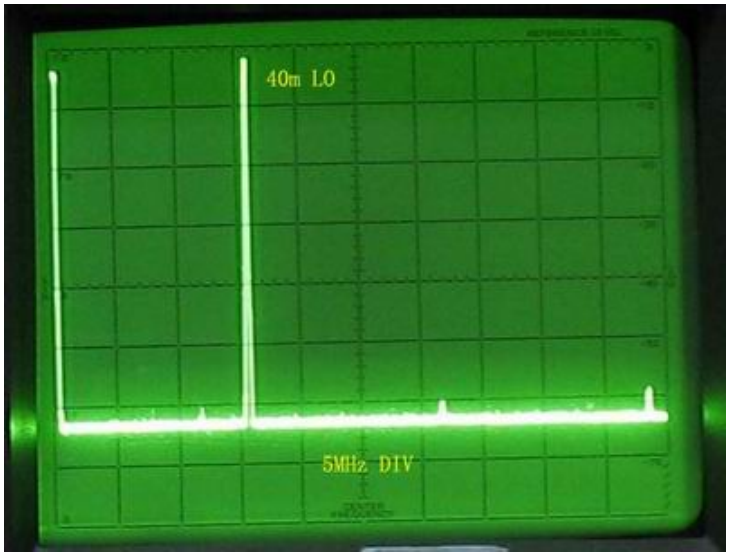
Construction Guide of High-Performance 4-Band Backpack SSB/CW/AM Transceiver Kit

TJ4A is a 4-band SSB/CW/AM backpack transceiver suitable for field operation. With high performance DDS LO, TJ4A offers wider and clean tuning range (Photo below is the LO spectrum in 40m).

Doubly-Balanced Diode Ring Mixer is used as the receiving mixer, featuring low noise and strong signal handling ability.

Features

New MCU (STM8S105C6T6)
User Friendly Operation System
New DDS LO with no birdies in tuning range
Dual VFO system
Multi-Mode (SSB / CW /AM)
Automatic Bandwidth System
99 memories
Automatic keyer and straight key compatible
Dual Data Input
Dual ANT Connector



RX Frequency Coverage

With Standard BPF
BAND 1: 3.5 – 4.0 MHz
BAND 2: 6.5 – 7.5 MHz
BAND 3: 13.5 – 14.5 MHz
BAND 4: 21 – 22 MHz

With Optional BPF
BAND 1: 1.6 – 4.0 MHz
BAND 2: 4 – 7.5 MHz
BAND 3: 7.5 – 14.5 MHz
BAND 4: 14.5 – 22 MHz

Note: Standard BPF is supplied with the kit.

TX Frequency Coverage

With Standard BPF

BAND 1: 3.5 – 4.0 MHz

BAND 2: 7 – 7.5 MHz

BAND 3: 14 – 14.5 MHz

BAND 4: 21 – 21.5 MHz

Sensitivity

0.3 uV

Band Width

SSB: 2.1 KHz

CW: 1 KHz

AM: 6 KHz

Power Output

20 W

Note: Output power is adjustable.

Power Supply

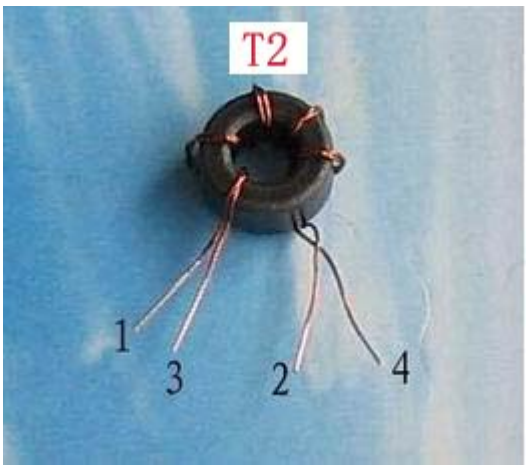
10 V – 12.5 V

Construction

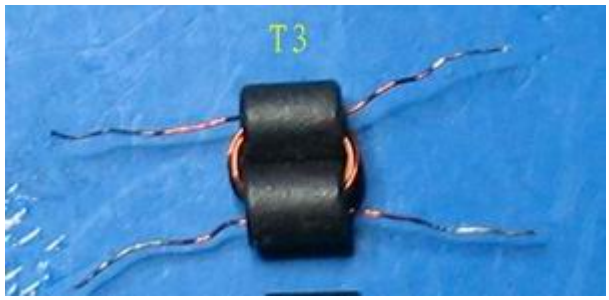
Coils

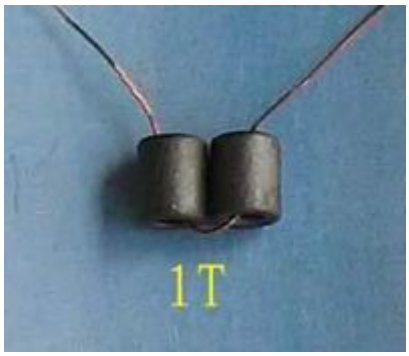
Main Board

T2（Component Side）: Broadband transformer, 8 turns on FB43-2401 core. Cut 10 cm long enameled wires. Say Wire A is red, Wire B blue. Twist the wires before winding. Connect 2 (the finish of A) with 3 (the start of B) as the tap. Leave about 1 cm for each lead. Remove about 5 mm enamel from the leads, and tin. Note: the illustrated coil is 5 turns.

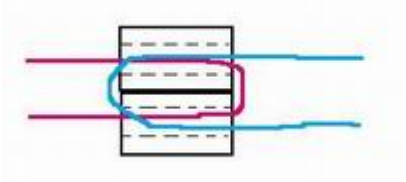


T3：Broadband transformer, 3-turn primary (C11 side), 9-turn secondary (U2 side), 0.31 enameled wire threading through the binocular core made up of 2 small sleeves. A length of 7.5 cm wire is the exact length for 3 turns with about 1 cm on each end. A length of 20.2 cm wire is the exact length for 9 turns with about 1 cm on each end. Wind primary first. Remove about 5 mm enamel from the leads, and tin.

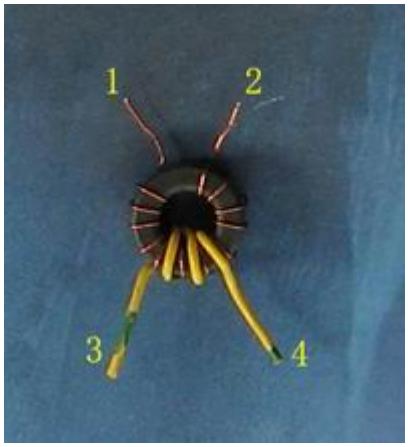




Red wire stands for the primary, blue for secondary. Mark the primary or the secondary with a mark pen to avoid getting confused.

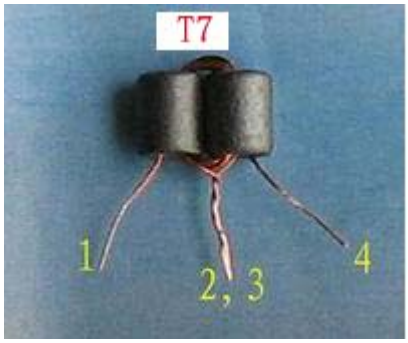


T4, T5: 9MHz transformer, Can coil, no number on the can.



T6： Broadband transformer, 12-turn primary, 3-turn secondary, 0.31 enameled wire on FB-43-2402 core. The 3-turn primary is wound on middle part the secondary. For clearer instruction, the yellow wire is used as the primary. The photo shows the actual turns. Remove about 5 mm enamel from the leads, and tin. Cut 19.5 cm length of enameled wire for the 12-turn secondary, leaving about 1 cm for each lead. The length is the exact length for 12 turns with about 1 cm lead on each end. You wouldn't wind the wrong turns, because you don't have extra length of wire to wind more turns. Remove about 5 mm enamel from the leads, and tin.

T7，T8：Broadband transformer, 5 bifilar turns 0.31 enameled wire on the binocular core made up of 2 small sleeves. Cut a pair of 12 cm long enameled wire, and thread through the core. Say Wire A is red, Wire B blue. Connect 2 (the finish of A) with 3 (the start of B) as the tap. You don't have to twist the wire. Leave about 1 cm for each lead. Remove about 5 mm enamel from the leads, and tin.



L1：23 turns on T37-2 core. Cut 30 cm length of 0.31enameled wire for the winding, leaving about 1 cm for each lead.

L2，L3：BFO inductor, can coil labeled 3.

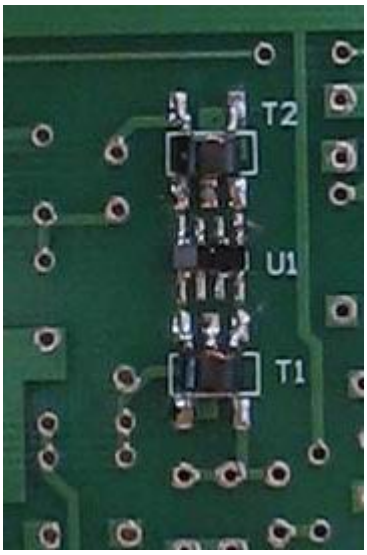
L4，L5：80m BPF inductor, can coil labeled 3.

L6，L7：40m BPF inductor, can coil labeled 2.

L8，L9：20m BPF inductor, can coil labeled 1.

L10，L11：15m BPF inductor, can coil labeled 0.

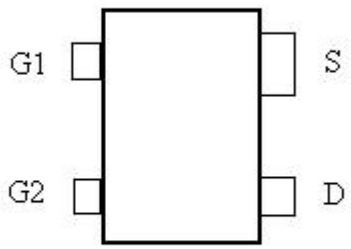
T1, T2 (on the PCB back): mixer transformers, handled with care.



Solder Components

Resistors and caps are not difficult to solder. However, some SMD components are tiny. Solder carefully. Use magnifying glass, if necessary. They are not damaged easily, but they would fly away and hide. The transistor 108T is very small (smaller than the SMD transistor labeled J6). Handle carefully.

V11 is MOSFET. The wider lead is “S”. Solder According too the silk print.



V11

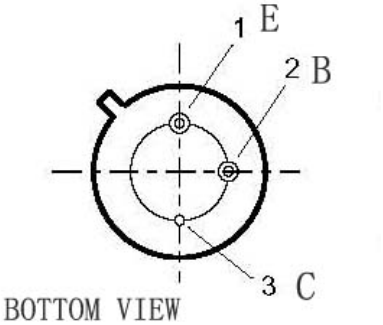
Lead definition of 2N4427 is illustrated in the picture.

Q1 is hot when working. Please use a heat sink.

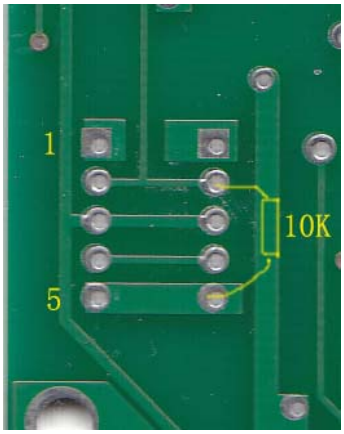
Use an IC socket for U6.

Notice the white line when mount RL1. There is also a line one the relay.

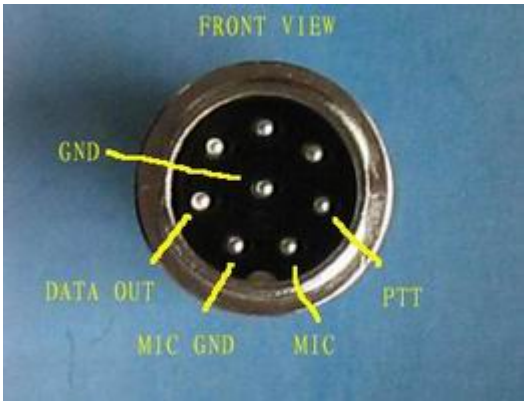
Solder a 10K resister across Pin 2 and Pin 5 of CN4.



Use the jumper cap for A and B. Or jumper with a resistor lead.



Definition of Connectors



CN1：Control port. Connect it to CN1 of PA board with the supplied 14-wire cable.

CN4, CN5：8-PIN aviation plug Connector. The 5 pins are defined (starting from top) as MIC GND, MIC INPUT, DATA OUT (for PSK service), PTT, GND. Connect to the 8-pin sockets with 5-wire cable.

CN3：AF gain control connector. Connect it to the AF gain pot with 3-wir cable.

CN6：Control port. Connect to CN3 of DDS board with 14-wire cable.

CN7：LO input. Connect to CN4 of DDS board with coaxial cable.

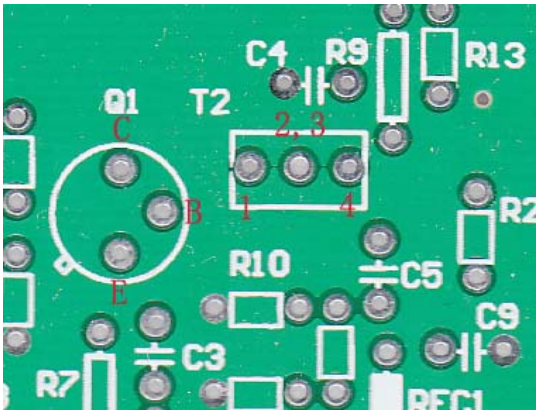
CN8：Power level（DRIVE）control connector. Connect to the PWR pot with 3-wire cable.

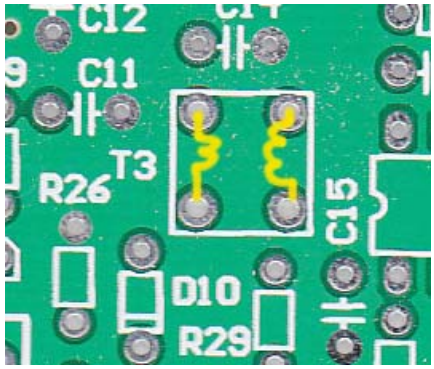
CN9：TX output. Connect to CN2 of PA board.

