MOTION & CONTROL

NSK

Bearings for Railway Rolling Stock

Bearings for modern railway systems must offer excellent durability and high-speed capability with minimal maintenance requirements. Incorporating years of experience and engineering know-how, NSK bearings consistently exceed industry expectations.

Celebrating a World on the Move

NSK Motion and Control Solutions Span the Globe

Cover: 500 Series Shinkansen Train, Sponsored by JR WEST

NSK was established in 1916. Over its long history, NSK has developed various types of bearings and supplied them to customers all over the world, contributing greatly along the way to the advancement of industries and machinery. At present, NSK is the largest bearing manufacturer in Japan and the second largest in the world. From early on, NSK has utilized its expertise accumulated through bearing engineering and production to expand into automotive components, precision machinery and electronic components. Along with product diversification, NSK has expanded its production capacity to include 17 plants in Japan and a global sales and manufacturing network. Starting with an American sales and distribution base established in 1962 in Ann Arbor, Michigan, the company has expanded its sales network to cover 25 countries in North and South America, Europe, Asia, Oceania and Africa. In 1972, NSK established a production foothold in a suburb of São Paulo, Brazil. Today, NSK has 30 manufacturing plants operating in the United States, Europe and Asian countries other than Japan. In 1988, NSK set up the American Technical Center (ATC) in Ann Arbor, Michigan, and, in 1990, the European Technology Center (ETC) in England. These facilities have allowed NSK to provide quicker and better engineering services to customers in North and South America and Europe.

NSK

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NSK Bearings Facilitate Safe and Comfortable Railway Transportation

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NSK and Rolling Stock Bearings

In 1932 NSK pioneered the manufacture of rolling stock bearings in Japan by producing tapered roller journal bearings with sleeves for the gasoline-operated vehicles of JNR (Japan National Railways). Since then, NSK has worked closely with Japanese national, municipal and private railroad companies as well as railway operators all over the world to develop high-performance, high-reliability bearings. Particularly noteworthy is the fact that NSK bearings have been used in all *Shinkansen* trains since the high-speed trains started operation in 1964 with the 0 Series. Today, one of the latest models, the 500 Series, has a maximum operating speed of 300 km per hour. Reflecting the customer's trust in their high performance and reliability, NSK bearings are found in the axles, main motors and drive systems of the 500 Series.

In 1987, the government-owned Japan National Railways was divided and reorganized into seven private JR companies. These companies have since taken active steps to improve their service by increasing train speed and vigorously improving the efficiency of train operation and maintenance. Examples of recent advances include the aforementioned 500 Series of JR West, which broke the 300-km/h-speed barrier, and JR East's 209 Series of conventional trains with car overhaul maintenance intervals of 2 000 000 km or 13 years of service. These advancements in rolling stock technology required the development of bearings that were smaller, yet capable of rotating at higher speeds with greater durability. Responding to such challenges, NSK develops and manufactures high-quality bearings with better performance and reliability for axle boxes, main motors and gear units for both *Shinkansen* and conventional trains.

Contents

Axle Bearings for Railway Rolling Stock

Introduction to Axle Bearings for Railway Rolling Stock

Characteristics of Axle Bearings

Rolling stock axle bearings are subject to radial impact loads caused by rail joints, switches and sometimes wheel flats, as well as to the static and dynamic radial loads of vehicle weight. They are also liable to receive axial loads generated by lateral movement as trains run on curved rails or in a snaking motion. All of these loads together form complex combinations that act on axle bearings. Axle bearings must therefore be designed on the basis of not only dimensional requirements of the axle journal and bearing box geometry, but also these complex load conditions. Additionally, as axle bearings play a critical role in the safety of railroad operation, they are periodically disassembled for inspection. For this reason, simple and dependable procedures for disassembly, inspection and re-assembly are important design factors as well. Utilizing its vast know-how and experience, NSK has designed, manufactured and supplied a wide variety of axle bearings.

Globally, while plane bearings are still widely used, rolling bearings are increasingly being selected to replace them. All types of radial roller bearings, including tapered roller bearings, spherical roller bearings and cylindrical roller bearings, have been used in rolling stock axles based on the particular merits of each type.

To improve operating efficiency, bearings must offer longer inspection intervals, simplified maintenance procedures and increased integration of bearing components and adjacent parts. To meet these needs, unitized bearings with advanced sealing devices have been introduced and are now widely used in modern rolling stock.

Types of Axle Bearings and Their Applications

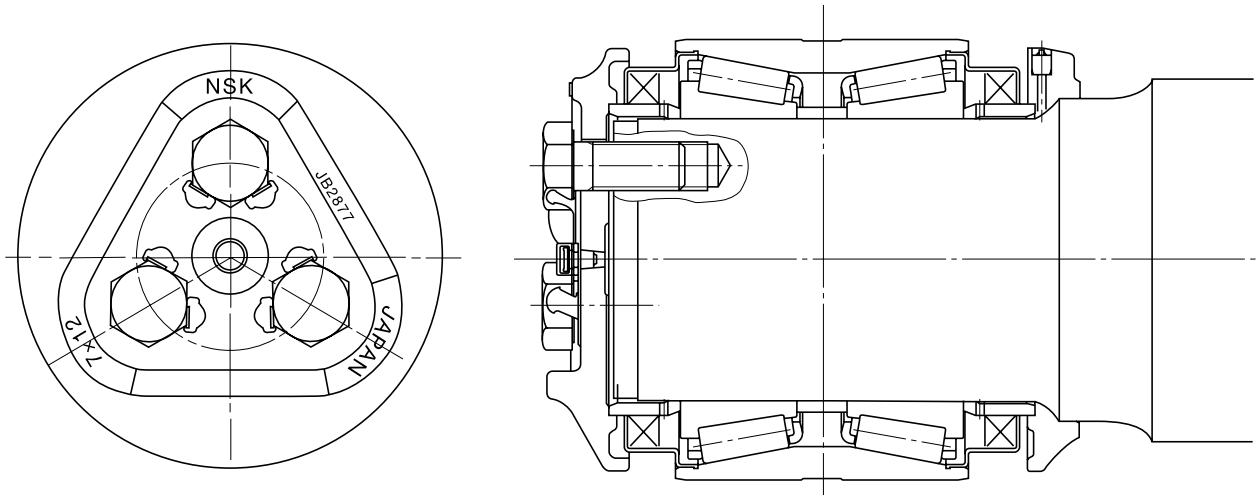
Axle bearings currently in use are classified into the following six types based both on bearing type and sealing device:

1. RCT Bearings (Sealed-Clean Rotating End Cap Tapered Roller Bearings)
2. RCC Bearings (Sealed-Clean Rotating End Cap Cylindrical Roller Bearings)
3. Spherical roller bearings
4. Cylindrical roller bearings combined with ball bearings
5. Cylindrical roller bearings with ribs
6. Tapered roller bearings

To ensure sufficient load-carrying capacity, all of these types are usually manufactured in double-row configurations.

RCT Bearings (Sealed-Clean Rotating End Cap Tapered Roller Bearings)

Sponsored by Hitachi, Ltd.



Indian National Railways,
AC Electric Locomotive, Series WAG6B
Bearing Number: J-386D1 (AAR Class G)

Preventing grease deterioration and leakage, as well as the intrusion of water and other foreign matter into the grease, are vital for eliminating bearing trouble and lengthening maintenance intervals. Clearly, bearing seals offer the best way of achieving these objectives.

RCT bearings are highly integrated with surrounding components and incorporate advanced sealing mechanisms. They offer outstanding performance, durability and ease of handling. The NSK RCT inch series was approved by the Association of American Railroads (AAR) for use on freight car axles and has been widely used in markets all over the world. In Japan, RCT bearings have long been used as container car axle bearings, earning a reputation among users for their excellent performance and durability. Recently, RCT bearings are being used in a broader range of applications including *Shinkansen* trains and new models of conventional electric and diesel trains.

The following outlines the features and usage of current RCT bearings:

1. Generally, RCT bearings consist of an end cap, cap screws, a locking plate for fastening the end cap, a seal wear ring, a double-row tapered roller bearing and a backing ring. The latest variation has a backing ring that also serves as a seal wear ring.
2. When the axle end needs to be exposed for inspection or re-machining of the wheel, it can be exposed easily by loosening the cap screws and removing the end cap. A recent variation incorporates a smaller rubber cover designed to further ease access to the end of the axle.
3. Oil seals, mounted in seal cases, are press-fitted onto both ends of the outer ring and are in contact with the seal wear rings with a specified interference and pressure. The seals are spring-loaded contact seals. They are capable of preventing grease leakage and the intrusion of water and foreign matter into the bearing. The seal packing is made of nitrile or acrylic rubber in most cases, although it may be made of fluoric rubber for high-speed applications such as in *Shinkansen* trains.
4. An amount of grease equivalent to approximately one-half to one-third of the bearing's internal volume, including seal lips, is prepacked in the bearing. No grease replenishment is necessary for the duration of the bearing's service life. Grease with NLGI consistency number 2 is used for axle bearings. Lithium or sodium grease is most often used, though other kinds of grease such as lithium-calcium compound grease or urea-based grease may be used depending on bearing conditions like speed, load and maintenance frequency.
5. The mounting and dismounting of RCT bearings is performed by press-fitting or press-pulling using special-purpose tools. The press-fitting operation is controlled by the amount of interference between the outside diameter of the axle journal and the bore diameter of the bearing's inner ring, as well as by the load applied from the press-fitting.
6. For the assembly of bogies with axles supported by RCT bearings, saddle-type adapters are used instead of the bearing boxes commonly used for ordinary bearings. The use of such adapters can reduce the weight of the bogie and make assembly work easier.

Fig. 1-1 RCT (JT14)

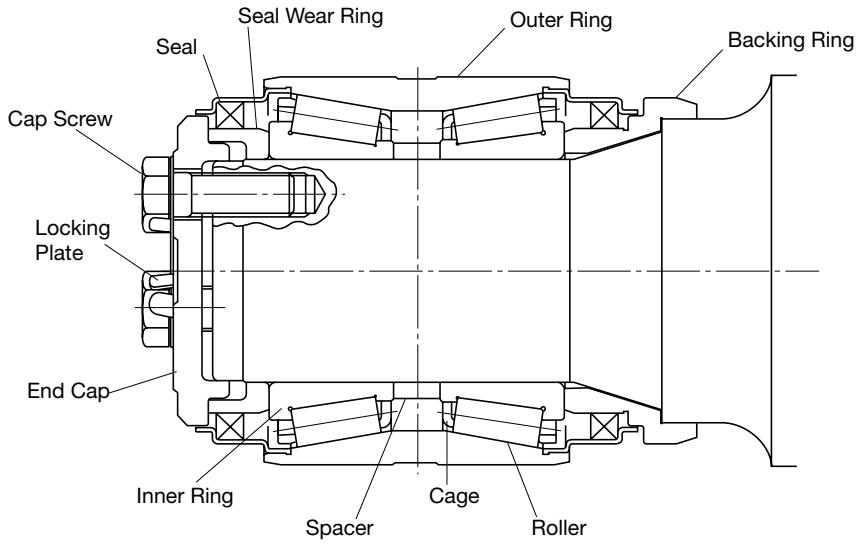


Fig. 1-2 RCT (JT14)

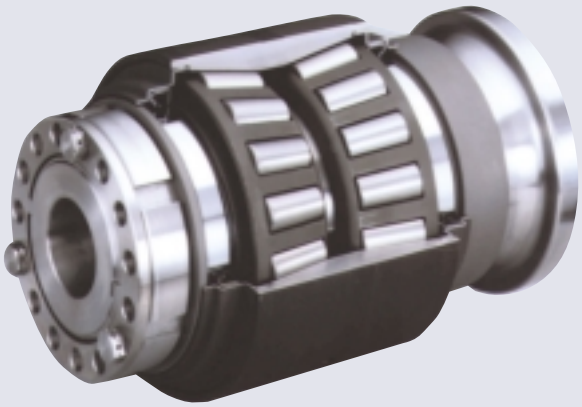
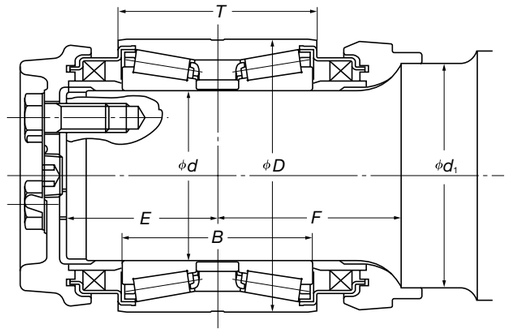


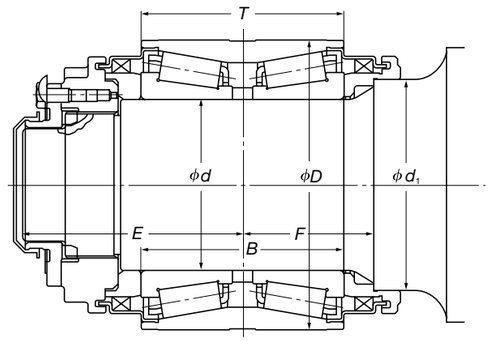
Fig. 1-3 RCT (WJT1)

RCT Bearings (Sealed-Clean Rotating End Cap Tapered Roller Bearings)

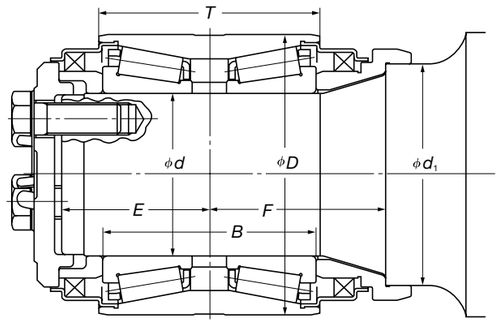
RCT Bearing Table



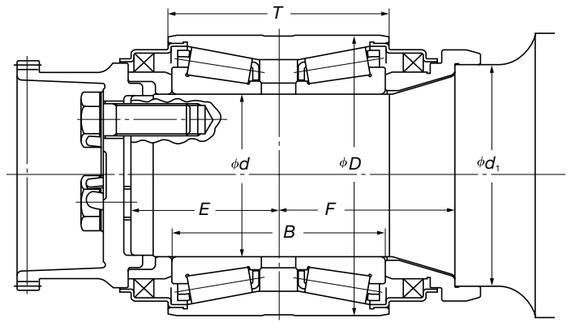
JT11



WJT13



JT14-KOO



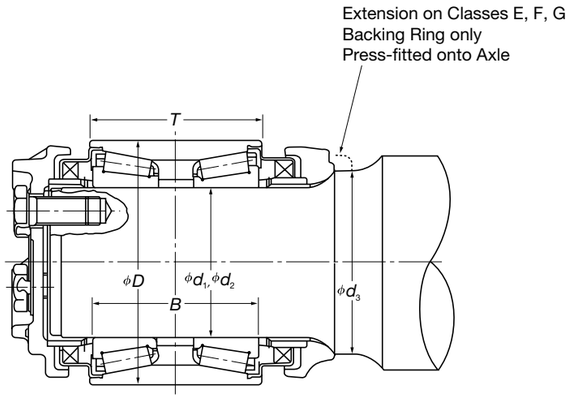
JT14-OTU

Class	Assembly Number	Bearing Number	Fastening Device(2)	Dimensions (mm)							Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)	Mass (kg) approx.	Main Application
				d	*D*	*T*	*B*	d_1	*E*	*F*				
90	J-908	AR90-31	A	90	154	90	80	110	55	80	297 000	480 000	14.5	Electric Car
110	J-318	JT9	A	110	175	130	125	155	105	135	470 000	940 000	22.4	Freight Car
110	J-358A	AR110-31(1)	B	110	200	150	145	139	140	117	650 000	1 150 000	25.7	Shinkansen
110	J-359	AR110-32	A	110	185	135	130	145	80	113	550 000	1 060 000	21.8	Electric Car
110	J-910	JT20	A	110	188	150	145	150	100	120	605 000	1 110 000	26.3	Electric Car
110	J-901	JT14	A	110	190	150	145	150	100	120	605 000	1 110 000	25.1	Electric Car
110	J-905	JT17	A	110	195	150	145	150	100	120	650 000	1 180 000	27.0	Electric Car
110	J-909	JT13	A	110	205	140	130	150	85	105	745 000	1 270 000	27.0	Diesel Car
110	J-902	AR110-35	B	110	220	145	144	155	112	110	690 000	1 090 000	35.3	Diesel Car
115	J-900	AR115-9	B	115	210	150	145	144	98	117	710 000	1 250 000	30.9	Shinkansen
120	J-319	JT10	A	120	195	142	136	155	113	135	645 000	1 290 000	26.6	Freight Car
120	J-904	JT18	A	120	220	145	145	155	120	117	750 000	1 250 000	35.9	Electric Car
120	J-355	JT12	A	120	220	155	155	150	125	100	845 000	1 530 000	37.6	Electric Car
120	J-907A	WJT1	B	120	220	155	150	149	146.5	117	780 000	1 310 000	31.8	Shinkansen
120	J-356	WJT32X	B	120	230	150	144	155	145	113	815 000	1 300 000	37.5	Electric Car
120	J-912	AR120-27	B	120	230	155	155	142	203	117	855 000	1 410 000	38.7	Shinkansen
125	J-915	JT23	B	125	235	155	165	150	181	117	800 000	1 290 000	37.8	Shinkansen
130	J-320	JT11	A	130	208	152	146	165	115	139	660 000	1 350 000	31.1	Freight Car
130	J-913	WJT13	B	130	220	155	155	160	168	100	765 000	1 410 000	34.0	Electric Car
130	J-920	FJT1	A	130	220	155	155	171	115	140.7	820 000	1 550 000	37.4	Freight Car
130	J-914	AR130-30	B	130	230	155	155	160	203	117	720 000	1 230 000	35.6	Shinkansen
130	J-911	JT22	B	130	245	170	165	161	202	119	960 000	1 610 000	46.4	Shinkansen
130	J-351	JT130D-2	B	130	250	175	185	163	200	140	1 040 000	1 850 000	53.0	Shinkansen
130	J-353	JT130D-3(1)	B	130	250	175	185	160	245	140	1 040 000	1 850 000	55.0	Shinkansen
130	J-367	JT130C-1	A	130	230	150	150	165	95	125	895 000	1 620 000	29.8	Freight Car (China)

