One of the key elements of the project is the ability to measure the force on the cylinder. This data will be displayed as the load the bridge is bearing. This means that the force needs to be measured as accurately and precisely as possible. We had looked at S-TYPE LOAD CELLS but came to the conclusion that a pressure sensor attached to the hydraulic sensor would be cheaper.

To read the data from the sensor we needed an ADC that could communicate over I²C. We looked on DIGIKEY, but because we were looking for only through hole components, (Neither of us has ever done any toaster oven reflow) the pickings were very slim. We decided to see what prebuilt options existed, and after a quick search, found THIS ADAFRUIT ADC.

Once one arrived we decided to test it and see what kind of accuracy and precision we could expect.

We hooked up the ADC using an Arduino clone as an I²C to serial converter, with the poling was set to 10hz in the sketch.

Since the voltage range we are going to be testing is 0-5V, we set the benchtop powersupply to 100mV so that we would have a worst case sort of scenario in terms of http://en.wikipedia.org/wiki/Signal-to-noise\_ratio SNR. Current on the power supply was limited to 4mA, but the only time current, was observed was when the voltage was being changed and the large capacitor needed to charge/ discharge. The 100mV was then put from ground to one of the single ended inputs. The ADC was getting power from the laptop (an Acer Aspire One running Debian) through the Arduino.

At first we had trouble getting the ADC to register more than 11 bits, but that was because we were using the library for the 12 bit ADC. After we changed libraries, there was quite a bit of noise. We didn't measure it, but it was about .2%, so +- 200uV at 100mV. We then added a 2200 uF capacitor and a 2pF capacitor in parallel and a 1K resistor in series with the input. We used the smaller capacitor in case the larger one had a high http://en.wikipedia.org/wiki/Equivalent\_series\_resistance ESR

After the filter was added, the noise went down to +- 1 resolution gradient. The output was logged for a few minutes and then graphed in https://www.libreoffice.org/ Libre Office Calc. Some interesting behavior was noticed. Over the course of about 2 minutes, the signal was definitely cyclical. At first we thought it was 60Hz noise, but it was way too slow. The data was plugged into a FFT analyzer, and the only spike was at 1.4Hz.

One possible cause is the RC time constant of the filter, so we calculated what that would be:

2200 Farad \* 10^-6 \* 1 \*10^3 Ohm = 2.2 seconds = .45 Hz This frequency is an order of magnitude off. For verification we measured the period of one wave in the graph, and found it to be about 10 seconds. The shape of the signal also matched that of a capacitor charging and discharging.

The FFT calculator did not show any spikes around the .1 Hz mark, as expected from a signal with a period of ~10 seconds, so we concluded that the signal does not have a clear frequency.

We think what is happening is the power supply also has capacitors on the order of 10,000 uF as that would give about the right time constant, and a ADC with about 10 bits of resolution, as that would get it to "Bounce"

within the about .08% that the graph shows.

~Ben