

Electronics Technology and Robotics III

Control and Navigation 11 – Servos

- **Administration:**
 - Prayer
- **Servos:**
 - Introduction: A servo is a small device that incorporates a three wire DC motor, a gear train, a potentiometer, an integrated circuit, and an output shaft bearing (Figure 1). Of the three wires that stick out from the motor casing, one is for power, one is for ground, and one is a control input line. The shaft of the servo can be positioned to specific angular positions by sending a coded signal. Most servos have an angular position range of 180 degrees (check your servo). As long as the servo receives the coded signal on the input line, the servo will maintain the angular position of the shaft. If the coded signal changes, then the angular position of the shaft changes. Typically, a servo is used in hobby applications such as controlling steering for an RC (radio-controlled) car or the rudder for an RC airplane.

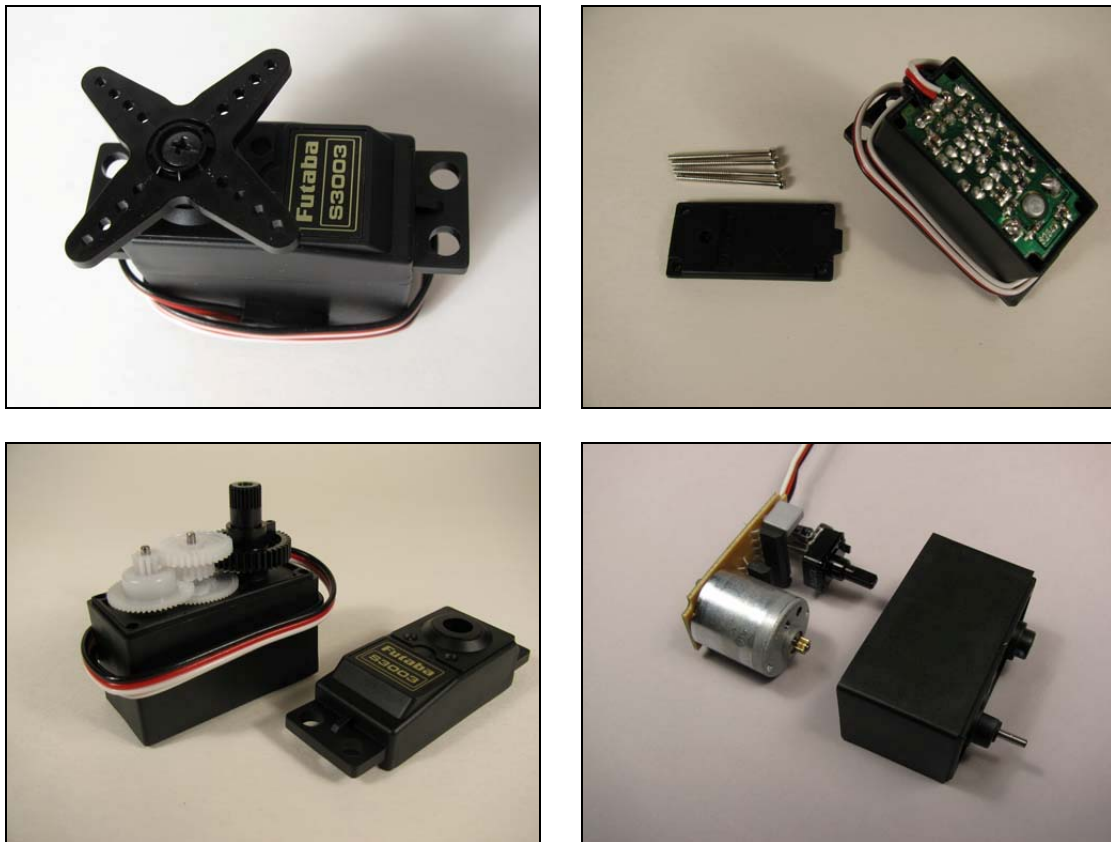


Figure 1: Hobby Servo in Various Stages of Disassembly

- When servos are commanded to move, they will move to the position and hold that position. If an external force pushes against the servo while the servo is holding a position, the servo will resist from moving out of that position. The maximum amount of rotational force the servo can exert is the torque rating of the servo.

