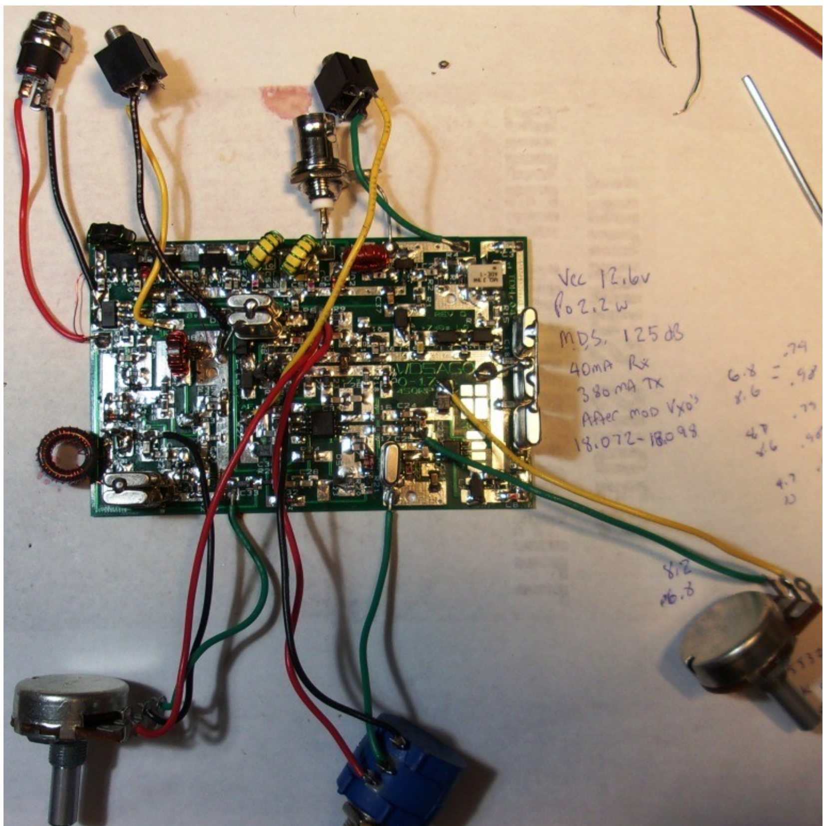
O-17

A newer version of the Ozark 17m Trans-Receiver SMD kit for the 4SQRP Group

By Tommy Henderson—WD5AGO



Building Level: Advanced (SMD)
Completed Circuit shown above.
Below shown with Hammond 1590-BB
or Bud CU 234 (enclosure not included).

O-17

A newer version of the Ozark 17m Trans-receiver SMD kit. Rev-D3 3/1/21

Tommy Henderson WD5AGO

O-17 w/Optional readout and enclosure

Building Level: Advanced (SMD)

About the O-17

In 2003, several of us in the 4SQRP group were at OzarkCon discussing kits which could be developed for alternative bands, thus the design of the Ozark 17. Only 40 kits were produced by the author, due to the usage of 805 size SMD components. The circuit used a pair of 2N2222's at 1.2 W output with CW break in and a separate superheterodyne 4 dB noise figure (n/f), high IP receiver. Transmit (TX) and receiver (RX) circuits were controlled by separate VXO's with 12kHz band coverage. An opportunity to bring the Ozark 17 back with some improvements in component layout was made. Power, VXO coverage, and filtering were increased while component count of different values was decreased. The PCB has a complete ground plane and larger SMD pads, large enough to use leaded components if the builder so desires. SMD component size was increased by using 1206 size or larger parts and the PCB was expanded ½ inch to ease parts placement. Circuit design and layout also lends the PCB to be converted to other bands from 160 m through 6 m. With many more kit builders now comfortable using SMD's, prompted bring back this project.

Receiver Overview

Only minor changes to the receiver circuit were made and it begins with a 5 pole LP filter, shared by the transmitter. Following are RF clamping diodes and an 18 MHz BP filter. This forms the receivers RF attenuation circuit which reduces TX power to -5 dBm ahead of the LNA. A low noise MMIC - GALI 66 (3 dB n/f @ >18 dBg) RF amplifier provides an MDS of approximately -125 dBm. A 2 dB attenuator is used between the MMIC and the ADE-1 doubly balanced mixer to help with overloading and isolation. The RX LO uses 2 - 12.096 MHz crystals in a VXO controlled colpitts oscillator. Frequency swing with two SMD inductors, two diodes and a 10 kΩ potentiometer provides approximately 28 kHz of RX-VXO from 18.072 to 18.100 +/- 2 kHz. A 10 turn - 10 kΩ (or higher) Pot is preferred for finer RX tuning. Following the RX-VXO circuit is a buffer amplifier with LP filtering. It produces +12 dBm of LO power with all harmonics 45 dB down. A 5 dB attenuator (R13, 14, and 15) is needed to reduce the LO drive to the +7 dBm required by the mixer. If the builder desires higher IMD RX performance, +10 or +13 dBm mixers can be directly substituted once changes to the LO attenuator (located on the schematic) is complete.

Following the mixer is a 6 MHz, 430 Hz BW, 3 pole crystal ladder IF filter which provides greater than 30 dB of opposite sideband rejection with an insertion loss of 3 dB. Matched crystals increases the IF filters performance to 38 dB. The crystal filter impedance is 50 Ω for easier matching. The filters Z_{OUT} is stepped up to 1.5 kΩ to match the NA/SA-602 mixer input. This mixer is used as a product detector also operating at 6 MHz. PCB pad size will allow an SMD (SOIC) or an 8 Pin DIP IC, mounted dead bug style, to be used. The SA602 balanced audio output passes through an RC filter to decrease high frequency hiss before driving a 660 Hz BP difference amplifier of 33 dBg. The audio circuit sectioned was modified from one described by Dave, K1SWL using the TS922 DIP op-amp in one of his QRP circuits. This device is no longer available in 8 pin DIP. After modifications in gain and BP frequency, either the TS922 – 8 pin SOIC or the popular but older NE5532 – 8 pin DIP may be used. The second half of the op-amp is used as a 660 Hz BP amplifier with 30 dBg. It directly drives headphones. The BP-AF amplifier combination provides additional selectivity.

A potentiometer is used on the output of the SA602 Mixer as the volume control, which also provides some tone control and reduced drive to the op-amp circuit. Audio output before clipping is 2 Vpp. Total gain from RF to AF is 85 +/-3 dB and RX current is 40mA.

Transmitter Overview

Using two 18.096 MHz crystals in a colpitts VXO provides 30 kHz of frequency coverage. The TX-VXO circuit uses a 1N4004 rectifier diode acting as a varactor, a 10 kΩ or higher value potentiometer, and one hand wound inductor. Several SMD inductor combinations tried would not provide both stability and band coverage needed. A 5.8 uH inductor wound on a blue mix toroid provided the highest performance and closest to the RX-VXO tuning range. TX-VXO coverage is 18.071 to 18.101 +/- .002 MHz. The TX-VXO tuning Pot shares an 8 volt reference with the RX-VXO. Using 12 volts as the reference added only 2 kHz to the upper end of the band; however, decreasing frequency stability.

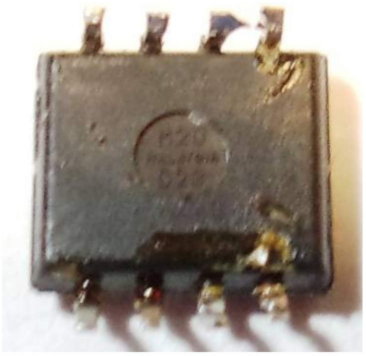
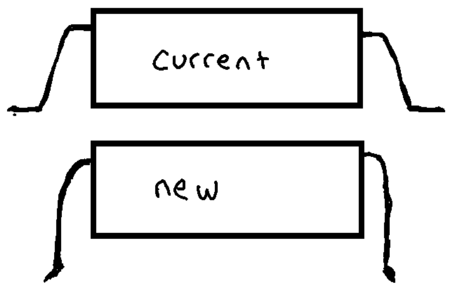
Another 2N2222 is used for the buffer/driver RF amp along with an output matching transformer (T1 = 5:1 TR). A 1 inch long lead from the transformer secondary is connected to a 33 Ω resistor (R40) while it drives the final power amplifier (PA). This parallel base resistor controls the drive level for the PA transistors and provides some TX stability. R40 value can be increased to drive lower gain PA transistors. Several transistors tested from different manufactures required more drive than others. Three high power PZT2222's in parallel are used in class C for the PA. The PA load impedance is approximately 38 Ω. A five pole low pass with an elliptic filter section provides PA matching and reduces harmonics better than 47 dB. Total TX current draw is approximately 400 mA (270 mA in the PA transistors) with an output power of 2.0 to 2.2 watts (about 61% overall efficiency). Up to 3 watts output was achieved, which is near maximum of the transistors ratings, therefore 2.5 watts is the recommended maximum to increase transistor life. A 36 V Zener (D11) was later added to help prevent PA damage in the event of poor loading. An optional spot switch reducing power 20 dB was added to aid in TX frequency offset adjusting. CW break-in is still functional with TX spot on or off.

Building

Become familiar with the O-17 parts page (BOM), PCB layout, and schematic. Soldering components in sections does lend to easier troubleshooting however, the LO, RF, and AF sections on this PCB are designed in a way that it can be troubleshot with it completed. A block diagram is shown in Fig 1. Winding the 6 toroids can be started anytime which are shown in the BOM. Construction begins on page 10 by placing and soldering the active, larger SMD components first as their size is easier to work around than smaller parts. Capacitors especially need attention as few have markings to identify their values. It is recommended to isolate each value and mark a color and even a pattern (say two dots) with a marker on each capacitor. This process alone has saved a lot of time troubleshooting sections with incorrect parts placement. Using flux along with a hot, fine tip soldering iron also helps in SMD construction. When the O-17 was updated from the original Ozark 17, the pads were oversized which allows easier soldering of either SMD or if the builder uses leaded components (mounted dead bug style). The draw back to large pad sizes is the silk screen pattern cannot cross over the pad which makes some component locations seem difficult. Parts placement pages are provided with comments for each section. Pictures speak louder than words! When the PCB is completed; the enclosure and knobs, is up to the builder however, several examples are illustrated. No internal tuning is required. The builder may install a spot switch to track the TX frequency offset to the RX frequency during tuning. A 600 to 700 Hz offset is about right. A complete wrap-up of the project, examples (including modifications), testing, and specifications are located at the end of the building section.

Attention 4SQRP Group Builders: We want to thank you for your support of the 4SQRP group in selecting this kit to build and the efforts of the 4SQRP kitting group. While several kits were built and tested, some component modifications may need to be made with the parts provided. Notes are added to this manual version to help the builder with component locations and modifications to performance and testing. To help the builder with a "heads up" those items of interest are listed below:

1. **IC2,** The NE5532 used **in some** of the 4SQRP kit is the larger SOIC package (over sized). Pin alignment will be beyond the pad size for a standard SOIC. Compare the size of U2 to U1, if U2 is larger, then it is the oversized SOIC. If they are the same size, please continue on to build.
    - Fix: Prep the PCB around IC2 by gently scraping off some of the green screening over the pads (approximately 0.05 in, to the point were the larger IC pads are.

    - Prep the N5532 by gently binding the leads down at a angle shown above instead of flat pin mounting. Note pin 1 is the round dot as the lettering is difficult to see (shown above was highlighted).
    - If no audio output is picked up, the two likely culprits are: the Pin alignment of the SOIC is not soldered in place or the Phone Jack is not wired correctly.

2. **VXO Coverage on RX is less than specified on some kits.**
    - Some of the crystal pars and components for the receive VXO may prevent greater than 18 kHz of tuning. If you notice the receiver tuning does not go low enough in band, the easiest modification is to replace L6 : 6.8 uH SMD inductor with a 8.2 uH or even a 10 uH. With 18.084 to 18.101 MHz VXO coverage observed in 1 build, a 10 uH provided coverage from 18.071 to 18.098 MHz.

3. **TX signal is touchy at the bottom end of the band on some built kits**.
    - This is common with VXO's as the Potentiometer is at Zero ohms and the varactor diode is operating at maximum capacitance however, some drift or warble may occur.
    - Removing C41 (22 pF) was the easiest mod while this will shift your lowest frequency up a few kHz, adding 1 more turn to L8 (25t) will bring the low end back to 18.072 MHz. If that is not enough stability then reduce the oscillator voltage (Change D10 from 10 V to a 8 or 8.2 V zener).

4. **Spot Switch in Kit:** Is a momentary N/O - will not work for spotting. If one is needed use a SPDT.

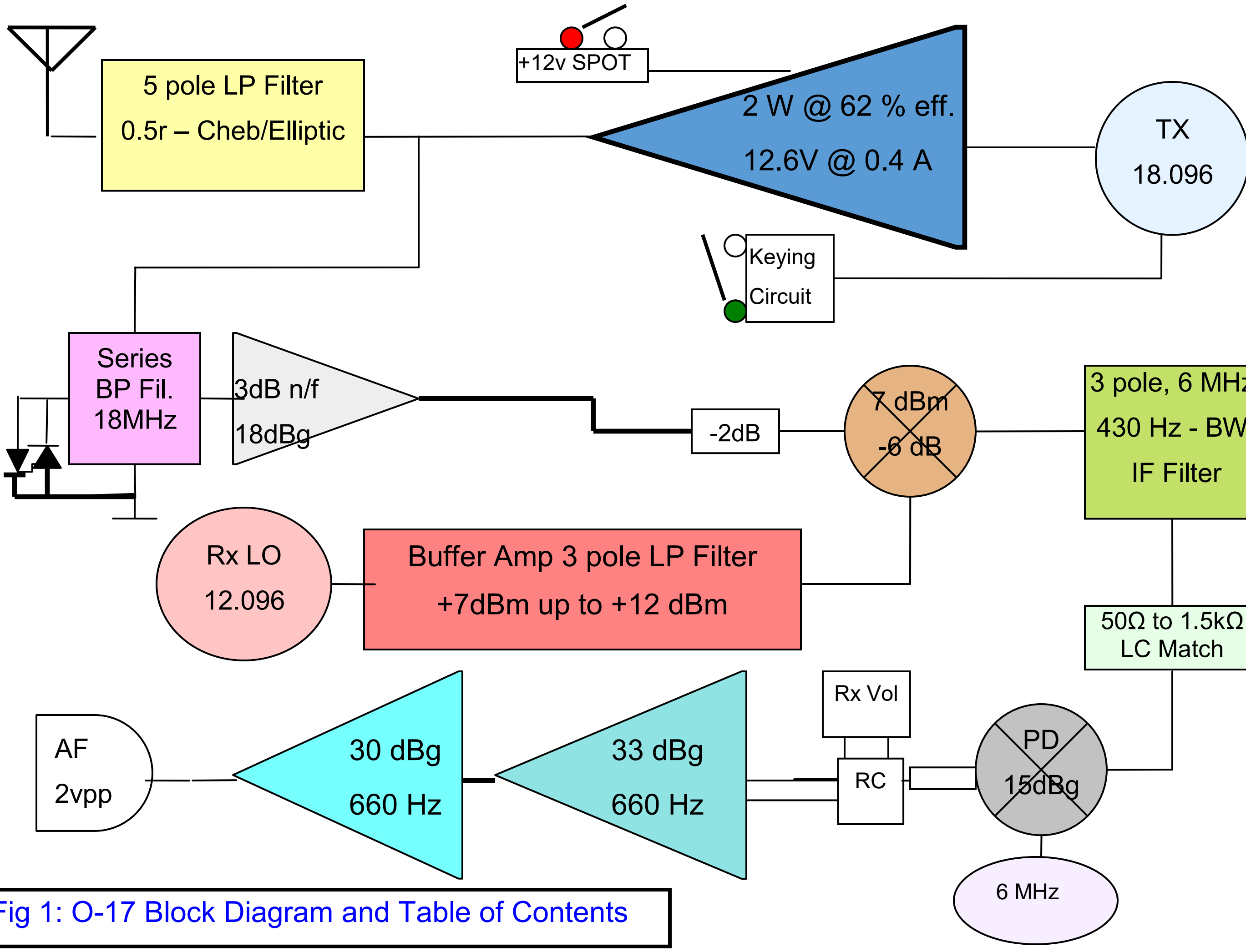
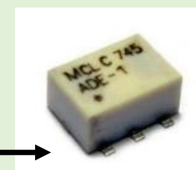
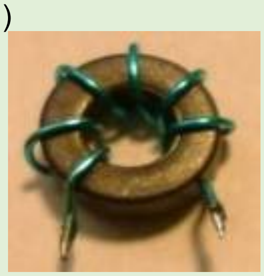


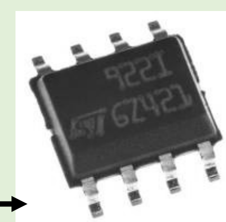
Fig 1: O-17 Block Diagram and Table of Contents

