NTN®

Electric Motor Bearings Handbook

NTN BEARINGS FOR EM ELECTRIC MOTORS

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March 2024

About NTN

Toward the Realization of a "NAMERAKA Society" with Core Technology of Bearings

NTN's global mission is to make the world NAMERAKA - a Japanese word meaning smooth & harmonious -- by developing high quality and innovative bearing solutions to reduce energy loss for industries around the globe. By utilizing our core technology of bearings in a wide range of fields, we will realize a sustainable "NAMERAKA Society" where people can easily lead a secure and fulfilling life in harmony with nature.

Corporate History

NTN began in 1918 when investor Noboru Niwa, his sales company Tomoe Trading Co., and engineer Jiro Nishizono joined together to design and manufacture the first NTN ball bearings.

By 1939, NTN had constructed what would become its global manufacturing center, Kuwana Works, and in 1954, NTN became the first Japanese industrial manufacturer to be awarded the prestigious Deming Prize for statistical quality control. NTN continued to grow throughout the 1950s and 1960s as additional factories were built and NTN sales operations expanded to Europe.

NTN Bearing Corporation of America was established in 1963 to support local sales of NTN bearings in the American market. The corporation was now capable of manufacturing ball bearings, spherical, tapered, cylindrical, and needle roller bearings and automotive constant velocity joints. By the mid-1980s, NTN had acquired the Bower™ brand from Federal-Mogul Corporation, thereby expanding the company's catalog of tapered and cylindrical roller bearings. Ten years later, NTN acquired BCA™, again from Federal-Mogul, to round out its product line with automotive clutch release bearings and specialty agricultural bearing assemblies.

The success has continued into the new millennium with seven new North American plants.

A two-year, phased investment in French bearing manufacturer SNR was completed in 2008, with NTN acquiring a controlling stake in the company. As the fifth largest bearing manufacturer in Europe, SNR's involvement in aerospace and its superior spherical roller bearing products have been key contributors to NTN's continued growth.

2018 marked NTN's 100th Anniversary.

Today, NTN operates more than fifty plants worldwide and is the third largest bearing manufacturer in the world.

Deep Groove Ball Bearings

The most common type of bearing, deep groove ball bearings (also known as DGBBs, ball bearings, or Conrad bearings) are used in a wide variety of applications including electric motors. As the name suggests, the ball shaped rolling elements rotate in deep grooves within the inner and outer rings of the bearing.

The NTN Advantage

With 100% in-process gauging and 200% post-process noise testing, nobody matches the silent operation of NTN's product. NTN's DGBBs are recognized globally for quality and precision engineering designed to minimize downtime. NTN is proud to have the quietest bearings in the industry which are never manufactured in low cost countries. NTN's "LU" seal is a double-lip design that adjusts for wear and provides the best sealing efficiency in the marketplace. We stock a variety of size, sealing and clearance combinations for the electric motor market.

Part Number Nomenclature

Type	Series	Bore Diameter	Seal/Shield	Clearance		Lubricant
6	2	05	LLU	C3	/	EM

1. Type
- 6: Single row deep groove ball bearing

2. Series
- 2: ISO 02 series
- 3: ISO 03 series

3. Bore Diameter
- 00: 10 mm
- 01: 12 mm
- 02: 15mm
- 03: 17 mm
- 04 +: # * 5 = bore diameter in mm (ex. 05 = 25 mm)

Seal/Shield
- LU, LLU: Contact type rubber seal(s)
- LB, LLB: Non-contact type rubber seal(s)
- Z, ZZ: Steel shield(s)

4. Clearance
- C3: Clearance greater than normal
- C4: Clearance greater than C3

5. Lubricant
- EM: Electric motor grease

Characteristics

Duty	Load Capabilities	Speed Capabilities	Seal & Shield Offerings	Lubrication Options	Cage Types
Normal	Radial Some Axial	High	Contact Seals Non-Contact Seals Shields	Available with or without lubrication	Riveted Steel Nylon Brass

Competitor Interchange

Bearing Size	NTN	SKF	FAG	Koyo	Nachi
62xx	62xx	62xx	62xx	62xx	62xx
63xx	63xx	63xx	63xx	63xx	63xx

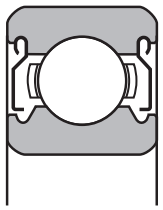
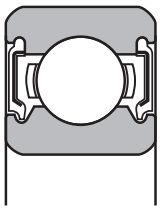
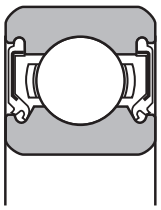
Seals / Shields	NTN	SKF	FAG	Koyo	Nachi
1 Contact Seal	LU	RS1	RSR	RS	NSE
2 Contact Seals	LLU	2RS1	2RSR	2RS	2NSE
1 Non-Contact Seal	LB	RZ	—	RU	NK
2 Non-Contact Seals	LLB	2RZ	—	2RU	2NK
1 Shield	Z	Z	ZR	Z	Z
2 Shields	ZZ	2Z	2ZR	ZZ	ZZ

Clearance	NTN	SKF	FAG	Koyo	Nachi
Greater than normal	C3	C3	C3	C3	C3
Greater than C3	C4	C4	C4	C4	C4

Lubricant	NTN	SKF	FAG	Koyo	Nachi
EM Grease	EM	EM*	—	—	—

** JEM for SKF indicates C3 clearance and EM grease*

Sealed Ball Bearings: Construction and Characteristics

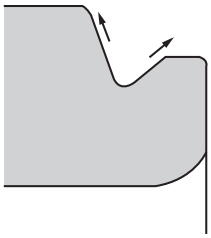
Types and Codes		Shielded Type	Sealed Type	
		Non-Contact Type ZZ	Non-Contact Type LLB	Contact Type LLU
Construction				
		Metal shield plate is affixed to the outside ring; the inner ring incorporates a V-groove and labyrinth clearance.	The outer ring incorporates synthetic rubber molded to a steel plate; seal edge is aligned with V-groove along inner ring surface with labyrinth clearance.	The outer ring incorporates synthetic rubber molded to a steel plate; seal edge contacts V-groove along inner ring surface.
Performance Comparison	Torque	Small	Small	Higher
	Dust Proofing	Good	Better than ZZ-type	Excellent
	Water Proofing	Poor	Poor	Very good
	High Speed Capacity	Same as open type	Same as open type	Limited by contact seals
	Allowable Temp. Range(1)	Depends on lubricant	−20 to 120 °C	−20 to 110 °C

(1) Please consult NTN Engineering about applications which exceed the allowable temperature range of products listed on this table.

Note: This chart lists double shielded and double sealed bearings, but single shielded (Z) and single sealed (LB, LU) are also available. Grease lubrication should be used with single shielded and single sealed bearings.

NTN Ball Bearings Shield and Seal Types

1. Grooved Type Sealing figure for Excellent Performance (all models)



A v-shaped groove is cut around the inner ring. Under centrifugal force, the outer surface of the V acts to keep out dirt; the inner surface of the V acts to seal in the grease.

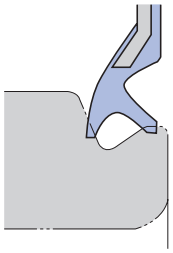
2. Rust Resistant Shield (ZZ spec)

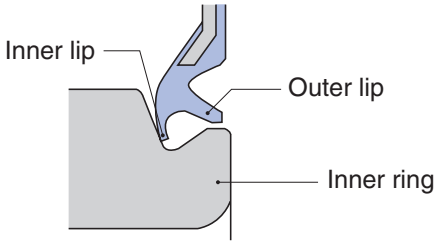
In order to obtain rust resistant properties, the shield is made of a strip steel covered by a hard surface-coating. This assures long bearing service life and minimal noise levels.

3. Non-contact seal (LB spec)

This is a unique seal offering from NTN that provides strong protection in clean to moderate contamination environments while allowing higher speeds and lower heat generation due to its non-contact design. For this reason, the LB seal is the most popular NTN seal and is well suited for most electric motor application. If water is present, then the LU seal is preferred.

4. Double-Lip Seal Adjusts for Wear (LLU spec)

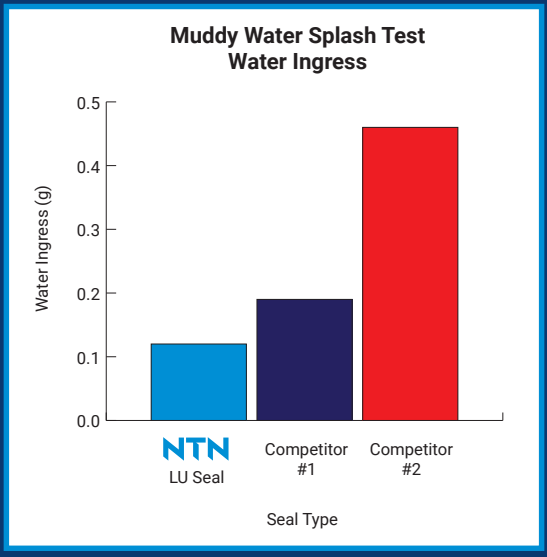




NTN provides the best contact seal in the marketplace for excluding contamination and keeping grease inside the bearing. The inner lip of a double-lip seal is pressed against the inside surface of the V-groove; the outer lip is spread open by the elastic force of rubber to create a small gap between the outer lip and the inner ring, creating a labyrinth effect. Should the inner lip wear, the contact pressure will decrease; however, the outer lip will get closer to the inner ring. In effect, a constant degree of sealing will be maintained; and, as a result, bearing service life will be noticeably lengthened.

NTN LU Seals vs. the Competition

In an effort to gauge the durability and quality of NTN's LU seals against the seals of our competitors, NTN performed a muddy water spalsh test to determine the effectiveness of our seal at reducing the risk of failure when exposed to environmental contaminants. Water was sprayed onto the bearings for 240 cycles, each lasting 300 seconds, for a total of 20 hours. The graph to the right shows the results of how much water made its way into the bearing during the test.



