Precision Miniature Motors Aid Aerospace and Defense Applications

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The applications for miniature motors span a wide range, from pumps that deliver insulin to regulate blood sugar, to motors that roll out paper in everyday desktop printers. As expected, application demands also vary greatly over this range, from simple office uses to extremely hazardous environmental uses. Aerospace and defense applications typically fall into the latter category. In this article, we will review these stringent requirements and illustrate examples of how these can be addressed in the design of precision miniature motors.

DC Coreless and Brushless DC products are typically selected for these applications, primarily due to the higher efficiencies and lower weight of these motors. Stepper motors also have their place in applications where precision is required, but cost is a driving factor. All three technologies fit well in aerospace and defense applications, due to their ability to be adapted not only to the high performance demands, but also to the environmental aspects of this market. In aerospace and defense applications, temperature ranges

required can be severe, decreasing to –50degC and rising to 200degC. Motor components must be specially designed not only to survive in these temperature extremes, but also to allow easy start-up and to provide high output performance throughout the entire operating range. Advancements in materials, particularly metals used in motor housings, special bearing lubricants, and plastics for insulation of the coils, now allow motors to operate in these taxing A&D environments.

Besides temperature extremes, higher shock and vibration requirements are demanded in most A&D applications. General motor design practices seek to mitigate these factors; however, specialized design is required to allow miniature motors to perform in these extreme environments. For example, experience illustrates that even small movement of the coil can damage the motor to the point of failure. Motor design, therefore, must ensure that the critical internal components of the motor (rotor, shaft, bearings) are adequately secured to prevent movement, even when exposed to the most severe shock and vibration conditions. In addition, exposure to potentially hazardous materials often encountered in these applications is another potential motor failure mode that must be addressed in motor design for A&D application. Motor design engineers seek to incorporate advanced materials coupled with specialized design in sealing the motor. The optimum design ensures that the motor can not only operate at peak efficiencies in these extreme environments, but even more importantly, ensure the motor operates safely.

Let’s take a look at a few of the more typical miniature motor applications for aerospace and defense. Various types of valves and actuators are used on aircraft vehicles to perform a variety of critical functions, from regulating the flow of fuel to the engine to controlling the airflow into the aircraft environmental control systems. Due to their physical location in the aircraft/vehicle system, these applications typically are located in extreme environments, yet demand maximum performance from a given motor frame size. Typical design considerations include modifications to 1) magnet material, to ensure that magnet strength does not degrade as temperatures elevate; 2) lamination materials, to ensure that the motors can withstand the temperature ranges that they will be exposed to; and 3) lead wires that connect the motors to the drive board to ensure that they remain pliable in extreme cold and withstand melting in extreme heat. Note: Teflon materials typically address these requirements. All of these design modifications to the motor must be considered to ensure high performance operation throughout wide temperature extremes over the lifecycle of the aircraft/vehicle.

Window Shade automation is a recent innovation in commercial aircraft aimed at providing ease of use for passengers, as well as allowing increased control for the airline personnel. These new systems allow the passenger to raise or lower the shade at the touch of a button, providing passenger convenience while allowing flight attendants to uniformly close the shades, controlling the ambient light within the cabin. DC Coreless motors are used in this application due to their high power density, low noise, and low temperature rise. The ability to operate the motors without a control is an obvious advantage; moreover, the high efficiency and low weight of these motors reduces power/fuel consumption -- a key objective for every airline flying today.

The last category of applications involves one-time use, where precision control in a high speed/extreme vibration environment is imperative. As the motor performance is directly proportional to the performance of the system, every potential parameter that can even marginally affect performance during operation must be addressed in the motor design. Custom brushless DC motors are ideal for these applications since they provide a high power density in small, low-weight designs. Since precision is the key objective, encoder feedback is typically used to ensure proper positioning as well as self-correction.

As is evident from the above applications, manufacturers supplying precision motors into the specialized A&D market must be able to provide custom motor designs for each specific application. Due to the unique requirements in this market, engineers must thoroughly understand how to optimize specific design criteria dictated by the requirements. Manufacturers, who offer a variety of motor technologies, have the unique ability to analyze the specific demands of the requirement across all technologies as well as design considerations and, in many cases, offer multiple custom motion control solutions to the customer.

Aerospace and defense applications have existed for many years now and continue to expand with the advancements in technology. As evidenced in this article, refining design with material advancements to provide optimized motion control solutions will continue to be the challenge in addressing the demands of this ever evolving market.