**555 Timer Project**

## Objective

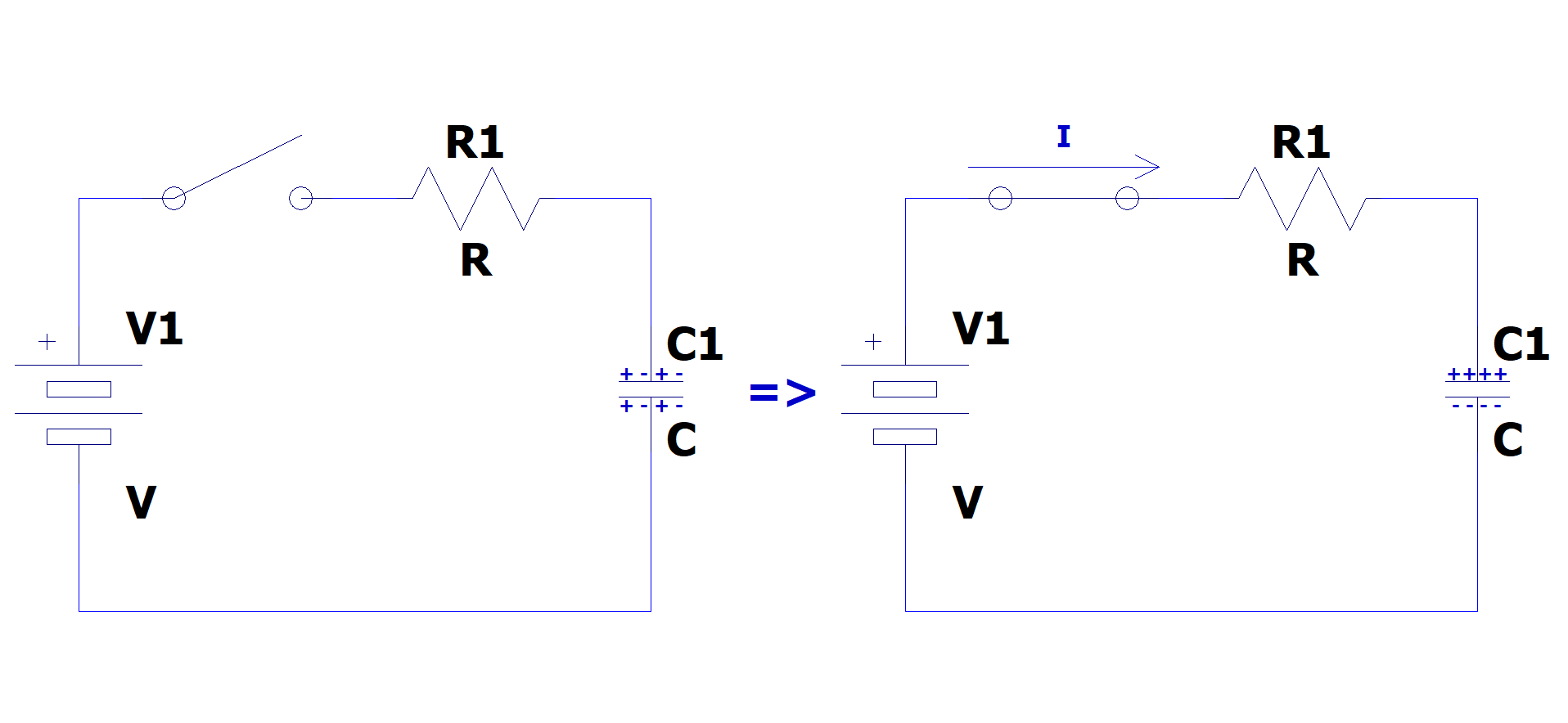
In this project, we will examine the charge and discharge time of a resistor-capacitor (RC) circuit. We will also learn about a simple integrated circuit (IC), 555 Timer. We will learn how the charge and discharge time of an RC circuit is used in simple designs with the 555 timers to create pulses of different duration.

We will end the project with building a circuit that once triggered turns on an LED for a duration of our choosing. Time permitted, we will extend the circuit to one that toggle an LED indefinitely.

