

# ADC

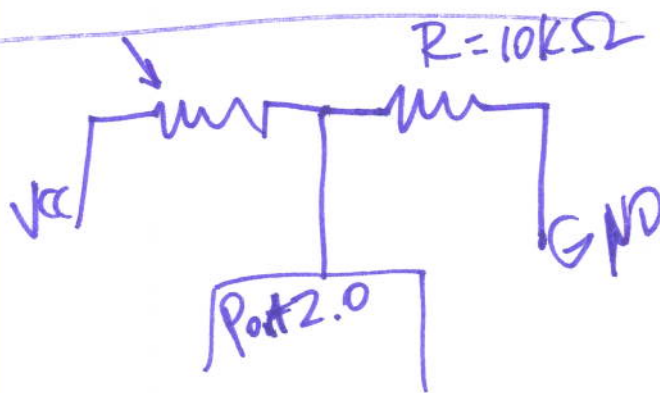
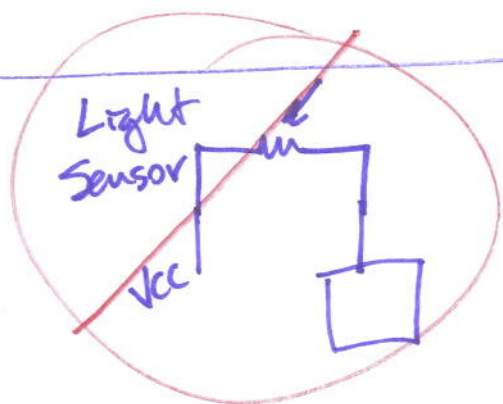
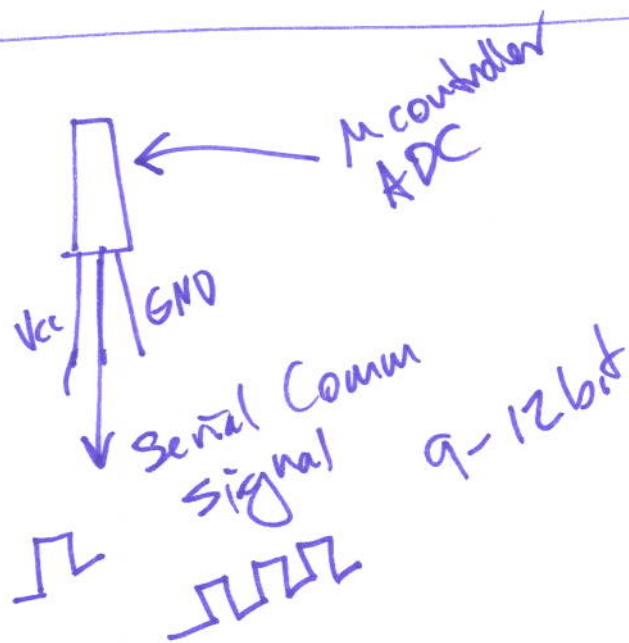
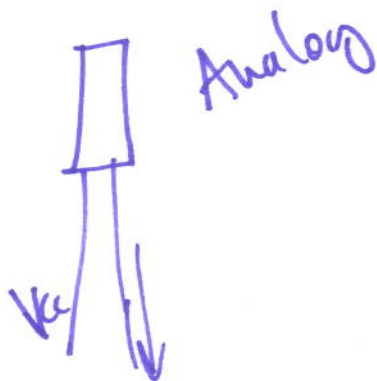
①

This is an ANALOG world. You can

Measure these:

- \* Temperature
- \* Velocity
- \* Humidity
- \* Power

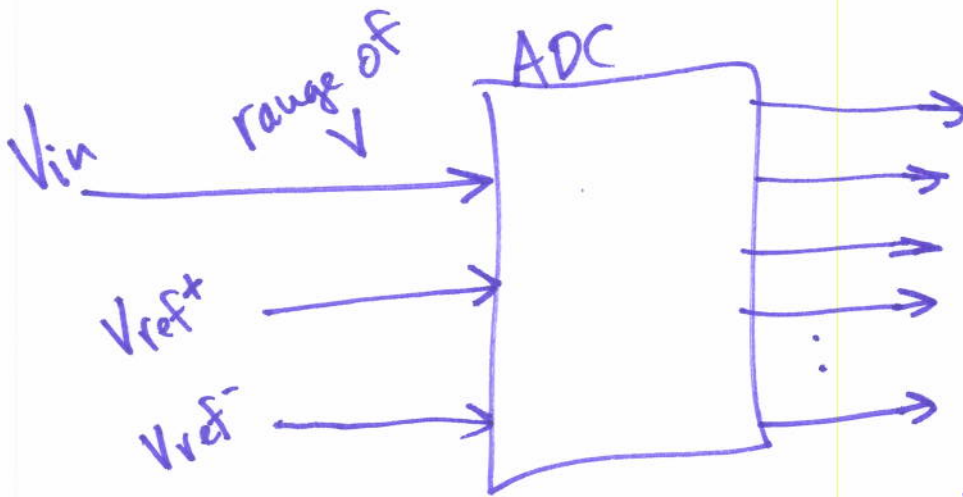
- \* light
- \* Sound
- \* Acceleration
- \* Time
- \* Pressure
- \* magnetic field
- \* Current
- \* distance



# Embedded Systems

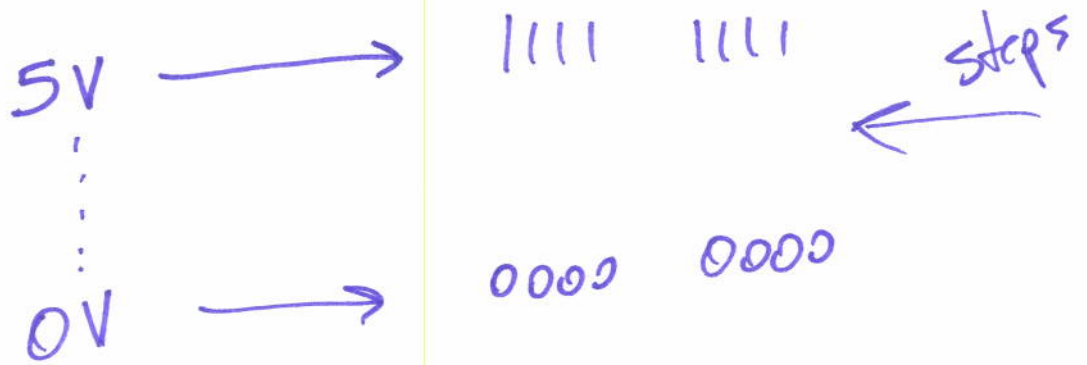
## Lecture 11

(2)

