Construction notes / guidance JT2A kit

Version 1.4, May 27th 2012, pa1ap

Notes are provided with best intentions but do not provide guarantee for success. You follow them on your own risk.

Tools needed:

1) Good digital multi-meter to measure the resistors (they are tiny) as well to align the battery charger circuit and AGC circuit
2) Oscilloscope with 10:1 probe is very useful and without one I would not have been able to get the kit working. This might have to do with my natural curiosity though ;-)
3) Dummy load and RF power meter needed to align transmitter of the kit
4) Frequency counter would be good to have but not required
5) General coverage reference SSB/CW receiver would be essential to align the oscillators as well verify the transmit output
6) Good soldering iron with small and bigger tip. The PCB is very good quality and the ground pins conduct heat very well. Hence connections to ground will need a bigger tip (more consistent heat) than the other connections. Don't size your soldering iron to small.

Before anything:

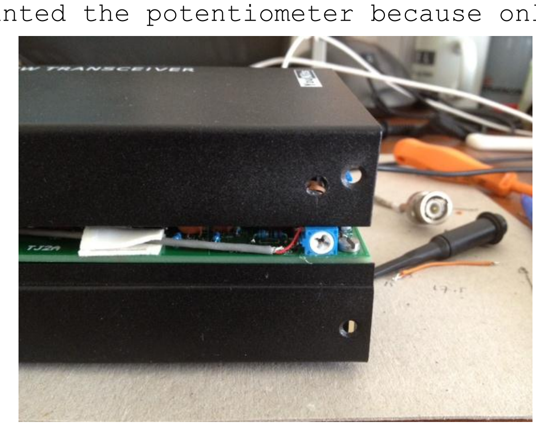
1) Decide which bands you want to operate… The documentation assumes 40/20 meter band. Deviating from 40/20 influences the coils, can's and some of the capacitors. Make sure you know before starting.
2) The coil can's have different values and cannot be used without consideration. If you check the can's you will notice two (2) have no print on the side but the remaining can's have marking 1-5. The documentation provides a list of their usage.
3) There are five(5) all black cores with a small difference. The three (3) all black FB-43-2402 cores are similar diameter but higher than the other two (2) all black cores. The other two (2) all black cores are smaller (rfc 6,7). Do not confuse them.
4) There are two wire sizes 0.31 and 0.47 wire size. I did not notice this and used 0.31 only for T3, T6, T7, T8. This because the smallest wire size just fitted the core size. For all other cores I used 0.47 size. Not as intended but it seems to work regardless. Also I would recommend to actually count the number of turns as the turns really depend on how tidy you make the turns.
5) The VXO adds inductance to the VXO crystals and as such will –lower- the crystal resonance frequency. The combination of inductance (L3 or L4) and D9 variable capacitor provides the VXO range. The VXO frequency seems always to resonate below what's on the crystal.
6) On crystals: I actually received crystals with 8.000Mhz printed on them and after check with youkits this was explained as misprint… I can confirm the printed 8.000Mhz actually resonates at 9.000Mhz.

General construction

1) The hardest part would be to figure out the correct resistors. With my old(er) eyes and the tiny resistors I could not decode the color coding. Hence I needed to measure them.
2) The next steps can be used as step by step construction sequence
3) Use the larger size resistor for R16, R22, and R68 and mount them on the pcb
4) Use a component lead to jump (bridge) R13 and R69 and mount the leads on the pcb. Make sure the lead does not touch the pcb screen to avoid unintended connection to ground.
5) Do not mount R36 (22k) but mount R36 as 10K -> vxo mod
6) Mount L2 as 220 Ohm resistor -> vxo mod
7) Mount the remaining resistors following the component list, except the funny 10K resistor over CN1 lead.. See suggestion on adding 10K potentiometer further down…
8) Mount the remaining capacitors following the component list -except for- C53, C54, C55, C1, C19, C38
9) Mount C1 (100-200pF) -> vxo mod
10) Mount C19 (100-470pF) -> AGC mod
11) Mount C38 (4.3pF) -> AGC mod
12) Jump (bridge) C55 with lead ->vxo mod
13) Mount the diodes… double check the type of diodes…
14) Mount transistors (front and back pcb)
15) Add a 10K resistor between base of Q10 and GND ->vxo mod
16) Mount the relais and double check you insert them correctly
17) Mount the remaining stuff

