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Brushless DC motors enable logistics automation solutions

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Growing levels of automation in the logistics value chain present engineering challenges that extend from the factory floor to last-mile delivery. At the same time, competitive pressures heighten the need to drive out costs and increase productivity.

Growing demand for cost-effective and efficient transportation solutions for the logistics sector shines a spotlight on the inherent benefits that BLDC motors provide.

These factors favor autonomous transportation solutions that provide a high degree of efficiency and reliability. A critical piece of technology is the motor, and design engineers increasingly realize the value that brushless DC (BLDC) motors provide for O&M cost savings and high reliability.

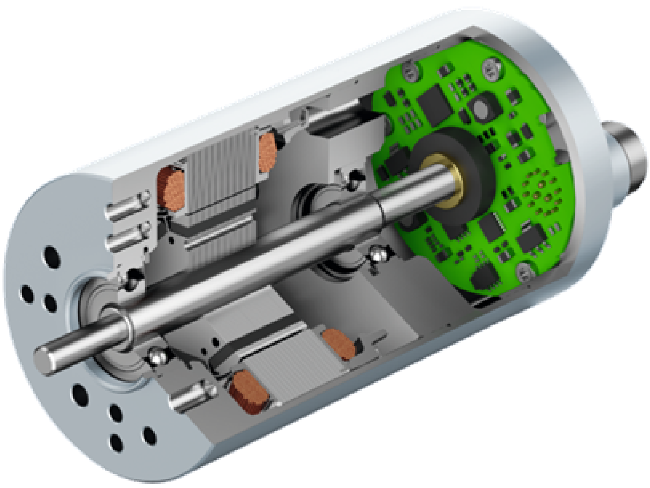

Figure 1. ebm-papst's ECI-63 K4 motor with integrated electronics. Source: ebm-papst

Traditional motors require brushes, which switch current from coil to coil as part of what is known as the commutation process. By contrast, brushless motors rely on electronics to handle the commutation task. Electronically switching current in this way is efficient, results in no wear and ends the need to replace brushes and commutators.

BLDC advantages

BLDC motors have fewer parts to wear out, offer high levels of reliability and efficiency and can often be relied on to provide up to 20,000 hours of service. That compares with service lives of roughly 3,000 to 5,000 hours for brushed motors. Brushless motors operate with less noise given their lack of brushes and low electromagnetic interference.

In addition, BLDC motors typically make use of rare earth magnets that generate greater flux density, thus allowing the rotor to be smaller for a given torque. The magnets deliver higher power than a brush-type DC motor of the same size. They also feature smaller motor geometry and are lighter than brushed DC and induction AC motors.

BLDC basics

A BLDC motor is a permanent magnet synchronous electric motor that runs on DC power and operates similarly to a conventional DC motor. They differ from conventional DC motors in four main ways: windings, magnets, sensors and controllers.

Windings

A BLDC motor stator features steel laminations that carry windings. The windings are placed into slots that are arranged in either a star or a delta connection. Based on stator windings, BLDC motors can operate in single-phase, two-phase or three-phase configurations.

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Each winding has several interconnected coils, with one or more coils in each slot. A stator winding is selected by voltage rating based on the power supply. BLDC motors with 48 V or less, for example, are often used in robotics, automotive and small actuating applications. Some industrial and automation system applications may use 100 V or even higher-rated motors.

Magnets

BLDC motors feature a permanent magnet in the rotor. While the number of rotor poles traditionally has ranged from two to eight pole pairs, modern designs may carry as many as 16 poles. For maximum torque, the magnetic material's flux density must be high. Rare earth alloy magnets are commonly used, including samarium cobalt (SmCo), neodymium (Nd) and ferrite and boron (NdFeB). Rotor configurations may vary so that design engineers can specify a circular core with a permanent magnet on the periphery or a circular core with rectangular magnets, among other setups.

Sensors

Hall effect sensors provide data that synchronizes stator armature excitation with the rotor's position. Before energizing a winding, the rotor position must be acknowledged. When a rotor magnetic pole passes the Hall effect sensors, a high or low signal is generated and the controller decides which coils to energize. The BLDC motor's electronic controller circuit energizes the appropriate motor winding by turning transistors or other solid-state switches, rotating the motor.

Controller

BLDC motors operate by an electronic drive that switches the supply voltage between stator windings as the rotor turns. A transducer monitors the rotor's position and provides data to the electronic controller. The magnetic field generated by the permanent magnets and the field induced by the current in the stator windings interact, creating mechanical torque.

While BLDC motors are relatively simple in pure mechanical terms, they require control electronics and regulated power supplies. An electronic controller replaces the brush assembly and performs comparative timed power distribution with a solid-state circuit. Several methods are available to implement the control unit, including a microcontroller, a hard-wired microelectronic unit or a programmable logic controller, among others.

Industrial automation and logistics

Economic growth in the manufacturing sector and in consumer markets, plus the continued shift to online shopping has forced logistics centers to up their game. To meet demand, manufacturers, logistics companies and other stakeholders must move rising volumes of goods through their facilities as efficiently and cost-effectively as possible.

Logisticians increasingly use automated guided vehicles (AGVs) to improve efficiency and reduce operating costs. AGVs are mobile robots used for material handling and tracking or to handle repetitive tasks. While they come in many different shapes and sizes, all AGVs require compact, dynamic drive systems that meet exacting requirements in terms of transport speed, positioning accuracy and service life.

Figure 2. AGVs at work in a logistics center. Source: ebm-papst

AGVs operate most economically when they achieve the longest possible travel routes and times without repeatedly charging their on-board energy storage units. AGV drive systems also need to be lightweight and compact even as they retain high power densities and deliver maximum energy efficiency. Motors should also be designed for a safety extra-low voltage not to mention being "smart" to provide relief for the control system by incorporating the motion component as part of the motor.

Not surprisingly, design requirements from AGV manufacturers are varied, including drive power, transmission variants, reduction stages, closed-loop control systems and connection technology. Best practices typically recommend designing a customized drive solution that combines a variety of different modules.

BLDC motors supplied by drive system specialist ebm-papst are designed for such modular drive systems. The ECI-42, ECI-63 and ECI-80 model series are particularly well suited to applications in AGVs, allowing manufacturers and users to collaborate with a single expert in the industry, even with a significant range of variants.

With diameters of 42, 63 and 80 mm, motors from ebm-papst cover a power range of between 30 and 750 W. Their drive systems can be quickly and flexibly adapted to the specific task at hand thanks to their modular design, meaning they can be combined with control electronics, transmissions, encoders and brakes as needed.

Growing demand for cost-effective and efficient transportation solutions for the logistics sector shines a spotlight on the inherent benefits that BLDC motors provide. To learn more about the range of BLDC solutions, contact ebm-papst.

EBM-PAPST INC.

100 Hyde Road
Farmington, CT 06034 USA
Tel: (860) 674-1515

IEEE GLOBALSPEC

201 Fuller Road, Suite 202
Albany, NY 12203-3621
Tel: +1 518 880 0200