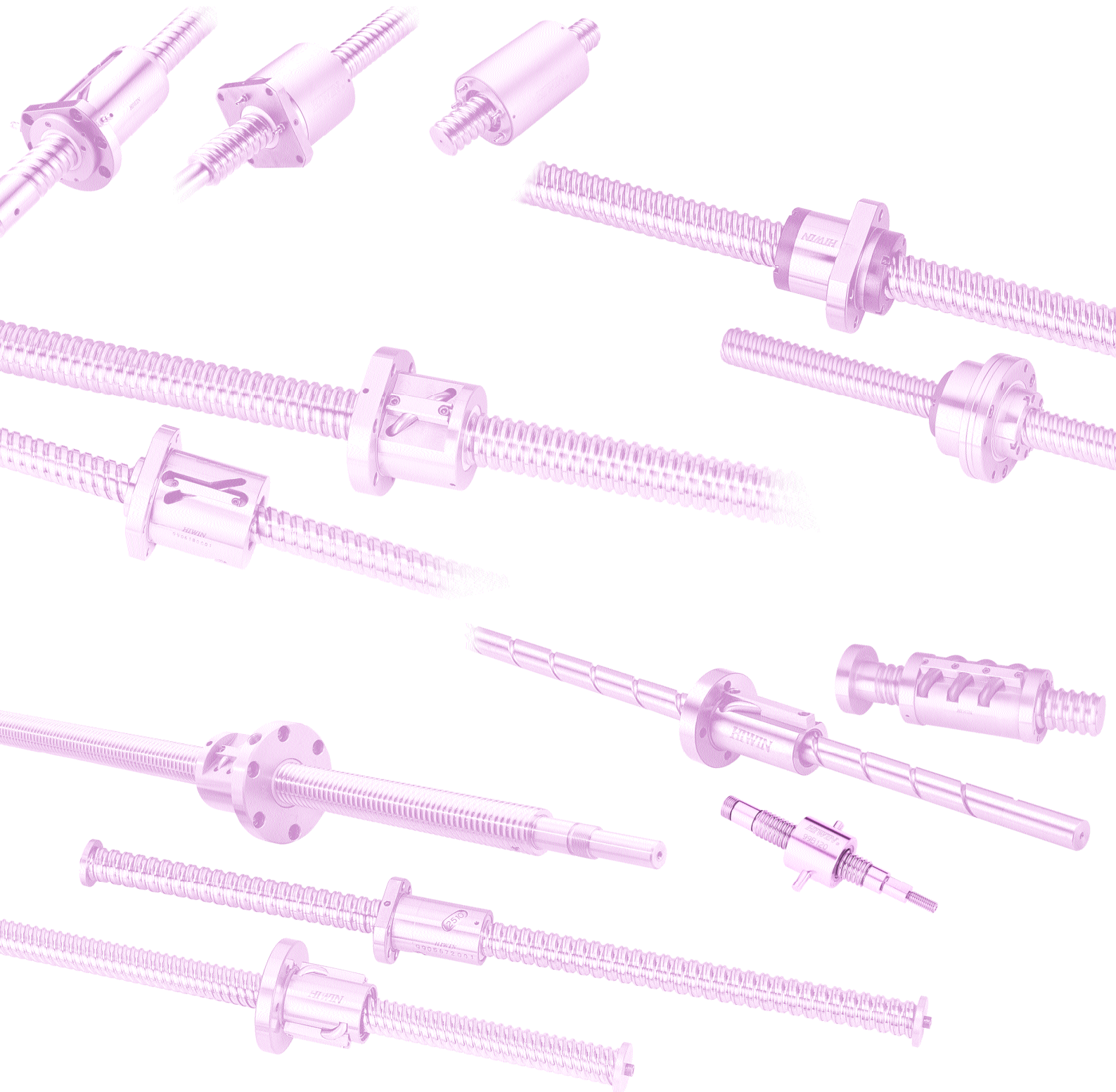


**HIWIN®**

# Ballscrews

## Technical Information



# Ballscrews

## Technical Information Index

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(The specifications in this catalogue are subject to change without notification.)

## 1. Introduction

Ballscrews, also called a ball bearing screws, recirculating ballscrews, etc., consist of a screw spindle and a nut integrated with balls and the balls' return mechanism, return tubes or return caps. Ballscrews are the most common type of screws used in industrial machinery and precision machines. The primary function of a ballscrew is to convert rotary motion to linear motion or torque to thrust, and vice versa, with the features of high accuracy, reversibility and efficiency. HIWIN provides a wide range of ballscrews to satisfy your special requirements.

The combination of state-of-the-art machining technology, manufacturing experiences, and engineering expertise makes HIWIN ballscrew users "High-Tech Winners". HIWIN uses precise procedures to create exact groove profiles, either by grinding or precision rolling. Accurate heat treatment is also used to ensure the hardness of our ballscrews. These result in maximum load capacity and service life.

HIWIN precision ballscrews provide the most smooth and accurate movement, together with low drive torque, high stiffness and quiet motion with predictable lengthened service life. HIWIN rolled ballscrews also provide smooth movement and long life for general applications with less precision in lower price. HIWIN has modern facilities, highly skilled engineers, quality manufacturing and assembly processes, and uses quality materials to meet your special requirements.

It is our pleasure to provide you with the technical information and selection procedure to choose the right ballscrews for your applications through this catalogue.

## 2. Technological Features of *HIWIN* Ballscrews

### 2.1 Characteristics of *HIWIN* Ballscrews

There are many benefits in using HIWIN ballscrews, such as high efficiency and reversibility, backlash elimination, high stiffness, high lead accuracy, and many other advantages. Compared with the contact thread lead screws as shown in (Fig. 2.1), a ballscrew add balls between the nut and spindle. The sliding friction of the conventional screws is thus replaced by the rolling motion of the balls. The basic characteristics and resultant benefits of HIWIN ballscrews are listed in more details as follows:

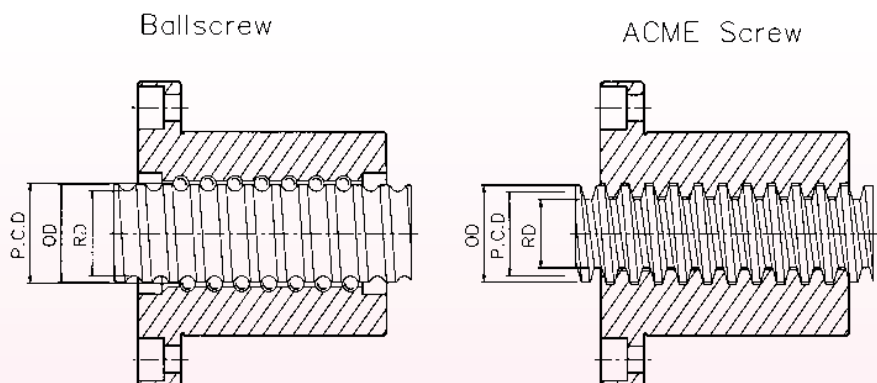


Fig 2.1 Basic configuration of ballscrews and Contact thread lead screws

### (1) High efficiency and reversibility

Ballscrews can reach an efficiency as high as 90% because of the rolling contact between the screw and the nut. Therefore, the torque requirement is approximately one third of that for conventional screws. It can be seen from Fig. 2.2 that the mechanical efficiency of ball screws are much higher than conventional lead screws.

HIWIN ballscrews have super surface finish in the ball tracks which reduce the contact friction between the balls and the ball tracks. Through even contact and the rolling motion of the balls in the ball tracks, a low friction force is achieved and the efficiency of the ballscrew is increased. High efficiency renders low drive torque during ballscrew motion. Hence, less drive motor power is needed in operation resulting in lower operation cost.

HIWIN uses a series of test equipment and testing procedures to guarantee the efficiency.

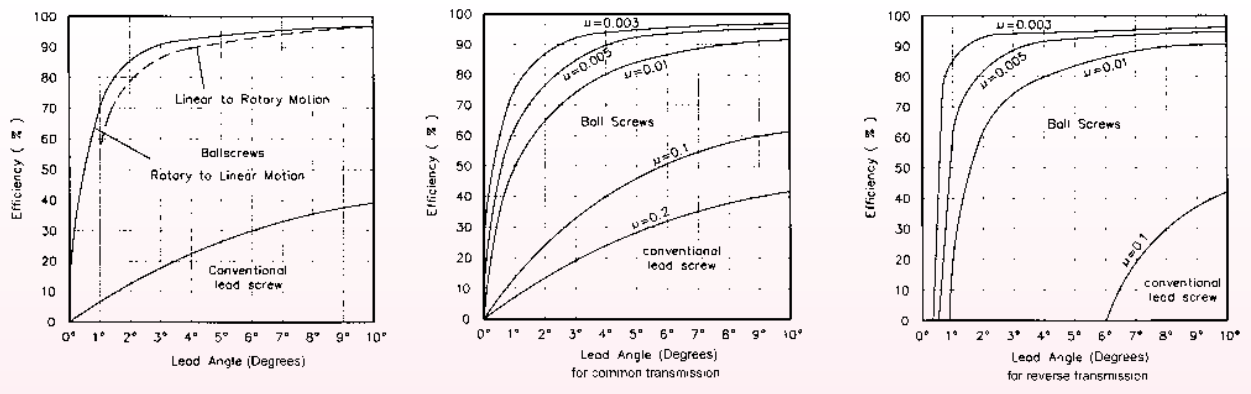


Fig 2.2 Mechanical efficiency of ballscrews.

### (2) Backlash elimination and high stiffness

Computer Numerically Controlled (CNC) machine tools require ballscrews with zero axial backlash and minimal elastic deformation (high stiffness). Backlash is eliminated by our special designed Gothic arch form balltrack (Fig. 2.3) and preload.

In order to achieve high overall stiffness and repeatable positioning in CNC machines, preloading of the ballscrews is commonly used. However, excessive preload increases friction torque in operation. This induced friction torque will generate heat and reduce the life expectancy. With our special design and fabrication process, we provide optimized ballscrews with no backlash and less heat losses for your application.

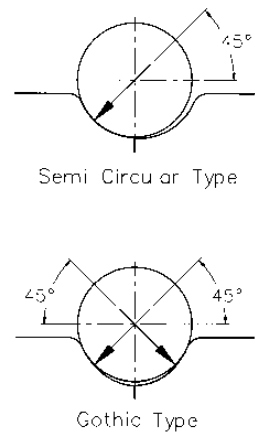


Fig 2.3 Typical contact types for ballscrews

### (3) High lead accuracy

For applications where high accuracy is required HIWIN's modern facilities permit the achievement of ISO, JIS and DIN standards or specific customer requirements.

This accuracy is guaranteed by our precise laser measurement equipment and reported to each customer.

### (4) Predictable life expectancy

Unlike the useful life of conventional screws is governed by the wear on the contact surfaces, HIWIN's ballscrews can usually be used till the metal fatigue. By careful attention to design, quality of materials, heat treatment and manufacture, HIWIN's ballscrews have proved to be reliable and trouble free during the period of expected service life. The life achieved by any ballscrew depends upon several factors including design, quality, maintenance, and the major factor, dynamic axial load (C).

Profile accuracy, material characteristics and the surface hardness are the basic factors which influence the dynamic axial load.

For machine tool applications it is recommended that the life at average axial load should be a minimum of  $1 \times 10^6$  revs (or 250,000 meters). High quality ballscrews are designed to conform with the B rating (i.e. 90% probability of achieving the design life). Fifty percent of the ballscrews can exceed 2 to 4 times of the design life.

### (5) Low starting torque and smooth running

Due to metal to metal contact, conventional contact thread lead screws require high starting force to overcome the starting friction. However, due to rolling ball contact, ballscrews need only a small starting force to overcome their starting friction.

HIWIN uses a special design factor in the balltrack (conformance factor) and manufacturing technique to achieve a true balltrack. This guarantees the required motor torque to stay in the specified torque range.

HIWIN has special balltrack profile tracing equipment to check each balltrack profile during the manufacturing process. A sample trace is shown in Fig. 2.4.

HIWIN also uses computer measurement equipment to accurately measure the friction torque of ballscrews. A typical distance-torque diagram is shown in Fig. 2.5.

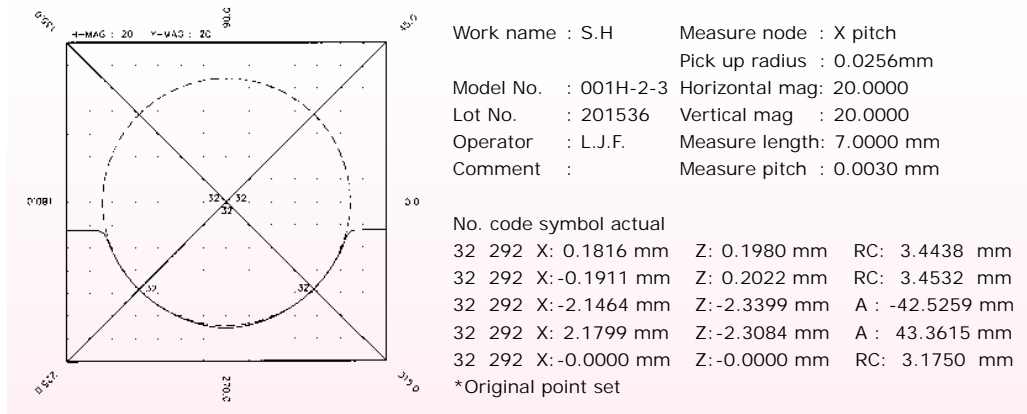


Fig 2.4 Balltrack checking by HIWIN profile tracer

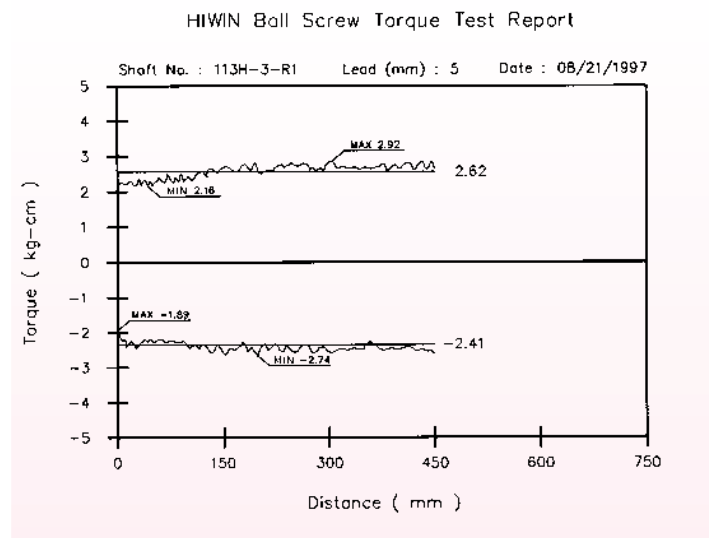


Fig 2.5 HIWIN preload checking diagram

### (6) Quietness

High quality machine tools require low noise during fast feeding and heavy load conditions.

HIWIN achieves this by virtue of its return system, balltrack designs, assembly technique, and careful control of surface finish and dimensions.

### (7) Short lead time

HIWIN has a fast production line and can stock ballscrews to meet short lead times.

### (8) Advantages over hydraulic and pneumatic actuators

The ballscrew used in an actuator to replace the traditional hydraulic or pneumatic actuator has many advantages, i.e. fast response, no leakage, no filtering, energy savings and good repeatability.

Fig. 2.6 illustrates the typical mechanism for synchronizing four ballscrews. Where the hydraulic or pneumatic one, if used, would be much more complex.

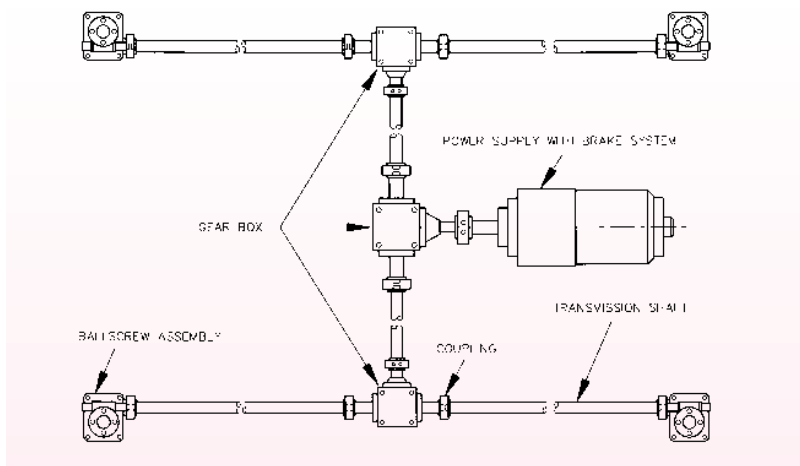


Fig 2.6 Typical mechanism of synchronization

## 2.2 Applications for Ballscrews

HIWIN ballscrews are used in the following fields and the recommended application grade can be found in Table 4.5.

1. CNC machinery : CNC machine center, CNC lathe, CNC milling machine, CNC EDM, CNC grinder, wire cutting machine, boring machine, special purpose machine, etc.
2. Precision machine tools : Milling machine, grinder, EDM, tool grinder, gear manufacturing machine, drilling machine, planer, etc.
3. Industrial machinery : Printing machine, paper-processing machine, automatic machine, textile machine, drawing machine, etc.
4. Electronic machinery : Robot measuring instrument, X-Y table, medical equipment, surface mounting device, semi-conductor equipment, factory automation equipment, etc.
5. Transport machinery : Material handling equipment, elevated actuator, etc.
6. Aerospace industry : Aircraft flaps, thrust open-close reverser, airport loading equipment, missile fin actuator, etc.
7. Miscellaneous : Antenna leg actuator, valve operator, etc.



### 3. Classification of Standard Ballscrews

#### 3.1 Standard Ballscrew Spindle

HIWIN recommends our standard regular ballscrews for your design. However, high lead, miniature or other special types of ballscrews, may also be available upon your request. Table 3.1 shows the standard ballscrew spindles which are available.

#### 3.2 Nut Configuration

##### (1) Type of return tube design

HIWIN ballscrews have three basic ball recirculation designs. The first, called the **external recirculation** type ballscrew, consists of the screw spindle, the ball nut, the steel balls, the return tubes and the fixing plate. The steel balls are introduced into the space between the screw spindle and the ball nut. The balls are diverted from the balltrack and carried back by the ball guide return tube form a loop. Since the return tubes are located outside the nut body, this type is called the external recirculation type ballscrew Fig. 3.1.

The second design, called the **internal recirculation** type ballscrew, consists of the screw spindle, the ball nut, the steel balls and the ball return caps. The balls make only one revolution around the screw spindle. The circuit is closed by a ball return cap in the nut allowing the balls to cross over adjacent ball tracks. Since the ball return caps are located inside the nut body, this is called the internal recirculation type ballscrew Fig. 3.2.

The third design is called **endcap recirculation** type ballscrew Fig.. 3.3.

The basic design of this return system is the same as the external recirculation type nut Fig. 3.4 except that the return tube is made inside the nut body as a through hole. The balls in this design traverse the whole circuit of the balltracks within the nut length. Therefore, a short nut with the same load capacity as the conventional design can be used.



Fig 3.1 External recirculation type nut with return tubes



Fig 3.2 Internal recirculation type nut with return caps



Fig 3.3 Endcap recirculation type nut with return system

Table 3.1 : HIWIN standard ballscrew spindle and lead

Unit: mm

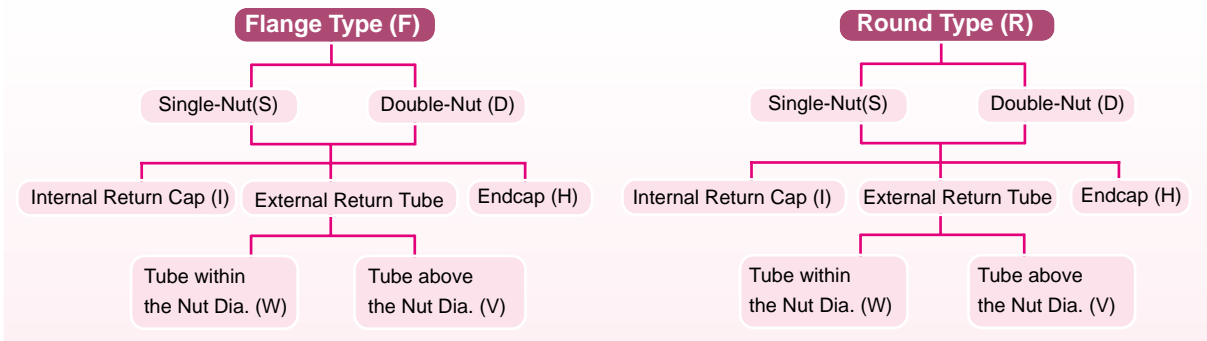
Type	Miniature					Regular								High Lead				Super High Lead							
lead dia.	1	1.5	2	2.5	3	3.175	4	4.23	5	5.08	6	6.35	8	10	12	12.7	16	20	24	25	25.4	32	40	50	
6	G	G	G																						
8	G	G	G	G									G												
10	G	G	G	G			G							G											
12		G	G	G			G		G					G											
15														G				G							
16			G	G			G		G	G			G	G		G						G			
20			G	G			G		G	G	G			G		G		G					G		
22									G	G															
25				G			G		G	G	G	G	G	G		G	G	G		G				G	
28								G	G	G	G	G		G											
32						G	G		G	G	G	G	G	G	G	G		G		G	G	G			
36									G	G		G	G	G											
40				G	G		G		G	G	G	G	G	G	G	G		G		G			G	G	
45									G	G				G	G										
50									G	G	G	G	G	G	G	G		G		G			G	G	
55													G	G	G	G									
63												G	G	G	G	G		G			G		G	G	
70														G	G					G					
80														G	G	G	G								
100														G	G	G	G								

\* G : Precision ground grade ballscrews, either left-hand or right-hand screws are available.



## (2) Type of nuts

The type of nuts to select depends on the application requirements. HIWIN standard nuts are classified by three letters as follows (see also Chapter 5 for details) :



\* Other Types of nut shape can also be made upon your design.

- The special high-lead double-start nut is classified by adding D in front of the above three letters.
- The compression preload nut is classified by adding P in front of the above three letters.
- The offset pitch preload single nut is classified by adding O in front of the above letters.

Examples :

**RDI** means round type, double nut with internal return caps.

**FSW** means flange type, single nut with external return tube within the nut diameter.

**DFSV** means two-start, flange, single nut with external return tube above the nut diameter.

## (3) Number of circuits

The HIWIN nomenclature for the number of circuits in the ball-nut is described as follows:

### For the external type design:

- A : 1.5 turns per circuit
- B : 2.5 turns per circuit
- C : 3.5 turns per circuit
- D : 4.5 turns per circuit
- E : 5.5 turns per circuit

### For the internal type design:

- T : 1.0 turn per circuit

### For end cap type design:

- U : 2.8 turns per circuit (high lead)
- S : 1.8 turns per circuit ( super high lead)
- V : 0.7 turns per circuit ( extra high lead)

Example :

B2 : designates 2 external return tube ball circuits. Each circuit has 2.5 turns.

T3 : designates 3 internal return ball circuits. Each circuit has a maximum of 1 turn.

S4 : designates 4 internal return ball circuits. Each circuit has 1.8 turns.

HIWIN recommends that number of circuits for the external type design be 2 for 2.5 or 3.5 turns ( that is, B2 or C2), and 3, 4 or 6 circuits for the internal type. Those shapes are shown in Fig. 3.4 and Fig. 3.5.



Fig 3.4 Circuit for external return tube



Fig 3.5 Circuit for internal return cap

### 3.3 Spindle End and Journal Configuration

#### ◆ Mounting methods

Bearing mounting methods on the end journals of ballscrews are crucial for stiffness, critical speed and column buckling load. Careful consideration is required when designing the mounting method. The basic mounting configurations are shown as follows Fig. 3.6.

#### ◆ Spindle end journal configurations

The most popular journal configurations are shown in Fig. 3.7.

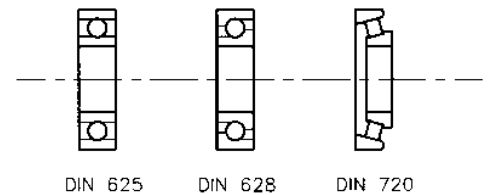
Table 3.2 lists the recommended dimensions and the bearings for the configurations of Fig. 3.7.

Table 3.2 Dimension for spindle ends

Model	d1	d5 (h5) j6	d6	d7	d8 h7	E	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	p9 bxt1	Recommended Bearing	
																			I . II . III DIN 625	III . IV.V DIN 625 628 720
10	10	8	7.6	M8x0.75	6	6	16	7	29	26	0.9	39	50	56	18	10	12	3.0x1.8	608	738B
12	12	8	7.6	M8x0.75	6	6	16	7	29	26	0.9	39	50	56	18	10	12	3.0x1.8	608	738B
14	14	10	9.6	M10x0.75	8	8	20	9	37	34	1.15	45	54	62	20	10	14	3.0x1.8	6200	7200BTVP
16	16	12	11.5	M12x1	10	8	21	10	41	38	1.15	46	56	66	20	10	14	4.0x2.5	6201	7301BTVP
20	20	15	14.3	M15x1	12	-	22	11	47	44	1.15	55	70	84	25	13	16	5.0x3.0	6202	7202BTVP
25	25	17	16.2	M17x1	15	-	23	12	49	46	1.15	56	72	86	25	13	16	5.0x3.0	6203	7203BTVP
28	28	20	19	M20x1	16	-	26	14	58	54	1.35	68	82	100	28	20	18	6.0x3.5	6204	7602020TVP
32	32	25	23.9	M25x1.5	20	-	27	15	64	60	1.35	79	94	116	36	22	26	7.0x4.0	6205	7602025TVP
36	36	25	23.9	M25x1.5	20	-	27	15	64	60	1.35	79	94	116	36	22	26	7.0x4.0	6205	7602025TVP
40	40	30	28.6	M30x1.5	25	-	28	16	68	64	1.65	86	102	126	42	22	32	8.0x4.0	6206	7602030TVP
45	45	35	33.3	M35x1.5	30	-	29	17	80	76	1.65	97	114	148	50	24	40	10.0x5.0	6207	7602035TVP
50	50	40	38	M40x1.5	35	-	36	23	93	88	1.95	113	126	160	60	24	45	12.0x5.0	6308	7602040TVP
55	55	45	42.5	M45x1.5	40	-	38	25	93	88	1.95	125	138	168	70	24	50	14.0x5.5	6309	7602045TVP
63	63	50	47	M50x1.5	45	-	33	27	102	97	2.2	140	153	188	80	27	60	14.0x5.5	6310	7602050TVP
70	70	55	52	M55x2.0	50	10	44	29	118	113	2.2	154	167	212	90	27	70	16.0x6.0	6311	7602055TVP
80	80	65	62	M65x2.0	60	10	49	33	132	126	2.7	171	184	234	100	30	80	18.0x7.0	6313	7602065TVP
100	100	75	72	M75x2.0	70	10	53	37	140	134	2.7	195	208	258	120	30	90	20.0x7.5	6315	7602075TVP

\* We reserve the right to modify and improve data value without prior notice.

\* Different diameters and leads are available upon request.



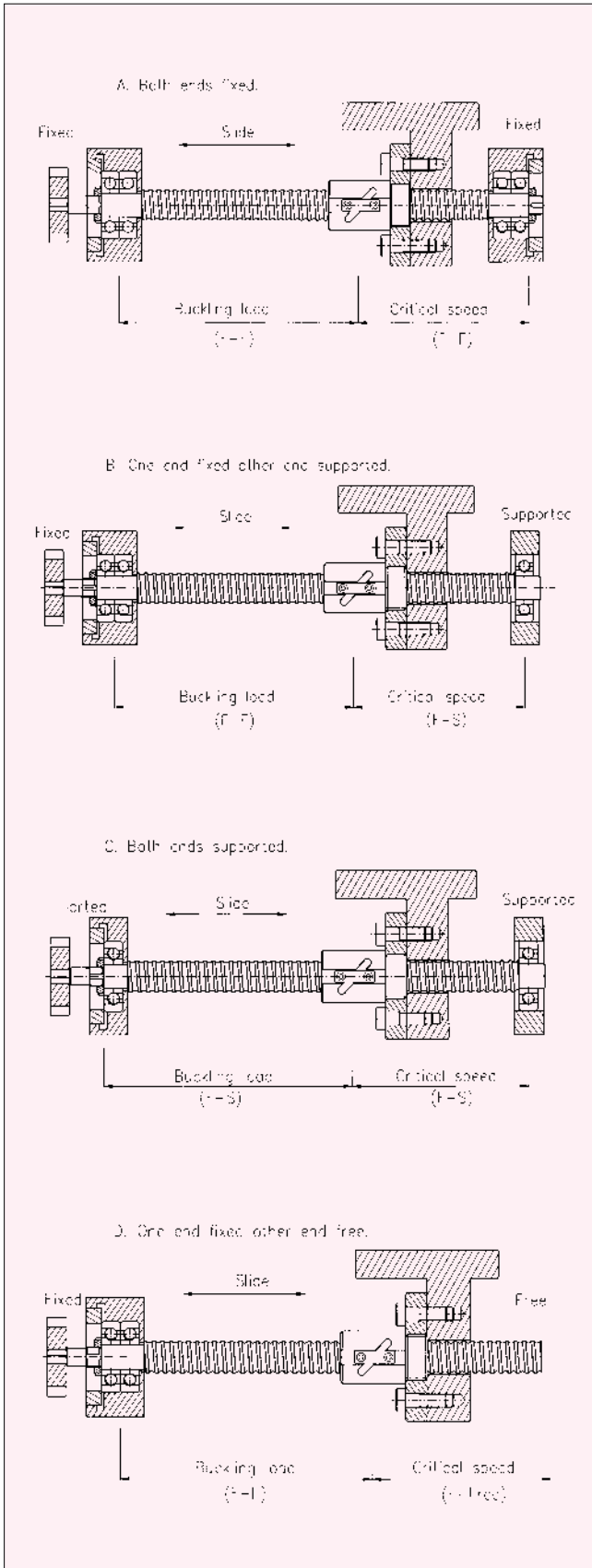


Fig 3.6 Recommended mounting methods for the ballscrew end journals

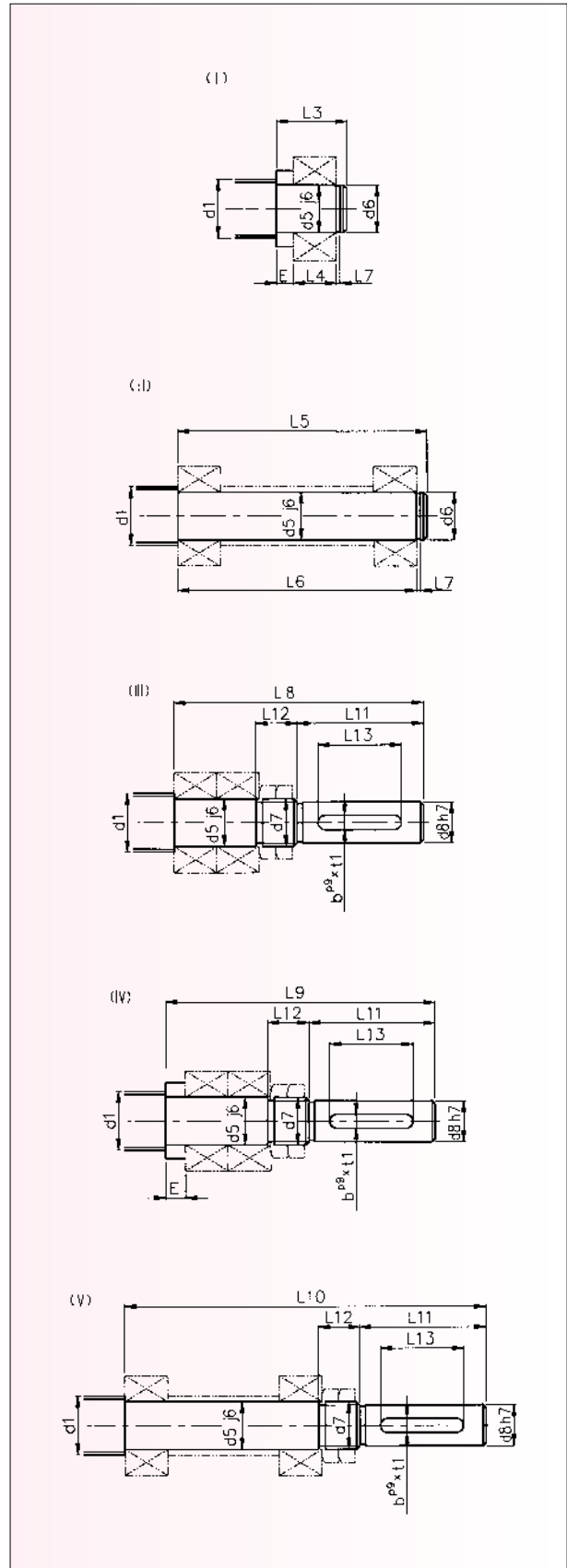


Fig 3.7 Configurations of spindle ends

## 4. Design and Selection of HIWIN Ballscrews

### 4.1 Fundamental Concepts for Selection & Installation

- (1) A ballscrew must be thoroughly cleaned in white spirit and oil to protect against corrosion. Trichloroethylene is an acceptable degreasing agent, ensuring the ball track free from dirt and damage (paraffin is not satisfactory). Great care must be taken to ensure that the ball track is not struck by a sharp edged component or tool, and metallic debris does not enter the ball nut (Fig. 4.1).
- (2) Select a suitable grade ballscrew for the application (ref. Table 4.5). Install with corresponding mounting disciplines. That is, precision ground ballscrews for CNC machine tools demand accurate alignment and precision bearing arrangement, where the rolled ballscrews for less precision applications, such as packaging machinery, require less precise support bearing arrangement. It is especially important to eliminate misalignment between the bearing housing center and the ballnut center, which would result in unbalanced loads (Fig. 4.2). Unbalanced loads include radial loads and moment loads (Fig. 4.2a). These can cause malfunction and reduce service life (Fig.4.2b).



Keep all parts clean.

Fig 4.1 Carefully clean and protect

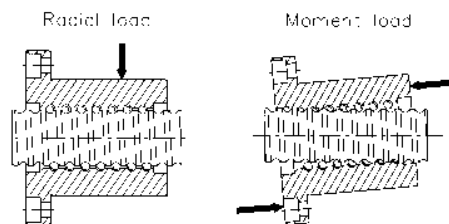


Fig 4.2(a) Unbalance load caused by misalignment of the support bearings and nut brackets, inaccurate alignment of the guide surface, inaccurate angle or alignment of the nut mounting surface

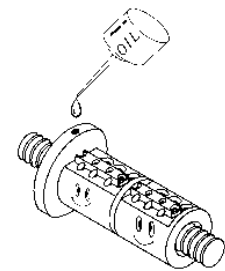


Fig 4.2 Oil lubrication method

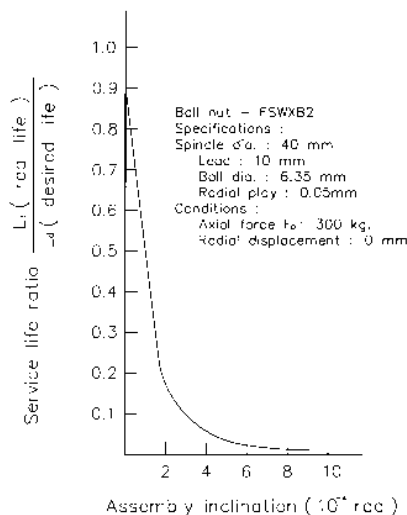


Fig 4.2(b) The effect on service life of a radial load caused by misalignment

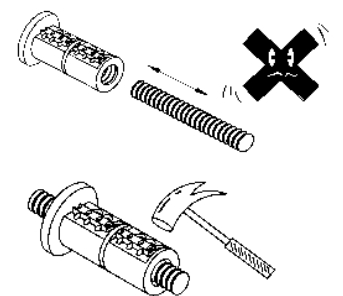


Fig 4.3 Carefully protect the nut

- (3) To achieve the ballscrews' maximum life, recommends the use of antifriction bearing oils. Oil with graphite and  $M_6S_2$  additives must not be used. The oil should be maintained over the balls and the balltracks.
- (4) Oil mist bath or drip feeds are acceptable. However, direct application to the ball nut is recommended (Fig. 4.3).

(5) Select a suitable support bearing arrangement for the screw spindle. Angular contact ball bearings (angle=60°) are recommended for CNC machinery. Because of higher axial load capacity and ability to provide a clearance-free or preloaded assembly (Fig. 4.4).

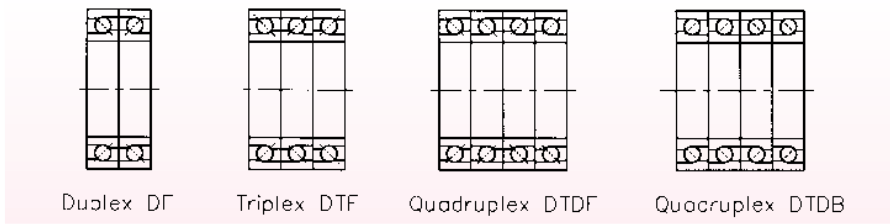


Fig 4.4 Different arrangement of ballscrew support bearings

(6) A dog stopper should be installed at the end to prevent the nut from over-travelling which results in damage to ballscrew assembly (Fig 4.5).

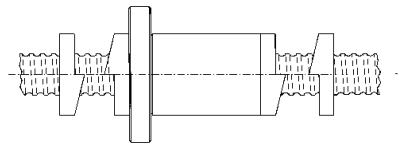


Fig 4.5 A dog stopper to prevent the nut from over travelling

(7) In environments contaminated by dust or metallic debris, ballscrews should be protected using telescopic or bellow-type covers. The service life of a ballscrew will be reduced to about one-tenth normal condition if debris or chips enter the nut. The bellow type covers may need to have a threaded hole in the flange to fix the cover. Please contact engineers when special modifications are needed (Fig 4.6).

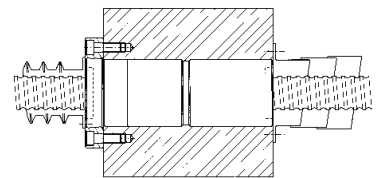


Fig 4.6 Ballscrew protection by telescopic or bellow type covers

(8) If you select an internal recirculation type or an endcap recirculation type ballscrew, one end of the ball thread must be cut through to the end surface. The adjacent diameter on the end journal must be 0.5 ~ 1.0 mm less than the root diameter of the balltracks (Fig 4.7).

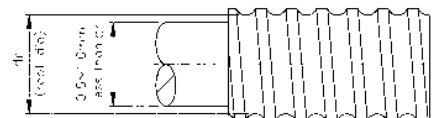


Fig 4.7 Special arrangement for the end journal of an internal recirculation screw

(9) After heat treating the ballscrew spindle, both ends of the balltracks adjacent to the journal have about 2 to 3 leads left soft, for the purpose of machining. These regions are shown in (Fig. 4.8) with the mark “●” on HIWIN drawings.

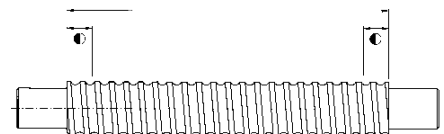


Fig 4.8 The heat treatment range of the ballscrew spindle

(10) Excessive preload increases the friction torque and generates heat which reduces the life expectancy. But insufficient preload reduces stiffness and increases the possibility of lost motion. recommends that the maximum preload used for CNC machine tools should not exceed 8% of the basic dynamic load C (10<sup>6</sup> revs).

(11) For an internal recirculation nut, when the nut needs to be disassembled from/assembled to the screw spindle, a tube with an outer dia. 0.2 to 0.4 mm less than the root diameter (ref. M39) of the balltracks should be used to release/connect the nut to from/to the screw spindle via one end of the screw spindle shown in Fig. 4.9.

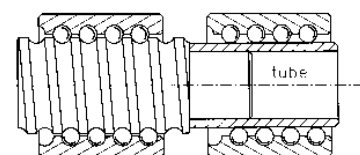


Fig 4.9 The method of separating the nut from the screw spindle

(12) As shown in Fig 4.10, the support bearing must have a chamfer to allow it to seat properly and maintain proper alignment. suggests the DIN 509 chamfer as the standard construction for this design (Fig. 4.11).

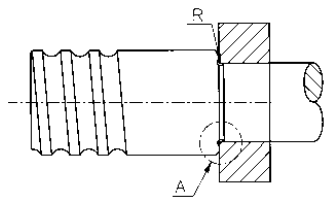


Fig 4.10 Chamfer for seating the face of bearing end.

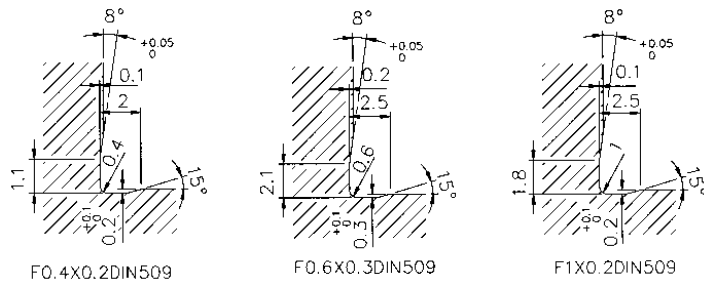


Fig 4.11 Suggested chamfer dimension per DIN 509 for the "A" dimension in Fig 4.10

## 4.2 Ballscrews Selection Procedure

The selection procedure for ballscrews is shown in (Table 4.1) From the known design operation condition, (A) select the appropriate parameter of ballscrew, (B) follow the selection procedure step by step via the reference formula, and (C) find the best ballscrew parameters which can be met for the design requirements.

Table 4.1 Ballscrew selection procedure

Step	Design operation condition (A)	Ballscrew parameter (B)	Reference formula(C)
Step 1	Positioning accuracy	Lead accuracy	Table 5.2
Step 2	(1) Max. speed of DC motor ( $N_{max}$ ) (2) Rapid feed rate ( $V_{max}$ )	Ballscrew lead	$l \geq \frac{V_{max}}{N_{max}}$
Step 3	Total travel distance	Total thread length	Total length = thread length + journal end length Thread length = stroke + nut length + 100 mm (unused thread)
Step 4	(1) Load condition (%) (2) Speed condition (%)	Mean axial load Mean speed	M7 ~ M10
Step 5	Mean axial force ( $\leq 1/5 C$ is the best)	Preload	M1
Step 6	(1) Service life expectancy (2) Mean axial load (3) Mean speed	Basic dynamic load	M13 ~ M14
Step 7	(1) Basic dynamic load (2) Ballscrew lead (3) Critical speed (4) Speed limited by $D_m$ -N value	Screw diameter and nut type (select some range)	M31 ~ M33 and dimension table
Step 8	(1) Ballscrew diameter (2) Nut type (3) Preload (4) Dynamic load	Stiffness (check the best one via lost motion value)	M34 ~ M40
Step 9	(1) Surrounding temperature (2) Ballscrew length	Thermal displacement and target value of cumulative lead (T)	M41 and 4.6 temperature rising effect
Step 10	(1) Stiffness of screw spindle (2) Thermal displacement	Pretension force	M45
Step 11	(1) Max. table speed (2) Max. rising time (3) Ballscrew specification	Motor drive torque and motor specification	M19 ~ M28

### 4.3 Accuracy Grade of **HIWIN** Ballscrews

Precision ground ballscrews are used in applications requiring high positioning accuracy and repeatability, smooth movement and long service life. Ordinary rolled ballscrews are used for application grade less accurate but still requiring high efficiency and long service life. Precision grade rolled ballscrews have an accuracy between that of the ordinary grade rolled ballscrews and the higher grade precision ground ballscrews. They can be used to replace certain precision ground ballscrews with the same grade in many applications.

HIWIN makes precision grade rolled ballscrew up to C6 grade. Geometric tolerances are different from those of precision ground screws (See Chapter 6). Since the outside diameter of the screw spindle is not ground, the set-up procedure for assembling precision rolled ballscrews into the machine is different from that of ground ones. Chapter 7 contains the entire description of rolled ballscrews.

#### (1) Accuracy grade

There are numerous applications for ballscrews from high precision grade ballscrews, used in precision measurement and aerospace equipment, to transport grade ballscrews used in packaging equipment. The quality and accuracy classifications are described as follows: lead deviation, surface roughness, geometrical tolerance, backlash, drag torque variation, heat generation and noise level.

HIWIN precision ground ballscrews are classified to 7 classes. In general, HIWIN precision grade ballscrews are defined by the so called “ $e_{300}$ ” value see Fig 4.12 and rolled grade ballscrews are defined differently as shown in Chapter 7.

Fig. 4.12 is the lead measuring chart according to the accuracy grade of the ballscrews. The same chart by the DIN system is illustrated in Fig. 4.13. From this diagram, the accuracy grade can be determined by selecting the suitable tolerance in Table 4.2. Fig. 4.14 shows HIWIN’s measurement result according to the DIN standard. Table 4.2 shows the accuracy grade of precision grade ballscrews in HIWIN’s specification. The relative international standard is shown in Table 4.3.

The positioning accuracy of machine tools is selected by  $\pm E$  value with the  $e_{300}$  variation. The recommended accuracy grade for machine applications is shown in Table 4.5. This is the reference chart for selecting the suitable ballscrews in different application fields.

#### (2) Axial play (Backlash)

If zero axial play ballscrews (no backlash) are needed, preload should be added and the preload drag torque is specified for testing purpose. The standard axial play of HIWIN ballscrews is shown in Table 4.4. For CNC machine tools, lost motion can occur in zero-backlash ballscrews through incorrect stiffness. Please consult our engineers when determining stiffness and backlash requirements.

#### (3) Geometrical tolerance

It is crucial to select the ballscrew of the correct grade to meet machinery requirements. Table 4.6 and Fig 4.15 are helpful for you to determine the tolerance factors, which are based on certain required accuracy grades.

Table 4.2 HIWIN accuracy grade of precision ballscrew

Unit: 0.001mm

Accuracy Grade		0		1		2		3		4		5		6			
$e_{2\pi}$		3		4		4		6		8		8		8			
$e_{300}$		3.5		5		6		8		12		18		23			
Thread length	Item	$\pm E$		$e$		$\pm E$		$e$		$\pm E$		$e$		$\pm E$		$e$	
	above	below															
-	315	4	3.5	6	5	6	6	12	8	12	12	23	18	23	23		
315	400	5	3.5	7	5	7	6	13	10	13	12	25	20	25	25		
400	500	6	4	8	5	8	7	15	10	15	13	27	20	27	26		
500	630	6	4	9	6	9	7	16	12	16	14	30	23	30	29		
630	800	7	5	10	7	10	8	18	13	18	16	35	25	35	31		
800	1000	8	6	11	8	11	9	21	15	21	17	40	27	40	35		
1000	1250	9	6	13	9	13	10	24	16	24	19	46	30	46	39		
1250	1600	11	7	15	10	15	11	29	18	29	22	54	35	54	44		
1600	2000			18	11	18	13	35	21	35	25	65	40	65	51		
2000	2500			22	13	22	15	41	24	41	29	77	46	77	59		
2500	3150			26	15	26	17	50	29	50	34	93	54	93	69		
3150	4000			30	18	32	21	60	35	62	41	115	65	115	82		
4000	5000							72	41	76	49	140	77	140	99		
5000	6300							90	50	100	60	170	93	170	119		
6300	8000							110	60	125	75	210	115	210	130		
8000	10000											260	140	260	145		
10000	12000											320	170	320	180		



Table 4.4 Standard combination of grade and axial play

Unit: 0.001mm

Grade	0	1	2	3	4	5	6
Axial Play	5	5	5	10	15	20	25

Table 4.3 International standard of accuracy grade for ballscrews

Unit: 0.001mm

Grade	0	1	2	3	4	5	6	7	10
ISO, DIN		6		12		23		52	210
JIS	3.5	5		8		18		50	210
HIWIN	3.5	5	6	8	12	18	23	50	210

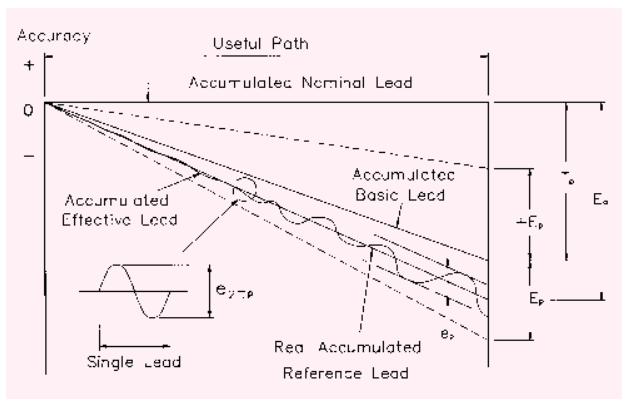


Fig 4.12 HIWIN lead measuring curve of precision ballscrew

- $T_p$ : Target point of accumulated lead.  
This value is determined by customers' different application requirements.
- $E_p$ : Total reference lead deviation.  
Maximum deviation for accumulated reference lead line over the full length.
- $e_{2rp}$ : Single lead variation.
- $E_a$ : Real accumulated reference lead measured by laser system.
- $e_p$ : Total relative lead deviation.  
Maximum deviation of the real accumulated lead from the real accumulated reference lead in the corresponding range.
- $e_{300p}$ : Lead deviation over path of 300mm.  
The above deviation in random 300 mm within thread length.

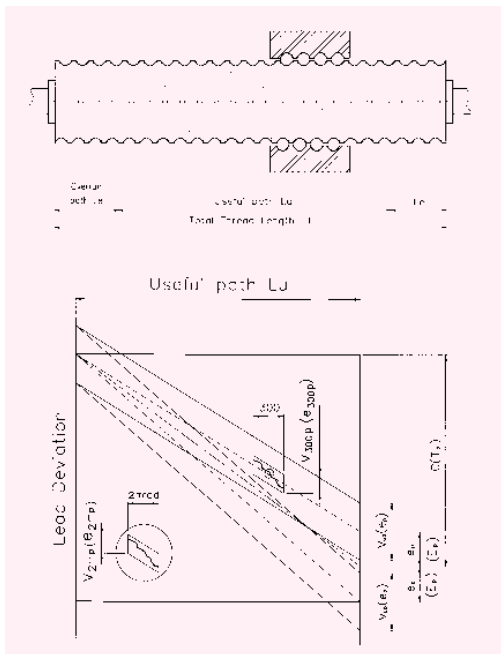


Fig 4.13 DIN lead measuring curve of precision ballscrew

- $e_{oa} (E_a)$ : Average lead deviation over useful path  $L_u$ .  
A straight line representing the tendency of the cumulative actual lead.  
This is obtained by the least square method and measured by the laser system. The value is added by path compensation over the useful path and the mean travel deviation.
- $c (T_p)$ : Path compensation over useful path  $L_u$ .  
Selection parameter. This value is determined by customer and maker as it depends on different application requirements.
- $e_p (E_p)$ : Mean travel deviation.
- $V_{UP} (e_p)$ : Lead variation over useful path  $L_u$ .
- $V_{300p} (e_{300p})$ : Lead variation over path of 300 mm.
- $V_{2rp} (e_{2rp})$ : Lead variation over 1 rotation.

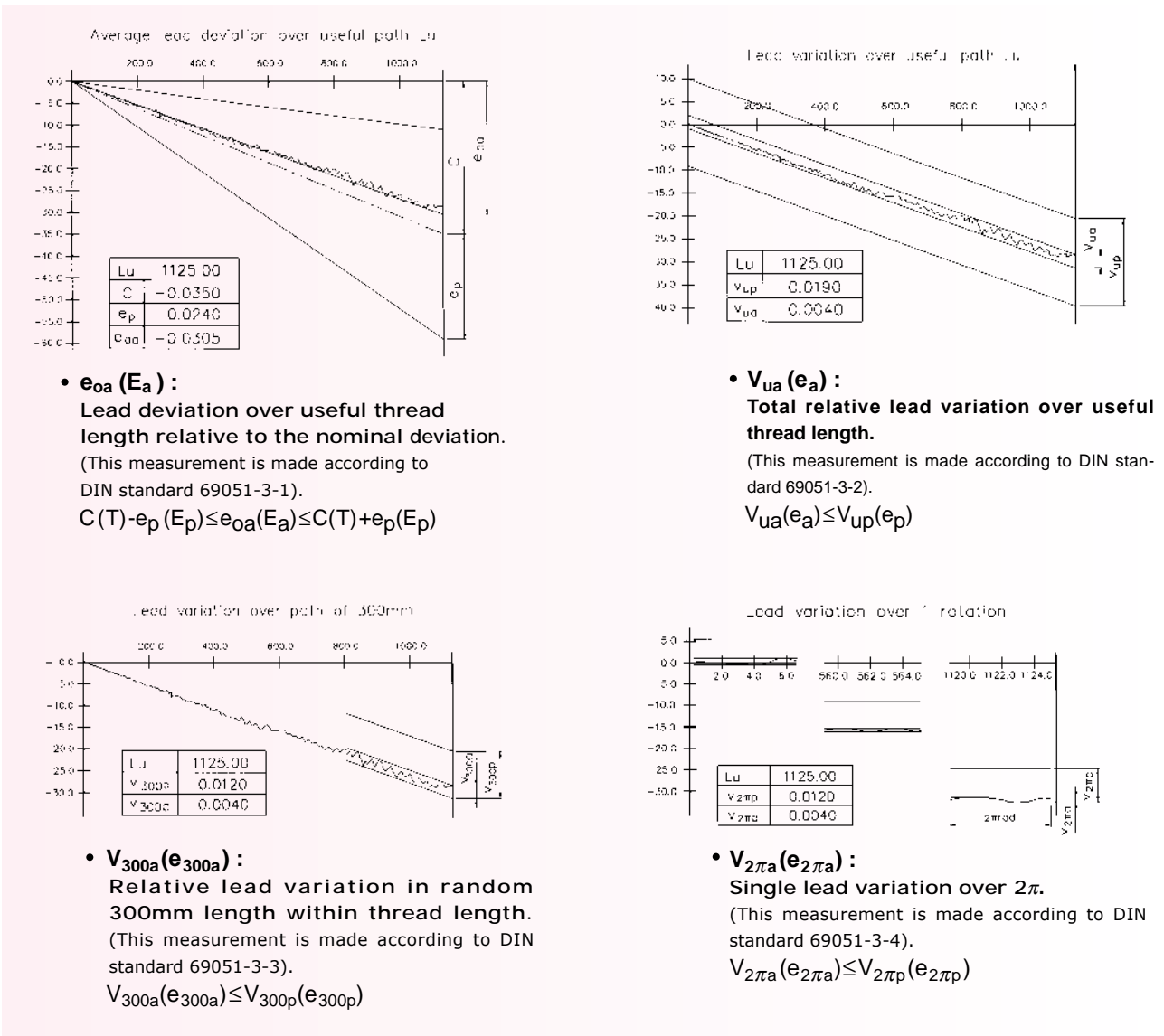


Fig 4.14 Lead accuracy measuring chart from dynamic laser measurement equipment according to DIN 69051 standard

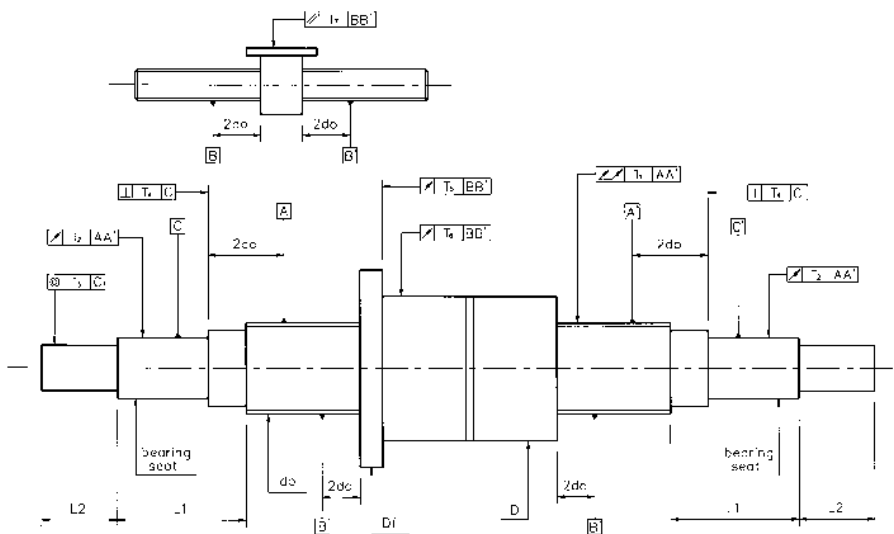
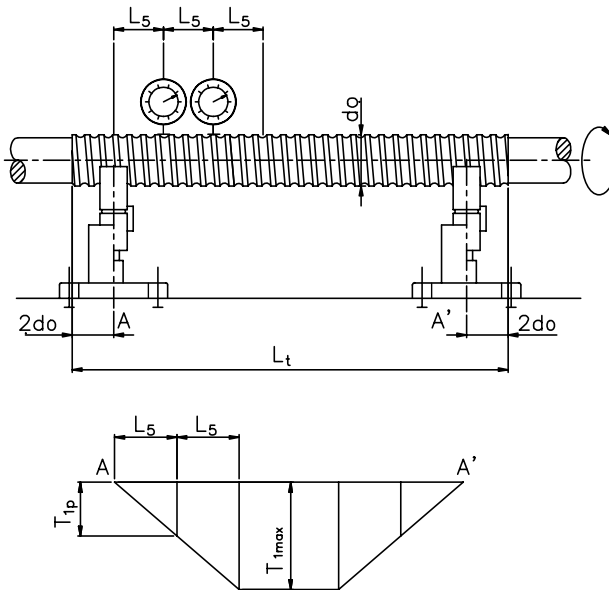


Fig 4.15 Geometrical tolerance of HIWIN precision ground ballscrew

Table 4.5 Recommended accuracy grade for machine applications

Application grade	A X I S	Accuracy grade													
		0	1	2	3	4	5	7	PR1	PR2	PR3				
CNC Machinery Tools	Lathes	X	•	•	•	•	•								
		Z				•	•	•							
	Milling machines	X		•	•	•	•	•							
		Y		•	•	•	•	•							
	Boring machines	Z			•	•	•	•							
		X		•	•	•	•								
	Machine Center	Y		•	•	•	•								
		Z			•	•	•								
		X	•	•											
	Jig borers	Y	•	•											
		Z	•	•											
		X				•	•	•							
	Drilling machines	Y				•	•	•							
		Z					•	•	•						
		X	•	•	•										
	Grinders	Y		•	•	•									
		X		•	•	•									
		Z			•	•	•	•							
EDM	Y		•	•	•										
	Z			•	•	•	•								
	X		•	•	•										
Wire cut EDM	Y		•	•	•										
	U		•	•	•	•									
	V		•	•	•	•	•								
Laser Cutting Machine	X			•	•	•									
	Y			•	•	•									
	Z			•	•	•									
General Machinery	Punching Press	X			•	•	•								
		Y			•	•	•								
	Single Purpose Machines		•	•	•	•	•	•							
	Wood working Machine								•	•	•	•			
	Industrial Robot (Precision)		•	•	•	•									
	Industrial Robot (General)						•	•	•	•					
	Coordinate Measuring Machine	•	•	•											
	Non-CNC Machine				•	•	•								
	Transport Equipment					•	•	•	•	•	•	•			
	X-Y Table		•	•	•	•	•								
	Linear Actuator						•	•	•	•					
	Aircraft Landing Gear						•	•	•	•					
	Airfoil Control						•	•	•	•					
	Gate Valve							•	•	•	•	•			
	Power steering							•	•	•					
	Glass Grinder			•	•	•	•	•							
	Surface Grinder					•	•								
	Induction Hardening Machine							•	•	•	•				
Electromachine		•	•	•	•	•	•								

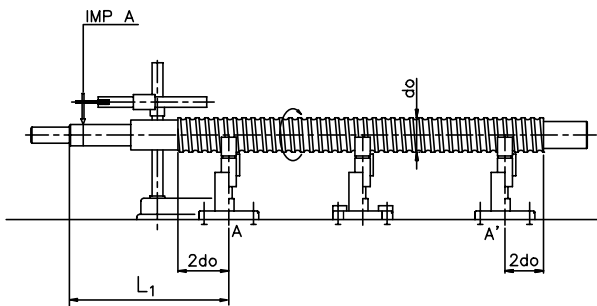
Table 4.6 Tolerance table and measurement method for HIWIN precision ballscrews



T1: True running deviation of external diameter relative to AA' (This measurement is made according to DIN 69051 and JIS B1192)

Nominal Diameter do (mm)	reference length	T <sub>1p</sub> [ μm ] for <b>HIWIN</b> tolerance class									
		0	1	2	3	4	5	6	7		
above 6	up to 12	L5	0	1	2	3	4	5	6	7	
12	25	80									
25	50	160	20	20	20	23	25	28	32	40	
50	100	315									
100	200	630									
		1250									
Lt/do		T <sub>1max</sub> [ μm ] (for Lt ≥ 4L5) for <b>HIWIN</b> tolerance class									
above	up to	0	1	2	3	4	5	6	7		
40	40	40	40	40	45	50	60	64	80		
60	60	60	60	60	70	75	85	96	120		
80	80	100	100	100	115	125	140	160	200		
	100	160	160	160	180	200	220	256	320		

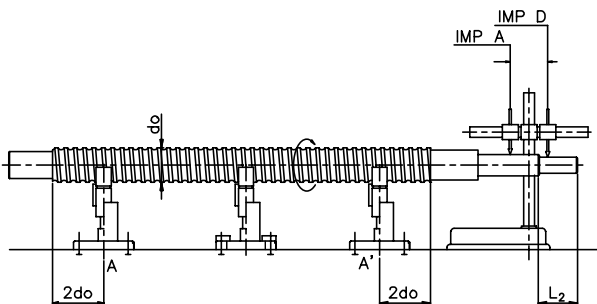
T2: Run out deviation of bearing relative to AA' (This measurement is made according to DIN 69051 and JIS B1192)



Nominal Diameter do (mm)	reference length	L <sub>r</sub>	T <sub>2p</sub> [ μm ] (for L <sub>1</sub> ≤ L <sub>r</sub> ) for <b>HIWIN</b> tolerance class							
			0	1	2	3	4	5	6	7
above 6	up to 20	80	6	8	10	11	12	16	20	40
20	50	125	8	10	12	14	16	20	25	50
50	125	200	10	12	16	18	20	26	32	63
125	200	315	-	-	-	20	25	32	40	80

if  $L_1 > L_r$ , then  $t_{2a} \leq T_{2p} \frac{L_1}{L_r}$

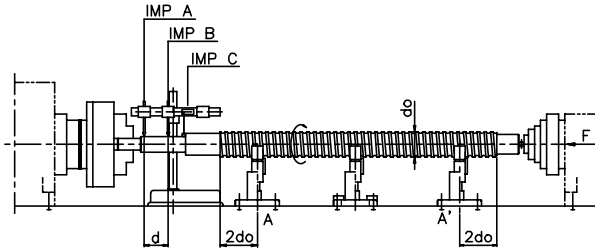
T3: Coaxial deviation relative to AA' (This measurement is made according to DIN 69051 and JIS B1192)



Nominal Diameter do (mm)	reference length	L <sub>r</sub>	T <sub>3p</sub> [ μm ] (for L <sub>2</sub> ≥ L <sub>r</sub> ) for <b>HIWIN</b> tolerance class									
			0	1	2	3	4	5	6	7		
above 6	up to 20	80	4	5	5	6	6	7	8	12		
20	50	125	5	6	6	7	8	9	10	16		
50	125	200	6	7	8	9	10	11	12	20		
125	200	315	-	-	-	10	12	14	16	25		

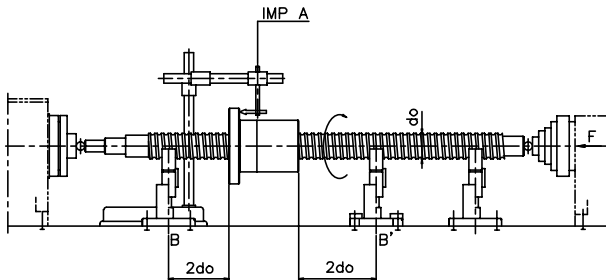
if  $L_2 > L_r$ , then  $t_{3a} \leq T_{3p} \frac{L_2}{L_r}$

T4 : Run-out deviation of bearing end shoulder relative to AA' (This measurement is made according to DIN 69051 and JIS B1192)



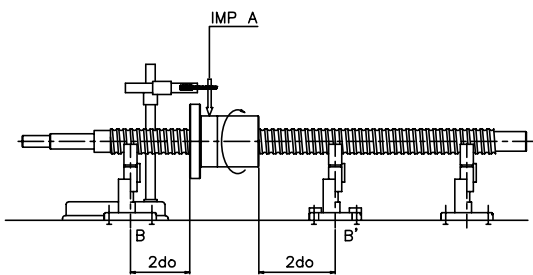
Nominal Diameter do (mm)		$T_{4p}$ [ $\mu\text{m}$ ] for HIWIN tolerance class							
above	up to	0	1	2	3	4	5	6	7
6	63	3	3	3	4	4	5	5	6
63	125	3	4	4	5	5	6	6	8
125	200	-	-	-	6	6	8	8	10

T5 : Face running deviation of locating face (only for nut) relative to BB' (This measurement is made according to DIN 69051 and JIS B1192)



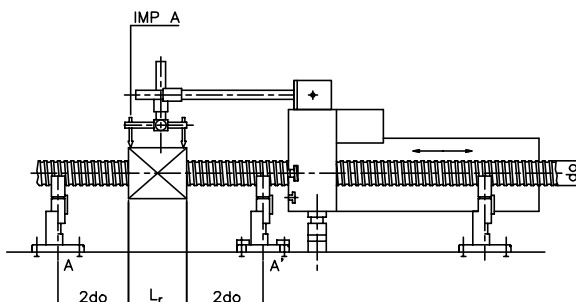
Nut Flange Diameter do (mm)		$T_{5p}$ [ $\mu\text{m}$ ] for HIWIN tolerance class							
above	up to	0	1	2	3	4	5	6	7
-	20	5	6	7	8	9	10	12	14
20	32	5	6	7	8	9	10	12	14
32	50	6	7	8	8	10	11	15	18
50	80	7	8	9	10	12	13	16	18
80	125	7	9	10	12	14	15	18	20
125	160	8	10	11	13	15	17	19	20
160	200	-	11	12	14	16	18	22	25
200	250	-	12	14	15	18	20	25	30

T6 : Run-out deviation of external diameter (only for nut) relative to BB' (This measurement is made according to DIN 69051 and JIS B1192)



Nut Flange Diameter do (mm)		$T_{6p}$ [ $\mu\text{m}$ ] for HIWIN tolerance class							
above	up to	0	1	2	3	4	5	6	7
-	20	5	6	7	9	10	12	16	20
20	32	6	7	8	10	11	12	16	20
32	50	7	8	10	12	14	15	20	25
50	80	8	10	12	15	17	19	25	30
80	125	9	12	16	20	24	22	25	40
125	160	10	13	17	22	25	28	32	40
160	200	-	16	20	22	25	28	32	40
200	250	-	17	20	22	25	28	32	40

T7 : Deviation of parallelism (only for nut) relative to BB' (This measurement is made according to DIN 69051 and JIS B1192)



Mounting basic length (mm) Lr		$T_{7p}$ [ $\mu\text{m}$ ]/100mm for HIWIN tolerance class							
above	up to	0	1	2	3	4	5	6	7
-	50	5	6	7	8	9	10	14	17
50	100	7	8	9	10	12	13	15	17
100	200	-	10	11	13	15	17	24	30

## 4.4 HIWIN Preload Methods

The specially designed Gothic ball track can make the ball contact angle around  $45^\circ$ . The axial force  $F_a$ , which comes from an outside drive force or inside preload force, causes two kinds of backlash. One is the normal backlash,  $S_a$ , caused by the manufacturing clearance between ball track and ball. The other is the deflection backlash,  $\Delta \ell$ , caused by the normal force  $F_n$  which is perpendicular to the contact point.