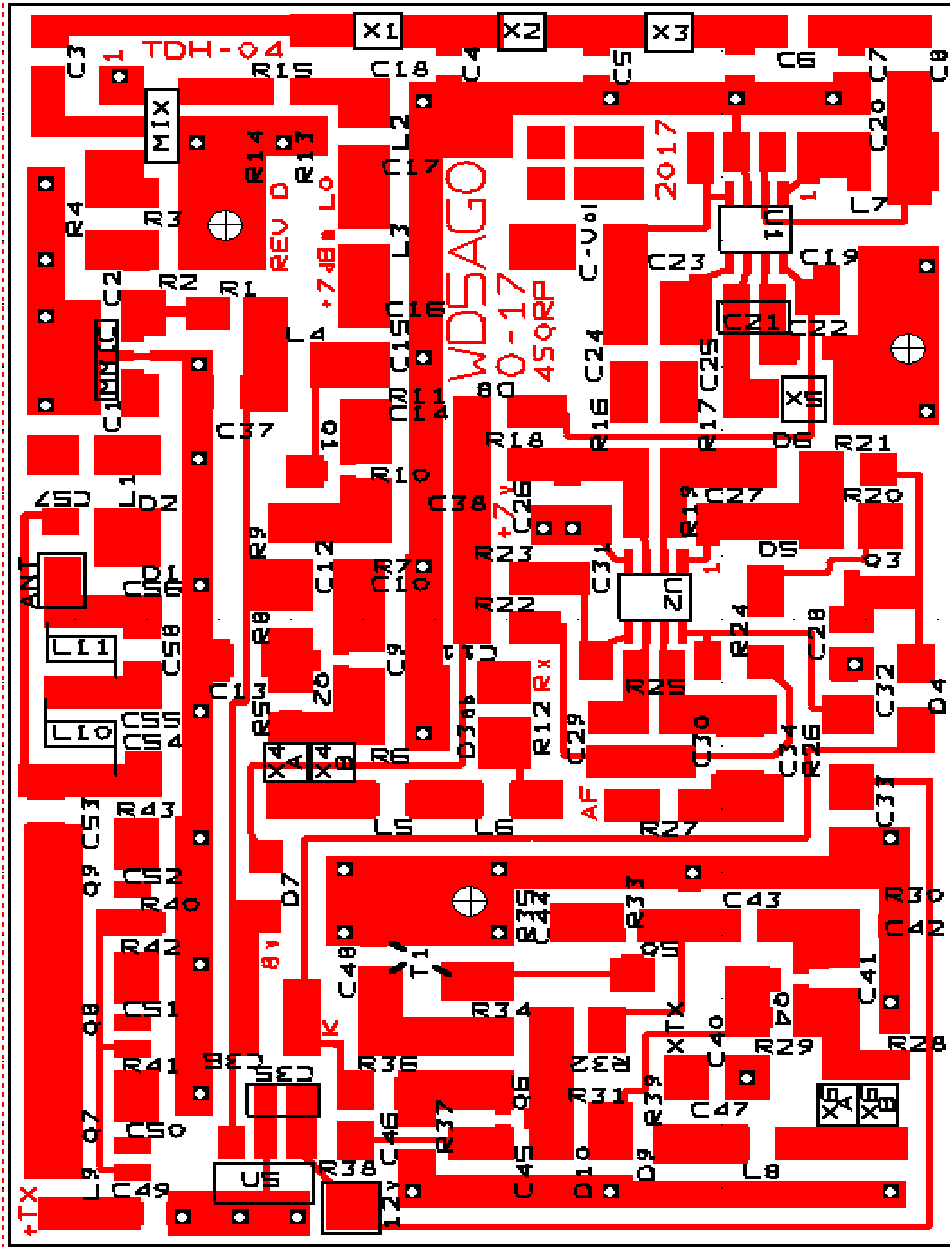
SMD's! Builder Assumes Responsibility:

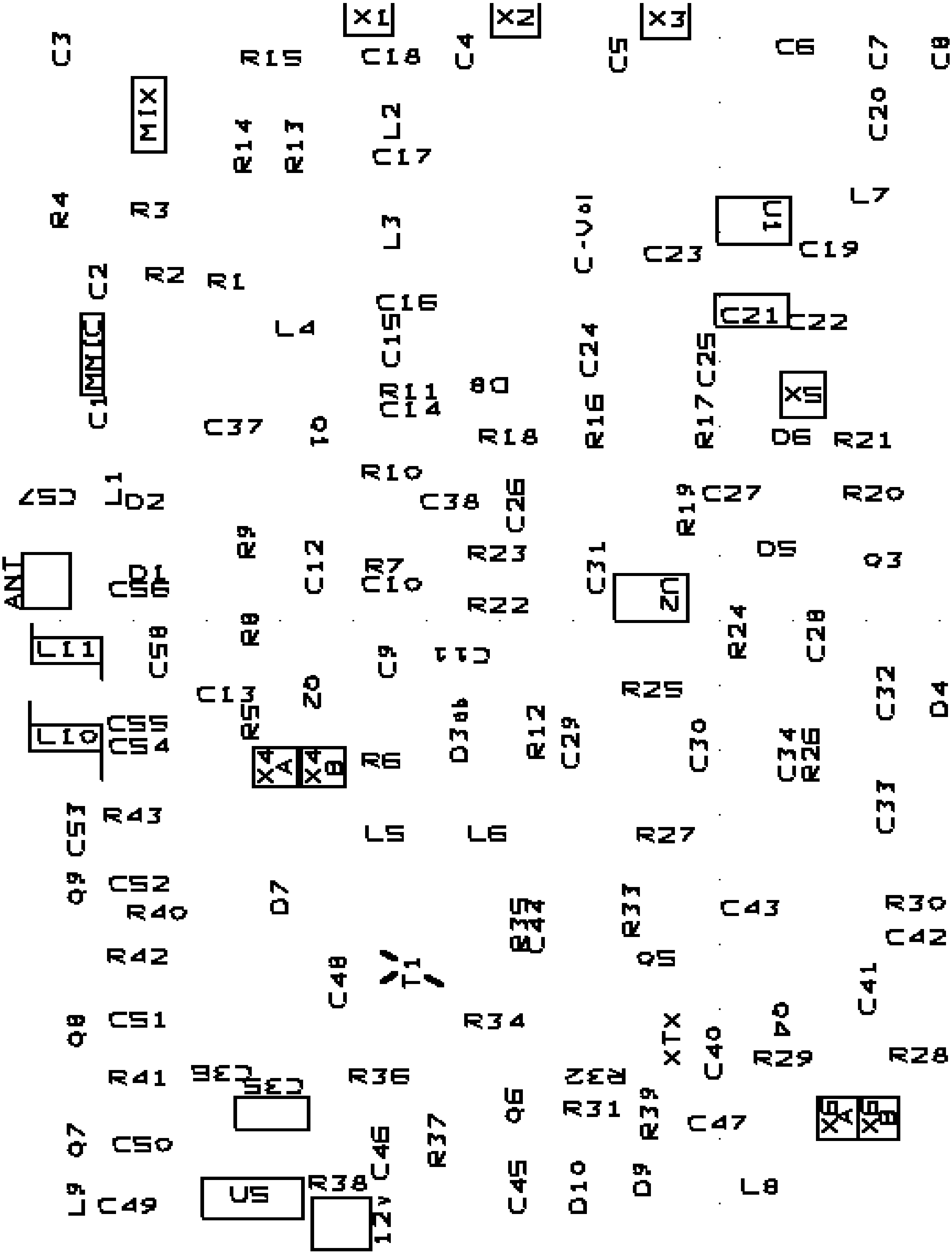
SMD (surface mount device) parts are small compared to leaded parts. Some care is suggested while using them as they may fly away speedily without warning to never be found again! Body armor might be of some use, however, not required. Higher than normal soldering iron temperature helps in building SMD circuits which can burn you. Eye protection is recommended.

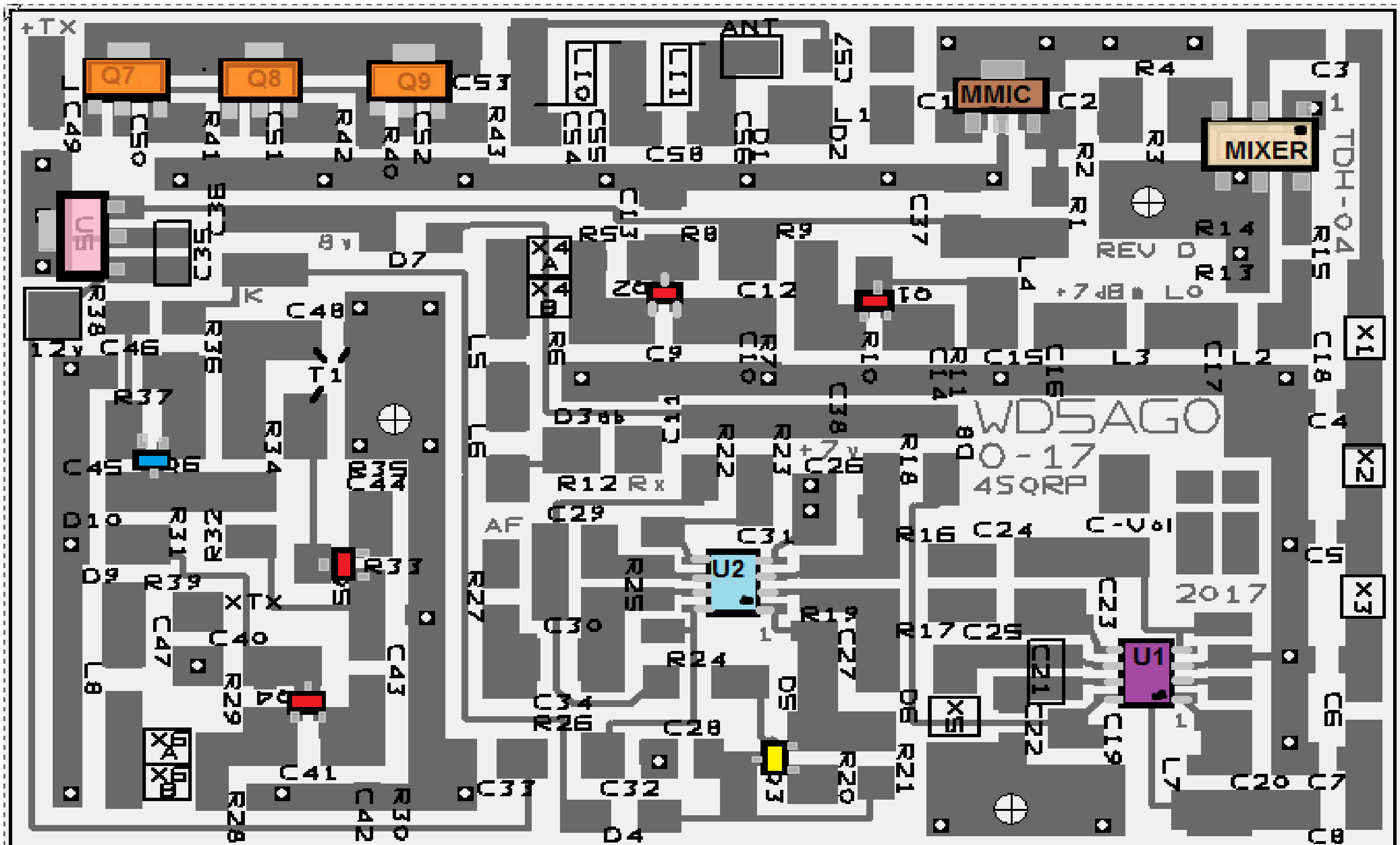
O-17 Parts Reference **Resistors**	Part Value SMD Size	Notes Quantity Marking	Part Reference **Capacitors**	Part Value	Notes Quantity and Marking " "
R1	**280 Ω – 1206 SMD**	(1) - 2800	C1, C2, C11, C13, C14, C40, C44, C45, C46, C47, C48, C49, C50, C51, C52	**0.01 uF – 1206 SMD**	(15) "package marked black"
R2, R3, R7, R30	**475 Ω (470 Ω ok) – 1206**	(4) - 4750	C3, C4, C5, C6, C55	**390 pF – 1206**	(5) "green"
R4, R8, R26, R27, R34, R38	**10 Ω – 1206**	(6) - 10R0	C7, C56	**220 pF – 1206**	(2) "purple"
R5, R24, R29	**22 kΩ – 1206**	(3) - 2202	C8, C21	**120 pF – 1206**	(2) "red"
R6, R9, R12, R16, R17, R28, R32, R36, R37, R39	**10 kΩ – 1206**	(10) - 103	C9, C10, C12, C42, C43	**56 pF – 1206**	(5) "orange"
R10, R33	**3.3 kΩ – 1206**	(2) - 3301	C15	**10 pF – 1206**	(1) "brown"
R11, R35	**120 Ω – 1206**	(2) - 1200	C16, C41, C57, C58	**22 pF – 1206**	(4) "yellow"
R13, R14, R31	**180 Ω – 1206**	(3) – 1800	C17, C18	**470 pF – 1206**	(2) "blue"
R15, R40	**33 Ω – 1206**	(2) – 33R0	C19, C20, C24, C25, C28, C31, C32, C35, C37, C38, C53	**0.1 uF – 1206**	(11) "gray or silver"
R18, R19, R22	**510 kΩ – 1206**	(3) – 5103	C23	**0.047 uF**	(1) "orange/ silver"
R20	**7.5 MΩ – 1206**	(1) - 755	C22, C26, C27, C54	**180 pF – 1206**	(4) "purple/ silver"
R21, R23, R25	**1 MΩ – 1206**	(3) - 1004	C29	**2700 pF**	(1) "red/silver"
R41, R42, R43	**2.7 Ω – 1206**	(3) – 2R70	C30	**1000 pF**	(1) "green/silver"
RX-VXO	**10 kΩ, 10 turn POT**	(1) – 10k w/ dial counter	C33, C36	**1uF Elec. 16v**	(2) #105 Electrolytic "yellow/black"
R-Vol, TX-VXO	**10 kΩ POTs**	(2) 10k	C34, C39	**33uF Elec. 10v**	(2) #336 Electrolytic "pink/black"

Part Refer.	Part Value (Marking)	Notes Quantity and Mark	Part Refer.	Part Value (Marking)	Notes Quantity and Mark
L1	26t of #30 – wire on T37-2 Red ~ 2.8 uH (15” of Red #30 wire)	(1) 	X1, X2, X3, X5	6.000 MHz - Leaded	(4) 
L2	560nH – 1812 SMD (R56M)	(1) 	X4a, X4b	12.096 MHz - Leaded	(2) 
L3, L5	4.7uH – 1812 SMD (4R7)	(2) 	X6a, X6b	18.096 MHz - Leaded	(2) 
L4	15uH – 1812 SMD (150K)	(1) 	Mixer	ADE-1 (Dot Pin 1)	(1) 
L6, L7	6.8uH – 1812 SMD (6R8)	(2) 	Q1, Q2, Q4, Q5	2N2222 – SOT (1P)	(4) 
L8	24t #30 – T50-1 Blue ~ 5.8 uH (18” of Red #30 wire)	(1) 	Q3	J310 – SOT (6T)	(1) 
L9	6t #26 – T37-43 Black ~ 12.5 uH (5” of Green #26 wire)	(1) 	Q6	2N3906 – SOT (2A)	(1) 

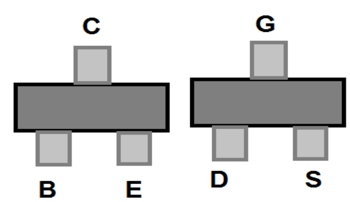
O-17 Part Ref.	Part Value (Marking)	Notes Quantity and Marking	Part Reference	Part Value (Marking)	Notes Quantity and Marking
L10, L11	12t #26 T37-6 Yellow ~ 0.4 uH (8” of Green #26 wire)	(2) 	Q7, Q8, Q9	PZT2222 – SOT 223 (P1F or PZT or 2222)	(3) 
T1	**15t Pri. – 3t Sec. – T37-43 Black** **(Primary 9.5” of Red #30) (Secondary 3.5” of Red or Green with 1.5” lead #28)**	(1) 	MMIC	MMIC – GALI-S66+ (66 and smaller than Q7-Q9)	(1) 
D1, D2, D4, D5, D6, D7, D8	1N4148 – SMD Smaller diode	(7) 	U1	SA602 – SOIC or Leaded Pin 1 →	(1) 
D3a, D3b, D9	1N4004 Diode Leaded	(3) 	U2	TS922 – SOIC or **NE5532 - SOIC** Either can be leaded Pin 1 →	(1) 
D10	10V Zener 1N5240B Leaded Smaller Glass 1/2W	(1) 	**U5** *No…..* *(U3 and U4 were deleted)*	LM78M08 – SOT 223 8 Volt Reg. (C8)	(1) 
D11	36V 1W Zener 1N4753A Larger Glass	(1) 	Hook up wire for Pots and Jacks	#24 to #26	3.5 ft vinyl or PTFE Red, Yellow, Green, Black
S1	**SPST SW** **N/C to operate- *Optional***	(1) For Tx-spot, not required. A DPDT can also be used for Spot.	Enamel Wire for Inductors	Red #30 – 48”. Green #26 – 24”	4ft and 2ft of Enamel wire


TDH-04
REV D
WD5AGO
O-17
45QRP
2017
+7dBm LO
C-Vol
+7v
Rx
AF
TX
ANT
MIX
+TX
12v
8v


X1
X2
X3
C3
R15
C18
C4
C5
C6
C7
C8
MIX
R14
R13
L2
C17
C20
R4
R3
L3
C-Vol
U1
L7
C23
C19
C2
R2
R1
C16
C21
C22
L4
C15
MMIC
C1
C24
C25
X5
R11
C14
D8
C37
Q1
R18
R16
R17
D6
R21
R10
C57
J1
D2
C38
C26
R19
C27
R20
R9
C12
R7
C10
R23
C31
D5
Q3
ANT
D1
C56
R22
U2
L11
C58
R8
C9
C11
R24
C28
C13
Q2
R5
L10
C55
C54
X4A
X4B
R6
D3
R12
C29
R25
C30
C34
R26
C32
D4
C53
R43
L5
L6
R27
C33
Q9
C52
R40
D7
R35
C44
R33
C43
R30
C42
R42
C48
T1
Q5
C41
Q8
C51
R34
XTX
C40
Q4
R29
R28
R41
C36
C35
R36
R32
Q6
R31
R39
C47
X6A
X6B
Q7
C50
C46
R37
L9
C49
U5
R38
12v
C45
D10
D9
L8



Solid State Components: Place component legs in center with the pads and position as shown above. The ICs markings may be faint; the lower left will be pin #1 with the markings reading top down. The collectors or gates on the SOT-23 transistors are located on the center tab. The Mixer letters will be upside down from this view (mount Pin 1 (Dot) top right). Adding a small amount of flux to pads may help hold components to PCB and use solder sparingly.



