



SPACEA™

Bearings, Ball Screws and NSK Linear Guides, for Special Environments



SPACEA™

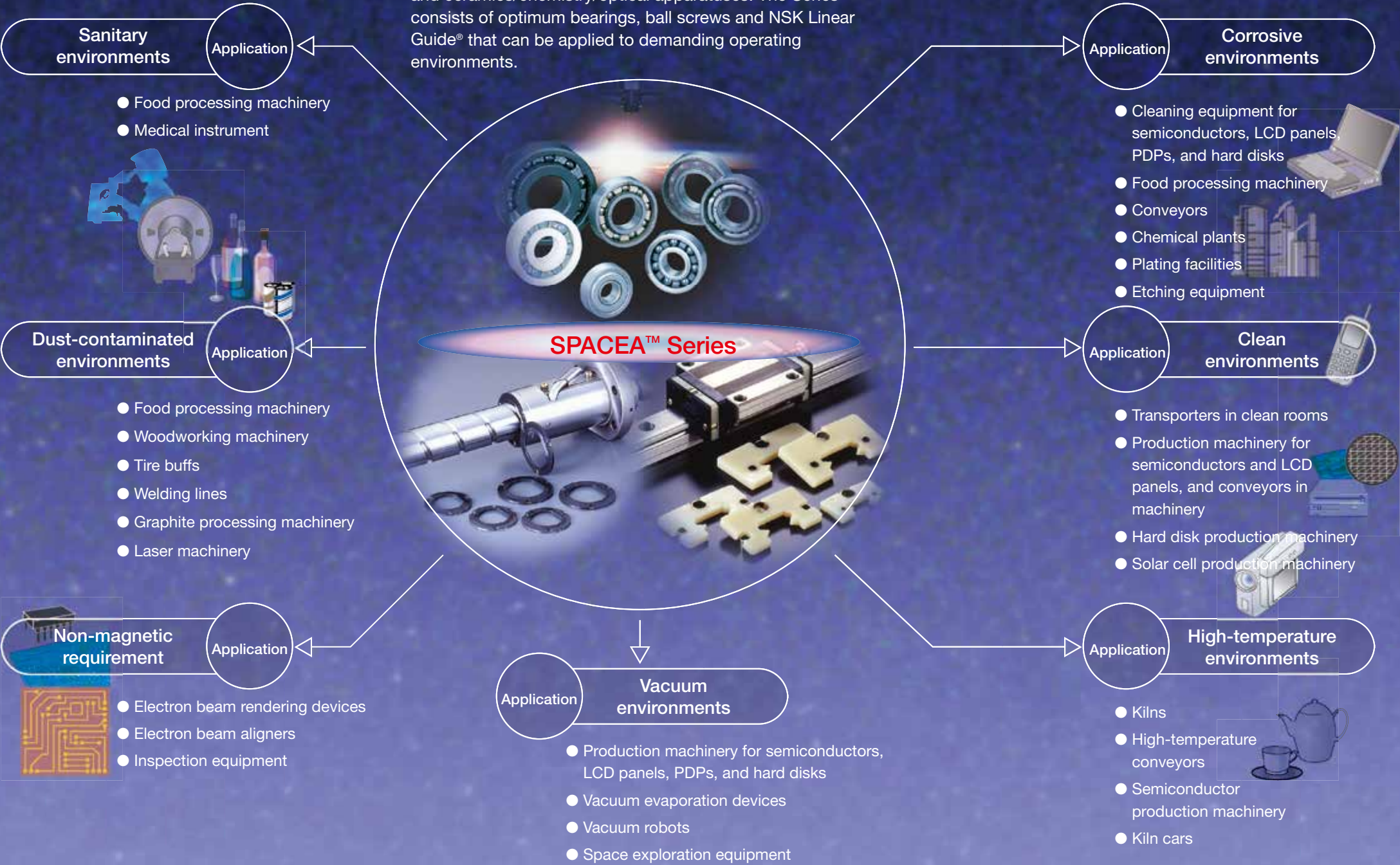
Bearings, Ball Screws and NSK Linear Guides, for Special Environments

The SPACEA™ Series—responding to extreme, special environments

The NSK SPACEA™ Series was developed with vacuum lubrication technology, materials technology, and thin-film technology for space exploration equipment. Our lineup of bearings, ball screws and NSK Linear Guide® for special environments will meet the strict requirements for harsh operating conditions, offering high functionality and quality. The high-quality SPACEA™ Series is applicable in vacuum, corrosive, clean, high-temperature, non-magnetic, and radiation-resistant environments, among others.



The SPACEA™ Series is adaptable to a wide variety of applications, including machinery for semiconductors, LCDs, hard disk production, pharmaceutical/cosmetics production, and ceramics/chemistry/optical apparatuses. The Series consists of optimum bearings, ball screws and NSK Linear Guide® that can be applied to demanding operating environments.



Applicable in a variety of operating conditions, responding to a broad range of applications.

Table of Contents

SPACEA™ Series	P2-7
Global Network	P4-5
Research and Development	P6-7
SPACEA™ Bearings	A1-A72
Table of Contents of SPACEA™ Bearings	A1-A2
Inventory	A3-A4
Selection Guide	A5-A8
Dimensions, Accuracy and Availability	A9-A28
Product Information	A29-A66
Applications of SPACEA™ Series Bearings	A67-A72
SPACEA™ Series Ball Screws and NSK Linear Guide®	B1-B34
Table of Contents of SPACEA™ Series Ball Screws and NSK Linear Guide®	B1-B2
Inventory	B3-B4
Selection Guide	B5-B6
Types and Specifications	B7-B8
Dimensions and Availability	B9-B12
Product Information	B13-B32
Applications of SPACEA™ Series Ball Screws and NSK Linear Guide®	B33-B34
Appendices	C1-C24
Specification Inquiry	C25

NSK's global network is the key to our ability to develop innovative products that incorporate the latest technologies.

The network connects each sales branch, distribution center, production facility, and technology center and enables us to gather the latest information from each location. Data is instantly accessible to every part of the network, resulting in products of the highest quality. Our global system also includes activities such as receiving and processing orders, shipping products, and supplying technical support. No matter how difficult or complex the challenge, NSK is able to respond immediately.

NSK's global network means excellent products and superior customer service.

NSK has established a communication system that links the major markets of the world in Europe, Asia, Japan, and the Americas. We use this highly developed system to share information, in real time, related to changes and trends in each market. As a result, we can react quickly to meet changing customer needs, supplying the best, high-quality products. Our global network makes NSK a truly global company. We are able to transcend borders and other restrictions to meet the needs of our customers around the globe.



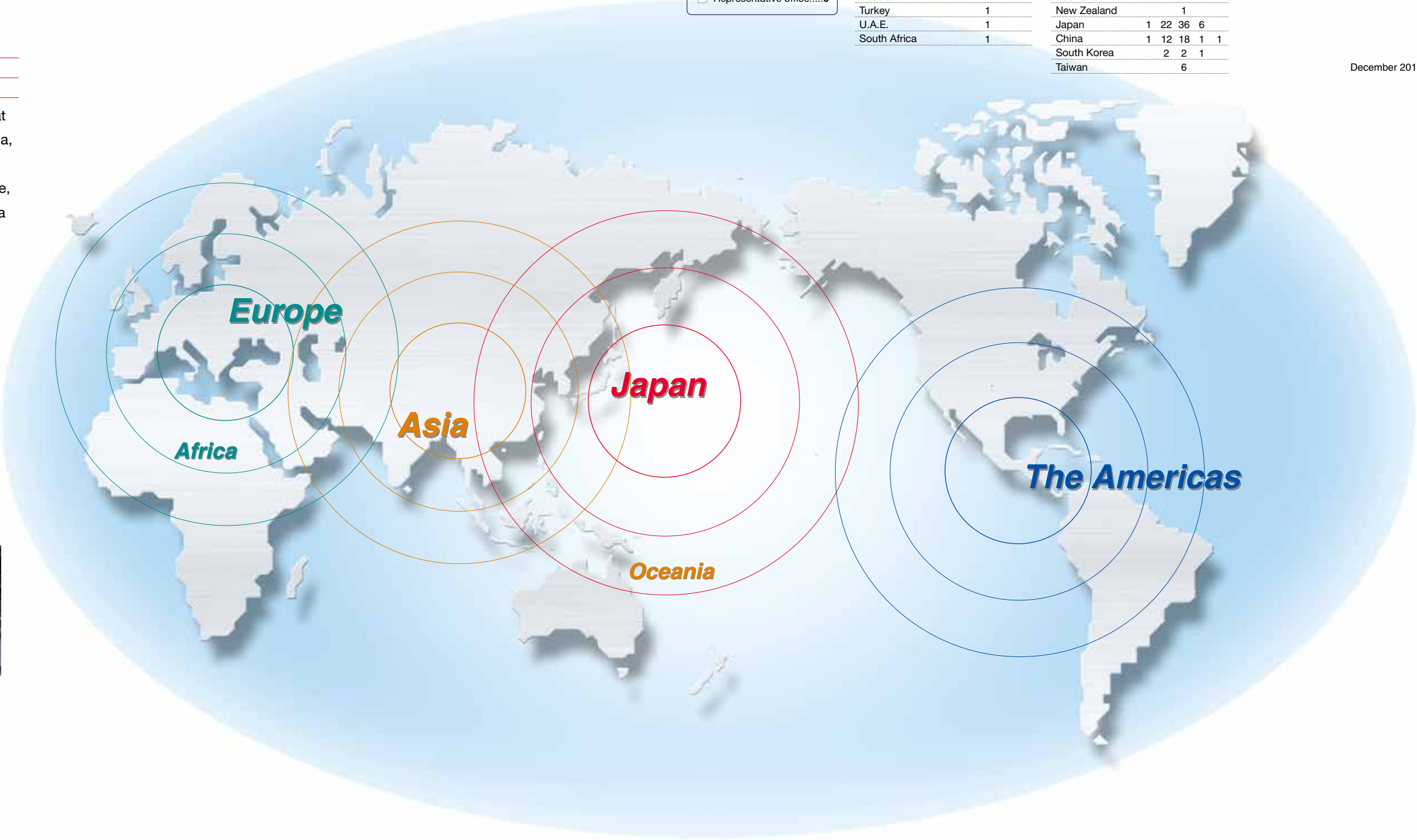
● Headquarters.....6
■ Plant.....65
■ Sales office.....123
■ Technical office.....14
□ Representative office.....6

EUROPE/AFRICA	●	■	■	■	□
U.K.	1	4	2	1	
Germany		1	2	1	2
France			1		
Italy			1		
Holland			1		
Spain			1		
Poland		4	3	1	
Russia			1		
Turkey			1		
U.A.E.			1		
South Africa			1		

ASIA/OCEANIA	●	■	■	■	□
Singapore	1		2		
Indonesia		3	2		
Thailand		2	3	1	
Malaysia		2	4		
Philippines					1
Vietnam			1	1	
India		1	4	8	
Australia				4	
New Zealand				1	
Japan		1	22	36	6
China		1	12	18	1
South Korea			2	2	1
Taiwan				6	

THE AMERICAS	●	■	■	■	□
U.S.A.	1	7	10	1	
Canada			3		
Mexico		1	1		1
Brazil			1	5	1
Peru				1	
Argentina				1	

December 2015



NSK Research and Development

Extensive commitment to research and development through a network of four bases in the United States, Europe, and Asia, with Japan as the nucleus.

NSK's R&D centers concentrates on enhancements in the core technologies of tribology, materials technology, analytical technology, and mechatronics. These are the basis for the development of NSK's current and future product lineups. We have been working intensely on basic technologies that will be required to develop the next generation of products.

NSK Technology Development Center Fujisawa (Japan)



European Technology Centre (England)



American Technology Center (USA)

Titanium alloy bearings

Test rig for bearings for vacuum conditions

Lubrication Unit "NSK K1™"

T R I B O L O G Y

SPACEA™ Series bearings, ball screws and NSK Linear Guide™ are technology-driven products that continue to evolve, supported by advanced technologies developed in the NSK R&D centers. Lubrication technology, materials technology, and evaluation technology are integrated to create new SPACEA™ products.

● Lubrication technology

Clean lubricant DFO
Clean greases: LG2, LGU
Special solid lubricant
Vacuum high-temperature solid lubricant

● Materials technology

High corrosion-resistant, long-life stainless steel: ES1
High corrosion-resistant, high hardness stainless steel: ESZ
High corrosion-resistant, non-magnetic stainless steel: ESA
Fiber-reinforced, high corrosion-resistant fluororesin materials
High corrosion-resistant ceramic materials
High hardness titanium alloys

● Evaluation technology

In-vacuo rotation/direct-acting tester
Clean environment rotation/direct-acting tester
Corrosive environment bearing endurance tester
Dust-contaminated environment direct-acting tester

SPACEA™ Series bearings

Wide range of product variation with high quality and high functionality

NSK's SPACEA™ Series bearings for special environments have a wide array of product variation applicable to vacuum environments, corrosive environments, clean environments, sanitary environments, high-temperature environments, dust-contaminated environments and non-magnetic requirement. The SPACEA™ Series offers high quality and high performance in severe operating environments, throughout a wide range of applications and in all kinds of machines and apparatuses.

Optimal bearings for particular applications can be found in the SPACEA™ Bearing Selection Guide on pages A5–A8.



Table of Contents of SPACEA™ Bearings

A	Inventory	A3–A4
B	Selection Guide	A5–A8
C	Dimensions, Accuracy and Availability	A9–A28
D	Specifications, Operating Instructions, and Technical Data	
	1. Food Grade Grease-Packed Bearings	A29–A30
	2. Stainless Steel Bearings	A31–A32
	3. Stainless Steel Angular Contact Ball Bearings	A33
	4. Stainless Steel Self-Aligning Ball Bearings	A34
	5. Molded-Oil™ Bearings (For corrosive environments, For sanitary environments)	A35–A36
	6. Hybrid Bearings	A37–A38
	7. Corrosion-Resistant Coated Bearings	A39–A40
	8. ESZ Bearings	A41–A42
	9. ESA Bearings	A43–A44
	10. All-Ceramic Bearings	A45–A46
	11. Aqua-Bearing™	A47–A48
	12. LG2/LGU Grease-Packed Bearings	A49–A50
	13. DL2 Grease-Packed Bearings	A51–A52
	14. E-DFO Bearings, V-DFO Bearings	A53–A54
	15. YS Bearings with Self-Lubricating Cage	A55–A56
	16. KPM Grease-Packed Bearings	A57–A58
	17. YS Bearings with Spacer Joints	A59–A60
	18. SJ Bearings	A61–A62
	19. Titanium Alloy Bearings	A63–A64
	20. Molded-Oil™ Bearings (For Dust-Contaminated Environments)	A65–A66
E	Applications of SPACEA™ Series Bearings	A67–A72

Inventory

NSK's SPACEA™ Series bearings for special environments are optimal for applications in operating environments that are too severe for ordinary bearings, such as semiconductor/FPD/hard-disk production machinery, food processing machinery, medical/cosmetics production machinery, and ceramics/chemistry/optical apparatuses.

Sanitary environments

- **For food processing machinery**
 - Food grade grease-packed bearings
 - Molded-Oil™ bearings with food grade lubricant



Food grade grease-packed bearings

Vacuum environments

- **Clean**
 - DL2 grease-packed bearings
 - DFO bearings
 - YS bearings with self-lubricating cage
- **High-temperature**
 - YS bearings with spacer joints
 - SJ bearings
- **Non-magnetic**
 - ESA bearings
 - Titanium alloy bearings



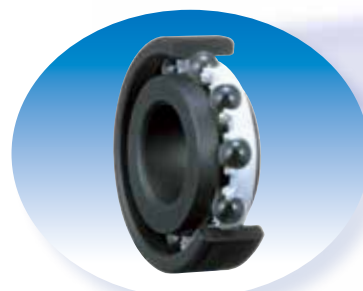
YS bearings with spacer joints

Corrosive environments

- **Water environments**
 - Stainless steel bearings
 - Molded-Oil™ bearings
 - Hybrid bearings
 - Corrosion-resistant coated bearings
- **Alkali and weak acid environments**
 - ESZ bearings
 - ESA bearings
- **Strong acid and reactive gas environments**
 - Aqua-Bearing™
 - All-ceramic bearings



Stainless steel bearings



Aqua-Bearing™

Clean environments

- **Normal atmosphere, room temperature**
 - LG2 grease-packed bearings
 - LGU grease-packed bearings
- **Normal atmosphere, high-temperature/vacuum, medium-temperature**
 - DL2 grease-packed bearings
- **Vacuum, high-temperature**
 - YS bearings with self-lubricating cage
 - DFO bearings



Clean grease-packed bearings



DFO bearings

High-temperature environments

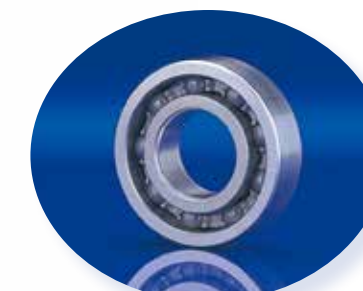
- **Normal atmosphere, high-temperature**
 - KPM grease-packed bearings
- **Vacuum, high-temperature**
 - YS bearings with spacer joints
 - SJ bearings



SJ bearings

Non-magnetic requirement

- **Non-magnetic (relative permeability 1.01 or less)**
 - ESA bearings
- **Completely non-magnetic (relative permeability 1.001 or less)**
 - Titanium alloy bearings
 - All-ceramic bearings



Titanium alloy bearings

Dust-contaminated environments

- **Normal atmosphere, dust-contaminated**
 - Molded-Oil™ bearings

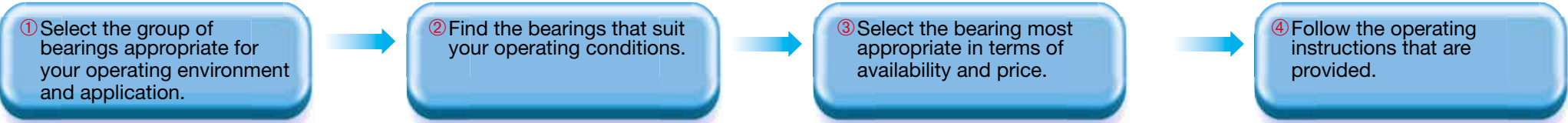





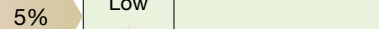




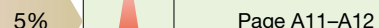

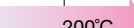

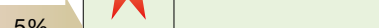




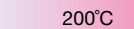




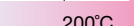


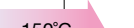

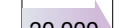
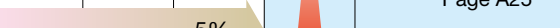


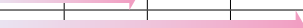



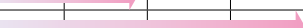
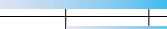

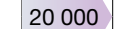
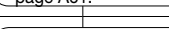








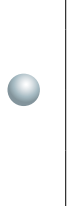







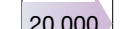









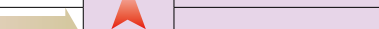
Molded-Oil™ bearings

SPACEA™

SPACEA™ Series Bearings

1. Select the most appropriate bearing with the following selection flow chart.



① Operating environment			Product name	② Operating conditions															③ Price comparison	③ Availability	④ ·Specifications ·Operating instructions ·Technical data		
				Degree of vacuum Pa			Operating temperature °C					Cleanliness ⁽¹⁾			Limiting rotational speed $d_m n^{(2)}$			Limiting load $P/C_H^{(3)}$					
				Normal atmosphere	≥10 ⁻⁴	≥10 ⁻⁵	≤100	≤200	≤300	≤400		100–1 000	100	10	≤20 000	≤50 000	≤150 000	≤1%				≤2%	≤5%
Sanitary environments	For food processing machinery		H1R grease-packed bearings														Page A11–A12	Page A29–A30					
			H3G grease-packed bearings																				
			High-temperature H1B grease-packed bearings																				
			Molded-Oil™ bearings with food grade lubricant										<div>For details, please refer to page A35.</div>			–	Page A18	Page A35–A36					
Vacuum	Clean	Classification of air cleanliness: Class 100–1 000					<div>For details, please refer to page A51.</div>									Page A23–A24	Page A51–A52						
		V-DFO bearings					<div>For details, please refer to page A54.</div>							Page A25		Page A53–A54							
		E-DFO bearings										Page A26	Page A55–A56										
		YS bearings with self-lubricating cage									<div>For details, please refer to page A55.</div>			Page A28		Page A61–A62							
	High-temperature	Up to 400°C												<div>For details, please refer to page A61.</div>		Page A26	Page A59–A60						
		Up to 350°C											<div>For details, please refer to page A59.</div>										
	Non-magnetic	Non-magnetic (relative permeability 1.01 or less)														Page A21	Page A43–A44						
		Completely non-magnetic (relative permeability 1.001 or less)												–		Page A63–A64							
Corrosive	Water	High-humidity environments													Page A13–A16	Page A31–A32							
		Molded-Oil™ bearings							<div>For details, please refer to page A35.</div>			Page A18	Page A35–A36										
		Water spray, immersed										Page A19	Page A37–A38										
		Hybrid bearings									Page A39–A40												
	Water, sterilization liquid	Corrosion-resistant coated bearings											Page A20		Page A41–A42								
	Weak acid and alkali environments	ESZ bearings													Page A21	Page A43–A44							
		ESA bearings																					
	Strong acid and reactive gas environments	Aqua-Bearing™														Page A22	Page A47–A48						
All-ceramic bearings												Page A21	Page A45–A46										

Notes

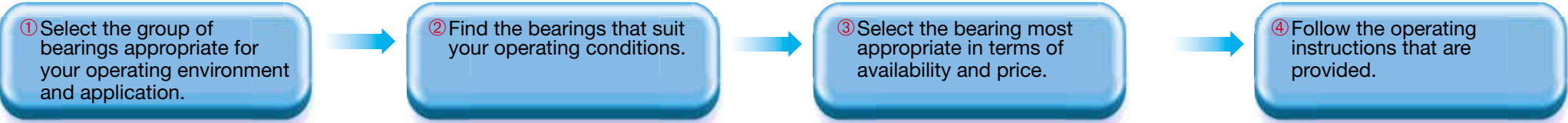
(1) Cleanliness may vary depending on operating conditions, surrounding structures and other factors.




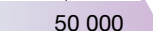


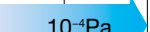
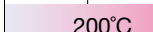
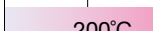





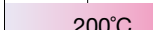



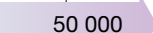















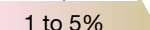
(2) $d_m n$ = (bore diameter of bearing, mm+outer diameter of bearing, mm) ÷ 2 × rotational frequency (min)⁻¹

(3) The limiting load is estimated based on the endurance (total rotational frequency) corresponding to 10⁷ as a guideline.
P: equivalent load (N), C_H: load rating (N) of the stainless bearing
(The durability is different by operating environment or conditions.)

Remarks: Please consult NSK about a unidentified point about bearing specification.

1. Select the most appropriate bearing with the following selection flow chart.



① Operating environment		Product name	② Operating conditions															③ Price comparison	③ Availability	④ ·Specifications ·Operating instructions ·Technical data		
			Degree of vacuum Pa			Operating temperature °C					Cleanliness ⁽¹⁾			Limiting rotational speed $d_m n^{(2)}$			Limiting load $P/C_H^{(3)}$					
			Normal atmosphere	≥10 ⁻⁴	≥10 ⁻⁸	≤100	≤200	≤300	≤400		100–1 000	100	10	≤20 000	≤50 000	≤150 000	≤1%				≤2%	≤5%
Clean	For use in normal atmosphere only	LG2/LGU grease-packed bearings					70°C (LG2)														Page A23–A24	Page A49–A50
	From normal atmosphere up to vacuum	DL2 grease-packed bearings						For details, please refer to page A51.														Page A51–A52
	Low outgas and low particle emissions	V-DFO bearings						For details, please refer to page A54.													Page A25	Page A53–A54
		E-DFO bearings											20 000									
		YS bearings with self-lubricating cage													For details, please refer to page A55.			High	Page A26			
High-temperature	For use in normal atmosphere only, up to 230°C	KPM grease-packed bearings																			Page A27	Page A57–A58
	From normal atmosphere up to 10 ⁻⁸ Pa, up to 400°C	SJ bearings												For details, please refer to page A61.			Page A28	Page A61–A62				
	From normal atmosphere up to 10 ⁻⁸ Pa, up to 350°C	YS bearings with spacer joints												20 000	For details, please refer to page A59.			High	Page A26		Page A59–A60	
Non-magnetic	Non-magnetic (relative permeability 1.01 or less)	ESA bearings																		Page A21	Page A43–A44	
	Completely non-magnetic (relative permeability 1.001 or less)	Titanium alloy bearings											20 000				–	Page A63–A64				
		All-ceramic bearings																High		Page A21	Page A45–A46	
Dust-contaminated	Dust, wood waste, etc.	Molded-Oil™ bearings											For details, please refer to page A65.						–	Page A66	Page A65–A66	

Notes

(1) Cleanliness may vary depending on operating conditions, surrounding structures and other factors.

(2) $d_m n$ = (bore diameter of bearing, mm+outer diameter of bearing, mm) ÷ 2 × rotational frequency (min)⁻¹

(3) The limiting load is estimated based on the endurance (total rotational frequency) corresponding to 107 as a guideline.
 P : equivalent load (N), C_H : load rating (N) of the stainless bearing
(The durability is different by operating environment or conditions.)

Remarks: Please consult NSK about a unidentified point about bearing specification.

1. Stainless steel-based SPACEA™ Series Bearings

Accuracy of boundary dimensions and running accuracy

Note: The dimensional tolerance of the bore and outside diameter for corrosion-resistant coated bearings may deviate from the JIS0 standard for coating thickness (maximum 5 μm in diameter).

● Dimensional accuracy of bore diameter of inner ring

Unit: μm

Nominal bearing bore diameter <i>d</i> (mm)		Single plane mean bore diameter deviation (Deviation of single bore diameter) <i>Δd_{mp}</i>		Mean bore diameter variation (Out-of-roundness) <i>V_{dp}</i>				Mean bore diameter variation (Cylindricity) <i>V_{dmp}</i>
				Diameter series				
				7, 8, 9	0, 1	2, 3, 4		
Over	Incl	High	Low	Max				Max
2.5	10	0	−8	10	8	6		6
10	18	0	−8	10	8	6		6
18	30	0	−10	13	10	8		8
30	50	0	−12	15	12	9		9

● Dimensional accuracy of outside diameter of outer ring

Unit: μm

Nominal bearing outside diameter <i>D</i> (mm)		Single plane mean outside diameter deviation (Deviation of single outside diameter) <i>ΔD_{mp}</i>		Mean outside diameter variation (Out-of-roundness) <i>VD_p</i>				Mean outside diameter variation (Cylindricity) <i>V_{dmp}</i>
				Open type bearings			Sealed/ Shielded	
				Diameter series				
				7, 8, 9	0, 1	2, 3, 4	2, 3, 4	
Over	Incl	High	Low	Max				Max
6	18	0	−8	10	8	6	10	6
18	30	0	−9	12	9	7	12	7
30	50	0	−11	14	11	8	16	8
50	80	0	−13	16	13	10	20	10

● Dimensional accuracy of inner/outer ring width

Unit: μm

Nominal bearing bore diameter <i>d</i> (mm)		Deviation of single ring width ΔB_s or ΔC_s		Ring width variation (Max-min) VB_s or VC_s
Over	Incl	High	Low	Max
2.5	10	0	−120	15
10	18	0	−120	20
18	30	0	−120	20
30	50	0	−120	20

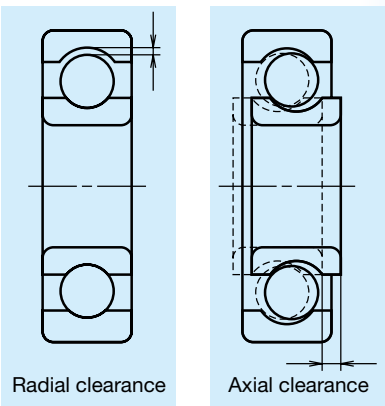
● Running accuracy

Unit: μm

Nominal bearing bore diameter <i>d</i> (mm)		Radial runout of assembled bearing inner ring <i>k</i> _{ia}	Radial runout of assembled bearing outer ring <i>k</i> _{ea}	
Over	Incl	High	Low	Max
2.5	10	10		15
10	18	10		15
18	30	13		20
30	50	15		25

Bearing internal clearance and the standard value

Internal clearance of bearings is the amount that one ring, either the inner or outer, can be displaced relative to the other ring when one is fixed and the other is displaced either vertically or horizontally. The amount of displacement in the radial plane is called radial clearance, while the amount of displacement in the axial plane is called axial clearance. Clearance is measured by adding a specific measuring load to a bearing in order to obtain a stable measured value. As a result, the measured clearance value, or measured internal clearance, becomes slightly larger than the theoretical internal clearance value (also known as geometrical clearance in the case of a radial bearing). The difference is known as the elastic deformation volume, or approach amount. Theoretical internal clearance is derived by compensating the increment of clearance caused by elastic deformation. Internal clearance of bearings prior to installation is usually defined by the theoretical internal clearance value.



● Radial internal clearance of nominal bearing bore diameter

Unit: μm

Nominal bearing bore diameter <i>d</i> (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

Remarks When using the above values as measured clearance, the radial clearance increment caused by the measuring load will be compensated as the clearance compensation values listed in the following table. For compensation values for C2 clearance, the smaller value will be applied to the smallest clearance and the larger value shall be applied to the largest clearance.

Clearance compensation volume

Unit: μm

Nominal bearing bore diameter <i>d</i> (mm)		Measuring load (N)	Clearance compensation value				
			C2	CN	C3	C4	C5
Over	Incl						
10	18	24.5	3–4	4	4	4	4
18	50	49	4–5	5	6	6	6

● Radial internal clearance of extra-small ball bearings

Unit: μm

Clearance number	MC1		MC2		MC3		MC4		MC5		MC6	
Clearance	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
	0	5	3	8	5	10	8	13	13	20	20	28

Remarks 1. Standard clearances are MC3 values.
2. When used as measured internal clearance, the correction values in the following table will be added.

Clearance correction volume

Unit: μm

Clearance number	MC1	MC2	MC3	MC4	MC5	MC6
Clearance correction value	1	1	1	1	2	2

Remarks The measuring load for an extra-small ball bearing is 4.4 N.

1. Food Grade Grease-Packed Bearings

Available on a production by-order basic

Bearings Specifications Technical data A29–A30 pages

● A inquiry is the following name

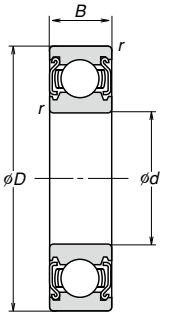
Basic bearing number with H3G grease

Basic bearing number with H1R grease

Basic bearing number with H1B grease for high temperature

◆ See the Molded-Oil™ Bearings with food grade lubricant on page A18.

Boundary dimensions				Basic bearing number ⁽¹⁾	NSF H3		NSF H1				Limiting load ⁽³⁾ (reference value) (N)
Bore diameter <i>d</i> (mm)	Outside diameter <i>D</i> (mm)	Width <i>B</i> (mm)	Chamfer dimension (min.) <i>r</i> (mm)		H3G grease		H1R grease		H1B grease for high temperature		
					Availability	Limiting speeds ⁽²⁾ (reference value) (min ⁻¹)	Availability	Limiting speeds ⁽²⁾ (reference value) (min ⁻¹)	Availability	Limiting speeds ⁽²⁾ (reference value) (min ⁻¹)	
4	9	4	0.1	684	○	53,000	○	37,100	○	31,800	27
	11	4	0.15	694	○	48,000	○	33,600	○	28,800	40
	12	4	0.2	604	○	48,000	○	33,600	○	28,800	40
	13	5	0.2	624	○	40,000	○	28,000	○	24,000	55
5	11	5	0.15	685	○	45,000	○	31,500	○	27,000	30
	13	4	0.2	695	○	43,000	○	30,100	○	25,800	45
	14	5	0.2	605	○	40,000	○	28,000	○	24,000	56
	16	5	0.3	625	○	36,000	○	25,200	○	21,600	73
6	13	5	0.15	686	○	40,000	○	28,000	○	24,000	46
	15	5	0.2	696	○	40,000	○	28,000	○	24,000	56
	17	6	0.3	606	○	38,000	○	26,600	○	22,800	96
	19	6	0.3	626	○	32,000	○	22,400	○	19,200	99
7	14	5	0.15	687	○	40,000	○	28,000	○	24,000	50
	17	5	0.3	697	○	36,000	○	25,200	○	21,600	68
	19	6	0.3	607	○	36,000	○	25,200	○	21,600	99
	22	7	0.3	* 627	○	30,000	○	21,000	○	18,000	140
8	16	5	0.2	688	○	36,000	○	25,200	○	21,600	53
	19	6	0.3	698	○	36,000	○	25,200	○	21,600	95
	22	7	0.3	* 608	○	34,000	○	23,800	○	20,400	140
	24	8	0.3	* 628	○	28,000	○	19,600	○	16,800	140
9	17	5	0.2	* 689	○	36,000	○	25,200	○	21,600	56
	20	6	0.3	699	○	34,000	○	23,800	○	20,400	100
	24	7	0.3	* 609	○	32,000	○	22,400	○	19,200	140
	26	8	0.9	* 629	○	28,000	○	19,600	○	16,800	190
9.525	22.225	7.142	0.4	* R6	○	32,000	○	22,400	○	19,200	140
10	19	5	0.3	* 6800	○	34,000	○	23,800	○	20,400	73
	22	6	0.3	* 6900	○	32,000	○	22,400	○	19,200	110
	26	8	0.3	* 6000	○	30,000	○	21,000	○	18,000	190
	30	9	0.6	* 6200	○	24,000	○	16,800	○	14,400	21
12	21	5	0.3	* 6801	○	32,000	○	22,400	○	19,200	82
	24	6	0.3	* 6901	○	30,000	○	21,000	○	18,000	120
	28	8	0.3	* 6001	○	28,000	○	19,600	○	16,800	210
	32	10	0.6	* 6201	○	20,000	○	14,000	○	12,000	290
15	24	5	0.3	* 6802	○	28,000	○	19,600	○	16,800	88
	28	7	0.3	* 6902	○	26,000	○	18,200	○	15,600	180
	32	9	0.3	* 6002	○	24,000	○	16,800	○	14,400	230
	35	11	0.6	* 6202	○	20,000	○	14,000	○	12,000	320



Shielded Type (example)

Boundary dimensions				Basic bearing number ⁽¹⁾	NSF H3		NSF H1				Limiting load ⁽³⁾ (reference value) (N)
Bore diameter <i>d</i> (mm)	Outside diameter <i>D</i> (mm)	Width <i>B</i> (mm)	Chamfer dimension (min.) <i>r</i> (mm)		H3G grease		H1R grease		H1B grease for high temperature		
					Availability	Limiting speeds ⁽²⁾ (reference value) (min ⁻¹)	Availability	Limiting speeds ⁽²⁾ (reference value) (min ⁻¹)	Availability	Limiting speeds ⁽²⁾ (reference value) (min ⁻¹)	
17	26	5	0.3	* 6803	○	26,000	○	18,200	○	15,600	110
	30	7	0.3	* 6903	○	24,000	○	16,800	○	14,400	190
	35	10	0.3	* 6003	○	22,000	○	15,400	○	13,200	250
	40	12	0.6	* 6203	○	17,000	○	11,900	○	10,200	400
20	32	7	0.3	* 6804	○	22,000	○	15,400	○	13,200	170
	37	9	0.3	* 6904	○	19,000	○	13,300	○	11,400	270
	42	12	0.6	* 6004	○	18,000	○	12,600	○	10,800	390
	47	14	1	* 6204	○	15,000	○	10,500	○	9,000	540
25	37	7	0.3	* 6805	○	18,000	○	12,600	○	10,800	190
	42	9	0.3	* 6905	○	16,000	○	11,200	○	9,600	290
	47	12	0.6	* 6005	○	15,000	○	10,500	○	9,000	420
	52	15	1	* 6205	○	13,000	○	9,100	○	7,800	590
30	55	13	1	* 6006	○	13,000	○	9,100	○	7,800	560
	62	16	1	* 6206	○	11,000	○	7,700	○	6,600	820
35	62	14	1	* 6007	○	11,000	○	7,700	○	6,600	680
	72	17	1.1	6207	○	9,500	○	6,650	○	5,700	1090
40	68	15	1	6008	○	10,000	○	7,000	○	6,000	710
	80	18	1.1	6208	○	7,500	○	5,250	○	4,500	1240

Symbol of availability: ○ Available on a production-by-order basis.

Notes (1) A basic bearing number with an asterisk (*) indicates that NSK's ES1 steel has been adopted for the bearing's inner and outer ring.

(2) The limiting speed is for Shielded type. Please contact NSK for limiting speed for contact sealed type.

(3) The limiting load is a pure radial load that has been calculated based on a bearing life of 10⁷ rotations.

Remarks 1. The radial internal clearance for the bearings with bore diameters smaller than 10 mm is MC3. The radial internal clearance for bearings with bore diameters of 10 mm or larger is CN. See the radial internal clearance tables on page A10 for further details.

2. Shielded type is standard items.

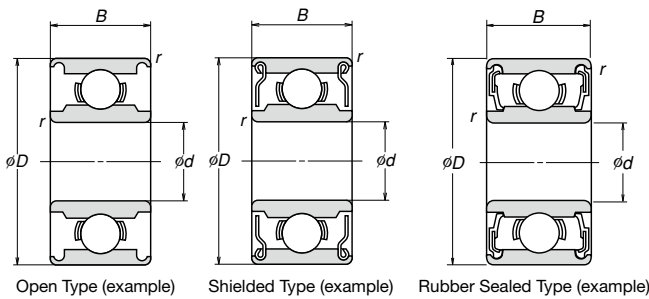
2-1. Stainless steel bearings (Bore Diameter 1–12 mm)

● A inquiry is the following name

- Stainless steel bearing Basic bearing number (Open Type)
- Stainless steel bearing Basic bearing number (ZZ Type)
- Stainless steel bearing Basic bearing number (DD Type)

Stocked as standard inventory items

Bearings Specifications Technical dataA31–A32 pages



Boundary dimensions				Basic bearing number ⁽¹⁾	Dynamic load, rating, C _H (reference value) (N)	Availability			Limiting speeds (reference value) (min ⁻¹)	Limiting load ⁽²⁾ (reference value) (N)
Bore diameter d (mm)	Outside diameter D (mm)	Width B (mm)	Chamfer dimension (min.) r (mm)			Open	Shielded (ZZ)	Rubber sealed (DD)		
1	3	1	0.05	681	81	●	●		10 000	4
	3	1.5	0.05	MR31	81	●			10 000	4
	4	1.6	0.1	691	120	●			10 000	6
1.2	4	2.5	0.1	MR41X	96	●	●		10 000	4
1.5	4	2	0.05	681X	96	●	●		10 000	4
	5	2.6	0.15	691X	202	●	●		10 000	10
	6	3	0.15	601X	281	●	●		10 000	14
2	5	2.3	0.08	682	144	●	●		10 000	7
	5	2.5	0.1	MR52	144	●	●		10 000	7
	6	3	0.15	692	281	●	●		10 000	14
	6	2.5	0.15	MR62	281	●	●		10 000	14
	7	3	0.15	MR72	328	●	●		10 000	16
2.5	7	3.5	0.15	602	328	●	●		10 000	16
	6	2.6	0.08	682X	177	●	●		10 000	8
	7	3.5	0.15	692X	328	●	●		10 000	16
	8	2.5	0.2	MR82X	475	●			10 000	23
3	8	4	0.15	602X	469	●	●		10 000	23
	6	2.5	0.1	MR63	177	●	●		10 000	8
	7	3	0.1	683	265	●	●		10 000	13
	8	2.5	0.15	MR83	336	●			10 000	16
	8	4	0.15	693	475	●	●		10 000	23
	9	4	0.15	MR93	486	●	●		10 000	24
	9	5	0.15	603	486	●	●		10 000	24
	10	4	0.15	623	538	●	●	●	10 000	26
4	13	5	0.2	633	1 100	●	●		10 000	55
	7	2.5	0.1	MR74	217	●	●		10 000	10
	8	3	0.1	MR84	336	●	●		10 000	16
	9	4	0.1	684	545	●	●	●	10 000	27
	10	4	0.15	MR104	604	●	●	●	10 000	30
	11	4	0.15	694	815	●	●	●	10 000	40
	12	4	0.2	604	815	●	●	●	10 000	40
	13	5	0.2	624	1 110	●	●	●	10 000	55
5	16	5	0.3	634	1 140	●	●	●	10 000	56
	8	2.5	0.1	MR85	185	●	●		10 000	9
	9	3	0.15	MR95	367	●	●		10 000	18
	10	4	0.15	MR105	367	●	●	●	10 000	18
	11	4	0.15	MR115	609		●		10 000	30
	11	5	0.15	685	609	●	●	●	10 000	30
	13	4	0.2	695	916	●	●	●	10 000	45
	14	5	0.2	605	1 130	●	●	●	10 000	56
	16	5	0.3	625	1 470	●	●	●	10 000	73
	19	6	0.3	635	1 990	●	●	●	10 000	99

Boundary dimensions				Basic bearing number ⁽¹⁾	Dynamic load, rating, C _H (reference value) (N)	Availability			Limiting speeds (reference value) (min ⁻¹)	Limiting load ⁽²⁾ (reference value) (N)
Bore diameter d (mm)	Outside diameter D (mm)	Width B (mm)	Chamfer dimension (min.) r (mm)			Open	Shielded (ZZ)	Rubber sealed (DD)		
6	10	3	0.1	MR106	423	●	●		10 000	21
	12	4	0.15	MR126	608	●	●	●	10 000	30
	13	5	0.15	686	920	●	●	●	10 000	46
	15	5	0.2	696	1 140	●	●	●	10 000	56
	17	6	0.3	606	1 920	●	●	●	10 000	96
	19	6	0.3	626	1 990	●	●	●	10 000	99
7	22	7	0.3	636	2 800	●	●	●	10 000	140
	11	3	0.1	MR117	388	●	●		10 000	19
	13	4	0.15	MR137	460	●	●		10 000	23
	14	5	0.15	687	1 000	●	●	●	10 000	50
	17	5	0.3	697	1 370	●	●	●	10 000	68
	19	6	0.3	607	1 990	●	●	●	10 000	99
8	22	7	0.3	627	2 800	●	●	●	10 000	140
	12	3.5	0.1	MR128	463	●	●		10 000	23
	14	4	0.15	MR148	696	●	●	●	10 000	34
	16	5	0.2	688	1 070	●	●	●	10 000	53
	19	6	0.3	698	1 900	●	●	●	10 000	95
	22	7	0.3	608	2 800	●	●	●	10 000	140
9	24	8	0.3	628	2 850	●	●	●	9 370	140
	28	9	0.3	638	3 890	●	●	●	8 330	190
	17	5	0.2	689	1 130	●	●	●	10 000	56
	20	6	0.3	699	2 100	●	●	●	10 000	100
	24	7	0.3	609	2 850	●	●	●	9 090	140
	26	8	0.6	629	3 890	●	●	●	8 570	190
10	30	10	0.6	639	4 350	●	●		7 690	210
	15	3	0.15	6700	729	●			10 000	36
		4					●	●		
	19	5	0.3	* 6800	1 460	●	●	●	10 000	73
	22	6	0.3	* 6900	2 290	●	●	●	9 370	110
	26	8	0.3	* 6000	3 900	●	●	●	8 330	190
12	30	9	0.6	* 6200	4 350	●	●	●	7 500	210
	18	4	0.2	6701	789	●	●	●	10 000	39
	21	5	0.3	* 6801	1 630	●	●	●	9 090	82
	24	6	0.3	* 6901	2 460	●	●	●	8 330	120
	28	8	0.3	* 6001	4 350	●	●	●	7 500	210
	32	10	0.6	* 6201	5 800	●	●	●	6 810	290

Symbol of availability: ● Stocked as standard inventory items.⁽³⁾

Notes (1) A basic bearing number with an asterisk (*) indicates that NSK's ES1 steel has been adopted for the bearing's inner and outer ring.

(2) The limiting load is a pure radial load that has been calculated based on a bearing life of 10⁷ rotations.

(3) Orders placed for standard inventory items may incur some delay in actual delivery. Furthermore, products shipped from Japan may incur additional delays.

Remarks 1. Open-type bearings do not include grease. Customers need to ensure that an optimum lubricant is made available for use with these bearings.

2. The radial internal clearance for bearings with bore diameters smaller than 10 mm is MC3. The radial internal clearance for bearings with bore diameters of 10 mm or larger is CN. See the radial internal clearance tables on page A10 for further details.

2-1. Stainless steel bearings
(Bore Diameter 15–60 mm)

Stocked as standard inventory items

Bearings Specifications Technical data A31–A32 pages

A inquiry is the following name

- Stainless steel bearing Basic bearing number (Open Type)
- Stainless steel bearing Basic bearing number (ZZ Type)
- Stainless steel bearing Basic bearing number (DD Type)

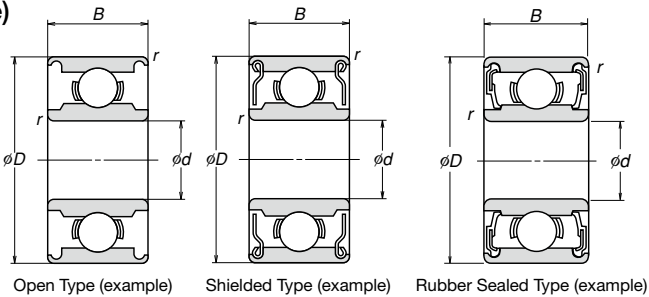


Table with 10 columns: Bore diameter d, Outside diameter D, Width B, Chamfer dimension r, Basic bearing number, Dynamic load rating, Availability (Open, Shielded, Rubber sealed), Limiting speeds, Limiting load.

Symbol of availability: ● Stocked as standard inventory items.
Notes (1) A basic bearing number with an asterisk (*) indicates that NSK's ES1 steel has been adopted for the bearing's inner and outer ring.
(2) The limiting load is a pure radial load that has been calculated based on a bearing life of 10^7 rotations.
(3) Orders placed for standard inventory items may incur some delay in actual delivery. Furthermore, products shipped from Japan may incur additional delays.
Remarks 1. Open-type bearings do not include grease. Customers need to ensure that an optimum lubricant is made available for use with these bearings.
2. The radial internal clearance for the bearings on this page is CN. See the radial internal clearance tables on page A10 for further details.

2-2. Stainless steel bearings (with flanged outer ring)

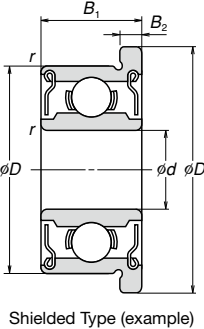
Stocked as standard inventory items

Bearings Specifications Technical data A31–A32 pages

A inquiry is the following name

Stainless steel bearing Basic bearing number

Table with 11 columns: Bore diameter d, Outside diameter D, Width B1, Flanged Outside diameter D2, Flanged Width B2, Chamfer dimension r, Basic bearing number, Dynamic load rating, Availability, Limiting speeds, Limiting load.

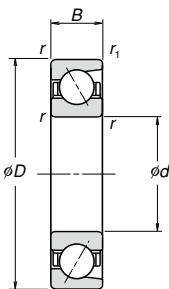


Symbol of availability: ● Stocked as standard inventory items.
Notes (1) The limiting load is a pure radial load that has been calculated based on a bearing life of 10^7 rotations.
(2) Orders placed for standard inventory items may incur some delay in actual delivery. Furthermore, products shipped from Japan may incur additional delays.
Remarks 1. The radial internal clearance for bearings with bore diameters smaller than 10 mm is MC3. The radial internal clearance for bearings with bore diameters of 10 mm or larger is CN. See the radial internal clearance tables on page A10 for further details.
2. Shielded Type is standard inventory items.

3. Stainless steel Angular Contact Ball Bearings

Stocked as standard inventory items

Bearings Specifications Technical data A33 pages



A inquiry is the following name

Stainless steel bearing Basic bearing number for Normal atomosphere

Stainless steel bearing Basic bearing number for Vacuum environment

Boundary dimensions					Basic bearing number ⁽¹⁾	Dynamic load, rating, C _H (reference value) (N)	Availability		Limiting speeds (reference value) (min ⁻¹)	Limiting load ⁽²⁾ (reference value) (N)
Bore diameter d (mm)	Outside diameter D (mm)	Width B (mm)	Chamfer dimension (min.) r (mm)	Chamfer dimension (min.) r ₁ (mm)			For use in Normal atmosphere and Clean environments	For use in Vacuum, Clean and High-temperature environments		
6	17	6	0.3	0.15	* 706A	1 730	●	●	10 000	86
8	22	7	0.3	0.15	* 708A	2 840	●	●	10 000	140
10	26	8	0.3	0.15	* 7000A	4 250	●	●	8 330	210
12	28	8	0.3	0.15	* 7001A	4 600	●	●	7 500	230
15	28	7	0.3	0.15	* 7902A5	3 850	●	●	6 970	190
	32	9	0.3	0.15	* 7002A	4 900	●	●	6 380	240
	35	11	0.6	0.3	* 7202A	6 900	●	●	6 000	340
17	35	10	0.3	0.15	* 7003A	5 200	●	●	5 760	260
20	37	9	0.3	0.15	* 7904A5	5 600	●	●	5 260	280
	42	12	0.6	0.3	* 7004A	8 750	●	●	4 830	430
	47	14	1	0.6	* 7204A	11 600	●	●	4 470	580
25	47	12	0.6	0.3	* 7005A	9 150	●	●	4 160	450
	52	15	1	0.6	* 7205A	13 100	●	●	3 890	650
30	47	9	0.3	0.15	* 7906A5	6 700	●	●	3 890	330

Symbol of availability: ● Stocked as standard inventory items.⁽³⁾

Notes (1) A basic bearing number with an asterisk (*) indicates that NSK's ES1 steel has been adopted for the bearing's inner and outer ring.

(2) The limiting load is a pure radial load that has been calculated based on a bearing life of 10⁷ rotations.

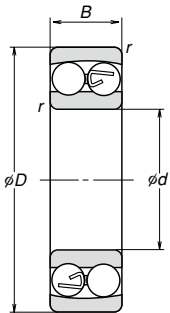
(3) Orders placed for standard inventory items may incur some delay in actual delivery. Furthermore, products shipped from Japan may incur additional delays.

Remarks: Customers need to ensure that an optimum lubricant is made available for use with these bearings.

4. Stainless steel Self-Aligning Ball Bearings

Stocked as standard inventory items

Bearings Specifications Technical data A34 pages



A inquiry is the following name

Stainless steel bearing Basic bearing number

Boundary dimensions				Basic bearing number ⁽¹⁾	Dynamic load, rating, C _H (reference value) (N)	Availability	Limiting speeds (reference value) (min ⁻¹)	Limiting load ⁽²⁾ (reference value) (N)	Radial internal clearance (mm)
Bore diameter d (mm)	Outside diameter D (mm)	Width B (mm)	Chamfer dimension (min.) r (mm)						
10	30	9	0.6	* 1200	4 750	●	7 500	230	0.006–0.017
12	32	10	0.6	* 1201	4 850	●	6 810	240	0.006–0.019
15	35	11	0.6	* 1202	6 450	●	6 000	320	0.008–0.021
17	40	12	0.6	* 1203	6 800	●	5 260	340	0.008–0.021
20	47	14	1	* 1204	8 500	●	4 470	420	0.010–0.023
25	52	15	1	* 1205	10 400	●	3 890	520	0.011–0.024

Symbol of availability: ● Stocked as standard inventory items.⁽³⁾

Notes (1) A basic bearing number with an asterisk (*) indicates that NSK's ES1 steel has been adopted for the bearing's inner and outer ring.

(2) The limiting load is a pure radial load that has been calculated based on a bearing life of 10⁷ rotations.

(3) Orders placed for standard inventory items may incur some delay in actual delivery. Furthermore, products shipped from Japan may incur additional delays.

Remarks: Customers need to ensure that an optimum lubricant is made available for use with these bearings.

