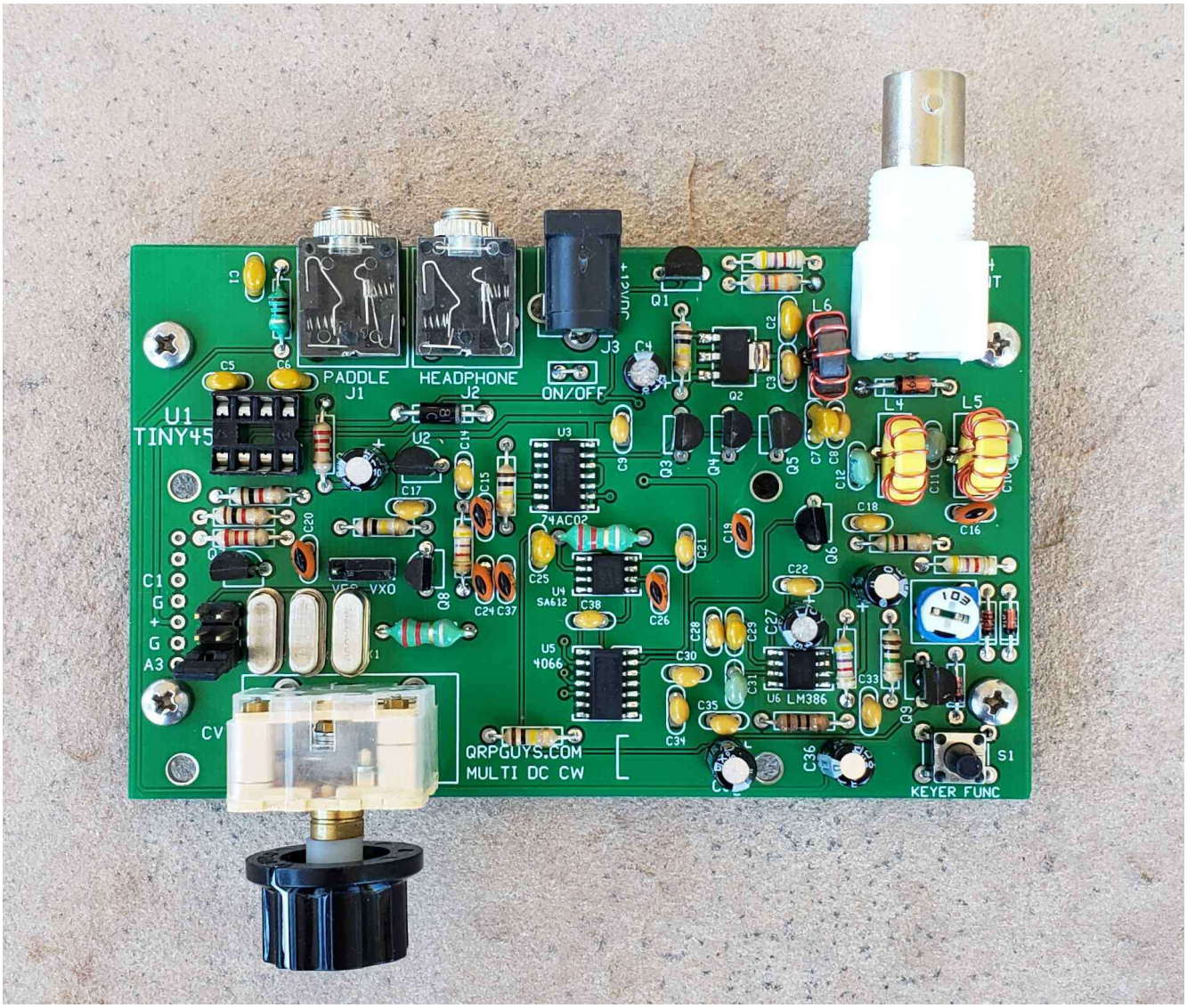
The MULTI-DC
Tri-band CW transceiver
for the 10-12-15 meter bands



Features:

- Chirp free crystal control with receive mode VXO tuning.
- Optional Digital VFO for full band coverage.
- Up to 5 watt output typical with 13.8V supply
- Iambic keyer with message memories
- Direct Conversion receiver
- Low current receiver ~15 ma, ~45 ma w/optional VFO
- Efficient transmitter
- Wide supply range, 8 to 13.8V.
- Receiver MDS: ~0.5 – 1.0 uV
- Max transmit current : ~850 ma (10M, 13.8V supply, 5W output)

Parts list:

QTY	VALUE	CODE		QTY	VALUE	NOTES
1	10 OHMS	BRN/BLK/BLK/GLD		1	LM386MX	SO-8 AUDIO AMP
1	51 OHMS	GRN/BRN/BLK/GLD		1	SA602A or SA612A	SO-8 MIXER
2	1 K OHM	BRN/BLK/RED/GLD		1	74AC02M	SO-14 QUAD NOR
2	2.2 K OHM	RED/RED/RED/GLD		1	78L05	TO-92 5V REGULATOR
4	4.7 K OHM	YEL/VIO/RED/GLD		1	CD4066BM	SO-14 ANALOG SWITCH
1	47 K OHM	YEL/VIO/ORG/GLD		1	ATTINY45A	DIP8 KEYER CHIP
4	100 K OHM	BRN/BLK/YEL/GLD		2	2N3904	TO-92 NPN
1	1 M OHM	BRN/BLK/GRN/GLD		3	2N7000	TO-92 N-CH MOSFET
1	10 K OHM	(103) 6mm TRIMMER		3	BS170	TO-92 N-CH MOSFET
				1	NDT2955	SO-233 P-CH PWR MOSFET
1	0.56uH	RFC GRN/BLU/SIL/SIL				
1	2. 2 uH	RFC RED/RED/GLD/GLD or SIL				
1	10 uH	RFC BRN/BLK/BLK/GLD or SIL		1	21.060 MHz	HC-49/US CRYSTAL
				1	24.906 MHz	HC-49/US CRYSTAL
1	15 pF	15 C0G 5% 50V		1	28.060 MHz	HC-49/US CRYSTAL
1	22 pF	22 C0G 5% 50V				
3	47 pF	47 C0G 5% 50V		1	FT37-43	BLACK FERRITE TOROID
2	68 pF	68 C0G 5% 50V		2	T37-6	YELLOW TOROID
2	150 pf	151 C0G 5% 50V		1	8 PIN DIP SOCKET	
7	10 nF (0.01 uF)	103 X7R 10% 50V		2	3.5 mm JACK	
14	100 nF (0.1 uF)	104 X7R 10% 50V		1	2.1 X 5.5 mm	DC PWR JACK
				1	BNC JACK	RT ANGLE/PCB MOUNT
2	4.7 uF	4.7 ALUM ELECTROLYTIC		1	3 x1 PIN SIP	HEADER PINS
4	100 uF	100 ALUM ELECTROLYTIC		1	3X2 PIN HEADER	HEADER PINS
				1	STD. SHUNT	VFO/VXO SW.
3	1N4148	SS DIODE, GLASS		1	TALL SHUNT	BAND SW.
1	1N5817	SHOTTKY DIODE, PLASTIC		1	POLYVARICON	W/HARDWARE
1	1N4756A	47V 1W ZENER, GLASS		1	KNOB	
				1	CIRCUIT BOARD	
				1	5 FEET	#26 MAGNET WIRE
				1	TACTILE SW.	S1
				1	1X5 FEM. HEADER	VFO HEADER
				12	M3X5MM SCREW	HARDWARE
				4	M3X12MM THREADED PLASTIC SPACER	HARDWARE
				4	M3X15MM THREADED PLASTIC SPACER	HARDWARE

