STEP 1: ADC Simulation and Testing

Objective

Your goal is to build a free-running analog to digital converter similar to that in Figure 17 on the ADC0804 data sheet. Certain design decisions need to be considered and evaluated with the overall project in mind.

Pre-requisite

- Review ECEL 303 Lab Instruction on ADC
- Watch/follow video/tutorials on using Multisim
- Watch video on using an HP logic analyzer

Components Required

- ECEL 304 Data Acquisition Board
- ADC 0804
- 10 Segment LED Array
- 8 x 1.2 kΩ Resistor Array
- Resistor (to be calculated)
- Capacitor (to be calculated)

Equipment/Cables Required

- HP Oscilloscope/Logic Analyzer
- Multimeter
- DC Power Supply
- Function Generator
- Banana-to-Alligators Cables
- BNC-to-Alligators Cables
- BNC-to-BNC Cables
- BNC Splitter/T-joint
- Logic Analyzer Cable/Kit

Software Required

- Multisim
- MATLAB/Excel

DC Measurements (Hardware)

1. Set-up the ADC clock (Put it in Continuous Free-Running Mode). Refer to Figure 17 on the Harris ADC0804 data sheet.
   a. $\overline{RD}$, $\overline{CS}$ and GND needs to be connected together.
   b. $\overline{WR}$ and $\overline{INTR}$ needs to be connected together. A push button between them and ground needs to be connected.
   c. Short VCC and VREF on the board and supply +5V to them.

2. Determine appropriate values of R and C .
   a. Use chart or equation provided in datasheet.
   b. Also, see figure 5. f_{CLK} vs Clock Capacitor in the Harris ADC0804 datasheet.
   c. Things to consider:
      i. What are the capabilities/limitations of the chosen ADC? How many samples/second can it measure?
      ii. What is the maximum frequency you want to measure?
      iii. How often do you want to sample the signal? How does this compare to the ADC capability? A design compromise may be required here.
      iv. How many internal clock pulses are required to make a measurement?
   d. Find the closest R and C values and put them on the board.
   e. Observe CLK IN (ADC Pin 4) on the scope to verify the clock frequency.
   f. Use LED's to check for functionality and accuracy (NOTE: LEDs are active low).
      i. Take data for at least 15 dc input voltages over the span of 0 to 5 V. What is the voltage resolution of the ADC?
      ii. Generate a result table: DC input voltage, ADC output (binary bits), calculated output voltage and percent error.

Analog Measurements (Hardware)

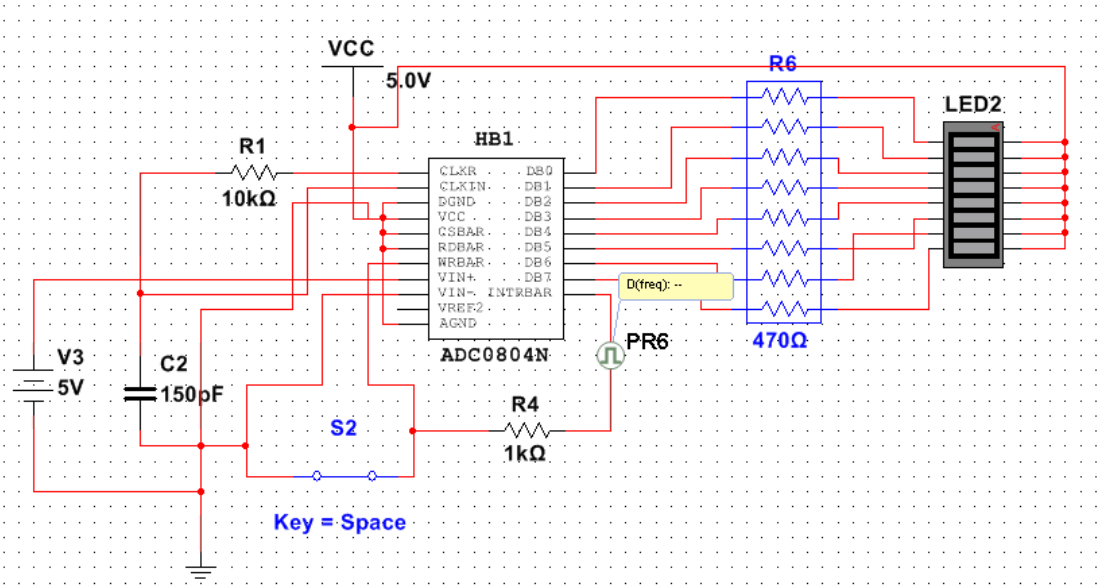
1. Observe ADC output bus (bits 7..0) on analyzer channels 0 to 7 for a ramp input (0 to 5 V ramp, 10 Hz frequency). Can you observe the binary count from 0 to 255?

2. Add an analyzer connection (channel 8) to the $\overline{\text{INTR}}$.

3. Use the cursors to measure the period between pulses on the $\overline{\text{INTR}}$ pin.
   a. How many internal clock cycles does this period represent? Use your measurements of the pin 4 waveform to get your answer. How does this number of clock cycles match with data sheet specifications?

DC/Analog Measurements (Simulation)

1. In Multisim, construct the ADC0804 in Continuous Free-Running Mode as you did above for in "DC Measurements (Hardware)". Use the following schematic as a reference:



   a. The ADC0804 isn't available in Multisim. However, a hierarchial block, *ADC0804.ms14*, has been created for you that very closely emulates its behavior. It is available on BBLearn in the "Week 1" folder.
   b. All the other parts can be found in the following locations in Multisim:

PART	DESCRIPTION	GROUP	LIBRARY
DC_POWER	DC Voltage Source	Sources	POWER_SOURCES
GROUND	Analog Ground	Sources	POWER_SOURCES
VDD	CMOS Supply	Sources	POWER_SOURCES
? (Resistor Value)	Resistor	Basic	RESISTOR
? (Capacitor Value)	Capacitor	Basic	CAPACITOR
SPST	Single Pole Single Throw Switch	Basic	SWITCH
8Line_Isolated	8 x Isolated Resistor Array	Basic	RPACK
BAR_LED_RED	8 Segment LED Array	Diodes	LED

   c. Use the capacitor and resistor value that you calculated

2. Repeat 2e and 2f from "DC Measurements (Hardware)" in Multisim.

3. Repeat 1 and 3 from "Analog Measurements (Hardware)" in Multisim.

In your report, be sure to include (but not limited to) the following:

- Design goal for the ADC internal clock frequency and the calculations of the required values of R and C
- Report on the measured clock frequency and comparison to your design goal
- Table from the DC measurements. Comment on the accuracy and resolution of the ADC.
- Report on the logic analyzer measurements.