6200 SERIES BEARING CAPACITY AND FUNDAMENTAL FREQUENCIES

Bearing Number	Dynamic Load Rating (lbs)	Static Load Rating (lbs)	Allowable Speed (RPM) Grease Open Type, ZZ, LLB	Allowable Speed (RPM) Oil Open Type, Z, LB	Allowable Speed (RPM) LLU	Ball Pass Frequency Outer Ring*	Ball Pass Frequency Inner Ring*	Fundamental Train Frequency*	Ball Spin Frequency*
6200	1,270	535	25,000	30,000	18,000	3.07	4.93	0.38	2.04
6201	1,510	620	22,000	26,000	16,000	2.62	4.38	0.37	1.86
6202	1,930	810	19,000	23,000	15,000	2.61	4.39	0.37	1.84
6203	2,380	1,030	18,000	21,000	12,000	2.63	4.37	0.38	1.89
6204	3,190	1,500	16,000	18,000	10,000	3.08	4.92	0.39	2.06
6205	3,480	1,760	13,000	15,000	8,900	3.59	5.41	0.40	2.36
6206	4,840	2,540	11,000	13,000	7,300	3.58	5.42	0.40	2.34
6207	6,380	3,450	9,800	11,000	6,300	3.57	5.43	0.40	2.31
6208	7,300	4,000	8,700	10,000	5,600	3.61	5.39	0.40	2.42
6209	8,090	4,600	7,800	9,200	5,200	3.62	5.38	0.40	2.46
6210	8,760	5,200	7,100	8,300	4,700	4.09	5.91	0.41	2.66
6211	10,790	6,550	6,400	7,600	4,200	4.08	5.92	0.41	2.62
6212	13,030	8,100	6,000	7,000	3,800	4.08	5.92	0.41	2.63
6213	14,270	9,000	5,500	6,500	3,600	4.10	5.90	0.41	2.69
6214	15,510	9,900	5,100	6,000	3,400	4.11	5.89	0.41	2.70
6215	16,520	11,100	4,800	5,600	3,200	4.57	6.43	0.42	2.88
6216	18,090	11,900	4,500	5,300	3,000	4.14	5.86	0.41	2.80
6217	20,680	14,400	4,200	5,000	2,800	4.58	6.42	0.42	2.89
6218	23,820	16,100	4,000	4,700	2,600	4.11	5.89	0.41	2.73
6219	27,200	18,400	3,700	4,400	2,500	4.10	5.90	0.41	2.69
6220	30,340	20,900	3,500	4,200	2,300	4.09	5.91	0.41	2.66
6221	33,040	23,600	3,400	4,000	2,300	4.09	5.91	0.41	2.64
6222	35,850	26,300	3,200	3,800	2,200	4.08	5.92	0.41	2.62
6224	38,660	29,500	2,900	3,400	2,000	4.10	5.90	0.41	2.69
6226	41,580	33,000	2,700	3,100	1,800	4.12	5.88	0.41	2.75
6228	41,360	33,500	2,500	2,900	1,600	4.19	5.81	0.42	2.99
6230	43,830	38,000	2,300	2,700	1,500	4.67	6.33	0.42	3.23
6232	46,080	42,000	2,100	2,500		5.15	6.85	0.43	3.47
6234	52,830	50,130	2,000	2,400		5.13	6.87	0.43	3.37
6236	56,650	54,170	1,900	2,200		4.66	6.34	0.42	3.20
6238	63,390	63,170	1,800	2,100		4.64	6.36	0.42	3.13
6240	66,990	69,690	1,700	2,000		5.12	6.88	0.43	3.32

**Frequencies are listed at the fundamental frequencies and should be multiplied by the bearing rotational speed in RPM.*

6300 SERIES BEARING CAPACITY AND FUNDAMENTAL FREQUENCIES

Bearing Number	Dynamic Load Rating (lbs)	Static Load Rating (lbs)	Allowable Speed (RPM) Grease Open Type, ZZ, LLB	Allowable Speed (RPM) Oil Open Type, Z, LB	Allowable Speed (RPM) LLU	Ball Pass Frequency Outer Ring*	Ball Pass Frequency Inner Ring*	Fundamental Train Frequency*	Ball Spin Frequency*
6300	2,040	785	23,000	27,000	16,000	2.08	3.92	0.35	1.47
6301	2,420	945	20,000	24,000	15,000	2.03	3.97	0.34	1.38
6302	2,850	1,230	17,000	21,000	12,000	2.56	4.44	0.37	1.73
6303	3,370	1,470	16,000	19,000	11,000	2.55	4.45	0.36	1.70
6304	3,950	1,780	14,000	17,000	10,000	2.57	4.43	0.37	1.76
6305	5,280	2,450	12,000	14,000	8,100	2.61	4.39	0.37	1.83
6306	6,630	3,350	10,000	12,000	6,600	3.09	4.91	0.39	2.07
6307	8,310	4,300	8,800	10,000	6,000	3.06	4.94	0.38	2.01
6308	10,110	5,400	7,800	9,200	5,300	3.07	4.93	0.38	2.04
6309	13,150	7,200	7,000	8,200	4,700	3.06	4.94	0.38	2.00
6310	15,390	8,650	6,400	7,500	4,200	3.07	4.93	0.38	2.04
6311	17,870	10,100	5,800	6,800	3,900	3.07	4.93	0.38	2.04
6312	20,340	11,700	5,400	6,300	3,600	3.07	4.93	0.38	2.05
6313	23,150	13,500	4,900	5,800	3,300	3.07	4.93	0.38	2.04
6314	25,850	15,300	4,600	5,400	3,100	3.08	4.92	0.38	2.05
6315	28,320	17,300	4,300	5,000	2,900	3.08	4.92	0.39	2.06
6316	30,570	19,400	4,000	4,700	2,700	3.09	4.91	0.39	2.07
6317	33,040	21,800	3,800	4,500	2,600	3.09	4.91	0.39	2.08
6318	35,510	24,100	3,600	4,200	2,400	3.09	4.91	0.39	2.09
6319	37,990	26,800	3,300	3,900	2,300	3.10	4.90	0.39	2.10
6320	43,160	31,500	3,200	3,700	2,200	3.07	4.93	0.38	2.04
6321	45,860	34,500	3,000	3,600	2,100	3.08	4.92	0.38	2.05
6322	51,030	40,000	2,900	3,400	1,900	3.06	4.94	0.38	2.02
6324	51,480	41,580	2,600	3,100	1,700	3.13	4.87	0.39	2.19
6326	57,100	48,100	2,400	2,800	1,500	3.13	4.87	0.39	2.20
6328	62,940	55,300	2,200	2,600	1,500	3.13	4.87	0.39	2.20
6330	64,070	63,840	2,100	2,400		3.59	5.41	0.40	2.37
6332	69,690	64,290	1,900	2,300		3.19	4.81	0.40	2.36
6334	80,930	79,800	1,800	2,100		3.14	4.86	0.39	2.21
6336	87,670	91,040	1,700	2,000		3.58	5.42	0.40	2.35
6338	88,790	93,290	1,600	1,900		3.63	5.37	0.40	2.48

**Frequencies are listed at the fundamental frequencies and should be multiplied by the bearing rotational speed in RPM.*

Angular Contact Ball Bearings

Angular contact ball bearings (ACBBs) are non-separable type bearings which are similar to deep groove ball bearings. As the name suggests, the line connecting the contact points of the inner ring, steel ball and outer ring creates an angle.

The NTN Advantage

Customers can be confident that NTN's angular contact bearings will meet or exceed the required specifications. For the electric motor rebuilders market, NTN provides angular contact ball bearings with a ball-guided cage. This design allows for better lubrication flow allowing critical components to be properly lubricated and maximizing bearing life. NTN manufactures our ACBBs in Japan under the strictest quality standards.

Part Number Nomenclature

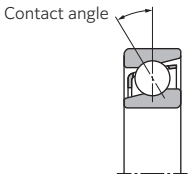
Type	Series	Bore Diameter	Contact Angle	Cage	Cage Guidance	Arrangement
7	3	18	B	L1	B	G

1. Type
- 7: Single row angular contact ball bearing

2. Series
- 2: ISO 02 series
- 3: ISO 03 series

3. Bore Diameter
- 00: 10mm
- 01: 12mm
- 02: 15mm
- 03: 17mm
- 04+: # * 5 = bore diameter in mm (ex. 18 = 90 mm)

4. Contact Angle
- Blank: 30°
- B: 40°
- C: 15°



5. Cage
- L1: Machined brass
- Blank: Pressed steel

6. Cage Guidance
- B: Ball guided
- Blank: Standard cage guidance

7. Arrangement
- G: Universal flush ground

Characteristics

Duty	Load Capabilities	Speed Capabilities	Seal & Shield Offerings	Lubrication Options	Cage Types
Normal	Radial Axial	High	None	None	Machined Brass Phenolic Steel Nylon

Competitor Interchange

Bearing Size	NTN	SKF	FAG	Koyo	Nachi
72xx	72xx	72xx	72xx	72xx	72xx
73xx	73xx	73xx	73xx	73xx	73xx

Contact Angle	NTN	SKF	FAG	Koyo	Nachi
15°	C	C	C	C	C
30°	—	A	—	A	A
40°	B	B	B	B	B

Cage	NTN	SKF	FAG	Koyo	Nachi
Machined Brass	L1	M	MP	FY	UM
Nylon	—	P	TVP	FG	Y

7200 SERIES BEARING CAPACITY AND FUNDAMENTAL FREQUENCIES

Bearing Number	Dynamic Load Rating (lbs)	Static Load Rating (lbs)	Allowable Speed (RPM) Grease Lubrication	Allowable Speed (RPM) Oil Lubrication	Ball Pass Frequency Outer Ring*	Ball Pass Frequency Inner Ring*	Fundamental Train Frequency*	Ball Spin Frequency*
7201B	1,570	820	21,000	28,000	4.04	5.96	0.40	1.91
7202B	1,880	980	18,000	25,000	4.03	5.97	0.40	1.89
7203B	2,470	1,370	17,000	22,000	4.46	6.54	0.41	1.94
7204B	2,990	1,730	15,000	20,000	4.53	6.47	0.41	2.11
7205B	3,350	2,110	14,000	19,000	5.49	7.51	0.42	2.40
7206B	4,600	3,050	11,000	14,000	5.48	7.52	0.42	2.38
7207B	6,100	4,150	9,300	12,000	5.47	7.53	0.42	2.35
7208B	7,200	5,150	8,300	11,000	5.94	8.06	0.42	2.47
7209B	8,100	5,900	7,400	9,900	5.95	8.05	0.43	2.50
7210B	8,450	6,450	6,700	9,000	6.46	8.54	0.43	2.70
7211B	10,500	8,100	6,100	8,200	6.44	8.56	0.43	2.66
7212B	12,600	10,000	5,700	7,600	6.45	8.55	0.43	2.67
7213B	14,300	11,800	5,200	7,000	6.90	9.10	0.43	2.73
7214B	15,500	13,000	4,900	6,500	6.90	9.10	0.43	2.74
7215B	16,100	13,900	4,500	6,000	7.40	9.60	0.44	2.92
7216B	18,100	15,600	4,300	5,700	6.94	9.06	0.43	2.84
7217B	20,200	18,100	4,000	5,300	7.41	9.59	0.44	2.93
7218B	24,100	21,100	3,800	5,000	6.91	9.09	0.43	2.77
7219B	27,200	24,100	3,500	4,700	6.90	9.10	0.43	2.73
7220B	29,200	25,600	3,400	4,500	6.46	8.54	0.43	2.71
7221B	32,000	29,000	3,200	4,300	6.45	8.55	0.43	2.68
7222B	34,500	32,500	3,000	4,000	6.44	8.56	0.43	2.66
7224B	37,000	36,500	2,800	3,700	6.47	8.53	0.43	2.72
7226B	40,000	40,500	2,500	3,400	6.49	8.51	0.43	2.79
7228B	41,000	44,000	2,300	3,100	7.00	9.00	0.44	3.03
7230B	47,000	53,000	2,200	2,900	6.98	9.02	0.44	2.96
7232B	53,500	62,500	2,000	2,700	6.96	9.04	0.44	2.90
7234B	60,000	73,000	1,900	2,500	6.95	9.05	0.43	2.86
7236B	62,000	78,500	1,800	2,400	7.43	9.57	0.44	2.98
7238B	61,500	80,000	1,700	2,200	7.49	9.51	0.44	3.17
7240B	68,500	92,000	1,600	2,100	7.47	9.53	0.44	3.10

