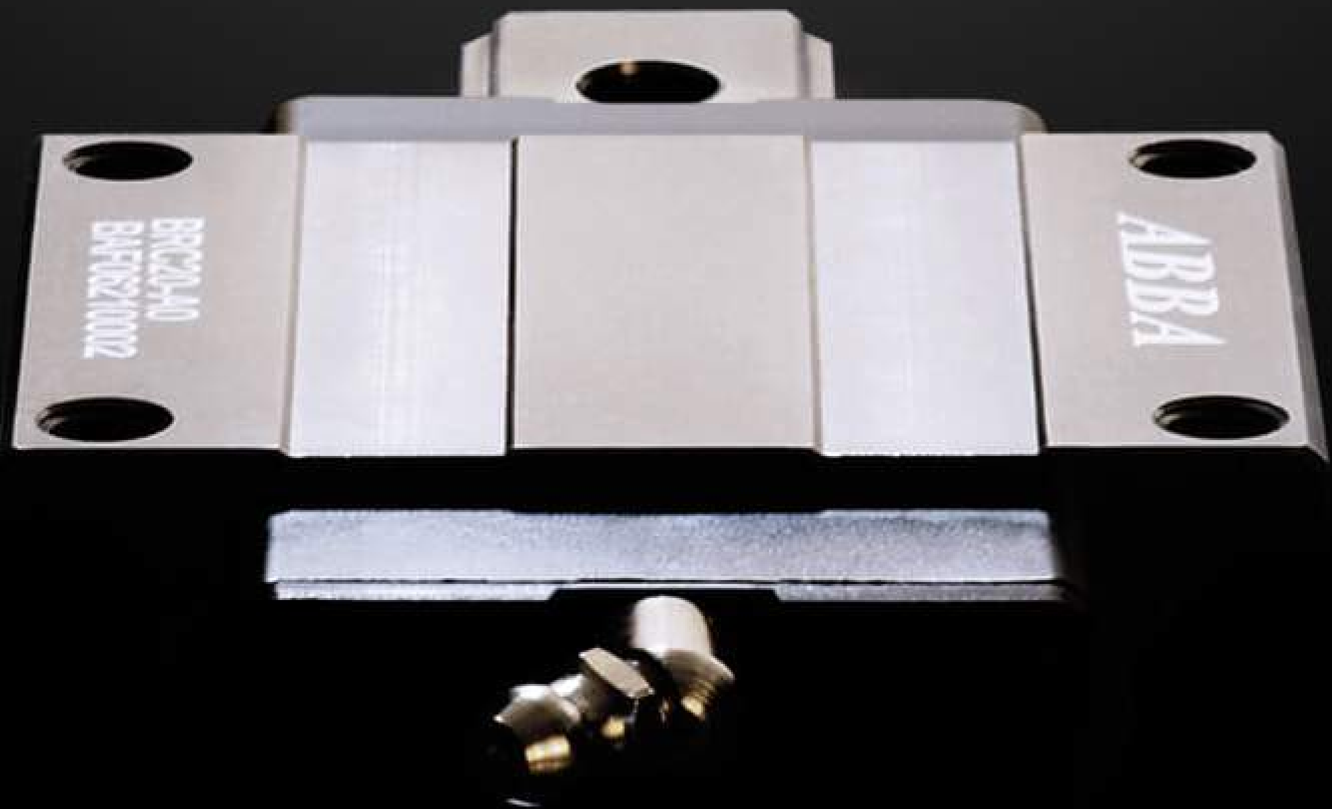
ABBA LinearTech

An Ewellix company



Linear motion components

Product catalogue

Origin

We, ABBA Linear Tech Co., LTD., established in 1999, was the first professional Linear Guide manufacturer in Taiwan putting four-row linear guides with self-lubricant patent into mass production. We are always focus on product innovation development and design. Since possessing critical technology of industries, global market share of ABBA increases year by year. ABBA became world-renowned Linear Motion Brand. Both technology and quality are always at the forefront of the industry.

1999
ABBA was established

2002
Awarded 2002 and 2003 Taiwan Excellence Award

2003
Awarded 2003 Rising Star Award

2007
Acquired by the SKF Group and being part of the SKF Motion Technologies business area

2015
Plant Expansion

Heritage

In 2007, ABBA joined SKF group and be part of the SKF Motion Technologies business area. We showed the huge scale of World Factory by being linked with other global professional Linear Motion Factories. For achieving maximum capability, we continue expanding processing equipment to make sure that we are able to supply global demand.

SYMBOL OF EXCELLENCE

Taiwan Excellence Award

ISO 9001:2008

2018

SKF Motion Technologies are acquired by Triton

2019

SKF Motion Technologies changes name into Ewellix

ABBA LinearTech

An Ewellix company

Vision

Due to professional manufacturing technology of Linear Guide for 20 years, stable products quality and excellent manufacturing environment, ABBA continues to develop steadily. SKF Motion Technologies department which ABBA was belonged to was divided from the SKF Group into an independent enterprise and renamed as "Ewellix" on 2019 Oct.7th. We will keep going on the right track with " Commitment, Agility, and Collaboration" according to Ewellix’s core value. And continuing the strategies of Brand management, Channels development and Diverse industrial application. When we bring Ewellix Group power into full play and integrate global business resources, we may create infinite possibility in Linear Guides and Linear Motion area. Together leading the Linear Motion industry to a New Era.

Achievement

Award of Creative Innovation Prize

Certificates of Patents

Rising Star Award

National Business Start-up Award

Contents

1 Standard Linear Guide

2 Ball Caged Linear Guide

3 Miniature Linear Guide

4 Cam Roller Linear Guide

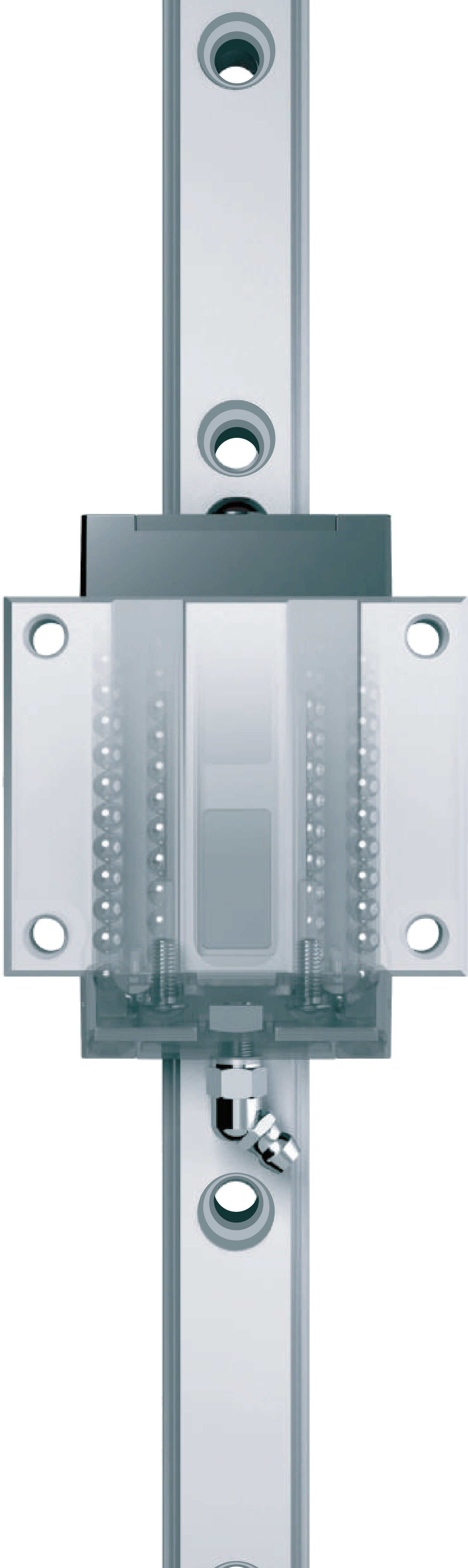
5 Round Shaft Linear Guide

6 Ball Screw

7 Support Unit

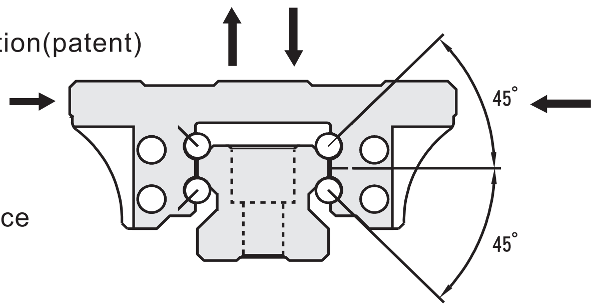
8 Self-lubricated Linear Bearing

1
Standard Linear Guide

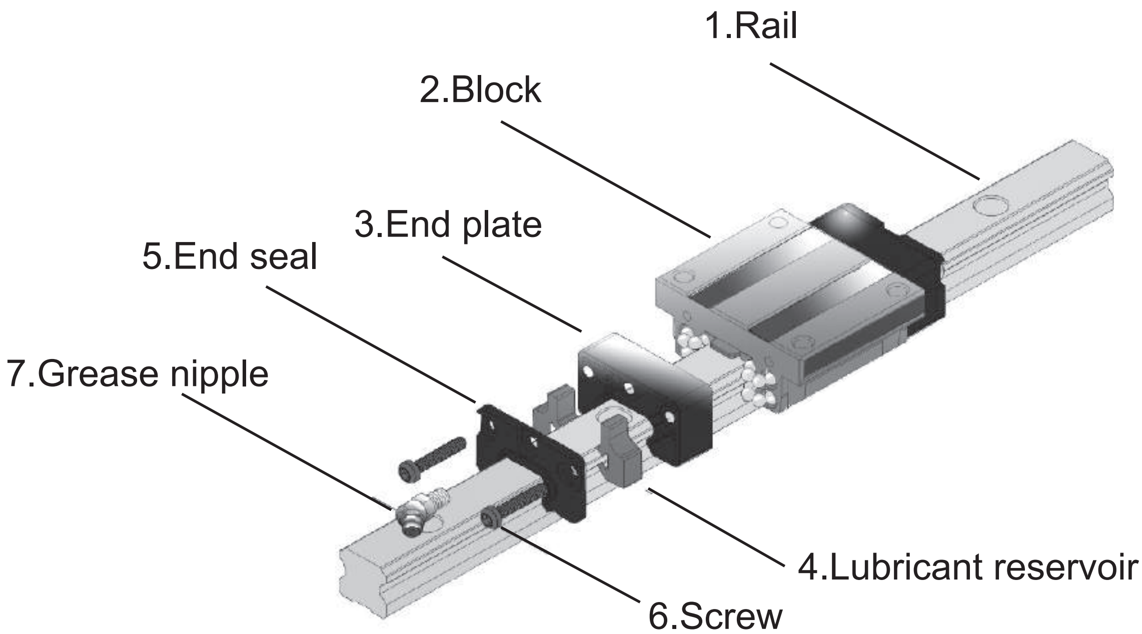


1.1 Characteristics

1. Built-in long life lubrication(patent)
2. Equivalent loading capacity in four directions
3. Smooth running due to new ball re-circulation(patent)
4. High rigidity: 4-row angular contact
5. International standard dimension
6. High accuarcy, low friction, low maintenance
7. High speed, low noise
8. Integral all-round sealing
9. Interchangeability
10. Green production

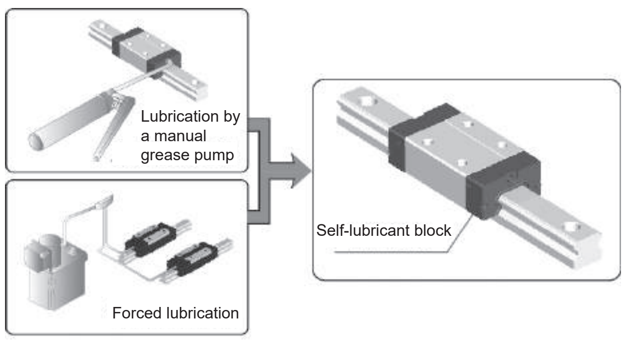


1.2 Construction

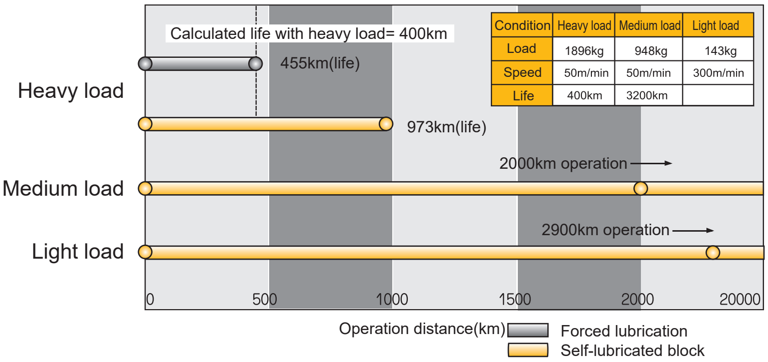


1.3 Advantage

1 **Maintence free - No need for frequent periodic lubrication or automatic lubrication systems.**

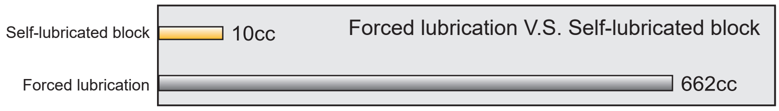


2 Extended intervals between maintenance.



Condition	Heavy load	Medium load	Light load
Load	1896kg	948kg	143kg
Speed	50m/min	50m/min	300m/min
Life	400km	3200km	

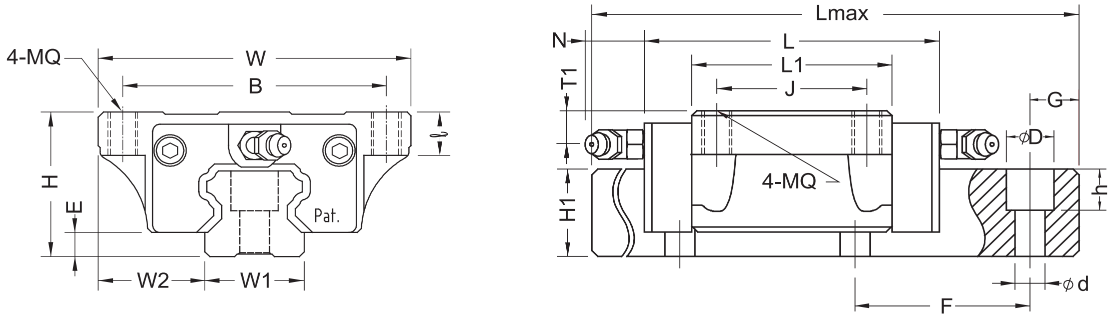
3 Curtailing lubrication cost.

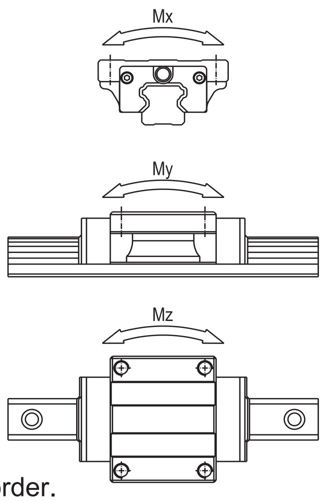


Forced lubrication:0.03cc/6min X 8h/day X 276day X 1year=662cc
Operation distance=3500km/year

4 No oil leakage concern, easy for cleaning.

1.4 Interchangeability Notice





1. Check the mounting height (H)
2. Check the mounting width (W2)
3. Check the block length (L)
4. Check the block's body size (L1)
5. Check the hole diameter and pitches on the block (BXJ)
6. Check the rail width (W1)
7. Check the pitch of the rail (F)
8. Check the hole diameter and rail size (dxDxh)
9. When a specific length is required, please advise the (G) values in your order.

1.5 Accuracy Selection

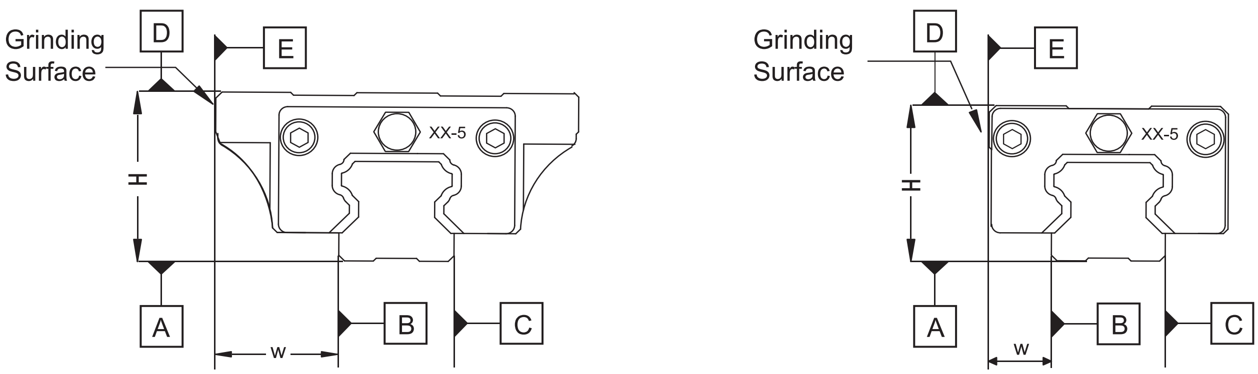
We have three grades for your selection: Normal(N)/ High(H)/ Precision(P)

The accuracy of linear guides can be divided into three types: Running parallelism, Tolerance, and Difference of heights and widths. (As several blocks are used on one rail, or as several shafts are installed on the same surface, the Difference of heights and widths of each model are specified.)

	Application	Accuracy Grade N	Accuracy Grade H	Accuracy Grade P
NC Machine tools	Machining Center			○
	Lathe			○
	Milling Machine			○
	Boring Machine			○
	Jig Borer			○
	Grinding Machine			○
	Electro-discharge Machine			○
	Punching Press Machine		○	○
	Laser Cutting Machine		○	○
	Wood Working Machine	○	○	○
	NC Drilling Machine		○	○
	Milling Center		○	○
	Packaging Machine	○		
	ATC	○		
	Wire Cut Machine			○
	Grinding Wheel Machine		○	○

	Application	Accuracy Grade N	Accuracy Grade H	Accuracy Grade P
Industrial Robots	Orthogonal Type	○	○	○
	Multi-joint Type	○	○	
Semiconductor Machines	Wire Bonder			○
	Prober			○
	Inserter Machine		○	○
	PCB Driller		○	○
Other Machines	Injection Molding Machine	○	○	
	Measuring Machine			○
	Business Machine	○	○	
	Transporting Machine	○	○	
	X-Y Table		○	○
	Painting Machine	○	○	
	Welding Machine	○	○	
	Medical Machine	○	○	
	Digitizer		○	○
	Test Equipment			○

1.6 Accuracy Standard



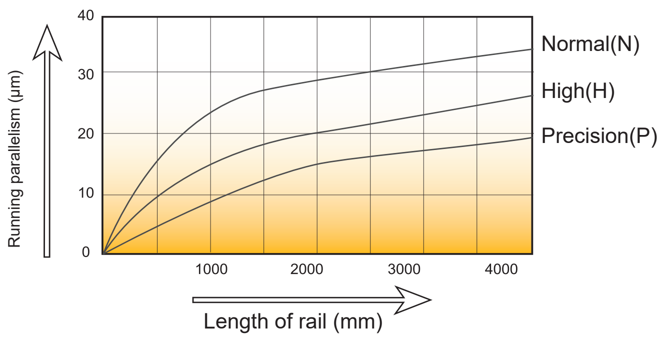


Fig.1.6.1 BR rail length and running parallelism

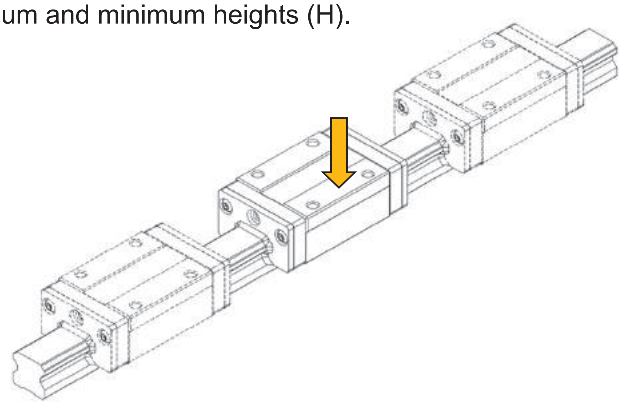
Unit : mm

ITEM	GRADE		
	Normal (N)	High (H)	Precision (P)
Tolerance of height (H)	± 0.1	± 0.04	0 -0.04
Tolerance of width (W)	± 0.1	± 0.04	0 -0.04
Difference of heights (△H)	0.03	0.02	0.01
Difference of widths (△W)	0.03	0.02	0.01
Running parallelism between the block surface D and rail surface A	△C Refer to Fig.1.6.1		
Running parallelism between the block surface E and rail surface B and C	△D Refer to Fig.1.6.1		

1.6.1 Definitions

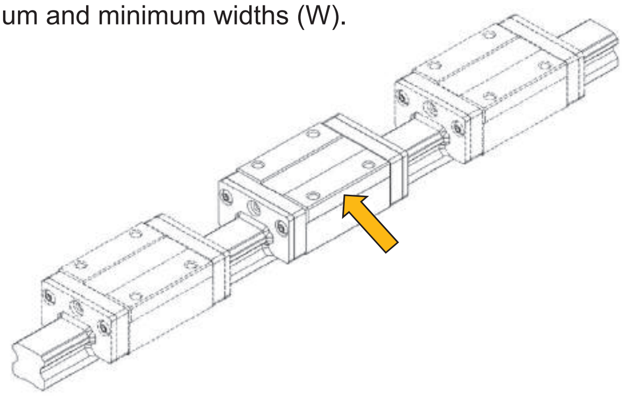
1 Difference of heights (△H)

The difference is obtained by measuring the different blocks on the same rail position in terms of the difference between the maximum and minimum heights (H).



2 Difference of widths (△W)

The difference is obtained by measuring the different blocks on the same rail position in terms of the difference between the maximum and minimum widths (W).



3 Running parallelism

This is refer to the running parallelism tolerance between the two reference planes of rail and block when the block is moved along the entire rail length, the rail being screwed to the reference plane.

1.7 Preload

1 Radial clearance

The radial clearance of the linear guide means the radial movement of the central portion of the block when the linear guide is fixed, moving the block up and down lightly at the center of its length. There are five types of radial clearances: ZF (Clearance), Z0 (No Preload), Z1 (Light preload), Z2 (Medium preload), and Z3 (Heavy preload). The radial clearance of the linear block has a significant impact on the running accuracy, load resistance and rigidity, so it is important to choose the clearance appropriately according to the application. In general, considering the impact of vibration caused by reciprocating motion, choosing a negative clearance will bring good effects on service life and accuracy.

2 Preload

The purpose of tpreload is to increase the rigidity of the block and eliminate the internal load applied to the steel ball in advance, such as clearance. The codes Z1, Z2, and Z3 of the ABBA linear guide indicate that the clearance value is negative after the preload is applied. The method of adjusting the preload is to change the size of the steel ball. Generally, the work of adjusting the preload must be completed at the original factory. If distributors or customers would like to adjust the preload by themselves, please contact the factory for related technical information.

Choice of radial clearance and preload

	ZF (Clearance)	Z0 (No Preload)	Z1 (Light preload)	Z2 (Medium preload)	Z3 (Heavy preload)
Conditions of Use	Nearly no precision is required and sliding resistance is very small	The load direction is constant, the vibration and impact are small, and the two axes are used side by side. The accuracy is not required, but small sliding resistance is required.	Cantilever load or moment acts, one axis is used, and high accuracy is required during light load	High rigidity is required, with vibration or impact, heavy cutting machine tools etc.	With highest rigidity requirements and extreme impact resistance
Application	Conveyor	Flame cutting machine Automatic packaging machine Welding machine Robotic arm Injection molding machine	Grinding table feed shaft Automatic coating machine High-speed material supply-device PCB punching machine Precision XY Stage	Machining Center CNC lathe Grinding wheel feed shaft Milling machine Boring machine	Steel plate cutting machine Punch

3 Consider load and life during preload

When using preload to linear guide, it is necessary to consider the preload load for life calculation due to the internal load in the block beforehand.

4 Rigidity

When linear guide is borne to a load, steel balls, blocks, or rails are elastically deformed within the allowable load range. At this time, the ratio of the load to the displacement is the rigidity value. With the increase of the preload amount, the rigidity of the linear guide also increases. For the 4-directions equivalent loading capacity type of ABBA, the effect of the preload can keep the external load until increasing up to about 2.8 times the preload.

Table 1.7.1 Preload class and preload force

Class \ Item	Code	Preload force
Clearance	ZF	0
No preload	Z0	0
Light preload	Z1	0~0.02 C
Medium preload	Z2	0.02C~0.05 C
Heavy preload	Z3	0.05C~0.07 C

C: Basic dynamic load rating

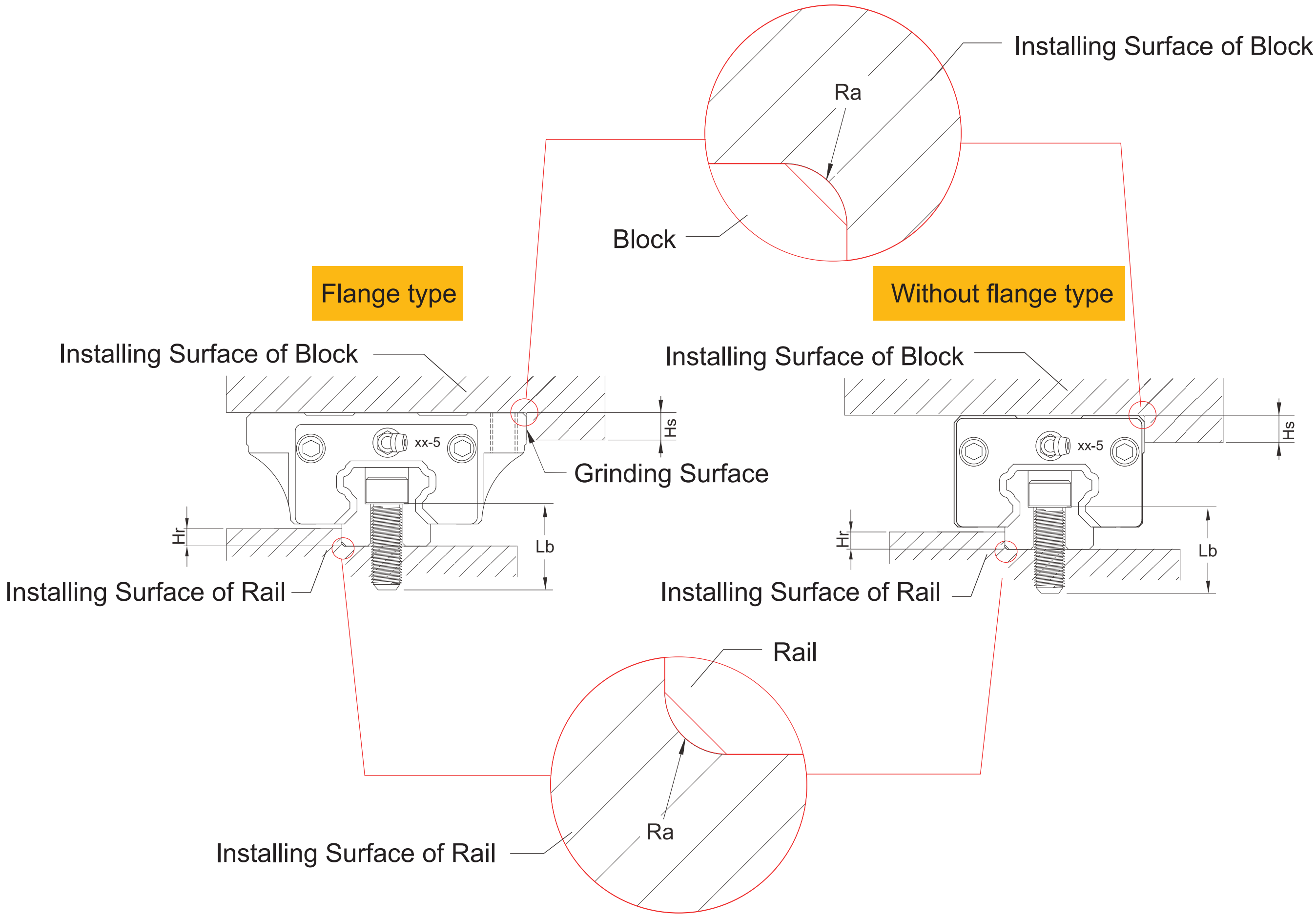
Table 1.7.2 Relationship between optional precision and preload of linear guide

Unit : μm

Accuracy	Non-interchangeable type			Interchangeable type
	P	H	N	N
Preload	-	-	ZF	ZF
	Z0	Z0	Z0	Z0
	Z1	Z1	Z1	Z1
	Z2	Z2	Z2	-
	Z3	Z3	Z3	-

Note:
The interchangeable type is packaged for rail and block separately, which can be assembled by the customer with guaranteed accuracy. Non-interchangeable rail and block have been assembled and packed together. After receiving the goods, users cannot disassemble, exchange, or change the direction of the blocks, otherwise the product may lose its original accuracy.

1.8 Suggestion in Assembly



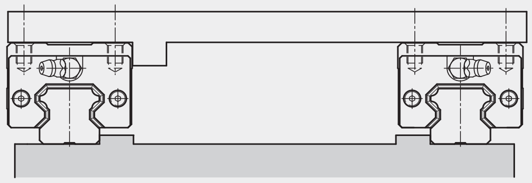
Unit : mm

Item	Maximum Fillet of rail (Ra)	Maximum shoulder height (Hr) of rail		Maximum shoulder height (Hs) of block		Rail Bolt length suggestion(Lb)	Recommended size of block lock bolt		
							Locked from above		Locked from below
		Min.	Max.	Min.	Max.		Flange type	Without flange type	Flange type
BR-15	0.6	2.5	3.5	3	4	M4x20	M5	M4	M4
BR-20	0.6	2.5	4	4	5	M5x25	M6	M5	M5
BR-25	0.8	3	5	4	5	M6x30	M8	M6	M6
BR-30	0.8	3	5	4	6	M8x30	M10	M8	M8
BR-35	0.8	3.5	6	5.5	6	M8x35	M10	M8	M8
BR-45	0.8	4.5	8	6	8	M12x45	M12	M10	M10

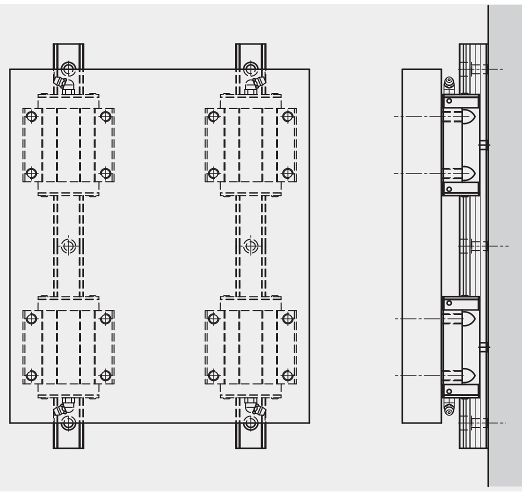
1.9 Configuration of Linear Guide

The linear guide can be configured differently according to the demand of the machine structure and the load direction. The main configuration methods are as follows. When using oil lubrication, the lubricating oil path of the block will vary due to different configuration methods. Please specify the configuration method when ordering.

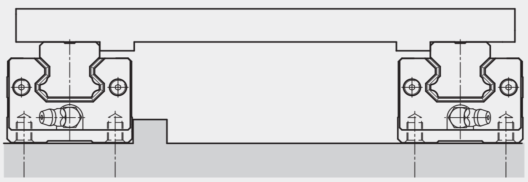
Horizontal mode



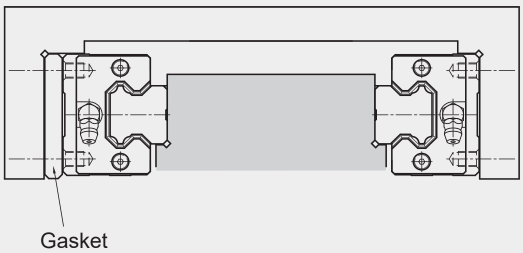
Vertical mode



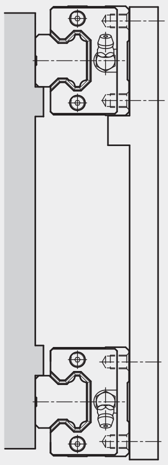
Inverted mode



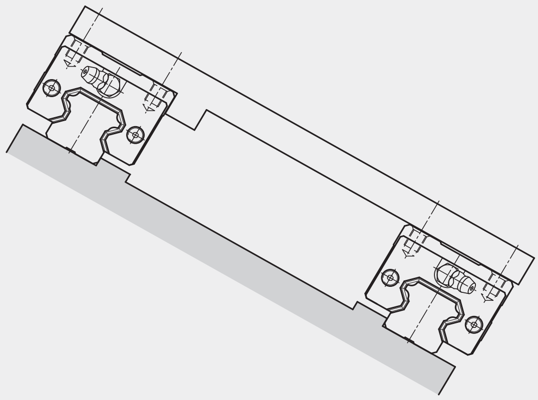
Relative mode



Wall hanging mode

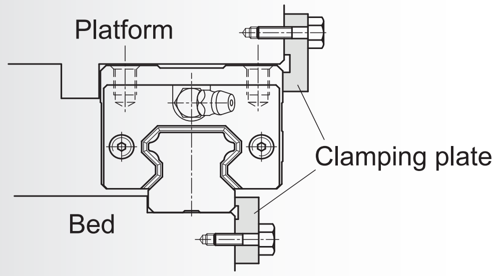


Tilt mode



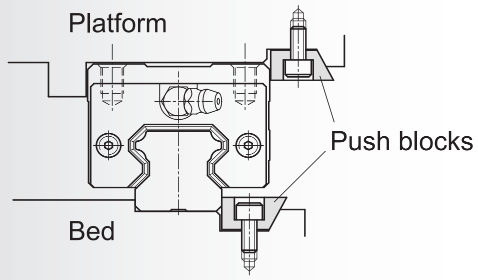
1.10 Fixing method of Linear Guide

When there is vibration or impact force in the machine, the rail and block are likely to deviate from the original fixed position, which affects the running accuracy and service life. To avoid this situation, it is recommended to fix the rail and block according to the following fixing methods.



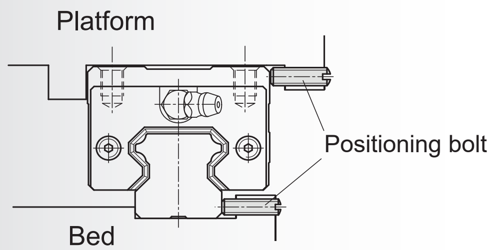
Clamping plate fixing method

In this method, the sides of the rail and block need to protrude slightly from the edges of the bed and the platform, and the clamping plate needs to be processed to prevent interference with the corners of the rail or block during installation.



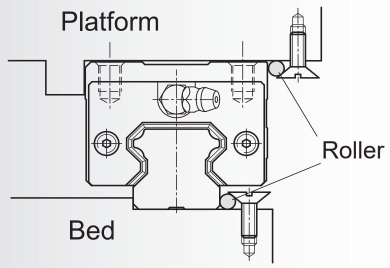
Push fixing method

This method applies pressure by locking the push block. Excessive locking force can easily cause the rail to bend or the outer shoulder to deform, so please pay more attention to the appropriateness of the locking force when installing.



Positioning bolt fixing method

Due to installation space constraints, the size of the bolts should not be too large.

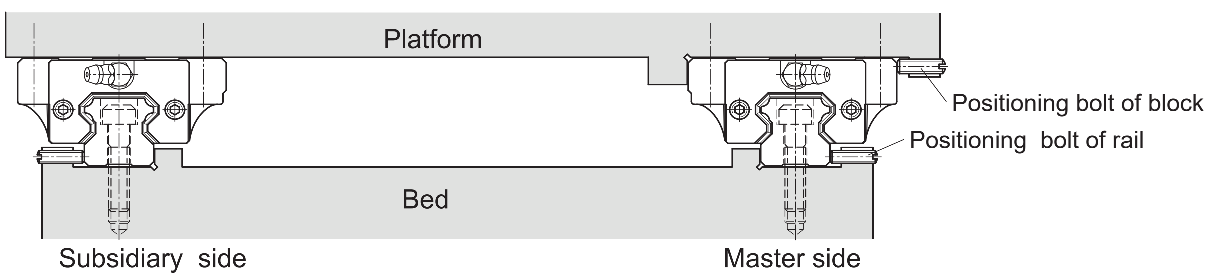


Roller fixing method

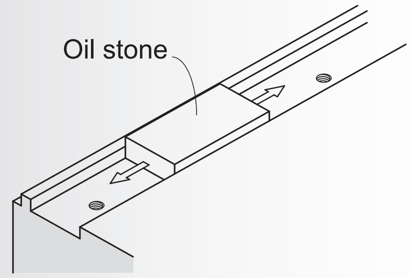
The roller uses the slant of the bolt head to push the pressure, so please pay more attention to the position of the bolt head.

1.11 Installation of linear guides

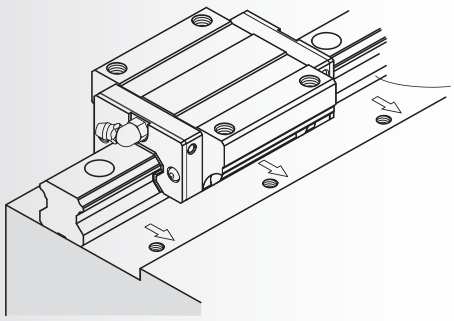
1.11.1 Installation with vibration and stirke in the machine with high rigidity and high accurcy required



1 Installation of rail

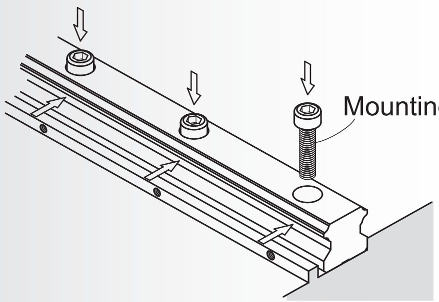


1.Be sure to remove the processing burrs and dirt on the installation surface of the bed before installation.

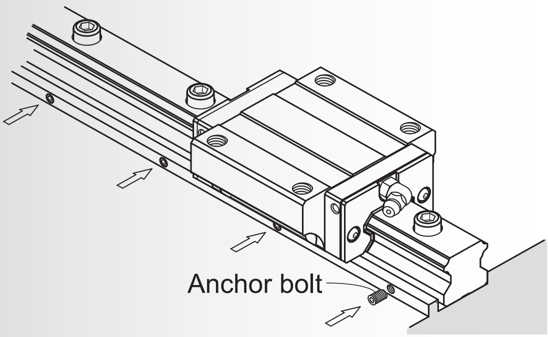


2. Place the linear guide on the bed, so that the master surface of the rail is attached to the side mounting surface of the bed.

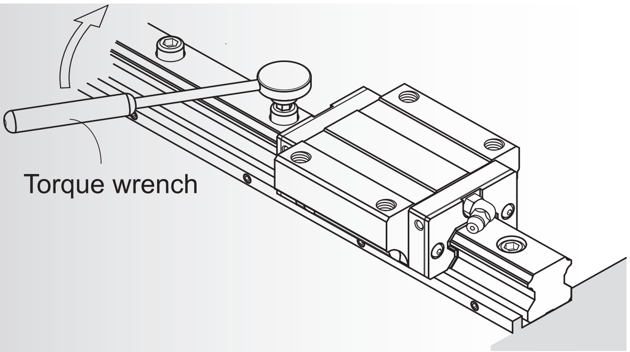
Note:
Both sides of the ABBA linear guide can be used as the master surface.



3. Lock the assembly bolts, but do not fully tighten them, and make the master surface of the rails as close as possible to the side mounting surface of the bed. Please pay attention to whether the bolt holes and the assembly bolts match before installation.

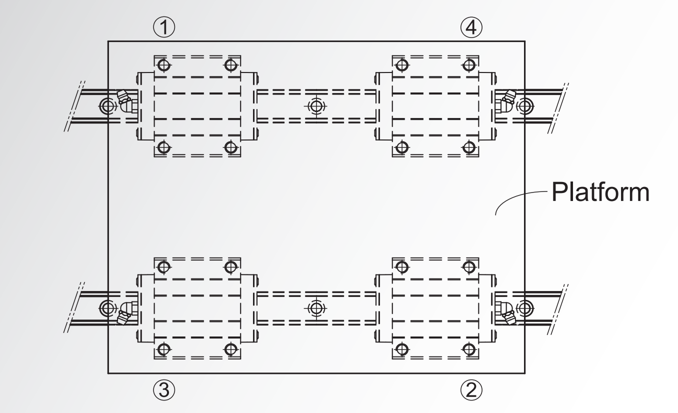


4. Tighten the rail positioning bolts in order to make the rail and the bed side mounting surface closely fit.



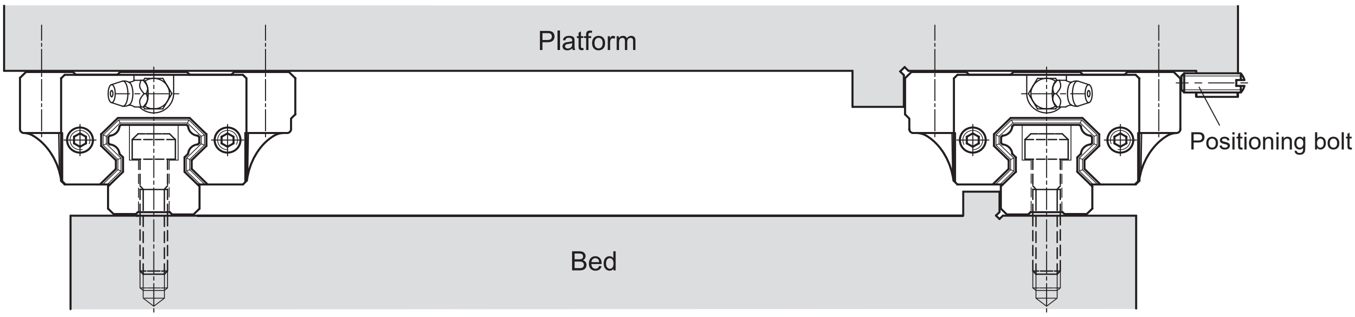
5. Use a torque wrench to tighten the mounting bolts according to the specified torque value. The tightening order of the mounting bolts is sequentially locked from the center of the rail to both ends.Stable accuracy can be obtained by this method.
6.Install the remaining paired rails please follow steps 1 to 5.

2 Installation of block

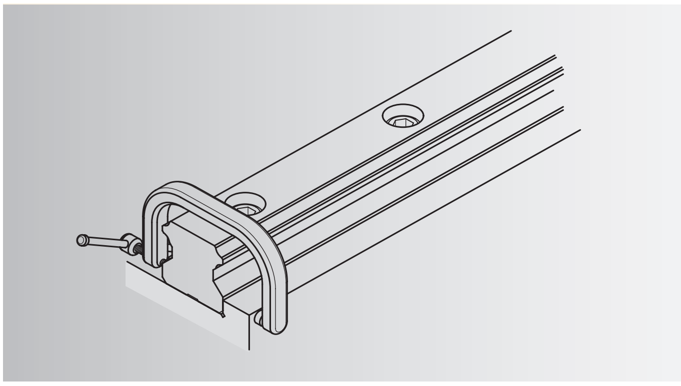


1. Install the platform on the block and lock the block mounting bolts, but not fully tightened.
2. Use the positioning bolts to lock the master surface of the block and the lateral mounting surface of the platform to position the platform.
3. Tighten the block mounting bolts in the order of the diagonal of the block from ① to ④.

1.11.2 Installation of rail without positioning bolts

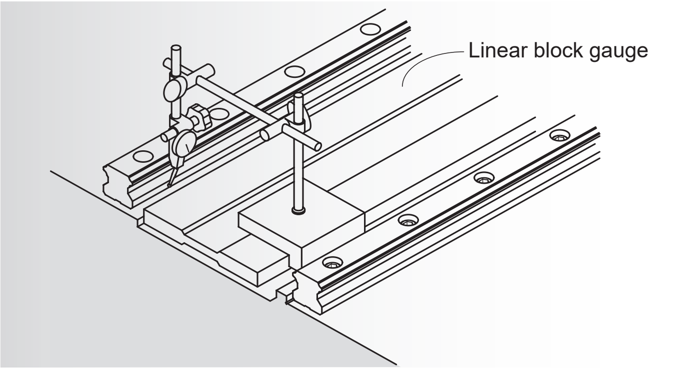


1 Installation of master side rail



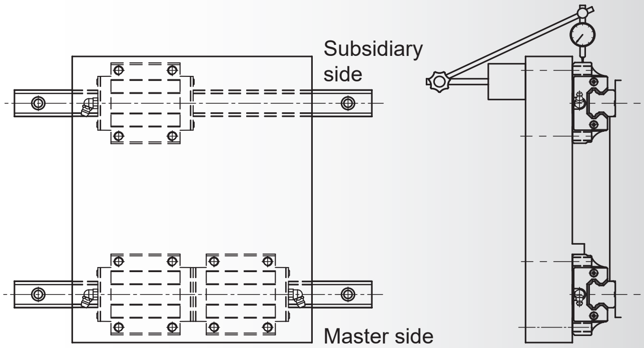
Lock the assembly bolts, but do not fully tighten them. Use a vise to press the rail master surface against the bed's lateral mounting surface, and then use a torque wrench to tighten the rail mouting bolts in order according to the specified torque value.

2 Installation of subsidiary side rail



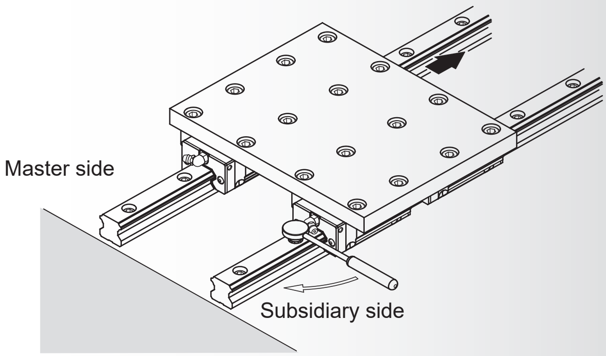
Linear block gauge method

Place the linear block gauge between the two rails, use the micrometer to adjust it to the reference side of rail parallel to the reference surface, and then use the linear block gauge as a reference to adjust the straightness of the driven side of rail by using the micrometer. The rail mounting bolts are tightened in sequence from the end of shaft.



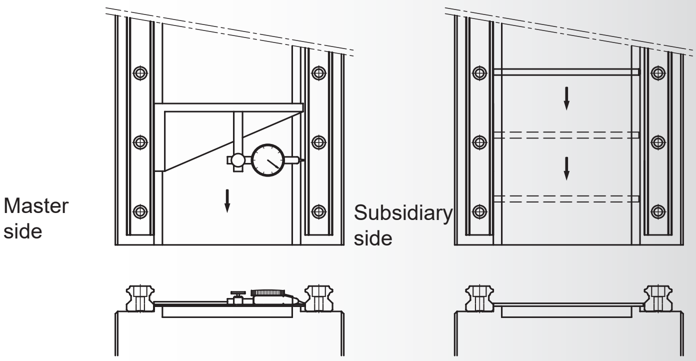
Moving platform method

The two blocks on the reference side are fixed and locked on the platform, and the rail on the driven side and one block are locked on the bed and platform individually, but not completely locked tightly. Fix the micrometer on the platform, and make its probe contact the side of the subsidiary side block, move the platform from the shaft end to calibrate the parallelism of the subsidiary side rail, and simultaneously tighten the mounting bolts in sequence.



Imitating the reference side rail method

The two blocks on the master side and one block on the subsidiary side are fixed and locked on the platform, while the rail on the subsidiary side and the other block are locked on the bed and the platform indivisually, but not completely locked tightly. Move the platform from the shaft end, adjust the parallelism of the subsidiary side rail according to the change of rolling resistance, and simultaneously tighten the mounting bolts in sequence.

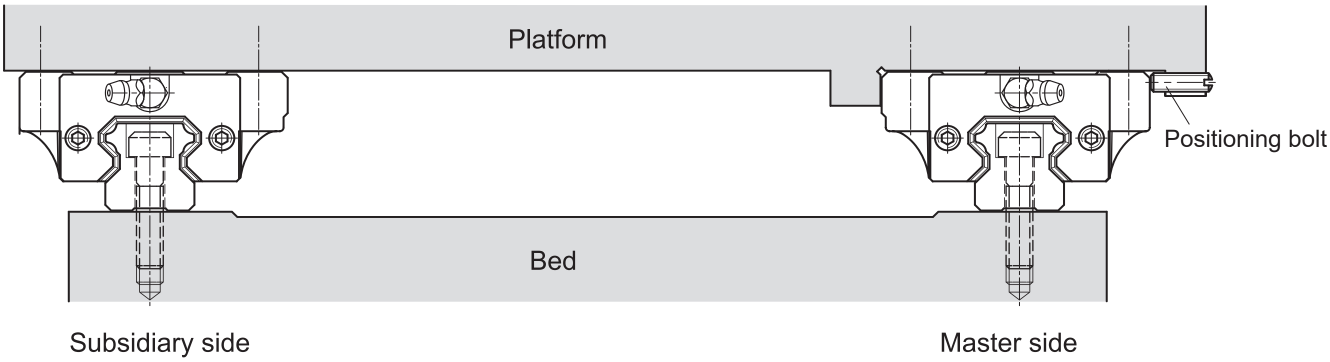


Special tool installation method

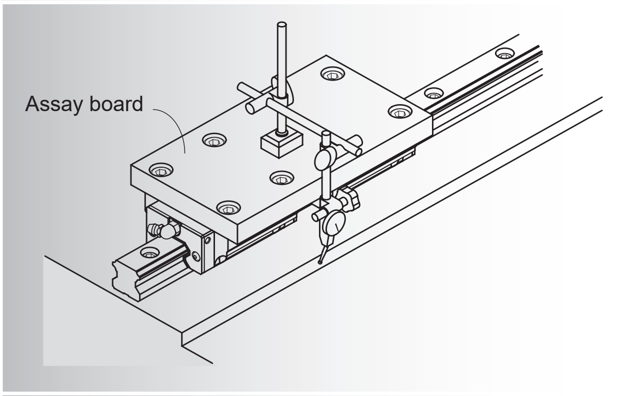
Use a special tool to adjust the parallelism of the subsidiary side rail to the master surface according to the installation interval based on the lateral master surface of the master side rail, and simultaneously tighten the mounting bolts in sequence.

3 Installation of the block is the same as the previous example

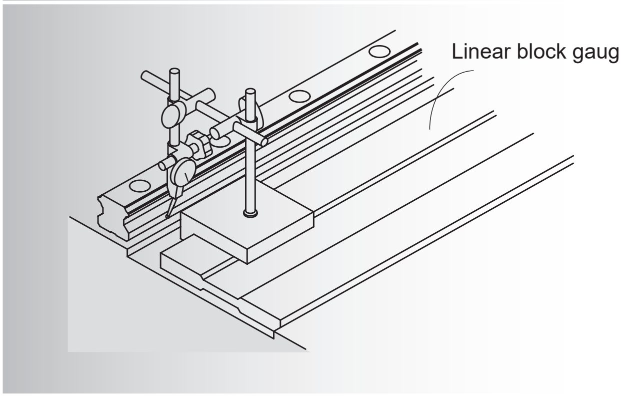
1.11.3 Installation of rails without lateral positioning surfaces



1 Installation of master side rail



Use the false datum method
Hold the two blocks tightly and fix them on the measuring plate, and use the micrometer to calibrate the straightness of the rail from the end of the shaft, and then tighten the mounting bolts in sequence.



Linear block gauge method
The rails were first locked on the bed with mounting bolts, but not completely locked. Based on a linear block gauge, a micrometer was used to calibrate the straightness of the rails from the shaft end, and at the same time tighten the mounting bolts in order.

2 Installation of subsidiary side rail and block is the same as the previous example

1.11.4 Recommended torque for mounting bolts of rail

When installing the rail, the locking force of the mounting bolts will affect the overall assembly accuracy. Therefore, the uniformity of the locking force is very important. It is recommended to tighten the mounting bolts with a torque wrench according to the torque values in the table on the right. Different mounting surfaces and bolt strengths have different bolt torque.

Bolt torque value

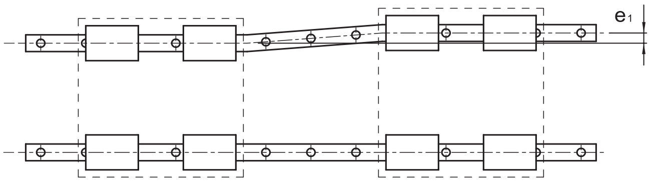
Unit : kgf*cm

Bolt strength	Nominal bolt model	Mounting surface material: Steel or cast iron	Mounting surface material: Aluminum
8.8	M4	25	19
	M5	52	38
	M6	88	65
	M8	220	157
	M10	440	314
	M12	770	539
	M14	1240	884
	M16	2000	1426
12.9	M4	49	32
	M5	95	63
	M6	162	108
	M8	392	265
	M10	794	529
	M12	1373	912
	M14	2067	1378
	M16	3333	2222

1.11.5 Permissible deviations of mounting

Due to the design of the 4-row X-shaped of the ABBA linear guide, it has excellent self-aligning ability. Even if the mounting surface is slightly skewed or deviation, it can still have smooth linear motion. The following is an explanation for the ABBA linear guide can correct the maximum error on the mounting surface.
However, for high-precision applications, the mounting surface must are with enough rigidity. And the permissible deviations of mounting are also need to be cut in half.

