STEPPER MOTOR

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.

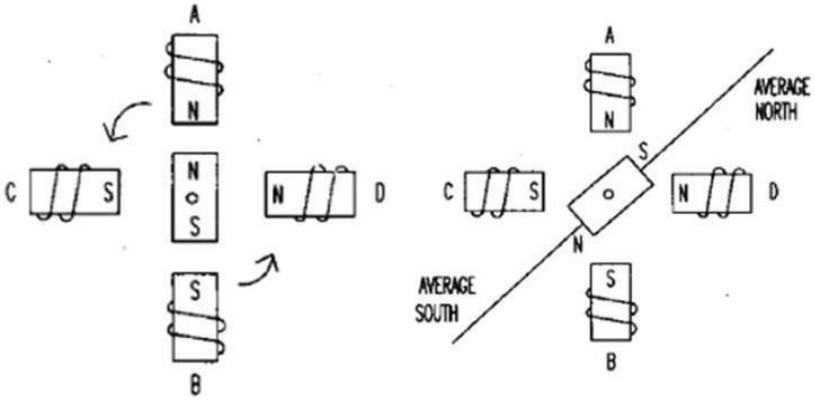

Fig: Rotor Alignment

Stepper motors commonly have a permanent magnet rotor (also called the shaft) surrounded by a stator. The variable reluctance stepper motors do not have a Permanent Magnet rotor. The most common stepper motors have four stator windings that are paired with a center-tapped common.

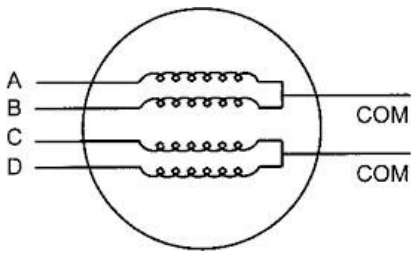

Fig: Stator windings configuration

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.

Conventional motor shaft runs freely, the stepper motor shaft moves in a fixed repeatable movement. This repeatable fixed movement is possible as a result of basic magnetic theory where poles of the same polarity repel and opposite poles attract.

The direction of the rotation is based on 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 has a total of 6leads, 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	COUNTER CLOCKWISE
	1	1	0	0	1	
	2	1	1	0	0	
	3	0	1	1	0	
	4	0	0	1	1	

Half step 8 step sequence

CLOCKWISE	STEP #	WINDING A	WINDING B	WINDING C	WINDING D	COUNTER CLOCKWISE
	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	

Step angle

The step angle is the minimum degree of rotation associated with a single step.

Steps per second and rpm relation

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

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

Motor speed

The motor speed, measured in steps per second, is a function of the switching rate.

Holding torque

With the motor shaft at standstill or zero rpm condition, the amount of torque, from an external source, required to break away the shaft from its holding position. The unit of torque is ounce-inch (or kg-cm).

Unipolar versus bipolar stepper motor interface

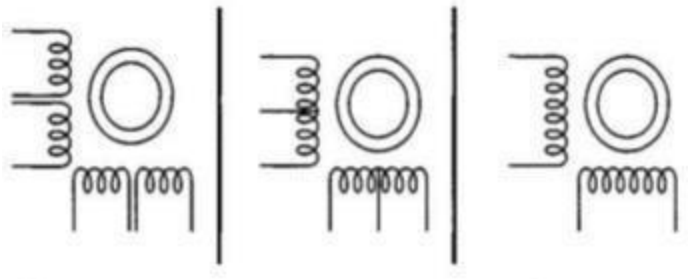

Fig: Universal **Fig: Unipolar** **Fig: Bipolar**

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.

Universal: A universal stepper motor has eight connections**.**

Unipolar: Unipolar has six connections.

Bipolar: Bipolar has four connections**.**

The universal stepper motor can be configured for all three modes, while the unipolar can be either unipolar or bipolar, but bipolar cannot be configured for universal nor unipolar mode.

Using transistors as drivers

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.

