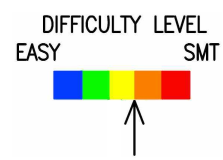
QRPGuys Digital DSB *II* Transceiver Kit, w/smd mixer



First, familiarize yourself with the parts and check for all the components. If a part is missing, please contact us at qrpguys.parts@gmail.com and we will send you one.

Please read all the instructions before starting to assemble the transceiver.

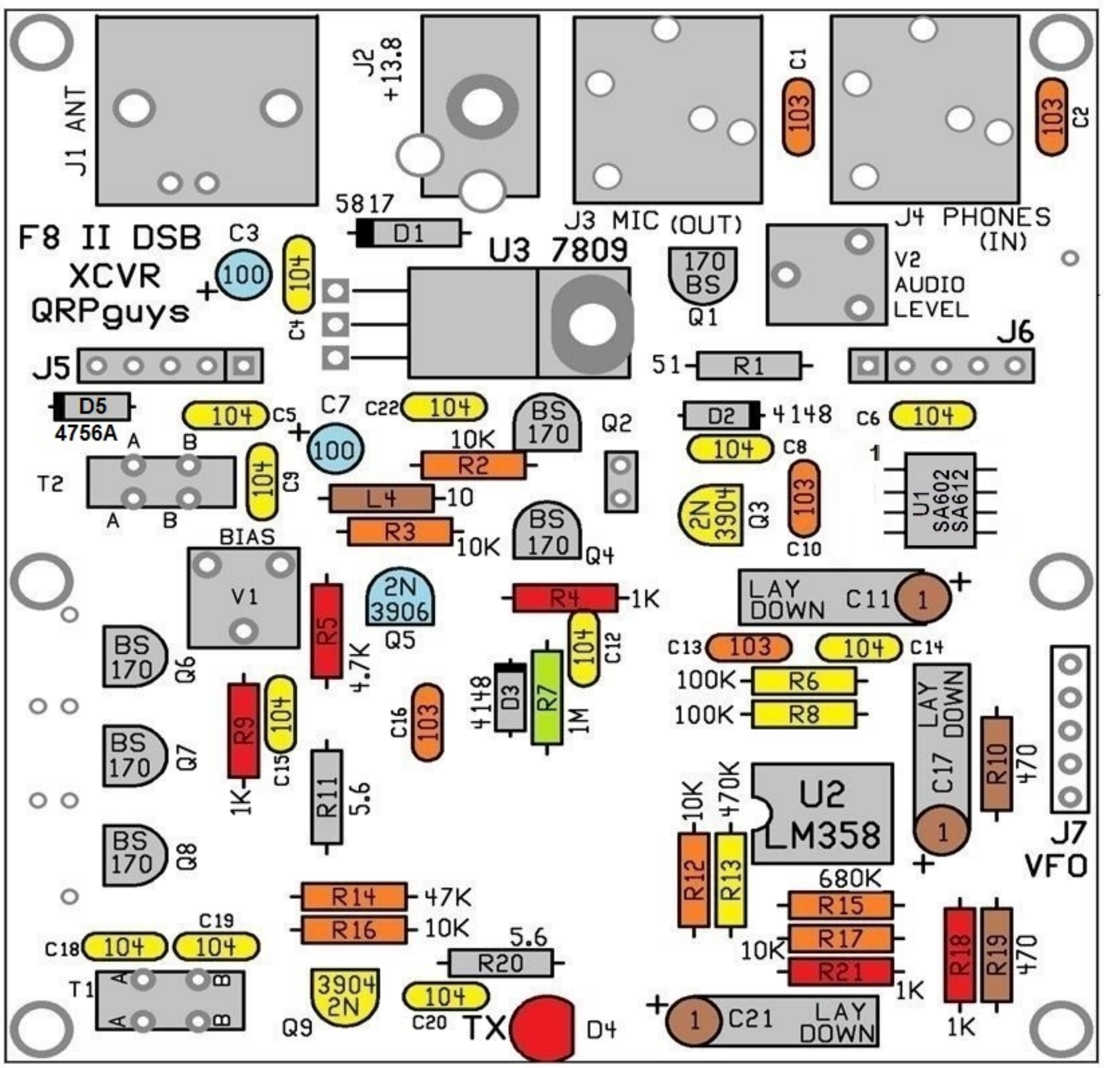
Parts List:

Location	Quantity	value	Type
C1, C2, C10, C13, C16	5	10 nF - 103	X7R MMLC
C3, C7	2	100 uF electrolytic ≥16V	Long lead plus
C4, C5, C6, C8, C9, C12, C14, C15, C18, C19, C20, C22	12	100 nF - 104	X7R MMLC
C11, C17, C21	3	1 uF electrolytic ≥16V	Long lead plus
D1	1	1N5817	BLACK PLASTIC
D2, D3	2	1N4148	SMALL GLASS
D4	1	CLEAR LENS RED LED	
D5	1	1N4756 47V 1W ZENER	SMALL GLASS
J1	1	BNC JACK	PCB MOUNT
J2	1	2.1mm DC JACK	PCB MOUNT
J3, J4	2	3.5mm PHONE JACK	STEREO, SWITCHED
J5, J6, J7	3	5 POSITION SIP JACK	0.1” CENTERS
L4	1	10 uH choke	BRN/BLK/BLK/GLD or BRN/BLK/BLK/SIL

Q1, Q2, Q4, Q6, Q7, Q8	6	BS170	TO-92 MOSFET
Q3, Q9	2	2N3904	TO-92 NPN
Q5	1	2N3906	TO-92 PNP
R11, R20	2	5.6 OHMS	GRN/BLUE/GOLD/GLD
R1	1	51 OHMS	GRN/BRN/BLK/GLD
R10, R19	2	470 OHMS	YEL/VIO/BRN/GLD
R4, R9, R18, R21	4	1K	BRN/BLK/RED/GLD
R5	1	4.7K	YEL/VIO/RED/GLD
R2, R3, R12, R16, R17	5	10K	BRN/BLK/ORG/GLD
R14	1	47K	YEL/VIO/ORG/GLD
R6, R8	2	100K	BRN/BLK/YEL/GLD
R13	1	470K	YEL/VIO/YEL/GLD
R15	1	680K	BLUE/GRY/YEL/GLD
R7	1	1 MEG	BRN/BLK/GRN/GLD
U1	1	SA602 or SA612A	SO8 MIXER/OSC
U2	1	LM358	DIP8 DUAL OPAMP
U3	1	LM7809	TO-220 9V/1A REG
V1, V2	2	2K	6mm Trimmer resistor
T1, T2	2	FT37-43	FERITE CORE, BLACK
DIP SOCKET	1	8 PIN DIP SOCKET	
PCB	1	MAIN CIRCUT BOARD	
Screw	1	4-40 1/4”	
Nut	1	4-40 nut	
FEET	4	RUBBER FEET	
TEST pins	1	2 position SIP pin strip	
	1	Jumper (Berg connector)	

