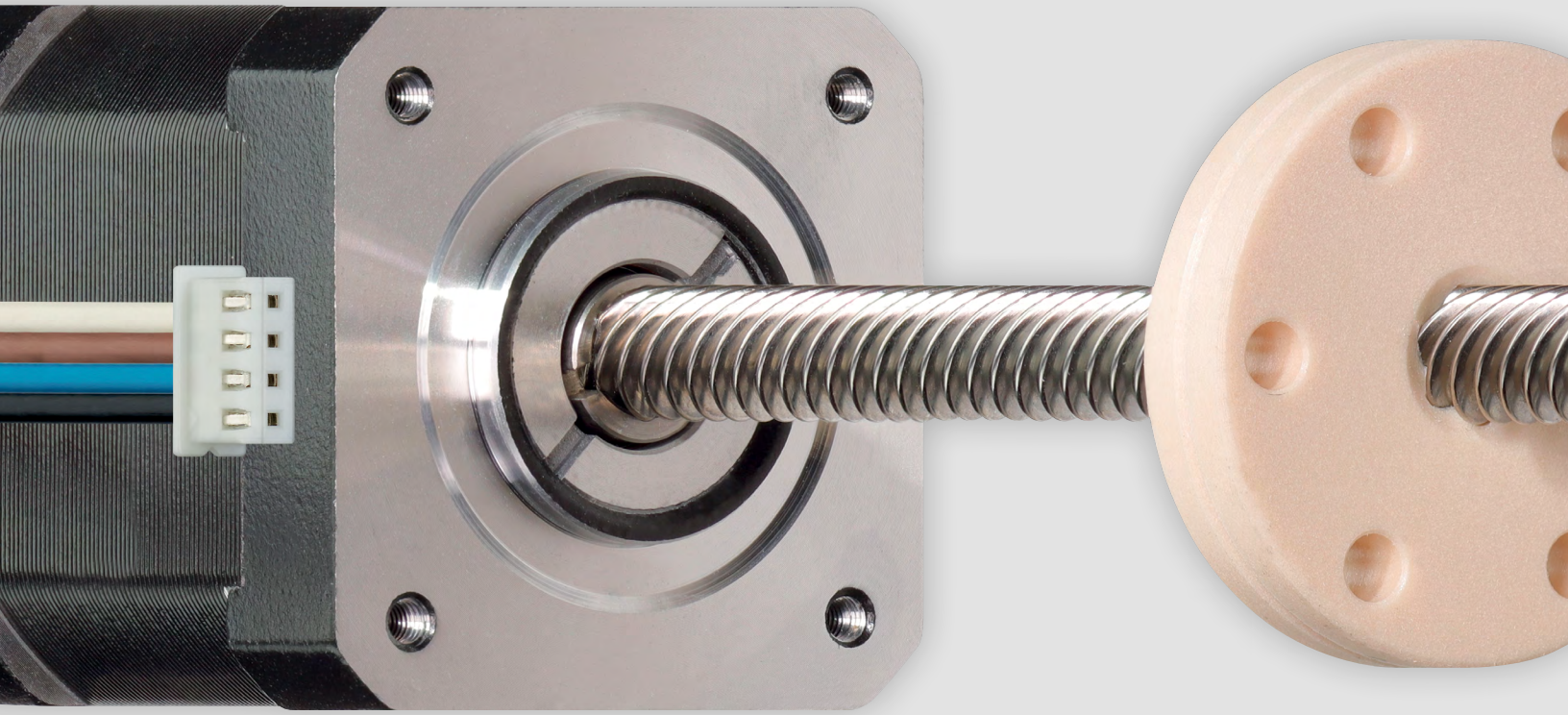
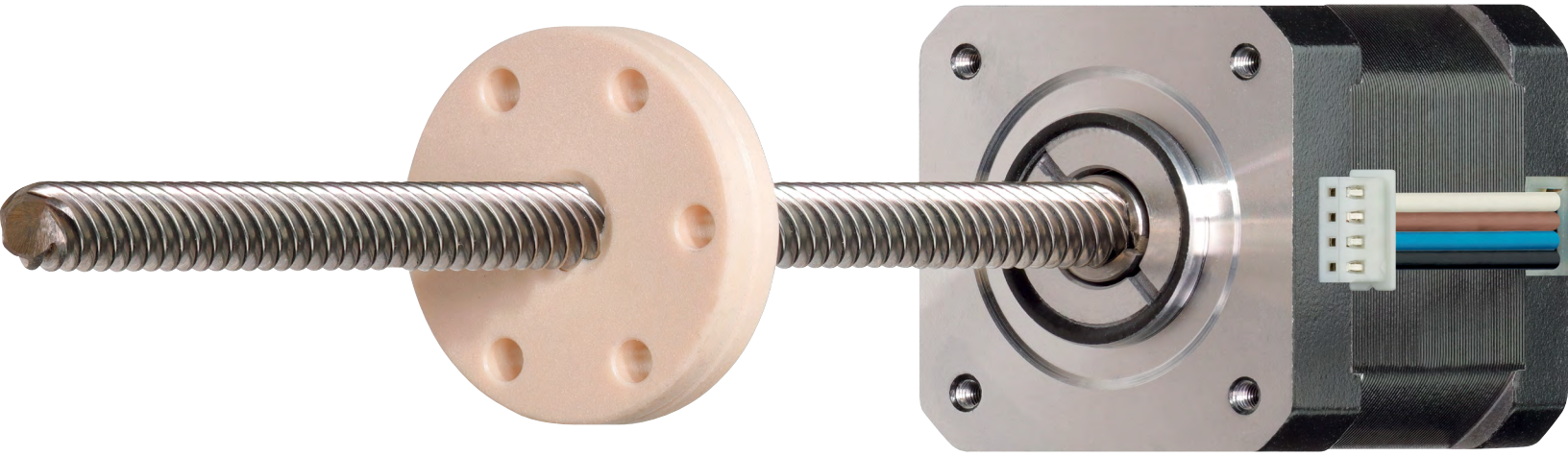


