PENNSTATE

EET 105: ELECTRICAL SYSTEMS
LABORATORY EXPERIMENTS

INTRODUCTION TO ELECTRONIC INTEGRATED CIRCUITS (CHIPS)

Although the different electronic chips and other circuit elements will be analyzed in detail in future courses, I believe that it is important for students to have a basic exposure of some of the most used integrated circuits. With this, the purpose of this lab is to give to you, the student, some hands-on experience in the use of these devices.

1.- Integrated circuits (chips)

Contrary to resistors in which we can read the value of resistance by looking at its color code, or capacitors in which the manufacturer stamps the value in pF or µF, the manufacturer of integrated circuits stamp several numbers or letters that seem not to have too much meaning about the function they perform. When faced with an unknown chip, your best bet is to enter the code in an Internet search engine in order to find its function.

However, there are several clues that can help us in identifying a specific integrated circuit:

First, we can identify the manufacturer of the chip by looking at its logo. There are several resources that can help with this, for example:

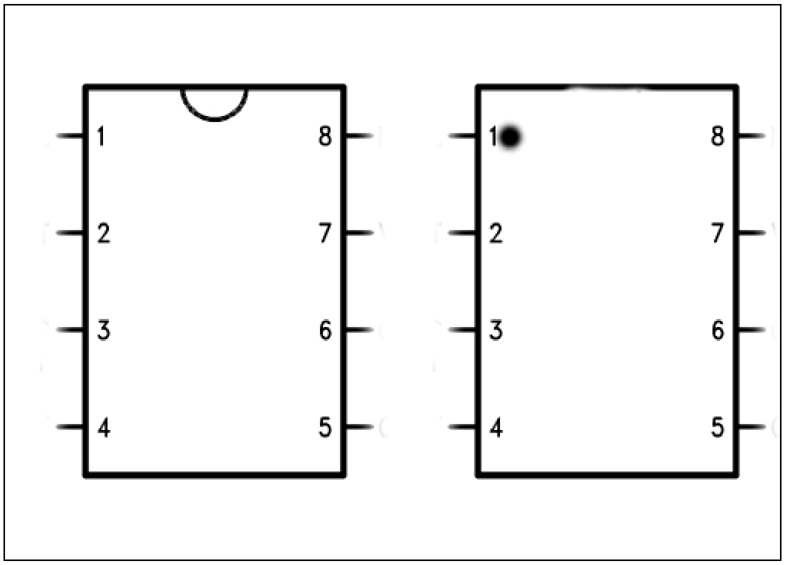
http://www.engineering.uiowa.edu/~eshop/mflogo.dir/ic-id.html
http://www.canics.com/mfglogos.html

Second, the letters in front of the numbers in the part code can give us an idea of the general function of the chip. For example, chips that start with LS tend to be digital chips, chips that start with DAC tend to be digital-to-analog converters, etc. Here, experience in using similar parts plays a major role.

Third¸ we can identify when was the chip manufactured by studying the numbers that appear after the identifier code, typically in a new line. The manufacturing code consists of 4 digits. The first two digits indicate the year in which it was manufactured, while the last 2 digits indicate the week of the year in which it was manufactured.

The manufacturer of the integrated circuit provides extensive information about the chip, including DC and AC performance data, typical applications and pinout. The pin out is especially important because it tells the reader what is the function of each one of the chip's pins.

The pin numbering always starts with 1 and continues counterclockwise around the chip. The figure below shows the two main methods for identifying Pin 1: The pin located at the bottom left of the notch, or the pin that has somehow been marked by the manufacturer.