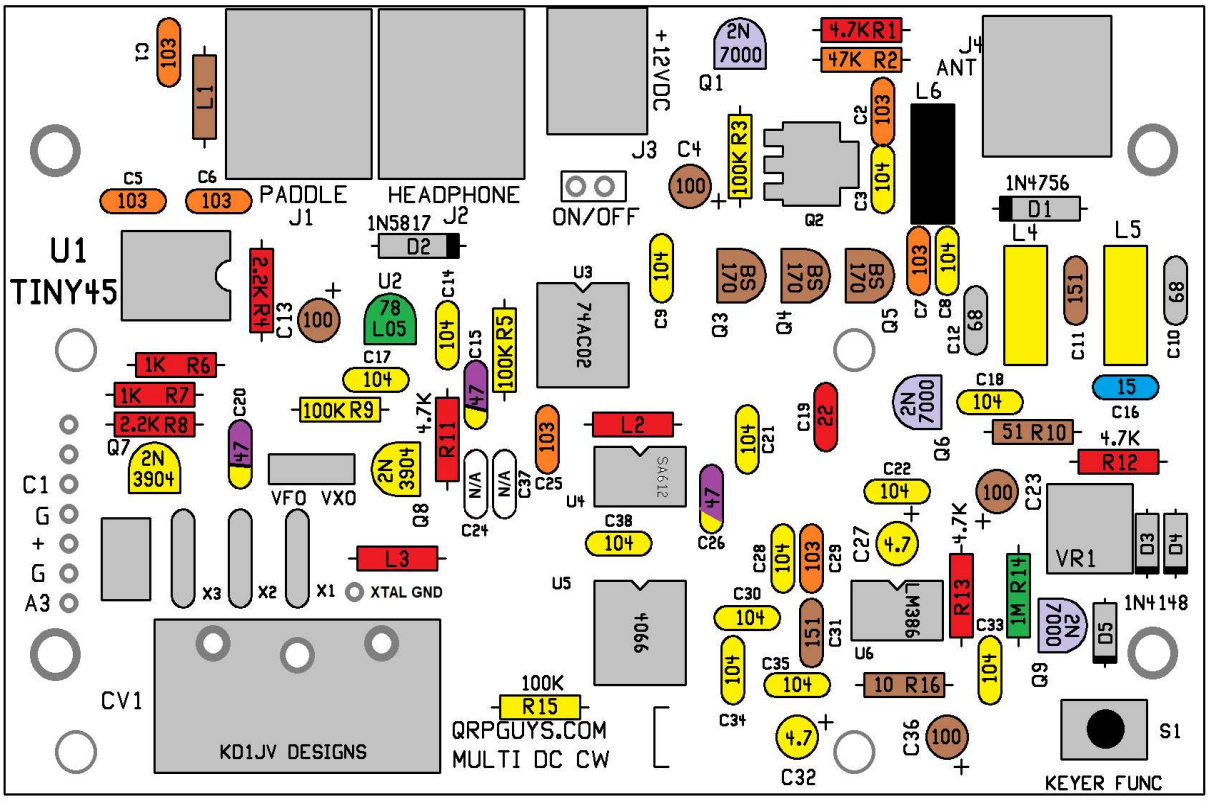
First, familiarize yourself with the parts and check for all the components. If a part is missing, please contact us and we will send one. To request a part, please use qrpguys.parts@gmail.com.

PARTS LOCATION DIAGRAM:

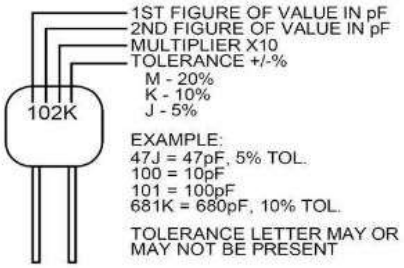
To aid in locating parts, the values are color coded, primarily using the zero multiplier resistor color. Note that several resistor values share the same zero multiplier color.

It is helpful to print this page for easy reference while assembling.

With the exception of C37 and C38, parts are numbered on the board in rows from left to right starting at the upper left hand corner.



Note: When reading the 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.



There are multiple construction variables for the transceiver. Your decision will result in the installation or elimination of various components and the side of the pcb they are installed.

Read the entire assembly manual through carefully and install the components for the operating configuration you want. Your decision will make assembly easier and prevent the difficult removal of components assembled in error.

Some construction possibilities are.

- Simple desktop operation (no case), with crystal controlled VXO
- Simple desktop operation (no case), with optional Si5351A VFO
- Recommended eBay case, with optional Si5351A VFO
- User fabricated pcb case with optional Si5351A VFO

Optional Digital VFO:

The QRPguys Si5351 Digital VFO can be used with the Multi-DC transceiver. This will provide full band coverage and enables you to listen to SSB stations in the phone segment of the bands and SWBC stations outside the ham bands. There is a high pass filter on the input to the receiver mixer which provides enough attenuation of signals below 21 MHz to prevent overloading, but SWBC stations will be strong enough to copy well below the roll off frequency of the filter.

Adding our Si5351A VFO increases the current consumption of the transceiver by 30 ma for a total of about 45 ma. Still, not bad.

The Si5351A VFO can be added at any time after the transceiver has been built, some parts will have to be removed from the transceiver board. Remember to move the VXO/VFO jumper to "VFO" when installing the VFO.

Mounting option 1:

The VFO is mounted on the solder side of the transceiver board. This option allows for keeping the crystal control parts in place, allowing the option of using the VFO or the crystals. You might want to switch to crystal control for battery operation to increase battery life. However, the VFO will need to be unplugged to gain the reduced current benefit.

If you already have the VFO for use with the QRPguys FT8 II Transceiver, mounting on the solder side will allow you to swap the VFO between the two rigs. However, you will need to update the firmware for the VFO and add two SIP pins to pick up the A3 connection for the Multi-DC board. The firmware for the Atmega238P is on the main page for download. After the upgrade it will work for both FT8 II Transceiver and the Multi-DC Transceiver. All VFO's shipped after 2/21/21 will have the universal firmware.

Mounting option 2:

Enclosure for the Multi-DC transceiver:

The board is designed to mount in the cover of a 5.30(L) x 2.95(W) x 1.92 (H) inch ABS plastic box available from PI Manufacturing Corp. They have an EBAY store. 1:1 drill drawings showing the location of the holes needed for the jacks are provided at the end of this manual.

The box is deep enough to hold three 18650 sized li-ion cells and a holder. These would power the rig for quite some time. The Mutli-DC transceiver will operate to the batteries terminal voltage of 2.75 volts (X3 = 8.25V) and still produce between 1.5 and 2W of RF power.

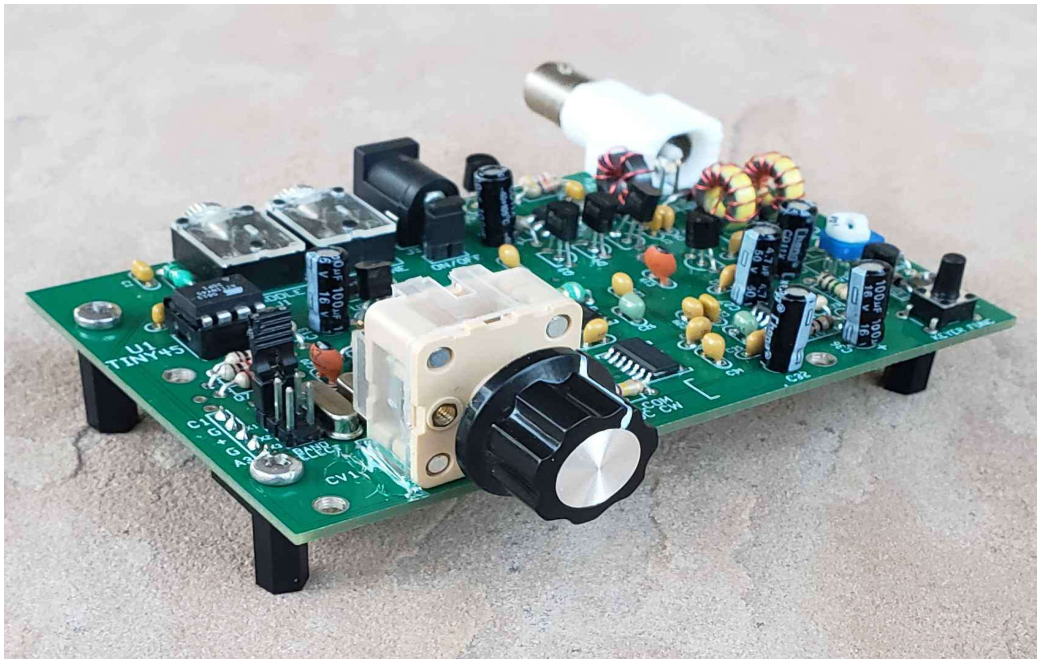
This suggested enclosure is most suited for the crystal controlled only configuration. The fact a battery pack fits makes it a good choice for portable operation.

It is possible to use this enclosure with the optional VFO mounted on the solder side of the board. This would require adding half inch (1/2") board spacers to lift the board off the lid mounting posts. The VXO variable cap would also need to be removed.

Plans for a PCB enclosure are on the QRPguys.com web page for this product. This is a good option for a "desktop" configuration, as it provides the lowest profile. In this case, the VFO board is also mounted on the back side of the Multi-DC board.

Option 3: Make a 3D printed case. Sorry no plans available yet. Looking for volunteers :)

Option 4: Who needs an enclosure? At least, add the included standoffs in the mounting holes to keep it off the table.