Selecting the ideal lead screw actuator

Engineering reliable, space-saving solutions for dynamic industrial applications

Introduction & background

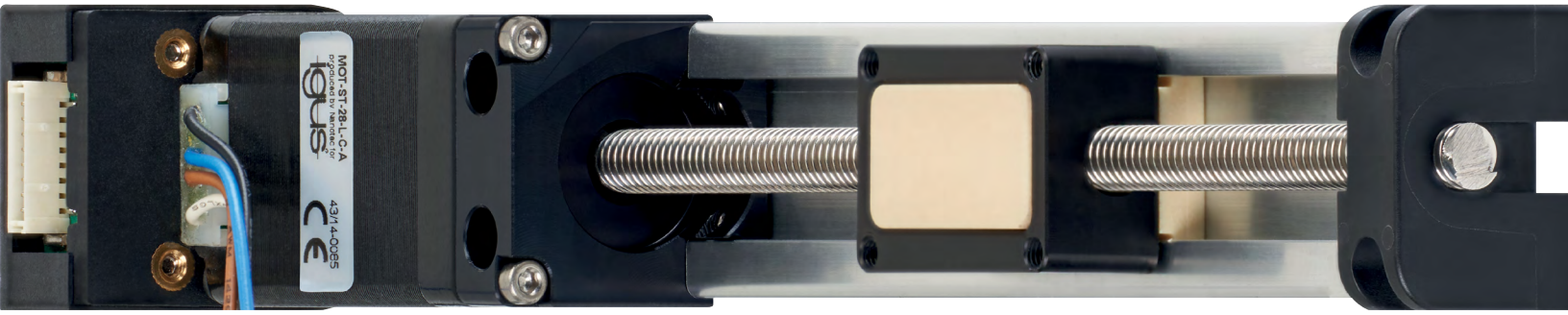
Lead screw actuators convert rotational movement to linear movement — a process that is involved in near-endless drive technology applications. But what should design engineers consider when selecting and designing lead screw actuators? And how should engineers distinguish the ideal use cases for lead screws from those of other linear actuator technologies? This white paper will answer these questions and provide an overview of igus' own line of high-performance drive technology products.



