

## Ball Screws



## The Company

ACT industrial possesses expertise for the mastery of high precision motion technologies. The group company was established in the year of 2010. Now it employs over 830 staffs worldwide. ACT industrial specializes in the development, manufacturing and marketing of the following high precision motion brands product lines: Precision Planetary Gearbox and Pinion, Precision Spiral Bevel Gearbox, Ultra Precision Strain Wave Gear, Precision Planetary Roller Screw, Gearbox Wheel Solutions for AMRs and Precision Servo Motor Solutions. Our aim is to be dedicated to serve global automation industrial clients with the reliable precision motion solutions.



Ball screw assembly is a mechanical component composed of a screw shaft, nut, and ball bearings. Its function is to convert rotational motion into linear motion or vice versa, representing a progressive development from traditional sliding screw assemblies. Due to its excellent frictional characteristics, the ball screw assembly is widely applied in various industrial equipment, precision instruments, and precision CNC lathes.

Currently, our company manufactures ball screw assemblies with the following specifications:

Minimum specification: Diameter  $\phi 6\text{mm}$ , lead 1mm;

Maximum specification: Diameter  $\phi 100\text{mm}$ , lead 32mm;

Single screw shaft total length: 1 meter;

Maximum rated dynamic load: 20 metric tons;

In addition to conventional ball screw assemblies, our company specializes in custom machining of non-standard and special-shaped screw/nut structures, which is a key strength of our manufacturing capabilities.

## Characteristics of Ball Screw Assemblies

### 1. High Efficiency:

In ball screw assemblies, freely rolling ball bearings transmit force and motion between the screw shaft and nut. This transmission method replaces the direct contact between the screw and nut in traditional screw assemblies, thereby substituting minimal rolling friction for traditional sliding friction. The drastically reduced friction significantly improves the transmission efficiency of ball screw assemblies. The transmission efficiency of precision ball screw assemblies exceeds **\*\*90%\*\***, while that of traditional sliding screw assemblies is only **\*\*20%–30%\*\***. As a result, the transmission torque of the entire assembly is reduced to approximately 1/3 of that of sliding screw assemblies, and heat generation is significantly minimized.

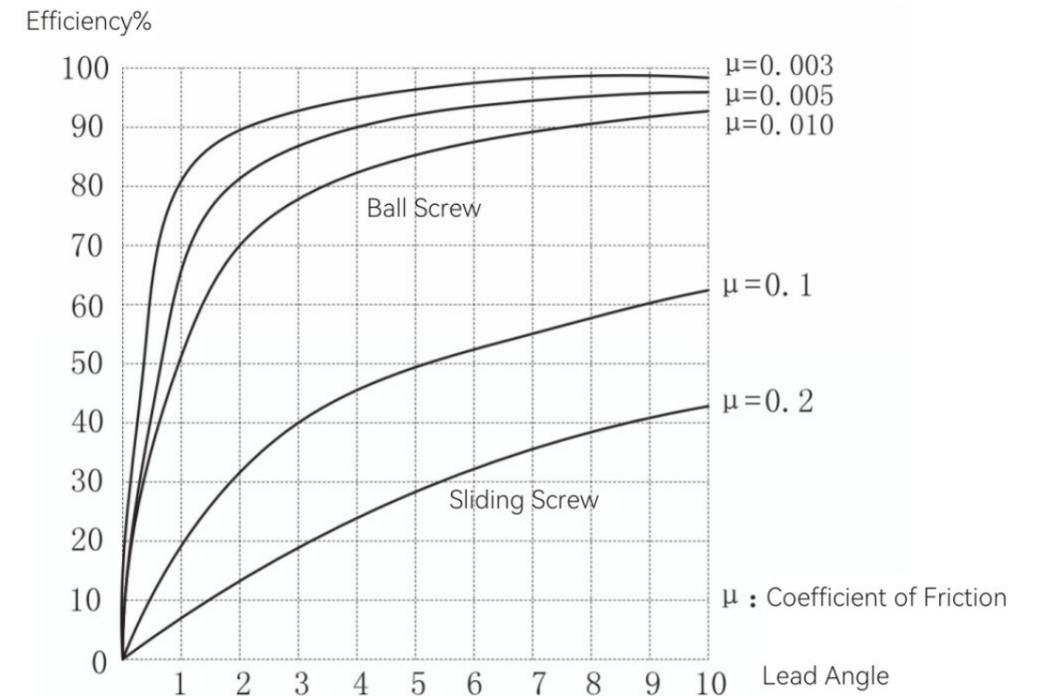


Figure 1: Mechanical Efficiency of Ball Screw Assemblies

**2. High Precision:**

Measures such as low heat generation during the motion of ball screw assemblies, pre-stretching the screw shaft to compensate for thermal elongation, and preloading to eliminate axial clearance enable the screw assembly to achieve high positioning accuracy and repeat positioning accuracy.

**3. High Speed:**

Due to minimal friction during operation, precision ball screw assemblies can achieve very high running speeds, meeting the requirements of heavy-load and high-speed applications.

**4. High Rigidity:**

Although preloading to eliminate axial clearance in precision ball screw assemblies increases friction and reduces partial efficiency, it provides the high rigidity required for transmission while significantly minimizing axial return play.

**5. High Synchronization:**

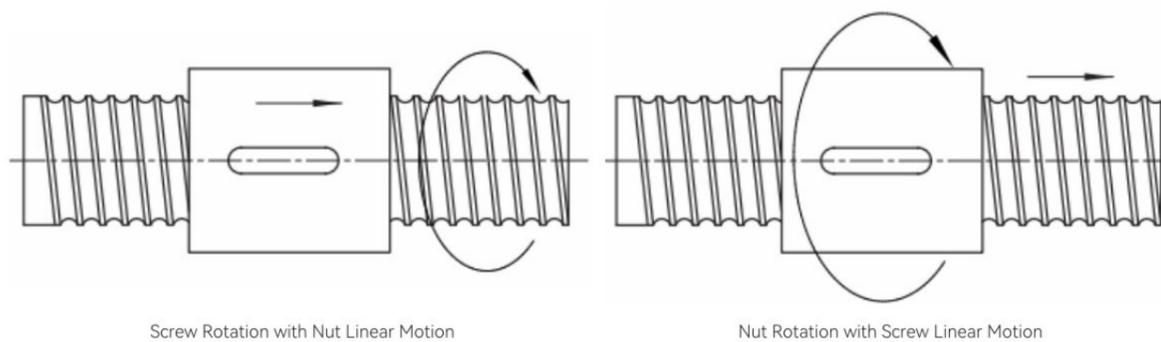
The smooth operation, elimination of axial clearance, and manufacturing consistency of precision ball screw assemblies ensure excellent working synchronization when multiple sets of ball screw assemblies are used to drive the same device or multiple components.

**6. Long Service Life:**

Precision ball screw assemblies achieve a long actual service life through strict control of raceway shape accuracy, surface hardness, material selection, and other factors.

**7. Reversibility:**

Unlike sliding screw assemblies with sticky friction, ball screw assemblies eliminate potential crawling phenomena during transmission. They can smoothly achieve two transmission modes - converting rotational motion into linear motion or linear motion into rotational motion.

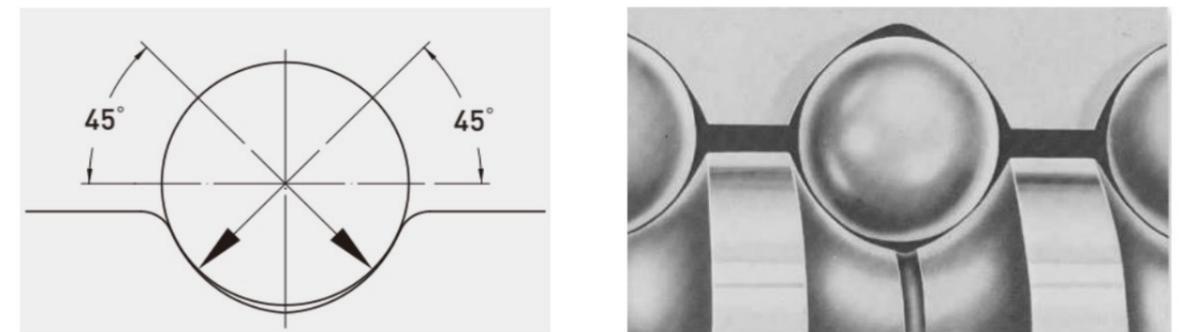


**Internal Structure of Ball Screw Assembly**

**■ Raceway Type**

Precision ball screw assemblies adopt a double-arc raceway profile. The ball contact angle remains essentially constant at 45° during operation, ensuring stable transmission efficiency, load capacity, and axial rigidity.

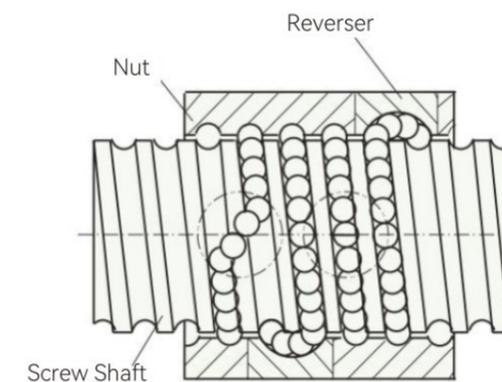
Double-Arc Raceway Profile



**■ Recirculation Method**

Most precision ball screw assemblies adopt the internal recirculation method, where balls never disengage from the screw surface during circulation. The internal recirculation method offers advantages such as short ball circulation path, flexible reversal, compact structure, high rigidity, reliable operation, long service life, and smaller outer diameter of nut assembly, meeting various high-sensitivity, high-precision, and high-rigidity feed positioning requirements. Our company can also design the most suitable ball recirculation method according to customer requirements and application scenarios.

Internal Recirculation Structure Diagram



Internal Recirculation Ball Return Mode

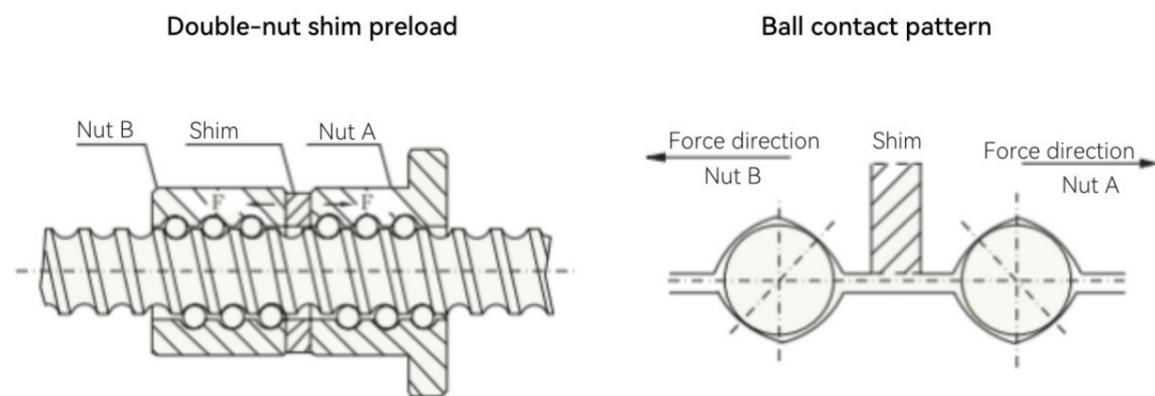


### Preload Methods

Our company can select the most suitable screw assembly preload method for customers based on specific application scenarios.

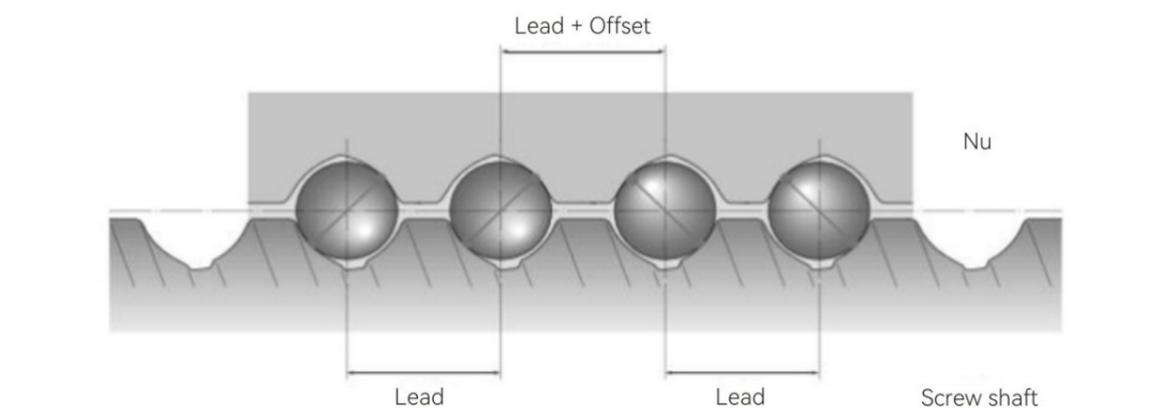
#### 1. Double-Nut Shim Preload:

- Characteristics: Compact structure, convenient for assembly and disassembly, high rigidity.



#### 2. Single-nut variable lead preload

- Characteristics: simple structure, compact size, high technicality



#### 3. Single-nut preload by increasing ball diameter

- Characteristics: simple and compact structure, wide application

### Manufacturing Scope of Ball Screw Assemblies

Our company's ball screw assemblies are all manufactured by precision grinding, mostly used in scenarios requiring precise positioning, repeat positioning, smooth operation, and long service life.

Manufacturing range of standard ball screw assemblies	
Screw shaft diameter	6 — 100 mm
Screw shaft length	Maximum length 1000 mm
Lead	1 — 32 mm
Precision class	C1、C2、C3、C4、C5、C7、C10

The table below shows the manufacturing dimension range of our company's standard ball screw assemblies. Please contact our sales personnel if your requirements are outside this range.

#### Combinations of standard screw shaft diameters and leads

Nominal diameter	Lead													
	1	2	3	4	5	6	8	10	12	16	20	25	30	32
6	✓	✓												
8	✓	✓												
10		✓	✓											
12			✓	✓										
16			✓	✓	✓									
20			✓	✓	✓	✓								
25				✓	✓	✓	✓							
32				✓	✓	✓	✓	✓						
40					✓	✓	✓	✓	✓					
50					✓	✓	✓	✓	✓	✓				
63						✓	✓	✓	✓	✓	✓			
80							✓	✓	✓	✓	✓	✓		
100								✓	✓	✓	✓	✓	✓	✓

Note: The above are recommended combinations of our company. For other combination requirements, please contact our sales personnel.

### Manufacturing Precision of Ball Screw Assemblies

In accordance with GB/T 17587.3 (Chinese National Standard), ball screw assemblies are classified into Positioning Ball Screw Assemblies (Class P) and Transmission Ball Screw Assemblies (Class T) based on application scope and requirements. The precision grades are divided into seven levels: 1, 2, 3, 4, 5, 7, and 10. Grade 1 represents the highest precision, with subsequent grades decreasing sequentially.

The detailed precision grade data of the screw pairs are shown in Table 1 and Table 2:

Table 1: Precision grades of  $e_p$  and  $V_{up}$  (Class P) (extracted from GB/T 17587.3)

Effective Stroke (Lu)		Tolerance Grade								Tolerance Grade							
		1	2	3	4	5	7	10									
>	≤	$e_p$ (μm)								$V_{up}$ (μm)							
	315	6	8	12	16	23			6	8	12	17	23				
315	400	7	9	13	18	25	-	-	6	9	12	18	25	-	-		
400	500	8	10	15	20	27	-	-	7	9	13	19	26	-	-		
500	630	9	11	16	22	30	-	-	7	10	14	20	29	-	-		
630	800	10	13	18	25	35	-	-	8	11	16	22	31	-	-		
800	1000	11	15	21	29	40	-	-	9	12	17	24	35	-	-		
1000	1250	13	18	24	34	46	-	-	10	14	19	27	39	-	-		
1250	1600	15	21	29	40	54	-	-	11	16	22	31	44	-	-		
1600	2000	18	25	35	48	65	-	-	13	18	25	36	51	-	-		
2000	2500	22	30	41	57	77	-	-	15	21	29	41	59	-	-		
2500	3150	26	36	50	69	93	-	-	17	21	34	49	69	-	-		
3150	4000	32	45	62	86	115	-	-	21	29	41	58	82	-	-		
4000	5000	-	-	76	110	140	-	-	-	-	49	70	99	-	-		
5000	6300	-	-	-	-	170	-	-	-	-	-	-	119	-	-		