BAND PARTS, SEE TABLE	QUANITIY	VALUE	
CAPACITORS	6	22 pF – marked 22 or 220	C0G
	1	33 pF – marked 33 or 330	C0G
	1	47 pF – marked 47 or 470	C0G
	1	68 pF – marked 68 or 680	COG
	3	100 pF – marked 101	C0G
	2	150 pF – marked 151	C0G
	2	220 pF – marked 221	C0G
	3	330 pF - marked 331	C0G
	1	560 pF – marked 561	C0G
	1	680 pF – marked 681	C0G

INDUCTORS	1	0.68 uH	BLU/GRY/SIL/GLD or BLU/GRY/SIL/SIL
	1	1.2 uH	BRN/RED/GLD/GLD or BRN/RED/GLD/SIL
	1	2.2 uH	RED/RED/GLD/GLD or RED/RED/GLD/SIL
	4	T37-2 RED CORES	
	2	T37-6 YELLOW CORES	
crystals	1	7.074 MHz	HC-49/US
	1	10.136 MHz	HC-49/US
	1	14.074 MHz	HC-49/US
Miscellaneous	3	Band module boards	
	12' 1’	#26 magnet wire #26 magnet wire, diff. color	
	12	Small tie wraps	
P1, P2	6	5 position 90° SIP pin strips	



Parts placement diagram: Print this page for quick reference

Assembly:

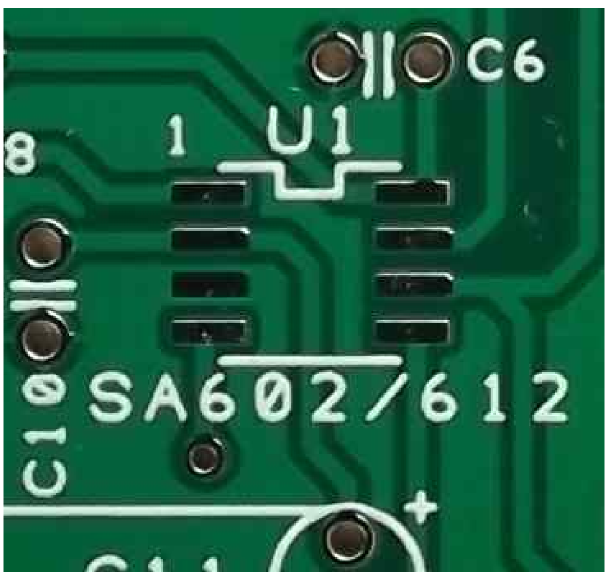
The first step is to sort the parts into groups of similar types. This will make finding the needed part type and value quicker.

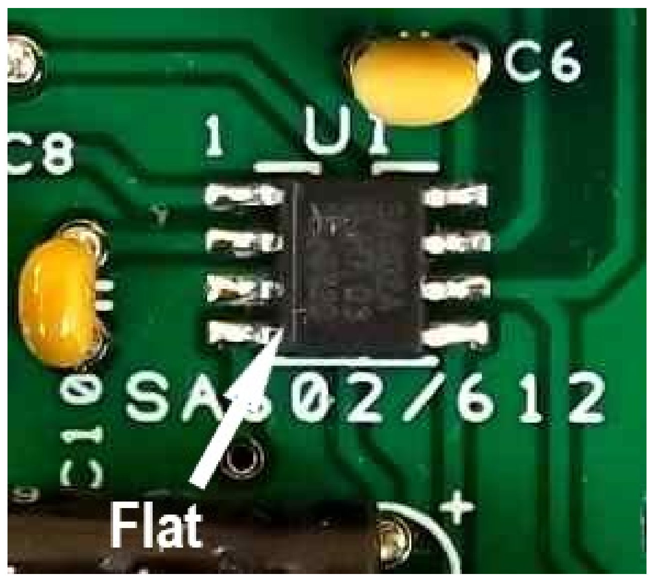
All components mount on the front side of the pcb.

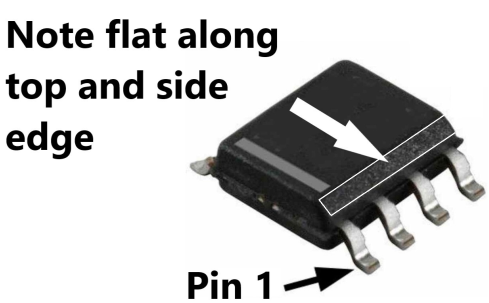
The first item to install is the only SMD component. We needed to change from the DIP8 form to the SO8 surface mount form because of shrinking availability and to keep the kit low priced.

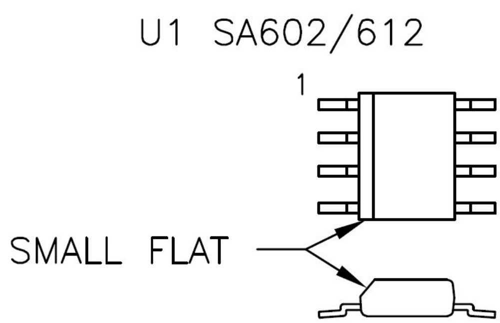
Use your favorite smd soldering method or we have found the process below to be quite satisfactory.