Assembly:

The IC's:

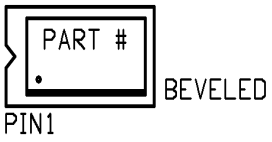
The first parts to be soldered in place are the five SMD (Surface Mounted Device) parts. For this, a pair of tweezers and some small diameter solder wire is the best way to deal with these parts. 0.020" solder is the largest you'd want to use. 032 is way too big. 015 is even better, but the 020 is good for general circuit board soldering.

- Start by lightly tinning one corner pad.
- Locate the pin 1 end of the chip and position it towards the notch in the part outline. Make sure you get this right. An upside down chip will short out the 5 volt regulator and possibly damage the chip. Worse, once in place it's a pain to remove without special tools.
- Carefully line up the leads with the pads and touch the tip of your soldering iron to the lead over the tinned pad. This is where holding it in place with tweezers works best.
- Double check that the rest of the leads are still lined up.
- You can now proceed to solder the rest of the leads, but be careful not to nudge the chip slightly when soldering the second lead.
- Ensure that every pin is soldered and that there are no shorts between pins, use solder wick to remove the excess solder. In fact, even if you don't see any shorts, removing excess solder with the wick is a good idea and helps insure the pins are soldered to the pads on the board. Lay the wick across the pins and touch the tip of your iron onto the brad.

Finding Pin 1:

The pin 1 end of the chip is indicated on the board by the notch in the part outline.

Pin 1 on the chip can be marked in one of several ways.



1. A dot or dimple.
2. A line on the pin 1 end of the chip
3. The manufactures logo
4. The orientation of the printing.
5. A slight bevel along the side of the package.

[ ] U3 – 74AC02 – 14 pin (maybe labeled AC02)
[ ] U4 – SA602A or SA612A – 8 pin
[ ] U5 – 4066 – 14 pin
[ ] U6 – LM386 – 8 pin (maybe labeled 386)
[ ] Q2 – 2955 – SOT-233 Like the IC's tin one pad first, the large tab is best.

Resistors:

Note that several resistors have similar color codes. The 51 and 1M resistors are easy to mix up since their color code is the same, but reversed. Also double check 4.7K and 47K values as their color coding is similar. Verifying the value with an ohm meter is a good idea if there is any doubt.

[ ] (4.7 K) R1, R11, R12, R13 - (yellow-violet-red-gold)
[ ] (47 K) R2 - (yellow-violet-orange-gold)
[ ] (100K) R3, R5, R9, R15 – (brown-black-yellow-gold)
[ ] (1 K) R6, R7 – 1K (brown-black-red-gold)
[ ] (2.2K) R4, R8 – (red-red-red-gold)
[ ] (51) R10 – (green-brown-black-gold)
[ ] (1M) R14 – (brown-black-green-gold)
[ ] (10) R16 – (brown-black-black-gold)

RFC Inductors:

L1,2,3 are molded RF chokes. They look like resistors, but a little fatter and with an ohm meter will read 0 ohms.

[ ] L1 – 10 uH (brown-black-black-gold or silver)
[ ] L2 – 2.2 uH (red-red-gold-gold or silver)
[ ] L3 – 0.56 uH (grn-blu-silver-silver)

Diodes:

The black ring at one end of the diode indicates direction, face towards black end of part outline.

[ ] D1 – 1N4756A – large, glass body
[ ] D2 – 1N5817 – large, black body
[ ] D3, D4, D5 – 1N4148 – small, glass body

Capacitors:

It is helpful to sort the capacitors first. The numbers can be hard to read, this is where a magnifying glass is needed to make sure you have the correct value. Do not confuse the manufacturing codes with the component value. If it looks strange, look on the other side of the component. Also the value may be followed by a tolerance code of M,K, or J.

Most of the caps are 100 nF or 10 nF, so we'll start with those. The value as marked on the part is listed first. (value) then Part location Cxx.

[ ] (104) C3, C8, C9, C14, C17, C18, C21, C22, C28, C30, C33, C34, C35, C38
[ ] (103) C1, C2, C5, C6, C7, C25, C29
[ ] (68) C12, C10
[ ] (151) C11, C31
[ ] (15) C16
[ ] (47) C15, C20, C26, C37 not used
[ ] (22) C19, C24 not used

Everything else:

[ ] crystals - X1, X2, X3 – It doesn't matter what order you install the three crystals, but we'd suggest 21.060 for X1, 24.906 for X2 and 28.060 for X3. Solder a clipped resistor lead across the tops of the crystals to the Crystal GND pad. Do not overheat the crystals.
NOTE: Crystals are not mounted if building for VFO option.

[ ] 8 pin DIP socket. Be sure to check that all the leads stick through the pads before soldering. If one pin gets folded under the socket it's a pain to fix if all the other pins are soldered!

[ ] J1 and J2 – 3.5mm phone jacks

Transistors: Follow the silkscreened board outlines for placement

[ ] 2N7000 – Q1, Q6, Q9
[ ] BS170 – Q3, Q4, Q5
[ ] 2N3904 – Q7, Q8
[ ] 78L05 - U2

SIP's:

[ ] header pins.

- One 3 pin row at VFO/VXO select pads
- One 3X2 pin at the X1-X2-X3 select pads. If you are mounting the board in the recommended ABS case, mount these pins on the solder side of the board. That way you can access them without having to open the case. Drill a hole in the lid to access the jumper shunt.

[ ] VR1 – AGC 10K trimmer resistor. Mount on front side for crystal controlled option, and solder side for VFO option. When mounted on the solder side the CW/CCW setting instructions are reversed.

Electrolytic caps:

[ ] 4.7 uF – C27, C32, long lead is PLUS
[ ] 100 uF – C4, C13, C23, C36, long lead is PLUS

Toroids:

Turns should be more or less evenly spaced around the core. Each time the wire passes through the inside of the core, is a turn. The wire should be wound as tight to the core as practical. The transmitter will not like having loose turns on the cores.

[ ] L6 – 8 turns on FT37-43 (black core)
[ ] L4 – 9 turns on T37-6 (yellow core)
[ ] L5 – 12 turns on T37-6 (yellow core)

The magnet wire insulation can be burned off with a soldering iron. Turn the temp up as high as it will go and make a little blob of solder on the tip of the iron. Tin the wire before mounting the core, as the solder pad will suck away too much heat to melt through the insulation and make a reliable connection. The core should be mounted snug to the board, but make sure you don't pull the wire through the hole past your tinned area.

Last bits:

[ ] J3 – DC power jack
[ ] J4 – BNC jack
[ ] CV1 – Polyvaricon capacitor. Secure to the board at side edges with a small amount of hot melt glue. * Polyvaricon is not mounted for the VFO option.
[ ] Insert the DIP IC (TINY45A) into the U1 socket.
[ ] TACT switch – SW1, Mount on component side for VXO option. Mount on solder side for VFO option.
[ ] Solder a jumper across the ON/OFF pads behind the power jack, or wire in an optional ON/OFF switch.

VFO option mounting:

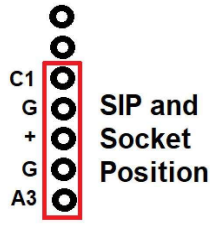
The VFO board is mounted on the back (solder side) of the main board.

- Use the SIP pins on the VFO and female sockets on the main board. Use this if mounting in the suggested plastic enclosure and desktop option.

IMPORTANT

Location of SIP pins and SIP socket for solder side mounting:

The "A3 thru C1" pads on the VFO needs to be connected to the main board via the 5 pin SIP and socket. If the VFO is being built specifically for this rig, the SIP pins are mounted two pads down from the top in order to pick up the C1 thru A3 pad on the solder side of the VFO board. The female socket is mounted on the solder side of the main board.



If the VFO had been used with the QRPguys FT8 transceiver, and add two pins on the VFO board for A3 and GND. Hard wire those two connections if you don't have extra pins. Also, you must re-flash the Atmege328P with the new firmware.

Smoke test:

To ensure you don't see smoke when you power up the board, carefully inspect your workmanship. The only reason a kit does not work first time is due to soldering issues. This fact has been proven many times. Everyone seems to be able to put the parts in the correct locations, but then, sometimes resistors get mixed up.

- Double check for shorts between leads on the SMD IC's and that they are all soldered.
- Ground pads take a little more heat than signal pads, so these can be suspect.
- Sometimes a lead looks soldered, but the solder is just stuck to the lead and didn't flow into the pad.
- Use an ohm meter to verify continuity across the toroid coils.

Power supply:

It a good idea to use a power cord with a 1A fuse or a power supply with a 1A current limit. Should there be any serious problems, this will ensure nothing really gets damaged. Another possibility is a 9V radio battery or a battery pack of AAA batteries. Avoid using a wallwart.

Test equipment:

You should have a dummy load and QRP power meter to verify transmitter operation. A commercial rig which covers the 15, 12 and 10 meter band will be helpful to verify operation.