5. Molded-Oil™ bearings

Stocked as standard inventory items

Available on a production-by-order basis

Bearings Specifications Technical data A35–A36 pages

A inquiry is the following name

Molded-Oil™ bearing Basic bearing number Stainless steel

Molded-Oil™ bearing with food grade lubricant Basic bearing number

Boundary dimensions				Basic bearing number ⁽¹⁾	Availability		Limiting speeds ⁽²⁾ (reference value) (min ⁻¹)	Applied load ⁽³⁾ (reference value) (N)
Bore diameter d (mm)	Outside diameter D (mm)	Width B (mm)	Chamfer dimension (min.) r (mm)		General grade lubricant	Food grade lubricant		
10	22	6	0.3	* 6900	●	○	9 370	23 – 110
	26	8	0.3	* 6000	●	○	8 330	39 – 190
	30	9	0.6	* 6200	●	○	7 500	44 – 210
12	24	6	0.3	* 6901	●	○	8 330	25 – 120
	28	8	0.3	* 6001	●	○	7 500	44 – 210
	32	10	0.6	* 6201	●	○	6 810	58 – 290
15	32	9	0.3	* 6002	●	○	6 380	48 – 230
	35	11	0.6	* 6202	●	○	6 000	65 – 320
17	35	10	0.3	* 6003	●	○	5 760	51 – 250
	40	12	0.6	* 6203	●	○	5 260	82 – 400
20	42	12	0.6	* 6004	●	○	4 830	80 – 390
	47	14	1	* 6204	●	○	4 470	110 – 540
25	47	12	0.6	* 6005	●	○	4 160	86 – 420
	52	15	1	* 6205	●	○	3 890	120 – 590
30	55	13	1	* 6006	●	○	3 520	120 – 560

Symbol of availability: ● Stocked as standard inventory items.⁽⁴⁾

Notes (1) A basic bearing number with an asterisk (*) indicates that NSK's ES1 steel has been adopted for the bearing's inner and outer ring.

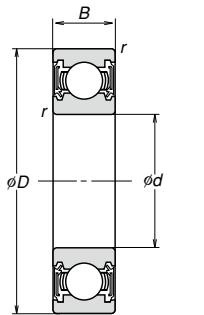
(2) The limiting speed of these bearings has been calculated for 25°C operating conditions. Limiting speeds will be slower for operating conditions of 35°C or higher. (Refer to page A35 for further details.)

(3) The applied load is a pure radial load that has been calculated based on a bearing life of 10⁷ rotations.

(4) Orders placed for standard inventory items may incur some delay in actual delivery. Furthermore, products shipped from Japan may incur additional delays.

Remarks 1. The radial internal clearance for the bearings on this page is CN. See the radial internal clearance tables on page A10 for further details.

2. Rubber sealed type is standard inventory items.



Rubber Sealed Type (example)

6. Hybrid Bearings

Available on a production-by-order basis

Bearings Specifications Technical data A37–A38 pages

● A inquiry is the following name

Hybrid bearing Basic bearing number Dimensions, Accuracy and Availability of bearings refer to the following Clause 7.

7. Corrosion-resistant coated bearings

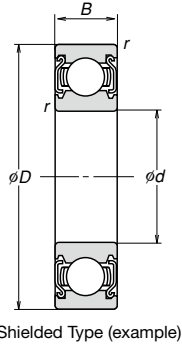
● A inquiry is the following name

Corrosion-resistant coated bearing Basic bearing number

Available on a production-by-order basis

Bearings Specifications Technical data A39–A40 pages

Boundary dimensions				Basic bearing number ⁽¹⁾	Availability		Limiting speeds (reference value) (min ⁻¹)	Limiting load ⁽²⁾ (reference value) (N)
Bore diameter <i>d</i> (mm)	Outside diameter <i>D</i> (mm)	Width <i>B</i> (mm)	Chamfer dimension (min.) <i>r</i> (mm)		Hybrid bearings	Corrosion-resistant coated bearings		
10	26	8	0.3	* 6000	○	○	1 000	78
	30	9	0.6	* 6200	○	○	1 000	87
12	28	8	0.3	* 6001	○	○	1 000	87
	32	10	0.6	* 6201	○	○	900	110
15	32	9	0.3	* 6002	○	○	850	95
	35	11	0.6	* 6202	○	○	800	130
17	35	10	0.3	* 6003	○	○	760	100
	40	12	0.6	* 6203	○	○	700	160
20	37	9	0.3	* 6904	○	○	700	100
	42	12	0.6	* 6004	○	○	640	150
	47	14	1	* 6204	○	○	590	210
25	42	9	0.3	* 6905	○	○	590	110
	47	12	0.6	* 6005	○	○	550	170
	52	15	1	* 6205	○	○	510	230
30	55	13	1	* 6006	○	○	470	220



Symbol of availability: ○ Available on a production-by-order basis.

Notes (1) A basic bearing number with an asterisk (*) indicated that NSK's ES1 steel has been adopted for the bearing's inner and outer ring.

(2) The limiting load is a pure radial load that has been calculated based on a bearing life of 10⁷ rotations.

Remarks 1. The radial internal clearance for the bearings on this page is range from CN (minimum clearance) to C3 (maximum clearance). See the radial internal clearance tables on page A10 for further details.
2. Shielded type is standard items.

8. ESZ Bearings

Available on a production-by-order basis

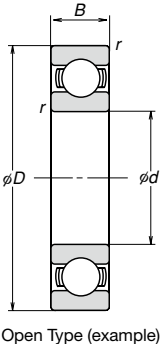
Bearings Specifications Technical data A41–A42 pages

Deep groove ball bearings

● A inquiry is the following name

ESZ bearing Basic bearing number

Boundary dimensions				Basic bearing number	Availability	Limiting speeds (reference value) (min ⁻¹)	Limiting load ⁽¹⁾ (reference value) (N)
Bore diameter <i>d</i> (mm)	Outside diameter <i>D</i> (mm)	Width <i>B</i> (mm)	Chamfer dimension (min.) <i>r</i> (mm)				
10	26	8	0.3	6000	○	1 000	78
	30	9	0.6	6200	○	1 000	87
12	28	8	0.3	6001	○	1 000	87
	32	10	0.6	6201	○	900	110
15	32	9	0.3	6002	○	850	95
	35	11	0.6	6202	○	800	130
17	35	10	0.3	6003	○	760	100
	40	12	0.6	6203	○	700	160
20	42	12	0.6	6004	○	640	150
	47	14	1	6204	○	590	210
25	47	12	0.6	6005	○	550	170
	52	15	1	6205	○	510	230
30	55	13	1	6006	○	470	220
	62	16	1	6206	○	430	330
35	62	14	1	6007	○	410	270
	72	17	1.1	6207	○	370	430
40	68	15	1	6008	○	370	280
	80	18	1.1	6208	○	330	490
45	75	16	1	6009	○	330	350
	85	19	1.1	6209	○	300	530
50	80	16	1	6010	○	300	370
	90	20	1.1	6210	○	280	590
55	90	18	1.1	6011	○	270	480
	100	21	1.5	6211	○	250	740
60	95	18	1.1	6012	○	250	500
	110	22	1.5	6212	○	230	890



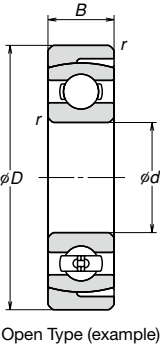
See the "Symbol of Availability," "Notes," and "Remarks" below the following bearing nomenclature for "Bearings with an Aligning Housing Ring."

Deep groove ball bearings with aligning housing ring

● A inquiry is the following name

ESZ bearing Basic bearing number

Boundary dimensions				Basic bearing number	Availability	Limiting speeds (reference value) (min ⁻¹)	Limiting load ⁽¹⁾ (reference value) (N)
Bore diameter <i>d</i> (mm)	Outside diameter <i>D</i> (mm)	Width <i>B</i> (mm)	Chamfer dimension (min.) <i>r</i> (mm)				
10	35	9	0.6	CD200	○	1 000	87
12	37	10	0.6	CD201	○	900	110
15	40	11	0.6	CD202	○	800	130
17	46	12	0.6	CD203	○	700	160
20	54	14	1	CD204	○	590	210
25	60	15	1	CD205	○	510	230
30	72	16	1	CD206	○	430	330



Symbol of availability: ○ Available on a production-by-order basis.

Note (1) The limiting load is a pure radial load that has been calculated based on a bearing life of 10⁷ rotations.

Remarks 1. The radial internal clearance for the bearings on this page is C3. See the radial internal clearance tables on page A10 for further details.
2. Open type is standard items.

9. ESA Bearings

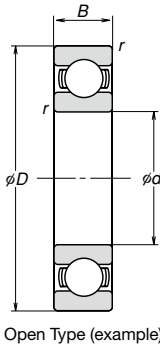
Available on a production-by-order basis

Bearings Specifications Technical data A43–A44 pages

● A inquiry is the following name

ESA bearing Basic bearing number

Boundary dimensions				Basic bearing number	Availability	Limiting speeds (reference value) (min ⁻¹)	Limiting load ⁽¹⁾ (reference value) (N)
Bore diameter <i>d</i> (mm)	Outside diameter <i>D</i> (mm)	Width <i>B</i> (mm)	Chamfer dimension (min.) <i>r</i> (mm)				
8	22	7	0.3	608	○	1 000	56
10	26	8	0.3	6000	○	1 000	78
12	28	8	0.3	6001	○	1 000	87
15	32	9	0.3	6002	○	850	95
20	42	12	0.6	6004	○	640	150
	47	14	1	6204	○	590	210
25	52	15	1	6205	○	510	230
30	55	13	1	6006	○	470	220



Symbol of availability: ○ Available on a production-by-order basis.

Note (1) The limiting load is a pure radial load that has been calculated based on a bearing life of 10⁷ rotations.

Remarks 1. The radial internal clearance for bearings with bore diameters smaller than 10 mm range from MC3 (minimum clearance) to MC5 (maximum clearance). The radial internal clearance for bearings with bore diameters of 10 mm or larger range from CN (minimum clearance) to C4 (maximum clearance). See the radial internal clearance tables on page A10 for further details.
2. Open type is standard items.

10. All-Ceramic Bearings

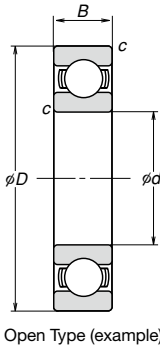
Available on a production-by-order basis

Bearings Specifications Technical data A45–A46 pages

● A inquiry is the following name

All-ceramic bearing Basic bearing number

Boundary dimensions				Basic bearing number	Availability	Limiting speeds (reference value) (min ⁻¹)	Limiting load ⁽¹⁾ (reference value) (N)
Bore diameter <i>d</i> (mm)	Outside diameter <i>D</i> (mm)	Width <i>B</i> (mm)	Chamfer dimension (min.) <i>r</i> (mm)				
8	22	7	0.3	608	○	1 000	140
10	19	5	0.3	6800	○	1 000	73
	26	8	0.3	6000	○	1 000	190
12	28	8	0.3	6001	○	1 000	210
20	42	12	0.6	6004	○	640	390
	47	14	1	6204	○	590	540
30	62	16	1	6206	○	430	820
40	68	15	1	6008	○	370	710



Symbol of availability: ○ Available on a production-by-order basis.

Note (1) The limiting load is a pure radial load that has been calculated based on a bearing life of 10⁷ rotations.

Remarks 1. The radial internal clearance for bearings with bore diameters smaller than 10 mm range from MC3 (minimum clearance) to MC5 (maximum clearance). The radial internal clearance for bearings with bore diameters of 10 mm or larger range from CN (minimum clearance) to C4 (maximum clearance). See the radial internal clearance tables on page A10 for further details.
2. Open type is standard items.

11. Aqua-Bearing™

Available on a production-by-order basis

Bearings Specifications Technical data A47–A48 pages

● A inquiry is the following name

Aqua-Bearing™ Basic bearing number with ceramic balls

Aqua-Bearing™ Basic bearing number with glass balls

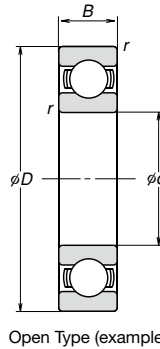
Boundary dimensions ⁽¹⁾				Basic bearing number	Availability		Limiting speeds (reference value) (min ⁻¹)	Limiting load ⁽²⁾ (reference value) (N)	Radial internal clearance (mm)
Bore diameter <i>d</i> (mm)	Outside diameter <i>D</i> (mm)	Width <i>B</i> (mm)	Chamfer dimension (min.) <i>r</i> (mm)		Ceramic balls	Special glass balls			
10	22	6	0.3	6900	○	○	1 000	22	0.04–0.12
	26	8	0.3	6000	○	○	1 000	39	
	30	9	0.6	6200	○	○	1 000	43	
12	24	6	0.3	6901	○	○	1 000	24	0.05–0.14
	28	8	0.3	6001	○	○	1 000	43	
	32	10	0.6	6201	○	○	900	58	
15	28	7	0.3	6902	○	○	930	37	0.05–0.14
	32	9	0.3	6002	○	○	850	47	
	35	11	0.6	6202	○	○	800	65	
17	30	7	0.3	6903	○	○	850	39	0.05–0.14
	35	10	0.3	6003	○	○	760	51	
20	37	9	0.3	6904	○	○	700	54	0.05–0.15
	42	12	0.6	6004	○	○	640	79	
	47	14	1	6204	○	○	590	100	
25	42	9	0.3	6905	○	○	590	59	0.06–0.16
	47	12	0.6	6005	○	○	550	85	

Symbol of availability: ○ Available on a production-by-order basis.

Notes (1) Tolerances: bore diameter: 0 mm to +0.05 mm; outer diameter: -0.05 mm to 0 mm

(2) The limiting load is a pure radial load that has been calculated based on a bearing life of 10⁷ rotations.

Remarks : Open type is standard items.



12. LG2/LGU Grease-Packed Bearings

Stocked as standard inventory items

Available on a production-by-order basis

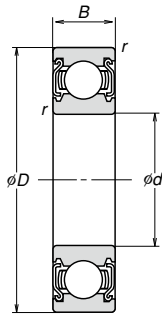
A inquiry is the following name

Bearings Specifications Technical data A49–A50 pages

Basic bearing number with LG2 grease

Basic bearing number with LGU grease

Dimensions, Accuracy and Availability of bearings refer to the following Clause 13.



Shielded Type (example)

13. DL2 Grease-Packed Bearings

Available on a production-by-order basis

Bearings Specifications Technical data A51–A52 pages

A inquiry is the following name

Basic bearing number with DL2 grease

Boundary dimensions				Basic bearing number ⁽¹⁾	Availability			Limiting speeds (reference value) (min ⁻¹)	Limiting load ⁽²⁾ (reference value) (N)
Bore diameter d (mm)	Outside diameter D (mm)	Width B (mm)	Chamfer dimension (min.) r (mm)		LG2 grease	LGU grease	DL2 grease		
3	6	2.5	0.1	MR63	●			1 000	8
	8	4	0.15	693	●			1 000	23
	10	4	0.15	623	●			1 000	26
4	7	2.5	0.1	MR74	●			1 000	10
	9	4	0.1	684	●	○	○	1 000	27
	11	4	0.15	694	●	○	○	1 000	40
	12	4	0.2	604	●	○	○	1 000	40
5	13	5	0.2	624	●	○	○	1 000	55
	11	5	0.15	685	○	○	○	1 000	30
	13	4	0.2	695	●	○	○	1 000	45
	14	5	0.2	605	●	○	○	1 000	56
6	16	5	0.3	625	●	○	○	1 000	73
	13	5	0.15	686	●	○	○	1 000	46
	15	5	0.2	696	●	○	○	1 000	56
	17	6	0.3	606	●	○	○	1 000	96
7	19	6	0.3	626	●	○	○	1 000	99
	14	5	0.15	687	●	○	○	1 000	50
	17	5	0.3	697	●	○	○	1 000	68
	19	6	0.3	607	●	○	○	1 000	99
8	22	7	0.3	* 627	○	○	○	1 000	140
	16	5	0.2	688	●	○	○	1 000	53
	19	6	0.3	698	●	○	○	1 000	95
	22	7	0.3	608	●	○	○	1 000	140
9	24	8	0.3	628	●	○	○	1 000	140
	17	5	0.2	689	●	○	○	1 000	56
	20	6	0.3	699	○	○	○	1 000	100
	24	7	0.3	* 609	○	○	○	1 000	140
9.525	26	8	0.6	* 629	○	○	○	1 000	190
	22.225	7.142	0.4	* R6	○	○	○	1 000	140

Symbol of availability: ● Stocked as standard inventory times.⁽³⁾ ○ Available on a production-by-order basis.

Notes (1) A basic bearing number with an asterisk (*) indicates that NSK's ES1 steel has been adopted for the bearing's inner and outer ring. However, stocked as standard inventory items are used standard stainless steel.

(2) The limiting load is a pure radial load that has been calculated based on a bearing life of 10⁷ rotations.

(3) Orders placed for standard inventory items may incur some delay in actual delivery. Furthermore, products shipped from Japan may incur additional delays.

Remarks 1. The radial internal clearance for bearings with bore diameters smaller than 10 mm is MC3. The radial internal clearance for bearings with bore diameters of 10 mm or larger is CN. See the radial internal clearance tables on page A10 for further details.

2. Sheilded type is standard items.

Boundary dimensions				Basic bearing number ⁽¹⁾	Availability			Limiting speeds (reference value) (min ⁻¹)	Limiting load ⁽²⁾ (reference value) (N)
Bore diameter d (mm)	Outside diameter D (mm)	Width B (mm)	Chamfer dimension (min.) r (mm)		LG2 grease	LGU grease	DL2 grease		
10	19	5	0.3	* 6800	●	○	○	1 000	73
	22	6	0.3	* 6900	●	○	○	1 000	110
	26	8	0.3	* 6000	●	○	○	1 000	190
	30	9	0.6	* 6200	●	○	○	1 000	210
12	21	5	0.3	* 6801	●	○	○	1 000	82
	24	6	0.3	* 6901	●	○	○	1 000	120
	28	8	0.3	* 6001	●	○	○	1 000	210
	32	10	0.6	* 6201	●	○	○	1 000	290
15	24	5	0.3	* 6802	○	○	○	1 000	88
	28	7	0.3	* 6902	●	○	○	1 000	180
	32	9	0.3	* 6002	●	○	○	1 000	230
	35	11	0.6	* 6202	●	○	○	1 000	320
17	26	5	0.3	* 6803	○	○	○	1 000	110
	30	7	0.3	* 6903	●	○	○	1 000	190
	35	10	0.3	* 6003	●	○	○	1 000	250
	40	12	0.6	* 6203	●	○	○	1 000	400
20	32	7	0.3	* 6804	●	○	○	1 000	170
	37	9	0.3	* 6904	●	○	○	1 000	270
	42	12	0.6	* 6004	●	○	○	1 000	390
	47	14	1	* 6204	●	○	○	1 000	540
25	37	7	0.3	* 6805	○	○	○	1 000	190
	42	9	0.3	* 6905	●	○	○	1 000	290
	47	12	0.6	* 6005	●	○	○	1 000	420
	52	15	1	* 6205	●	○	○	1 000	590
30	42	7	0.3	6806	○	○	○	1 000	190
	47	9	0.3	6906	○	○	○	1 000	300
	55	13	1	* 6006	○	○	○	1 000	560
	62	16	1	* 6206	○	○	○	1 000	820
35	62	14	1	* 6007	○	○	○	1 000	680
	72	17	1.1	6207	○	○	○	930	1 090
40	68	15	1	6008	○	○	○	920	710
	80	18	1.1	6208	○	○	○	830	1 240

14. DFO Bearings

Available on a production-by-order basis

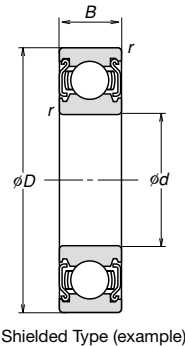
Bearings Specifications Technical data A53–A54 pages

● A inquiry is the following name

E-DFO bearing Basic bearing number

V-DFO bearing Basic bearing number

Boundary dimensions				Basic bearing number ⁽¹⁾	E-DFO Bearings			V-DFO Bearings		
Bore diameter <i>d</i> (mm)	Outside diameter <i>D</i> (mm)	Width <i>B</i> (mm)	Chamfer dimension (min.) <i>r</i> (mm)		Availability	Limiting speeds (reference value) (min ⁻¹)	Limiting load ⁽²⁾ (reference value) (N)	Availability	Limiting speeds (reference value) (min ⁻¹)	Limiting load ⁽²⁾ (reference value) (N)
4	9	4	0.1	684	○	1 000	27	○	1 000	10
	11	4	0.15	694	○	1 000	40	○	1 000	16
	12	4	0.2	604	○	1 000	40	○	1 000	16
	13	5	0.2	624	○	1 000	55	○	1 000	22
5	11	5	0.15	685	○	1 000	30	○	1 000	12
	13	4	0.2	695	○	1 000	45	○	1 000	18
	14	5	0.2	605	○	1 000	56	○	1 000	22
	16	5	0.3	625	○	1 000	73	○	1 000	29
6	13	5	0.15	686	○	1 000	46	○	1 000	18
	15	5	0.2	696	○	1 000	56	○	1 000	22
	17	6	0.3	606	○	1 000	96	○	1 000	38
	19	6	0.3	626	○	1 000	99	○	1 000	39
7	14	5	0.15	687	○	1 000	50	○	1 000	20
	17	5	0.3	697	○	1 000	68	○	1 000	27
	19	6	0.3	607	○	1 000	99	○	1 000	39
	22	7	0.3	* 627	○	1 000	140	○	1 000	56
8	16	5	0.2	688	○	1 000	53	○	1 000	21
	19	6	0.3	698	○	1 000	95	○	1 000	38
	22	7	0.3	* 608	○	1 000	140	○	1 000	56
	24	8	0.3	* 628	○	1 000	140	○	1 000	57
9	17	5	0.2	* 689	○	1 000	56	○	1 000	22
	20	6	0.3	699	○	1 000	100	○	1 000	42
	24	7	0.3	* 609	○	1 000	140	○	1 000	57
	26	8	0.6	* 629	○	1 000	190	○	1 000	78
9.525	22.225	7.142	0.4	* R6	○	1 000	140	○	1 000	56
10	19	5	0.3	* 6800	○	1 000	73	○	1 000	29
	22	6	0.3	* 6900	○	1 000	110	○	1 000	45
	26	8	0.3	* 6000	○	1 000	190	○	1 000	78
	30	9	0.6	* 6200	○	1 000	210	○	1 000	87
12	21	5	0.3	* 6801	○	1 000	82	○	1 000	32
	24	6	0.3	* 6901	○	1 000	120	○	1 000	49
	28	8	0.3	* 6001	○	1 000	210	○	1 000	87
	32	10	0.6	* 6201	○	900	290	○	900	110
15	24	5	0.3	* 6802	○	1 000	88	○	1 000	35
	28	7	0.3	* 6902	○	930	180	○	930	74
	32	9	0.3	* 6002	○	850	230	○	850	95
	35	11	0.6	* 6202	○	800	320	○	800	130
17	26	5	0.3	* 6803	○	930	110	○	930	44
	30	7	0.3	* 6903	○	850	190	○	850	78
	35	10	0.3	* 6003	○	760	250	○	760	100
	40	12	0.6	* 6203	○	700	400	○	700	160
20	32	7	0.3	* 6804	○	760	170	○	760	68
	37	9	0.3	* 6904	○	700	270	○	700	100
	42	12	0.6	* 6004	○	640	390	○	640	150
	47	14	1	* 6204	○	590	540	○	590	210
25	37	7	0.3	* 6805	○	640	190	○	640	76
	42	9	0.3	* 6905	○	590	290	○	590	110
	47	12	0.6	* 6005	○	550	420	○	550	170
	52	15	1	* 6205	○	510	590	○	510	230
30	42	7	0.3	6806	○	550	190	○	550	77
	47	9	0.3	6906	○	510	300	○	510	120
	55	13	1	* 6006	○	470	560	○	470	220
	62	16	1	* 6206	○	430	820	○	430	330
35	62	14	1	* 6007	○	410	680	○	410	270
	72	17	1.1	6207	○	370	1 090	○	370	430
40	68	15	1	6008	○	370	710	○	370	280
	80	18	1.1	6208	○	330	1 240	○	330	490



15. YS Bearings with Self-Lubricating Cage

Available on a production-by-order basis

Bearings Specifications Technical data A55–A56 pages

● A inquiry is the following name

YS bearing with self-lubricating cage Basic bearing number

Dimensions, Accuracy and Availability of bearings refer to the following Clause 17.

17. YS Bearings with Spacer Joints

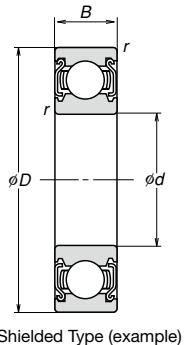
Available on a production-by-order basis

Bearings Specifications Technical data A59–A60 pages

● A inquiry is the following name

YS bearing with spacer joints Basic bearing number

Boundary dimensions				Basic bearing number ⁽¹⁾	Availability		Limiting speeds (reference value) (min ⁻¹)	Limiting load ⁽²⁾ (reference value) (N)
Bore diameter <i>d</i> (mm)	Outside diameter <i>D</i> (mm)	Width <i>B</i> (mm)	Chamfer dimension (min.) <i>r</i> (mm)		YS Bearings with Self-Lubricating Cage	YS Bearings with Spacer Joints		
4	9	4	0.1	684	○		1 000	10
	11	4	0.15	694	○		1 000	16
	12	4	0.2	604	○		1 000	16
	13	5	0.2	624	○		1 000	22
5	11	5	0.15	685	○		1 000	12
	13	4	0.2	695	○		1 000	18
	14	5	0.2	605	○		1 000	22
	16	5	0.3	625	○		1 000	29
6	13	5	0.15	686	○		1 000	18
	15	5	0.2	696	○		1 000	22
	17	6	0.3	606	○	○	1 000	38
	19	6	0.3	626	○	○	1 000	39
7	14	5	0.15	687	○		1 000	20
	19	6	0.3	607	○	○	1 000	39
	22	7	0.3	* 627	○		1 000	56
8	16	5	0.2	688	○		1 000	21
	19	6	0.3	698	○	○	1 000	38
	22	7	0.3	* 608	○	○	1 000	56
	24	8	0.3	* 628	○	○	1 000	57
9	17	5	0.2	* 689	○		1 000	22
	20	6	0.3	699	○	○	1 000	42
	24	7	0.3	* 609	○	○	1 000	57
	26	8	0.6	* 629	○	○	1 000	78
10	19	5	0.3	* 6800	○	○	1 000	29
	22	6	0.3	* 6900	○	○	1 000	45
	26	8	0.3	* 6000	○	○	1 000	78
	30	9	0.6	* 6200	○	○	1 000	87
12	21	5	0.3	* 6801	○	○	1 000	32
	24	6	0.3	* 6901	○	○	1 000	49
	28	8	0.3	* 6001	○	○	1 000	87
	32	10	0.6	* 6201	○	○	900	110
15	24	5	0.3	* 6802	○	○	1 000	35
	28	7	0.3	* 6902	○	○	930	74
	32	9	0.3	* 6002	○	○	850	95
	35	11	0.6	* 6202	○	○	800	130
17	26	5	0.3	* 6803	○	○	930	44
	30	7	0.3	* 6903	○	○	850	78
	35	10	0.3	* 6003	○	○	760	100
	40	12	0.6	* 6203	○	○	700	160
20	32	7	0.3	* 6804	○	○	760	68
	37	9	0.3	* 6904	○	○	700	100
	42	12	0.6	* 6004	○	○	640	150
	47	14	1	* 6204	○	○	590	210
25	37	7	0.3	* 6805	○	○	640	76
	42	9	0.3	* 6905	○	○	590	110
	47	12	0.6	* 6005	○	○	550	170
	52	15	1	* 6205	○	○	510	230
30	47	9	0.3	6906	○	○	510	120
	55	13	1	* 6006	○	○	470	220
	62	16	1	* 6206	○	○	430	330
	72	17	1.1	* 6207	○	○	370	430
35	68	15	1	* 6008	○	○	370	280
	80	18	1.1	* 6208	○	○	330	490
45	75	16	1	* 6009	○	○	330	350



Symbol of availability: ○ Available on a production-by-order basis.

Notes

- (1) A basic bearing number with an asterisk (*) indicates that NSK's ES1 steel has been adopted for the bearing's inner and outer ring bearing steel material.
- (2) The limiting load is a pure radial load that has been calculated based on a bearing life of 10⁷ rotations.

Remarks

- 1. The radial internal clearances for the bearings on this page are listed below. See the radial internal clearance tables on page A10 for further details.
<YS bearings with self-lubricating cage>
Bore diameters smaller than 10 mm: 0.008 mm to 0.023 mm.
Bore diameters of 10 mm or larger: C3
<YS bearings with spacer joints>
Bore diameters smaller than 10 mm: 0.014 mm to 0.029 mm.
Bore diameters of 10 mm or larger: C4
- 2. Shielded type is standard items.

Symbol of availability: ○ Available on a production-by-order basis.

Notes (1) A basic bearing number with an asterisk (*) indicates that NSK's ES1 steel has been adopted for the bearing's inner and outer ring.

(2) The limiting load is a pure radial load that has been calculated based on a bearing life of 10⁷ rotations.

Remarks 1. The radial internal clearance for bearings with bore diameters smaller than 10 mm is MC3. The radial internal clearance for bearings with bore diameters of 10 mm or larger is CN. See the radial internal clearance tables on page A10 for further details.
2. Shielded type is standard items.

16. KPM Grease-Packed Bearings

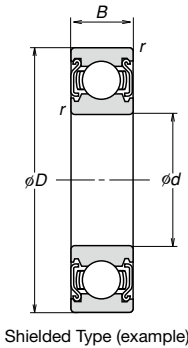
Available on a production-by-order basis

Bearings Specifications Technical data A57–A58 pages

● A inquiry is the following name

Basic bearing number with KPM grease

Boundary dimensions				Basic bearing number ⁽¹⁾	Availability ⁽²⁾	Limiting speeds (reference value) (min ⁻¹)	Limiting load ⁽³⁾ (reference value) (N)
Bore diameter d (mm)	Outside diameter D (mm)	Width B (mm)	Chamfer dimension (min.) r (mm)				
4	9	4	0.1	684	○	1 000	27
	11	4	0.15	694	○	1 000	40
	12	4	0.2	604	○	1 000	40
	13	5	0.2	624	○	1 000	55
5	11	5	0.15	685	○	1 000	30
	13	4	0.2	695	○	1 000	45
	14	5	0.2	605	○	1 000	56
	16	5	0.3	625	○	1 000	73
6	13	5	0.15	686	○	1 000	46
	15	5	0.2	696	○	1 000	56
	17	6	0.3	606	○	1 000	96
	19	6	0.3	626	○	1 000	99
7	14	5	0.15	687	○	1 000	50
	17	5	0.3	697	○	1 000	68
	19	6	0.3	607	○	1 000	99
	22	7	0.3	* 627	○	1 000	140
8	16	5	0.2	688	○	1 000	53
	19	6	0.3	698	○	1 000	95
	22	7	0.3	* 608	○	1 000	140
	24	8	0.3	* 628	○	1 000	140
9	17	5	0.2	* 689	○	1 000	56
	20	6	0.3	699	○	1 000	100
	24	7	0.3	* 609	○	1 000	140
	26	8	0.6	* 629	○	1 000	190
9.525	22.225	7.142	0.4	* R6	○	1 000	140
10	19	5	0.3	* 6800	○	1 000	73
	22	6	0.3	* 6900	○(C3)	1 000	110
	26	8	0.3	* 6000	○(C3)	1 000	190
	30	9	0.6	* 6200	○(C3)	1 000	210
12	21	5	0.3	* 6801	○(C3)	1 000	82
	24	6	0.3	* 6901	○(C3)	1 000	120
	28	8	0.3	* 6001	○(C3)	1 000	210
	32	10	0.6	* 6201	○(C3)	1 000	290
15	24	5	0.3	* 6802	○(C3)	1 000	88
	28	7	0.3	* 6902	○(C3)	1 000	180
	32	9	0.3	* 6002	○(C3)	1 000	230
	35	11	0.6	* 6202	○(C3)	1 000	320
17	26	5	0.3	* 6803	○(C3)	1 000	110
	30	7	0.3	* 6903	○(C3)	1 000	190
	35	10	0.3	* 6003	○(C3)	1 000	250
	40	12	0.6	* 6203	○(C3)	1 000	400
20	32	7	0.3	* 6804	○(C3)	1 000	170
	37	9	0.3	* 6904	○(C3)	1 000	270
	42	12	0.6	* 6004	○(C3)	1 000	390
	47	14	1	* 6204	○(C3)	1 000	540
25	37	7	0.3	* 6805	○(C3)	1 000	190
	42	9	0.3	* 6905	○(C3)	1 000	290
	47	12	0.6	* 6005	○(C3)	1 000	420
	52	15	1	* 6205	○(C3)	1 000	590
30	42	7	0.3	6806	○	1 000	190
	47	9	0.3	6906	○	1 000	300
	55	13	1	* 6006	○(C3)	1 000	560
	62	16	1	* 6206	○(C3)	1 000	820
35	62	14	1	* 6007	○(C3)	1 000	680
	72	17	1.1	6207	○	930	1 090
40	68	15	1	6008	○	920	710
	80	18	1.1	6208	○	830	1 240



Symbol of availability: ○ Available on a production-by-order basis.

Notes

- (1) A basic bearing number with an asterisk (*) indicates that NSK's ES1 steel has been adopted for the bearing's inner and outer ring.
- (2) Some of bearings may have a radial internal clearance of C3, which is indicated as so with parentheses in the "Availability" column.
- (3) The limiting load is a pure radial load that has been calculated based on a bearing life of 10⁷ rotations.

Remarks

- 1. The radial internal clearance for bearings with bore diameters smaller than 10 mm is MC3. The radial internal clearance for bearings with bore diameters of 10 mm or larger is CN. See the radial internal clearance tables on page A10 for further details.
- 2. Sheleled type is standard items.

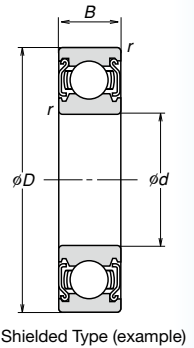
18. SJ Bearings

Available on a production-by-order basis

Bearings Specifications Technical data A61–A62 pages

● A inquiry is the following name

SJ bearing Basic bearing number



Boundary dimensions				Basic bearing number ⁽¹⁾	Availability	Limiting speeds (reference value) (min ⁻¹)	Limiting load ⁽²⁾ (reference value) (N)	Radial internal clearance (min)
Bore diameter d (mm)	Outside diameter D (mm)	Width B (mm)	Chamfer dimension (min.) r (mm)					
8	22	7	0.3	* 608	○	1 000	56	0.037–0.080
10	26	8	0.3	* 6000	○	1 000	78	0.037–0.080
	30	9	0.6	* 6200	○	1 000	87	
12	28	8	0.3	* 6001	○	1 000	87	0.045–0.090
	32	10	0.6	* 6201	○	900	110	
15	32	9	0.3	* 6002	○	850	95	0.045–0.090
	35	11	0.6	* 6202	○	800	130	
17	35	10	0.3	* 6003	○	760	100	0.045–0.090
	40	12	0.6	* 6203	○	700	160	
20	42	12	0.6	* 6004	○	640	150	0.048–0.096
	47	14	1	* 6204	○	590	210	
30	55	13	1	* 6006	○	470	220	0.053–0.106

Symbol of availability: ○ Available on a production-by-order basis.

Notes (1) A basic bearing number with an asterisk (*) indicates that NSK's ES1 steel has been adopted for the bearing's inner and outer ring.

(2) The limiting load is a pure radial load that has been calculated based on a bearing life of 10⁷ rotations.

Remarks: Shielded type is standard items.

19. Titanium Alloy Bearings

Available on a production-by-order basis

Bearings Specifications Technical data A63–A64 pages

This bearing product is available on a production-by-order basis. Please contact NSK for more information.

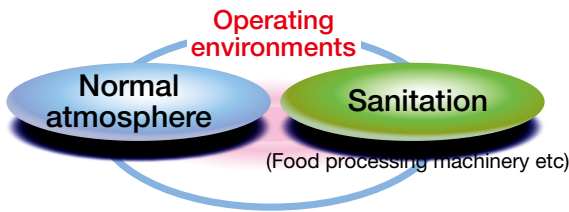
1. Food Grade Grease-Packed Bearings

Page A11-A12


Dimensions, accuracy
and availability of
bearings.

These Stainless steel bearings, employ food-grade grease registered as NSF* for improved safety, and are suitable for food processing machinery and pharmaceutical manufacturing equipment.

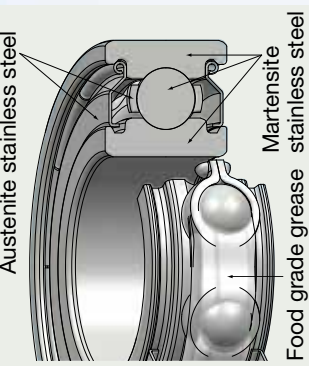
*NSF (National Sanitation Foundation International) : U.S. non-profit third party accreditation organization that is internationally recognized in the field of public safety and health.



Product Specifications



Representative structure



Structure		Shielded Type, Sealed Type
Specifications	Outer/Inner rings	Martensite stainless steel
	Balls	Martensite stainless steel
	Cage	Stainless steel
	Lubricant	Food grade grease
	Seals/Shields	Nitrile rubber/Austenite stainless steel

Applications: Food processing machinery, pharmaceutical manufacturing equipment

- Operating Instructions and Notes
- Bearing should not be unpacked unit immediately before mounting.
 - See the tables of SPACEA™ bearing nomenclature on page A11 and A12 for the limiting loads and limiting rotational speeds.
 - Do not eat food-grade grease because this grease is not foodstuffs.
 - All comments referencing certain values or degrees of performance in this catalog are intended to be used as a reference only. NSK provides this guide “As Is” without warranty of any kind, either expressed or implied.

Features

- H3G grease is registered as NSF* H3 categorized at the highest safety level, and is acceptable to use area contacted with foodstuffs.
- H3G grease exhibits low torque and water resistance so that this grease provides low leakage in water environments.
- H3G grease is applicable temperature up to 90°C, H1R grease is up to 120°C and H1B grease is up to 200°C.
- H1R grease and H1B grease acquire Halal certification that is the food regulations of Islamic religious law.
- H1R grease and H1B grease acquire KOSHER certification that is the food regulations of Jewish religious law.

< NSF Categories for Lubricants Used in Food Processing Equipment >

Safety Level

High H3 Lubricants designed to be contact with foodstuffs. The highest safety level

H1 Lubricants usable in locations with possible incidental contact with foodstuffs

Low H2 Lubricants usable in locations without direct contact with foodstuffs

Performance

- Properties of grease

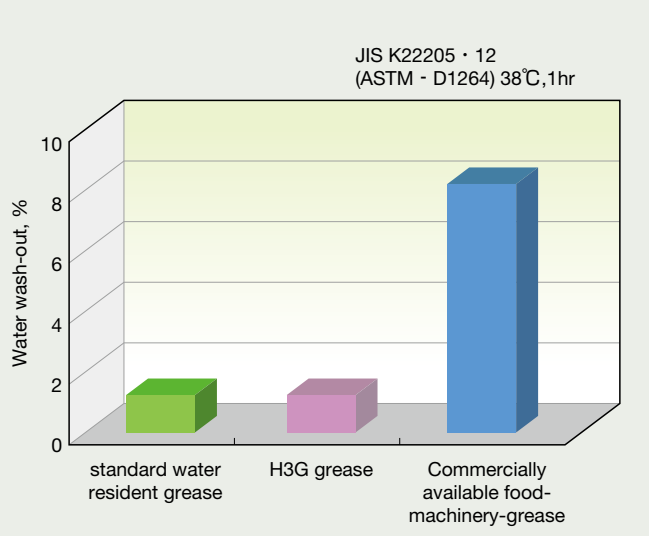
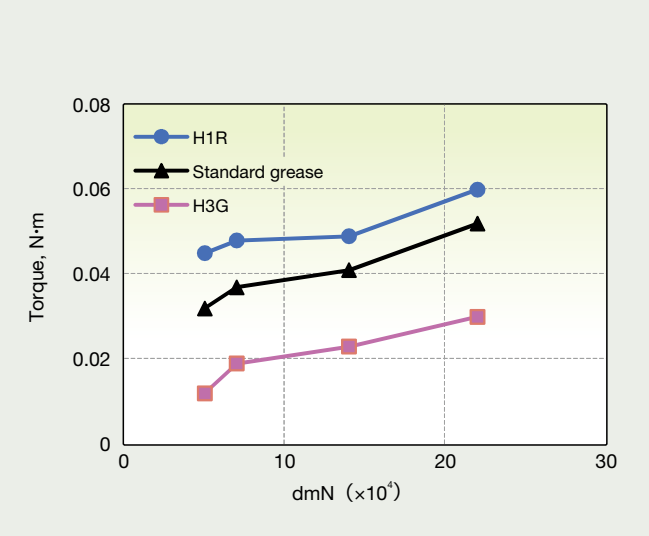
Name	H3G	H1R	H1B
NSF categories	H3	H1	H1
Base oil	High-grade food oil	Synthetic hydrocarbon oil	Fluorine oil
Thickener	Food additives	Aluminum alloy soap	PTFE
Kinematic viscosity (mm ² /s, 40°C)	14.8	150	415
Consistency	255	280	280
Water wash-out	1.0%	7.6%	0.1%
Operating temperature	0 – 90°C	0 – 120°C	0 – 200°C

- Results of torque test

H3G grease have lower torque than standard grease.

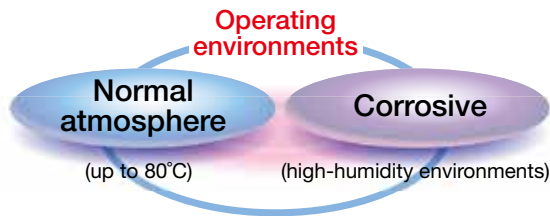
- Results of water resistance test

H3G grease have water resistance same as or more than standard water resident grease.



2. Stainless Steel Bearings Page A13–A16 Dimensions, accuracy and availability of bearings.

Stainless steel bearings, the standard products of the NSK SPACEA™ Series for special environments, are suitable for high-humidity environments.



Product Specifications

Representative structure

Structure		Open Type, Shielded Type, Sealed Type
Specifications	Outer/Inner rings	Martensite stainless steel
	Balls	Martensite stainless steel
	Cage	Polyamide resin or stainless steel
	Lubricant	Lithium-based grease (Open Type bearings do not come with packed grease.)
	Shields/Seals	Austenite stainless steel/Nitrile rubber

Applications: Equipment used in high-humidity environments: food processing, cleaning, chemical processing, fishery equipment

Operating Instructions and Notes

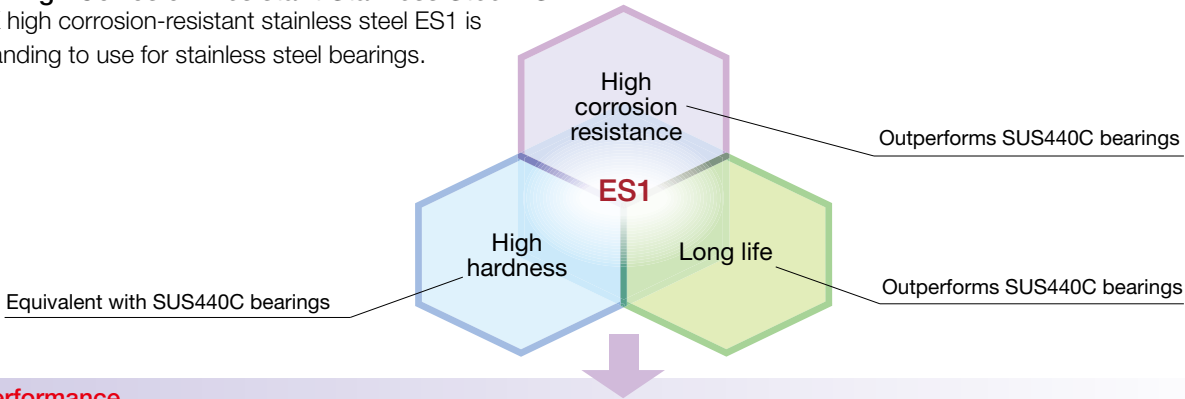
- For use in normal atmospheric conditions only.
- Bearings stocked as standard inventory items are prepacked with NS7 (lithium-based) grease.
- Bearing should not be unpacked until immediately before mounting.
- See the tables of SPACEA™ bearing nomenclature on pages A13 through A16 for the limiting loads and limiting rotational speeds.
- The performance of bearing is affected by environments and conditions. Bearings can not be used in certain corrosive environment and conditions. Confirm environment and conditions where bearings are used.
- All comments referencing certain values or degrees of performance in this catalog are intended to be used as a reference only. NSK provides this guide “As Is” without warranty of any kind, either expressed or implied.

Features

- For use in normal atmosphere only, grease lubrication
- Higher corrosion resistance than bearing steel
- Open Type, Shielded Type, and Contact-seal Type are available (see A13–A16)

NSK High Corrosion-Resistant Stainless Steel ES1

NSK high corrosion-resistant stainless steel ES1 is expanding to use for stainless steel bearings.



Performance

Material	Hardness, HRC	Corrosion resistance ⁽¹⁾	Features
NSK high corrosion-resistant stainless steel ES1	58–62	○	NSK-developed steel
Martensite stainless steel SUS440C	58–62	△	Ordinary stainless steel
Bearing steel SUJ2	60–64	×	Ordinary steel for bearings

Note (1) Comparative assessment between three kinds of materials

● Corrosion resistance of ES1

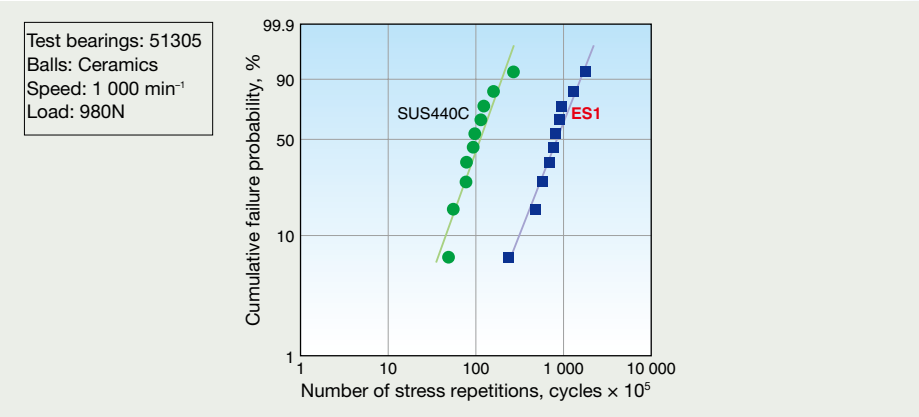
Outperforms SUS440C in corrosion resistance

Test sample: $\phi 18 \times 10$ mm
(#800 emery paper, passivated)
Test solution: 5% NaCl solution
Immersion time: 8 hours (room temperature)

Salt spray test (JIS Z 2371)
Test solution: 5% NaCl solution
Test time: 1 hour
Temperature: 35°C

● Immersion rolling fatigue life

Outperforms SUS440C in durability



3. Stainless Steel Angular Contact Ball Bearings

For use in Normal atmosphere and Clean environments
For use in Vacuum, Clean and High-temperature environments

Page A17 Dimensions, accuracy and availability of bearings.



Features

- Outperforms standard bearing steel in terms of corrosion resistance.
- Achieves high running accuracy to ISO tolerance class P5.
- Supplied as bearings for universal matching with light preload when mounted in a face-to-face (DF) arrangement or back-to-back (DB) arrangement.
- Stainless steel angular contact ball bearings suitable for cleanroom environments in normal atmospheric conditions. Stainless steel angular contact ball bearings for cleanroom, vacuum, and high-temperature environments. Suitable for use in vacuum equipment or cleanroom applications operating under high-temperature conditions.

Specifications of Bearings

Application environment		Normal atmosphere and Clean environments	Vacuum, Clean and High-temperature environments
Contact angle		30° (symbol: A) or 25° (symbol: A5)	
Material	Outer/Inner rings, Balls	Martensite stainless steel	
	Cage	Polyamide resin (Cage symbol: TYN)	Natural PEEK resin (symbol:T4N) or Stainless steel
Arrangement		Universal arrangement (single row)	
Preload		Light preload	
Accuracy		P5	

Operating Instructions and Notes

- Bearing should not be unpacked until immediately before mounting.
- Apply a coating of grease most appropriate for bearings used in normal atmospheric conditions or cleanroom environments after cleaning the bearings and removing the anti-corrosion agent.
- Apply a coating of grease most appropriate for bearings used in vacuum, cleanroom, or high-temperature environments. These bearings have already been degreased and have already been washed to remove the anti-corrosion agent.
- See the tables of SPACEA™ bearing nomenclature on page A17 for the limiting loads and limiting rotational speeds.
- All comments referencing certain values or degrees of performance in this catalog are intended to be used as a reference only. NSK provides this guide “As Is” without warranty of any kind, either expressed or implied.

4. Stainless Steel Self-Aligning Ball Bearings

For use in High corrosion-resistant stainless steel ES1

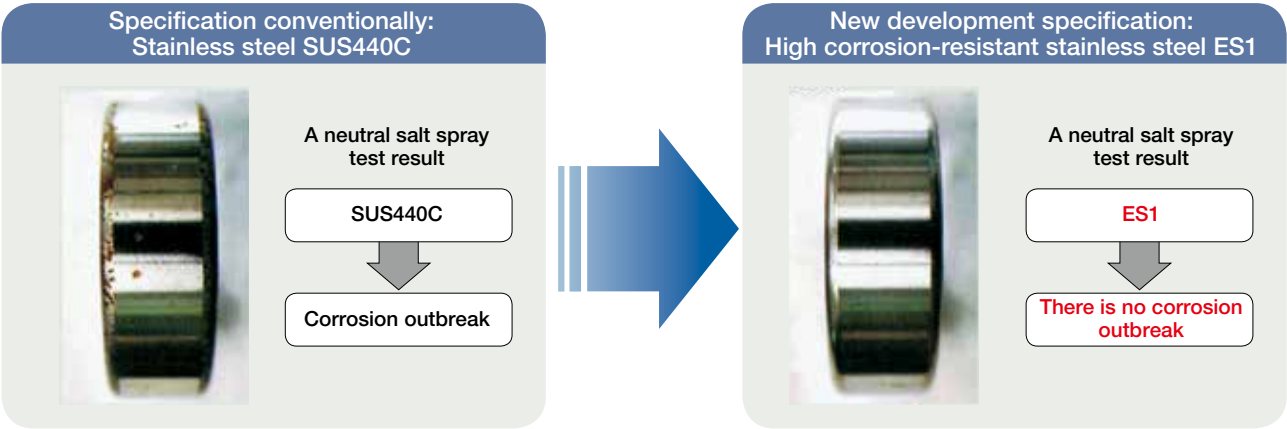
Page A17 Dimensions, accuracy and availability of bearings.



Applications: Liquid-crystal bases cleaning equipment, film cleaning systems, etching equipment, conveyance equipment

Features

- Highly resistant to corrosion through the use of ES1 highly corrosion-resistant stainless steel.
- Self-aligning with the ability to accommodate misalignment of the axis and housing ranging from 4 to 7 degrees.



Operating Instructions and Notes

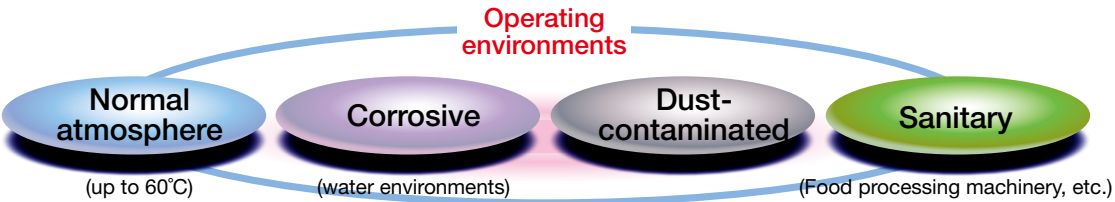
- Bearing should not be unpacked until immediately before mounting.
- Apply a coating of grease most appropriate for the bearing after cleaning the bearings and removing the anti-corrosion agent.
- See the tables of SPACEA™ bearing nomenclature on page A17 for the limiting loads and limiting rotational speeds.
- All comments referencing certain values or degrees of performance in this catalog are intended to be used as a reference only. NSK provides this guide “As Is” without warranty of any kind, either expressed or implied.

5. Molded-Oil™ Bearings

Page A18

Dimensions, accuracy and availability of bearings.

