MODIFICATION OF KYODO WEST NARROWBAND BSR RECEIVERS FOR WIDER BAND OPERATION

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Modification of these receivers is *not* for the faint of heart. You need to be *very* comfortable with challenging (de)soldering tasks. Since this implies substantial skill, I'm providing guidance, *not* step by step instructions.

Basic Modification Data

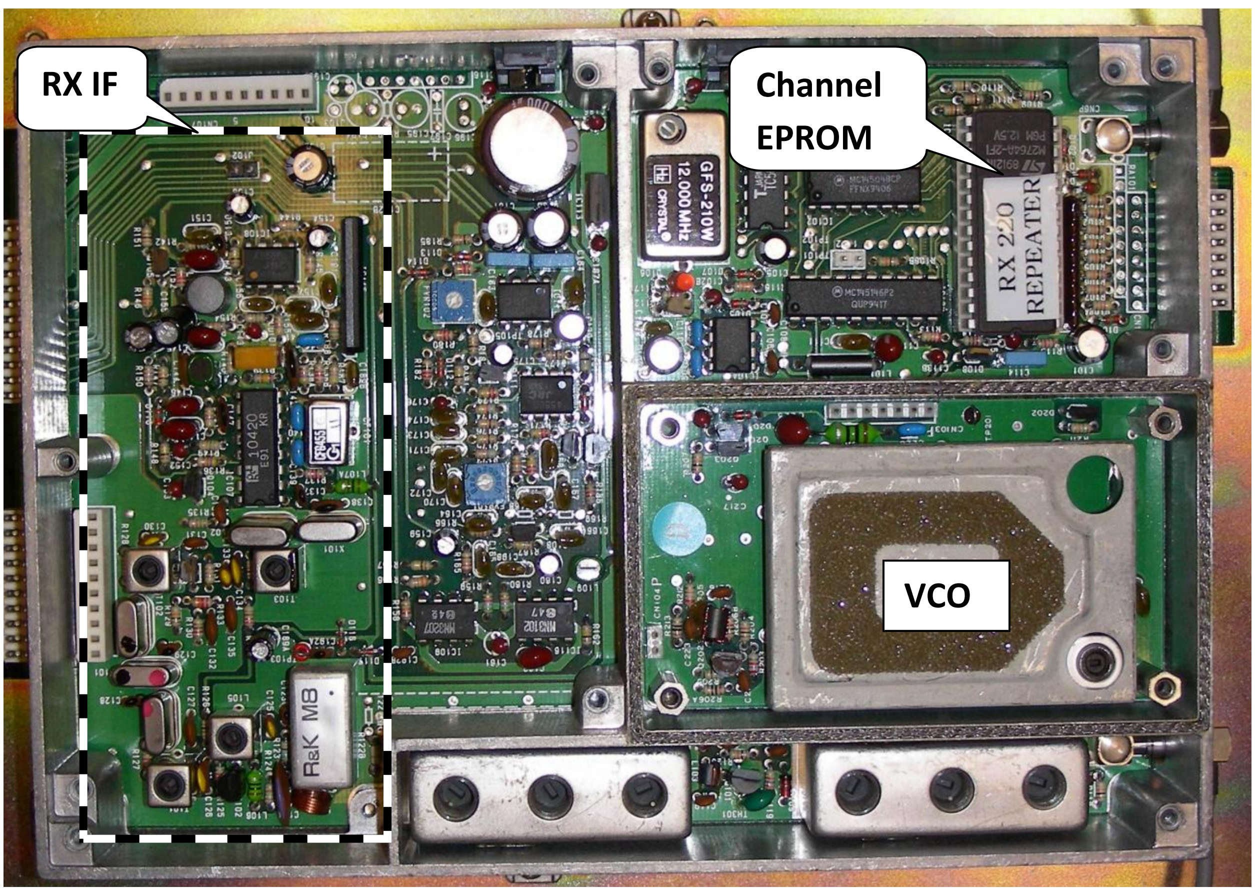

Figure 1 Unmodified 220 MHz Receiver

Figure 1 shows an unmodified receiver. Figure 2 shows an unmodified receiver IF. The 220 Mhz and UHF radio IFs are virtually identical. These instructions will work for either band.

