STROKE BUSH

The NB stroke bush is a linear and rotational motion mechanism utilizing the rotational motion of ball elements between an outer cylinder and a shaft. It is compact and can withstand high loading.
The retainer is made of a light metal alloy with high wear resistance. Smooth motion is achieved under high-speed and high-acceleration conditions.
Although the linear motion is limited to a specific stroke length, the combined rotation and stroke motion is achieved with very little frictional resistance.
The NB stroke bush can be conveniently used in a variety of applications.

STRUCTURE AND ADVANTAGES

The retainer in the NB stroke bush positions the ball elements in a zigzag arrangement. The inner surface of the outer cylinder is finished by precision grinding, resulting in smooth motion of the ball elements. Each of the ball elements is held in a separate hole and smooth motion is achieved for both rotational motion and linear motion. The retainer moves half the length of the linear motion, therefore, the stroke length is limited to approximately twice the length the retainer can travel within the outer cylinder.

● High Precision

High-carbon chromium bearing steel is used for the outer cylinder. It is heat treated and ground to achieve high rigidity and accuracy.

● Ease of Mounting and Replacement

The highly accurate fabrication of the NB stroke bush results in uniform dimensions, facilitating parts replacement and housing fabrication.

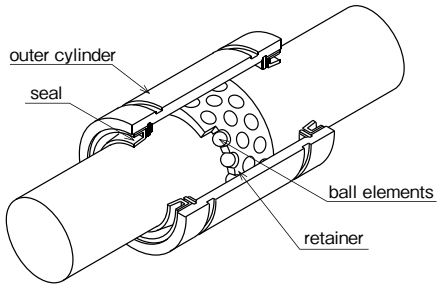
● Light Weight and Space Saving

The use of an aluminum alloy for the retainer and the thin-wall outer cylinder makes the NB stroke bush light weight and compact.

● Lubrication

One lubrication hole is provided on each oil groove of the outer cylinder, making it easy to lubricate the SR stroke bush.

Figure E-1 Structure of SR Stroke Bush



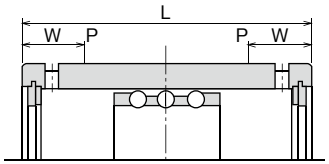
ACCURACY

The accuracies of the SR stroke bush are stated in the dimension tables. Since the outer cylinder deforms due to tension from the retaining ring, the dimension of the outer cylinder is an average value at points P, where calculated using the following equation:

$$W=4+\frac{L}{8}$$

W: the distance from the end of the outer cylinder to measurement point P
L: the length of the outer cylinder

Figure E-2 Outer Cylinder Measurement Points



FIT

The fits generally used between the shaft and the housing are listed in Table E-1. The inner contact diameters of the SR stroke bush are listed in the dimension tables. The shaft diameter tolerance should be selected to achieve the desired amount of radial clearance (see Table E-2). Please pay attention that high-speed linear motion can cause the retainer to slip due to inertial force.
In selecting a shaft, please take note of:
Hardness: 58HRC or more (refer to hardness coefficient on page Eng-5) recommended
Surface Roughness: less than Ra0.4 recommended

Table E-1

normal operating condition		vertical use or highly accurate case	
shaft	housing	shaft	housing
k5,m5	H6,H7	n5,p6	J6,J7

Table E-2 Radial Clearance Negative Limit

part number	limit (μm)
6	− 2
8～10	− 3
12～16	− 4
20～30	− 5
35～50	− 6
60～80	− 8
100	−10

RATED LOAD AND RATED LIFE

The relationship between the rated load and life of the stroke bush is expressed as follows:

$$L=\left(\frac{f_H \cdot f_T \cdot f_C}{f_W} \cdot \frac{C}{P}\right)^3$$

L: rated life (10^6 rotations)　f_H: hardness coefficient
f_T: temperature coefficient　f_C: contact coefficient
f_W: applied load coefficient
C: basic dynamic load rating (N)
P: applied load (N)
※Refer to page Eng-5 for the coefficients.

●For combined rotation and stroke motion

$$L_h=\frac{10^6 \cdot L}{60\sqrt{(dm \cdot n)^2+(10 \cdot S \cdot n_1)^2}/dm}$$

●For stroke motion

$$L_h=\frac{10^6 \cdot L}{600 \cdot S \cdot n_1/(\pi \cdot dm)}$$

L_h: life time (hr)　S: stroke length (mm)
n: revolutions per min. (rpm)
n_1: number of cycles per minute (cpm)
dm: ball pitch diameter (mm) ≒ 1.15 dr

ALLOWABLE SPEED FOR COMBINED ROTATION AND STROKE MOTION

The allowable speed for combined rotation and stroke motion is obtained from the following equation:

$$DN \geqq dm \cdot n+10 \cdot S \cdot n_1$$

The value of DN is given as follows depending on the lubrication method.

for oil lubrication	DN=600,000
for grease lubrication	DN=300,000

note……$n \leqq 5{,}000$　$S \cdot n_1 \leqq 50{,}000$

USE AND HANDLING PRECAUTIONS

Maximum Stroke

The maximum stroke in the dimension table is the stroke limit.