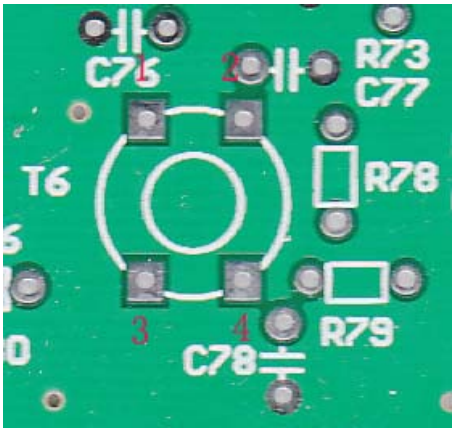
KEY：CW key socket.

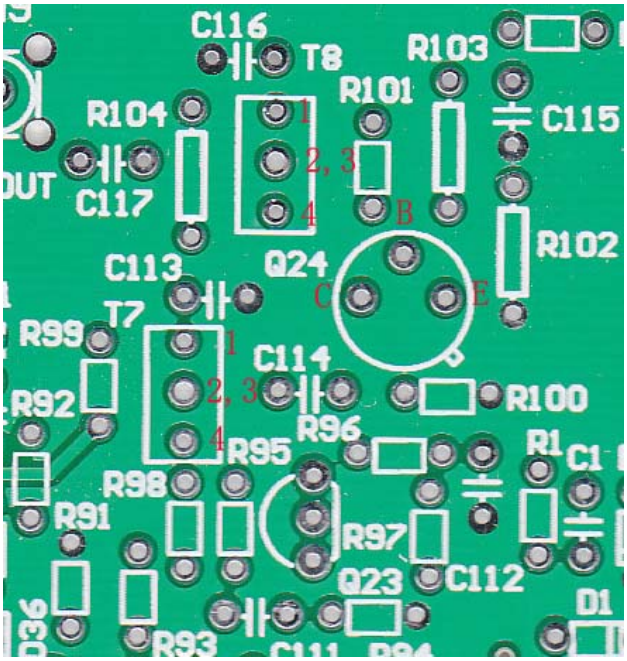
PH：Audio out for earphones or louder speaker.

Solder coils according to the following illustrations.

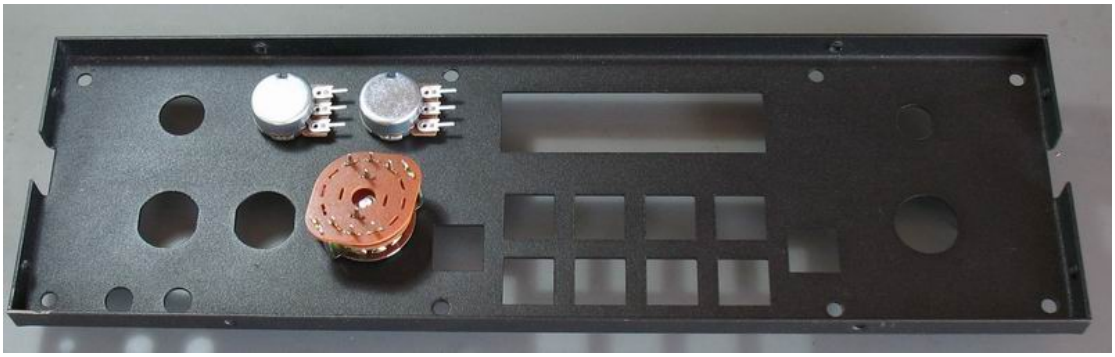




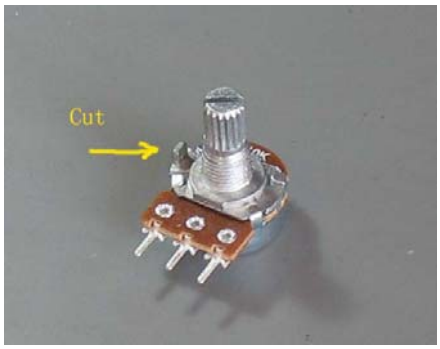


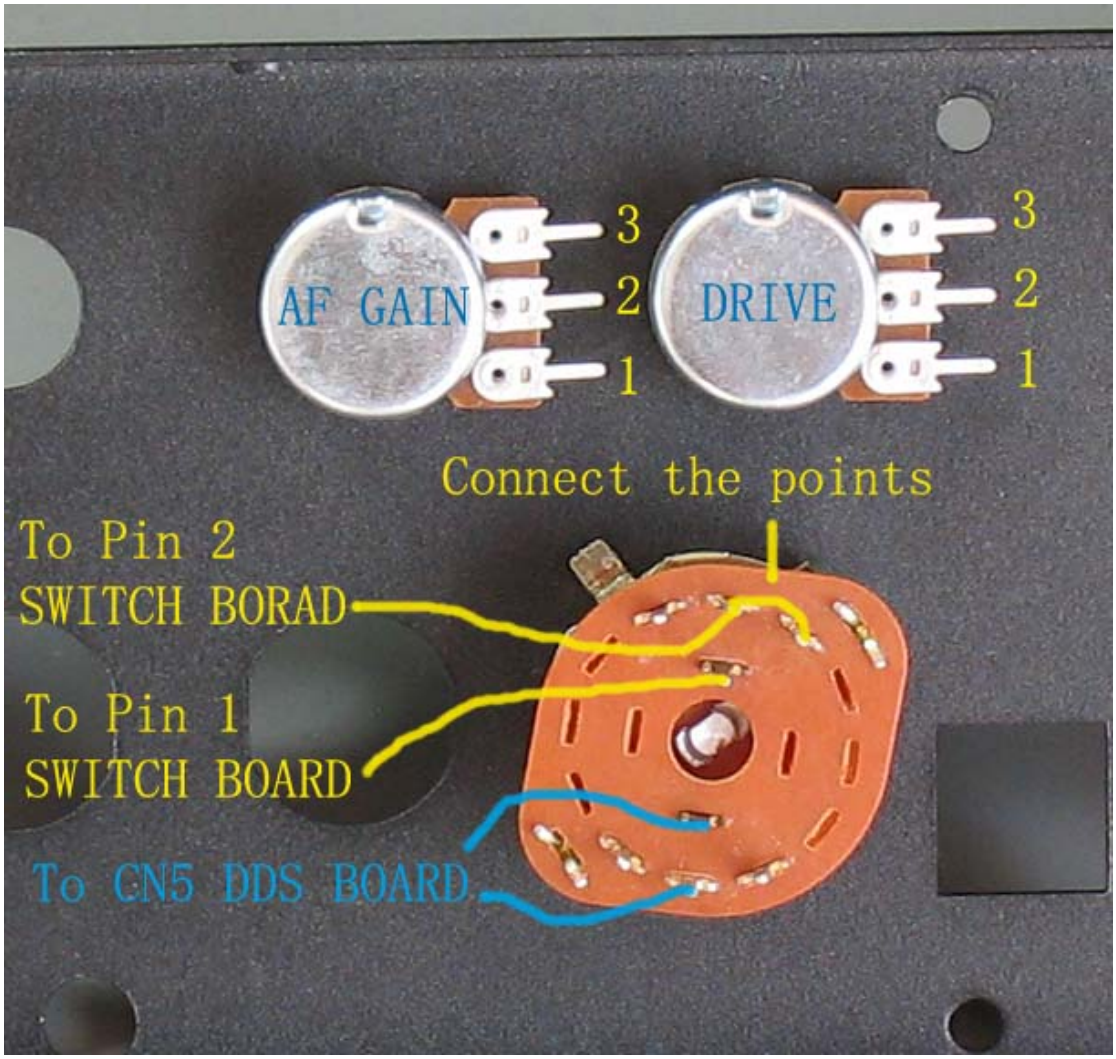


Front Face Assembly



Do not use the long crews supplied with the handles. Find 4 shorter ones in the kit to fasten the handle to the front face. Remove the stopper of the pot with pliers. The power switch should be installed at a certain angle (See illustration).





Connect the AF gain pot leads to CN3 as the number indicated. DRIVE pot is also connected the same way. Number 3 pin is connected to the GND pad.

Solder 4 wires to the power switch: Supply control (illustrated in yellow) and key lock control (blue) .

Bridge the 2 contact leads as indicated. Connect the bridged leads and the arm lead to the 2-pin connector below CN3 of the Switch board.

Connect another 2 contact leads to CN5 of the DDS board(Illustrated in blue).If you do not want LOCK function, doo not bother to solder these 2 wires. Bridge CN5 of DDS board.

You have completed the most difficult wiring job.

DDS Unit

T1: Broad band transformer, same as T2 of the main board, 5 turns on FB43-2401 core.

Most of the components have been installed in the factory. However, still some components are left for you to solder. Install 100MHz XTL as indicated. Pat attention to the dot.

Definition of Connectors

- CN1：MCU communication port, for factory only. No connection.
- CN2：LCD port. Connect to LCD with pins.
- CN3：Control port. Connect to CN6 of main board with 14-wire cable.。
- CN4：LO output. Connect to CN7 of main board with 50 ohm coaxial cable.
- CN5：LOCK control port. If you do not need lock function, simply short circuit this port.
- CN6：Key port. Connect to key pad with pins.

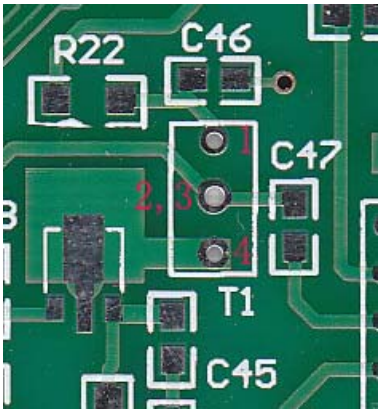
Construct DDS Assembly

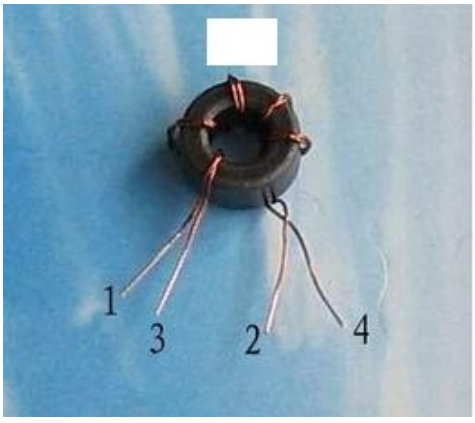
Key board

Remove the 2 plastic pins on then button back with pliers.

The clearance between the key and the key opening in the front face is a round 1mm. The PCB mounting holes are manufactured with some clearance so that the keys project through the key openings with suitable clearance on all sides.

Plug in the connecting pins. Install 3 shorter (10 mm) brass pillars. Fasten it to the DDS board.

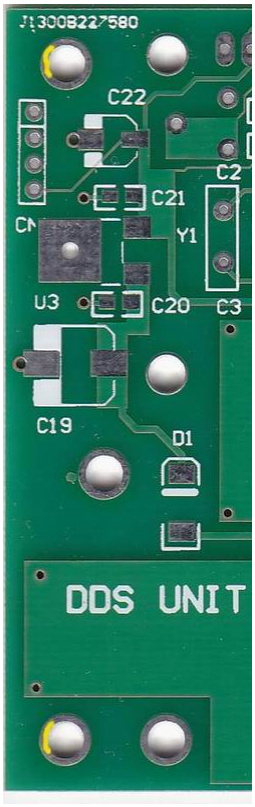


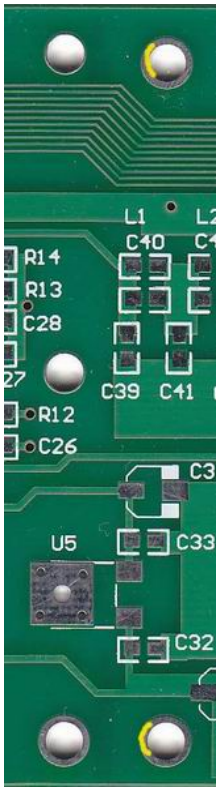


If the buttons can not achieve a running fit, use a file to trim the mounting holes of the 4 long pillars. Remove about 0.2mm from the right side (see the yellow mark), i.e., to make the 4 mounting holes a little oblong.

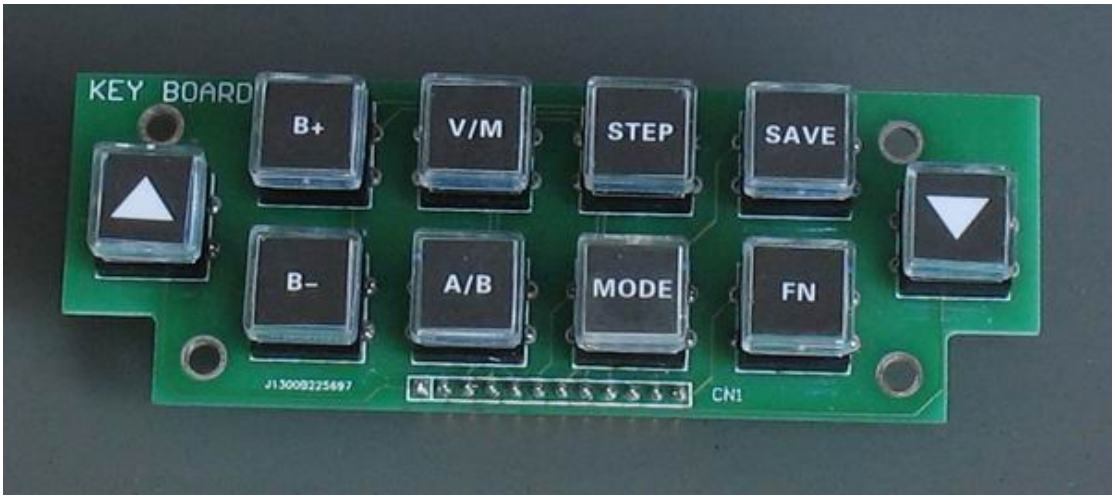
Cut the button card, select the color you prefer. Insert the card into the button cap.

