ALX-SSB 5 Band Filter Assembly Manual

18 September 2018

Contents

Theory of Operation:

The purpose of a Bandpass Filter is to filter out or reject all unwanted signals. The original KN-Q7A, CS-Series Receive Filter selects only those frequencies desired for the band of operation. That signal is then fed into the Mixer and beats with the IF to give us the frequency we want to listen to. In the original KN-Q7A and CS-Series the Band Pass filters were positioned on the Main Circuit Board and were designed for a Single Band.

The Sandwich VFO (Arduino) provides us with an excellent opportunity to experiment with several options. The VFO provides full band coverage. There is an optional jumper called JP10. This was provided to allow the Sandwich to work with either IF option of the KN-Q7A kit. Usually, the jumper is in or it is not. Since current CS-series transceivers use only a Single IF crystal value, a jumper at JP10 is no longer necessary. By connecting a switch to JP10, it can be repurposed to tell the Sandwich VFO to select different frequency bands.

By slightly changing the Arduino code in the Sandwich VFO, we can provide coverage for a primary operating band (base band) with the switch open (e.g.: 40 Meters) and a secondary operating band with the switch closed (e.g.: 80 Meters).

By placing a 40 Meter receive filter in the path, all other frequencies are rejected. We switch the 80 Meter receive filter in the path at the same time selecting the code for 80 Meters in the Sandwich. Thus, we now have a dual band receive radio.

This new filter combines both the receive and transmit filters into a single board. This reduces the number of components needed for the radio. The signal coming from the NE602 is already operating in the frequency we need. It is still a good idea to filter the signal to clean out any noise that might be there. When transmitting, the bandpass filter is switched from receive to transmit.

Note: This will work with any of the KN-Q7A, CS-Series or ALX-SSB Series base radios. Thus, we can have 40/80 Meter, 40/20 Meter etc.

With the introduction of the ALX-SSB Transceiver we have modified the "Sandwich" into a single board Digital VFO with the Arduino attached on the back. This modification also includes an OLED Frequency Display as well as integrating the Gain Control. We also include a push button for frequency changing.

Figure 1

There are now three pins attached to the back of the Arduino shown in Figure 1 in the lower right-hand corner. These are used to select the appropriate band pass filter on the Filter Board.

Presently, there are Four different Band Pass filters that can be selected. The bands covered are 80, 40, 20, 17 and 15 Meters. If the 5 Band Option is Purchased. Options are also provided for Single Band and Dual Band operation at a slightly reduced cost. See: QRVTronics.com for current price list and availability.

A software upgrade is also available for the proper operation of the 5 Band Filter which is included with the purchase of the Filter Option.

It should be noted that the 5 Band Filter Board is provided as a KIT. Some assembly and modification to the original board is required.

Parts Included:

Single Board Quad Band Board

Part		Value	Type
4 – D1 – D4		1N4148 or equivalent	diode
4 – K1 – K4	OR	G5V-5-H1 9V or equivalent	Large relay
4 – K1 – K4	OR	EC2-12NU or equivalent	Medium relay
4 – K1 – K4		UA2-12NU or equivalent	Small relay

(Relay type will vary depending on availability of relay)

3 – NPN	8050 or equivalent	Transistor
1 – PCB		
1 – Set of Cables	Relay control to Arduino A10, A11, A12	
3 – 2.2K	Resistors – frequency independent (total of 5 – 2.2K)	

80 Meter

1 – C2	2p	capacitor
2 – C1, C3	27p	capacitor
2 – L1, L2	DIY7-3.8	inductor

40 Meter

1 – C5	2p	capacitor
2 – C4, C6	27p	capacitor
2 – L3, L4	DIY7-7	inductor

20 Meter

1 – C8	68p	capacitor
1 – R4	2.2K	resistor
1 – L5	DIY7-14	inductor

17 Meter & 15 Meter

1 – C11	47p	capacitor
1 – R5	2.2K	resistor
1 – L7	DIY7-21	inductor

OR

12 Meter & 10 Meter

1 – C11	27p	capacitor
1 – R5	2.2K	resistor
1 – L7	DIY7-21	inductor

Board Overview:

Do to the availability of certain relays, I have created several Filter Boards.

Boards are shown completed.