**Frequencies are listed at the fundamental frequencies and should be multiplied by the bearing rotational speed in RPM.*

7300 SERIES BEARING CAPACITY AND FUNDAMENTAL FREQUENCIES								
Bearing Number	Dynamic Load Rating (lbs)	Static Load Rating (lbs)	Allowable Speed (RPM) Grease Lubrication	Allowable Speed (RPM) Oil Lubrication	Ball Pass Frequency Outer Ring*	Ball Pass Frequency Inner Ring*	Fundamental Train Frequency*	Ball Spin Frequency*
7302B	2,810	1,500	17,000	22,000	3.97	6.03	0.40	1.78
7303B	3,350	1,800	15,000	20,000	3.96	6.04	0.40	1.76
7304B	3,900	2,170	13,000	18,000	3.99	6.01	0.40	1.81
7305B	5,500	3,300	11,000	15,000	4.43	6.57	0.40	1.89
7306B	6,950	4,600	9,600	13,000	5.36	7.64	0.41	2.12
7307B	8,200	5,450	8,400	11,000	4.92	7.08	0.41	2.06
7308B	10,100	6,850	7,400	9,900	4.93	7.07	0.41	2.09
7309B	13,200	9,000	6,600	8,900	4.89	7.11	0.41	2.01
7310B	15,300	10,800	6,000	8,100	4.91	7.09	0.41	2.03
7311B	17,800	12,700	5,500	7,300	4.94	7.06	0.41	2.09
7312B	20,200	14,800	5,100	6,800	4.94	7.06	0.41	2.10
7313B	22,900	16,900	4,700	6,300	4.93	7.07	0.41	2.09
7314B	25,600	19,300	4,400	5,800	4.94	7.06	0.41	2.10
7315B	28,100	21,900	4,100	5,400	4.95	7.05	0.41	2.11
7316B	30,500	25,400	3,800	5,100	4.95	7.05	0.41	2.12
7317B	33,000	27,400	3,600	4,800	4.99	7.01	0.42	2.22
7318B	35,000	30,500	3,400	4,500	4.96	7.04	0.41	2.14
7319B	37,500	33,500	3,200	4,200	4.96	7.04	0.41	2.15
7320B	42,500	40,000	3,000	4,000	4.94	7.06	0.41	2.09
7321B	45,500	43,500	2,900	3,800	4.94	7.06	0.41	2.10
7322B	51,000	51,000	2,700	3,700	4.52	6.48	0.41	2.07
7324B	50,500	52,000	2,500	3,300	5.00	7.00	0.42	2.24
7326B	56,000	60,500	2,300	3,100	5.00	7.00	0.42	2.24
7328B	62,000	69,500	2,100	2,800	5.00	7.00	0.42	2.25
7330B	67,500	78,500	2,000	2,600	5.01	6.99	0.42	2.25
7332B	71,000	86,500	1,800	2,400	5.49	7.51	0.42	2.40
7334B	80,000	100,000	1,700	2,300	5.01	6.99	0.42	2.26

**Frequencies are listed at the fundamental frequencies and should be multiplied by the bearing rotational speed in RPM.*

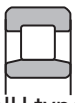
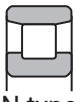
Cylindrical Roller Bearings

Cylindrical roller bearings (CRBs) can support heavier loads compared to bearings with ball shaped rolling elements. CRBs are available in a variety of ring configurations, sizes, clearances and cage types. CRBs can operate at higher speeds than other roller bearings, but can only accept loads in the radial direction.

The NTN Advantage

NTN has been manufacturing our ISO CRBs for over 95 years in Japan. Our ULTAGE series CRBs have up to 20% higher dynamic load rating compared to standard “E” type bearings. The optimized internal geometry of our ULTAGE CRBs reduces edge stress and reduces operating temperature. All of the features of NTN’s ULTAGE CRBs lead to longer bearing life and increased productivity for the end user.

Cylindrical Roller Bearing Types and Characteristics

Type Code	Design	Characteristics
NU type **N type**	 NU type  N type	• NU type outer rings have two ribs. The outer ring, roller and cage assembly can be separated from the inner ring. N type inner rings have two ribs. The inner ring, roller and cage assembly can be separated from the outer ring. • Unable to accommodate any axial loading. • This is widely used as the floating side bearing in a fixed-float arrangement.
NJ type	 NJ type	• NJ type has two ribs on the outer ring, a single rib on the inner ring • Can receive single direction axial loads. • When there is no distinction between the fixed side and floating side bearing, these types can be used as a pair in close proximity.
NUP type	 NUP type	• NUP type has a collar ring attached to the ribless side of the inner ring. Collar rings are separable, and therefore it is necessary to fix the inner ring axially. • Can accommodate axial loads in either direction. • Widely used as the shaft’s fixed-side bearing.

Part Number Nomenclature

Ring Type	Series	Bore Diameter	Capacity	Cage	Clearance
NJ	23	10	EA	G1	C3

1. Ring Type

- NU: Straight inner ring w/ outer ring and roller assembly
- N: Straight outer ring w/ inner ring and roller assembly
- NJ: One lip inner ring w/ outer ring and roller assembly
- NUP: Non-separable ring and roller assembly

2. Series

- 2: ISO 02 series
- 22: ISO 02 series wide
- 3: ISO 03 series
- 23: ISO 03 series wide

3. Bore Diameter

- 00: 10mm
- 01: 12mm
- 02: 15mm
- 03: 17mm
- 04+: # * 5 = bore diameter in mm (ex. 10 = 50 mm)

Capacity

- EA: ULTAGE® extra capacity design
- E: Extra capacity
- Blank: Standard

4. Cage

- G1: Brass
- GR: Brass
- T2X: Nylon

5. Clearance

- C3: Greater than normal
- C4: Greater than C3

ULTAGE®

The ULTAGE Advantage

Combining premium-grade materials, optimized design and precision manufacturing, ULTAGE is the new generation of high-performance bearings from NTN that delivers unmatched service life, the highest limiting speeds and the best load capacities on the market to maximize the productivity of your equipment. ULTAGE cylindrical roller bearings are denoted with an EA in the nomenclature.

Competitor Interchange

Ring Type	NTN	SKF	FAG	Koyo	Nachi
NU	NU	NU	NU	NU	NU
NJ	NJ	NJ	NJ	NJ	NJ
NUP	NUP	NUP	NUP	NUP	NUP
N	N	N	N	N	N

Bearing Size	NTN	SKF	FAG	Koyo	Nachi
2xx	2xx	2xx	2xx	2xx	2xx
22xx	22xx	22xx	22xx	22xx	22xx
3xx	3xx	3xx	3xx	3xx	3xx
23xx	23xx	23xx	23xx	23xx	23xx

Capacity	NTN	SKF	FAG	Koyo	Nachi
Extra	E	E	E	R	E

Cage	NTN	SKF	FAG	Koyo	Nachi
Brass	G1 or GR	CM	M1	FY	MY
Nylon	T2X	CP	TVP2	FG	G

Clearance	NTN	SKF	FAG	Koyo	Nachi
Greater than normal	C3	C3	C3	C3	C3
Greater than C3	C4	C4	C4	C4	C4

CRB 200 SERIES BEARING CAPACITY AND FUNDAMENTAL FREQUENCIES								
Bearing Number Applies to N, NU, NJ, NUP, and NF Types	Dynamic Load Rating (lbs)	Static Load Rating (lbs)	Allowable Speed (RPM) Grease Lubrication	Allowable Speed (RPM) Oil Lubrication	Roller Pass Frequency Outer Ring*	Roller Pass Frequency Inner Ring*	Fundamental Train Frequency*	Roller Spin Frequency*
204E	5,800	5,100	18,000	15,000	4.29	6.71	0.39	2.16
204EA	7,300	5,600	21,600	15,000	4.68	7.32	0.39	2.16
205EA	7,800	6,200	18,000	13,000	5.25	7.75	0.40	2.51
206EA	10,300	8,400	15,600	11,000	5.24	7.76	0.40	2.49
207EA	13,400	11,200	13,200	9,500	5.71	8.29	0.41	2.61
208EA	14,800	12,500	12,000	8,500	5.73	8.27	0.41	2.66
209EA	16,700	14,900	9,000	7,600	6.24	8.76	0.42	2.89
210EA	18,300	17,200	8,100	6,900	7.17	9.83	0.42	3.13
211EA	22,900	22,100	8,900	6,300	7.30	9.70	0.43	3.48
212EA	25,900	24,100	8,200	5,800	6.70	9.30	0.42	2.99
213EA	28,600	26,800	7,600	5,400	6.72	9.28	0.42	3.04
214EA	31,500	30,800	7,100	5,000	7.21	9.79	0.42	3.21
215EA	34,600	35,100	6,600	4,700	7.70	10.30	0.43	3.38
216EA	37,100	37,500	6,100	4,400	7.71	10.29	0.43	3.41
217	30,100	31,500	5,300	4,500	7.35	9.65	0.43	3.62
217EA	30,100	31,500	5,300	4,500	7.21	9.79	0.42	3.22
218EA	48,300	48,800	5,500	3,900	7.22	9.78	0.42	3.24
219	41,400	43,800	4,700	4,000	6.85	9.15	0.43	3.41
219EA	58,500	59,600	5,200	3,600	7.16	9.84	0.42	3.10
220	45,600	48,800	4,500	3,800	6.86	9.14	0.43	3.43
220EA	66,300	68,500	3,500	4,100	7.17	9.83	0.42	3.13
221	50,100	54,200	4,300	3,600	6.86	9.14	0.43	3.45
222	59,800	65,200	4,000	3,400	6.82	9.18	0.43	3.31
222EA	77,500	82,000	3,100	3,700	7.20	9.80	0.42	3.19
224E	83,200	94,400	3,400	2,900	7.20	9.80	0.42	3.18
226	67,400	76,400	3,400	2,900	7.80	10.20	0.43	3.69
226E	91,000	102,300	3,100	2,600	7.19	9.81	0.42	3.16

**Frequencies are listed at the fundamental frequencies and should be multiplied by the bearing rotational speed in RPM.*

Cylindrical Roller Bearings require a minimum dynamic radial load to prevent roller skidding. This minimum load can be estimated to be 2% of the bearing's dynamic capacity. Other factors apply, NTN Application Engineering should be consulted.