Linear axis with lead screw stepper motor

What is a lead screw actuator?

A lead screw actuator consists of a combination of an electric stepper motor and a permanently fixed screw that drives a nut. The motor is equipped with a mechanically fixed cavity for receiving the lead screw. The motor-shaft connection is made with screws, adhesive, pressure, or welding. igus lead screw actuators make this permanent connection using a combination of screws and adhesive, creating a linear actuator.



Lead screw motor with lead screw inserted

What requirements does the **motor need to fulfill?**

Lead screw motors must be capable of absorbing greater axial forces than conventional industrial electric motors with the same output. This is because the linear system being moved places an axial load on the motor. To counteract this, the motor must supply a comparable push force. Conventional motors are unsuited for this, and therefore should not be used in linear actuator applications.

Example: A NEMA23 stepper motor in the drylin E product line from igus is designed for an axial load of at least 500N, but a conventional motor can typically only handle 15N.

Scope of use

Lead screw actuators are ideal for small to medium linear adjustments and are frequently integrated with customized linear guides. The igus® range offers a distinct advantage by providing low-cost automation with scalable precision to meet specific application needs. Furthermore, every system is engineered for completely grease-free operation.

These compact actuators are versatile and widely utilized across several sectors:

Office & Desktop Equipment: Precise movements in scanners or printers.

Medical Technology: Reliable adjustments in sensitive lab environments.

Food & Beverage: Maintenance-free components for coffee machines.

Industrial Automation: Space-saving solutions for compact machinery with limited installation envelopes.

Performance specifications

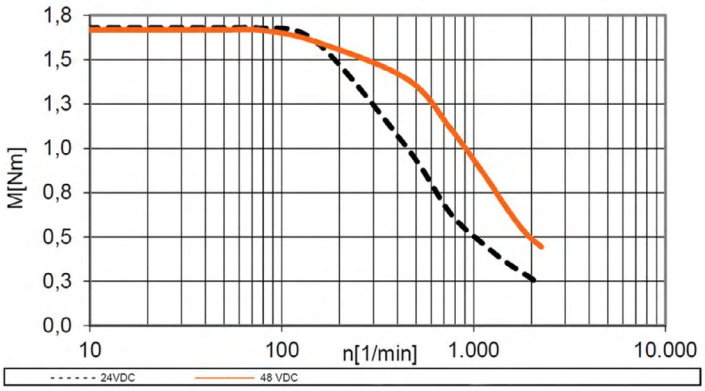
The igus® lead screw motor range is available in NEMA 8 to 23 frame sizes, offering a versatile power-to-size ratio. Performance is defined by the following parameters:

Feed Force: Up to 500N, depending on the screw pitch.

Torque: Up to 2Nm, as specified by the torque-speed characteristic curve.

Travel Speed: Maximum speeds of 0.4m/s (pitch-dependent).

Positioning Accuracy: Typically precise up to 0.1mm.



Tips for configuring lead screw actuators

Configuring a lead screw motor is a straightforward process when following a few core parameters. To select the correct actuator, you must first define your application requirements:

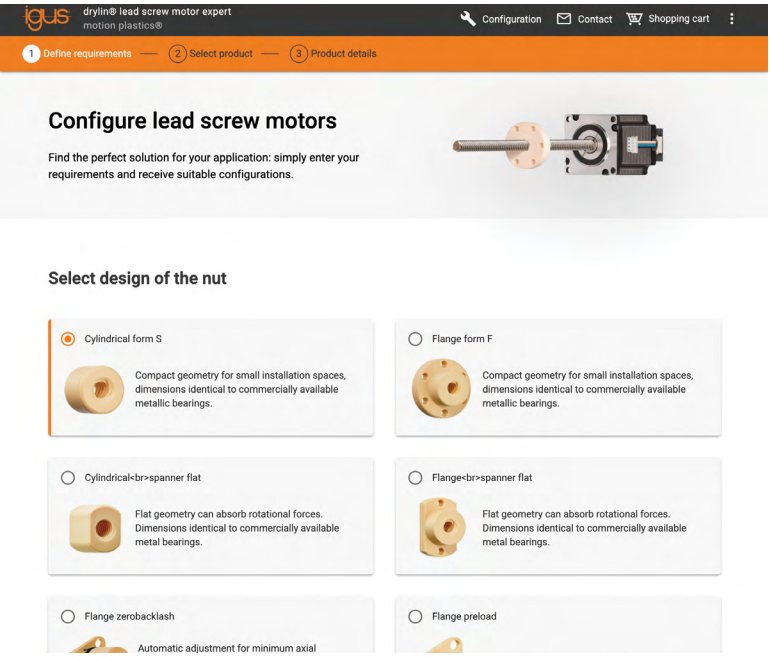
Mechanical Needs: Stroke length, load requirements, and desired feed rate.

