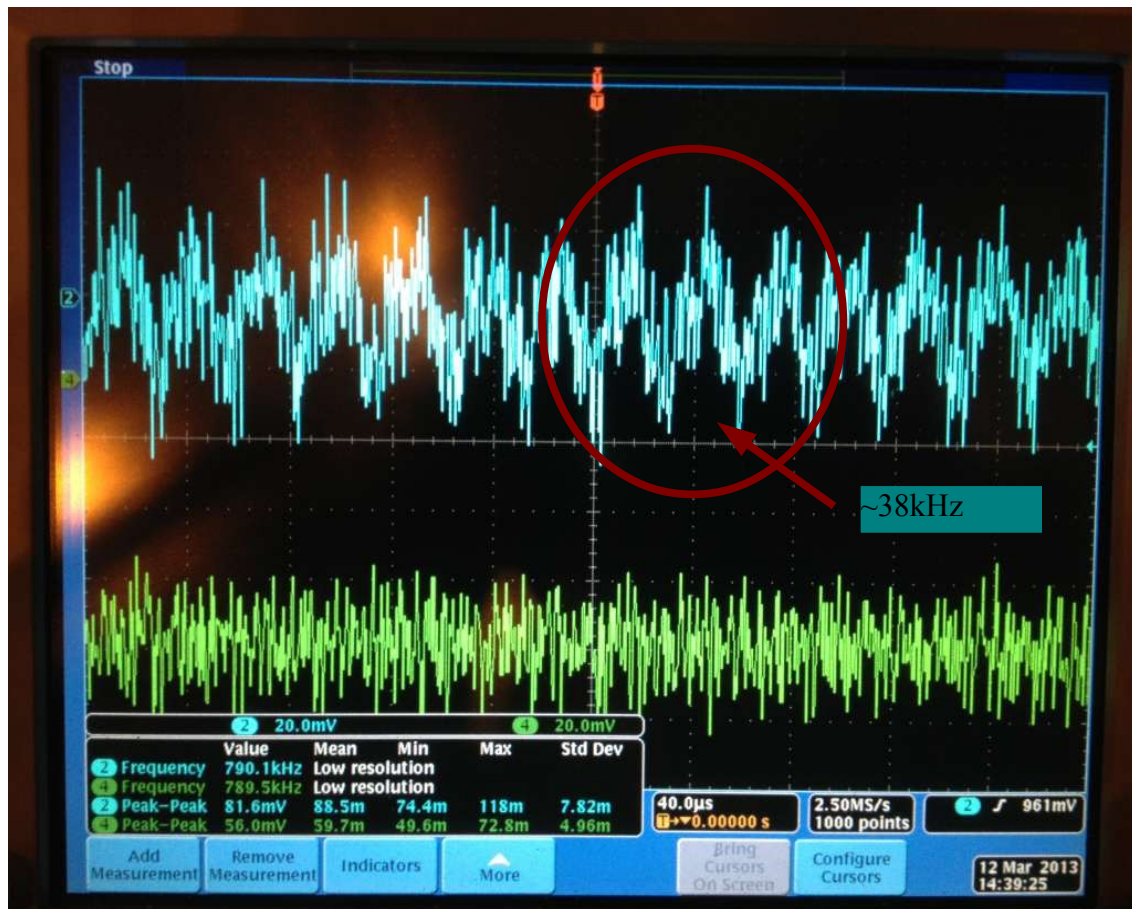


Preamp Carrier Board Periodic Noise Issue and Solution

IDLAB 3/27/2013

Objective

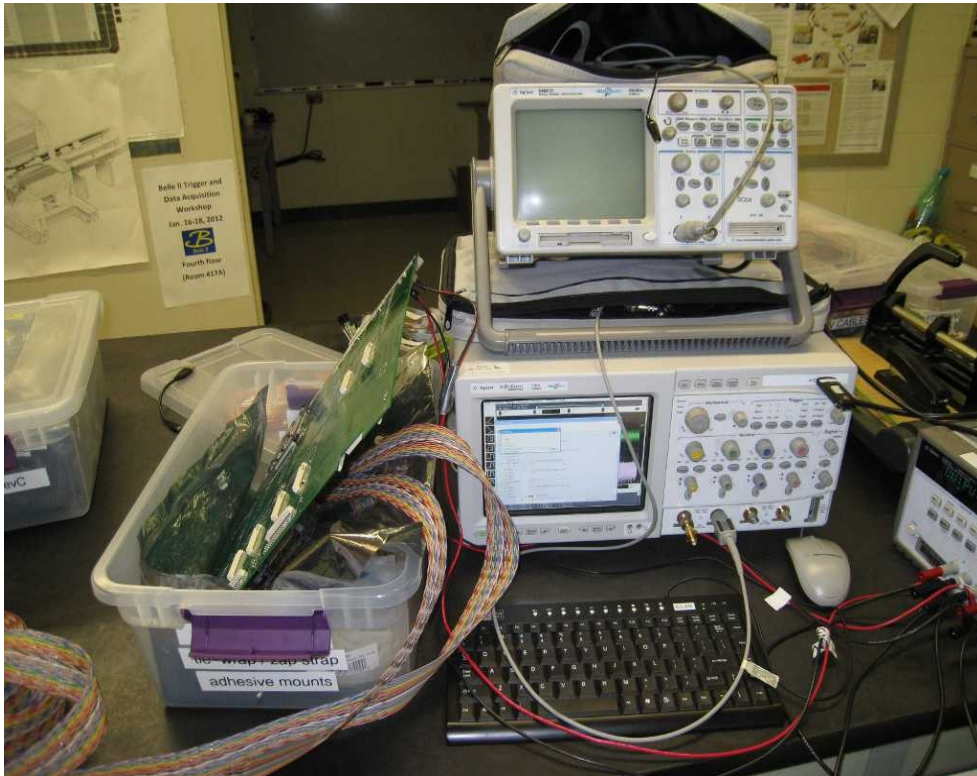
We saw $\sim 40\text{kHz}$ periodic noise at the output of the preamps. They are typically around 80 mV peak-to-peak, which could affect the MPPC