Set up:

Skip ahead and read the operating instructions.
Make a "clip lead" antenna for you commercial rig to "sniff" around the Multi-DC board.
Select the 15 meter band crystal at the jumper block.
Ensure the VXO/VFO jumper is in the VXO position.
Plug in your paddle, headphones and power supply.

Apply power.

For 1 sec. the display will read [dC **]. The ** is the revision of the firmware. Following that, for 1 sec. will be the band [bn **], and then the default qrp operating frequency, [60.00].

Verify the crystal oscillator is working by listening for it with the big rig. For 15M, you should find it at about 21.057 MHz. Find and note the VXO tuning range.

With the crystal oscillator known to be working, you can listen for a signal from your big rig. Turn the rig's power level down as low as it will go and transmit into a dummy load.

Once the receiver has been verified working, reverse the process and transmit to the big rig. A RF power meter in line with the dummy load should be used to verify power output. Use a straight key mode to measure power.

Now you can "calibrate" your dial. Find what frequency you are transmitting at with the big rig. Then key the big rig and tune for zero beat. Mark this position. This is your transmit frequency, to which you will tune to either side of for reception.

Repeat this process for the 12 and 10 meter bands.

AGC setting:

The VR1 trimmer sets the maximum volume of the receiver. To set the AGC, turn VR1 full CW. Gradually turn CCW until you hear some "motorboating". Continuing turning until it just does stop. That is the recommended position. CW/CCW instructions reversed when VR1 is mounted on the solder side.

Since the receiver isn't exceptionally sensitive, most signals will not start to pump the AGC. But if an exceptionally strong station does show up, it won't blow your ears out. It will still be pretty loud though.

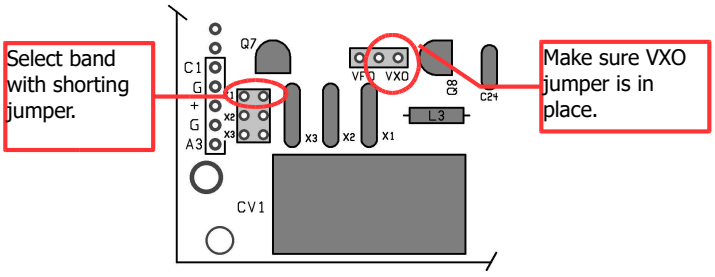
Depending on your comfort and headphones, the side tone may be too loud, to lessen try increasing R15 to 470K.

Operation:

Crystal control:

The operation in this configuration is very simple.

Select which band you want with the shorting jumper on the X1-X2-X3 crystal select SIP pins. Make sure the VFO/VXO jumper is in the VXO position.



The transmit frequency is fixed and is a few kHz lower than what's marked on the crystal. The receiver frequency is variable and is more or less centered around the transmit frequency. The range depends on the band, but is roughly +/- 4 kHz. Nominally, you will tune about 600 Hz one side or the other of your transmit frequency to hear a station calling on your transmit frequency. On 15 and 12, tune above transmit frequency to hear station zero beat to MultiDC transmit frequency. On 10M, tune below. Oscillator stops when the polyvaricon is about ½ full capacity, but can tune low enough to get a good beat note from other station.

Because this DC receiver's selectivity is about +/- 3 kHz, this is not a rig you want to use for contest weekend or when the band is real active! An external audio filter would be helpful in these situations. It also makes it hard to know if you're going to transmit anywhere near the frequency a station calling CQ is on. It would be helpful to "calibrate" your dial to know where the zero beat frequency of your transmitter is. If you hear a station calling which seems to be on your frequency, it is best to tune either side of your transmit frequency to make sure you can hear a beat note on either side of it.

The simplest method is just to be the station calling CQ and have them come to you.

Digital VFO option:

The digital VFO makes responding to stations calling CQ practical, along with giving full band coverage (and beyond), but it is a two step process.

1. Tune for zero beat. (No tone)
2. Activate RIT. Close the VFO function switch for 1 second.

- The VFO will automatically shift higher by 600 Hz to provide the beat note. When the transmitter is keyed, the VFO will automatically shift back to the zero beat frequency.
- The receiver offset sideband can be changed by tapping the VFO function switch, or

with the tune up and down switches. The tuning rate is automatically set 10 Hz for fine tuning.
- Exit RIT mode by closing the RIT switch for 1 second.

VFO Function switch:

- A short click of the switch advances the tuning rate. Tuning rates of 10 Hz, 100 Hz, 1 kHz, 5 kHz, 10 kHz and 100 kHz are available. The decade digit for the selected tuning rate will blink when selected. The 1 kHz digit will blink twice when the 5 kHz rate is selected.
- A 1 second closure of the switch activates RIT. The display shifts to show the difference between the transmit frequency and the receive frequency. [r 0.60] An offset of +600 Hz is automatically applied with RIT is enabled.
- A two second closure of the switch is the band select mode. Use the up and down tuning switches to select the desired band. [b XX] where XX is 16(0) to 10 meter bands.

Calibration:

- A 5 second closure of the switch enters calibration mode. The MSD becomes a 'C".
- Ideally, a frequency counter is used to then calibrate the VFO frequency. Use the tuning switches to adjust the VFO frequency. Each click of the switch only moves the calibration 1Hz, so it may a take a few.
- Alternately, you can zero beat a SWBC station.
  - First, find a SWBC station. Note that when outside the ham bands, the display shifts to show the MHz digits. Only the 100 kHz, 10 kHz and 5 kHz tuning rates are available outside the ham bands.
  - Once you find a SWBC station, you will likely find the audio is wobbly or has a beat note mixed in.
  - Activate cal mode.
  - Use the tuning switches to eliminate the audio wobble and beat note. You will now be zero beat. Remember each click only moves a single Hz.
- Click the Function switch to save and exit.

Rotary encoder option:

An inexpensive EC11 rotary encoder (e.g. Mouser #52-PEC11R4115KN0018) and be connected to the VFO A0, A1, and Gnd. pads for rotary tuning.

Keyer:

The default power up speed is 20 wpm. The keyer implements Iambic B mode keying.

Changing code speed:

- Hold closed the Keyer function switch for a second.
- The Morse letter "S" will sound by the sidetone.
- The DOT paddle increases speed.
- The DASH paddle reduces speed.
- This function will automatically exit after a 1 second pause in paddle closer, or click the function switch.

Morse Message memory:

Two memories are available.

To enter a message:

- Hold the function switch closed until the Morse letter "M" is sounded.
- You may now start to key in your message.
- Ideal timing is used to determine letter element groups and word spacing.
- The pause between letter elements must be between 3 and 7 dot time length long.
- A pause longer than 7 dot time inserts a word space. A pause shorter than 3 dot time keeps entering elements into the buffer, producing gibberish when played back.
- Once you have completed your message, click the function switch
- The message will play back so you can hear if you ran letters together or not.
- If the message sounds good, store it into one of the memory locations by tapping either the DOT paddle (we'll call this memory 1) or the DASH paddle (memory 2).
- OR, click the Function switch to clear and try again.

To send a message:

"Tap" the Function switch for less than ½ second, then tap either the DOT or DASH paddle within another ½ second.

Once a message starts to send, it can be paused or terminated using the paddle or set to beacon mode. Paddle and Function switch are sensed during word space.

- DOT paddle will terminate message sending.
- DASH paddle will pause message sending.

Beacon Mode:

Only the Message 1 location can be set to Beacon mode.

- Use the "Enter a message" instructions and store the beacon message in location 1
- Activate the message with the DOT paddle.
- Close the Function switch to enable Beacon mode (the letter "B" will enunciate by the sidetone). *The switch is only sensed during a word space, if there are no word spaces, the switch will not be read.*
- Use the DOT or DASH paddle as above to pause or terminate message sending.

Straight key mode:

Grounding the DASH input when power is applied activates Straight key mode. Using a mono plug on a Straight key does the trick. If previously programmed, Message location 1 is available to send in Straight key mode. It can only be terminated, since the DASH input is not available.

Transmitter considerations:

It is possible for the transmitter to become unstable when attempting to transmit into a poorly matched load. The current into the PA MOSFETs can start to exceed safe limits with high SWR, especially on 10M. Therefore, these conditions should be avoided!

If you need to use an antenna tuner or to make sure the SWR is safe, it is recommended that you use an absorbent, resistor SWR bridge. These are available from QRPguys, with or without an associated tuner.

Want lower power output?

1. Lower the supply voltage. The Multi-DC transceiver will operate down to about 8 volts, at which point the RF power output will be between 1.5 and 2 watts depending on band.