CRB 200 SERIES BEARING CAPACITY AND FUNDAMENTAL FREQUENCIES

Bearing Number Applies to N, NU, NJ, NUP, and NF Types	Dynamic Load Rating (lbs)	Static Load Rating (lbs)	Allowable Speed (RPM) Grease Lubrication	Allowable Speed (RPM) Oil Lubrication	Roller Pass Frequency Outer Ring*	Roller Pass Frequency Inner Ring*	Fundamental Train Frequency*	Roller Spin Frequency*
228	77,600	89,900	3,100	2,700	7.80	10.20	0.43	3.69
228E	97,800	115,800	2,800	2,400	8.15	10.85	0.43	3.45
230	77,500	98,000	2,500	2,900	7.80	10.20	0.43	3.68
230E	111,300	133,800	2,600	2,200	8.16	10.84	0.43	3.46
232	106,800	128,100	2,700	2,300	7.80	10.20	0.43	3.68
234	119,100	142,800	2,500	2,200	7.80	10.20	0.43	3.69
236	123,600	151,700	2,400	2,000	8.28	10.72	0.44	3.84
238E	173,100	214,700	2,000	1,700	8.15	10.85	0.43	3.46
240	155,100	194,500	2,100	1,800	8.28	10.72	0.44	3.83
244	190,000	242,800	1,900	1,600	8.27	10.73	0.44	3.81

**Frequencies are listed at the fundamental frequencies and should be multiplied by the bearing rotational speed in RPM.*

Cylindrical Roller Bearings require a minimum dynamic radial load to prevent roller skidding. This minimum load can be estimated to be 2% of the bearing's dynamic capacity. Other factors apply, NTN Application Engineering should be consulted.

CRB 2200 AND 2300 SERIES BEARING CAPACITY AND FUNDAMENTAL FREQUENCIES								
Bearing Number Applies to N, NU, NJ, NUP, and NF Types	Dynamic Load Rating (lbs)	Static Load Rating (lbs)	Allowable Speed (RPM) Grease Lubrication	Allowable Speed (RPM) Oil Lubrication	Roller Pass Frequency Outer Ring*	Roller Pass Frequency Inner Ring*	Fundamental Train Frequency*	Roller Spin Frequency*
2204EA	8,700	7,000	19,200	14,000	4.68	7.32	0.39	2.16
2205EA	9,300	7,800	15,600	11,000	5.25	7.75	0.40	2.51
2206EA	13,000	11,200	13,200	6,700	5.24	7.76	0.40	2.49
2207EA	16,400	14,700	12,000	8,500	5.71	8.29	0.41	2.61
2208EA	19,200	17,400	10,700	7,600	5.73	8.27	0.41	2.66
2209EA	20,200	19,000	9,600	6,800	6.24	8.76	0.42	2.89
2210EA	22,100	21,800	8,800	6,200	7.17	9.83	0.42	3.13
2211EA	27,000	27,400	7,900	5,600	7.30	9.70	0.43	3.48
2212EA	34,800	35,300	7,300	5,200	6.70	9.30	0.42	2.99
2213EA	39,600	40,700	6,700	4,800	6.72	9.28	0.42	3.04
2214EA	41,400	43,600	6,200	4,500	7.21	9.79	0.42	3.21
2215EA	42,900	46,500	5,900	4,200	7.70	10.30	0.43	3.38
2216EA	49,500	54,600	5,500	3,900	7.71	10.29	0.43	3.41
2217EA	57,800	62,700	5,200	3,700	7.21	9.79	0.42	3.22
2218EA	64,300	70,800	4,900	3,500	7.22	9.78	0.42	3.24
2220EA	88,800	100,000	3,600	3,100	7.17	9.83	0.42	3.13
2304EA	11,100	8,800	16,800	12,000	3.77	6.23	0.38	1.91
2305EA	15,200	12,600	13,200	9,700	4.25	6.75	0.39	2.09
2306EA	19,800	17,400	11,600	8,300	4.72	7.28	0.39	2.23
2307EA	26,300	24,500	10,200	7,200	5.16	7.84	0.40	2.32
2308EA	30,300	27,400	9,000	6,400	4.73	7.27	0.39	2.25
2309EA	36,400	34,400	8,200	5,700	5.17	7.83	0.40	2.35
2310EA	43,200	42,000	7,300	5,200	5.22	7.78	0.40	2.44
2311EA	53,500	52,400	6,700	4,700	5.18	7.82	0.40	2.36
2312EA	59,100	58,900	6,200	4,400	5.21	7.79	0.40	2.43
2313EA	65,900	64,500	5,800	4,100	5.18	7.82	0.40	2.36
2314EA	73,100	73,100	5,300	3,800	5.21	7.79	0.40	2.42
2315EA	87,700	88,800	4,900	3,500	5.19	7.81	0.40	2.38
2317E	97,800	109,000	3,700	3,100	5.64	8.36	0.40	2.48
2320	102,300	113,500	3,400	2,900	5.76	8.24	0.41	2.72

**Frequencies are listed at the fundamental frequencies and should be multiplied by the bearing rotational speed in RPM.*

Cylindrical Roller Bearings require a minimum dynamic radial load to prevent roller skidding. This minimum load can be estimated to be 2% of the bearing's dynamic capacity. Other factors apply, NTN Application Engineering should be consulted.

CRB 300 SERIES BEARING CAPACITY AND FUNDAMENTAL FREQUENCIES

Bearing Number Applies to N, NU, NJ, NUP, and NF Types	Dynamic Load Rating (lbs)	Static Load Rating (lbs)	Allowable Speed (RPM) Grease Lubrication	Allowable Speed (RPM) Oil Lubrication	Roller Pass Frequency Outer Ring*	Roller Pass Frequency Inner Ring*	Fundamental Train Frequency*	Roller Spin Frequency*
315E	54,000	59,100	4,700	4,000	5.19	7.81	0.40	2.38
315EA	63,800	59,100	5,600	4,000	5.19	7.81	0.40	2.38
316	47,400	46,500	4,800	4,100	5.77	8.23	0.41	2.75
316E	57,600	63,400	4,400	3,700	5.21	7.79	0.40	2.42
317	52,800	51,300	4,600	3,900	5.32	7.68	0.41	2.66
317E	73,100	74,200	4,100	3,500	5.64	8.36	0.40	2.48
318	59,800	59,600	4,300	3,700	5.34	7.66	0.41	2.71
318E	59,800	59,600	4,300	3,700	5.21	7.79	0.40	2.43
319	64,500	65,000	4,000	3,400	5.77	8.23	0.41	2.75
319E	83,200	86,600	3,600	3,100	5.69	8.31	0.41	2.58
320	74,200	75,300	3,800	3,300	5.76	8.24	0.41	2.72
320E	94,400	95,500	3,500	2,900	5.20	7.80	0.40	2.39
321	79,800	80,900	3,700	3,100	5.73	8.27	0.41	2.66
322	88,800	89,900	3,500	3,000	5.72	8.28	0.41	2.64
322E	112,400	118,000	3,100	2,700	5.66	8.34	0.40	2.51
324	112,400	114,700	3,200	2,700	5.27	7.73	0.41	2.54
324E	112,400	114,700	3,200	2,700	5.21	7.79	0.40	2.43
326	139,400	149,500	2,900	2,500	5.70	8.30	0.41	2.60
326E	154,000	165,200	2,600	2,200	5.65	8.35	0.40	2.49
328	154,000	167,500	2,700	2,300	5.73	8.27	0.41	2.66
328E	165,200	178,700	2,400	2,100	5.68	8.32	0.41	2.55
330	149,500	181,000	2,500	2,100	5.75	8.25	0.41	2.71
330E	170,900	206,800	2,200	1,900	5.68	8.32	0.41	2.55
332	174,200	196,700	2,300	2,000	6.24	8.76	0.42	2.89
336	224,800	258,500	2,000	1,700	6.21	8.79	0.41	2.83

**Frequencies are listed at the fundamental frequencies and should be multiplied by the bearing rotational speed in RPM.*

Cylindrical Roller Bearings require a minimum dynamic radial load to prevent roller skidding. This minimum load can be estimated to be 2% of the bearing's dynamic capacity. Other factors apply, NTN Application Engineering should be consulted.

Ceramic Bearing Products

If an electric current passes through a standard steel bearing, it will cause an arc between the rolling element and the raceway surface. This arc eventually damages the bearing raceway and leads to bearing failure. NTN combats stray electric currents with our MEGAOHM™ product line consisting of deep groove ball bearings and cylindrical roller bearings that utilize ceramic materials to coat the outer ring.

The NTN Advantage

NTN's premium offerings are drop in replacements for standard bearings, and are cost effective solutions to combat stray electric currents. NTN product offers even more protection than our competitors since our coating is twice as thick. Along with our ceramic ball bearings, we have the premium solution to protect your end user's electric motor.

MEGAOHM Deep Groove Ball Bearing Part Number Nomenclature

Prefix		Type	Series	Bore Diameter	Clearance
7MC3	–	6	2	28	C3

1. Prefix
- 7MC3: Ceramic coating

2. Type
- 6: Single row deep groove ball bearing

3. Series
- 2: ISO 02 Series
- 3: ISO 03 Series

Bore Diameter
- 00: 10mm
- 01: 12mm
- 02: 15mm
- 03: 17mm
- 04+: # * 5 = bore diameter in mm (ex. 28 = 140 mm)

4. Clearance
- C3: Greater than normal
- C4: Greater than C3

MEGAOHM Cylindrical Roller Bearing Part Number Nomenclature

Prefix		Type	Series	Bore Diameter	Internal Design	Cage	Clearance
7MC3	–	NU	2	19	E	GRB	C3

1. Prefix
- 7MC3: Ceramic coating

2. Type
- NU: Straight inner ring w/outer ring and roller assembly
- N: Straight outer ring w/inner ring and roller assembly
- NJ: One lip inner ring w/ outer ring and roller assembly
- NUP: One lip inner ring w/ collar, outer ring and roller assembly

3. Series
- 2: ISO 02 Series
- 3: ISO 03 Series

Bore Diameter
- 00: 10mm
- 01: 12mm
- 02: 15mm
- 03: 17mm
- 04+: # * 5 = bore diameter in mm (ex. 19 = 95 mm)

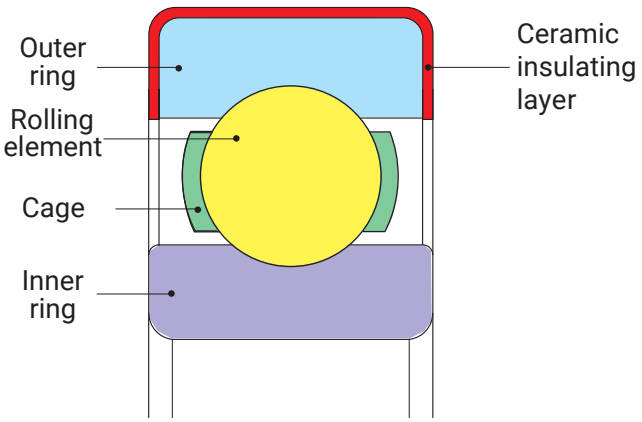
4. Internal Design
- E: High-capacity CRB