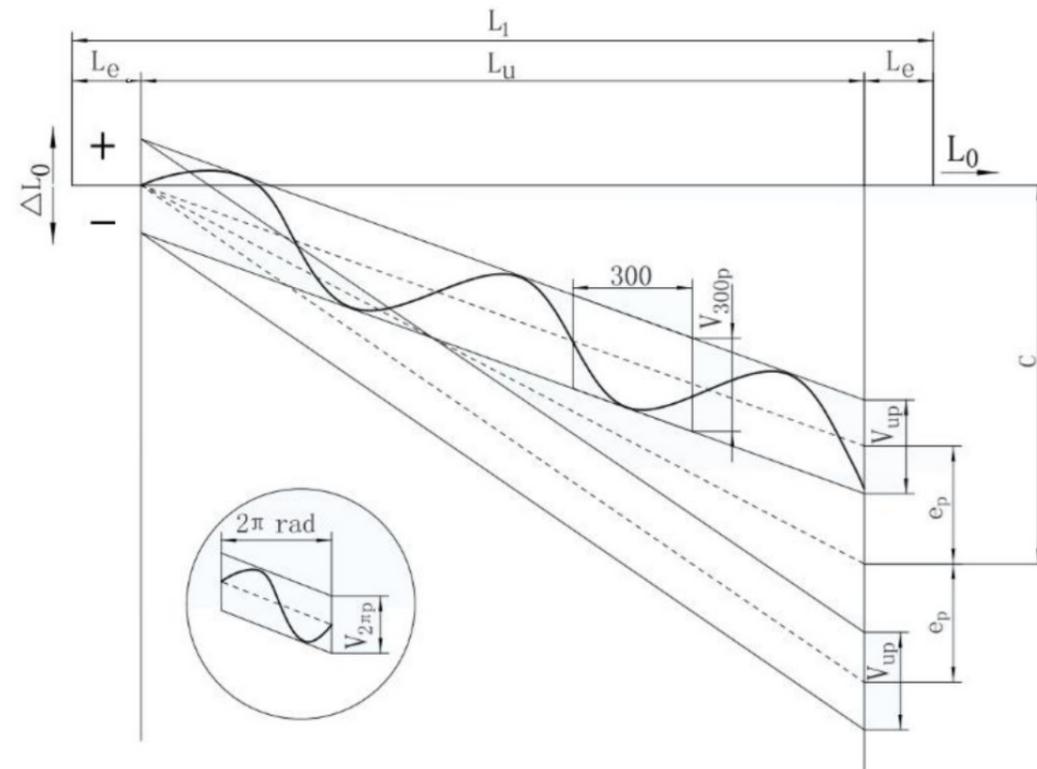
Note: The formula for the tolerance grade of the limit value of the mean actual stroke error ( $e_p$ ) for Class T precision ball screw assemblies is as follows:

$$e_p = 2 \times \frac{Lu}{300} \times V_{300p}$$

Table 2: Precision grades of  $V_{300p}$  and  $V_{2\pi p}$  (Classes P and T) (extracted from GB/T 17587.3)

$V_{300p}$ (μm) Tolerance Grade							$V_{2\pi p}$ (μm) Tolerance Grade						
1	2	3	4	5	7	10	1	2	3	4	5	7	10
6	8	12	16	23	52	210	4	5	6	7	8	10	10

### Stroke deviation and variation



Graphical illustration of stroke deviation and variation (extracted from GB/T 17587.3)

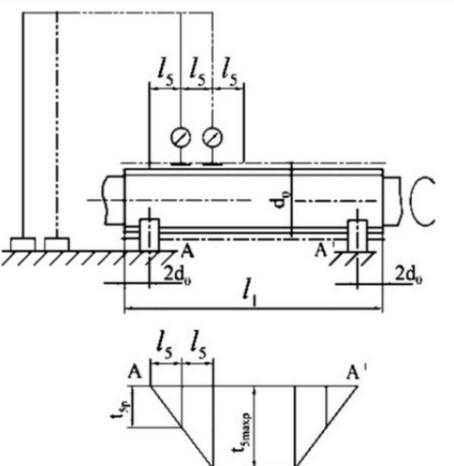
#### Meaning of symbols in the figure above

- $L_0$  — Nominal diameter
- $L_1$  — Thread length
- $L_0$  — Stroke error
- $L_u$  — Effective stroke (Lu)
- $L_e$  — Over-travel
- $C$  — Stroke compensation for effective stroke, determined by user (Standard: C=0)
- $e_p$  — Limit value of mean actual stroke error
- $V_{up}$  — Tolerance for stroke fluctuation of effective stroke Lu
- $V_{300p}$  — Tolerance for stroke fluctuation over 300mm stroke
- $V_{2\pi p}$  — Tolerance for stroke fluctuation per revolution

Ball screw assembly acceptance criteria

In accordance with GB/T 17587.3

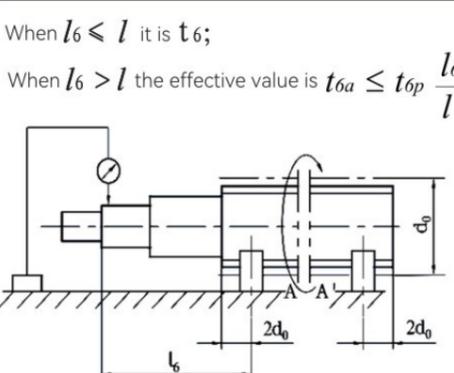
Radial runout  $t_5$  of ball screw outer diameter at each  $L_5$  length to determine straightness relative to AA'



Nominal diameter $d_o$ mm	$L_5$ mm	Standard tolerance grade						
		1	2	3	4	5	7	10
$\geq 6-12$	80	$t_{5p}$ $\mu\text{m}$ over $L_5$ length						
$>12-25$	160							
$>25-50$	315	20	22	25	28	32	40	80
$>50-100$	630							
$>100-200$	1250							
Length-diameter ratio $l_i/d_o$	$l_i$ mm	$t_{5max}$ $\mu\text{m}$ Over $l_i \geq 4L_5$ length						
		1	2	3	4	5	7	10
$\leq 4$		40	45	50	57	64	80	160
$>40-60$		60	67	75	85	96	120	240
$>60-80$		100	112	125	142	160	200	400
$>80-100$		160	180	200	225	256	320	640

Radial runout of support journal relative to AA' at each  $L$  length

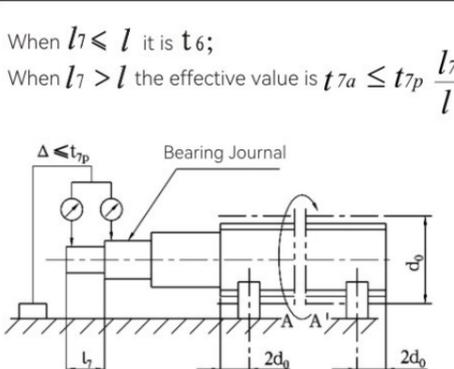
When  $l_6 \leq l$  it is  $t_6$ ;  
When  $l_6 > l$  the effective value is  $t_{6a} \leq t_{6p} \frac{l_6}{l}$



Nominal diameter $d_o$ mm	$l$ mm	Standard tolerance grade						
		1	2	3	4	5	7	10
$\geq 6-20$	80	$t_{6p}$ $\mu\text{m}$ over $l$ length						
$>20-50$	125	10	11	12	16	20	40	63
$>50-125$	200	12	14	16	20	25	45	80
$>125-200$	315	16	18	20	26	32	63	100
$>200-315$	630	25	32	40	50	63	100	160

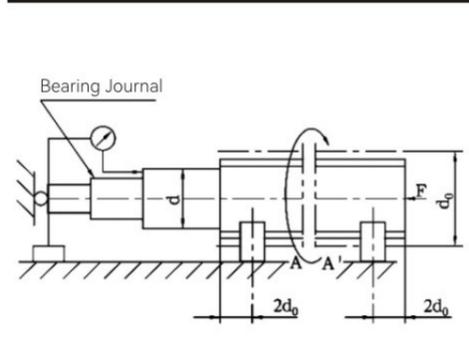
Radial runout of journal relative to support journal

When  $l_7 \leq l$  it is  $t_6$ ;  
When  $l_7 > l$  the effective value is  $t_{7a} \leq t_{7p} \frac{l_7}{l}$



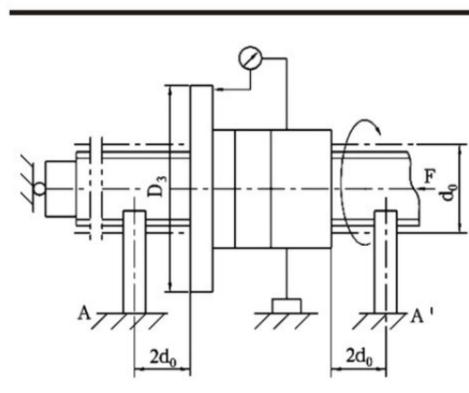
Nominal diameter $d_o$ mm	$l$ mm	Standard tolerance grade						
		1	2	3	4	5	7	10
$\geq 6-20$	80	$t_{7p}$ $\mu\text{m}$ over $l$ length						
$>20-50$	125	5	6	6	7	8	12	16
$>50-125$	200	6	7	8	9	10	16	20
$>125-200$	315	8	9	10	11	12	20	25
$>200-315$	630	12	14	16	20	25	40	50

End face runout  $t_8$  of support journal shoulder relative to AA'



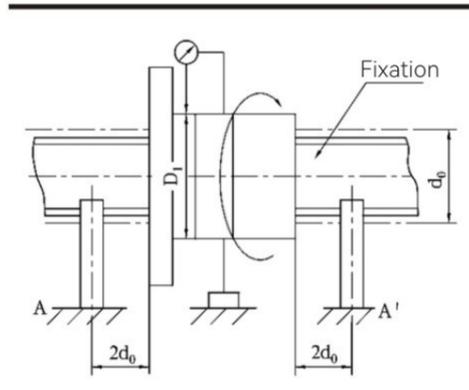
Nominal diameter $d_o$ mm	Standard tolerance grade						
	1	2	3	4	5	7	10
$\geq 6-63$	$t_{8p}$ $\mu\text{m}$						
$>63-125$	3	4	4	5	5	6	10
$>125-200$	4	5	5	6	6	8	12
$>200-315$	-	6	6	7	8	10	16

End face runout  $t_9$  of ball nut mounting end face relative to AA' (only for ball nuts with preload)



Diameter of nut mounting end face $D_3$ mm	Standard tolerance grade						
	1	2	3	4	5	7	10
$\geq 16-32$	$t_{9p}$ $\mu\text{m}$						
$>32-63$	10	11	12	14	16	20	-
$>63-125$	12	14	16	18	20	25	-
$>125-250$	16	18	20	22	25	32	-
$>250-500$	20	22	25	28	32	40	-
$>500-630$	-	-	32	36	40	50	-

Radial runout of journal relative to support journal



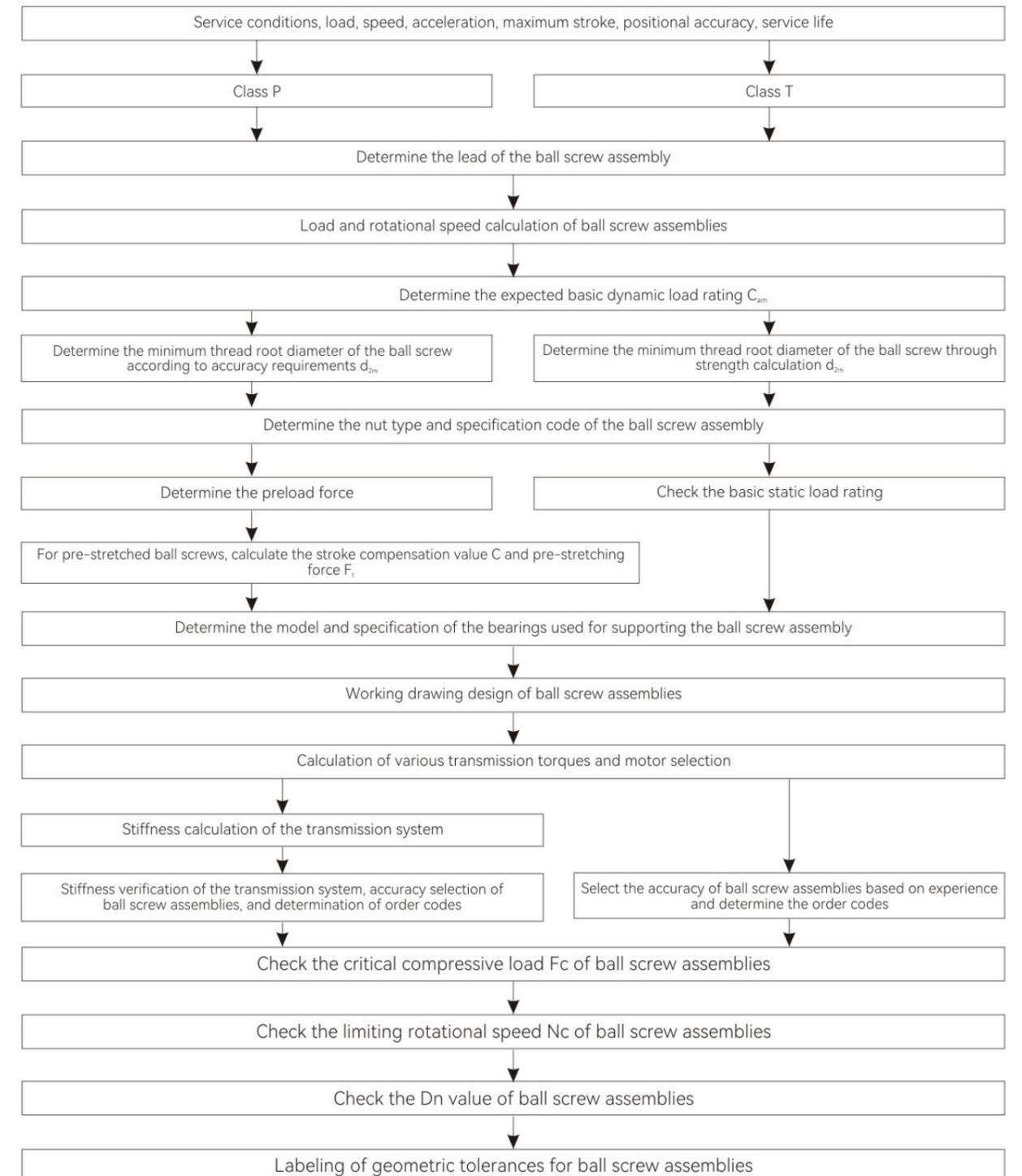
Ball nut mounting diameter $D_1$ mm	Standard tolerance grade						
	1	2	3	4	5	7	10
$\geq 16-32$	$t_{10p}$ $\mu\text{m}$						
$>32-63$	10	11	12	14	16	20	-
$>63-125$	12	14	16	18	20	25	-
$>125-250$	16	18	20	22	25	32	-
$>250-500$	20	23	25	28	32	40	-
$>500-630$	-	-	32	36	40	50	-

Precision grades applicable to various machines

Purpose	Axle type	Precision grade							
		1	2	3	4	5	7	10	
CNC machine tools	Lathe	X	✓	✓	✓	✓			
		Z			✓	✓	✓		
	Milling machine, boring machine	X	✓	✓	✓	✓	✓		
		Y	✓	✓	✓	✓	✓		
	Composite processing machine	Z		✓	✓	✓	✓		
		X	✓	✓	✓	✓			
		Y	✓	✓	✓	✓			
	Jig boring machine	Z		✓	✓	✓			
		X	✓						
		Y	✓						
	Drilling machine	X			✓	✓	✓		
		Y			✓	✓	✓		
		Z				✓	✓		
	Grinding machine	X	✓	✓					
Y		✓	✓	✓					
Electrical discharge machining (EDM) machine	X	✓	✓	✓					
	Y	✓	✓	✓					
	Z		✓	✓	✓				
Wire cutting machine	X	✓	✓	✓					
	Y	✓	✓	✓					
	U	✓	✓	✓	✓				
	V	✓	✓	✓	✓				
laser processing machine	X		✓	✓	✓				
	Y		✓	✓	✓				
	Z		✓	✓	✓				
General machinery	High-speed punch press	X			✓	✓	✓		
		Y			✓	✓	✓		
	Special-purpose machine		✓	✓	✓	✓	✓		
	Woodworking machine							✓	✓
	Robotic arm (precision grade)		✓	✓	✓	✓			
	Robotic arm (general grade)						✓	✓	
	Traditional machinery				✓	✓	✓		
	Conveying device					✓	✓	✓	✓
	X-Y platform		✓	✓	✓	✓	✓		
	Linear actuator						✓	✓	
	Aerospace load gear						✓	✓	
	Airfoil controller						✓	✓	
	Valve							✓	✓
	Power steering gear							✓	
	Glass grinding machine			✓	✓	✓	✓		
	Surface grinding machine					✓	✓		
Induction heat treatment							✓	✓	
Semiconductor equipment		✓	✓	✓	✓	✓			
All-electric injection molding machine						✓	✓	✓	

Calculation and selection of ball screw assemblies

Calculation steps and process



### Selection key points

#### 1. Efficiency

When converting input torque into axial force, the efficiency formula is as follows

$$\eta \approx \frac{\tan \alpha}{\tan(\alpha + \rho)}$$

$\eta$  ----- Efficiency (~0.9)  
 $\rho$  ----- Friction angle  
 $\eta'$  ----- Efficiency (~0.8)

When converting input axial force into torque, the efficiency formula is as follows

$$\eta' \approx \frac{\tan(\alpha - \rho)}{\tan \alpha}$$

Lead angle

$$\tan \alpha \approx \frac{P_h}{d_0 \times \pi}$$

$\alpha$  ----- Lead angle  
 $P_h$  ----- Lead  
 $d_0$  ----- Screw mean diameter

Friction angle

$$\rho = 0.20^\circ \sim 0.35^\circ$$

#### 2. Dynamic conversion formulas

Linear motion:	Stroke	$s = vt$
	Velocity	$v = s/t$
	Acceleration	$a = v/t$
	Axial force	$F = m \cdot a$
	Torque	$M = F \cdot r$
	Power	$P = F \cdot v$

#### Important unit conversions

$$1 \text{ N} = 1 \text{ Kg} \frac{\text{m}}{\text{s}^2}$$

$$1 \text{ Kg} = 9.80665 \text{ N}$$

$$1 \text{ PS} = 75 \text{ Kg} \frac{\text{m}}{\text{s}^3} = 0.7355 \text{ KW}$$

$$1 \text{ W} = 1 \text{ Nm} = 1 \text{ J}$$

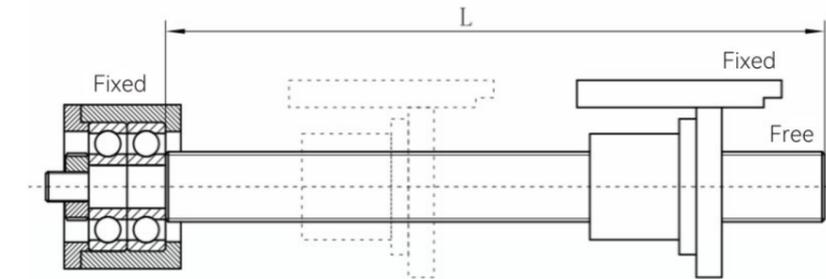
$$\eta = P_{ab} / P_{zu}$$

Rotational motion:	Rotation angle	$\phi = \omega \cdot t$
	Speed	$v = d\pi n = v/r$
	Angular velocity	$\omega = 2\pi n = v/r$
	Axial force	$F = m \cdot r \cdot \omega^2$
	Torque	$M = J \cdot \omega$
	Power	$P = M \cdot \omega$

