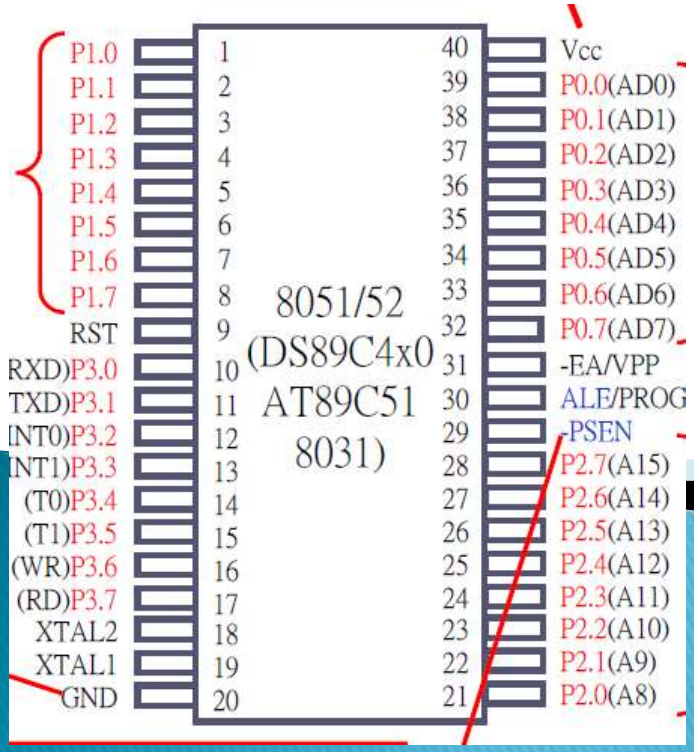
STEPPER MOTOR INTERFACIN G



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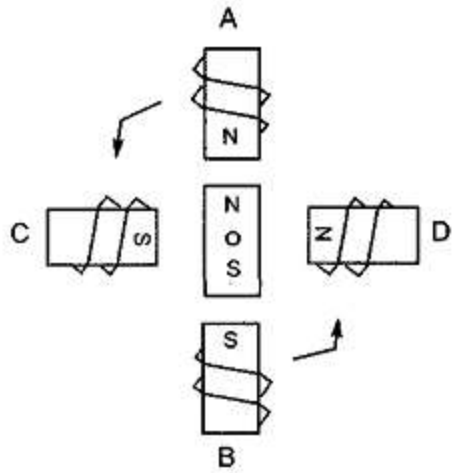
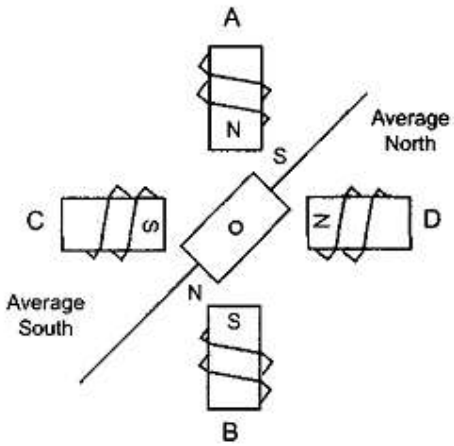
STEPPER MOTOR INTERFACING