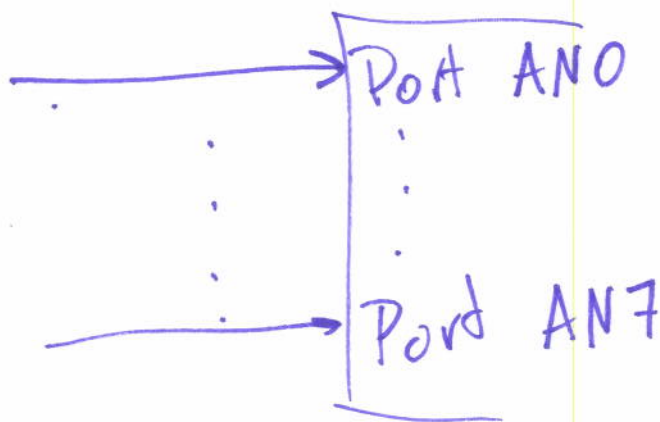


range 5V to 0V  
3.3V to 0V

8 bits to represent  
this voltage



$V_{ref+}$ ,  $V_{ref-}$  hardwired  
which parts will serve as  $V_{in}$

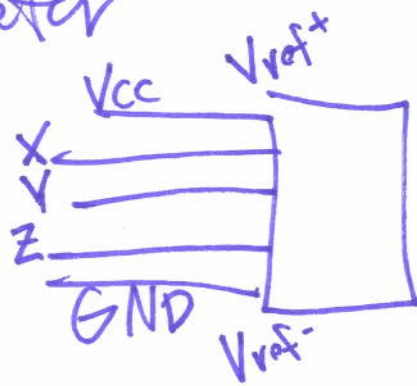


- \* Pot
- \* Microphone

Quiz/Test  
Question  
Multiple Choice

# Embedded Systems

## Accelerometer

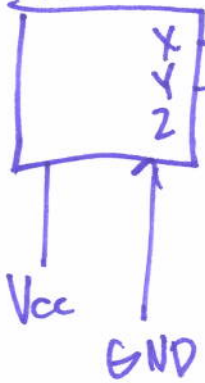


Lectwell

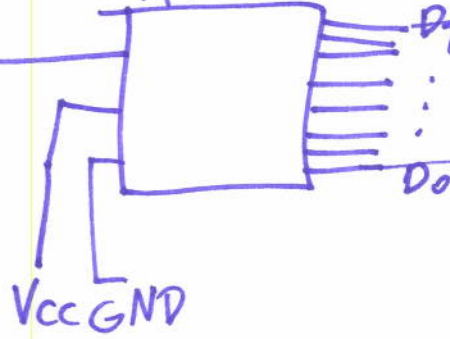
(3)

5V to 0V range  
2 to 3V operation

Accel

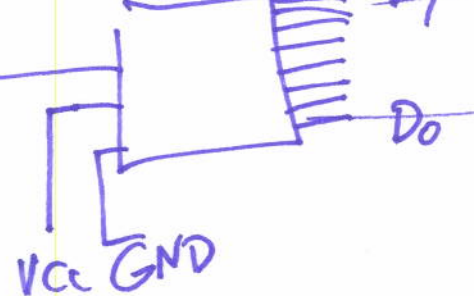


ADC



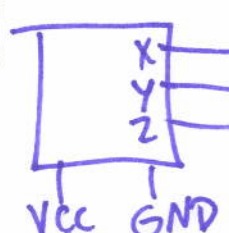
0 to 255

ADC



Microcontroller

Accel



Microcontroller

# Embedded Systems

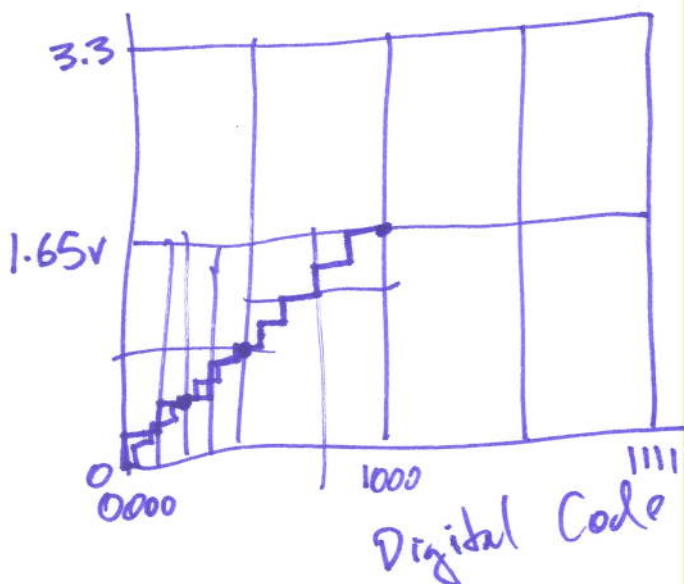
## LECTURE 11

(4)

### Guessing Game

Find a number between  
0 and 255

Guess 1 = 60	L	= 127 H
Guess 2 = 20	L	= 185 L
Guess 3 = 10	L	= 150 L
Guess 4 = 2	H	= 138 L
Guess 5 = 5	L	= 132 H
Guess 6 = 4	L	= 135 L
Guess 7 = 3	!!!	= 133!!!!





Em bedded Systems Lecture 11

$$n = \left[ \frac{(V_{in} - V_{ref-})(2^N - 1)}{V_{ref+} - V_{ref-}} + \frac{1}{2} \right] \text{int} \quad (5)$$

$N =$  bits in our ADC

$V_{in} =$  input analog signal

$V_{ref+} =$  highest voltage  $V_{in}$  could be

$V_{ref-} =$  lowest " " " "

$$n = \left[ \frac{(V_{in})(2^N - 1)}{V_{ref+}} + \frac{1}{2} \right] \text{int}$$

For example

$V_{in} = 5V$

$V_{ref+} = 10V$

$V_{ref-} = -10V$

$N = 12$

What is  $n$ ?

Max  $n$  could be?

$= 4095$

min  $n$  could be?