[ ] Solder U1, the SA602/612, smd component first, by wiping a thin layer of flux on the board, position the chip, carefully noting the flat along the side and top edge for the orientation of Pin 1, and touch each pin with a dry iron. Once you are sure of the orientation, you can go back and add a little solder to each pin if needed. Be sure there are no solder bridges between pins. Use Solder Wick® if necessary to remove any excess. *Do a continuity check with an ohm meter from each pin of U1 to the end of the trace to check your work. Note that pin 3 is GND.*





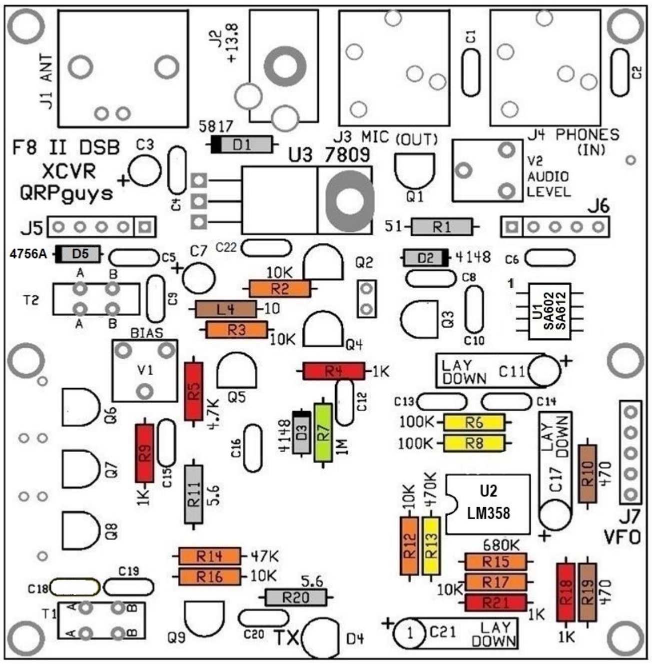




Resistors:

Caution: Several of the values have very similar color codes and differ only by the zero multiplier color. It is also easy to mix up the 51 and 1 Meg resistors as 51 is green/black/brown/gold and 1 meg is brown/black/green/gold.

L4 is a RF choke. It looks like a resistor, but is a bit fatter. With an ohm meter, it will read 0 ohms.



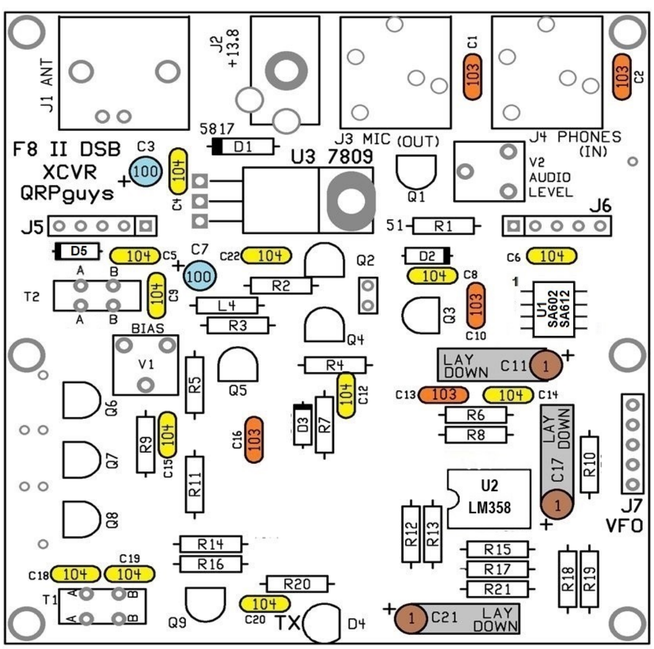
[ ] R1 - 51 GRN/BRN/BLK/GLD
[ ] R2, 3, 12, 16, 17 – 10K BRN/BLK/ORG/GLD
[ ] R4, R9, R18, R21 - 1K BRN/BLK/RED/GLD
[ ] R5 - 4.7K YEL/VOL/RED/GLD
[ ] R6, R8 - 100K BRN/BLK/YEL/GLD
[ ] R7 - 1 Meg BRN/BLK/GRN/GLD
[ ] R10, R19 - 470 YEL/VOL/BRN/GLD
[ ] R11, R20 - 5.6 GRN/BLU/GLD/GLD
[ ] R13 – 470K YEL/VOL/YEL/GLD
[ ] R14 – 47K YEL/VOL/ORG/GLD
[ ] R15 – 680K BLU/GRY/YEL/GLD

[ ] L4 – 10 uH BRN/BLK/BLK/GLD or BRN/BLK/BLK/SIL

[ ] D1 – 1N5817 Black plastic body
[ ] D2, D3 – 1N4148 Small Glass body
[ ] D5 – 1N4756A ZENER Larger Glass body

Match the diode stripe on the component with the silkscreen

Capacitors:



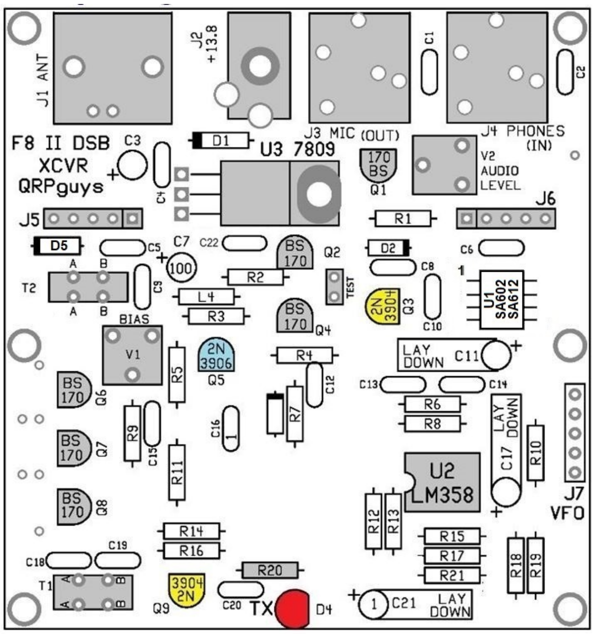
[ ] C1, C2, C10, C13, C16 – 103 Orange highlight
[ ] C4,5,6,8,9,12,14,15,18,19,20,22 – 104 – Yellow highlight 12 places

[ ] C11, C17, C21 – 1 uF – ***long lead is plus.*** These caps need to be laid down flat to the board.

[ ] C3, C7- 100 uF – ***long lead is plus.***

Note: When reading capacitor values, do not confuse the manufacturing codes with the component value. If it looks strange it may be a manufacturing code, look on the other side of the component. Also, the value may be followed by a tolerance code - M,K, or J.

