Electronic Engineering Laboratory IV  
BEE31101  
Instruction Sheet

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*Error! Bookmark not defined.*
1.0 Outcomes

After completing this module, students should be able to:
1. Create and apply basic concept of servo motor control (C3, PS)
2. Organize time management in group effectively according task given. (P5, TS)
3. Adapt the current cache memory technology with etiquette. (A4, ET)

2.0 Guidelines

1. **Grouping**: Lab group is not predetermined and consists with at most two team members.

2. **Pre-Lab**: Must be submitted to the instructor at the beginning of lab sessions. Verified by the instructor and returned to the students at the end of lab session. The verified pre-lab will be attached with the final report for submission.

3. **Lab Activities**: All lab activities such as sample code, examples and lab assignments must be held in the respective lab location and completed within the given times.

4. **Demonstration**: Student must demonstrate the successful sample code, examples and lab assignments to the respective instructor. Verification only will be given upon completion of all lab activities and initialized by the instructor on the cover page.

5. **Report Organization**: Report must be organized according to given report template.

6. **Report Submission**: Report must be received by respective technical staff (at respective lab) **before 4.00 pm; not later than three (3) days** upon completion of lab session.
3.0 Pre-Lab (5%)

1. Explain the application of servo motor

(2 marks)

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2. Explain the different between servo motor and stepper motor

(4 marks)

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3. Explain the basic operational of servo motor

(4 marks)

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FKEE, Semester II Session 2015/2016
4.0 Procedures

Overview

HOW SERVO MOTOR WORKS?
Servos are controlled by sending an electrical pulse of variable width, or pulse width modulation (PWM), through the control wire. There is a minimum pulse, a maximum pulse, and a repetition rate. A servo motor can usually only turn 90 degrees in either direction for a total of 180 degree movement. The motor’s neutral position is defined as the position where the servo has the same amount of potential rotation in both the clockwise or counter-clockwise direction. The PWM sent to the motor determines position of the shaft, and based on the duration of the pulse sent via the control wire; the rotor will turn to the desired position. The servo motor expects to see a pulse every 20 milliseconds (ms) and the length of the pulse will determine how far the motor turns. For example, a 1.5ms pulse will make the motor turn to the 90-degree position. Shorter than 1.5ms moves it to 0 degrees, and any longer than 1.5ms will turn the servo to 180 degrees.

![Servo Pulse Diagram]

When these 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 force the servo can exert is called the torque rating of the servo. Servos will not hold their position forever though; the position pulse must be repeated to instruct the servo to stay in position.

This pulse corresponds to a servo position, usually from 0 to 180 degrees.
5V for 500 microseconds = 0.5 milliseconds and corresponds to 0 degrees
5V for 1500 microseconds = 1.5 milliseconds and correspond to 90 degrees
5V for 2000 microseconds = 2.0 milliseconds and corresponds to 180 degrees
The relationship is linear, so use mathematics to determine the pulse which corresponds to a given angle. Note that if you send a signal that is greater or lower than the servo can accept, you might damage the actuator.

Servos are extremely useful in robotic application. The motors are small, and have built with a motor, control circuitry, a set of gears, and the case, and are extremely powerful for their size. A standard servo has 42 oz/inches of torque, which is pretty strong for its size. It also draws power proportional to the mechanical load. A lightly loaded servo, therefore, doesn’t consume much energy. There are 3 wires in it: power, ground, and control. The amount of power applied to the motor is proportional to the distance it needs to travel. So, if the shaft needs to turn a large distance, the motor will run at full speed. If it needs to turn only a small amount, the motor will run at a slower speed.

The control wire is used to communicate the angle. The angle is determined by the duration of a pulse that is applied to the control wire. In other words, the duration of the pulse dictates the angle of the output shaft.
5.0 Lab Activity (30%)

Part A

Run Program 1 in your MPLAB and download it in the Proteus as shown in Figure 1. Report the output from this program. This program apply the TMR0 concept from lab 7 to get the time value.

