Memorandum

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Subject: Investigation of Suck-Outs in B6-002 Cartridge Gain and Power Density

This memo documents using the HP 8722D vector network analyzer in the time domain mode to locate a poor connection in the cold Band 6 cartridge that caused a 4-dB suck-out in gain and power density. The cause of the suck-out in Pol 1 USB of Cartridge B6-002 were traced to a bad connection at the output of the 2 dB attenuator in the IF path inside the cold cartridge section.

Figure 1 is the cartridge gain for Pol 0, measured using the usual "ΔP/ΔT" technique. Ignore the sharp dips in the data, which are caused by the software occasionally calculating too high a value for the IF attenuator. Figure 2 shows the same gain for Pol 1, but note the 4 dB suck-out from 7.0 to 7.8 GHz.

Section 1 below documents tests that confirmed the software and CTS hardware wasn't causing the suck-out, and additional swapping of the warm IF cables at the 300K plate proved the problem resided inside the cold section of the cartridge.

Figure 3 to Figure 6 show return loss of the IF outputs at the 300K plate cold cartridge interface. To measure this data, the network analyzer was connected at the end of the cable normally attached to the input of the warm IF amps. The return loss generally looks nominal, with perhaps only Figure 4 showing slightly higher peaks.

In an attempt to locate the position of the mismatch in the cold cartridge body, the HP8722D VNA was configured to display time domain graphs using the same 3-13 GHz sweep parameters that produced the calibrated return loss plots. It's not clear if the frequency domain calibration maps to the time domain, but losses generally render useless such time-domain calibrations, anyway. Note that a larger sweep range would increase the resolution in the time domain, but it wasn't necessary for these measurements.

Figure 7 to Figure 10 show the time domain plots measured looking into the IF output of the cold cartridge, again with the connector normally attached to the warm IF amp input as the interface. Figure 8 maps peaks in the time domain to components in the IF subsystem, which were identified by using the same time domain set up on a warm cartridge and removing each component to find the corresponding peak.

The same data for a warm cartridge (B6-006) is graphed in Figure 11 to Figure 14. It is instructive to compare the cold time domain plots with the warm plots by flipping between page 4 and page 5.

The smeared peak in Figure 7 at the output of the 2 dB attenuator appears to be the cause of the gain suck-out. We could replicate that peak almost exactly in warm cartridge B6-006 by loosening the connector on the output side of the pad.