Deviation in parallelism (e_1)



Unit : μm

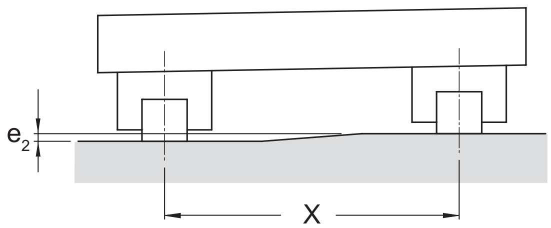
Nominal size	Parallelism error tolerance for 2 axes (e_1): Z3	Z2	Z1	Z0	ZF
15	10	13	18	25	35
20	12	18	20	25	35
25	15	20	22	30	42
30	20	27	30	40	55
35	22	30	35	50	68
45	25	35	40	60	85

Height deviation in lateral direction (e_2)

Height deviation in lateral direction (e_2) can be calculated as follows:

$$e_2 = \frac{X \times f_{e2}}{500}$$

e_2 : Height deviation in lateral direction (μm)
X : Center distance between two rails (mm)
f_{e2} : Height deviation in lateral direction coefficient



Unit : μm

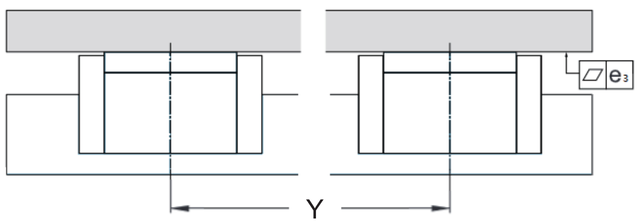
Nominal size	Height deviation in lateral direction coefficient (f_{e2}): Z3	Z2	Z1	Z0	ZF
15	90	100	160	250	270
20	90	100	160	250	270
25	90	100	160	250	270
30	100	110	170	260	280
35	100	110	170	260	280
45	100	110	170	260	280

Flatness in top mounting plane (e_3)

Flatness in top mounting plane (e_3) can be calculated as follows:

$$e_3 = \frac{Y \times f_{e3}}{500}$$

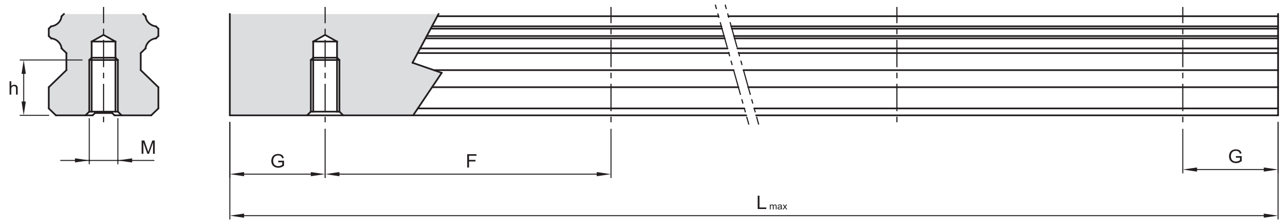
e_3 : Flatness in top mounting plane (μm)
Y : Center distance between two blocks (mm)
f_{e3} : Flatness in top mounting plane deviation coefficient



Unit : μm

Nominal size	Flatness in top mounting plane deviation coefficient (f_{e3}): Short block	Standard length block	Extended length block
15	28	20	14
20	28	20	14
25	28	20	14
30	33	24	17
35	33	24	17
45	33	24	17

1.12 Dimension of blind hole

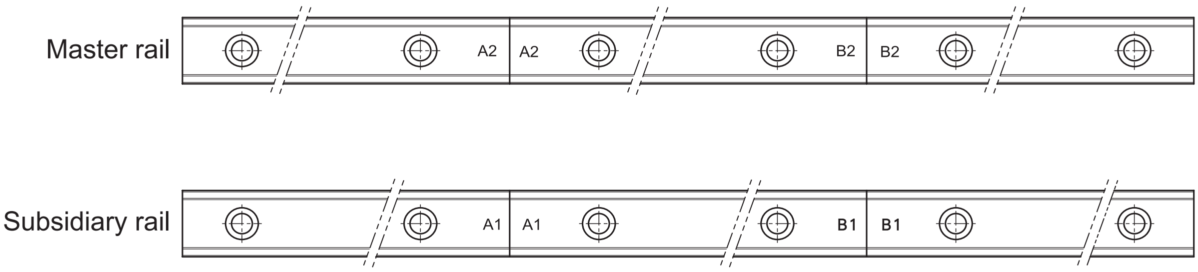


Nominal size	Screw size (M)	Screw Tread h (mm)
15	M5	8
20	M6	10
25	M6	12
30	M8	15
35	M8	17
45	M12	24

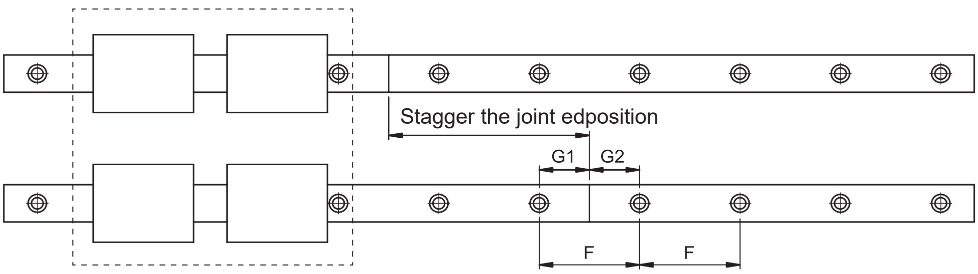
1.13 Indication and assembling of Linear Guide

1.13.1 Jointed rail

1. Jointed rails can be ordered if a rail length is required that exceeds maximum length of rail. Refer to below for markings.



2. To avoid accuracy problems due to discrepancies between the two rails such as matched pair, butt-joint rails, the jointed positions should be staggered as below.



Note:
ABBA gives priority to the accuracy and smoothness of the joint, so G1 + G2 = F, but it is not guaranteed that G1 = G2 = F/2.

1.13.2 Definition of the end distance (G value)

The end distance (G value) of ABBA linear guide is selected as follows:
If customers have no special requirements, the calculation of standard end distance is as follows:
Total length of rail/Rail mounting hole distance = Integer * Hole distance + Remainder
Remainder/2 = End distance
But if the distance from the end to the edge of the nearest mounting hole is less than 5mm,
(Remainder+Rail mounting hole distance)/2 = End distance

Example 1 :

BRS25-A0C2Z0-00250ND0-00S00 type linear guide
Total length of rail= 260, Rail mounting hole distance= 60
Total length of rail 260 / Rail mounting hole distance 60 = 4*60+20
End distance= 20/2= 10mm
But the hole diameter of the rail (D value) = 11mm, so the radius = 5.5mm
From the end of the rail to the edge of the nearest mounting hole
10-5.5 = 4.5mm < 5mm,
Then increase its end distance to (20+60) / 2 = 40mm,
Meet the requirements after increasing the end distance

Example 2 :

BRS35-LRC2Z1-09800ND0-00S00 type linear guide
Total length of rail= 9800, Rail mounting hole distance= 80
Total length of rail 9800 / Rail mounting hole distance 80 = 122*80+40
End distance= 40/2= 20mm
But the hole diameter of the rail (D value) = 14mm, so the radius = 7mm
From the end of the rail to the edge of the nearest mounting hole
20-7 = 13mm > 5mm,
Meet the requirements

1.14 Definition of load rating and coefficient

1.14.1 Definition of load rating

Basic static load rating: C_0

We define the basic static load rating C_0 as a static load of constant magnitude acting in one direction under which the sum of the permanent deformations of rolling elements and raceway equals 0.0001 times of the diameter of the rolling elements.

Basic dynamic load rating: C

When each group of identical linear motion system is applied independently under the same condition, basic dynamic load rating C is the load of constant magnitude acting in one direction that results in a nominal life of 50km.

1.14.2 Static safety factor f_s

Static safety factor : fs

Static safety factor fs is the ratio of the basic static load rating C_0 to the load acting on the linear guide system.

$$fs=(fc*C_0)/P \quad \text{or} \quad fs=(fc*M_0)/M$$

fs : Static safety factor
C_0: Basic static load rating
P : Design load
fc : Contact factor
M_0: Static permissible moment
M : Design moment

Reference value of static safety factor fs shown below:

Operating condition	Load condition	Minimum fs
Normally stationary	Small impact and deflection	1.0 ~ 1.3
	Big impact or twisting load is applied	2.0 ~ 3.0
Normally moving	Small impact or twisting load is applied	1.0 ~ 1.5
	Big impact or twisting load is applied	2.5 ~ 5.0

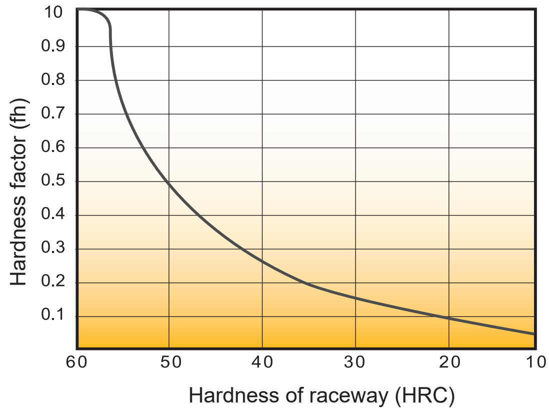
1.14.3 Contact factor fc

In linear motion system, it is hard to obtain identical load distribution due to moments, errors and other factors on the mounting surfaces. When multiple blocks on a rail are used in close contact, the basic load ratings C and C_0 corresponding with contact factors are shown aside.

Numbers of blocks in close contact	Contact factor fc
2	0.81
3	0.72
4	0.66
5	0.61
Normal operation	1

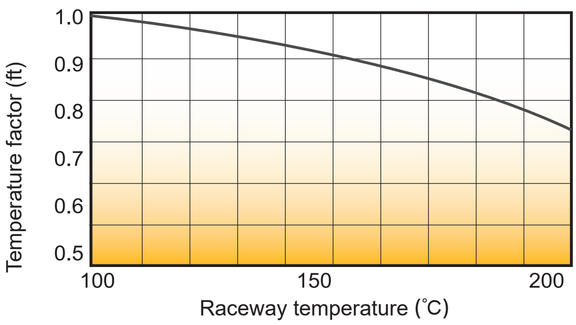
1.14.4 Hardness factor fh

For linear motion system, its optimum load carrying capacity is HRC 58 to 64 hardness on the race-ways.
If the hardness is under HRC 58, both the basic dynamic load rating and basic static load rating should be multiplied by hardness factor fh.



1.14.5 Temperature factor ft

When a linear motion system is subject to tempera-ture above 100˚C, the temperature factor should be taken in to consideration.



1.14.6 Load factor fw

The load acting on an block is resulting from acceleration, impact loads and vibration. It is extremely difficult to quantify these additional dynamic forces.
So in order to estimate the impact of this load on system life, the load must be multiplied by factor fw.
Depending on he mean speed and strength of the impact load, the suggested fw values listed in the table below.

Vibration & impact	Speed (V)	fw
Light external vibrations or impacts	At low speed $V \leqq 15m/min$	1~1.5
Small external vibrations or impacts	At medium speed $15 < V \leqq 60m/min$	1.5~2.0
Significant external vibrations or impacts	At high speed $V > 60m/min$	2.0~3.5

1.14.7 Minimum stroke factor fm

When the single trip of running stroke is shorter than the length of the iron piece of the block, the operating life of the block will be reduced. At this time, minimum stroke factor fm must be multiplied by the calculation result of the life.

Length of block iron / single trip of running stroke	fm
1	1
0.9	0.91
0.8	0.82
0.7	0.73
0.6	0.63
0.5	0.54
0.4	0.44
0.3	0.34
0.2	0.23

1.15 Life calculation formula

Given the basic dynamic load rating C and equivalent load P, the life of the linear guide is calculated as follows:

$$L = fs * \left(\frac{fh * ft * fc}{fw} * \frac{C}{P}\right)^3 * 50$$

L: Nominal life (km)

(When a batch of the same linear motion system moves one by one under the same conditions, 90% of them can reach the total running distance without surface peeling.)

P: Equivalent load

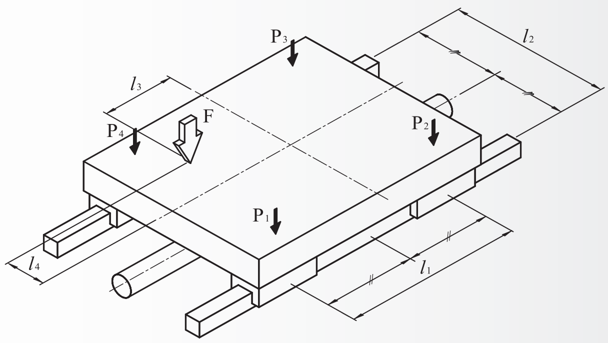
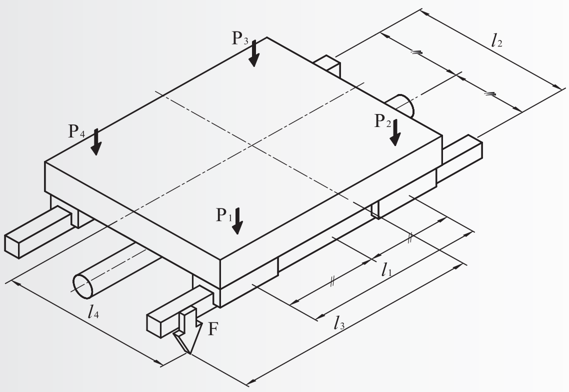
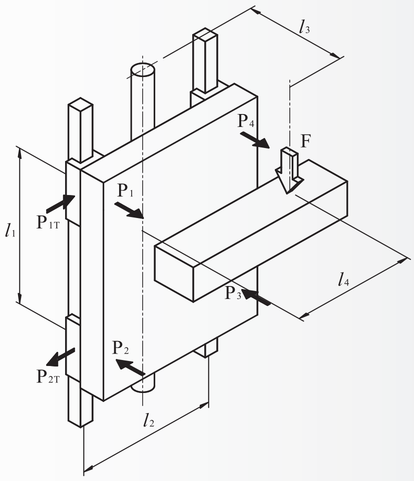
Use the following formula to calculate the nominal life (L). When the stroke length and reciprocation times are constant, the life can be calculated as follows

$$Ln = \frac{L * 10^6}{2 * Ls * N_1 * 60}$$

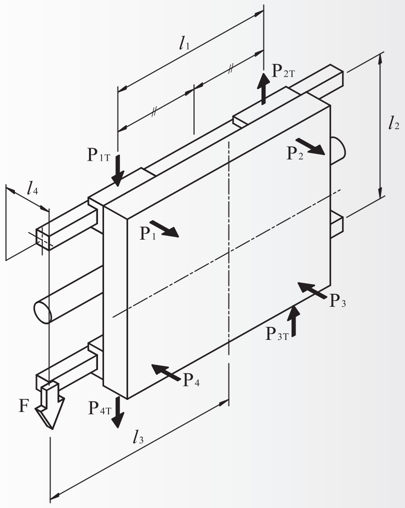
Ln: Life time (h)
Ls: Stroke length (mm)
N_1:Reciprocation times/per minute (min^{-1})

1.16 Calculation of workload

The load acting on the linear guide will change depending on the position of the gravity of the object, the thrust position, and the inertial force generated by the acceleration and deceleration as start and stop during operation. Therefore, when using a linear guide, various conditions of usage must be considered to calculate the correct workload.

Mode	Use configuration	Block load calculation formula
Constant velocity motion of horizontal usage or static		$P_1=\frac{F}{4}+\frac{F\cdot l_3}{2\cdot l_1}-\frac{F\cdot l_4}{2\cdot l_2}$ $P_2=\frac{F}{4}-\frac{F\cdot l_3}{2\cdot l_1}-\frac{F\cdot l_4}{2\cdot l_2}$ $P_3=\frac{F}{4}-\frac{F\cdot l_3}{2\cdot l_1}+\frac{F\cdot l_4}{2\cdot l_2}$ $P_4=\frac{F}{4}+\frac{F\cdot l_3}{2\cdot l_1}+\frac{F\cdot l_4}{2\cdot l_2}$
Constant velocity motion of horizontal cantilever usage or static		$P_1=\frac{F}{4}+\frac{F\cdot l_3}{2\cdot l_1}+\frac{F\cdot l_4}{2\cdot l_2}$ $P_2=\frac{F}{4}-\frac{F\cdot l_3}{2\cdot l_1}+\frac{F\cdot l_4}{2\cdot l_2}$ $P_3=\frac{F}{4}-\frac{F\cdot l_3}{2\cdot l_1}-\frac{F\cdot l_4}{2\cdot l_2}$ $P_4=\frac{F}{4}+\frac{F\cdot l_3}{2\cdot l_1}-\frac{F\cdot l_4}{2\cdot l_2}$
Constant velocity motion of vertital usage or static		$P_1=P_2=P_3=P_4=\frac{F\cdot l_3}{2\cdot l_1}$ $P_{1T}=P_{2T}=P_{3T}=P_{4T}=\frac{F\cdot l_4}{2\cdot l_1}$

Constant velocity motion of Wall hanging usage or static

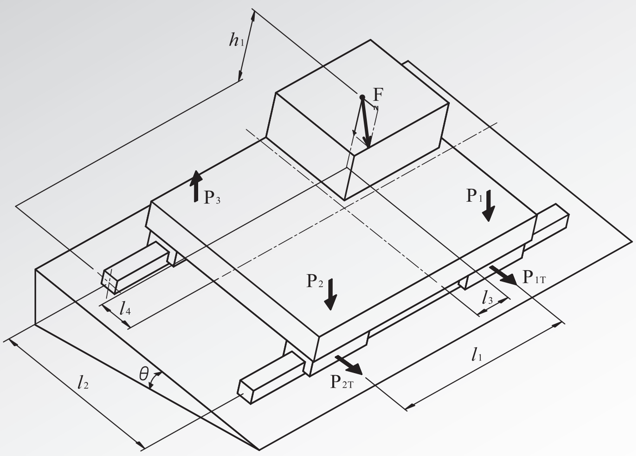


$$P_1 = P_2 = P_3 = P_4 = \frac{F \cdot l_4}{2 \cdot l_2}$$

$$P_{1T} = P_{4T} = \frac{F}{4} + \frac{F \cdot l_3}{2 \cdot l_1}$$

$$P_{2T} = P_{3T} = \frac{F}{4} - \frac{F \cdot l_3}{2 \cdot l_1}$$

Side tilting usage



$$P_1 = \frac{F \cdot \cos\theta}{4} + \frac{F \cdot \cos\theta \cdot l_3}{2 \cdot l_1} - \frac{F \cdot \cos\theta \cdot l_4}{2 \cdot l_2} + \frac{F \cdot \sin\theta \cdot h_1}{2 \cdot l_2}$$

$$P_2 = \frac{F \cdot \cos\theta}{4} - \frac{F \cdot \cos\theta \cdot l_3}{2 \cdot l_1} - \frac{F \cdot \cos\theta \cdot l_4}{2 \cdot l_2} + \frac{F \cdot \sin\theta \cdot h_1}{2 \cdot l_2}$$

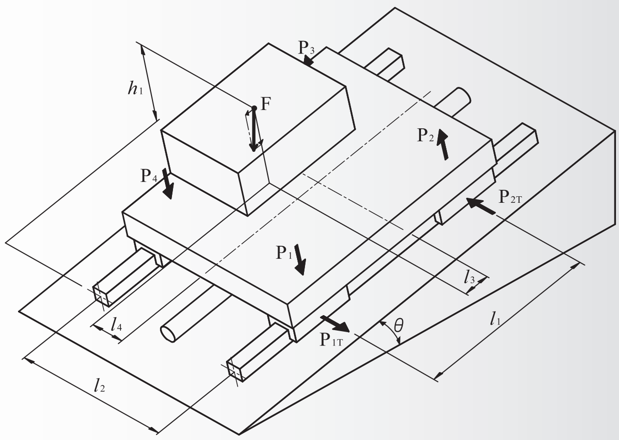
$$P_3 = \frac{F \cdot \cos\theta}{4} - \frac{F \cdot \cos\theta \cdot l_3}{2 \cdot l_1} + \frac{F \cdot \cos\theta \cdot l_4}{2 \cdot l_2} - \frac{F \cdot \sin\theta \cdot h_1}{2 \cdot l_2}$$

$$P_4 = \frac{F \cdot \cos\theta}{4} + \frac{F \cdot \cos\theta \cdot l_3}{2 \cdot l_1} + \frac{F \cdot \cos\theta \cdot l_4}{2 \cdot l_2} - \frac{F \cdot \sin\theta \cdot h_1}{2 \cdot l_2}$$

$$P_{1T} = P_{4T} = \frac{F \cdot \sin\theta}{4} + \frac{F \cdot \sin\theta \cdot l_3}{2 \cdot l_1}$$

$$P_{2T} = P_{3T} = \frac{F \cdot \sin\theta}{4} - \frac{F \cdot \sin\theta \cdot l_3}{2 \cdot l_1}$$

Front tilting usage



$$P_1 = \frac{F \cdot \cos\theta}{4} + \frac{F \cdot \cos\theta \cdot l_3}{2 \cdot l_1} - \frac{F \cdot \cos\theta \cdot l_4}{2 \cdot l_2} + \frac{F \cdot \sin\theta \cdot h_1}{2 \cdot l_1}$$

$$P_2 = \frac{F \cdot \cos\theta}{4} - \frac{F \cdot \cos\theta \cdot l_3}{2 \cdot l_1} - \frac{F \cdot \cos\theta \cdot l_4}{2 \cdot l_2} - \frac{F \cdot \sin\theta \cdot h_1}{2 \cdot l_1}$$

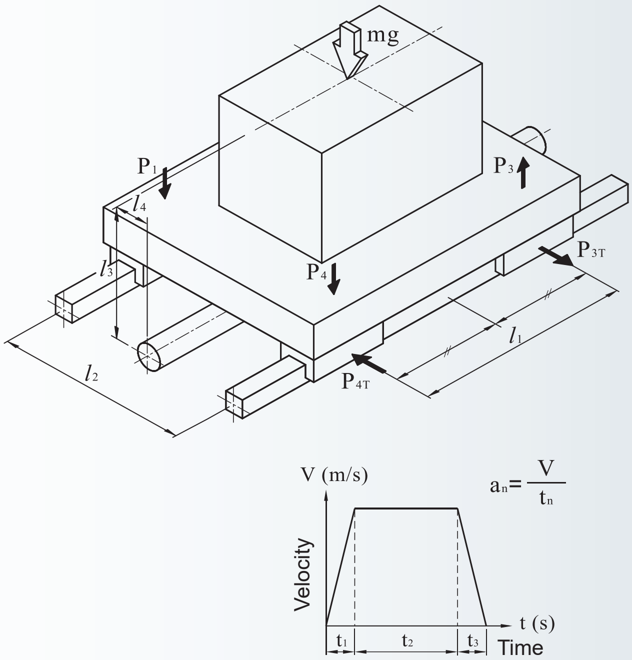
$$P_3 = \frac{F \cdot \cos\theta}{4} - \frac{F \cdot \cos\theta \cdot l_3}{2 \cdot l_1} + \frac{F \cdot \cos\theta \cdot l_4}{2 \cdot l_2} - \frac{F \cdot \sin\theta \cdot h_1}{2 \cdot l_1}$$

$$P_4 = \frac{F \cdot \cos\theta}{4} + \frac{F \cdot \cos\theta \cdot l_3}{2 \cdot l_1} + \frac{F \cdot \cos\theta \cdot l_4}{2 \cdot l_2} + \frac{F \cdot \sin\theta \cdot h_1}{2 \cdot l_1}$$

$$P_{1T} = P_{4T} = + \frac{F \cdot \sin\theta \cdot l_4}{2 \cdot l_1}$$

$$P_{2T} = P_{3T} = - \frac{F \cdot \sin\theta \cdot l_4}{2 \cdot l_1}$$

Horizontal usage with inertia effect



Speed-time relationship diagram

As accelerating

$$P_1 = P_4 = \frac{mg}{4} - \frac{m \cdot a_1 \cdot l_3}{2 \cdot l_1}$$

$$P_2 = P_3 = \frac{mg}{4} + \frac{m \cdot a_1 \cdot l_3}{2 \cdot l_1}$$

$$P_{1T} = P_{2T} = P_{3T} = P_{4T} = \frac{m \cdot a_1 \cdot l_4}{2 \cdot l_1}$$

As constant speed

$$P_{1T} = P_{2T} = P_{3T} = P_{4T} = \frac{mg}{4}$$

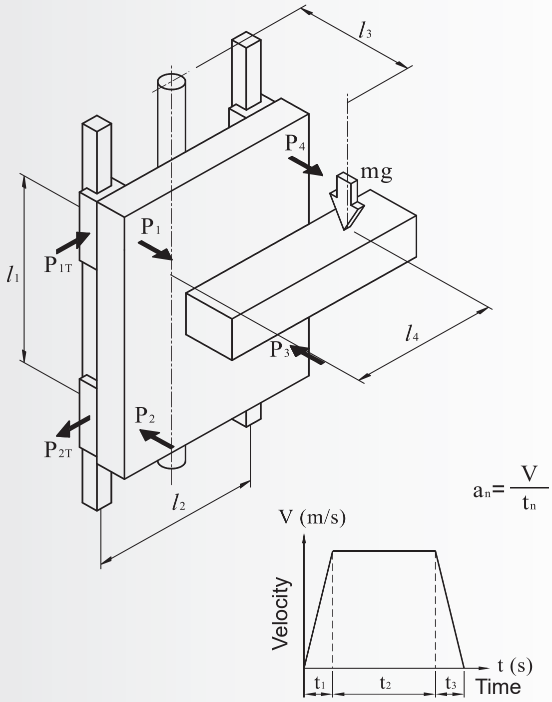
As decelerating

$$P_1 = P_4 = \frac{mg}{4} + \frac{m \cdot a_3 \cdot l_3}{2 \cdot l_1}$$

$$P_2 = P_3 = \frac{mg}{4} - \frac{m \cdot a_3 \cdot l_3}{2 \cdot l_1}$$

$$P_{1T} = P_{2T} = P_{3T} = P_{4T} = \frac{m \cdot a_3 \cdot l_4}{2 \cdot l_1}$$

Vertical usage with inertia effect



Speed-time relationship diagram

As accelerating

$$P_1 = P_2 = P_3 = P_4 = \frac{m \cdot (g + a_1) \cdot l_3}{2 \cdot l_1}$$

$$P_{1T} = P_{2T} = P_{3T} = P_{4T} = \frac{m \cdot (g + a_1) \cdot l_4}{2 \cdot l_1}$$

As constant speed

$$P_1 = P_2 = P_3 = P_4 = \frac{m \cdot g \cdot l_3}{2 \cdot l_1}$$

$$P_{1T} = P_{2T} = P_{3T} = P_{4T} = \frac{m \cdot g \cdot l_4}{2 \cdot l_1}$$

As decelerating

$$P_1 = P_2 = P_3 = P_4 = \frac{m \cdot (g - a_3) \cdot l_3}{2 \cdot l_1}$$

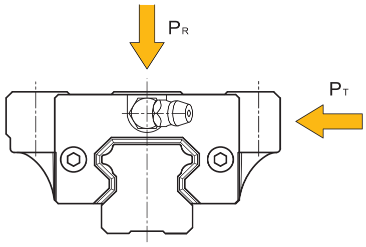
$$P_{1T} = P_{2T} = P_{3T} = P_{4T} = \frac{m \cdot (g - a_3) \cdot l_4}{2 \cdot l_1}$$

1.17 Calculation of equivalent load

The block of the linear guide can withstand loads and moments in radial, reverse-radial, and lateral directions at the same time. When there are multi-directional loads, all loads can be converted into equivalent loads in the radial or lateral direction. Then calculate its life or static safety factor.
ABBA's BR series linear guides are designed with equal load capacity in four directions. When two or more (including two) rails are used in pairs, the equivalent load is calculated as follows.

$$P_E = |P_R| + |P_T|$$

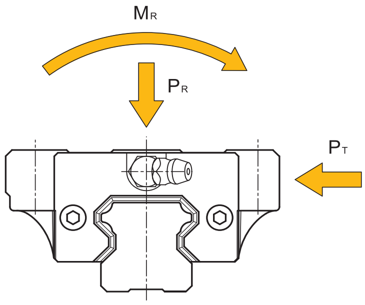
P_E : Equivalent load (kgf)
P_R : Radial or reverse radial load (kgf)
P_T : Lateral load (kgf)



In the case of a single rail, the equivalent load must take into account the moment effect, and its calculation formula is as follows.

$$P_E = |P_R| + |P_T| + C_0 \cdot \frac{|M|}{M_R}$$

P_E : Equivalent load (kgf)
P_R : Radial or reverse radial load (kgf)
P_T : Lateral load (kgf)
C_0 : Basic static load rating (kgf)
M : Calculation torque (kgf *m)
M_R : Allowable static torque (kgf *m)



1.18 Calculation of average load with variable load

When the block in operation is subjected to a variable load, the average load equivalent to the fatigue life of the block can be obtained according to the varying load conditions to calculate its fatigue life. The basic calculation formula for the average load of rolling elements as steel balls is shown below.

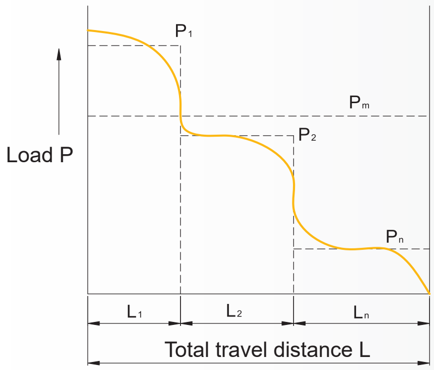
$$P_m = \sqrt[i]{\frac{1}{L} \sum_{n=1}^{n} (P_n^{i} \cdot L_n)}$$

P_m : Average load (kgf)
P_n : Variable load (kgf)
L : Total travel distance (mm)
L_n : Traveling distance as load P_n working

Calculation example of average load

Variable load types	Average load calculation

Grade variable load



$$P_m = \sqrt[3]{\frac{1}{L}\left(P_1^{\,3} \cdot L_1 + P_2^{\,3} \cdot L_2 \cdots\cdots + P_n^{\,3} \cdot L_n\right)}$$

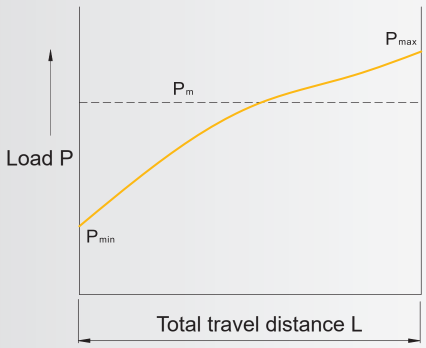
P_m : Average load (kgf)

P_n : Variable load (kgf)

L : Total travel distance (mm)

L_n : Traveling distance as load P_n working

Monotonic variable load



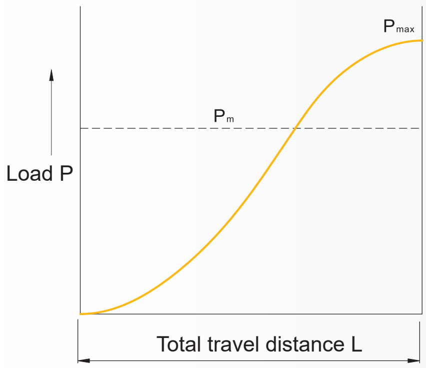
$$P_m \cong \frac{1}{3}\left(P_{min} + 2 \cdot P_{max}\right)$$

P_m : Average load (kgf)

P_{min} : Minimum load (kgf)

P_{max} : Maximum load (kgf)

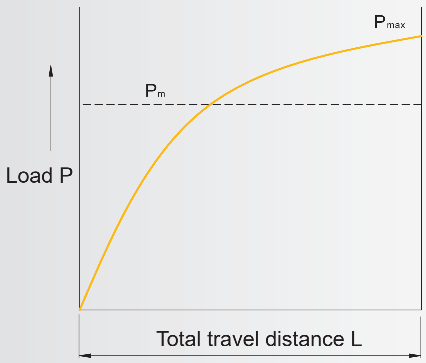
Sinusoidal variable load



$$P_m \cong 0.65 \cdot P_{max}$$

P_m : Average load (kgf)

P_{max} : Maximum load (kgf)



$$P_m \cong 0.75 \cdot P_{max}$$

P_m : Average load (kgf)

P_{max} : Maximum load (kgf)

1.19 Friction

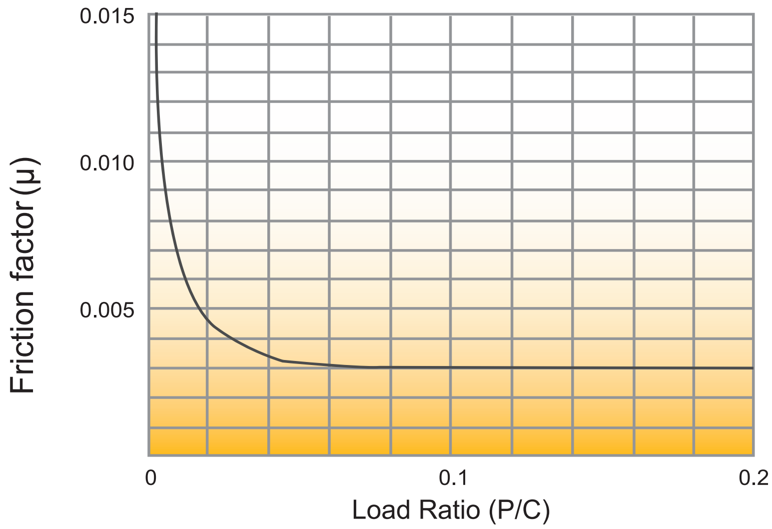
Refer to the following formula to calculate friction

$F = \mu * W + f$

F : Friction (kgf) W : Load (kgf)

μ : Friction factor f : Running resistance of standard dust wiper

μ : Friction factor



P : Load (kgf)

C : Basic dynamic load rating (kgf)

f: Friction resistance of standard front seal

Unit : kgf

Friction resistance	
Model	Standard front seal
BR15	0.4
BR20	0.5
BR25	0.6
BR30	0.8
BR35	0.95
BR45	1.4

Note:
The value is based on the block with standard front seal at both ends and added with Grease No.2.

1.20 Lubrication

1.20.1 Factory pre-lubrication

BR blocks are factory pre-lubricated with Grease No.2 and the lubricant reservoir is factory pre-lubricated with Grease No.00.

1.20.2 Grease re-lubrication

1 Re-lubrication intervals recommendation

1. Norminal size 30 and below: per 100km; nominal size 35 and above: per 40km
2. Make supplimentary periodically per 3 months.

Re-lubrication intervals should be apply upon one of above condition comes first.

2 Grease inputting recommendation

Recommended whether for first or relubrication, you should

1. Wipe off the anti-rust oil on the surface of the rail and block to prevent it from diluting the grease.
2. Fill the entire space inside the block with grease until it just overflows.

Note:
Because the block scraper of ABBA has a good scraping and sealing effect, so the grease on the surface of the rail can not enter the block, nor can it have lubrication effect.

3 Recommended re-lubricition amount

Unit : ml

<table>
<tr><th colspan="6">Recommended re-lubricition amount</th></tr>
<tr><th>Nominal size</th><th>Amount</th><th>Nominal size</th><th>Amount</th><th>Nominal size</th><th>Amount</th></tr>
<tr><td>BRC15A0</td><td rowspan="3">2～3</td><td>BRC25R0</td><td>3～4</td><td>BRD35A0</td><td rowspan="3">6～8</td></tr>
<tr><td>BRC15R0</td><td>BRC25U0</td><td rowspan="2">2～3</td><td>BRD35R0</td></tr>
<tr><td>BRC15U0</td><td>BRC25SU</td><td>BRD35U0</td></tr>
<tr><td>BRC15SU</td><td>1～2</td><td>BRC25LA</td><td rowspan="5">4～6</td><td>BRD35SU</td><td>4～6</td></tr>
<tr><td>BRC20A0</td><td rowspan="4">2～3</td><td>BRC25LR</td><td>BRD35LA</td><td rowspan="2">7～10</td></tr>
<tr><td>BRC20R0</td><td>BRC30A0</td><td>BRD35LR</td></tr>
<tr><td>BRC20U0</td><td>BRC30R0</td><td>BRD45A0</td><td rowspan="3">9～14</td></tr>
<tr><td>BRC20SU</td><td>BRC30U0</td><td>BRD45R0</td></tr>
<tr><td>BRC20LA</td><td rowspan="3">3～4</td><td>BRC30SU</td><td>3～5</td><td>BRD45U0</td></tr>
<tr><td>BRC20LR</td><td>BRC30LA</td><td rowspan="2">6～8</td><td>BRD45LA</td><td rowspan="2">11～17</td></tr>
<tr><td>BRC25A0</td><td>BRC30LR</td><td>BRD45LR</td></tr>
</table>

Table 1.20.1

4 Grease performance

Item	No. 00	No. 2
Base oil	Mineral oil	Mineral oil
Soap base	Lithium	Lithium
Drop point°C	168	180
Appearance	Amber	Amber
Viscosity of base oil (cSt, @ 40 °C)	15.5	16
Viscosity of base oil (cSt, @ 100 °C)	170	200

Table 1.20.2

1.20.3 Oil re-lubrication

1. First time re-lubrication: apply to whole internal block, please refer to table 1.20.1 for appropriate grease amount.

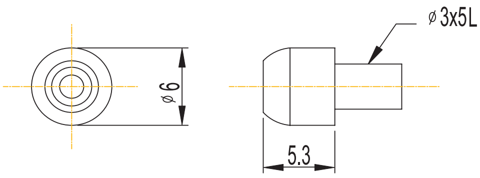
2. Re-lubricaton amount: $Q=n/150$ (cm^3/hrs)
   n: Nominal size of rail (mm)

3. Recommended lubrication oil spec.
   Oil mist lubrication: ISO VG32~68
   Clearance oil lubrication: ISO VG68~220
   Oil type : DIN 51517 CLP or CGLP

1.21 Grease nipple(standard)

P140129 (NLA01)

Standard front seal	15	○	20		25		30		35		45	
Standard front seal + U type metal frame scraper plate	15	○	20		25		30		35		45	

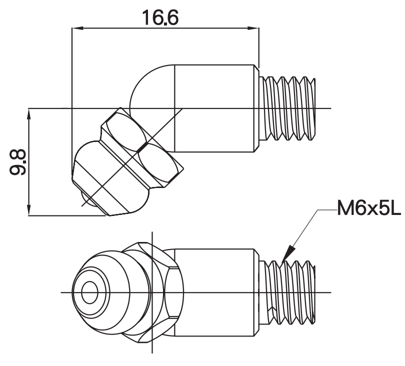


●Note: ○: Be applicable

Unmarked: Not applicable

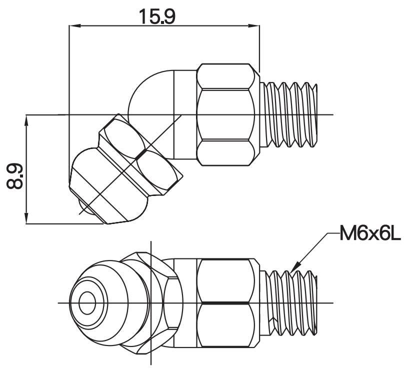
P140880

Standard front seal	15		20	○	25		30		35		45	
Standard front seal + U type metal frame scraper plate	15		20		25		30		35		45	



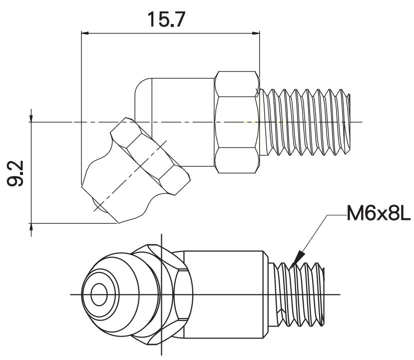
P140135 (NLB02)

Standard front seal	15		20		25	○	30	○	35	○	45	
Standard front seal + U type metal frame scraper plate	15		20		25		30		35		45	



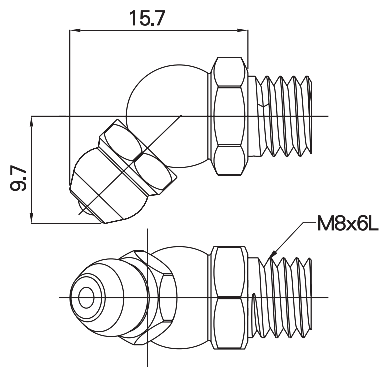
P140137 (NLB03)

Standard front seal	15		20		25		30		35		45	
Standard front seal + U type metal frame scraper plate	15		20	○	25	○	30	○	35	○	45	



P140138 (NLB04)

Standard front seal	15		20		25		30		35		45	○
Standard front seal + U type metal frame scraper plate	15		20		25		30		35		45	○

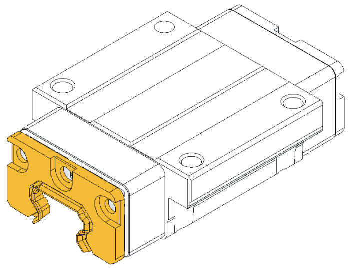


Note:
For optional pipe nipples or other special nipples, please contact ABBA or ABBA authorized distributors.

1.22 Accessories

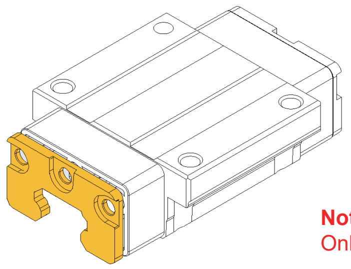
1.22.1 Standard front seal

Standard front seals are contact seals that can prevent external contaminants from entering the block
Standard front seal is suitable for normal environment.



1.22.2 Low friction shield

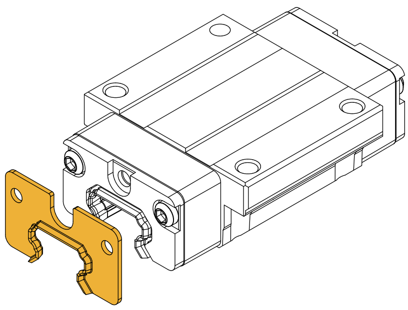
Low friction shields are non-contact seals that can reduce running resistance caused by standard front seals. It is suitable for environments that require low running resistance and no external pollutants, such as clean rooms etc.



Note:
Only SIZE15-30 can be selected, please contact ABBA for other sizes.

1.22.3 Scraper plate

Scraper plates are non-contact seals that needs to be placed outside the seal. Its function is to prevent the seal from being damaged by larger pollutants or hot metal chips. Suitable for environments with large pollutants or metal chips, such as milling machines etc.

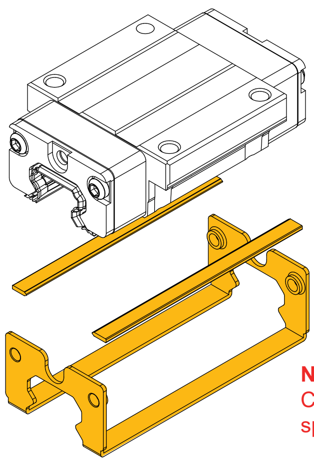


Unit : mm

Model	Thickness
BR15	1
BR20	1
BR25	1.5
BR30	1
BR35	1
BR45	1

1.22.4 U type metal frame + side seals

U type metal frames can hold two side seals and change the block dimension values of L and E as below table. Refer to P38~43 for definition of L and E.



Unit : mm

Model	L	E
BR15	68	2.6
BR20	79.8	3
BR25	90	5
BR30	111	7
BR35	111	7.5
BR45	140.2	12

Note:
Currently only standard blocks are available. For other specifications, please contact ABBA or ABBA authorized distributors.

1.23 BR Lubrication reservoir kit

BR lubrication reservoir kit is run by high oil content of reservoir and optimization of film forming designed to provide adequate and proper amount of lubricant to grooves of rails, thus reaching good effect of environmental protection and extend relubrication intervals.

1.23.1 Characteristics

1 Effectivily extend the relubrication intervals

Make supplimentary periodically up to 4000km

2 High reliability and interchangeability

- End-users can install or replace BR lubrication reservoir kit by themselves easily.
- Replace BR lubrication reservoir kit on the rail directly without moving the block out.

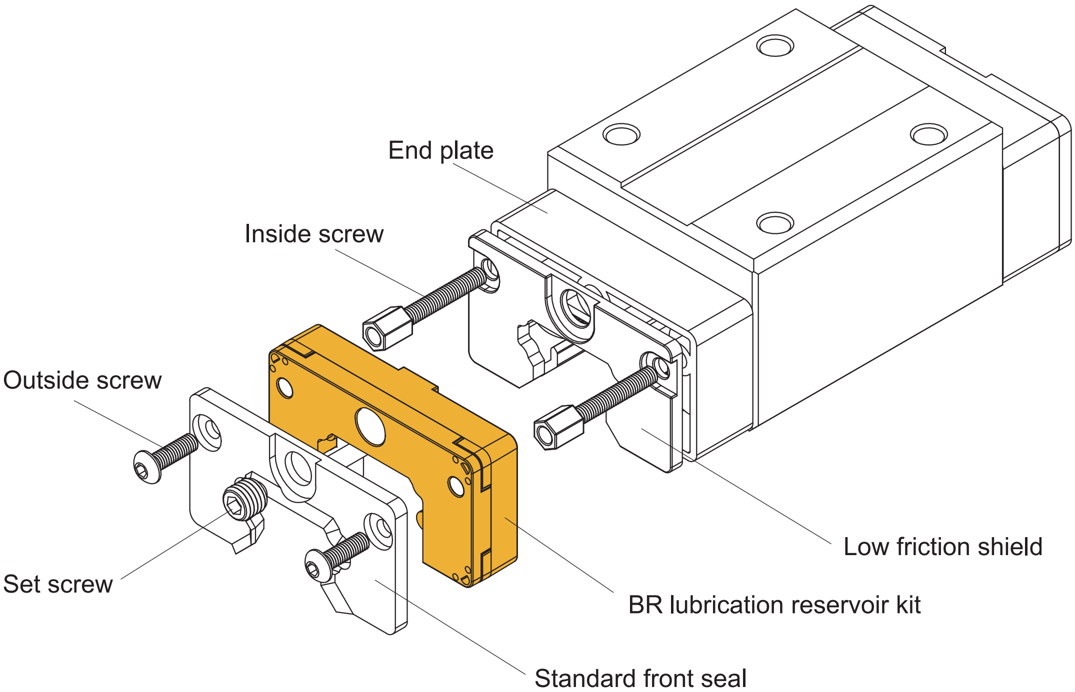
3 Friendly to environment

Through optimization of the film forming methods to reduce the waste of lubrication oil, thus preventing environmental pollutions.

4 High-performance lubrication oil

- Using the lubrication oil which is compliance with ISO3448, viscosity grade 680. Perfectly compatible with the lubrication oil of blocks.
- Allowable temperature range: -10~50˚C(working continuosly) or -10~80˚C(working temporarilly)

1.23.2 Construction

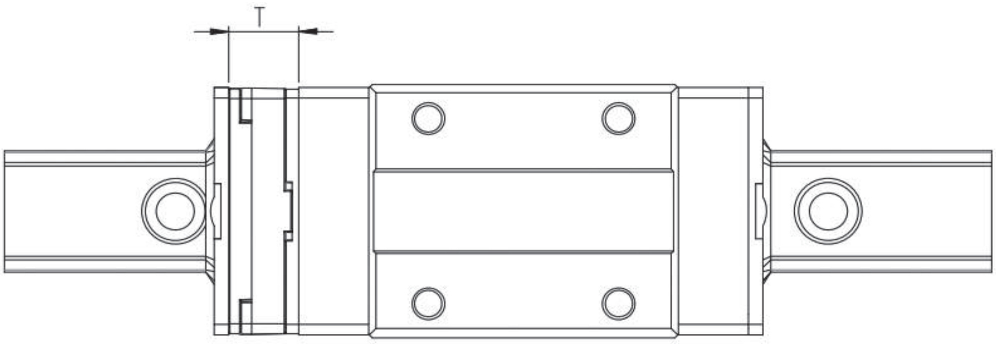


1.23.3 Applicable scope

- Series : BR series
- Size : 15 / 20 / 25 / 30
- Block : available for all blocks types
- End plate : available for standard end plate only
- Preload : available for all preload classes
- Precision : available for all accuracy classes

1.23.4 Installation size

BR lubrication reservoir kit will increase the length of block.
Please refer to the below table for thickness T.

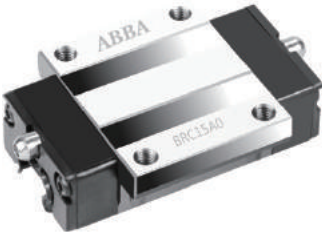


Unit : mm

Size	BR lubrication reservoir kit thickness T
15	13
20	13
25	13
30	10

1.24 Product overview

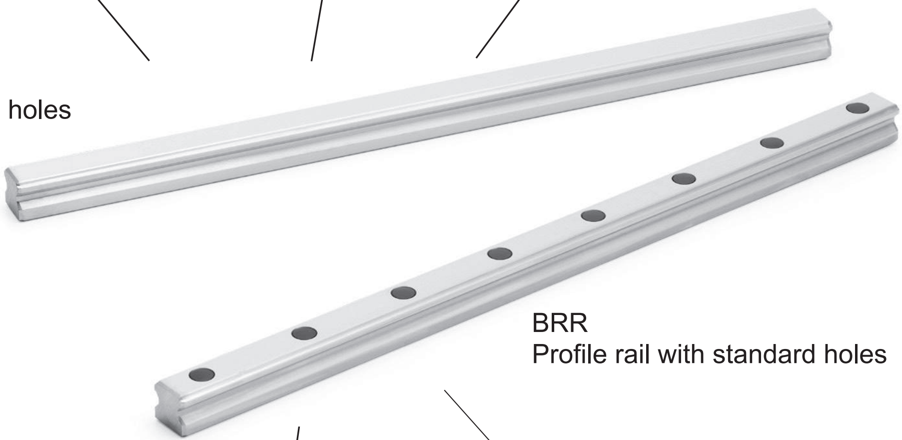
BRC-A0
BRD-A0
Flanged block, standard length, standard height



BRC-R0
BRD-R0
Slim-line block, standard length, extended height

BRC-U0
BRD-U0
Slim-line block, standard length, standard height

BRR
Profile rail with blind holes



BRR
Profile rail with standard holes

BRC-LA
BRD-LA
Flanged block, extended length, standard height

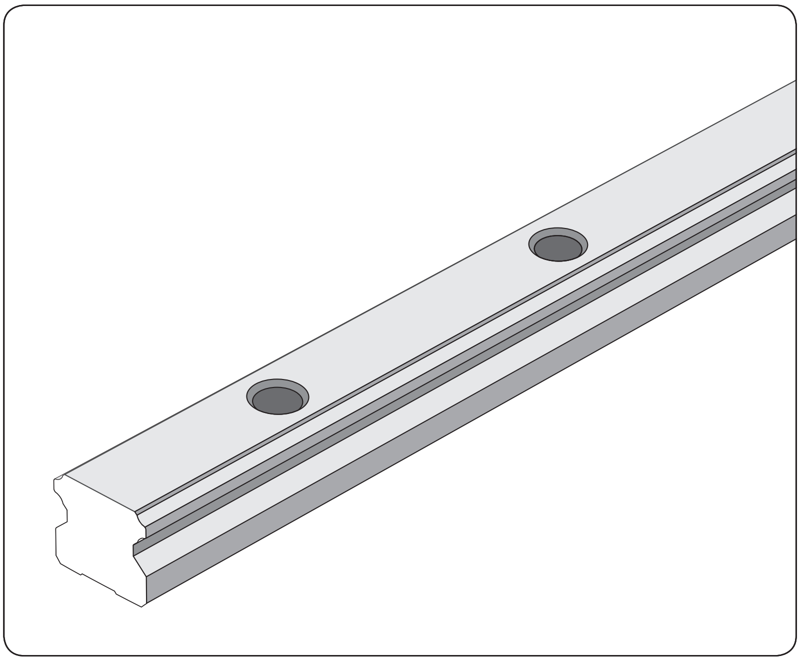
BRC-LR
BRD-LR
Slim-line block, extended length, extended height

BRC-SU
BRD-SU
Slim-line block, short length, standard height

1.25 Rail drilling method

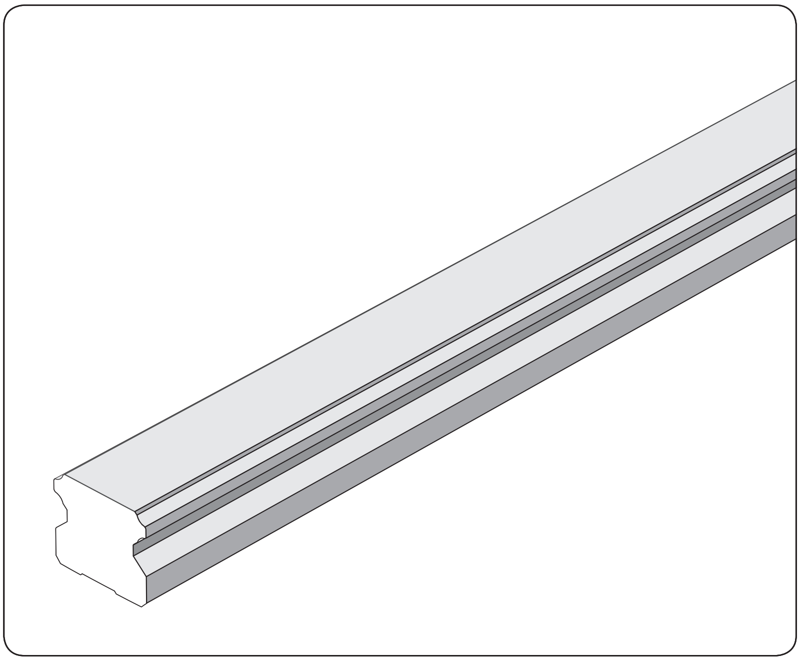
D0 Standard hole

For upper installation, plastic hole plugs are equipped as standard.



