introduction to Precision lead screws & Miniature Ball Screws
Dynetics - your partner in movement

Dynetics represents leading manufacturers with great technical expertise in micro-motor drive solutions, as well as cooling with fans and blowers using a variety of technologies. Dynetics helps you to optimize your designs economically through solutions with an optimal price / performance ratio. We offer micromotors with gearbox, sensors, motor control. For unit cooling we have axial / radial fans and blowers in the program. Many of our products can be customized.
Introducing Lead Screws and Ball Screws.

The Major difference between Lead Screws and Ball Screws is that Ball Screws have Balls inside the Nut, and Lead Screws not. Also Lead Screws have surface contact at flank of Groove, on the other hand, Ball Screws have point contact at Shaft and Nut groove via Balls. Therefore Ball Screws rotate more smoothly than Lead Screws.

![Image of Lead Screw and Ball Screw]

**Lead Screw**

**Ball Screw**

**Ball Screws: The conversion from rotational to linear, and vice versa**

The restriction on size or length of Ball Screws

The range of manufacturing for KSS Ball Screws is determined by 2 factors. One is the Shaft diameter, the other is total length for each Shaft diameter. KSS’s manufacturing range is 1.8mm to 16mm of Shaft diameter, but 20mm of diameter will also be available as a special order.

Limit of total length for each Shaft diameter is shown in table below.

<table>
<thead>
<tr>
<th>Accuracy grade</th>
<th>Maximum limit (mm)</th>
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<tbody>
<tr>
<td></td>
<td>Precision Ball Screws</td>
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<tr>
<td>Shaft dia. (mm)</td>
<td>C0</td>
</tr>
<tr>
<td>4</td>
<td>90</td>
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<tr>
<td>5</td>
<td>90</td>
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<tr>
<td>6</td>
<td>140</td>
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<td>8</td>
<td>200</td>
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<td>10</td>
<td>260</td>
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<tr>
<td>12</td>
<td>320</td>
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<td>14</td>
<td>380</td>
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<td>15</td>
<td>450</td>
</tr>
<tr>
<td>16</td>
<td>450</td>
</tr>
</tbody>
</table>

These numbers will vary depending on the end-journal profile and accuracy grade.

It is difficult to produce Ball Screws with long length and small diameter. Especially bending issue by heat treatment, critical speed and buckling issue will come up.

Maximum limit of shaft lengths are determined by the requested accuracy.
"Direct (Forward) operation" and "Reverse (backward) operation".

Ball Screws are mechanical parts, which convert rotational motion into linear motion and vice versa. These are called “Direct operation” or “Forward operation” and “Reverse operation” or “Backward operation” (see figure below).

Direct (Forward) operation: Motor (Shaft) rotates and Nut moves linearly (Bule). Or Nut rotates and Shaft moves linearly (Pink).

Reverse (Backward) operation: Apply load on Nut and make Shaft rotate (Bule). Or push Shaft and make Nut rotate (Pink).

Forward efficiency and Backward efficiency and torque,

The convert (Rotation to linear motion, linear motion to rotation) efficiency is called “Forward efficiency” or “Backward efficiency”.

The Torque during Direct (Forward) or Reverse (Backward) operation is called Forward Torque or Backward Torque, especially the load to make Reverse (Backward) operation is often called Backward resistance.
About Axial play

And the difference between Axial play and backlash

Ball Screws are assembled with small clearance between Shaft and Nut groove. We call this “Axial play”

If Ball Screws receive Axial load, groove of Shaft and Nut contact to Ball, after that the Elastic displacement will appear on the contact surface. Total of initial clearance (Axial play) and Elastic displacement becomes Backlash (see figure below).

Removing the Axial play

To eliminate Axial play, which means to make the clearance between groove and Balls be negative, is what we call Preload. By Preloading, it is possible to have zero of Axial play, to decrease Axial elastic displacement, and to increase Rigidity.
There are several types of Preload possible:

1) **Double Nut Preload**
   
   This is the way to insert the Spacer into 2 sets of Nut to eliminate clearance.

![Double Nut Preload Diagram]

2) **Oversized Ball Preload**
   
   It is convenient way to apply Preload by single Nut. Slightly larger Balls than clearance between Shaft and Nut groove are inserted to eliminate Axial play. It is suitable way for light Preload.

![Oversized Ball Preload Diagram]

3) **Off-set Preload (Integral Preload)**
   
   There is a dimensional allowance between the individual Nut circuit, which provides the same proper amount of Preload. Nut length can be shorter than Double Nut. This way is available on condition that number of circuits would be more than two.