(Quantity – Color Placement): Reference = Part Value – (Notes)

(4 – Red): Q1, Q2, Q4, Q5 **= 2N2222 – *(marked 1P, small SOT 23)***

(1 – Yellow): Q3 **= J310 – *(marked 6T)***

(1 – Blue): Q6 **= 2N3906 – *(marked 2A)***

(3 – Orange): Q7, Q8, Q9 **= PZT2222 – (*marked PZT size SOT 223)***

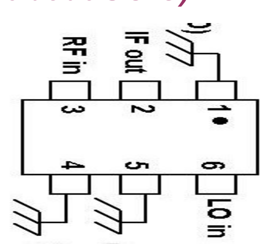
(1 – Brown): MMIC – (*marked 66)*

(1 – Purple): U1 **= SA602 - *(or marked NA602 or 611, SOIC) Pin 1*** →

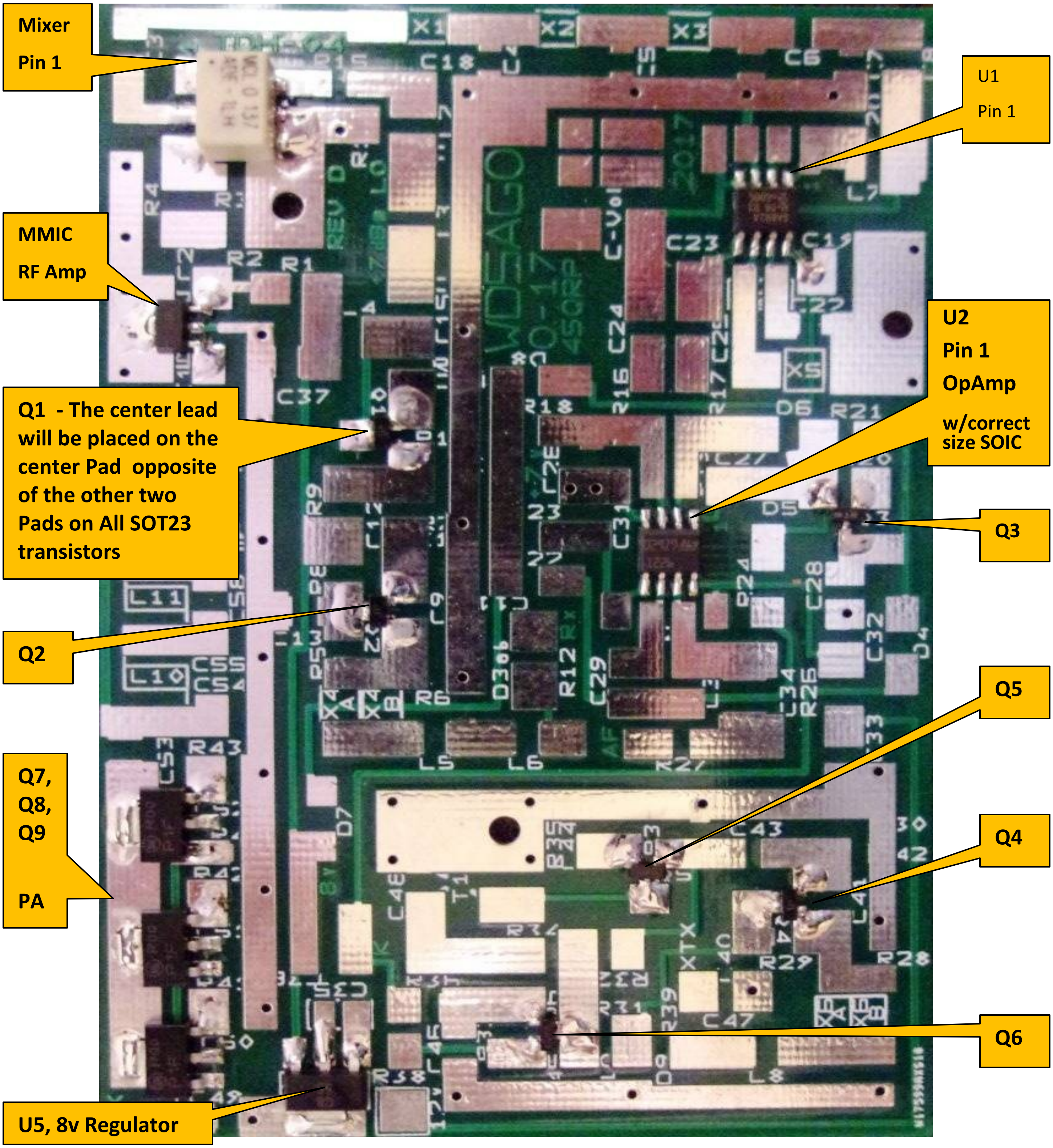
(1 – Light Blue): U2 = NE5532 or TS922 – (IC OpAmp, read note on page 5 about SOIC)

(1 – Pink): U5 **= LM7808 – *(marked 08 size SOT-223)***

(1 - Ivory): Mixer – *ADE-1 (Pin 1 mounts top-right)* →

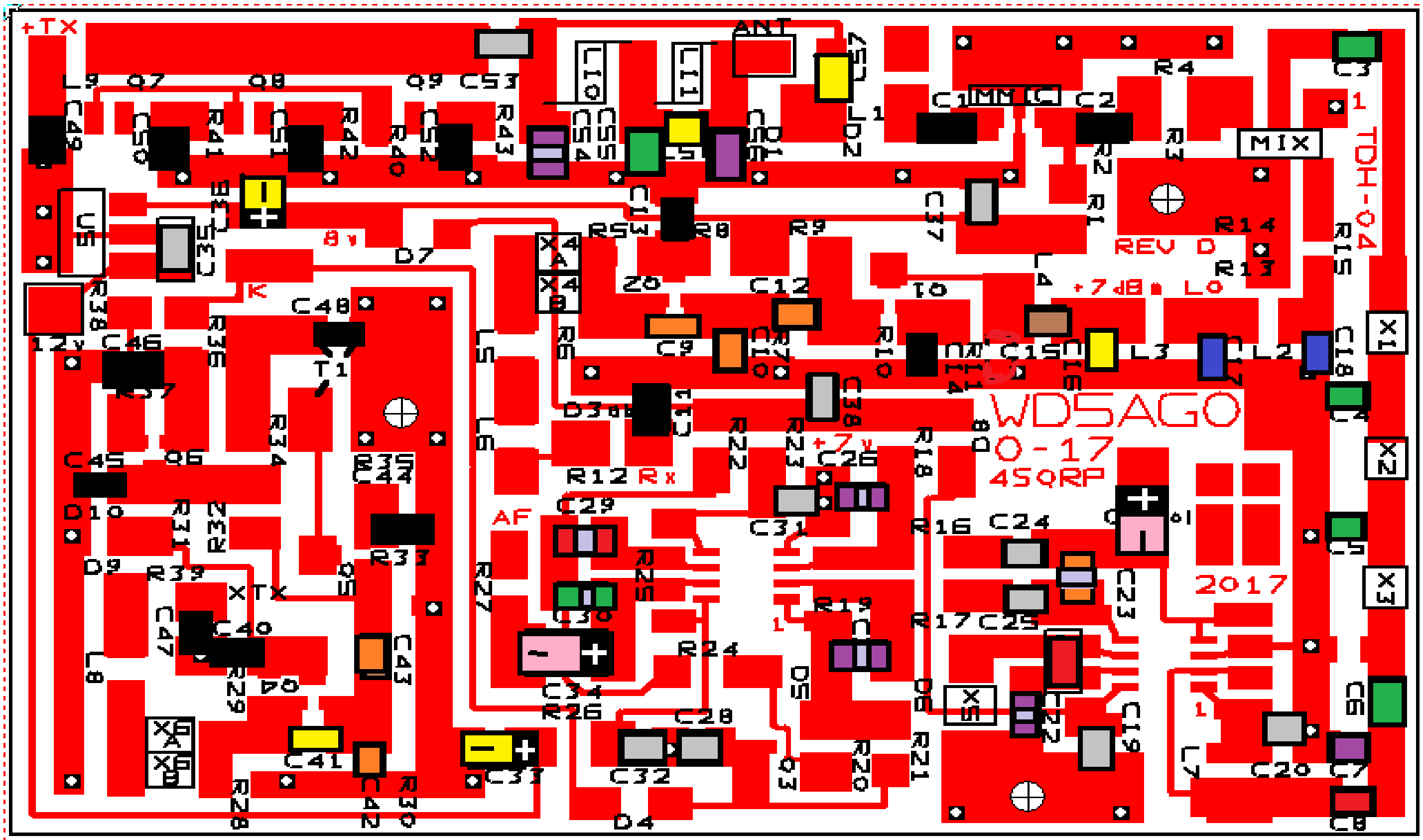


To help with component placement, the next Page illustrates actual picture and layout.



Above: Actual view of components: Solid State

Next Page: The next parts to solder are the Capacitors which have no markings. The package should be marked; please take care to not mix values. The safest way to proceed is to open, color dot, and solder all the same values before opening another value. Some SMD parts will cross over small traces and others will share a pad (side-by-side) with other components. Place components on one side of the Pad as shown below. Some parts are marked with one color and others use two colors (gray center).



Capacitors: View both the PCB above and the Picture on the next page to help with placement. Color marking components is another way to identify non marked capacitors.

(Quantity – Color Placement): Reference = **Part Value –** (Notes if any)

(15 – Black): C1, 2, 11, 13, 14, 40, 44, 45, 46, 47, 48, 49, 50, 51, 52 = **0.01uF**

(note: caps may a share pad, place as shown, i.e. C14, C44…)

(5 – Green): C3, C4, C5, C6, C55 = **390pF**

(2 – Purple): C7, C56 = **220pF**

(2 – Red): C8, C21 (next to U1, pins 6-7) = **120pF**

(5 – Orange): C9, 10, 12, 42, 43 = **56pf** *(note: C9 shares w/Q2, C10 shares w/R7)*

(1 – Brown): C15 = **10pF**

(4 – Yellow): C16, 41, 57, 58 = **22pF** *(note: C16 center, C58 center of C55 and 56)*

(2 – Blue): C17, C18 = **470pF** *(C17 center, leave room to place L3 and L2 later)*

(11 – Gray): C19, 20, 24, 25, 28, 31, 32, 35, 37, 38, 53 = **0.1uF**

(1 - Orange/Gray "Half colors have stripe center**"):** C23 = **0.047uF** (near U1)

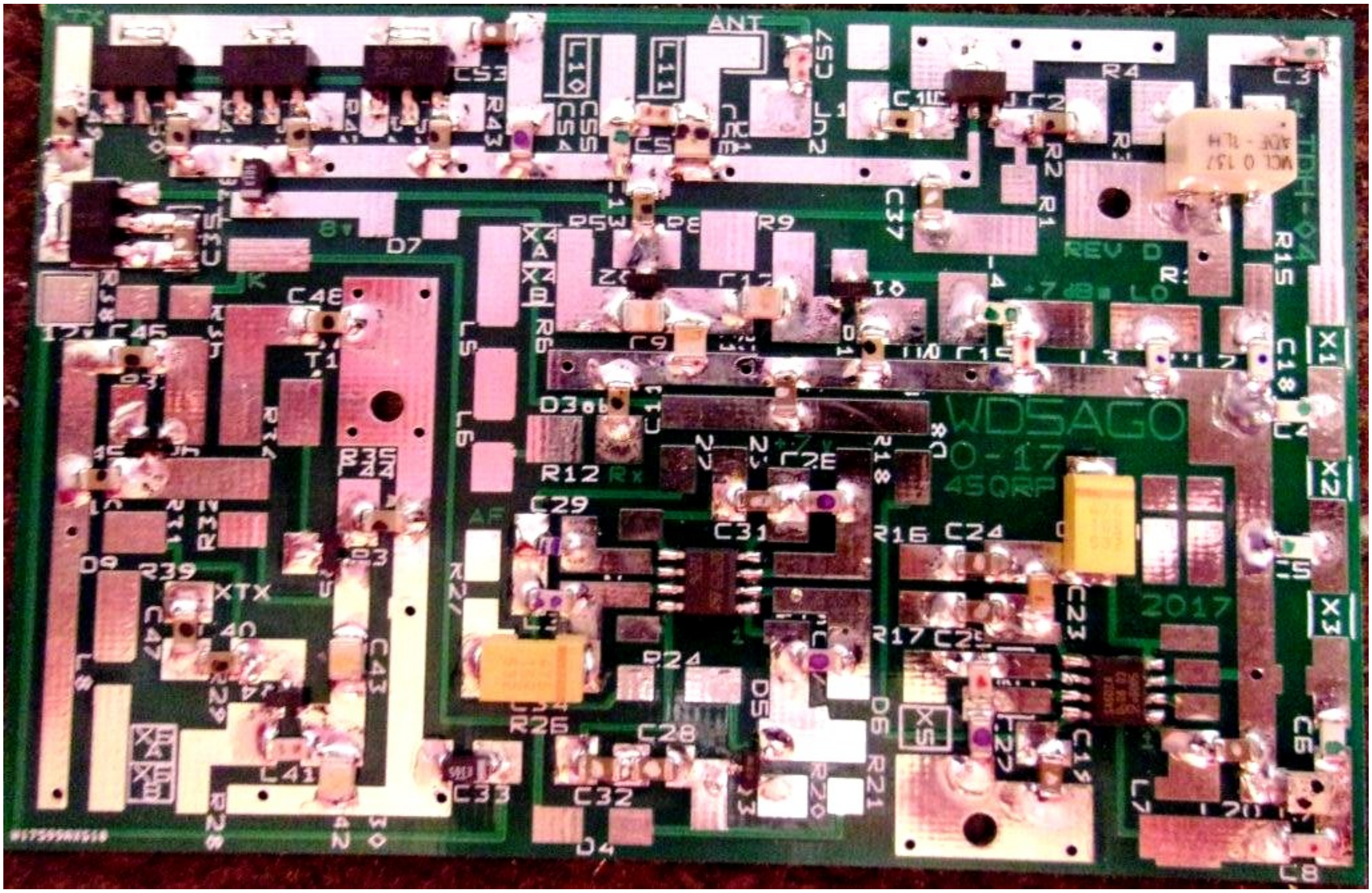
(4 - Purple/Gray): C22, 26, 27, 54 = **180pF** *(note: place C27 in middle, off pin 1 of U2)*

(1 - Red/Gray): C29 = **2700pF** (off pin 6 of U2)

(1 - Green/Gray): C30 = **1000pF** (off pin 7 of U2)

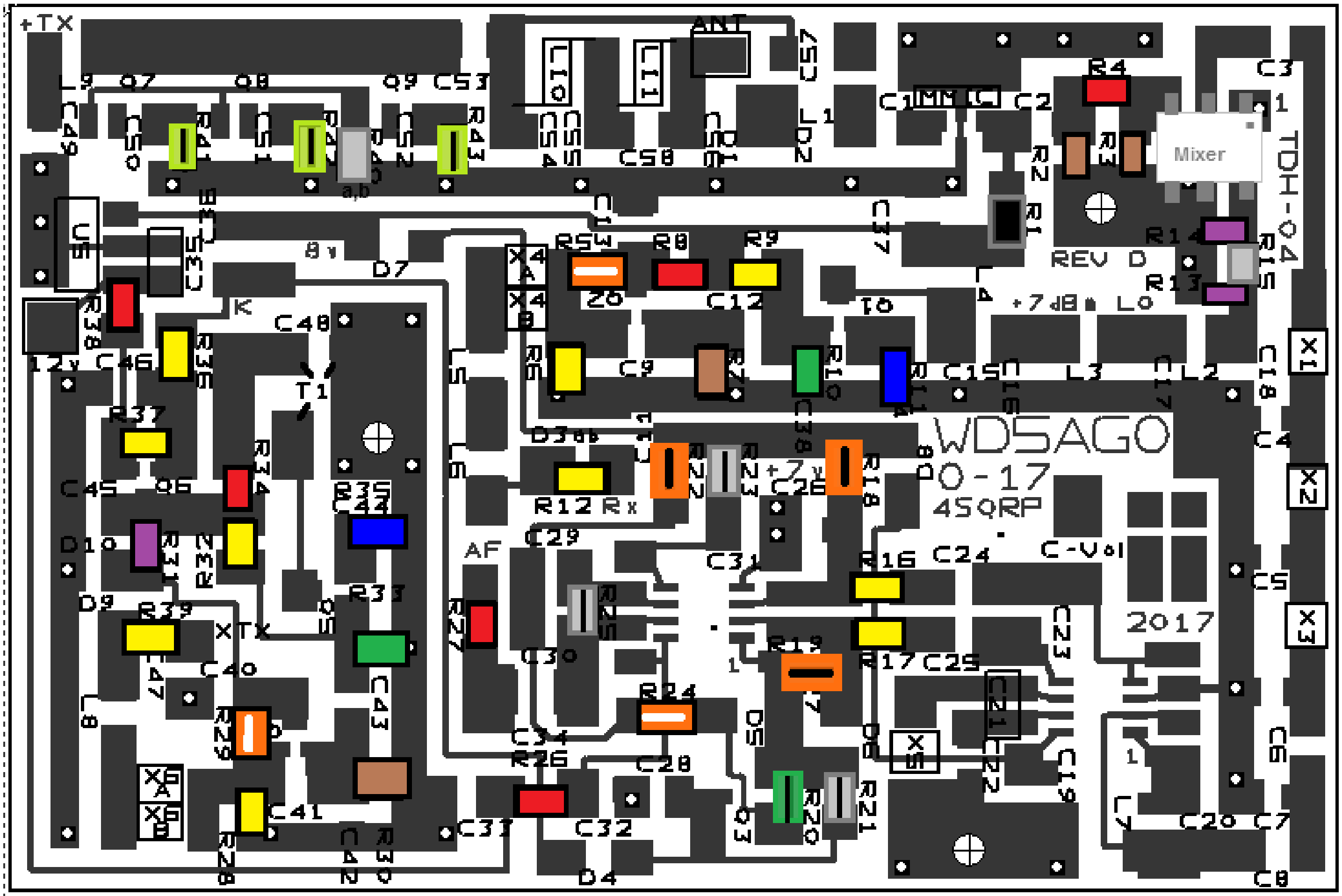
(2 - Yellow/Black): C33, C36 = **1uF** electrolytic *(Bar marking is Positive + on SMD's)*

(2 - Pink/Black): C34, C39 = **33uF** electrolytic (largest cap's), place C39 on C-Vol on PCB



Above: PCB with Capacitors added. A color dot placed on the capacitors using a Sharpie may help with future troubleshooting. Some of the capacitors above have several different dots to help keep track of components. When soldering, a tooth pick is another tool which works well to hold down SMDs during this process. Use just enough solder to cause a fillet next to the SMD. There are several methods to soldering, including SMD's. My preferred iron uses a 750° to 800° F fine point tip. Get in, heat, and get out!

Next Page: The next components to solder are the resistors. The good thing is their values are marked from the factory! For easier parts location and placement, like before, a color and or part reference number can be used. The PCB color code is not marked on the resistor packages. Color markings for parts placement includes solid and solid with a white or black line down the middle. Also like the capacitors, several resistors will share pads. There is plenty of room for both, but not if one component is placed on the wrong side of the pad. All pictures show general layout for the components. Resistor R40 (33 Ω) will have a wire connected to it later. R30 is shown soldered near the pad end but will be moved over slightly as C42 is already mounted. Several resistors jumper over traces which include: R16, R17, R24, and R26. Resistors R16 and R17 are 10 kΩ's; however, in some pictures, a 7.5k was used.. Resistors 41, 42, and 43 (2.7 Ω's) will be side by side with bypass capacitors as noted in the pictures to come. Some pictures may have two smaller resistors in parallel for the 2.7 ohms.



Resistors: Note: The difference between solid color and striped markings.