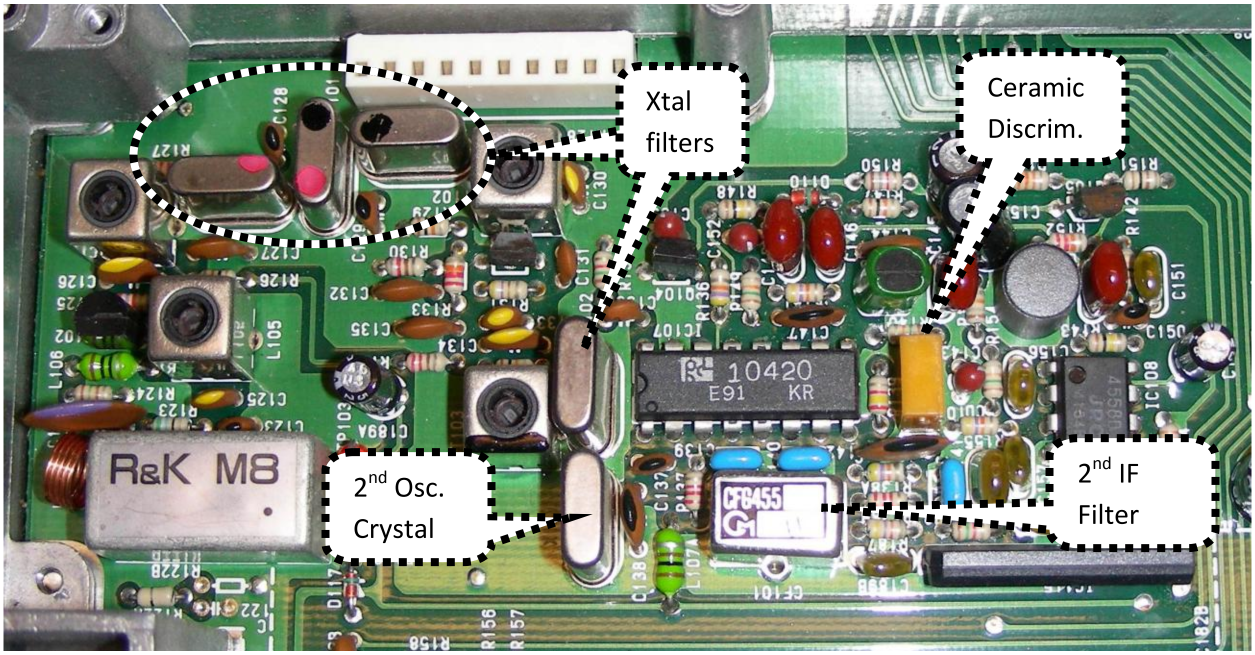

Figure 2 Unmodified Receiver IF

To modify a receiver for wider band (5 kHz deviation) you need to:

1. Replace the monolithic crystal filters
2. Replace the 455 KHz ceramic 2nd IF filter.
3. Swamp the 455 KHz ceramic discriminator (to broaden it.) I used a 1K resistor in the two receivers I've done. One fellow reported needing to use 100 ohms.

The unmodified receiver uses a 21.6 MHz first IF. The likely common replacement parts are going to use a 21.4 MHz IF, so you will also need to:

4. Replace the second oscillator crystal. You can use either a 20.945 MHz or a 21.855 MHz crystal. It needs to be a 20 pF parallel resonant crystal.

The crystal filter and second oscillator crystal are in HC-6/U packages in an unmodified receiver. I used parts in the smaller UM-5 package without difficultly.

Replacing Parts

The receiver circuit board design provides no thermal relief around ground connections. The practical effect of this is that you are working against a great big heatsink when soldering and desoldering. If you don't know what you are doing you are going to trash the circuit board.

I used a desoldering station and an auxiliary solder sucker to free the non-ground component leads. I then preheated the board with a heat gun and used a really big iron that was operating at normal temperature to free the grounded leads of parts. I did not use an exceptionally hot iron, just a great big one with lots of thermal mass. I used the aforementioned desoldering station and auxiliary solder sucker to clean out the ground through holes.

