FACTFILE:
GCSE Technology and Design

OPTION A:
ELECTRONIC AND MICROELECTRONIC CONTROL SYSTEMS

Rewarding Learning

2.14 Timers – Monostable

Learning Outcomes

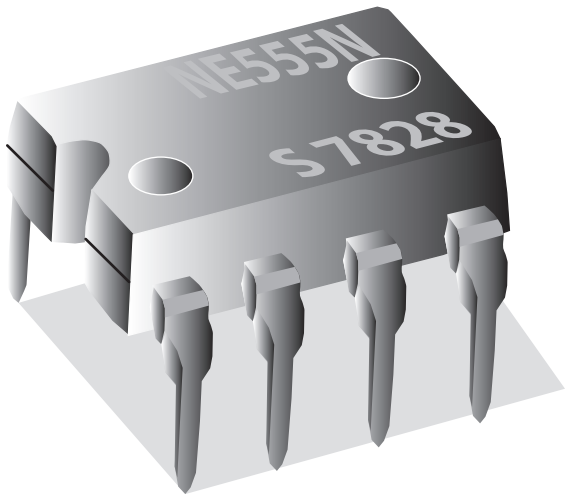
You should be able to:

- demonstrate knowledge and understanding of the function and use of a 555 integrated circuit to provide monostable outputs;
- interpret output waveforms for monostable circuits;
- perform calculations for the output of a monostable circuit using a 55 timer, using: Time T = 1.1 x C x R

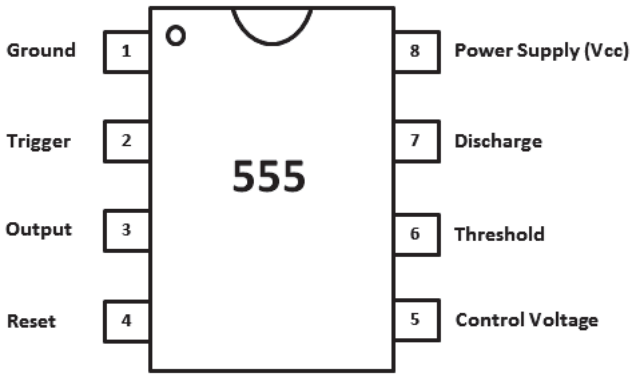
The 555 timer IC (integrated circuit) is very stable, relatively cheap and reliable. It may be used as monostable or astable. It has 8 legs, configured in DIL (Dual In Line) format. This means the numbers go down one side and up the other. We can recognise Pin 1 because it is the pin to the left of the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

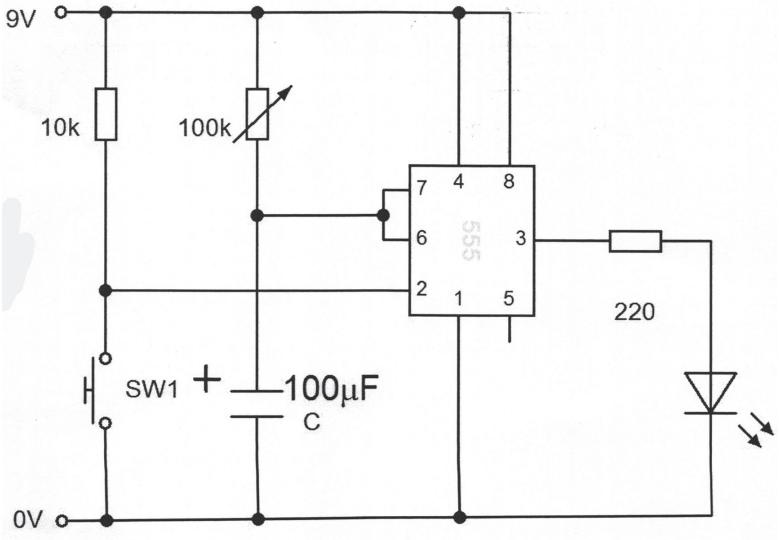


You are not required to learn the names on the pin layout shown above.

What is a monostable and when is it used in a 555 timer circuit?

Monostable means that once the circuit is switched on it will time once and then stop (mono means one). In order to start it again it must be switched on manually a second time. In this way it can be used to produce time delays.

