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Experiment No: 3

This experiment is divided into two sections and both sections are due to be completed in a single lab session. For the first session roll numbers 1-12 or 25-36 will work on section A, and roll numbers 13-24 or 37-48 will carry out section B. After completion, students will swap the lab works.

Initial report must include programs (mnemonics and opcodes) for all sample programs and given problems. Also include necessary look-up tables that would be used in programs, if applicable.

Section A

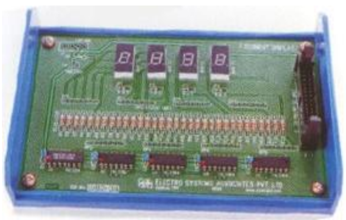
Interfacing Seven Segment Display

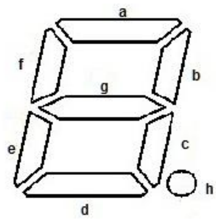
Introduction

The seven segment display module consists of a four digit 7 segment displays driven by the outputs of four cascaded serial-in-parallel-out-shift registers. Data to be displayed is transmitted serially, bit by bit, to the interface over the 8255A PPI port line PB_0. Each bit is clocked into the shift registers by providing a common clock through the port line PC_0. Thus, information for all the four digits is provided by 32 bits clocked into the shift registers serially.

Display Code

Since the outputs of shift registers are connected to the cathode sides of LED segments, low input must be given to the segments for making them glow and high inputs for making them blank. Each display has 7 bar segments and a dot (a, b, c, d, e, f, g, and h) as shown in figure below. To display any character, its corresponding segment must be given low input.





To display digit **3**, the segments a, b, c, d & g must glow. Hence, these segments must be given low inputs and the rest must be high as:

Segment	h	g	f	e	d	c	b	a
Bit Position	D7	D6	D5	D4	D3	D2	D1	D0
Input	1	0	1	1	0	0	0	0
Hex Code	B				0			

The display codes for some alpha-numeric characters are given in table below:

Displayed Character	Hex Code
A	88
b	83
C	C6
d	....
E	....
F	....

Displayed Character	Hex Code
H	89
h	....
....	....
t	....
U	....
y	....

Displayed Number	Hex Code
0	C0
1	F9
2	A4
3	B0
4	....

Displayed Number	Hex Code
5	....
6	....
7	....
8	....
9	90

The data can be sent to the seven segment display module via **PB_0** pin of Port B of 8255 within the microprocessor kit. The 8 bit data for each 7 segment display has to be sent serially from MSB to LSB, with clock pulses via **PC_0** of Port C after each bit.

Installation

The interface module has a 26-pin connector which is connected to connector **J2** of the microprocessor trainer kit using a flat ribbon cable. The +5V DC power supply required for the interface is drawn from the microprocessor trainer kit through the ribbon cable.

Sample Program

Run the following program and observe the output on 7 segment display.

```
        MVI     A, 80H
        OUT     43H
        MVI     A, 89H   ; to display character H
        CALL    DISP     ; call display subroutine
        RST 5
```

; Following subroutine displays the content of accumulator in 7- segment display

```
DISP:   MVI     C, 08H   ; counter to transmit 8-bit
L1:     RLC              ; to pass each bit serially from MSB to LSB
        MOV     E, A
        OUT     41H      ; to pass a bit via PB0
        MVI     A, 01H
        OUT     42H      ; clock signal on PC0 (rise)
        DCR     A
        OUT     42H      ; clock signal on PC0 (fall)
        MOV     A, E
        DCR     C
        JNZ     L1
        RET
```

Note

- This program displays a single character only. To display multiple characters, store the list of display codes for the required characters in memory (look-up table) and use them one by one by using a loop.
- You can display scrolling characters by using appropriate delay. For this, display a character and insert a delay loop before displaying the next character. On sending a new data to the display interface, the previous characters are automatically scrolled left.

Problems

1. Write an assembly language program to display the sequence of digits 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 in a right to left scrolling fashion with appropriate delay. Use appropriate list of display codes.

2. Display "PAUSE" continuously in a scrolling fashion. Modify the look-up table to display any word(s) in scrolling fashion.

Section B

STEPPER MOTOR INTERFACE

Introduction and Theory

Stepper Motor control is a very popular application of microprocessors in control area, as stepper motors are capable of accepting pulses directly from the microprocessor and move accordingly.

The motor used in the lab is a permanent magnet stepper motor. The principle and operation of such motor is explained below.

