MOTION & CONTROL™

NSK

INDUSTRIAL MOTOR BEARINGS

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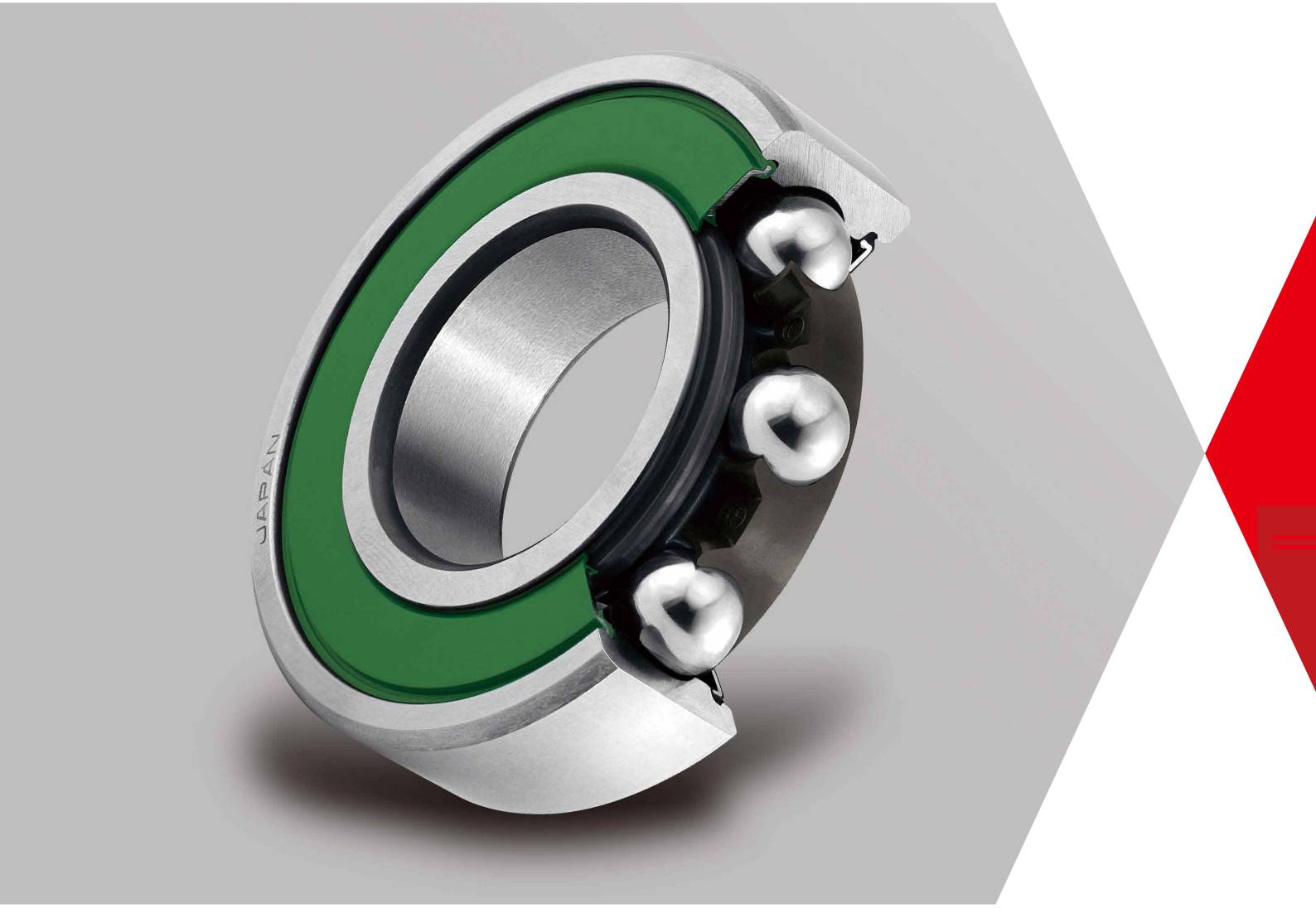
INDUSTRIAL MOTOR

All industries are powered by motors. NSK's proven bearings take loads and support smooth and quiet rotation in rotating motor components.
Our top priority is to deliver solutions that protect the environment. To this end, we focus on Tribology to create technologies that reduce energy loss and improve life.
We address trends towards electric power by offering high-performance bearings with low energy loss, high reliability, and long product life.
This catalog details NSK's industrial motor bearings, including products with low torque, long life, and low heat generation.



BEARINGS

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NSK Solutions for Industrial Motor Needs

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	Longer maintenance intervals	Longer seizure life		
	Vibrating and unbalanced loads	Improved creep resistance		○
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	Longer maintenance intervals	Longer seizure life		
	High-speed rotation and unbalanced loads	Improved creep resistance		○

Bearing Components							
Ball		Cage		Seal	Grease		
Ceramic Balls	Seizure-Resistant Heat-Treated Steel Balls	Plastic Cages for EV Motors	Plastic Cages	DW Seal	EA7	LGU	EA9
P. 18–19	**P. 14–15**	**P. 14–15**	**P. 16–17**	**P. 8–9**	**P. 6**	**P. 7**	**P. 10–11**
				●		●	
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○	●	●					
○	●	●			●		○

●:Recommended ○:Option

High-Reliability EA7 Grease for Servomotors

Machine tools, robots, and carrier equipment require servomotors to endure repeated start/stop/reverse operations under harsh conditions with microvibrations caused by slight positioning errors during servo-lock.
These conditions may lead to an insufficient oil film on the bearing raceway surface, resulting in fretting damage. In response, NSK developed EA7 grease with excellent fretting resistance, long life, and improved reliability.

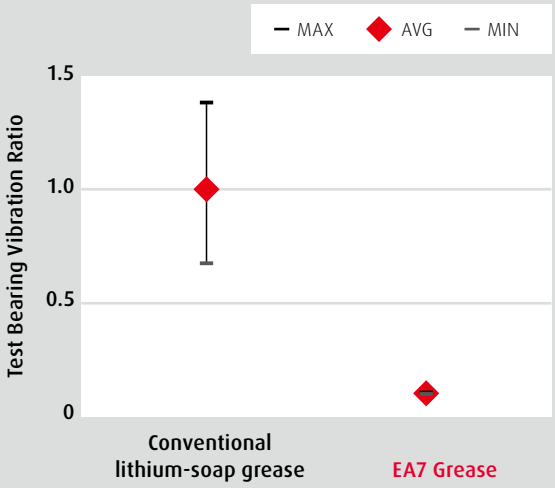
Features

1 Better Reliability Under Harsh Operating Conditions

EA7 grease improves fretting resistance in environments with micro-vibrations, reducing vibration and achieving longer bearing life.

Fretting: Wear due to repeated sliding between two surfaces. When bearings face vibrations or oscillations while stopped, an insufficient oil film may result, leading to this damage.

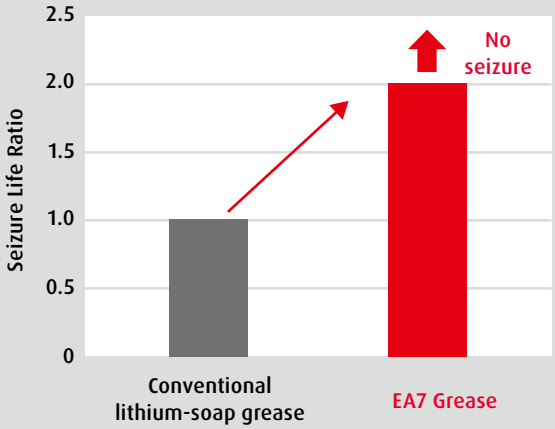
Tested bearings: ø8×ø22×7
Preload: 49 N
Oscillation angle: 1° (±0.5°)
Oscillation frequency: 30 Hz
Oscillations: 5 000 000



2 Longer Maintenance Intervals

Bearings filled with EA7 Grease have a much longer life than those with conventional lithium-soap grease.

Tested bearings: ø25×ø62×17
Rotational speed: 10 000 min^{-1}
Temperature: 140 °C



DATA

Example Bearing Designation

6203	T1XL	VV	CM	EA7

- EA7: EA7 Grease
- CM: Radial Clearance
- VV: Seal/Shield
- T1XL: Cage
- 6203: Basic Designation

Low-Particle-Emission LGU Grease for Servomotors

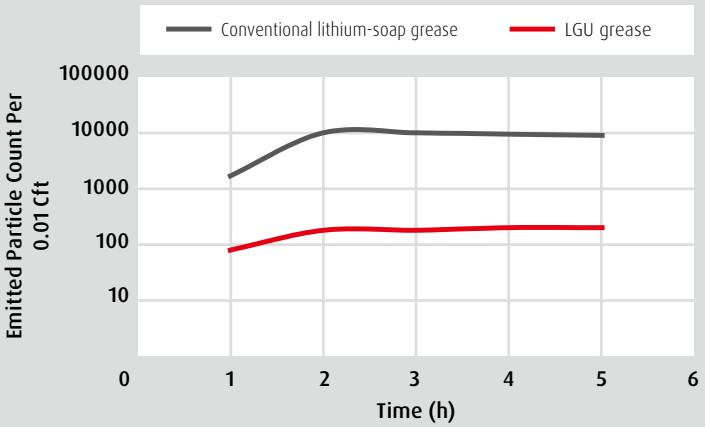
LGU grease features an optimized grease composition free of sulfur and metal elements.
This greatly reduces particle emissions, helping to prevent encoder contamination and brake slip.

Features

1 Less Encoder Contamination and Brake Slip

LGU grease has nearly 90% less particle emissions than conventional lithium-soap grease.

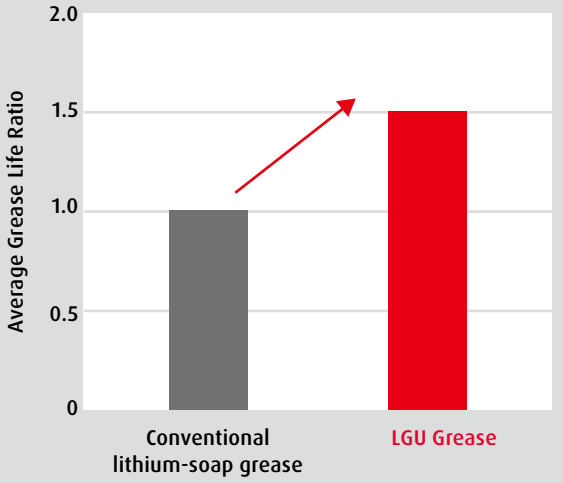
Tested bearings: ø8×ø22×7
Grease Fill: Light (L)
Rotational Speed: 1 800 min^{-1}
Particle Size: Over 0.1 µm



2 Longer Maintenance Intervals

Bearings with LGU grease realize a grease life 1.5 times longer than that with conventional lithium-soap grease.

Tested bearings: ø25×ø62×17
Rotational speed: 10 000 min^{-1}
Temperature: 140 °C



DATA

Example Bearing Designation

6203	T1XL	DDW	CM	LGU

- LGU: LGU Grease
- CM: Radial Clearance
- DDW: Seal/Shield
- T1XL: Cage
- 6203: Basic Designation

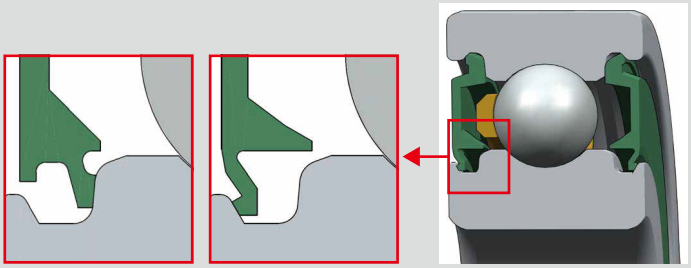
Low-Particle-Emission DW Seal for Servomotors

Light-contact DW seals have an optimized seal lip structure that prevents grease from leaking from the bearing and realizes low torque. These features help prevent encoder contamination and brake slip in servomotors.