Precision: Positioning accuracy (resolution) and lead screw concentricity.

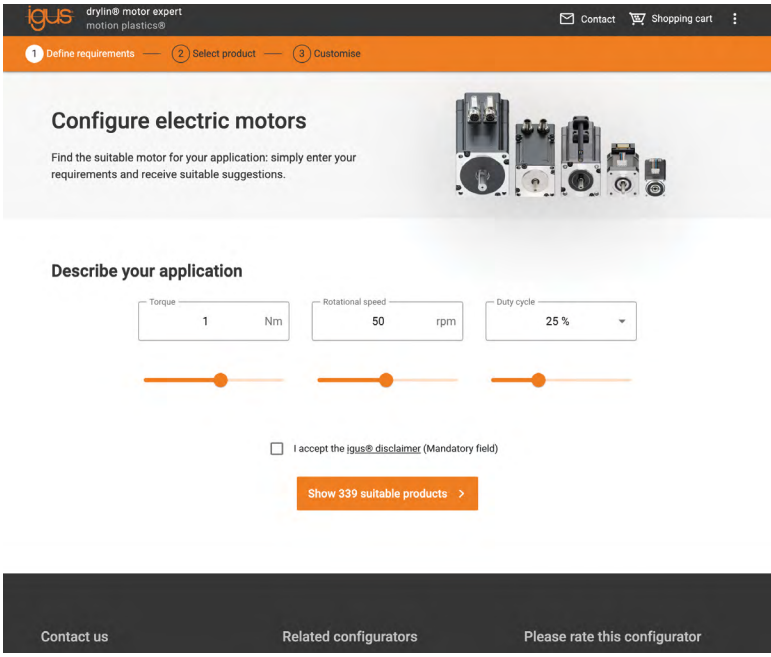
Environment: External factors such as operating temperature and required IP protection class.

Performance is primarily driven by the relationship between motor speed and screw pitch. During the design phase, it is essential to calculate the expected service life (measured in total strokes) to ensure long-term reliability.

To simplify the process, manufacturers like igus® provide online tools like product configurators, service life calculators, and selection tools.



drylin lead screw motor configurator



drylin motor configurator

Concentricity & precision standards

A critical factor in selecting a lead screw motor is concentricity, which is directly influenced by the straightness of the lead screw. The drylin® E product range offers two distinct precision tiers to meet different application requirements:

Standard: These lead screw actuators have a maximum concentricity deviation of 0.2mm.

Custom: Customer-specific lead screw actuators that offer 0.1mm concentricity deviation while remaining within limit values.

Note: All concentric runs are measured 100mm from the motor flange.

Component selection & design

The feed rate of a linear actuator is dictated by the specific type of lead screw and its pitch. Within the igus® range, users can choose between standard trapezoidal threads, ideal for heavy loads and manual adjustments, or dryspin® high-helix threads, which are engineered for high-efficiency and rapid travel speeds.

Beyond geometry, the material pairing of the lead screw and nut is a vital factor in system longevity. A field-proven combination features a stainless steel lead screw paired with a nut made from high-performance polymers. These specialized plastics feature incorporated solid lubricants, creating a maintenance-free system that eliminates the need for external oil or grease.

