For New Technology Network

NTN®

NTN corporation

Spherical Plain Bearings

CAT. No. 5301-Ⅱ／E

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NTN SPHERICAL PLAIN BEARINGS

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Spherical plain bearings are used in equipment that undergo articulated movement, involving oscillating or aligning motions.

NTN spherical plain bearings are classified broadly into the self-lubricating type with a solid PTFE based liner and the lubrication type in which contact between the inner and outer rings is metal-to-metal.

1. Types of Spherical Plain Bearings

1.1 Self-lubricating type spherical plain bearings

Self-lubricating spherical plain bearings are primarily intended for situations where a long life, free from maintenance and lubrication requirements, is desired. They are also used in parts of machines where lubrication would be difficult.

In the **NTN** self-lubricating spherical plain bearing a self-lubricating PTFE based liner is securely bonded to the outer ring.
Therefore, lubrication, maintenance and inspection are necessary. As there is no oil staining, the bearing is always clean.
It is particularly suitable where the load works in one direction only or where there is a low frequency of oscillating movement.

The inner ring is made of high carbon chromium bearing steel and its sliding surface is hard chromium plated.

Where higher pressures are involved, a special type of spherical plain bearing with a steel mesh reinforced liner is available. Please contact **NTN** for details of this item.

The following types of **NTN** spherical plain bearings are available:

SAR 1 Series : Equivalent to ISO "E" series
SAR 1 ··SS Series : Equivalent to ISO "E" series, with seal
SAR 2 Series : Inch series
SAR 4 Series : Special dimension series

All of these types are suitable for a temperature range of −50˚C (−58˚F) to +100˚C (+212˚F).

1.2 Lubrication type spherical plain bearings

Lubrication type spherical plain bearings feature sliding surfaces where both the inner and outer rings are steel. The outer ring has a single fracture for assembly. The absence of a fitting groove greatly increases the strength of the bearing.

These bearings are particularly suited for subjection to impact loads or alternating loads.

Both the inner and outer rings are manufactured from high carbon chromium bearing steel. After heat treatment and grinding, their surfaces are treated with a phosphate film, which renders them highly resistant to rust. Furthermore, their sliding surfaces are coated with molybdenum disulfide, which provides very effective lubrication of the bearing in its initial stage of operation. Both the inner and outer rings are provided with an oil hole, so that oil can be inserted either from the shaft or from the housing.

The **NTN** lubrication type spherical plain bearing comes in the following types;

SA 1 Series : Equivalent to ISO "E" series
SA 1··SS Series : Equivalent to ISO "E" series, with seal
SA 2 Series : Inch series
SA 4 Series : Special dimensions series
SAT Series : Thrust type series

The temperature range for the SA1··SS series is −20˚C (−4˚F) to + 70˚C (+158˚F), but for the other series, the temperature range is −50˚C (−58˚F) to + 150˚C (+302˚F).

2. Tolerances of Spherical Plain Bearings

Definitions.

The symbols used in the tolerance table are defined as follows;

Symbols

d = bearing bore diameter, nominal
Δ_{dmp} = single plane mean bore diameter deviation
V_{dp} = bore diameter variation in a single radial plane
V_{dmp} = mean bore diameter variation
Δ_{Bs} = deviation of a single width of the inner ring
D = bearing outside diameter, nominal
Δ_{Dmp} = single plane mean outside diameter deviation
V_{Dp} = outside diameter variation in a single radial plane
V_{Dmp} = mean outside diameter variation
Δ_{Cs} = deviation of a single width of the outer ring
Δ_{Ts} = deviation of mean height of thrust spherical plain bearings

Table 1 gives the dimensions of oil holes and grooves in the inner rings and the outer rings.
Two equally spaced oil holes are provided.
Four equally spaced oil holes are provided if the nominal bearing outside diameter exceeds 200mm. (7.8740 inch).

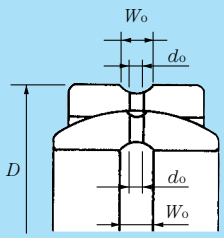


Table 1 Dimensions of lubrication grooves and holes

D				W_0		d_0	
mm		inch		mm	inch	mm	inch
over	incl.	over	incl.				
—	30	—	1.1811	2	0.08	1.5	0.06
30	50	1.1811	1.9685	3	0.12	2	0.08
50	65	1.9685	2.5591	4	0.16	2.5	0.10
65	80	2.5591	3.1496	5	0.20	3	0.12
80	120	3.1496	4.7244	7	0.28	4	0.16
120	180	4.7244	7.0866	9	0.35	5	0.20
180	250	7.0866	9.8425	11	0.43	6	0.24
250	400	9.8425	15.7480	13	0.51	8	0.31
400	500	15.7480	19.6850	16	0.63	10	0.39

Table 2 Tolerance of spherical plain bearings

Inner ring

d				Δ_{dmp}				V_{dp}		V_{dmp}		Δ_{Bs}				Δ_{Ts}			
mm		inch		μm		0.0001 inch		μm	0.0001 inch	μm	0.0001 inch	μm		0.0001 inch		μm		0.0001 inch	
over	incl.	over	incl.	high	low	high	low	max		max		high	low	high	low	high	low	high	low
2.5	10	0.0984	0.3937	0	− 8	0	− 3	8	3	6	2.5	0	−120	0	− 47	—	—	—	—
10	18	0.3937	0.7087	0	− 8	0	− 3	8	3	6	2.5	0	−120	0	− 47	—	—	—	—
18	30	0.7087	1.1811	0	−10	0	− 4	10	4	8	3	0	−120	0	− 47	+200	−200	+79	−79
30	50	1.1811	1.9685	0	−12	0	− 4.5	12	4.5	9	3.5	0	−120	0	− 47	+200	−200	+79	−79
50	80	1.9685	3.1496	0	−15	0	− 6	15	6	11	4.5	0	−150	0	− 59	+250	−250	+98	−98
80	120	3.1496	4.7244	0	−20	0	− 8	20	8	15	6	0	−200	0	− 79	—	—	—	—
120	180	4.7244	7.0866	0	−25	0	−10	25	10	19	7.5	0	−250	0	− 98	—	—	—	—
180	250	7.0866	9.8425	0	−30	0	−12	30	12	23	9	0	−300	0	−118	—	—	—	—
250	315	9.8425	12.4016	0	−35	0	−14	35	14	26	10	0	−350	0	−138	—	—	—	—

Outer ring

D				Δ_{Dmp}				V_{Dp}		V_{Dmp}		Δ_{Cs}			
mm		inch		μm		0.0001 inch		μm	0.0001 inch	μm	0.0001 inch	μm		0.0001 inch	
over	incl.	over	incl.	high	low	high	low	max		max		high	low	high	low
10	18	0.3937	0.7087	0	−8	0	− 3	10	4	6	2.5	0	−240	0	− 94
18	30	0.7087	1.1811	0	−9	0	− 3.5	12	4.5	7	3	0	−240	0	− 94
30	50	1.1811	1.9685	0	−11	0	− 4.5	15	6	8	3	0	−240	0	− 94
50	80	1.9685	3.1496	0	−13	0	− 5	17	6.5	10	4	0	−300	0	−118
80	120	3.1496	4.7244	0	−15	0	− 6	20	8	11	4.5	0	−400	0	−157
120	150	4.7244	5.9055	0	−18	0	− 7	24	9.5	14	5.5	0	−500	0	−197
150	180	5.9055	7.0866	0	−25	0	−10	33	13	19	7.5	0	−500	0	−197
180	250	7.0866	9.8425	0	−30	0	−12	40	16	23	9	0	−600	0	−236
250	315	9.8425	12.4016	0	−35	0	−14	47	19	26	10	0	−700	0	−276
315	400	12.4016	15.7480	0	−40	0	−16	53	21	30	12	0	−800	0	−315
400	500	15.7480	19.6850	0	−45	0	−18	60	24	34	13	0	−900	0	−354

