TJ6-1 High-Performance SSB/CW QRP Transceiver

Construction Guide

With the SMD doubly-balanced diode ring mixer as the receiving mixer, **TJ6A** offers excellent low-noise reception and strong signal handling ability. **TJ6A** is used with DDS (AD9850) as LO, offering wider frequency tuning range.

Operating Power:
12 – 13.8 V

Output Power:
10 W (15 m: 4W)

Receiving Frequency:
BAND 1: 3.5 – 4 MHz
BAND 2: 7 – 7.5 MHz
BAND 3: 10 – 15 MHz
BAND 4: 18 – 21.5 MHz

Transmitting Frequency:
BAND 1: 3.5 – 4 MHz
BAND 2: 7 – 7.5 MHz
BAND 3:14 – 14.5 MHz
BAND 4: 21 – 21.5 MHz

Operating Mode:
LSB, USB, CW

IF:
9 MHz

Tuning Step:
10 Hz
100 Hz
1 KHz
10 KHz
100 KHz

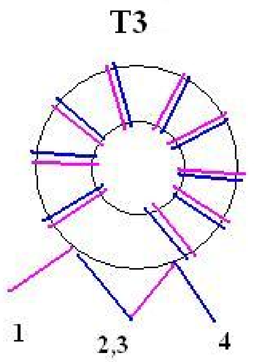
New Features:
Plug-in RX and TX BPF modules
Plug-in IF XTL filter module

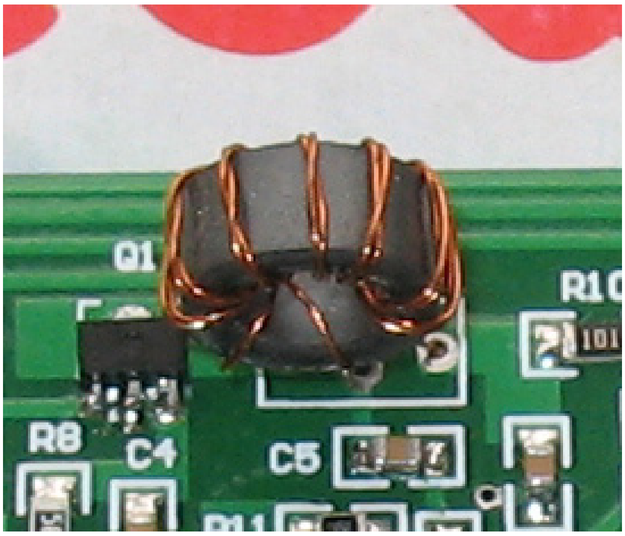
Construction

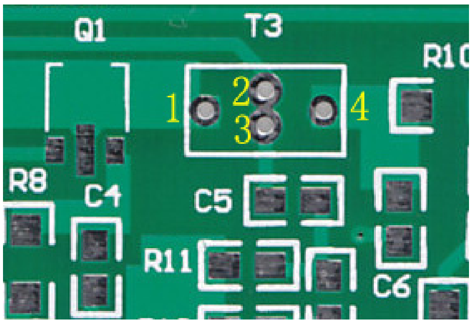
Transformers and Coils

Main Board

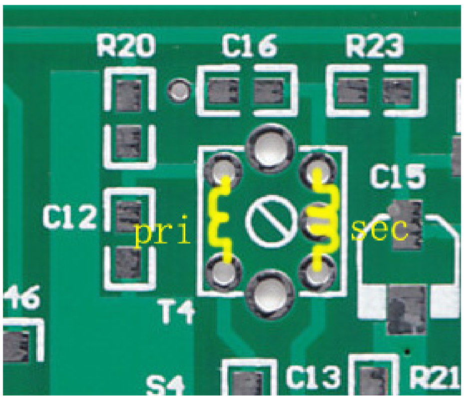
T3：Broad-band ferrite transformer, 8 bifilar turns, 0.31 wire, on the broadband core. Cut 2 wires of 18 cm long, and twist them. See photo. Pay attention to the phase. As shown in the picture, red wire is Wire A; black wire is Wire B. The end of Wire A (2) is connected with the start of Wire B (3) as the tap.

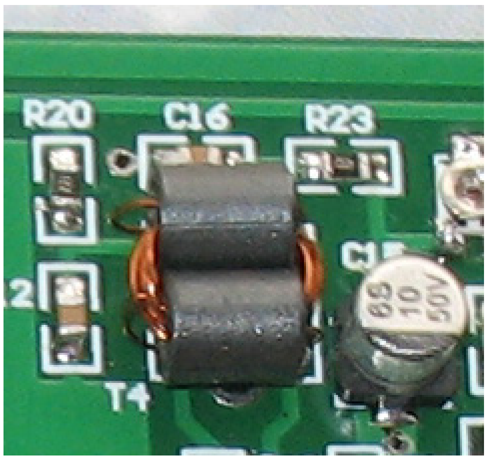


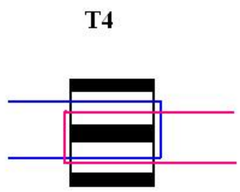




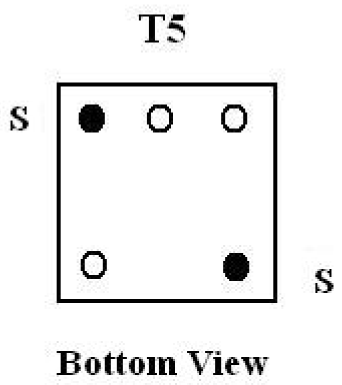
T4：IF transformer. Use 2 sleeves to form a binocular core. 0.31 wire, primary (C12 side) 5 turns, secondary (C15 side) 10 turns. Cut 14 cm of wire for primary; 23 cm for secondary. Mark primary and secondary before winding the transformer, so that you can identify the primary and secondary easily.