signals. It becomes an problem for data taking, we have to solve it.



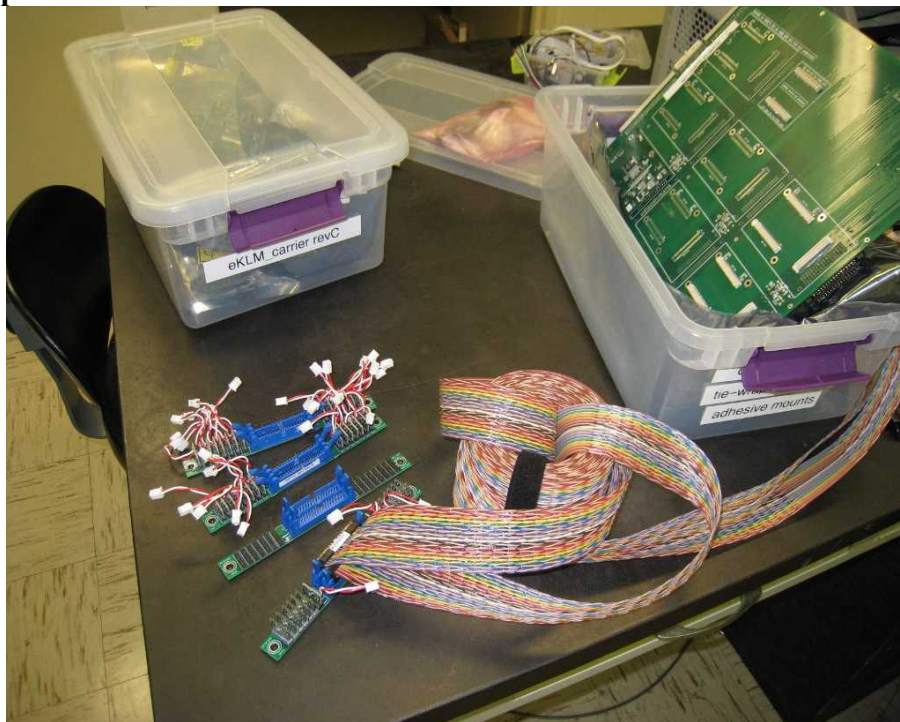
Pic-FujiHallKEK: This photo was taken at Fuji Hall, KEK.

The upper blue signal was the MPPC signal from the Sci-Fi Tracker.
The lower green signal was from a carrier board with ceramic capacitors on R1 and R2.