5. Cage
- GRB: Brass cage

6. Clearance
- C3: Greater than normal
- C4: Greater than C3

MEGAOHM 7MC3 Series vs. The Competition

Characteristic	NTN 7MC3	Leading Competitor
Coating Thickness	0.2 mm	0.1 mm
Electrical Resistance at 500 V (DC)	> 2,000 MΩ	> 100 MΩ
Voltage Resistance	> 3 kV	< 3 kV
Chipping (Drop test up to 0.8 m)	0 of 8 chipped	3 of 8 chipped



Ceramic Ball Deep Groove Ball Bearing Part Number Nomenclature

Prefix	Type	Series	Bore Diameter	Seal/Shield	Clearance	Lubricant
5S	– 6	2	07	ZZ	C3	/ EM

1. Prefix
- 5S: Ceramic rolling elements

2. Type
- 6: Single row deep groove ball bearing

3. Series
- 2: ISO 02 Series
- 3: ISO 03 Series

4. Bore Diameter
- 00: 10mm
- 01: 12mm
- 02: 15mm
- 03: 17mm
- 04+: # * 5 = bore diameter in mm (ex. 07=35 mm)

Seal/Shield
- LU: Contact seal
- LLU: Two contact seals
- LB: Non-contact seal
- LLB: Two non-contact seals
- Z: Steel shield
- ZZ: Two steel shields

5. Clearance
- C3: Greater than normal
- C4: Greater than C3

6. Lubricant
- EM: Electric motor grease

Competitor Interchange

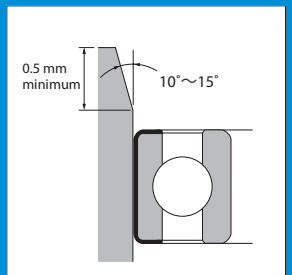
Ceramic Feature	NTN	SKF	FAG	Koyo	Nachi
Coated Outer Ring	7MC3	VL0241*	J20AA*	–	–
Rolling Element	5S	HC5*	HC	3NC	SH6

**Please consult NTN Engineering about applications which exceed the allowable temperature range of products listed on this table.*
Note: This chart lists double shielded and double sealed bearings, but single shielded (Z) and single sealed (LB, LU) are also available. Grease lubrication should be used with single shielded and single sealed bearings.

Operating Precautions

To avoid an accident or failure resulting from damage to insulated bearings, carefully observe the following:

- Providing approximately 15˚ of relief (illustrated at right) at the entrance to the housing will facilitate assembly.
- Never drop an insulated bearing or strike it directly with a hammer during installation.
- Do not use an insulated bearing if a defect is visible on the surface or it has an unusual appearance.



Relief at entrance of housing bore

MEGAOHM CERAMIC COATED BEARING STOCKED PART NUMBERS 6200 SERIES

Ceramic Insulated Ball Bearing 6200 Series	Dynamic Load Rating (lbs)	Static Load Rating (lbs)	Allowable Speed (RPM) Grease Lubrication	Allowable Speed (RPM) Oil Lubrication	Ball Pass Frequency Outer Ring*	Ball Pass Frequency Inner Ring*	Fundamental Train Frequency*	Ball Spin Frequency*
7MC3-6214C3	15,510	9,900	5,100	6,000	4.11	5.89	0.41	2.70
7MC3-6215C3	16,520	11,100	4,800	5,600	4.57	6.43	0.42	2.88
7MC3-6216C3	18,090	11,900	4,500	5,300	4.14	5.86	0.41	2.80
7MC3-6217C3	20,680	14,400	4,200	5,000	4.58	6.42	0.42	2.89
7MC3-6218C3	23,820	16,100	4,000	4,700	4.11	5.89	0.41	2.73
7MC3-6219C3	27,200	18,400	3,700	4,400	4.10	5.90	0.41	2.69
7MC3-6220C3	30,340	20,900	3,500	4,200	4.09	5.91	0.41	2.66
7MC3-6222C3	35,850	26,300	3,200	3,800	4.08	5.92	0.41	2.62
7MC3-6224C3	38,660	29,500	2,900	3,400	4.10	5.90	0.41	2.69
7MC3-6226C3	41,580	33,000	2,700	3,100	4.12	5.88	0.41	2.75
7MC3-6228C3	41,360	33,500	2,500	2,900	4.19	5.81	0.42	2.99
7MC3-6230C3	43,830	38,000	2,300	2,700	4.67	6.33	0.42	3.23
7MC3-6236C3	56,650	54,170	1,900	2,200	4.66	6.34	0.42	3.20

MEGAOHM CERAMIC COATED BEARING STOCKED PART NUMBERS 6300 SERIES

Ceramic Insulated Ball Bearing 6200 Series	Dynamic Load Rating (lbs)	Static Load Rating (lbs)	Allowable Speed (RPM) Grease Lubrication	Allowable Speed (RPM) Oil Lubrication	Ball Pass Frequency Outer Ring*	Ball Pass Frequency Inner Ring*	Fundamental Train Frequency*	Ball Spin Frequency*
7MC3-6310C3	15,390	8,650	6,400	7,500	3.07	4.93	0.38	2.04
7MC3-6311C3	17,870	10,100	5,800	6,800	3.07	4.93	0.38	2.04
7MC3-6312C3	20,340	11,700	5,400	6,300	3.07	4.93	0.38	2.05
7MC3-6313C3	23,150	13,500	4,900	5,800	3.07	4.93	0.38	2.04
7MC3-6314C3	25,850	15,300	4,600	5,400	3.08	4.92	0.38	2.05
7MC3-6315C3	28,320	17,300	4,300	5,000	3.08	4.92	0.39	2.06
7MC3-6316C3	30,570	19,400	4,000	4,700	3.09	4.91	0.39	2.07
7MC3-6317C3	33,040	21,800	3,800	4,500	3.09	4.91	0.39	2.08
7MC3-6318C3	35,510	24,100	3,600	4,200	3.09	4.91	0.39	2.09
7MC3-6319C3	37,990	26,800	3,300	3,900	3.10	4.90	0.39	2.10
7MC3-6320C3	43,160	31,500	3,200	3,700	3.07	4.93	0.38	2.04
7MC3-6322C3	51,030	40,000	2,900	3,400	3.06	4.94	0.38	2.02
7MC3-6324C3	51,480	41,580	2,600	3,100	3.13	4.87	0.39	2.19
7MC3-6326C3	57,100	48,100	2,400	2,800	3.13	4.87	0.39	2.20
7MC3-6328C3	62,940	55,300	2,200	2,600	3.13	4.87	0.39	2.20
7MC3-6330C3	64,070	63,840	2,100	2,400	3.59	5.41	0.40	2.37

**Frequencies are listed at the fundamental frequencies and should be multiplied by the bearing rotational speed in RPM.*

MEGAOHM CERAMIC COATED BEARING STOCKED PART NUMBERS CYLINDRICAL ROLLER BEARINGS								
Ceramic Insulated Cylindrical Roller Bearing	Dynamic Load Rating (lbs)	Static Load Rating (lbs)	Allowable Speed (RPM) Grease Lubrication	Allowable Speed (RPM) Oil Lubrication	Roller Pass Frequency Outer Ring*	Roller Pass Frequency Inner Ring*	Fundamental Train Frequency*	Roller Spin Frequency*
7MC3-NU212EGRBC3	21,900	24,100	5,800	8,200	6.70	9.3	0.42	2.99
7MC3-NU220EGRBC3	56,000	68,500	3,500	4,100	7.17	9.83	0.42	3.13
7MC3-NU222EGRBC3	66,000	82,000	3,100	3,700	7.20	9.8	0.42	3.19
7MC3-NU313EGRBC3	40,500	43,000	4,600	6,500	5.18	7.82	0.40	2.36
7MC3-NU317EGRBC3	65,500	74,000	3,500	4,100	5.64	8.36	0.40	2.48
7MC3-NU318EGRBC3	71,000	80,000	3,300	3,900	5.21	7.79	0.40	2.43
7MC3-NU319EGRBC3	75,500	86,500	3,100	3,600	5.69	8.31	0.41	2.58
7MC3-NU320EGRBC3	85,500	95,500	2,900	3,500	5.20	7.8	0.40	2.39
7MC3-NU322EGRBC3	101,000	118,000	2,700	3,100	5.66	8.34	0.40	2.51
7MC3-NU324EGRBC3	119,000	137,000	2,400	2,800	5.21	7.79	0.40	2.43
7MC3-NU328EGRBC3	150,000	179,000	2,100	2,400	5.68	8.32	0.41	2.55

CERAMIC ROLLING ELEMENT DEEP GROOVE BALL BEARINGS STOCKED PART NUMBERS							
Ceramic Rolling Element Ball Bearings	Dynamic Load Rating (lbs)	Static Load Rating (lbs)	Allowable Speed (RPM) Grease Lubrication	Ball Pass Frequency Outer Ring*	Ball Pass Frequency Inner Ring*	Fundamental Train Frequency*	Ball Spin Frequency*
5S-6207ZZC3/EM	5,778	2,383	9,800	3.57	5.43	0.40	2.31
5S-6208ZZC3/EM	6,542	2,788	8,700	3.61	5.39	0.40	2.42
5S-6209ZZC3/EM	7,306	3,170	7,800	3.62	5.38	0.40	2.46
5S-6210ZZC3/EM	7,868	3,619	7,100	4.09	5.91	0.41	2.66
5S-6211ZZC3/EM	9,779	6,550	6,400	4.08	5.92	0.41	2.62
5S-6212ZZC3/EM	11,802	4,564	6,000	4.08	5.92	0.41	2.63
5S-6213ZZC3/EM	12,927	6,250	5,500	4.10	5.90	0.41	2.69
5S-6307ZZC3/EM	7,531	2,990	8,800	3.06	4.94	0.38	2.01
5S-6308ZZC3/EM	9,105	3,732	7,800	3.07	4.93	0.38	2.04
5S-6309ZZC3/EM	11,915	4,968	7,000	3.06	4.94	0.38	2.00

**Frequencies are listed at the fundamental frequencies and should be multiplied by the bearing rotational speed in RPM.*

Thrust Spherical Roller Bearings

Thrust spherical roller bearings (Thrust SRBs) use spherical rolling elements to accept thrust loads. Thrust SRBs can allow for some mounting error and shaft deflection due to the self-aligning nature of the design. Thrust SRBs can be used in vertically mounted electric motors.