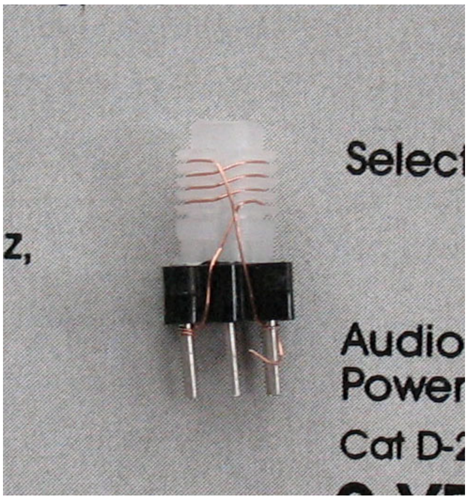




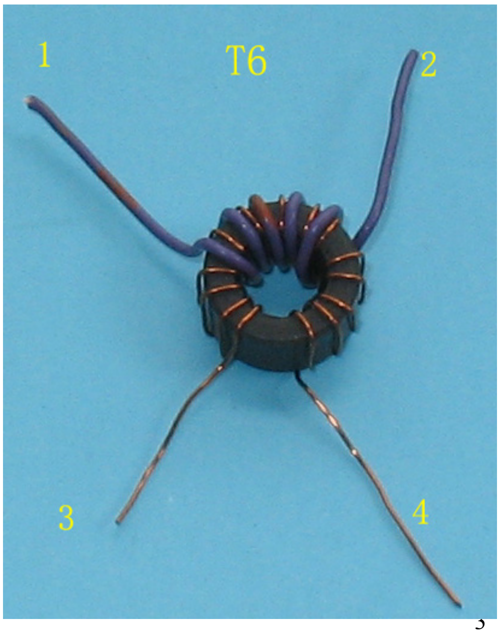


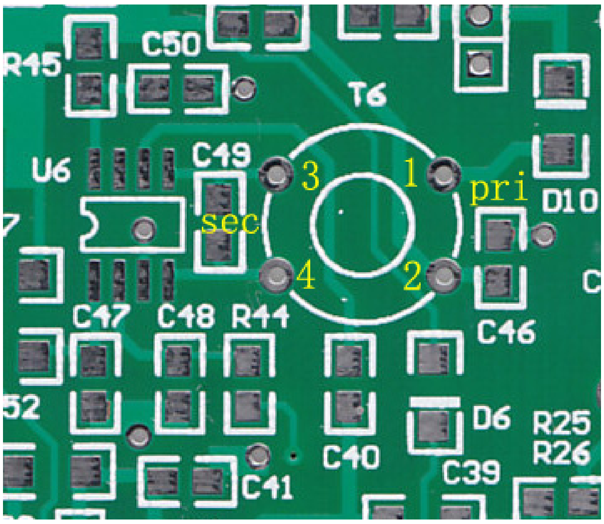
T5: Use the can former (See picture). 0.1 wire, primary (the 3-pin side) 16 turns, counter clockwise, the turns spread in 4 slots. Secondary (2-pin side), 4 turns in the bottom slot, counter clockwise. Wind the 2-pin side first. Pay attention to the start. See the illustration.



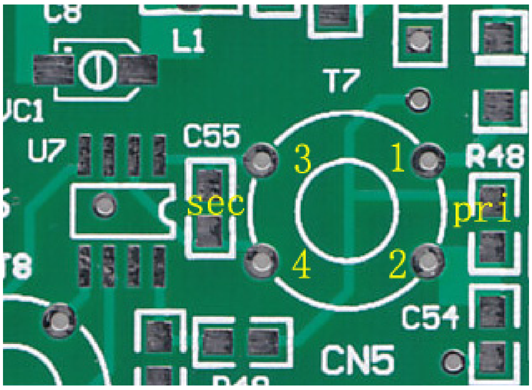


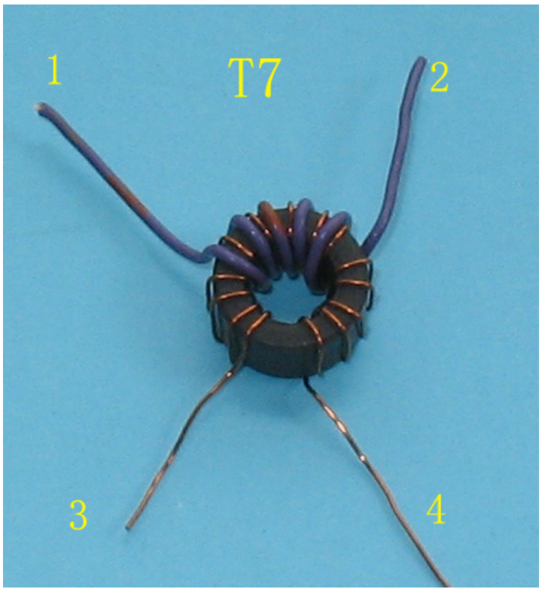
T6: Broad band transformer. 0.31 wire, primary 6 turns, secondary 15 turns on broadband toroid. Wind secondary first. Spread 15 turns evenly on the core. Do not overlap. Place the primary on the middle part of the secondary, see photo. For convenience of illustration, a purple wire is used for the primary.

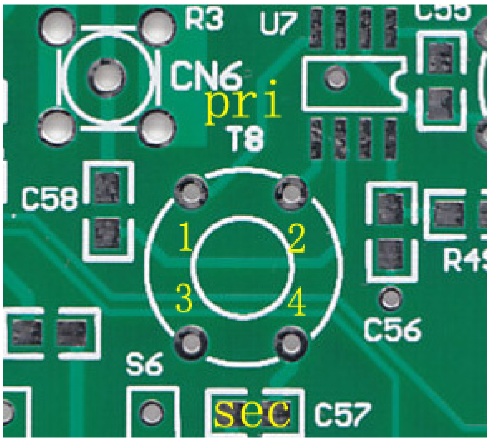




T7: IF transformer. 0.31 wire, primary 8 turns, secondary 22 turns on NXO-10 toroid. Wind secondary first. Spread 22 turns evenly on the core. Do not overlap. Place the primary on the middle part of the secondary.

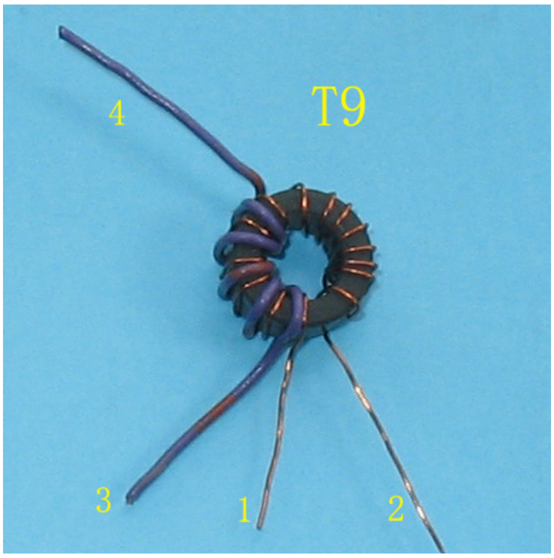


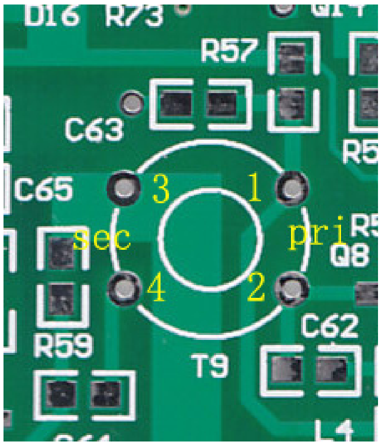




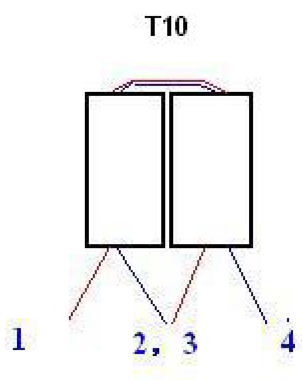
T8: Broad band transformer. 0.31 wire, primary 15 turns, secondary 3 turns on broadband toroid. Wind primary first. Spread 15 turns evenly on the core. Do not overlap. Place the secondary on the middle part of the primary.