$= 0$

Max  $n =$  1111 1111 1111 = 10V

Min  $n =$  0000 0000 0000 = -10V

What is

$n = 3071$

decimal  
Hex

$$\begin{aligned}
 n &= \left[ \frac{5V - -10V (4095)}{10V - -10V} + \frac{1}{2} \right] \text{int} && \textcircled{6} \\
 &= \left[ \frac{15 \cdot 4095}{20} + \frac{1}{2} \right] \text{int} \\
 &= [3071.75] \text{int} \\
 &= 3071_{10} && \text{0x BFF}
 \end{aligned}$$

If we want to perform an Analog to Digital Conversion, what do we need to know?

- How frequently will we sample?
- How precise will I measure? (10 bits? 12 bits)
- How fast can I measure?
- Range of values (upper/lower)?
- Which channels? AN0 to AN7
- Sample & Hold?
- How many times?
- Triggered on what?

## Setup Registers

7

### ADC Conversion

Initialize your ADC Control registers  
Initialize a read  
Read the data & use

ADC\_value = ADDR0 & 0X0FFF;

Initializing Control Register

ADO.ADCSR.BYTE = 0X00;

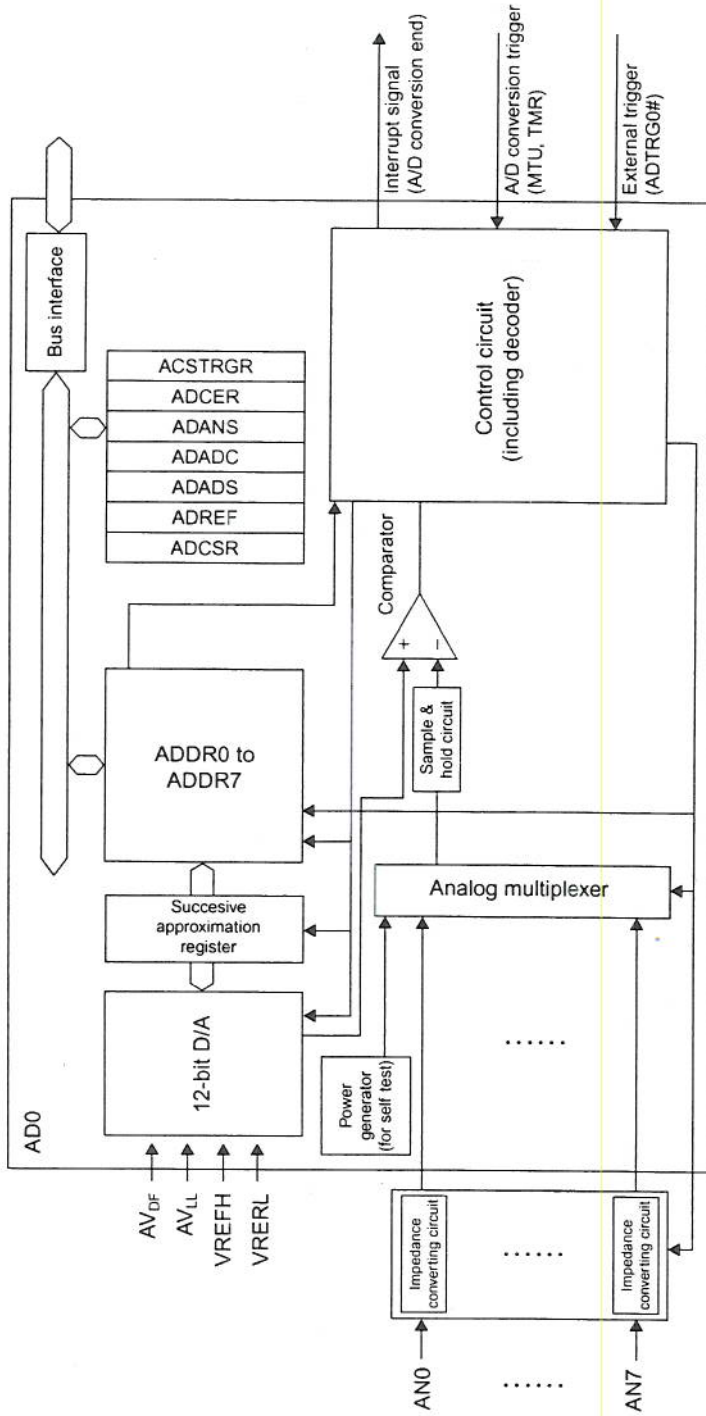


Figure 6.7 Block diagram of 12-bit ADC.