Figure 1: Cartridge Gain, Pol 0

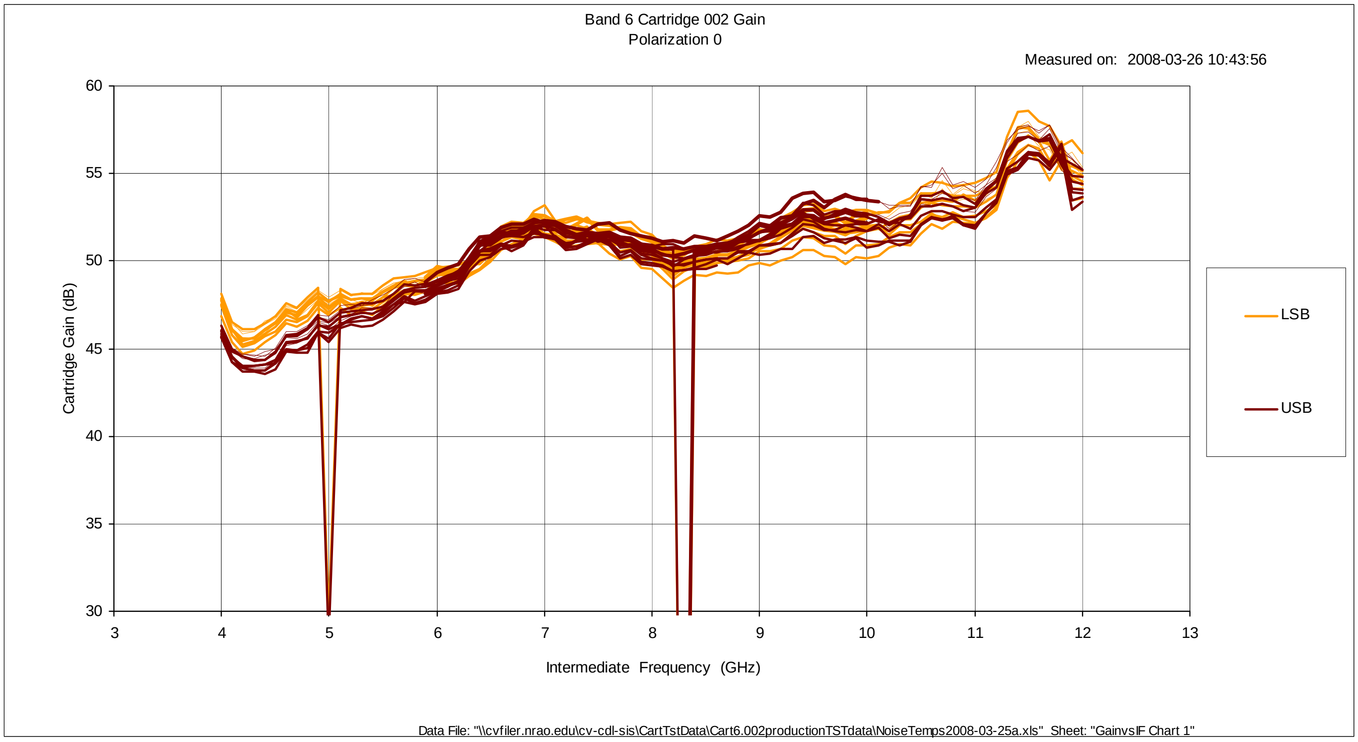


Figure 2: Cartridge Gain, Pol 1

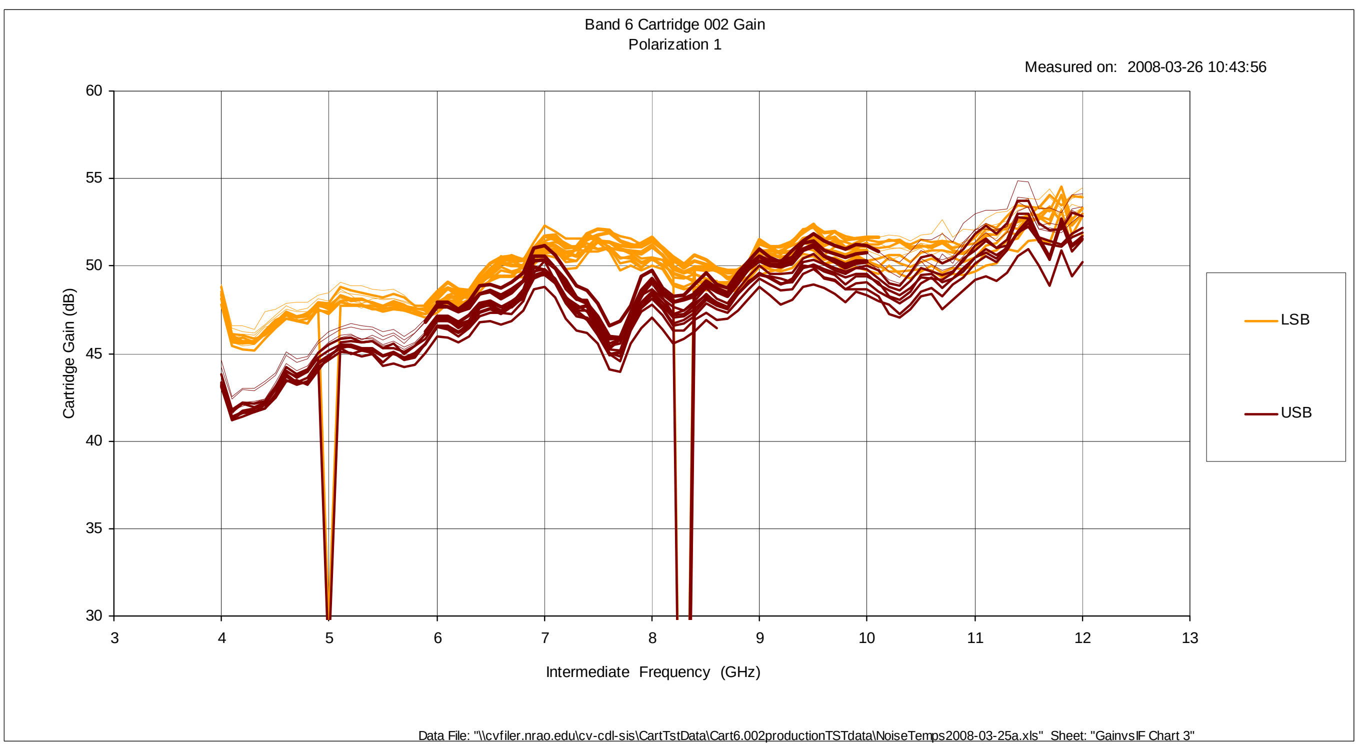


Figure 3: Retn Loss, Pol 1 USB, B6-002, Cold

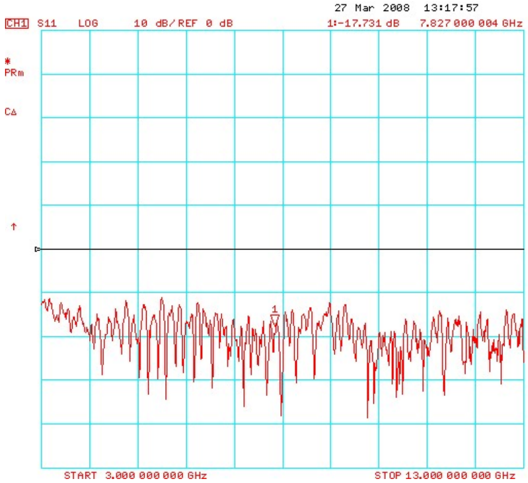