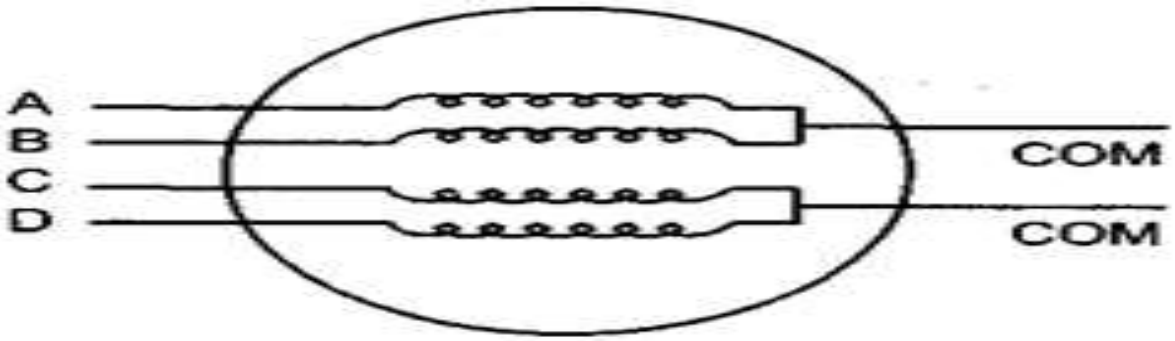
- A *stepper motor* is a widely used device that translates electrical pulses into mechanical movement. In applications such as disk drives, dot matrix printers, and robotics, the stepper motor is used for position control. Stepper motors commonly have a permanent magnet rotor (also called t d





- The most common stepper motors have four stator windings that are paired with a center-tapped common. 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 .
- where poles of the same polarity repel.
- and opposite poles attract.
- The direction of the rotation is dictated by the stator poles.

- The direction of the rotation is dictated by the stator poles.
- The stator poles are determined by the current sent through the wire coils.
- As the direction of the current is changed, the polarity is also changed causing the reverse motion of the rotor. The stepper motor discussed here has a total of 6 leads: 4 leads representing the four stator windings and 2 commons for the center-tapped leads. As the sequence of power is applied to each stator winding
- the rotor will rotate.



Normal 4-Step Sequence

Clockwise

Step #	Winding A	Winding B	Winding C	Winding D
1	1	0	0	1
2	1	1	0	0
3	0	1	1	0
4	0	0	1	1

Counter-clockwise

- once we start we must continue in the proper order. For example, if we start with step 3 (0110), we must continue in the sequence of steps 4, 1,2, etc.
- It must be noted that although we can start with any of the sequences

Step angle

- How much movement is associated with a single step? This depends on the internal construction of the motor, in particular the number of teeth on the stator and the rotor. The *step angle* is the minimum degree of rotation associated with a single step. Various motors have different step angles. It shows some step angles for various motors. , notice the term *steps per revolution.* This is the total number of steps needed to rotate one complete rotation or 360 degrees (e.g., 180 steps x 2 degrees =360

