Binary Inputs

ECE 376 Embedded Systems

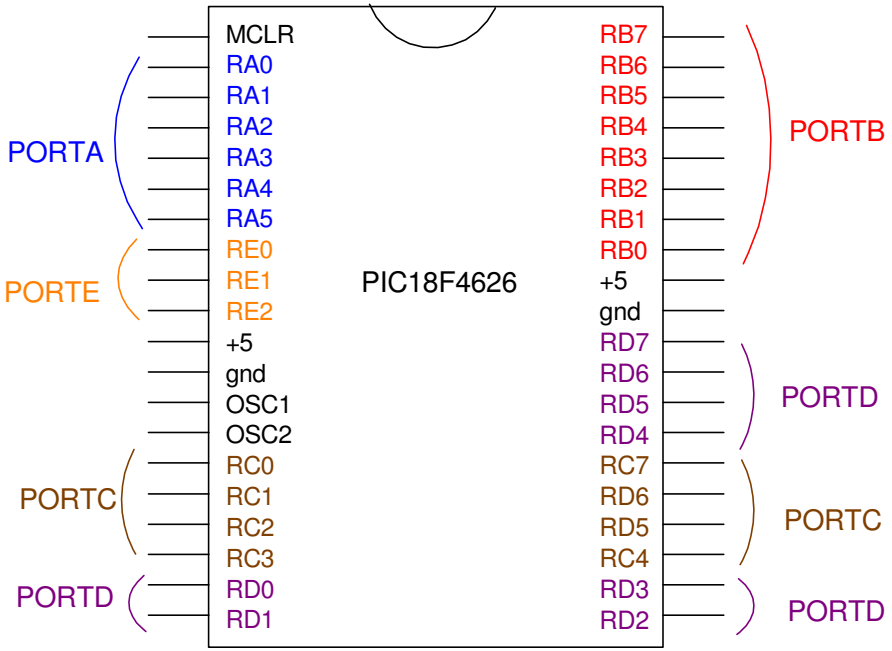
Jake Glower - Lecture #4

Please visit Bison Academy for corresponding
lecture notes, homework sets, and solutions

Binary Inputs: PORTA..E

The PIC18f4620 chip has

- 33 I/O lines
- Split into five ports:
- 0V = logic 0
- 5V = logic 1

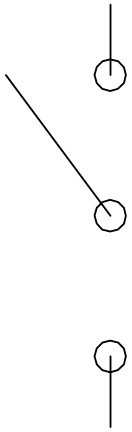


	PORTA	PORTB	PORTC	PORTD	PORTE
Pins	2..7	33..40	15..18, 24..26	19..22, 27..30	3
Binary Input	5	8	8	8	3
Binary Output	5	8	8	8	3
Analog Input	5	5	-	-	3

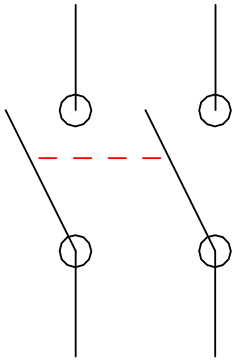
Types of Switches

- SP: Single Pole. 2 connectors
- DP: Douple Pole. Two sets of 2 connectors
- ST: Single Throw. Open or closed
- DT: Double Throw. Center lead can connect to two different leads