## Theory Overview

### Charge/Discharge Time of an RC Circuit

A capacitor is a passive device for storing electric charge. When an electric source like a battery is connected to a capacitor, the battery induces a current in the circuit which moves electrons from one of the capacitor’s plates to the other. As the charge builds up on the capacitor’s plates, the voltage across the capacitor increases until it reaches that of the battery. At that point the current and movement of charges stop.



As one can imagine, the current at the moment a battery is attached to a capacitor is the largest, and as the capacitor collects more charge, the current slows down. Eventually, once the capacitor reaches its full charge, the current comes to a stop.

The charge and voltage build up across the capacitor follow a similar profile. At time 0, the charge, and therefore the voltage, across the capacitor are 0. The charge, and therefore the voltage, builds up quickly at the beginning, but as the capacitor reaches its maximum charge, the charge build-up slows down.

The time it takes to charge a capacitor is a function of how large the capacitor is (its capacitance) and how large the resistance is between the battery and the capacitor. The chart below displays the charge time of a capacitor as a function of multiples of RC.



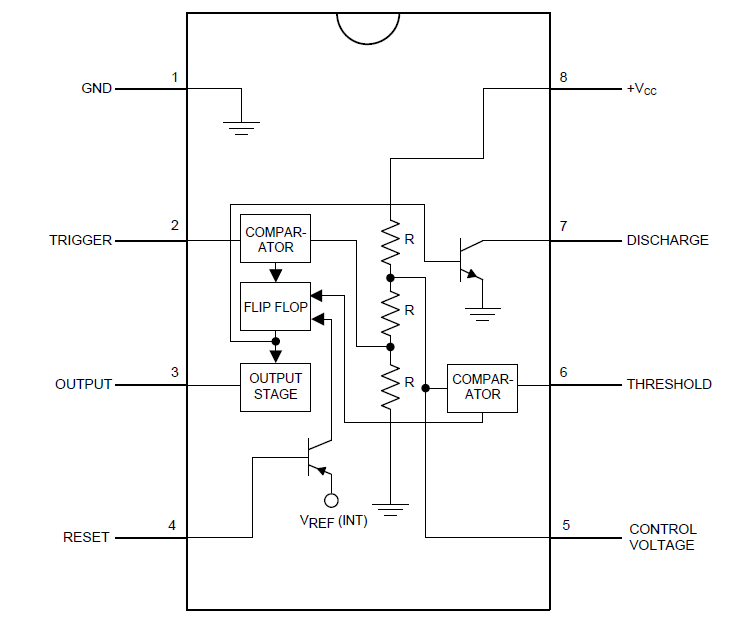
A capacitor charges to ~63% of the input voltage after a time t63% = 1RC. It charges to ~95% of the input voltage after a time t95% = 3RC. It follows a similar profile when discharging. In other words, a capacitor discharging through a resistor loses ~63% of its charge in a time t63% = 1RC and ~95% if its charge in a time t95% = 3RC.

Electrical engineers use these time constants to design RC circuits that produce very specific time durations. In the next section we learn about one such circuit.

### 555 Timer IC

The 555 timer IC is a highly stable device for accurate time delays or oscillation. Additional inputs are provided for triggering or resetting the device if desired. In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor. For a stable operation as an oscillator, the free running frequency and duty cycle are accurately controlled with two external resistors and one capacitor.

The block diagram of the device is given below.



In this mode of operation, the timer functions as a one-shot (Figure 11). The external capacitor is initially held

discharged by a transistor inside the timer. Upon application of a negative trigger pulse of less than 1/3 VCC to

pin 2, the flip-flop is set which both releases the short circuit across the capacitor and drives the output high.

Figure 11. Monostable

The voltage across the capacitor then increases exponentially for a period of t = 1.1 RA C, at the end of which

time the voltage equals 2/3 VCC. The comparator then resets the flip-flop which in turn discharges the capacitor

and drives the output to its low state. Figure 12 shows the waveforms generated in this mode of operation. Since

the charge and the threshold level of the comparator are both directly proportional to supply voltage, the timing

interval is independent of supply.