Features

1 Light-Contact Seal Lip

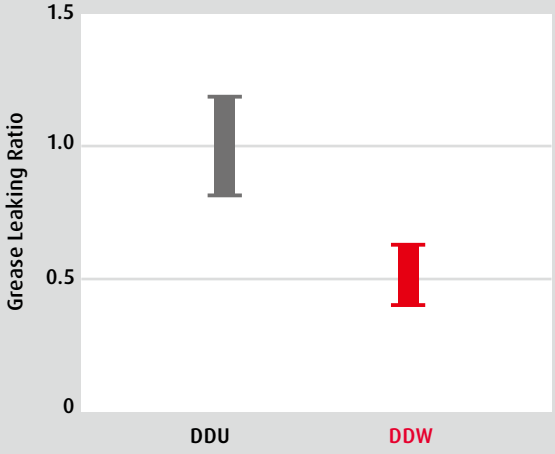
A special seal lip structure lowers lip pressure, resulting in low torque.
The main lip has outward contact with the beveled portion of the inner ring seal groove. This prevents the seal from opening due to internal pressure and prevents grease leakage.



2 Less Encoder Contamination and Brake Slip

DW seals minimize grease leakage.

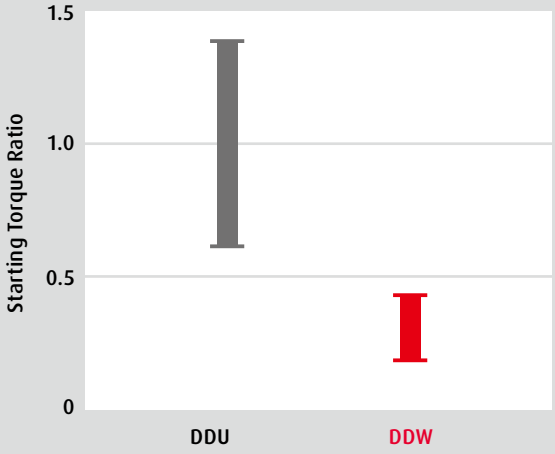
Tested Bearings: ø17 × ø26 × 5
Rotational Speed: 10 000 min^{-1}
Temperature: 50 °C
Time: 50 h



3 Lower Energy Consumption

DW seals greatly reduce starting torque compared to DU seals.

Tested bearings: ø17 × ø40 × 12
Temperature: 25 °C



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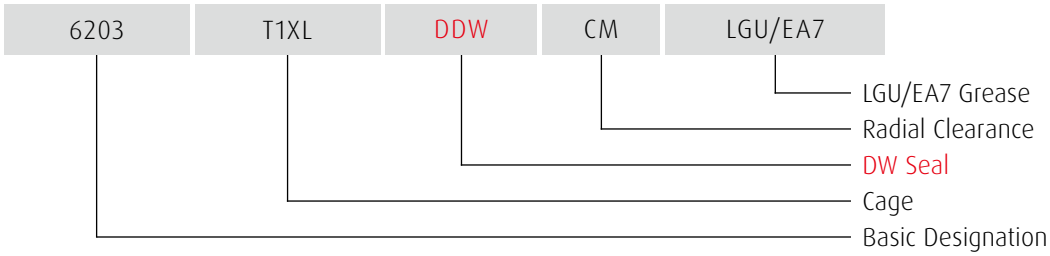
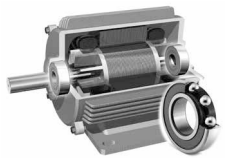
Example Bearing Designation



Designation	Boundary Dimensions (mm)		
	Bore Dia.	Outside Dia.	Width
6000	10	26	8
6200		30	9
6300		35	11
6001	12	28	8
6201		32	10
6301		37	12
6002	15	32	9
6202		35	11
6302		42	13
6003	17	35	10
6203		40	12
6303		47	14
6004	20	42	12
6204		47	14
6304		52	15
6005	25	47	12
6205		52	15
6305		62	17

Designation	Boundary Dimensions (mm)		
	Bore Dia.	Outside Dia.	Width
6006	30	55	13
6206		62	16
6306		72	19
6007	35	62	14
6207		72	17
6307		80	21
6008	40	68	15
6208		80	18
6308		90	23
6209	45	85	19
6309		100	25
6010	50	80	16
6210		90	20
6310		110	27
6311	55	120	29

DW seals are made of nitrile rubber (operating temp: -30 to 110 °C)



Low Torque & Long-Life Bearings for High-Efficiency Motors

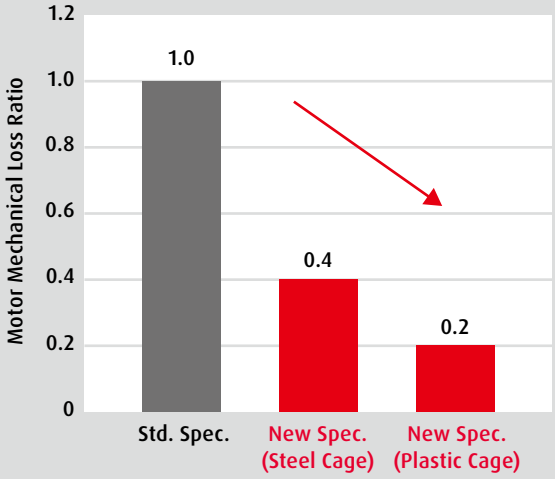
NSK optimized the type of grease and fill amount, grease shear, and agitation resistance during bearing rotation to not only realize low torque and long life, but also save energy. Using a plastic cage allows for even lower torque and longer life.

Features

1 Increases Motor Efficiency

Our new specification steel cages achieve 60% less mechanical loss than conventional products. For even less mechanical loss, new plastic cages achieve a huge 80% reduction.

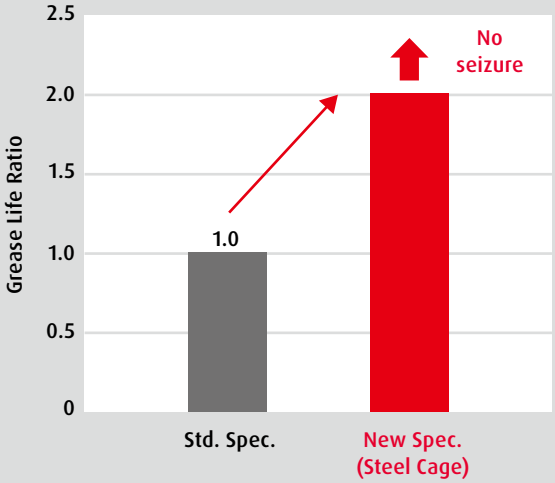
Motor: 7.5 kW 2P 200 V 50 Hz
Temperature: 25 °C



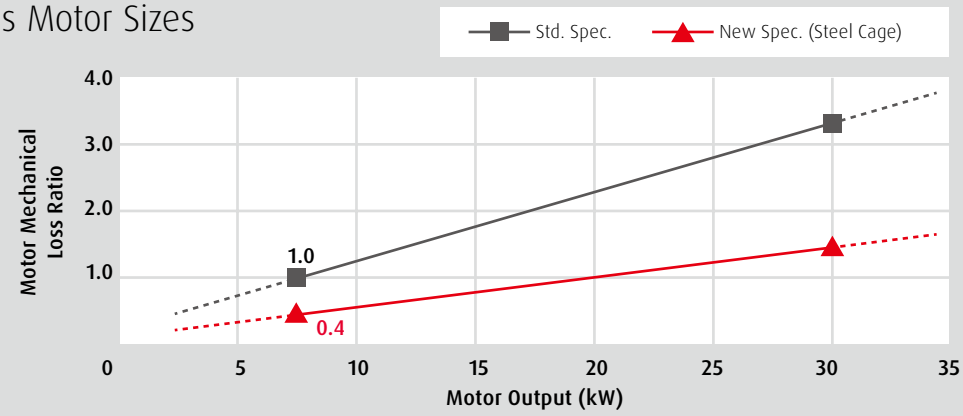
2 Longer Motor Maintenance Intervals

Using new EA9 grease makes seizure life over 2 times longer, improving durability.

Tested bearings: ø25 × ø62 × 17
Rotational speed: 10 000 min^{-1}
Temperature: 140 °C



3 Effective for Various Motor Sizes



*Please contact NSK regarding bearings used in pumps and compressors.

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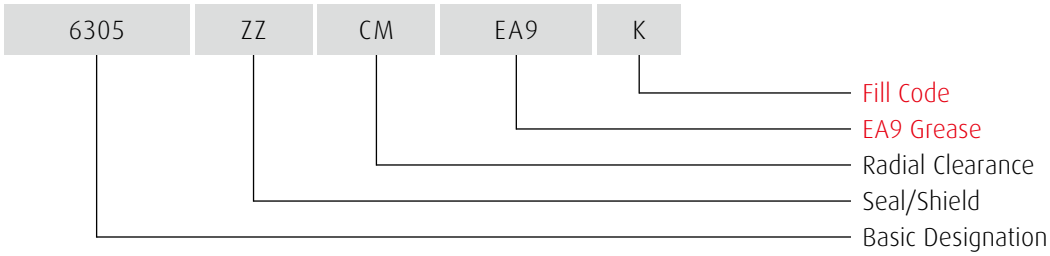
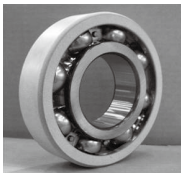
Example Bearing Designation



Designation	Boundary Dimensions (mm)			Grease Fill Code
	Bore Dia.	Outside Dia.	Width	
6200	10	26	8	K
6300		35	11	K
6201	12	32	10	K
6301		37	12	K
6202	15	35	11	K
6302		42	13	K
6203	17	40	12	K
6303		47	14	K
6204	20	47	14	K
6304		52	15	K
6205	25	52	15	K
6305		62	17	K
6206	30	62	16	K
6306		72	19	K
6207	35	72	17	K
6307		80	21	K
6208	40	80	18	K
6308		90	23	K

Designation	Boundary Dimensions (mm)			Grease Fill Code
	Bore Dia.	Outside Dia.	Width	
6209	45	85	19	L
6309		100	25	L
6210	50	90	20	L
6310		110	27	L
6211	55	100	21	L
6311		120	29	L
6212	60	110	22	L
6312		130	31	L
6213	65	120	23	L
6313		140	33	L
6214	70	125	24	L
6314		150	35	L
6215	75	130	25	L
6315		160	37	L
6216	80	140	26	L
6316		170	39	L

*The filling code indicates how much grease should be applied into the bearing, in increasing quantity from K to L to S. For low torque specifications, K or L fills are recommended.



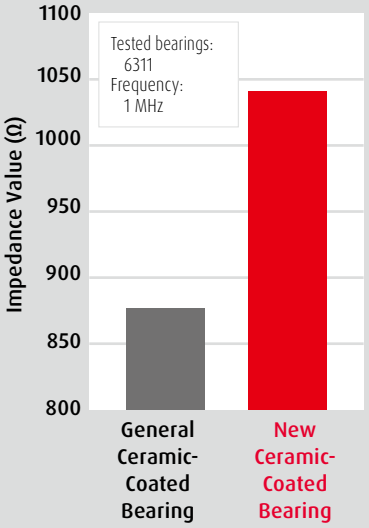
Ceramic-Coated Insulated Bearings for Inverter Motors

By coating the outer ring with insulating ceramic material,
electric current cannot pass through the bearing and cause electrical erosion.

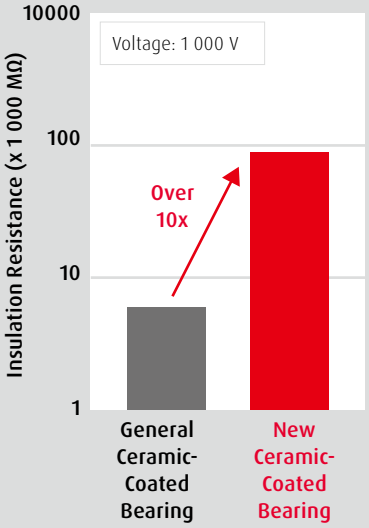
Features

A Solution to Electrical Erosion in Large Motors

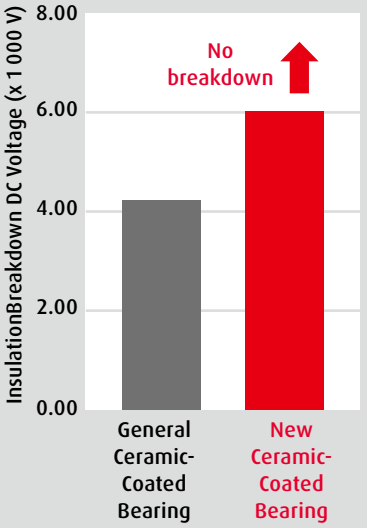
We've enhanced the ceramic coating to dramatically improve insulation performance over regular ceramic-coated bearings.