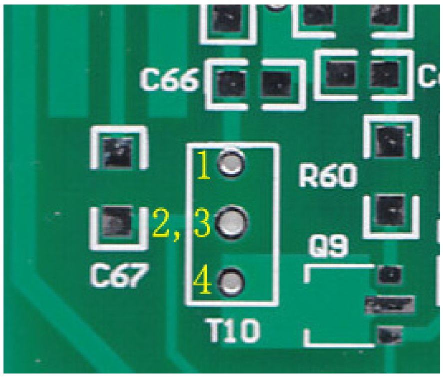
T9: Broad band transformer. 0.31 wire, primary 15 turns, secondary 3 turns on broadband toroid. Wind primary first. Spread 15 turns evenly on the core. Do not overlap. Place the secondary on the cold end (R57 end) of the primary.





T10: Broad band transformer. 5 bifilar turns, 0.31 wire, on the binocular core formed by 2 sleeves. See photo. Pay attention to the phase. As shown in the picture, red wire is Wire A; black wire is Wire B. End of wire A (2) and start of Wire B (3) are connected as the tap.





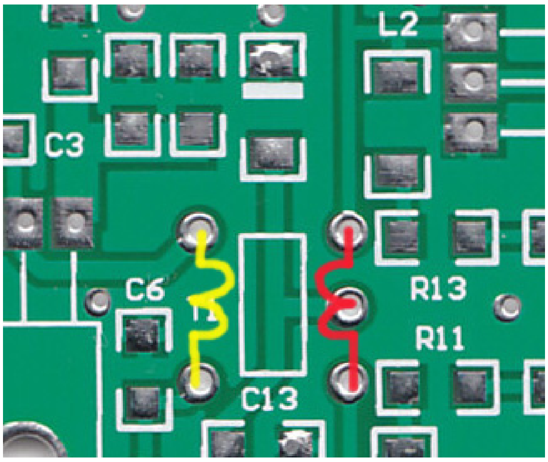
L1: 21 turns，0.31 wire, on NXO-10 toroid core.

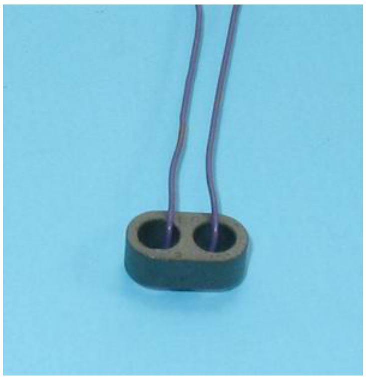
L2： 26 turns，0.1 wire on can former, spread in 5 slots.

L3： Use the can former. 0.1 wire, 16 turns, (the 3-pin side), spread in 5 slots.

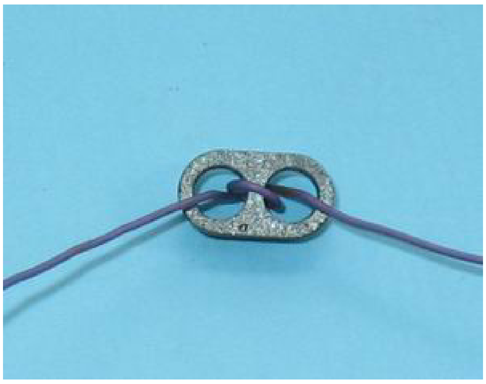
PA Board

T1: Primary (yellow) 4 turns 0.38 wire or insulated wire on the binocular core; secondary (red) 2 turns, center tapped. See photo. The picture at right shows 1 turn.

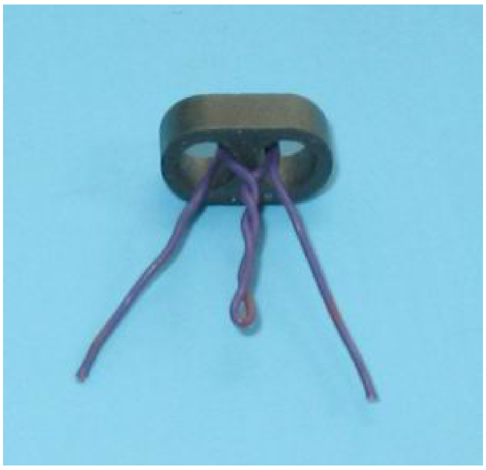




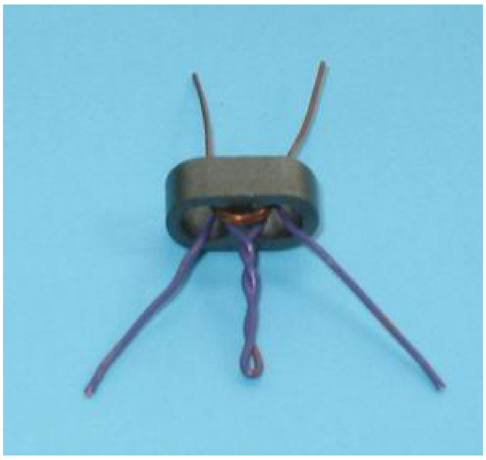
The picture below shows 2 turns.



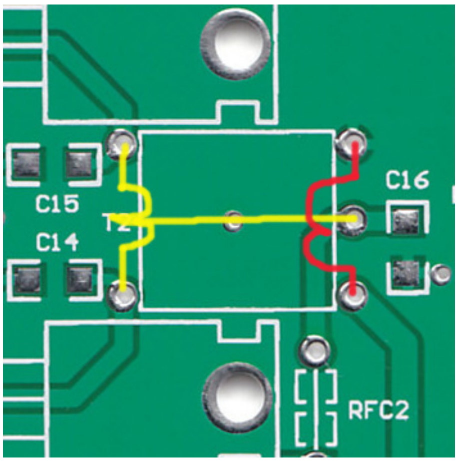
The picture below shows how to tap.



Finished transformaer.



T2: Use two sleeves to form 1 binocular core. Primary (yellow) 2 turns 0.38 - 0.47 wire or insulated wire, center tapped; secondary (red) 3 turns. See photo.

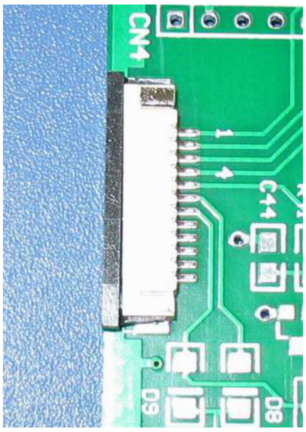


RFC1, RFC2: 3 turns, 0.47 wire, on the small toroid.
L3, L4: 8 turns, 0.47 wire, on T50-2 toroid.
L5, L6: 11 turns, 0.47 wire, on T50-2 toroid.
L7, L8: 16 turns, 0.47 wire, on T50-2 toroid.
L9, L10: 22 turns, 0.31 wire, on T50-2 toroid.

