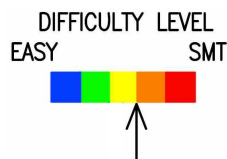
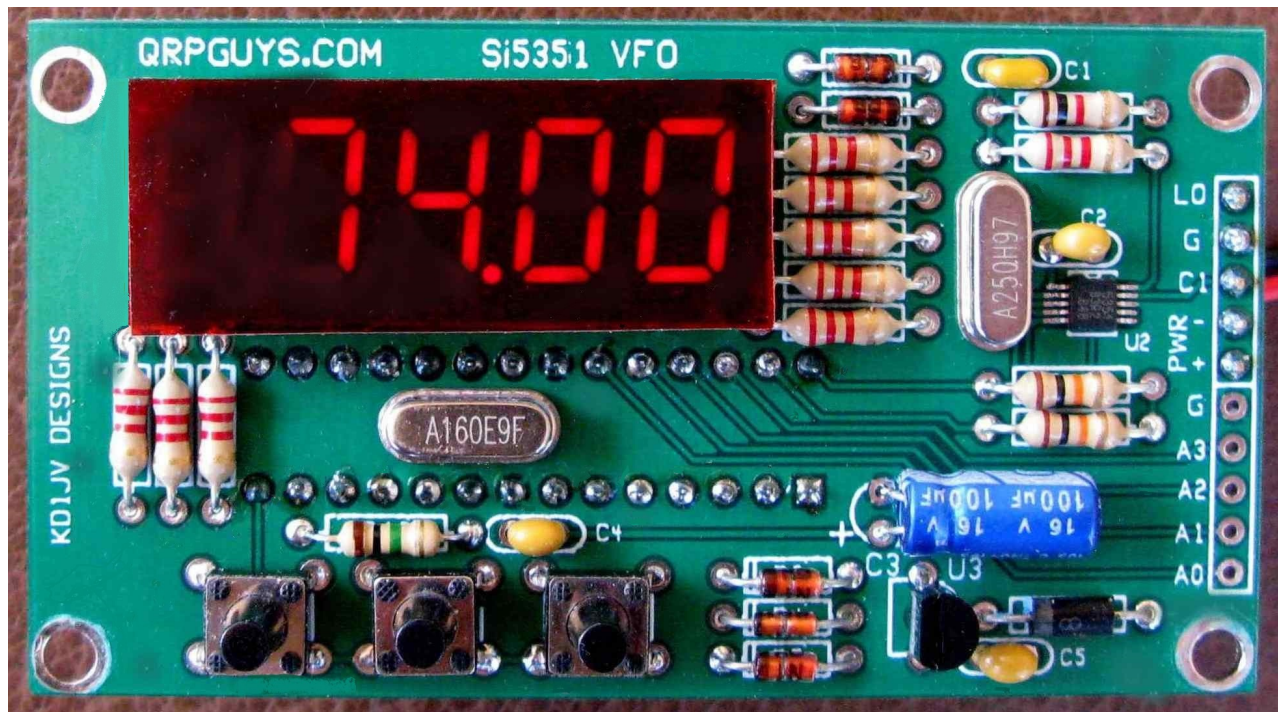




## QRPGuys/KD1JV Si5351A VFO



The Si5351A VFO board was designed to complement the QRPGuys FT8 v. II DSB Transceiver. For 160m-17m the default frequency is for the FT8 frequencies, for 15m-10m the default frequency is for qrp calling frequencies. The VFO enables the transceivers to operate in other parts of the band so that other modes can be used or monitored.

Connect an amplified speaker to the transceiver and it can be used as a general converge receiver. Tuning outside the selected ham band is allowed. The absolute limits are 500 kHz and 30 MHz. When tuned outside the ham band, the display will shift to show the MHz digit(s). Best reception will occur when tuning below the frequency of installed band module.

As a starting point, the VFO is programmed with the FT8 frequency for 160 to 17 meters so that additional bands can be added beyond the 40-30-20 mix currently supported using crystals. For 15m-10m the qrp frequencies are default.