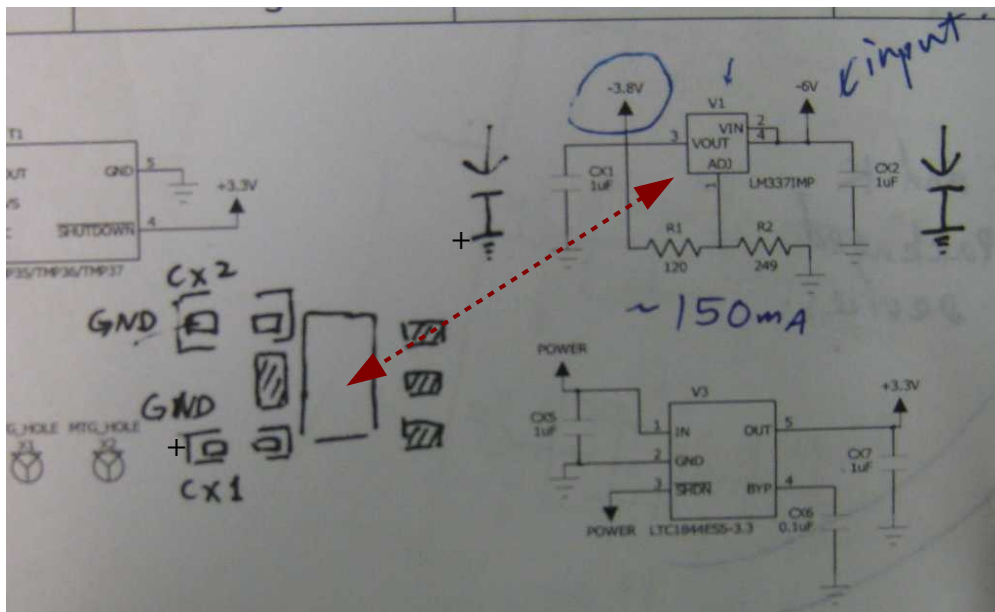
Test Setup



Pic-Setup1



Pic-Setup2



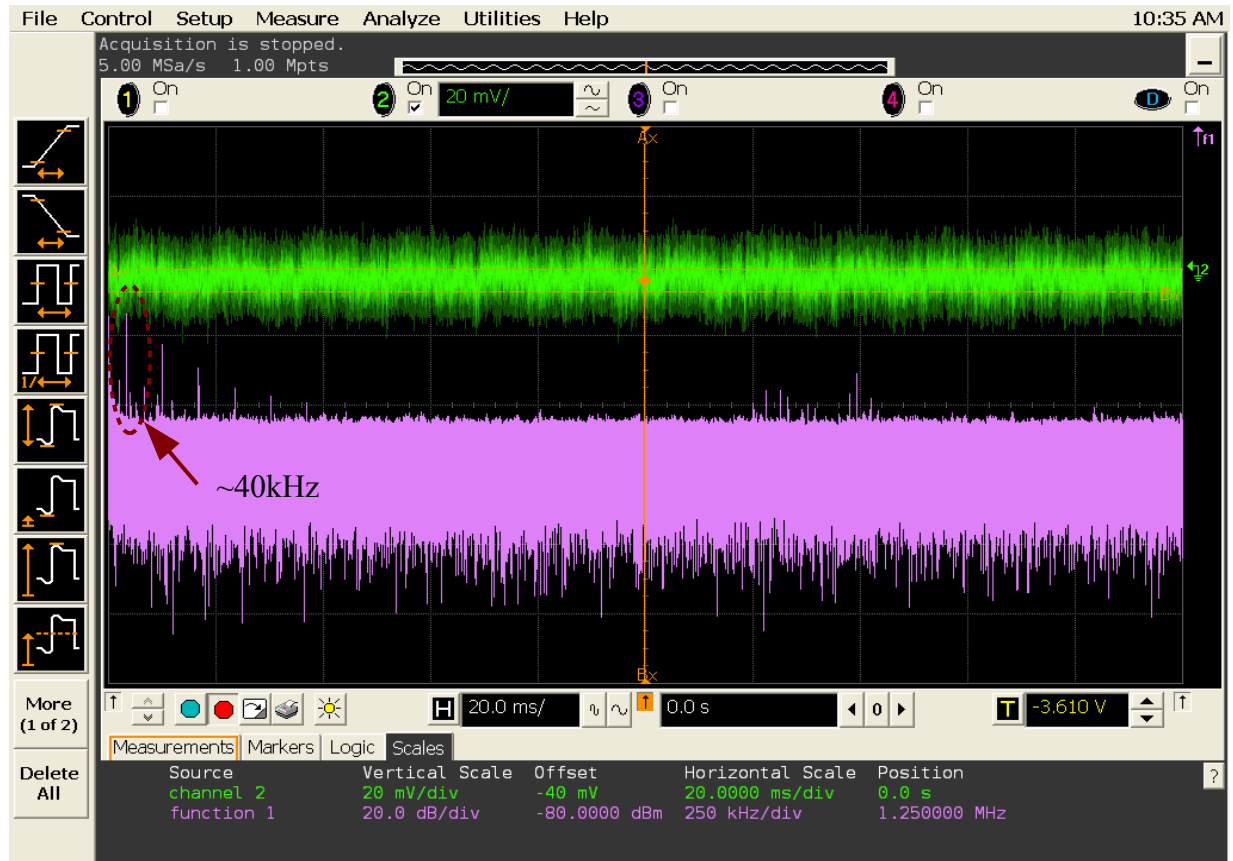
Pic-Setup3: Where and how I soldered the Tantalum capacitors.