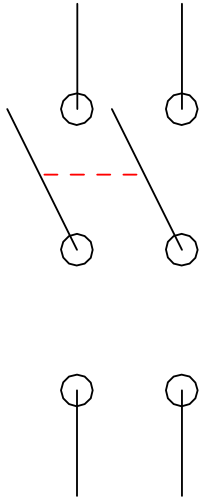
SPST



SPDT



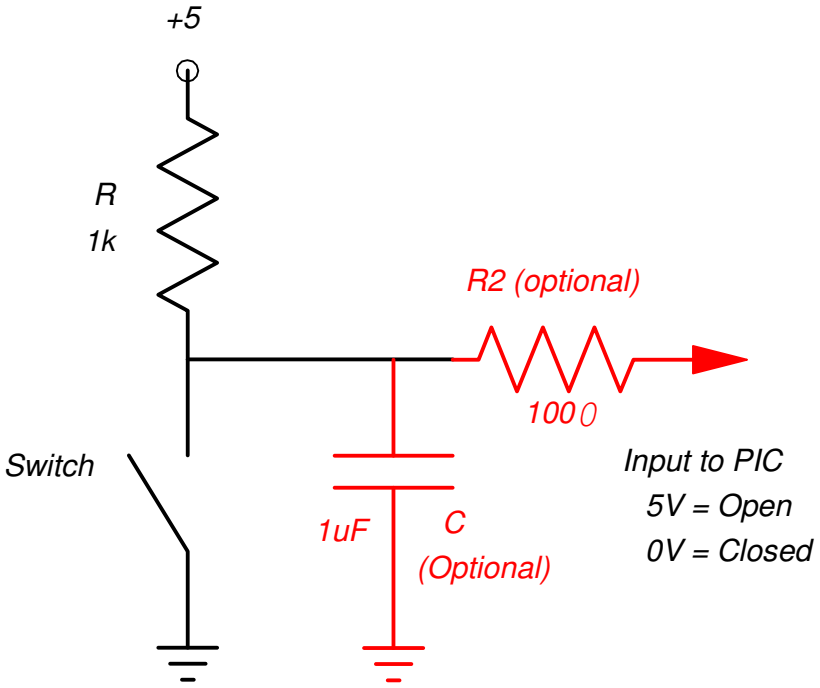
DPST

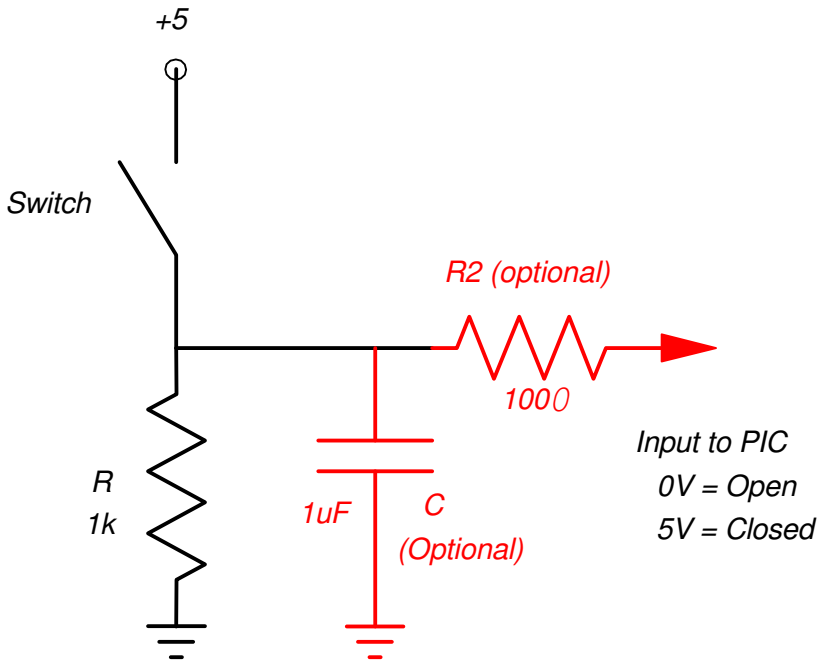


DPDT

Reading a SPST Switch

- Convert Open / Closed to 0V / 5V
- R: Limits current when switch is closed
- C: Eliminates bouncing (multiple-reads)
- R2: Dummy protection



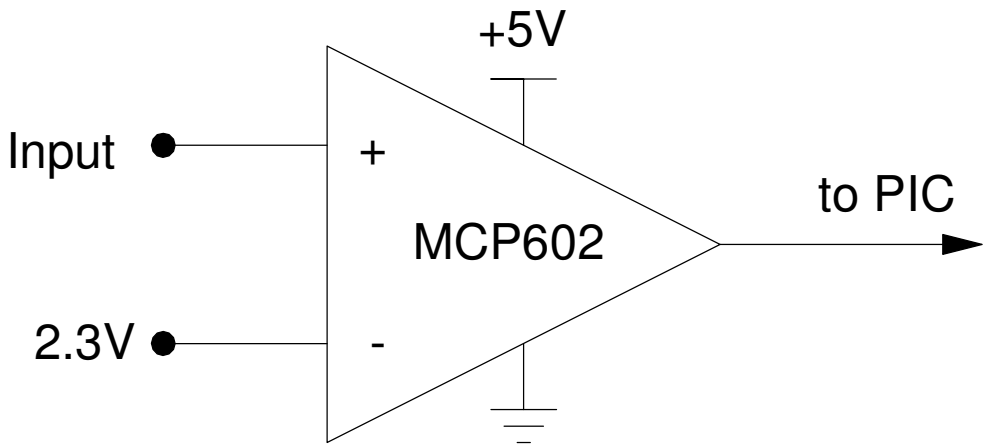


Y = X > 2.3V

Design a circuit which outputs

- +5V when the input is more than 2.3V
- 0V when the input is less than 2.3V

Solution: Use a op-amp (such as the MCP602) in your lab kit

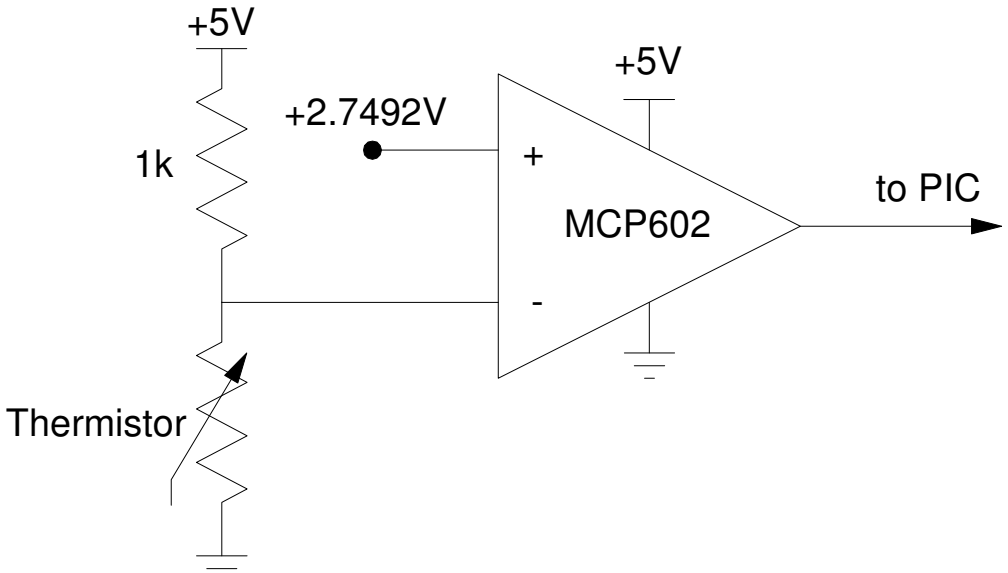


Y = Temperature > 20C

- Y = +5V when the temperature is above +20C
- Y = 0V when the temperature is below +20C

