Brush DC Motors turning More Advanced

"Off-the-shelf" brush-commutated DC motors typically tend to serve as a "starting point," because virtually every application for a motor carries particular design and performance criteria to be accommodated.

Motor manufacturers usually address these criteria by customizing products with components to satisfy the demands. An end-user thereby gains a motor designed to perform as required and, in the process, others ultimately may benefit if and when a custom component becomes "standard." Many innovations in motor technology, in fact, have originated as specific solutions to specific customer challenges.

Innovations have further been driven by overall marketplace needs. As examples, motor manufacturers have been obliged to offer more power in smaller packages in the race to keep pace with miniaturization; motor designs have incorporated new components in new ways to help extend motor life; and new or improved materials have been tapped with the goals to promote motor quality and output.

All permanent magnet DC motors, of course, operate similarly by converting electrical energy into mechanical energy through the interaction of two magnetic fields. One field is produced by a permanent magnet assembly; the other field is produced by an electrical current flowing in the motor windings. The relationship between these two fields results in a torque that tends to rotate the rotor. As the rotor turns, the current in the windings is commutated, or switched, to produce a continuous torque output.

Beyond these basics, however, today's (and tomorrow's) brush-commutated DC motors continue to move in highly advanced directions.

'Brushing Up' on Motor Life'

Since the primary cause of failure in brush-commutated DC motors over time is ongoing brush wear caused by the interface between brush and commutator, manufacturers have sought to slow the wearing process by targeting brush assemblies, brush size, and brush materials.

The traditional method for mounting brushes in DC motor assemblies has been to solder the brushes onto standard cantilever springs to enable the required constant contact with the commutator. The conventional spring design, however, exhibits inherent drawbacks as force levels diminish over time, often resulting in premature motor failure.

This problem can be overcome by housing brushes within a specially designed cartridge and utilizing torsion springs to ensure desired even force over the life of a motor.

The **cartridge brush assembly** fits into the motor base and consists of a two-piece, high-temperature plastic snap-together assembly in which each of two brushes is seated securely within its own specially constructed slot.

This cartridge design restricts the brushes to traveling in a track in a desired linear motion. The design further can provide for an ideal region of pressure for brushes to withstand the detrimental effects of mechanical wear.

The introduction of the "**SuperBrush**" (in selected Pittman brush-commutated DC motors) has paved the way for potentially longer brush life. "SuperBrushes" contain 60% more brush material and offer the correlated potential for longer motor life compared with smaller (and quicker-wearing) conventional brushes.

An increasing variety of **alternative brush materials** can be specified as another means to help prolong effective brush life. Electrographitic is one among many relatively new (and durable) brush materials now offered by manufacturers in addition to standard copper graphite brushes to curb the problems associated with brush wear. Combinations of materials can be engineered for optimal life and electrical characteristics. Selecting the right brush material for each specific application can optimize overall motor life.

A Matter of Size and Performance

As end-products get smaller, so do the "envelopes" for the motors. The irony is that while small brush DC motors offer minimal room to house components, the demand for power output associated with larger motors is unrelenting.

As a real-world example illustrating one way to realize power from small-diameter motors, our 22mm brush DC motor family has been augmented with an **extended motor length** (1.900 in.). This new longer motor is designed to provide up to 40% more continuous torque (up to 2 oz-in) and deliver more power compared with shorter 22mm diameter models.

Other benefits from added motor length are the capability to dissipate more heat at a faster rate than is possible with shorter motors (which, in turn reduces the potential for undesired heat buildup) and the availability of expanded room to house components.

A challenge for motor designers working with smaller motor lines is how (and where) to integrate tabs and wires, capacitors for RFI suppression, brush assemblies, and other components, whether standard or custom. **Internal PC boards for surface-mounting internal components** have emerged as a viable and practical solution.

These boards serve as a platform to incorporate the various required components without affecting motor size and weight. They can be engineered in a circular shape for mounting easily inside a motor's frame or configured for mounting in an encoder housing. Either way, the boards can maximize available space and provide a reliable and secure means to locate a variety of motor components crucial to performance.

Advances in materials have further enabled designers to keep motor performance levels high in ever-smaller motor packages. An example is our pending **thinner bonded neodymium** magnet in development for introduction this year in selected series of brush-commutated DC motors, which can provide both design and performance advantages.

Two-pole permanent magnet stators in brush-commutated DC motors generally are constructed of ceramic magnets (which are enclosed in heavy-gauge steel return rings). The new thinner bonded neodymium magnet is more powerful but takes up less space than conventional ceramic-only types.

This impacts positively on the development of **specially adapted armatures**. The availability of smaller, thinner magnet materials allows for larger-motor armatures to be designed into smaller motor frames. This can imbue a small motor with a capability to produce more continuous torque and, consequently, more power.

End-users enjoy more brush DC motor options at their disposal than ever before, even as more stringent specifications impact on motor size and performance.

One way to navigate all the choices and evaluate all the options, while helping to ensure a product performs as specified, is by partnering with a qualified motor manufacturer from the very beginnings of an end-product's design stage. This can minimize (and even eliminate) costly mistakes at the outset and even enhance end-product design and performance.

Such early involvement can additionally open a window (and provide early access) to the latest innovations in brush-commutated DC motor technology.

This technical article was prepared by the engineering team at Haydon Kerk Pittman Motion Solutions, a leader in motion technologies. Complex custom and ready-to-ship standard lead screw assemblies are made at USA facilities with a full range of onsite capabilities including designing, engineering and manufacturing.