### 3. Installation methods of ball screw assemblies

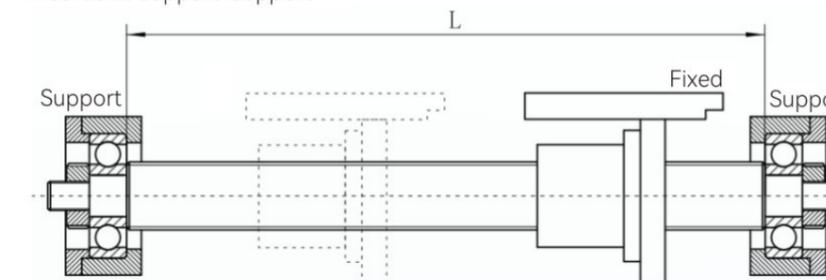
When selecting the specifications of ball screw assemblies, the influence of installation methods must be considered. Different installation methods correspond to different allowable axial loads and critical rotational speeds. The following are the four most commonly used installation methods:

Method 1: Fixed-Free



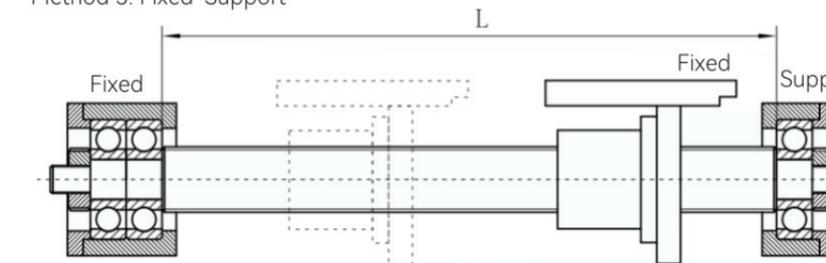
1. Low rotational speed
2. Short screw shaft

Method 2: Support-Support



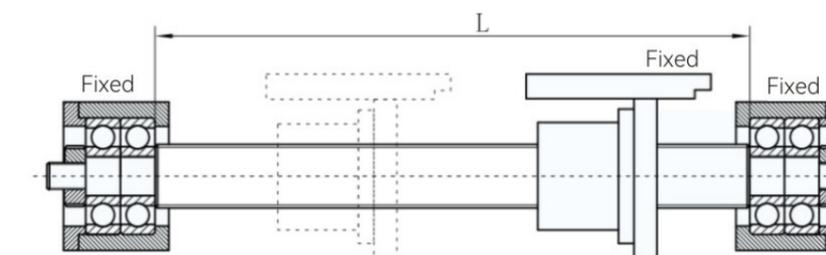
1. Medium rotational speed
2. Medium precision

Method 3: Fixed-Support



1. Commonly used method
2. Medium rotational speed
3. High precision

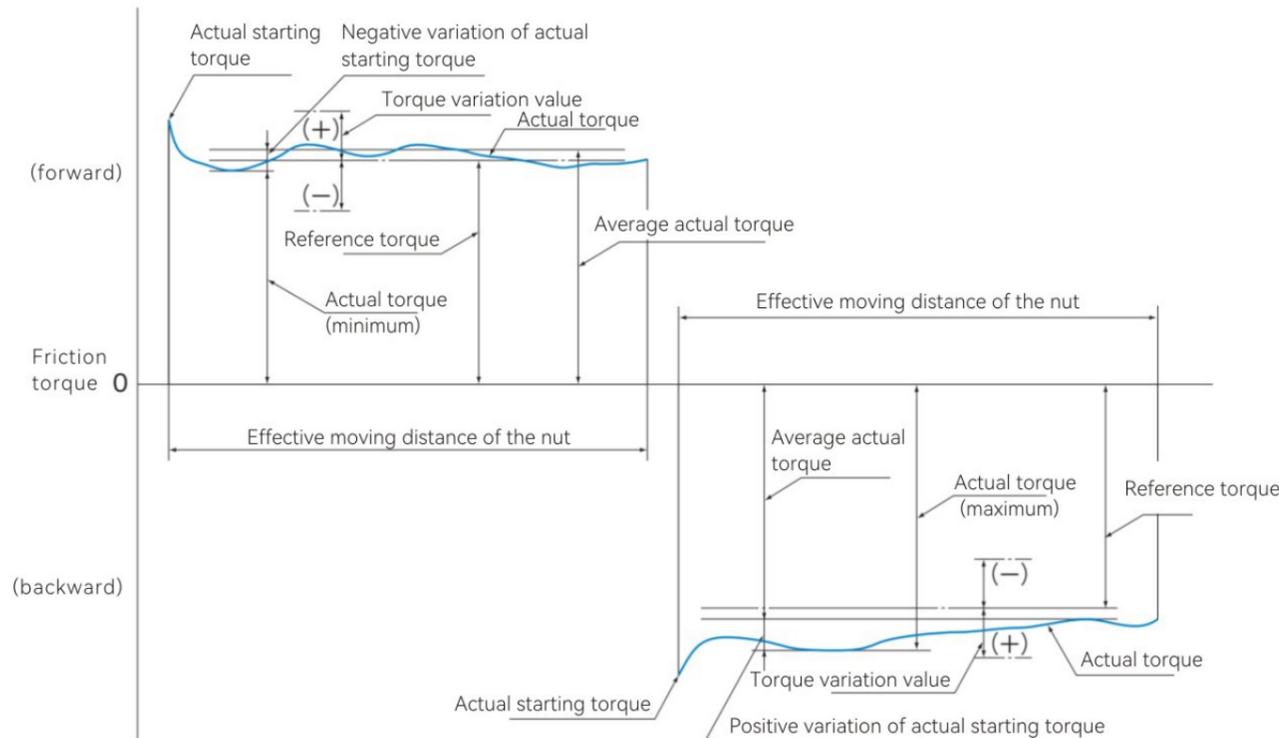
Method 4: Fixed-Fixed



1. High rotational speed
2. High precision

#### 4. Preload torque

● Graph of preload torque;



● Preload dynamic torque

The torque required to continuously rotate the screw shaft of a preloaded ball screw when no external load is applied

● Actual torque

Preload dynamic torque obtained from actual testing of the ball screw

● Torque variation value

The allowable variation of preload dynamic torque set as the target value, expressed as positive or negative relative to the standard torque

● Torque variation rate

The ratio of the torque variation value to the standard torque

● Standard torque

Preload dynamic torque set as the target value

● Calculation of standard torque

The standard torque of a preloaded ball screw assembly is calculated by the following formula

$$T_p = 0.05 (\tan\beta)^{-0.5} \frac{F_{a0} \cdot Ph}{2\pi}$$

- $T_p$  : Standard torque (N·mm)
- $\beta$  : Lead angle
- $F_{a0}$  : Preload force (N)
- $Ph$  : Lead (mm)

#### 5. Allowable axial load and allowable rotational speed

● Buckling load of the screw shaft

When the maximum compressive load is applied axially to the ball screw, a screw shaft that does not buckle shall be selected. The buckling load can be calculated using the following formula. For safety, a safety factor of 0.5 shall be multiplied.

$$P_1 = \frac{\eta_1 \cdot \pi^2 \cdot E \cdot I}{l_a^2} \cdot 0.5 = \eta_2 \frac{d_1^4}{l_a^2} \cdot 10^4$$

- $P_1$  : Buckling load (N)
- $l_a$  : Installation spacing (mm)
- $E$  : Young's modulus ( $2.06 \times 10^5$  N/mm<sup>2</sup>)
- $I$  : Minimum moment of inertia of the screw shaft section (mm<sup>4</sup>)

$$I = \frac{\pi}{64} d_1^4 \quad d_1 : \text{Minor diameter of the screw shaft thread (mm)}$$

$\eta_1, \eta_2$  = Coefficient related to the installation method

Fixed-free	$\eta_1=0.25$	$\eta_2=1.3$
Fixed-support	$\eta_1=2$	$\eta_2=10$
Fixed-fixed	$\eta_1=4$	$\eta_2=20$

● Allowable tensile and compressive load of the screw shaft

When applying axial load to the ball screw, the buckling load, yield stress, and allowable tensile and compressive load of the screw shaft must be considered. When the installation distance is short, the difference in installation methods has little effect, and the allowable tensile and compressive load can be calculated by the following formula.

$$P_2 = \sigma \frac{\pi}{4} d_1^2 = 116d_1^2$$

- $P_2$  : Allowable tensile and compressive load (N)
- $\sigma$  : Allowable tensile and compressive stress (MPa)
- $d_1$  : Minor diameter of the screw shaft thread (mm)

● Critical speed of the screw shaft

As the rotational speed of the ball screw increases, it gradually approaches the natural frequency of the screw shaft, which may cause resonance and make further rotation impossible. Therefore, it must be operated below the resonance point (critical speed). The critical speed can be calculated using the formula on the right, and the calculation result should be multiplied by a safety factor of 0.8.

The allowable rotational speed of the ball screw is determined by the critical speed of the screw shaft and the DN value. The allowable rotational speed  $N_2$  determined by the critical speed  $N_1$  of the screw shaft and the DN value shall take the lower rotational speed of the two as the reference value for the maximum rotational speed. Please confirm and select the applicable rotational speed based on this premise.

$$N_1 = \frac{60 \cdot \lambda_1^2}{2\pi \cdot l_b^2} \times \sqrt{\frac{E \times 10^3 \cdot I}{\gamma \cdot A}} \times 0.8 = \lambda_2 \cdot \frac{d_1}{l_b^2} \cdot 10^7$$

- $N_1$  : Allowable rotational speed at critical speed (min<sup>-1</sup>)
- $l_b$  : Installation spacing (mm)
- $E$  : Young's modulus ( $2.06 \times 10^5$  N/mm<sup>2</sup>)
- $I$  : Minimum moment of inertia of the screw shaft section (mm<sup>4</sup>)

$$I = \frac{\pi}{64} d_1^4 \quad d_1 : \text{Minor diameter of the screw shaft thread (mm)}$$

- $\gamma$  : Density (specific gravity) ( $7.85 \times 10^{-4}$  kg/mm<sup>3</sup>)
- $A$  : Cross-sectional area of the screw shaft (mm<sup>2</sup>)

$$A = \frac{\pi}{4} d_1^2$$

$\lambda_1, \lambda_2$  : Coefficient related to the installation method

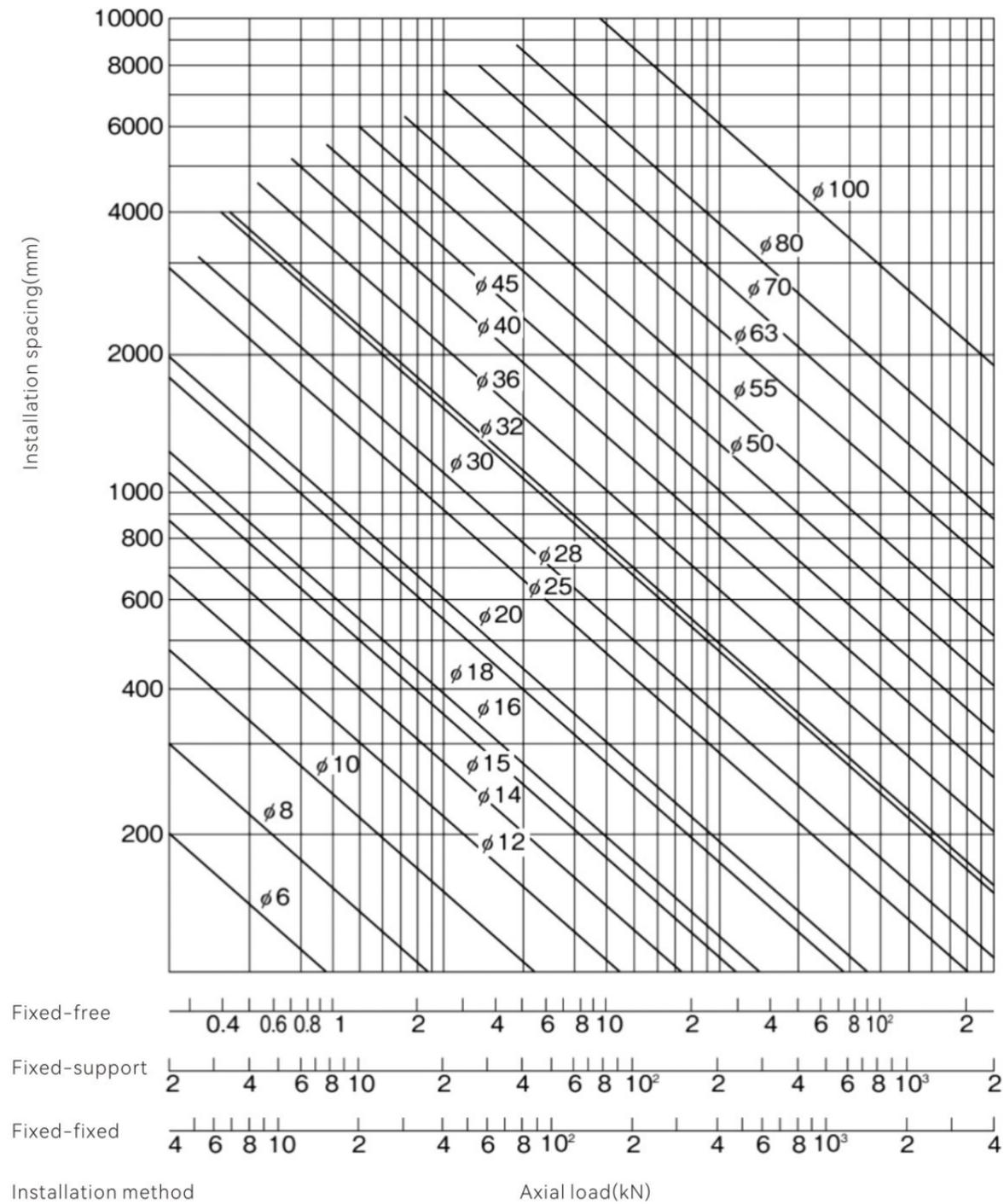
Fixed-free	$\lambda_1=1.875$	$\lambda_2=3.4$
Support-support	$\lambda_1=3.142$	$\lambda_2=9.7$
Fixed-support	$\lambda_1=3.927$	$\lambda_2=15.1$
Fixed-fixed	$\lambda_1=4.73$	$\lambda_2=21.9$

$$N_2 = \frac{DN}{D}$$

- $N_2$  : Allowable rotational speed determined by the DN value
- $D$  : Ball center diameter

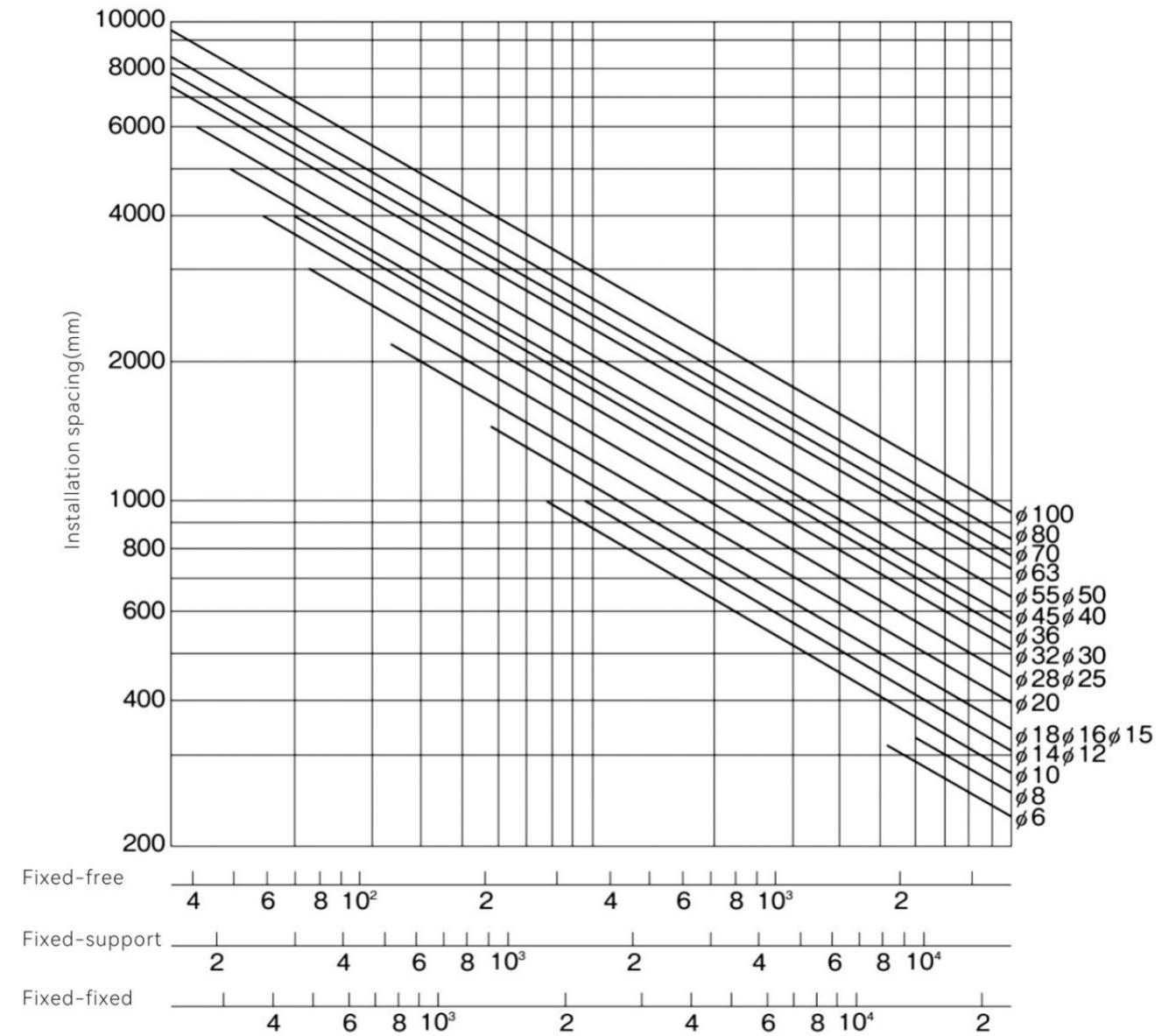
As shown in Figure A, it shows the relationship between the value of allowable axial load and the minor diameter of the screw root thread, installation spacing, and installation method.

