Converting the R1 (403-433 MHz) UHF Spectra to the 70 cm ham band

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Background

There are a number of articles on the web about converting the 450-470 range Spectra's to the 70 cm amateur band, but a dearth of information on the 403-433 MHz radios. This procedure has been done on several radios successfully.

Programming

The first step is the previously documented RSS hacks to allow it to accept out of band frequencies. Once you've hacked your RSS to allow out of band programming, temporarily program the radio to transmit and receive in 1 MHz increments from 440 MHz to 450 MHz.

VCO Modification

The next step is retuning the VCO. There is a microstrip resonator in the VCO that is accessible through a slotted 'window'. See fig. 1.

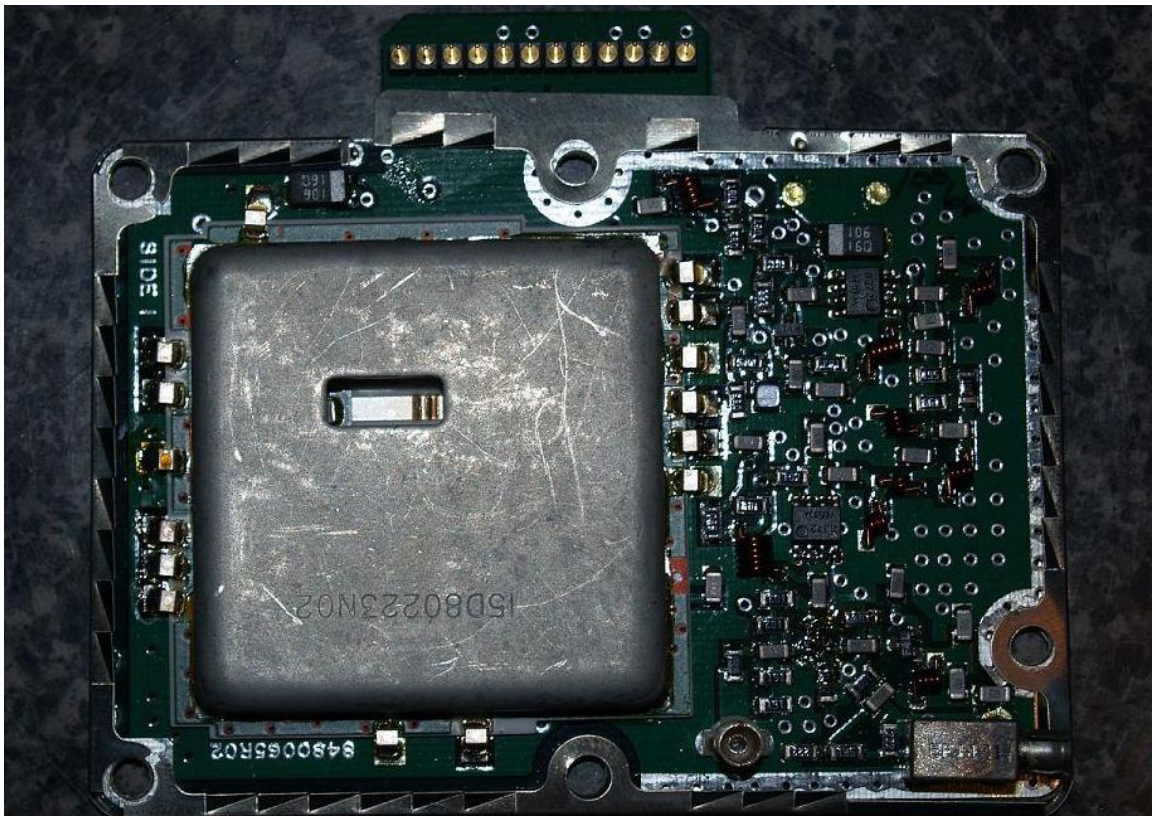

Fig 1

The microstrip resonator is visible, as are the laser cuts done at the factory during tuning. Motorola uses a laser to cut the microstrip for tuning. Since we’re going up in frequency, some means of cutting the microstrip shorter is necessary. It's on a ceramic substrate that makes it impossible to cut with a knife, but it's quite easy to cut with a diamond or carbide Dremmel tip. A small pointed diamond tip was used for this conversion. See fig 2.