- The potentiometer allows the control circuitry to monitor the current angle of the servo motor (Figure 2). The motor, through a series of gears, turns the output shaft and the potentiometer simultaneously. The potentiometer position is fed back into the servo control circuit and when the control circuit detects that the position is correct, it stops the motor. If the control circuit detects that the angle is not correct, it will turn the motor the correct direction until the angle is corrected.

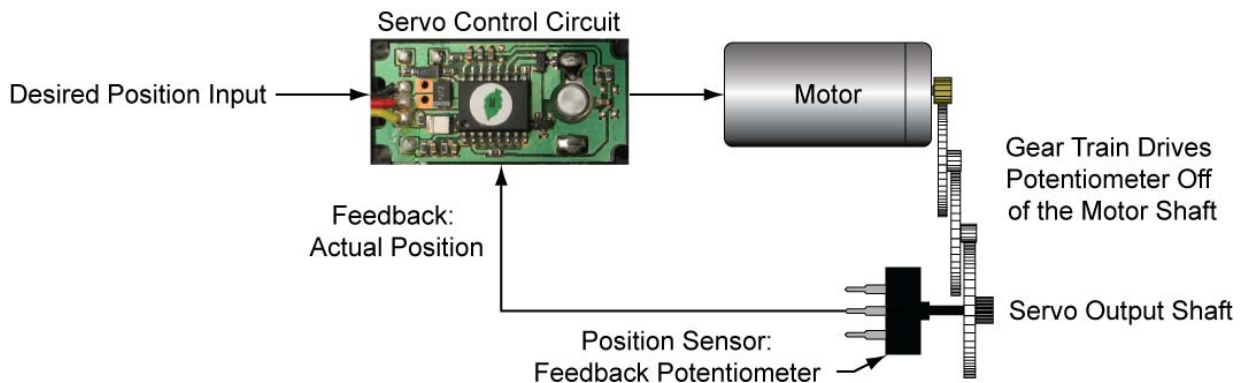


Figure 2: Feedback Circuitry in a Servo

- Normally a servo is used to control an angular motion of between 0 and 180 degrees. It is not mechanically capable (unless modified) of turning any farther due to the mechanical stop build on to the main output gear (Figure 3). So if you send a control signal that is outside the acceptable range of angular positions, the mechanical stop physically prevents the servo from reaching that errant position.



Figure 3: Mechanical Stop on the Main Output Gear

To make a servo act as a small DC motor with continuous rotation, see the lesson on hacking servos at:

http://cornerstonerobotics.org/curriculum/lessons_year2/erii17_hacking_servos.pdf

- The rotational position of a servo is determined by the pulse width in a waveform that has a period of 20 ms.
 - Pulse Width and Period Illustrated:

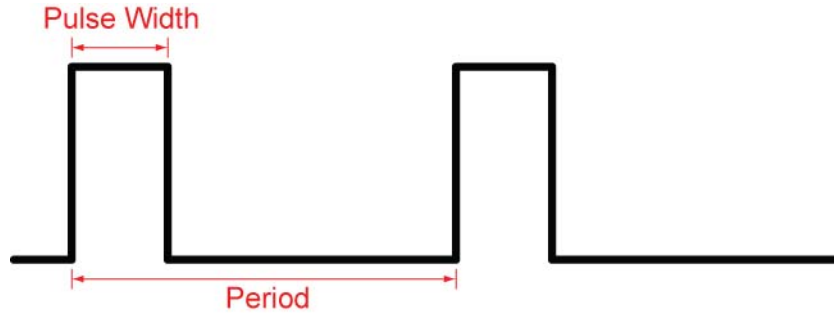
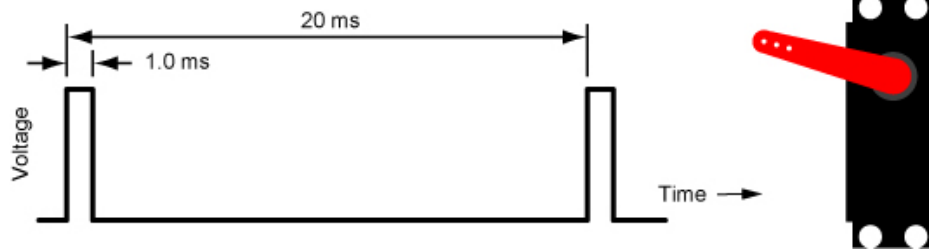
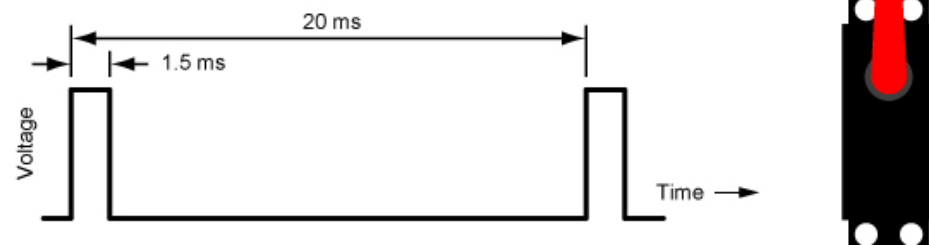