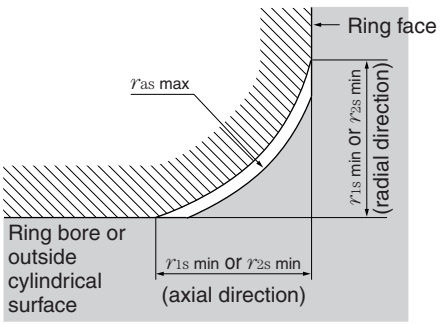


Table 3 Tolerances for chamfer dimensions

r_{1s} min or r_{2s} min		d				r_{1s} max or r_{2s} max				(Reference) Shaft or housing fillet radius r_{as} max	
		mm		inch		radial direction		axial direction			
mm	inch	over	incl.	over	incl.	mm	inch	mm	inch	mm	inch
0.3	0.012	—	40	—	1.5748	0.6	0.024	1	0.039	0.3	0.012
		40	—	1.5748	—	0.8	0.031	1	0.039		
0.6	0.024	—	40	1.5748	1.5748	1	0.039	2	0.079	0.6	0.024
		40	—		—	1.3	0.051	2	0.079		
1	0.039	—	50	1.9685	1.9685	1.5	0.059	3	0.118	1	0.039
		50	—		—	1.9	0.075	3	0.118		
1.1	0.043	—	120	4.7244	4.7244	2	0.079	3.5	0.138	1	0.039
		120	—		—	2.5	0.098	4	0.157		

3. Loads Acting on Spherical Plain Bearings

3.1 Equivalent radial load

Loads applying to spherical plain bearings include a radial load, that is, a load acting vertically to the axis of the bearing, and a thrust load which acts parallel to it. Arbitary directions of the load must be divided into radial and thrust loads, and an equivalent radial load is obtained by the following formula (1):

$$P_r = F_r + YF_a \cdots\cdots (1)$$

where in

P_r = equivalent radial load, N, lbf
F_r = radial load, N, lbf
F_a = thrust load, N, lbf
Y = axial load factor

Axial load factors Y to be used are shown in Table 4 below.

In the case of the self-lubricating type, however, the thrust load should not exceed the permissible axial loads P_t mentioned in the dimension table.

Table 4 Axial load factor Y

F_a/F_r / Bearing types	0.1	0.2	0.3	0.4	0.5	0.5 <
Self-lubrication type	1	2	3	Unfit		
Lubrication type	1	2	3	4	5	Unfit

3.2 Fluctuating load

When the magnitude of load applied to the bearing is not constant but is subject to simple periodical fluctuations, an average load can be obtained by the following formula (2):

$$F_m = \frac{F_{min} + 2F_{max}}{3} \cdots\cdots (2)$$

where

F_m = average load, N, lbf
F_{min} = minimum fluctuating load, N, lbf
F_{max} = maximum fluctuating load, N, lbf

4. Selection of Spherical Plain Bearings

In the selection of **NTN** spherical plain bearings, the choice of either the self-lubricating type or the lubrication type is determined by the part of the machine where it is to be used, and by operating conditions such as surface pressure, direction in which the load applies, operating temperature, and lubricating conditions.

4.1 Dynamic load and dynamic load rating

Permissible loads for spherical plain bearings against their dynamic load rating vary with their types and with the nature of the loads applying. The limits for these loads are shown in Table 5.

Table 5 Limit loads

Direction of load / Bearing type	Load acting in one direction	Load acting in a variable direction
Self-lubricating	1 C_d	0.5 C_d
Lubrication type	0.3 C_d	0.6 C_d

In the case of the self-lubricating type, the influence of the operating temperature on the dynamic load rating must be taken into account, using the following formula (3).

$$C_{dt} = f_t \cdot C_d \cdots\cdots (3)$$

where,

C_{dt} = dynamic load rating with temperature factor considered taken into account, N, lbf
C_d = dynamic load rating, N, lbf (see the dimensions table)
f_t = temperature factor (see Fig. 1)

4.2 Permissible thrust load

The limit of a thrust load is acting on spherical plain bearings is determined by the ratio of the thrust load F_a and the radial load F_r as follows:

Self-lubricating type bearing:

$$F_a / F_r \leqq 0.3$$

Lubrication type bearing:

$$F_a / F_r \leqq 0.5$$

In the case of the self-lubricating type bearing, however, the thrust load should not exceed the permissible axial load P_t mentioned in the table of dimensions. Further-more, P_t must be adjusted by a temperature factor f_t, as shown in Fig. 1.

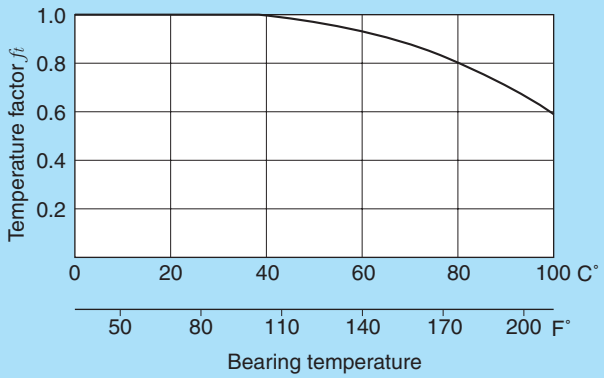


Fig. 1 Temperature factor f_t

4.3 Sliding speed and load

It is recommended that **NTN** spherical plain bearings be used within the permissible range of values as shown in Fig. 2, for the relationship between the sliding speed V and the load P applied to the bearing. Should you desire to use them beyond this range, please consult **NTN**.

The sliding speed can be obtained by the following formula (4) :

$$V = 8.7 \times 10^{-6} (d + D) \cdot \theta \cdot f \cdots\cdots (4)$$

where,

V = sliding speed, m/min, f_t/min
d = bore of the bearing, mm, inch
D = O.D. of the bearing, mm, inch
θ = oscillating angle deg.
f = frequency of oscillation cpm

4.4 Static load and load rating

In cases where the load applied to the bearing is static or where the bearing undergoes oscillating movement only at rare intervals, the limiting maximum load applied to the bearing is as shown in Table 6.

Table 6 Limit loads for static use

Bearing type	Permissible load (max)	Remarks
Self-lubricating type	1.5 times C_d	The influence of temperature must be taken into account. (refer to formula (3).)
Lubrication type	1/6 of C_s	For general use.
	1/4 of C_s	Applicable where the frequency of use is very low and the bearing is well lubricated.

C_d = dynamic load rating
C_s = static load rating

Where a static load close to C_s is applied, it is also necessary to review the strength of the shaft.

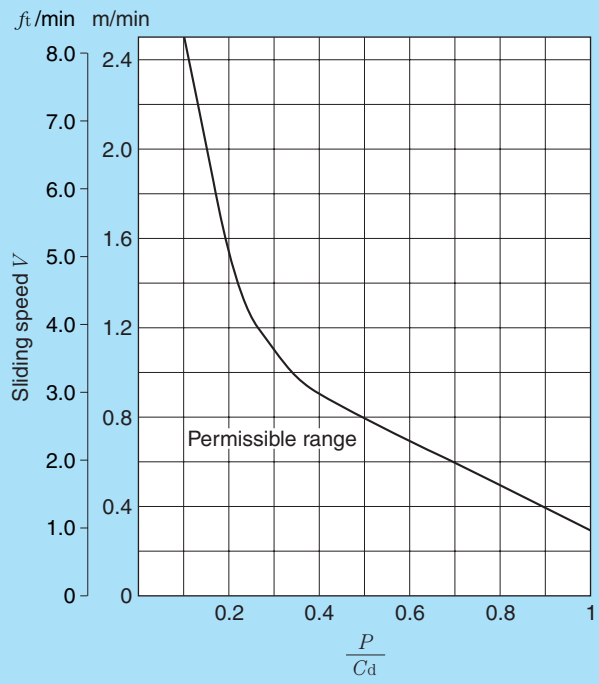


Fig. 2 Permissible P - V value curve

5. Life of Spherical Plain Bearings

5.1 Self-lubricating type bearings

The life of self-lubricating type bearings is determined by the degree of wear of the PTFE based material on the sliding part. The wear progresses in stages, through initial wear, normal wear and abnormal wear. The time of occurrence of abnormal wear is considered as the limit to continuous use of the bearing.

