Adding a 6th Band to the Alachua County QuintPlexor

by Gordon Gibby KX4Z

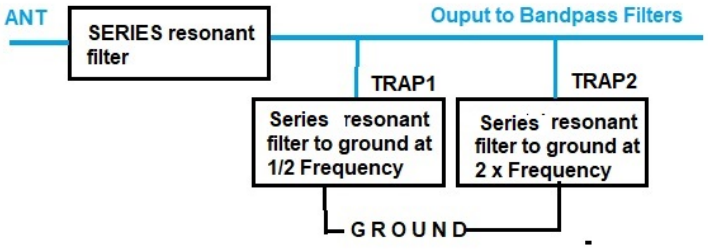
Problem & Proposed Solution

The current Alachua County EOC has only one coaxial cable available for HF antennas. (We're moving and we hope to have more at the new location!) Also, we would like to be able to operate as many as 4 HF stations on one HF antenna during our annual FIELD DAY EXERCISE. Setting up multiple antennas far apart from each other to reduce inter-station desensing in the hot Florida Sun in June is NO PICNIC!

The VA6AM line of antenna multiplexers https://va6am.com/ created by Pavel has been our solution and has worked well when combined with external bandpass filters to boost the total isolation between stations on different bands to 70dB. Our Quintplexor allowed operation on 10 or 6 meters/ 15 meters / 20 meters / 40 meters and 80 or 160 meters. Because there aren't many bands left working after midnight, we desired to provide a 6th output and have separate connections for 80meters and 160 meters.

Technology

Pavel's very successful design for the individual filters that connect directly to the common antenna always starts with a series resonant filter at the band of interest. This immediately reduces the parasitic loss of power that otherwise would be drained away from the antenna by other bands' filters.



Pavel then places two series resonant tuned circuits to ground to act as TRAPS. One is set to the band that is about 1/2 of the frequency of this filter, and the other is set to the band that is twice the frequency of this filter. The impedances X_L and X_C of the L and C that make up these filters is selected so that at the in-between frequency of the desired band, the lower trap presents a resultant of $1.5X_L$ and the upper trap presents a resultant of $1.5X_C$ -- thus making a parallel-tuned resonant circuit at the desired filter band, and NOT shorting that band to ground.

Calculations

A bit of scaling from other bands and calculations come up with the following prescriptions for an 80-meter and 160-meter individual multiplexer filters.

80 Meter MultiPLEXOR	Series Tuned Input	40 meter series trap to ground	160 M series trap to ground
Inductor	~ 6μH*	760 nH*	2.8 uH*
ACTUAL TURNS in our instance	24 turns T130-6	8 turns T130-6	17 turns T130-6
Capacitor	~320 pf >= 1kV	~550 pf >=1kV	~2500 pf, >= 1kV

* = tune to desired performance

160m MultiPLEXOR	Series Tuned Input	1/2 F trap 0.9 MHz	2F trap (80m) 3.6 MHz
Inductor	~ 12µH*	6 uH*	1.5 uH*
Turns	35 turns T130-6	25 turns T130-6 or 37 turnsT80-6	13 turns T130-6 or 18 turns T80-6
Capacitor	~580 pf	5200 pf	1300 pf

* = adjust to desired performance

PARTS

Toroids can be easily obtained from https://kitsandparts.com/ There are many other sources.
Silver Mica capacitors can be used if 500V or more, but I have had good success using 3kV "blue dot" type ceramic capacitors obtained on amazon: https://www.amazon.com/BOJACK-Voltage-Ceramic-Capacitor-Assortment/dp/B08HZ21X8L
I use fairly large enamel-insulated magnet wire (enamel to reduce inter-winding capacitance) - 14AWG for small number of turns, 18AWG if more turns. Learned this from Pavel.
I use either the T130-6 or T80-6 iron powder cores, nothing smaller for 100W
I use my own printed circuit board design, originally created to build Butterworth bandpass filters. I have now "shared" this design on PCBWAY.COM so others can get it easily if they wish (Disclaimer: they may send me a small remittance):
https://www.pcbway.com/project/shareproject/Ham_Radio_Butterworth_BandPass_Filters_6421b6db.html

