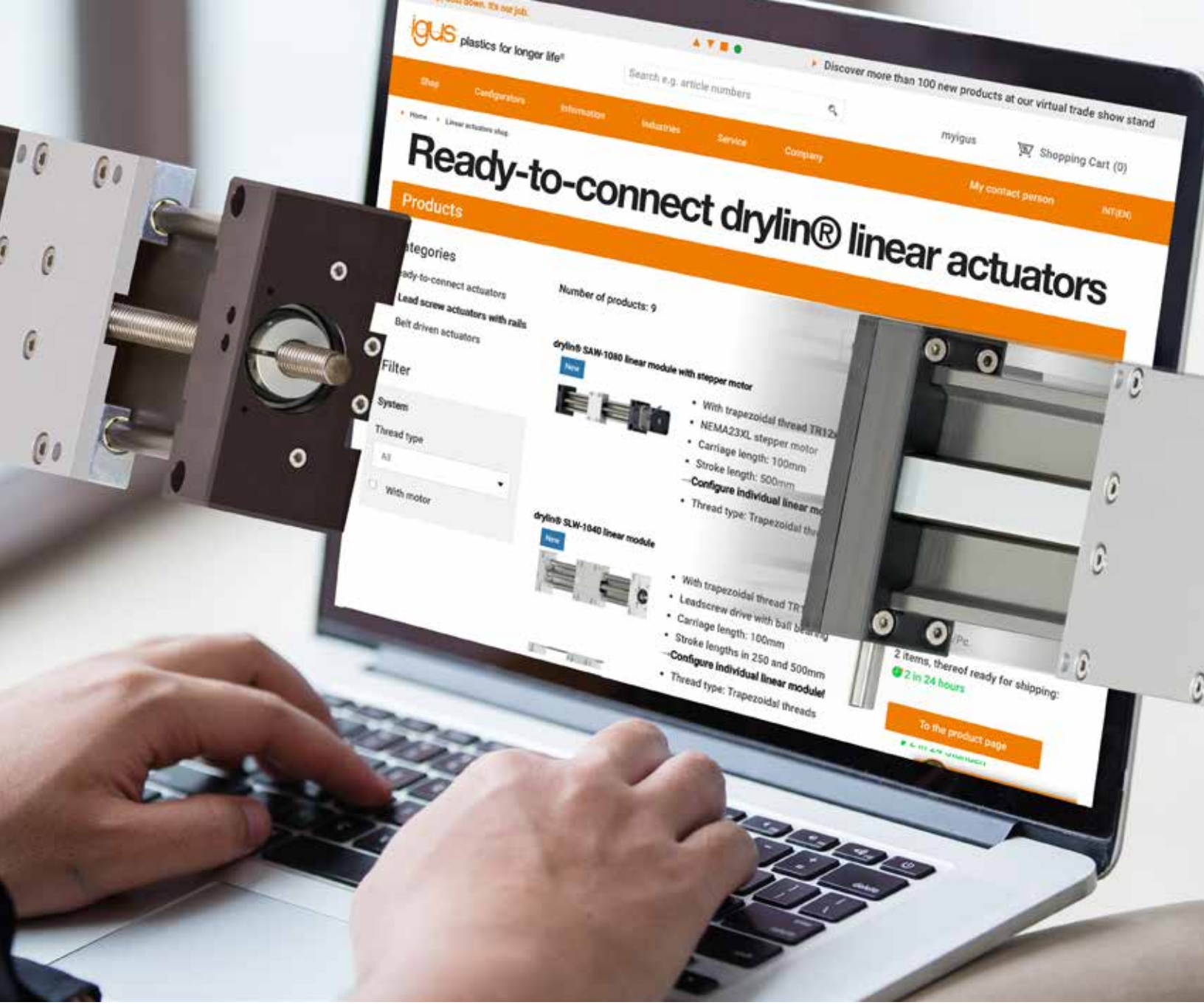



# WHITE PAPER:

## Toothed belt drive or lead screw drive:

How do I choose the right linear actuator?

igus®

## 1 The most common linear drive systems

In the area of automation and mechanical engineering, linear axes are important elements that can be used for simple positioning tasks or for the implementation of complex, high-precision multi-axis systems. Linear actuators and linear axes are driven in different ways.
The two most common types of linear drive are linear actuators with lead screw drive and linear axes with toothed belt drive. Here, you can find out what advantages the systems have and how they differ from each other.