Figure A - Allowable Axial Load Diagram



As shown in Figure B, it shows the relationship between the value of allowable rotational speed and the minor diameter of the screw root thread, installation spacing, and installation method.

Figure B - Allowable Rotational Speed Diagram



## 6. Axial Load Calculation

### Horizontal Application

When transporting workpieces horizontally to and fro using a general conveying device, the axial load is calculated by the following formulas;

$$Fa_1 = \mu \cdot mg + f + ma$$

$$Fa_2 = \mu \cdot mg + f$$

$$Fa_3 = \mu \cdot mg + f - ma$$

$$Fa_4 = -\mu \cdot mg - f - ma$$

$$Fa_5 = -\mu \cdot mg - f + ma$$

$V_{max}$  : Maximum Speed (m/s)

$t_1$  : Acceleration Time (s)

$$\alpha = \frac{V_{max}}{t_1} \text{ Acceleration (m/s}^2\text{)}$$

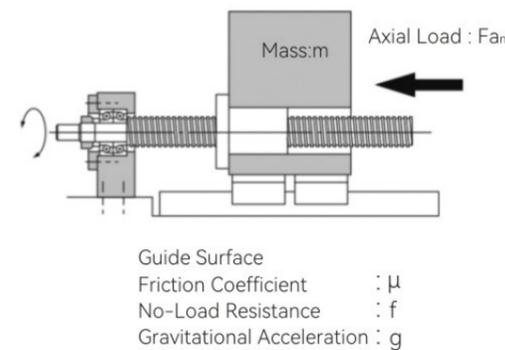
$Fa_1$  : Axial Load During Forward Acceleration (N)

$Fa_2$  : Axial Load During Forward Constant Speed (N)

$Fa_3$  : Axial Load During Forward Deceleration (N)

$Fa_4$  : Axial Load During Return Acceleration (N)

$Fa_5$  : Axial Load During Return Constant Speed (N)



$Fa_6$  : Axial Load During Return Deceleration (N)

$m$  : Transported Mass (kg)

$\mu$  : Friction Coefficient of Guide Surface (-)

$f$  : Guide Surface Resistance (No-Load) (N)

### Vertical Application

When transporting workpieces vertically up and down using a general conveying device, the axial load is calculated by the following formulas;

$$Fa_1 = mg + f + ma$$

$$Fa_2 = mg + f$$

$$Fa_3 = mg + f - ma$$

$$Fa_4 = mg - f - ma$$

$$Fa_5 = mg - f$$

$$Fa_6 = mg - f + ma$$

$V_{max}$  : Maximum Speed

$t_1$  : Acceleration Time

Acceleration

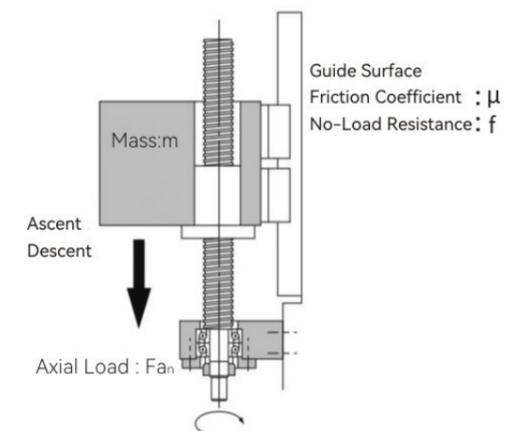
$Fa_1$  : Axial Load During Ascent Acceleration (N)

$Fa_2$  : Axial Load During Ascent Constant Speed (N)

$Fa_3$  : Axial Load During Ascent Deceleration (N)

$Fa_4$  : Axial Load During Descent Acceleration (N)

$Fa_5$  : Axial Load During Descent Constant Speed (N)



$Fa_6$  : Axial Load During Descent Deceleration (N)

$m$  : Transported Mass (kg)

$f$  : Guide Surface Resistance (No-Load) (N)

## 7. Calculation of Rated Life

When a ball screw is subjected to external loads during motion, cyclic stress is continuously applied to the rolling surfaces or balls. When the stress reaches a certain limit, fatigue damage occurs on the rolling surfaces, and fish-scale-like spalling appears on part of the surface. This phenomenon is called surface spalling. The service life of a ball screw refers to the total number of revolutions the screw rotates until the first surface spalling occurs on either the rolling surface or the balls due to rolling fatigue of the material. Regarding the operational life of ball screws, even those manufactured using the same method and operated under identical conditions can exhibit significant differences in lifespan. Therefore, the following defined rated life is used as the benchmark for ball screw life: The rated life is the total number of revolutions at which 90% of a batch of identical ball screws, each operating under the same conditions, will not experience surface spalling (scaly spalling of the metal surface).

### 1. Dynamic Rating Axial Load (Ca)

The axial load of constant magnitude and direction acting on the axis, under which a sufficient number of identical ball screws can achieve a rated life of one million rotations.

### 2. Static Rating Axial Load (Coa)

For ball screws, the basic static rating axial load is defined by the axial load. It is defined as a static load of constant magnitude and direction at which the sum of the permanent deformation of the rolling elements and the rolling surface reaches 0.0001 times the diameter of the rolling elements at the contact part subjected to the maximum stress.

### 3. Static Safety Factor (fs)

Typically, the basic static rating axial load (Coa) is equal to the allowable axial load of the ball screw. Depending on the operating conditions, the following static safety factor must be considered for the calculated load. Attention must be paid to unexpected external forces acting on the ball screw during stationary or moving states, such as inertial forces generated by impacts or start-stop operations.

### 4. Mean Axial Load (Fm)

The mean axial load (Fm) refers to a constant load magnitude that produces the same life as when variable loads act on the ball screw. When the load changes in stages, the mean axial load can be calculated by the following formula.

$$F_{amax} = \frac{C_{oa}}{f_s}$$

$F_{amax}$  : Allowable Axial Load (kN)

$C_{oa}$  : Basic Static Load Rating (kN)

$f_s$  : Static Safety Factor

$$F_m = \sqrt[3]{\frac{1}{l} (Fa_1^3 l_1 + Fa_2^3 l_2 + \dots + Fa_n^3 l_n)}$$

$F_m$  : Mean Axial Load (N)

$Fa_n$  : Variable Load (N)

$l_n$  : Travel Distance Under Load (Fn)

$l$  : Total Travel Distance

When calculating the mean axial load using rotational speed and time instead of travel distance, first calculate the travel distance using the following formula and then compute the mean axial load.

Table 3. Static Safety Factor (fs)

Machine Type	Load Conditions	Lower Limit of fs
General Industrial Machinery	Without Vibration or Shock	1.0~3.5
	With Vibration or Shock	2.0~5.0
Machine Tool	Without Vibration or Shock	1.0~4.0
	With Vibration or Shock	2.5~7.0

$$l = l_1 + l_2 + \dots + l_n$$

$$l_1 = N_1 \cdot t_1$$

$$l_2 = N_2 \cdot t_2$$

$$l_n = N_n \cdot t_n$$

$N$ : Rotational Speed  
 $t$ : Time

### Calculation of Rated Life

The rated life is expressed in three forms: total number of revolutions, total running distance, and total running time. It is defined as the value that 90% of a sufficient number of identical ball screw mechanisms under the same operating conditions can reach before the occurrence of fatigue limit phenomena.

#### 【 Revolution Life (L<sub>10</sub>) 】

The rated life (L<sub>10</sub>) is calculated by the following formula based on the basic dynamic load rating (Ca) and the axial load (Fa) applied to the ball screw;

$$L_{10} = \left( \frac{C_a}{F_a} \right)^3 \times 10^6$$

- L<sub>10</sub> : Rated Life (rev.)
- C<sub>a</sub> : Basic Dynamic Load Rating (N)
- F<sub>a</sub> : Axial Load (N)

In practical applications, it is difficult to accurately determine the applied load due to continuous changes caused by vibration and impact during operation. Taking these conditions into account, the rated life (L<sub>10m</sub>) considering service conditions can be calculated using the following formula.

#### Service Condition Factor α

$$\alpha = \frac{1}{f_w}$$

- α : Service Condition Factor
- f<sub>w</sub> : Load Factor

#### Rated Life Considering Service Conditions L<sub>10m</sub>

$$L_{10m} = \left( \alpha \times \frac{C_a}{F_a} \right)^3 \times 10^6$$

- L<sub>10m</sub> : Rated Life Considering Service Conditions (rev.)
- C<sub>a</sub> : Basic Dynamic Load Rating (N)
- F<sub>a</sub> : Axial Load (N)

Table 4. Load Factor (Fw)

Vibration & Shock	Speed (V)	f <sub>w</sub>
Tiny	At very low speed V ≤ 0.25m/s	1~1.2
Small	At low speed 0.25 < V ≤ 1m/s	1.2~1.5
Medium	At medium speed V ≤ 0.25m/s	1.5~2
Large	At high speed V > 2m/s	2~3.5

#### Running Distance Life (L<sub>s</sub>)

The running distance life is calculated using the formula below based on the rated life (L<sub>10</sub>) and the lead of the ball screw.

$$L_s = \frac{L_{10} \times Ph}{10^6}$$

- L<sub>s</sub> : Running Distance Life (km)
- Ph : Lead of Ball Screw (mm)

#### Operating Time Life (L<sub>h</sub>)

If the number of revolutions per minute (n) is known, the operating time life can be calculated by substituting the rated life (L<sub>10</sub>) into the following formula.

$$L_h = \frac{L_{10}}{60 \times N} = \frac{L_{10} \times Ph}{2 \times 60 \times n \times l_s}$$

- L<sub>h</sub> : Operating Time Life (h)
- N : Revolutions per Minute (min<sup>-1</sup>)
- n : Round Trips per Minute (min<sup>-1</sup>)
- Ph : Lead of Ball Screw (mm)
- l<sub>s</sub> : Stroke Length (mm)

## 8. Rigidity of Ball Screw System

To improve the positioning accuracy of feed screws for NC machine tools and precision machinery, and to reduce displacement caused by cutting forces, it is necessary to design by comprehensively considering the rigidity of each component. When the axial rigidity of the feed screw system is represented by K, the axial elastic displacement can be calculated by the following formula.

$$\delta = \frac{F_a}{K}$$

- δ : Axial Elastic Displacement of Feed Screw System (μm)
- F<sub>a</sub> : Applied Axial Load (N)

The axial rigidity of the feed screw system can be calculated by the following formula.

$$\frac{1}{K} = \frac{1}{K_s} + \frac{1}{K_N} + \frac{1}{K_B} + \frac{1}{K_H}$$

- K : Axial Rigidity of Feed Screw System (N/μm)
- K<sub>s</sub> : Axial Rigidity of Screw Shaft (N/μm)
- K<sub>N</sub> : Axial Rigidity of Nut (N/μm)
- K<sub>B</sub> : Axial Rigidity of Support Bearings (N/μm)
- K<sub>H</sub> : Rigidity of Nut Housing and Bearing Housing (N/μm)

### Axial Rigidity of Screw Shaft

The axial rigidity of the screw shaft varies depending on the installation method of the screw shaft.

When the installation method is fixed-supported (or free), K<sub>s</sub> is calculated by the following formula

$$K_s = \frac{A \cdot E}{1000 \cdot L}$$

- A : Cross-sectional Area of Screw Shaft (mm<sup>2</sup>)

$$A = \frac{\pi}{4} d_1^2$$

- d<sub>1</sub> : Minor Diameter of Screw Shaft Thread (mm)
- E : Young's Modulus (2.06 × 10<sup>5</sup> N/mm<sup>2</sup>)
- L : Installation Spacing (mm)

The axial rigidity curve of the screw shaft is shown in Figure C.

When the installation method is fixed-fixed (or free), K<sub>s</sub> is calculated by the following formula

$$K_s = \frac{A \cdot E \cdot L}{1000 \cdot a \cdot b}$$

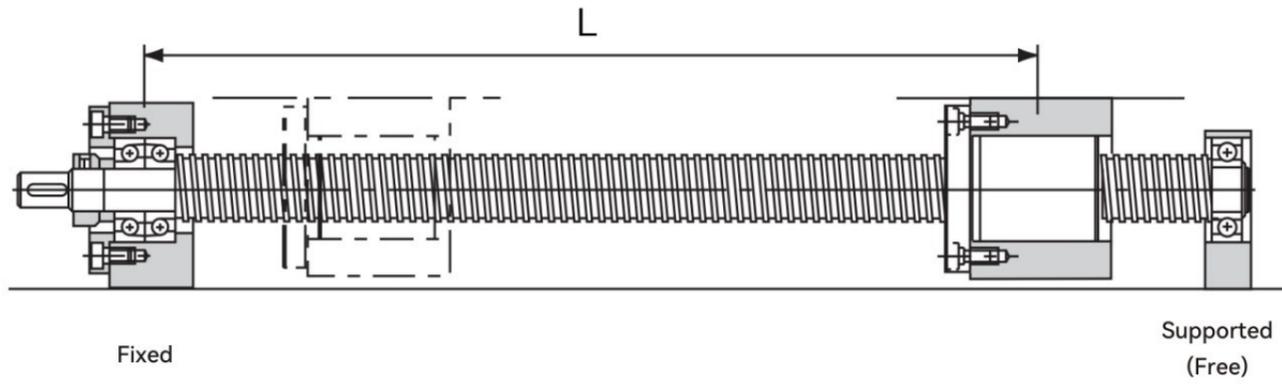
When at position a = b =  $\frac{L}{2}$ , the value of K<sub>s</sub> is minimized,

and the axial elastic displacement is maximized.

$$K_s = \frac{4A \cdot E}{1000L}$$

The axial rigidity curve of the screw shaft is shown in Figure D.

Installation Method: Fixed-Supported (or Free)



Installation Method: Fixed-Fixed

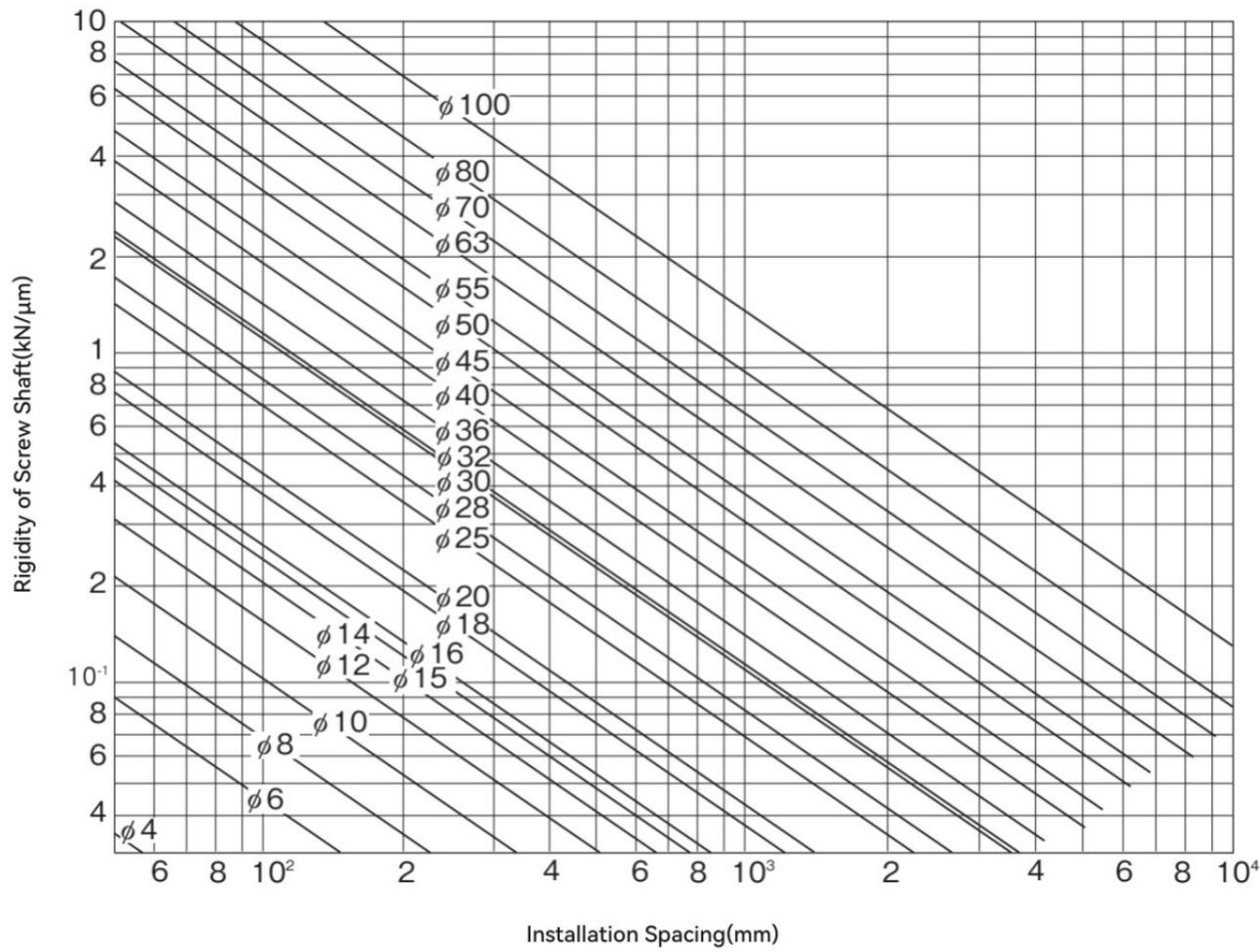
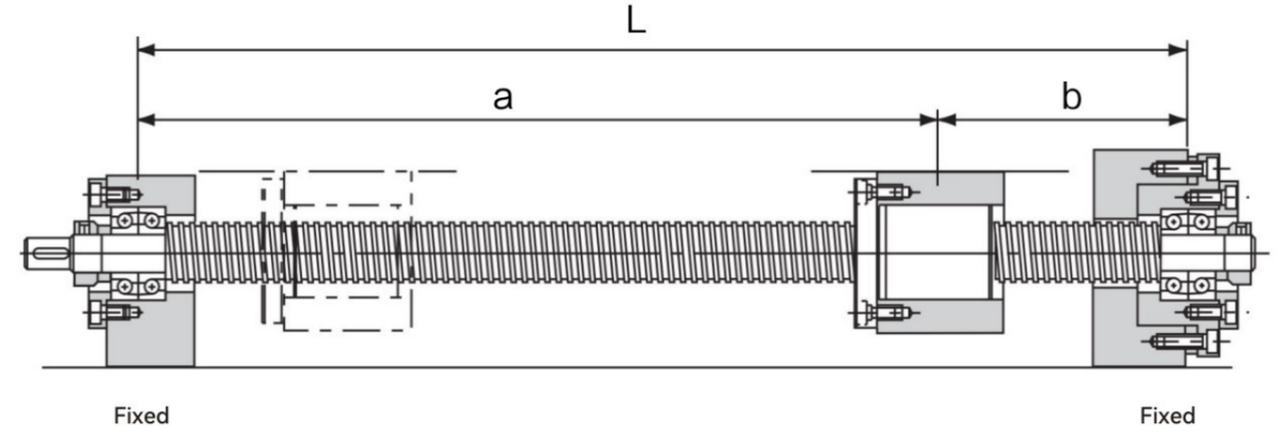


