Program 14
Control the speed and direction of stepper motor

Stepper motor Interfacing/Control using 8085 and 8051

Stepper Motor

A stepper motor is a device that translates electrical pulses into mechanical movement in steps of fixed step angle.

- The stepper motor rotates in steps in response to the applied signals.
- It is mainly used for position control.
- It is used in disk drives, dot matrix printers, plotters and robotics and process control circuits.

Structure

Stepper motors have a permanent magnet called rotor (also called the shaft) surrounded by a stator. The most common stepper motors have four stator windings that are paired with a center-tap. This type of stepper motor is commonly referred to as a four-phase or unipolar stepper motor. The center tap allows a change of current direction in each of two coils when a winding is grounded, thereby resulting in a polarity change of the stator.

Interfacing

Even a small stepper motor require a current of 400 mA for its operation. But the ports of the microcontroller cannot source this much amount of current. If such a motor is directly connected to the microprocessor/microcontroller ports, the motor may draw large current from the ports and damage it. So a suitable driver circuit is used with the microprocessor/microcontroller to operate the motor.

## Motor Driver Circuit (ULN2003)

Stepper motor driver circuits are available readily in the form of ICs. ULN2003 is one such driver IC which is a High-Voltage High-Current Darlington transistor array and can give a current of 500mA.This current is sufficient to drive a small stepper motor. Internally, it has protection diodes used to protect the motor from damage due to back emf and large eddy currents. So, this ULN2003 is used as a driver to interface the stepper motor to the microcontroller.

Operation

The important parameter of a stepper motor is the **step angle**. It is the minimum angle through which the motor rotates in response to each **excitation pulse**. In a four phase motor if there are 200 steps in one complete rotation then then the step angle is $360/200 = 1.8^O$. So to rotate the stepper motor we have to apply the excitation pulse. For this the controller should send a hexa decimal code through one of its ports. **The hex code mainly depends on the construction of the stepper motor**. So, all the stepper motors do not have the same Hex code for their rotation. (refer the operation manual supplied by the manufacturer.)

For example, let us consider the hex code for a stepper motor to rotate in clockwise direction is 77H , BBH , DDH and EEH. This hex code will be applied to the input terminals of the driver through the assembly language program. To rotate the stepper motor in anti-clockwise direction the same code is applied in the reverse order.

Stepper Motor interface- Schematic Diagram (for 8051)
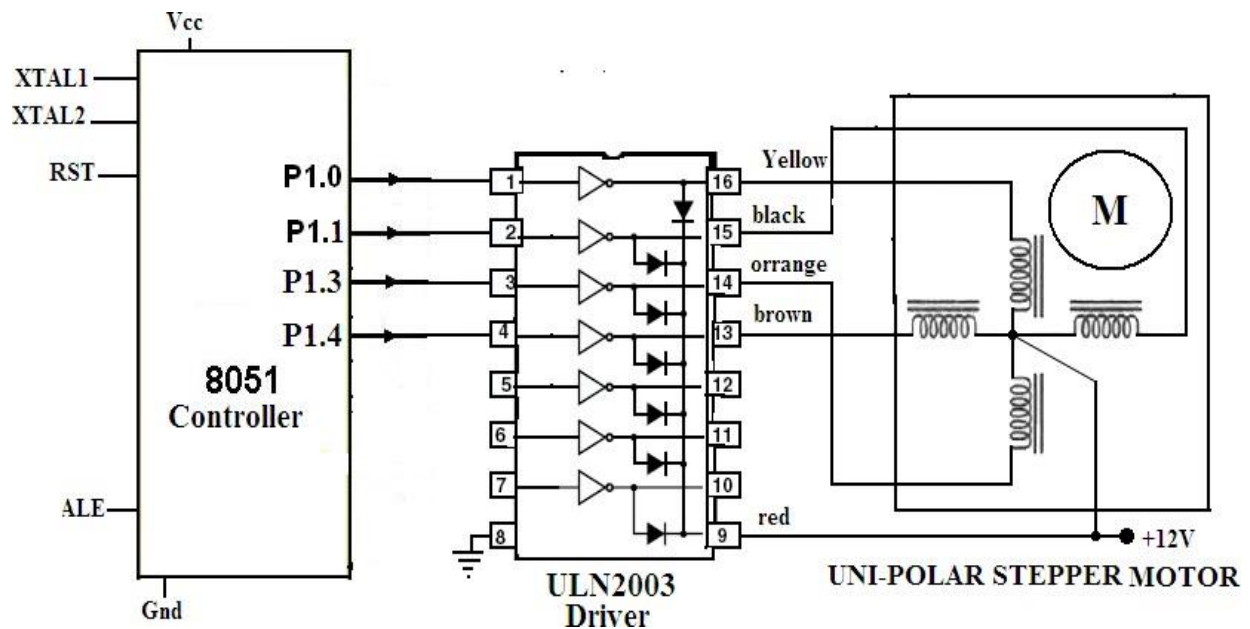
The assembly language program for 8051 is given below.