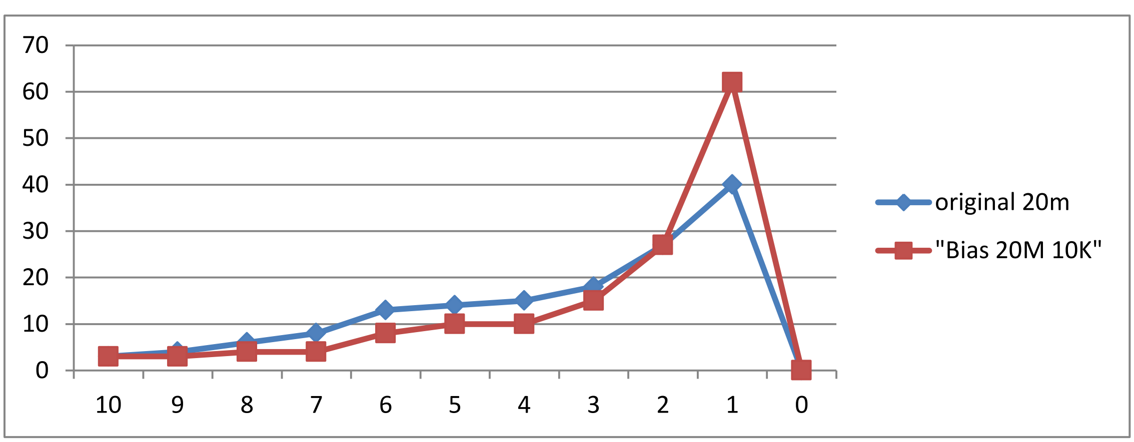
Modifications

1) VXO method #1: modification works well and is included in above steps.
2) VXO method #2: I would not recommend as it decreases VXO range to about 28Khz. Don't apply this modification.
3) AGC modification: Seems to work well and is included in above steps.
4) I have mounted a small pcb potentiometer (10K) to the PCB (near D23) with the adjustment facing the sidewall of the upper cabinet. This potentiometer connects the mic connector (CN1) to the mic connector CN2 and as such provides me the means to adjust the mic audio level using a small Philips screwdriver. For this I drilled a small hole through the sidewall of the upper cabinet (the one holding the speaker). Drilling should be done -after- you have mounted the potentiometer because only

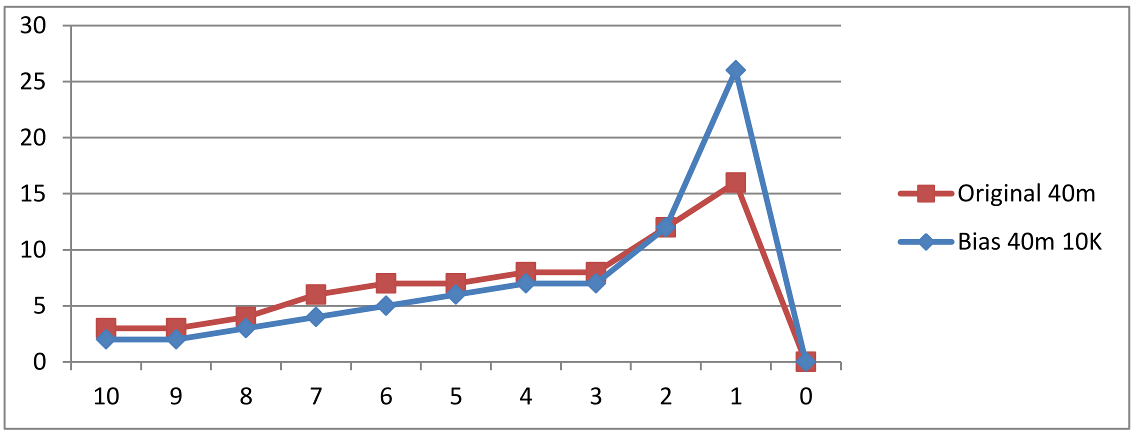


after mounting the potentiometer you will know the exact location. To mount the potentiometer I used a clear spot and soldered one side of the potentiometer to ground. The potentiometer is mounted on its side. The two outer connections face to the left (on the picture) which means that one end of the potentiometer is very close to ground already. The potentiometer wiper is on the right (on the picture) which is connected to the CN2 connector using the grey shielded cable. To mount you remove some of the paint on the pcb at the place where the potentiometer pin needs to be soldered. Then I used 10 second (super) glue to fix the potentiometer to the pcb followed by soldering one pin of potentiometer to the ground connection. This way the ground connection and glue fixes the potentiometer. CN1 is connected to the other outer pin of the potentiometer. This way the CN1 connection is terminated with 10K ohm and the mic is connected using the potentiometer wiper contact.