## 2 The lead screw drive is the right choice if high precision is required

In the case of linear actuators with lead screw drive, a hand wheel or motor transmits the rotary movement to the lead screw. This rotary movement is then converted into a linear movement of the linear carriage. Linear actuators with lead screw drive are ideal for positioning applications with small cycles. Due to the level of torque that lead screws generate, they are highly suitable for moving heavy loads up to 25,000N (5.625lbf). Different lead screw diameters, pitches and materials as well as stepper motors, DC motors and hand wheels satisfy a very wide range of requirements.

### 2.1 Speed limitation in the case of lead screws

The limiting factor for speed depends on the type of lead screw bearing used: the lead screw can be supported on plain bearings or ball bearings.
The rotary movement of a lead screw that is longer than the recommended maximum length can potentially lead to resonance and noise. The maximum permissible speed of igus® linear actuators is 1,500rpm. The maximum length in relation to the speed of the lead screw linear actuator with ball bearings can be determined with the help of the table.

| Linear actuator | SHT-BB-08 | SLW-BB-0630<br>SLW-BB-0660<br>SAW-0630 | SHT-BB-12<br>SLW-BB-1040<br>SAW-0660<br>SAW-1040 | SAW-1080 | SLW-BB-1660<br>SAW-1660 | SHT-BB-20<br>SLW-BB-2080 | SHT-BB-30<br>SLW-BB-25120 |
|---|---|---|---|---|---|---|---|
| Lead screw Ø / Stroke up to | Ø6mm | Ø8mm | Ø10mm | Ø12mm | Ø14mm | Ø18mm | Ø24mm |
| **100mm** | 500rpm | 1,000rpm | 1,500rpm | 1,500rpm | 1,500rpm | 1,500rpm | 1,200rpm |
| **200mm** | 300rpm | 550rpm | 1,000rpm | 1,000rpm | 1,000rpm | 1,250rpm | 1,000rpm |
| **300mm** | 100rpm | 150rpm | 750rpm | 750rpm | 750rpm | 1,000rpm | 850rpm |
| **400mm** | - | - | 550rpm | 550rpm | 550rpm | 800rpm | 700rpm |
| **500mm** | - | - | 400rpm | 400rpm | 400rpm | 600rpm | 600rpm |
| **600mm** | - | - | 250rpm | 250rpm | 250rpm | 400rpm | 500rpm |
| **700mm** | - | - | 100rpm | 100rpm | 100rpm | 300rpm | 400rpm |
| **800mm** | - | - | - | - | - | 200rpm | 300rpm |
| **900mm** | - | - | - | - | - | 100rpm | 200rpm |
| **1,000mm** | - | - | - | - | - | - | 100rpm |

*The table shows a selection of lead screw linear actuators with the lead screw diameters, the stroke length and the recommended max. rpm.*

## 2.2 Linear positioning tolerance

As a rule, new igus® linear actuators with lead screw drive allow a linear positioning tolerance of +/- 0.1mm. In the case of high cycle requirements, however, the wear in the lead screw nut has to be taken into account. In this case, a clearance-free or pre-loaded lead screw nut is recommended. The tolerance for lead screw drives is lower than in the case of belt-driven actuators, which can be between +/-0.2mm and +/-0.35mm (+/-0.4mm for some cost-effective "econ" versions).

## 2.3 Lead screw with self-locking

Linear actuators with a single-start trapezoidal lead screw drive are able to transmit large axial forces. At low speeds, they are suitable for precise positioning or formatting and are also self-locking. This means that the pitch angle and the sliding friction prevent movement of the nut and lead screw without the application of outside forces. The linear carriage stays where it is and there is no independently occurring reverse movement. In many applications, the self-locking feature also functions as a brake at the same time. In motor-driven systems, the costs for motors with a braking function can be saved.