(Quantity – Color Placement): Reference **= Part Value –** (Notes, if any)

(1 – Black), R1 = **280Ω** *(marked 281 or 2800, place near MMIC)*

(4 – Brown), R2, R3, R7, R30 = **475Ω or 470Ω** *(marked 4750 or 471)*

(6 – Red), R4, R8, R26, R27, R34, R38 = **10Ω** *(marked 10R0 or 100)*

(3 – Orange/White Stripe), R5, R24, R29 = **22kΩ** *(marked 223 or 2202)*

(10 – Yellow), R6, R9, R12, R16, R17, R28, R32, R36, R37, R39 = **10kΩ** *(marked 103)*

(2 – Green), R10, R33 = **3.3kΩ** *(marked 3301 or 332)*

(4 – Blue), R11, R35 = **120Ω** *(marked 1200 or 121)*

(3 – Purple), R13, R14, R31 = **180Ω** *(181 or 1800, also note enough spacing to mount R15)*

(2 – Gray), R15, R40 = **33Ω** *(marked 33R0 or 330)*

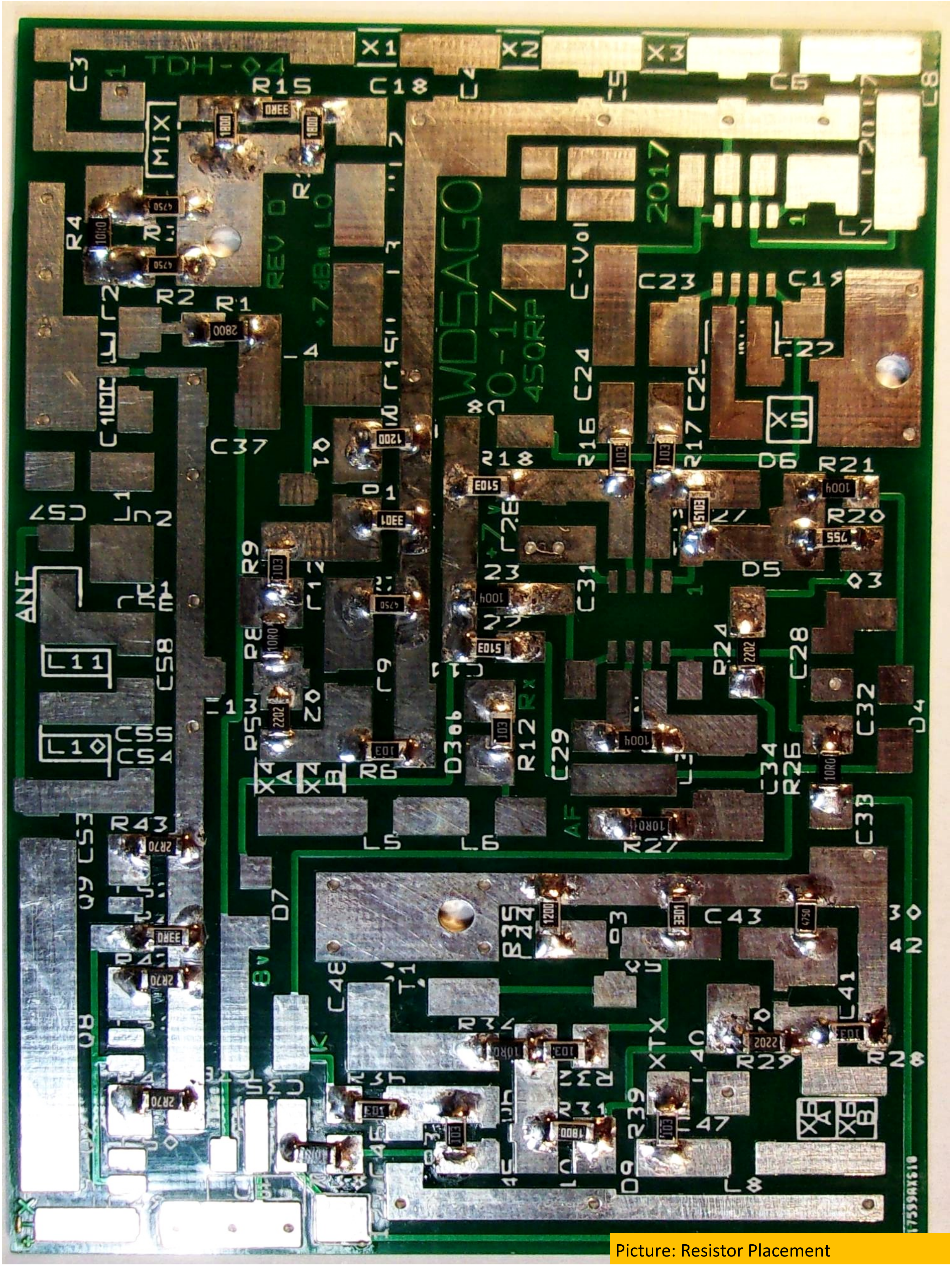
(3 – *Orange/Black stripe*), R18, R19, R22 = **510kΩ** *(marked 514 or 5103)*

(1 – *Green/Black stripe*), R20 = **7.5MΩ** *(marked 755 or 7504)*

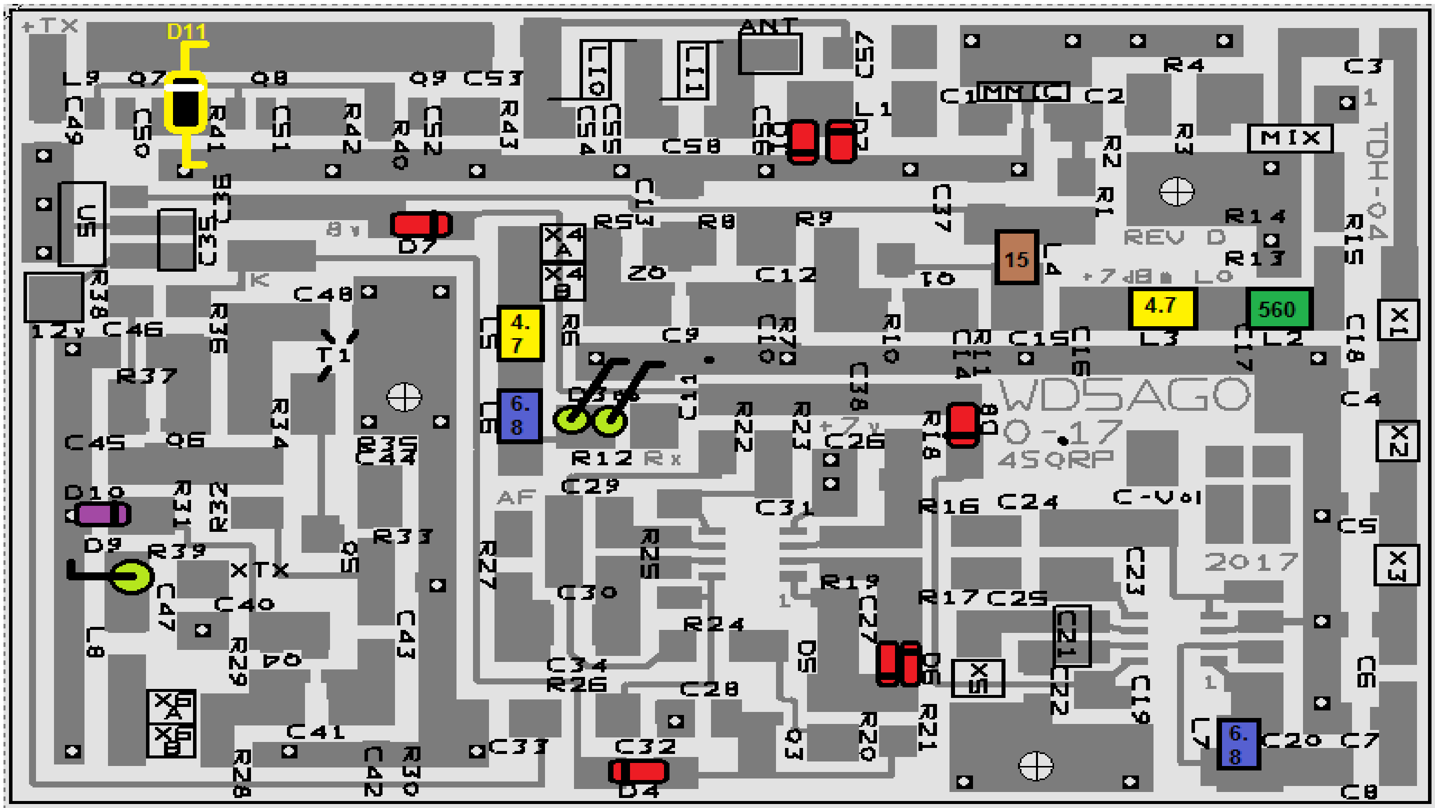
(3 – *Gray/Black stripe*), R21, R23, R25 = **1MΩ** *(marked 105 or 1004)*

(3 – *Lime/Black stripe*), R41, R42, R43 = **2.7Ω** *(marked 2R70, PA emitter resistors)*

The following page is just Resistor Parts Layout



Picture: Resistor Placement



Above and Page 18: SMD Inductors, Diodes, and Leaded Diode Placement. D10 shows an SMD, leaded can also be used. D3a, D3b, and D9 are mounted vertically and D11 is mounted horizontal. Save the lead cutoffs from the diodes to be used for crystal grounding later.

(1 – Green), L2 = **560nH**

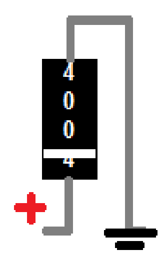
(2 – Yellow), L3, L5 = **4.7uH** (when mounting L5, move and solder closer to the L6 side)

(1 – Brown), L4 = **15uH**

(2 – Blue), L6, L7 = **6.8uH** (L6—VXO inductor can be increased to 8.6 uH larger Freq. coverage)

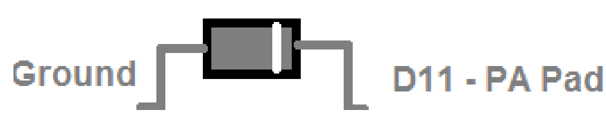
(7 – Red), D1, D2, D4, D5, D6, D7, D8 = **1N4148** (SMD: mount with band "cathode" in direction shown. When two SMD diodes are side by side, they should be pointing in opposite directions).

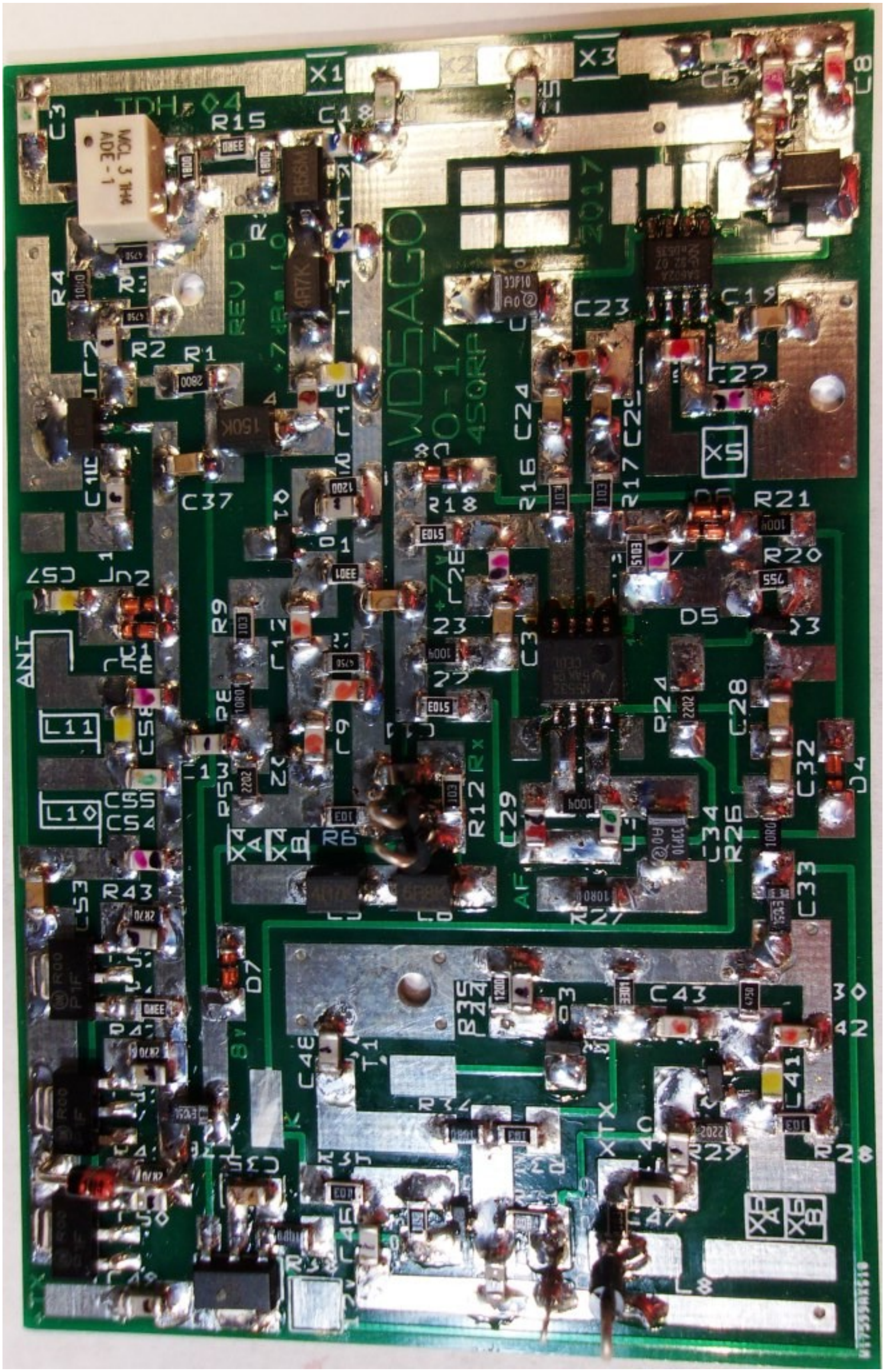
(3 – Round Lime), D3a, D3b, D9 = **1N4004** (leaded acting as a Varactor. Cut + cathode lead 0.3" long and bend as shown, bend anode lead over and cut off excess wire, this lead goes to ground which is the large trace just above D3 and to the left of D9. Use two 1N4004 on R12's pad).



(1 – Purple), D10 = **10V** zener, bend leaded zener just like above. While a SMD is shown, place the leaded zener with band going to R31 pad and anode going to ground next to D9.

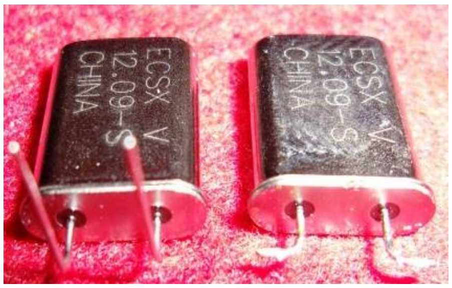
(1 – Blk-Yellow Leads), D11 – **36V** Zener, (connect Cathode to Q7 and Anode to ground) Bend leads as shown .125" long x .25" high and solder to Ground (bottom of R41) and PA pad.

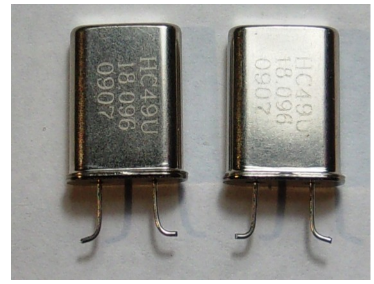




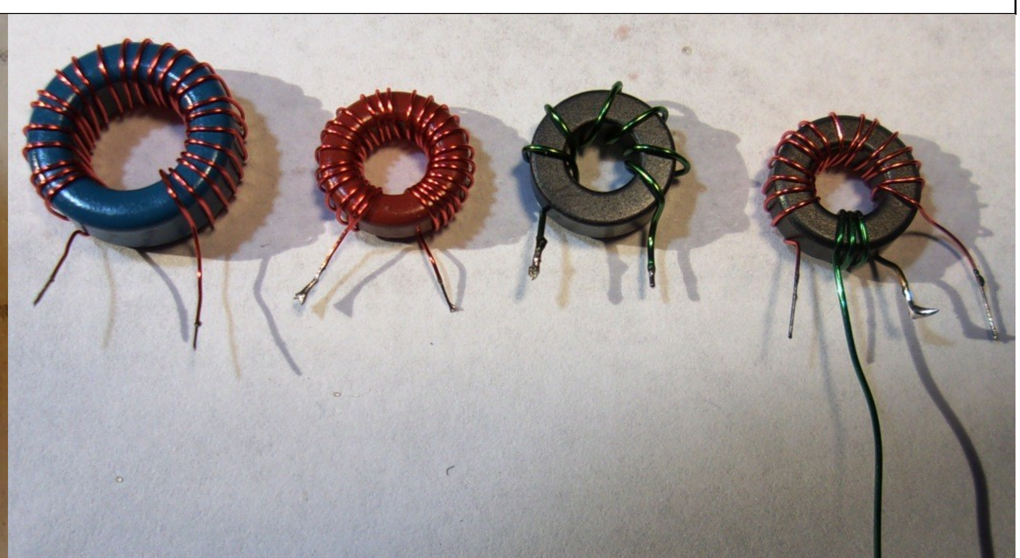
PCB with SMD Components in Place: Solid State, Capacitors, Resistors, Inductors and Leaded Diodes. Note IC2 Pad and IC mod using larger SOIC.

Leaded Parts: Crystals, Toroid Inductors, and Pots are next. Prep all crystals as shown below except one of the 12 MHz by bending and cutting off the leads approximately ¼" down and out the side as shown in the Pic. One of the 12 MHz crystals, bend both leads forward (**X4a**) instead of off to the sides and leave about ¼" lead. Solder each of the crystals across the silk screen pads. Solder the 12 MHz crystal with leads bent (**X4b**) to the sides next to the L5. With the remaining room on the same pad, use the other 12 MHz crystal with leads bent in front to connect to the top side of the same pad as X4b. Both crystals will fit, leave enough lead to work with. The 18 MHz and 6 MHz crystals leads are prepped the same. The IF crystals will be touching side-by-side (**see pg 21**) which is fine as they are to be connected together and grounded. Use a small amount solder across the tops followed with a cutoff wire from the diodes. Then another wire from crystals to ground as shown on pg 21. The other crystal casings did not require grounding, but I prefer to ground then anyway. Try to only heat up a top corner of the casing.

