



SELECTION

S-2000 SPHERICAL ROLLER BEARINGS

DODGE Spherical Roller Bearings have the capacity to carry heavy radial loads and combined radial and thrust loads. The maximum recommended load which can be applied is limited by various components in the system such as bearing, housing, shaft, shaft attachment, speed and life requirements as listed in this catalog. DODGE spherical roller bearings have been applied successfully even when these limits have been exceeded under controlled operating conditions. Contact DODGE Application Engineering (864-284-5700) for applications which exceed the recommendations of this catalog.

L₁₀ Hours Life - The life which may be expected from at least 90% of a given group of bearings operating under identical conditions.

$$L_{10} \text{ Life, Hours} = \left(\frac{C}{P} \right)^{10/3} \times \left(\frac{16667}{\text{RPM}} \right)$$

Where: C = Dynamic Capacity
(Table 1 on page B12-9) lbs.

P = Equivalent Radial Load, lbs.

GENERAL

Heavy Service - For heavy shock loads, frequent shock loads, or severe vibrations, add up to 50% (according to severity of conditions) to the Equivalent Radial Load to obtain a Modified Equivalent Radial Load. Consult DODGE Application Engineering for additional selection assistance.

Thrust load values shown in the table below are recommended as a guide for general applications that will give adequate L₁₀ life. Spherical bearings require a radial load at least equal to the thrust load for proper operation. If the thrust load exceeds this limit, consult Application Engineering. Where substantial radial load is also present, it is advisable to calculate actual L₁₀ life to assure that it meets the requirements. The effectiveness of the shaft attachment to carry thrust load depends on proper tightening of the set screws, shaft tolerance and shaft deflections. Therefore, it is advisable to use auxiliary thrust carrying devices such as shaft shoulder, snap ring or a thrust collar to locate the bearing under thrust loads heavier than shown below, or where extreme reliability is desired.

RPM	20-200	201 - 2000	Over 2000
Recommended Thrust Load	C/20	C/40	C/60

The shaft tolerances recommended below are adequate for normal radial and radial/thrust load applications. The radial load is limited by the attachment to the shaft (see Table 1 on page B12-9). Where the applied radial load (F_R) exceeds this limit (maximum allowable slip fit radial load), a snug-to-light press fit of the shaft is required. Since the allowable load, especially at a

low speed, is very large, the shaft should be checked to assure adequate shaft strength.

The magnitude and direction of both the thrust and radial load must be taken into account when selecting a housing. **When pillow blocks are utilized, heavy loads should be directed through the base. Where uplift loads are involved, see Tables 6, 7 and 8 on pages B12-12 and B12-13 and for maximum values.** Where a load pulls the housing away from the mounting base, both the hold-down bolts and housing must be of adequate strength. Auxiliary load carrying devices such as shear bars are advisable for side or end loading of pillow blocks and radial loads for flange units.

Shaft Tolerances	
Shaft Size	S-2000
UP TO 1-1/2"	+.0000 -.0005"
1-9/16 TO 4"	+.000 -.001"
4-7/16 TO 5"	+.000 -.0015"

BEARING SUPPORTING RADIAL LOADS ONLY

1. Define L₁₀ Life Hours desired.

2. Establish bearing radial load, F_R

(F_R = P for Pure Radial Load Conditions). The DODGE program BEST™* can be used to find application loads.

3. Establish RPM.

Using the easy selection Table 4 on page B12-10, find, under the RPM column, the equivalent radial load that equals or is slightly higher than the application radial load for the desired life. The shaft size on the far left will be the minimum shaft size that you can use for your application.

If the desired life is different than the values shown on the chart, use alternate Method A shown below.

Example: 1. L₁₀ Life = 30,000 Hours
2. Radial load = 4000 lbs.
3. RPM = 1,020

At the intersection of the 1,020 RPM column and the 30,000 hours L₁₀ life row, the equivalent radial load of 4092 lbs. exceeds the 4000 lbs. radial load for shaft size 2-7/16". A bearing with bore 2-7/16", or larger, may be used for this application.

