**STEPPER MOTORS AND DRIVES**

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A stepper motor is a brushless, synchronous electric motor that converts digital pulses into mechanical shaft rotation. Every revolution of the stepper motor is divided into a discrete number of steps, in many cases 200 steps, and the motor must be sent a separate pulse for each step. The stepper motor can only take one step at a time and each step is the same size. Since each pulse causes the motor to rotate a precise angle, typically 1.8°, the motor's position can be controlled without any feedback mechanism. As the digital pulses increase in frequency, the step movement changes into continuous rotation, with the speed of rotation directly proportional to the frequency of the pulses. Step motors are used every day in both industrial and commercial applications because of their low cost, high reliability, high torque at low speeds and a simple, rugged construction that operates in almost any environment.

**Stepper Motor Advantages**

1. The rotation angle of the motor is proportional to the input pulse.
2. The motor has full torque at standstill (if the windings are energized).
3. Precise positioning and repeatability of movement since good stepper motors have an accuracy of 3 to 5% of a step and this error is non-cumulative from one step to the next.
4. Excellent response to starting/stopping/reversing.
5. Very reliable since there are no contact brushes in the motor. Therefore the life of the step motor is simply dependant on the life of the bearing.
6. The stepper motors response to digital input pulses provides open-loop control, making the motor simpler and less costly to control.
7. It is possible to achieve very low speed synchronous rotation with a load that is directly coupled to the shaft.
8. A wide range of rotational speeds can be realized as the speed is proportional to the frequency of the input pulses.

**Types of Step Motors**

There are three basic types of step motors: variable reluctance, permanent magnet, and hybrid. This discussion will concentrate on the hybrid motor, since these step motors combine the best characteristics of the variable reluctance and permanent magnet motors. They are constructed with multi-toothed stator poles and a permanent magnet rotor Standard hybrid motors have 200 rotor teeth and rotate at 1.8º step angles. Because they exhibit high static and dynamic torque and run at very high step rates, hybrid step motors are used in a wide variety of commercial applications including computer disk drives, printers/plotters, and CD players. Some industrial and scientific applications of stepper motors include robotics, machine tools, pick and place machines, automated wire cutting and wire bonding machines, and even precise fluid control devices.

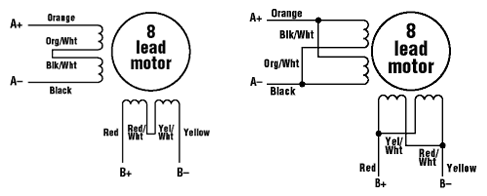
**Step Modes**

Stepper motor "step modes" include Full, Half and Micro step. The type of step mode output of any stepper motor is dependent on the design of the driver. Omegamation™ offers stepper motor drives with switch selectable full and half step modes, as well as micro stepping drives with either switch-selectable or software-selectable resolutions.   
  
**FULL STEP**  
 Standard hybrid stepping motors have 200 rotor teeth, or 200 full steps per revolution of the motor shaft. Dividing the 200 steps into the 360º of rotation equals a 1.8º full step angle. Normally, full step mode is achieved by energizing both windings while reversing the current alternately. Essentially one digital pulse from the driver is equivalent to one step.   
 **HALF STEP**  
 Half step simply means that the step motor is rotating at 400 steps per revolution. In this mode, one winding is energized and then two windings are energized alternately, causing the rotor to rotate at half the distance, or 0.9º. Although it provides approximately 30% less torque, half-step mode produces a smoother motion than full-step mode.   
  
**MICROSTEP**  
 Micro stepping is a relatively new stepper motor technology that controls the current in the motor winding to a degree that further subdivides the number of positions between poles. Omegamation micro stepping drives are capable of dividing a full step (1.8º) into 256 micro steps, resulting in 51,200 steps per revolution (.007º/step). Micro stepping is typically used in applications that require accurate positioning and smoother motion over a wide range of speeds. Like the half-step mode, micro stepping provides approximately 30% less torque than full-step mode.

**Linear Motion Control**

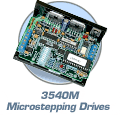
The rotary motion of a stepper motor can be converted to linear motion using a lead screw/worm gear drive system *(See figure B)*. The lead, or pitch, of the lead screw is the linear distance traveled for one revolution of the screw. If the lead is equal to one inch per revolution, and there are 200 full steps per revolution, then the resolution of the lead screw system is 0.005 inches per step. Even finer resolution is possible by using the step motor/drive system in micro stepping mode.

**Series vs. Parallel Connection**

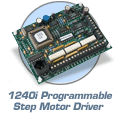
There are two ways to connect a stepper motor, in series or in parallel. A series connection provides a high inductance and therefore greater torque at low speeds. A parallel connection will lower the inductance which results in increased torque at faster speeds.  


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| --- | --- |
| Series connection | Parallel connection |

**Types of Stepper Motor Drives**

http://www.omega.com/prodinfo/images/t.gif[**Step and Direction**](http://www.omega.com/pptst/3540M.html)

These step motor drives accept step pulses and direction/enable signals from a controller, such as a PLC or PC. Each step pulse causes the motor to rotate a precise angle, with the frequency of the pulses determining the speed of rotation. The direction signal determines the direction of rotation (CW or CCW), while the enable signal turns the motor on or off.  
  
  
[**Oscillator**](http://www.omega.com/ppt/pptsc.asp?ref=ST_Series)

Step motor drives with a built-in digital oscillator accept an analog input or joystick for speed control. These systems are generally used in applications requiring continuous motion rather than position control, such as mixers, blenders, and dispensers.  
[**Stand-Alone Programmable**](http://www.omega.com/ppt/pptsc.asp?ref=1240i)

All of these stepper drives can be programmed for stand-alone operation; the motion control program is created with a simple drag-and-drop high-level software interface (included free), then downloaded and executed upon power-up. The motion control program typically waits for an input such as a switch closure or button press before executing the programmed motion.  
[](http://www.omega.com/ppt/pptsc.asp?ref=STAC6)[**High Performance**](http://www.omega.com/pptst/STAC6.html)  
 These step motor drives offer advanced features such as self-test diagnostics, fault protection, auto-tuning, torque ripple smoothing, command signal smoothing, and anti-resonance algorithms. Some drives are stand-alone programmable, while others offer step/direction and analog inputs. High-performance drives will provide the best possible performance for your motion control system.

