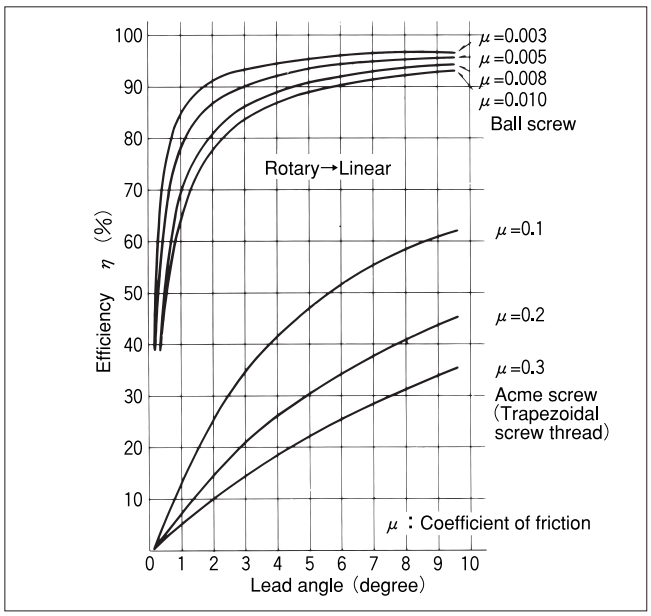
High reliability and high precision

With the precision gauge manufacturing know-how accumulated over many years, KURODA ball screws are ground, assembled and inspected in our tightly temperature-controlled factory to ensure offering the highest accuracy and high reliability.

High transmission efficiency

Ball screws have an extremely high transmission efficiency of over 90%, as compared with the conventional Acme screws, and the required torque is only $^{1}/_{3}$ or less.
This makes it possible to convert linear motion to rotary motion easily.



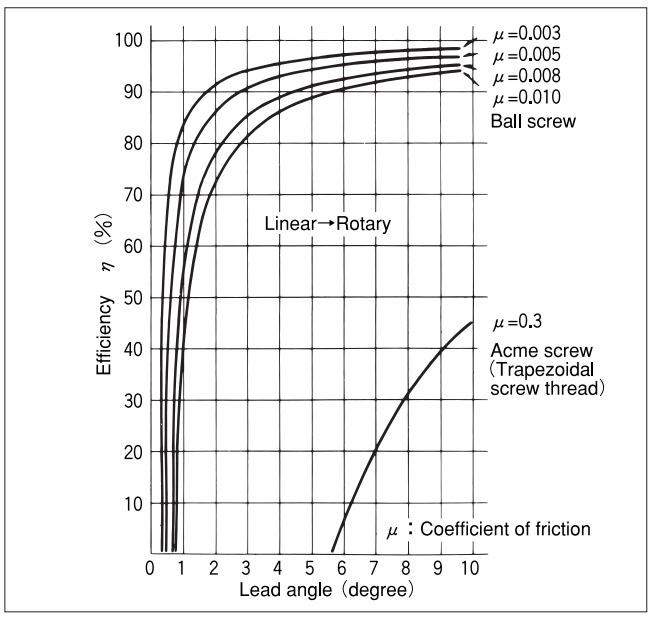


Fig.1 Mechanical efficiency of ball screw

Outstanding durability

Careful selection of materials, heat treatment under optimum conditions, and advanced machining and grinding techniques ensure outstanding durability of KURODA Ball Screws.

Minimized axial play

As the groove of KURODA's Ball Screws is Gothic-arch-shaped, the axial play can be extremely narrowed so that the screw can smoothly roll.
In addition, the axial play can be eliminated by preloading and resultantly rigidity is increased.

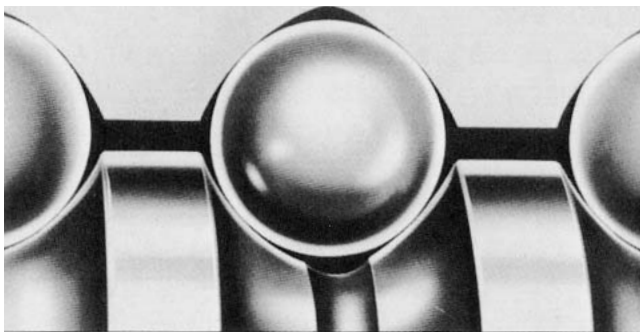


Fig. 2 Groove shape of ball screw

Precision fine feed

The starting torque is extremely reduced due to rolling contact of balls. So, unlike the Acme screws, the ball screws are free from stick-slip even at a low speed, making precision fine feed possible.