Permanent Magnet (PM) Stepper Motor

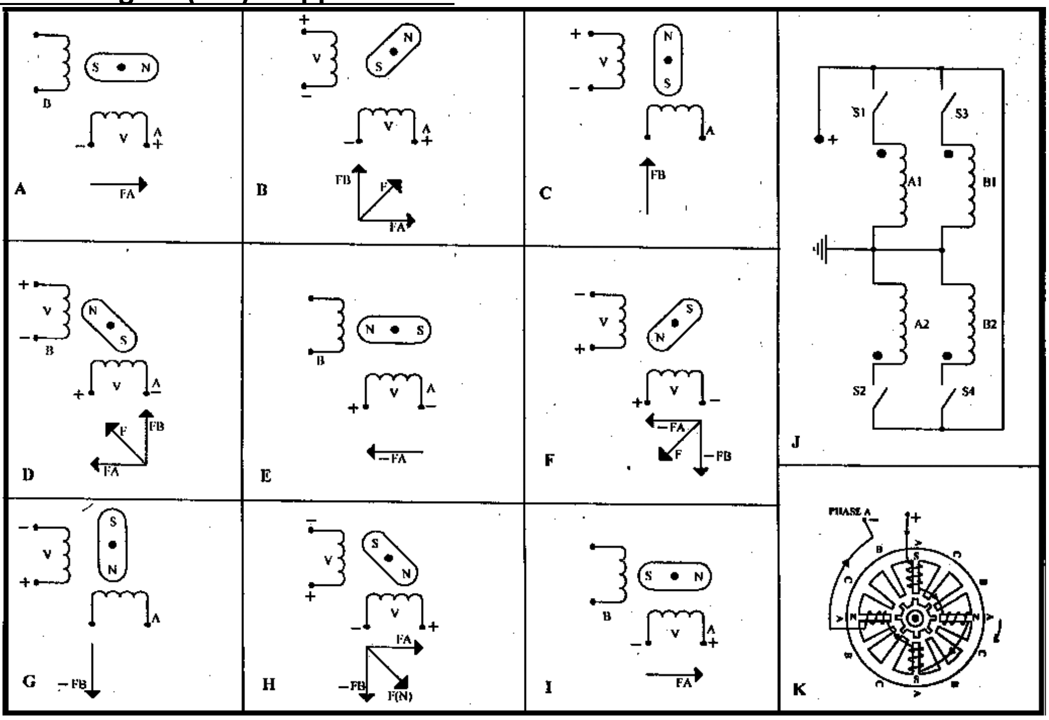


Fig 1: Stepper Motor in Operation

Fig 1 shows a PM stepper motor in its simplest form. It consists of two stator windings A, B and a rotor having two magnetic poles N and S. When a voltage +V is applied to stator winding A, a magnetic field F_A is generated as shown in Fig (A). The rotor positions itself such that its poles lock with corresponding stator poles.

With the winding 'A' excited as before, winding 'B' is now switched on to a voltage +V as shown in Fig (B). This produces a magnetic field F_B in addition to F_A. The resulting magnetic field F makes an angle of 45 degrees as shown in Fig (B). The rotor consequently moves through 45˚ in anti-clock-wise direction, again to cause locking of rotor poles with corresponding stator poles.

While winding 'B' has voltage +V applied to it, winding 'A' is switched off in Fig(C). The rotor then moves through a further 45˚ in anti-clockwise direction to align itself with stator field F_B. With voltage +V on winding B, a voltage -V is applied to winding A as shown in Fig (D). Then the stator magnetic field has two components: F_A, F_B and their resultant F makes an angle of 135˚ position.

In this way it can be seen that, as the pattern of excitation of the state of windings is changed, the rotor moves successively through 45 degrees steps through Fig (E) to (H), and completes one full revolution in anti-clock-wise direction.