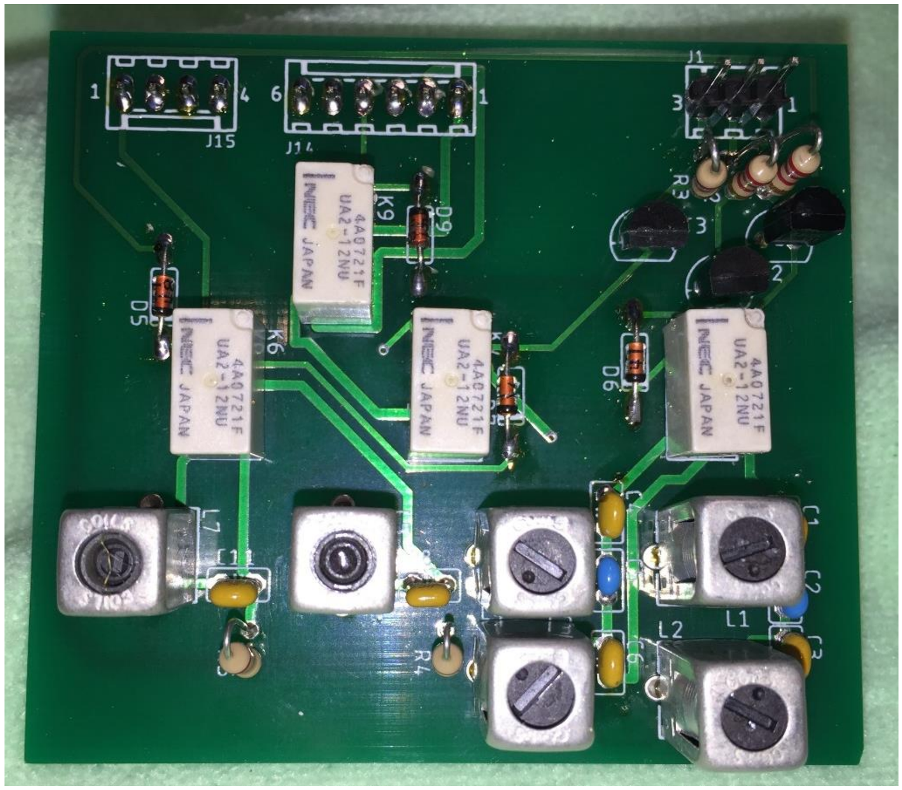


Figure 2
Small Relay Board

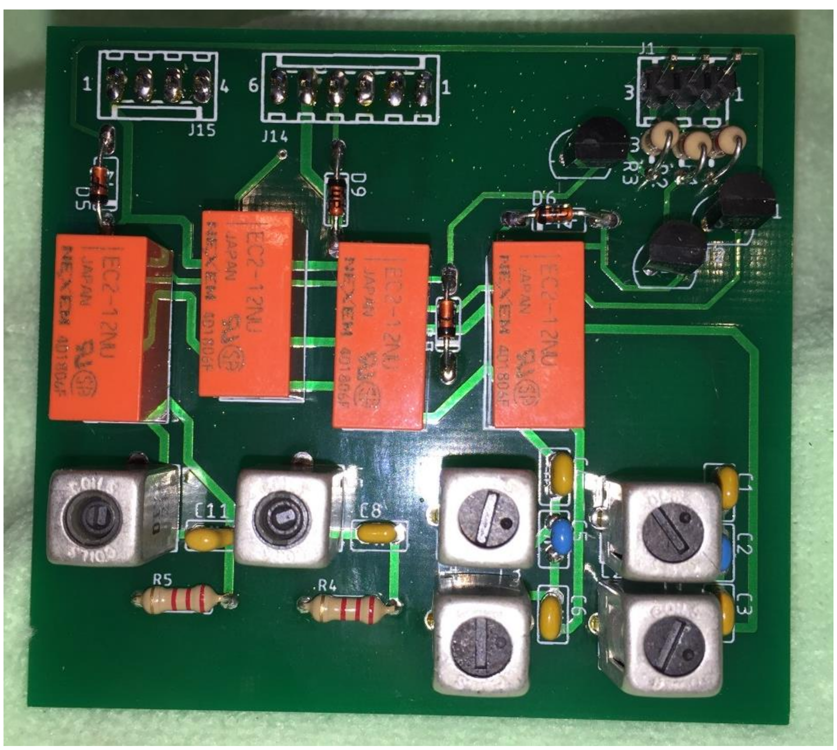


Figure 3
Medium Relay Board

Board Assembly:

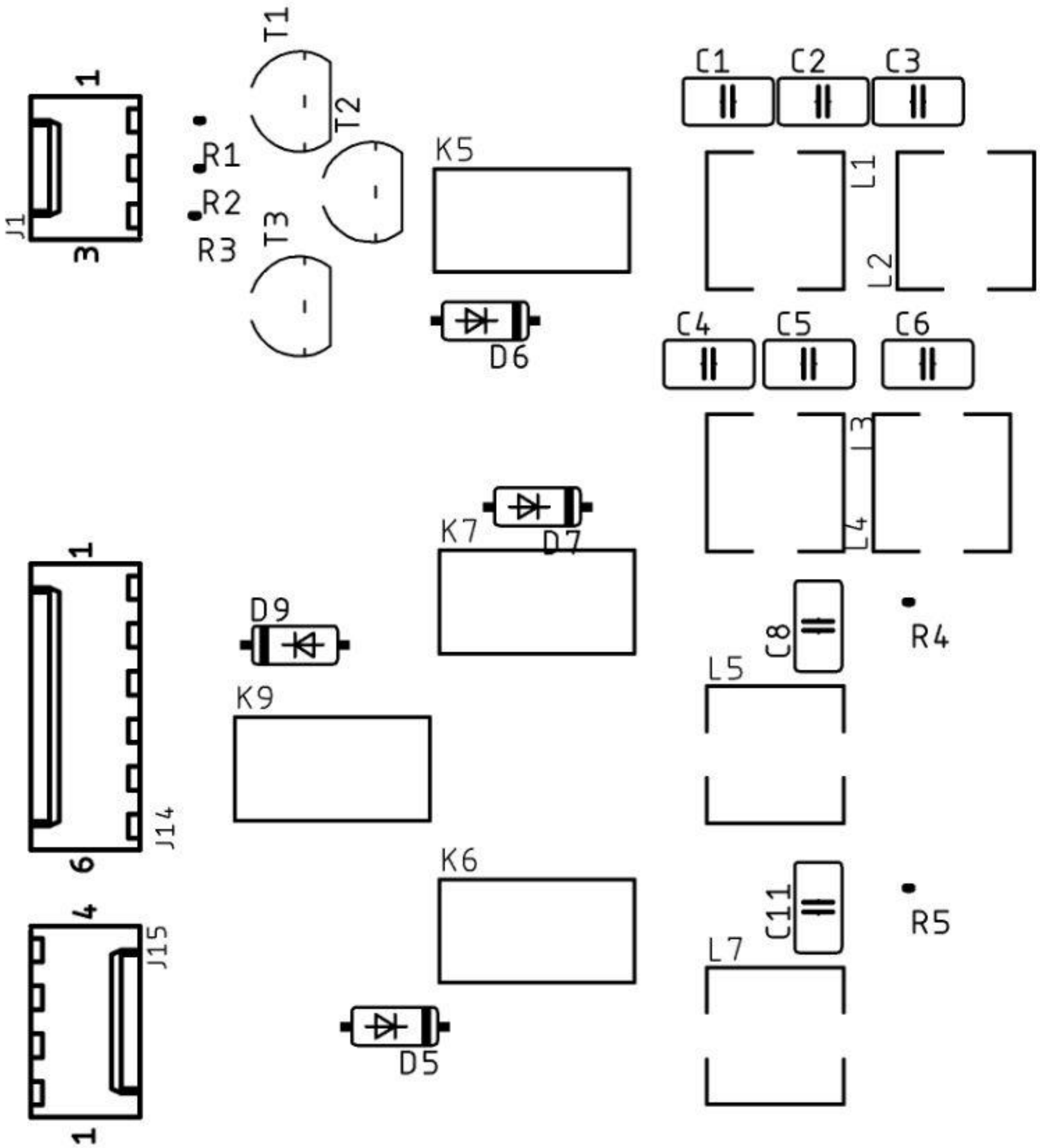


Figure 4

- ☐ Check to make certain that all components are with the appropriate kit.
- ☐ Install the 4 Diodes as marked on the Board. Make certain that they are oriented properly.
- ☐ Solder the Diodes and trim the leads
- ☐ Install the 2 pF capacitors C2 and C5 – 80/40 Meter Bands
- ☐ Install the 27 pF capacitors C1, C3, C4 and C6 – 80/40 Meter Bands

