EE214: A Signal Processing Chain

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A typical real-time system

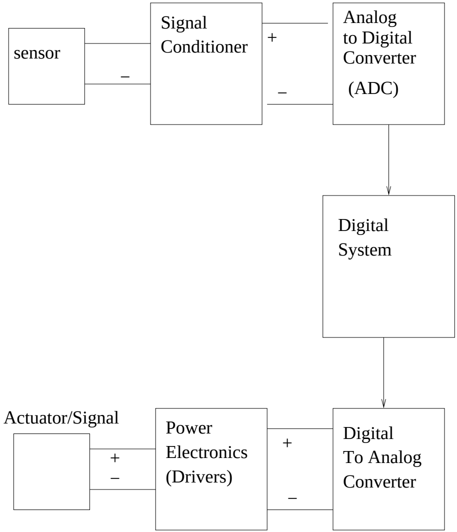

Figure: Real-time system

A 3-bit ADC

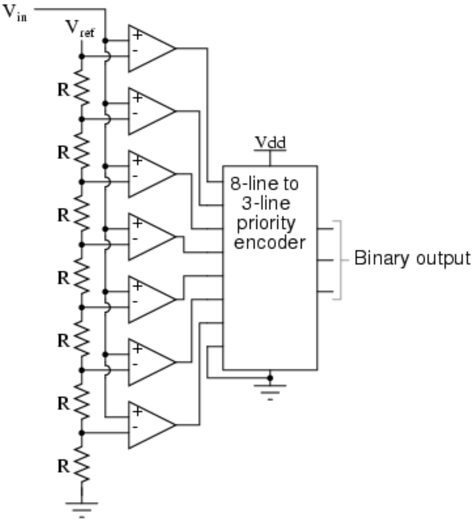

Figure: A Flash ADC (figure taken from https://www.allaboutcircuits.com/textbook/digital/chpt-13/flash-adc/)

A successive approximation 8-bit ADC

```
int result[] = {0,0,0,0,0,0,0,0};
void convertToDigital (float x) {
  int i;
  for(i=7; i >= 0; i--)
  {
      if (x < epsilon)
         break;
      if(x > 0.5) {
        result[i] = 1;
        x = 2*(x-0.5);
      }
      else {
        result[i] = 0;
        x = 2*x;
      }
  }
}
```

Interface to a successive approximation ADC

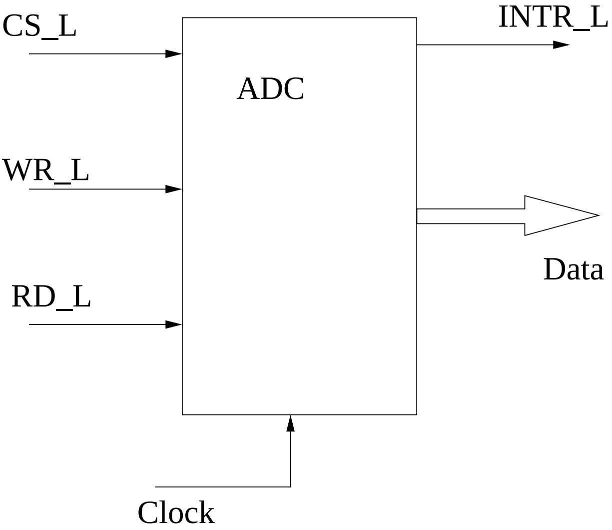

Figure: ADC Interface

Algorithm to Interface to a successive approximation ADC

Initially, CS_L = WR_L = RD_L = 1.

1. Make CS_L = 0. This initializes the ADC.
2. Make WR_L = 0. This starts conversion. Keep WR_L low for enough time.
3. Wait until INTR_L becomes low. This indicates completion of conversion.
4. Make WR_L = 1.
5. Make RD_L = 0. Wait for some time. Sample Data from ADC into local register.
6. Make RD_L = 1.
7. Make CS_L = 1.
8. Go to the beginning, and repeat as per your requirement.

Read the document

The ADC-DAC interface document is available on Moodle. READ IT.