Figure 4: Retn Loss, Pol 1 LSB, B6-002, Cold

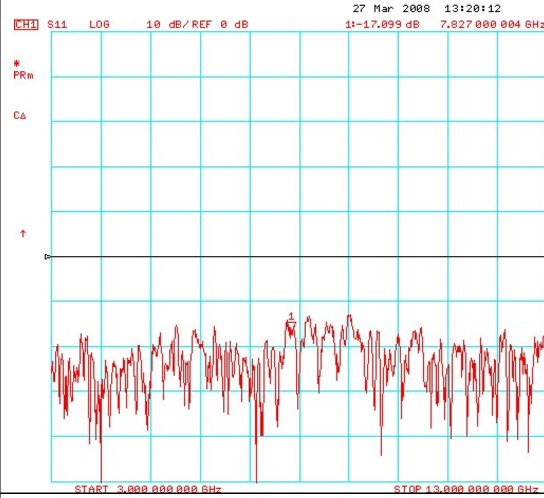


Figure 5: Retn Loss, Pol 0 LSB, B6-002, Cold

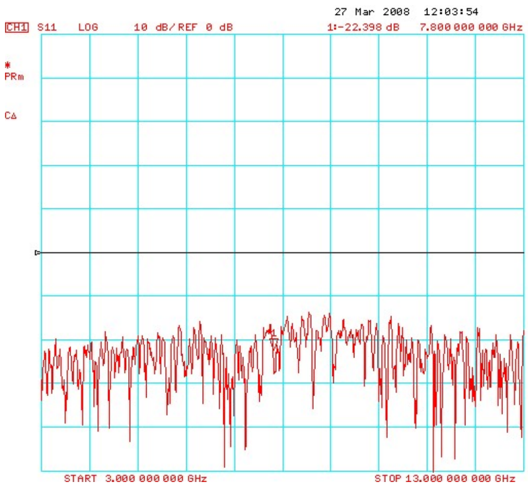


Figure 6: Retn Loss, Pol 0 USB, B6-002, Cold