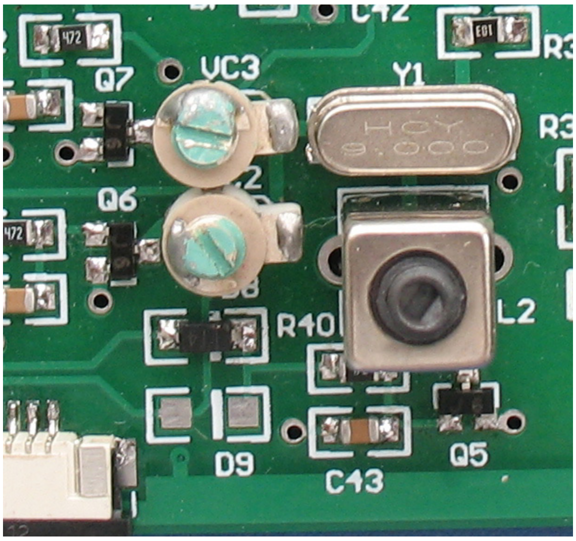
Soldering Components

Main Board

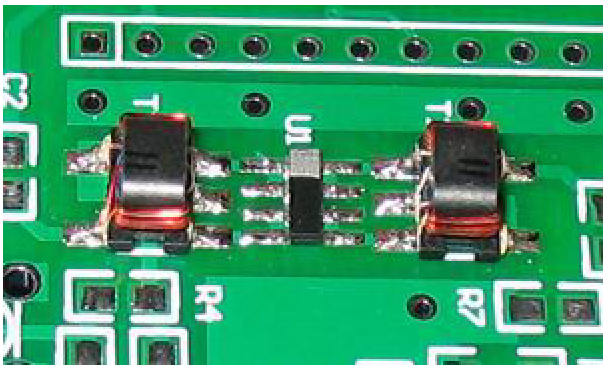
Solder the FFC (flexible flat cable) connectors first. Solder also the side pads to the PCB. Use ohm meter to check the FFC pins after all the FFC connectors are soldered. RL1 is the last component to solder. Now, go on to solder other components.



VC2 and VC3 are ceramic variable capacitors. Solder the rotator pin to the left pad.

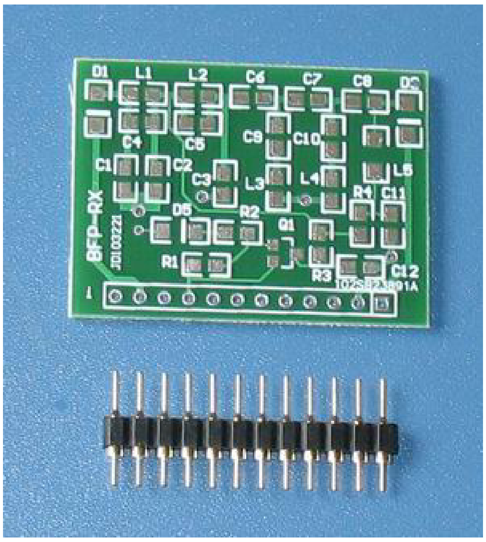


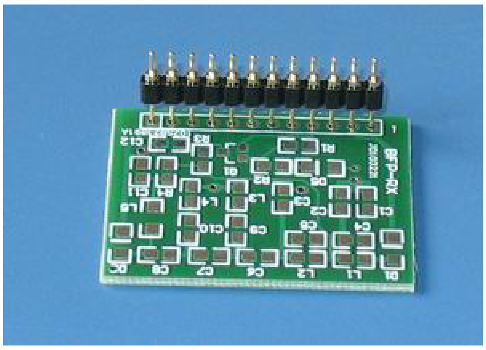
Solder T1, T2 and U1.

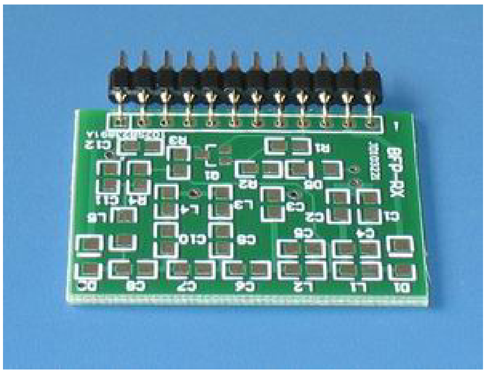


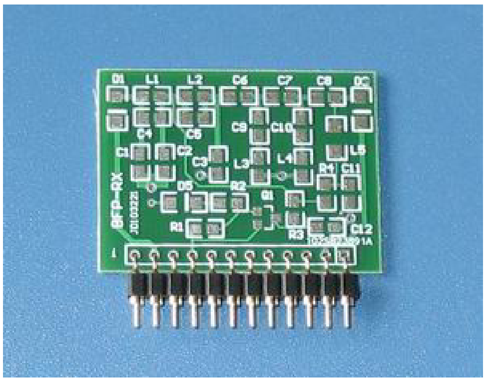
L4 and C75 is not necessary.

Bend the headers to make the BPF modules, see pictures. Place the PCB on a flat surface; put in the headers; push the headers; the module is done. Solder the headers. Do not put the header on the wrong side. Solder the header sockets to S1, S2, S5, and S6.





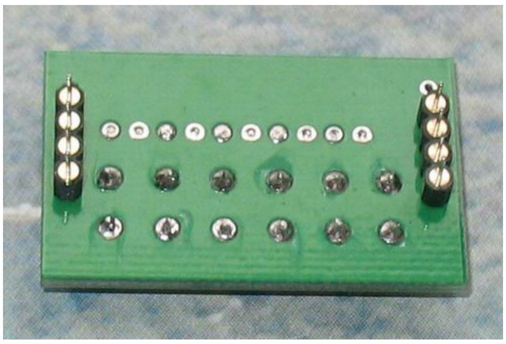




There are 5 modules in the kit, four of them BPF's: 2 single-sided for receiving, 2 double-sided for transmitting.

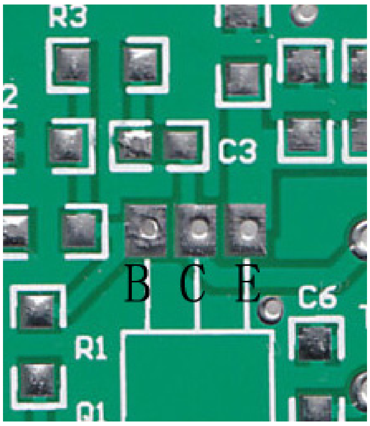
The narrow module is XTL filter. Y1 through Y6 are 9.000MHz crystals. C1 through C7 are 47p capacitors. Solder 4-pin headers to the module. Solder header socket to S3 and S4 on the PCB.