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



Points to note:

- On a monostable timer, pins 6 and 7 are joined together.
- The VR and capacitor control the time delay. The time delay can be changed by adjusting the VR and/or charging the valve of the capacitor.
- 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.

Electronic timers are used as a process device in many school projects. These circuits can be adapted to suit many purposes in timer circuits. There are several reliable IC timers but the 555 timer is the most common. Whether you are putting together an alarm or a circuit to activate a computer, a timer is the common component.

In the monostable mode, the 555 timer acts as a “one-shot” pulse generator. The pulse begins when the 555 timer receives a signal at the trigger (pin 2) input that falls below a third of the voltage supply. The duration of the output pulse is determined by the time constant of an RC network, which consists of a capacitor (C) and a resistor (R) connected in series. The output pulse ends when the voltage on the capacitor equals 2/3 of the supply voltage. The output pulse width can be lengthened or shortened to the need of the specific application by adjusting the values of the RC network.

To summarise:

A monostable circuit produces a single output pulse when triggered. It is called a monostable because it is stable in just one state: 'output low'. The 'output high' state is temporary.

These circuits can be used to turn on lights and LEDs etc.

The easiest way to recognise a monostable circuit is if pins 6 and 7 are connected together.

When the switch is pressed PIN 2 goes low.

PIN 3 then goes high switching on the output.

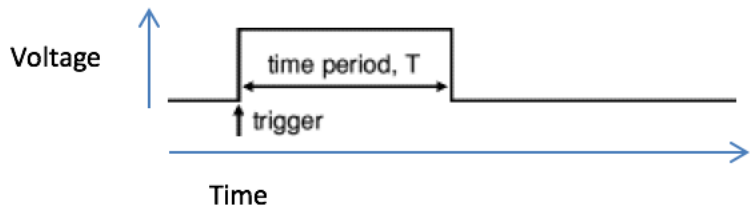
The current then can flow from the +9v to the 0v turning on the output

After a period of time the output goes low and stays low. The LED is off.

The Monostable Waveform

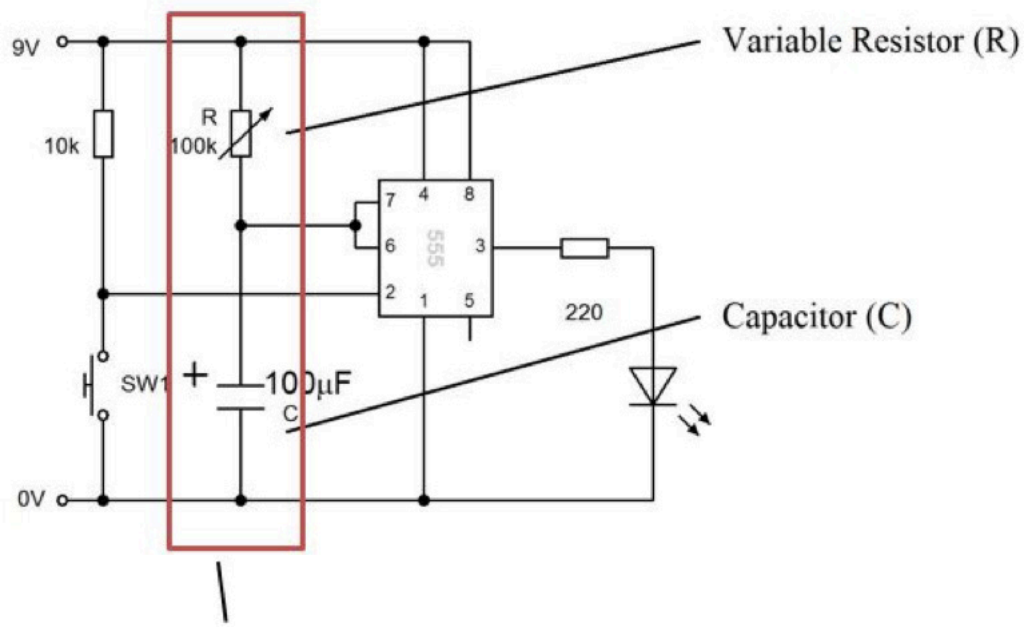
The monostable is a "one-shot" pulse generator. What this means is that once the input switch is pressed, pin 2 (the trigger) sends a signal to pin 3 (the output) and it goes high for a period of time. The time it goes high for is determined by the RC network.