Everything else:

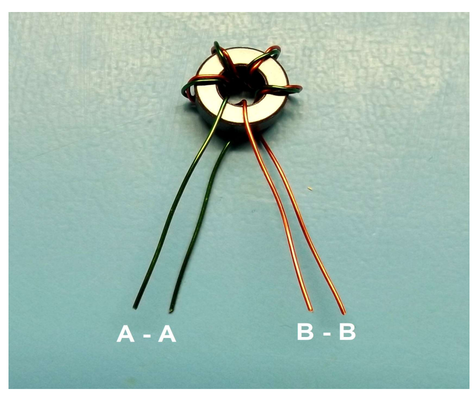


[ ] U3 – 7809 Bend the leads at the point where they narrow. Secure with 4-40 screw and nut.
[ ] J5, J6, J7 – 5 pins SIP socket. Make sure these are set square to the board before soldering more than one pin.

[ ] U2 - 8 pin DIP socket. Note orientation of notch on socket and match with notch on part board outline. Make sure all the pins are sticking out the solder pads before soldering any!
[ ] J3, J4 – 3.5mm phone jacks
[ ] Q1, Q2, Q4 – BS170 MOSFET Note orientation of the flat side of part. Make sure it matches the board outline.
[ ] Q3, Q9 – 2N3904 NPN
[ ] Q5 – 2N3906 PNP

[ ] Q6, Q7, Q8 – These parts require some heat sinking. Therefore, these parts get mounted with the flat side of the package pressed against the large, tinned pad to the left of the board. Make "U" shaped pieces of resistor lead clippings to hold the body of the BS170's to the board, using the small holes on either side of the package.

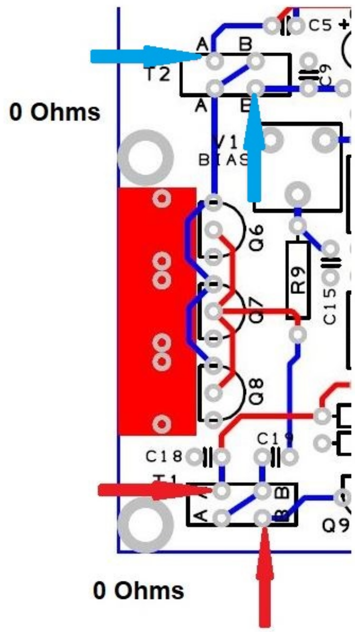
[ ] D4 – CLEAR LENS RED LED – the ***short*** lead goes into hole on flat side of part outline.
[ ] TEST – 2 pin SIP header, short pin end in the board
[ ] V1, V2 – 2K trimmer pots
[ ] J2 – DC power Jack.
[ ] J1 – BNC antenna jack



[ ] T1, T2 – bifilar wound on T37-43 ferrite core (black).

- Cut 6" length of each color magnet wire
- The two wires can be lightly twisted together, but this is not necessary
- Wind 5 turns on the core as shown.
- **Trim and tin the wire ends.** Either scrape or melt the insulation using a hot iron with a blob of solder.
- Orientate the common wire ends so they are opposite each other on the core.
- The wires will now be in the proper position for inserting into the board.

Be sure to tin the wire ends before installing. This is a leading cause of failure. Be sure not to pull the wire thru the hole past where you have it tinned.



Special Note:

Do not proceed until you make this check. *If you have installed T1 correctly, you should read 0 ohms with an ohm meter between the two pads marked by the red arrows on T1. If you have installed T2 correctly, you should read 0 ohms with an ohm meter between the two pads marked by the blue arrows on T2. If not, investigate and correct before going any further.*

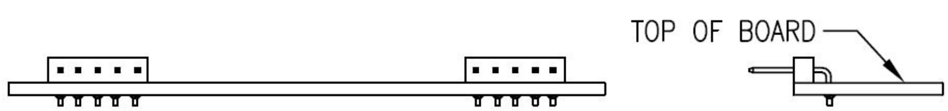
[ ] Stick the rubber bumper feet on the bottom of the board.

Assembling the band modules:

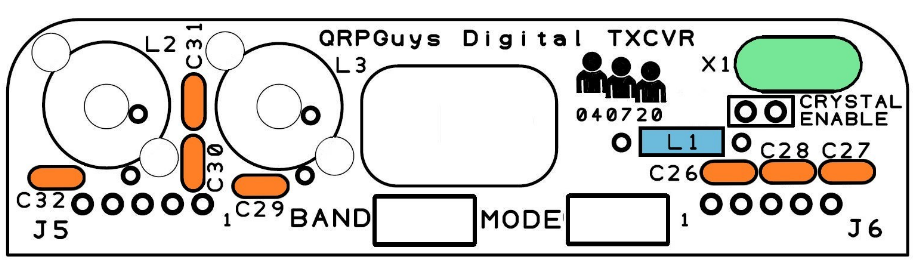
We supply three band modules and detailed the values for 20/30/40m. Additional bare band module pcb's are available for operation on other bands. At the end of this document we have modeled additional band component values. They are starting points; tweaking of the values may be necessary, and you will need to source your own components.

[ ] Before populating with components, ***mark each module with the band in the space provided with a permanent marker*****.** They can easily get mixed up during assembly and difficult to correct.

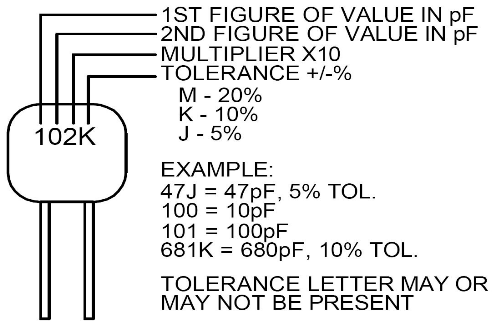
[ ] J5,J6 – 5 pin right angle SIP header strip. Short 90° pins go into board. Mount on the top of the board as shown.



Use the placement graphic and tables below to install the capacitors, crystals, and inductors.



Note: When reading module capacitor values, do not confuse the manufacturing codes with the component value. If it looks strange, it may be a manufacturing code, look on the other side of the component.



Be sure you have read the values correctly. Sort all the capacitors out before you start assembling them onto the modules. They are difficult to remove and correct.

L1 molded inductors look like a resistors, but are fatter. With an ohm meter, will read 0 ohms.