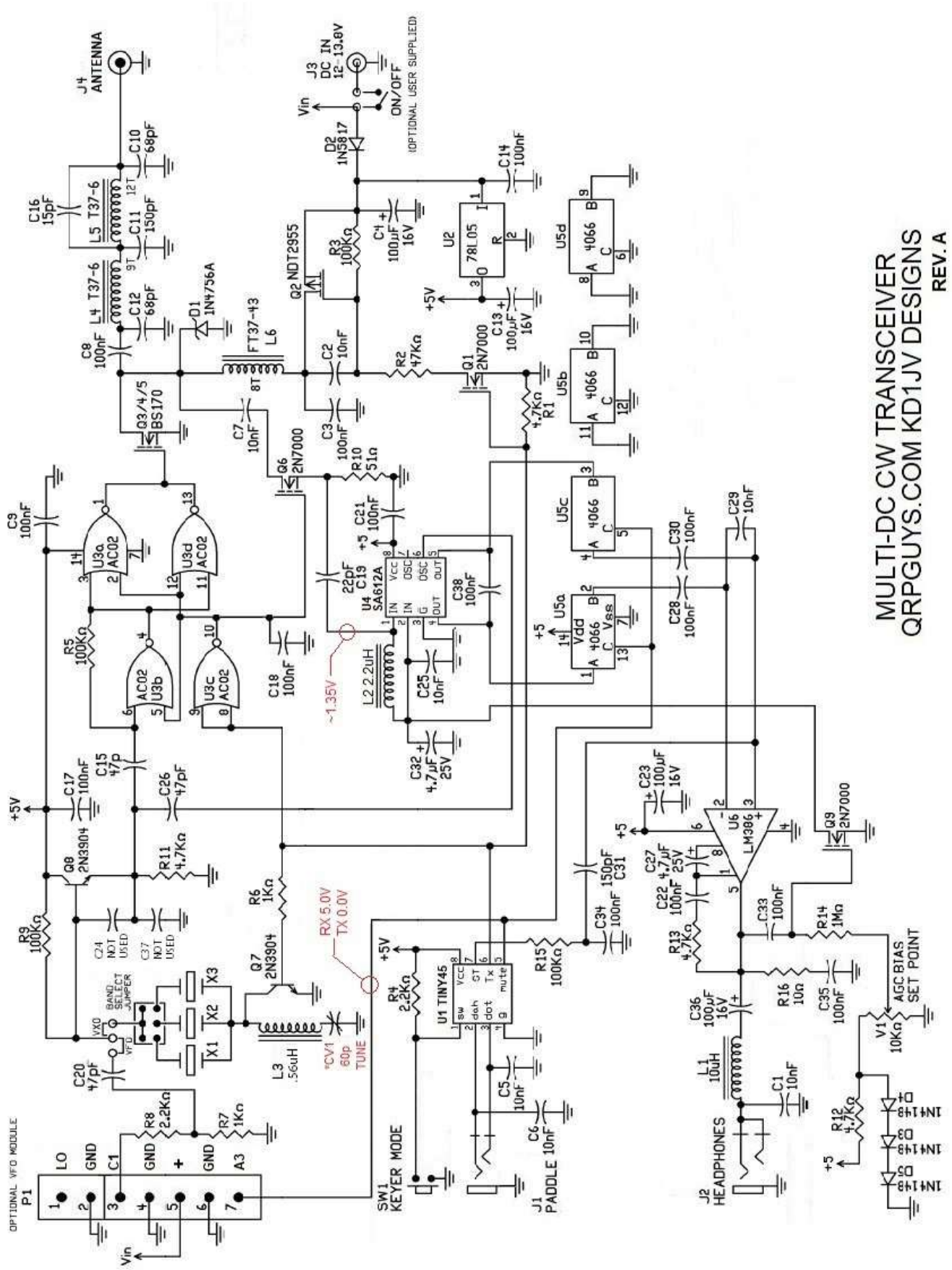
What about other bands?

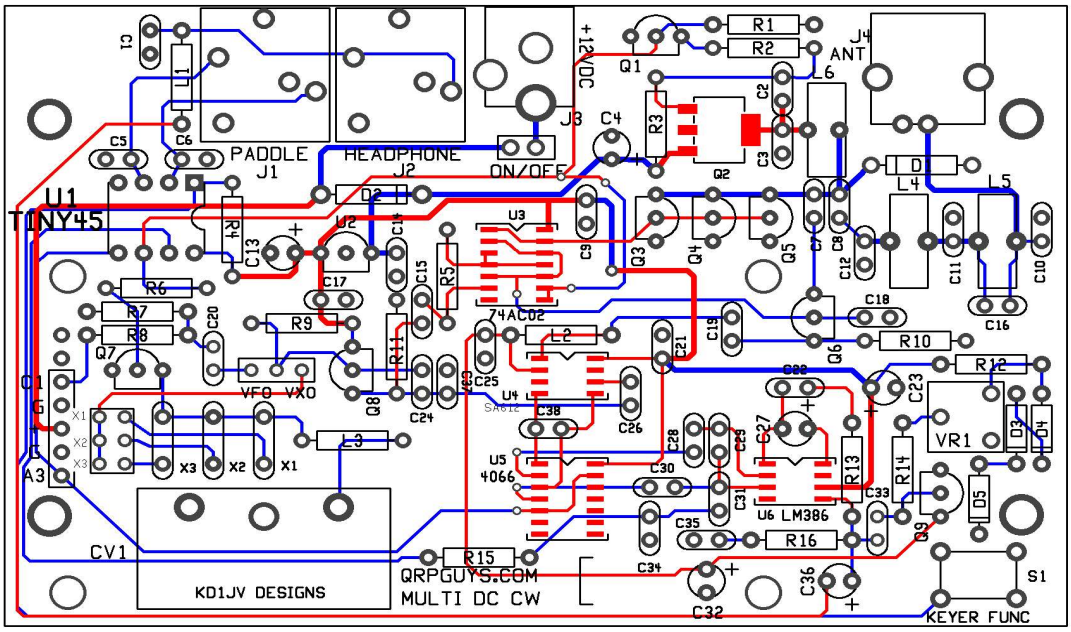
Sorry, not recommended. We are able to make a three band 15/12/10 meter rig because these bands have a relatively small frequency spread and are not harmonically related. Therefore we can get away with a single transmitter Low Pass Filter for all three bands and meet spectral purity regulations.

So, if this rig were to be modified for a lower band, it would become a single band radio. In addition, bands like 20 and 40 have much more activity than 15/12/10 which make using a Direct Conversion receiver challenging. In addition, operating at lower a frequency and closer to the SWBC bands can cause overloading of the mixer unless the front end filtering is improved.

There are better options for single band rigs for the lower frequency bands and no doubt you already own several.

Schematic:


MULTI-DC CW TRANSCEIVER
QRPGUYS.COM KD1JV DESIGNS
REV. A
J4 ANTENNA
J3 DC IN 12-13.8V
ON/OFF
(OPTIONAL USER SUPPLIED)
D2 1N5817
Vin
C14 100nF
U2 78L05
+5V
C13 100µF 16V
C1 100µF 16V
R3 100KΩ
Q2 NDT2955
D1 1N4756A
L4 T37-6 12T
L5 T37-6 9T
C16 15pF
C10 68pF
C11 150pF
C12 68pF
C8 100nF
FT37-43 L6 8T
C2 10nF
R2 47KΩ
Q1 2N7000
R1 4.7KΩ
C7 10nF
C3 100nF
Q3/4/5 BS170
Q6 2N7000
R10 51Ω
C21 100nF
C9 100nF
U3a AC02
U3d AC02
U3b AC02
U3c AC02
R5 100KΩ
U4 SA612A
C19 22pF
C38 100nF
C18 100nF
~1.35V
L2 2.2uH
C25 10nF
C32 4.7µF 25V
U5a U5b U5c U5d 4066
C30 100nF
C29 10nF
C28 100nF
C17 100nF
C15 47p
C26 47pF
C23 100µF 16V
U6 LM386
C27 4.7µF 25V
C22 100nF
C33 100nF
R14 1MΩ
R13 4.7KΩ
R16 10Ω
C35 100nF
C36 100µF 16V
L1 10uH
C1 10nF
J2 HEADPHONES
V1 10KΩ AGC BIAS SET POINT
R12 4.7KΩ
D4 D3 D5 IN4148
Q9 2N7000
C31 150pF
C34 100nF
R15 100KΩ
R4 2.2KΩ
U1 TINY45
C5 10nF
C6 10nF
J1 PADDLE
SW1 KEYER MODE
R6 1KΩ
Q7 2N3904
RX 5.0V
TX 0.0V
*CV1 60p TUNE
L3 .56uH
X1 X2 X3
C24 NOT USED
C37 NOT USED
BAND SELECT JUMPER
VXO
VFO
C20 47pF
Q8 2N3904
R11 4.7KΩ
R9 100KΩ
R8 2.2KΩ
R7 1KΩ
OPTIONAL VFO MODULE
P1
LO GND C1 GND + GND A3
Vin



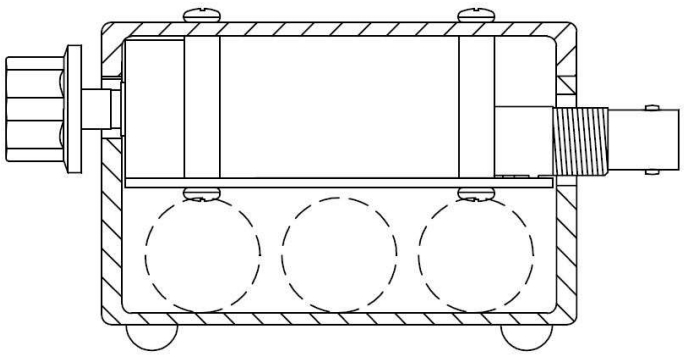
Board tracks. Ground plane not shown for clarity. Most "floating" pads are grounds.