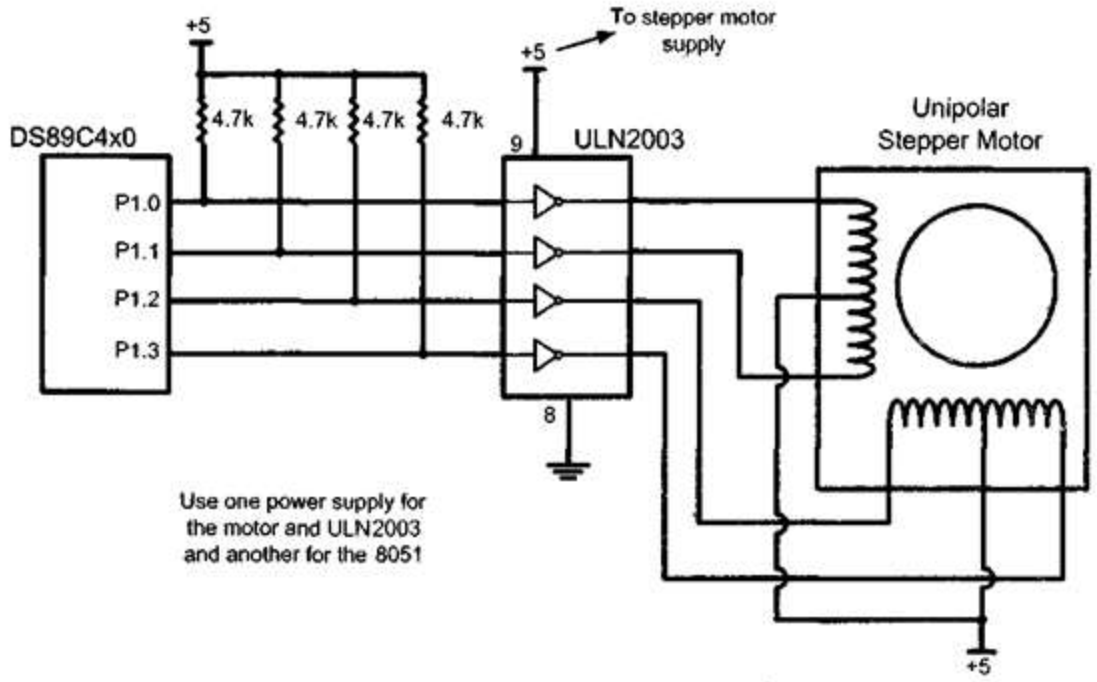
Table 17-4: Stepper Motor Step Angles

Step Angle	Steps per Revolution
0.72	500
1.8	200
2.0	180
2.5	144
5.0	72
7.5	48
15	24

lacks sufficient current to drive the stepper motor we used ULN2003

- The four leads of the stator winding are controlled by four bits of the 8051 port (Pl.O – P1.3).
- However, since the 8051 lacks sufficient current to drive the stepper motor windings,
- we must use a driver such as the ULN2003 to energize the stator.
- Insteadof the ULN2003, we could have used transistors as drivers,
- notice that if transistors are used as drivers, we must also use diodes to take care of inductive current generated when the coil is turned off.
- One reason that using the ULN2003 is preferable to the use of transistors as drivers is that the ULN2003 has an internal diode to take care of back EMF

. 8051 Connection to Stepper Motor



Steps per second and rpm relation

The relation between rpm (revolutions per minute), steps per revolution, and steps per second is as follows.

$$\text{Steps per second} = \frac{\text{rpm} \times \text{Steps per revolution}}{60}$$

Example 17-2

Give the number of times the four-step be applied to a stepper motor to make an 80-degree move if the motor has a 2-degree step angle

A motor with a 2-degree step angle has the following characteristics:
Step angle: 2 degrees Steps per revolution: 180
Number of rotor teeth: 45 Movement per 4-step sequence: 8 degrees
To move the rotor 80 degrees, we need to send 10 consecutive four-step sequences, since 10×4 steps x 2 degrees = 80 degrees.

Half-Step 8-Step Sequence

Clockwise ↓

Step #	Winding A	Winding B	Winding C	Winding D
1	1	0	0	1
2	1	0	0	0
3	1	1	0	0
4	0	1	0	0
5	0	1	1	0
6	0	0	1	0
7	0	0	1	1
8	0	0	0	1

Counter-clockwise ↑

Motor speed

The motor speed, measured in steps per second (steps/s), is a function of the switching rate

Holding torque

the amount of torque, from an external source, required to break away the shaft from its holding position. This is measured with rated voltage and current applied to the motor." The unit of torque is ounce-inch (or kg-cm)

Wave drive 4-step sequence

Clockwise ↓

Step #	Winding A	Winding B	Winding C	Winding D
1	1	0	0	0
2	0	1	0	0
3	0	0	1	0
4	0	0	0	1