D4 Blind hole

For underneath installation with blind hole.



1.26 Maintenance and usage of Linear Guide

Since ABBA Linear Guides are very precise products, please pay careful attention to the following:

ABBA's Linear Guides will be rust-proofed before leaving the factory. Therefore, please clean the rust-proof oil before use and fill it with lubricant immediately. If the product is rusted due to not input lubrication, we will not be able to do free repair.


Check lubrication daily

If you do not use the product within one month after purchasing the product, please do anti-rust treatment regularly. The anti-rust treatment time also needs to be adjusted according to the regional temperature.

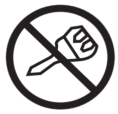

Regular maintenance

ABBA's Linear Guides have self-lubricating blocks (depending on the model), which greatly saves the lubricants cost and reduces the maintenance times. Please check the operating conditions regularly. If there is no oil film on the surface of the rails, please fill in the lubricant immediately. If the rail surface is contaminated by dust and metal dust, please clean it with kerosene before filling it with lubricant.

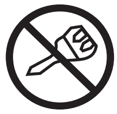

Check lubrication daily


Avoid dust

Do not disassemble the block by yourself lest foreign matter enter the block, which will affect the accuracy and shorten the service life. In addition, the rail should be placed on an appropriate surface, otherwise the rail will be deformed.


Prohibition of disassembly

If the linear blocks are installed vertically, please pay special attention to the sliding of the block. If the block accidentally falls, please find an ABBA authorized distributors for assistance immediately.


Prohibition of disassembly


Avoid Slipping off

Be sure to use the product in a clean environment, and install a protective cover on the outside of the product to prevent the entry of dust and metal dust, which will affect the accuracy and service life of the product.


Avoid dust

If the product is used in a harsh environment, such as a corrosive environment, ABBA also provides hard chrome plating. Please contact with ABBA or ABBA authorized distributor.

Do not use in an environment higher than 80 degrees Celsius, as it may damage the seals of the product and shorten the service life.

Notice temperature limit

For non-interchangeable products, you cannot arbitrarily replace the block or change its installation direction, otherwise the accuracy of the product cannot be guaranteed.

1.27 Ordering key of System

B R S 1 5 - A 0 C 2 Z 1 - 1 0 8 0 0 N D 0 - A 0 S W 2

Size
15, 20, 25, 30, 35, 45

Block type [1)]

A0	Flanged block(Standard length, Standard height)
LA	Flanged block(Extended length, Standard height)
SU	Slim-line block(Short length, Standard height)
U0	Slim-line block(Standard length, Standard height)
R0	Slim-line block(Standard length, Extended height)
LR	Slim-line block(Extended length, Extended height)

End Cap Type [2)]

C	Standard End Cap(for 15, 20, 25, 30)
D	Short End Cap(for 15, 20, 25, 30, 35, 45)

Number of blocks per rail

1~9	1~9 blocks per rail
A~W	>9 blocks per rail (10=A, 11=B, 12=C...)

Preload class [3)]

ZF	Clearance, Preload=0
Z0	No preload, Preload=0
Z1	Light preload, Preload=0~0.02C
Z2	Medium preload, 0.02~0.05C
Z3	Heavy preload, 0.05~0.07C

Rail length
00080~99999 mm(1 mm steps)

Accuracy class [3)]

N	Normal
H	High
P	Precision

Rail hole

D0	Standard hole(Standard hole distance, the distance of the first and last attachment holes is produced equidistantly.)
D4	Blind hole(Standard hole distance, the distance of the first and last attachment holes is produced equidistantly.)

Join rail track [4)]

A	Yes
0	No

Rail treatment

0	Standard (anti-rust oil)
B	Black oxidation plating
H	Hard chromium plating

Sealing [5)]

S	Standard front seal (only end seal)
1	Standard front seal + Scraper plate
0	Low friction shield
V	BR lubrication reservoir kit + Standard front seal
W	BR lubrication reservoir kit + Standard front seal + Scraper plate
U	Standard front seal + U type metal frame + side seals

No. of parallel rails [6)]

00	Single rail
W2~W9	Parallel rails (W2 : 2 rails, W3 : 3 rails)

1) Nipple/set screw quantity per block
   A. Size 15 : 0˚ nipple(2pcs)
   B. Size 20/25/30/35/45 : 45˚nipple(1pc)+ screw(1 pc)

2) C: End cap with Self-lubricant part
   D: End cap without Self-lubricant part

3) Refer to following table for limitation

System			
Accuracy	P	H	N
Preload	-	-	ZF
	Z0	Z0	Z0
	Z1	Z1	Z1
	Z2	Z2	Z2
	Z3	Z3	Z3

4) Please contact ABBA if you need to join rails for coated rails, P class or H class with parallel used product.

5) Block type cross table
●/○ : Block type available
● : Sealing U type, Standard seal + Metal frame to hold two side seals

BRC (Standard End Cap)	A0	LA	SU	U0	R0	LR
15	●		○	●	●	
20	●	○	○	●	●	○
25	●	○	○	●	●	○
30	●	○	○	●	●	○
35						
45						

BRD (Short End Cap)	A0	LA	SU	U0	R0	LR
15	○		○	○	○	
20	○	○	○	○	○	○
25	○	○	○	○	○	○
30	○	○	○	○	○	○
35	●	○	○	●	●	○
45	●	○		●	●	○

6) Use in parallel or on the same surface, consistent with the description of difference.

1.28 Ordering key of Rail

B R R 1 5 - 1 0 8 0 0 N D 0 - A 0

Size
15, 20, 25, 30, 35, 45

Rail length
00080~99999 mm (1 mm steps)

Accuracy class
N Normal

Rail hole
D0 Standard hole(Standard hole distance, the distance of the first and last attachment holes is produced equidistantly.)
D4 Blind hole(Standard hole distance, the distance of the first and last attachment holes is produced equidistantly.)

Join rail track [1)]
A Yes
0 No

Rail treatment
0 Standard (anti-rust oil)
B Black oxidation plating
H Hard chromium plating

1) Please contact ABBA if you need to join rails for coated rails, P class or H class with parallel used product.

1.29 Ordering key of Block

B R C 1 5 - A 0 Z 1 - N 0 S

End Cap Type [1]

C	Standard End Cap(for 15, 20, 25, 30)
D	Short End Cap(for 15, 20, 25, 30, 35, 45)

Size

15, 20, 25, 30, 35, 45

Block type [2]

A0	Flanged block(Standard length, Standard height)
LA	Flanged block(Extended length, Standard height)
SU	Slim-line block(Shot length, Standard height)
U0	Slim-line block(Standard length, Standard height)
R0	Slim-line block(Standard length, Extended height)
LR	Slim-line block(Extended length, Extended height)

Preload class [3]

ZF	Clearance, Preload=0
Z0	No preload, Preload=0
Z1	Light preload, Preload=0~0.02C

Accuracy class [3]

N	Normal

Block treatment

0	Standard (anti-rust oil)
B	Black oxidation plating
H	Hard chromium plating

Sealing [4]

S	Standard front seal (only end seal)
1	Standard front seal + Scraper plate
0	Low friction shield
U	Standard front seal + U type metal frame + side seals

1) C: End cap with Self-lubricant part
D: End cap without Self-lubricant part

2) Nipple/set screw quantity per block
A. Size 15 : 0˚ nipple(2pcs)
B. Size 20/25/30/35/45 : 45˚nipple(1pc)+ screw(1 pc)

3) Refer to following table for limitation

Block			
Accuracy	P	H	N
Preload	-	-	ZF
	-	-	Z0
	-	-	Z1

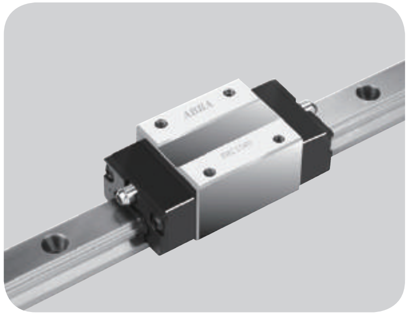
4) Block type cross table
●/○ : Block type available
● : Sealing U type, Standard seal + Metal frame to hold two side seals

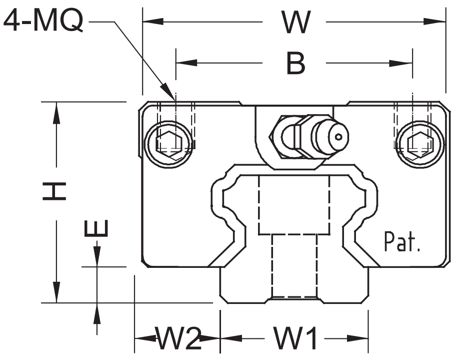
BRC (Standard End Cap)	A0	LA	SU	U0	R0	LR
15	●		○	●	●	
20	●	○	○	●	●	○
25	●	○	○	●	●	○
30	●	○	○	●	●	○
35						
45						

BRD (Short End Cap)	A0	LA	SU	U0	R0	LR
15	○		○	○	○	
20	○	○	○	○	○	○
25	○	○	○	○	○	○
30	○	○	○	○	○	○
35	●	○	○	●	●	○
45	●	○		●	●	○

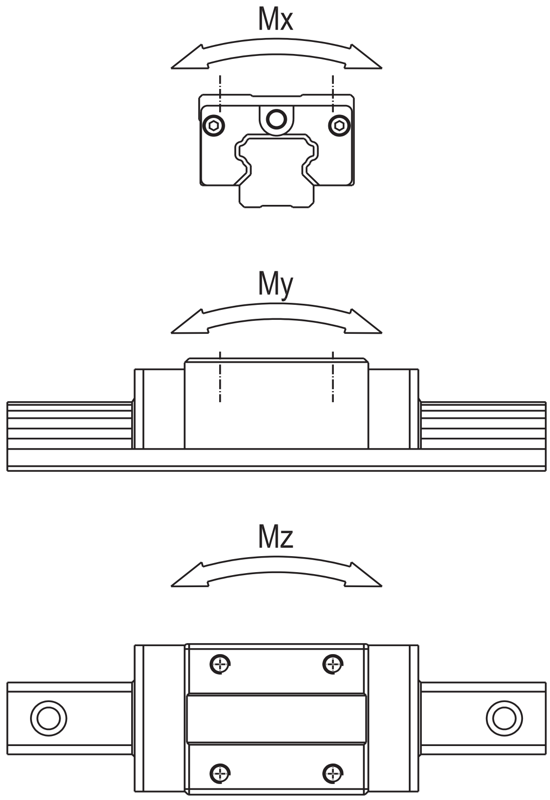
1.30 Dimension of Linear Guide

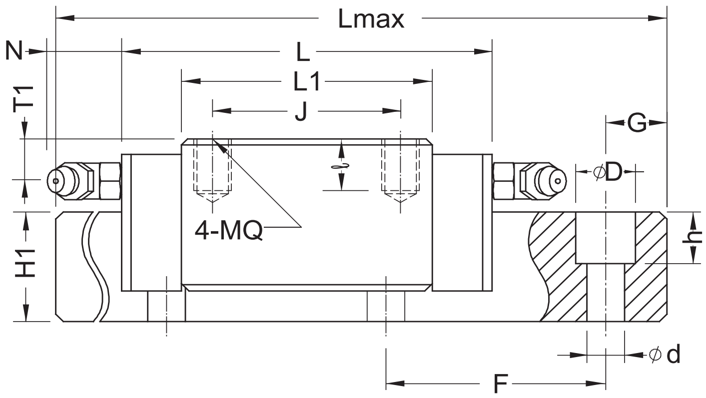
1.30.1 BRC-R0/LR, BRD-R0/LR





Model No.	Assembly (mm)				Block (mm)							Rail (mm)			
	H	W	W2	E	L	BxJ	MQxℓ	L1	Oil hole	T1	(N)	W1	H1	F	dxDxh
BRC15R0	28	34	9.5	4.6	66	26x26	M4x6	40	⌀ 3	8.3	5	15	14	60	4.5x7.5x5.8
BRD15R0					56										
BRC20R0	30	44	12	5	77.8	32x36	M5x8	48.8	M6x1	7	15.6	20	18	60	6x9.5x9.0
BRD20R0					67.8										
BRC20LR					92.4	32x50		63.4							
BRD20LR					82.4										
BRC25R0	40	48	12.5	7	88	35x35	M6x10	57	M6x1	11.8	15.6	23	22	60	7x11x9.5
BRD25R0					78										
BRC25LR					110.1	35x50		79.1							
BRD25LR					100.1										
BRC30R0	45	60	16	9	109	40x40	M8x13	72	M6x1	10	15.6	28	26	80	9x14x12.5
BRD30R0					99										
BRC30LR					131.3	40x60		94.3							
BRD30LR					121.3										
BRD35R0	55	70	18	9.5	109	50x50	M8x13	80	M6x1	15	15.6	34	29	80	9x14x12.5
BRD35LR					134.8	50x72		105.8							
BRD45R0	70	86	20.5	14	138.2	60x60	M10x16.5	105	M8x1	18.5	16	45	38	105	14x20x17.5
BRD45LR					163	60x80		129.8							

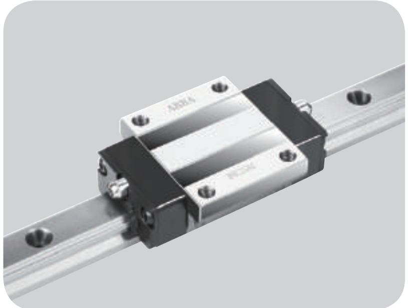


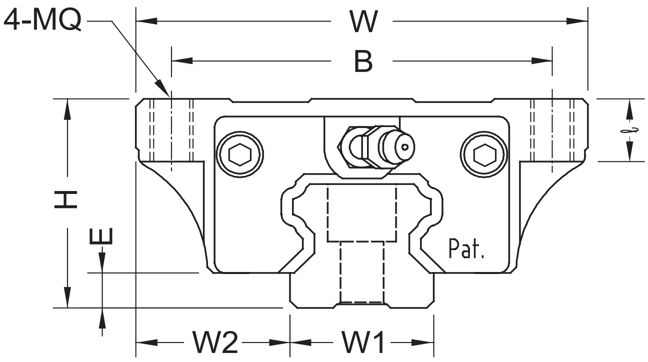


Model No.	Ref. data (mm)		Basic load rating (Kgf)		Static moment (Kgf*m)			Weight	
	Lmax	G	C	C_0	Mx	My	Mz	Block (Kg)	Rail (Kg/m)
BRC15R0	4000	20	850	1350	10.1	6.8	6.8	0.19	1.4
BRD15R0									
BRC20R0	4000	20	1400	2400	24	14.6	14.6	0.31	2.6
BRD20R0									
BRC20LR			1650	3000	30	23.8	23.8	0.47	
BRD20LR									
BRC25R0	4000	20	1950	3200	36.8	22.8	22.8	0.45	3.6
BRD25R0									
BRC25LR			2600	4600	52.9	45.5	45.5	0.56	
BRD25LR									
BRC30R0	4000	20	2850	4800	67.2	43.2	43.2	0.91	5.2
BRD30R0									
BRC30LR			3600	6400	89.6	75.4	75.4	1.2	
BRD30LR									
BRD35R0	4000	20	3850	6200	105.4	62	62	1.5	7.2
BRD35LR			4800	8300	141.1	109.8	109.8	1.9	
BRD45R0	4000	22.5	6500	10500	236.3	137.8	137.8	2.3	12.3
BRD45LR			7700	13000	292.5	210.9	210.9	2.8	

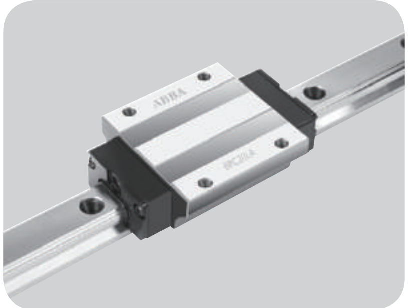
Note: BR35 and BR45 are not equipped with self-lubricant parts.

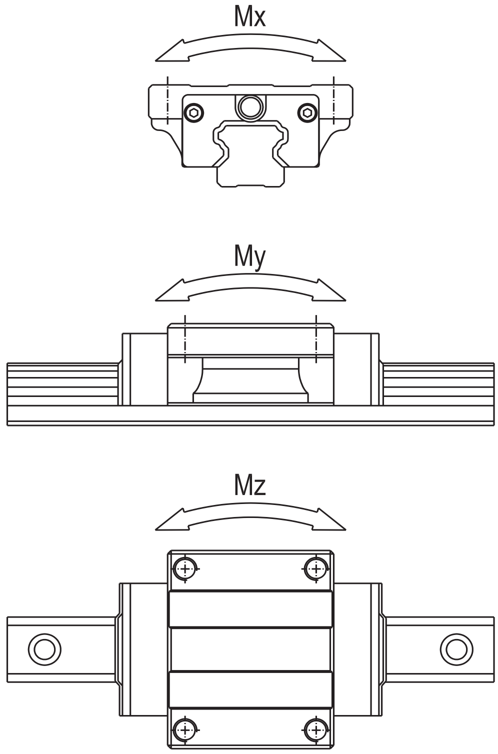
1.30.2 BRC-A0/LA, BRD-A0/LA

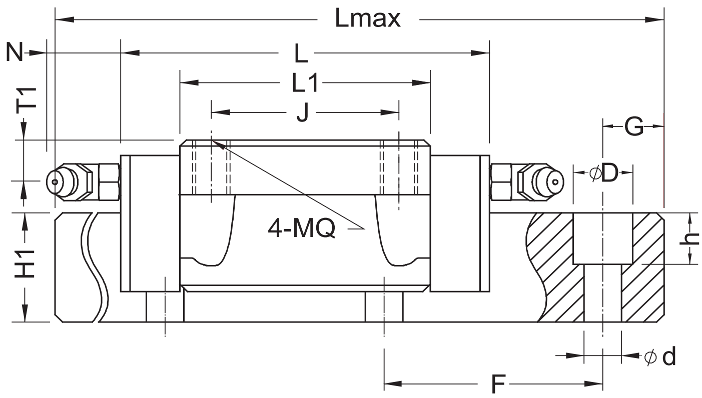




Model No.	Assembly (mm)				Block (mm)							Rail (mm)			
	H	W	W2	E	L	BxJ	MQxℓ	L1	Oil hole	T1	(N)	W1	H1	F	dxDxh
BRC15A0	24	47	16	4.6	66	38x30	M5x8	40	∅ 3	4.3	5	15	14	60	4.5x7.5x5.8
BRD15A0					56										
BRC20A0	30	63	21.5	5	77.8	53x40	M6x9	48.8	M6x1	7	15.6	20	18	60	6x9.5x9.0
BRD20A0					67.8										
BRC20LA					92.4			63.4							
BRD20LA					82.4										
BRC25A0	36	70	23.5	7	88	57x45	M8x12	57	M6x1	7.8	15.6	23	22	60	7x11x9.5
BRD25A0					78										
BRC25LA					110.1			79.1							
BRD25LA					100.1										
BRC30A0	42	90	31	9	109	72x52	M10x12	72	M6x1	7	15.6	28	26	80	9x14x12.5
BRD30A0					99										
BRC30LA					131.3			94.3							
BRD30LA					121.3										
BRD35A0	48	100	33	9.5	109	82x62	M10x13	80	M6x1	8	15.6	34	29	80	9x14x12.5
BRD35LA					134.8			105.8							
BRD45A0	60	120	37.5	14	138.2	100x80	M12x15	105	M8x1	8.5	16	45	38	105	14x20x17.5
BRD45LA					163			129.8							



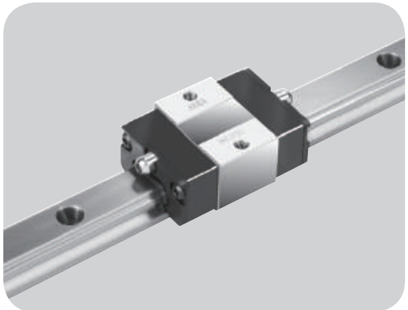


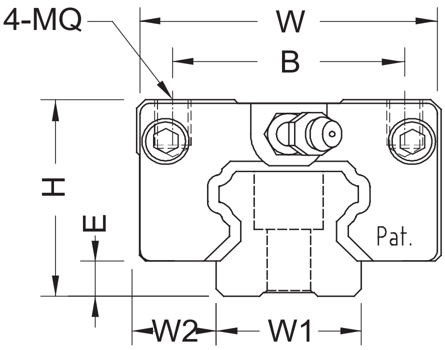


Model No.	Ref. data (mm)		Basic load rating (Kgf)		Static moment (Kgf*m)			Weight	
	Lmax	G	C	C_0	Mx	My	Mz	Block (Kg)	Rail (Kg/m)
BRC15A0	4000	20	850	1350	10.1	6.8	6.8	0.21	1.4
BRD15A0									
BRC20A0	4000	20	1400	2400	24	14.6	14.6	0.4	2.6
BRD20A0									
BRC20LA			1650	3000	30	23.8	23.8	0.52	
BRD20LA									
BRC25A0	4000	20	1950	3200	36.8	22.8	22.8	0.57	3.6
BRD25A0									
BRC25LA			2600	4600	52.9	45.5	45.5	0.72	
BRD25LA									
BRC30A0	4000	20	2850	4800	67.2	43.2	43.2	1.1	5.2
BRD30A0									
BRC30LA			3600	6400	89.6	75.4	75.4	1.4	
BRD30LA									
BRD35A0	4000	20	3850	6200	105.4	62	62	1.6	7.2
BRD35LA			4800	8300	141.1	109.8	109.8	2	
BRD45A0	4000	22.5	6500	10500	236.3	137.8	137.8	2.7	12.3
BRD45LA			7700	13000	292.5	210.9	210.9	3.6	

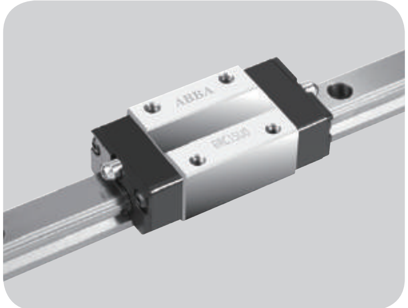
Note: BR35 and BR45 are not equipped with self-lubricant parts.

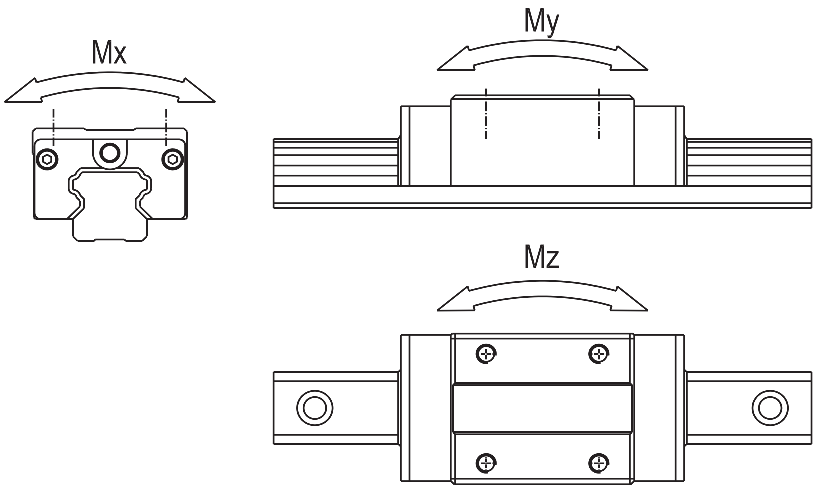
1.30.3 BRC-SU/U0, BRD-SU/U0

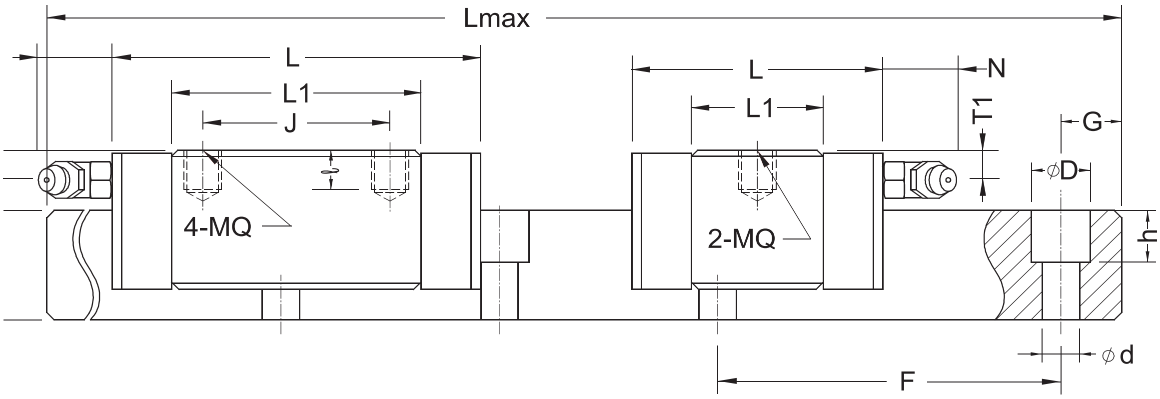




Model No.	Assembly (mm)				Block (mm)							Rail (mm)			
	H	W	W2	E	L	BxJ	MQxℓ	L1	Oil hole	T1	(N)	W1	H1	F	dxDxh
BRC15U0	24	34	9.5	4.6	66	26x26	M4x5.6	40	⌀3	4.3	5	15	14	60	4.5x7.5x5.8
BRD15U0					56										
BRC15SU					47.6	26x -		21.6							
BRD15SU					37.6										
BRC20U0	28	42	11	5	77.8	32x32	M5x6.4	48.8	M6x1	5	15.6	20	18	60	6x9.5x9.0
BRD20U0					67.8										
BRC20SU					57	32x -		28							
BRD20SU					47										
BRC25U0	33	48	12.5	7	88	35x35	M6x8	57	M6x1	4.8	15.6	23	22	60	7x11x9.5
BRD25U0					78										
BRC25SU					62.5	35x -		31.5							
BRD25SU					52.5										
BRC30U0	42	60	16	9	109	40x40	M8x11.5	72	M6x1	7	15.6	28	26	80	9x14x12.5
BRD30U0					99										
BRC30SU					75.6	40x -		38.6							
BRD30SU					65.6										
BRD35U0	48	70	18	9.5	109	50x50	M8x11.2	80	M6x1	8	15.6	34	29	80	9x14x12.5
BRD35SU					74.7	50x -		45.7							
BRD45U0	60	86	20.5	14	138.2	60x60	M10x13	105	M8x1	8.5	16	45	38	105	14x20x17.5





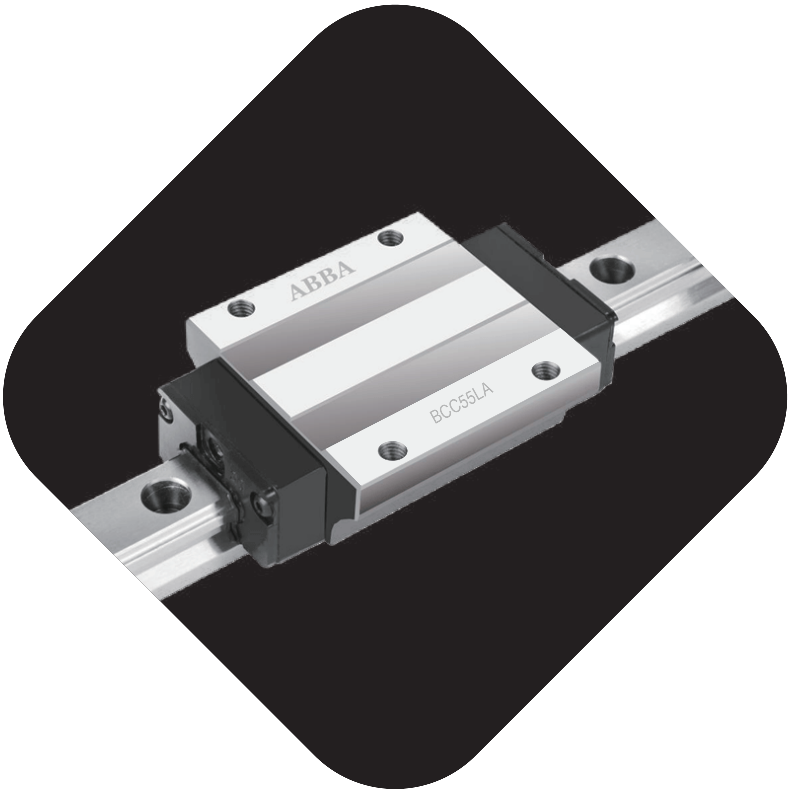


Model No.	Ref. data (mm)		Basic load rating (Kgf)		Static moment (Kgf*m)			Weight	
	Lmax	G	C	C_0	Mx	My	Mz	Block (Kg)	Rail (Kg/m)
BRC15U0 BRD15U0	4000	20	850	1350	10.1	6.8	6.8	0.17	1.4
BRC15SU BRD15SU			520	680	5.1	1.8	1.8	0.1	
BRC20U0 BRD20U0	4000	20	1400	2400	24	14.6	14.6	0.26	2.6
BRC20SU BRD20SU			950	1400	7	4.9	4.9	0.17	
BRC25U0 BRD25U0	4000	20	1950	3200	36.8	22.8	22.8	0.38	3.6
BRC25SU BRD25SU			1250	1750	17.5	6.9	6.9	0.21	
BRC30U0 BRD30U0	4000	20	2850	4800	67.2	43.2	43.2	0.81	5.2
BRC30SU BRD30SU			1750	2400	33.6	11.6	11.6	0.48	
BRD35U0	4000	20	3850	6200	105.4	62	62	1.2	7.2
BRD35SU			2500	3650	62.1	20.9	20.9	0.8	
BRD45U0	4000	22.5	6500	10500	236.3	137.8	137.8	2.1	12.3

Note: BR35 and BR45 are not equipped with self-lubricant parts.

Standard
Ball Caged
Miniature
Cam Roller
Round Shaft
Linear Guide
Ball Screw
Support Unit
Ball Screw
Self-lubricated Linear Bearing
Other components

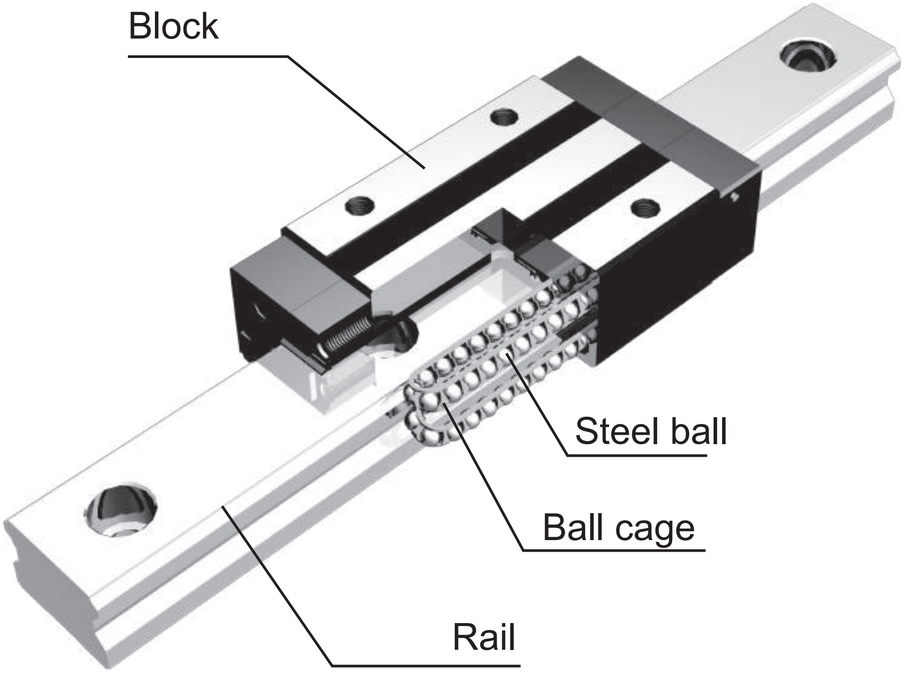
2
Ball Caged Linear Guide

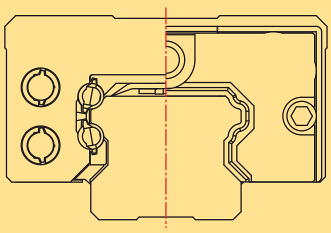


2.1 Characteristics

1. Interchangeable design
2. Equivalent loading, long service life
3. Good lubricity, long-term free of oil and maintenance
4. Equipped with ball cage, lower noise and smoother running

2.2 Construction



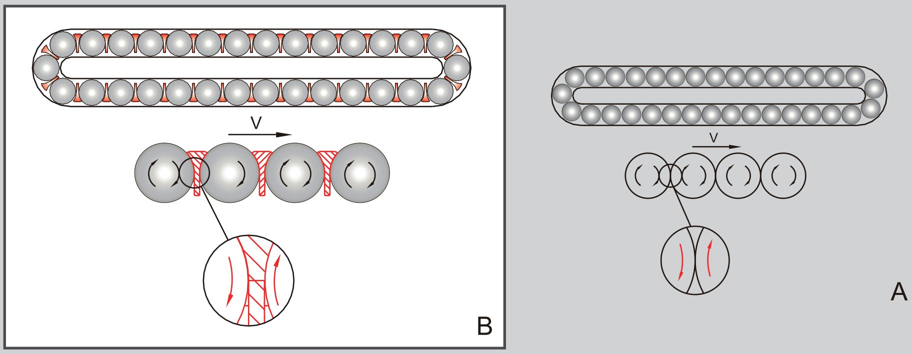


Structure

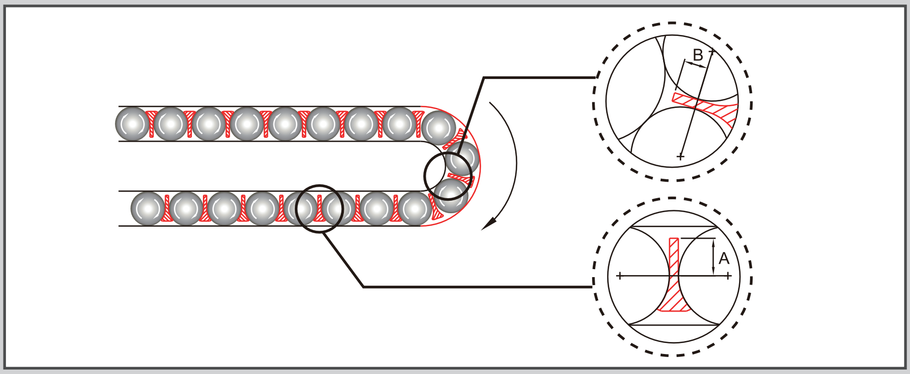
BC series is equipped with ***ABBA*** 's latest developed Ball cage, which lowers the noise, and enables high speed running, longer life time, and outstanding accuracy.

2.3 Feature

New (with ball cage)

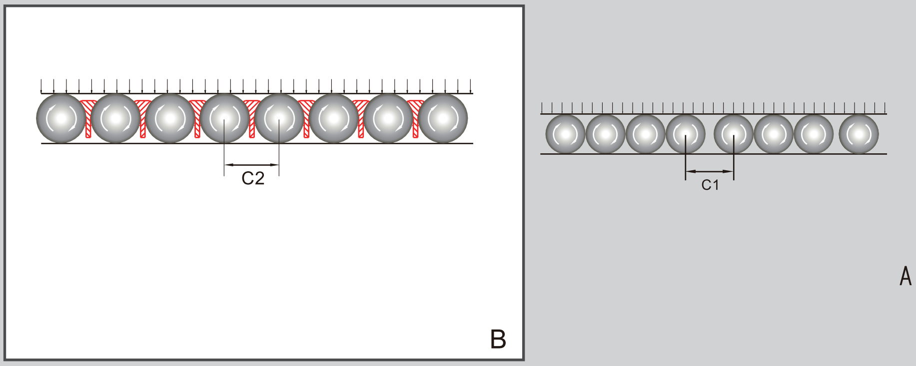


Feature 1
Steel ball chafes against each other in drawing A, so its friction is two times larger in drawing B, so that the life time in B is longer than in A.

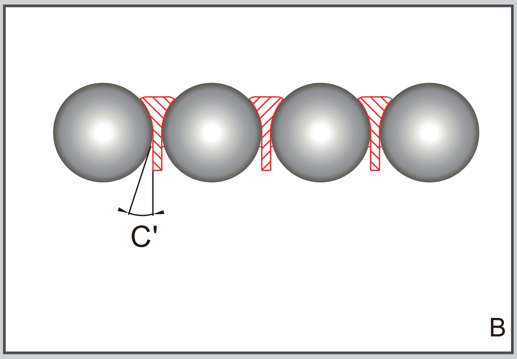


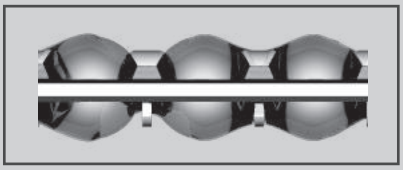
Feature 2
The difference between ABBA's ball cage and others' is that there will be no press and intervention from the inner part of the ball cage when it is turning so that friction is lowered and life time extends.

New (with ball cage)

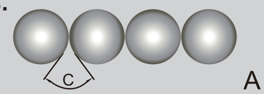


Feature 3
It shows in drawing B that due to the ball cage, steel balls are loaded equivalent-ly so that their service life could be longer.





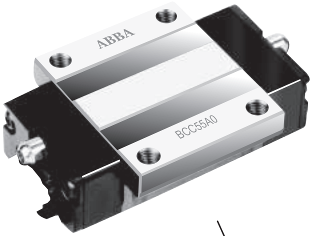
Oil membrance adheres easily between the ball cage and steel balls.



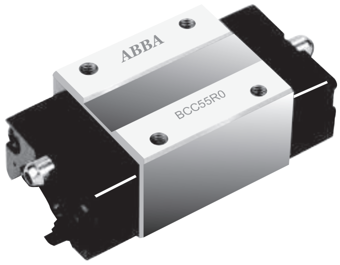
Feature 4
As demonstrated above, the included angle in drawing A(C) is larger than the one in drawing B(C') with ball cage. Therefore,oil membrance adheres easily in the structure of BC series.

2.4 Product overview

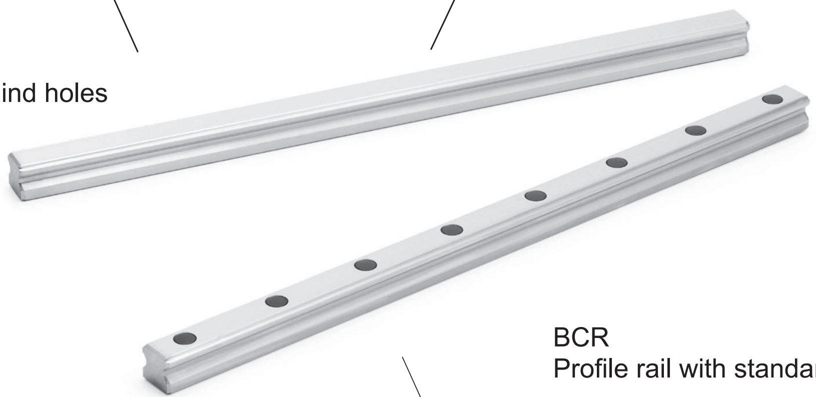
BCC-A0
Flanged block, standard length,
standard height



BCC-R0
Slim-line block, standard length,
extended height

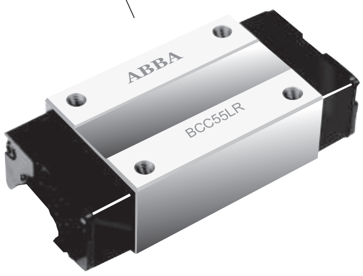


BCR
Profile rail with blind holes



BCR
Profile rail with standard holes

BCC-LA
Flanged block, extended length,
standard height



BCC-LR
Slim-line block, extended length,
extended height

2.5 Ordering key of System

B C S 5 5 - A 0 C 2 Z 1 - 1 0 8 0 0 N D 0 - A 0 S W 2

Size
55

Block type
- A0 Flanged block(Standard length, Standard height)
- LA Flanged block(Extended length, Standard height)
- R0 Slim-line block(Standard length, Extended height)
- LR Slim-line block(Extended length, Extended height)

End Cap Type
- C Standard End Cap

Number of blocks per rail
- 1~9 1~9 blocks per rail
- A~W >9 blocks per rail (10=A, 11=B, 12=C...)

Preload class 1)
- ZF Clearance, Preload=0
- Z0 No preload, Preload=0
- Z1 Light preload, Preload=0~0.02C

Rail length
00080~99999 mm(1 mm steps)

Accuracy class 1)
- N Normal
- H High
- P Precision

Rail hole
- D0 Standard hole(Standard hole distance, the distance of the first and last attachment holes is produced equidistantly.)
- F0 Standard hole(Standard hole distance, the distance of the first and last attachment holes is not produced equidistantly.)
- D4 Blind hole(Standard hole distance, the distance of the first and last attachment holes is produced equidistantly.)
- F4 Blind hole(Standard hole distance, the distance of the first and last attachment holes is not produced equidistantly.)
- DX Special machining, customized according to drawing number

Join rail track
- A Yes (Refer to drawing for detail)
- 0 No

Rail treatment 2)
- 0 Standard (anti-rust oil)

Sealing
- S Standard front seal (only end seal)
- 1 Standard front seal + Scraper plate

No. of parallel rails
- 00 Single rail
- W2~W9 Parallel rails (W2 : 2 rails, W3 : 3 rails)

1) Refer to following table for limitation

System			
Accuracy	P	H	N
Preload	–	–	ZF
	Z0	Z0	Z0
	Z1	Z1	Z1
	Z2	Z2	Z2
	Z3	Z3	Z3

2) Block surface treatment
A. Standard: Anti-rust oil
B. Non-Standard:See drawing

3) Nipple/set screw quantity per block
A. Size 20/25/30/35/45/55 : 45˚nipple(1pc)+ screw(1 pc)

2.6 Ordering key of Rail

B C R 5 5 - 1 0 8 0 0 N D 0 - A 0

Size

55

Rail length

00080~99999 mm(1 mm steps)

Accuracy class

N	Normal

Rail hole

D0	Standard hole(Standard hole distance, the distance of the first and last attachment holes is produced equidistantly.)
F0	Standard hole(Standard hole distance, the distance of the first and last attachment holes is not produced equidistantly.)
D4	Blind hole(Standard hole distance, the distance of the first and last attachment holes is produced equidistantly.)
F4	Blind hole(Standard hole distance, the distance of the first and last attachment holes is not produced equidistantly.)
DX	Special machining, customized according to drawing number

Rail hole

A	Yes (Refer to drawing for detail)
0	No

Rail treatment

0	Standard (anti-rust oil)

2.7 Ordering key of Block

B C C 5 5 - A 0 Z 1 - N 0 S

Size

55

Block type

A0	Flanged block(Standard length, Standard height)
LA	Flanged block(Extended length, Standard height)
R0	Slim-line block(Standard length, Extended height)
LR	Slim-line block(Extended length, Extended height)

Preload class

ZF	Clearance, Preload=0
Z0	No preload, Preload=0
Z1	Light preload, Preload=0~0.02CC

Accuracy class

N	Normal

Block treatment

0	Standard (anti-rust oil)

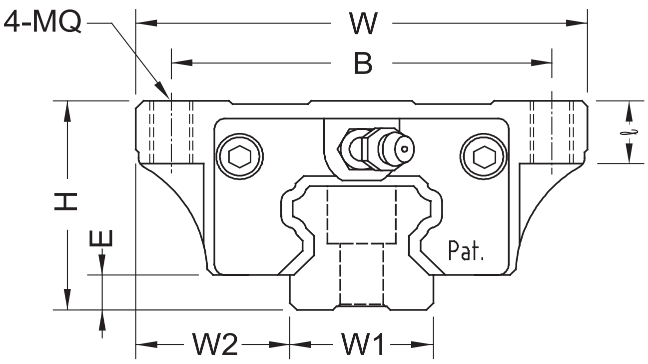
Sealing

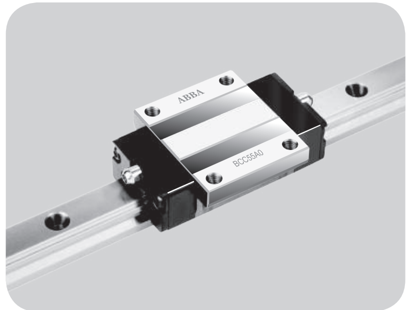
S	Standard front seal (only end seal)
1	Standard front seal + Scraper plate

1) Nipple/set screw quantity per block
A. Size 20/25/30/35/45/55 : 45˚nipple(1pc)+ screw(1 pc)

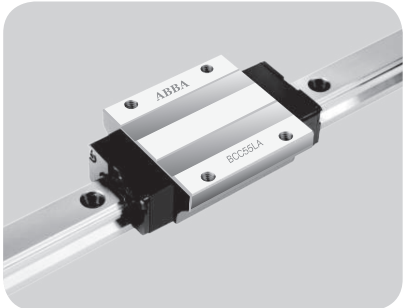
2.8 Dimension of Linear Guide

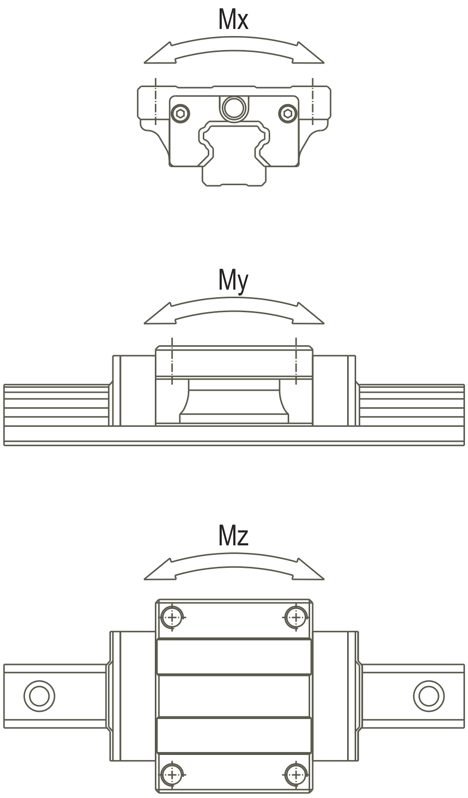
2.8.1 BCC-A0/LA

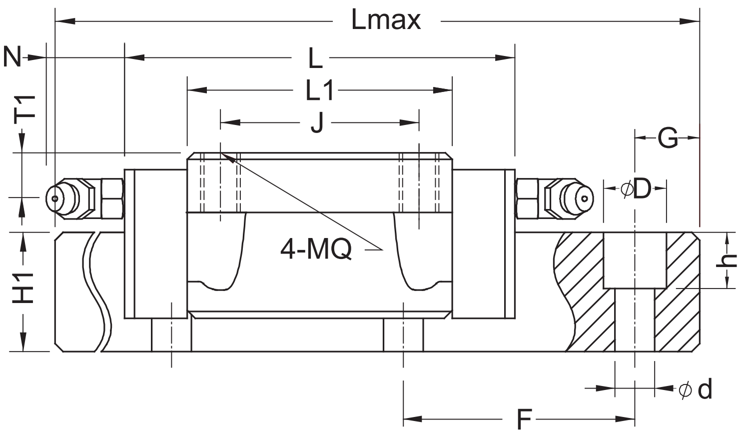




Model No.	Assembly (mm)				Block (mm)							Rail (mm)			
	H	W	W2	E	L	BXJ	MQxℓ	L1	Oil hole	T1	(N)	W1	H1	F	dxDxh
BCC55A0	70	140	43.5	12.7	181	116x95	M14x21	131	M8x1	20	16	53	38	120	16x23x20.1
BCC55LA					223			173							



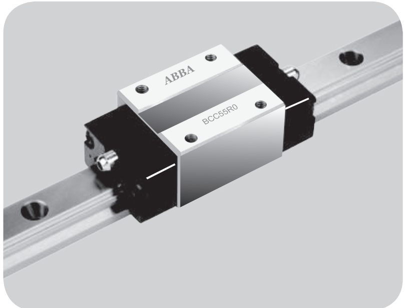


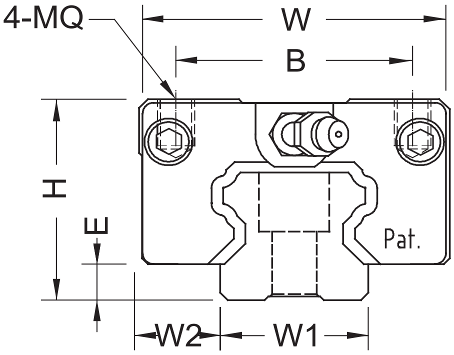


Model No.	Ref. data (mm)		Basic load rating (Kgf)		Static moment (Kgf*m)			Weight	
	Lmax	**G**	**C**	**C_0**	**Mx**	**My**	**Mz**	**Block (Kg)**	**Rail (Kg/m)**
BCC55A0	4000	30	7600	12800	446	355	355	5.4	14.5
BCC55LA			9300	17100	580	600	600	7.1	

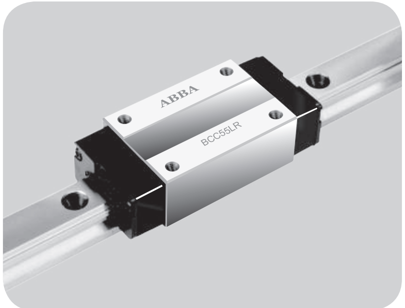
Linear Guide
Standard
Ball Caged
Miniature
Cam Roller
Round Shaft
Ball Screw
Ball Screw
Support Unit
Other components
Self-lubricated Linear Bearing

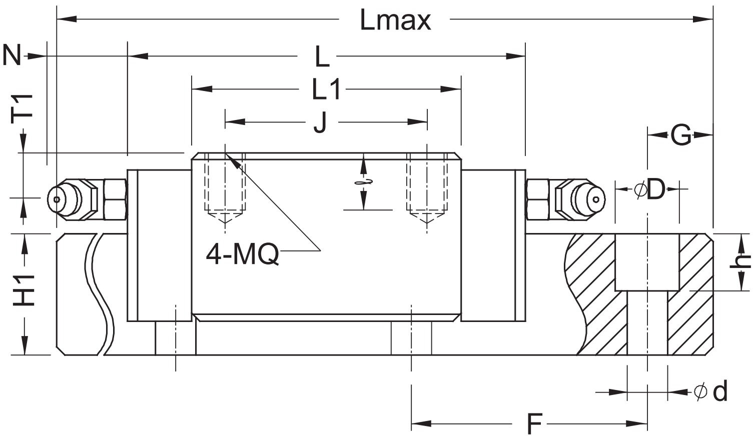
2.8.2 BCC-R0/LR

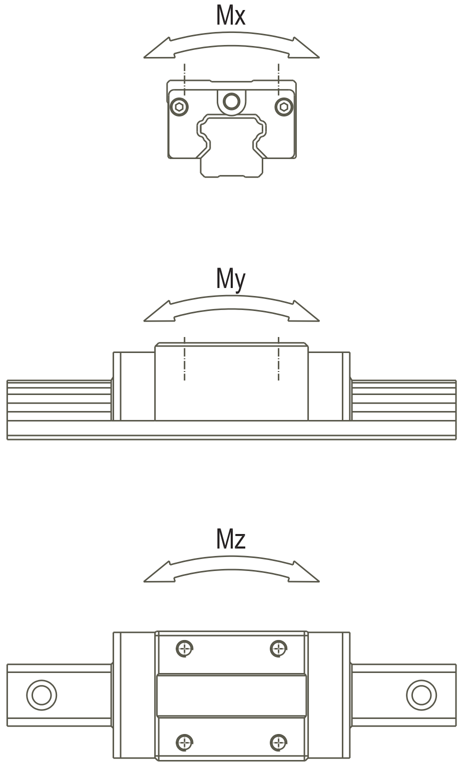




Model No.	Assembly (mm)				Block (mm)							Rail (mm)			
	H	W	W2	E	L	BxJ	MQxℓ	L1	Oil hole	T1	(N)	W1	H1	F	dxDxh
BCC55R0	80	100	23.5	12.7	181	75x75	M12x19	131	M8x1	30	16	53	38	120	16x23x20.1
BCC55LR					223	75x95		173							



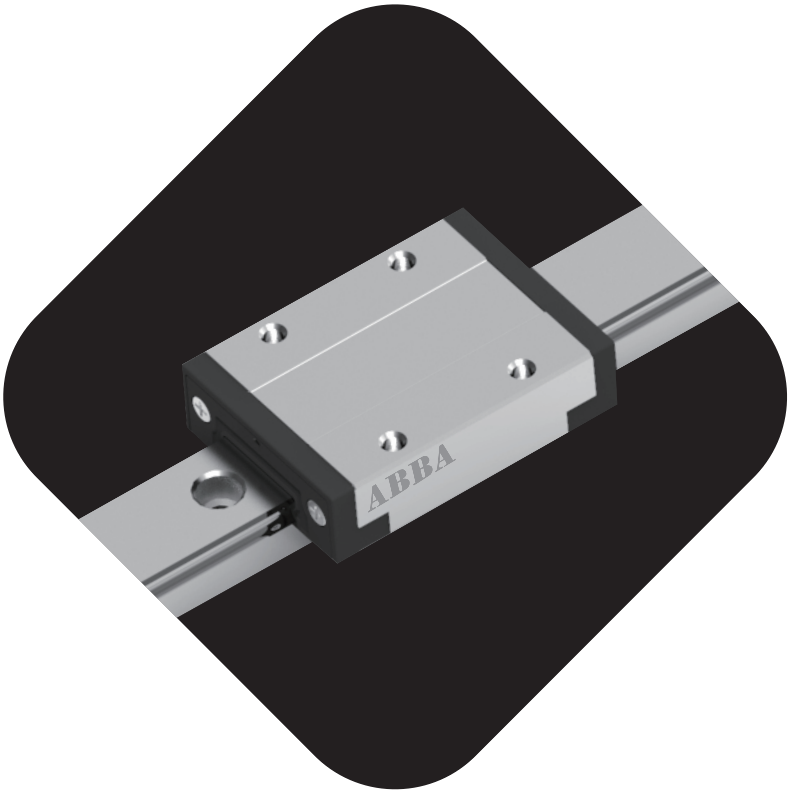




Model No.	Ref. data (mm)		Basic load rating (Kgf)		Static moment (Kgf*m)			Weight	
	Lmax	G	C	C_0	Mx	My	Mz	Block (Kg)	Rail (Kg/m)
BCC55R0	4000	30	7600	12800	446	355	355	5.2	14.5
BCC55LR			9300	17100	580	600	600	6.7	

