ESTAT ACTUATION

SCHNEEBERGER LINEAR TECHNOLOGY

Advanced Electroadhesive Brakes Provide Stopping Power for Linear Motion Systems

How paper-thin electroadhesive linear brakes **unlock significant power and weight savings** in new and legacy linear motion systems.

By: Kirby Witte, VP of Engineering, ESTAT Actuation

Linear motion systems must pack all the right features and components in increasingly compact designs. Brake technologies are a critical part of this puzzle, providing load holding, emergency stopping and other safety capabilities in the event of power failures. Unfortunately, traditional brake technologies like friction, electromagnetic and spring brakes are far too bulky and power-hungry to support the latest advancements in compact linear motion systems.

Tackling these challenges head-on is electroadhesive brake technology, which uses static voltage fields to keep components stationary. Using a design consisting of electrostatic “webs,” these innovative, 0.015-inch thick components deliver compact, lightweight braking with minimal power requirements, unlocking many benefits in both new and legacy machine designs.

Electrostatic Adhesion 101

The static voltage fields in electroadhesive technology are generated by proprietary electrostatic webs, which are layered devices consisting of a carrier structure, electrode and dielectric friction surface material. These webs of paper-thin ceramic composite materials feature extremely high capacitance, enabling them to take advantage of electrostatic forces.

Pairs of these electrostatic webs can function as brakes, clutches and torque limiters in motion applications when one web is installed on the moving components and the other is installed on the stationary components. Without an applied voltage, the two webs can freely move past each other. But when voltage is applied, the two webs adhere via electrostatic forces. Essentially, this process "glues" the two surfaces with the toggle of a switch. Removing the voltage allows the two surfaces to move freely past each other once again.

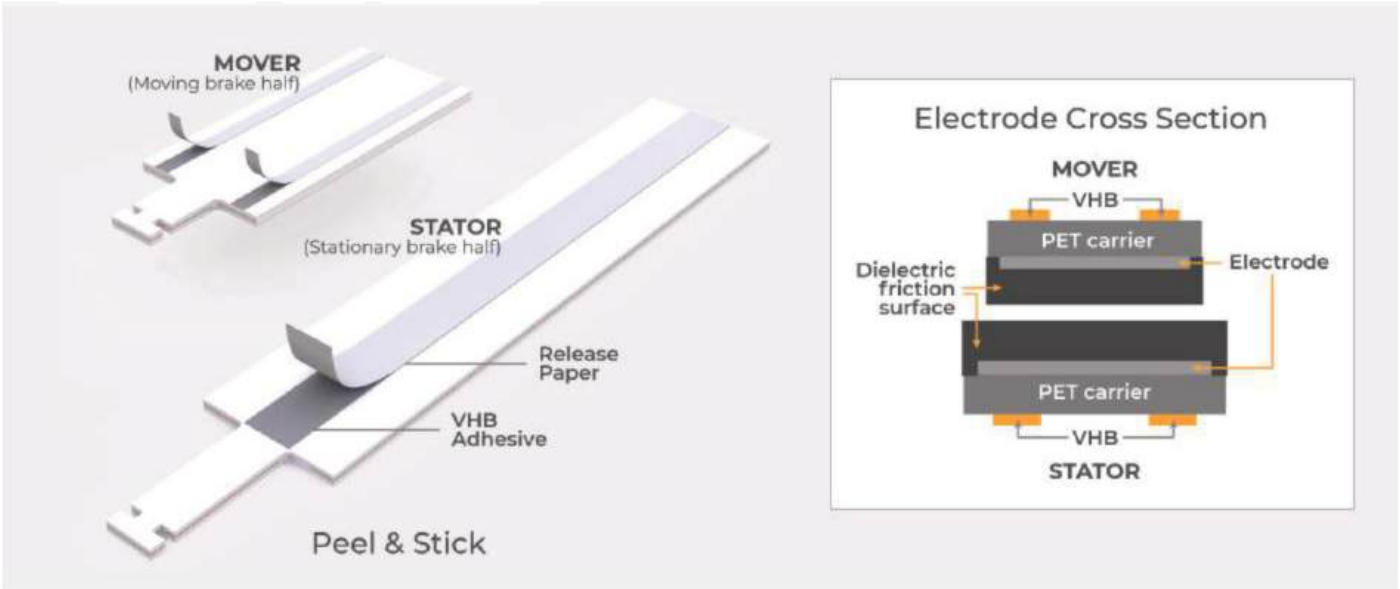
Brakes designed with electroadhesive technology are ideal for a wide range of linear motion applications. Keep in mind, however, that due to their extremely thin dimensions, these brakes don't have much mass to dissipate heat, lowering the brake's lifespan if used in dissipative brake applications.