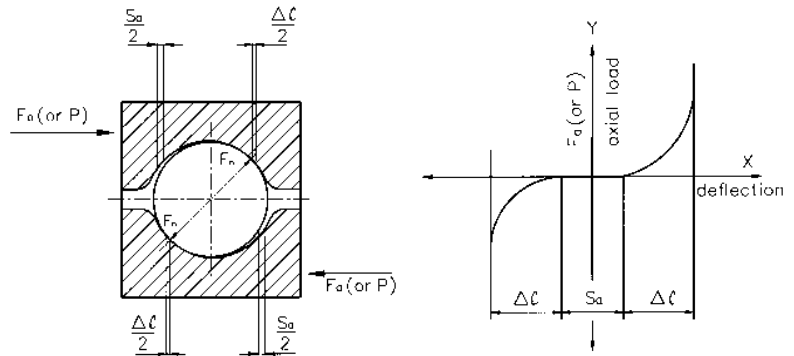


Fig 4.16 Gothic form profile and preloading relation

The clearance backlash can be eliminated by the use of an preload internal force  $P$ . This preload can be obtained via a double nut, an offset pitch single nut, or by adjusting the ball size for preloaded single nuts (Fig. 5.7~ Fig. 5.8).

The deflection backlash is caused by the preload internal force and the external loading force and is related to that of the effect of lost motion.

### (1) Double nut preloading

Preload is obtained by inserting a spacer between the 2 nuts (Fig. 4.17). "Tension preload" is created by inserting an oversize spacer and effectively pushing the nuts apart. "Compression preload" is created by inserting an undersize spacer and correspondingly pulling nuts together. Tension preload is primarily used for precision ballscrews. However, compression preload type ballscrews are also available upon your request. If pretension is necessary to increase stiffness, please contact us for the amount of pretension to be used in the ballscrew journal ends. (0.02mm to 0.03mm per meter is recommended, but the T value should be selected according to the compensation purpose).

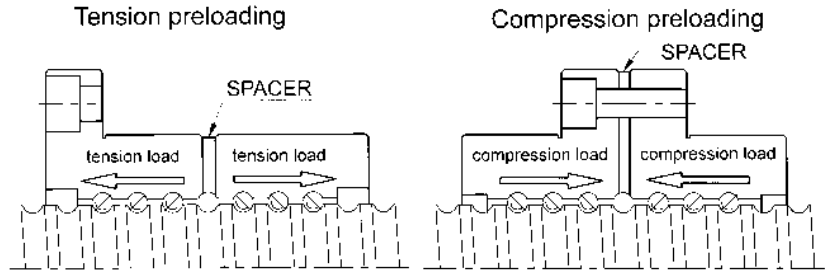


Fig 4.17 Preload by spacer

### (2) Single nut preloading

There are two ways of preloading a single nut. One is called "the oversized-ball preloading method". The method is to insert balls slightly larger than the ball groove space (oversized balls) to allow balls to contact at four points (Fig. 4.18).

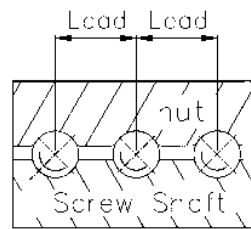


Fig 4.18 Preload by ball size

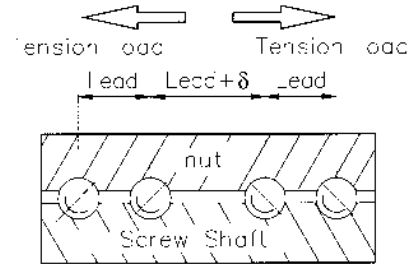


Fig 4.19 Offset type preloading

The other way is called "The offset pitch preloading method" as shown in

Fig. 4.19. The nut is ground to have a  $\delta$  value offset on the center pitch. This method is used to replace the traditional double nut preloading method and has the benefit of a compact single nut with high stiffness via small preload force. However, it should not be used in heavy duty preloading. The best preload force is below 5% of dynamic load (C).

### (3) Preload calculation

$$P = \frac{F_{bm}}{2.8} \quad \dots\dots\dots \text{M1}$$

P : preload force (kgf)  
F<sub>bm</sub>: Mean operating load (kgf)  
(Ref. M8~M10)

$$T_d = \frac{K_p \times P \times \ell}{2\pi} \quad \dots\dots\dots \text{M2}$$

Preload drag torque (Fig. 4.20)  
T<sub>d</sub>: preload drag torque (kgf-mm)  
P : preload (kgf)  
ℓ : lead (mm)  
K<sub>p</sub>: preload torque coefficient  
K<sub>p</sub> =  $\frac{1}{\eta_1} - \eta_2$  (is between 0.1 and 0.3.)  
η<sub>1</sub>, η<sub>2</sub> are the mechanical efficiencies of the ballscrew.

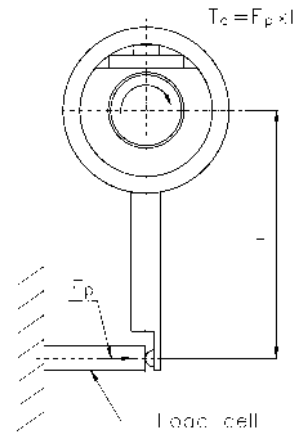


Fig. 4.20 : Preload drag torque measuring method (according to JIS B1192)

(1) for common transmission (to convert rotary motion to linear motion)

$$\eta_1 = \frac{\tan(\alpha)}{\tan(\alpha + \beta)} = \frac{1 - \mu \tan \alpha}{1 + \mu / \tan \alpha} \quad \dots\dots\dots \text{M3}$$

(2) for reverse transmission (to convert linear rotary motion to rotary motion)

$$\eta_2 = \frac{\tan(\alpha - \beta)}{\tan \alpha} = \frac{1 - \mu / \tan \alpha}{1 + \mu \tan \alpha} \quad \dots\dots\dots \text{M4}$$

$$\alpha = \tan^{-1} \frac{\ell}{\pi D_m} \quad \dots\dots\dots \text{M5}$$

$$\beta = \tan^{-1} \mu \quad \dots\dots\dots \text{M6}$$

α : lead angle (degrees)  
D<sub>m</sub> : pitch circle diameter of screw shaft (mm)  
ℓ : lead (mm)  
β : friction angle (0.17 °~0.57 °)  
μ : friction coefficient (0.003~0.01)

### (4) Uniformity of preload drag torque

(1) Measuring method

Preload creates drag torque between the nut and screw. It is measured by rotating the screw spindle at constant speed while restraining the nut with a special fixture as shown in Fig. 4.20. The load cell reading force Fp is used to calculate the preload drag torque of the ballscrew.

HIWIN has developed a computerized drag torque measuring machine which can accurately monitor the drag torque during screw rotation. Therefore, the drag torque can be adjusted to meet customer requirements (Fig. 2.5). The measurement standard for preload drag torque is shown in Fig. 4.21 and Table 4.7.



(2) Measuring conditions

1. Without wiper.
2. The rotating speed, 100 rpm.
3. The dynamic viscosity of lubricant, 61.2 ~74.8 cSt (mm/s) 40 °C, that is , ISO VG 68 or JIS K2001.
4. The return tube up.

(3) The measurement result is illustrated by the standard drag torque chart. Its nomenclature is shown in Fig. 4.21.

(4) The allowable preload drag torque variation as a function of accuracy grade is shown in Table 4.7.

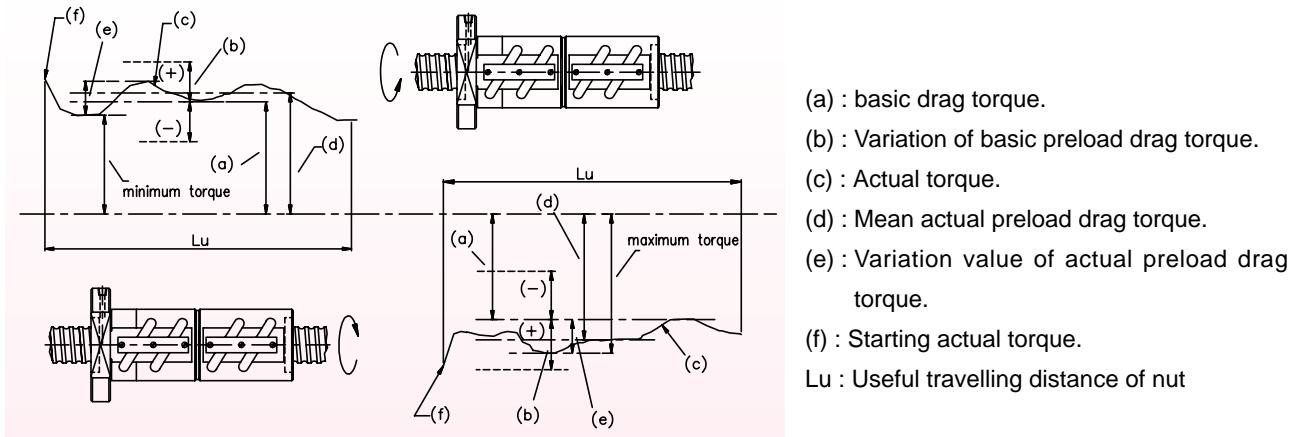


Fig 4.21 Nomenclature of drag torque measurement

Table 4.7 : Variation range for preload drag torque (According to JIS B1192)

Unit: ± %

(1) Basic Dragtorque (kgf - cm)		Useful stroke length of thread (mm)																							
		4000 mm maximum														over 4000 mm									
		Slender ratio ≤ 40							40 < Slender ratio < 60																
		Accuracy grade							Accuracy grade							Accuracy grade									
Above	Up To	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
2	4	30	35	40	40	45	50	60	-	40	40	50	50	60	60	70	-	-	-	-	-	-	-	-	-
4	6	25	30	35	35	40	40	50	-	35	35	40	40	45	45	60	-	-	-	-	-	-	-	-	-
6	10	20	25	30	30	35	35	40	40	30	30	35	35	40	40	45	45	-	-	-	40	43	45	50	50
10	25	15	20	25	25	30	30	35	35	25	25	30	30	35	35	40	40	-	-	-	35	38	40	45	45
25	63	10	15	20	20	25	25	30	30	20	20	25	25	30	30	35	35	-	-	-	30	33	35	40	40
63	100	-	15	15	15	20	20	25	30	-	-	20	20	25	25	30	35	-	-	-	25	23	30	35	35

- Note :
1. Slender ratio=Thread length of spindle/ Nominal spindle O.D.(mm)
  2. Refer to the designing section of the manual to determine the basic preload drag torque.
  3. Table 4.10 shows the conversion table for Nm.
  4. For more information, please contact our engineering department.

## 4.5 Calculation Formulas

### Service life

- The average number of rpm,  $n_{av}$

$$n_{av} = n_1 \times \frac{t_1}{100} + n_2 \times \frac{t_2}{100} + n_3 \times \frac{t_3}{100} + \dots \quad \dots\dots\dots \text{M7}$$

$n_{av}$  : average speed (rpm)

$n$  : speed (rpm)

$\frac{t_1}{100}$  : % of time at speed  $n_1$ , etc.

- The average operating load  $F_{bm}$

(1) With variable load and constant speed

$$F_{bm} = \sqrt[3]{F_{b1}^3 \times \frac{t_1}{100} \times f_{p1}^3 + F_{b2}^3 \times \frac{t_2}{100} \times f_{p2}^3 + F_{b3}^3 \times \frac{t_3}{100} \times f_{p3}^3 + \dots} \quad \dots\dots\dots \text{M8}$$

$F_{bm}$  : average operating load (kgf) ;  $F_b$  : axial load

$f_p$  : operation condition factor

$f_p$  : 1.1 ~ 1.2 when running without impact

1.3 ~ 1.8 when running in the normal condition

2.0 ~ 3.0 when running with heavy impact and vibration

(2) With variable load and variable speed

$$F_{bm} = \sqrt[3]{F_{b1}^3 \times \frac{n_1}{n_{av}} \times \frac{t_1}{100} \times f_{p1}^3 + F_{b2}^3 \times \frac{n_2}{n_{av}} \times \frac{t_2}{100} \times f_{p2}^3 + F_{b3}^3 \times \frac{n_3}{n_{av}} \times \frac{t_3}{100} \times f_{p3}^3 + \dots} \quad \dots\dots\dots \text{M9}$$

(3) With linear variable load and constant speed

$$F_{bm} = \frac{F_{bmin} \times f_{p1} + 2 \times F_{bmax} \times f_{p2}}{3} \quad \dots\dots\dots \text{M10}$$

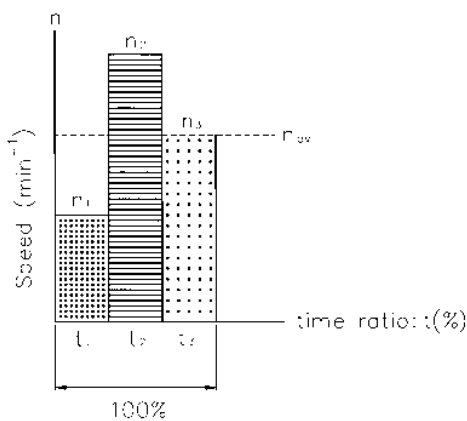


Fig 4.22 Equivalent speed

◆ **Example 4.5 - 1**

A HIWIN ballscrew is subjected to the following operating conditions. Calculate the average running speed and operating load.

Operating Condition :

For smooth running without impact  $f_p = 1.1$

Condition	Axial load (kgf) ( $F_b$ )	Revolution (rpm) (n)	Loading time ratio (%) (t)
1	100	1000	45
2	400	50	35
3	800	100	20

**Calculation**

$$n_{av} = 1000 \times \frac{45}{100} + 50 \times \frac{35}{100} + 100 \times \frac{20}{100} = 487.5rpm \quad (\text{ref.M7})$$

$$F_{bm} = \sqrt[3]{100^3 \times \frac{1000}{487.5} \times \frac{45}{100} \times 1.1^3 + 400^3 \times \frac{50}{487.5} \times \frac{35}{100} \times 1.1^3 + 800^3 \times \frac{100}{487.5} \times \frac{20}{100} \times 1.1^3} = 318.5 \text{ kgf}$$

**The resultant axial force,  $F_a$**

For a single nut without preload

$$F_a = F_{bm} \quad \dots\dots\dots \text{M11}$$

For a single nut with preload P

$$F_a \leq F_{bm} + P \quad \dots\dots\dots \text{M12}$$

**Expected service life for applications**

Table 4.8 shows the recommended service life for general applications by service distance.

In the right of Table 4.8 is the formula for service life in hours.

Shock load, vibration, temperature, lubrication, position deviation, etc. must be taken into account also.

**For single nut**

● Service life represented in revolutions :

$$L = \left( \frac{C}{F_a} \right)^3 \times 10^6 \quad \dots\dots\dots \text{M13}$$

$L$  : Service life in running revolution (revolutions)

$C$  : dynamic load rating (kgf) ( $10^6$  rev)

**For symmetrical preload double nut arrangement**

(a) Service life represented in revolutions :

$$F_{bm}(1) = P \left( 1 + \frac{F_{bm}}{3P} \right)^{3/2} \quad \dots\dots\dots L(1) = \left( \frac{C}{F_{bm}(1)} \right)^3 \times 10^6$$

$$F_{bm}(2) = F_{bm}(1) - F_{bm} \quad \dots\dots\dots L(2) = \left( \frac{C}{F_{bm}(2)} \right)^3 \times 10^6$$

$$L = \left[ L(1)^{-10/9} + L(2)^{-10/9} \right]^{-9/10} \quad \text{..... M14}$$

$L$  : Service life in running revolution (revolutions)

$P$  : Preload force (kgf)

(b) conversion from revolutions to hours :

$$L_h = \frac{L}{n_{av} \times 60} \quad \text{..... M15}$$

$L_h$  : Service life in hours (hours)

$n_{av}$ : average speed (rpm, Ref. M7)

(c) Conversion from travel distance to hours :

$$L_h = \left( \frac{L_d \times 10^6}{\ell} \right) \times \frac{1}{n_{av} \times 60} \quad \text{..... M16}$$

$L_h$  : Running life (in hours)

$L_d$  : Running life (in distance, Km)

$\ell$  : Ballscrew lead (mm per rev)

$n_{av}$ : Average running speed (rpm)

Table 4.8 Typical design service life for general application

Machine Type	Service Life in Distance, Ld (km)
Machine Tools	250
General Machinery	100 ~ 250
Control Mechanisms	350
Measuring Equipment	210
Aircraft Equipment	30

(The above service life is calculated by the dynamic load rating for 90% reliability.)

(d) the modified service life for different reliability factors is calculated by

$$L_m = L \times f_r \quad \text{..... M17}$$

$$L_{nm} = L_h \times f_r \quad \text{..... M18}$$

with the reliability factor  $f_r$  ( Table 4.9)

Table 4.9 Reliability factor for service life

Reliability %	$f_r$
90	1
95	0.63
96	0.53
97	0.44
98	0.33
99	0.21

◆ **Example 4.5 - 2**

By the example 5.4-1, if the design service life of the ballscrew is 3500 hours, lead = 10mm, single nut with zero backlash, find the nominal diameter of the HIWIN ballscrew.

**Calculation**

$$P = \frac{F_{bm}}{2.8} = \frac{318.5}{2.8} = 114 \text{ kgf} \quad (\text{Assume zero backlash when } F_{bm} = 318.5 \text{ kgf})$$

$$F_a = F_{bm} + p = 318.5 + 114 = 432.5 \text{ kgf} \quad (\text{Ref formula M1})$$

$$L = L_h \times n_{av} \times 60 = 3500 \times 487.5 \times 60 = 1.02375 \times 10^8 \quad (\text{revolutions})$$

$$C' = F_a \left( \frac{L}{10^6} \right)^{1/3} = 432.5 \times \left( \frac{1.02375 \times 10^8}{10^6} \right)^{1/3} = 2023 \text{ kgf} \quad C' \leq \text{rating}$$

So, from the dimensions table of HIWIN ballscrews, select FSV type nut with spindle nominal diameters equals 32mm and C1 circuits which can satisfy this application.

◆ **Example 4.5 - 3**

If the ballscrew nominal diameter=50mm, lead=8mm, and service life  $L=7 \times 10^6$  revolutions, find the permissible load on the screw spindle.

**Calculation**

From the dimensions table of HIWIN ballscrew, the FSV type ballscrew with nominal diameter =50 mm, lead=8 mm and B3 type return tube has the dynamic load rating  $C=5674$ .

$$F_a = C \div \left( \frac{L}{10^6} \right)^{1/3} = 5674 \div \left( \frac{7 \times 10^6}{10^6} \right)^{1/3} = 2966 \text{ kgf}$$

**Drive torque and drive power for the motor**

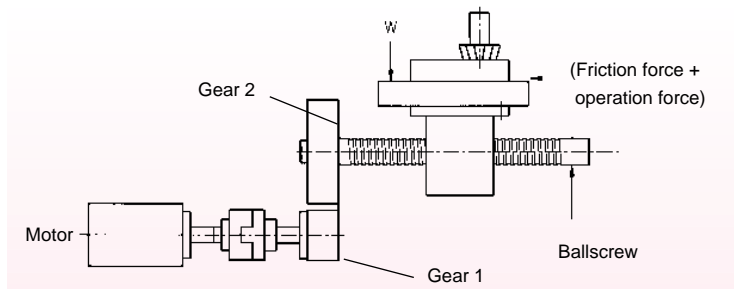


Fig 4.23 Load operation by ballscrew

Fig. 4.23 shows the terms for a feed system operated by ballscrew. The formula for motor drive torque is given below :

(a) Common transmission (to convert rotary motion to linear motion)

$$T_a = \frac{F_b \times \ell}{2\pi\eta_1} \quad \dots\dots\dots \text{M19}$$

$T_a$  = Drive torque for common transmission (kgf-mm)

$F_b$  = Axial load (kgf)

$F_b = F_{bm} + \mu \times W$  (for horizontal motion)

$\ell$  = Lead (mm)

$\eta_1$  = Mechanical efficiency (0.85 ~ 0.95, Ref. M3)

$W$  = Table weight + Work piece weight (kgf)

$\mu$  = Friction coefficient of table guide way (0.005 ~ 0.02)

(b) Reverse transmission (to convert linear motion to rotary motion)

$$T_c = \frac{F_b \times \ell \times \eta_2}{2\pi} \quad \dots\dots\dots \text{M20}$$

$\eta_2$  = Mechanical efficiency (0.75 ~ 0.85, Ref. M4)

$T_c$  = Torque for reverse transmission (kgf-mm)

(c) Motor drive torque

**For normal operation :**

$$T_M = (T_a + T_b + T_d) \times \frac{N_1}{N_2} \quad \dots\dots\dots \text{M21}$$

- T<sub>M</sub> = Motor drive torque (kgf-mm)
- T<sub>b</sub> = Friction torque of supporting bearing (kgf-mm)
- T<sub>d</sub> = Preload drag torque (kgf-mm, Ref. M2)
- N<sub>1</sub> = Number of teeth for driver gear
- N<sub>2</sub> = Number of teeth for driven gear

**For acceleration operation :**

$$T^a = J\alpha \quad \dots\dots\dots \text{M22}$$

- T<sup>a</sup> : Motor drive torque during acceleration (kgf-mm)
- J : System inertia (kgf-mm-sec<sup>2</sup>)
- α : Angular acceleration (rad/sec<sup>2</sup>)

$$\alpha = \frac{2\pi N_{dif}}{60 t_a} \quad \dots\dots\dots \text{M23}$$

- N<sub>dif</sub> = rpm<sub>stage2</sub> - rpm<sub>stage1</sub>
- t<sub>a</sub> : acceleration rising time (sec)

$$\text{Where } J = J_M + J_{G1} + J_{G2} \left( \frac{N_1}{N_2} \right)^2 + \frac{1}{2g} W_s \left( \frac{D_N}{2} \right)^2 \left( \frac{N_1}{N_2} \right)^2 + \frac{W}{g} \left( \frac{\ell}{2\pi} \right)^2 \left( \frac{N_1}{N_2} \right)^2 \quad \dots\dots\dots \text{M24}$$

= Motor inertia+ Equivalent gear inertia+ Ballscrew inertia+ Load inertia  
(Fig.4.23)

- W<sub>s</sub> : Ballscrew weight (kgf)
- D<sub>N</sub> : Ballscrew nominal diameter (mm)
- g : Gravity coefficient (9800 mm/sec<sup>2</sup>)
- J<sub>M</sub> : Inertia of motor (kgf-mm-sec<sup>2</sup>)
- J<sub>G1</sub> : Inertia of driver gear (kgf-mm-sec<sup>2</sup>)
- J<sub>G2</sub> : Inertia of driver gear (kgf-mm-sec<sup>2</sup>)

**Total operating torque :**

$$T_{Ma} = T_M + T^a \quad \dots\dots\dots \text{M25}$$

- T<sub>Ma</sub> : Total operating torque (kgf-mm)

The inertia of a disc is calculated as following :

For disc with concentric O.D.

$$J = \frac{1}{2g} \pi \rho_d R^4 L \quad \dots\dots\dots \text{M26}$$

- J : Disc inertia (kgf • mm • sec<sup>2</sup>)
- ρ<sub>d</sub> : Disc specific weight (7.8x10<sup>-6</sup> kgf/mm<sup>3</sup>) for steel
- R : Disc radius (mm)
- L : Disc length (mm)
- g : Gravity coefficient (9800 mm/sec<sup>2</sup>)

(d) Drive power

$$P_d = \frac{T_{pmax} \times N_{max}}{974} \dots\dots\dots M27$$

- $P_d$  : Maximum drive power (watt) safety
- $T_{pmax}$  : Maximum drive torque (safety factor  $\times T_{ma}$  , kgf-mm)
- $N_{max}$  : Maximum rotation speed (rpm)

(e) Check the acceleration time

$$t_a = \frac{J}{T_{M1} - T_L} \times \frac{2\pi N_{max}}{60} \cdot f \dots\dots\dots M28$$

- $t_a$  = Acceleration rising time
- $J$  = Total inertia moment
- $T_{M1} = 2 \times T_{mr}$
- $T_{Mr}$  = Motor rated torque
- $T_L$  = Drive torque at rated feed
- $f$  = Safety factor = 1.5

Table 4.10 : Shows the conversion relationship of different measurement units for the motor torque or preload drag torque.

Table 4.10 Conversion table for motor torque

kgf -cm	kgf -mm	Nm	kpm (kgf -m)	OZ-in	ft- l bf
1	10	$9.8 \times 10^{-2}$	$10^{-2}$	13.8874	$7.23301 \times 10^{-2}$
0.1	1	$9.8 \times 10^{-3}$	$1.0 \times 10^{-3}$	1.38874	$7.23301 \times 10^{-3}$
10.19716	$1.019716 \times 10^2$	1	0.1019716	$1.41612 \times 10^2$	0.737562
$10^2$	$10^3$	9.80665	1	$1.38874 \times 10^3$	7.23301
$7.20077 \times 10^{-2}$	0.720077	$7.06155 \times 10^{-3}$	$7.20077 \times 10^{-4}$	1	$5.20833 \times 10^{-3}$
13.82548	$1.382548 \times 10^2$	1.35582	0.1382548	$1.92 \times 10^2$	1

◆ **Example 4.5 - 4**

Consider the machining process driven by the motor and ballscrew as Fig. 4.24.

Table weight  $W_1 = 200$  kgf

Work weight  $W_2 = 100$  kgf

Friction coefficient of slider  $\mu = 0.02$

Operating condition : Smooth running without impact

Axial feed force (kgf)	Revolution (rpm)	Loading time ratio (%) (t)
100	500	20
300	100	50
500	50	30

Acceleration speed : 100 rad/sec<sup>2</sup>

Motor Condition : Motor diameter : 50 mm, Motor length : 200 mm,

Gear condition : Driver gear diameter G1 : 80 mm, Thickness : 20 mm, Teeth : 30  
Driven gear diameter G2 : 240 mm, Thickness : 20 mm, Teeth : 90



Ballscrew condition :  
 Nominal diameter : 50 mm, Pitch : 10 mm  
 Length : 1200 mm, Weight : 18 kgf  
 No backlash when axial feed force = 300 kgf  
 Bearing torque  $T_b = 10 \text{ kgf}\cdot\text{mm}$   
 Mechanical efficiency  $\eta_i = 0.80$

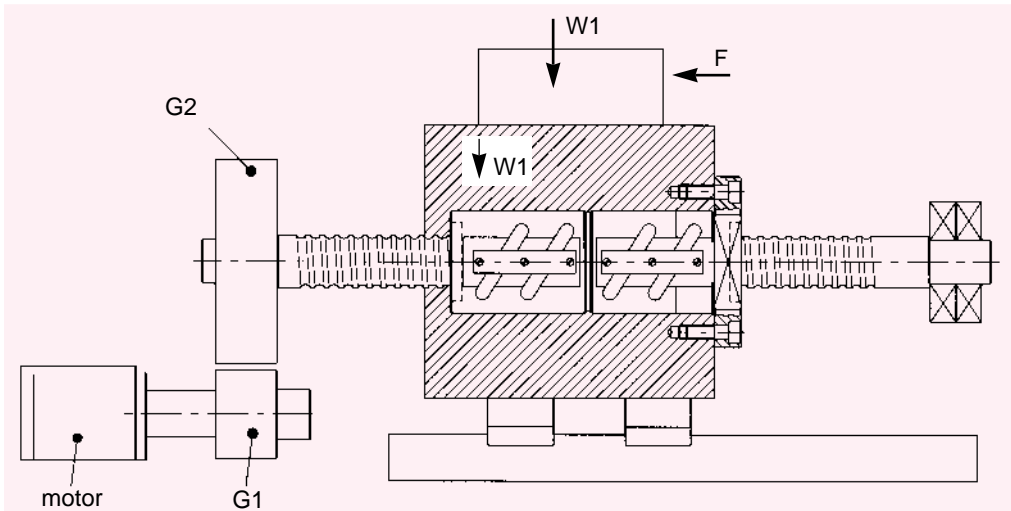


Fig 4.24 Milling process in the machine

### Calculation

(1) Motor drive torque in normal rating condition :

$$n_{av} = 500 \times \frac{20}{100} + 100 \times \frac{50}{100} + 50 \times \frac{30}{100} = 165 \text{ rpm} \quad (\text{Ref. M7})$$

$$F_1 = 100, F_2 = 300, F_3 = 500$$

$$F_{bm} = \sqrt[3]{100^3 \times 1 \times \frac{20}{100} \times \frac{500}{165} + 300^3 \times 1 \times \frac{50}{100} \times \frac{100}{165} + 500^3 \times 1 \times \frac{30}{100} \times \frac{50}{165}} = 272 \text{ kgf} \quad (\text{Ref. M9})$$

$$P = \frac{300}{2.8} \cong 110 \text{ kgf} \quad (\text{axial feed force} = 300 \text{ kgf}, \text{Ref. M1})$$

$$F_b = F_{bm} + \mu W = 272 + (200 + 100) \times 0.02 = 278 \text{ kgf}$$

$$T_a = \frac{F_b \times \ell}{2\pi\eta_i} = \frac{278 \times 10}{2\pi \times 0.80} = 553 \text{ kgf}\cdot\text{mm} \quad (\text{Ref. M19})$$

$$T_d = 0.2 \times \frac{P \times \ell}{2\pi} = \frac{0.2 \times 110 \times 10}{2\pi} = 35 \text{ kgf}\cdot\text{mm} \quad (\text{Ref. M2})$$

$$T_M = (T_a + T_b + T_d) \times \frac{N_1}{N_2} = (553 + 35 + 10) \times \frac{30}{90} = 199 \text{ kgf}\cdot\text{mm} \quad (\text{Ref. M21})$$

(2) Motor torque in acceleration operation :

(I) Inertia of motor

$$J_M = \frac{1}{2 \times 9800} \times \pi \times 7.8 \times 10^{-6} \times (25)^4 \times 200 = 0.1 \text{ kgf}\cdot\text{mm} \cdot \text{sec}^2$$

(II) Inertia of gear

$$J_{Gear(eq)} = J_{G1} + J_{G2} \times \left(\frac{N_1}{N_2}\right)^2$$

$$J_{G1} = \frac{1}{2 \times 9800} \times \pi \times 7.8 \times 10^{-6} \times \left(\frac{80}{2}\right)^4 \times 20 = 0.064 \text{ kgf} \cdot \text{mm} \cdot \text{sec}^2$$

$$J_{G2} = \frac{1}{2 \times 9800} \times \pi \times 7.8 \times 10^{-6} \times \left(\frac{240}{2}\right)^4 \times 20 = 5.18 \text{ kgf} \cdot \text{mm} \cdot \text{sec}^2$$

$$J_{Gear(eq)} = 0.064 + 5.18 \times \left(\frac{30}{90}\right)^2 = 0.640 \text{ kgf} \cdot \text{mm} \cdot \text{sec}^2$$

(III) Inertia of ballscrew

$$J_{ballscrew} = \frac{1}{2 \times 9800} \times 18 \times \left(\frac{50}{2}\right)^2 \left(\frac{30}{90}\right)^2 = 0.064 \text{ kgf} \cdot \text{mm} \cdot \text{sec}^2$$

(IV) Inertia of load

$$J_{load} = \frac{300}{9800} \times \left(\frac{10}{2 \times \pi}\right)^2 \times \left(\frac{30}{90}\right)^2 = 0.009 \text{ kgf} \cdot \text{mm} \cdot \text{sec}^2$$

(V) Total inertia

$$J = 0.1 + 0.64 + 0.064 + 0.009 = 0.813 \text{ kgf} \cdot \text{mm} \cdot \text{sec}^2$$

(3) Total motor torque:

$$T'a = J \cdot \alpha = 0.813 \times 100 = 81.3 \text{ kgf} \cdot \text{mm}$$

$$T_{Ma} = T_M + T'a = 199 + 81.3 = 280 \text{ kgf} \cdot \text{mm}$$

(4) Drive power:

$$T_{pmax} = 2 \times 280 = 560 \text{ kgf} \cdot \text{mm} \quad (\text{safety factor} = 2)$$

$$P_d = \frac{560 \times 1500}{974} = 862 \text{ W} = 1.16 \text{ Hp}$$

(5) Selection motor:

Select the DC motor rated torque :  $T_{Mr} > 1.5T_M$ ,

and maximum motor torque :  $T_{Max} > 1.5T_{pmax}$

Thus the DC servo motor with following specification can be chosen.

Rated output : 950 w

Rated torque : 30 kgf-cm (300 kgf • mm)

Rated rotational speed : 2000 rpm

Maximum torque : 65 kgf x cm (650 kgf • mm)

Moment of inertia of motor : 0.20 kgf • mm • sec<sup>2</sup>

(6) Check the acceleration time:

$$T_L = \left( \frac{F_d \times \ell}{2\pi\eta_1} + T_b + T_d \right) \times \frac{N_1}{N_2} = \left( \frac{100 \times 10}{2\pi \times 0.8} + 10 + 35 \right) \times \frac{30}{90} = 81.3 \text{ kgf} \cdot \text{mm}$$

$$t_a \geq \left( \frac{0.879}{300 \times 2 - 81.3} \right) \times \frac{2\pi \times 2000}{60} \times 1.5 = 0.53 \text{ sec}$$

### Buckling load

$$F_k = 40720 \left( \frac{N_f d_r^4}{L_t^2} \right) \quad \text{----- M29}$$

$$F_p = 0.5 F_k \quad \text{----- M30}$$

$F_k$ = Permissible load (kgf)	fixed - fixed	$N_f = 1.0$
$F_p$ = Maximum permissible load (kgf)	fixed - supported	$N_f = 0.5$
$d_r$ : Root diameter of screw shaft (mm)	supported - supported	$N_f = 0.25$
$L_t$ : distance between support bearing (mm)	Fixed - free	$N_f = 0.0625$
$N_f$ : Factor for different mounting types	* 1kgf = 9.8N; 1daN=10N	

The buckling load diagram for different spindle diameter and support method is shown in Fig 4.25.

### Critical speed

$$N_c = 2.71 \times 10^8 \times \frac{M_f d_r}{L_t^2} \quad \text{----- M31}$$

$$N_p = 0.8 N_c \quad \text{----- M32}$$

$N_c$ = critical speed (rpm)	fixed - fixed	$M_f = 1$
$N_p$ = Maximum permissible load (rpm)	fixed - supported	$M_f = 0.692$
$d_r$ : Root diameter of screw shaft (mm)	supported - supported	$M_f = 0.446$
$L_t$ : distance between support bearing (mm)	Fixed - free	$M_f = 0.147$
$M_f$ : Factor for different mounting types		

The critical speed for different spindle and support method is shown in (Fig 4.26).

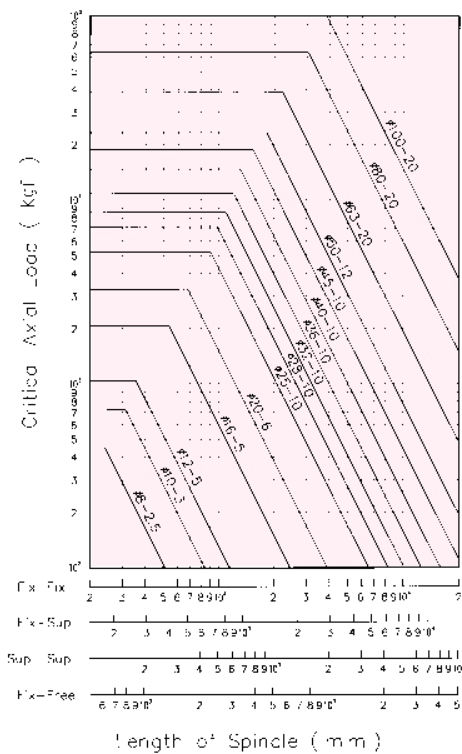


Fig 4.25 Shows the buckling load for different screw spindle diameter and length

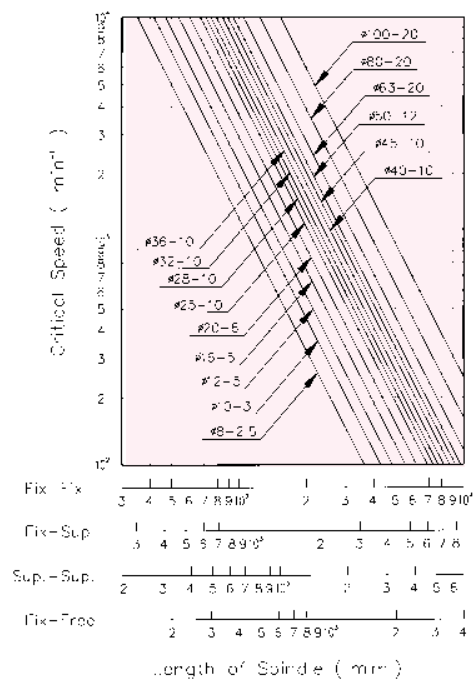


Fig 4.26 shows the critical speed for different screw spindle diameter and length

**$D_m$ -N value for ballscrew surface speed**

$D_m$ -N value has a strong influence over ballscrew noise, working temperature and service life of return system.

For HIWIN ballscrew,

$$D_m \times N \leq 70,000 \quad \dots\dots\dots \text{M33}$$

$D_m$  : Pitch circle diameter (mm)

$N$  : Maximum speed (rpm)

Ballscrew structure enhancement designed by HIWIN when  $D_m$ -N value ranges from 70,000 to 150,000 . If  $D_m$ -N value above 150,000 , please consult our company.

**Stiffness**

Stiffness is an indication of the rigidity of a machine. The stiffness of the ballscrew is determined by nut-spindle rigidity via axial load, balltrack contact rigidity and screw spindle rigidity. When assembling the ballscrew in the machine, the stiffness of support bearing, mounting condition of nut with machine table etc. also should be considered. Fig 4.27 shows the relation of total stiffness of the machine feed system.

From testing, the stiffness of nut-spindle relation and ball and balltrack relation can be combined into the stiffness of nut,  $K_n$ , and listed in dimension table of different nut type. The stiffness of the ballscrew is shown as :

$$\frac{1}{K_{bs}} = \frac{1}{K_s} + \frac{1}{K_n} \quad \dots\dots\dots \text{M34}$$

$K_{bs}$  : Total stiffness of ballscrew (kgf/ $\mu$ m)

The stiffness of the screw spindle is shown as :

$$K_s = 67.4 \frac{d_r^2}{L_1} \quad \dots\dots\dots \text{M35}$$

$$K_s = 16.8 \frac{d_r^2}{L_1} \quad \dots\dots\dots \text{M36}$$

The stiffness chart is shown in Fig 4.28

$$d_r : \text{root diameter of screw spindle (mm)} = D_m - D_b \quad \dots\dots\dots \text{M37}$$

$D_b$  : Diameter of ball (mm)

$K_s$  : Screw spindle stiffness (kgf/ $\mu$ m)

$K_n$  : Nut stiffness (kgf/ $\mu$ m)

The stiffness of the nut is tested using an axial force equal to the highest possible preload of 10% dynamic load (C) and is shown in the dimension table of each nut. When the preload is less than this value, the stiffness of the nut is calculated by extrapolation method as :

$$K_n = 0.8 \times K \left( \frac{P}{0.1C} \right)^{1/3} \quad \dots\dots\dots \text{M38}$$

$K_n$  : Stiffness of nut

$K$  : Stiffness in the dimension table

$P$  : Preload

$C$  : dynamic load on dimension table ( $10^6$  rev)

Since the offset pitch type preloading method is single nut instead of double nut, it has a good stiffness with a small preload force. The preload of the offset type nut is calculated by 10% of the dynamic load by formula :

$$K_n = 0.8 \times K \left( \frac{P}{0.1C} \right)^{1/3} \quad \dots\dots\dots \text{M39}$$

Single nut with backlash is calculated when the external axial force is equal to 0.28 C, thus :

$$K_n = 0.8 \times K \left( \frac{F_b}{2.8 \times 0.1C} \right)^{1/3} \dots\dots\dots M40$$

The axial stiffness of the whole feed system includes the stiffness of support bearings and nut mounting table. The designer should consider the total stiffness carefully.

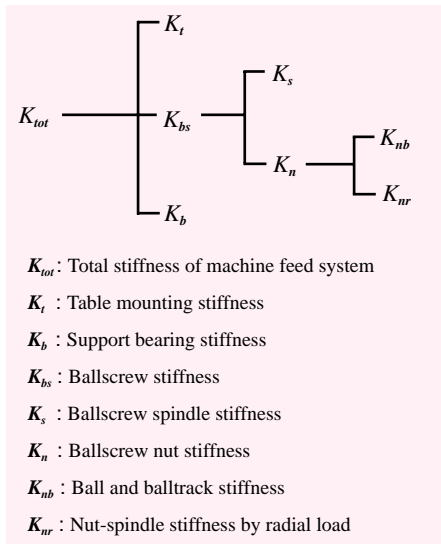


Fig 4.27 Stiffness distribution for ballscrew feed system

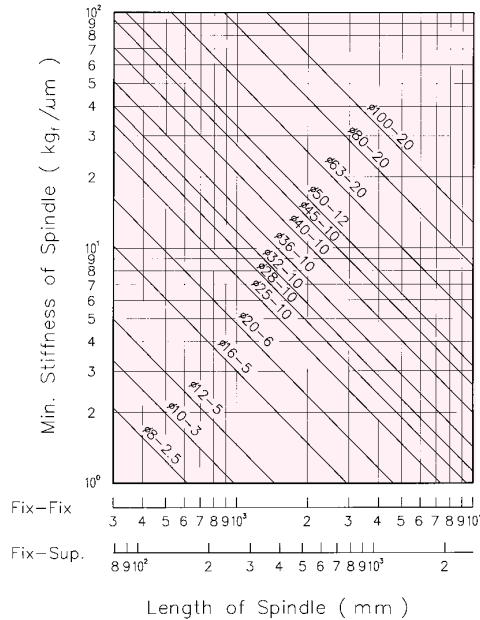


Fig 4.28 Stiffness chart for ballscrew spindle

**Thermal expansion**

$$\Delta L = 11.6 \times 10^{-6} \times \Delta T \times L_s \dots\dots\dots M41$$

$\Delta L$  : Thermal expansion of screw spindle (mm)

$\Delta T$  : (°C) Temperature rise at screw spindle

$L_s$  : Total length of screw spindle (mm)

The T value should be chosen to compensate for the temperature rise of the ballscrew. HIWIN recommends a T value of -0.02 ~ -0.03 per meter for CNC machine tools.

**Basic dynamic axial load rating C (theoretical)**

The dynamic load is the load at which 90% of the ballscrews will achieve the service life of 1 x 10<sup>6</sup> rev (C). The reliability factor can be adjusted by Table 4.9. The dynamic load is shown on the dimension table of each nut type.

**Basic static axial load rating Co (theoretical)**

The static load is the load which will cause the balltrack to have a plastic deformation exceeding 0.0001x ball diameter. To calculate the maximum static load of a ballscrew, the static safety factor S<sub>f</sub> of the application condition should be considered.

$$S_f \times F_a(\max) < Co \dots\dots\dots M42$$

S<sub>f</sub> : Static factor = 2.5 max

Co : Static load from the dimension table of the nut type

F<sub>a</sub>(max) : Maximum static axial load

◆ **Example 4.5 - 5**

Ball screw specification: 1R40-10B2-FSW-1000-1200-0.012	Lead $\ell = 10$ mm
Pitch circle diameter $D_m = 41.4$ mm	Turns = 2.5x2
Ball diameter : 6.35 mm	Lead angle $\alpha = 4.4^\circ$
Root diameter $d_r = 34.91$ mm	Friction angle $\beta = 0.286^\circ$
Column load : fixed - supported	Preload $P = 250$ kgf
Critical speed : fixed - supported	Mean axial force $F_b = 700$ kgf
Stiffness of bearing $K_b = 105$ kgf/ $\mu$ m	$N_f = 0.5$ ; $L_t = 1000$ mm ; $M_f = 0.692$

Calculation

1. Buckling load  $F_p$

$$F_k = 40720 \times \frac{N_f d_r^4}{L_t^2} = 40720 \times \frac{0.5 \times 34.91^4}{1000^2} = 30240 \text{ kgf (Ref. M2)}$$

$$F_p = 0.5 \times F_k = 0.5 \times 30240 = 15120 \text{ kgf}$$

2. Critical speed  $N_p$

$$N_c = 2.71 \times 10^8 \times \frac{0.692 \times 34.90}{1000^2} = 6545 \text{ rpm}$$

$$N_p = 0.8 \times N_c = 0.8 \times 6545 = 5236 \text{ rpm}$$

3. Mechanical efficiency  $\eta$  (theoretical)

(I) Common transmission

$$\eta_1 = \frac{\tan \alpha}{\tan(\alpha + \beta)} = \frac{\tan(4.396^\circ)}{\tan(4.396^\circ + 0.286^\circ)} = 0.938 \text{ (Ref. M3)}$$

(II) Reverse transmission

$$\eta_2 = \frac{\tan(\alpha - \beta)}{\tan \alpha} = \frac{\tan(4.396^\circ - 0.286^\circ)}{\tan(4.396^\circ)} = 0.934 \text{ (Ref. M4)}$$

4. Stiffness  $K$

$$K_s = 16.8 \frac{d_r^2}{L_1} = 16.8 \times \frac{34.91^2}{1000} = 20.5 \text{ kgf}/\mu\text{m} \quad p = 250 < 0.1C (= 537)$$

$$\therefore K_n = 0.8 \times K \left( \frac{P}{0.1C} \right)^{1/3} = 0.8 \times 74 \times \left( \frac{250}{0.1 \times 5370} \right)^{1/3} = 46 \text{ kgf}/\mu\text{m}$$

$$\frac{1}{K} = \frac{1}{K_s} + \frac{1}{K_n} = \frac{1}{20.5} + \frac{1}{46} \quad K = 14.18 \text{ kgf}/\mu\text{m}$$

5. Lost motion during axial force  $F_b=700$ kgf

$$\frac{1}{K_t} = \frac{1}{K} + \frac{1}{K_b} = \frac{1}{14} + \frac{1}{105} \quad K_t = 12.35 \text{ kgf}/\mu\text{m}$$

$$\delta / 2 = \frac{F}{K} = \frac{700}{12.4} = 56 \mu\text{m} = 0.056 \text{ mm} \quad (\text{each way}) \quad \text{Total lost motion } \delta = 2 \times 0.056 = 0.112 \text{ mm}$$

If the preload increases to  $2 \times 250 = 500$  kgf then  $K_n = 58$  kgf/ $\mu$ m and  $K = 15.1$  kgf/ $\mu$ m. Total stiffness  $K_t = 13.2$  kgf/ $\mu$ m and total lost motion  $d = 0.106$  mm. The difference is only 6  $\mu$ m (5% change). comparing with 250 kgf, preloaded nut, but the temperature rise caused by 500 kgf preload is heavy. The spindle stiffness is sometimes more important than the nut stiffness. The best way to increase the stiffness of the system is not in the heavy preloading of the ballscrew nut. If the support method changes to fixed-fixed, then  $K_s = 82$  kgf/ $\mu$ m and  $K_t$  becomes 23 kgf/ $\mu$ m. The total lost motion  $\delta = 0.061$  mm. The difference is 51  $\mu$ m (45%).

### Material specification

Table 4.11 shows the general material used for HIWIN ballscrew. HIWIN also makes ballscrew from stainless steel. Please contact us if you have special requirements.

### Manufacturing range

The maximum length to which a ballscrew can be manufactured depends on spindle diameter and accuracy grade (Table 4.12). Since high accuracy ballscrews require a high degree of straightness to the screw spindle, the higher the slender ratio (length/diameter), the more difficult to manufacture and the less the spindle stiffness.

HIWIN recommends the maximum lengths shown in Table 4.12.

If a longer length is required, please contact with HIWIN engineer.

Table 4.11 Material Specifications

Item	Steel specification			
	BSI	DIN	AISI	JIS
Spindle	EN43C	1.1213	1055	S55C
	EN19C	1.7225	4140	SCM440H
		1.7228	4150	SCM445H
Nut	EN34	1.6523	3310	SNM 220(21)
	EN36		8620	SCM420H SCM415H
	Ball	EN31	1.3505	52100

Table 4.12 General manufacturing range of HIWIN screw spindle vs. diameter and accuracy grade

Unit: mm

Total length Grade	O.D.																	
	6	8	10	12	16	20	25	28	32	36	40	45	50	55	63	70	80	100
C0	110	170	300	400	600	700	1000	1000	1200	1300	1500	1600	1800	2000	2000	2000	2000	2000
C1	110	170	400	500	720	950	1300	1500	1800	1800	2300	2500	3100	3500	4000	4000	4000	4000
C2	140	200	500	630	900	1300	1700	1800	2200	2200	2900	3200	4000	5000	5200	5500	6300	6300
C3	170	250	500	630	1000	1400	1800	2000	250	3200	3500	4000	4500	5000	6000	7100	10000	10000
C4	170	250	500	630	1000	1400	1800	2000	2500	3200	3500	4000	4500	5000	6000	7100	10000	10000
C5	170	250	500	630	1410	1700	2400	2500	3000	3200	3800	4000	5000	5500	6900	7100	10000	10000
C6	400	800	1000	1200	1500	1800	2500	3000	3000	4000	4000	4000	5600	5600	6900	7100	10000	10000
C7	400	800	1000	1200	3000	3000	4000	4000	4500	4500	5600	5600	5600	5600	6900	7100	10000	10000

■ Please consult with HIWIN in this area

### Heat treatment

HIWIN's homogenous heat treatment technique gives the ballscrew maximum life capability. Table 4.13 shows the hardness value of hardness in each component of HIWIN ballscrews. The surface hardness of the ballscrew affects both dynamic and static load value. The dynamic and static values shown in the dimension table are the values for a surface hardness equal to HRC 60. If the surface hardness is lower than this value, the following formula will give you the calibration result.



$$C'o = C_o \times f_{HO} \quad f_{HO} = \left( \frac{\text{Real Hardness(HRC)}}{60} \right)^3 \leq 1 \quad \dots\dots\dots \text{M43}$$

$$C' = C \times f_H \quad f_H = \left( \frac{\text{Real Hardness(HRC)}}{60} \right)^2 \leq 1 \quad \dots\dots\dots \text{M44}$$

Where  $f_H$  and  $f_{HO}$  are the hardness factor.

$C'o$ : Calibrated static load

$C_o$  : Static load

$C'$  : Calibrated dynamic load

$C$  : Dynamic load

Table 4.13 Hardness of each component of HIWIN ballscrew

Item	Treat Method	Hardness (HRC)
Spindle	Induction Hardening	58-62
Nut	Carburizing or Induction Hardening	58-62
Ball		62-66

## 4.6 Temperature Rise Effect on Ballscrews

The temperature rise of ballscrew during the working period will influence the accuracy of the machine feed system, especially in a machine designed for high speed and high accuracy.

The following factors have the effect of raising the temperature in a ballscrew.

- (1) Preload
- (2) Lubrication
- (3) Pretension

Fig 4.29 shows the relation of working speed, preload and temperature rise. Fig 4.30 shows the relation of nut temperature rise to preload friction torque. From Fig 4.29, Fig 4.30 and example 4.5-5, doubling the preload of the nut will increase the temperature about 5 degrees, but the stiffness increase only by about 5% (few  $\mu\text{m}$ ).

### (1) Preload effect

To avoid any lost motion in the machine feed system, increasing the rigidity of the ballscrew nut is important. However, to increase the rigidity of the ballscrew nut, it is necessary to preload the nut to a certain level.

Preloading the nut will increase the friction torque of the screw, making it more sensitive to an increase in temperature during working period.

HIWIN recommends using a preload of 8% of the dynamic load for medium and heavy preload, 6% ~ 8% for medium preload, 4% ~ 6% for light and medium and below 4% for light preload.

The heaviest preload should not exceed 10% of the dynamic load for best service life and a low temperature rise effect.

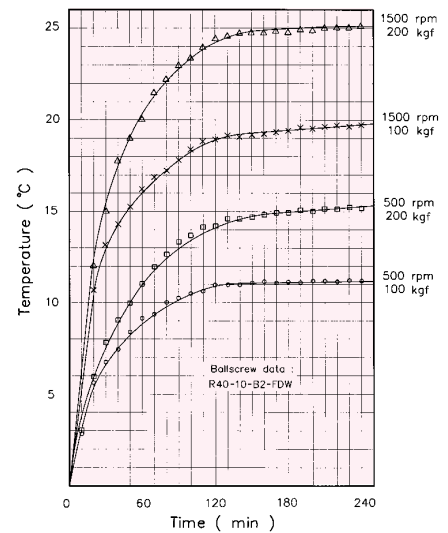


Fig 4.29 The relation of working speed, preload and temperature rise

## (2) Lubrication effect

The selection of lubricant will directly influence the temperature rise of the ballscrew.

HIWIN ballscrews require appropriate lubrication either by greasing or oiling. Antifriction bearing oil is recommended for ballscrew oil lubrication. Lithium soap based grease is recommended for ballscrew greasing. The basic oil viscosity requirement depends on the speed, working temperature and load condition of the application. (Fig 4.31) shows the relation of oil viscosity, working speed and rise in temperature.

When the working speed is higher and the working load is lower, a low viscosity oil is better. When the working speed is lower and the working load is heavy, a high viscosity oil is preferred.

Generally speaking, oil with a viscosity of 32 ~ 68 cSt at 40 °C (ISO VG 32-68) is recommended for high speed lubrication (DIN 51519) and viscosity above 90 cSt at 40 °C (ISO VG 90) is recommended for low speed lubrication.

In high speed and heavy load applications the use of a forced coolant is necessary to lessen the temperature. The forced lubrication of coolant can be done by a hollow ballscrew.