Part Number Nomenclature

Series	Bore Diameter	Capacity
294	20	E

1. **Series**
   - 294: ISO thrust SRB
2. **Bore Diameter**
   - 00: 10 mm
   - 01: 12 mm
   - 02: 15 mm
   - 03: 17 mm
   - 04+: # * 5 = bore diameter in mm (ex. 20 = 100 mm)
3. **Capacity**
   - E: Extra capacity with pressed steel cage
   - Blank: Standard capacity with machined brass cage

**E type and non E Type Thrust SRBs are not interchangeable with each other*

The NTN Advantage

Throughout the industry, NTN is known for producing the highest quality bearings and our Thrust SRBs are no different. Our Thrust SRBs are designed and manufactured in Japan using only the highest grade materials. We manufacture and inventory a variety of sizes commonly used in the electric motor rebuilders market starting at a bore size of 60 mm. When you purchase a “standard” Thrust SRB bearing from NTN, you receive what our competition calls “premium.”

Competitor Interchange

Series	NTN	SKF	FAG	Koyo	Nachi
294xx	294xx	294xx	294xx	294xx	294xx

Capacity	NTN	SKF	FAG	Koyo	Nachi
E	E	E	E	E	E

THRUST SPHERICAL BEARING CAPACITY AND FUNDAMENTAL FREQUENCIES								
Bearing Number	Dynamic Load Rating (lbs)	Static Load Rating (lbs)	Allowable Speed (RPM) Grease Lubrication	Allowable Speed (RPM) Oil Lubrication	Roller Pass Frequency Outer Ring*	Roller Pass Frequency Inner Ring*	Fundamental Train Frequency*	Roller Spin Frequency*
29412E	101,100	208,700	1,650	3,050	6.68	8.32	0.45	2.73
29413E	119,400	251,300	1,530	2,850	6.68	8.32	0.45	2.79
29414E	136,600	291,000	1,420	2,650	6.70	8.30	0.45	2.83
29415E	151,600	330,600	1,330	2,500	6.70	8.30	0.45	2.81
29416E	177,200	381,300	1,250	2,350	6.66	8.34	0.44	2.74
29417E	184,300	418,800	1,170	2,200	7.18	8.82	0.45	2.95
29418E	209,800	460,700	1,110	2,100	6.68	8.32	0.45	2.71
29420E	262,300	577,600	1,000	1,850	6.65	8.35	0.44	2.70
29422E	310,800	696,600	900	1,700	6.67	8.34	0.44	2.71
29424E	341,700	798,000	830	1,550	7.16	8.84	0.45	2.93
29426E	399,000	959,000	760	1,450	7.16	8.84	0.45	2.91
29428E	414,400	976,600	710	1,400	7.15	8.85	0.45	2.94
29430E	496,000	1,183,800	660	1,300	7.14	8.86	0.45	2.88
29432E	321,800	1,300,700	620	1,200	7.14	8.86	0.45	2.88

**Frequencies are listed at the fundamental frequencies and should be multiplied by the bearing rotational speed in RPM.*

Single Point Lubricators

Over 55% of premature bearing failures are lubrication related. NTN recognizes the importance that proper lubrication plays in the life and performance of electric motors. NTN offers our single point lubricators with a variety of lubricants, but most importantly the same Electric Motor grease found in our bearings.

NTN Advantage

Our single point lubricator tools help maintenance professionals safely and automatically schedule lubrication of bearings or chains. Save time, increase productivity, prevent avoidable injuries, and ensure regular maintenance is done on time, every time with NTN single point lubricators.

Part Number Nomenclature

Series		Single Point Lubricator Type	Component	Grease Volume		Grease Thickener & Application	Packaging
LUB	–	DRV	KT	120	–	PGEM	B

1. Series
- LUB: Lubricator Series

2. Single Point Lubricator Type*
- RDY: Ready Unit, Gas Powered
- SMRT: Smart Unit, Electrochemical Powered**
- DRV: Drive Unit, Electromechanical Powered***

3. Component
- KT: Complete Single Point Lubricators
- RFL: Grease Refill Kit (Includes Batteries for Drive Units)

Grease Volume
- 60: 60 cc
- 120: 120 cc
- 125: 125 cc
- 130: 130 cc
- 250: 250 cc

4. Grease Thickener & Application**
- PGEM Polyurea, Electric Motor Grease

5. Packaging
- Blank: 1x1 Box
- B: Bulk Packaging

** Mounting adapter sold separately.*
*** Complete Smart units come with battery powered control cap, lubrication cup.*
**** Complete Drive units come with motor, lubrication cup, battery pack, and support base.*
***** Additional grease types available if necessary*

Installation & Removal Tools

Over 33% of bearings fail because of contamination or poor installation practices. NTN offers a variety of installation and removal tools that align with our recommended best practices. We offer tools for both cold and hot installation along with tools that properly remove bearings without damaging the application.

The NTN Advantage

The mounting of a bearing on a machine is a key stage in determining the length of the bearing's life. NTN's complete line of installation products allows maintenance professionals to select the correct tool for the job. When it does come time to remove the bearing and rebuild the machine, NTN again offers the correct tool for the job. Utilize NTN's virtual or in-person training with an application engineer to ensure installation using best practices.

Pullers

Deep Groove Ball Bearing Puller Set

2/3 Arms Self-Centering Mechanical Pullers

NTN Part Number	Max Spread (mm)	Max Reach (mm)	Capacity (tons)
TLS-MECHPULLER2/3-120	120	80	2
TLS-MECHPULLER2/3-180	180	120	3
TLS-MECHPULLER2/3-270	270	160	5

2/3 Arms Self-Centering Hydraulic Pullers

NTN Part Number	Max Spread (mm)	Max Reach (mm)	Capacity (tons)	Cylinder Stroke (mm)
TLS-SCHYDPULLER-4T	325	190	4	60
TLS-SCHYDPULLER-12T	485	305	12	85
TLS-SCHYDPULLER-20T	570	365	20	111

Cold Mounting

Mounting Tool Kit Case

NTN Part Number	Bore Diameter	OD	What's in the Box?
TLS-1FTSET33	10-50 mm 0.40-1.97 in	26-110 mm 1.02-4.33 in	• 33 impact rings • 3 mounting sleeves • 1 dead blow mallet

Induction Heaters

SmartTEMP S

NTN Part Number	Bore Diameter	Max Bearing Weight
TLS-SMARTTEMP-S-110V	10-400 mm 0.40-15.75 in	50 kg/110 lbs

SmartTEMP M

NTN Part Number	Bore Diameter	Max Bearing Weight
TLS-SMARTTEMP-M-110V	10-500 mm 0.40-19.7 in	100 kg/220 lbs

SmartTEMP L

NTN Part Number	Bore Diameter	Max Bearing Weight
TLS-SMARTTEMP-L-460V	20-600 mm 0.80-23.6 in	200 kg/440 lbs

SmartTEMP XL/XL PIVOT, XXL and XXXL

For Larger Bearing Sizes

Max. Weight of Workpiece	Min. Bore Diameter	Max Outer Diameter
400 kg/880 lbs to 1,600 kg/3,525 lbs	30 mm/1.18 in to 85 mm/3.35 in	1,000 mm/39.7 in to 2,000 mm/78.7 in

Contact your local distributor for more information on the larger XL/XL PIVOT, XXL and XXXL SmartTEMP induction heaters.

Failure Modes

Understanding why an application fails is critical to solving the challenges faced by end users. In order to do this, NTN offers inspection of returned bearings at no charge to our customers. Typical bearing failures can be identified during inspections leading to an appropriate solution for the end user.

Typical causes of electric motors, are shown below. As indicated below, bearing failures are make up 13% of total failure with many of the other conditions also contributing to bearing problems.

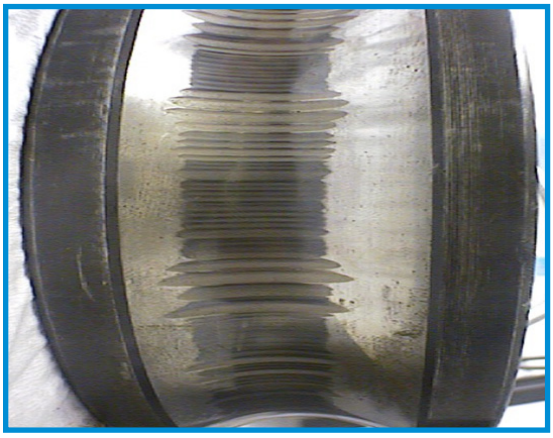
Common Causes of Motor Failure

- **30%** Overload causing insulation failure
- **19%** Contaminants (water, dust, etc.)
- **14%** Single phasing
- **13%** Bearing failure
- **10%** Natural aging
- **9%** Misalignment
- **5%** Rotor failure

The illustrations on the following pages show examples of typical electric motor bearing failures along with solutions from NTN.

Application Problem: Electrical Discharge Through Bearings

Electrical discharge damage can often occur when electric motors are used in conjunction with a variable frequency drive (VFD). This is often called bearing fluting.



Electrical Damage: Fluting

- Small frosted gray ovals with major axis across rolling path.
- Caused by an AC discharge.

NTN Solutions:
The NTN MEGAOHM™ series electrically insulates the bearing, eliminating a path for electrical discharge. There are two MEGAOHM™ solutions available: ceramic coated bearings or ceramic rolling element bearings.

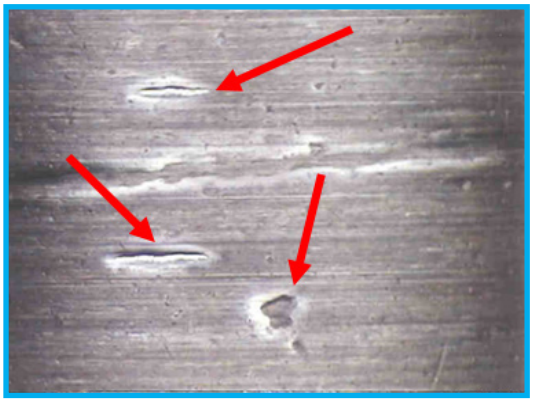
NTN offers MEGAOHM™ ceramic coated bearings in deep groove ball bearings or cylindrical roller bearings and drop-in replacements for standard products. The ceramic coating prevents electrical current from passing through the bearing. The downside of this solution is that the coating can become damaged and ineffective if the bearings are not handled with care or installed properly.

MEGAOHM™ ceramic rolling element bearings are available in deep groove ball bearings. Like the ceramic coated bearings, they are a drop-in replacement for standard deep groove ball bearings. The lightweight design offers higher limiting speeds and improved performance in marginal lubrication conditions. However, the lightweight design also makes them brittle so they too must be handled with care.

For additional information on NTN's MEGAOHM™ product offering, see pages 21-25 of this handbook.

Application Problem: Contamination

Contamination is a leading cause of bearing failure. Improper sealing allows dirt and debris to enter the bearing and excessive grease purge.