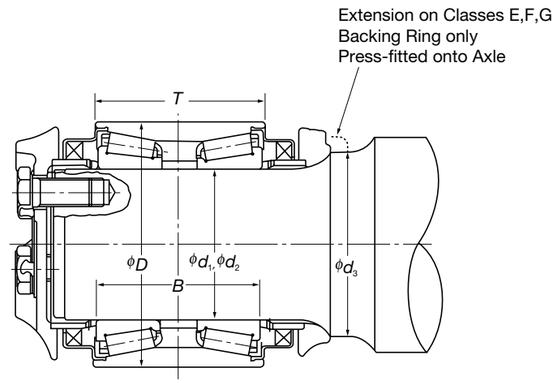
Notes (1) Labyrinth seal type, otherwise oil seal type
(2) A: Bolt, B: Nut

RCT Bearings (Sealed-Clean Rotating End Cap Tapered Roller Bearings)

RCT AAR22 Bearing Table



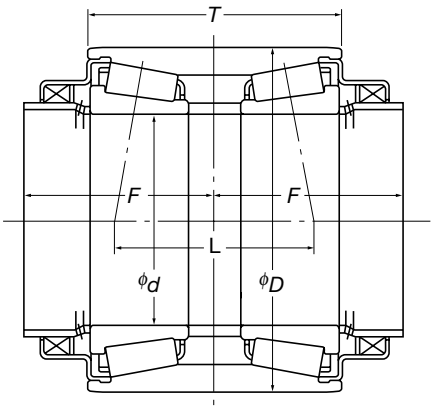
End Cap and Backing Ring with Shroud (J-370 Series)



End Cap and Backing Ring without Shroud (J-360 Series)

Class	Journal Size	Unit Number		Bearing Number		Dimensions mm (upper line)/inch (lower line)							Basic Dynamic Load Rating N (lbf)	Basic Static Load Rating N (lbf)	Mass of Unit (kg) approx.
		Non-shroud Type	Shroud Type			d_1 (bearing) Max.-min.	d_2 (axle) Max.-min.		D	T	B	d_3			
B	$4^{1}/_{4} \times 8$	J-361	J-371	HM120848R	HM120817XDR	101.625–101.600 4.001–4.000	101.702–101.676 4.0040–4.0030		165.100 $6^{1}/_{2}$	114.300 $4^{1}/_{2}$	106.362 $4^{3}/_{16}$	127.000 5	415 000 (93 000)	775 000 (174 000)	19.9
C	5×9	J-362	J-372	HM124646R	HM124618XDR	119.087–119.062 4.6885–4.6875	119.164–119.139 4.6915–4.6905		195.262 $7^{11}/_{16}$	142.875 $5^{5}/_{8}$	136.525 $5^{3}/_{8}$	149.225 $5^{7}/_{8}$	585 000 (132 000)	1 140 000 (255 000)	33.0
D	$5^{1}/_{2} \times 10$	J-363	J-373	HM127446R	HM127415XDR	131.775–131.750 5.1880–5.1870	131.864–131.839 5.1915–5.1905		207.962 $8^{3}/_{16}$	152.400 6	146.050 $5^{3}/_{4}$	161.925 $6^{3}/_{8}$	635 000 (143 000)	1 250 000 (282 000)	37.5
E	6×11	J-364	J-374	HM129848R	HM129814XDR	144.475–144.450 5.6880–5.6870	144.564–144.539 5.6915–5.6905		220.662 $8^{11}/_{16}$	163.512 $6^{7}/_{16}$	155.575 $6^{1}/_{8}$	178.613–178.562 7.032–7.030	665 000 (149 000)	1 350 000 (305 000)	47.0
F	$6^{1}/_{2} \times 12$	J-365	J-375	HM133444R	HM133416XDR	157.175–157.150 6.1880–6.1870	157.264–157.239 6.1915–6.1905		252.412 $9^{15}/_{16}$	184.150 $7^{1}/_{4}$	177.800 7	191.313–191.262 7.532–7.530	905 000 (204 000)	1 840 000 (415 000)	66.5
G	7×12	J-366	J-376	HN136948R	HM136916XDR	177.812–177.787 7.0005–6.9995	177.902–177.876 7.0040–7.0030		276.225 $10^{7}/_{8}$	185.725 7.312	180.975 $7^{1}/_{8}$	203.251–203.200 8.002–8.000	1 010 000 (227 000)	2 170 000 (485 000)	86.0

Inch-Series RCT Bearing Unit Table

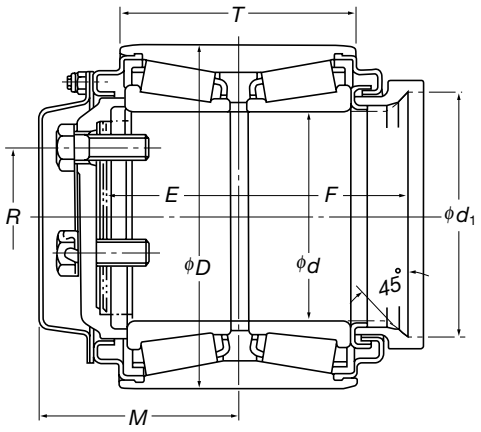


Inch-Series Inboard Bearing Unit

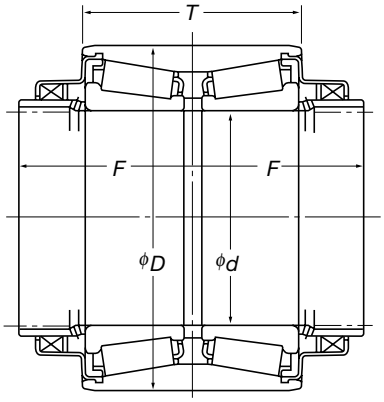
Inch-Series Inboard Bearing Units

Class	Assembly Number	Dimensions (mm) (2nd Line: 1/25.4)				
		d	*D*	*F*	*T*	*L*
B (4 1/4 × 8)	J-361X	101.600	165.1	91	114	54.4
		4.0000	6.5000	3 19/32	4 1/2	2.14
C (5 × 9)	J-362X	119.062	195.262	109	143	105.7
		4.6875	7.6875	4 9/32	5 5/8	4.16
	J-362X1	119.062	195	103	132	94.1
		4.6875	7.6772	4 1/16	5 11/64	3.71
D (5 1/2 × 10)	J-363X1	131.750	207.962	114	152	116.8
		5.1875	8.1875	4 15/32	6	4.60
	J363X1	131.750	210	103	132	96.4
		5.1875	8.2677	4 1/16	5 13/64	3.80
E (6 × 11)	J-364X	144.450	220.662	121	164	127.5
		5.6870	8.6875	4 3/4	6 7/16	5.02
	J-364X1	144.450	220	109	140	104
		5.6870	8.6614	4 9/32	5 33/64	4.09
F (6 1/2 × 12)	J-365X	157.150	252.412	137	184	143.3
		6.1870	9.9375	5 3/8	7 1/4	5.64
	J-365X1	157.150	250	125	160	119.1
		6.1870	9.8425	4 29/32	6 19/64	4.69
G (7 × 14)	J-366X	177.788	276.225	135	186	144.8
		6.9995	10.8750	5 5/16	7 5/16	5.70

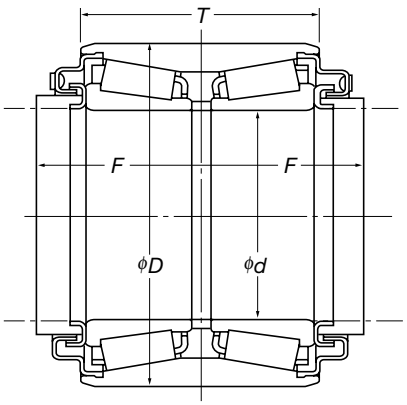
Metric-Series RCT Bearing Unit Tables



Outboard, Labyrinth Type



Inboard, Contact Seal Type



Inboard, Labyrinth Type

Outboard, Labyrinth Type

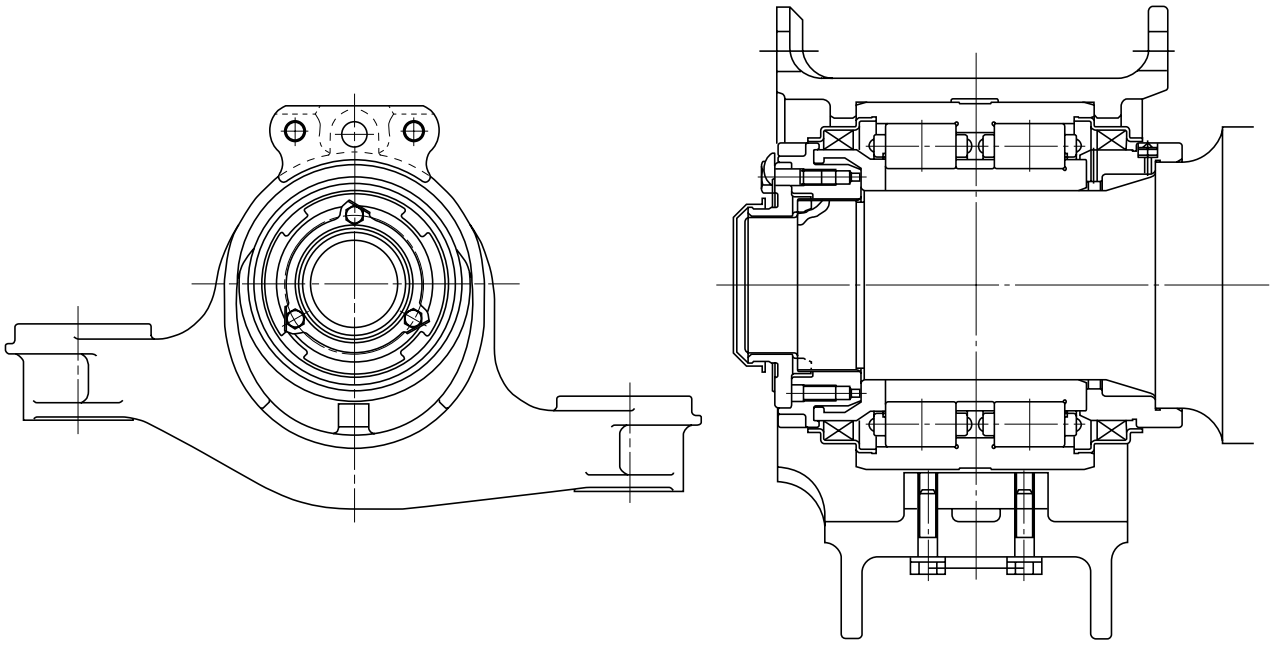
Class	Bearing Number	Dimensions (mm)								
		d	*D*	*T*	M (Max)	Cap Screw	d_1	*R*	*F*	*E*
120	JT120A	120	195	132	110	M16 × 2-6H (5/8-11UNC)	138.162–138.122	80	90	75
130	JT130A	130	210	132	112	M16 × 2-6H (5/8-11UNC)	150.174–150.134	80	95	75
140	JT140A	140	220	140	118	M16 × 2-6H (5/8-11UNC)	160.174–160.134	100	100	80
150	JT150A	150	250	160	132	M20 × 2.5-6H (3/4-10UNC)	170.186–170.146	100	105	90

Inboard, Contact Seal Type

Class	Bearing Number	Dimensions (mm)			
		d	*D*	*T*	*F*
120	JT120A	120	195	132	103
130	JT130A	130	210	132	103
140	JT140A	140	220	140	109
150	JT150A	150	250	160	124

Inboard, Labyrinth Type

Class	Bearing Number	Dimensions (mm)			
		d	*D*	*T*	*F*
120	JT120A	120	195	132	90
130	JT130A	130	210	132	90
140	JT140A	140	220	140	95
150	JT150A	150	250	160	105



JR East Company, Commuter Train, Series 205

Bearing Number: JC32

The most remarkable characteristic of RCC and RCT bearings is that they are both prepacked with grease and thoroughly sealed with oil seals. In electric trains in Japan, the usage of RCC bearings preceded that of RCT bearings in large part because RCC bearings are more easily disassembled and reassembled and therefore better facilitate inspection and maintenance.

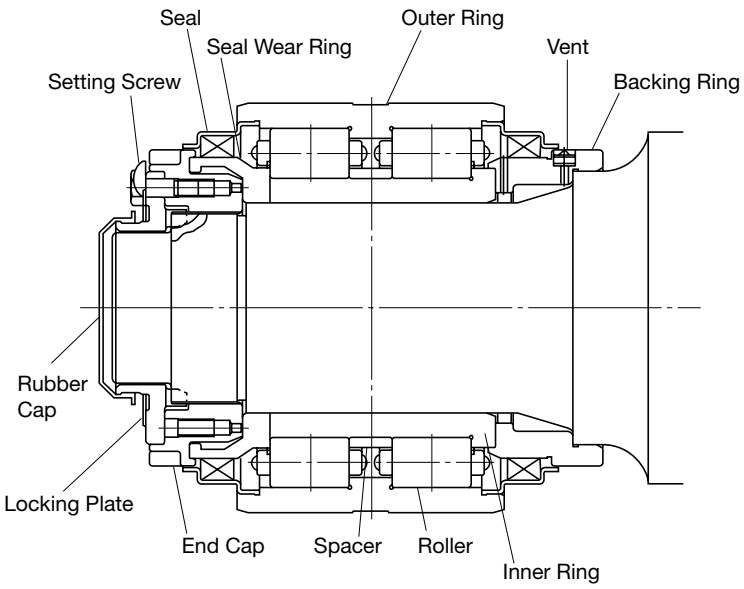
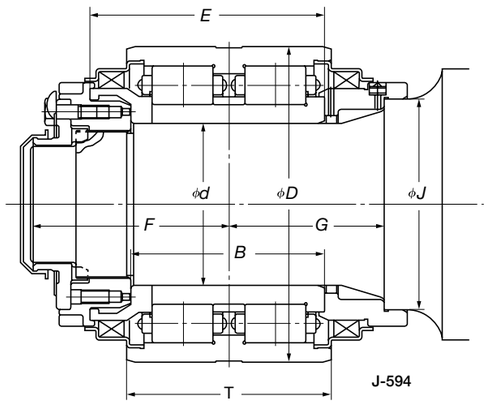


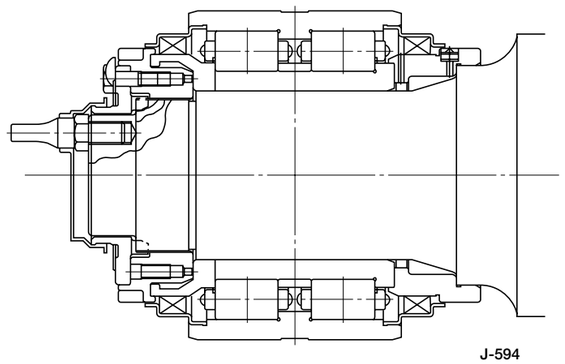
Fig. 1-4 RCC (JC32)

RCC Bearings (Sealed-Clean Rotating End Cap Cylindrical Roller Bearings)