Figure 4: Pulse Waveform Terms

- Pulse width for counterclockwise position of the servo horn:



- Pulse width for center position of the servo horn:



- Pulse width for clockwise position of the servo horn:

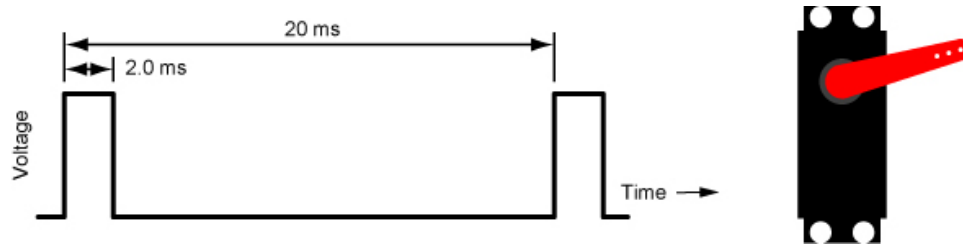


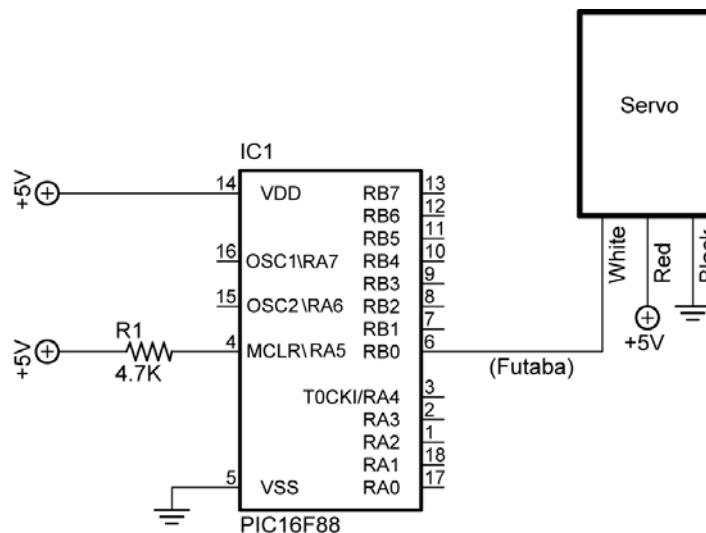
Figure 5: Pulse Widths and the Corresponding Servo Angular Positions

- The pulse width is critical in the servo control signal. The period of the waveform (20 ms) is not as critical.
- When using different servos, experiment with the pulse width limits to determine the servos range of motion.
- Perform Servos and Stepper Motors Control Lab 1 – servo1.pbp, servo2.pbp, servo3.pbp, and servo4.pbp.

Electronics Technology and Robotics III

Control and Navigation 11 – Servos Lab 1 – servo1.pbp, servo2.pbp, servo3.pbp, and servo4.pbp