This limit to the continuous use of a bearing is, under conditions of normal wear expressed in terms of the total sliding distance covered before the amount of wear (amount of increase in clearance) reaches a certain limit value.

The total sliding distance S, with the amount of wear taken at 0.1 mm (0.004inch) ,is shown in Fig. 3. In general use, bearings can be continuously used for two to three (2-3) times the values obtained from this graph.

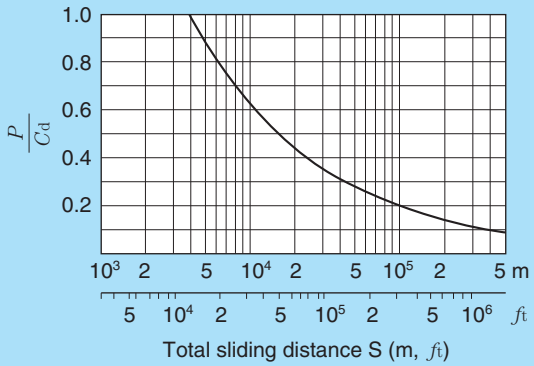


Fig. 3 Load applied to the bearing and the total sliding distance

5.2 Lubrication type bearings

The total service life of lubrication type bearings can be obtained from the following formula (5):

$$L_h = \frac{f_w \cdot f_1 \cdot L_1}{60 \cdot f} \quad \cdots\cdots (5)$$

where,

L_h : total service life h
f_w : lubrication factor
f_1 : factor of load direction
L_1 : initial service life
f : frequency of oscillation cpm

The procedure for this calculation is as follows:

(1) Sliding speed V ····· from formula (4)
(2) Speed factor f_n ····· from Fig. 4
(3) Initial service life L_1 ····· from Fig. 5
(4) Number of oscillations during the interval of relubrication : Z_w ····· from formula (6)

$$Z_w = 60 \cdot f \cdot H \quad \cdots\cdots (6)$$

where,

f : frequency of oscillation cpm
H : interval of relubrications h

(5) Lubrication factor f_w ·····from Fig. 6
(6) Factor of load direction f_1·····from Table 7

Using the values obtained as above, the total service life is to be calculated from formula (5) .

Table 7 Factor of load direction

Load conditions	f_1
Load acting in one direction	1
Load acting in a variable direction	5

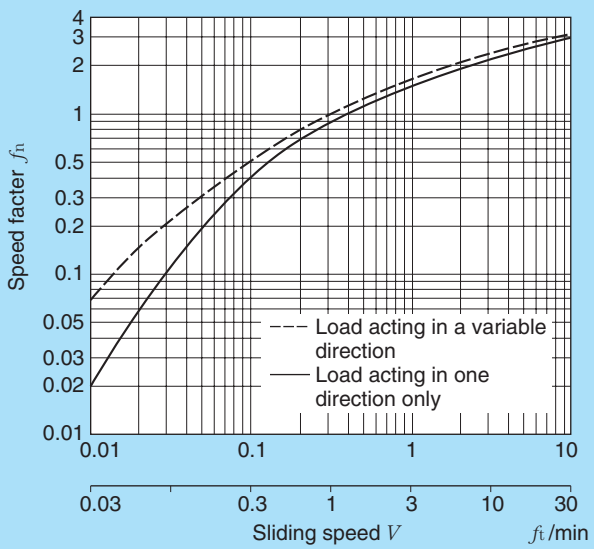
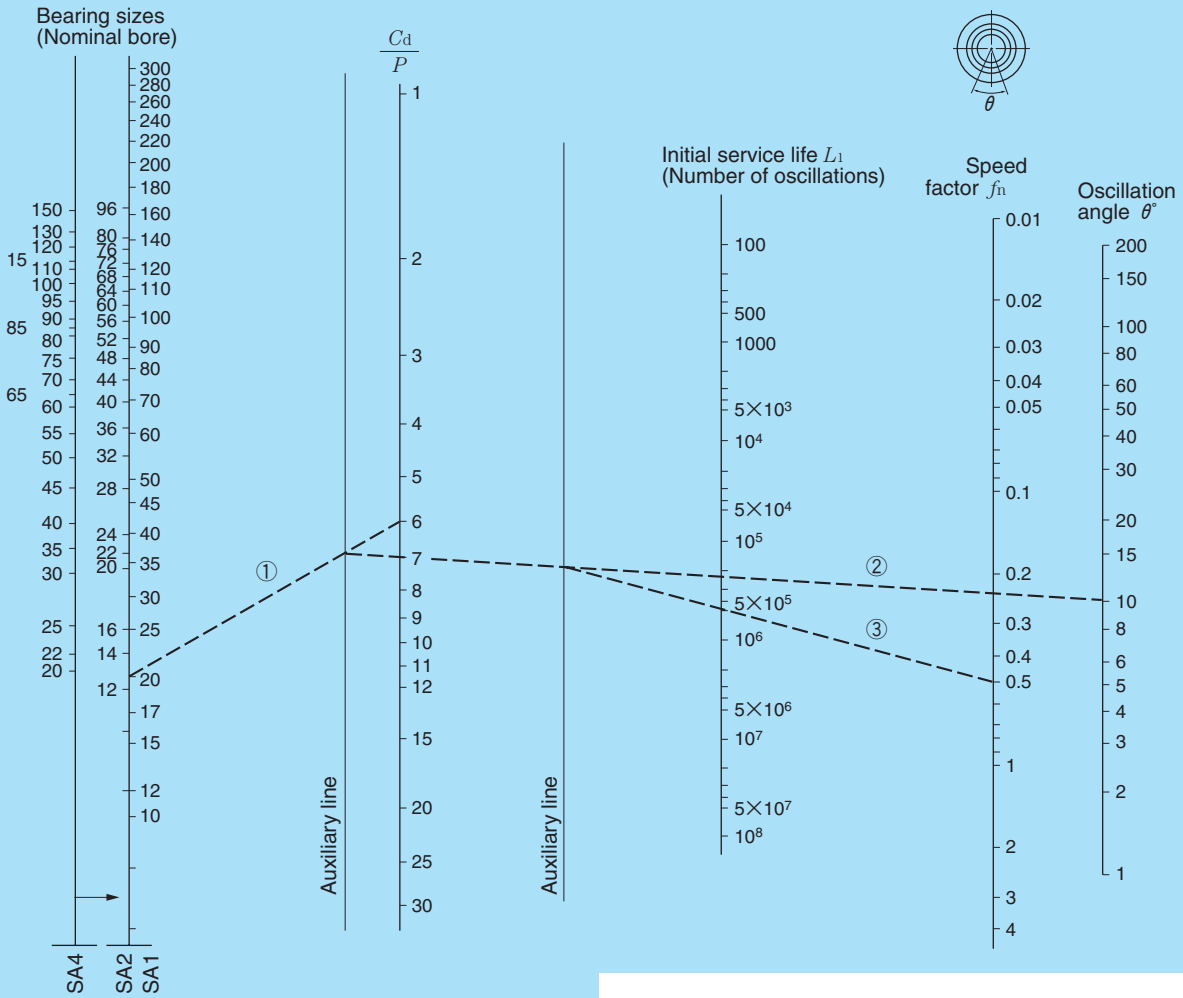


Fig. 4 Speed factor f_n



Example: SA1-20B

Load condition $\frac{Cd}{P} = 6$

Oscillation angle $\theta = 10^\circ$
Speed factor $f_n = 0.5$
Initial service life L_1, in this instance, works out as:

$L_1 = 5 \times 10^5$ times

When a bearing of the SA4 series is used, move the SA4 scale to the position of the SA1 scale, and then connect its size number with its $\frac{Cd}{P}$ value.