Notes

- For all the plots below, the green line is the input signal from preamp.
- When testing, the scope probe is attached to the test point on TARGET4 daughter card.
- The purple region is the FFT of the input signal(green line).
- More details about testing and the saved waveform files can be found here:
<https://drive.google.com/folderview?id=0BxDOJC6YgEhiTUZhaThjcDhZdkE&usp=sharing>
- Table of scales for the FFT measurements.

Scope H. Scale	Vertical Scale	Offset	Horizontal Scale	Position
20 us	20 dB/div	-45dBm	200 MHz/div	1.0 GHz
50 us	20 dB/div	-45dBm	100 MHz/div	500 MHz
100 us	20 dB/div	-45dBm	50 MHz/div	250 MHz

Background Noise



Pic-bg032701: The scope probe is not attached and the lights in the room are on.

As we zoom in, the 40 kHz periodic noise becomes clear. The closer look is shown in Pic-bg032702.



Pic-bg032702: A zoom-in look of Pic-bg032701. It's clear that the 40kHz periodic noise exists in the background.

The 40kHz noise is from the Fluorescent lamps. As I turned off the lights, the 40kHz periodic noise disappeared. You can find more information at:

1. Interference Problems of Fluorescent Lamps Operating on High Frequency Electronic Ballasts with Infrared Remote Control Equipment and Infrared Simultaneous Interpretation System
http://www.emsd.gov.hk/emsd/e_download/pee/infrared_interference_emsdweb.pdf
2. Silence of the Lamps: Reducing radio frequency interference from small fluorescent lamps
<http://www.randombio.com/fluorescent-lamp-interference.html>

Causes of the Issue

The voltage regulator LM337 on preamp carrier board needs input and output by-pass Tantalum capacitors for stability. Without them, the 40kHz background noise picked up by the long ribbon cable will be amplified through the preamps.

Without an input by-pass Tantalum capacitor, the periodic noise always appears even with an output by-pass Tantalum capacitor.

