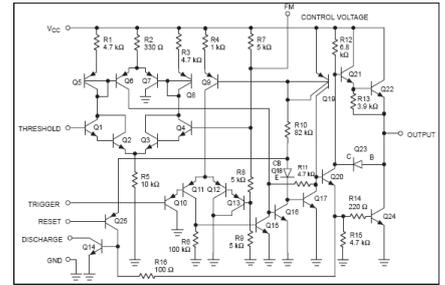


# AS Systems & Control Study Notes

## Part 5: Astable Multivibrators

### Week 5: Learning Objectives

- Know the function and applications of astable multivibrators:
- 555 based circuit
- PWM motor speed control



The internal circuit of a 555 Timer IC

### Astable Multivibrators

An astable multivibrator is used to generate electrical pulses. They have many applications in electronic systems.

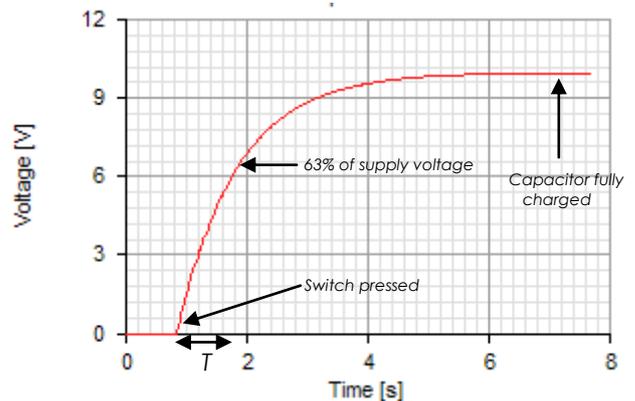
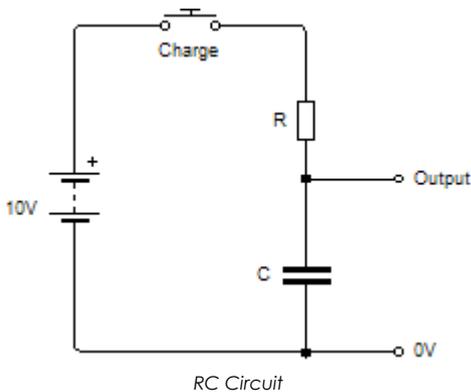
All astable circuits are based on an RC circuit and therefore relies on the time it takes for a capacitor to charge and discharge via a resistor. The time it takes for the capacitor to charge up to 63% of the supply voltage is known as the Time Constant (T.)

The time constant of the circuit can be calculated with the formula:

$$T = C \times R$$

Where T is the time constant, C is the capacitance value and R is the resistance value.

The circuit and graph shown below demonstrate what happens when the switch is closed:

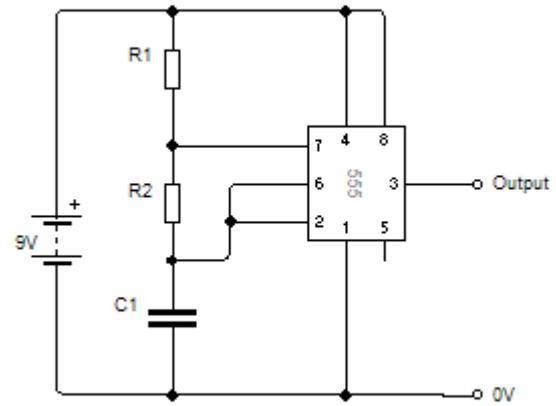


Voltage measured across capacitor when switch is pressed

### 555 Timer based astable circuit

The 555 timer IC was designed in 1970 by Signetics. Although it is over thirty years old it is still used due to its simplicity and versatility.

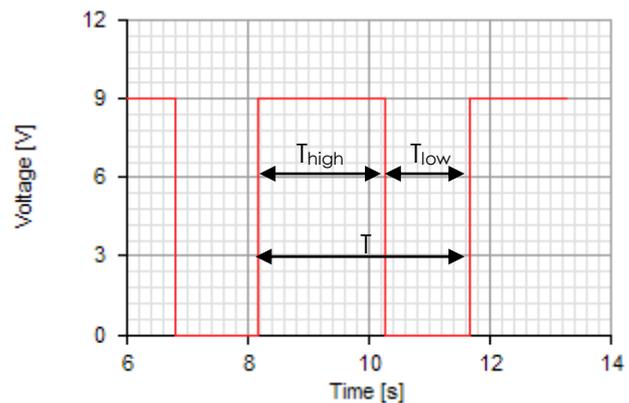
The circuit to the right shows how a 555 IC can be used to construct an astable multivibrator:



555 based astable multivibrator circuit

The graph to the right shows a possible output for the circuit above. The high pulse has been set to be longer than the low pulse.

The properties of the circuit's output can be calculated with the following formulae:



Possible output from 555 IC (approx 60% duty cycle)

$$F = \frac{1.44}{(R1 + 2R2) C1}$$

$$T_{high} = 0.69(R1 + R2) C1$$

$$T_{low} = 0.69(R2 \times C1)$$

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

$$\text{Duty cycle} = \frac{T_{high}}{T}$$

Where:

F = Frequency (Hertz)

T = Period (S)

T<sub>high</sub> = Length of time pulse is high (S)

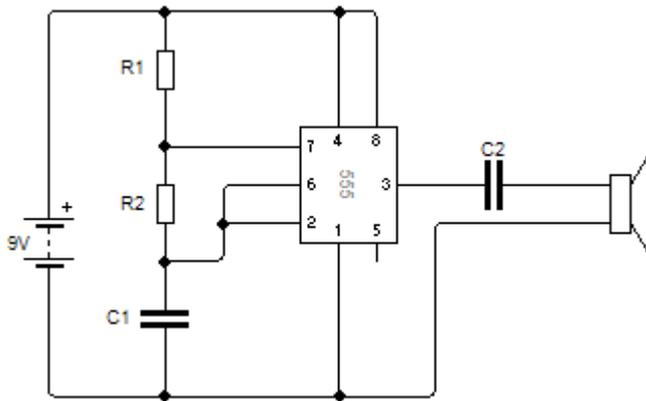
T<sub>low</sub> = Length of time pulse is low (S)

Duty cycle = Proportion of time the output is high irrelative to the whole time period.

### Tone generator circuit

An astable multivibrator can be used to drive a number of different output devices. The circuits below show some examples of astable applications.

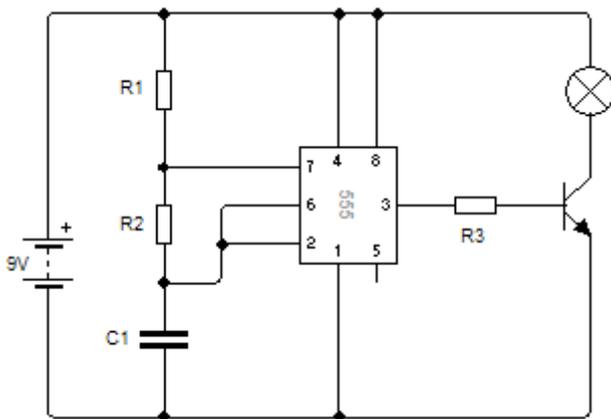
The first circuit shows how an astable circuit can be used to produce a tone from a speaker. The frequency of the tone is set by the values of the timing components R1, R2 and C1. C2 is used to block DC currents which could damage the speaker.



Circuit to produce a tone from a speaker

### Lamp flashing circuit

Adding a lamp to the output of the 555 timer can be used to make it flash at a rate determined by the timing components. The transistor may be omitted if the lamp is of low power.



Circuit to produce a tone from a speaker