High speed rotation

High transmission efficiency and very little rise in temperature of the ball screw permit high speed rotation.

Easier maintenance

Due to rolling contact of balls, periodical greasing is required under normal operating conditions.

Wide variation

To meet the diversified needs of customers for downsizing, higher precision and speed improvements, KURODA offers a wide variety of ball screws, including subminiature ball screws, extra-large lead ball screws(shaft nominal OD:lead=1:3), standard ball screws GE, GG, HG, GP/DP, GY and GW Series (with shaft ends unworked), etc.

CONSTRUCTION

Ball screws are so designed that steel balls are interposed between the screw shaft and nut and these balls roll and recirculate in the thread groove.
KURODA's ball screws are available in 4 standard types:

•Tube Method

It is the most popular recirculating system of ball screws using a bent tube as a recirculating part.
In this system, steel balls led from the pick-up tube to the thread groove are returned to the recirculating part after turning along the thread groove of 1.5, 2.5, or 3.5 turns, and thus forming a circuit.
In order to increase the load capacity, up to 3 circuits of two and half turns of circulating system can be incorporated in one nut.

•Guide Plate Method

As the joint corresponding to “bend” can be formed by machining as desired, the efficient circulation of steel balls is possile.
Since it is a hog-backed plate, it can restore almost cylindrical shape in appearance, assuring excellent rotation balance.
This method is used for miniature size ball screws.

•End Cap Method

In this recirculating method, a function to scoop up and return steel balls is provided at the end cap fitted to both ends of the nut.
The nut is provided with a through-hole through which steel balls move in and out.
This method is used for large lead size(where screw lead is twice or 3 times as much as the screw shaft outside diameter).

•Deflector Method

This method is the most compact recirculating system of ball screws among many types that have been designed and manufactured up to now. It also features excellent rotational balance and high reliability.
Steel balls which roll and move between the screw shaft and nut circulate at each lead while being guided by a deflector incorporated in the nut, and thus forming a circuit.

MATERIALS AND HEAT TREATMENT

The hardness of the thread groove surface has a great influence on the life of ball screws because of their characteristics.
Moreover, the shaft should have sufficient strength required for the transmission shaft.
Therefore, the ball screw is usually made of materials shown in the right table and the case hardness of steel is controlled to HRC 58(minimum standard hardness)to HRC 62.
When heat resistance and corrosion resistance are required, stainless steel(SUS 440C)is used so that hardness of HRC 56 to 59 can be attained by quench hardening treatment.