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The figures are meant only to illustrate the principle of operation of PM stepper motor. The PM stepper motor used in this lab has 50 teeth on its rotor. It has four phases **A**, **B**, **C** and **D** for the stator and each phase consists of two windings (electromagnets) arranged in cross pattern. Thus there are eight main poles on the stator, each having five teeth in the pole face. The step angle i.e. the angle by which the motor shaft rotates for every single excitation, is given by,

A = 360 / (N*K) degrees

Where, N = number of rotor tooth
K = excitation sequence factor

PM stepper motors have three modes of excitation:

a. Single Phase Mode (Wave drive): Figs (A, C, E and G) illustrate the single phase mode in which only one of the motor windings is excited at a time. For the PM stepper motor used in lab, there are four phases and hence there will be four steps in a complete sequence in this mode **(A only, B only, C only** and **D only)** i.e. excitation sequence factor K=4, so that step angle is 1.8 degrees.

b. Two Phase Mode (Full step drive): Here two adjacent stator phases are excited at a time as shown in figs (B, D, F and H). For the stepper motor in lab, there are four steps in the excitation sequence **(A&B, B&C, C&D** and **D&A)** i.e. K=4 and step angle is 1.8 degrees. However, the rotor positions in the two-phase mode are 0.9 degrees away from those in single phase mode.

c. Hybrid Mode (Half step drive): This is a combination of single phase and two phase modes as shown in Figs (A-H). There will be eight steps in an excitation sequence i.e. K=8 and step angle is 0.9 degrees.

Step Sequences

Full Step Drive

A	B	C	D
1	1	0	0
0	1	1	0
0	0	1	1
1	0	0	1

Two phases are always ON. Motor will have full rated torque.

Wave Drive

Only one phase ON at a time. Motor will have least torque but same step angle as full step drive.

A	B	C	D
1	0	0	0
0	1	0	0
0	0	1	0
0	0	0	1

Half Step Drive

A	B	C	D
1	1	0	0
0	1	0	0
0	1	1	0
0	0	1	0
0	0	1	1
0	0	0	1
1	0	0	1
1	0	0	0

Alternately, one phase and two phase are ON.

Angular resolution increases.

Torque is about 70% of rated

Motor we use in lab has angular resolution of 1.8 degree in full step and wave drive and 0.9 degree in half step drive.

Table 1

Circuit Description

The stepper motor interface uses four transistor pairs (SL100 & 2N3055) in a Darlington pair configuration. Each Darlington pair is used to excite the particular winding of the motor connected to 4 pin connector on the interface. The inputs to these transistors are from lower nibble of Port A i.e. **PA_0**, **PA_1**, **PA_2**, and **PA_3** of 8255A of the Microprocessor Trainer kit as shown in the following table. The freewheeling diodes across each winding protect transistors from switching transients.

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Table 2

Port A	**PA7**	**PA6**	**PA5**	**PA4**	**PA3**	**PA2**	**PA1**	**PA0**
Winding	-	-	-	-	B	A	D	C

Installation

- Plug in four-pin polarized connector and the three-pin connector of the motor to the corresponding connectors on the stepper motor interface module.
- Connect the 3 pin female connector of the stepper motor power supply to the connector on the interface marked as **GND +5/12V**.
- Connect connector **J1** on the interface module to the connector **J2** on Microprocessor trainer kit using 26-pin flat ribbon cable.

Sample Program

Comment on the excitation mode used in the program below and draw the excitation table. Run the following program. Observe the output and note down the direction of rotation.

```
       MVI  A, 80H   ; All ports are O/P
       OUT  43H

       MVI  A, 88H   ; Initial control bit pattern
LOOP:  OUT  40H

       CALL DELAY    ; Delay between steps
       RRC
; Change RRC to RLC to reverse the direction

       JMP  LOOP
```

```
; DELAY subroutine gives an approx. delay of 1.5s.

DELAY: PUSH PSW
       LXI  D, FFFFH
DLAY1: DCX  D
       MOV  A, D
       ORA  E
       JNZ  DLAY1
       POP  PSW
       RET
```

Note

For full step drive, the excitation table is as follows. Store the table in memory and use the sequence one by one using a loop. (**Generate similar table for half step drive.**)

				B	**A**	**D**	**C**	
PA7	**PA6**	**PA5**	**PA4**	**PA3**	**PA2**	**PA1**	**PA0**	
0	0	0	0	1	1	0	0	**0C H**
0	0	0	0	1	0	0	1	**09 H**
0	0	0	0	0	0	1	1	**03 H**
0	0	0	0	0	1	1	0	**06 H**

Calculate the number of steps required to rotate the motor for given angle (total angle/step angle) and adjust the number of loops required in the program accordingly.

Problems

1. Write a program for 180 degrees rotation of the stepper motor using full step sequence in the direction opposite to that of sample program.

2. Write a program for 270 degrees rotation of the stepper motor using half step sequence in the direction same as that of sample program.