40M

[ ] L1 – 2.2 uH – Red/Red/Gold/Gold or Red/Red/Gold/Silver
[ ] C26 – 100 pfd – marked 101
[ ] C27 – 22 pfd – marked 22 or 220
[ ] C28 – 22 pfd – marked 22 or 220
[ ] C29 – 330 pfd – marked 331
[ ] C30 – 680 pfd – marked 681
[ ] C31 – 68 pfd – marked 68 or 680 (don't mix up the 681 and 68 values!)
[ ] C32 – 330 pfd – marked 331
[ ] L2 – 20 turns on T37-2 RED core – make sure turns are snug to the core and more or less evenly spaced around the core. Loose winding does not work well.
[ ] L3 – 18 turns on T37-2 RED core
[ ] X1 – 7.074 MHz crystal. If you are ***not*** using the optional VFO, you need to jumper the "CRYSTAL ENABLE" pads with a clipped piece of a resistor lead. Otherwise ***omit*** the jumper for VFO operation.

30M

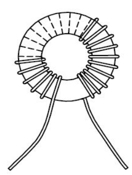
[ ] L1 – 1.2 uH – Brown/Red/Gold/Gold or Brown/Red/Gold/Silver
[ ] C26 – 100 pfd – marked 101
[ ] C27 – 22 pfd – marked 22 or 220
[ ] C28 – 22 pfd – marked 22 or 220
[ ] C29 – 220 pfd – marked 221
[ ] C30 – 560 pfd – marked 561
[ ] C31 – 47 pfd – marked 47 or 470
[ ] C32 – 220 pfd – marked 221
[ ] L2 – 18 turns on T37-2 RED core – make sure turns are snug to the core and more or less evenly spaced around the core. Loose winding does not work well.
[ ] L3 – 13 turns on T37-2 RED core
[ ] X1 – 10.136 MHz crystal. If you are ***not*** using the optional VFO, you need to jumper the "CRYSTAL ENABLE" pads with a clipped piece of a resistor lead. Otherwise ***omit*** the jumper for VFO operation.

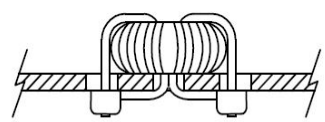
20M

[ ] L1 – 0.68 uH – Blue/Gray/Silver/Gold or Blue/Gray/Silver/Silver
[ ] C26 – 100pfd – marked 101
[ ] C27 – 22 pfd – marked 22 or 220
[ ] C28 – 22 pfd – marked 22 or 220
[ ] C29 – 150 pfd – marked 151
[ ] C30 – 330 pfd – marked 331
[ ] C31 – 33 pfd – marked 33 or 330 (don't mix up the 331 and 33 values!)
[ ] C32 – 150 pfd – marked 151
[ ] L2 – 17 turns on T37-6 YELLOW core – make sure turns are snug to the core and more or less evenly spaced around the core. Loose winding does not work well.
[ ] L3 – 15 turns on T37-6 YELLOW core
[ ] X1 – 14.074 MHz crystal. If you are ***not*** using the optional VFO, you need to jumper the "CRYSTAL ENABLE" pads with a clipped piece of a resistor lead. Otherwise ***omit*** the jumper for VFO operation.

Winding the toroids:

[ ] Wind each of the L2 and L3 toroids using 12" of the supplied magnet wire. Use the tables above and wind them in the direction shown in the graphic below and they will align with the pcb holes. When you are certain of the turn count, trim the leads ~3/8" and ***tin them*** before installing the toroids flat on the top of the board, centered on the silkscreen outline. Secure each toroid to the pcb using two of the supplied plastic zip ties, as shown below.





Be sure to tin the wire ends before installing. The transceiver will not work if you do not tin the magnet wire. This is a leading cause of failure. Be sure not to pull the wire thru the hole past where you have it tinned.

Test and set up:

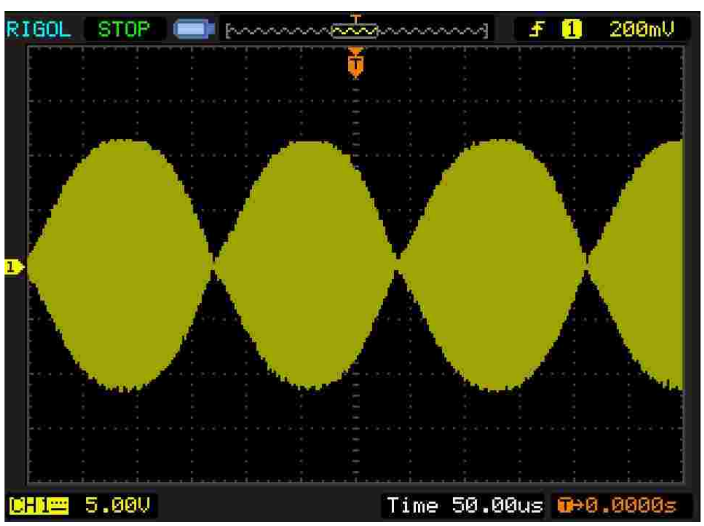
[ ] Apply 12V to 13.8V to the board.
[ ] Verify 9V (+/- 0.25) between pins 8 and 4 of U2. (Optional)
[ ] Remove power
[ ] Install LM358 IC into U2 socket.
The following bias adjustment is made without a band module or optional vfo attached.
[ ] Connect your DMM in series with the positive power supply lead and set the meter to measure current. To be safe, use the 10A scale.
[ ] Set the V1 (BIAS) trimmer to fully ***Clockwise***.
[ ] Apply power to the board again.
[ ] Insert the shorting jumper (Berg connector) into the [TEST] SIP pins. This will force the board into transmit mode. The RED LED should now be on.
[ ] Note the amount of current the board is drawing.
[ ] Slowly adjust the V1 trimmer ***Counterclockwise*** while watching the current meter. Adjust until the current ***GOES UP*** by about 15 ma. This is just enough to put the PA into linear mode.
[ ] Remove power
[ ] Remove the shorting plug from the [TEST] pins.

You are now ready for on-air testing.

[ ] Start the WSJT-X program on your PC or Laptop.
[ ] Make the required MIC and Headphone connections between the PC and DSB board. MIC to MIC and PHONES to PHONES. (I found nice stereo jumper cables at the Dollar Store).
[ ] Plug in the desired band module. The component side of the board faces you, the end with the LED. Use the band module with the crystal.
[ ] If using the VFO, be sure to remove the *crystal enable* jumper and set the VFO to the desired band and frequency.
[ ] Connect up your antenna.
[ ] Power up the board.
[ ] If the band is open, you should start to see signals. Adjust the Sound card input level and the V2 audio output level to appropriate settings for your conditions.
[ ] Replace the antenna with a 50 ohm dummy load.
[ ] Set the sound card output level to minimum.
[ ] Activate FT8 transmit in the program.
[ ] Increase sound card output level until the board switches into Transmit. (RED LED goes on) you can continue to increase the output level a little bit to ensure reliable triggering of the VOX circuit.