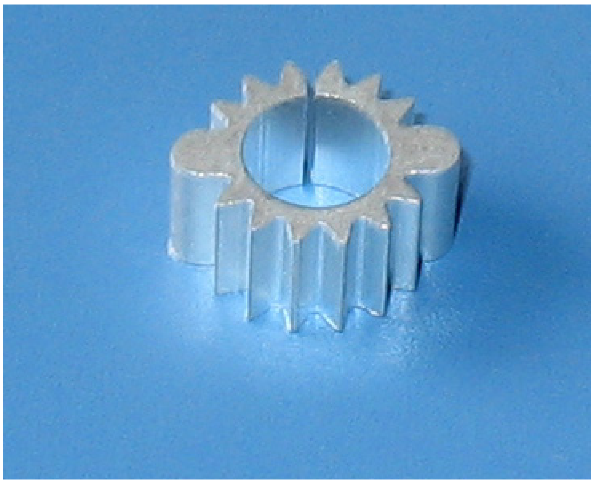
After all the components are soldered, plug in the RX modules into S1 and S2. S1 is for Band 1 and Band 2; S2 for Band 3 and Band 4. Plug XTL Filter module into S3 and S4. Do not plug into the wrong direction. For the BPF modules, the black plastic bar is on the left side. For the XTL filter module, the label "XTL FIL" on the XTL filter PCB is to the upper side of the main PCB.

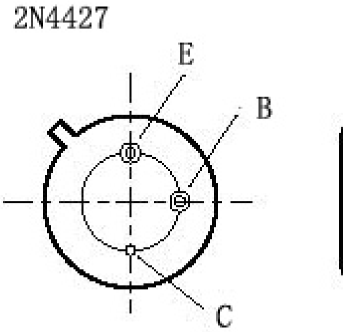


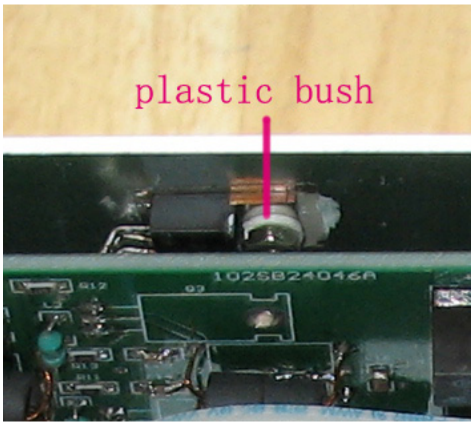
PA BOARD

Q1 is 2N4427. Please bend the leads to suit the PCB (See photo). Before soldering 2N4427, press it into the heat sink. If it is very difficult to press it in, please widen the sink slot a little on the side, so that the transistor slides in tightly.

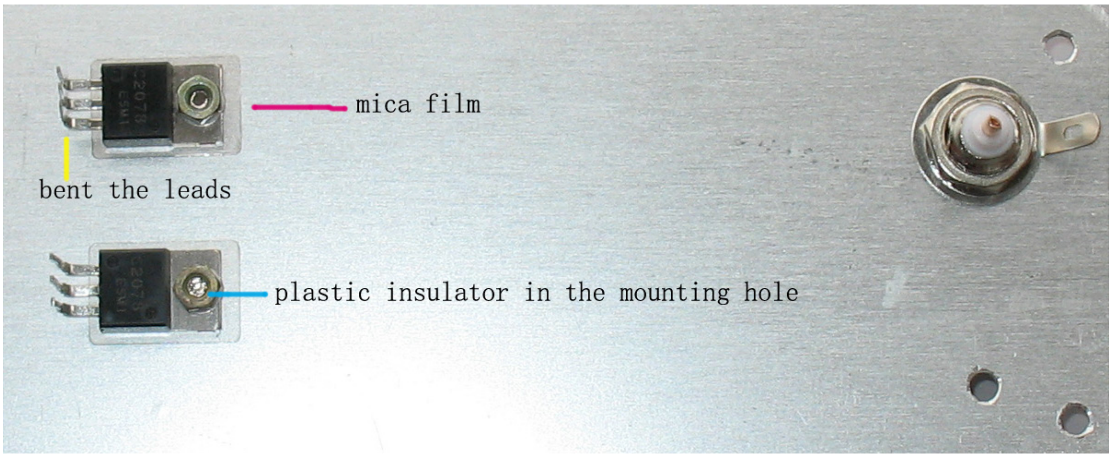






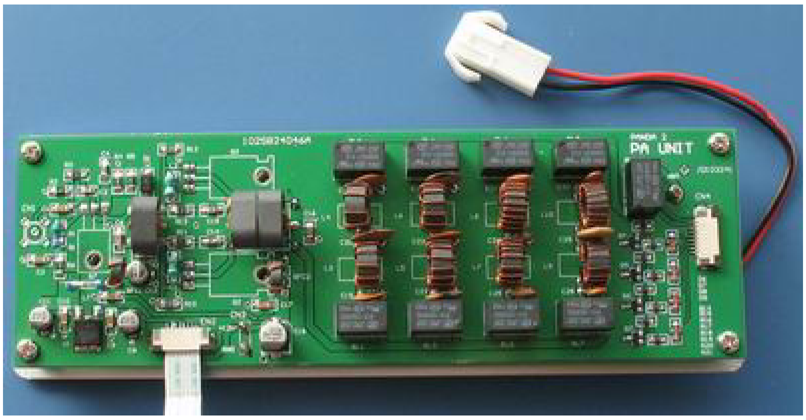


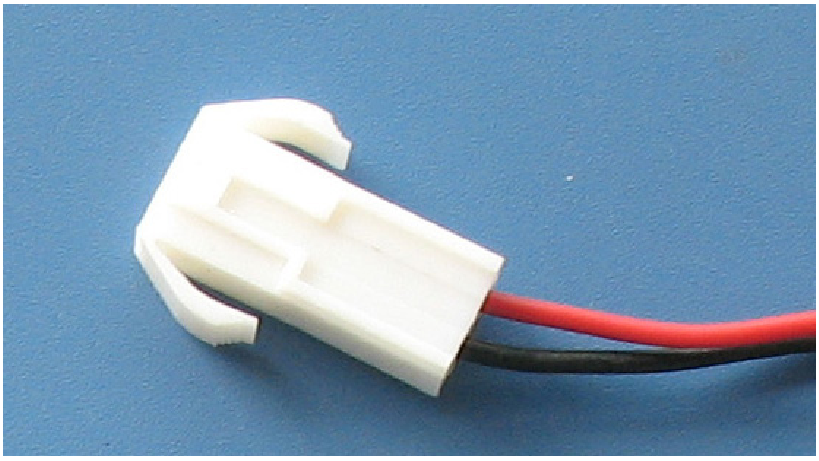
Do not solder Q2 and Q3 until all the components have been soldered. Bend the transistor leads, so that they can go though the pad holes on the PCB. Use the mica film between the



transistor sink and the aluminum back cover. Insert the white plastic bush into the mounting hole of the transistor sink before applying the screw nut. Mount the BNC socket. Mount four 8mm-brass spacers on the 4 corners of the back cover. Place the PA PCB on to the back cover. Align the leads of the transistors and the BNC. Use 4 screws to mount the PCB. Solder the leads of Q2, Q3 and BNC.

Connect 2 thick wires to CN3. Thread the 2 wires through the POWER lead hole. Connect the power connectors to the power leads.