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

To use a rotary encoder, use Mouser #652-PEC11R4115KN0018. Connect to A0, A1, and Gnd. of the header strip. Connect the encoder switch to the VFO function switch, S1.

Four I/O ports are available for adding additional control functions. The Firmware is written with the Arduino IDE and is open source, allowing for the user to modify the sketch to add functions. One clock output is used with the Digital FT8 transceiver, the other is used for the Multi DC CW Transceiver. The output level at LO is about 1V p-p.

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 [grpguys.parts@gmail.com](mailto:grpguys.parts@gmail.com).

***Please use these instructions for a standalone VFO or for the FT8 V.II. The instructions for a VFO connected to the AFP-FSK Digital Transceiver or MultiDC Transceiver are at the ends of the transceiver manuals***

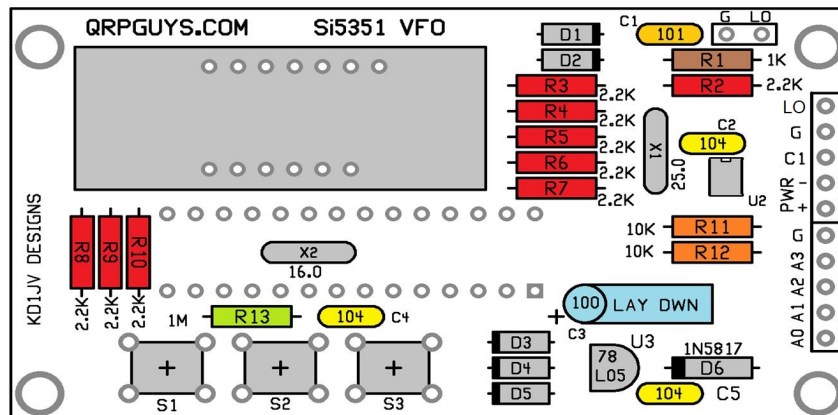
***Please read all the instructions before starting assembly.***

## Assembly:

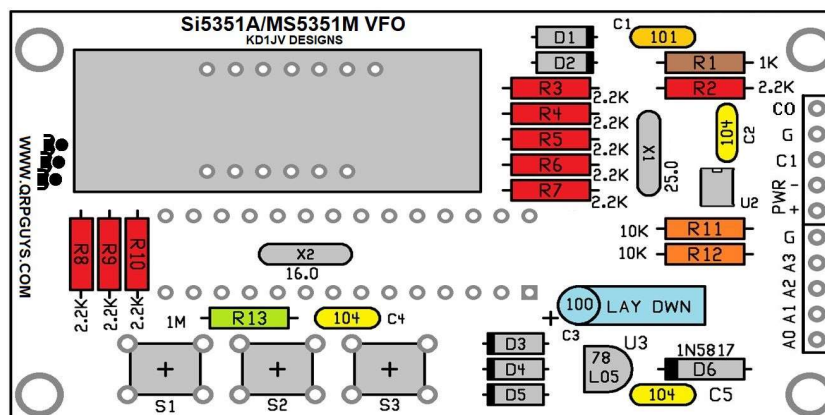
Parts list:

Quantity	Value		Quantity	Value	
	Capacitors		1	78L05	TO-92
1	100 pF [101]		1	Si5351A	MSOP10
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/gold]		1	PCB	Circuit board
9	2.2 K [Red/Red/Red/gold]		1	Mounting hardware	4-M3 x 5mm screw 2-M3 x 30mm screw 2-M3 x 22mm nylon spacer 4-M3 x 8mm nylon spacer 2-M3 clearance x 22mm nylon spacer
1	1 M [Brn/Blk/Grn/gold]				
2	10 K [Brn/Blk/Org/gold]		1	Misc.	Red acetate filter, 3/4"x2"
			24"		#26 stranded wire.
			1		SIP 5 position pin strip

## Assembly details:

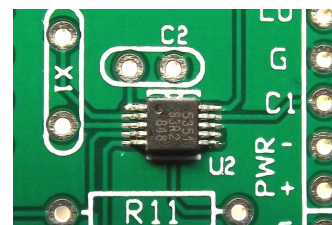
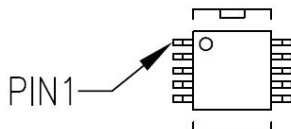
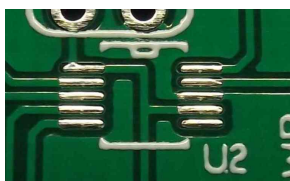


Board v. 022321 and earlier, note placement of C2



Board v. 052721 and later, note placement of C2

- If U2 is not installed, solder the Si5351A, smd 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<sup>®</sup> if necessary to remove any excess. You can 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.