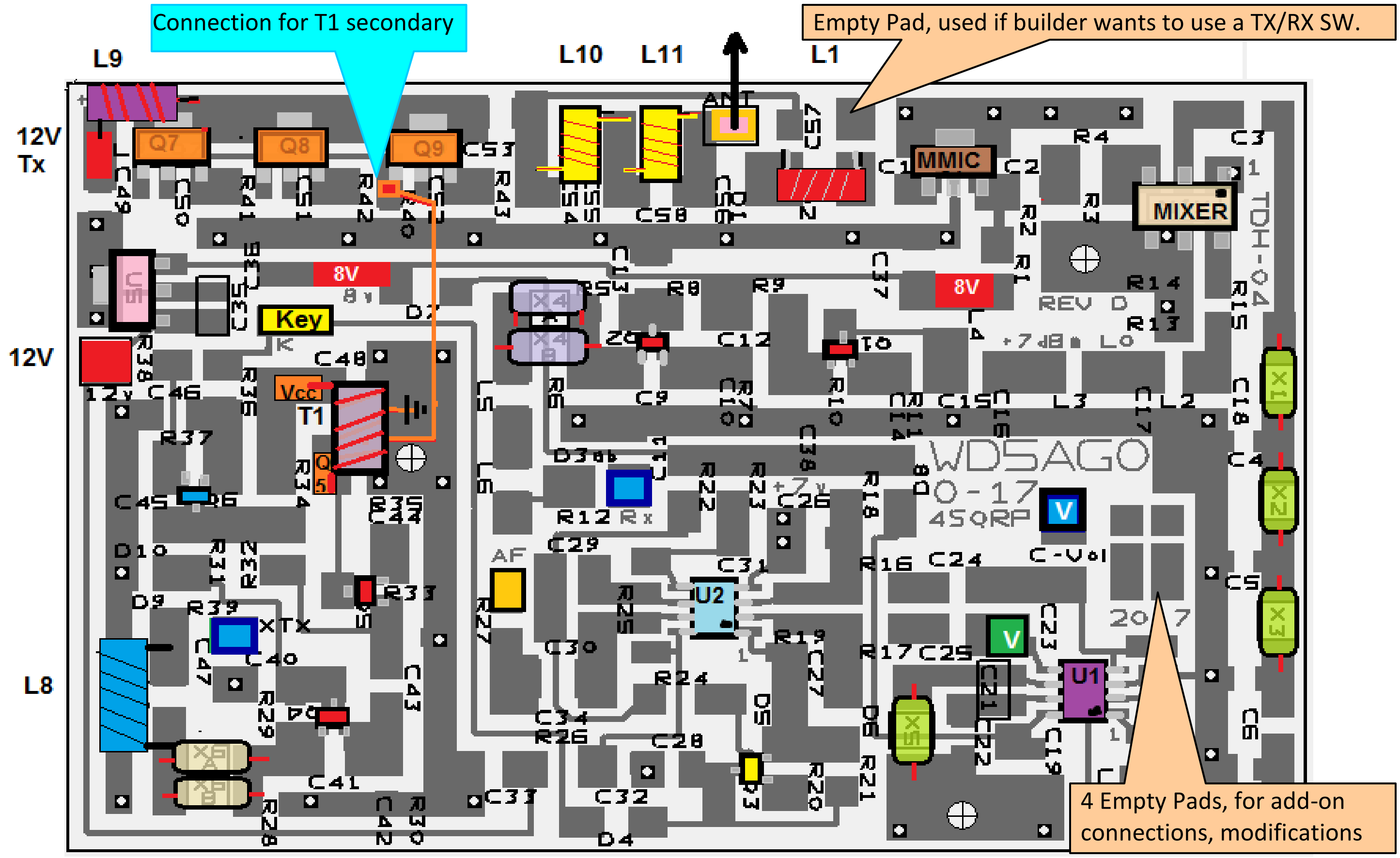




Inductors and Transformer: Wind each one of the toroids shown in the BOM. All wound toroids are shown below. The transformer (**T1**) is wound on a F37-43 (black toroid). Wind 15 turns and in the same winding direction add the secondary coil of 3 turns. Red or Green wire can be used for the Secondary if you prefer color coding. Leave the secondary wire about 1 to 1.5 inches long on the left side which will connect to the PA transistors (T1 winding is also shown on **pg 21**). All other wires from T1 and the inductors should have ¼" to ½" length when soldered to PCB. Tin the wire leads as shown below by using a hot iron and solder over the wire ends. Some wires may need to be scraped of enamel first. Connecting T1 is shown on the silk screen but is also described on page 21. Wires for L8 which is used in the TX-VXO, can be ½ inch long so it can be mounted off the board and RTV in place, it should not be able to move around. Connecting and soldering all the other toroid inductors to the associated pads are shown in the PCB image below. They do not need to be mounted to close to the PCB, leave some room to get the iron in and out.



Above: 2-PA Filter = L10 and L11, Tx VXO = L8, Rx Filter = L1, PA Choke = L9, and PA Driver = T1, see next page.



Final Non-SMD Parts Placement, pages 19, 20, 21, and 22.

(4 – Light green): X1, X2, X3, X5 = **6.000 MHz** Crystal (they will be touching together!)

(2 – Light purple): X4a, X4b = **12.096 MHz** Crystal (X4a will be near top of the pad)

(2 – Light tan): X6a, X6b = **18.096 MHz** Crystal

(1 – Red): L1 = 26t #30 – T37-2 Red (from D1's Pad to C1 pad, top-middle of PCB)

(1 – Blue): L8 = 24t #30 – T50-1 Blue (from D9 pad to X6a, X6b Pad), leads ½" long is ok.

(1 – Purple): L9 = 6t #26 – T37-43 Black (+TX Pad to Collector Pad of Q7)

(2 – Yellow): L10, L11 = 12t #26 - T37-6 Yellow (connect to pads as shown), ½" leads ok.

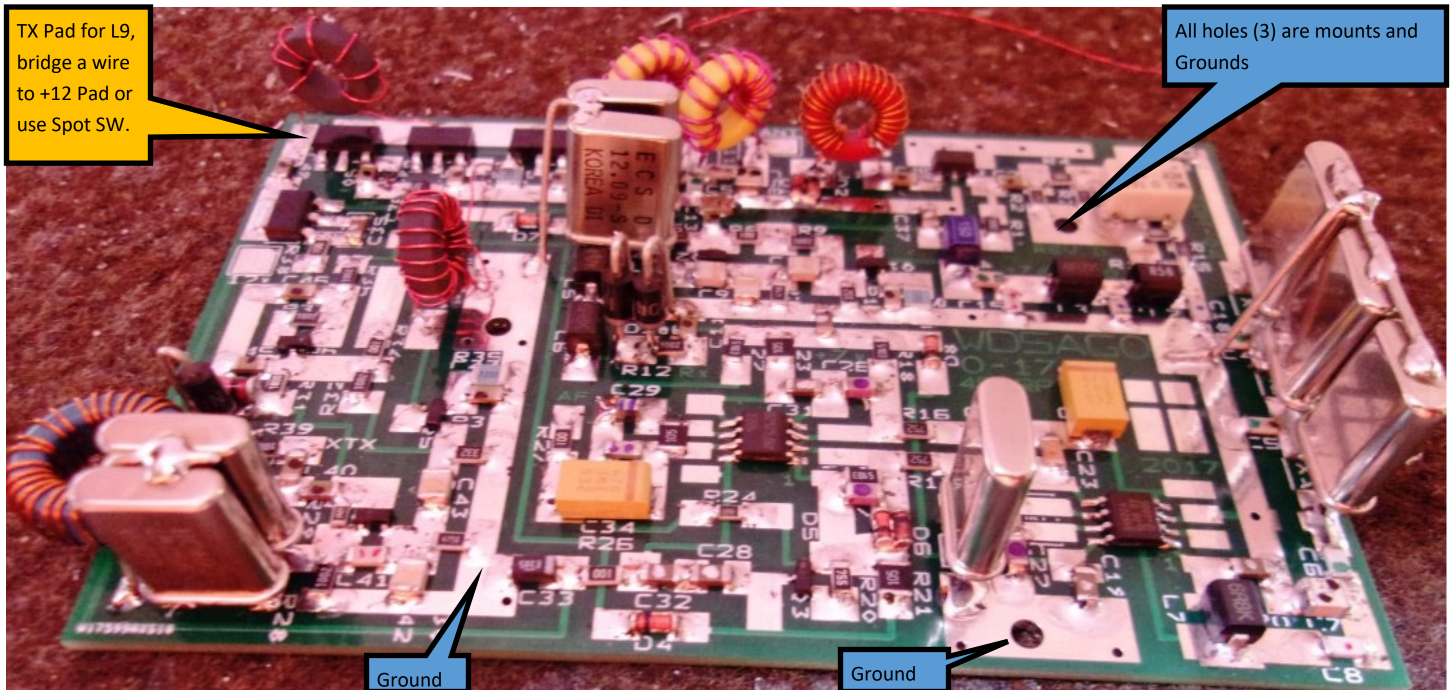
(1 – Gray/Purple/Blk): T1 = 15t Pri. – 3t Sec. – #30 - T37-43 Gray (connections on pg 21)

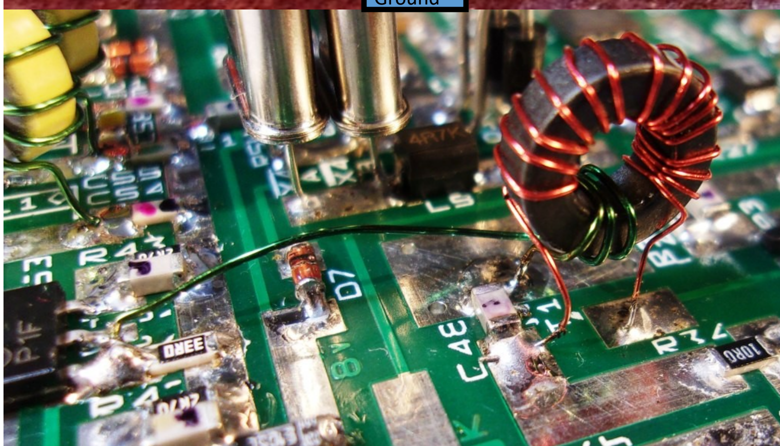
Reference Pot wiring on Page 21—23:

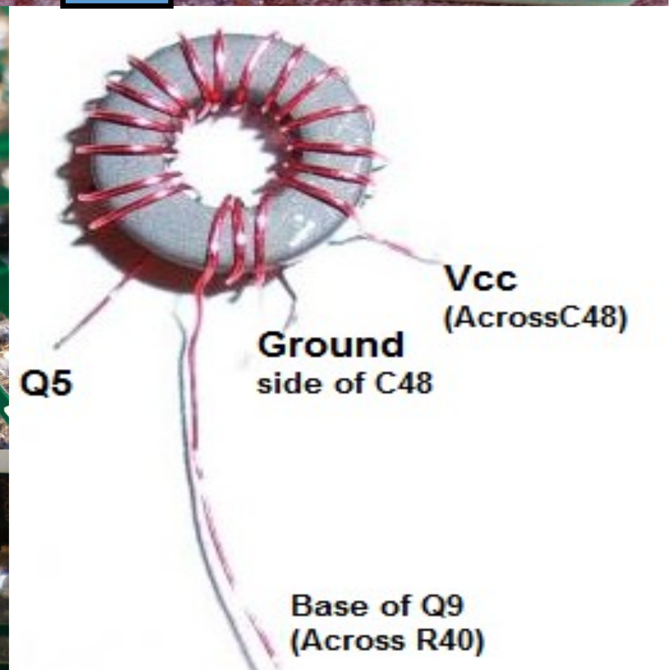
RX-VXO Pot. Cut a piece of hook-up wire to length which will allow connection of the Pot **Red** lead to **+ 8V** on board, somewhere between 4 to 6 inches. Connect **Blue** center tap lead to **Rx** pad on PCB (next to R12). **Green** side of Pot goes to **ground**, mounting holes are grounded. Wiring is shown on page 23.

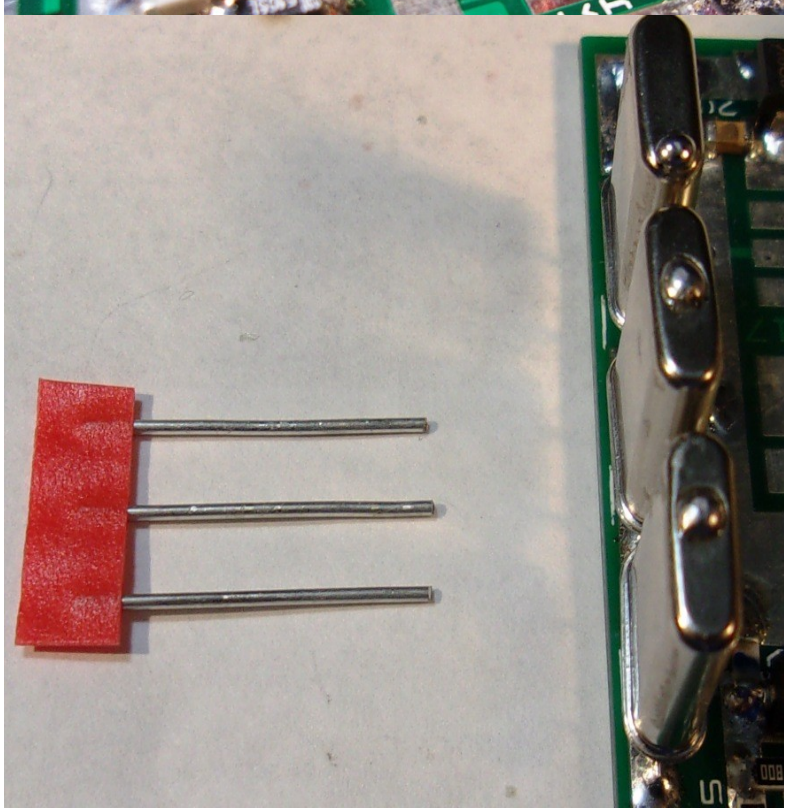
TX-VXO Pot. Connect Red lead to **+8V** on board, Blue center tap to **XTx** pad in blue on PCB, Green to **ground**. To have cleaner wire runs, the +8V connections can be connected together on the VXO Pots, including grounds, as shown in the picture on page 23.

R-Vol. Pot. Connect only two wires, Blue center tap to Blue pad marked **V (C-Vol or top of C39)** and Green wire of Pot to Green Pad marked **V** (right side of **C23**).





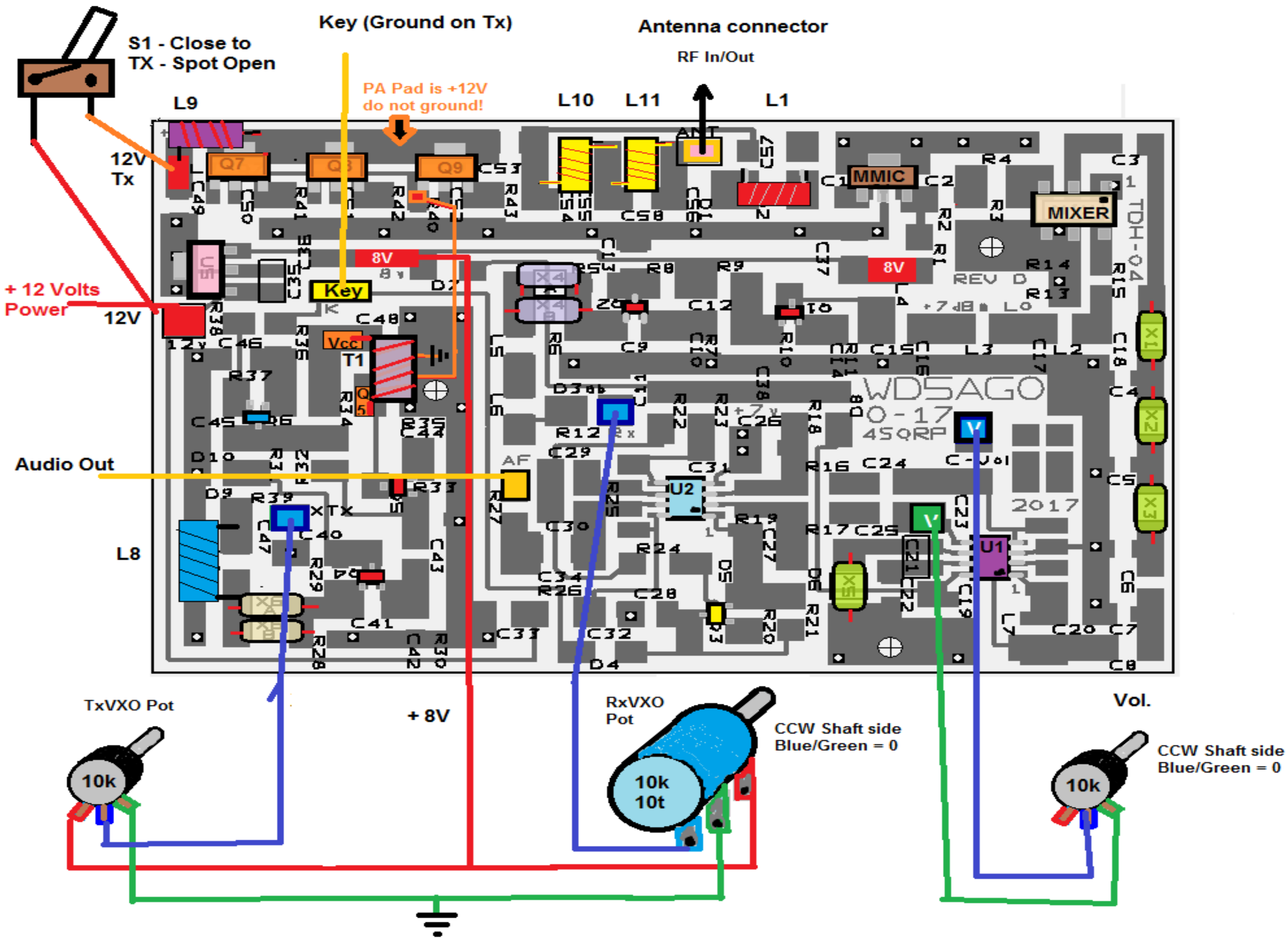




Top: Complete PCB ready for wiring

Middle: Details of placement and wire connections for the Transformer. Note ether Red or Green wire used for the secondary. I like to have color coded wires if possible.

Bottom: Use your wire clippings for grounding straps on the crystals. The 3 I.F. crystals must be grounded for best performance. Use a higher heat setting for a shorter time on the crystals. Solder to the tops as shown. Bridge the crystals with one of the cutoff wires then one ground as shown at the top of page.



Using the hook up wire provided, make the following connections to fit your enclosure, 5" to 6" is a good start.

+12 Volts: DC Power. Connect to your Power Jack or a Feed-through Cap. Note connections on pg 23.