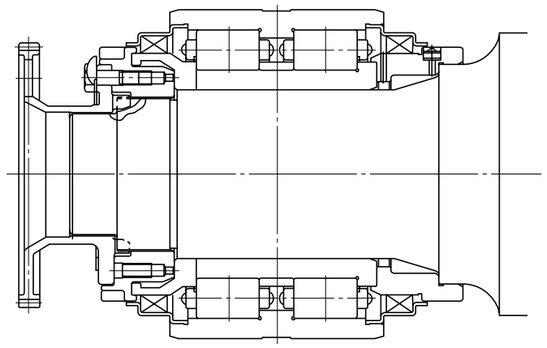
RCC Bearing Table



JC32-KOO



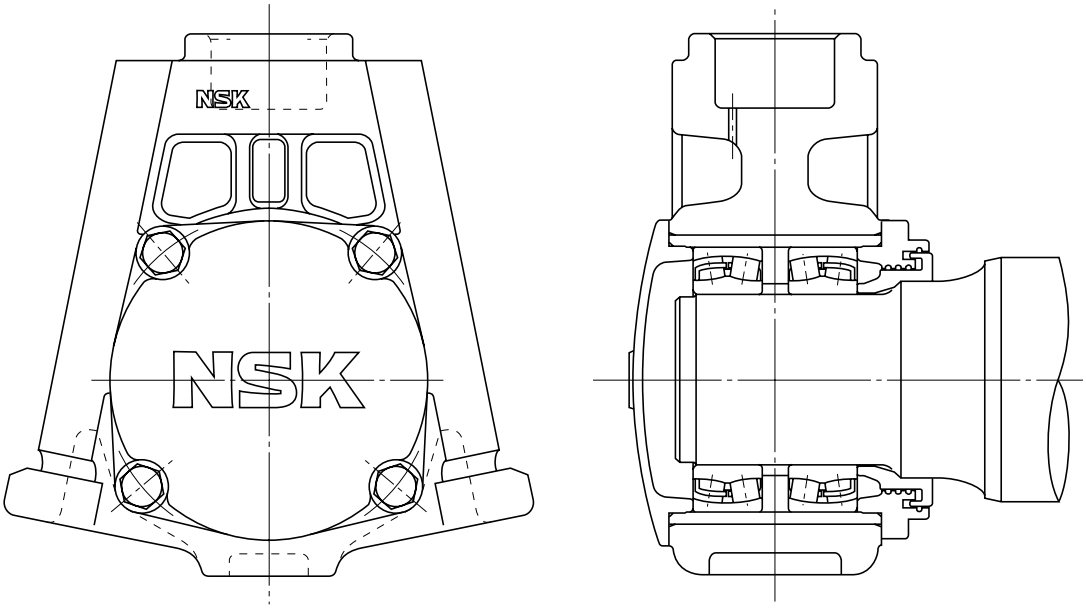
JC32-OTU



JC32-HEI

Size	Assembly Number	Bearing Number	Dimensions (mm)								Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)	Mass (kg) approx.	Main Application
			d	*D*	*T*	*B*	*J*	*E*	*F*	*G*				
100	J-580A	100JRF01A	100	195	150	175	130	—	120	105	670 000	1 040 000	27.0	Electric Car
110	J-447B	2M110-3	110	220	160	154	170	—	135	140	875 000	1 370 000	43.9	Electric Car
110	J-577	110JRF01	110	220	170	182	140	210	128	112	875 000	1 370 000	39.7	Electric Car
120	J-480B	2M120-7	120	240	160	164	150	197	128	112	935 000	1 450 000	55.8	Electric Car
120	J-504	2M120-8	120	195	140	134	155	176	135	132	545 000	915 000	28.6	Electric Car
120	J-556B	JC17	120	240	170	180	168	218	130	125	1 020 000	1 580 000	55.3	Diesel Car
120	J-566	JC24X	120	195	142	132	155	—	118	140	515 000	855 000	23.8	Freight Car
120	J-574	JC26	120	240	160	162	168	193	158	113	935 000	1 420 000	51.2	Electric Car
120	J-574A	JC26A	120	240	160	162	168	196	120	125	935 000	1 420 000	52.0	Electric Car
120	J-587	JC28X	120	220	150	141.5	155	175.5	110	113	700 000	1 110 000	33.5	Electric Car
120	J-590	JC30	120	230	150	142	155	171	134	113	830 000	1 290 000	37.8	Electric Car
120	J-594	JC32	120	230	150	142	155	171	145	113	830 000	1 290 000	39.0	Electric Car
120	J-605	120JRF04	120	220	175	182	140	210	128	112	850 000	1 430 000	35.9	Electric Car
120	J-802	120JRF05	120	240	170	182	150	205	128	112	1 020 000	1 580 000	50.0	Electric Car
120	J-803	120JRF04A	120	220	175	182	150	210	128	112	850 000	1 430 000	35.3	Electric Car
120	J-805	120JRF06	120	220	155	157	150	190	113	100	765 000	1 250 000	31.3	Electric Car
120	J-806	120JRF07	120	220	160	172	160	200	128	112	765 000	1 250 000	33.0	Electric Car
120	J-809	JC36	120	220	145	145	155	171	145	117	700 000	1 120 000	36.0	Diesel Car
120	J-810A	120JRF09	120	220	160	185.5	145	—	128	104	765 000	1 250 000	31.6	Electric Car
120	J-811	120JRT07	120	220	160	204	150	242	128	112	815 000	1 320 000	36.1	Electric Car
120	J-817	120JRF04J	120	220	175	175	144	197	118	113	850 000	1 430 000	31.7	Electric Car
130	J-555	2M130-8	130	260	180	182	160	215	128	112	1 030 000	1 610 000	62.0	Electric Car
130	J-567	130JRF01	130	250	170	170	165	208	95	135	1 030 000	1 610 000	55.4	Freight Car (China)
130	J-578	130JRF02	130	260	175	182	160	212.5	128	112	1 030 000	1 610 000	59.8	Electric Car
130	J-589	130JRF03	130	240	160	160	170	188	131	116	825 000	1 310 000	42.7	Electric Car
130	J-801	130JRF03A	130	240	160	160	165	188	116	105	825 000	1 310 000	43.8	Electric Locomotive, Diesel Locomotive
130	J-807	130JRF03	130	240	160	160	160	188	118	112	825 000	1 310 000	49.9	Electric Car
130	J-816	130JRF03A	130	240	160	160	160	188	100	112	825 000	1 310 000	39.9	Electric Car
130	J-814	130JRF05	130	230	160	185.5	155	—	128	104	800 000	1 340 000	35.9	Electric Car

Sponsored by Singapore Mass Rapid Transit Corporation



Singapore Mass Rapid Transit Corporation, Subway

Bearing Number: J-232, J-232A

Spherical roller bearings have relatively high radial load-carrying capacity and can also carry axial loads. These features are conducive to designing the adjacent parts of the bearing in more compact arrangements. When a single spherical roller bearing is mounted on an axle journal, the bearing box is allowed to move freely in relation to the axle center because of the self-aligning property of the bearing. Therefore, by setting the load-carrying point below the bearing's axis of rotation, the bearing box can be stabilized and misalignment minimized. Excessive misalignment may result in contact between the slinger and the rear cover and lead to wear and heating. When a single spherical roller bearing is used, the use of a wing-type bearing box is recommended.

When two spherical roller bearings are used in a double-row configuration to provide higher load-carrying capacity, the self-aligning capability of the bearing is lost and, for design reasons, the journal must be longer. While this type of bearing is used worldwide, it is most popular in Europe, where it has been standardized by the International Union of Railways (UIC).

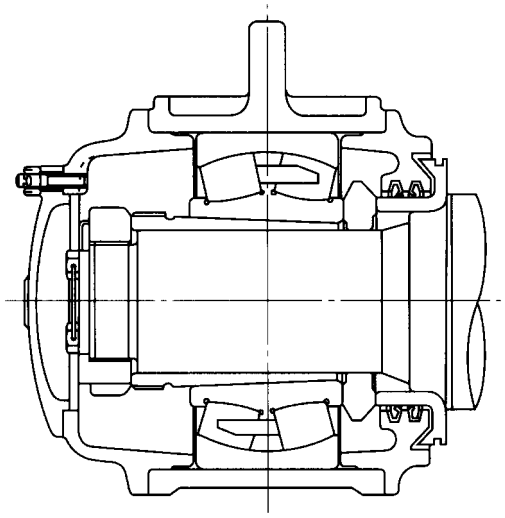


Fig. 1-5 Spherical Roller Bearing with Withdrawal Sleeve

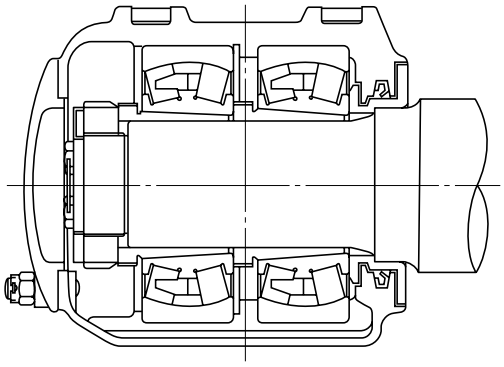


Fig. 1-6 Double Spherical Roller Bearing with Withdrawal Sleeve

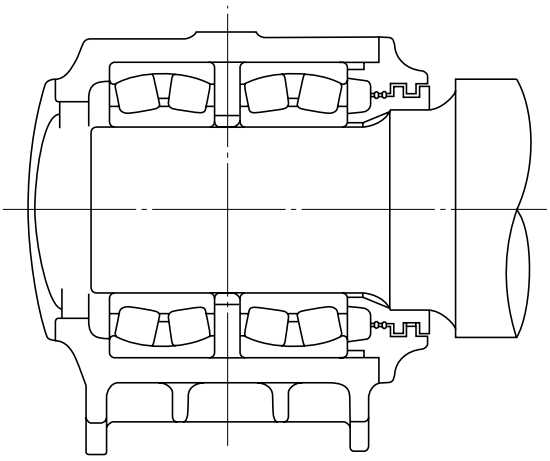
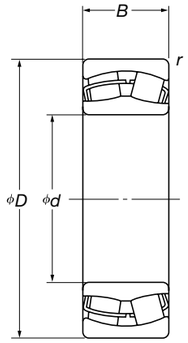
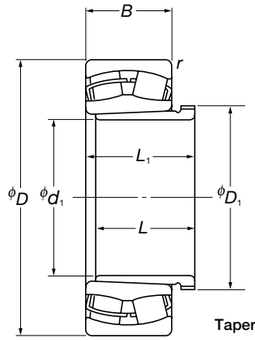


Fig. 1-7 Double Spherical Roller Bearings

Spherical Roller Bearing Table



Cylindrical Bore



Tapered Bore + Withdrawal Sleeve

Bearing Number		Withdrawal Sleeve	Boundary Dimensions (mm)								Basic Dynamic Load Rating N (lbf)	Basic Static Load Rating N (lbf)	Mass (kg) approx.	
Cylindrical Bore	Tapered Bore		d	d_1	D	B	$r^{(1)}$	L	L_1	D_1			Bearing	Bearing and Sleeve
230092C	—	—	99.746	—	180	60.3	3.5	—	—	—	420 000 (94 000)	605 000 (135 000)	6.6	—
23220C	23220CK	AHX3220	100	95	180	60.3	2.1	73	77	M110 × 2	420 000 (94 000)	605 000 (135 000)	6.6	7.40
23122C	23122CK	AHX3122	110	105	180	56	2	68	72	M120 × 2	385 000 (86 500)	630 000 (141 000)	5.8	6.55
231255C	—	—	119.105	—	200	62	2 5	—	—	—	465 000 (105 000)	720 000 (162 000)	8.00	—
23124C	23124CK	AHX3124	120	115	200	62	2	75	79	M130 × 2	465 000 (105 000)	720 000 (162 000)	7.95	8.90
23224C	23224CK	AHX3224	120	115	215	76	2.1	90	94	M135 × 2	630 000 (142 000)	970 000 (218 000)	12.3	13.6
22324C	22324CK	AHX2324	120	115	260	86	3	105	109	M135 × 2	845 000 (190 000)	1 130 000 (253 000)	22.8	24.4
23126C	23126CK	AHX3126	130	125	210	64	2	78	82	M140 × 2	505 000 (113 000)	825 000 (186 000)	8.80	9.90
229750C	—	—	130	—	220	73	2.7 5	—	—	—	575 000 (129 000)	960 000 (216 000)	11.7	—
23226C	23226CK	AHX3226	130	125	230	80	3	98	102	M145 × 2	700 000 (158 000)	1 080 000 (243 000)	14.5	16.1
22326C	22326CK	AHX2326	130	125	280	93	4	115	119	M145 × 2	995 000 (223 000)	1 350 000 (305 000)	28.4	30.5
230906C	—	—	131.796	—	220	73	2.7 5	—	—	—	575 000 (129 000)	960 000 (216 000)	11.6	—
228285C	—	—	139.734	—	218	80	1.5 5	—	—	—	605 000 (136 000)	1 040 000 (235 000)	11.3	—
23128C	23128CK	AHX3128	140	135	225	68	2.1	83	88	M150 × 2	580 000 (130 000)	945 000 (212 000)	10.5	11.8
23228C	23228CK	AHX3228	140	135	250	88	3	104	109	M155 × 3	835 000 (187 000)	1 300 000 (292 000)	19.1	20.9
231019C	—	—	144.475	—	250	80	2.7 5	—	—	—	725 000 (163 000)	1 180 000 (266 000)	16.8	—
228708C	—	—	152.434	—	250	100	2.7 5	—	—	—	860 000 (193 000)	1 450 000 (325 000)	19.7	—
231481C	—	—	157.174	—	270	86	2 5	—	—	—	855 000 (192 000)	1 400 000 (315 000)	21.1	—
	22338MK	AH2338	—	180	400	132	5	160	167	Tr210 × 4	1 750 000 (395 000)	2 340 000 (525 000)	79.6	86.2
22228M	—	—	140	—	250	68	3	—	—	—	655 000 (147 000)	910 000 (205 000)	14.9	—
23026Ca3	—	—	130	—	200	52	2 5	—	—	—	400 000 (90 000)	655 000 (148 000)	5.9	—
22328	—	—	140	—	300	102	4	—	—	—	1 160 000 (260 000)	1 590 000 (360 000)	35.4	—
23120C	—	—	100	—	165	52	2	—	—	—	345 000 (78 000)	530 000 (119 000)	4.4	—

Note (1) The upper and lower numbers for dimension r refer to radial and axial directions, respectively.

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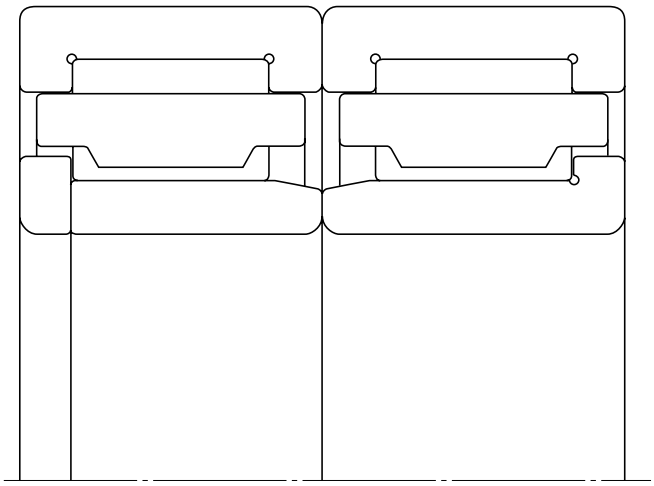


The Ministry of Railways, P.R.China,
Passenger Car, Series 25K
Bearing Numbers: 42726T/152726T

Cylindrical Roller Bearings Combined with Ball Bearings

Cylindrical roller bearings (CRBs) have high load-carrying capacity because of the linear contact between their rollers and raceways. They are capable of high running speeds because of their relatively small friction coefficient and they offer advantages in maintenance because they are more easily disassembled, inspected and reassembled. Furthermore, they allow the free setup of their axial clearance.

However, ordinary CRBs require another bearing to handle axial loads, increasing the number of parts required for supporting the axle journal. Usually, the axial loads are borne by a single-row radial ball bearing such as a deep groove ball bearing or an angular contact ball bearing installed between the bearing box front cover and the axle end. To absorb axial loads, a rubber buffer or a coned disc spring is placed between the ball bearing's outer ring and the bearing box front cover. Sealing is provided by a seal between the rear cover and the bearing box. In Japan, bearings of this type of construction have long been used and referred to as "journal box type" bearings. For conventional rolling stock, bearing boxes containing a double-row cylindrical roller bearing for radial loads and an angular contact ball bearing with a rubber buffer for axial loads have been used for many years. Initially for *Shinkansen* trains, bearing boxes essentially identical to the conventional type were employed, although the combination of an angular contact ball bearing and a rubber buffer was replaced early on by a deep groove ball bearing and a coned disc spring.

Cylindrical Roller Bearings with Ribs

With this type of bearing, axial load is borne by ribs on the outer and inner rings and by the ends of the rollers. This type is referred to as the UIC type and has been standardized in Europe. When compared with cylindrical roller bearings combined with ball bearings, the UIC type offers the advantages of reduced cost and simpler and more compact housing construction owing to the absence of the ball bearing. Formerly, it was believed that insufficient load-carrying capacity of the bearing ribs could lead to problems at high speeds. However, with the adoption of this type of bearing for the 300 Series *Shinkansen*, it was demonstrated that improved design of the ribs and roller ends coupled with better finishing accuracy eliminated such problems. This type of axle bearing can be constructed with a sealing arrangement between the rear cover and the bearing box or, as described in the section on RCT bearings, they can have an internally sealed construction.