AC Insulation Resistance



DC Insulation Resistance

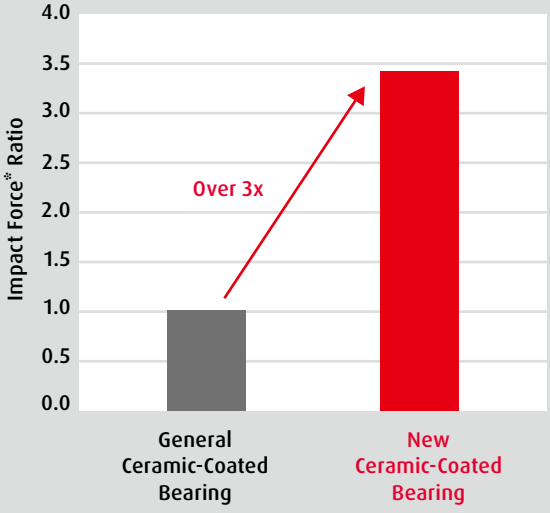


Insulation Breakdown Voltage

1

Easy to Handle and Mount

Optimized specifications make the impact resistance of our new ceramic-coated bearings over 3 times higher than conventional products.



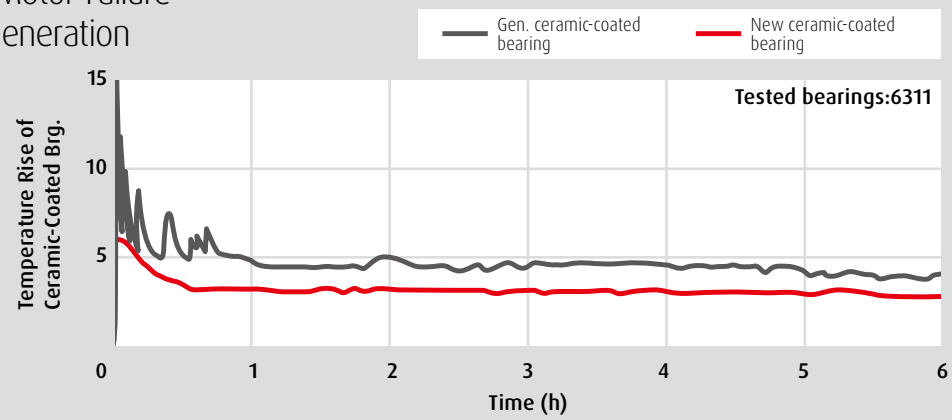
Mechanical Strength Test Results for Impact Resistance of Ceramic Coating (Surface Side)

2

*Refers to force on the surface coating

Reduced Premature Motor Failure From Bearing Heat Generation

Our optimized ceramic coating more effectively dissipates heat.



Heat Dissipation Test Results

3

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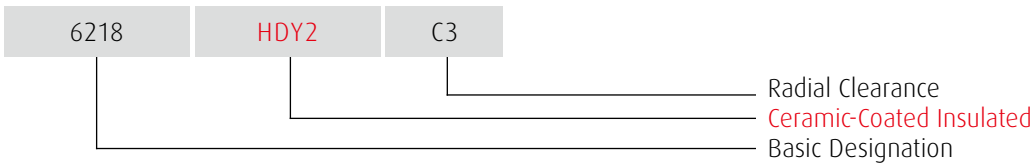
Example Bearing Designation

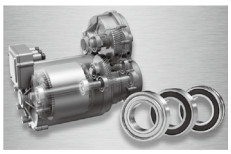


Designation	Boundary Dimensions (mm)		
	Bore Dia.	Outside Dia.	Width
6312	60	130	31
6313	65	140	33
6215	75	130	25
6315		160	37
6216	80	140	26
6316		170	39
6217	85	150	28
6317		180	41

Designation	Boundary Dimensions (mm)		
	Bore Dia.	Outside Dia.	Width
6218	90	160	30
6318		190	43
6219	95	170	32
6319		200	45
6220	100	180	41
6320		215	47
6322	110	240	50
6224	120	215	40
6226	130	230	40

- Listed bearings are offered as standard open bearings with C3 clearance.

- Please handle ceramic bearings with the same care as standard bearings.
- Be sure to avoid strong impacts to the outer ring when mounting the bearing using methods involving a hammer or similar. Excessive impacts may cause breaking or cracking of the ceramic coating and/or scratches on the bearing raceway. Bearings cannot be used if damaged.



Electric Vehicle (EV) Motor Bearings

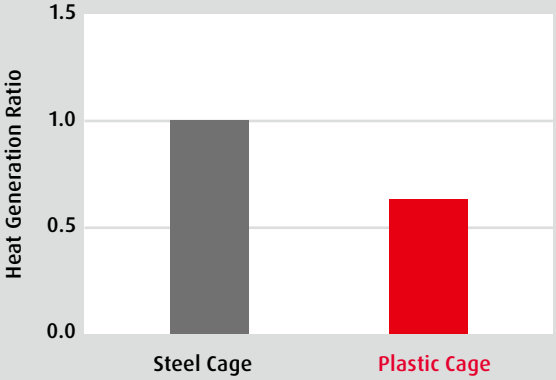
NSK bearings improve the high-speed rotation performance of EV motors by utilizing a plastic cage, specialized grease, and steel balls heat-treated to resist seizure.

Features

1 Plastic Cage for High-Speed Rotation

Today's applications cause bearings to face high temperature and speeds. In response, our plastic cages feature excellent heat resistance. We also examined cage strength through our proven analysis technologies to optimize the shape of the cage.

Tested bearings: ø20 × ø47 × 14
Rotational speed: 3 000 min^{-1}

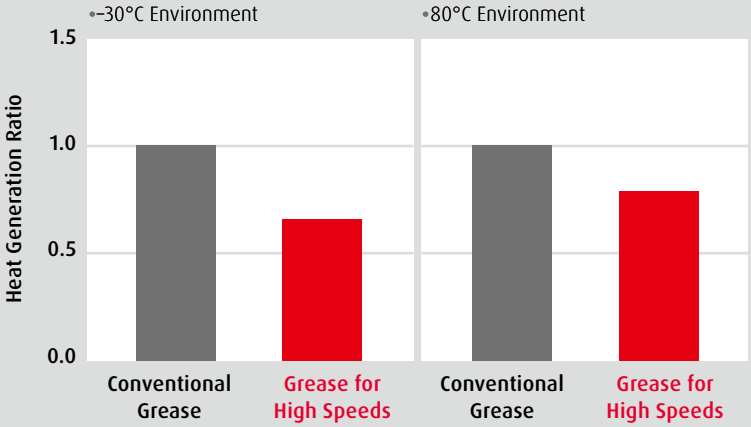


Comparison of Heat Generation by Cage Material

2 Grease for High-Speed Rotation

By matching the thickener to the grease, we reduced bearing heat generation across a wide temperature range.

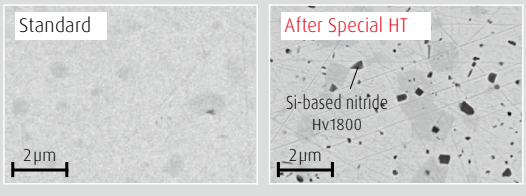
Tested bearings: ø35 × ø62 × 14
Rotational speed: 3 000 min^{-1}



Reduction in Generated Heat

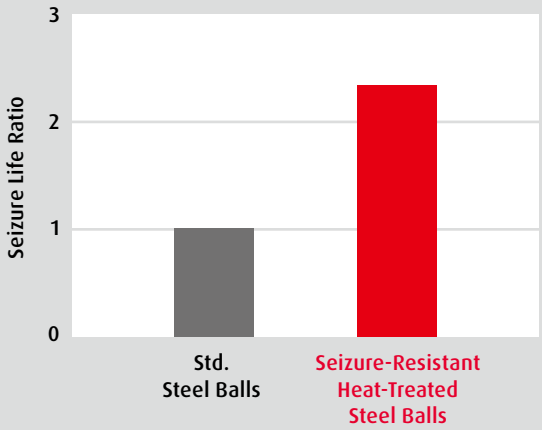
3 Seizure-Resistant Heat-Treated Steel Balls for High-Speed Rotation

Steel balls with a hard nitride formed on the surface improve seizure resistance.



Standard Steel Ball Special Heat-Treated Steel Ball

Difference in Ball Surface Structure



Seizure Resistance Comparison

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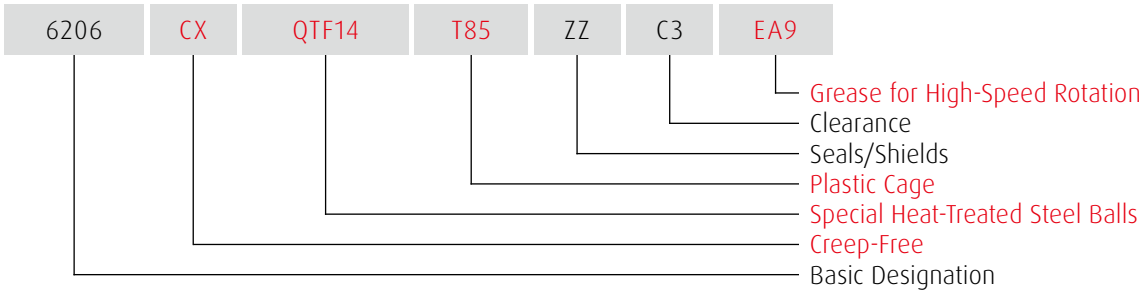
Example Bearing Designation



Designation	Boundary Dimensions (mm)			Limiting Speeds (min^{-1})		Seizure-Resistant HT Ball Spec
	Bore Dia.	Outside Dia.	Width	n	n' (Seizure-Resistant HT Ball Spec.)	
6005	25	47	12	19000	20000	QTF14
6205		52	15	16000	18000	QTF14
6006	30	55	13	16000	18000	QTF14
6206		62	16	14000	15000	QTF14
6007	35	62	14	14000	15000	QTF14
6207		72	17	12000	13000	QTF14
6008	40	68	15	13000	14000	QTF14
6208		80	18	11000	—	—
6009	45	75	16	12000	13000	QTF14
6209		85	19	10000	11000	QTF14
6010	50	80	16	11000	12000	QTF14
6210		90	20	9000	10000	QTF14
6011	55	90	18	9500	10000	QTF14

• Plastic cages for EV motors use T85 (Nylon 4,6).

• Please contact NSK regarding reduction gear bearings.

Bearings With Plastic Cages

Plastic cages are lighter than steel cages, have excellent self-lubricating properties, and have a low coefficient of friction. For this reason, they generate little heat and are excellent under high speed rotation. In addition, since they don't need as much grease, they effectively reduce bearing torque and contamination.

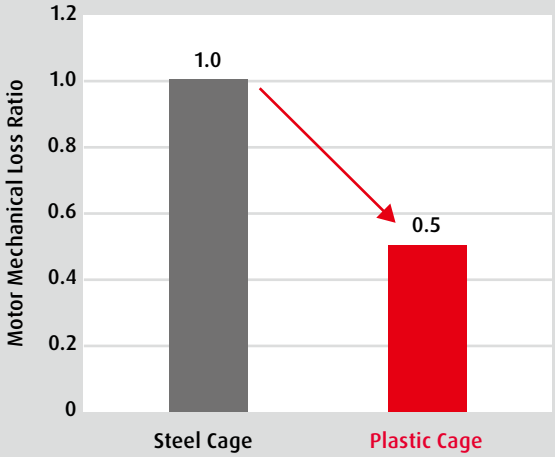
Features

Motor Energy Savings

Plastic cages reduce mechanical loss in motors by up to 50% compared to steel cages.