### The VFO will not operate if the diodes are installed incorrectly.

- 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. *Trim leads flush after soldering.*
- U3 – 78L05, **observe outline**
- U1 – MEGA328P in socket. **Match notch on end of chip with notch on socket.**
- This completes assembly of the board.

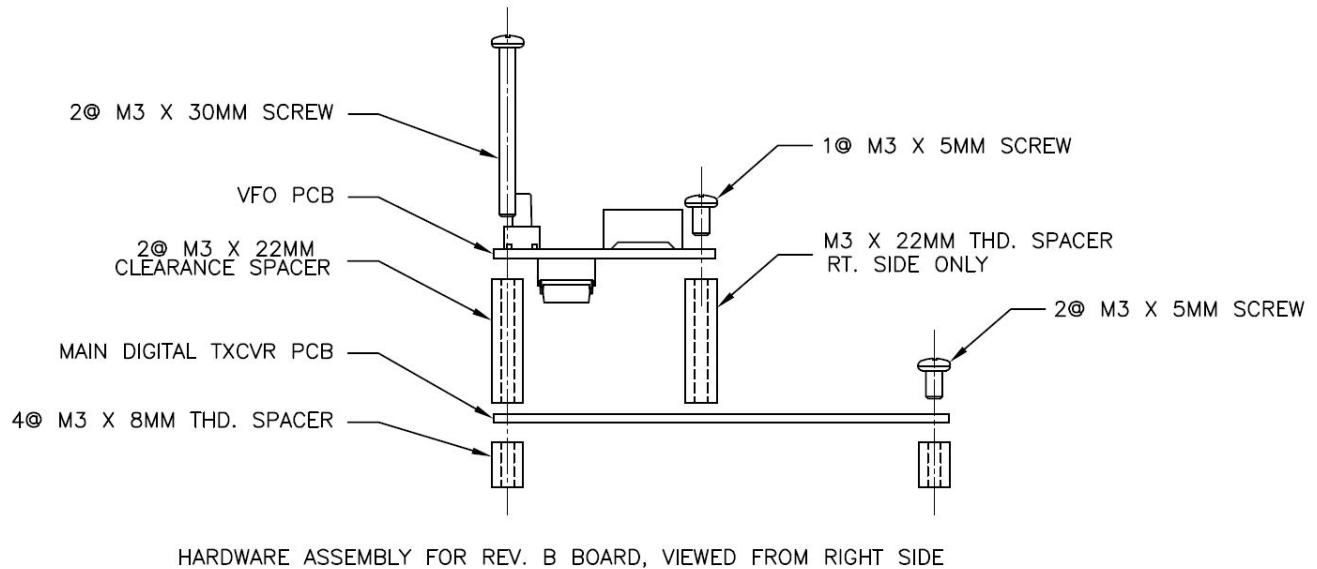
## Preliminary testing:

- 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 all segments on.
  - After a second the band will be displayed. Initially this will be 160M [bn 16]
  - After another second, the operating frequency is displayed, [840.00]
- You can now see if the switches work.
- If you have a frequency counter, connect to the "LO" pad and the frequency should read about what is indicated by the display.
  - Enter the calibration mode and set the frequency to match. For best results, use the highest frequency band, 17 meters.