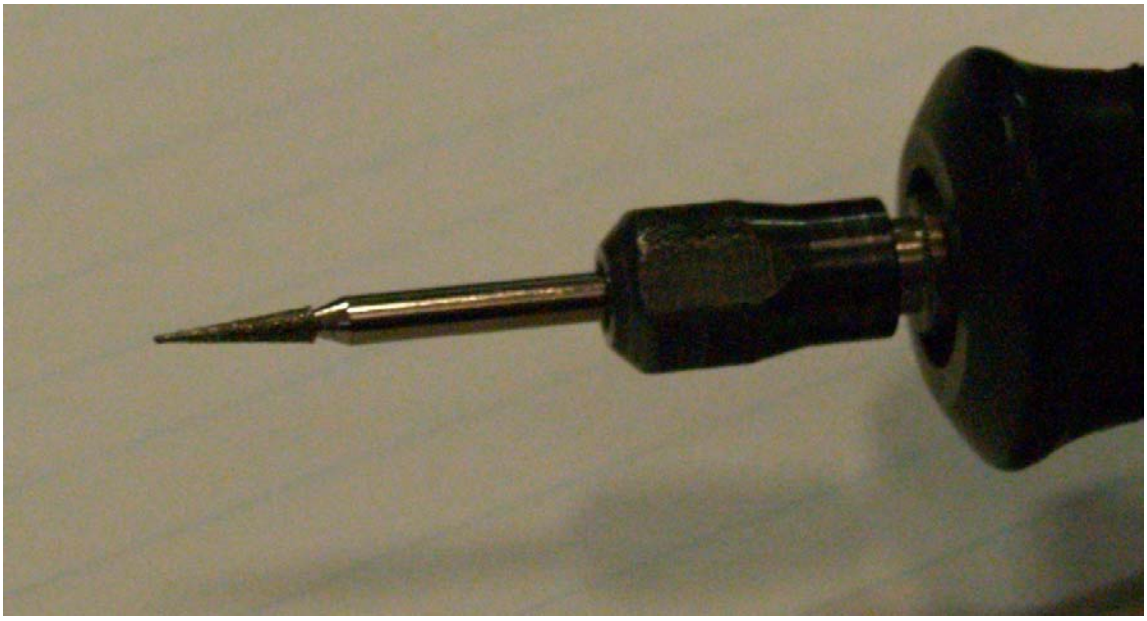

Fig 2

This is where a steady hand comes in. Since it was deemed to risky to try to remove the cover, it was decided to attempt to work through the window. The technique is similar to that shown in Fig. 3.