Fig 4.32 shows the comparison of a ballscrew applied with coolant and without coolant. Fig 4.33 shows a typical application for hollow ballscrew in machine tools. The inspection and replenishing of the ballscrew lubricant is listed in Table 4.14.

## (3) Pretension effect

When the temperature rises in the ballscrew, the effect of thermal stress will elongate the screw spindle. It can make the spindle length unstable.

The elongating relationship can be calculated according to M41. This elongation can be compensated via the pretension force. For the purpose of pretension, there is a negative T value indicated in the design drawing to compensate the pretension value.

Since a large pretension force will cause the burn down of the supporting bearing, HIWIN recommends using pretension when the temperature rise is below 5 °C. Also, if the diameter of the screw spindle is greater than 50 mm, it is not suitable for pretension. A large spindle diameter requires a high pretension force, causing burn down of the supporting bearing.

HIWIN recommends a T compensation value of about 3°, (about -0.02~0.03 for each 1000 mm screw spindle).

Since different applications require different T values, please contact HIWIN engineer.

The pretension force is calculated as :

$$P_f = K_s \times \Delta L \quad \dots\dots\dots M45$$

$K_s$  : Stiffness of screw spindle (kgf/μm)

$P_f$  : Pretension force (kgf)

$\Delta L$  : Pretension value (μm)

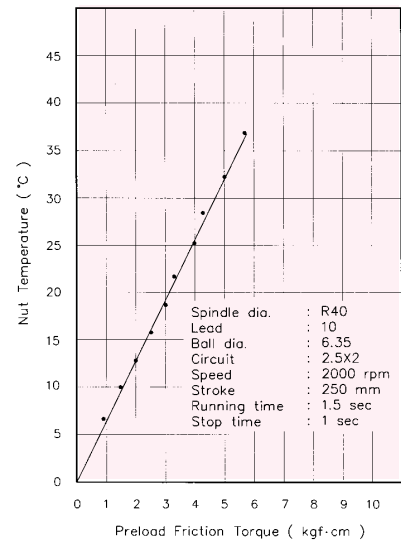


Fig 4.30 The relation of nut temperature rise to preload friction torque

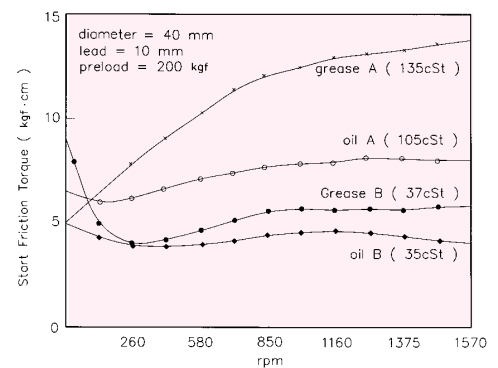


Fig 4.31 The influence of oil viscosity on the friction torque

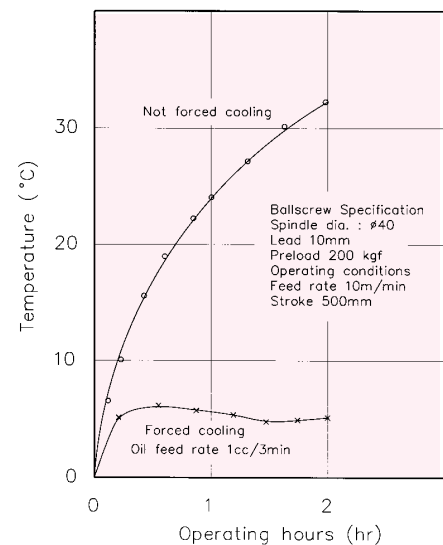


Fig 4.32 Ballscrew temperature rise with the coolant and without the coolant

Table 4.14 : Inspection and replenishment of Lubricant

Lubrication Method	Inspection & Replenishment Guide
Oil	<ul style="list-style-type: none"> <li>• Check the oil level and clean the contamination once a week.</li> <li>• When contamination happens, replacing the oil is recommended.</li> </ul>
Grease	<ul style="list-style-type: none"> <li>• Inspect for contamination of chips every 2 or 3 months.</li> <li>• If contamination happens, remove old grease and replace with new grease.</li> <li>• Replace grease once a year.</li> </ul>

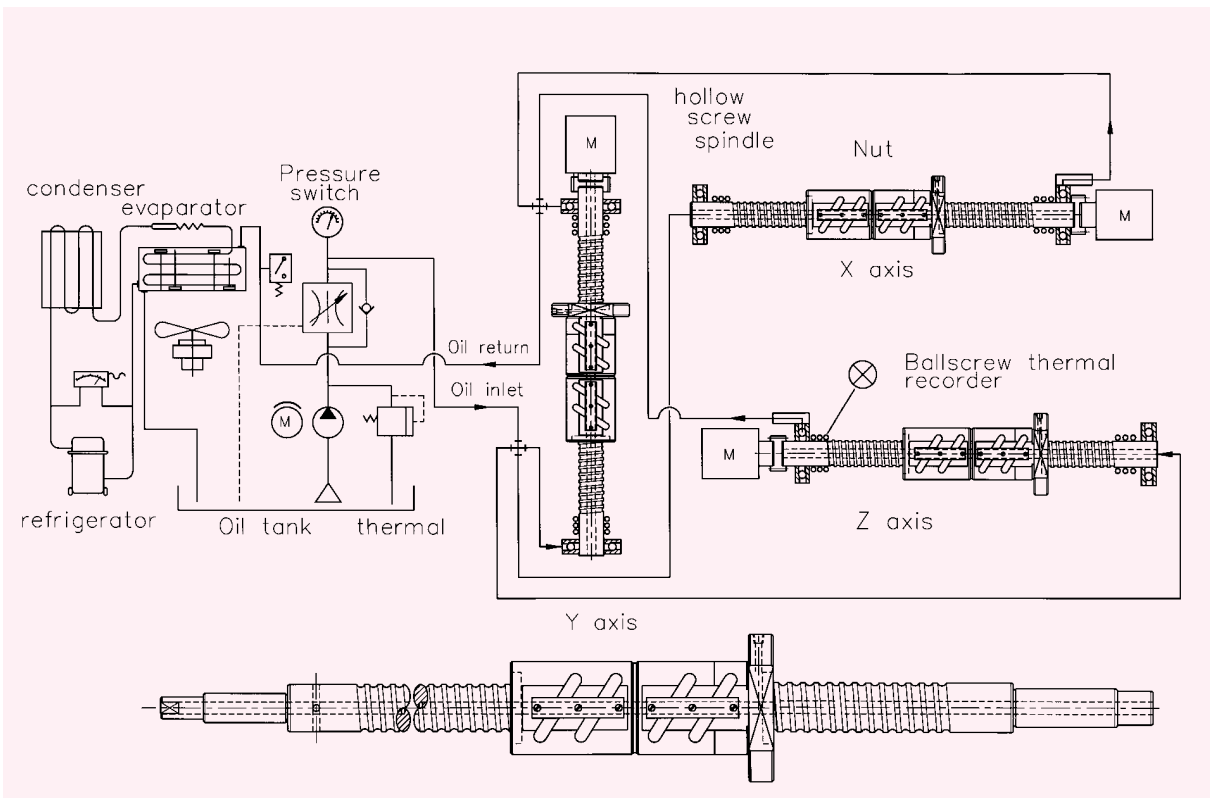


Fig 4.33 High accuracy machine tools with hollow ballscrew lubrication

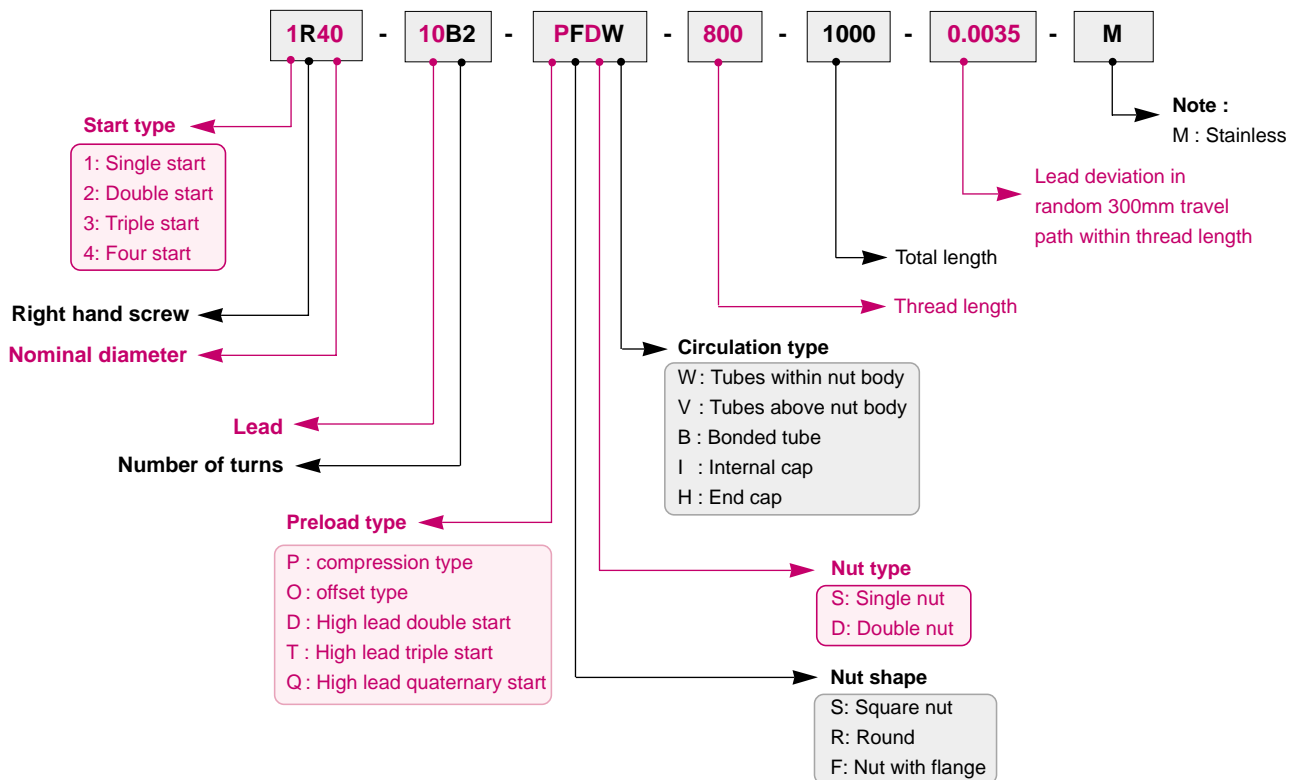
## 5. Specification Illustration

HIWIN manufactures ballscrews according to customer blueprint or specifications. Please read the following information for understanding in ballscrew designing.

1. Nominal diameter.
2. Thread lead.
3. Thread length, total length.
4. End journal configuration.
5. Nut configuration
6. Accuracy grade (lead deviation, geometrical tolerance).
7. Working speed.
8. Maximum static load, working load, preload drag torque.
9. Nut safety requirements.
10. Lubrication hole position.

### HIWIN Ballscrew Nomenclature

HIWIN ballscrews can be specified as follows:



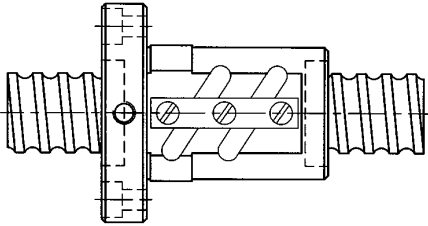
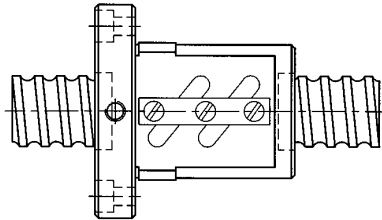
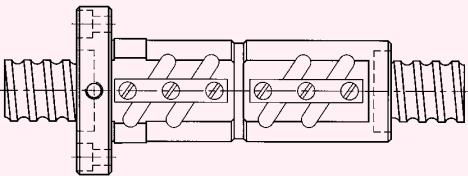
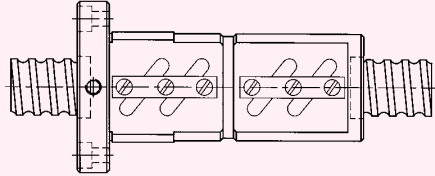
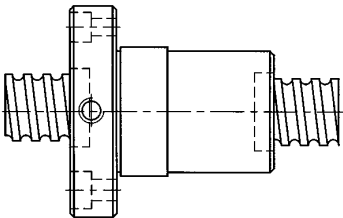
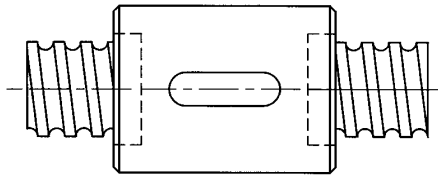
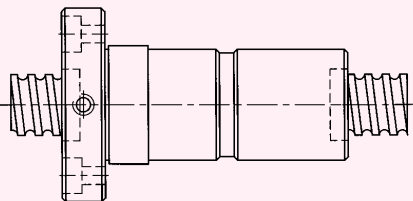
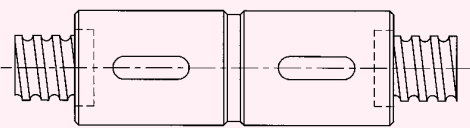
### Number of turns

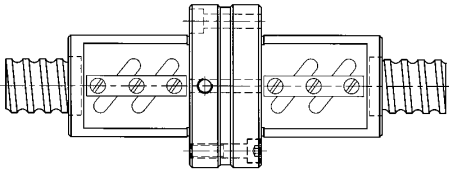
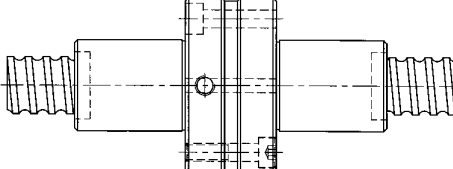
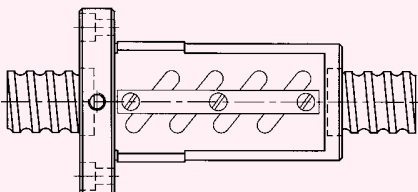
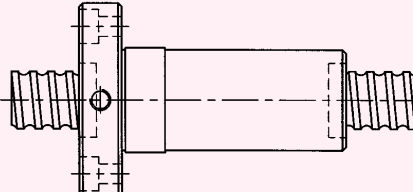
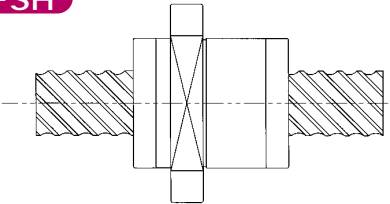
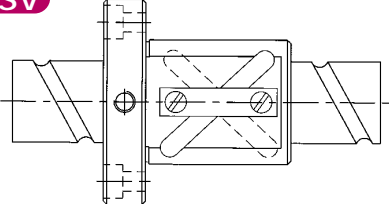
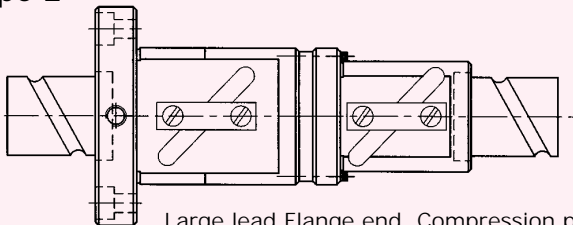
A: 1.5, B: 2.5, C: 3.5	T3: 3 turns,	S1: 1.8x1	U1 : 2.8x1
A2 : 1.5x2	T4: 4 turns,	S2: 1.8x2	U2 : 2.8x2
B2 : 2.5x2	T5: 5 turns,	S4: 1.8x4	V1 : 0.7x2
C1 : 3.5x1	T6: 6 turns,		

- Note :
1. Different diameters and leads are available upon request.
  2. Right hand thread is standard, left hand thread is available upon request.
  3. Longer lengths are available upon request.
  4. Stainless steel is available upon request.
  5. Complete questionnaire on page 121~122 and consult with HIWIN engineers.
  6. If you need to order DIN 69051 type, please mark "DIN".

## 6. Precision Ground Ballscrews

### 6.1 Ground Ballscrew Series

page	General	Type	page
40 ∩ 42	<p>★ <b>FSV</b></p>  <p>Flange end, Single nut, Tube above the nut diameter</p>	<p>★ <b>FSW</b></p>  <p>Flange end, Single nut, Tube within the nut diameter</p>	43 ∩ 45
46 ∩ 48	<p>★ <b>FDV</b></p>  <p>Flange end, Double nut, Tube above the nut diameter</p>	<p>★ <b>FDW</b></p>  <p>Flange end, Double nut, Tube within the nut diameter</p>	49 ∩ 51
52 ∩ 53	<p>★ <b>FSI</b></p>  <p>Flange end, Single nut, Internal Recirculation Cap</p>	<p><b>RSI</b></p>  <p>Round, Single nut, Internal Recirculation Cap</p>	54 ∩ 55
56 ∩ 57	<p>★ <b>FDI</b></p>  <p>Flange end, Double nut, Internal Recirculation Cap</p>	<p><b>RDI</b></p>  <p>Round, Double nut, Internal Recirculation Cap</p>	58 ∩ 59

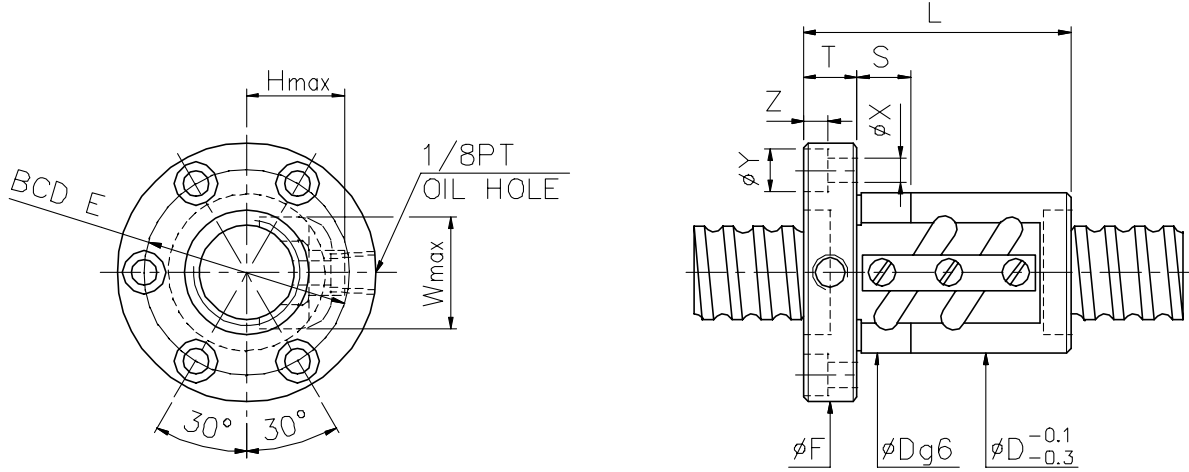
page	General Type		page
60 ? 61	<p>★ <b>PFDW</b> -Type 1</p>  <p>Flange to flange, Double nut, Tube within the nut diameter</p>	<p><b>PFDI</b></p>  <p>Flange to flange, Double nut, Internal Recirculation Cap</p>	63 ? 64
65 ? 66	<p>★ <b>OFSW</b></p>  <p>Offset pitch preload, Flange end, Single nut, Tube within the nut diameter</p>	<p>★ <b>OFSI</b></p>  <p>Offset pitch preload, Flange end, Single nut, Internal Recirculation Cap</p>	67
page	High Lead Type		page
68	<p>★ <b>FSH</b></p>  <p>Large lead, Flange mounted, Single nut, End cap</p>	<p>★ <b>DFSV</b></p>  <p>Double start, Flange end, Single nut, Tube above the nut diameter</p>	69
62	<p>★ <b>PFDW</b> -Type 2</p>  <p>Large lead, Flange end, Compression preload, Double nut, Tube within nut diameter</p>		62

\*Different design required by the drawing approval, please contact with HIWIN engineers for the other type listed above.

\*Double asterisks(★★): Self-Lubricating Ballscrew E1 design is available, except the shaft diameter under 16mm or ball diameter under 2.381mm.

6.2 Dimension for Precision Ground Ballscrew

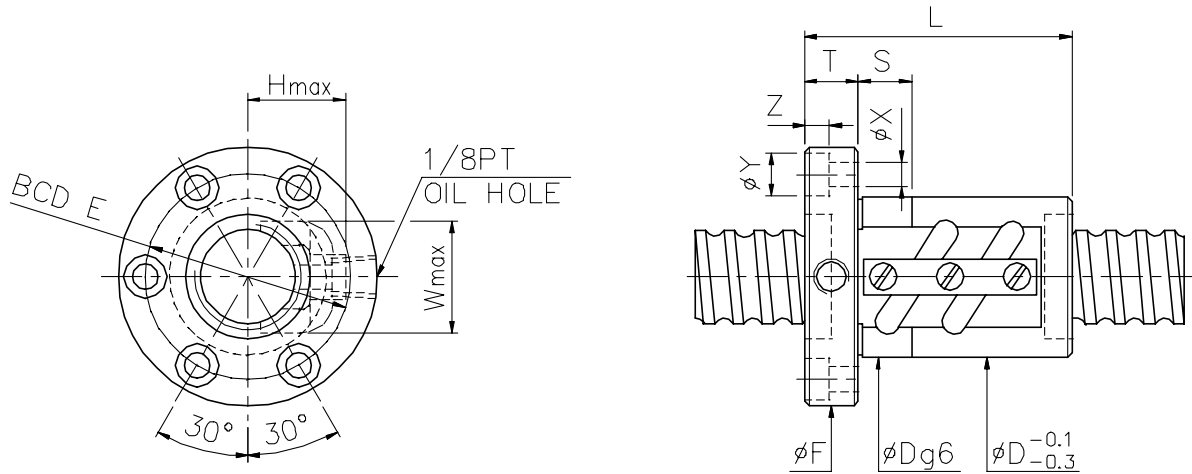
**F S V** Type



Model	Size		Ball Dia.	Circuits	Stiffness kgf/μm K	Dynamic Load 1x10 <sup>6</sup> revs C (kgf)	Static Load Co (kgf)	Nut		Flange			Return Tube		Bolt			Fit
	Nominal Dia.	Lead						D	L	F	T	BCD-E	W	H	X	Y	Z	
16-5B1	16	5	3.175	2.5x1	16	763	1400	31	45	54	12	41	24	22	5.5	9.5	5.5	12
16-5B2		5	3.175	2.5x2	33	1385	2799	31	60	54	12	41	24	22	5.5	9.5	5.5	12
16-5C1		5	3.175	3.5x1	22	1013	1946	31	50	54	12	41	24	22	5.5	9.5	5.5	12
20-5B1	20	5	3.175	2.5x1	19	837	1733	35	45	58	12	46	27	25	5.5	9.5	5.5	12
20-5B2		5	3.175	2.5x2	39	1519	3465	35	60	58	12	46	27	25	5.5	9.5	5.5	12
20-6B1		6	3.969	2.5x1	20	1139	2187	36	48	60	12	47	28	27	5.5	9.5	5.5	12
20-6C1	20	6	3.969	3.5x1	28	1512	3041	36	66	60	12	47	28	27	5.5	9.5	5.5	12
20-20A1		20	3.969	1.5x1	13	719	1281	36	66	60	12	47	28	27	5.5	9.5	5.5	12
25-5B2		25	5	3.175	2.5x2	46	1704	4417	40	60	64	12	52	31	26	5.5	9.5	5.5
25-5C1	5		3.175	3.5x1	35	1252	3085	40	50	64	12	52	31	26	5.5	9.5	5.5	12
25-6B2	6		3.969	2.5x2	48	2308	5523	42	68	68	12	55	32	28	6.6	11	6.5	12
25-6C1	25	6	3.969	3.5x1	35	1690	3844	42	55	68	12	55	32	28	6.6	11	6.5	12
25-10B1		10	4.763	2.5x1	25	1592	3237	45	65	72	16	58	34	29	6.6	11	6.5	12
25-16B1		16	4.763	2.5x1	28	1592	3237	45	84	72	16	58	34	29	6.6	11	6.5	12
25-20B1	25	20	4.763	2.5x1	28	1592	3237	45	96	72	16	58	34	29	6.6	11	6.5	12
25-25A1		25	4.763	1.5x1	16	1019	1927	45	90	72	16	58	34	29	6.6	11	6.5	12
28-5B1		28	5	3.175	2.5x1	26	984	2466	44	45	70	12	56	34	28	6.6	11	6.5
28-5B2	5		3.175	2.5x2	50	1785	4932	44	60	70	12	56	34	28	6.6	11	6.5	12
28-6A2	6		3.175	1.5x2	29	1150	2960	44	55	70	12	56	34	28	6.6	11	6.5	12
32-5B2	32	5	3.175	2.5x2	55	1886	5666	50	60	76	12	63	38	30	6.6	11	6.5	12
32-5C1		5	3.175	3.5x1	39	1388	3967	50	50	76	12	63	38	30	6.6	11	6.5	12
32-6B2		6	3.969	2.5x2	56	2556	7020	52	68	78	12	65	39	32	6.6	11	6.5	12
32-6C1	32	6	3.969	3.5x1	39	1888	4936	52	55	78	12	65	39	32	6.6	11	6.5	12
32-8B2		8	4.763	2.5x2	59	3284	8453	54	86	88	16	70	40	33	9	14	8.5	15
32-8C1		8	4.763	3.5x1	41	2428	5948	54	70	88	16	70	40	33	9	14	8.5	15
32-10B2	32	10	6.350	2.5x2	60	4810	11199	57	98	91	16	73	44	37	9	14	8.5	15
32-10C1		10	6.350	3.5x1	44	3519	7785	57	78	91	16	73	44	37	9	14	8.5	15
32-20B1		20	4.763	2.5x1	33	1810	4227	54	100	88	16	70	40	33	9	14	8.5	15
32-25B1	32	25	4.763	2.5x1	33	1810	4227	54	118	88	16	70	40	33	9	14	8.5	15
32-32A1		32	4.763	1.5x1	18	1154	2505	54	110	88	16	70	40	33	9	14	8.5	15

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while axial load is 30% of dynamic load rating.

**FSV Type**

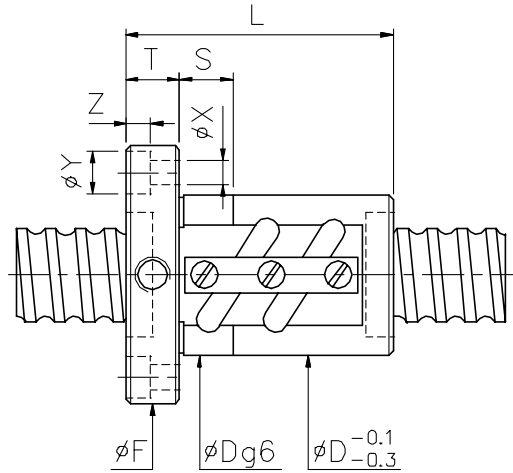
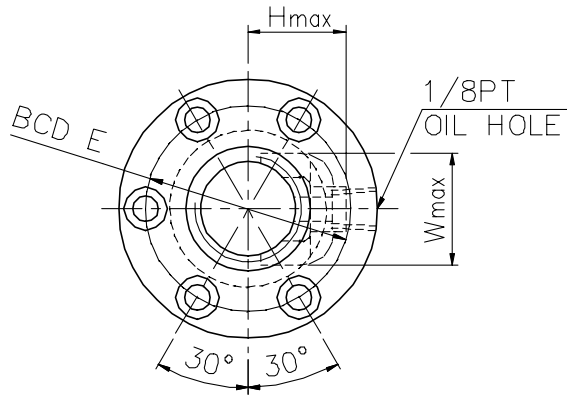


Model	Size		Ball Dia.	Circuits	Stiffness kgf/μm K	Dynamic Load 1x10 <sup>6</sup> revs C (kgf)	Static Load Co (kgf)	Nut		Flange			Return Tube		Bolt			Fit
	Nominal Dia.	Lead						D	L	F	T	BCD-E	W	H	X	Y	Z	
36-6B1	36	6	3.969	2.5x1	35	1486	3969	55	50	82	12	68	42	32	6.6	11	6.5	12
36-6B2		6	3.969	2.5x2	60	2696	7937	55	68	82	12	68	42	32	6.6	11	6.5	12
36-10B2		10	6.350	2.5x2	68	5105	12669	62	102	104	18	82	49	40	11	17.5	11	15
40-5B2	40	5	3.175	2.5x2	66	2071	7134	58	65	92	16	72	46	34	9	14	8.5	15
40-6B2		6	3.969	2.5x2	69	2817	8855	60	72	94	16	76	47	36	9	14	8.5	15
40-8B2		8	4.763	2.5x2	70	3634	10603	62	86	96	16	78	48	38	9	14	8.5	15
40-8C1		8	4.763	3.5x1	49	2679	7438	62	70	96	16	78	48	38	9	14	8.5	15
40-10B2		10	6.350	2.5x2	74	5370	14138	65	102	106	18	85	52	42	11	17.5	11	15
40-10C1		10	6.350	3.5x1	51	3932	9841	65	82	106	18	85	52	42	11	17.5	11	15
40-25B1		25	6.350	2.5x1	39	2959	7069	65	123	106	18	85	52	42	11	17.5	11	15
40-32B1	32	6.350	2.5x1	39	2959	7069	65	146	106	18	85	52	42	11	17.5	11	15	
40-40A1	40	6.350	1.5x1	24	1875	4159	65	133	106	18	85	52	42	11	17.5	11	15	
45-10B1	45	10	6.350	2.5x1	45	4170	11161	70	74	112	18	90	58	48	11	17.5	11	15
45-10B2		10	6.350	2.5x2	79	5655	15905	70	104	112	18	90	58	48	11	17.5	11	15
45-12B2		12	7.938	2.5x2	81	7627	19799	74	123	122	22	97	60	49	13	20	13	20
50-5A2	50	5	3.175	1.5x2	48	1447	5382	70	63	104	16	86	56	40	9	14	8.5	15
50-5A3		5	3.175	1.5x3	73	2051	8072	70	73	104	16	86	56	40	9	14	8.5	15
50-6B2		6	3.969	2.5x2	81	3093	11149	72	75	106	16	88	57	43	9	14	8.5	15
50-6B3		6	3.969	2.5x3	119	4384	16723	72	93	106	16	88	57	43	9	14	8.5	15
50-8B2		8	4.763	2.5x2	84	4004	13409	75	88	116	18	95	58	45	11	17.5	11	15
50-8B3		8	4.763	2.5x3	124	5674	20114	75	112	116	18	95	58	45	11	17.5	11	15
50-10B2		10	6.350	2.5x2	87	5923	17670	78	104	119	18	98	62	48	11	17.5	11	15
50-10B3		10	6.350	2.5x3	129	8394	26505	78	134	119	18	98	62	48	11	17.5	11	15
50-10C1		10	6.350	3.5x1	60	4393	12481	78	84	119	18	98	62	48	11	17.5	11	15
50-12B1		12	7.938	2.5x1	46	4420	11047	82	87	130	22	105	64	52	13	20	13	20
50-12B2		12	7.938	2.5x2	90	8022	22094	82	123	130	22	105	64	52	13	20	13	20
50-12C1	12	7.938	3.5x1	63	5875	15380	82	99	130	22	105	64	52	13	20	13	20	
50-40A1	40	7.938	1.5x1	27	2801	6499	82	135	130	22	105	64	52	13	20	13	20	
50-50A1	50	7.938	1.5x1	30	2801	6499	82	162	130	22	105	64	52	13	20	13	20	

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while axial load is 30% of dynamic load rating.



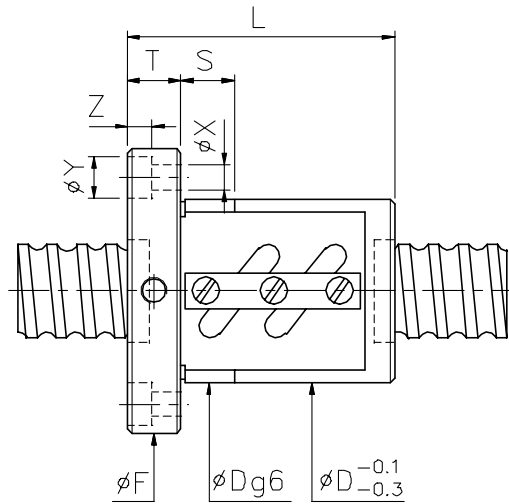
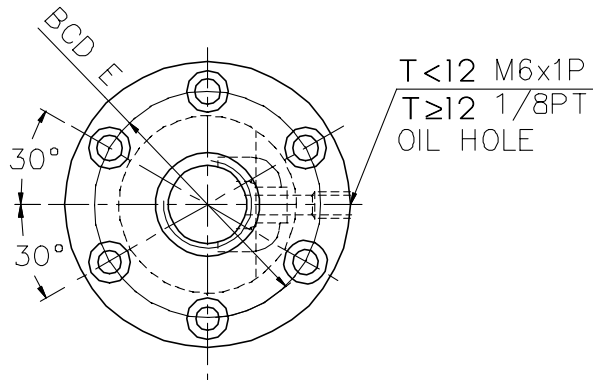
**F S V** Type



Model	Size		Ball Dia.	Circuits	Stiffness kgf/μm K	Dynamic Load 1x10 <sup>6</sup> revs C (kgf)	Static Load Co (kgf)	Nut		Flange			Return Tube		Bolt			Fit
	Nominal Dia.	Lead						D	L	F	T	BCD-E	W	H	X	Y	Z	
55-10C1	55	10	6.350	3.5x1	66	4562	13661	84	84	125	18	103	68	54	11	17.5	11	20
55-12B2		12	7.938	2.5x2	95	8392	24390	88	123	136	22	110	70	56	13	20	13	20
63-8A2	63	8	4.763	1.5x2	54	2826	10129	87	76	129	18	107	70	50	11	17.5	11	20
63-8A3		8	4.763	1.5x3	80	4004	15193	87	92	129	18	107	70	50	11	17.5	11	20
63-10B2	63	10	6.350	2.5x2	104	6533	22371	90	107	132	20	110	74	53	11	17.5	11	20
63-10B3		10	6.350	2.5x3	154	9258	33556	90	137	132	20	110	74	53	11	17.5	11	20
63-12B2	63	12	7.938	2.5x2	109	8943	28062	94	124	142	22	117	76	57	13	20	13	20
63-16B2		16	9.525	2.5x2	141	14862	46009	100	153	150	22	123	78	62	13	20	13	20
63-20B2	63	20	9.525	2.5x2	141	14862	46009	100	176	150	22	123	78	62	13	20	13	20
70-10B2		70	10	6.350	2.5x2	115	6843	25011	104	109	152	20	128	80	56	13	20	13
70-10B3	10		6.350	2.5x3	170	9688	37516	104	139	152	20	128	80	56	13	20	13	20
70-12B2	70	12	7.938	2.5x2	120	9382	31275	110	125	159	22	133	82	58	13	20	13	20
70-12B3		12	7.938	2.5x3	170	13296	46912	110	159	159	22	133	82	58	13	20	13	20
80-10B2	80	10	6.350	2.5x2	126	7202	28538	115	109	163	22	137	90	64	13	20	13	20
80-10B3		10	6.350	2.5x3	186	10207	42807	115	139	163	22	137	90	64	13	20	13	20
80-12B2	80	12	7.938	2.5x2	130	9797	35422	120	125	169	22	143	92	67	13	20	13	25
80-12B3		12	7.938	2.5x3	192	13884	53132	120	159	169	22	143	92	67	13	20	13	25
80-16B2	80	16	9.525	2.5x2	171	16485	58851	125	156	190	28	154	94	70	18	26	17.5	25
80-16B3		16	9.525	2.5x3	252	23363	88276	125	204	190	28	154	94	70	18	26	17.5	25
80-20B2	80	20	9.525	2.5x2	171	16485	58851	125	185	190	28	154	94	70	18	26	17.5	25
80-20B3		20	9.525	2.5x3	252	23363	88276	125	245	190	28	154	94	70	18	26	17.5	25
100-12B2	100	12	7.938	2.5x2	156	10761	44586	145	132	209	28	173	112	76	18	26	17.5	25
100-12B3		12	7.938	2.5x3	229	15251	66894	145	168	209	28	173	112	76	18	26	17.5	25
100-16B2	100	16	9.525	2.5x2	200	18123	74425	150	162	228	32	185	114	80	22	32	21.5	30
100-16B3		16	9.525	2.5x3	305	25684	111637	150	212	228	32	185	114	80	22	32	21.5	30
100-20B2	100	20	9.525	2.5x2	200	18123	74425	150	190	228	32	185	114	80	22	32	21.5	30
100-20B3		20	9.525	2.5x3	305	25684	111637	150	250	228	32	185	114	80	22	32	21.5	30

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while axial load is 30% of dynamic load rating.

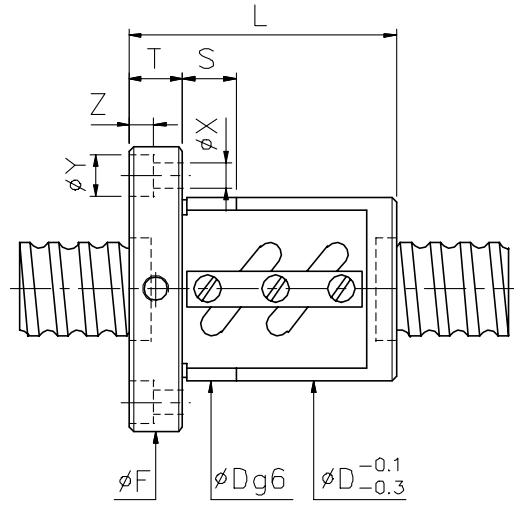
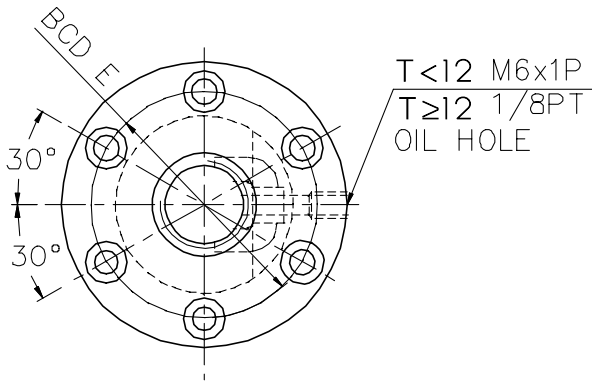
**F S W Type**



Model	Size		Ball Dia.	Circuits	Stiffness kgf / $\mu\text{m}$ K	Dynamic Load 1x10 <sup>6</sup> revs C (kgf)	Static Load Co (kgf)	Nut		Flange			Bolt			Fit	
	Nominal Dia.	Lead						D	L	F	T	BCD-E	X	Y	Z		S
12-4B1	12	4	2.381	2.5x1	8	383	638	30	38	50	10	40	4.5	8	4	12	
12-4C1		4	2.381	3.5x1	9	511	893	30	44	50	10	40	4.5	8	4	12	
12-5B1		5	2.381	2.5x1	8	383	638	30	40	50	10	40	4.5	8	4	12	
14-5B1	14	5	3.175	2.5x1	10	710	1216	37	40	57	11	45	5.5	9.5	5.5	12	
16-5B1		5	3.175	2.5x1	16	763	1400	40	45	64	12	51	5.5	9.5	5.5	12	
16-5B2	16	5	3.175	2.5x2	33	1385	2799	40	60	64	12	51	5.5	9.5	5.5	12	
16-5C1		5	3.175	3.5x1	22	1013	1946	40	50	64	12	51	5.5	9.5	5.5	12	
20-5B1	20	5	3.175	2.5x1	19	837	1733	44	45	68	12	55	5.5	9.5	5.5	12	
20-5B2		5	3.175	2.5x2	39	1519	3465	44	60	68	12	55	5.5	9.5	5.5	12	
20-6B1		6	3.969	2.5x1	20	1137	2187	48	48	72	12	59	5.5	9.5	5.5	12	
20-6C1	20	6	3.969	3.5x1	28	1512	3041	48	66	72	12	59	5.5	9.5	5.5	12	
25-5B2		5	3.175	2.5x2	46	1704	4417	50	60	74	12	62	5.5	9.5	5.5	12	
25-5C1	25	5	3.175	3.5x1	35	1252	3085	50	50	74	12	62	5.5	9.5	5.5	12	
25-6B2		6	3.969	2.5x2	48	2308	5523	56	68	82	12	69	6.6	11	6.5	12	
25-6C1		6	3.969	3.5x1	35	1690	3844	56	55	82	12	69	6.6	11	6.5	12	
25-10B1	25	10	4.763	2.5x1	25	1592	3237	60	65	86	16	73	6.6	11	6.5	12	
28-5B1		28	5	3.175	2.5x1	26	984	2466	55	45	85	12	69	6.6	11	6.5	12
28-5B2	5		3.175	2.5x2	50	1785	4932	55	60	85	12	69	6.6	11	6.5	12	
28-6A2	6		3.175	1.5x2	29	1150	2960	55	55	85	12	69	6.6	11	6.5	12	
32-5B2	32	5	3.175	2.5x2	55	1886	5666	58	60	84	12	71	6.6	11	6.5	12	
32-5C1		5	3.175	3.5x1	39	1388	3967	58	50	84	12	71	6.6	11	6.5	12	
32-6B2	32	6	3.969	2.5x2	56	2556	7020	62	68	88	12	75	6.6	11	6.5	12	
32-6C1		6	3.969	3.5x1	39	1888	4936	62	55	88	12	75	6.6	11	6.5	12	
32-8B2		8	4.763	2.5x2	59	3284	8453	66	86	100	16	82	9	14	8.5	15	
32-8C1	32	8	4.763	3.5x1	41	2428	5948	66	70	100	16	82	9	14	8.5	15	
32-10B2		10	6.350	2.5x2	60	4810	11199	74	98	108	16	90	9	14	8.5	15	
32-10C1	32	10	6.350	3.5x1	44	3519	7785	74	78	108	16	90	9	14	8.5	15	
36-6B1		36	6	3.969	2.5x1	35	1486	3969	65	50	100	12	82	6.6	11	6.5	12
36-6B2			6	3.969	2.5x2	60	2696	7937	65	68	100	12	82	6.6	11	6.5	12
36-10B2	10		6.350	2.5x2	68	5105	12669	75	102	125	18	98	11	17.5	11	15	

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while axial load is 30% of dynamic load rating.

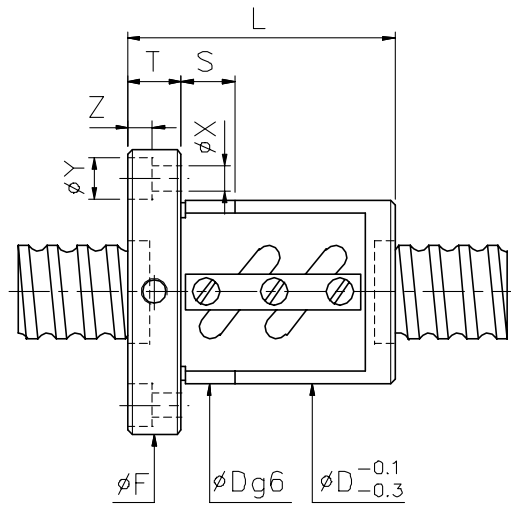
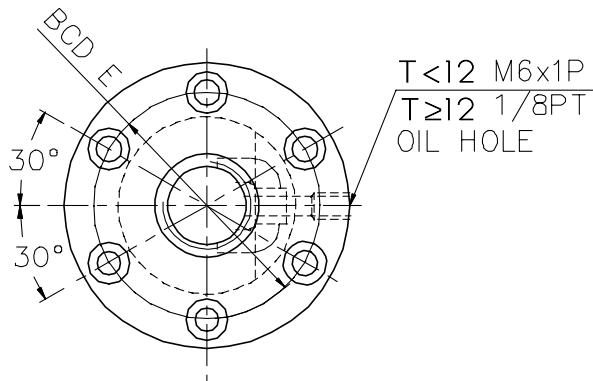
**F S W** Type



Model	Size		Ball Dia.	Circuits	Stiffness kgf / μm K	Dynamic Load 1x10 <sup>6</sup> revs C (kgf)	Static Load Co (kgf)	Nut		Flange			Bolt			Fit
	Nominal Dia.	Lead						D	L	F	T	BCD-E	X	Y	Z	
40-5B2	40	5	3.175	2.5x2	66	2071	7134	68	65	102	16	84	9	14	8.5	15
40-6B2		6	3.969	2.5x2	69	2817	8855	70	72	104	16	86	9	14	8.5	15
40-8B2		8	4.763	2.5x2	70	3634	10603	74	86	108	16	90	9	14	8.5	15
40-8C1		8	4.763	3.5x1	49	2679	7438	74	70	108	16	90	9	14	8.5	15
40-10B2		10	6.350	2.5x2	74	5370	14138	84	102	125	18	104	11	17.5	11	15
40-10C1		10	6.350	3.5x1	51	3932	9841	84	82	125	18	104	11	17.5	11	15
40-12B1		12	7.144	2.5x1	36	3425	7837	86	81	128	18	106	11	17.5	11	20
40-12B2		12	7.144	2.5x2	72	6217	15674	86	117	128	18	106	11	17.5	11	20
40-16A2		16	7.144	1.5x2	42	4007	9405	86	118	128	18	106	11	17.5	11	20
40-16B1		16	7.144	2.5x1	37	3425	7837	86	102	128	18	106	11	17.5	11	20
45-10B1	45	10	6.350	2.5x1	45	3116	7953	88	74	132	18	110	11	17.5	11	15
45-10B2		10	6.350	2.5x2	79	5655	15905	88	104	132	18	110	11	17.5	11	15
45-12B2		12	7.938	2.5x2	81	7627	19799	96	123	142	22	117	13	20	13	20
50-5A2	50	5	3.175	1.5x2	48	1447	5382	80	63	114	16	96	9	14	8.5	15
50-5A3		5	3.175	1.5x3	73	2051	8072	80	73	114	16	96	9	14	8.5	15
50-6B2		6	3.969	2.5x2	81	3093	11149	84	75	118	16	100	9	14	8.5	15
50-6B3		6	3.969	2.5x3	119	4384	16723	84	93	118	16	100	9	14	8.5	15
50-8B2		8	4.763	2.5x2	84	4004	13409	87	88	128	18	107	11	17.5	11	15
50-8B3		8	4.763	2.5x3	124	5674	20114	87	112	128	18	107	11	17.5	11	15
50-10B2		10	6.350	2.5x2	87	5923	17670	94	104	135	18	114	11	17.5	11	15
50-10B3		10	6.350	2.5x3	129	8394	26505	94	134	135	18	114	11	17.5	11	15
50-10C1		10	6.350	3.5x1	60	4393	12481	94	84	135	18	114	11	17.5	11	15
50-12B1		12	7.938	2.5x1	46	4420	11047	102	87	150	22	125	13	20	13	20
50-12B2		12	7.938	2.5x2	90	8022	22094	102	123	150	22	125	13	20	13	20
50-12C1		12	7.938	3.5x1	63	5875	15380	102	99	150	22	125	13	20	13	20
55-10C1	55	10	6.350	3.5x1	66	4562	13661	100	84	140	18	118	11	17.5	11	20
55-12B2		12	7.938	2.5x2	95	8392	24390	105	123	154	22	127	13	20	13	20

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while axial load is 30% of dynamic load rating.

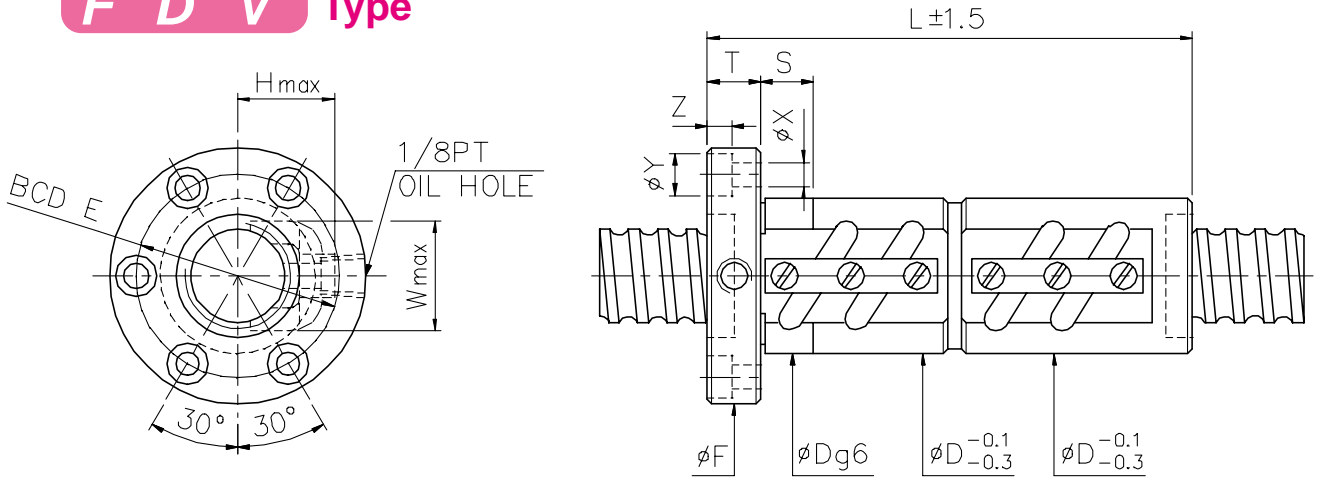
**F S W Type**



Model	Size		Ball Dia.	Circuits	Stiffness kgf / $\mu\text{m}$ K	Dynamic Load $1 \times 10^6$ revs C (kgf)	Static Load Co (kgf)	Nut		Flange			Bolt			Fit
	Nominal Dia.	Lead						D	L	F	T	BCD-E	X	Y	Z	
63-8A2	63	8	4.763	1.5x2	54	2826	10129	104	76	146	18	124	11	17.5	11	20
63-8A3		8	4.763	1.5x3	80	4004	15193	104	92	146	18	124	11	17.5	11	20
63-10B2		10	6.350	2.5x2	104	6533	22371	110	107	152	20	130	11	17.5	11	20
63-10B3		10	6.350	2.5x3	154	9528	33556	110	137	152	20	130	11	17.5	11	20
63-12B2		12	7.938	2.5x2	109	8943	28062	118	124	166	22	141	13	20	13	20
63-16B2		16	9.525	2.5x2	141	14862	46009	124	153	172	22	147	13	20	13	20
63-20B2	20	9.525	2.5x2	141	14862	46009	124	176	172	22	147	13	20	13	20	
70-10B2	70	10	6.350	2.5x2	115	6843	25011	124	109	170	20	145	13	20	13	20
70-10B3		10	6.350	2.5x3	170	9698	37516	124	139	170	20	145	13	20	13	20
70-12B2		12	7.938	2.5x2	120	9382	31275	130	125	178	22	152	13	20	13	20
70-12B3	12	7.938	2.5x3	170	13296	46912	130	159	178	22	152	13	20	13	20	
80-10B2	80	10	6.350	2.5x2	126	7202	28538	130	109	178	22	152	13	20	13	20
80-10B3		10	6.350	2.5x3	186	10207	42807	130	139	178	22	152	13	20	13	20
80-12B2		12	7.938	2.5x2	130	9797	35422	136	125	185	22	159	13	20	13	20
80-12B3		12	7.938	2.5x3	192	13844	53132	136	159	185	22	159	13	20	13	20
80-16B2		16	9.525	2.5x2	171	16485	58851	145	156	210	28	174	18	26	17.5	25
80-16B3		16	9.525	2.5x3	252	23363	88276	145	204	210	28	174	18	26	17.5	25
80-20B2	20	9.525	2.5x2	171	16485	58851	145	185	210	28	174	18	26	17.5	25	
80-20B3	20	9.525	2.5x3	252	23363	88276	145	245	210	28	174	18	26	17.5	25	
100-12B2	100	12	7.938	2.5x2	156	10761	44596	160	132	224	24	188	18	26	17.5	25
100-12B3		12	7.938	2.5x3	229	15251	66894	160	168	224	24	188	18	26	17.5	25
100-16B2		16	9.525	2.5x2	200	18123	77425	170	162	248	32	205	22	32	21.5	30
100-16B3		16	9.525	2.5x3	305	25684	111637	170	212	248	32	205	22	32	21.5	30
100-20B2		20	9.525	2.5x2	200	18123	74425	170	190	248	32	205	22	32	21.5	30
100-20B3		20	9.525	2.5x3	305	25684	111637	170	250	248	32	205	22	32	21.5	30

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while axial load is 30% of dynamic load rating.

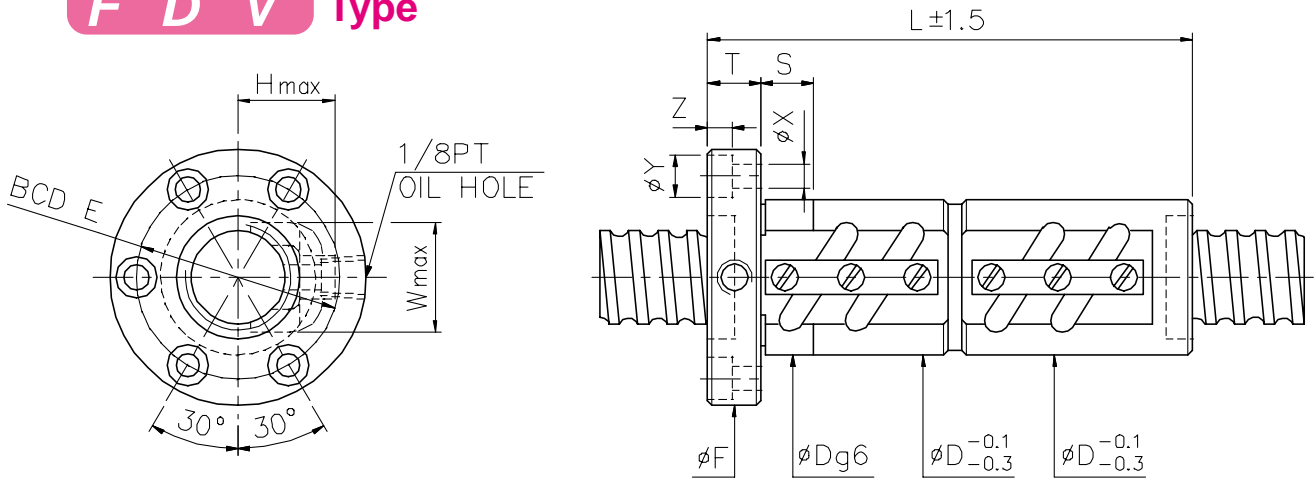
**F D V Type**



Model	Size		Ball Dia.	Circuits	Stiffness kgf / μm K	Dynamic Load 1x10 <sup>6</sup> revs C (kgf)	Static Load Co (kgf)	Nut		Flange			Return Tube		Bolt			Fit
	Nominal Dia.	Lead						D	L	F	T	BCD-E	W	H	X	Y	Z	
16-5B1	16	5	3.175	2.5x1	32	763	1400	31	80	54	12	41	24	22	5.5	9.5	5.5	24
16-5B2		5	3.175	2.5x2	65	1385	2799	31	110	54	12	41	24	22	5.5	9.5	5.5	24
16-5C1		5	3.175	3.5x1	46	1013	1946	31	90	54	12	41	24	22	5.5	9.5	5.5	24
20-5B1	20	5	3.175	2.5x1	38	837	1733	35	80	58	12	46	27	25	5.5	9.5	5.5	24
20-5B2		5	3.175	2.5x2	76	1519	3465	35	110	58	12	46	27	25	5.5	9.5	5.5	24
20-6B1		6	3.969	2.5x1	40	1139	2187	36	92	60	12	47	28	27	5.5	9.5	5.5	24
20-6C1	6	3.969	3.5x1	55	1512	3041	36	104	60	12	47	28	27	5.5	9.5	5.5	24	
25-5B1	25	5	3.175	2.5x1	46	939	2209	40	80	64	12	52	31	26	5.5	9.5	5.5	24
25-5B2		5	3.175	2.5x2	90	1704	4417	40	110	64	12	52	31	26	5.5	9.5	5.5	24
25-5C1		5	3.175	3.5x1	68	1252	3085	40	90	64	12	52	31	26	5.5	9.5	5.5	24
25-6B2		6	3.969	2.5x2	94	2308	5523	42	128	68	12	55	32	28	6.6	11	6.5	24
25-6C1		6	3.969	3.5x1	66	1690	3844	42	104	68	12	55	32	28	6.6	11	6.5	24
25-10B1	10	4.763	2.5x1	48	1592	3237	45	122	72	16	58	34	29	6.6	11	6.5	24	
28-5B1	28	5	3.175	2.5x1	51	984	2466	44	80	70	12	56	34	28	6.6	11	6.5	24
28-5B2		5	3.175	2.5x2	98	1785	4932	44	110	70	12	56	34	28	6.6	11	6.5	24
28-6A2		6	3.175	1.5x2	59	1150	2960	44	110	70	12	56	34	28	6.6	11	6.5	24
32-5B1	32	5	3.175	2.5x1	55	1039	2833	50	80	76	12	63	38	30	6.6	11	6.5	24
32-5B2		5	3.175	2.5x2	109	1886	5666	50	110	76	12	63	38	30	6.6	11	6.5	24
32-5C1		5	3.175	3.5x1	76	1388	3967	50	90	76	12	63	38	30	6.6	11	6.5	24
32-6B1		6	3.969	2.5x1	57	1409	3510	52	92	78	12	65	39	32	6.6	11	6.5	24
32-6B2		6	3.969	2.5x2	112	2556	7020	52	128	78	12	65	39	32	6.6	11	6.5	24
32-6C1		6	3.969	3.5x1	78	1888	4936	52	104	78	12	65	39	32	6.6	11	6.5	24
32-8B1		8	4.763	2.5x1	58	1810	4227	54	110	88	16	70	40	33	9	14	8.5	30
32-8B2		8	4.763	2.5x2	115	3284	8453	54	158	88	16	70	40	33	9	14	8.5	30
32-8C1		8	4.763	3.5x1	82	2428	5948	54	126	88	16	70	40	33	9	14	8.5	30
32-10B1		10	6.350	2.5x1	58	2651	5600	57	122	91	16	73	44	37	9	14	8.5	30
32-10B2	10	6.350	2.5x2	118	4810	11199	57	182	91	16	73	44	37	9	14	8.5	30	
32-10C1	10	6.350	3.5x1	86	3519	7785	57	142	91	16	73	44	37	9	14	8.5	30	

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while preload is 10% of dynamic load rating and axial load is applied.