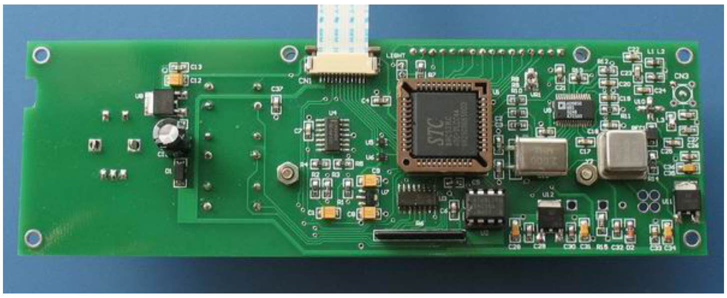




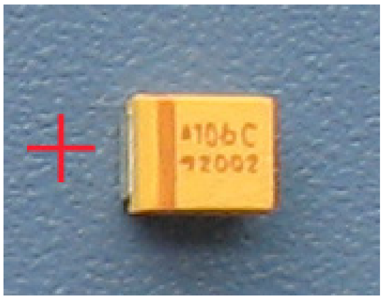
The bias resistor R7 is made up of one 10 ohm resistor and 68 ohm resistor.

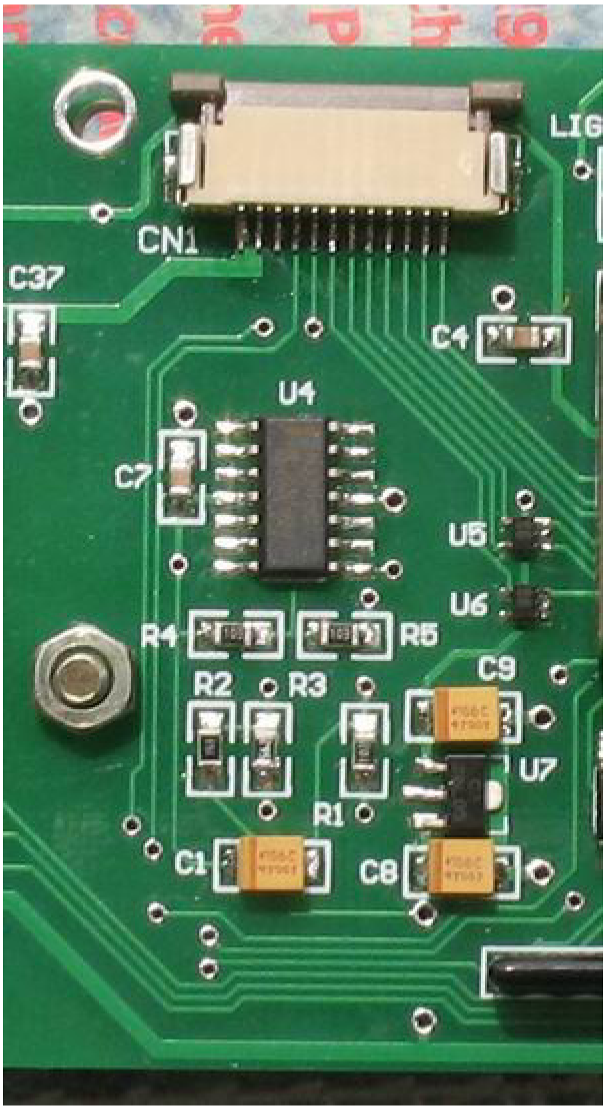
DDS Board

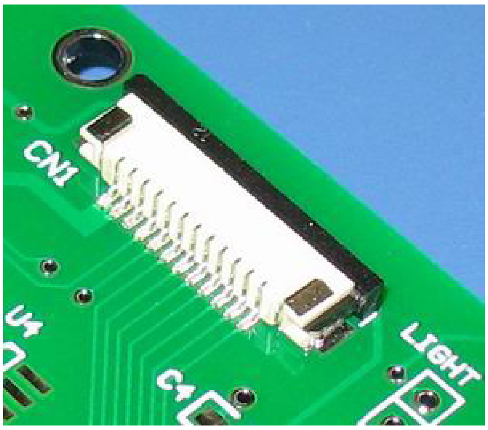
Do no mount MCU socket until all the components have been soldered. Solder the FFC connectors first. Check the connection of the connectors after soldering.

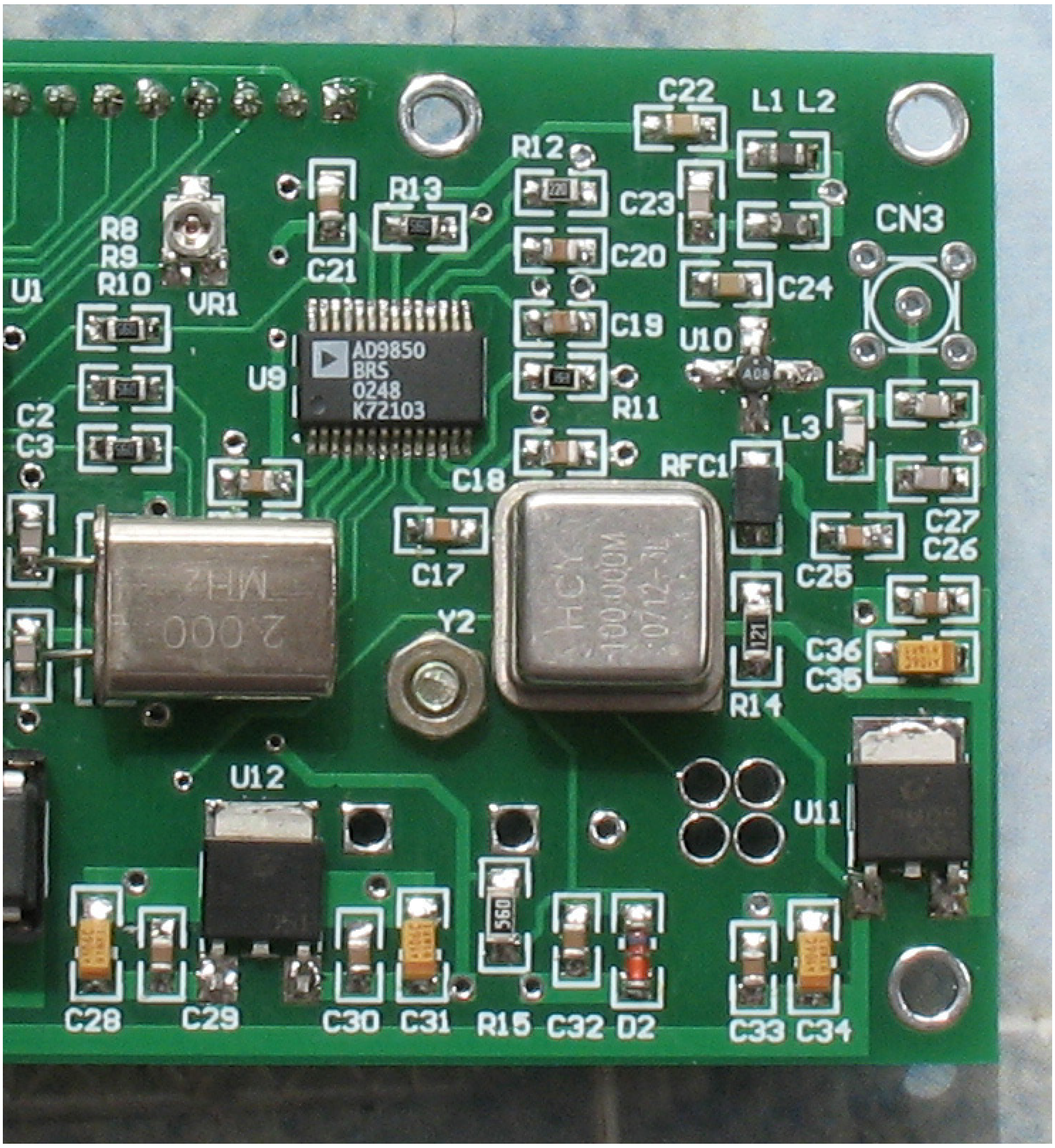


The side with the bar is the + pole of TAN capacitors.

