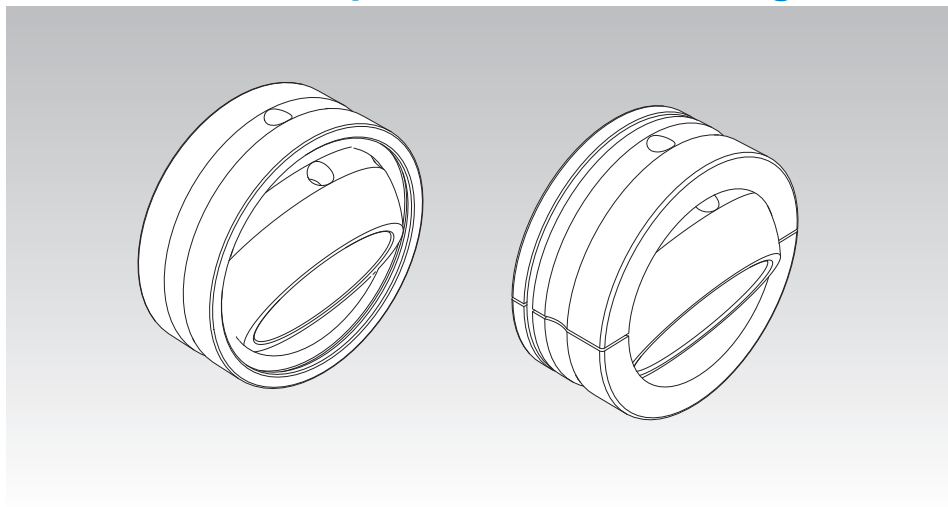


Features of the Spherical Plain Bearing



Structure and Features

Spherical Bearings models SB and SA1 are self-aligning plain bearings designed for heavy loads. The inner and outer rings of these models use high-carbon chromium bearing steel that is hardened and ground, are treated with phosphate coating, which is highly resistant to corrosion and wear, and seized with molybdenum disulfide (MoS_2).

The spherical plain bearing is capable of receiving a large radial load and thrust loads in both directions. Furthermore, because of its high resistance to impact loads, the spherical plain bearing is optimal for low-speed, heavy-load rocking components such as the cylinder clevises or hinges of civil-engineering and construction machinery and the suspensions of trucks.

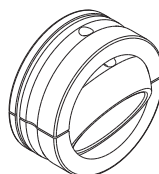
Types of the Spherical Plain Bearing

Types and Features

Model SB

The most popular type of Spherical Plain Bearing in Japan, model SB has wide spherical contact areas and is used as a bearing for heavy loads. The outer ring is split at two points, enabling the inner ring to be accommodated.

Specification Table⇒ **A21-8**



Model SB

Model SA1

This type of Spherical Plain Bearing is widely used in Europe. The outer ring is split at one point (outer rings with diameter of $\phi 100$ or thicker are split at two points), and the width and thickness are smaller than model SB. Thus, this model can be used in small spaces. Types attached with contamination protection seals on both ends (model SA1···UU) are also available.

Specification Table⇒ **A21-10**



Model SA1

Selecting a Spherical Plain Bearing

When selecting a Spherical Plain Bearing, follow the instructions below while referring to the basic dynamic load rating (C) and the basic static load rating (C₀) indicated in the corresponding specification table, as a measuring stick.

[Spherical Plain Bearing Service Life G]

The basic dynamic load rating (C) is used to calculate the service life when the bearing oscillates under a load.

The basic dynamic load rating is calculated based on the contact surface pressure of the spherical sliding section.

The Spherical Plain Bearing service life G is expressed in the total number of rocking motions until it becomes impossible for the bearing to perform normal operation due to the increase in the radial clearance or in the temperature of the bearing as a result of wear on the spherical sliding section.

Since the bearing service life is affected by various factors such as the material of the bearing, magnitude and direction of the load, lubrication conditions and sliding speed, the calculated value can be used as an empirical, practical value.

$$G = b_1 \cdot b_2 \cdot b_3 \cdot b_4 \cdot b_5 \frac{3}{Da \cdot \beta} \cdot \frac{C}{P} \times 10^8$$

- G : Bearing service life
(total number of rocking motions or total number of revolutions)
- C : Basic dynamic load rating (N)
- P : Equivalent radial load (N)
- b₁ : Load direction factor (see Table1)
- b₂ : Lubrication factor (see Table1)
- b₃ : Temperature factor (see Table1)
- b₄¹ : Dimension factor (see Fig.1)
- b₅ : Material factor (see Fig.2)
- Da : Spherical diameter (see the specification table) (mm)
- β : Oscillation half-angle (°)
(for rotary motion, β=90°)

¹ If Da (spherical diameter) is 40 or less, use b₄ = 1.