3

Miniature Linear Guide



3.1 Characteristics

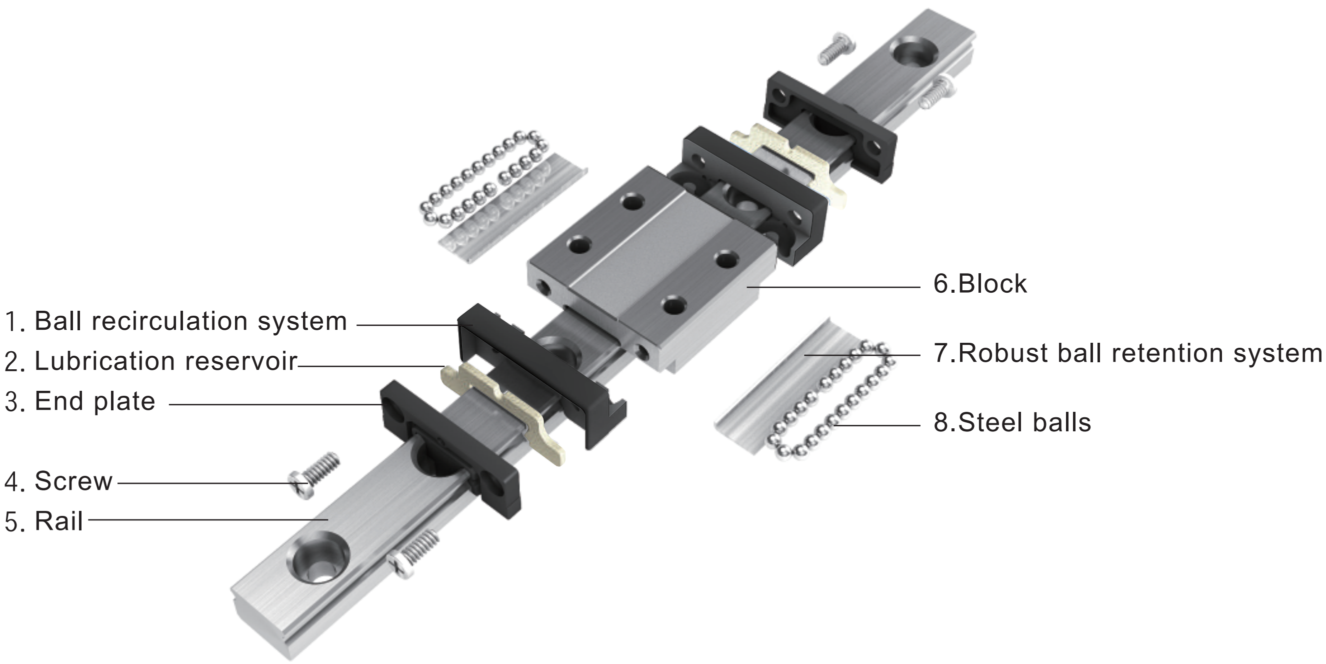
1. New anti-drop design of Robust Ball Retention System
2. Safe and quick mounting
3. Optimized ball recirculation
4. Smooth running for position accuracy
5. All BM blocks are factory pre-lubricated and equipped with a lubrication reservoir which secures the lubrication condition in the complete guiding system.
6. Optimized seal design
7. Reduced friction
8. Stainless steel components
9. Interchangeable according to ISO 12090-2

3.2 Product specification

The allowable use conditions of BM products are as follows :

Item	Allowable use condition
Speed	5 m/s
Acceleration	140 m/s^2
Ambient temperature	-20~ +80°C (With standard front seal) -20~ +100°C (With low friction shield)
Maximum dynamic load	<0.5 C
Maximum static load	<0.5 C_0
Minimum load	>0.001 C

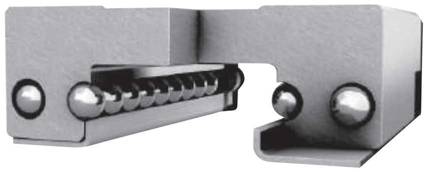
3.3 Construction



3.4 Advantage

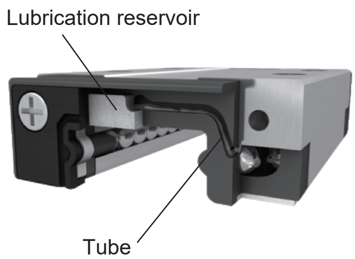
1 New anti-drop design of Robust Ball Retention System

- Safe and quick mounting
- Good accuracy due to anti-drop design
- Smooth running due to new Robust Ball Retention System



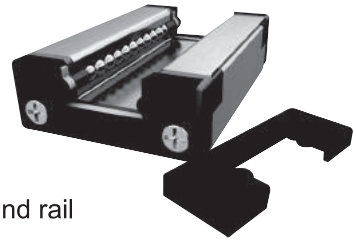
2 Lubrication reservoir

- Service life up to 20,000km
- Factory pre-lubricated with FDA-grade lubricants, lowering maintenance cost



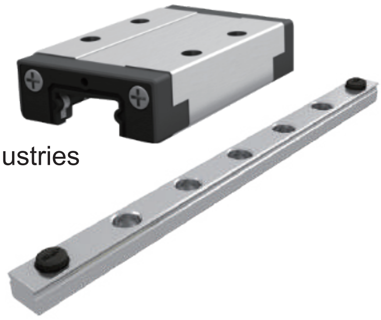
3 Optimized seal design

- Extend seal life due to good abrasion-resistant material
- Excellent dust protection due to minimal clearance between rail and Robust Ball Retention System
- Dustproof function and low friction due to optimized contact of seal and rail



4 Stainless steel components

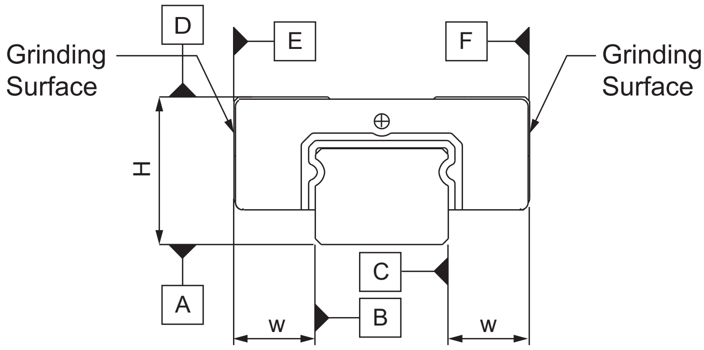
- Multi-purpose material for corrosion protection
- Suitable for sanitary environment such as the Medical and Food industries



5 Optimized ball recirculation design

- Low noise, suitable for Medical and Office environments
- Smooth runnung, suitable for long-term operation

3.5 Accuracy Standard



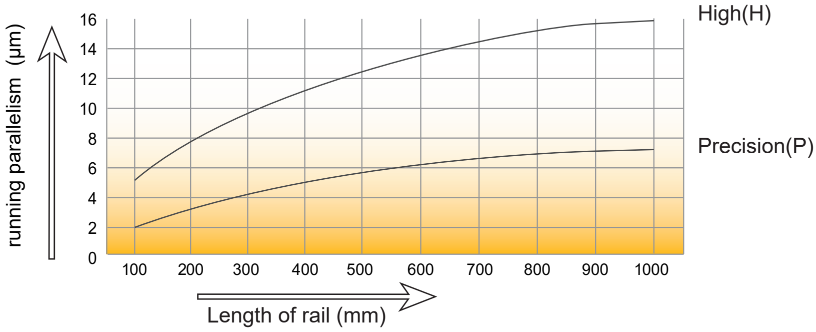


Fig.3.5.1 BM running parallelism

Unit: mm

Item	Grade	
	Precision (P)	High(H)
Tolerance of height (H)*	±0.010	±0.020
Tolerance of width (W)*	±0.015	±0.025
Difference of heights (△H)**	0.007	0.015
Difference of widths (△W)**	0.007	0.015
Running parallelism of Block side D relative to Rail side A	△C Refer to Fig.1	
Running parallelism of Block side E F relative to Rail side B C	△E & △F Refer to Fig.1	

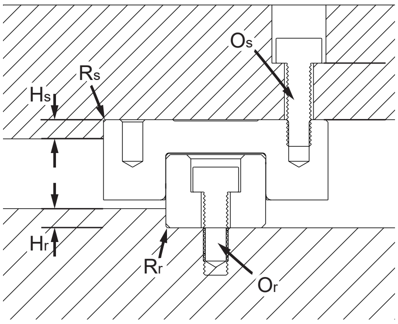
* The tolerances apply over the entire guide length for any combination of block and rail.
**The tolerance △H and △W relate to the ideal centre of the block. Each dimension is derived from the mean value of two measured points with identical centre distance.

3.6 Preload

Item / Class	Code	Preload	Description
No preload	Z0	0	The best running smoothness and minimum friction
Light preload	Z1	0~0.02C	Preloaded and has good running smoothness
Medium preload	Z2	0.02~0.08C	Higher preload and rigidity, but normal running smoothness

3.7 Suggestion in Assembly

3.7.1 Assembly design



Unit : mm

Item	Maximum Fillet of rail (R_r)	Maximum shoulder height (H_r) of rail		Maximum Fillet of block (R_s)	Maximum shoulder height (H_s) of block	Recommended size of rail lock bolt(O_r)	Recommended size of block lock bolt (O_s)
		Min.	Max.				
BMH 7	0.3	1.1	1.3	0.2	2.2	M2x5	M2
BMH 9	0.3	1.3	1.6	0.2	2.5	M3x8	M3
BMH 12	0.4	2	2.6	0.2	3.5	M3x10	M3
BMH 15	0.4	3	3.6	0.4	4.5	M3x10	M3
BMW 7	0.3	1.1	1.3	0.2	2.2	M3x5	M3
BMW 9	0.3	1.3	1.6	0.2	2.5	M3x8	M3
BMW 12	0.4	2	2.6	0.2	3.5	M3x10	M3
BMW 15	0.4	3	3.6	0.4	4.5	M4x12	M4

3.7.2 Recommended torque for mounting bolts of rail

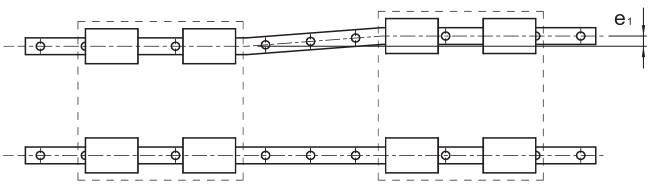
When installing the rail, the locking force of the mounting bolts will affect the overall assembly accuracy. Therefore, the uniformity of the locking force is very important. It is recommended to tighten the mounting bolts with a torque wrench according to the torque values in the table on the right.

Unit : kgf*cm

Nominal bolt model	Bolt torque
M2	3.3
M3	11.2
M4	26.5

3.7.3 Tolerance of mounting surface

Deviation in parallelism (e_1)



Unit : μm

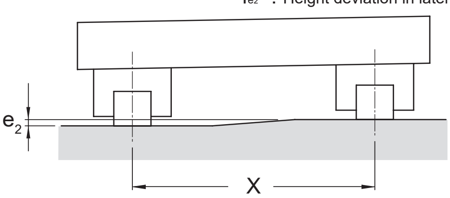
Nominal size	Parallelism error tolerance for 2 axes(e_1)		
	Z2	Z1	Z0
BMH 7	1	2	5
BMH 9	2	3	6
BMH 12	2	4	7
BMH 15	4	7	10
BMW 7	1	2	5
BMW 9	2	3	6
BMW 12	2	4	7
BMW 15	4	7	10

Height deviation in lateral direction(e_2)

Height deviation in lateral direction (e_2) can be calculated as follows:

$$e_2 = \frac{X \times f_{e2}}{500}$$

e_2 : Height deviation in lateral direction (μm)
X : Center distance between two rails (mm)
f_{e2} : Height deviation in lateral direction coefficient



Unit : μm

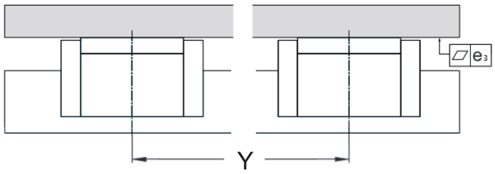
Nominal size	Height deviation in lateral direction coefficient (f_{e2})		
	Z2	Z1	Z0
BMH 7	36	60	120
BMH 9	39	65	130
BMH 12	42	70	140
BMH 15	50	75	150
BMW 7	36	60	120
BMW 9	39	65	130
BMW 12	42	70	140
BMW 15	50	75	150

Flatness in top mounting plane(e_3)

Flatness in top mounting plane (e_3) can be calculated as follows:

$$e_3 = \frac{Y \times f_{e_3}}{500}$$

e_3 : Flatness in top mounting plane (μm)
Y : Center distance between two blocks (mm)
f_{e_3} : Flatness in top mounting plane deviation coefficient



Unit : μm

Nominal size	Flatness in top mounting plane deviation coefficient (f_{e_3})
BMH 7	25
BMH 9	27
BMH 12	29
BMH 15	35
BMW 7	25
BMW 9	27
BMW 12	29
BMW 15	35

3.8 Running resistance

The maximum running resistance value of the series is based on the validation result with no load and lubricant viscosity grade 460 under room temperature.. The detailed data is shown in the table on the below:

Standard

Nominal size	Block type	Maximum running resistance (g)					
		Standard front seal			Low friction shield		
		Z2	Z1	Z0	Z2	Z1	Z0
BMH 7	U0	300	170	100	270	140	70
	LU	300	170	100	270	140	70
BMH 9	U0	300	170	100	270	140	70
	LU	300	170	100	270	140	70
BMH 12	U0	310	180	110	280	150	80
	LU	310	180	110	280	150	80
BMH 15	U0	310	180	120	280	150	90
	LU	310	180	120	280	150	90

Wide

Nominal size	Block type	Maximum running resistance (g)					
		Standard front seal			Low friction shield		
		Z2	Z1	Z0	Z2	Z1	Z0
BMW 7	U0	350	200	100	320	170	70
	LU	350	200	100	320	170	70
BMW 9	U0	350	200	100	320	170	70
	LU	350	200	100	320	170	70
BMW 12	U0	460	250	110	430	220	80
	LU	460	250	110	430	220	80
BMW 15	U0	460	330	120	430	300	90
	LU	460	330	120	430	300	90

3.9 Lubrication

3.9.1 Factory pre-lubrication

The medical lubricant Klüber PARALIQ P460 is added to the inside of the BM block and the self-lubrication system. This lubricant complies with FDA's safety guidelines sec. 21 CFR 178.3570 regulations, and has passed NSF H1 level certification.

3.9.2 Grease re-lubrication

1. Lubricating oil can be injected into the block through the lubrication holes on both sides of the block by using a syringe, and the block must slide back and forth on the rail several times during lubrication to ensure sufficient lubrication inside the block.

Lubrication hole

2. Lubricition amount :

Standard Unit: mm³

Nominal size	Amount
BMH 7	50
BMH 9	70
BMH 12	90
BMH 15	150

Wide Unit: mm³

Nominal size	Amount
BMW 7	60
BMW 9	90
BMW 12	140
BMW 15	200

3. Re-lubrication intervals recommendation
The relubrication interval will vary greatly due to application conditions (such as load, speed, ambient temperature, pollution... etc.). Generally, it is recommended to be at least every 1000km or every year (whichever comes first) must be relubricated.

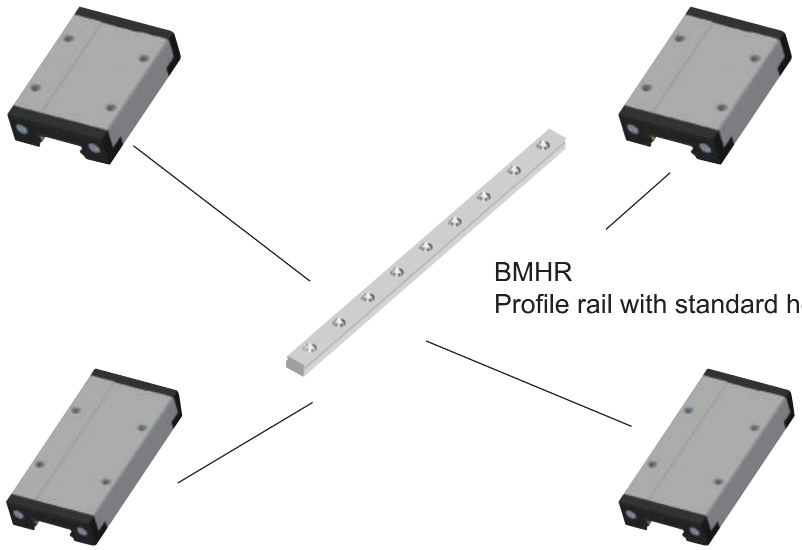
4. Recommended lubricating oil : Klüber PARALIQ P 460

3.10 Product overview

3.10.1 BMHC/BMHR Standard type

BMHC-U0-0
Standard type, Standard length, Low friction shield

BMHC-U0-S
Standard type, Standard length, Front seal



BMHR
Profile rail with standard holes

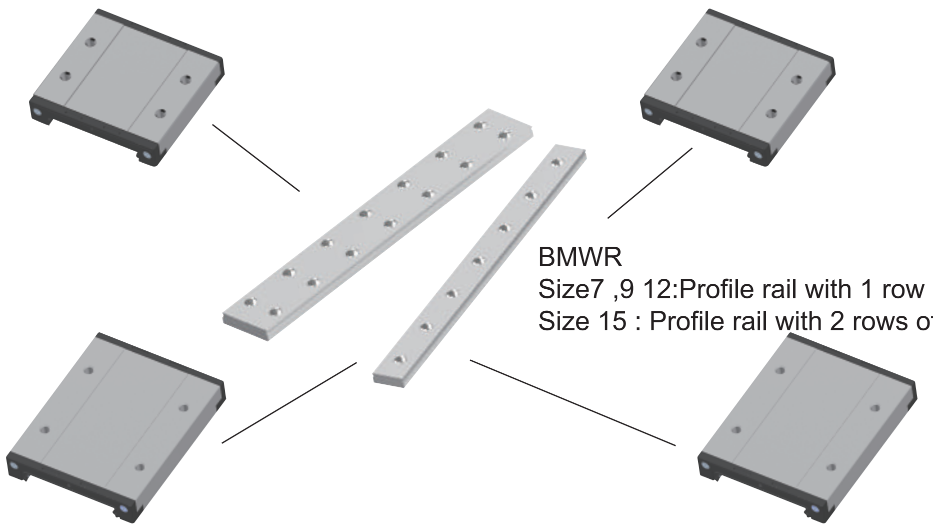
BMHC-LU-0
Standard type, Extended length, Low friction shield

BMHC-LU-S
Standard type, Extended length, Front seal

3.10.2 BMWC/BMWR Wide type

BMWC-U0-0
Wide type, Standard length, Low friction shield

BMWC-U0-S
Wide type, Standard length, Front seal



BMWR
Size7 ,9 12:Profile rail with 1 row of standard holes
Size 15 : Profile rail with 2 rows of standard holes

BMWC-LU-0
Wide type, Extended length, Low friction shield

BMWC-LU-S
Wide type, Extended length, Front seal

3.11 Ordering key of System

BMH S 7 - U 0 2 Z 1 - 0 1 0 0 H D 0 - S W 2

Rail Type

H	Standard rail
W	Wide rail

Size

7, 9, 12, 15

Block type

U0	Slim-line block(Standard length, standard height)
LU	Slim-line block(Extended length, standard height)

Number of blocks per rail

1~9	1~9 blocks per rail
A~W	>9 blocks per rail (10=A, 11=B, 12=C...)

Preload class

Z0	No preload
Z1	Light preload

Rail length

XXXX	Size 7 : Up to 1,000 mm length (1 mm steps)
	Size 9, 12, 15 : Up to 2,000 mm length (1 mm steps)

Accuracy class

H	High
P	Precision[1)]

Rail hole

D0	Standard hole (Standard hole distance. Distance of the first and last attachment holes are produced equidistantly)
F0	Standard hole (Standard hole distance. Distance of the first and last attachment holes are not produced equidistantly)

Sealing

S	Front seal
0	Low friction shield

No. of Parallel Rails

00	Single rail
W2~W9	Parallel rails (W2 : 2 rails, W3 : 3 rails)[1)]

1) Available as system

3.12 Ordering key of Rail

BMH R 7 - 0 1 0 0 H D 0

Rail Type

H Standard rail
W Wide rail

Size

7, 9, 12, 15

Rail length

XXXX Size 7 : Up to 1,000 mm length (1 mm steps)
Size 9, 12, 15 : Up to 2,000 mm length (1 mm steps)

Accuracy class

H High

Rail hole

D0 Standard hole (Standard hole distance. Distance of the first and last attachment holes are produced equidistantly)
F0 Standard hole (Standard hole distance. Distance of the first and last attachment holes are not produced equidistantly)

3.13 Ordering key of Block

BMH C 7 - U 0 Z 1 - H S

Rail Type

H Standard rail
W Wide rail

Size

7, 9, 12, 15

Block type

U0 Slim-line block(Standard length, standard height)
LU Slim-line block(Extended length, standard height)

Preload class

Z0 No preload
Z1 Light preload

Accuracy class

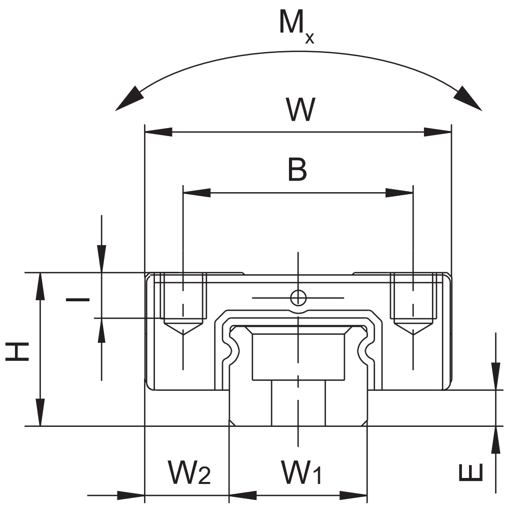
H High

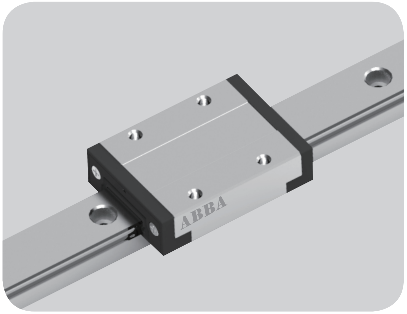
Sealing

S Front seal
0 Low friction shield

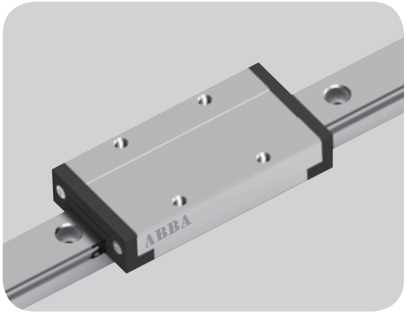
3.14 Dimension of Linear Guide

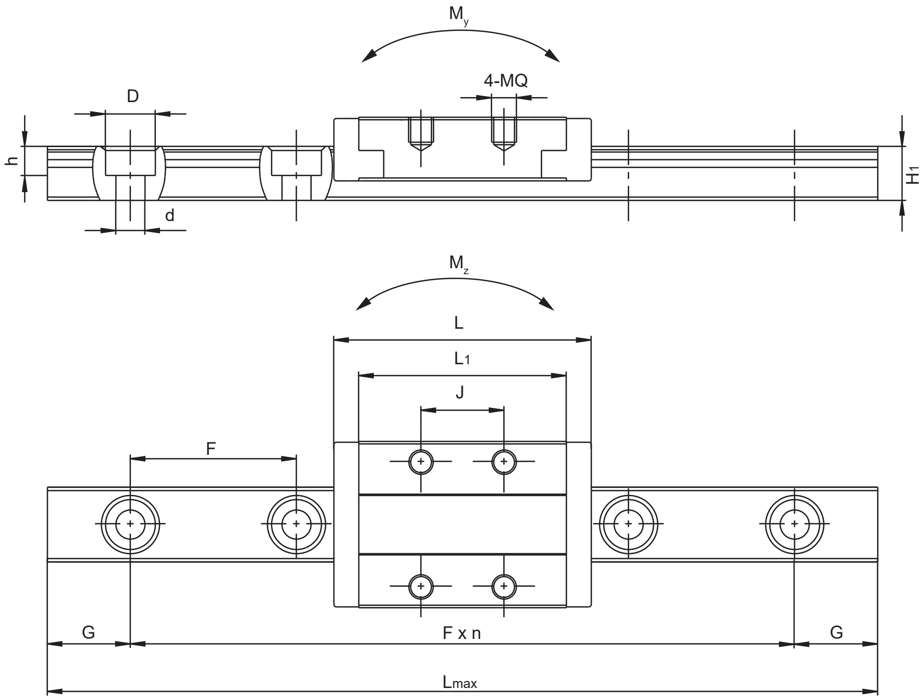
3.14.1 BMHC-U0/LU Standard type





Model No.	Assembly (mm)				Block (mm)				Rail (mm)			
	H	W	W2	E	L	BxJ	MQxl	L1	W1	H1	F	dxDxh
BMHC7U0 **BMHC7LU**	8	17	5	1.5	23.5 31.5	12x8 12x13	M2x2.5	18 26	7	4.8	15	2.5x4.5x2.5
BMHC9U0 **BMHC9LU**	10	20	5.5	2.35	31 40.5	15x10 15x16	M3x3	25 34.4	9	6.5	20	3.5x6x3.5
BMHC12U0 **BMHC12LU**	13	27	7.5	3.35	35 46.5	20x15 20x20	M3x3.5	29 40.5	12	8.8	25	3.5x6x4.5
BMHC15U0 **BMHC15LU**	16	32	8.5	4	44 62	25x20 25x25	M3x4	37 55	15	9.5	40	3.5x6x4.5

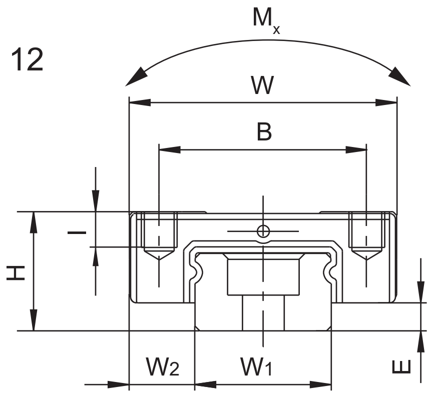


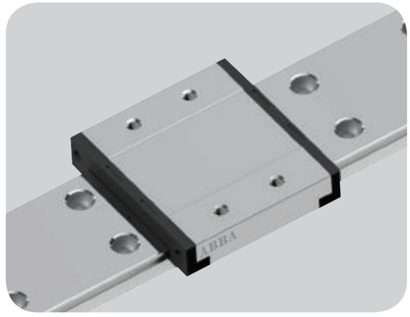


Model No.	Ref. data (mm)			Basic load rating (Kgf)		Static moment (Kgf*m)			Weight	
	Lmax	Gmin	Gmax	(C)	(C0)	Mx	My	Mz	Block (Kg)	Rail (Kg/m)
BMHC7U0	1000	4.5	11	117	149	0.47	0.27	0.27	0.01	0.23
BMHC7LU				163	245	0.81	0.89	0.89	0.02	
BMHC9U0	2000	5	15	218	285	1.17	0.76	0.76	0.02	0.4
BMHC9LU				293	438	1.89	2.04	2.04	0.03	
BMHC12U0	2000	5	20	321	397	2.19	1.19	1.19	0.04	0.75
BMHC12LU				456	642	3.66	3.40	3.40	0.06	
BMHC15U0	2000	5	35	500	596	3.97	2.44	2.44	0.09	1.05
BMHC15LU				706	998	6.53	6.45	6.45	0.13	1.05

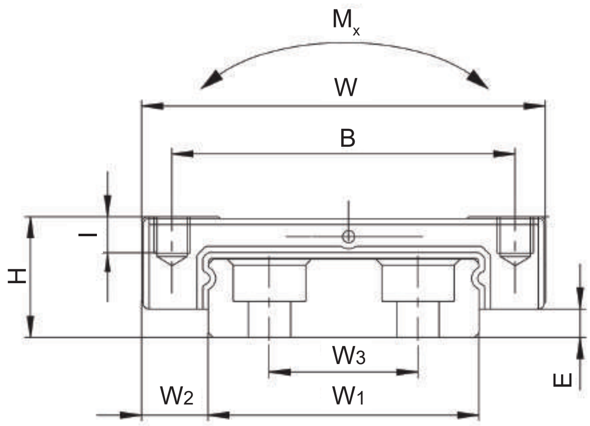
3.14.2 BMWC-U0/LU Wide type

For BMWC 7 / 9 / 12

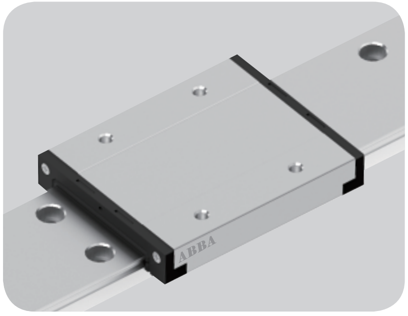


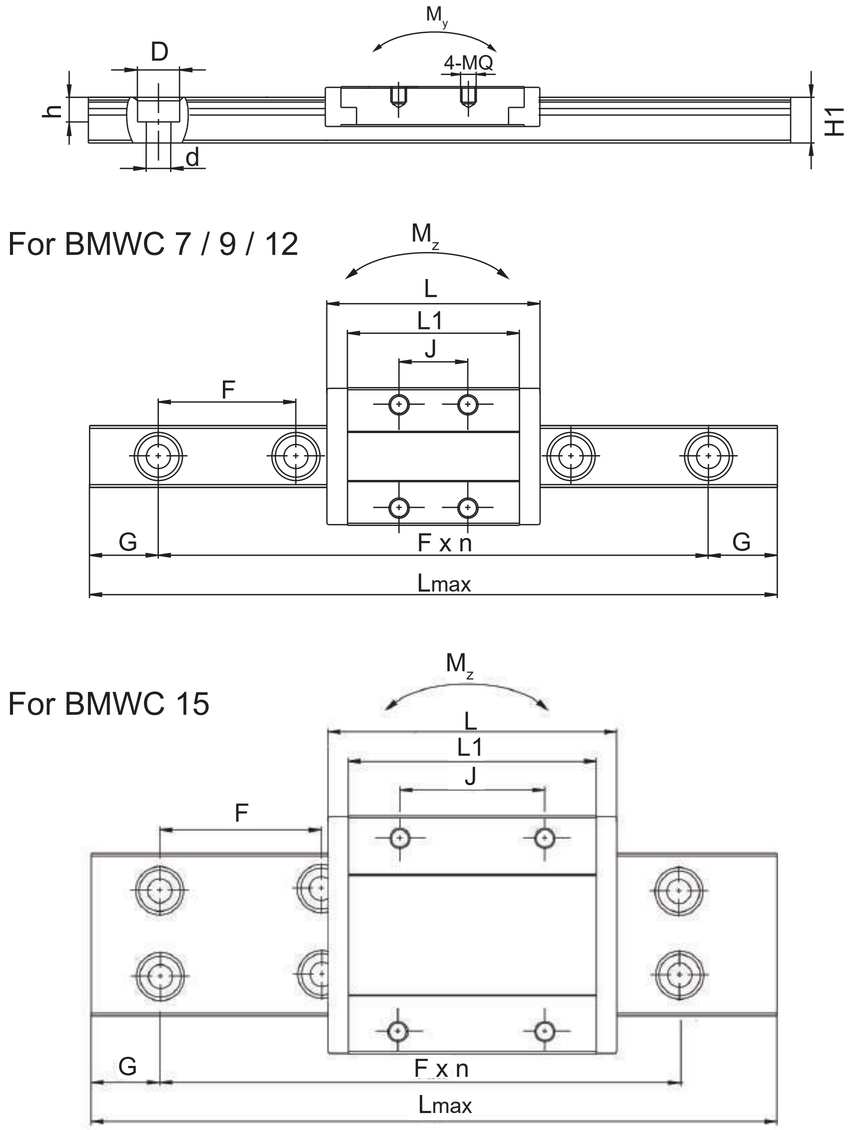


For BMWC 15



Model No.	Assembly (mm)					Block (mm)				Rail (mm)			
	H	W	W_2	W_3	E	L	BxJ	MQxl	L_1	W_1	H_1	F	dxDxh
BMWC7U0 **BMWC7LU**	9	25	5.5	-	2	31 41.5	19x10 19x19	M3x3	25.5 36	14	5.2	30	3.5x6x3.5
BMWC9U0 **BMWC9LU**	12	30	6	-	2.5	39 50.5	21x12 23x24	M3x3	33 44.5	18	7	30	4.5x8x4.5
BMWC12U0 **BMWC12LU**	14	40	8	-	3	43.5 58	28x15 28x28	M3x3.5	37.5 52	24	8.5	40	4.5x8x4.5
BMWC15U0 **BMWC15LU**	16	60	9	23	4	55.5 74.5	45x20 45x35	M4x4.5	48.5 67.5	42	9.5	40	4.5x8x4.5

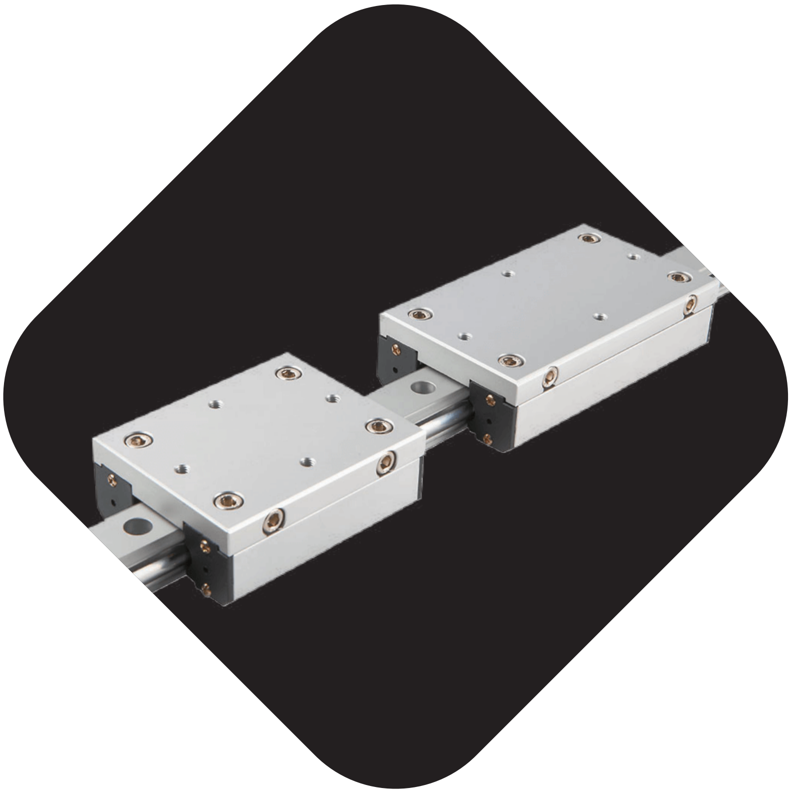




Model No.	Ref. data (mm)			Basic load rating (Kgf)		Static moment (Kgf*m)			Weight	
	Lmax	Gmin	Gmax	(C)	(C0)	Mx	My	Mz	Block (Kg)	Rail (Kg/m)
BMWC7U0	2000	5	25	157	224	1.50	0.65	0.65	0.02	0.54
BMWC7LU				213	352	2.34	1.61	1.61	0.03	
BMWC9U0	2000	5	25	277	413	3.69	1.76	1.76	0.05	0.94
BMWC9LU				366	596	5.27	3.68	3.68	0.07	
BMWC12U0	2000	6	34	398	540	7.04	2.91	2.91	0.09	1.53
BMWC12LU				546	846	9.87	5.90	5.90	0.12	
BMWC15U0	2000	6	34	642	866	18.23	5.54	5.54	0.19	2.97
BMWC15LU				841	1274	24.65	10.76	10.76	0.26	

4

Cam Roller Linear Guide



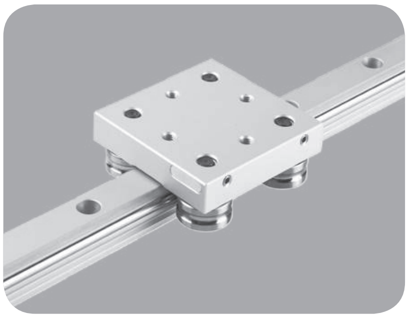
4.1 CRC Standard type

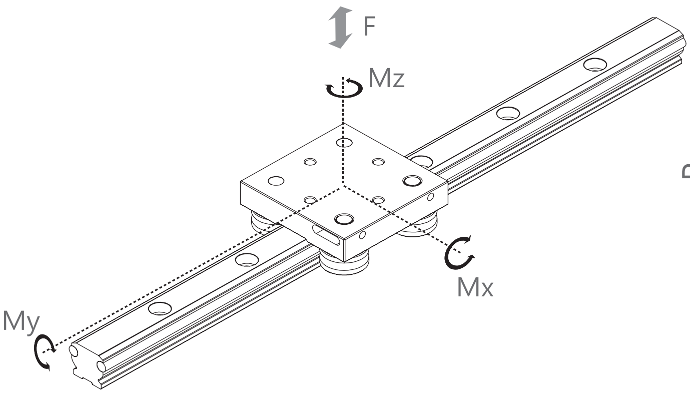
Ordering Key : CRC25 X 0870 - B2 (20,10)

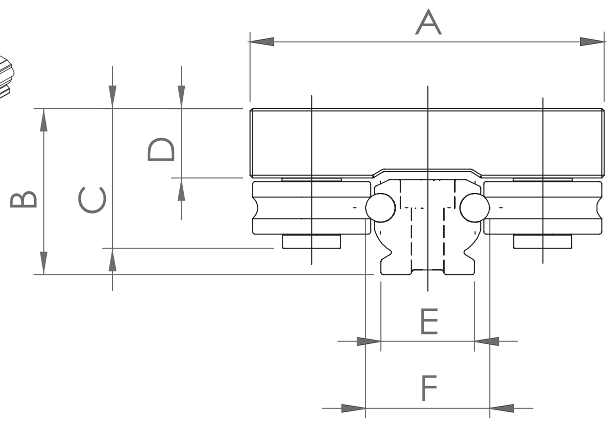
1 2 3 4

1. Block type : CRC
2. Rail length : 870 mm
3. Number of blocks : 2
4. End distance of screw hole : 20, 10

   (Evenly spaced on both end if not specific)



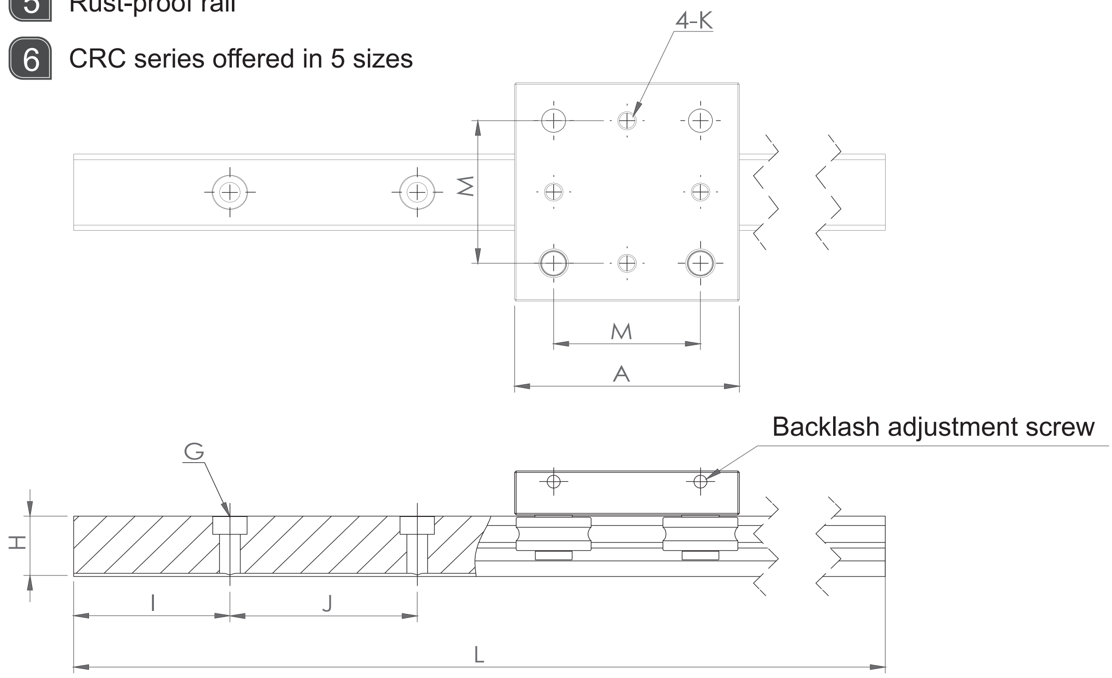




Model No.	Dimensions (mm)						Basic Load Rating (kgf)		Static Moment Load (kgf-m)		
	A	B	C	D	E	F	C	C_0	Mx	My	Mz
CRC 20	54	23	20.5	10.8	17	21	72	70	3.6	2.4	3.4
CRC 25	72	34	29.5	14.5	19	25	215	185	17.6	10.8	15.5
CRC 32	80	35	29.5	14.5	25	32	215	185	23	14	19.8
CRC32L	100	46	42	19.2	22	32	410	410	32	20	31.5
CRC 42	110	46	42	19.2	28	42	410	410	45.8	29	45

Features

1. Block roller clearance pre-adjusted at factory
2. Adjustable roller clearance on block
3. Low noise
4. Lubrication not required
5. Rust-proof rail
6. CRC series offered in 5 sizes



Unit : mm

Model No.	Dimensions						
	G	H	I	J	K	L	M
CRC 20	ø4.5xø8x4.5dp	13.5	1/2J	60	M5	100-4000	36
CRC 25	ø5.7xø10x6.5dp	20	1/2J	60	M6	100-4000	47
CRC 32	ø6.6xø11.5x8dp	20	1/2J	60	M6	100-4000	54
CRC32L	ø6.6xø10.5x8dp	24.8	1/2J	60	M8	100-4000	63
CRC 42	ø9xø14x12dp	24.8	1/2J	80	M8	100-4000	73

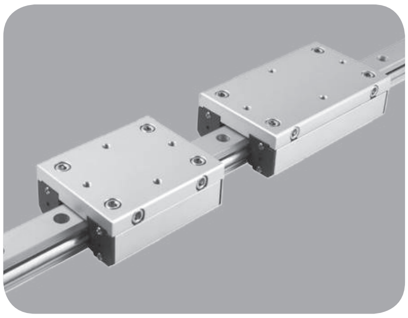
Note: I value will be 1/2 J or evenly spaced on both end if not specific.

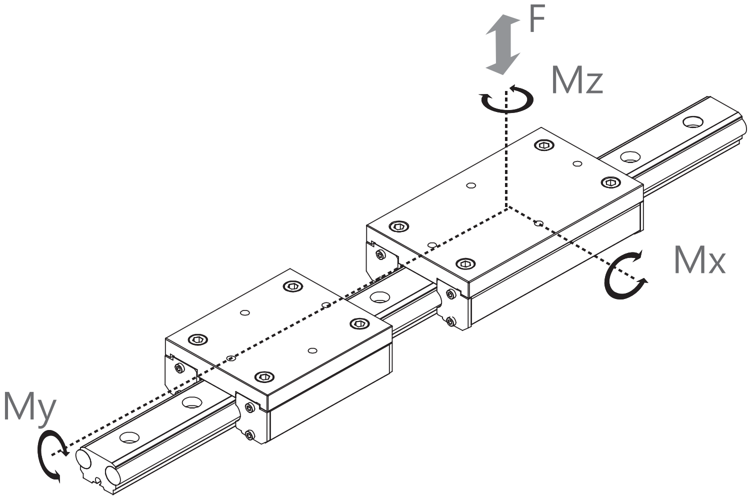
4.2 CRD Dust-proof type

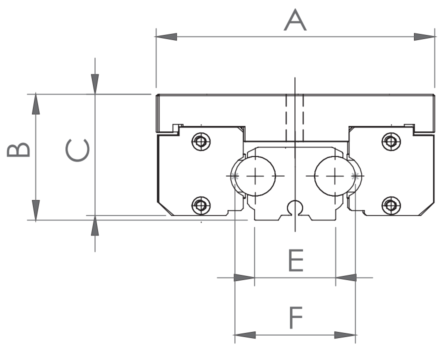
Ordering Key : CRD12 X 0880 - B2 (20,10)

1 2 3 4

1. Block type :
   CRD12 : Standard block type
   CRD12L : Extended length block type
2. Rail length : 880 mm
3. Number of blocks : 2
4. End distance of screw hole : 20, 10
   (Evenly spaced on both end if not specific)





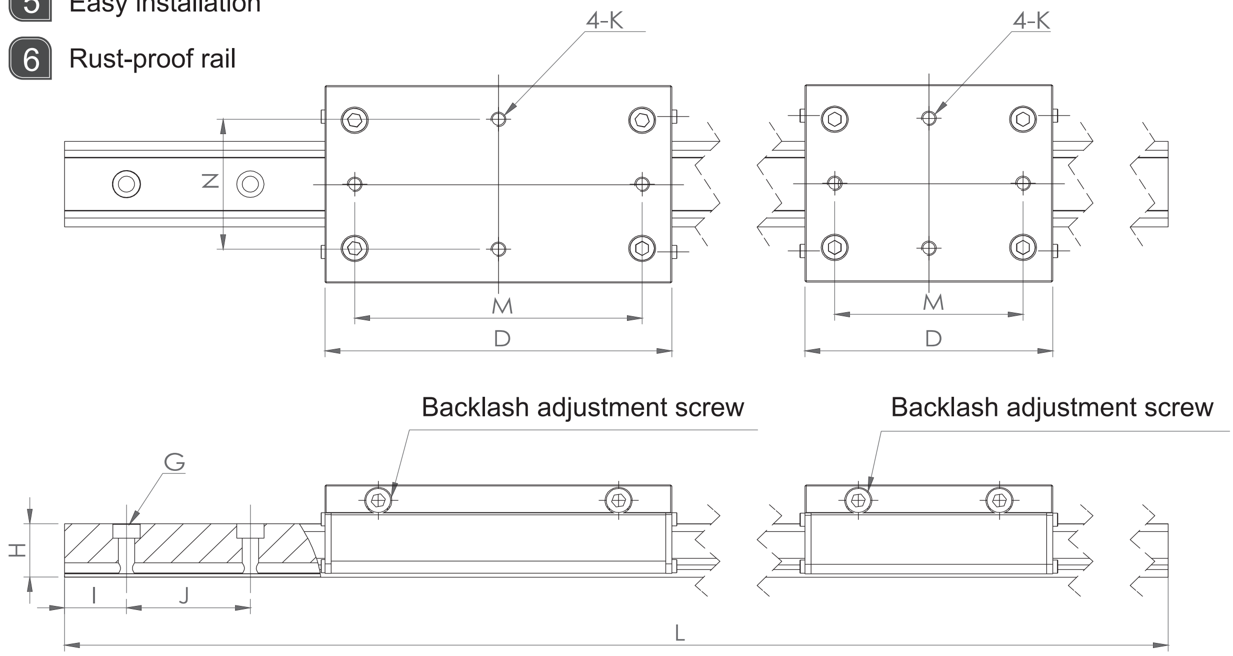


Unit : mm

Model No.	Dimensions				
	A	B	C	E	F
CRD12	82	38.5	36.5	24	36
CRD12L	82	38.5	36.5	24	36

Features

1. Dust-proof block
2. Adjustable roller clearance on block
3. Low noise
4. Lubrication not required
5. Easy installation
6. Rust-proof rail



Unit : mm

Model No.	Dimensions								
	D	G	H	I	J	K	L	M	N
CRD12	100	ø7xø10x6	22	1/2J	50	M6	100~4000	76	54
CRD12L	140	ø7xø10x6	22	1/2J	50	M6	100~4000	116	54

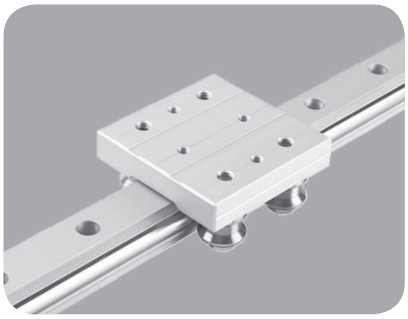
Note: I value will be 1/2 J or evenly spaced on both end if not specific.

Model No.	Basic Load Rating (kgf)		Static Moment Load (kgf-m)			Weight	
	C	C_0	Mx	My	Mz	Block (kg)	Rail (kg/m)
CRD12	250	500	4	5.4	4.8	0.6	3
CRD12L	250	500	7.4	5.4	8.8	0.8	3

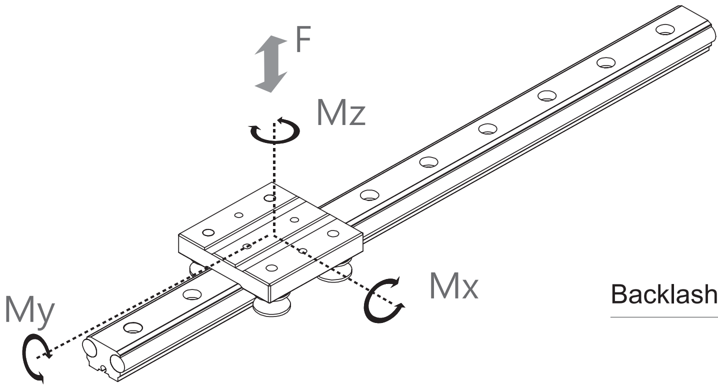
4.3 CRE Economic type

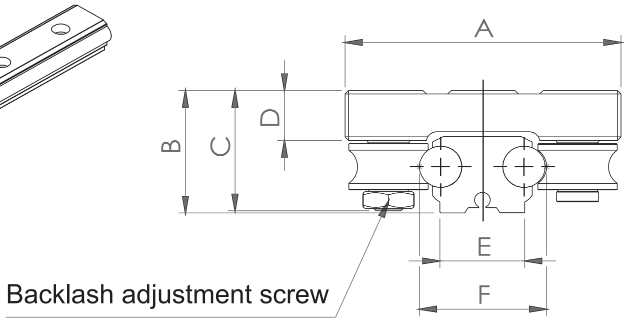
Ordering Key : CRE12 X 0880 - B2 (20,10)

1 = CRE12, 2 = 0880, 3 = B2, 4 = (20,10)



1. Block type :
   CRE : Economic Block type
2. Rail length : 880 mm
3. Number of blocks :2
4. End distance of screw hole : 20, 10
   (Evenly spaced on both end if not specific)



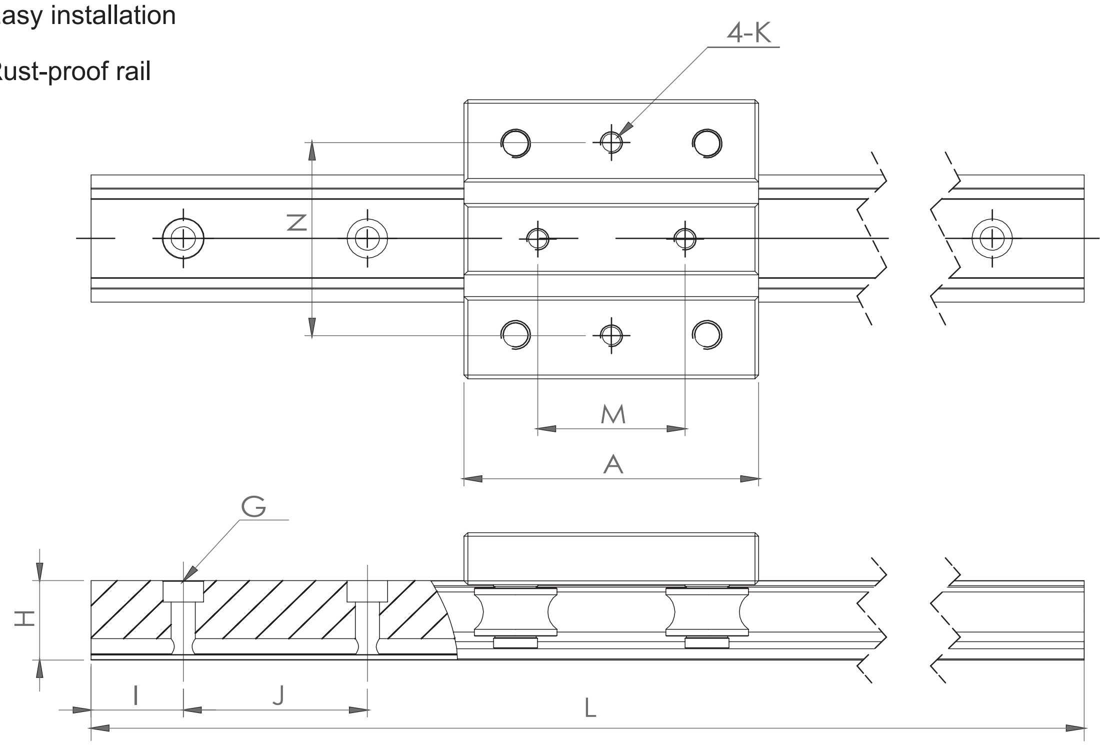


Unit : mm

Model No.	Dimensions					
	A	B	C	D	E	F
CRE12	78	35.5	34	14.5	24	36

Features

1. Adjustable roller clearance on block
2. Low noise
3. Lubrication not required
4. Easy installation
5. Rust-proof rail



Unit : mm

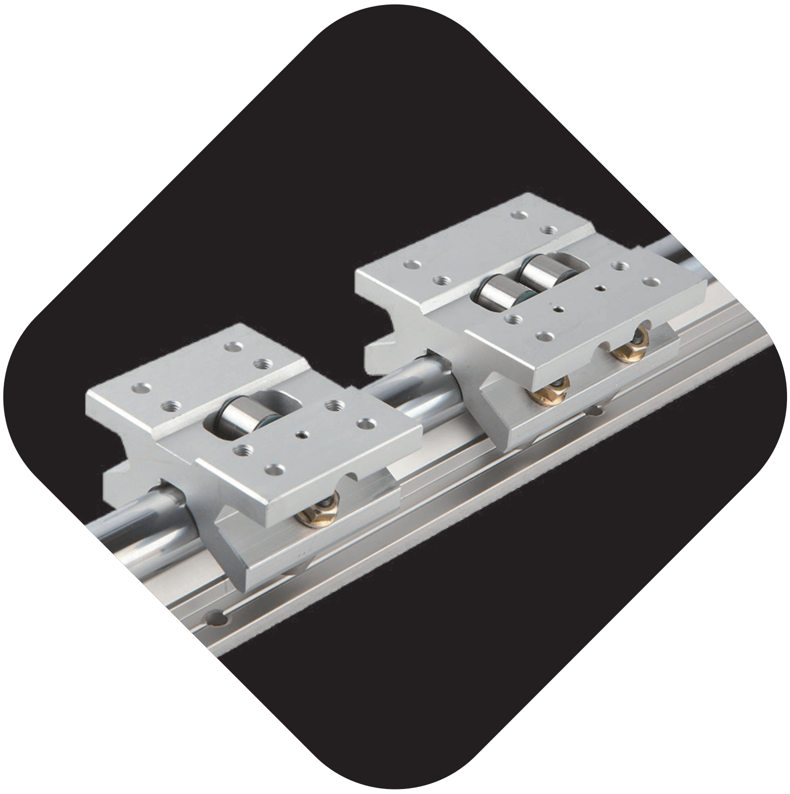
Model No.	Dimensions							
	G	H	I	J	K	L	M	N
CRE12	ø7xø10x6	22	1/2J	50	M6	100-4000	40	54

Note: I value will be 1/2 J or evenly spaced on both end if not specific.