![Off-set Preload Diagram]

4) **Constant pressure Preload**
   
   It is the way to insert the Spring instead of Spacer between 2 sets of Nut.
   
   KSS adopts oversized Ball Preload, which is said to be suitable for Miniature Ball screws.

![Constant pressure Preload Diagram]
Lead Screws compared to Ball screws

Lead Screws do not have Balls inside the Nut unlike Ball Screws. Shaft and Nut of Lead Screw are contacted at flank surface each other. So the efficiency is much lower than Ball Screws, which means that Lead Screws have high friction coefficient.

Generally, Precision Lead Screws are less expensive than Precision Ball Screws, even though Precision Lead Screws are processed by groove grinding. For the usage of low accuracy application, they can be produced by turning process only. In this case, Lead Screws would show a great price advantage compared to Ball Screws.

No restriction on Nut configuration

Since there is no Ball re-circulation part on Lead Screws, Nut configuration is not restricted.

Ultra small pitch

There is no need to create re-circulation part and Balls like Ball Screws, ultra small Pitch would be available. For example, 0.1mm Pitch would be available on 3mm diameter of Shaft. On the other hand, 0.5mm Pitch should be the smallest on 3mm Ball Screw.

No Nut falling by weight

If Ball Screws are not pre-loaded and put in vertical position, the Nut will move due to its own weight. But it will not happen on Lead Screws because of high friction on the flank surface contact. This can be utilized as brake function when vertical use.

Variations and Features of KSS Lead Screws

KSS processes Lead Screws by groove grinding, so that they can produce high accurate Lead Screws.

KSS can also provide appropriate accuracy of Lead Screws by a unique turning process. In addition, (mainly for bulk orders), KSS can use Rolling technology on the Shaft, which would lead to a cost down solution. Furthermore, KSS can provide plastic Nuts created by injection mold for mass production.

KSS can produce customer specified Lead Screws, as long as they are based on official standard, such as JIS, ACME, ISO ANSI etc.
Compact drive technology, ventilation and cooling

**Stepper motors**
- Hybrid, PM, low vibration, low noise
- Compact design up to 50 Nm, linear, 2 & 3-phase versions
- 0.6° - 3.75° step angle, integrated driver electronics
- Manufacturers: Nidec Servo, Shinano Kenshi, NPM, KSS

**Stepper and BLDC motor controller / driver boards and modules**
- Single & Multi axes 2, 3, 4 & 5 phases unipolar, bipolar
- Up to 4 axes, microstep, up to 8A. Various communication
- Fieldbus (CANopen, MODBUS) Ethernet, RS485, USB
- Manufacturers: Nidec Servo, SHS, NPM, ELMO, Panasonic

**Brushed motors and geared motors**
- Torque up to 35Nm
- Manufacturers: Nidec Servo, Tsukasa, Canon

**Brushless Motors and gears**
- Outside, or insid-runners; Optionally with integrated driver electronics
- Manufacturers: Nidec Servo, Nidec, Tsukasa, Canon, Mellor

**Motors with ironless rotor and gearbox**
- Brushed, or brushless 0.4-46W torque to 20Nm planetary gear
- Manufacturers: E-DriveSystem, Canon, TopBand

**Piezo motors**
- 10 to 150 mm, up to 3Nm, noiseless, short response time integrated speed / position torque sensors
- Manufacturers: Tekceleo

**Linear servo motors / Electric cylinders and modules**
- Ultra-precise, Dynamic, Stable.
- Height reproducibility, compact direct drive. Maintenance and cogging free shaft diameter from 4mm to 100mm stroke from 20mm to 4600mm captive / non-captive. Top thrust force up to 10kN;
- Manufacturer: NPM, KSS

**AC geared motors**
- Shaded pole & EC motors
- Motors up to 90W torque up to 30Nm
- Manufacturer: Nidec Servo, Mellor, DKM

**Fans and blowers**
- Reliable, kugelgelagert
- Lifetime up to 100,000 hours. Tested to VDE / UL / CSA IP54-65 versions
- Manufacturer: Nidec Servo, Nidec

**Embedded IC’s**
- One-chip stepper motor driver ICs, programmable pulse generators, integrated homing, anti-feedback, S-curve. Reduces engine noise Linear spiral, helical / circular interpolation
- Manufacturer: Nippon Pulse

**Ball Screws**
- High accuracy, minimal friction, integr. Ball feedback, high rigidity, smooth running
- Manufacturer: KSS

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