- ☐ Install the 68-pF capacitor for C8 – 20 Meter Band
- ☐ Install the 47-pF capacitor for C11 – 17/15 Meter Band
- ☐ Solder the capacitors and trim the leads
- ☐ Install the 2.2K resistors at R4 and R5.
- ☐ Install the 2.2K resistors at R1, R2 and R3 – bend the leads as appropriate.
- ☐ Install the NPN transistors – T1, T2 and T3
- ☐ Solder the resistors and transistors.
- ☐ Install the Relays – K5, K6, K7 and K9
- ☐ Solder the relays in place.
- ☐ Locate the 6 DIY7 coils
  - Place the DIY7-3.8 – Location L1 and L2
  - Solder first one lead to make certain it is secure and installed properly – Then solder all other leads including the shield tabs.
  - Place the DIY7-7 – Location L3 and L4
  - Solder first one lead to make certain it is secure and installed properly – Then solder all other leads including the shield tabs.
  - Place the DIY7-14 – Location L5
  - Solder first one lead to make certain it is secure and installed properly – Then solder all other leads including the shield tabs.
  - Place the DIY7-21 – Location L7
  - Solder first one lead to make certain it is secure and installed properly – Then solder all other leads including the shield tabs.

This completes the basic filter board.

NOTE: Calibrate board prior to connecting the J14 and J15 cables. This will make calibration easier.

- ☐ Determine how you want to orient the Header Pin Connectors
  - 4 – Pin – Voltage and Filter Output (J15)
  - 6 – Pin – Filter input, power control and Ground (J14)
  - 3 – Pin – Connections to Arduino for control (J1)
- ☐ Use straight pins or right-angle header pins for J14 and J15
- ☐ Use straight pins for J1.
- ☐ Solder header pins in place.

Cable Wiring for Filter Board

- ☐ Connect the wiring cable for J15 (See Figure 4 for connector location)
    - J15 – 1 connect to +12 supply – See Figure 6
    - J15 – 2 Not used with these two relay boards (+8VDC)
    - J15 – 3 connect to See Figure 5
    - J15 – 4 connect to See Figure 5

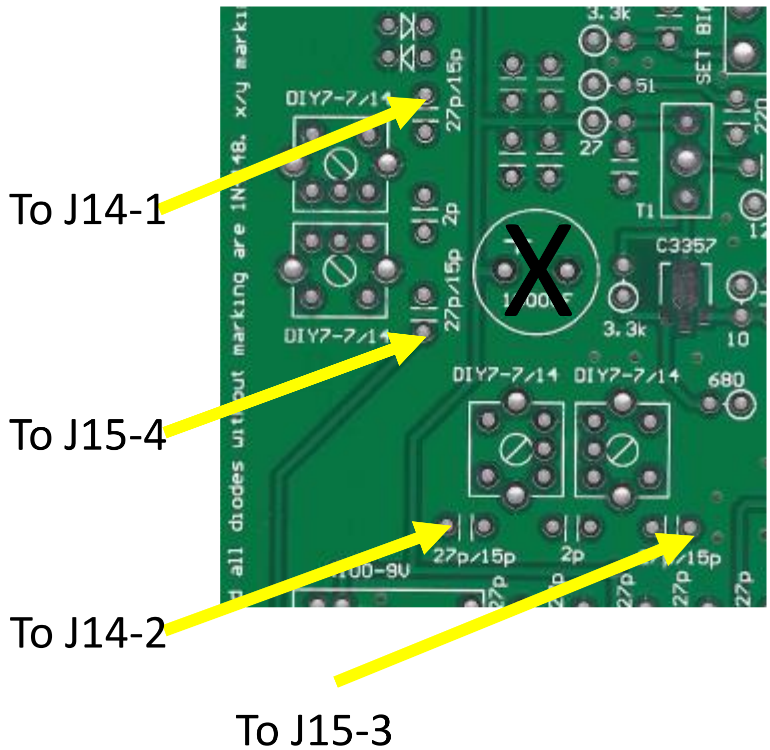
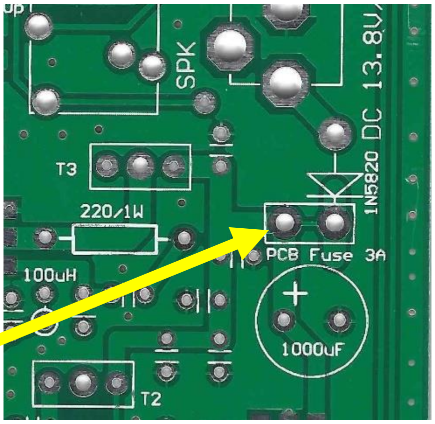