Retainer Slippage

The retainer can slip under high-speed motion, vertical application, unbalanced-loading, and vibrating conditions.
It is suggested that the stroke to be set as a 80% of the maximum stroke in the dimension table. It is also recommended that the bush be cycled to perform the maximum stroke several times, so that the retainer returns to its central position.

SLIDE ROTARY BUSH FR/FRA TYPE

NB Slide Rotary Bush FR type provides combined functions of linear and rotary motion without stroke limitation. Unlike the traditional slide bush, ball elements are arranged around the shaft within the inner space of a bush maintaining compact dimensions while providing high load capacity and high rigidity.

STRUCTURE AND ADVANTAGES

FR type is supplied as a set of a bush and shaft. Constructed with combination of a load carrying outer cylinder and a return cap, it is designed for smooth compound motions. For ease of mounting, the FRA type is also available, which has the FR bush preinstalled within a factory made housing.

●High Load Capacity, High Rigidity

High load capacity, high rigidity, and long life are achieved by ball elements placed all around the inner space between an outer cylinder and a linear shaft.

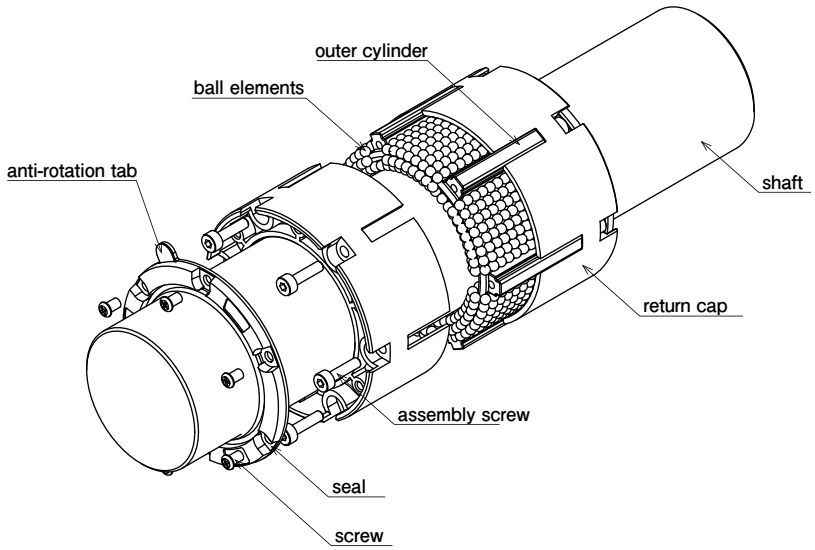
●Smooth Motion

Although it is an all-ball bearing construction, load carrying balls are designed to align along the linear direction to provide smooth motion in both linear and rotational directions.

●High Accuracy

Each set of a bush and shaft is matched and controlled to ensure smooth and highly accurate motion.

Figure E-7 Structure of FR type



RATED LIFE AND LOAD RATING

The rated life and load rating are defined as follows.

●Rated Life

When a group of slide rotary bushing of the same type are used under the same conditions, the rated life is the number of rotations achieved by 90% of the group without causing flaking.

●Basic Dynamic Load Rating

The basic dynamic load rating is the dynamic load with a constant direction and magnitude at which a rated life of 106 rotations can be achieved.

●Basic Static Load Rating

The basic static load rating is the static load with a constant direction that would result in a certain contact stress at the mid-point of the ball elements and tracking surface that are experiencing the maximum stress.

Equation (1) gives the relation between the applied load and the rated life of Slide Rotary Bush.

$$L=\left(\frac{f_C}{f_W}\cdot\frac{C}{P}\right)^3 \quad \cdots\cdots (1)$$

L: rated life (106 rotations) fc: contact coefficient (Table E-4) fw: applied load coefficient (Table E-5) C: basic dynamic load rating (N) P: applied load (N)

Table E-4 Contact Coefficient

number of linear bearings in close contact on a shaft	contact coefficient fc
1	1.00
2	0.81
3	0.72
4	0.66
5	0.61

Table E-5 Applied Load Coefficient

operating conditions		applied load coefficient fw
loading	velocity	
no shock and vibration	15m/min or less	1.0～1.5
low shock and vibration	40m/min or less	1.5～2.0
high shock and vibration	40m/min or less	2.0～3.5

Since the slide rotary bush is used in combined linear and rotary motion, the life time is obtained using Equations (2) and (3).

