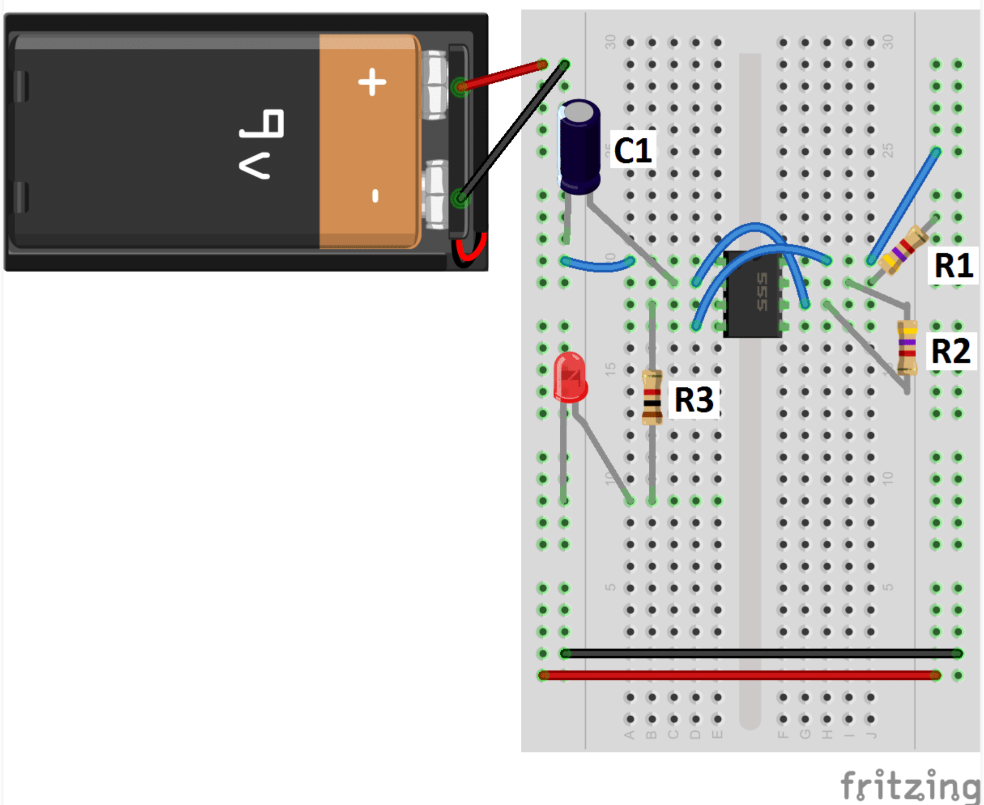
ASTABLE MODE

Posted by Scott Campbell | DIY Electronics | 38



This is part 3 of a series of articles on the 555 timer. Part 1 goes into more detail about the pins and how the chip functions, so you might want to start there if you haven't read it already: 555 Timer Basics – Monostable Mode.

ASTABLE MODE OF THE 555 TIMER

The astable mode is what most people think of when it comes to the 555 timer. Many times when you see a project with flashing LEDs, it's a 555 timer at work. But it has a lot of other interesting applications too. For example, it can also generate frequencies to produce sound when the output is connected to a speaker. It can even be used as a simple analog to digital converter (ADC).

BONUS: I made a quick start guide for this tutorial that you can download and go back to later if you can't set this up right now. It includes all of the wiring diagrams and instructions you need to get started.

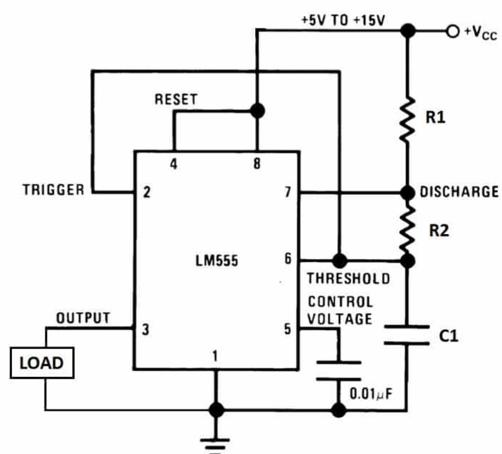
In astable mode, the 555 timer acts as an oscillator that generates a square wave. The frequency of the wave can be adjusted by changing the values of two resistors and a capacitor connected to the chip. The formulas below will tell you the length of the output's on and off cycles with different resistors and capacitors:

$$t_{on} = 0.69 \times C1 \times (R1 + R2)$$
$$t_{off} = 0.69 \times C1 \times R2$$

$$t_{on}: \ Length\ of\ high\ output\ pulse\ in\ seconds$$
$$t_{off}: \ Length\ of\ low\ output\ pulse\ in\ seconds$$
$$R1: \ Resistance\ of\ R1\ in\ Ohms$$
$$R2: \ Resistance\ of\ R2\ in\ Ohms$$
$$C1: \ Capacitance\ of\ C1\ in\ Farads$$

With this equation, you can see that increasing the values of either C1 or R2 will increase both the time the output stays on and the time it stays off. Increasing the value of R1 will only lengthen the time the output stays on.

HOW ASTABLE MODE WORKS



- *Pin 2 – Trigger*: Turns on the output when the voltage supplied to it drops below 1/3 of Vcc
- *Pin 6 – Threshold*: Turns off the output when the voltage supplied to it reaches above 2/3 Vcc.
- *Pin 7 – Discharge*: When the output voltage is low, it discharges C1 to ground.

In astable mode, the output cycles on and off continuously. In the schematic above, notice that the threshold pin and the trigger pin are that the threshold pin and the trigger pin are connected to C1. This makes the voltage the same at the trigger pin, threshold pin, and C1.

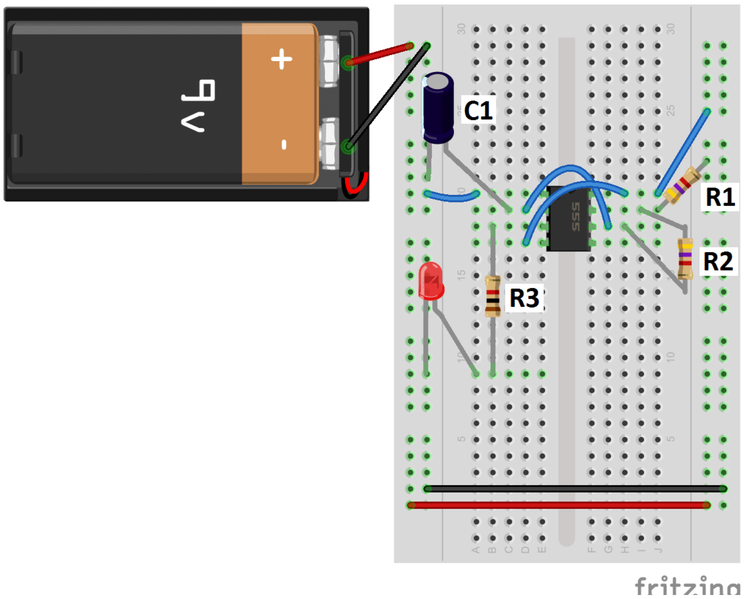
At the beginning of an on/off cycle, the voltage is low at C1, the trigger pin, and the threshold pin. Whenever the trigger pin voltage is low, the output is on, and the discharge pin is off. Since the discharge pin is off, current can flow through resistors R1 and R2, charging capacitor C1.

Once C1 charges to 2/3 Vcc, the output is switched off by the threshold pin. When the output goes off, the discharge pin switches on. This allows the charge accumulated on capacitor C1 to drain to ground.

Once the voltage across C1 drops to 1/3 Vcc, the trigger pin turns off the discharge pin, so C1 can start charging again.