1

Motor: 5 kW 2P 200 V 50 Hz
Temperature: 25 °C

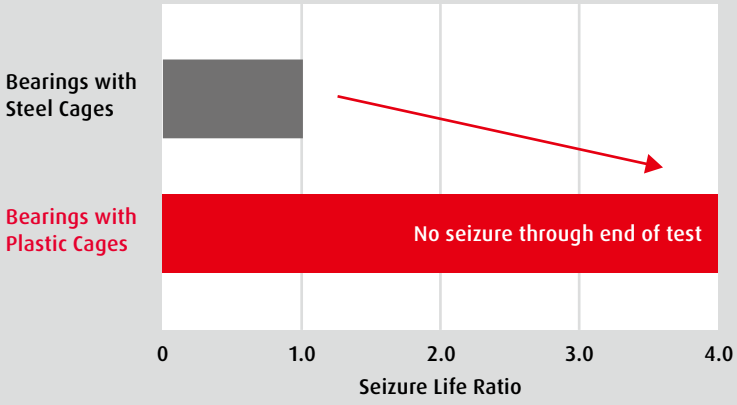


Longer Motor Maintenance Intervals

Plastic cages greatly extend bearing life under high-speed operating conditions.

2

Tested bearings: ø35 × ø15 × 11
Rotational Speed: 20 000 min^{-1}
Temperature: 120 °C

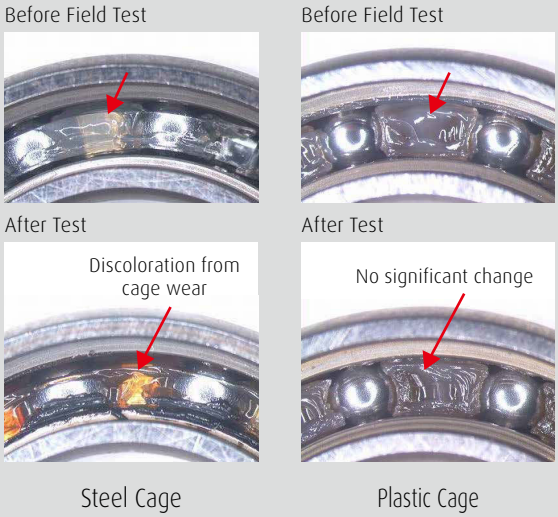


Usable in Magnetic Environments

Steel cages are affected by magnetic forces, resulting in abnormal friction that shortens the seizure life. Plastic cages don't face this issue and can be used easily and with longer life in magnetic environments, such as with servomotors.

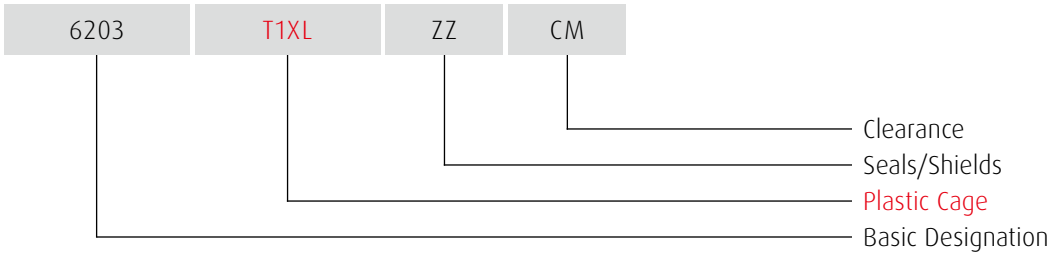
3

Tested bearings: ø12 × ø21 × 5
Misalignment: 0.3 deg
Rotational speed: 1 800 min^{-1}
Preload: 20 N
Environment temperature: 40 °C
Test period: 2 weeks
Magnetic strength: 3 500 Gs



DATA

Example Bearing Designation



Designation	Plastic Cage	Boundary Dimensions (mm)		
		Bore Dia.	Outside Dia.	Width
6000	T1X	10	26	8
6200	T1XL		30	9
6300*	T1X		35	11
6001	T1XL	12	28	8
6201	T1XL		32	10
6301	T1X		37	12
6002	T1XL	15	32	9
6202	T1XL		35	11
6302	T1X		42	13
6003	T1XL	17	35	10
6203	T1XL		40	12
6303	T1X		47	14
6004	T1X	20	42	12
6204	T1XL		47	14
6304	T1XL		52	15

Designation	Plastic Cage	Boundary Dimensions (mm)		
		Bore Dia.	Outside Dia.	Width
6005	T1XL	25	47	12
6205	T1XL		52	15
6305	T1X		62	17
6006	T1X	30	55	13
6206	T1X		62	16
6306	T1X		72	19
6007	T1X	35	62	14
6207	T1X		72	17
6307	T1X		80	21
6008	T1X	40	68	15
6208	T1XA		80	18
6308	T1XA		90	23

*Indicates a plastic cage that is not mass produced. Please contact NSK for details.
- Plastic cages for industrial motors use T1X, T1XL, and T1XA (Nylon 6,6).
- The maximum operating temperature of polyamide cages is normally 120 °C or less.

Ceramic Ball Bearings

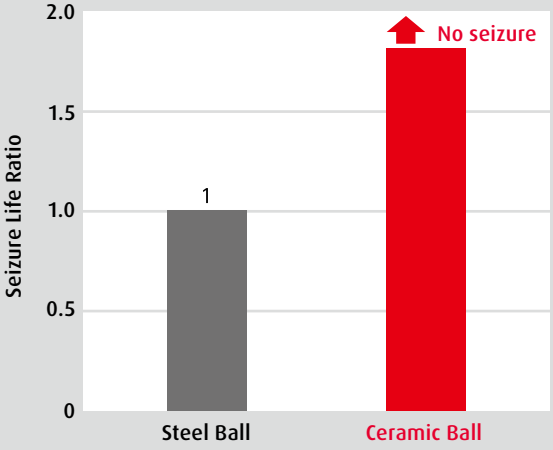
Lightweight ceramic materials have excellent insulation, heat resistance, durability, and low thermal expansion. Using ceramic balls extends seizure life dramatically and prevents electric current from passes through the bearing, stopping electric erosion.

Features

"Maintenance-Free" Motors

Compared to steel ball bearings, ceramic ball bearings have a significantly longer seizure life.

Tested bearings: ø8×ø22×7
Lubrication: Light oil 10 mg
Rotational speed: 1 800 min^{-1}
Temperature: 100 °C



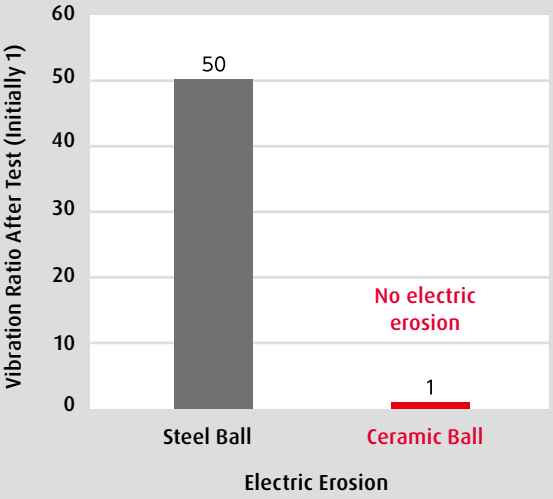
1

No Electric Erosion

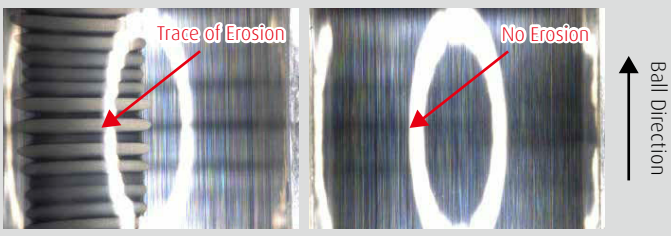
By insulating the rolling elements, electric currents can not pass through the bearing, preventing electric erosion.

•Electric Erosion Reproduction Test

Tested Bearings: ø8×ø22×7
with grease lubrication
Rotational Speed: 1 500 min^{-1}
Applied voltage: Steel ball 3 V
Ceramic ball 50 V



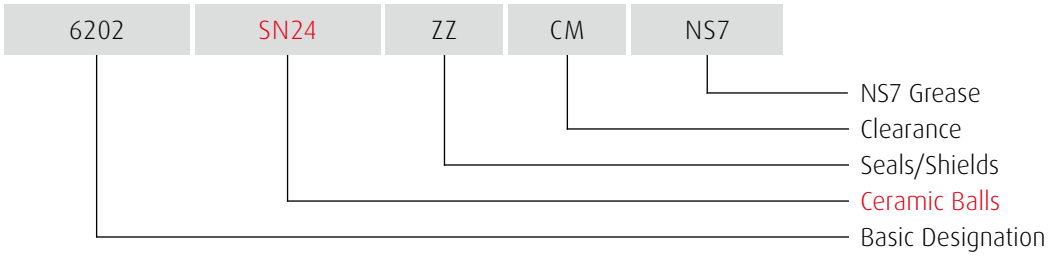
•Race Surface After Test



2

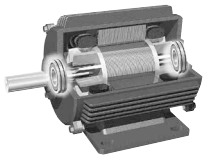
DATA

Example Bearing Designation



Designation	Boundary Dimensions (mm)		
	Bore Dia.	Outside Dia.	Width
608	8	22	7
6000	10	26	8
6200		30	9
6001	12	28	8
6201		32	10
6002	15	32	9
6202		35	11
6302		42	13
6003	17	35	10
6203		40	12
6004	20	42	12
6204		47	14
6205	25	52	15
6305		62	17

Designation	Boundary Dimensions (mm)		
	Bore Dia.	Outside Dia.	Width
6206	30	62	16
6306		72	19
6207	35	72	17
6307		80	21
6208	40	80	18
6308		90	23
6209	45	85	19
6309		100	25
6010	50	80	16
6310		110	27
6211	55	100	21
6311		120	29
6012	60	95	18
6214	70	125	24



Creep-Free Bearings

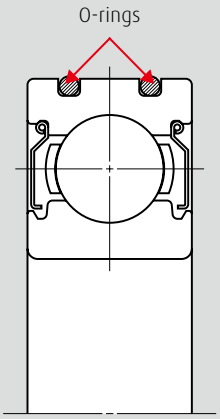
Creep may occur in EV motors used under high speed or in large motors with large unbalanced loads.
NSK's Creep-Free Bearings dramatically reduce the occurrence of creep by restricting the amount of clearance between the outer ring and housing.
Since boundary dimensions are identical to standard bearings, the housing does not need to be reworked when replacing the bearings, and assembly is easy.

Features

Special Structure to Prevent Creep

Creep-Free Bearings come with two O-rings mounted in the outer ring and help prevent creep by restricting the amount of clearance between the outer ring and housing.
No special machining is required; bearings can be used with the same housing as standard bearings.

1

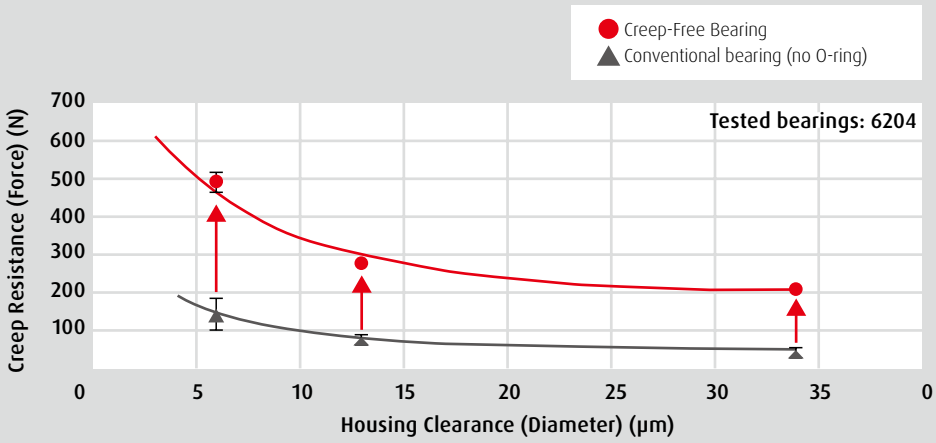


Structure of a Creep-Free Bearing

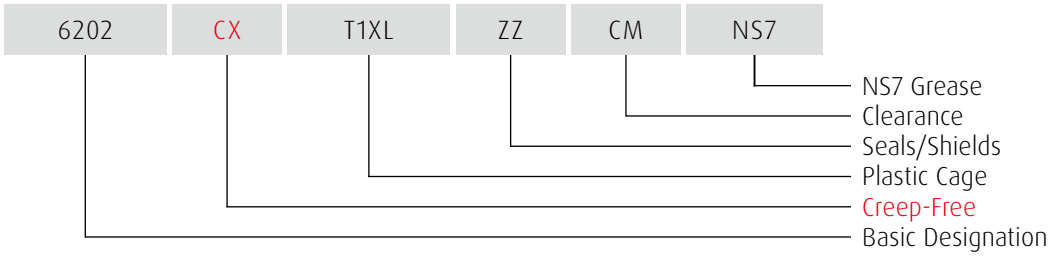
Usable Under High Speeds and Unbalanced Loads

In creep limit load tests, the more the housing clearance is reduced, the more creep can be prevented.
Creep-Free Bearings are up to four times more resistant to creep than conventional bearings.