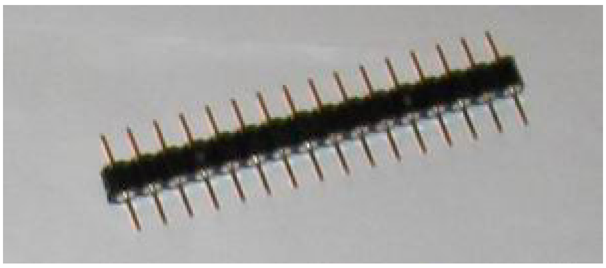


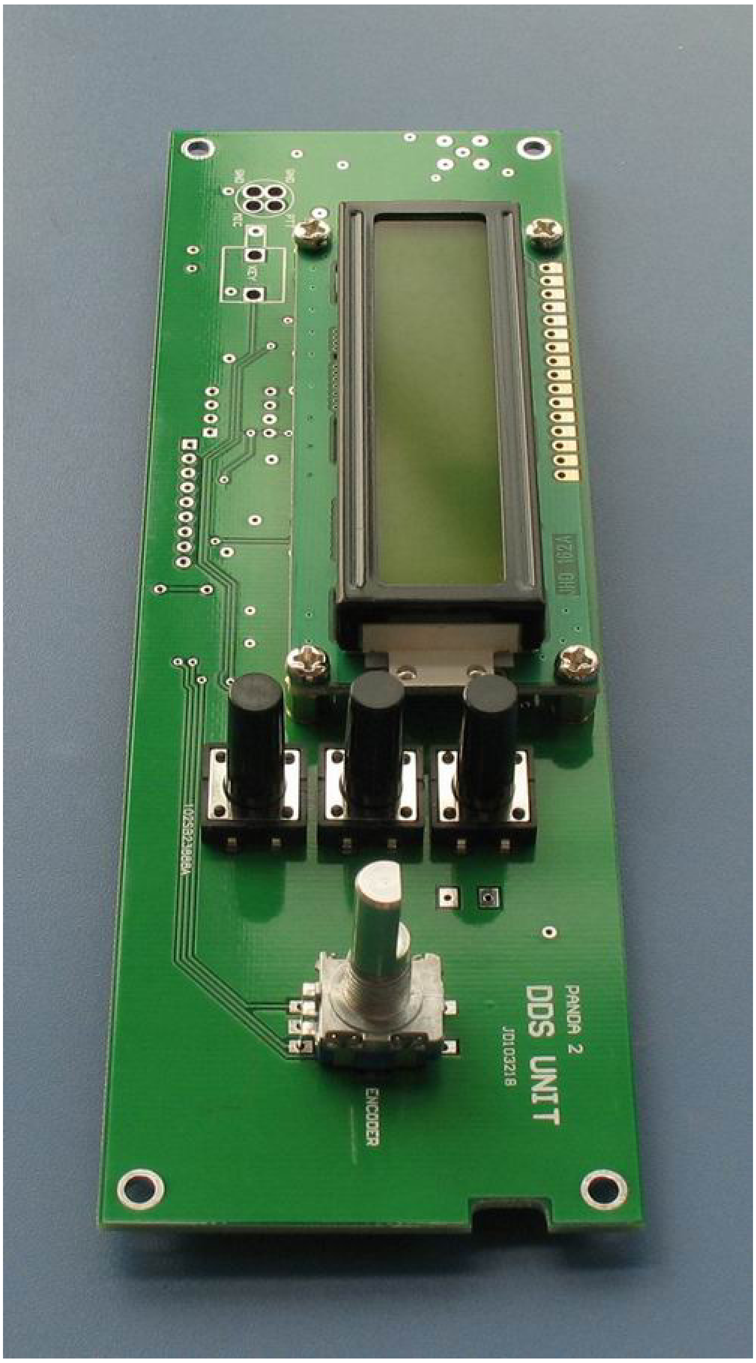






Use 16-pin header to connect the LCD. Use the 5 mm long brass spacers to connect LCD and PCB.





It is suggested the encoder be mounted on the front cover. In this case the encoder leads have to be extended.

The MIC socket leads have to be extended since they are not long enough.

Bridge LIGHT connector.

Plug in MCU and U2.

Use the 15mm long brass spacer and screws to connect the front face and DDS Unit.

DDS unit is completed.

Connecting the assemblies

The assemblies are connected by FFC. The FFC connector has locking device (brown plastic). Pull out the lock before inserting the FFC. Inserting FFC, push in the lock. The blue side of FFC is always up.

Lock is pulled out

FFC is locked

The 12-pin FFC is used to connect DDS and CN4 of Main Board.

The 16 cm long 8-pin FFC is used to connect CN8 of Main Board to CN2 of PA Board.

The 20 cm long 8-pin FFC is used to connect CN1 of Main Board to CN4 of PA Board.

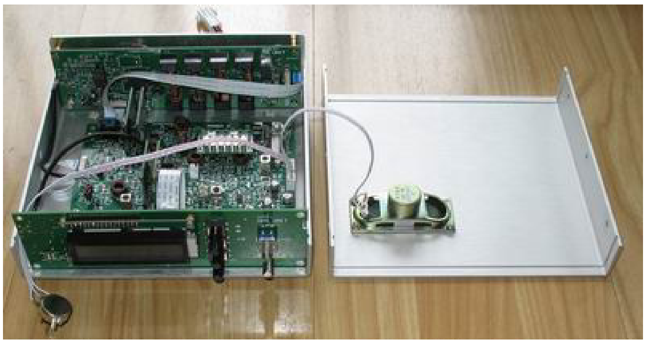
CN3 of DDS Board is connected through the coaxial cable to CN6 of Main Board. The SMA connector is soldered on the Main Board.

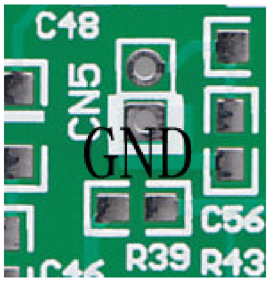
CN7 of Main Board is connected through the coaxial cable to CN1 of PA Board. The SMA connector is soldered on the Main Board.

