What is a 555 Timer?

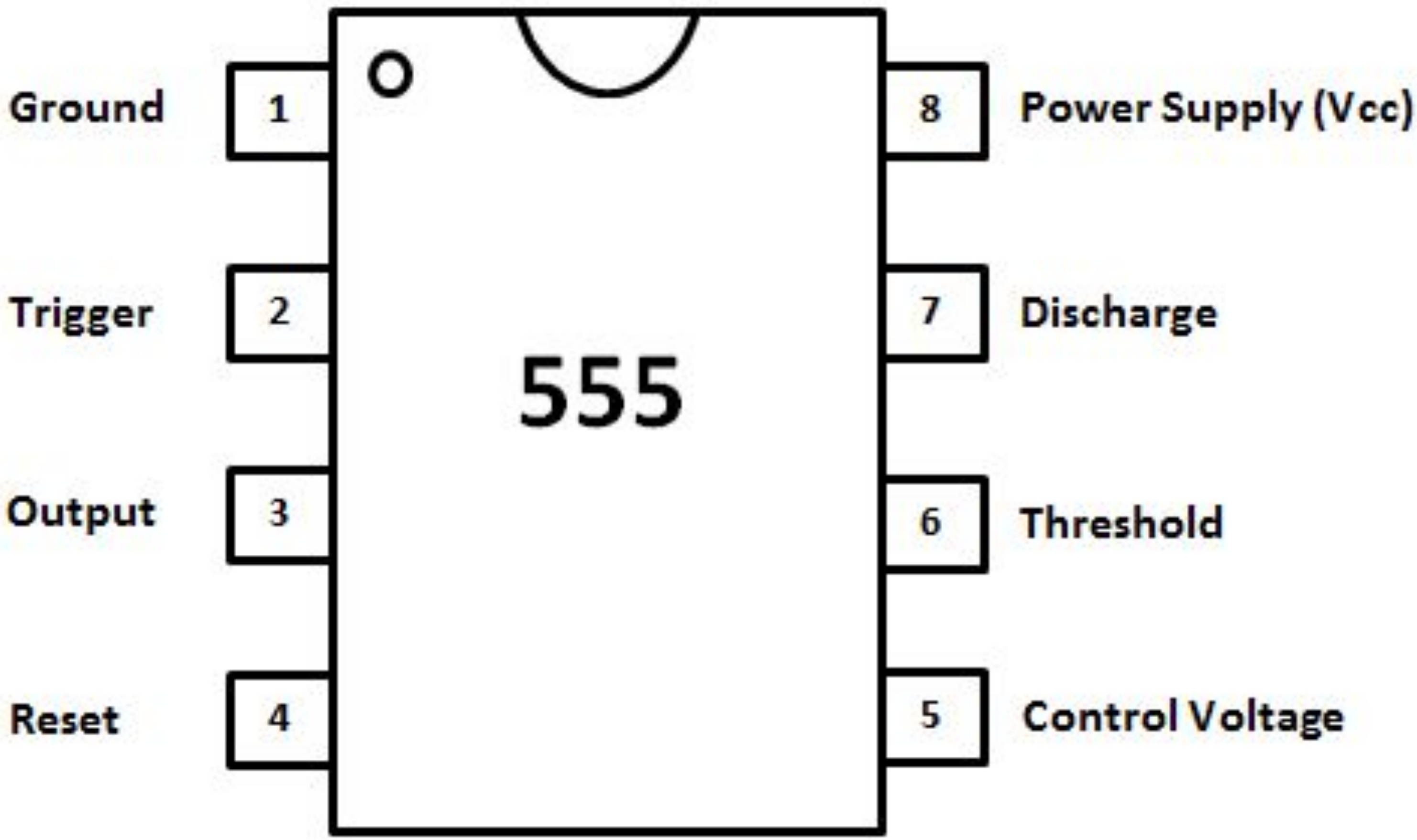
- The 555 timer is an 8-pin IC that is capable of producing accurate time delays and/or oscillators.
- In the time delay mode, the delay is controlled by one external resistor and capacitor.
- In the oscillator mode, the frequency of oscillation and duty cycle are both controlled with two external resistors and one capacitor.