## 2.4 Lead screw with high helix thread

In linear actuators with a high helix lead screw, small radial movements are converted into the largest possible axial movement. With a lead screw diameter of 18 mm, a forward feed of up to 100 mm can be achieved with just one revolution. For applications in medium speed ranges, high helix threads are convincing due to their high efficiency and effectiveness. In practical applications, however, they are also characterized by their smooth running and low vibration tendency. High helix threads are generally not self-locking. In safety-critical areas, linear slides can thus also be adjusted manually if necessary. To avoid unintentional movements, appropriate holding devices, such as a clamp, should be provided. Electric motors with a braking function are recommended, especially for electrical adjustments in vertical installation positions.

## 2.5 Lead screw support – plain bearings vs. ball bearings

There are two kinds of bearing support: "plain bearing support" and "ball bearing support".

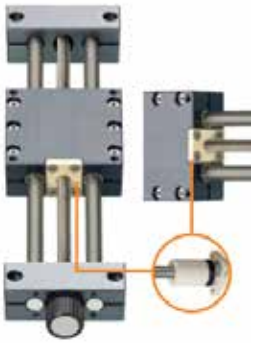
### Lead screw with plain bearing support

- Cost-efficient
- Robust
- Corrosion-resistant
- Optimized for linear actuators that can be moved manually

### Lead screw with ball bearing support

- Precise movement
- Especially suitable for highly dynamic applications
- For high speeds
- Optimized for electrical movement with motor

## 2.6 The characteristics of a linear axis with lead screw drive



SHT linear actuator with preloaded lead screw nut and self-adjusting zero backlash function.

- Stroke lengths up to 1,000mm
- For low to medium speeds
- Max. static load: 25,000N

## 3 For high speeds: linear axes with toothed belt drive

The main advantage of the belt drive system, which is also sometimes called the toothed-belt drive, is the possibility of high speeds. drylin® ZLW belt drives are designed for speeds up to 5m/s, for example. By using a belt guided by a pulley system with grooved ball bearing, you avoid friction heat problems that can occur with lead screws.

The maximum permissible load is based on the belt tension. The drylin(R) ZLW-20 system is capable of axial loads of up to 75kg (750N) which means that a horizontal pay load of up to 300kg is possible. In the case of such high forces, an igus® technician should carry out the technical design. Higher loads lead to damage to the axis. For example, the belt can jump over the pulley and may even be destroyed.

### Deflection of the belt

**Deflection of the toothed belt**

The figure shows the deflection of the belt. Deep groove ball bearings are fitted onto the machined ends on the left and right.

- Stroke lengths up to 3,000mm
- For high speeds
- Max. static load: 3,000N

### 3.1 Toothed-belt axes in the case of long strokes

In the case of long strokes, belt-driven linear axes are especially suitable. Lead screws tend to sag and vibrate, and there tends to be friction on the inside of the nut. Whereas a lead screw system with a Ø of 20mm is limited to strokes of up to 1,000mm, a belt-driven system can achieve a maximum standard stroke of 3,000mm. Stroke lengths of up to 6000mm have already been achieved, however this requires an exact check by the igus® technician in advance.

### 3.2 The characteristics of a linear axis with toothed belt drive

- Shaft end support with deep groove ball bearings
- Self-lubricating linear guide system with polymer plain bearings
- Different linear carriage lengths
- Hard anodized aluminum profile
- Polyurethane or neoprene toothed belt

## 4 Rollers

In drive technology, linear carriages with a plain bearing system or a ball circulating system can move on the linear profiles. igus® relies on the plain bearing system in its drylin® linear and drive technology.
The plain bearing liners which are made of high-performance polymers and are used for this are completely self-lubricating and can be used without the need for any maintenance. The basic principle of the plain bearing results in decisive advantages over the ball circulating system.

### Self-lubricating and maintenance-free

The plain bearings that are made of high-performance polymers and are used by igus® need no external lubrication whatsoever. This means a reduction of maintenance expenditure and the elimination of costs for lubricant.