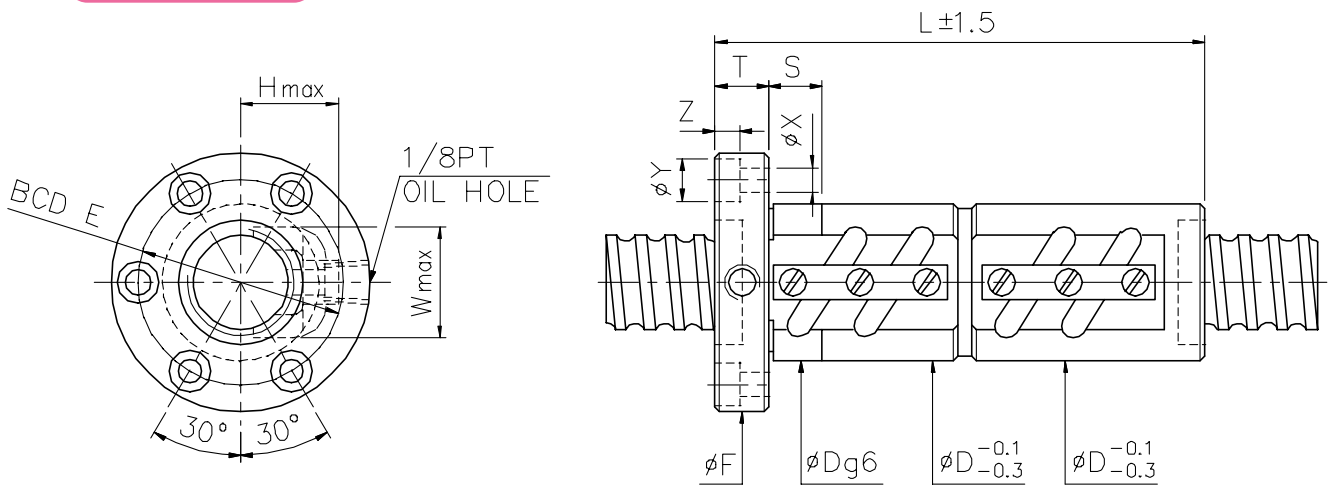
**F D V Type**



Model	Size		Ball Dia.	Circuits	Stiffness kgf / $\mu\text{m}$ K	Dynamic Load $1 \times 10^6$ revs C (kgf)	Static Load Co (kgf)	Nut		Flange			Return Tube		Bolt			Fit
	Nominal Dia.	Lead						D	L	F	T	BCD-E	W	H	X	Y	Z	
36-6B1	36	6	3.969	2.5x1	62	1486	3969	55	92	82	12	68	42	32	6.6	11	6.5	24
36-6B2		6	3.969	2.5x2	121	2696	7937	55	128	82	12	68	42	32	6.6	11	6.5	24
36-10B2		10	6.350	2.5x2	132	5105	12669	62	184	104	18	82	49	40	11	17.5	11	30
40-5B1	40	5	3.175	2.5x1	65	1141	3567	58	84	92	16	72	46	34	9	14	8.5	30
40-5B2		5	3.175	2.5x2	132	2071	7134	58	114	92	16	72	46	34	9	14	8.5	30
40-6B2		6	3.969	2.5x2	136	2817	8855	60	132	94	16	76	47	36	9	14	8.5	30
40-8B1		8	4.763	2.5x1	69	2003	5302	62	110	96	16	78	48	38	9	14	8.5	30
40-8B2		8	4.763	2.5x2	137	3634	10603	62	158	96	16	78	48	38	9	14	8.5	30
40-8C1		8	4.763	3.5x1	96	2679	7438	62	126	96	16	78	48	38	9	14	8.5	30
40-10B1		10	6.350	2.5x1	72	2959	7069	65	132	106	18	85	52	42	11	17.5	11	30
40-10B2	10	6.350	2.5x2	145	5370	14138	65	192	106	18	85	52	42	11	17.5	11	30	
40-10C1	10	6.350	3.5x1	102	3932	9841	65	152	106	18	85	52	42	11	17.5	11	30	
40-12B1	12	7.144	2.5x1	70	3425	7837	70	153	112	18	90	55	43	11	17.5	11	40	
40-12B2	12	7.144	2.5x2	141	6217	15674	70	225	112	18	90	55	43	11	17.5	11	40	
45-10B1	45	10	6.350	2.5x1	76	3116	7953	70	134	112	18	90	58	48	11	17.5	11	30
45-10B2		10	6.350	2.5x2	156	5655	15905	70	194	112	18	90	58	48	11	17.5	11	30
45-12B2		12	7.938	2.5x2	162	7627	19799	74	230	122	22	97	60	49	13	20	13	40
50-5A2	50	5	3.175	1.5x2	96	1447	5382	70	107	104	16	86	56	40	9	14	8.5	30
50-5A3		5	3.175	1.5x3	143	2051	8072	70	127	104	16	86	56	40	9	14	8.5	30
50-6B2		6	3.969	2.5x2	161	3093	11149	72	134	106	16	88	57	43	9	14	8.5	30
50-6B3		6	3.969	2.5x3	235	4384	16723	72	170	106	16	88	57	43	9	14	8.5	30
50-8B1		8	4.763	2.5x1	81	2206	6705	75	112	116	18	95	58	45	11	17.5	11	30
50-8B2		8	4.763	2.5x2	165	4004	13409	75	160	116	18	95	58	45	11	17.5	11	30
50-8B3		8	4.763	2.5x3	244	5674	20114	75	208	116	18	95	58	45	11	17.5	11	30
50-10B2		10	6.350	2.5x2	173	5923	17670	78	194	119	18	98	62	48	11	17.5	11	30
50-10B3		10	6.350	2.5x3	255	8394	26505	78	254	119	18	98	62	48	11	17.5	11	30
50-10C1		10	6.350	3.5x1	120	4393	12481	78	154	119	18	98	62	48	11	17.5	11	30
50-12B2		12	7.938	2.5x2	178	8022	22094	82	232	130	22	105	64	52	13	20	13	40
50-12C1		12	7.938	3.5x1	123	5875	15380	82	184	130	22	105	64	52	13	20	13	40

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while preload is 10% of dynamic load rating and axial load is applied.

**F D V** Type

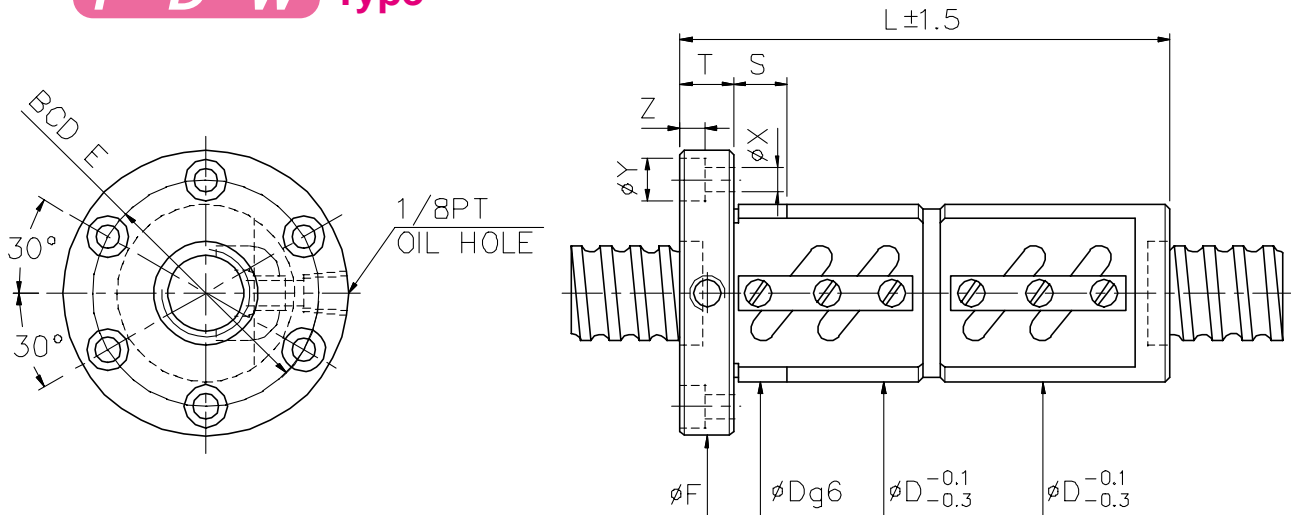


Model	Size		Ball Dia.	Circuits	Stiffness kgf/μm K	Dynamic Load 1x10 <sup>6</sup> revs C (kgf)	Static Load Co (kgf)	Nut		Flange			Return Tube		Bolt			Fit
	Nominal Dia.	Lead						D	L	F	T	BCD-E	W	H	X	Y	Z	
55-10C1	55	10	6.350	3.5x1	132	4562	13661	84	154	125	18	103	68	54	11	17.5	11	40
55-12B2		12	7.938	2.5x2	185	8392	24390	88	232	136	22	110	70	56	13	20	13	40
63-8A2	63	8	4.763	1.5x2	107	2826	10129	87	142	129	18	107	70	50	11	17.5	11	40
63-8A3		8	4.763	1.5x3	154	4004	15193	87	171	129	18	107	70	50	11	17.5	11	40
63-10B2		10	6.350	2.5x2	206	6533	22371	90	196	132	20	110	74	53	11	17.5	11	30
63-10B3		10	6.350	2.5x3	305	9258	33556	90	256	132	20	110	74	53	11	17.5	11	30
63-12B2		12	7.938	2.5x2	214	8943	28062	94	232	142	22	117	76	57	13	20	13	40
63-16B2		16	9.525	2.5x2	280	14862	46009	100	296	150	22	123	78	62	13	20	13	40
63-20B2	20	9.525	2.5x2	280	14862	46009	100	334	150	22	123	78	62	13	20	13	40	
70-10B2	70	10	6.350	2.5x2	228	6843	25011	104	196	152	20	128	80	56	13	20	13	40
70-10B3		10	6.350	2.5x3	334	9698	37516	104	256	152	20	128	80	56	13	20	13	40
70-12B2		12	7.938	2.5x2	236	9382	31275	110	232	159	22	133	82	58	13	20	13	40
70-12B3	12	7.938	2.5x3	336	13296	46912	110	302	159	22	133	82	58	13	20	13	40	
80-10B2	80	10	6.350	2.5x2	251	7202	28538	115	200	163	22	137	90	64	13	20	13	40
80-10B3		10	6.350	2.5x3	368	10207	42807	115	260	163	22	137	90	64	13	20	13	40
80-12B2		12	7.938	2.5x2	257	9797	35422	120	232	169	22	143	92	67	13	20	13	40
80-12B3		12	7.938	2.5x3	380	13884	53132	120	302	169	22	143	92	67	13	20	13	40
80-16B2		16	9.525	2.5x2	340	16485	58851	125	302	190	28	154	94	70	18	26	17.5	50
80-16B3		16	9.525	2.5x3	498	23363	88276	125	398	190	28	154	94	70	18	26	17.5	50
80-20B2	20	9.525	2.5x2	338	16485	58851	125	345	190	28	154	94	70	18	26	17.5	50	
80-20B3	20	9.525	2.5x3	498	23363	88276	125	470	190	28	154	94	70	18	26	17.5	50	
100-12B2	100	12	7.938	2.5x2	301	10761	44596	145	240	209	28	173	112	76	18	26	17.5	50
100-12B3		12	7.938	2.5x3	452	15251	66894	145	312	209	28	173	112	76	18	26	17.5	50
100-16B2		16	9.525	2.5x2	400	18125	74425	150	308	228	32	185	114	80	22	32	21.5	60
100-16B3		16	9.525	2.5x3	595	25684	111637	150	404	228	32	185	114	80	22	32	21.5	60
100-20B2		20	9.525	2.5x2	400	18123	74425	150	350	228	32	185	114	80	22	32	21.5	60
100-20B3		20	9.525	2.5x3	595	25684	111637	150	475	228	32	185	114	80	22	32	21.5	60

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while preload is 10% of dynamic load rating and axial load is applied.



**F D W** Type

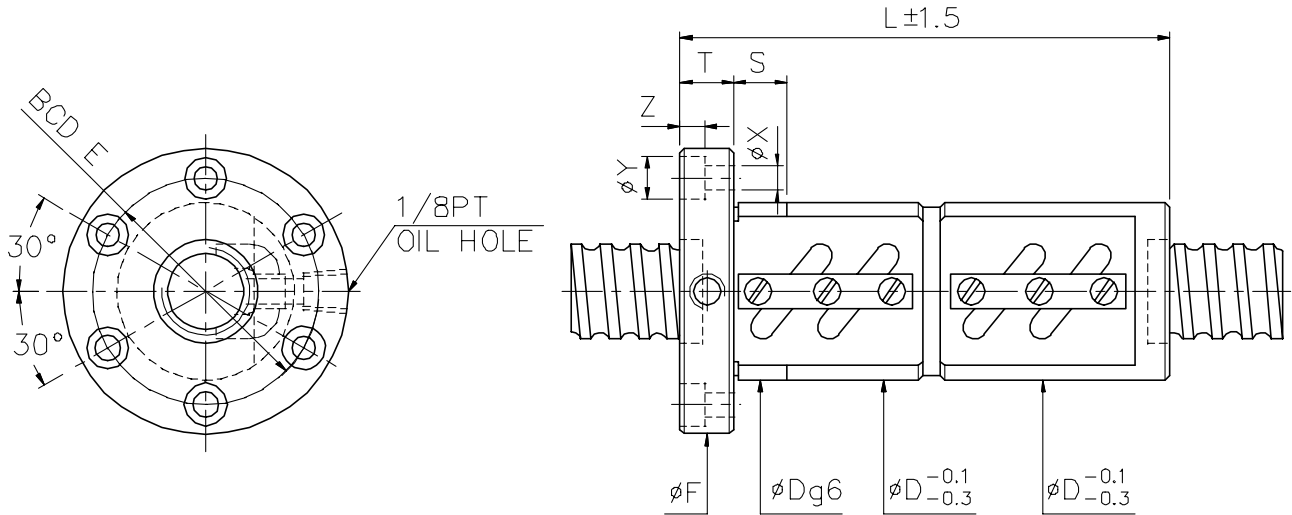


Model	Size		Ball Dia.	Circuits	Stiffness kgf/μm K	Dynamic Load 1x10 <sup>6</sup> revs C (kgf)	Static Load Co (kgf)	Nut		Flange			Bolt			Fit	
	Nominal Dia.	Lead						D	L	F	T	BCD-E	X	Y	Z		S
16-5B2	16	5	3.175	2.5x2	65	1385	2799	40	110	64	12	51	5.5	9.5	5.5	24	
16-5B1		5	3.175	2.5x1	32	763	1400	40	80	64	12	51	5.5	9.5	5.5	24	
16-5C1		5	3.175	3.5x1	46	1013	1946	40	90	64	12	51	5.5	9.5	5.5	24	
20-5B1	20	5	3.175	2.5x1	38	837	1733	44	80	68	12	55	5.5	9.5	5.5	24	
20-5B2		5	3.175	2.5x2	76	1519	3465	44	110	68	12	55	5.5	9.5	5.5	24	
20-6B1		6	3.969	2.5x1	40	1139	2187	48	92	72	12	59	5.5	9.5	5.5	24	
20-6C1	20	6	3.969	3.5x1	55	1512	3041	48	104	72	12	59	5.5	9.5	5.5	24	
25-5B1		25	5	3.175	2.5x1	46	939	2209	50	80	74	12	62	5.5	9.5	5.5	24
25-5B2			5	3.175	2.5x2	90	1704	4417	50	110	74	12	62	5.5	9.5	5.5	24
25-5C1	5		3.175	3.5x1	68	1252	3085	50	90	74	12	62	5.5	9.5	5.5	24	
25-6B2	25	6	3.969	2.5x2	94	2304	5524	56	128	82	12	69	6.6	11	6.5	24	
25-6C1		6	3.969	3.5x1	66	1690	3844	56	104	82	12	69	6.6	11	6.5	24	
25-10B1		10	4.763	2.5x1	48	1592	3237	60	122	86	16	73	6.6	11	6.5	24	
28-5B1	28	5	3.175	2.5x1	51	984	2466	55	80	85	12	69	6.6	11	6.5	24	
28-5B2		5	3.175	2.5x2	98	1785	4932	55	110	85	12	69	6.6	11	6.5	24	
28-6A2		6	3.175	1.5x2	59	1150	2960	55	110	85	12	69	6.6	11	6.5	24	
32-5B1	32	5	3.175	2.5x1	55	1039	2833	58	80	84	12	71	6.6	11	6.5	24	
32-5B2		5	3.175	2.5x2	109	1886	5666	58	110	84	12	71	6.6	11	6.5	24	
32-5C1		5	3.175	3.5x1	76	1388	3967	58	90	84	12	71	6.6	11	6.5	24	
32-6B1	32	6	3.969	2.5x1	57	1409	3510	62	92	88	12	75	6.6	11	6.5	24	
32-6B2		6	3.969	2.5x2	112	2556	7020	62	128	88	12	75	6.6	11	6.5	24	
32-6C1		6	3.969	3.5x1	78	1888	4936	62	104	88	12	75	6.6	11	6.5	24	
32-8B1	32	8	4.763	2.5x1	58	1810	4227	66	110	100	16	82	9	14	8.5	30	
32-8B2		8	4.763	2.5x2	115	3284	8453	66	158	100	16	82	9	14	8.5	30	
32-8C1		8	4.763	3.5x1	82	2428	5948	66	126	100	16	82	9	14	8.5	30	
32-10B1	32	10	6.350	2.5x1	58	2651	5600	74	122	108	16	90	9	14	8.5	30	
32-10B2		10	6.350	2.5x2	118	4810	11199	74	182	108	16	90	9	14	8.5	30	
32-10C1		10	6.350	3.5x1	86	3519	7785	74	142	108	16	90	9	14	8.5	30	

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while preload is 10% of dynamic load rating and axial load is applied.



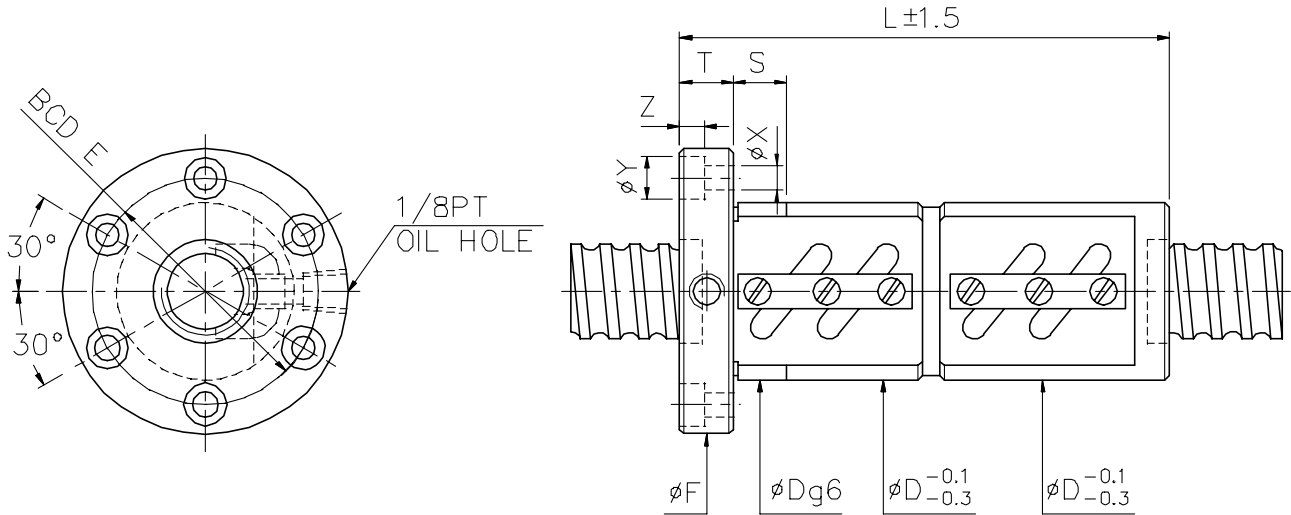
**F D W** Type



Model	Size		Ball Dia.	Circuits	Stiffness kgf / $\mu\text{m}$ K	Dynamic Load $1 \times 10^6$ revs C (kgf)	Static Load Co (kgf)	Nut		Flange			Bolt			Fit
	Nominal Dia.	Lead						D	L	F	T	BCD-E	X	Y	Z	
36-6B1	36	6	3.969	2.5x1	62	1486	3969	65	92	100	12	82	6.6	11	6.5	24
36-6B2		6	3.969	2.5x2	121	2696	7937	65	128	100	12	82	6.6	11	6.5	24
36-10B2		10	6.350	2.5x2	132	5105	12669	75	184	120	18	98	11	17.5	11	30
40-5B1	40	5	3.175	2.5x1	65	1141	3567	68	84	102	16	84	9	14	8.5	30
40-5B2		5	3.175	2.5x2	132	2071	7134	68	114	102	16	84	9	14	8.5	30
40-6B2		6	3.969	2.5x2	136	2817	8855	70	132	104	16	86	9	14	8.5	30
40-8B1		8	4.763	2.5x1	69	2003	5302	74	110	108	16	90	9	14	8.5	30
40-8B2		8	4.763	2.5x2	137	3634	10603	74	158	108	16	90	9	14	8.5	30
40-8C1		8	4.763	3.5x1	96	2679	7438	74	126	108	16	90	9	14	8.5	30
40-10B1		10	6.350	2.5x1	72	2959	7069	84	132	125	18	104	11	17.5	11	30
40-10B2		10	6.350	2.5x2	145	5370	14138	84	192	125	18	104	11	17.5	11	30
40-10C1		10	6.350	3.5x1	102	3932	9841	84	152	125	18	104	11	17.5	11	30
40-12B1		12	7.144	2.5x1	70	3425	7837	86	153	128	18	106	11	17.5	11	40
40-12B2		12	7.144	2.5x2	141	6217	15674	86	225	128	18	106	11	17.5	11	40
40-16A2		16	7.144	1.5x2	83	4007	9405	86	214	128	18	106	11	17.5	11	40
40-16B1	16	7.144	2.5x1	72	3425	7837	86	182	128	18	106	11	17.5	11	40	
45-10B1	45	10	6.350	2.5x1	76	3111	7953	88	134	132	18	110	11	17.5	11	30
45-10B2		10	6.350	2.5x2	156	5655	15905	88	194	132	18	110	11	17.5	11	30
45-12B2		12	7.938	2.5x2	162	7627	19799	96	230	142	22	117	13	20	13	40
50-5A2	50	5	3.175	1.5x2	96	1447	5382	80	107	114	16	96	9	14	8.5	30
50-5A3		5	3.175	1.5x3	143	2051	8072	80	127	114	16	96	9	14	8.5	30
50-6B2		6	3.969	2.5x2	161	3093	11149	84	134	118	16	100	9	14	8.5	30
50-6B3		6	3.969	2.5x3	235	4384	16723	84	170	118	16	100	9	14	8.5	30
50-8B1		8	4.763	2.5x1	81	2206	6705	87	112	128	18	107	11	17.5	11	30
50-8B2		8	4.763	2.5x2	165	4004	13409	87	160	128	18	107	11	17.5	11	30
50-8B3		8	4.763	2.5x3	244	5674	20114	87	208	128	18	107	11	17.5	11	30
50-10B2		10	6.350	2.5x2	173	5923	17670	94	194	135	18	114	11	17.5	11	30
50-10B3		10	6.350	2.5x3	255	8394	26505	94	254	135	18	114	11	17.5	11	30
50-10C1		10	6.350	3.5x1	120	4393	12481	94	154	135	18	114	11	17.5	11	30
50-12B2		12	7.938	2.5x2	178	8022	22094	102	232	150	22	125	13	20	13	40
50-12C1		12	7.938	3.5x1	123	5875	15380	102	184	150	22	125	13	20	13	40

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while preload is 10% of dynamic load rating and axial load is applied.

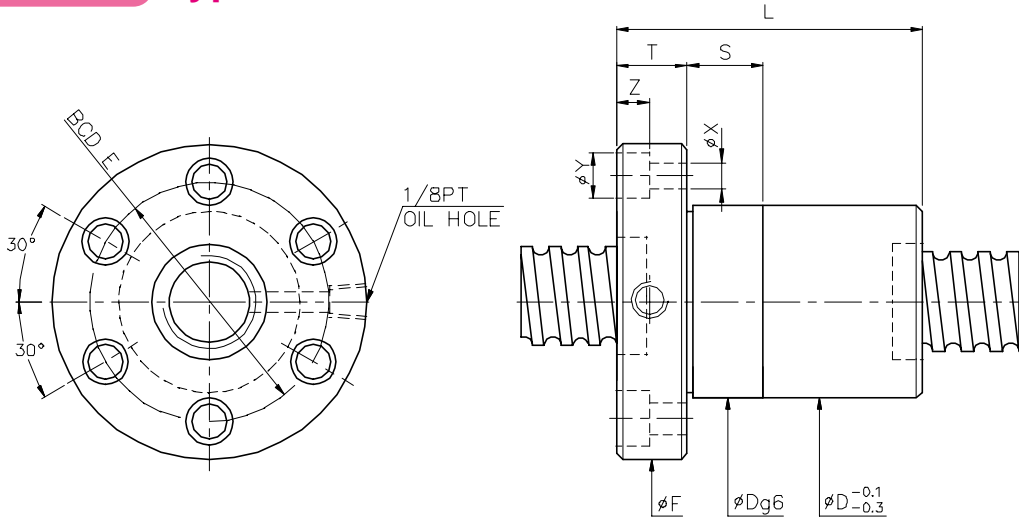
**F D W** Type



Model	Size		Ball Dia.	Circuits	Stiffness kgf/μm K	Dynamic Load 1x10 <sup>6</sup> revs C (kgf)	Static Load Co (kgf)	Nut		Flange			Bolt			Fit
	Nominal Dia.	Lead						D	L	F	T	BCD-E	X	Y	Z	
55-10C1	55	10	6.350	3.5x1	132	4562	13661	100	154	140	18	118	11	17.5	11	40
55-12B2		12	7.938	2.5x2	185	8392	24390	105	232	154	22	127	13	20	13	40
63-8A2	63	8	4.763	1.5x2	107	2826	10129	104	142	146	18	124	11	17.5	11	40
63-8A3		8	4.763	1.5x3	154	4004	15193	104	174	146	18	124	11	17.5	11	40
63-10B2		10	6.350	2.5x2	206	6533	22371	110	196	152	20	130	11	17.5	11	30
63-10B3		10	6.350	2.5x3	305	9258	33556	110	256	152	20	130	11	17.5	11	30
63-12B2		12	7.938	2.5x2	214	8943	28062	118	232	166	22	141	13	20	13	40
63-16B2		16	9.525	2.5x2	280	14862	46009	124	296	172	22	147	13	20	13	40
63-20B2		20	9.525	2.5x2	280	14862	46009	124	334	172	22	147	13	20	13	40
70-10B2		70	10	6.350	2.5x2	228	6843	25011	124	196	170	20	145	13	20	13
70-10B3	10		6.350	2.5x3	334	9698	37516	124	256	170	20	145	13	20	13	40
70-12B2	12		7.938	2.5x2	236	9382	31275	130	232	178	22	152	13	20	13	40
70-12B3	12		7.938	2.5x3	336	13296	46912	130	302	178	22	152	13	20	13	40
80-10B2	80	10	6.350	2.5x2	251	7202	28538	130	200	178	22	152	13	20	13	40
80-10B3		10	6.350	2.5x3	368	10207	42807	130	260	178	22	152	13	20	13	40
80-12B2		12	7.938	2.5x2	257	9797	35422	136	232	185	22	159	13	20	13	40
80-12B3		12	7.938	2.5x3	380	13884	53132	136	302	185	22	159	13	20	13	40
80-16B2		16	9.525	2.5x2	340	16485	58851	145	302	210	28	174	18	26	17.5	50
80-16B3		16	9.525	2.5x3	498	23363	88276	145	398	210	28	174	18	26	17.5	50
80-20B2		20	9.525	2.5x2	338	16485	58851	145	345	210	28	174	18	26	17.5	50
80-20B3		20	9.525	2.5x3	498	23363	88276	145	470	210	28	174	18	26	17.5	50
100-12B2	100	12	7.938	2.5x2	301	10761	44596	160	240	224	28	188	18	26	17.5	50
100-12B3		12	7.938	2.5x3	452	15251	66894	160	312	224	28	188	18	26	17.5	50
100-16B2		16	9.525	2.5x2	400	18123	74425	170	308	248	32	205	22	32	21.5	60
100-16B3		16	9.525	2.5x3	595	25684	111637	170	404	248	32	205	22	32	21.5	60
100-20B2		20	9.525	2.5x2	400	18123	74425	170	350	248	32	205	22	32	21.5	60
100-20B3		20	9.525	2.5x3	595	25684	111637	170	475	248	32	205	22	32	21.5	60

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while preload is 10% of dynamic load rating and axial load is applied.

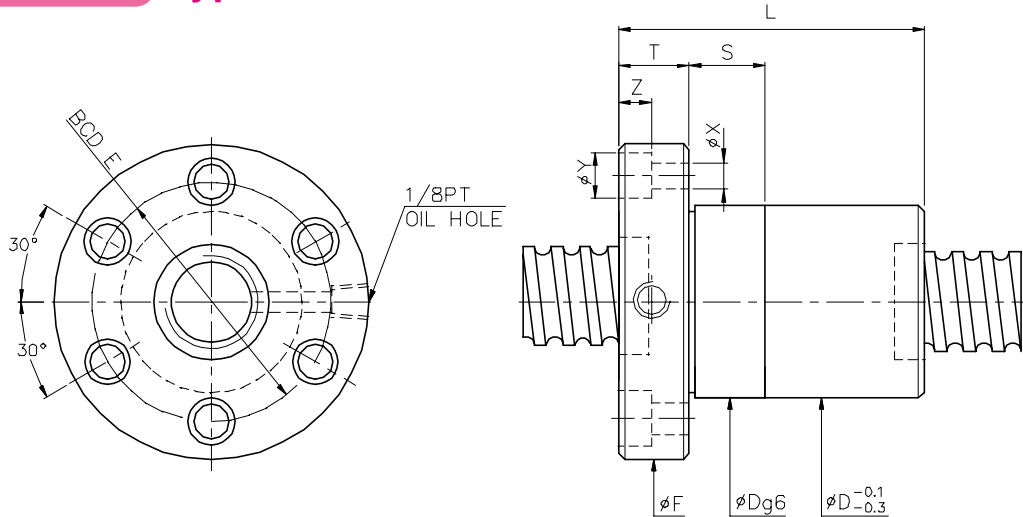
**F S I** Type



Model	Size		Ball Dia.	Circuits	Stiffness kgf / μm K	Dynamic Load 1x10 <sup>6</sup> revs C (kgf)	Static Load Co (kgf)	Nut		Flange			Bolt			Fit	
	Nominal Dia.	Lead						D	L	F	T	BCD-E	X	Y	Z		S
16-5T3	16	5	3.175	3	11	731	1331	28	30	46	54	12	41	5.5	9.5	5.5	12
16-5T4		5	3.175	4	12	936	1775	28	30	52	54	12	41	5.5	9.5	5.5	12
20-5T3	20	5	3.175	3	20	852	1767	32	34	46	57	12	45	5.5	9.5	5.5	12
20-5T4		5	3.175	4	27	1091	2356	32	34	53	57	12	45	5.5	9.5	5.5	12
20-6T3		6	3.969	3	20	1091	2081	34	36	51	60	12	48	5.5	9.5	5.5	12
20-6T4		6	3.969	4	27	1398	2774	34	36	61	60	12	48	5.5	9.5	5.5	12
25-5T3	25	5	3.175	3	28	977	2314	37	40	46	64	12	52	5.5	9.5	5.5	12
25-5T4		5	3.175	4	37	1252	3085	37	40	53	64	12	52	5.5	9.5	5.5	12
25-6T3		6	3.969	3	28	1272	2762	38	42	51	65	12	53	5.5	9.5	5.5	12
25-6T4		6	3.969	4	37	1628	3682	38	42	61	65	12	53	5.5	9.5	5.5	12
32-5T3	32	5	3.175	3	33	1117	3081	44	48	46	74	12	60	6.6	11	6.5	12
32-5T4		5	3.175	4	42	1431	4108	44	48	53	74	12	60	6.6	11	6.5	12
32-5T6		5	3.175	6	63	2027	6162	44	48	66	74	12	60	6.6	11	6.5	12
32-6T3		6	3.969	3	33	1446	3620	45	50	51	76	12	62	6.6	11	6.5	12
32-6T4		6	3.969	4	43	1852	4826	45	50	61	76	12	62	6.6	11	6.5	12
32-6T6		6	3.969	6	65	2625	7239	45	50	75	76	12	62	6.6	11	6.5	12
32-8T3		8	4.763	3	35	1810	4227	47	52	63	78	16	64	6.6	11	6.5	12
32-8T4		8	4.763	4	47	2317	5635	47	52	74	78	16	64	6.6	11	6.5	12
32-10T3	10	6.350	3	35	2539	5327	51	56	72	82	16	68	6.6	11	6.5	12	
32-10T4		6.350	4	48	3252	7102	51	56	83	82	16	68	6.6	11	6.5	12	
40-5T4	40	5	3.175	4	50	1599	5280	51	54	53	80	16	66	6.6	11	6.5	12
40-5T6		5	3.175	6	74	2265	7919	51	54	66	80	16	66	6.6	11	6.5	12
40-6T4		6	3.969	4	50	2136	6420	53	56	65	88	16	72	9	14	8.5	15
40-6T6		6	3.969	6	74	3028	9630	53	56	79	88	16	72	9	14	8.5	15
40-8T4		8	4.763	4	52	2132	6421	55	60	78	92	16	75	9	14	8.5	15
40-8T6		8	4.763	6	76	3021	9632	55	60	99	92	16	75	9	14	8.5	15
40-10T3		10	6.350	3	40	2959	7069	60	65	76	96	16	80	9	14	8.5	15
40-10T4		10	6.350	4	51	3789	9426	60	65	87	96	16	80	9	14	8.5	15
50-5T4	50	5	3.175	4	62	1757	6745	62	65	57	96	16	80	9	14	8.5	15
50-5T6		5	3.175	6	91	2490	10117	62	65	70	96	16	80	9	14	8.5	15

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while axial load is 30% of dynamic load rating.

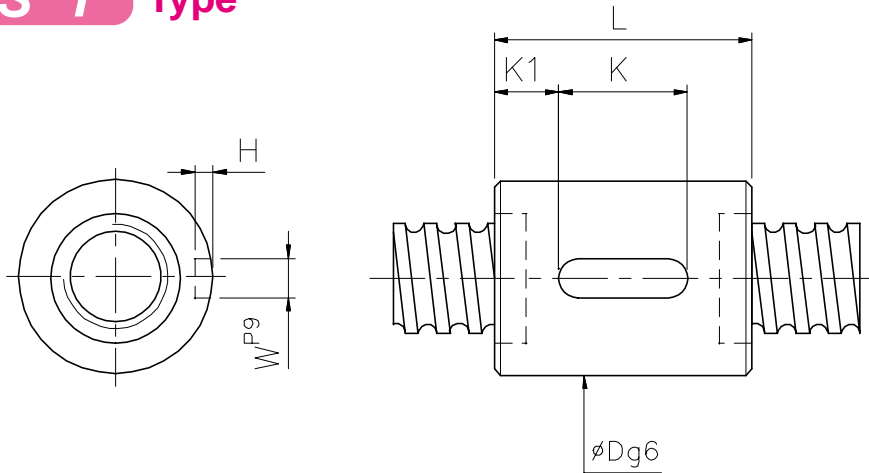
**F S I Type**



Model	Size		Ball Dia.	Circuits	Stiffness kgf / $\mu\text{m}$ K	Dynamic Load $1 \times 10^6$ revs C (kgf)	Static Load Co (kgf)	Nut		Flange			Bolt			Fit		
	Nominal Dia.	Lead						D	L	F	T	BCD-E	X	Y	Z		S	
50-6T4	50	6	3.969	4	62	2388	8250	64	68	65	100	16	84	9	14	8.5	15	
50-6T6		6	3.969	6	93	3384	12375	64	68	79	100	16	84	9	14	8.5	15	
50-8T4		8	4.763	4	62	2998	9578	65	70	78	102	16	85	9	14	8.5	15	
50-8T6		8	4.763	6	92	4249	14367	65	70	99	102	16	85	9	14	8.5	15	
50-10T3		10	6.350	3	50	3397	9256	69	74	78	114	18	92	11	17.5	11	20	
50-10T4		10	6.350	4	63	4350	12341	69	74	89	114	18	92	11	17.5	11	20	
50-10T6		10	6.350	6	94	6165	18511	69	74	112	114	18	92	11	17.5	11	20	
50-12T3		12	7.938	3	50	4420	11047	73	78	90	118	18	96	11	17.5	11	20	
50-12T4		12	7.938	4	63	5660	14730	73	78	103	118	18	96	11	17.5	11	20	
63-6T4		63	6	3.969	4	75	2614	10542	78	80	66	119	18	98	11	17.5	11	20
63-6T6			6	3.969	6	113	3704	15813	78	80	81	119	18	98	11	17.5	11	20
63-8T4			8	4.763	4	77	3395	12541	79	82	80	122	18	100	11	17.5	11	20
63-8T6	8		4.763	6	114	4812	18811	79	82	101	122	18	100	11	17.5	11	20	
63-10T4	10		6.350	4	79	4860	15858	82	88	91	134	20	110	14	20	13	20	
63-10T6	10		6.350	6	115	6887	23786	82	88	114	134	20	110	14	20	13	20	
63-12T4	12		7.938	4	78	6479	19293	86	92	105	138	20	114	14	20	13	20	
63-12T6	12		7.938	6	113	9182	28939	86	92	133	138	20	114	14	20	13	20	
80-10T4	80		10	6.350	4	96	5559	21118	99	105	91	152	20	127	14	20	13	20
80-10T6			10	6.350	6	140	7879	31677	99	105	114	152	20	127	14	20	13	20
80-12T4			12	7.938	4	97	7430	25681	103	110	109	170	24	138	18	26	17.5	25
80-12T6			12	7.938	6	141	10530	38521	103	110	137	170	24	138	18	26	17.5	25
80-16T3		16	9.525	3	95	9663	31622	108	115	118	174	24	143	18	26	17.5	25	
80-16T4		16	9.525	4	130	12375	42162	108	115	136	174	24	143	18	26	17.5	25	
80-20T3		20	9.525	3	95	9663	31622	108	115	138	174	24	143	18	26	17.5	25	
80-20T4		20	9.525	4	125	12375	42162	108	115	161	174	24	143	18	26	17.5	25	
100-12T4		100	12	7.938	4	105	8306	33001	123	130	109	190	24	158	18	26	17.5	25
100-12T6			12	7.938	6	175	11772	49502	123	130	137	190	24	158	18	26	17.5	25
100-16T4			16	9.525	4	107	13569	53161	125	135	136	194	24	163	18	26	17.5	30
100-16T6			16	9.525	6	140	19230	79741	125	135	173	194	24	163	18	26	17.5	30
100-20T4	20		9.525	4	155	13569	53161	125	135	161	194	24	163	18	26	17.5	30	

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while axial load is 30% of dynamic load rating.

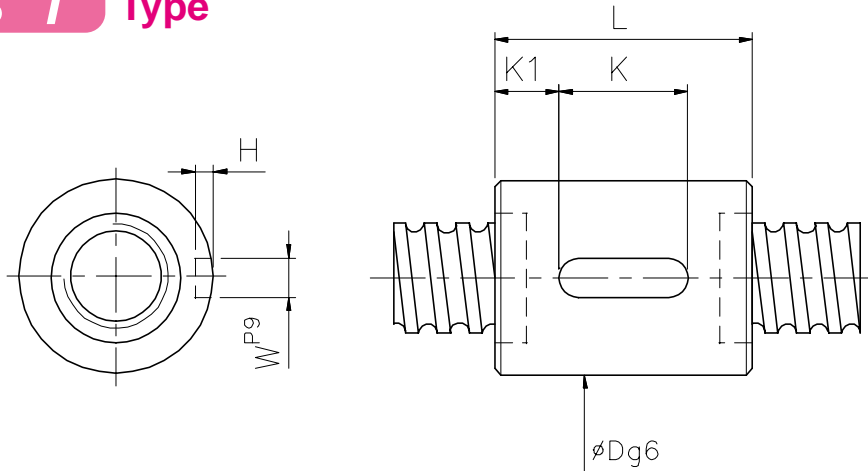
**R S I** Type



Model	Size		Ball Dia.	Circuits	Stiffness kgf / μm K	Dynamic Load 1x10 <sup>6</sup> revs C ( kgf )	Static Load Co ( kgf )	Nut		Keyway				
	Nominal Dia.	Lead						D	L	K	W	H	K <sub>1</sub>	
16-5T3	16	5	3.175	3	11	731	1331	28	30	40	20	3	1.8	10
16-5T4		5	3.175	4	12	936	1775	28	30	46	20	3	1.8	13
20-5T3	20	5	3.175	3	20	852	1767	32	34	41	20	3	1.8	10.5
20-5T4		5	3.175	4	27	1090	2356	32	34	48	20	3	1.8	14
20-6T3	20	6	3.969	3	20	1091	2081	34	36	46	20	4	2.5	13
20-6T4		6	3.969	4	27	1398	2774	34	36	56	25	4	2.5	15.5
25-5T3	25	5	3.175	3	28	977	2314	37	40	41	20	4	2.5	10.5
25-5T4		5	3.175	4	37	1252	3085	37	40	48	20	4	2.5	14
25-6T3	25	6	3.969	3	28	1272	2762	38	42	46	20	4	2.5	13
25-6T4		6	3.969	4	37	1628	3682	38	42	56	25	4	2.5	15.5
32-5T3	32	5	3.175	3	33	1117	3081	44	48	41	20	4	2.5	10.5
32-5T4		5	3.175	4	42	1431	4108	44	48	48	20	4	2.5	14
32-5T6	32	5	3.175	6	63	2027	6162	44	48	61	25	4	2.5	18
32-6T3		6	3.969	3	33	1446	3620	45	50	46	20	5	3	13
32-6T4	32	6	3.969	4	43	1852	4826	45	50	56	25	5	3	15.5
32-6T6		6	3.969	6	65	2625	7239	45	50	70	32	5	3	19
32-8T3	32	8	4.763	3	35	1810	4227	47	52	59	25	5	3	17
32-8T4		8	4.763	4	47	2317	5635	47	52	70	25	5	3	22.5
32-10T3	32	10	6.350	3	35	2539	5327	51	56	68	25	6	3.5	21.5
32-10T4		10	6.350	4	48	3252	7102	51	56	79	32	6	3.5	23.5
40-5T4	40	5	3.175	4	50	1599	5280	51	54	48	20	4	2.5	14
40-5T6		5	3.175	6	74	2265	7919	51	54	61	25	4	2.5	18
40-6T4	40	6	3.969	4	50	2136	6420	53	56	56	25	5	3	15.5
40-6T6		6	3.969	6	74	3028	9630	53	56	70	32	5	3	19
40-8T4	40	8	4.763	4	52	2728	7596	55	60	70	25	5	3	22.5
40-8T6		8	4.763	6	76	3866	11394	55	60	91	40	5	3	25.5
40-10T3	40	10	6.350	3	40	2959	7069	60	65	68	25	6	3.5	21.5
40-10T4		10	6.350	4	51	3789	9426	60	65	79	32	6	3.5	23.5
50-5T4	50	5	3.175	4	62	1757	6745	62	65	48	20	4	2.5	14
50-5T6		5	3.175	6	91	2490	10117	62	65	61	25	4	2.5	18

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while axial load is 30% of dynamic load rating.

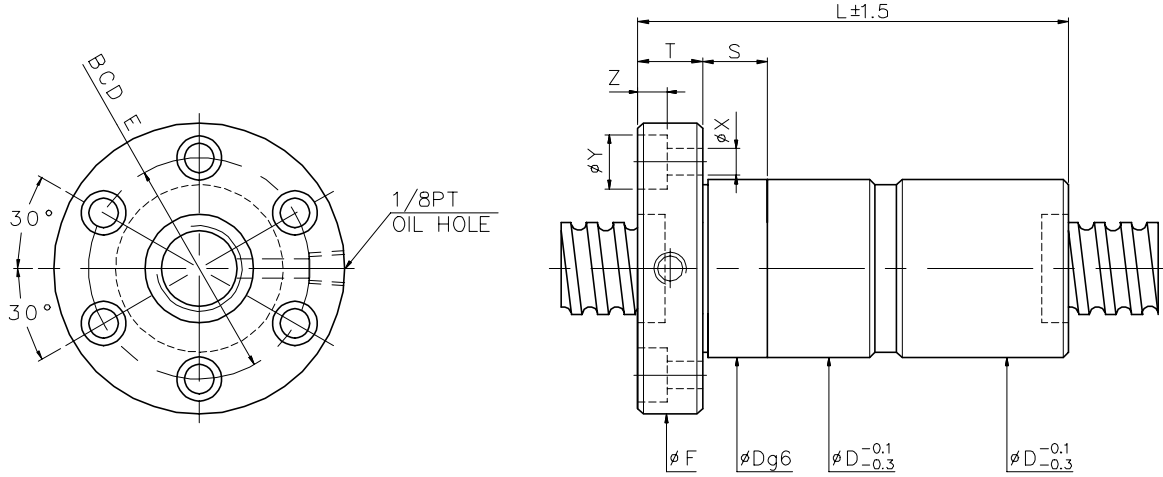
**R S I Type**



Model	Size		Ball Dia.	Circuits	Stiffness kgf / μm K	Dynamic Load 1x10 <sup>6</sup> revs C ( kgf )	Static Load Co ( kgf )	Nut		Keyway				
	Nominal Dia.	Lead						D	L	K	W	H	K <sub>1</sub>	
50-6T4	50	6	3.969	4	62	2388	8250	64	68	56	25	5	3	15.5
50-6T6		6	3.969	6	93	3384	12375	64	68	70	32	5	3	19
50-8T4		8	4.763	4	62	2998	9578	65	70	70	32	5	3	19
50-8T6		8	4.763	6	92	4249	14367	65	70	91	40	5	3	25.5
50-10T3		10	6.350	3	50	3397	9256	69	74	68	32	6	3.5	18
50-10T4		10	6.350	4	63	4350	12341	69	74	79	32	6	3.5	23.5
50-10T6		10	6.350	6	94	6165	18511	69	74	102	40	6	3.5	31
50-12T3		12	7.938	3	50	4420	11047	73	78	82	40	6	3.5	21
50-12T4		12	7.938	4	63	5660	14730	73	78	95	40	6	3.5	27.5
63-6T4		63	6	3.969	4	75	2674	10542	78	80	56	25	6	3.5
63-6T6	6		3.969	6	113	3704	15813	78	80	70	32	6	3.5	19
63-8T4	8		4.763	4	77	3395	12541	79	82	70	32	6	3.5	19
63-8T6	8		4.763	6	114	4812	18811	79	82	91	40	6	3.5	25.5
63-10T4	10		6.350	4	79	4860	15858	82	88	79	32	8	4	23.5
63-10T6	10		6.350	6	115	6887	23786	82	88	102	40	8	4	31
63-12T4	12	7.938	4	78	6479	19293	86	92	95	40	8	4	27.5	
63-12T6	12	7.938	6	113	9182	28939	86	92	123	50	8	4	36.5	
80-10T4	80	10	6.350	4	96	5559	21118	99	105	79	32	8	4	23.5
80-10T6		10	6.350	6	140	7879	31677	99	105	102	40	8	4	62
80-12T4		12	7.938	4	97	7430	25681	103	110	95	40	8	4	27.5
80-12T6		12	7.938	6	141	10530	38521	103	110	123	50	8	4	36.5
80-16T3		16	9.525	3	95	9663	31622	108	115	106	40	10	5	33
80-16T4		16	9.525	4	130	12375	42162	108	115	124	50	10	5	37
80-20T3	20	9.525	3	95	9663	31622	108	115	126	50	10	5	38	
80-20T4	20	9.525	4	125	12375	42162	108	115	149	63	10	5	43	
100-12T4	100	12	7.938	4	105	8306	33001	123	130	95	40	8	4	27.5
100-12T6		12	7.938	6	175	11772	49502	123	130	123	50	8	4	36.5
100-16T4		16	9.525	4	107	13569	53161	125	135	124	50	10	5	37
100-16T6		16	9.525	6	140	19230	79741	125	135	161	63	10	5	49
100-20T4	20	9.525	4	155	13569	53161	125	135	149	63	10	5	43	

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while axial load is 30% of dynamic load rating.

**F D I** Type

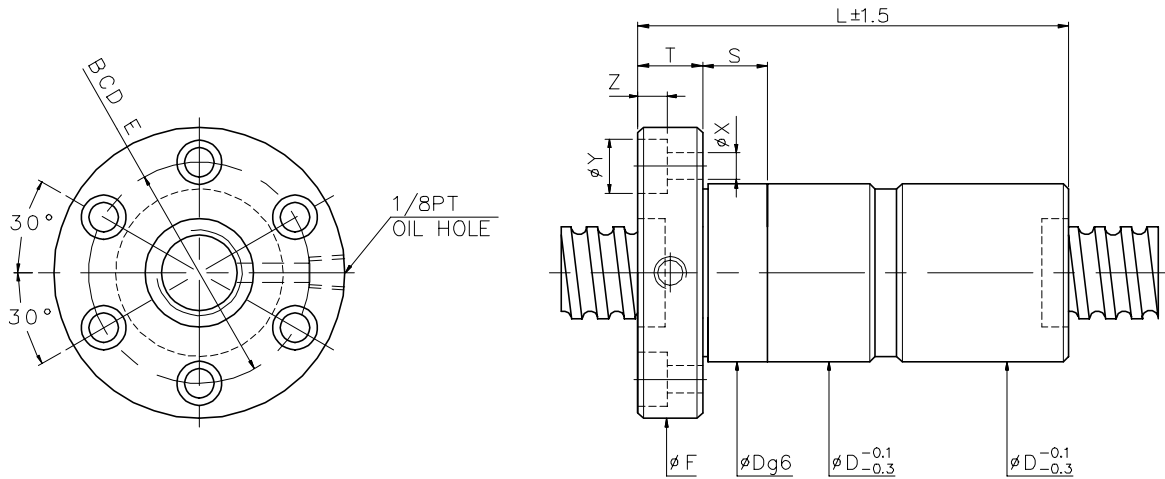


Model	Size		Ball Dia.	Circuits	Stiffness kgf/μm K	Dynamic Load 1x10 <sup>6</sup> revs C (kgf)	Static Load Co (kgf)	Nut			Flange			Bolt			Fit	
	Nominal Dia.	Lead						D	L	F	T	BCD-E	X	Y	Z	S		
16-5T3	16	5	3.175	3	20	731	1331	28	30	78	54	12	41	5.5	9.5	5.5	24	
16-5T4		5	3.175	4	23	936	1775	28	30	90	54	12	41	5.5	9.5	5.5	24	
20-5T3	20	5	3.175	3	39	852	1767	32	34	78	57	12	45	5.5	9.5	5.5	24	
20-5T4		5	3.175	4	54	1090	2356	32	34	92	57	12	45	5.5	9.5	5.5	24	
20-6T3		6	3.969	3	39	1091	2081	34	36	89	60	12	48	5.5	9.5	5.5	24	
20-6T4		6	3.969	4	54	1398	2774	34	36	109	60	12	48	5.5	9.5	5.5	24	
25-5T3	25	5	3.175	3	55	977	2314	37	40	78	64	12	52	5.5	9.5	5.5	24	
25-5T4		5	3.175	4	73	1252	3085	37	40	96	64	12	52	5.5	9.5	5.5	24	
25-6T3		6	3.969	3	56	1272	2762	38	42	89	65	12	53	5.5	9.5	5.5	24	
25-6T4		6	3.969	4	75	1628	3682	38	42	109	65	12	53	5.5	9.5	5.5	24	
32-5T3	32	5	3.175	3	64	1117	3081	44	48	78	74	12	60	6.6	11	6.5	24	
32-5T4		5	3.175	4	82	1431	4108	44	48	96	74	12	60	6.6	11	6.5	24	
32-5T6		5	3.175	6	121	2027	6162	44	48	118	74	12	60	6.6	11	6.5	24	
32-6T3		6	3.969	3	65	1446	3620	45	50	89	76	12	62	6.6	11	6.5	24	
32-6T4		6	3.969	4	84	1852	4826	45	50	109	76	12	62	6.6	11	6.5	24	
32-6T6		6	3.969	6	125	2625	7239	45	50	137	76	12	62	6.6	11	6.5	24	
32-8T3		8	4.763	3	68	1810	4227	47	52	110	78	16	64	6.6	11	6.5	24	
32-8T4		8	4.763	4	82	2317	5635	47	52	136	78	16	64	6.6	11	6.5	24	
32-10T3		10	6.350	3	68	2539	5327	51	56	129	82	16	68	6.6	11	6.5	24	
32-10T4		10	6.350	4	82	3252	7102	51	56	155	82	16	68	6.6	11	6.5	24	
40-5T4	40	5	3.175	4	99	1599	5280	51	54	96	80	16	66	6.6	11	6.5	24	
40-5T6		5	3.175	6	146	2265	7919	51	54	122	80	16	66	6.6	11	6.5	24	
40-6T4		6	3.969	4	100	2136	6420	53	56	113	88	16	72	9	14	8.5	30	
40-6T6		6	3.969	6	148	3028	9630	53	56	141	88	16	72	9	14	8.5	30	
40-8T4		8	4.763	4	102	2728	7596	55	60	136	92	16	75	9	14	8.5	30	
40-8T6		8	4.763	6	150	3866	11394	55	60	178	92	16	75	9	14	8.5	30	
40-10T3		10	6.350	3	76	2959	7069	60	65	133	96	16	80	9	14	8.5	30	
40-10T4		10	6.350	4	101	3789	9426	60	65	155	96	16	80	9	14	8.5	30	
50-5T4		50	5	3.175	4	121	1757	6745	62	65	96	96	16	80	9	14	8.5	30
50-5T6			5	3.175	6	177	2490	10117	62	65	122	96	16	80	9	14	8.5	30

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while preload is 10% of dynamic load rating and axial load is applied.



**F D I** Type

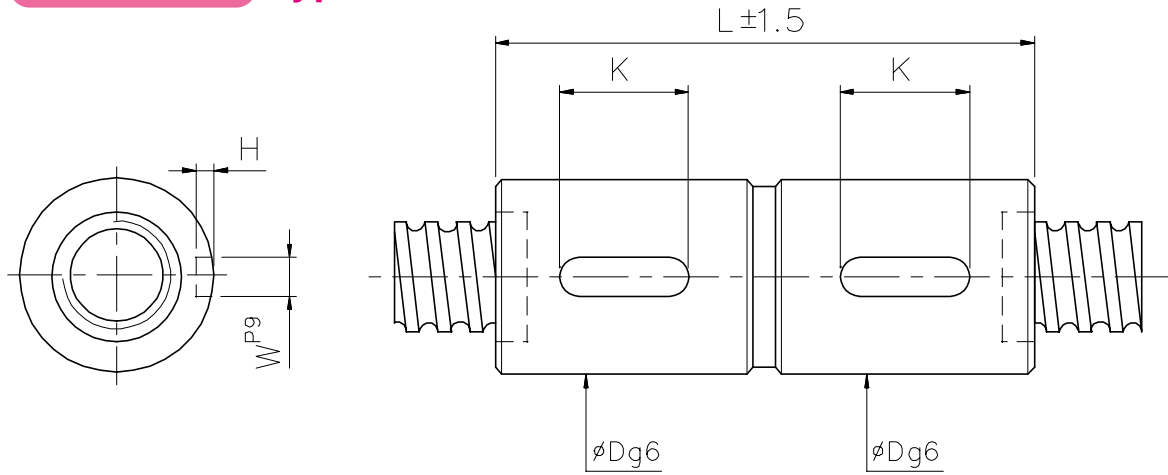


Model	Size		Ball Dia.	Circuits	Stiffness kgf / $\mu$ m K	Dynamic Load $1 \times 10^6$ revs C (kgf)	Static Load Co (kgf)	Nut			Flange			Bolt			Fit	
	Nominal Dia.	Lead						D	L	F	T	BCD-E	X	Y	Z	S		
50-6T4	50	6	3.969	4	123	2388	8250	64	68	113	100	16	84	9	14	8.5	30	
50-6T6		6	3.969	6	179	3384	12375	64	68	147	100	16	84	9	14	8.5	30	
50-8T4		8	4.763	4	122	2998	9578	65	70	136	102	16	85	9	14	8.5	30	
50-8T6		8	4.763	6	178	4249	14367	65	70	178	102	16	85	9	14	8.5	30	
50-10T3		10	6.350	3	95	3397	9256	69	74	135	114	18	92	11	17.5	11	40	
50-10T4		10	6.350	4	124	4350	12341	69	74	157	114	18	92	11	17.5	11	40	
50-10T6		10	6.350	6	184	6165	18511	69	74	203	114	18	92	11	17.5	11	40	
50-12T3		12	7.938	3	94	4420	11047	73	78	158	118	18	96	11	17.5	11	40	
50-12T4		12	7.938	4	124	5660	14730	73	78	184	118	18	96	11	17.5	11	40	
63-6T4		63	6	3.969	4	148	2674	10542	78	80	115	119	18	98	11	17.5	11	40
63-6T6			6	3.969	6	220	3704	15813	78	80	143	119	18	98	11	17.5	11	40
63-8T4			8	4.763	4	152	3395	12541	79	82	138	122	18	100	11	17.5	11	40
63-8T6	8		4.763	6	222	4812	18811	79	82	180	122	18	100	11	17.5	11	40	
63-10T4	10		6.350	4	158	4860	15858	82	88	159	134	20	110	14	20	13	40	
63-10T6	10		6.350	6	228	6887	23786	82	88	205	134	20	110	14	20	13	40	
63-12T4	12		7.938	4	152	6479	19293	86	92	186	138	20	114	14	20	13	40	
63-12T6	12		7.938	6	224	9182	28939	86	92	242	138	20	114	14	20	13	40	
80-10T4	80		10	6.350	4	190	5559	21118	99	105	172	152	20	127	14	20	13	40
80-10T6			10	6.350	6	277	7879	31677	99	105	214	152	20	127	14	20	13	40
80-12T4			12	7.938	4	192	7430	25681	103	110	190	170	24	138	18	26	17.5	50
80-12T6			12	7.938	6	280	10530	38521	103	110	246	170	24	138	18	26	17.5	50
80-16T3		16	9.525	3	188	9663	31622	108	115	208	174	24	143	18	26	17.5	50	
80-16T4		16	9.525	4	254	12375	42162	108	115	244	174	24	143	18	26	17.5	50	
80-20T3		20	9.525	3	189	9663	31622	108	115	250	174	24	143	18	26	17.5	50	
80-20T4		20	9.525	4	248	12375	42162	108	115	296	174	24	143	18	26	17.5	50	
100-12T4		100	12	7.938	4	206	8306	33001	123	130	190	190	24	158	18	26	17.5	50
100-12T6			12	7.938	6	343	11772	49502	123	130	246	190	24	158	18	26	17.5	50
100-16T4			16	9.525	4	212	13569	53161	125	135	244	194	24	163	18	26	17.5	60
100-16T6			16	9.525	6	276	19230	79741	125	135	318	194	24	163	18	26	17.5	60
100-20T4	20		9.525	4	300	13569	53161	125	135	296	194	24	163	18	26	17.5	60	

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while preload is 10% of dynamic load rating and axial load is applied.



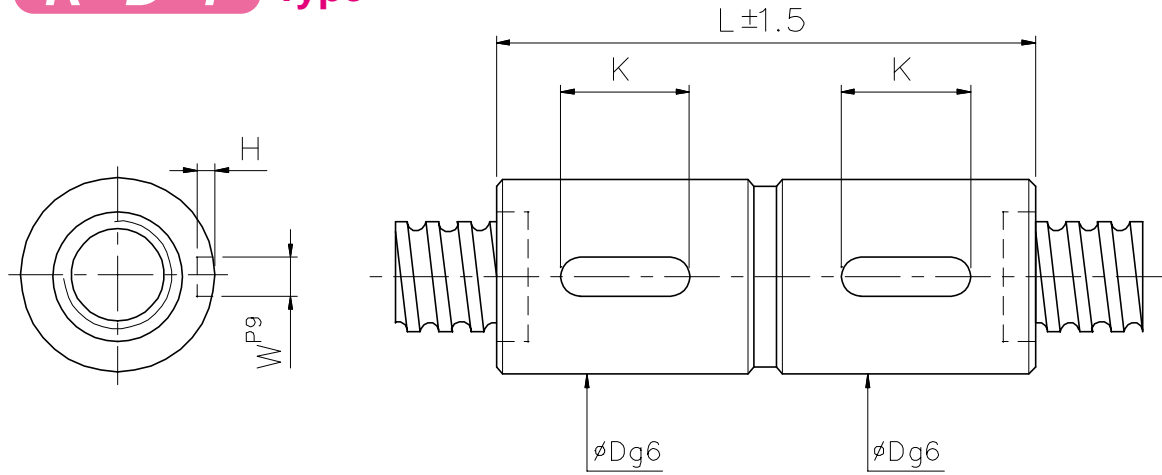
**R D I** Type



Model	Size		Ball Dia.	Circuits	Stiffness kgf/μm K	Dynamic Load 1x10 <sup>6</sup> revs C ( kgf )	Static Load Co ( kgf )	Nut		Keyway			
	Nominal Dia.	Lead						D	L	K	W	H	
16-5T3	16	5	3.175	3	20	731	1331	28	30	72	20	3	1.8
16-5T4		5	3.175	4	23	936	1775	28	30	85	20	3	1.8
20-5T3	20	5	3.175	3	39	852	1767	32	34	75	20	3	1.8
20-5T4		5	3.175	4	54	1091	2356	32	34	85	20	3	1.8
20-6T3	20	6	3.969	3	39	1091	2081	34	36	87	20	4	2.5
20-6T4		6	3.969	4	54	1398	2774	34	36	103	25	4	2.5
25-5T3	25	5	3.175	3	55	977	2314	37	40	75	20	4	2.5
25-5T4		5	3.175	4	73	1252	3085	37	40	85	20	4	2.5
25-6T3	25	6	3.969	3	56	1272	2762	38	42	87	20	4	2.5
25-6T4		6	3.969	4	75	1628	3682	38	42	103	25	4	2.5
32-5T3	32	5	3.175	3	64	1117	3081	44	48	75	20	4	2.5
32-5T4		5	3.175	4	82	1431	4108	44	48	85	20	4	2.5
32-5T6	32	5	3.175	6	121	2027	6162	44	48	105	25	4	2.5
32-6T3		6	3.969	3	65	1446	3620	45	50	87	20	5	3
32-6T4	32	6	3.969	4	84	1852	4826	45	50	103	25	5	3
32-6T6		6	3.969	6	125	2625	7239	45	50	127	32	5	3
32-8T3	32	8	4.763	3	68	1810	4227	47	52	109	25	5	3
32-8T4		8	4.763	4	82	2317	5635	47	52	127	25	5	3
32-10T3	32	10	6.350	3	68	2539	5327	51	56	135	25	6	3.5
32-10T4		10	6.350	4	82	3252	7102	51	56	155	32	6	3.5
40-5T4	40	5	3.175	4	99	1599	5280	51	54	85	20	4	2.5
40-5T6		5	3.175	6	146	2265	7919	51	54	105	25	4	2.5
40-6T4	40	6	3.969	4	100	2136	6420	53	56	103	25	5	3
40-6T6		6	3.969	6	148	3028	9630	53	56	127	32	5	3
40-8T4	40	8	4.763	4	102	2728	7596	55	60	127	25	5	3
40-8T6		8	4.763	6	150	3866	11394	55	60	161	40	5	3
40-10T3	40	10	6.350	3	76	2959	7069	60	65	135	25	6	3.5
40-10T4		10	6.350	4	101	3789	9426	60	65	155	32	6	3.5
50-5T4	50	5	3.175	4	121	1757	6745	62	65	85	20	4	2.5
50-5T6		5	3.175	6	177	2490	10117	62	65	105	25	4	2.5

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while preload is 10% of dynamic load rating and axial load is applied.