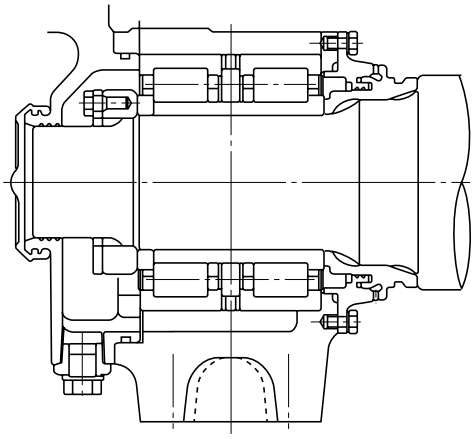


Fig. 1-8 Double-Row Cylindrical Roller Bearing with Rib to Sustain Axial Load

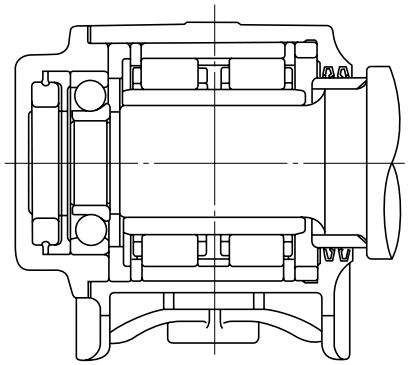


Fig. 1-9 Axle Box with an Angular Contact Ball Bearing and Buffer to Sustain Axial Load

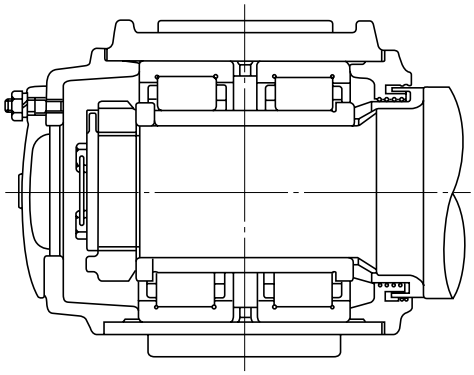


Fig. 1-10 Axle Box with Roller-Guiding Ribs to Sustain Axial Loads

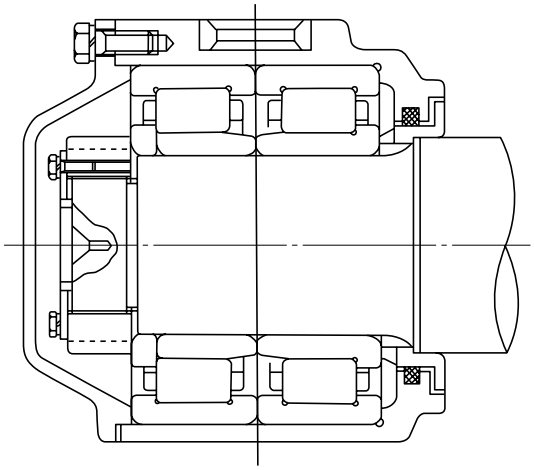


Fig. 1-11 Axle Box with Roller-Guiding Ribs to Sustain Axial Loads (UIC Standard Type)

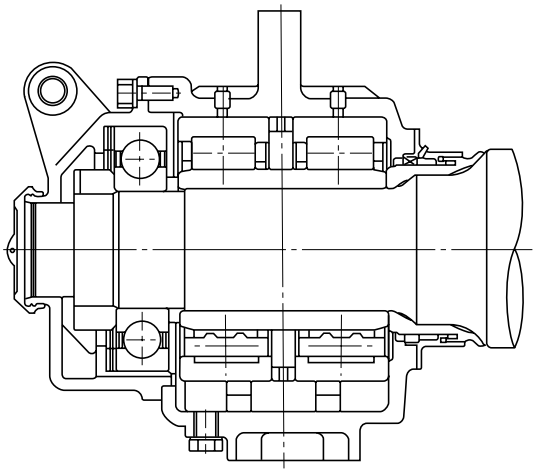


Fig. 1-12 Axle Box with Deep Groove Ball Bearing and Conical Disc Springs to Sustain Axial Load

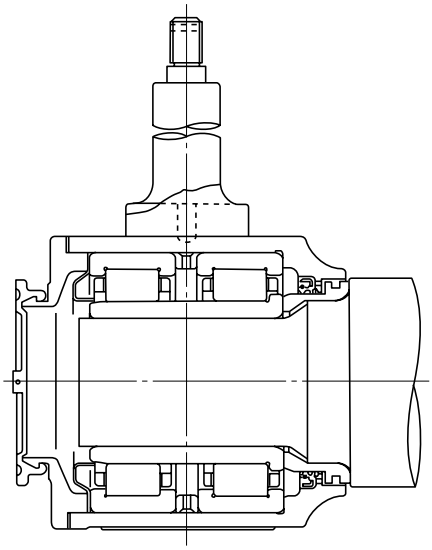
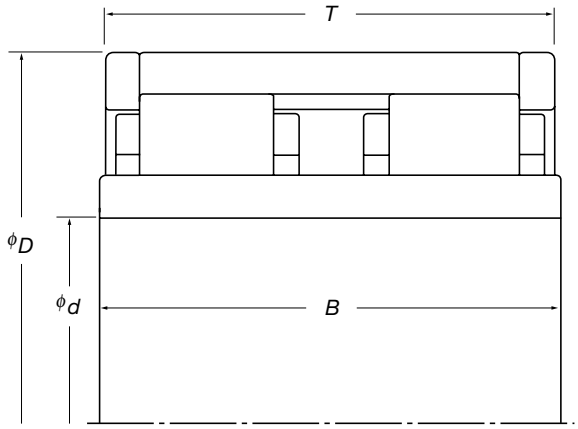


Fig. 1-13 Axle Box with Single Inner Ring to Sustain Axial Load

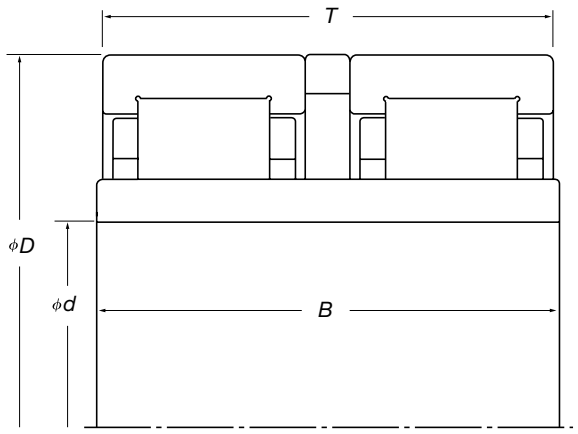
Cylindrical Roller Bearing Tables

Type A



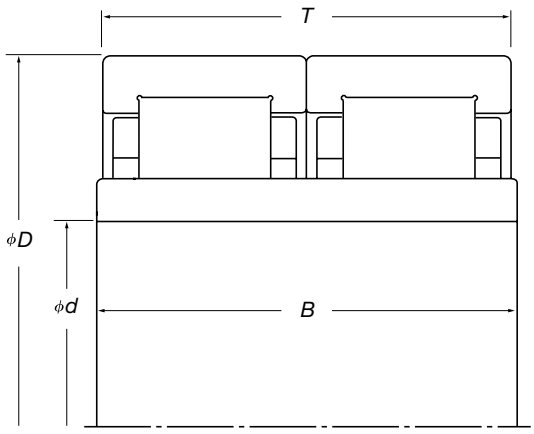
Class	Bearing Number	Dimensions (mm)				Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)	Mass (kg) approx.	Main Application
		d	*D*	*T*	*B*				
85	2U85-1	85	155	105	125	400 000	605 000	9.6	Electric Car
95	2U95-1C	95	170	105	125	440 000	690 000	11.3	Passenger Car (Taiwan)
100	2U100-1	100	180	120	130	500 000	795 000	13.7	Electric Car
100	2U100-2A	100	190	130	140	690 000	1 100 000	17.2	Diesel Car (Taiwan)
110	JC1A	110	225	140	150	835 000	1 230 000	28.2	Electric Car
110	JC3	110	200	160	180	720 000	1 190 000	23.1	Passenger Car
110	JC10	110	225	140	180	935 000	1 430 000	28.4	Diesel Locomotive
120	JC11	120	240	160	180	1 020 000	1 580 000	35.5	Electric Car
110	2U110-2	110	230	150	160	935 000	1 430 000	32.6	Electric Car
110	2U110-3	110	220	160	180	945 000	1 510 000	30.5	Electric Car
110	2U110-7A	110	225	140	150	935 000	1 430 000	28.5	Passenger Car (Taiwan)
120	2U120-4	120	250	140	140	1 070 000	1 610 000	34.6	Electric Car
120	2U120-6A	120	240	160	180	1 020 000	1 580 000	35.6	Electric Car
120	2U120-7	120	220	160	180	850 000	1 430 000	28.2	Electric Car
130	JC5A	130	260	160	180	1 080 000	1 710 000	43.4	Diesel Locomotive
130	JC18	130	260	160	205	1 080 000	1 710 000	44.8	Diesel Locomotive, Electric Locomotive
130	2U130-2A	130	260	160	180	1 080 000	1 710 000	43.4	Diesel Locomotive (Korea)
130	2U130-5	130	220	160	180	790 000	1 390 000	25.3	Electric Car
130	2U130-6	130	240	160	180	990 000	1 650 000	34.5	Electric Car
140	2U140-2	140	280	185	205	1 440 000	2 260 000	56.7	Electric Locomotive
160	160JRX01	160	280	160	180	1 060 000	1 730 000	43.1	Electric Locomotive (China)

Type B



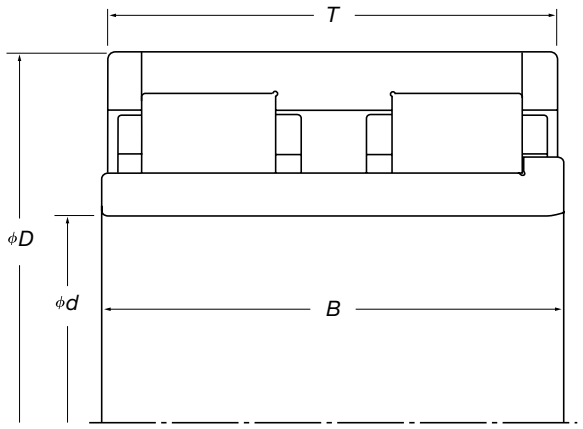
Class	Bearing Number	Dimensions (mm)				Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)	Mass (kg) approx.	Main Application
		d	*D*	*T*	*B*				
85	2P85-1	85	150	120	130	365 000	585 000	8.8	Electric Car
90	90JRU01	90	160	120	130	355 000	530 000	8.6	Electric Car
110	2P110-4MA	110	225	140	150	935 000	1 430 000	27.4	Freight Car (New Zealand)
120	2P120-6MA	120	240	160	180	935 000	1 450 000	35.0	Electric Car
130	JC9	130	280	210	215	1 440 000	2 250 000	61.5	Shinkansen
130	JC29	130	270	210	215	1 280 000	2 000 000	56.0	Shinkansen
133	JC9-2	133	280	210	215	1 440 000	2 250 000	60.4	Shinkansen
160	160JRU01	160	260	140	140	820 000	1 460 000	29.0	Electric Car
170	170JRU01	170	340	230	230	1 660 000	2 760 000	97.9	Locomotive (Prototype)

Type C



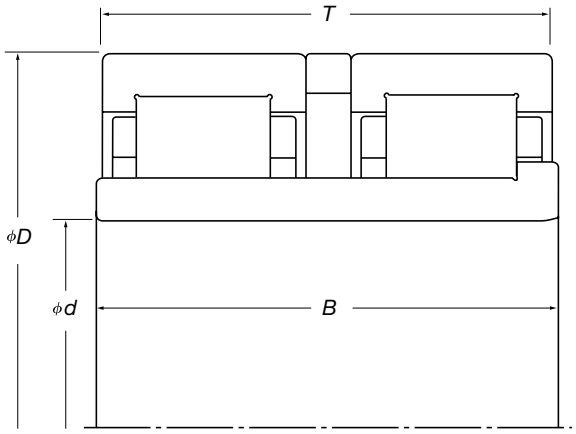
Class	Bearing Number	Dimensions (mm)				Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)	Mass (kg) approx.	Main Application
		d	*D*	*T*	*B*				
110	JC2A	110	235	160	180	935 000	1 430 000	35.4	Passenger Car, Electric Car

Type D



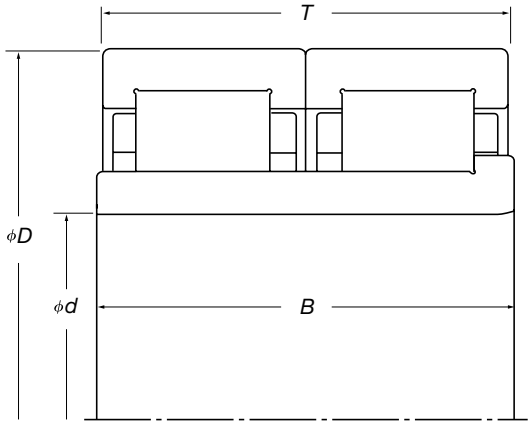
Class	Bearing Number	Dimensions (mm)				Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)	Mass (kg) approx.	Main Application
		d	*D*	*T*	*B*				
100	2J100-1	100	180	130	143	560 000	915 000	15.2	Electric Car

Type E



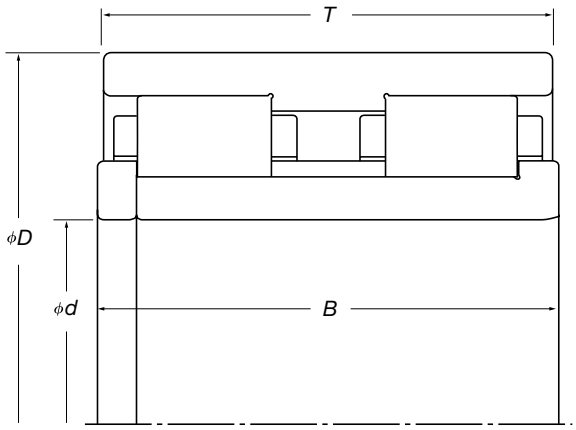
Class	Bearing Number	Dimensions (mm)				Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)	Mass (kg) approx.	Main Application
		d	*D*	*T*	*B*				
85	85JRJ02	85	150	120	125	365 000	585 000	8.7	Electric Car
90	90JRJ01	90	160	118.5	130	355 000	530 000	9.3	Electric Car
110	110JRJ01	110	200	150	160	625 000	995 000	19.9	Electric Car
110	2J110-2	110	220	180 (80 × 2)	190	875 000	1 370 000	31.6	Electric Car
120	120JRJ01	120	220	180	183	850 000	1 430 000	29.5	Electric Car
120	2J120-1	120	240	180 (80 × 2)	190	935 000	1 450 000	38.1	Electric Car
120	2J120-3M	120	240	180 (80 × 2)	180	935 000	1 450 000	37.2	Electric Car

Type F



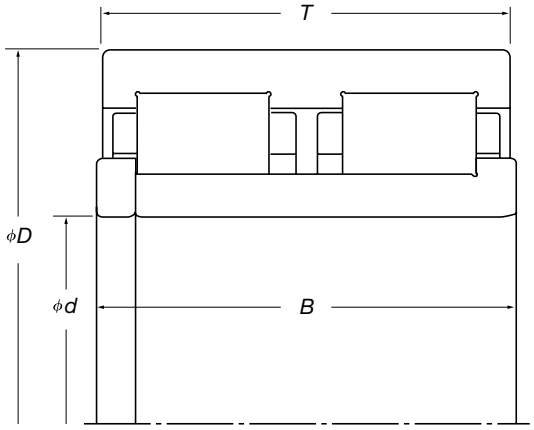
Class	Bearing Number	Dimensions (mm)				Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)	Mass (kg) approx.	Main Application
		d	*D*	*T*	*B*				
110	2J110-1	110	225	70 × 2	150	935 000	1 430 000	28.4	Electric Car
120	120JRJ02A	120	240	160	180	935 000	1 450 000	36.0	Electric Car

Type G



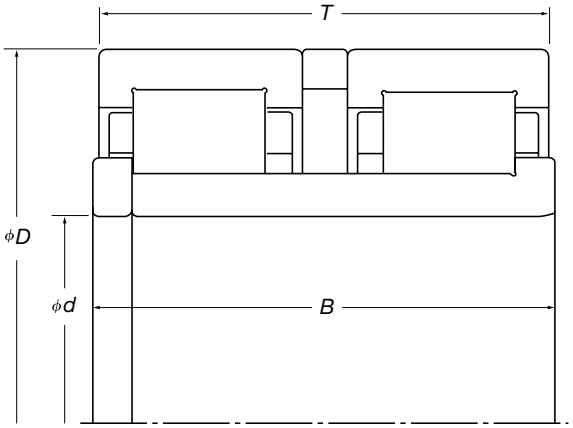
Class	Bearing Number	Dimensions (mm)				Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)	Mass (kg) approx.	Main Application
		d	*D*	*T*	*B*				
110	2M110-3A	110	220	160	154	875 000	1 370 000	28.9	Electric Car
120	2M120-9	120	240	180	185	935 000	1 450 000	38.7	Electric Car
120	120JRF02	120	220	160	165	850 000	1 430 000	28.0	Electric Car
130	2M130-1	130	270	153	135	820 000	1 140 000	39.2	Electric Car
150	2M150-3	150	270	153	135	790 000	1 220 000	35.3	— (Canada)