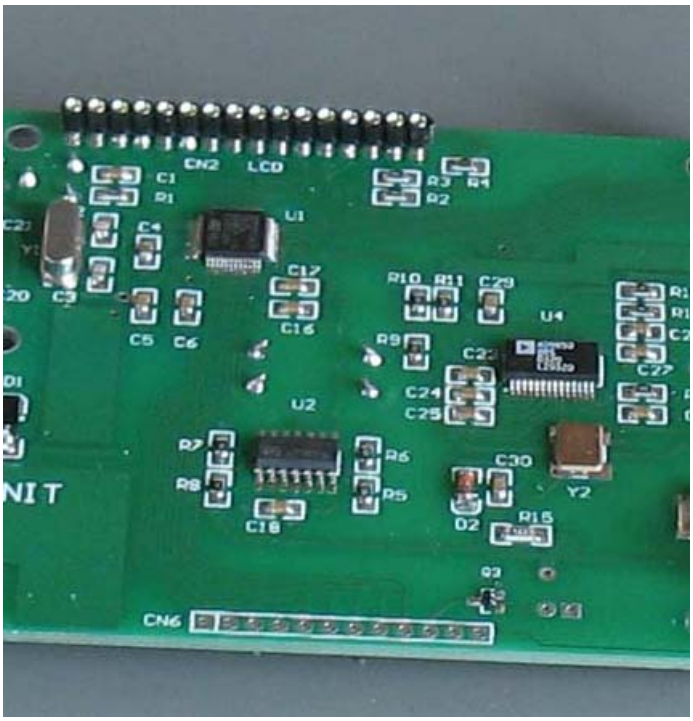
Fasten 4 long brass pillars to the front face, using the socket head cap screws. Place a space between the front face and the pillar. Install the DDS assembly to the front face, and make sure that the buttons achieve running fit (work smoothly). If not, observe the clearance, adjust the screws, until the buttons meet no resistance. Now remove the DDS assembly. Solder the connector pins.

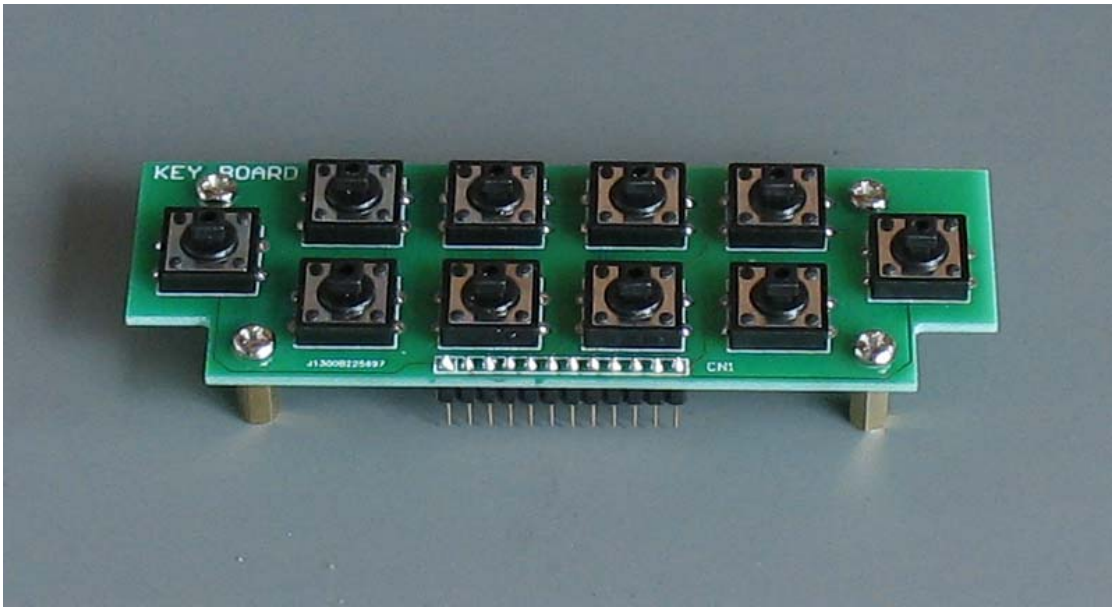




Don’t forget to install the IF SET button on the back. This button is seldom used. No need to put on a cap.



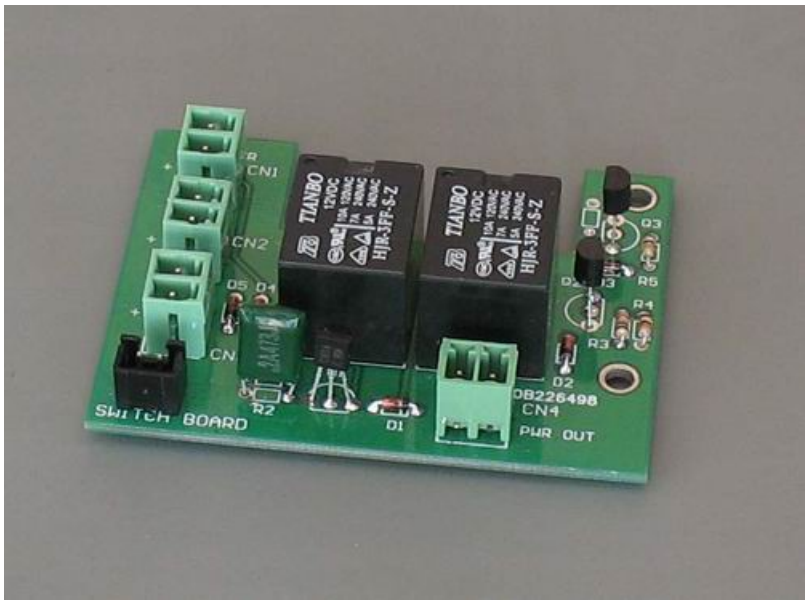




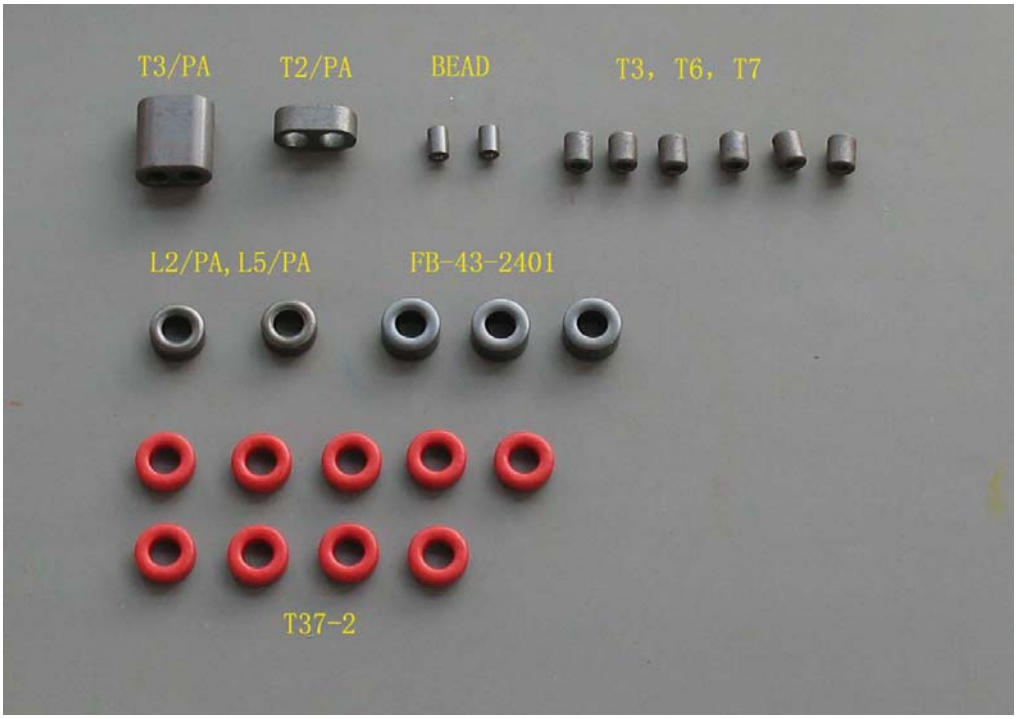
Now, let’s move to SWITCH board construction.

Switch Board

This board has only a few components. It is mounted to the back of the DDS board (Note: R2 is a 4.7K resistor.) Definition of the connectors.



- CN1：External power input connector.
- CN2：Battery input connector.
- CN3：Charging connector. **Important!** CN3 directly routes to the external power, and **does not have current limiting device. This connector only suits the battery pack with charging management.** Insert a diode between the connector and the battery charging port, if necessary, to prevent the current flow back.
- CN4：Power supply output. The power to operate the rig is from this connector. Connect to CN3 of PA with the heavy duty wires supplied with the kit. Turn the power switch to OFF before plug in or disconnect external power.



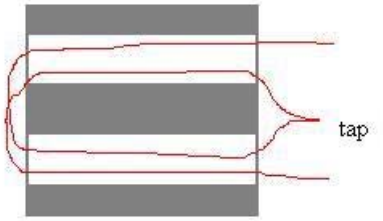
PA Board

Transformers and Inductors

T2： Broad band transformer, 4 turn-primary, 2 turn-secondary center tapped, through the small binocular core. Use insulated wire supplied with the kit for primary, 0.31 enameled wire for secondary. Wind secondary first.

T3：Broad band transformer, through BN43-202 core. 2-turn primary, 0.47 enameled wire, center tapped, 4-turn secondary. Use insulated wire for the secondary winding. The illustrations below

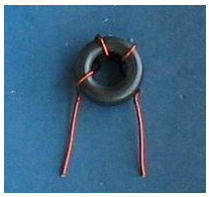
1T



2 T, center-tapped

show how to count turns and tap.

L2, L5： 3 turns on the RFC toroid, 0.47 enameled wire. The RFC core is smaller than FB43-2401.



L3, L4： A piece of wire through a bead. Resistor lead can be used as the wire.

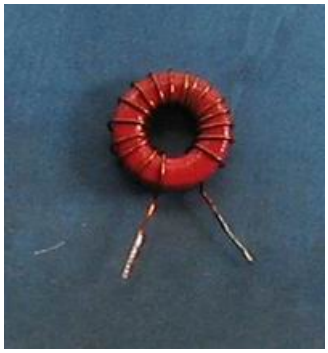
L6, L7： 0.47 wire, 10 turns on T37-2 core. Cut 14 cm long enameled wire. Remove about 5 mm enamel from the leads, and tin.

L8, L9： 20m LPF inductor, 12 t, 0.47 enameled wire on T37-2 core. Cut 16 cm long enameled wire. Leave about 1 cm for each lead. Remove about 5 mm enamel from the leads, and tin.

L10，**L11：** 40m LPF inductor, 17 turns 0.47 enameled wire on T37-2 core. Cut 22 cm long enameled wire. Leave about 1 cm for each lead. Remove about 5 mm enamel from the leads, and tin.

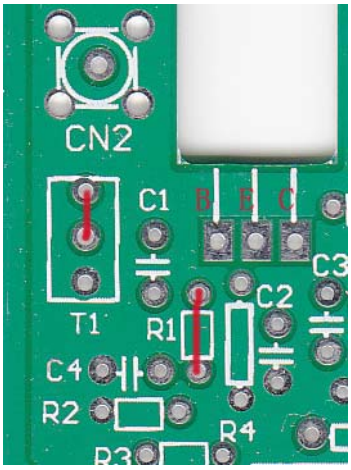
L12、**L13：** 0.47 wire, 23 turns on T37-2 core. Cut 30 cm long enameled wire. Remove about 5 mm enamel from the leads, and tin.

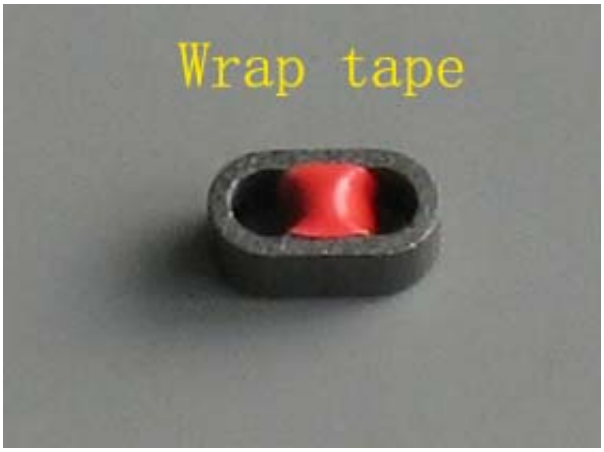
The photo on the right indicates 17 turns.

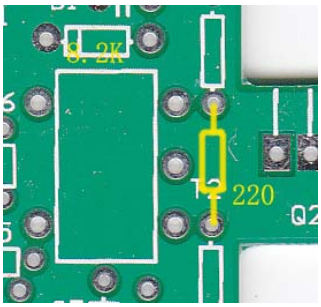


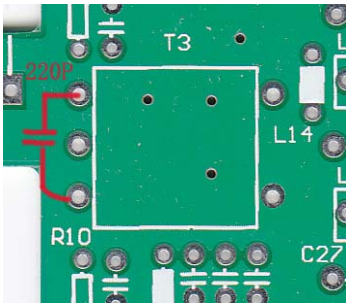
Notes:

- Q1 is very hot when working. Use a heat sink. Q1 mounting pads are for C1971, but now a 2N4427is used instead. Please shape 2N4427's leads to fit the pads. B, E, C are marked.
- No transformer for T1. Please bridge the pads (See photo).
- Bridge R1 with a resistor lead.。
- U1 does not need a heat sink.
- R8 and R9 are not used.
- Solder an 8.2K resistor to the pads of D1.
- Solder a 68-ohm (1/4W) resistor across the secondary of T2.
- Solder a 220P ceramic cap (larger disc) across the primary of T3.
- Wrap a piece of tape to prevent the sharp edges of T2 to damage the insulation of the wire.