2



Example Bearing Designation



Designation	Boundary Dimensions (mm)		
	Bore Dia.	Outside Dia.	Width
6000	10	26	8
6200		30	9
6300		35	11
6001	12	28	8
6201		32	10
6301		37	12
6002	15	32	9
6202		35	11
6302		42	13
6003	17	35	10
6203		40	12
6303		47	14
6004	20	42	12
6204		47	14
6304		52	15
6005	25	47	12
6205		52	15
6305		62	17
6006	30	55	13
6206		62	16
6306		72	19
6007	35	62	14
6207		72	17
6307		80	21
6008	40	68	15
6208		80	18
6308		90	23

Designation	Boundary Dimensions (mm)		
	Bore Dia.	Outside Dia.	Width
6009	45	75	16
6209		85	19
6309		100	25
6010	50	80	16
6210		90	20
6310		110	27
6011	55	90	18
6211		100	21
6311		120	29
6012	60	95	18
6212		110	22
6312		130	31
6013	65	100	18
6213		120	23
6313		140	33
6014	70	110	20
6214		125	24
6314		150	35
6015	75	115	20
6215		130	25
6016	80	125	22
6216		140	26
6017	85	130	22
6217		150	28
6018	90	140	24
6019	95	145	24
6020	100	150	24

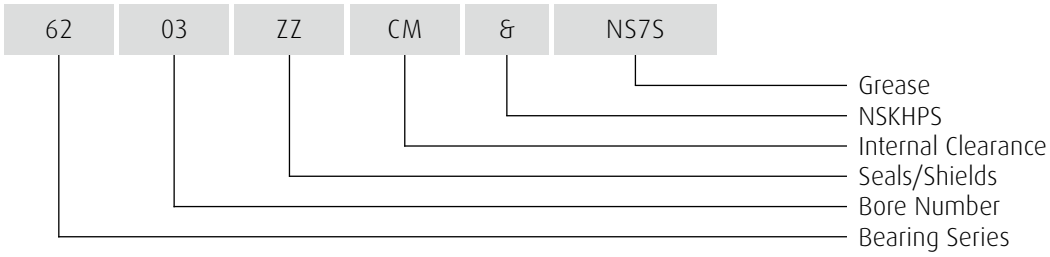
- If oil or grease is applied to the outside surface of the bearing, use a mineral oil or a synthetic hydrocarbon oil (such as NSK EA2).
- The O-rings are made of nitrile rubber (operating temperature range: -30 to 120 °C) as standard. Please contact NSK for use under special environments, such as at high temperatures.

NSKHPS High-Performance Standard Series Deep Groove Ball Bearings -For High Efficiency Motors & General Motors

As motors become smaller and lighter, bearings must also become more compact, reliable, and capable of carrying heavy loads. NSK responds to these trends with NSKHPS: our new standard line of high-performance bearings.
Compared to conventional bearings, NSKHPS Series deep groove ball bearings have 15% longer life and 15% higher limiting speed.
Our current NSKHPS Series has an extensive lineup based on the most commonly used bearing series.

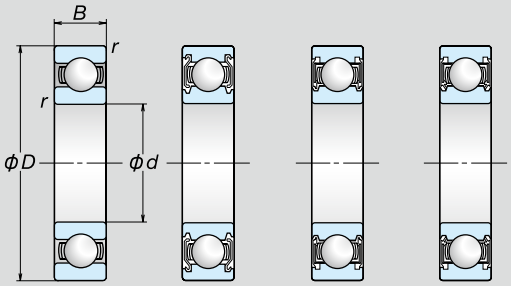
DATA

Example Bearing Designation



62	Bearing Series	60, 62, 63: Single-Row Deep Groove Ball Bearings
03	Bore Number	Bore number indicates bore diameter. 00:10mm; 01:12mm; 02:15mm; 03:17mm 04 or Larger: Bore Number × 5 (mm)
ZZ	Seals/Shields	ZZ: Shield on Both Side DDU: Contact Rubber Seal on Both Side VV: Non-Contact Rubber Sealed on Both Side
CM	Internal Clearance	Omitted: CN Clearance* C3: Clearance Greater than CN C4: Clearance Greater than C3 CM: For Electric Motors*
&	NSKHPS	&: NSKHPS Bearings
NS7S	Grease	NS7: NS Hi-Lube

*CM clearance can be used instead of CN clearance (the opposite is not possible).



Open Type | Shielded Type ZZ | Non-Contact Shielded Type VV | Contact Shielded Type DDU

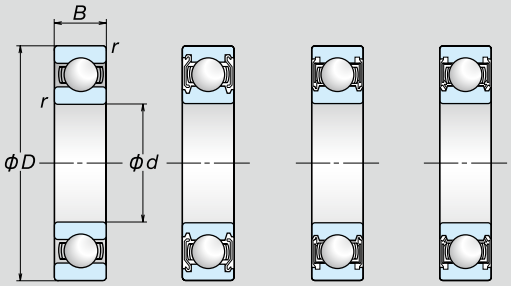
Dynamic Equivalent Load $P = XF_r + YF_a$

$\frac{f_0 F_a}{C_{0r}}$	e	$\frac{F_a}{F_r} \leqq e$		$\frac{F_a}{F_r} > e$	
		X	Y	X	Y
0.172	0.19	1	0	0.56	2.30
0.345	0.22	1	0	0.56	1.99
0.689	0.26	1	0	0.56	1.71
1.03	0.28	1	0	0.56	1.55
1.38	0.30	1	0	0.56	1.45
2.07	0.34	1	0	0.56	1.31
3.45	0.38	1	0	0.56	1.15
5.17	0.42	1	0	0.56	1.04
6.89	0.44	1	0	0.56	1.00

Static Equivalent Load $P_0 = 0.6\ F_r + 0.5\ F_a$

When $F_r > 0.6\ F_r + 0.5\ F_a$, use $P_0 = F_r$.

Designation					Boundary Dimensions (mm)				Basic Load Ratings (kN)		Factor	Limiting Speeds (min^{-1})		
												Grease		Oil
Open	Shielded	Sealed		NSKHPS	d	D	B	r (min.)	C_r	C_{0r}	f_0	Open ZZ VV	DDU	Open
6200	ZZ	VV	DDU	&	10	30	9	0.6	5 350	2 390	13.2	28 000	18 000	34 000
6300	ZZ	VV	DDU	&		35	11	0.6	8 500	3 450	11.2	26 000	17 000	30 000
6001	ZZ	VV	DDU	&	12	28	8	0.3	5 350	2 370	13.0	32 000	18 000	38 000
6201	ZZ	VV	DDU	&		32	10	0.6	7 150	3 050	12.3	26 000	17 000	32 000
6301	ZZ	VV	DDU	&		37	12	1.0	10 200	4 200	11.1	24 000	16 000	28 000
6002	ZZ	VV	DDU	&	15	32	9	0.3	5 850	2 830	13.9	26 000	15 000	32 000
6202	ZZ	VV	DDU	&		35	11	0.6	8 000	3 750	13.2	22 000	14 000	28 000
6302	ZZ	VV	DDU	&		42	13	1.0	12 000	5 450	12.3	19 000	13 000	24 000
6003	ZZ	VV	DDU	&	17	35	10	0.3	6 300	3 250	14.4	24 000	13 000	28 000
6203	ZZ	VV	DDU	&		40	12	0.6	10 100	4 800	13.2	20 000	12 000	24 000
6303	ZZ	VV	DDU	&		47	14	1.0	14 300	6 650	12.4	17 000	11 000	20 000
6004	ZZ	VV	DDU	&	20	42	12	0.6	9 850	5 000	13.8	20 000	11 000	24 000
6204	ZZ	VV	DDU	&		47	14	1.0	13 400	6 600	13.1	17 000	11 000	20 000
6304	ZZ	VV	DDU	&		52	15	1.1	16 700	7 900	12.4	16 000	10 000	19 000
6005	ZZ	VV	DDU	&	25	47	12	0.6	10 600	5 850	14.5	18 000	9 500	22 000
6205	ZZ	VV	DDU	&		52	15	1.0	14 700	7 850	13.9	15 000	9 000	18 000
6305	ZZ	VV	DDU	&		62	17	1.1	21 600	11 200	13.2	13 000	8 000	16 000
6006	ZZ	VV	DDU	&	30	55	13	1.0	13 900	8 300	14.7	15 000	8 000	18 000
6206	ZZ	VV	DDU	&		62	16	1.0	20 400	11 300	13.8	12 000	7 500	15 000
6306	ZZ	VV	DDU	&		72	19	1.1	28 000	15 000	13.3	11 000	6 700	13 000
6007	ZZ	VV	DDU	&	35	62	14	1.0	16 800	10 300	14.8	13 000	6 700	15 000
6207	ZZ	VV	DDU	&		72	17	1.1	27 000	15 300	13.8	11 000	6 300	13 000
6307	ZZ	VV	DDU	&		80	21	1.5	35 000	19 200	13.2	10 000	6 000	12 000
6008	ZZ	VV	DDU	&	40	68	15	1.0	17 600	11 500	15.3	12 000	6 000	14 000
6208	ZZ	VV	DDU	&		80	18	1.1	30 500	17 900	14.0	9 500	5 600	12 000
6308	ZZ	VV	DDU	&		90	23	1.5	43 000	24 000	13.2	9 000	5 300	11 000
6009	ZZ	VV	DDU	&	45	75	16	1.0	22 000	15 200	15.3	10 000	5 300	12 000
6209	ZZ	VV	DDU	&		85	19	1.1	33 000	20 400	14.4	9 000	5 300	11 000
6309	ZZ	VV	DDU	&		100	25	1.5	55 500	32 000	13.1	7 500	4 800	9 500
6010	ZZ	VV	DDU	&	50	80	16	1.0	22 900	16 600	15.6	9 500	4 800	11 000
6210	ZZ	VV	DDU	&		90	20	1.1	37 000	23 200	14.4	8 000	4 800	10 000
6310	ZZ	VV	DDU	&		110	27	2.0	65 000	38 500	13.2	7 100	4 300	8 500



Open Type | Shielded Type ZZ | Non-Contact Shielded Type VV | Contact Shielded Type DDU

Dynamic Equivalent Load $P = XF_r + YF_a$

$\frac{f_0 F_a}{C_{0r}}$	e	$\frac{F_a}{F_r} \leqq e$		$\frac{F_a}{F_r} > e$	
		X	Y	X	Y
0.172	0.19	1	0	0.56	2.30
0.345	0.22	1	0	0.56	1.99
0.689	0.26	1	0	0.56	1.71
1.03	0.28	1	0	0.56	1.55
1.38	0.30	1	0	0.56	1.45
2.07	0.34	1	0	0.56	1.31
3.45	0.38	1	0	0.56	1.15
5.17	0.42	1	0	0.56	1.04
6.89	0.44	1	0	0.56	1.00

Static Equivalent Load $P_0 = 0.6\ F_r + 0.5\ F_a$

When $F_r > 0.6\ F_r + 0.5\ F_a$, use $P_0 = F_r$.