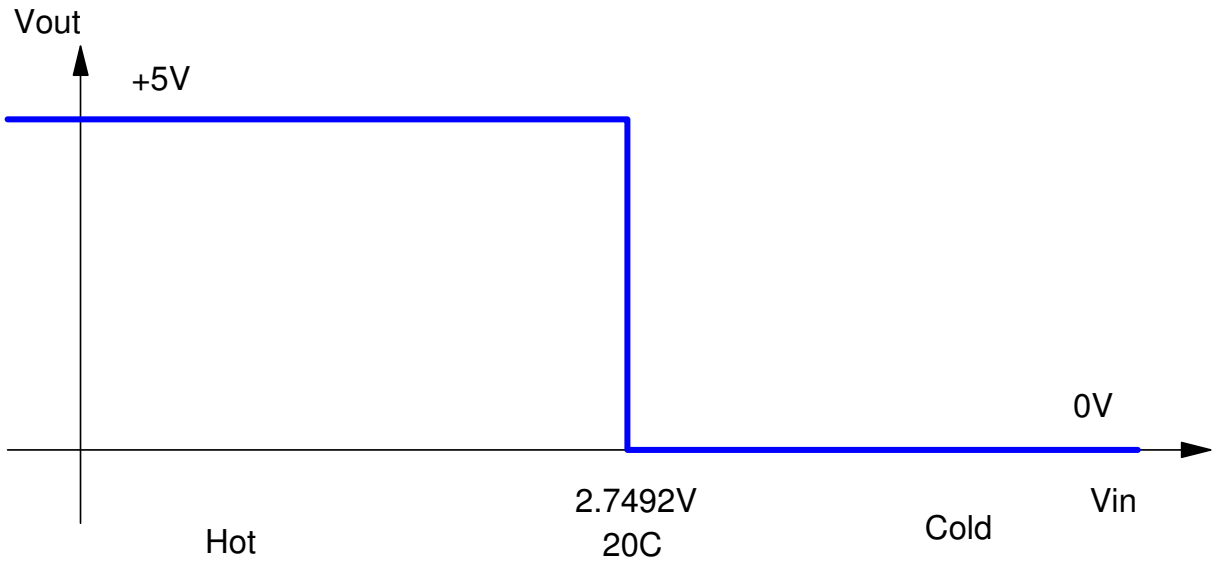
Solution: Use a Thermistor and a voltage divider

- R(20C) = 1250 Ohms
- Vx(20C) = 2.778V



I/O Characteristics:

- At 20C (2.778V), the output switches.
- For voltages below 2.778V (T > 20C), the output goes to 5V
- For voltages above 2.778V (T < 20C), the output goes to 0V