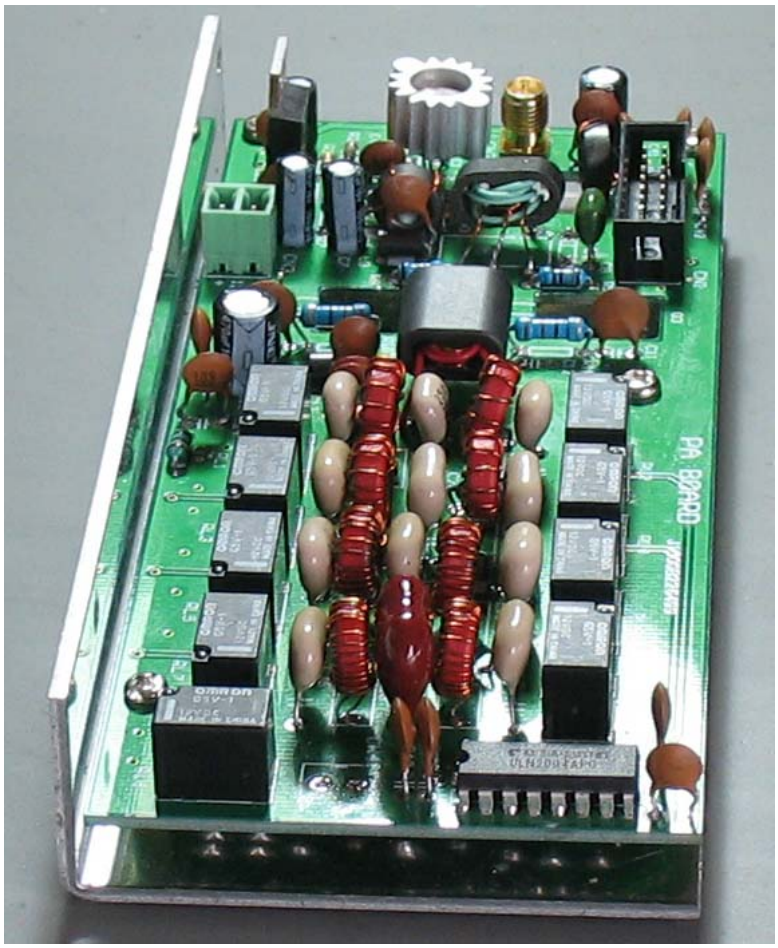




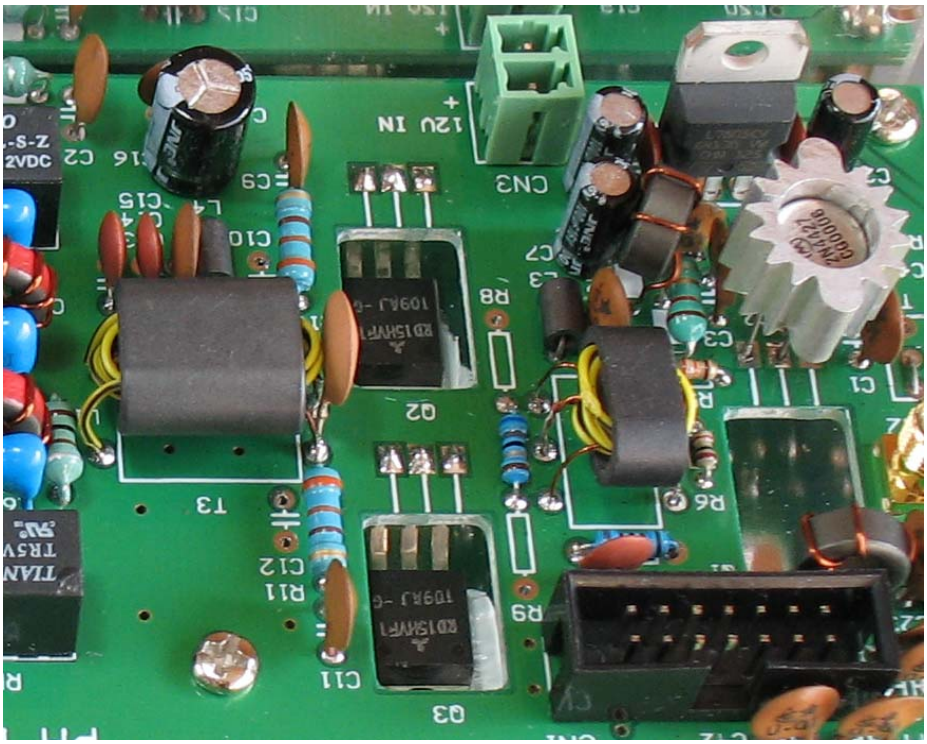
Install Q1 and 2. Bend the leads and insert to the mounting pads. Do not solder. Place 4 pillars (10 mm brass pillar) on the aluminum plate (heat sink), and fasten the PA board. Align the mounting holes of Q1 and Q2. Once aligned, use the screw to hold. If you happen to have silicon grease, apply some between the transistors and the plate before installing the transistors. Now solder the leads.

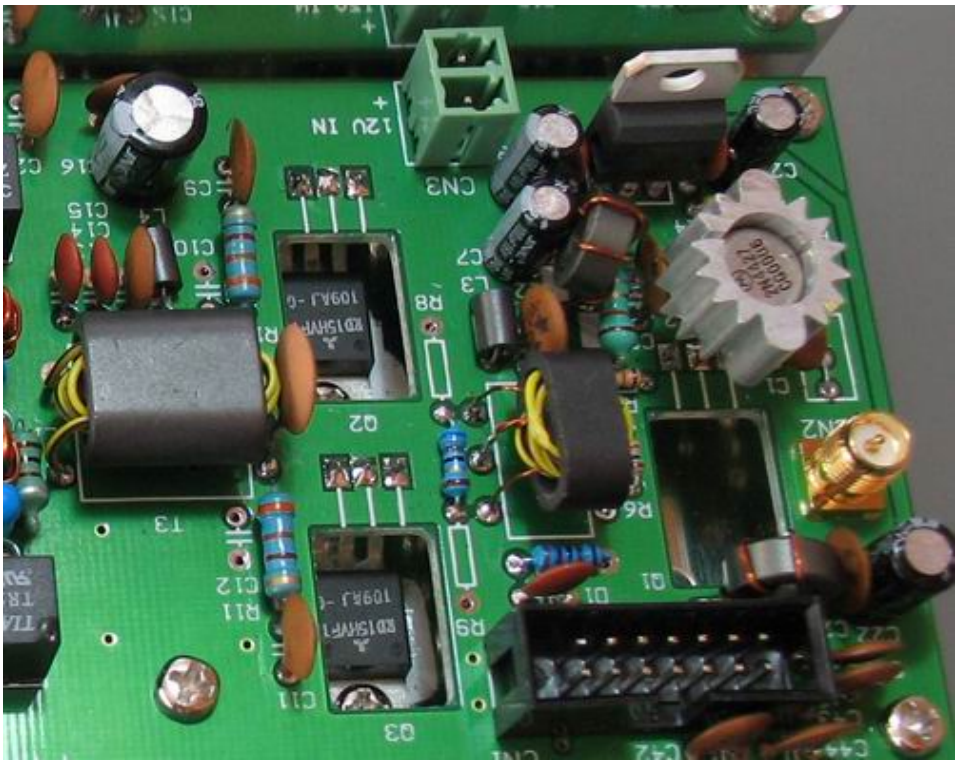
Position the PA assembly upright and use 2 screws to fasten it. The coaxial cable runs from underside of the PA assembly. Use 2 thick wires to connect CN4 to the ANT sockets. Use wires as short as possible. The 2 sockets are in parallel.

Do not run the power lines over the main board. Run them along the gap between the main board and DDS board.

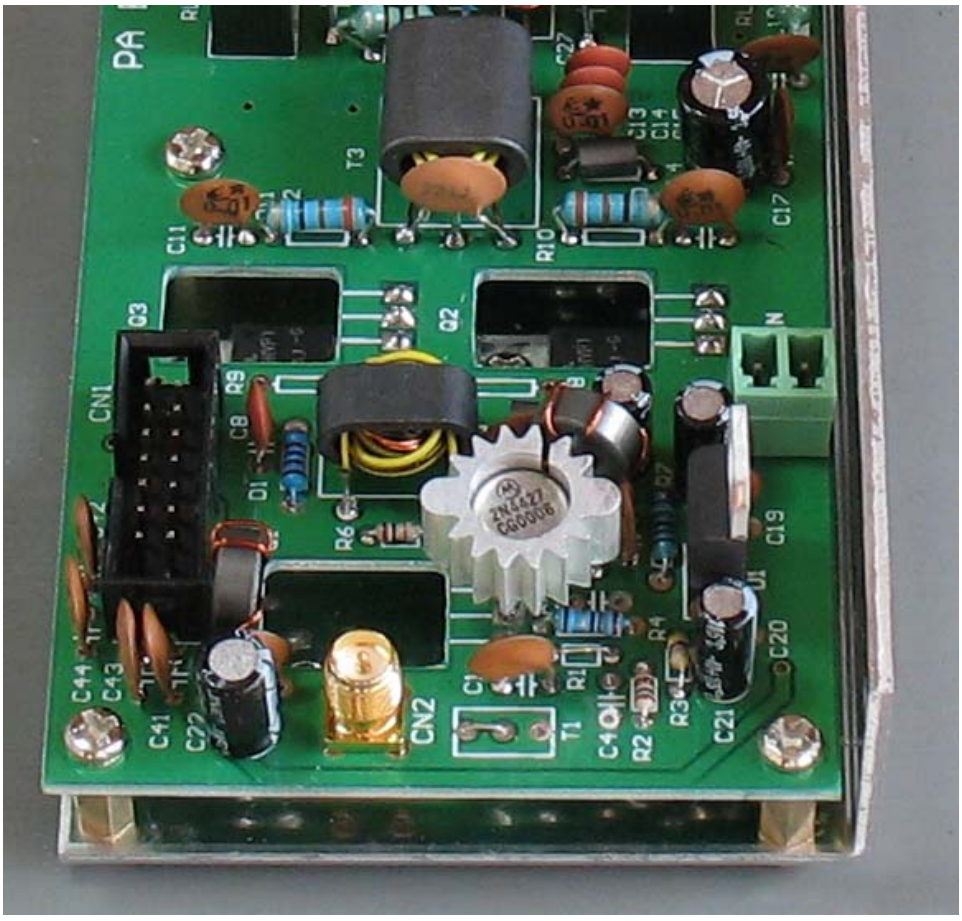


See how to tap.