Type H



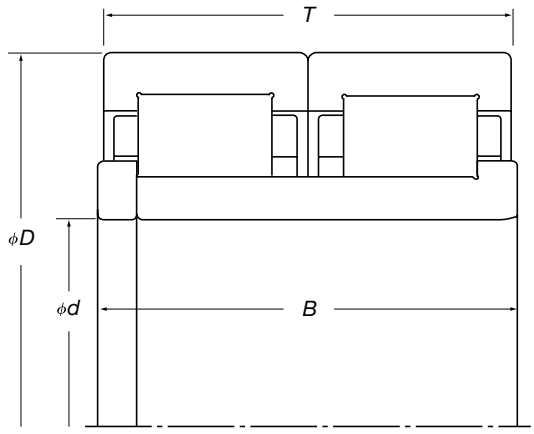
Class	Bearing Number	Dimensions (mm)				Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)	Mass (kg) approx.	Main Application
		d	*D*	*T*	*B*				
130	JC14	130	260	160	160	1 140 000	1 840 000	46.6	Diesel Locomotive

Type I



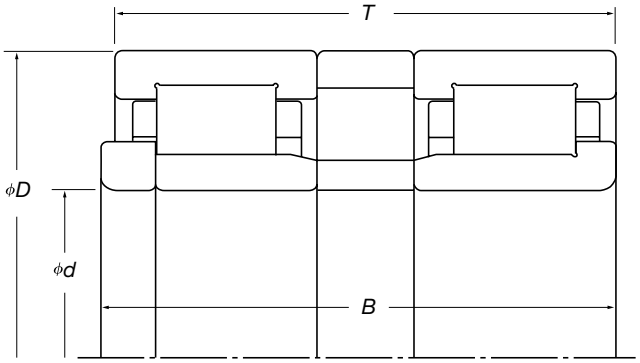
Class	Bearing Number	Dimensions (mm)				Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)	Mass (kg) approx.	Main Application
		d	*D*	*T*	*B*				
95	95JRT01	95	190	125	130	800 000	1 340 000	15.7	Electric Car
95	95JRT02	95	170	115	125	440 000	685 000	11.4	Electric Car
100	2O100-1	100	200	170	170	650 000	1 030 000	24.8	Electric Car
110	JC6K	110	220	172	180	790 000	1 190 000	30.5	Freight Car (Thailand)
110	2O110-1	110	220	180	185	875 000	1 370 000	31.8	Electric Car
120	JC12	120	240	176	180	1 020 000	1 580 000	38.1	Electric Car
120	JC34	120	230	165	170	945 000	1 460 000	31.0	Shinkansen
120	JC35	120	225	165	170	875 000	1 380 000	30.0	Shinkansen
120	120JRT01	120	240	180	185	935 000	1 450 000	37.8	Electric Car
120	120JRT04	120	220	160	165	810 000	1 340 000	28.3	Electric Car
120	2O120-4	120	240	180	185	935 000	1 450 000	38.1	Electric Car
120	2O120-11	120	220	180	183	850 000	1 430 000	29.8	Electric Car
120	2O120-12	120	220	180	185	850 000	1 430 000	29.9	Electric Car
125	JC38	125	235	165	170	945 000	1 470 000	32.1	Shinkansen
130	JC21	130	260	180	205.5	1 030 000	1 610 000	46.0	Electric Car
130	JC37	130	265	166	166	1 140 000	1 700 000	43.4	Shinkansen
130	130JRT01	130	260	180	185	1 030 000	1 610 000	45.6	Electric Car
130	130JRT08	130	235	165	170	895 000	1 520 000	32.1	Electric Car (Korea)
130	2O130-6	130	260	180	185	1 030 000	1 610 000	45.7	Electric Car
130	2O130-7	130	240	180	185	915 000	1 490 000	35.3	Electric Car
140	2O140-1	140	250	155	160	865 000	1 480 000	33.5	Electric Car
170	170JRT01	170	340	230	230	1 660 000	2 760 000	99.4	Locomotive (Prototype)

Type J



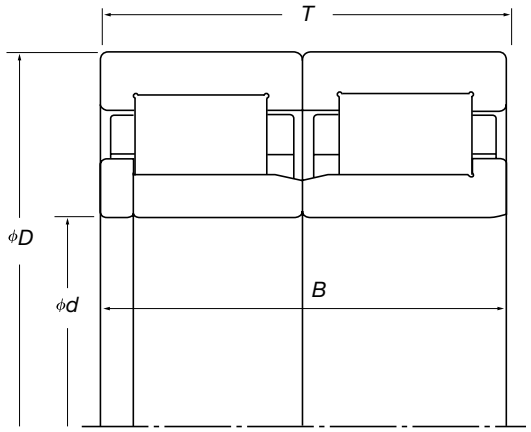
Class	Bearing Number	Dimensions (mm)				Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)	Mass (kg) approx.	Main Application
		d	*D*	*T*	*B*				
120	JC27X	120	230	150	177	935 000	1 440 000	30.3	Electric Car
120	JC400K	120	230	150	177	885 000	1 340 000	30.6	Electric Car

Type K



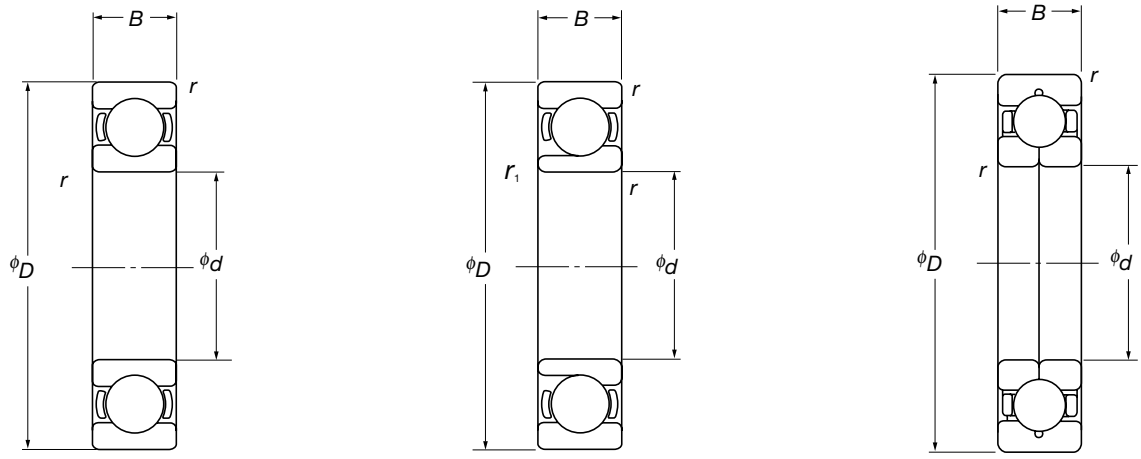
Class	Bearing Number	Dimensions (mm)				Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)	Mass (kg) approx.	Main Application
		d	*D*	*T*	*B*				
130	J130-5/U130-5DB+KL38	130	240	198 (80 × 2)	204	880 000	1 450 000	38.3	— (India)

Type L



Class	Bearing Number	Dimensions (mm)				Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)	Mass (kg) approx.	Main Application
		d	*D*	*T*	*B*				
110	J110-2/U110-4DB	110	215	73 × 2	73 × 2	800 000	1 240 000	25.4	Freight Car (Indonesia)
120	J120-1C/U120-2C	120	240	80 × 2	80 × 2	960 000	1 500 000	35.1	— (China)
120	J120-1D/U120-2D	120	240	80 × 2	80 × 2	960 000	1 500 000	35.4	— (Turkey)
120	42724T/152724T	120	240	80 × 2	80 × 2	910 000	1 400 000	35.1	Passenger Car (China)
130	JC130M	130	250	160	160	1 030 000	1 610 000	38.0	Passenger Car (CCCP), Freight Car (CCCP)
130	42726T/152726T	130	250	80 × 2	80 × 2	103 000	1 610 000	36.9	Passenger Car (China)
130	J130-3/U130-4	130	250	80 × 2	80 × 2	103 000	1 610 000	37.1	— (China)
150	J150-5/U150-2	150	270	160 (80 × 2)	160 (80 × 2)	1 020 000	1 700 000	41.0	Rolling Stock for Steel Plants

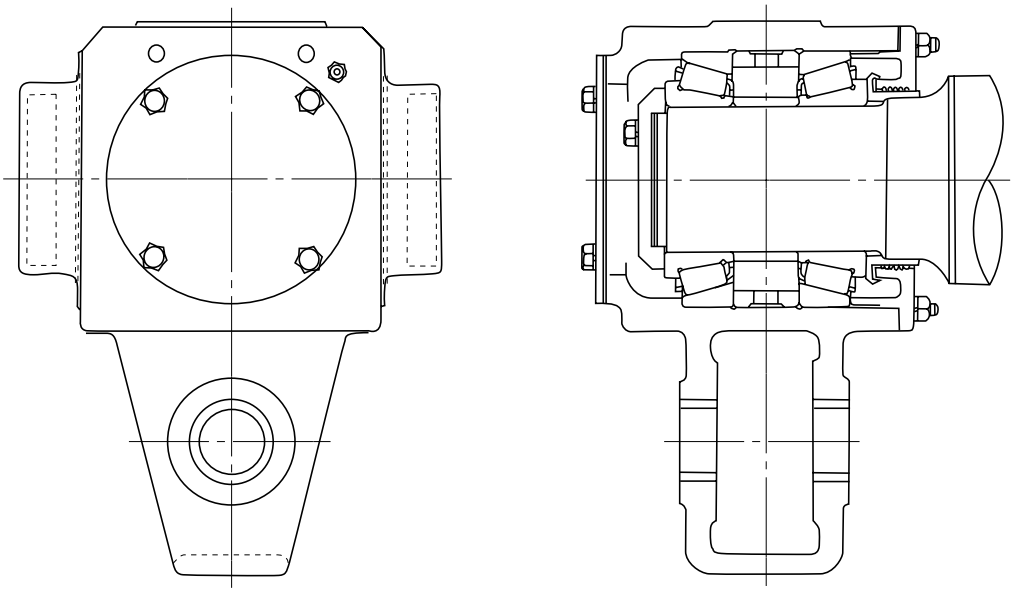
Table of Ball Bearings for Axial Loads



Class	Bearing Number		Boundary Dimensions (mm)					Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)	Mass (kg) approx.	Examples of Matching Radial Roller Bearings
	Deep Groove	Angular Contact	*d*	*D*	*B*	*r*	r_1				
70	JB8	—	70	150	35	3.5	—	99 500	68 000	2.56	JC2, JC3, JC10
70	JB8A	—	70	150	35	3.5	—	99 500	68 000	2.56	JC2, 2U95-1
70	6314	—	70	150	35	3.5	—	104 000	68 000	2.56	JC11
75	6315	—	75	160	37	3.5	—	113 000	77 000	3.05	2U100, JC1
85	—	JB1D	85	180	41	4.0	2.0	121 000	93 000	4.30	JC2, JC11
85	—	JB1E	85	180	41	4.0	2.0	141 000	116 000	4.80	JC2, JC11
100	6220	—	100	180	34	3.5	—	122 000	93 000	3.15	2U110, 2U130, JC1
100	—	JB2	100	215	47	4.0	2.0	170 000	138 000	6.60	2U140
100	6320	—	100	215	47	4.0	—	173 000	141 000	7.00	JC5
110	—	JB3	110	215	47	4.0	2.0	165 000	142 000	6.40	JC5
110	—	JB5*	110	215	47	4.0	—	179 000	167 000	6.80	JC5
125	JB4	—	125	260	55	4.0	—	207 000	185 000	13.0	JC9
125	JB9	—	125	250	55	4.0	—	186 000	162 000	11.9	JC29

* Four-point contact ball bearing

Sponsored by Hitachi, Ltd.



Moroccan Railways, DC Electric Locomotive, Series E1200

Bearing Numbers: 32230 WADB + KL65C3

Tapered roller bearings can carry radial and axial loads simultaneously and therefore permit compact design of the bearing and its adjacent parts. This type of bearing, however, requires precise internal clearance adjustment in order to perform properly.

Tapered roller bearings are used either in sets of two, or in a double-row configuration in which there is one outer ring or one inner ring for the two rows of rollers. There are two types of duplex arrangements: back-to-back and face-to-face, as shown in Figs. 1-14 and 1-15, respectively. For rolling stock axle applications where heavy moment loads are expected, the back-to-back arrangement, which provides a greater distance between load centers ($l_1 > l_2$), is preferable.

When the rollers are rolling under load, part of their load is transferred to the large rib of the inner ring. The rollers maintain sliding contact with and are guided by the rib. This results in the friction coefficient of these bearings being higher than that of cylindrical bearings. Recently, however, improvements in surface roughness and contact geometry have virtually eliminated the friction problems associated with tapered roller bearings for axles.

This type of axle bearing can be designed with a sealed arrangement between the rear cover and the bearing box or, as described in the section on RCT bearings, they can have an internally sealed construction.

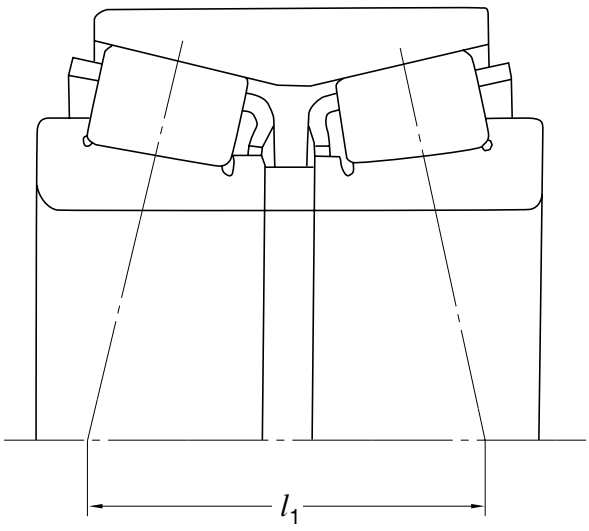


Fig. 1-14 Back-to-Back Arrangement

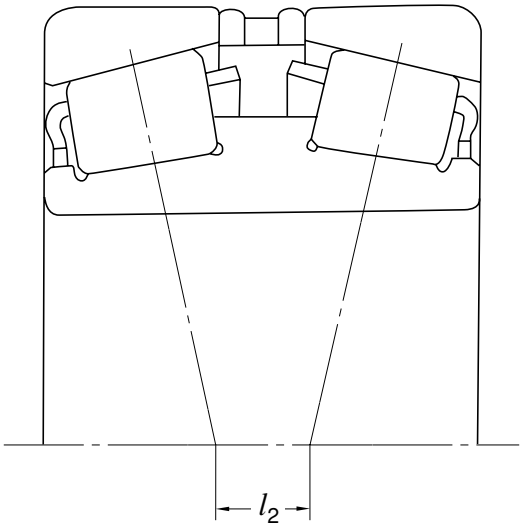
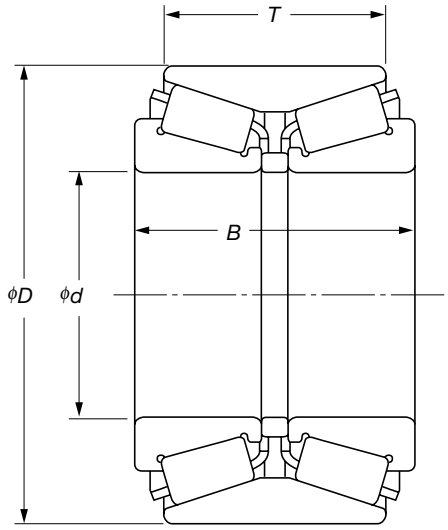
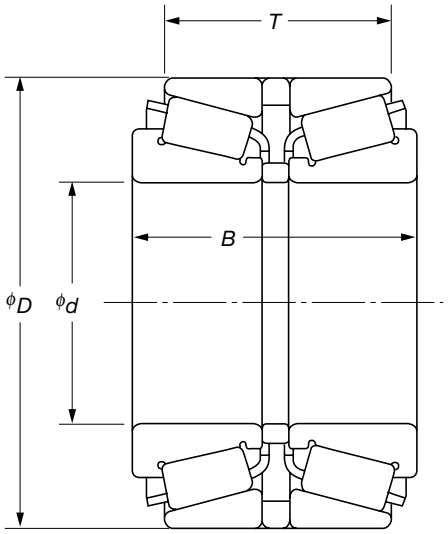