The Benefits of Ultra-Slim Linear Brakes

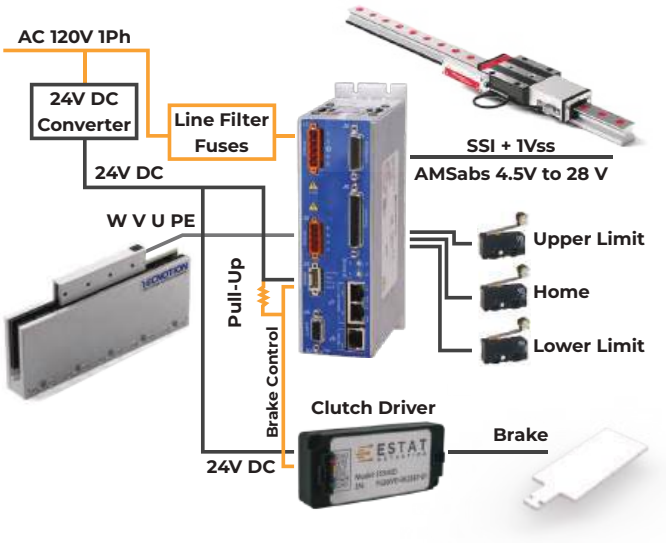
ESTAT's UltraSlim Linear brakes are ideal for linear motion systems that require extremely compact and efficient components. One of the brake's most prominent features is its 0.015-inch thickness, supporting installation in the most cramped environments and unlocking new machine designs. At the same time, the brake easily integrates into existing machines, avoiding costly redesign.

Here's an overview of the advantages of these paper-thin electroadhesive brakes.

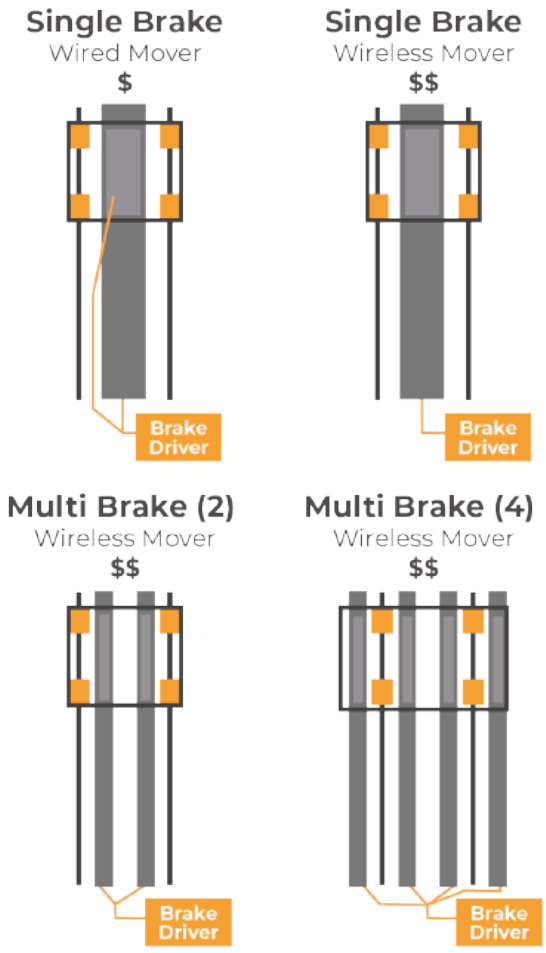
Electrostatic Web Installation & Structure



Cross section of a linear brake showing the layered structure of the electrostatic web.