Model No.	Basic Load Rating (kgf)		Static Moment Load (kgf-m)			Weight	
	C	C_0	Mx	My	Mz	Block (kg)	Rail (kg/m)
CRE12	200	400	3.6	4.9	4.3	0.35	3

5

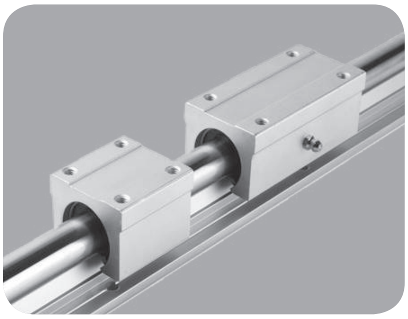
Round Shaft Linear Guide



5.1 RLG Standard type

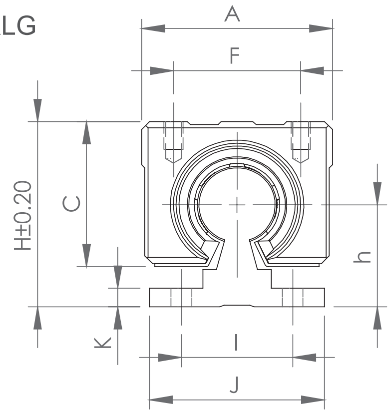
Ordering Key : RLG 20 X 0810 - B2 (40,20)

1 2 3 4 5

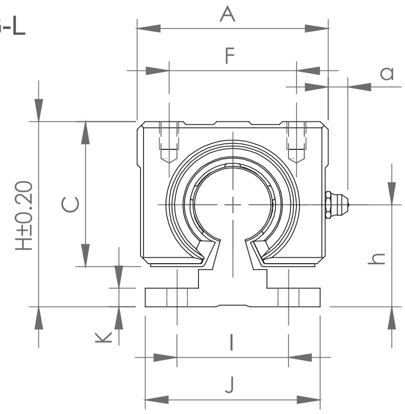


1. Block type
   RLG：Standard Block type
   RLG-L：Extended length Block type
2. Shaft diameter：ø20 ㎜
3. Rail length : 810 mm
4. Number of blocks : 2
5. End distance of screw hole : 40, 20
   (Evenly spaced on both end if not specific)

• RLG



• RLG-L

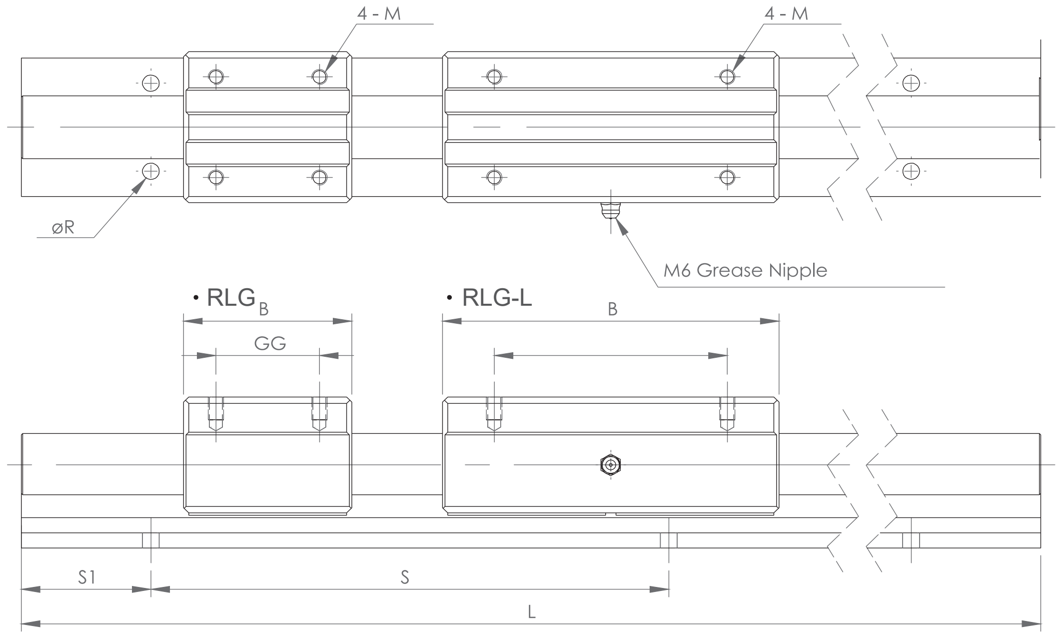


Unit : mm

Model No.	Shaft Dia.	Dimensions										
		A	a	B	C	F	G	H	h	I	J	K
RLG10	Ø10	36		32	24	25	20	33	18	22	32	4
RLG10L			7.5	65			40					
RLG12	Ø12	36		34	24	26	24	34	18.5	23	32	4
RLG12L			7.5	68			45					
RLG13	Ø13	40		39	28	28	26	38	21	25	34	4.5
RLG13L			7.5	75			50					
RLG16	Ø16	45		45	33	32	30	45	25	30	40	5
RLG16L			7.5	85			60					
RLG20	Ø20	48		50	39	35	35	50	27	30	45	5
RLG20L			7.5	95			70					
RLG25	Ø25	60		65	47	40	40	60	33	35	55	6
RLG25L			7.5	130			90					
RLG30	Ø30	70		70	56	50	50	70	37	40	60	7
RLG30L			7.5	140			100					
RLG35	Ø35	80		80	63	55	55	80	43	45	65	8
RLG40	Ø40	90		90	72	65	65	90	48	55	75	9
RLG50	Ø50	120		110	92	94	80	115	62	70	95	11

Features

1. Heat treated and hard chromium plated SUJ2 shaft
2. Shaft is fully supported to prevent unwanted shaft deflection in heavy load and long stroke conditions
3. Available in Standard, or Extended length block type



Unit : mm

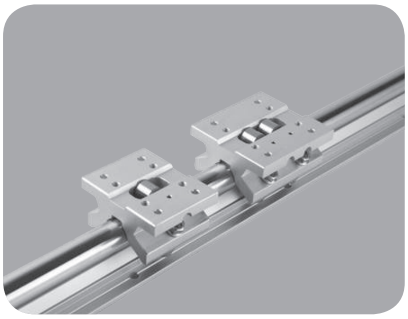
Dimensions (mm)					Bearing Model	Basic Load Rating (kgf)	
L	M	ØR	S	S1 *		C	C_0
200-4000	M5	4.5	100	1/2 S	LM 10-OP	38	56
						60	112
200-4000	M5	4.5	100		LM12-OP	52	80
						83	160
200-3000	M5	4.5	100		LM 13-OP	52	80
						83	160
200-4000	M5	5.5	150		LM 16-OP	79	120
						125	240
200-6000	M6	5.5	150		LM 20-OP	90	140
						142	279
300-6000	M6	6.5	200		LM 25-OP	100	160
						159	320
300-6000	M8	6.5	200		LM 30-OP	160	280
						253	560
300-6000	M8	9	200		LM 35-OP	170	320
400-6000	M10	9	300		LM 40-OP	220	410
400-6000	M10	11	300		LM 50-OP	389	810

Note: S1 value will be 1/2 S or evenly spaced on both end if not specific.

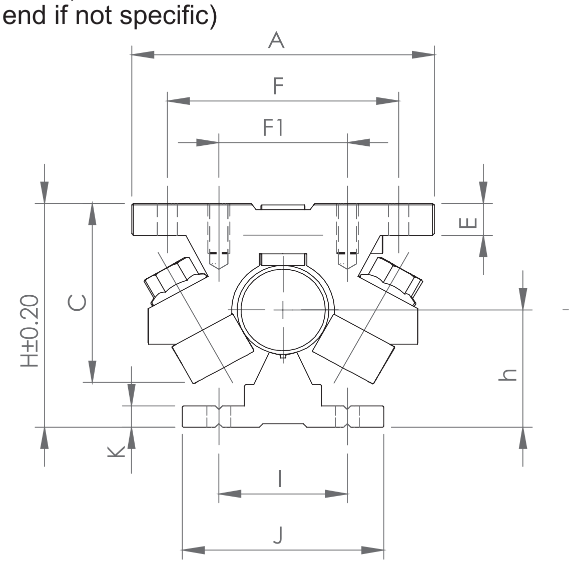
5.2 RLR High impact type

Ordering Key : RLR 20 X 0860 - B2 (40,20)

1 2 3 4 5



1. Block type
   RLR：Standard Block type
   RLR-L：Extended length, heavy load Block type
2. Shaft diameter：ø20 ㎜
3. Rail length : 860 mm
4. Number of blocks : 2
5. End distance of screw hole : 40, 20
   (Evenly spaced on both end if not specific)

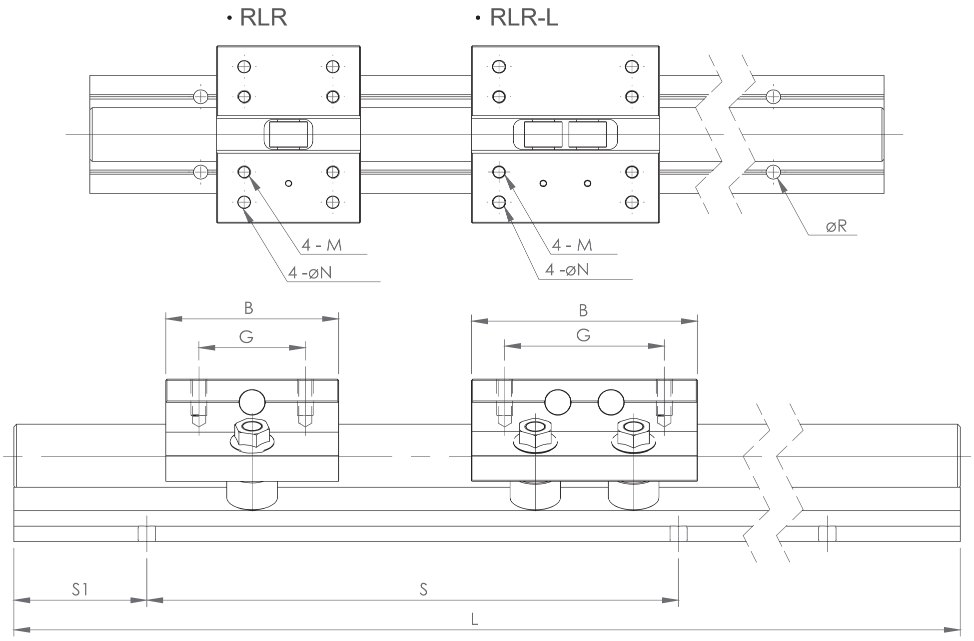


Unit : mm

<table>
<tr><th rowspan="2">Model No.</th><th rowspan="2">Shaft Dia.</th><th colspan="10">Dimensions</th></tr>
<tr><th>A</th><th>B</th><th>C</th><th>E</th><th>F</th><th>F1</th><th>G</th><th>H</th><th>h</th><th>I</th></tr>
<tr><td>RLR 20</td><td rowspan="2">Ø20</td><td rowspan="2">70</td><td>55</td><td rowspan="2">41.6</td><td rowspan="2">8</td><td rowspan="2">50</td><td rowspan="2">27</td><td>32</td><td rowspan="2">51.6</td><td rowspan="2">27</td><td rowspan="2">30</td></tr>
<tr><td>RLR 20L</td><td>75</td><td>46</td></tr>
<tr><td>RLR 25</td><td rowspan="2">Ø25</td><td rowspan="2">83</td><td>65</td><td rowspan="2">49.6</td><td rowspan="2">9</td><td rowspan="2">63</td><td rowspan="2">35</td><td>40</td><td rowspan="2">63</td><td rowspan="2">33</td><td rowspan="2">35</td></tr>
<tr><td>RLR 25L</td><td>85</td><td>60</td></tr>
<tr><td>RLR 30L</td><td>Ø30</td><td>95</td><td>100</td><td>59.5</td><td>12</td><td>73</td><td>40</td><td>73</td><td>72</td><td>37</td><td>40</td></tr>
</table>

Features

1. Heat treated and hard chromium plated SUJ2 shaft
2. Shaft is fully supported to prevent unwanted shaft deflection in heavy load and long stroke conditions
3. Available in Standard, or Extended length block type
4. Roller clearance adjustable on block
5. RLR series feature in high load capacity, low noise, and high impacts capability



Dimensions (mm)								Basic Load Rating (kgf)	
J	K	L	M	ØN	ØR	S	S1 *	C	C_0
45	5	300 - 6000	M5	4.3	5.5	200	1/2 S	230	150
						200		460	300
55	6	300 - 6000	M6	5.5	6.5	200		350	270
						200		700	540
60	7	300 - 6000	M8	6.5	6.5	200		1450	1100

Note: S1 value will be 1/2 S or evenly spaced on both end if not specific.

6

Ball Screw

6.1 Technological description of Ball Screws

6.1.1 Lead / Travel Accuracy

Accuracy

1. Lead accuracy of ABBA Ball screws (grade C0~C5) is specified in 4 basic terms (E, e, e_{300}, $e2\pi$). There are defined in Fig.6.1.1.1 Tolerance of deviation (± E) and variation (e) of accumlated reference travel are shown in Table 6.1.1.1~ 6.1.1.3

2. Accumulated travel deviations for grade C7 and C10 are specified only by the allowable value per 300mm measured within any portion of the thread length as e_{300} of table 6.1.1.3 They are 0.05mm for C7 and 0.21mm for C10.

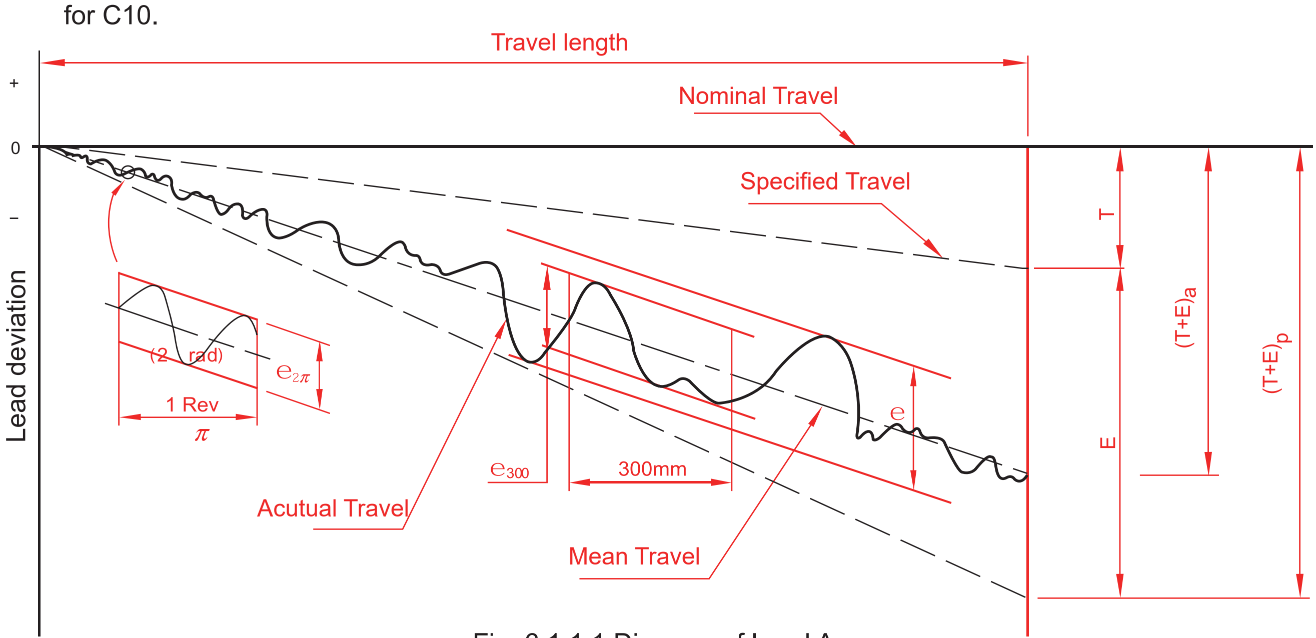


Fig. 6.1.1.1 Diagram of Lead Accuracy

Table 6.1.1.1 Definition of Terms of Lead Accuracy

T+E	Cumulative Traval lead	It's a straight line, it represents the tendency of actual cumulative lead. This is the data after laser detection calculated by the method of least squares.
P		Allowable value
a		Actual measured value.
T	Travel Compensation	Travel compensation is the difference between specified and nominal travel within the useful travel. A slightly smaller value compared to nominal travel is often selected by the customer to compensate for an expected elongation caused by temperature rise or external load. Therefore " T " is usually a negative value. Note: If no compensation is needed, specified travel is the same as nominal travel.
E	Mean Travel Deviation	Mean Travel deviation is the difference between Mean Travel and Specified travel within travel length
e	Travel Variations	Maximum width of variation over the travel length.
e_{300}		Actual width of variation for the length of 300mm taken anywhere within the travel length.
$e_{2\pi}$		Wobble error, actual width of variation for one revolution(2π radian)

Table 6.1.1.2 Mean Travel Deviation (± E) and Travel Variation (e) (JIS B 1192)

Grade		C0		C1		C2		C3		C5		C7	C10
Travel Length(mm) Over	Incl.	±E	e	±E	e	±E	e	±E	e	±E	e	e	e
	100	3	3	3.5	5	5	7	8	8	18	18		
100	200	3.5	3	4.5	5	7	7	10	8	20	18		
200	315	4	3.5	6	5	8	7	12	8	23	18		
315	400	5	3.5	7	5	9	7	13	10	25	20		
400	500	6	4	8	5	10	7	15	10	27	20		
500	630	6	4	9	6	11	8	16	12	30	23		
630	800	7	5	10	7	13	9	18	13	35	25		
800	1000	8	6	11	8	15	10	21	15	40	27		
1000	1250	9	6	13	9	18	11	24	16	46	30		
1250	1600	11	7	15	10	21	13	29	18	54	35	±50/300mm	±210/300mm
1600	2000			18	11	25	15	35	21	65	40		
2000	2500			22	13	30	18	41	24	77	46		
2500	3150			26	15	36	21	50	29	93	54		
3150	4000			32	18	44	25	60	35	115	65		
4000	5000					52	30	72	41	140	77		
5000	6300					65	36	90	50	170	93		
6300	8000							110	62	210	115		
8000	10000									260	140		
10000	12500									320	170		

Table 6.1.1.3 Variation per 300mm (e300) and Wobble Error (e2 π) (JIS B 1192)

Unit : μm

Grade	C0	C1	C2	C3	C5	C7	C10
e_{300}	3.5	5	7	8	18	50	210
$e_{2\pi}$	3	4	4	6	8		

6.1.2 Backlash in the Axial direction (customer demand)

The preload grade of the axial clearance of the standard ball screw

6.1.2.1 Maximum Backlash in the Axial direction (P0)

Unit : mm

Maximum Backlash in the Axial direction	
Screw Shaft OD	Maximum Backlash in the Axial direction of Rolled Ball Screw
4mm~14mm	0.05
15mm~50mm	0.08
50mm~80mm	0.12

6.1.2.2 Maximum Backlash in the Axial direction (P1)

Unit : mm

Maximum Backlash in the Axial direction	
Screw Shaft OD	Maximum Backlash in the Axial direction of Rolled Ball Screw
4mm~80mm	0

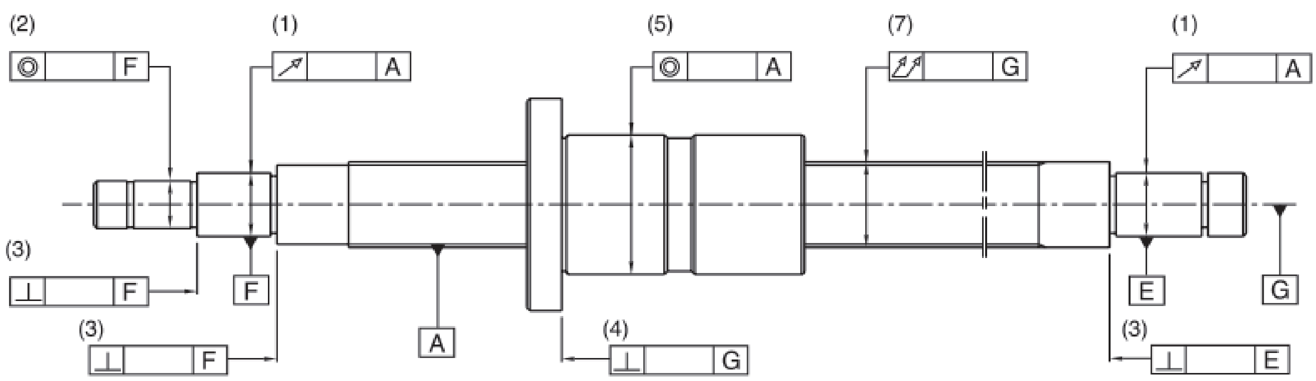
6.1.3 Definition of the geometric tolerance of the ball screw

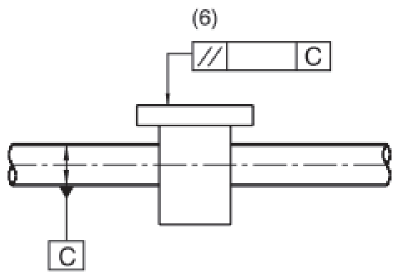
To use a ball screw properly dimensional accuracy and tolerances are most important

1. With respect to the axis A of the thread groove surface, the radial runout value of the screw support part is measured.
2. Measure the coaxiality of the part mounting part with respect to the axis F of the screw support part.
3. The right angle of the end surface of the supporting part is measured with respect to the axis E of the supporting part of the screw shaft.
4. With respect to the screw axis G, measure the right angle of the reference surface of the nut or the mounting surface of the flange.
5. With respect to the screw axis A, the coaxiality of the outer periphery of the nut (cylindrical type) is measured.
6. Measure the parallelism of the outer edge of the nut (flat-head type mounting surface) with respect to the screw axis C.
7. The total yaw value in the radial direction of the screw shaft axis.

The accuracy items mentioned here are based on JIS B1192~1997. .

Mounting accuracy and tolerances

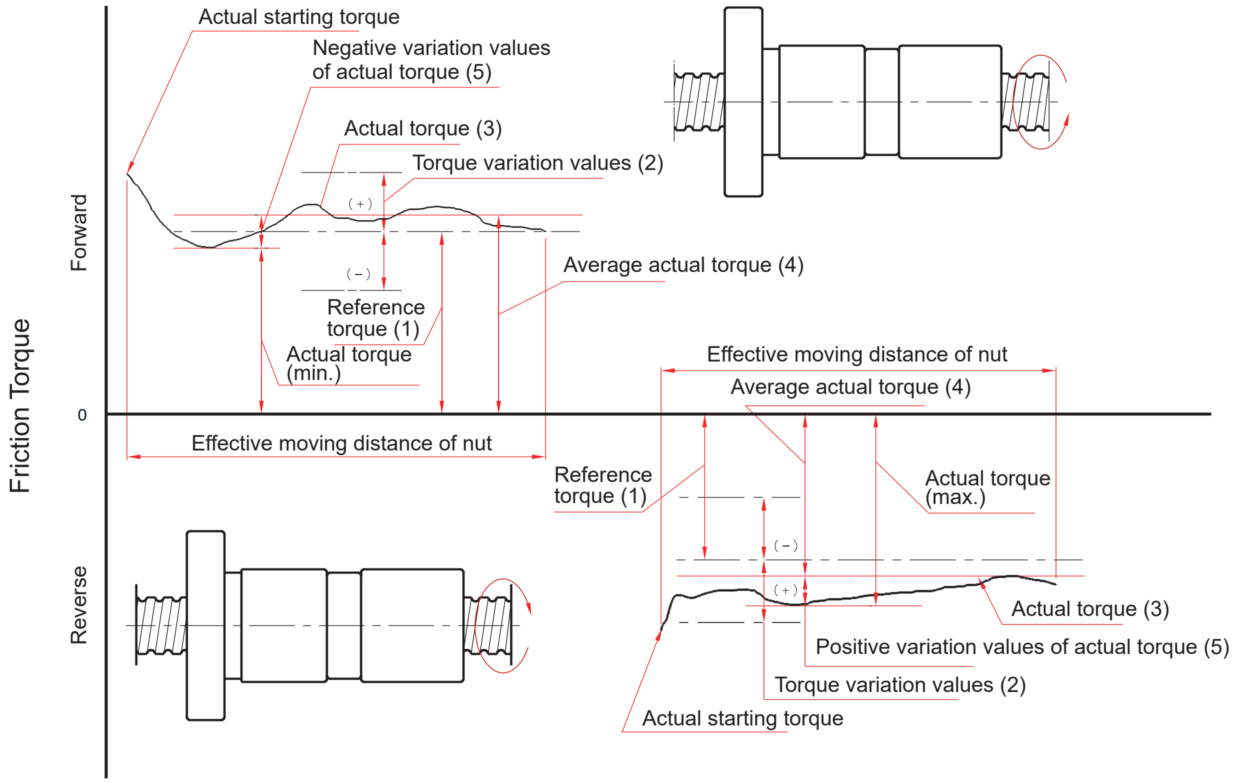




6.1.4 Preload torque

- Terms in relation to the preload torque generated during the rotation of the preload ball screws are shown in 6.1.4.1.
- Permissible ranges of torque variation rates is shown in 6.1.4.2.

6.1.4.1 Descriptions of preload torque



Glossary

(1) Preload
The stress generated inside the screws when inserting a set of steel balls of one gage (approximately 2μ) larger into the nut or using them on the 2 nuts which exercise mutual displacements along the screws axis in order to eliminate the gaps of the screw or upgrade the rigidity of the screw.

(2) Preload dynamic torque
The dynamic torque required for continously rotating the screws shaft or the nuts under unload condition after the specified preload has been applied upon the ball screws.

(3) Reference
The targeted preload dynamic torque.

(4) Torque variation values
The variation values of the targeted preload torque variation rates are specified generally based on JIS standard as.

(5) Torque variation rate
The rate of variation values in relation to the reference torque.

(6) Actual torque
The actually measured preload dynamic torque of the ball screws.

(7) Average actual torque
The arithmetic average of the maximal and minimal actual torque values measured when the nuts are exercising reciprocating movements.

(8) Actual torque variation values
The maximum variation values measured within the effective length of the threads when the nuts are exercising reciprocating movements, the positive or negative values relative to the actual torque are adopted.

(9) Actual torque variation rate
The rate of actual torque variation values in relation to the average actual torque.

Standard
Ball Caged
Miniature
Cam Roller
Round Shaft
Linear Guide
Ball Screw
Support Unit
Ball Screw
Self-lubricated Linear Bearing
Other components

6.1.4.2 Permissible ranges of torque variation rates

Reference torque kgf • cm		Effective threading length (mm)		
		Below 4000		4000~10000
		Slenderness 1 : below 40	Slenderness 1 : 40 ~ 1 : 60	–
		Grade	Grade	Grade
Over	Incl.	C5	C5	C5
2	4	±50%	±60%	-
4	6	±40%	±45%	-
6	10	±35%	±40%	±45%
10	25	±30%	±35%	±40%
25	63	±25%	±30%	±35%
63	100	±20%	±25%	±30%

Note:
1. Slenderness is the value of dividing the screws shaft outside diameter with the screws shaft threading length.
2. For reference torque less than 2 kgf • cm, ABBA specifications will apply.

Calculation of reference torque Tp

The formula for computing reference torque (kgf • cm) of the ball screws is given in following :

$$Tp = 0.05\,(\tan\beta)^{-0.5} \cdot \frac{Fao \cdot \ell}{2\pi}$$

Where, Fao : Preload (Kgf)

β : Lead angle

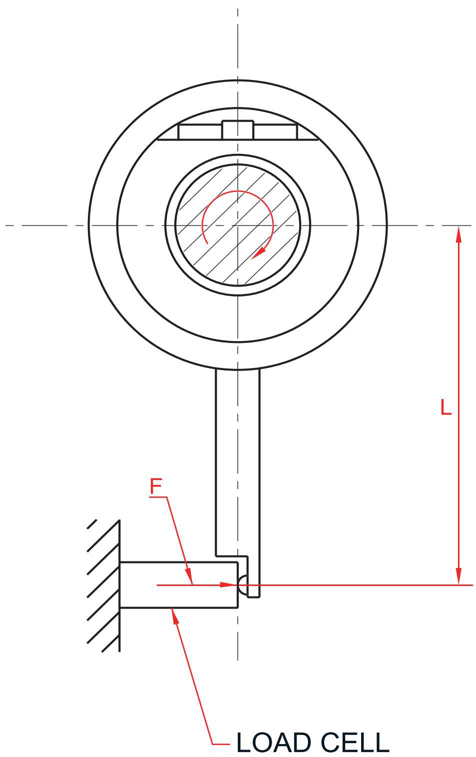
ℓ : Lead (cm)

Measurement conditions

The preload dynamic torque Tp is determined first by adopting the following measurement conditions together with the method illustrated in the right diagram for measuring the force F needed to rotate the screws shaft without bringing the nuts to rotate along with the shaft after the screws shaft has started rotating, then multiplying the measured value of F with the arm of force L, the product is Tp.

Tp=F • L

Measure conditions
(1) Measurement is executed under the condition of not attaching with scraper.
(2) The rotating speed during measurement maintains at 100 rpm.
(3) According to JSK 2001 (industrial lubrication oil viscosity classificaiton standards), the lubrication oil used should be in compliance with ISO VG68.



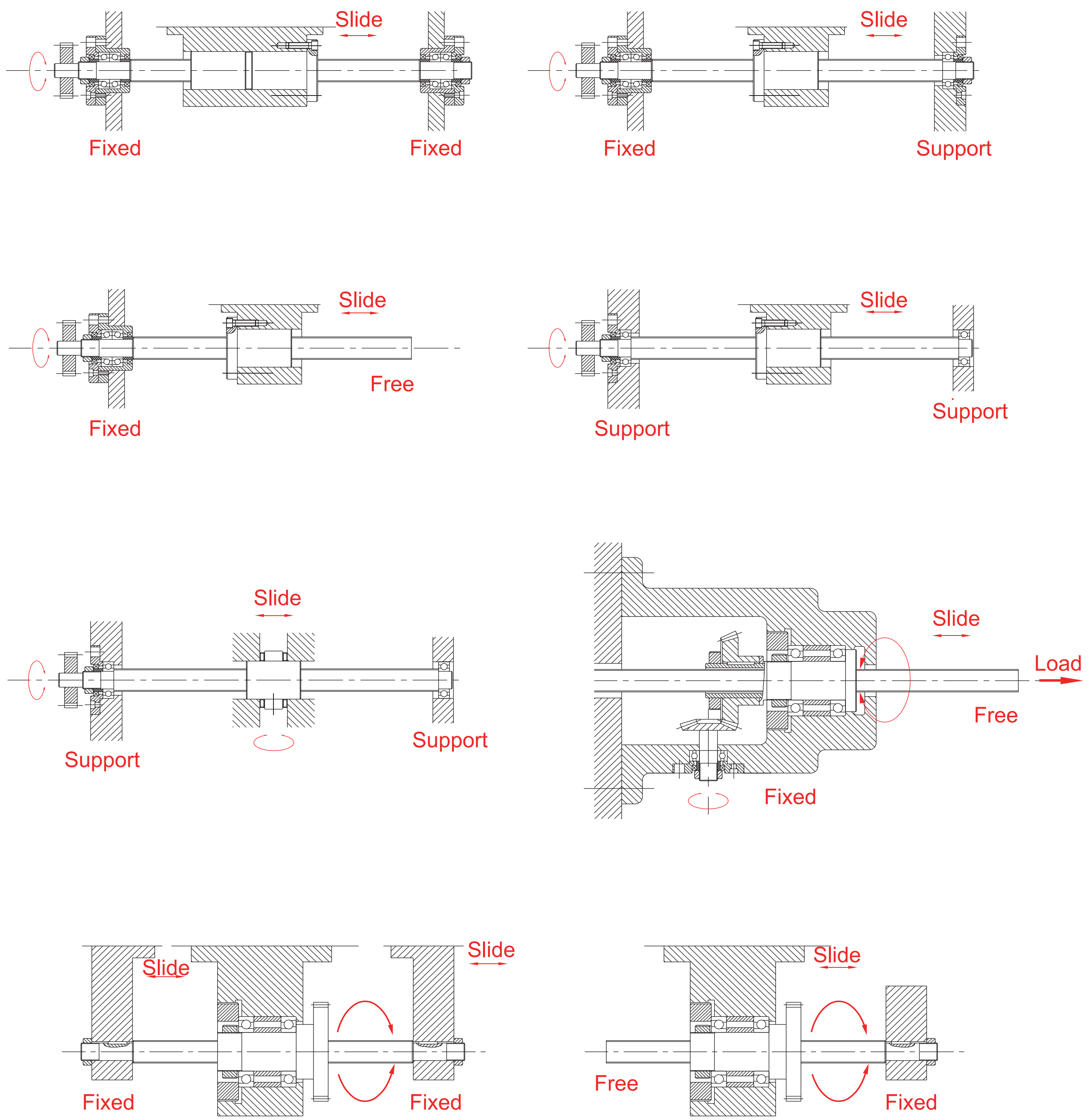
Preload dynamic torque measuring method

6.2 Screw shaft design

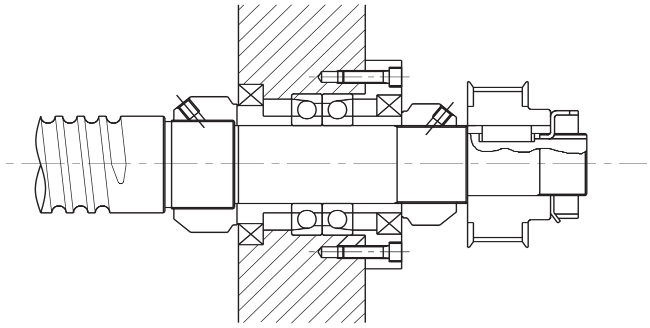
6.2.1 Mounting methods

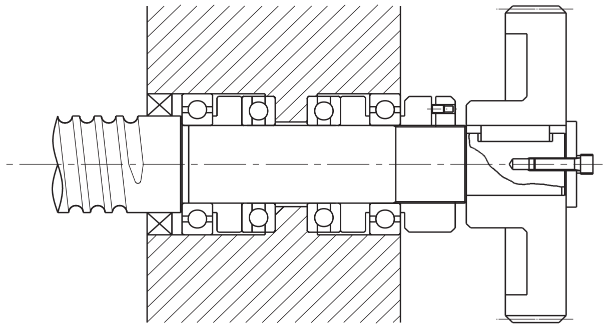
Both the critical speed and column bucking load depend upon the method of mounting and the unsupported length of the shaft, the most common mounting methods for ball screws are shown below.

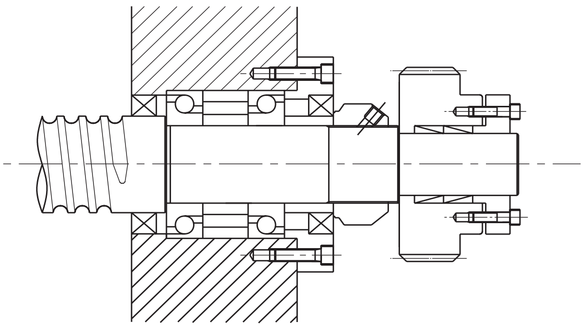
Most common mounting methods for ball screws

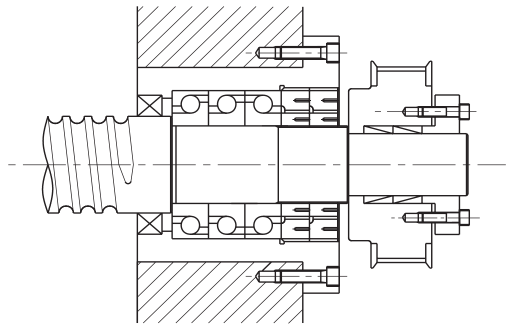


Most machines mounting methods for ball screws

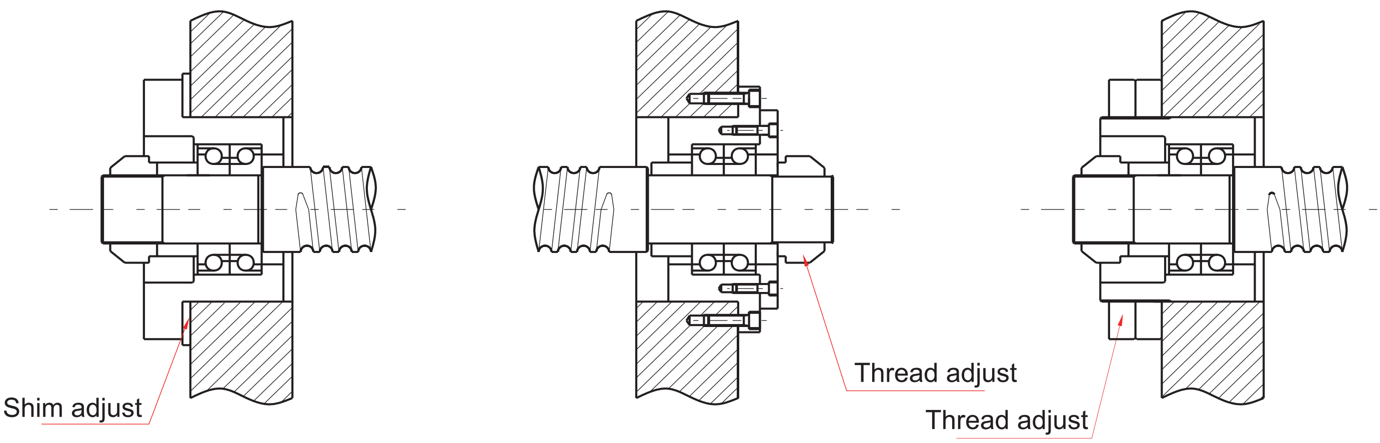








Most common mounting methods for ball screws



6.2.2 Buckling load

1 Buckling load

The safety of the screw shaft against buckling needs to be checked when the shaft is expected to receive buckling loads. The diagram below summarizes the allowable compressive load for buckling for each nominal outside diameter of screw shaft. (Calculation with the equation shown right when the nominal outside diameter of the screw shaft exceed 125mm.) Select the graduation of allowable axial load according to the method of ball screw support.

$$P = \alpha \times \frac{N\pi^2 E}{L^2} = m\frac{dr^4}{L^2} \times 10^3$$

Where,

α : Safety factor (0.5)

E : Vertical elastic modules ($E = 2.1 \times 10^4 kgf/mm^2$)

I : Min. secondary moment of screw shaft sectional area

2 Allowable tensile compressive stress

When the mounting distance is short, please check the following two items which are irrelevant to the mounting method.

- Check the allowable tensile / buckling load (the formula shown below)
- Allowable load of the ball groove

$$P = \sigma A = 11.8dr^2 \ (kgf)$$

Where, $P = \sigma \cdot A = \sigma \cdot \pi \cdot dr^2/4$

σ : Allowable tensile compressive stress (kgf/mm^2)

A : Sectional area (mm^2) of screw shaft root bottom diameter

dr : Screw shaft root diameter (mm)

$$I = \frac{\pi\, dr^4}{64\ mm^4}$$

dr : Screw shaft root diameter (mm)

L : Mounting distance (mm)

m • N : Coefficient determined from mounting method of ball screw

Support - Support	m=5.1	(N=1)
Fixed - Support	m=10.2	(N=2)
Fixed - Fixed	m=20.3	(N=4)
Fixed - Free	m=1.3	(N=1/4)

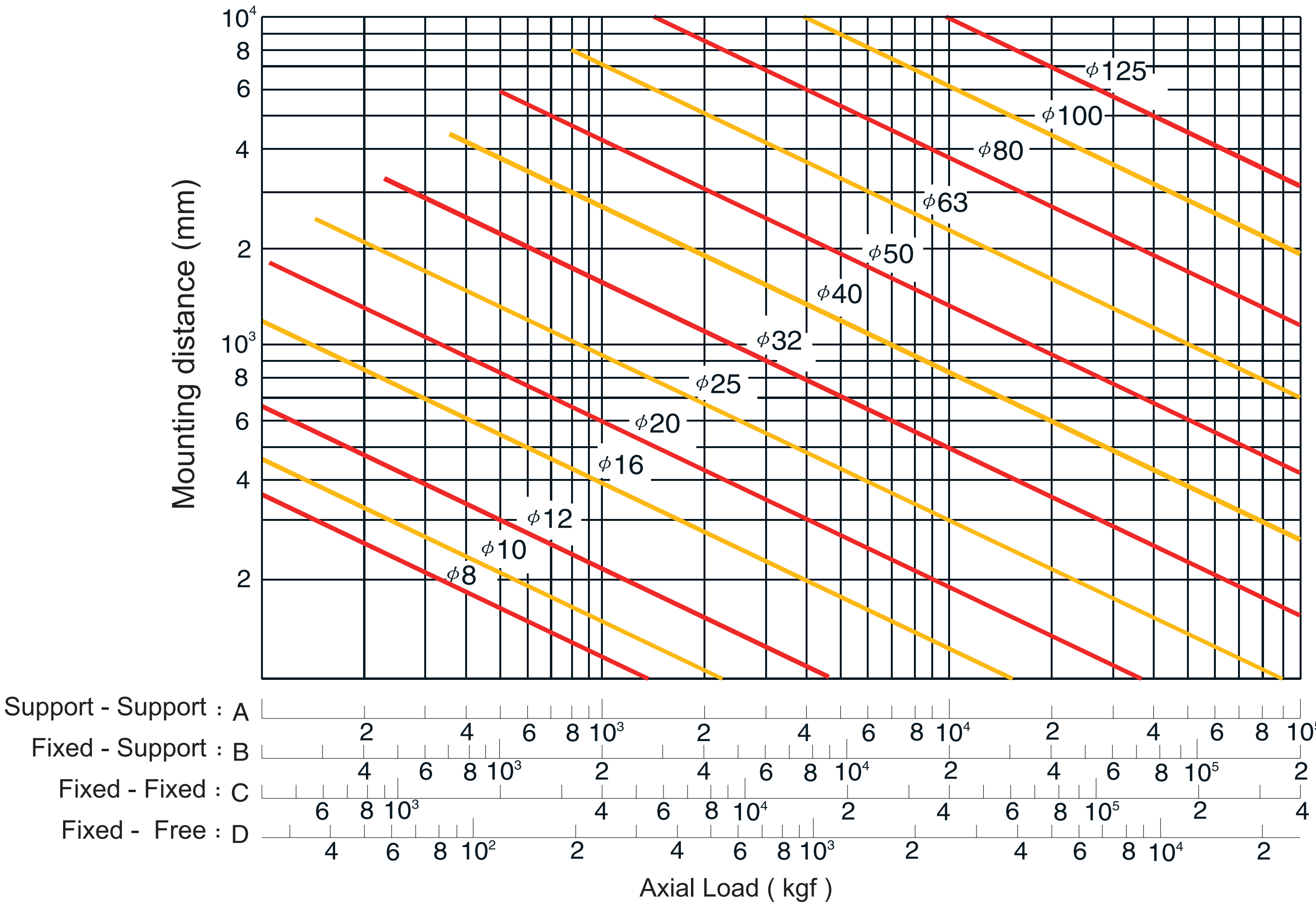


Fig. 6.2.2.1 Allowable buckling load for frustration

6.2.3 Allowable rotation

1 Critical speed

It is necessary to check if the Ball Screw rotation speed is resonant with the natural frequency of the screw shaft.
ABBA has determined 80% or less of this critical speed as an allowable rotation speed. The diagram below summarizes the allowable rotation speed of shaft nominal diameters up to outside diameter of the screw shaft exceeds 125mm.)
Select the graduation of allowable rotation speed according to the method of supporting the Ball Screw.
Where the working rotation speed presents a problem in terms of critical speed, it would be best to provide an intermediate support to increase the natural frequency of the screw shaft.

2 dm.n value

The allowable rotation speed is regulated also by the dm.n value (dm: diameter of central circle of steel ball, n: revolution speed rpm) which expresses the peripheral speed.

Generally;
For general industry (Ground) dm.n≦50,000
High lead seires dm.n≦ 130,000

Product exceeding the above limits can be produced, please contact ABBA.

$$n = \alpha \times \frac{60\lambda^2}{2\pi L^2}\sqrt{\frac{E I g}{\gamma A}} = f \frac{dr}{L^2} \times 10^7 \ (rpm)$$

Where,

- n : Allowable rotation speed (rpm)
- α : Safety factor (0.8)
- E : Vertical elastic modules ($E = 2.1 \times 10^4 kgf/mm^2$)
- I : Min. secondary moment of screw shaft sectional area $I = \frac{\pi dr^4}{64} mm^4$
- dr : Screw shaft root diameter (mm)
- g : Acceleration of gravity ($g = 9.8 \times 10^3 mm / s^2$)
- γ : Density ($\gamma = 7.8 \times 10^{-6}$ kgf / mm^3)
- A : Screw shaft sectional area ($A = \pi dr^2 /4\ mm^2$)
- L : Mounting distance (mm)
- f、λ : Coefficient determined from the Ball Screw mounting method

Support - Support	$f = 9.7$	($\lambda = \pi$)
Fixed - Support	$f = 15.1$	($\pi = 3.927$)
Fixed - Fixed	$f = 21.9$	($\pi = 4.730$)
Fixed - Free	$f = 3.4$	($\pi = 1.875$)

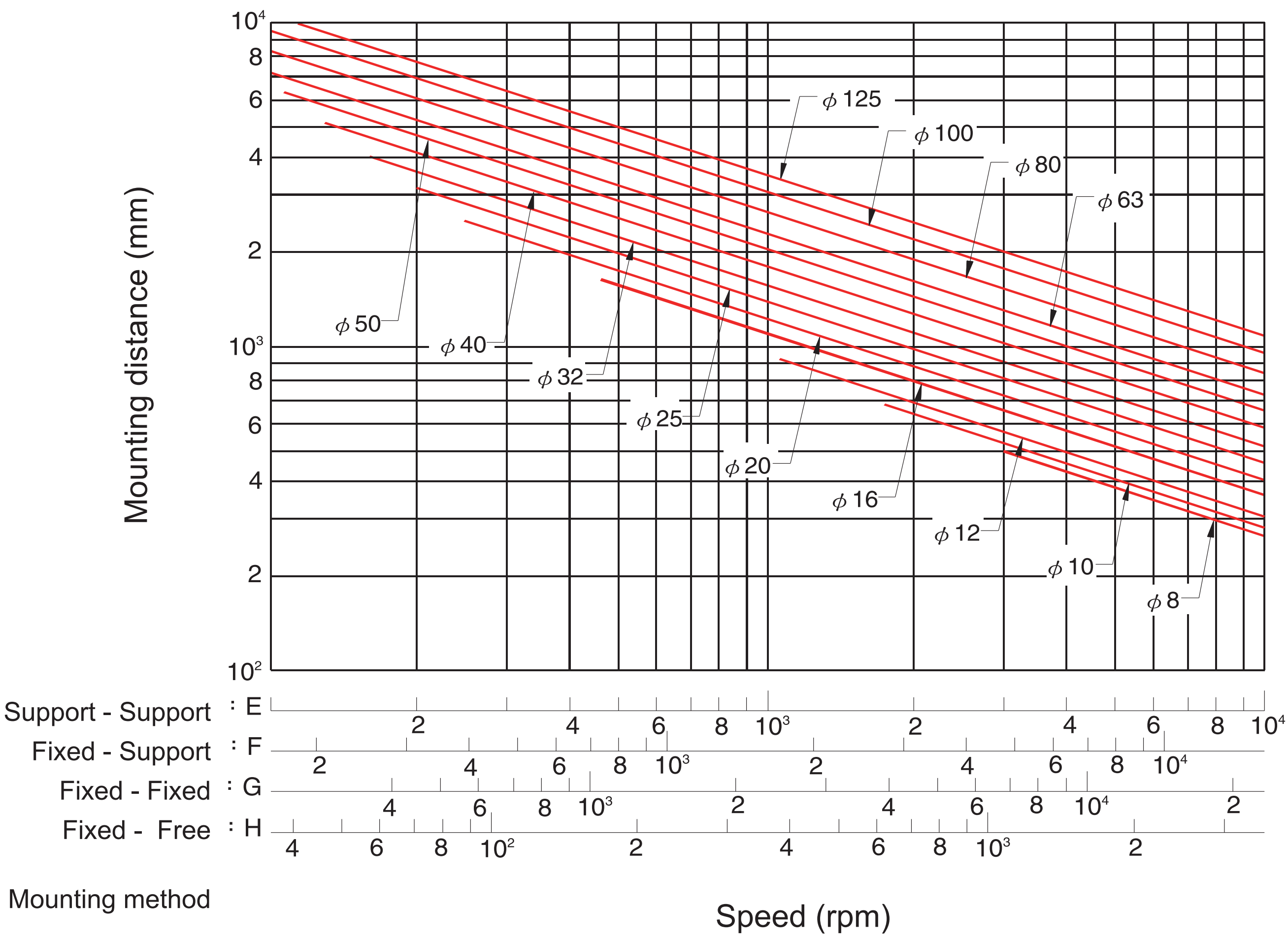


Fig. 6.2.3.1 Critical speed V.S. Shaft Dia.

6.3 Nut design

6.3.1 Selection of nut

The mounting method is an important item when selecting the appropriate Ball Screw specifications. The following are installation examples. When the conditions of use need to be judged under stricter conditions or whenjudgment conditions are unknown due to special mounting method is used , please contact ABBA.

1. **Series**
   When making selection of series, please take into consideration of demanded accuracy, intended delivery time, dimensions (the outside diameter of the screw, ratio of lead / the outside diameter of the screw), preload load, etc.
2. **Circulation type**
   Selection of circulation type; please focus on the economy of space for the nut installation portion.
   (a) External circulation type
   - Economy
   - Suitable for mass production
   - Applicable to those with larger lead / the outside diameter of the screw

   (b) Internal circulation type
   - With nuts of finely crafted outside diameter (occupying small space)
   - Applicable to those with smaller lead / the outside diameter of the screw

   (c) High lead type
   - High Speed, High DN Value
   - Low Noise, Environmental protection
   - Small size, Space saving
3. **Number of loop circuits**
   Performance and life of service should be considered when selecting number of loop circuits.
4. **Shape of flanges**
   Please make selection based on the available space for the installation of nuts.
5. **Oil hole**
   Oil holes are provided for the precision Ball Screws, please use them during machine assembling and regular furnishing.

6.3.1.1 External ball circulation nuts

Feature

1. Offers smoother ball running
2. Offers better solution and quality for long lead or large diameter Ball Screws

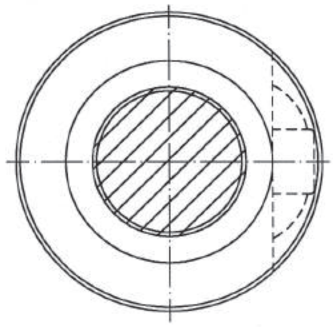


Fig. 6.3.1.1 Immersion type

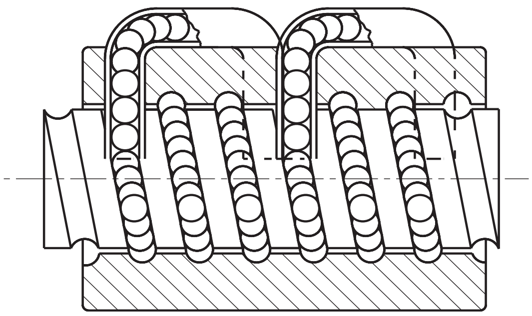


Fig. 6.3.1.2 Enternal ball circulation's nut

6.3.1.2 Internal ball circulation nuts

Feature

The advantage of internal ball circulation nut is that the outer diameter is smaller than that of external ball circulation nut (Fig.6.3.1.3). Hence it is suitable for the machine with limit space for Ball Screw installation.
It is strictly required that there is at least one end of screw shaft with complete threads. Also the rest area next to this complete thread must be with smaller diameter than the nominal diameter of the screw shaft. Above are required for easy assembling the ball nut onto the screw shaft.