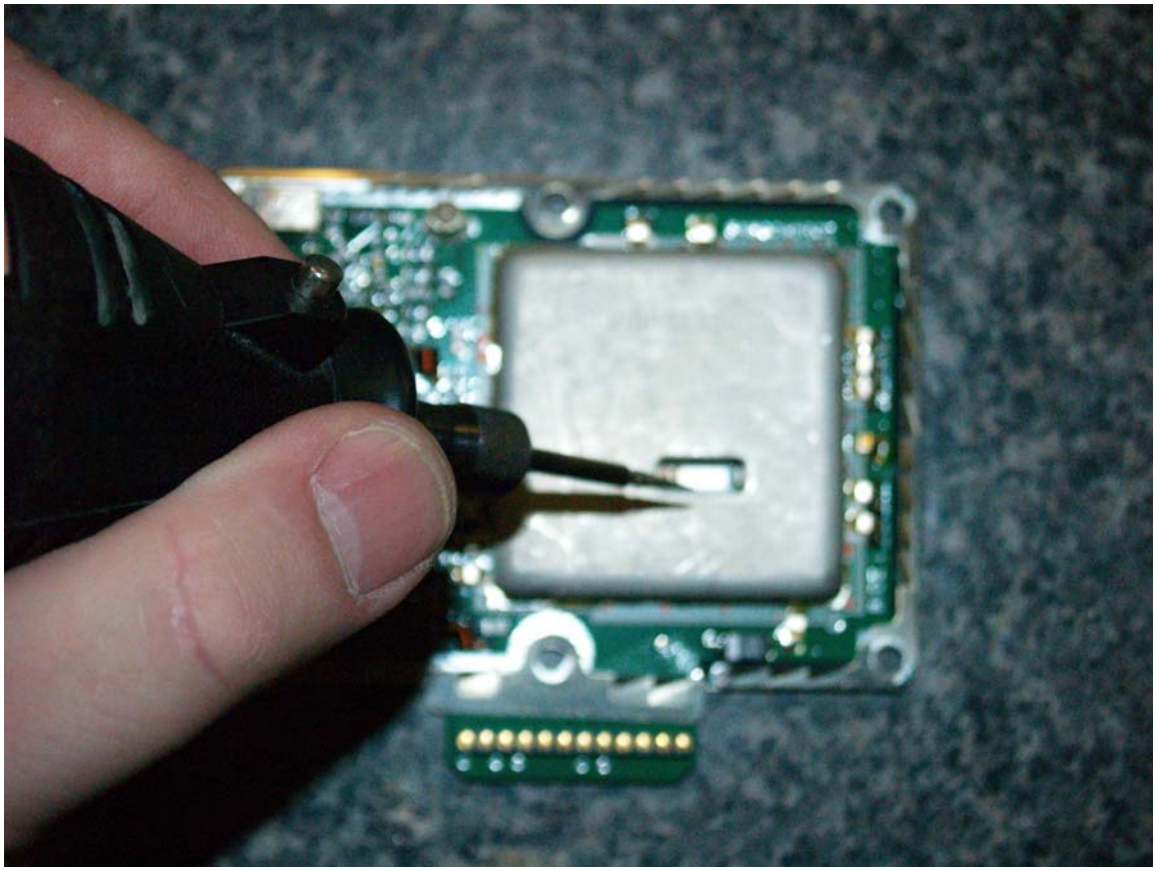

Fig 3

Make small cuts to avoid overshooting, and test in the radio at each step. Let the Dremmel do the work. Applying too much pressure on the substrate could crack it, rendering the VCO useless. Repeated assembly and disassembly will be required, in order to test the radio after each cut. This is where having the radio programmed in 1 MHz steps will come in. Starting at the low frequency end, step the mode switch until the VCO goes out of lock, indicated by FAIL 001 flashing on the screen. Take just enough off that you can step from 440 to 450 without losing lock.

Your cuts don't have to be pretty. They merely have to shorten the electrical length of the resonator. Once you’re done, your VCO will look like Fig 4. Use a can of compressed air to blow out the debris after each cut.

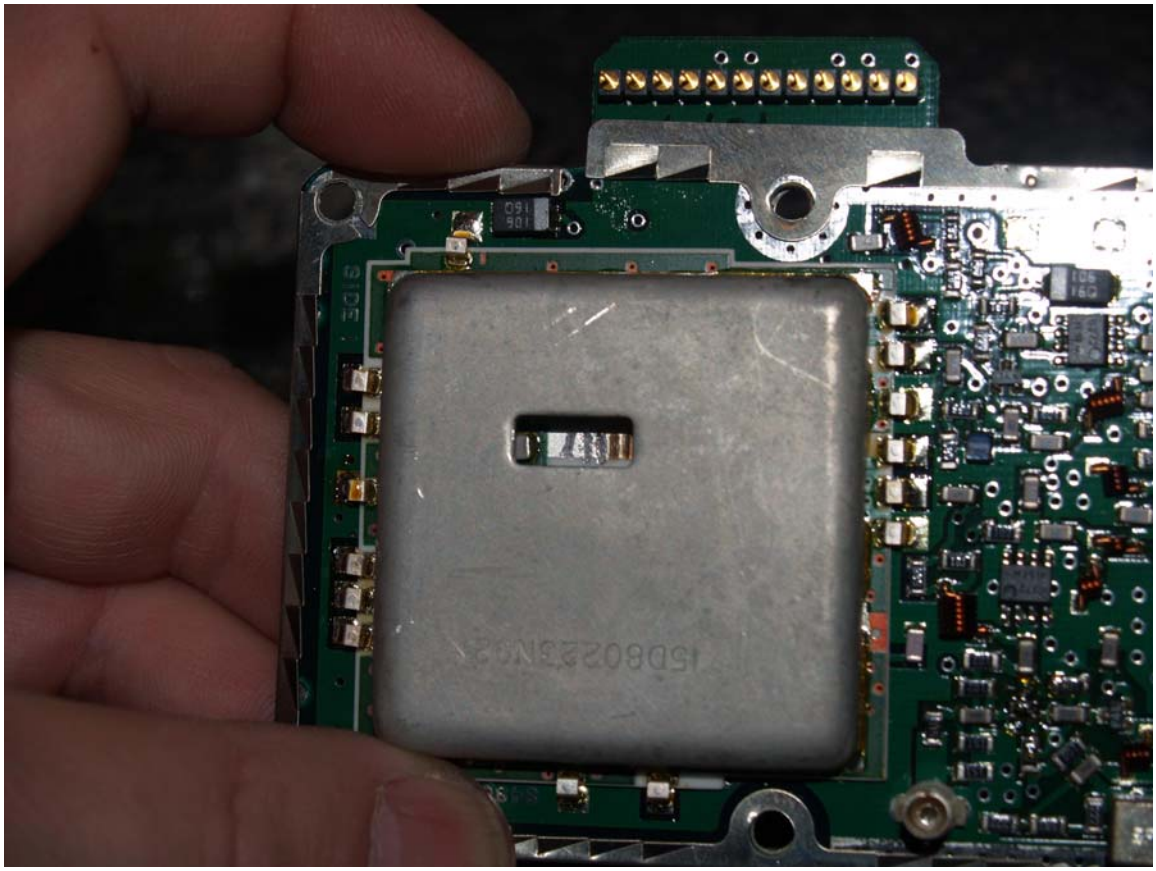

Fig 4

Filter retuning

The next step is the most difficult, and requires access to a spectrum analyzer/tracking generator or a network analyzer. From the factory, the filter has a response about 40 MHz wide, centered on around 420 MHz. What’s needed is to move this response higher so that it rolls off somewhere above 450 MHz. The unmodified frequency response is shown in Fig. 5.

