# A detailed example of the mechanics behind CAL FIL

November 30, 1999, (*taken from email conversation*)

I had a talk with Eric about your problem. I misunderstood your situation: I thought you were using the spectrogram program to plot the center frequency of the *noise* output of the RX--I didn't realize you were using a carrier and tracking its pitch, which the K2 will preserve regardless of how you move the BFO! I can assure you that what you're experiencing is not related to the firmware rev., by the way.

**An example may help:**
- VFO dial 7000.0
- XFIL 4913.6 (center of xtal filter at present bandwidth)
- Sig gen 7000.0
- BFO 4913.1
- Sidetone 0.6
- VCO 11913.7 (VFO + BFO + sidetone)

The signal generator's carrier is not quite centered in the filter passband with the present setup -- it's 100 Hz too high: 11913.7 - 7000.0 = 4913.7 = IF carrier freq.

But you'll hear the signal at a 600 Hz pitch because that's where you have the sidetone set (BFO - IF): abs( 4913.1 - 4913.7 ) = 0.6 kHz

What happens when you run CAL PLL and move the CW-N BFO down 100 Hz to 4913.0? The new VCO value is calculated as soon as you switch filters or modes (in your case, you moved from CW-N to CW-R, then back again): VCO = 7000 + 4913.0 + 0.6 = 11913.6

The IF carrier signal now *is* centered in the filter passband, which is the desired result: 11913.6 - 7000.0 = 4913.6 = new IF carrier freq.

BUT, you still hear it at 600 Hz: abs( 4913.0 - 4913.6 ) = 0.6 khz

So what we've done is to move the signal in relation to the filter, while *preserving* pitch. (This is similar to IF shift on other radios.) No matter how far you move the BFO, this will always be the case. Hence your spectrogram program will think the signal has not moved--although it *will* be better centered in the crystal filter passband, at least if you've correctly determined what the center frequency of the filter is. You can now move your signal generator or the K2's VFO around a bit to check if the filter center corresponds to the desired pitch. Actually, if you can find the filter center frequency at each bandwidth used (using the "zero-pitch" method), you can then just set the CW-N and CW-R BFOs directly to Fcenter - sidetone and Fcenter + sidetone. That's why we added the BFO DISPLAY mode to CAL FIL.

HOWEVER, the bigger problems are still (1) the counter's quantization error, and (2) a small amount of drift with temperature. No matter how much you tweak the BFO, you'll potentially always be off by as much as the sum of these two.

I hope this helps!

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