Table 1

Type		b ₁		b ₂		b ₃		
		Load direction		Regular lubrication		Temperature °C		
		Fixed	Alternating	Not provided	Provided	□30 +80	+80 +150	+150 +180
Spherical Plain Bearing	Without seal	1	5	0.08	1	1	1	0.7
	With seal	1	5	0.08	1	1	□	□

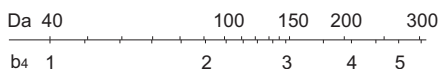


Fig.1 Dimension Factor

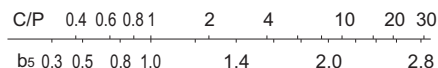


Fig.2 Material Factor

Point of Selection

Selecting a Spherical Plain Bearing

[Equivalent Radial Load]

The Spherical Plain Bearing is capable of receiving a radial load and a thrust load simultaneously. If the magnitude and direction of the load applied are constant, the equivalent radial load is obtained from the following equation.

$$P = Fr + YFa$$

- P : Equivalent radial load (N)
 Fr : Radial load (N)
 Fa : Thrust load (N)
 Y : Thrust load factor (see Table2)

Table2 Thrust Load Factor

Fa/Fr ≤	0.1	0.2	0.3	0.4	0.5
Thrust load factor (Y)	0.8	1	1.5	2.5	3

[Static Safety Factor f_s]

If the Spherical Plain Bearing is to be used under a stationary load or in slight rocking motion, select a model using the basic static load rating (C_0) as a guide. The basic static load rating refers to the stationary load that the bearing can receive without damaging the bearing and without causing permanent deformation that would prevent smooth motion.

In general, aim for a static safety factor of 3 or greater, taking into account the rigidity of the shaft and the housing.

$$f_s = \frac{C_0}{P} \geq 3$$

- f_s : Static safety factor
 C_0 : Basic static load rating
 P : Equivalent radial load

[pV Value]

The permissible sliding speed at which the Spherical Plain Bearing can be used varies depending on the load, lubrication conditions and cooling status. The recommended pV value for continuous motion under a load applied in a constant direction is calculated as follows.

$$pV \leq 400 \text{ N/mm}^2 \cdot \text{mm/s}$$

If the Spherical Plain Bearing performs adiabatic operation or the load direction changes, the heat produced on the sliding surface easily radiates. Therefore, it is possible to set a higher pV value. The contact surface pressure (p) of the Spherical Plain Bearing is obtained from the following equation.

$$p = \frac{P}{Da \cdot B}$$

p	: Contact surface pressure	(N/mm ²)
P	: Equivalent radial load	(N)
Da	: Spherical diameter (see the specification table)	(mm)
B	: Outer ring width (see the specification table)	(mm)

The sliding speed is calculated as follows.

$$V = \frac{\pi \cdot Da \cdot \beta \cdot f}{90 \times 60}$$

V	: Sliding speed	(mm/s)
β	: Oscillation half-angle	(°)
f	: Number of rocking motions per minute	(min ⁻¹)

The spherical plain bearing can be used at sliding speeds of up to 100 mm/s in oscillating motion or up to 300 mm/s in rotary motion under favorable lubrication conditions.

Accuracy Standards

The dimensional tolerances of the Spherical Plain Bearing are defined as indicated in Table3.

Table3 Accuracy of the Spherical Plain Bearing

Unit: μm

Nominal dimension of the inner diameter (d) and outer diameter (D) (mm)		Tolerance in inner diameter (dm)		Tolerance in outer diameter (Dm)		Tolerance of the inner outer ring in width (B _i , B)	
Above	Or less	Upper	Lower	Upper	Lower	Upper	Lower
10	18	0	$\square 8$	$\square$	$\square$	0	$\square 120$
18	30	0	$\square 10$	0	$\square 9$	0	$\square 120$
30	50	0	$\square 12$	0	$\square 11$	0	$\square 120$
50	80	0	$\square 15$	0	$\square 13$	0	$\square 150$
80	120	0	$\square 20$	0	$\square 15$	0	$\square 200$
120	150	0	$\square 25$	0	$\square 18$	0	$\square 250$
150	180	0	$\square 25$	0	$\square 25$	0	$\square 250$
180	250	0	$\square 30$	0	$\square 30$	0	$\square 300$
250	315	$\square$	$\square$	0	$\square 35$	0	$\square 350$
315	400	$\square$	$\square$	0	$\square 40$	0	$\square 400$

Notes: $\square dm$ and $\square Dm$ represent the arithmetic averages of the maximum and minimum diameters obtained in measuring the inner and outer diameters at two points.

