LAB 8: 8255 PPI TO CONTROL STEPPER MOTOR
In this experiment, you will be using the 8255 programmable peripheral interface (PPI) to control or positioning stepper motor. Could you recall the features of 8255? The 8255 have several ports, which can be used as input or output, depending on our choice. Therefore, before using the 8255 for input or output, you have to tell the 8255 how it is going to be used. To do this, you will first give a control word to the 8255, and then you will be able to perform normal I/O operations with the 8255. (Initialization)

[Note: For this course, we will always use mode 0. D7 should always be 1 (active).]

Stepper Motor
A stepper motor has several coils arranged in a circle, and the rotating shaft is inside the circle. Whenever a coil is excited, the shaft is attracted towards the coil and rotates to point to the coil. Therefore, if there are n coils, there will be n positions that the shaft can rotate to, depending on which coil is excited. If two adjacent coils are excited, the shaft will rotate to in between the two coils. So there are n more positions that the shaft can rotate to. Altogether, if there are n coils, there are 2n positions.

The stepper motor in this experiment has 4 coils, which means there are 8 possible positions.

Coil A corresponds to the bit B3, Coil A’ corresponds to B1, Coil B to B2 and Coil B’ to B0. In order to excite a coil, a 0 must be output to the corresponding bit. Therefore to excite only coil A, the 8-bit output would be XXX0111 (B4 to B7 are don’t care). In term of connections to PPI, Coil A is connected to Port B 3, Coil B to Port B 2, Coil A’ to Port B1 and Coil B’ to Port B0.

1-phase excitation is when only one coil is excited at a time, so that the shaft rotates from one coil to another. 2-phase excitation is when 2 adjacent coils are excited together, so that the coil rotates to positions between the coils. 1-2 phase excitation is when the coils are excite in such a manner that the shaft rotates from a coil to between two coils and vice versa (it uses both 1-phase and 2-phase excitation).

1-Phase Excitation Example.
Stepper Motor Clockwise Rotation 1 Phase (Table 1)

The figure shows excitation values for stepper motor with starting position at coil A:

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>A'</th>
<th>B'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Step2</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Step3</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Step4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure below illustrates clockwise of 2-phase excitation:

1-2 phase excitation – shafts starts at A, and proceed anticlockwise to between A and B'.
Step 1.

For each of the excitation phases above, show as in Table 1, which coils to be excited and their corresponding excitation values for clockwise and anti clockwise rotations. Assume the shaft starts at Coil A.

1- Phase Excitation Clockwise

<table>
<thead>
<tr>
<th>Step</th>
<th>A</th>
<th>B</th>
<th>A'</th>
<th>B'</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>07H</td>
</tr>
<tr>
<td>Step2</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0BH</td>
</tr>
<tr>
<td>Step3</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0DH</td>
</tr>
<tr>
<td>Step4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0EH</td>
</tr>
</tbody>
</table>

2- Phase Excitation Clockwise

1-2 Phase Excitations

Step 2: Control word

In order to control our motor, you will be using port B as output. Determine the control word needed to make port B the output.
**Step 3: Rotating the motor anticlockwise**

Before executing the program below, check the jumper for following settings. The stepper motor is to be connected to JP1. Position of Mini Jumpers on Jumper:

i. JP5: 5th
ii. JP6: 2nd
iii. JP7: 4th
iv. JP8: 1st
v. JP9: 6th
vi. JP10: 3rd

Since we are using the 8255, before controlling the motor, you have to initialize the control port. Use the information in the previous steps in the following program.

You will be using 1-2 phase excitation. In order to rotate the motor, we have to output the positions you want it to rotate. For example, to move it to between coils A and B, you have to output (XXXX0011). Then to move it to coil A, you would have to output (XXXX0111). An easy way to do this is to put all these values in memory, then read the values from memory whenever you need to output. Select a certain address. Put the 1-2 phase excitation values in memory from the address you have selected.

```assembly
MOV DX, control port address
MOV AL, control word
OUT DX, AL (output to control port)
MOV DX, port B address
@ MOV DI, memory address of first 1-2 phase excitation value
MOV CX, 8
** PUSH CX
MOV AL, [DI]
OUT DX, AL
INC DI
MOV CX, F0
# LOOP #
PUSH CX
LOOP **
JMP @
```

Execute the program.

**Question:** Explain the purpose of each line of the program.

- What change(s) would you make to rotate the shaft clockwise?
- What is the minimum angle that the motor can rotate? Write a program to make it rotate by this angle (assume the shaft is now at coil A).
Step 4: Make changes to the above program for 1-phase excitation. Execute the program.
Questions

1. A 8255 PPI is to be used in an industrial environment where it is required to monitor 5 separate sensors. Depending on the conditions of these sensors, suitable action is taken by rotating a stepper motors. Sensors are connected to Port A of 8255, while Stepper Motor are connected to Port B.

The 8255 is connected to pin no. 3 of a address decoder (74ls138). A0, A1 and A3 is used to selects the output pin of address decoder. A4 is connected to G2b of address decoder. A5 and A6 are connected to 8255 to select the Ports. Input levels of A8 till A15 is given below

A8: 0
A9: 0
A10: 0
A11 – A15: 1

A8 till A15 is connected (by some logic gates) to NAND gate to G2A of Decoder.

Draw a schematic diagram for the above circuit by using samples of figure1 of Lab 7. Determine the suitable Control Word (Sensors must be connected to input Port and Motors are connected to output Ports) if 8255 is to be used under Mode 1. Determine the possible address for Control Port, Port A and Port B of the PPI.

2. For Figure II below, write assembly language instructions to transfer information from the device.
3. List the types of Stepper Motor.
4. List about 10 applications where you can find the Stepper Motor.
5. What are steps in stepper motor? How does we achieve higher precision (smoothness) in rotating a stepper motor? What is a Stepper Motor driver?