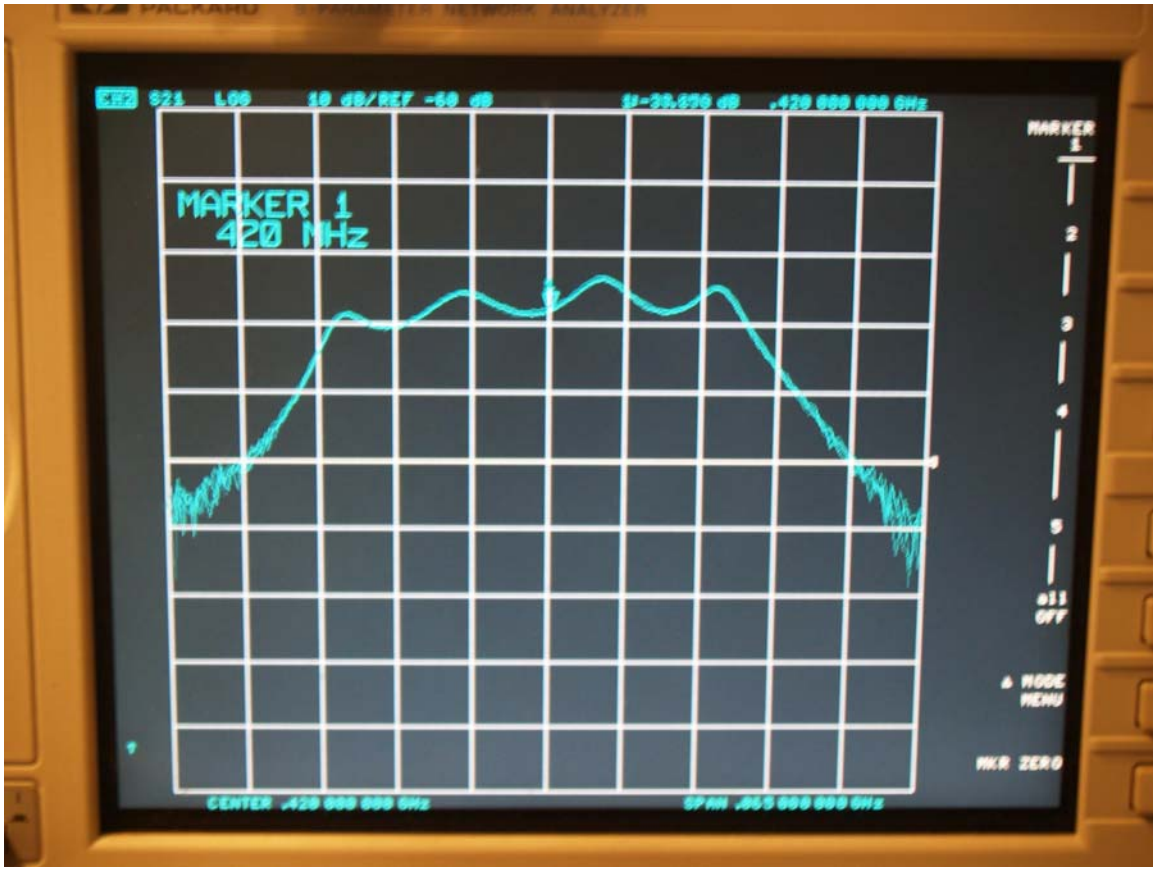

Fig 5

Remove the receiver front end and locate the filter. On one side of the filter, you can see each resonator. On each resonator, there is an oval shaped pad that is exposed. This pad is where the filter gets tuned. You'll probably see that it's already been cut some. Fig 6 clearly shows 4 of the 5 resonator sections in the filter. The other one is under the shield cover on the left.

