J. Effland 21 Feb 2008 Revised 22 Feb 2008 – changes recommended by Tony Kerr

This reports on the investigation conducted to understand the oscillations observed in Band 6 Cartridge B6-007 installed in the first receiver in the NA FEIC.

Spikes in noise power and noise temperature were observed in Pol 0 at low LO frequencies (<u>Figure 1</u> and <u>Figure 2</u>) but higher LO frequencies appear normal (<u>Figure 3</u>)

- 1. Tony Kerr and Matt Morgan checked the configuration and concluded that the problem is likely due to an oscillating preamp when the receiver is tuned to low LO frequencies or when the LO is off and the mixer is biased in a region of high dynamic resistance:
  - Turning off preamp bias for the affected polarization causes the spikes to disappear. In fact, turning off just one of the preamps causes the spikes to disappear.
  - Adjusting preamp bias didn't eliminate the oscillations until the bias voltages were close to zero.
  - I-V curves measured for each mixer chip confirm that the mixer chip-preamp causing the spectral peaks has a normal I-V characteristic when the preamp is off, but when the preamp is on it has a negative resistance (Figure 4). I-V curves for the other mixer chip-preamp are normal with the LO on and off.
  - I-V curves with preamp and LO on at higher frequencies are normal (Figure 5).
  - The problem occurs at lower LO frequencies, but the highest frequency exhibiting oscillations varies between 225 and 229 GHz
- 2. Despite Tony's and Matt's findings, as an act of desperation, we performed the following additional tests:
  - Replaced bias box C2-015 with C2-022, which is known good because it was just used for PAS testing of a Band 7 cartridge.
  - Replaced WCA-6.007 with WCA-6.009 (along with that WCA's warm IF plate).
- 3. Tony Kerr also measured the oscillations as a function of the mixer junction voltage with the LO turned off, to present varying impedances into the preamp input. As shown in <u>Table 1</u>, the oscillations occur for high impedances present below the knee of the mixer I-V curve.
- 4. A final measurement supports Geoff Ediss' theory that the oscillations occur only for physical mixer temperatures below 4K, which is a temperature where the cartridge is never tested. Figure 6 shows a time plot of the 4.5 GHz signal resulting from the oscillations with a chopper running at the input of the receiver. The step at the first left division shows the signal disappearing when mixer heater is turned on to heat the mixer to ~13K. Of course, at that physical temperature, the mixer is no longer superconducting and so is not working, as seen in the 2<sup>nd</sup> division from the left. As the mixer cools, it starts working and the Y-Factor appears in the 3<sup>rd</sup> and 4<sup>th</sup> divisions from the left. Finally, the mixer cools to below 4K and the oscillation commences as shown in the 5<sup>th</sup> division from the left. All temperatures have a ±0.2K uncertainty because the temperature sensor correction factors have not yet been loaded into the FETMS database.

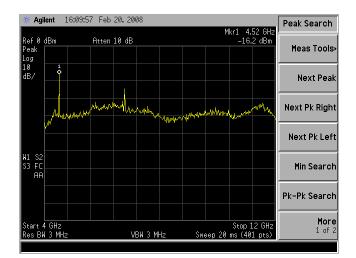


Figure 1: Spectrum Analyzer Plot of Oscillations

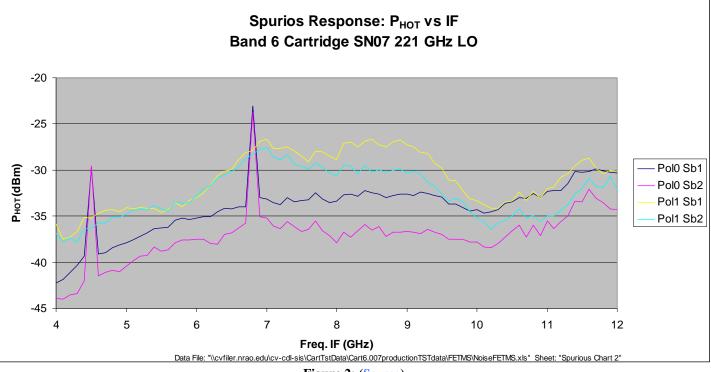
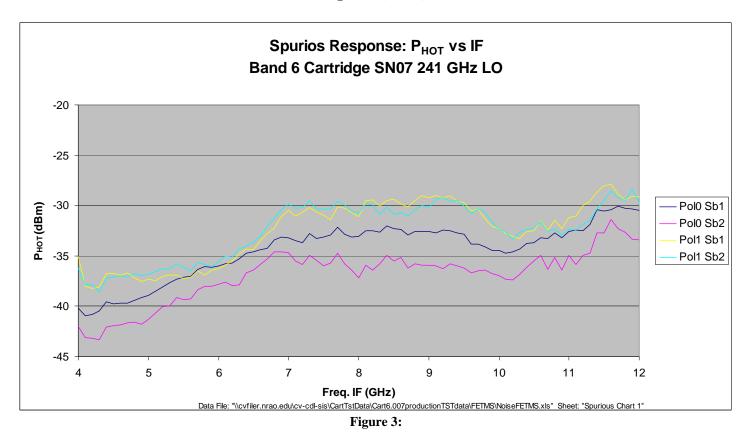


Figure 2: (Source)