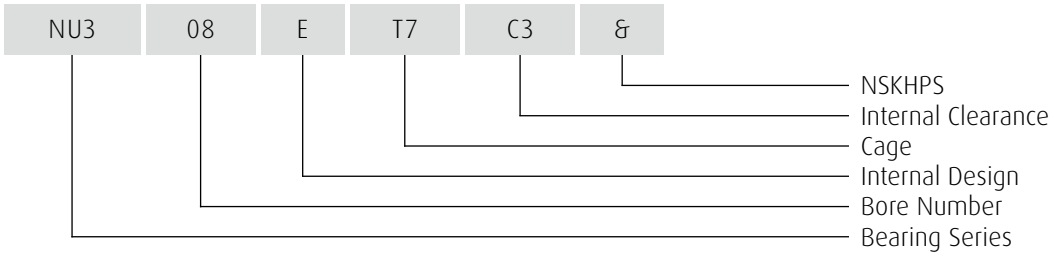
Desgnation					Boundary Dimensions (mm)				Basic Load Ratings (kN)		Factor	Limiting Speeds (min^{-1})		
												Grease		Oil
Open	Shielded	Sealed		NSKHPS	d	D	B	r (min.)	C_r	C_{0r}	f_0	Open ZZ VV	DDU	Open
6011	ZZ	VV	DDU	&	55	90	18	1.1	29 700	21 200	15.3	8 500	4 500	10 000
6211	ZZ	VV	DDU	&		100	21	1.5	45 500	29 300	14.3	7 500	4 300	9 000
6311	ZZ	VV	DDU	&		120	29	2.0	75 000	44 500	13.1	6 700	4 000	8 000
6012	ZZ	VV	DDU	&	60	95	18	1.1	31 000	23 200	15.6	8 000	4 000	9 500
6212	ZZ	VV	DDU	&		110	22	1.5	55 000	36 000	14.3	6 700	3 800	8 000
6312	ZZ	VV	DDU	&		130	31	2.1	86 000	52 000	13.1	6 000	3 600	7 100
6013	ZZ	VV	DDU	&	65	100	18	1.1	32 000	25 200	15.8	7 500	4 000	9 000
6213	ZZ	VV	DDU	&		120	23	1.5	60 000	40 000	14.4	6 300	3 600	7 500
6313	ZZ	VV	DDU	&		140	33	2.1	97 500	60 000	13.2	5 600	3 400	6 700
6014	ZZ	VV	DDU	&	70	110	20	1.1	40 000	31 000	15.6	7 100	3 600	8 500
6214	ZZ	VV	DDU	&		125	24	1.5	65 500	44 000	14.5	6 000	3 400	7 100
6314	ZZ	VV	DDU	&		150	35	2.1	109 000	68 000	13.2	5 300	3 200	6 300
6015	ZZ	VV	DDU	&	75	115	20	1.1	41 500	33 500	15.8	6 700	3 400	8 000
6215	ZZ	VV	DDU	&		130	25	1.5	69 500	49 500	14.7	5 600	3 200	6 700
6315	ZZ	VV	DDU	&		160	37	2.1	119 000	77 000	13.2	4 800	2 800	6 000
6016	ZZ	VV	DDU	&	80	125	22	1.1	50 000	40 000	15.6	6 300	3 200	7 100
6216	ZZ	VV	DDU	&		140	26	2.0	76 500	53 000	14.6	5 300	3 000	6 300
6316	ZZ	VV	DDU	&		170	39	2.1	129 000	86 500	13.3	4 500	2 800	5 600
6017	ZZ	VV	DDU	&	85	130	22	1.1	52 000	43 000	15.8	6 000	3 000	7 100
6217	ZZ	VV	DDU	&		150	28	2.0	88 000	62 000	14.5	4 800	2 800	6 000
6317	ZZ	VV	DDU	&		180	41	3.0	139 000	97 000	13.3	4 300	2 600	5 000
6018	ZZ	VV	DDU	&	90	140	24	1.5	61 000	50 000	15.6	5 600	2 800	6 300
6218	ZZ	VV	DDU	&		160	30	2.0	101 000	71 500	14.5	4 500	2 600	5 600
6318	ZZ	VV	DDU	&		190	43	3.0	150 000	107 000	13.3	4 000	2 400	4 800
6019	ZZ	VV	DDU	&	95	145	24	1.5	63 500	54 000	15.8	5 300	2 600	6 000
6219	ZZ	VV	DDU	&		170	32	2.1	114 000	82 000	14.4	4 300	2 600	5 000
6319	ZZ	VV	DDU	&		200	45	3.0	160 000	119 000	13.3	3 400	2 400	4 300
6020	ZZ	VV	DDU	&	100	150	24	1.5	63 000	54 000	15.9	5 000	2 600	6 000
6220	ZZ	VV	DDU	&		180	34	2.1	128 000	93 000	14.4	4 000	2 400	4 800
6021	ZZ	VV	DDU	&	105	160	26	2.0	76 000	66 000	15.8	4 500	2 400	5 600
6221	ZZ	VV	DDU	&		190	36	2.1	140 000	105 000	14.4	3 800	2 200	4 500
6022	ZZ	VV	DDU	&	110	170	28	2.0	89 000	73 000	15.5	4 500	2 200	5 300
6024	ZZ	VV	DDU	&	120	180	28	2.0	92 500	80 000	15.7	4 000	2 200	4 800

NSKHPS High-Performance Standard Series Cylindrical Roller Bearings -For General Motors

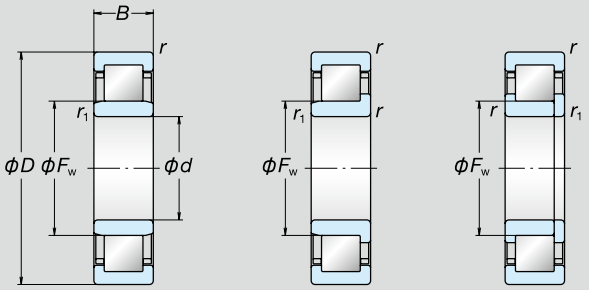
As motors become smaller and lighter, bearings must also become more compact, reliable, and capable of carrying heavy loads. NSK responds to these trends with NSKHPS: our new standard line of high-performance bearings.
Compared to conventional bearings, the NSKHPS Series of cylindrical roller bearings has up to 60% longer life and 15% higher limiting speed.
Our current NSKHPS Series has an extensive lineup based on the most commonly used bearing series.

DATA

Example Bearing Designation



NU3	Bearing Series	NU2, NU22, NU3, NU23 NJ2, NJ22, NJ3, NJ23 : Cylindrical Roller Bearings NUP2, NUP22, NUP3, NUP23
08	Bore Number	Bore number indicates bore diameter. Bore Number × 5 (mm)
E	Internal Design	E: High Load Capacity
T7	Cage	W: Pressed-Steel Cage M: Machined-Brass Cage T : Polyamide-Resin Cage T7: L-PPS Resin Cage
C3	Internal Clearance	Omitted: CN Clearance C3: Clearance Greater than CN C4: Clearance Greater than C3
&	NSKHPS	&: NSKHPS Bearings



Designation★						Boundary Dimensions (mm)						Basic Load Ratings (kN)		Limiting Speeds (min⁻¹)		Permissible Axial Movement
Basic Number & Internal Design Code	Cage				NSK HPS	*d*	*D*	*B*	*r* (min.)	r_1 (min.)	*Fw*	C_r	C_{0r}	Grease	Oil	*S* (mm)
	W	M	T	T7												
NU205E	✻	✻	✻	✻	&	25	52	15	1	0.6	31.5	33 500	27 700	12 000	14 000	1.2
NU2205E		✻	✻	✻	&		52	18	1	0.6	31.5	40 000	34 500	12 000	14 000	1.2
NU305E	✻	✻	✻	✻	&		62	17	1.1	1.1	34	48 000	37 500	10 000	12 000	1.2
NU2305E		✻	✻	✻	&		62	24	1.1	1.1	34	65 500	56 000	9 000	11 000	1.2
NU206E	✻	✻	✻	✻	&	30	62	16	1	0.6	37.5	45 000	37 500	9 500	12 000	1.2
NU2206E		✻	✻	✻	&		62	20	1	0.6	37.5	56 500	50 000	9 500	12 000	1.2
NU306E	✻	✻	✻	✻	&		72	19	1.1	1.1	40.5	61 000	50 000	8 500	10 000	1.2
NU2306E		✻	✻	✻	&		72	27	1.1	1.1	40.5	86 000	77 500	8 000	9 500	1.2
NU207E	✻	✻	✻	✻	&	35	72	17	1.1	0.6	44	58 000	50 000	8 500	10 000	1.2
NU2207E		✻	✻	✻	&		72	23	1.1	0.6	44	71 000	65 500	8 500	10 000	2.2
NU307E	✻	✻	✻	✻	&		80	21	1.5	1.1	46.2	76 500	65 500	7 500	9 500	1.2
NU2307E		✻	✻	✻	&		80	31	1.5	1.1	46.2	107 000	101 000	6 700	8 500	1.2
NU208E	✻	✻	✻	✻	&	40	80	18	1.1	1.1	49.5	64 000	55 500	7 500	9 000	1.2
NU2208E		✻	✻	✻	&		80	23	1.1	1.1	49.5	83 000	77 500	7 500	9 000	1.2
NU308E	✻	✻	✻	✻	&		90	23	1.5	1.5	52	95 500	81 500	6 700	8 000	1.2
NU2308E		✻	✻	✻	&		90	33	1.5	1.5	52	131 000	122 000	6 000	7 500	1.2
NU209E	✻	✻	✻	✻	&	45	85	19	1.1	1.1	54.5	72 500	66 500	6 700	8 000	1.2
NU2209E		✻	✻	✻	&		85	23	1.1	1.1	54.5	87 500	84 500	6 700	8 500	1.2
NU309E	✻	✻	✻	✻	&		100	25	1.5	1.5	58.5	112 000	98 500	6 000	7 500	1.4
NU2309E		✻	✻	✻	&		100	36	1.5	1.5	58.5	158 000	153 000	5 300	6 700	1.4
NU210E	✻	✻	✻	✻	&	50	90	20	1.1	1.1	59.5	79 500	76 500	6 300	7 500	1.7
NU2210E		✻	✻	✻	&		90	23	1.1	1.1	59.5	96 000	97 000	6 300	8 000	1.2
NU310E	✻	✻	✻	✻	&		110	27	2	2	65	127 000	113 000	5 000	6 000	1.4
NU2310E		✻	✻	✻	&		110	40	2	2	65	187 000	187 000	5 000	6 300	1.9
NU211E	✻	✻	✻	✻	&	55	100	21	1.5	1.1	66	99 000	98 500	5 600	7 100	1.2
NU2211E		✻	✻	✻	&		100	25	1.5	1.1	66	117 000	122 000	5 600	7 100	1.2
NU311E	✻	✻	✻	✻	&		120	29	2	2	70.5	158 000	143 000	4 500	5 600	1.4
NU2311E		✻	✻	✻	&		120	43	2	2	70.5	231 000	233 000	4 500	5 600	1.4

✻ : Available cage ★ NJ and NUP type bearings are also available. Please consult NSK for details.