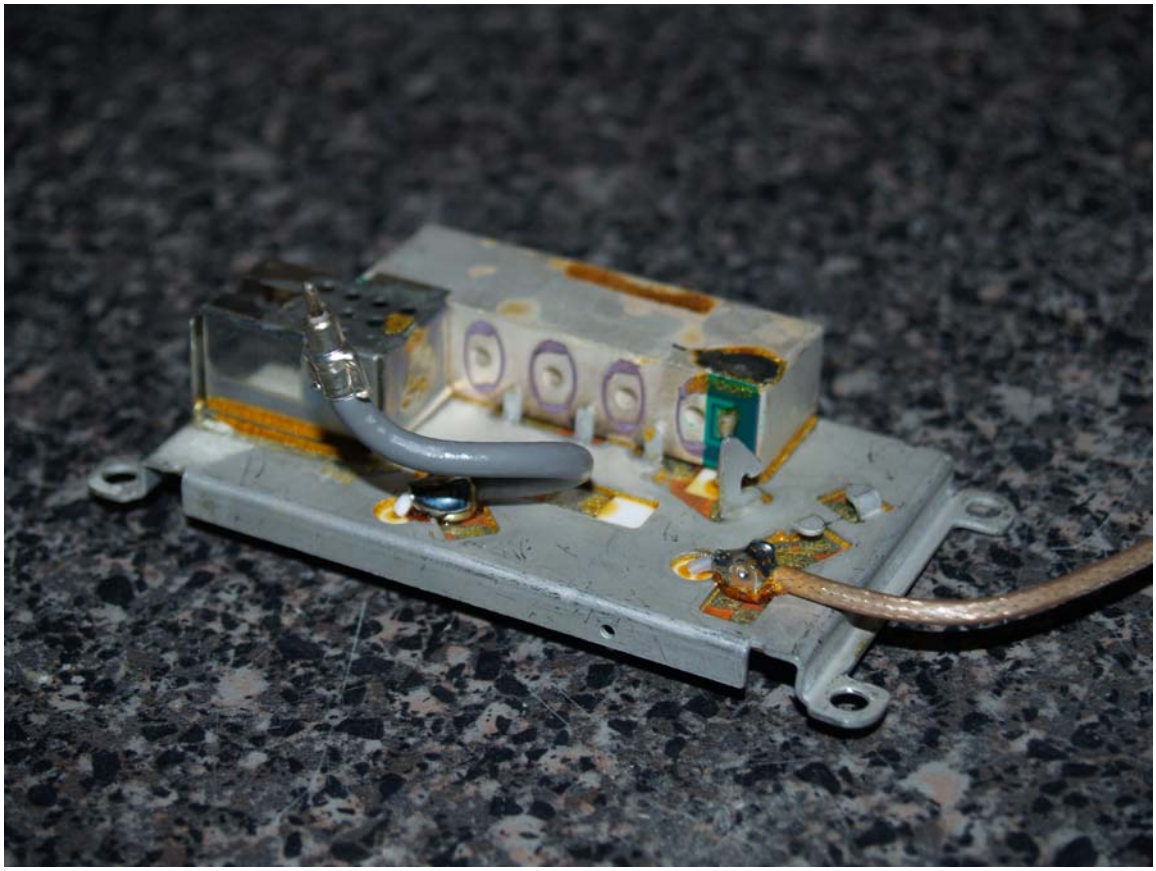

Fig 6

Fig 7

On each end of the filter, there is a small (less than 1/4" square) green printed board where the input and output connections are made to the filter. The input is under the shielded box that must be removed or cut open. A fiberglass cutting wheel (Fig 7.) was used on a Dremmel tool to cut open the shield on the input side of the filter, as it was determined to be too risky to try to remove it. When the cover is removed, it should expose the first resonator, as well as the input connection to it. See Fig. 8.