Tip

When designing a lead screw actuator, it is beneficial to consider whether the nut can be integrated directly into the component being moved. This holistic approach allows users to reduce the overall part count, simplify the assembly process, and create a more compact system footprint. For low-volume projects or specialized prototypes, 3D printing provides a cost-effective way to produce these customized nuts without the high overhead of traditional tooling.

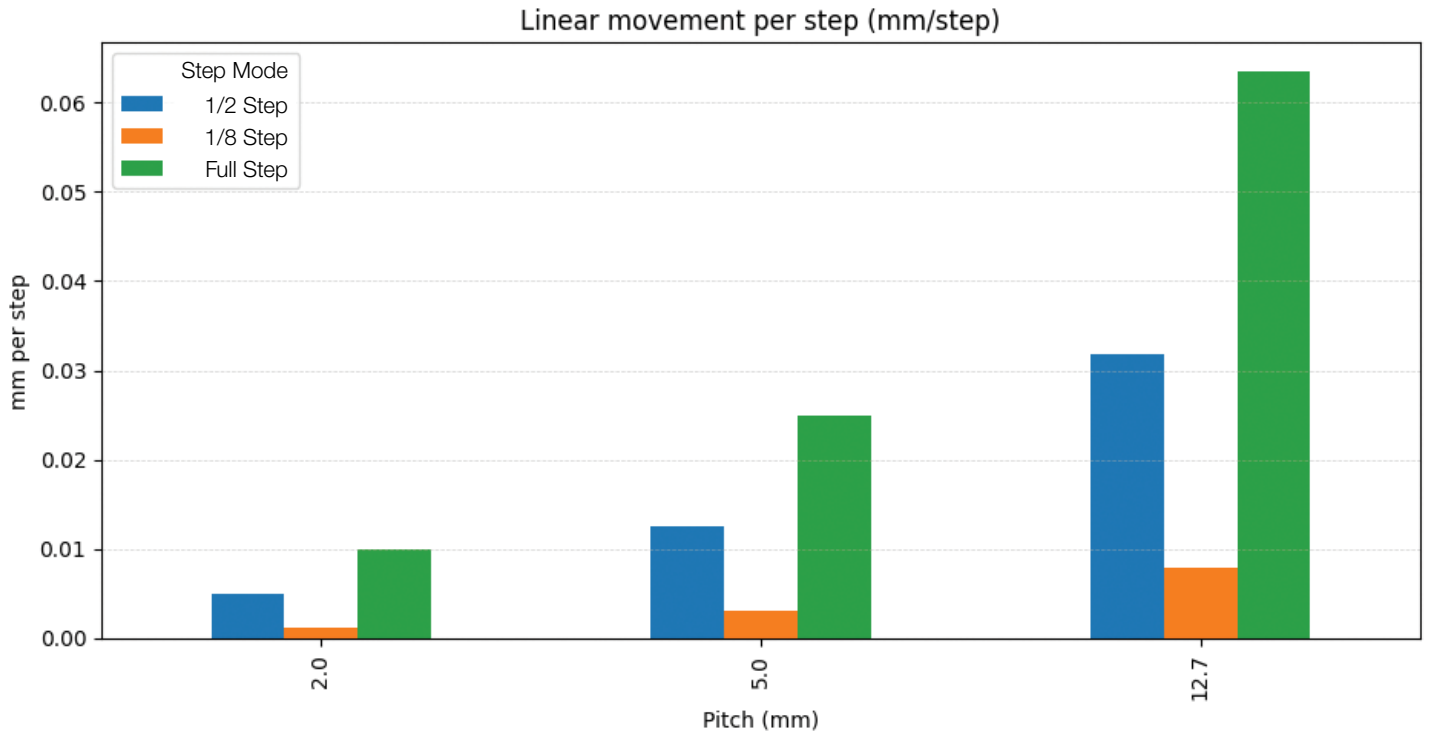
Lead screw pitch

The pitch of a lead screw is the distance between two adjacent threads. There is a large range of lead screw pitches, and the pitch of a lead screw has a direct impact on compatibility with other components and the efficiency of the system. The right pitch can even enable a linear actuator to achieve self-locking operation.

Learn more: What is screw pitch, and how is it different from screw lead?