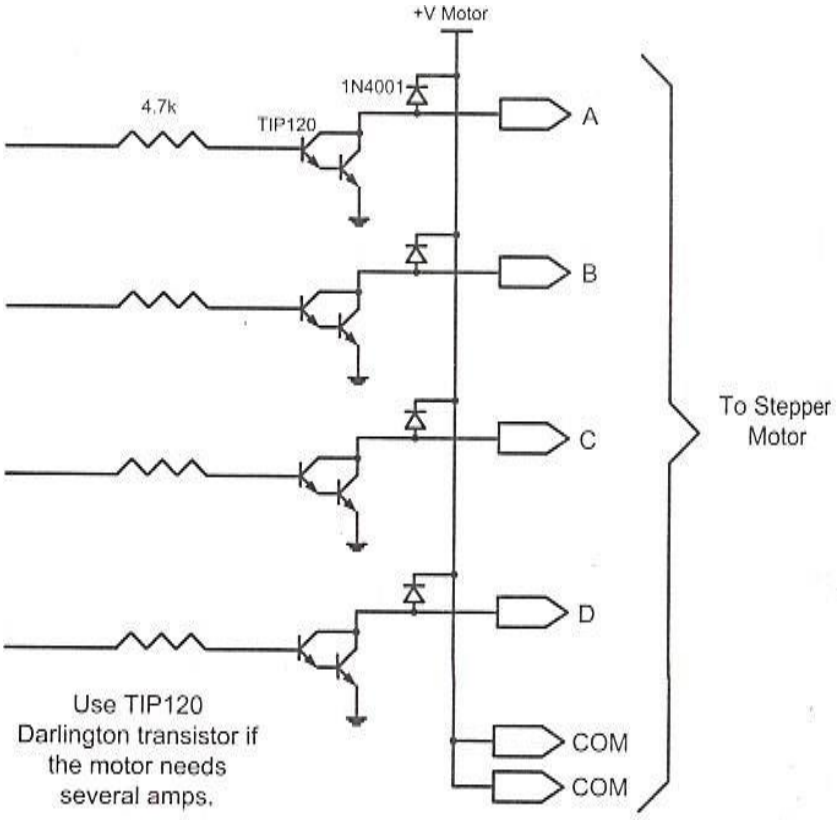

Fig: Using transistors for stepper motor driver

Controlling stepper motor via optoisolator

Optoisolators are widely used to isolate the stepper motor"s EMF voltage and keep it from damaging the microcontroller system.

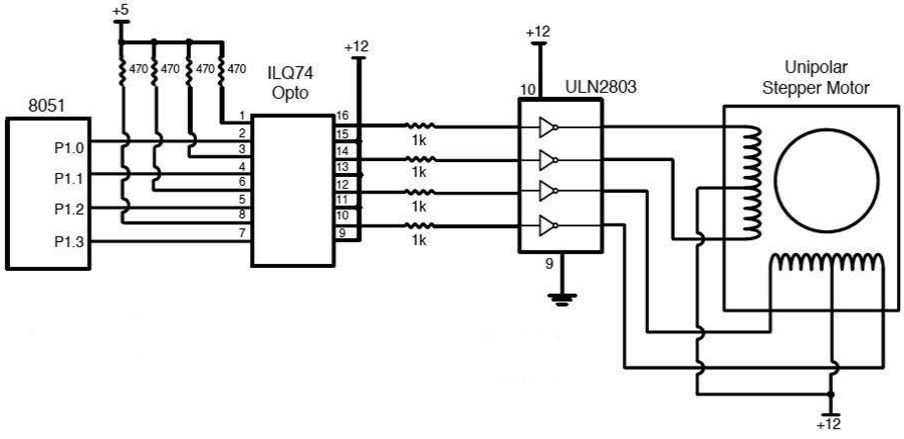

Fig: Controlling stepper motor via optoisolator

PROGRAM

```
        MOV R0, # COUNT ; initialize rotation count
AGAIN:  MOV DPTR, #ETC ; initialize pointer to excitation code table
```

```
        MOV R1, #04 ; initialize counter to excitation code sequence
BACK:   MOVX A,@DPTR ; get the excitation code MOV P1, A ; send
the excitation code LCALL DELAY ; wait for some time
        INC DPTR            ; increment pointer
        DJNZ R1, BACK ; decrement R1 if not zero go to BACK
        DJNZ R0, AGAIN ; decrement R0 if not zero go to AGAIN
        RET
ETC:    DB 03H, 06H, 09H, 0CH; code sequence for clockwise
rotation DELAY: MOV R2, #0FH ; move the delay value to R2
LOOP:   DJNZ R1, LOOP ; decrement R1 if not zero repeat the loop RET
        ; return back to main program
```