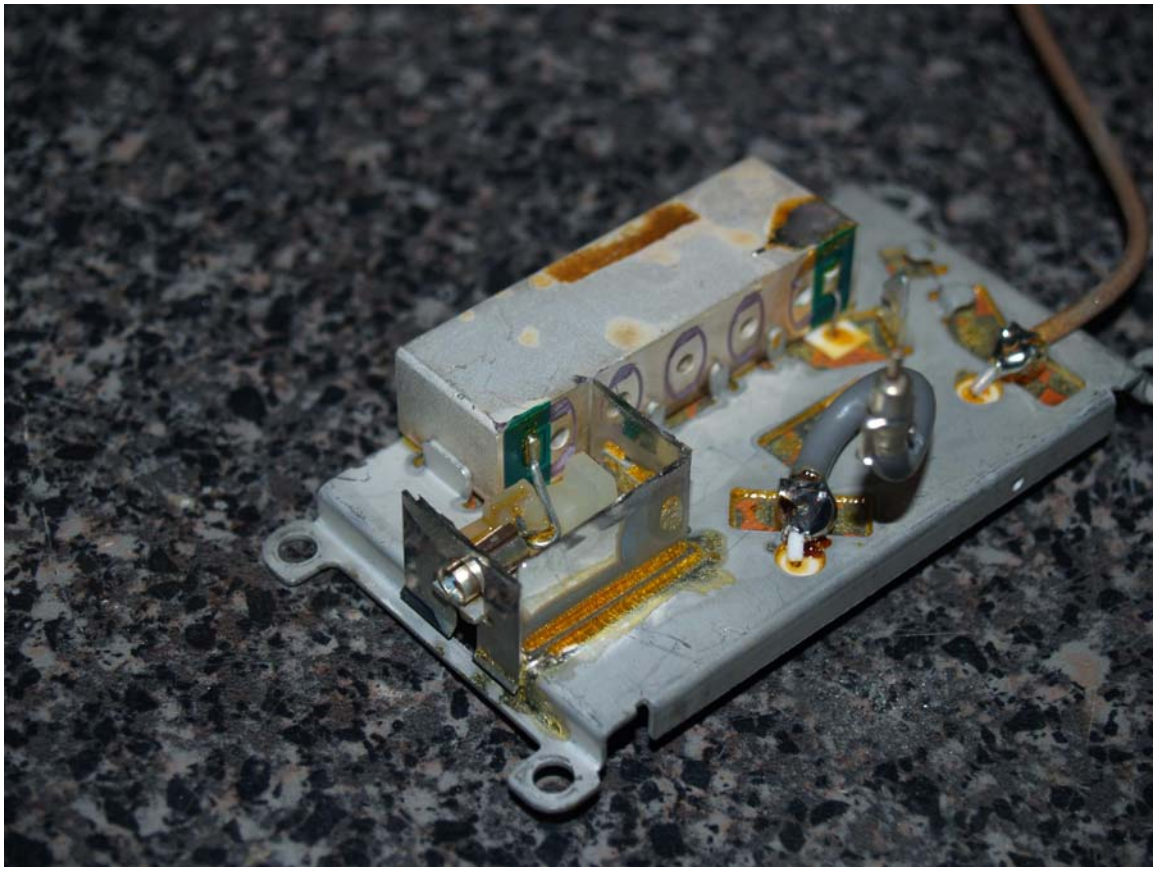

Fig 8

You will need two short pieces of RG-174 or similar coax with connectors (BNC or SMA) on one end of each piece. Solder the RG-174 coaxes to the input and output pads on the filter, and connect to the network analyzer. (Fig. 9)