If you have a watt meter in line with the antenna, you will notice the power will continue to increase as the audio input continues to increase. *Do not do this.* The apparent increase in power is due to overloading the mixer and amplifier stages, putting them into a non-linear region.

As you see below, if you look at the RF output with an oscilloscope, it should look like a string of pearls. This is the result of the two side bands mixing. Increasing the drive will turn the string of pearls into more of a picket fence and then approach being a wall. This is the result of the amplifier stages saturating, resulting in the signal flat topping creating spurious outputs to the annoyance of others in the band. Always keep your signal clean. We're transmitting on two side bands.



[ ] Reconnect the antenna and you are good to go.

Refer to the WSJT-X documentation and our website links for more details on operation.

Theory of operation:

The Digital DSB transceiver is built around the ubiquitous SA602/612A mixer-oscillator chip. It provides both the receive and transmit functions.

Receiver:

The antenna is first routed through the transmitter's Low Pass Filter (LPF) and then into a BS170 MOSFET, which is the receiver input T/R switch. The received signal is coupled into a new High Pass Filter (HPF) circuit comprised of C26 and L1. Stray capacitance (~88pF) resonates L1 to about the operating frequency.

The received input signal is applied to the input of the SA602 mixer (U1) to produce the base line audio output. The Local Oscillator is either the crystal on the band module using the internal oscillator of the SA602, or an optional Digital VFO.

U2b, one half of a LM358 op amp, provides audio gain for decent sensitivity. A non-inverting configuration is used so that the input can be high impedance, allowing for reasonably small value input coupling caps. The gain is set to 47. The amplifier then drives an audio level pot so the audio level can be adjusted to a level suitable for your PC sound card. Q1 provides muting of the audio output by shorting the input to the audio level pot to ground.

Transmitter:

The SA602/612 requires very little input signal to saturate. Therefore a resistor divider is placed between the audio input from the sound card to the mixer input. This allows you to set the audio output from the sound card to a reasonable level and not overdrive the mixer.

The other half of the LM358 (U2a) is used as a VOX circuit. The peak detector circuit of D3 and C12 isn't required for FT8 operation, but is included if one wishes to experiment with other modes where the audio input can drop to zero for short periods of time.

The output of the Peak Detector activates the T/R switching.

- Q4 turns on, activating this sequence:
- Q2 is turned off, which disconnects the antenna from the mixer input.
- Q5 is turned on, which switches on the power to the transmit circuits.
- Q1 is turned on, muting the audio output.
- Q3 is turned on, shunting any transmit RF which might leak through Q1.

Q6-Q7-Q8 amplifies the RF output from the mixer to a level sufficient to drive the PA. The PA is comprised of three BS170 MOSFETS in parallel. Bias is applied to the gates to place the amplifier into linear mode. This also reduces the amount of drive needed since the input signal does not have to first exceed the ~2.5V it takes to start to turn on the MOSFETS. The signal then goes to the Low Pass Filter (LPF) and finally the antenna.

Power to the circuits is supplied by a 9V, 1A regulator. This ensures the power output remains in a safe operating area and if there is a problem, the internal over current protection will shut down the regulator. Since the maximum operating voltage of the SA602/612 is 9V, a diode is placed in series with the 9V supply insure the voltage to the chip does not exceed the maximum recommended supply voltage.

Trouble shooting:

Soldering issues are the most common reason for a board not to work the first time. A careful visual inspection will often locate the problem. Ground pads take a little extra heat compared to other pads, so take note of these. Solder can stick to the component lead, but not flow into the hole. These bad connections can be hard to spot.

Another problem area is the tinning of the magnet wire used to wind the cores. The wire should have been tinned before you tried to solder the leads to the board, but sometimes the wire gets pulled in past the tinned area so the solder doesn't real stick or makes an intermittent connection.

The bifilar wound cores should have continuity between all four pads if the wires are in the right place. If the pair is reversed, there will only be continuity between the two pads on opposite sides of the core. If you cannot adjust the PA bias, it is likely T2 is not installed correctly or has a soldering issue.

Did you do the continuity check of soldering U2?

Double check resistor locations. Make sure you didn't mix up values with similar color codes.

The voltage chart on page 12 can be useful to narrow down a problem area. The exact voltage will vary a little a little depending on component tolerances and your meter. Only be concerned if the voltages are significantly different than those shown.

Almost all of the construction issues with the DSB transceiver have been traced to the faulty installation of T1 or T2. Check carefully the correct orientation of the primary, secondary, tinning and final soldering of the toroid leads. Double check the T1 and T2 continuity check described earlier.

VOX/switching problems:

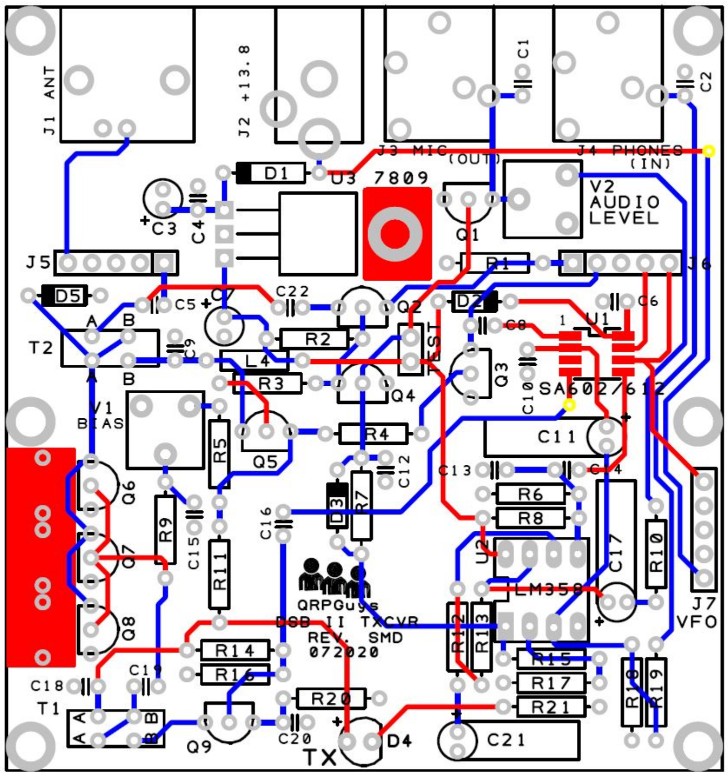
To test the vox circuit there must be enough audio from the sound card. Check that the computer is outputting audio to J3. The vertical slider marked (Pwr) on the right side of the WSJT-X program is the output from the sound card. Moving the slider up should put the transceiver into transmit, illuminating the LED. In order for the transceiver to enter into transmit mode and the TX LED to come on, Q5 has to be biased “ON” through R3 and Q4. Q4 turns on when it’s gate is biased to about 2V. The gate of Q4 is biased to about 2V when the output of U2a (pin1) goes above about 2.4V. This should take a minimum of 37 mV in respect to ground on Pin 2.

