

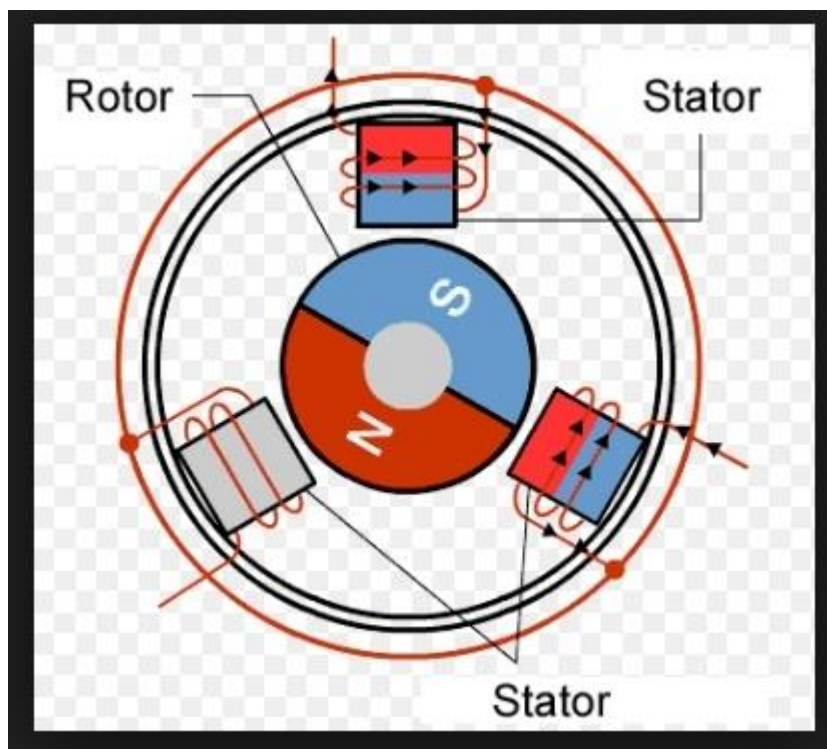
# Interfacing Stepper Motor with 8051 Microcontroller

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In this section, we will see how to connect a stepper motor with Intel 8051 Microcontroller. Before discussing the interfacing techniques, we will see what are the stepper motors and how they work.

## Stepper Motor

Stepper motors are used to translate electrical pulses into mechanical movements. In some disk drives, dot matrix printers, and some other different places the stepper motors are used. The main advantage of using the stepper motor is the position control. Stepper motors generally have a permanent magnet shaft (rotor), and it is surrounded by a stator.



Normal motor shafts can move freely but the stepper motor shafts move in fixed repeatable increments.

## Some parameters of stepper motors –

- **Step Angle** – The step angle is the angle in which the rotor moves when one pulse is applied as an input of the stator. This parameter is used to determine the positioning of a stepper motor.
- **Steps per Revolution** – This is the number of step angles required for a complete revolution. So the formula is  $360^\circ / \text{Step Angle}$ .

- **Steps per Second** – This parameter is used to measure a number of steps covered in each second.
- **RPM** – The RPM is the Revolution Per Minute. It measures the frequency of rotation. By this parameter, we can measure the number of rotations in one minute.

The relation between RPM, steps per revolution, and steps per second is like below:

$$\text{Steps per Second} = \text{rpm} \times \text{steps per revolution} / 60$$

## Interfacing Stepper Motor with 8051 Microcontroller

We are using Port P0 or P2 of 8051 for connecting the stepper motor. Here ULN2003 is used. This is basically a high voltage, high current Darlington transistor array. Each ULN2003 has seven NPN Darlington pairs. It can provide high voltage output with common cathode clamp diodes for switching inductive loads.

The Unipolar stepper motor works in three modes.

- **Wave Drive Mode** – In this mode, one coil is energized at a time. So all four coils are energized one after another. This mode produces less torque than full step drive mode.

The following table is showing the sequence of input states in different windings.

Steps	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

**Full Drive Mode** – In this mode, two coils are energized at the same time. This mode produces more torque. Here the power consumption is also high

The following table is showing the sequence of input states in different windings.