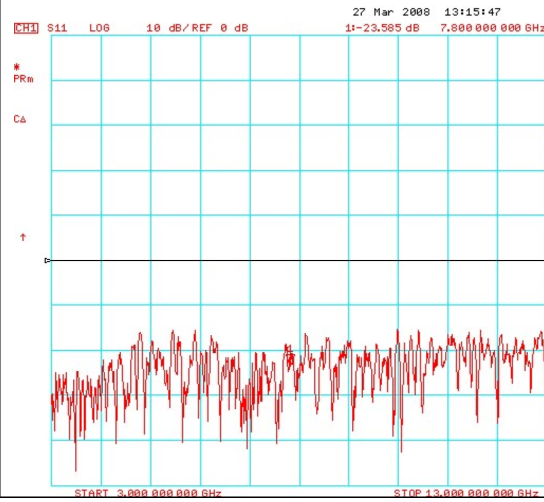


Figure 7: Time Domain, Pol 1 USB, B6-002, Cold

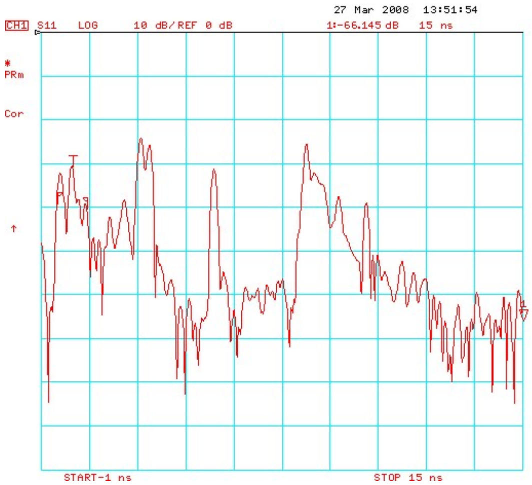


Figure 8: Time Domain, Pol 1 LSB, B6-002, Cold

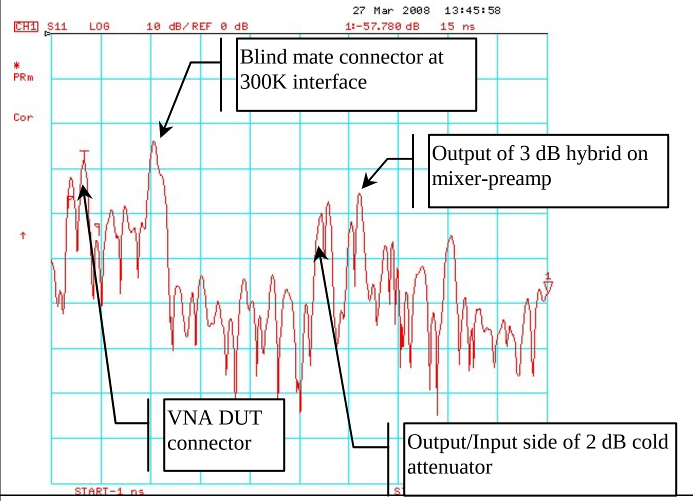