Fig. 1-15 Face-to-Face Arrangement

Tapered Roller Bearing Table



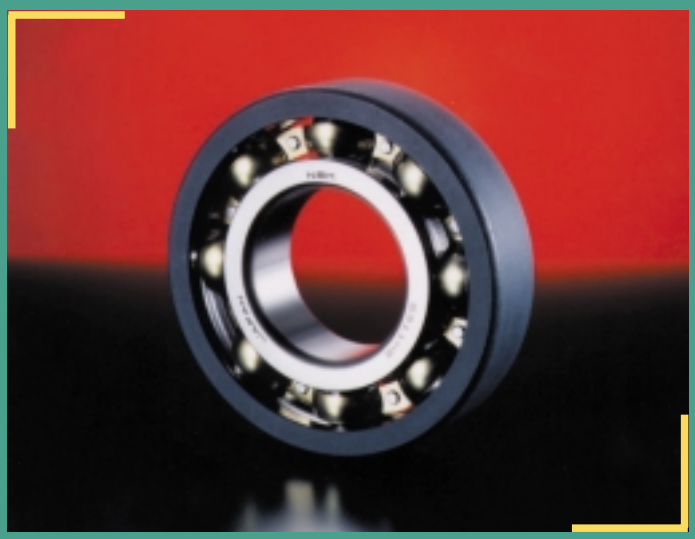
Type A



Type B

Class	Bearing Number	Bearing Type	Boundary Dimensions (mm)				Basic Dynamic Load Rating		Basic Static Load Rating		Mass (kg) approx.	Main Application
			d	*D*	*T*	*B*	(N)	(lbf)	(N)	(lbf)		
110	110KBE2201+L	A	110	220	115	145	820 000	184 000	1 350 000	305 000	23.6	Rolling Stock for Steel Plants
120	120KBE2001+L	A	120	200	84	100	515 000	116 000	885 000	199 000	11.3	Rolling Stock for Steel Plants
120	120KBE52X+L	A	120	215	109	132	720 000	161 000	1 170 000	264 000	18.3	Rolling Stock for Steel Plants
120	JT21	A	120	220	130	155	860 000	194 000	1 480 000	335 000	23.5	Shinkansen
130	130KBE2302+L	A	130	230	115	145	850 000	191 000	1 480 000	330 000	23.4	Rolling Stock for Steel Plants
140	140KBE2302+L	A	140	230	110	140	820 000	185 000	1 550 000	350 000	20.5	Rolling Stock for Steel Plants
140	140KBE2701A+L	A	140	270	95	120	870 000	195 000	1 440 000	325 000	29.3	Rolling Stock for Steel Plants
140	JT8	B	140	280	170	210	1 170 000	263 000	1 920 000	435 000	50.0	Electric Locomotive
150	150KBE2502+L	A	150	250	95	115	745 000	168 000	1 320 000	296 000	20.2	Rolling Stock for Steel Plants
160	160KBE2701A+L	A	160	270	120	140	990 000	222 000	1 880 000	425 000	31.0	Rolling Stock for Steel Plants
170	170KBE2802A+L	A	170	280	130	150	1 110 000	249 000	2 160 000	485 000	33.3	Rolling Stock for Steel Plants
180	180KBE3401+L	A	180	340	140	180	1 410 000	320 000	2 510 000	565 000	68.1	Rolling Stock for Steel Plants

Bearings for Traction Motors



Bearings for Traction Motors

Sponsored by The Ministry of Railways, P.R.China

The Ministry of Railways, P.R.China,
DC Electric Locomotive, Series SS8

Bearing Number: NU332E-TM0101 (Loaded Side)
NH322E-TM0101 (Non-Loaded Side)

Characteristics and Recent Trends of Traction Motor Bearings

1) Characteristics of Bearings

Characteristically, the bearings for a traction motor perform high-$d_m n$ revolution, with frequent starts and stops, while carrying radial load equivalent to the mass of the rotor shaft of the traction motor. The weight of the coupler is added to the radial load when the motor is used in a parallel Cardan device, and the reaction force of the mating gears is added when the motor is suspended by a nose suspension device. The radial load further includes dynamic components arising from the vibration of the bogie during operation.

Bearings and the grease they contain can be affected by heat generated by the traction motor during operation. Compared with other rolling stock bearings, traction motor bearings are most liable to be affected by heat.

2) Characteristics of Recent Traction Motors

Recent electric trains have VVVF-controlled AC motors in place of conventional DC motors. More compact and lighter, these AC motors rotate faster than conventional motors. In response to the higher speed and operating temperature, the bearings and grease have improved speed capability, heat resistance and durability in comparison to bearings used in conventional motors. Specific improvements to these bearings include a better cage-guiding system that reduces deterioration of the grease, improved insulation to protect bearings from electrical pitting and greater dimensional stability through specialized heat treatment.

Types of Traction Motor Bearings

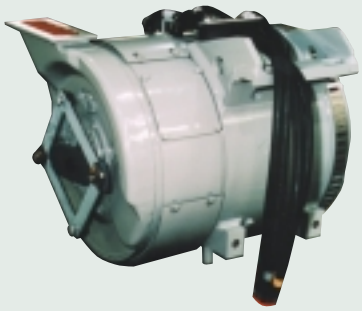
Depending on how the traction motor is mounted on the bogie, the arrangement of the bearings is different.

1) Nose Suspension Type

In electric locomotives equipped with a high-output traction motor, the motor is mounted in a nose suspension, and its armature transmits its rotation power via a pinion directly connected to it (Fig. 3-1, P51). Traction motor bearings are operated under high load with occasional impact loads caused by the reaction force of mating gears. An NU-type cylindrical roller bearing is used on the loaded side of the motor, and an NH- or NUP-type cylindrical roller bearing capable of carrying axial loads is used on the non-loaded side. The bearings are in diameter series 3 and have high load-carrying capacity. Cylindrical roller bearings offer the advantage of easy disassembly, inspection and reassembly for maintenance.

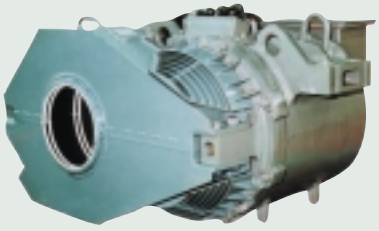
2) Cardan Drive Type

The improved performance and reduced size and weight of traction motors have permitted them to be mounted on bogies in Cardan systems. In conventional electric trains, traction motors are mounted in parallel Cardan systems using torsion shafts (Fig. 3-2, P51), and, for *Shinkansen* or standard-gauge trains, using gear couplings (Fig. 3-4, P51). In this parallel Cardan system, the coupling, which is interposed between the traction motor and the gear, eliminates the reaction force of the mating gears on the bearings. Recently, as the mass of the rotors has been reduced, cylindrical roller bearings of diameter series 3 or 2 with smaller thicknesses have been used on the loaded side, and deep groove ball bearings on the non-loaded side.



DC Motor for Electric Car

AC Motor for Electric Car



AC Motor for Electric Locomotive

Sponsored by TOSHIBA CORPORATION

Specifications for New Traction Motor Bearings

1) Dimension Stabilizing Heat Treatment

To control variations in the dimensions and internal clearances of traction motor bearings caused by temperature rise during operation, a special heat treatment known as dimension stabilizing heat treatment is applied to the bearings.

2) Improvement in Cage Guide System

The cage of a rotating bearing is guided by the bore surface of the outer ring (outer ring-guided), or by the rolling elements (rolling element-guided). When the cage is outer ring-guided, the cage is in sliding contact with the bore surface of the outer ring. If lubrication becomes insufficient due to deterioration of grease or electrical pitting, the guiding surface of the cage and the bore surface of the outer ring are prone to wear. On the other hand, when the cage is rolling element-guided, better lubrication is maintained in the sliding contact interfaces between the cage and rolling elements. This helps to prevent grease deterioration even when lubricating conditions are less favorable. Lately, owing to advances in cage manufacturing technology and for greater cost efficiency, rolling element-guided cages are increasingly used in traction motor bearings.

3) Development of Insulated Bearings

Insulating bearings is the most reliable method for preventing electrical pitting. Bearing insulation can be achieved by coating the outer diameter and end face surfaces of the bearing outer ring with an insulating material such as alumina ceramics or PPS (polyphenylene sulfide). Ceramics are applied by thermal spraying and PPS by injection molding.

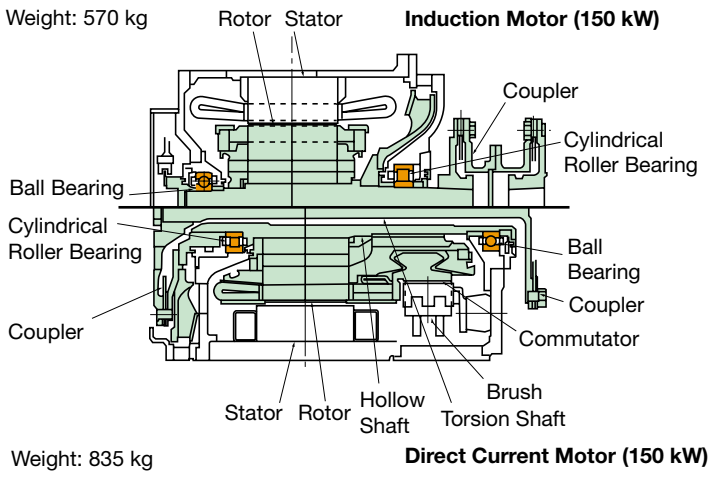


Fig. 2-1 Comparison between Induction Motor and Direct Current Motor

In Japan, ceramic-insulated bearings were adopted for the traction motors of the *Shinkansen* 300 Series, and since then, have been increasingly used in newer generation *Shinkansen* trains.

PPS is a resin that is easy to mold and has good heat resistance, dimensional stability and heat conductivity. For use as bearing insulation, its toughness is improved by adding fiberglass. While its physical properties are slightly inferior to alumina, PPS is less expensive. PPS-coated insulated bearings are used in many of the newly built conventional trains equipped with AC traction motors.

4) Use of Heat-Resistant Grease

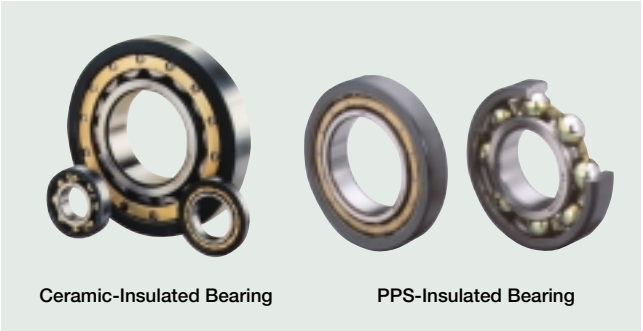
Lithium grease has been used in DC motor bearings for many years. With the recent trend toward the replacement of DC traction motors with AC motors, a lithium-complex soap grease was developed to achieve higher heat resistance and durability. This new type of grease, Unimax R No. 2, is used extensively in AC traction motor bearings for *Shinkansen* 300 Series trains as well as newly manufactured trains for conventional railroad lines.

Bearings for Motor Generators

Even though motor generators are already larger than other electrical auxiliary equipment in railcars, they are becoming even larger because of the need for air-conditioning systems. The operating conditions for motor generator bearings are just as severe as for traction motors and include:

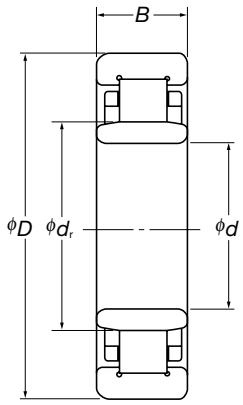
1. High ambient temperature
2. High speed with grease lubrication and a long interval for overhaul
3. High vibration

Sealed bearings are commonly used in motor generators.

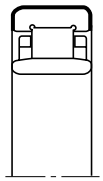


Ceramic-Insulated Bearing PPS-Insulated Bearing

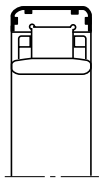
Table on Bearings for Electric Car Traction Motors



Non-Insulated

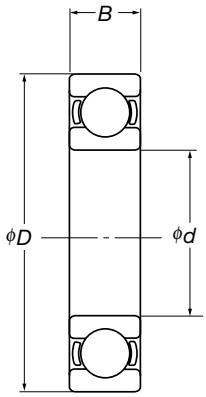


Ceramic-Insulated

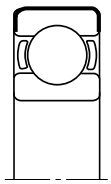


PPS-Insulated

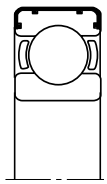
Cylindrical Roller Bearing



Non-Insulated



Ceramic-Insulated

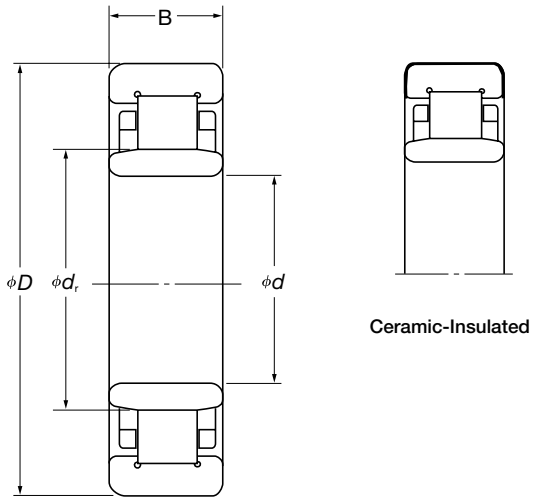


PPS-Insulated

Ball Bearing

Loaded Side, Cylindrical Roller Bearings	Boundary Dimensions (mm)				Non-Loaded Side, Ball Bearings	Boundary Dimensions (mm)		
	d	*D*	*B*	d_r		d	D	B
NU212	60	110	22	73.5	6310	50	110	27
NU312	60	130	31	77	6310	50	110	27
NU213	65	120	23	79.6	6310	50	110	27
NU313	65	140	33	83.5	6311	55	120	29
NU214	70	125	24	84.5	6310 6311	50 55	110 120	27 29
NU314	70	150	35	90	6311	55	120	29
NU215	75	130	25	88.5	6311 6312	55 60	120 130	29 31
NU315	75	160	37	95.5	6311 6312 6314	55 60 70	120 130 150	29 31 35
NU415	75	190	45	104.5	6313	65	140	33
NU216	80	140	26	95.3	6312	60	130	31
NU316	80	170	39	103	6312	60	130	31
NU416	80	200	48	110	6313	65	140	33
NU217	85	150	28	101.8	6217	85	150	28
NU218	90	160	30	107	6218	90	160	30
NU219	95	170	32	113.5	6219	95	170	32

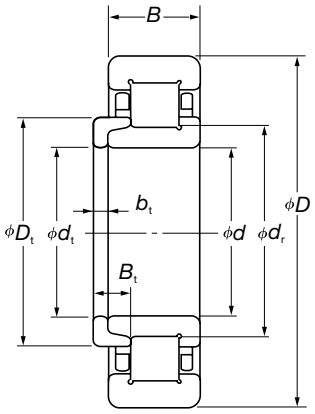
Tables on Bearings for Electric Locomotive Traction Motors



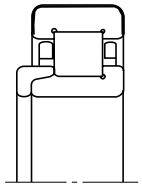
Cylindrical Roller Bearing (NU Type)

Boundary Dimensions (mm)				Basic Number	Internal Design(1)	Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)	Mass (kg) approx.
d	*D*	*B*	d_r					
90	190	43	113.5	NU318	E	315 000	355 000	6.1
90	225	54	123.5	NU418	—	375 000	400 000	11.5
100	180	46	119	NU2220	EA	320 000	425 000	5.3
100	215	47	127.5	NU320	E	380 000	425 000	8.6
105	260	60	144.5	NU421	—	495 000	555 000	17.3
110	240	50	143	NU322	E	425 000	485 000	11.5
120	215	40	143.5	NU224	E	320 000	395 000	6.3
120	260	55	154	NU324	E	530 000	610 000	15.0
130	280	58	167	NU326	—	560 000	665 000	18.1
			165		B	655 000	795 000	18.8
			167		E	615 000	735 000	18.2
140	300	62	180	NU328	E	665 000	795 000	22.3
			178		F	705 000	860 000	22.9
150	320	65	193	NU330	E	760 000	920 000	27.1
			193		EA	715 000	855 000	26.8
			190.5		J	800 000	985 000	27.3
			190		L	790 000	970 000	27.5
160	340	68	208	NU332	—	700 000	875 000	31.5
			204		E	860 000	1 050 000	31.5
180	380	75	231	NU336	E	985 000	1 230 000	43.5

Note (1) E, EA: High Capacity Type B, L, J: Specific Types, respectively

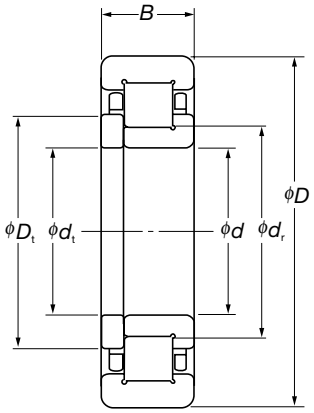


Non-Insulated



Ceramic-Insulated

Cylindrical Roller Bearing (NH Type)



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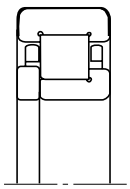


Ceramic-Insulated

Cylindrical Roller Bearing (NUP Type)