What is a 555 Timer?

<u>Applications:</u>

- basic timing functions: turning a light on for a certain amount of time
- create a warning light that flashes on and off
- create musical notes of a certain frequency
- control the positioning of a servo motor

Pin Layout


Ground
1
Trigger
2
Output
3
Reset
4
555
8
Power Supply (Vcc)
7
Discharge
6
Threshold
5
Control Voltage

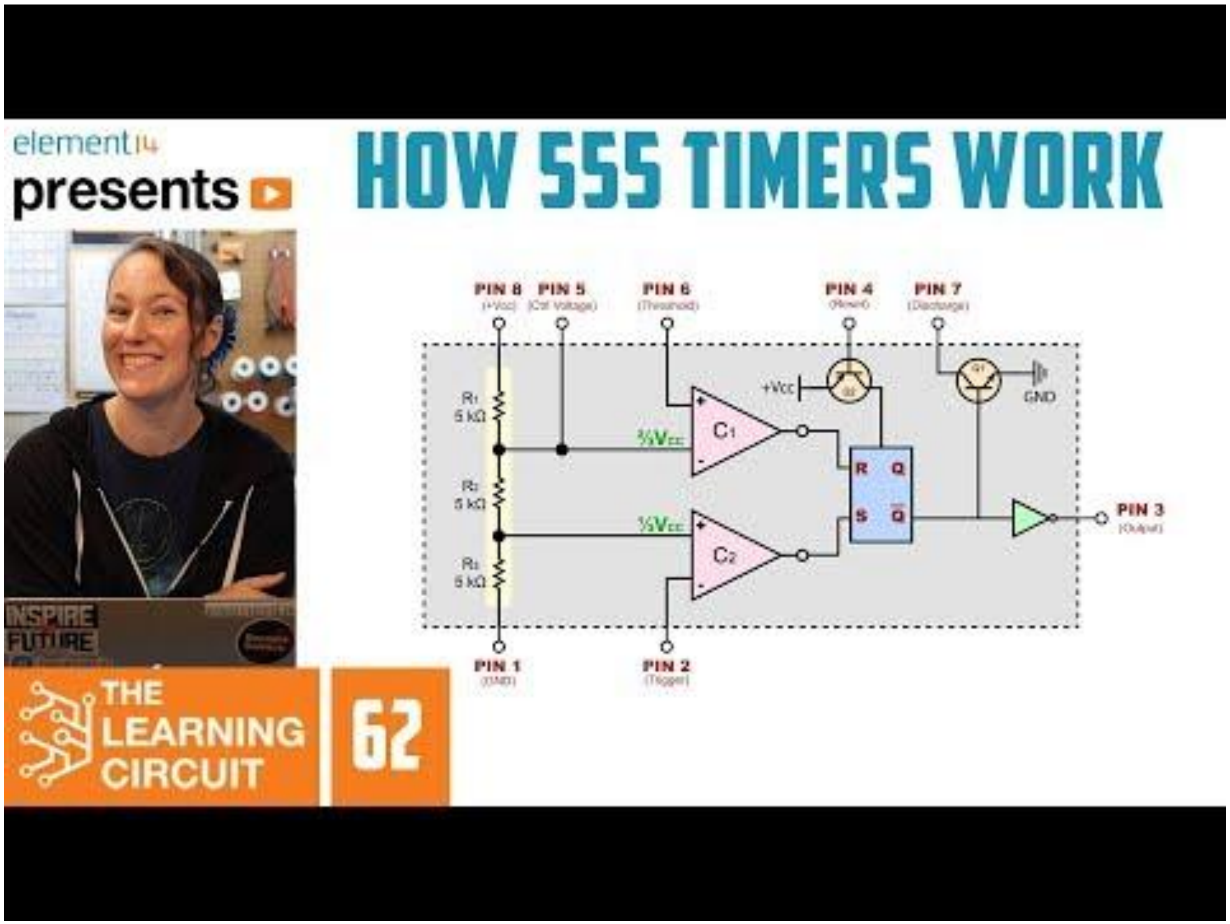
Pin Explanations

- **Ground:** Pin 1 is connected to ground (-)
- **VCC:** Pin 8 is connected to the positive supply voltage. 15 v=>Vcc >= 4.5v
- **Output:** Pin 3 is the output pin. The output is either low, which is very close to 0 V, or high, which is close to the supply voltage that’s placed on pin 8.