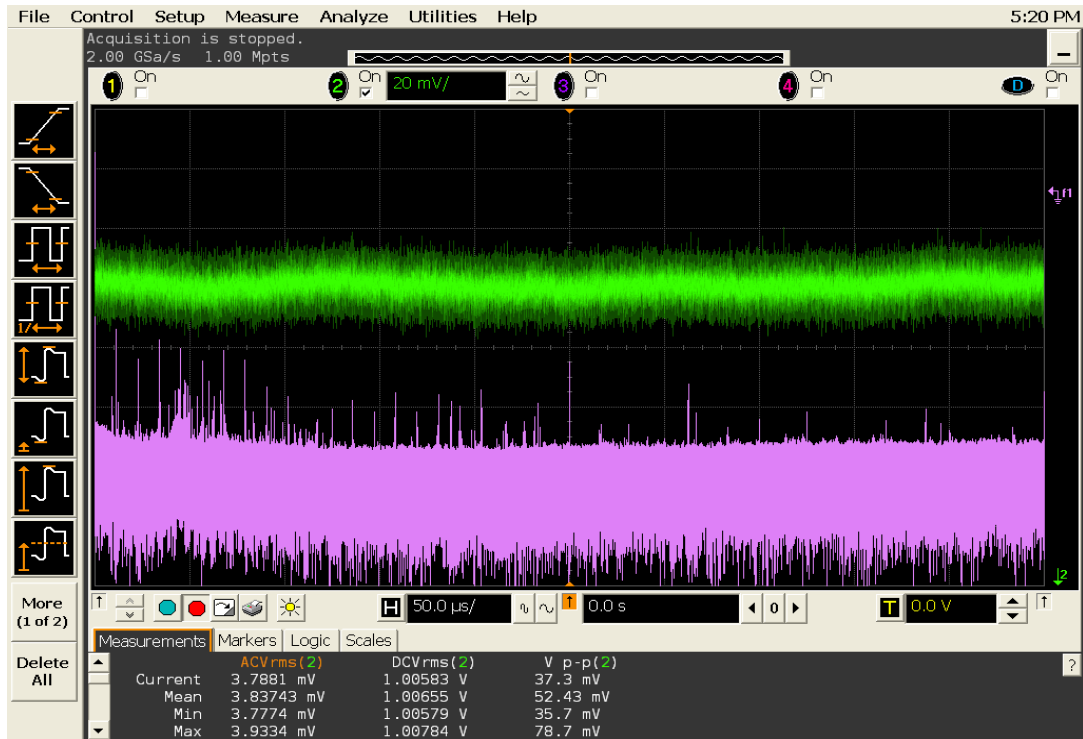


Pic-PAC14.03: CX1 was replaced with a 2.2 μ F Tantalum capacitors and CX2 was removed on carrier board#14.

FFT Scale: vertical=20dB/div; offset=-45dBm
horizontal=100MHz/div; position(center line)=500MHz

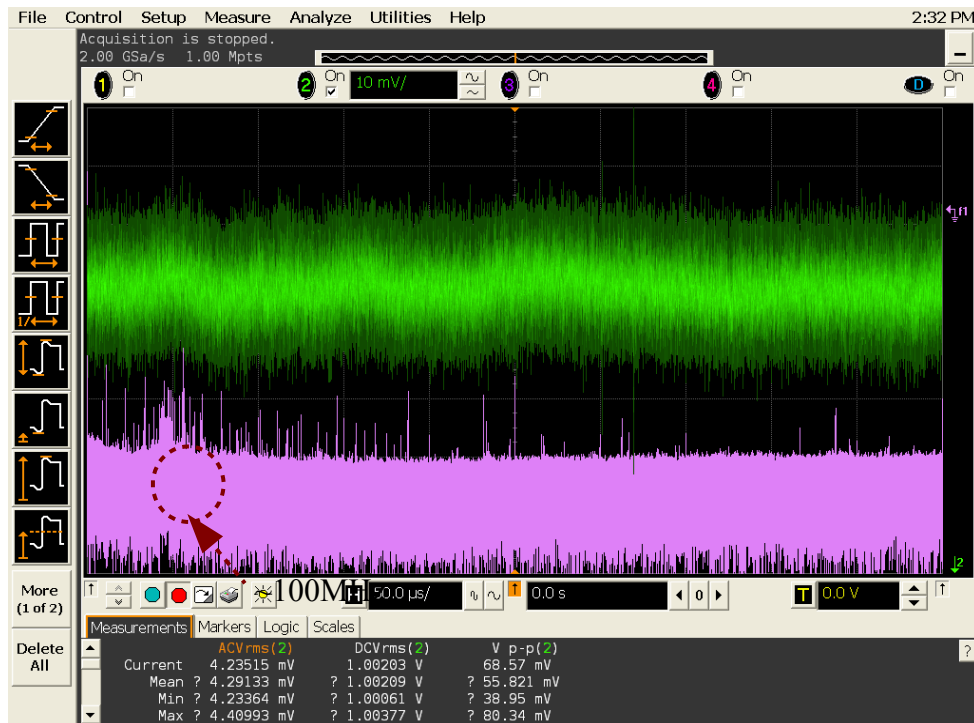
Adding a input by-pass Tantalum capacitor, the periodic noise always disappears.

