / TRANSMITTER Sections:



Using the rig in the field:

So, how the heck to you use a tiny radio while sitting on a rock on top of a mountain anyway? Here's an idea for a portable lap board to which the rig, tuner, paddle, batteries and notepaper mount to:



A common clip board is used! With this set up you can sit on a rock or log with the clip board resting on your legs.

Drill out the rivets fastening the paper clip to the board and drill new holes to mount the clip lower on the board. Sticky back Velcro strips are added to the bottom of the antenna tuner, MTR rig and paddle so they can be removed from the board for transportation, but are held securely in place when operating.

I'm not too sure about the Velcro to mount the paddle, it flops around a little when you push on the paddle arms. Depending on the type of paddle you use, a more secure method of mounting it would be desired.

You might want to add an elastic to hold down the loose end of the notepaper.