Stepper motors and drives, what is full step, half step and microstepping?

Stepper motor is a brushless DC motor that rotates in steps. This is very useful because it can be precisely positioned without any feedback sensor, which represents an open-loop controller. The stepper motor consists of a rotor that is generally a permanent magnet and it is surrounded by the windings of the stator. As we activate the windings step by step in a particular order and let a current flow through them they will magnetize the stator and make electromagnetic poles respectively that will cause propulsion to the motor. So that' the basic working principle of the stepper motors.

Full step and half step

Stepper drives control how a stepper motor operates, there are three commonly used excitation modes for stepper motors, full step, half step and microstepping. These excitation modes have an effect on both the running properties and torque the motor delivers.

A stepper motor converts electronic signals into mechanical movement each time an incoming pulse is applied to the motor. Each pulse moves the shaft in fixed increments. If the stepper motor has a 1.8° step resolution, then in order for shaft to rotate one complete revolution, in full step operation, the stepper motor would need to receive 200 pulses, 360° ÷ 1.8 = 200.

There are two types of full step excitation modes.

In one-phase on - full step, Fig1, the motor is operated with only one phase energized at a time. This mode requires the least amount of power from the driver of any of the excitation modes.

In two-phase on - full step, Fig2, the motor is operated with both phases energized at the same time. This mode provides improved torque and speed performance. Two-phase on provides about 30% to 40% more torque than one phase on, however it requires twice as much power from the driver.

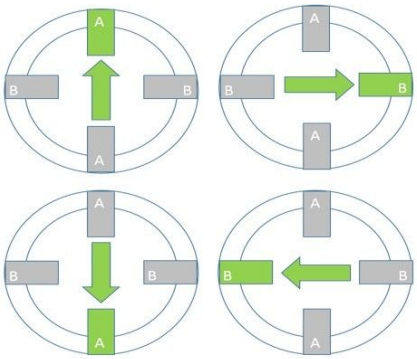


Fig 1 – One phase on – full step

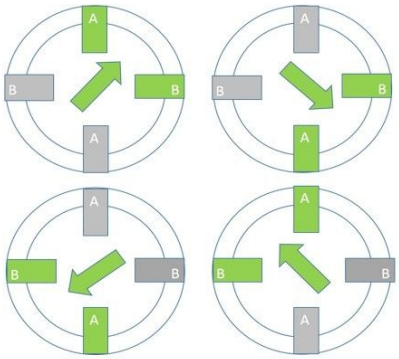


Fig2 – Two phase on – full step

Half step excitation mode is a combination of one phase on and two phase on full step modes. This results in half the basic step angle. This smaller step angle provides smoother operation due the increased resolution of the angle.

Half step produces about 15% less torque than two phase on - full step, however modified half stepping eliminates the torque decrease by increasing the current applied to the motor when a single phase is energized. See Fig3