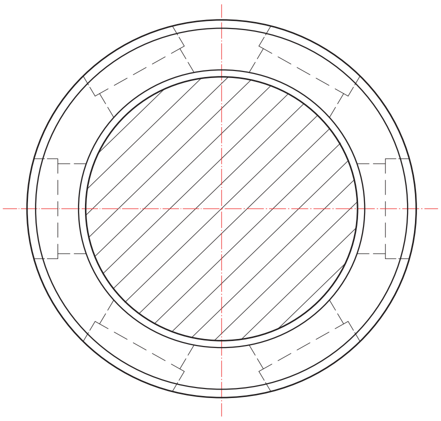


Fig. 6.3.1.3 Internal ball circulation's side view

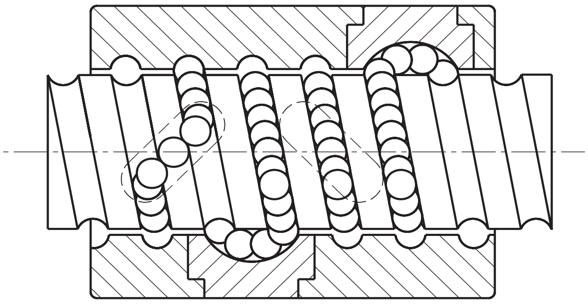


Fig. 6.3.1.4 Internal ball circulation's nut

6.3.1.3 High lead Ball Screws

Feature

It is important for a high lead Ball Screw to be with characteristics of high rigidity, low noise and thermal control. ABBA designs and treatments are taken for following:

1 High DN value

- The DN value can be 130,000 in normal case. For some special cases, for example in a fixed ends case, the DN value can be as high as 140,000. Please contact our engineers for this special application.

2 High speed

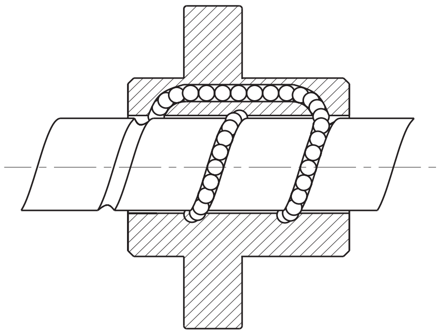
- ABBA high speed Ball Screws provide 100 m/min and even higher traverse speed for machine tools for high performance cutting.

3 High rigidity

- Both the screw and ball nut are surface hardened to a specific hardness and case depth to maintain high rigidity and durability.
- Multiple thread starts are available to make more steel balls loaded in the ball nut for higher rigidity and durability.

4 Low noise

- Special design of ball circulation tubes (patent pending) offer smooth ball circulation inside the ball nut. It also makes safe ball fast running into the tubes without damaging the tubes.
- Accurate ball circle diameter (BCD) through whole threads for consistent drag torque and low noise.



Low noise circulation's nut

6.3.2 Axial Rigidity

Excessively weak rigidity of the screw's peripheral structure is one of the primary causes that result in lost motion. Therefore in order to achieve excellent positioning accuracy for the precision machines such as NC working machine, etc., axial rigidity balance as well as torsional rigidity for the parts at various portions of the transmission screw have to be taken into consideration at time of designing.

Static rigidity K

The axial elastic deformation and rigidity of the transmission screw system can be determined from the formula below.

$$K = \frac{P}{e} \quad (\text{kgf}/\mu\text{m})$$

P : Axial load borne by the transmission screw system (kgf)

e : Axial flexural displacement (mm)

$$\frac{1}{K} = \frac{1}{K_S} + \frac{1}{K_N} + \frac{1}{K_B} + \frac{1}{K_H} \quad (\text{mm}/\text{kgf})$$

K_S : Axial rigidity of screw shaft (1)

K_N : Axial rigidity of nut (2)

K_B : Axial rigidity of bracing shaft (3)

K_H : Axial rigidity of installation portions of nuts and bearings (4)

(1) Axial rigidity Ks and displacement δ_S of screw shaft

$$K_S = \frac{P}{\delta_S} \quad (\text{kgf}/\mu\text{m})$$

P : Axial load (kgf)

For places of Fixed - Fixed installation

$$\delta_{SF} = \frac{PL}{4AE} \quad (\text{mm})$$

For places other than Fixed - Fixed installation

$$\delta_{SS} = \frac{PL_O}{AE} \quad (\text{mm})$$

$$\delta_{SS} = 4\delta_{SF}$$

δ_{SF} : Direction displacement at places of fixed-fixed installation

δ_{SS} : Direction displacement at places other than fixed-fixed installation

A : Cross-sectional area of the screw shaft tooth root diameter (mm^2)

E : Longitudinal elastic modulus (2.1×10^4 kgf/mm^2)

L : Distance between installations (mm)

L_O : Distance between load applying points (mm)

(2) Axial rigidity K_N and displacement δ_N of nut

$$K_N = \frac{P}{\delta_S} \quad (\text{kgf}/\mu\text{m})$$

(a) In case of single nut

$$\delta_{NS} = \frac{K}{\sin\beta}\left(\frac{Q^2}{d}\right)^{1/3} \times \frac{1}{\xi} \quad (\mu\text{m})$$

$$Q = \frac{P}{n\cdot\sin\beta} \quad (\text{kgf})$$

$$n = \frac{D_O\pi m}{d} \quad (\text{each})$$

Q : Load of one steel ball (kgf)

n : Number of steel ball

k : Constant determined based on material, shape, dimensions

$k \fallingdotseq 5.7\times10^{-4}$

β : Angle of contact (45°)

P : Axial load (kgf)

d : Steel ball diameter (mm)

ξ : Accuracy, internal structure coefficient

m : Effective number of balls

D_O : Steel ball center diameter (mm)

ℓ : Lead (mm)

α : Lead angle

$$D_O = \frac{\ell}{\tan\alpha\cdot\pi}$$

(b) In case of double nuts

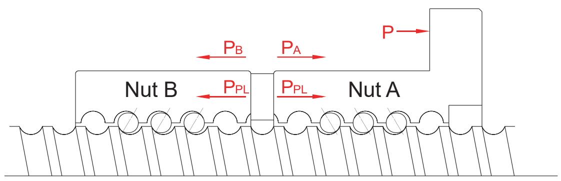


Fig. 6.3.2.1 Preloaded for the double nuts

When an axial load P of approximately 3 times of the preload load P_{PL} is exerted, for the purpose of eliminating the preload PPL on nut B, please set the preload load P_{PL} at no more than 1/3 of the maximal axial load (0.25 Ca should be taken as the standard maximal preload load). With respect to the displacement value, it should be of 1/2 of the single nut displacement when axial load is 3 times of the preload.

$$K_N = \frac{P}{\delta_{NW}} = \frac{3P_{PL}}{\delta_{NS}/2} = \frac{6P_{PL}}{\delta_{NS}} \ (kgf/mm)$$

δ_{NS} : Displacement of single nut (mm)

δ_{NW} : Displacement of double nuts (mm)

(Explanation of the rigidity of double nuts)

As shown in diagram Fig. 6.3.2.1 and 6.3.2.2, when a preload P_{PL} is applied on the 2 nuts A, B, both nuts A & B would produce flexural deformations that will reach point X. If an external force P is exerted from here, nut A would move from point X to point X1, while nut B would move from X to X2. Then, based on the computing formula for displacement δ_{NS} of the single nut, we can obtain:

$$\delta_0 = aP_{PL}^{2/3}$$

While displacements of nuts A & B are

$$\delta_A = aP_{PL}^{2/3}$$

since displacements of nuts A & B generated due to exertion of external force P are equal, therefore

$$\delta_A - \delta_0 = \delta_0 - \delta_B$$

or if P is the only external force P that exerts on nuts A, B, if P_A increases

$$P_A - P_B = P$$

$$\delta_B = 0$$

for preventing the external force applied on nut B being absorbed by nut A thus decreasing, so

When $\delta_B = 0$

$$aP_A^{2/3} - aP_{PL}^{2/3} = aP_{PL}^{2/3}$$

$$P_A^{2/3} = 2P_{PL}^{2/3}$$

$$P_A = \sqrt{8}\,P_{PL} \fallingdotseq 3P_{PL}$$

or based on $\delta_A - \delta_0 = \delta_0$

$$\delta_0 = \frac{\delta_A}{2}$$

thus it can also be judged from Fig. 6.3.2.3 that, when axial load is 3 times of preload laod, for a single nut with 1/2 displacement, the rigidity is 2 times as high.

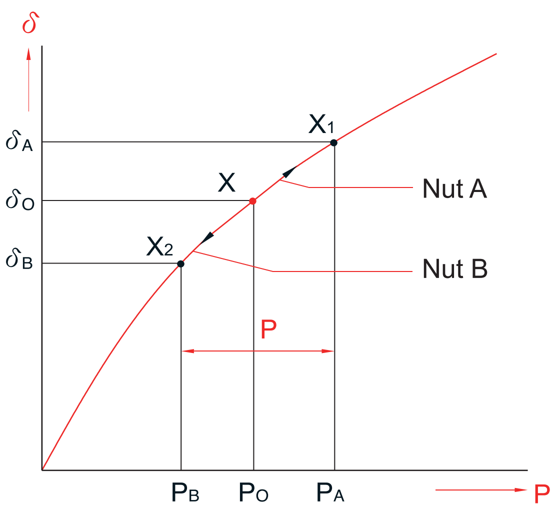


Fig. 6.3.2.2

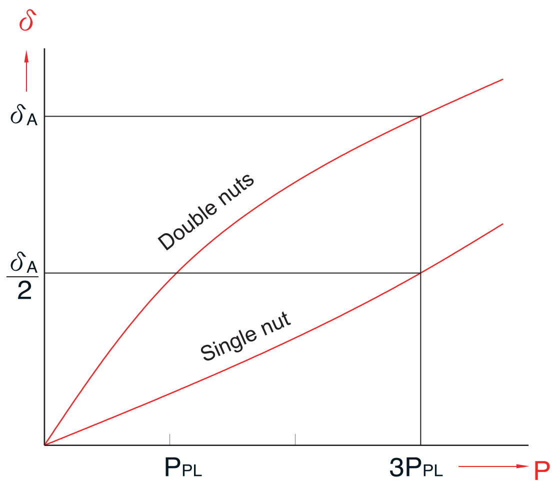


Fig. 6.3.2.3

(3) Axial rigidity K_B and displacement δ_B of bracing shaft

$$K_B = \frac{P}{\delta_B} \ (kgf/mm)$$

The rigidity of the assembled diagonal thrust ball bearing that is used as the bracing bearing for the Ball Screw and is widely utilized in the field of precision machines can be found from the following formula.

$$\delta_B = \frac{2}{\sin\beta}\left(\frac{Q^2}{d}\right)^{1/3}$$

$$Q = \frac{P}{n \cdot \sin\beta} \ (kgf)$$

Q : Load of one steel ball (kgf)

β : Angle of contact (45°)

d : Steel ball diameter (mm)

ℓ_a : Effective distance of scroll

P : Axial load (kgf)

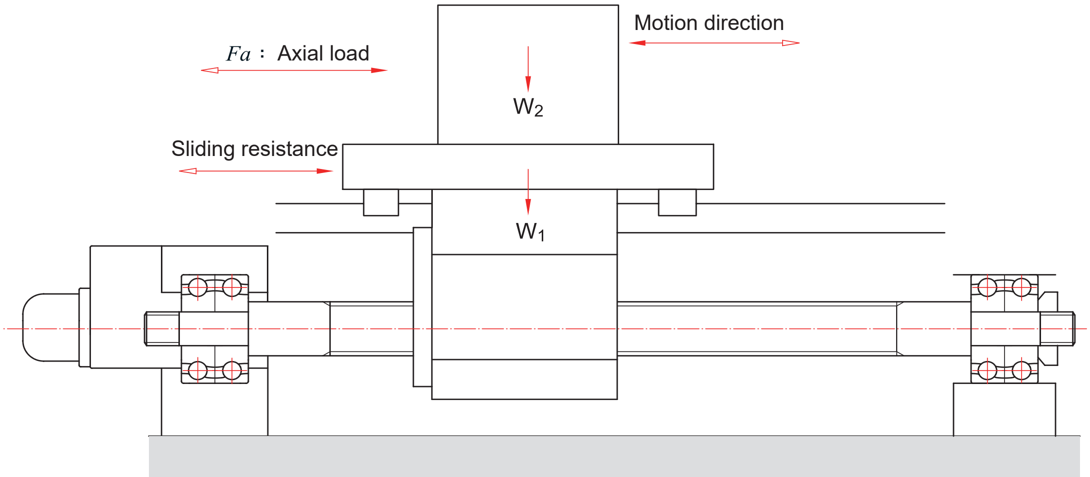
n : Number of steel ball

(4) Axial rigidity K_H and displacement δ_H of installation portions of nuts and bearings.

In early stage of machine development, special attentions should be paid to the requirement of high rigidity for the installation portion.

$$K_H = \frac{P}{\delta_H} \ (kgf/mm)$$

6.3.2.1 Horizontal reciprocating moving mechanism



Horizontal reciprocating moving mechanism

For reciprocal operation to move work horizontally (back and forth) in an conveyance system, the axial load (Fa) can be gotten using the following equations:

Acceleration (leftward)	$Fa_1 = \mu \times mg + f + ma$
Constant speed (leftward)	$Fa_2 = \mu \times mg + f$
Deceleration (leftward)	$Fa_3 = \mu \times mg + f - ma$
Acceleration (rightward)	$Fa_4 = -\mu \times mg - f - ma$
Constant speed (rightward)	$Fa_5 = -\mu \times mg - f$
Deceleration (rightward)	$Fa_6 = -\mu \times mg - f + ma$

Here

a : Acceleration

$$a = \frac{V\text{max}}{t}$$

Vmax : Rapid feed speed

t : Acceleration time

m : Total weight (table weight + work piece weight)

μ : Sliding surface friction coefficient

f : Non-load resistance

6.3.2.2 Vertital reciprocating moving mechanism

For reciprocal operation to move work vertically (back and forth) in an conveyance system, the axial load (Fa) can be gotten using the following equations:

Acceleration (upward)	$Fa_1 = mg + f + ma$
Constant speed (upward)	$Fa_2 = mg + f$
Deceleration (upward)	$Fa_3 = mg + f - ma$
Acceleration (downward)	$Fa_4 = mg - f - ma$
Constant speed (downward)	$Fa_5 = mg - f$
Deceleration (downward)	$Fa_6 = mg - f + ma$

Here

a : Acceleration

$$a = \frac{V\text{max}}{t_a}$$

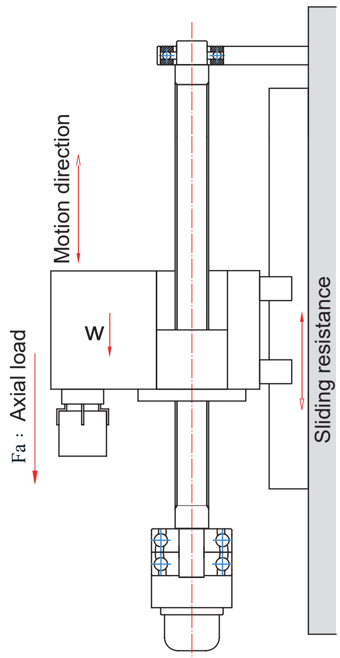
Vmax : Rapid feed speed

t_a : Acceleration time

m : Total weight (table weight + work piece weight)

μ : Sliding surface friction coefficient

f : Non-load resistance



Vertital reciprocating moving mechanism

6.4 Preload and effect

6.4.1 Ball Screw's preload and effect

In order to get high positioning accuracy, there are two ways to reach it. One is commonly known as to clear axial play to zero. The other one is to increase Ball Screw rigidity to reduce elastic deformation while taking axial load. Both two ways are done by preloading.

1 Methods of preloading

a. Double-nut method:

A spacer inserted between two nuts exerts a preload. There are two ways for it.

One is illustrated in Fig. 6.4.1.1 That is to use a spacer with thickness complies with required magnitude of preload. The spacer makes the gap between Nut A and B to be bigger, hence to produce a tension force on Nut A and B. it is called "extensive preload".

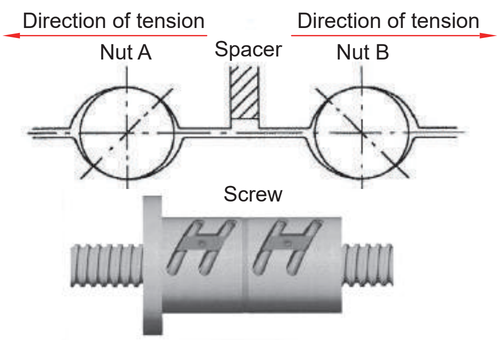


Fig. 6.4.1.1 Extensive preload

b. Single-nut method:

As that illustrated on Fig. 6.4.1.2 using oversize balls onto the space between Ball nut and screw to get required preload. The balls shall make four-point contact with grooves of Ball nut and screw.

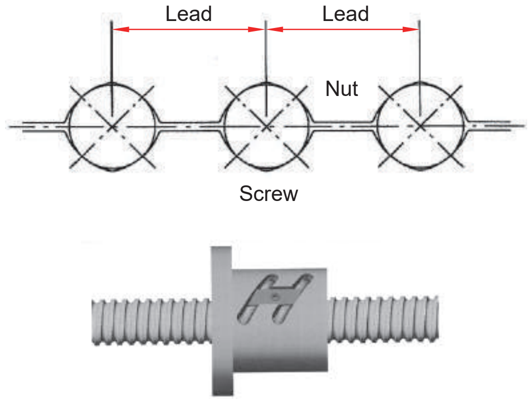


Fig. 6.4.1.2 Four point contact preload

2 Relation between preload force and elastic deformation

Fig. 6.4.1.3 Nuts A and B are assembled with preloading spacer. The preload forces on Nut A and B are F_{ao},but with reversed direction. The elastic in Fig. 6.4.1.4 deformation on both Nuts are δ_{a0}.

$$\delta_A = \delta_{a0} + \delta_{a1}$$
$$\delta_B = \delta_{a0} - \delta_{a1}$$

The load in nut A and nut B are:

$$F_A = F_{ao} + F_a - F_a' = F_a + F_p$$
$$F_B = F_{ao} - F_a' = F_p$$

Note: F_A and F_B have opposite directions

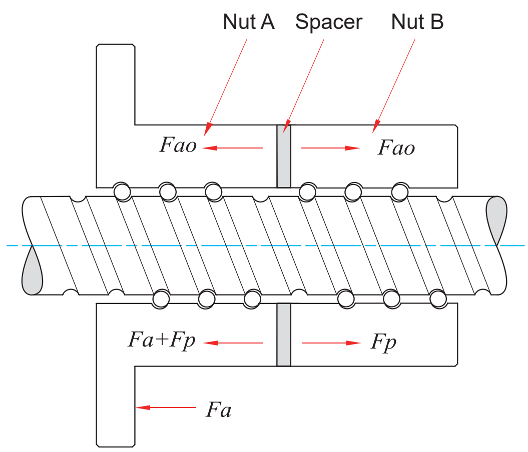


Fig. 6.4.1.3 Double-nut positioning preload

It means F_a is offset with an amount F_a' because of the deformation of Nut B decreases. As a result, the elastic deformation of Nut A is reduced. This effect shall be continued until the deformation of Nut B becomes zero, that is, until the elastic deformation δ_{a1} caused by the external axial force equals δ_{a0} , and the preload force applied to Nut B is completely released. The formula related the external axial force and elastic deformation is

$$\delta_{a0} = K \times Fao^{2/3} \text{ and } 2\delta_{a0} = K \times F_l^{2/3}$$

$$(F_l / Fao)^{2/3} = (2\delta_{a0} / \delta_{a0}) = 2$$

$$F_l = 2.8Fao \fallingdotseq 3Fao$$

Therefore, the preload amount of a Ball Screw is recommended to set as 1/3 of its axial load. Too much preload for a Ball Screw shall cause temperature raise and badly affect its life. However, taking the life and efficiency into consideration, the maximum preload amount of Ball Screw is commonly set to be 10% of its rated basic dynamic load.

Shown on Fig. 6.4.1.5 with the axial load to be three times as the preload, the elastic displacement for the non-preloaded ball nut is two times as that of the preloaded nut.

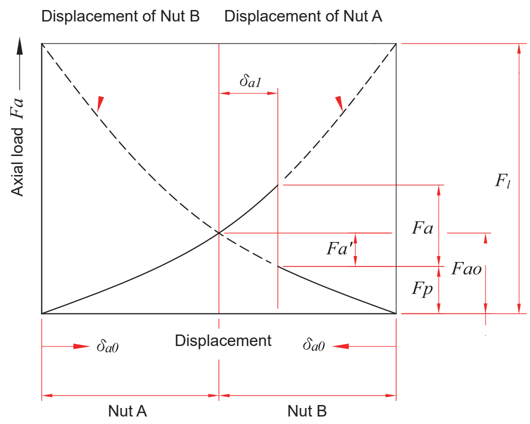


Fig. 6.4.1.4 Positioning preload diagram

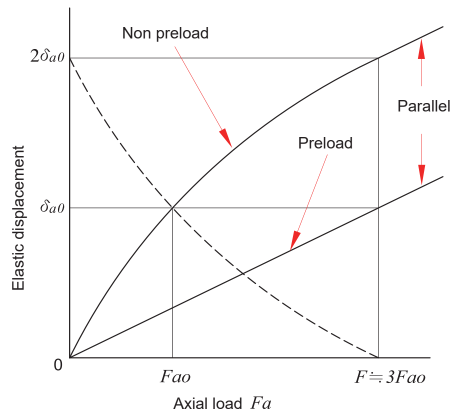


Fig. 6.4.1.5 Elastic displacement curve

6.4.2 Positioning accuracy

6.4.2.1 Causes of error in positioning accuracy

Lead error and rigidity of feed system are common causes of feed accuracy error. Other causes like thermal deformation and feed system assembly are also playing important roles in feed accuracy.

6.4.2.2 Considering thermal displacement

If the screw-shaft temperature increases during operation, the heat elongates the screw shaft, thereby reducing the positioning accuracy. Expansion and shrinkage of a screw shaft due to heat can be calculated using equation as below.

$$\Delta L_\theta = \rho \cdot \theta \cdot L$$

Here

ΔL_θ : Thermal displacement (μm)

ρ : Thermal-expansion coefficient (12μm/m˚C)

θ : Screw-shaft temperature change (˚C)

L : Ball screw length (mm)

That is to say, an increase in the screw shaft temperature of 1 expands the shaft by 12μm per meter. The higher the Ball Screw speed, the greater the heat generation. Thus, temperature increases reduce positioning accuracy. Where high accuracy. Where high accuracy is required, anti-temperature- elevation measures must be provided as follows:

Note: refer to Appendix (2) for examples of Ball Screws classes for different uses.

(1) To control temperature :
- Selecting appropriate preload
- Selecting correct and appropriate lubricant
- Selecting larger lead for Ball Screw and decrease the rotation speed

(2) Compulsory cooling:
- Ball Screw with hollow cooling
- Lubrication liquid or cooling air can be used to cool down external surface of Ball Screw.

(3) To keep off effect upon temperature raise:
- Set a negative cumulative lead target value for the Ball Screw
- Warm up the machine to stable machine's operating temperature
- Pretension by using on Ball Screw while installing onto the machine
- Positioning by closed loop

6.5 Life

6.5.1 Life of the Ball Screw

Even though the Ball Screw has been used with correct manner, it shall naturally be worn out and can no longer be used for a specified period. its life is defined by the period from starting use to ending use caused by nature fail.
a. Fatigue life - Time period for surface flaking off happened either on balls or on thread grooves.
b. Accuracy life - Time period for serious loosing of accuracy caused by wearing happened on thread groove surface, hence to make Ball Screw can no longer be used.

6.5.2 Fatigue life

The basic dynamic rate load (Ca) of the Ball Screw is used to calculate its fatigue life.

6.5.2.1 Basic dynamic rate load Ca

The basic dynamic rate load (Ca) is the revolution of 10^6 that 90% of identical Ball Screw units in a group, when operated independently of one another under the same conditions, can achieve without developing flaking.

6.5.2.2 Fatigue life

1 Calculation life:

There are three ways to show fatigue life:
a. Total number of revolutions
b. Total operating time
c. Total travel

$$L = \left(\frac{Ca}{Fa \times f_W}\right)^3 \times 10^6$$

$$L_t = \frac{L}{60 \times n}$$

$$L_s = \frac{L \times l}{10^6}$$

Here

L : Fatigue life (total number of revolutions) rev
L_t : Fatigue life (total operating time) (hr)
L_s : Fatigue life (total travel) (km)
Ca : Basic dynamic rate load (kgf)
Fa : Axial load (kgf)
n : Rotation speed (rpm)
l : Lead (mm)
f_w : Load factor (refer to Table 6.1)

Load factor f_w

Vibration and impact	Velocity (V)	f_w
Light	V<15 (m/min)	1.0~1.2
Medium	15<V<60 (m/min)	1.2~1.5
Heavy	V>60 (m/min)	1.5~3.0

Too long or too short fatigue life are not suitable for Ball Screw selection. Using longer life make the Ball Screw selection. Using longer life make the Ball Screw's dimensions too large. It's an uneconomical result. Following table is a reference of Ball Screw's fatigue life.

Machine center ....20,000 hrs
Production machine..................................10,000 hrs
Automatic controller..................................15,000 hrs
Surveying instruments ....15,000 hrs

2 Mean load

When axial load change constantly. It is required to calculate the mean axial load (F_m) and the mean rotational speed (N_m) for fatigue life. Setting axial load (Fa) as Y-axis; rotational number ($n.t$) as X-axis. Getting three kind curves or lines.

a. Gradational variation curve (Fig. 6.5.2.1)

Mean load can be calculated by using equation :

$$F_m = \left(\frac{F_1^3 \cdot n_1 \cdot t_1 + F_2^3 \cdot n_2 \cdot t_2 + \cdots + F_n^3 \cdot n_n \cdot t_n}{n_1 \cdot t_1 + n_2 \cdot t_2 + \cdots + n_n \cdot t_n} \right)^{\frac{1}{3}}$$

Mean rotation speed can be calculated by using equation :

$$N_m = \frac{n_1 \cdot t_1 + n_2 \cdot t_2 + \cdots + n_n \cdot t_n}{t_1 + t_2 + \cdots + t_n}$$

Axial load (kgf)	Rotation speed (rpm)	Time ratio (Sec)
F_1	n_1	t_1
F_2	n_2	t_2
⋮	⋮	⋮
F_n	n_n	t_n

b. Similar straight line (Fig. 6.5.2.2)

When mean load variation curve is like similar straight line Fig.6.5.2.2.

Mean rotational speed can be calculated by using equation.

$F_m = 1/3(F_{min} + F_{max})$

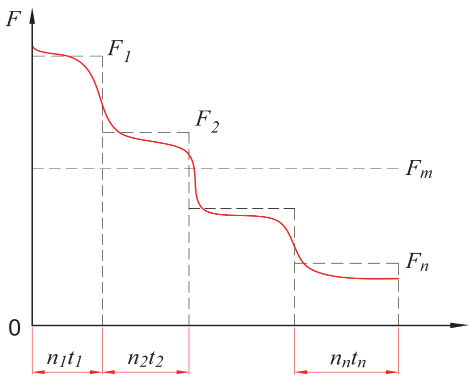


Fig. 6.5.2.1 Gradational variation curve's load

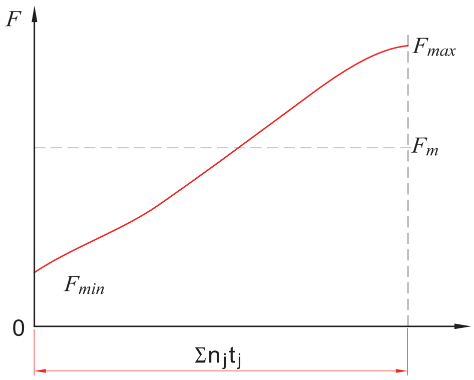


Fig. 6.5.2.2 Similar straight line's load

c. There are two cases when it display as Sine curve :

1. When mean load variation curve is shown as the diagram below (Fig.6.5.2.3)
   Mean rotational speed can be calculated by using equation.
   $F_m = 0.65F_{max}$
2. When mean load variation curve is shown as the diagram below (Fig.6.5.2.4)
   Mean rotational speed can be calculated by using equation.
   $F_m = 0.75F_{max}$

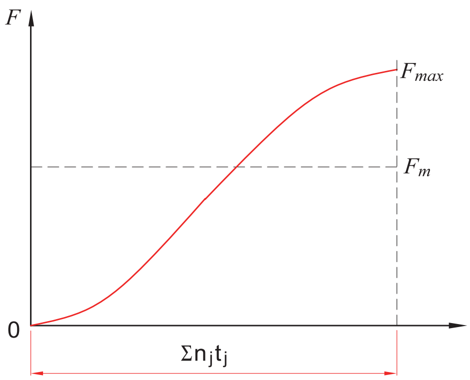


Fig. 6.5.2.3 Variation like Sine's curve load (1)

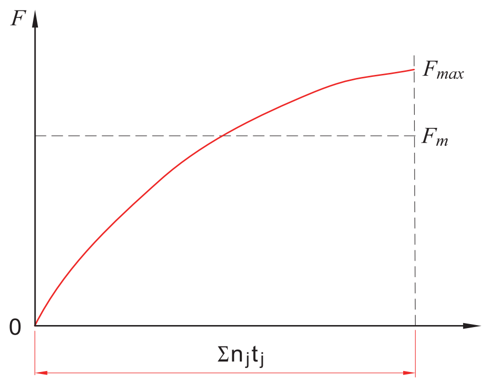


Fig. 6.5.2.4 Variation like Sine's curve load (2)

6.5.3 Material and Hardness

Material and Hardness of ABBA Ball Screws

Denomination	Material	Heat treating	Hardness (HRC)
Rolled	S55C	Induction hardening	58~62
Nut	SCM415H	Carburized hardening	58~62

6.5.4 Lubrication

Lithium base lubricants are used for Ball Screw lubrication.
Their viscosity are 30~40 cst (40˚C) and ISO grades of 32~100.
Selecting:

1. Low temperature application : Using the lower viscosity lubricant.
2. High temperature, high load and low speed application : Using the higher viscosity lubricant.

Checking and supply interval of lubricant

The following table shows the general indicators of lubricant inspection and replenishment intervals.
Wipe off the old lubricant attached to the screw shaft during replenishment before replenishing

Manner	Checking interval	Checking item	Supply or replacing interval
Automatic interval oil supply	Every week	Oil volume and purity	To supply on each check, its volume depends on oil tank capacity
Lubricating grease	Within 2-3 months after starting operation of machine	Foreign matter	Normally supply once a year as per the result of check
Oil bath	Everyday before operation of machine	Oil surface	To supply as per wasting condition

6.5.5 Dustproof

Same as the rolling bearings, if there is the particles such as chips or water get into the Ball Screw, the wearing problem shall be deteriorated. In some serious cases, Ball Screw shall then be damaged. In order to prevent these problems from happening, there are wipers assembled at both ends of ball nut to scrape chips and dust. There is also the “O-Ring” at the wipers to seal the lubrication oil from leaking from ball nut.

6.5.6 Key points for Ball Screws selection and calculation

Key points for Ball Screws selection

When Ball Screws are subjected to selection, it is a most fundamental rule that you must clearly find out what the operation conditions are before going ahead with the final design. Moreover, the elements of your selection include load weight, stroke, torque, position determination accuracy, tracking motion, hardness, lead stroke, nut inside diameter, etc., all elements are mutually related, any change to one of the elements are mutually related, any change to one of the elements, special attention should always be paid to the balance among the elements.

1. Setting of operation conditions

(a) Machine service life time reckoning of H (hr)

H = ☐ × ☐ × ☐ × ☐

hours/day　days/year　life years　Running

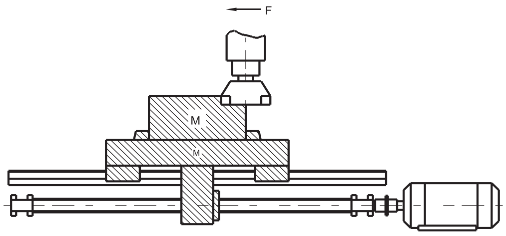
(b) Mechanical conditions

Calculation Date / Difference Operations	Speed/rotations	Cutting resistance	Sliding resistance	Time used
Fast feed	m / min / min^{-1}	kgf	kgf	%
Light cutting	/			
Medium cutting	/			
Heavy cutting	/			

(c) Position determination accuracy

Feed accuracy error factor includes load accuracy and system rigidity. Thermal displacement due to heat generation and positional error of the guide system is also important factors.

Calculation for Ball Screws selection



Design conditions

1.	Working table weight	300	Kg
2.	Working object weight	400	Kg
3.	Maximum stroke	700	mm
4.	Fast feed speed	10	m/min
5.	Minimal disassembly ability	10	μ m/stroke
6.	Driving Motor DC Motor	(MAX 1000 min^{-1})	
7.	Guiding surface friction coefficeint	(μ= 0.05～0.1)	
8.	Running rate	60%	
9.	Accuracy review items		
10.	Inertia generated during acceleration/deceleration can be neglected because the time periods involved are comparatively small.		

1. Setting of operation conditions

(a) Machine service life time reckoning of H (hr)

H = 12hr X 250 days X 10 years X 0.6 Running
=18000hr

(b) Mechanical conditions

Calculation Date / Difference Operations	Speed/rotations	Cutting resistance	Sliding resistance	Time used
Fast feed	10m/min/1000min^{-1}	0 kgf	70 kgf	10 %
Light cutting	6 / 600	100	70	50
Medium cutting	2 / 200	200	70	30
Heavy cutting	1 / 100	300	70	10

Sliding resistance = (300+400) × 0.1=70 kgf

Key points for Ball Screws selection	Calculation for Ball Screws selection
2.Ball Screws lead stroke ℓ (mm) $\ell = \frac{\text{Fast feed stroke (m/min)} \times 1000}{\text{Max. Rotating speed (min}^{-1})}$ (mm)	**2.Ball Screws lead stroke ℓ (mm)** $\ell = \frac{10000}{1000} = 10$ (mm) Minimal disassembly = $\frac{10\text{mm}}{1000\text{ stroke}}$ = 0.01 mm/stroke
3.Computation of average load Pe (kgf) $Pe = \left(\frac{P_1^3 n_1 t_1 + P_2^3 n_2 t_2 + \cdots + P_n^3 n_n t_n}{n_1 t_1 + n_2 t_2 + \cdots + n_n t_n}\right)^{1/3}$ $Pe = \frac{2Pmax + Pmin}{3}$ $pe \fallingdotseq 0.65 Pmax$ $pe \fallingdotseq 0.75 Pmin$	**3.Computation of average load Pe (kgf)** Pe = $\left(\frac{70^3 \times 1000 \times 10 + 170^3 \times 600 \times 50 + 270^3 \times 200 \times 30 + 370^3 \times 100 \times 10}{1000 \times 10 + 600 \times 50 + 200 \times 30 + 100 \times 10}\right)^{1/3}$ $= \left(\frac{31.7 \times 10^{13}}{4.7 \times 10^4}\right)^{1/3}$ $\fallingdotseq$ 189 kgf
4.Average number of rotation n_m $n_m = \frac{n_1 t_1 + n_2 t_2 + \cdots + n_n t_n}{100}$	**4.Average number of rotation n_m** $n_m = \frac{1000 \times 10 + 600 \times 50 + 200 \times 30 + 100 \times 10}{100}$ $= \frac{4.7 \times 10^4}{100}$ $= 470 \text{ min}^{-1}$
5.Calculation of required dynamic rated load Ca (kgf) Ca = Pe • fs	**5.Calculation of required dynamic rated load Ca (kgf)** Ca =189×5=945 (kgf)
6.Calculation of required static rated load Coa (kgf) Coa=Pmax • fs	**6.Calculation of required static rated load Coa (kgf)** Coa = 369×5 =1845 (kgf)
7.Selection of nut type Ca＞945 Coa＞1845 Select the nut types with basic dynamic rated load and basic static rated load as specified above.	**7.Selection of nut type** Choose SFI 4010 on the catalogue Ca = 3178 kgf Coa = 9480 kgf

Key points for Ball Screws selection	Calculation for Ball Screws selection

8. Calculation of life confirmation Lt (h)

$$L_t = \left(\frac{Ca}{Pe \cdot fw}\right)^3 \cdot \frac{1}{60 n_m} \cdot 10^6$$

8. Calculation of life confirmation Lt (h)

$$L_t = \left(\frac{3178}{189 \cdot 2}\right)^3 \cdot \frac{1}{60 \cdot 470} \cdot 10^6$$

$$= 20479 \text{ (h)}$$

9. Determination of screw length

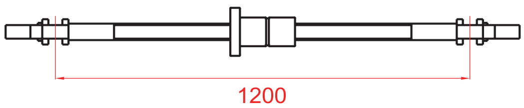
Screw length =
Maximal stroke + Nut length + 2 X reserved length at shaft end

9. Determination of screw length

Screw length = 700 + 93 + 2 x 81 = 874 mm

10. Mounting distance of screw length

10. Mounting distance of screw length (Fixed - Fixed)



11. Permissible axial load

11. Permissible axial load

Omitted because of Fixed - Fixed

12. Permissible revolution speed n and dm

$$n = \alpha \times \frac{60\lambda^2}{2\pi L^2}\sqrt{\frac{EIg}{\gamma A}} = f\frac{dr}{L^2} \times 10^7 \text{ (rpm)}$$

dm = Shaft dia. X Maximal speed

12. Permissible revolution speed n and dm

$$n = \frac{21.9 \times 35.2 \times 10^7}{1200^2}$$

$$= 5353 \text{min}^{-1} > n\text{max}$$

$$dm = 40 \times 1000$$

$$= 40000 < 50000$$

13. Countermeasure against thermal

$$\Delta L_\theta = \rho \cdot \theta \cdot L$$

Here

ΔL_θ : Thermal displacement (μm)

ρ : Thermal-expansion coefficient (12μm/m˚C)

θ : Screw-shaft temperature change (˚C)

L : Ball screw length (mm)

13. Countermeasure against thermal

It is estimated there would be a temperature rise of 2~5˚C with the Ball Screws of the general machinery, take temperature rise of 2˚C to computer the extension of Ball Screw.

$$\Delta L_\theta = \rho \cdot \theta \cdot L$$

$$= 12 \times 10^{-6} \times 2 \times 700 \text{ mm} \fallingdotseq 0.0168 \text{ mm}$$

$$F_P = \frac{EA\Delta L_\theta}{L}$$

$$= \frac{2.06 \times 10^4 \times \frac{\pi \times 35.2^2}{4} \times 0.0168}{700} \fallingdotseq 481 \text{ kgf}$$

Deviation can be corrected by estimating the temperature rise per extension of 0.0168mm, and taking into consideration of the pre-tension of 481 kgf.

Key points for Ball Screws selection	Calculation for Ball Screws selection

Key points for Ball Screws selection

14. Rigidity review

(1) Axial rigidity Ks and displacement δ_S of screw shaft

$$K_S = \frac{P}{\delta_S} \ (\text{kgf / mm})$$

P = Axial load (kgf)

For places of Fixed - Fixed installation

$$\delta_{SF} = \frac{PL}{4AE} \ (\text{mm})$$

(2) Axial rigidity K_N and displacement δ_N of nut

$$K_N = \frac{P}{\delta_S} \ (\text{kgf / mm})$$

In case of single nut

$$\delta_{NS} = \frac{K}{\sin\beta}\left(\frac{Q^2}{d}\right)^{1/3} \times \frac{1}{\xi} \ (\text{mm})$$

$$Q = \frac{P}{n \cdot \sin\beta} \ (\text{kgf})$$

$$n = \frac{D_0 \pi m}{d} \ (\text{each})$$

(3) Axial rigidity K_B and displacement δ_B of Support bearing

$$K_B = \frac{P}{\delta_B} \ (\text{kgf / mm})$$

Calculation for Ball Screws selection

14. Rigidity review

(1) Rigidity

$$\delta_{SF} = \frac{PL}{4AE} = \frac{27 \times 1200}{4 \times \frac{\pi \times 35.2^2}{4} \times 2.06 \times 10^4}$$

$= 0.00036$ mm

$$K_S = \frac{370}{0.00036} = 10.3 \times 10^5 \ \text{kgf / mm}$$

(2) Rigidity of steel ball and nut groove

$$n = \frac{41.8 \times \pi \times 2.5}{6.35} = 52$$

$$Q = \frac{370}{52 \sin 45^\circ} = 10$$

$$\delta_{NS} = \frac{0.00057}{\sin 45^\circ}\left(\frac{10^2}{6.35}\right)^{1/3} \times \frac{1}{0.7}$$

$= 2.9 \times 10^{-3}$ mm

$$K_N = \frac{370}{2.9 \times 10^{-3}} = 1.28 \times 10^5 \ \text{kgf/mm}$$

(3) Rigidity of brancing bearings
Where, nut rigidity 50 kgf/mm

$$\delta_B = \frac{370}{50 \times 2} = 3.7 \ \mu\text{m}$$

$$K_B = \frac{370}{0.0037} = 1 \times 10^5 \ \text{kgf/mm}$$

◎ $\delta_{TOTAL} = 0.36 + 2.9 + 3.7 = 6.96 \ \mu\text{m}$

15. Confirmation of the Ball Screw life

15. Confirmation of the Ball Screw life

L = 20479(h) > 18000 (h)

6.6 Driving torque

Driving torque Ts of the transmission shaft

$T_S = T_P + T_D + T_F$ (in fixed speed)

$T_S = T_G + T_P + T_D + T_F$ (when accelerating)

- T_G : Acceleration torque (1)
- T_P : Load torque (2)
- T_D : Preload torque (3)
- T_F : Friction torque (4)

1 Acceleration torque T_G

$T_G = J\alpha$ (kgf • cm)

$$\alpha = \frac{2\pi n}{60\Delta t} \quad (rad/s^2)$$

- J : Moment of inertia (kgf • cm • s^2)
- α : Angular acceleration (rad/s^2)
- n : Revolutions (min^{-1})
- Δt : Starting time (sec)

2 Load torque T_P

$$T_P = \frac{P \cdot \ell}{2\pi\eta_1} \quad (kgf \cdot cm)$$

$P = F + \mu Mg$

- P : Axial load (kgf)
- ℓ : lead (cm)
- η_1 : Positive efficiency
  - The efficiency when rotating motion is altered to linear motion
- F : Cutting force (kgf)
- μ : Friction coefficient
- M : Mass of moving object (kg)
- g : Acceleration of gravity (9.8 m/s^2)

$$T_P = \frac{P \cdot \ell \cdot \eta_2}{2\pi}$$

- η_2 : Reverse efficiency
  - The efficiency when linear motion returns to rotating motion

3 Preload torque T_D

$$T_D = \frac{K \cdot P_{PL} \cdot \ell}{\sqrt{\tan\alpha} \cdot 2\pi} \quad (kgf \cdot cm)$$

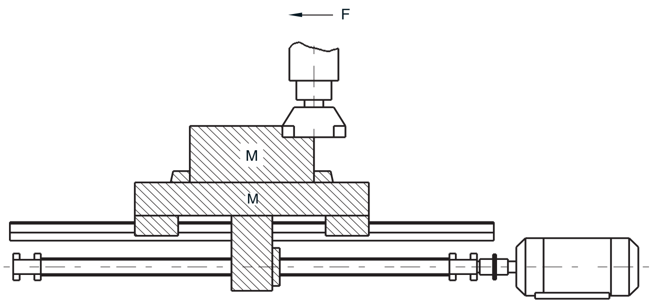
- K : Internal coefficient (0.05 is usually adopted)
- P_{PL} : Preload (kgf)
- ℓ : Lead (cm)
- α : Lead angle

4 Friction torque T_F

$T_F = T_B + T_O + T_J$ (kgf • cm)

- T_B : Friction torque of bracing shaft
- T_O : Friction torque of free shaft
- T_J : Friction torque motor shaft

The friciton torque of the bracing shaft would be affected by the lubrication oil. Or special attention has to be paid to unexpected excessive friction torque which may be generated when oil seal is overly tight, or may result in temperature rise.



Moment of inertia of load

【For reference】Moment of inertia of load

$J = J_{BS} + J_{CU} + J_W + J_M$

- J_{BS} : Moment of inertia Ball Screws shaft
- J_{CU} : Moment of inertia coupler
- J_W : Moment of inertia linear motion part
- J_M : Moment of inertia Roller shaft part of motor shaft

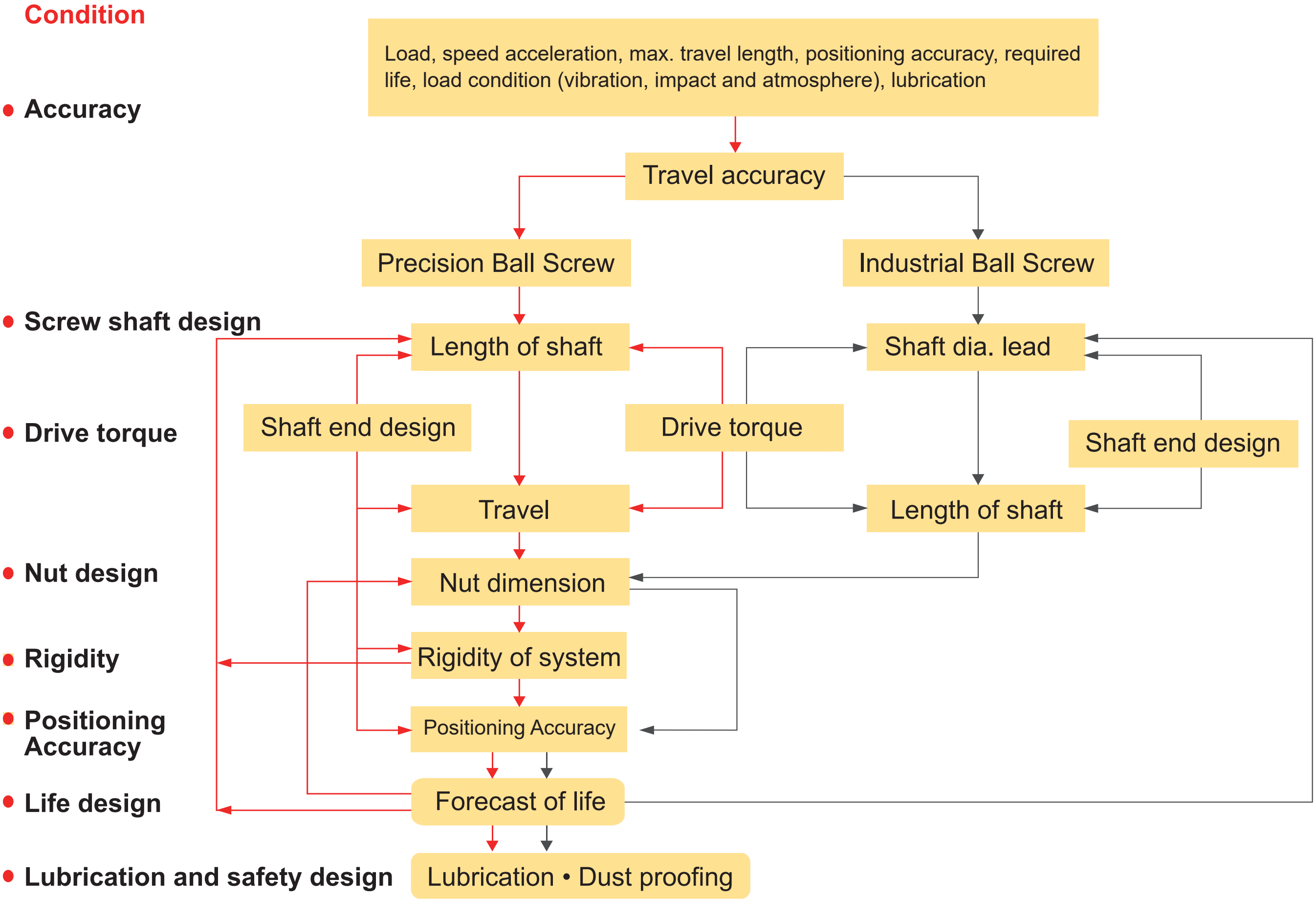
Conversion formula for moment of inertia of load

Moment of inertia converted from motor shaft \ Formula	J
Cylinder load	$\frac{\pi\rho L D^4}{32}$
Linearly moving object	$\frac{M}{4}\left(\frac{V_\ell}{\pi \cdot N_M}\right)^2 = \frac{M}{4}\left(\frac{P}{\pi}\right)^2$
Unit	kg • m^2
Moment if inertia during deceleration	$J_M = \left(\frac{J_\ell}{N_M}\right)^2 \cdot J_\ell$

- ρ : Density (kg / m^3) $\rho = 7.8 \times 10^3$
- L : Cylinder length (m)
- D : Cylinder diameter (m)
- M : Mass of linear motion part (kg)
- V_ℓ : Velocity of linearly moving object (m / min)
- N_M : Motor shaft revolutions (min^{-1})
- P : The moving magnitude of the linearly moving object per every rotation of the motor (m)
- N_ℓ : Rotations in longitudinal moving direction (min^{-1})
- J_ℓ : Moment of inertia in load direction
- J_M : Moment of inertia in motor direction

6.7 Selecting correct type Ball Screw

Condition



ABBA Ball Screw size list

Dia. \ Lead	1	2	2.5	3	4	5	5.08	6	10	12.7	16	20	25	32	40	50
6	◉															
8	◉	◉	◉													
10		◉		◉	◉											
12		◉			◉	◉			◉	◉						
14		◉			◉	◉										
15												◉				
16		◉			◉	◉	◉		◉		◉					
20						◉			◉			◉				
25					◉	◉			◉			◉	◉			
32						◉		◉	◉			◉		◉		
40						◉		◉	◉			◉			◉	
50									◉			◉				◉
63									◉			◉			◉	
80									◉			◉				

◉ Rolled Ball Screw

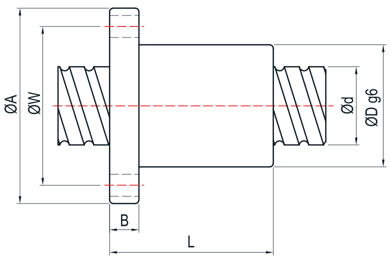
6.8 Ordering key of Ball Screw

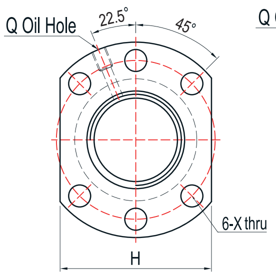
2R25-25A2-2-FSED-2000-2500-0.05-R-P0

- **Preload** : P0 With backlash   P1 Non-backlash
- **R:** Rolled
- **Accuracy grade** 0.05 : C7
  0.018 : C5
- **Screw Overall length**
- **Screw length**
- **Flange type** N: Non-cutting
  S: Single-cutting
  D: Double-cutting
- **Circulation type** H: Convex tube outer circulation
  U: European regulations DIN69051
  I : Inner loop
  E: High lead
  C: Low noise
- **Nut type** Y: Cylindrical keyway
  K: Miniature
  S: Single nut
  D: Double nut
- **Flange type** (F:With flange, R:Without flange, X:Special flange)
- **Number of nuts on a single screw**
- **Number of ball return caps per nut**
- **No. of Turn (circuits) or Turn x Row**
  T: 1 circuit
  A: 1.8 circuits
  B: 2.5 circuits
  C: 3.5 circuits
- **Lead**
- **Shaft dia.**
- **Direction of helix** R : Right / L : Left
- **Number of thread teeth** (single thread is not marked)