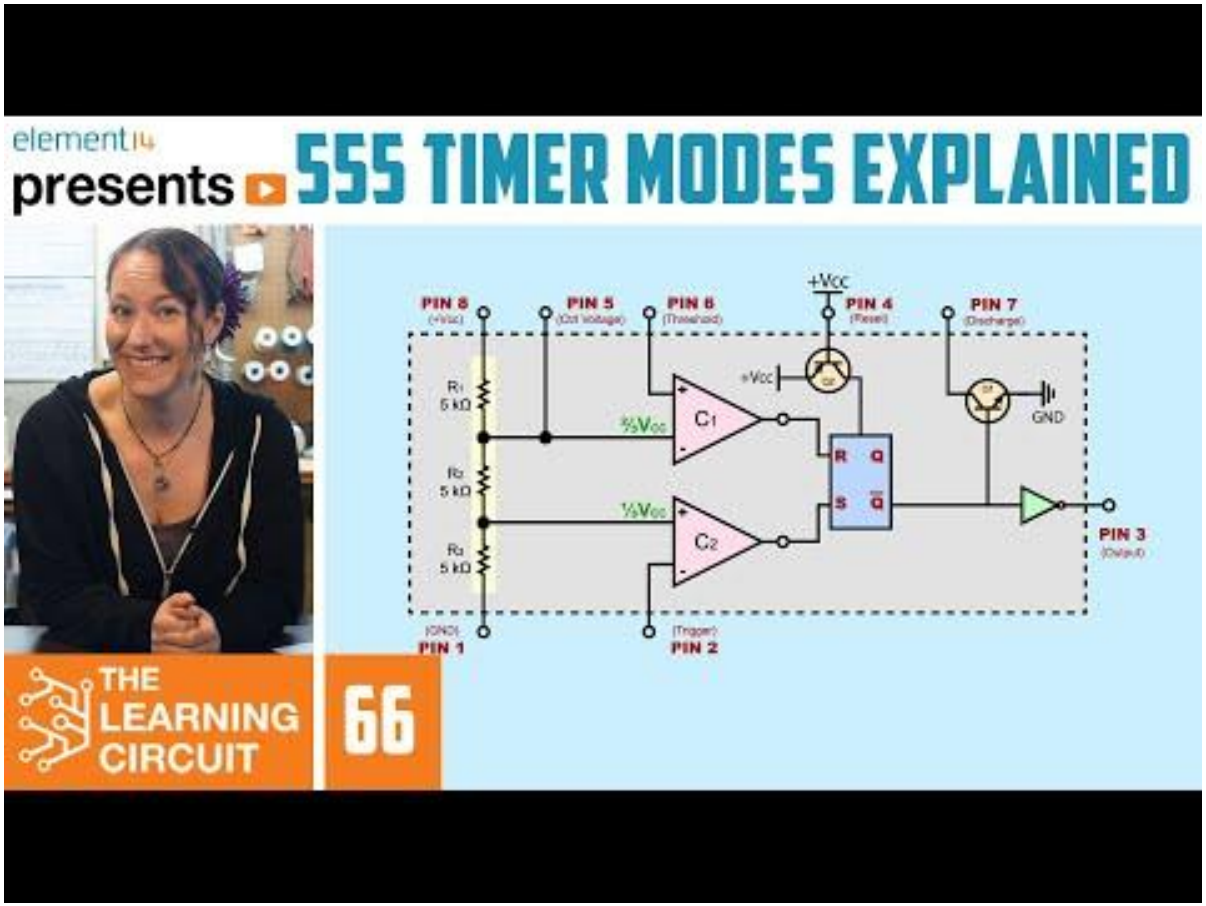
Pin Explanations

- **Output:** The exact shape of the output — that is, how long it’s high and how long it’s low, depends on the connections to the remaining five pins:
  a. Trigger
  b. Discharge
  c. Threshold
  d. Control
  e. Reset