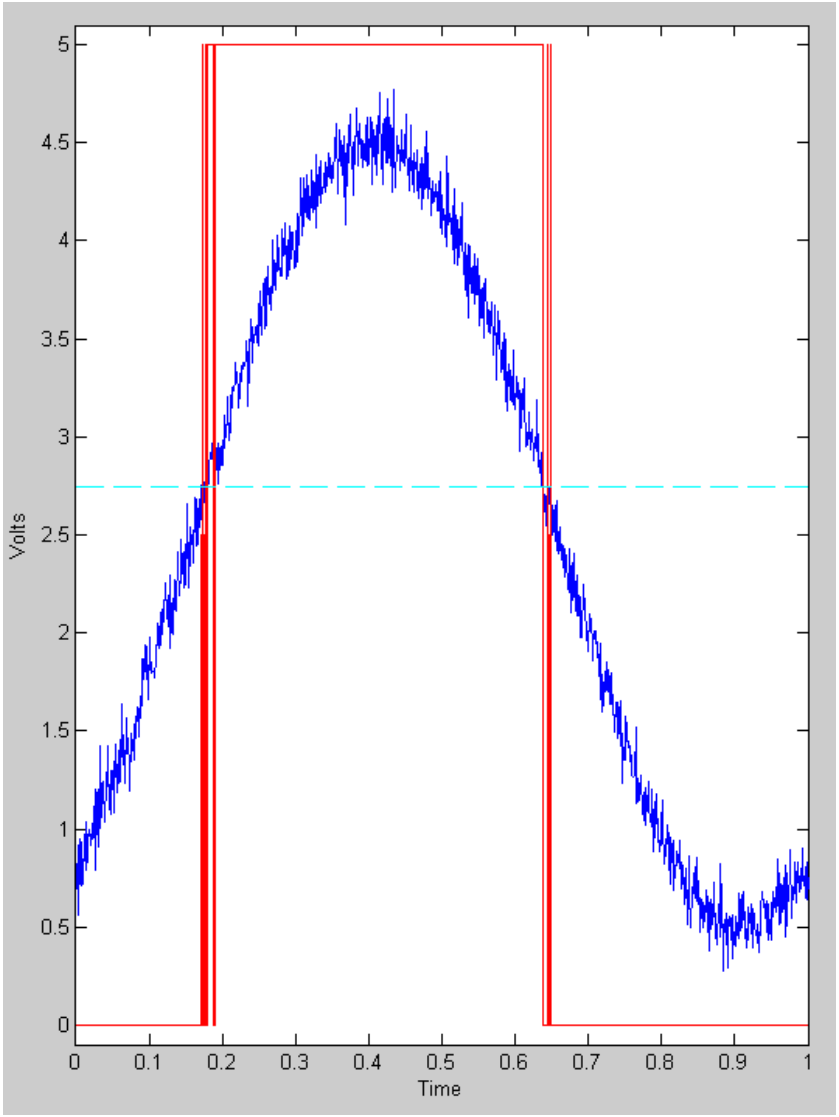


Input / Output Characteristic of the Comparitor

Comparitors and Noise

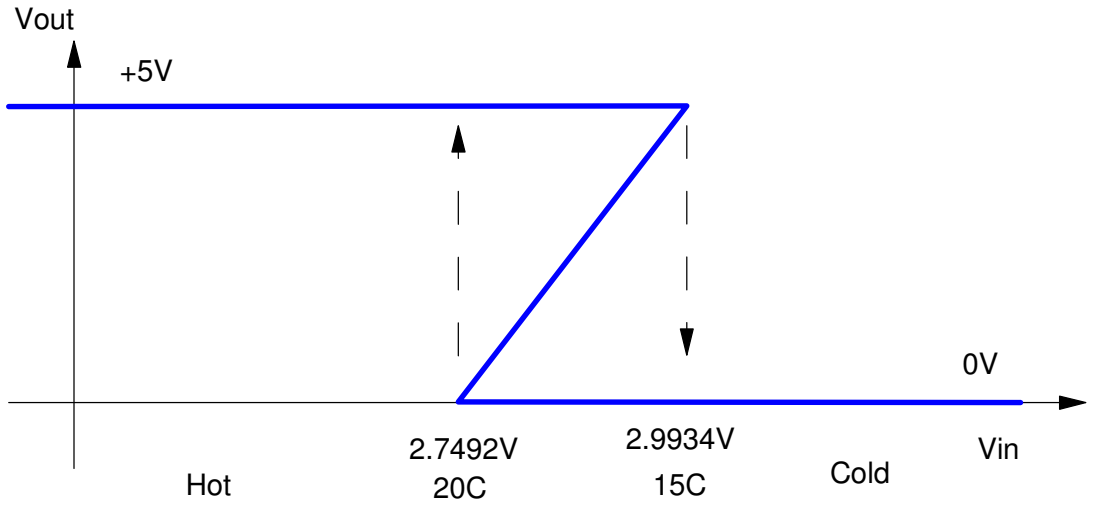
Problem with comparitors:

- If the input signal has noise on it, you can get chatter at the 0-1 and 1-0 transistions.
- This chatter can mess up counters, which interprit this as multiple 0-1 transistions.



Removing Chatter:

- Software: Add a delay
- Hardware: Add hysteresis
  - The output switches to +5V when the temperature goes above +20C
  - The output switches to 0V when the temperature drops below +15C



Schmitt Trigger:

As Va increases, Output Decreases

- Connect to the - input

Turn on at +20C

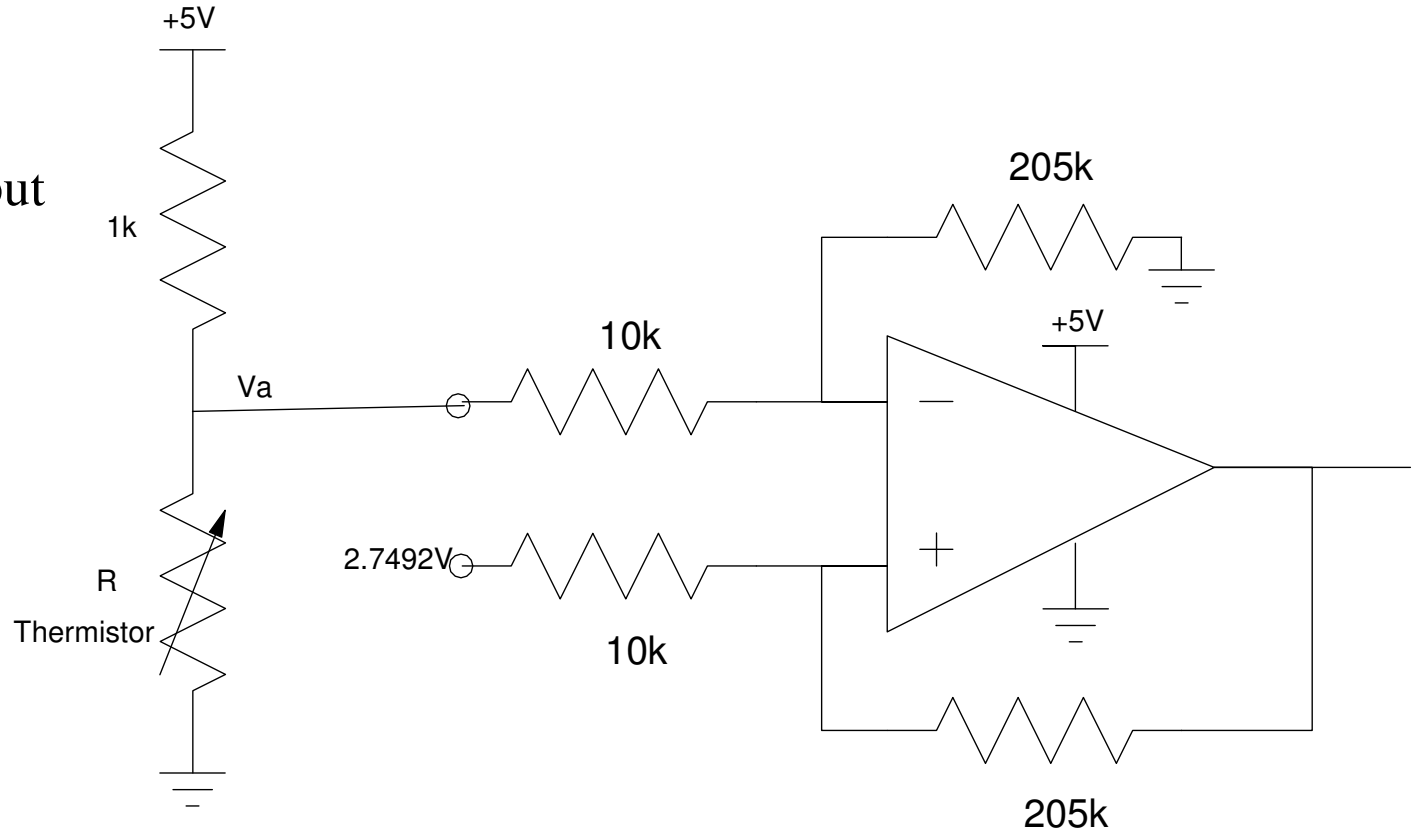
- R = 1250.6 Ohms
- Va = 2.7492V
- Apply 2.7492V to + input

