

### OBJECTIVES

This lab will introduce you to the concept of using your microcontroller to control a servo via user input. You will be introduced to pulse width modulation (PWM) and the specific pulse duration that most servos utilize. Using the UART, users will control the angle of the servo. Next, a CDS cell or potentiometer or IR sensor will be used to control the position of the servo.

**This Lab expects that you have completed the first two labs and have acquired your own microcontroller board.**

### REQUIRED MATERIALS

- Microcontroller board
- Wire Jumpers
- Breadboard
- CDS cell or potentiometer or IR sensor
- Oscilloscope (if needed)
- Multimeter (if needed)

### DISCUSSION

In this section we will describe what a PWM signal is and how to use a PWM to control a servo.

### PWM

PWM is a method that microcontrollers use to create an analog signal using digital I/O pins. The microcontroller switches a pin on and off at a selected frequency creating a square wave. Depending on the microcontroller's output pin voltage, the height of the square wave is usually 5V or less. Changing the on off time can simulate voltages from 0V to the maximum output pin voltage. For instance, if the output pin voltage is 5V and you have a 50% duty cycle, the apparent output voltage would be 2.5V.

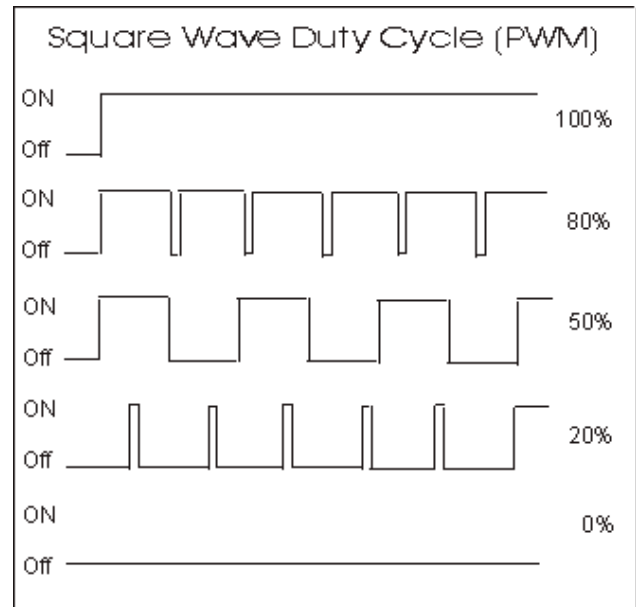


Figure 1 Graphs showing various duty cycles.

### Servo Control

Servos come in different shapes and sizes. While mechanically different, most are controlled using the same communication protocol. Using PWM signals of variable width at a fixed frequency, the movement of a servo can be controlled. Most servos expect to receive a signal every 20 ms or 50 Hz. During the 20 ms signal, the pin will be high for only 1 to 2 ms. The duration of the pulse dictates the servo position where 1 ms points the servo to the extreme left and 2 ms points to the extreme right. A duration in between keeps the servo pointed somewhere between the two extremes. The diagram below shows how the pulse duration changes the position of the servo.

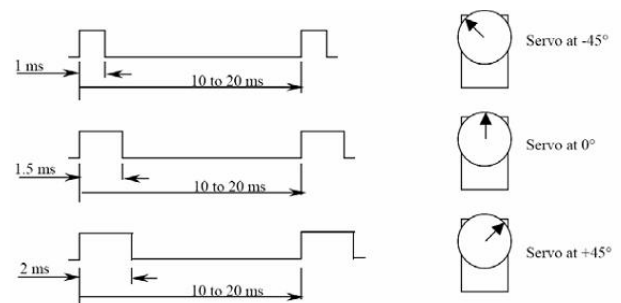


Figure 2 Diagram showing pulse duration vs. servo position.

The 20 ms PWM used to drive servos can also be used to drive an assortment of actuators such as motor controllers, electronic speed controllers, vehicle steering, vehicle throttle, ect...

## LAB PROCEDURE

### Connecting the Servo

Using wires, breakout the servo connector to a breadboard. Before powering your board and power supply, connect the power supply (5-6V) to the center (red) wire, GND to the (brown) right wire, and your microcontroller's PWM pin to the (orange) left wire. Ensure that you have a common ground between your servo and microcontroller. Failure to have a common ground will result in erratic behavior of the servo rendering it uncontrollable.

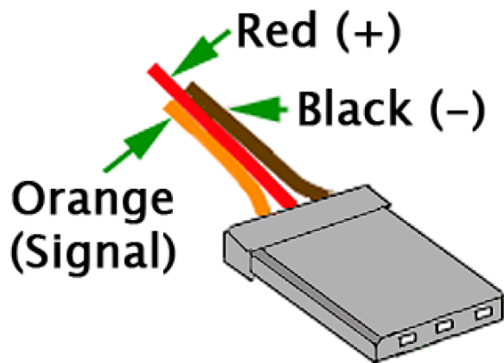


Figure 3 Pin out of a servo.

Turn on your microcontroller and power up your servo. The servo should not move. You are now ready to program your board.

### Programming the Board

Before you begin moving the servo, setup your UART for two way communication (baud rate 9600). A good method to test your communication is to use a debug LED. Have the LED turn on when the microcontroller reads an "a" in the serial port. Have the microcontroller turn off the LED when "s" is received. Having the microcontroller echo the user entered character in the terminal window is also acceptable.

Now that your serial port is working we can begin utilizing the servo. Either making your own PWM servo signal or using a servo library, have the servo start at the extreme left (1 ms). Next check the UART for user input. An "s" will move the servo to the extreme right. If the user enters an "a", have the servo move to the extreme left position.

After you've completed the UART portion of the lab build the below circuit using one CDS cell and a resistor. The ADC pin will be connected in between both components.

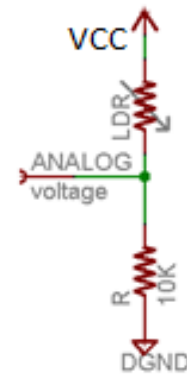


Figure 4 CDS cell in series with 10K resistor

Display the ADC value in a terminal window. Next, have the servo change its position in relation to the amount of ambient light detected by the ADC (proportional). For example, when the CDS cell is completely covered, the servo moves to the extreme left. As your hand moves away from the CDS cell, the servo slowly pans to the right until it hits the extreme.