S1: Spot switch connects +12V power to the PA. Key w/spot SW open to tune TX on RX signal. If you do not need a Spot switch, <u>jumper L9 +TX pad to 12V Pad.</u>

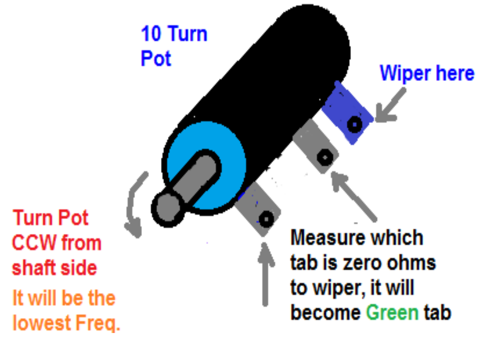
Key: Ground K pad to TX, full break-in.

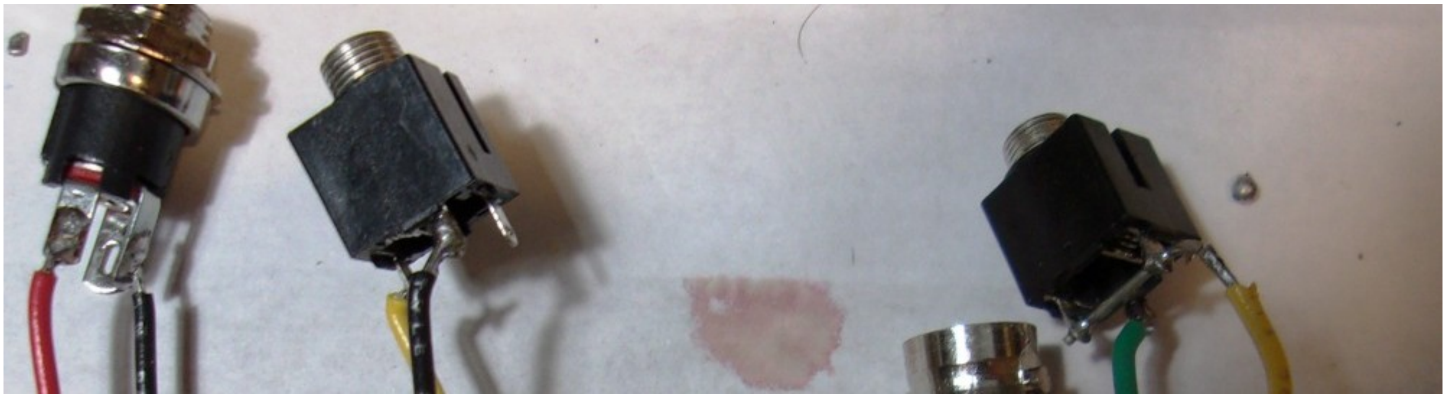
AF: Audio Output, Connect AF Pad to phone jacks for head phones, ground is return. All mounts are grounds.

Ant: Connect to your BNC coax connector. Ground is return to box or PCB.

Pots: Connect as shown. PCB is grounded at mounting holes. Make sure PCB box is grounded. Note 10 turn Pot wiring on pg 23.

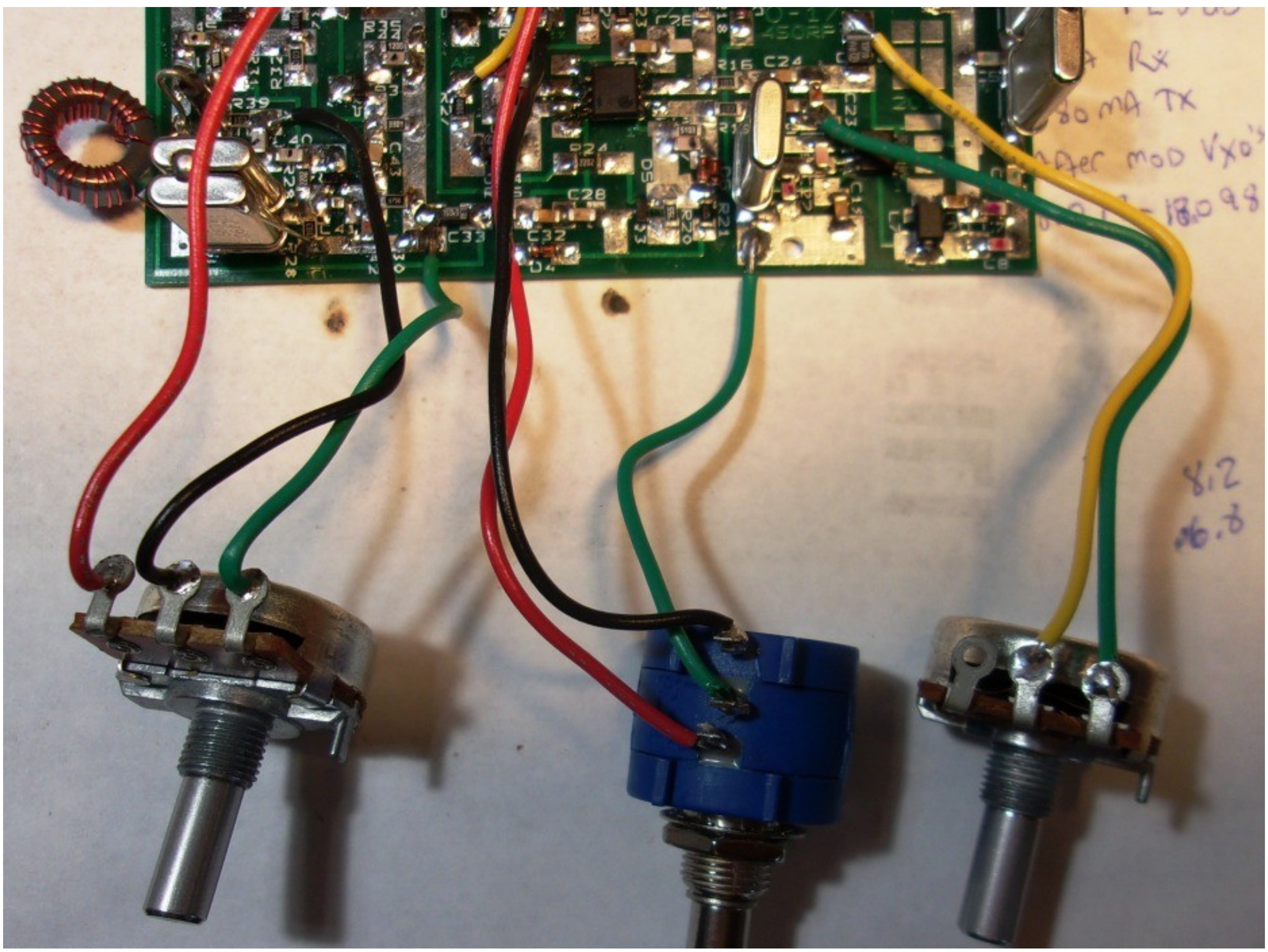
Enclosure: Although a enclosure is not provided, it is encourage to operate the O-17 in a metal one. Some of the Tx drift and Rx noise is reduced while in a metal enclosure.

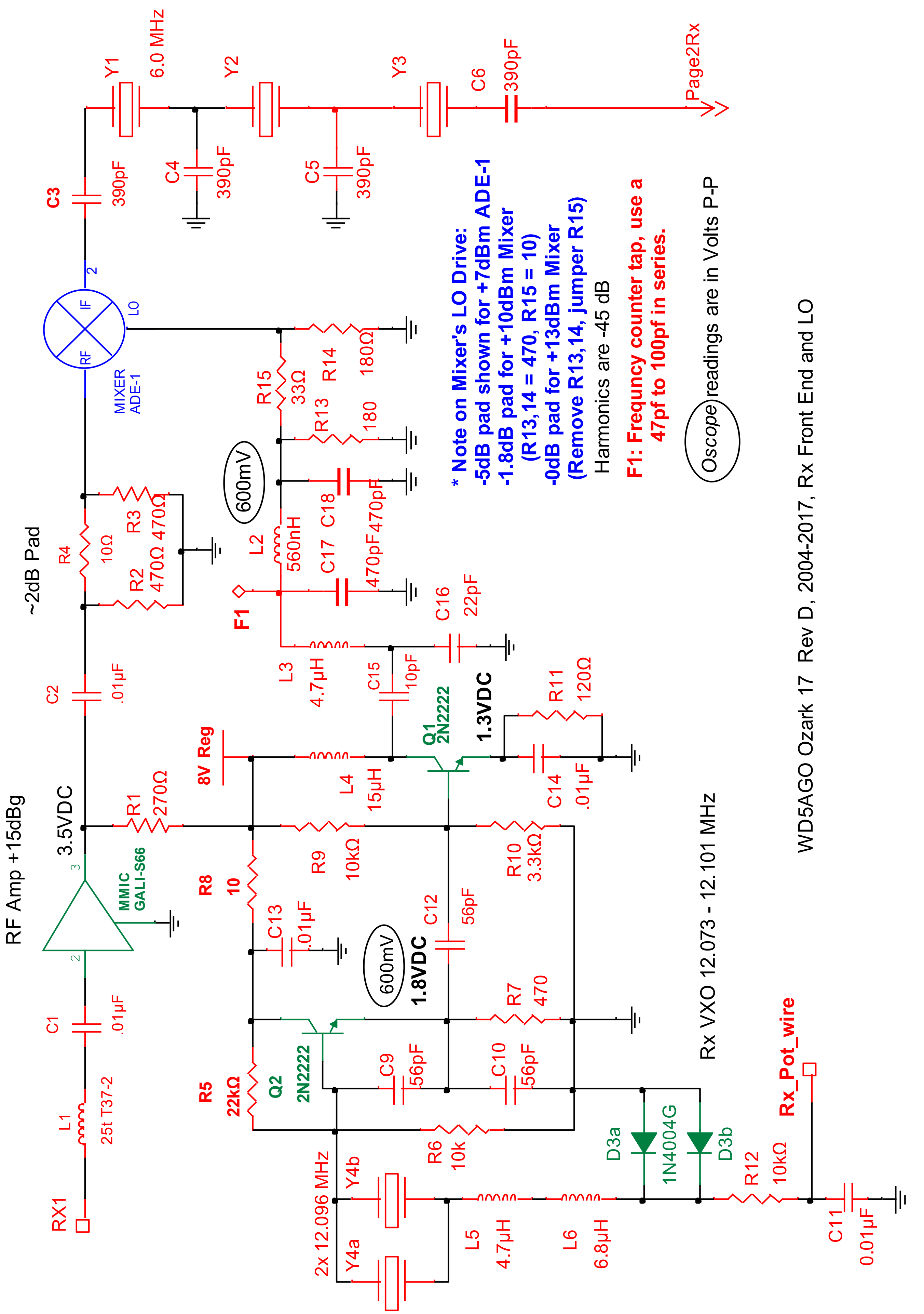


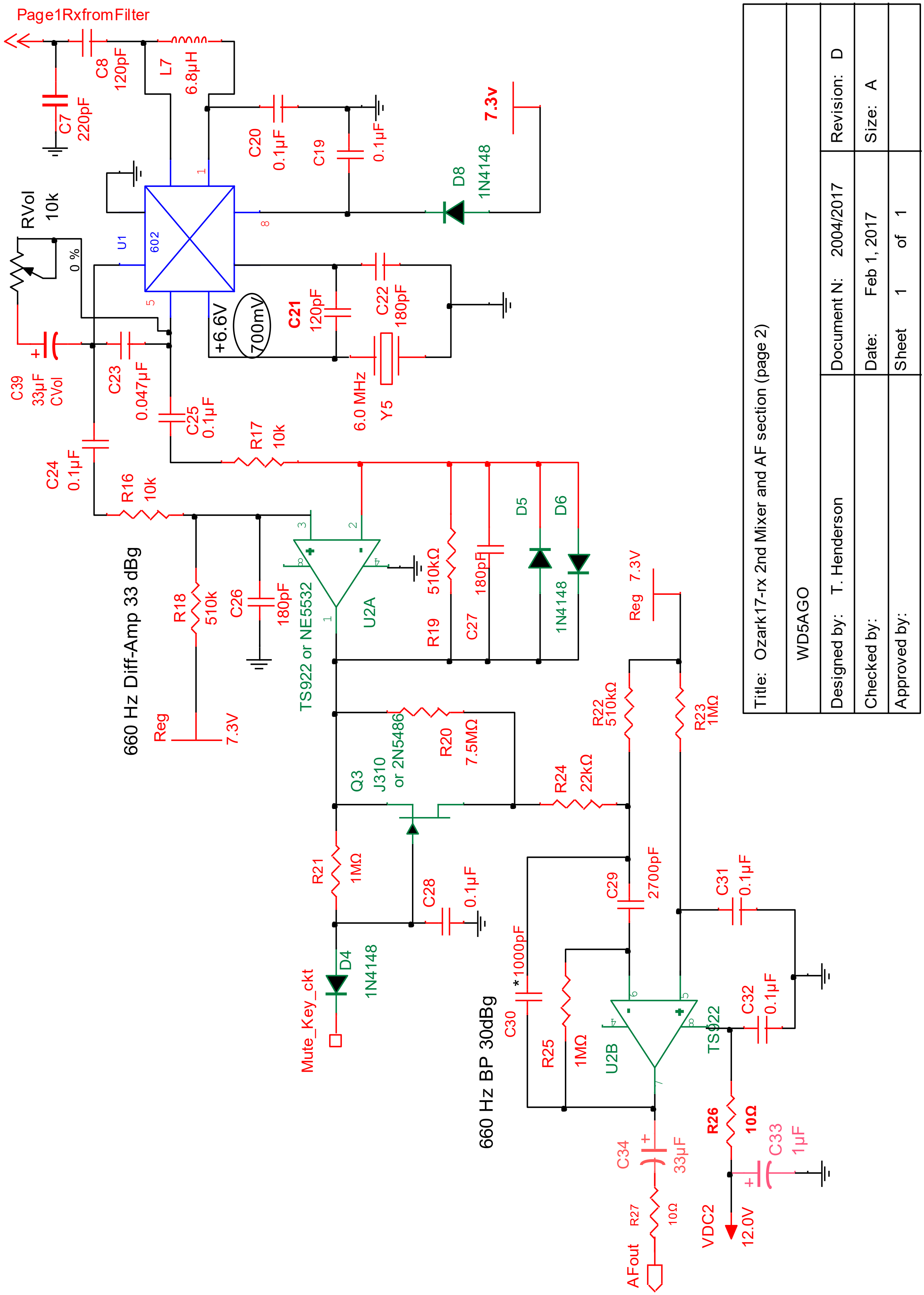


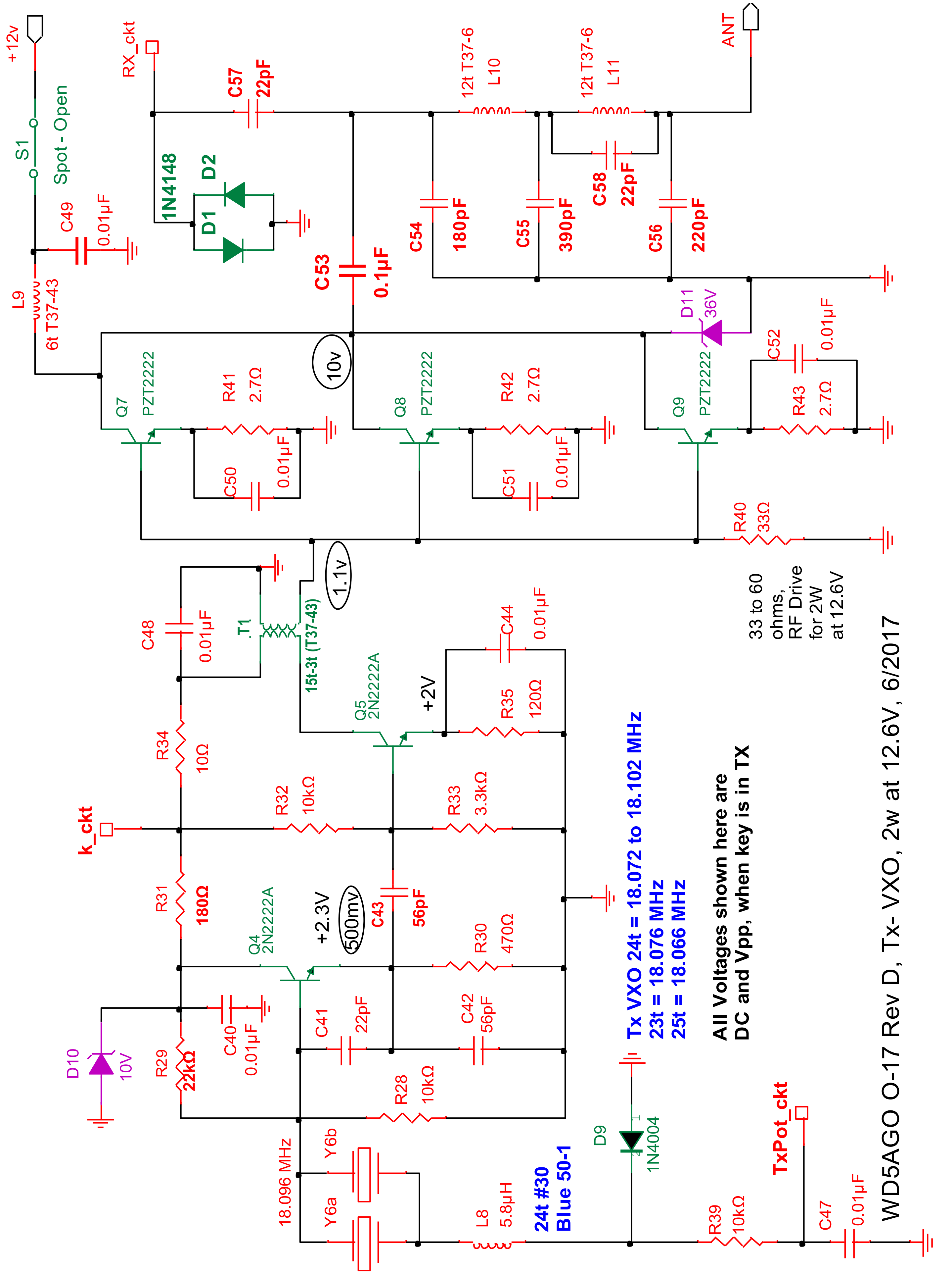
Above: Connections to Jacks: Left is 12V power. +12 connection is made from the PCB +12V pad and the right side lug with ground being on bottom side as shown. **Middle** is CW key input. Key input is the top side lug if the middle is on the middle right side. Ground on Transmit and if plugs are grounded to metal enclosure, only yellow wire is needed. **Right** Head Phone Jack. The top and bottom lugs are soldered together for Mono output plug. Middle lug is ground. **Antenna** is a short wire to BNC center pin. Using a metal enclosure helps with stability, RX noise, and less ground connections. The **Spot switch** if used (not shown here), would be between the +12V Pad and the Pad of L9. Opening the Spot SW open power to the PA transistors, else use a wire to bridge the connection from +12V Pad and +12V PA pad on L9.