Figure 9: Time Domain, Pol 0 LSB, B6-002, Cold

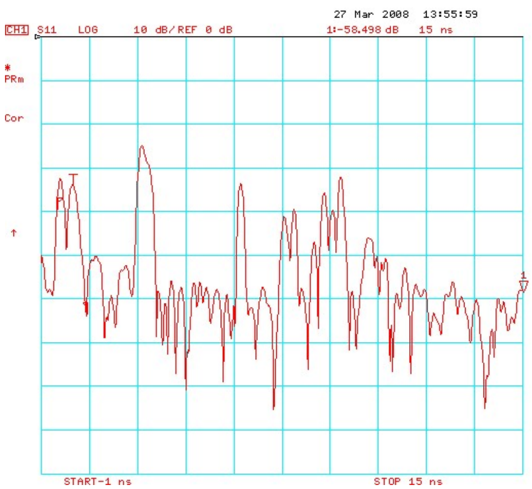


Figure 10: Time Domain, Pol 0 USB, B6-002, Cold

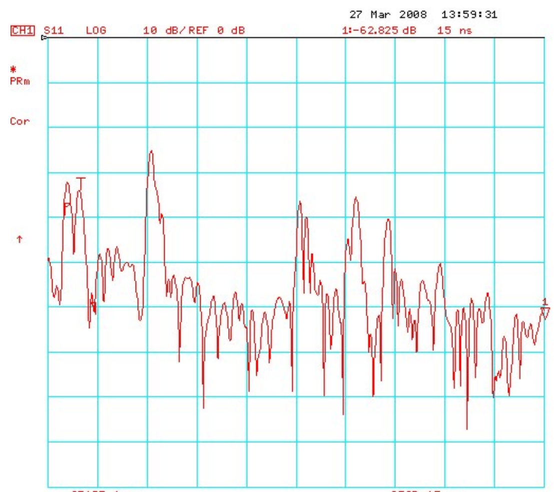


Figure 11: Time Domain, Pol 1 USB, B6-006, Warm

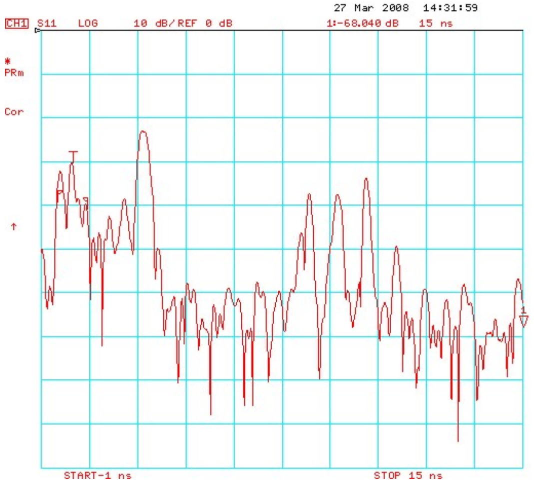