* The DODGE Bearing Evaluation and Selection Technique (BEST) is a menu driven computer program that calculates bearing loads, fatigue life and operating temperature for a two bearing shaft system based on user supplied input parameters. This interactive program is available at www.ptwizard.com under the Product Selection area.

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ALTERNATE METHOD A - SELECTING A BEARING FOR AN L₁₀ LIFE VALUE NOT SHOWN IN THE EASY SELECTION CHART.

The L₁₀ life equation can be rearranged so that the bearing dynamic capacity **C** is identified in terms of L₁₀, RPM and P

$$C = \left(\frac{L_{10} \times \text{RPM}}{16667} \right)^{0.3} \times P$$

(P = F_R for Pure Radial Load Conditions)

Since the L₁₀, RPM and P are known, solve for C. Select from the dynamic capacity column on Table 1 on page B12-9 the **C** value equal to or greater than the **C** value just calculated. The bore size on the far left represents the proper bore size selection. Check that the application RPM does not exceed the MAX. RPM on Table 1. Also check that the radial load does not exceed the Maximum Allowable Slip Fit Radial Load shown on Table 1 on page B12-9. If it does, a line-to-line to light press fit of shaft is required. When selecting an L₁₀ life of less than 30,000 hours, particular attention must be paid to shaft deflection and proper lubricant selection.

SELECTING BEARINGS SUPPORTING COMBINATION RADIAL AND THRUST LOADS

When a bearing supports both a radial load and a thrust load, the loading on the two rows is shared unequally depending on the ratio of thrust to radial load. The use of the X (radial factor) and Y (thrust factor) from Table 1 converts the applied thrust load and radial loads to an equivalent radial load having the same effect on the life of the bearing as a radial load of this magnitude.

The equivalent radial load $P = XF_R + YF_A$

Where:

P = Equivalent radial load, lbs.

F_R = Radial load, lbs. (see Table 1 for allowable slip fit maximum load)

F_A = Thrust (axial) load, lbs.

e = Thrust load to radial load factor (Table 1)

X = Radial load factor (Table 1)

Y = Thrust load factor (Table 1)

To find X and Y, calculate F_A/F_R and compare to **e** for the selected bore size. Determine X and Y from Table 1 on page B12-9 depending on whether F_A/F_R is equal to or less than **e**,

or F_A/F_R is greater than **e**. Substitute all known values into the equivalent radial load equation. P (equivalent radial load) can be used in the life formula to determine L₁₀, or it can be compared to the allowable equivalent radial load ratings for the speed and hours life desired in the easy selection Table 4 on page B12-10.

SELECTING BEARINGS SUPPORTING ONLY THRUST LOADS

Spherical Roller Bearings generally are not recommended for pure thrust load applications. However, they will perform satisfactorily under very light pure thrust loads. Consult DODGE Application Engineering (864-284-5700).

SELECTING LUBRICATION

DODGE S2000 spherical roller bearings are lubricated at the factory with Mobilgrease XHP 222 grease. Mobilgrease XHP 222 grease is a superior industrial grease using a lithium complex thickener and highly refined base oil. This grease will adequately handle low and medium speeds with low and medium loads at normal temperatures as defined on Table 5 on page B12-11. For very low and high speeds, for heavy loads and for low and high temperatures, special greases must be used. Contact DODGE Application Engineering (864-284-5700). DODGE engineers will recommend bearings and lubricants for the above unusual conditions. DODGE also has the expertise to custom design and build special bearings for your needs. The only maintenance requirement for DODGE Unitized roller bearings is periodic relubrication at regular intervals as outlined in the appropriate instruction manuals.

