**Lab 8:**

**Stepper Motor Control**

**Name (Print):** \_\_\_\_\_\_\_REZA SHISHEIE\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ID\_\_\_\_\_2708062\_\_\_\_\_\_\_\_\_  
  
**Give brief answers to the following questions. You can edit this document and insert your answers after each question.**

**Due dates:**

**MW – Wed, Apr 11, beginning of class  
TTH – Tue, Apr 10 , beginning of class**

**Circle one: MW or TTH**

1. (1 pt) What are the rated voltage and current for the Mabuchi PF35T-48L4 stepper motor?  
     
   **Ans.**   
     
   voltage = 7v  
   current =350 mA
2. (1 pt) What is the value of the absolute maximum current that can be provided by a PORTD I/O pin on the PIC? What is the value of the absolute maximum DC collector current for a Fairchild BD679A Darlington transistor ?  
     
   **Ans. DONE**  
     
   PORTD I/O pin current = 200mA  
   BD679A collector current = 4A **see attached datasheet**
3. (1 pt) Go to the Sparkfun Electronics page and search for “H-Bridge Motor Driver.” What are the values of the absolute maximum output supply voltage and output current?  
     
   **Ans.** **DONE**  
     
   maximum output voltage = 4.5V up to 36V  
   maximum output current = 1A **see attached data sheet**  
   The SN754410 is a quadruple high-current half-H driver designed to provide bidirectional drive currents up to 1 A at voltages from 4.5 V to 36 V.
4. (1 pt) For a two-phase, 40-pole bipolar stepper motor, use the formula from the slides to calculate the how many degrees the motor rotates in one step. Suppose the motor is driven with a 250 Hz phase voltage frequency. How fast will the motor rotate in RPM?   
     
   **Ans. DONE**

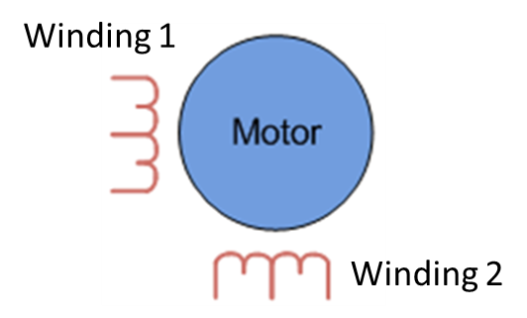
One step = 180/40=4.5 degree per step  
Mechanical frequency = Te = Tm(2/P) 🡪 Tm= Te (P/2) = 20/250 = 0.08 sec = 80 ms

Fm = 1/0.08 = 12.5 Hz 🡪 RPM = 12.5\*60 = 750

1. (1 pt) Suppose the resistances between the leads of a six-lead unipolar stepper are measured as follows:  
     
   Red / Blue = 50 Ω Green / Black = 50 Ω  
   Red / Orange = 100 Ω Green / Yellow = 50 Ω  
   Black / Yellow = 100 Ω Orange / Blue = 50 Ω  
     
   All other wire pairs have infinite resistance. Define Winding 1 as the winding that contains the black lead. Which three wires are in Winding 1, and which of the three is the center tap? Which three wires are in Winding 2, and which of the three is the center tap? Label the windings, colors, and resistances on the diagram below.

Winding 1: black, green, yellow —> center: green

Winding 2: red, blue orange —> center: blue



Black

R1

Green

R2

Yellow

R3 R4

Red Blue Orange

1. (1 pt) In the lab08.asm code,  
     
   a) Approximately how long does it take lab08.asm to rotate the motor one step ?  
     
   b) Calculate the electrical period (in milliseconds) and the electrical frequency (in Hertz) of the phase voltage waveform applied to the stepper motor?  
     
   **Ans. DONE**a) each step takes 50 ms

b) the motor has two phases. It has 3.6 degree angle which means that it has 180/3.6 = 50 poles. Thus each mechanical cycle is 50/2 electrical cycles. Knowing each step takes 50 ms:

Electrical period: 4\*25ms = 100ms

Electrical frequency = 1/0.1 = 10 Hz

Mechanical period: 25\*100ms = 2.5 s

1. (2 pt) Use a stopwatch to measure the time required for 20 revolutions of the rotor. Use the formula from the slides to calculate the mechanical frequency *fm* of the rotor (in Hz and RPM) of the stepper motor.  
     
   **Ans.** **DONE**

It take 48 seconds to do 20 revolutions

Mechanical frequency = 20/48 = 0.41 Hz

RPM = 20/(48/60) = 25 RPM

1. (1 pt) Using the information from the previous two problems, calculate the number of poles in the stepper motor.  
     
   **Ans.** *P* = 50  
   the motor has two phases. It has 3.6 degree angle which means that it has 180/3.6 = 50 poles.
2. (1 pt) The motor in this lab rotates by energizing the winding leads in the four-step sequence 0101, 1001, 1010, 0110. Give a four-step sequence that would rotate the motor in the same direction using half the power, starting with 0100. (There is more than one possible answer).  
     
   **Ans.**

Instead of energizing two-coil excitation and stabilize at the middle we can do single-coil excitation and stabilize exactly next to each coil.   
Two-coil excitation: 0101 , 1001 , 1010 , 0110 —> bd, da, ac, cb

Single-coil excitation: 0100 , 0001 , 1000 , 0010 —> b, d, a, c

1. (1 pt) What are undocumented instructions and why should they not be used in the final product.  
     
   **Ans.** **DONE**  
   undocumented instructions are alternative mnemonics for standard instructions that were not fully implemented/tested. It causes product line mergers/compatibility issues (portability) and are not recommended for new designs because of liability issues.

1. (1 pt) Watch “Microchip Stepper Motor Video – Part 1.” What type of motor should you buy if you want high resolution and quiet operation?  
     
   **Ans.**   
   Hybrid
2. (1 pt) Watch “Microchip Stepper Motor Video – Part 2.” What is the name of the phenomenon that results in motor vibration and noise and how can we alleviate this problem?  
     
   **Ans.**Anti-resonance is characterized by motor vibration. At each step ringing happens. In severe cases there is no time to settle for each step which causes missing steps. One of the ways is overcome this problem is half-stepping.
3. (2 pts) Experimentally estimate how fast the motor rotates in RPM if the WaitTime constant equals the following values. What is the relationship between WaitTime and the motor speed? Explain what happens at low WaitTimes. (Hint: sear stepper motor slipping or stalling.)

|  |  |  |
| --- | --- | --- |
| **WaitTime** | **Time for 10**  **revolutions (sec)** | **RPM** |
| 32 | 15.49 | 60/1.549 = 38 |
| 16 | 7.75 | 60/0.775 = 77 |
| 8 | 3.78 | 60/0.378 = 160 |
| 4 | It took a few steps and stopped | N/A |
| 2 | Very quickly vibrates | N/A |
| 1 | Does not run | N/A |

**Ans.**the motor slips in low wait time and thus either no moving or jiggling.

1. (12 pts) Modify the code so that when the code is run after a reset, the motor is off. On the first press of the button, the motor rotates clockwise looking into the shaft of the motor. On the next press, the motor rotates counter-clockwise. On the third press it stops. The cycle then repeats. Demonstrate your system and explain your code to the instructor or TA.  
     
   **Student Name** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
    **Instructor/TA signature** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **Date**\_\_\_\_\_\_\_\_\_\_\_\_\_  
     
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