Molded-oil™ bearings, made of stainless steel, are lubricated with NSK's original oil-impregnated material, Molded-oil™, and are suitable for corrosive and dust-contaminated environments in normal atmosphere. In addition, food-grade lubricants are available.



Product Specifications

General grade Food grade

Representative structure

Structure		Open Type, Shielded Type, Sealed Type
Specifications	Outer/Inner rings	Martensite stainless steel
	Balls	Martensite stainless steel
	Cage	Stainless steel
	Lubricant	Molded-oil™ (General grade or Food-grade lubricants)
	Seals/Shields	Nitrile rubber/Austenite stainless steel

Applications: Semiconductor cleaning equipment, liquid-crystal bases, hard-disk cleaning equipment, food processing machinery, various conveyor lines

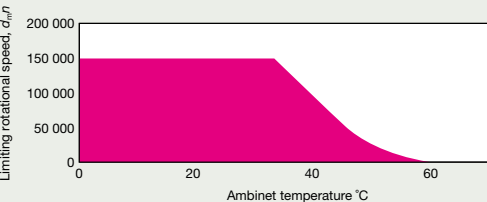
Operating Instructions and Notes

- For use in normal atmospheric conditions only.
- Whereas the solid lubricant used in these bearings will melt at a temperature of 120°C, take care not to exceed temperatures of 100°C when heating this bearing during the shrink-fit process for mounting.
- A radial load is required for the bearings to properly rotate. The minimum radial load recommended for maintaining proper rotation is at least 1 % of the basic dynamic load rating.
- Bearing should not be unpacked until immediately before mounting.
- The scope of application (limiting load, limiting $d_m n$ value) is listed in the table to the right.
- Avoid exposure to organic solvents with a degreasing effect.
- The performance of bearing is affected by environments and conditions. Bearings can not be used in certain corrosive environment and conditions. Confirm environment and conditions where bearings are used.
- All comments referencing certain values or degrees of performance in this catalog are intended to be used as a reference only. NSK provides this guide "As Is" without warranty of any kind, either expressed or implied.

The scope of Molded-oil™ bearings

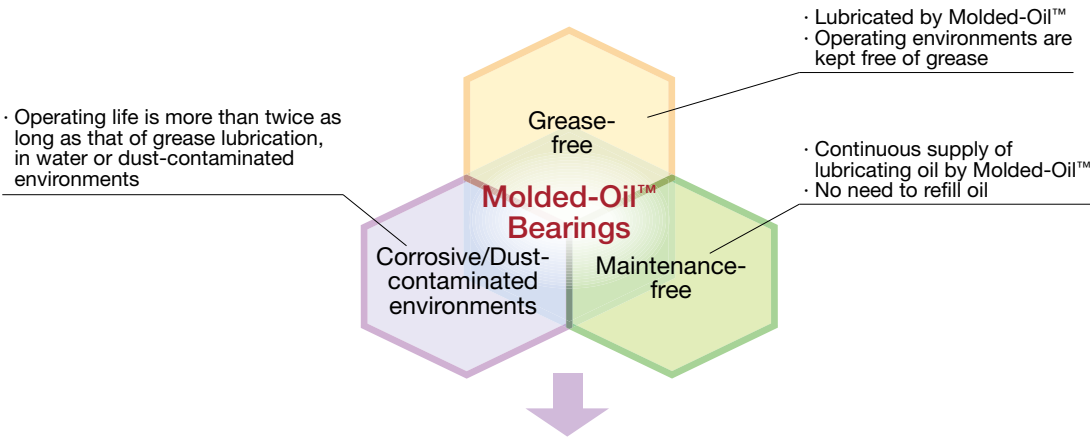
Applied load	Between 1% and 5%, inclusive, of the stainless steel bearing load rating C_H <Load more than 1% is necessary.>
Limiting rotational speed, $d_m n^{(1)}$	150 000 <In the case of more than 35 degrees, please refer to chart below.>

Note (1) $d_m n$ = (Bearing bore diameter, mm + Bearing outside diameter, mm) ÷ 2 × Rotational speed, min⁻¹



Features

- Molded-Oil™—provides continuous supply of lubrication oil
- Grease-free property with no oil refilling keeps operating environments clean
- Operating life more than twice as long as grease lubrication, in water or dust-contaminated environments
- Contact-seal Type available in standard inventory (see A18)
- NSF H1 food-grade lubricants for food processing machinery are available.



Performance

Portion containing high proportion of polyolefin

Polyolefin is used for packaging food in supermarkets, replacing dioxin-generating vinyl chloride.

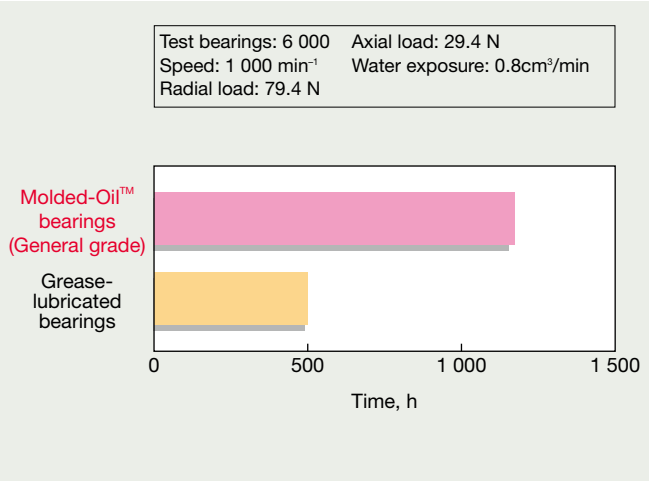
Portion containing high proportion of lubricating oil

Food-grade lubricant of Molded-Oil™ uses lubricating oil registered for NSF H1* category.
*NSF lubricants Category Code H1: Intended contact with foodstuffs.

Close-up of Molded-Oil™ 100 μm

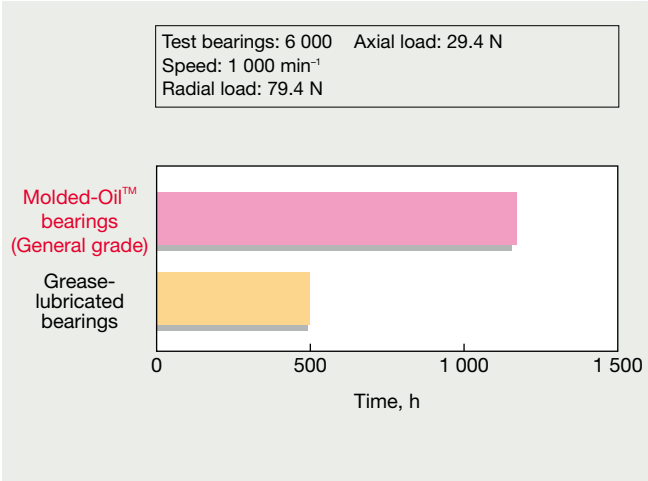
● Durability under wet conditions

Molded-Oil™ bearings have an operating life that is more than twice as long as that of grease-lubricated bearings.



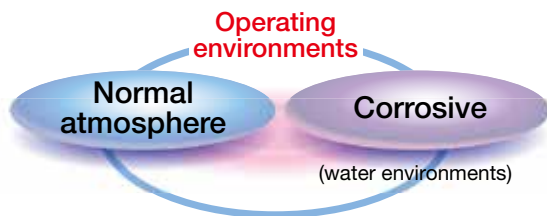
● Durability in water-immersed conditions

Molded-Oil™ bearings have an operating life that is more than twice as long as that of grease-lubricated bearings.




6. Hybrid Bearings Page A19 Dimensions, accuracy and availability of bearings.

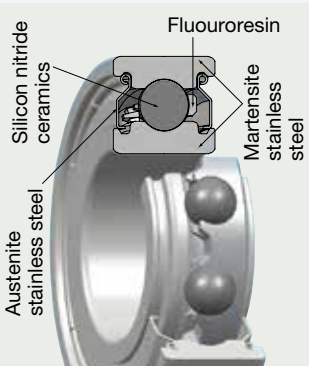
Hybrid bearings, combining ceramic balls and fluororesin self-lubricating cage, are suitable for corrosive environments in normal atmosphere.



Product Specifications



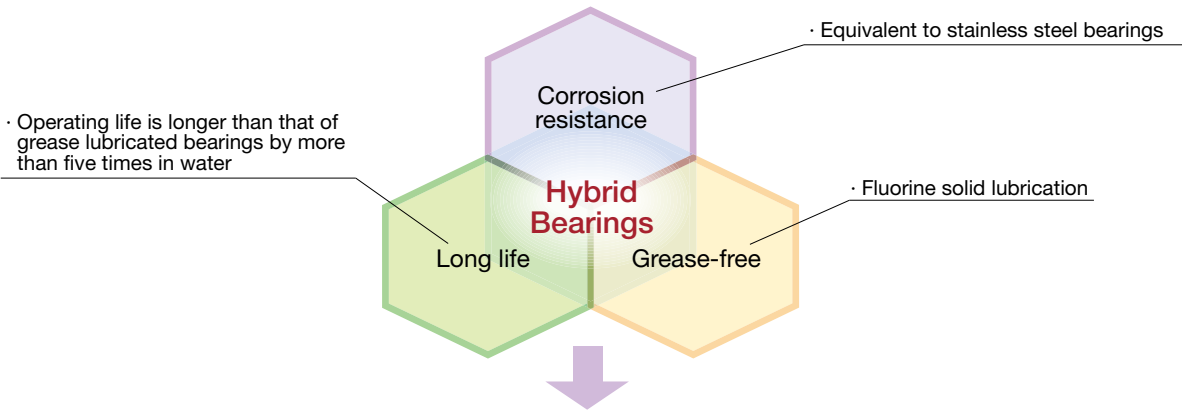
Representative structure



	Structure	Shielded Type (Open Type)
Specifications	Outer/Inner rings	Martensite stainless steel
	Balls	Silicon nitride ceramics
	Cage	Fluororesin
	Lubricant	Fluorine solid lubricant
	Shields	Austenite stainless steel

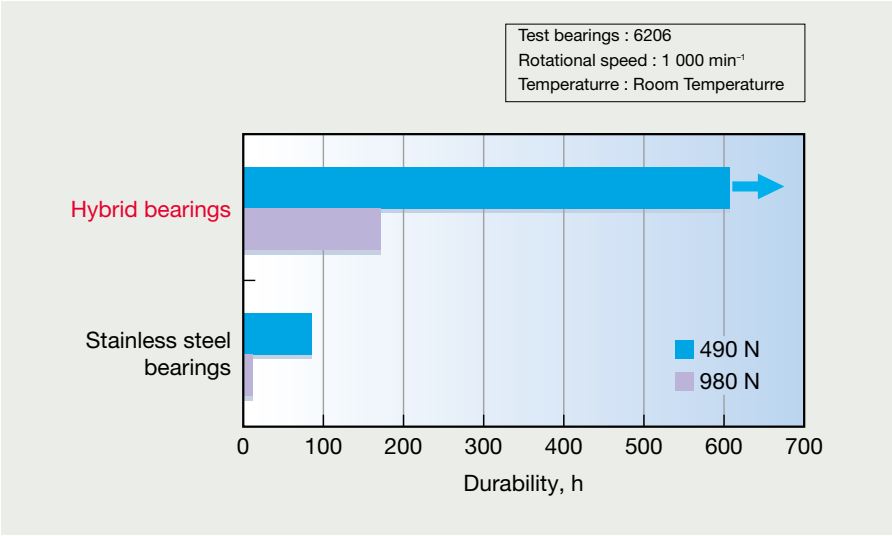
Applications: Devices and conveyor lines used in water-spray and water environments such as food processing and fishery equipment

- Features**
- Grease-free, fluorine solid lubricant
 - Operating life more than five times as long as that of stainless steel bearings in water-immersed environments



Performance

- **Durability in water-immersed environments**
Hybrid bearings have an operating life more than five times as long as that of stainless steel bearings.



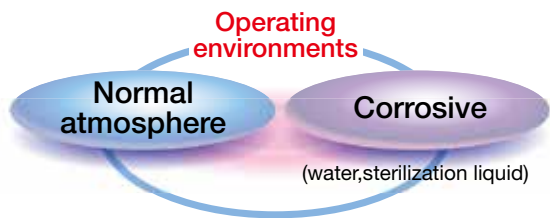
- Operating Instructions and Notes**
- Bearing should not be unpacked until immediately before mounting.
 - See the tables of SPACEA™ bearing nomenclature on page A19 for the limiting loads and limiting rotational speeds.
 - A special clearance is adopted for the radial internal clearance. See the tables of SPACEA™ bearing nomenclature on page A19.
 - The performance of bearing is affected by environments and conditions. Bearings can not be used in certain corrosive environment and conditions. Confirm environment and conditions where bearings are used.
 - All comments referencing certain values or degrees of performance in this catalog are intended to be used as a reference only. NSK provides this guide "As Is" without warranty of any kind, either expressed or implied.

7. Corrosion-Resistant Coated Bearings


Page A19

Dimensions, accuracy and availability of bearings.

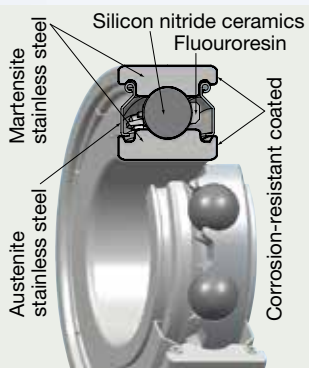
Corrosion-resistant coated bearings are coated with a nickel coating on the outer and inner rings to enhance corrosion resistance and durability, and are suitable for corrosive environments in normal atmosphere.



Product Specifications



Representative structure



	Structure	Shielded Type
Specifications	Outer/Inner rings	Martensite stainless steel and nickel coating
	Balls	Silicon nitride ceramics
	Cage	Fluororesin
	Lubricant	Fluorine solid lubricant
	Shields	Austenite stainless steel

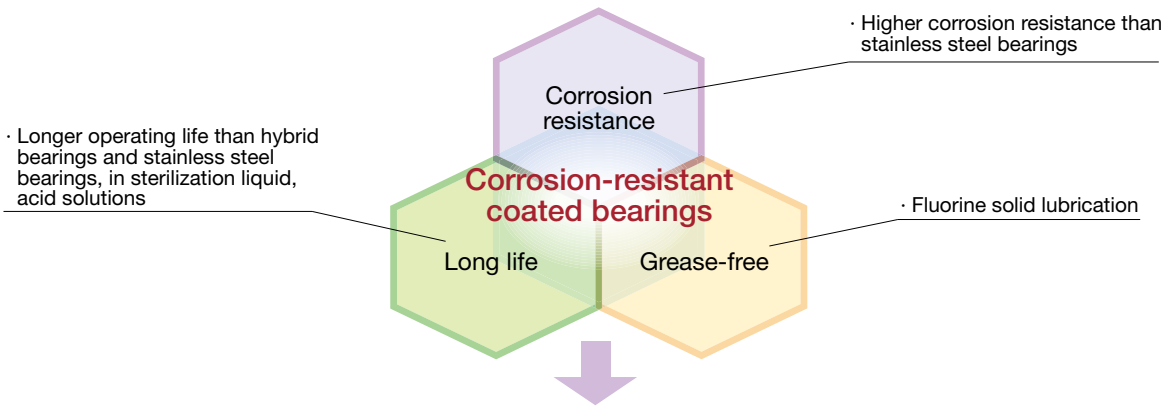
Applications: Semiconductor/FPD/HD cleaning equipment, etching equipment, food processing machinery, various conveyor lines

Operating Instructions and Notes

- Bearing should not be unpacked until immediately before mounting.
- See the tables of SPACEA™ bearing nomenclature on page A19 for the limiting loads and limiting rotational speeds.
- A special clearance is adopted for the radial internal clearance. See the tables of SPACEA™ bearing nomenclature on page A19.
- Dimensional tolerances of the bore and the outside diameter for corrosion-resistant coated bearings may deviate from the JIS0 standard for coating thickness by a maximum of 5 μm in diameter.
- The performance of bearing is affected by environments and conditions. Bearings can not be used in certain corrosive environment and conditions. Confirm environment and conditions where bearings are used.
- All comments referencing certain values or degrees of performance in this catalog are intended to be used as a reference only. NSK provides this guide "As Is" without warranty of any kind, either expressed or implied.


Features

- Grease-free, fluorine solid lubricant
- Higher corrosion-resistance and longer life than stainless steel bearings or hybrid bearings
- Resistant to sterilization liquids such as hydrogen peroxide and oxonia




Performance

Immersed in a sodium hypochlorite solution
Concentration: 150 ppm



After 10 hours



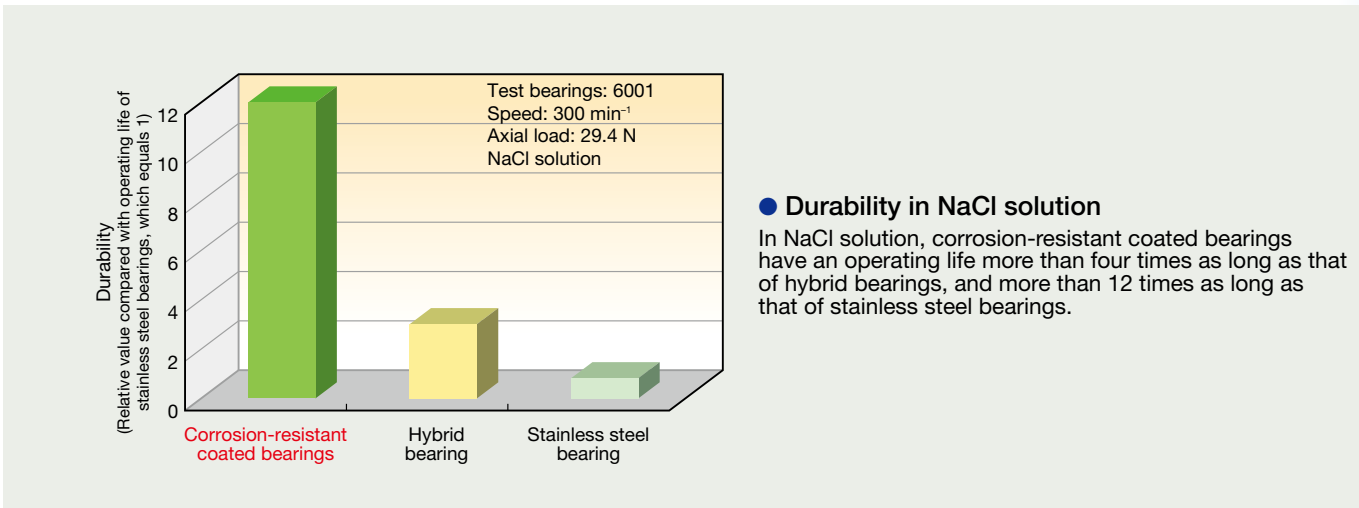
After 72 hours

Stainless steel bearing SUS440C

Corrosion-resistant coated bearings

● Corrosion resistance in sodium hypochlorite solution

While stainless steel bearings rusted in 10 hours, corrosion-resistant coated bearings did not rust, even after 72 hours.



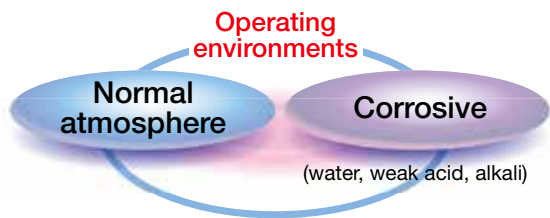
8. ESZ Bearings

Page A20

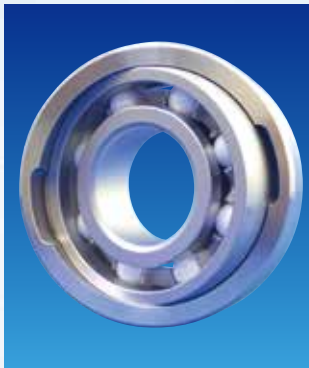
Dimensions, accuracy and availability of bearings.

ESZ bearings are highly corrosion-resistant, high-hardness stainless steel bearings offering corrosion resistance on a par with SUS630, and offering a higher degree of hardness by than 30 % in comparison with SUS630.

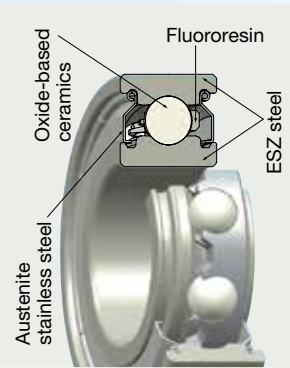
The bearings are suitable for corrosive environments in normal atmosphere.



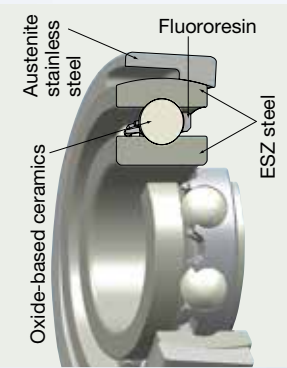
Product Specifications



Representative structure



Representative structure with aligning housing ring



Structure		Deep groove ball bearings	Deep groove ball bearings with aligning housing ring
		Shielded Type (Open Type)	Open Type
Specifications	Outer/Inner rings	High corrosion-Resistant, high hardness stainless steel: ESZ	High corrosion-Resistant, high hardness stainless steel: ESZ
	Balls	Oxide-based ceramics or silicon nitride ceramics	Oxide-based ceramics or silicon nitride ceramics
	Cage	Fluororesin or PEEK resin	Fluororesin
	Lubricant	Solid lubricant	Solid lubricant
	Shields	Austenite stainless steel	—
	Aligning housing ring	—	Austenite stainless steel

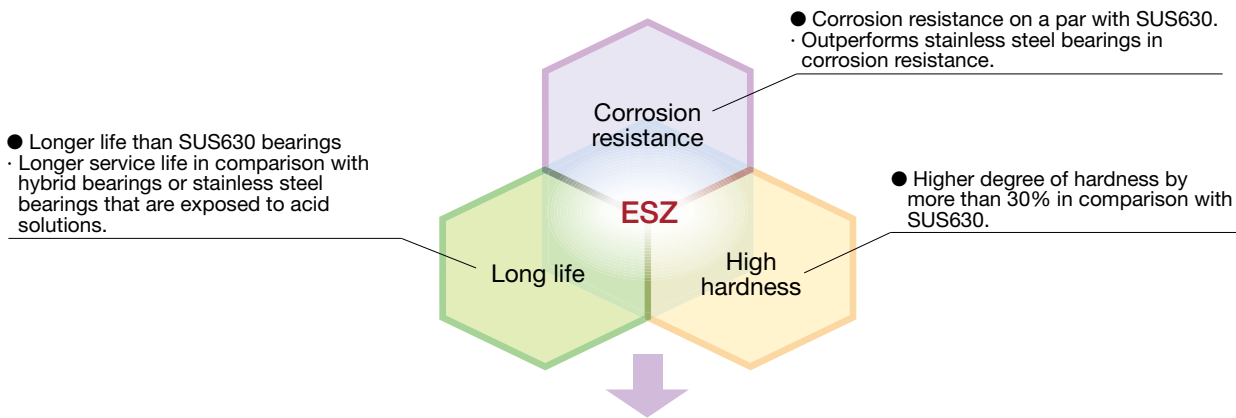
Applications: High function film conveyor, cleaning equipment, food processing machinery, various conveyor lines

Operating Instructions and Notes

- Bearing should not be unpacked until immediately before mounting.
- See the tables of SPACEA™ bearing nomenclature on page A20 for the limiting loads and limiting rotational speeds.
- C3 is the standard radial internal clearance.
- When bearings with aligning housing ring are used under radial loads, move the phase between the slots at the end face of the aligning housing ring and direction of radial load.
- Fit between the aligning housing ring and housing should be loose with a sufficient amount of clearance to ensure smooth, self-aligning performance.
- Please contact NSK if a bearing with an aligning housing ring will be mounted to a vertical shaft.
- The performance of bearing is affected by environments and conditions. Bearings can not be used in certain corrosive environment and conditions. Confirm environment and conditions where bearings are used.
- All comments referencing certain values or degrees of performance in this catalog are intended to be used as a reference only. NSK provides this guide “As Is” without warranty of any kind, either expressed or implied.

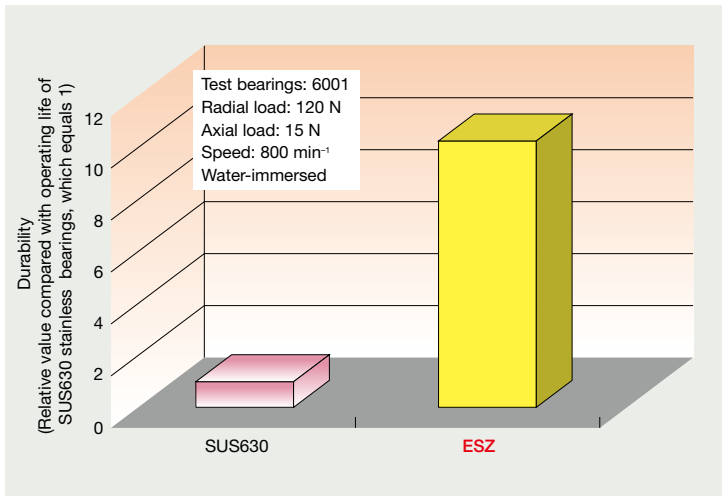
Features

- Product lineup includes standard deep groove ball bearings and deep groove ball bearings with aligning housing ring.
- Corrosion resistance on a par with SUS630. Able to withstand exposure to sodium hypochlorite solutions.
- Hardness increased by more than 30 % in comparison with SUS630 material.
- Able to accommodate bending that is associated with wider rollers and allows for misalignment of the shaft and housing.

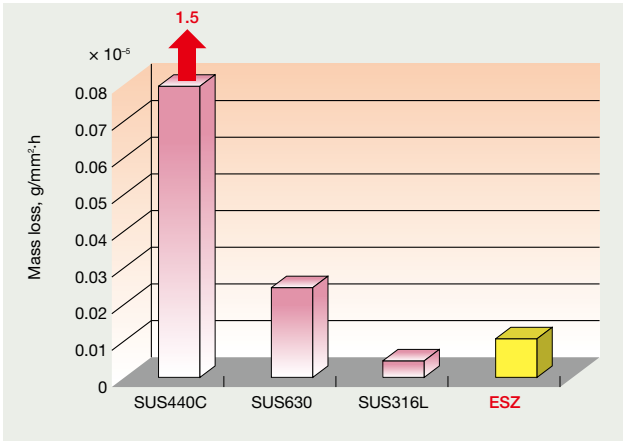


Performance

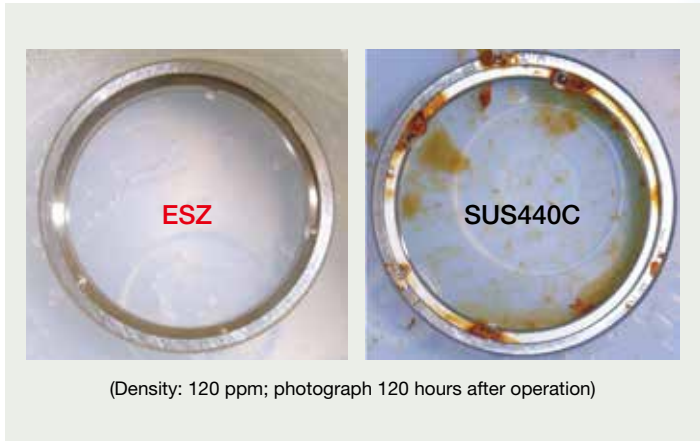
- Durability in water-immersed conditions
Longer life than SUS630 bearings



- Results of 5% sulfuric acid immersion test
Equal to or higher than SUS630



- Results of sodium hypochlorite solution immersion test

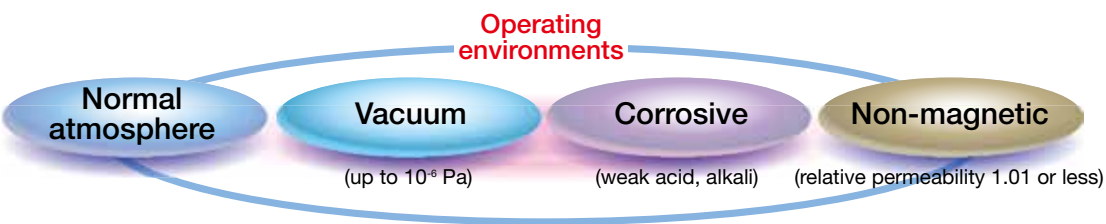


9. ESA Bearings

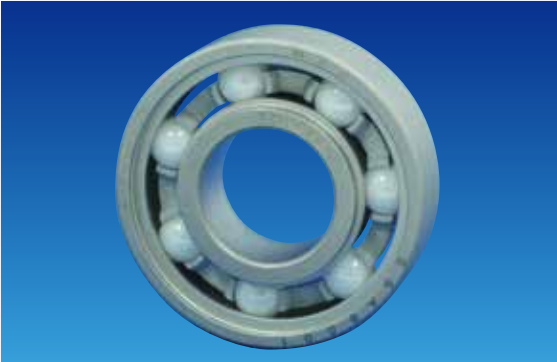
Page A21

Dimensions, accuracy and availability of bearings.

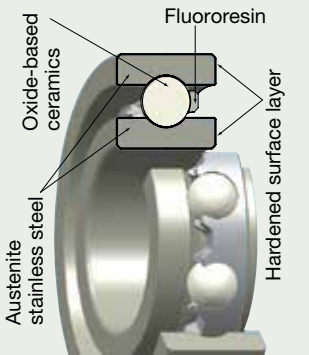
ESA Bearings, combining austenite stainless steel and hardened surface layers, possess high hardness, corrosion resistance and non-magnetic properties, and are suitable for corrosive environments and non-magnetic requirement in normal atmosphere and vacuum.



Product Specifications



Representative structure



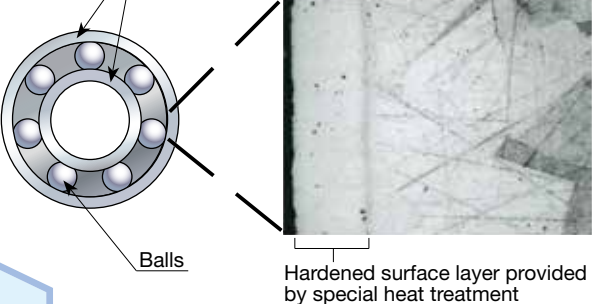
Structure		Open Type only
Specifications	Outer/Inner rings	Surface layer hardened austenite stainless steel
	Balls	Oxide-based ceramics
	Cage	Fluororesin
	Lubricant	Fluorine solid lubricant

Applications: Corrosive environments: Cleaning equipment (except for etching equipment)
Non-magnetic requirement: Electron beam drawing devices, electron beam exposure equipment, inspection equipment

- Operating Instructions and Notes
- Bearing should not be unpacked until immediately before mounting.
 - See the tables of SPACEA™ bearing nomenclature on page A21 for the limiting loads and limiting rotational speeds.
 - A special clearance is adopted for the radial internal clearance. See the tables of SPACEA™ bearing nomenclature on page A21.
 - The performance of bearing is affected by environments and conditions. Bearings can not be used in certain corrosive environment and conditions. Confirm environment and conditions where bearings are used.
 - All comments referencing certain values or degrees of performance in this catalog are intended to be used as a reference only. NSK provides this guide “As Is” without warranty of any kind, either expressed or implied.

Features

- Grease-free, fluorine solid lubricant
- Higher corrosion resistance and hardness than conventional stainless steel SUS440C
- Non-magnetic (equivalent to conventional non-magnetic stainless steel bearings)
- Applicable from normal atmosphere up to 10⁻⁶ Pa



Outer/Inner rings: Austenite stainless steel

Balls

Hardened surface layer provided by special heat treatment

High hardness

High corrosion resistance

Non-magnetic

Equal to or higher than SUS316 or SUS304

Harder than SUS440C (hardened surface layer HV800–1000)

Equivalent to conventional non-magnetic stainless steel bearings (relative permeability 1.01 or less)

Performance

Comparison with conventional materials

Material	Hardness (HV) ⁽¹⁾	Relative permeability	Corrosion ⁽³⁾ resistance	Features
ESA	800–1 000 ⁽²⁾	1.01 or less	○	NSK-developed steel
SUS440C	650–750	Ferromagnetic	△	Ordinary stainless steel
Non-magnetic stainless steel	450	1.01 or less	△	Due to its properties, it is difficult to machine, requiring advanced processing technology
Silicon nitride	1 500	1.001 or less	◎	Due to its properties, it is difficult to machine, requiring advanced processing technology; high cost

Notes

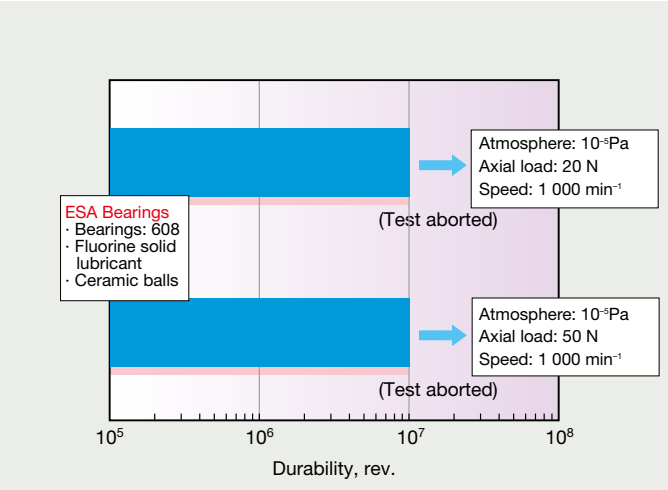
(1) Indicated in HV hardness for comparison

(2) Hardened surface layer

(3) Comparative assessment between four kinds of materials

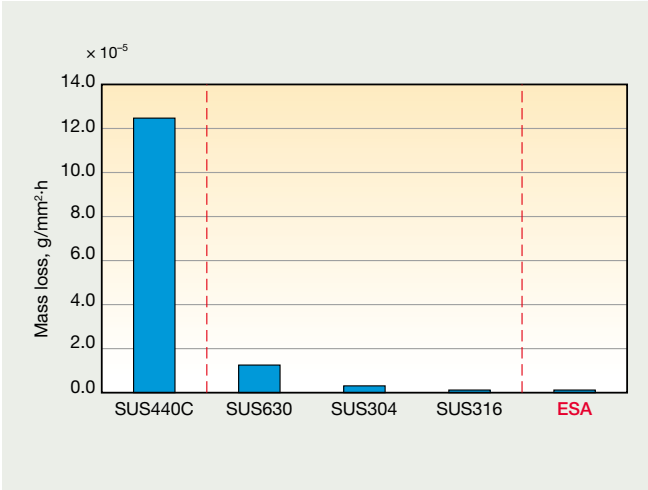
Durability

ESA bearings have durability of more than 10⁷ rotations.



Results of 20% sulfuric acid immersion test

Corrosion resistance is equivalent with SUS316, 304

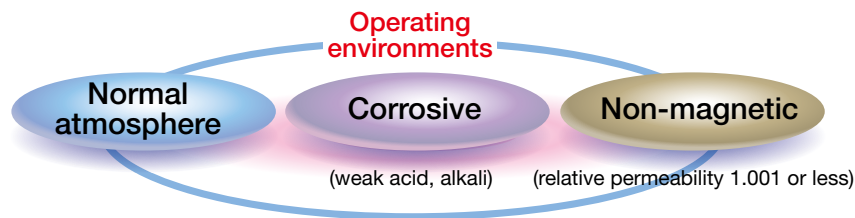


10. All-Ceramic Bearings

Page A21

Dimensions, accuracy and availability of bearings.

With ceramic outer/inner rings and balls, all-ceramic bearings have self-lubricating fluororesin cage and are suitable for corrosive environments and non-magnetic requirement in normal atmosphere.



Product Specifications

Representative structure

Structure		Open Type only
Specifications	Outer/Inner rings	Oxide-based ceramics
	Balls	Oxide-based ceramics
	Cage	Fluororesin
	Lubricant	Fluorine solid lubricant

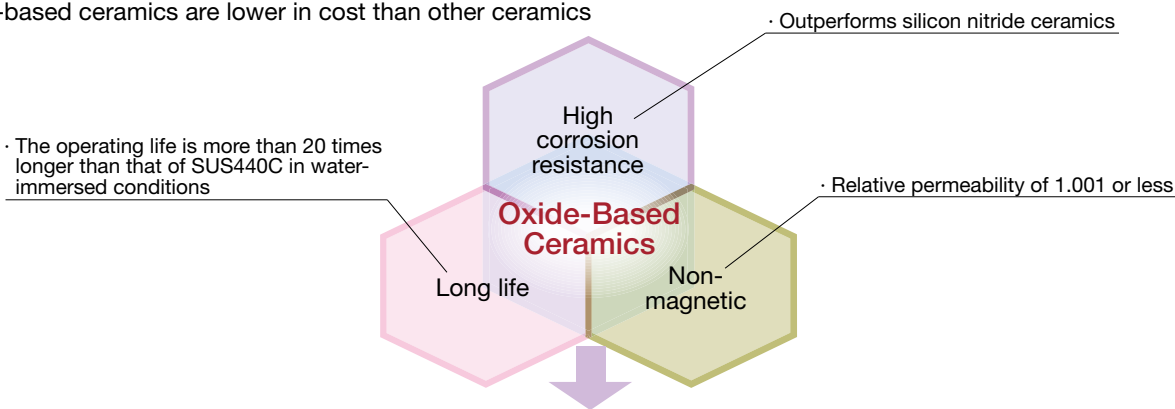
Applications: Corrosive environments: Semiconductor production machinery, chemical processing equipment, metal plating equipment
Non-magnetic requirement: Electron beam drawing devices, electron beam exposure equipment, inspection equipment

Operating Instructions and Notes

- Bearing should not be unpacked until immediately before mounting.
- See the tables of SPACEA™ bearing nomenclature on page A21 for the limiting loads and limiting rotational speeds.
- Due to the fragility of ceramic materials, please observe the following precautions:
 - ★ Do not drop or strike the bearing.
 - ★ Allow for sufficient clearance when installing the bearing.
 - ★ Do not strike the bearing with a hammer or other tool when installing the bearing to a shaft or axle box.
- A special clearance is adopted for the radial internal clearance. See the tables of SPACEA™ bearing nomenclature on page A21.
- The performance of bearing is affected by environments and conditions. Bearings can not be used in certain corrosive environment and conditions. Confirm environment and conditions where bearings are used.
- All comments referencing certain values or degrees of performance in this catalog are intended to be used as a reference only. NSK provides this guide "As Is" without warranty of any kind, either expressed or implied.

Features

- Grease-free, fluorine solid lubricant
- Higher corrosion resistance and longer life than conventional stainless steel bearings and hybrid bearings
- Completely non-magnetic
- Oxide-based ceramics are lower in cost than other ceramics



Performance

Comparison of performance and cost

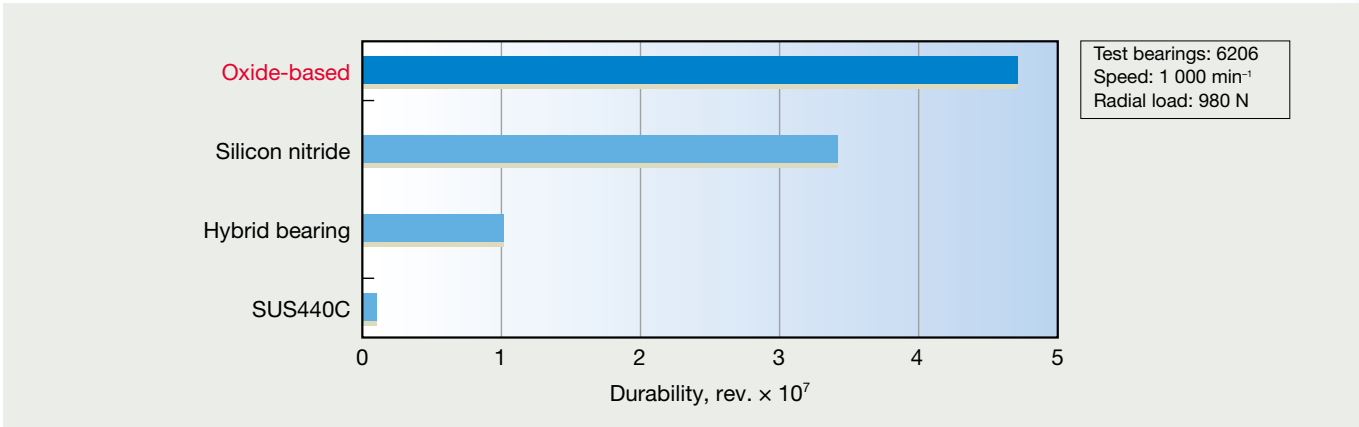
Oxide-based ceramics (ZrO₂) are:
★ More corrosion-resistant than stainless steel SUS440C or silicon nitride ceramics (Si₃N₄)
★ Lower in price than other ceramics

Evaluation item		Ceramics		Stainless steel
		Oxide-based	Silicon nitride	SUS440C
Corrosion resistance	3% Sulfuric acid (room temperature)	○	△	×
	8% Hydrochloric acid (room temperature)	○	△	×
	5% Fluoric acid (room temperature)	△	△	×
Relative permeability		1.001 or less	1.001 or less	Ferromagnetic body
Cost		●	▲	★

Corrosion resistance evaluation○: Slightly corroded △: Partially corroded ×: Corroded
COST.....Low ← ★ < ● < ▲ → High

Durability in water-immersed conditions

Oxide-based ceramics (ZrO₂) are 20 times more durable than SUS440C under water-immersed conditions.

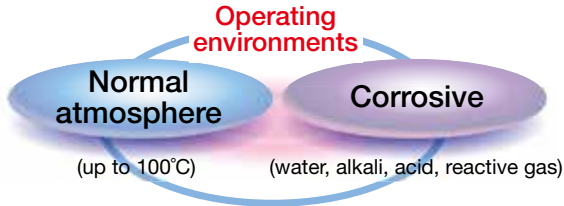


11. Aqua-Bearing™

Page A22

Dimensions, accuracy
and availability of
bearings.

Aqua-Bearing™ features a special fluororesin for outer/inner rings and cage equipped to meet a broad range of applications in water, alkali and strong acid environments. Aqua-Bearing™ is suitable for corrosive environments exclusively in normal atmosphere.



Product Specifications

Representative structure

Structure		Open Type only
Specifications	Outer/Inner rings	Special fluororesin
	Balls	Ceramics or special glass balls
	Cage	Fluororesin
	Lubricant	Fluorine solid lubricant

Applications: Semiconductor cleaning equipment, liquid-crystal bases cleaning equipment, hard-disk cleaning equipment, metal plating equipment, etching equipment, food processing machinery

- Operating Instructions and Notes
- For use in normal atmospheric conditions only.
 - Bearing should not be unpacked until immediately before mounting.
 - See the tables of SPACEA™ bearing nomenclature on page A22 for the limiting loads and limiting rotational speeds.
 - The Aqua-Bearing™ adopts special standards for dimensional accuracy of the inner ring bore diameter, outside diameter of the outer ring, and radial internal clearance. See the tables of SPACEA™ bearing nomenclature on page A22.
 - Please note that the bearing fit is large due to the linear expansion coefficient of the special fluororesin material ($\alpha = 1.7 \times 10^{-4}/^{\circ}\text{C}$).
 - Please note that the bearing cannot be used in certain applications due the density and/or type of medical drug.
 - All comments referencing certain values or degrees of performance in this catalog are intended to be used as a reference only. NSK provides this guide “As Is” without warranty of any kind, either expressed or implied.

Features

- High corrosion resistance equivalent to that of ceramic bearings
- Excellent durability in acid solvents: over 1 000 times more resistant than SUS440C stainless bearings and over five times more resistant than conventional resin (PE) bearings
- Special self-lubricating fluororesin makes grease or oil unnecessary

Performance

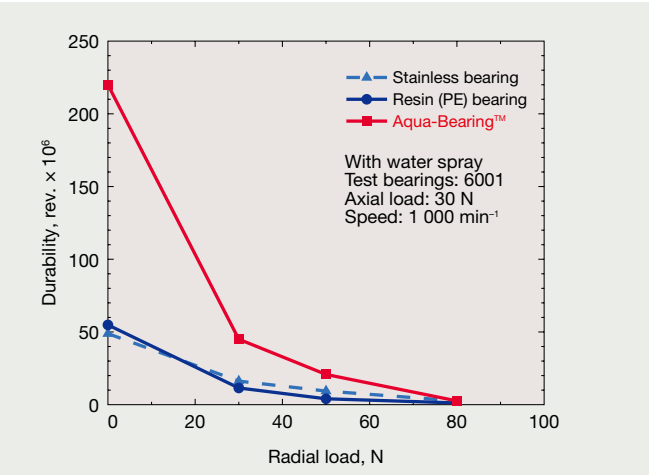
- Comparison of corrosion resistance

Corrosion resistance equal to or higher than all-ceramic bearings (oxide-base)

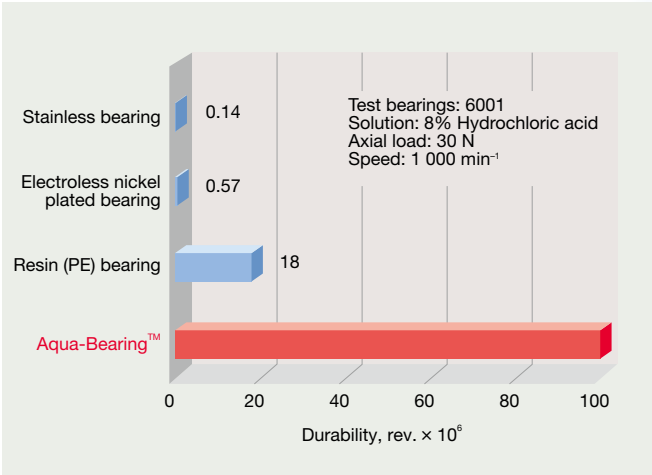
	Aqua-Bearing™	PE	All-ceramic bearings (Oxide based)
5% Sulfuric acid	△	×	△
8% Hydrochloric acid	△	×	△
Aqua regalis	◎	×	◎
15% Acetic acid	◎	△	◎
70% Aqua fortis	△	×	△
70% Phasphoric acid	◎	△	◎
40% Hydrogen peroxide solution	◎	△	◎

Corrosion resistance evaluation ◎: Not corroded △: Partially corroded ×: Corroded

● Results of water-spray durability tests
Remarkable durability can be observed under light-load conditions.

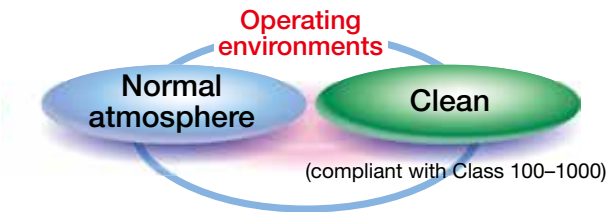


● Results of durability tests in strong acid solution
Durability is higher than that of SUS440C bearings and conventional resin bearings by, respectively, more than 1 000 times and five times.




12. LG2/LGU Grease-Packed Bearings Page A23–A24 Dimensions, accuracy and availability of bearings.

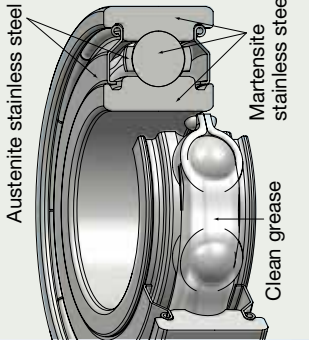
LG2/LGU clean grease-packed stainless steel bearings are suitable for clean environments in normal atmosphere.



Product Specifications



Representative structure



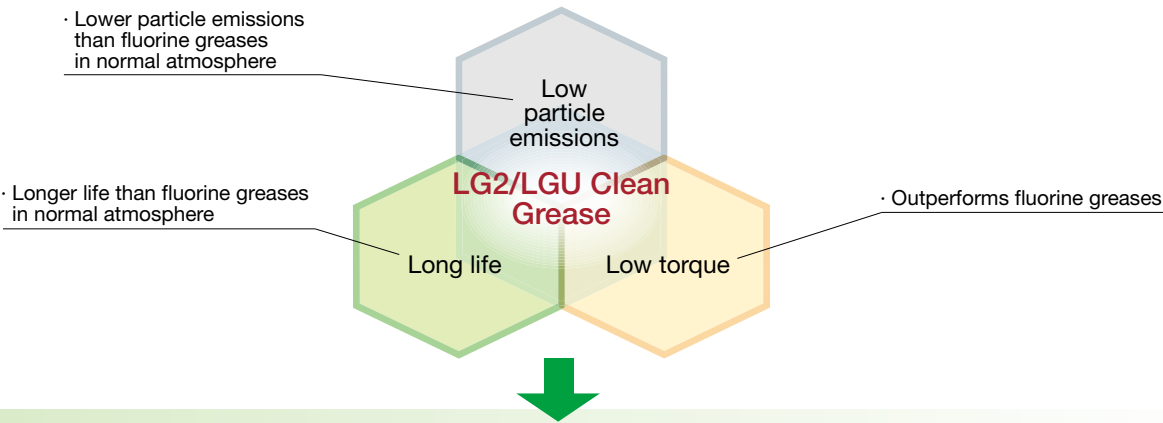
Structure		Shielded Type
Specifications	Outer/Inner rings	Martensite stainless steel
	Balls	Martensite stainless steel
	Cage	Stainless steel or resin
	Lubricant	NSK clean grease LG2/LGU
	Shields	Austenite stainless steel

Applications: Equipment in clean rooms

Operating Instructions and Notes

- The LG2/LGU grease products are for use in normal atmospheric conditions only.
- Bearing should not be unpacked until immediately before mounting.
- See the tables of SPACEA™ bearing nomenclature on pages A23 and A24 for the limiting loads and limiting rotational speeds.
- Cleanliness may vary depending on operating conditions, surrounding components, and other factors.
- All comments referencing certain values or degrees of performance in this catalog are intended to be used as a reference only. NSK provides this guide “As Is” without warranty of any kind, either expressed or implied.

- Features**
- Clean grease lubrication for use in normal atmosphere only
 - Lower particle emissions, lower torque, longer operating life and higher corrosion resistance than commercially available fluorine greases
 - LGU grease is free of metallic elements



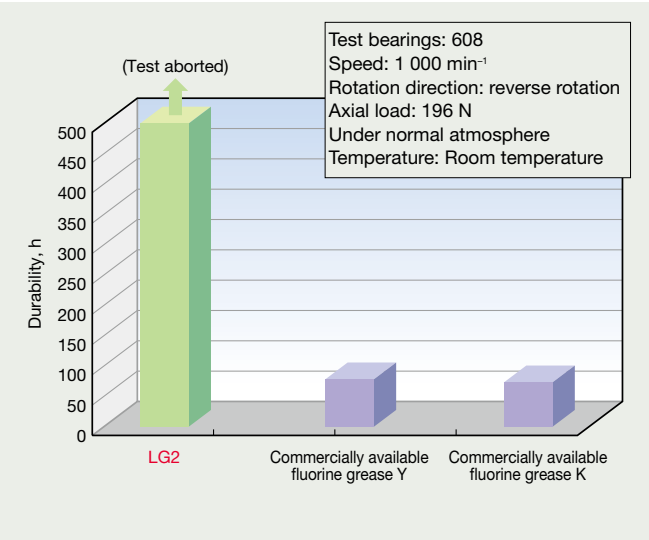
Performance

● **Properties of grease**

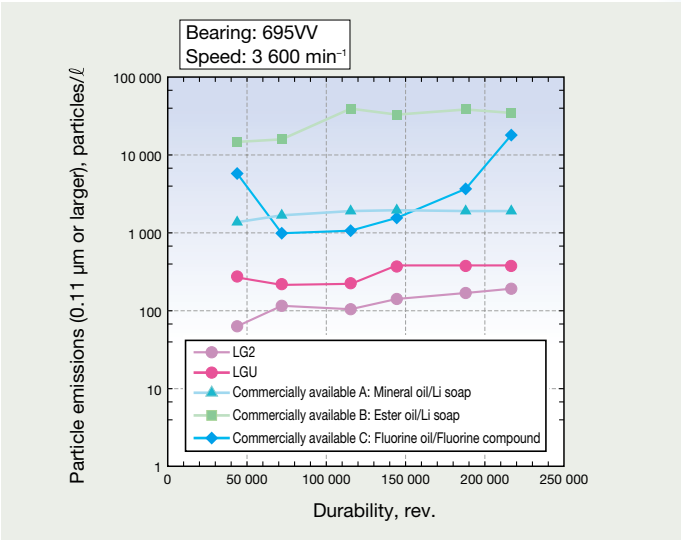
Operating environment	For use in normal atmosphere only	
Product	LG2	LGU
Base oil	Mineral oil and synthetic hydrocarbon oil	Synthetic hydrocarbon oil
Thickener	Lithium soap	Diurea
Kinematic viscosity (mm²/s, 40°C)	32	96
Consistency	199	201
Maximum operating temperature, °C	up to 70	up to 120

LGU grease is free of metallic elements

● **Results of durability tests in normal atmosphere**
LG2/LGU grease has a longer life than any other grease in normal atmosphere.