### Corrosion-resistant and hygienic

Lubricants are used to prevent corrosion when ball circulating systems made of metal are used. Particles of dust and dirt stick to the lubricant. Cleaning the system often takes a lot of time and causes high costs due to long shutdown times and expensive cleaning agents.
The plain bearing system, in contrast, operates completely without external lubrication. The result: dirt or dust does not stick to surfaces, time-consuming cleaning is unnecessary and there is no possible contamination due to lubricants, such as oil and grease. The polymers used are corrosion-free and resistant to dirt, dust and moisture.

### Reduce costs by up to 40%

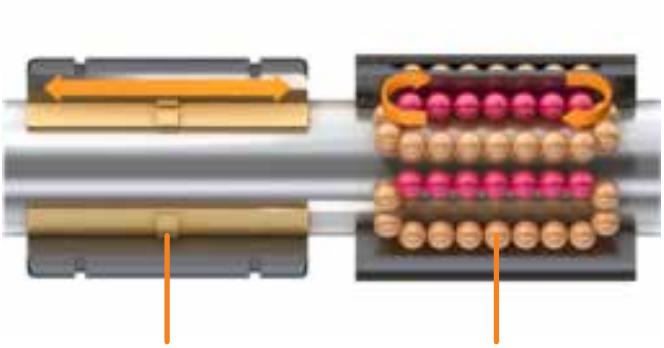
A complex ball circulating system is considerably more expensive than a polymer plain bearing but this is not only due to the material and the design. Pricing must also take account of the costs of maintenance, cleaning and lubrication.

### Less wear

The bearing system is not the only thing that undergoes wear. The material of the linear profile also suffers from the continuous load. The balls of a ball circulating system exert a significantly higher contact pressure on the profile system. This can lead to material abrasion. As the polymer plain bearings have a much larger contact surface, the pressure on the linear rail material is distributed over a larger area. The rail profile is therefore subjected to less stress and a considerably longer service life is ensured.

### Bearing change

Replacement of the plain bearing liner is also much easier. The plain bearing can be removed and installed in the bearing blocks with little disassembly of the complete system. This saves valuable time and money and the system is ready to use again more quickly. In addition, work on the linear axis is associated with less dirt due to the low degree of contamination.




### 4.1 Plain bearing replacement in just a few seconds

With the innovative WJ200UMA pillow block from the drylin® W product range, it is possible to replace the liner more easily without complicated disassembly work being required for your linear system. The supplied tool allows a replacement of the liner within seconds. The liners can be changed quickly and easily, whilst on the rail: Loosen the lateral fixing lid, slide out the liner, clip on the new one and slide it into the housing, put the cover on, and you're finished. In less than 30 seconds the bearing is changed and ready for use again.

To WJ200UMA pillow block

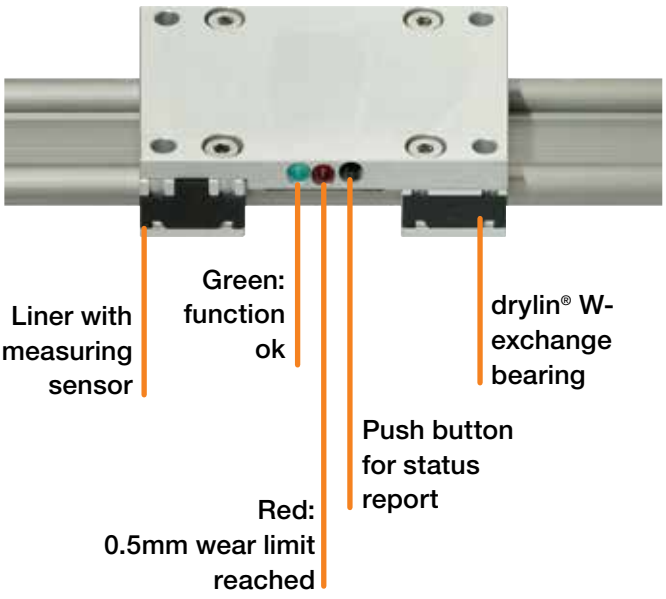
# 5 Maintenance of igus® linear actuators

Easy and quick maintenance saves time and money. But when is the right time for maintenance of the linear actuator? When should the plain bearings be replaced? How long can be plain bearings be used?
With the smart solutions for condition monitoring or with the maintenance information, the best time for plain bearing maintenance can be planned and undesirable downtime can be avoided.