ASSEMBLY LANGUAGE PROGRAM (8051)

```
Main   : MOV A, # 0FF H          ;   Initialization of Port 1
         MOV P1, A               ;
         MOV A, #77 H            ; Code for the Phase 1
         MOV P1, A                ;
         ACALL DELAY             ;  Delay subroutine
         MOV A, # BB H           ; Code for the Phase II
         MOV P1, A               ;
         ACALL DELAY             ;  Delay subroutine.
         MOV A, # DD H           ; Code for the Phase III
         MOV P1, A               ;
         ACALL DELAY             ; Delay subroutine
         MOV A, # EE H            ;  Code for the Phase 1
         MOV P1, A               ;
         ACALL DELAY             ; Delay subroutine
         SJMP MAIN; Keep the motor rotating continuously.
```
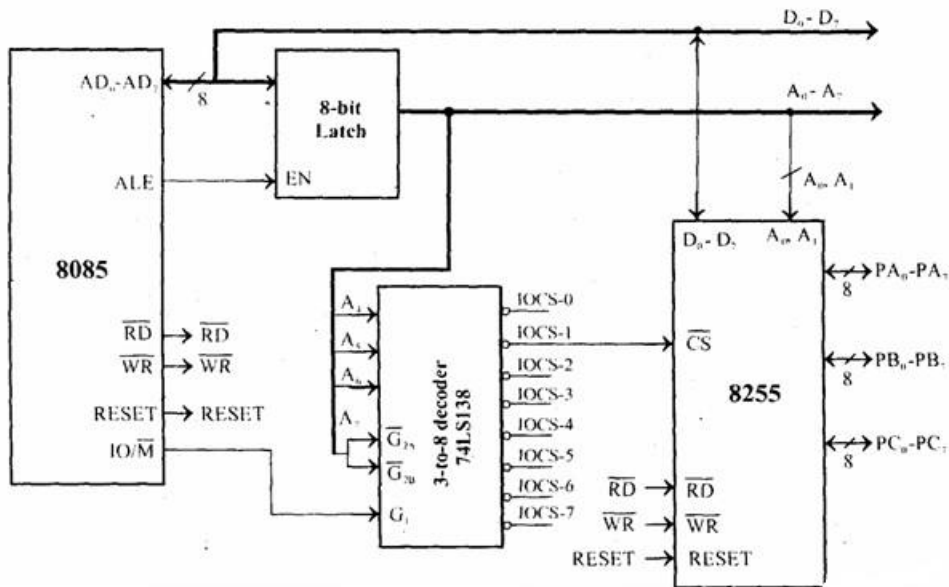
DELAY Subroutine

```
         MOV R4, #0FF H          ;  Load R4 with FF
         MOV R5, # 0FF           ; Load R5 with FF
LOOP1:   DJNZ R4, LOOP1          ; Decrement R4 until zero,wait
LOOP2:   DJNZ R5, LOOP2          ; Decrement R5 until zero,wait
         RET                     ; Return to main program .
```

Stepper Motor interface - Schematic Diagram for (8085)
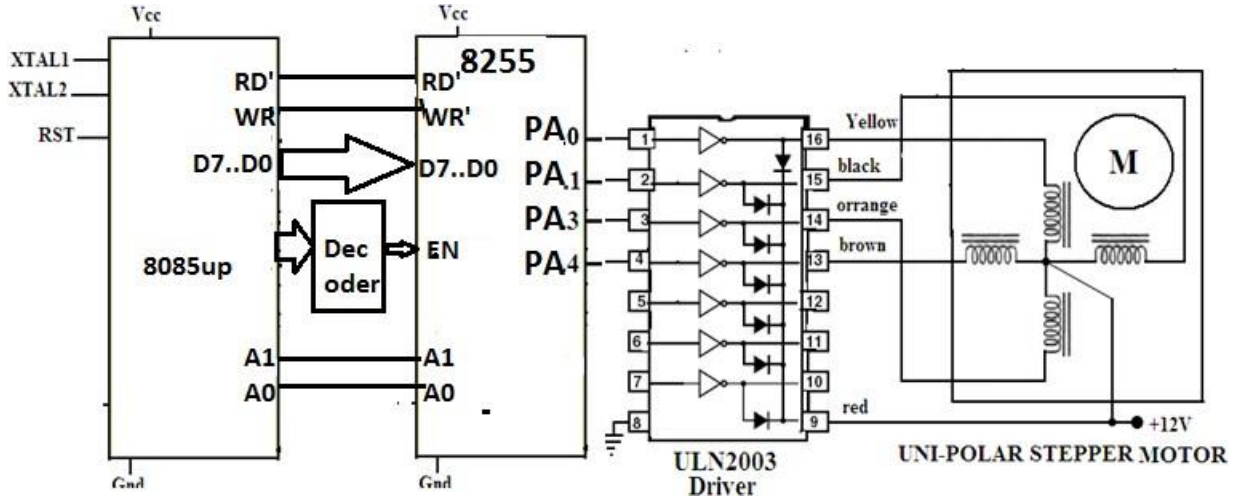
Detailed Connection diagram between 8085 and 8255

ASSEMBLY LANGUAGE PROGRAM (8085)

```
Main   : MVI A, 80              ;   80H → Control word to configure PA,PB,PC in O/P
         OUT CWR_Address        ;  Write control word in CWR of 8255
         MVI A, 77             ; Code for the Phase 1
         OUT PortA_Address     ; sent to motor via port A of 8255         ;
         CALL DELAY             ;  Delay subroutine
         MVI A,  BB            ; Code for the Phase II
         OUT PortA_Address     ; sent to motor via port A of 8255
         CALL DELAY            ;  Delay subroutine.
         MVI A,  DD           ; Code for the Phase III
         OUT PortA_Address    ; sent to motor via port A of 8255;
         CALL DELAY           ; Delay subroutine
         MVI A,  EE H          ;  Code for the Phase 1
         OUT PortA_Address    ; sent to motor via port A of 8255                 ;
         CALL DELAY           ; Delay subroutine
         JMP MAIN             ; Keep the motor rotating continuously.
```

DELAY Subroutine

```
         MVI C, FF              ; Load C with FF -- Change it for the speed variation
LOOP1:  MVI D,FF                ; Load D with FF
LOOP2:  DCR D
        JNZ  LOOP2
        DCR C
        JNZ LOOP1
         RET                    ; Return to main program .
```