Fig. 5 Nomogram of the initial service life L, (Lubrication type bearings)

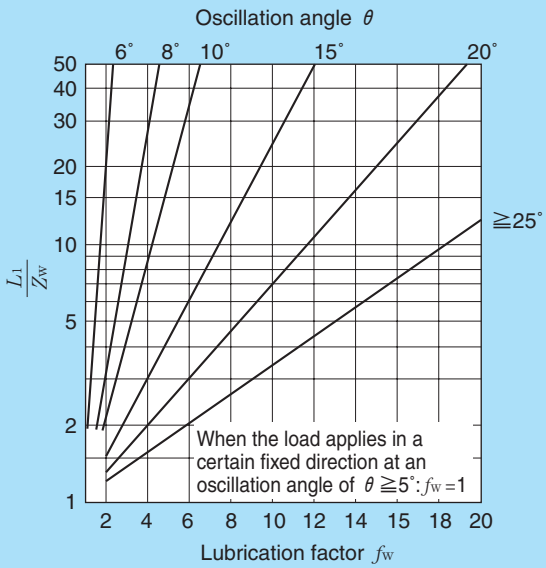


Fig. 6 Lubrication factor f_w

6. Recommended Fit and Internal Clearance

6.1 Recommended fit

The recommended fits for **NTN** self-lubricating type and lubrication type spherical plain bearings are shown in Tables 8 and 9.

Table 8 Recommended fit for self-lubricating type spherical plain bearings

Operating conditions		Fit		
		Shaft	Housing	
			Steel	Light alloy
Rotating inner ring load	Normal load	k6 ❶	H7	J7
	Heavy load	m6 ❶		
Rotating outer ring load	Normal load	h6	K7 ❷	M7 ❷
	Heavy load		M7 ❷	—

Notes:
❶ When mounting the bearing, take special care not to apply a large axial load. When it is necessary, for convenience of fitting, to adopt a clearance fit for mounting the bearing on the shaft, fit "h6" or "g6" may be used. In this case the surface of the shaft must be hardened and it is recommended that the fitting surfaces be coated with molybdenum disulphide.
❷ When it is necessary for the bearing to be able to move in the axial direction in the housing, or when the load is light, fit "H7" may be used. In these cases, it is recommended that the fitting surfaces be coated with molybdenum disulphide. Use special care not to let molybdenum disulphide enter into the sliding surface of the bearings.

Table 9 Recommended fit for lubrication type spherical plain bearings

Operating conditions		Fit		
		Shaft	Housing	
			Steel	Light alloy
Rotating inner ring load	Normal load	k6 ❶	J7	K7
	Heavy load	m6 ❶		
Rotating outer ring load	Normal load	h6 ❷	K7	M7
	Heavy load		N7	P7

Notes:
❶ When it is necessary, for convenience of fitting, to adopt a clearance fit for mounting the bearing on the shaft, fit "h6" or "g6" may be used. In this instance, however, the surface of the shaft must be hardened and it is recommended that the fitting surfaces be coated with molybdenum disulphide.
❷ When the sliding speed is high, fit "j6" is recommended.

6.2 Internal bearing clearance

Internal clearance of **NTN** self-lubricating type and lubrication type spherical plain bearings are shown in Table 10.

Table 10 Internal clearance

Nominal bore d				Srelf-lubricating type				Lubrication type			
mm		inch		min		max		min		max	
over	incl.	over	incl.	μm	0.0001 inch	μm	0.0001 inch	μm	0.0001 inch	μm	0.0001 inch
6	10	0.2362	0.3937	8	3	32	13	50	20	80	31
10	18	0.3937	0.7087	10	4	40	16	50	20	90	35
18	30	0.7087	1.1811	12	4.5	50	20	60	24	100	39
30	50	1.1811	1.9685	15	6	60	24	70	28	120	47
50	80	1.9685	3.1496	18	7	72	28	80	31	150	59
80	120	3.1496	4.7244	—	—	—	—	100	39	180	71
120	180	4.7244	7.0866	—	—	—	—	120	47	210	83
180	250	7.0866	9.8245	—	—	—	—	170	67	270	106
250	315	9.8425	12.4016	—	—	—	—	200	79	310	122

Notes: Tolerance in inchs are converted from the original figures specified in μm and rounded for reference.

7. Cautions to Installation

To install the oil lubricating bearing to the housing, position the bearing so that the cut in the outer ring shall be perpendicular to the load acting direction as illustrated in Fig. 7.

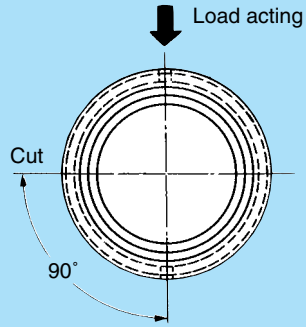
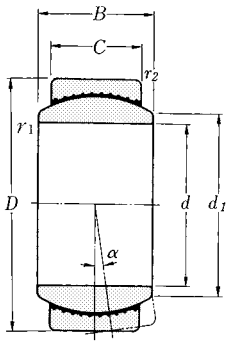


