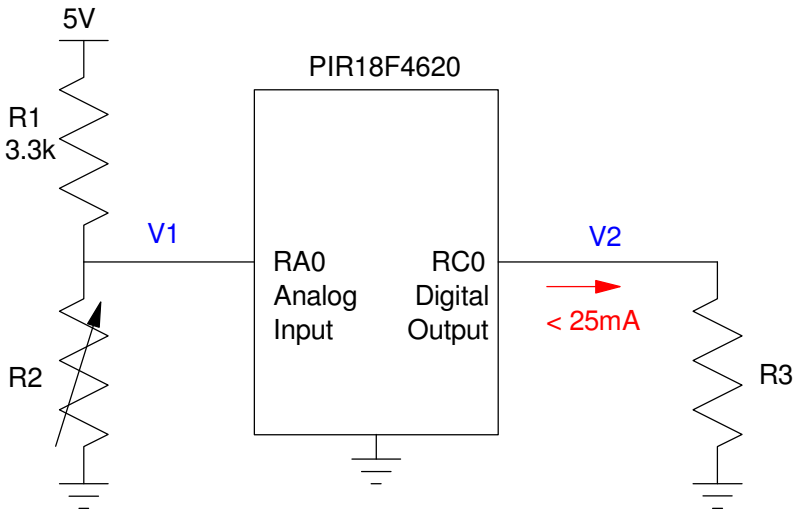
ECE 376 - Homework #1

PIC Background.
Please submit as a hard copy, submit on BlackBoard, or email

Problem	Answer
1) How many clocks does it take to write the LCD display? • Check Homework #9 solutions for Spring 2023	**6.2007ms**
2) A PIC's output is limited to 25mA. Assuming V2 is 5V, what is the smallest resistance youcan connect to the output? (how small can R3 be?)	**200 Ohms**
A PIC can measure voltage to 4.88mV. To give an idea of how small this is....	
3) What is the smallest change in R2 a PIC can measure if R2 = 2000 Ohms nominally? • How much does R2 have to change from 2000 Ohms for V1 to change by 4.88mV?	**8.32 Ohms**
4) Assume R2 is a thermistor. • What temperature is it if R2 = 2000 Ohms? • How much does the temperature have to change for V1 to change by 4.88mV?	**0.085C**
A PIC can measure time to 100ns. To give an idea of how small this is....	
5) The average NFL quarterback can throw a football 87 km/h. Fow far does the football travel in 100ns?	**2.416um**
6) Assume for the 555 timer • R1 = 1k, R2 = 2k, C = 0.1uF • What frequency does the 555 timer output on pin #3?	**2885.39 Hz**
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?	**0.83Hz**
8) With this circuit, you can build an Ohm-meter (replace R2 with the resistance to be measured.) Assume R2 = 10k Ohms (nominally). How much does R2 have to change for the period to change by 100ns? • i.e. What is the resolution of this circuit when used as an Ohm-meter?	**0.72 Ohms**
9) Replace R2 with a thermistor which reads 2k Ohms nominally. How much does the temperature have to change for the period to increase by 100ns? • i.e. what is the resolution in degrees C?	**0.0074C**



Problem #1 to #3

2) A PIC's output is limited to 25mA. Assuming V2 is 5V, what is the smallest resistance youcan connect to the output? (how small can R3 be?)

$$R = \left(\frac{5V}{25mA}\right) = 200\Omega$$

3) What is the smallest change in R2 a PIC can measure if R2 = 2000 Ohms nominally?

- How much does R2 have to change from 2000 Ohms for V1 to change by 4.88mV?

If R2 = 2000 Ohms

$$V_1 = \left(\frac{R_2}{R_2+R_1}\right)5V = 1.887V$$

If V1 is 4.88mV more, then

$$V_1 + 4.88mV = 1.89167V = \left(\frac{R_2}{R_2+3300}\right)5V$$

$$R_2 = 2008.32V$$

The change in R2 required to produce a 4.88mV change in V1 is 8.32 Ohms

4) Assume R2 is a thermistor.

- What temperature is it if R2 = 2000 Ohms?
- How much does the temperature have to change for V1 to change by 4.88mV?
- $R_2 = 1000 \cdot \exp\left(\frac{3905}{T+273} - \frac{3905}{298}\right)\Omega$

2000 Ohms corresponds to a temperature of

T = 10.02897C

2008.32 Ohms corresponds to a temperature of

T = 9.94383C

The difference is -0.08514C

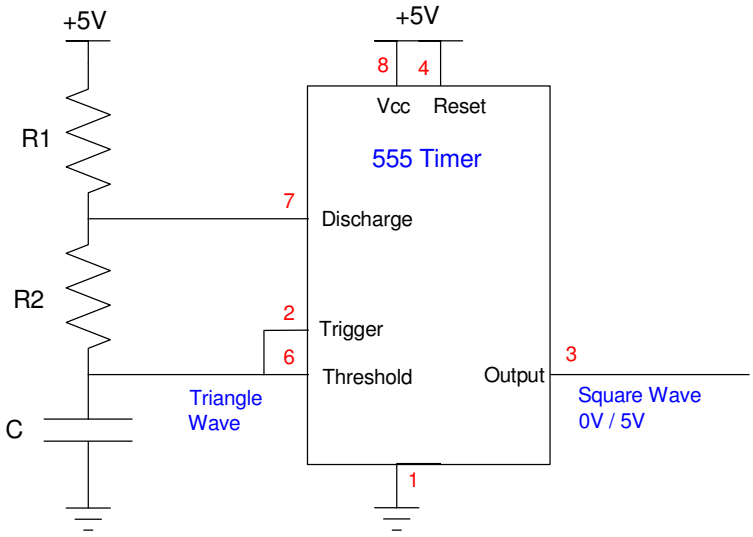
A PIC can detect a change in temperature of 0.085C

5) The average NFL quarterback can throw a football 87 km/h. Fow far does the football travel in 100ns?

$$d = v \cdot t$$

$$d = 87\left(\frac{km}{h}\right)\left(\frac{1000m}{km}\right)\left(\frac{1h}{3600s}\right) \cdot 100ns = 2.416\mu m$$

An average NFL quarterback's pass travels 2.4 micons in one clock



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

6) Assume for the 555 timer

- R1 = 1k, R2 = 2k, C = 0.1uF
- What frequency does the 555 timer output on pin #3?

$$T = (R_1 + 2R_2) \cdot C \cdot \ln(2)$$

$$T = 346.6\mu s$$

$$f = \frac{1}{T} = 2885.3901Hz$$

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?

$$f_2 = \frac{1}{T+100ns} = 2884.5578Hz$$

$$\delta f = f_1 - f_2 = 0.8323Hz$$

8) With this circuit, you can build an Ohm-meter (replace R2 with the resistance to be measured.) Assume R2 = 2000 Ohms (nominally). How much does R2 have to change for the period to change by 100ns?

i.e. What is the resolution of this circuit when used as an Ohm-meter?

$$T + 100ns = (R_1 + 2R_2) \cdot C \cdot \ln(2)$$

$$R_2 = 2000.7213\Omega$$

$$\delta R = 0.72135\Omega$$

9) Replace R2 with a thermistor which reads 2k Ohms nominally. How much does the temperature have to change for the period to increase by 100ns?
i.e. what is the resolution in degrees C?

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

2000 Ohms corresponds to a temperature of

T = 10.02897C

2000.7213 Ohms corresponds to a temperature of

T = 10.0216C

with a difference of 0.0074C