MISALIGNMENT CONSIDERATIONS

In nearly all applications, good design practice requires two bearings supporting the shaft. In cases where three or more bearings are installed, unless precautions are taken to line the bearings up both vertically and horizontally, it is possible to induce heavy loads. In the case of two bearings, alignment is not as critical, especially with DODGE Unitized Spherical Roller Bearings. S2000 bearings are designed to allow a maximum of ±1° of static and dynamic misalignment. To ensure good alignment, mounting surfaces must be checked for flatness and must lie in the same plane. When tightening base bolts, each bolt should be alternately tightened in incremental torque values until full torque is achieved to prevent the angular shifting of the pillow block that occurs when one bolt is tightened to its full torque. Shimming may be required to minimize misalignment.



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Table 1: S2000-HD Spherical Roller Bearings

Shaft Size Inches	Basic Bearing Description	e	F _A /F _R < e		F _A /F _R > e		Max. Allowable Slip Fit Radial Load F _R * lbs.	Dynamic Capacity (C) lbs.	Static Capacity Co lbs.	Maximum Speed **	
			X	Y	X	Y				Labyrinth RPM	TRIDENT Triple Lip RPM
1-3/8 1-7/16 1-1/2	22208	0.28	1.0	2.4	0.67	3.6	3,750	20,800	21,000	3,600	2,900
1-11/16 1-3/4	22209	0.26	1.0	2.6	0.67	3.9	3,750	20,800	22,000	3,360	2,460
1-15/16 2	22210	0.24	1.0	2.8	0.67	4.2	4,000	22,000	24,000	3,180	2,200
2-3/16	22211	0.23	1.0	2.9	0.67	4.3	4,860	27,000	29,000	2,700	1,950
2-7/16	22213	0.24	1.0	2.8	0.67	4.2	6,840	39,000	47,500	2,250	1,740
2-11/16 2-15/16 3	22215	0.22	1.0	3.1	0.67	4.6	7,500	41,500	53,000	2,040	1,490
3-7/16	22218	0.23	1.0	2.9	0.67	4.3	11,500	65,500	81,500	1,560	1,280
3-15/16	22220	0.24	1.0	2.8	0.67	4.2	14,400	83,000	104,000	1,320	1,075
4-7/16	22222	0.25	1.0	2.7	0.67	4.1	18,400	104,000	132,000	1,200	990
4-15/16	22226	0.26	1.0	2.6	0.67	3.9	25,700	146,000	196,000	1,020	870

* If load exceeds the maximum allowable slip fit load, line- to-line to light press fit of shaft required. Maximum slip fit radial loads apply if recommended shaft sizes are used.

** Maximum speed is dependent on load and ambient conditions, consult DODGE Engineering.

After final alignment of the shaft and installation of the housings, tighten both setscrews hand tight, then the setscrews should be tightened alternately and in small increments to the torque specified in Table 2. After 24 hours operation, the setscrews should be retightened to the torque in Table 2 to assure full locking of the inner race to the shaft. Care should be taken that the socket key or driver is in good condition with no rounded corners and the key is fully engaged in the setscrew and held square with the setscrew to prevent rounding out of the setscrew socket when applying maximum torque.

Table 2: Set Screw Torque Values

Set Screw Torque Table		
Shaft Size	Socket Set Screw Size	Tightening Torque
1-3/8 - 1-3/4 in.	5/16 in.	165 Inch Pounds
1-15/16 - 2-7/16 in.	3/8 in.	290 Inch Pounds
2-11/16 - 3-7/16 in.	1/2 in.	620 Inch Pounds
3-15/16 - 4-15/16 in.	5/8 in.	1325 Inch Pounds

Table 3: Lubrication Intervals

Lubrication Guide (In Weeks)								
Read Preceding Paragraphs Before Establishing Lubrication Schedule								
Hours Run per Day	1 to 250 RPM	251 to 500 RPM	501 to 750 RPM	751 to 1000 RPM	1001 to 1500 RPM	1501 to 2000 RPM	2001 to 2500 RPM	2501 to 3000 RPM
8	12	12	10	7	5	4	3	2
16	12	7	5	4	2	2	2	1
24	10	5	3	2	1	1	1	1

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Table 4: Easy Selection Table for S-2000 Double Row Spherical Roller Bearings