Fig. 7

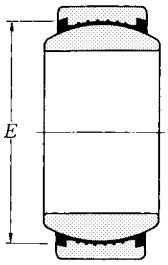
NTN Spherical Plain Bearings

Self-lubricating type

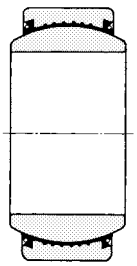
Series SAR1
SAR1··SS



SAR1
$d \leqq 20$mm



SAR1
$d \geqq 25$mm



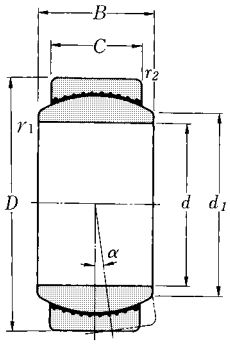
SAR1··SS
with seal

Bearing numbers		Dimensions mm inch								Max. angle of misalignment	Dynamic load rating	Limiting thrust load	Mass
SAR1	SAR1··SS	d	D	B	C	$r_{1s\ min}$	$r_{2s\ min}$	d_1 (Ref.)	E (Ref.)	α	C_d N lbf	P_t N lbf	kg lb
SAR1-10	—	10 0.3937	19 0.7480	9 0.3543	6 0.2362	0.6 0.024	0.3 0.012	13.1 0.516	—	12°	8 400 1 890	510 115	0.010 0.022
SAR1-12	—	12 0.4724	22 0.8661	10 0.3937	7 0.2756	0.6 0.024	0.6 0.024	15.3 0.602	—	10°	11 400 2 570	735 165	0.015 0.033
SAR1-15	—	15 0.5906	26 1.0236	12 0.4724	9 0.3543	0.6 0.024	0.6 0.024	18.7 0.736	—	8°	17 300 3 900	1 160 260	0.025 0.055
SAR1-17	—	17 0.6693	30 1.1811	14 0.5512	10 0.3937	0.6 0.024	0.6 0.024	21.2 0.835	—	10°	21 800 4 900	1 360 305	0.040 0.088
SAR1-20	—	20 0.7874	35 1.3780	16 0.6299	12 0.4724	0.6 0.024	0.6 0.024	23.7 0.933	—	9°	26 900 6 050	1 590 355	0.062 0.137
SAR1-25	**SAR1-25SS**	25 0.9843	42 1.6535	20 0.7874	16 0.6299	0.6 0.024	0.6 0.024	29.3 1.154	37.2 1.465	7°	40 500 9 100	2 290 515	0.102 0.225
SAR1-30	**SAR1-30SS**	30 1.1811	47 1.8504	22 0.8661	18 0.7087	0.6 0.024	0.6 0.024	34.2 1.346	42 1.654	6°	51 000 11 500	2 640 595	0.138 0.304
SAR1-35	**SAR1-35SS**	35 1.3780	55 2.1654	25 0.9843	20 0.7874	0.6 0.024	1 0.039	39.8 1.567	48.8 1.921	6°	65 000 14 600	3 050 685	0.220 0.485
SAR1-40	**SAR1-40SS**	40 1.5748	62 2.4409	28 1.1024	22 0.8661	0.6 0.024	1 0.039	45 1.772	55.2 2.173	7°	81 000 18 300	3 700 830	0.300 0.661
SAR1-45	**SAR1-45SS**	45 1.7717	68 2.6772	32 1.2598	25 0.9843	0.6 0.024	1 0.039	50.8 2.000	62.4 2.457	7°	106 000 23 800	5 000 1 120	0.400 0.882
SAR1-50	**SAR1-50SS**	50 1.9685	75 2.9528	35 1.3780	28 1.1024	0.6 0.024	1 0.039	56 2.205	68.4 2.693	6°	124 000 28 000	5 500 1 240	0.530 1.17
SAR1-60	**SAR1-60SS**	60 2.3622	90 3.5433	44 1.7323	36 1.4173	1 0.039	1 0.039	66.8 2.630	81 3.189	6°	178 000 40 000	7 450 1 670	0.960 2.12

NTN Spherical Plain Bearings

Self-lubricating type

Series SAR4

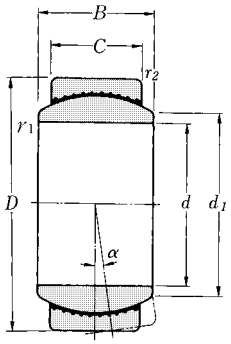


Bearing numbers	Dimensions mm inch							Max. angle of misalignment	Dynamic load rating	Limiting thrust load	Mass
	d	D	B	C	$r_{1s\ min}$	$r_{2s\ min}$	d_1 (Ref.)	α	C_d N lbf	P_t N lbf	kg lb
SAR4-22	22 0.8661	37 1.4567	19 0.7480	16 0.6299	0.3 0.012	0.3 0.012	25.7 1.012	6°	32 000 7 150	1 680 375	0.085 0.187
SAR4-25	25 0.9843	42 1.6535	21 0.8268	18 0.7087	0.3 0.012	0.3 0.012	29.2 1.150	5°	39 000 8 800	1 940 435	0.120 0.265
SAR4-30	30 1.1811	50 1.9685	27 1.0630	23 0.9055	0.6 0.024	0.6 0.024	34.7 1.366	6°	54 500 12 200	2 330 525	0.222 0.489
SAR4-35	35 1.3780	55 2.1654	30 1.1811	26 1.0236	0.6 0.024	0.6 0.024	39.4 1.511	5°	72 000 16 100	3 350 755	0.270 0.595
SAR4-40	40 1.5748	62 2.4409	33 1.2992	28 1.1024	0.6 0.024	0.6 0.024	44.6 1.756	6°	91 000 20 400	4 300 965	0.370 0.816
SAR4-45	45 1.7717	72 2.8346	36 1.4173	31 1.2205	0.6 0.024	0.6 0.024	52.9 2.083	5°	117 000 26 200	5 150 1 160	0.570 1.26
SAR4-50	50 1.9685	80 3.1496	42 1.6535	36 1.4173	0.6 0.024	0.6 0.024	58.5 2.303	5°	147 000 33 000	6 400 1 440	0.820 1.81

NTN Spherical Plain Bearings

Self-lubricating type

Series SAR2 (Inch size)

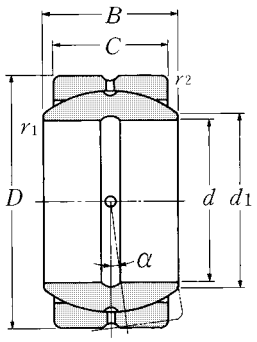


Bearing numbers	Dimensions mm inch							Max. angle of misalignment	Dynamic load rating		Limiting thrust load		Mass
	d	D	B	C	$r_{1s\ min}$	$r_{2s\ min}$	d_1 (Ref.)	α	C_d lbf / N		P_t lbf / N		lb / kg
SAR2-12	0.7500 19.05	1.2500 31.75	0.656 16.662	0.562 14.275	0.012 0.3	0.024 0.6	0.862 21.9	6°	5 650 25 200		340 1 520		0.123 0.056
SAR2-14	0.8750 22.225	1.4375 36.512	0.765 19.431	0.656 16.662	0.012 0.3	0.024 0.6	1.000 25.4	6°	7 150 32 000		375 1 680		0.190 0.086
SAR2-16	1.0000 25.4	1.6250 41.275	0.875 22.225	0.750 19.05	0.012 0.3	0.024 0.6	1.114 28.3	6°	8 800 39 000		435 1 940		0.273 0.124
SAR2-20	1.2500 31.75	2.0000 50.8	1.093 27.762	0.937 23.8	0.024 0.6	0.024 0.6	1.417 36	6°	12 900 57 000		535 2 370		0.512 0.232
SAR2-22	1.3750 34.925	2.1875 55.562	1.187 30.15	1.031 26.187	0.024 0.6	0.039 1	1.547 39.3	5°	16 100 72 000		755 3 350		0.763 0.346
SAR2-24	1.5000 38.1	2.4375 61.912	1.312 33.325	1.125 28.575	0.024 0.6	0.039 1	1.622 41.2	6°	18 300 81 000		830 3 700		0.926 0.420
SAR2-28	1.7500 44.45	2.8125 71.438	1.531 38.887	1.312 33.325	0.024 0.6	0.039 1	2.000 50.8	6°	25 200 112 000		1 030 4 600		1.42 0.643
SAR2-32	2.0000 50.8	3.1875 80.962	1.750 44.45	1.500 38.1	0.024 0.6	0.039 1	2.228 56.6	6°	29 500 131 000		1 030 4 600		2.05 0.931