Turn off at +15C

- R = 1576.2 Ohms
- Va = 2.9934V

Slope = 20.5

- $\left(\frac{5V-0V}{2.9934V-2.7492V}\right) = 20.5$
- R1 / R2 = 20.5



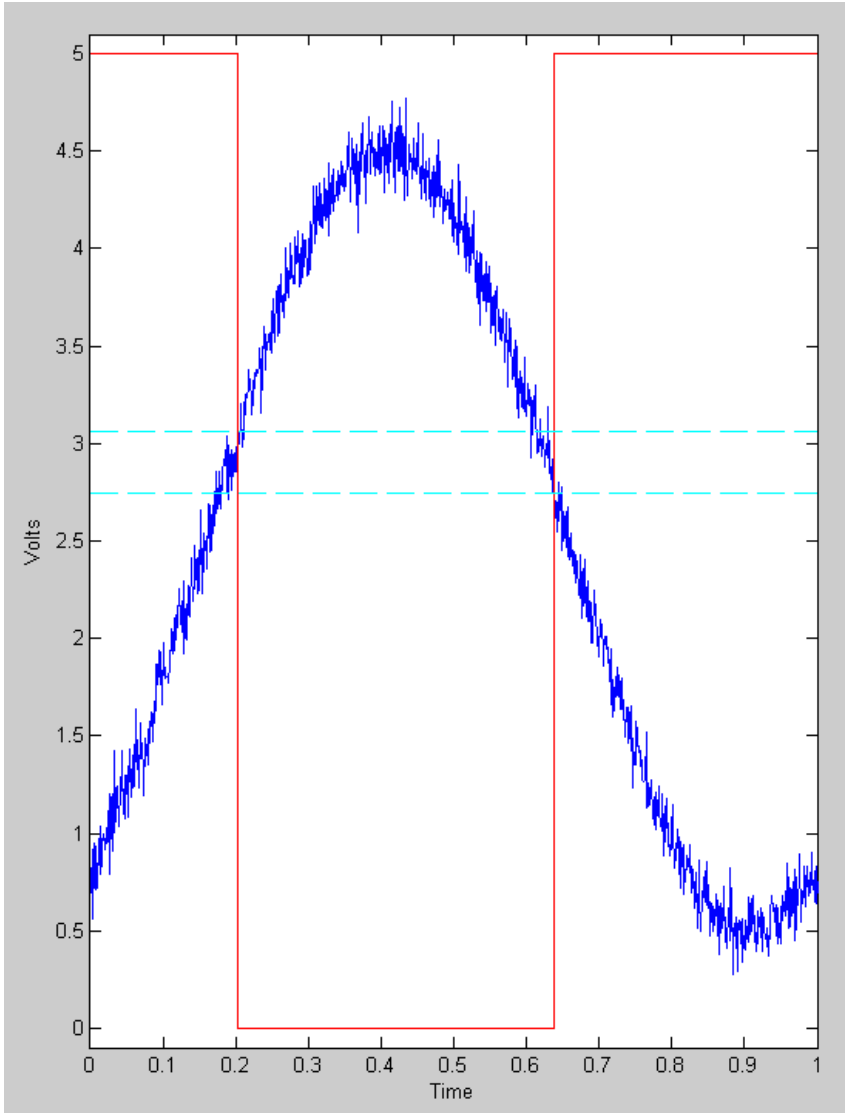
Schmitt Triggers and Noise

Hysteresis adds two thresholds:

- Y = 5V when X < 2.7492V
- Y = 0V when X > 2.9934V
- No change when 2.74V < X < 2.99V

By adding a hysteresis, chatter is avoided

- This prevents multiple counts



Changing Sensors

Change R and you can measure...