**The VFO is now ready to use.**

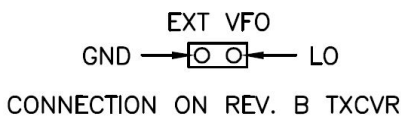
### Mounting the VFO to a Rev. B Digital Transceiver board:

- Using the supplied board spacers and screws, attach the VFO board over the top of the FT8 board, using the two mounting holes on the front edge. One spacer is used in the upper right corner of the VFO board for additional support, but is not attached to the FT8 board. There is no spacer for the upper left corner, as it is above the FT8 PA area.



### Electrical connection of the VFO to a Rev. B Digital Transceiver board:

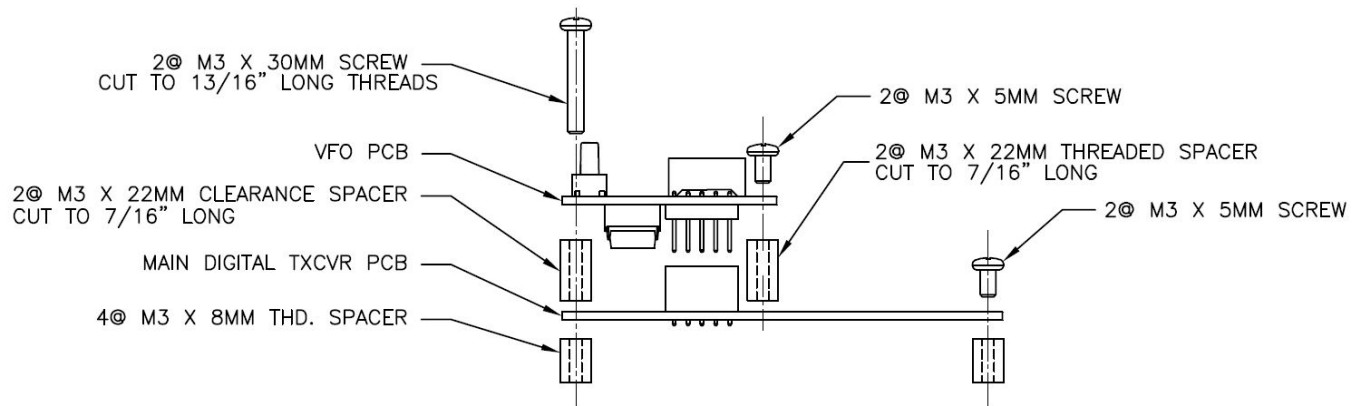
- The 9V pad on the FT board can be used to power the VFO, but it may induce noise into the receiver from the display multiplexing. Although less convenient, connecting to the DC in to the FT8 board at J2 is better. Ground can be picked up on the end of R1, to the right of the 9V regulator tab.
- Jumper the VFO output from pad labeled "LO" (at the top right edge of the VFO board) to the corresponding pad on the FT8 board (see below). Ideally you should use a twisted pair or a short piece of ribbon cable, connecting the respective signal and ground pads together.



### Mounting and electrical connection of the VFO to the Rev. II Digital Transceiver board:

The electrical connections are accomplished with a 5 pin SIP and socket.

- Install the 5 position pin strip, **on the bottom of the board**, with the long pins facing down at the 5 spaces closest to R2.
- Use the hardware sequence below for a FT8 II board. The VFO board mounts closer to the main board than the Rev. B board. You will need to shorten the four 22mm spacers to 7/16" long, and the two 30mm screw threads to 13/16" (19mm) long. Two rear spacers are attached to the VFO board with two 3mm x 5mm long screws, but are for support only. The spacers rest on top of the FT8 board.



HARDWARE ASSEMBLY FOR REV. II BOARD, VIEWED FROM RIGHT SIDE

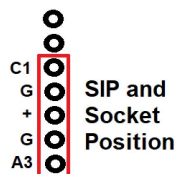
### Digital Transceiver Rev. B or Rev. II Band Module modification:

- If the VFO is used on the Digital Transceiver Rev. B or II, the crystal on the band module must have the crystal or "crystal enable" jumper **removed**. The two 22 pF capacitors can stay, but are no longer really required.
- *You still need the LPF and HPF on each of the respective band modules. Also, remember to change modules when changing bands.*