NTN Spherical Plain Bearings

Lubrication type

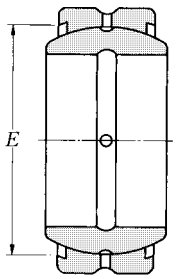
Series SA1
SA1··SS



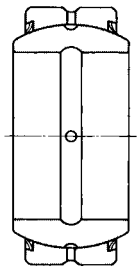
SA1
15mm ≧ d ≧ 140mm

Bearing numbers ❶		Dimensions mm / inch								Max. angle of misalignment	Dynamic load rating	Static load rating	Mass
SA1	SA1··SS	d	D	B	C	$r_{1s\ min}$	$r_{2s\ min}$	d_1 (Ref.)	E (Ref.)	α	C_d N / lbf	C_s N / lbf	kg / lb
SA1-10B ❷	—	10 0.3937	19 0.7480	9 0.3543	6 0.2362	0.6 0.024	0.3 0.012	13.1 0.561	—	12°	9 350 2 100	56 000 12 600	0.012 0.026
SA1-12B ❷	—	12 0.4724	22 0.8661	10 0.3937	7 0.2756	0.6 0.024	0.6 0.024	15.3 0.602	—	10°	12 500 2 820	75 000 16 900	0.017 0.037
SA1-15B	—	15 0.5906	26 1.0236	12 0.4724	9 0.3543	0.6 0.024	0.6 0.024	18.7 0.736	—	8°	19 600 4 400	118 000 26 500	0.032 0.071
SA1-17B	SA1-17BSS	17 0.6693	30 1.1811	14 0.5512	10 0.3937	0.6 0.024	0.6 0.024	21.2 0.835	25.6 1.008	10°	24 900 5 600	149 000 33 500	0.049 0.108
SA1-20B	SA1-20BSS	20 0.7874	35 1.3780	16 0.6299	12 0.4724	0.6 0.024	0.6 0.024	23.7 0.933	29.2 1.150	9°	33 500 7 550	202 000 45 500	0.065 0.143
SA1-25B	SA1-25BSS	25 0.9843	42 1.6535	20 0.7874	16 0.6299	0.6 0.024	0.6 0.024	29.3 1.154	35.5 1.398	7°	55 500 12 500	335 000 75 000	0.115 0.254
SA1-30B	SA1-30BSS	30 1.1811	47 1.8504	22 0.8661	18 0.7087	0.6 0.024	0.6 0.024	34.2 1.346	40.6 1.598	6°	72 000 16 200	430 000 97 000	0.160 0.353
SA1-35B	SA1-35BSS	35 1.3780	55 2.1654	25 0.9843	20 0.7874	0.6 0.024	1 0.039	39.8 1.567	46.6 1.835	6°	92 000 20 700	555 000 124 000	0.258 0.569
SA1-40B	SA1-40BSS	40 1.5748	62 2.4409	28 1.1024	22 0.8661	0.6 0.024	1 0.039	45 1.772	53.5 2.106	7°	114 000 25 700	685 000 154 000	0.315 0.694
SA1-45B	SA1-45BSS	45 1.7717	68 2.6772	32 1.2598	25 0.9843	0.6 0.024	1 0.039	50.8 2.000	59.9 2.358	7°	147 000 33 000	885 000 198 000	0.413 0.910
SA1-50B	SA1-50BSS	50 1.9685	75 2.9528	35 1.3780	28 1.1024	0.6 0.024	1 0.039	56 2.205	65.6 2.583	6°	181 000 40 500	1 090 000 244 000	0.560 1.23
SA1-60B	SA1-60BSS	60 2.3622	90 3.5433	44 1.7323	36 1.4173	1 0.039	1 0.039	66.8 2.630	78.9 3.106	6°	282 000 63 500	1 690 000 380 000	1.10 2.43
SA1-70B	SA1-70BSS	70 2.7559	105 4.1339	49 1.9291	40 1.5748	1 0.039	1 0.039	77.9 3.067	90.2 3.551	6°	360 000 81 000	2 170 000 485 000	1.54 3.40
SA1-80B	SA1-80BSS	80 3.1496	120 4.7244	55 2.1654	45 1.7717	1 0.039	1 0.039	89.4 3.520	104.6 4.118	6°	465 000 104 000	2 780 000 625 000	2.29 5.05

❶ Bearing number with a suffix "B" designates one-piece outer ring with fractured split. Bearing number without a suffix "B" denotes two-piece outer ring bound with a steel band.
❷ SA1-10B and SA1-12B no lubricating groove and hole.



SA1
17mm ≦ d ≦ 120mm



SA1··SS
with seal

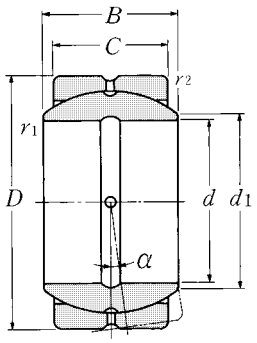
Bearing numbers ❶		Dimensions mm inch								Max. angle of misalignment	Dynamic load rating	Static load rating	Mass
SA1	SA1··SS	d	D	B	C	$r_{1s\ min}$	$r_{2s\ min}$	d_1 (Ref.)	E (Ref.)	α	C_d N lbf	C_s N lbf	kg lb
SA1-90B	**SA1-90BSS**	90 3.5433	130 5.1181	60 2.3622	50 1.9685	1 0.039	1 0.039	98.1 3.862	113.8 4.480	5°	565 000 127 000	3 400 000 760 000	2.82 6.22
SA1-100B	**SA1-100BSS**	100 3.9370	150 5.9055	70 2.7559	55 2.1654	1 0.039	1 0.039	109.5 4.311	130.5 5.138	7°	700 000 158 000	4 200 000 945 000	4.43 9.77
SA1-110B	**SA1-110BSS**	110 4.3307	160 6.2992	70 2.7559	55 2.1654	1 0.039	1 0.039	121.2 4.772	141.1 5.555	6°	755 000 170 000	4 550 000 1 020 000	4.94 10.9
SA1-120B	**SA1-120BSS**	120 4.7244	180 7.0866	85 3.3465	70 2.7559	1 0.039	1 0.039	135.6 5.339	157.3 6.193	6°	1 100 000 247 000	6 600 000 1 480 000	8.12 17.9
SA1-140	—	140 5.5118	210 8.2677	90 3.5433	70 2.7559	1 0.039	1 0.039	155.9 6.138	—	7°	1 240 000 278 000	7 400 000 1 670 000	11.3 24.9
SA1-160	—	160 6.2992	230 9.0551	105 4.1339	80 3.1496	1 0.039	1 0.039	170.2 6.701	—	8°	1 570 000 355 000	9 400 000 2 120 000	14.4 31.7
SA1-180	—	180 7.0866	260 10.2362	105 4.1339	80 3.1496	1.1 0.043	1.1 0.043	199 7.835	—	6°	1 770 000 395 000	10 600 000 2 380 000	18.9 41.7
SA1-200	—	200 7.8740	290 11.4173	130 5.1181	100 3.9370	1.1 0.043	1.1 0.043	213.5 8.405	—	7°	2 450 000 550 000	14 700 000 3 300 000	28.1 61.9
SA1-220	—	220 8.6614	320 12.5984	135 5.3150	100 3.9370	1.1 0.043	1.1 0.043	239.6 9.433	—	8°	2 700 000 605 000	16 200 000 3 650 000	36.1 79.6
SA1-240	—	240 9.4488	340 13.3858	140 5.5118	100 3.9370	1.1 0.043	1.1 0.043	265.3 10.445	—	8°	2 940 000 660 000	17 700 000 3 950 000	40.4 89.1
SA1-260	—	260 10.2362	370 14.5669	150 5.9055	110 4.3307	1.1 0.043	1.1 0.043	288.3 11.350	—	7°	3 500 000 790 000	21 000 000 4 750 000	52.0 115
SA1-280	—	280 11.0236	400 15.7480	155 6.1024	120 4.7244	1.1 0.043	1.1 0.043	313.8 12.354	—	6°	4 100 000 925 000	24 700 000 5 550 000	66.0 146
SA1-300	—	300 11.8110	430 16.9291	165 6.4961	120 4.7244	1.1 0.043	1.1 0.043	336.7 13.256	—	7°	4 400 000 990 000	26 500 000 5 950 000	75.9 167

❶ Bearing numbers with a suffix "B" designates one-piece outer ring with fractured split. Bearing numbers without a suffix "B" denotes two-piece outer ring bound with a steel band.