Designation★						Boundary Dimensions (mm)						Basic Load Ratings (kN)		Limiting Speeds (min^{-1})		Permissible Axial Movement
Basic Number & Internal Design Code	Cage				NSK HPS	d	D	B	r (min.)	r_1 (min.)	F_W	C_r	C_{0r}	Grease	Oil	S (mm)
	W	M	T	T7												
NU212E	✻	✻	✻	✻	&	60	110	22	1.5	1.5	72	112 000	107 000	5 300	6 300	1.2
NU2212E		✻	✻	✻	&		110	28	1.5	1.5	72	151 000	157 000	5 300	6 300	1.2
NU312E		✻	✻	✻	&		130	31	2.1	2.1	77	169 000	157 000	4 800	5 600	1.5
NU2312E		✻	✻	✻	&		130	46	2.1	2.1	77	251 000	262 000	4 300	5 300	1.5
NU213E	✻	✻	✻	✻	&	65	120	23	1.5	1.5	78.5	124 000	119 000	4 800	5 600	1.4
NU2213E		✻	✻	✻	&		120	31	1.5	1.5	78.5	171 000	181 000	4 800	6 000	1.4
NU313E		✻	✻	✻	&		140	33	2.1	2.1	82.5	204 000	191 000	4 300	5 300	1.5
NU2313E		✻	✻	✻	&		140	48	2.1	2.1	82.5	263 000	265 000	3 800	4 800	1.5
NU214E		✻	✻	✻	&	70	125	24	1.5	1.5	83.5	136 000	137 000	5 000	6 300	1.4
NU2214E		✻	✻	✻	&		125	31	1.5	1.5	83.5	179 000	194 000	4 500	5 600	1.4
NU314E		✻	✻	✻	&		150	35	2.1	2.1	89	231 000	222 000	4 000	5 000	1.5
NU2314E		✻	✻	✻	&		150	51	2.1	2.1	89	310 000	325 000	3 600	4 500	1.5
NU215E		✻	✻	✻	&	75	130	25	1.5	1.5	88.5	150 000	156 000	4 800	6 000	1.4
NU2215E		✻	✻	✻	&		130	31	1.5	1.5	88.5	186 000	207 000	4 300	5 300	1.4
NU315E		✻	✻	✻	&		160	37	2.1	2.1	95	271 000	263 000	3 800	4 800	1.4
NU2315E		✻	✻	✻	&		160	55	2.1	2.1	95	370 000	395 000	3 400	4 300	4.4
NU216E		✻	✻	✻	&	80	140	26	2	2	95.3	160 000	167 000	4 500	5 300	1.4
NU2216E		✻	✻	✻	&		140	33	2	2	95.3	214 000	243 000	4 000	5 000	1.4
NU316E		✻	✻	✻	&		170	39	2.1	2.1	101	289 000	282 000	3 600	4 300	1.5
NU2316E		✻	✻	✻	&		170	58	2.1	2.1	101	400 000	430 000	3 200	4 000	1.5
NU217E		✻	✻	✻	&	85	150	28	2	2	100.5	192 000	199 000	4 300	5 000	1.3
NU2217E		✻	✻	✻	&		150	36	2	2	100.5	250 000	279 000	3 800	4 500	1.3
NU317E		✻			&		180	41	3	3	108	360 000	330 000	3 400	4 000	2.0
NU2317E		✻			&		180	60	3	3	108	485 000	485 000	3 000	3 800	1.6
NU218E		✻	✻	✻	&	90	160	30	2	2	107	205 000	217 000	4 000	4 800	1.4
NU2218E		✻	✻	✻	&		160	40	2	2	107	274 000	315 000	3 600	4 300	1.9
NU318E		✻			&		190	43	3	3	113.5	390 000	355 000	3 200	3 800	1.5
NU2318E		✻			&		190	64	3	3	113.5	535 000	535 000	2 800	3 400	3.1
NU219E		✻	✻		&	95	170	32	2.1	2.1	112.5	249 000	265 000	3 800	4 500	1.4
NU2219E		✻	✻		&		170	43	2.1	2.1	112.5	325 000	370 000	3 400	4 000	1.4
NU319E		✻			&		200	45	3	3	121.5	410 000	385 000	3 000	3 600	1.5
NU2319E		✻			&		200	67	3	3	121.5	565 000	585 000	2 600	3 400	1.6
NU220E		✻			&	100	180	34	2.1	2.1	119	305 000	305 000	3 600	4 300	1.4
NU2220E		✻			&		180	46	2.1	2.1	119	410 000	445 000	3 200	3 800	1.4
NU320E		✻			&		215	47	3	3	127.5	465 000	425 000	2 800	3 400	1.8
NU2320E		✻			&		215	73	3	3	127.5	700 000	715 000	2 400	3 000	1.8
NU221E		✻			&	105	190	36	2.1	2.1	125	320 000	310 000	3 400	4 000	1.4
NU321E		✻			&		225	49	3	3	133	525 000	480 000	2 600	3 200	1.8
NU222E		✻			&	110	200	38	2.1	2.1	132.5	360 000	365 000	3 200	3 800	1.4
NU2222E		✻			&		200	53	2.1	2.1	132.5	470 000	515 000	2 800	3 400	1.4
NU322E		✻			&		240	50	3	3	143	555 000	525 000	2 600	3 000	3.8
NU2322E		✻			&		240	80	3	3	143	830 000	880 000	2 200	2 800	3.3

✻ : Available cage ★ NJ and NUP type bearings are also available. Please consult NSK for details.

Technical Data

1. Bearing Sound and Vibration

Diagnosis with Sound and Vibration

Classification of sounds and vibrations

Sounds and vibrations accompany the rotation of rolling bearings. The frequency and amplitude of such sounds and vibrations vary depending on the type of bearing, mounting conditions, operational conditions, etc. The sounds and vibrations of a rolling bearing can be classified under the following four main categories and each category can be further classified into several subcategories, as described in Table 1 below.
However, boundaries between groups are not definite. Even if some types of sounds or vibrations are inherent in the bearings, the volume might be related to the manufacturing process.
Conversely, some types of sounds or vibrations, even if caused by manufacturing, cannot be eliminated under normal conditions.
By recording the sounds and vibrations of a rotating machine and analyzing them, the cause may be inferred. As shown by the figures on the next page, a mechanically normal bearing shows a stable waveform. However, a bearing with damage such as a scratch shows a waveform with wide swings indicating large-amplitude sounds at regular intervals (refer to Figs.1 and 2).

Table 1 Classification of Sounds and Vibrations in a Rolling Bearing

	Sound Type		Vibration		Features
Structural	Race noise		Free vibration of raceway ring		Continuous noise: basic unavoidable noise that all bearings generate
	Roller/ball click noise		Free vibration of raceway ring, free vibration of cage		Regular noise at a certain interval: found in large bearings and horizontal shafts, radial loads and low rpm
	Squeal noise		Free vibration of raceway ring		Intermittent or continuous: generally found in large cylindrical roller bearings and under radial load, grease lubrication, and particular speeds
	Cage noise	"CK" sound	Free vibration of cage		Regular noise at a set interval: generated by all bearing types
		"CG" sound	Vibration of cage		Intermittent or continuous: lubrication with certain greases
		Tapping sound	Free vibration of cage		Set interval: slightly irregular under radial load and during initial stage
	Rumbling		Vibration from passage of rolling element		Continuous: found in all bearing types under radial load
Manufacturing	Chatter noise		Vibration due to waviness	Inner ring	Continuous noise
				Outer ring	
				Rolling element	Continuous with rollers, occasional with balls
Handling	Flaw noise		Vibration due to flaw	Inner ring	Regular noise at a set interval
				Outer ring	
				Rolling element	
	Contamination noise		Vibration due to contamination		Irregular
Other	Seal noise		Free vibration of a seal		Contact seal
	Lubricant noise		—		Irregular
	Rumbling		Runout	f_r	Continuous
				f_c	Continuous
				f_r-$2f_c$	Continuous

n : Positive integer (1, 2, 3...) Z : Number of rolling elements f_{RiN} : Natural frequency of ring in radial bending mode (Hz)
f_{MI} : Natural frequency in the mode of angular vibration in inertia of outer ring-spring system (Hz)
f_r : Rotation frequency of inner ring (Hz) f_c : Orbital revolution frequency of rolling elements (Hz)

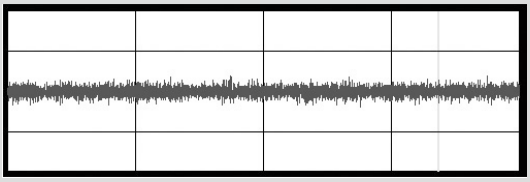


Fig. 1 Sound waveform of a normal bearing

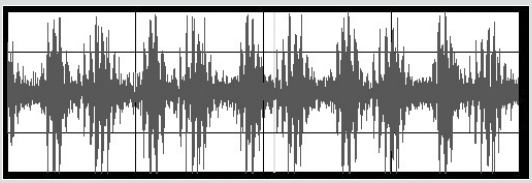
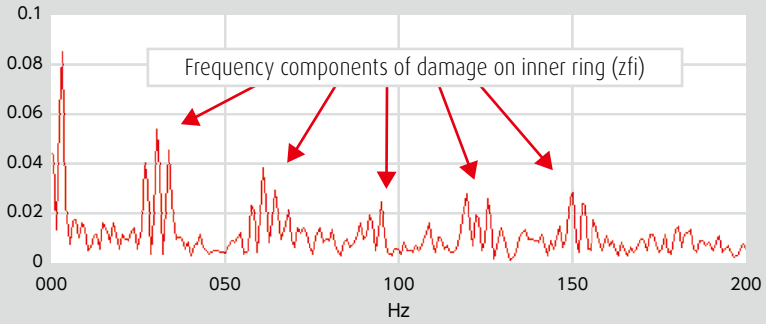


Fig. 2 Sound waveform of a scratched bearing

When the inner ring raceway surface is damaged

Bore diameter: 100 mm
Recording and analysis method: Envelope analysis sounds recorded by microphone for a test machine
Number of rotations: 50 min^{-1}



Example of analysis result

Generated Frequency (Frequency Analysis)			Source	Countermeasures
FFT of Original Wave		FFT After Envelope (Basic No.)		
Radial (Angular) Direction	Axial Direction			
f_{RiN}, f_{MI}	f_{AiN}, f_{AM}	—	Selective resonance from waviness (rolling friction)	Improve rigidity around bearings, provide appropriate radial clearance, use high-viscosity lubricant and high-quality bearings
f_{RiN}, f_{MI} Natural frequency of cage	f_{AiN}, f_{AM}	Zf_c	Collision of rolling elements with inner ring or cage	Reduce radial clearance, apply preload, use high-viscosity oil
($\fallingdotseq f_{R2N}$, f_{R3N})	—	?	Self-induced vibration caused by sliding friction at rolling surface	Reduce radial clearance, apply preload, change grease, replace with bearings with countermeasures
Natural frequency of cage		f_c	Collision of cage with rolling elements or rings	Apply preload, use high-viscosity lubricant, reduce mounting error
Natural frequency of cage		?	Self-induced vibration caused by friction at cage guide surface	Change grease brand, replace with cage with countermeasures
Natural frequency of cage		Zf_c	Collision of cage and rolling element caused by grease resistance	Reduce radial clearance, apply preload, use low-viscosity lubricant
Zf_c	—	—	Displacement of inner ring due to rolling element passage	Reduce radial clearance, apply preload
$nZf_i \pm f_r$ ($nZ \pm 1$ peaks)	nZf_i (nZ peaks)	—	Inner ring raceway waviness, irregularity of shaft exterior	Use high-quality bearings, improve shaft accuracy
nZf_c ($nZ \pm 1$ peaks)	nZf_c (nZ peaks)	—	Outer ring raceway waviness, irregular housing bore	Use high-quality bearings, improve housing bore accuracy
$2nf_b \pm f_c$ ($2n$ peaks)	$2nf_b$ ($2n$ peaks)	—	Rolling element waviness	Use high-quality bearings
f_{RiN}, f_{MI}	f_{AiN}, f_{AM}	Zf_i	Nicks, dents, rust, flaking on inner ring raceway	Replace bearing and take care when handling
		Zf_c	Nicks, dents, rust, flaking on outer ring raceway	Replace bearing and take care when handling
		$2f_b$	Nicks, dents, rust, flaking on rolling elements	Replace bearing and take care when handling
f_{RiN}, f_{MI}	f_{AiN}, f_{AM}	Irregular	Entry of dirt or debris	Wash the bearing, improve sealing
Natural frequency of seal		(f_r)	Self-induced vibration due to friction at seal contact area	Change the seal, change the grease
?	?	Irregular	Lubricant or lubricant bubbles crushed between rolling elements and raceways	Change the grease
f_r	—	—	Irregular inner ring cross-section	Use high-quality bearings
f_c	—	—	Ball variation in bearing, rolling elements non-equidistant	Use high-quality bearings
f_r-$2f_c$	—	—	Non-linear vibration due to rigid variation by ball variation	Use high-quality bearings

f_{AiN} : Ring natural frequency in axial bending mode (Hz)
f_{AM} : Natural frequency in the mode of axial vibration in mass of an outer ring spring system (Hz)
f_i : $f_i = f_r - f_c$ (Hz) f_b : Rotation frequency of rolling element around its center (Hz)

2. Grease for Motors

Grease Properties Table

Name	Thickener	Base Oil	Dropping Point (°C)	Worked Penetration	Operating Temperature (°C)	Base Oil Viscosity (mm^2/s) (40°C)
NS7	Lithium soap	Ester + Diester	192	250	−40 to +130	24.1
ENS	Urea	Polyolester	>260	264	−40 to +160	30.5
EA7	Urea	Poly-α-olefin	>260	243	−40 to +160	46
EA9	Urea	Poly-α-olefin	>260	314	−40 to +140	47
LGU	Urea	Poly-α-olefin	>260	201	−40 to +120	95.8
KPM	PTFE	Perfluoro-polyether	None	290	−20 to +200	420

3. Grease Life Equations

Grease Life of Sealed Ball Bearings

When grease is packed into single-row deep groove ball bearings, the grease life may be estimated using Equation (1), Equation (2), or Fig. 3:

(General-purpose grease (1))

$$\log t = 6.54 - 2.6 \frac{n}{N_{max}} - \left(0.025 - 0.012 \frac{n}{N_{max}}\right) T \quad \cdots\cdots(1)$$

(Wide-range grease (2))

$$\log t = 6.12 - 1.4 \frac{n}{N_{max}} - \left(0.018 - 0.006 \frac{n}{N_{max}}\right) T \quad \cdots\cdots(2)$$

where t : Average grease life (h)
n : Speed (min^{-1})
N_{max} : Limiting speed with grease lubrication (min^{-1})
(values for ZZ and VV types are listed in the bearing tables)
T : Operating temperature °C

Equation (1), Equation (2), and Fig. 3 apply under the following conditions:

(a) Speed n

$$0.25 \leqq \frac{n}{N_{max}} \leqq 1$$

when $\frac{n}{N_{max}} < 0.25$, assume $\frac{n}{N_{max}} = 0.25$

(b) Operating Temperature T

For general-purpose grease (1) 70 °C ≤ T ≤ 110 °C

For wide-range grease (2) 70 °C ≤ T ≤ 130 °C

When T < 70 °C, assume T = 70 °C

(c) Bearing Loads

The bearing loads should be about 1/10 or less the basic load rating C_r.