● **Results of particle emission tests in normal atmosphere**
LG2/LGU grease are lowest in particle emissions in normal atmosphere.

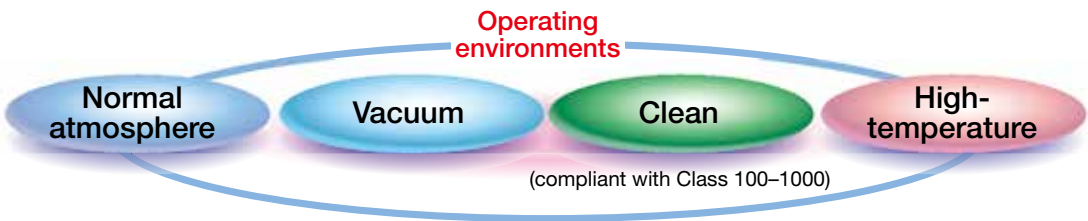


13. DL2 Grease-Packed Bearings

Page A23–A24

Dimensions, accuracy and availability of bearings.

DL2 clean grease-packed stainless steel bearings are suitable for clean environments from normal atmosphere up to vacuum.



Product Specifications

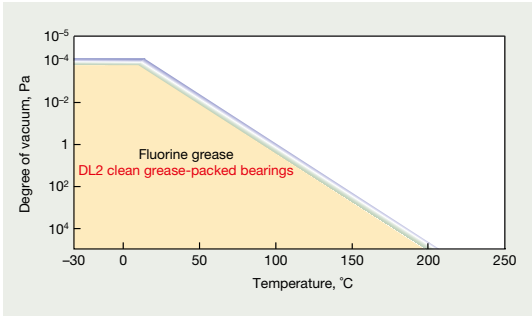
Representative structure

Structure		Shielded Type
Specifications	Outer/Inner rings	Martensite stainless steel
	Balls	Martensite stainless steel
	Cage	Stainless steel
	Lubricant	DL2 clean grease
	Shields	Austenite stainless steel

Applications: Liquid crystal and semiconductor manufacturing equipment, hard disk manufacturing equipment

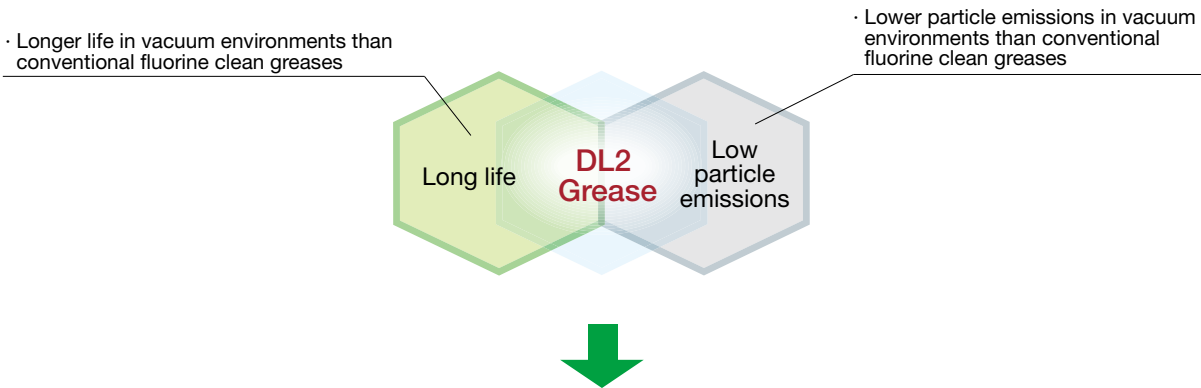
Operating Instructions and Notes

- Bearing should not be unpacked until immediately before mounting.
- The scope of application (degree of vacuum, temperature) is listed in the table to the right.
- See the tables of SPACEA™ bearing nomenclature on page A23 and A24 for the limiting loads and limiting rotational speeds.
- Ensure an optimum radial internal clearance for maximum rotational performance by applying a fit to the bearing that takes into consideration bearing load, operating temperatures, materials of the shaft and/or housing (due to coefficient of linear expansion), etc.
- Cleanliness may vary depending on operating conditions, surrounding components, and other factors.
- All comments referencing certain values or degrees of performance in this catalog are intended to be used as a reference only. NSK provides this guide “As Is” without warranty of any kind, either expressed or implied.



Features

- Fluorine clean grease lubrication
- More suitable for vacuum and at higher temperatures than LG2/LGU greases
- Lower particle emissions and longer life than conventional fluorine clean greases



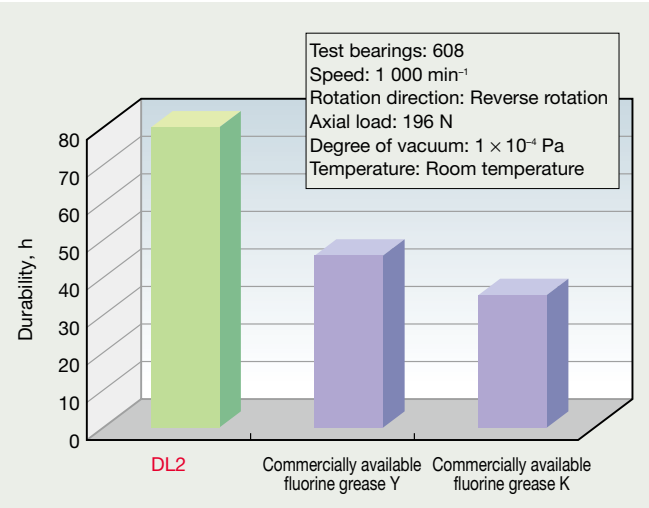
Performance

● Properties of grease

Operating environments	From normal atmosphere up to vacuum
Name	DL2
Base oil	Fluorine oil
Thickener	PTFE
Kinematic viscosity (mm ² /s, 40°C)	200
Consistency	280
Maximum operating temperature, °C	up to 200

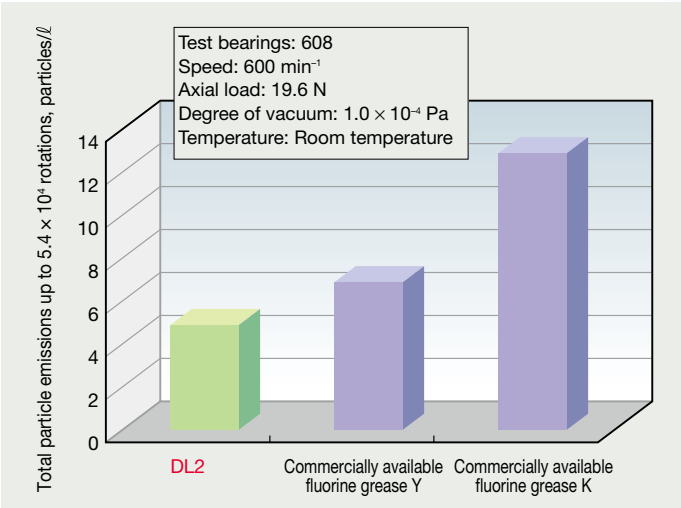
● Results of durability tests in vacuum

DL2 clean grease has a longer operating life than any other grease in vacuum environments.



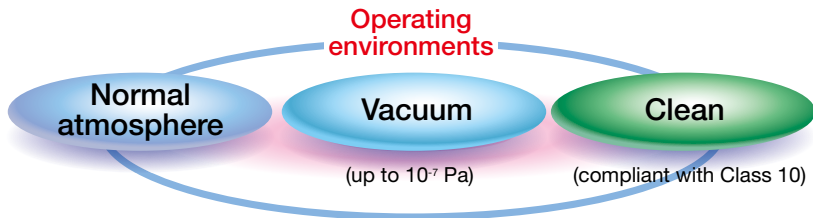
● Results of particle emission tests in vacuum

DL2 clean grease is lowest in particle emissions in vacuum environments.



14. E-DFO Bearings, V-DFO Bearings Page A25 Dimensions, accuracy and availability of bearings.

Newly developed specification DFO bearings that take advantage of clean lubrication coatings: V-DFO and E-DFO. The V-DFO specification uses low vapor pressure fluorinated lubricant while the E-DFO specification uses a low vapor pressure hydrocarbon lubricant. Both specifications are applied to the inner and outer rings, balls, and cage to deliver superior cleanliness and long service life. The bearings are suitable for cleanroom environments ranging from normal atmospheric conditions to vacuum conditions.



Product Specifications

Representative structure

Structure		E-DFO	V-DFO
		Shielded Type	Shielded Type
Specifications	Outer/Inner rings	Martensite stainless steel and E-DFO	Martensite stainless steel and V-DFO
	Balls	Martensite stainless steel and E-DFO	Martensite stainless steel and V-DFO
	Cage	Stainless steel and E-DFO	Stainless steel and V-DFO
	Lubricant	NSK clean lubricant E-DFO	NSK clean lubricant V-DFO
	Shields	Austenite stainless steel	Austenite stainless steel

Applications: Liquid crystal and semiconductor manufacturing equipment, hard disk manufacturing equipment, solar cell manufacturing equipment, robots for vacuum environments

- Operating Instructions and Notes**
- Bearing should not be unpacked until immediately before mounting.
 - Avoid storing the bearing for an overly extended or lengthy amount of time.
 - Wear clean gloves when handling.
 - Mount the bearing without washing.
 - Avoid exposure to any oil or moisture.
 - See the tables of SPACEA™ bearing nomenclature on page A25 for the limiting loads and limiting rotational speeds.
 - Cleanliness may vary depending on operating conditions, surrounding components, and other factors.
 - All comments referencing certain values or degrees of performance in this catalog are intended to be used as a reference only. NSK provides this guide "As Is" without warranty of any kind, either expressed or implied.

Features

- Operating life more than four times longer than conventional fluorine-coated bearings
- Lower particle emissions and outgassing than MoS₂ solid lubricated bearings
- Applicable in environments for which lubricants containing metallic elements such as MoS₂ are not suitable
- Applicable from normal atmosphere up to vacuum 10⁻⁷ Pa (room temperature), although the degree of vacuum in which the bearings can be used varies according to the operating temperature

Equal or superior to conventional fluorine-coated bearings

Structural Illustration of DFO Lubricant Coating

DFO lubricant coating

Stainless steel ball

Treated surface

DFO lubricant coating that combines the properties of liquids and solids

DFO Bearings

Long life

- Operating life ten times equal longer than that of conventional fluorine grease bearings. (E-DFO)
- Operating life more than four times longer than that of conventional fluorine-coated bearings. (V-DFO)

Low particle emissions

Low outgassing

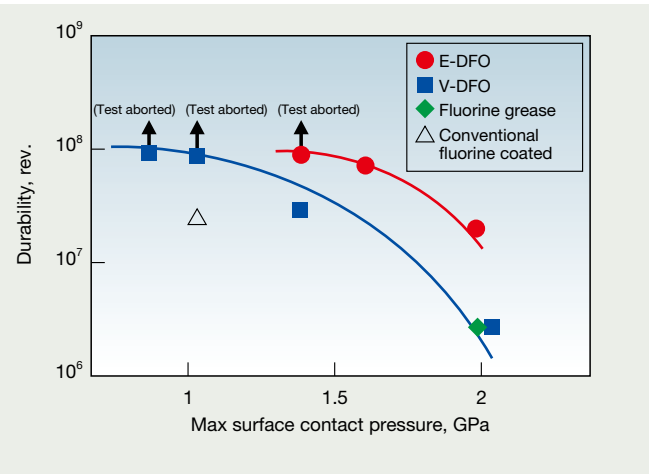
- Lower outgassing than conventional fluorine-coated bearings

Performance

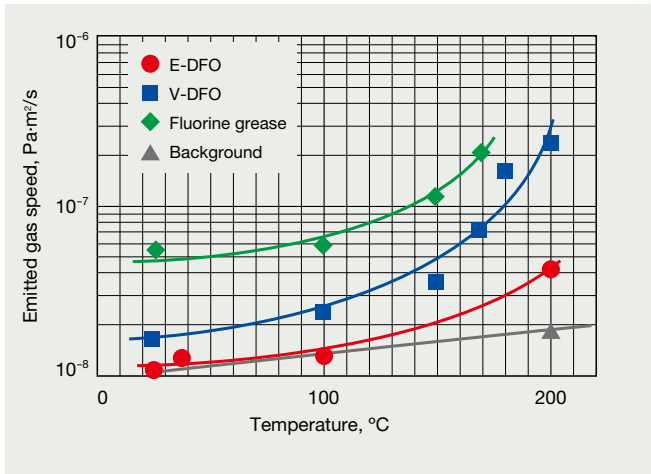
● **Comparison of operating environments for clean lubrication coatings E-DFO and V-DFO:**

Conditions	E-DFO	V-DFO
Corrosive gas	×	○
Vacuum	◎ (up to 150°C)	○ (up to 150°C)
Normal atmosphere	◎ (up to 50°C)	◎ (up to 200°C)
Limiting Load	◎ (up to 5%)	○ (up to 2%)

- **Highly durable under vacuum conditions**
1. E-DFO offers about ten times more durability than conventional fluorine grease.
 2. V-DFO offers four times or more durability than that of a fluorine coated bearing.
- Test conditions
Test bearings: 708
Speed: 3 000 min⁻¹
Degree of vacuum: 2 × 10⁻⁴ Pa



- **Outgassing characteristics under high-temperature conditions**
- Excellent outgassing characteristics
- Test conditions
Test bearings: 608
Degree of vacuum: 8 × 10⁻⁴ Pa

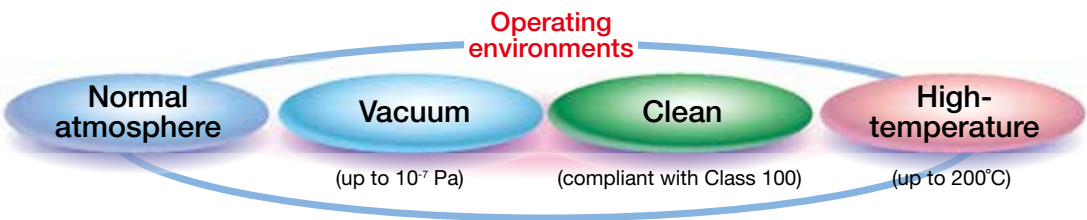


15. YS Bearings with Self-Lubricating Cage

Page A26

Dimensions, accuracy
and availability of
bearings.

YS bearings for clean environments have newly developed self-lubricating cage, delivering high cleanliness and long life. These bearings are suitable for clean environments from normal atmosphere up to vacuum.



Product Specifications

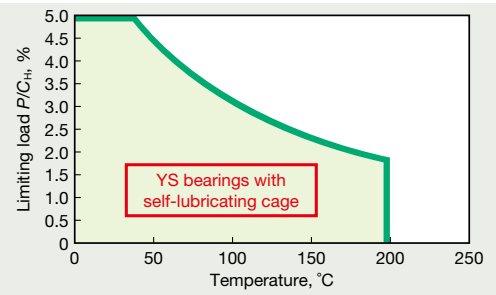
Representative structure

Structure		Shielded Type
Specifications	Outer/Inner rings	Martensite stainless steel
	Balls	Martensite stainless steel and MoS ₂ coating
	Cage	PEEK composite material
	Lubricant	MoS ₂ solid lubricant
	Shields	Austenite stainless steel

Applications: Vapor deposition equipment, sputtering equipment, etching equipment, vacuum pumps

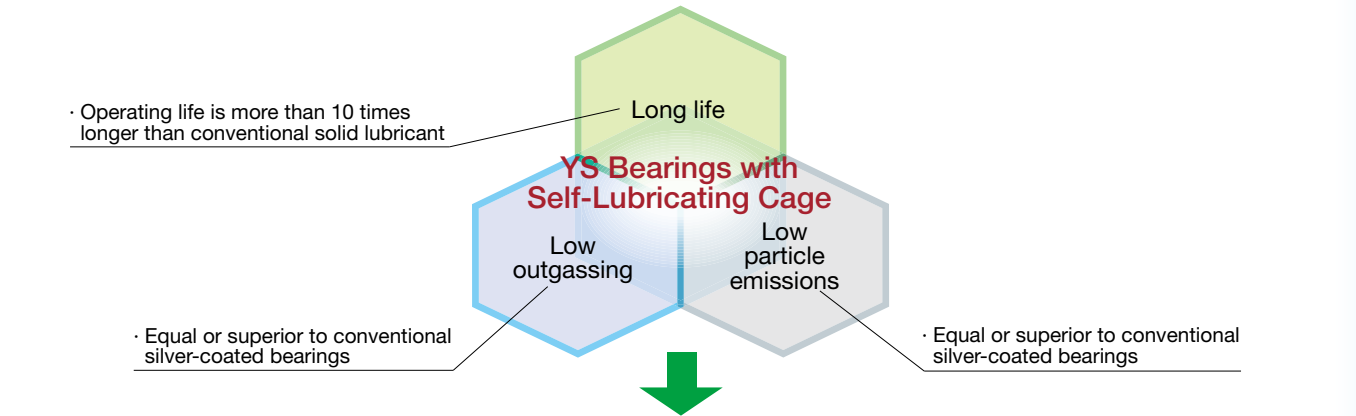
Operating Instructions and Notes

- Bearing should not be unpacked until immediately before mounting.
- Avoid storing the bearing for an overly extended or lengthy amount of time.
- Avoid exposure to any oil or moisture.
- The scope of application (limiting load, temperature) is listed in the table to the right.
- See the tables of SPACEA™ bearing nomenclature on page A26 for the limiting loads and limiting rotational speeds.
- Ensure an optimum radial internal clearance for maximum rotational performance by applying a fit to the bearing that takes into consideration bearing load, operating temperatures, materials of the shaft and/or housing (due to coefficient of linear expansion), etc.
- Cleanliness may vary depending on operating conditions, surrounding components, and other factors.
- All comments referencing certain values or degrees of performance in this catalog are intended to be used as a reference only. NSK provides this guide “As Is” without warranty of any kind, either expressed or implied.



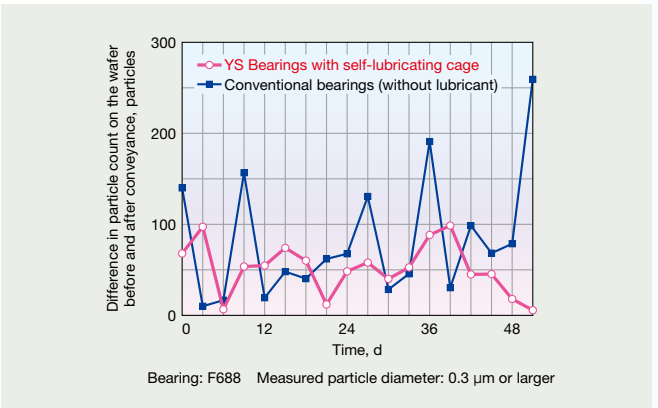
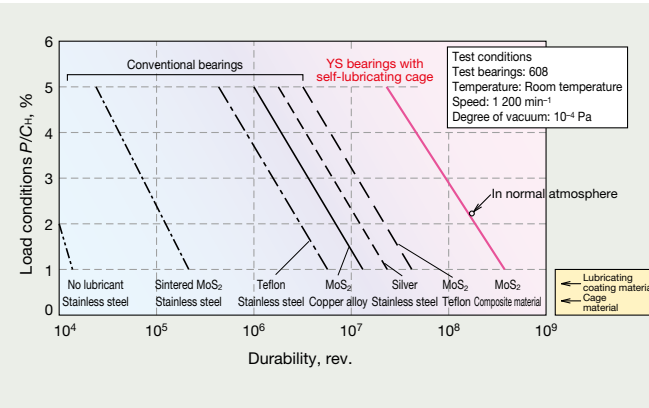
Features

- Utilizes newly developed, long-life MoS₂ self-lubricating cage
- Operating life is longer than that of conventional high-temperature solid-lubricant bearings by more than 10 times
- Particle emissions and outgassing are as low as that of conventional silver-coated bearings
- Applicable from normal atmosphere up to vacuum 10⁻⁷ Pa

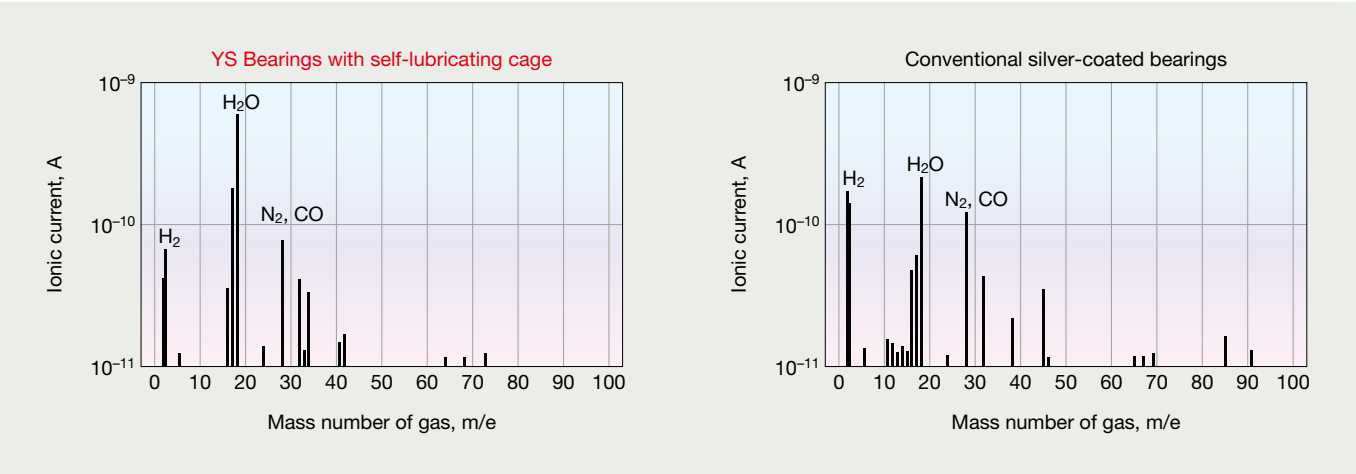


Performance

- **Durability**
Over ten times more durable than conventional bearings for vacuum environments
- **Particle emissions evaluation in actual line of vacuum robots for wafer conveyance**
Equal or superior to conventional bearings for vacuum environments



- **Outgassing characteristics**
Virtually no outgassing of high mass number species; similar to conventional (silver-coated) bearings

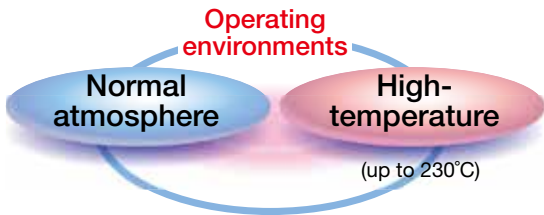


16. KPM Grease-Packed Bearings

Page A27

Dimensions, accuracy
and availability of
bearings.

These high-temperature bearings are grease-packed with NSK's long-life, high-temperature grease KPM, for use in normal atmosphere only.



Product Specifications

Representative structure

Structure		Shielded Type
Specifications	Outer/Inner rings	Martensite stainless steel
	Balls	Martensite stainless steel
	Cage	Stainless steel
	Lubricant	NSK high-temperature grease KPM
	Shields	Austenite stainless steel

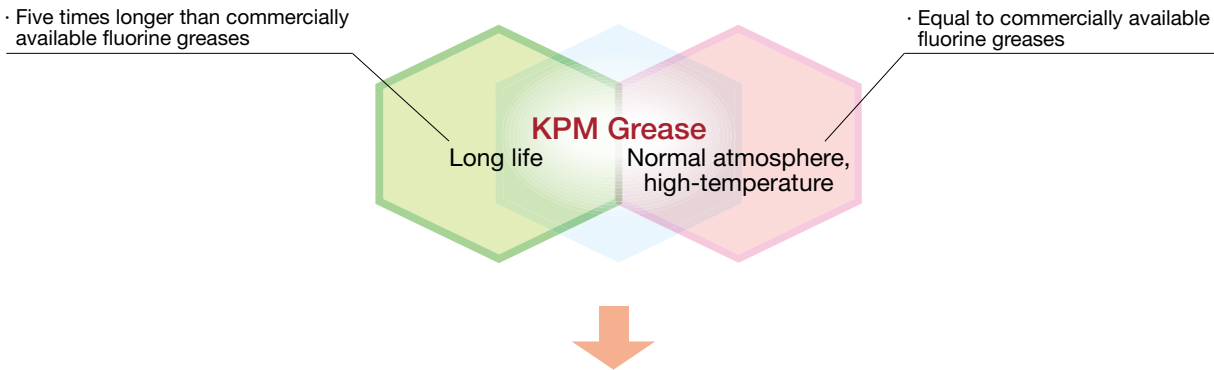
Applications: Copying machines, kilns, high-temperature conveyance equipment, other equipment for high-temperature environments

Operating Instructions and Notes

- KPM grease is to be used in normal atmospheric conditions only.
- Not applicable to cleanroom environments.
- Bearing should not be unpacked until immediately before mounting.
- See the tables of SPACEA™ bearing nomenclature on page A27 for the limiting loads and limiting rotational speeds.
- Ensure an optimum radial internal clearance for maximum rotational performance by applying a fit to the bearing that takes into consideration bearing load, operating temperatures, materials of the shaft and/or housing (due to coefficient of linear expansion), etc.
- All comments referencing certain values or degrees of performance in this catalog are intended to be used as a reference only. NSK provides this guide “As Is” without warranty of any kind, either expressed or implied.

Features

- Applicable in high-temperature environments, up to 230°C
- Longer operating life than commercially available fluorine greases (five times longer at 200°C)
- Longer operating life than that of solid lubricant high-temperature bearings



Performance

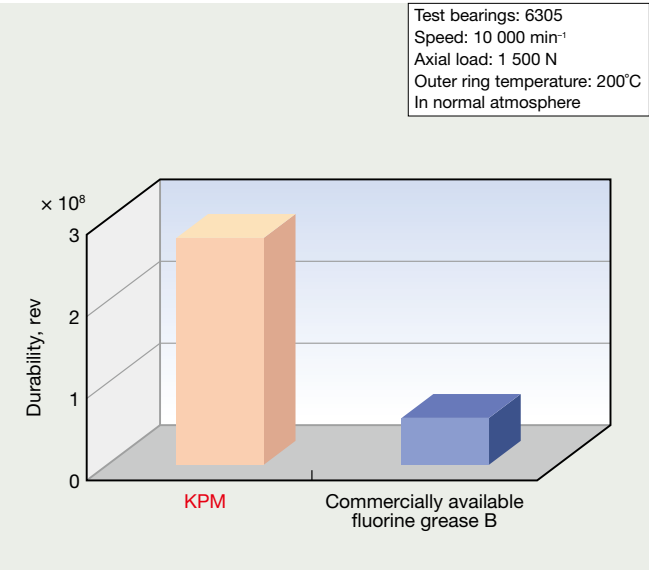
● Properties of grease

Name	NSK high-temperature grease KPM	Commercially available fluorine grease B
Base oil	Fluorine oil	Fluorine oil
Thickener	PTFE	PTFE
Kinematic viscosity (mm ² /s, 40°C)	420	390
Consistency	290	280
Maximum operating temperature, °C	230	230

KPM: NSK-developed grease for use in normal atmosphere only

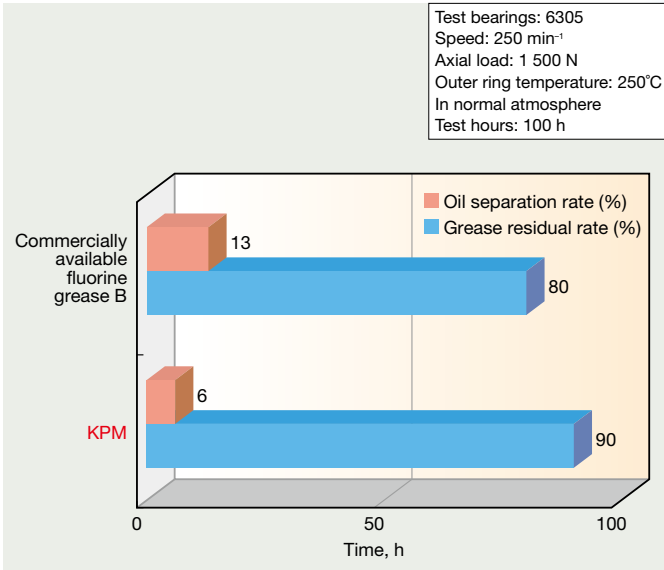
● Durability

KPM's operating life is approximately five times longer than that of commercially available fluorine greases.



● Oil separation and grease residual rates

KPM is highly heat resistant, with lower oil separation rates at higher temperatures than commercially available fluorine greases.

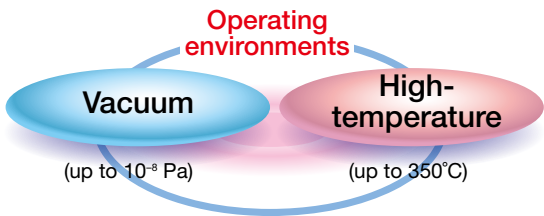


17. YS Bearings with Spacer Joints


Page A26

Dimensions, accuracy
and availability of
bearings.

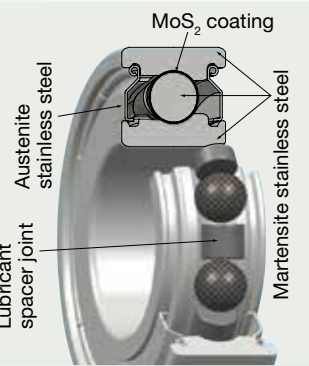
YS bearings with spacer joints made of an alloy-based self-lubricating material (sintered alloy) between balls. They are suitable for high-temperature and vacuum environments.



Product Specifications



Representative structure

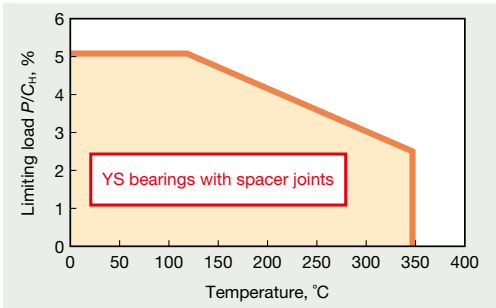


Structure		Shielded Type
Specifications	Outer/Inner rings	Martensite stainless steel
	Balls	Martensite stainless steel and MoS ₂ coating
	Cage	Lubricating spacer joints (sintered alloy)
	Lubricant	MoS ₂ solid lubricant
	Shields	Austenite stainless steel

Applications: Ion implantation equipment, sputtering equipment, vacuum vapor deposition equipment

Operating Instructions and Notes

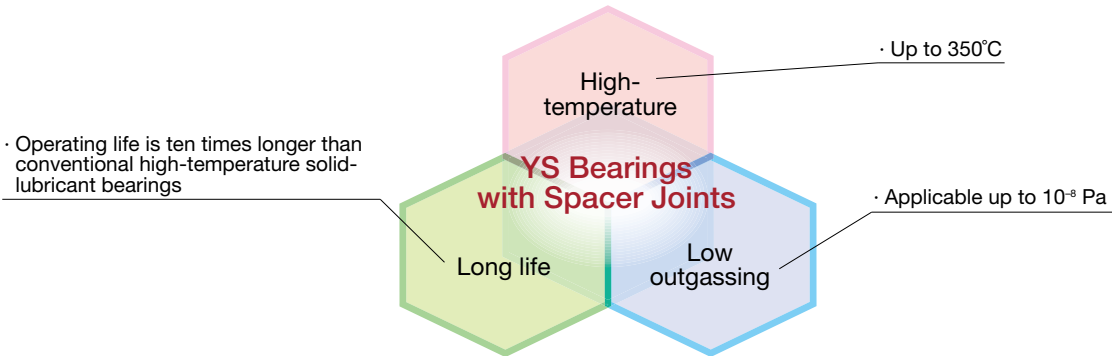
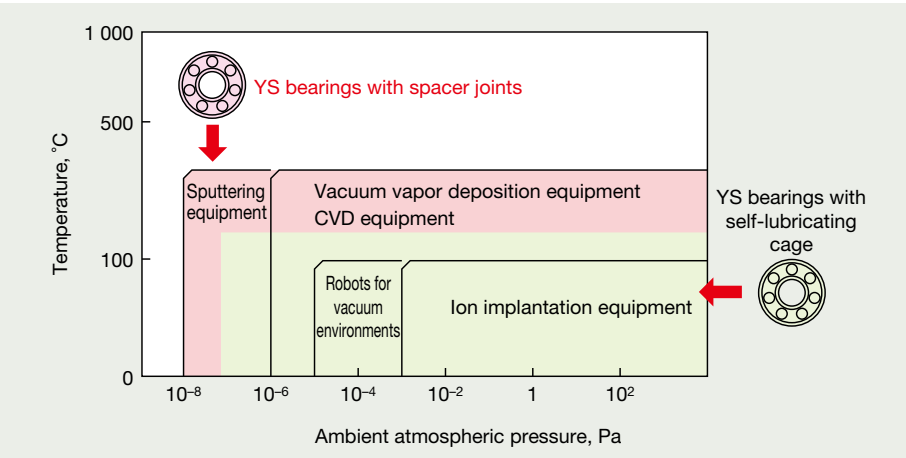
- For use in vacuum environments.
- Restrictions apply to bearings mounted to a vertical shaft due to a notch in the outer and inner rings. (Refer to the manual that is provided with the bearing.)
- Bearing should not be unpacked until immediately before mounting.
- Avoid storing the bearing for an overly extended or lengthy amount of time.
- Avoid exposure to any oil or moisture.
- The scope of application (limiting load, temperature) is listed in the table to the right.
- See the tables of SPACEA™ bearing nomenclature on page A26 for the limiting loads and limiting rotational speeds.
- Ensure an optimum radial internal clearance for maximum rotational performance by applying a fit to the bearing that takes into consideration bearing load, operating temperatures, materials of the shaft and/or housing (due to coefficient of linear expansion), etc.
- All comments referencing certain values or degrees of performance in this catalog are intended to be used as a reference only. NSK provides this guide "As Is" without warranty of any kind, either expressed or implied.



Features

- Grease-free, MoS₂ solid lubrication
- Applicable from vacuum up to 10⁻⁸ Pa and temperatures up to 350°C
- Operating life is longer than that of conventional high-temperature solid-lubricant bearings by more than 10 times

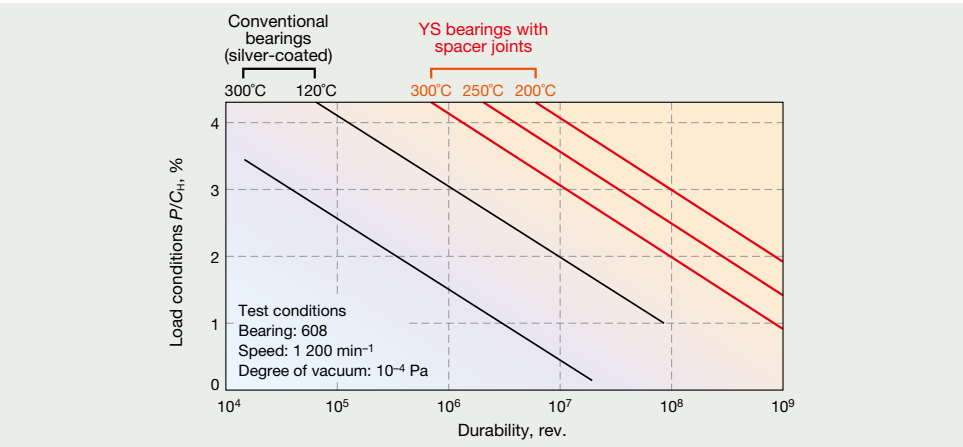
Applications of bearings for semiconductor production equipment



Performance

Durability

Over ten times more durable than conventional high-temperature solid-lubricant bearings.

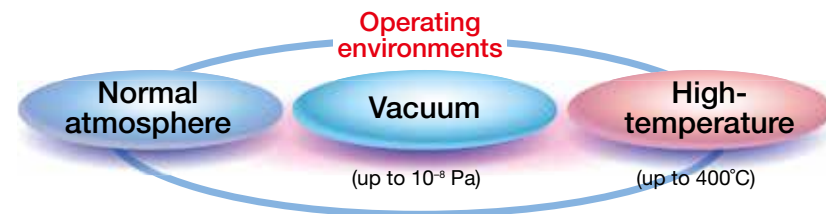


18. SJ Bearings

Page A28

Dimensions, accuracy and availability of bearings.

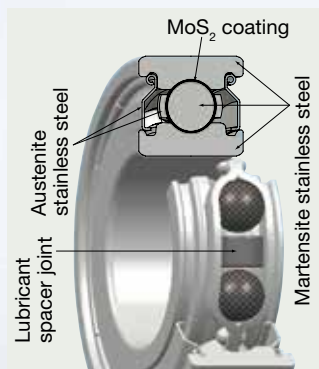
SJ bearings have a “peapod” structure, with solid lubricant spacer joints mounted between two balls in cage pockets. These bearings are suitable for high-temperature environments from normal atmosphere up to vacuum.



Product Specifications



Representative structure

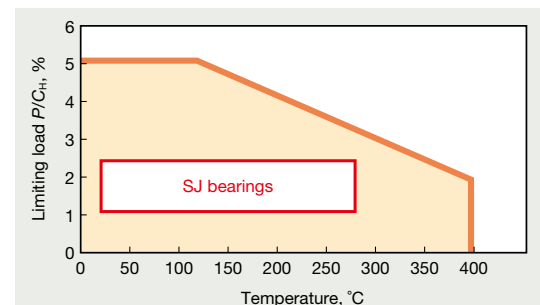


	Structure	Shielded Type
Specifications	Outer/Inner rings	Martensite stainless steel
	Balls	Martensite stainless steel and MoS ₂ coating
	Cage	Stainless steel and lubricating spacer joints (sintered alloy)
	Lubricant	MoS ₂ solid lubricant
	Shields	Austenite stainless steel

Applications: Vacuum vapor deposition equipment, kilns, kiln cars, steel plants, high-temperature conveyance equipment

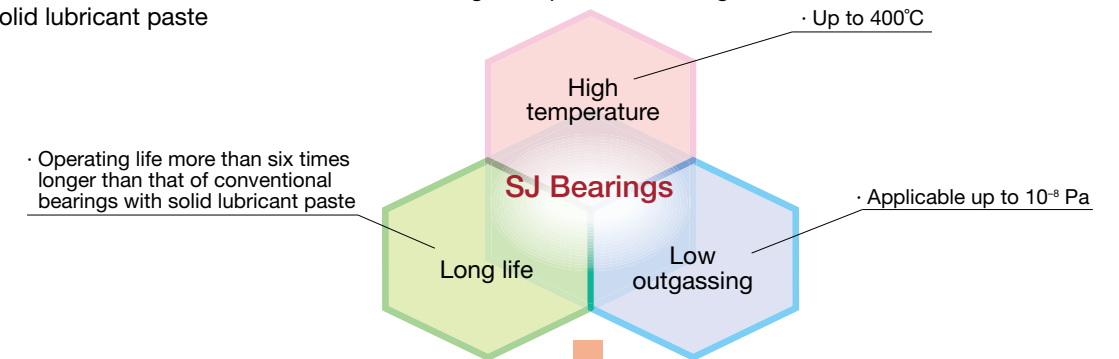
Operating Instructions and Notes

- Do not use this bearing in an environment that risks exposure to excessive moisture or humidity.
- Bearing should not be unpacked until immediately before mounting.
- Avoid storing the bearing for an overly extended or lengthy amount of time.
- Avoid exposure to any oil or moisture.
- The scope of application (limiting load, temperature) is listed in the table to the right.
- See the tables of SPACEA™ bearing nomenclature on page A28 for the limiting loads and limiting rotational speeds.
- Ensure an optimum radial internal clearance for maximum rotational performance by applying a fit to the bearing that takes into consideration bearing load, operating temperatures, materials of the shaft and/or housing (due to coefficient of linear expansion), etc.
- All comments referencing certain values or degrees of performance in this catalog are intended to be used as a reference only. NSK provides this guide “As Is” without warranty of any kind, either expressed or implied.



Features

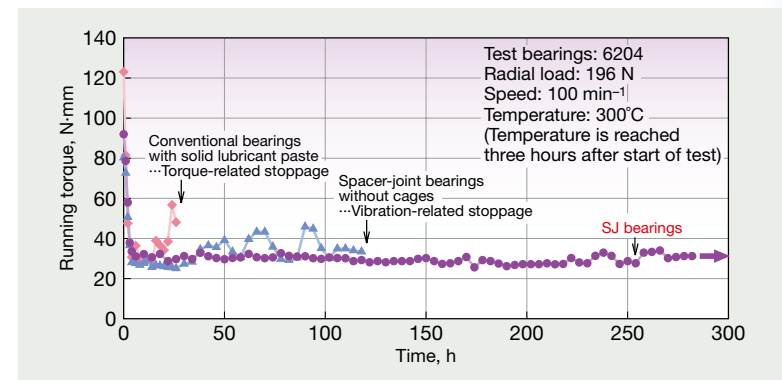
- Grease-free, MoS₂ solid lubricant
- Applicable from normal atmosphere up to vacuum 10⁻⁸ Pa and temperatures up to 400°C
- “Peapod” structure provides excellent torque stability and long life
- Over six times more durable than conventional high-temperature bearings with solid lubricant paste



Performance

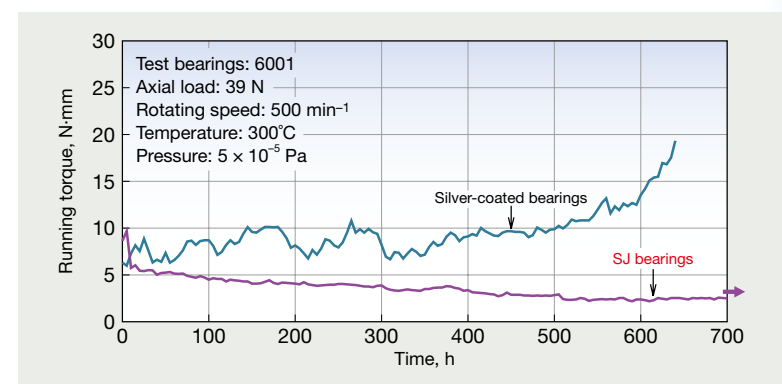
● Durability

More than six times more durable than bearings with conventional solid lubricant paste, and more than twice as durable as conventional cageless bearings with spacer joints.



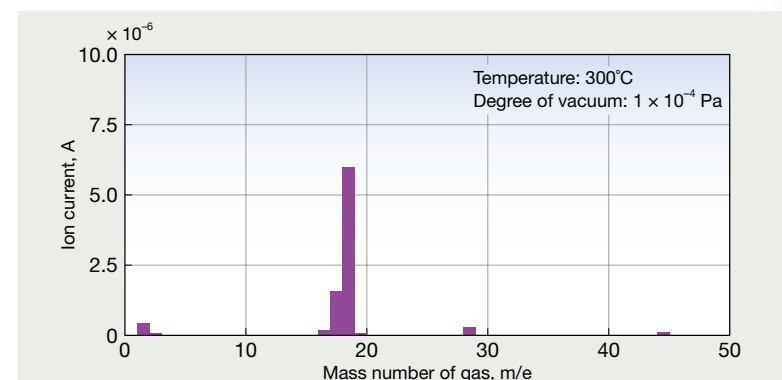
● Durability of bearings in vacuum conditions

Outperforms silver-coated bearings in durability and torque stability.



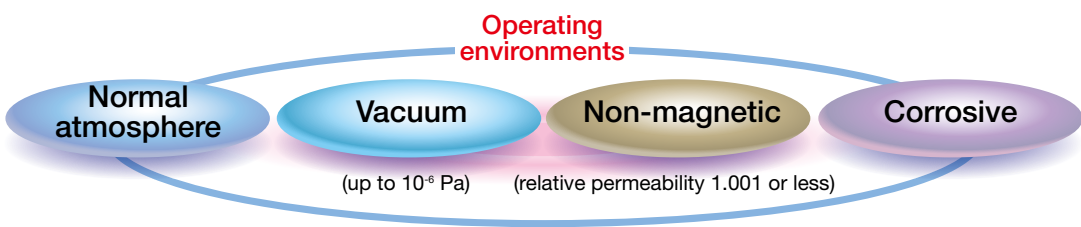
● Outgassing in vacuum conditions

In high-temperature and vacuum environments, outgassing from chemical decomposition of solid lubricant spacer joints was not confirmed. Therefore, SJ bearings have no pollution concerns.



19. Titanium Alloy Bearings

Titanium alloy bearings have special titanium alloy inner/outer rings and ceramic balls, making them completely non-magnetic (relative permeability 1.001 or less). These bearings are suitable for non-magnetic requirement from normal atmosphere up to vacuum.



Product Specifications

Representative structure

Structure		Open Type only
Specifications	Outer/Inner rings	Special titanium alloy
	Balls	Silicon nitride ceramics
	Cage	Fluororesin
	Lubricant	Fluorine solid lubricant

Applications: Electron beam drawing devices, electron beam exposure equipment, inspection equipment.

Operating Instructions and Notes

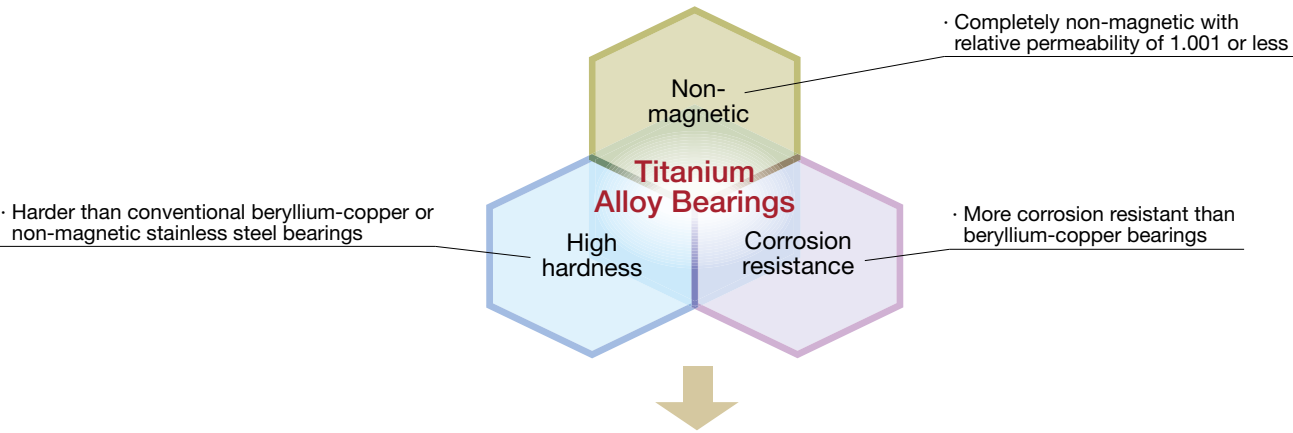
- Applicable to corrosive environments.
- Electrically conductive bearings are also available.
- Bearing should not be unpacked until immediately before mounting.
- The scope of application (limiting load, limiting $d_m n$ value) is listed in the table to the right.
- All comments referencing certain values or degrees of performance in this catalog are intended to be used as a reference only. NSK provides this guide “As Is” without warranty of any kind, either expressed or implied.

The scope Titanium alloy bearings	
Limiting load	1% of the stainless steel bearing load rating C_H
Limiting rotational speed $d_m n^{(1)}$	20 000

Note (1) $d_m n$ = (Bearing bore diameter, mm + Bearing outside diameter, mm) ÷ 2 × Rotational speed, min⁻¹

Features

- Grease-free, fluorine solid lubricant
- Completely non-magnetic with relative permeability of 1.001 or less
- More corrosion resistant than conventional non-magnetic beryllium-copper alloy bearings
- Free of harmful chemical substance such as beryllium in conventional beryllium-copper alloy
- Harder than conventional beryllium-copper alloy
- Applicable from normal atmosphere up to vacuum 10^{-6} Pa



Performance

Comparison with conventional bearings

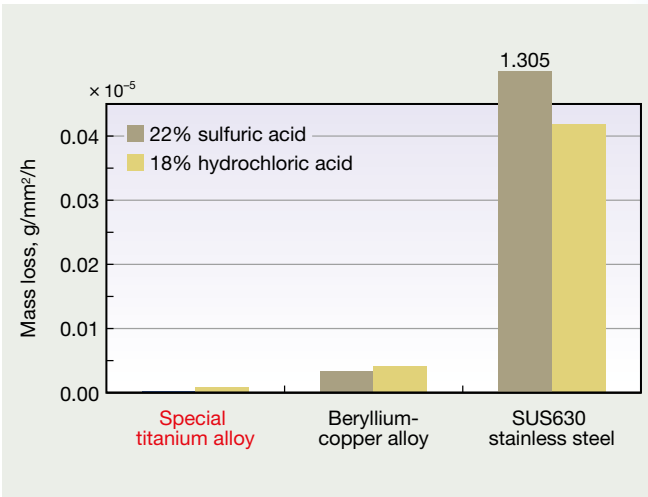
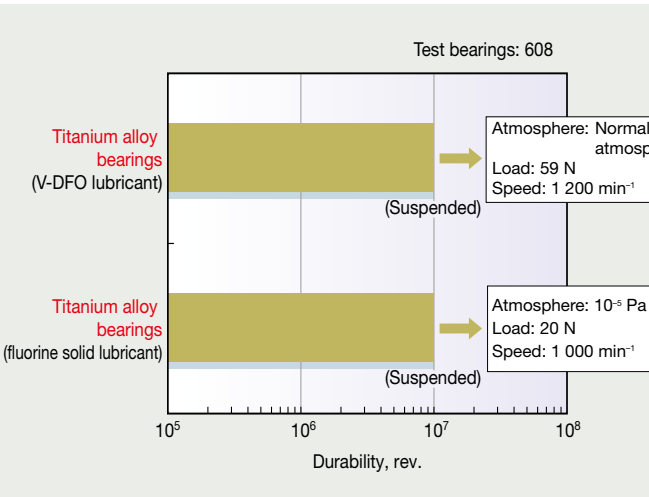
Material	Hardness (HV) ⁽¹⁾	Relative permeability	Corrosion ⁽²⁾ resistance	Features
Special titanium alloy	450-500	1.001 or less	◎	NSK-developed material
SUS440C	670	Ferromagnetic	△	Commercially available stainless steel
Non-magnetic stainless steel	450	1.01 or less	△	Due to its properties, it is difficult to machine, requiring advanced processing technology
Beryllium-copper alloy	320-400	1.001 or less	○	Generates harmful oxidation by-products
Silicon nitride ceramics	1 500	1.001 or less	◎	High in cost

Notes (1) Indicated in HV hardness for comparison
(2) Comparative assessment between five kinds of materials

Results of corrosion resistance test

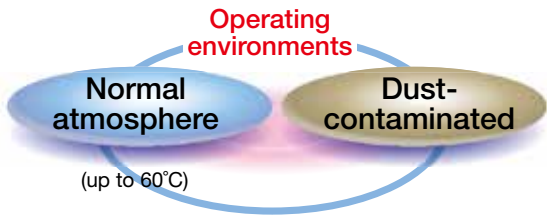
The special titanium alloy is more corrosion resistant than SUS630 or beryllium-copper alloys

Durability




20. Molded-Oil™ Bearings (For Dust-Contaminated Environments)

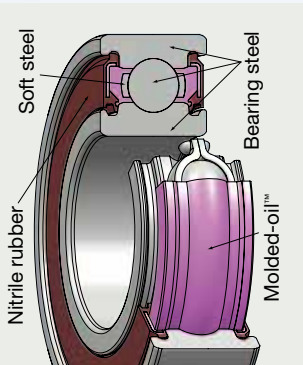
Molded-Oil™ bearings, lubricated with NSK's own oil-impregnated material, are suitable in dust-contaminated environments; for use in normal atmosphere only.



