Analog Things

Interfacing to a Temperature Sensor

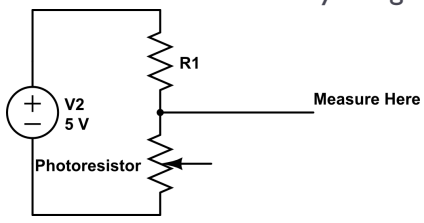
- Imagine that you need to interface to a non-serial temperature sensor…
  http://www.ti.com/lit/ds/symlink/lmt70.pdf
- Notice from the data sheet that this outputs a variable voltage depending on the temperature.
- How can my digital device (sees 1 or 0) read in an analog value?

Analog to Digital Conversion

- An ADC is used to measure the value of a voltage
- Typically, they measure analog voltages from ~0V to ~5V
- Voltage is converted to a binary number
  - Analog voltages are mapped linearly to this space
- Resolution can be configured using Vref- and Vref+

Uses of an ADC

- Many sensors provide their output using what is basically a variable resistor
  - A photoresistor decreases in resistivity as light increases



- Others simply output an analog voltage
  - Analog temperate sensors outputs a voltage that varies with temperature

Example

- Consider an ADC configured with…
  - Vref+ = 5V
  - Vref- = 0V
  - 10-bit resolution
  - 10-bit result is 0b0110110010
- What is the analog voltage?

Example (cont)

- 10-bits is the range 0 -> 1023
- A result of 0 would be 0V
- A result of 1023 would be 5V

- 5V / 1024 ~= 4.88mV (volts / increment)

- If my results is 0b0110110010 (434) then the analog voltage is…
  - 434 * 4.88mV = 2117.92 mV ~= 2.12V

Example 2

- Consider an ADC configured with…
  - Vref+ = 3V
  - Vref- = 1V
  - 10-bit resolution
  - 10-bit result is 0b0110110010
- What is the analog voltage?

Example 2 (cont)

- 10-bits is the range 0 -> 1023
- A result of 0 would be 1V
- A result of 1023 would be 3V

- 2V / 1024 ~= 1.95mV (volts / increment)

- If my results is 0b0110110010 (434) then the analog voltage is…
  - (434 * 1.95mV) + 1V ~= 1.85V

Timing

- Analog to digital conversion is not instantaneous
- Usually you start the conversion, wait, then read the answer
- How long to wait depends on the processor

Choosing Reference Voltages

- You can't pick any arbitrary values for Vref+ and Vref-
- The possible ranges are limited
- The more stable your reference voltages, the more accurate your results
- VDD/VSS are not always stable…

ADC on mbed LPC1768

- Looking at the datasheet…
  http://www.nxp.com/documents/data_sheet/LPC1769_68_67_66_65_64_63.pdf
- Single, 12-bit ADC
- Can be used with 8 different pins
- Assuming Vref+ of 3.3V and Vref- of 0V…
  - What is the resolution of a 12-bit ADC?

mbed API

- https://developer.mbed.org/handbook/AnalogIn