Shaft Size Inches	L ₁₀ Life Hours	Allowable Equivalent Radial Load Rating (lbs.) at Various Revolutions per Minute																
		50	100	150	250	500	870	1,020	1,200	1,320	1,560	1,750	2,040	2,250	2,700	3180	3360	3600
1-3/8 to 1-1/2	10,000	7,498	6,090	5,393	4,626	3,758	3,182	3,034	2,890	2,808	2,671	2,581	2,465	2,393	1,495	2,157	2,122	2,078
	30,000	5,393	4,380	3,878	3,327	2,703	2,289	2,182	2,078	2,020	1,921	1,856	1,773	1,721	1,495	1,552	1,526	1,495
	40,000	4,947	4,018	3,558	3,052	2,479	2,100	2,002	1,907	1,853	1,762	1,703	1,626	1,579	1,495	1,423	1,400	1,371
	60,000	4,380	3,558	3,150	2,703	2,195	1,859	1,773	1,688	1,641	1,560	1,508	1,440	1,398	1,324	1,260	1,240	1,214
	100,000	3,758	3,052	2,703	2,319	1,883	1,595	1,521	1,448	1,407	1,339	1,293	1,235	1,199	1,136	1,081	1,063	1,042
1-11/16 to 1-3/4	10,000	7,498	6,090	5,393	4,626	3,758	3,182	3,034	2,890	2,808	2,671	2,581	2,465	1,579	2,266	2,157	2,122	
	30,000	5,393	4,380	3,878	3,327	2,703	2,289	2,182	2,078	2,020	1,921	1,856	1,773	1,579	1,630	1,552	1,526	
	40,000	4,947	4,018	3,558	3,052	2,479	2,100	2,002	1,907	1,853	1,762	1,703	1,626	1,579	1,495	1,423	1,400	
	60,000	4,380	3,558	3,150	2,703	2,195	1,859	1,773	1,688	1,641	1,560	1,508	1,440	1,398	1,324	1,260	1,240	
	100,000	3,758	3,052	2,703	2,319	1,883	1,595	1,521	1,448	1,407	1,339	1,293	1,235	1,199	1,136	1,081	1,063	
1-15/16 to 2	10,000	7,930	6,441	5,704	4,893	3,975	3,366	3,209	3,057	2,970	2,825	2,729	1,720	2,531	2,396	2,282		
	30,000	5,704	4,633	4,102	3,519	2,859	2,421	2,308	2,198	2,136	2,032	1,963	1,720	1,820	1,724	1,641		
	40,000	5,232	4,250	3,763	3,228	2,622	2,221	2,117	2,017	1,960	1,864	1,801	1,720	1,670	1,581	1,505		
	60,000	4,633	3,763	3,332	2,859	2,322	1,966	1,875	1,786	1,735	1,650	1,594	1,523	1,479	1,400	1,333		
	100,000	3,975	3,228	2,859	2,452	1,992	1,687	1,608	1,532	1,489	1,416	1,368	1,306	1,269	1,201	1,144		
2-3/16	10,000	9,733	7,905	7,000	6,005	4,878	4,131	3,939	3,751	3,645	3,467	2,210	3,199	3,106	2,941			
	30,000	7,000	5,686	5,035	4,319	3,508	2,971	2,833	2,698	2,622	2,494	2,210	2,301	2,234	2,115			
	40,000	6,421	5,216	4,618	3,962	3,218	2,726	2,599	2,475	2,405	2,288	2,210	2,111	2,050	1,940			
	60,000	5,686	4,618	4,089	3,508	2,850	2,413	2,301	2,191	2,130	2,026	1,957	1,869	1,815	1,718			
	100,000	4,878	3,962	3,508	3,010	2,445	2,070	1,974	1,880	1,827	1,738	1,679	1,603	1,557	1,474			
2-7/16	10,000	14,058	11,419	10,111	8,674	7,046	5,967	5,689	5,418	5,266	5,008	4,838	4,621	4,487				
	30,000	10,111	8,213	7,272	6,239	5,068	4,292	4,092	3,897	3,787	3,602	3,480	3,324	3,227				
	40,000	9,275	7,534	6,671	5,723	4,649	3,937	3,753	3,575	3,474	3,304	3,192	3,049	2,960				
	60,000	8,213	6,671	5,907	5,068	4,116	3,486	3,324	3,165	3,076	2,926	2,827	2,700	2,621				
	100,000	7,046	5,723	5,068	4,348	3,531	2,991	2,851	2,716	2,639	2,510	2,425	2,316	2,249				
2-11/16 to 3	10,000	14,959	12,151	10,759	9,230	7,497	6,350	6,054	5,766	5,697	5,329	5,149	4,917					
	30,000	10,759	8,739	7,738	6,639	5,392	4,567	4,354	4,147	3,697	3,833	3,703	3,537					
	40,000	9,870	8,017	7,098	6,090	4,946	4,189	3,994	3,804	3,697	3,516	3,397	3,244					
	60,000	8,739	7,098	6,285	5,392	4,380	3,709	3,537	3,368	3,273	3,113	3,008	2,873					
	100,000	7,497	6,090	5,392	4,626	3,758	3,182	3,034	2,890	2,808	2,671	2,580	2,464					
3-7/16	10,000	23,611	19,178	16,981	14,569	11,833	10,022	9,555	6,004	8,844	8,411							
	30,000	16,981	13,793	12,213	10,478	8,511	7,208	6,872	6,004	6,360	6,050							
	40,000	15,577	12,653	11,203	9,612	7,807	6,612	6,304	6,004	5,835	5,549							
	60,000	13,793	11,203	9,920	8,511	6,913	5,855	5,582	5,316	5,166	4,914							
	100,000	11,833	9,612	8,511	7,302	5,931	5,023	4,789	4,561	4,432	4,216							