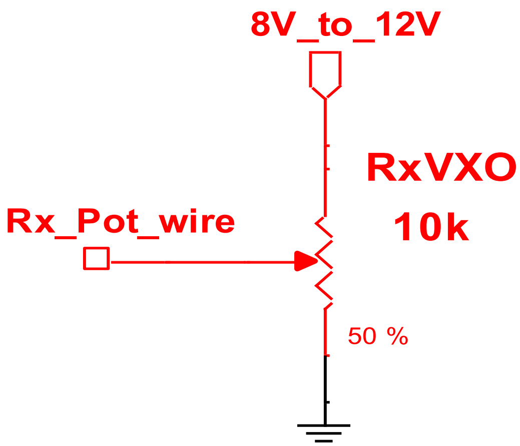
Bottom: Wiring to Pots. Black wire replaces Blue wire from the pictorial from the pervious page. The grounds for the TX and RX VXO maybe at the same point on the PCB or ground to box chassis.



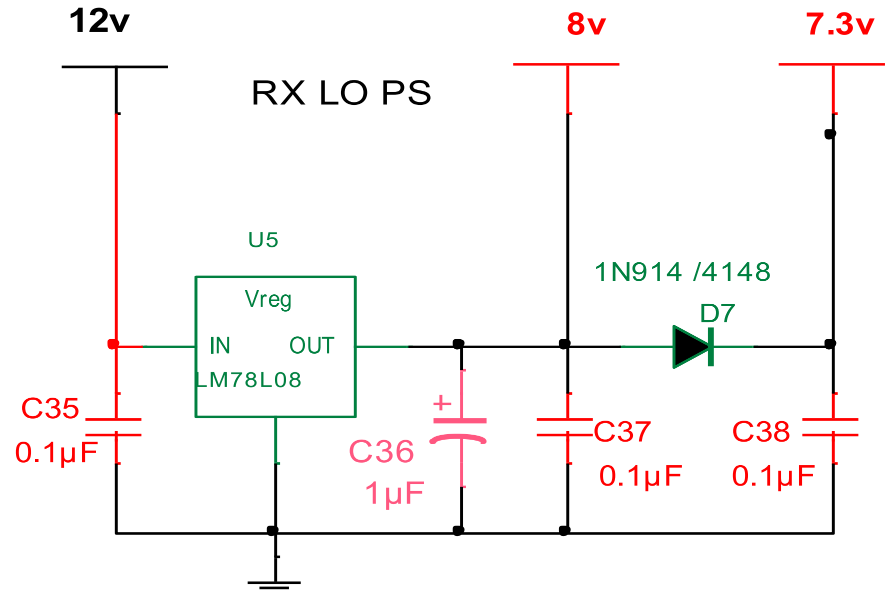

RF Amp +15dBg
3.5VDC
~2dB Pad
RX1
L1
25t T37-2
C1
.01µF
MMIC
GALI-S66
R1
270Ω
C2
.01µF
R4
10Ω
R2
470Ω
R3
470Ω
MIXER
ADE-1
RF
IF
LO
C3
390pF
Y1
6.0 MHz
C4
390pF
Y2
C5
390pF
Y3
C6
390pF
Page2Rx
R15
33Ω
R14
180Ω
R13
180
600mV
C18
470pF
L2
560nH
C17
470pF
F1
C16
22pF
L3
4.7µH
C15
10pF
Q1
2N2222
1.3VDC
R11
120Ω
C14
.01µF
8V Reg
L4
15µH
R9
10kΩ
R10
3.3kΩ
R8
10
C13
.01µF
600mV
1.8VDC
C12
56pF
R7
470
R5
22kΩ
Q2
2N2222
C9
56pF
C10
56pF
R6
10k
2x 12.096 MHz
Y4b
Y4a
L5
4.7µH
L6
6.8µH
D3a
1N4004G
D3b
R12
10kΩ
Rx_Pot_wire
C11
0.01µF
* Note on Mixer's LO Drive:
-5dB pad shown for +7dBm ADE-1
-1.8dB pad for +10dBm Mixer
(R13,14 = 470, R15 = 10)
-0dB pad for +13dBm Mixer
(Remove R13,14, jumper R15)
Harmonics are -45 dB
F1: Frequncy counter tap, use a
47pf to 100pf in series.
Oscope readings are in Volts P-P
Rx VXO 12.073 - 12.101 MHz
WD5AGO Ozark 17 Rev D, 2004-2017, Rx Front End and LO

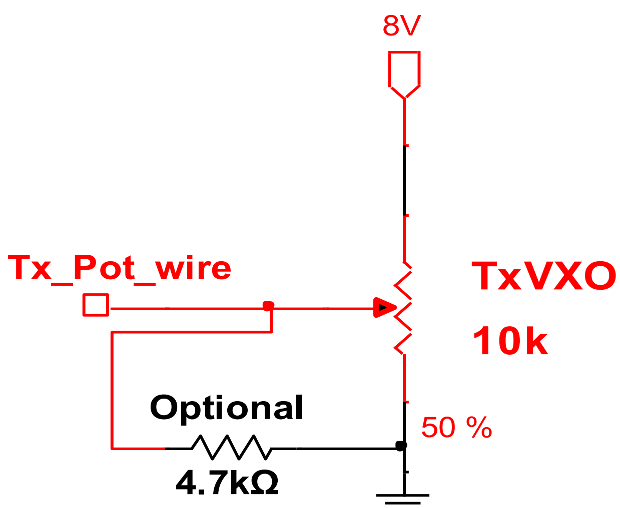

Title: Ozark17-rx 2nd Mixer and AF section (page 2)
WD5AGO
Designed by: T. Henderson
Document N: 2004/2017
Revision: D
Checked by:
Date: Feb 1, 2017
Size: A
Approved by:
Sheet 1 of 1
Page1RxfromFilter
C8 120pF
C7 220pF
L7 6.8µH
C20 0.1µF
C19 0.1µF
7.3v
D8 1N4148
RVol 10k
0 %
U1
602
+6.6V
700mV
C21 120pF
C22 180pF
6.0 MHz Y5
C39 33µF CVol
C23 0.047µF
C25 0.1µF
C24 0.1µF
R17 10k
R16 10k
660 Hz Diff-Amp 33 dBg
R18 510k
C26 180pF
Reg 7.3V
TS922 or NE5532
U2A
R19 510kΩ
C27 180pF
D5
D6
1N4148
Reg 7.3V
Q3 J310 or 2N5486
R20 7.5MΩ
R24 22kΩ
R22 510kΩ
R23 1MΩ
R21 1MΩ
C28 0.1µF
C29 2700pF
C31 0.1µF
D4 1N4148
Mute_Key_ckt
660 Hz BP 30dBg
C30 *1000pF
R25 1MΩ
U2B
TS922
C32 0.1µF
R26 10Ω
C33 1µF
C34 33µF
R27 10Ω
AFout
VDC2 12.0V


WD5AGO O-17 Rev D, Tx- VXO, 2w at 12.6V, 6/2017
All Voltages shown here are
DC and Vpp, when key is in TX
Tx VXO 24t = 18.072 to 18.102 MHz
23t = 18.076 MHz
25t = 18.066 MHz
33 to 60
ohms,
RF Drive
for 2W
at 12.6V
+12v
S1
Spot - Open
L9
6t T37-43
C49
0.01µF
RX_ckt
C57
22pF
1N4148
D1
D2
C53
0.1µF
12t T37-6
L10
12t T37-6
L11
ANT
C54
180pF
C55
390pF
C58
22pF
C56
220pF
D11
36V
C52
0.01µF
Q7
PZT2222
R41
2.7Ω
C50
0.01µF
10v
Q8
PZT2222
R42
2.7Ω
C51
0.01µF
Q9
PZT2222
R43
2.7Ω
R40
33Ω
1.1v
T1
15t-3t (T37-43)
C48
0.01µF
R34
10Ω
Q5
2N2222A
+2V
C44
0.01µF
R35
120Ω
k_ckt
R32
10kΩ
R33
3.3kΩ
R31
180Ω
Q4
2N2222A
+2.3V
500mv
C43
56pF
R30
470Ω
D10
10V
R29
22kΩ
C40
0.01µF
C41
22pF
C42
56pF
R28
10kΩ
18.096 MHz
Y6a
Y6b
L8
5.8µH
24t #30
Blue 50-1
D9
1N4004
R39
10kΩ
TxPot_ckt
C47
0.01µF

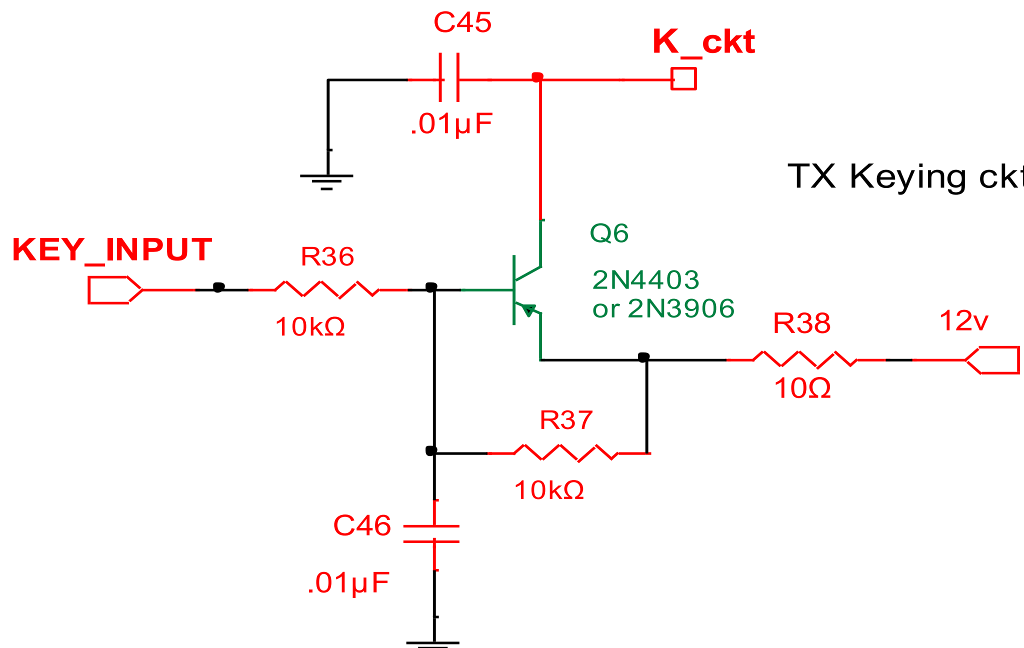


10 Turn 10k or higher value is perfered
for RxPOT
0 volts on center tap = the lowest freq.





Optional: Adding a 4.7k resistor from center
tap to ground will help with low end tuning
speed on single turn pot.

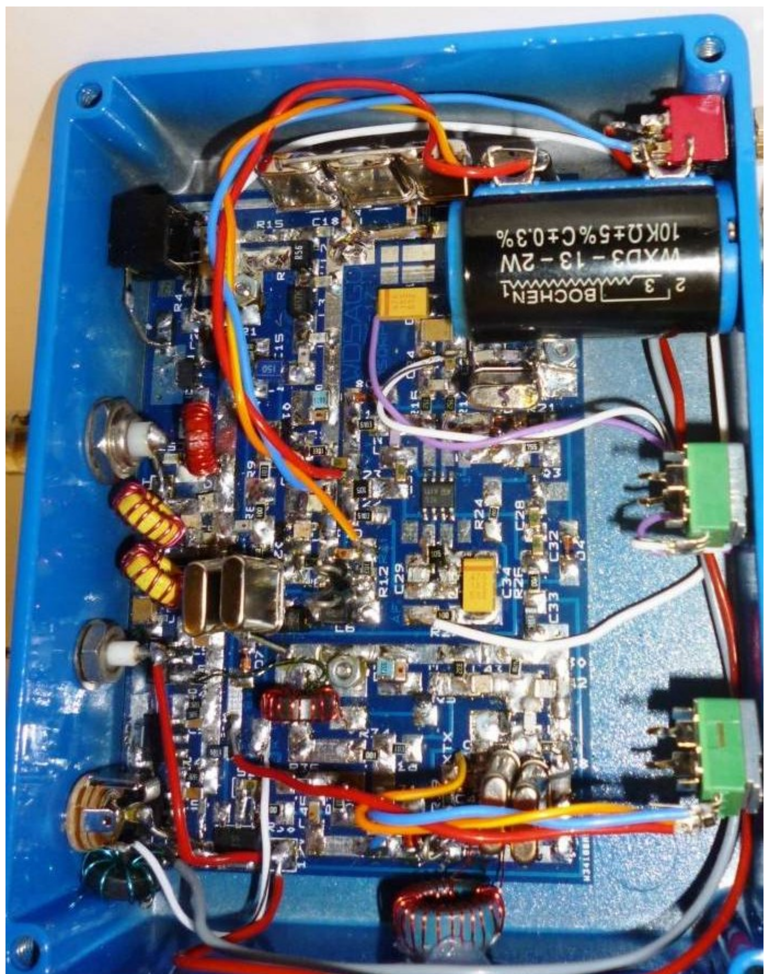


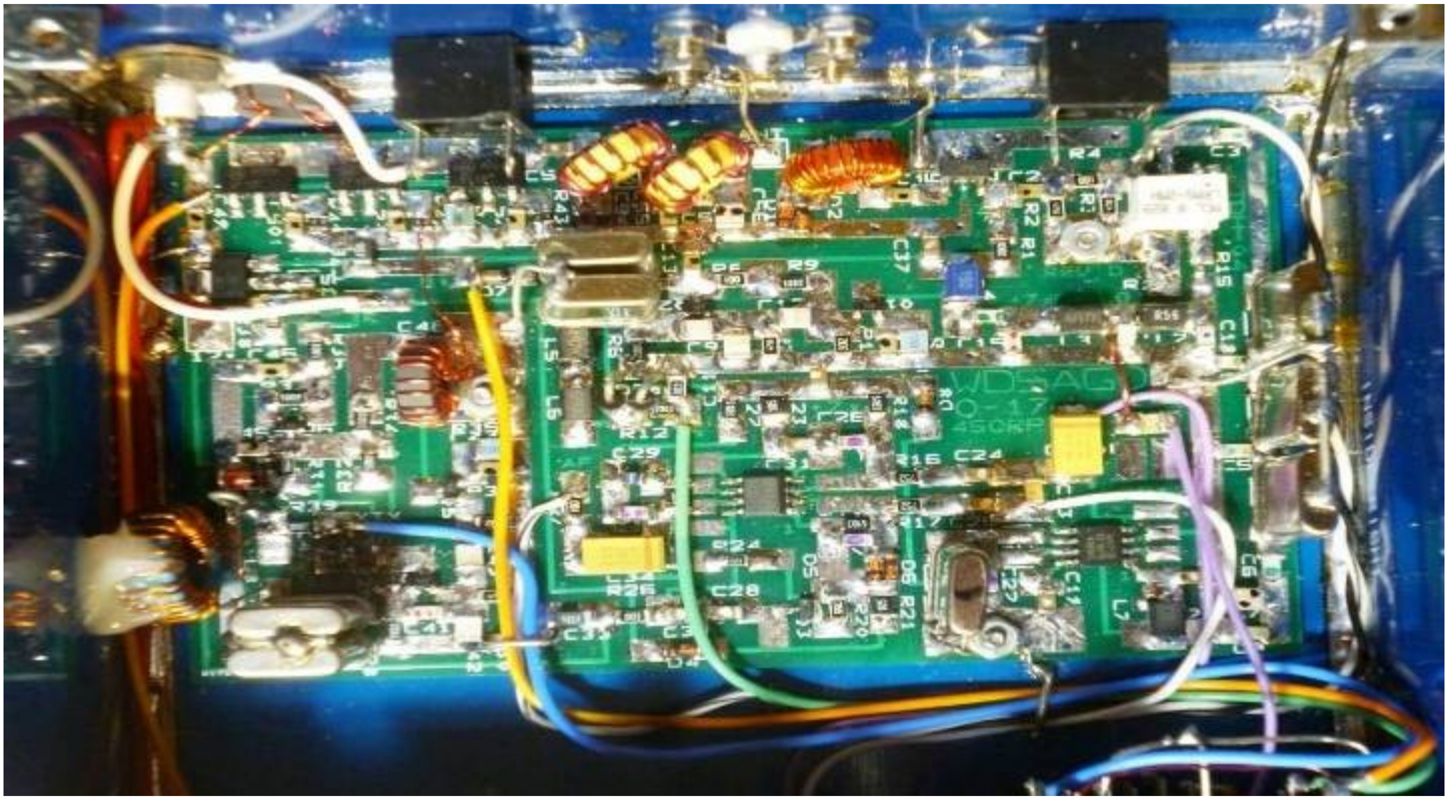
Top: Original Ozark 17's in a machined enclosures. Some of the mods for the O-17 were tested in the old version with 10 turn mechanical dial, it's a good option.

Middle: New O-17 Rev.C PCB (blue) in a Hammond 1590bb enclosure,

Bottom: O-17 on current Rev D PCB. A digital frequency counter (several found on the web) is used. To use, tap signal off the RX-LO between L2 and L3 (F1 on schematic) and add a 47pF in series to counter. The F1 tap reduced LO power 0.5 dB and increased harmonics 3 dB, which is ok. This O-17 example also used the 4SQRP blue enclosure. Everyone has a different flavor for enclosures so layout and design is left to the builder.

A Dial Frequency scale for a 1 and 10 turn Pot are shown on page 29. When using a 10 turn pot, a dial counter or a frequency counter will be needed. A mechanical counter uses less power, provides a simple way to set frequency and may cause less interference.





Above: Inside the O-17, complete and ready to test! Wire connections are shown, including the capacitor tap off the RX-LO (F1) for a freq-counter. There are 4 empty PCB pads just right of the C -Vol Capacitor to use for circuit modifications. Please note some frequency counters produce noise which the RX may pick up. A little RTV was used to hold L8 in place. Power is connected to a feed-through capacitor or a jack provided. Panel jacks for Key, Phones, and a BNC for the Antenna are also at the top.

Begin by testing the receiver. With headphones connected and +12 VDC applied, 40 mA of current should be measured. Use the signal from another transmitter of known calibration (loaded into a dummy load) or connect the rig to a signal source set to -110 dBm on 18.080 MHz. Some noise should be present. The signal should be heard (Vol. turned ¼ way up) once it is tuned in by the RX-VXO. The receiver has a low noise figure so there will not be a lot of background noise heard.

