SERVO MOTOR CONTROLLING 555 TIMER

In this project, we are making a "Servo Motor Controller using 555 Timer IC". A servo motor is an "actuator" that is used to control the angular position, velocity, and acceleration. Servo motor operates at the "PWM" principles, which implies its angle of rotation is constrained by the span of the pulse applied to its "Control PIN". Fundamentally servo engine is comprised of a DC motor that is constrained by a variable resistor which is known as a "Potentiometer" and a few gears.

We can make a servo motor controller circuit with different strategies but here we are using a simple method for making this basic servo controller circuit in which the primary component is a 555 timer IC. A servo motor is an extremely proficient DC motor that is constrained by electrical signals.

COMPONENTS REQUIRED

S. No	Component	Value	Qty
1	Resistor	10K, 240K	1, 1
2	555 Timer IC		1
3	Variable resistor	50K	1
4	Ceramic Capacitor	120nF, 10nF	1, 1
5	DC Supply	6V	1
6	Diode	1N4148	1

Why Servo Motors?

Servo Motors are used in a variety of fields. These are mainly used as actuators in those areas where we need a precise movement to control output load. The best example is an RC car. Let's see you want a movement of 45 degrees, not more not less. In that case, you can't use a simple DC motor because it will overshoot the desired position every time you power it up. And thus we need a Servo Motor to achieve this task as it will not only make a precise 45-degree rotation but will also stop smoothly at the desired position.

There are many types of servo motors and their main feature is the ability to precisely control the position of their shaft. A servo motor is a closed-loop system that uses position feedback to control its motion and final position.

Technicalities of a Servo Motor

A servo motor is made up of three key components:

- A DC motor
- Gearbox
- Potentiometer, either analogue or Digital
- Control circuit

There are total 3 wires that come out of a Servo Motor:

RED: To positive of the supply

BLACK: To negative of the supply

ORANGE OR YELLOW: Connected to a reference voltage i.e., a PWM source

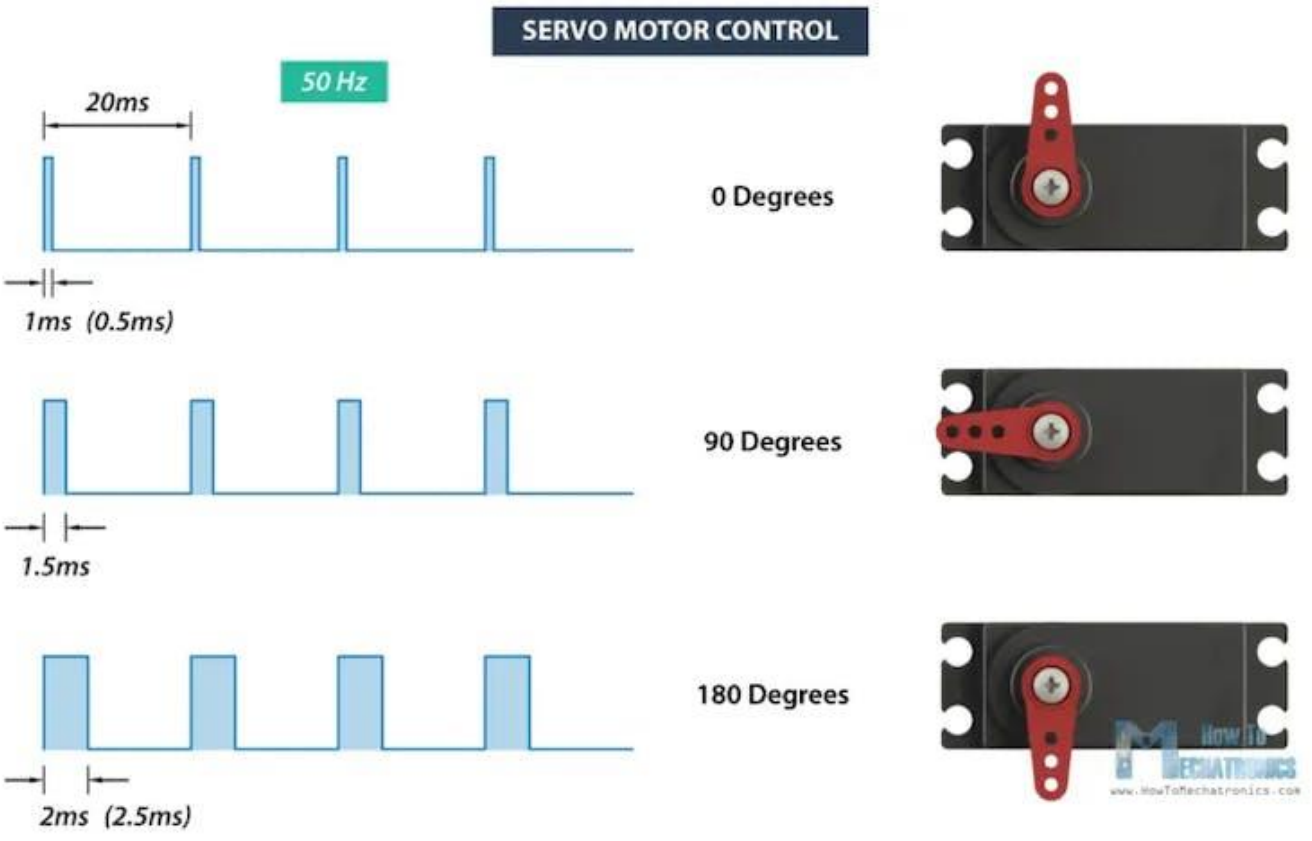
Servo Motor can rotate 90 degrees in either direction, covering a maximum of 180 degrees i.e., either 90 degrees clockwise or 90 degrees anticlockwise from its neutral position.