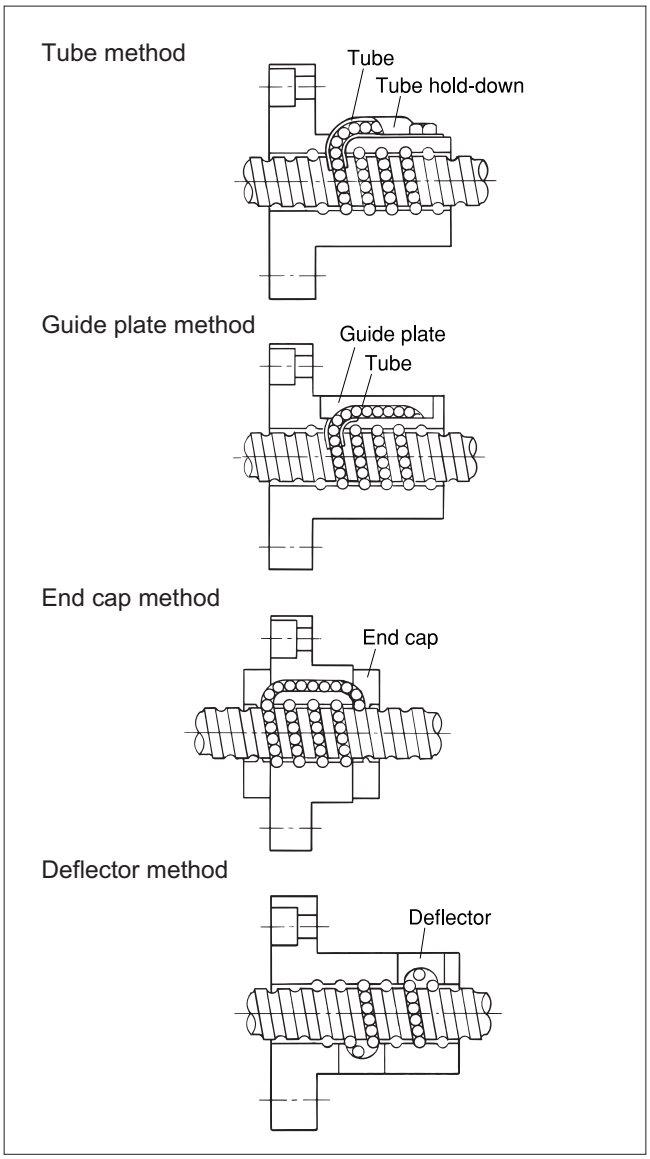


Fig.3 Circuit system

Table 1 Materials and heat treatment

•Ground ball screw

	Material	Heat treatment method	Hardness
Ball nut	Chromium molybdenum steel SCM420(SCM22)	Carburizing hardening	58-62HRC
Screw shaft	Chromium molybdenum steel SCM415S(SCM21) SCM420(SCM22)	Carburizing hardening	58-62HRC
	Chromium molybdenum steel AISI4150HV	Induction hardening	58-62HRC

•Rolled ball screw

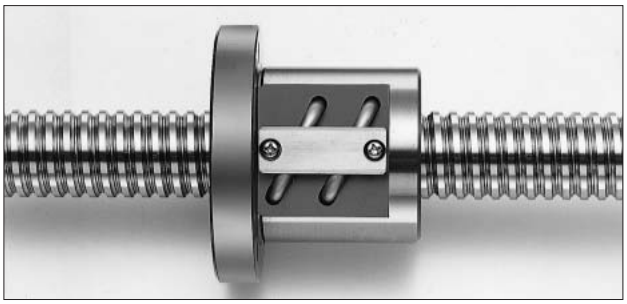
	Material	Heat treatment method	Hardness
Screw shaft	S45C S55C	Induction hardening	56-62HRC
Ball nut	SCM420	Carburizing hardening	58-62HRC
Steel ball	SUJ2	Hardening	60HRC or higher

TYPES

•Type of Nut

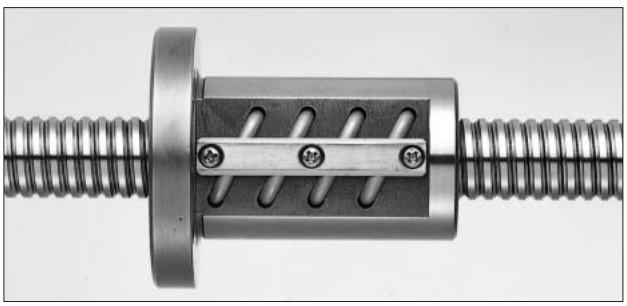
Single Nut

This is the simplest type, consisting of a single nut. When it is used for usual applications, a some axial clearance should be provided. However, by strictly controling the accuracy of the axial clearance can be eliminated and the nut can be preloaded. The single preload nut type is suitable for small-sized NC machine tools, semiconductor manufacturing equipment, assembly robots and measuring instruments that require precise positioning under light or normal preload.



Integral Nut

The thread of the nut is divided into the load side and preload side, and the amount equivalent to preload is offset for preloading. The load side and preload side of the double nut are integrated, thereby reducing the length and assuring stable rigidity and satisfactory performance. The integral nut is suitable for preload larger than normal and appropriate for all machines and equipment over medium load.