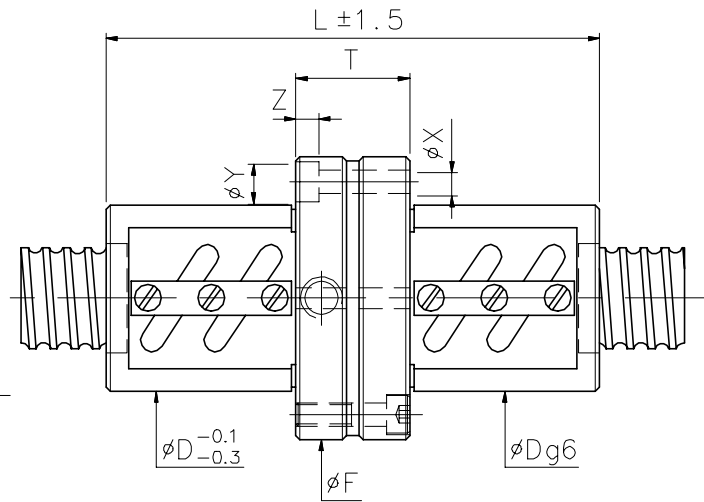
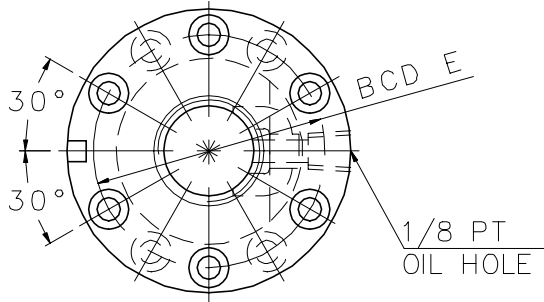
**R D I** Type



Model	Size		Ball Dia.	Circuits	Stiffness kgf/ $\mu$ m K	Dynamic Load 1x10 <sup>6</sup> revs C ( kgf )	Static Load Co ( kgf )	Nut		Keyway			
	Nominal Dia.	Lead						D	L	K	W	H	
50-6T4	50	6	3.969	4	123	2388	8250	64	68	103	25	5	3
50-6T6		6	3.969	6	179	3384	12375	64	68	127	32	5	3
50-8T4		8	4.763	4	122	2998	9578	65	70	127	32	5	3
50-8T6		8	4.763	6	178	4249	14367	65	70	161	40	5	3
50-10T3		10	6.350	3	95	3397	9256	69	74	135	32	6	3.5
50-10T4		10	6.350	4	124	4350	12341	69	74	155	32	6	3.5
50-10T6		10	6.350	6	184	6165	18511	69	74	197	40	6	3.5
50-12T3		12	7.938	3	94	4420	11047	73	78	161	40	6	3.5
50-12T4		12	7.938	4	124	5660	14730	73	78	185	40	6	3.5
63-6T4		63	6	3.969	4	148	2614	10542	78	80	106	25	6
63-6T6	6		3.969	6	220	3704	15813	78	80	130	32	6	3.5
63-8T4	8		4.763	4	152	3395	12541	79	82	131	32	6	3.5
63-8T6	8		4.763	6	222	4812	18811	79	82	165	40	6	3.5
63-10T4	10		6.350	4	158	4860	15858	82	88	160	32	8	4
63-10T6	10		6.350	6	228	6887	23786	82	88	202	40	8	4
63-12T4	12	7.938	4	152	6479	19293	86	92	185	40	8	4	
63-12T6	12	7.938	6	224	9182	28939	86	92	238	50	8	4	
80-10T4	80	10	6.350	4	190	5559	21118	99	105	160	32	8	4
80-10T6		10	6.350	6	277	7879	31677	99	105	202	40	8	4
80-12T4		12	7.938	4	192	7430	25681	103	110	185	40	8	4
80-12T6		12	7.938	6	280	10530	38521	103	110	238	50	8	4
80-16T3		16	9.525	3	188	9663	31622	108	115	200	40	10	5
80-16T4		16	9.525	4	254	12375	42162	108	115	236	50	10	5
80-20T3		20	9.525	3	189	9663	31622	108	115	245	50	10	5
80-20T4		20	9.525	4	248	12375	42162	108	115	289	63	10	5
100-12T4	100	12	7.938	4	206	8306	33001	123	130	185	40	8	4
100-12T6		12	7.938	6	343	11772	49502	123	130	238	50	8	4
100-16T4		16	9.525	4	212	13569	53161	125	135	236	50	10	5
100-16T6		16	9.525	6	276	19230	79741	125	135	310	63	10	5
100-20T4	20	9.525	4	300	13569	53161	125	135	289	63	10	5	

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while preload is 10% of dynamic load rating and axial load is applied.

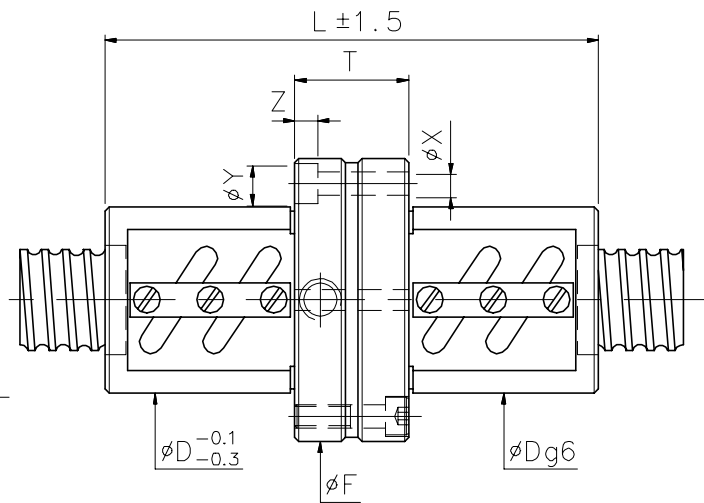
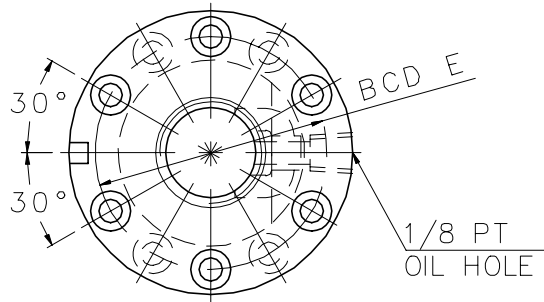
## PFDW Type 1



Model	Size		Ball Dia.	Circuits	Stiffness kgf/μm K	Dynamic Load 1x10 <sup>6</sup> revs C (kgf)	Static Load Co (kgf)	Nut		Flange			Bolt		
	Nominal Dia.	Lead						D	L	F	T	BCD-E	X	Y	Z
20-5B1	20	5	3.175	2.5x1	38	837	1733	44	87	67	27	55	5.5	9.5	5.5
20-5B2		5	3.175	2.5x2	76	1519	3465	44	117	67	27	55	5.5	9.5	5.5
20-6B1		6	3.969	2.5x1	40	1139	2187	48	95	71	29	59	5.5	9.5	5.5
20-6C1		6	3.969	3.5x1	55	1512	3041	48	107	71	29	59	5.5	9.5	5.5
25-5B1	25	5	3.175	2.5x1	46	939	2209	50	86	73	28	61	5.5	9.5	5.5
25-5B2		5	3.175	2.5x2	90	1704	4417	50	116	73	28	61	5.5	9.5	5.5
25-5C1		5	3.175	3.5x1	68	1252	3085	50	96	73	28	61	5.5	9.5	5.5
25-6B2		6	3.969	2.5x2	94	2308	5523	56	131	82	29	69	5.5	9.5	5.5
25-6C1	6	3.969	3.5x1	66	1690	3844	56	107	82	29	69	5.5	9.5	5.5	
32-5B1	32	5	3.175	2.5x1	55	1039	2833	58	91	85	33	71	6.6	11	6.5
32-5B2		5	3.175	2.5x2	109	1886	5666	58	121	85	33	71	6.6	11	6.5
32-6B1		6	3.969	2.5x1	57	1409	3510	62	95	89	29	75	6.6	11	6.5
32-6B2		6	3.969	2.5x2	112	2556	7020	62	131	89	29	75	6.6	11	6.5
32-8B1		8	4.763	2.5x1	58	1810	4227	66	125	100	39	82	9	14	8.5
32-8B2		8	4.763	2.5x2	115	3284	8453	66	173	100	39	82	9	14	8.5
32-10B1		10	6.350	2.5x1	58	2651	5600	74	148	108	38	90	9	14	8.5
32-10B2		10	6.350	2.5x2	118	4810	11199	74	208	108	38	90	9	14	8.5
32-10C1		10	6.350	3.5x1	86	3519	7785	74	168	108	38	90	9	14	8.5

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while preload is 10% of dynamic load rating and axial load is applied.

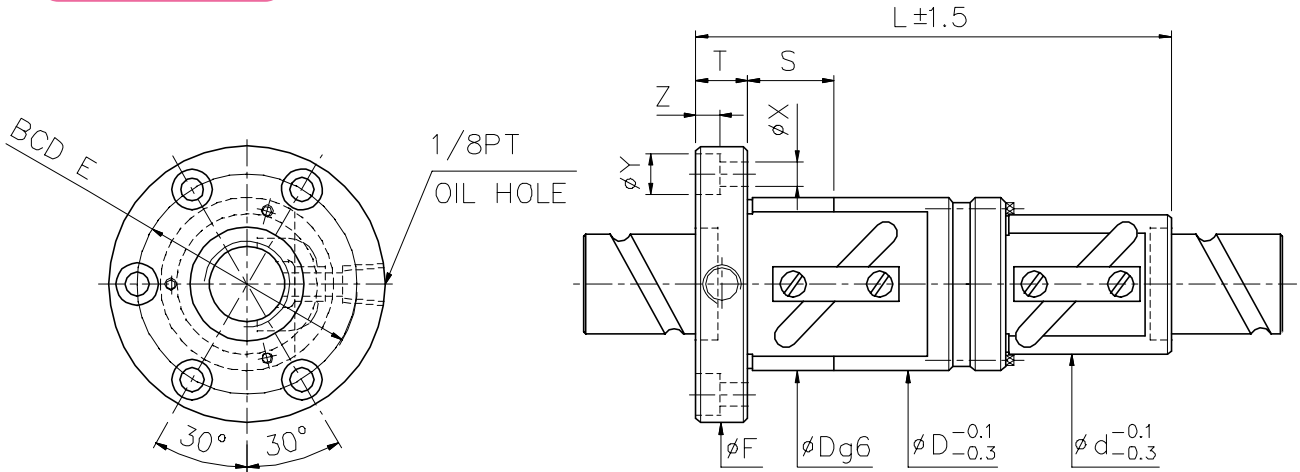
**PFDW Type 1**



Model	Size		Ball Dia.	Circuits	Stiffness kgf/μm K	Dynamic Load 1x10 <sup>6</sup> revs C (kgf)	Static Load Co (kgf)	Nut		Flange			Bolt		
	Nominal Dia.	Lead						D	L	F	T	BCD-E	X	Y	Z
40-5B1	40	5	3.175	2.5x1	65	1141	3567	68	96	101	38	83	9	14	8.5
40-5B2		5	3.175	2.5x2	132	2071	7134	68	126	101	38	83	9	14	8.5
40-6B1		6	3.969	2.5x1	67	1552	4428	70	101	104	35	86	9	14	8.5
40-6B2		6	3.969	2.5x2	136	2817	8855	70	137	104	35	86	9	14	8.5
40-8B1		8	4.763	2.5x1	69	2003	5302	74	125	108	39	90	9	14	8.5
40-8B2		8	4.763	2.5x2	137	3634	10603	74	173	108	39	90	9	14	8.5
40-10B1		10	6.350	2.5x1	72	2959	7069	84	158	125	48	104	11	17.5	11
40-10B2		10	6.350	2.5x2	145	5370	14138	84	218	125	48	104	11	17.5	11
40-10C1		10	6.350	3.5x1	102	3932	9841	84	178	125	48	104	11	17.5	11
40-12B1		12	7.144	2.5x1	70	3425	7837	86	174	128	48	106	11	17.5	11
40-12B2	12	7.144	2.5x2	141	6217	15674	86	246	128	48	106	11	17.5	11	
50-8B1	50	8	4.763	2.5x1	81	2206	6705	87	133	129	47	107	11	17.5	11
50-8B2		8	4.763	2.5x2	165	4004	13409	87	181	129	47	107	11	17.5	11
50-10B1		10	6.350	2.5x1	87	3264	8835	94	158	135	48	113	11	17.5	11
50-10B2		10	6.350	2.5x2	173	5923	17670	94	218	135	48	113	11	17.5	11
50-12B2		12	7.938	2.5x2	178	8022	22094	102	260	150	58	125	14	20	13
50-12C1		12	7.938	3.5x1	123	5875	15380	102	200	150	58	125	14	20	13
63-10B2	63	10	6.350	2.5x2	206	6533	22371	110	228	156	58	132	14	20	13
63-10B3		10	6.350	2.5x3	305	9258	33556	110	288	156	58	132	14	20	13
63-12B2		12	7.938	2.5x2	214	8943	28062	118	260	166	58	141	14	20	13
80-12B2	80	12	7.938	2.5x2	257	9797	35422	136	260	185	58	159	14	20	13
80-12B3		12	7.938	2.5x3	380	13884	53132	136	340	185	58	159	14	20	13
80-20B2		20	9.525	2.5x2	338	16485	58851	145	404	204	66	173	18	26	17.5
100-20B2	100	20	9.525	2.5x2	400	18123	74425	170	404	243	86	205	22	32	21.5

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while preload is 10% of dynamic load rating and axial load is applied.

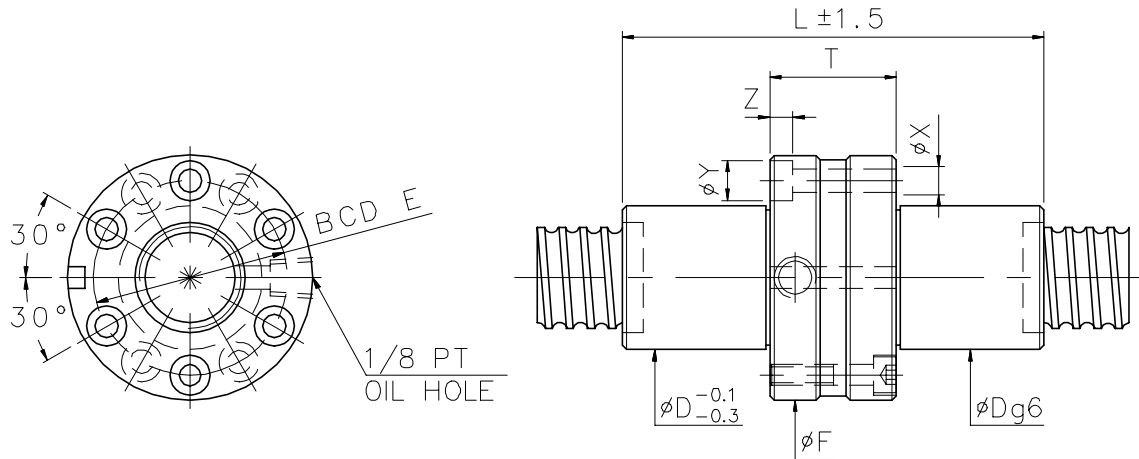
## PFDW Type 2



Model	Size		Ball Dia.	Circuits	Stiffness kgf/μm K	Dynamic Load 1x10 <sup>6</sup> revs C (kgf)	Static Load Co (kgf)	Nut			Flange			Bolt			Fit
	Nominal Dia.	Lead						D	d	L	F	T	BCD-E	X	Y	Z	
20-20A1	20	20	3.969	1.5x1	26	719	1281	48	34	140	72	12	59	5.5	9.5	5.5	24
25-16B1	25	16	4.763	2.5x1	56	1592	3237	62	45	148	89	16	75	6.6	11	6.5	24
25-20B1		20	4.763	2.5x1	56	1592	3237	62	45	178	89	16	75	6.6	11	6.5	24
25-25A1	32	25	4.763	1.5x1	32	1019	1927	62	45	166	89	16	75	6.6	11	6.5	24
32-20B1		20	4.763	2.5x1	66	1810	4227	68	54	181	102	16	84	9	14	8.5	30
32-25B1	40	25	4.763	2.5x1	66	1810	4227	68	54	218	102	16	84	9	14	8.5	30
32-32A1		32	4.763	1.5x1	36	1154	2505	68	54	205	102	16	84	9	14	8.5	30
40-25B1	50	25	6.350	2.5x1	78	2959	7069	84	65	224	126	18	104	11	17.5	11	30
40-32B1		32	6.350	2.5x1	78	2959	7069	84	65	276	126	18	104	11	17.5	11	30
40-40A1	50	40	6.350	1.5x1	48	1875	4159	84	65	274	126	18	104	11	17.5	11	30
50-40A1		40	7.938	1.5x1	54	2801	6499	106	82	264	152	22	128	13	20	13	40
50-50A1	50	50	7.938	1.5x1	60	2801	6499	106	82	320	152	22	128	13	20	13	40

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while preload is 10% of dynamic load rating and axial load is applied.

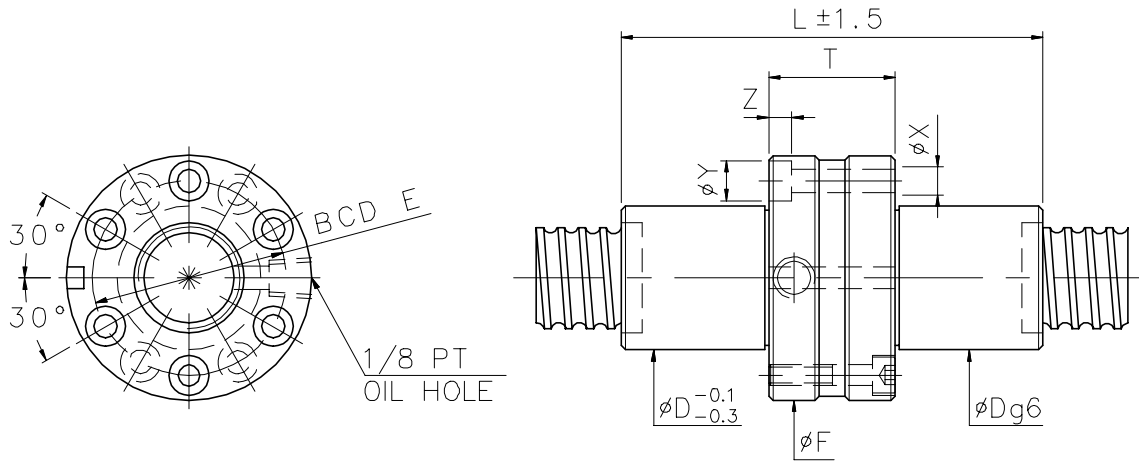
**PFDI Type**



Model	Size		Ball Dia.	Circuits	Stiffness kgf / $\mu\text{m}$ K	Dynamic Load $1 \times 10^6$ revs C (kgf)	Static Load Co (kgf)	Nut			Flange			Bolt			
	Nominal Dia.	Lead						D	L	F	T	BCD-E	X	Y	Z		
20-5T3	20	5	3.175	3	39	852	1767	32	34	100	58	30	46	5.5	9.5	5.5	
20-5T4		5	3.175	4	54	1091	2356	32	34	110	58	30	46	5.5	9.5	5.5	
20-6T3		6	3.969	3	39	1091	2081	34	36	111	58	29	46	5.5	9.5	5.5	
20-6T4		6	3.969	4	54	1398	2774	34	36	127	58	29	46	5.5	9.5	5.5	
25-5T3	25	5	3.175	3	55	977	2314	37	40	100	63	30	51	5.5	9.5	5.5	
25-5T4		5	3.175	4	73	1252	3085	37	40	110	63	30	51	5.5	9.5	5.5	
25-6T3		6	3.969	3	56	1272	2762	38	42	111	63	29	51	5.5	9.5	5.5	
25-6T4		6	3.969	4	75	1628	3682	38	42	127	63	29	51	5.5	9.5	5.5	
32-5T3	32	5	3.175	3	64	1117	3081	44	48	100	75	30	61	6.6	11	6.5	
32-5T4		5	3.175	4	82	1431	4108	44	48	110	75	30	61	6.6	11	6.5	
32-6T3		6	3.969	3	65	1446	3620	45	50	111	75	29	61	6.6	11	6.5	
32-6T4		6	3.969	4	84	1852	4826	45	50	127	75	29	61	6.6	11	6.5	
32-8T3		8	4.763	3	68	1810	4227	47	52	139	85	35	68	9	14	8.5	
32-8T4		8	4.763	4	82	2317	5635	47	52	157	85	35	68	9	14	8.5	
32-10T3		10	6.350	3	68	2539	5327	51	56	165	89	35	72	9	14	8.5	
32-10T4		10	6.350	4	82	3252	7102	51	56	185	89	35	72	9	14	8.5	
40-5T4		40	5	3.175	4	99	1599	5280	51	54	115	90	35	72	9	14	8.5
40-5T6			5	3.175	6	146	2265	7919	51	54	135	90	35	72	9	14	8.5
40-6T4	6		3.969	4	100	2136	6420	53	56	133	90	35	72	9	14	8.5	
40-6T6	6		3.969	6	148	3028	9630	53	56	157	90	35	72	9	14	8.5	
40-8T4	8		4.763	4	102	2728	7596	55	60	157	94	35	76	9	14	8.5	
40-8T6	8		4.763	6	150	3866	11394	55	60	191	94	35	76	9	14	8.5	
40-10T3	10		6.350	3	76	2529	7069	60	65	175	106	45	85	11	17.5	11	
40-10T4	10		6.350	4	101	3789	9426	60	65	195	106	45	85	11	17.5	11	

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while preload is 10% of dynamic load rating and axial load is applied.

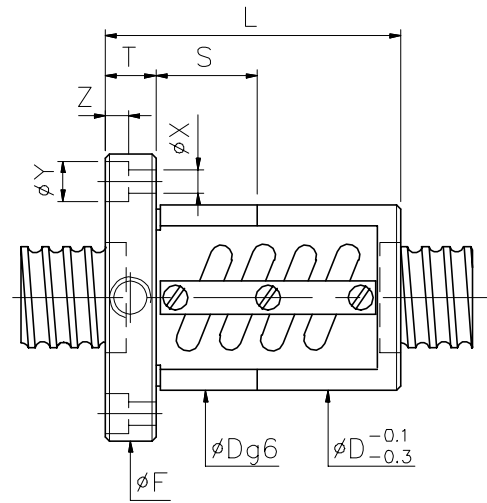
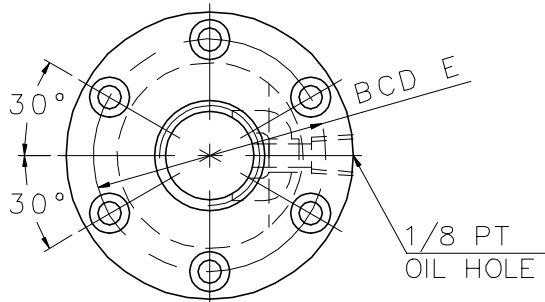
**PFDI** Type



Model	Size		Ball Dia.	Circuits	Stiffness kgf / $\mu\text{m}$ K	Dynamic Load $1 \times 10^6$ revs C (kgf)	Static Load Co (kgf)	Nut			Flange			Bolt		
	Nominal Dia.	Lead						D	L	F	T	BCD-E	X	Y	Z	
50-5T4	50	5	3.175	4	121	1757	6745	62	65	115	100	35	82	9	14	8.5
50-5T6		5	3.175	6	177	2490	10117	62	65	135	100	35	82	9	14	8.5
50-6T4		6	3.969	4	123	2388	8250	64	68	136	100	38	83	9	14	8.5
50-6T6		6	3.969	6	179	3384	12375	64	68	160	100	38	83	9	14	8.5
50-8T4		8	4.763	4	122	2998	9578	65	70	165	112	43	90	11	17.5	11
50-8T6		8	4.763	6	178	4249	14367	65	70	199	112	43	90	11	17.5	11
50-10T3		10	6.350	3	95	3397	9256	69	74	175	114	45	93	11	17.5	11
50-10T4		10	6.350	4	124	4350	12341	69	74	195	114	45	93	11	17.5	11
50-10T6		10	6.350	6	184	6165	18511	69	74	235	114	43	93	11	17.5	11
50-12T3		12	7.938	3	94	4420	11047	73	78	203	121	49	97	14	20	13
50-12T4		12	7.938	4	124	5660	14730	73	78	227	121	49	97	14	20	13
63-6T4		63	6	3.969	4	148	2614	10542	78	80	142	122	44	100	11	17.5
63-6T6	6		3.969	6	220	3704	15813	78	80	166	122	44	100	11	17.5	11
63-8T4	8		4.763	4	152	3395	12541	79	82	165	124	43	102	11	17.5	11
63-8T6	8		4.763	6	222	4812	18811	79	82	199	124	43	102	11	17.5	11
63-10T4	10		6.350	4	158	4860	15858	82	88	205	133	55	109	14	20	13
63-10T6	10		6.350	6	228	6887	23786	82	88	245	133	53	109	14	20	13
63-12T4	12	7.938	4	152	6479	19293	86	92	230	136	52	113	14	20	13	
63-12T6	12	7.938	6	224	9182	28939	86	92	280	136	52	113	14	20	13	
80-10T4	80	10	6.350	4	190	5559	21118	99	105	205	151	55	127	14	20	13
80-10T6		10	6.350	6	277	7879	31677	99	105	245	151	53	127	14	20	13
80-12T4		12	7.938	4	192	7430	25681	103	110	230	156	52	132	14	20	13
80-12T6		12	7.938	6	280	10530	38521	103	110	280	156	52	132	14	20	13
80-20T3		20	9.525	3	189	9663	31622	108	115	301	173	65	143	18	26	17.5
80-20T4		20	9.525	4	248	12375	42162	108	115	346	173	66	143	18	26	17.5
100-10T6	100	10	6.350	6	236	8662	40469	120	125	245	171	53	147	14	20	13
100-12T6		12	9.525	6	343	19230	79741	125	135	292	188	64	158	18	26	17.5
100-20T4		20	9.525	4	300	13569	53161	125	135	356	205	76	169	22	32	21.5

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while preload is 10% of dynamic load rating and axial load is applied.

**OFSW** Type

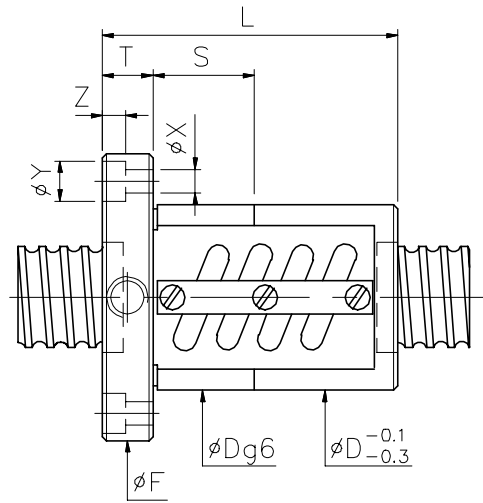
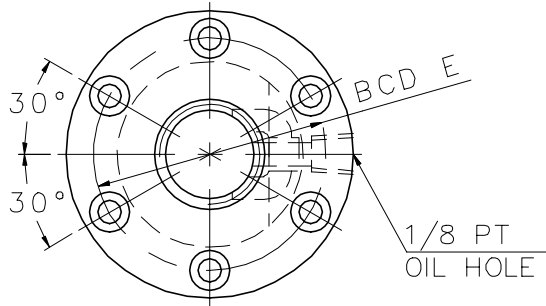


Model	Size		Ball Dia.	Circuits	Stiffness kgf / $\mu\text{m}$ K	Dynamic Load $1 \times 10^6$ revs C (kgf)	Static Load Co (kgf)	Nut		Flange			Bolt			Fit
	Nominal Dia.	Lead						D	L	F	T	BCD-E	X	Y	Z	
16-5B1	16	5	3.175	2.5x1	32	763	1400	40	58	64	12	51	5.5	9.5	5.5	24
16-5A1		5	3.175	1.5x1	20	482	820	40	50	64	12	51	5.5	9.5	5.5	24
20-5B1	20	5	3.175	2.5x1	38	837	1733	44	60	68	12	55	5.5	9.5	5.5	24
20-5A2		5	3.175	1.5x2	46	979	2079	44	70	68	12	55	5.5	9.5	5.5	24
20-6B1		6	3.969	2.5x1	40	1139	2187	48	69	72	12	59	5.5	9.5	5.5	24
25-5B1	25	5	3.175	2.5x1	46	939	2209	50	60	74	12	62	5.5	9.5	5.5	24
25-5A2		5	3.175	1.5x2	48	1078	2594	50	70	74	12	62	5.5	9.5	5.5	24
25-5C1		5	3.175	3.5x1	68	1252	3085	50	72	74	12	62	5.5	9.5	5.5	24
25-6A2		6	3.969	1.5x2	56	1462	3249	56	82	82	12	69	6.6	11	6.5	24
25-6C1		6	3.969	3.5x1	66	1690	3844	56	81	82	12	69	6.6	11	6.5	24
25-10A1		10	4.763	1.5x1	29	1019	1927	60	81	86	16	73	6.6	11	6.5	24
28-5B1	28	5	3.175	2.5x1	51	984	2466	55	60	85	12	69	6.6	11	6.5	24
28-5B2		5	3.175	2.5x2	98	1785	4932	55	96	85	12	69	6.6	11	6.5	24
28-6A2		6	3.175	1.5x2	59	1150	2960	55	80	85	12	69	6.6	11	6.5	24
32-5B1	32	5	3.175	2.5x1	55	1039	2833	58	62	84	12	71	6.6	11	6.5	24
32-5A2		5	3.175	1.5x2	65	1216	3400	58	70	84	12	71	6.6	11	6.5	24
32-5C1		5	3.175	3.5x1	76	1388	3967	58	72	84	12	71	6.6	11	6.5	24
32-6B1		6	3.969	2.5x1	57	1409	3510	62	70	88	12	75	6.6	11	6.5	24
32-6A2		6	3.969	1.5x2	67	1633	4168	62	81	88	12	75	6.6	11	6.5	24
32-6C1		6	3.969	3.5x1	78	1888	4936	62	83	88	12	75	6.6	11	6.5	24
32-8B1		8	4.763	2.5x1	58	1810	4227	66	92	100	16	82	9	14	8.5	30
32-8A2		8	4.763	1.5x2	69	2094	5009	66	106	100	16	82	9	14	8.5	30
32-8C1		8	4.763	3.5x1	82	2428	5948	66	108	100	16	82	9	14	8.5	30
32-10B1		10	6.350	2.5x1	58	2651	5600	74	110	108	16	90	9	14	8.5	30
32-10A1		10	6.350	1.5x1	36	1673	3278	74	90	108	16	90	9	14	8.5	30
36-6B1	36	6	3.969	2.5x1	62	1486	3969	65	68	100	12	82	6.6	11	6.5	24
36-6B2		6	3.969	2.5x2	121	2696	7937	65	103	100	12	82	6.6	11	6.5	24
36-10A1		10	6.350	1.5x1	40	1779	3718	75	90	120	18	98	11	17.5	11	30

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while preload is 10% of dynamic load rating and axial load is applied.



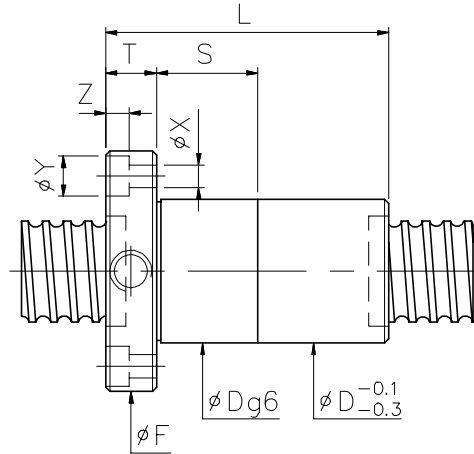
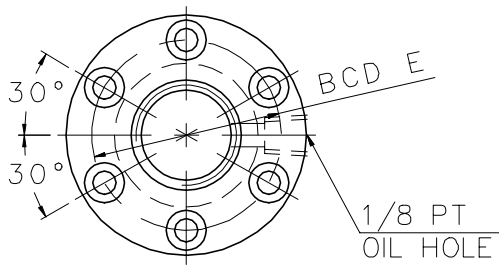
**OFSW Type**



Model	Size		Ball Dia.	Circuits	Stiffness kgf / $\mu\text{m}$ K	Dynamic Load $1 \times 10^6$ revs C (kgf)	Static Load Co (kgf)	Nut		Flange			Bolt			Fit	
	Nominal Dia.	Lead						D	L	F	T	BCD-E	X	Y	Z		S
40-5B1	40	5	3.175	2.5x1	65	1141	3567	68	65	102	16	84	9	14	8.5	30	
40-5B2		5	3.175	2.5x2	132	2071	7134	68	95	102	16	84	9	14	8.5	30	
40-6B2		6	3.969	2.5x2	136	2817	8855	70	109	104	16	86	9	14	8.5	30	
40-8B1		8	4.763	2.5x1	69	2003	5302	74	90	108	16	90	9	14	8.5	30	
40-8C1		8	4.763	3.5x1	96	2679	7438	74	108	108	16	90	9	14	8.5	30	
40-10B1		10	6.350	2.5x1	72	2959	7069	84	110	125	18	104	11	17.5	11	30	
40-10C1		10	6.350	3.5x1	102	3932	9841	84	132	125	18	104	11	17.5	11	30	
40-12B1		12	7.144	2.5x1	72	3425	7837	86	117	128	18	106	11	17.5	11	40	
40-16A1		16	7.144	1.5x1	46	2208	4703	86	117	128	18	106	11	17.5	11	40	
45-10B1		45	10	6.350	2.5x1	76	3111	7953	88	110	132	18	110	11	17.5	11	30
45-12B1	12		7.938	2.5x1	81	4202	9900	96	132	142	22	117	13	20	13	40	
50-5A2	50	5	3.175	1.5x2	96	1447	5382	80	74	114	16	96	9	14	8.5	30	
50-5A3		5	3.175	1.5x3	143	2051	8072	80	103	114	16	96	9	14	8.5	30	
50-6B2		6	3.969	2.5x2	161	3093	11149	84	110	118	16	100	9	14	8.5	30	
50-8B1		8	4.763	2.5x1	81	2206	6705	87	92	128	18	107	11	17.5	11	30	
50-8B2		8	4.763	2.5x2	165	4004	13409	87	140	128	18	107	11	17.5	11	30	
50-10B2		10	6.350	2.5x2	173	5923	17670	94	170	135	18	114	11	17.5	11	30	
50-10C1		10	6.350	3.5x1	120	4393	12481	94	130	135	18	114	11	17.5	11	30	
50-12B1		12	7.938	2.5x1	123	4420	11047	102	132	150	22	125	13	20	13	40	
55-10C1		55	10	6.350	3.5x1	132	4562	13661	100	130	140	18	118	11	17.5	11	40
55-12B1			12	7.938	2.5x1	128	4624	12195	105	132	154	22	127	13	20	13	40
63-8A2	63	8	4.763	1.5x2	107	2826	10129	104	108	146	18	124	11	17.5	11	40	
63-10B2		10	6.350	2.5x2	206	6533	22371	110	172	152	20	130	11	17.5	11	40	
63-12B1		12	7.938	2.5x1	107	4927	14031	118	135	166	22	141	13	20	13	40	
63-16B1		16	9.525	2.5x1	140	8189	23005	124	158	172	22	147	13	20	13	40	
63-20A1		20	9.525	1.5x1	84	5306	13890	124	147	172	22	147	13	20	13	40	
70-10B1	70	10	6.350	2.5x1	114	3770	12506	124	112	170	20	145	13	20	13	40	
70-12B1		12	7.938	2.5x1	118	5169	15638	130	132	178	22	152	13	20	13	40	

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while preload is 10% of dynamic load rating and axial load is applied.

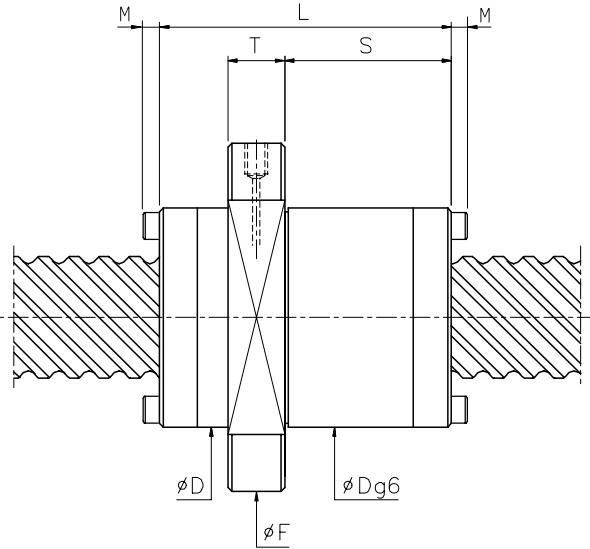
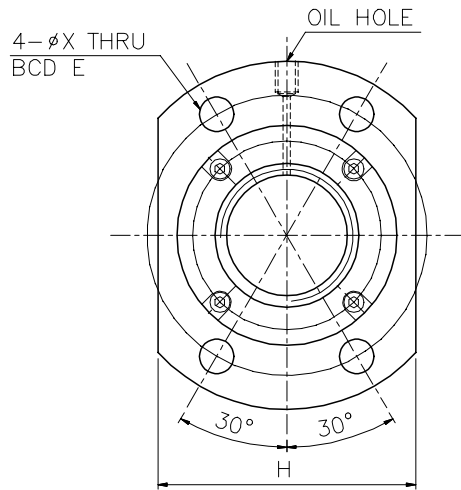
**OFSI** Type



Model	Size		Ball Dia.	Circuits	Stiffness kgf / $\mu\text{m}$ K	Dynamic Load $1 \times 10^6$ revs C (kgf)	Static Load Co (kgf)	Nut		Flange			Bolt			Fit
	Nominal Dia.	Lead						D	L	F	T	BCD-E	X	Y	Z	
20-5T3	20	5	3.175	3x2	39	852	1767	34	67	57	12	45	5.5	9.5	5.5	24
20-6T3		6	3.969	3x2	39	1091	2081	36	77	60	12	48	5.5	9.5	5.5	24
25-5T3	25	5	3.175	3x2	55	977	2314	40	67	64	12	52	5.5	9.5	5.5	24
25-6T3		6	3.969	3x2	56	1272	2762	42	77	65	12	53	5.5	9.5	5.5	24
32-5T3	32	5	3.175	3x2	64	1117	3081	48	67	74	12	60	6.5	11	6.5	24
32-5T4		5	3.175	4x2	82	1431	4108	48	77	74	12	60	6.5	11	6.5	24
32-6T3		6	3.969	3x2	65	1446	3620	50	67	76	12	62	6.5	11	6.5	24
32-6T4		6	3.969	4x2	84	1852	4826	50	90	76	12	62	6.5	11	6.5	24
32-8T3		8	4.763	3x2	68	1810	4227	52	100	78	16	64	6.6	11	6.5	24
32-8T4		8	4.763	4x2	82	2317	5635	52	117	78	16	64	6.6	11	6.5	24
32-10T3	10	6.350	3x2	68	2539	5327	56	120	82	16	68	6.6	11	6.5	24	
40-5T4	40	5	3.175	4x2	99	1599	5280	54	81	80	16	66	6.6	11	6.5	24
40-5T6		5	3.175	6x2	146	2265	7919	54	102	80	16	66	6.6	11	6.5	24
40-6T4		6	3.969	4x2	100	2136	6420	56	94	88	16	72	9	14	8.5	30
40-6T6		6	3.969	6x2	148	3028	9630	56	119	88	16	72	9	14	8.5	30
40-8T4		8	4.763	4x2	102	2728	7596	60	117	92	16	75	9	14	8.5	30
40-10T3		10	6.350	3x2	76	2959	7069	65	123	96	16	80	9	14	8.5	30
40-10T4	10	6.350	4x2	101	3789	9426	65	143	96	16	80	9	14	8.5	30	
50-5T4	50	5	3.175	4x2	121	1757	6745	65	81	96	16	80	9	14	8.5	30
50-5T6		5	3.175	6x2	177	2490	10117	65	102	96	16	80	9	14	8.5	30
50-6T4		6	3.969	4x2	123	2388	8250	68	94	100	16	84	9	14	8.5	30
50-6T6		6	3.969	6x2	179	3384	12375	68	119	100	16	84	9	14	8.5	30
50-8T4		8	4.763	4x2	122	2998	9578	70	120	102	16	85	9	14	8.8	30
50-10T3		10	6.350	3x2	95	3397	9256	74	123	114	18	92	11	17.5	11	40
50-10T4	10	6.350	4x2	124	4350	12341	74	143	114	18	92	11	17.5	11	40	
50-12T3	12	7.938	3x2	94	4420	11047	78	147	118	18	96	11	17.5	11	40	
63-6T3	63	6	3.969	3x2	148	2614	10542	80	96	119	18	98	11	17.5	11	40
63-6T4		6	3.969	4x2	220	3704	15813	80	121	119	18	98	11	17.5	11	40
63-8T4		8	4.763	4x2	152	3395	12541	82	119	122	18	100	11	17.5	11	40
63-10T4		10	6.350	4x2	158	4860	15858	88	147	134	20	110	14	20	13	40
63-12T3		12	7.938	3x2	114	5059	14470	92	150	138	20	114	14	20	13	40

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while preload is 10% of dynamic load rating and axial load is applied.

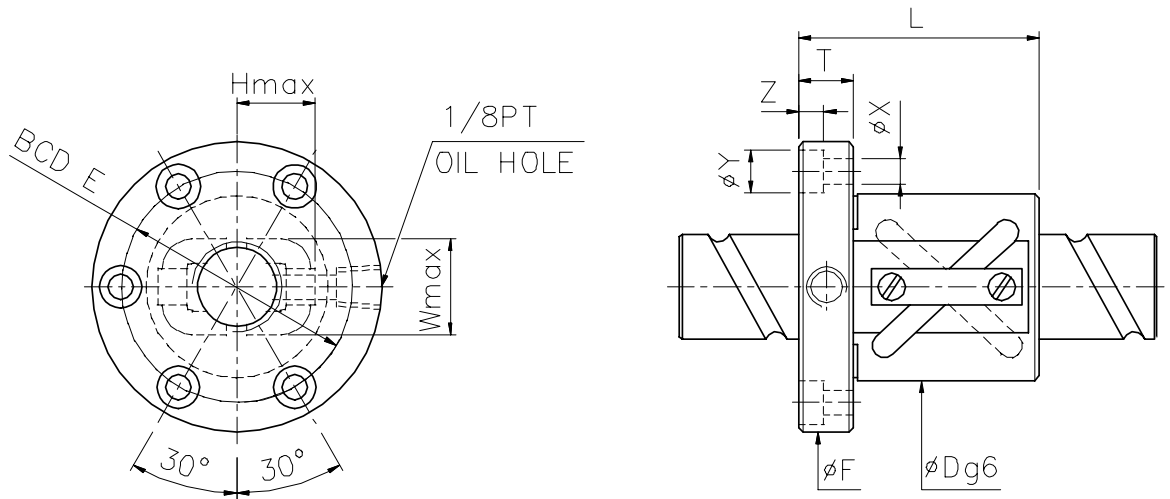
**FSH** Type



Model	Size		Ball Dia.	Circuits	Stiffness kgf / μm K	Dynamic Load 1x10 <sup>6</sup> revs C (kgf)	Static Load Co (kgf)	Nut		Flange				Bolt		Fit	
	Nominal Dia.	Lead						D	L	F	T	BCD-E	H	X	S	M	
16-16S2	16	16	3.175	1.8x2	35	860	1690	32	48	53	10	42	38	4.5	26	0	
16-16S4				1.8x4	68	1570	3370										
16-16S2	16	16	3.175	1.8x2	35	860	1690	33	48	58	10	45	38	6.6	26	0	
16-16S4				1.8x4	68	1570	3370										
20-20S2	20	20	3.175	1.8x2	42	970	2120	39	48	62	10	50	46	5.5	27.5	0	
20-20S2				1.8x2	42	970	2120	38	58	62	10	50	46	5.5	32.5	3	
20-20S4				1.8x4	81	1760	4240	38	58	62	10	50	46	5.5	32.5	3	
25-25S2	25	25	3.969	1.8x2	53	1470	3410	47	67	74	12	60	56	6.6	39.5	3	
25-25S4				1.8x4	105	2670	6830										
32-32S2	32	32	4.762	1.8x2	66	2090	5200	58	85	92	15	74	68	9	48	0	
32-32S4				1.8x4	128	3800	10400										
40-40S2	40	40	6.35	1.8x2	82	3420	8740	72	102	114	17	93	84	11	60	0	
40-40S4				1.8x4	159	6220	17480										
50-50S2	50	50	7.938	1.8x2	100	5030	13280	90	125	135	20	112	104	14	83.5	0	
50-50S4				1.8x4	193	9110	26560										

Remark : Stiffness values listed above are derived from theoretical formula to the elastic deformation between balltrack and balls while preload is 5% of dynamic load rating and axial load is applied.

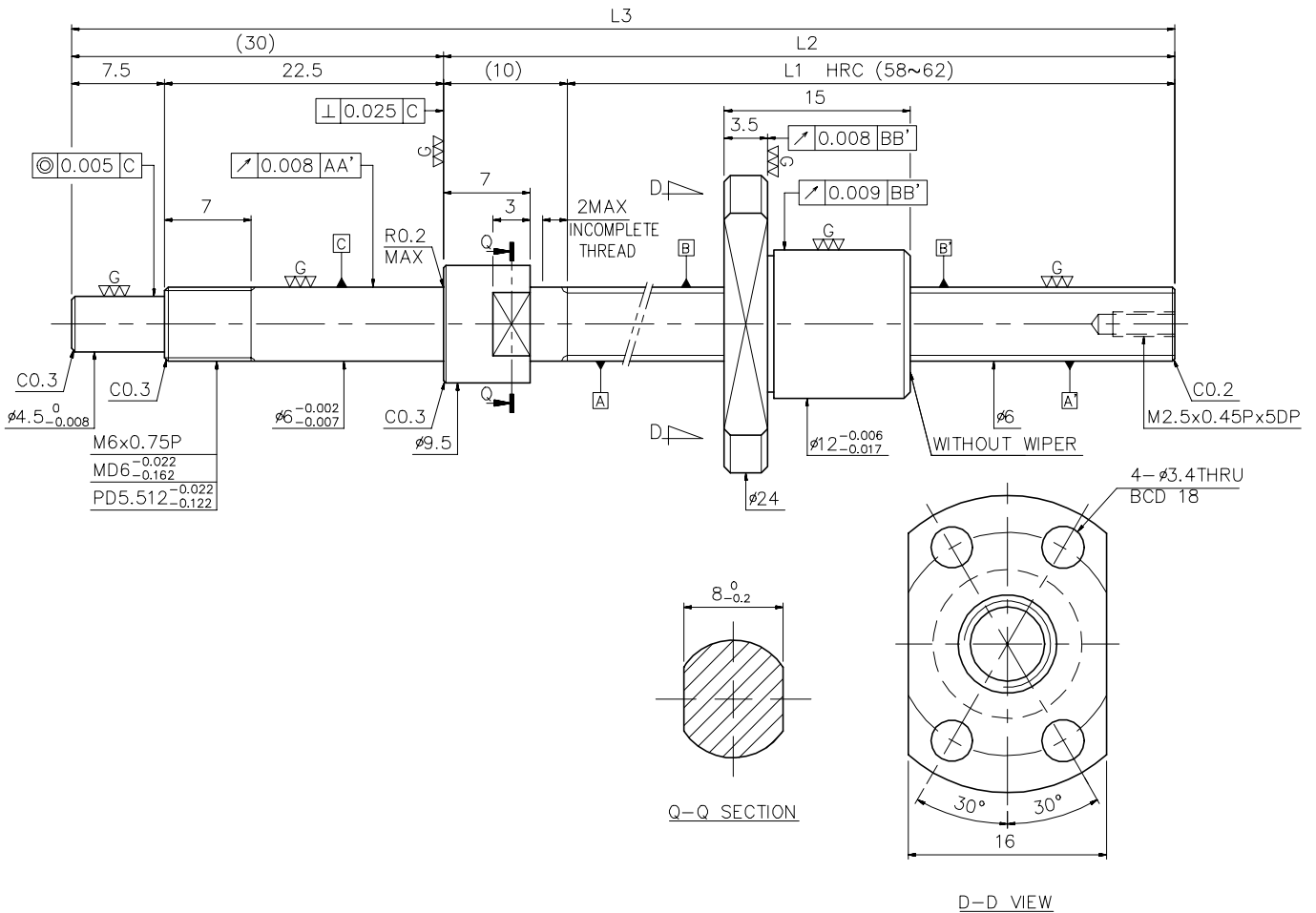
**DFSV** Type



Model	Size		Ball Dia.	Circuits	Dynamic Load 1x10 <sup>6</sup> revs C (kgf)	Static Load Co (kgf)	Nut		Flange			Return Tube		Bolt		
	Nominal Dia.	Lead					D	L	F	T	BCD-E	W	H	X	Y	Z
16-16A2	16	16	3.175	1.5x2	704	1376	32	50	55	12	43	22	22	5.5	9.5	5.5
20-20A2	20	20	3.175	1.5x2	793	1745	36	59	60	12	47	28	27	5.5	9.5	5.5
25-25A2	25	25	3.969	1.5x2	1174	2730	42	69	70	12	55	32	28	6.6	11	6.5
32-32A2	32	32	4.763	1.5x2	1682	4208	54	84	100	15	80	40	37	9	14	8.5
40-40A2	40	40	6.350	1.5x2	2806	7222	65	105	106	18	85	52	42	11	17.5	11

## 6.3 Miniature Ground Ballscrew

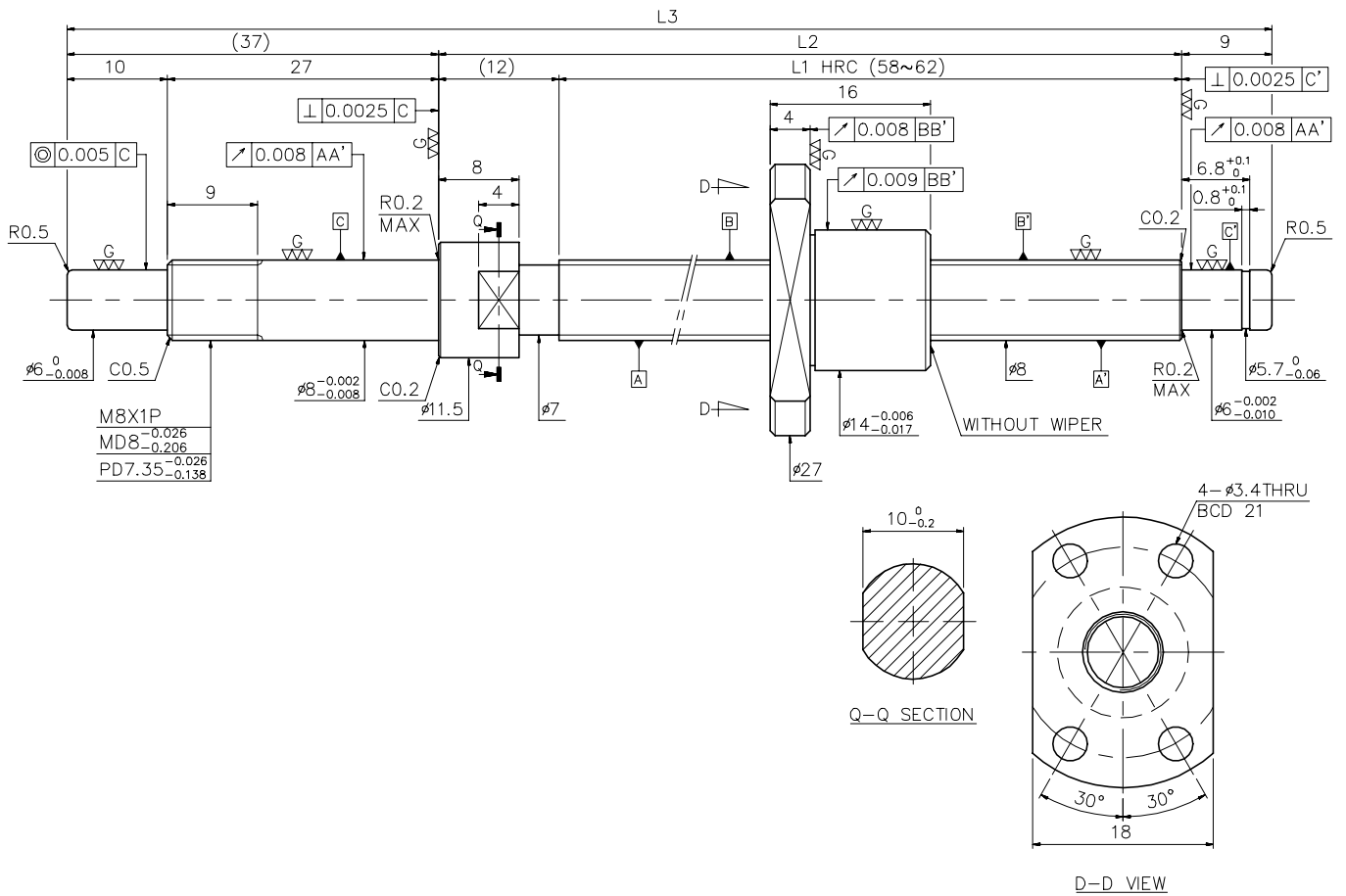
### **FSI** Type (Shaft OD 6, Lead 1.0)



Ballscrew Data		
Direction	Right Hand	
Lead (mm)	1.0	
Lead Angle	2.99°	
P.C.D. (mm)	6.1	
Steel Ball (mm)	ø 0.8	
Circuits	1x3	
Dynamic Load C (kgf)	66	
Static Load Co (kgf)	111	
Axial Play (mm)	0	0.005 MAX
Drag Torque (kgf-cm)	0.13 MAX	0.03 MAX
Spacer Ball	-	-

Stroke	HIWIN Code	Unit: mm			Accuracy grade
		L1	L2	L3	
40	R6-1.0T3-FSI-65-105-0.008	65	75	105	3
70	R6-1.0T3-FSI-95-135-0.008	95	105	135	3
100	R6-1.0T3-FSI-125-165-0.008	125	135	165	3

**FSI Type** (Shaft OD 8, Lead 1.0)

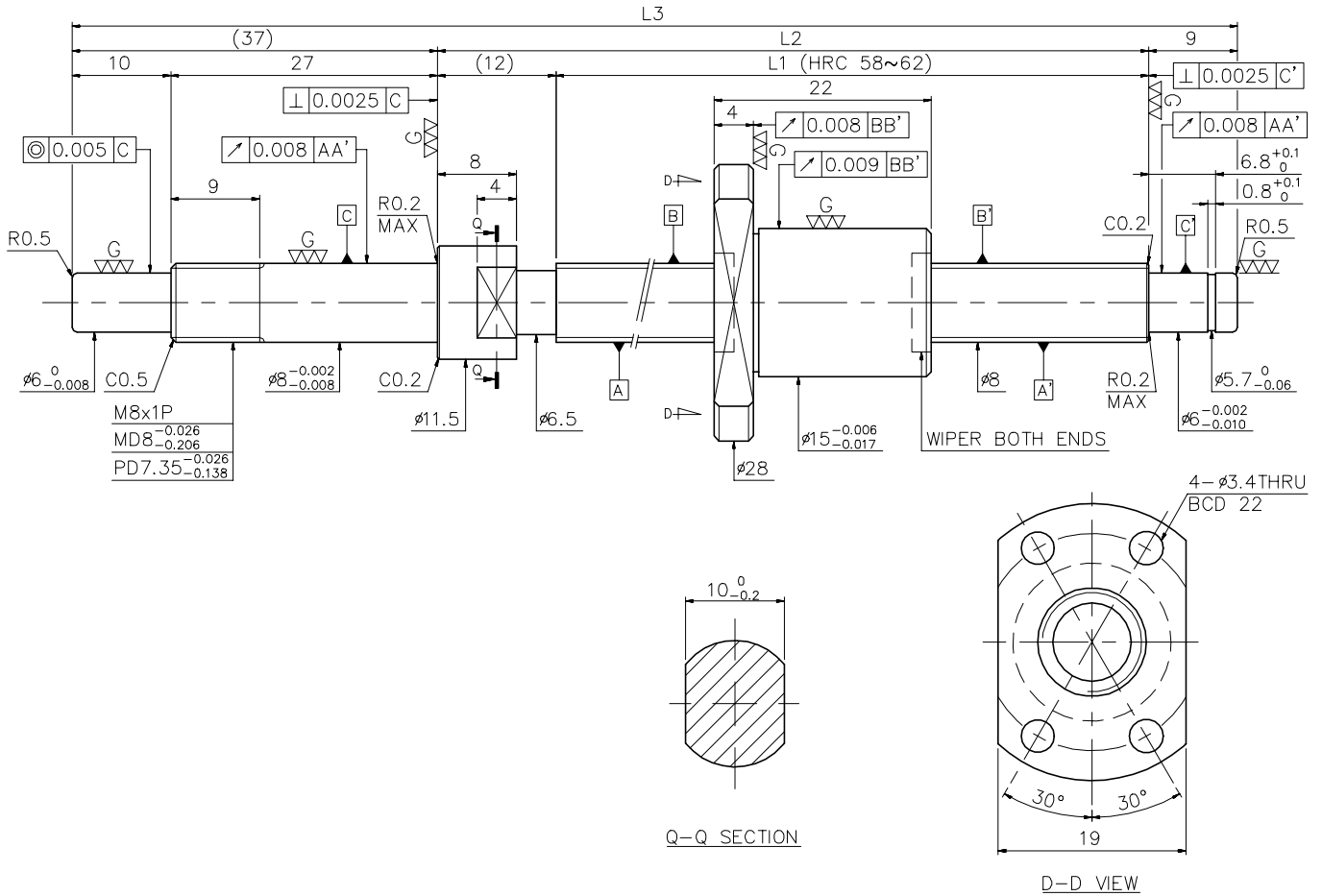


Ballscrew Data	
Direction	Right Hand
Lead (mm)	1.0
Lead Angle	2.25°
P.C.D. (mm)	8.1
Steel Ball (mm)	ø 0.8
Circuits	1x3
Dynamic Load C (kgf)	79
Static Load Co (kgf)	157
Axial Play (mm)	0      0.005 MAX
Drag Torque (kgf-cm)	0.18 MAX      0.03 MAX
Spacer Ball	-      -

Unit: mm

Stroke	HIWIN Code	L1	L2	L3	Accuracy grade
40	R8-1.0T3-FSI-80-138-0.008	80	92	138	3
70	R8-1.0T3-FSI-110-168-0.008	110	122	168	3
100	R8-1.0T3-FSI-140-198-0.008	140	152	198	3
150	R8-1.0T3-FSI-190-248-0.008	190	202	248	3