Figure 5

- ☐ Connect the wiring cable for J14
    - J14 – 1 connect to See Figure 5
    - J14 – 2 connect to See Figure 5
    - J14 – 3 Not connected to this board (+8VT)
    - J14 – 4 Connect to +8VT – See Figure 7
    - J14 – 5 GND
    - J14 – 6 GND

J15-1



J14-4

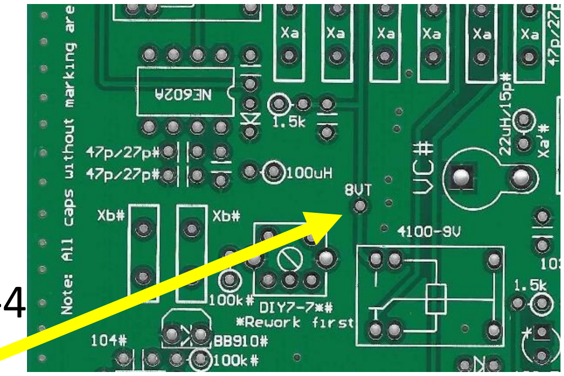


Figure 6

Figure 7

This completes the wiring of the two power and signal cables.

- ☐ If not previously configured, solder a 3-pin header to the Arduino ports A10, A11 and A12.

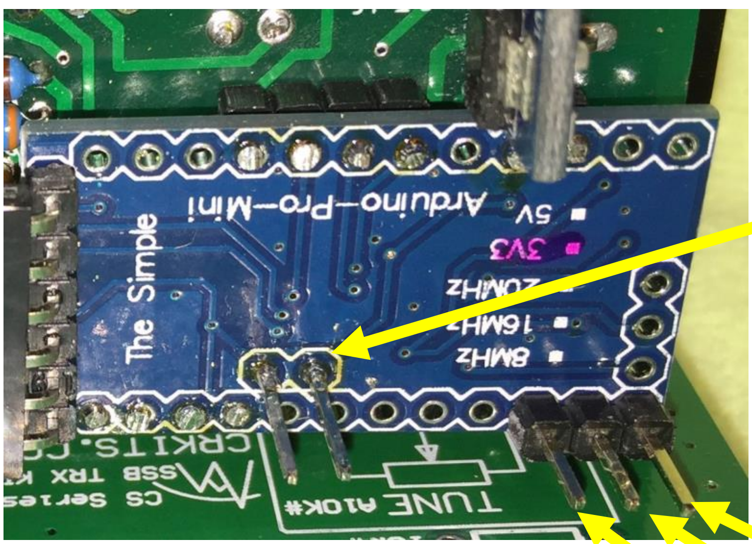


Figure 8

I2C Bus – not used in this application

A10 to J1-1

A11 to J1-2

A12 to J1-3

- ☐ Connect ribbon cable as shown:

Also see Figure 4

CALIBRATION of FILTERS

You may calibrate the filters the same way that you did when first assembling your radio. This does not require any additional equipment.

You will need to change the Band switch to check both receive filter paths.

However, if you have access to a signal generator and oscilloscope, you can adjust the coils more precisely.

Filter Calibration

Filter is not installed in the radio for ease of calibration. Filter can be calibrated once it has been installed, but this way is easier.

The Band Pass Filters need to be adjusted so the passband lies at the center of the SSB ham bands, in this case the 20 and 40m bands, so about 14.22 and 7.22 MHz respectively. We'll need the following test equipment to do that accurately.

- Function generator, capable of generating 7 and 30 MHz sinusoidal signals of about 50-100mV pk-pk
- Scope, at least 50MHz bandwidth
- Scope probes to match scope bandwidth
- Spectrum analyzer, at least 25MHz bandwidth (nice to have)
- DVM for checking resistances and capacitances

For each BPF board the transformers are adjusted to achieve maximum signal, provided by the function generator and measured by the scope. The test setup looks like this for the 20m BPF board:

Set the function generator to a small signal, perhaps 100mV pk-pk at 14.22 MHz, roughly the middle of the 20m band.