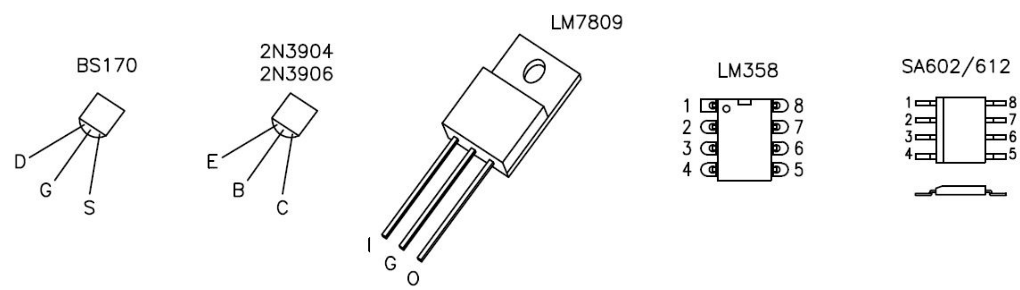
So, where does this go wrong?

Is Pin 1 of U2 high or low?

- Low – no problem
- High – (~8.5V) check resistors R15, R17, R18 for cold solder connections. Check U2 socket lead connections to board.
- Gate of Q4 high, but Pin 1 low? Check for short across jumper pins and or connection to R7 bad.
- Gate of Q4 low, Drain also low? Q4 defective. Verify short with ohm meter.
- Gate of Q4 low, Drain high? Q5 Shorted.
- Check C11 polarity. If backwards, the cap leakage would trigger U2.

X-ray view of board. “floating” pads are connected to ground plane, not shown for clarity.