Figure C - Axial Rigidity of Screw Shaft (Fixed-Free, Fixed-Supported)

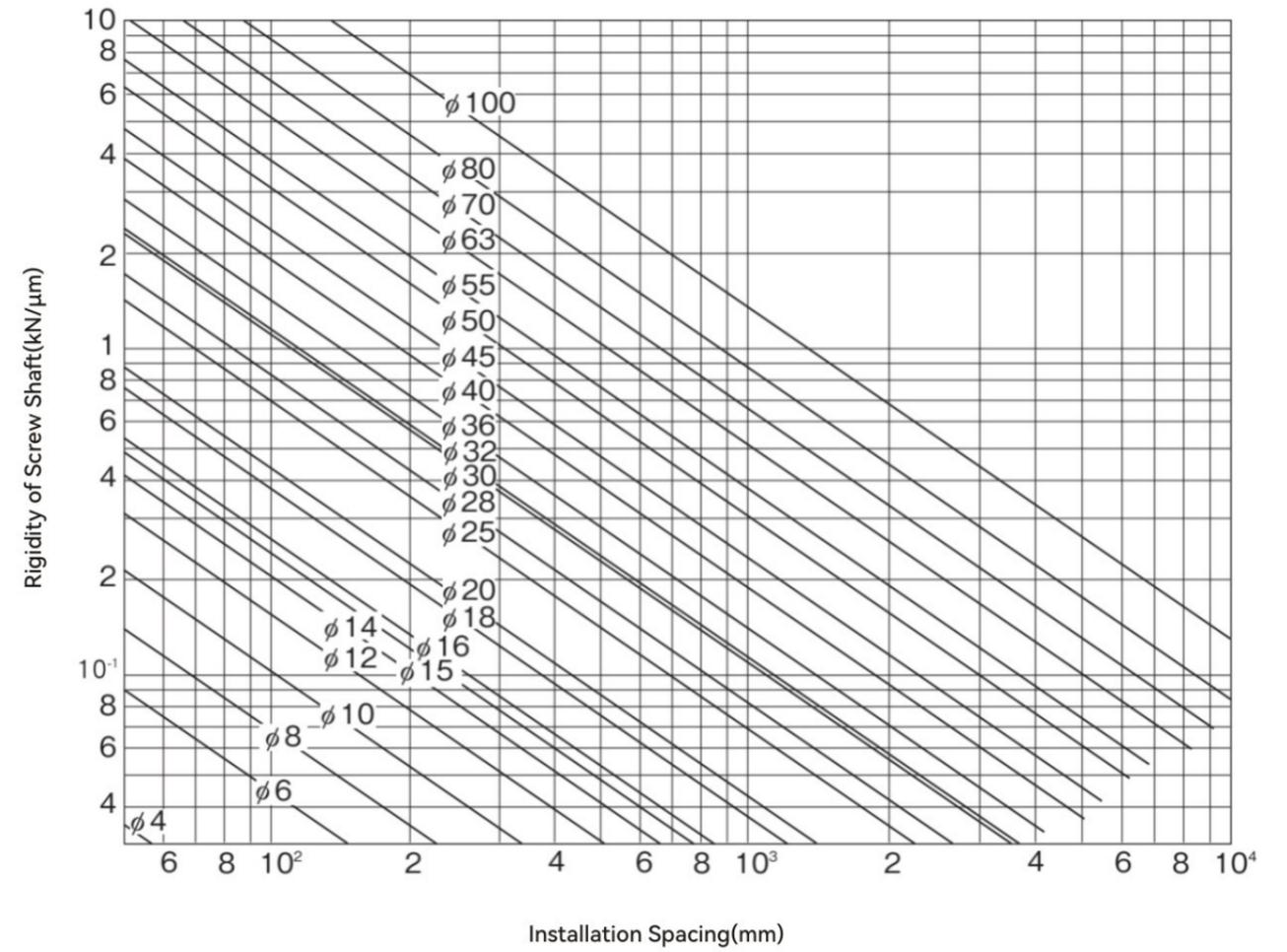


Figure D - Axial Rigidity of Screw Shaft (Fixed-Fixed)

## Axial Rigidity of Nut

The axial rigidity of the nut varies significantly depending on the preload.

### Non-Preloaded Type

- When an axial load equal to 30% of the basic dynamic load rating (Ca) is applied, the theoretical axial rigidity value can be found in the dimensional table of the corresponding model. This value does not include the rigidity of mounting components such as the nut support. Generally, use approximately 80% of the tabulated value as a reference.
- When the axial load is not equal to 30% of the basic dynamic load rating (Ca), the rigidity value is calculated by the following formula.

$$K_N = K \left( \frac{F_a}{0.3C_a} \right)^{\frac{1}{3}} \times 0.8$$

$K_N$ : Axial Rigidity of Nut	(N/μm)
$k$ : Rigidity Value in Dimensional Table	(N/μm)
$F_a$ : Applied Axial Load	(N)
$C_a$ : Basic Dynamic Load Rating	(N)

### Preloaded Type

- When a preload equal to 10% of the basic dynamic load rating (Ca) is applied, the theoretical axial rigidity value can be found in the dimensional table of the corresponding model. This value does not include the rigidity of mounting components such as the nut support. Generally, use approximately 80% of the tabulated value as a reference.
- When the preload is not equal to 10% of the basic dynamic load rating (Ca), the rigidity value is calculated by the following formula.

$$K_N = K \left( \frac{F_{a_0}}{0.1C_a} \right)^{\frac{1}{3}} \times 0.8$$

$K_N$ : Axial Rigidity of Nut	(N/μm)
$k$ : Rigidity Value in Dimensional Table	(N/μm)
$F_{a_0}$ : Preload	(N)
$C_a$ : Basic Dynamic Load Rating	(N)

## Axial Rigidity of Support Bearings

The rigidity of ball screw support bearings varies depending on the type of bearings used. The calculation of the rigidity for typical angular contact ball bearings is as follows. For specific questions about support bearings, please contact the bearing manufacturer.

$$K_B = \frac{3F_{a_0}}{\delta a_0}$$

$K_B$ : Axial Rigidity of Support Bearings	(N/μm)
$F_{a_0}$ : Preload of Support Bearings	(N)
$\delta a_0$ : Axial Displacement	(μm)

$$\delta a_0 = \frac{0.45}{\sin \alpha} \left( \frac{Q^2}{D_a} \right)^{\frac{1}{3}}$$

$$Q = \frac{F_{a_0}}{Z \sin \alpha}$$

$Q$ : Axial Load	(N)
$D_a$ : Ball Diameter of Support Bearings	(mm)
$\alpha$ : Initial Contact Angle of Support Bearings	(°)
$Z$ : Number of Steel Balls	

## Rigidity of Nut Housing and Bearing Housing

In mechanical design, this should be fully considered to improve its rigidity as much as possible.

## 9. Driving Torque

The rotational torque required for positive transmission that converts the rotational motion of a ball screw into linear motion can be calculated by the following formula. (The calculation method for reverse transmission is similar and will not be elaborated here.)

### At Constant Speed

$$T_t = (T_1 + T_p + T_4) / A$$

$T_t$ : Torque Required at Constant Speed	(N · mm)
$T_1$ : Frictional Torque Caused by External Loads	(N · mm)
$T_p$ : Torque Caused by Preload of Ball Screw	(N · mm)
$T_4$ : Other Torques (Frictional Torque of Support Bearings, Oil Seals, etc.)	(N · mm)
$A$ : Gear Reduction Ratio	

### During Acceleration

$$T_k = T_t + T_3$$

$T_k$ : Torque Required During Acceleration (N · mm)
$T_3$ : Acceleration Torque (N · mm)

### During Deceleration

$$T_g = T_t - T_3$$

$T_g$ : Torque Required During Deceleration (N · mm)
--

### Frictional Torque T1 Caused by External Loads

The rotational torque required for external loads (such as guide surface resistance or external forces) in the rotational force of the ball screw can be calculated by the following formula.

$$T_1 = \frac{F_a \cdot Ph}{2\pi \cdot \eta}$$

$T_1$ : Frictional Torque Caused by External Loads	(N · mm)
$F_a$ : Axial Load	(N)
$Ph$ : Lead of Ball Screw	(mm)
$\eta$ : Efficiency of Ball Screw (0.9~0.95)	

### Torque Tp Caused by Preload of Ball Screw

The standard torque of a preloaded ball screw pair is calculated by the following formula.

$$T_p = 0.05 (\tan \beta)^{-0.5} \frac{F_{a_0} \cdot Ph}{2\pi}$$

$T_p$ : Standard Torque Due to Preload	(N · mm)
$\beta$ : Lead Angle	(N · mm)
$F_{a_0}$ : Preload Load	(N · mm)
$Ph$ : Lead of Ball Screw	(mm)

### Acceleration Torque T3

When the ball screw drive system accelerates or decelerates in rotation, in addition to the driving torque required at constant speed, additional torque is needed to drive the acceleration/deceleration motion. This part of the torque is called acceleration torque and can be calculated by the following formula.

$$T3 = J \times \omega' \times 10^3$$

T3 : Acceleration Torque	( N · mm )
J : Total Moment of Inertia of Screw Drive System	( kg · m <sup>2</sup> )
ω' : Angular Acceleration	( rad/s <sup>2</sup> )

### System Moment of Inertia J

The total moment of inertia of the ball screw drive system converted to the motor shaft is composed of multiple parts and can be obtained by the following formula.

$$J = \frac{1}{A^2} \left[ m \left( \frac{Ph}{2\pi} \right)^2 \times 10^{-6} + J_s + J_A \right] + J_B$$

m : Transport Mass	( kg )
Ph : Lead of Ball Screw	( mm )
J <sub>s</sub> : Moment of Inertia of Screw Shaft	( kg · m <sup>2</sup> )
J <sub>A</sub> : Moment of Inertia of Gears on Screw Shaft Side, etc.	( kg · m <sup>2</sup> )
J <sub>B</sub> : Moment of Inertia of Gears on Motor Side, etc.	( kg · m <sup>2</sup> )
A : Gear Reduction Ratio	
ω' : Angular Acceleration	$\omega' = \frac{2\pi \cdot Nm}{60t}$ ( rad/s <sup>2</sup> )
Nm : Motor Speed	( r/min )
t : Acceleration Time	( s )

The moment of inertia of screws, shafts, couplings, gears, etc. shall be referred to the following moment of inertia formula for a cylinder.

$$J' = \frac{1}{8} mD^2 \times 10^{-6}$$

J' : Moment of Inertia of Cylinder	( kg · m ) <sup>2</sup>
m : Mass of Cylinder	( kg )
D : Outer Diameter of Cylinder	( mm )

## 10. Motor Selection

There are many types of motors. Generally, the standard is that the driving torque at constant speed should not exceed 30% of the motor's rated torque.

### Motor Speed

The required motor speed is calculated by the following formula based on the feed speed, lead of the ball screw, and gear reduction ratio.

$$Nm = (V \times A \times 1000 \times 60) / Ph$$

Nm : Motor Required Speed	( r/min )
V : Feed Speed	( m/s )
Ph : Lead of Ball Screw	( mm )
A : Gear Reduction Ratio	( r/min )
Nr : Motor Rated Speed	

(Nr ≥ Nm, The motor rated speed must be greater than or equal to the Nm value.)

### Motor Torque

The torque required by the motor varies during constant-speed motion, acceleration, and deceleration. For the calculation of rotational torque, refer to the relevant formulas in Section 9.

### Maximum Torque

The maximum torque required by the motor must not exceed the motor's own instantaneous maximum torque.

$$T_{max} \leq T_{pmax}$$

T <sub>max</sub> : Maximum Torque Acting on the Motor
T <sub>pmax</sub> : Motor's Own Instantaneous Maximum Torque

### Inertia Matching

The moment of inertia J<sub>m</sub> of the motor shall satisfy the following requirements:

$$J_m \geq J/B$$

J <sub>m</sub> : Moment of Inertia of the Motor	( kg · m <sup>2</sup> )
J : Total Moment of Inertia of the Screw Drive System	( kg · m <sup>2</sup> )
B : Coefficient Determined by the Motor and Driver	

( The value of B is typically between 3 and 10. Specific values shall be confirmed through the motor manufacturer's product manual. )

### Equivalent Torque

The torque value of the motor is not constant during this working condition cycle. The torque value varies in different time periods, and its equivalent value is calculated by the following formula:

$$T_{rms} = \sqrt{\frac{T_1^2 \times t_1 + T_2^2 \times t_2 + T_3^2 \times t_3}{t}}$$

T <sub>rms</sub> : Equivalent Torque
T <sub>n</sub> : Variable Torque
t <sub>n</sub> : Time Under Torque T <sub>n</sub>
t : Cycle Time (t=t <sub>1</sub> +t <sub>2</sub> +t <sub>3</sub> )

The equivalent torque value calculated by the above formula must not exceed the motor's rated torque.

$$T_{rms} \leq T_r$$

T <sub>r</sub> : Motor Rated Torque
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### Determination of specific parameters

#### 1. Lead

Lead is determined by the transmission relationship diagram, the maximum movement speed of the workbench, the highest rotational speed of the motor, and the gear ratio.

$$P_h = \frac{iV_{max}}{n_{max}}$$

When the motor is directly connected to the ball screw pair:

$$P_h = \frac{V_{max}}{n_{max}}$$

#### 2. Load and Speed

##### 1) Minimum Load

The transmission force of the ball screw pair when the machine is unloaded, such as the frictional force together with the weight of the worktable.

##### 2) Maximum Load

The transmission force of the ball screw pair when the machine bears the maximum load. For example, during machine tool cutting, the sum of the axial component of the cutting force on the ball screw and the frictional force of the guide rail is Fmax (at this time, the guide rail frictional force is caused by the total weight of the worktable, workpiece, and fixture, as well as the component of the cutting force in the vertical guide rail direction).

##### 3) Equivalent Speed nm and Equivalent Load Fm

When the ball screw pair operates at speeds n1, n2, n3, ..., with the working time percentage at each speed being t1%, t2%, t3%...tn%, and the applied loads being F1, F2, F3...Fn, respectively.

$$n_m = \frac{n_1 \times t_1 + n_2 \times t_2 + \dots + n_n \times t_n}{t_1 + t_2 + \dots + t_n}$$

$$F_m = \sqrt[3]{\frac{F_1^3 \cdot n_1 \cdot t_1 + F_2^3 \cdot n_2 \cdot t_2 + \dots + F_n^3 \cdot n_n \cdot t_n}{n_1 \cdot t_1 + n_2 \cdot t_2 + \dots + n_n \cdot t_n}}$$

#### 3. Basic Dynamic Load Rating Cam

1) Calculation based on the expected working hours Lh (hours) of the ball screw pair.

$$C_{am} = \sqrt[3]{60 \times \frac{F_m \cdot f_w}{100 \times f_a \cdot f_c} \cdot L_h}$$

2) Calculation based on the expected running distance Ls (km) of the ball screw pair:

$$C_{am} = \sqrt[3]{\frac{L_s}{P} \times \frac{F_m \cdot f_w}{f_a \cdot f_c}}$$

Lh—Expected working hours (hours)Ls—Expected running distance (km), generally 250 km

fa—Accuracy coefficient, see Table 5

fw—Load coefficient, see Table 4 in Section 7 of the selection key points

fc—Reliability coefficient, generally 1; for important applications, the value of when requiring that a set of identical ball screw pairs under the same conditions have a service life exceeding 90% of the expected life is shown in Table 6

Table 5 - Accuracy Coefficient Fa

Accuracy Grade	1、2、3	4、5	7	10
fa	1.0	0.9	0.8	0.7

Table 6 - Reliability Coefficient c

Reliability%	90	95	96	97	98	99
fc	1.0	0.62	0.53	0.44	0.33	0.21

3) For ball screw pairs with preload, the calculation shall also be performed according to the maximum axial load Fmax.

$$C_{am} = f \cdot F_{max}$$

Where fe--Preload coefficient, see Table 7

Table 7 - Preload Coefficient fe

Preload Coefficient	Light Preload	Medium Preload	Heavy Preload
fe	6.7	4.5	3.4

Note: The larger value among the above three calculation results shall be selected as the Cam of the ball screw pair.

