PASADENA CITY COLLEGE

The Principles of Operation and Applications of a 555 IC Timer

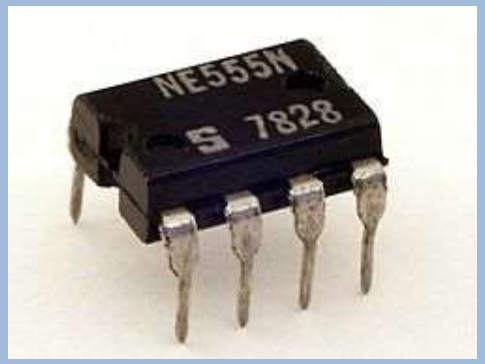


Figure 1 – Signetics 555 timer [1]

Background

- The 555 timer is an Integrated Circuit (I.C.) containing over 40 discrete components
- It was first manufactured in 1972
- Why study such an old device?
- Designed as a **universal** timer: can be configured for many purposes
- Current production of over one billion devices annually!

Terms / Abbreviations

Concepts / terms used with the 555 timer

- τ (time constant) = R x C
- Duty Cycle (Time on / Total Time)

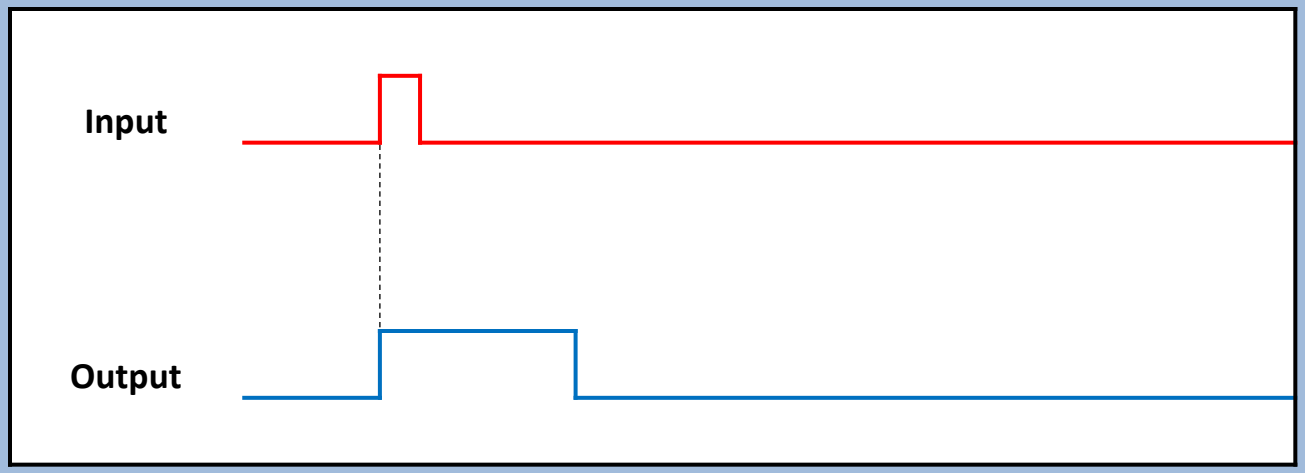
- Monostable
- Bistable
- Astable

New Terms

Terms / Abbreviations

Monostable - one stable state (usually off)

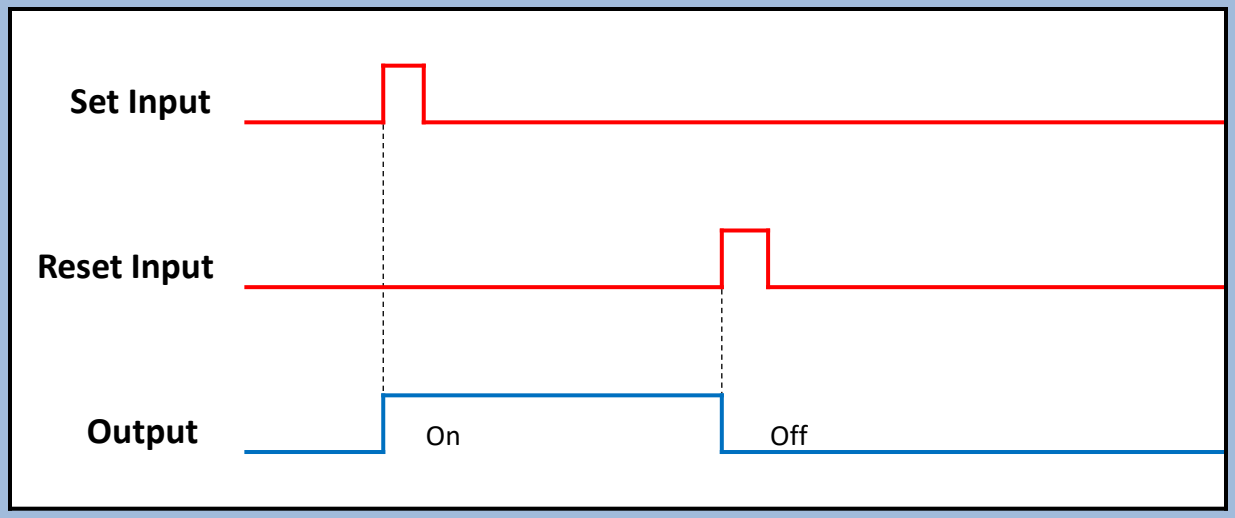
Also called a "One Shot"



Terms / Abbreviations

Bistable - Two stable states (off / on)

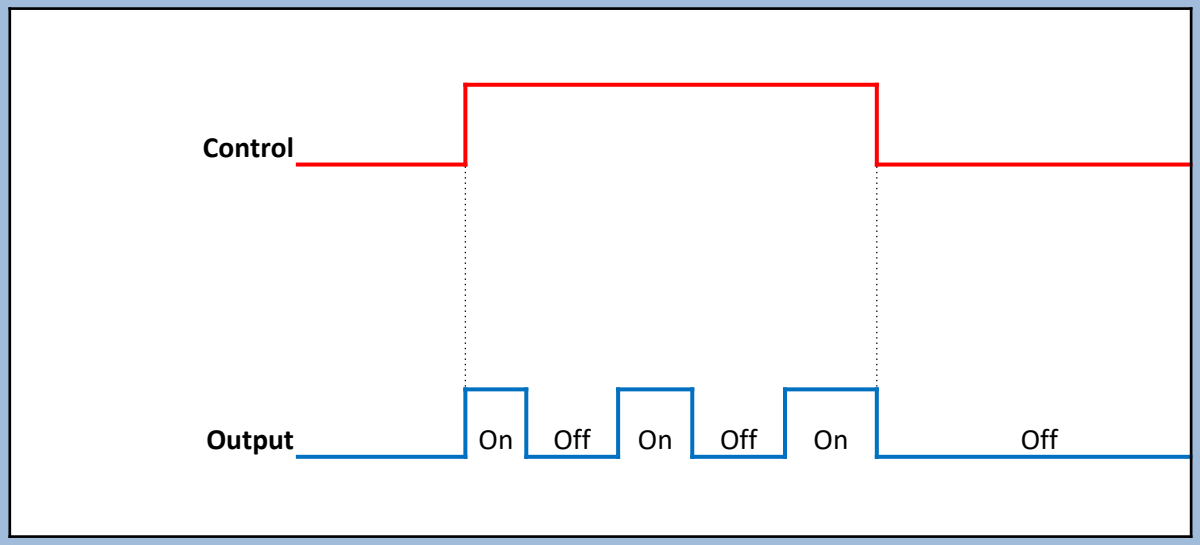
Also called a “Flip-Flop”



Terms / Abbreviations

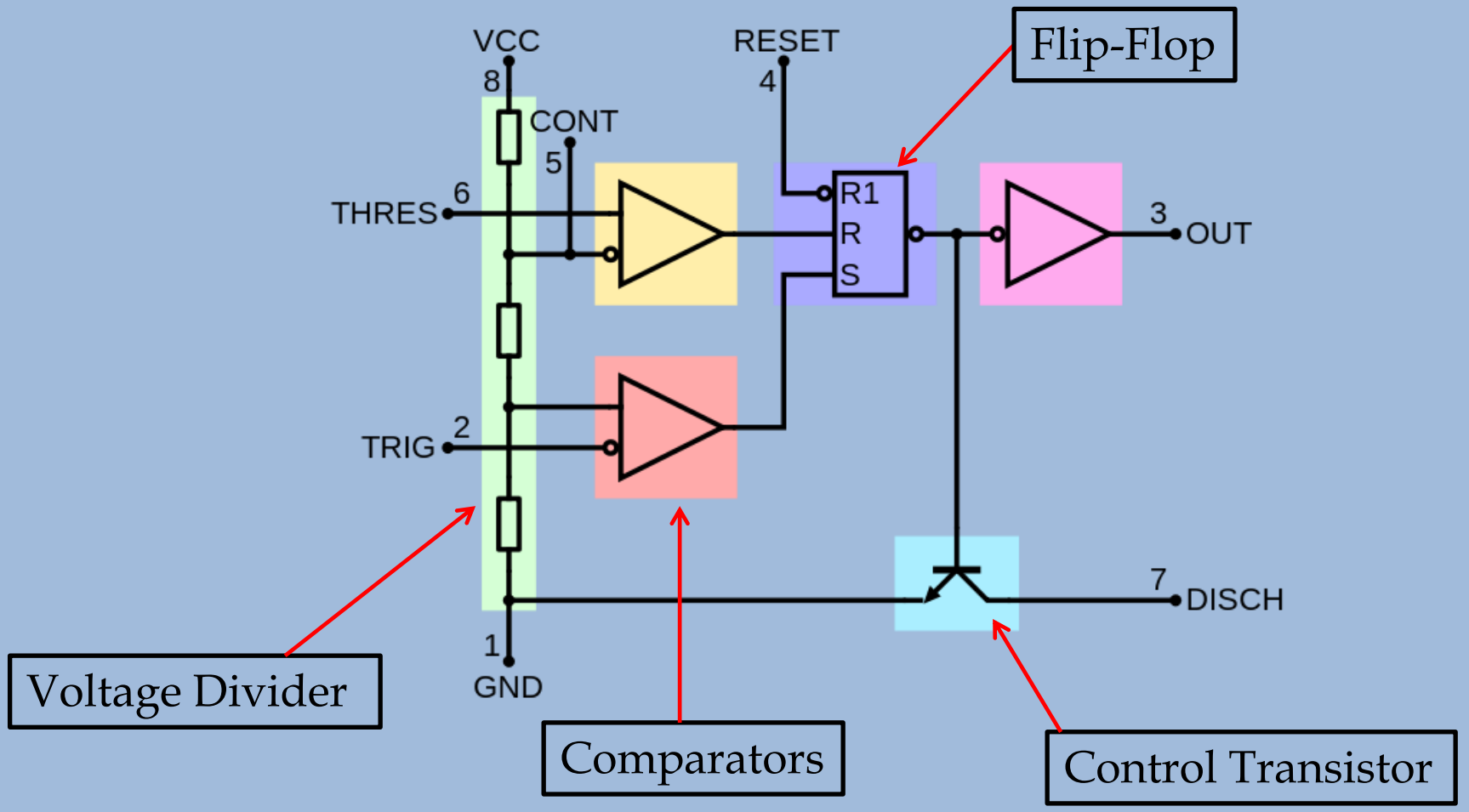
Astable - No stable state

- Also called an *oscillator*
- Most common application of the 555 timer



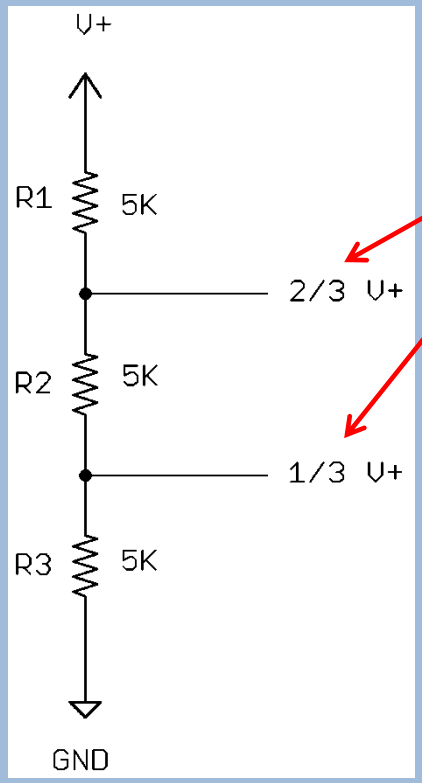
Principles of Operation

- The 555 timer is composed of several subsystems:



Principles of Operation

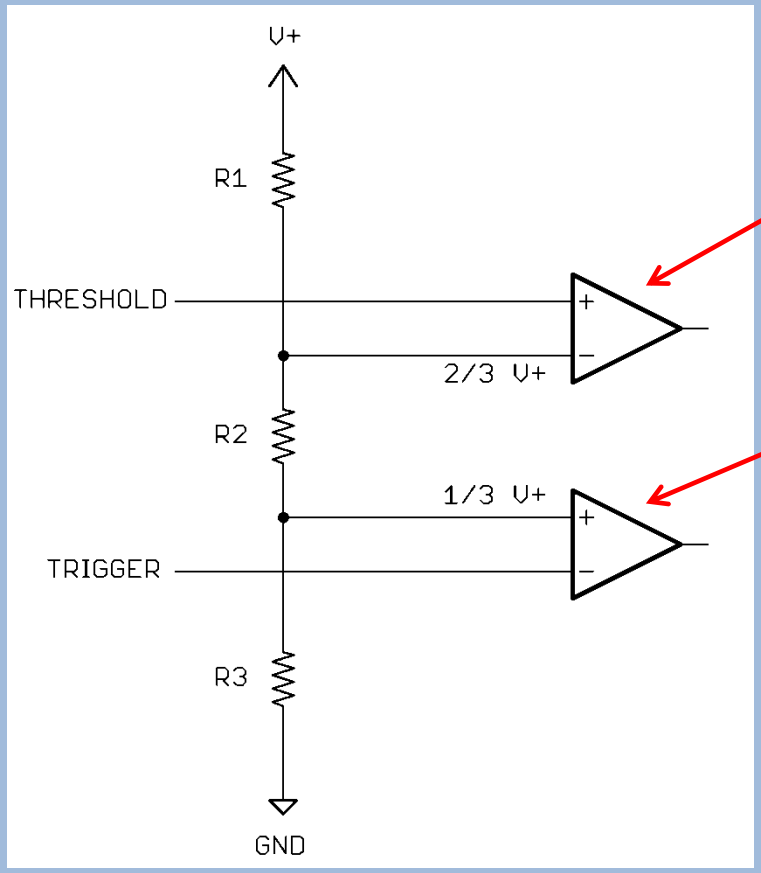
- Voltage divider:



Creates two fixed voltages as percentage of total voltage

Principles of Operation

- Comparators:



Comparator turns on output if voltage > 2/3 V+

Comparator turns on output if voltage < 1/3 V+

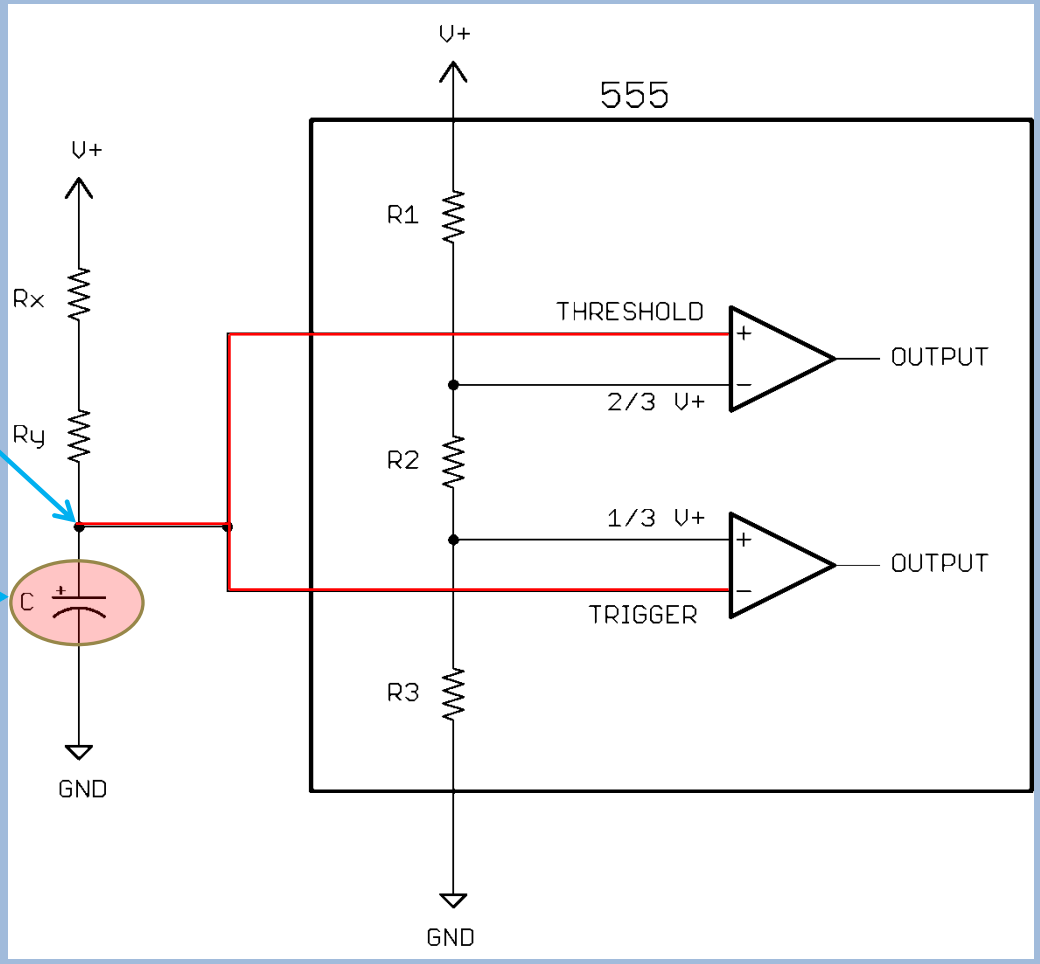
Principles of Operation

- External RC Network:

As C charges, the voltage at the threshold / trigger point increases.

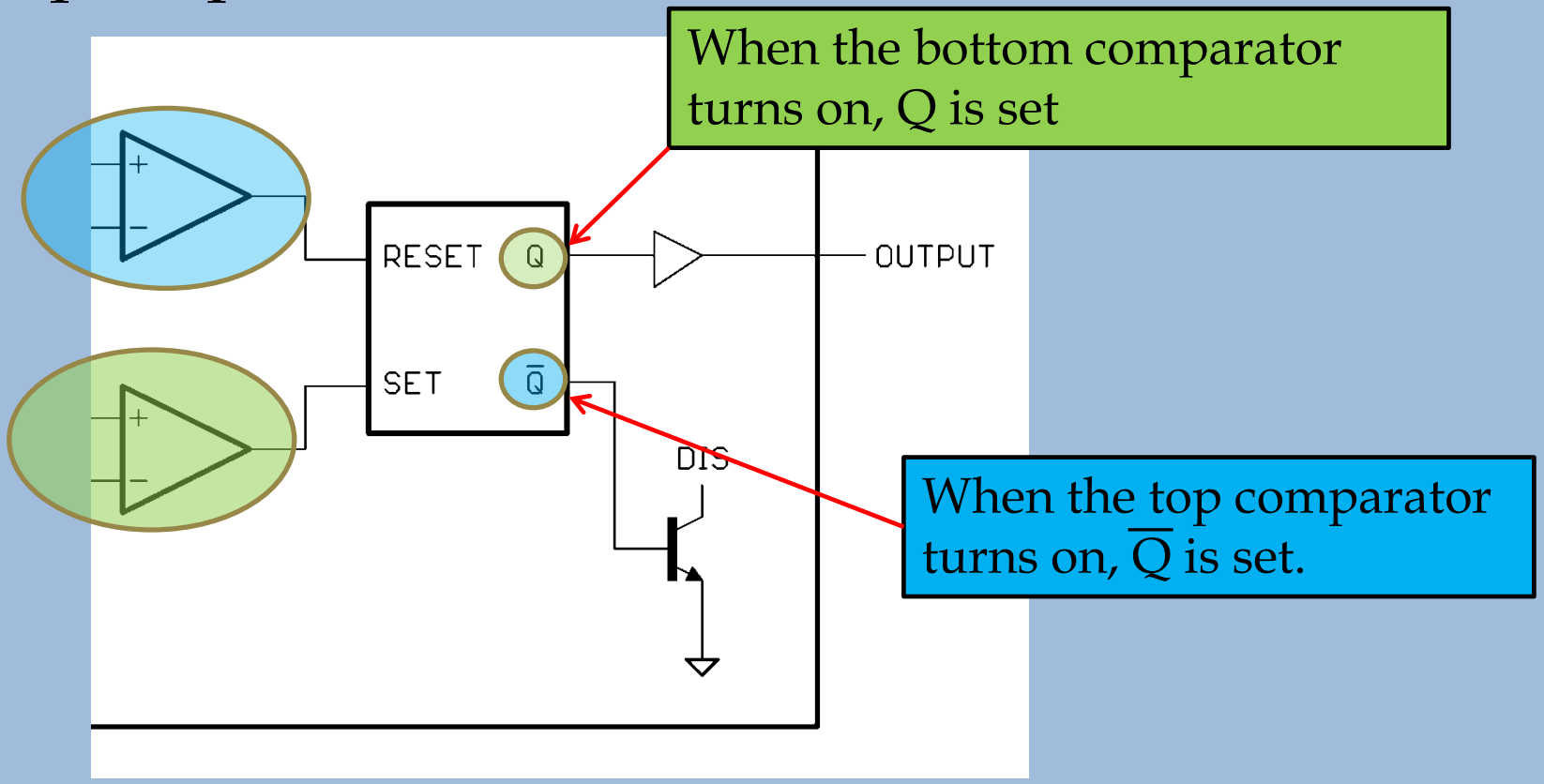
Capacitor C charges through Rx and Ry

tau= (Rx + Ry) x C

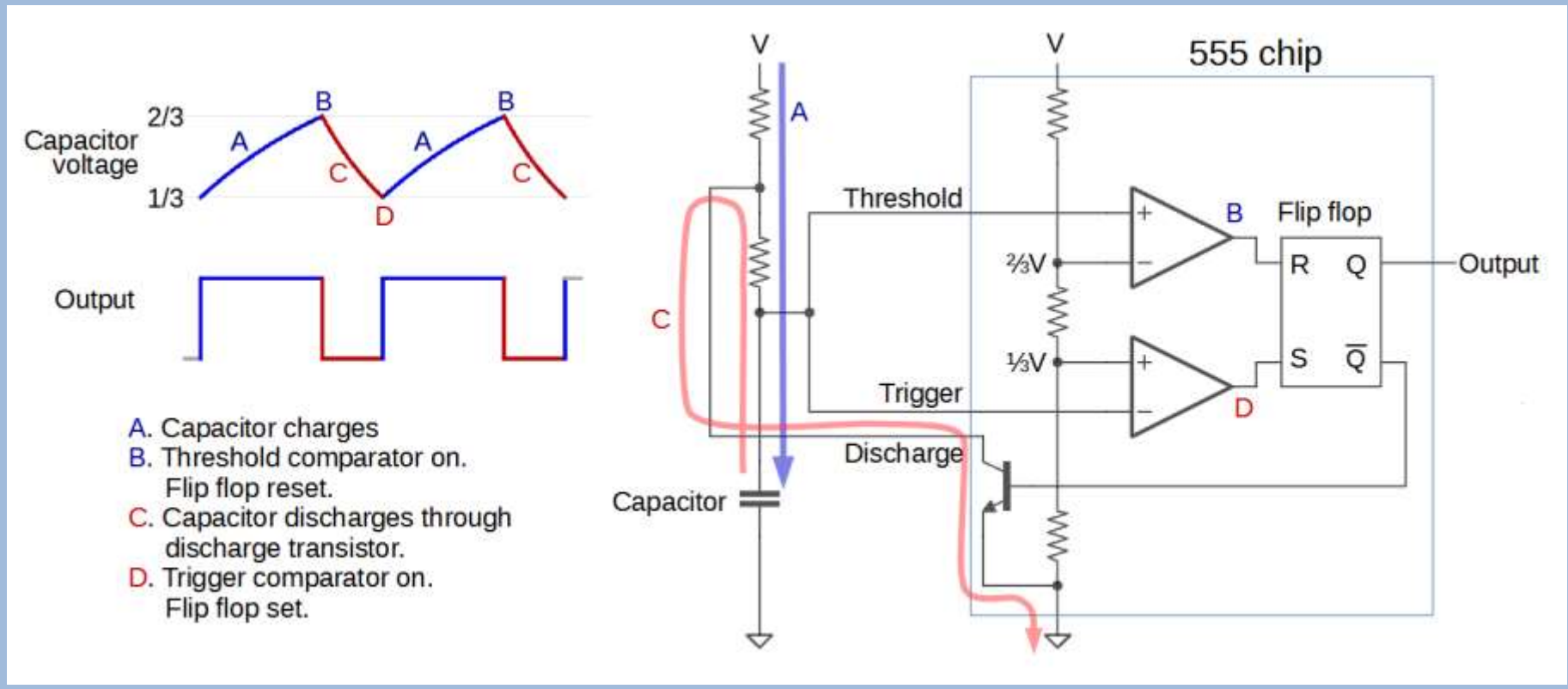


Principles of Operation

- Flip Flop / Transistor:

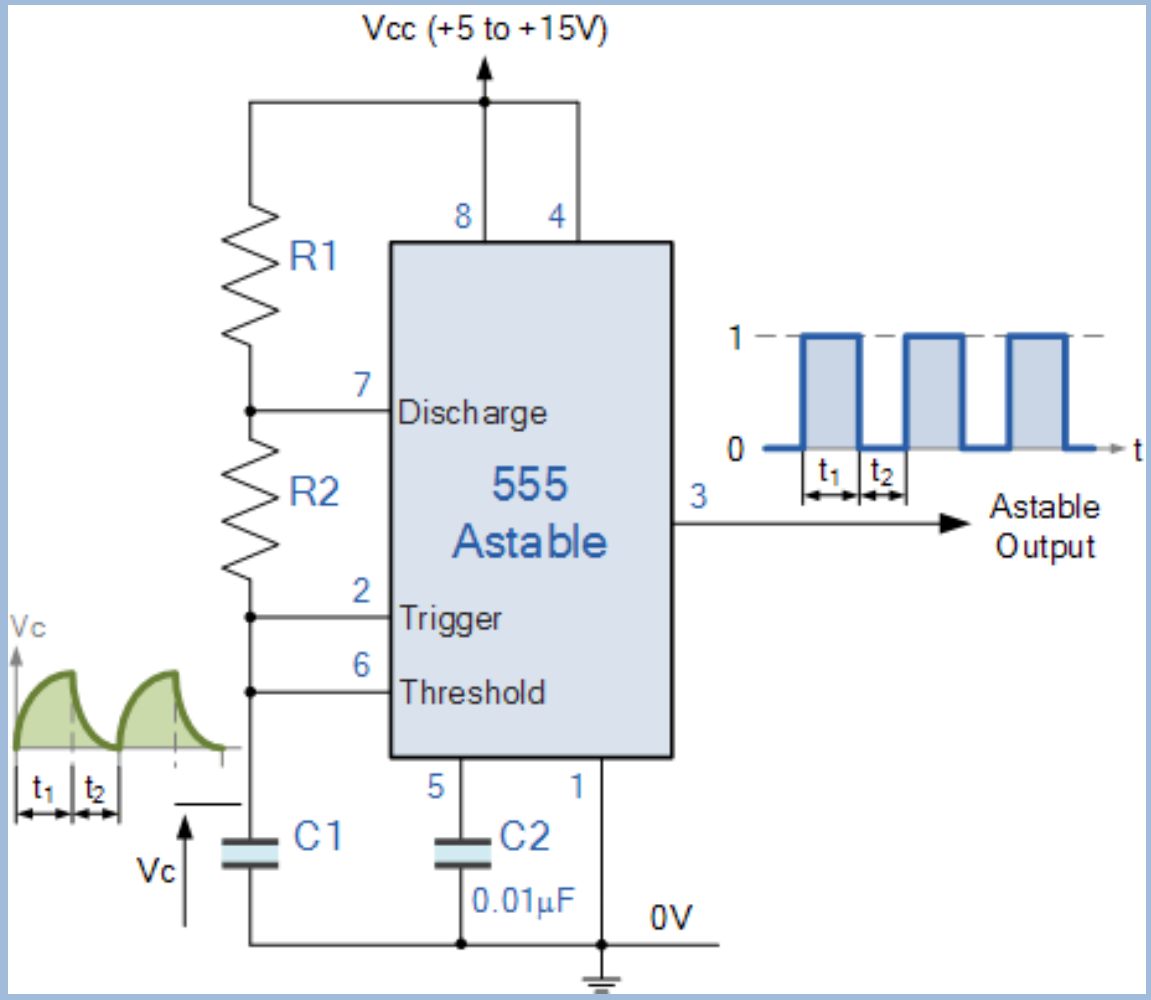


Principles of Operation



Astable Circuit [2]

Applications - Astable



Astable Circuit [2]

Oscillator / Timer Applications

Oscillator

Vehicle Turn Signals [3]

Timer

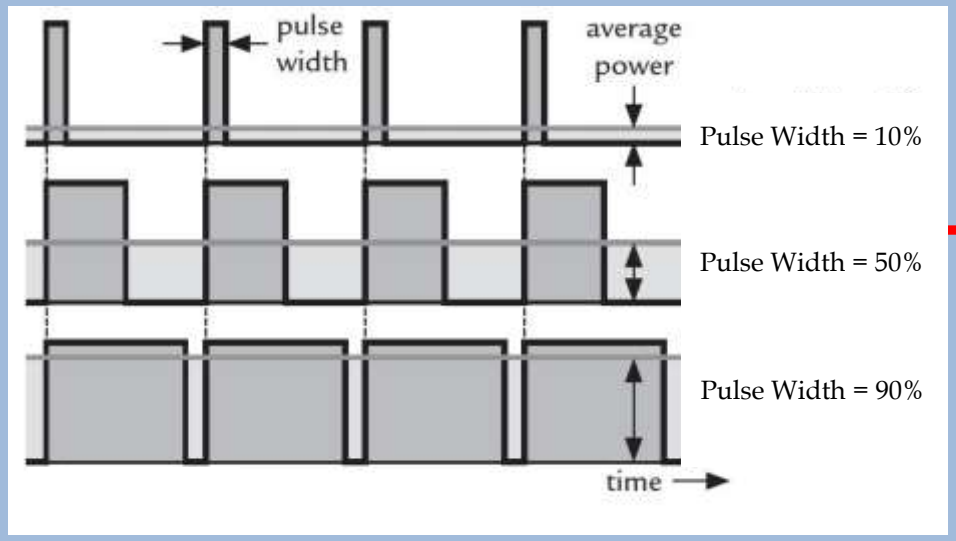
Room light controller [4]

Oscillator and Timer

Coffee maker clock/timer [5]

Duty Cycle Applications

Varying the duty cycle controls the average voltage output:



Duty Cycle values [6]

Power drill speed control [7]

Calculations required for applications:

Designing an oscillator with the 555 timer requires:

- **Calculating <u>Frequency</u> :**

$$f = \frac{1.44}{(R1+2R2)\times C}$$

- **Calculating <u>Duty Cycle</u> :**

$$DC = \frac{R1+R2}{(R1+2R2)}$$

Calculation Example

Determine the frequency and duty cycle of a 555 circuit with the following values:

R1 = 10.0K R2 = 5.00K C = 4.70uF

In-class exercise Solution:

R1 = 10.0K R2 = 5.00K C = 4.70uF

$$f = \frac{1.44}{(10\times10^{3}\Omega + 2\times 5\times10^{3}\Omega)\times 4.7\times 10^{-6}F} = \boxed{15.4\ \text{Hz}}$$

$$DC = \frac{R1+R2}{(R1+2R2)} = \frac{10K\Omega+5K\Omega}{(10K\Omega+2\times5K\Omega)} = \boxed{75.0\%}$$

References

- 1: http://static.righto.com/images/555/555_operation.png
- 2: www.electronics-tutorials.ws/waveforms/555_timer.html
- 3: www.aliexpress.com/
- 4: www.teambasedapproach.com/03/
- 5: www.severin.com/
- 6: http://www.lightinthebox.com/
- 7: https://www.dewalt.com