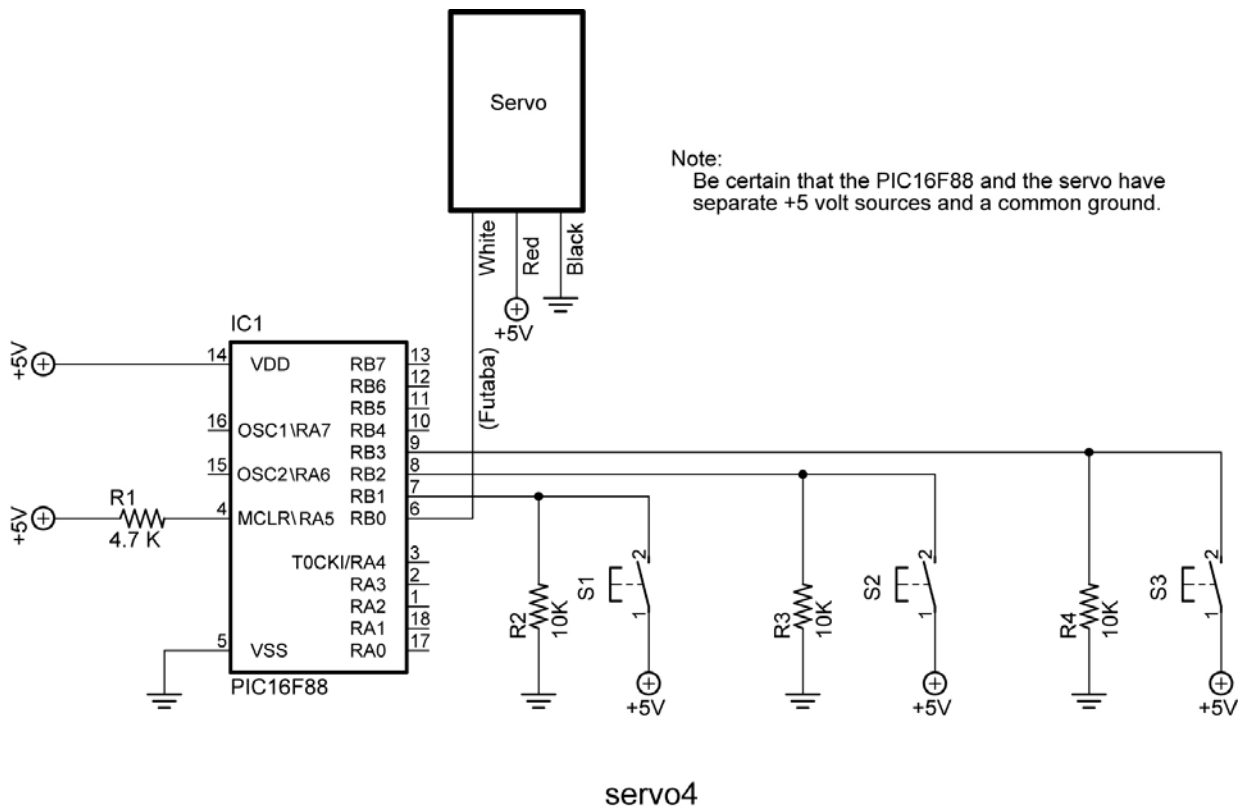
- **Purpose:** The purpose of this lab is to acquaint the student with:
 - PicBasic Pro commands **GOSUB** and **PULSOUT**.
 - The basic operation of a hobby servo.
- **Apparatus and Materials:**
 - 1 – Breadboard or Analog/Digital Trainer
 - 1 – Oscilloscope
 - 1 – PIC16F88
 - 1 – 1K Resistor
 - 3 – 10K Resistors
 - 3 – NO Momentary Switches
 - 1 – Futaba 3003 Servomotor
- **Procedure:**
 - Wire your breadboard for servo1 shown below. Program the 16F88 with **servo1.pbp** (NOT 16F877A servo1.pbp).
 - **Make certain that the servo power supply is separate from the PIC power supply, i.e., have two +5V power supplies.** Otherwise, if the servo spikes the single power line supplying power to both the servo and the PIC, the 16F88 may reset.
 - Relate the program code to the observed servo motions.



servo1, servo2, and servo3

- Open **servo2.pbp** and download to your chip. Use the same schematic as for servo1.pbp above.
- Observe the servo behavior. This servo action is suitable for panning sensor devices such as sonar sensors.
- Open **servo3.pbp** and download to your chip. Use the same schematic as for servo1.pbp above.
- Observe the waveforms on the oscilloscope. Verify that the waveforms are consistent with the program code.

- Open **servo4.pbp** and download to your chip. Wire your breadboard for servo4 shown below.
- Observe the waveforms on the oscilloscope. Verify that the waveforms are consistent with the program code.



- **Challenge:**
 - Write a program that slows the panning motion of **servo3.pbp**. Save the program as **pan1.pbp**.