●When linear and rotary motions are combined

$$L_h=\frac{10^6\cdot L}{60\sqrt{(dm\cdot n)^2+(10\cdot S\cdot n_1)^2}/dm} \cdots (2)$$

●When only linear motion is involved

$$L_h=\frac{10^6\cdot L}{600\cdot S\cdot n_1/(\pi\cdot dm)} \quad \cdots\cdots (3)$$

Lh: life time (hr) S: stroke length (mm) n: revolutions per minute (rpm) n1: number of cycles per minute (cpm)dm: ball pitch diameter (mm)≒1.07dr (dr is the inner contact diameter of FR type)

HOUSING

NB Slide Rotary Bush FR type is manufactured with a properly controlled clearance between the shaft and the bush. When designing a custom housing, the recommended tolerance for the housing bore is H7 or H6.
When rotational motion is involved anti-rotation tab option (Z) is recommended to prevent the bush from rotating within the housing.
Please refer to Table E-6 for the recommended dimensions of housing when using the anti-rotation tab. FRA type is provided with anti-rotation tab as standard feature.

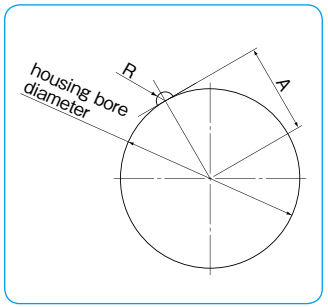


Table E-6

part number	recommended dimensions				
	housing bore diameter		R		A
	mm	tolerance mm	mm	tolerance mm	mm
FR20	32	+0.025 0	1.75	+0.1 0	16
FR25	40		2.25		20
FR30	45				22.5
FR40	60	+0.030 0	2.75		30
FR50	80		4		40

USE AND HANDLING PRECAUTIONS

Ball Drop

FR type is a set of a bush and shaft. Ball elements will drop out if the bush is removed from the shaft since the balls are not retained inside the cylinder. When FR bush must be removed from the shaft, please use a temporary shaft identical to the FR shaft diameter.

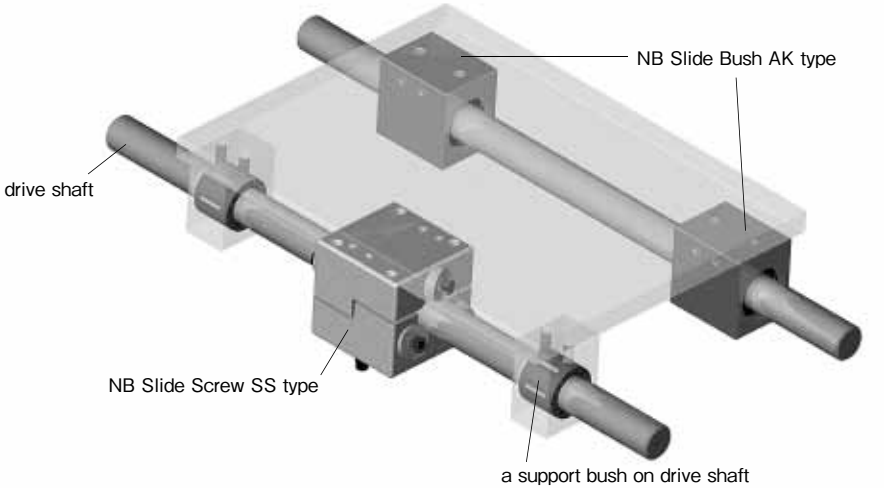
●Lubrication

The purpose of lubrication includes the reduction of friction among the rolling elements as well as between the rolling elements and the raceway, prevention of sintering, reduction of wear, and the prevention of rust. To maximize the performance of FR type, the lubricant type and lubrication method should be selected properly according to the operating conditions. The FR type is pre-lubricated with lithium soap based grease No. 0 for immediate use. Please relubricate with a similar type of grease depending on the operating conditions.

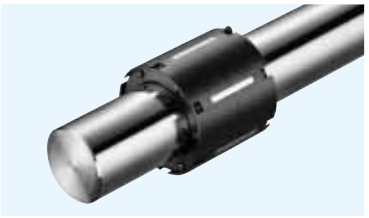
●Operating Temperature Range

FR type' s allowable temperature range is from -20 to 80 degrees Celsius.