It has been tested on 4 different preamp carrier boards with 2.2 μ F, 4.7 μ F and 1 μ F Tantalum capacitors. They worked equally well.



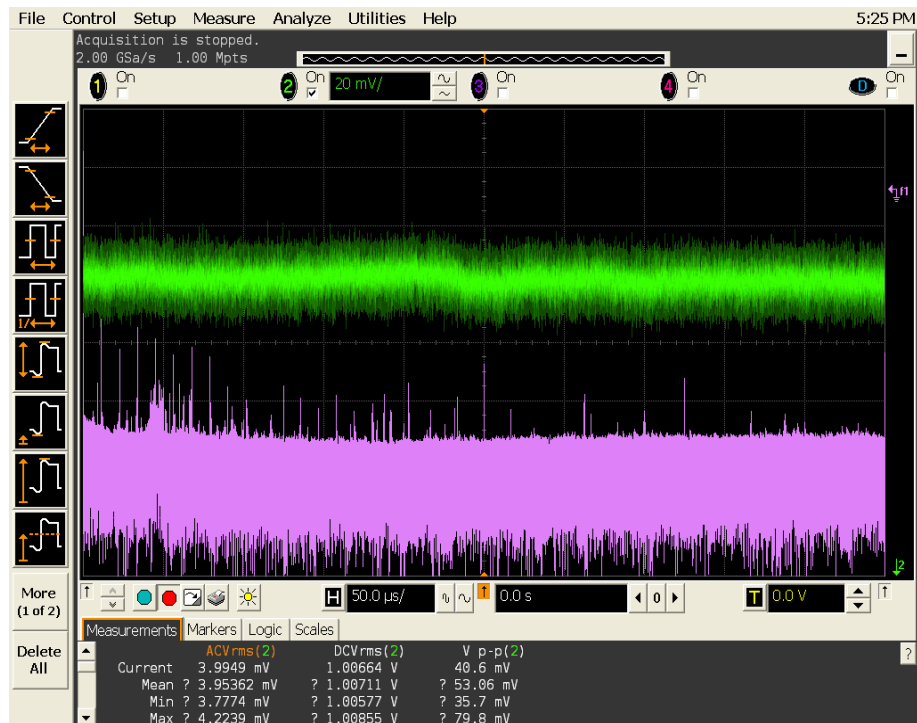
Pic-PAC12.14: No capacitor on CX1(output) and 2.2 uF Tantalum Capacitor on CX2(input). 2 preamps on the carrier board#12.

FFT Scale: vertical=20dB/div; offset=-45dBm
horizontal=100MHz/div; position(center line)=500MHz



Pic-PAC14.05: Both CX1(output) and CX2(input) were replaced with 2.2 uF Tantalum capacitors.

FFT Scale: vertical=20dB/div; offset=-45dBm
horizontal=100MHz/div; position(center line)=500MHz