IMPORTANT: The ferrite slugs in the transformer cans are very brittle and can crack if too much force is applied by a tool to adjust the slug positions. Use a plastic screwdriver or a tool specific for tuning transformers. Also, touching the cans or the probes with a finger can cause an erroneous reading.

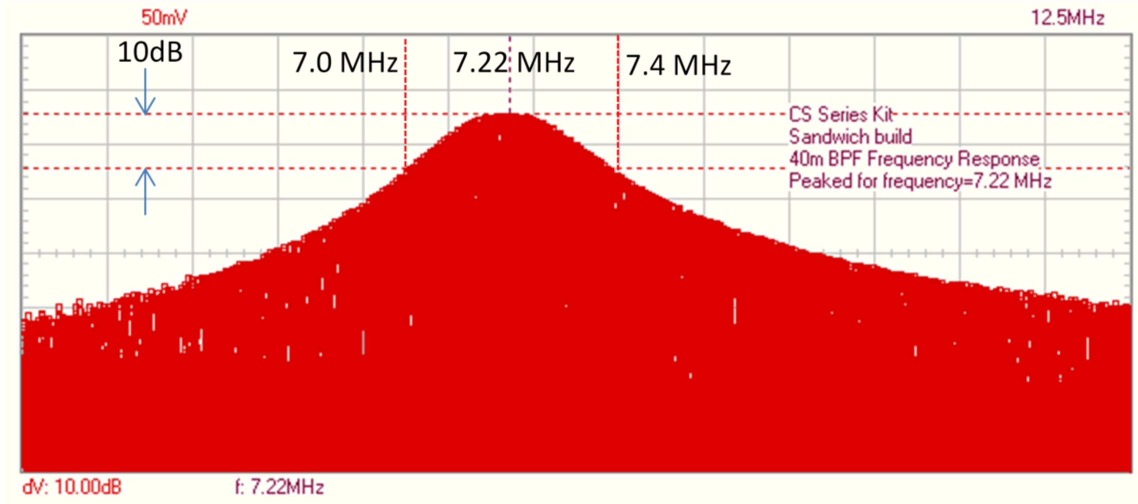
Adjust one transformer at a time, turning the ferrite slug and watching the scope trace for maximum amplitude of the test signal. Go back and forth tuning the transformers until maximum signal is reached.

If a spectrum analyzer is available, we can sweep the signal generator and see the frequency response of the BPF and verify the peak response is at the desired frequency.

- ☐ Locate a standard 9-volt battery.
- ☐ Connect the NEGATIVE pin to the cable going to J14 pin 6
- ☐ Connect the POSITIVE of the battery to J15 pin 1
- ☐ Connect a Signal Source (Generator) to J14 pin 1
- ☐ Connect an Oscilloscope to J15 pin 4
- ☐ Set the source for (80 Meters – 3.800 MHz)
- ☐ Adjust L1 and L2 for maximum Amplitude on the Oscilloscope
- ☐ Connect J1 pin 1 to the Positive of the battery and you should hear a relay click.
- ☐ Set the source for (40 Meters – 7.225 MHz)
- ☐ Adjust L3 and L4 for maximum Amplitude on the Oscilloscope
- ☐ Disconnect J1 pin 1 from positive of the battery
- ☐ Connect J1 pin 3 to the Positive of the battery and you should hear another relay click.
- ☐ Set the source for (20 Meters – 14.225 MHz)
- ☐ Adjust L5 for maximum Amplitude on the Oscilloscope
- ☐ Leave J1 pin 3 connected and also connect J1 pin 2
- ☐ Set the source for (15 Meters – 21.275 MHz)
- ☐ Adjust L7 for maximum Amplitude on the Oscilloscope
- ☐ Disconnect the connections to the 9-volt battery
- ☐ Disconnect all other wires connecting to the filter
- ☐ Return to the Cable Wiring for Filter Board on Page 7

A spectrum analyzer was used in "persist" mode here while the signal generator frequency was swept back and forth.

Again, a spectrum analyzer plot shows the 40m BPF passband centered about 7.22 MHz:



The signal is 10dB down at 7.0 MHz and 7.4 MHz.