5) Replace the silly and too small speaker by a better quality one. I have ordered some replacement speakers as used for lcd screen. Just realized I have an old speaker / mic from kenwood vhf transceiver which I might be able to connect. Perhaps using the speaker of an old mobile phone with handfree function could be used too. Work in progress.
6) Include the front and back side relais / BFO shielding as recommended.
7) I used a small 50ohm coax cable to connect the antenna pins to the antenna BNC connector. This allows easier connection as well prevents "leaking" into the surrounding wires such as mic cable.
8) I found an interesting hint on making the VXO control less linear and as such the frequency control a little more linear. Original VXO control changes the voltage to the variable capacitor diode in linear way. However the combination of capacity and inductance behaves a lot less linear. With original VXO control the bottom segment of the VXO changes a lot more when moving the potentiometer from 1 to 2 than the upper segment of the VXO where the frequency change from 8-9 is very small. On 40 Meter the lower segment of the VXO changes 10-15Khz per "notch" and the upper segment of the VXO changes 2-4Khz per notch. To change this one can make the voltage towards the variable capacity diode to follow a hyperbolic curve trough including a resistor of 10K between positive supply and the wiper. Keep in mind that the dial indicator at zero (0) actually means zero (0) volt to the capacitor diode. At zero volt the diode provides maximum capacity.

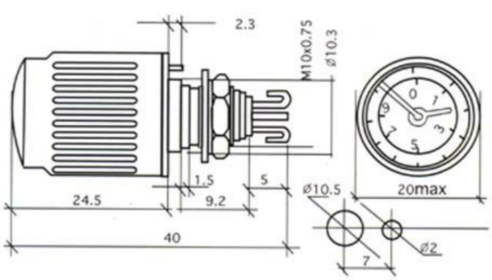


X axis represent the dial notch position 10-0. Y axis represents associated frequency change in Khz. How this modification translates into benefit is the question at hand. The range 10-1 clearly benefits from a more universal frequency change but 1-0 shows an increased frequency range over a tiny area. Perhaps I should include a fixed resistor to lift the lowest value a bit to avoid the bigger jump but this will come at the cost of losing a bit of range. For 40M I would lose about 20Khz (out of 74Khz) and about 30Khz (out of 148Khz) for 20M. I found that 8 Khz per notch is workable but higher values are not so nice with a single turn potentiometer. Hence the reason for



the 10 turn potentiometer modification as described below…

9) I found an interesting 10 turn potentiometer with the "clockwork" inside the knob itself which could be used for the VXO control. It does not claim more space within the unit as the original potentiometer. I have ordered it and will install it later. I will swap position of audio and frequency control to provide a better protection of the frequency control against undesired bumping when stowed away during transport. The knob is a little higher than the volume knob. On google / ebay you can search for something like "10 Turn Dial Pointer Potentiometer 10k Ohm WXD2-53".



Alignment:

1) I found that for all can's (inductors) there are two resonance points. One with the core 1..3mm sticking out of the can and the other at the far bottom of the can. I would recommend to adjust all can's with the cores residing at the top of the can's to allow easy adjustments as well preserve the bottom threat for the final adjustments once you have proven all works as designed. Having the core at the bottom will provide a better secure position for the core and as such more stability.
2) The IF xtal center frequency is not 9.0000Mhz but 0.5Khz lower. In other words 8.9995Khz. This is important to realize when adjusting the BFO frequencies. Source youkits.
3) BFO L1 resonates easily and straightforward to adjust. Adjust to 8.9980Khz (1.5Khz away from IF xtal center frequency)
4) BFO VC1, VC2 are supposed to make the BFO resonate above 8.9995Mhz. In my case I had to adjust both to their smallest value to achieve this. This depends on the frequency of the crystal and might vary depending on crystal quality. Anyway, adjust USB to 9.0010Mhz (1.5Khz above if xtal center frequency). And CW to match IF xtal center frequency + 700Hz (9.0002).
   a. I am using a CW receiver for this purpose which has zero beat function. I just move the receiver antenna close to the TJ2a and can copy the BFO signal. This way there is no pulling of the BFO oscillator. Same approach applies to the VXO adjustment as described in next point.
5) L3 and L4 are very sensitive for adjustment and even touching the core will change the frequency. I would suggest for first rough alignment to adjust the frequency dial to the middle position and adjust the frequency of the VXO to match that expected value approximately.
6) L5/L6 and L7/L8 is easiest to adjust using transmit into dummy load and can also be adjusted when in receiving mode.
7) VXO voltage at the cold side of L2 (which is actually 220 Ohm resistor) should be indeed around 1V tt. I did find the 40M VXO to have slightly higher output than 20M VXO (1.2 / 1.0V). The note that the waveform is distorted because of the 20M filter is incorrect since this one got removed already..
8) The AGC potentiometer needs to be adjusted using the multi-meter approach. Please do not adjust the potentiometer at maximum hiss sound since that would not improve the receiver at all. There is a small peak when turning the potentiometer which generates a loud hissing sound.. That is not desired.
9) To test SSB transmit without connecting the mic (to check carrier level) just connect the mic key pin with ground using a screw driver.
10) To measure the transmit output I have a digital power meter as well scope with 10:1 probe connected to the dummy load pins. This provides me a good indication of output voltage which can be translated back to output power. Power (mW) = 2.5 x (Utt) ^2. When Utt=30V the output power is 2.225 Watts. I measured up to 52 Volts which translates

to 6.76 Watts… of course my scope might not provide the best accuracy despite the fancy cursors to measure values but it is good indication.

Measurements after alignment (scope with 10:1 probe):

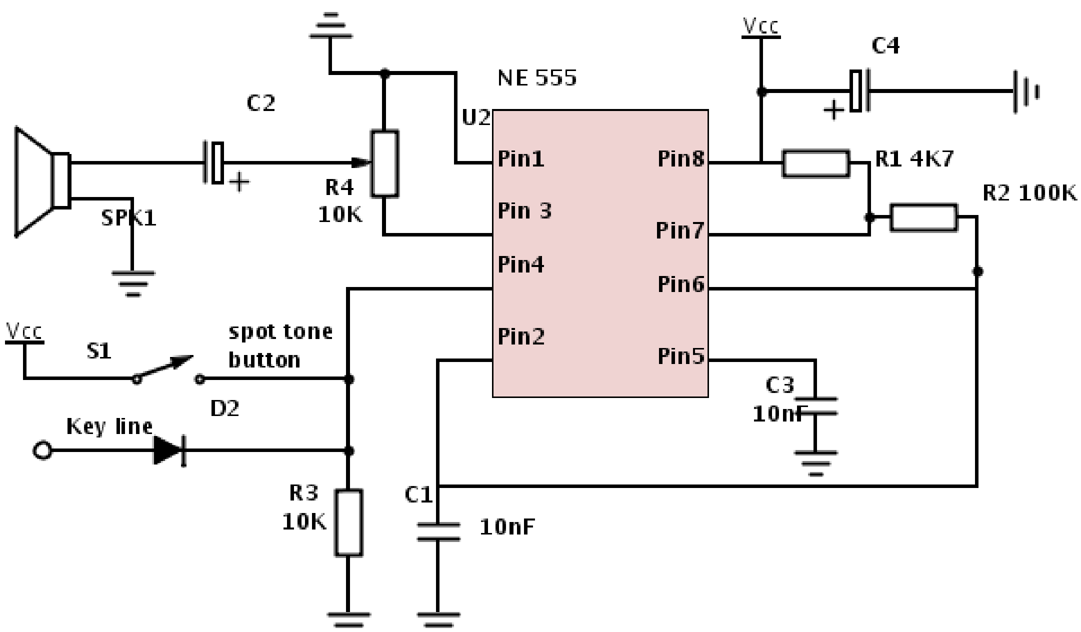
1) VXO method #1 only.
2) BFO LSB 8.99804, USB 9.00108, CW 9.00036
3) Pin 3 U3 (mixer) LSB 400mVtt, USB & CW 332mVtt
4) Cold side L2 (220 Ohm resistor)
    a. 20M F-low 784mV, F-high 1040mV
    b. 40m F-low 944mV, F-high 1260mV
5) TX mixer U5 pin6
    a. 20M F-low 177mV, F-high 228mV
    b. 40m F-low 219mV, F-high 290mV
6) RX mixer Q1 R1 hot side
    a. 20M F-low 728mV, F-high 988mV
    b. 40m F-low 880mV, F-high 1140mV
7) IF mixer U3 pin6
    a. LSB 408mV, USB 334mV, CW 334mV
8) TX output over dummy load
    a. 20M F-low 34V, F-high 34V (~2.9Watt = ~ 34dBm)
    b. 40m F-low 47V, F-high 47V (~5.5Watt = ~ 37dBm)
9) TX output SSB no mic
    a. 20M F-low 182mV, F-high 346mV
    b. 40m F-low 348mV, F-high 548mV
    c. R62 ~ 300 Ohm
    d. The following calculation applies
        i. 20M 346mV = 0.3mW = -5dBm
        ii. 40M 548mV = 0.75mW = -1.2dBm
10) R60 with CW key down
    a. 20M F-low 50mV, F-high 118mV
    b. 40m F-low 118mV, F-high 104mV
11) R65 with cw key down
    a. 20M F-low 740mV, F-high 1330mV
    b. 40m F-low 480mV, F-high 664mV
12) Frequency band #1 7.018 – 7.092, band #2 14.001 – 14.149