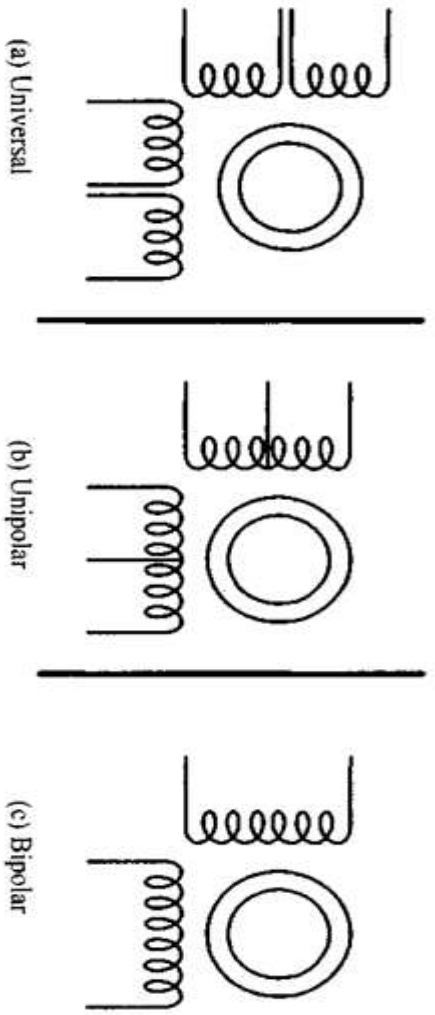
Counter-clockwise ↑

- In addition to the 8-step and the 4-step sequences discussed earlier, there is another sequence called the wave drive 4-step sequence

Step Angle	Drive System	Volts	Phase Resistance	Current
7.5	unipolar	5 V	9 ohms	550 mA
3.6	unipolar	7 V	20 ohms	350 mA
7.5	bipolar	5 V	6 mA	800 mA

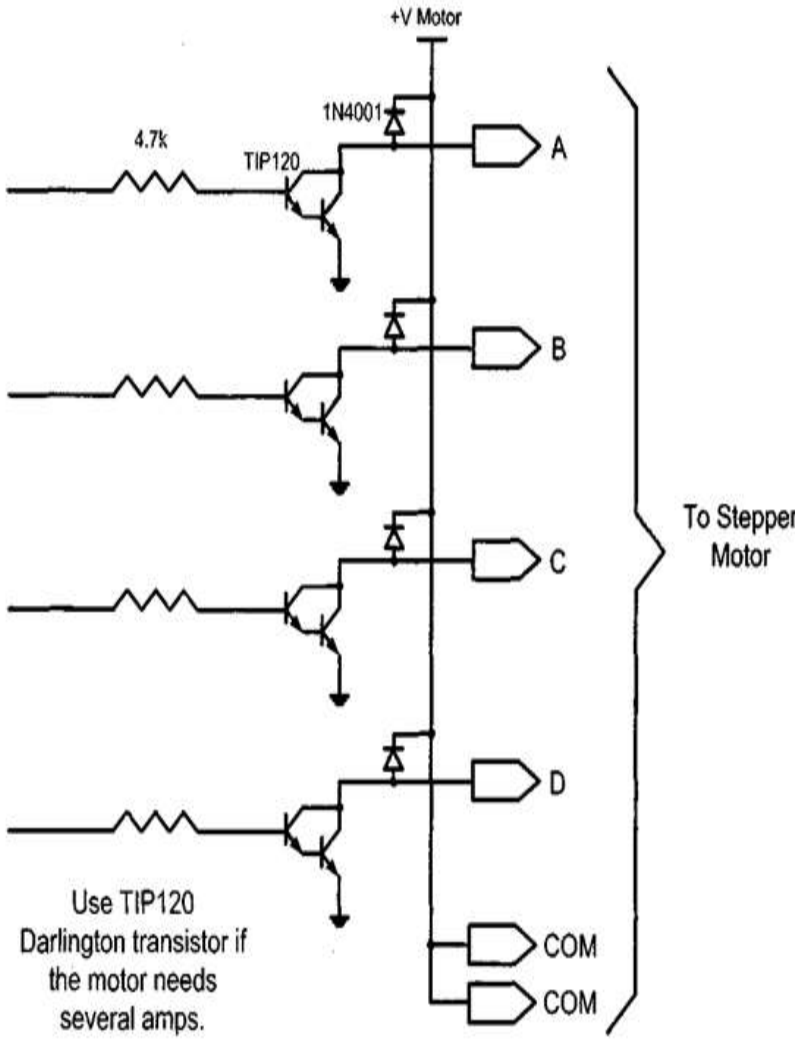
Common Stepper Motor Types

- There are three common types of stepper motor interfacing: universal, unipolar, and bipolar.
- They can be identified by the number of connections to the motor
- A universal stepper motor has eight, while the unipolar has six and the bipolar has four.
- The universal stepper motor can be configured for all three modes, while the unipolar can be either unipolar or bipolar. Obviously the bipolar cannot be configured for universal nor unipolar mode

