MACHINE DESIGN

Thin is In December 12, 2002

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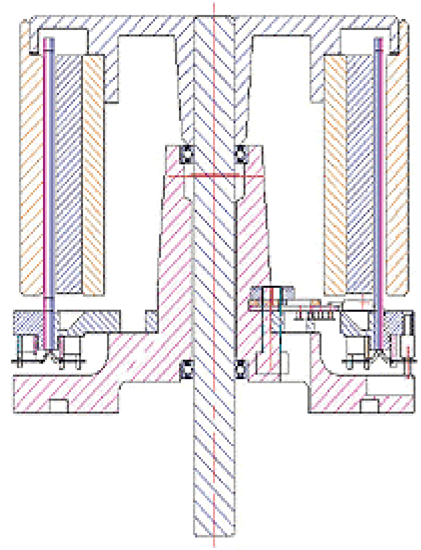


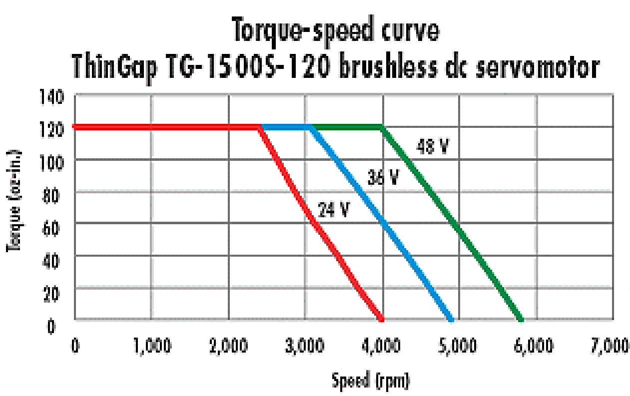
A cutaway view of the motor shows the thin copper stator coil, iron, and permanent-magnet placement.

Today's OEM demands motion-control systems that increase throughput and can handle smaller-scale moves. All industries are looking for finer speed and motion control. For instance, in data-storage devices, the design challenge is to squeeze more data onto the storage medium. That requires precise control of the reading head and, in turn, more accurate servomotors. The biggest barriers to getting greater accuracy from a servomotor are cogging torque and hysteresis. Engineers usually focus their efforts on reducing these two parameters, but a new motor succeeds in eliminating them entirely.

The ThinGap servomotor eliminates both hysteresis and cogging torque by eliminating magnetic materials in the stator that can distort, demagnetize, or saturate with peak currents. There is no iron in the stator coil. Instead, the stator is made of nonmagnetic, high-temperature materials with no magnet wire or iron laminations, which also gets rid of slot harmonics and eliminates iron losses. The rotor contains the entire magnetic circuit; permanent magnets and the magnetic return structure are fixed on the rotating drive shaft, eliminating eddy currents and hysteresis losses.

There's another advantage to not having wire windings; consistency. Every motor is built with the same automated and repeatable process control. The stator and armature conductors are formed as a freestanding thin shell, which lowers heat generation and aids in heat dissipation. Air moving over both the inside and outside of the coil dissipates heat.

The biggest problem with wire-wound, slotted, iron-core motors is cogging. Motor designers in the past have tried various tricks to minimize cogging such as skewing magnets and minimizing slot size. But cogging is inherent because the motor design uses iron and there is magnetic attraction between rotor and stator. At the same time, hysteresis in conventional motors limits precise motion control. ThinGap eliminates hysteresis by getting rid of the relative motion of magnetic components, which also eliminates magnetic friction. The only friction present is in the motor bearings, making the motor ideal for applications with air bearings, magnetic bearings, and oil-film journal bearings with low radial spring-force constant.



Torque remains constant over a wider speed range compared with iron-core servomotors.

Saturation in the rotor and stator coil limits peak power in iron-core motors. With no magnetic materials, the ThinGap stator coil can't become saturated with high current. This translates into higher peak power at lower duty cycles. Another feature of the motor is the low electrical inductance. Low inductance means faster response times and the ability to accelerate rapidly. An added benefit is that the control systems for the new servomotors are not as complex because programs don't need algorithms to anticipate and correct for cogging torque. This simplifies programming and tuning of the motor, saving time and effort.

Servomotors are tested for overshoot and settling time by examining the S-curve profile. A finely tuned servomotor follows the curve in forward and reverse movements. The ThinGap motor smoothly follows the S-curve with minimal overshoot and settling time.