The dimensional tolerances of the inner and outer diameters are the values before they are surface treated.

The dimensional tolerance of the outer ring is the value before it is split.

Tolerances of the inner and outer diameters in width (B_i, B) are assumed to be equal, and obtained from the nominal dimension of the inner diameter of the inner ring.

Radial Clearance

Table4 shows radial clearances of the Spherical Plain Bearing.

Table4 Radial Clearances of the Spherical Plain Bearing

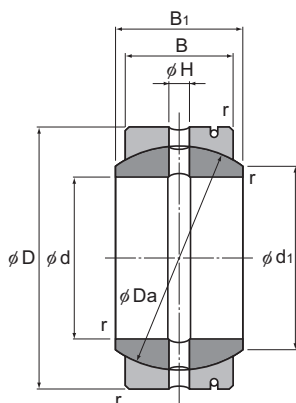
Unit: μm

Bearing inner diameter (d) (mm)		Radial clearance	
Above	Or less	Min.	Max.
$\square$	17	70	125
17	30	75	140
30	50	85	150
50	65	90	160
65	80	95	170
80	100	100	185
100	120	110	200
120	150	120	215
150	240	130	230

Notes: The radial clearance indicates the value before the outer ring is split.

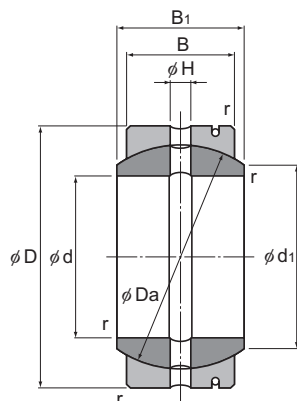
The axial clearance is approximately twice the radial clearance.

Model SB



Unit: mm

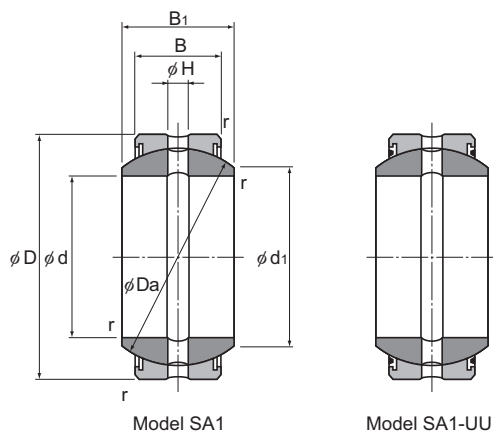
Model No.	Main dimensions								Basic load rating		Mass kg
	Inner diameter d	Outer diameter D	Outer ring width B	Inner ring width B ₁	d ₁	Da	H	r	C kN	C ₀ kN	
SB 12	12	22	9	11	14	18	1.5	0.5	3.82	95.3	0.019
SB 15	15	26	11	13	17.5	22	2.5	0.5	5.69	142	0.028
SB 20	20	32	14	16	23	28	2.5	0.5	9.22	230	0.053
SB 22	22	37	16	19	25.5	32	2.5	0.5	12.1	301	0.085
SB 25	25	42	18	21	29	36	4	0.5	15.3	381	0.116
SB 30	30	50	23	27	36	45	4	1	24.3	609	0.225
SB 35	35	55	26	30	40	50	4	1	30.6	765	0.3
SB 40	40	62	28	33	44	55	4	1	36.3	906	0.375
SB 45	45	72	31	36	50.5	62	6	1	45.2	1130	0.6
SB 50	50	80	36	42	58.5	72	6	1	61	1530	0.87
SB 55	55	90	40	47	64.5	80	6	1	75.3	1880	1.26
SB 60	60	100	45	53	72.5	90	6	1	95.3	2380	1.7
SB 65	65	105	47	55	76	94	6	1	104	2600	2.05



