white paper

# The ACME Lead Screw System

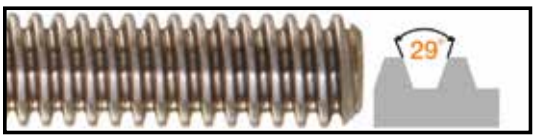
**by Matt Mowry**
Product Manager, drylin® linear systems, igus® Inc.

## Introduction

Lead screws are a common technology used to convert rotary motion into linear motion, and are often used to provide actuation to a set of linear bearings. Lead screws and plastic nuts are excellent lower-cost alternatives to ball screws and metallic nuts when used in applications where extreme precision (micron level) is not required. One of the most common lead screw geometries in North American manufacturing is the ACME lead screw system.

ACME lead screws were developed in America in the mid-1800s and have been routinely utilized since. Designed with a trapezoidal shape, a flank angle of 29 degrees and a higher pitch than fastening screws, they were made for applications requiring frequent positioning, including power transmission applications moving high axial loads.

High-performance plastic ACME nuts are ideal to use in an ACME system. igus® triboplastic iglide® ACME nuts from the drylin® product line are made of composite plastic materials, which offer lower friction and wear values than many other materials across a wide range of applications. The triboplastics operate free from oil and grease, and they do not require maintenance. They are also able to operate on traditional ferrous lead screws, as well as light-weight aluminum lead screws. Furthermore, they can handle high axial loads, they are insensitive to dirt and dust, they are corrosion-resistant, they have lower wear than other plastics, and they handle vibrations and impact loading better than bronze nuts do.




## Speeds and Loads

Due to the tight pitch geometry of ACME systems, they are best suited for low-speed positioning applications. For designs requiring a high linear feed rate, we recommend higher helix lead screws such as dryspin® technology. For even higher cycle applications, we recommend belt-driven actuators. For more information on how to choose between lead screws or belt drives, please read our tech talk, "3 Tips for Selecting a Linear Slide Table."

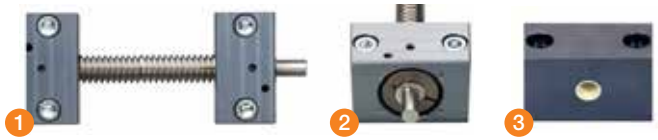
The maximum RPM typically recommended for an ACME lead screw is dependent on the radial and axial support from the radial bearings or bushings. For applications exceeding 100 RPM, it is highly recommended that the lead screw be supported by ball bearings. Many radial ball bearings are also capable of carrying the axial load generated by many applications. For those applications under 100 RPM, plastic bushings like iglide® bearings may be used, which do not require lubrication and are ideal for many industries.

**Load and Speed Capacity**: drylin® ACME nuts are dependent on the size. For example:
Size: Max Static Axial Load
¼"-16 = 111lbf
½-10 = 2508lbf
1-5 = 6385lbf

| | Max Recommended Stroke Length / by diameter | | | |
|---|---|---|---|---|
| **RPM** | Ø3/8ths (10mm) | Ø1/2" (12mm) | Ø3/4" (20mm) | Ø1" (25mm) |
| 100 | 1500 | 1500 | 1500 | 1200 |
| 200 | 1000 | 1000 | 1250 | 1000 |
| 300 | 750 | 750 | 1000 | 850 |
| 400 | 550 | 550 | 800 | 700 |
| 500 | 400 | 400 | 600 | 600 |
| 600 | 250 | 250 | 400 | 500 |
| 700 | 100 | 100 | 300 | 400 |
| 800 | N/R | N/R | 200 | 300 |
| 900 | N/R | N/R | 100 | 200 |
| 1000 | N/R | N/R | N/R | 100 |

* N/R = Not Recommended at that length

1. **screw support blocks**
2. **lead screw support with ball bearing**
3. **lead screw support with plain bearing**

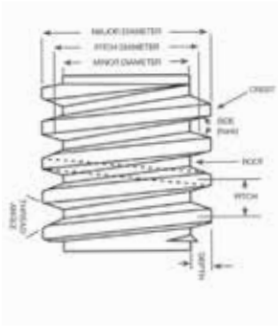



igus® offers online calculation tools to check the feasibility of a particular screw/nut combination for your application:



igus® white paper

## Lead and Basic Geometry



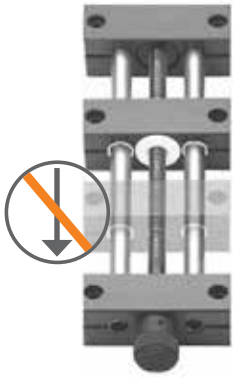
Standards for single-start ACME screws apply to the thread dimensions. ACME lead screws are called out by their major (outer) diameter, and then by the threads-per-inch (TPI), or turns-per-inch. For example, let's say a ¾ ACME screw has a major ID of 0.75" and 10 TPI. To calculate the lead (linear travel in inches per one screw revolution), simply divide 1 inch by the TPI. In this example, a 10-TPI nut will travel 0.10" per one revolution.