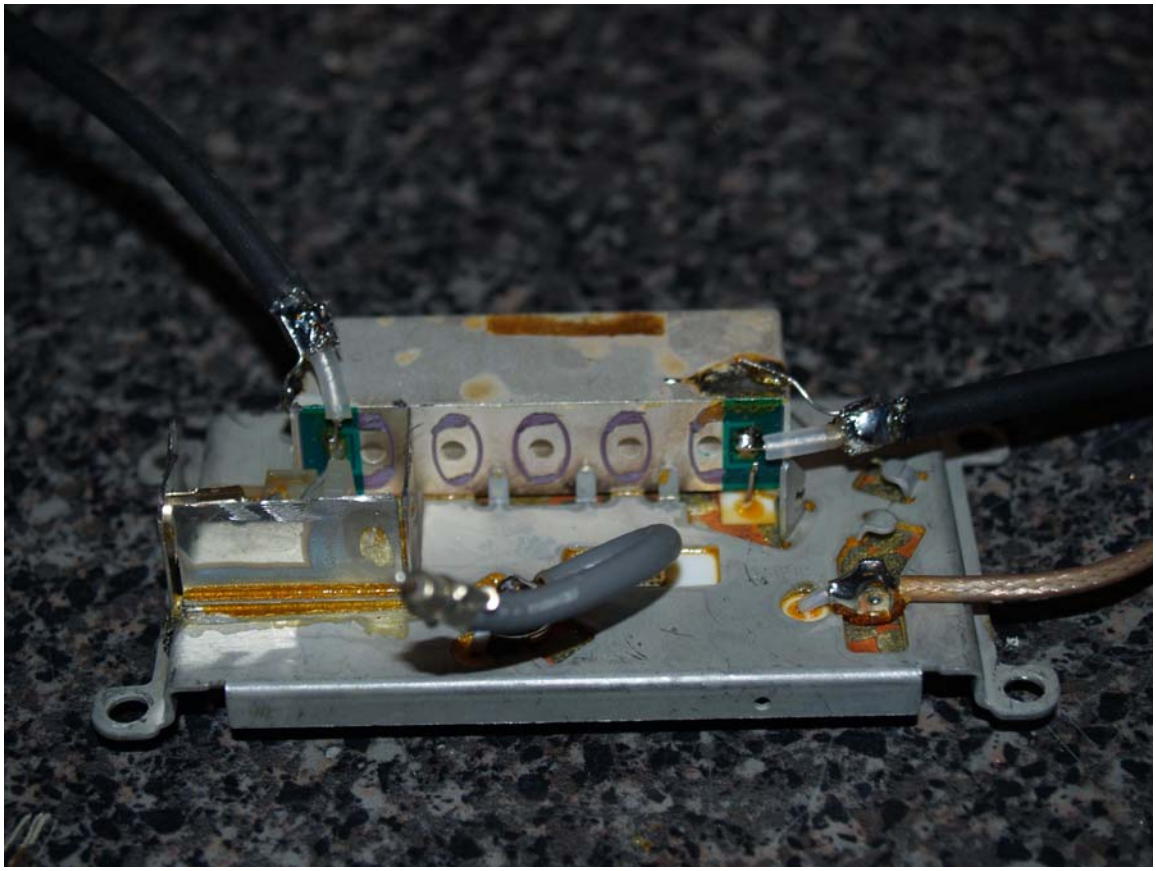

Fig 9

Configure the analyzer to sweep from 400 to 500 MHz. While observing the trace, start removing material from the oval shaped pads on each of the 5 filter resonators, a very small amount at a time. Fig. 10 shows the technique used. A bit was shaved off both sides of the oval to avoid taking too much material off one side.