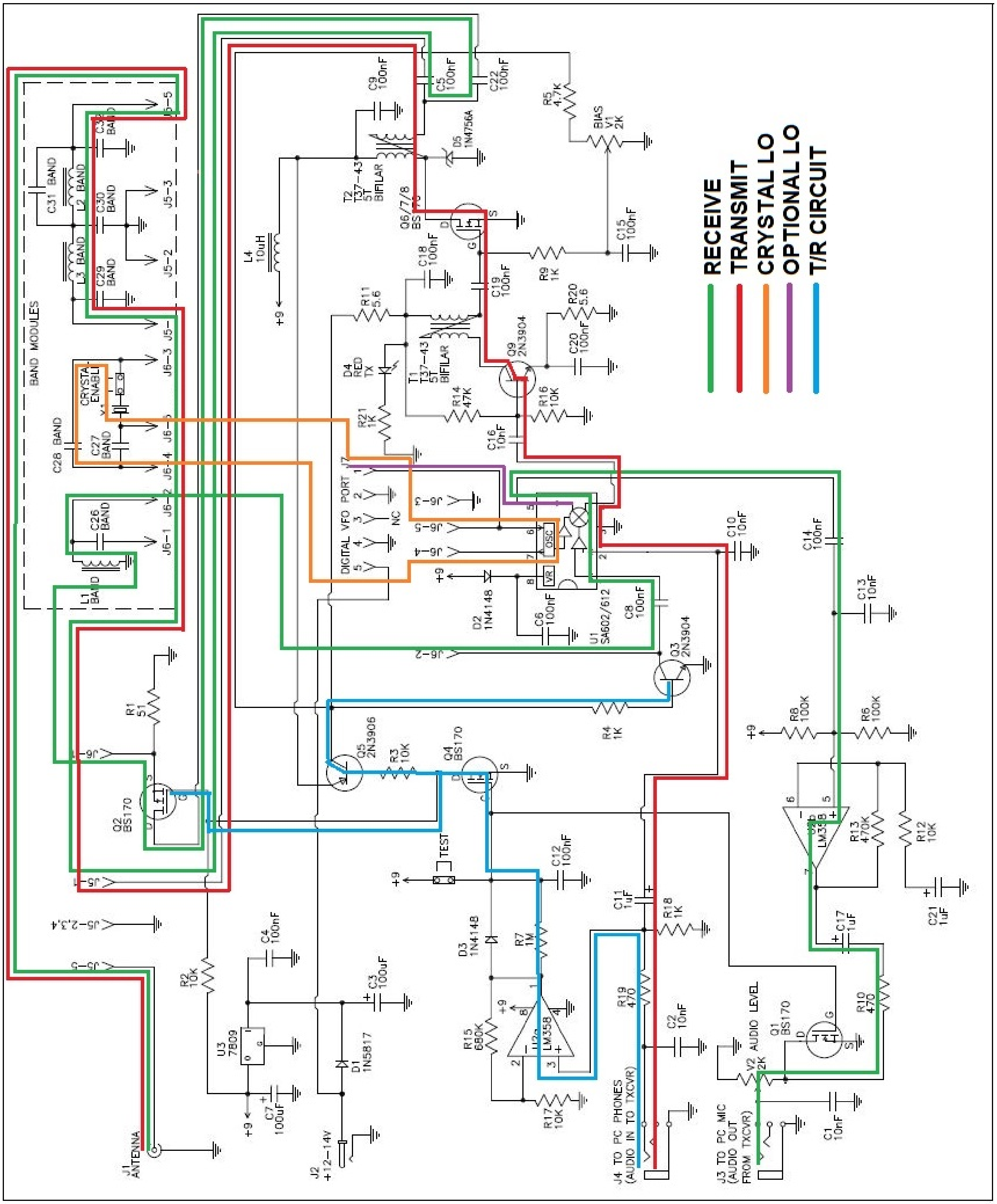


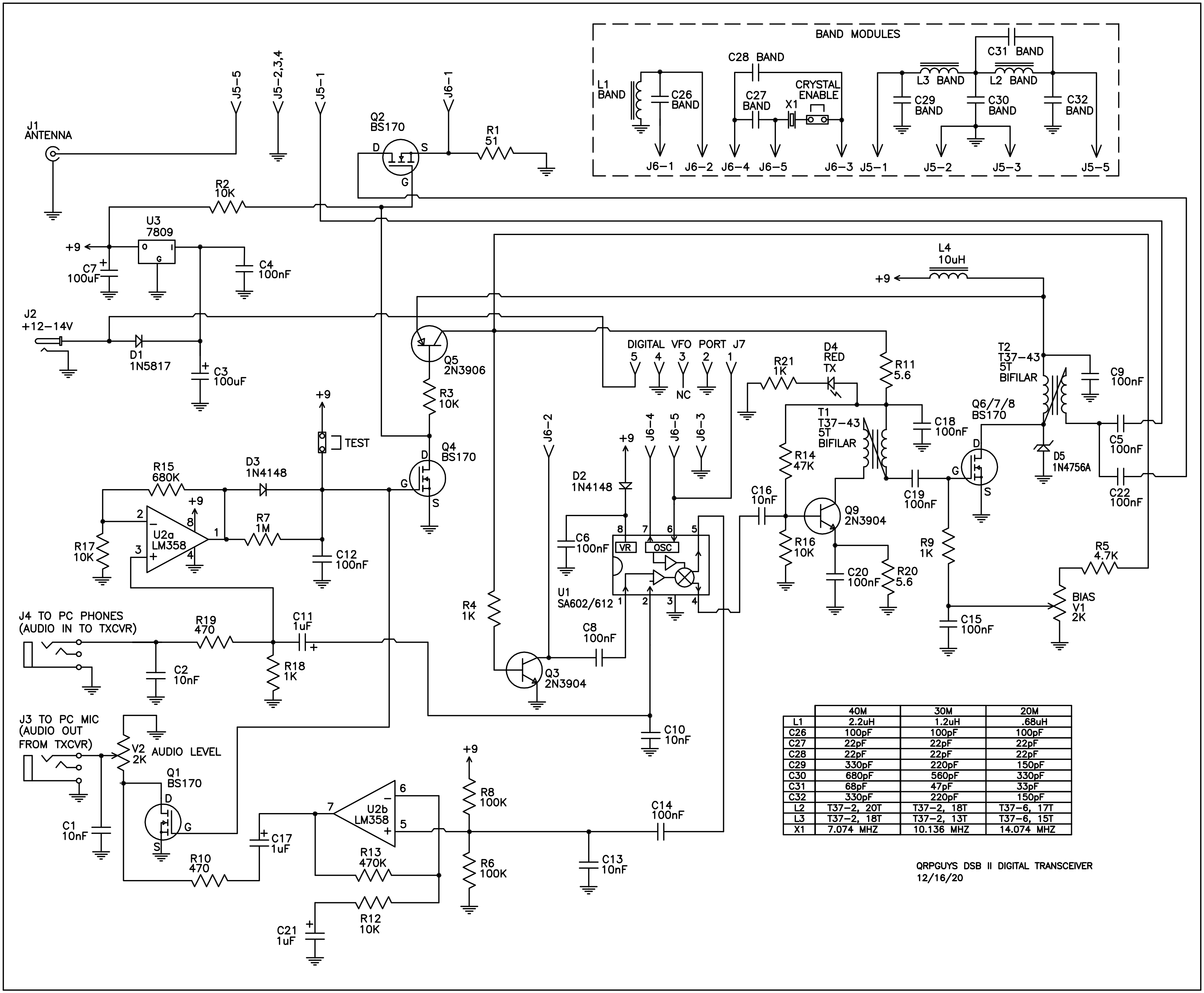


D=Drain G=Gate S=Source E=Emitter B= Base C=Collector I=Input G=Ground O=Output

Rx	D / C	G / B	S / E	Tx	D / C	G / B	S /E
Q1	0V	0V	0V		0V	9V	0V
Q2	0V	9V	0V		0V	0V	0V
Q4	9V	0V	0V		0V	9V	0V
Q6/7/8	9V	0V	0V		9V	~2.5V	0V
Q3	0V	0V	0V		0V	0.78V	0V
Q5	0V	9V	9V		8.8V	8.15V	9V

Pin	1	2	3	4	5	6	7	8
U1	1.42	1.42	0	7.15	7.15	8.3	7.5	8.35
U2 Rx	0	0	0	0	4.5	4.5	4.5	9


RECEIVE
TRANSMIT
CRYSTAL LO
OPTIONAL LO
T/R CIRCUIT



	40M	30M	20M
L1	2.2uH	1.2uH	.68uH
C26	100pF	100pF	100pF
C27	22pF	22pF	22pF
C28	22pF	22pF	22pF
C29	330pF	220pF	150pF
C30	680pF	560pF	330pF
C31	68pF	47pF	33pF
C32	330pF	220pF	150pF
L2	T37–2, 20T	T37–2, 18T	T37–6, 17T
L3	T37–2, 18T	T37–2, 13T	T37–6, 15T
X1	7.074 MHZ	10.136 MHZ	14.074 MHZ

QRPGUYS DSB II DIGITAL TRANSCEIVER
12/16/20

In the table below are some "modeled" values for additional bands to experiment with. Some tweaking may be required. You will need to source your own components. If you choose to model your own high pass filter (L1 & C26), be sure to add the 88pF stray capacitance inherent in the design to C26. That has been done with the modeling you see below.

	160M	80M	60M	17M
L1	10uH	10uH	4.7uH	.56uH
C26	680pF	100pF	100pF	68pF
C27	22pF	22pF	22pF	22pF
C28	22pF	22pF	22pF	22pF
C29	680pF	680pF	680pF	100pF
C30	1640pF(820pF)X2	1360pF(680pF)X2	1200pF	220pF
C31	180pF	220pF	150pF	15pF
C32	680pF	680pF	680pF	47pF
L2	T37-1, 35T	T37-2, 23T	T37-2, 20T	T37-6, 16T
L3	T37-1, 35T	T37-2, 23T	T37-2, 20T	T37-6, 13T
X1*	1.840 MHZ	3.573 MHZ	5.357 MHZ	18.100 MHZ

* IF OPTIONAL VFO NOT USED

Notes: