Rewarding Learning

2.14 Timers – Astable

Learning Outcomes

You should be able to:

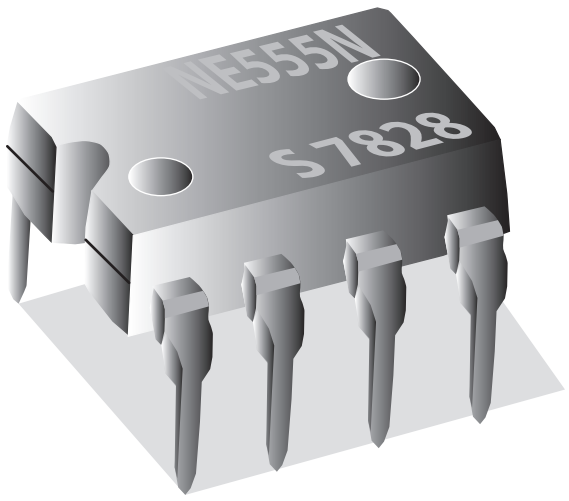
- demonstrate knowledge and understanding of the function and use of a 555 integrated circuit to provide astable outputs;
- interpret output waveforms for astable circuits;
- perform calculations using Period $T = \frac{1}{f}$;
- perform calculations for the output of an astable circuit using a 555 timer using;

  Frequency (Hz) = $F = \frac{1.44}{(R_1 + 2R_2)C}$

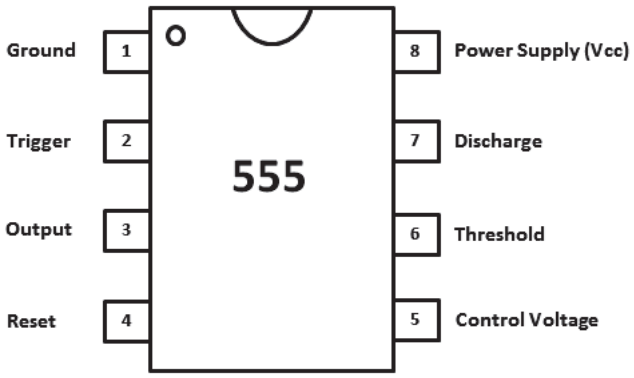
The 555 timer IC (integrated circuit) is very stable, relatively cheap and reliable. It may be used as monostable or astable. It has 8 legs, configured in DIL (Dual In Line) format. This means the numbers go down one side and up the other. We can recognise Pin 1 because it is the pin to the left of the notch. Some 555 timers will also have a dot beside pin 1 as shown below.

The 555 IC looks like the picture below, but it is in fact only about the size of your finger nail.

Image from: http://circuitdigest.com/article/555-timer-ic



The pin layout for a 555 timer

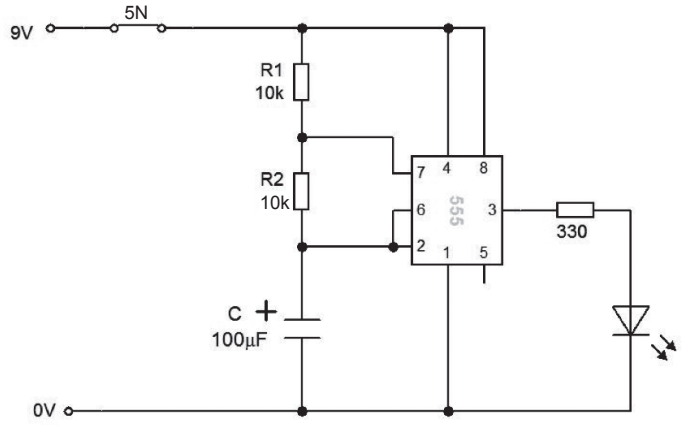


You are not required to learn the names on the pin layout shown above.

What does astable mode mean when is it used in a 555 timer circuit?

Astable means that the output is not stable in either the on or off state, but instead pulses on and off continuously. The frequency (number of pulses per second) is determined by the RC network connected to the 555 timer. This consists of the two 10K resistors and the 100µF capacitor. When an LED is connected to an astable timer, it gives a continuous flashing light. When set to a very high frequency and using a loudspeaker as an output a tone will be generated.

The diagram below shows how the 555 timer and components can be arranged to work in astable mode.



Points to note:

- On an astable timer, pins 2&6 are joined together;
- The 555 IC shows a different pin arrangement from the previous image. This is because the circuit diagram shows the electronic symbol for the 555;
- The single pole single throw switch Sw must be closed in order for the astable to work;
- In the arrangement shown the LED will flash continuously until the switch is opened again.

Astable Mode

The output of the 555 timer in astable mode continuously cycles through two output states- high and low or more commonly on and off. Looking at the circuit diagram, we can see that the trigger pin (Pin 2) is connected to the threshold pin (Pin 6).

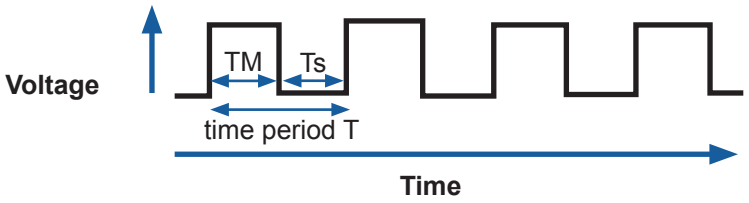
555 Astable:

- Astable refers to a system which has no stable state;
- An astable circuit produces a constantly changing output pulse until current is removed;
- The easiest way to recognise an astable circuit is if pins 2 and 6 are connected together;
- Pin 3 constantly changes from high to low switching the output on an d off in a flashing manner;
- The input switch should be a single pole single throw switch because a constant power source is required;
- These circuits can be used to flash lights and LEDs;
- The frequency of an astable circuit can be changed – this means how often and how long the output goes high and low for.

The Astable Waveform

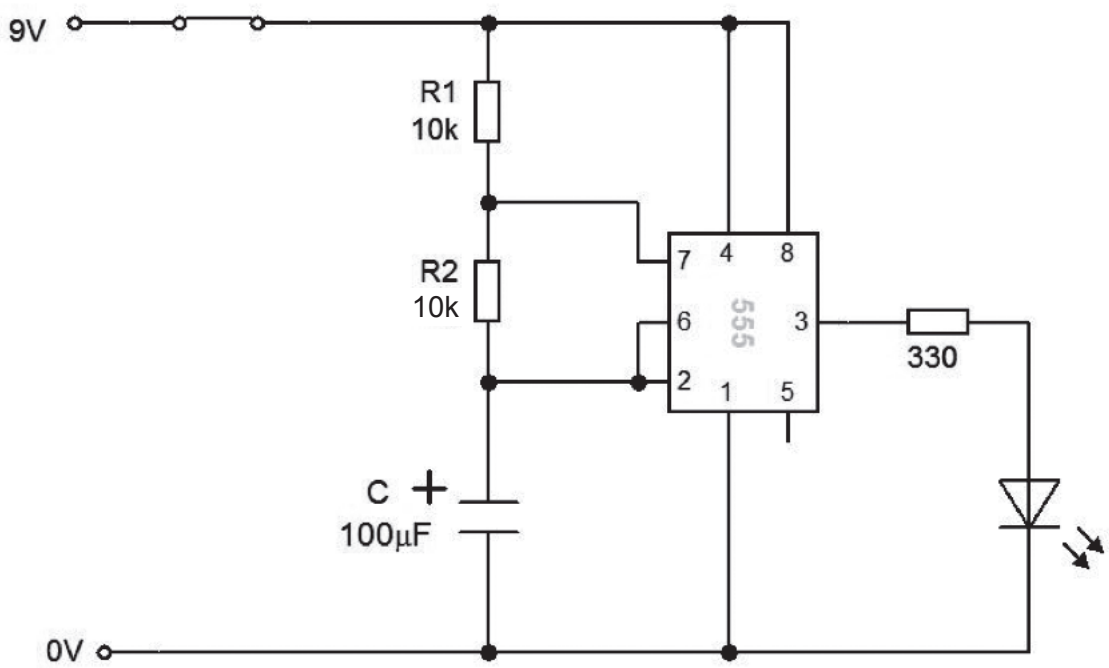
The Astable means that the 555 can operate repeatedly; it will switch on, then off, then on, then off, continuously. The 555 astable is sometimes called an oscillator or a pulse generator.

The output from Pin 3 of an Astable Timer looks like this:



555 astable output, a square wave
(Tm and Ts may be different periods of time)

An astable circuit produces a 'square wave'; this is a digital waveform with sharp transitions between low (0V) and high (+Vs). Note that the durations of the low and high states may be different. The circuit is called an astable because it is not stable in any state: the output is continually changing between 'low' and 'high'.



Time period and frequency

There is a connection between the time period and frequency of the output of an astable.

The time period (T) of the square wave is the time for one complete cycle, but it is often better to consider frequency (f) which is the number of cycles per second.

Time period example or period is given by the formula:

T= 1/f,

therefore frequency, f = 1/T

For the output of an astable circuit using a 555 IC timer frequency (Hz) is given by the formula:

$$f = \frac{1.44}{(R_1 + 2R_2) \times C_1}$$

In the circuit shown, R1 = 10k, R2 = 10k and C = 100 µF(microfarads). This gives:

f = 1.44 / (R1 + 2R2) × C = 1.44 / (10000 + (2 × 10000)) × 0.0001 = 0.48Hz

T = time period in seconds (s)
f = frequency in Hertz (Hz)
R1 = resistance in Ohms (Ω)
R2 = resistance in Ohms (Ω)
C1 = capacitance in Farads (F)

Revision Questions

June 2014 – Q.1

1 (a) With reference to integrated circuits what does DIL mean? Explain with the aid of a sketch how pin one can be identified.

DIL _____

Sketch

Identity of pin one _____

_____

2 Potential divider circuits form part of timing circuits.

(i) Explain what an astable output is

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(ii) Calculate the output frequency in Hertz of a 555 timer astable for which R1 = 10k, R2 = 68k and C = 10 µF

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