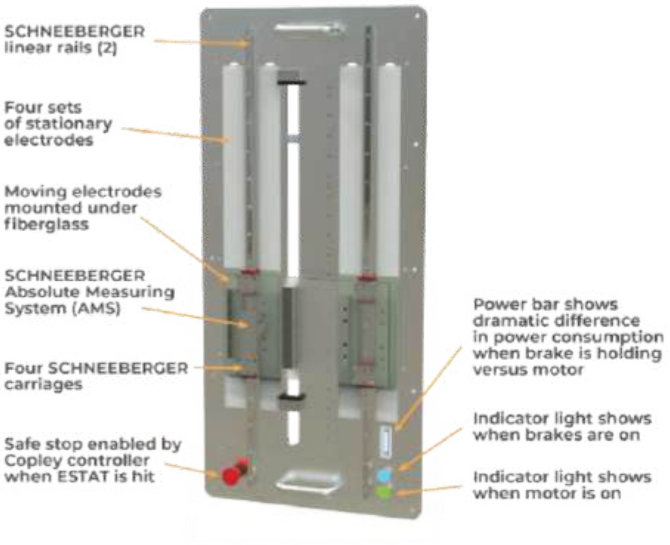


- **Simple installation.** A pressure-sensitive adhesive on the back side of both the mover and stator facilitates installation. To install each brake half, simply peel the wax paper covering the adhesive and stick the brake to the surface of your actuator. Although the brake is flexible enough for peel-and-stick installation, it is also extremely hard and durable to provide excellent brake performance. Just be sure to remove your watch before installation — the brake might scratch it.
- **Lightweight designs.** Compared to electroadhesive brakes, traditional brake technologies are much heavier and introduce a lot of inertia that must be overcome. To achieve the required motion profiles, many linear motion systems will incorporate larger motors to accommodate the brake's weight. Because the electroadhesive brake is so light, its weight is insignificant and does not require bigger motor specification.
- **Low power and zero magnetic interference.** By relying on electrostatic adhesion, the brake consumes a negligible amount of power and supports highly energy-efficient machine designs. Additionally, the electroadhesive brakes are magnetically transparent. They will not electromagnetically interfere with sensors or actuators and are unaffected by the electromagnetic interference (EMI) of other devices. Magnetic transparency allows you to install these brakes directly next to magnetic sensors. This feature also makes electroadhesive brakes uniquely suited for medical applications — even allowing their use in magnetic resonance imaging (MRI) machines.



ESTAT UltraSlim Linear brakes support multiple configurations.

- **Single driver for multiple brakes.** All electroadhesive brakes require a brake driver to operate, and a single brake driver can run several brakes simultaneously. Depending on the design, the brake requires 300 to 500 volts (V) provided through ESTAT's brake driver. The driver can receive 4.5 to 24.5 V per power input. At maximum, a driver consumes 3.4 watts (W) and will consume less than 0.05 W most of the time.
- **Fast response and silent operation.** These brakes are also silent during operation and offer extremely fast response times under 30 milliseconds (ms).
- **Fine-tuned performance.** Electroadhesive technology is highly tunable. By raising or lowering the input voltage to the brake, you can easily increase or decrease the braking force. This capability is especially useful in applications in which the brake may be used as a mechanical fuse to decouple the drive if shock loads exceed acceptable limits. This protects expensive harmonic drives and other components from damage.



The ESTAT, SCHNEEBERGER, Copley Controls and Tecnotion demonstration system.

- **Flexible configurations.** Electroadhesive linear brakes are available in multiple configurations to meet installation weight and scale requirements. The first configuration is the least costly and features a single brake with a wire that runs to the mover. Applications that need minimal moving weight may require the next configuration consisting of a single brake and wireless mover. Additional configurations consist of multiple brakes running off of one brake driver.

Specifying an Electroadhesive Brake

The process of designing a motion system with an electroadhesive brake is fairly similar to working with conventional technologies. First and foremost, reserve brake selection until after you have specified your motion profiles, rails, carriages, motors and control systems. Because an electroadhesive brake has negligible power requirements and such low weight, implementing this technology rarely leads to iterative design.

Electroadhesive brakes provide a braking force of 1 newton per square centimeter (N/cm^2) of unit area of overlap between the static and dynamic layer. Here are some key considerations for specifying these brakes:

- Mounting space: ESTAT can design a brake to accommodate any spaces equal to or bigger than 0.015 inch.
- How to extend the brake area, if necessary.
- Number of required voltage drivers.
- Power requirements.
- Control requirements.

After specifying your brake, draft the wiring diagram that depicts how to ground the system and incorporate limit switches and emergency stops. Then, install your motion system.

Easy System Integration

To demonstrate how easy electroadhesive brakes integrate with common linear motion systems, ESTAT partnered with SCHNEEBERGER to design a demonstration system. This motion system consisted of two SCHNEEBERGER linear rails, four carriages and the integrated Absolute Measuring System (AMS) for distance measurement. Tecnotion provided an ironless linear motor, and Copley Controls provided a XEC-230-15 servo drive.

A Copley Controls XEC servo drive.

The XEC drive was an ideal choice for the demonstration because it meets modern standards for electromagnetic compatibility (EMC) and safe torque off (STO). It also has expanded network and feedback capabilities. In new machine designs especially, selecting drives with these safety features goes a long way toward reducing costs and requirements for additional components in order to meet evolving safety standards.

This demonstration system shows the ease with which ESTAT's electroadhesive brake technology integrates with standard linear motion components like guide rails, stages, motors and controllers.

"The UltraSlim Linear brake is extremely easy to install," adds Dean Crumlish, Product Manager and Senior Applications Engineer at Copley Controls. "From a controls perspective, we treat it like we would any other brake. It's very useful for direct drive motor applications that require tunable friction control and don't feature a shaft."