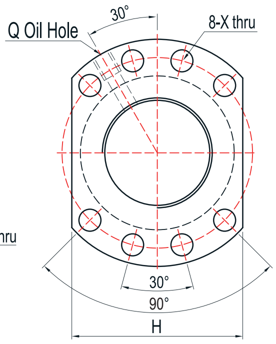
6.9 Dimension of Ball Screw

6.9.1 FSU (DIN69051)

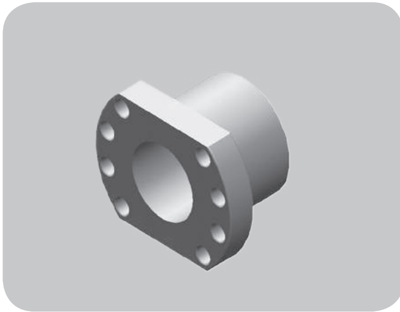




Type A



Type B

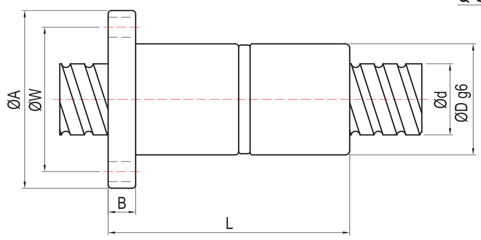


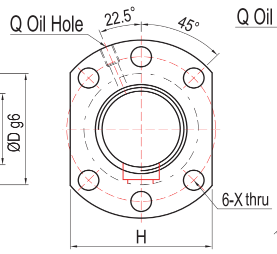
Unit : mm

Model No.	Dimensions														
	d	l	Da	D	A	B	L	W	X	Type	H	Q	n	Ca(Kgf)	Coa(kgf)
1204-4	12	4	2.381	24	40	10	40	32	4.5	A	30	M6	T4	816	1489
1604-4	16	4	2.381	28	48	10	45	38	5.5	A	40	M6	T4	939	2048
★ 1605-3	16	5	3.175	28	48	10	42	38	5.5	A	40	M6	T3	1063	1957
★ 1605-4	16	5	3.175	28	48	10	50	38	5.5	A	40	M6	T4	1361	2609
2005-3	20	5	3.175	36	58	10	47	47	6.6	A	44	M6	T3	1192	2542
★ 2005-4	20	5	3.175	36	58	10	53	47	6.6	A	44	M6	T4	1527	3390
2006-3	20	6	3.969	36	58	10	52	47	6.6	A	44	M6	T3	1589	3062
2010-3	20	10	3.969	36	58	10	68	47	6.6	A	44	M6	T3	1603	3122
2504-4	25	4	2.381	40	62	11	46	51	6.6	A	48	M6	T4	1173	3350
2505-3	25	5	3.175	40	62	10	47	51	6.6	A	48	M6	T3	1340	3268
★ 2505-4	25	5	3.175	40	62	10	53	51	6.6	A	48	M6	T4	1716	4357
2510-3	25	10	4.762	40	62	12	75	51	6.6	A	48	M6	T3	2260	4657
2510-4	25	10	4.762	40	62	12	85	51	6.6	A	48	M6	T4	2894	6210
★ 3205-4	32	5	3.175	50	80	12	53	65	9	A	62	M6	T4	1932	5705
3206-4	32	6	3.969	50	80	12	58	65	9	A	62	M6	T4	2592	6979
3210-3	32	10	6.35	50	80	16	77.5	65	9	A	62	M6	T3	3721	7924
3210-4	32	10	6.35	50	80	16	90	65	9	A	62	M6	T4	4765	10565
★ 4005-4	40	5	3.175	63	93	16	56	78	9	B	70	M8	T4	2147	7250
4006-4	40	6	3.969	63	93	14	60	78	9	B	70	M6	T4	2880	8862
4010-4	40	10	6.35	63	93	18	93	78	9	B	70	M8	T4	5331	13636
5006-4	50	6	3.969	75	110	15	62	93	11	B	85	M8	T4	3208	11324
5010-4	50	10	6.35	75	110	18	93	93	11	B	85	M8	T4	5986	17502
6310-4	63	10	6.35	90	125	18	98	108	11	B	95	M8	T4	6727	22820
6320-3	63	20	9.525	95	135	20	138	115	13.5	B	100	M8	T3	8931	24831
8010-4	80	10	6.35	105	145	20	98	125	13.5	B	110	M8	T4	7519	29386
8020-3	80	20	9.525	125	165	25	143	145	13.5	B	130	M8	T3	10076	32217

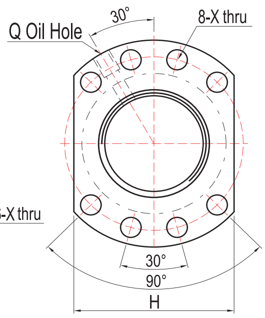
Note: with sign ★ can produce left helix

6.9.2 FDU (DIN69051)

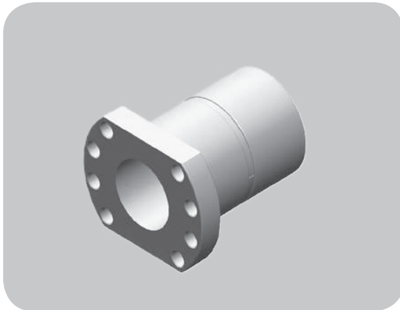




Type A



Type B

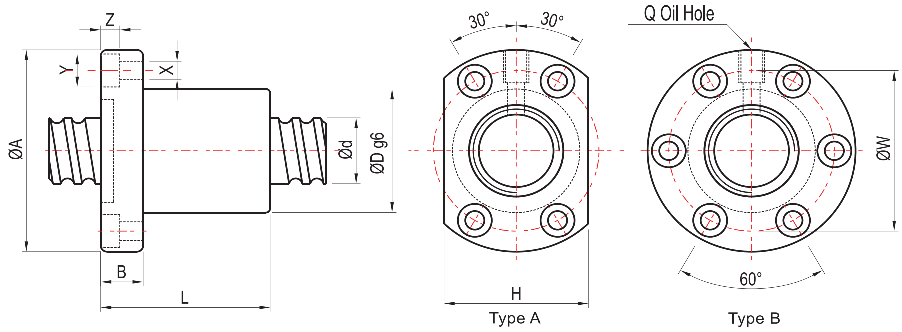


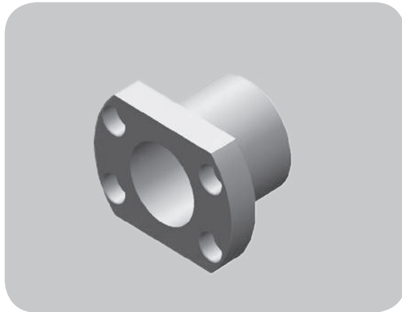
Unit : mm

Model No.	Dimensions													
	d	l	Da	D	A	B	L	W	X	Type	H	Q	n	Ca(Kgf)	Coa(kgf)
★ 1605-3	16	5	3.175	28	48	10	80	38	5.5	A	40	M6	T3	1063	1957
★ 2005-4	20	5	3.175	36	58	12	92	47	6.6	A	44	M6	T4	1527	3390
★ 2505-4	25	5	3.175	40	62	12	92	51	6.6	A	48	M6	T4	1716	4357
2510-4	25	10	4.762	40	62	12	153	51	6.6	A	48	M6	T4	2896	6210
★ 3205-4	32	5	3.175	50	80	12	92	65	9	A	62	M6	T4	1932	5705
3210-4	32	10	6.35	50	80	16	160	65	9	A	62	M6	T4	4765	10565
4005-4	40	5	3.175	63	93	15	96	78	9	B	70	M8	T4	2147	7250
4010-4	40	10	6.35	63	93	18	162	78	9	B	70	M8	T4	5331	13636
5010-4	50	10	6.35	75	110	16	162	93	11	B	85	M8	T4	5986	17502
6310-4	63	10	6.35	90	125	18	182	108	11	B	95	M8	T4	6727	22820
6320-3	63	20	9.525	95	135	20	253	115	13.5	B	100	M8	T3	8931	24831
8010-4	80	10	6.35	105	145	20	182	125	13.5	B	110	M8	T4	7519	29386
8020-3	80	20	9.525	125	165	25	253	145	13.5	B	130	M8	T3	10076	32217

Note: with sign ★ can produce left helix

6.9.3 FSI



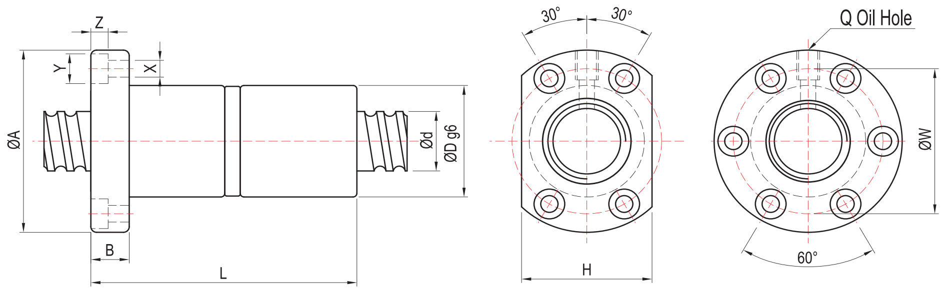


Unit : mm

Model No.	Dimensions																
	d	l	Da	D	A	B	L	W	X	Y	Z	Type	H	Q	n	Ca(Kgf)	Coa(kgf)
1404-4	14	4	2.381	26	46	10	47	36	4.5	8	4.5	A	34	M6	T4	880	1769
1405-3	14	5	3.175	26	46	10	45	36	4.5	8	4.5	A	34	M6	T3	995	1686
1604-4	16	4	2.381	30	49	10	45	39	4.5	8	4.5	A	34	M6	T4	939	2048
★ 1605-3	16	5	3.175	30	49	10	42	39	4.5	8	4.5	A	34	M6	T3	1063	1957
★ 1605-4	16	5	3.175	30	49	10	50	39	4.5	8	4.5	A	34	M6	T4	1361	2609
1610-3	16	10	3.175	34	58	10	65	45	5.5	9.5	5.5	A	36	M6	T3	1490	3207
★ 2005-4	20	5	3.175	34	57	12	53	45	5.5	9.5	5.5	A	40	M6	T4	1527	3390
2010-3	20	10	3.969	46	74	13	54	59	6.6	11	5.5	A	46	M6	T3	1648	3554
2504-4	25	4	2.381	40	63	11	46	51	5.5	9.5	5.5	A	46	M6	T4	1173	3350
★ 2505-4	25	5	3.175	40	63	12	53	51	5.5	9.5	5.5	A	46	M8	T4	1716	4357
2510-4	25	10	4.762	46	72	12	85	58	6.5	11	6.5	A	52	M6	T4	2894	6210
★ 3205-4	32	5	3.175	46	72	12	53	58	6.5	11	6.5	A	52	M8	T4	1932	5705
3206-4	32	6	3.969	62	89	12	63	75	6.5	11	6.5	B	-	M8	T4	2592	6897
3210-4	32	10	6.35	54	88	16	90	70	9	14	8.5	A	62	M8	T4	4765	10565
★ 4005-4	40	5	3.175	56	90	16	56	72	9	14	8.5	A	64	M8	T4	2147	7250
4010-4	40	10	6.35	62	104	18	93	82	11	17.5	11	A	70	M8	T4	5331	13636
5010-4	50	10	6.35	72	114	18	93	92	11	17.5	11	A	82	M8	T4	5986	17502
6310-4	63	10	6.35	85	131	22	100	107	14	20	13	B	-	M8	T4	6727	22820
6320-3	63	20	9.525	95	153	23	130	123	18	26	17.5	B	-	M8	T3	8931	24831
8010-4	80	10	6.35	105	150	22	92	127	14	20	13	B	-	M8	T4	7519	29386
8020-3	80	20	9.525	115	173	23	130	143	18	26	17.5	B	-	M8	T3	10076	32217

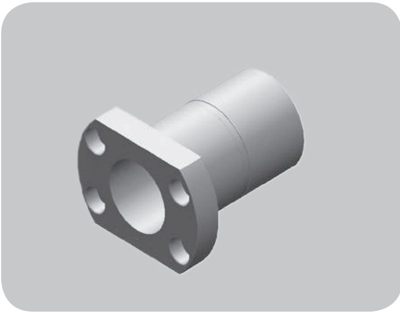
Note: with sign ★ can produce left helix

6.9.4 FDI



Type A

Type B

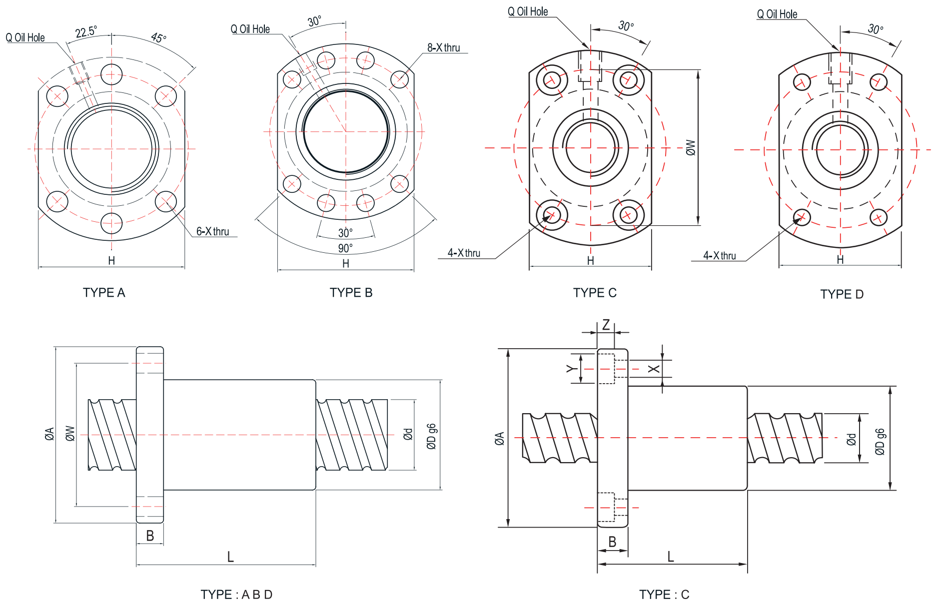


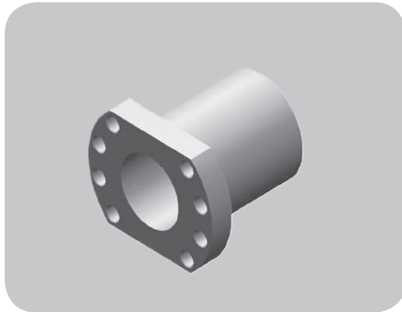
Unit : mm

Model No.	Dimensions															
	d	l	Da	D	A	B	L	W	X	Y	Z	Type	H	Q	n	Ca(Kgf)	Coa(kgf)
★ 1605-3	16	5	3.175	30	49	10	80	39	4.5	8	4.5	A	34	M6	T3	1063	1957
★ 2005-4	20	5	3.175	34	57	12	92	45	5.5	9.5	5.5	A	40	M6	T4	1527	3390
★ 2504-4	25	4	2.381	40	63	11	80	51	5.5	9.5	5.5	A	46	M6	T4	1173	3350
★ 2505-4	25	5	3.175	40	63	12	92	51	5.5	9.5	5.5	A	46	M8	T4	1716	4357
2510-4	25	10	4.762	46	72	12	156	58	6.5	11	6.5	A	52	M6	T4	2894	6210
★ 3205-4	32	5	3.175	46	72	12	92	58	6.5	11	6.5	A	52	M8	T4	1932	5705
3210-4	32	10	6.35	54	88	16	160	70	9	14	8.5	A	62	M8	T4	4765	10565
★ 4005-4	40	5	3.175	56	90	16	96	72	9	14	8.5	A	64	M8	T4	2147	7250
4010-4	40	10	6.35	62	104	18	162	82	11	17.5	11	A	70	M8	T4	5331	13636
5010-4	50	10	6.35	72	114	18	162	92	11	17.5	11	A	82	M8	T4	5986	17502
6310-4	63	10	6.35	85	131	22	182	107	14	20	13	B	-	M8	T4	6727	22820
6320-3	63	20	9.525	95	153	23	253	123	18	26	17.5	B	-	M8	T3	8931	24831
8010-4	80	10	6.35	105	150	22	182	127	14	20	13	B	-	M8	T4	7519	29386
8020-3	80	20	9.525	115	173	23	253	143	18	26	17.5	B	-	M8	T3	10076	32217

Note: with sign ★ can produce left helix

6.9.5 FSC



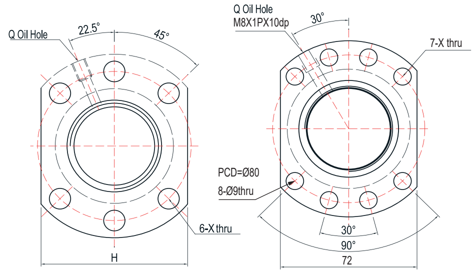


Unit : mm

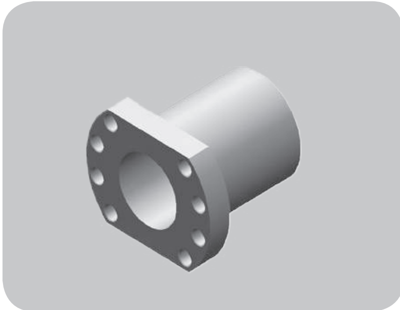
Model No.	Dimensions														
	d	I	Da	D	A	B	L	W	X	Y	Z	Type	H	Q	n	Ca(Kgf)	Coa(kgf)
1205-3	12	5	2	24	40	8	30	32	3.6	-	-	D	25	-	T3	513	1051
1210-2	12	10	2	30	50	10	40	40	4.5	8	4.5	C	32	M6	T2	347	657
1520-2	15	20	3.175	34	55	12	57	45	6	-	-	D	34	M6	T2	729	1353
1610-3	16	10	3.175	28	48	12	43	38	5.5	-	-	A	40	M6	T3	1097	2245
1616-4	16	16	3.175	28	48	12	61	38	5.5	-	-	A	40	M6	T4	1361	2886
2010-3	20	10	3.969	46	74	13	54	59	6.6	11	5.5	C	46	M6	T3	1648	3554
2525-4	25	25	3.969	47	74	12	67	60	6.6	-	-	A	56	M6	T4	2236	5590
3220-3	32	20	3.969	50	80	13	78	65	9	-	-	A	62	M6	T3	2013	5522
3232-4	32	32	4.762	56	86	16	82	71	9	-	-	A	65	M6	T4	3197	8612
4020-3	40	20	5.556	63	93	15	83	78	9	-	-	B	70	M8	T3	3530	9793
4040-4	40	40	6.35	65	95	18	100	80	9	-	-	B	72	M8	T4	5225	14404
5020-5	50	20	6.35	75	110	18	121	93	11	-	-	B	85	M8	T5	7401	23822
6310-6	63	10	6.35	90	135	20	94	108	13.5	-	-	B	100	M8	T6	8170	31750

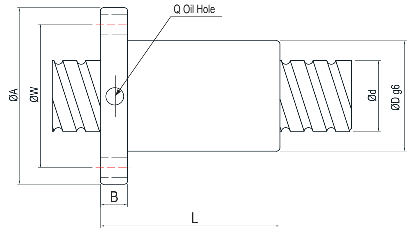
Note: Steel balls 3.5mm, please order 3.5mm shaft to meet

6.9.6 FSS



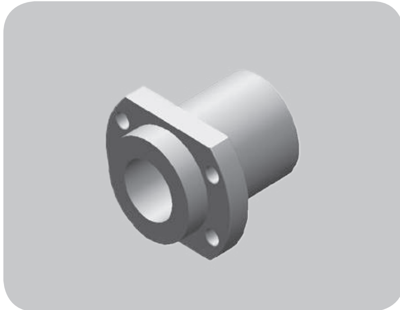
TYPE A TYPE B

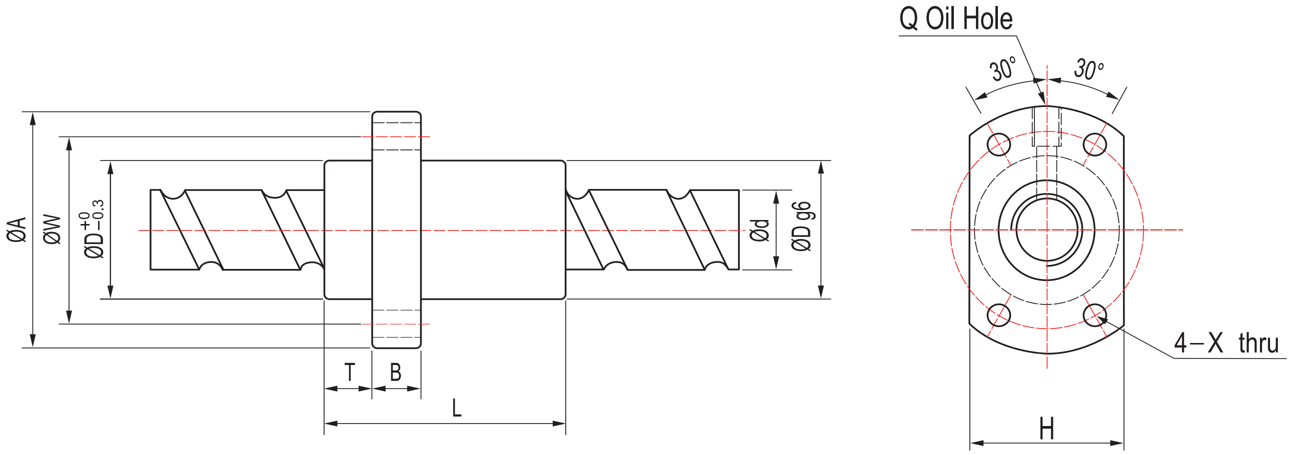




Unit : mm

Model No.	Dimensions													
	d	l	Da	D	A	B	L	W	X	Type	H	Q	n	Ca(Kgf)	Coa(kgf)
1205-2.8	12	5	2	24	40	8	30	32	4.5	A	30	-	B1	513	1051
1210-1.8	12	10	2	24	40	8	34	32	4.5	A	30	-	A1	347	657
1605-3.8	15	5	2.778	28	48	10	36	38	5.5	A	40	M6	C1	1159	2514
1610-2.8	15	10	2.778	28	48	10	46	38	5.5	A	40	M6	B1	891	1852
1616-1.8	15	16	2.778	28	48	10	45	38	5.5	A	40	M6	A1	609	1191
1520-1.8	15	20	2.778	28	48	10	54	38	5.5	A	40	M6	A1	609	1191
2005-3.8	20	5	3.175	36	58	10	36	47	6.6	A	44	M6	C1	1584	3867
2010-3.8	20	10	3.175	36	58	10	56	47	6.6	A	44	M6	C1	1584	3867
2020-3.6	20	20	3.175	36	58	10	55	47	6.6	A	44	M6	A2	1497	3581
2510-3.8	25	10	3.5	40	62	10	64	51	6.6	A	48	M6	C1	1978	5157
2525-1.8	25	25	3.175	40	62	10	65	51	6.6	A	48	M6	A1	920	2266
3232-3.6	32	32	4.762	50	80	16	82	65	9	A	62	M6	A2	3197	8612
4040-3.6	40	40	6.35	63	93	18	100	78	9	B	70	M8	A2	5225	14404



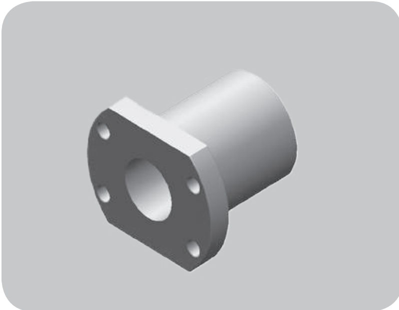


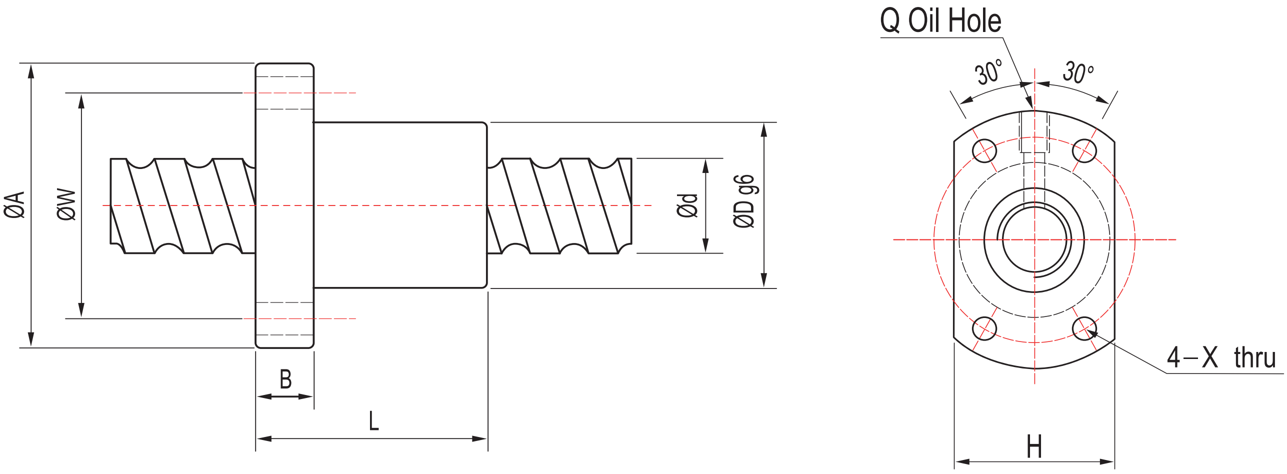
Unit : mm

Model No.	Dimensions													
	d	I	Da	D	A	B	T	L	W	X	H	Q	n	Ca(Kgf)	Coa(kgf)
1616-3.6	16	16	3.175	32	53	10	10.5	48	42	4.5	38	M6	A2	1361	2886
★ 2020-3.6	20	20	3.175	39	62	10	10.8	55	50	5.5	46	M6	A2	1497	3581
2520-3.6	25	20	3.5	47	74	12	11	65	60	6.6	49	M6	A2	1888	4885
2525-3.6	25	25	3.969	47	74	12	11.2	67	60	6.6	56	M6	A2	2236	5590
3232-3.6	32	32	4.762	58	92	15	14	82	74	9	68	M6	A2	3197	8612
4040-3.6	40	40	6.35	73	114	17	17	100	93	11	84	M6	A2	5225	14404
5050-3.6	50	50	7.938	90	135	20	21.5	125	112	14	92	M6	A2	7838	22704

Note: with sign ★ can produce left helix

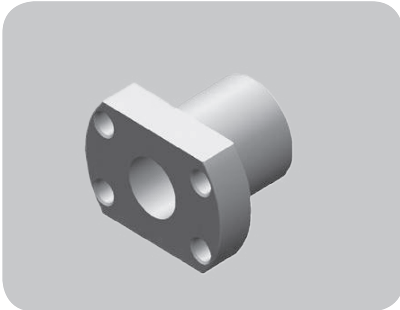
6.9.8 FSB

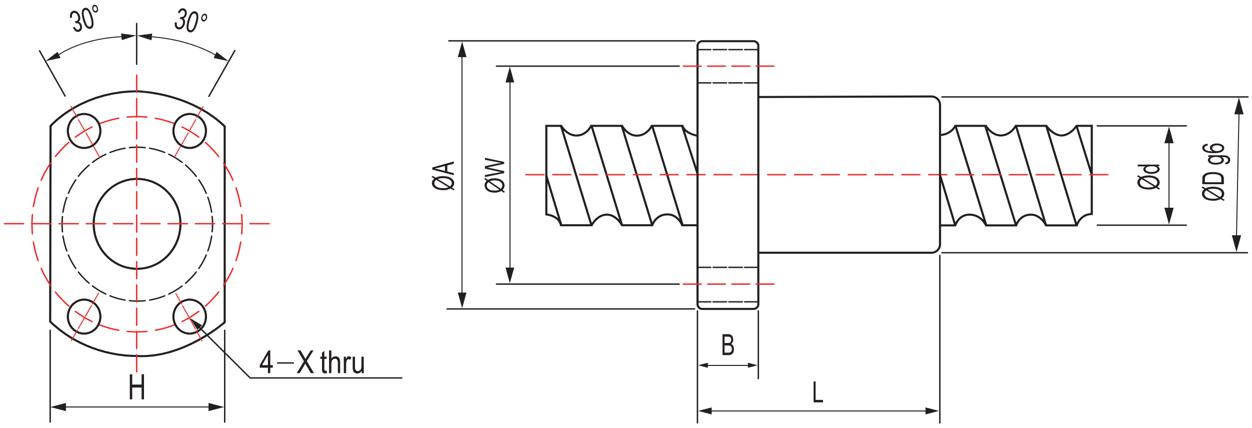




Unit : mm

Model No.	Dimensions												
	d	l	Da	D	A	B	L	W	X	H	Q	n	Ca(Kgf)	Coa(kgf)
1404-3	14	4	2.381	31	50	10	40	40	4.5	37	M6	T3	687	1327
1405-3	14	5	3.175	32	50	10	45	40	4.5	38	M6	T3	995	1686
1605-3	16	5	3.175	34	54	10	42	44	4.5	40	M6	T3	1063	1957
2005-3	20	5	3.175	40	60	10	47	50	4.5	46	M6	T3	1192	2542
2505-3	25	5	3.175	43	67	10	47	55	5.5	50	M6	T3	1340	3268
2510-3	25	10	4.762	60	96	15	75	78	9	72	M6	T3	2260	4257
2510-4	25	10	4.762	60	96	15	97	78	9	72	M6	T4	2894	6210
3210-3	32	10	6.35	67	103	15	78	85	9	78	M6	T3	3721	7924
3210-4	32	10	6.35	67	103	15	97	85	9	78	M6	T4	4765	10565
4010-4	40	10	6.35	76	116	17	100	96	11	88	M6	T4	5331	13636

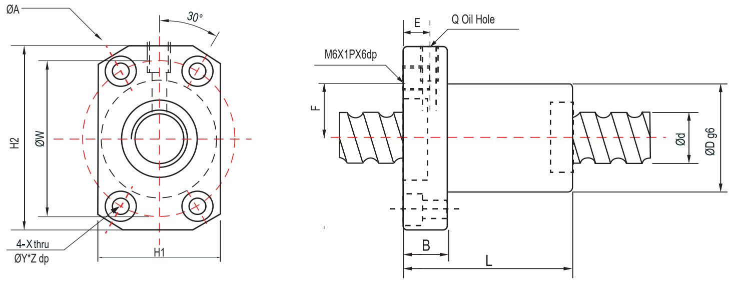


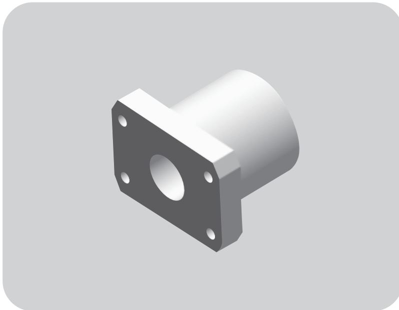


Unit : mm

Model No.	Dimensions											
	d	I	Da	D	A	B	L	W	X	H	n	Ca(Kgf)	Coa(kgf)
0601-3	6	1	0.8	12	24	3.5	18	18	3.4	16	T3	111	201
0801-3	8	1	0.8	14	27	4	20	21	3.4	18	T3	126	272
0802-3	8	2	1.2	16	29	4	26	23	3.4	20	T3	215	398
0825-3	8	2.5	1.2	16	29	4	26	23	3.4	20	T3	215	397
1002-3	10	2	1.2	18	35	5	28	27	4.5	22	T3	241	508
1003-3	10	3	1.8	24	44	8	32	34	4.5	27	T3	401	700
1004-3	10	4	2	26	46	10	35	36	4.5	28	T3	468	798
1202-3	12	2	1.2	20	37	5	28	29	4.5	24	T3	263	617
1204-3	12	4	2.381	28	48	6	35	39	5.5	30	T3	645	1117
1205-3	12	5	2	28	48	6	35	39	5.5	30	T3	506	952
1402-3	14	2	1.2	21	40	6	28	31	5.5	26	T3	282	724
1602-3	16	2	1.2	25	43	10	32	35	5.5	29	T3	301	837

6.9.10 FPA

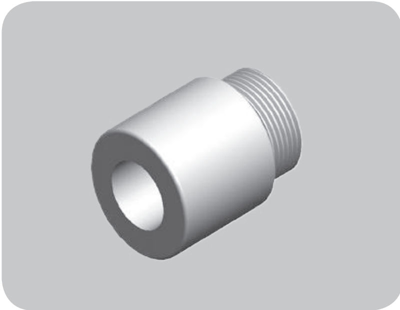


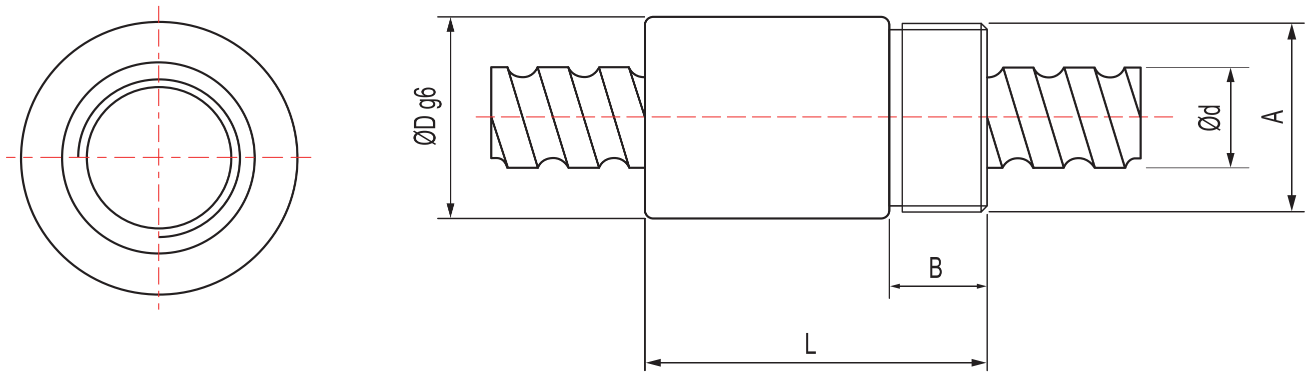


Unit : mm

Model No.	Dimensions																	
	d	l	Da	D	A	B	E	F	L	W	X	Y	Z	H1	H2	Q	n	Ca(Kgf)	Coa(kgf)
1205-4	12	5	2	30	50	10	6	15	43	40	4.5	8	4.4	32	45	M4	T4	667	1426
1210-3	12	10	2	30	50	10	6	15	44	40	4.5	8	4.4	32	45	M4	T3	507	1022
1520-2	15	20	3.175	34	57	12	6	17	57	45	6	9.5	5.4	34	50	M6	T2	729	1353
1605-3	16	5	3.175	34	57	10	6	17	42	45	5.5	9.5	5.4	34	50	M6	T3	1063	1957
1610-3	16	10	3.175	34	57	11	6	17	44	45	5.5	9.5	5.4	34	50	M6	T3	1097	2245
2005-3	20	5	3.175	44	67	11	6	22	48	55	5.5	9.5	5.4	44	60	M6	T3	1192	2542
2010-3	20	10	3.969	46	74	13	6.5	24	54	59	6.6	11	6.5	46	66	M6	T3	1648	3554
2020-4	20	20	3.175	46	74	13	6.5	24	55	59	6.6	11	6.5	46	66	M6	T4	1497	3581

6.9.11 RSK(without wipers)

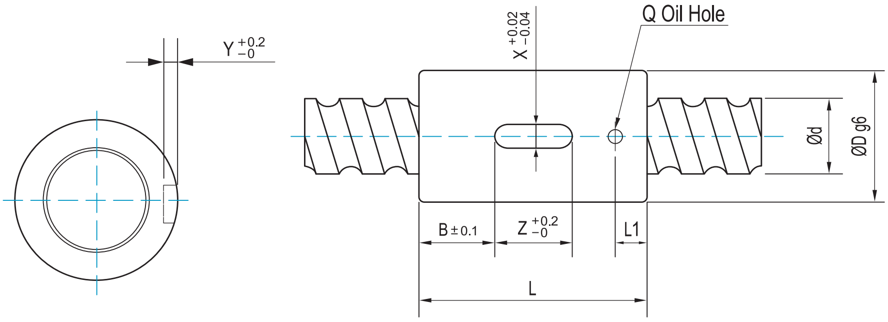


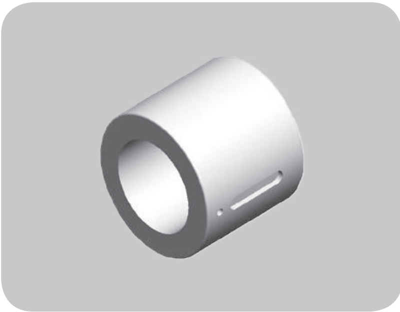


Unit : mm

Model No.	Dimensions									
	d	l	Da	D	A	B	L	n	Ca(Kgf)	Coa(kgf)
0825-3	8	2.5	1.2	17.5	M15X1P	8	26	T3	215	397
1003-3	10	3	1.8	21	M18X1P	9	29	T3	401	700
1204-3	12	4	2.381	25.5	M20X1P	10	34	T3	637	1117
1205-3	12	5	2	25.5	M20X1P	10	39	T3	506	952
1605-3	16	5	3.175	32.5	M26X1.5P	12	42	T3	1063	1957

6.9.12 RSY



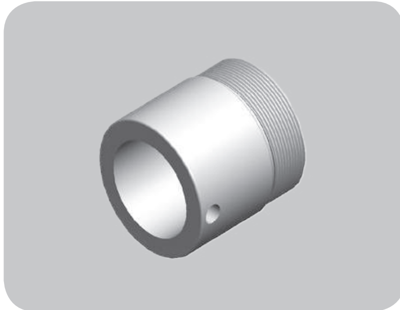


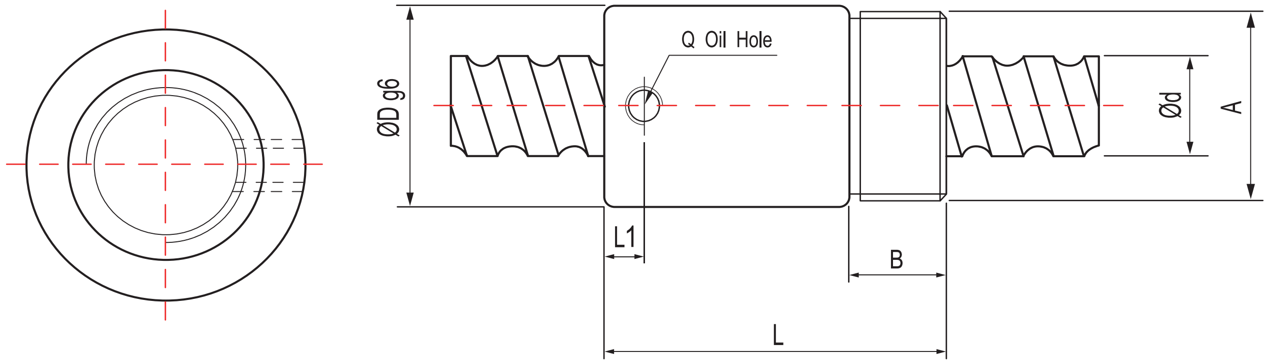
Unit : mm

Model No.	Dimensions													
	d	I	Da	D	L	B	X	Y	Z	Q	L1	n	(Ca Kgf)	(Coa (K
1202-3	12	2	1.2	24	30	9	3	1.5	12	Ø3	4	T3	263	617
1204-3	12	4	2.381	24	35	11.5	3	1.5	12	Ø3	5	T3	637	1117
1205-3	12	5	2	24	40	14	3	1.5	12	Ø3	5	T3	506	952
1205-4	12	5	2	24	36	10	3	1.5	12	Ø3	5	T4	667	1426
1210-2	12	10	2	24	40	14	3	1.5	12	Ø3	5	T2	380	730
1602-3	16	2	1.2	28	40	10	5	2	20	Ø3	5	T3	301	837
1604-4	16	4	2.381	28	45	12.5	5	2	20	Ø3	7	T4	939	2048
1605-3	16	5	3.175	28	45	12.5	5	2	20	Ø3	7	T3	1063	1957
★1605-4	16	5	3.175	28	50	15	5	2	20	Ø3	7	T4	1361	2609
1610-3	16	10	3.175	28	45	12.5	5	2	20	Ø3	7	T3	1164	2405
1616-2	16	16	3.175	28	45	12.5	5	2	20	Ø3	7	T2	821	1603
2005-3	20	5	3.175	36	47	13.5	5	2	20	Ø3	7	T3	1192	2542
★2005-4	20	5	3.175	36	53	16.5	5	2	20	Ø3	7	T4	1527	3390
2010-3	20	10	3.969	36	68	24	5	2	20	Ø3	7	T3	1749	3808
2020-4	20	20	3.175	36	55	17.5	5	2	20	Ø3	7	T4	1639	3979
★2505-4	25	5	3.175	40	53	16.5	5	2	20	Ø3	7	T4	1716	4357
▲2510-3	25	10	3.5	40	54	17	5	2	20	Ø3	7	T3	1614	4071
★3205-4	32	5	3.175	50	53	11.5	6	2.5	30	Ø3	7	T4	1932	5705
3210-3	32	10	6.35	50	70	20	6	2.5	30	Ø3	7	T3	3721	7924
3220-3	32	20	3.969	50	78	24	6	2.5	30	Ø3	7	T3	2136	5917
★4005-4	40	5	3.175	63	56	13	6	2.5	30	Ø3	7	T4	2147	7250
4010-3	40	10	6.35	63	80	25	6	2.5	30	Ø3	7	T3	4163	10227
4020-3	40	20	5.556	63	83	26.5	6	2.5	30	Ø3	7	T3	3746	10492
5010-3	50	10	6.35	75	82	23	6	2.5	36	Ø3	7	T3	4674	13126
6310-4	63	10	6.35	85	90	29	6	3.5	32	Ø5	14	T4	6727	22820

Note: 1. with sign ★ can produce left helix
2. Steel balls 3.5mm, please order 3.5mm shaft to meet

6.9.13 RSU



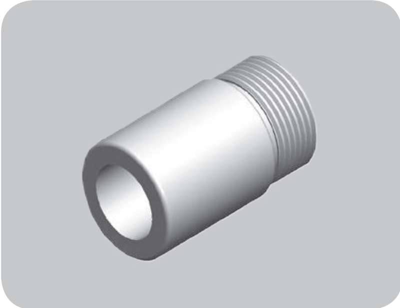


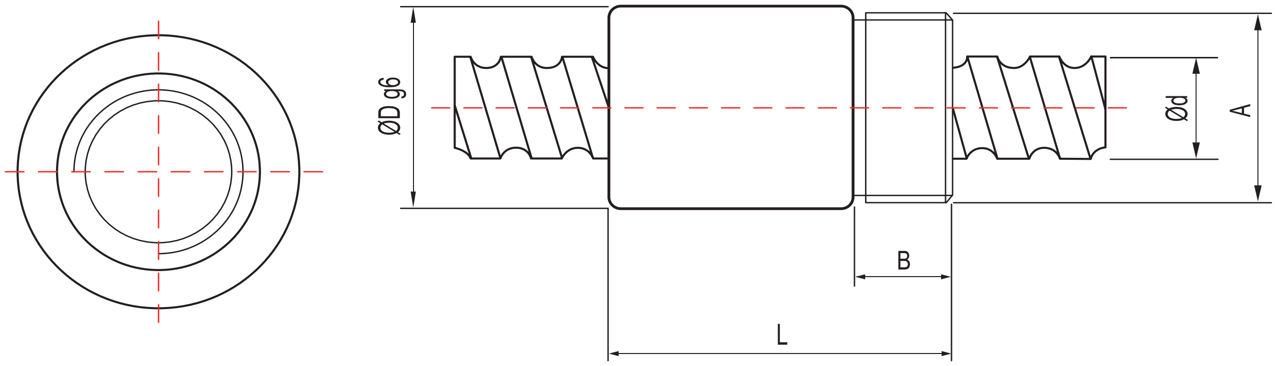
Unit : mm

Model No.	Dimensions										
	d	I	Da	D	A	B	L	Q	L1	n	Ca(Kgf)	Coa(kgf)
▲ 1604-3	16	4	2.381	29	M22X1.5P	8	32	-	-	T3	733	1536
1605-4	16	5	3.175	32	M30X1.5P	16	56	M6	6.5	T4	1361	2609
2005-4	20	5	3.175	38	M35X1.5P	16.5	59.5	M6	7	T4	1527	3390
2505-4	25	5	3.175	42	M40X1.5P	17	60	M6	7	T4	1716	4357
2510-4	25	10	4.762	42	M40X1.5P	17	90	M6	10	T4	2894	2610
3205-4	32	5	3.175	52	M48X1.5P	19	60	M6	7	T4	1932	5705
3210-4	32	10	6.35	52	M48X1.5P	19	93	M6	12	T4	4765	10565
4005-4	40	5	3.175	58	M56X1.5P	19	59	M8	6	T4	2174	7250
4010-4	40	10	6.35	65	M60X1.5P	27	102	M8	12	T4	5331	13636
5010-4	50	10	6.35	78	M72X1.5P	29	104	M8	12	T4	5986	17502

Note: ▲without wipers

6.9.14 RSH





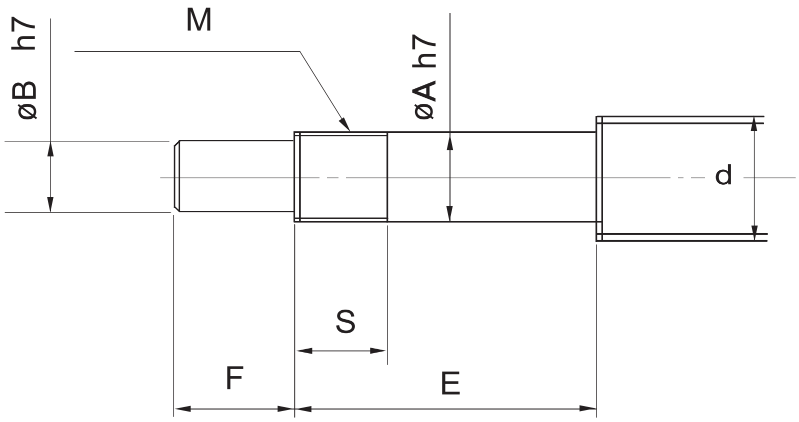
Unit : mm

Model No.	Dimensions									
	d	I	Da	D	A	B	L	n	Ca(Kgf)	Coa(kgf)
12H2-1.5	12	12.7	2.381	29.5	M25x1.5P	12	50	A1	391	711
16H5-3.5	16	5.08	3.175	25.4	15/16”x16un	12.7	43.43	C1	1328	2805

7

Support Unit

7.1 Recommended Shaft End Shape(Fixed side) - BK.FK.EK

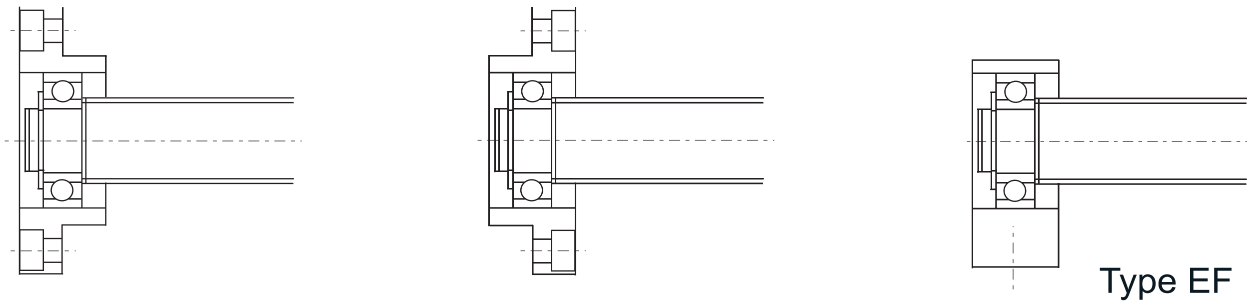


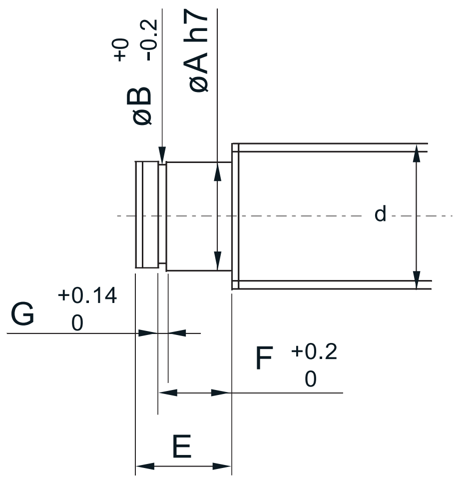
Unit : mm

Model No.	Ball Screw shaft OD	Shaft Support Portion OD				Metric screw thread	
BK (Type BK)	d	A	B	E	F	M	S
BK 10	12/14/15	10	8	36	15	M10X1	12
BK 12	14/15/16	12	10	36	15	M12X1	12
BK 15	18/20	15	12	40	20	M15X1	12
BK 17	20/25	17	15	53	23	M17X1	17
BK 20	25/28	20	17	53	25	M20X1	15
BK 25	32/36	25	20	66	30	M25X1.5	20
BK 30	36/40	30	25	73	38	M30X1.5	25
BK 35	45	35	30	82	45	M35X1.5	26
BK 40	50	40	35	94	50	M40X1.5	30

Model No.		Ball Screw shaft OD	Shaft Support Portion OD				Metric screw thread	
Type FK	Type EK	d	A	B	E	F	M	S
FK 06	EK 06	8	6	4	28	8	M6X0.75	8
FK 08	EK 08	10/12	8	6	32	9	M8X1	10
FK 10	EK 10	12/14/15	10	8	36	15	M10X1	12
FK 12	EK 12	14/15/16	12	10	36	15	M12X1	12
FK 15	EK 15	18/20	15	12	48	20	M15X1	13
FK 17	–	20/25	17	15	59	23	M17X1	17
FK 20	EK 20	25/28/30	20	17	64	25	M20X1	16
FK 25	–	30/32/36	25	20	76	30	M25X1.5	20
FK 30	–	36/40	30	25	73	38	M30X1.5	25

7.2 Recommended Shaft End Shape(Floated side) - FF.EF.BF



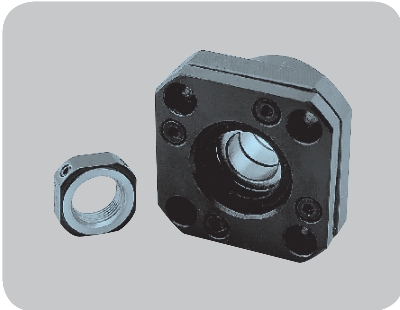


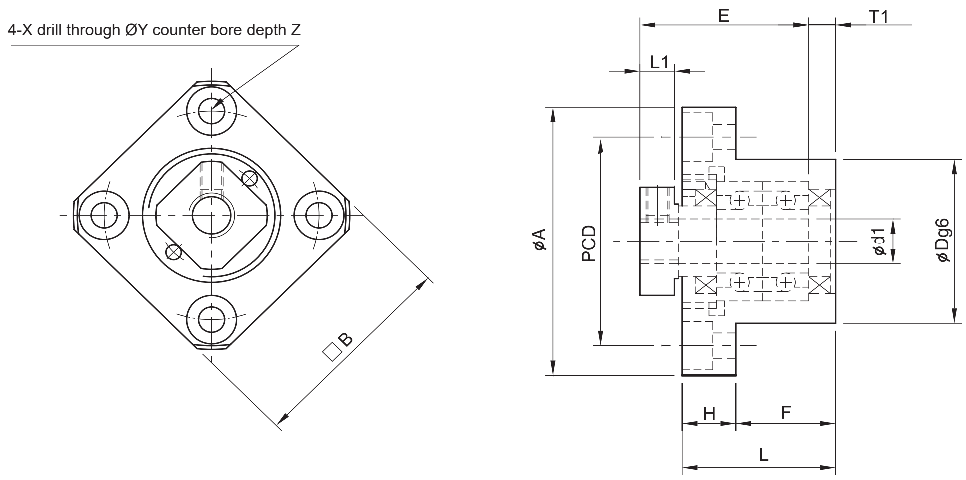
Unit : mm

Model No.	Ball Screw shaft OD	Shaft Support Portion OD		Snap-ring Groove		
Type: FF/EF/BF	d	A	E	B	F	G
FF/EF06	8	6	9	5.7	6.8	0.8
EF 08	10	6	9	5.7	6.8	0.8
FF/EF/BF10	12/14/15	8	10	7.6	7.9	0.9
FF/EF/BF12	14/15/16	10	11	9.6	9.15	1.15
FF/EF/BF15	18/20	15	13	14.3	10.15	1.15
FF/BF17	20/25	17	16	16.2	13.15	1.15
★FF/EF/BF20	25/28/30	20	19 (16)	19	15.35(13.35)	1.35
FF/BF 25	30/32/36	25	20	23.9	16.35	1.35
FF/BF 30	36/40	30	21	28.6	17.75	1.75
BF 35	40/45	35	22	33	18.75	1.75
BF 40	50	40	23	38	19.95	1.95

Note: ( ) shows the dimension of BF20 which is different from those of type FF20 and EF20. When placing an order, always specify the model number of the Support Unit to be used.