Overflow time = 4 x TOSC x Prescaler x (256 – TMR0)

Program 1

```c
#include <p16f877a.inc>
#define _XTAL_FREQ 40000000
COUNT EQU 0x20

ORG 0x00
BSF STATUS,RP0
MOVLW B'00000000' ; Motor located at PORTB
MOVWF TRISB
MOVLW B'11111111' ;BUTTON LOCATED AT PORTC
MOVWF TRISC
MOVLW B'00000100' ; Prescaler =32 (Bit 2,1,0 = 100)
MOVWF OPTION_REG
BCF STATUS,RP0

; -90 DEGREE ROTATION = 0.5ms (high), delay = 19.5ms (low) , Total high and low = 20ms
TEST  BTFSS PORTC,0
    GOTO PRESS
    GOTO RELEASE
PRESS  BTFSS PORTC,0
    GOTO LOOP
    GOTO RELEASE
LOOP  MOVLW D'40'
    MOVWF COUNT
    MOVLW D'100'
    MOVWF TMR0
    BSF PORTB,0
    BCF INTCON,TMR0IF
WAIT_0.5ms  BTFSS INTCON,TMR0IF
    GOTO WAIT_0.5ms
    GOTO DELAY_19.5ms
DELAY_19.5ms  MOVLW D'100'
    MOVWF TMR0
    BCF INTCON, TMR0IF
    BcF PORTB,0
decfsz COUNT
    GOTO WAIT
    GOTO TEST
WAIT  BTFSS INTCON, TMR0IF
    GOTO WAIT
    GOTO DELAY_19.5ms
```
; 0 DEGREE ROTATION = 1.5ms (high), delay = 18.5ms (low). Total high and low = 20ms
RELEASE    BTFSS PORTC,1
            GOTO PRESS2
            GOTO TEST

PRESS2    BTFSS PORTC,1
            GOTO LOOP2
            GOTO TEST

LOOP2      MOVlw D'4'
            MOVWF COUNT

DELAY_1.5ms    MOVlw D'100'
            MOVWF TMR0
            BCF INTCON, TMR0IF
            BSF PORTB,0
            DECFsz COUNT
            GOTO WAIT2
            GOTO LOW_PULSE

WAIT2    BTFSS INTCON,TMR0IF
            GOTO WAIT2
            GOTO DELAY_1.5ms

LOW_PULSE   MOVlw D'38'
            MOVWF COUNT

DELAY_18.5ms   MOVlw D'100'
            MOVWF TMR0
            BCF INTCON, TMR0IF
            BCF PORTB,0
            DECFsz COUNT
            GOTO WAIT3
            GOTO RELEASE

WAIT3    BTFSS INTCON, TMR0IF
            GOTO WAIT3
            GOTO DELAY_18.5ms

END
### Activity 1

1. Continue program 1 by adding one more button at pin RC2 and make it run +90 degree. *(Write all the codes and make a comment on each line of code)*

2. Then, change the crystal oscillator to 20MHz and insert a new value to TMR0 and file COUNT. *(Write all the codes and make a comment on each line of code)*
7.0 Observations (15%)

1. From program 1, observe the output from Proteus simulation (4 marks)

2. Then, observe the output after add one more button at RC2. (4 marks)
3. Write your detailed observation when changing the crystal to 20MHz

(7 marks)

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8.0 Questions (15%)

1. Based on Program 1, prove the 0.5ms for high pulse need pre-loaded value of 100 to be inserted into TMR0. (Show your calculation)

(3 marks)

2. Based on Program 1, shows the relation between 19.5ms overflow time with the contain inside file COUNT equal to 40.

(4 marks)
3. Based on Program 1, shows the relation between 1.5ms overflow time with the contain inside file COUNT equal to 4.

(4 marks)

4. Based on Program 1, shows the relation between 18.5ms overflow time with the contain inside file COUNT equal to 38.

(4 marks)
Conclusion

References