Unit: mm

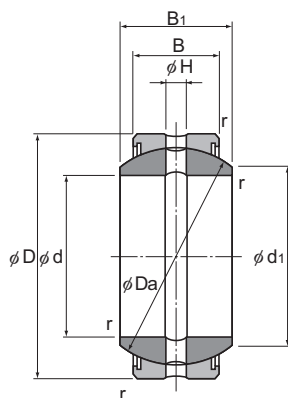
Model No.	Main dimensions								Basic load rating		Mass
	Inner diameter	Outer diameter	Outer ring width	Inner ring width					C	C ₀	
	d	D	B	B ₁	d ₁	Da	H	r	kN	kN	kg
SB 70	70	110	50	58	81.5	100	8	1	118	2940	2.22
SB 75	75	120	55	64	89.5	110	8	1	142	3560	3.02
SB 80	80	130	60	70	97.5	120	8	1	170	4240	3.98
SB 85	85	135	63	74	100.5	125	8	1	185	4640	4.29
SB 90	90	140	65	76	105.5	130	8	1	199	4970	4.71
SB 95	95	150	70	82	113.5	140	8	1	230	5760	6.05
SB 100	100	160	75	88	121.5	150	10	1.5	265	6620	7.42
SB 110	110	170	80	93	130	160	10	1.5	301	7530	8.55
SB 115	115	180	85	98	132.5	165	10	1.5	330	8250	10.3
SB 120	120	190	90	105	140	175	10	1.5	371	9260	12.4
SB 130	130	200	95	110	148.5	185	10	1.5	414	10300	13.8
SB 150	150	220	105	120	166	205	10	1.5	507	12600	17

Model SA1

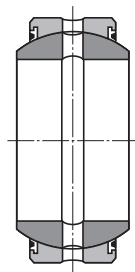


Unit: mm

Model No.		Main dimensions								Basic load rating		Mass
Standard type	Seal type	Inner diameter d	Outer diameter D	Outer ring width B	Inner ring width B ₁	d ₁	Da	H	r	C kN	C ₀ kN	kg
SA1 12	SA1 12UU	12	22	7	10	15	18	1.5	0.3	2.94	74.1	0.017
SA1 15	SA1 15UU	15	26	9	12	18.4	22	2.5	0.3	4.7	117	0.032
SA1 17	SA1 17UU	17	30	10	14	20.7	25	2.5	0.3	5.88	147	0.049
SA1 20	SA1 20UU	20	35	12	16	24.2	29	2.5	0.3	8.23	205	0.065
SA1 25	SA1 25UU	25	42	16	20	29.3	35.5	4	0.3	13.3	334	0.115
SA1 30	SA1 30UU	30	47	18	22	34.2	40.7	4	0.3	17.3	431	0.16
SA1 35	SA1 35UU	35	55	20	25	39.8	47	4	1	22.1	553	0.258
SA1 40	SA1 40UU	40	62	22	28	45	53	4	1	27.5	686	0.315
SA1 45	SA1 45UU	45	68	25	32	50.8	60	6	1	35.3	882	0.413
SA1 50	SA1 50UU	50	75	28	35	56	66	6	1	43.5	1090	0.56
SA1 60	SA1 60UU	60	90	36	44	66.8	80	6	1.5	67.7	1700	1.1
SA1 70	SA1 70UU	70	105	40	49	77.9	92	8	1.5	86.6	2170	1.54



Model SA1



Model SA1-UU

Unit: mm

Model No.		Main dimensions								Basic load rating		Mass
Standard type	Seal type	Inner diameter d	Outer diameter D	Outer ring width B	Inner ring width B_1	d_1	Da	H	r	C kN	C_0 kN	kg
SA1 80	SA1 80UU	80	120	45	55	89.4	105	8	1.5	111	2780	2.29
SA1 90	SA1 90UU	90	130	50	60	98.1	115	8	2	135	3380	2.84
SA1 100	SA1 100UU	100	150	55	70	109.5	130	8	2	169	4210	4.43
SA1 110	SA1 110UU	110	160	55	70	121.2	140	8	2	181	4530	4.94
SA1 120	SA1 120UU	120	180	70	85	135.6	160	8	2	264	6590	8.12
SA1 140	SA1 140UU	140	210	70	90	155.9	180	8	3	296	7410	11.3
SA1 160	SA1 160UU	160	230	80	105	170.2	200	10	3	376	9410	14.4
SA1 180	SA1 180UU	180	260	80	105	199	225	10	3	424	10600	18.9
SA1 200	SA1 200UU	200	290	100	130	213.5	250	10	3	588	14700	28.1
SA1 220	SA1 220UU	220	320	100	135	239.6	275	10	3.5	647	16200	36.1
SA1 240	SA1 240UU	240	340	100	140	265.3	300	10	3.5	706	17600	40.4

Note: Model numbers □.100□ or higher have double-slit outer rings.