Notes (1) Mineral-oil based greases (e.g. lithium-soap based grease) often used around −10 to 110 °C.

Notes (2) Synthetic-oil based greases used over a wide temperature range around −40 to 130 °C.

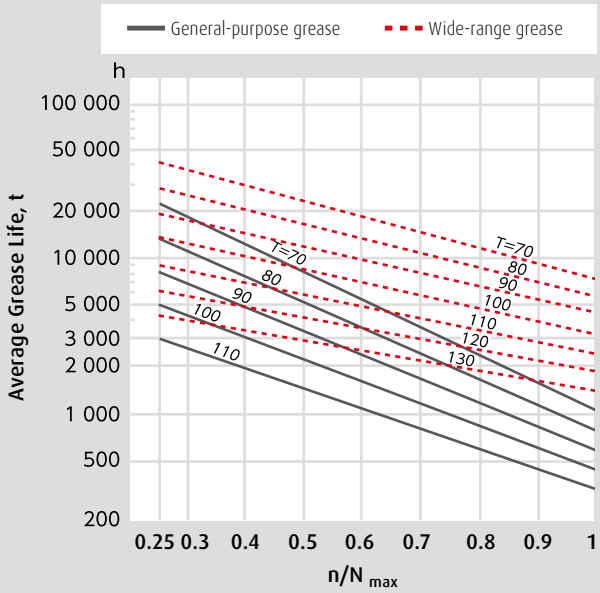


Fig. 3 Grease Life of Sealed Ball Bearings

4. Radial Internal Clearance

Radial Internal Clearances in Deep Groove Ball Bearings

Units: μm

Nominal Bore Diameter *d* (mm)		Clearance									
		C2		CN		C3		C4		C5	
over	incl.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
10 only		0	7	2	13	8	23	14	29	20	37
10	18	0	9	3	18	11	25	18	33	25	45
18	24	0	10	5	20	13	28	20	36	28	48
24	30	1	11	5	20	13	28	23	41	30	53
30	40	1	11	6	20	15	33	28	46	40	64
40	50	1	11	6	23	18	36	30	51	45	73
50	65	1	15	8	28	23	43	38	61	55	90
65	80	1	15	10	30	25	51	46	71	65	105
80	100	1	18	12	36	30	58	53	84	75	120
100	120	2	20	15	41	36	66	61	97	90	140
120	140	2	23	18	48	41	81	71	114	105	160
140	160	2	23	18	53	46	91	81	130	120	180
160	180	2	25	20	61	53	102	91	147	135	200
180	200	2	30	25	71	63	117	107	163	150	230
200	225	2	35	25	85	75	140	125	195	175	265
225	250	2	40	30	95	85	160	145	225	205	300
250	280	2	45	35	105	90	170	155	245	225	340
280	315	2	55	40	115	100	190	175	270	245	370
315	355	3	60	45	125	110	210	195	300	275	410
355	400	3	70	55	145	130	240	225	340	315	460
400	450	3	80	60	170	150	270	250	380	350	510
450	500	3	90	70	190	170	300	280	420	390	570
500	560	10	100	80	210	190	330	310	470	440	630
560	630	10	110	90	230	210	360	340	520	490	690
630	710	20	130	110	260	240	400	380	570	540	760
710	800	20	140	120	290	270	450	430	630	600	840

Remarks To obtain the measured values, use the clearance correction values in the table below. For the C2 clearance class, the smaller value should be used for bearings with minimum clearance and the larger value for bearings near the maximum clearance range.

Units: μm

Nominal Bore Dia. *d* (mm)		Measuring Load		Radial Clearance Correction Amount				
over	incl.	(N)	{kgf}	C2	CN	C3	C4	C5
10 (incl)	18	24.5	2.5	3 to 4	4	4	4	4
18	50	49	5	4 to 5	5	6	6	6
50	280	147	15	6 to 8	8	9	9	9

Remark For values exceeding 280 mm, please contact NSK.

Radial Internal Clearances in Bearings for Electric Motors

Deep Groove Ball Bearings for Electric Motors

Units: μm

Nominal Bore Dia. *d* (mm)		Clearance		Remarks	
		CM		Recommended Fit	
over	incl.	min.	max.	Shaft	Housing Bore
10 (incl)	18	4	11	js5 (j5)	H6, 7 (1) or JS6, 7 (J6, J7) (2)
18	30	5	12	k5	
30	50	9	17		
50	80	12	22		
80	100	18	30		
100	120	18	30	m5	
120	160	24	38		

Notes (1) Applicable to outer rings that require movement in the axial direction.
(2) Applicable to outer rings that do not require movement in the axial direction.

Remark The radial internal clearance increase caused by the measuring load is equal to the correction amount for CN clearance listed in the table above.

Cylindrical Roller Bearings for Electric Motors

Units: μm

Nominal Bore Dia. *d* (mm)		Clearance				Remarks	
		Interchangeable CT		Non-interchangeable CM		Recommended Fit	
over	incl.	min.	max.	min.	max.	Shaft	Housing Bore
24	40	15	35	15	30	k5	JS6, JS7 (J6, J7) (1) or K6, K7 (2)
40	50	20	40	20	35	m5	
50	65	25	45	25	40		
65	80	30	50	30	45		
80	100	35	60	35	55		
100	120	35	65	35	60		
120	140	40	70	40	65		
140	160	50	85	50	80		
160	180	60	95	60	90	n6	
180	200	65	105	65	100		

Notes (1) Applicable to outer rings that require movement in the axial direction.
(2) Applicable to outer rings that do not require movement in the axial direction.

5. Example Bearing Damage in Motors

Seizure

Damage	Possible Causes	Countermeasures
When sudden overheating occurs during rotation, the bearing becomes discolored. If operation continues, the raceway rings, rolling elements, and cage will soften, melt, and deform as damage accumulates.	-Poor lubrication -Excessive load (excessive preload) -Excessive rotational speed -Excessively small internal clearance -Entry of water and debris -Poor precision of shaft and housing, excessive shaft bending	• Review the lubricant and lubrication method • Re-investigate the suitability of the bearing type selected • Review the preload, bearing clearance, and fitting • Improve the sealing mechanism • Check the precision of the shaft and housing • Improve the mounting method

Photo 1

Part: Inner ring of an angular contact ball bearing
Symptom: Raceway discoloration, melting at ball pitch intervals
Cause: Excessive preload

Photo 2

Part: Outer ring in Photo 1
Symptom: Raceway discoloration, melting at ball pitch intervals
Cause: Excessive preload

Photo 3

Part: Balls and cage of Photo 1
Symptom: Cage damaged by melting, balls discolored and covered by some melt
Cause: Excessive preload

Photo 4

Part: Inside a deep groove ball bearing
Symptom: Grease nearly depleted, carbonization
Cause: Poor lubrication

Photo 5

Part: Inside a deep groove ball bearing
Symptom: Cage damage, grease depleted, carbonization
Cause: Poor lubrication

Photo 6

Part: Cylindrical roller bearing
Symptom: Seizure of roller at ring raceway surface
Cause: Excessively small internal clearance generated heat from motion of the inner ring and rollers under high speed and light load

Creep

Damage	Possible Causes	Countermeasures
A phenomenon in bearings where relative slippage occurs at the fitting surfaces. Creep causes a shiny appearance, occasionally with scoring or wear.	-Insufficient interference or loose fit -Insufficient sleeve tightening	• Check interference and prevent rotation • Correct the sleeve tightening • Review precision of the shaft and housing • Apply axial preload • Tighten the raceway ring side face • Apply adhesive to the fitting surface • Apply a film of assembly paste to the fitting surface

Photo 7

Part: Inner ring of a spherical roller bearing
Symptom: Creep accompanied by scoring of bore surface
Cause: Insufficient interference

Photo 8

Part: Outer ring of a spherical roller bearing
Symptom: Creep over entire circumference of outside surface
Cause: Loose fit between outer ring and housing

Electrical Erosion

Damage	Possible Causes	Countermeasures
When electric current passes through a bearing, arcing and burning occur throughout the thin oil film at points of contact between the race and rolling elements. The points of contact are melted locally to form "fluting" or groove-like corrugations which can be seen by the naked eye. Magnification of these grooves reveals crater-like depressions that indicate melting by arcing.	-Electric potential difference between inner and outer rings -High-frequency electric potential difference generated by instruments or substrates used near a bearing.	• Design electric circuits that prevent current flow through the bearings • Insulate the bearing

Photo 9

Part: Inner ring of a cylindrical roller bearing
Symptom: Belt pattern of electrical erosion accompanied by pits on the raceway surface

Photo 10

Part: Balls of a deep groove ball bearing
Symptom: A dark color covering the entire ball surface

Enlargement

Photo 11

Part: Inner ring of a deep groove ball bearing
Symptom: Fluting on the raceway surface (high frequency)

Photo 12

Part: Outer ring of a deep groove ball bearing
Symptom: Fluting on the raceway surface (high frequency)

Motor Bearings Specification Request

Please contact your nearest NSK branch with the following:

◆Basic Parameters

Motor Parameters	Application		
	Rotational Speed		
	Output	Max. : _____kw ; Normal: _____kw	
	Position	☐ Horizontal ☐ Vertical ☐ Inclined (inclination angle): _____°	
	Ambient Temp.	Range _____ to _____°C ; Normal: _____°C	
	Cooling Method	☐ Water ☐ Oil ☐ Air ; ☐ Other _____	
		Drive Side Bearing	Non Drive Side Bearing
Bearing Parameters	Designation		
	Dimensions	Bore dia. ϕ____ × Outside dia. ϕ____ × Width ____mm	Bore dia. ϕ____ × Outside dia. ϕ____ × Width ____mm
	Lubrication Type	☐ Grease (Brand: _____) ; ☐ Oil (Brand: _____)	
	Seal/Shield Type	☐ Open ☐ Shielded (ZZ) ☐ Sealed (VV/DDU/DDW)	
	Load	Axial Fa: _____N ; Radial Fr : _____N	
		Rotor weight: _____kg ; Side magnetic force: _____N	
	Bearing Temp.	Min. : _____°C ; Max. : _____°C ; Normal : _____°C	
	Required Life	_____Hours (or) _____Years	
Fitting Parameters	Fitting – Housing	_____ to _____mm	_____ to _____mm
	Fitting – Shaft	_____ to _____mm	_____ to _____mm
	Shaft Hollow Dia.	ϕ_____mm (0 for non-hollow shafts)	ϕ_____mm (0 for non-hollow shafts)
	Shaft Material		
	Housing Material		
	Bearing Preload	☐ None ; ☐ With preload : Type (☐ Spring / ☐ Shim / ☐ Other _____) : Location (☐ Drive side / ☐ Non drive side)	

◆To help analyze the bearing load, please provide a layout and dimensions.

Motor Layout	Related Dimensions
	Distance From Bearing Center: _____mm Distance From Load Center to Front Bearing Center: _____mm Distance From Load Center to Rear Bearing Center: _____mm

MOTION & CONTROL™

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