Chassis templates:

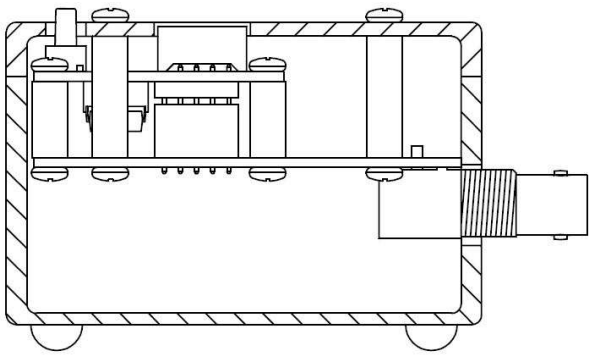
These templates are for the PI Manufacturing Corp. ABS chassis. These should print to scale. Use the 1.000" reference to verify scale.

These dimensions are guidelines only. You may need to adjust them for the spacers you use and batteries chosen, etc. Extensions for the keyer push button and access for the VXO band switch may be necessary as well. Front and rear drill drawings line up with the lid in place. Align the top edge of the drawing with the top edge of the top of the box. Hold in place with some tape.

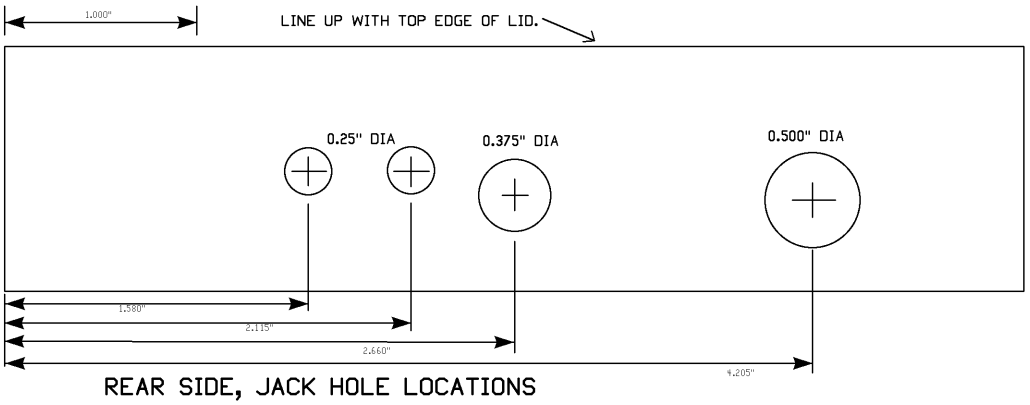
There are ribs along the walls inside the box. There are board slots if someone were to make a whole lot of small boards and line them up inside. Not sure if anyone has ever done that. The jacks are positioned so that the mounting holes end up in the center between these ribs. Unfortunately, the BNC jack had to be moved to the side a little to clear the board mounting hole, so it will run into a rib on one side.



