Homework 7: Due Tues, Nov 3

Problem 1 - End Point Calculation

A linear histogram test was performed on an unsigned binary 3-bit ADC resulting in the following distribution of code hits beginning with code 0. A servo loop method found the code edge between 0 and 1 to be 5mV and the servo loop method for the code edge between 6 and 7 to be 1.15V.

histogram: 9, 6, 9, 8, 11, 13, 7, 22

(a) Determine the average LSB voltage for the 3-bit ADC.

(b) Determine the width of each code and the location of the code edges in V's.

(c) Plot the transfer function for this ADC.

(d) Calculate the DNL for each code and determine the value that would be datalogged for this data.

(e) Calculate the INL relative to the end point line for each code and determine the value that would be datalogged for this data.

Problem 2 - Sinusoidal Histogram Calculation

A sinusoidal histogram test was performed on a similar unsigned binary 3-bit ADC resulting in the following distribution of code hits beginning with code 0.

histogram: 12, 16, 13, 7, 6, 15, 11, 20

(a) Sketch the histogram. What does the shape of the histogram tell you about the offset voltage and amplitude of the sinusoid?

(b) Calculate the offset voltage in LSBs of the output data sinusoid. Does this answer match your intuition in part (a)?

(c) Calculate the amplitude in LSBs of the output data sinusoid. What would be the maximum expected amplitude in LSBs? What does this tell you about the measured output?

(d) Calculate the ideal sinwave distribution for the measured offset voltage and amplitude.

(e) Find the normalized histogram in LSB's and plot it.

Problem 3 - ADC Datasheet

Use the MCP3221 datasheet to answer the following questions.

(a) What is the ideal LSB for this ADC? Where are the edges for the ideal transfer function?

(b) This ADC uses an I^2C bus to be controlled and send out data. To understand how the use the I2C bus, answer the following questions:

i. What kind of pin should the SDA pin be set to (e.g. input, output, bidirectional)?

ii. If the DPU is the "master" and the ADC is the "slave" and the ADC is used in continuous conversion mode, how many times does the DPU need to send the ADC the device and address bits during the linear ramp test?

iii. How should the vector editor be set up to initialize the ADC and start receiving data? Be sure to indicate when the vector editor should be Capturing data. Note: a bidirectional pin can use both "1" and "0" to indicate it is acting like a driver and "H" and "L" to indicate it is acting like a receiver. Hint: use "Burst" for repeated commands and use a loop to get all codes measured. Assume you have enough capture memory to hold all code bits.

(c) Draw a schematic to test the DC accuracy portion of this chip using the linear ramp histogram method.

(d) To test this with a linear ramp histogram and incorporate any potential V_{OS} and Gain error, what should the min and max of the ramp be?

(e) How many times must you loop through the code measurement part of the vector editor to test this so that an ideal ADC would obtain 10 measurements per code? How many digital clocks does that represent? (don't include the set-up clocks).

(f) How long would it take to obtain all of this data?

(g) Once the DC transfer function has been determined as in problem 1, how would you determine the following test specifications given the datasheet units given: (i) DNL, (ii) INL, and (iii) offset error, and (iv) gain error .

(h) The Functional Block Diagram gives a block diagram implementation of the successive approximation ADC shown in class. How does this block diagram map to the circuit shown in class?

(i) This ADC uses an SAR (successive approximation redistribution) architecture. In section 4.0, they mention the acquisition time and the conversion time. Knowing the architecture, what is happening during the acuisition time? During the conversion time?