**FSI Type** (Shaft OD 8, Lead 1.5)

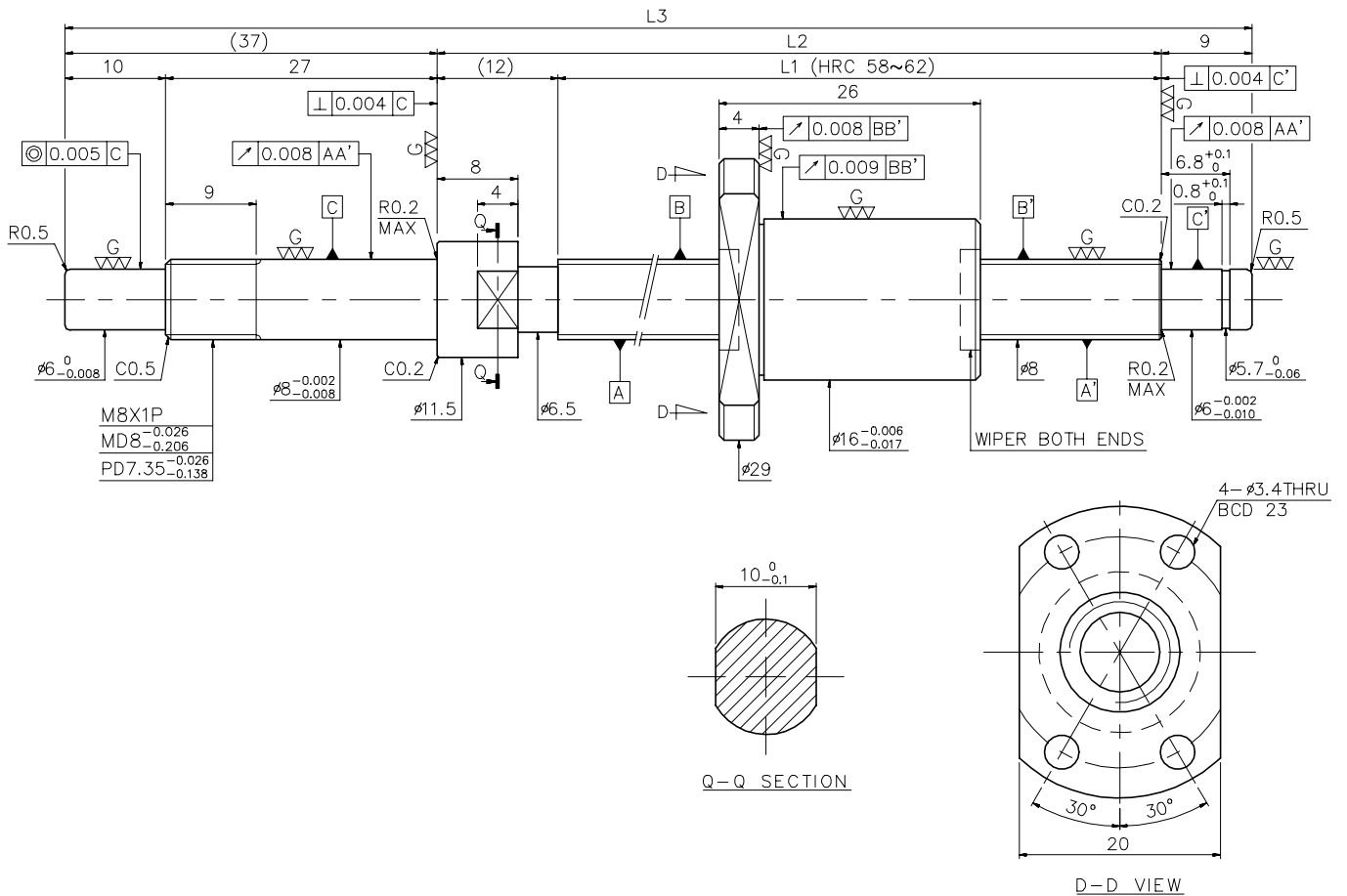


Ballscrew Data	
Direction	Right Hand
Lead (mm)	1.5
Lead Angle	3.37°
P.C.D. (mm)	8.1
Steel Ball (mm)	ø 1
Circuits	1x3
Dynamic Load C (kgf)	105
Static Load Co (kgf)	191
Axial Play (mm)	0      0.005 MAX
Drag Torque (kgf-cm)	0.2 MAX      0.05 MAX
Spacer Ball	-      -

Unit: mm

Stroke	HIWIN Code	L1	L2	L3	Accuracy grade
40	R8-1.5T3-FSI-80-138-0.008	80	92	138	3
70	R8-1.5T3-FSI-110-168-0.008	110	122	168	3
100	R8-1.5T3-FSI-140-198-0.008	140	152	198	3
150	R8-1.5T3-FSI-190-248-0.008	190	202	248	3

**FSI Type** (Shaft OD 8, Lead 2)



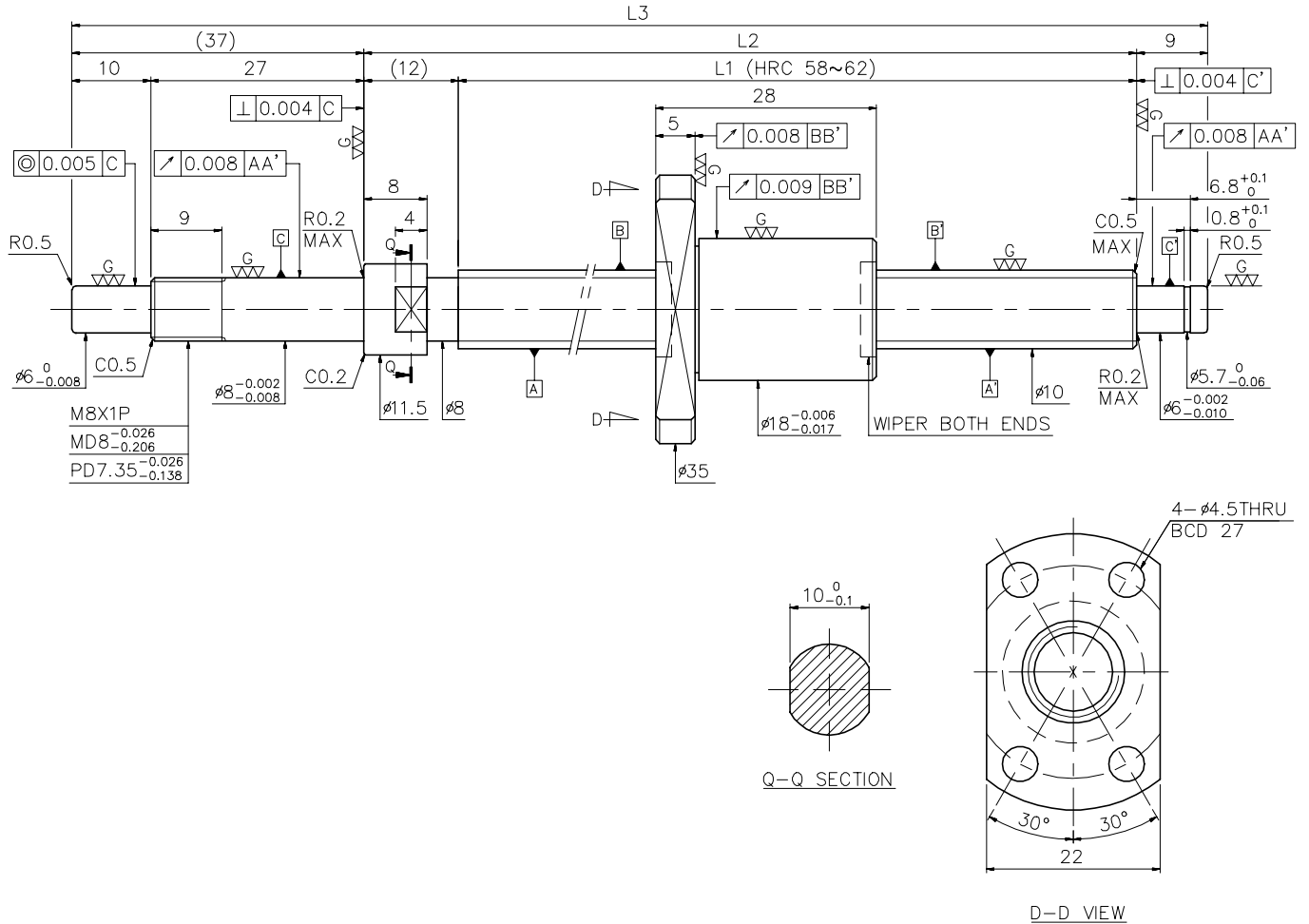
Ballscrew Data	
Direction	Right Hand
Lead (mm)	2
Lead Angle	4.44°
P.C.D. (mm)	8.2
Steel Ball (mm)	ø 1.5
Circuits	1x3
Dynamic Load C (kgf)	170
Static Load Co (kgf)	267
Axial Play (mm)	0      0.005 MAX
Drag Torque (kgf-cm)	0.2 MAX      0.05 MAX
Spacer Ball	-      -

Unit: mm

Stroke	HIWIN Code	L1	L2	L3	Accuracy grade
40	R8-2T3-FSI-80-138-0.008	80	92	138	3
70	R8-2T3-FSI-110-168-0.008	110	122	168	3
100	R8-2T3-FSI-140-198-0.008	140	152	198	3
150	R8-2T3-FSI-190-248-0.008	190	202	248	3



**FSI Type** (Shaft OD 10, Lead 2)

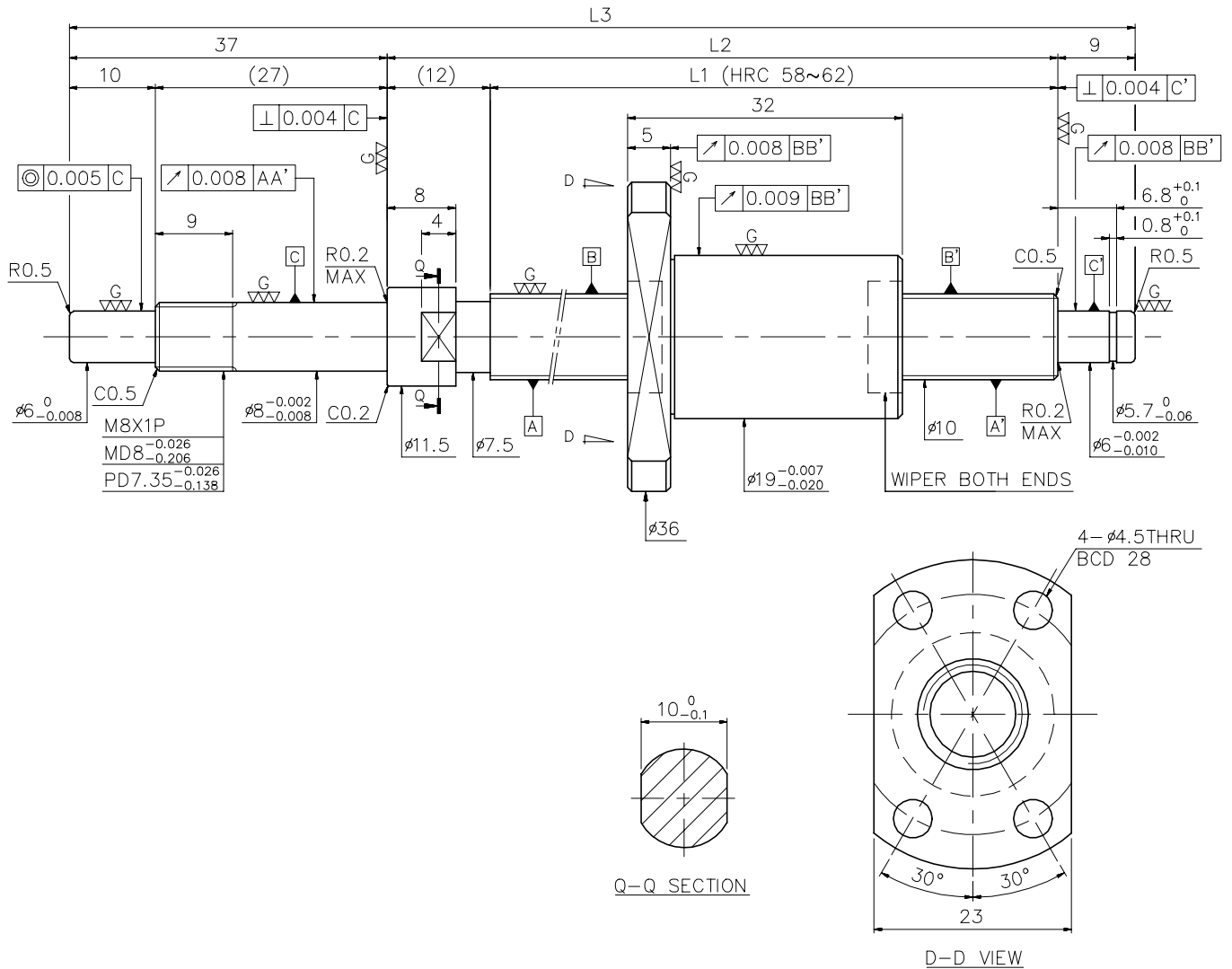


Ballscrew Data	
Direction	Right Hand
Lead (mm)	2
Lead Angle	3.57°
P.C.D. (mm)	10.2
Steel Ball (mm)	φ 1.5
Circuits	1x3
Dynamic Load C (kgf)	196
Static Load Co (kgf)	348
Axial Play (mm)	0      0.005 MAX
Drag Torque (kgf-cm)	0.1 ~ 0.25      0.05 MAX
Spacer Ball	-      -

Unit: mm

Stroke	HIWIN Code	L1	L2	L3	Accuracy grade
50	R10-2T3-FSI-100-158-0.008	100	112	158	3
100	R10-2T3-FSI-110-208-0.008	150	162	208	3
150	R10-2T3-FSI-140-258-0.008	200	212	258	3
200	R10-2T3-FSI-250-308-0.008	250	262	308	3

**FSI Type** (Shaft OD 10, Lead 2.5)

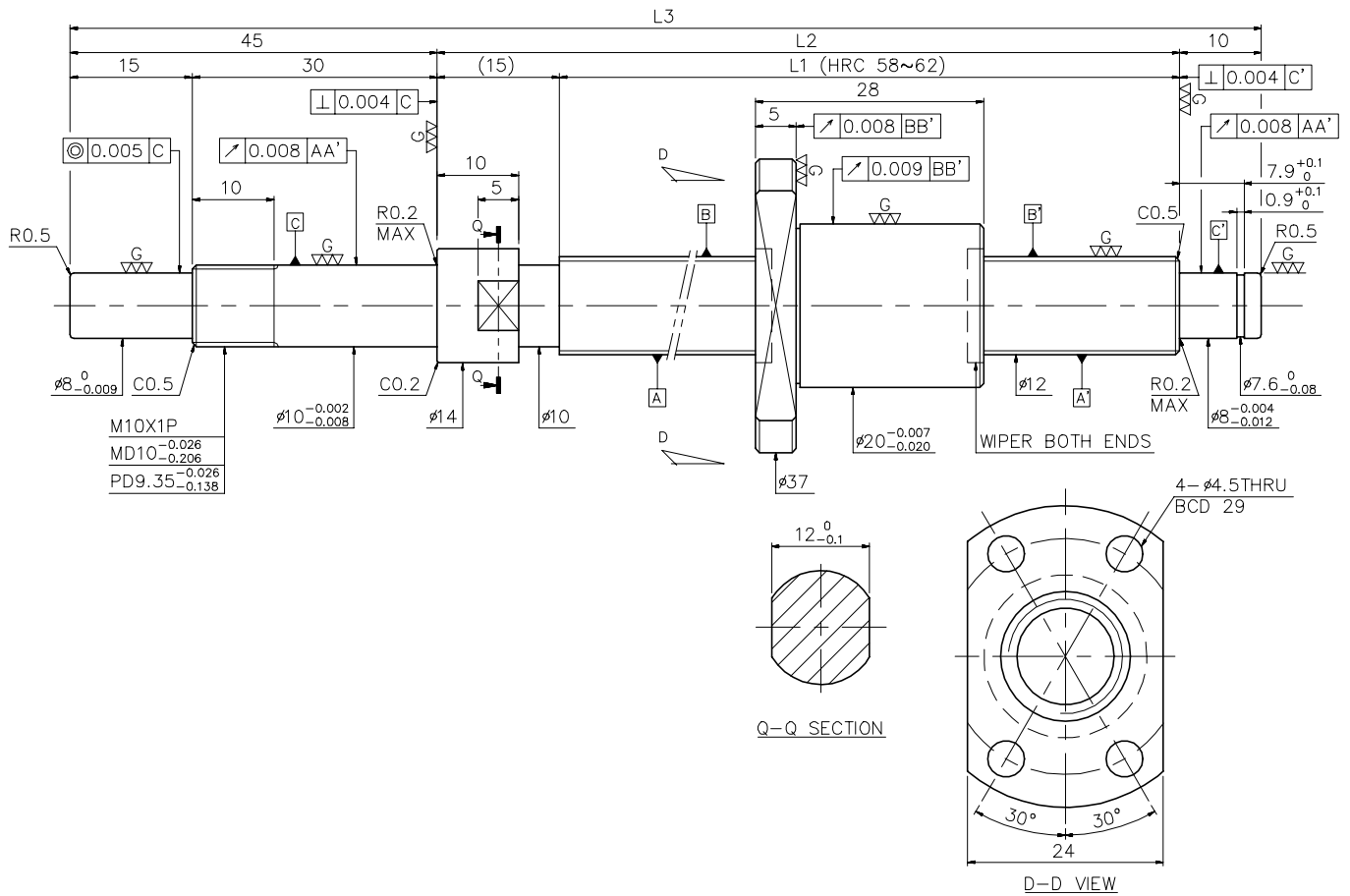


Ballscrew Data	
Direction	Right Hand
Lead (mm)	2.5
Lead Angle	4.46°
P.C.D. (mm)	10.2
Steel Ball (mm)	ø 2
Circuits	1x3
Dynamic Load C (kgf)	274
Static Load Co (kgf)	438
Axial Play (mm)	0      0.005 MAX
Drag Torque (kgf-cm)	0.02 ~ 0.3      0.05 MAX
Spacer Ball	-      -

Unit: mm

Stroke	HIWIN Code	L1	L2	L3	Accuracy grade
50	R10-2.5T3-FSI-100-158-0.008	100	112	158	3
100	R10-2.5T3-FSI-150-208-0.008	150	162	208	3
150	R10-2.5T3-FSI-200-258-0.008	200	212	258	3
200	R10-2.5T3-FSI-250-308-0.008	250	262	308	3

**FSI Type** (Shaft OD 12, Lead 2)

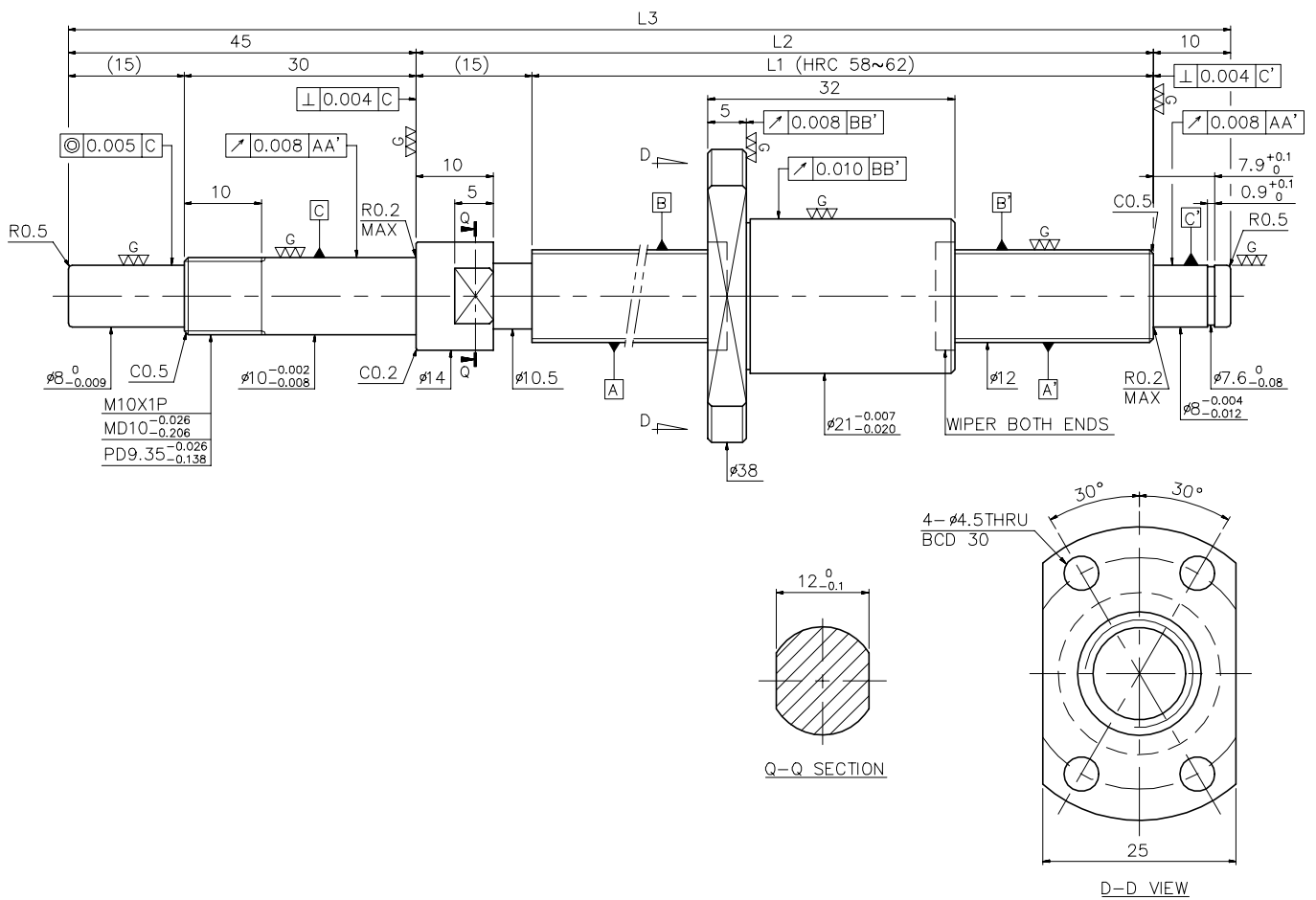


Ballscrew Data		
Direction	Right Hand	
Lead (mm)	2	
Lead Angle	2.99°	
P.C.D. (mm)	12.2	
Steel Ball (mm)	ø 1.5	
Circuits	1x3	
Dynamic Load C (kgf)	217	
Static Load Co (kgf)	430	
Axial Play (mm)	0	0.005 MAX
Drag Torque (kgf-cm)	0.04 ~ 0.36	0.1 MAX
Spacer Ball	-	-

Unit: mm

Stroke	HIWIN Code	L1	L2	L3	Accuracy grade
50	R12-2T3-FSI-110-180-0.008	100	125	180	3
100	R12-2T3-FSI-160-230-0.008	160	175	230	3
150	R12-2T3-FSI-210-280-0.008	210	225	280	3
200	R12-2T3-FSI-260-330-0.008	260	275	330	3
250	R12-2T3-FSI-310-380-0.008	310	325	380	3

**FSI Type** (Shaft OD 12, Lead 2.5)



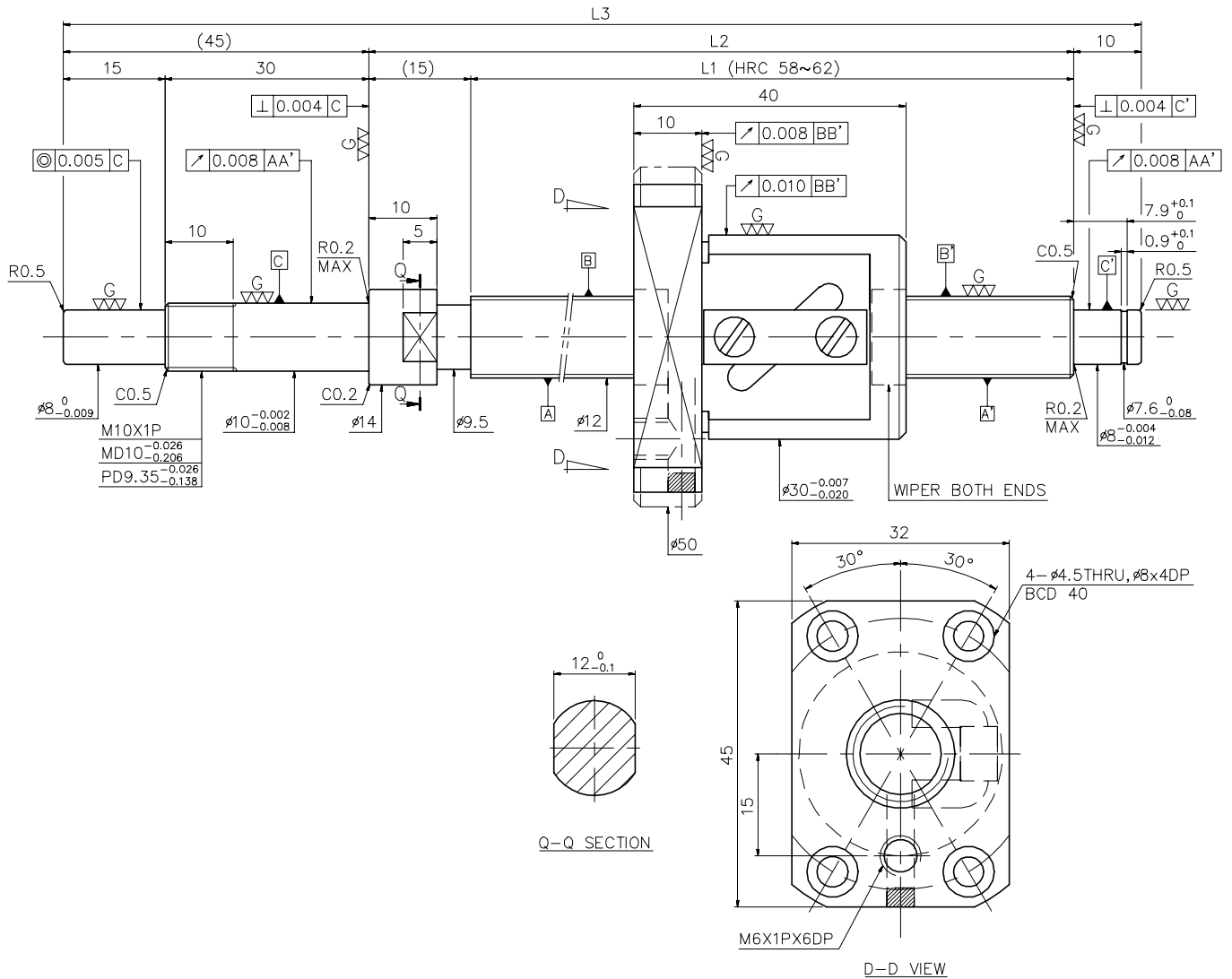
**Ballscrew Data**

Direction	Right Hand	
Lead (mm)	2.5	
Lead Angle	3.73°	
P.C.D. (mm)	12.2	
Steel Ball (mm)	ø 1.5	
Circuits	1x3	
Dynamic Load C (kgf)	217	
Static Load Co (kgf)	430	
Axial Play (mm)	0	0.005 MAX
Drag Torque (kgf-cm)	0.04 ~ 0.4	0.1 MAX
Spacer Ball	-	-

Unit: mm

Stroke	HIWIN Code	L1	L2	L3	Accuracy grade
50	R12-2.5T3-FSI-110-180-0.008	100	125	180	3
100	R12-2.5T3-FSI-160-230-0.008	160	175	230	3
150	R12-2.5T3-FSI-210-280-0.008	210	225	280	3
200	R12-2.5T3-FSI-260-330-0.008	260	275	330	3
250	R12-2.5T3-FSI-310-380-0.008	310	325	380	3

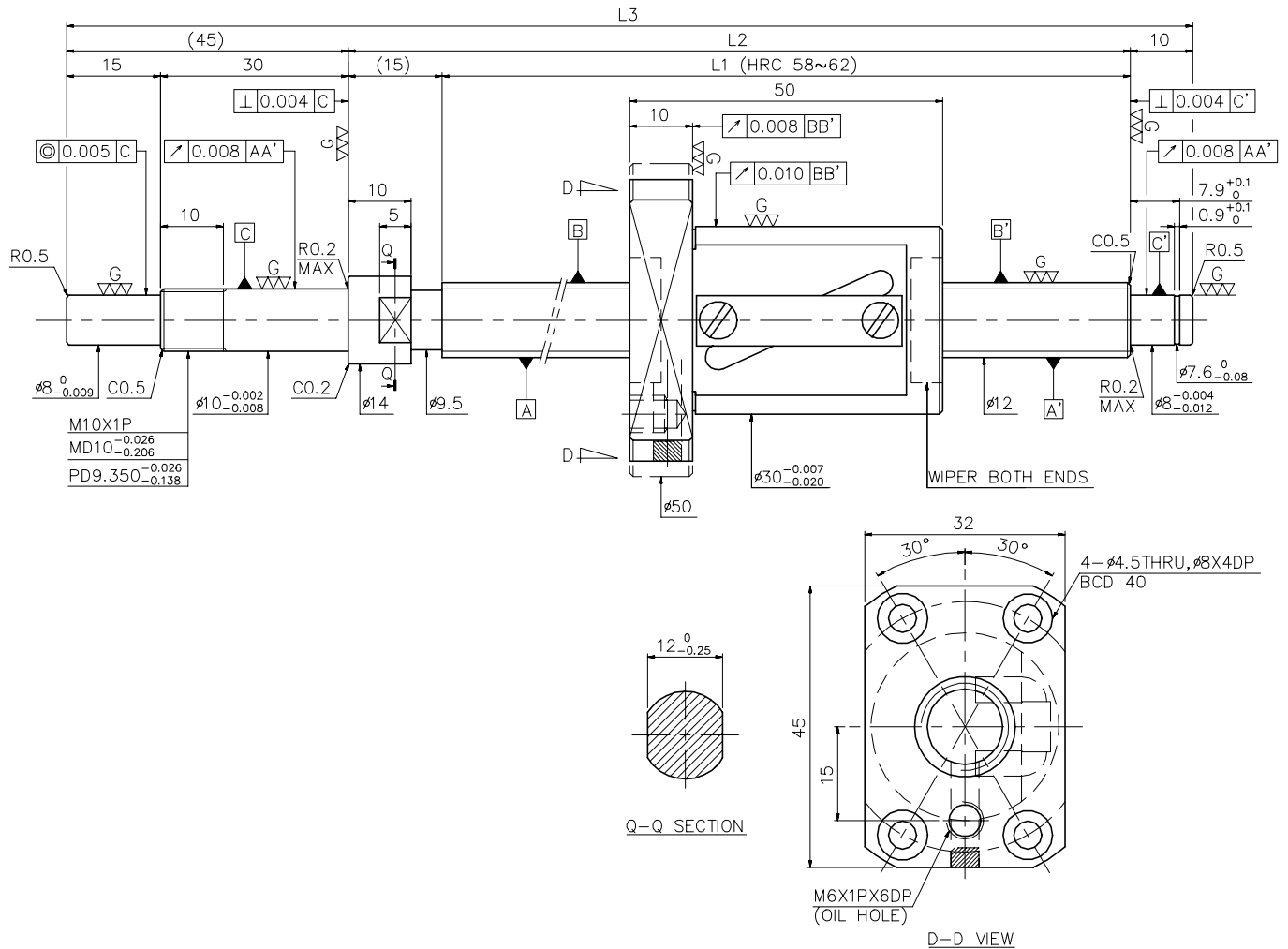
## FSW Type (Shaft OD 12, Lead 5)



Ball screw Data		
Direction	Right Hand	
Lead (mm)	5	
Lead Angle	7.4°	
P.C.D. (mm)	12.25	
Steel Ball (mm)	ø 2.381	
Circuits	2.5x1	
Axial Play (mm)	0	0.005 MAX
Dynamic Load C (kgf)	241	382
Static Load Co (kgf)	319	637
Drag Torque (kgf-cm)	0.1 ~ 0.46	0.1 MAX
Spacer Ball	-	-

Stroke	HIWIN Code	Unit: mm			Accuracy grade
		L1	L2	L3	
50	R12-5B1-FSW-110-180-0.008	110	125	180	3
100	R12-5B1-FSW-160-230-0.008	160	175	230	3
150	R12-5B1-FSW-210-280-0.008	210	225	280	3
200	R12-5B1-FSW-260-330-0.008	260	275	330	3
250	R12-5B1-FSW-310-380-0.008	310	325	380	3
350	R12-5B1-FSW-410-480-0.008	410	425	480	3
450	R12-5B1-FSW-510-580-0.008	510	525	580	3

**FSW Type** (Shaft OD 12, Lead 10)



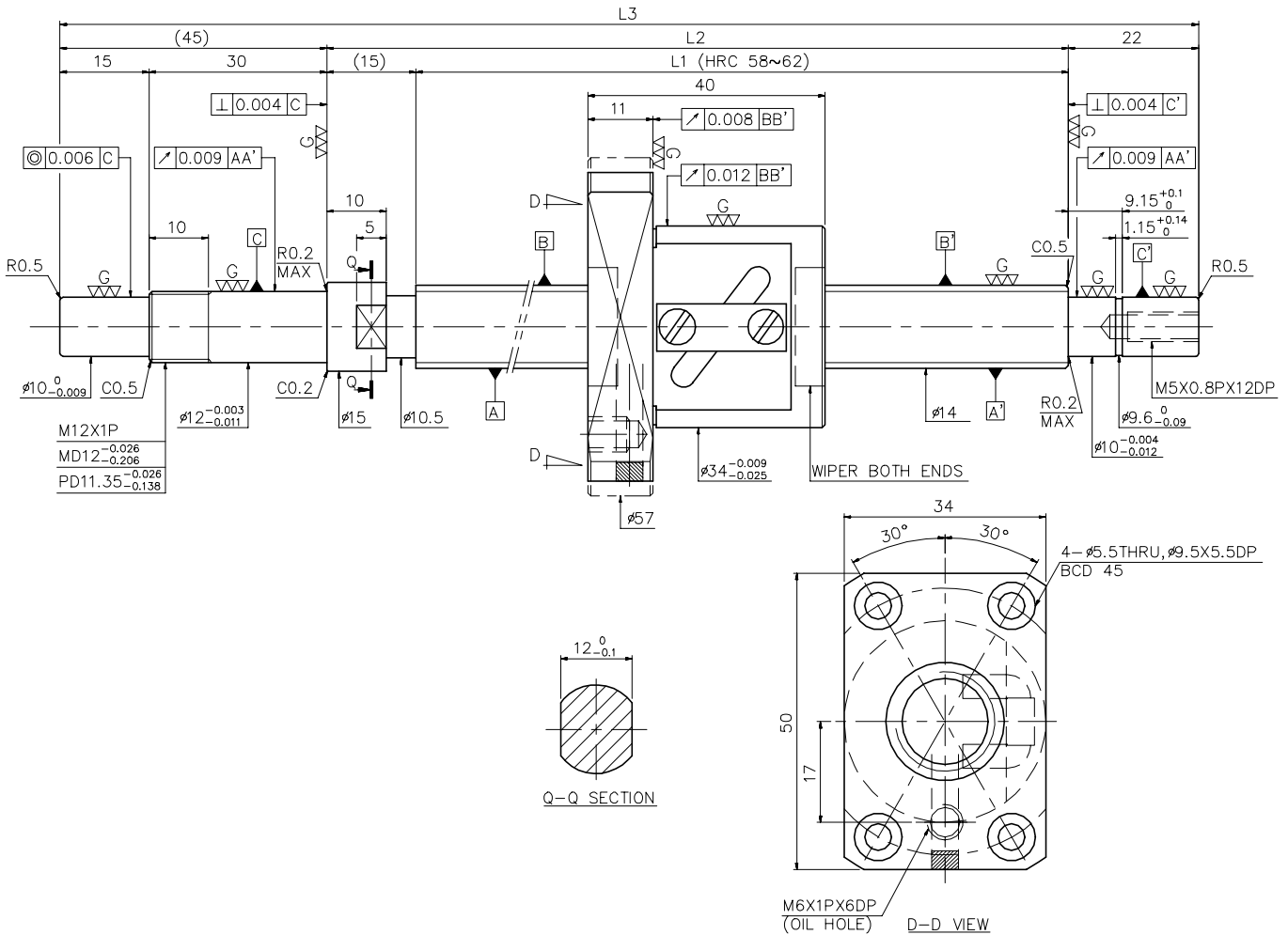
**Ballscrew Data**

Direction	Right Hand	
Lead (mm)	10	
Lead Angle	14.57°	
P.C.D. (mm)	12.25	
Steel Ball (mm)	ø 2.381	
Circuits	2.5x1	
Axial Play (mm)	0	0.005 MAX
Dynamic Load C (kgf)	241	382
Static Load Co (kgf)	319	637
Drag Torque (kgf-cm)	0.1 ~ 0.5	0.15 MAX
Spacer Ball	1:1	-

Unit: mm

Stroke	HIWIN Code	L1	L2	L3	Accuracy grade
100	R12-10B1-FSW-160-230-0.008	160	175	230	3
150	R12-10B1-FSW-210-280-0.008	210	225	280	3
250	R12-10B1-FSW-310-380-0.008	310	325	380	3
350	R12-10B1-FSW-410-480-0.008	410	425	480	3
450	R12-10B1-FSW-510-580-0.008	510	525	580	3

## FSW Type

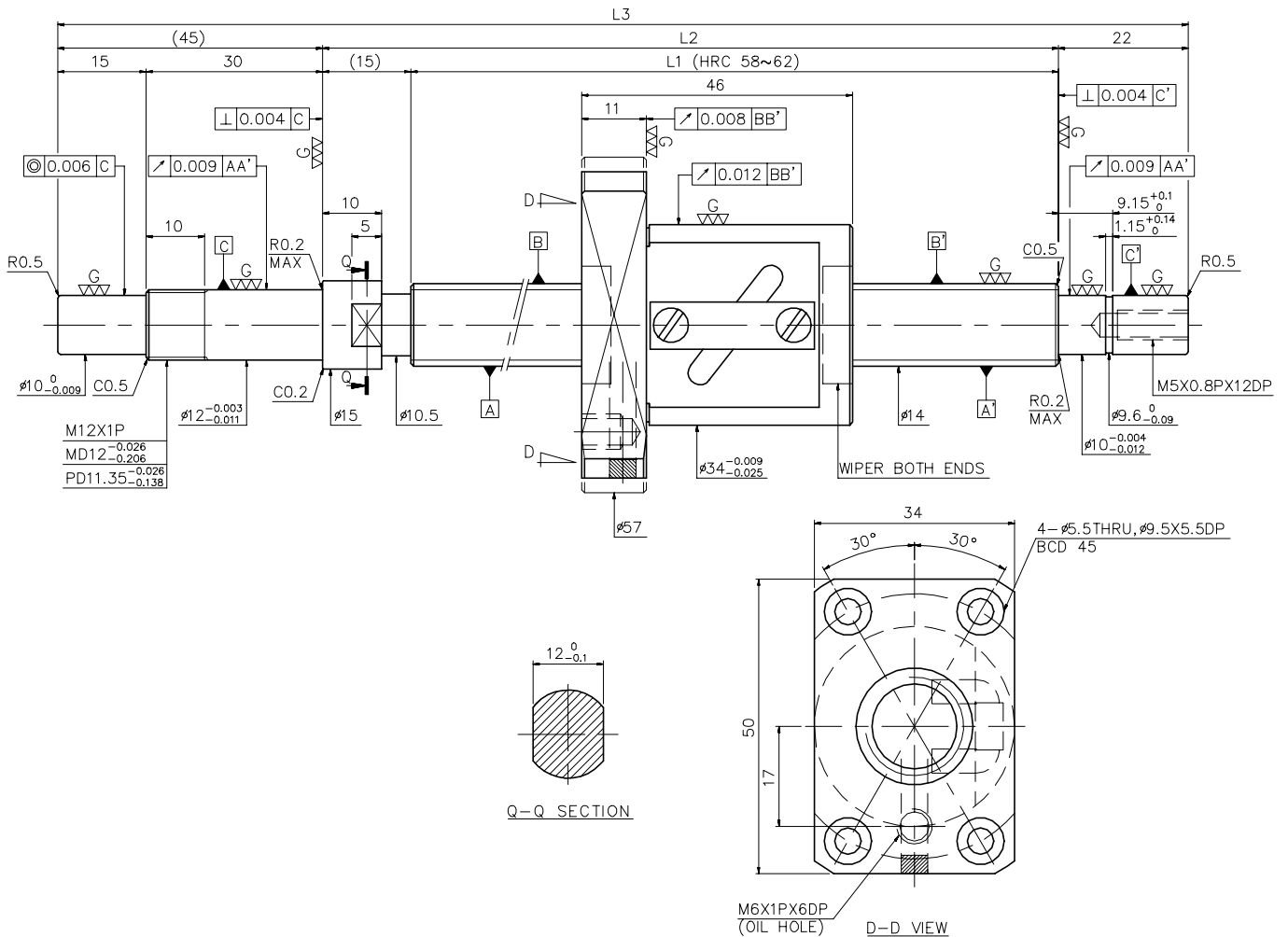
 (Shaft OD 14, Lead 5)


Ballscrew Data	
Direction	Right Hand
Lead (mm)	5
Lead Angle	6.22°
P.C.D. (mm)	14.6
Steel Ball (mm)	$\phi 3.175$
Circuits	2.5x1
Axial Play (mm)	0      0.005 MAX
Dynamic Load C (kgf)	448      710
Static Load Co (kgf)	608      1215
Drag Torque (kgf-cm)	0.1 ~ 0.7      0.2 MAX
Spacer Ball	1:1      -

Unit: mm

Stroke	HIWIN Code	L1	L2	L3	Accuracy grade
100	R14-5B1-FSW-189-271-0.008	189	204	271	3
150	R14-5B1-FSW-239-321-0.008	239	254	321	3
250	R14-5B1-FSW-339-421-0.008	439	354	421	3
350	R14-5B1-FSW-439-521-0.008	439	454	521	3
450	R14-5B1-FSW-539-621-0.008	539	554	621	3
600	R14-5B1-FSW-689-771-0.008	689	704	771	3

**FSW Type** (Shaft OD 14, Lead 8)



Unit: mm

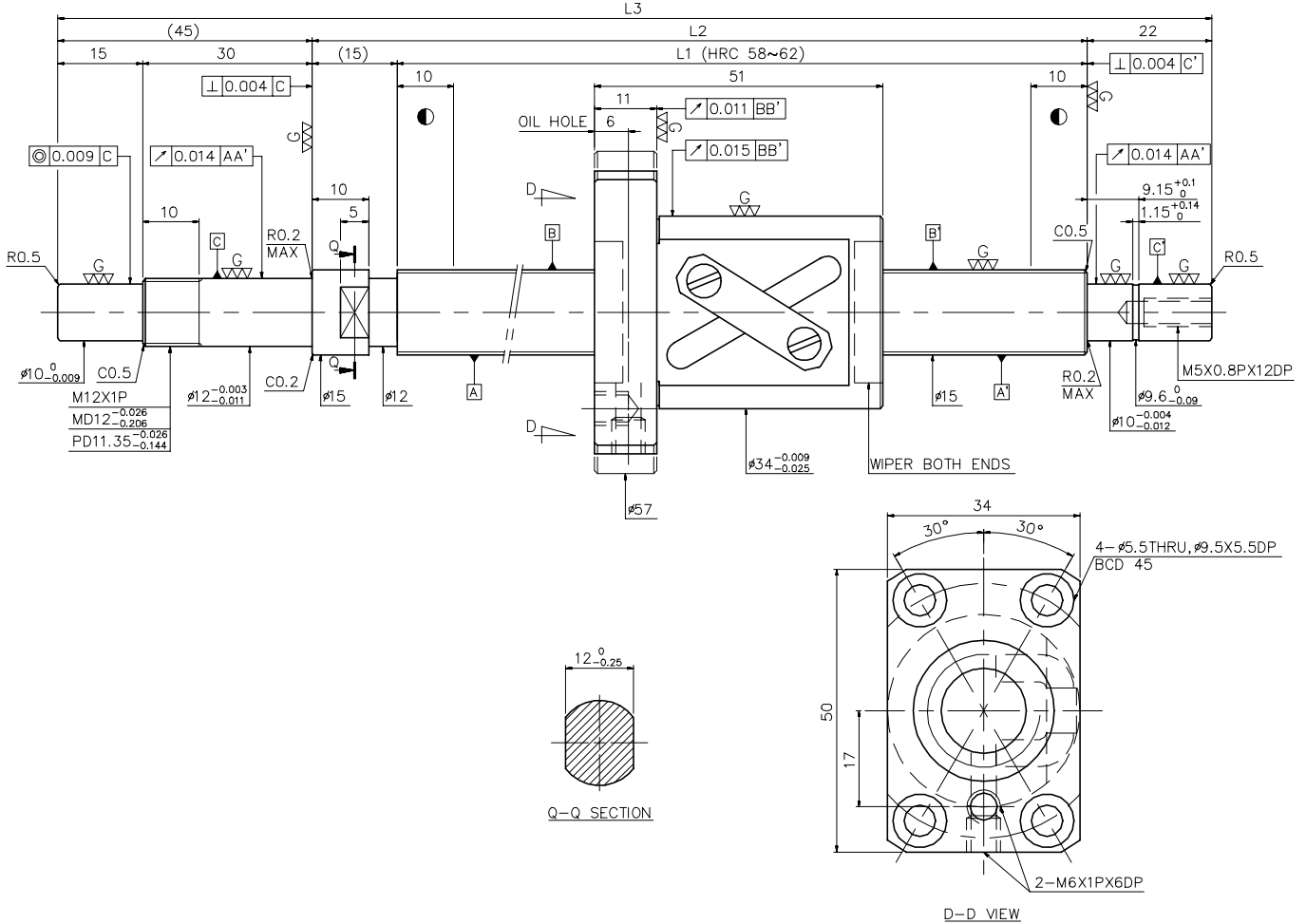
Ball screw Data		
Direction	Right Hand	
Lead (mm)	8	
Lead Angle	9.89°	
P.C.D. (mm)	14.6	
Steel Ball (mm)	ø 3.175	
Circuits	2.5x1	
Axial Play (mm)	0	0.005 MAX
Dynamic Load C (kgf)	448	710
Static Load Co (kgf)	608	1215
Drag Torque (kgf-cm)	0.1 ~ 0.7	0.24 MAX
Spacer Ball	1:1	-

Stroke	HIWIN Code	L1	L2	L3	Accuracy grade
100	R14-8B1-FSW-189-271-0.008	189	204	271	3
150	R14-8B1-FSW-239-321-0.008	239	254	321	3
200	R14-8B1-FSW-289-371-0.008	289	304	371	3
250	R14-8B1-FSW-339-421-0.008	339	354	421	3
300	R14-8B1-FSW-389-471-0.008	389	404	471	3
350	R14-8B1-FSW-439-521-0.008	439	454	521	3
400	R14-8B1-FSW-489-571-0.008	489	504	571	3
450	R14-8B1-FSW-539-621-0.008	539	554	621	3
500	R14-8B1-FSW-589-671-0.008	589	604	671	3
550	R14-8B1-FSW-639-721-0.008	639	654	721	3
600	R14-8B1-FSW-689-771-0.008	689	704	771	3
700	R14-8B1-FSW-789-871-0.008	789	804	871	3



## 6.4 Dimension for Stock Precision Ground Ballscrew

### FSW Type (Shaft OD 15, Lead 10)

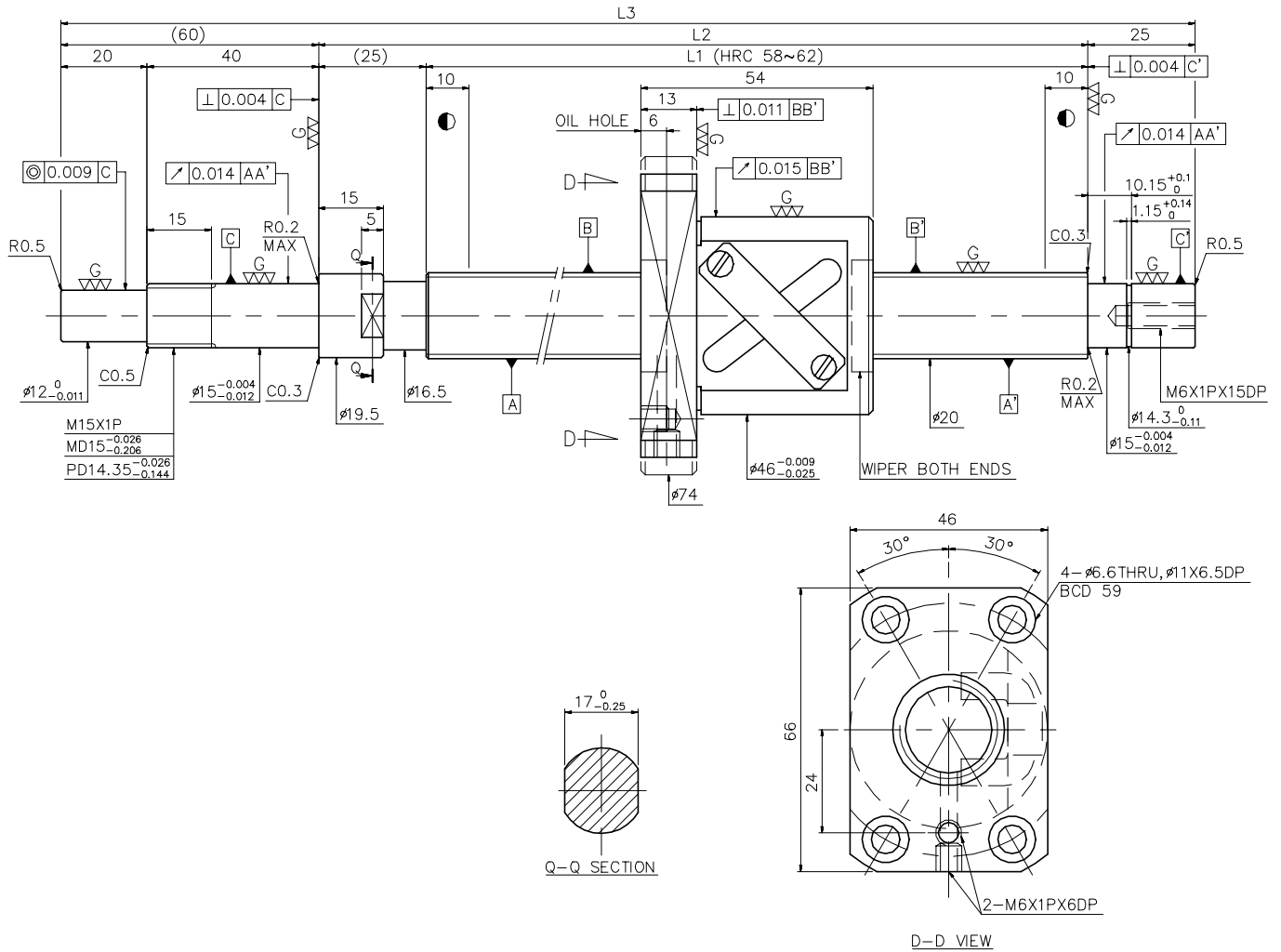


Unit: mm

Ballscrew Data		
Direction	Right Hand	
Lead (mm)	10	
Lead Angle	11.53°	
P.C.D. (mm)	15.6	
Steel Ball (mm)	ø 3.175	
Circuits	2.5x1	
Axial Play (mm)	0	0.005 MAX
Dynamic Load C (kgf)	460	729
Static Load Co (kgf)	645	1290
Drag Torque (kgf-cm)	0.2 ~ 0.8	0.24 MAX
Spacer Ball	1:1	-

Stroke	HIWIN Code	L1	L2	L3	Accuracy grade
100	R15-10B1-FSW-189-271-0.018	189	204	271	5
150	R15-10B1-FSW-239-321-0.018	239	254	321	5
200	R15-10B1-FSW-289-371-0.018	289	304	371	5
250	R15-10B1-FSW-339-421-0.018	339	354	421	5
300	R15-10B1-FSW-389-471-0.018	389	404	471	5
350	R15-10B1-FSW-439-521-0.018	439	454	521	5
400	R15-10B1-FSW-489-571-0.018	489	504	571	5
450	R15-10B1-FSW-539-621-0.018	539	554	621	5
500	R15-10B1-FSW-589-671-0.018	589	604	671	5
550	R15-10B1-FSW-639-721-0.018	639	654	721	5
600	R15-10B1-FSW-689-771-0.018	689	704	771	5
700	R15-10B1-FSW-789-871-0.018	789	804	871	5
800	R15-10B1-FSW-889-971-0.018	889	904	971	5
1000	R15-10B1-FSW-1089-1171-0.018	1089	1104	1171	5

**FSW Type** (Shaft OD 20, Lead 10)

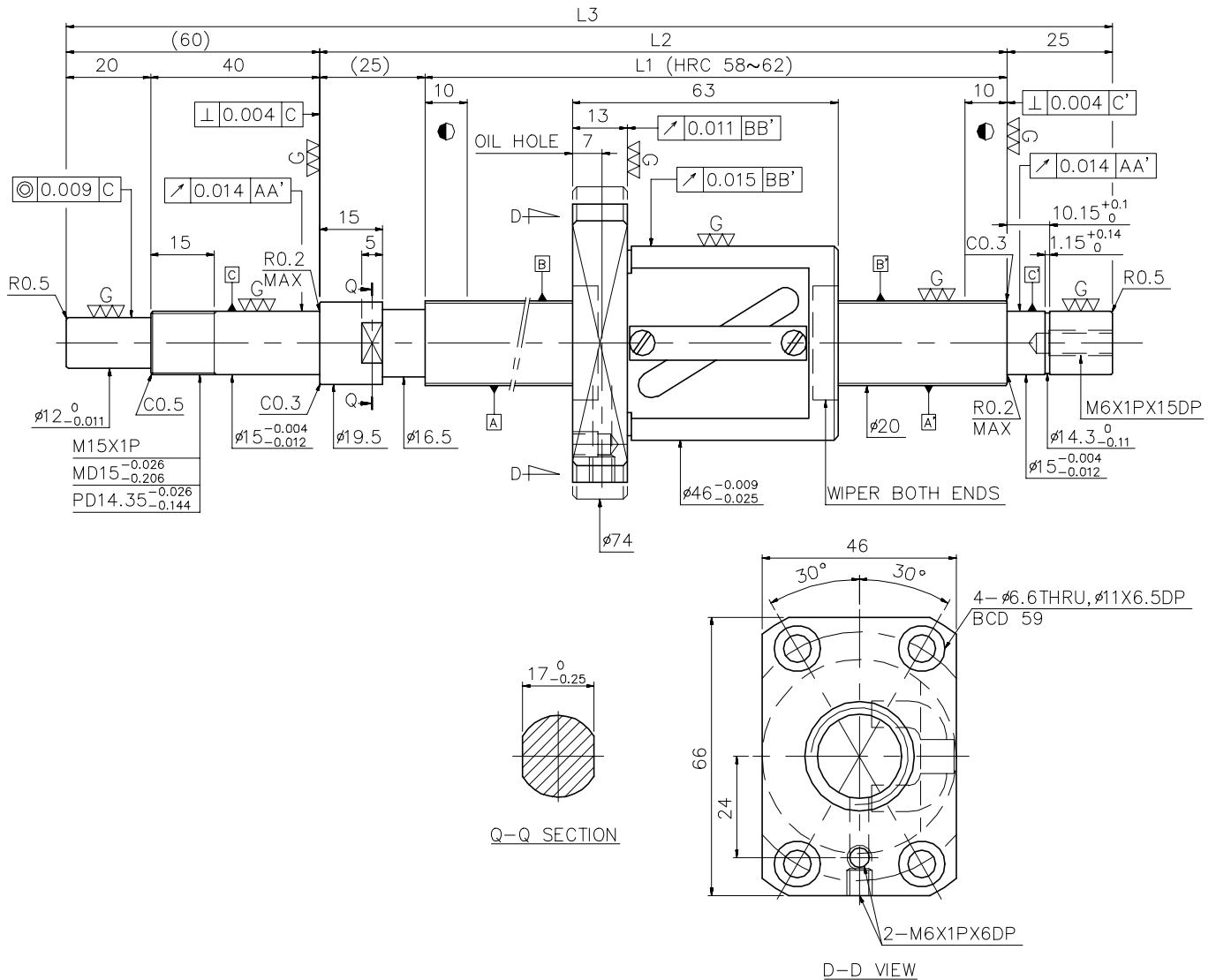


Unit: mm

Ballscrew Data		
Direction	Right Hand	
Lead (mm)	10	
Lead Angle	8.7°	
P.C.D. (mm)	20.8	
Steel Ball (mm)	ø 3.969	
Circuits	2.5x1	
Axial Play (mm)	0	0.005 MAX
Dynamic Load C (kgf)	718	1139
Static Load Co (kgf)	1094	2187
Drag Torque (kgf-cm)	0.2 ~ 1.2	0.3 MAX
Spacer Ball	1:1	-

Stroke	HIWIN Code	L1	L2	L3	Accuracy grade
200	R20-10B1-FSW-289-399-0.018	289	314	399	5
300	R20-10B1-FSW-389-499-0.018	389	414	499	5
400	R20-10B1-FSW-489-599-0.018	489	514	599	5
500	R20-10B1-FSW-589-699-0.018	589	614	699	5
600	R20-10B1-FSW-689-799-0.018	689	714	799	5
700	R20-10B1-FSW-789-899-0.018	789	814	899	5
800	R20-10B1-FSW-889-999-0.018	889	914	999	5
900	R20-10B1-FSW-989-1099-0.018	989	1014	1099	5
1000	R20-10B1-FSW-1089-1199-0.018	1089	1114	1199	5
1100	R20-10B1-FSW-1189-1299-0.018	1189	1214	1299	5
1200	R20-10B1-FSW-1289-1399-0.018	1289	1314	1399	5

**FSW Type** (Shaft OD 20, Lead 20)

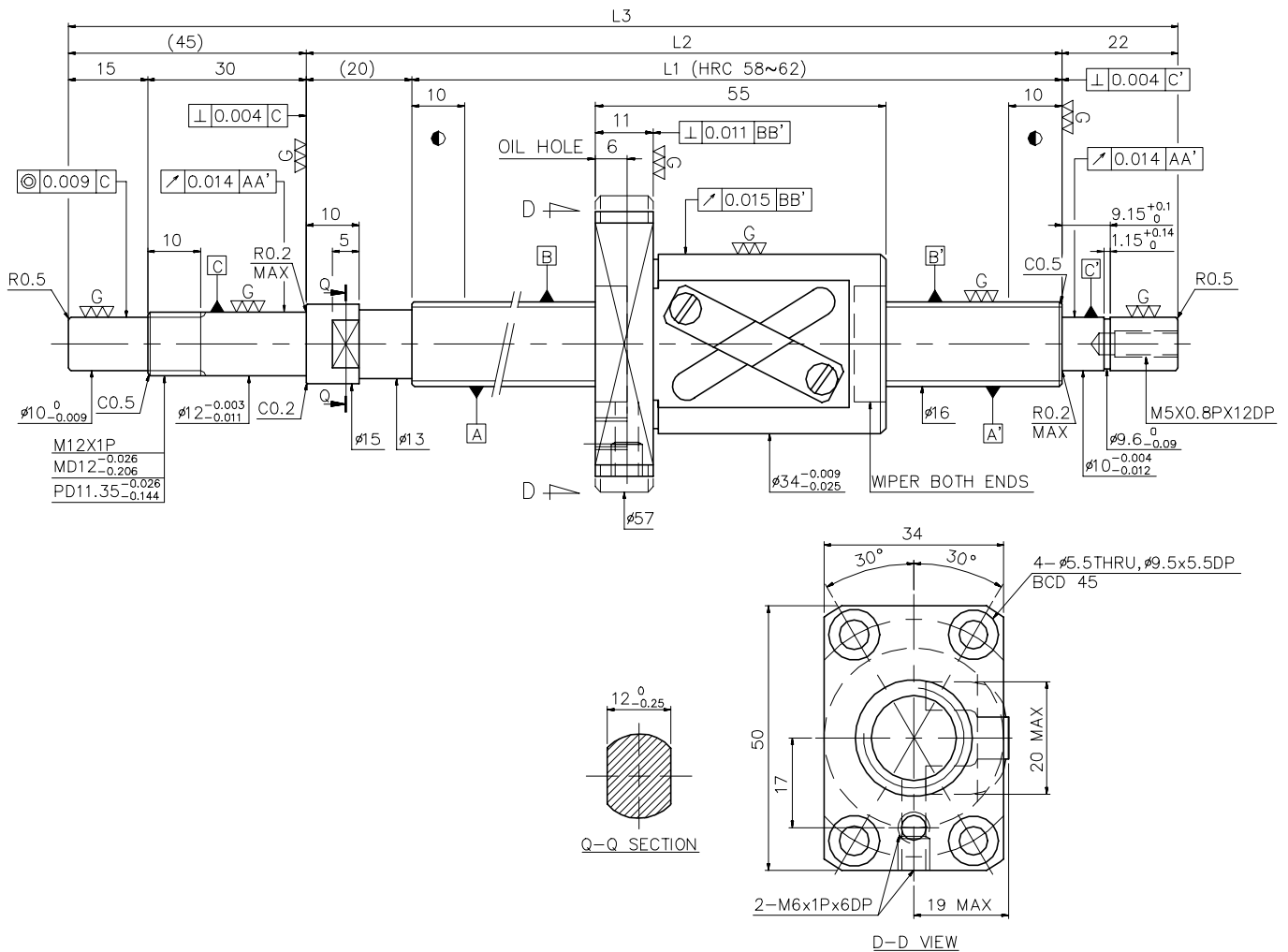


Unit: mm

Ball screw Data		
Direction	Right Hand	
Lead (mm)	20	
Lead Angle	17.01°	
P.C.D. (mm)	20.8	
Steel Ball (mm)	ø 3.969	
Circuits	1.5x1	
Axial Play (mm)	0	0.005 MAX
Dynamic Load C (kgf)	453	719
Static Load Co (kgf)	641	1280
Drag Torque (kgf-cm)	0.2 ~ 1.2	0.3 MAX
Spacer Ball	1:1	-