Product Specifications



Representative structure



Structure		Sealed Type
Specifications	Outer/Inner rings	Bearing steel
	Balls	Bearing steel
	Cage	Soft steel
	Lubricant	Molded-oil™
	Seals	Nitrile rubber

Applications: Food processing equipment, agricultural machines, woodworking machines, various conveyor lines

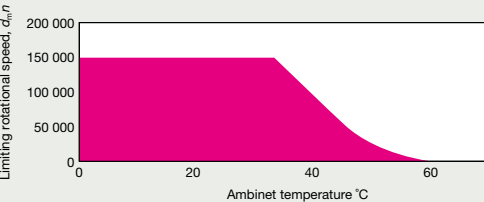
Operating Instructions and Notes

- For use in normal atmospheric conditions only.
- Whereas the solid lubricant used in these bearings will melt at a temperature of 120°C, take care not to exceed temperatures of 100°C when heating this bearing during the shrink-fit process for mounting.
- A radial load is required for the bearings to properly rotate. The minimum radial load recommended for maintaining proper rotation is at least 1 % of the basic dynamic load rating.
- Bearing should not be unpacked until immediately before mounting.
- See the SPACEA™ “5. Molded-Oil™ Bearings (stainless steel)” on pages A35 and A36 for applications requiring corrosion resistance.
- The scope of application (limiting load, limiting $d_m n$ value) is listed in the table to the right.
- All comments referencing certain values or degrees of performance in this catalog are intended to be used as a reference only. NSK provides this guide “As Is” without warranty of any kind, either expressed or implied.

The scope of Molded-oil™ bearings

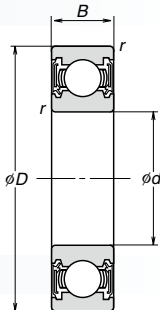
Applied load	Between 1% and 5%, inclusive, of the stainless steel bearing load rating C_H <Load more than 1% is necessary.>
Limiting rotational speed, $d_m n^{(1)}$	150 000 <In the case of more than 35 degrees, please refer to chart below.>

Note (1) $d_m n$ = (Bearing bore diameter, mm + Bearing outside diameter, mm) ÷ 2 × Rotational speed, min⁻¹



Features

- Continuous controlled flow of oil from the Molded-Oil™ inside the bearing provides sufficient lubrication
- Grease-free property keeps operating environments clean with no oil refilling
- Operating life in dust-contaminated environments more than twice as long as that of grease lubricant
- Contact-seal Type is a standard inventory item (See the table below)



Rubber Sealed Type (example)

Table of Dimensions and Availability (Contact-seal Type)

- A inquiry is the next name: Molded-Oil™ bearing **Basic bearing number**

Boundary dimensions				Basic bearing number	Availability	Limiting speeds ⁽¹⁾ (reference value) (min ⁻¹)	Applied load ⁽²⁾ (reference value) (N)	
Bore diameter d (mm)	Outside diameter D (mm)	Width B (mm)	Chamfer dimension (min.) r (mm)					
10	22	6	0.3	6900	●	9 370	25	– 110
	26	8	0.3	6000	●	8 330	40	– 190
	30	9	0.6	6200	●	7 500	45	– 210
12	24	6	0.3	6901	●	8 330	25	– 120
	28	8	0.3	6001	●	7 500	45	– 210
	32	10	0.6	6201	●	6 810	60	– 290
15	28	7	0.3	6902	●	6 970	40	– 180
	32	9	0.3	6002	●	6 380	50	– 230
	35	11	0.6	6202	●	6 000	65	– 320
17	35	10	0.3	6003	●	5 760	55	– 250
	40	12	0.6	6203	●	5 260	85	– 400
20	42	12	0.6	6004	●	4 830	80	– 390
	47	14	1	6204	●	4 470	110	– 540
25	47	12	0.6	6005	●	4 160	90	– 420
	52	15	1	6205	●	3 890	120	– 590
	62	17	1.1	6305	●	3 440	180	– 870
30	55	13	1	6006	●	3 520	120	– 560
	62	16	1	6206	●	3 260	170	– 820
	72	19	1.1	6306	●	2 940	230	– 1 130
35	62	14	1	6007	●	3 090	140	– 680
	72	17	1.1	6207	●	2 800	220	– 1 090
	80	21	1.5	6307	●	2 600	290	– 1 410
40	68	15	1	6008	●	2 770	150	– 710
	80	18	1.1	6208	●	2 500	250	– 1 240
	90	23	1.5	6308	●	2 300	350	– 1 720
45	75	16	1	6009	●	2 500	180	– 890
	85	19	1.1	6209	●	2 300	270	– 1 330
	100	25	1.5	9309	●	2 060	450	– 2 250
50	80	16	1	6010	●	2 300	190	– 920
	90	20	1.1	6210	●	2 140	300	– 1 490
	110	27	2	6310	●	1 870	520	– 2 600

Symbol of availability: ● Stocked as standard inventory items.⁽³⁾

Notes (1) Limiting speed of these bearings has been calculated for 25°C operating conditions. Limiting speeds will be slower for operating conditions of 35°C or higher.

(Refer to the previous page for further details.)

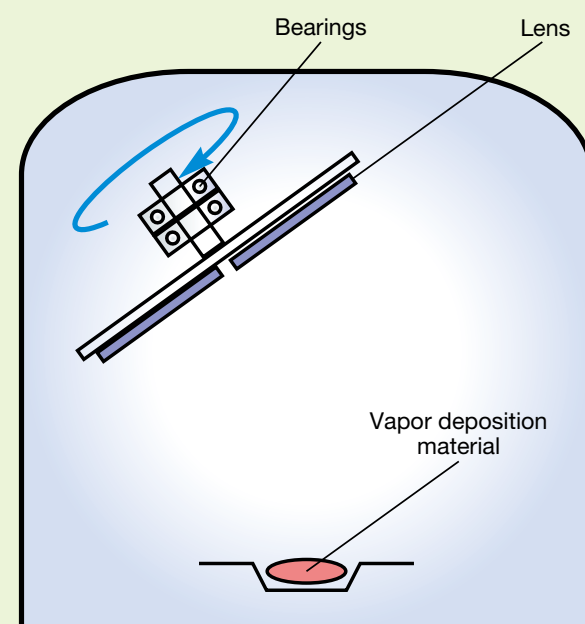
(2) The applied load is a pure radial load that has been calculated based on a bearing life of 10⁷ rotations.

(3) Orders placed for standard inventory items may incur some delay in actual delivery. Furthermore, products shipped from Japan may incur additional delays.

Remarks 1. The radial internal clearance for the bearings on this page is CN. See the radial internal clearance tables on page A10 for further details.

2. Rubber sealed type is standard inventory items.

Vacuum Vapor Deposition Equipment

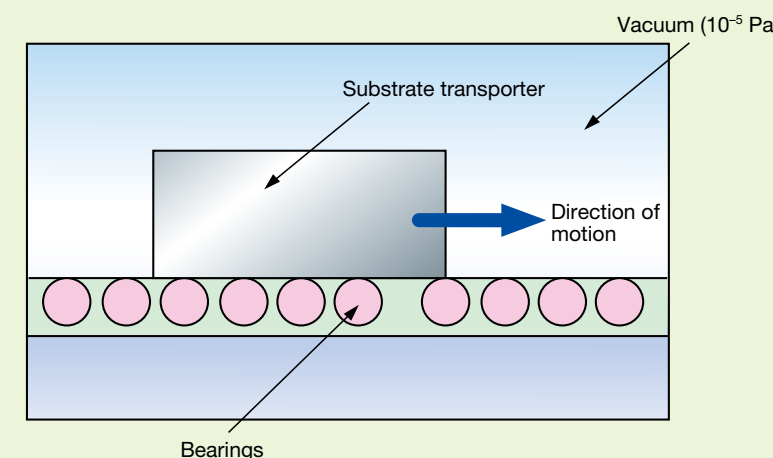


- Operating Conditions**
- Vacuum/Clean environments**
- Degree of vacuum: 10^{-4} Pa
 - Temperature: 200 to 300°C, inclusive
 - Speed: Up to 100 min⁻¹
 - Load: Up to 50 N

- Conventional bearings**
- Silver-coated bearing (6002, 6004, etc.)
 - Operating life: 2 to 3 months

- NSK SPACEA™ Series**
- YS Bearings with Spacer Joints**
- Operating life: More than 1 year

Sputtering Equipment

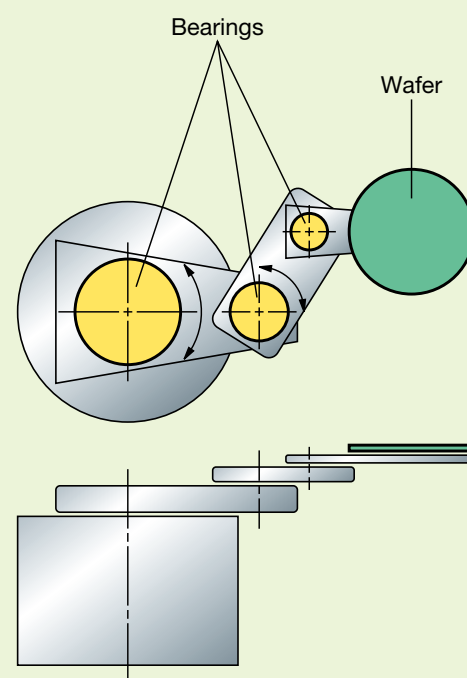


- Operating Conditions**
- Vacuum/Clean environments**
- Degree of vacuum: 10^{-5} Pa
 - Temperature: Up to 150°C, inclusive
 - Speed: Up to 500 min⁻¹
 - Load: Up to 50 N

- Conventional bearings**
- Fluororesin coated bearing (bore diameter: 3/8")
 - Operating life: 3 months

- NSK SPACEA™ Series**
- V-DFO Bearings**
- Operating life: 6 months

Robots for Vacuum Environments

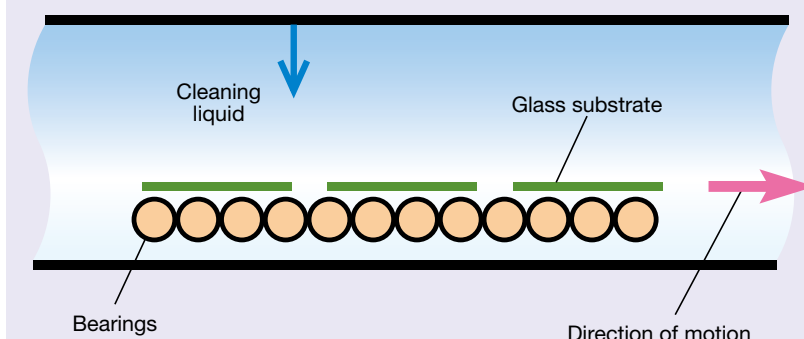


- Operating Conditions**
- Vacuum/Clean environments**
- Degree of vacuum: 10^{-4} Pa
 - Temperature: Up to 120°C
 - Speed: Low-speed swing
 - Load: Moment load

- Conventional bearings**
- Thin-walled bearing
 - Inner/Outer rings: Stainless steel
 - Balls: Special glass balls
 - Operating life: 2 to 3 months

- NSK SPACEA™ Series**
- N Series Thin-Walled Bearings**
- (NBA2504, NBX15206, etc.)
- Inner/Outer rings: Stainless steel
- Balls: Ceramics
- Operating life: More than 1 year

Liquid Crystal Cleaning Equipment

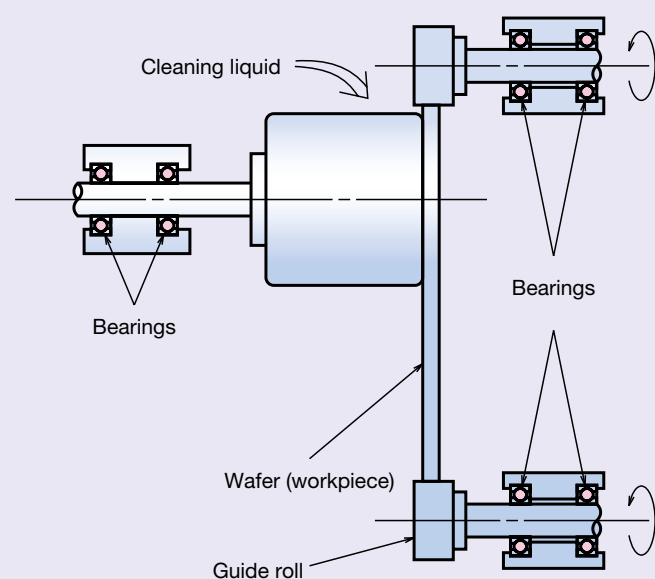


- Operating Conditions**
- Corrosive environments**
- Cleaning liquid-spray environments
 - Speed: Up to 50 min⁻¹
 - Load: Light load

- Conventional bearings**
- Plain resin bearing
 - Operating life: 2 to 3 months

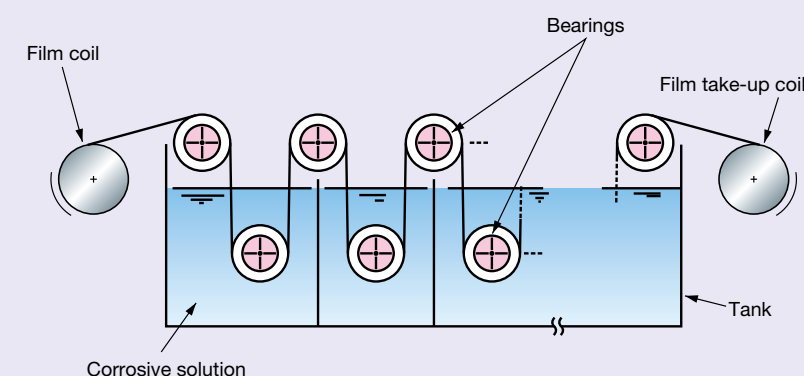
- NSK SPACEA™ Series**
- Aqua-Bearing™**
- Operating life: More than 1 year

Silicon Wafer Cleaning Equipment



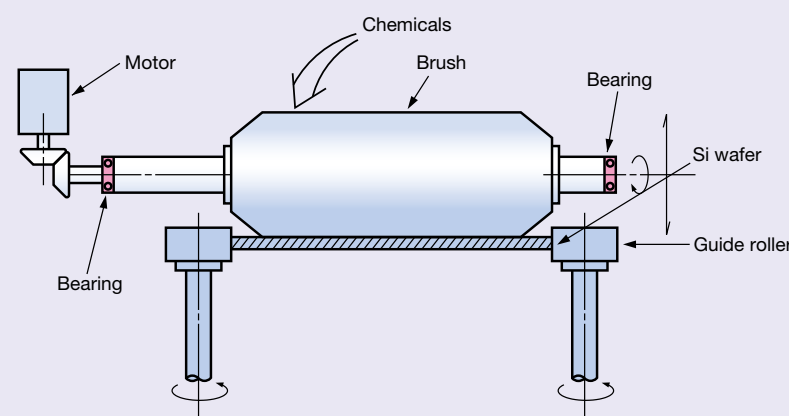
- Operating Conditions**
- Corrosive environments**
- Cleaning liquid-spray environments
 - Speed: Up to 100 min⁻¹
 - Load: Up to 50 N
- Conventional bearings**
- Stainless steel bearing (degreased products 6000, 6001, 6901, etc.)
 - Operating life: 2 weeks to 1 month
- NSK SPACEA™ Series Hybrid Bearings**
- Operating life: 2 to 3 months

Cleaning Device



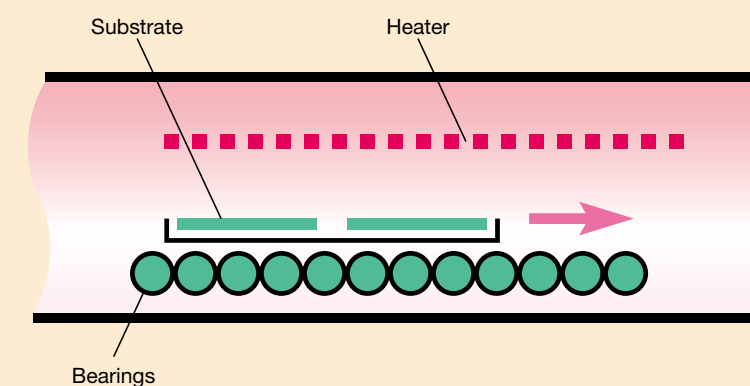
- Operating Conditions**
- Corrosive environments**
- Strong acid solution
 - Speed: Up to 100 min⁻¹
 - Load: Up to 100 N
 - Temperature: Up to 80°C
- Conventional bearings**
- All-ceramic bearing (silicon nitride 6204, 6206, etc.)
 - Operating life: More than 1 year
- NSK SPACEA™ Series All-Ceramic Bearings**
- Operating life: More than 3 years

Wafer Polishing Equipment (CMP Equipment)



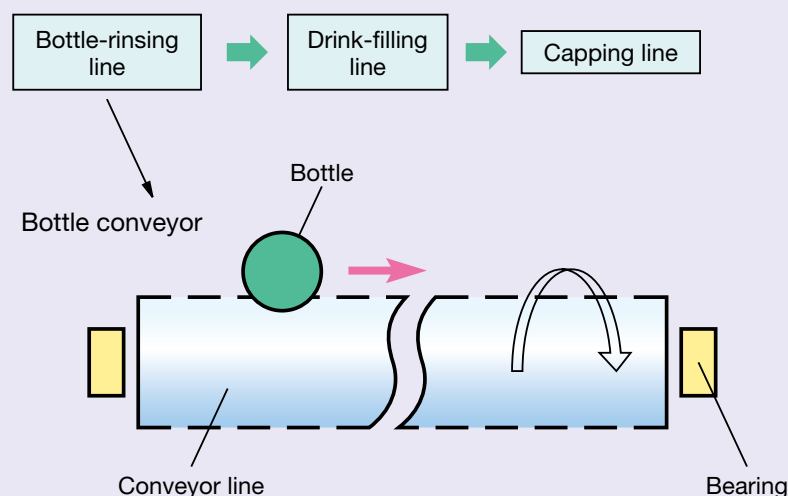
- Operating Conditions**
- Corrosive environments**
- Cleaning liquid-spray environments
 - Speed: Up to 30 min⁻¹
 - Load: Light load
- Conventional bearings**
- Stainless steel bearing (6001, 6800, etc.)
 - Operating life: 2 weeks to 1 month
- NSK SPACEA™ Series All-Ceramic Bearings**
- Operating life: More than 1 year

Furnace Conveyor



- Operating Conditions**
- High-temperature environments**
- Normal atmosphere
 - Temperature: Up to 400°C
 - Speed: Up to 100 min⁻¹
- Conventional bearings**
- Stainless steel bearing (degreased products 6204, 6205, etc.)
 - Operating life: 1 month
- NSK SPACEA™ Series SJ Bearings**
- Operating life: More than 1 year

Aseptic Filling Equipment for Soft Drinks



Operating Conditions

Corrosive environments

- Corrosive liquid-spray (for sterilization and rinsing)
- Speed: Up to 300 min⁻¹
- Load: Up to 50 N
- Temperature: Up to 80°C

Conventional bearings

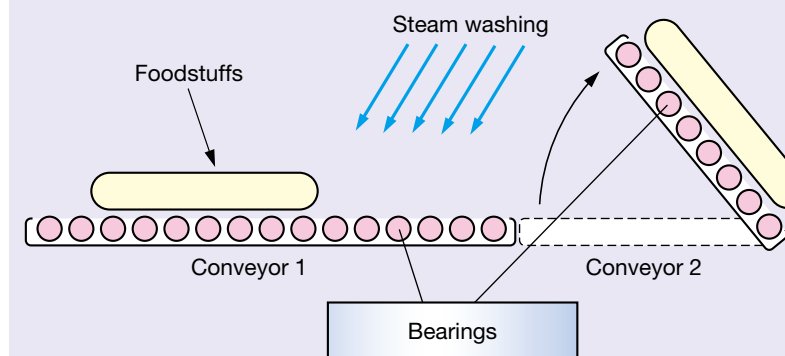
- Stainless steel bearing (6205, 6212, 6306, etc.)
- Operating life: Several months

NSK SPACEA™ Series

Corrosion-Resistant Coated Bearings

- Operating life: More than 1 year

Raw Material Preparation Device



Operating Conditions

Corrosive environments

- Water spray, steam
- Speed: Up to 1 000 min⁻¹
- Temperature: Up to 80°C

Conventional bearings

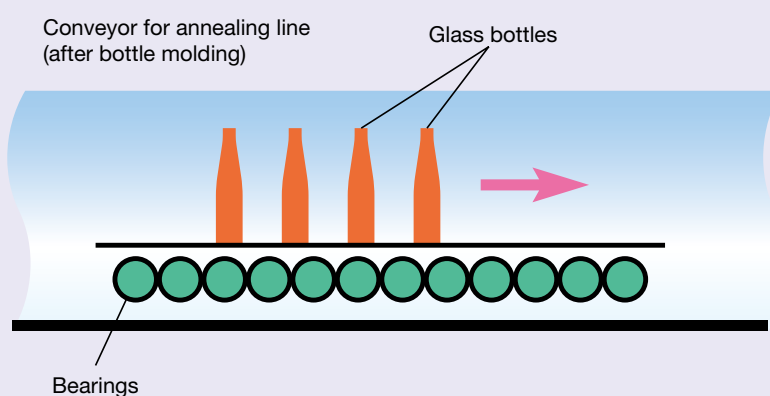
- Grease-packed stainless steel bearing

NSK SPACEA™ Series

Hybrid Bearings

- Operating life: More than five times longer than conventional bearings

Conveyor for Glass-Bottle Production Machine



Operating Conditions

High-temperature/Corrosive environments

- Corrosive gas atmosphere
- Temperature: Up to 200°C
- Speed: Up to 100 min⁻¹

Conventional bearings

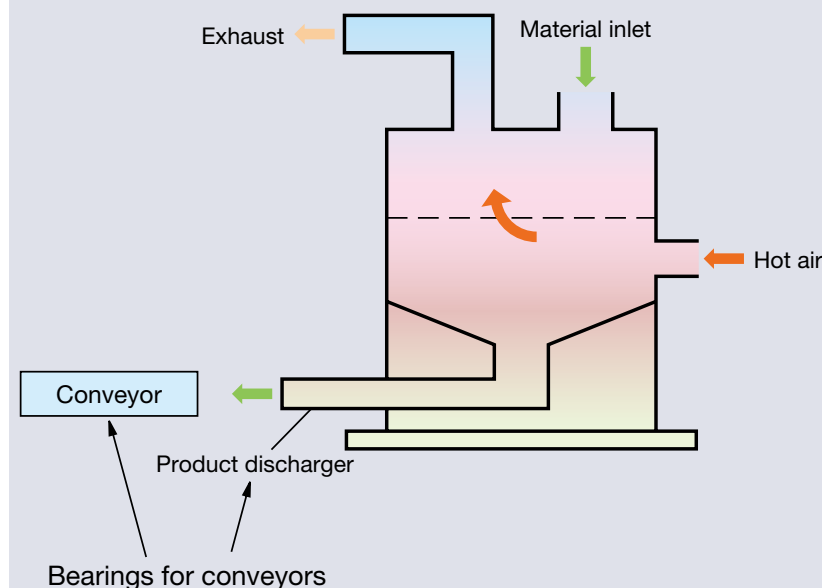
- High-temperature grease-packed stainless steel bearing (6005, 6306, etc.)
- Operating life: Several months

NSK SPACEA™ Series

Corrosion-Resistant Coated Bearings

- Operating life: More than 1 year

Grain Dryer



Operating Conditions

Dust-contaminated environments

- Chaff, powder, and dust
- Temperature: Up to 60°C
- Speed: Up to 100 min⁻¹

Conventional bearings

- Stainless steel bearing (696, 6800, etc.)
- Operating life: Approx. 2 months

NSK SPACEA™ Series

Molded-Oil™ Bearings

- Operating life: More than 1 year

NSK proudly offers cutting-edge products developed with state-of-the-art technology

SPACEA™ Series—NSK Ball Screws and NSK Linear Guides for Special Environments—offers a wide array of products for special environments, including vacuum and clean, corrosive, sanitary, dust-contaminated, high-temperature, and non magnetic environments. NSK’s state-of-the-art technology creates products that deliver high performance in a variety of severe conditions.

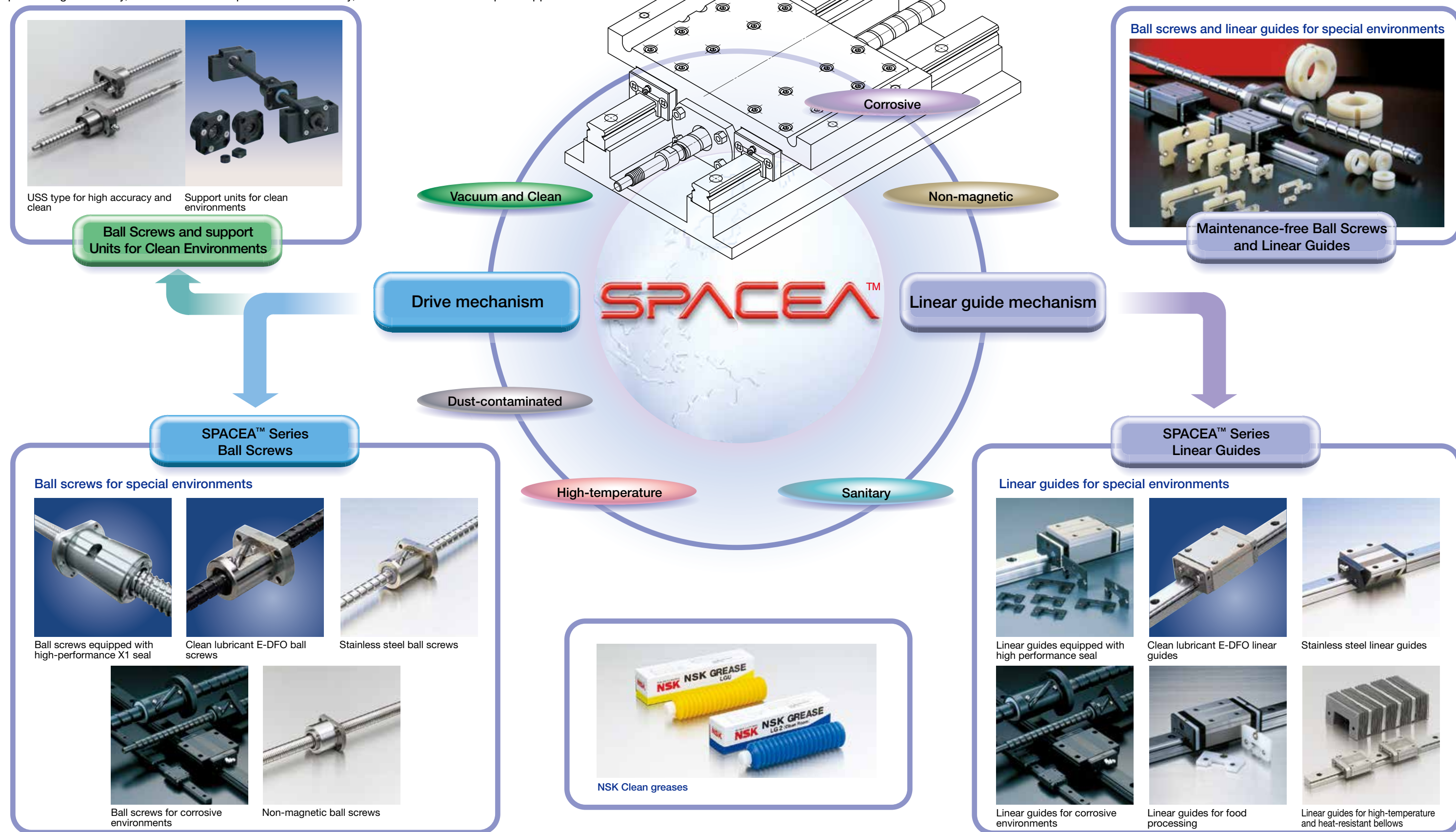
Optimal products for specific applications can be found in the SPACEA series ball screws and linear guides Selection Guide on pages B5–B6.



Table of Contents of SPACEA™ Series Ball Screws and NSK Linear Guide™	
A	Inventory B3–B4
B	Selection Guide B5–B6
C	Types and Specifications B7–B8
D	Dimensions and Availability B9–B12
	1. Ball Screws
	2. Clean Support Unit
	3. NSK Linear Guide™
E	Specifications, Operating Instructions, and Technical Data B13–B32
	1. Corrosion-resistant Ball Screws and NSK Linear Guide™ (Fluoride Low-temperature Chrome Plating) B13–B14
	2. LG2/LGU Clean Greases B15–B16
	3. NSK Clean Lubricant E-DFO B17–B18
	4. Clean Environments Standard Ball Screws USS B19–B20
	5. Support Units for Clean Environments B21–B22
	6. Lubrication Unit for “NSK K1™” B23–B26
	7. NSK High Performance Seals..... B27–B30
	8. Ball Screws and NSK Linear Guide™ for High-temperature Environments B31–B32
F	Applications of SPACEA™ Series Ball Screws and NSK Linear Guide™ B33–B34
	1. Semiconductor Manufacturing Equipment
	2. LCD/Semiconductor Production Machinery

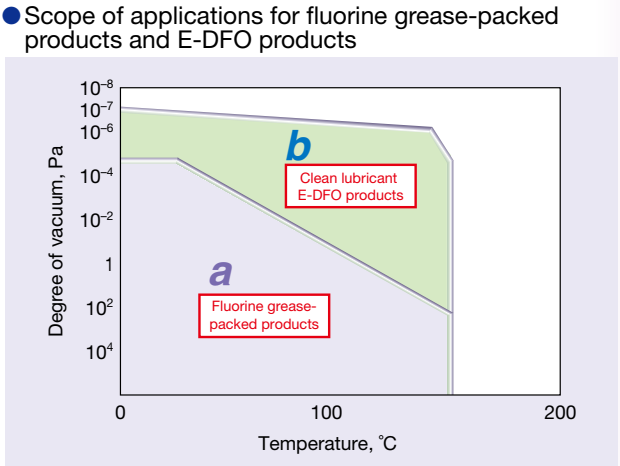
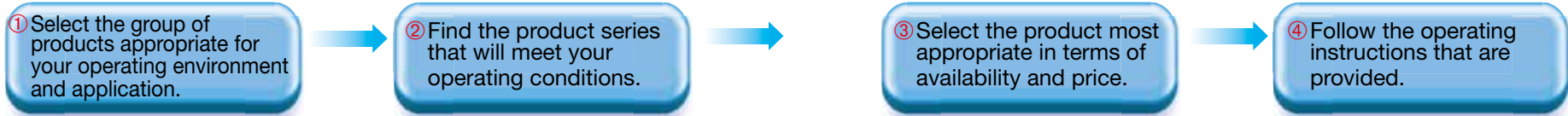
Product lineup listed by operating environment

NSK's SPACEA™ series ball screws and NSK linear guides are the optimal components for linear drive mechanisms for demanding operating environments, such as semiconductor/FPD/hard disk production machinery, food processing machinery, medicine/cosmetic production machinery, and ceramics/chemical/optical apparatus.





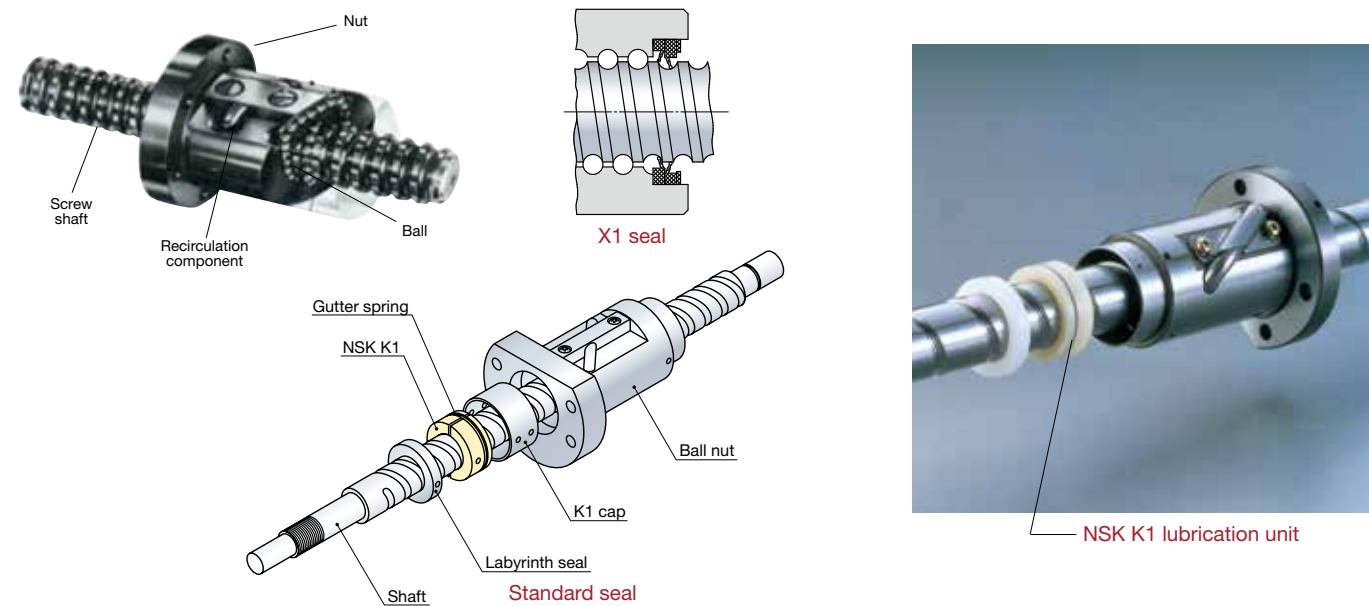
Select the most appropriate product with the following selection flow chart.



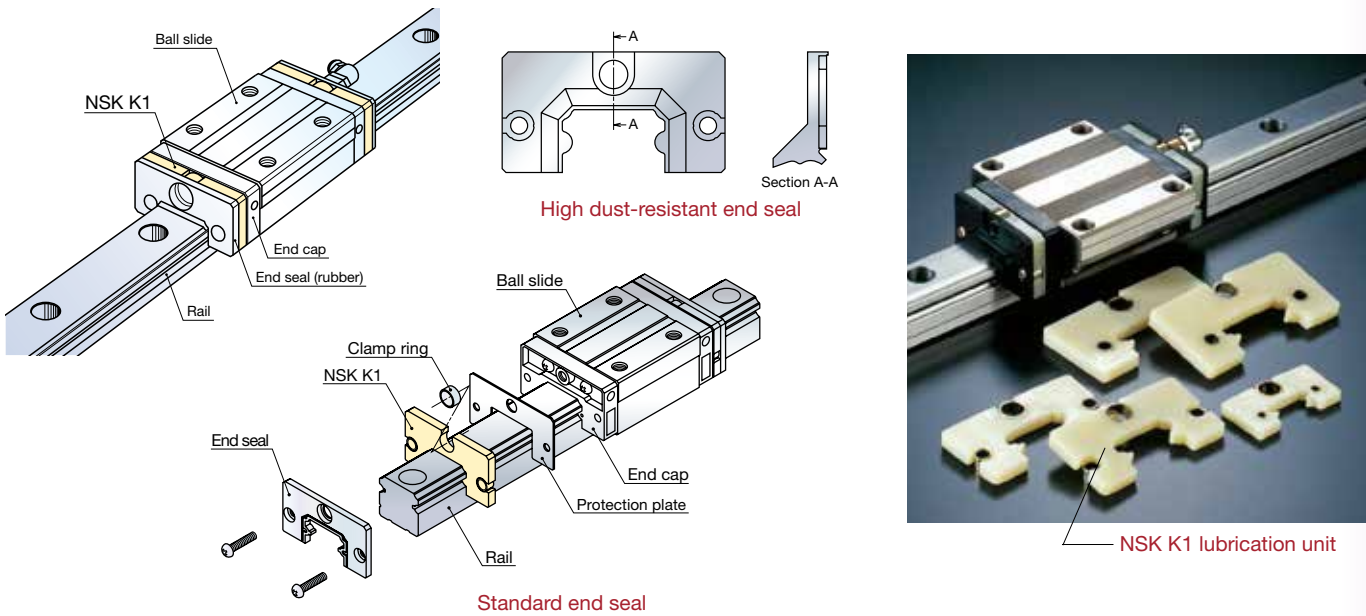
① Operating environment			Product name		② Operating conditions													③ Price comparison	③ Dimensions (availability)	④ · Specifications · Operating instructions · Technical data			
					Degree of vacuum Pa				Temperature °C			Cleanliness ⁽¹⁾			Limiting rotational speed <i>d·n</i> value ⁽²⁾						Limiting speed of linear guide m/min		
					Normal atmosphere	10 ⁻⁴ ≤	10 ⁻⁸ ≤		≤100	≤200	≤300	100– 1 000	≤100	≤10	≤50 000	≤100 000	≤150 000				≤100	≤200	≤300
Vacuum and clean	Clean	Normal atmosphere (room temperature)	LG2 clean grease-packed ball screws and linear guides						≤70°C						≤70 000			≤100				Ball screws (B9)	B15–B16, B19–B20, B23–B25
			LGU clean grease-packed ball screws and linear guides						≤120°C														
	Vacuum	From normal atmosphere up to vacuum (room temperature)	Fluorine grease-packed ball screws and linear guides		See the scope of applications for fluorine grease-packed products (upper right) <i>a</i>							≤70 000			≤100			Low					
		From normal atmosphere up to vacuum (up to 150°C)	Clean lubricant E-DFO ball screws and linear guides		See the scope of applications for E-DFO products (upper right) <i>b</i>								≤70 000			≤100			High				
	Non-magnetic	Non-magnetic (relative permeability 1.01 or less) (from normal atmosphere up to vacuum)		Non-magnetic stainless steel ball screws and linear guides		10 ⁻⁶ Pa				≤150°C					≤70 000			≤100			–		
Corrosive	Water	Water vapor, high-humidity environments	Ball screws and linear guides for corrosive environments	(Standard grease) (Standard seal)				≤80°C							≤70 000			≤100				Low	
		Water-immersed, water-spray	Ball screws and linear guides for corrosive environments															High					
	Weak acid, weak alkali Strong acid, strong alkali	Corrosion-resistant coated ball screws and linear guides	(Fluorine grease) (Corrosion-resistant seal)		≤80°C						≤70 000				≤100				Low				
		Stainless steel ball screws and linear guides			≤150°C										High								
Sanitary	Food processing environments		Ball screws and linear guides for food processing					≤80°C					≤70 000			≤100			–				
Dust-contaminated	Dust or wood chips		Ball screws equipped with high-performance X1 seal Linear guides equipped with high performance seal					≤80°C					≤70 000			≤100			Low 				
High-temperature	Normal atmosphere (up to 150°C)		Ball screws and linear guides for high-temperature environments					≤150°C					≤70 000			≤100				–			
Non-magnetic	From normal atmosphere up to vacuum		Non-magnetic stainless steel ball screws and linear guides		10 ⁻⁶ Pa			≤150°C					≤70 000			≤100			–				

(1) Cleanliness may vary depending on surrounding structures and other factors.
(2) d·n = Shaft diameter of ball screws, mm × rotational speed (min⁻¹)

SPACEA™ Series Ball Screws



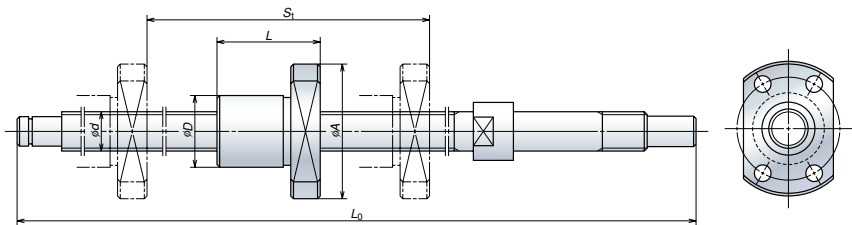
SPACEA™ Series NSK Linear Guide™



Operating environment			Product name	Component specifications							· Specifications · Operating instructions · Technical data
				Ball screw specifications	Shaft, nut	Ball	Recirculation components	Seal	Corrosion-resistant coating	Lubricant	
				Linear guide specifications	Rail, ball slides		End cap				
Vacuum and clean	Clean	Normal atmosphere (room temperature)	Clean grease-packed ball screws and linear guides	Standard material	Standard material	Standard material	Standard seal	Fluoride low-temperature chrome plating	LG2 clean grease, NSK K1	B15–B16, B19–B20, B23–B24	
	Vacuum	From normal atmosphere up to vacuum (room temperature)	Fluorine grease-packed ball screws and linear guides	Martensite stainless steel	Martensite stainless steel	Austenite stainless steel	–		LGU clean grease, NSK K1		
		From normal atmosphere up to vacuum (up to 150°C)	Clean lubricant E-DFO ball screws and linear guides					Fluorine grease	B13–B14		
	Non-magnetic	From normal atmosphere up to vacuum	Non-magnetic stainless steel ball screws and linear guides	Special austenite stainless steel	Ceramics	Austenite stainless steel	Standard seal	–	E-DFO (+ DLC) or Molybdenum disulfide	B17–B18	
Corrosive	Water	Water vapor, high-humidity environments	Corrosion-resistant coated ball screws and linear guides	Standard material	Standard material	Standard material	Standard seal	Fluoride low-temperature chrome plating	Standard grease + NSK K1	B13–B14, B23–B24	
		Water-immersed, water-spray	Stainless steel ball screws and linear guides	Martensite stainless steel	Martensite stainless steel	Austenite stainless steel					
	Weak acid, weak alkali Strong acid, strong alkali		Corrosion-resistant coated ball screws and linear guides	Standard material	Standard material		Corrosion-resistant seal	Fluoride low-temperature chrome plating	Fluorine grease	B13–B14	
			Stainless steel ball screws and linear guides	Martensite stainless steel	Martensite stainless steel						
Sanitary	Food processing environments		Ball screws and linear guides for food processing	Martensite stainless steel	Martensite stainless steel	Austenite stainless steel	Standard seal	–	Grease for food processing applications, NSK K1 for food processing applications and medical devices	B25–B26	
Dust-contaminated	Dust or wood chips		Ball screws equipped with high-performance X1 seal	Standard material	Standard material	Standard material	X1 seal	Fluoride low-temperature chrome plating	Standard grease	B13–B14, B27	
			Linear guides equipped with high performance seal				High dust-resistant seal		Standard grease + NSK K1	B13–B14, B23–B24, B28–B30	
High-temperature	Normal atmosphere (up to 150°C)		Ball screws and linear guides for high-temperature environments	Martensite stainless steel	Martensite stainless steel	Austenite stainless steel	(High dust-resistant seal)	–	Heat-resistant grease, Fluorine grease	B31–B32	
Non-magnetic	From normal atmosphere up to vacuum		Non-magnetic stainless steel ball screws and linear guides	Special austenite stainless steel	Ceramics	Austenite stainless steel	Standard seal	–	Standard grease, Fluorine grease	–	

Note: Under radioactive operating conditions, resins used in standard products may cause distortion of the products, and resins used in lubricants may deteriorate;

1. Dimensions of Ball Screws



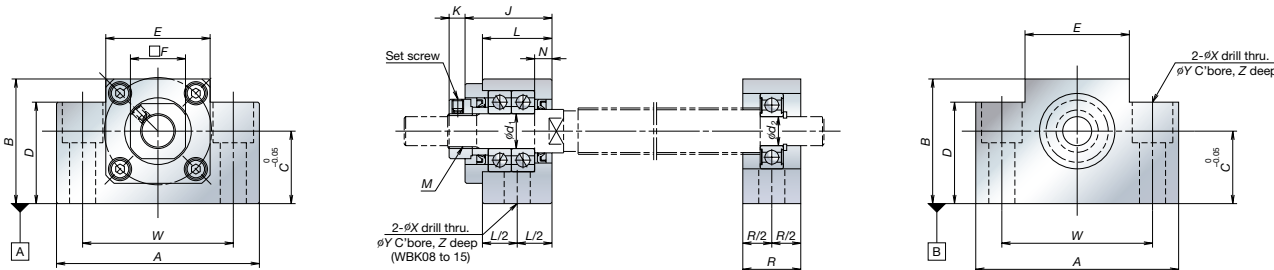
Series	Dimensions (mm)										Suitability for special environments (availability)					
	Shaft diameter	Lead	Effective turns of balls	Number of start	Nut outer diameter	Flange outer diameter	Nut length	Maximum shaft length	Stroke	Dynamic load rating (N)	Clean	Vacuum	Corrosive	High-temperature	Dust-contaminated	Sanitary
KA	6	1	1×3	1	12	24	21	174	100	470						
	8	1	1×3	1	14	27	21	248	150	545						
	10	2	1×3	1	16	29	28	248	150	1 080						
	10	4	2.5×3	1	18	35	29	308	200	1 210						
	12	2	1×3	1	20	37	29	380	250	1 360						
	12	5	2.5×1	1	30	50	40	580	450	3 070						
	12	10	2.5×1	1	30	50	50	580	450	3 070						
	15	10	2.5×1	1	34	57	51	1 161	1 000	5 780						
	16	20	1.7×1	1	34	55	45	1 161	1 000	4 150						
	20	2	1×4	1	25	44	40	461	300	2 870						
US	20	20	1.5×1	1	46	74	63	1 208	1 000	5 760						
	10	5	2.7×1	1	23	43	29	521	433	2 930						
	12	5	2.7×1	1	24	44	30	621	530	3 200						
	15	5	2.7×1	1	28	51	30	761	653	5 460						
	10	2	1×3	1	22	39	29	308		1 210						
	10	4	2.5×1	1	26	46	34	430		2 250						
	12	2	1×3	1	24	41	29	380		1 360						
	12	5	2.5×1	1	30	50	40	580		3 070						
	12	10	2.5×1	1	30	50	50	580		3 070						
	15	10	2.5×1	1	34	57	51	1 161		5 780						
Production on demand	16	20	1.7×1	1	34	55	45	1 161		4 150						
	16	2	1×4	1	30	49	40	461		2 870						
	20	20	1.5×1	1	46	74	63	1 208		5 760						
	25	5	2.5×2	1	50	73	55	1 800		13 600						
	25	25	1.5×1	1	44	71	90	1 800		8 280						
	25	25	1.5×1	1	47	74	119	1 800		8 280						
	32	5	2.5×2	1	58	85	106	2 400		15 100						
	32	10	2.5×2	1	74	108	125	2 400		37 900						
	32	20	2.5×1	1	78	105	107	2 400		14 700						
	32	25	2.5×1	1	78	105	120	2 400		14 700						
	32	32	1.5×1	1	51	85	109	2 400		9 450						
	32	32	1.7×2	2	56	86	109	2 800		25 000						
	40	25	2.5×1	1	100	133	136	3 000		23 400						
	40	32	1.5×2	1	100	133	122	3 000		24 600						
	40	40	1.5×1	1	64	106	133	3 000		15 100						
	40	10	2.5×2	1	82	124	173	2 900		52 000						
	40	12	2.5×2	1	86	128	197	2 900		61 000						
	40	16	3.7×1	1	86	128	172	2 900		57 100						
	40	20	2.7×2	2	86	128	164	2 900		66 900						
50	8	2.5×4	1	82	120	162	3 300		55 400							
	10	2.5×2	1	88	132	117	3 300		44 300							
	8	2.5×2	1	82	124	146	2 900		37 300							
	16	3.7×1	1	92	134	173	2 900		59 600							
	20	2.7×2	2	92	134	164	2 900		69 100							
	8	2.5×4	1	90	129	149	3 500		57 500							
	10	2.5×4	1	93	135	163	3 500		85 700							
	25	2.5×1	1	120	156	140	3 300		34 900							
	32	2.5×1	1	120	156	158	3 300		34 900							
	40	1.5×1	1	120	156	140	3 300		36 700							
50	50	1.5×1	1	80	126	161	3 500		22 500							
	50	1.5×2	2	120	156	158	3 500		36 700							
	10	2.5×2	1	93	135	174	2 900		57 700							
	12	2.5×2	1	100	146	200	2 900		77 600							
	16	3.7×1	1	98	140	173	2 900		61 800							
	20	2.7×2	2	98	140	164	2 900		73 200							

○Contact NSK for the details of availability

Note: The dynamic load ratings listed are those of martensite stainless steel screws, with the internal clearance as a reference. The dynamic load ratings may vary depending on materials or internal specifications.

2. Dimensions of Clean Support Unit

● Square type support unit



Unit: mm

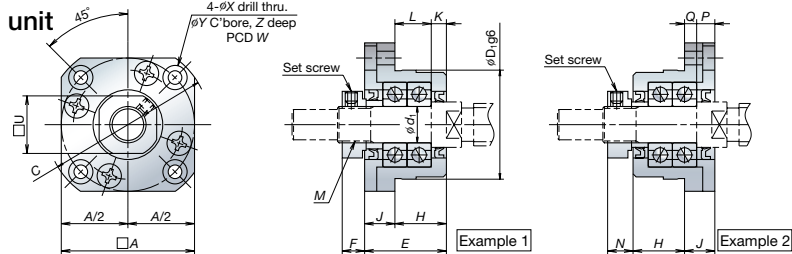
Fixed support side unit (square type)									
Reference No. (for use in clean environments)	Locknut tightening torque (reference) [N·cm]	Set screw tightening torque (reference) [N·cm]	d ₁	F	J	K	L	N	M
WBK08-01C	230	69 (M3)	8	14	23	7	—	4	M8 × 1
WBK10-01C	280	147 (M4)	10	17	30	5.5	24	6	M10 × 1
WBK12-01C	630	147 (M4)	12	19	30	5.5	24	6	M12 × 1
WBK15-01C	790	147 (M4)	15	22	31	12	25	5	M15 × 1

Unit: mm

Simple support side unit			Common dimensions with square type								
Reference No. (for use in clean environments)	d ₂	R	A	B	C	D	E	W	X	Y	Z
WBK08S-01C	6	15	52	32	17	26	25	38	6.6	11	12
WBK10S-01C	8	20	70	43	25	35	36	52	9	14	11
WBK12S-01C	10	20	70	43	25	35	36	52	9	14	11
WBK15S-01C	15	20	80	50	30	40	41	60	11 9	17 14	15 11

Note: For dimensions of X, Y, and Z for WBK15S-01C, the upper number indicates dimensions of fixed support side unit, and the lower number shows dimensions of simple support side unit.

● Round type support unit



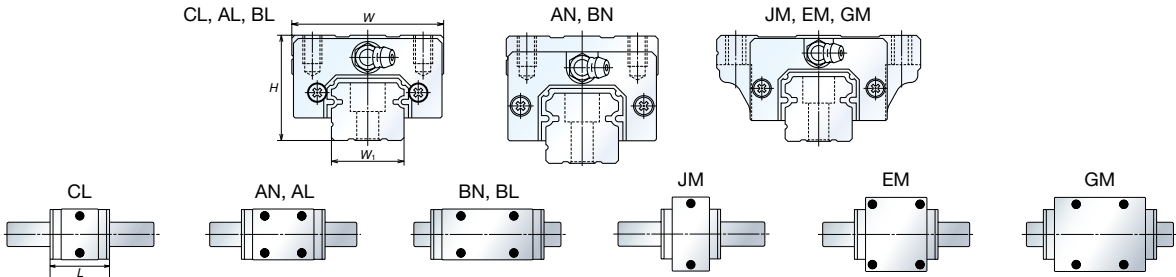
Unit: mm

Fixed support side unit (round type)																		
Reference No. (for use in clean environments)	d ₁	A	C	U	W	X	Y	Z	D ₁	E	F	H	J	K	L	N	P	Q
WBK08-11C	8	35	43	14	35	3.4	6.5	4	28	23	7	14	9	4	10	8	5	4
WBK10-11C	10	42	52	17	42	4.5	8	4	34	27	7.5	17	10	5	12	8.5	6	4
WBK12-11C	12	44	54	19	44	4.5	8	4	36	27	7.5	17	10	5	12	8.5	6	4
WBK15-11C	15	52	63	22	50	5.5	9.5	6	40	32	12	17	15	6	11	14	8	7

Note: Refer to the dimensions of square type support unit for tightening torque of locknuts and setscrews.