TUNING

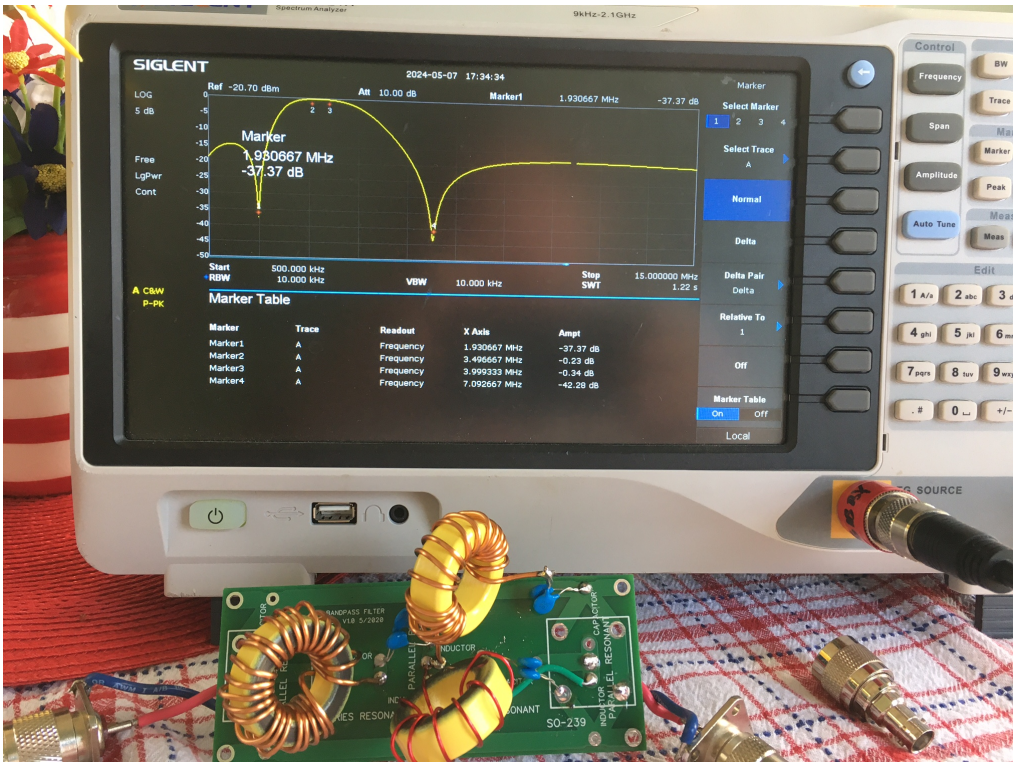
My approach to tuning is to first electrically separate and tune the input series tuned filter to pass the desired band well. Get it centered up on the desired band! Then add the 2F and 1/2F trap filters and look at where the notches are located and how much isolation is being provided at the extreme ends of those bands, and compare to the passband their interaction creates. If a notch is unacceptably far off, it can be nudged back to the desired position while observing for any undesired impact on the desired passband.

The toroid turns can be "scrunched" to raise inductance and lower resonant frequency, or "spread out" to reduce inductance and raise resonant frequency. However, if there is a large discrepancy, a turn or two can be removed or added. Because of the way the math works, the turns to remove or add are proportional to the frequency change needed.

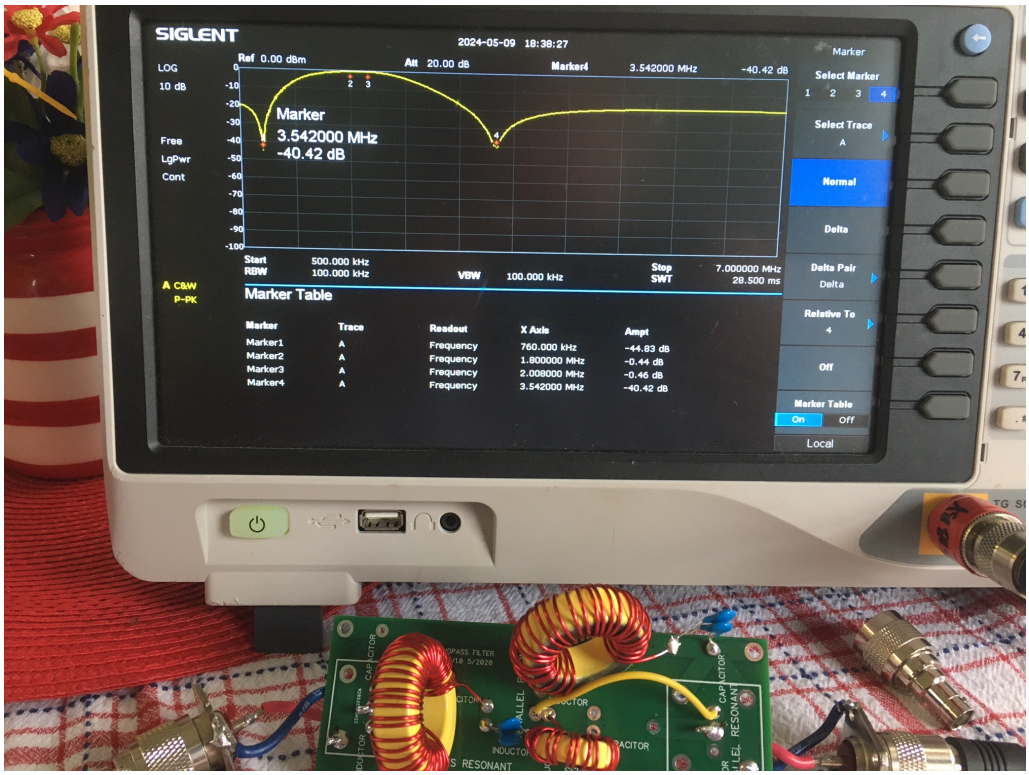
This worked out much easier than expected. The 80-meter filter was built and tuned (using a spectrum analyzer) in less than two hours; the 160-meter filter in one hour. Good performance (for my limited skill-level) of passband loss in the 0.4dB range and very impressive next-band notches. The ultimate rejection of Pavel's filters is somewhat more limited to about 20dB -- necessitating the use of an external bandpass filter of a different design (eg. a Butterworth) that has a steadily increasing isolation farther away from the design frequency. The well known ARRL design works well.
https://www.arrl.org/files/file/Technology/tis/info/pdf/8809017.pdf

OUTCOME

I was very pleased with the results.



80 meter filter with passband losses of approximately 025-0.35dB and notches of -37 to -42 dB



160 meter filter with passband losses just under 0.5dB and 80 meter notch as deep as -40 dB at 3.54 MHz