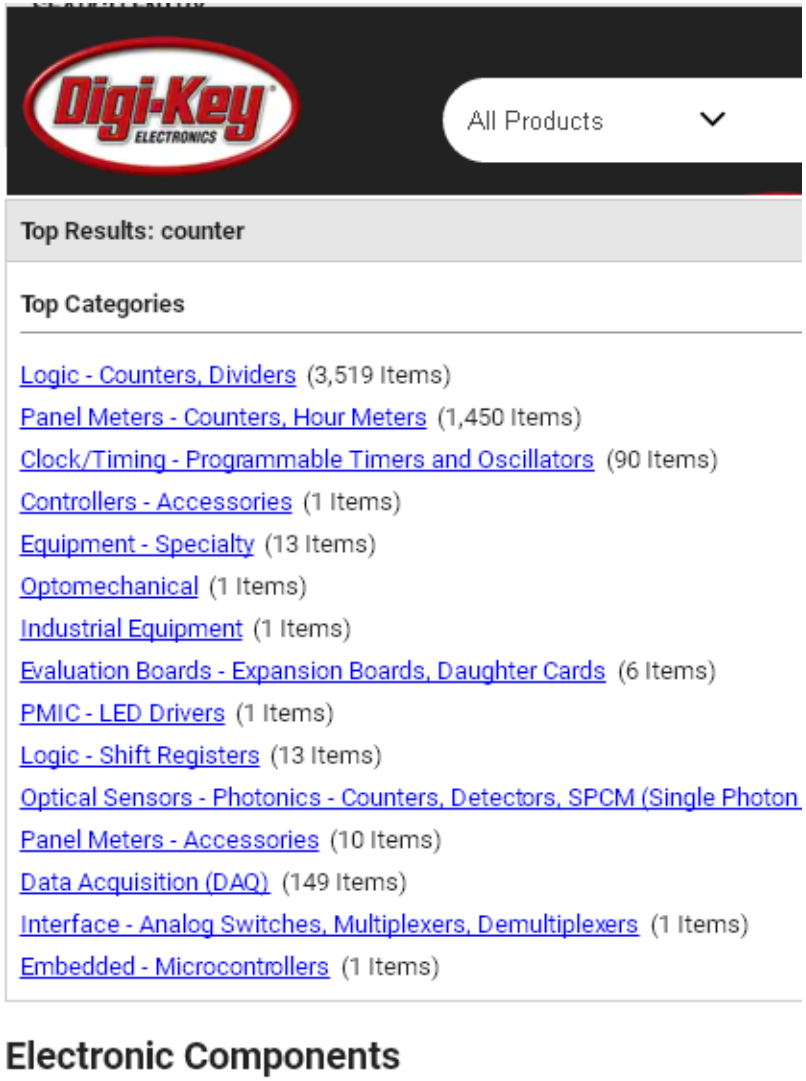
- CdS sensors convert light to resistance
- Photovoltaic sensors convert light to voltage (current actually...)
- Gas sensors convert O2, CO2, methane, etc to a resisance or voltage
- Strain gages convert strain (or weight or pressure) to resistance
- Tachometers convert motor speed to a voltage.

10,000+ sensors are available from Digikey

Counters

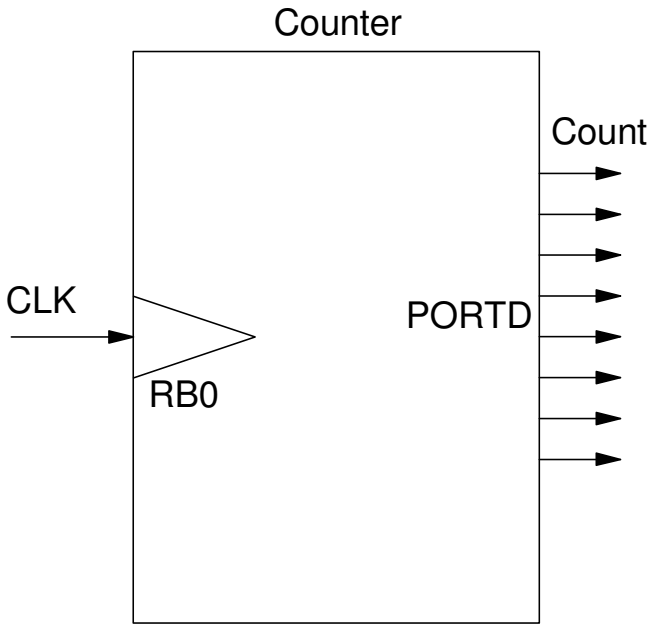
Once you have whatever you're measuring converted to TTL levels (0V / 5V), you can write a program to do things, like count.

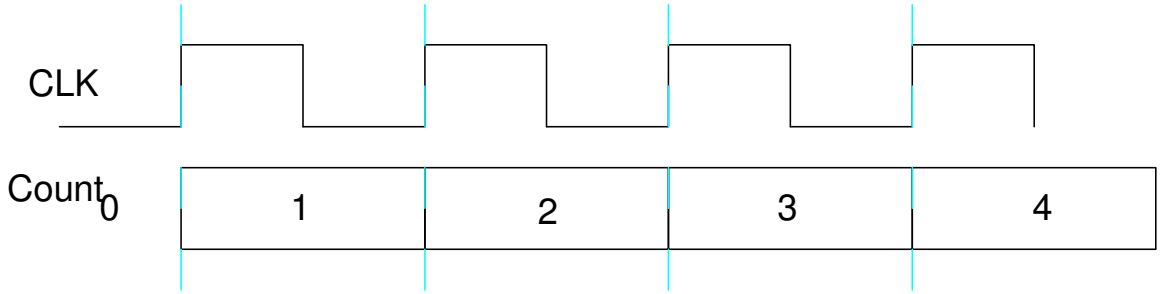
- Count each riding edge (counter)
- Up / Down Counter
- Multiple Counters
  - Hungry Hungry Hippo