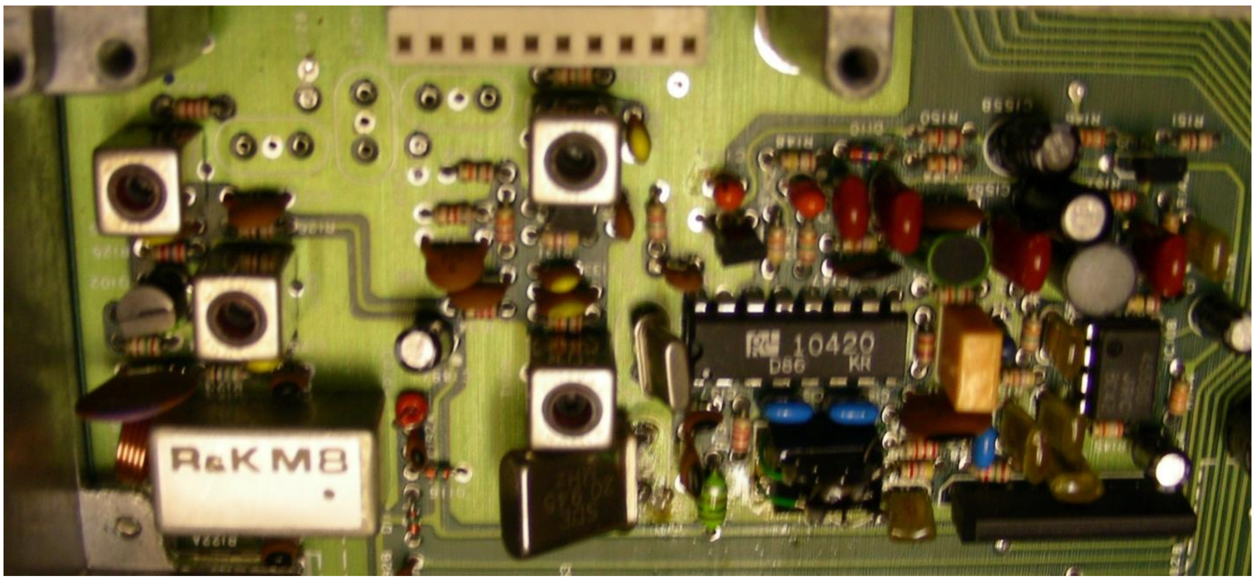

Figure 3 Partially Modified Receiver

Parts Selection

21.4 Monolithic Crystal Filters

Digikey stocks ECS monolithic crystal filters. You'll note that they stock two pole and four pole filters. *All* monolithic crystal filters in crystal can packages are two pole filters. When you order a four pole filter, you get two matched parts. If you order a six pole filter you get three matched parts. If you look carefully at Figure 2 you will note red and black paint dots on the filter. These indicate the matched ends of the individual filter elements. If you look a little more carefully and compare Figure 2 and Figure 3, you note a couple of missing capacitors. The original filters called for inter-crystal matching caps. The replacements I used did not.

Strictly speaking, we should use 15 KHz filters for everything (see “Other Stuff

Some Theory” on page 5.) I used 20 KHz because I wasn’t going to be able to guarantee matching or tolerances with off the shelf parts.

Don’t worry too much about impedance matching. If it’s more than 500 ohms and less than 2K, you should be able to ignore this.

Likewise, don’t worry too much about part matching. We’ll end up a little wider than we have to be, but we don’t really have the luxury of specifying an optimized part.

The original parts were in a three lead version of the HC-6/U package. Most new leaded parts come in UM-5 packages. These are about hald the size, but work just fine.

Second Oscillator Crystal

Not much to say here. The original is 20 pf parallel resonant. The replacement needs to be, too. The original is in an HC-6/U package. Anything that will fit should work fine.

455 KHz Second IF Filter

The original filter is a four pole ceramic filter. I couldn’t find anything in a similar package, but I found lots of stuff with similar specifications. The original filter electrical specifications are:

1. CENTRE FREQUENCY (f_o) : 455KHz ± 1.5KHz. MAX.
2. BAND WIDTH AT 6 dB : ±4.5 KHz Min.(TO 455KHz)
3. BAND WIDTH AT 40 dB : ±10 KHz Max.(TO 455KHz)
4. STOP BAND ATTENUATION : 30 dB Min(AT f_o ±100KHz)
5. RIPPLE : 2.0dB Max.
6. INSERTION LOSS : 6.0 dB Max (at the lowest loss peak)
7. TEMPRATURE COEFFICIENT OF CENTER FRENQUENCY : 50PPM/℃ Max.(-20°C TO +80°C)
8. INPUT/OUTPUT IMPEDANCE : 2.0K

You need something that is at least 20Khz wide at the 6 DB points.

Mechanically you are not likely to find anything close to a drop in match. It’s not really obvious in Figure 3, but I “dead-bugged” the filter with hot melt glue and used wire wrap wire to ma the electrical connections. This is almost DC (455 KHz,) so the 15 mm of wire just doesn’t matter.

If you use a filter with substantially different termination impedances (and that is going to be hard to find in ceramic) and you see too much audio distortion even with fairly low deviation, take a look at the IF ripple. If it’s more than a couple of db, swap the loading resistors out on the detector (R137 and R138B next to IC107)