3. Dimensions of Linear Guides

NH, VH, NS, LH Series



Series	Model No.	Dimensions (mm)						Suitability for special environments (availability)					
		Height H	Overall width W	Ball slide length (L)		Rail width W ₁	Dynamic load rating (N)	Clean	Vacuum	Corrosive	High-temperature	Sanitary	Dust-contaminated
				Standard	With NSK K1								
NH	NH15AN	28	34	55	65.6	15	14 200	○					
	NH15BN	28	34	74	84.6	15	18 100	○					
	NH15EM	24	47	55	65.6	15	14 200	○					
	NH15GM	24	47	74	84.6	15	18 100	○					
	NH20AN	30	44	69.8	80.4	20	23 700	○	○				
	NH20BN	30	44	91.8	102.4	20	30 000	○	○				
	NH20EM	30	63	69.8	80.4	20	23 700	○	○				
	NH20GM	30	63	91.8	102.4	20	30 000	○	○				
	NH25AN	40	48	79	90.6	23	33 500	○	○				
	NH25BN	40	48	107	118.6	23	45 500	○	○				
	NH25AL	36	48	79	90.6	23	33 500	○	○				
	NH25BL	36	48	107	118.6	23	45 500	○	○				
	NH25EM	36	70	79	90.6	23	33 500	○	○				
	NH25GM	36	70	107	118.6	23	45 500	○	○				
	NH30AN	45	60	85.6	97.6	28	41 000	○	○				
	NH30BN	45	60	124.6	136.6	28	61 000	○	○				
	NH30AL	42	60	85.6	97.6	28	41 000	○	○				
	NH30BL	42	60	124.6	136.6	28	61 000	○	○				
	NH30EM	42	90	98.6	110.6	28	47 000	○	○				
	NH30GM	42	90	124.6	136.6	28	61 000	○	○				
	NH35AN	55	70	109	122	34	62 500	○	○				
	NH35BN	55	70	143	156	34	81 000	○	○				
	NH35AL	48	70	109	122	34	62 500	○	○				
	NH35BL	48	70	143	156	34	81 000	○	○				
	NH35EM	48	100	109	122	34	62 500	○	○				
	NH35GM	48	100	143	156	34	81 000	○	○				
	NH45AN	70	86	139	154	45	107 000	○	○				
	NH45BN	70	86	171	186	45	131 000	○	○				
	NH45AL	60	86	139	154	45	107 000	○	○				
	NH45BL	60	86	171	186	45	131 000	○	○				
	NH45EM	60	120	139	154	45	107 000	○	○				
	NH45GM	60	120	171	186	45	131 000	○	○				
	NH55AN	80	100	163	178	53	158 000	○	○				
	NH55BN	80	100	201	216	53	193 000	○	○				
	NH55AL	70	100	163	178	53	158 000	○	○				
	NH55BL	70	100	201	216	53	193 000	○	○				
	NH55EM	70	140	163	178	53	158 000	○	○				
	NH55GM	70	140	201	216	53	193 000	○	○				
	NH65AN	90	126	193	211	63	239 000	○	○				
	NH65BN	90	126	253	271	63	310 000	○	○				
	NH65EM	90	170	193	211	63	239 000	○	○				
	NH65GM	90	170	253	271	63	310 000	○	○				
VH	VH15AN	28	34	70.6		15	14 200	○					○
	VH15BN	28	34	89.6		15	18 100	○					○
	VH15EM	24	47	70.6		15	14 200	○					○
	VH15GM	24	47	89.6		15	18 100	○					○
	VH20AN	30	44	87.4		20	23 700	○					○
	VH20BN	30	44	109.4		20	30 000	○					○
	VH20EM	30	63	87.4		20	23 700	○					○
	VH20GM	30	63	109.4		20	30 000	○					○
	VH25AN	40	48	97		23	33 500	○					○
	VH25BN	40	48	125		23	45 500	○					○
	VH25AL	36	48	97		23	33 500	○					○
	VH25BL	36	48	125		23	45 500	○					○
	VH25EM	36	70	97		23	33 500	○					○
	VH25GM	36	70	125		23	45 500	○					○
	VH30AN	45	60	104.4		28	41 000	○					○
	VH30BN	45	60	143.4		28	61 000	○					○
	VH30AL	42	60	104.4		28	41 000	○					○
	VH30BL	42	60	143.4		28	61 000	○					○
	VH30EM	42	90	117.4		28	47 000	○					○
	VH30GM	42	90	143.4		28	61 000	○					○
	VH35AN	55	70	128.8		34	62 500	○					○
	VH35BN	55	70	162.8		34	81 000	○					○
	VH35AL	48	70	128.8		34	62 500	○					○
	VH35BL	48	70	162.8		34	81 000	○					○
	VH35EM	48	100	128.8		34	62 500	○					○
	VH35GM	48	100	162.8		34	81 000	○					○
	VH45AN	70	86	161.4		45	107 000	○					○
	VH45BN	70	86	193.4		45	131 000	○					○
	VH45AL	60	86	161.4		45	107 000	○					○
	VH45BL	60	86	193.4		45	131 000	○					○
	VH45EM	60	120	161.4		45	107 000	○					○
	VH45GM	60	120	193.4		45	131 000	○					○
	VH55AN	80	100	185.4		53	158 000	○					○
	VH55BN	80	100	223.4		53	193 000	○					○
	VH55AL	70	100	185.4		53	158 000	○					○

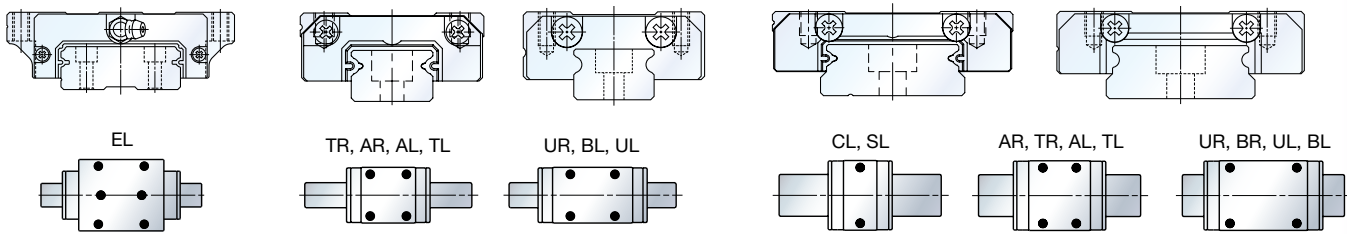
LW Series

PU Series

LU Series

PE Series

LE Series



Series	Model No.	Dimensions (mm)						Suitability for special environments (availability)						
		Height H	Overall width W	Ball slide length (L)		Rail width W ₁	Dynamic load rating (N)	Clean	Vacuum	Corrosive	High-temperature	Sanitary	Dust-contaminated	
				Standard	With NSK K1									
VH	VH55BL	70	100	223.4		53	193 000	○		○			○	
	VH55EM	70	140	185.4		53	158 000	○		○			○	
	VH55GM	70	140	223.4		53	193 000	○		○			○	
NS	NS15CL	24	34	40.4	50	15	7 250	○	○	○	○	○		
	NS15AL	24	34	56.8	66.4	15	11 200	○	○	○				
	NS15JM	24	52	40.4	50	15	7 250	○	○	○	○	○		
	NS15EM	24	52	56.8	66.4	15	11 200	○	○	○	○	○		
	NS20CL	28	42	47.2	57.8	20	10 600	○	○	○	○	○		
	NS20AL	28	42	65.2	75.8	20	15 600	○	○	○				
	NS20JM	28	59	47.2	57.8	20	10 600	○	○	○	○	○		
	NS20EM	28	59	65.2	75.8	20	15 600	○	○	○				
	NS25CL	33	48	59.6	70.2	23	17 700	○	○	○	○	○		
	NS25AL	33	48	81.6	92.2	23	26 100	○	○	○	○	○		
	NS25JM	33	73	59.6	70.2	23	17 700	○	○	○	○	○		
	NS25EM	33	73	81.6	92.2	23	26 100	○	○	○	○	○		
	NS30CL	42	60	67.4	79.4	28	24 700	○	○	○	○*	○		
	NS30AL	42	60	96.4	108.4	28	38 000	○	○	○	○*	○		
	NS30JM	42	90	67.4	79.4	28	24 700	○	○	○	○*	○		
	NS30EM	42	90	96.4	108.4	28	38 000	○	○	○	○*	○		
	NS35CL	48	70	77	90	34	34 500	○		○		○		
	NS35AL	48	70	108	121	34	52 500	○		○		○		
	NS35JM	48	100	77	90	34	34 500	○		○		○		
	NS35EM	48	100	108	121	34	52 500	○		○		○		
LW	LW17EL	17	60	51.4	61.6	33	5 600	○		○	○*	○		
	LW21EL	21	68	58.8	71.4	37	6 450	○		○	○*	○		
	LW27EL	27	80	74	86.6	42	12 800	○		○	○	○		
	LW35EL	35	120	108	123	69	33 000	○		○		○		
	LW50EL	50	162	140.6	155.6	90	61 500	○		○				
PU	PU05TR	6	12	19.4	24.4	5	520	○		○				
	PU07AR	8	17	23.4	29.4	7	1 090	○		○				
	PU09TR	10	20	30	36.4	9	1 490	○		○		○		
	PU09UR	10	20	41	47.4	9	2 100	○		○		○		
	PU12TR	13	27	35	42	12	2 830	○		○		○		
	PU12UR	13	27	48.7	55.7	12	4 000	○		○		○		
	PU15AL	16	32	43	51.2	15	5 550	○		○		○		
LU	PU15BL	16	32	61	69.2	15	8 100	○		○		○		
	LU05TL	6	12	18	24.4	5	545	○		○				
	LU07AL	8	17	20.4	29.4	7	1 090	○		○				
	LU09AL,TL	10	20	26.8	34.2	9	1 760	○	○	○	○	○		
	LU09AR,TR	10	20	30	36.4	9	1 490	○		○		○		
	LU09BL,UL	10	20	41	47.4	9	2 600	○	○	○		○		
	LU12AL,TL	13	27	34	41	12	2 830	○	○	○	○	○		
	LU12AR,TR	13	27	35.2	42.2	12	2 830	○		○		○		
	LU12BL,UL	13	27	47.5	54.5	12	4 000	○	○	○	○	○		
	LU15AL	16	32	43.6	51.8	15	5 550	○	○	○	○*	○		
PE	LU15BL	16	32	61	69.2	15	8 100	○	○	○	○	○		
	PE05AR	6.5	17	24.1	28.9	10	690	○		○				
	PE07TR	9	25	31.1	37.1	14	1 580	○		○				
	PE09TR	12	30	39.8	46.8	18	3 000	○		○		○		
	PE09UR	12	30	51.2	58.2	18	4 000	○		○				
	PE12AR	14	40	45	53	24	4 350	○		○		○		
	PE12BR	14	40	60	68	24	5 800	○		○		○		
	PE15AR	16	60	56.6	66.2	42	7 600	○		○		○		
LE	PE15BR	16	60	76	85.6	42	10 300	○		○		○		
	LE05CL	6.5	17	20	-	10	595	○		○				
	LE05AL	6.5	17	24	-	10	725	○		○				
	LE07SL	9	25	22.4	28.4	14	980	○		○				
	LE07TL	9	25	31	37	14	1 580	○	○	○	○*			
	LE07UL	9	25	42	48	14	2 180	○	○	○	○*			
	LE09CL,SL	12	30	26.4	33.4	18	1 860	○	○	○	○*	○		
	LE09AL,TL	12	30	39	46	18	3 000	○	○	○	○*			
	LE09AR,TR	12	30	39.8	46.8	18	3 000	○		○		○		
	LE09BL,UL	12	30	50.4	57.4	18	4 000	○	○	○	○*	○		
	LE12CL	14	40	30.5	38.5	24	2 700	○		○		○		
	LE12AL	14	40	44	52	24	4 350	○	○	○	○	○		
	LE12AR	14	40	45	53	24	4 350	○		○		○		
	LE12BL	14	40	59	67	24	5 800	○	○	○	○	○		
	LE15CL	16	60	41.4	51	42	5 000	○		○		○		
	LE15AL	16	60	55	64.6	42	7 600	○	○	○	○	○		
	LE15AR	16	60	56.6	66.2	42	7 600	○		○		○		
	LE15BL	16	60	74.4	84	42	10 300	○	○	○	○	○		
	LH	LH08AN	11	16	24	31	8	1 240	○		○			
		LH10AN	13	20	31	40	10	2 250	○		○			
LH12AN		20	27	45	54	12	5 650	○	○	○	○*	○		

1. Corrosion-resistant Ball Screws and NSK Linear Guide™
(Fluoride Low-temperature Chrome Plating)

Ball screws and NSK linear guides are used in various applications and environments, such as industrial machinery, semiconductor and LCD manufacturing equipment, and aerospace equipment. A major concern in these settings is preventing rust which may occur during wet processing in manufacturing equipment utilizing chemicals, particularly machines that use water, such as washing machines and machines used in various manufacturing stages of semiconductors and LCDs.

NSK applies, with successful results, a fluoro-resin coating as a surface treatment on electrolytic anti-rust black film (fluoride low-temperature chrome plating) as the optimal rust prevention coating for linear guides and ball screws in such machines and equipment.



Fluoride Low-temperature Chrome Plating Processing

Electrolytic rust-resistant black plating + fluoro-resin coating

- Black plating: treated to form a stable thin film (1-2 μm), which is a form of black chrome galvanization
- Fluoro-resin coating is applied to this film to enhance corrosion resistance
- The low-temperature treatment with no hydrogen brittleness enables stable, accurate control
- The thin-film and high corrosion-resistance properties reduce factors that might adversely affect the accuracy of parts
- Outstanding durability on rolling surfaces, compared with other surface treatments
- More economical than other surface-treated or stainless steel products

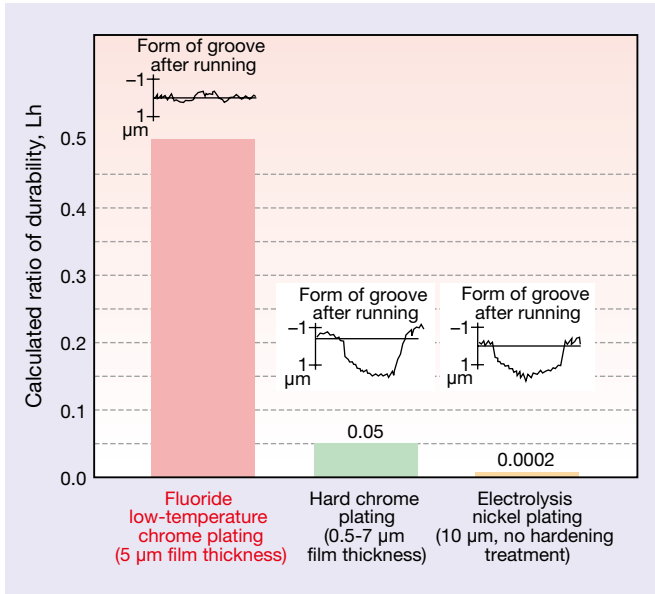
Note: Avoid using organic solvents, which may degrade the treatment's rust prevention properties.

Test results of corrosion resistance to humidity

Sample		Fluoride low-temperature chrome plating	Hard chrome plating	Electrolysis nickel plating	SUS440C	Standard product
Characteristics						
Rust condition	Upper face	(Grinding) B	(Grinding) B	(Grinding) A	(Grinding) C	(Grinding) D
	Side face	(Grinding) A	(Grinding) A	(Grinding) A	(Grinding) C	(Grinding) E
	Bottom face	(Grinding) A	(Grinding) A	(Grinding) A	(Grinding) C	(Grinding) E
	End face	(Cutting) A	(Cutting) C	(Cutting) A	(Cutting) C	(Cutting) E
	Chamfer, Grinding off	(Drawing) A	(Drawing) D	(Drawing) A	(Drawing) C	(Drawing) E
Rust prevention	Test conditions <ul style="list-style-type: none">● Testing machine: Dabaiespeck high-temperature and high-humidity vessel● Temperature: 70°C● Relative humidity: 95%● Time: 96 hours					
	To/From the setting condition of temperature and humidity <ul style="list-style-type: none">Rise time: 5 hoursFall time: 2 hours					
Film thickness		5 μm	0.5-7 μm	10 μm	—	—

Rust condition A: No rust B: No rust, but slight discoloration C: Spot rust D: Slightly rusted E: Completely rusted

Surface treatment durability test results for linear guides



Comprehensive evaluation

	Available length	Rust-resistant capability	Quality stability	Durability	Cost
Fluoride low-temperature chrome plating	◎ (4 m)	◎	○	◎	Low
Hard chrome plating	△ (2 m)	○	×	△	High
Electrolysis nickel plating	◎ (4 m)	◎	△	×	High
SUS440C	○ (3.5 m)	○	◎	◎	High

◎ : Superior
△ : Not as good
○ : No problem for use
× : Problem—restricted use

Test results of corrosion resistance to chemical exposure

Test conditions—Base material of rail: equivalent to SUS440C
Concentration of chemical: 1 normal (1N)

Fluoride low-temperature chrome plating	Soaking/Vapor	Hard chrome plating	No surface treatment
	24-hour soaking Nitric acid		
	24-hour soaking Hydrofluoric acid		
	72-hour vapor Hydrochloric cleansing liquid HCl : H ₂ O ₂ : H ₂ O = 1 : 1 : 8		
○	Hydrochloric liquid (soaking)	○	▲
○	Sulfuric acid (soaking)	○	×
○	Ammonia or sodium hydroxide	○	△

○ : No damage △ : Partial damage to surface ▲ : Damage to entire surface × : Corrosion exists

2. LG2/LGU Clean Greases

NSK LG2/LGU clean greases are recommended for products used in clean rooms, including products with low-dust specifications: NSK's linear guides, ball screws, monocarriers, XY modules, megatorque motors, and XY tables. LG2/LGU clean greases exhibit low-dust and corrosion-resistant properties among other outstanding characteristics, in contrast to fluorine greases conventionally used in clean rooms. They are highly regarded among manufacturers of semiconductor production equipment.



Features of NSK Clean Greases

- Low-dust characteristics that outperform fluorine greases
- Low torque—less than 20% of that of fluorine greases
- Over ten times more durable than fluorine greases
- Superior rust prevention compared to fluorine greases

Note: LG2/LGU clean greases are for use in normal atmosphere only.
Fluorine greases or other NSK greases are recommended for vacuum applications.

● Properties of grease

Operating environment	For use in normal atmosphere only		From normal atmosphere up to vacuum
Product	LG2	LGU	Commercially available fluorine grease K
Base oil	Mineral oil and synthetic hydrocarbon oil	Synthetic hydrocarbon oil	Fluorine oil
Thickener	Lithium soap	Diurea	PTFE
Kinematic viscosity (mm²/s, 40°C)	32	95.8	270
Consistency	199	201	280 ± 15
Maximum operating temperature, °C	up to 70	up to 120	up to 200

- LG2 and LGU are NSK-developed greases.
- LGU grease is free of metallic elements.

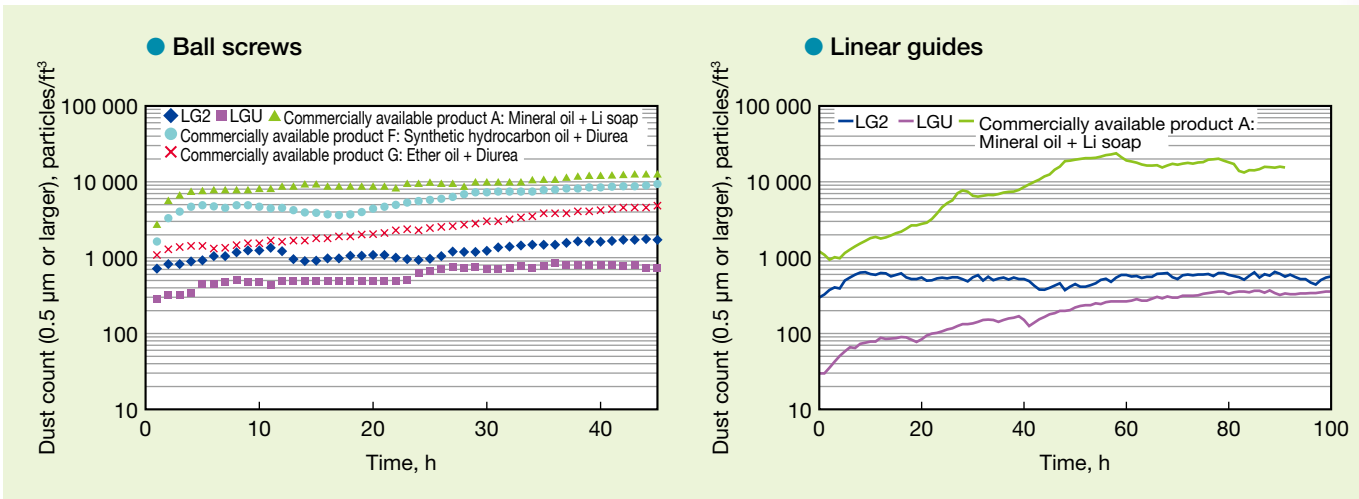
● Comprehensive evaluation

Characteristics	LG2/LGU	Fluorine grease	Ordinary grease
Low partide emission	○	○/△	△/×
Torque	○	×	○/△
Durability	○	△/×	○
Rust prevention	○	△/×	○

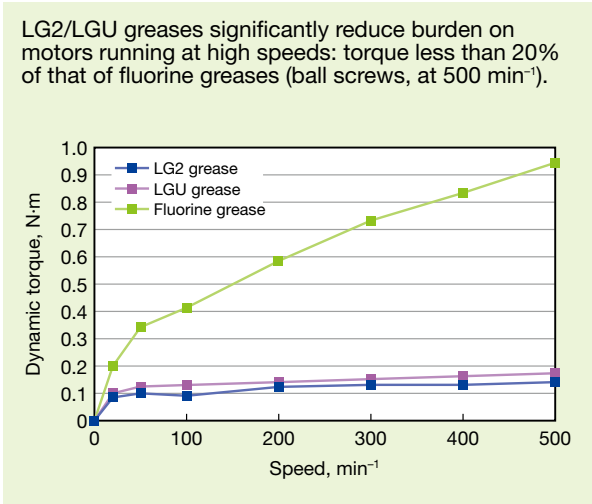
○: Excellent △: Poor ×: Not recommended

● Properties of grease

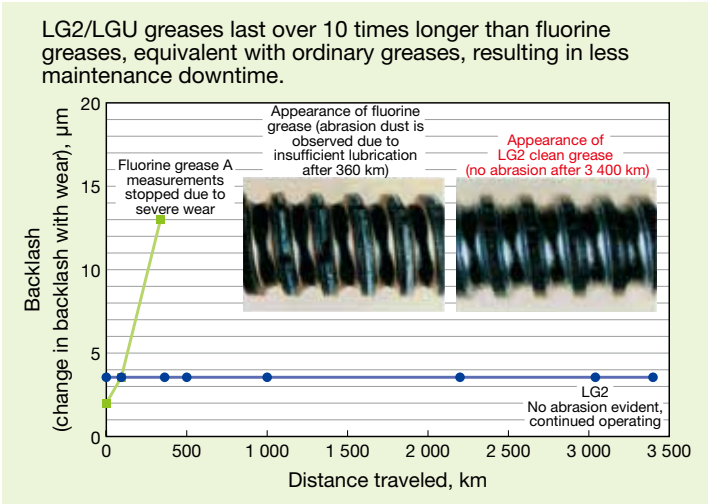
LG2/LGU greases offer stable low-dust characteristics over a longer period of time compared to fluorine greases.



● Stable low-torque characteristics



● Long life



● Superior rust prevention

NSK clean greases have high rust-prevention capability providing high reliability.



3. NSK Clean Lubricant E-DFO

NSK clean lubricant E-DFO forms a hydrocarbon oil film directly on raceway surfaces of ball screws, linear guides and balls, resulting in lower particle emissions and outgassing, and a longer life than that of existing fluororesin coating or solid lubrication in vacuum environments.

E-DFO treatment technology by NSK is the first in the world to provide special lubrication coating to rolling surfaces (patent pending).

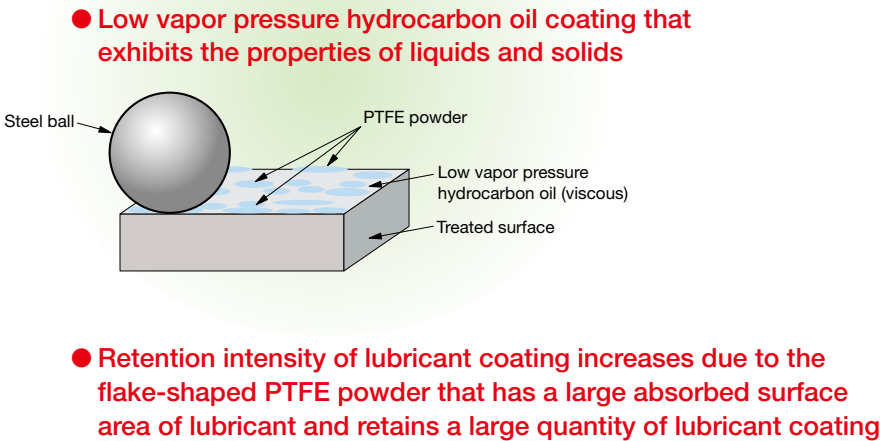
Features of Clean Lubricant E-DFO

E-DFO lubricant coating: Thin lubricant film technology for low vapor pressure oil and absorbed substance holds its lubrication coating well.

- Low particle emissions and superior outgassing properties compared to conventional fluororesin-coated products and solid lubricant products
- Far more durable than fluororesin-coated products



● Structural illustration of E-DFO lubricant coating



- Notes:**
- E-DFO coating:** E-DFO coating is a clear, colorless, low vapor pressure hydrocarbon-based, semi-dry coating that is viscous on the surface.
- To open and handle the product:** Open the package immediately before use in a clean space with the lowest possible humidity (less than 60%). Handle with gloves for clean rooms. Do not touch the product with bare hands.
 - To store:** Store the product in a clean dry container such as a desiccator or vacuum chamber when not being used for a long period of time, or if not used immediately after opening. Do not use slushing oil or anti-tarnish paper on the product.
 - Do not clean:** E-DFO coated products do not require cleaning. Do not clean or wipe the coating on the rolling surface—this will directly affect the lubricating function.
 - Do not apply new lubricant:** E-DFO coated ball screws and linear guides do not require additional lubricant. Do not use NSK K1 lubrication unit, which will degrade E-DFO's lubricating property.
 - Installation position:** When using ball screws and linear guides vertically, an oil receiver is required under the screw shafts and rails as the E-DFO coating may drop.

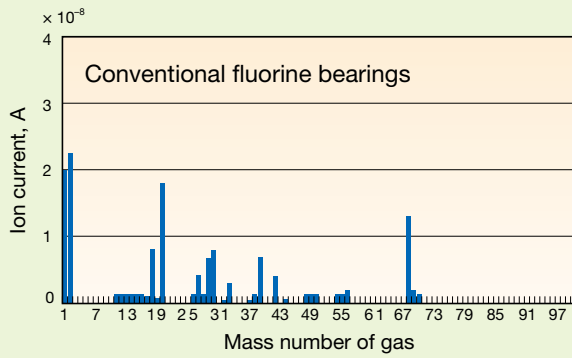
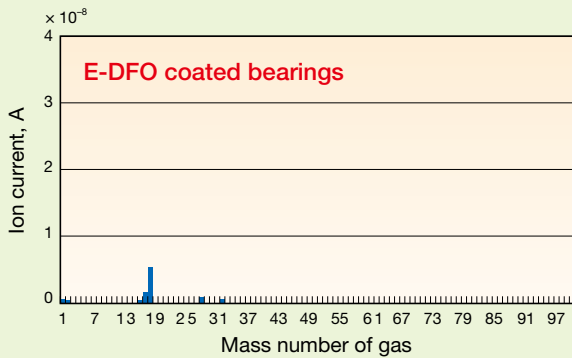
● Comprehensive evaluation

Lubricant	Performance			Compatible operating environment		
	Durability	Particle emissions	Outgassing	Operating environment	Ball screws	Linear guides
E-DFO	○	○	◎	Normal atmosphere, vacuum	●	●
Fluororesin	△	△	○	Normal atmosphere, vacuum	—	—
MoS ₂	○	△/○	○	Normal atmosphere, vacuum	●	●
Commercially available fluorine grease	◎	◎	△	Normal atmosphere, vacuum	●	●

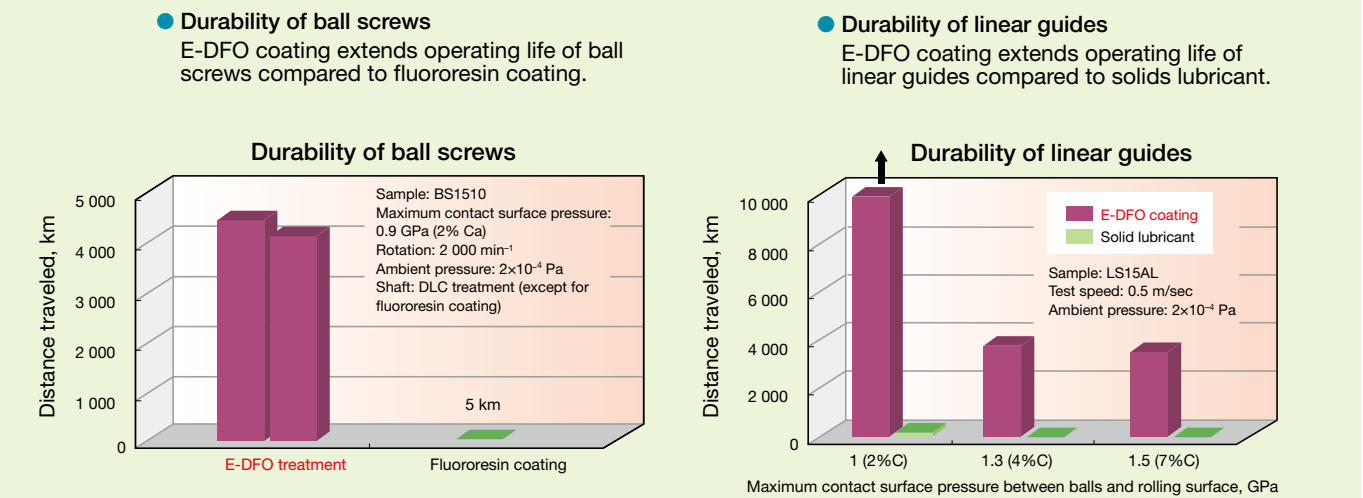
◎: Excellent ○: Good △: Satisfactory ●: Applicable

● Low outgassing properties

- Outgassing property in high-temperature environments (measurement example with bearings)
Outperforms conventional fluorine-coated bearings.



● Long life



4. Clean Environment Correspondence Standard Ball Screw
Compact FA Series USS type for High-Accuracy and Clean Uses

Ideal for semiconductor manufacturing equipment, LCD manufacturing equipment, inspection equipment etc., precision series with a clean function



Applications

Clean uses for semiconductor manufacturing equipment, LCD manufacturing equipment, inspection equipment etc.

Specifications

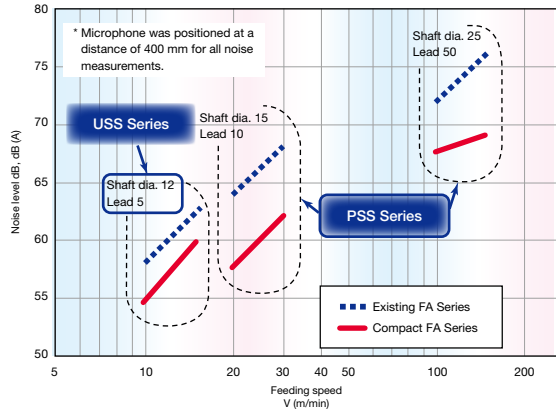
- Accuracy grade : C3 grade of JIS
- Axial play : 0 (Oversize ball preload)

Features of USS Type

- High-speed, low-noise and compact ... Used with the end-deflector recirculation system, high-speed, low-noise and compact
- Low-dust emissions Dust particles are reduced by 90% compared to general lithium grease because NSK LG2 clean grease is used as the standard.

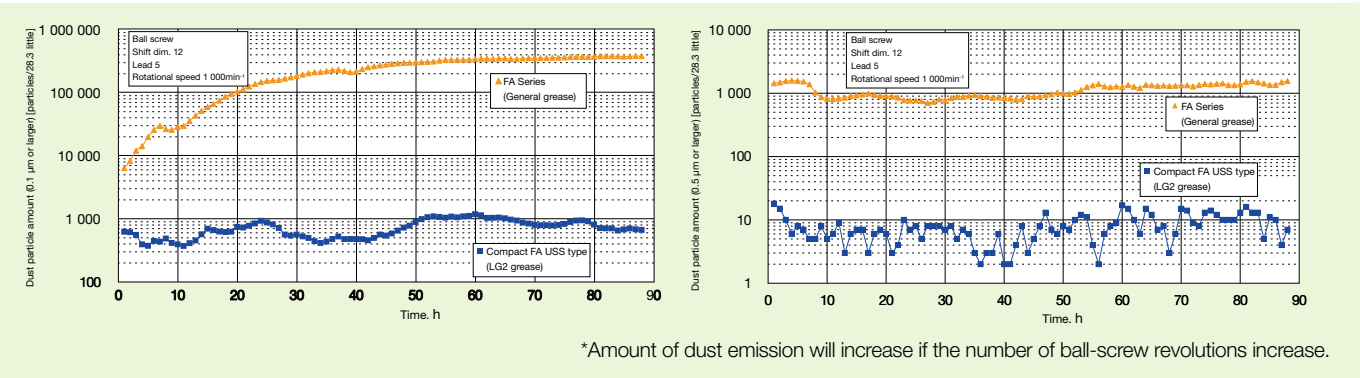
Low-noise

Used with the end-deflector recirculation system. Noise is reduced by 6 dB compared to the tube recirculation system. Vibrations are reduced as well.

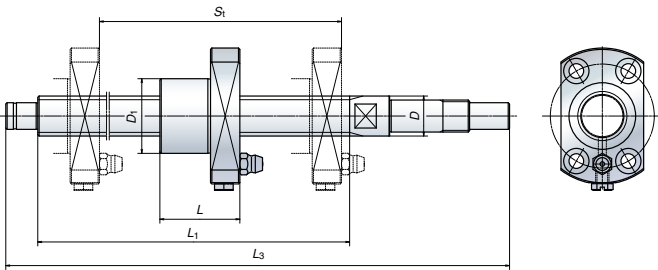
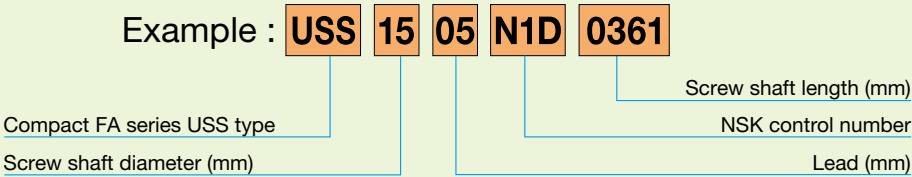


Low-dust emissions (Series comparison)

Compared to the finished shaft end FA type with a general lithium-based grease, dust count of USS type adopting NSK clean grease LG2 is approximately 1/100



Compact FA series USS type reference number



Dimension table

Reference no.	Screw shaft dia. <i>d</i>	Lead <i>l</i>	Basic load ratings (N)		Stroke St		Nut dimensions		Screw shaft dimensions		Lead accuracy			Dynamic preload torque ^{*1} (N·cm)	Permissible rotational speed (min ⁻¹) ^{*2} Fixed-Simple
			Dynamic	Static			Diameter	Overall length	Threaded length	Shaft length	Travel compensation	Deviation	Variation		
					<i>C</i> _a	<i>C</i> _{0a}									
USS1005N1D0221	10	5	2 930	4 790	100	133	23	29	162	221	0	0.010	0.008	0.2 ~ 1.8	5 000
USS1005N1D0321					200	233			262	321		0.012	0.008	0.2 ~ 2.0	
USS1005N1D0521					400	433			462	521		0.015	0.010	0.2 ~ 3.0	
USS1205N1D0221	12		3 200	5 860	100	130	24	30	160	221		0.010	0.008	0.2 ~ 1.8	
USS1205N1D0321					200	230			260	321		0.012	0.008	0.2 ~ 2.0	
USS1205N1D0621					500	530			560	621		0.016	0.012	0.2 ~ 3.0	
USS1505N1D0261	15		5 460	10 200	100	159	28	30	189	261		0.010	0.008	0.2 ~ 5.0	4 130
USS1505N1D0361					200	259			289	361		0.012	0.008	0.2 ~ 5.0	
USS1505N1D0561					400	459			489	561		0.015	0.010	0.2 ~ 6.0	
USS1505N1D0761					600	653			689	761		0.018	0.013	0.2 ~ 6.0	

*1. Indicates ball screw preload control value. Approximately 0.5 N·cm of torque is added due to thin plastic seals.
*2. Contact NSK if permissible rotational speed is to be exceeded.

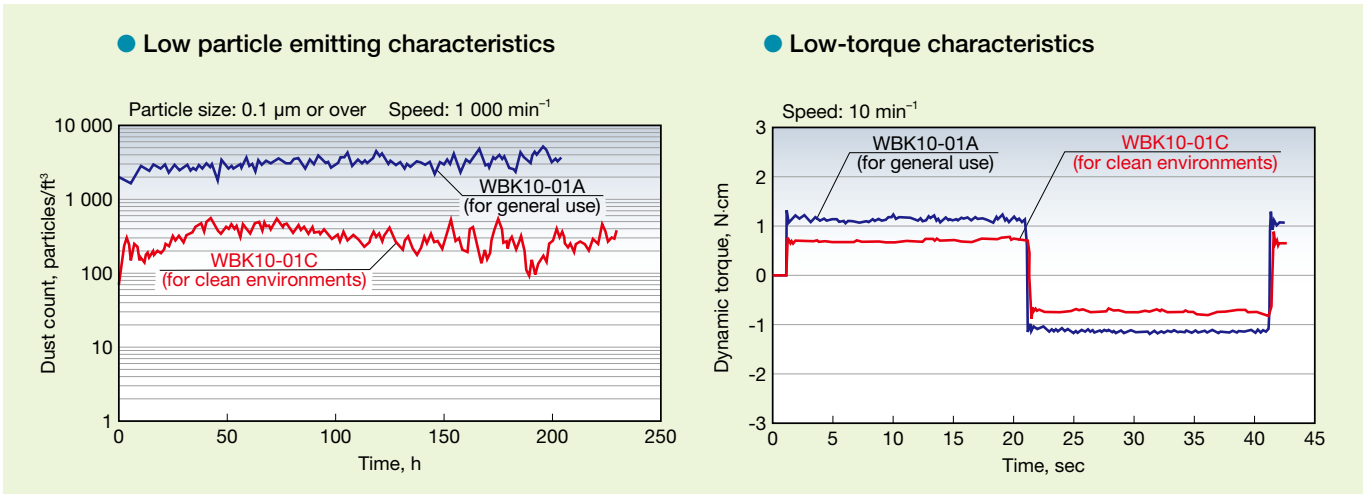
Precautions for use Temperature range for use : 0 - 80°C

5. Support Units for Clean Environments

NSK has developed support units for ball screws used in clean environments. They come equipped with all required parts, such as bearing locknuts to be mounted directly to NSK standard ball screws, of which shaft ends are machined. Please refer to the table of dimensions of standard screw shaft ends for NSK standard ball screws with blank shaft ends.

Features of Clean Support Unit

- Extremely low particle emissions Uses LG2 clean grease, which has a proven feature of low particle emissions
Particle emissions are 1/10 of general support units
- Low torque Features low-torque characteristics of special bearings
(50% lower than general support unit)
- High rust prevention Low-temperature chrome plating is applied for housing surfaces and stainless steel is applied for small parts



Coding of reference numbers

Example: **WBK 08 S - 01 C**

Product code for support unit

Nominal size code (internal bore of bearing)*

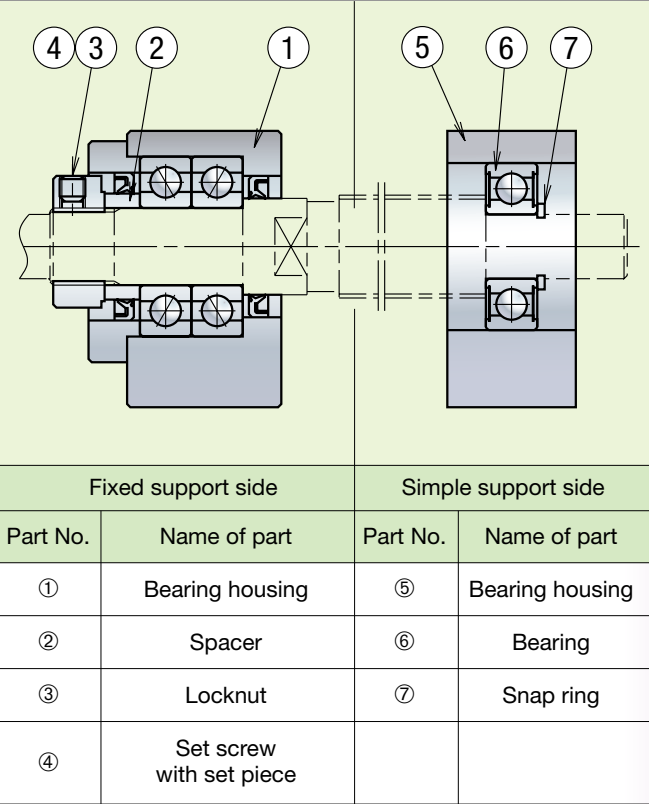
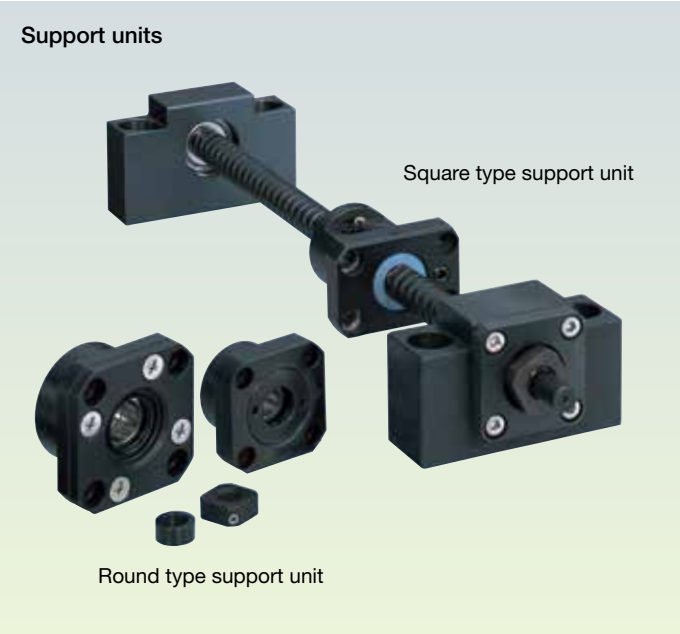
Mounting code
No code: Fixed support unit
S: Simple support unit

C: For clean environments

01: Square type
11: Round type

* For simple support units, please note that size codes of 12 or less do not represent internal bores of bearing.

Structure



- Two types are available: the square floor-mounted type for surface mounting; and the round type inserted into a hole.
- While the square type consists of a fixed support side unit (motor side) for the ball screw shaft and the opposing simple support side, the round type has no simple support side housing.

Bearing type, grease, housing surface treatment, and small parts material

Bearing, grease	Surface treatment	Set screw and snap ring material
Special bearings, LG2	Low-temperature chrome plating	Stainless steel

Specifications

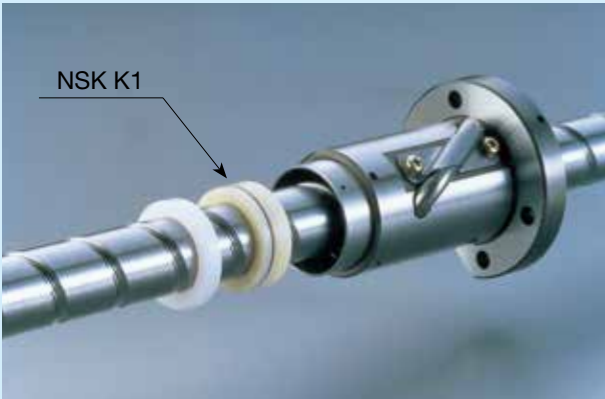
Reference No.	Fixed support side unit				Simple support side support unit		
	Axial direction			Maximum starting torque (N·cm)	Reference No.	Bearing Reference No.	Radial direction
	Basic dynamic load rating C _a (N)	Load limit (N)	Stiffness (N/μm)				Basic dynamic load rating C (N)
WBK08-01C (square) WBK08-11C (round)	3 100	1 100	36	0.52	WBK08S-01C	606VV	2 260
WBK10-01C (square) WBK10-11C (round)	4 250	1 364	50	1.1	WBK10S-01C	608VV	3 300
WBK12-01C (square) WBK12-11C (round)	4 700	2 443	57	1.2	WBK12S-01C	6000VV	4 550
WBK15-01C (square) WBK15-11C (round)	5 100	2 757	63	1.3	WBK15S-01C	6002VV	5 600

6. Lubrication Unit “NSK K1™”

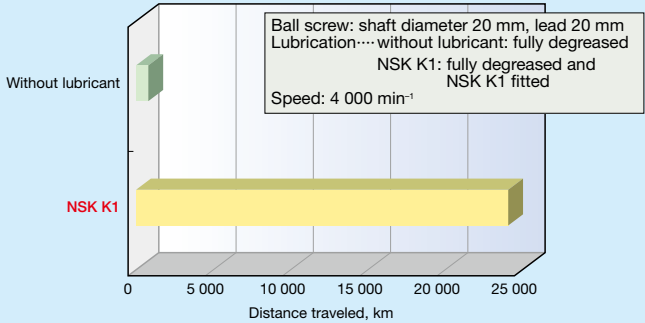
(1) Ball screws and linear guides, equipped with NSK K1™ for general industry

NSK has developed the maintenance-free ball screws and linear guides with the newly-developed NSK K1 lubrication unit. (NSK K1 lubrication unit for food processing equipment and medical devices is also available. See pages B25–B26.)

Features of Ball Screws



Durability tests without lubricant
The linear guide without lubricant was damaged after operating over a distance of 8.6 km, but the equipped with NSK K1 operated for more than 20 000 km.



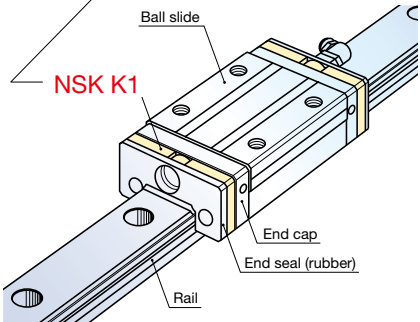
Note: The range of operating temperatures and chemicals to avoid contact with are the same as for the aforementioned linear guides.

Features of NSK Linear Guide™

- NSK linear guides equipped with the NSK K1 lubrication unit enhances lubrication
- The newly developed porous synthetic resin contains ample lubricant to ensure extended maintenance-free performance
- Easy installation: mounts to the inside of the standard-end seal (rubber)



- Notes:**
To maintain optimal performance of NSK K1 for extended use, please follow the instructions below:
- Range of operating temperatures · Maximum operating temperature: 50°C
Maximum instantaneous operating temperature: 80°C
 - Chemicals to avoid contact with ... Organic solvents with degreasing properties, such as hexane and immersion in white kerosene thinner or anti-corrosive oil (containing white kerosene)

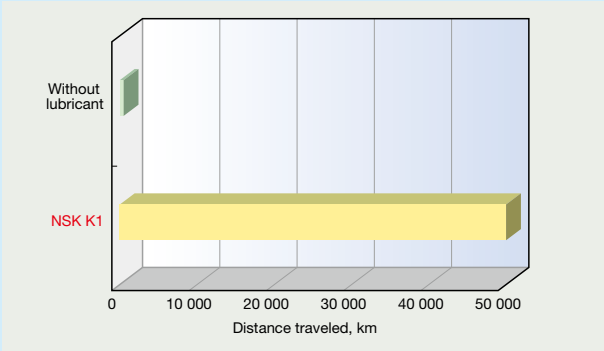


Performance of the NSK Linear Guides

Durability test without lubricant

The linear guide without lubricant was damaged after a short period of use, but the equipped with NSK K1 covered a distance exceeding 50 000 km.

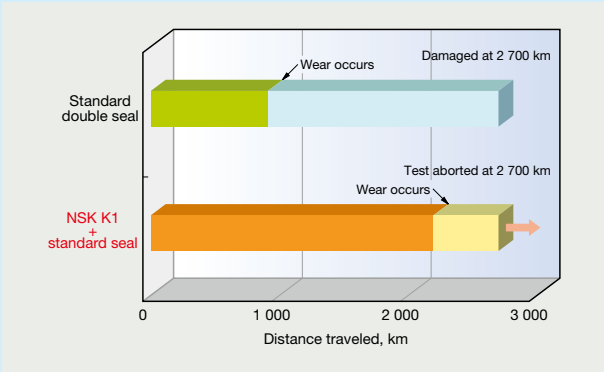
Conditions
 Linear guide: LH30AN (preload Z1)
 Lubrication... without lubricant: fully degreased
 NSK K1: fully degreased and NSK K1 fitted
 Speed: 60 m/min



Water-immersion test

In a water-immersion test run once a week for 24 hour intervals, the ball groove of a linear guide fitted with standard double seals quickly showed wear and damage at 2 700 km. By comparison, the linear guide equipped with NSK K1 showed only 1/3 as much wear as the standard linear guides, confirming the seal's significant lubricating efficacy.

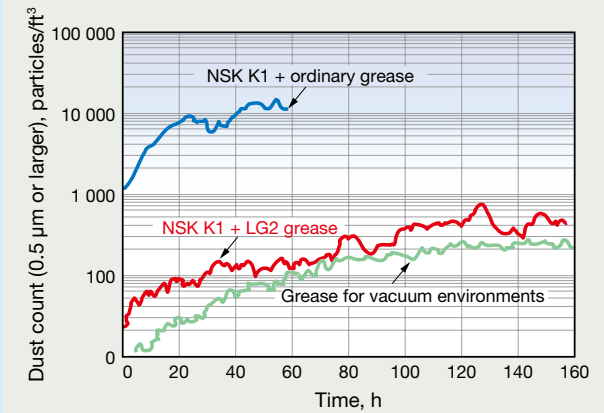
Conditions
 Linear guide: LS30 stainless steel (preload Z1)
 Water immersion: Run once a week for 24 hours, fully immersed in water
 Lubrication: Full grease-packing for food processing machinery
 Speed: 24 m/min



Dust characteristics

The combination of NSK K1 and LG2/LGU clean greases (low particle emission grease) produces no more dust than conventional vacuum grease.

Conditions
 Linear guide: LS20
 Speed: 36 m/min



Notes: Compatibility of NSK K1 with oils and chemicals

The table at right shows the results of a test in which NSK K1 were immersed in chemicals and oils at 40°C. NSK K1 were found to be stable when in contact with grease and cutting lubricants, and use in combination with these substances presents no problems. However, exposure to chemicals with degreasing properties, such as white kerosene and hexane, quickly removed oil content from the surface of the seals, suggesting that the lubricating effect may deteriorate under these conditions.

Chemicals/Oil	Compatibility
Cutting lubricants (water-based, oil-based)	A
Grease (mineral oil-based, ester-based)	A
Rust preventives (without solvents)	A
Rust preventives (with solvents)	B
White kerosene	B
Hexane	C

A: Compatible B: Use sparingly, for brief periods only C: Incompatible

6. Lubrication Unit “NSK K1™”

(2) Linear guides equipped with lubrication unit “NSK K1™” for food processing and medical equipment.

The NSK K1 lubrication unit for food processing and medical equipment is a phenomenal new material seal that is safe and secure. NSK K1 FDA-compliant material is used for the lubrication unit, so it is used without anxiety for food processing and medical equipment.