Boundary Dimensions (mm)								Basic Number	Internal Design[1]	Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)	Mass (kg) approx.
d	D	B	d_r	d_t	D_t	B_t	b_t					
60	130	31	77	60	84.2	15.5	9	NH312	—	124 000	126 000	2.3
65	140	33	83.5	65	91	17	10	NH313	—	143 000	151 000	2.9
70	150	35	90	70	98	17.5	10	NH314	—	158 000	168 000	3.4
75	160	37	95.5	75	104.2	18.5	11	NH315	—	190 000	205 000	4.2
			95			16.5			E	240 000	263 000	4.2
75	160	37	95	75	104.2	—	—	NUP315	E	240 000	263 000	3.9
80	170	39	103	80	111.8	19.5	11	NH316	—	201 000	223 000	5.0
			101		110.4	17			E	256 000	282 000	5.0
85	180	41	108	85	117.5	20.5	12	NH317	—	225 000	247 000	5.8
90	190	43	115	90	125	—	—	NUP318	B	240 000	265 000	6.3
			113.5		124.2				E	315 000	355 000	6.3
90	190	43	115	90	125	21	12	NH318	—	240 000	265 000	6.8
			113.5		124.2	18.5			E	315 000	355 000	6.8
100	215	47	129.5	100	140.5	22.5	13	NH320	—	315 000	365 000	9.7
			129.5		140.5	22.4			A	310 000	355 000	9.5
			129.5		140.5	22.5			B	310 000	355 000	9.5
			127.5		139	22.3			E	380 000	425 000	9.6
110	240	50	143	110	155	22	14	NH322	E	425 000	485 000	12.9
120	260	55	154	120	168.5	23.4	14	NH324	—	475 000	550 000	16.6
130	280	58	167	130	182	24	14	NH326	—	560 000	665 000	20.2
					181	23			E	615 000	735 000	20.1

Note ([1]) E: High-Capacity Type A, B: Specific Types, respectively

Interchangeability of Traction Motor Bearings

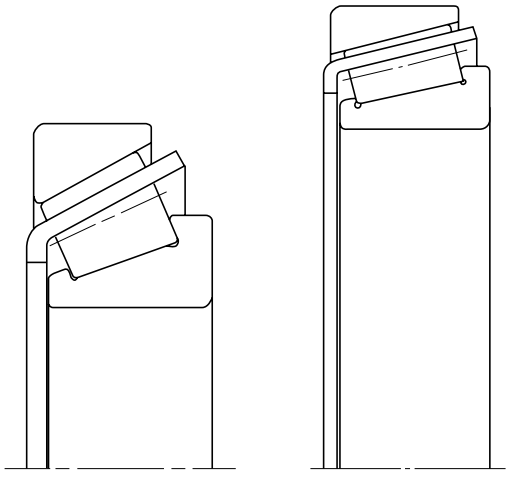
	NSK Bearing Numbers[1]	Internal Clearance	Tolerance Class	Other Maker's Numbers (SKF)
	NU315E-TM0102	C4	P6	NU315ECMC4VA301
	NU316E-TM0101	C4	P6	NU316ECMC4VA301
	NU317E-TM0101	C4	P6	NU317ECMC4VA301
	NU318E-TM0101	C4	P6	NU318ECMC4VA301
	NU320E-TM0102	C4	P6	NU320ECMC4VA301
	NU322E-TM0101	C4	P6	NU322ECMC4VA301
	NU324E-TM0102	C4	P6	NU324ECMC4VA301
	NU326B-TM0113[3]	CG185	P6A	468540VAS
	NU326E-TM0101	C4	P6	NU326ECMC4VA301
	NU328E-TM0102	C4	P6	NU328ECMC4VA301
	NU330E-TM0101	C4	P6	NU330ECMC4VA301
	NU330E-TM1105[2]	C4	P6	NU330ECMRDC4VA301
	NU330J-TM0111	CG205	P6	466830M/W23
	NU332E-TM0101	C4	P6	NU332ECMC4VA301
	NU332EH2[4]-TM0101	C4	P6	NU332ECMC4VA309
	NH312E-TM0101	C4	P6	NH312ECMC4VA301
	NH313E-TM0101	C4	P6	NH313ECMC4VA301
	NH314E-TM0101	C4	P6	NH314ECMC4VA301
	NH315E-TM0102	C4	P6	NH315ECMC4VA301
	NH316E-TM0101	C4	P6	NH316ECMC4VA301
	NH317E-TM0101	C4	P6	NH317ECMC4VA301
	NH318E-TM0101	C4	P6	NH318ECMC4VA301
	NH320E-TM0102	C4	P6	NH320ECMC4VA301
	NH320B-TM0312[3]	CG153	P6A	NH320M2/W23B/W83
	NH320EH2[4]-TM0102	C4	P6	NH320ECMC4VA309
	NH322E-TM0101	C4	P6	NH322ECMC4VA301
	NH324E-TM0102	C4	P6	NH324ECMC4VA301
	NH324E-TM0105[2]	C4	P6	NH324ECMRDC4VA301
	NH326E-TM0101	C4	P6	NH326ECMC4VA301
	NH328E-TM0102	C4	P6	NH328ECMC4VA301

Notes (1) E: High-Capacity Type B, J: Specific Types, respectively
(2) One-Piece Roller Drop Type
(3) Two-Piece Roller Drop Type
(4) Ceramic-Insulated Type

Gear Unit Bearings

Gear Unit Bearings

Sponsored by NIPPON SHARYO, LTD.



Tuy Medio Line of Venezuela (IAFE),
Series 2000 Suburban EMU for Caracas

Bearing Numbers: 30314DAQWAP6A (Pinion Side)
32944QWASA (Gear Side)

Characteristics and Types of Gear Unit Bearings

Gear unit bearings are used to facilitate the smooth transmission of rotating force to the axles under vibration during train operation. The bearings are usually operated under harsh conditions. The reaction forces from the mating gears as well as the inertia force of the pinion shaft and the gearbox are applied to the gear bearings. Gear unit bearings are most often lubricated by an oil bath whose oil is splashed by the gears as they turn. Pinion bearings, however, are located higher up in the gearbox and their lubrication is generally more difficult.

For gears and pinions, pairs of single-row tapered roller bearings are used in combination. Pinion bearings are used in face-to-face arrangements on the traction motor side and wheel side, while gear bearings are arranged either back-to-back or face-to-face depending on the type of coupling.

Specifications for New Gear Unit Bearings

1) Improved Cage Strength

Stresses generated in portions of the cage by vibration during train operation increase as the train runs faster. The cage is required to have higher fatigue strength to resist these stresses. Particularly for *Shinkansen* trains, cage stress was reduced by increasing the thickness of the cage sheet. Also, the fatigue strength and wear resistance of the cage were increased by nitriding the cage surfaces, increasing the reliability of cages for gear unit bearings.

2) Dimension Stabilizing Heat Treatment

When used to support gears on *Shinkansen* trains operated continuously at high speeds, the bearings are subjected to high temperature rise caused by the agitation of the lubricating oil. They are also prone to creep in the inner ring due to expansion of the inner ring bore diameter after extended operation. To prevent creep, the bearing inner ring is specially heat treated for dimensional stabilization.

3) Measures to Prevent Rib Seizure

In tapered roller bearings, seizure may occur between the inner ring rib and roller end faces because of excessive thrust force at high speeds. Improvements in surface roughness and geometry, combined with advances in gearbox design and lubricating conditions, have been applied to NSK bearings to prevent such rib seizure.

Driving Gear Bearings for Diesel Vehicles

Diesel railway cars and locomotives use three power transmission methods:

1. Direct drive or mechanical transmission (Fig. 3-5)
2. Electrical transmission (Fig. 3-6)
3. Hydraulic transmission (Fig. 3-7)

Presently, electrical and hydraulic transmission systems are mainly used because they allow higher speeds, greater power and easier control.

In the case of electrical transmission, electricity generated by a diesel engine drives the traction motor. The driving method of the traction motor is the same as in electric vehicles. The operating conditions for the reduction gears and reverse gears of the hydraulic and direct-drive systems are similar to the gear units in electric vehicles. However, hydraulic drive applies complex gear systems for changing speed and direction using many kinds of bearings. Customers therefore require that bearings have minimal maintenance requirements.

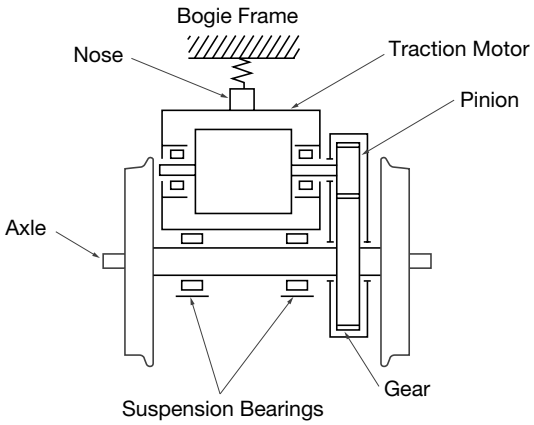


Fig. 3-1 Nose Suspension Drive System

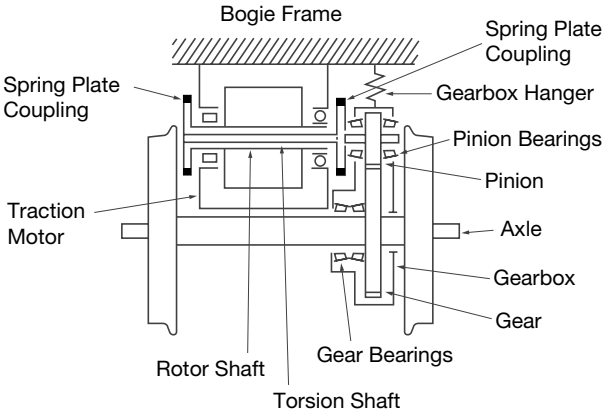


Fig. 3-2 Cardan Drive System with Hollow Shaft Motor

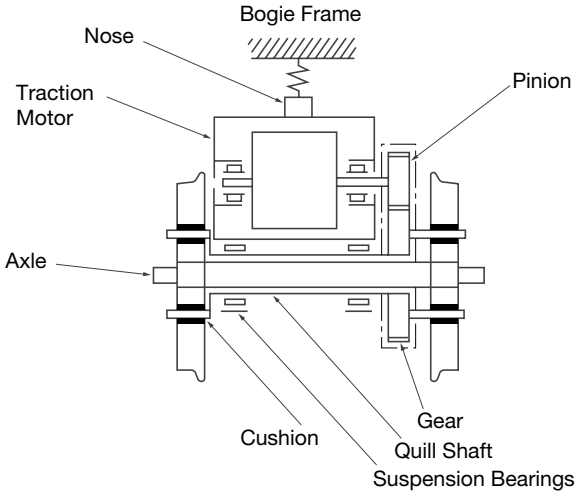


Fig. 3-3 Quill Drive System

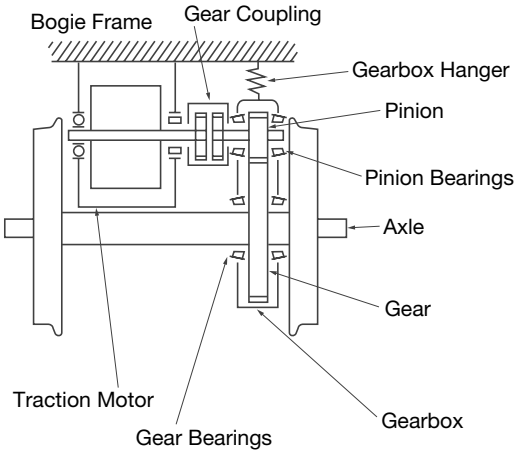


Fig. 3-4 Gear Coupling Drive System

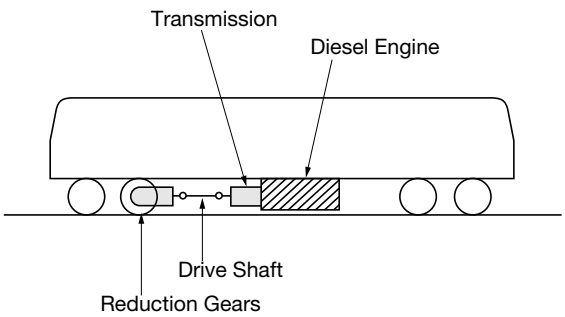


Fig. 3-5 Diesel Direct-Drive or Mechanical Transmission

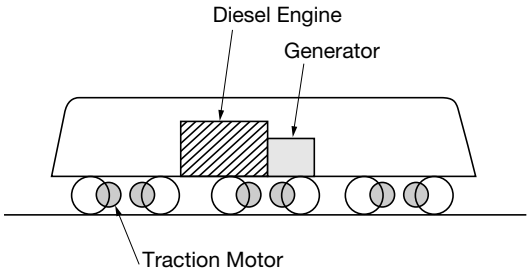


Fig. 3-6 Diesel Electric Transmission

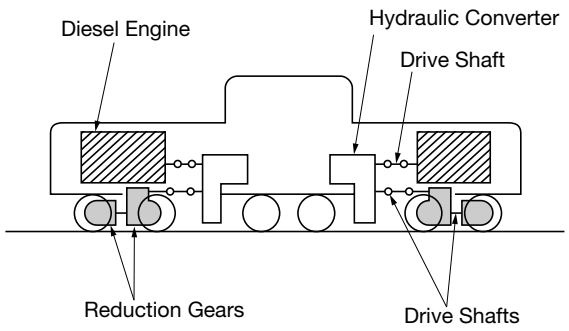


Fig. 3-7 Diesel Hydraulic Transmission

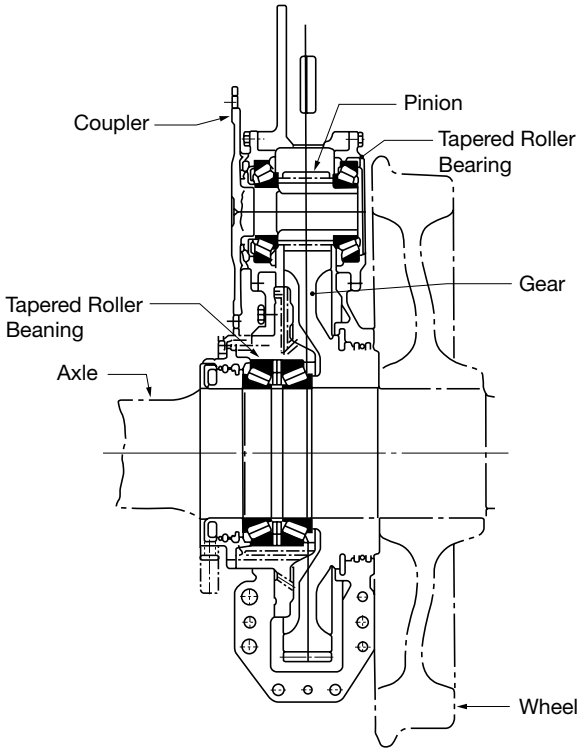


Fig. 3-8 Cardan Drive System with Hollow Shaft Motor

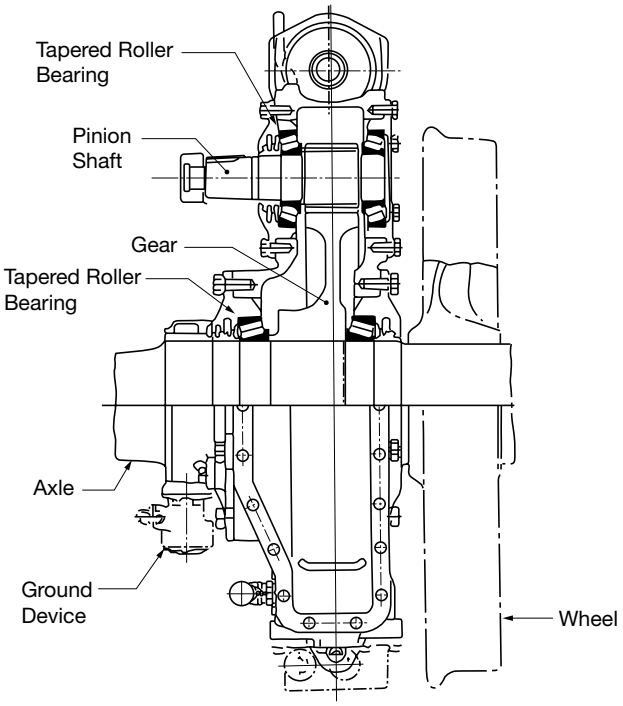
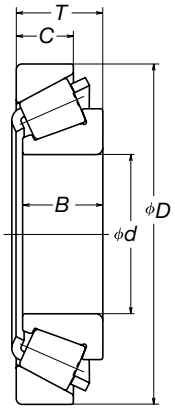