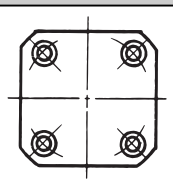
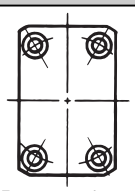
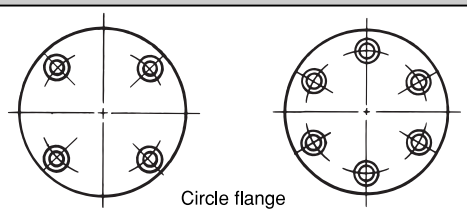


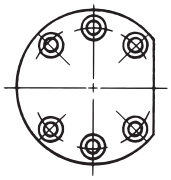
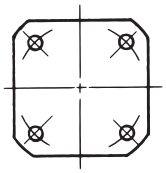
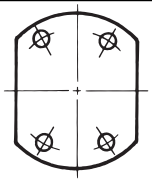
Double Nut

In this type, the predetermined preload is applied to two nuts by turning them in the opposite directions respectively and the nuts are fixed with a pin inserted between them. The axial clearance is eliminated and the rigidity can be increased by preloading. The double nut type is suitable for machines which require higher rigidity and precise positioning under medium or heavy preload.

•Configuration of Flange

It is expressed by a type symbol shown in the following figure for each nominal size.

Type symbol	A	B	C
Flange type	 Square flange	 Rectangle flange	 Circle flange

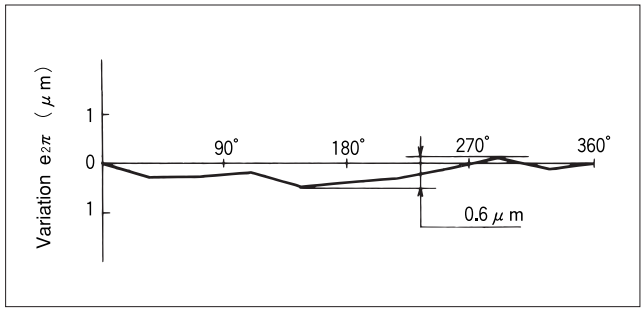
Type symbol	D	E	H
Flange type	 Single side cut, circle flange	 Square（without spot facing）	 Double side cut, circle flange

SPECIAL SPECIFICATIONS BALL SCREW

In order to satisfy the needs of various industrial worlds for packaging machines, semiconductors and LCD manufacturing equipment, clean robots, SEM-related apparatus and small machine tools, KURODA manufactures precision ball screws of special specifications, such as super-precision ball screws (higher than C0 grade), stainless-steel ball screws for special environment, low noise ball screws, high-speed ball screws, etc. upon order.

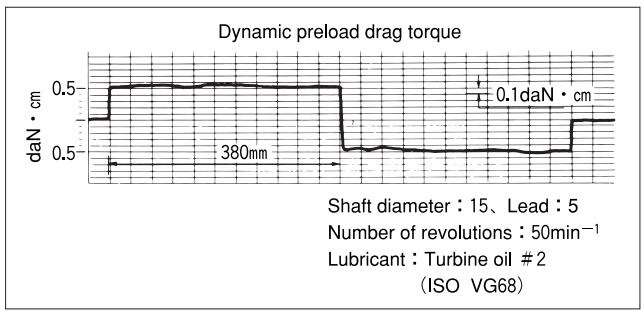
• Super-precision Ball Screws(Wobble $e_{2\pi}$=1.5μm).

With the higher circuit integration on semiconductor chips in recent years, it is necessary to minimize the wobble $e_{2\pi}$ for super-precision positioning. Answering this requirement, KURODA realized, by hand-lapping, to reduce the wobble to 0.0015mm/2π rad or less.
To measure and evaluate the conformance to this special specification, KURODA own designed automatic laser lead measuring machine and a special data evaluation system using a minicomputer are employed, and measured data (in units of 0.0001 mm)are attached to the super-precision ball screws supplied.



• Super-precision Ball Screws(Capable of 0.1μm/pulse feed)

In the case of high-precision fine feed, it may sometimes occur that due to the variation of torque the mechanical system fails to act in response to the signal from the control system and the machine does not move as accurately as expected.
In the case of laser scanners, SEM-related equipment, inspection machines, analytical equipment, etc., torque fluctuations are expressed as the change of traveling speed, making correct feed impossible.
Also, in the case of the closed loop control, as the friction in the mechanical system affects the control loop, precise matching of the mechanical system and the control system is very important.
To minimize torque variation at very small torque, the thread groove form and the cylindricity of the screw shaft are tightly controlled by lapping work, thereby putting ball screws capable of 0.1μm/pulse feed in practical use.
Measurement data of continuous torque variation measured with a crystal type piezoelectric Kistler Sensor is also attached to these ball screws.