How does it work?

The DC motor is a high speed and low torque but the gearbox reduces the speed to around 60 RPM and at the same time increases the torque.

The potentiometer is attached to the final gear or the output shaft, so as the motor rotates the potentiometer rotates as well, thus producing a voltage that is related to the absolute angle of the output shaft. In the control circuit, this potentiometer voltage is compared to the voltage coming from the signal line. If needed, the controller activates an integrated H-Bridge which enables the motor to rotate in either direction until the two signals reach a difference of zero.

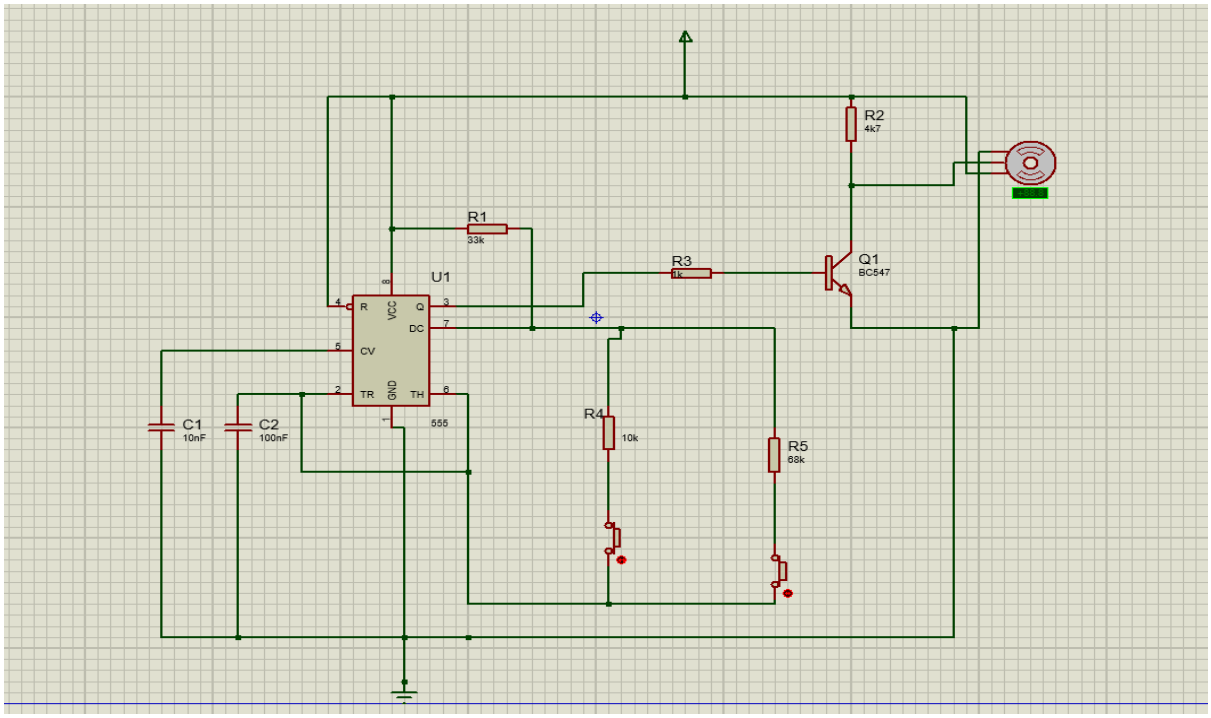
A servo motor is controlled by sending a series of pulses through the signal line. The frequency of the control signal should be 50Hz or a pulse should occur every 20ms. The width of the pulse determines the angular position of the servo and these types of servos can usually rotate 180 degrees (they have a physical limit of travel).