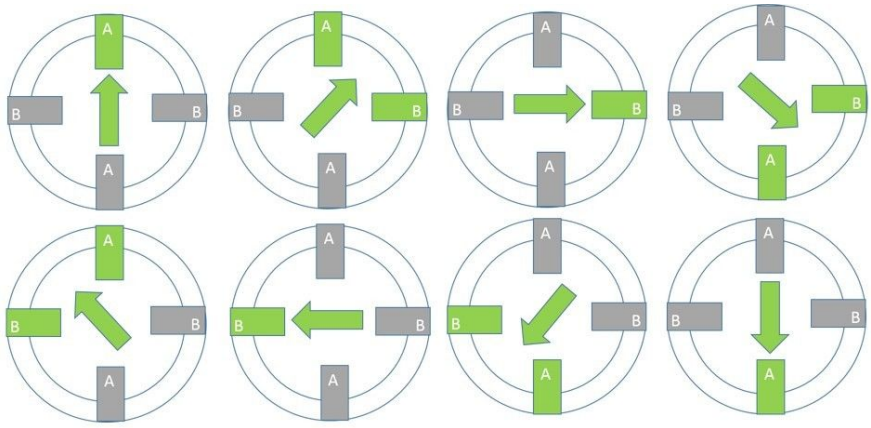


Fig3 - One-two phase on - half step

28BYJ-48 - 5V Stepper Motor

Pin Configuration

No:	Pin Name	Wire Color	Description
1.	Coil 1	orange	This Motor has a total of four coils. One end of all the coils are connect to +5V (red) wire and the other end of each coil is pulled out as wire colors Orange, Pink, Yellow and Blue respectively.
2.	Coil 2	Pink	
3.	Coil 3	yellow	
4.	Coil 4	blue	
5.		red	We should supply +5V to this wire, this voltage will appear across the coil that is grounded.

28BYJ-48 Stepper Motor Technical Specifications

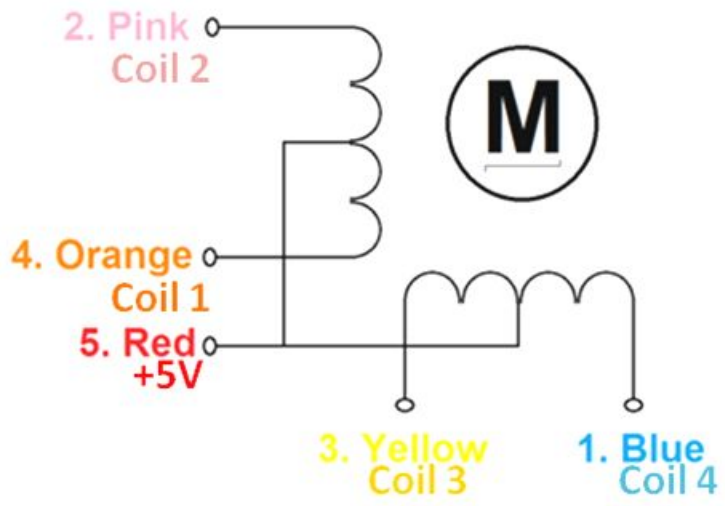
- Rated Voltage: 5V DC
- Number of Phases: 4
- Stride Angle: 5.625°/64
- Pull in torque: 300 gf.cm
- Insulated Power: 600VAC/1mA/1s
- Coil: Unipolar 5 lead coil

Where to use 28-BYJ48 Stepper Motor

The most commonly used stepper motor is the 28-BYJ48 Stepper Motors. You can find this (or similar) motors in your DVD drives, Motion camera and many more place. The motor has a 4 coil unipolar arrangement and each coil is rated for +5V hence it is relatively easy to control with any basic microcontrollers. These motors has a stride angle of 5.625°/64, this means that the motor will have to make 64 steps to complete one rotation and for every step it will cover a 5.625° hence the level of control is also high. However, these motors run only on 5V and hence cannot provide high torque, for high torque application you should consider the Nema17 motors. So if you are looking for a compact easy to use stepper motor with decent torque then this motor is the right choice for you.

How to use 28-BYJ48 Stepper Motor

These stepper motors consume high current and hence a driver IC like the ULN2003 is mandatory. To know how to make this motor rotate we should look into the coil diagram below.



As we can see there are four coils in the motor and one end of all the coil is tied to +5V (Red) and the other ends (Orange, Pink, Yellow and Blue) are taken out as wires. The Red wire is always provided with a constant +5V supply and this +5V will be across (energize) the coil only if the other end of the coil is grounded. A stepper motor can be made to rotate only if the coils are energized (grounded) in a logical sequence. This logical sequence can be programmed using a microcontroller or by designing a digital circuit. The sequence in which each coil should be triggered is shown in the table below. Here “1” represent the coil is held at +5V, since both the ends of coil is at +5V (red and other end) the coil will not be energised. Similarly “0” represents the coil is held to ground, now one end will be +5V and the other one is grounded so the coil will be energised.

For datasheet and gear ratios refer:
robocraft.ru/files/datasheet/28BYJ-48.pdf