In addition, KURODA manufactures trapezoidal feed screws and triangular feed screws of 0.1μm or less for super-precision positioning utilizing a spring preload.

• Super-precision Ball Screws (with the total deflection of screw shaft axis $^1/_4$ to $^1/_3$ of JIS C0 grade)

When the bend of the screw shaft is within the permissible total deflection given in the catalog (P.392 and P.393), it is corrected by rigid guides (ordinary construction) on both sides of the ball screw and will not affect the feed accuracy.
However, where these guides are replaced with some. KURODA manufactures special ball screws with the total deflection of the screw shaft axis from 1/4 to 1/3 of the C0 grade of tolerance of JIS.

• High-speed Ball Screws

Intended for applications requiring high speed operation of more than 70000 DmN, such as machine tools and robots.

• Maintenance-free Ball Screws

Long life ball screw incorporating greasing unit, intended for use in clean environment.

• Ball Screws For Special Environment

•Stainless-steel Ball Screw

KURODA manufactures ball screws made entirely from stainless steel having high resistance to corrosion and chemicals for use in special environments such as vacuum, clean room, etc.

Material : Screw shaft, nut ——————— SUS 440C
Other parts ——————————— SUS 304

•LD treatment

For use in environment where corrosion resistance is required, ball screws coated with chromium oxide by LD treatment are manufactured upon order. The film thickness is 1 to 2μm and the coating at points of contact of the ball is removed in early stages of running. However, the anticorrosive effect will be maintained thereafter.

•Airtight packed type
•Prelubricated type with special greases

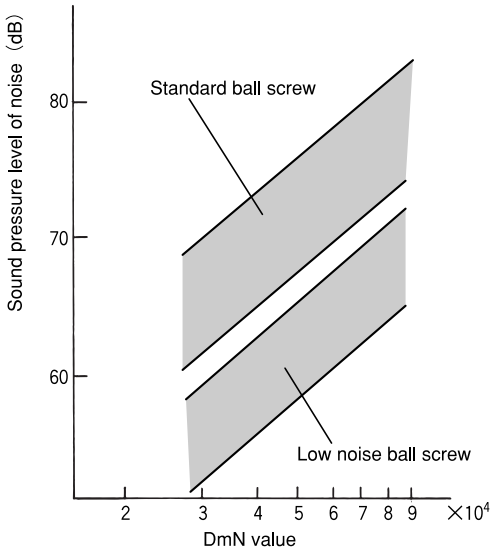
• Low Noise Ball Screws

Noises from the ball screw include the ball screw's own running noise and the vibration and noise of the entire mechanical system incorporating the ball screw.
Causes of the ball screw's running noise can be classified into improper handling, poor workmanship of the ball screw, and discontinuity of balls in the recirculation path.
Seeking for various noise reduction measures for many years, KUODA has developed abundant know-how for

- •Improvement of the from and accuracy of the ball track surface,
- •Reduction of the undulation of the ball track surface,
- •Improvement of the roughness of the finished surface, and
- •Rational design of the recirculation system.

KURODA has reduced noise and vibration to a great extent by implementing these measures, and thus the running noise of these ball screws is very kow as compared with conventional ball screws. These low noise ball screws are now contributing to the noise reduction of packaging machines, transfer robots, machine tools, etc.

Sound pressure level of generated noise of low noise ball screw



Dm：Screw shaft OD（mm）＋Value A
（For value A, refer to P.375）
N：Number of revolutions of ball screw（min^{-1}）

（Measurement position：1000㎜ from screw）

<Example of actual application>

Sound pressure level of noise generated at 3000min^{-1}

Screw shaft OD (mm)	Lead (mm)	Overall length of screw shaft(mm)	Sound pressure level of noise(dB)
Ø15	10 15 20	500 or less	58
		800 or less	62
Ø20	20	600 or less	62
		1200 or less	65

Measuring method :Sound pressure value of ball screw alone with screw shaft supported at center of rotation and nut moved in axial direction

Measurment distance :1000mm