16.317: Microprocessor Systems Design I

Fall 2013

Homework 7

Due **Wednesday, 12/11/13**

Notes:

- Solutions to this assignment must be typed.
- You may work individually or in groups of two students on this assignment.
- This assignment is worth a total of 50 points.

Introduction

In this assignment, you will use the PIC 16F684 microcontroller to control a bipolar stepper motor by generating a series of control signals that will rotate the motor. Because the motor is a current driven device, your microcontroller should connect to the motor through an H-bridge driver, using the schematic shown on page 2.

You may use the .asm file provided on the web *(bipolar_control.asm)* as a starting point.

For a detailed description of stepper motors and how they work, please visit either of the tutorials in references [2] and [3] given below. **For more hints on working with the PICkit, proceed to the last page of this assignment and read the "additional hints" section.**

References

[1] PIC16F684 Microcontroller Datasheet
[2] R. Laidman, Stepper Motors and Control, Part II - Bipolar Stepper Motor and Control, http://www.stepperworld.com/Tutorials/pgBipolarTutorial.htm
[3] D. Jones, Stepping Motor Types, http://www.cs.uiowa.edu/~jones/step/types.html

Assignment Details

You will use the schematic shown on the next page, which shows the connection of the PIC16F684, driver circuit and bipolar stepper motor. The parts used in the design include a 0.1uF capacitor, one L293D dual H-bridge driver, one stepper motor, and 8 diodes. All parts except the motor were provided when you checked out your PICkit. Note that Vdd = 5V.

Please note the following:

- You will complete this circuit on your own breadboard—you'll only use the PICkit to program your microcontroller in this assignment. All connections should be made directly on your board.
- Please use a chip socket if at all possible to hold the microcontroller, rather than plugging the chip itself directly into the breadboard or PICkit evaluation board. Doing so will prevent you from damaging the microcontroller while moving it from one board to the other.
    - You can also connect your microcontroller to the breadboard by keeping it mounted on the development board and using header J3 to connect the board to your breadboard, which should contain the rest of the circuit. See page 35 of the "PICKit 1 User's Guide" for the pinout of this header.

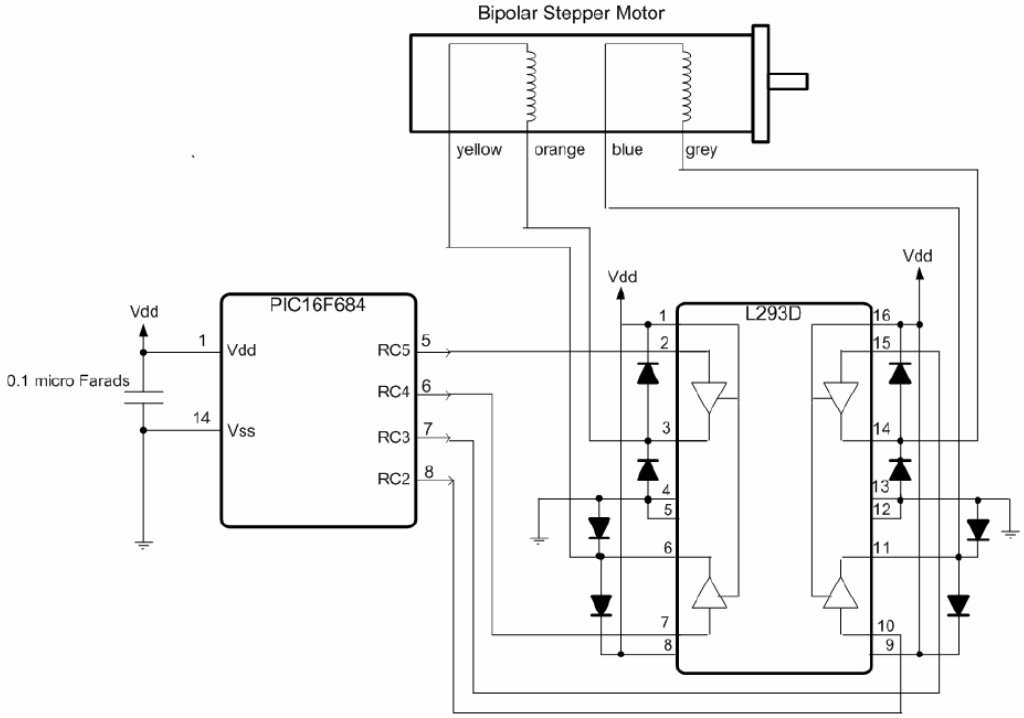

Figure 1: Circuit schematic for motor control circuit. Note that Vdd = 5 V.

Assignment notes (cont.)

- As noted below, you will be required to demonstrate that (a) your microcontroller outputs are correct and (b) your driver chip outputs are correct as part of the check-off process. **You must complete both of these steps before you will be allowed to test your circuit with a motor.**

Questions and Deliverables

1. (10 points) Record the pattern of at least two of the four output pins (RC2-5) of PIC16F684 using the oscilloscope. Describe what these pins show.
   - The logic analyzers in the lab allow you to look at all 4 channels at once; however, you can also use a typical dual-channel oscilloscope to measure the state of these pins.
   - Photos of the logic analyzer or oscilloscope screens are acceptable.
2. (10 points) Demonstrate the driver circuit wired on your breadboard and show the outputs of the driver chip (pins 3, 6, 11, 14) on the oscilloscope or logic analyzer.
3. (10 points) Demonstrate the rotation of the stepper motor, either by directly showing your working motor to Dr. Geiger or by taking a video of the working motor.
4. (5 points) How fast is the motor rotating? Report this value either in seconds/rotation or rotations/second.
5. (10 points) Modify bipolar_control.asm to vary the rotation speed of the stepper motor, and demonstrate
6. (5 points) Explain how you modified the motor's rotational speed and report its new rotational speed, as in question 4.

Additional Hints

- Chapter 4 of the PICKit 1 User's Guide describes how to set up and run your first PIC program. You can use the button debouncing example *(debounce.asm)* found on the course schedule page. If properly installed and downloaded, pressing the pushbutton on the development board should cause LED D0 to toggle on and off.
- The newest version of MPLAB (MPLAB X) doesn't support the PICKit 1. You therefore have the following options:
    - Use the CD provided with your PICKit to install the version of MPLAB provided when the kit was issued.
    - Download MPLAB v8.92 directly from the manufacturer's website:

      http://www.microchip.com/stellent/idcplg?IdcService=SS_GET_PAGE&nodeId=1406&dDocName=en019469&part=SW007002

      Near the bottom of this page, select "MPLAB IDE v8.92" from the list of downloads.
    - Use the version of MPLAB 8 (I believe it's MPLAB 8.43) on the lab machines on Ball 407.