A BLINKING LED CIRCUIT

To observe the 555 timer in astable mode, let's build a circuit that uses the 555 timer's oscillating output to make an LED flash on and off:

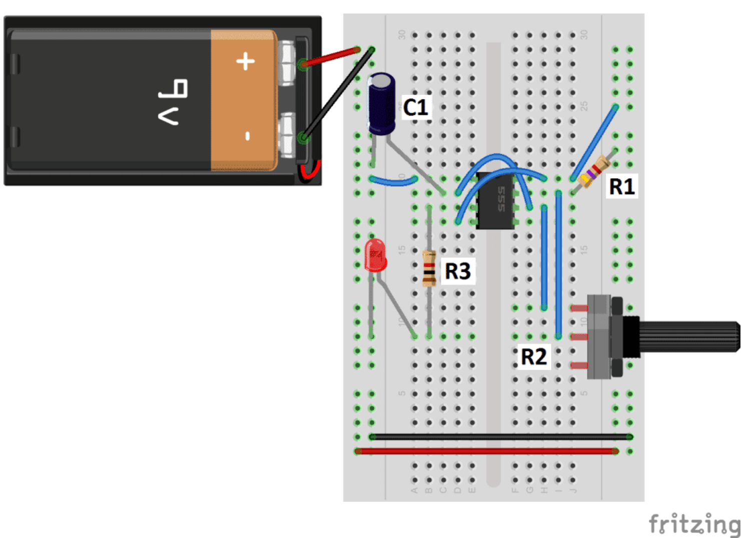


- R1: 4.7K Ohm resistor
- R2: 4.7K Ohm resistor
- R3: 1K Ohm resistor
- C1: 100 µF capacitor

The values of R1, R2, and C1 affect the speed of the blinking. Larger values will make the LED blink slower, while smaller values will make the LED blink faster. Resistor R3 is just there to limit the current to the LED so it doesn't burn out. If you want to set the blinking to a certain speed, you can use the formula at the beginning of this article to calculate the resistance or capacitance you need.

BLINKING LED CONTROLLED BY A POTENTIOMETER

An easy way to observe the effect of resistance on the blinking speed is to use a 10K Ohm potentiometer for R2:



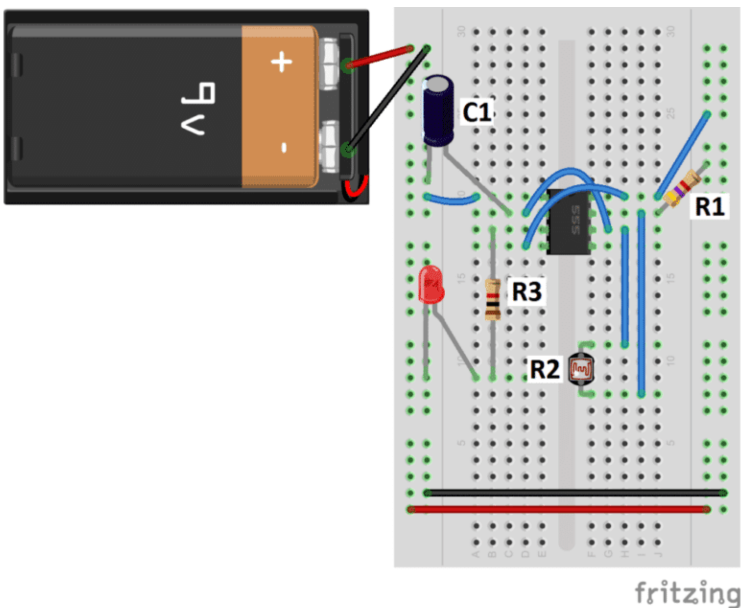
- R1: 4.7K Ohm resistor
- R2: 10K Ohm potentiometer
- R3: 1K Ohm resistor

- R3: 1K Ohm resistor
- C1: 100 μF capacitor

Adjusting the potentiometer will change the rate of the LED flashing.

BLINKING LED CONTROLLED BY A PHOTORESISTOR

Instead of using a potentiometer to control the blinking rate, try connecting a photoresistor:



- R1: 4.7K Ohm resistor
- R2: Photoresistor
- R3: 1K Ohm resistor
- C1: 100 μF capacitor

The resistance of a photoresistor decreases as more light shines on it, so the LED will flash more quickly when exposed to more light.

If you want to learn more about the 555 timer, the book Timer, Op Amp, and Optoelectronic Circuits and Projects Book Vol. 1 By Forrest Mims is a great resource to have on your bench.