#### 4. Preload Force Fp

When selecting a preloaded nut type ball screw pair, the preload force Fp needs to be determined.

1) When the maximum axial working load Fmax can be determined:

$$F_p = \frac{1}{3} F_{max}$$

2) When the maximum axial working load Fmax cannot be determined:

$$F_p = \xi C_a$$

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Ca—Basic dynamic load rating, found in the catalog

ξ—Preload type, see Table 8

Table 8 - Preload Coefficient ξ

Preload Coefficient	Light Preload	Medium Preload	Heavy Preload
ξ	6.7	4.5	3.4

## 5. Thermal Deformation Compensation

During operation, the temperature of the screw shaft will rise, causing the screw shaft to expand due to heat, which reduces positioning accuracy. The expansion and contraction of the screw shaft due to heat can be calculated by the following formula.

$$\Delta L = \rho \cdot \Delta t \cdot L$$

$\Delta L$ — Axial Expansion/Contraction of Screw Shaft	(mm)
$L$ — Effective Length of Screw Thread	(mm)
$\rho$ — Coefficient of Thermal Expansion	( $12 \times 10^{-6}/^{\circ}\text{C}$ )
$\Delta t$ — Temperature Change of Screw Shaft	( $^{\circ}\text{C}$ )

For the fixed-fixed supported installation of ball screw pairs, thermal deformation can be compensated by pre-stretching. The pre-stretching force can be calculated by the following formula. Excessive pre-stretching may damage the bearings. It is recommended to use a pre-stretching value corresponding to a temperature rise of less than  $5^{\circ}\text{C}$ .

$$F_t = \Delta L \cdot A \cdot E / L = 1.94 \Delta t d_1^2$$

$F_t$ — Pre-stretching Force	(N)
$A$ — Cross-sectional Area of Screw Shaft : $\pi d^2$	( $\text{mm}^2$ )
$E$ — Young's Modulus	( $2.06 \times 10^5 \text{N}/\text{mm}^2$ )
$d_1$ — Minor Diameter of Screw Shaft Thread	(mm)

### Measures to Prevent Temperature Rise

As shown above, when the temperature of the screw shaft rises by  $1^{\circ}\text{C}$ , the screw shaft elongates by  $12\mu\text{m}$  per 1m. When the ball screw is used under high-speed conditions, heat generation increases, and the temperature rises faster, thereby reducing positioning accuracy. Therefore, when high precision is required, measures must be taken to prevent temperature rise.

- Minimize the preload of the ball screw and support bearings as much as possible.
- Increase the lead of the ball screw and reduce the rotational speed.
- Select appropriate lubricants.
- Cool the outside of the screw shaft with lubricating oil or cold air.
- Apply pre-stretching to the screw shaft.
- Set the target value of the ball screw's reference running distance to a negative value.

Generally, the temperature rise caused by heat generation is considered to be  $2^{\circ}\text{C} \sim 5^{\circ}\text{C}$ , and the negative value range is ( $-0.02\text{mm} \sim -0.06\text{mm}/\text{m}$ ).

## Design Considerations for Ball Screw Pairs

### Full Threads

When assembling, the nut must be screwed in from one end. Therefore, when designing the shaft end, at least one end must have full threads, and the diameter from the thread to the shaft end must be at least 0.2mm smaller than the root diameter of the thread to facilitate smooth installation of the nut.



Incomplete Threads



Full Threads

### Avoid Nut Separation

During mechanism design, pay close attention to the surrounding structure when installing the ball screw. Avoid situations where the surrounding structure forces the separation of the screw and nut for installation, as this can cause steel balls to fall off, preload changes, and reduced assembly accuracy. In severe cases, the ball screw pair may be damaged and unusable. If nut separation is unavoidable, contact our technical personnel.

### Hardness at Both Ends of Effective Threads

Ball screws are induction heat-treated. Due to the width of the induction coil, the first 15mm at both ends of the threads are not within the effective heat-treatment range, resulting in reduced hardness. Therefore, the effective thread length must be considered during design.

### Screw Auxiliary Support

When the screw is too long, its own weight may cause the middle part to sag, subjecting the screw to radial loads and adding bending stress to the shaft ends. In such cases, auxiliary supports must be installed below the screw to reduce sagging caused by its weight. The structure of the auxiliary support must ensure no collision or interference when the nut passes through.

### Other Considerations

- Avoid designing an excessively tight fit between the nut's positioning outer diameter and the nut seat. Tapping the nut during installation may damage the reverser.
- The ball nut should not bear radial loads or overturning moments. The resultant axial force on the nut should pass through the screw's axis.
- Ensure sufficient rigidity when designing the nut seat and bearing seat, and add reinforcing ribs in the load-bearing direction.

### Accessories for Ball Screw Pairs

#### 1. Dust Seal

If dust or foreign matter enters the nut of a ball screw, it may cause premature wear, damage to the screw groove, or breakage of the circulation part, leading to poor operation. Installing a dust seal prevents external foreign matter from entering.

#### 2. Shaft Sleeve

When both ends of the screw need to retain a smooth shaft, one end is kept as a smooth shaft and the other end is fitted with a shaft sleeve to facilitate nut installation and removal. This method meets the requirements and simplifies assembly/disassembly.



Shaft Sleeve



Sleeve

#### 3. Sleeve

For complete ball screw pairs that require only the nut (without the screw), the nut and balls can be installed on a sleeve. Additionally, the sleeve can be used as an effective tool for nut installation and removal. The outer diameter of the sleeve for the same ball screw pair is 0.2~0.3mm smaller than the root diameter of the screw.

### Safe Operation of Ball Screw Pairs

#### Precautions for Using Ball Screw Pairs:

- The ball nut should move within the effective stroke. If necessary, limit switches should be installed at both ends of the stroke to prevent the nut from exceeding the stroke and detaching from the screw shaft, which may cause the balls to fall off. If the nut detaches from the screw shaft or the balls fall off, contact our technical personnel immediately.
- Due to their high transmission efficiency, ball screw pairs do not have a self-locking function. When transmitting in the vertical direction, if the weight of the component is not balanced, it is necessary to prevent backdriving caused by the component's own weight when the transmission stops or the motor loses power. Methods to prevent backdriving include worm gear transmission, hydraulic/electrical brakes, overrunning clutches, etc.

### Lubrication

The lubricant and grease used for ball screws are lithium soap-based oils with a viscosity of 30~140cst (at 40°C). The lubricating oil is of the ISO grade 32~100.

#### Selection Criteria

1. For high-speed or low-temperature applications: Use lubricants with low base oil viscosity.
2. For high-temperature, high-load, oscillating, or low-speed applications: Use lubricants with higher base oil viscosity.

Table 9 shows the general indicators for lubricant inspection, replenishment intervals, and amounts. Before replenishing, it is necessary to wipe off the old lubricant attached to the lead screw shaft.

Table 9. Lubricant Replenishment Interval and Replenishment Amount

Lubrication Method	Inspection Interval	Inspection Items	Replenishment or Replacement Interval
Automatic Interval Oil Supply	Every week	Oil quantity, dirt	Replenish at each inspection, but make appropriate supplementation according to the oil tank capacity.
Grease	2-3 months at the initial stage of work	Whether foreign matter is mixed in	Usually replenish once a year, but appropriately supplement according to inspection results.
Oil Bath	Before starting work every day	Oil level management	Appropriately supplement according to consumption conditions.

Lubrication Method	Inspection and Addition Principles
Oil	<p>Inspect every week and replenish promptly at each inspection, making appropriate supplementation according to the oil tank capacity. Replace the lubricating oil if it becomes dirty.</p> <p>Calculation of Oil Injection Volume:                      Oil injection volume per ten minutes is <math>Q = \frac{\text{Outer Diameter of Screw Shaft(mm)}^2}{90} \times c \cdot c</math></p>

Lubrication Method	Inspection and Addition Principles
Grease	<p>Inspect for foreign matter mixing during the initial 2-3 months of operation. Replace the grease if it becomes dirty.</p> <p>Supplement grease appropriately according to usage conditions and operating environment, with the injection volume being 50% of the internal volume of the nut. The following formula is for the required injection volume of lubricating grease:                      Avoid mixing greases of different brands as much as possible.</p>

Ball Diameter d	Ø1.588	Ø2.0	Ø2.381	Ø2.778	Ø3.175	Ø3.969	Ø4.762
G Value	0.8	1.0	1.0	15	1.2	1.3	2.0

Ball Diameter d	Ø6.350	Ø7.144	Ø7.938	Ø9.525	Ø12.7	Ø15.875	Ø19.05
G Value	3.0	3.5	3.9	5.0	6.0	9.6	12

Formula:

$$Q = \left[ \left( \sqrt{(\pi \times dm)^2 + Ld^2} \times \pi d^2 \times \text{Number of Circulation Turns} \right) \times \frac{1}{1000} + \left( \frac{\pi L \times (2DG + G^2)}{4} \right) \right] \times \frac{1}{1100}$$

- $Q$  Injection Volume of Lubricating Grease(cm<sup>3</sup>)
- $D$  Outer Diameter of Screw Shaft(mm)
- $d$  Steel Ball Diameter(mm)
- $dm$  Pitch Circle Diameter(mm)
- $G$  Steel Ball Size Coefficient
- $Ld$  Lead(mm)
- $L$  Nut Length(mm)

### Installation

#### Installation Sequence of Ball Screw Pair

Confirm alignment → Install ball screw → Lubricate → Check operating conditions → Trial run → Check positioning accuracy

#### Confirm Alignment

Align the ball nut and support bearings. Proper alignment is critical for the lifespan, performance, and transmission accuracy of the ball screw. For precision-grade products, the recommended tilt error is ≤1/2000, and eccentricity ≤0.02mm.

#### Installation of Ball Screw and Nut

Wipe the outer circumference and inner diameter of the nut. While keeping the ball screw horizontal, gently insert it into the nut housing. Avoid impacting the shaft ends.

#### Bearing Installation

Use a special sleeve to install the bearings onto the ball screw to avoid direct impact. Ensure proper fit and alignment.

#### Bearing Fixation

When securing bearings with locknuts, adjust shaft end runout while applying the specified tightening torque. Use locknut anti-loosening measures.

#### Grease Supplementation

If the ball screw is pre-greased, no additional lubrication is required. If not, remove anti-rust oil and fill the nut with grease.

#### Operation Check

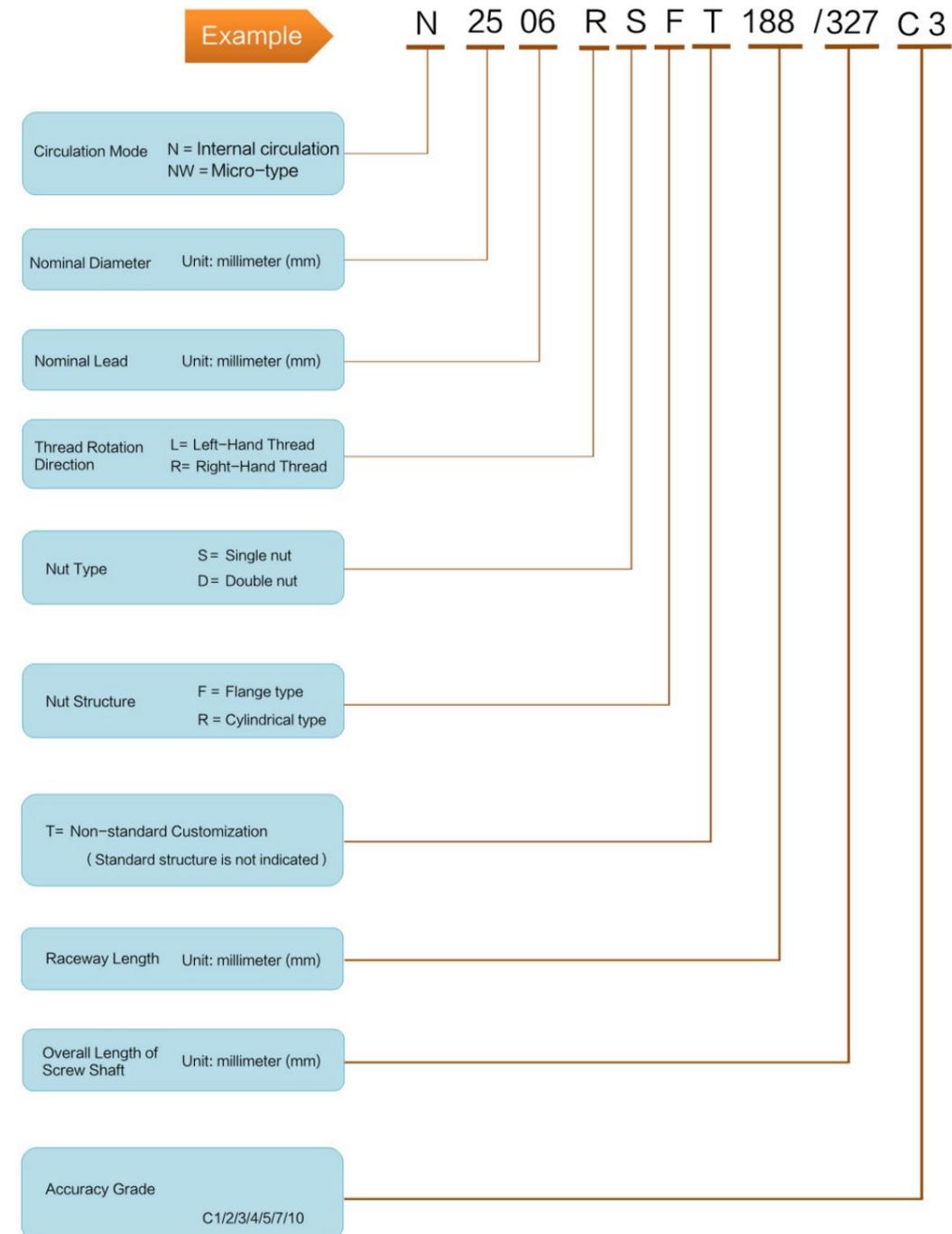
Verify correct installation by checking the driving torque across the entire stroke using a torque wrench. Ensure smooth operation.

#### Trial Run

Check for vibration and noise at low, medium, and high speeds. Run continuously for ~2 hours to allow for running-in and monitor for abnormalities. Wipe off excess grease expelled during this process.

### Model Identification of Ball Screw Pairs

Under non-customized conditions, specifications can be identified as follows. For non-standard customization, drawings can be provided, or direct communication with our technical personnel is available.



Product Series

Standard Series

The standard series specifications of ball screw pairs include: NSF/NDF flange single/double nut series, NSR/NDR cylindrical single/double nut series, and NW micro series.

NSF Flange single nut



NDF Flange double nut



NSR Cylindrical single nut



Custom Series

Our company can customize the design of ball screw pairs according to customer requirements, focusing on actual applications and working conditions. This mainly includes special-shaped shaft ends of the screw and special-shaped nuts with installation-friendly structures.

