



Six Motor Types for Automation Applications

Motion examines motor technology basics

Steve Keeney, Motion Automation Intelligence

Motor solutions are the lifeblood of many applications, powering the precise movements and operations that keep automated systems running smoothly. While each system presents unique demands, the wide variety of motor types available ensures there is an option suitable for each specific need. It is vital to understand the pitfalls of choosing an inappropriate motor, given the countless motor types, brands and sizes.

To make informed decisions, it helps to become familiar with the six most common motor types and their key characteristics relevant to automation applications.

AC Motors

AC motors convert electrical energy into mechanical energy, distributing an alternating current over long ranges. They are flexible, efficient and tend to operate quietly, making them ideal for use in applications such as pumps, fans, blowers and other systems that need constant, variable or adjustable speed control.

AC motors work by using alternating current (AC) to create a rotating magnetic field in the stator, which induces a current in the rotor, causing it to rotate and generate mechanical power. This process is based on electromagnetic induction and the interaction between the magnetic fields of the stator and rotor.

Manufacturers use AC motors for multiple reasons, including:

- **Efficiency:** AC motors have high speed to torque, allowing them to operate without overheating or braking.
- **Brushless Design:** Brushless motors do not create friction, which reduces heat output and increases the motor's lifespan.
- **Quiet Operation:** AC motors run with a very low humming sound.
- **Simplicity and Accessibility:** With only one moving part (the rotor), AC motors are available in various shapes and sizes with different power outputs—suiting them to many applications.
- **Speed Control:** The frequency can be changed to control the motor's speed.

Brushed DC Motors

Brushed DC motors are used in applications that need high peak torques and use simple speed controllers. They are cost-efficient, easily controlled and have a linear torque-speed relationship.

A brushed DC motor has four components: a stator, rotor, brushes and a commutator. Basically, the permanent magnets mounted on the motor's outside create an electromagnetic field. Their operation allows them to produce high torque during acceleration and deceleration, making them ideal for industrial applications that involve dispensing, packaging and some robotic applications.

One drawback of brushed DC motors is the mechanical wear and tear on the brushes and the commutator, shortening their lifespan. However, their low initial cost can compensate for their frequent replacement needs.

Brushless DC Motors

Brushless DC motors are similar in function to brushed DC motors, except that they operate without brushes. While a brushed DC motor has magnets on the outside (the stator), brushless DC motors have magnets on the internal rotor. They do not use brushes to generate an electromagnetic field.

This design makes brushless DC motors quieter, more efficient, and longer lasting than brushed DC motors. They can also run cooler during continuous operation. While these benefits come with a slightly higher initial cost, brushless DC motors are ideal for hazardous environments with dust, grease, oil, and other contaminants.

Geared DC Motors

Geared DC motors, or gearmotors, have an attached gear assembly that allows the motor to increase the torque and reduce speed as needed—a process called gear reduction.

Gearmotors are rarely (if ever) used with external gearboxes, as the primary need for any reduction is usually addressed by gearmotor selection itself. They are small with a high torque-to-size ratio, creating a smaller motor footprint.

Stepper Motors

Stepper motors are brushless electric motors that move in precise, fixed increments, making them ideal for applications requiring repeatable positioning. Their unique design allows them to turn at a specific angle with each electrical pulse. Electrically, they operate by energizing multiple coils arranged in phases. When pulses are sent to these coils in a controlled sequence, they create a rotating magnetic field that moves the rotor step by step.

Stepper motors offer several advantages. In lower torque ranges, they are among the most cost-effective motors to produce. They provide precise, repeatable positioning without the need for feedback, making them suitable for open-loop positioning applications. They also deliver high torque at low speeds and are relatively easy to control with digital controllers.

However, stepper motors have limitations. As they typically lack feedback sensors, any missed steps go undetected, resulting in inaccurate positioning. Their torque and efficiency decrease at higher speeds, and they can experience resonance or vibration, which may require digital or mechanical damping techniques. And,

unless a more expensive digital controller is used, a stepper motor will consume power continuously, even when not in motion.

Common applications for stepper motors include medical equipment, 2D and 3D printers, camera and optics control, and small gantry systems.

Servomotors

Servomotors often convert rotary motion into linear motion with their position and velocity feedback. They work in mechanical systems with a feedback device such as an encoder or resolver. These motors provide detailed feedback but require a controller to manage commutation and position/velocity control. This continuously informs the user of the motor's position, speed and torque, making servo motors useful in precise or demanding applications requiring coordinated motion or robotics in industrial production.

Most servomotors today are brushless, offering accuracy, reliability, and efficiency, even in harsh environments. These motors also feature high acceleration, run quietly and operate on closed-loop control, with a high torque-to-inertia ratio comparable to AC motors. Their downside is their higher upfront cost.

Common applications for servomotors include robotics, conveyor belts, metal cutting and forming machines, printing presses, CNC and machine tooling, and food and beverage packaging.

Starter's Guide

Choosing the right motor for your automation application is a critical decision that can significantly impact performance, efficiency and overall success. No single motor fits every scenario, but understanding the unique features, benefits and drawbacks of each motor type will better equip decision makers to match the technology to the application. While this article's information provides a good start, partnering with a third-party expert can yield the best possible outcome with specialized knowledge and unbiased guidance tailored to your unique requirements.

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Steve Keeney is Strategic Product & Marketing Director for the Motion Automation Intelligence (Motion Ai) business group. Previously a Regional Manager for Rockwell Automation, he was a partner and owner of Applied Machine and Motion Control, Inc. (AMMC) when the company joined the Motion team in 2020. Throughout his 34-year career, Steve has focused on conceptualizing and applying automation, machine and motion control solutions.