The monostable waveform looks like this:



This waveform represents what is happening at Pin 3, once the switch is pressed. pin 3 immediately goes high for a period of time (T) and then returns to low again.

Look at this monostable circuit again:



The section above is called the RC network; it has a resistor (in this case a variable resistor) and a capacitor in series.

With reference to the waveform, this would mean that once the push switch is pressed, pin 2 immediately goes low and at the same time Pin 3 immediately goes high. When 3 goes high, the LED shown in the diagram above, will turn on for the timed period. The variable resistor VR1 can be used to increase or decrease the timing cycle.

The Timed Period

At this stage, it would be worthwhile to have some understanding of how the timed period is worked out. The duration of the pulse is called the **time period** (T) and this is determined by resistor R and capacitor C:

For the output of a monostable circuit using a 555 timer, Time (T) is given by the formula;

T = 1.1 × C × R

T = time period in seconds (s)
R = resistance in Ohms (Ω)
C = capacitance in Farads (F)
The maximum reliable time period is about 10 minutes.

Worked example:

Question:

A monostable 555 timer has the following component values: R is 100K and C is 100 microfarads. Calculate the length of time that the timer will stay on.

Answer:
Time on = 1.1 × 100000 × 0.0001 = 11 seconds

Past Paper Questions

June 2014 – Q.1d

(d) Potential divider circuits form part of timing circuits as shown in **Fig. 5**. A timing circuit produces either an astable or monostable output.

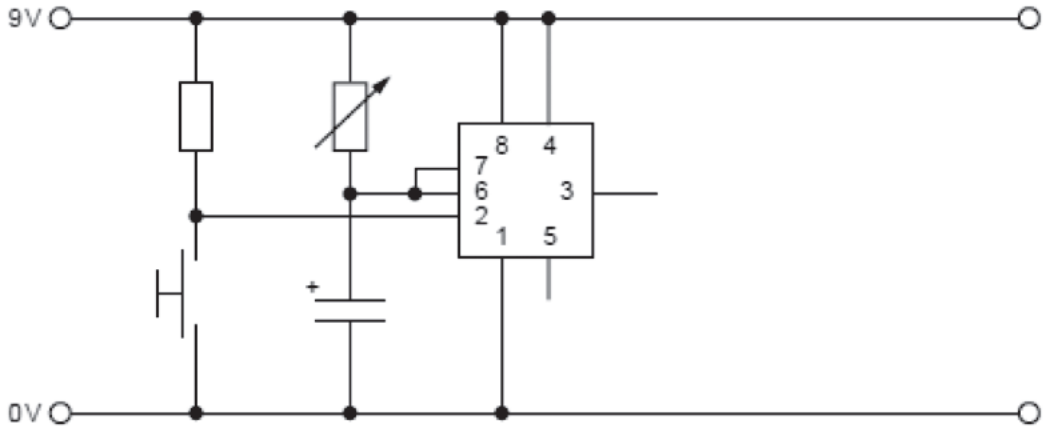


Fig. 5

(i) Explain what an astable output is and what a monostable output is.

Astable output _____

_____

_____ [2]

Monostable output _____

_____

_____ [2]

(ii) Does the circuit in **Fig. 5** produce a monostable or an astable output?

_____ [2]

(iii) Name the integrated circuit (IC) component used in the circuit to provide the output.

_____ [1]

(iv) Outline what is meant by the term time constant.

_____

_____ [2]

(v) Use the capital letters **A** and **B** to clearly mark on **Fig. 5** the two components used to provide the time constant. [2]

(vi) Name the **two** components used in the circuit to provide the time constant.

_____ [2]

(vii) Outline how the time constant in this circuit can be changed.

_____

_____ [2]

(viii) An LED is to be fitted in the circuit to indicate when the output is high. Complete the circuit in **Fig. 5** so that the LED will operate as described. [6]