## 5.1 The linear carriage with condition monitoring

Linear actuators can be configured with a drylin® W-isense linear carriage. The functional and wear tests can be carried out directly on the carriage. If the green LED lights up, everything is OK and the carriage can continue to be operated. The red LED recommends a bearing replacement and this can be easily done in less than 30 seconds directly on the rail without disassembly.

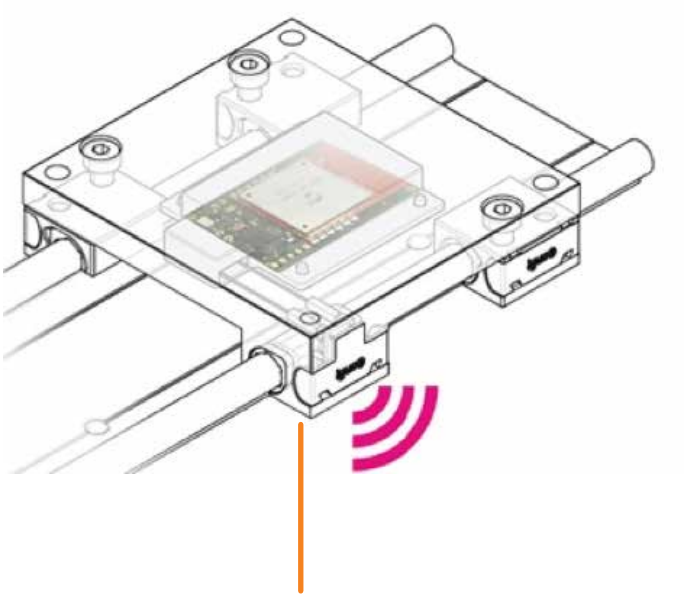
- Fast offline check
- Easy handling and visualization by LED
- For drylin® W linear actuators with lead screw and toothed belt
- Functionality without integration in IT environment, no interface issues
- Simple spare parts management
- Fast bearing replacement with practical mounting tool




## 5.2 Predictive maintenance from a distance

In addition to direct condition monitoring with the help of the LEDs, it is also possible to monitor the condition of the bearings by means of remote diagnosis and then plan a possible bearing change. Integrated conductor paths in the linear liners serve as sensors and signal when the wear limit is reached. The wear status is transmitted to the evaluation unit wirelessly.

- drylin® isense actuator for predictable maintenance
- For drylin® W linear actuator with lead screw and toothed belt
- Avoid sudden failures
- Detect and monitor maintenance requirements via remote diagnostics
- Time-saving bearing change without removal of the linear actuator



**Plain bearing with sensor technology for predictive maintenance**

## 6 An individual drive system in just a few steps

You can use the online configurator for drive technology to enter your requirements and then be shown the drive technology system you need. Moreover, you can submit an inquiry or order motors and additional accessories such as the motor control system.

- Fast and easy configuration
- Optional accessories
- Detailed parts list
- Fast delivery

To the drive technology configurator

## 7 Linear actuators with a single click

The linear actuator shop offers a very easy route to the pre-harnessed linear actuator. Ready-to-connect, configured linear actuators with lead screw drive or toothed belt drive offering different stroke lengths can be ordered with just a few clicks of the mouse and are ready to ship within 24 hours.

- With lead screw drive or toothed belt drive
- Two defined stroke lengths for each system
- For manual or electrical operation
- Ready to install with lead screw clamp, position indicator and hand wheel
- No time-consuming searching and assembly
- Reduced design work with PDF
- CAD file

## 8 The particularly cost-effective linear actuator

'econ' is used by igus® to designate the cost-effective, maintenance-free entry-level models of the drylin® linear axes. There are suitable entry-level models in almost every product line and installation size, either with a lead screw or toothed belt. The econ series is characterized by cost-effective components produced via injection molding, anodized aluminum profiles and a fast assembly.
drylin® econ models are configured and delivered so that they are ready to install and are the perfect alternative to complex in-house solutions for simple adjustment tasks.

To the econ linear actuators

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**Contact**

Matt Mowry
Product Manager
drylin® linear systems
Low-cost Automation Products
e-mail: mmowry@igus.net

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