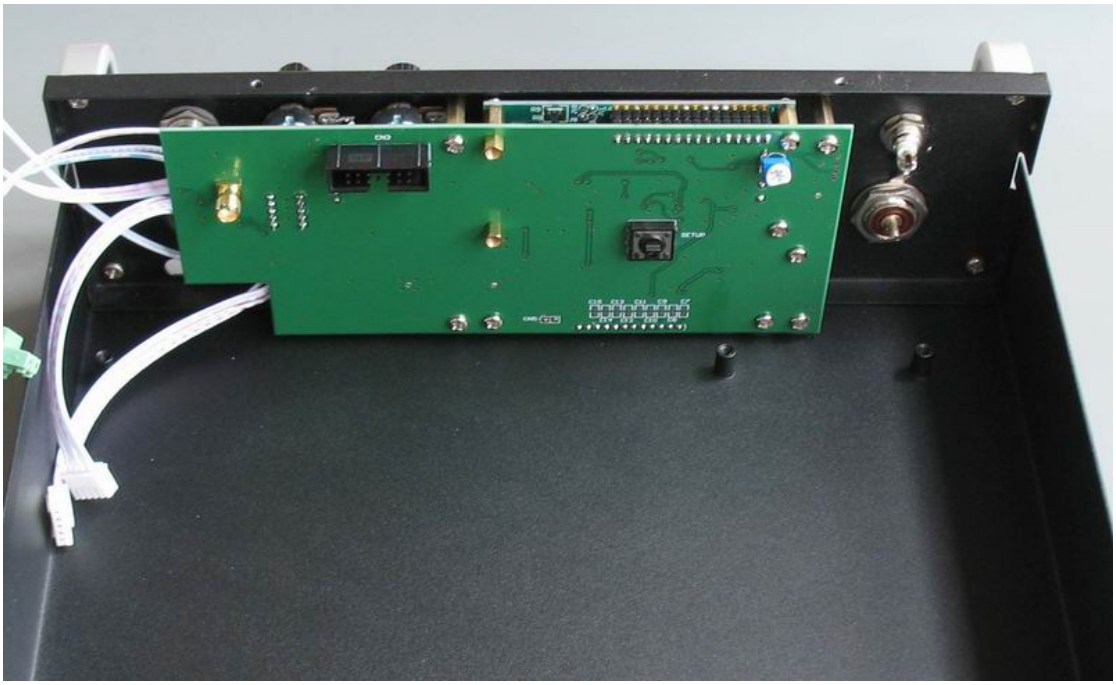


Close-up pictures of T2 and T3



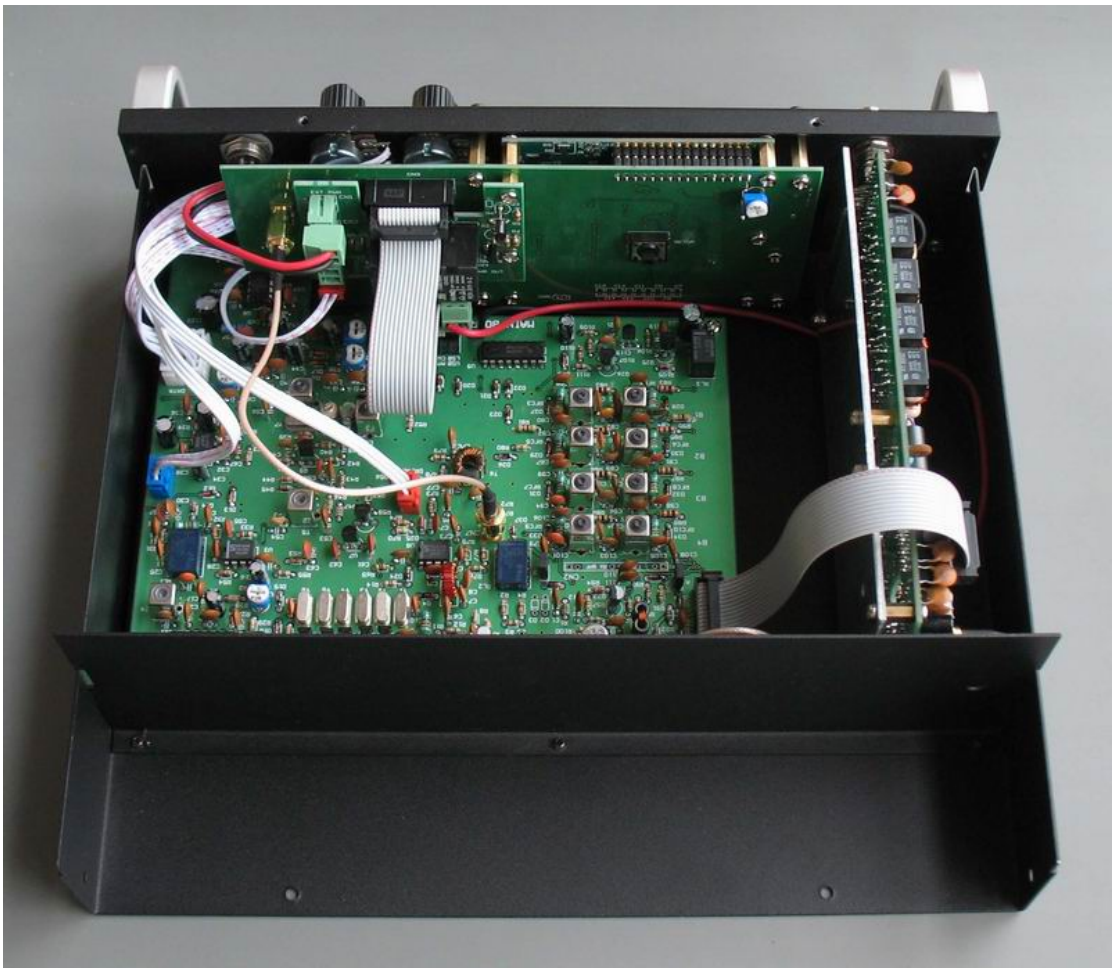
Now let’s assemble the assemblies to the bottom case.

First, place the DDS assembly. Fasten it with flat screws.

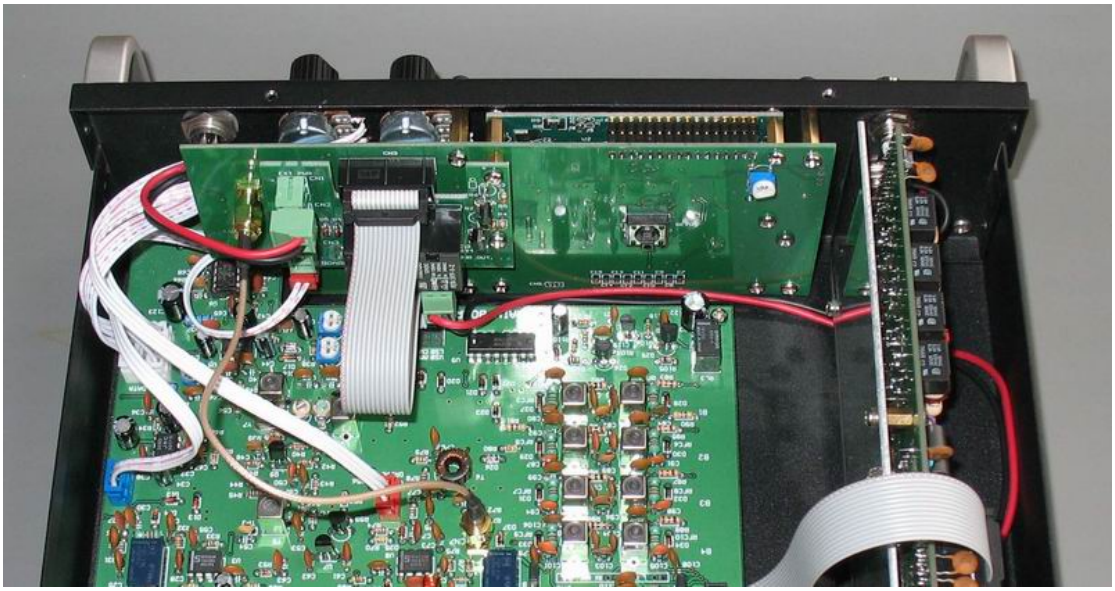


Place the main board. Use 4 screws to fasten it to the case.

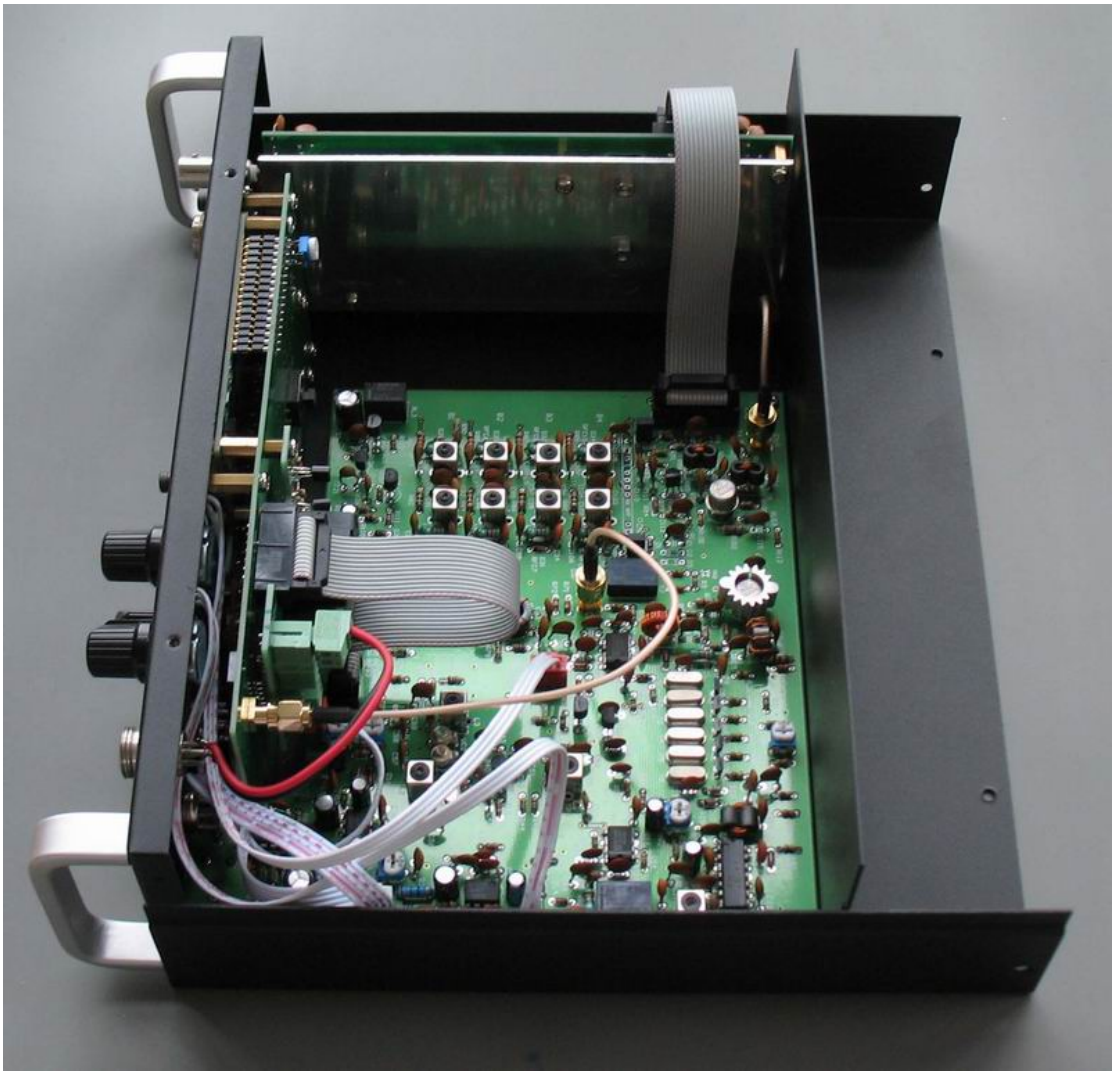
Place the power switch unit, place the PA assembly, plug in the connectors, place the battery wall.



Please notice how to run the heavy duty power lines. Run them along the edge.




PA BOARD
MAIN BOARD



Place the back cover.

Let’s move to alignment work.

Alignment

Alignment is not very complicated. However, you need a frequency counter. Plug in earphones, and antenna. Plug in power connector. Double check the polarity of the plug. Turn the power switch to “ON”. Now, you can hear the relay a click sound of the relay, a Morse code of “R”. LCD lightens. That means the switch board, U4, U6, DDS unit work.

DDS Unit

If no letters appear on the LCD, do not worry. Adjust VR1 until letters appear.

You have set up the parameter before using. Press IF SET button on the PCB back, and LSB SETUP appears：

This is for setting up the LSB offset. Use the default value 0000. Press the IF SET again, and USB SETUP appears:

Set up the USB offset. Press the front panel F+ and F- to set the above displayed data, +2100.

Press the IF SET again, and CW SETUP appears:

Set up the CW offset. Press the front panel F+ and F- to set the above displayed data, +0920. Press the IF SET again, and AM SETUP appears:

Set up the AM offset. Press F+ and F- to set the above displayed data, +2000.

Press the IF SET again, and IF SETUP display appears:

Set up the XTL filter offset. Press F+ and F- to set the above displayed data, +8.998430. The

cursor indicates the tuning rate. Press STEP to select 10Hz, 100Hz, 1KHz rate.

Press the IF SET again, and DDS clock SETUP appears:

Set up the DDS clock. The default value is 125MHz. 100MHz is used in the kit. Press F+ and F- to set the above displayed value, 100000000. The cursor indicates the tuning rate. Press STEP to select 10Hz, 100Hz, 1KHz rate.

Press the IF SET again to exit setup.

Now, press B+, B-, STEP, MODE, V/M, A/B to see if they function.

Press A/B to shift VFO A to VFO B and vice versa. Press MODE to select LSB, USB, CW, and AM. Press F+ or F- to tune frequency. Hold the button, tuning would be automatic. Band is changed automatically during tuning.

Press V/M to enter the saved frequencies. M01 indicates memory N01. Mode can be changed in memories. F+ and F- function as the memory number selection buttons. As many as 99 frequencies can be saved. Press V/M again to exit the memory.

How to save the frequency? For example, the present frequency is 7.050. Press SAVE, and the following display appears:

The system suggests you to save the frequency in 01. However, you may save it in a different memory number. Press F+ or F- to select the memory number where you want to save the frequency. Press SAVE, and the frequency is saved.

Connect the frequency counter to TP2 of the main board. LO frequency can be measured. The measured frequency is always IF offset + displayed frequency.

FN is used to set up the keyer, such as speed, wpm, exchanging the paddles, etc., which will be discussed in detail later.

Switch the power switch to LCK, buttons are disabled.

Now let's proceed to the alignment of the main board.

Main Board

BFO

Connect the frequency counter TP3. Adjust the slug of T5 half way into the can (About 2mm inside the can. This is around the resonant position. See photo on P26 for reference). If you happen to have an RF volt meter, trim T5 to peak. If you don't have, never mind. It can be calibrated later.

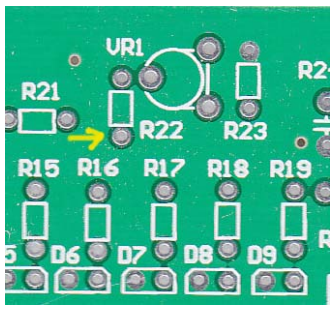
Set the mode to LSB. Adjust L2, until the frequency counter reading is around8.99843MHz. Set the mode to USB. Adjust VC1, until the frequency counter reading is around 9.00055. Set the mode to CW. Adjust VC2, until the reading is around 9.00000MHz.

Before carrying out CW transmission calibration, check the bias of the PA transistors in case wrong values are used (In this case the transistors would be very hot when KEY or PTT is pressed). Disconnect CN9. Connect the volt meter between T2 tap and GND to measure the DC bias voltage of the PA transistors. Press KEY of PTT. The voltage reading is around 2.6 – 2.7V. If the reading is very high, say, close to 4V, stop immediately, and check the bias network (8.2k and 6.8K) to see if the wrong resistor values are used. If the reading is within the range, and the heat sink is not hot, you can carry out CW transmission calibration.

Connect a 50-ohm dummy load at ANT (You could use two 2W 100-ohm resistors in parallel to act as a 50-ohm dummy load now). Set the mode to CW, with the frequency connected to TP3. For the convenience of calibration, set the KEY to the straight key mode. Hold FN button until you hear the Morse code ".-.", input "-.-" using your key. Now you will hear ".-.", indicating your instruction has been received. Press KEY and adjust L3, until the frequency counter reads 8.99935MHz。

Switch to AM mode. You will hear the relay working. In this mode BFO stop working. No frequency will be detected at TP3.