555 Timer Overview



555 Timer Modes



Pin Explanations

Trigger (2) - Make the output high when input is < ⅓ Vcc (Active LOW)

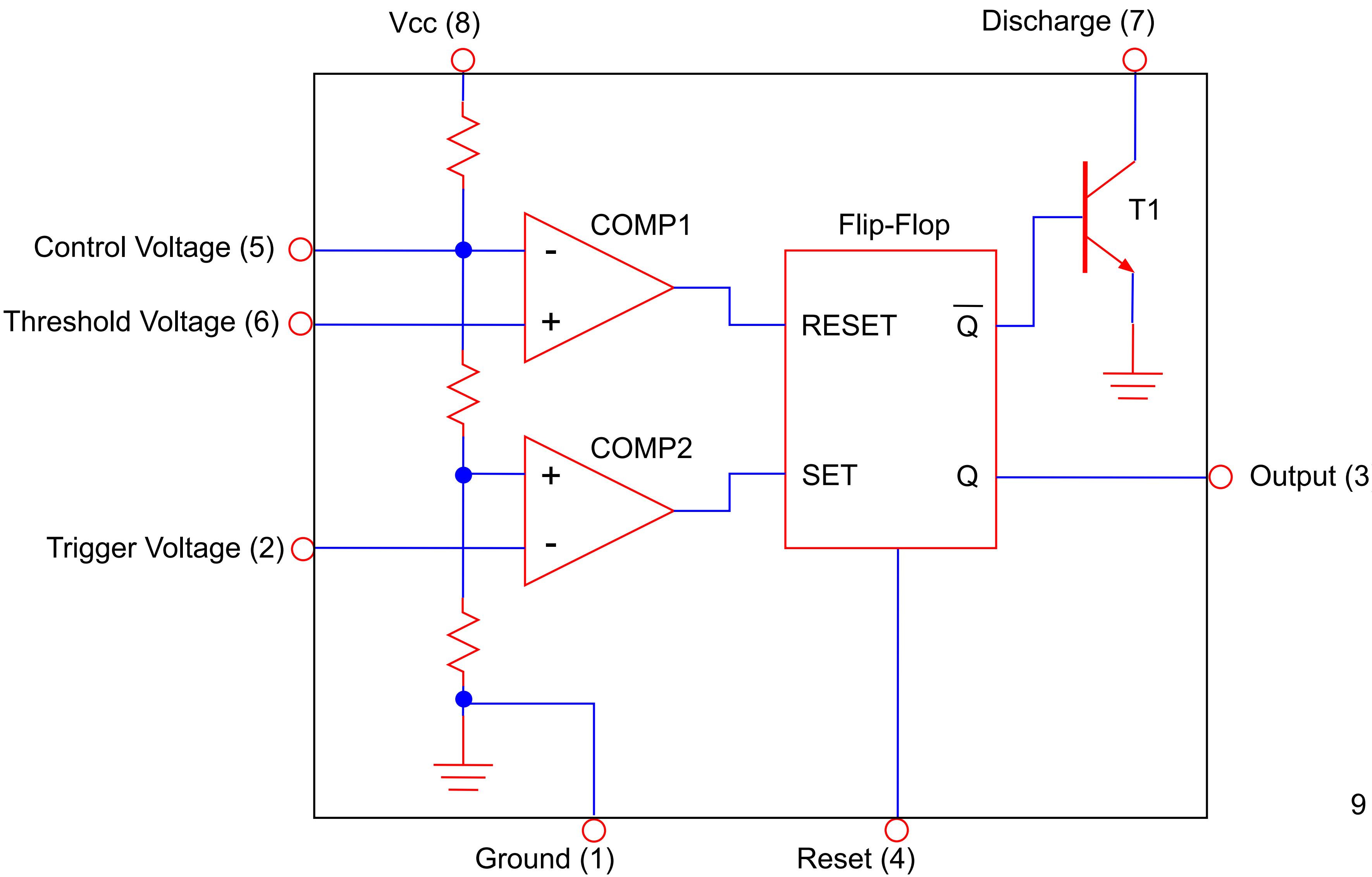
Reset (4)- Resets circuit when voltage < 0.8V (Active LOW)

Discharge (7) - This pin is used to discharge an external capacitor that works in conjunction with a resistor to control the timing interval.

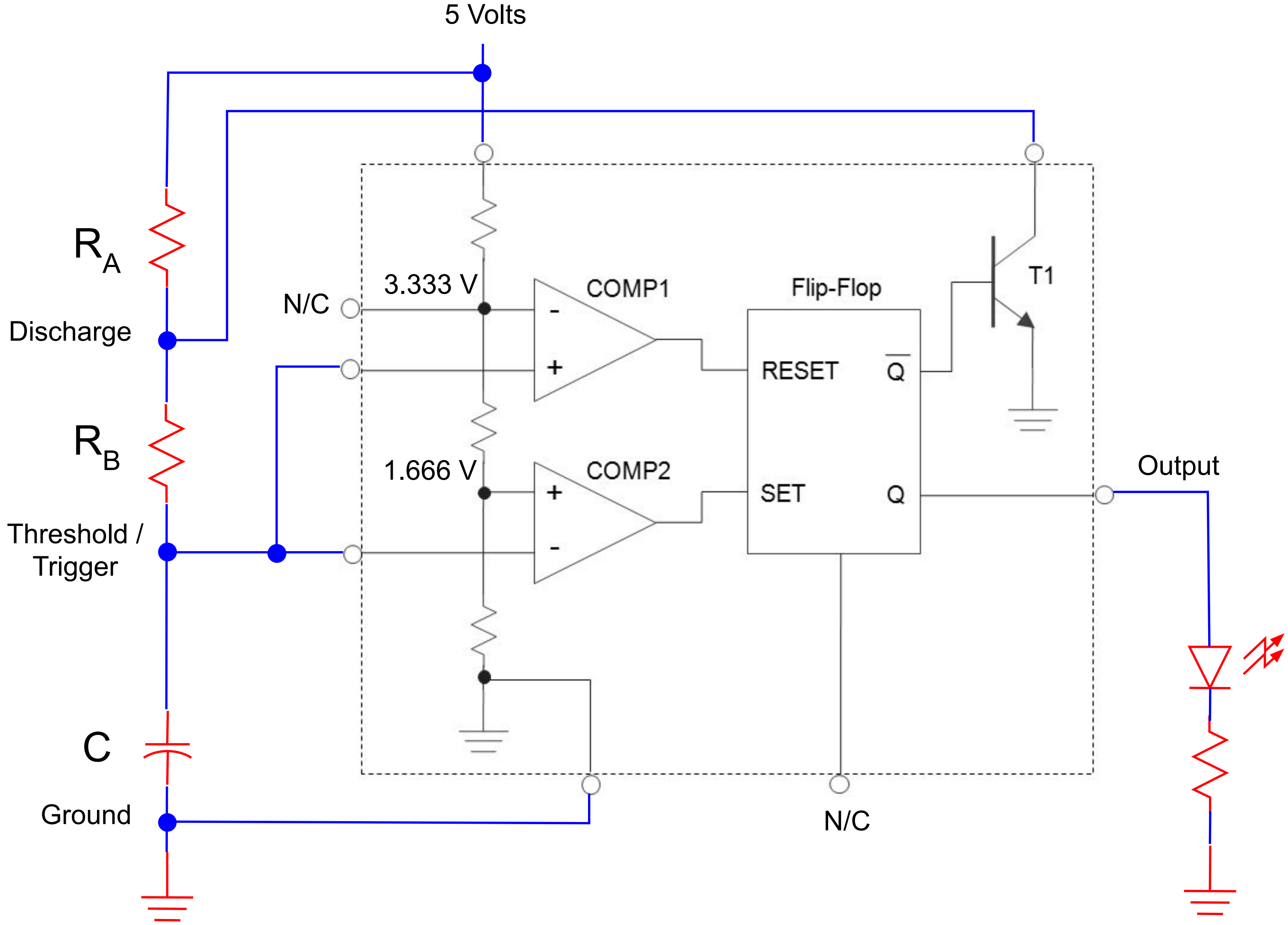
Threshold (6) - The purpose of this pin is to monitor the voltage across the capacitor that's discharged by pin 7. When this voltage reaches two thirds of the supply voltage (Vcc), the timing cycle ends, and the output on pin 3 goes low.

Control (5) - Voltage applied with varying the timing frequency of the output. Usually connected to ground through a small capacitor. The purpose of the capacitor is to level out any fluctuations in the supply voltage that might affect the operation of the timer.

Block Diagram for a 555 Timer



Schematic of a 555 Timer in Oscillator Mode



555 Timer – Period / Frequency / DC

Period:

$$t_{HIGH} = 0.693\,(R_A + R_B)\,C$$

$$t_{LOW} = 0.693\,R_B C$$

$$T = t_{HIGH} + t_{LOW}$$

$$T = [0.693\,(R_A + R_B)\,C] + [0.693\,R_B C]$$

$$T = 0.693\,(R_A + 2R_B)\,C$$

Duty Cycle:

$$DC = \frac{t_{HIGH}}{T} \times 100\%$$

$$DC = \frac{0.693\,(R_A + R_B)\,C}{0.693\,(R_A + 2R_B)\,C} \times 100\%$$

$$DC = \frac{(R_A + R_B)}{(R_A + 2R_B)} \times 100\%$$

Frequency:

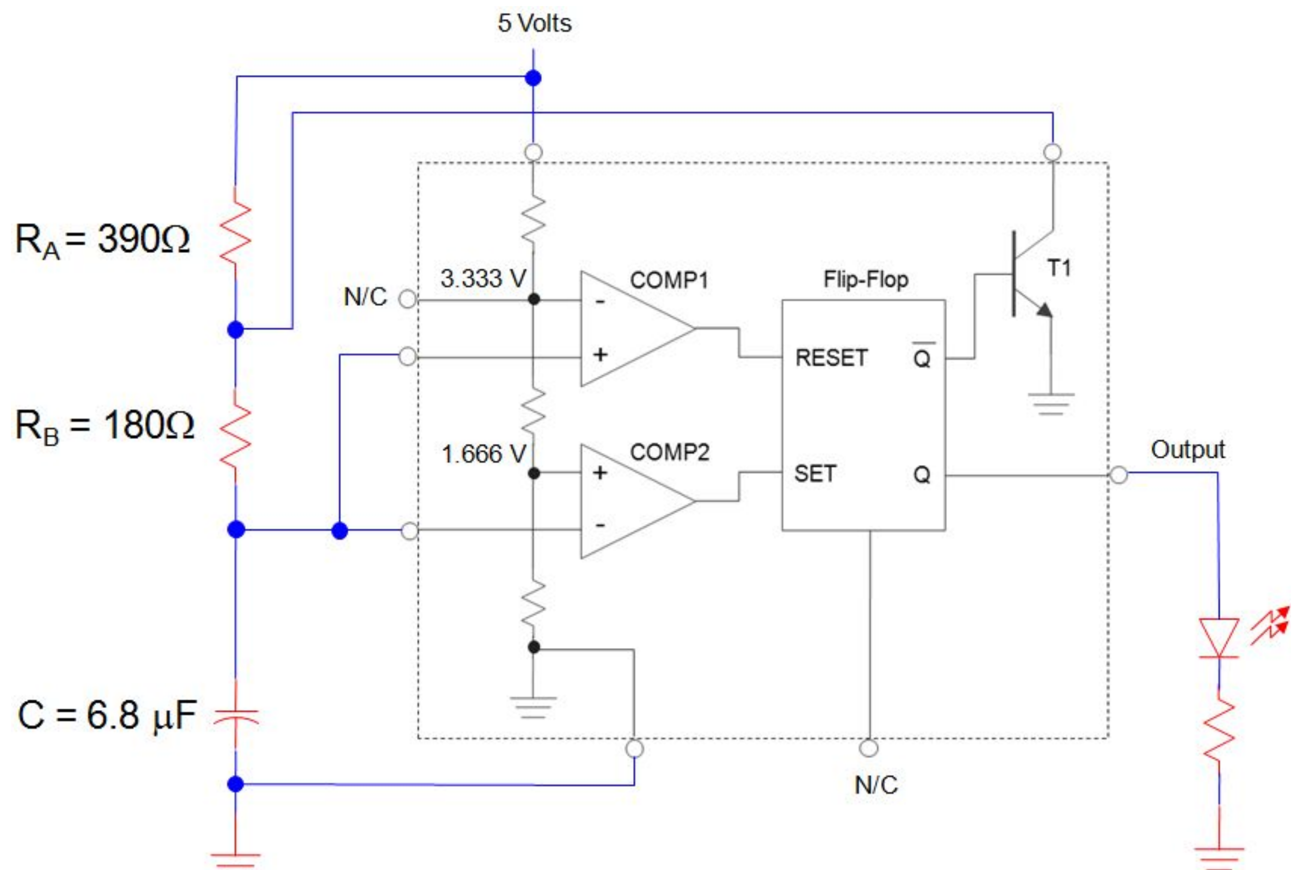
$$F = \frac{1}{T}$$

$$F = \frac{1}{0.693\,(R_A + 2R_B)\,C}$$

Example: 555 Oscillator

Example:

For the 555 Timer oscillator shown below, calculate the circuit's, period (T), frequency (F), and duty cycle (DC).



Example: 555 Oscillator

Solution:

$R_A = 390\ \Omega \quad R_B = 180\ \Omega \quad C = 6.8\ \mu F$

Period:

$$T = 0.693\left(R_A + 2R_B\right)C$$

$$T = 0.693\left(390\Omega + 2\times 180\Omega\right)\times 6.8\mu F$$

$$\boxed{T = 3.534\ \text{mSec}}$$

Frequency:

$$F = \frac{1}{T}$$

$$F = \frac{1}{3.534\ \text{mSec}}$$

$$\boxed{F = 282.941\ \text{Hz}}$$

Duty Cycle:

$$DC = \frac{\left(R_A + R_B\right)}{\left(R_A + 2R_B\right)}\times 100\%$$

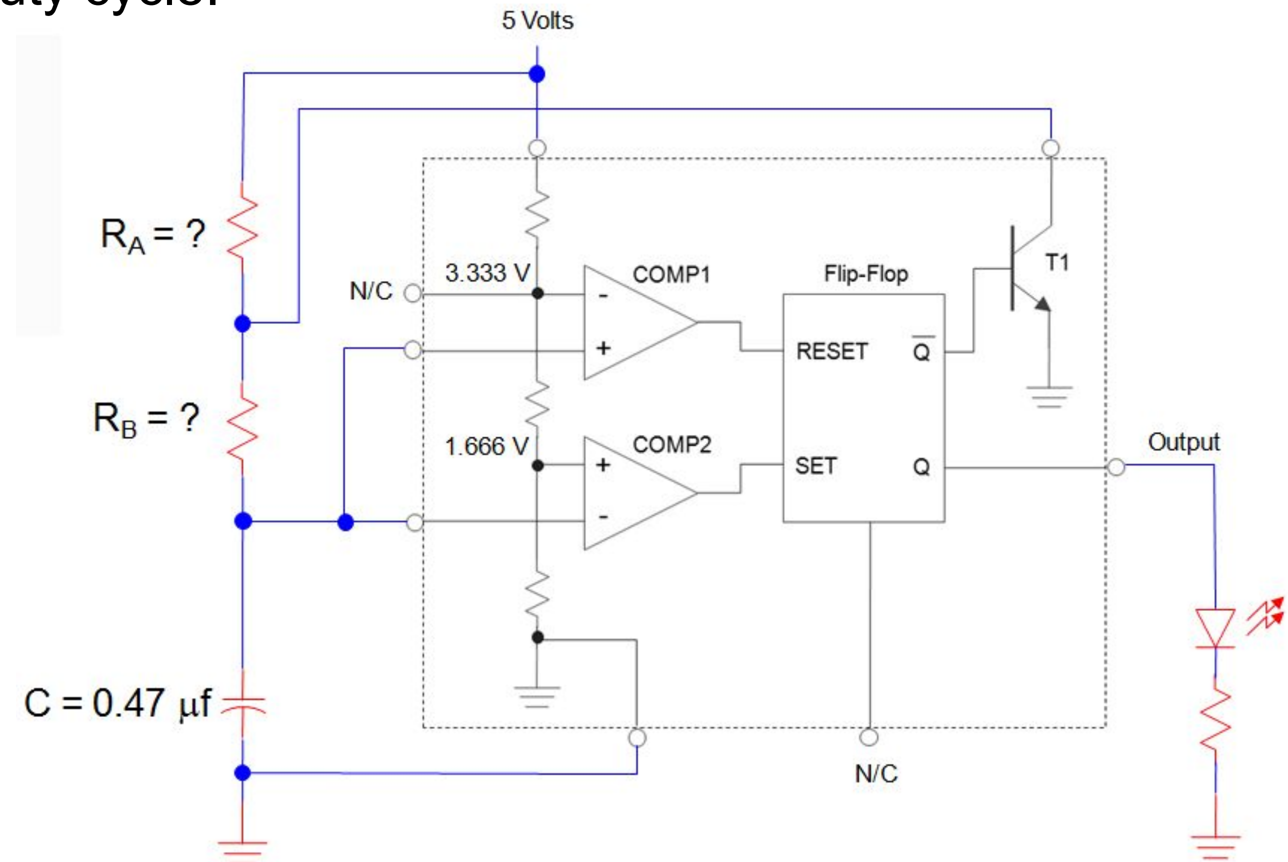
$$DC = \frac{\left(390\ \Omega + 180\ \Omega\right)}{\left(390\ \Omega + 2\times 180\ \Omega\right)}\times 100\%$$

$$\boxed{DC = 76\%}$$

Example: 555 Oscillator

Example:

For the 555 Timer oscillator shown below, calculate the value for R_A & R_B so that the oscillator has a frequency of 2.5 KHz @ 60% duty cycle.



Example: 555 Oscillator

Solution:

Frequency:

$$T = \frac{1}{f} = \frac{1}{2.5\,\text{kHz}} = 400\mu\text{Sec}$$

$$T = 0.693\left(R_A + 2R_B\right)C = 400\mu\text{Sec}$$

$$T = 0.693\left(R_A + 2R_B\right)0.47\mu\text{f} = 400\mu\text{Sec}$$

$$R_A + 2R_B = \frac{400\mu\text{Sec}}{0.693 \times 0.47\mu\text{f}} = 1228.09\,\Omega$$

$$R_A + 2R_B = 1228.09$$

Duty Cycle:

$$DC = \frac{\left(R_A + R_B\right)}{\left(R_A + 2R_B\right)} \times 100\% = 60\%$$

$$\frac{\left(R_A + R_B\right)}{\left(R_A + 2R_B\right)} = 0.6$$

$$R_A + R_B = 0.6\left(R_A + 2R_B\right)$$

$$R_A + R_B = 0.6 \times R_A + 1.2 \times R_B$$

$$0.4 \times R_A = 0.2 \times R_B$$

$$R_A = 0.5 \times R_B$$

Two Equations & Two Unknowns!

Example: 555 Oscillator

Solution:

Frequency:

$$R_A + 2R_B = 1228.09$$

Duty Cycle:

$$R_A = 0.5 \times R_B$$

Substitute and Solve for R_B

$$R_A + 2R_B = 1228.09\,\Omega$$

$$0.5 \times R_B + 2R_B = 1228.09\,\Omega$$

$$2.5R_B = 1228.09\,\Omega$$

$$\boxed{R_B = 491.23\,\Omega}$$

Substitute and Solve for R_A

$$R_A + 2R_B = 1228.09\,\Omega$$

$$R_A + 2(491.23\,\Omega) = 1228.09\,\Omega$$

$$R_A + 982.472\,\Omega = 1228.09\,\Omega$$

$$\boxed{R_A = 245.618\,\Omega}$$