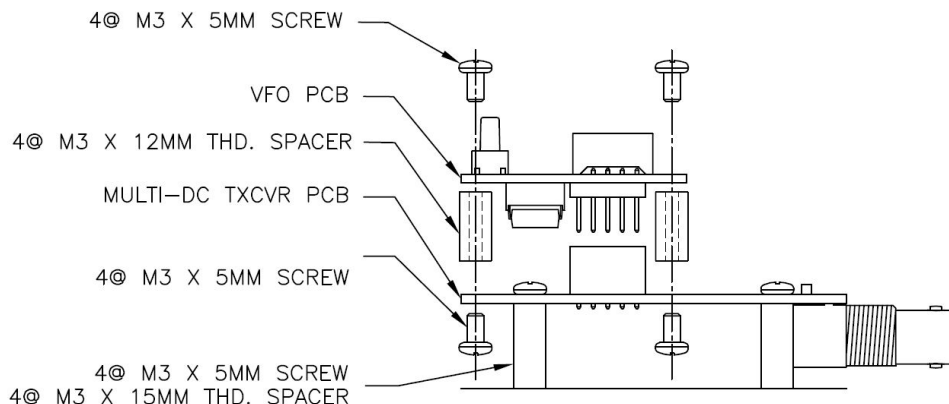
Once the VFO is wired in, you can connect up the antenna, supply and computer and give it a test run.

### Mounting and electrical connection of the VFO to the Multi-DC CW Transceiver:

**The 5 pin male SIP and female socket must be aligned with the C1 thru A3 pins marked on the VFO pcb and Multi-DC pcb.**



Mount the 5 position socket on the back of the Multi-DC board and the 5 pin male SIP on the back of the VFO. The graphic below describes the hardware sequence. Remember to mount the "Keyer Function" switch on the same side as the VFO, and to not install C24 and C37.



HARDWARE ASSEMBLY FOR DESKTOP VFO OPTION, VIEWED FROM RIGHT SIDE

## Operation:

The VFO is controlled by three push buttons.

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

## **MENU:**

The **MENU** switch is used to change the tuning rate, change the band, set RIT for Multi DC transceiver only, and to enter calibration mode.

- 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.
- The RIT function is used for the Multi-DC transceiver only. 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] The default receive offset of +600 Hz is automatically applied with RIT is enabled. **For the Digital Transceiver, do not use RIT. You want to transmit and receive on the same frequency.**
- 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:**