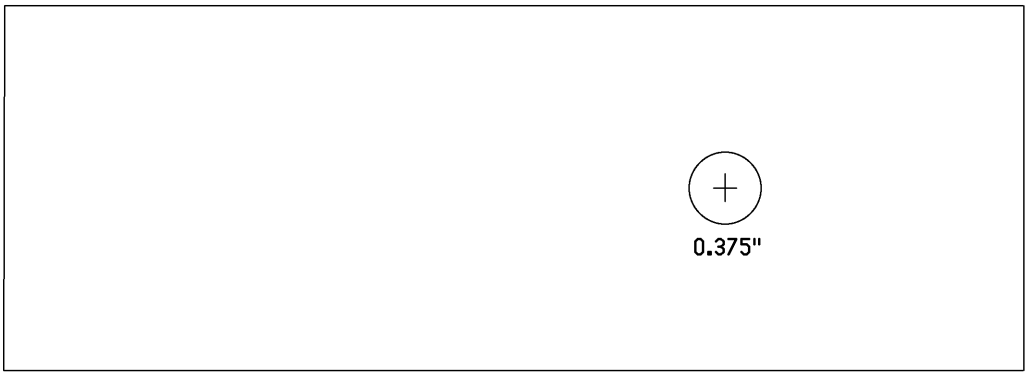
VXO OPTION, IN EBAY CASE



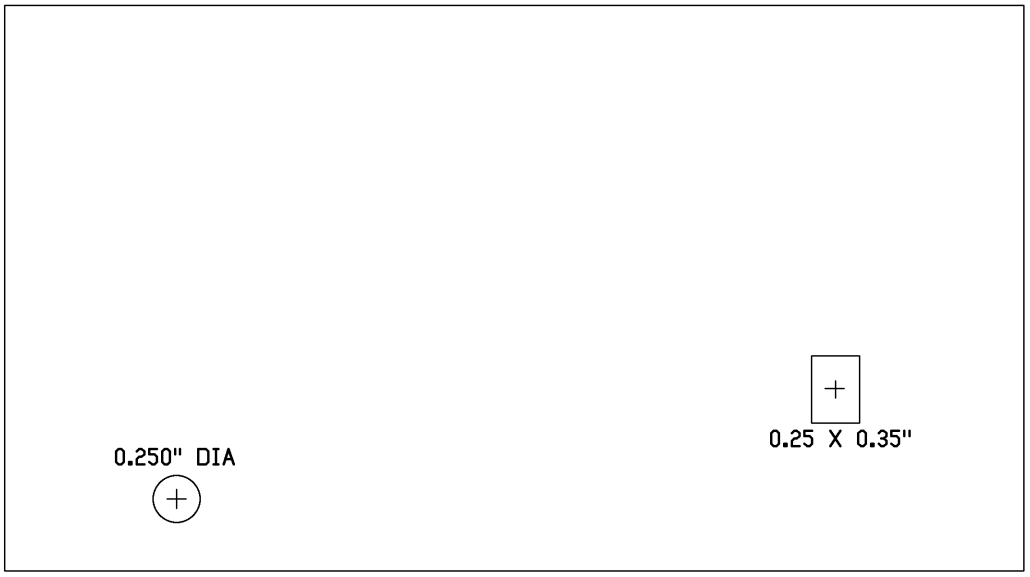
VFO OPTION, IN EBAY CASE



REAR SIDE, JACK HOLE LOCATIONS



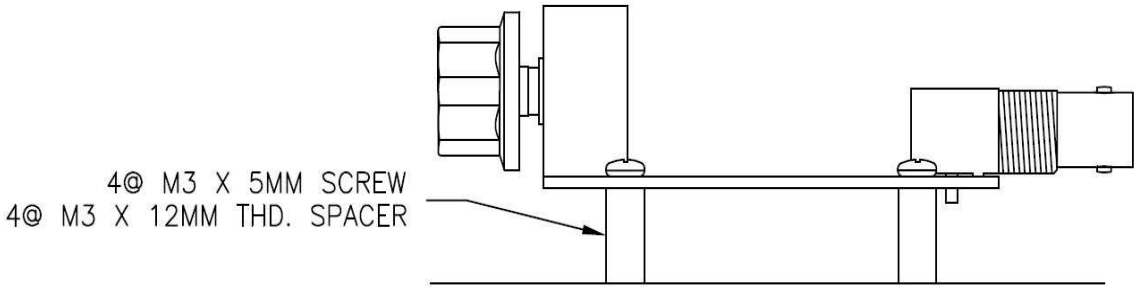
FRONT SIDE



LID

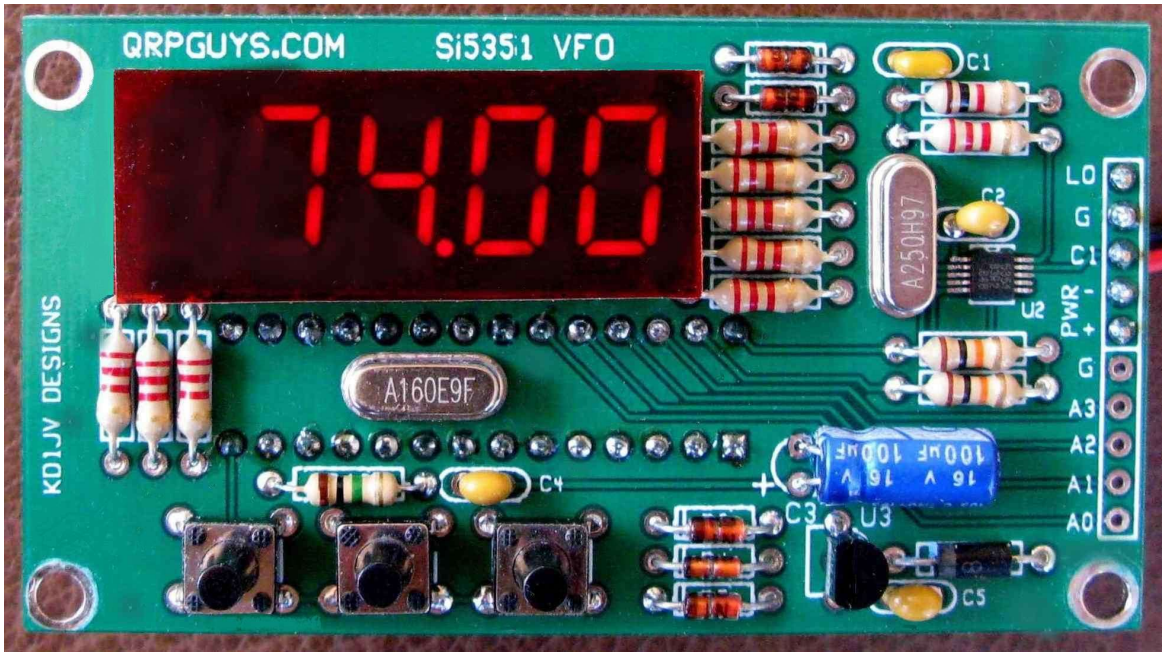
Simple desktop operation (no case), with crystal controlled VXO:

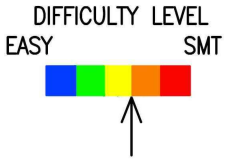
There is no need to install the 5 pin SIP female header on the back side. In this configuration all the remaining electrical components are installed on the front side. The board is kept off your operating surface by four threaded 12nn long nylon standoffs attached to the solder side of the board and M3 x 5mm long screws to retain them.



HARDWARE ASSEMBLY FOR DESKTOP VXO OPTION, VIEWED FROM RIGHT SIDE

Si5351A VFO for the Multi-DC Transceiver





This Si5351A VFO was specifically designed to complement the QRPGuys Multi-DC 15-10m.

Because this VFO is designed to be used with a Direct Conversion transceiver, the VFO output is at the display frequency with no offset.

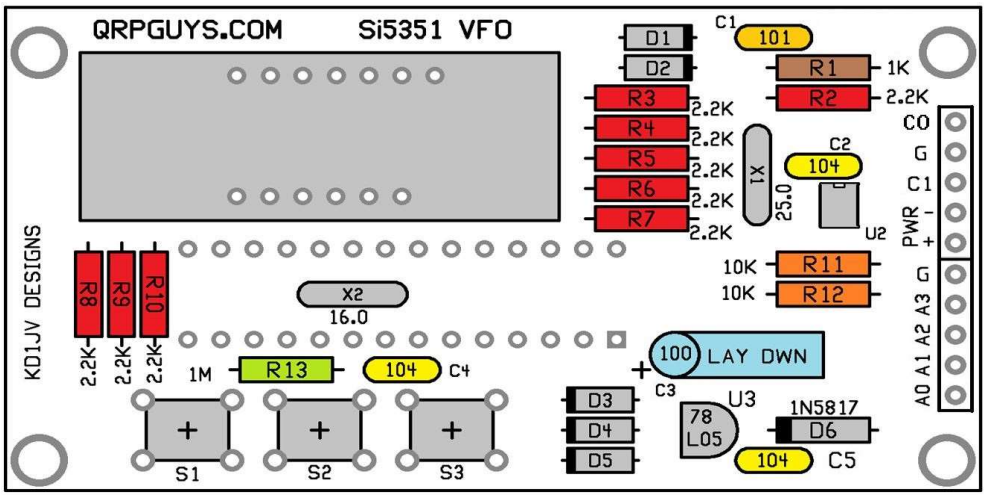
First, familiarize yourself with the parts and check for all the components. If a part is missing, please contact us at <qrpguys.parts@gmail.com> and we will send you one.

Assembly:

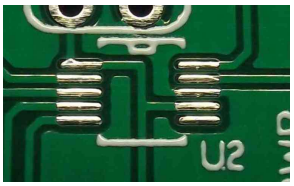
Parts list:

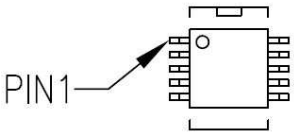
	Quantity	Value		Quantity	Value	
		Capacitors		1	78L05	TO-92
	1	100 pF [101]		1	Si5351A or MS5351M	MSOP10, Pre-installed
	3	100 nF [104]		1	MEGA328	28 pin DIP
	1	100 uF electrolytic		1	5 digit	7 segment LED display
				1	16.00 MHz	HU-49US
		Diodes		1	25.00 MHz	HU-49US
	5	1N4148 glass body				
	1	1N5817 black plastic body		3	11mm	TACT switch
				1	28 pin DIP	IC socket
		Resistors				
	1	1 K [BRN/BLK/RED/GLD]		1	PCB	Circuit board
	9 1 2	2.2 K [RED/RED/RED/GLD] 1 M [BRN/BLK/GRN/GLD] 10 K [BRN/BLK/ORG/GLD]		1 1	Misc.	Red acetate filter, 3/4"x2" SIP 10 position pin strip

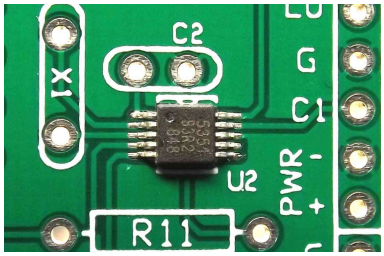
Assembly details:



[ ] If your board has the 5331 pre-installed you can proceed to diodes in the next step, otherwise solder U2, the Si5351A or MS5351M component first. Use your favorite method, or wipe a thin layer of flux on the board, position the chip, noting the orientation of Pin1, and touch each pin with a dry iron. There is enough solder tinned on the board to achieve a good joint on each pin. Be sure there are no solder bridges between pins. Use Solder Wick® if necessary to remove any excess. ***IMPORTANT*** *Do a continuity check from each pin of U2 to the end of the trace to check your work.* Note that pin 6 is unused and pin 8 is GND.







[ ] D1 to D5 (5 places) 1N4148 diode – glass body. Note banded end, match with the silkscreen outline.
[ ] D6 (1 place) 1N5817 diode – black plastic body. Note banded end, match with the silkscreen outline.

[ ] R1 – 1 K resistor [Brown-Black-Red-Gold]
[ ] R2 to R10 (9 places) 2.2 K resistor [Red-Red-Red-Gold]
[ ] R11, R12 (2 places) 10 K resistor [Brown-Black-Orange-Gold]
[ ] R13 (1 place) 1 Meg resistor [Brown-Black-Green-Gold]

[ ] X1- 25.00 MHz crystal
[ ] X2 – 16.00 MHz crystal – Make sure the leads are soldered as the DIP socket will cover these pads and will difficult to fix if there is a soldering issue there.

[ ] C1 (1 place) 100 pF [101]
[ ] C2, C4, C5 (3 places) 100 nF (0.1 uF) [104]
[ ] C3 – 100 uF electrolytic. Lay this part down flat to board. Long lead is + .

[ ] 28 pin DIP socket. This gets installed on the bottom of the board. Match notch on socket with notch on board. Before soldering more than one (1) lead, make sure all of them are sticking out of pads and the socket is set flat onto the board. If a lead gets folded under the socket as you insert it, fixing it will be difficult once more than one lead is soldered.
[ ] Display – this can only go in one way.
[ ] S1, S2, S3 – TACT switches.
[ ] U3 – 78L05, observe the silkscreen outline
[ ] Install the two 5 pin SIPs at J5 on the back side of the pcb.
[ ] U1 – ATMEGA328P in socket. Match notch on end of chip with notch on socket.