CN2 of Main Board is connected to AF GAIN port. The thick white line indicates GND.

CN3 of Main Board is connected to Speaker. The Speaker is mounted on the casing. The thick white line indicates GND.

CN5 of Main Board is connected to MIC socket of the DDS Unit. The thick white line indicates GND.





Setup and Alignment

DDS Unit

Turn on the power. LCD lights up. Display appears in about 2 seconds. For the first time to turn the power, DDS Unit works at Band 1.

Connect a frequency counter to CN3 of DDS Unit. The measured frequency is 9 MHz higher than that of the DDS LCD. For example: LCD displays 3.500.00, the measured the frequency is 12.5MHz.

Press STEP to change tuning step (10Hz, 100Hz, 1KHz, 10KHz, 100KHz).

Press MODE to change the operation mode (USB, LSB, CW).

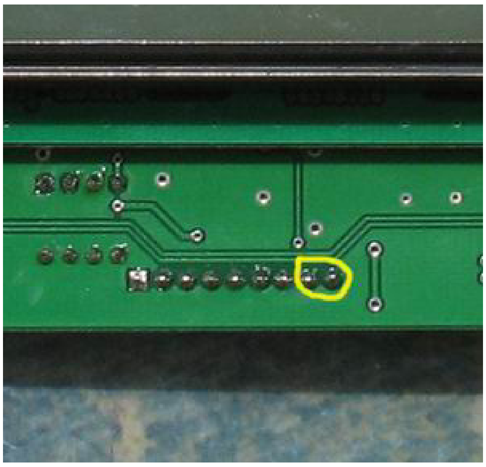
Press MEM to call the memorized frequencies (MEM 0 – MEM 7).

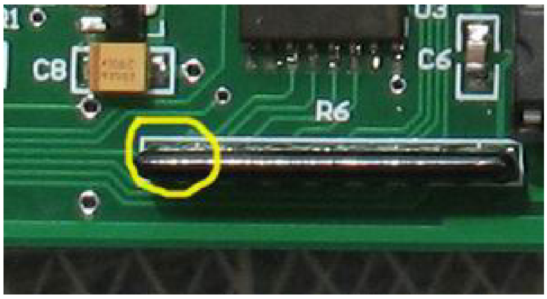
Press tuning knob to change the band.

Turn the tuning knob to tune the frequency.

In USB mode, DDS frequency is 3 KHz higher than that displayed in LCD. In CW mode, DDS frequency is 2 KHz higher.

The center frequency *fc* of the DIY crystal filter is not that accurate, and calibration should be made to have correct frequency display. For this kit, *fc* is 2200 Hz higher.





Short-circuit 8 and 9 pins of the 9-pin 10K resistor to the ground (Use a piece of hookup wire, with one end connected to the ground of the DDS Unit or to the casing). IFS (IF setup) appears on the lower left corner of the LCD. DDS Unit is ready to be calibrated. In this mode, DDS Unit works at Band 1. The frequency displayed on the lower right corner indicates Band 1 frequency. The 0 in the middle refers to the IF default setting.

Set STEP to100 Hz. Turn the tuning knob counter-clockwise, until LCD displays 2200. Press MEM to save the setting and exit.

Main Board

BFO

Set the mode to LSB. Connect a frequency counter to C36.Turn the slug of L2, until the reading is around 8.99778 MHz.

Set the mode to USB. Adjust VC2 until the reading is around 9.0008, i.e. 3 KHz higher than that of LSB.

Now switch to LSB, see if the BFO frequency is correct. If the frequency is change, repeat the adjustment.

U2

Do not connect the antenna. Use a digital meter to measure the voltage of pins 4 and 6 of U2. Adjust VR2 until voltage of pin 4 is around 1.19V, pin 6 around 0.65, or V4-V6 = 0.5V. Now AGC works at the best condition. **Never short-circuit pins 2 and 3**. This would damage the IC.

Another simple way to adjust U2 is to wear earphones, adjust VR2, until you hear a relatively louder hiss sound.

Adjust T5. Listen the carefully. Turn the slug, peak the weak hiss sound until you hear a relatively louder hiss sound.

Connect the antenna. Select band 2, tune the frequency to 7.000 – 7.060 and try to get a signal. Or use a signal generator to generate a 7.000MHz signal. Adjust T5 to peak the received signals.

The BPF's are of broadband, and no adjustment is needed. If no signal is received, connect the antenna to C1 of the Main Board. If the kit receives the signal with antenna connected in this position, check the connection of CN1 of Main Board to CN4 of PA Board. If no signal is received, move the antenna to C2. If no signal is received, check if the XTL FIL module is plugged in the wrong direction. If the kit receives the signal, please check the BPF module. Forgot to solder some component? Check the band voltage:

At Band 1, Pin 7 of S1 is 0V. At other bands, 3.8 – 4.5V.

At Band 2, Pin 6 of S1 is 0V. At other bands, 3.8 – 4.5V.

At Band 3, Pin 7 of S2 is 0V. At other bands, 3.8 – 4.5V.

At Band 4, Pin 6 of S2 is 0V. At other bands, 3.8 – 4.5V.

The band control voltage is from MCU via FFC of CN1 of DDS Unit and CN4 of the Main Board.

The kit's background noise is very low. Receiving sensitivity is around -100 dbm, with good selectivity.

Disconnect CN7. Connect a 47 - 51 ohm resistor between CN7 and GND as the load. Press KEY (short KEY to GND). Side tone can be heard. Side tone is not controlled by AF GAIN. Adjust VR3 to get comfortable volume.

Set the mode to CW. Set the frequency to 7010. Connect frequency counter to CN7. Press KEY (short KEY to GND), and frequency reading should be around 7010. If the reading is not stable, adjust L3, until a stable frequency reading is measured. This frequency is around 7010 (maybe 1 or 2 KHz lower than 7010, but very stable). Adjust VC3, until the reading is 7010 (Not that precise. Around 100Hz difference is allowed). This is the CW transmitting frequency. This adjustment may cause changes to LSB and USB. If it does, please slightly adjust L2 and VC2.

If no frequency is detected at CN7, check the BPF modules of S5 and S6.

L3 and C59 work as 9MHz trap to remove the possible leaked 9MHz IF signal. Through the above mentioned adjustment, the IF leakage is suppressed. However, the advanced DIYER could further adjust L4 to achieve the best performance. At CW mode, connect a RF volt meter to CN7. Adjust L3, until a slight dip appears on the volt meter. Or, use a scope in LSB mode. Adjust L3, until 9MHZ signal is removed. L4 and C75 could be installed to suppress the IF leakage to the maximum.

Now, remove the load resistor from CN7. Connect CN7 to CN1 of the PA. Connect a 50-ohm dummy load to ANT. Connect a RF volt meter to ANT. At CW mode, press KEY, 20 - 25V rms could be read at 80m, 40m and 20m. 12 – 15V rms could be read at 15m. Switch to SSB mode; talk to the microphone, and almost the same level could be measured.

Remove the dummy load. Connect the antenna. You can try your luck with this kit.