Figure 12: Time Domain, Pol 1 LSB, B6-006, Warm

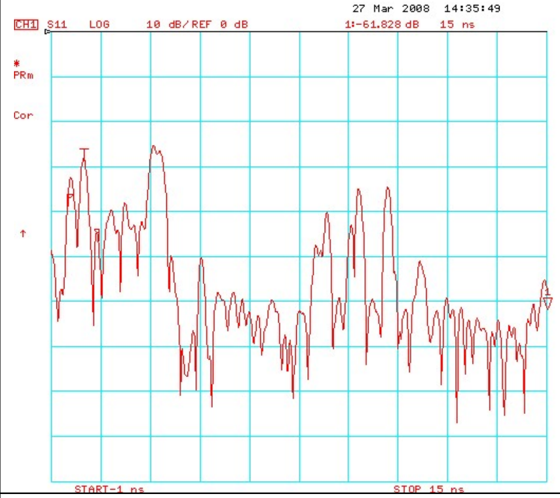


Figure 13: Time Domain, Pol 0 LSB, B6-006, Warm

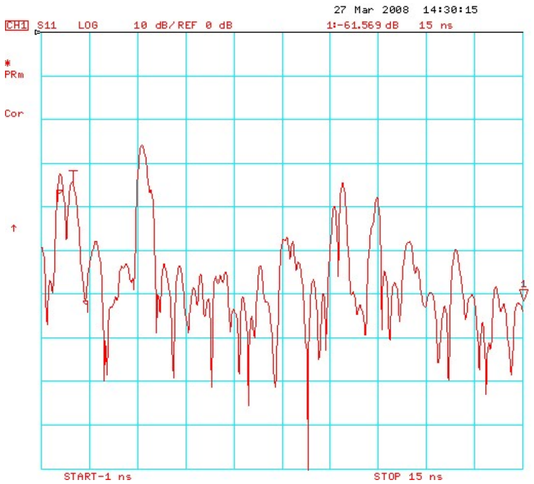
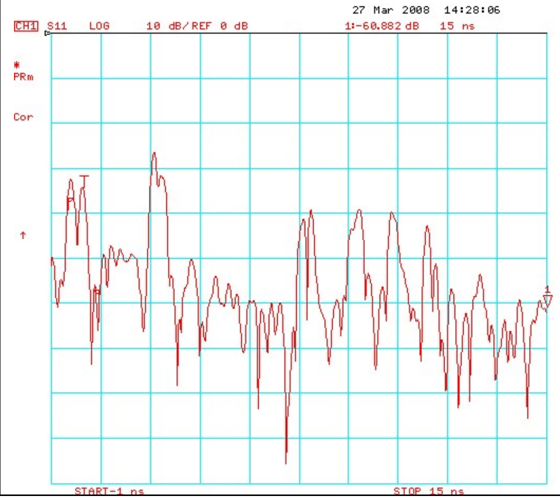