Only the labyrinth seal (L seal) may be used to the right of the heavy line.

In the light shaded area, a line-to-line to light press fit on the shaft is required.

For applications in the dark shaded area, the maximum load for the specific speed is shown. The load does not correspond to the 10 shown at the left.

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Table 4: Easy Selection Table for S-2000 Double Row Spherical Roller Bearings (continued)

Shaft Size Inches	L ₁₀ Life Hours	Allowable Equivalent Radial Load Rating (Lbs.) At Various Revolutions Per Minute																		
		50	100	150	250	500	870	1,020	1,200	1,320	1,560	1,750	2,040	2,250	2,700	3180	3360	3600		
3-15/16	10,000	29,919	24,302	21,518	18,461	14,995	12,699	7,988	11,531	11,206										
	30,000	21,518	17,478	15,476	13,278	10,785	9,134	7,988	8,294	8,060										
	40,000	19,739	16,033	14,197	12,180	9,893	8,378	7,988	7,608	7,393										
	60,000	17,478	14,197	12,571	10,785	8,760	7,419	7,073	6,737	6,547										
	100,000	14,995	12,180	10,785	9,252	7,515	6,365	6,068	5,779	5,616										
4-7/16	10,000	37,489	30,450	26,963	23,132	18,789	10,498	15,171	14,449											
	30,000	26,963	21,901	19,392	16,637	13,513	10,498	10,911	10,392											
	40,000	24,733	20,090	17,789	15,261	12,396	10,498	10,009	9,533											
	60,000	21,901	17,789	15,751	13,513	10,976	9,296	8,863	8,441											
	100,000	18,789	15,261	13,513	11,593	9,417	7,975	7,603	7,242											
4-15/16	10,000	52,628	42,747	37,851	32,473	26,377	14,738	21,298												
	30,000	37,851	30,745	27,224	23,356	18,971	14,738	15,318												
	40,000	34,722	28,203	24,973	21,424	17,402	14,738	14,051												
	60,000	30,745	24,973	22,112	18,971	15,409	13,050	12,442												
	100,000	26,377	21,424	18,971	16,275	13,220	11,196	10,674												

Only the labyrinth seal (L seal) may be used to the right of the heavy line.