Hard limit at the screw shaft end



Gear at the screw shaft end



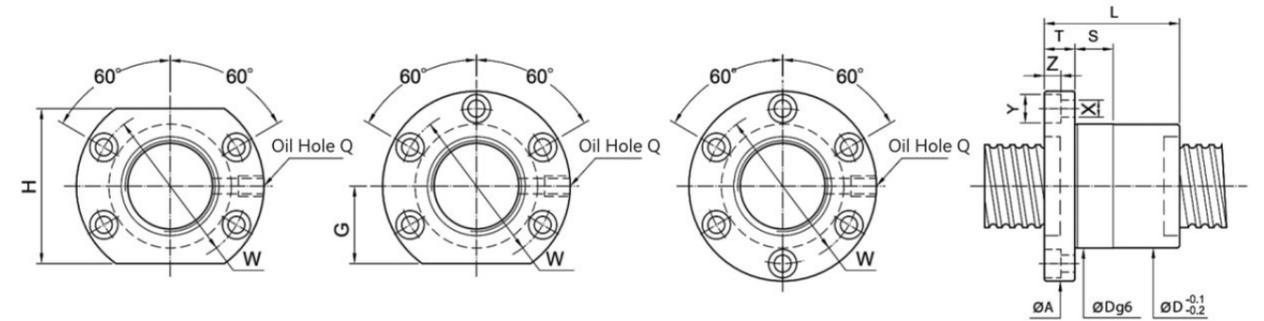
Nut with convex key



Special-shaped ball screw pair components



NSF Series (Flange Single Nut)

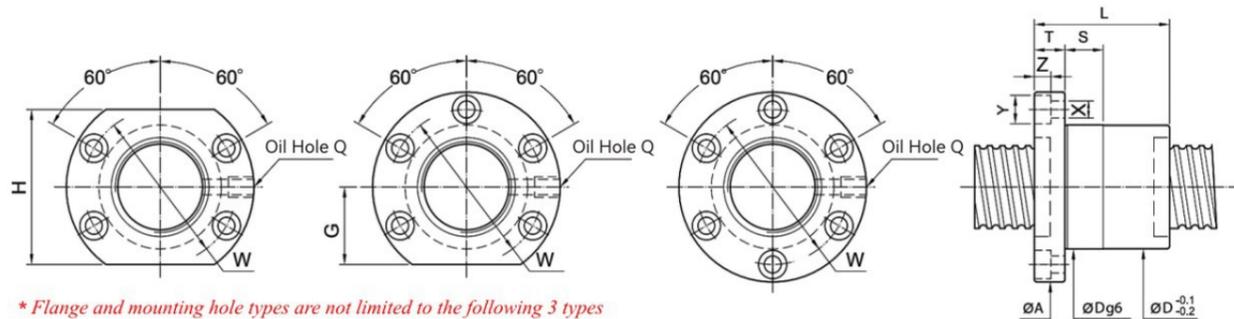


\* Flange and mounting hole types are not limited to the following 3 types

Unit: mm

Screw Shaft Dimensions		Ball Diameter	Number of Circulation Turns	Basic Rating Load (kgf)		Nut		Flange					Fit	Mounting Hole			Oil Hole	Rigidity	
Outer Diameter	Lead			Dynamic Load Ca	Static Load Coa	Dg6	L	A	T	W	G	H	S	X	Y	Z	Q	kgf/μm	
16	4	2.381	3	432	915	28	42	49	10	39	20	40	20	4.5	8	4.5	M6x1	16	
	5	3.175	3	760	1210	30	42	49	10	39	20	40	20	4.5	8	4.5	M6x1	18	
			4	970	1630		49	49	10	39	20	40	20	4.5	8	4.5	M6x1	23	
20	4	2.381	4	580	1520	34	44	60	12	48	22	44	12	5.5	9.5	5.5	M6x1	24	
			3	850	1700		47											21	
	5	3.175	4	1080	2250	34	53	57	12	45	20	40	12	5.5	9.5	5.5	M6x1	28	
			6	1550	3400		62											41	
	6	3.969	3	1060	2030	34	53	57	12	45	20	40	12	5.5	9.5	5.5	M6x1	22	
			4	1360	2710		61											29	
25	4	2.381	3	485	1425	40	40	63	12	51	22	44	15	5.5	9.5	5.5	M8x1	23	
			3	970	2280		47											25	
	5	3.175	4	1240	3050	40	53	63.5	12	51	22	44	15	5.5	9.5	5.5	M8x1	32	
			5	1500	3810		57											41	
		6	3.969	3	1270	2720	40	53	63.5	12	51	22	44	15	5.5	9.5	5.5	M8x1	25
			4	1620	3630		61											33	
	8	3.969	4	1620	3630	40	69	63.5	12	51	22	44	15	5.5	9.5	5.5	M8x1	33	
			5	1950	4550		77											42	
32	4	2.381	3	560	1840	43	40	68	15	55	26	52	15	6.6	11	6.5	M8x1	28	
			5	870	3070		49											M8x1	45
			3	1095	3060		47												31
	5	3.175	4	1400	4080	48	53	73.5	12	60	30	60	15	6.6	11	6.5	M8x1	41	
			6	1980	6120		62												60
			3	1500	3750		53												32
		6	3.969	4	1920	5000	48	61	73.5	12	60	30	60	15	6.6	11	6.5	M8x1	43
				6	2720	7500		73											63
	8	4.762	3	1820	4230	50	68	83	16	66	32	64	15	6.6	11	6.5	M8x1	32	
			4	2330	5640		77											43	
			3	2605	5310		80												33
	10	6.35	4	3340	7080	54	80	88	16	70	34	68	15	9	14	8.5	M8x1	45	
							90												45

NSF Series (Flange Single Nut)

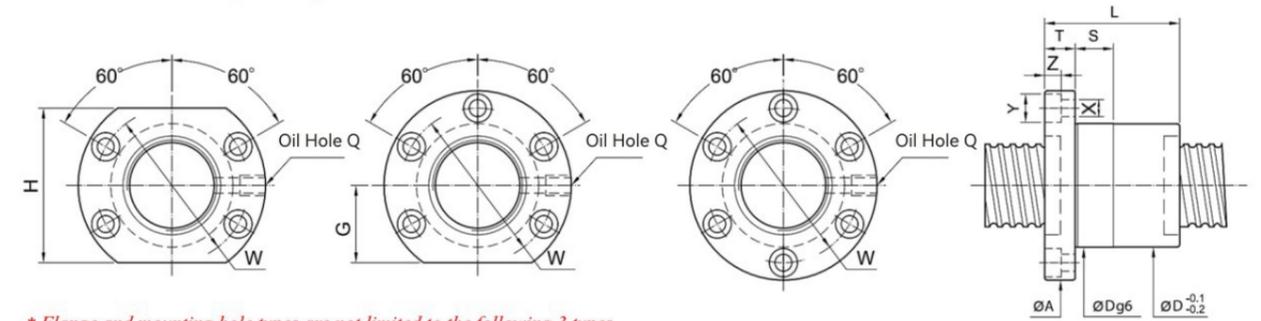


\* Flange and mounting hole types are not limited to the following 3 types

Unit: mm

Screw Shaft Dimensions		Ball Diameter	Number of Circulation Turns	Basic Rating Load (kgf)		Nut		Flange					Fit	Mounting Hole			Oil Hole	Rigidity
Outer Diameter	Lead			Dynamic Load Ca	Static Load Coa	Dg6	L	A	T	W	G	H	S	X	Y	Z	Q	kgf/μm
40	5	3.175	4	1575	5290	55	56											49
			5	1910	6610	61	61	88.5	16	72	29	58	15	9	14	8.5	M8 × 1	61
			6	2230	7940	65	65											
	6	3.969	3	1660	4810	55	56											39
			4	2130	6410	65	65	88.5	16	72	34	68	15	9	14	8.5	M8 × 1	51
	8	4.762	3	2120	5720	60	64											40
			4	2720	7620	77	77	93	16	76	36	72	20	9	14	8.5	M8 × 1	52
			6	3850	11430	94	94											
	10	6.35	3	3010	7100	64	83											41
			4	3850	9470	93	93	106	18	84	43	86	20	11	17.5	11	M8 × 1	53
			5	4670	11830	99	99											
	12	6.35	3	3010	7100	63	82											41
4			3850	9470	100	100	106	18	84	43	86	20	11	17.5	11	M8 × 1	53	
5		4670	11830	108	108												67	
7.144		3	4010	9250	70	93	110	18	85	45	90	20	11	17.5	11	M8 × 1	43	
50	5	3.175	4	1730	6760	66	55										60	
			5	2100	8450	61	61	98	16	82	36	72	20	9	14	8.5	PT1/8"	74
			6	2450	10140	65	65											
	6	3.969	4	2380	8250	66	65											61
			5	2880	10310	64	64	98	16	82	36	72	20	9	14	8.5	PT1/8"	76
			6	3370	12380	77	77											
	8	4.762	4	3010	9610	70	79											63
			5	3650	12010	84	84	113	18	90	42	84	20	11	17.5	11	PT1/8"	77
			6	4260	14420	96	96											
	10	6.35	3	3430	9300	74	83											49
			4	4390	12400	93	93	116	18	94	42	84	20	11	17.5	11	M8 × 1	65
			5	5320	15500	99	99											
6			6220	18600	114	114												95

NSF Series (Flange Single Nut)

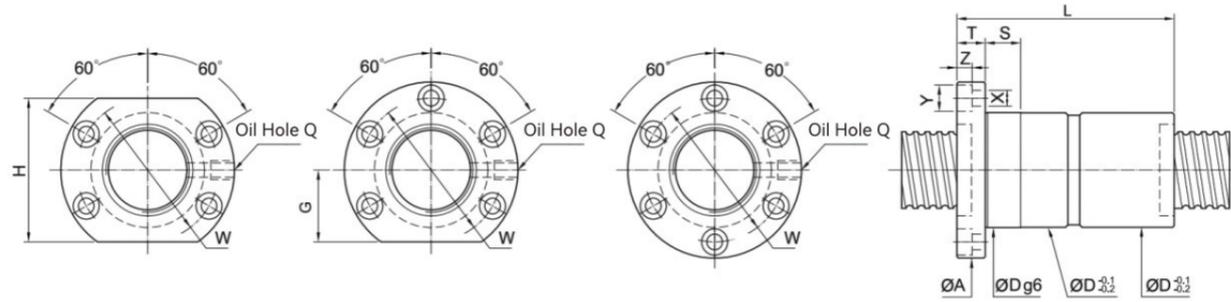


\* Flange and mounting hole types are not limited to the following 3 types

Unit: mm

Screw Shaft Dimensions		Ball Diameter	Number of Circulation Turns	Basic Rating Load (kgf)		Nut		Flange					Fit	Mounting Hole			Oil Hole	Rigidity	
Outer Diameter	Lead			Dynamic Load Ca	Static Load Coa	Dg6	L	A	T	W	G	H	S	X	Y	Z	Q	kgf/μm	
50	12	7.144	4	5520	16330	75	104											67	
			5	6690	20410	117	117	121	22	97	47	94	20	14	20	13	PT1/8"	84	
		3	4510	11150	75	99	121	22	97	47	94	20	14	20	13	PT1/8"	50		
	16	6.35	4	5770	14870	75	111											60	
			3	3430	9300	74	104	116	18	94	42	84	20	11	17.5	11	PT1/8"	49	
			4	4780	18300	82	96	124	18	102	46	92	20	11	17.5	11	PT1/8"	111	
63	6	3.969	4	2610	10550	80	67										73		
			6	3700	15830	80	80	122	18	100	45	90	20	11	17.5	11	PT1/8"	107	
	8	4.762	4	3375	12200	82	80										76		
			6	4780	18300	96	96	124	18	102	46	92	20	11	17.5	11	PT1/8"	111	
	10	6.35	4	5020	16450	85	98											79	
			6	7110	24680	118	118	132	22	107	48	96	20	14	20	13	PT1/8"	116	
12	7.938	4	6580	19430	90	111											80		
		6	9320	29150	136	136	136	22	112	52	104	20	14	20	13	PT1/8"	111		
20	9.525	3	8490	23610	95	146											79		
		4	10870	31480	156	156	153	28	123	59	118	20	18	26	17.5	PT1/8"	89		
80	10	6.35	4	5510	21200	105	98											95	
			5	6670	26500	105	105	151	22	127	57	114	20	14	20	13	PT1/8"	118	
			6	7810	31800	118	118												140
	12	7.938	4	7500	25700	110	111											98	
			6	10620	38550	136	136	156	22	132	59	118	20	14	20	13	PT1/8"	143	
	20	9.525	3	9770	31700	115	146											97	
4			12510	42270	168	168	173	28	143	66	132	20	18	26	17.5	PT1/8"	127		
100	10	6.35	3	4760	20090	125	84											91	
			4	6090	26790	95	95	171	22	147	67	134	25	14	20	20	PT1/8"	120	
			5	7380	33490	104	104												148
	16	9.525	6	8630	40190	115	115											176	
			4	14440	54960	140	140												140
			5	17490	68700	135	157	205	28	169	73	146	30	18	26	26	PT1/8"	173	
20	9.525	6	20460	82440	175	175											205		
		4	14440	54960	159	159												140	
		5	17490	68700	135	180	205	28	169	73	146	30	18	26	26	PT1/8"	173		
6	20460	82440	200	200													205		

NDF Series (Flange Double Nut)

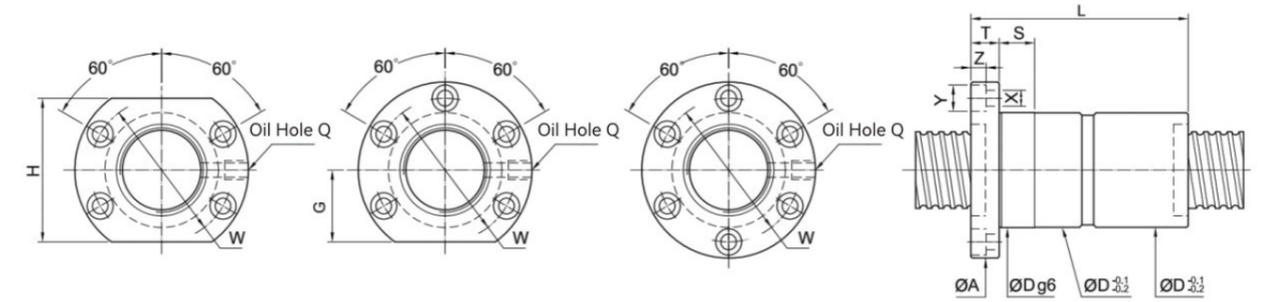


Flange and mounting hole types are not limited to the following 3 types

Unit: mm

Screw Shaft Dimensions		Ball Diameter	Number of Circulation Turns	Basic Rating Load ( kgf )		Nut		Flange					Fit	Mounting Hole			Oil Hole	Rigidity
Outer Diameter	Lead			Dynamic Load Ca	Static Load Coa	Dg6	L	A	T	W	G	H		S	X	Y		
16	4	2.381	3	435	920	30	66	48.5	10	39	20	40	10	4.5	8	4.5	M6 × 1	31
	5	3.175	3	765	1240	30	80	49	10	39	20	40	10	4.5	8	4.5	M6 × 1	35
20	5	3.175	4	980	1650	30	89	49	10	39	20	40	10	4.5	8	4.5	M6 × 1	47
			3	860	1710	34	82	57	12	45	20	40	12	5.5	9.5	5.5	M6 × 1	43
	6	3.969	4	1100	2280	34	92	57	12	45	20	40	12	5.5	9.5	5.5	M6 × 1	56
			3	1080	2050	34	93	57	12	45	20	40	12	5.5	9.5	5.5	M6 × 1	43
25	5	3.175	4	1380	2730	34	107	57	12	45	20	40	12	5.5	9.5	5.5	M6 × 1	56
			3	980	2300	40	82	63.5	12	51	22	44	15	5.5	9.5	5.5	M8 × 1	51
	6	3.969	4	1250	3070	40	92	63.5	12	51	22	44	15	5.5	9.5	5.5	M8 × 1	67
			3	1257	2740	40	93	63.5	12	51	22	44	15	5.5	9.5	5.5	M8 × 1	52
32	5	3.175	4	1630	3650	40	107	63.5	12	51	22	44	15	5.5	9.5	5.5	M8 × 1	68
			3	1095	3060	48	82	73.5	12	60	30	60	15	6.6	11	6.5	M8 × 1	63
			4	1400	4080	48	92	73.5	12	60	30	60	15	6.6	11	6.5	M8 × 1	82
			6	1980	6120	48	118	73.5	12	60	30	60	15	6.6	11	6.5	M8 × 1	122
	6	3.969	3	1500	3750	48	93	73.5	12	60	30	60	15	6.6	11	6.5	M8 × 1	65
			4	1920	5000	48	109	73.5	12	60	30	60	15	6.6	11	6.5	M8 × 1	86
	8	4.762	6	2720	7500	48	133	73.5	12	60	30	60	15	6.6	11	6.5	M8 × 1	125
			3	1820	4230	50	117	83	16	66	32	64	15	6.6	11	6.5	M8 × 1	66
	10	6.35	4	2230	5640	50	135	83	16	66	32	64	15	6.6	11	6.5	M8 × 1	86
			3	2605	5310	54	139	88.5	16	70	34	68	15	9	14	8.5	M8 × 1	67
40	5	3.175	4	3340	7080	54	160	88.5	16	70	34	68	15	9	14	8.5	M8 × 1	89
			4	1575	5290	55	96	88.5	16	72	29	58	15	9	14	8.5	M8 × 1	100
			5	1910	6610	55	111	88.5	16	72	29	58	15	9	14	8.5	M8 × 1	124
	6	3.969	6	2230	7940	55	122	88.5	16	72	34	68	15	9	14	8.5	M8 × 1	147
			3	1660	4810	55	97	88.5	16	72	34	68	15	9	14	8.5	M8 × 1	77
			4	2130	6410	55	113	88.5	16	72	34	68	15	9	14	8.5	M8 × 1	103
6	3020	9620	55	137	88.5	16	72	34	68	15	9	14	8.5	M8 × 1	149			

NDF Series (Flange Double Nut)

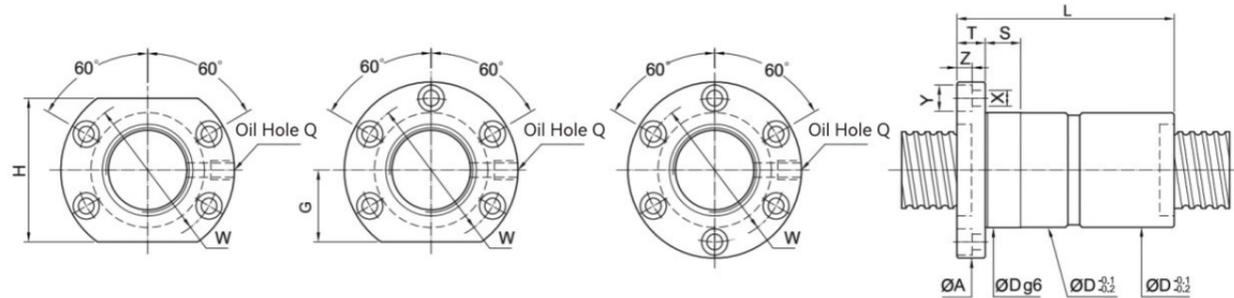


Flange and mounting hole types are not limited to the following 3 types

Unit: mm

Screw Shaft Dimensions		Ball Diameter	Number of Circulation Turns	Basic Rating Load ( kgf )		Nut		Flange					Fit	Mounting Hole			Oil Hole	Rigidity
Outer Diameter	Lead			Dynamic Load Ca	Static Load Coa	Dg6	L	A	T	W	G	H		S	X	Y		
40	8	4.762	3	2120	5720	60	121											80
			4	2720	7620	60	134	93	16	76	36	72	20	9	14	8.5	M8 × 1	105
			6	3850	11430	60	172											
	10	6.35	3	3010	7100	64	142											82
			4	3850	9470	64	162	106	18	84	43	86	20	11	17.5	11	M8 × 1	107
			5	4670	11830	64	189											
12	7.144	3	3010	7100	63	154											82	
		5	4670	11830	63	204	106	18	84	43	86	20	11	17.5	11	M8 × 1	133	
		3	4010	9250	70	160											86	
50	5	3.175	4	5130	12330	70	185	110	18	85	45	90	20	11	17.5	11	M8 × 1	114
			4	1730	6760	66	96											119
			5	2100	8450	66	111	98	16	82	36	72	20	9	14	8.5	PT1/8"	148
	6	3.969	6	2450	10140	66	122											174
			4	2380	8250	66	111											123
			5	2880	10310	66	122	98	16	82	36	72	20	9	14	8.5	PT1/8"	151
	8	4.762	6	3370	12380	66	142											181
			4	3010	9610	70	136											125
			5	3650	12010	70	157	113	18	90	42	84	20	11	17.5	11	PT1/8"	155
	10	6.35	6	4260	14420	70	174											185
			3	3430	9300	74	143											99
			4	4390	12400	74	162	114	18	92	42	84	20	11	17.5	11	PT1/8"	129
12		7.938	5	5320	15500	74	189											161
			6	6220	18600	74	205											191
			5	6680	20420	75	213	121	22	97	47	94	20	14	20	13	PT1/8"	166
16	6.35	3	4510	11150	75	171											101	
		4	5770	14870	75	195	121	22	97	47	94	20	14	20	13	PT1/8"	132	
		3	3430	9300	74	201	114	18	92	42	84	20	11	17.5	11	PT1/8"	99	