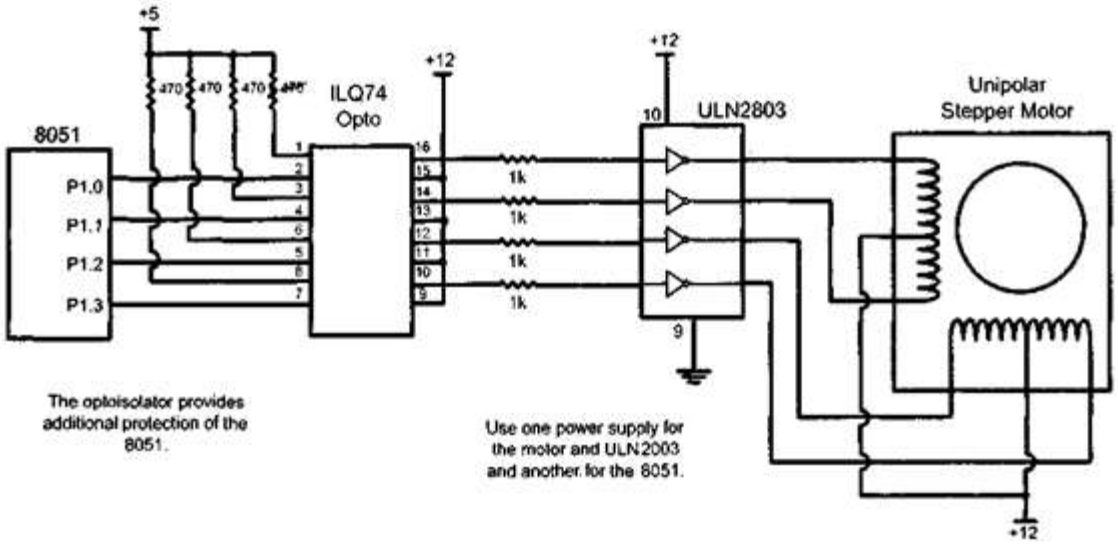


Using transistors as drivers

- shows an interface to a unipolar stepper motor using transistors. Diodes are used to reduce the back EMF spike created when the coils are energized and de-energized
- TIP transistors can be used to supply higher current to the motor
- These transistors can accommodate higher voltages and currents.



Controlling stepper motor via optoisolator



Optoisolators are widely used to isolate the stepper motor's EMF voltage and keep it from damaging the digital/microcontroller system

Example 17-2

- A switch is connected to pin P2.7. Write a C program to monitor the status of SW and perform the following:
- If SW = 0, the stepper motor moves clockwise.
- If SW = 1, the stepper motor moves counterclockwise.

```
#include <reg.h>
sbit SW=P2^7;

void main()
   {
      SW = 1;
      while(1)
         {
            if(SW == 0)
               {
                  P1 = 0x66;
                  MSDelay(100);
                  P1 = 0xCC;
                  MSDelay(100);
                  P1 = 0x99;
                  MSDelay(100);
                  P1 = 0x33;
                  MSDelay(100);
               }
            else
               {
                  P1 = 0x66;
                  MSDelay(100);


                  P1 = 0x33;
                  MSDelay(100);
                  P1 = 0x99;
                  MSDelay(100);
                  P1 = 0xCC;
                  MSDelay(100);
               }
         }
   }

void MSDelay(unsigned int value)
   {
      unsigned int x, y;
      for(x=0;x<1275;x++)
         for(y=0;y<value;y++);
   }
```

THANKX