This completes assembly of the board.

Preliminary testing:

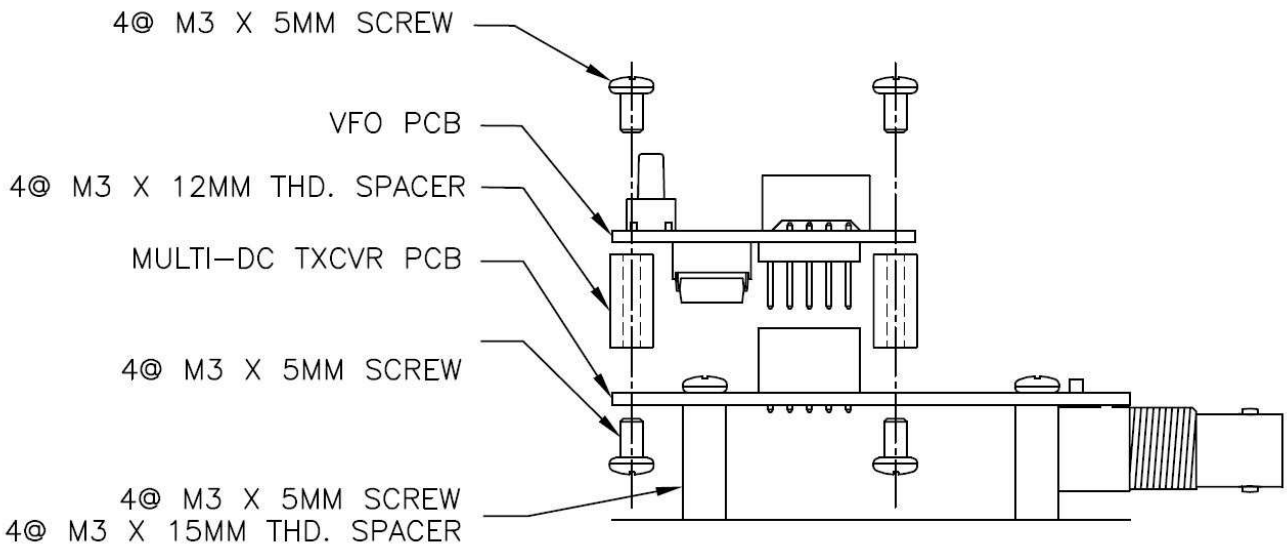
- Before applying power, do a double check of your soldering, making sure you didn't miss any.
- Temporarily tack a couple of clipped resistor leads to the PWR + & -, and connect 9 to 12 volts to the power terminals.
- The display should light up with DC **. ** being the firmware revision. After a second, bn "band" will be displayed, then finally by the frequency.

The VFO is now ready to use.

Mounting the VFO assembly to the main board:

Simple desktop operation (no case), with optional Si5351A VFO:

Remove CV1 polyvaricon if installed. It will create interference if it remains on the board. In this configuration the VFO is mounted on the solder side of the board, plugging into the installed SIP female socket mounted on the backside. Make sure the pins and socket are soldered to the correct position on the pcb. Mount the keyer function switch on the same side as the VFO.



HARDWARE ASSEMBLY FOR DESKTOP VFO OPTION, VIEWED FROM RIGHT SIDE

VFO Operation:

The VFO is controlled by three push buttons.

1. Menu.
2. Tune down.
3. Tune up.

MENU:

Menu button 1/2 sec. push, change decade digit for tuning rate.
Menu button 1 sec. push 'r' RIT + or -
Menu button 2 sec. push, 'dS', display shift
Menu button 3 sec. push, 'bn' appears. Tune up or down, push “Menu” button to select.
Menu button 12 sec. push , 'CAL', calibration
Menu button 15 sec. push, 'rES', clear eeprom stored information (frequency calibration value).

Calibration:

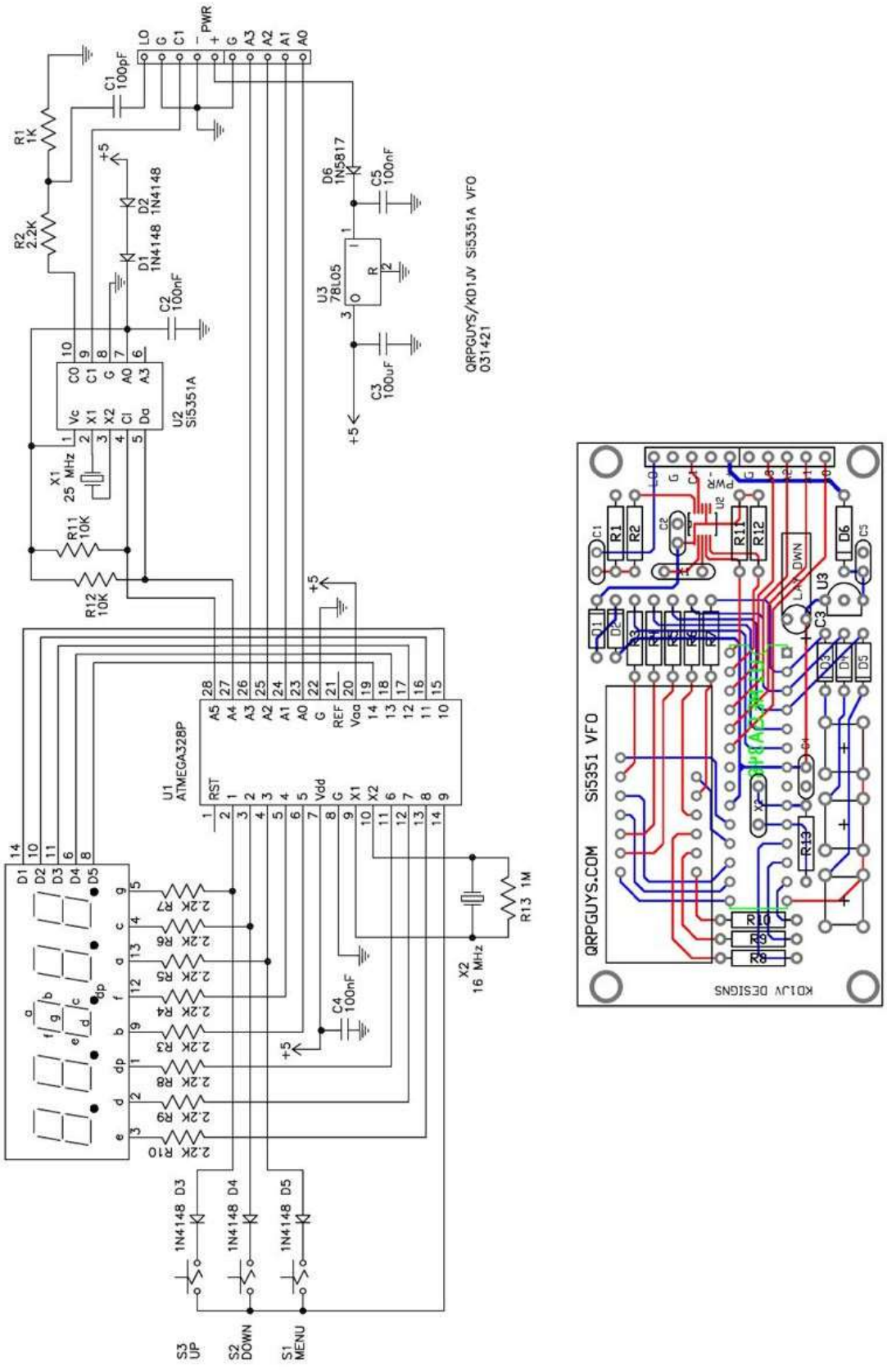
- An ~12 second closure of the switch enters calibration mode. The MSD becomes a 'C".
- Ideally, a frequency counter is used to then calibrate the VFO frequency. Use the tuning switches to adjust the VFO frequency.
- Alternately, you can zero beat a SWBC station.
    - First, find a SWBC station. Note that when outside the ham bands, the display shifts to show the MHz digits. Only the 100 kHz, 10 kHz and 5 kHz tuning rates are available outside the ham bands.
    - Once you find a SWBC station, you will likely find the audio is wobbly or has a beat note mixed in.
    - Activate calibration mode.
    - Use the tuning switches to eliminate the audio wobble and beat note. You will now be zero beat. Remember each click only moves a single Hz.
- Click the Menu switch to save and exit.

Tune Up and Tune Down:

The frequency is advanced or decremented by the selected tuning rate each time the switch is clicked.

The Arduino sketch for the Atmega328P is open source and available on the main page for download.

Notes:


QRPGUYS/KD1JV Si5351A VFO
031421
Si5351 VFO
QRPGUYS.COM
KD1JV DESIGNS