Point of Design

Spherical Plain Bearing

Fit

The fitting between the Spherical Plain Bearing and the shaft or the housing is selected according to the conditions. Table1 shows recommended values.

Table1 Recommended Fitting Values

Service condition		Shaft	Housing
Inner ring rotational load	Normal load	k6	H7
	Indeterminate load	m6	H7
Outer ring rotational load	Normal load	g6	M7
	Indeterminate load	h6	N7

Notes: If the product is to be installed so that the inner ring rotates and the fitting with the shaft is to be clearance fitting, harden the surface of the shaft in advance.
 N7 is recommended for light alloy housings.

[Shaft Designing]

If the inner ring is to be fit onto the shaft in loose fitting and the product is to be used under a heavy load, the shaft may slip on the inner circumference of the inner ring. To prevent the slippage, the shaft hardness must be 58 HRC or higher and the surface roughness must be Ra0.80 or below.

Permissible Tilt Angles

The permissible tilt angle of the Spherical Plain Bearing varies according to the shaft shape as indicated in Table2.

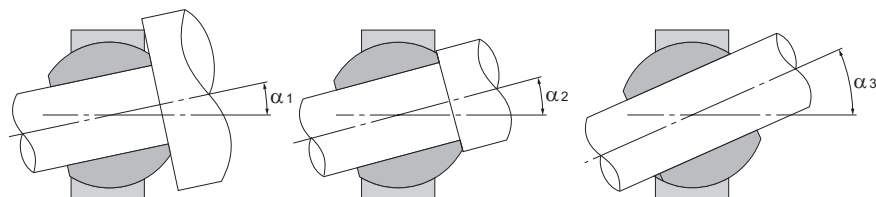


Table2 Permissible Tilt Angles

Unit: °

Unit: °

Model No.	Permissible tilt angles		
	α_1	α_2	α_3
SB 12	5	7	18
SB 15	4	6	18
SB 20	3	4	14
SB 22	4	6	16
SB 25	4	5	16
SB 30	4	6	17
SB 35	4	5	14
SB 40	4	6	12
SB 45	4	5	13
SB 50	4	5	16
SB 55	4	6	16
SB 60	4	6	18
SB 65	4	5	16
SB 70	4	5	15
SB 75	4	5	18
SB 80	4	5	18
SB 85	4	6	16
SB 90	4	5	16
SB 95	4	5	17
SB 100	4	5	18
SB 110	4	5	16
SB 115	4	5	14
SB 120	4	6	15
SB 130	4	5	14
SB 150	4	5	12

Model No.	Permissible tilt angles		
	α_1	α_2 ^{Note}	α_3
SA1 12	8	11 (6)	25 (6)
SA1 15	6	8 (5)	18 (5)
SA1 17	7	10 (7)	23 (7)
SA1 20	6	9 (6)	21 (6)
SA1 25	6	7 (4)	18 (4)
SA1 30	4	6 (4)	16 (4)
SA1 35	5	6 (4)	16 (4)
SA1 40	5	7 (4)	16 (4)
SA1 45	6	7 (4)	16 (4)
SA1 50	5	6 (4)	15 (4)
SA1 60	5	6 (3)	14 (3)
SA1 70	5	6 (4)	14 (4)
SA1 80	4	6 (4)	14 (4)
SA1 90	4	5 (3)	12 (3)
SA1 100	5	7 (5)	14 (5)
SA1 110	5	6 (4)	15 (4)
SA1 120	4	6 (4)	15 (4)
SA1 140	5	7 (5)	16 (5)
SA1 160	6	8 (6)	13 (6)
SA1 180	5	6 (5)	16 (5)
SA1 200	6	7 (6)	13 (6)
SA1 220	6	8 (6)	15 (6)
SA1 240	6	8 (6)	17 (6)

Note: The values in the parentheses apply to types attached with a seal.

Model No.

Spherical Plain Bearing

Model Number Coding

Model number configurations differ depending on the model features. Refer to the corresponding sample model number configuration.

[Spherical Plain Bearing]

● Models SB and SA1

SB25

Model No.

SA1 25 UU

Model No.

Seal
No symbol: none
UU: With