Automatic Bandwidth Control



Connect volt meter between R22 and ground (See the photo at right, the yellow arrow indicating the test point of R22). It is suggested to use high impedance volt meter such as digital meter.

Adjust VR1 until the voltage reading meets the requirement:

LSB: 5.5V

USB：5.5 V

CW：4.1 V

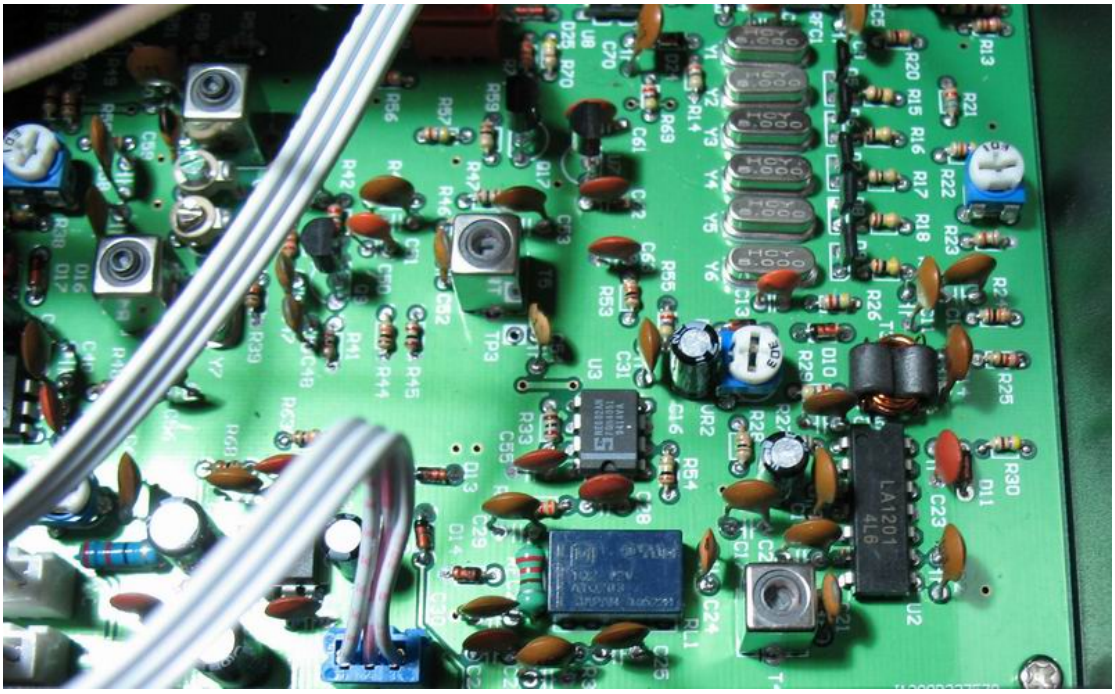
AM：8.5V

Note: Tolerances are allowed.

AGC and U2

Do not connect the antenna. Use a digital volt 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. Now the chip works and AGC works properly. Never short-circuit pins 2 and 3. This would damage the IC.

Another simple way to adjust U2 is to listen carefully with the maximum volume, and adjust VR2, until you hear a relatively louder hiss sound. Adjust T4. Listen the carefully. Turn the slug to peak the weak hiss sound until you hear a relatively louder hiss sound. Notice the position of the slug of T4. The slug is about half way inside the shielding case (about 2 mm inside the can). The photo below illustrates the slug height.



Checking Band and Mode Control Voltages

U9 – U13 and Q20 form the band and mode control switches, sending out control voltages under the control of MCU.

Band 1

D27: 6.8V

D29, D31, D33: 0V

Band 2

D29: 6.8V

D27, D31, D33: 0V

Band 3

D31: 6.8V

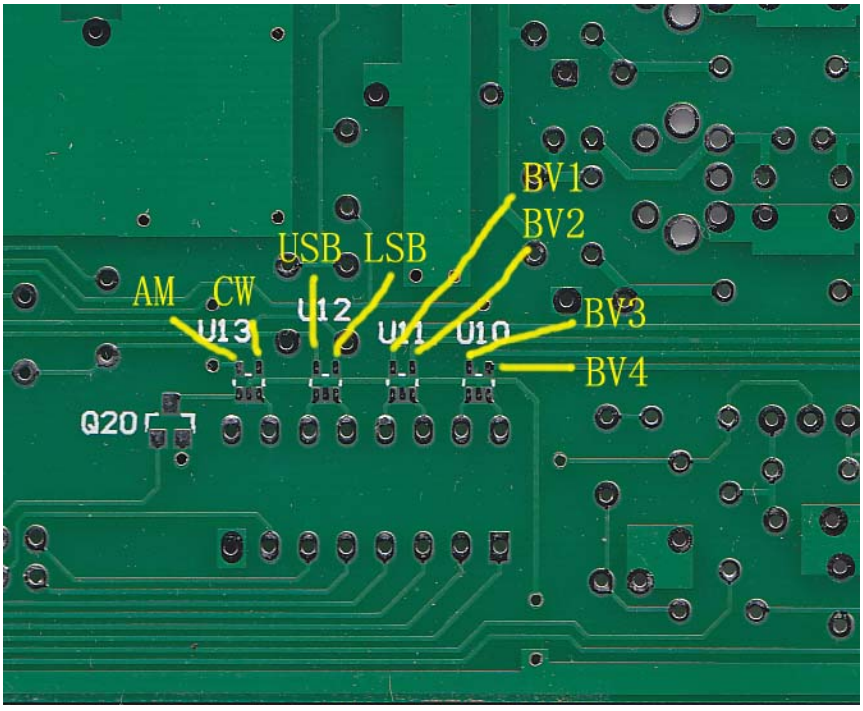
D29, D27, D33: 0V

Band 4

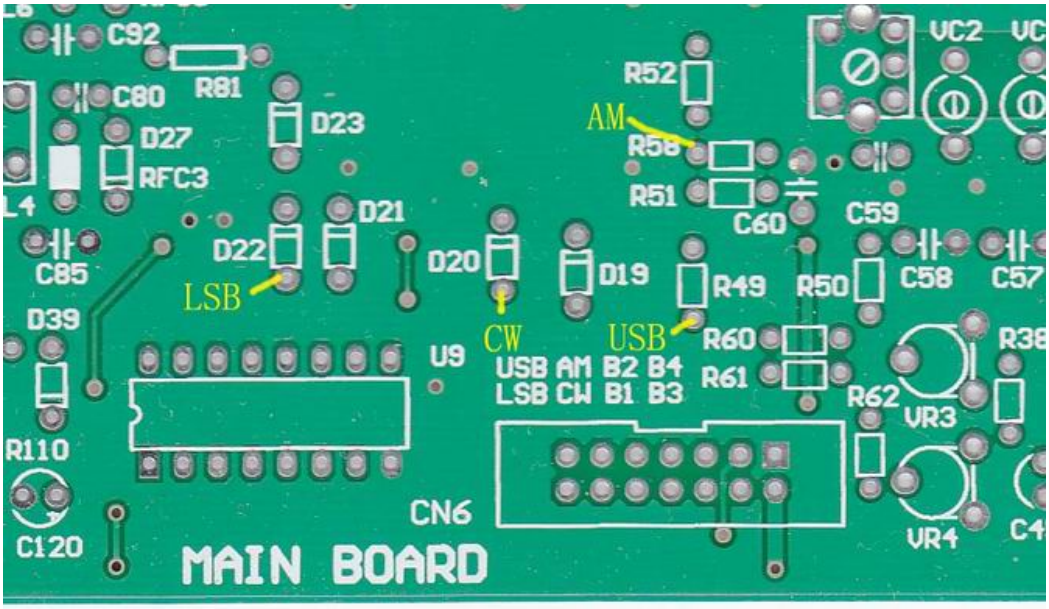
D33: 6.8V

D29, D31, D27: 0V

If the mode and band control voltages are not correct, please check the test points as indicated. Control voltage failure is usually caused by the cold solder.



However, the voltages can be measured on the top side:



BPF

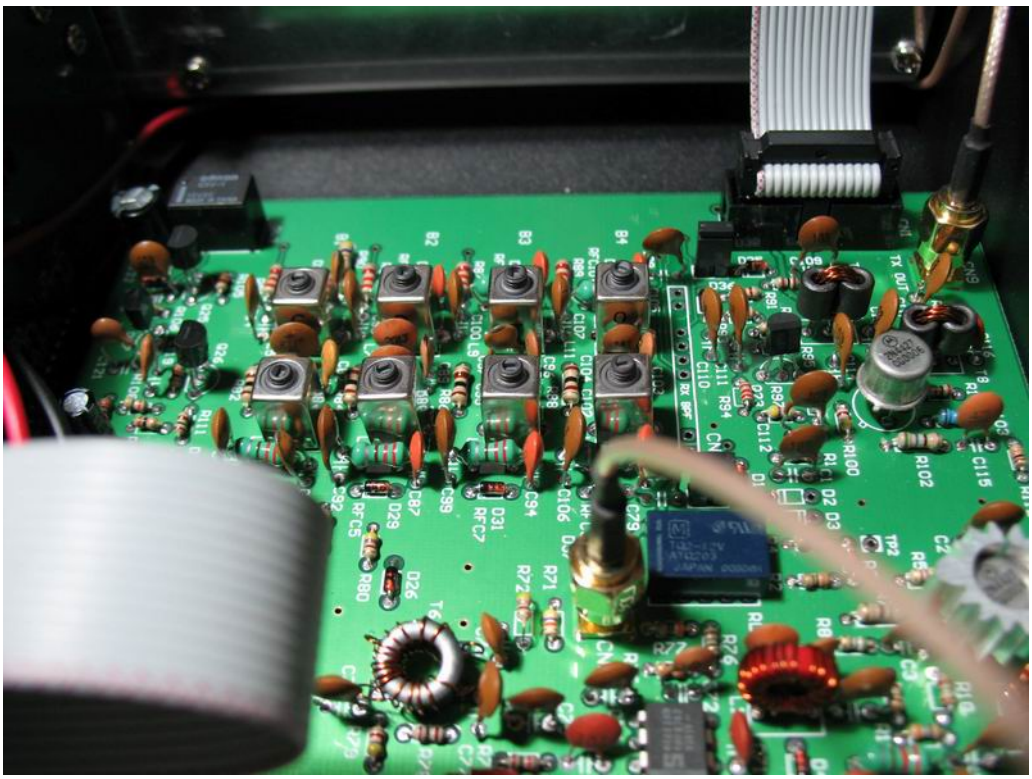
Remove the dummy load, and connect the antenna. Connect the antenna.

Switch to Band 1. Set the slugs of L4 and L5 about 1.5 – 2 mm above the can (Photo below illustrates the slug height). Tune the frequency to around 3.8MHz to get a signal or the noise. Trim L4 and L5 to peak the received signals. Adjust the inductors one by one. After peaking L4, adjust L5 to peak. Then adjust L5 to peak again. Trim T4 to peak again. If the peak is not very sharp, use a smaller value for C24, say 4.3P. C24 ranges from 4.3P – 20P. Never forget T5. Trim T5 to peak.

Switch to Band 2. Set the slugs of L6 and L7 about 1.5 mm above the can. Tune the frequency to 7.050 – 7.1 to get a signal or the noise. Trim L6 and L7 to peak the received signals.

Switch to Band 3. Set the slugs of L8 and L9 about 1.5 mm above the can. Tune the frequency to 14.1 – 14.2 to get a signal or the noise. Trim L8 and L9 to peak the received signals

Switch to Band 4. Set the slugs of L10 and L11 about 1.5 mm above the can. Tune the frequency to 21.1 – 21.2 to get a signal or the noise. Trim L10 and L11 to peak the received signals.



Calibrating Battery Level

VR4 is the battery sampling device. Adjust it until the battery level is full or one bar to full at the supply of 12.5V.

Calibrating S Meter

The bars at the LCD left corner represent the signal strength, each long bar representing 1S, i.e., S2 – S59+30dB. Receive a very strong signal, and adjust VR3 until all the bars appear.

Transmission

Connect a 50-ohm dummy load.

Let's take 40m for example. Tune the frequency to 7.050, switch the mode to CW, with POWER to LOW POWER (Counter-clockwise to the end). Press the key, around 1W will be measured. If you happen to have an oscilloscope, 20V p-p will be measured. Trim L6 and l7 to peak. Now Increase the drive by PWR LEVEL, 18 – 20W will be obtained. Warning: If you use two 2W 100-ohm resistor as the dummy load, do not use too much power. Or measure instantly. Otherwise the resistors would be burned.

Switch to LSB, press PTT, speak to the microphone, LCD S meter bars also work, indicating transmission condition, and the output is around 18 – 20W at the HIGH power level.

If the output power is more than 20W, increase R72 to 470 ohms to reduce the drive.

QSK

C120（1uF）determines QSK delay. For full QSK, C120 is not necessary. In this case, the relays release as soon as the key is up. However, the TR relays have to withstand the frequent switching. With C120 in position, there will be a short delay, i.e., the relay does not release at the short key-up intervals to avoid the frequent relay contact motion.

Miscellaneous

C122 -- Optional. A 470uF/16V could be used.