APPLICATION EXAMPLES



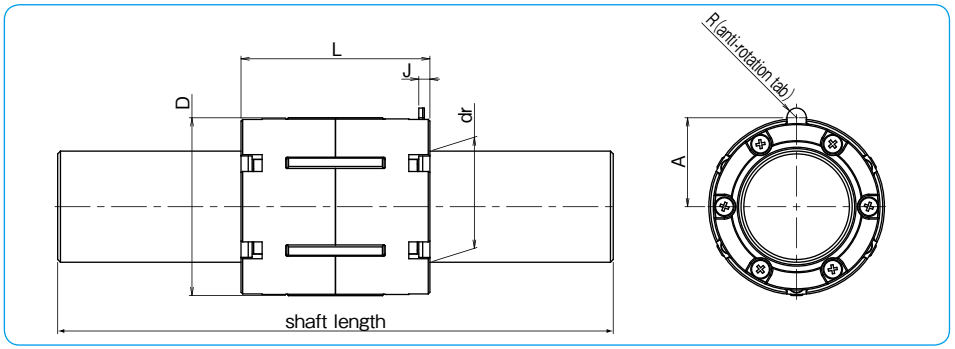
FR TYPE



part number structure

Example **FR 30 UU Z - 2 - 300**

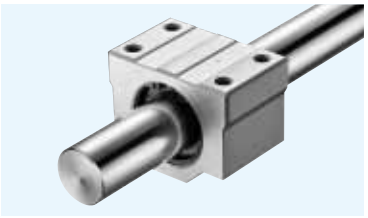
- **FR** : FR type
- **30** : Inner contact diameter (dr)
- **UU** : seal — **blank** : without seal / **UU** : seals on both sides
- **Z** : anti-rotation tab — **blank** : no anti-rotation tab / **Z** : with anti-rotation tab
- **2** : number of bush attached to one shaft
- **300** : shaft length



part number	inner contact diameter dr mm	D*1 mm	D*1 tolerance μm	L mm	L tolerance mm	R mm	R tolerance mm	A mm	J mm	basic load rating dynamic C N	basic load rating static Co N	allowable revolutions per minute rpm	allowable speed m/min	*2 mass g
FR20	20	32	0 −16	34	0 −0.5	1.75	0 −0.2	16	2	1,910	3,010	2,000	40	55
FR25	25	40		41		2.25		20	2.4	3,130	4,780	1,500		105
FR30	30	45		42	0 −0.6			22.5	2.5	3,570	5,750	1,000		122
FR40	40	60	0 −19	56	0 −0.7	2.75		30	3	6,970	10,600	800		302
FR50	50	80		74	0 −1	4		40	3	13,500	18,800			885

*1 : excluding resin part
*2 : excluding shaft

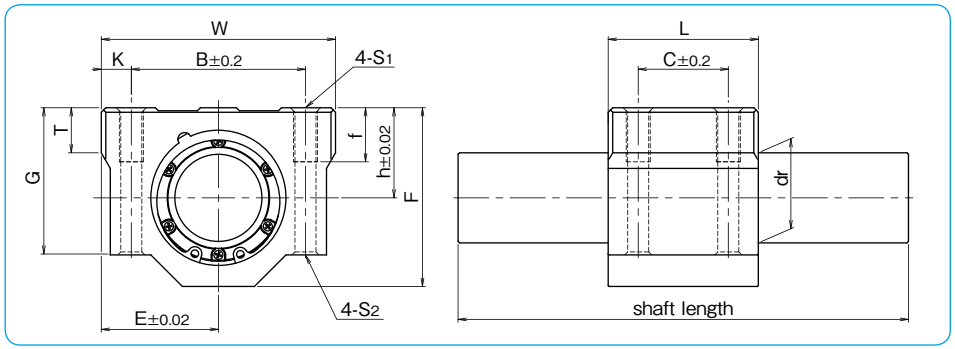
FRA TYPE



part number structure

Example **FRA 30 UU - 2 - 300**

- **FRA** : FRA type
- **30** : Inner contact diameter (dr)
- **UU** : seal — **blank** : without seal / **UU** : seals on both sides
- **2** : number of bush attached to one shaft
- **300** : shaft length



part number	inner contact diameter dr mm	h mm	E mm	W mm	L mm	F mm	G mm	T mm	B mm	C mm	K mm	S1	f mm	S2 mm	basic load rating dynamic C N	basic load rating static Co N	allowable revolutions per minute rpm	allowable speed m/min	*1 mass g
FRA20	20	21	27	54	40	41	35	11	40	25	7	M6	12	5.2	1,910	3,010	2,000	40	170
FRA25	25	26	38	76	50	51.5	42	12	54	30	11	M8	18	7	3,130	4,780	1,500		360
FRA30	30	30	39	78	50	59.5	49	15	58	30	10				3,570	5,750	1,000		420
FRA40	40	40	51	102	65	78	62	20	80	40	11	M10	25	8.7	6,970	10,600	800		950
FRA50	50	52	61	122	84	102	80	25	100	50	11				13,500	18,800			2,120

*1 : excluding shaft