Stroke	HIWIN Code	L1	L2	L3	Accuracy grade
200	R20-20A1-FSW-310-420-0.018	310	335	420	5
300	R20-20A1-FSW-410-520-0.018	410	435	520	5
400	R20-20A1-FSW-510-620-0.018	510	535	620	5
500	R20-20A1-FSW-610-720-0.018	610	635	720	5
600	R20-20A1-FSW-710-820-0.018	710	735	820	5
700	R20-20A1-FSW-810-920-0.018	810	835	920	5
800	R20-20A1-FSW-910-1020-0.018	910	935	1020	5
900	R20-20A1-FSW-1010-1120-0.018	1010	1035	1120	5
1000	R20-20A1-FSW-1110-1220-0.018	1110	1135	1220	5
1100	R20-20A1-FSW-1210-1320-0.018	1210	1235	1320	5
1200	R20-20A1-FSW-1510-1620-0.018	1510	1535	1620	5

**FSV Type** (Shaft OD 16, Lead 16)

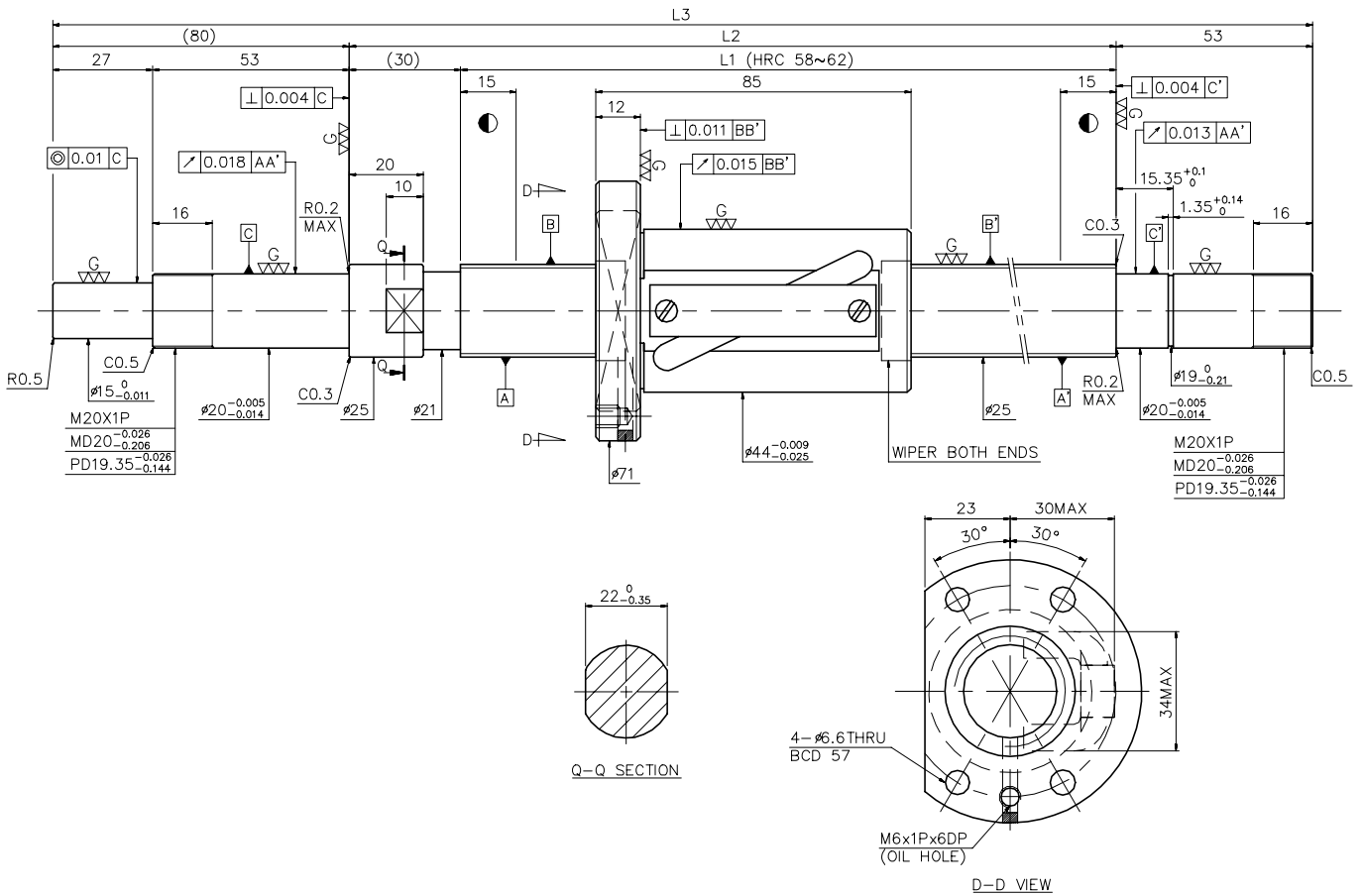


Unit: mm

Ball screw Data		
Direction	Right Hand	
Lead (mm)	16	
Lead Angle	17.05°	
P.C.D. (mm)	16.6	
Steel Ball (mm)	ø 3.175	
Circuits	1.5x1	
Axial Play (mm)	0	0.005 MAX
Dynamic Load C (kgf)	304	481
Static Load Co (kgf)	410	819
Drag Torque (kgf-cm)	0.2 ~ 0.8	0.24 MAX
Spacer Ball	1:1	-

Stroke	HIWIN Code	L1	L2	L3	Accuracy grade
100	R16-16A1-FSV-184 -271-0.018	184	204	271	5
150	R16-16A1-FSV-234 -321-0.018	234	254	321	5
200	R16-16A1-FSV-284 -371-0.018	284	304	371	5
250	R16-16A1-FSV-334 -421-0.018	334	354	421	5
300	R16-16A1-FSV-384 -471-0.018	384	404	471	5
350	R16-16A1-FSV-434 -521-0.018	434	454	521	5
400	R16-16A1-FSV-484 -571-0.018	484	504	571	5
450	R16-16A1-FSV-534 -621-0.018	534	554	621	5
500	R16-16A1-FSV-584 -671-0.018	584	604	671	5
550	R16-16A1-FSV-634 -721-0.018	634	654	721	5
600	R16-16A1-FSV-684 -771-0.018	684	704	771	5
700	R16-16A1-FSV-784 -871-0.018	784	804	871	5
800	R16-16A1-FSV-884 -971-0.018	884	904	971	5
1000	R16-16A1-FSV-1084-1171-0.018	1084	1104	1171	5

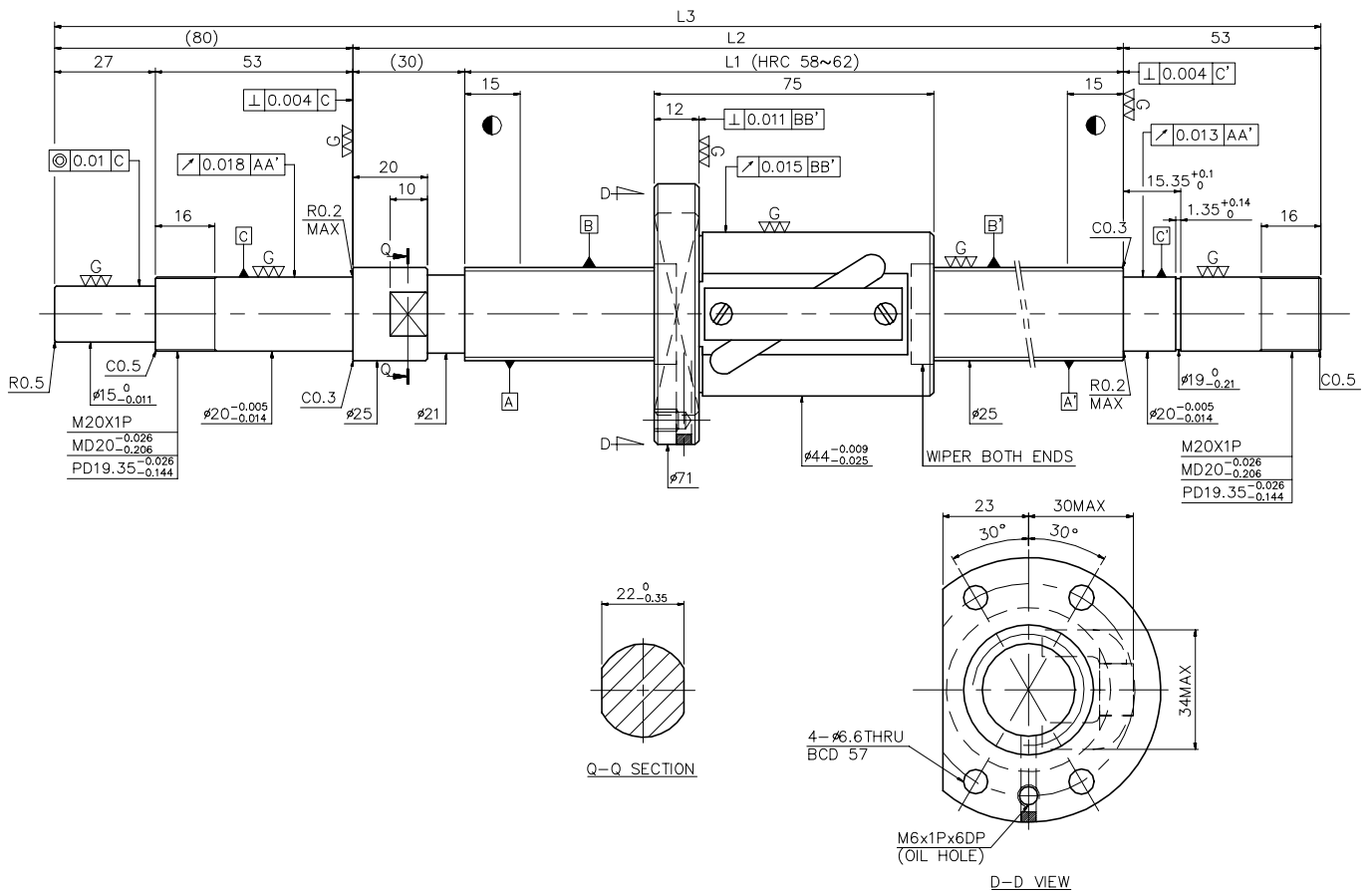
**FSV Type** (Shaft OD 25, Lead 20)



Ballscrew Data		
Direction	Right Hand	
Lead (mm)	20	
Lead Angle	13.75°	
P.C.D. (mm)	26	
Steel Ball (mm)	ø 4.763	
Circuits	2.5x1	
Axial Play (mm)	0	0.005 MAX
Dynamic Load C (kgf)	1003	1591
Static Load Co (kgf)	1619	3236
Drag Torque (kgf-cm)	0.4 ~ 205	0.5 MAX
Spacer Ball	1:1	-

Stroke	HIWIN Code	Unit: mm			Accuracy grade
		L1	L2	L3	
600	R25-20B1-FSV-750-913-0.018	750	780	913	5
800	R25-20B1-FSV-950-1113-0.018	950	980	1113	5
1000	R25-20B1-FSV-1150-1313-0.018	1150	1180	1313	5
1200	R25-20B1-FSV-1350-1513-0.018	1130	1380	1513	5
1400	R25-20B1-FSV-1550-1713-0.018	1550	1580	1713	5
1600	R25-20B1-FSV-1750-1913-0.018	1750	1780	1913	5
2000	R25-20B1-FSV-2150-2313-0.018	2150	2180	2313	5

**FSV Type** (Shaft OD 25, Lead 25)

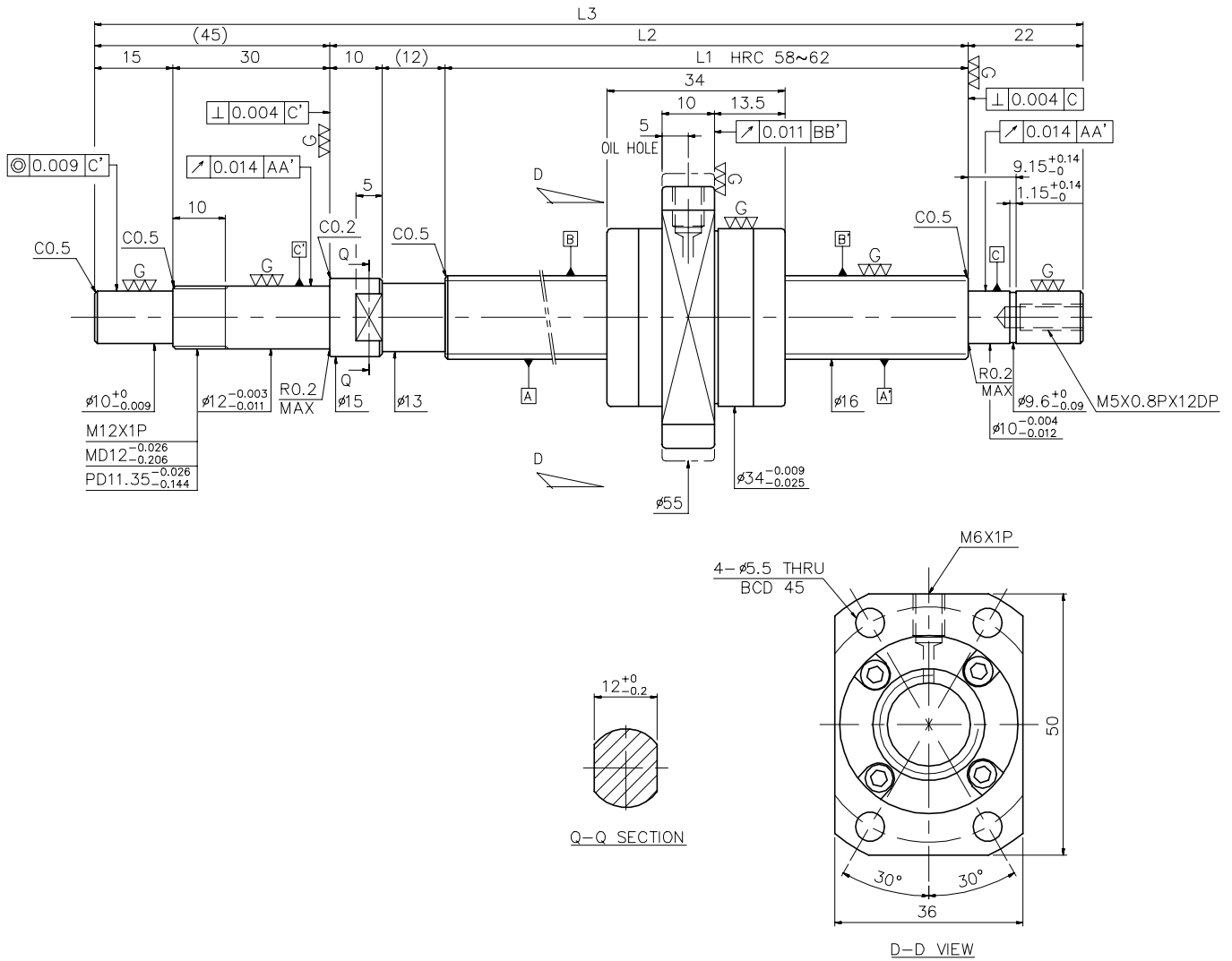


Ball screw Data		
Direction	Right Hand	
Lead (mm)	25	
Lead Angle	17.01°	
P.C.D. (mm)	26	
Steel Ball (mm)	ø 4.763	
Circuits	1.5x1	
Axial Play (mm)	0	0.005 MAX
Dynamic Load C (kgf)	642	1018
Static Load Co (kgf)	964	1926
Drag Torque (kgf-cm)	0.4 ~ 2.5	0.5 MAX
Spacer Ball	1:1	-

Stroke	HIWIN Code	Unit: mm			Accuracy grade
		L1	L2	L3	
600	R25-25A1-FSV-750-913-0.018	750	780	913	5
800	R25-25A1-FSV-950-1113-0.018	950	980	1113	5
1000	R25-25A1-FSV-1150-1313-0.018	1150	1180	1313	5
1200	R25-25A1-FSV-1350-1513-0.018	1350	1380	1513	5
1400	R25-25A1-FSV-1550-1713-0.018	1550	1580	1713	5
1600	R25-25A1-FSV-1750-1913-0.018	1750	1780	1913	5
2000	R25-25A1-FSV-2150-2313-0.018	2150	2180	2313	5

## 6.5 Ultra High Lead Ground Ballscrew

### DFSH Type (Shaft OD 16, Lead 32)

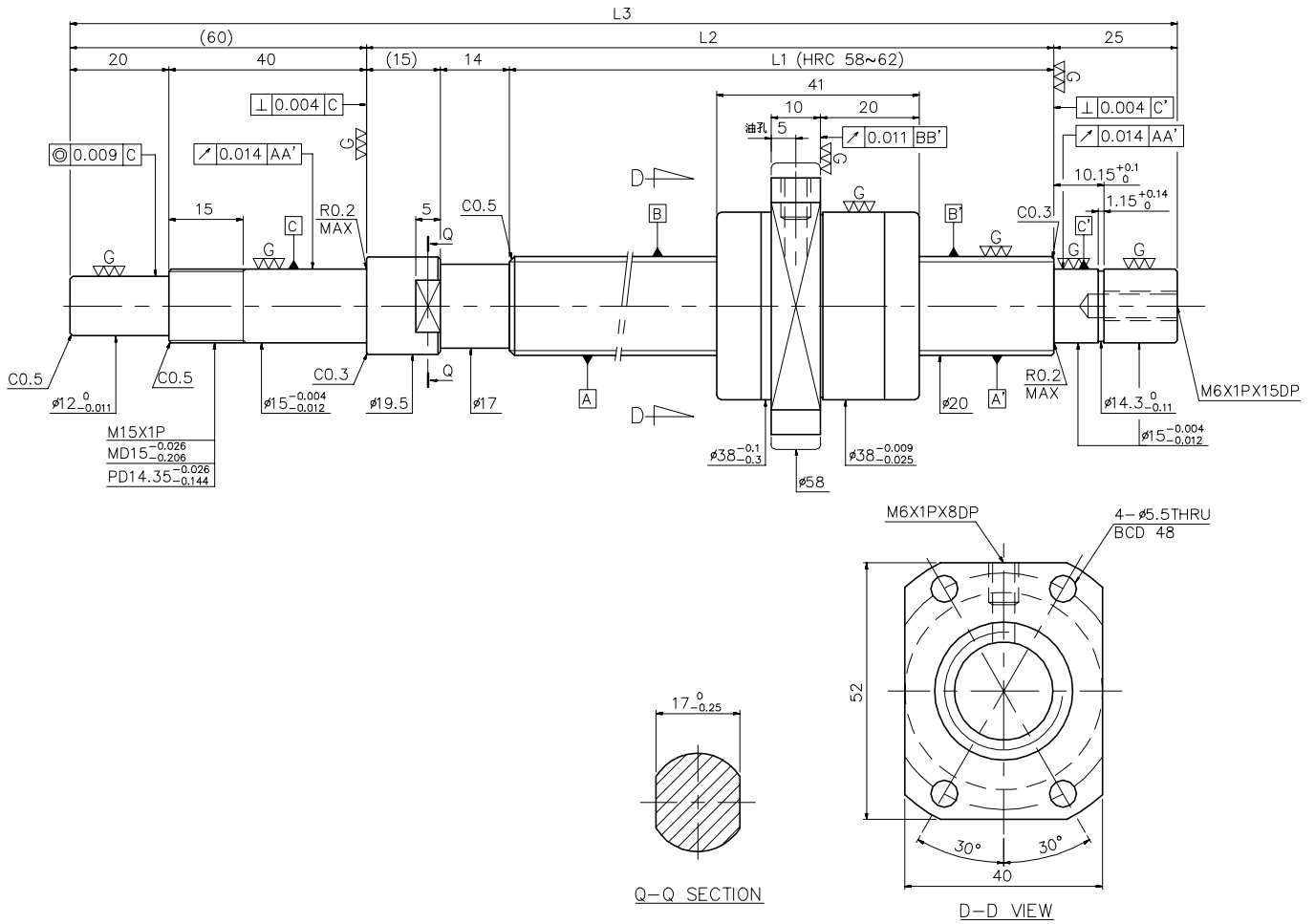


Ballscrew Data	
Direction	Right Hand
Lead (mm)	32
Lead Angle	31.53°
P.C.D. (mm)	16.6
Steel Ball (mm)	ø 3.175
Circuits	0.7x2
Dynamic Load C (kgf)	432
Static Load Co (kgf)	755
Axial Play (mm)	0      0.005 MAX
Drag Torque (kgf-cm)	0.05 ~ 1.0      0.24 MAX
Spacer Ball	-      -

Unit: mm

Stroke	HIWIN Code	L1	L2	L3	Accuracy grade
300	2R16-32V2-DFSH-382-471-0.018	382	404	471	3
500	2R16-32V2-DFSH-582-671-0.018	582	604	671	3
800	2R16-32V2-DFSH-882-971-0.018	882	904	971	3
1200	2R16-32V2-DFSH-1282-1371-0.018	1282	1304	1371	3

**DFSH** Type (Shaft OD 20, Lead 40)



Ballscrew Data	
Direction	Right Hand
Lead (mm)	40
Lead Angle	31.47°
P.C.D. (mm)	20.8
Steel Ball (mm)	ø 3.175
Circuits	0.7x2
Dynamic Load C (kgf)	500
Static Load Co (kgf)	987
Axial Play (mm)	0      0.005 MAX
Drag Torque (kgf-cm)	0.2 ~ 1.2      0.3 MAX
Spacer Ball	-      -

Stroke	HIWIN Code	Unit: mm			Accuracy grade
		L1	L2	L3	
400	2R20-40V2-DFSH-506-620-0.018	506	535	620	5
600	2R20-40V2-DFSH-706-820-0.018	706	735	820	5
800	2R20-40V2-DFSH-906-1020-0.018	906	935	1020	5
1000	2R20-40V2-DFSH-1106-1220-0.018	1106	1135	1220	5
1200	2R20-40V2-DFSH-1306-1420-0.018	1306	1335	1420	5
1600	2R20-40V2-DFSH-1706-1820-0.018	1706	1735	1820	5



## 7. HIWIN Rolled Ballscrews

### 7.1 Introduction

HIWIN Rolled Ballscrews are made by the rolling process of the screw spindle instead of the grinding process. Rolled ballscrews not only have the benefit of low friction and smooth running for the linear feed system compared with traditional screws, but also can be supplied by quick stock delivery and lower production price.

HIWIN uses the most advanced technology in the ballscrew rolling process. By maintaining the homogeneous manufacturing procedure of selecting materials, rolling, heat treating, machining and assembling.

HIWIN rolled ballscrews can be classified into two grades. They are :

- Precision rolled grade (PR)
- High precision rolled grade (HR)

In general, both grades use the same preload method as the precision ground ballscrews, except that there are some differences in the lead error definition and the geometric tolerance. Each grade of the rolled ballscrews can be ordered according to the same nut dimension of the precision ground ballscrew. The dimensions of general type rolled ballscrews are listed in section 7.4. The geometric tolerances are shown in Table 7.4 and Table 7.6. If the ends of the spindle are unmachined, the geometric tolerance does not apply. The production scale of each type of the ballscrews and the accuracy classification are described in the following sections (the unit of length used is in mm).

### 7.2 Precision Rolled Ballscrews

Table 7.1 gives the lead accuracy of the precision rolled ballscrews. The lead accuracy is measured by the accumulated lead error of any portion of 300 mm in length. The maximum axial plays of the precision rolled ballscrews are shown in Table 7.2. These ballscrews can be preloaded as the precision ground ones. The categories of the precision rolled ballscrews are listed in Table 7.3.

Fig. 7.1 and Table 7.4 show the geometric tolerance of the general rolled ballscrews. has a variety of the precision rolled ballscrews for our customers' urgent requirement.

Table 7.1 Accuracy grade of precision rolled ballscrew

Unit: mm

Cumulative lead	PR1	PR2	PR3	PR4
error / 300 mm	±0.023	±0.05	±0.1	±0.21

Table 7.2 Maximum axial play of precision rolled ballscrew

Unit: mm

Ball diameter	≤2	2.381 3.175	3.969	4.763	6.35	7.144	7.938	9.525
Axial play	0.06	0.07	0.10	0.12	0.15	0.16	0.17	0.18

### 7.3 High Precision Rolled Ballscrews

The lead accuracy of the high precision rolled ballscrew is shown in table 7.5.

Fig. 7.2 and Table 7.6 show the geometric tolerances of preloaded high precision rolled ballscrews. Since the spindles of these ballscrews are made according to the accuracy tolerances, the geometric tolerances can be maintained at the highest precision level. Preload method of this type is the same as that of the precision ground type. Thus, they are comparable to the relative grade precision ground ballscrews, with lower price and shorter delivery period.

Table 7.7 gives the axial backlash of standard non-preloaded high precision rolled ballscrews. Table 7.8 shows the dimensions of the high precision rolled ballscrews. Since the rolled ballscrews have a different heat treatment process, they are hard to machine by regular machine tools. Hence, we provide the service of machining the journal ends to satisfy your requirements.

Table 7.3 Category of HIWIN precision rolled ballscrew

Unit: mm

Nominal diameter do (mm)	Lead																Max. screw length
	2	2.5	3	4	5	5.08	6	8	10	12	16	20	25	32	40	50	
8	●	■	●														800
10	●	■	●	●	●												1000
12	●	■	●	■	●	●				●							1200
14		■	●	●	●												1400
15					●				●			●					1500
16	■	■		●	■	■			■		●						1600
20		■		●	■	■	●	●	●			●					2000
25				●	■	■		●	■				●				2500
28					●		●							●			2500
32				●	■	■	●	●	●			●					3200
36					●	●	●	●	●	●		●					3600
40					■	■	●	●	●	●		●			●		4000
45									●	●		●					4600
50					●		●		●	●	●	●			●	●	5000
55									●								5500
63									■		●	■			●		5750

■ : Right and left hand ballscrews      ● : Right hand ballscrews only

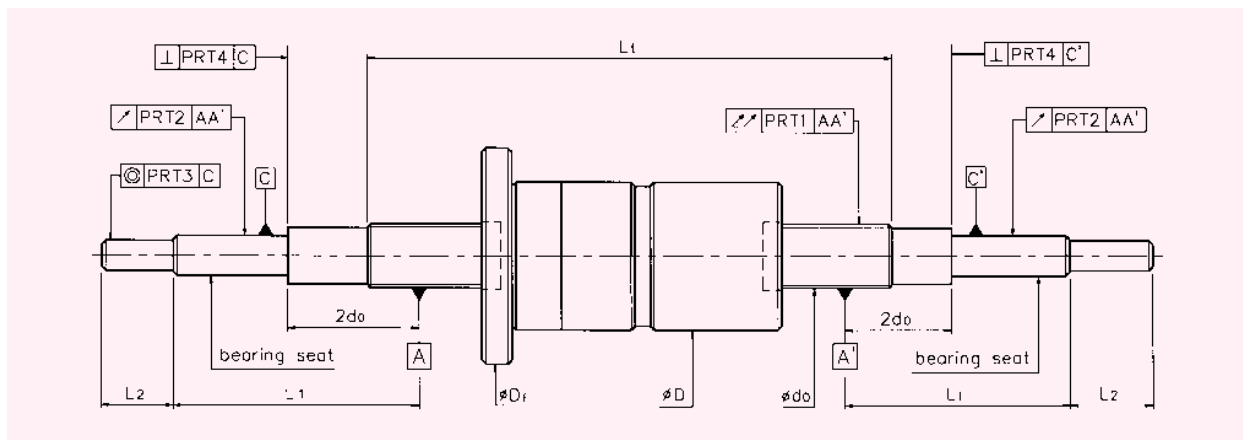


Fig. 7.1 Geometric tolerance of HIWIN precision rolled ballscrew

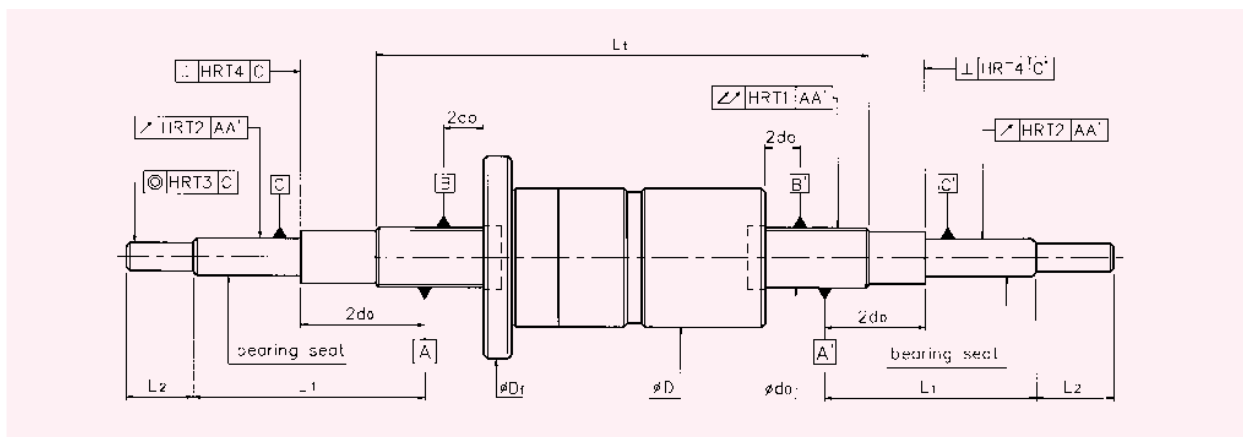


Fig. 7.2 Geometric tolerance of HIWIN high precision rolled ballscrew

Table : 7.4 Geometric tolerance range of HIWIN precision rolled ballscrew

unit:  $\mu\text{m}$

Nominal diameter $d_0$ (mm)	PRT1					PRT2			PRT3			PRT4
	Lt/ $d_0$					L1			L2			
	$\leq 20$	$\leq 40$	$\leq 60$	$\leq 80$	$\leq 100$	$< 50$	$< 125$	$< 200$	$< 50$	$< 125$	$< 200$	
12 / 14	60	80	120	200	320	40	–	–	12	–	–	6
16	60	80	120	200	320	40	–	–	12	–	–	6
20	60	80	120	200	320	40	50	–	–	16	–	6
25 / 28	60	80	120	200	320	40	50	–	–	16	–	6
32 / 36	60	80	120	200	320	40	50	–	–	16	–	6
40 / 45	60	80	120	200	320	40	50	–	–	16	–	6
50	60	80	120	200	320	40	50	63	–	–	20	6
63	60	80	120	200	320	40	50	63	–	–	20	8

\* Note: The geometric tolerance of grade PR4 is not included.

Fig 7.6 Geometric tolerance range of HIWIN high precision rolled ballscrew

unit:  $\mu\text{m}$

Nominal diameter $d_0$ (mm)	HRT1		HRT2			HRT3			HRT4
	Lt/ $d_0$		L1			L2			
	$\leq 20$	$\leq 40$	$< 50$	$< 125$	$< 200$	$< 50$	$< 125$	$< 200$	
16	50	64	25	–	–	10	–	–	5
20	50	64	25	32	–	–	12	–	5
25	50	64	25	32	–	–	12	–	5
32	50	64	25	32	–	–	12	–	5
40	50	64	25	32	–	–	12	–	5
50	50	64	25	32	40	–	–	16	5

Table 7.5 Lead accuracy of HIWIN high precision rolled ballscrew

Accuracy Grade		HR1	
Thread length (mm)	Item	$\pm E$	e
	above		
–	315	23	23
315	400	25	25
400	500	27	26
500	630	30	29
630	800	35	31
800	1000	40	35
1000	1250	46	39
1250	1600	54	44
1600	2000	65	51
2000	2500	77	59
2500	2800	93	69

Table 7.7 Axial play of standard non-preloaded high precision rolled ballscrews

unit: mm

Accuracy grade	HR1
Max. axial play	0.02

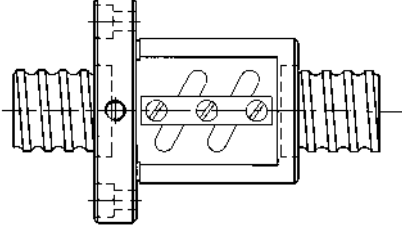
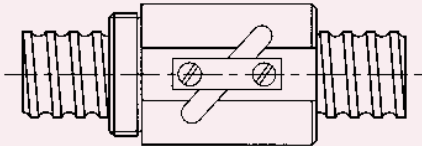
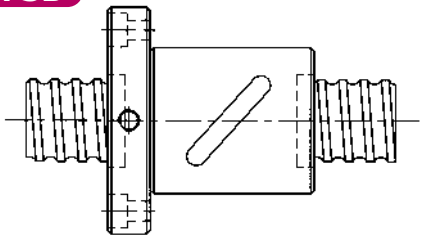
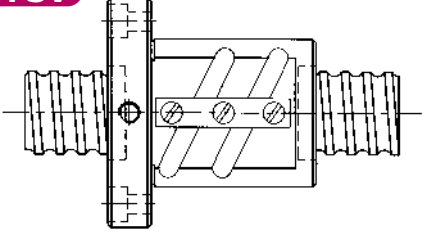
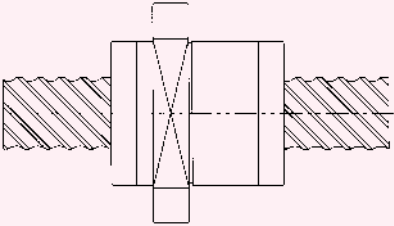
Table 7.8 Category of the high precision rolled ballscrews

unit: mm

Nominal diameter $d_0$ (mm)	Lead		Max. screw length
	5	10	
16	■		640
20	■		800
25	■	●	1000
32	■	●	1200
40	■	●	1600
50		●	3000

■ : Right and left hand ballscrews    ● : Right hand ballscrews only

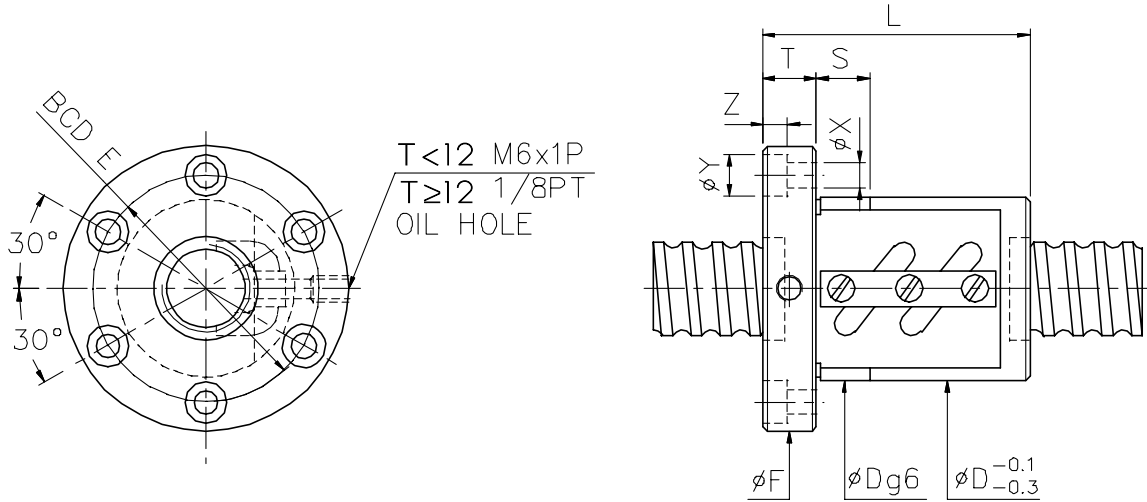
## 7.4 General Type of Rolled Ballscrews

page	General Type	page
94	<p>★ ★ <b>FSW</b></p>  <p>Flange end, Single nut, Tube within the nut diameter</p>	94
95	<p><b>RSV</b></p>  <p>Round, Single nut, Tube above the nut diameter</p>	96
97	<p>★ ★ <b>FSB</b></p>  <p>Flange end, Single nut, Bonded return tube</p>	98
98	<p>★ ★ <b>FSV</b></p>  <p>Flange end, Single nut, Tube above the nut diameter</p>	98
page	High Lead Type	page
99	<p>★ ★ <b>FSH</b></p>  <p>Large lead, Flange mounted, Single nut, End cap</p>	99

\* Double asterisks(★★): Self-Lubricating Ballscrew E1 design is available, except the shaft diameter under 16mm or ball diameter under 2.381mm.

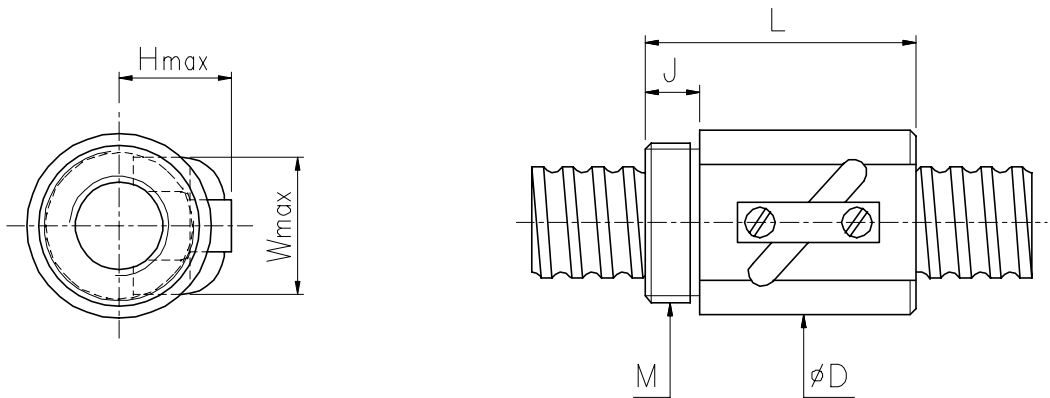
## 7.5 Dimensions for Rolled Ballscrews

### F S W Type



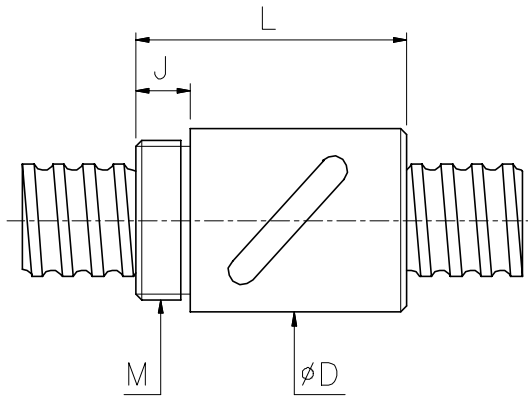
Model	Size		Ball Dia.	Circuits	Dynamic Load 1x10 <sup>6</sup> revs C ( kgf )	Static Load Co ( kgf )	Nut		Flange					Fit	
	Nominal Dia.	Lead					L	D	F	BCD-E	Thickness		Bolt		
										T	X	Y	Z	S	
8-2.5B1	8	2.5	2.000	2.5x1	218	317	34	22	43	31	8	5.5	9.5	5.5	8
10-2.5B1	10	2.5	2.000	2.5x1	252	405	34	24	46	34	8	5.5	9.5	5.5	8
10-4B1	10	4	2.381	2.5x1	304	466	41	26	49	37	10	5.5	9.5	5.5	10
12-4B1	12	4	2.381	2.5x1	344	574	41	30	50	40	10	5.5	9.5	5.5	12
16-5B1	16	5	3.175	2.5x1	679	1226	43	40	64	51	10	5.5	9.5	5.5	12
20-5C1	20	5	3.175	3.5x1	1001	2149	50	44	68	55	12	5.5	9.5	5.5	12
25-5B2	25	5	3.175	2.5x2	1534	3975	60	50	74	62	12	5.5	9.5	5.5	12
25-10B1	25	10	4.763	2.5x1	1459	2983	65	60	86	73	16	6.6	11	6.5	12
32-5B2	32	5	3.175	2.5x2	1702	5098	60	58	84	71	12	6.6	11	6.5	12
32-10B2	32	10	6.350	2.5x2	4379	10345	98	74	108	90	16	9	14	8.5	15
40-10B2	40	10	6.350	2.5x2	4812	12732	102	84	125	104	18	11	17.5	11	15
50-10C2	50	10	6.350	3.5x2	7146	22477	126	94	135	114	18	11	17.5	11	20
63-10C2	63	10	6.350	3.5x2	7869	28290	128	110	152	130	20	11	17.5	11	20

**R S V Type**



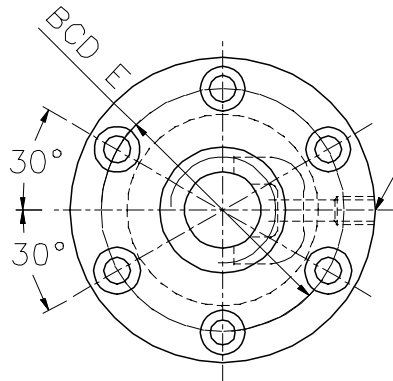
Model	Size		Ball Dia.	Circuits	Dynamic Load 1x10 <sup>6</sup> revs C ( kgf )	Static Load Co ( kgf )	Nut		Mounting Thread	Mounting Thread length	Return Tube width	Return Tube height
	Nominal Dia.	Lead					L	D				
									M	J	W	H
8-2.5B1	8	2.5	2.000	2.5x1	218	317	28	18	M18x1P	10	15	15
10-2.5B1	10	2.5	2.000	2.5x1	252	405	30	20	M18x1P	10	17	17
10-4B1	10	4	2.381	2.5x1	305	466	32	23	M22x1P	10	20	20
12-4B1	12	4	2.381	2.5x1	344	574	32	25	M24x1P	10	22	21
16-5B1	16	5	3.175	2.5x1	679	1226	40	31	M28x1.5P	10	23	25
20-5C1	20	5	3.175	3.5x1	1001	2149	45	35	M32x1.5P	12	27	22
25-5B2	25	5	3.175	2.5x2	1534	3975	58	40	M38x1.5P	16	31	25
25-10B2	25	10	4.763	2.5x2	2663	6123	94	45	M38x1.5P	16	38	32
32-5B2	32	5	3.175	2.5x2	1702	5098	60	54	M50x2P	18	38	29
32-10B2	32	10	6.350	2.5x2	4379	10345	95	58	M52x2P	18	44	36
40-10B2	40	10	6.350	2.5x1	4812	12732	102	65	M60x2P	25	52	41
50-10C2	50	10	6.350	3.5x2	7146	22477	130	80	M75x2P	30	62	46
63-10C2	63	10	6.350	3.5x2	7869	28290	132	95	M90x2P	40	74	52

**R S B** Type

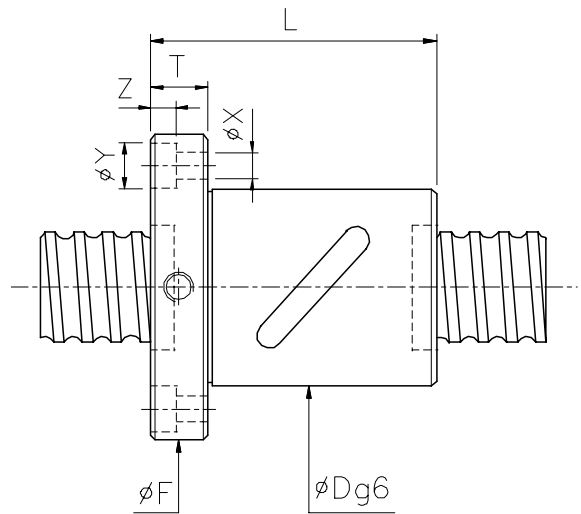


Model	Size		Ball Dia.	Circuits	Dynamic Load 1x10 <sup>6</sup> revs C ( kgf )	Static Load Co ( kgf )	Nut		Mounting Thread M	Mounting Thread length J
	Nominal Dia.	Lead					L	D		
8-2.5B1	8	2.5	2.000	2.5x1	218	317	24	22	M18x1P	7.5
10-2.5B1	10	2.5	2.000	2.5x1	252	405	24	24	M20x1P	7.5
10-4B1	10	4	2.381	2.5x1	304	466	34	26	M22x1P	10
12-4B1	12	4	2.381	2.5x1	344	574	34	28	M25x1.5P	10
16-5B1	16	5	3.175	2.5x1	679	1226	42	36	M30x1.5P	12
20-5C1	20	5	3.175	3.5x1	1001	2149	54	40	M36x1.5P	14
25-5B2	25	5	3.175	2.5x2	1534	3975	69	46	M42x1.5P	19
32-5B2	32	5	3.175	2.5x2	1702	5098	69	54	M50x2P	19
32-10B2	32	10	6.350	2.5x2	4379	10345	105	68	M62x2P	19
40-10B2	40	10	6.350	2.5x2	4812	12732	110	76	M70x2P	24
50-10C2	50	10	6.350	3.5x2	7146	22477	135	88	M82x2P	29
63-10C2	63	10	6.350	3.5x2	7869	28290	135	104	M95x2P	29

**F S B** Type



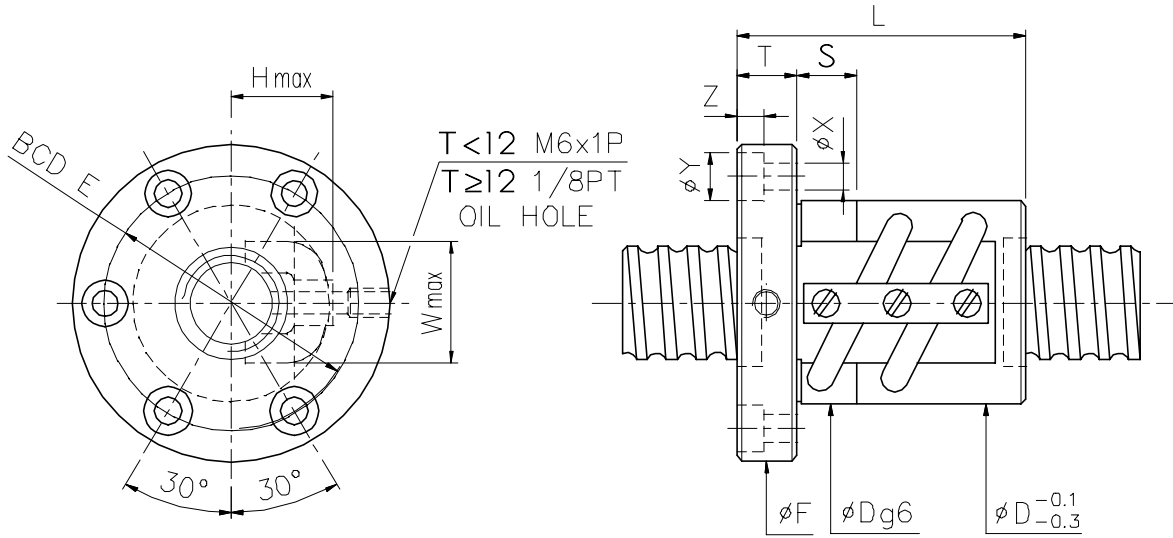
T < 12 M6x1P  
T ≥ 12 1/8PT  
OIL HOLE



Model	Size		Ball Dia.	Circuits	Dynamic Load 1x10 <sup>6</sup> revs C ( kgf )	Static Load Co ( kgf )	Nut		Flange			Bolt		
	Nominal Dia.	Lead					L	D	F	BCD-E	T	X	Y	Z
8-2.5B1	8	2.5	2.000	2.5x1	218	317	34	22	43	31	8	5.5	9.5	5.5
10-2.5B1	10	2.5	2.000	2.5x1	252	405	34	24	46	34	8	5.5	9.5	5.5
10-4B1	10	4	2.381	2.5x1	304	466	41	26	49	37	10	5.5	9.5	5.5
12-4B1	12	4	2.381	2.5x1	344	574	41	28	51	39	10	5.5	9.5	5.5
16-5B1	16	5	3.175	2.5x1	679	1226	43	36	60	47	10	5.5	9.5	5.5
20-5C1	20	5	3.175	3.5x1	1001	2149	50	40	64	51	12	5.5	9.5	5.5
25-5B2	25	5	3.175	2.5x2	1534	3975	60	46	70	58	12	5.5	9.5	5.5
32-5B2	32	5	3.175	2.5x2	1702	5098	60	54	80	67	12	6.6	11	6.5
32-10B2	32	10	6.350	2.5x2	4379	10345	98	68	102	84	16	9	14	8.5
40-10B2	40	10	6.350	2.5x2	4812	12732	102	76	117	96	18	11	17.5	11
50-10C2	50	10	6.350	3.5x2	7146	22477	126	88	129	108	18	11	17.5	11
63-10C2	63	10	6.350	3.5x2	7869	28290	128	104	146	124	20	11	17.5	11

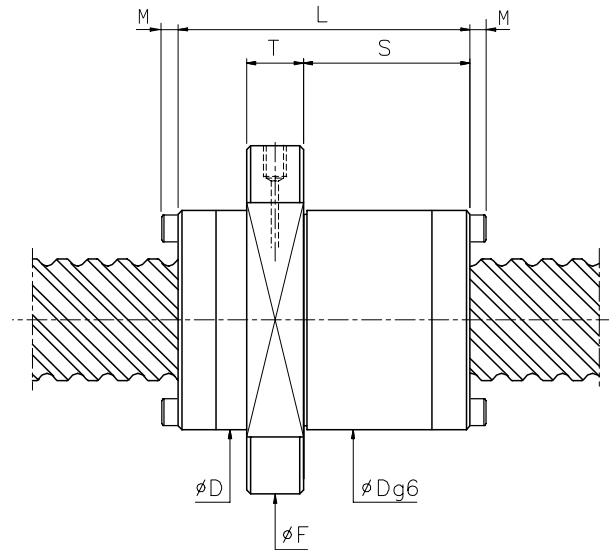
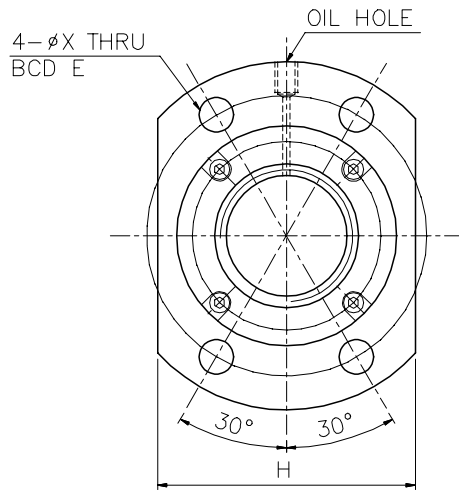


**F S V** Type



Model	Size		Ball Dia.	Circuits	Dynamic Load 1x10 <sup>6</sup> revs C ( kgf )	Static Load Co ( kgf )	Nut		Flange			Return Tube		Bolt			Fit
	Nominal Dia.	Lead					L	D	F	BCD-E	T	W	H	X	Y	Z	
8-2.5B1	8	2.5	2.000	2.5x1	218	317	34	18	41	29	8	15	15	5.5	9.5	5.5	8
10-2.5B1	10	2.5	2.000	2.5x1	252	405	34	20	43	31	8	17	17	5.5	9.5	5.5	8
10-4B1	10	4	2.381	2.5x1	304	466	41	23	46	34	10	20	20	5.5	9.5	5.5	10
12-4B1	12	4	2.381	2.5x1	344	574	41	25	48	36	10	22	21	5.5	9.5	5.5	12
16-5B1	16	5	3.175	2.5x1	679	1226	43	31	55	42	10	23	25	5.5	9.5	5.5	12
20-5C1	20	5	3.175	3.5x1	1001	2149	50	35	59	46	12	27	22	5.5	9.5	5.5	12
25-5B2	25	5	3.175	2.5x2	1534	3975	60	40	64	52	12	31	25	5.5	9.5	5.5	12
32-5B2	32	5	3.175	2.5x2	1702	5098	60	54	80	67	12	38	29	6.6	11	6.5	12
32-10B2	32	10	6.350	2.5x2	4379	10345	98	58	92	74	16	44	36	9	14	8.5	15
40-10B2	40	10	6.350	2.5x2	4812	12732	102	65	106	85	18	52	41	11	17.5	11	15
50-10C2	50	10	6.350	3.5x2	7146	22477	126	80	121	100	18	62	46	11	17.5	11	20
63-10C2	63	10	6.350	3.5x2	7869	28290	128	95	137	115	20	74	52	11	17.5	11	20

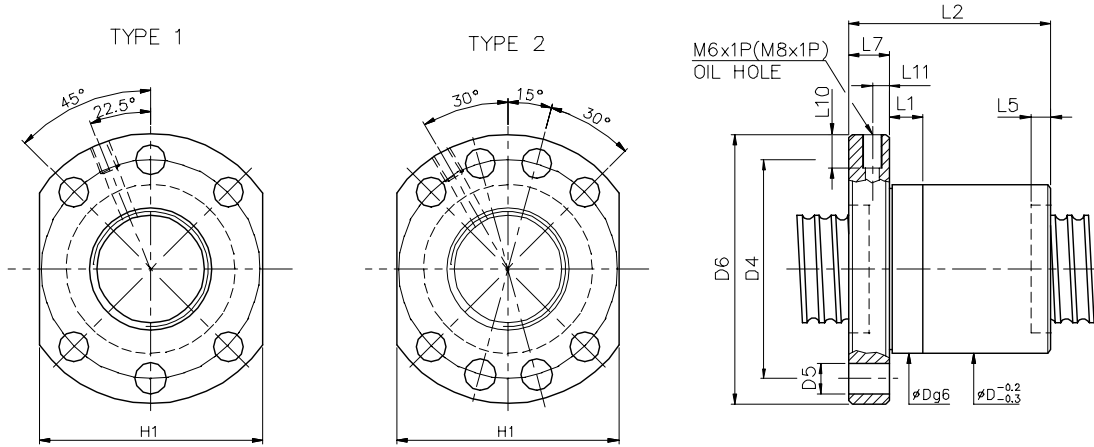
**F S H Type**



Model	Size		Ball Dia.	Circuits	Dynamic Load 1x10 <sup>6</sup> revs C (kgf)	Static Load Co (kgf)	Nut		Flange			Bolt X	Fit											
	Nominal Dia.	Lead					D	L	F	T	BCD-E		H	S	M									
16-16S2	16	16	3.175	1.8x2	710	1380	32	48	53	10	42	38	4.5	26	0									
16-16S4				1.8x4	1290	2760																		
16-16S2	16	16	3.175	1.8x2	710	1380	33	48	58	10	45	38	6.6	26	0									
16-16S4				1.8x4	1290	2760																		
20-20S2	20	20	3.175	1.8x2	800	1740	39	48	62	10	50	46	5.5	27.5	0									
20-20S2				1.8x2	800	1740										38	58	62	10	50	46	5.5	32.5	3
20-20S4				1.8x4	1450	3480										38	58	62	10	50	46	5.5	32.5	3
25-25S2	25	25	3.969	1.8x2	1210	2800	47	67	74	12	60	56	6.6	39.5	3									
25-25S4				1.8x4	2190	5600																		
32-32S2	32	32	4.762	1.8x2	1720	4280	58	85	92	15	74	68	9	48	0									
32-32S4				1.8x4	3110	8530																		
40-40S2	40	40	6.35	1.8x2	2810	7170	72	102	114	17	93	84	11	60	0									
40-40S4				1.8x4	5100	14330																		
50-50S2	50	50	7.938	1.8x2	4120	10890	90	125	135	20	112	104	14	83.5	0									
50-50S4				1.8x4	7470	21780																		

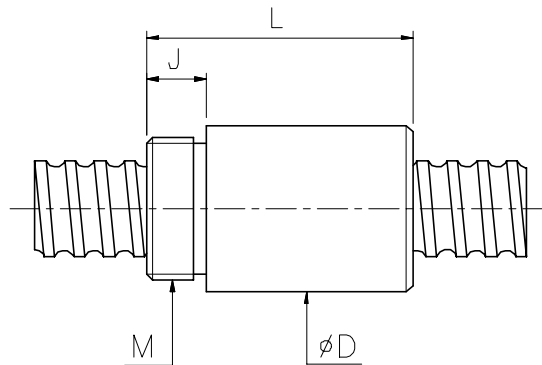
## 7.6 Dimensions for Stock Rolled Ballscrews

### FSI Type (DIN 69051 part 5 form B)



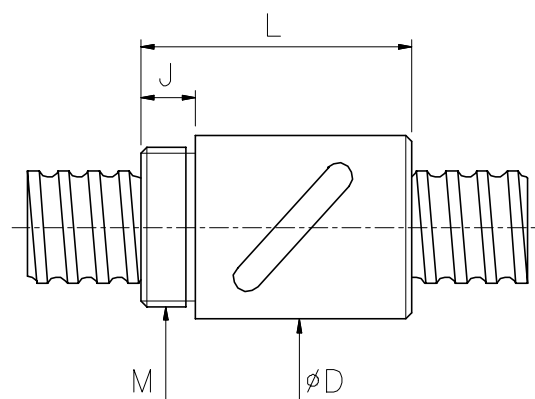
Model	Size		Ball Dia.	Circuits	Dynamic Load 1x10 <sup>6</sup> revs C ( kgf )	Static Load Co ( kgf )	D	D4	Flange Hole No.	D5	D6	H1	L1	L2	L7	L11	M-Oil Hole
	Nominal Dia.	Lead															
16-5T3	16	5	3.175	3	664	1196	28	38	6	5.5	48	40	10	44	10	5	M6x1P
20-5T3	20	5	3.175	3	733	1495	36	47	6	6.6	58	44	10	44	10	5	M6x1P
20-5T4		5	3.175	4	939	1993	36	47	6	6.6	58	44	10	52	10	5	M6x1P
25-5T3	25	5	3.175	3	880	2082	40	51	6	6.6	62	48	10	44	10	5	M6x1P
25-5T4		5	3.175	4	1127	2776	40	51	6	6.6	62	48	12	52	10	5	M6x1P
25-10T3		10	4.763	3	1430	2914	40	51	6	6.6	62	48	16	74	10	5	M6x1P
32-5T3	32	5	3.175	3	1008	2773	50	65	6	9	80	62	10	46	12	6	M6x1P
32-5T4		5	3.175	4	1291	3697	50	65	6	9	80	62	10	53	12	6	M6x1P
32-5T6		5	3.175	6	1830	5545	50	65	6	9	80	62	10	66	12	6	M6x1P
32-10T3		10	6.350	3	2264	4803	50	65	6	9	80	62	16	74	12	6	M6x1P
32-10T4	10	6.350	4	2900	6404	50	65	6	9	80	62	16	85	12	6	M6x1P	
40-5T4	40	5	3.175	4	1414	4621	63	78	8	9	93	70	10	53	14	7	M8x1P
40-5T6		5	3.175	6	2004	6932	63	78	8	9	93	70	10	66	14	7	M8x1P
40-10T3		10	6.350	3	2652	6367	63	78	8	9	93	70	16	74	14	7	M8x1P
40-10T4		10	6.350	4	3396	8489	63	78	8	9	93	70	16	87	14	7	M8x1P
50-5T4	50	5	3.175	4	1562	5940	75	93	8	11	110	85	10	57	16	8	M8x1P
50-5T6		5	3.175	6	2214	8910	75	93	8	11	110	85	10	70	16	8	M8x1P
50-10T3		10	6.350	3	3045	8334	75	93	8	11	110	85	16	78	16	8	M8x1P
50-10T4		10	6.350	4	3899	11112	75	93	8	11	110	85	16	89	16	8	M8x1P
50-10T6		10	6.350	6	5526	16668	75	93	8	11	110	85	16	112	16	8	M8x1P

**RSI Type (with V-thread)**



Model	Size		Ball Dia.	Circuits	Dynamic Load 1x10 <sup>6</sup> revs C ( kgf )	Static Load Co ( kgf )	L	D	M	J
	Nominal Dia.	Lead								
8-2.5T2	8	2.5	2	2	133	178	23.5	17.5	M15x1P	7.5
10-2.5T2	10	2.5	2	2	178	263	25	19.5	M17x1P	7.5
10-4T2	10	4	2.381	2	198	282	32	24	M22x1P	10

**RSB Type (with V-thread)**

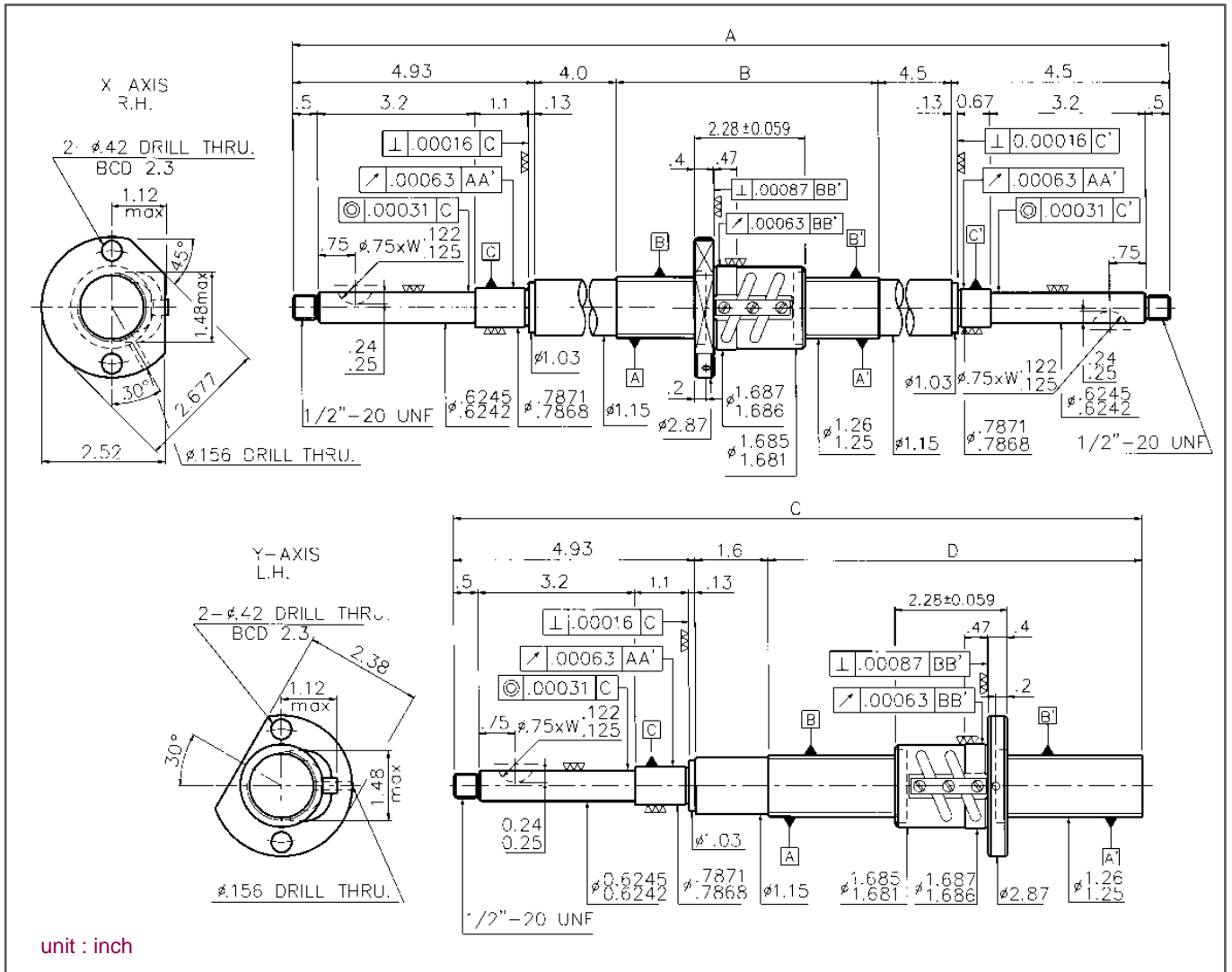


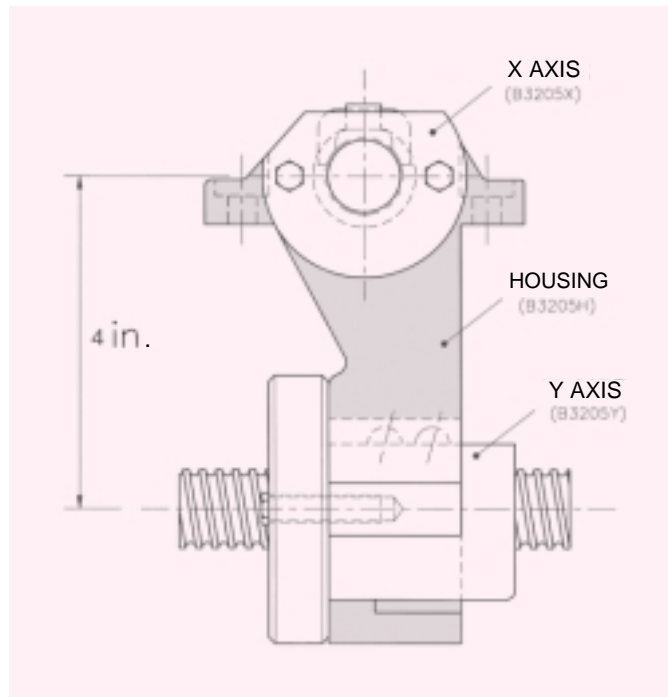
Model	Size		Ball Dia.	Circuits	Dynamic Load 1x10 <sup>6</sup> revs C ( kgf )	Static Load Co ( kgf )	L	D	M	J
	Nominal Dia.	Lead								
12-4B1	12	4	2.381	2.5x1	344	574	34	25.5	M20x1P	10

## 8. Ballscrew Retrofit Kits for Manual Milling Machine

### Precision Ground Ballscrew Set

1. Precision ground, lead accuracy within  $\pm 0.0005"$  /ft.
2. Stock size meet various CNC systems' requirements.
3. High strength and long service life.