If the signal cannot be heard, begin troubleshooting by checking the voltage points labeled on the receiver schematics. DC and AC voltages are listed at key points. The LO output frequency should be 12.085 MHz +/- 15 kHz as seen at the mixer. Check component placement and solder joints especially around U1 and U2. Once the receiver appears to be working, connect a 50 Ω load to the antenna jack to test the transmitter.

The transmitter is activated with the PCB **KEY** pad input grounded. A signal will be heard in the receiver (if working) after tuning. The optional Spot SW position does not affect the receiver picking up the TX signal. With the Spot SW (if used) in the Operate or CW position and circuit is Keyed, a current of approximately 400 mA should be measured. Power output will be approximately 2 watts. If these numbers are not measured, or the transmitter fails to operate, check the voltages (w/key grounded) noted on the transmitter section of the schematic.

The PA output filter windings are critical, so +/- 1 Turn will affect P_{OUT}. If power is below 1.5 W then increase R40 to 47 Ω. If power is above 2.5 watts, lower DC voltage or decrease R40 to 20 Ω. This condition may happen if DC power is running above +13 VDC. Never run the transmitter without a proper load. There are no protection circuits (other than D11) for the PA transistors. Next, verify TX frequency. A frequency counter or another HF receiver is good to have for this measurement.

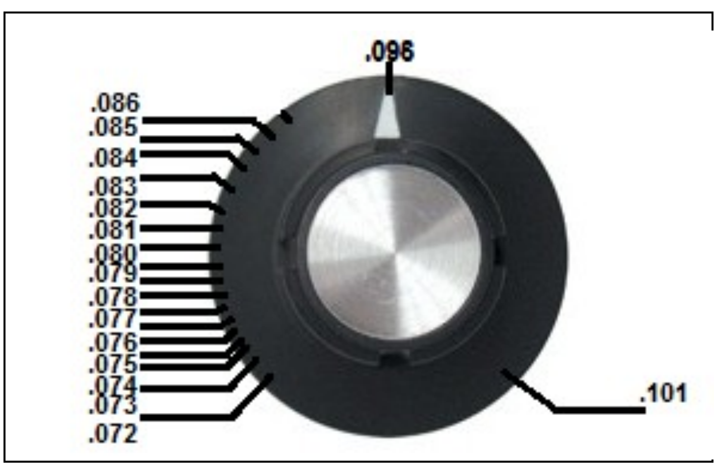
Operation: Before operation of a working circuit, it is recommended to place the O-17 in a metal enclosure to operate. Some of the benefits is less noise pickup from shortwave stations near 6 MHz in the evening’s, Pots rotating, and more stable TX.

Alignment: TX frequency should only need calibration once as the O-17 has no noticeable drift. If the O-17 receiver is calibrated, (Digital Dial) the TX signal can be heard and calibrated with Spot SW on or off. Start by keying the rig while connected to a 50 Ω dummy load and verify frequency calibration. Band edge is **18.068 MHz.** Most 17m CW activity lies between 18.072 and 18.086 MHz with the QRP water hole at 18.096 MHz. The dial markings shown below should be close to the correct frequency for both a single turn and 10 turn POT.

Transmit: Begin by connecting the antenna jack to a resonant antenna. The PA is somewhat sensitive to loading, so SWR should be 1.5:1 or less. If not, some TX frequency shifting maybe be noticed. Check for signals on the band using the RX-VXO and adjust volume to a comfortable receiving level. Some signals may become strong therefore adjust levels accordingly. Flip SW to “Spot” (if a switch was installed), Key the “TX” and adjusting the stronger (of the USB and LSB signal) TX-VXO to be heard in the headphones (the opposite 600 to 700 Hz sideband will be weaker). Place the TxVXO frequency to 600 to 700 Hz tone as heard. Switch Spot to “operate or CW”. The rig is ready for operation! DC power from 11.5 to 13 volts is recommended.

Information to move the O-17 to other bands will be introduced soon. Updating the Ozark 17 design layout for the O-17 was not intended for the SMD beginner or the new technician. Provisions were made to make the O-17 easier to build, while keeping PCB size small and providing an experimental training tool for 2nd year students in college electronics. Many modifications were made with available/easier to find parts. On the following pages are appendences which may help the builder understand more on the operation and theory of the kit. I have more fun experimenting, so provided are some extra experiments evaluated. It was a “pleasure and a learning process” going back over my old Ozark 17 design notes with this rig. Good Luck and work some 17m DX!

73’s -Tommy, WD5AGO



Typical Dial Frequency for: Single turn dial and 10 turn dial calibration if not using a digital readout.

Modifications: One of the many activities of amateur radio is experimenting. There is “meat left on the bone” for the O-17 to do mod’s. The intent for the O-17 was to also have college students build and test. Listed here are circuit modifications and notes. Included are 10 turn Pot examples which have different connections. Please look over this section as you may have an idea arise that was not covered in the text.

Add a 10 turn Pot to the RXVXO if not already supplied. Some builders may want to use one on the TXVXO, which is also fine. An example of the typical dial frequency for a 10 turn counter is shown on pg 30. Two 10 turn Pots are illustrated below, although, the one on the bottom is the more common and is available with the 4SQRP kit. Make connections as noted.

The VXO tuning rate on the low end is fast; adding resistance from wiper to ground will help, if you chose to, a 4.7 k resistor is suggested. A 10k to 100kΩ Pot can also be used for the VXO’s.

Increasing or decreasing R40 is the easiest way to lower or raise RF power. Going above 100 Ω may cause instability and over drive.

The RX line on Rev D was moved to the hot side of the PA filter which increased the noise figure. NF is still below 4.5 dB, and the power input to the LNA during TX is -5 dBm which is 10 dB below its maximum rating. One way to lower NF and shut power off on RX is to add a TX/RX switch and do away with CW break-in. I prefer to accept the filter/switching loss and RX power drain during TX.

RX gain can be increased another 3 dB by using a 400 to 600 nH inductor between the 280 Ω and Po of the MMIC. Just cut the trace provided. We prefer to use it at lower gain with higher stability.

Higher level Mixers (+10 and +13 dBm) were tested and performed very well. The MMIC-LNA can be switched to a higher IP MMIC to increase IMD and have a bullet proof front end. The RX schematic lists the different resistor values to change the LO drive power for each mixer type.

The 2 dB Pad ahead of the mixer can be increased if the RX seems to hot or to help IMD, but that is normally not a problem. Another RF filter could also be added in its place.

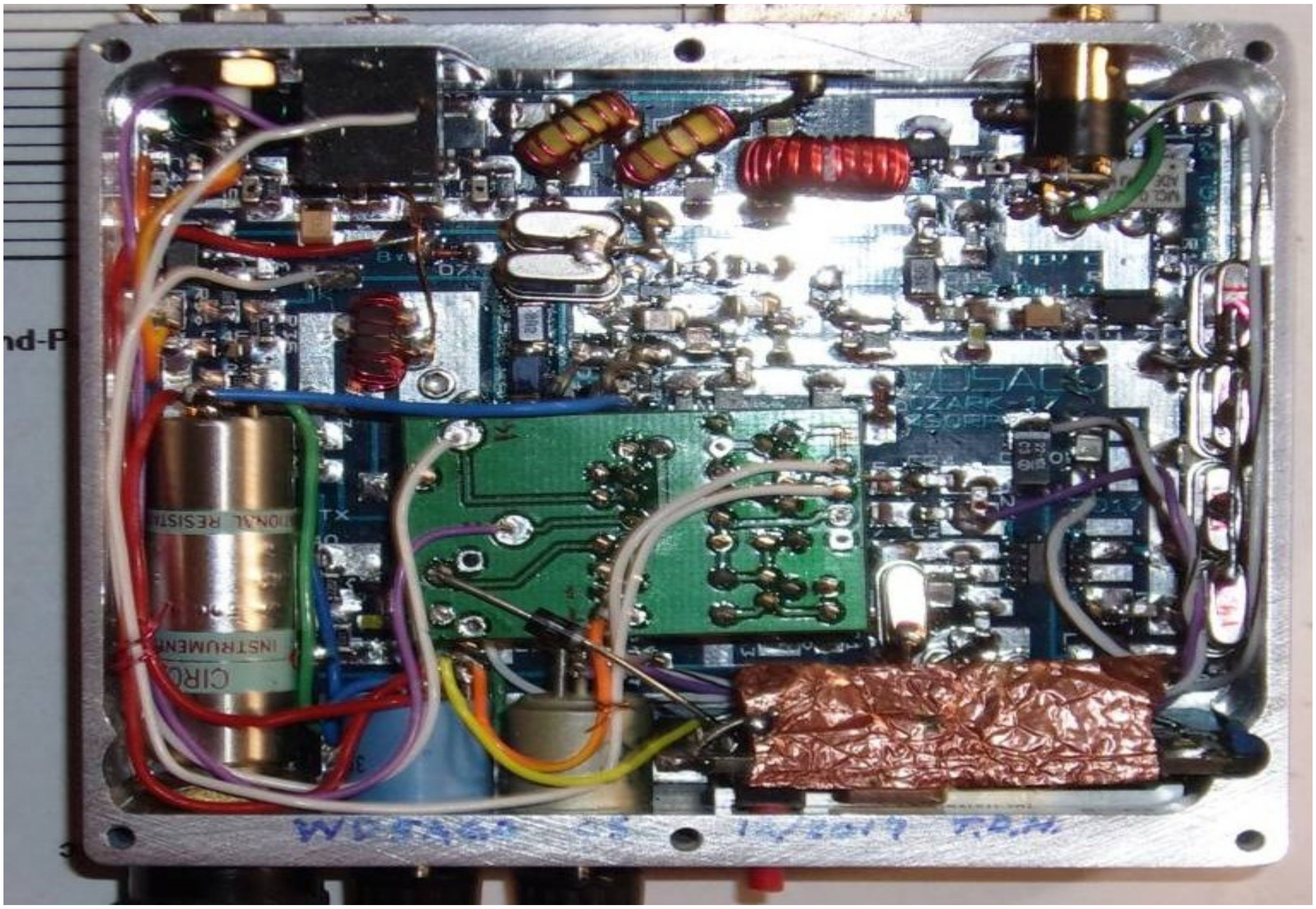
On the PCB a place is available to add 1 more crystal to the IF filter. Reasoning; if the rig was to be converted to a crowded band and higher sideband rejection was needed. A 4th crystal was added for evaluation, just duplicate the capacitor pattern (390 pF) and cut a trace for the 390 pf in series. This will not be a matched 50 Ω filter but is close enough. Values for a corrected 50 Ω filter and graph are on pg 33. The 4 pole **(w/o match)** provided -42 dB of rejection while the a 4 pole Chebyshev with all different matching components **(w/50)** provided -50 dB of opposite SSB rejection. This extra IF filtering was not needed on 17 m as the **3 pole** Chebyshev with -35 dB of rejection is fine on this band.

It was noticed that if the builder chooses to use an internal Digital Frequency Counter (DFC), it could produce **noise** in the receiver. If it is a problem (we tested two DFCs), turn the DFC off during RX, which can be done with a DPST for the Spot switch (on during Spot, off on CW). Shielding the DFC did cut down on noise enough during operation. If all else fails, use a Mechanical Dial!

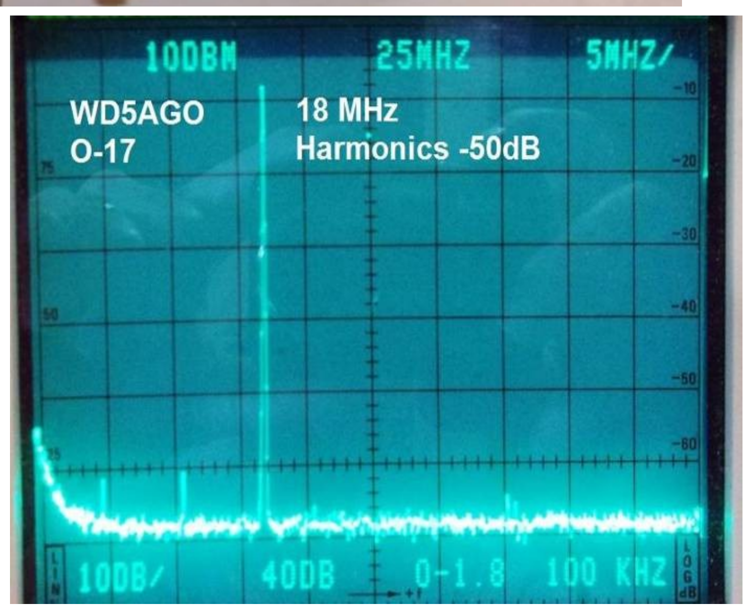
Design information is provided in the schematics to move the TX-VXO range if you want to run higher or lower in the band: **band edge is 18.068 MHz.** The RX-VXO range may be moved **lower** in band with an 8.2 uH or 10 uH in place of L6 (6.8 uH) or a 3 pF variable from D3 to ground.

Converting the O-17 to other Ham Bands is possible. To date, 160m 80m and 40m are competed, 10m and 6m will be next.

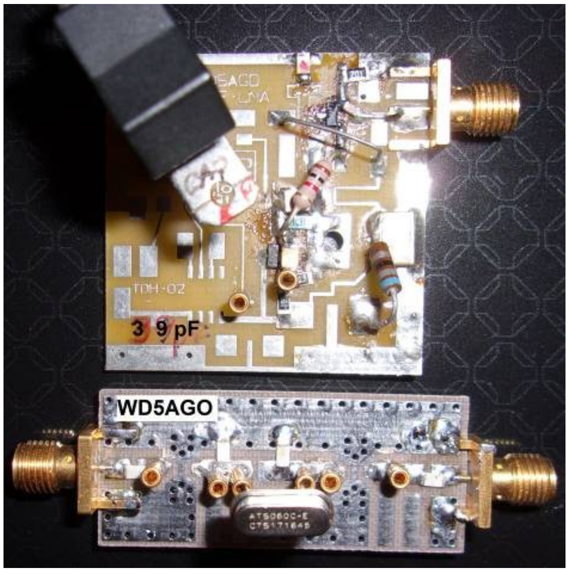
Another O-17 Proto Type: This is the author's current operating unit. A digital frequency counter (dial) displays last 4 digits. The dial did generate noise in the receiver; however, shielding lowered it to acceptable levels. This O-17 covers 18.065 to .097 on RX and TX 18.073 to .101. To widen VXO range, change one or both RX-VXO inductors to 8.2uH, this makes the RX and TX track different but I wanted to start the receiver below band to have closer to linear tuning in band. A keyer circuit is mounted near the Pots. The O-17 does not extra IF filtering, however, a 4 pole 50Ω crystal filter was evaluated here. This increased opposite SSB rejection from -38 to -50 dB. This circuit is also using a +13 dBm high level mixer. A 5 dB pad was added between LNA and mixer because a higher IP GALI 39 MMIC was used. This unit measured MDS = -132 dB, BDR = 110 dB.

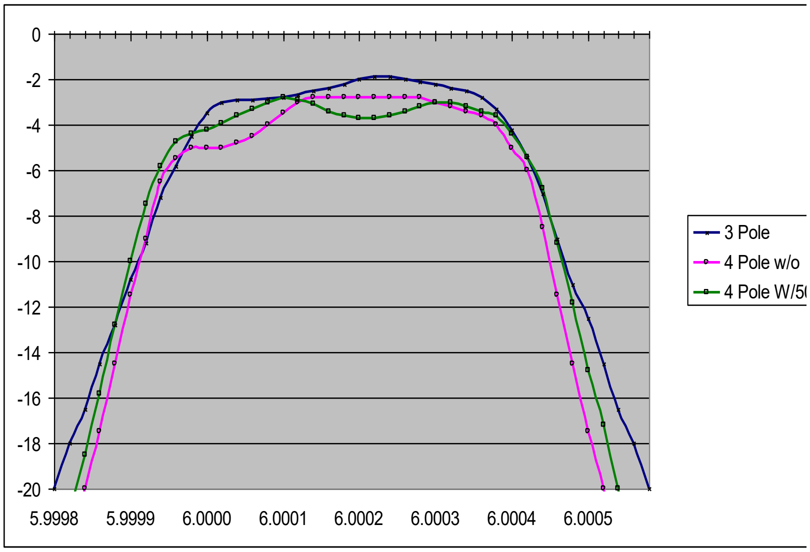


Spectral Output: All harmonics are better than 50 dB down and the other signals present are the counters oscillator. If you find the output power to be higher than **2.5W**, lower R40 to 20 Ω or cut back DC Voltage. Some PZT2222 are "hotter" than others. Of course, if output is to low, increase R40 to 47 Ω. 2 Watts output is a good number. D11 (36 V Zener) was added to help protect the 2222's from open loads. The PA collector pad is large and does a good job of dissipating the heat (a 1.4 W difference). A small piece of copper could be soldered to the pad if heating becomes a problem (PA pad is +12 VDC).



Crystal Filter Testing: Using a HB Osc./SW method (G3UUR) and a HB crystal test board. The *Graph* below illustrates three measured IF filter designs. Tested were: a 3 Pole (in current O-17), a 4 Pole w/o matching (390 pF are kept constant for all capacitors which is not 50 Ω for this crystal configuration), and a 4 Pole w/50: (to correct for 50 Ω match, replace C's with *430 pf's on series input and output capacitors, a 370 pF shunt, a 430 pF shunt center, and another 370 pF shunt)*. The -3 dB points in order were 430, 470, and 500 Hz while -20 dB points were: 780, 680, and 720 Hz, however by -35 dB the 4 Pole w/50 is narrower than the 4 Pole w/o filter. The current 3 Pole filter offers a good compromise in parts count and performance. Opposite sideband rejection in order was: -35 (O-17), -42 (4 pole w/o matching), and -50 dB (4 pole w/50 new components).





O-17 Specifications:

VXO coverage: 18.072 to 18.101 MHz (+/- 2 kHz for both TX and RX), stable.

Tuning: A Typical 1 Turn and 10 Turn Pot tuning shown on pg. 30

DC Power Input: 12.6 V = RX @ 40 mA, on TX @ 370 to 400 mA total

RF Power Output: 2W nominal**:** 11.6 V = 1.6 W, 12.6 V = 2.1 W, 13.6 V Max = 2.5 W

PA Efficiency: 62% (12.6 V, PA Ic = 260 mA)

Harmonics: < - 47 dB (- 50 dB typical, exceeds current FCC specifications)

Audio Output: 8 to 16 Ω head phones, 2 Vpp max before distortion 600 to 720 Hz BP.

MDS: < -125 dBm (-130 dBm typical)

Noise Figure: 4 dB, (System gain 85 dB +/- 3dB)

RX input power: - 20 dBm at $P1_{dB}$, maximum power before RX damage = +10 dBm.

Blocking Dynamic Range: 105 dB (20 kHz spacing)

Opposite sideband rejection: - 35 dB typical, *(3 pole with matched crystals)*

Your Notes