NTN Spherical Plain Bearings

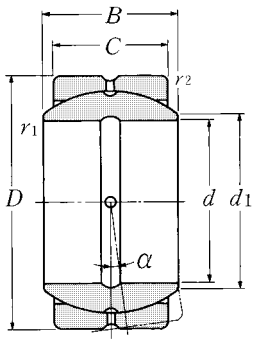
Lubricating type

Series SA4



Bearing ❶ numbers	Dimensions mm / inch							Max. angle of misalignment α	Dynamic load rating Cd N / lbf	Static load rating Cs N / lbf	Mass kg / lb
	d	D	B	C	$r_{1s\ min}$	$r_{2s\ min}$	d_1 (Ref.)				
SA4-20B	20 0.7874	32 1.2598	16 0.6299	14 0.5512	0.3 0.012	0.3 0.012	23.6 0.929	4°	39 000 8 800	235 000 53 000	0.050 0.110
SA4-22B	22 0.8661	37 1.4567	19 0.7480	16 0.6299	0.3 0.012	0.3 0.012	25.7 1.012	6°	50 000 11 300	300 000 67 500	0.085 0.187
SA4-25B	25 0.9843	42 1.6535	21 0.8268	18 0.7087	0.3 0.012	0.3 0.012	29.2 1.150	5°	63 500 14 300	380 000 85 500	0.116 0.256
SA4-30B	30 1.1811	50 1.9685	27 1.0630	23 0.9055	0.6 0.024	0.6 0.024	34.7 1.366	6°	99 000 22 300	595 000 134 000	0.225 0.496
SA4-35B	35 1.3780	55 2.1654	30 1.1811	26 1.0236	0.6 0.024	0.6 0.024	39.4 1.552	5°	126 000 28 400	755 000 170 000	0.300 0.661
SA4-40B	40 1.5748	62 2.4409	33 1.2992	28 1.1024	0.6 0.024	0.6 0.024	44.6 1.756	6°	152 000 34 500	915 000 206 000	0.373 0.822
SA4-45B	45 1.7717	72 2.8346	36 1.4173	31 1.2205	0.6 0.024	0.6 0.024	52.9 2.083	5°	195 000 43 500	1 170 000 262 000	0.600 1.32
SA4-50B	50 1.9685	80 3.1496	42 1.6535	36 1.4173	0.6 0.024	0.6 0.024	58.5 2.303	5°	254 000 57 000	1 530 000 345 000	0.870 1.92
SA4-55B	55 2.1654	90 3.5433	47 1.8504	40 1.5748	0.6 0.024	0.6 0.024	64.7 2.547	5°	315 000 70 500	1 880 000 425 000	1.25 2.76
SA4-60B	60 2.3622	100 3.9370	53 2.0866	45 1.7717	0.6 0.024	0.6 0.024	72.7 2.862	6°	395 000 89 500	2 380 000 535 000	1.70 3.75
SA4-65B	65 2.5591	105 4.1339	55 2.1654	47 1.8504	0.6 0.024	0.6 0.024	76.2 3.000	5°	435 000 97 500	2 600 000 585 000	2.05 4.52
SA4-70B	70 2.7559	110 4.3307	58 2.2835	50 1.9685	0.6 0.024	0.6 0.024	81.5 3.209	5°	490 000 110 000	2 940 000 660 000	2.22 4.89

❶ Bearing numbers with a suffix "B" designates one-piece outer ring with fractured split. Bearing numbers without a suffix "B" denotes two-piece outer ring bound with a steel band.



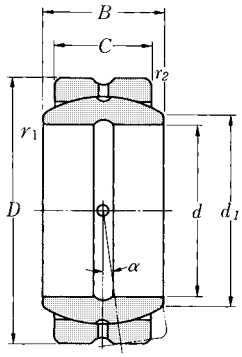
Bearing ❶ numbers	Dimensions mm inch							Max. angle of misa-lignment	Dynamic load rating	Static load rating	Mass
	d	D	B	C	$r_{1s\ min}$	$r_{2s\ min}$	d_1 (Ref.)	α	C_d N lbf	C_s N lbf	kg lb
SA4-75B	75 2.9528	120 4.7244	64 2.5197	55 2.1654	0.6 0.024	0.6 0.024	89.5 3.524	5°	595 000 133 000	3 550 000 800 000	3.02 6.66
SA4-80B	80 3.1496	130 5.1181	70 2.7559	60 2.3622	0.6 0.024	0.6 0.024	97.5 3.839	5°	705 000 159 000	4 250 000 950 000	3.98 8.77
SA4-85B	85 3.3465	135 5.3150	74 2.9134	63 2.4803	0.6 0.024	0.6 0.024	100.7 3.965	6°	770 000 174 000	4 650 000 1 040 000	4.28 9.44
SA4-90B	90 3.5433	140 5.5118	76 2.9921	65 2.5591	0.6 0.024	0.6 0.024	105.5 4.154	5°	830 000 186 000	4 950 000 1 120 000	4.71 10.4
SA4-95B	95 3.7402	150 5.9055	82 3.2283	70 2.7559	0.6 0.024	0.6 0.024	113.5 4.468	5°	960 000 216 000	5 750 000 1 300 000	6.05 13.3
SA4-100B	100 3.9370	160 6.2992	88 3.4646	75 2.9528	1 0.039	1 0.039	121.5 4.783	5°	1 100 000 248 000	6 600 000 1 490 000	7.42 16.4
SA4-110B	110 4.3307	170 6.6929	93 3.6614	80 3.1496	1 0.039	1 0.039	130.2 5.126	5°	1 260 000 282 000	7 550 000 1 690 000	8.50 18.7
SA4-115B	115 4.5276	180 7.0866	98 3.8583	85 3.3465	1 0.039	1 0.039	132.7 5.224	5°	1 380 000 310 000	8 250 000 1 860 000	10.3 22.7
SA4-120B	120 4.7244	190 7.4803	105 4.1339	90 3.5433	1 0.039	1 0.039	140 5.512	5°	1 540 000 345 000	9 250 000 2 080 000	12.3 27.1
SA4-130B	130 5.1181	200 7.8740	110 4.3307	95 3.7402	1 0.039	1 0.039	148.7 5.854	5°	1 720 000 385 000	10 300 000 2 320 000	13.8 30.4
SA4-150	150 5.9055	220 8.6614	120 4.7244	105 4.1339	1 0.039	1 0.039	166.2 6.543	5°	2 110 000 475 000	12 700 000 2 850 000	17.0 37.5

❶ Bearing numbers with a suffix "B" designates one-piece outer ring with fractured split. Bearing numbers without a suffix "B" denotes two-piece outer ring bound with a steel band.

NTN Spherical Plain Bearings

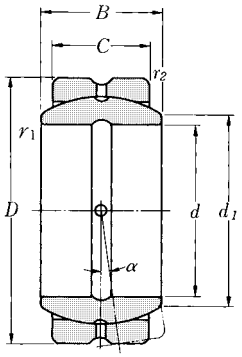
Lubrication type

Series SA2 (Inch size)



Bearing ❶ numbers	Dimensions mm inch							Max. angle of misalignment α	Dynamic load rating	Static load rating	Mass
	d	D	B	C	$r_{1s\ min}$	$r_{2s\ min}$	d_1 (Ref.)		C_d lbf / N	C_s lbf / N	lb / kg
SA2-12B	0.7500 19.05	1.2500 31.75	0.656 16.662	0.562 14.275	0.012 0.3	0.024 0.6	0.862 21.9	6°	8 650 38 500	52 000 231 000	0.123 0.056
SA2-14B	0.8750 22.225	1.4375 36.512	0.765 19.431	0.656 16.662	0.012 0.3	0.024 0.6	1.000 25.4	6°	11 800 52 500	70 500 315 000	0.190 0.086
SA2-16B	1.0000 25.4	1.6250 41.275	0.875 22.225	0.750 19.05	0.012 0.3	0.024 0.6	1.114 28.3	6°	15 100 67 500	90 500 405 000	0.273 0.124
SA2-20B	1.2500 31.75	2.0000 50.8	1.093 27.762	0.937 23.8	0.024 0.6	0.024 0.6	1.417 36	6°	23 900 106 000	143 000 635 000	0.511 0.232
SA2-22B	1.3750 34.925	2.1875 55.562	1.187 30.15	1.031 26.187	0.024 0.6	0.039 1	1.547 39.3	5°	28 600 127 000	171 000 765 000	0.763 0.346
SA2-24B	1.5000 38.1	2.4375 61.912	1.312 33.325	1.125 28.575	0.024 0.6	0.039 1	1.622 41.2	6°	33 500 149 000	200 000 890 000	0.926 0.420
SA2-28B	1.7500 44.45	2.8125 71.438	1.531 38.887	1.312 33.325	0.024 0.6	0.039 1	2.000 50.8	6°	47 000 209 000	282 000 1 250 000	1.42 0.643
SA2-32B	2.0000 50.8	3.1875 80.962	1.750 44.45	1.500 38.1	0.024 0.6	0.039 1	2.228 56.6	6°	60 500 269 000	365 000 1 610 000	2.05 0.931
SA2-36B	2.2500 57.15	3.5625 90.488	1.969 50.013	1.687 42.85	0.024 0.6	0.039 1	2.559 65	6°	77 500 345 000	465 000 2 070 000	2.89 1.31
SA2-40B	2.5000 63.5	3.9375 100.012	2.187 55.55	1.875 47.625	0.039 1	0.039 1	2.886 73.3	5°	96 500 430 000	580 000 2 580 000	4.06 1.84
SA2-44B	2.7500 69.85	4.3750 111.125	2.406 61.112	2.062 52.375	0.039 1	0.039 1	3.118 79.2	6°	115 000 515 000	695 000 3 100 000	5.34 2.42
SA2-48B	3.0000 76.2	4.7500 120.65	2.625 66.675	2.250 57.15	0.039 1	0.039 1	3.421 86.9	6°	138 000 615 000	830 000 3 700 000	6.81 3.09