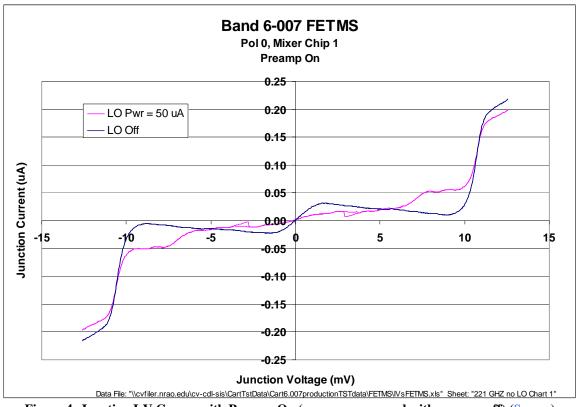


Figure 4: Junction I-V Curves with Preamp On (curves are normal with preamp off) (Source)

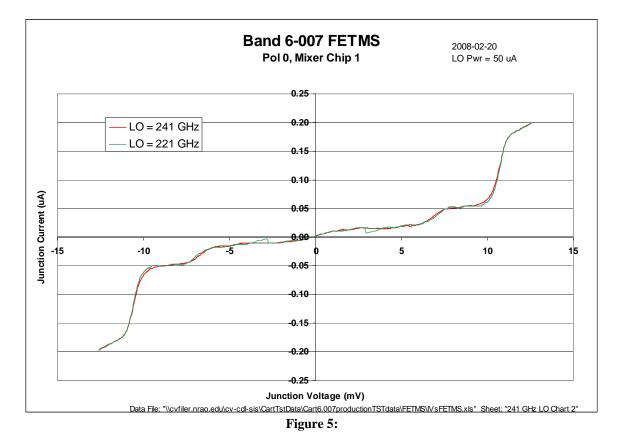


Table 1:Oscillation as a function of Mixer Bias Setting (with LO off)		
Vj (mV)	Ij (uA)	Spectrum
-15 -10.6 -10.2 -9.6	-262.7 -110.34 -45.91 -14.44	Agilent   09:03:09   Feb 21, 2008     Ref 0 dBm   Rtten 10 dB   -39:96 dBm   Format     Peak   -39:96 dBm   Format Now   Image: Constraint State St
-8.8	-5.71	Image: Solution of the second seco
-8.6	-6.33	Agilent 03:03:44 Feb 21, 2008 Peak Search   Ref 0 dBm Atten 10 dB -0.704 dBm   Peak -0.704 dBm Heas Tools-   10 0 -0.704 dBm   dB/ 0 0 0   18 0 0 0   18 0 0 0   18 0 0 0   18 0 0 0   18 0 0 0   18 0 0 0   18 0 0 0   18 0 0 0   19 0 0 0   10 0 0 0   10 0 0 0   10 0 0 0 0   10 0 0 0 0 0   10 0 0 0 0 0 0   10 0 0 0 0 0 0   10 0 0 0
-8	-7.71	Agilent 09:10:13 Feb 21, 2008 Peak Search   Ref 0 dBm_ Atten 10 dB 7,821 dBm   Peak 7,821 dBm Meas Tools   10 10 10   18 10 10   18 10 10   18 10 10   18 10 10   18 10 10   18 10 10   18 10 10   18 10 10   18 10 10   19 10 10   10 10 2   10 2 10   10 2 10   10 2 10   10 2 10   10 2 10

Table 1:Oscillation as a function of Mixer Bias Setting (with LO off)		
Vj (mV)	Ij (uA)	Spectrum
		* Agilent 89:10:37 Feb 21, 2008 Peak Search
		Ref Ø dBno   Atten 10 dB   Mkr1 4.52 GHz   Hote Goal off     Peak   5   5   6   6     10   6   8.87 dBm   Meas Tools>   10     18/   6   6   6   10   10
-6	-14.48	wolung water water and we with damage and water and water and
		AL S2 S3 FC FR
		Pk-Pk Search
		Start 4 GHz Stop 12 GHz Nore
		Res BN 3 MHz VBN 3 MHz Smeep 20 ms (401 pts) 1 01 2
-3	-19.88	Agient   09:11:07   Feb 21, 2008   Peak Search     Ref Ø dBm_o   Atten 10 dB   9:883 dBm
		Ref Ø dBmAtten 10 dB 9.883 dBm Pouk 1 10 1 18 dB/N Next Peak
		Next Pk Right
		Next Pk Left
		AL 52 S3 FC AR
		Pk-Pk Search
		Start 4   GHz   Stop 12   GHz   Hore     Res BN 3   MHz   VBN 3   MHz   Sweep 20   ms (401 pts)   1 of 2
		# Aglient 09:11:34 Feb 21, 2008 Peak Search
	1.11	Rof 8 dBm Atten 18 dB -1.874 dBm Heas Toolsy Peak Peak
		log 5 10 dB/ Next Peak
		Next Pk Right
0		HI S2
		N1 S2 S3 FC AR
		Start 4 GHz Stran 12 GHz More
		Start 4 GHz Stop 12 GHz Res BH 3 MHz VEH 3 MHz Smeep 20 ms (401 pts) 1 of 2

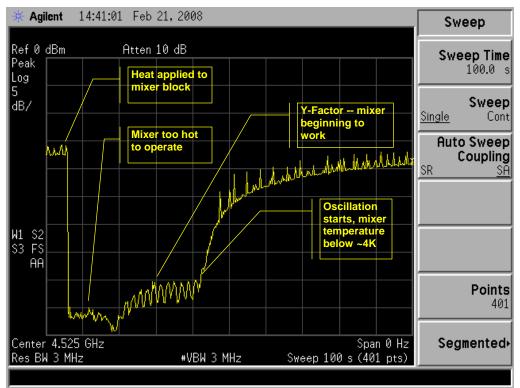


Figure 6: Time Display (100s) Showing Oscillation and Y-Factor