7.3 FK (Fixed Side)

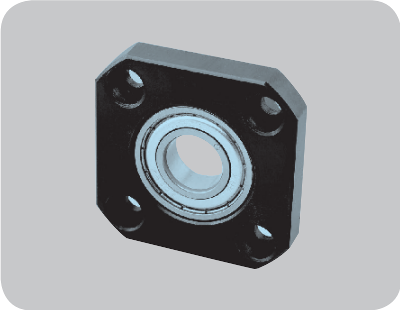


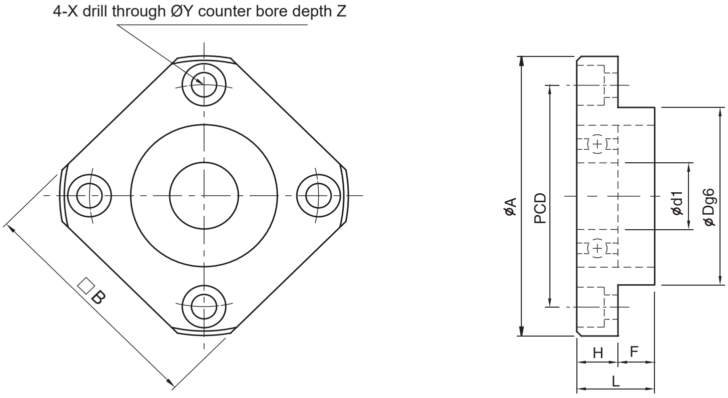


Unit : mm

Model No.	d1	L	H	F	E	Dg6	A	PCD	B	L1	T1	L2	T2	X	Y	Z	M	T
FK 5	5	16.5	6	10.5	18.5	20	34	26	26	5.5	3.5	5	3	3.4	6.5	4	M3	11
FK 6	6	20	7	13	22	22	36	28	28	5.5	3.5	6.5	4.5	3.4	6.5	4	M3	12
FK 8	8	23	9	14	26	28	43	35	35	7	4	8	5	3.4	6.5	4	M3	14
FK 10	10	27	10	17	29.5	34	52	42	42	7.5	5	8.5	6	4.5	8	4	M3	16
FK 12	12	27	10	17	29.5	36	54	44	44	7.5	5	8.5	6	4.5	8	4	M4	19
FK 15	15	32	15	17	36	40	63	50	52	10	6	12	8	5.5	9.5	6	M4	22
FK 17	17	45	22	23	47	50	77	62	61	11	9	14	12	6.6	11	10	M4	24
FK 20	20	52	22	30	50	57	85	70	68	8	10	12	14	6.6	11	10	M4	30
FK 25	25	57	27	30	59	63	98	80	79	13	10	20	17	9	15	13	M5	35
FK 30	30	62	30	32	61	75	117	95	93	11	12	17	18	11	17.5	15	M6	40

7.4 FF (Floated side)

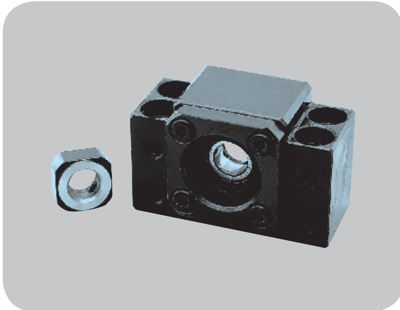


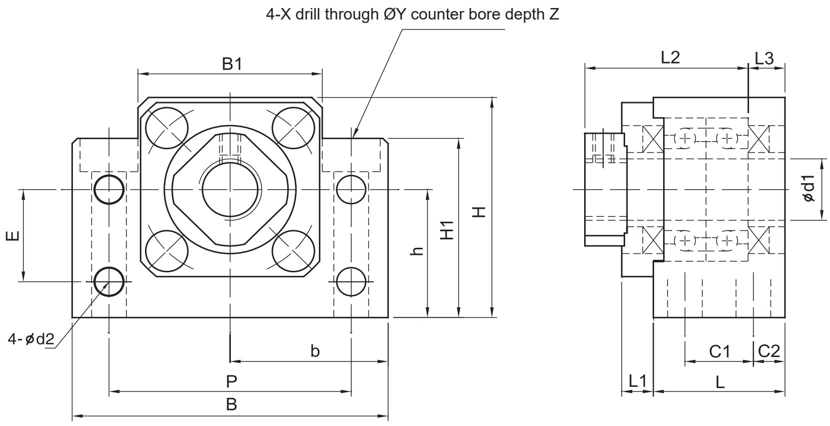


Unit : mm

Model No.	d1	L	H	F	Dg6	A	PCD	B	X	Y	Z
FF 06	6	10	64		22	36	28	28	3.46	.5	4
FF 10	8	12	7	5	28	43	35	35	3.4	6.5	4
FF 12	10	15	7	8	34	52	42	42	4.5	8	4
FF 15	15	17	9	8	40	63	50	52	5.5	9.5	5.5
FF 17	17	20	11	9	50	77	62	61	6.6	11	6.5
FF 20	20	20	11	9	57	85	70	68	6.6	11	6.5
FF 25	25	24	14	10	63	98	80	79	9	14	8.5
FF 30	30	27	18	9	75	117	95	93	11	17	11

7.5 BK (Fixed Side)

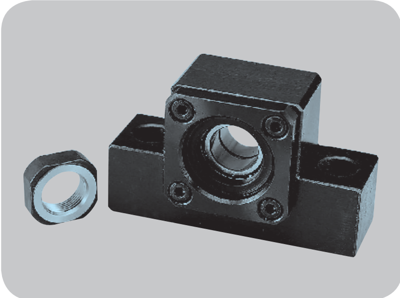


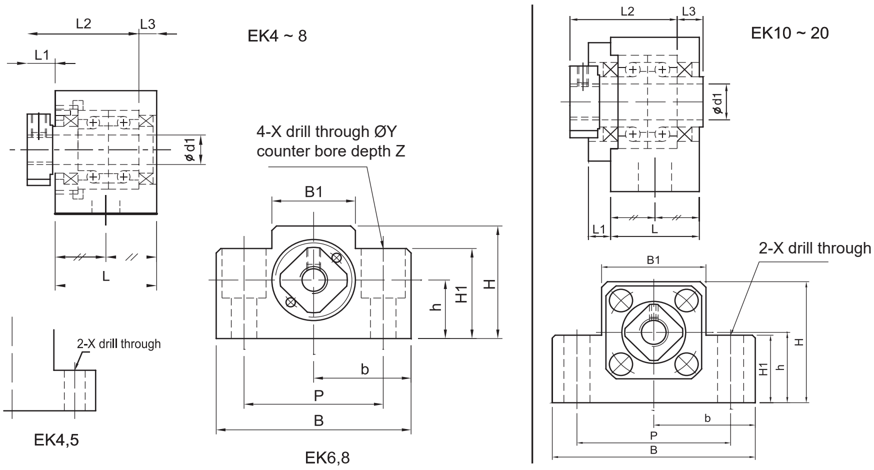


Unit : mm

Model No.	d1	L	L1	L2	L3	C1	C2	B	H	b ±0.02	h ±0.02	B1	H1	E	P	d2	X	Y	Z	M	T
BK 10	10	25	5	29.5	5	13	6	60	39	30	22	34	32.5	15	46	5.5	6.6	10.8	5	M4	16
BK 12	12	25	5	29.5	5	13	6	60	43	30	25	34	32.5	18	46	5.5	6.6	10.8	1.5	M4	19
BK 15	15	27	6	32	6	15	6	70	48	35	28	40	38	18	54	5.5	6.6	11	6.5	M3	22
BK 17	17	35	9	44	7	19	8	86	64	43	39	50	55	28	68	6.6	9	14	8.5	M4	24
BK 20	20	35	8	43	8	19	8	88	60	44	34	52	50	22	70	6.6	9	14	8.5	M4	30
BK 25	25	42	12	54	9	22	10	106	80	53	48	64	70	33	85	9	11	17	11	M5	35
BK 30	30	45	14	61	9	23	11	128	89	64	51	76	78	33	102	11	14	20	13	M6	40
BK 35	35	50	14	67	12	26	12	140	96	70	52	88	79	35	114	11	14	20	13	M8	50
BK 40	40	61	18	76	15	33	14	160	110	80	60	100	90	37	130	14	18	26	17.5	M8	50

7.6 EK (Fixed Side)

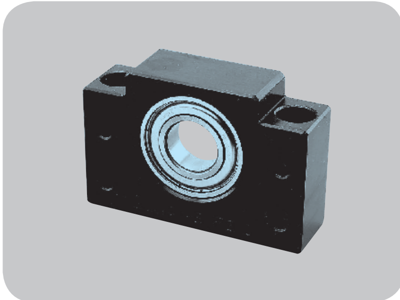


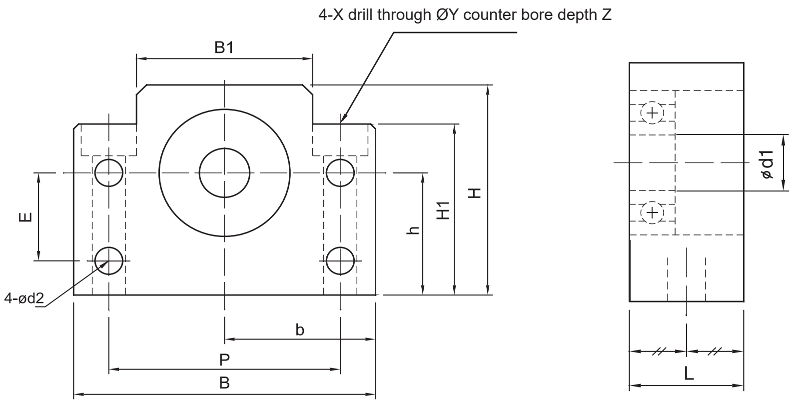


Unit : mm

Model No.	d1	L	L1	L2	L3	B	H	$b^{\pm0.02}$	$h^{\pm0.02}$	B1	H1	P	X	Y	Z	M	T
EK 05	5	16.5	5.5	18.5	3.5	36	21	18	11	20	8	28	4.5	–	–	M3	11
EK 06	6	20	5.5	22	3.5	42	25	21	13	18	20	30	5.5	9.5	11	M3	12
EK 08	8	23	7	26	4	52	32	26	17	25	26	38	6.6	11	12	M3	14
EK 10	10	24	6	29.5	6	70	43	35	25	36	24	52	9	–	–	M3	16
EK 12	12	24	6	29.5	6	70	43	35	25	36	24	52	9	–	–	M4	19
EK 15	15	25	6	36	5	80	49	40	30	41	25	60	11	–	–	M4	22
EK 20	20	42	10	50	10	95	58	47.5	30	56	25	75	11	–	–	M4	30

7.7 BF (Floated Side)

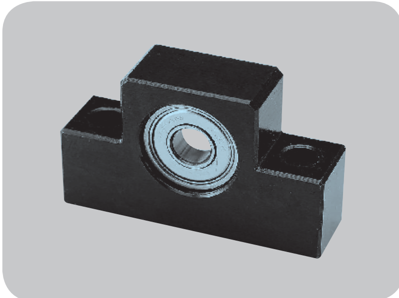


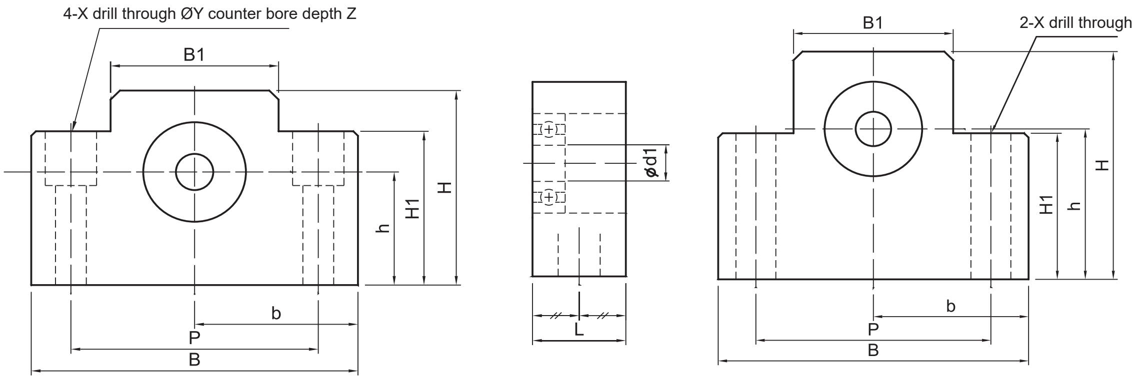


Unit : mm

Model No.	d1	L	B	H	$b^{\pm 0.02}$	$h^{\pm 0.02}$	B1	H1	E	P	d2	X	Y	Z
BF 10	8	20	60	39	30	22	34	32.5	15	46	5.5	6.6	10.8	5
BF 12	10	20	60	43	30	25	34	32.5	18	46	5.5	6.6	10.8	1.5
BF 15	15	20	70	48	35	28	40	38	18	54	5.5	6.6	11	6.5
BF 17	17	23	86	64	43	39	50	55	28	68	6.6	9	14	8.5
BF 20	20	26	88	60	44	34	52	50	22	70	6.6	9	14	8.5
BF 25	25	30	106	80	53	48	64	70	33	85	9	11	17	11
BF 30	30	32	128	89	64	51	76	78	33	102	11	14	20	13
BF 35	35	32	140	96	70	52	88	79	35	114	11	14	20	13
BF 40	40	37	160	110	80	60	100	90	37	130	14	18	26	17.5

7.8 EF (Floated side)





EF6, 8

EF10 ~ 20

Unit : mm

Model No.	d1	L	B	H	$b^{\pm0.02}$	$h^{\pm0.02}$	B1	H1	P	X	Y	Z
EF 06	6	12	42	25	21	13	18	20	30	5.5	9.5	11
EF 08	6	14	52	32	26	17	25	26	38	6.6	11	12
EF 10	8	20	70	43	35	25	36	24	52	9	–	–
EF 12	10	20	70	43	35	25	36	24	52	9	–	–
EF 15	15	20	80	49	40	30	41	25	60	9	–	–
EF 20	20	26	95	58	47.5	30	56	25	75	11	–	–

8

Self-lubricated Linear Bearing

8.1 Characteristics

(1) Excellent Wear Resistance

Unlike linear ball bearing that requires running on high hardness heat treated shaft (SUJ2), Self-Lubricated Linear Bearing can be used with Hard Chrome Plated Shaft (S45C). Under correct use, the life expectancy is much higher than linear ball bearings.

(2) Interchangeability

Full range of ABBA Self-Lubricated Linear Bearings product line includes Standard, Thin Profile, Profile, and Flanged Type. All Self-Lubricated bearings are interchangeable with our Linear Ball Bearings products.

(3) Multi-Functions

Suitable for either linear, rotary, or combination of both motions.

(4) High impact capability

Great capabilities of dampening high impacts, vibrations, and uneven loads while keeping the components from damaging.

(5) Self-Lubricating

Lubrications are not required; however, the use of adequate lubrications can minimize frictions and wear

(6) High load capacity

ABBA Self-Lubricating Linear Bearings can withstand average 3~4 times load capacity over linear ball bearings.

(7) Chemical and corrosion resistance

Great resistance to corrosion allows the bearing to be operating or submerging in alcohol, gasoline, water, oil and stand up to harsh environment.

(8) Reliable

Reliable bearing dimensions due to the liner will not expand to water or oil unlike general industrial use plastic. Thermal expansion effect is also minimal to the bearing, and will not cause binding to the shaft.

(9) Low friction

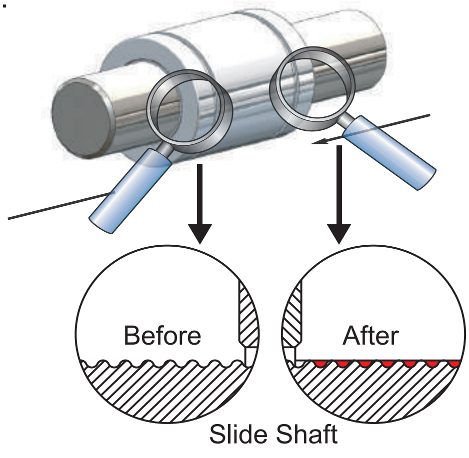
Low coefficient of friction eliminates oscillating, which is suitable for continuous and intermittent motions.

(10) Substitutability

In the case of the shaft had been scored by linear ball bearing, self-lubricated linear bearing can be installed to the damaged shaft after slight sanding the shaft by sand paper as emergency repair.

(11) Quiet operation

Quieter operation over linear ball bearing at any operating speed.

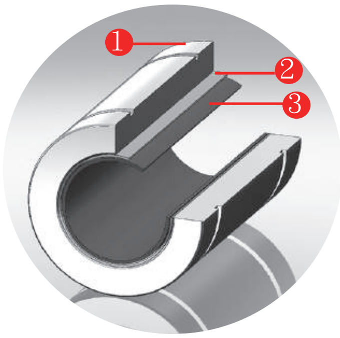


(12) Wide range of applications

Produces minimum particulates, which is suitable for vacuum and clean rooms applications. Applicable applications include Automation Machines, Transfer Equipment, Vice, Robotic Arms, Robots, Positioning Device, Automotive, Office Equipment, Semi-Conductor Manufacturing, Bio-Chemical Plant, Food Processing Plant, and Fabric Manufacturing related applications.

8.2 Structure

1. Anodized aluminum, 6060 T6
2.Water-proof Bonding Agent
3.Frelon thickness: 0.5mm



The composition of super wear-resistant sliding plate is

Teflon + Glass fiber + Metal powder + Special formula, which are imported high-tech materials, generally used in the wear-resistant rails of the million-level precision machine tool, it can slide uppon high load for a long time without abrasion. Its wear-resistant function is better than General DU bearings.

8.3 Size selection

Use the formula below to calculate Maximum PV Value (Load x Velocity), then multiply its value by Safety Factor. Cross reference the value to dimension chart in our catalogue page to select bearing size. The size of bearing is propotional to the load and Velocity.

Formula

- Maximum load = L / N x F
- Load x Velocity = L / N x V x F
- Axial Driving Force = μ x L

L : Total Load Capacity (kgf)
N : Number of Bearings
F : Safety Factor 2~3
V : Velocity (m/sec)
μ : Fricition Factor : 0.15~0.25

Example 1

Assuming a sliding platform has a load of 100kg, uses 4 bearings, and velocity is 0.6 m/sec. Cacula-tion of bearing size and required axial driving force is shown below.

Where

L = 100 kgf, N = 4, assume
F = 2.5, μ = 0.2, V=0.6 m/sec
- Maximum load = L / N x F = 100 / 4 x 2.5 = 62.5 kgf
- Load x Velocity = L / N x V x F = 100 / 4 x 0.6 x 2.5 = 37.5 kgf · m/sec
- Required Driving force = μ x L = 0.2 x 100 = 20 kgf

Cross reference the results to dimension chart, known TM 25 Bearing (Max. Load = 1000 kgf, Max. Load x Velocity = 52.8 kgf · m/sec) is capable of this application.

Example 2

Assuming all values remains unchanged, except velocity increases to 1.0 m/sec. Calculation of bearing size is shown below.

Where

- Load x Velocity = L / N x V x F = 100 / 4 x 1.0 x 2.5 = 62.5 kgf · m/sec

According to the dimension chart, TM30 bearing (Max · Load x Velocity =68.7 kgf · m/sec is capable of this application.

8.4 Life calculation

Bearing's Life Calculation is based on Maximum allowable amount of wear. Once this value has been decided, bearing's life can be calculated by using the formula below. Under constant load and velocity, bearing's life is proportional to bearing inner diameter.

Formula

$T = W / (K \times P \times V)$ $P = L / (A \times l \times N)$

T : Sliding time (hour)
K : Wearing rate : 1×10^{-7}
V : Velocity (m/min)
P : Pressure (kgf/cm^2)

W : Amount of Wear (mm)
A : Bearing inner diameter (cm)
l : Bearing length (cm)
L : Total load (kgf)
N : Number of Bearings

Example 3

To calculate the life of TM25 bearing from example 1.

Where

W = 0.05mm, K = 1×10^{-7}, A = 2.5

From dimension chart known

l = 5.9，L=100kgf

$V = 0.6 \times 60 = 36\ m / min$

$P = L / (A \times l \times N)$

$= 100 / (2.5 \times 5.9 \times 4)$

$= 1.69\ kgf / cm^2$

$T = W / (K \times P \times V)$

$= 0.05(1 \times 10^{-7} \times 1.69 \times 36)$

=8218 hours

Usage per day = 6 x 300 x 8 / 3600 = 4 hours
Total life time = 8218 / 4 = 2054 days

Note:
Allowable amount of wear is proportional to bearing's life. For example, if allowable amout of wear = 0.01mm, Bearing's life = 4108 days.

8.5 Cantilevered loads

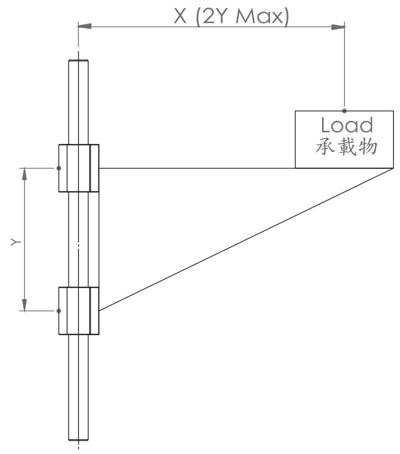
Example

When distance X equals to 100mm, minimum bearing separation Y must be at least 50mm.

Caution

- Binding of the bearing can occur when the ratio exceeds 2:1
- Adequate lubrications will help reduce friction and helps increase the 2:1 ratio

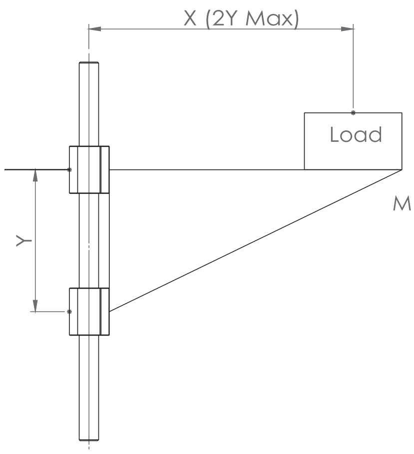
In the case of holding more than 2:1 ratio, method of using counter weight could be use to prevent binding. Use the formula shown below.



Formula

M x X = W x Z

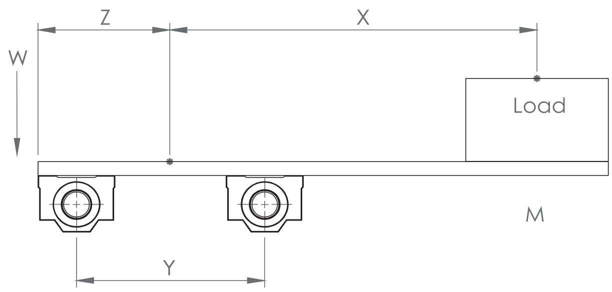
M : Mass of load
X : Distance from load to the shaft
W : Mass of counter weight
Z : 1.5 x (Y)



Example

40 x 200 = W x Z(1.5 x 50 = 75)
W = 40 x 200 / 75 = 106.7Kg

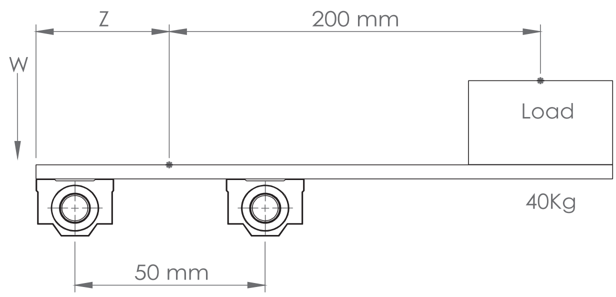
When W is calculated, load per bearing can be calculated.
M + W / # of bearings



Example

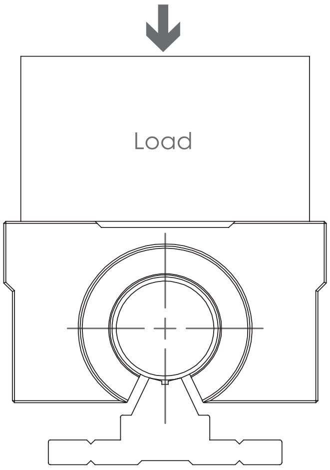
40 + 106.7 / 4 = 36.7 Kg / Bearing

If the ratio of the cantilever installation is greater than 2: 1, a counterweight method can be used to avoid bearing binding.

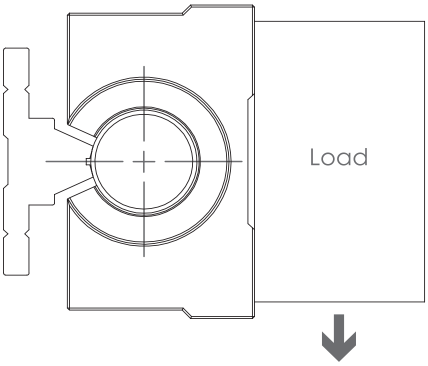


8.6 Open type bearing mounting configurations

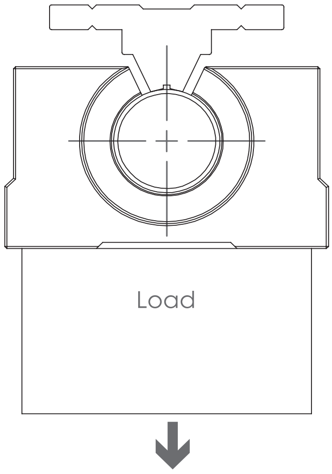
Load capacities on open type self-lubricated linear bearings will depending on their mounting configurations.



100% Capacity



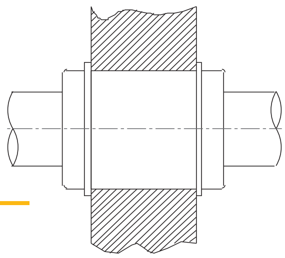
70% Capacity



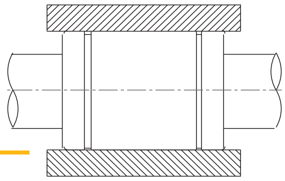
40% Capacity

Example

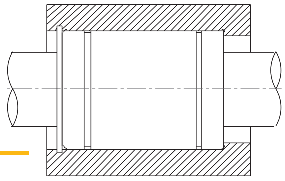
SM series bearing installed on the plate, and secured by two retaining rings.



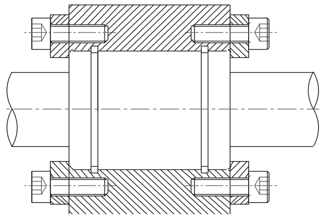
SM series bearing installed in the bore, and secured by two retaining rings.



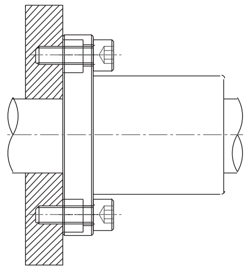
SM series bearing installed in the bore, and secured by one retaining ring.



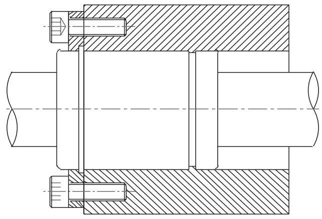
SM series bearing secured by two push plates.



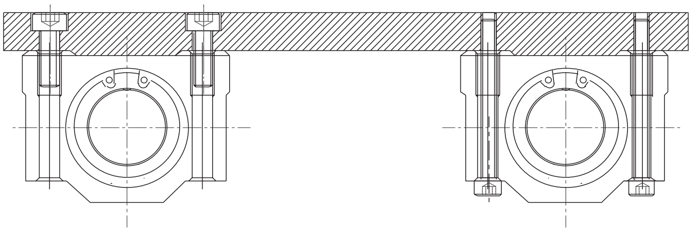
Flanged type bearing bolted onto the plate; adjust the parallelism to other bearings via lashes given in the bolt hole on the flange.



SM series bearing installed by a retaining ring; a push plate is pressed against the ring to secure the bearing.



When using SCM series pillow block bearing, bolts can be installed either from top or below.

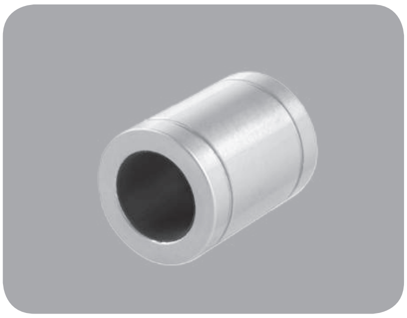


8.7 Round profile type

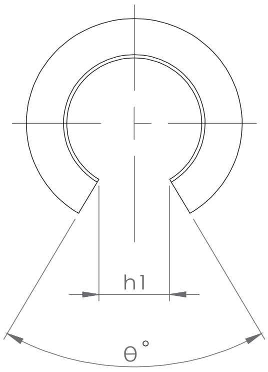
Ordering key : SM 20

(1) SM, (2) 20

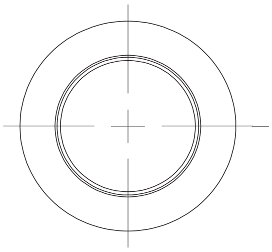
1. **SM Standard type self-lubricated linear bearing**
   SMP Open type self-lubricated linear bearing
2. **Bearing inner diameter**



· SMP Open type

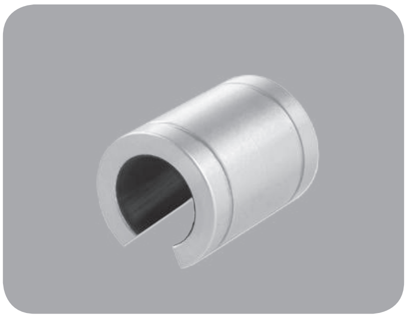


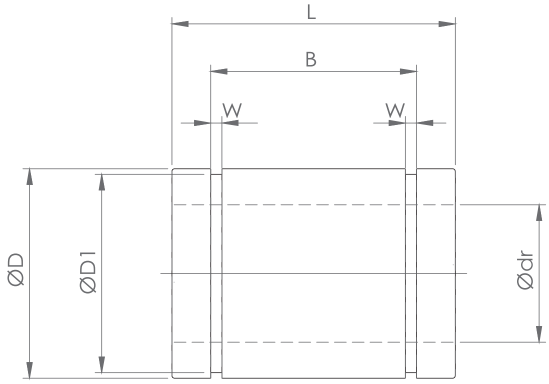
· SM Standard type



Unit : mm

Model No.		Inner Dia.	Dimensions						
Standard type	Open type	Ødr (F8)	ØD (h6)	L	B	W	ØD1	h1	θ°
SM 6	—	6	12	19	13.5	1.15	11.5	—	—
SM 8	—	8	15	24	17.5	1.15	14.3	—	—
SM 10	SMP 10	10	19	29	22.0	1.35	18.0	6.8	80°
SM 12	SMP 12	12	21	30	23.0	1.35	20.0	8	80°
SM 13	SMP 13	13	23	32	23.0	1.35	22.9	9	80°
SM 16	SMP 16	16	28	37	26.5	1.65	26.6	11	80°
SM 20	SMP 20	20	32	42	30.5	1.65	30.3	11	60°
SM 25	SMP 25	25	40	59	41.0	1.90	38.0	12	50°
SM 30	SMP 30	30	45	64	44.5	1.90	42.5	15	50°
SM 35	SMP 35	35	52	70	49.5	2.20	49.0	17	50°
SM 40	SMP 40	40	60	80	60.5	2.20	57.0	20	50°
SM 50	SMP 50	50	80	100	74.0	2.70	76.5	25	50°
SM 60	SMP 60	60	90	110	85.0	3.15	86.5	30	50°





Unit : mm

Model No.		Max. Static load	Max. PV	Max. Speed	Weight (g)	
Standard type	Open type	(kgf)	(kgf * m/sec)	(m / sec)	SM	SMP
SM 6	—	80	4.1	2	4.4	—
SM 8	—	130	6.9	2	8.3	—
SM 10	SMP 10	200	10.4	2	16.2	12.5
SM 12	SMP 12	250	12.9	2	19	13.9
SM 13	SMP 13	290	14.9	2	24.6	17.9
SM 16	SMP 16	410	21.2	2	41.7	30.0
SM 20	SMP 20	580	30.1	2	56	43.4
SM 25	SMP 25	1000	52.8	2	122.8	99.2
SM 30	SMP 30	1300	68.7	2	153.7	123.5
SM 35	SMP 35	1700	87.7	2	221	177.8
SM 40	SMP 40	2200	115.0	2	341.6	275.6
SM 50	SMP 50	3500	179.0	2	832.7	679.8
SM 60	SMP 60	4600	236.0	2	1057	860.8

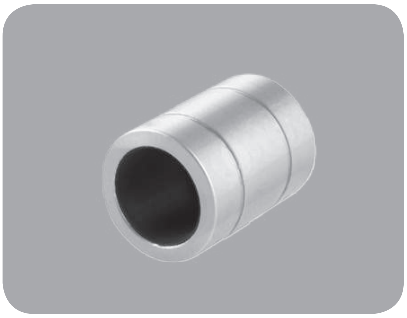
8.8 SMT Thin profile type

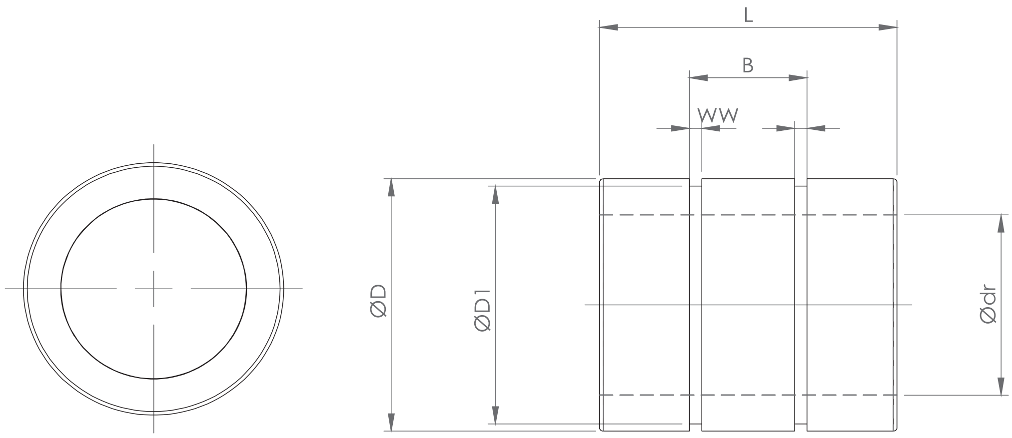
Ordering key : SMT 20

1 2

1 **SMT thin profile self-lubricated linear bearing**

2 **Bearing inner diameter**





Unit : mm

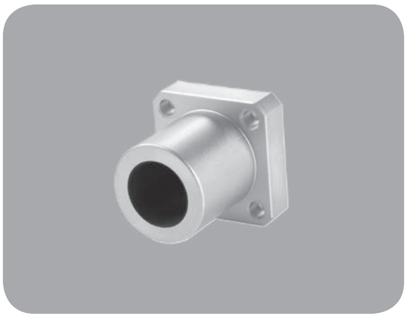
Model No.	Inner Dia.	Dimensions					Max. Static load	Max. PV	Max Speed	Weight
	Ødr (F8)	ØD (h6)	L	B	W	ØD1	(kgf)	(kgf * m/sec)	(m / sec)	(g)
SMT10	10	17	26	8.3	1.15	16.20	180	9.3	2	10.49
SMT12	12	19	28	8.7	1.35	18.00	230	12	2	12.97
SMT16	16	24	30	10.7	1.35	22.90	330	17.2	2	20.49
SMT20	20	28	30	13.3	1.65	26.60	420	21.5	2	24.59
SMT25	25	35	40	15.8	1.65	33.00	700	35.8	2	51.23
SMT30	30	40	50	18.8	1.90	38.00	1050	53.7	2	74.71
SMT40	40	52	60	24.4	2.20	49.00	1600	85.9	2	141.4
SMT50	50	62	70	29.4	2.20	59.00	2400	125	2	200.8

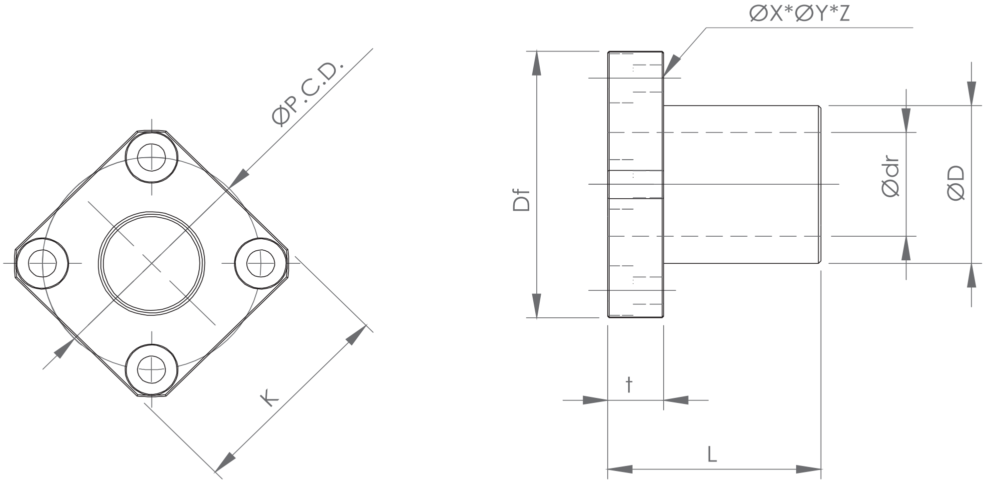
8.9 SMK Square flange type

Ordering key : SMK 20

(1) SMK (2) 20

1. **SMK Square flange self-lubricated bearing**
2. **Bearing inner diameter**





Unit : mm

Model No.	Inner Dia.	Dimensions								
	Ødr (F8)	ØD (h6)	L	ØDf	K	t	P.C.D.	ØX	ØY	Z
SMK 10	10	19	29	40	30	9	29	4.5	7.5	4.1
SMK 12	12	21	30	42	32	9	32	4.5	7.5	4.1
SMK 13	13	23	32	43	34	9	33	4.5	7.5	4.1
SMK 16	16	28	37	48	37	9	38	4.5	7.5	41
SMK 20	20	32	42	54	42	11	43	5.5	9.0	5.1
SMK 25	25	40	59	62	50	11	51	5.5	9.0	5.1
SMK 30	30	45	64	74	58	14	60	6.6	11.0	6.1
SMK 35	35	52	70	82	64	14	67	6.6	11.0	6.1
SMK 40	40	60	80	96	75	18	78	9.0	14.0	8.1
SMK 50	50	80	100	116	92	20	98	9.0	14.0	8.1

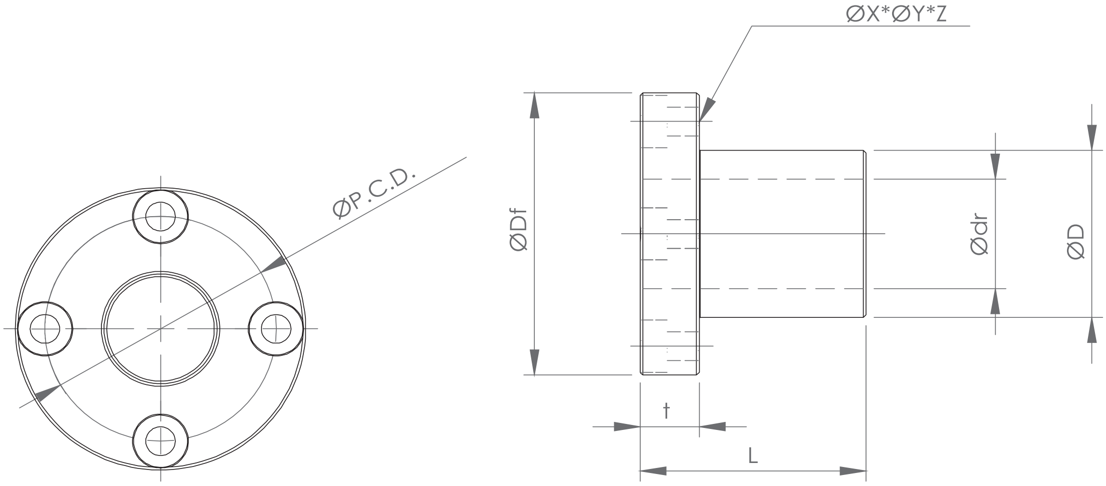
Model No.	Max. Static load	Max. PV	Max. Speed	Weight
	(kgf)	(kgf * m/sec)	(m / sec)	(g)
SMK 10	200	10.4	2	33
SMK 12	250	12.9	2	35
SMK 13	290	14.9	2	38
SMK 16	410	21.2	2	56
SMK 20	580	30.1	2	75
SMK 25	1000	52.8	2	149
SMK 30	1300	68.7	2	202
SMK 35	1700	87.7	2	296
SMK 40	2200	115.0	2	450
SMK 50	3500	179.0	2	1000

8.10 SMF Round flange type

Ordering key : SMF 20

1 2

1. **SMF Round flange self-lubricated bearing**
2. **Bearing inner diameter**



Unit : mm

Model No.	Inner Dia.	Dimensions							
	Ødr (F8)	ØD (h6)	L	ØDf	t	P.C.D.	ØX	ØY	Z
SMF 6	6	12	19	28	8	20	3.5	6.0	3.1
SMF 8	8	15	24	32	8	24	3.5	6.0	3.1
SMF 10	10	19	29	40	9	29	4.5	7.5	4.1
SMF 12	12	21	30	42	9	32	4.5	7.5	4.1
SMF 16	16	28	37	48	9	38	4.5	7.5	4.1
SMF 20	20	32	42	54	11	43	5.5	9.0	5.1
SMF 25	25	40	59	62	11	51	5.5	9.0	5.1
SMF 30	30	45	64	74	14	60	6.6	11.0	6.1

Model No.	Max. Static load	Max. PV	Max. Speed	Weight
	(kgf)	(kgf * m/sec)	(m / sec)	(g)
SMF 6	80	4.1	2	12
SMF 8	130	6.9	2	14
SMF 10	200	10.4	2	36
SMF 12	250	12.9	2	38
SMF 16	410	21.2	2	60
SMF 20	580	30.1	2	80
SMF 25	1000	52.8	2	160
SMF 30	1300	68.7	2	212

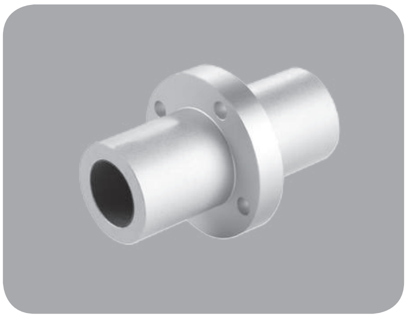
8.11 SMFD Center flange type

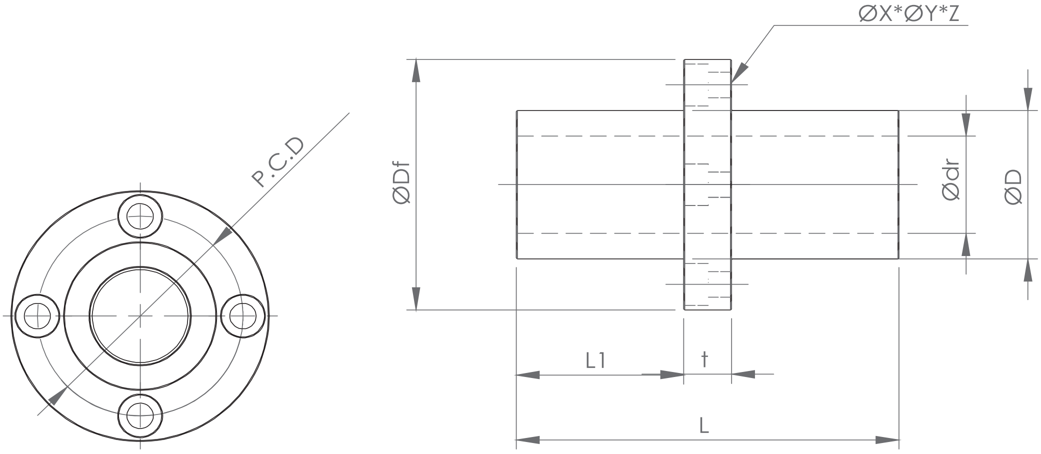
Ordering key : SMFD 20

(1) SMFD (2) 20

1 **SMFD Center flange self-lubricated bearing**

2 **Bearing inner diameter**





Unit : mm

Model No.	Inner Dia.	Dimensions								
	Ødr (F8)	ØD (h6)	L	L1	ØDf	t	P.C.D	ØX	ØY	Z
SMFD 16	16	28	70	28.5	48	13	38	4.5	7.5	4.1
SMFD 20	20	32	80	32.5	54	15	43	5.5	9.0	5.1
SMFD 25	25	40	112	48.5	62	15	51	5.5	9.0	5.1
SMFD 30	30	45	123	51.5	74	20	60	6.6	11.0	6.1

Model No.	Max. Static load	Max. PV	Max. Speed	Weight
	(kgf)	(kgf * m/sec)	(m / sec)	(g)
SMFD 16	780	38.1	2	113
SMFD 20	1100	54.2	2	150
SMFD 25	1900	95	2	303
SMFD 30	2470	123.7	2	407

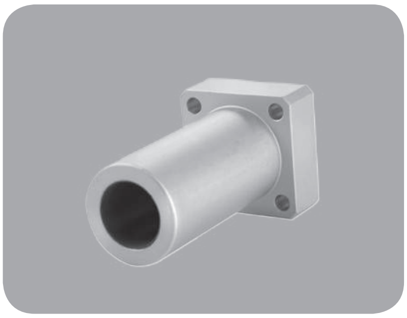
8.12 SMK-L Long square flange type

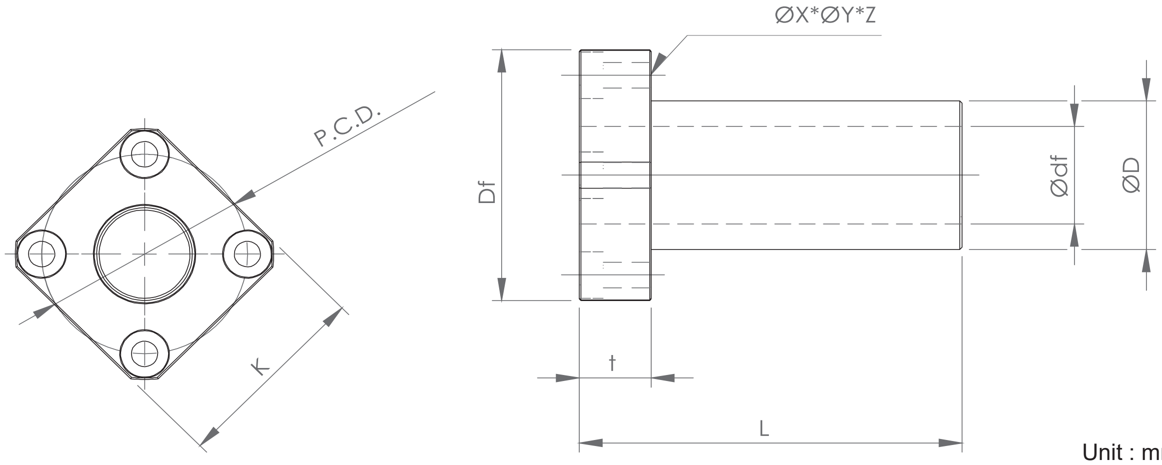
Ordering key : SMK-L 20

1 2

1. **SMK-L Long type round flange self-lubricated bearing**

2. **Bearing inner diameter**





Unit : mm

Model No.	Inner Dia.	Dimensions								
	Ødr (F8)	ØD (h6)	L	ØDf	K	t	P.C.D.	ØX	ØY	Z
SMK10L	10	19	55	40	30	10	29	4.5	7.5	4.1
SMK12L	12	21	57	42	32	13	32	4.5	7.5	4.1
SMK16L	16	28	70	48	37	13	38	4.5	7.5	4.1
SMK20L	20	32	80	54	42	15	43	5.5	9.0	5.1
SMK25L	25	40	112	62	50	15	51	5.5	9.0	5.1
SMK30L	30	45	123	74	58	20	60	6.6	11.0	6.1
SMK35L	35	52	135	82	64	20	67	6.6	11.0	6.1
SMK40L	40	60	151	96	75	22	78	9.0	14.0	8.1

Model No.	Max. Static load	Max. PV	Max. Speed	Weight
	(kgf)	(kgf * m/sec)	(m / sec)	(g)
SMK10L	380	18.7	2	62
SMK12L	475	23.2	2	67
SMK16L	780	38.1	2	106
SMK20L	1100	54.2	2	143
SMK25L	1900	95.0	2	283
SMK30L	2470	123.7	2	388
SMK35L	3230	157.9	2	570
SMK40L	4180	207.0	2	849

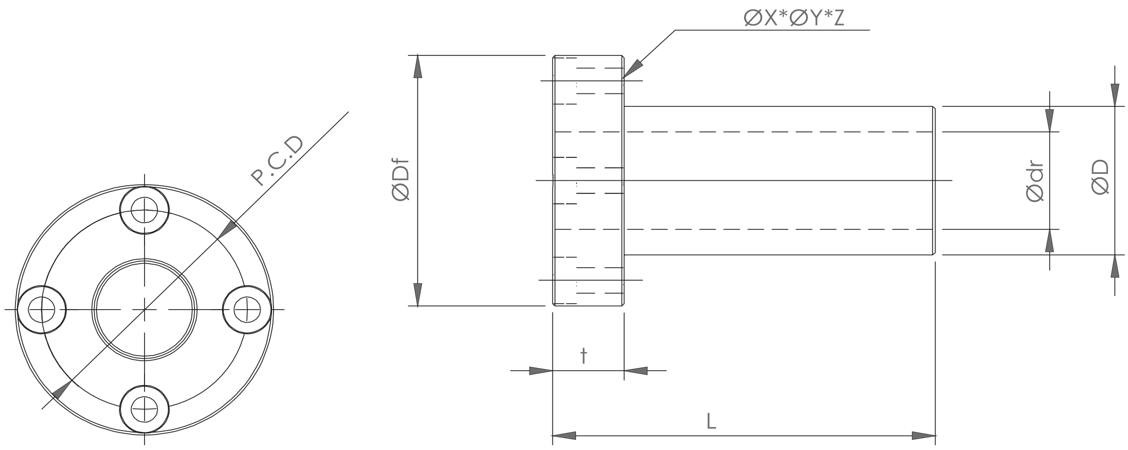
8.13 SMF-L Long round flange type

Ordering key : SMF-L 20

1 — SMF-L
2 — 20

1 **SMF-L Long type round flange self-lubricated bearing**

2 **Bearing inner diameter**



Unit : mm

Model No.	Inner Dia.	Dimensions							
	Ødr (F8)	ØD (h6)	L	ØDf	t	P.C.D.	ØX	ØY	Z
SMF12L	12	21	57	42	13	32	4.5	7.5	4.1
SMF16L	16	28	70	48	13	38	4.5	7.5	4.1
SMF20L	20	32	80	54	15	43	5.5	9.0	5.1
SMF25L	25	40	112	62	15	51	5.5	9.0	5.1
SMF30L	30	45	123	74	20	60	6.6	11.0	6.1

Model No.	Max. Static load	Max. PV	Max. Speed	Weight
	(kgf)	(kgf * m/sec)	(m / sec)	(g)
SMF12L	475	23.2	2	72
SMF16L	780	38.1	2	113
SMF20L	1100	54.2	2	150
SMF25L	1900	95.0	2	303
SMF30L	2470	123.7	2	407

Appendix 1

BR Series Model Code Transition

Standard end cap(BRC with lubricant reservoir)		
	Old item name	New item name
BR15	BRH15A	BRC15-A0
	BRH15B	BRC15-R0
	BRS15B	BRC15-U0
	BRS15BS	BRC15-SU
BR20	BRH20A	BRC20-A0
	BRH20AL	BRC20-LA
	BRH20B	BRC20-R0
	BRH20BL	BRC20-LR
	BRS20B	BRC20-U0
	BRS20BS	BRC20-SU
BR25	BRH25A	BRC25-A0
	BRH25AL	BRC25-LA
	BRH25B	BRC25-R0
	BRH25BL	BRC25-LR
	BRS25B	BRC25-U0
	BRS25BS	BRC25-SU
BR30	BRH30A	BRC30-A0
	BRH30AL	BRC30-LA
	BRH30B	BRC30-R0
	BRH30BL	BRC30-LR
	BRS30B	BRC30-U0
	BRS30BS	BRC30-SU

Rail		
Rail	Old item name	New item name
	BR	BRR

Short end cap(BRD without lubricant reservoir)		
	Old item name	New item name
BR15	BRH15A-S	BRD15-A0
	BRH15B-S	BRD15-R0
	BRS15B-S	BRD15-U0
	BRS15BS-S	BRD15-SU
BR20	BRH20A-S	BRD20-A0
	BRH20AL-S	BRD20-LA
	BRH20B-S	BRD20-R0
	BRH20BL-S	BRD20-LR
	BRS20B-S	BRD20-U0
	BRS20BS-S	BRD20-SU
BR25	BRH25A-S	BRD25-A0
	BRH25AL-S	BRD25-LA
	BRH25B-S	BRD25-R0
	BRH25BL-S	BRD25-LR
	BRS25B-S	BRD25-U0
	BRS25BS-S	BRD25-SU
BR30	BRH30A-S	BRD30-A0
	BRH30AL-S	BRD30-LA
	BRH30B-S	BRD30-R0
	BRH30BL-S	BRD30-LR
	BRS30B-S	BRD30-U0
	BRS30BS-S	BRD30-SU
BR35	BRH35A-S	BRD35-A0
	BRH35AL-S	BRD35-LA
	BRH35B-S	BRD35-R0
	BRH35BL-S	BRD35-LR
	BRS35B-S	BRD35-U0
	BRS35BS-S	BRD35-SU
BR45	BRH45A-S	BRD45-A0
	BRH45AL-S	BRD45-LA
	BRH45B-S	BRD45-R0
	BRH45BL-S	BRD45-LR
	BRS45B-S	BRD45-U0

Appendix 2

Examples of Ball Srews accuracy classes for different uses

Application			Accuracy grade C0	C1	C2	C3	C5	C7	C10
NC Machine Tools	Lathe	X	○	○	○	○	○	○	
		Z				○	○	○	
	Milling Machine Boring Machine	XY		○	○	○	○	○	
		Z			○	○	○	○	
	Machine Center	XY		○	○	○	○		
		Z			○	○	○		
	Jig Borer	Y	○	○					
		Z	○	○					
	Drilling Machine	XY				○	○	○	
		Z					○	○	
	Grinding Machine	X	○	○	○	○	○	○	
		Z		○	○	○	○	○	
	Electro-discharge Machine (EDM)	XY		○	○	○	○	○	
		(Z)			○	○	○	○	
	Wire Cut (EDM)	XY		○	○	○			
		UV		○	○	○	○	○	
	Punching Press	XY				○	○	○	
	Laser Cutting Machine	XY				○	○		
		Z				○	○		
	Wood Working Machine					○	○	○	○
Machines of general and special use					○	○	○	○	○
Semiconductor Machines	Explosure equipments		○	○					
	Chemical treatment					○	○	○	○
	Wire Bonder			○	○	○			
	Prober		○	○	○	○			
	Inserter				○	○	○	○	
	PCB Driller			○	○	○	○	○	
Industrial Robots	Orthogonal type	As' sy		○	○	○	○	○	
		Others					○	○	○
	Multi-joints type	As' sy			○	○	○		
		Others				○	○	○	
	Scara type				○	○	○	○	
Machines of steel molding							○	○	○
Injection Molding Machines							○	○	○
Three-dimensional Measuring Machines			○	○	○				
Business Machines							○	○	○
Pattern Image Machines			○	○					
Nuclear	Rod control					○	○	○	
	Mechnaical Snubber							○	○
Aircraft						○	○		

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