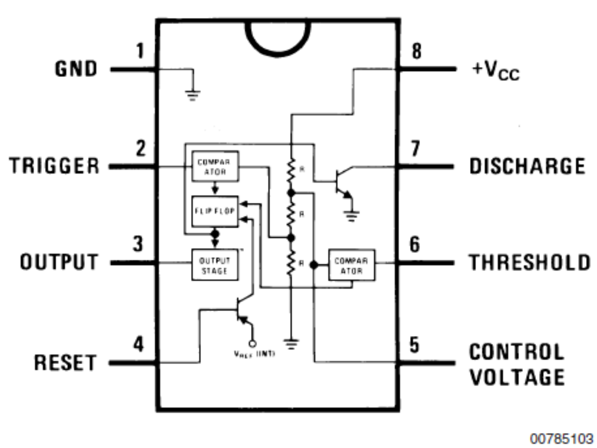


2.- The 555 Integrated Circuit and the LEDs

The 555 integrated circuit is the most popular chip ever manufactured. Originally designed in 1970, the 555 is still in production and can be found in everything from toys to aircraft. This chip has really withstood the test of time as its demand is not slowing.

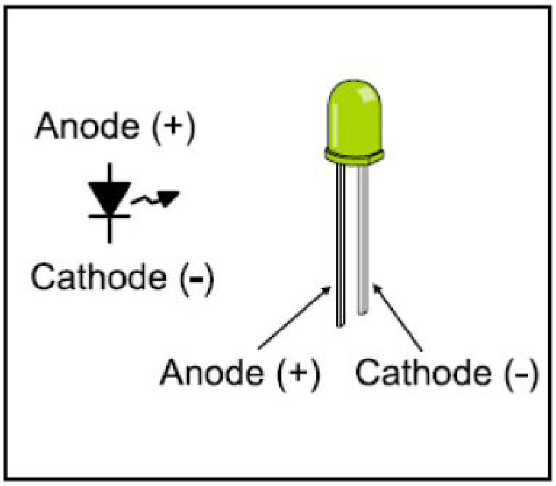
In this lab experience we will experiment with the 555 without worrying too much about how it works. This chip will be studied in detail in future courses. The pinout for the 555 is shown in the figure below.

Dual-In-Line, Small Outline
and Molded Mini Small Outline Packages



Top View

We will also use 2 Light Emitting Diodes (LED) that you have seen in multiple commercial devices. The figure below shows the symbol of the LED as well as a drawing of its physical representation:



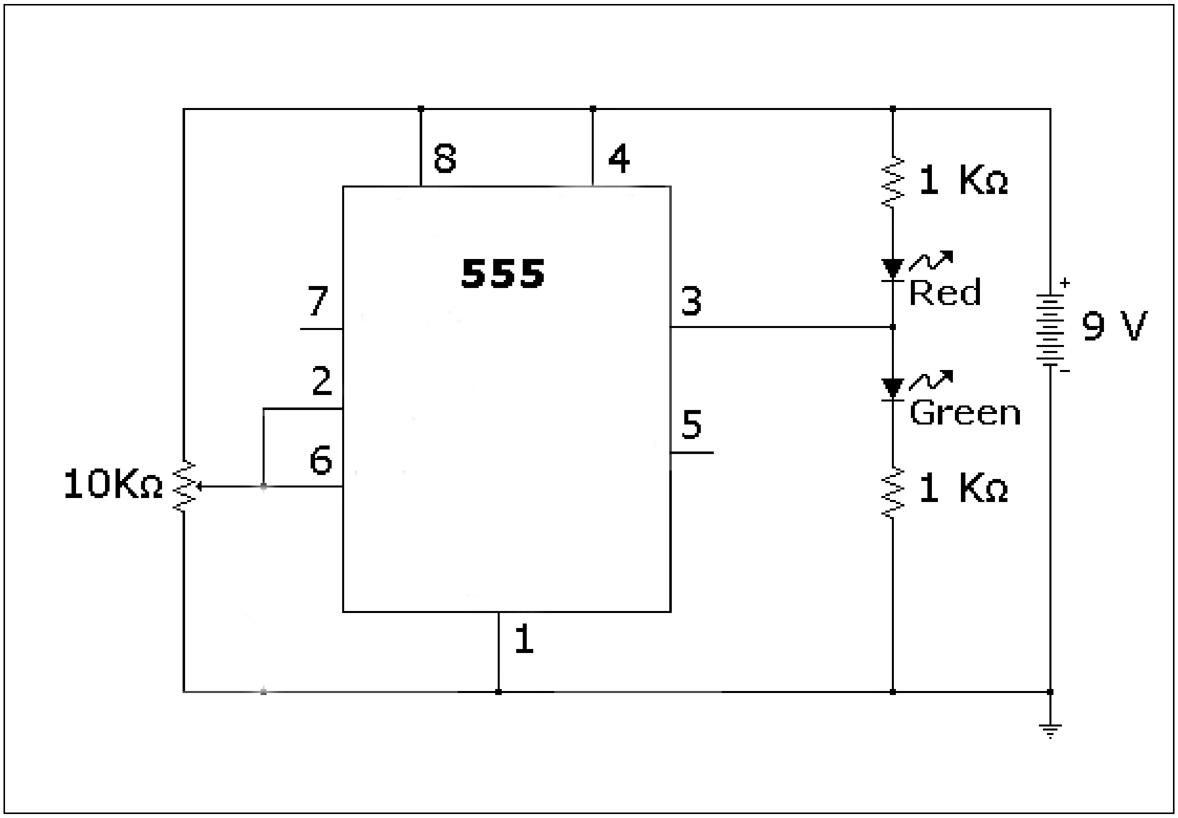
How do we know which lead is the Anode and which is the Cathode? There are two ways:

- You will notice that the leads have different length. The longest lead is the Anode (+)
- You will notice that the body of the LED has a flat notch. This corresponds to the Cathode

3.- Comparator with hysteresis

We say that a comparator has hysteresis when the tripping points for the comparator are different depending on the direction of the signal. What does is it mean? Consider the furnace in your house that is controlled by its thermostat. If we set the temperature at 65 °F, the furnace with turn on when the temperature measured by the thermostat falls below 65 °F. However, the furnace will not turn off until the temperature inside the house far exceeds this value, for example 70°F. Therefore, the two tripping points are different depending if the temperature of the house increases or decreases.

Let's apply the same principle to an electronic circuit. Build the circuit shown below, using the Power supply to generate the required 9 V_{DC}.



Connect the DMM to Pin 6 of the 555 IC. This is the Trigger Pin and indicates the voltage that makes the IC to change states.

Modify the potentiometer until the Voltage in Pin 6 is 6 Volts.

Slowly increase the voltage until the LEDs change states. Write down this voltage that we will call V_H. Continue until Voltage Pin 6 reaches 9 volts or close to 9 V. Complete the table below.

Increasing Trigger Voltage (V cc = 9 V)		
Voltage Pin 6	**Status Red LED**	**Status Green LED**
0 V		
9 V		

Repeat the same procedure as before but now starting at 9 V and decreasing the voltage until the LEDs change status again. We will call this voltage V_L. Continue decreasing the voltage until it reaches 0 V. Complete the table below:

Decreasing Trigger Voltage (Vcc = 9 V)		
Voltage Pin 6	**Status Red LED**	**Status Green LED**
0 V		
9 V		

Question 3.1: Are V_H and V_L the same? Why not?

Repeat the same experiment from before, but now using 7 Volts instead of the original 9 Volts.

Increasing Trigger Voltage (V cc = 7 V)		
Voltage Pin 6	**Status Red LED**	**Status Green LED**
0 V		
9 V		

Decreasing Trigger Voltage (Vcc = 7 V)		
Voltage Pin 6	**Status Red LED**	**Status Green LED**
0 V		
9 V		

Question 3.2: Can you observe a relationship between the triggering voltages found with 9V and 7 V? To help with this, calculate the following ratios:

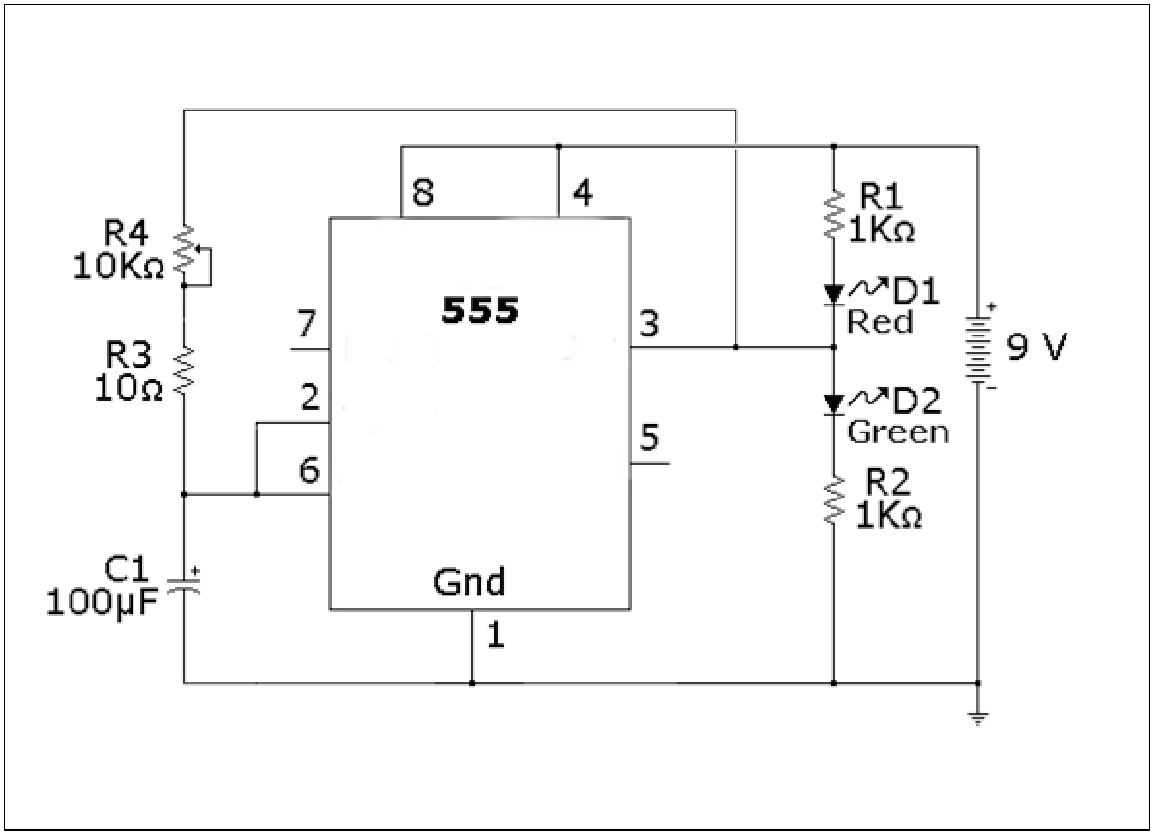
	Vcc = 9V	**Vcc = 7 V**
V_H/Vcc		
V_L/Vcc		

Explain your results…

4.- Simple RC Oscillator

In this part we will design an oscillator, that is, a circuit that generates a square wave that operates continuously. These type of oscillators are widely in electronics, for example as the clocks for digital circuits.

Modify your circuit in order to build the circuit from the figure below. Make sure that you observe the correct polarity of the electrolytic capacitor.



To verify that the circuit is working correctly, changing the value of the potentiometer R4 should result in a change in the frequency at which the LEDs are blinking. If you want you can connect a piezoelectric speaker to pin 3 to have an auditory output.

Connect the oscilloscope in Pin 3 (output) of the 555. Measure the highest and lowest frequency that your oscillator can generate:

f_{max} =
f_{min} =

Connect the other channel of the oscilloscope to Pin 6 (trigger voltage) of the 555. Configure the oscilloscope so both channels are displayed simultaneously.

For a frequency of your choice, sketch the waveforms measured at Pin 3 and Pin 6 simultaneously.

5 .- Write an individual laboratory report for this activity. Follow the guidelines and examples that are available in the EET 105's website. Take into account the suggestions and feedback from the instructor for past labs.