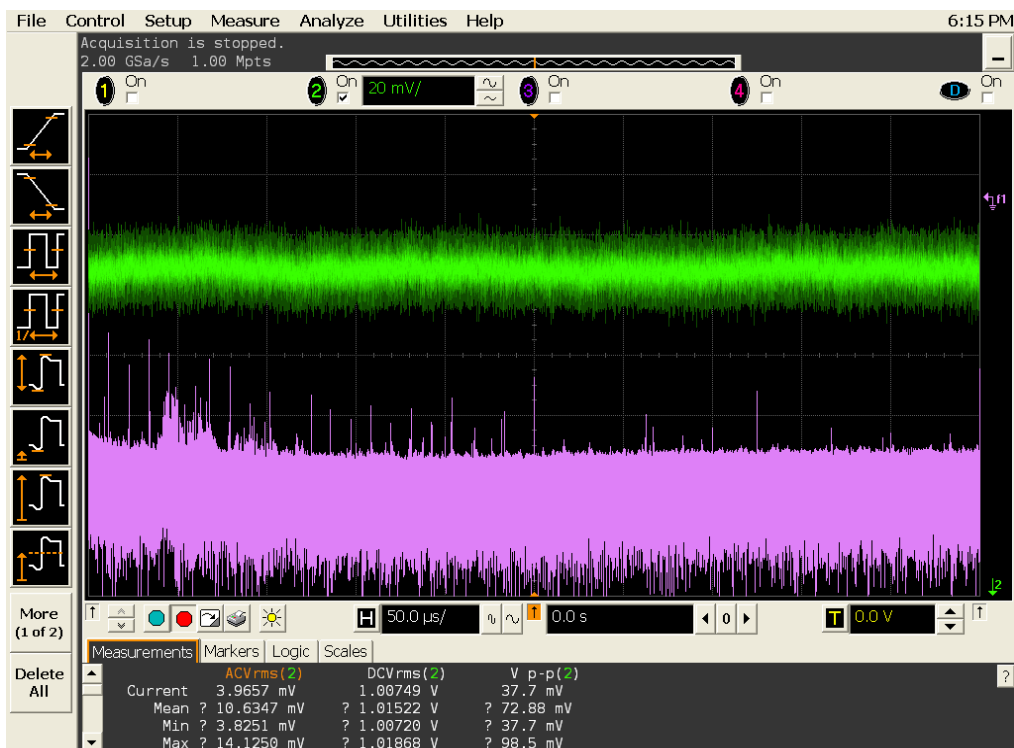


Pic-PAC12.16: No capacitor on CX1 and 2.2 μ F Tantalum Capacitor on CX2.

15 preamps on the carrier.

FFT Scale: vertical=20dB/div; offset=-45dBm

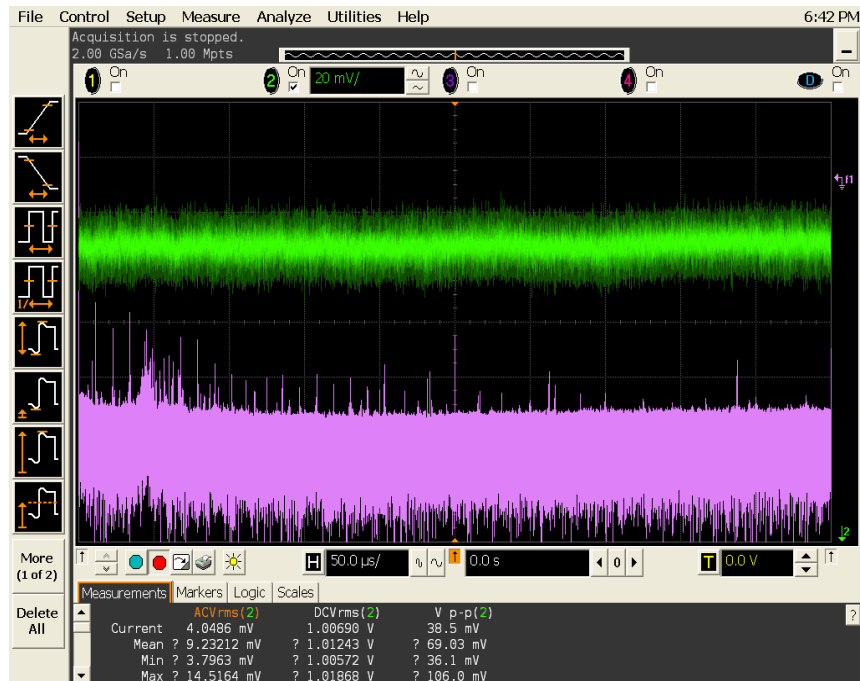
horizontal=100MHz/div; position(center line)=500MHz



Pic-PAC3.21: 4.7 μ F Tantalum capacitors on CX1(output) and CX2(input).

15 preamps on the carrier.

FFT Scale: vertical=20dB/div; offset=-45dBm
horizontal=100MHz/div; position(center line)=500MHz



**Pic-PAC11.25: 2.2uF Tantalum capacitors on both CX1(output) and CX2(input).
15 preamps on the carrier.**

FFT Scale: vertical=20dB/div; offset=-45dBm
horizontal=100MHz/div; position(center line)=500MHz

Conclusion

After testing on preamp carrier #14, #12, #3 and #11, it becomes very clear that in order to solve the noise issue, we MUST solder an input by-pass Tantalum capacitor.

We need an output Tantalum capacitor as well.

The ceramic capacitors doesn't work well. They reduce the periodic noise, but the results are not stable.

Procedure:

1. Desolder CX1 and CX2 on the preamp carrier board.
2. Follow the diagram Pic-Setup3.
The '+' side(The side closer to "bar") of the Tantalum capacitor should be connected to 'GND' for both CX1 and CX2.