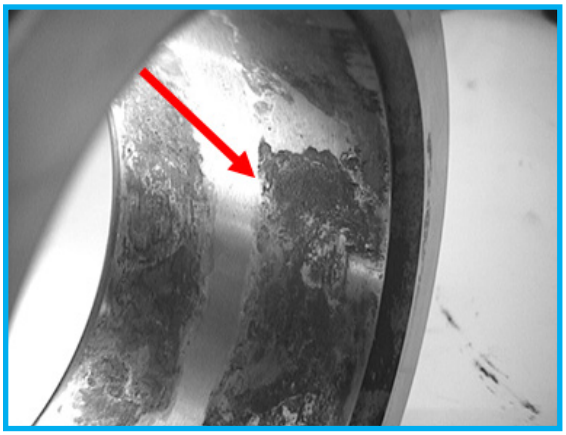
Debris Denting

- Small dents on rolling surface
- Caused by the rolling elements pushing contaminants into the raceways

NTN Solution:
NTN manufactures deep groove ball bearings with a dual contact seal (“LU” suffix) that provides optimum sealing efficiency. These orange-colored seals are best-in-class at keeping contamination out of the bearing and the grease inside because they adjust for wear. The inner lip of the double-lip seal rests against the inside surface of the V-groove while the outer lip spreads open by the elastic force of rubber to create a small gap between the outer lip and the inner ring, creating a labyrinth effect. Should the inner lip become worn out, the contact pressure will decrease, and the outer lip will get closer to the inner ring, maintain a constant degree of sealing and noticeably lengthening bearing service life.For additional information on NTN’s sealing capabilities, see pages 4-7 of this handbook.

Application Problem: Improper Shaft Fit

Bearing fits that are too loose for the specific bearing type and size in an electric motor will cause small microscopic movement between the shaft and the bearing bore. This will create damage called fretting corrosion which reduces the integrity of the bearing/shaft press fit.

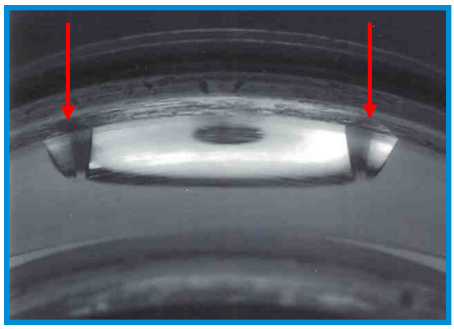


Fretting Corrosion

- Red translucent or opaque black discoloration over areas of high polish on outside surfaces of bearing
- Caused by insufficient fit
- Typically seen in the load zone area of the bearing

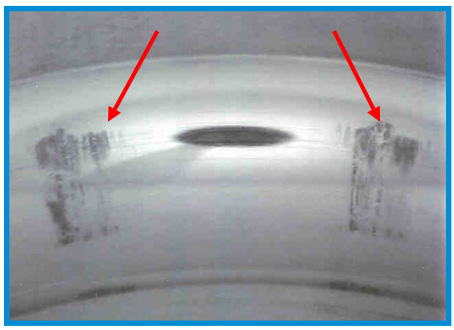
NTN Solution:
Utilize the shaft and housing fit recommendations shown on pages 36-40 of this handbook.

Other Typical Failure Modes



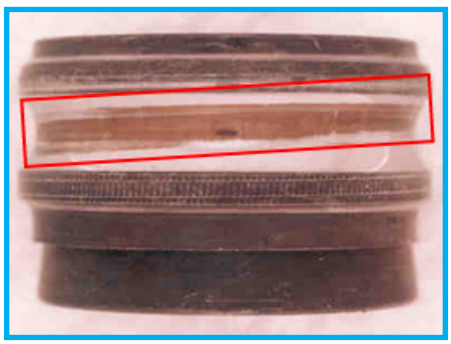
Brinelling

- Indentation caused when rolling element is pushed into the raceway
- Caused by impact or excessive static load
- Typically at roller spaced intervals



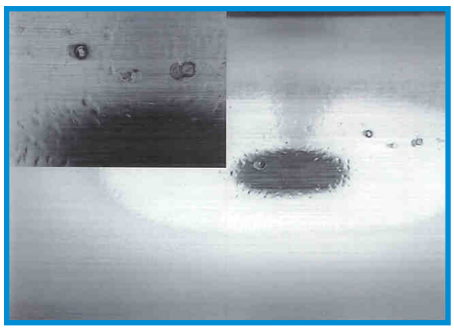
False Brinelling

- A physical removal of material at the contact between rolling element and raceway. Contact areas are polished.
- Caused by minute vibration while the bearing is non-operational



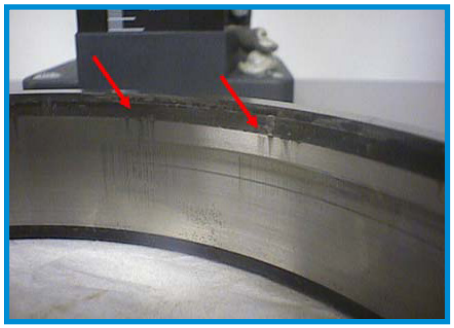
Wear

- Deterioration of surface finish
- Will increase the clearance in the bearing
- Caused by particulate contaminant or by insufficient lubrication



Electrical Damage: Pitting

- Minute pool(s) of melted bearing steel on raceways or rolling elements.
- Caused by large single discharge while the bearing is static.



Plow Marks

- Series of parallel marks across the raceway of cylindrical roller bearing
- Located precisely at roller intervals
- Caused when the end of the roller digs into the raceway during assembly

Bearing Fits

Resultant Fits

For rolling bearings, it is necessary to fix inner and outer rings on the shaft or in the housing so that relative movement does not occur between fitting surfaces during operation or under load. This relative movement between the mating surfaces of the bearing and the shaft or housing can occur in a radial direction, an axial direction, or in the direction of rotation. Types of resultant fits include tight, transition and loose fits, which describe whether or not there is interference between the bearing and the shaft or housing.

The most effective way to fix the mating surfaces between the bearing and shaft or housing is to apply a “tight fit”. The advantage of a tight fit for thin walled bearings is that it provides uniform load support over the entire ring circumference without any loss of load carrying capacity. However, with a tight fit, ease of installation and disassembly is lost; and when using a non-separable bearing as the floating-side bearing, axial displacement is not possible. For this reason, a tight fit cannot be recommended in all cases.

The Necessity of a Proper Fit

In some cases, an improper fit may lead to damage and short bearing life. Therefore, it is necessary to carefully select the proper fit. Some possible bearing failures caused by improper fit are listed below.

- Raceway cracking, early spalling and displacement of raceway
- Raceway and shaft or housing abrasion caused by creeping and fretting corrosion
- Seizing caused by negative internal clearances
- Increased noise and deteriorated rotational accuracy due to raceway groove deformation

Importance of Correct Fitting of Electric Motor Bearings

A bearing can only perform to its full capacity when it is correctly fitted on the shaft and in the housing. Insufficient interference on fitting surfaces could cause bearing rings to creep in a circumferential direction. Once this happens, considerable wear occurs on the fitting surface and both the shaft and the housing can be damaged. Furthermore, abrasive particles may enter the bearing causing vibration, excessive heat, damage to raceways, and lowered rotational efficiency. To ensure that slip does not occur between the fitted surfaces of the bearing rings and the shaft or housing, in an electric motor, the bearing is usually installed on the shaft with an interference fit and a loose fit in the housing. The tables on the following pages show the recommended shaft and housing fits for both ball and roller bearings.

Electric Motor Bearing Fits

ELECTRIC MOTOR SHAFT AND HOUSING FITS 6200 SERIES								
Bearing Part Number	Bearing Bore (mm)	Shaft Fit	Shaft Diameter Min. (in)	Shaft Diameter Max. (in)	Outer Diameter (mm)	Housing Fit	Housing Bore Min. (in)	Housing Bore Max. (in)
6201	12	j5	0.4723	0.4726	32	H6	1.2598	1.2605
6202	15	j5	0.5904	0.5907	35	H6	1.3780	1.3786
6203	17	j5	0.6692	0.6695	40	H6	1.5748	1.5754
6204	20	k5	0.7875	0.7878	47	H6	1.8504	1.8510
62/22	22	k5	0.8662	0.8666	50	H6	1.9685	1.9691
6205	25	k5	0.9843	0.9847	52	H6	2.0472	2.0480
62/28	28	k5	1.1024	1.1028	58	H6	2.2835	2.2841
6206	30	k5	1.1812	1.1815	62	H6	2.4409	2.4417
62/32	32	k5	1.2599	1.2604	65	H6	2.5591	2.5598
6207	35	k5	1.3780	1.3785	72	H6	2.8346	2.8354
6208	40	k5	1.5749	1.5753	80	H6	3.1496	3.1504
6209	45	k5	1.7717	1.7722	85	H6	3.3465	3.3473
6210	50	k5	1.9686	1.9690	90	H6	3.5433	3.5442
6211	55	k5	2.1654	2.1659	100	H6	3.9370	3.9379
6212	60	k5	2.3623	2.3628	110	H6	4.3307	4.3316
6213	65	k5	2.5591	2.5596	120	H6	4.7244	4.7253
6214	70	k5	2.7560	2.7565	125	H6	4.9213	4.9222
6215	75	k5	2.9528	2.9533	130	H6	5.1181	5.1191
6216	80	k5	3.1497	3.1502	140	H6	5.5118	5.5128
6217	85	k5	3.3466	3.3472	150	H6	5.9055	5.9065
6218	90	k5	3.5434	3.5440	160	H6	6.2992	6.3002
6219	95	k5	3.7403	3.7409	170	H6	6.6929	6.6939
6220	100	k5	3.9371	3.9377	180	H6	7.0866	7.0876
6221	105	m5	4.1344	4.1350	190	H6	7.4803	7.4815
6222	110	m5	4.3312	4.3318	200	H6	7.8740	7.8752
6224	120	m5	4.7249	4.7255	215	H6	8.4646	8.4657
6226	130	m5	5.1187	5.1194	230	H6	9.0551	9.0563
6228	140	m5	5.5124	5.5131	250	H6	9.8425	9.8437
6230	150	m5	5.9061	5.9068	270	H6	10.6299	10.6312
6232	160	m5	6.2998	6.3005	290	H6	11.4173	11.4186
6234	170	m6	6.6935	6.6945	310	H6	12.2047	12.2060
6236	180	m6	7.0872	7.0882	320	H6	12.5984	12.5998
6238	190	m6	7.4810	7.4821	340	H6	13.3858	13.3872
6240	200	m6	7.8747	7.8758	360	H6	14.1732	14.1746
6244	220	n6	8.6626	8.6638	400	H6	15.7480	15.7494