Positioning accuracy

The positioning accuracy of a lead screw actuator is determined by the relationship between the motor's mechanical resolution and the screw pitch. For a standard stepper motor with a resolution of 1.8°, a single 360° rotation of the motor shaft consists of 200 individual steps. To calculate the theoretical accuracy, the lead screw pitch is divided by these 200 steps. In practical applications, utilizing a small pitch — such as 2mm — allows for precise positioning within the hundredth of a millimeter range.



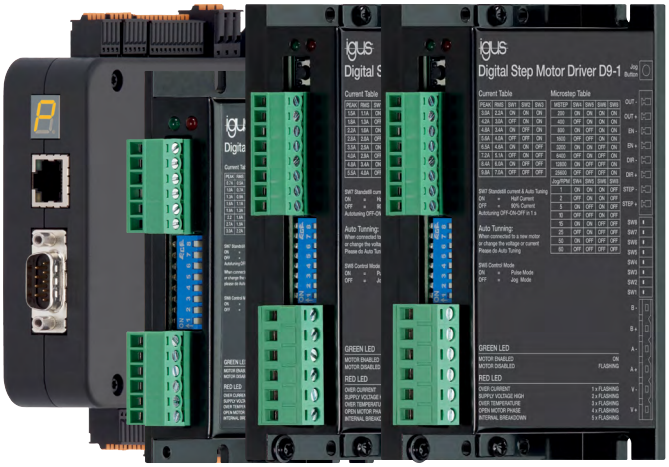
Selecting thread profiles

When selecting an actuator, the choice typically falls between a trapezoidal lead screw and a high-helix thread. The trapezoidal lead screw is often the preferred solution for applications where transmitting high axial forces is the primary requirement. This is due to the robust engagement between the nut and the thread, which provides the mechanical stability necessary to handle significant loads efficiently.

In addition to standard thread designs, users can opt for specialized geometries such as igus® dryspin® lead screws. These feature a flatter flank angle compared to conventional high-helix designs, allowing the actuator to convert input force into translational movement more efficiently. This geometry results in an exceptionally high degree of efficiency — up to 82% — while simultaneously extending the system's service life through reduced friction and wear.

Motor controllers

Integrated dryve® motor controllers from igus can be used to create complete, ready-to-install actuator systems out of the box. Beyond the basic assembly, lead screw actuators can be equipped with encoders to create a closed-loop system. When paired with a dryve motor controller, this setup ensures high positioning reliability while providing precise command over both travel and feed force. Users can further customize the interface by choosing from various electrical connection options, such as flying leads or integrated connectors.



Differentiation from other linear actuators

Design engineers have several options when implementing linear actuators, including electric cylinders, pneumatic cylinders, or modular systems that combine an electric motor and flange with a dedicated linear axis, such as the drylin® W guide.

However, a lead screw actuator is the ideal choice when an application requires a simple, space-saving, and cost-effective actuator for linear motion. The lead screw motor is particularly advantageous in these scenarios due to its exceptionally compact design, which allows for seamless integration into tight installation spaces.

Quality & selecting factors

When selecting lead screw motors, design engineers and purchasers must carefully evaluate the connection between the motor and the lead screw. This connection is subject to significant, often dynamic loads — particularly in the axial direction — during start-up and braking. While adhesive bonds and mechanical screw connections are common, they must be robust enough to withstand these repetitive stresses.

Performance over time is another critical quality factor. Because lead screws and nuts are dynamic components, they are naturally subject to wear; however, selecting high-quality material combinations can significantly extend service life compared to standard alternatives. Additionally, the straightness of the lead screw, determined by the quality of the manufacturer's straightening process, is a vital factor in ensuring smooth, consistent operation.

Conclusion

The performance profile detailed above establishes lead screw motors and drives as the standard for space-saving, cost-effective automation. This solution is particularly effective for design engineers whose applications involve moderate requirements across key design parameters, such as load, positioning accuracy, travel speeds, and cycle rates.

Across the broader landscape of mechanical engineering, there are countless applications where the lead screw motor serves as the ideal linear actuator, providing a balanced and reliable design under these specific operating conditions.