Generally, pulses with 1ms duration correspond to 0 degrees position, 1.5ms duration to 90 degrees and 2ms to 180 degrees. Though the minimum and maximum duration of the pulses can sometimes vary with different brands and they can be 0.5ms for 0 degrees and 2.5ms for 180 degrees position.

Controlling the Servo Motor using 555 Timer

Usually, a microcontroller like Arduino is used to control the servo motor. But, for the basic understanding of the working of the servo motor, we will use a 555 timer here.



Servo motors are controlled by using a PWM (Pulse Width Modulated) signal as their input. You may refer to this project: LED Dimmer and DC Motor Speed Controller Circuit Using PWM Technique for understanding how 555 timer IC can be used to generate PWM signal. It also explains how the ON time of each PWM pulse can be adjusted.

The position of the servo arm depends on the width of ON time (High pulse) of the input PWM signal. Generally, if we set the width of ON time to 1ms, the servo arm moves to 0 degree position. If we set the width of ON time to 3ms, the servo arm moves to 180 degree position.

The width of OFF time (Low Pulse) is maintained constant at around 18ms. In this circuit, 56K & 10k are used to alternate between two ON pulse widths corresponding to 0 degrees and 180 degrees. So clicking one button moves the servo arm to 0 degrees and the other moves the servo arm to 180 degrees.

The servo motor that we use in this project is easily available near you and it can rotate 90 degrees in both clockwise and anti-clockwise directions from its neutral position. so, to control the servo motor with 55 timer we use the pwm signals. When you press the pushbutton for forwarding movement then **PWM** signals are generated and the transistor starts conducting to the signal pin of the servo motor.

When the capacitor is fully charged the transistor stops conducting. If the backward pushbutton is pressed then PWM signals are generated at the reference pin of the motor and the shaft rotates in the anti-clockwise direction. this is how the servo motor 555 timer works.

In both cases, the frequency is between 40 to 60 Hz. You can also check the LED flasher lights that we made by using 555 timer ic.

Applications and Uses

The Servo motor controllers are used in:

- Printers
- Solar tracking devices
- Robots
- Antenna positioning frameworks
- Cameras and numerous other modern applications.

How the Circuit Works

The design employs a 555 oscillator/timer arranged in an astable mode to produce the correct PWM, in accordance with the adjustment of potentiometer R4.

A normal 555 astable circuit's working frequency and pulse width will vary when the value of one of the timing resistors is adjusted. Additionally, the proposed 555 pwm controller circuit allows for independent regulation of the duty cycle or pulse/space ratio without changing the frequency.

To accomplish this, two distinct channels are provided for the charging and discharging process of C1.

Capacitor C1 charges as soon as the supply DC is switched ON through R1, D2, and half of R4. When C1 charges to a level of 4V (two-thirds of the supply voltage), the IC 555 output switches state.

This causes pin 7 to go low. With pin7 at low or 0V, capacitor C1 starts discharging via the other half of R4, R3, D1, and R2.

The internal flip-flop of the IC changes state yet again as soon as the voltage across C1 drops to 2 volts.

This causes pin#7 to go high. Due to this the capacitor once again initiates its charging process.

Thus, adjusting R4 modifies the charge and discharge rates in complimentary ways, keeping the total cycle duration and frequency constant.

The circuit works at around 55 Hz and has a roughly 10% duty cycle with the component values as indicated in the diagram. The servo may rotate over its whole range of 180 degrees by adjusting R4 along an arc of 60 degrees.

The user can choose and experimentally discover the potentiometer's position in relation to the servo's motion. The circuit has been built so that the total of R2, R3, and R4 is almost equivalent to 100k. This enables the user to adjust the value of R4 for achieving the desired operating characteristics.

R2 and R3 offer a minimum amount of resistance in the discharge path. This ensures that the circuit is not harmed when R4 is adjusted to minimum.