Example 1: Up Counter

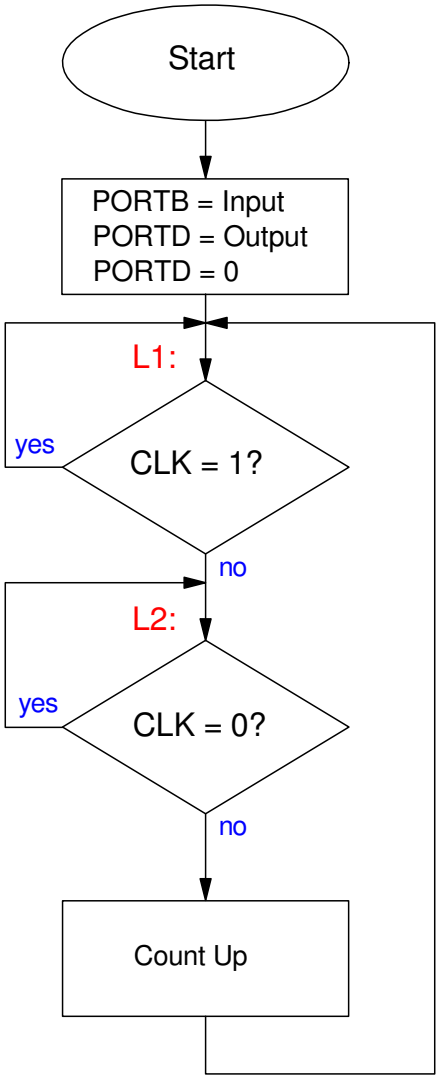
- Start with PORTD = 0
- Each rising edge on RB0, increment the count by one





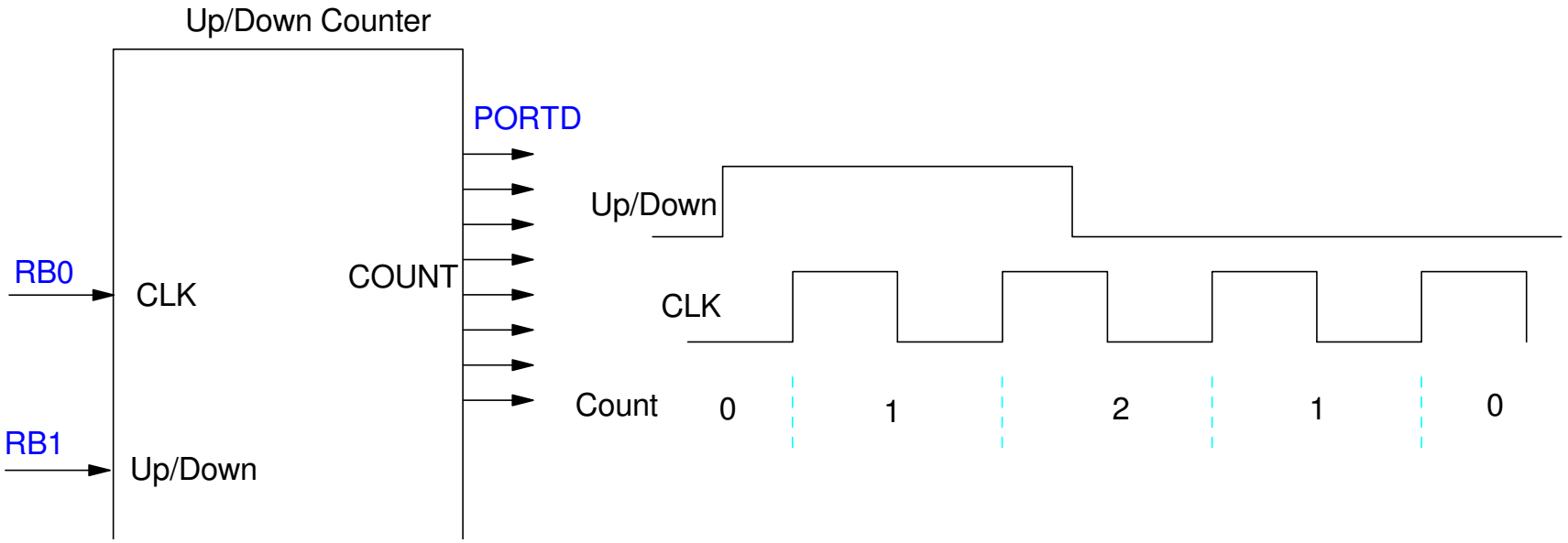
Counter: Flow Chart & Code

```
#include <p18f4620.inc>

COUNT equ 0

    org 0x800

    movlw 0xFF
    movwf TRISB
    clrf TRISD
    movlw 0x0F
    movwf ADCON1

    clrf  COUNT
    clrf  PORTD

; while(RB0 == 1);

L1:
    btfsc  PORTB,0
    goto   L1

; while(RB0 == 0);

L2:
    btfss  PORTB,0
    goto   L2

; Rising edge detected
; PORTD = PORTD + 1;

    incf   COUNT,F
    movff  COUNT, PORTD

    goto   L1

    end
```