**Traverse Screw (X Axis) in.**

Traverse Screw	A	B	Part Number
32	42	24.07	B3205X-32
36	46	28.07	B3205X-36
42	52	34.07	B3205X-42
48	58	40.07	B3205X-48

**Crossfeed Screw (Y Axis) in.**

Table size	C	D	Part Number
9	20.3	13.77	B3205Y-9
12	23.3	16.77	B3205Y-12
16	27.3	20.77	B3205Y-16

P.C. Dia.	1.28"
Ball Dia.	0.125"
Lead Angle	2.84°
Circuits	2.5x2
Lead	5TPI
Static Load	12491 lbf
Dynamic Load (1x10 <sup>6</sup> revs)	4158 lbf
Lead Accuracy	0.0003"/2π; 0.0005"/ft
Drag Torque (Preload)	3.5 in-lb (280lbs)

## 9. Optional Functions

### 9.1 E1 Self - lubricant



**1. Features :**

- Save Cost :  
Without lubrication piping system and oil purchase cost  
\* Example (Specification: ø 50 X30):

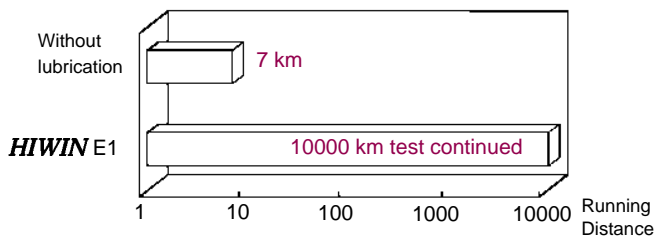
Item	Forced lubrication	HIWIN E1
Lubrication piping system	\$XXX	none
Oil cost	0.1c.c./min.x480min./dayx 280days/yearx5yearsxcost/c.c. =\$XXX	48 c.c. × cost/c.c. =\$XXX
Change cost	3~5times/yearx5yearsxcost/time =\$XXX	none
Waste oil disposal	3~5times/yearx5yearsxcost/time =\$XXX	none

- Prevent oil pollution :  
HIWIN E1 will not produce oil-related pollution. Also HIWIN E1 meet the severe hygienic requirement.
- Easy maintenance and long-term usage :  
There is no extra maintenance work needed by using HIWIN E1. Due to lubricate the loaded ball directly in HIWIN E1, it will maintain long-term running against wear.
- Save space :  
There is no need extra lubrication facility by using HIWIN E1, i.e. saving installation space. Accuracy pre-load and load performance are the same as HIWIN standard specification. Driving torque is no change due to the HIWIN E1.
- For special environment usage :  
In environment where in dusty condition, severe weather condition and washed down with water condition, effective lubrication is maintained by using HIWIN E1 in combination with grease.

## 2. Performance :

### Test condition 1 :

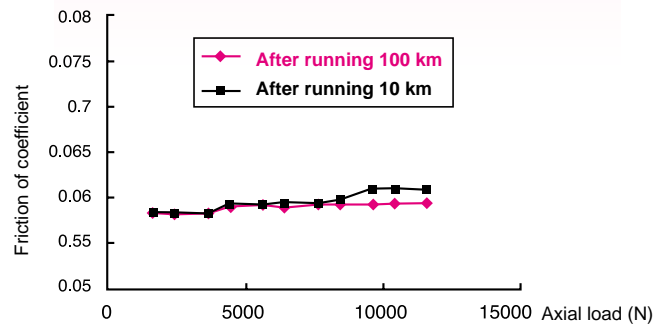
specification :  $\varnothing 50 \times 30$   
 speed : 2500 rpm ( 75 m/min)  
 stroke : 1180 mm



\* Note: above test with no grease added

### Test condition 2 :

specification :  $\varnothing 40 \times 20$   
 speed : 2500 rpm ( 2.0 m/min)  
 stroke : 1000 mm



Test results:

After running 100km, HIWIN E1 still run in good lubrication efficiency.

## 3. Lubricant in HIWIN E1 :

- 1 Synthetic high temperature lubricant
- 2 Low evaporation losses and minimal consumption due to excellent adhesion
- 3 Temperature range:  $-15\text{ }^{\circ}\text{C}$  to  $+240\text{ }^{\circ}\text{C}$
- 4 Protects against corrosion and tolerance rust
- 5 Non-toxic
- 6 Compatible with mineral oil

## 4. Application :

Machine tools

Industrial machinery : printing machine, paper-processing machine, automatic machine, textile machine etc.

Electronic machinery: robot, measuring instrument, medical equipment, X-Y table, factory automation equipment etc.

Transport machinery: material handling equipment, nuclear reactor, actuator etc.

Aircraft application : aircraft flaps, actuator, airport loading equipment etc.

Miscellaneous : antenna control, window control, medical bed control, car-parking equipment etc.

### ● Specification number :

Example: R40 – 10B2 – FSW**E1** – 800 – 1000 – 0.008



**HIWIN** E1 code

### ● Specification :

Nut type: FSV, FDV, FSW, FDW, PFDW, OFSW, DFSV, FSH

Please contact HIWIN engineers with other specification you need.

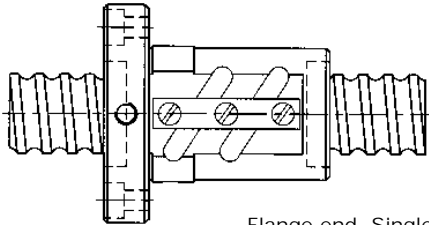
In order to get the good lubrication efficiency; please notify HIWIN engineers the ballscrew installation direction.



**HIWIN E1 Precision Ground Ballscrews**

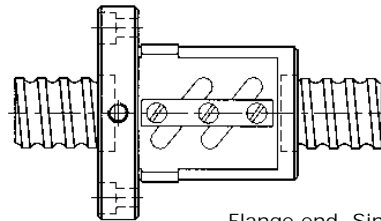
**General Type**

**FSV**



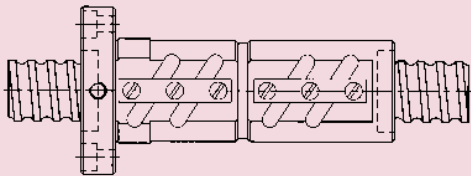
Flange end, Single nut,  
Tube above nut diameter

**FSW**



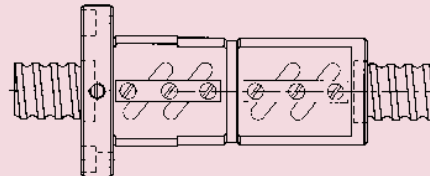
Flange end, Single nut,  
Tube within nut diameter

**FDV**



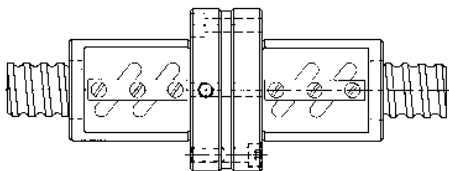
Flange end, Double nut,  
Tube above nut diameter

**FDW**



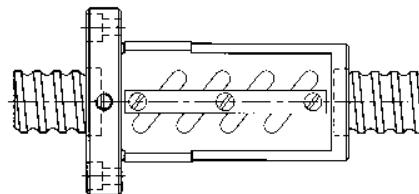
Flange end, Double nut,  
Tube within nut diameter

**PFDW**



Flange to flange, Double nut,  
Tube within nut diameter

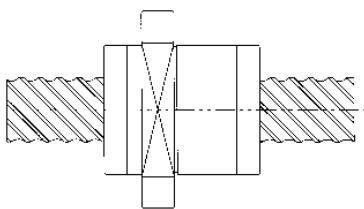
**OFSW**



Offset pitch preload, Flange end,  
Single nut, Tube within nut diameter

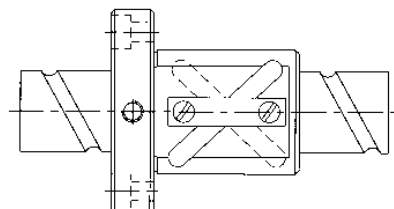
**High Lead Type**

**FSH**



Large lead, Flange mounted,  
Single nut, End cap

**DFSV**



Double start, Flange end,  
Single nut, Tube above nut diameter

\* Different design required by the drawing approval, please contact with HIWIN engineers for the other type listed above. ( The specifications in this catalogue are subject to change without notification. )

## 9.2 R1 Rotating Nut

● **Application:**

Semi-conductor industries, Robots, Wood machines, Laser cutting machines, Transporting equipment.

● **Features:**

**1. Compact and high positioning:**

It is a compact design using nut and support bearing as an integral unit. 45-degree steel ball contact angle make a better axial load. Zero backlash and higher stiffness construction give a high positioning.

**2. Simple installation:**

It is installed simply by fixing the nut on the housing with bolts.

**3. Rapid feed:**

No inertial effect produced by the integral unit rotating and the shaft fixed. Can select smaller power to meet the rapid feed requirement.

**4. Stiffness:**

Have a higher trust and moment stiffness, because the integral unit have an angular contact construction. There is no backlash while rolling.

**5. Quietness:**

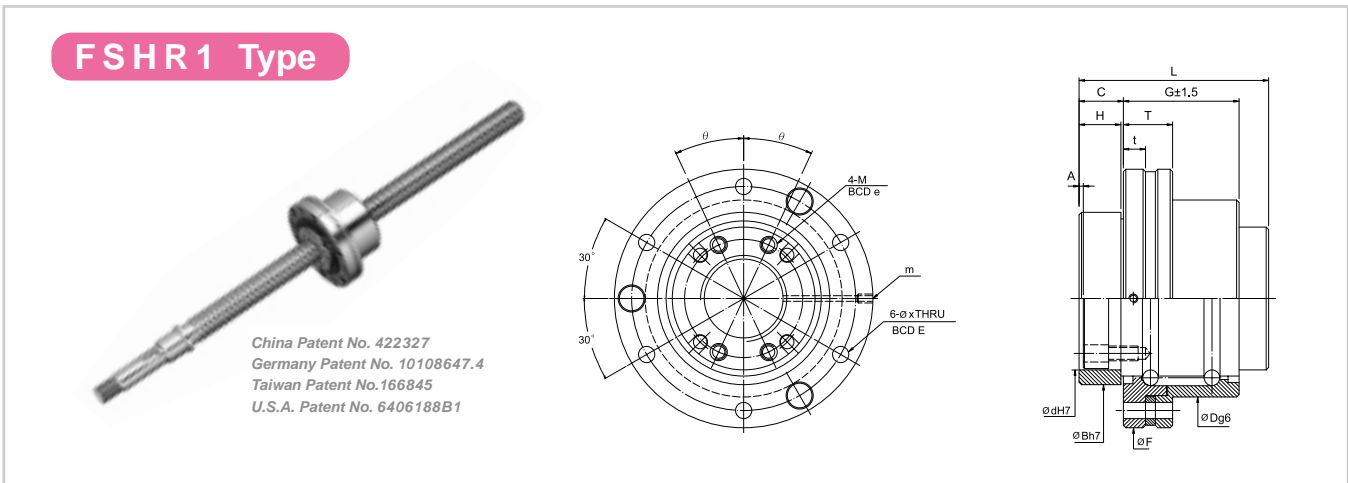
Special end cap design allows steel balls circulating inside the nut. Noise generated by high speed operation lower than ordinary ballscrew.

**Specification:**

Example: 2R40-40S2-DFSHR1-800-1000-0.018



HIWIN R1 code



Model	Bearing		Nut				Flange				Bolt				Bush			Oil hole	
	Dynamic Load (kgf)	Static Load (kgf)	D	G	L	C	F	T	t	E	e	$\theta$	M	X	d	B	H		A
16-16S2	1299	1826	52	25	44	11.4	68	13	6	60	26	20	M4x0.7p	4.5	33	40	11	2	M4x0.7p
20-20S2	1762	2531	62	30	50	12	78	13	6	70	31	20	M5x0.8p	4.5	39	50	11	2	M4x0.7p
25-25S2	1946	3036	72	37	63	16.5	92	13	6	81	38	20	M6x1p	5.5	47	58	15.5	3	M4x0.7p
32-32S2	3150	5035	80	47	80	21	105	20	9	91	48	25	M6x1p	6.6	58	66	20	3	M6x0.75p
40-40S2	4800	8148	110	62	98	22.5	140	20	9	123	61	25	M8x1.25p	9	73	90	21.5	3	M6x0.75p

## 9.3 High Load Drive

● **Application:**

High-load ball screw can be used for application on injection molding machines, die casting machines, general presses, power cylinders, robot ...

● **Features:**

**1. Heavy Load**

- A. 2~3 times load capacity than general standard series.
- B. High axial load and acceleration.
- C. Special lubrication design for short stroke.

**2. Accuracy**

JIS C5 and JIS C7

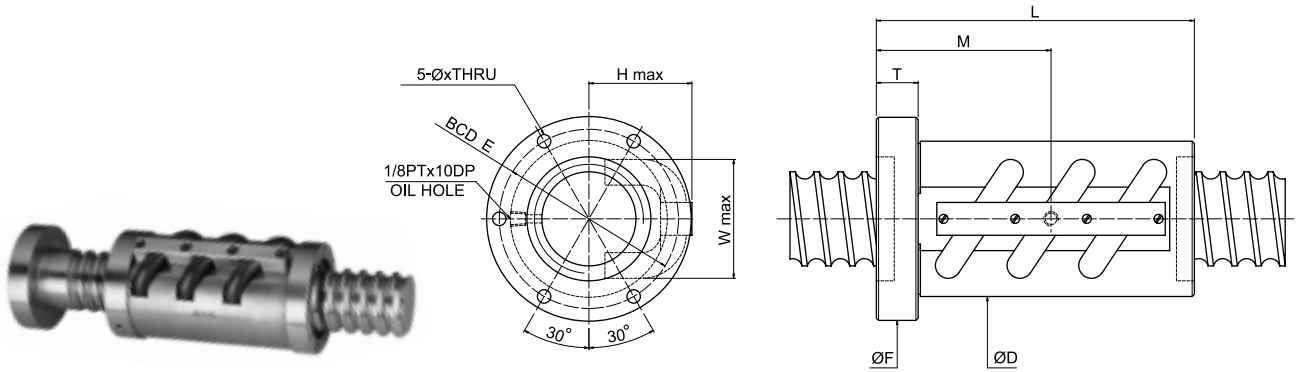
**3. High Speed Operation and High Life**

Enforced ball circulation systems for high speed condition and achieve long service life.

**4. Option**

Design in HIWIN Self-lubricant E1 Series.

### Ballscrew for High-Load Drive



Model No.	Shaft diameter	Lead	Turns Circuits	Dynamic C N (kgf)		Static Co N (kgf)		D	L	F	T	E	X	H	W	M
50-16B2	50	16	2.5X2	235000	(24000)	497000	(50700)	95	165	127	28	110	9	68	69	101
50-16B3		16	2.5X3	334000	(34100)	746000	(76100)	95	213	127	28	110	9	68	69	117
55-16B2	55	16	2.5X2	255000	(26000)	535000	(54600)	100	165	132	28	115	9	71	74	101
55-16B3		16	2.5X3	361000	(36800)	804000	(82000)	100	213	132	28	115	9	71	74	117
63-16B2	63	16	2.5X2	280000	(28600)	613000	(62500)	105	165	137	28	120	9	73	82	101
63-16B3		16	2.5X3	398000	(40600)	918000	(93700)	105	213	137	28	120	9	73	82	117
80-16B2	80	16	2.5X2	322000	(32900)	765000	(78100)	120	170	158	32	139	11	81	98	106
80-16B3		16	2.5X3	458000	(46700)	1150000	(117000)	120	218	158	32	139	11	81	98	122
80-25B3	80	25	2.5X3	650690	(66397)	2016555	(205771)	145	338	185	40	165	11	102	100	140
100-16B3	100	16	2.5X3	493000	(50300)	1430000	(146000)	140	218	178	32	159	11	91	117	122
100-25B3		25	2.5X3	738000	(75300)	2596000	(264900)	159	338	199	40	179	11	109	118	140
100-25B4		25	2.5X4	945000	(96400)	3461000	(353200)	159	413	199	40	179	11	109	118	165

## 9.4 High Speed (High $D_m$ -N Value)



HIWIN high-speed ballscrews is a represent of the unique core technology of HIWIN whose design is based on the development of the optimized bi-arc contact profile and multi-circuit continuing ball circulation system. It possesses the characteristics of high feeding speed, high accelerating, strong stiffness, high loading, less vibration, and low noise. With the constant temperature design, it could prevent the deformation to satisfy the requirement in high accuracy positioning.

### ● Application:

It can be installed into mold cutting, machining center, machine tools with speedy feeding, and other types of machine with request of high positioning accuracy in high speed.

### ● Features:

#### 1. High speed feeding

$D_m$ -N value is up to 150,000 (i.e. spiral rate=7.8 m/sec); feeding rate is 90m/min.

#### 2. High positioning accuracy

The accuracy is up to the requirement of JIS C3.

#### 3. Acceleration

Over 1.0 g (9.8 m/sec<sup>2</sup>) to avoid time consuming between accelerating and decelerating.

#### 4. Heavy stiffness

Optimized screw profile and structure design.

#### 5. Heavy Load

Multi-load ball distribution design.

#### 6. Low vibration noise

Using the best slender ratio and high-speed circulation to lower noise.

#### 7. Constant temperature

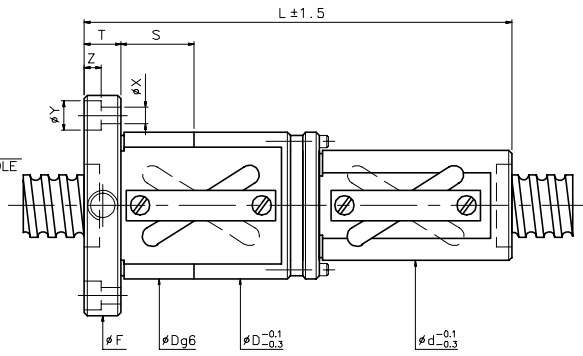
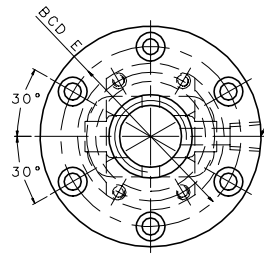
The efficient heat transfer can restrain the thermal deformation and improve the stability.

#### 8. Environment friendly

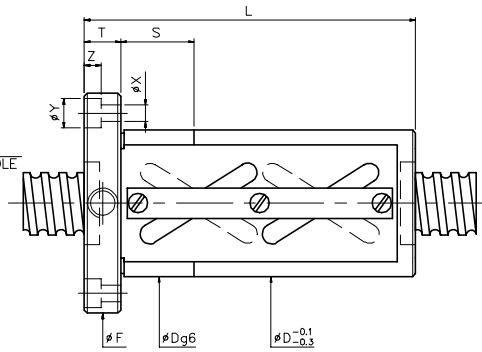
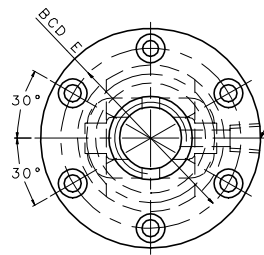
Optional self-lubricant function can reduce the lubricant consumption and to diminish the environment pollution caused by lubricant discard. It also solves the problem that lubricant thickens unevenly by deformation of oil film in spiral path.

**Ballscrew for High- $D_m$ -N Drive**

Nut Type I  
**PFDW**



Nut Type II  
**OFSW**



Model	Nominal Dia.	Lead	Circuits	Nut Type	Dynamic Load 1x10 <sup>6</sup> revs C(kgf)	Static Load Co(kgf)	Ball Dia.	Start Type	D	d	L	F	T	BCD-E	X	Y	Z	S
36-20C1	36	20	3.5x1	OFSW	4478	10201	6.35	2	94	-	121	136	18	114	11	17.5	11	30
36-20B2		20	2.5x2	PFDW	5447	13597	6.35	2	94	76	191	136	18	114	11	17.5	11	30
40-20C1	40	20	3.5x1	OFSW	4810	11367	6.35	2	96	-	121	138	18	116	11	17.5	11	30
40-20B2		20	2.5x2	OFSW	6537	16238	6.35	2	96	-	161	138	18	116	11	17.5	11	30
40-25B2		25	2.5x2	PFDW	6743	17002	7.144	2	98	80	230	140	18	118	11	17.5	11	30
40-30B2		30	2.5x2	PFDW	6743	17002	7.144	2	98	80	250	140	18	118	11	17.5	11	30
40-32B3		32	2.5x3	PFDW	7771	21823	6.35	3	96	78	270	142	22	118	13	20	13	30
45-20C1	45	20	3.5x1	OFSW	4845	12823	6.35	2	98	-	122	140	18	118	11	17.5	11	30
45-20B2		20	2.5x2	OFSW	6585	18318	6.35	2	98	-	162	140	18	118	11	17.5	11	30
45-25C1		25	3.5x1	OFSW	5501	14394	7.144	2	101	-	141	143	18	121	11	17.5	11	30
45-25B2		25	2.5x2	PFDW	6691	19186	7.144	2	101	83	230	143	18	121	11	17.5	11	30
45-30B2		30	2.5x2	PFDW	6691	19186	7.144	2	101	83	250	143	18	121	11	17.5	11	30
45-32B3		32	2.5x3	PFDW	7857	24730	6.35	3	98	80	270	144	22	120	13	20	13	30
50-20C1	50	20	3.5x1	OFSW	5027	14278	6.35	2	101	-	122	143	18	121	11	17.5	11	40
50-20B2		20	2.5x2	OFSW	6831	20397	6.35	2	101	-	162	143	18	121	11	17.5	11	40
50-25C1		25	3.5x1	OFSW	5782	16033	7.144	2	103	-	141	145	18	123	11	17.5	11	40
50-25B2		25	2.5x2	PFDW	7033	21370	7.144	2	103	85	230	145	18	123	11	17.5	11	40
50-30C1		30	3.5x1	OFSW	5782	16033	7.144	2	103	-	160	145	18	123	11	17.5	11	40
50-30B2		30	2.5x2	PFDW	7033	21370	7.144	2	103	85	250	145	18	123	11	17.5	11	40
50-32B3		32	2.5x3	PFDW	8148	27525	6.35	3	101	83	270	147	22	123	13	20	13	40
55-20C1	55	20	3.5x1	OFSW	5158	15733	6.35	2	103	-	122	145	18	123	11	17.5	11	40
55-20B2		20	2.5x2	OFSW	7009	22476	6.35	2	103	-	162	145	18	123	11	17.5	11	40
55-25C1		25	3.5x1	OFSW	6181	17670	7.144	2	105	-	141	147	18	125	11	17.5	11	40
55-25B2		25	2.5x2	PFDW	7518	23553	7.144	2	105	87	230	147	18	125	11	17.5	11	40
55-30C1		30	3.5x1	OFSW	6181	17670	7.144	2	105	-	160	147	18	125	11	17.5	11	40
55-30B2		30	2.5x2	PFDW	7518	23553	7.144	2	105	87	250	147	18	125	11	17.5	11	40
55-32B3		32	2.5x3	PFDW	8332	30207	6.35	3	103	85	270	149	22	125	13	20	13	40

## 9.5 Cool Type

### 9.5.1 Extra High $D_m$ -N Value Ballscrew - Cool Type I

Cool type I:

- New era for high speed ballscrew – achieving extra high  $D_m$ -N value (up to 200,000) and high positioning accuracy.
- Cool type I and a hollow shaft design.
- High speed machine tools and machining center.



#### Design Principle:

The cool type series feature using forced cooling fluid to pass through the nut, which minimize heat generation and thermal expansion during ballscrew operation.

- Cool type I as shown in the Figure 9.1:

Flowing fluids are circulated in passages that inside the nut, and exchanging heat with the cooler as shown in the Figure 2. In cooperation with hollow shaft design, it makes high quality of thermal control and maintains high accuracy. That combination is the most suitable for high-speed machine tools.

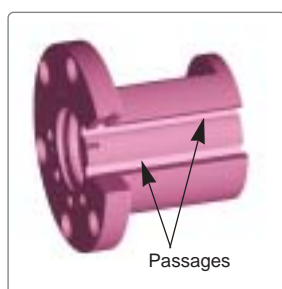


Fig. 9.1 Cool type I

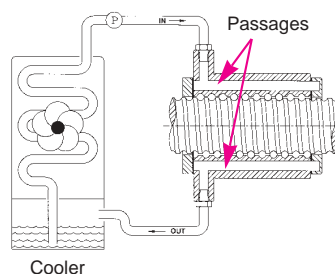


Fig. 9.2 Cool type I with cooler

#### • Specification:

1. We recommend shaft diameter above  $\varnothing 32\text{mm}$  to cool type design.
2. Nut type: FSV, FSW, PFDW, OFSW, DFSV, FSH, FSI, etc.
3. Please contact HIWIN with other specification you need.
4. The cool type I, compared with the standard specifications, will make a minor external dimension change of the nut, please contact HIWIN.

#### • Specification number:

Example: R50 - 30C1 - OFSWC1 - 1180 - 1539 - 0.008

↓  
C1: **HIWIN** cool type ballscrew for type I

● **Performance Comparison:**

For high-speed machine tools, hollow shaft design only is not enough against heat generation and thermal expansion, because nut itself is a heat source, as shown in Figure 9.3.

**Test condition:**  
 specification:  $\varnothing 50$ , lead 30 mm  
 speed: 2500 rpm ( 75 m/min),  
 back and forth feed continuously  
 acceleration: 9.8 m/sec<sup>2</sup>  
 stroke: 1180 mm  
 preload: 205 kgf  
 moving weight: 300 kgf  
 cooling rate: oil 2.5 liter/min  
 inlet temperature: 16°C  
 room temperature: 25°C

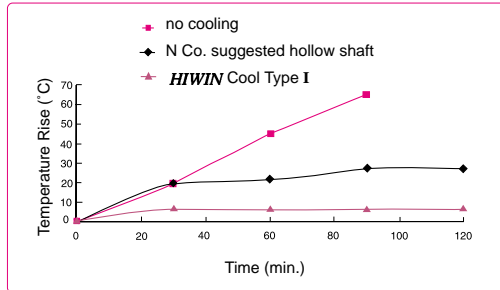
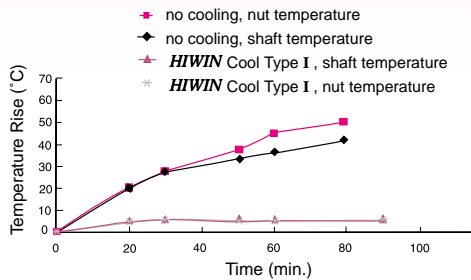


Fig 9.3 Nut temperature rise

**Cool type I Performance (1)**

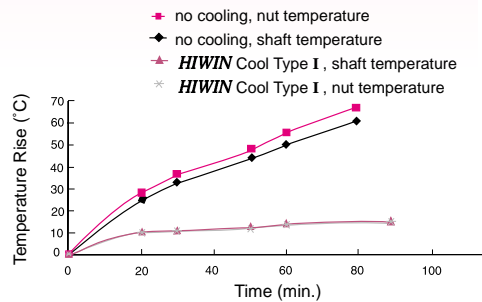
specification:  $\varnothing 50$ , lead 30 mm  
 D<sub>m</sub>-N value: 150,000  
 acceleration: 9.8 m/sec<sup>2</sup>



Cool type I: Temperature rise of ballscrew

**Cool type I Performance (2)**

specification:  $\varnothing 50$ , lead 30 mm  
 D<sub>m</sub>-N value: 200,000  
 acceleration: 9.8 m/sec<sup>2</sup>



Cool type I: Temperature rise of ballscrew

● **Features:**

1. Optimized design for high reliability

Use of computer simulation and FEM analysis, the cool type ballscrew features well thermal protection and high reliability.

2. Promote higher speed rotation and extra high D<sub>m</sub>-N value (up to 200,000)

Cool type ballscrew will eliminate high-speed rotation aftereffect, i. e., thermal problem, and promote higher speed rotation.

3. Prevent thermal distortion

Optimized heat transfer design to minimize heat generation and prevent thermal distortion.

4. Strengthen durability

When operating repeatedly, friction between balls cause heat generation. That may be made balls oxidized or decarburized, and shortened the service life. Cool type ballscrew will strengthen durability under a cooling environment.



FEM analysis for cool type ballscrew

**5. Extended lubricant life cycle**

When using lubrication, minimum heat generation further inhibits deterioration in the quality of lubrication and extends the lubricant life cycle.

**6. Keep temperature uniform and reduce warm-up time**

When high-speed operation, nut and shaft cooling effect indeed keep feed-system temperature constant and reduce warm-up time.

**7. Higher feeding accuracy**

Cooling effect of cool type ballscrew will stabilize against thermal expansion and equalize feeding accuracy.

**9.5.2 High Load Ballscrew - Cool Type II**

Cool type **II**:

- New era for ballscrew applied in electric – driven injection machine, presses, power units, and other replaceable hydraulic drives.
- electric-driven injection machine, presses, power units and other replaceable hydraulic drives.



**Cool type II**  
Germany Patent No. 10108647.4  
Taiwan Patent No. 193878

**Design Principle:**

The cool type series feature using forced cooling fluid to pass through the nut, which minimize heat generation and thermal expansion during ballscrew operation.

- Cool type **II** as shown in the Figure 9.4:

Flowing fluids are circulated through a space, which inside the nut, and exchanging heat with the cooler as shown in the Figure 9.5. It is the most suitable for electric-driven injection machine, presses, and power units. The cool type **II**, compared with the standard specifications, will make a minor external dimension change of the nut. Please contact **HIWIN**.

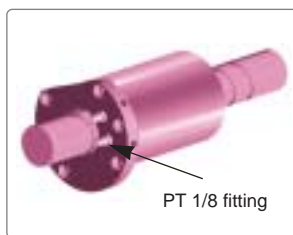


Fig. 9.4 Cool type II

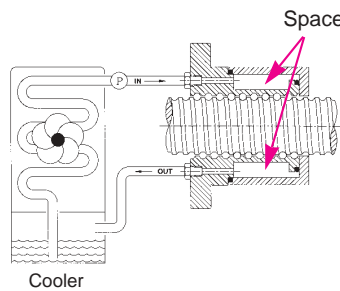


Fig. 9.5 Cool type II with cooler

**● Specification:**

1. We recommend shaft diameter above  $\varnothing 32\text{mm}$  to cool type design.
2. Nut type: FSV, FSW, PFDW, OFSW, DFSV, FSH, FSI, etc.
3. Please contact HIWIN with other specification you need.
4. The cool type **II**, compared with the standard specifications, will make a minor external dimension change of the nut, please contact HIWIN.

**● Specification number:**

Example: R63 - 16B3 - RSW**C2** - 400 - 600- 0.05



**C2: HIWIN cool type ballscrew for type II**



● Performance Comparison:

**Test condition:**

specification: ø50, lead 30 mm  
 speed: 1500 rpm ( 45 m/min),  
 back and forth feed continuously  
 acceleration: 4.9 m/sec<sup>2</sup>  
 stroke: 300 mm  
 preload: 205 kgf  
 moving weight: 300 kgf  
 cooling rate: oil 2.5 liter/min  
 inlet temperature: 16°C  
 room temperature: 25°C

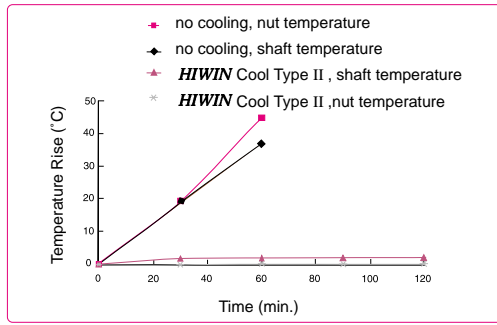


Fig. 9.6 Cool type II: Temperature rise of ballscrew

● Features:

1. Optimized design for high reliability

Use of computer simulation and FEM analysis, the cool type ballscrew features well thermal protection and high reliability.

2. Promote higher speed rotation and extra high D<sub>m</sub>-N value (up to 200,000)

Cool type ballscrew will eliminate high-speed rotation aftereffect, i. e., thermal problem, and promote higher speed rotation.

3. Prevent thermal distortion

Optimized heat transfer design to minimize heat generation and prevent thermal distortion.

4. Strengthen durability

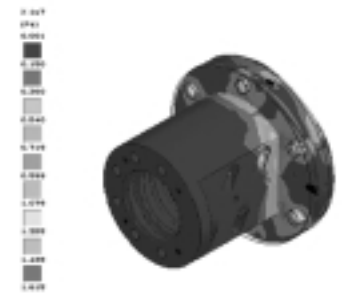
When operating repeatedly, friction between balls cause heat generation. That may be made balls oxidized or decarburized, and shortened the service life. Cool type ballscrew will strengthen durability under a cooling environment.

5. Extended lubricant life cycle

When using lubrication, minimum heat generation further inhibits deterioration in the quality of lubrication and extends the lubricant life cycle.

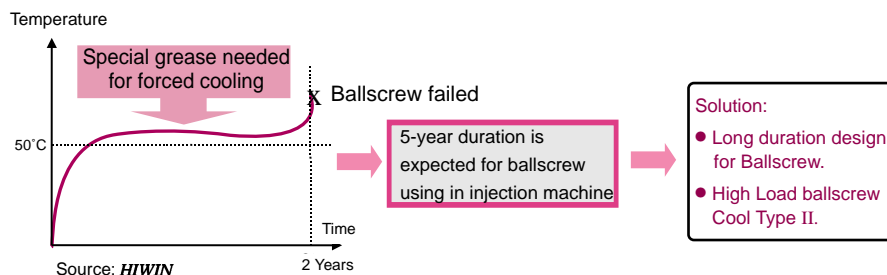
6. Higher feeding accuracy

Cooling effect of cool type ballscrew will stabilize against thermal expansion and equalize feeding accuracy.



FEM analysis for cool type ballscrew

**Average Life Cycle for Injection Machine Ballscrew**



Source: HIWIN

Fig. 9.7 Life cycle for ballscrew using in general injection machine

## A. Ballscrew Failure Analysis

### A1 Preface

In recent years, more and more ballscrews are installed in various machines to meet the requirements of higher accuracy and better performance. Ballscrews become one of the most widely used power transmission components. In CNC machines, ballscrews help improve their positioning accuracy and elongate their service life. Ballscrews are also increasingly used to replace ACME screws in manually operated machines.

A ballscrew is normally preloaded to minimize the backlash of machine movement. Even a high precision ballscrew will not provide good accuracy and long service life if it is not installed properly.

This article discusses primary ballscrew problems and their precautions. Some measuring procedures are also discussed to help users locate the cause of an abnormal backlash.

### A2 The Cause and Precautions of Ballscrew Problems

Three major categories of ballscrew problems and their precautions are discussed as follows.

#### A2-1 Too much play

##### 1. No preload or insufficient preload:

The ball nut will rotate and move downward by its own weight when a non-preloaded ballscrew is held vertically with the screw spindle constrained. A significant backlash may exist in a non-preloaded ballscrew unit. Therefore non-preload ballscrews are only used in the machinery, where low operation resistance but not positioning accuracy is the major concern.

HIWIN can determine the correct amount of preload based on different applications. We can also preset the amount of preload before shipment. Be sure to clearly specify the operation condition of your application when you order a ballscrew unit.

##### 2. Too much torsional displacement:

###### (1) Incorrect material selection:

Table 4.11 lists those materials normally used in ballscrew spindles and ball nuts.

###### (2) Incorrect heat treatment, hardened layer too thin, non-homogeneous hardness distribution, or material too soft:

Standard hardness of steel balls, ball nuts, and screw spindles are HRC 62-66, 58-62, and 58-62, respectively.

###### (3) Incorrect design-L/D ratio too high, etc:

The lower the L/D (length/diameter) ratio, the more rigid the spindle is. L/D ratio should be limited to under 60. (The accuracy grade related to this L/D range is shown in Table 4.12) There will be a significant deflection (torsional displacement) if the L/D ratio is too high. The ballscrew installation shown in Fig A-1 is supported at one end only. This kind of "non-rigid" design should be avoided if possible.

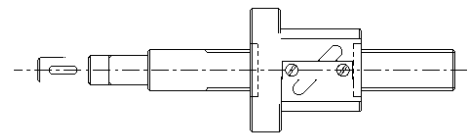


Fig. A-1 The Installation of Ballscrews

##### 3. Inappropriate bearing selection:

Angular ball bearings should be used in ballscrew installation. A ball bearing with high pressure angle specially designed for ballscrew installation is even a better choice. A regular deep groove ball bearing will generate a significant amount of axial play when axially loaded. It should not be used in this application.

##### 4. Inappropriate bearing installation:

- (1) If the bearing is not attached to the screw spindle properly, it would cause axial play under load. This problem may be caused by the bearing journal of the screw spindle being too long or the non-threaded part of the screw spindle being too short.

- (2) The perpendicularity between the bearing seating face and the thread axis of the bearing locknut on the ballscrew, or the parallelism between the opposite faces of the locknut is out of tolerance causing the bearing to tilt. The thread for bearing lock nut and the seating face of a bearing in the ballscrew journal should be machined in one setting to ensure the perpendicularity. It is even better if they can be ground.
- (3) Two lock nuts and a spring washer should be used in the bearing installation to prevent them from getting loose in operation.

**5. The ball nut housing or the bearing housing is not rigid enough:**

The ball-nut-mounted housing or the bearing-mounted housing may deflect under components' weight or machining load if it is not rigid enough. The test illustrated in Fig A-4 (d) can be used to check the rigidity of the ball-nut-mounted housing. Similar test can be used to check the rigidity of the bearing-mounted housing.

**6. The ball nut housing or the bearing housing is not mounted properly:**

- (1) Components may become loose due to vibration or lack of locating pin(s). Solid pins instead of spring pins should be used for locating purpose.
- (2) Ball-nut-seated screws are not seated firmly because the screws are too long or the thread holes on housing are too short.
- (3) Ball-nut-seated screws become loose due to vibration and lack of a spring washer.

**7. Parallelism or flatness of the housing surface is out of tolerance:**

In a machine assembly, a shim bar is frequently located between the housing location surface and the machine body for adjustment purpose. The clearance of table movement may vary at different locations if the parallelism or flatness of any matching component is out of tolerance no matter they are ground or scraped.

**8. The motor and the ballscrew spindle are not assembled properly:**

- (1) There will be a relative rotation between the motor shaft and the ballscrew spindle if the connecting coupling is not installed firmly or the coupling itself is not rigid enough.
- (2) Driving gears are not engaged properly or driving mechanism is not rigid. A timing belt should be used to prevent slipping if the ballscrew is to be driven by a belt.
- (3) Key is loose in the groove. Any inappropriate match among the hub, key, and key seat may cause these components to generate backlash.

**A2-2 Unsmooth operation**

**1. Defects from ballscrew manufacturing:**

- (1) The track surface of the ballscrew spindle or the ball nut is too rough.
- (2) The roundness of the bearing balls, the ball nut or the ballscrew spindle is out of tolerance.
- (3) The lead or the pitch circle diameter of the ball nut / the spindle is out of tolerance.
- (4) The return tube is not attached to the ball nut appropriately.
- (5) Uneven bearing ball size or hardness. The above problems should not be found in the manufacturers of top quality.

**2. Foreign objects enter the ball path:**

- (1) Packing material is trapped in the ball path. Various materials and anti-rust paper are normally used to pack ballscrew units for shipment. It is possible to have these foreign materials or other objects trapped in the ball path if proper procedures are not done while installing or aligning the ballscrew unit. This may cause the bearing balls to slide instead of rolling or even cause the ball nut to jam up completely.
- (2) Machined chips get in the ball track. The chips or dust generated during machining processes may be trapped in the bearing ball track if wiper kits are not used to keep them away from the surface of the ballscrew unit. This may cause unsmooth operation, deteriorate accuracy and reduce service life.

### 3. Over-travel:

Over-travel can damage the return tube and cause it to collapse or even break. When this happens, the bearing balls will not circulate smoothly. They may break and damage the groove on the ball nut or the ballscrew spindle under severe circumstances. Over-travel may happen during set-up or as the result of a limit switch failure or a machine collision. To prevent further damage, an over-traveled ballscrew should be checked or repaired by the manufacturer before it goes back to service.

### 4. Damaged return tube:

The return tube may collapse and cause the same problems as mentioned above if it is hit heavily during installation.

### 5. Misalignment:

Radial load exists if the center line of the ball nut's housing and the screw spindle's bearing support housing are not aligned properly. The ballscrew unit may bend if this misalignment is too big. An abnormal wear may still happen even if the misalignment is not significant enough to cause a noticeable bending. The accuracy of a ballscrew unit will deteriorate rapidly if it is misaligned. The higher the preload is set in the nut, the more demanding the alignment accuracy is required in the ballscrew.

### 6. The ball nut is not mounted properly on the nut housing:

Eccentric load exists when the mounted ball nut is tilted or misaligned. If this is the case, the motor current may fluctuate during rotation.

### 7. Ballscrew unit is damaged during transportation:

## A2-3 Fracture

#### 1. Broken bearing ball:

Cr-Mo steel is the most commonly used material for bearing balls. It takes about 1,400kg (3,080LB) to 1,600kg (3,520LB) to break a steel ball of 3.175 mm (1/8 in) diameter. The temperature of an under-lubricated or non-lubricated ballscrew raises substantially during operation. This temperature raise could make the bearing balls brittle or break which cause damage to the grooves of the ball nut or the ballscrew spindle consequently.

Therefore, lubricant replenishment should be considered during the design process. If an automatic lubricating system is not available, a periodical grease replenishment should be scheduled as part of maintenance program.

#### 2. Collapsed or broken return tube:

Over-travel of the ball nut or an impact on the return tube could cause the return tube to collapse or break. This may block the path of bearing balls and cause them to slide instead of rolling and break eventually.

#### 3. Ballscrew spindle end breaks:

##### (1) Inappropriate design:

Sharp corners on the ballscrew spindle should be avoided to reduce local stress concentration. (Fig. A2) shows some of the appropriate screw end designs.

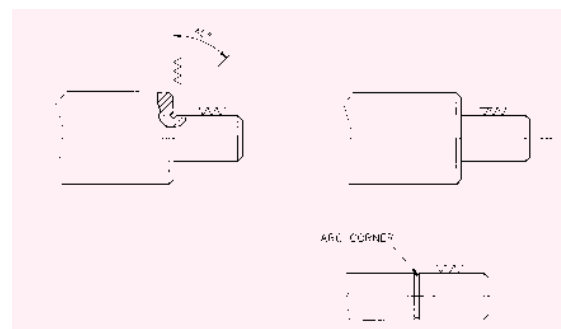


Fig A-2 The Design of Ballscrew Spindle End

(2) Bend of screw spindle journal:

The seating surface of the bearing of the ballscrew and the thread axis of the bearing's lock nut are not perpendicular to each other or the opposite sides of the lock nut are not parallel to each other. This will cause the end of screw spindle to bend and eventually break. The amount of deflection at the end of the ballscrew spindle (Fig A-3) before and after the bearing's lock nut being tightened should not exceed 0.01 mm (0.0004 in).

(3) Radial force or fluctuating stress:

Misalignment in the ballscrew installation creates abnormal fluctuating shear stress and causes the ballscrew to fail prematurely.

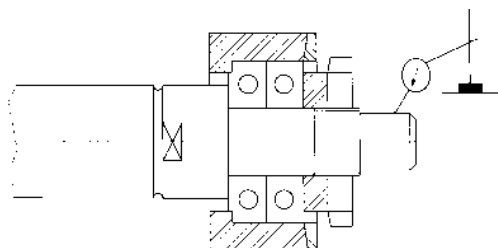


Fig A-3 The Deflection of Ballscrew Spindle

### A3 Locating the Cause of an Abnormal Backlash

The following measurement procedures can be performed to locate the cause of an abnormal backlash in the ballscrew installation.

1. Glue a gauge ball in the center hole at one end of the screw spindle. Use the flat plate of a dial indicator to check the axial movement of this gauge ball in axial direction while rotating the screw spindle (Fig A-4(a)). The movement should not exceed 0.003mm (0.00012 in), if the bearing hub, the ball nut, and the ball nut housing are all installed properly.

2. Use a dial indicator to check the relative movement between the bearing housing and the bearing seat while rotating the ballscrew (Fig A-4(b)). Any dial indicator reading other than zero indicates that either the bearing hub is not rigid enough or it is not installed properly.

3. Check the relative movement between the machine table and the ball nut housing (Fig A-4(c)).

4. Check the relative movement between the ball nut housing and the ball nut flange (Fig A-4(d)).

Contact the ballscrew manufacturer if an unsatisfactory backlash still exists while all the above checks are ok. The preload or the rigidity of the ballscrew may have to be increased.

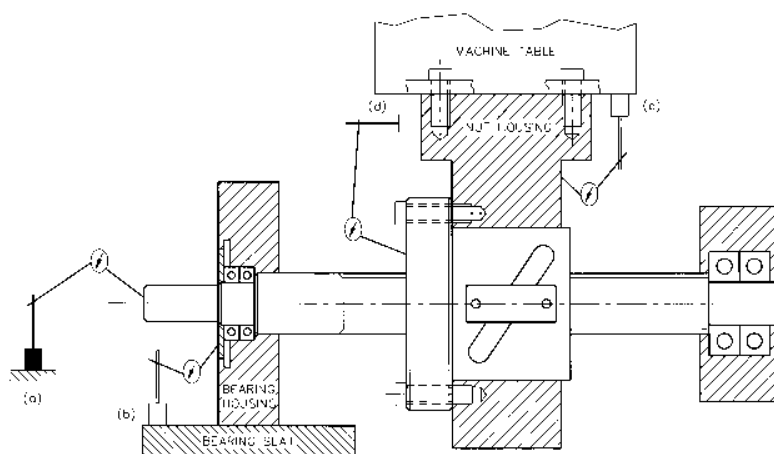


Fig. A-4 Locating the Cause of an Abnormal Backlash

**B. Standard Housing Dimension Tolerance**

Unit:  $\mu\text{m}=0.001\text{mm}$

dimensional range (mm)	E		F			G			H						Js		J		K		M		N		P		R		dimensional range (mm)	
	over	incl.	E10	E11	F6	F7	F8	G6	G7	H5	H6	H7	H8	H9	H10	Js6	Js7	J6	J7	K6	K7	M6	M7	N6	N7	P6	P7	R6		R7
3	6	+68	+95	+18	+22	+28	+12	+16	+5	+8	+12	+18	+30	+48	$\pm 4$	$\pm 6$	+5	+6	+2	+3	-1	0	-5	-4	-7	-8	-12	-11	3	6
6	10	+83	+115	+22	+28	+35	+14	+20	+6	+9	+15	+22	+36	+58	$\pm 4.5$	$\pm 7.5$	+5	+8	+2	+5	-3	0	-7	-4	-12	-9	-16	-13	6	10
10	14	+102	+142	+27	+34	+43	+17	+24	+8	+11	+18	+27	+43	+70	$\pm 5.5$	$\pm 9$	+6	+10	+2	+6	-4	0	-9	-5	-15	-11	-20	-16	10	14
14	18	+32	+32	+16	+16	+16	+6	+6	0	0	0	0	0	0	$\pm 6.5$	$\pm 10.5$	+8	+12	+2	+6	-4	0	-11	-7	-18	-14	-24	-20	14	18
18	24	+124	+170	+33	+41	+53	+20	+28	+9	+13	+21	+33	+52	+84	$\pm 8$	$\pm 12.5$	+10	+14	+3	+7	-4	0	-12	-8	-21	-17	-29	-25	24	30
24	30	+40	+40	+20	+20	+20	+7	+7	0	0	0	0	0	0	$\pm 8$	$\pm 12.5$	+10	+14	+3	+7	-4	0	-25	-28	-37	-41	-45	-41	24	30
30	40	+150	+210	+41	+50	+64	+25	+34	+11	+16	+25	+39	+62	+100	$\pm 9.5$	$\pm 15$	+13	+18	+4	+9	-5	0	-14	-9	-26	-21	-37	-32	30	40
40	50	+50	+50	+25	+25	+25	+9	+9	0	0	0	0	0	0	$\pm 9.5$	$\pm 15$	+13	+18	+4	+9	-5	0	-30	-33	-45	-51	-56	-62	40	50
50	65	+180	+250	+49	+60	+76	+29	+40	+13	+19	+30	+46	+74	+120	$\pm 11$	$\pm 17.5$	+16	+22	+4	+10	-6	0	-16	-10	-30	-24	-44	-38	50	65
65	80	+60	+60	+30	+30	+30	+10	+10	0	0	0	0	0	0	$\pm 11$	$\pm 17.5$	+16	+22	+4	+10	-6	0	-38	-45	-52	-59	-66	-73	65	80
80	100	+212	+292	+58	+71	+90	+34	+47	+15	+22	+35	+54	+87	+140	$\pm 12.5$	$\pm 20$	+18	+26	+4	+12	-8	0	-20	-12	-36	-28	-58	-50	80	100
100	120	+72	+72	+36	+36	+36	+12	+12	0	0	0	0	0	0	$\pm 12.5$	$\pm 20$	+18	+26	+4	+12	-8	0	-45	-52	-61	-68	-83	-90	100	120
120	140														$\pm 12.5$	$\pm 20$	+18	+26	+4	+12	-8	0	-45	-52	-61	-68	-83	-90	120	140
140	160	+245	+335	+68	+83	+106	+39	+54	+18	+25	+40	+63	+100	+160	$\pm 14.5$	$\pm 23$	+22	+30	+5	+13	-8	0	-22	-14	-41	-33	-71	-63	140	160
160	180	+85	+85	+43	+43	+43	+14	+14	0	0	0	0	0	0	$\pm 14.5$	$\pm 23$	+22	+30	+5	+13	-8	0	-37	-51	-70	-79	-100	-109	160	180
180	200														$\pm 14.5$	$\pm 23$	+22	+30	+5	+13	-8	0	-37	-51	-70	-79	-100	-109	180	200
200	225	+285	+390	+79	+96	+122	+44	+61	+20	+29	+46	+72	+115	+185	$\pm 14.5$	$\pm 23$	+22	+30	+5	+13	-8	0	-37	-51	-70	-79	-100	-109	200	225
225	250	+100	+100	+50	+50	+50	+15	+15	0	0	0	0	0	0	$\pm 14.5$	$\pm 23$	+22	+30	+5	+13	-8	0	-37	-51	-70	-79	-100	-109	225	250



## D. HIWIN Ballscrew Data Inquiry (A)

Company \_\_\_\_\_ Date \_\_\_\_\_  
 Address \_\_\_\_\_  
 Telephone \_\_\_\_\_ Fax. \_\_\_\_\_  
 Machine Type \_\_\_\_\_ Application \_\_\_\_\_  
 Attached Drawing Yes \_\_\_\_\_ (Drawing No. \_\_\_\_\_ ) No. \_\_\_\_\_  
 Please fill or check following items.

### 1. Load Condition

(a) Working Axial Load

Max. \_\_\_\_\_ kgf , at \_\_\_\_\_ rpm for \_\_\_\_\_ % of operation time

Normal. \_\_\_\_\_ kgf , at \_\_\_\_\_ rpm for \_\_\_\_\_ % of operation time

Min. \_\_\_\_\_ kgf , at \_\_\_\_\_ rpm for \_\_\_\_\_ % of operation time

(Total of operation time ratio should be 100%)

(b) Max. Axial Static Load \_\_\_\_\_ kgf

(c) Deviated Load, if any (Please avoid this load condition, if possible)

Radial Load \_\_\_\_\_ kgf Moment Load \_\_\_\_\_ kgf-cm

### 2. Operation Conditions

(a) Stroke \_\_\_\_\_ mm , Motor power used \_\_\_\_\_ kw

(b) Life Expectancy \_\_\_\_\_ x10<sup>6</sup> revs, \_\_\_\_\_ km, \_\_\_\_\_ hr

(c) Rotation  Shaft \_\_\_\_\_  Nut \_\_\_\_\_

(d) Mounting Method \_\_\_\_\_ Mounting Span \_\_\_\_\_ mm

(e) Shock/Vibration: Smooth \_\_\_\_\_ Normal \_\_\_\_\_ Vibration \_\_\_\_\_

### 3. Main Dimensions

(a) Screw Shaft O.D. \_\_\_\_\_ mm Turning Direction: R \_\_\_\_\_ L \_\_\_\_\_

(b) Lead \_\_\_\_\_ mm  (Pitch \_\_\_\_\_ mm) No. of Starts \_\_\_\_\_

(c) Total Length \_\_\_\_\_ mm Effective Threaded Length \_\_\_\_\_ mm

(d) Nut Type \_\_\_\_\_ Seal \_\_\_\_\_

(e) Support Bearing: Ball \_\_\_\_\_ Roller \_\_\_\_\_

### 4. Lead Accuracy, Axial Clearance, Preload and Stiffness

(a) Target Point of Accumulated Lead Tp: \_\_\_\_\_ mm

(b) Accuracy Grade \_\_\_\_\_ (Lead Deviation: \_\_\_\_\_ mm/300mm)

(c) Axial play \_\_\_\_\_ mm max.

(d) Preload \_\_\_\_\_ kgf (or Drag Torque \_\_\_\_\_ kgf-cm)

(e) Nut Stiffness Kn \_\_\_\_\_ kgf/μm

### 5. Other Conditions

(a) Lubrication: Grease \_\_\_\_\_ Oil \_\_\_\_\_

(b) Ambient Temperature \_\_\_\_\_  °C  °F

(c) Special Conditions \_\_\_\_\_



**E. HIWIN Ballscrew Request Form (B)**

**Request for quotation**

Customer Name: \_\_\_\_\_ Date: \_\_\_\_\_  
Address: \_\_\_\_\_ Phone: \_\_\_\_\_  
\_\_\_\_\_ Country: \_\_\_\_\_  
Desired Delivery Date: \_\_\_\_\_ Delivery Point: \_\_\_\_\_  
Type of Ball Screw: (1) \_\_\_\_\_ Quantity: \_\_\_\_\_  
(2) \_\_\_\_\_ Quantity: \_\_\_\_\_

**Required Specifications:**

- (1)  Single Start     Double Start     Triple Start     Four Start
  - (2) Direction of Turn:  Right     Left
  - (3) Shaft Diameter: \_\_\_\_\_
  - (4) Lead: \_\_\_\_\_
  - (5) Circuit: \_\_\_\_\_
  - (6) Nut Type: \_\_\_\_\_
  - (7)  Internal     External     Endcap
  - (8) Thread Length: \_\_\_\_\_
  - (9) Overall Length: \_\_\_\_\_
  - (10) Accuracy Grade: \_\_\_\_\_  
(Lead Deviation: \_\_\_\_\_ mm/300mm)
  - (11) Speed: rpm \_\_\_\_\_
  - (12)  Rolled     Ground     Endcap
- \* Please refer to HIWIN catalog P.38 for nut information.

Customer Special Requirement

● **Please answer the following questions.**

*Your kind answers would be very helpful in preparing quotation promptly.*

- (a) What kind of machine you build now?
  
  
  
  
  
  
  
  
  
  
- (b) How many ballscrews needed for each machine?
  
  
  
  
  
  
  
  
  
  
- (c) Annual requirement?
  
  
  
  
  
  
  
  
  
  
- (d) If it is not a new project, whose ballscrew are you using currently?

# Memo

# Memo