

PCB V5 ADC Problems

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1 Overview

On the V5 PCB, there is an issue with the ADC current sense module. The chip being used is the ACS716KLATR-6BB-T. This chip is bi-directional and outputs an analog voltage proportional to the current through its sensing path. This output is centered at 1.65V for zero current with a slope of 100 mV/A. Additionally, based upon the configuration of the chip upon the V5 PCB, an increase in current corresponds to a decrease in voltage. Also, for the purposes of the project, the current is unidirectional.

2 Problem

The issue at hand is that there is a floating offset present in the measured current value from the chip. At zero current, the measured current should be zero; however, this is not the case. When the ADC is read using the read ADC function (found in ADC.c) and the CurrentSensorPlotter.py python function that plots and average the current values, at zero current a value of about .05 to .08A is obtained. This can be seen in Figure 1. Additionally, it can also be seen that there is a wide variability for the ADC readings.

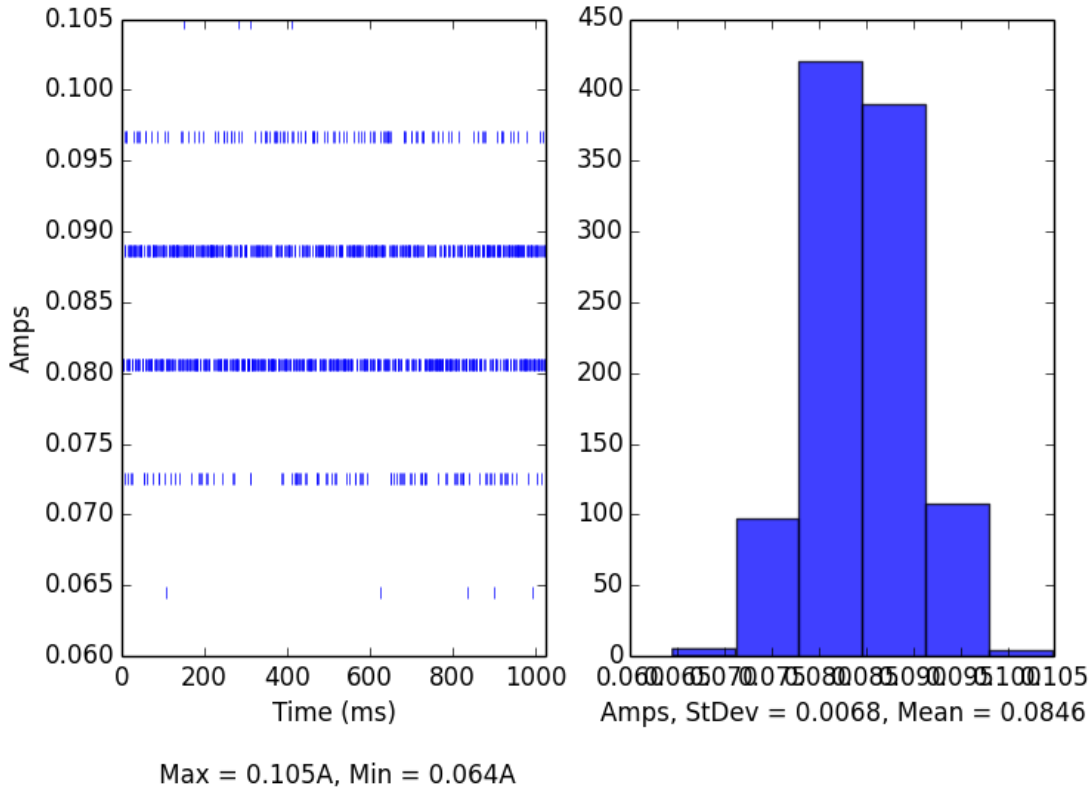


Figure 1: ADC Reading at Zero Current

It should be noted that for a while the measured current falls within an 8mA range, i.e. if the first reading gives a value of .085A, the next measurements for a while will have a minimum and maximum value that falls within 8mA. This is not an issue for the resolution of the current sensor is 8mA/ADC count, thus this falls within the expected range.

3 Testing

To test the problem, a power resistor was used in place of the motor with a multimeter in series to measure the actual current running through the resistor. A new motor state (`commutate(7)`) was created that sets line 1 low and line 2 high. The multimeter was indeed reading 0mA when the all floating motor state (`commutate(0)`) was in place. The offset described in Section 2 was present, however, in the value given by the ADC reading.

The motor state was then switched to `commutate(7)` using USER button. When the ADC reading was obtained, the value decreased compared to the floating state, which is as expected based upon the board setup. This test was done with two different power resistor values (500 and 1K ohms), with varying duty cycles, and with only the primary board, with the secondary board connected, and with one of the magnets on to see if these values affected the offset and it was due to the current running through the whole board and not just the motor. The latter test on the amount of components powered did not appear to affect the offset during testing.

If the difference between the floating state value and the `commutate(7)` state was taken, the value was very close to the measured current value from the multimeter. For example, the 500 ohm power resistor at a 50 percent duty gave a current reading of .02345A on the multimeter. The difference between the floating and `commutate(7)` ADC readings resulted in a current of .0241A, or a 2.77 percent error. This shows that the current sensor is accurately measuring the current, but there is that offset that is present.

4 Possible Solutions

To fix the problem, the source of the offset must be discovered. Somehow the problem must be isolated to determine the exact source of the problem, whether that be board design or some other issue, to allow for a solution to be implemented in code or in the V6 PCB design.

One possible solution would be to add some number of readings to the initialize ADC function and take the average of those readings to set as the zero current value and essentially negate the offset. One issue with this would be that if the offset is floating and changes over the time of running, the average value calculated at initialization would no longer serve as a good representation of the offset and would lead to error in the measured current reading and would therefore affect any code utilizing the current sensor readings.