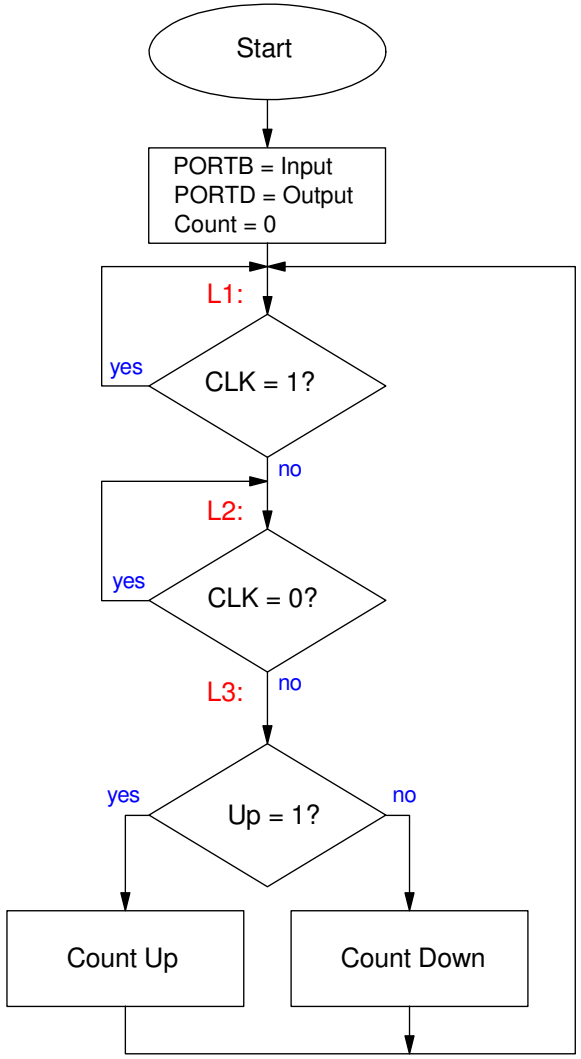
Example 2: Up / Down Counter

- Start with Count = 0
- Look for a rising edge on RB0
- When found
  - Count up if RB1 = 1
  - Count down if RB1 = 0



Up/Down Counter: Flow Chart and Code

```
#include <p18f4620.inc>

COUNT equ 0

    org 0x800

    movlw 0xFF
    movwf TRISB
    clrf TRISD
    movlw 0x0F
    movwf ADCON1

    clrf  COUNT
    clrf  PORTD

L1:
    btfsc  PORTB,0
    goto   L1

L2:
    btfss  PORTB,0
    goto   L2

L3:
    btfsc  PORTB, 1
    goto   Up

Down:
    decf   COUNT,F
    goto   L4
Up:
    incf   COUNT,F
L4:
    movff  COUNT, PORTD
    goto   L1

    end
```



Example 3: Multiple Counters

- Hungry-Hungry Hippo Game

Input:

- Push buttons RB0 and RB7

Output:

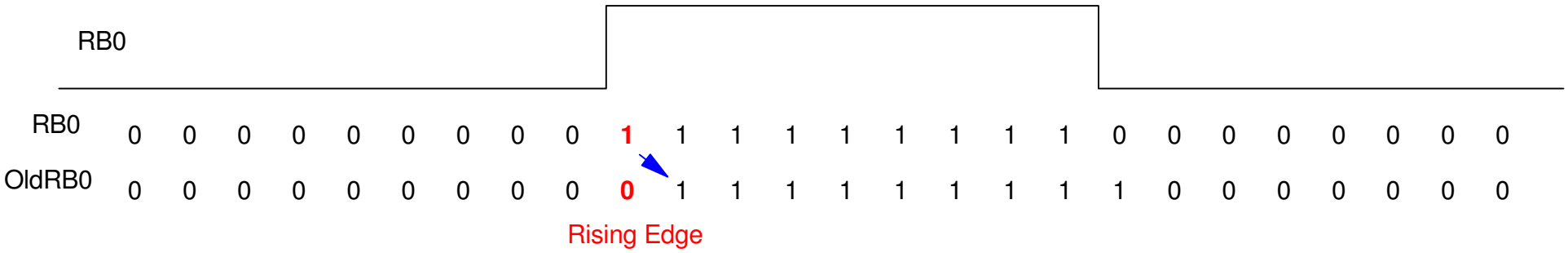
- PORTC and PORTD

Relationship:

- Start with PORTC = PORTD = 0
- Each time you detect a rising edge on RB0, increment PORTC by one
- Each time you detect a rising edge on RB7, increment PORTD by one

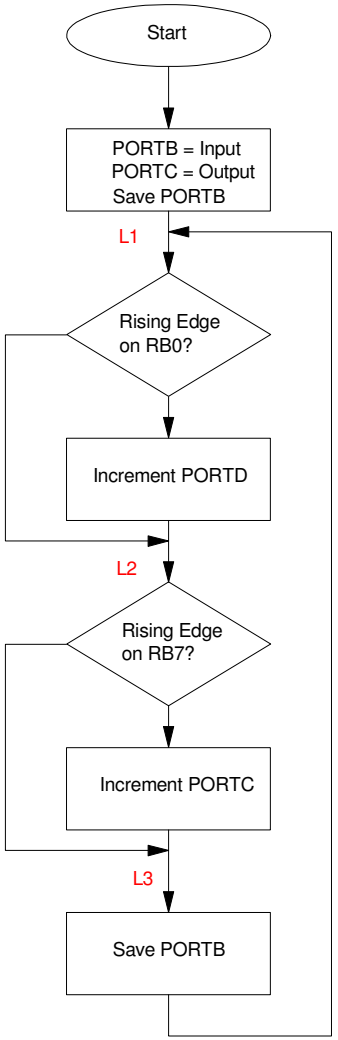
Note: Detect a rising edge on RBx when you see a 0-1 transition

- Curret value = 1
- Previous value was 0



Flow Chart & Assembler Code

```
#include <p18f4620.inc>

OldB equ 0

    org 0x800

    clrf TRISA
    movlw 0xFF
    movwf TRISB
    clrf TRISC
    clrf TRISD
    clrf TRISE
    movlw 0x0F
    movwf ADCON1
    movff PORTB, B

L1:
    movff  B, OldB
    movff  PORTB, B

    btfss  B, 0
    goto   L2
    btfsc  OldB, 0
    goto   L2
    incf   PORTD, F

L2:
    btfss  B,7
    goto   L3
    btfsc  OldB, 7
    goto   L3
    incf   PORTC, F

L3:
    goto   L1

end
```



Summary

PIC uses TTL logic levels

- 0V = logic 0
- 5V = logic 1

With an op-amp, you can convert signals to TTL logic levels

- Comparitor (no hysteresis, can result in chatter)
- Schmitt Trigger

With software, you can then count the number of rising edges

- Up Counter
- Up / Down Counter
- Multiple Counters