Steps	Winding A	Winding B	Winding C	Winding D
1	1	1	0	0
2	0	1	1	0
3	0	0	1	1
4	1	0	0	1

- **Half Drive Mode** – In this mode, one and two coils are energized alternately. At first, one coil is energized then two coils are energized. This is basically a combination of wave and full drive mode. It increases the angular rotation of the motor

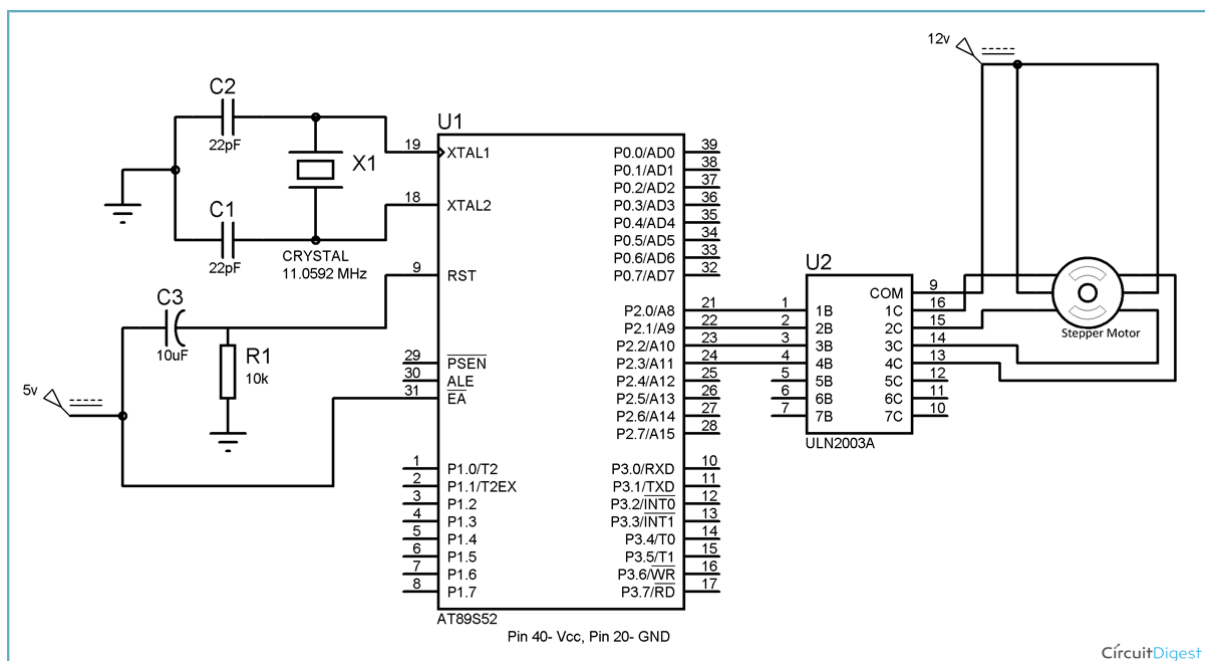
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Steps	Winding A	Winding B	Winding C	Winding D
1	1	0	0	0
2	1	1	0	0
3	0	1	0	0
4	0	1	1	0
5	0	0	1	0
6	0	0	1	1

Steps	Winding A	Winding B	Winding C	Winding D
7	0	0	0	1
8	1	0	0	1

## Interfacing Stepper Motor with 8051 Microcontroller

Interfacing with 8051 is very easy we just need to give the 0 and 1 to the four wires of stepper motor according to the above tables depending on which mode we want to run the stepper motor. And rest two wires should be connected to a proper 12v supply (depending on the stepper motor). Here we have used the unipolar stepper motor. We have connected four ends of the coils to the first four pins of port 2 of 8051 through the ULN2003A.



8051 doesn't provide enough current to drive the coils so we need to use a **current driver IC that is ULN2003A**. ULN2003A is the array of seven NPN Darlington transistor pairs. Darlington pair is constructed by connecting two bipolar transistors to achieve high current amplification. In ULN2003A, 7 pins are input pins and 7 pins are output pins, two pins are for Vcc (power supply) and Ground. Here we are using four input and four output pins. We can also use L293D IC in place of ULN2003A for current amplification.

You need to find out four coil wires and two common wires very carefully otherwise motor will not rotate. You can find it out by measuring resistance using multimeter, multimeter won't show any readings between the wires of two phases. Common wire and the other two wire in the same phase should show the same resistance, and the two end points of the two coils in the same phase will show the twice resistance in compared with resistance between common point and one end point.