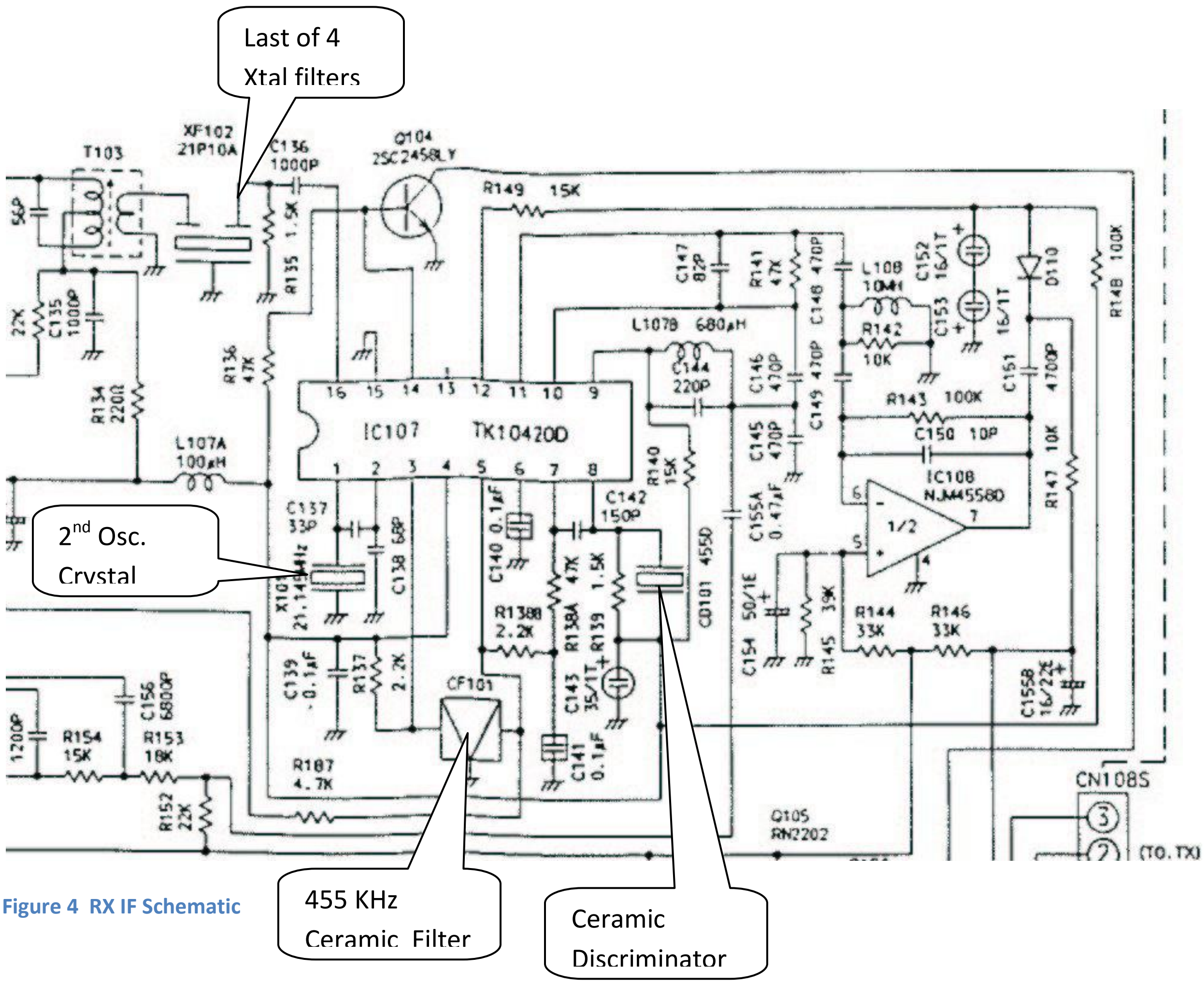

Figure 4 RX IF Schematic

Other Stuff

Some Theory

So, how do we figure out what bandwidth we really want? Carson's Rule[1] says that the required bandwidth is ***twice*** the peak deviation plus the highest modulating frequency. So for 4.5 KHz deviation and a 3 KHz communication channel we get $2(4.5 + 3) = 15$ (KHz)

In a real world engineering exercise we'd end up calculating all of the tolerances and adding some margin for that, but this hobby radio effort is more in the "*mark with chalk, chop with ax*" category.

[1] Carson's rule originates from John Renshaw Carson's 1922 paper; J.R. Carson, "Notes on the theory of modulation", Proc. IRE, vol. 10, no. 1 (Feb. 1922), pp. 57-64. See Wikipedia for a nice summary. http://en.wikipedia.org/wiki/Carson_bandwidth_rule

Some History

I originally planned on making up modification kits. After doing some research, I found that suitable parts were available cheaply off the shelf from a number of Chinese vendors. I ended up ordering samples from China Shoulder. I ordered and paid for 200 kits, but they ended up returning my check and refusing the order after a month. I never really got a chance to follow up after that. There is probably still a market for 200 kits if someone wants to do the follow up.

Unrelated to Bandwidth

These receivers were designed to run with a receiver combiner and are pretty deaf (~1 µV) without a preamp. There's not really enough gain and the noise figure was designed to be set by an external stage. I was putting one of these into repeater service I'd look hard at inserting a low noise gain block *after* the front end filter. This will get you much better sensitivity and preserve a lot of the out of band blocking performance. This is particularly important in areas with TV channel 13.

Revision History

Revision	Description of Change	Author
0.1	Initial content	Rich Osman
0.2	Some additional content and release for review	Rich Osman