In the light shaded area, a line-to-line to light press fit on the shaft is required.

For applications in the dark shaded area, the maximum load for the specific speed is shown. The load does not correspond to the L₁₀ shown at the left.

Table 5: Definition Of Operating Conditions For Unitized Spherical Roller Bearings

LOW SPEED	UP TO 20% OF MAX. RPM (TABLE 1)
MEDIUM SPEED	OVER 20% TO 80% OF MAX. RPM
HIGH SPEED	MOVER 80% OF MAX. RPM
LIGHT LOAD	UP TO 8% OF C (TABLE 1)
NORMAL LOAD	OVER 8% TO 18% OF C
HEAVY LOAD	OVER 18% OF C
	C = DYNAMIC CAPACITY
LOW TEMPERATURE	-20 TO -100°F
MEDIUM TEMPERATURE	OVER 20°F TO 200°F
HIGH TEMPERATURE	OVER 200°F TO 250°F

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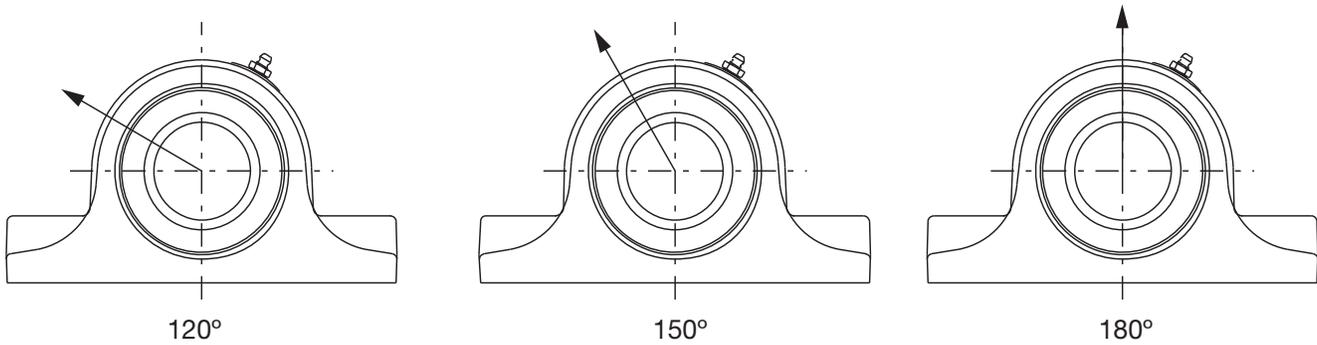


Table 6: S-2000 Housing Rating, 2-Bolt, Cast Iron*

Bore Size	Maximum Recommended Housing Cap Loads, lb		
	120°	150°	180°
1-3/8 to 1-1/2	2110	2640	3100
1-5/8 to 1-3/4	2380	2980	3500
1-15/16 to 2	3130	3910	4600
2-3/16	3330	4160	4900
2-7/16	3330	4160	4900
2-11/16 to 3	4420	5520	6500
3-3/16 to 3-7/16	4620	5780	6800
3-15/16	7500	9350	11000

Table 7: S-2000 Housing Rating, 4-Bolt, Cast Iron*

Bore Size	Maximum Recommended Housing Cap Loads, lb		
	120°	150°	180°
1-15/16 - 2	3200	4000	4700
2-3/16	3300	4100	4800
2-7/16	3810	4760	5600
2-11/16 to 3	4620	5780	6800
3-7/16	4700	5870	6900
3-15/16	7500	9350	11000
4-7/16	9900	12330	14500
4-15/16	13400	16750	19700

* When utilizing heavy cap loads on pillow block housings, the installation must adhere to the following procedures:

1. The pillow block base bolts must be of high strength (Grade 8) bolts and properly tightened to mounting structure.
2. Stop bars (shear strips) should be used against the plummer block where side loads are encountered.
3. In all cases where loads are heavy, the L_{10} life of the bearing should be checked for proper selection and life requirements.