While UltraSlim Linear brakes are applicable to any linear motion system, they are especially a natural fit for vertical linear motors. Even if a motor has an integrated brake, it may not meet the requirements of an emergency stopping brake and disengage during power failure. External brakes are installed in these applications to provide safety, but traditional brake technologies introduce vibrations and add weight to the entire system. The UltraSlim Linear offers an alternative solution that doesn't contribute to bulk or weight challenges and enables features like STO in vertical applications.

Learn More

Compact, lightweight and requiring little power, electroadhesive brakes are a thousand times more efficient than conventional brakes in many applications, enabling easy integration into both new and legacy linear motion designs.

*Find out more on **estat.tech**.*

The Benefits of the MONORAIL AMS System

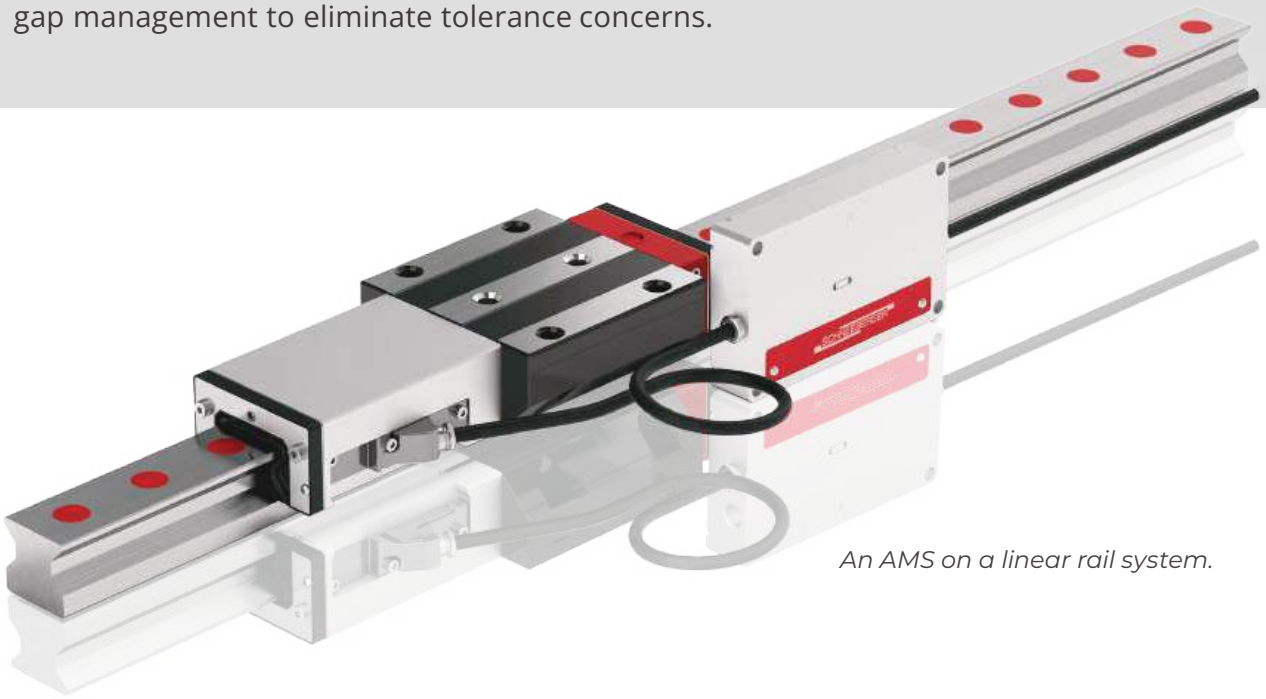
The MONORAIL AMS offers excellent precision and accuracy across various applications. Designed for space efficiency, it integrates the measuring system into the carriage and guideway, simplifying installation processes while saving time and labor costs.

For flexibility and compatibility, MONORAIL AMS is compatible with all control interfaces. And, the system is available in absolute signal and both analog and digital incremental output versions.

While a single rail piece has a maximum length of six meters, multiple rails can be combined to meet large-scale applications. The AMS Long was specifically developed for these applications by reading position over butt-joined rails. SCHNEEBERGER profile guideways offer enhanced durability because both the ball monorail and roller monorail feature larger contact area — increasing load capacity and life while reducing wear and friction.

Because SCHNEEBERGER's AMS system magnetic encoder is sensitive to EMI from brakes nearby, ESTAT's brakes are a perfect match. The magnetic transparency of ESTAT brakes eliminates the risk of signal interference and allows them to be mounted adjacent to the rail and carriage-mounted encoder.

And while ESTAT's brakes are easy to install, it is still essential to manage the gap between the brake's stationary and moving element. SCHNEEBERGER machines its rail systems to micron-level precision and ensures accurate gap management to eliminate tolerance concerns.



An AMS on a linear rail system.