Electric Motor Bearing Fits

ELECTRIC MOTOR SHAFT AND HOUSING FITS 6300 SERIES								
Bearing Part Number	Bearing Bore (mm)	Shaft Fit	Shaft Diameter Min. (in)	Shaft Diameter Max. (in)	Outer Diameter (mm)	Housing Fit	Housing Bore Min. (in)	Housing Bore Max. (in)
6300	10	j5	0.3936	0.3939	35	H6	1.3780	1.3786
6301	12	j5	0.4723	0.4726	37	H6	1.4567	1.4573
6302	15	j5	0.5904	0.5907	42	H6	1.6535	1.6542
6303	17	j5	0.6692	0.6695	47	H6	1.8504	1.8510
6304	20	k5	0.7875	0.7878	52	H6	2.0472	2.0480
63/22	22	k5	0.8662	0.8666	56	H6	2.2047	2.2055
6305	25	k5	0.9843	0.9847	62	H6	2.4409	2.4417
63/28	28	k5	1.1024	1.1028	68	H6	2.6772	2.6779
6306	30	k5	1.1812	1.1815	72	H6	2.8346	2.8354
63/32	32	k5	1.2599	1.2604	75	H6	2.9528	2.9535
6307	35	k5	1.3780	1.3785	80	H6	3.1496	3.1504
6308	40	k5	1.5749	1.5753	90	H6	3.5433	3.5442
6309	45	k5	1.7717	1.7722	100	H6	3.9370	3.9379
6310	50	k5	1.9686	1.9690	110	H6	4.3307	4.3316
6311	55	k5	2.1654	2.1659	120	H6	4.7244	4.7253
6312	60	k5	2.3623	2.3628	130	H6	5.1181	5.1191
6313	65	k5	2.5591	2.5596	140	H6	5.5118	5.5128
6314	70	k5	2.7560	2.7565	150	H6	5.9055	5.9065
6315	75	k5	2.9528	2.9533	160	H6	6.2992	6.3002
6316	80	k5	3.1497	3.1502	170	H6	6.6929	6.6939
6317	85	k5	3.3466	3.3472	180	H6	7.0866	7.0876
6318	90	k5	3.5434	3.5440	190	H6	7.4803	7.4815
6319	95	k5	3.7403	3.7409	200	H6	7.8740	7.8752
6320	100	k5	3.9371	3.9377	215	H6	8.4646	8.4657
6321	105	m5	4.1344	4.1350	225	H6	8.8583	8.8594
6322	110	m5	4.3312	4.3318	240	H6	9.4488	9.4500
6324	120	m5	4.7249	4.7255	260	H6	10.2362	10.2375
6326	130	m5	5.1187	5.1194	280	H6	11.0236	11.0249
6328	140	m5	5.5124	5.5131	300	H6	11.8110	11.8123
6330	150	m5	5.9061	5.9068	320	H6	12.5984	12.5998
6332	160	m5	6.2998	6.3005	340	H6	13.3858	13.3872
6334	170	m6	6.6935	6.6945	360	H6	14.1732	14.1746
6336	180	m6	7.0872	7.0882	380	H6	14.9606	14.9620
6338	190	m6	7.4810	7.4821	400	H6	15.7480	15.7494
6340	200	m6	7.8747	7.8758	420	H6	16.5354	16.5370
6344	220	n6	8.6626	8.6638	460	H6	18.1102	18.1118

Electric Motor Bearing Fits

ELECTRIC MOTOR SHAFT AND HOUSING FITS NU, NJ, N, NF 200 SERIES								
Bearing Part Number	Bearing Bore (mm)	Shaft Fit	Shaft Diameter Min. (in)	Shaft Diameter Max. (in)	Outer Diameter (mm)	Housing Fit	Housing Bore Min. (in)	Housing Bore Max. (in)
204	20	k5	0.7875	0.7878	47	H6	1.8504	1.8510
205	25	k5	0.9843	0.9847	52	H6	2.0472	2.0480
206	30	k5	1.1812	1.1815	62	H6	2.4409	2.4417
207	35	k5	1.3780	1.3785	72	H6	2.8346	2.8354
208	40	k5	1.5749	1.5753	80	H6	3.1496	3.1504
209	45	m5	1.7720	1.7724	85	H6	3.3465	3.3473
210	50	m5	1.9689	1.9693	90	H6	3.5433	3.5442
211	55	m5	2.1658	2.1663	100	H6	3.9370	3.9379
212	60	m5	2.3626	2.3632	110	H6	4.3307	4.3316
213	65	m5	2.5595	2.5600	120	H6	4.7244	4.7253
214	70	m5	2.7563	2.7569	125	H6	4.9213	4.9222
215	75	m5	2.9532	2.9537	130	H6	5.1181	5.1191
216	80	m5	3.1500	3.1506	140	H6	5.5118	5.5128
217	85	m5	3.3470	3.3476	150	H6	5.9055	5.9065
218	90	m5	3.5438	3.5444	160	H6	6.2992	6.3002
219	95	m5	3.7407	3.7413	170	H6	6.6929	6.6939
220	100	m5	3.9375	3.9381	180	H6	7.0866	7.0876
221	105	m5	4.1344	4.1350	190	H6	7.4803	7.4815
222	110	m5	4.3312	4.3318	200	H6	7.8740	7.8752
224	120	m5	4.7249	4.7255	215	H6	8.4646	8.4657
226	130	m5	5.1187	5.1194	230	H6	9.0551	9.0563
228	140	m5	5.5124	5.5131	250	H6	9.8425	9.8437
230	150	m5	5.9061	5.9068	270	H6	10.6299	10.6312
232	160	m5	6.2998	6.3005	290	H6	11.4173	11.4186
234	170	n6	6.6940	6.6950	310	H6	12.2047	12.2060
236	180	n6	7.0877	7.0887	320	H6	12.5984	12.5998
238	190	n6	7.4815	7.4827	340	H6	13.3858	13.3872
240	200	n6	7.8752	7.8764	360	H6	14.1732	14.1746

Electric Motor Bearing Fits

ELECTRIC MOTOR SHAFT AND HOUSING FITS NU, NJ, N, NF 300 SERIES								
Bearing Part Number	Bearing Bore (mm)	Shaft Fit	Shaft Diameter Min. (in)	Shaft Diameter Max. (in)	Outer Diameter (mm)	Housing Fit	Housing Bore Min. (in)	Housing Bore Max. (in)
304	20	k5	0.7875	0.7878	52	H6	2.0472	2.0480
305	25	k5	0.9843	0.9847	62	H6	2.4409	2.4417
306	30	k5	1.1812	1.1815	72	H6	2.8346	2.8354
307	35	k5	1.3780	1.3785	80	H6	3.1496	3.1504
308	40	k5	1.5749	1.5753	90	H6	3.5433	3.5442
309	45	m5	1.7720	1.7724	100	H6	3.9370	3.9379
310	50	m5	1.9689	1.9693	110	H6	4.3307	4.3316
311	55	m5	2.1658	2.1663	120	H6	4.7244	4.7253
312	60	m5	2.3626	2.3632	130	H6	5.1181	5.1191
313	65	m5	2.5595	2.5600	140	H6	5.5118	5.5128
314	70	m5	2.7563	2.7569	150	H6	5.9055	5.9065
315	75	m5	2.9532	2.9537	160	H6	6.2992	6.3002
316	80	m5	3.1500	3.1506	170	H6	6.6929	6.6939
317	85	m5	3.3470	3.3476	180	H6	7.0866	7.0876
318	90	m5	3.5438	3.5444	190	H6	7.4803	7.4815
319	95	m5	3.7407	3.7413	200	H6	7.8740	7.8752
320	100	m5	3.9375	3.9381	215	H6	8.4646	8.4657
321	105	m5	4.1344	4.1350	225	H6	8.8583	8.8594
322	110	m5	4.3312	4.3318	240	H6	9.4488	9.4500
324	120	m5	4.7249	4.7255	260	H6	10.2362	10.2375
326	130	m5	5.1187	5.1149	280	H6	11.0236	11.0249
328	140	m5	5.5124	5.5131	300	H6	11.8110	11.8123
330	150	m5	5.9061	5.9068	320	H6	12.5984	12.5998
332	160	m5	6.2998	6.3005	340	H6	13.3858	13.3872
334	170	n6	6.6940	6.6950	360	H6	14.1732	14.1746
336	180	n6	7.0877	7.0887	380	H6	14.9606	14.9620
338	190	n6	7.4815	7.4827	400	H6	15.7480	15.7494
340	200	n6	7.8752	7.8764	420	H6	16.5354	16.5370

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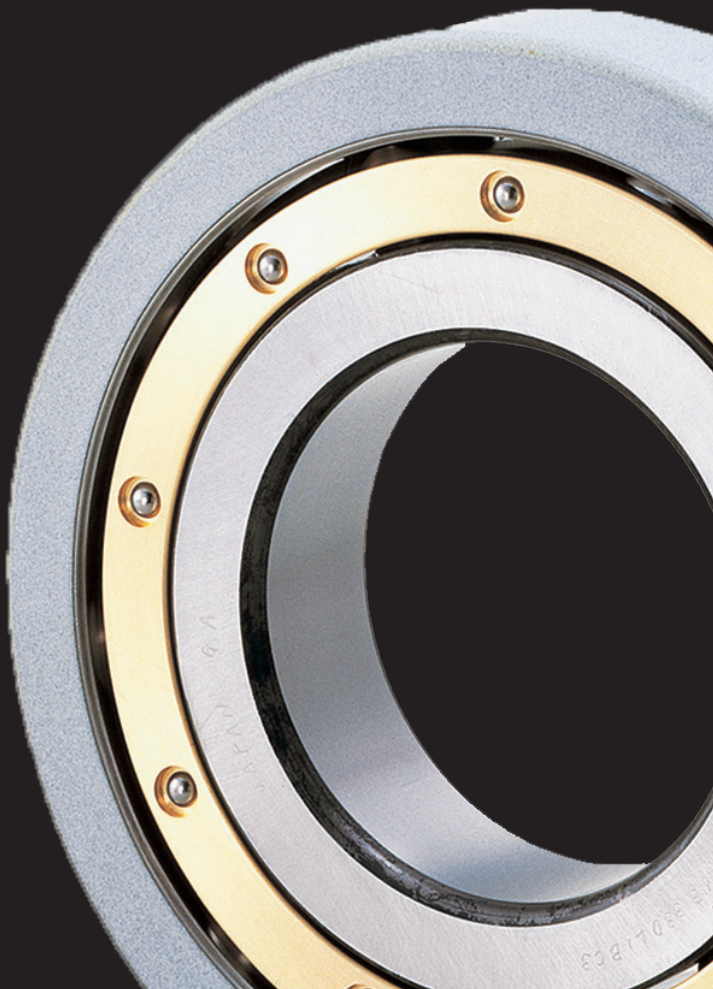

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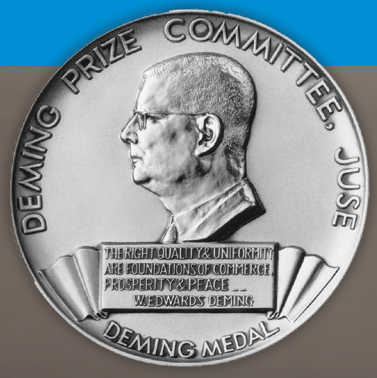

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