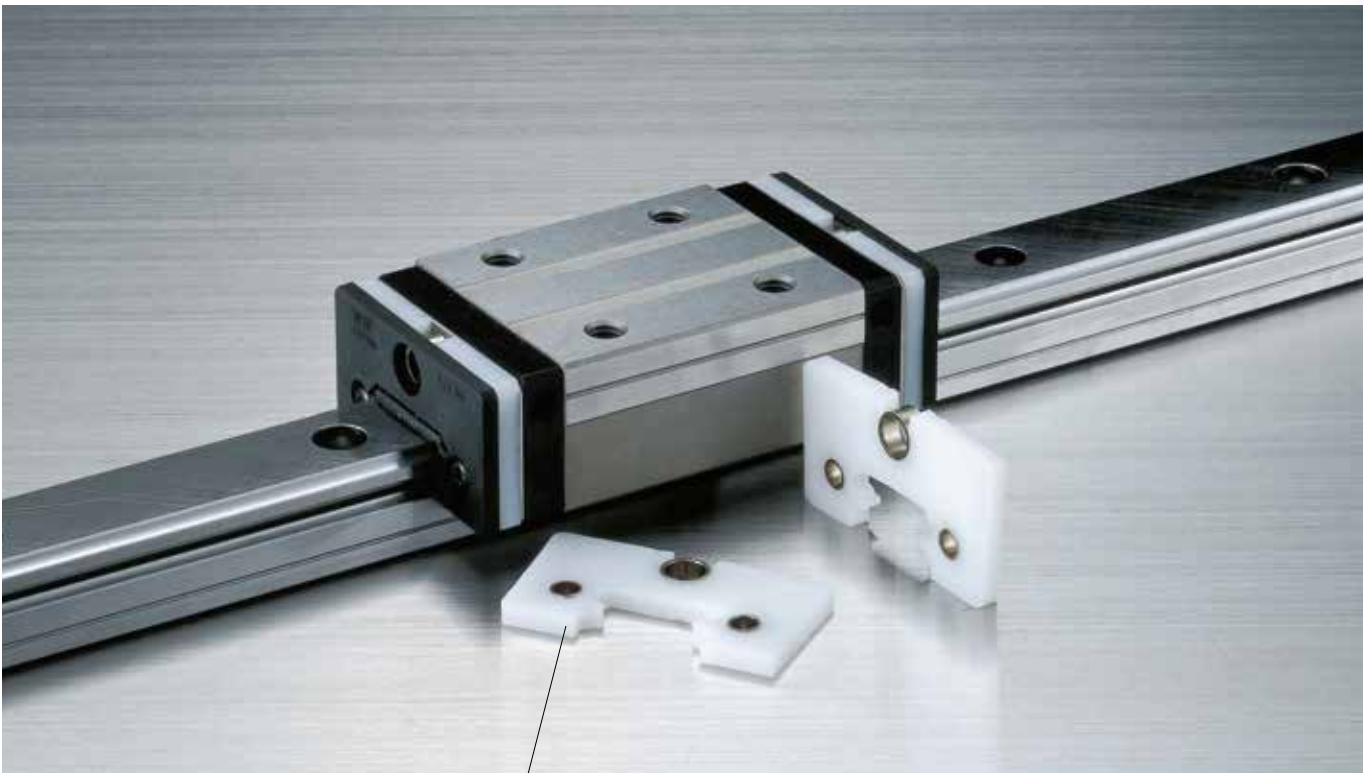
The newly developed porous synthetic resin contains abundant lubricant.

With the basic functions of highly praised NSK K1 for general industry (see pages B23–B24), more sophisticated materials make it applicable in food and medical equipment.

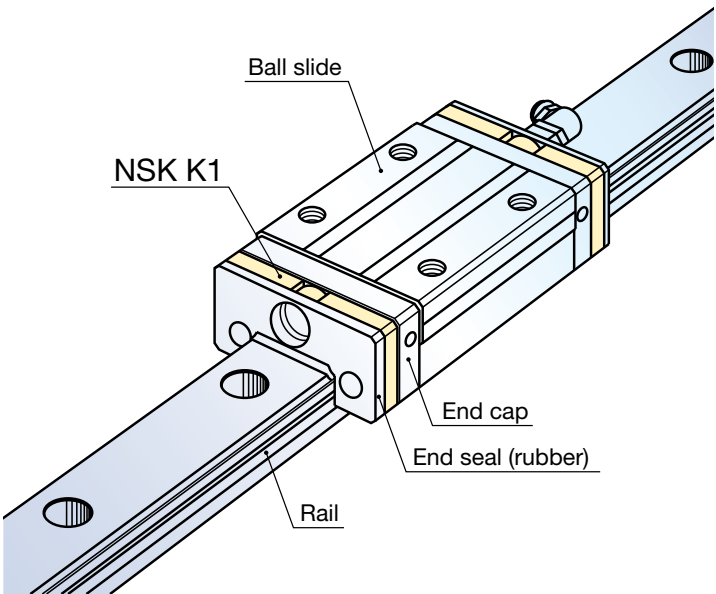
It also offers easy installation, mounted inside the standard end seal (rubber).

Features of NSK K1™ Lubrication Unit for Sanitary Environments

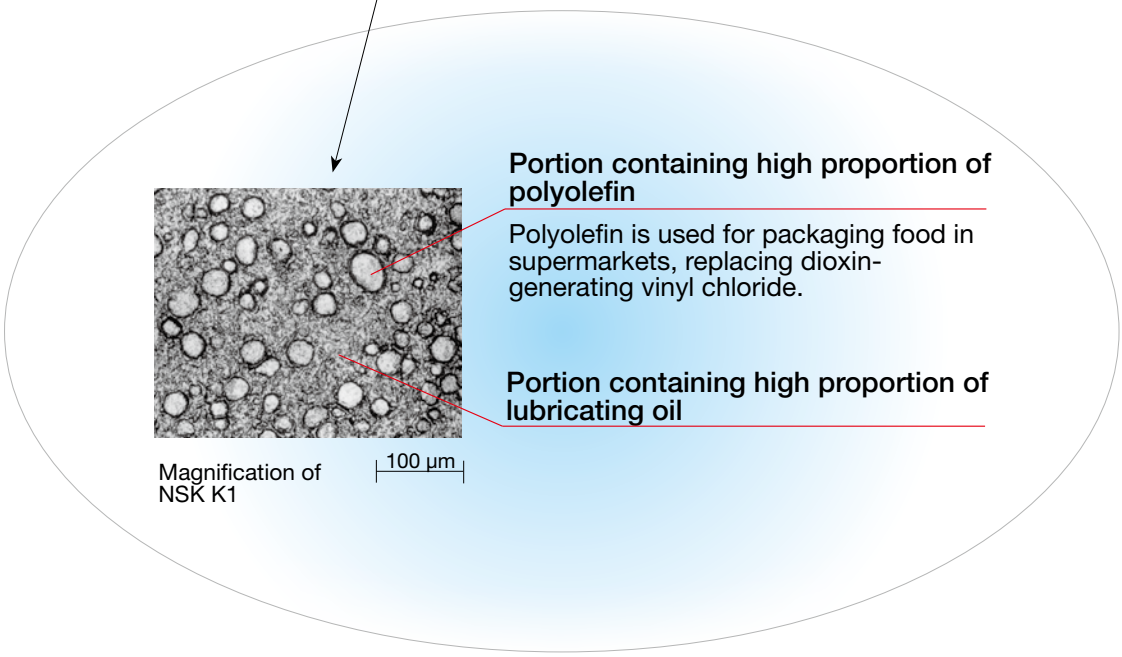
- **Very safe to handle**
Uses highly safe materials that are compliant with the US Food and Drug Administration’s (FDA) hygiene standards for food additives
- **Environmentally sound**
The newly developed porous synthetic resin provides a controlled supply of lubricant, preventing the dispersion of oil in sanitary environments
- **Resistant to harsh environments**
It is durable not only under normal environments but also under harsh environments, such as machinery submersed in water



Applying the reliable NSK K1 FDA-compliant material



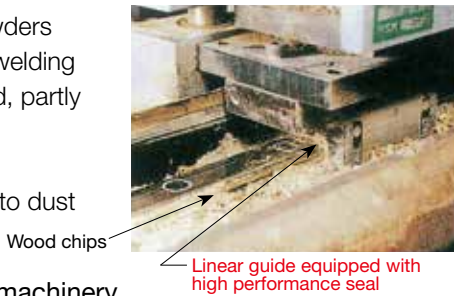
- Notes:**
To maintain optimal performance of NSK K1 over a long time, please follow the instructions below:
1. Range of operating temperatures: Maximum operating temperature: 50°C
Maximum instantaneous operating temperature: 80°C
 2. Chemicals to avoid contact with: Organic solvent with degreasing properties, such as hexane and thinner
Immersion in white kerosene or anti-corrosive oil (with white kerosene ingredients)



7. NSK High Performance Seals

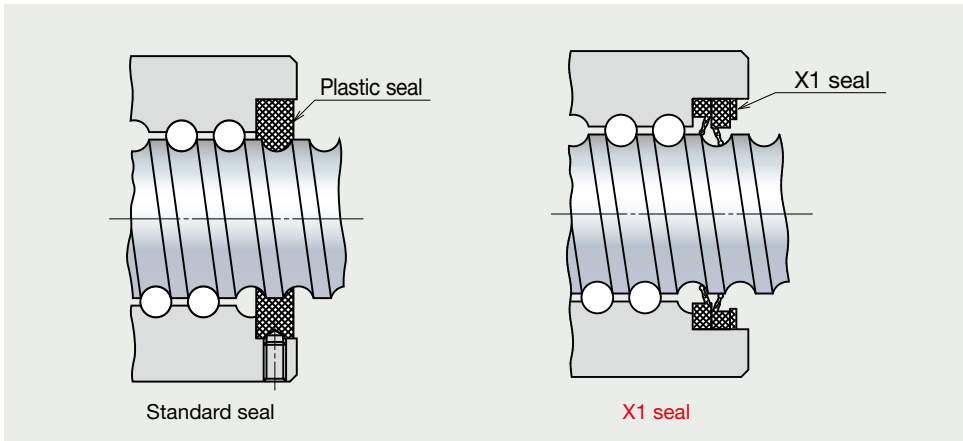
Examples of dust-contaminated environments include atmospheres where dry powders such as wood particles, rubber fragments, graphite powder, ceramic powder and welding spatter exist. In recent years, demand for dust-resistant performance has increased, partly because protective equipment for machinery is often eliminated for cost-reduction purposes. To meet this demand, NSK has developed a high performance seal more resistant to dust than conventional standard seals.

- **Applications:** Woodworking machinery (photo shown at right), tire buffing machinery, welding lines, graphite processing machinery, laser machinery



Features of Ball Screws Equipped with High Performance Seal

- **High dust-resistance** Improved sealing performance with seal design suitable for dust-resistance. Contributes to durability UP in a contaminated environment.
- **Superior grease retention**.. Ball screw with X1 seals has a double seal structure combining a dust-resistant seal and a grease-retaining seal to improve grease retention performance.
- **Low torque design** Optimized seal shape and low-friction material has been adopted to achieve low torque and low heat generation

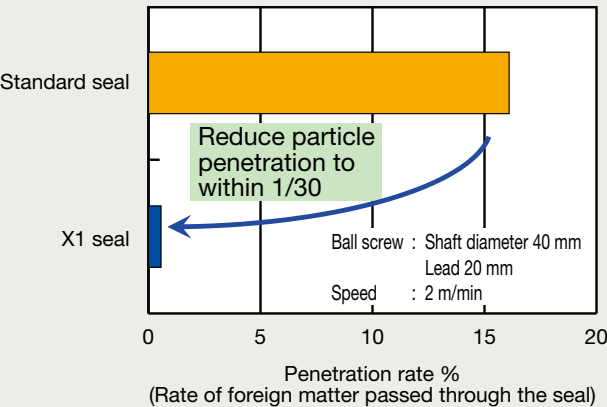


Note: Nut with X1 seal is slightly longer than the standard.

● Performance of "X1 seal" installed ball screw

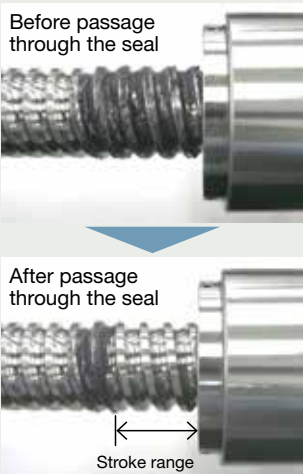
● Particle penetration rate test

Powder finer than 37- 148 μm in particle diameter, such as iron powder, was mixed with AS2 grease pasted on the screw shaft. After stroking the nut, particle penetration through the X1 seal was measured, and it was less than 1/30 of the penetration through a standard seal.



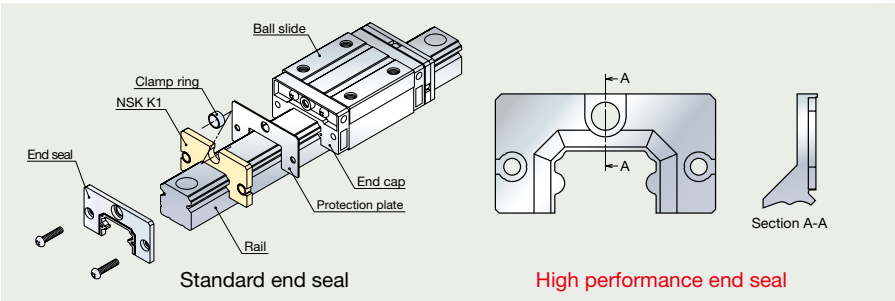
● Condition of particle penetration rate test

All contaminants adhering to the screw shaft are swept away after passage through X1 seal.



Features of Linear Guides Equipped with High Performance Seal

- **High dust-resistance** Sealed with three lips that extend from the main body of the seal
- **Long life**..... Incorporates NSK K1 lubrication unit to enhance dust-resistance and durability

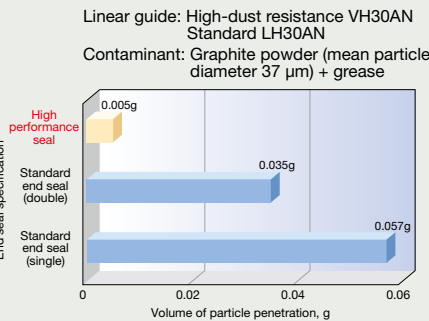


Note: Linear guides with extending seals also coming standard with the NSK K1 lubrication unit, so the length of the ball slide is slightly longer than linear guides with standard seals. (See the table below for more details.)

● Performance of linear guides equipped with high performance seal

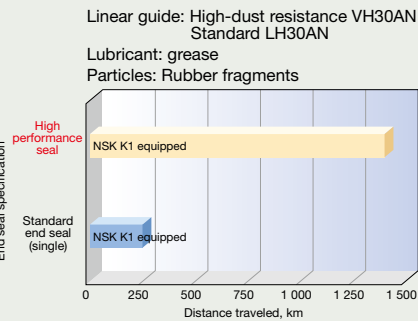
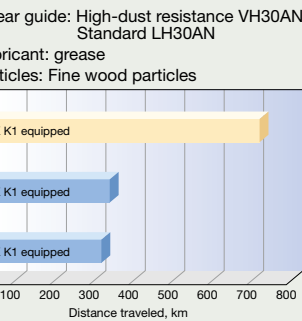
● High dust-resistance

The particle penetration through high performance seal is less than 1/10 of the penetration through a standard end seal (single).



● Long life

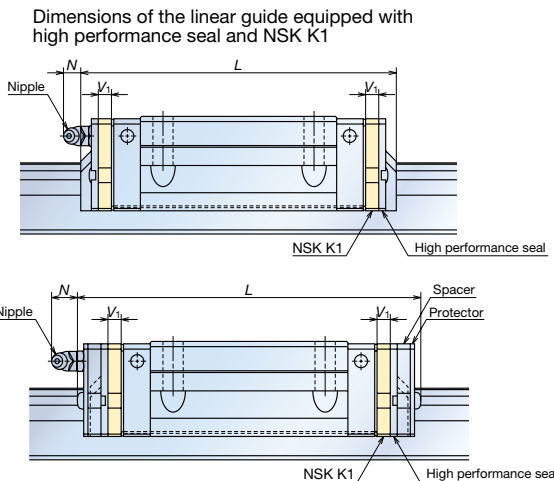
Improved dust-resistance extends the durability of high performance seal in a fine wood particles atmosphere to more than twice that of standard end seals, and more than five times longer in a rubber fragments atmosphere.



● Specifications of linear guides equipped with high performance seal

Unit: mm			
Model No.		Ball slide length L	Nipple extrusion N
VH15	AN/EM	70.6 (77)	1 (8.2)
	BN/GM	89.6 (96)	
VH20	AN/EM	87.4 (94.2)	11.1 (12.3)
	BN/GM	109.4 (116.2)	
VH25	AL/AN/EM	97 (104.4)	9.6 (12.9)
	BL/BN/GM	125 (132.4)	
VH30	AL/AN	104.4 (114.8)	11.4 (14.2)
	EM	117.4 (127.8)	
VH35	AL/AN/EM	128.8 (139.2)	10.9 (13.7)
	BL/BN/GM	162.8 (173.2)	
VH45	AL/AN/EM	161.4 (174.2)	12.5 (14.1)
	BL/BN/GM	193.4 (206.2)	
VH55	AL/AN/EM	185.4 (198.2)	12.5 (14.1)
	BL/BN/GM	223.4 (236.2)	

Dimensions in parentheses are those also equipped with protector.

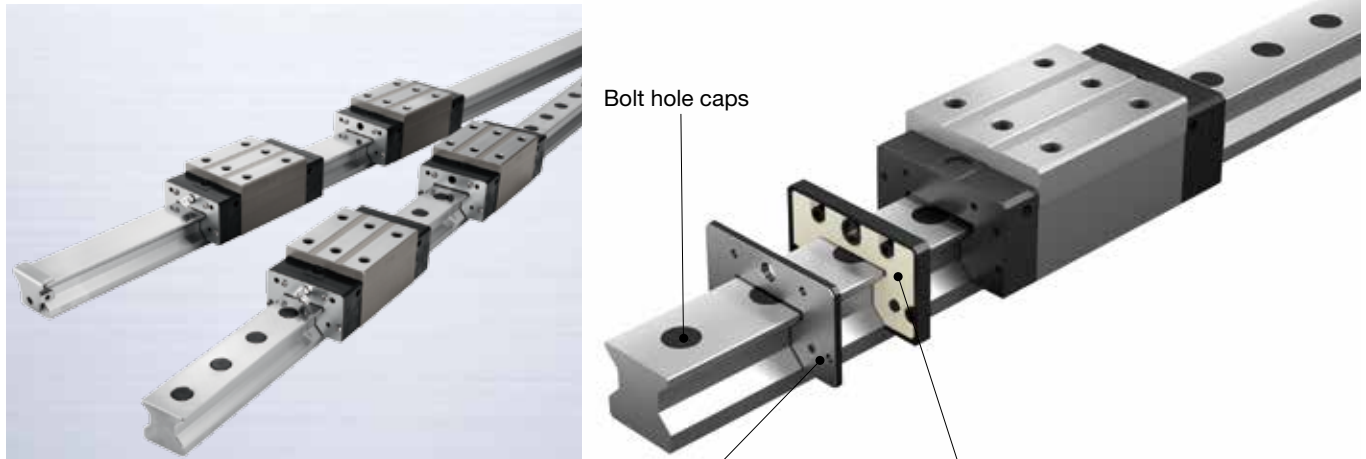


The data shown in the catalog are the results of our tests, and no warranty is given for sealing performance on actual usage on machinery. Sealing performance is affected by usage environment and lubrication conditions. Dust covers and other measures to keep machinery free of dust are recommended.

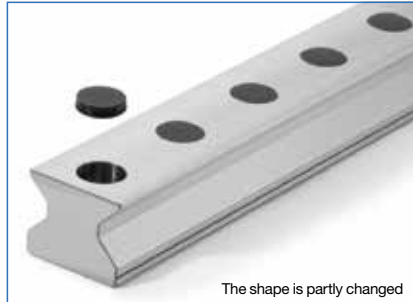
Features of Roller Guide Equipped with V1 Seal

- Best suited for machine tools** Product based on the RA Series roller guides having excellent track record in machine tool applications.
- Abrasion resistance** Adopted V1 seal made of new materials and a new shape for better abrasion resistance
- Long life**..... Outstanding lubrication effects by NSK K1 further improve durability

Roller guide equipped with V1 Seal



Bolt hole caps



These caps prevent foreign matter from building up inside the rail mounting holes. These are standard parts.

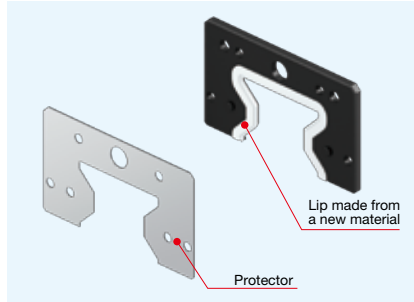
Rail cover (optional)



Covers the top surface of the rail and prevents foreign matter from entering in rail mounting bolt holes.

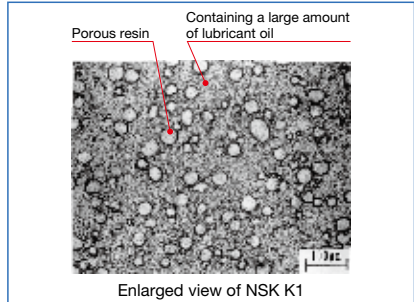
Note: Combination of V1 seal and NSK K1 are standard specifications. As V1 seal is different from a standard one, the overall slide length is slightly longer than that equipped the standard seal. (Refer to the table on page B30 for details)

V1 seal



V1 Seal made of new materials and in a new shape for better abrasion resistance prevents foreign matter getting into the roller slide for a long period.

NSK K1™ lubrication unit



Made of porous synthetic resin containing a large amount of lubrication oil. When moved through contact with the raceway surface, it supplies fresh lubricating oil.

Performance of roller guide equipped with V1 seal

Abrasion resistance
 Highly abrasion-resistant material used for seal lip

Taper abrasion test (ASTMD1044)
 Load: 9.8 N
 Average speed: 29.7 m/min,
 Approx. 40 km/day

With this new material, even if lubrication is poor, damage such as roughening of surfaces will not occur.

Durability test under extreme conditions - no lubrication
 Test sample: RA35
 Operation without lubrication on the seal
 Feed speed: 500 mm/sec

V1 Seal	Conventional end seal

Applicable range of roller guide equipped with V1 seal

Model	Roller slide model	Roller slide length L
RA35	AN/AL/EM	140.8
	BN/BL/GM	169
RA45	AN/AL/EM	173.2
	BN/BL/GM	209.2
RA55	AN/AL/EM	203.2
	BN/BL/GM	253.2

Since the sealing property (resistance to foreign matter) is affected by usage or the lubrication environment, please conduct an evaluation test for your particular application.

8. Ball Screws and NSK Linear Guide™ for High-temperature Environments

NSK has developed heat-resistant ball screws and linear guides for high-temperature environments requiring heat-resistant performance. In recent years, NSK linear guides and ball screws have been adopted in a variety of industries with such environments, including semiconductor/LCD-related plants, glassware plants and automobile assembly lines.

Features of High-temperature Linear Guides

- Maximum operating temperature:** 150°C; maximum instantaneous operating temperature: approximately 200°C (Standard series: 80°C; maximum instantaneous operating temperature: approximately 100°C)
- Heat-resistant bellows:** When combined with special purpose heat-resistant bellows, the linear guides can be used in environments where high-temperature particles, such as welding spatter, are dispersed
- All-stainless steel specification:** The all-stainless steel products are excellent at resisting not only heat, but corrosion and chemicals as well. They are also applicable in vacuum environments

- Applicable series and sizes of high-temperature linear guides**

The scope of applications of NSK high-temperature linear guides is shown below.
 Other series and model numbers not listed are also available upon request. Please contact NSK.

Applicable series	Size symbols*	
	Standard material specification	All-stainless steel specification (except for seals)
NH (high load capacity/aligning)	20, 25, 30, 35, 45, 55	20, 25, 30
NS (compact low type)	15, 20, 25, 30	15, 20, 25, 30
LW (broad type)	17, 21, 27	—
LU (miniature)	09, 12, 15	09, 12, 15
LE (miniature broad type)	—	09, 12, 15

Note: *Example of a basic symbol NH 20

Series

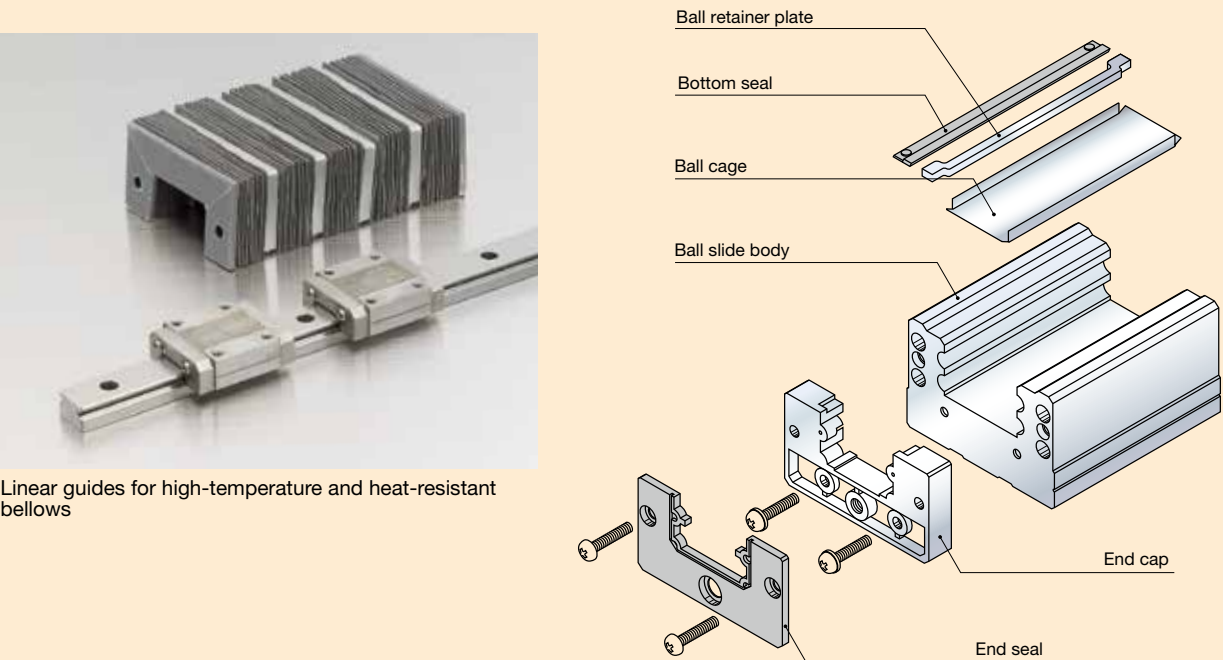
Size symbol

.....Indicates the rail width or assembly height.

For details, see NSK Catalog, Precision Machine Components (CAT. No.E3162)

- Structure of high-temperature linear guides**

Special high-carbon steel with excellent rolling durability or martensite stainless steel featuring high cleanliness are adopted for rails, ball slides and balls. Fluororubber with excellent heat resistance and chemical resistance is used for the seal, and austenite stainless steel with excellent corrosion resistance is used for other components.



- Materials used for components of linear guides for high temperatures**

Linear guide component	Material specification
Rail, ball slide	Martensite stainless steel
Ball	SUS440C
End cap, recirculation components of cage, small screws	Austenite stainless steel
Seal component	Fluororubber, etc.

Features of High-temperature Ball Screws

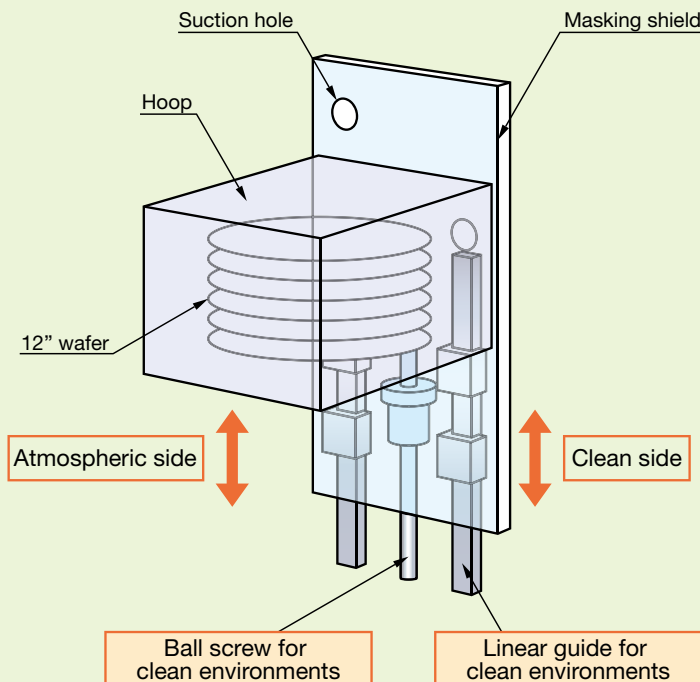
- Maximum operating temperature:** 150°C; maximum instantaneous operating temperature: approximately 200°C

- Materials used for components of ball screws for high temperatures**

Ball screw component	Material specification
Shaft, nut	Martensite stainless steel
Ball	SUS440C
Recirculation components	Austenite stainless steel

1. Semiconductor Manufacturing Equipment

Wafer Conveyor



Operating Conditions

Clean environments

- Cleanliness: Class 100
- Temperature: Room temperature
- Speed: 5 m/min
- Load: Pitching moment included

Feature

- Change from a commercially available vacuum grease to NSK clean grease

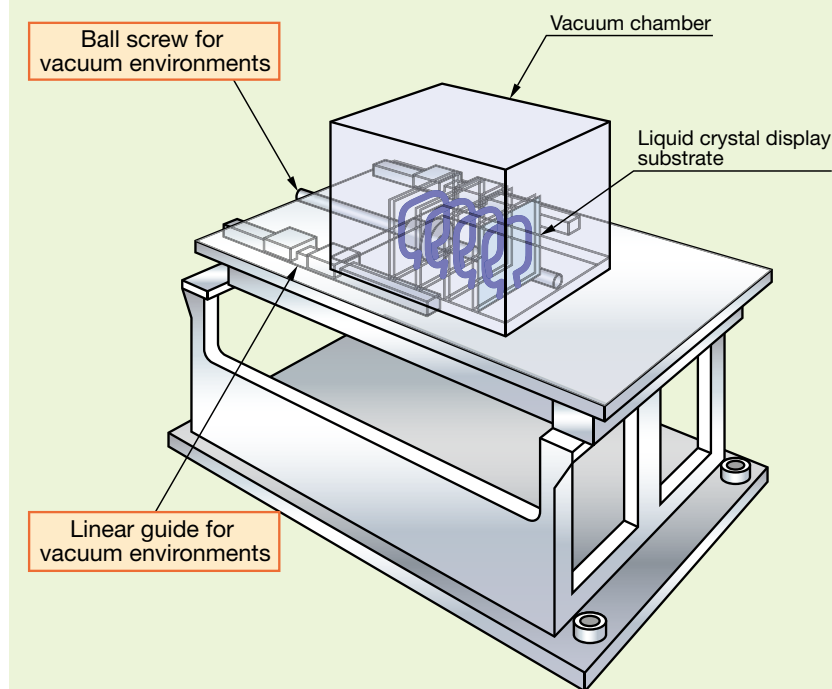
SPACEA™ Series

Ball screws and linear guides for clean environments

- Reduces costs and maintenance

2. LCD/Semiconductor Production Machinery

Liquid Crystal Filling Machine



Operating Conditions

Vacuum/Clean environments

- Degree of vacuum: 10^{-1} Pa
- Temperature: 100–150°C
- Speed: 10 m/min
- Load: Minimal

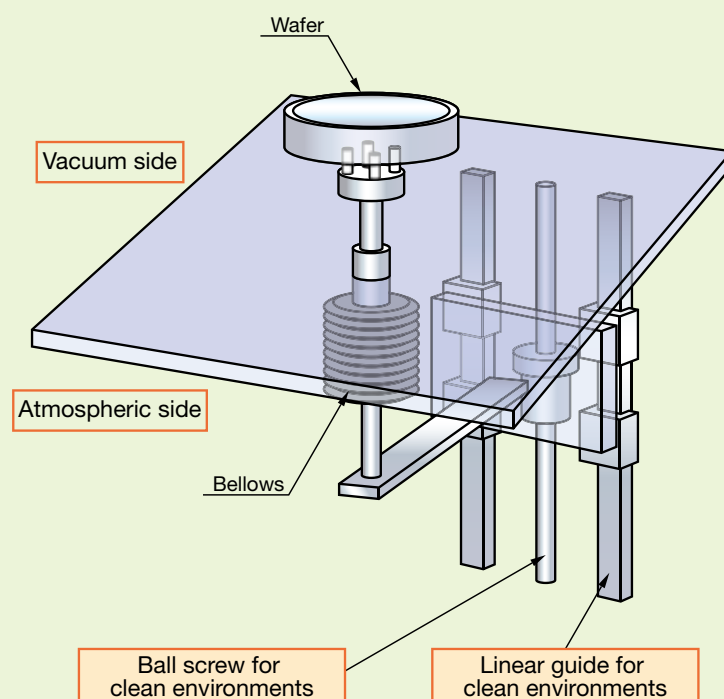
Feature

- Heat-resistant

SPACEA™ Series

Ball screws and linear guides for vacuum environments

Wafer Lift



Operating Conditions

Clean environments

- Cleanliness: Class 100
- Temperature: Room temperature
- Speed: 20 m/min
- Load: Pitching moment included

Feature

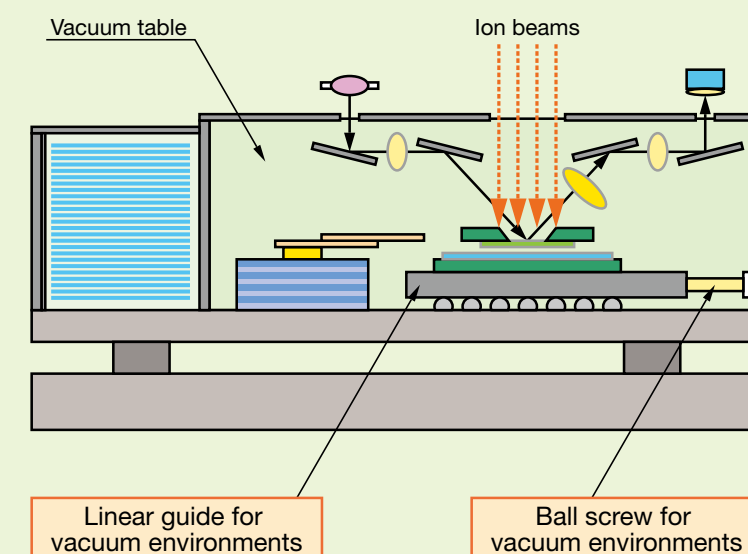
- Change from a commercially available vacuum grease to NSK clean grease

SPACEA™ Series

Ball screws and linear guides for clean environments

- Reduces costs and maintenance

Ion Implanting Equipment



Operating Conditions

Vacuum/Clean environments

- Degree of vacuum: 10^{-5} Pa
- Temperature: 100°C
- Speed: 1 m/min
- Load: Minimal

Feature

- Improved durability in vacuum environments, with E-DFO lubrication

SPACEA™ Series

Ball screws and linear guides for vacuum environments

This section provides descriptions of the physical properties of lubricants and materials used in SPACEA™ Series bearings, ball screws and NSK Linear Guides®. Unit conversion tables listing general weight, length, and hardness are also included for your reference.

Please use the Specification Inquiry for SPACEA™ Series (at the back of the catalog) when contacting NSK about SPACEA™ Series products.

Appendices

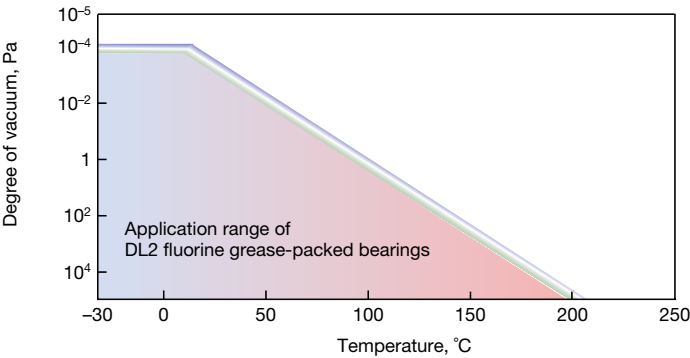
Physical Properties of Materials, Unit Conversion Tables..... C3–C24

1. Properties of SPACEA™ Series Greases
2. Characteristics of Representative Solid Lubricants
3. Characteristics of Metallic Materials
4. Characteristics of Ceramic Materials
5. Physical Properties of Plastic Materials
6. Properties of Commercially Available Fluorine Lubricants (Krytox)
7. Properties of Commercially Available Fluorine Lubricants
(Fomblin oil, Klübertemp / Klüberalfa grease)
8. Properties of Commercially Available Fluorine Lubricants (Barrierta, Demnum)
9. Conversion from International System of Units (SI)
10. N-kgf Conversion Table
11. kg-lb Conversion Table
12. inch-mm Conversion Table
13. Viscosity Conversion Table
14. Hardness Conversion Table
15. Dimensions of Abutment and Fillet
16. Tolerances for Shaft Diameters
17. Tolerances for Housing Bore Diameters

1. Properties of SPACEA™ Series Greases

Operating environment	Grease	Normal atmosphere, vacuum	Maximum operating temperature °C	Cleanliness ⁽¹⁾	Base oil	Thickener	Kinematic viscosity mm ² /s, 40°C	Consistency
Normal Atmosphere	NS7	Normal Atmosphere	100	—	Polyol ester oil + Diester oil	Lithium soap	26	250
Normal atmosphere, clean	LG2	Normal atmosphere	70	Class 100–1 000	Mineral oil and synthetic hydrocarbon oil	Lithium soap	32	199
	LGU		120		Synthetic hydrocarbon oil	Diurea	96	201
From normal atmosphere up to vacuum, clean	DL2	See the Scope of Applications of DL2 Grease-Packed Bearings below.			Fluorine oil	PTFE	200	280
Normal atmosphere, high-temperature	KPM	Normal atmosphere	230	—	Fluorine oil	PTFE	420	290
Normal atmosphere, sanitary environments	H3G	Normal atmosphere	90	—	High-grade food oil	Food additives	14.8	255
	H1R		120	—	Synthetic hydrocarbon oil	Aluminum alloy soap	150	280
	H1B		200	—	Fluorine oil	PTFE	415	280

Note (1) Cleanliness may vary depending on operating conditions, surrounding structures and other factors.



2. Characteristics of Representative Solid Lubricants

Solid lubricant	Relative density g/cm³	Molecular mass	Crystal structure	Electric resistance Ω · cm	Maximum operating temperature °C		Coefficient of friction		Particle emissions	Outgassing
					Normal atmosphere	Vacuum	Normal atmosphere	Vacuum		
Molybdenum disulfide MoS₂	4.8	160.07	Hexagonal crystal system	8.33 (-60°C)	350	650	0.006–0.25	0.001–0.2	△	○
Tungsten disulfide WS₂	7.4	248.02	Hexagonal crystal system	0.40 (92°C)	425	750	0.05–0.28	0.001–0.2	△	○
Graphite C	2.24	12.011	Hexagonal crystal system	2.6 × 10⁻³	550	—	0.05–0.3	0.4–1.0	△	○
Polytetrafluoroethylene PTFE	2.2	—	Long-chain	10¹⁴	260	260	0.04–0.2	0.04–0.2	◎	△
Polyimide	1.4	—	Long-chain	—	300	300	0.12	0.10	○	△
Gold Au	19.3	196.97	Face-centered cubic	2.2 × 10⁻⁶	200	200	0.2–0.5	—	△	◎
Silver Ag	10.5	107.87	Face-centered cubic	1.6 × 10⁻⁶	—	600	—	0.2–0.3	△	◎
Lead Pb	11.3	207.2	Face-centered cubic	2.08 × 10⁻⁶	100	350	0.05–0.5	0.05–0.5	△	◎

3. Characteristics of Metallic Materials

Metallic material	Thermal expansion coefficient × 10 ⁻⁶ / °C	Young's modulus GPa	Hardness ⁽¹⁾ HV	Relative permeability
Bearing steel SUJ2	12.5	208	700–800	Ferromagnetic
High corrosion-resistant stainless steel ES1	10.8	206	650–750	
Martensite stainless steel SUS440C	10.1	200		
High corrosion-resistant, high hardness stainless steel ESZ	10.6	202	580–650	
Precipitation-hardened stainless steel SUS630	10.8	200	390	
High corrosion-resistant, non-magnetic stainless steel ESA	16.0	193	800–1 000 (Hardened surface layer)	1.01 or less
Austenite stainless steel SUS304	16.3	193	150	1.04 or less
Completely non-magnetic titanium alloy	9.0	90	450–500	1.001 or less

Note (1) Converted to HV (Vickers hardness) for comparison

4. Characteristics of Ceramic Materials

Item	Unit	Silicon nitride ceramics	Oxide-based ceramics	Bearing steel
Density	g/cm³	3.23	5.9	7.8
Young's modulus	GPa	330	210	208
Fracture toughness	MPa · m ^{1/2}	6	7.5	18
Hardness (HV)	—	1 500	1 300	700
Thermal expansion coefficient	× 10⁻⁶ / °C	2.8	10.5	12.5
Thermal conductivity	W / m · k	31	3	50
Bending strength	MPa	900	1 100	≥2 500
Rotating capability in water immersion	—	◎	○	×
Rotating capability in acid solvents	—	△	○	×
Cost	—	High	Standard	Low

5. Physical Properties of Plastic Materials

Plastic materials used for the cage materials of bearings for special environments are generally doped with reinforcement such as carbon fibers, solid lubricants such as MoS₂, and abrasion-resistant additives.

Plastic	Classification ⁽¹⁾	Elasticity coefficient GPa	Strength GPa	Density g/cm³	Tm ⁽²⁾ °C	Heat distortion temperature ⁽³⁾ °C
Polyphenylene sulfide (PPS)	M, C	1.4	0.155	1.64	285	>260
Polyetheretherketone (PEEK)	M, C	3.9	0.1	1.3	335	152
Heat reversible polyimide (TPI)	M, C	2.94	0.092	1.33	388	238
Tetrafluoroethylene-ethylene copolymer (ETFE)	M, C	0.88–1.37	0.04–0.046	1.7–1.76	260	74 (104)
Polyvinylidene fluoride (PVDF)	M, C	1.6	0.045	1.76	170	90 (150)
Polytetrafluoroethylene (PTFE)	C	0.40	0.028	2.16	327	– (120)
Polyamide (nylon 6-6)	M, C	3.0	0.08	1.14	264	60 (180)
Nylon 4-6	M, C	3.14	0.1	1.18	295	220

Notes (1) Classification M: Moldable C: Crystalline (2) Tm: Melting point (3) Heat distortion temperature values in parentheses are at 454 kPa, all other values are at 181 MPa.

6. Properties of Commercially Available Fluorine Lubricants (Krytox)

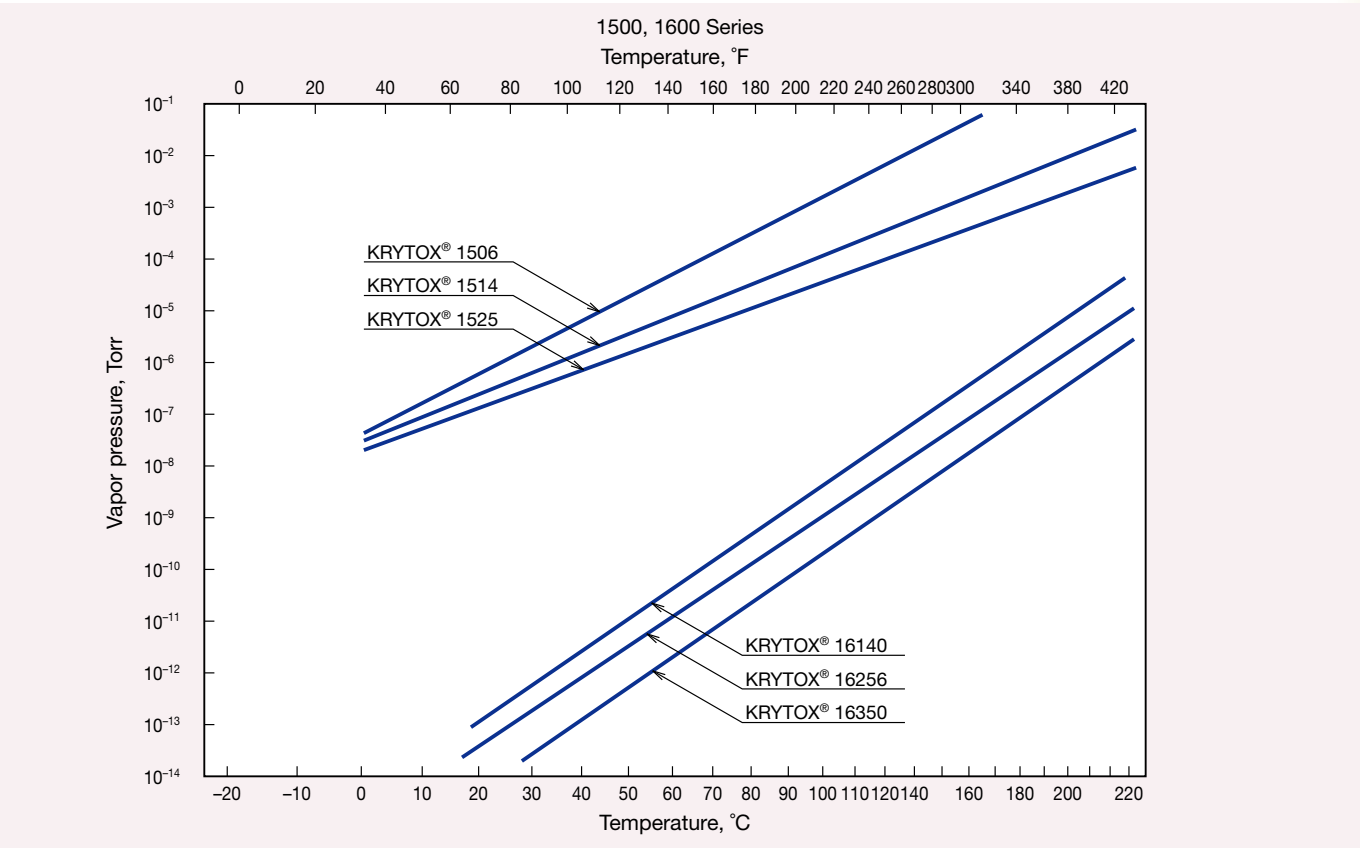
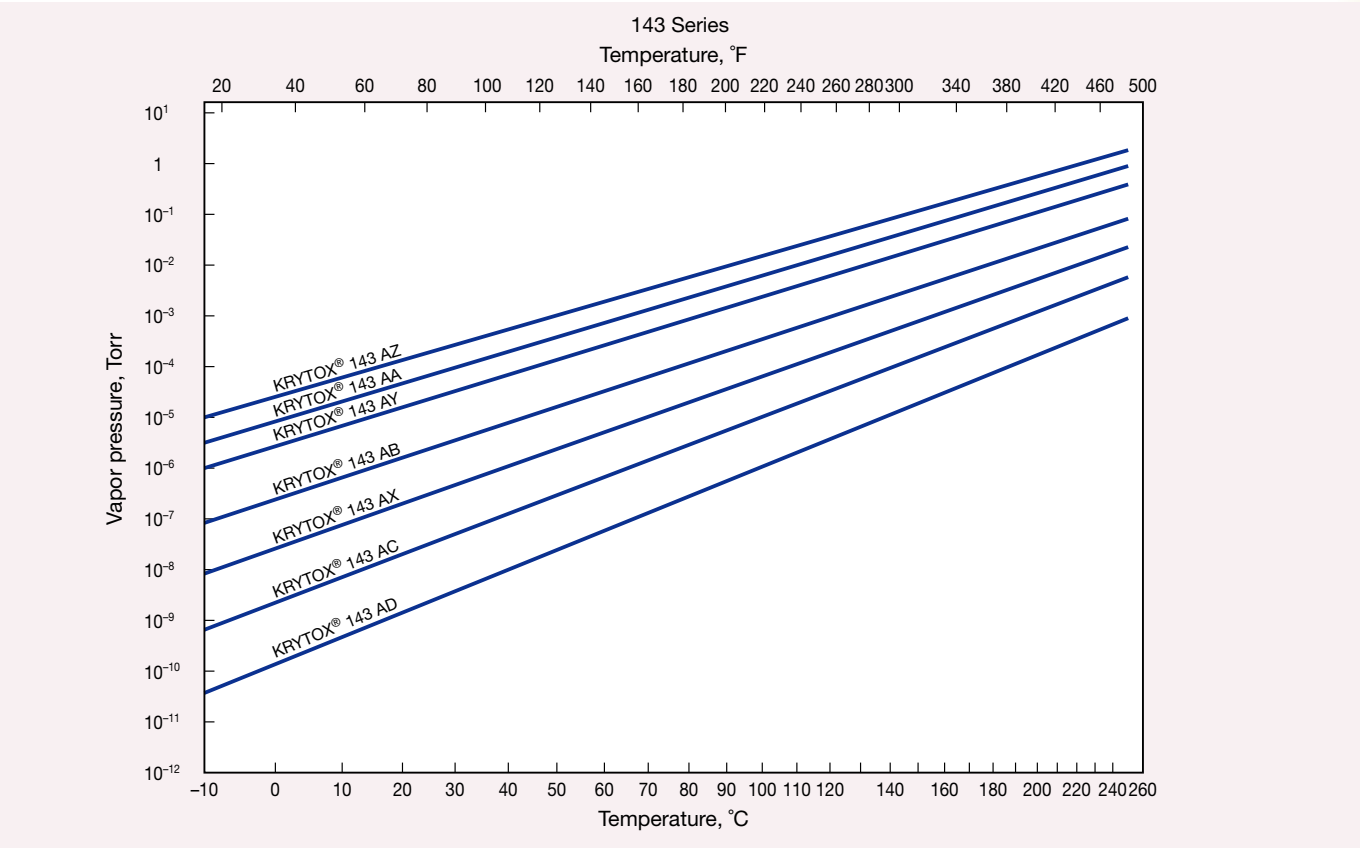
● Krytox oil (Dupont)

Product		Average molecular weight	Kinematic viscosity mm²/s				Viscosity index	Pour point °C	Vapor pressure (Knudsen number) Pa				Amount of evaporation, mass % (Temperature, 22 hours)	Density g/cm³ (0°C)	Range of operating temperatures
			20°C	38°C	50°C	100°C			20°C	38°C	100°C	260°C			
143 Series	AZ	1 850	40	18	—	3.3 (99°C)	29	−55	—	5 × 10 ^{−2}	—	200	80 (204°C)	—	—
	AA	2 450	85	35	—	5.3 (99°C)	89	−50	—	1 × 10 ^{−2}	—	100	40 (204°C)	—	—
	AY	3 000	150	55	—	7.5 (99°C)	107	−45	—	5 × 10 ^{−3}	—	20	20 (204°C)	—	—
	AB	3 700	230	85	—	10.3 (99°C)	113	−40	—	7 × 10 ^{−4}	—	4	5 (204°C)	—	—
	AX	4 800	450	150	—	16.4 (99°C)	125	−35	—	1 × 10 ^{−4}	—	1	2 (204°C)	—	—
	AC	6 250	800	270	—	26 (99°C)	134	−35	—	1 × 10 ^{−5}	—	0.3	1 (204°C)	—	—
	AD	8 250	1 500	500	—	43 (99°C)	144	−30	—	8 × 10 ^{−7}	—	4 × 10 ^{−2}	3 (260°C)	—	—
1500 Series	1506	—	60	—	15	4	—	−45	7 × 10 ^{−5}	—	0.1	—	—	—	—
	1514	—	140	—	30	7	—	−40	7 × 10 ^{−5}	—	3 × 10 ^{−2}	—	—	—	—
	1525	—	250	87	50	10	—	−35	7 × 10 ^{−5}	—	7 × 10 ^{−3}	—	—	—	—
1600 Series	16140	—	1 400	450	250	40	—	−25	1 × 10 ^{−11}	—	4 × 10 ^{−7}	—	—	—	—
	16256	—	2 560	—	400	55	—	−15	7 × 10 ^{−12}	—	1 × 10 ^{−7}	—	—	—	—
	16350	—	3 500	—	600	85	—	−5	7 × 10 ^{−13}	—	2 × 10 ^{−8}	—	—	—	—
GPL Series	100	—	7	4	—	—	—	<−55	—	—	—	—	87 (121°C)	1.87	−55/65
	101	—	16	8	—	2	—	<−55	—	—	—	—	29 (121°C)	1.89	−50/100
	102	—	36	15	—	3	—	−50	—	—	—	—	20 (121°C)	1.91	−50/130
	103	—	80	30	—	5	—	−40	—	—	—	—	7 (121°C)	1.92	−40/155
	104	—	180	60	—	9	—	−35	—	—	—	—	3 (121°C)	1.93	−35/180
	105	—	550	160	—	18	—	−30	—	—	—	—	<5 (204°C)	1.94	−30/205
	106	—	810	270	—	25	—	−25	—	—	—	—	<2 (204°C)	1.95	−25/260
	107	—	1 600	440	—	42	—	−20	—	—	—	—	<1 (204°C)	1.95	−20/288