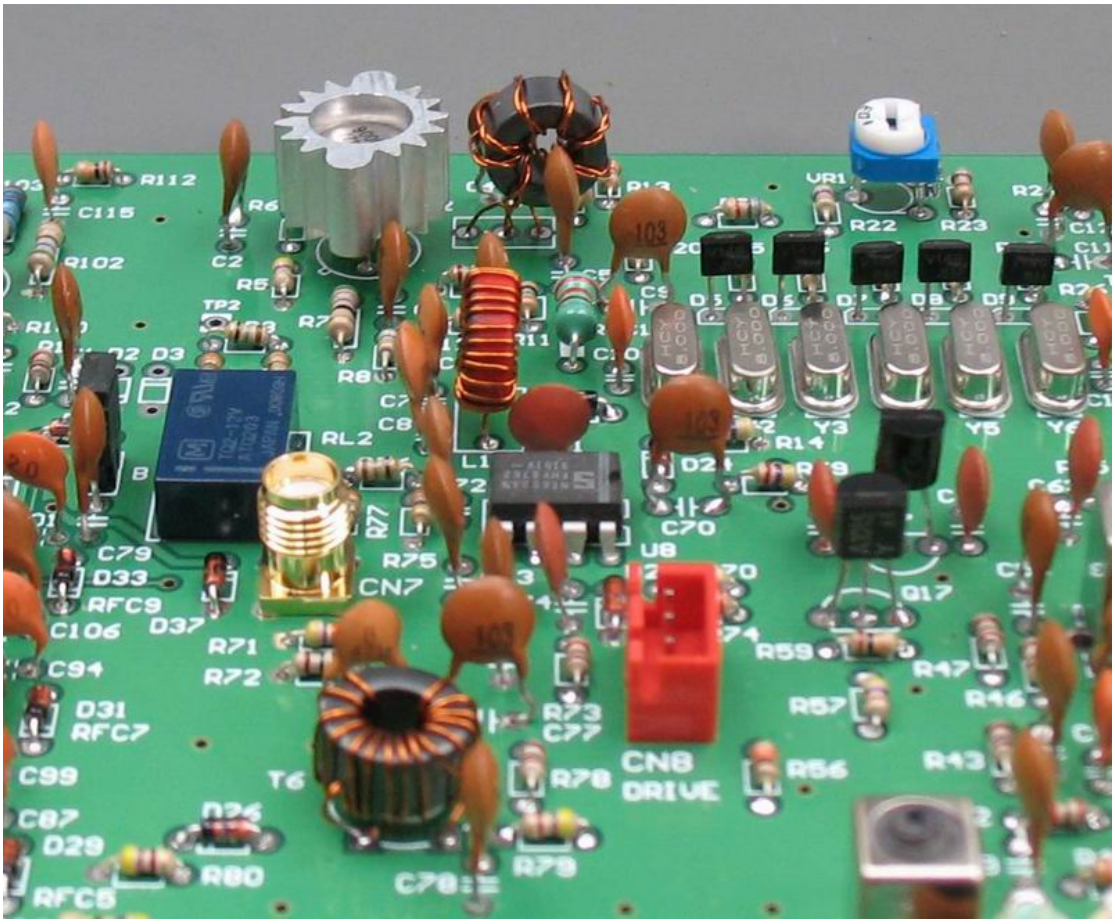
C121 -- absorbs interferences. 821 or 103 ceramic disc can be used.

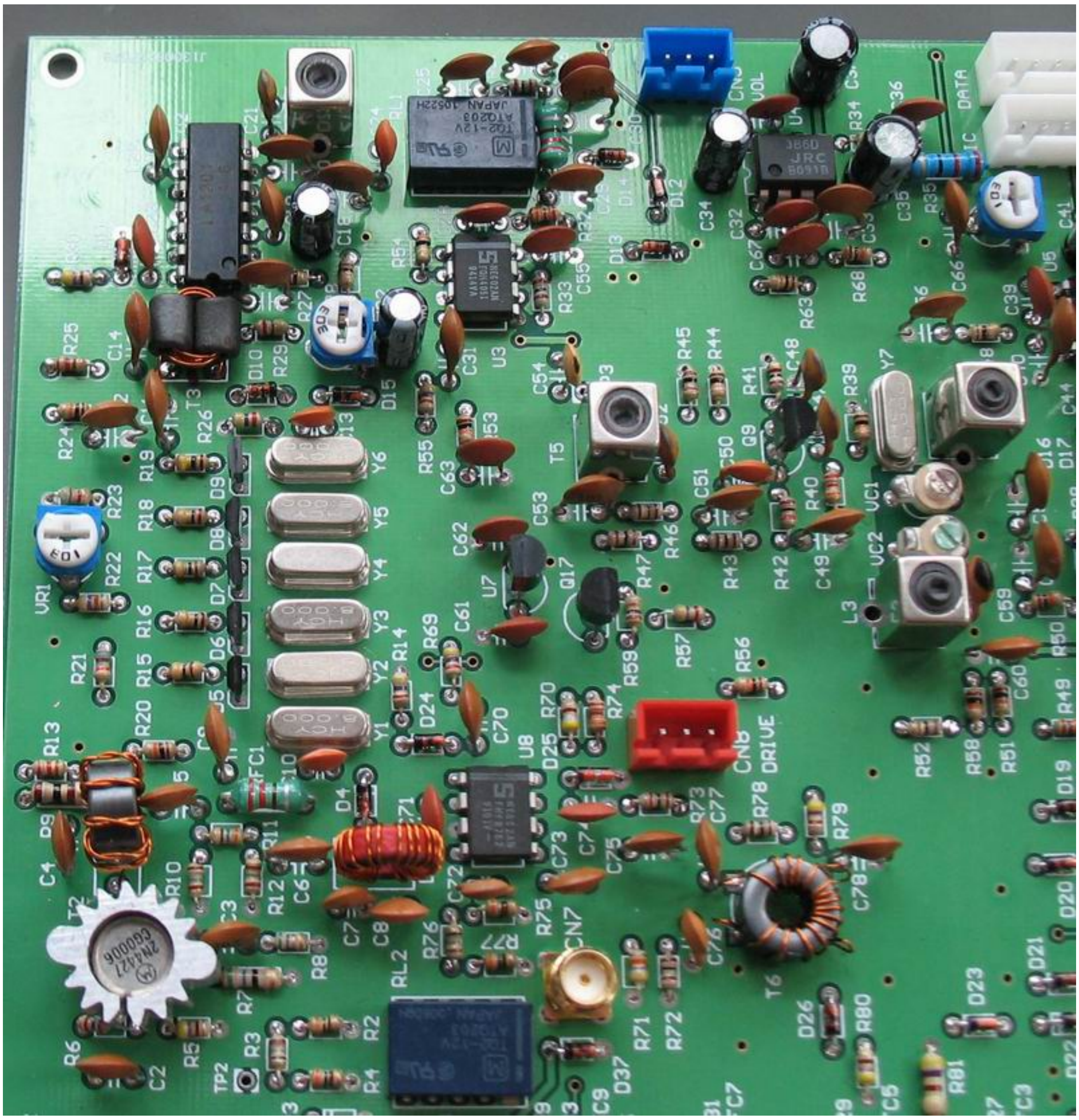
C24 -- This capacitor ranges from 4.3P – 20P. If the sound is a little distorted when very strong signal is tuned in, use a smaller value, say, 4.3P ceramic. The value is not very strict.

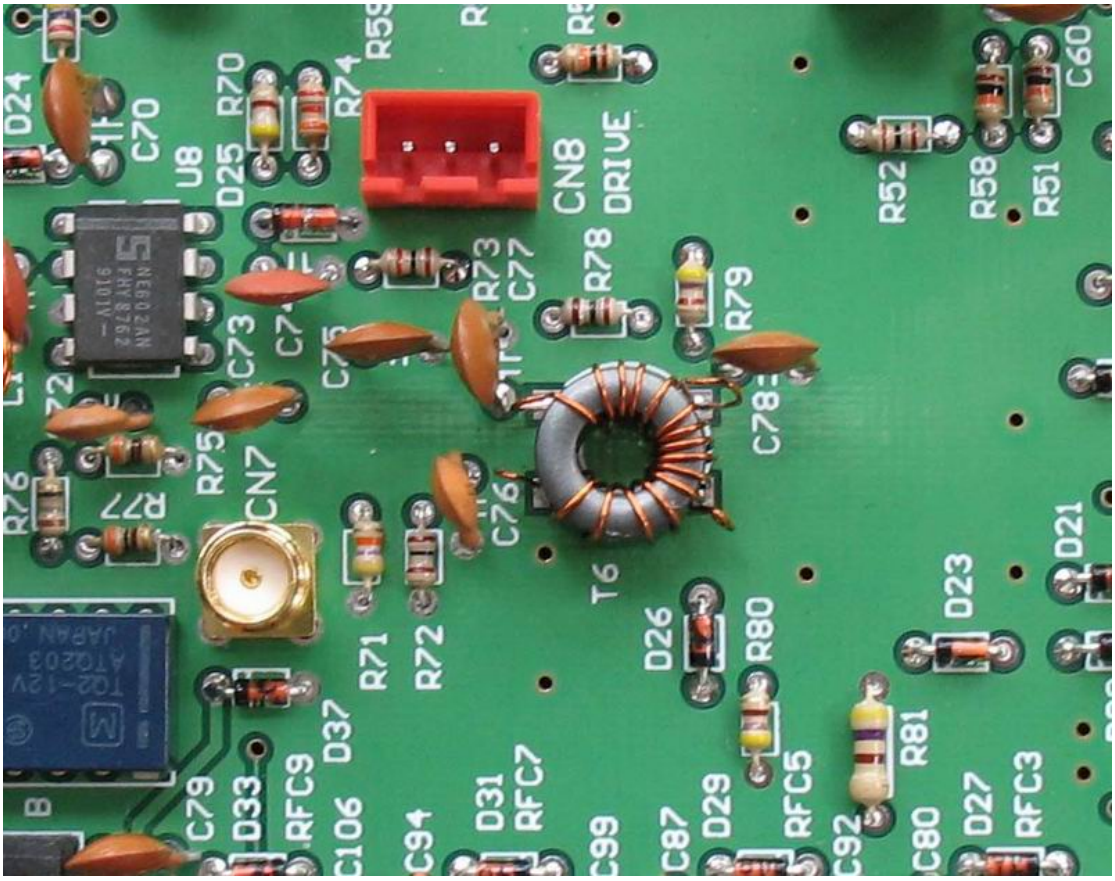
Keyer

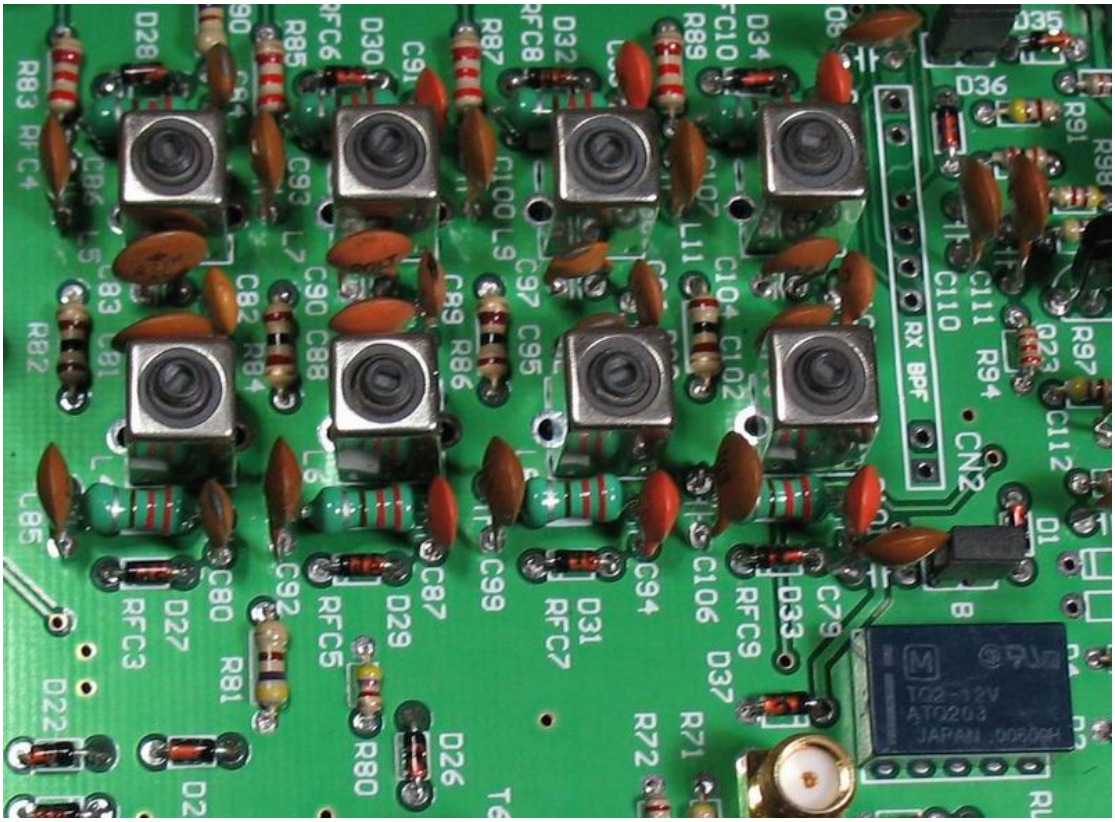
U6 has no backup battery. When the rig is turned off, all the settings of the keyer, such as speed, WPM, call sign, etc. would not be remembered. Next you turn on the rig, keyer will be loaded with the default values.