Assignment

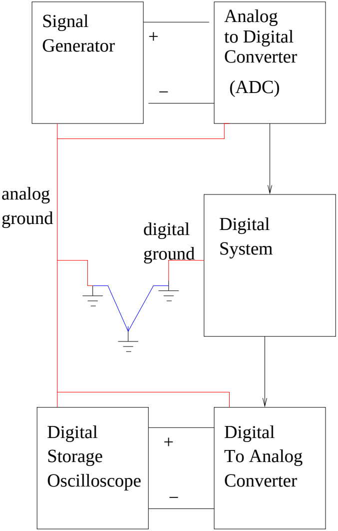

Figure: Experiment setup: use the Krypton kit for the digital system, ADC-DAC board for the rest

Assignment (part a): What you need to do

- You are given a specified sampling frequency, for example 1KHz.
- Design a circuit which will sample an analog signal at the sampling frequency (in this case, once every millisecond).
- The circuit should interface to the ADC and should implement the interface algorithm consistent with the ADC interface.
- The output of the circuit should be fed to the DAC.
- Observe inputs and outputs for various applied sinusoidal inputs (frequencies up to 500Hz in this case). Amplitudes should be varied within safe limits.

Assignment (part a): Hints

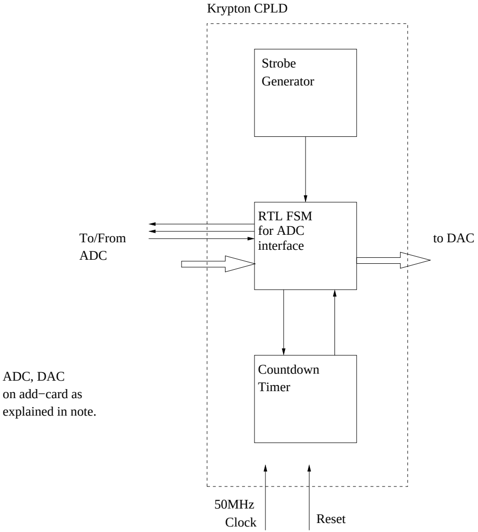

Figure: Recommendation: try to break your system into smaller subsystems.

Assignment (part b)

Let $x(k)$ be the k^{th} sample generated from the ADC. We design a digital system with output $y(k)$ which computes

$$y(k) = \frac{\sum_{m=0}^{8} x(k-m)}{8}$$

This is called a moving-average filter, and can be rewritten as

$$y(k) = y(k-1) + \frac{x(k) - x(k-8)}{8}$$

You are required to implement such a digital filter to process the ADC samples and drive the result to the DAC.

Assignment (part b): hints

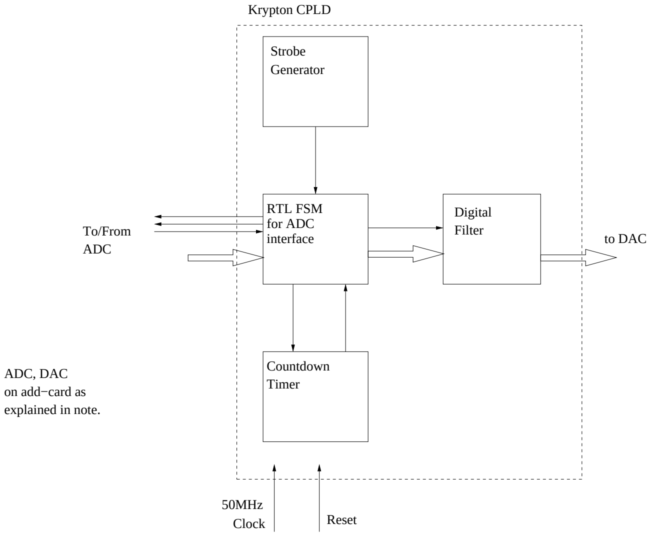

Figure: Recommendation: Incorporating the digital filter into your design

Assignment (part b): measurements

You will measure the frequency response of this filter.

- Fix the amplitude of the input signal to the ADC (say 5V peak-to-peak).
- Vary the frequency of the input signal from 50Hz to 500Hz in steps of 50Hz. For each frequency, measure the amplitude of the output signal (out of the DAC).
- Plot the ratio of amplitudes (output/input) as a function of frequency.
- What do you observe from this plot?

Winding up

Final exam will be 13 April 2019. You can submit your work for this assignment by April 30.