**Formula:** LEAD = 1 / threads-per-inch
**Example:** ACME 3/8-20 = 0.2 inch LEAD

There are several tolerance classes available on the market, such as 2G and 2C. For power transmission, ACME 2C, "centering," is most commonly used because it is well-suited for precision linear applications. ACME 2G, "general," is useful when extra radial clearance is required to overcome manufacturing tolerances. igus® ACME nuts are offered as standard in the 2C tolerance class, but 2G is also offered on a custom basis.

## Self-Locking/Back-Driving Benefit

An important feature of single-start ACME or trapezoidal systems is that they are not back-drivable. This means that they will not convert thrust loads (like gravity) into torque loads, thus they will not fall under their own weight; instead, the screws need to be turned for the system to move. In many applications, this may eliminate the need for a motor brake, and holding torque requirements on the motor may be reduced in some applications, which is a major benefit in comparison to other types of actuators.



**ACME threads resist back-driving**

## Dirt Resistance

drylin® lead screw drives feature completely dry-running operation. By avoiding lubricants, the adhesion of soft particles, such as dust and fibers is reduced. When compared to conventional, lubricated materials, this leads to significant improvements of screws' service life when operating in contaminated environments. However, in environments with significant contamination and hard particles, such as metal chips or granite dust, the lead screw should be covered.

## High Efficiency

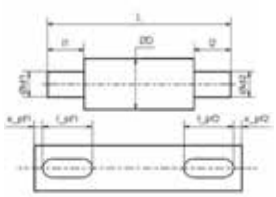
Efficiency is the ratio between the output and input power rating. drylin® lead screw nuts are characterized by low friction values, resulting in high efficiencies. Single start trapezoidal and ACME lead screw nuts achieve efficiencies between 20 and 48% under dry running conditions. High helix lead screw nuts achieve efficiencies between 50 and 80% under dry running conditions. Even though drylin® lead screw nuts were developed for completely dry running conditions, lubrication can help to additionally increase efficiency.

Learn more at www.igus.ca/info/lead-screw-systems

white paper

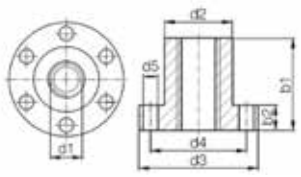
## Materials

**Screw Materials:** igus® screw materials are available in carbon steel, 304 stainless, and anodized aluminum. Carbon steel is the lowest in cost. 300-series stainless is one of the highest grades for corrosion resistance in extreme environments. Anodized aluminum is ideal for its low weight and non-magnetic properties. Custom machining services are also available for treatments such as journals or key ways.



Lead screws can be machined with various treatments

**Nut Materials:** igus® lead screw nuts are made with dry-running polymers and do not require any mariner ACME or external lubrication. Other commonplace materials for lead screw nuts are brass, oil-impregnated bronze and simple plastic materials such as POM or PA. Oil-impregnated bronze lead screw nuts require lubrication, have low chemical resistance and are sensitive to high temperatures. Though brass nuts are capable of operating with high working loads, they may also require lubrication, which can cause contamination. Simple plastic materials can be too sensitive to high temperatures, unable to withstand heavy loads, and they do not offer the wear resistance and lifetime that tribo-optimized plastic nuts do.



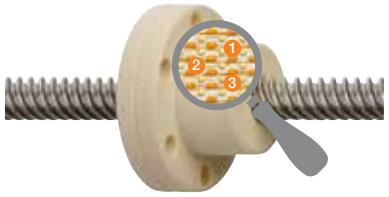
Plastic nuts are easily customizable from bar stock

**Self-lubricating and maintenance-free:**

**dryspin lead screw nuts made of 4 dry-tech materials**

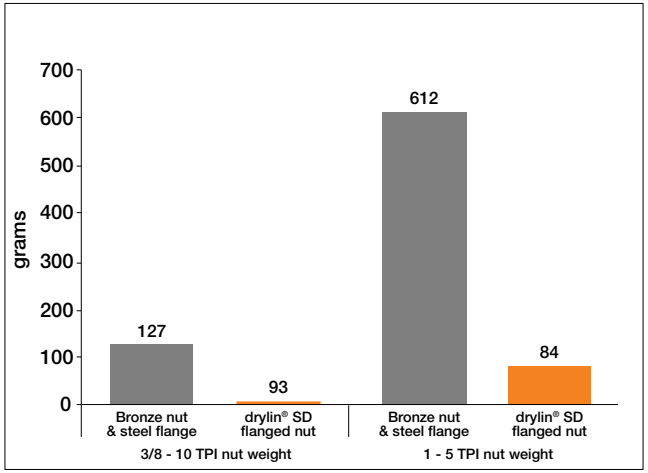
dry-tech lead screw nuts are made of wear-resistant iglide® high-performance plastics. 100% self-lubricating and maintenance-free. Durable in harsh environments. Clean and quiet in a hygienic environment. Predictable service life.