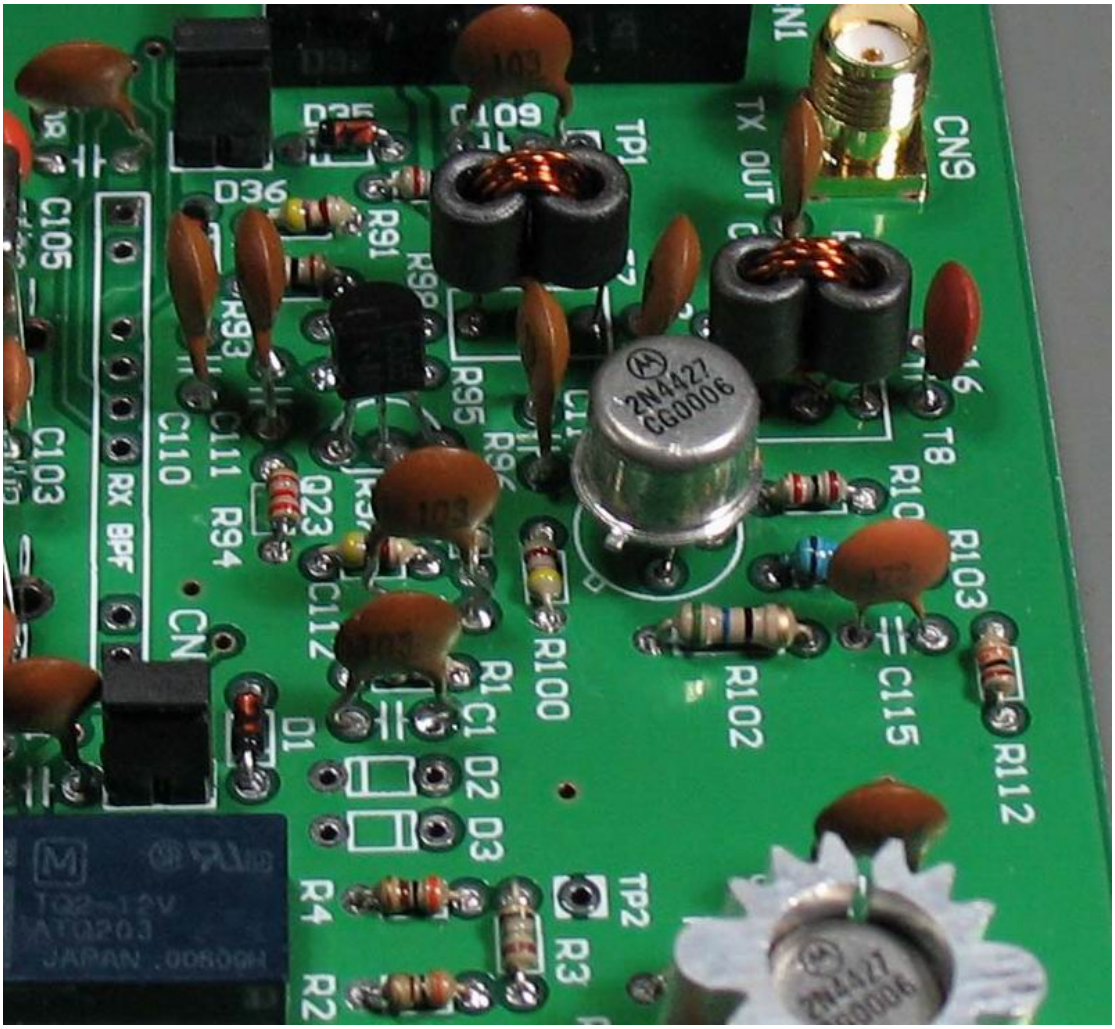
Some Pictures of the Main Board




DRIVE
CN8
DATA
VOL
JRC
JAPAN

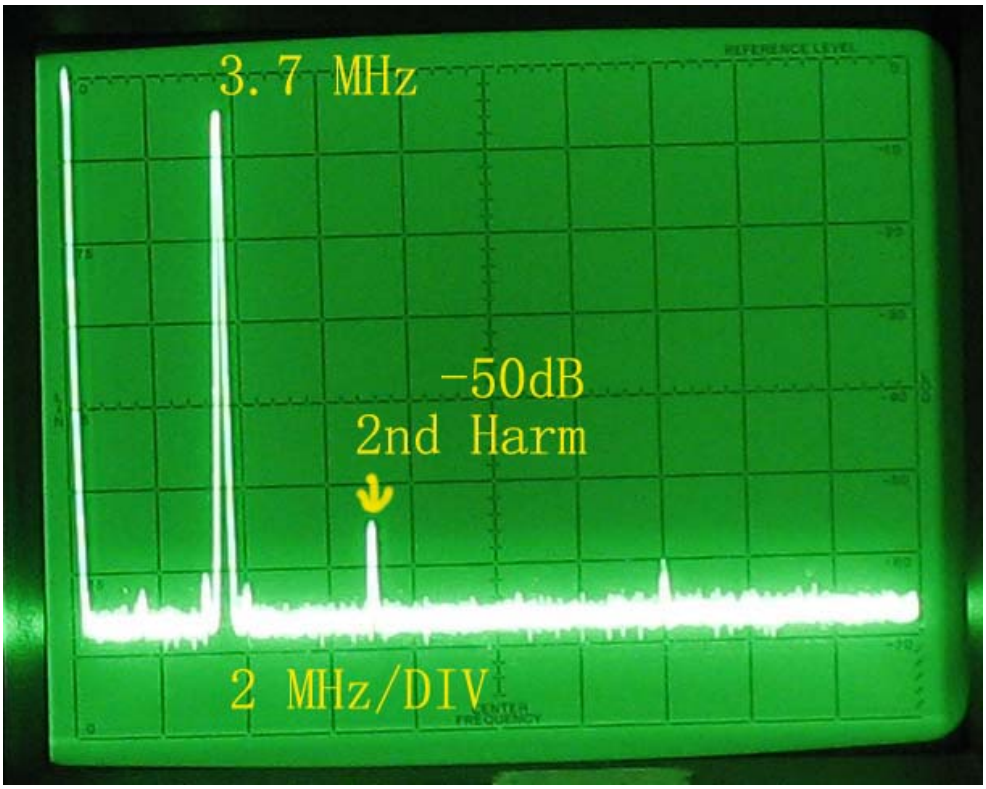

CN8
DRIVE
CN7
T6
U8
RX BPF
CN2

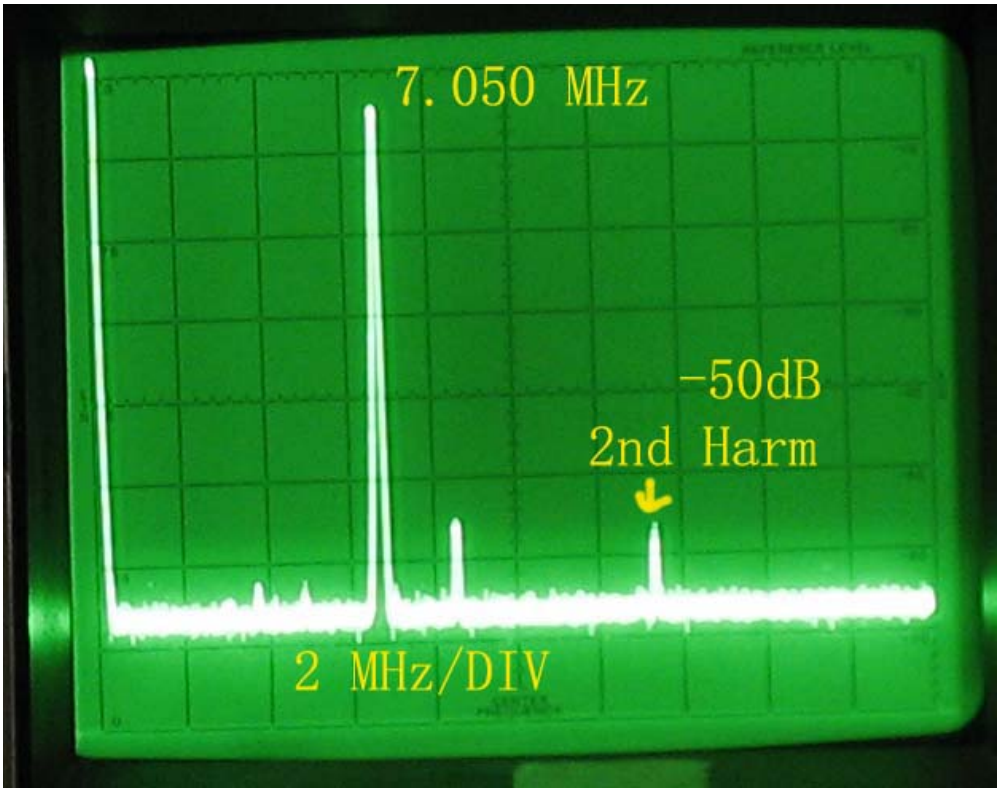

RX BPF
CN2

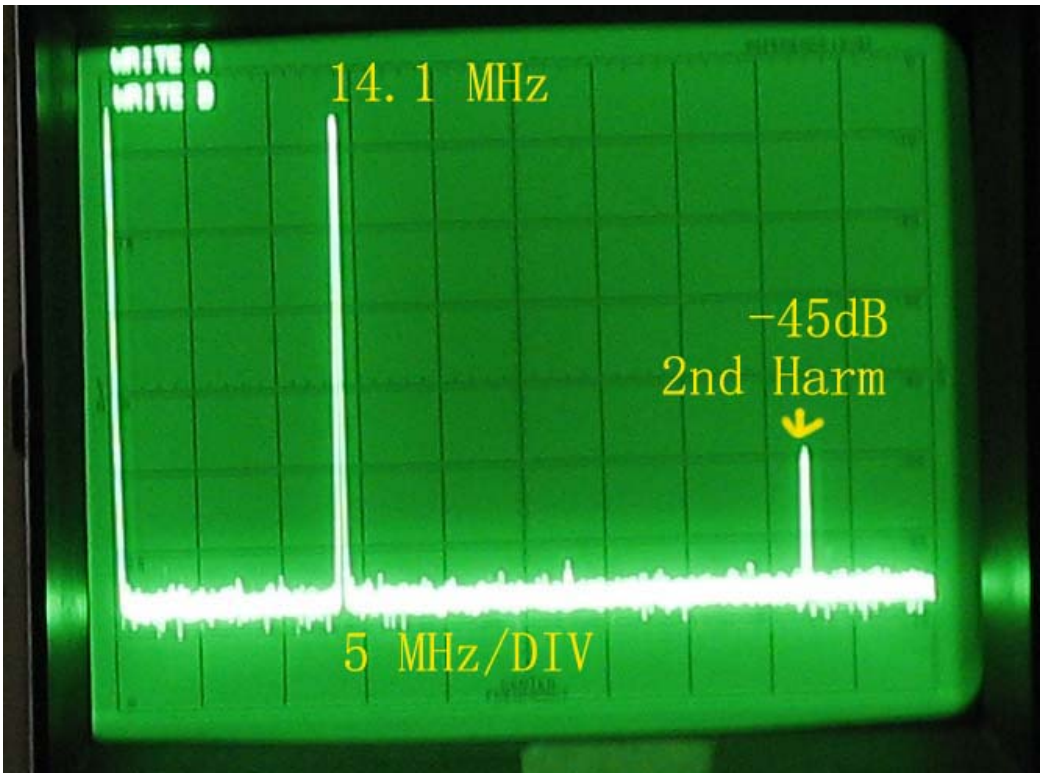

CN9
TX OUT
TP1
TP2
D36
C109
C105
C103
C110
C111
R91
R93
R94
R95
Q23
RX BPF
CN
C112
R100
R102
R103
C115
R112
D1
C1
D2
D3
R1
R2
R3
R4
2N4427
CG0006
T8
T02-12V
AT0203
JAPAN .00600H

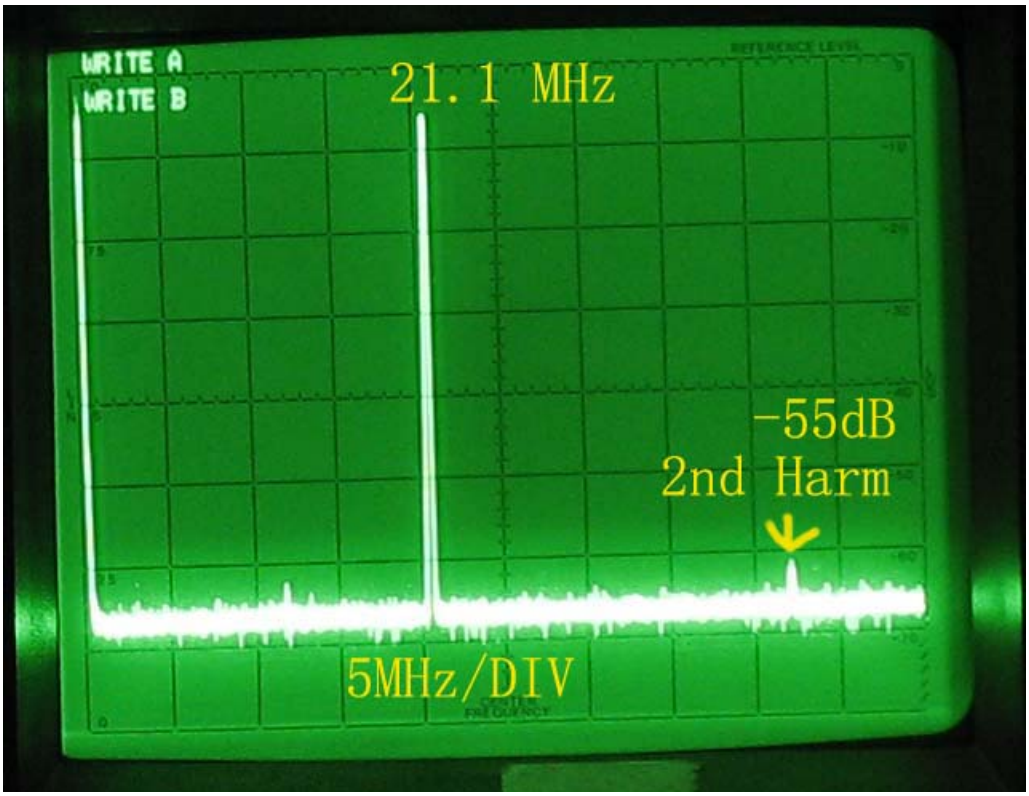
Spectrum

TJ4A complies with the FCC spectral purity requirement. The output spurious signals are 43dB below the carrier.






WRITE A
WRITE B
14.1 MHz
-45dB
2nd Harm
5 MHz/DIV


WRITE A
WRITE B
21.1 MHz
-55dB
2nd Harm
5MHz/DIV