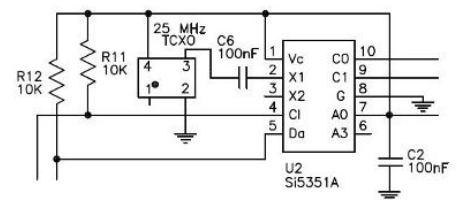
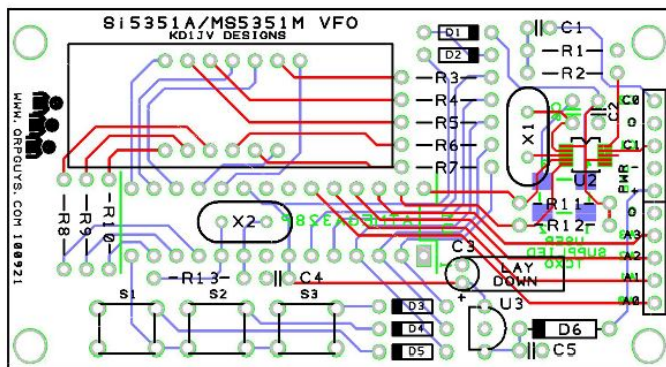
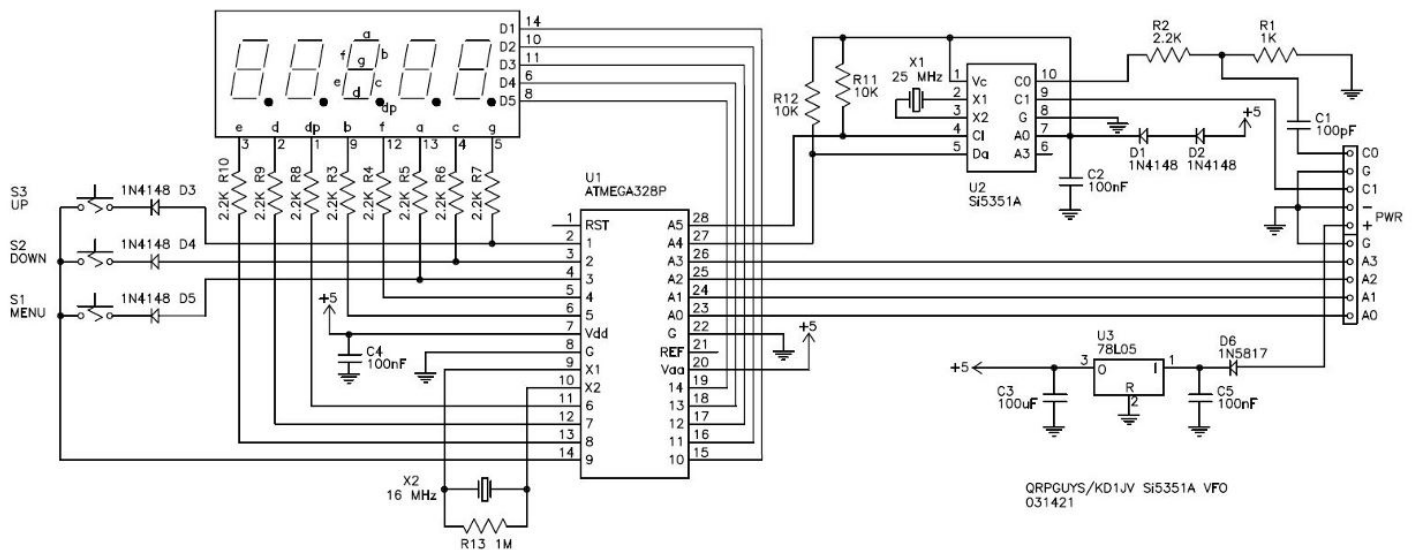
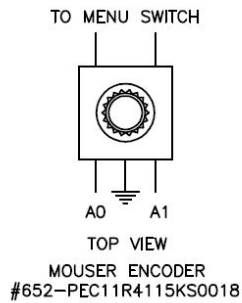
- An ~5 second closure of the switch enters calibration mode. The MSD becomes a 'C'.
- Ideally, a frequency counter is used to then calibrate the VFO frequency. Use the tuning switches to adjust the VFO frequency. Each click of the switch only moves the calibration 1Hz, so it may take a few.
- Alternately, 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.

## **Tune Up and Tune Down:**

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

## Rotary encoder use:

To use a rotary encoder, use Mouser #652-PEC11R4115KS0018. Connect to A0, A1, and Gnd. of the header strip. Connect the encoder switch to the VFO Menu switch S1.



Addendum:

### 25.000 MHz TCXO Modification

The current crystal controlled VFO design has excellent stability after a few minutes warm up. For the ultimate in stability Steve provided for the installation of a commonly available 5.0mm x 3.2mm SMT 25.000 MHz TCXO on the solder side of the VFO board. It can be added at any time. We will not be supplying the TCXO, but it is inexpensive and available from Mouser as part# 520-TXO-5032-25.0T or Digikey# XC2070CT-ND. An additional coupling capacitor, C6, 100nF 50VDC MLCC will also be needed, *and the 25.000MHz (X1) crystal is removed*. This modification still requires the calibration step described in the manual. However if line 36 of the .ino is set to (`#define SI5351BX_XTAL 25000000`) and the Atmega328P is re-flashed, it will be extremely close. Boards v. 052721 and later will have the tcxo user option. Again you will need to supply your own TCXO, coupling capacitor, remove X1, the 25 MHz crystal, and have the ability to install the SMT TCXO. A manual soldering iron is recommended. *Use caution if the hot air method of soldering is used. The MSOP10 SMT device is very close on the opposite side of the board.*

If you substitute a different tcxo be sure to get one with 1-3ppm tolerance.

