

# ECE 376 - Homework #1

*PIC Background. Due Monday, August 29th*

**A PIC's outputs are limited to <25mA on its I/O pins.**

- 1) Assuming the output V2 is 5V, what is the smallest resistance you can connect to an output pin?
  - i.e. how small can R3 be?

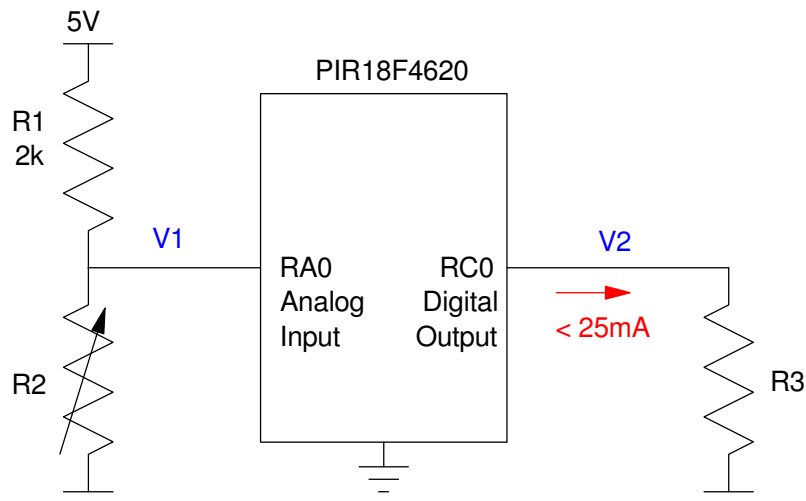
**A PIC can measure voltage to 4.88mV. To give an idea of how small this is....**

- 2) What is the smallest change in R2 a PIC can measure if R2 = 3000 Ohms nominally?
  - How much does R2 have to change from 3000 Ohms for V1 to change by 4.88mV?
- 3) Assume R2 is a thermistor with a voltage - resistance relationship of

$$R_2 = 1000 \exp\left(\frac{3905}{T+273} - \frac{3905}{298}\right) \Omega$$

where T is the temperature in degrees C.

- What temperature is it if R2 = 3000 Ohms?
- How much does the temperature have to change for V1 to change by 4.88mV?



Problem #1 to #3

**A PIC can measure time to 100ns. To give an idea of how small this is....**

- 4) The fastest baseball pitch is 105.1 mph (46.98 m/s) was thrown by Aroldis Chapman in 2010. The distance from the pitching mound to home plate is 60'6" (18.44m)
  - How long does it take this fastball to travel to home plate?
  - How much faster would the pitch have to be for it to take 100ns less to travel this distance?
- 5) The world record for a 200m dash is 19.19 seconds (Usain Bolt). How far behind would you have to be (in meters) if you cross the finish line 100ns behind Usain Bolt?
- 6) A 555 timer (below) outputs a square wave with the period of

$$T = (R_1 + 2R_2) \cdot C \cdot \ln(2) \text{ seconds}$$

- What frequency does the 555 timer output if  $R_1 = 1k$ ,  $R_2 = 3k$ ,  $C = 0.22\mu F$ ?

7) What is the smallest change in frequency a PIC can detect?

- i.e. how much does the frequency have to change for the period to change by 100ns?

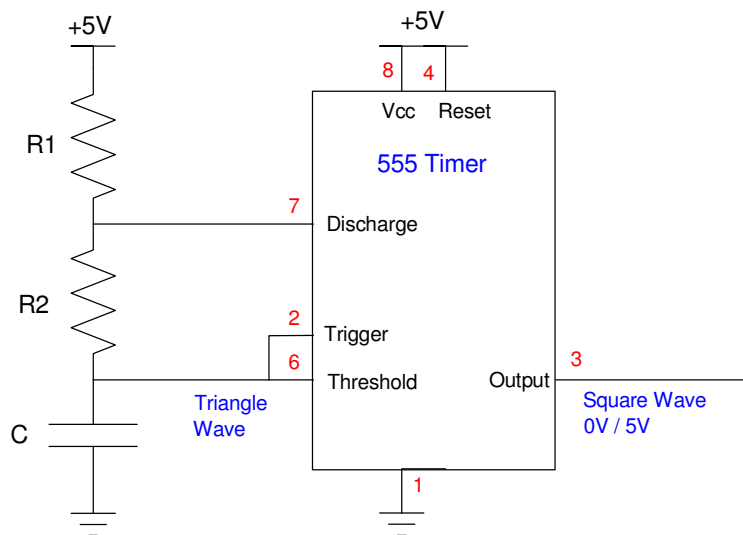
8) With this circuit, you can build an ohm-meter: by measuring the period, you can compute the resistance.

- What is the smallest change in  $R_2$  a PIC can detect?
- i.e. how much does  $R_2$  have to change from 3000 Ohms for the period to change by 100ns?

9) With this circuit, you can build a temperature sensor: by measuring the period, you can compute the resistance and from that determine the temperature. Assume  $R_2$  is a thermistor:

$$R_2 = 1000 \exp\left(\frac{3905}{T+273} - \frac{3905}{298}\right) \Omega$$

- What is the smallest change in temperature a PIC can detect?
- i.e. how much does the temperature have to change for the period to change by 100ns?



Astable 555 Timer: Problems 5-8

The square wave at the Output has a period of  $T = (R_1 + 2R_2) \cdot C \cdot \ln(2)$  seconds