Pending items:

1) Transmit power seems very high on both bands and I am investigating what's going on. I am measuring near 5.5 Watts at 40Meter.
2) VXO voltage level on transmit NE602 mixer pin 6 is only 64mV… I can change this by adding 5..10pF capacity (increasing to about 320mV). However I am not sure about the impact yet. According datasheet the voltage should be minimum of 200mV. Pending investigation
3) There is no side tone during CW key down. I will need to include a NE 555 or something similar to the key line as I cannot transmit without

sound ;-) I am also checking if I can combine this with zero beat indication at the same time.

a. I have found the NE555 to be small and easy to use for this purpose
b. The side tone will be connected to the PTT line using a diode. The diode will allow me to connect a push button to the ne555 as well.
c. The push button can be used to generate a side tone during receiving mode and hence help as zero beat indicator.
d. Figure below should be a tone generator. R1 =4K7, R2 = 100K, C = 10nF for ~700hz tone. The switch will activate the spot tone and I need to connect the anode of the diode D2 (connected to pin ne555) to the hot side of R74 which should go high when key is down. Furthermore the pulse output will need to connect to a potentiometer to allow audio volume control. The speaker would actually be pin 3 of U2 (audio amp) and C2 could also be 104 capacitor. This way you can adjust the audio level into the audio chain to match the rx audio level. There is a challenge though and that is the mute circuit which is activated when PTT is active and the audio is connected to ground. Right now I am not sure if I can work around the mute circuit or that I just connect the tone generator to the speaker. Will have to see what works best.



e. When pushing spot tone button the 700hz would be mixed with the received CW tone. When they are near equal the zero beat status would indicate itself through slow fading on the CW signal. This because the spot tone would cancel out the received CW signal. Of course you need to ensure that the spot tone frequency is matching would you have set through the BFO CW offset… If that’s the case the spot tone would ensure you are transmitting on the correct frequency (zero beat) as the other station.

4) R62 got changed by me to lower the carrier level. Originally it was about 1.5 Volt and now it is 548mV (R62 = 300 Ohm). Still I believe this is too large. Trying to locate the root cause to see how I can resolve this. Pending investigation.
   a. When doing the math 548mV would translate into 0.75 mW output power. Or about -1.2dBm.
   b. Mapping this to the 5.5Watt output power would equal 37dBm.
   c. So it seems the carrier is 38 dB suppressed.
5) The VXO signal seems a bit distorted and I need to double check if my measurement method is correct. The bottom seems flat which indicates the VXO is overdriving a component. To be investigated.
   a. I believe this is caused by the additional inductance which is displayed on the scope trace. The tx output signal is clean.