Figure 14: Time Domain, Pol 0 USB, B6-006, Warm

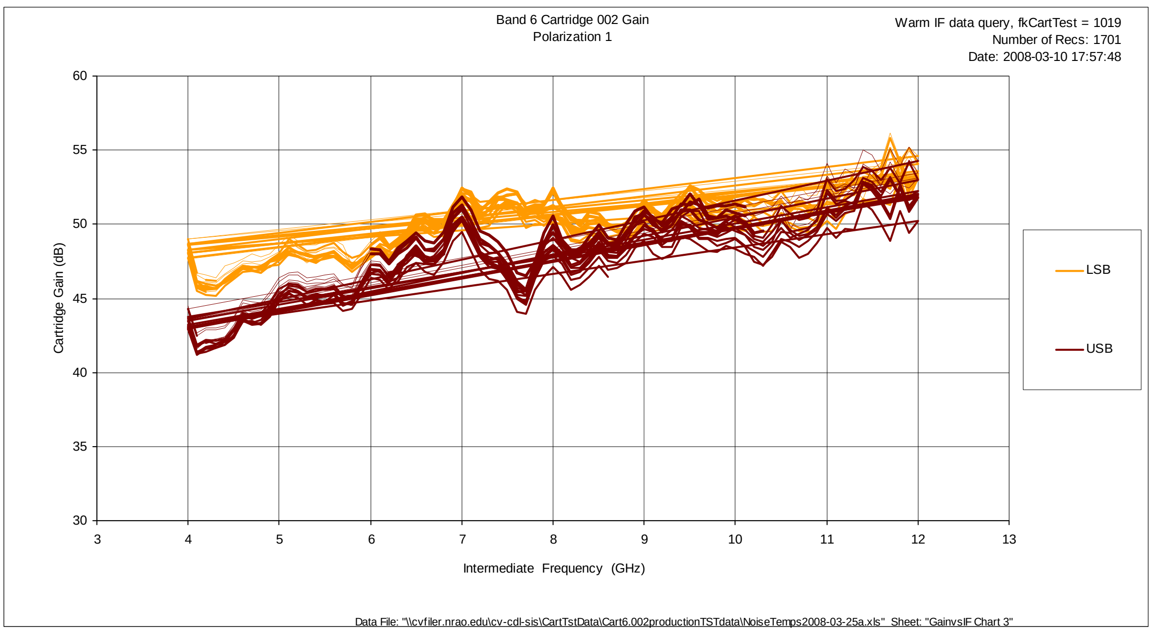


1. APPENDIX: CARTRIDGE GAIN PLOTS WITH SWAPPED CABLES

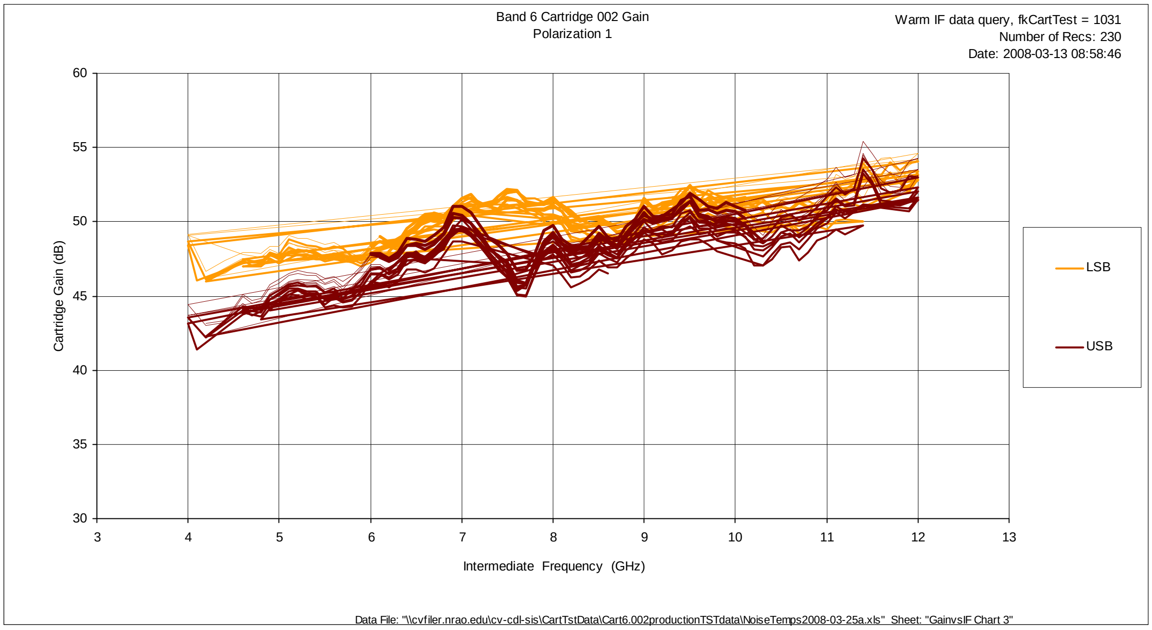
To alleviate concerns that the gain and power density suck-out visible in Pol 1 USB isn't caused by anomalies in the warm IF data, cartridge gain was computed using several different warm IF datasets.

It's unlikely that corrupted warm IF data manefests itself as a suck-out, because all the other polarizations and sidebands use exactly the same data and don't have any suck-outs, but for completeness, a number of datasets were graphed to show the warm IF data is okay. Note that the problem could reside in the warm IF amps, cables, or 6-way switch, but we'll check that by swapping cables at the cartridge 300K IF interface. Unfortunately, it's most likely that the problem resides in the cold cartridge IF cables.

The graph below shows Pol 1 gain computed using the most extensive warm IF dataset collected, that from 10 Mar 2008.



The next graph shows gain when the warm IF data is from a different set, that from 13 Mar 2008.



Finally, the graph below uses the average values for all warm IF data collected, beginning on 10 Mar 2008, which is basically the average values in the two data sets above. Also, the gain of just the warm IF plate is plotted on this data, to show the suck-out is much narrower and unrelated to the dip in gain for the warm IF system.