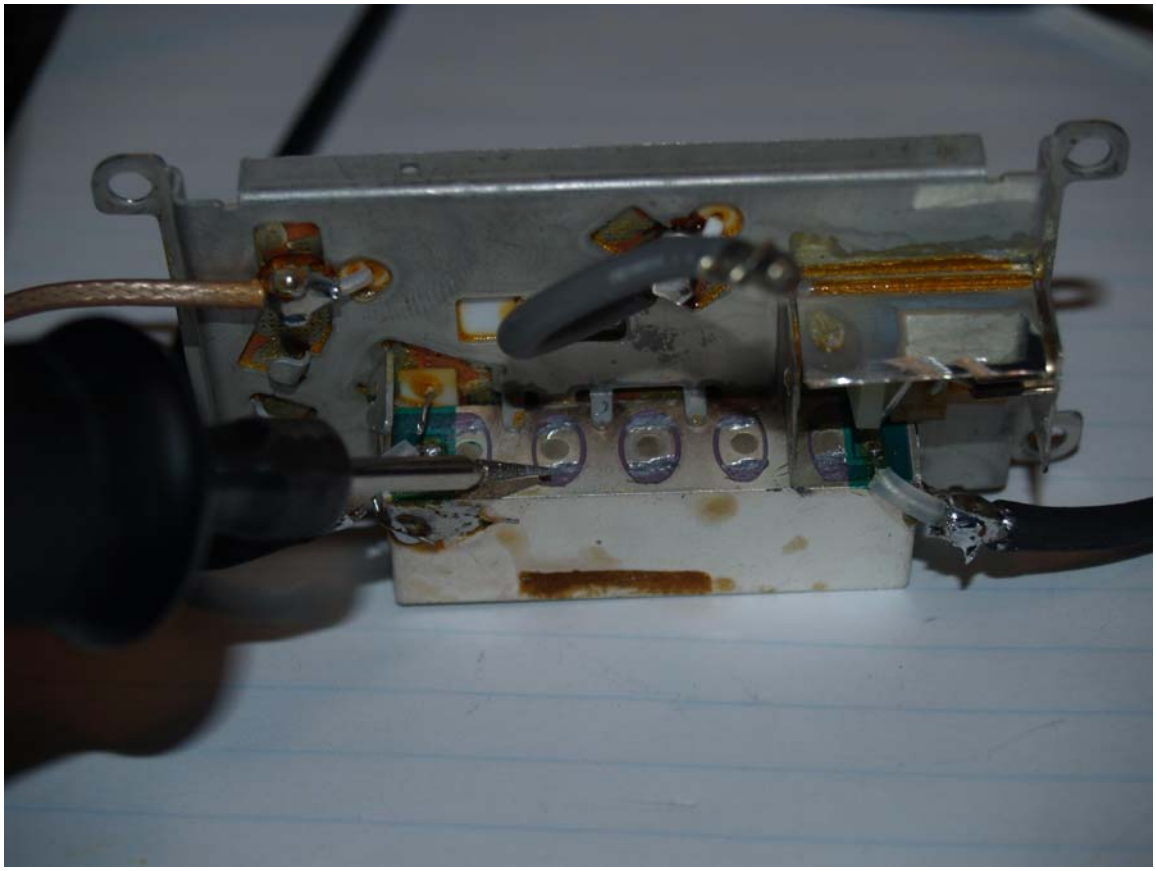

Fig 10

As you remove material, you will see the response break up into multiple responses with separate peaks and dips. Once you've removed material from all 5 resonators, the peaks should re-converge at a higher frequency. Slowly step the tuning up until it is as flat as you can make it. The ripple you end up with makes the difference between .2 uv and .4 uv sensitivity or so, across the band, so don’t spend too much effort trying to get it perfectly flat. You’ll probably ruin the filter in the process. If you've taken too much off, you can "snowflake" it back on with conductive paint. I use a toothpick with a small dab of conductive paint dried on, and touch it to the oval shaped conductor to see which peak is which during the tuning process.

The end result should look something like Fig. 11, with a useable response across the entire 420-450 spectrum, although the VCO won’t make it that far. The partial loss of the shield cover makes no measurable performance difference, so it was left off in the radios converted by the author.

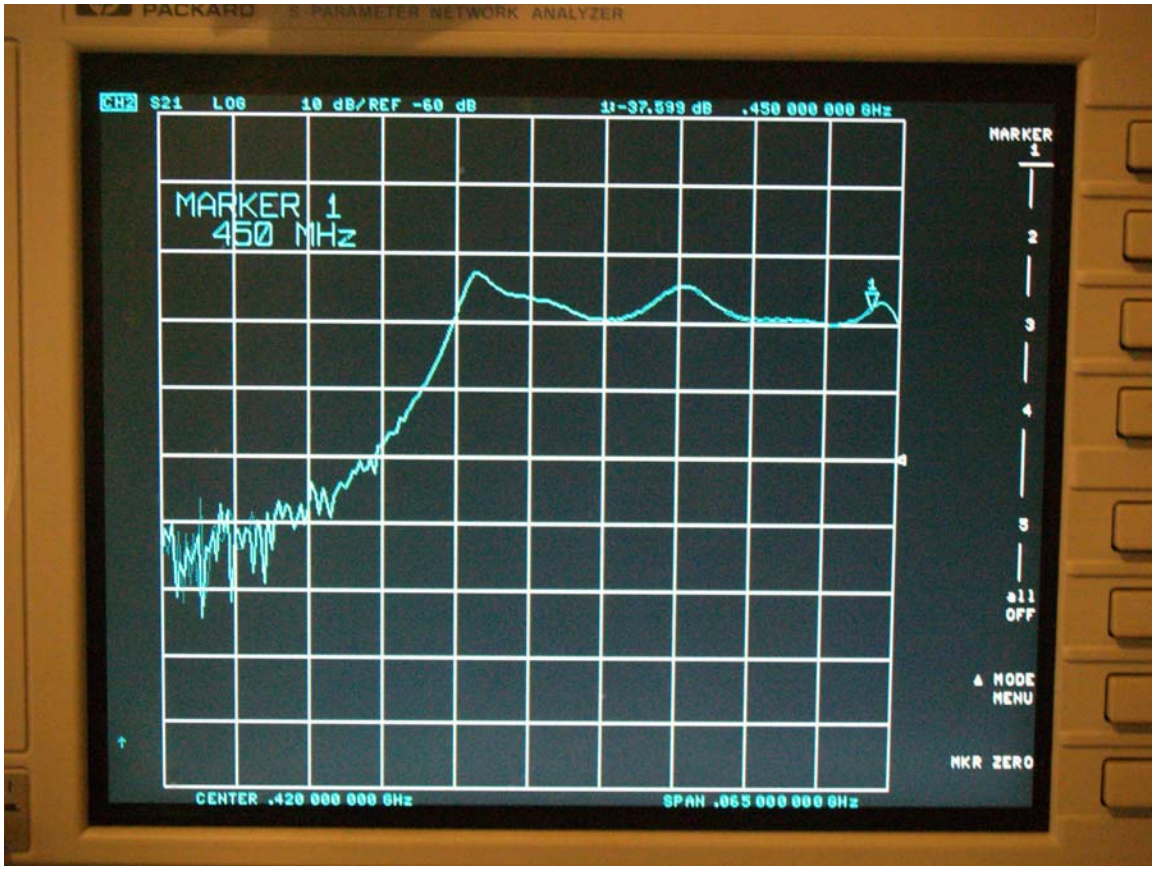

Fig 11

Transmitter

In all units converted by the author to date, every one of them has had rated transmitter performance all across the band, from 440 to 450 MHz, so no attempt was made (or needed) to retune any transmitter stages. Test your transmitter and receiver performance on the 1 MHz steps across the band to be sure you’re happy with it, then you can proceed to program the radio as needed.