Electrified Session 4: 555 Timer IC

October 2, 2006

The 555 is an integrated circuit (chip) implementing a variety of timer and multivibrator applications. The 555 timer is one of the most popular and versatile integrated circuit chips ever produced. This IC even 40 years after it was first made, remains popular for generating pulses in analog circuits.

The following figure shows the pin diagram of this IC. Generally, you don't need to know the detailed functions of the pins to get elementary 555 circuits working.

555 circuits

In general, a multivibrator is an electrical component used to implement a variety of simple two-state (high and low) systems such as oscillators and timers. The 555 IC uses external resistors and capacitors to generate timing and for control of the output. Multivibrators are of three types depending on the number of stable states.

The Astable Multivibrator

These circuits are not stable in any state and switch outputs after predetermined time periods. The result of this is that the output is a continuous square wave with the its properties depending on values of external resistors and capacitors. Thus, while designing these circuits following parameters need to be determined.

- Frequency (or the time period) of the wave.
- The duty cycle of the square wave.

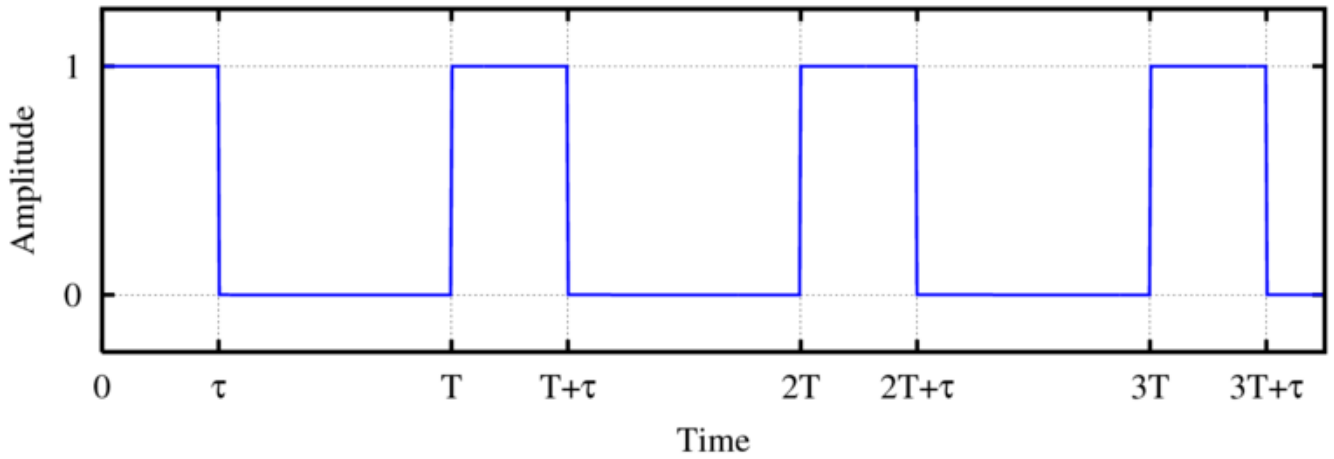

Figure 1: A typical square wave

Referring to the above figure, the time period is defined the time T. Duty cycle in defined as the On time/Period that is, τ/T in the above figure. The following circuit can be used to create an astable multivibrator.
Design formulas are as given below.

$$f = \frac{1.44}{(R_1 + 2R_2)C} \tag{1}$$

$$\text{High Time} = .69C(R_1 + R_2) \qquad \text{and} \qquad \text{Low Time} = .69CR_2 \tag{2}$$

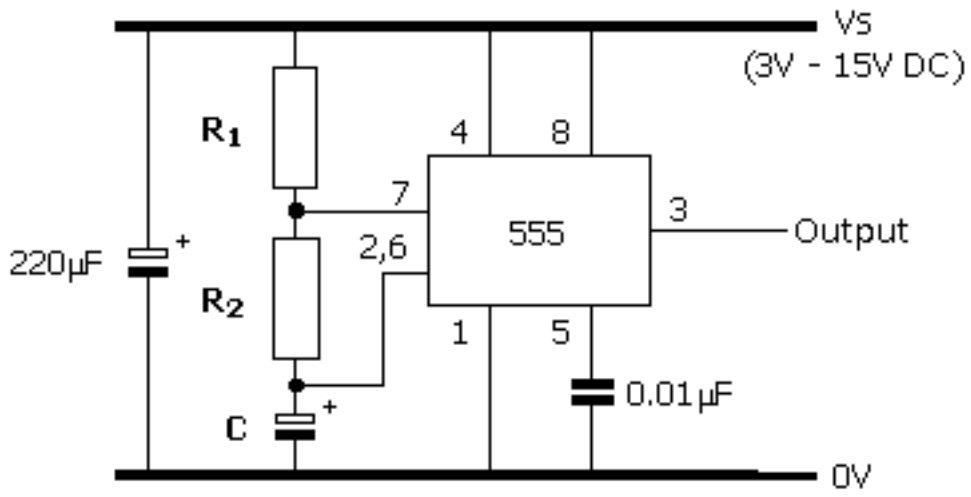

Figure 2: The 555 astable circuit

The Monostable Multivibrator

These circuits are stable only in one of the two states, not in the other. When no external trigger is present, the output stays at the stable state. When an external trigger is given to the IC, the output switches to the unstable state but it stays there *only* for a predetermined time. After that is falls back to the stable state. Thus following questions need to be answered while designing these circuits.

- How can the circuit be triggered to produce an output pulse?
- How is the duration, or period (t) when the output is at the unstable state, determined?

The following circuit is used to run 555 in a monostable mode.

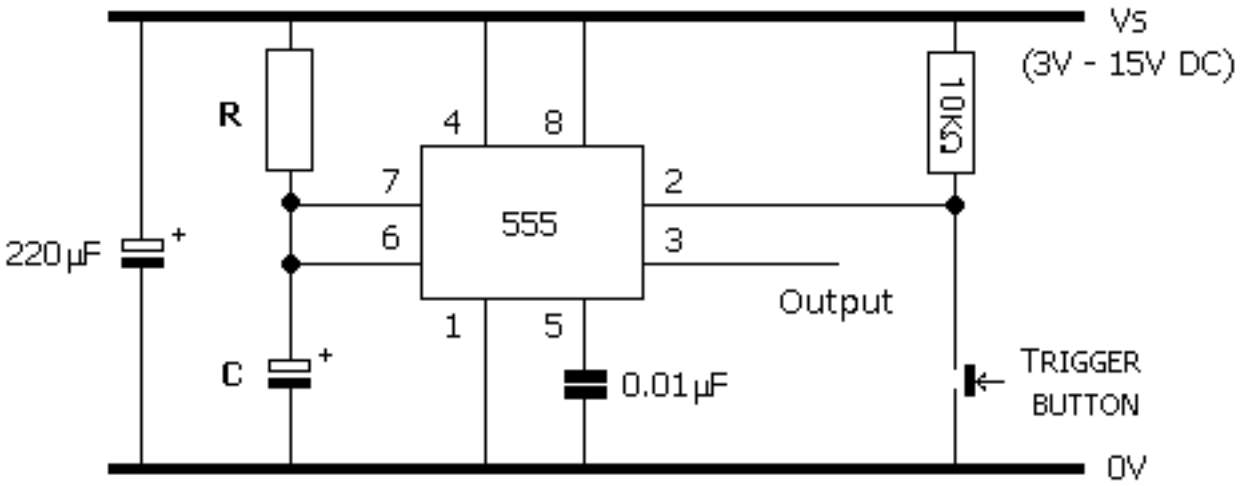

Figure 3: The 555 monostable circuit

Notice that, in the circuit, the trigger pin 2 is always kept high by the 10 kΩ resistor. When the switch is pressed the pin is grounded and this falling edge triggers the circuit. Also,

$$t = 1.1(RC) \tag{3}$$

The Bistable Multivibrator

In these circuits, the output is stable in both the states. The states are switched using an external trigger but unlike the monostable multivibrator, it does not return back to its original state. Another trigger is needed for this to happen. This operation is similar to a flip-flop. There are no design parameters in this output and hence the following circuit can be used.

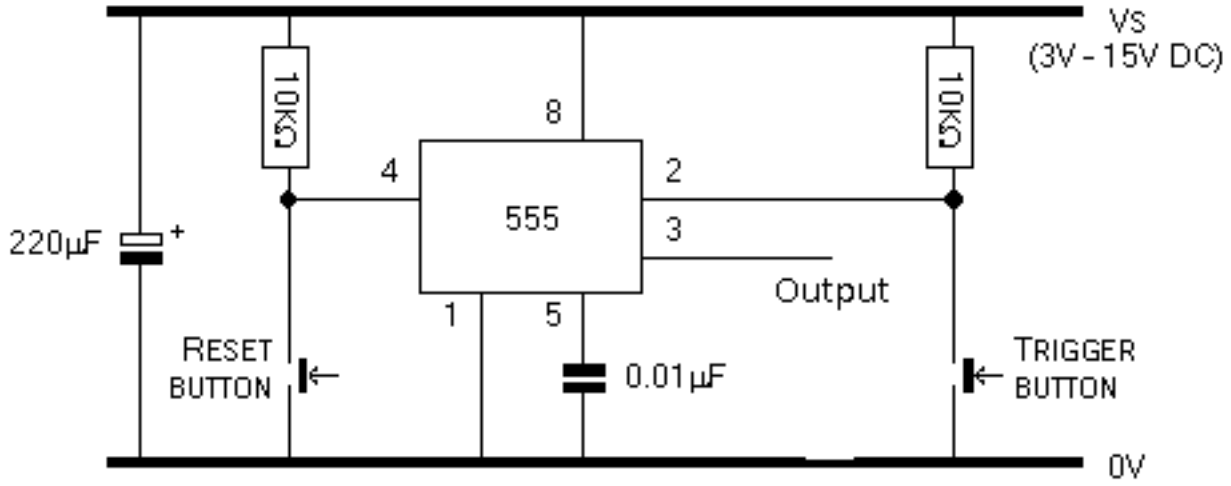

Figure 4: The 555 bistable circuit

TSOP: An application of 555 timer IC

An application of 555 timer ICs is presented here is in infra-red detection. TV remote controls use infra-red transmitters and recievers. A simple IR reciever is sensitive to noise, that is it is possible that the reciever picks up strat IR signals that were not sent by the transmitter. To get around this problem, a technique called modualation is used. The transmitter does not send continous signals. Instead, it switches the signal on and off at a particular frequency (38 kHz in case of most IR sensors). The reciever is tuned to recieve signals only in a small frequency band around this particular frequency. This makes sure that constant or randomly fluctuating IR signals are not accepted by the reciever.

TSOP 1738 is an example of such a reciever. It gives a output high if a modulated IR signal at 38 kHz is detected, low otherwise. Hence, it is required to make a transmitter that turns itself on or off at this frequency. This can be implemented using a a simple IR led and a square wave generated by a 555 timer. Can you think of a circuit to do this?