❶ Bearing numbers with a suffix "B" designates one-piece outer ring with fractured split. Bearing numbers without a suffix "B" denotes two-piece outer ring bound with a steel band.



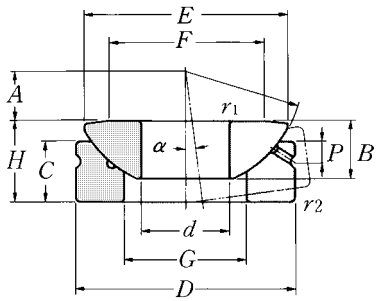
Bearing ❶ numbers	Dimensions mm inch							Max. angle of misalignment	Dynamic load rating	Static load rating	Mass
	d	D	B	C	$r_{1s\ min}$	$r_{2s\ min}$	d_1 (Ref.)	α	C_d lbf / N	C_s lbf / N	lb / kg
SA2-52B	3.2500 82.55	5.1250 130.175	2.844 72.238	2.437 61.9	0.039 1	0.039 1	3.724 94.6	6°	162 000 720 000	975 000 4 350 000	8.55 3.88
SA2-56B	3.5000 88.9	5.5000 139.7	3.062 77.775	2.625 66.675	0.039 1	0.039 1	4.004 101.7	6°	188 000 835 000	1 130 000 5 000 000	10.6 4.79
SA2-60B	3.7500 95.25	5.8750 149.225	3.281 83.337	2.812 71.425	0.039 1	0.039 1	4.280 108.7	6°	216 000 960 000	1 290 000 5 750 000	12.9 5.83
SA2-64B	4.0000 101.6	6.2500 158.75	3.500 88.9	3.000 76.2	0.039 1	0.039 1	4.559 115.8	6°	245 000 1 090 000	1 470 000 6 550 000	15.5 7.01
SA2-68B	4.2500 107.95	6.6250 168.275	3.719 94.463	3.187 80.95	0.039 1	0.039 1	4.839 122.9	6°	277 000 1 230 000	1 660 000 7 400 000	18.5 8.39
SA2-72B	4.5000 114.3	7.0000 177.8	3.937 100	3.375 85.725	0.039 1	0.039 1	5.142 130.6	6°	310 000 1 380 000	1 870 000 8 300 000	21.7 9.86
SA2-76B	4.7500 120.65	7.3750 187.325	4.156 105.562	3.562 90.475	0.039 1	0.039 1	5.421 137.7	6°	345 000 1 540 000	2 080 000 9 250 000	25.4 11.5
SA2-80B	5.0000 127	7.7500 196.85	4.375 111.125	3.750 95.25	0.039 1	0.039 1	5.724 145.4	6°	385 000 1 710 000	2 310 000 10 300 000	29.5 13.4
SA2-96	6.0000 152.4	8.7500 222.25	4.750 120.65	4.125 104.775	0.039 1	0.039 1	6.622 168.2	5°	480 000 2 130 000	2 870 000 12 800 000	38.4 17.4

❶ Bearing number with a suffix "B" designates one-piece outer ring with fractured split. Bearing number without a suffix "B" denotes two-piece outer ring bound with a steel band.

NTN Thrust Spherical Plain Bearings

Lubrication type

Series SAT



Bearing numbers	Dimensions mm inch												Max. angle of misa-lignment	Dynamic load rating	Static load rating	Mass
	d	D	H	B	C	$r_{1s\ min}$	$r_{2s\ min}$	E	F	G	P	A	α	C_d N lbf	C_s N lbf	kg lb
SAT20	20 0.7874	55 2.1654	20 0.7874	14.3 0.563	13 0.512	0.6 0.024	1 0.039	50 1.969	40 1.575	33.5 1.319	6 0.236	12.5 0.492	6° 	74 000 16 600	445 000 99 500	0.260 0.573
SAT25	25 0.9843	62 2.4409	22.5 0.8858	16 0.630	17 0.669	0.6 0.024	1 0.039	57.5 2.264	45 1.772	34.5 1.358	6 0.236	14 0.551	6° 	127 000 28 600	760 000 171 000	0.375 0.827
SAT30	30 1.1811	75 2.9528	26 1.0236	18 0.709	19.5 0.768	0.6 0.024	1 0.039	69 2.717	56 2.205	44 1.732	8 0.315	17.5 0.689	5° 	167 000 37 500	1 000 000 225 000	0.640 1.41
SAT35	35 1.3780	90 3.5433	28 1.1024	22 0.866	20 0.787	0.6 0.024	1 0.039	84 3.307	66 2.598	52 2.047	8 0.315	22 0.866	5° 	254 000 57 000	1 520 000 345 000	1.02 2.25
SAT40	40 1.5748	105 4.1339	32 1.2598	27 1.063	22 0.866	0.6 0.024	1 0.039	98 3.858	78 3.071	59 2.323	9 0.354	24.5 0.965	5° 	365 000 82 500	2 200 000 495 000	1.64 3.62
SAT45	45 1.7717	120 4.7244	36.5 1.4370	31 1.220	25 0.984	0.6 0.024	1 0.039	112 4.409	89 3.504	68 2.677	11 0.433	27.5 1.083	5° 	475 000 107 000	2 860 000 645 000	2.50 5.51
SAT50	50 1.9685	130 5.1181	42.5 1.6732	33.5 1.319	32 1.260	0.6 0.024	1 0.039	122.5 4.823	98 3.858	69 2.717	10 0.394	30 1.181	4° 	640 000 144 000	3 850 000 860 000	3.38 7.45
SAT60	60 2.3622	150 5.9055	45 1.7717	37 1.457	33 1.299	1 0.039	1 0.039	140 5.512	108 4.252	86 3.386	12.5 0.492	35 1.378	6° 	720 000 162 000	4 350 000 975 000	4.62 10.2
SAT70	70 2.7559	160 6.2992	50 1.9685	40 1.575	36 1.417	1 0.039	1 0.039	149.5 5.886	121.5 4.783	95 3.740	13.5 0.531	35 1.378	5° 	790 000 178 000	4 750 000 1 070 000	5.60 12.3
SAT80	80 3.1496	180 7.0866	50 1.9685	42 1.654	36 1.417	1 0.039	1 0.039	168 6.614	130 5.118	108 4.252	14.5 0.571	42.5 1.673	4° 	1 020 000 229 000	6 100 000 1 370 000	7.12 15.7