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About Altra Industrial Motion

Altra Industrial Motion (NASDAQ:AMIC) is a leading multi-national designer, producer and marketer of a wide range of electromechanical power transmission products. The company brings together strong brands covering over 40 product lines with production facilities in nine countries.

Altra's leading brands include Boston Gear, Warner Electric, TB Wood's, Formsprag Clutch, Wichita Clutch, Industrial Clutch, Ameridrives Couplings, Kilian Manufacturing, Marland Clutch, Nuttall Gear, Stieber Clutch, Twiflex Limited, Bibby Transmissions, Matrix International, Inertia Dynamics, Huco-Dynatork, Ameridrives Power Transmission, Delroyd Worm Gear and Warner Linear. For information on any of these technology leaders, visit www.AltraMotion.com or call 815-389-3771.

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Delroyd Worm Gear

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Altra Industrial Motion

A Controlled Stop

As seen in
Motion System Design
March, 2009

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A Controlled Stop

Electro-mechanical spring-applied and PM brakes — they help to make servomotor-driven machines safer, more reliable and more controllable.

by Peter Anderson
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Brechin, Angus, Scotland

Fast, powerful and highly controllable, servomotors are an essential part of many modern machine designs. But what happens when the power shuts down? Without energy to control the position of the motor shaft, it will tend to move in response to whatever external loads are applied at the time. At best, this means that an emergency shut down or an unexpected loss of power can result in a machine going out of sync. At worst, uncontrolled motion can present a significant safety risk.

Fortunately, spring-applied electromagnetic brakes can safely bring a motor to a stop, or hold its static position, without the need for external power.

The most common and cost effective brake for the majority of servomotor applications is the spring-applied design. These brakes operate by applying the force of a spring to a friction plate mounted on the motor shaft. In operation, a DC voltage applied to a coil disengages the brake. If the voltage is removed, the brake activates.

Design Considerations

When selecting a brake for a servomotor application, think carefully about the operating conditions and demands of the application. The selected brake must have sufficient static (holding) torque to keep the shaft in position under all operating conditions. The orientation of the motor should be established, especially if its axis is not horizontal, as this can affect loads experienced by the brake.

- In a highly dynamic application, the brake hub and friction plate should have minimum inertia, as this inertia adds to that which must be accelerated and decelerated by the motor, increasing its power requirement. The brake dimensions must be kept to a minimum for a given static torque. Servomotors usually have a compact overall diameter, and the brake diameter must be smaller, while keeping the brake's overall length to a minimum.
- Determine how the static parts of the brake are fitted to the motor, to maintain the brake's concentricity and squareness to the motor shaft. How is the brake hub to be fastened to the motor shaft, with regard to torque transmission and axial location? Normally a bore and keyway would be used; other methods could include shrink fit, driving pin, or D connection. If space is restricted, can the hub spline be machined on the motor shaft?
- Consider electrical requirements. The power absorbed by the brake coil should be kept to a minimum, as the brake coil is continuously powered while the motor is in use, generating heat in a confined space with high ambient temperatures (up to 150° C). Brake coil wiring must be specified along with the length and termination of any flying leads. Find out if any regulations apply to this wiring and any connectors used.

  Brake coils require a DC voltage, which is normally provided by rectifying the AC voltage used to power the motor. Ensure that the DC voltage and current is always supplied to the brake coil while the motor is running, in order to keep the brake disengaged — as the speed of a servomotor can be controlled by varying the supply voltage.
- The speed of electrical response in the brake control circuit must also be considered, to ensure the brake is disengaged before the motor begins to rotate. Consider this timing in the event that the motor is controlling falling loads, such as lifts or cranes. Or, for emergency stops, for example, loss of power when the motor is in a dynamic condition, remember that servomotor brakes have a limited ability to absorb energy.
- If the brake can handle the energy of a single dynamic stop, the frequency of these dynamic stops should be determined, to predict the wear life of the friction material.

Why is this braking?

Why do some servo-applications require the brakes we discuss here? Servomotor applications often require rapid duty cycle with fast rates of acceleration and deceleration. So, servomotors are often made to minimum dimensions — with a compact square section preferable to a short overall length (to keep inertia low) or even a short "pancake" design.

Servomotor brakes are robust and reliable. Even so, their integration requires care and full consideration must be given to the specific characteristics of each motor installation.

Backlash

In many safety-critical applications, it is sufficient that the brake can bring the motor to a controlled stop or hold it in approximate position in the event of power loss. In some high-precision applications, however, where many different servomotors may operate in exact synchronization, there is a need to control the precise position of the motor shaft. Here backlash is a concern.

Spring applied brakes have a small but significant backlash. In many cases, such as where the motor is coupled to a gearbox which itself exhibits backlash, backlash in the brake will be lower than that exhibited by other parts of the system and the spring-applied design will provide adequate precision.

That said, the need for a zero backlash brake calls for a different design altogether. Permanent magnet brakes are the choice here. Their magnets generate the braking force. A DC voltage applied to the coil generates a magnetic force, which opposes that from the permanent magnet, and a release spring disengages the brake.

Using finite element analysis (FEA) tools, design engineers can optimize the magnetic path within the brakes, to maximize torque while minimizing power consumption and cost. Also, continuous product development including evaluation and the introduction of special friction materials suitable for high temperature use ensure these brakes are suitable for the most arduous application conditions.

Backlash Busters

Spring-applied electromagnetic and permant magnet brakes offer solutions to design engineers in a wide variety of industrial applications — packaging, semiconductors, forklifts, automotive, machine tool, medical, printing, robotics, assembly, paper converting, and more. Spring-applied,electrically-released brakes offer either low or zero-backlash; PM brakes provide zero backlash for high-precision application. Design strategies are also available for applications requiring low noise, such as in the medical industry or in theatre hoists.