Fig. 3-9 Cardan Drive System with Gear Coupling

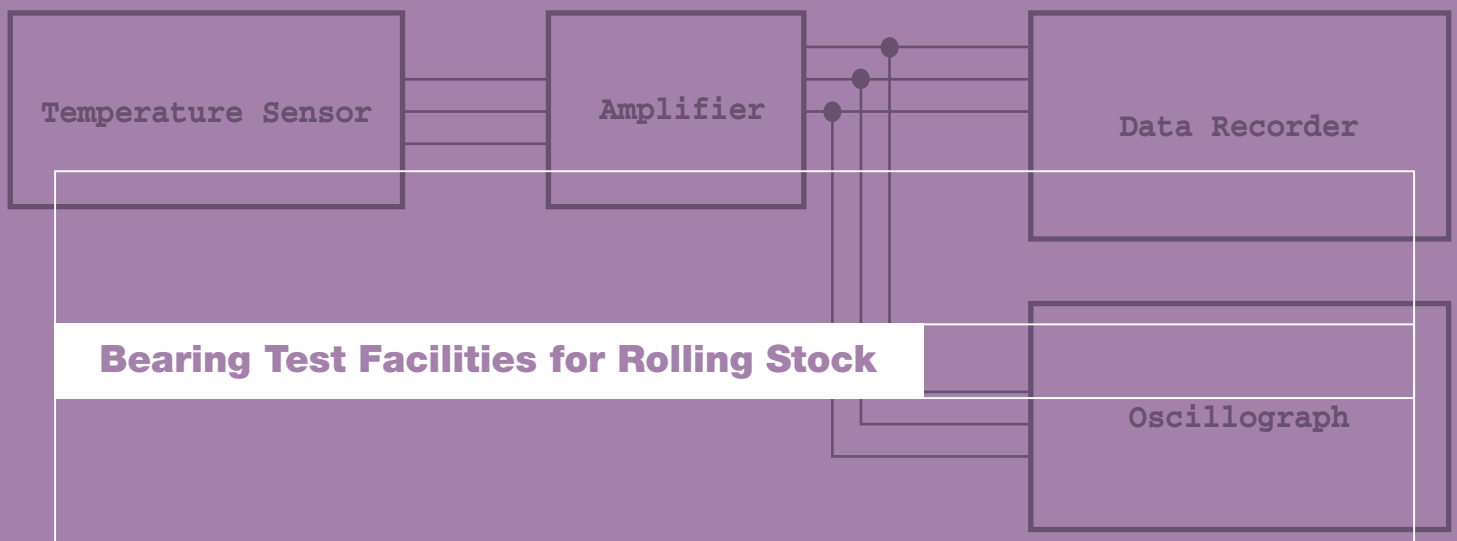
Table on Tapered Roller Bearings for Gear Units

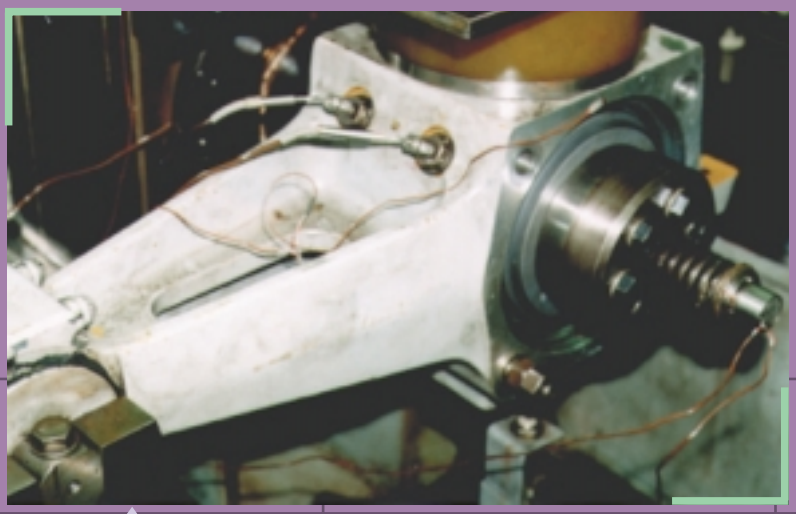


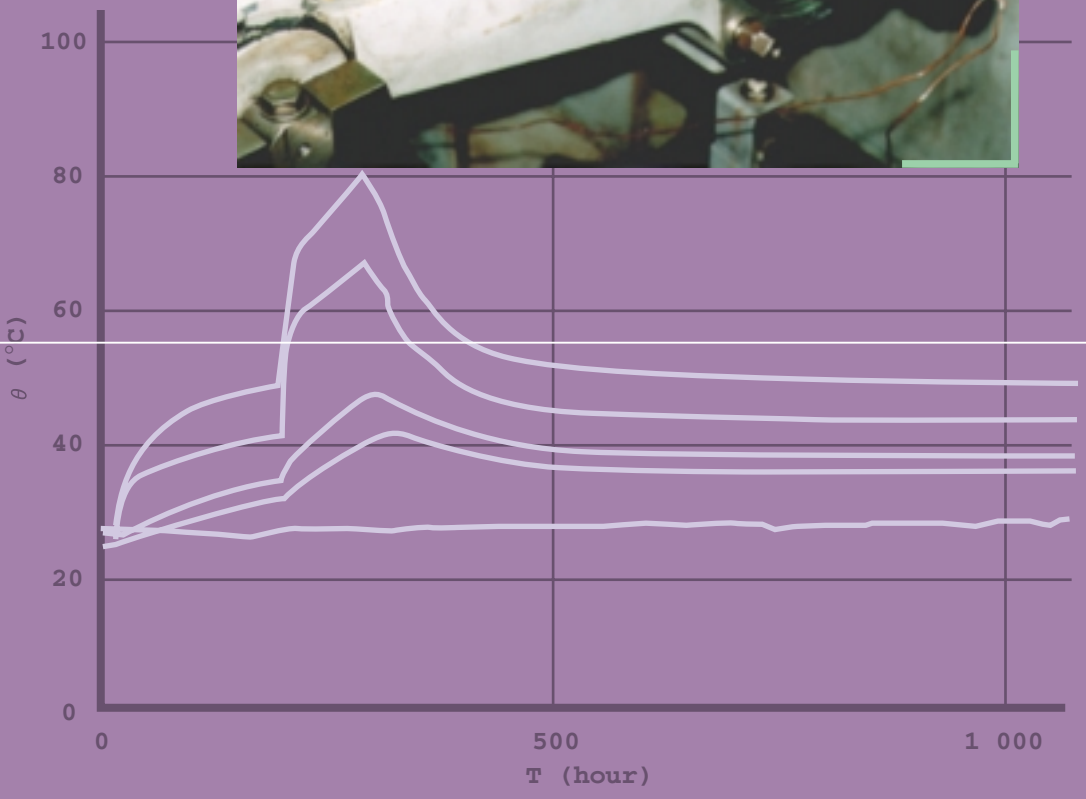
Bearing Number	Boundary Dimensions (mm)					Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)	Application(2)
	d	D	T	B	C			
QT30	60	130	33.5	31	22	127 000	139 000	Gear (P)
30312DQWAP6	60	130	33.5	31	22	127 000	139 000	Gear (P)
30313DQWAP6U1	65	140	36	33	23	147 000	163 000	Gear (P)
QT31	70	150	40	37	27	172 000	198 000	Gear (P)
QT9	70	150	38	35	25	165 000	185 000	Gear (P)
QT9A	70	150	38	35	25	165 000	185 000	Gear (P)
QT9B-1	70	150	38	35	25	165 000	185 000	Gear (P)
QT9B-2	70	150	38	35	25	165 000	185 000	Gear (P)
QT9C	70	150	38	35	25	165 000	185 000	Gear (P)
30314QWAP6	70	150	38	35	30	194 000	218 000	Gear (P)
30314DAQWAP6A	70	150	38	35	25	165 000	185 000	Gear (P)
QT7	75	160	40	37	27	189 000	224 000	Gear (P)
QT7A	75	160	40	37	27	189 000	224 000	Gear (P)
QT20X	75	160	40	37	31	197 000	215 000	Reverse gears
30315QWAP6	75	160	40	37	31	209 000	233 000	Gear (P)
30315DXQWAP6	75	160	40	37	26	189 000	224 000	Gear (P)
QT4	80	170	42.5	39	28	208 000	241 000	Gear (P)
QT4A	80	170	42.5	39	28	208 000	241 000	Gear (P)
30316QWAP6	80	170	42.5	39	33	235 000	265 000	Gear (P)
30316DXQU18	80	170	42.5	39	27	208 000	241 000	Reduction gears
QT18	85	180	45.5	42	29	244 000	285 000	Gear (P)
30317QWAP6A	85	180	44.5	41	34	262 000	300 000	Gear (P)
30317DQWAP6A	85	180	44.5	41	29	233 000	269 000	Gear (P)
30318	90	190	46.5	43	36	305 000	360 000	Reduction gears
30319	95	200	49.5	45	38	335 000	400 000	Reduction gears
30320QWAP6A	100	215	51.5	47	39	365 000	435 000	Reduction gears
30322	110	240	54.5	50	42	410 000	475 000	Reduction gears
30328QWAP6	140	300	67.75	62	53	600 000	740 000	Gear (G)
30330	150	320	72	65	55	690 000	860 000	Gear (G)
32030	150	225	48	45	38	340 000	560 000	Gear (G)
32032	160	240	51	48	41	380 000	645 000	Gear (G)
32034	170	260	57	54	46	470 000	830 000	Gear (G)
QT23	180	290	70	70	54	640 000	1 080 000	Reduction gears
QT1(3)	190	280	49	46	36.5	605 000	1 240 000	Gear (G)
QT6	190	300	49	46	36.5	705 000	1 270 000	Gear (G)
32038	190	290	64	60	52	555 000	960 000	Gear (G)
QT26-4	192	280	58	60	41	410 000	780 000	Gear (G)
QT29(1)	193.675	282.575	50.8	47.625	36.513	360 000	600 000	Gear (G)
QT26-2	194	280	58	60	41	410 000	780 000	Gear (G)
QT26	195	280	58	60	41	410 000	780 000	Gear (G)
QT13(3)	200	290	49	46	36.5	625 000	1 330 000	Gear (G)
QT25	200	280	51	48	41	410 000	780 000	Gear (G)
QT27	200	290	55	60	41	410 000	790 000	Gear (G)
32040	200	310	70	66	56	640 000	1 140 000	Gear (G)
QT34	202	290	58	60	41	435 000	855 000	Gear (G)
QT28(3)	202.5	290	49	46	36.5	645 000	1 320 000	Gear (G)
QT33	205	283	51	48	41	415 000	795 000	Gear (G)
QT36	210	290	51	48	41	420 000	810 000	Gear (G)
QT5	210	320	701	66	56	665 000	1 180 000	Gear (G)
QT24	210	320	70	75	56	665 000	1 180 000	Gear (G)
QT19-1	214	330	70	70	56	685 000	1 210 000	Gear (G)
QT35	215	315	65	70	49	595 000	1 130 000	Gear (G)
QT32	218	315	65	70	49	595 000	1 130 000	Gear (G)
32944QWASA	220	300	51	48	41	425 000	855 000	Gear (G)
32052Q	260	400	87	82	71	1 130 000	2 020 000	Gear (G)

Notes (1) Sizes have been converted to millimeters from inches.
(2) Gear (P): Pinion-Side Bearing of Gear Unit, Gear (G): Gear-Side Bearing of Gear Unit
(3) Double-Row Configuration

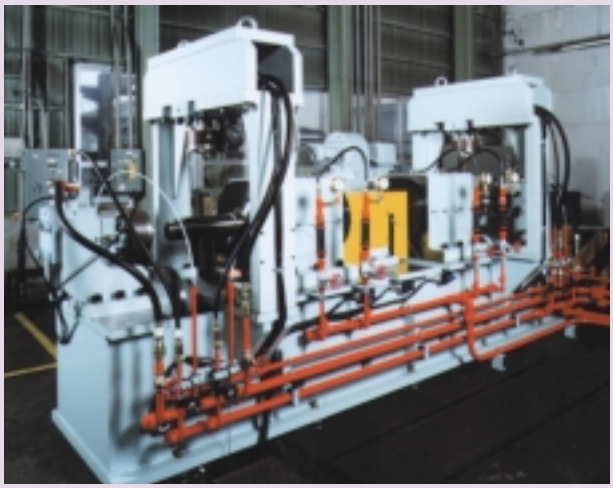
Bearing Test Facilities for Rolling Stock







Bearing Test Facilities for Rolling Stock

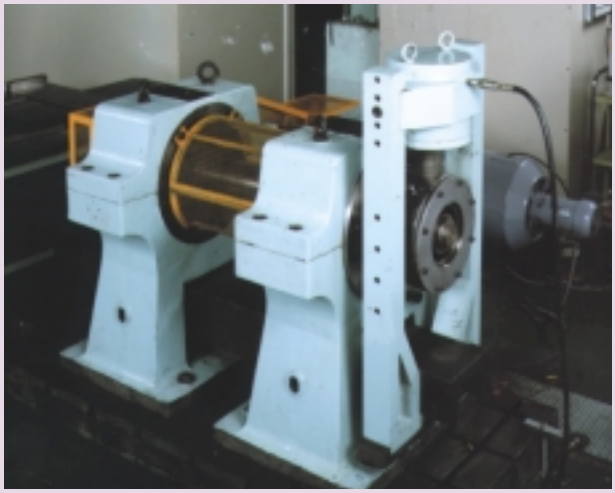


UIC-compliant rotation test equipment for railway axle box bearings

This equipment can test railway axle box bearings based on UIC515-5O standards. It can test two bearings simultaneously under identical conditions and programmed operation including forward and reverse rotation. The loading mechanism utilizes a servo-pulsar and can apply various fluctuating radial and axial loads. Additionally, bearing rotational tests can be conducted by inputting the load data of an actual vehicle. The test equipment can simulate *Shinkansen* conditions and is equipped with a cooling device.

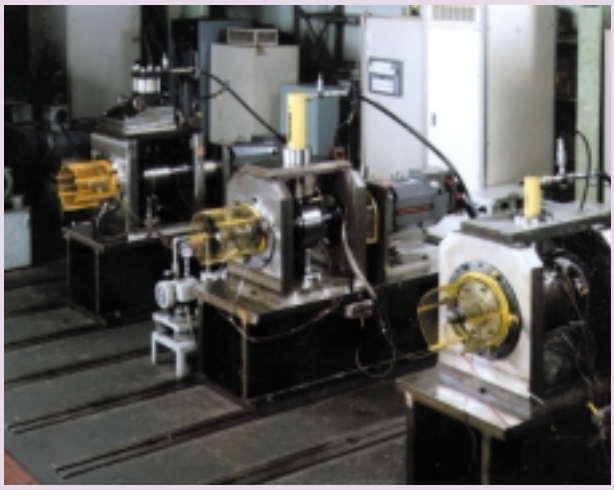
Rotation test equipment for railway axle box bearings

This equipment can test performance and durability for railway axle box bearings using actual axle boxes for bullet trains and conventional trains. It can test programmed operation including forward and reverse rotation and stopping. To create the load conditions of bearings in actual vehicles, radial load can be applied by hydraulic pistons and axial loads can be applied in turn to both rows of a double-row bearing by moving the axle box back and forth with a hydraulic piston. Additionally, replicating cooling conditions during actual running, an air cooling device is included.



Rotation test equipment for bearings for large traction motors

This equipment can test the performance and durability of traction motor bearings for electric locomotives with bores of ϕ150 mm and over. To simulate actual running conditions, programmed operation can be conducted with rapid acceleration to the maximum speed of actual trains under load conditions equivalent to actual vehicles. Additionally, to replicate heat generated by the rotor, high-temperature tests can be conducted.

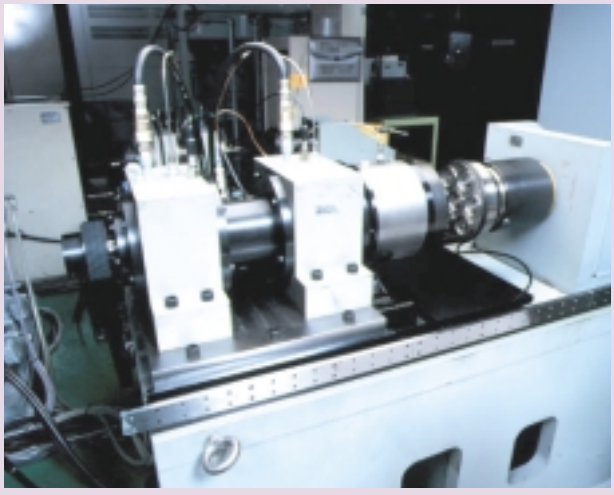


Rotation test equipment for bearings for small traction motors

This equipment can test the performance and durability of electric car traction motor bearings whose bores are ϕ100 mm or less. Simulating actual running conditions of motors and providing the required conditions for pre-delivery motor inspections, programmed operation can be conducted including rapid acceleration to the maximum speed of actual trains under load conditions equivalent to actual vehicles. Additionally, to replicate heat generated by the rotor, high-temperature tests can be conducted. The equipment is used primarily to evaluate bearings under radial load only, but it can also be used to test bearings with a fluctuating axial load. The bearings are usually tested with grease but sometimes with oil.

Drop impact test equipment

This equipment can apply impact loads to a bearing. Applying repeated drop impacts to a bearing is an effective means of evaluating the fatigue strength of the cage. The vibrating acceleration applied to the bearing with each impact can be set by changing the height from which the bearing is dropped.



***PV* test equipment**

This equipment is for testing the performance and durability of gear unit bearings. Bearing starting torque and dynamic torque can be measured during testing. Radial and axial loads are applied to the bearing using hydrostatic bearings. Additionally, accelerated testing on the seizure resistance between the rib and end faces of rollers in tapered or cylindrical roller bearings can be evaluated by creating lubricant-starved conditions.

Notes

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