▶ www.igus.com/dryspin

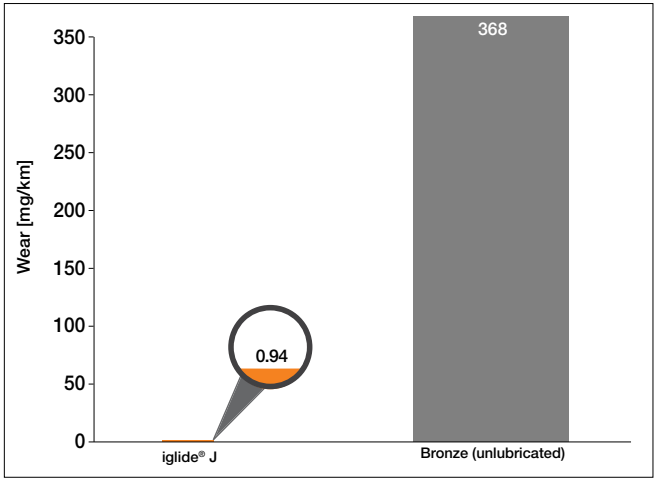



1. The base polymer is crucial for the wear resistance
2. Fibers and filling materials reinforce the bearing to absorb high forces or edge loads
3. Finally, the solid lubricants automatically lubricate the bearings and reduce the friction in the system

**1 Weight of bronze nut with steel flange vs. drylin SD flanged nut**

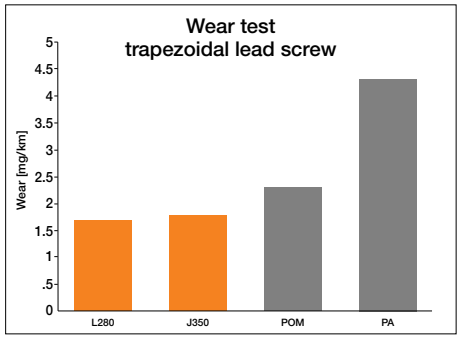


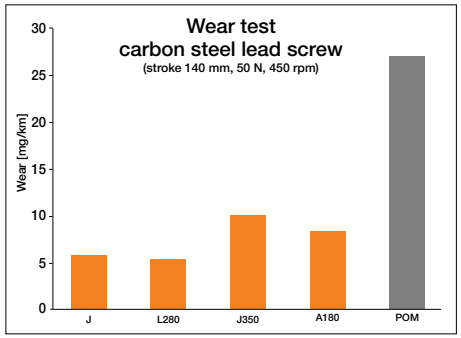

**2 Wear rate of unlubricated bronze nut vs. iglide® J nut**






Learn more at www.igus.ca/info/lead-screw-systems




igus® lead screw nuts are most commonly available in the following materials, most of which are available from bar stock for custom machined geometry:

**iglide® J/J4 - High efficiency at all speeds**
-Best standard nut materials
-Low wear
-Best coefficient of friction

**iglide® J350 - For temperatures up to 350˚F (176.6˚C)**
-Good coefficient of friction with medium loads
-For high, primarily static loads

**iglide® A180 - For applications requiring FDA compliance**
-For low water absorption
-When quiet operation is important

**iglide® R - The cost-effective option for serial production**
-High wear resistance for low loads
-Lowest humidity absorption

**iglide® L280 - Withstands high stresses**
-For especially high holding times
-Extremely high wear resistance



white paper

## Industries

Common industries where igus® dry-running ACME lead screw systems are used are anywhere where low speed positioning occurs. ACME systems are often used in machine setup applications, especially in the packaging industry, where adjusting machines for different package sizes is required. Other applications that use ACME systems often include medical technology, vision/inspection and sensor adjustment. ACME and trapezoidal (metric ACME) systems are also commonly used in 3D printers and automation applications.

## Conclusion

Lead screws excel in linear-motion applications because they offer a low coefficient of friction, high load capacity, are less costly than ball screws, and are corrosion resistant, among other advantages. Not only does igus® provide various iglide® ACME materials, but we also provide an online calculation tool where customers can calculate the service life of screw drives potentially used in their application, and configure and inquire about their custom dimensions for lead screw nuts. igus® has the largest test laboratory in the motion plastics industry, where around two billion test cycles are completed annually. Therefore, we are consistently providing customers with the cheapest product that performs best for their individual requirements.

**igus® test laboratory, Cologne, Germany**

## About igus®

igus® develops industry-leading energy chain® cable carriers, chainflex® continuous-flex cables, drylin® linear bearings and linear guides, iglide® plastic bushings, and igubal® spherical bearings. These seemingly unrelated products are linked together through a belief in making functionally advanced yet affordable plastic components and assemblies. With plastic bearing experience since 1964, cable carrier experience since 1971, and motion plastic cables since 1989, igus® provides the right solution from over 100,000 products from stock. No minimum order is ever required. For more information, contact igus® Canada at 1-800-965-2496 or www.igus.ca.

Learn more at www.igus.ca/leadscrews

# 9001:2015

igus® is certified in accordance with ISO 9001:2015 and ISO/TS 16949:2009 in the field of energy supply systems, cables and harnessing, as well as plastic bearings.

igus® Canada
180 Bass Pro Mills Drive
Vaughan, ON L4K 0G9
Tel: 800-965-2496
E-mail: orders@igus.com
www.igus.ca