NDF Series (Flange Double Nut)

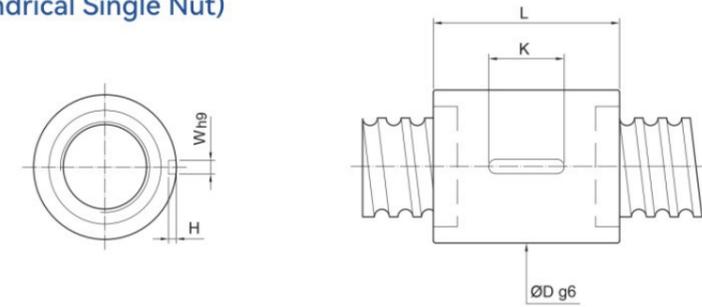


Unit: mm

Flange and mounting hole types are not limited to the following 3 types

Screw Shaft Dimensions		Ball Diameter	Number of Circulation Turns	Basic Rating Load ( kgf )		Nut		Flange					Fit	Mounting Hole			Oil Hole	Rigidity
Outer Diameter	Lead			Dynamic Load Ca	Static Load Coa	Dg6	L	A	T	W	G	H	S	X	Y	Z	Q	kgf/μm
63	6	3.969	4	2610	10550	80	120	18	100	45	90	20	11	17.5	11	PT1/8"	146	
			6	3700	15830		144										217	
	8	4.762	4	3375	12200	82	141	18	102	46	92	20	11	17.5	11	PT1/8"	151	
			6	4780	18300		178										222	
	10	6.35	4	5020	16450	85	166	22	107	48	96	20	14	20	13	PT1/8"	158	
			6	7110	24680		209										232	
12	7.938	4	6580	19430	90	195	22	112	52	104	20	14	20	13	PT1/8"	161		
		6	9320	29150		248										236		
20	9.525	3	8490	23610	95	255	28	123	59	118	20	18	26	17.5	PT1/8"	157		
		4	10870	31480		296										207		
80	10	6.35	4	5510	21200	105	166	22	127	57	114	20	14	20	13	PT1/8"	190	
			5	6670	26500		185										235	
			6	7810	31800		209										280	
	12	7.938	4	7500	25700	110	195	22	132	59	118	20	14	20	13	PT1/8"	196	
			6	10620	38550		248										288	
	20	9.525	3	9770	31700	115	254	28	143	66	132	20	18	26	17.5	PT1/8"	193	
4			12510	42270	297		254											
6			17720	63410	376		373											
100	10	6.35	3	4760	20090	125	143	22	147	67	134	25	14	20	13	PT1/8"	173	
			4	6090	26790		164										228	
			5	7380	33490		184										281	
			6	8630	40190		210										334	
	16	9.525	4	14440	54960	135	252	28	169	73	146	30	18	26	17.5	PT1/8"	266	
			5	17490	68700		285										329	
20	9.525	6	20460	82440	135	318	28	169	73	146	30	18	26	17.5	PT1/8"	391		
		4	14440	54960		299										266		
20	9.525	5	17490	68700	135	340	28	169	73	146	30	18	26	17.5	PT1/8"	329		
		6	20460	82440		381										391		

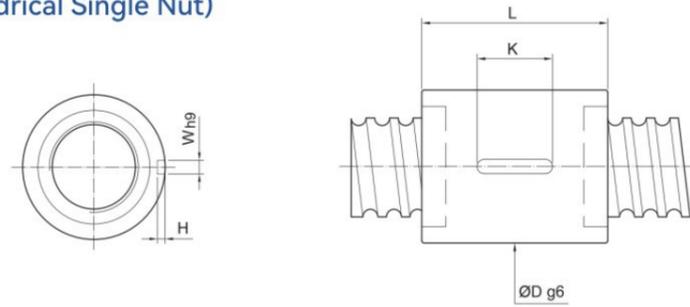
NSR Series (Cylindrical Single Nut)



Unit: mm

Screw Shaft Dimensions		Ball Diameter	Number of Circulation Turns	Basic Rating Load ( kgf )		Nut		Keyway			Rigidity
Outer Diameter	Lead			Dynamic Load Ca	Static Load Coa	Dg6	L	K	W	H	kgf/μm
16	5	3.175	3	765	1240	30	40	20	3	1.8	18
			4	860	1710		41				
20	5	3.175	3	1100	2280	34	48	20	3	1.8	28
			4	1080	2050		46				
25	5	3.175	3	980	2300	40	48	20	4	2.5	26
			4	1250	3070		56				
25	6	3.969	3	1275	2740	40	46	20	4	2.5	26
			4	1630	3650		56				
32	5	3.175	3	1095	3060	48	41	20	4	2.5	31
			4	1400	4080		48				
	6	3.969	3	1500	3750	50	61	25	5	3	43
			4	1920	5000		70				
	8	4.762	3	1820	4230	50	59	25	5	3	32
			4	2330	5640		70				
10	6.35	3	2605	5310	54	68	25	6	3.5	33	
		4	3340	7080		79					45
40	5	3.175	4	1575	5290	55	48	20	4	2.5	49
			6	2230	7940		61				
	6	3.969	4	2130	6410	55	56	25	5	3	51
			6	3020	9620		70				
	8	4.762	4	2720	7620	60	70	25	5	3	52
			6	3850	11430		91				
10	6.35	3	3010	7100	65	68	25	6	3.5	41	
		4	3850	9470		79					53
50	5	3.175	4	1730	6750	66	48	20	4	2.5	60
			6	2450	10130		61				
	6	3.969	4	2380	8250	66	56	25	5	3	61
6	3370	12380	70	90							

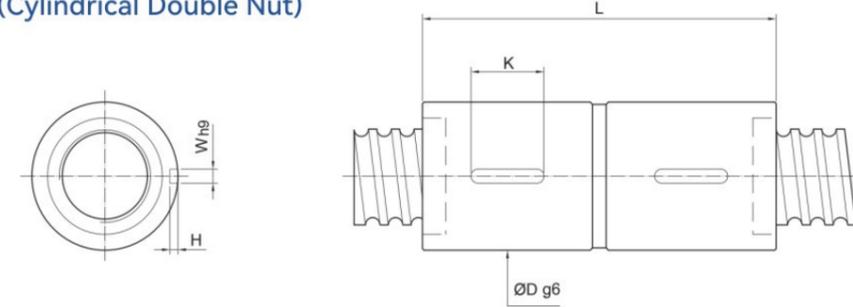
NSR Series (Cylindrical Single Nut)



Unit: mm

Screw Shaft Dimensions		Ball Diameter	Number of Circulation Turns	Basic Rating Load ( kgf )		Nut		Keyway			Rigidity kgf/μm	
Outer Diameter	Lead			Dynamic Load Ca	Static Load Coa	Dg6	L	K	W	H		
50	8	4.762	4	3010	9610	70	70	32	5	3	63	
			6	4260	14420		91				92	
	10	6.35	3	3430	9300	74	68	32	6	3.5	49	
			4	4390	12400		79				65	
	12	7.938	6.35	6	6220	18600	74	102	32	6	3.5	95
				3	4510	11150		82				50
4	5.770	14870	4	5770	14870	75	95	40	6	3.5	66	
			6	3700	15830		80				56	25
63	6	3.969	4	2610	10550	80	70	32	6	3.5	107	
			6	3375	12200		82				70	32
	8	4.762	4	4780	18300	82	91	40	6	3.5	111	
			6	5020	16450		85				79	32
	10	6.35	4	7110	24680	85	85	40	8	4	116	
			6	6580	19430		90				95	40
12	7.938	4	9320	29150	90	123	50	8	4	118		
		6	5510	21200		105				79	32	8
80	10	6.35	6	7810	31800	105	102	40	8	4	140	
			4	7500	25700		110				95	40
	12	7.938	6	10620	38550	110	123	50	8	4	143	
			4	9770	31700		115				126	50
	20	9.525	3	9770	31700	115	149	63	10	5	127	
			4	12510	42270		125				72	50
100	10	6.35	4	6090	26790	125	82	50	10	5	120	
			5	7380	33490		94				148	
			6	8630	40190		104				176	
			4	14440	54960		128				140	
	16	9.525	5	17490	68700	135	77	63	10	5	173	
			6	20460	82440		162				205	
20	9.525	4	14440	54960	135	144	63	10	5	140		
		5	17490	68700		164				173		
6	20460	82440	187	205								

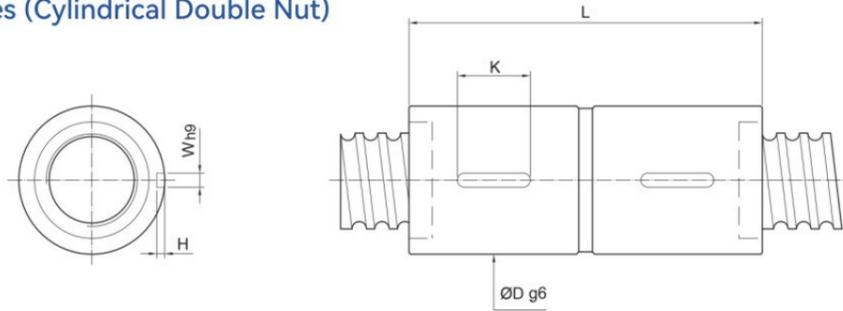
NDR Series (Cylindrical Double Nut)



Unit: mm

Screw Shaft Dimensions		Ball Diameter	Number of Circulation Turns	Basic Rating Load ( kgf )		Nut		Keyway			Rigidity kgf/μm			
Outer Diameter	Lead			Dynamic Load Ca	Static Load Coa	Dg6	L	K	W	H				
16	5	3.175	3	765	1240	28	75	20	3	1.8	35			
			4	980	1650		85				47			
20	5	3.175	3	860	1710	34	75	20	3	1.8	43			
			4	1100	2280		85				56			
	6	3.969	3	1080	2050	34	87	20	4	2.5	43			
			4	1380	2730		103				56			
25	5	3.175	3	980	2300	40	75	20	4	2.5	51			
			4	1250	3070		85				67			
	6	3.969	3	1275	2740	40	87	20	4	2.5	52			
			4	1630	3650		103				68			
32	5	3.175	3	1095	3060	48	75	20	4	2.5	63			
			4	1400	4080		85				82			
			6	1980	6120		105				122			
			3	1500	3750		87				65			
	6	3.969	4	1920	5000	50	103	25	5	3	86			
			6	2720	7500		127				125			
			3	1820	4230		109				66			
			4	2330	5640		127				86			
10	6.35	3	2605	5310	54	135	25	6	3.5	67				
		4	3340	7080		155				89				
		4	1575	5290		55				85	20	4	2.5	100
		6	2230	7940						105				147
6	3.969	4	2130	6410	55	103	25	5	3	103				
		6	3020	9620		127				149				
		4	2720	7620		60				127	25	5	3	105
		6	3850	11430						161				154
10	6.35	3	3010	7100	65	135	25	6	3.5	82				
		4	3850	9470		155				107				
50	5	3.175	4	1730	6750	66	85	20	4	2.5	119			
			6	2450	10130		105				174			
	6	3.969	4	2380	8250	66	103	25	5	3	123			
			6	3370	12380		127				181			

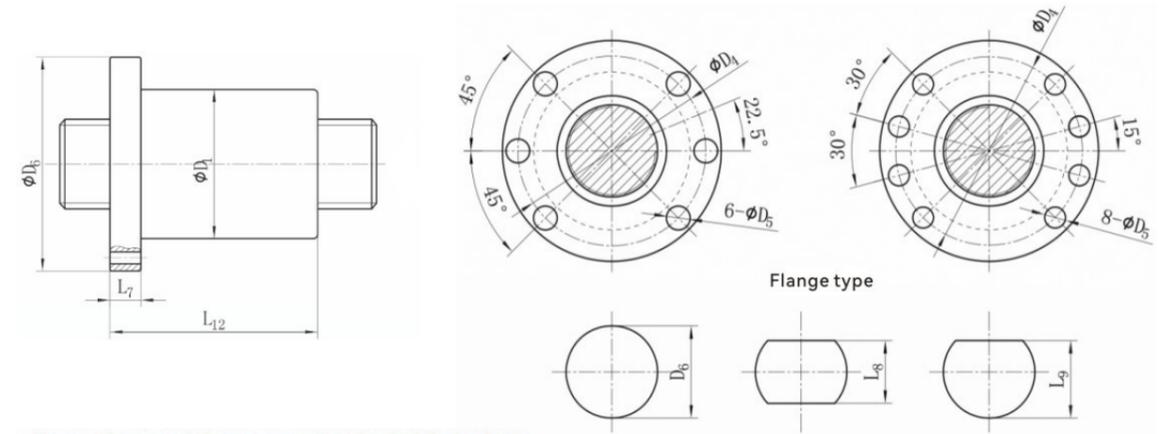
NDR Series (Cylindrical Double Nut)



Unit: mm

Screw Shaft Dimensions		Ball Diameter	Number of Circulation Turns	Basic Rating Load ( kgf )		Nut		Keyway			Rigidity kgf/μm	
Outer Diameter	Lead			Dynamic Load Ca	Static Load Coa	Dg6	L	K	W	H		
50	8	4.762	4	3010	9610	70	127	32	5	3	125	
			6	4260	14420		161				185	
	10	6.35	3	3430	9300	74	135	32	6	3.5	99	
			4	4390	12400		155				129	
	12	7.938	7.938	6	6220	18600	75	197	40	6	3.5	191
				3	4510	11150		161				101
			4	5770	14870		185				132	
63	6	3.969	4	2610	10550	80	106	25	6	3.5	146	
			6	3700	15830		130				217	
	8	4.762	4.762	4	3375	12200	82	131	32	6	3.5	151
				6	4780	18300		165				222
	10	6.35	6.35	4	5020	16450	85	160	32	8	4	158
				6	7110	24680		202				232
12	7.938	7.938	4	6580	19430	90	185	40	8	4	161	
			6	9320	29150		238				236	
80	10	6.35	4	5510	21200	105	160	32	8	4	190	
			6	7810	31800		202				280	
	12	7.938	7.938	4	7500	25700	110	185	40	8	4	196
				6	10620	38550		238				288
	20	9.525	9.525	3	9770	31700	115	245	50	10	5	193
				4	12510	42270		289				254
100	10	6.35	3	4760	20090	125	132	50	10	5	173	
			4	6090	26790		164				228	
			5	7380	33490		174				281	
			6	8630	40190		204				334	
	16	9.525	9.525	4	14440	54960	135	240	63	10	5	266
				5	17490	68700		274				329
				6	20460	82440		306				391
	20	9.525	9.525	4	14440	54960	135	284	63	10	5	266
				5	17490	68700		324				329
				6	20460	82440		366				391

NW Series (Micro Precision)



Flange and mounting hole types are not limited to the following 3 types

Unit: mm

Screw Shaft Dimensions		Ball Diameter	Basic Rating Load ( kgf )		Nut	Flange							Rigidity kgf/μm
Outer Diameter	Lead		Dynamic Load Ca	Static Load Coa		L12	D1	D6	D4	D5	L8	L9	
4	1	0.8	48	88	12	9	21	15	3.4	12	16	2.5	3.8
6	1	0.8	57	102	15	12	24	18	3.4	15	20	3.5	4.2
	2	1.588	158	206	24	14	26	20	3.4	15	20	3.5	5.1
8	1	0.8	65	138	16	14	27	21	3.4	18	23	4	5.3
	2	1.588	188	285	26	16	29	23	3.4	20	25	4	6.2
10	1	0.8	72	178	18	17	34	26	4.5	21	28	5	6.3
	2	1.588	215	365	28	18	35	27	4.5	22	29	5	6.8
	3	2.381	298	476	34	20	37	29	4.5	24	31	5	7.4
12	2	1.588	185	412	28	20	37	39	4.5	24	31	5	7.2
	3	2.381	340	603	34	22	39	31	4.5	26	33	5	8.5
	4	2.381	380	640	35	22	39	31	4.5	26	33	5	8.6

NT Series (Special-shaped Ball Screw Pair Customization)

Our company can carry out customized designs for ball screw pairs according to customer requirements, including special-shaped shaft end structures of the screw and installation structures of the nut. Customers can also provide specified drawings, communicate with our technical personnel, and process according to requirements.