● Krytox grease

Product	Base oil	Kinematic viscosity mm ² /s (38°C)	Thickener	Consistency NLGI No.	Vapor pressure (Knudsen number) Pa		Oil separation rate mass % (204°C, 30h)	Amount of evaporation mass % (204°C, 6.5h)	Density g/cm ³ (25°C)	Additive
					38°C	260°C				
240AZ	143AZ	18	PTFE	2	5 × 10 ^{−2}	200	15	60	1.89	None
240AA	143AA	35			1 × 10 ^{−2}	100	15	30	1.91	None
240AB	143AB	85			7 × 10 ^{−4}	4	11	5	1.92	None
240AC	143AC	270			1 × 10 ^{−5}	0.3	10	1	1.93	None
240AD	143AD	500			8 × 10 ^{−7}	4 × 10 ^{−2}	10	<1	1.93	None
250AC	143AC	270	PTFE	2	1 × 10 ^{−5}	0.3	11	1	2.02	MoS ₂ 5%
280AC	143AC	270			1 × 10 ^{−5}	0.3	11	1	1.95	Anti-rust agent 1%
283AC	143AC	270			1 × 10 ^{−5}	0.3	11	1	1.97	Anti-rust agent 3%
280AD	143AD	500			8 × 10 ^{−7}	4 × 10 ^{−2}	—	<1	—	Anti-rust agent 1%
283AD	143AD	500			8 × 10 ^{−7}	4 × 10 ^{−2}	—	<1	—	Anti-rust agent 3%
LVP	16256	2 560	PTFE	2	1 × 10 ^{−11}	1 × 10 ^{−3}	13.8	0.3 (204°C, 22h)	1.94	None
GPL204	GPL104	180 (20°C)	PTFE	—	—	—	6 (99°C)	—	—	None
GPL224	GPL104	180 (20°C)			—	—	6 (99°C)	—	—	Anti-rust agent
GPL207	GPL107	1 600 (20°C)			—	—	10	—	—	None
GPL227	GPL107	1 600 (20°C)			—	—	10	—	—	Anti-rust agent

● Vapor pressure of Krytox oil



7. Properties of Commercially Available Fluorine Lubricants
(Fomblin oil, Klübertemp / Klüberalfa Grease)

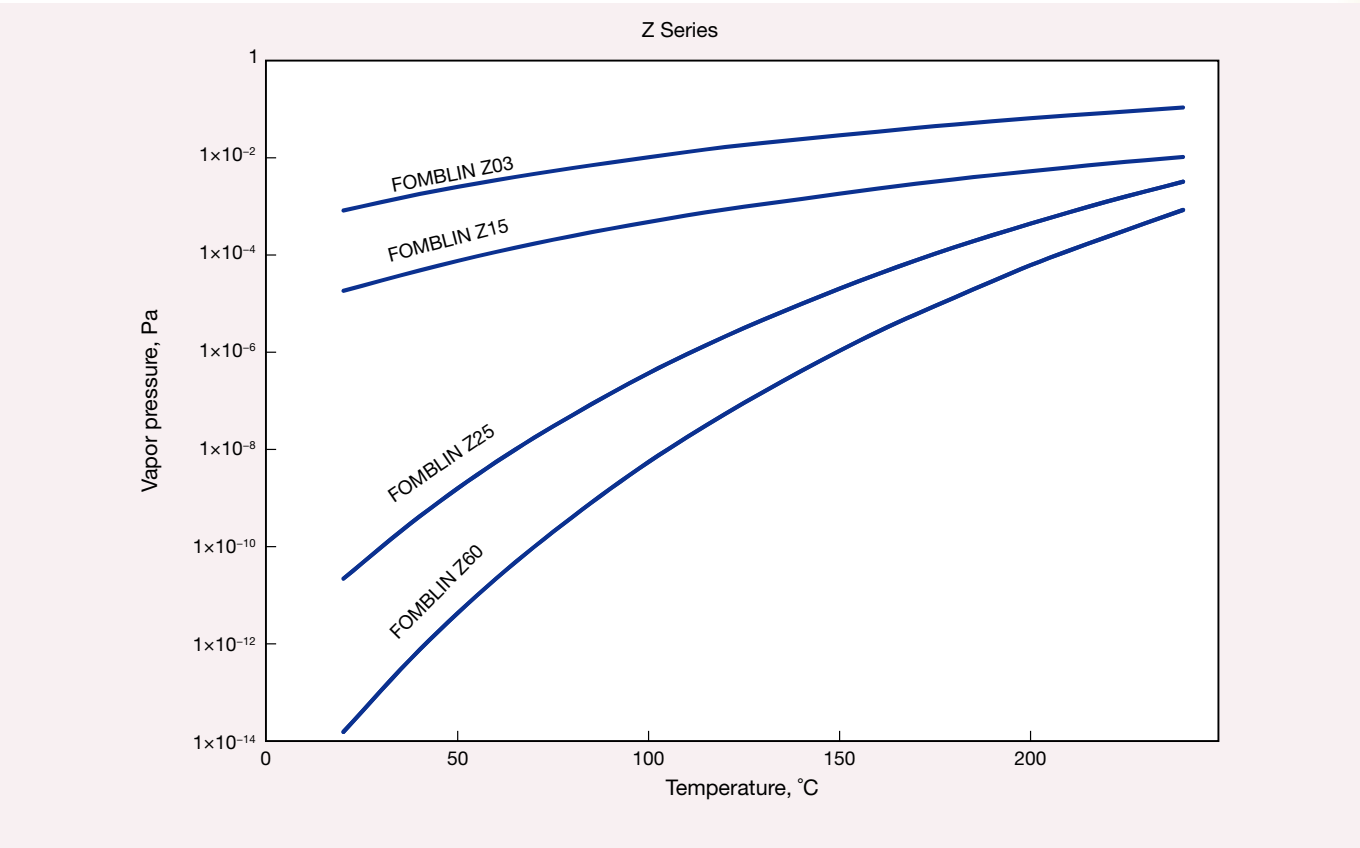
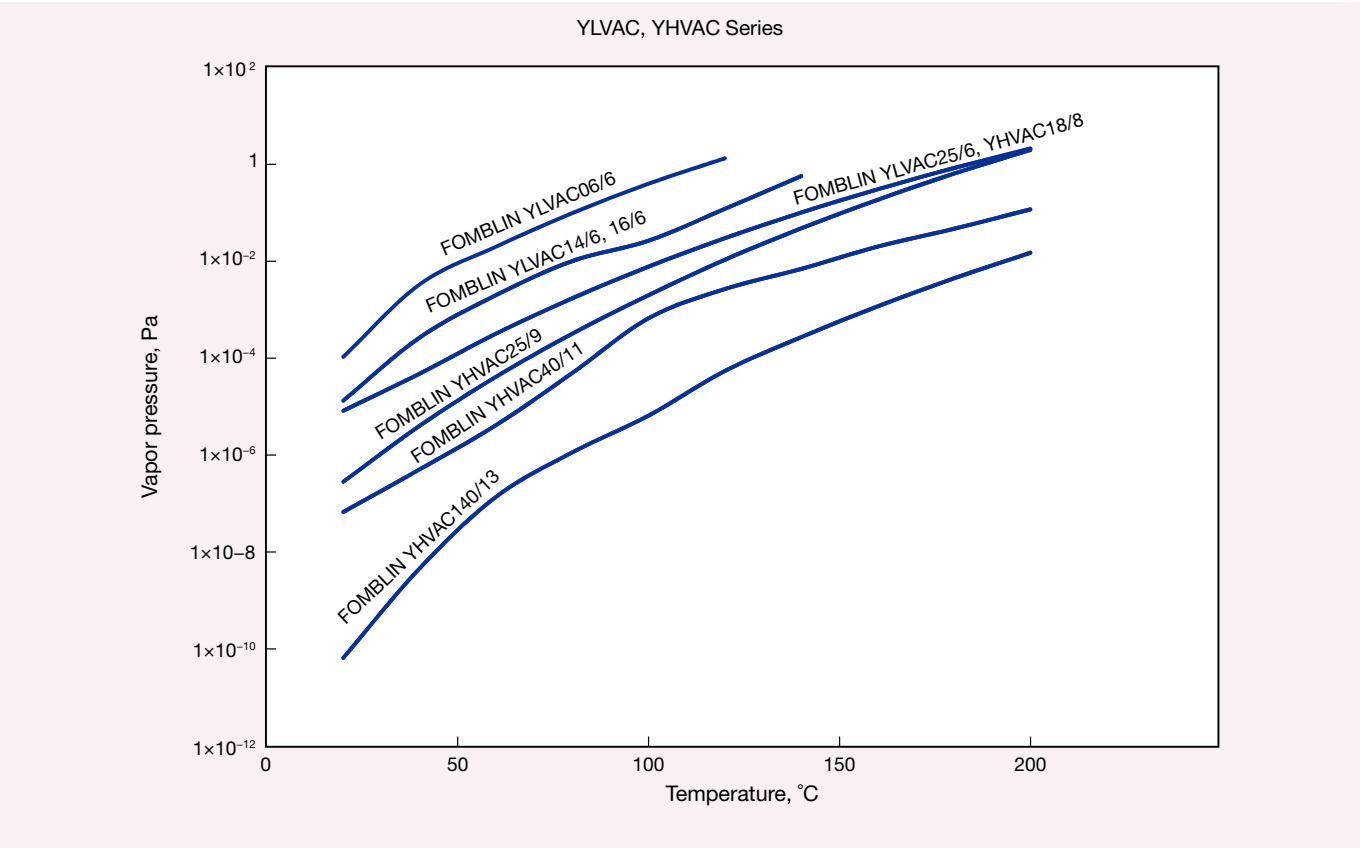
● Fomblin oil (Solvay Specialty Polymers)

Product		Average molecular weight	Kinematic viscosity mm²/s			Viscosity index	Pour point °C	Vapor pressure (Knudsen number) Pa		Amount of evaporation, mass % (Temperature, 22 hours)	Density g/cm³ (20°C)
			20°C	40°C	100°C			20°C	100°C		
Y Series	Y04	1 500	38	15	3.2	60	−58	—	—	9 (120°C)	1.87
	Y06	1 800	60	22	3.9	70	−50	—	—	6 (120°C)	1.88
	Y25	3 200	250	80	10	108	−35	—	—	15 (204°C)	1.90
	Y45	4 100	470	147	16	117	−30	—	—	1.7 (204°C)	1.91
	YR	6 250	1 200	345	33	135	−25	—	—	1.2 (204°C)	1.91
YLVAC Series	06/6	—	64	—	—	—	−50	$\leq 1.1 \times 10^{-4}$	$\leq 4.0 \times 10^{-1}$	—	1.88
	14/6	—	148	—	—	—	−45	$\leq 1.3 \times 10^{-5}$	$\leq 2.7 \times 10^{-2}$	—	1.89
	16/6	—	168	—	—	—	−45	$\leq 2.7 \times 10^{-6}$	$\leq 2.7 \times 10^{-2}$	—	1.90
	25/6	—	276	—	—	—	−35	$\leq 8.0 \times 10^{-6}$	$\leq 8.0 \times 10^{-3}$	—	1.90
YHVAC Series	18/8	—	190	—	9	—	−42	$\leq 2.6 \times 10^{-6}$	$\leq 2.6 \times 10^{-2}$	—	1.89
	25/9	—	285	—	12	—	−35	$\leq 2.6 \times 10^{-7}$	$\leq 2.6 \times 10^{-3}$	—	1.90
	40/11	—	474	—	—	—	−32	$\leq 6.6 \times 10^{-8}$	$\leq 6.6 \times 10^{-4}$	—	1.91
	140/13	—	1 508	—	—	—	−23	$\leq 6.5 \times 10^{-11}$	$\leq 6.5 \times 10^{-6}$	—	1.92
Z Series	Z03	4 000	30	18	5.6	317	−90	—	—	6.0 (149°C)	1.82
	Z15	8 000	160	92	28	334	−80	—	—	1.2 (204°C)	1.84
	Z25	9 500	263	157	49	358	−75	—	—	0.4 (204°C)	1.85
	Z60	13 000	600	355	98	360	−63	—	—	0.2 (204°C)	1.85

● Klübertemp / Klüberalfa grease (NOK Klüber)

Product		Base oil	Thickener	Consistency NLGI No.	Oil separation Rate mass % (204°C, 30h)	Amount of evaporation mass % (204°C, 22h)	Density g/cm³ (20°C)	Additive	Working Temperature Range °C
Klübertemp	GR OT20	Fomblin oil Y series	PTFE	2	—	—	1.90	None	−50/70
	GR UT18			2	—	—	1.90	None	−30/230
	GR RT15			2	≤12	≤3	1.90	None	−20/250
	GR RT2			2	≤12	≤3	1.90	Anti-rust agent (solid)	−20/250
Klüberalfa	GR YVAC1	Fomblin oil YHVAC140/13	PTFE	1	≤14	≤1	1.90	None	−20/250
	GR YVAC2			2	≤12	≤1	1.90	None	−20/250
	GR YVAC3			3	≤10	≤1	1.90	None	−20/250
	GR ZLHT	Fomblin oil Z series	PTFE	2	≤12	≤6	1.90	None	−65/200
	GR ZNF			3	≤9	≤2	1.90	None	−60/200

● Vapor pressure of Fomblin oil



8. Properties of Commercially Available Fluorine Lubricants (Barrierta, Demnum)

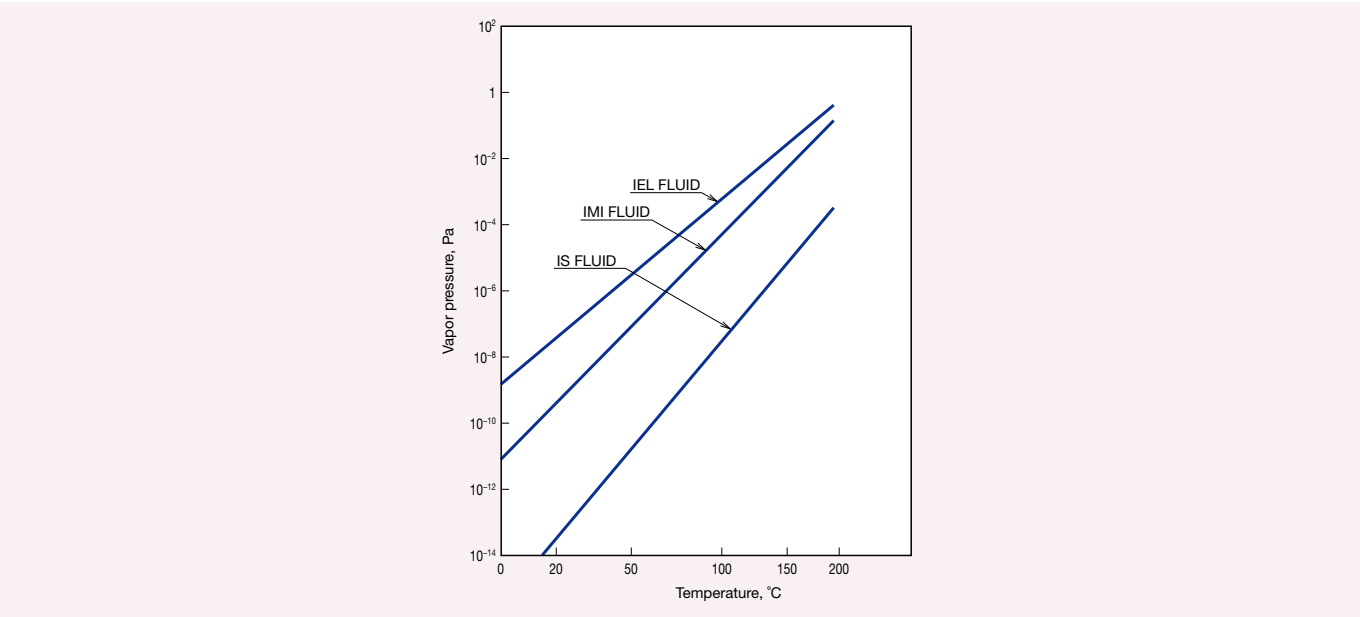
● Barrierta oil (NOK Klüber)

I Series	Average molecular weight	Kinematics viscosity mm²/s		Viscosity index	Pour point °C	Vapor pressure (Knudsen number) Pa (20°C)	Density g/cm³ (20°C)
		20°C	40°C				
IEL FLUID	3 500	280	95	130	−45	—	1.90
IMI FLUID	4 500	550	180	138	−40	—	1.90
IS FLUID	7 500	1 400	390	140	−30	—	1.90

● Barrierta grease

Product	Base oil	Kinematic viscosity mm²/s (40°C)	Thickener	Consistency NLGI No.	Vapor pressure (Knudsen number) (20°C)	Oil separation rate mass% (204°C, 24h)	Amount of evaporation mass% (204°C, 22h)	Density g/cm³ (25°C)	Additive
IEL	IEL FLUID	95	PTFE	2	6×10 ^{−6}	—	—	1.90	Anti-rust agent
IMI	IMI FLUID	180		2	7×10 ^{−7}	—	—	1.90	Anti-rust agent
IS	IS FLUID	390		2	2×10 ^{−8}	—	—	1.90	Anti-rust agent
L55/2 J	IS FLUID	390	PTFE	2	2×10 ^{−8}	—	—	1.95	Anti-rust agent
IEL/V	—	65	PTFE	2	5×10 ^{−6}	7.0	0.2	1.95	Anti-rust agent
IMI/V	—	180		2	9×10 ^{−10}	7.0	0.2	1.95	Anti-rust agent
IS/V	—	415		2	5×10 ^{−14}	7.0	0.1	1.95	None
SUPER IS/V	—	415		2	5×10 ^{−14}	7.0	0.1	1.95	None

● Vapor pressure of Barrierta oil



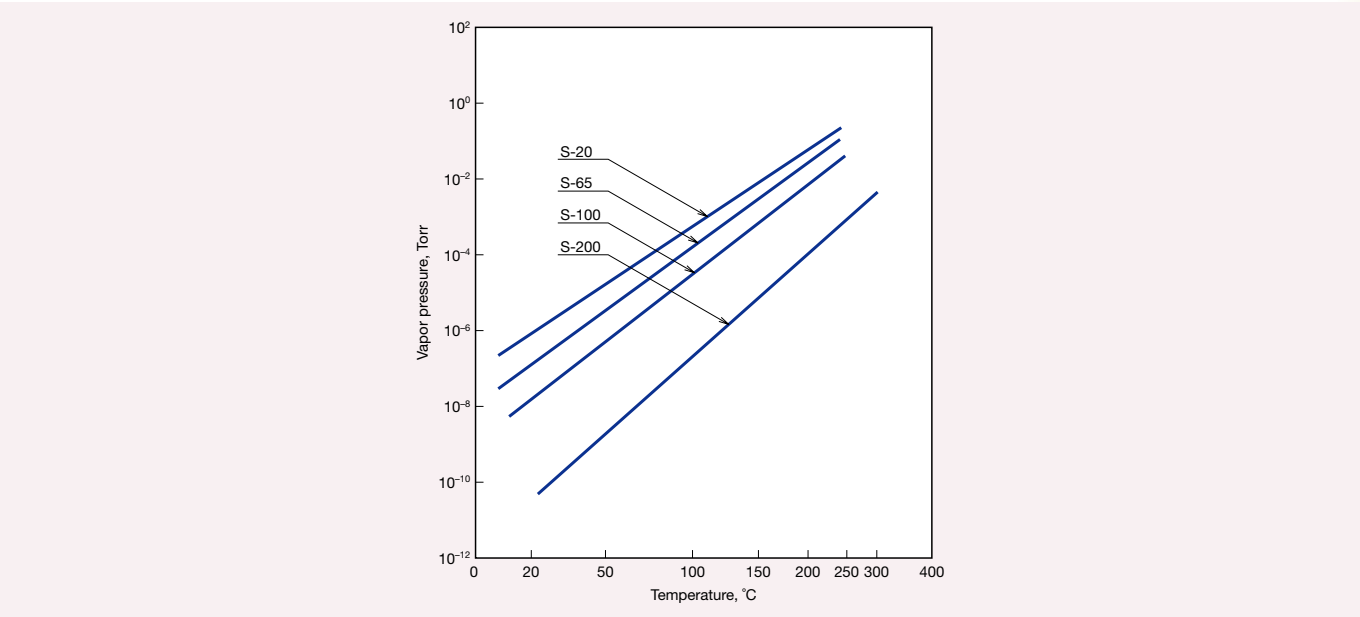
● Demnum oil (Daikin)

Product	Average molecular weight	Kinematic viscosity mm²/s			Viscosity index	Pour point °C	Density g/cm³ (20°C)
		20°C	40°C	60°C			
S-20	2 700	53	25	14	150	−75	1.86
S-65	4 500	150	65	33	180	−65	1.86
S-100	5 600	250	100	50	200	−60	1.88
S-200	8 400	500	200	95	210	−53	1.89

● Demnum grease

Product	Base oil	Kinematic viscosity mm²/s (40°C)	Thickener	Consistency NLGI No.	Oil separation rate mass % (200°C, 30h)	Amount of evaporation mass % (200°C, 22h)	Additive
L65	S-65	65	PTFE	2	<12	<1	None
L100	S-100	100	PTFE	2	<11	<1	None
L200	S-200	200	PTFE	2	<10	<0.1	None

● Vapor pressure of Demnum oil



9. Conversion from International System of Units (SI)

● Conversion Table of SI, CGS, and engineering system of units

Quantity System of units	Length	Mass	Time	Temperature	Acceleration	Force	Stress	Pressure	Energy	Power
SI	m	kg	s	K, °C	m/s ²	N	Pa	Pa	J	W
CGS	cm	g	s	°C	Gal	dyn	dyn/cm ²	dyn/cm ²	erg	erg/s
Engineering	m	kgf·s ² /m	s	°C	m/s ²	kgf	kgf/m ²	kgf/m ²	kgf·m	kgf·m/s

● Conversion rate from SI units

Conversion example: 1N = 1/9.80665 kgf

Quantity	SI unit		Units other than SI		Conversion rate from SI unit
	Name of unit	Symbol	Name of unit	Symbol	
Angle	Radian	rad	Degree	°	180/π
			Minute	′	10 800/π
			Second	″	648 000/π
Length	Meter	m	Micron	μ	10 ⁶
			Angstrom	Å	10 ¹⁰
Area	Square meter	m ²	Are	a	10 ⁻²
			Hectare	ha	10 ⁻⁴
Volume	Cubic meter	m ³	Liter	l, L	10 ³
			Deciliter	dl, dL	10 ⁴
Time	Second	s	Minute	min	1/60
			Hour	h	1/3 600
			Day	d	1/86 400
Number of vibrations, Frequency	Hertz	Hz	Cycle	s ⁻¹	1
Number of revolutions	Revolution per second	s ⁻¹	Revolutions per minute	rpm	60
Speed	Meter per second	m/s	Kilometer per hour	km/h	3 600/1 000
			Knot	kn	3 600/1 852
Acceleration	Meter per second ²	m/s ²	Gal	Gal	10 ²
			G	G	1/9.80665
Mass	Kilogram	kg	Ton	t	10 ⁻³
Force	Newton	N	Kilogram force	kgf	1/9.80665
			Kilogram-ton	tf	1/(9.80665 × 10 ³)
			Dyne	dyn	10 ³
Torque and moment of force	Newton-meter	N·m	Kilogram-force-meter	kgf·m	1/9.80665
Strength	Pascal	Pa	Kilogram per square centimeter	kgf/cm ²	1/(9.80665 × 10 ⁴)
	(Newton per square meter)	(N/m ²)	Kilogram per square millimeter	kgf/mm ²	1/(9.80665 × 10 ⁶)

● Prefixes of SI units

Exponential notation	Prefix		Exponential notation	Prefix	
	Name	Symbol		Name	Symbol
10 ¹⁸	Exa	E	10 ⁻¹	Deci	d
10 ¹⁵	Peta	P	10 ⁻²	Centi	c
10 ¹²	Tera	T	10 ⁻³	Milli	m
10 ⁹	Giga	G	10 ⁻⁶	Micro	μ
10 ⁶	Mega	M	10 ⁻⁹	Nano	n
10 ³	Kilo	k	10 ⁻¹²	Pico	p
10 ²	Hecto	h	10 ⁻¹⁵	Femto	f
10 ¹	Deca	da	10 ⁻¹⁸	Atto	a

● Conversion rate from SI units (continued)

Quantity	SI unit		Units other than SI		Conversion rate from SI unit
	Name of unit	Symbol	Name of unit	Symbol	
Pressure	Pascal (Newton per square meter)	Pa (N/m ²)	Kilogram-force per square meter	kgf/m ²	1/9.80665
			Meter water column	mH ₂ O	1/(9.80665 × 10 ³)
			Millimeter mercury	mmHg	760/(1.01325 × 10 ⁵)
			Torr	Torr	760/(1.01325 × 10 ⁵)
			Bar	bar	10 ⁻⁵
			Atmospheric pressure	atm	1/(1.01325 × 10 ⁵)
Energy	Joule (Newton-meter)	J (N·m)	Erg	erg	10 ⁷
			Calorie (international)	cal _{IT}	1/4.1868
			Kilogram-force-meter	kgf·m	1/9.80665
			kilowatt-hour	kW·h	1/(3.6 × 10 ⁶)
Power	Watt (Joule per second)	W (J/s)	Metric horsepower-hour	PS·h	= 3.77672 × 10 ⁻⁷
			Kilogram-force per meter per second	kgf/m/s	1/9.80665
			Kilocalorie per second	kcal/h	1/1.163
			Metric horsepower	PS	= 1/735.4988
Viscosity, Viscosity index	Pascal-second	Pa·s	Poise	P	10
Kinematic viscosity	Square meter per second	m ² /s	Stokes	St	10 ⁴
			Centi-Stokes	cSt	10 ⁶
Temperature, Temperature difference	Kelvin, Celsius	K, °C	Degree	°C	(See Note) ⁽¹⁾
Electric current, Magnetomotive force	Ampere	A	Ampere	A	1
Electrical voltage, Electromotive force	Volt	V	(Watt per ampere)	(W/A)	1
Magnetic field strength	Ampere per meter	A/m	Oersted	Oe	4π/10 ³
Magnetic flux density	Tesla	T	Gauss	Gs	10 ⁴
			Gamma	γ	10 ⁹
Electric resistance	Ohm	Ω	(Volt per ampere)	(V/A)	1

Note (1) To convert 7K to θ°C, θ = T - 273.15. In the case of temperature difference, ΔT = Δθ, with ΔT and Δθ indicating temperature differences measured in degrees Kelvin and Celsius, respectively.

Remarks Definitions of units and symbols are in parentheses.

10. N-kgf Conversion Table

Example: To convert 10N to kgf, go to 10 in the central column of the first block, then locate the corresponding figure in the kgf column on the right. You will see that 10N = 1.0197 kgf. To convert 10 kgf to N, find the number in the N column on the left that corresponds to 10, and you will see that 10 kgf = 98.066N.

1N = 0.1019716 kgf
1 kgf = 9.80665N

N			kgf			N			kgf			N			kgf		
9.8066	1	0.1020	333.43	34	3.4670	657.05	67	6.8321									
19.613	2	0.2039	343.23	35	3.5690	666.85	68	6.9341									
29.420	3	0.3059	353.04	36	3.6710	676.66	69	7.0360									
39.227	4	0.4079	362.85	37	3.7729	686.47	70	7.1380									
49.033	5	0.5099	372.65	38	3.8749	696.27	71	7.2400									
58.840	6	0.6118	382.46	39	3.9769	706.08	72	7.3420									
68.647	7	0.7138	392.27	40	4.0789	715.89	73	7.4439									
78.453	8	0.8158	402.07	41	4.1808	725.69	74	7.5459									
88.260	9	0.9177	411.88	42	4.2828	735.50	75	7.6479									
98.066	10	1.0197	421.69	43	4.3848	745.31	76	7.7498									
107.87	11	1.1217	431.49	44	4.4868	755.11	77	7.8518									
117.68	12	1.1237	441.30	45	4.5887	764.92	78	7.9538									
127.49	13	1.3256	451.11	46	4.6907	774.73	79	8.0558									
137.29	14	1.4276	460.91	47	4.7927	784.53	80	8.1577									
147.10	15	1.5296	470.72	48	4.8946	794.34	81	8.2597									
156.91	16	1.6315	480.53	49	4.9966	804.15	82	8.3617									
166.71	17	1.7335	490.33	50	5.0986	813.95	83	8.4636									
176.52	18	1.8355	500.14	51	5.2006	823.76	84	8.5656									
186.33	19	1.9375	509.95	52	5.3025	833.57	85	8.6676									
196.13	20	2.0394	519.75	53	5.4045	834.37	86	8.7696									
205.94	21	2.1414	529.56	54	5.5065	853.18	87	8.8715									
215.75	22	2.2434	539.37	55	5.6084	862.99	88	8.9735									
225.55	23	2.3453	549.17	56	5.7104	872.79	89	8.0755									
235.36	24	2.4473	558.98	57	5.8124	882.60	90	9.1774									
245.17	25	2.5493	568.79	58	5.9144	892.41	91	9.2794									
254.97	26	2.6513	578.59	59	6.0163	902.21	92	9.3814									
264.78	27	2.7532	588.40	60	6.1183	912.02	93	9.4834									
274.59	28	2.8552	598.21	61	6.2203	921.83	94	9.5853									
284.39	29	2.9572	608.01	62	6.3222	931.63	95	9.6873									
294.20	30	3.0591	617.82	63	6.4242	941.44	96	9.7893									
304.01	31	3.1611	627.63	64	6.5262	951.25	97	9.8912									
313.81	32	3.2631	637.43	65	6.6282	961.05	98	9.9932									
323.62	33	3.3651	647.24	66	6.7301	970.86	99	10.095									

11. kg-lb Conversion Table

Example: To convert 10 kg to lbs., go to 10 in the central column of the first block and find the corresponding number in the lb column on the right. You will see that 10 kg = 22.046 lb. To convert 10 lb. to kg, find the number in the kg column on the left corresponding to 10, and you will see that 10 lb. = 4.536 kg

1 kg = 2.2046226 lb
1 lb = 0.45359237 kg

kg			lb			kg			lb			kg			lb		
0.454	1	2.205	15.422	34	74.957	30.391	67	147.71									
0.907	2	24.409	15.876	35	77.162	30.844	68	149.91									
1.361	3	6.614	16.329	36	79.366	31.298	69	152.12									
1.811	4	8.818	16.783	37	81.571	31.751	70	154.32									
2.268	5	11.023	17.237	38	83.776	32.205	71	156.53									
2.722	6	13.228	17.690	39	85.980	32.659	72	158.73									
3.175	7	15.432	18.144	40	88.185	33.112	73	160.94									
3.629	8	17.637	18.597	41	90.390	33.566	74	163.14									
4.082	9	19.842	19.051	42	92.594	34.019	75	165.36									
4.536	10	22.046	19.504	43	94.799	34.473	76	167.55									
4.990	11	24.251	19.958	44	97.003	34.927	77	169.76									
5.443	12	26.455	20.412	45	99.208	35.380	78	171.96									
5.897	13	28.660	20.865	46	101.41	35.834	79	174.17									
6.350	14	30.865	21.319	47	103.62	36.287	80	176.37									
6.804	15	33.069	21.772	48	105.82	36.741	81	178.57									
7.257	16	35.274	22.226	49	108.03	37.195	82	180.78									
7.711	17	37.479	22.680	50	110.23	37.648	83	182.98									
8.165	18	39.683	23.133	51	112.44	38.102	84	185.19									
8.618	19	41.888	23.587	52	114.64	38.555	85	187.39									
9.072	20	44.092	24.040	53	116.84	39.009	86	189.60									
9.525	21	46.297	24.494	54	119.05	39.463	87	191.80									
9.979	22	48.502	24.948	55	121.25	39.916	88	194.01									
10.433	23	50.706	25.401	56	123.46	40.370	89	196.21									
10.886	24	52.911	25.855	57	125.66	40.823	90	198.42									
11.340	25	55.116	26.308	58	127.87	41.277	91	200.62									
11.793	26	57.320	26.762	59	130.07	41.730	92	202.83									
12.247	27	59.525	27.216	60	132.28	42.184	93	205.03									
12.701	28	61.729	27.669	61	134.48	42.638	94	207.23									
13.154	29	63.934	28.123	62	136.69	43.091	95	209.44									
13.608	30	66.139	28.576	63	138.89	43.545	96	211.64									
14.061	31	68.343	29.03	64	141.10	43.998	97	213.85									
14.515	32	70.548	29.484	65	143.30	44.452	98	216.05									
14.969	33	72.753	29.937	66	145.51	44.906	99	218.26									

12. Inch-mm Conversion Table

1" = 25.4 mm

Inches		0	1	2	3	4	5	6	7	8	9	10
Fraction	Decimal number	mm										
0	0.000000	0.000	25.400	50.800	76.200	101.600	127.000	152.400	177.800	203.200	228.600	254.000
1/64	0.015625	0.397	25.797	51.197	76.597	101.997	127.397	152.797	178.197	203.597	228.997	254.397
1/32	0.031250	0.794	26.194	51.594	76.994	102.394	127.794	153.094	178.594	203.994	229.394	254.794
3/64	0.046875	1.191	26.591	51.991	77.391	102.791	128.191	153.591	178.991	204.391	229.791	255.191
1/16	0.062500	1.588	26.988	52.388	77.788	103.183	128.588	153.988	179.388	204.788	230.188	255.588
5/64	0.078125	1.984	27.384	52.784	78.184	103.584	128.984	154.384	179.784	205.184	230.584	255.984
3/32	0.093750	2.381	27.781	53.181	78.581	103.981	129.381	154.781	180.181	205.581	230.981	256.381
7/64	0.109375	2.778	28.178	53.578	78.978	104.378	129.778	155.178	180.578	205.978	231.378	256.778
1/8	0.125000	3.175	28.575	53.975	79.376	104.775	130.175	155.575	180.975	206.375	231.776	257.175
9/64	0.140625	3.572	28.972	54.372	79.772	105.172	130.572	155.972	181.372	206.772	232.172	257.572
5/32	0.156250	3.969	29.369	54.769	80.169	105.569	130.969	156.369	181.769	207.169	232.569	257.969
11/64	0.171875	4.366	29.766	55.168	80.566	105.966	131.366	156.766	182.166	207.566	232.966	258.366
3/16	0.187500	4.762	30.162	55.562	80.962	106.362	131.762	157.162	182.562	207.962	233.362	258.762
13/64	0.203125	5.159	30.559	55.959	81.359	106.759	132.159	157.559	182.959	208.359	233.759	259.159
7/32	0.218750	5.556	30.956	56.356	81.756	107.156	132.556	157.956	183.356	208.756	234.156	259.556
15/64	0.234375	5.953	31.353	56.753	82.153	107.553	132.953	158.353	183.753	209.153	234.553	259.953
1/4	0.250000	6.350	31.750	57.150	82.550	107.950	133.350	158.750	184.150	209.550	234.950	260.350
17/64	0.265625	6.747	32.147	57.547	82.947	108.347	133.747	159.147	184.547	209.947	235.347	260.747
9/32	0.281250	7.144	32.544	57.944	83.344	108.744	134.144	159.544	184.944	210.344	235.744	261.144
19/64	0.296875	7.541	32.941	58.341	83.741	109.141	134.541	159.941	185.341	210.741	236.141	261.541
5/16	0.312500	7.938	33.338	58.738	84.138	109.538	134.938	160.338	185.738	211.138	236.538	261.938
21/64	0.328125	8.334	33.734	59.134	84.534	109.934	135.334	160.734	186.134	211.534	236.934	262.334
11/32	0.343750	8.731	34.131	59.531	84.931	110.331	135.731	161.131	186.531	211.931	237.331	262.731
23/64	0.359375	9.128	34.528	59.928	85.328	110.728	136.128	161.528	186.928	212.328	237.728	263.128
3/8	0.375000	9.525	34.925	60.325	85.725	111.125	136.525	161.925	187.325	212.725	238.125	263.525
25/64	0.390625	9.922	35.322	60.722	86.122	111.522	136.922	162.322	187.722	213.122	238.522	263.922
13/32	0.406250	10.319	35.719	61.119	86.519	111.919	137.319	162.719	188.119	213.519	238.919	264.319
27/64	0.421875	10.716	36.116	61.516	86.916	112.316	137.716	163.116	188.516	213.916	239.316	264.716
7/16	0.437500	11.112	36.512	61.912	87.312	112.712	138.112	163.512	188.912	214.312	239.712	265.112
29/64	0.453125	11.509	36.909	62.309	87.709	113.109	138.509	163.909	189.309	214.709	240.109	265.509
15/32	0.468750	11.906	37.306	62.706	88.106	113.506	138.906	164.306	189.706	215.106	240.506	265.906
31/64	0.484375	12.303	37.703	63.103	88.503	113.903	139.303	164.703	190.103	215.503	240.903	266.303
1/2	0.500000	12.700	38.100	63.500	88.900	114.300	139.700	165.100	190.500	215.900	241.300	266.700
33/64	0.515625	13.097	38.497	63.897	89.297	114.697	140.097	165.497	190.897	216.297	241.697	267.097
17/32	0.531250	13.494	38.894	64.294	89.694	115.094	140.494	165.894	191.294	216.694	242.094	267.494
35/64	0.546875	13.891	39.291	64.691	90.091	115.491	140.891	166.291	191.691	217.091	242.491	267.891
9/16	0.562500	14.288	39.688	65.088	90.488	115.888	141.288	166.688	192.088	217.488	242.888	268.288
37/64	0.578125	14.684	40.084	65.484	90.884	116.284	141.684	167.084	192.484	217.884	243.284	268.684
19/32	0.593750	15.081	40.481	65.881	91.281	116.681	142.081	167.481	192.881	218.281	243.681	269.081
39/64	0.609375	15.478	40.878	66.278	91.678	117.078	142.478	167.878	193.278	218.678	244.078	269.478
5/8	0.625000	15.875	41.275	66.675	92.075	117.475	142.875	168.275	193.675	219.076	244.475	269.875
41/64	0.640625	16.272	41.672	67.072	92.472	117.872	143.272	168.672	194.072	219.472	244.872	270.272
21/32	0.656250	16.669	42.069	67.469	92.869	118.269	143.669	169.069	194.469	219.869	245.269	270.689
43/64	0.671875	17.066	42.466	67.866	93.266	118.666	144.066	169.466	194.866	220.266	245.666	271.066
11/16	0.687500	17.462	42.862	68.262	93.662	119.062	144.462	169.862	195.262	220.662	246.162	271.462
45/64	0.703125	17.859	43.259	68.659	94.059	119.459	144.859	170.259	195.659	221.059	246.459	271.859
23/32	0.718750	18.256	43.656	69.056	94.456	119.856	145.256	170.656	196.056	221.456	246.856	272.256
47/64	0.734375	18.653	44.053	69.453	94.853	120.253	145.653	171.053	196.453	221.853	247.253	272.653
3/4	0.750000	19.050	44.450	69.850	95.250	120.650	146.050	171.450	196.850	222.250	247.650	273.050
49/64	0.765625	19.447	44.847	70.247	95.647	121.047	146.447	171.847	197.247	222.647	248.047	273.447
25/32	0.781250	19.844	45.244	70.644	96.044	121.444	146.844	172.244	197.644	223.044	248.444	273.844
51/64	0.796875	20.241	45.641	71.041	96.441	121.841	147.241	172.641	198.041	223.441	248.841	274.241
13/16	0.812500	20.638	46.038	71.438	96.838	122.238	147.638	173.038	198.438	223.838	249.238	274.638
53/64	0.828125	21.034	46.434	71.834	97.234	122.634	148.034	173.434	198.834	224.234	249.634	275.034
27/32	0.843750	21.431	46.831	72.231	97.631	123.031	148.431	173.831	199.231	224.631	250.031	275.431
55/64	0.859375	21.828	47.228	72.628	98.028	123.428	148.828	174.228	199.628	225.028	250.428	275.828
7/8	0.875000	22.225	47.625	73.025	98.425	123.825	149.225	174.625	200.025	225.425	250.825	276.225
57/64	0.890625	22.622	48.022	73.422	98.822	124.222	149.622	175.022	200.422	225.822	251.222	276.622
29/32	0.906250	23.019	48.419	73.819	99.219	124.619	150.019	175.419	200.819	226.219	251.619	277.019
59/64	0.921875	23.416	48.816	74.216	99.616	125.016	150.416	175.816	201.216	226.616	252.016	277.416
15/16	0.937500	23.812	49.212	74.612	100.012	125.412	150.812	176.212	201.612	227.012	252.412	277.812
61/64	0.953125	24.209	49.609	75.009	100.409	125.809	151.209	176.609	202.009	227.409	252.809	278.209
31/32	0.968750	24.606	50.006	75.406	100.806	126.206	151.606	177.006	202.406	227.806	253.206	278.606
63/64	0.984375	25.003	50.403	75.803	101.203	126.603	152.003	177.403	202.803	228.203	253.603	279.003

1" = 25.4 mm

Inches		11	12	13	14	15	16	17	18	19	20
Fraction	Decimal number	mm									
0	0.0000	279.400	304.800	330.200	355.600	381.000	406.400	431.800	457.200	482.600	508.000
1/16	0.0625	280.988	306.388	331.788	357.188	382.588	407.988	433.388	458.788	484.188	509.588
1/8	0.1250	282.575	307.975	333.375	358.775	384.175	409.575	434.975	460.375	485.775	511.175
3/16	0.1875	284.162	309.562	334.962	360.362	385.762	411.162	436.562	461.962	487.362	512.762
1/4	0.2500	285.750	311.150	336.550	361.950	387.350	412.750	438.150	463.550	488.950	514.350
5/16	0.3125	287.338	312.738	338.138	363.538	388.938	414.338	439.738	465.138	490.538	515.938
3/8	0.3750	288.925	314.325	339.725	365.125	390.525	415.925	441.325	466.725	492.125	517.525
7/16	0.4375	290.512	315.912	341.312	366.712	392.112	417.512	442.912	468.312	493.712	519.112
1/2	0.5000	292.100	317.500	342.900	368.300	393.700	419.100	444.500	469.900	495.300	520.700
9/16	0.5625	293.688	319.088	344.488	369.888	395.288	420.688	446.088	471.488	496.888	522.288
5/8	0.6250	295.275	320.675	346.075	371.475	396.875	422.275	447.675	473.075	498.475	523.875
11/16	0.6875	296.864	322.262	347.662	373.062	398.462	423.862	449.262	474.662	500.062	525.462
3/4	0.7500	298.450	323.850	349.250	374.650	400.050	425.450	450.850	476.250	501.650	527.050
13/16	0.8125	300.038	325.438	350.838	376.238	401.638	427.038	452.438	477.838	503.238	528.638
7/8	0.8750	301.625	327.025	352.425	377.825	403.225	428.625	454.025	479.425	504.825	530.225
15/16	0.9375	303.212	328.612	354.012	379.412	404.812	430.212	455.612	481.012	506.412	531.812

13. Viscosity Conversion Table

Kinematic viscosity mm ² /s	Saybolt universal second SUS (seconds)		Redwood 1 second R (seconds)		Engler viscosity E (degrees)
	100°F	210°F	50°C	100°C	
2	32.6	32.8	30.8	31.2	1.14
3	36.0	36.3	33.3	33.7	1.22
4	39.1	39.4	35.9	36.5	1.31
5	42.3	42.6	38.5	39.1	1.40
6	45.5	45.8	41.1	41.7	1.48
7	48.7	49.0	43.7	44.3	1.56
8	52.0	52.4	46.3	47.0	1.65
9	55.4	55.8	49.1	50.0	1.75
10	58.8	59.2	52.1	52.9	1.84
11	62.3	62.7	55.1	56.0	1.93
12	65.9	66.4	58.2	59.1	2.02
13	69.6	70.1	61.4	62.3	2.12
14	73.4	73.9	64.7	65.6	2.22
15	77.2	77.7	68.0	69.1	2.32
16	81.1	81.7	71.5	72.6	2.43
17	85.1	85.7	75.0	76.1	2.54
18	89.2	89.8	78.6	79.7	2.64
19	93.3	94.0	82.1	83.6	2.76
20	97.5	98.2	85.8	87.4	2.87
21	102	102	89.5	91.3	2.98
22	106	107	93.3	95.1	3.10
23	110	111	97.1	98.9	3.22
24	115	115	101	103	3.34
25	119	120	105	107	3.46
26	123	124	109	111	3.58
27	128	129	112	115	3.70
28	132	133	116	119	3.82
29	137	138	120	123	3.95
30	141	142	124	127	4.07
31	145	146	128	131	4.20
32	150	150	132	135	4.32
33	154	155	136	139	4.45
34	159	160	140	143	4.57
35	163	164	144	147	4.70
36	168	170	148	151	4.83
37	172	173	153	155	4.96
38	177	178	156	159	5.08
39	181	183	160	164	5.21
40	186	187	164	168	5.34
41	190	192	168	172	5.47
42	195	196	172	176	5.59
43	199	201	176	180	5.72
44	204	205	180	185	5.85
45	208	210	184	189	5.98
46	213	215	188	193	6.11
47	218	219	193	197	6.24
48	222	224	197	202	6.37
49	227	228	201	206	6.50
50	231	233	205	210	6.63
55	254	256	225	231	7.24
60	277	279	245	252	7.90
65	300	302	266	273	8.55
70	323	326	286	294	9.21
75	346	349	306	315	9.89
80	371	373	326	336	10.5
85	394	397	347	357	11.2
90	417	420	367	378	11.8
95	440	443	387	399	12.5
100	464	467	408	420	13.2
120	556	560	490	504	15.8
140	649	653	571	588	18.4
160	742	747	653	672	21.1
180	834	840	734	757	23.7
200	927	933	816	841	26.3
250	1 159	1 167	1 020	1 051	32.9
300	1 391	1 400	1 224	1 241	39.5

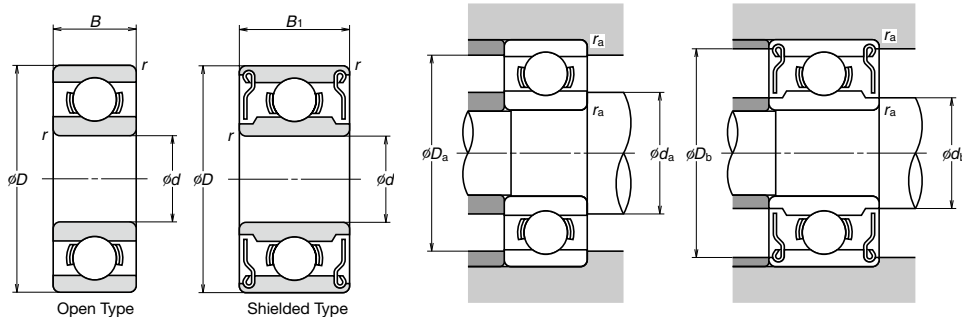
Remark: 1 mm²/s = 1 cSt

14. Hardness Conversion Table

(): Reference

Rockwell C scale hardness (1 471N) (150 kgf)	Vickers hardness	Brinell hardness		Rockwell hardness		Shore hardness
		Standard ball	Tungsten carbide ball	A scale	B scale	
				Load 588N (60 kgf) Brale indenter	Load 980.7N (100 kgf) 1.588 mm Ball (1/16 in)	
68	940	—	—	85.6	—	97
67	900	—	—	85.0	—	95
66	865	—	—	84.5	—	92
65	832	—	739	83.9	—	91
64	800	—	722	83.4	—	88
63	772	—	705	82.8	—	87
62	746	—	688	82.3	—	85
61	720	—	670	81.8	—	83
60	697	—	654	81.2	—	81
59	674	—	634	80.7	—	80
58	653	—	615	80.1	—	78
57	633	—	595	79.6	—	76
56	613	—	577	79.0	—	75
55	595	—	560	78.5	—	74
54	577	—	543	78.0	—	72
53	560	—	525	77.4	—	71
52	544	500	512	76.8	—	69
51	528	487	496	76.3	—	68
50	513	475	481	75.9	—	67
49	498	464	469	75.2	—	66
48	484	451	455	74.7	—	64
47	471	442	443	74.1	—	63
46	458	432	432	73.6	—	62
45	446	421	421	73.1	—	60
44	434	409	409	72.5	—	58
43	423	400	400	72.0	—	57
42	412	390	390	71.5	—	56
41	402	381	381	70.9	—	55
40	392	371	371	70.4	—	54
39	382	362	362	69.9	—	52
38	372	353	353	69.4	—	51
37	363	344	344	68.9	—	50
36	354	336	336	68.4	(109.0)	49
35	345	327	327	67.9	(108.5)	48
34	336	319	319	67.4	(108.0)	47
33	327	311	311	66.8	(107.5)	46
32	318	301	301	66.3	(107.0)	44
31	310	294	294	65.8	(106.0)	43
30	302	286	286	65.3	(105.5)	42
29	294	279	279	64.7	(104.5)	41
28	286	271	271	64.3	(104.0)	41
27	279	264	264	63.8	(103.0)	40
26	272	258	258	63.3	(102.5)	38
25	266	253	253	62.8	(101.5)	38
24	260	247	247	62.4	(101.0)	37
23	254	243	243	62.0	100.0	36
22	248	237	237	61.5	99.0	35
21	243	231	231	61.0	98.5	35
20	238	226	226	60.5	97.8	34
(18)	230	219	219	—	96.7	33
(16)	222	212	212	—	95.5	32
(14)	213	203	203	—	93.9	31
(12)	204	194	194	—	92.3	29
(10)	196	187	187	—	90.7	28
(9)	188	179	179	—	89.5	27
(6)	180	171	171	—	87.1	26
(4)	173	165	165	—	85.5	25
(2)	166	158	158	—	83.5	24
(0)	160	152	152	—	81.7	24

15. Dimensions of Shoulder and Fillet

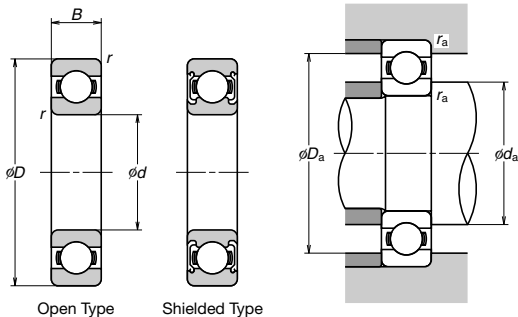


● Extra-Small Ball Bearings

Bore diameter <i>d</i> (mm)	Outside diameter <i>D</i> (mm)	Width		Chamfer dimension (minimum) <i>r</i> (mm)	Basic bearing number	Load rating <i>C_H</i> (reference value) (N)	Abutment and fillet dimensions (mm)				
		Open Type <i>B</i> (mm)	Shielded Type <i>B₁</i> (mm)				<i>d_a</i>	<i>d_b</i>	<i>D_a</i>	<i>D_b</i>	<i>r_a</i>
							Minimum	Maximum	Maximum	Minimum	Maximum
4	9	2.5	4	0.1	684	545	4.8	5.2	8.2	8.1	0.1
	11	4	4	0.15	694	815	5.2	5.6	9.8	9.9	0.15
	12	4	4	0.2	604	815	5.6	5.6	10.4	9.9	0.2
	13	5	5	0.2	624	1 110	5.6	6.0	11.4	11.3	0.2
	16	5	5	0.3	634	1 470	6.0	7.5	14.0	13.8	0.3
5	11	3	5	0.15	685	610	6.2	6.2	9.8	9.9	0.15
	13	4	4	0.2	695	915	6.6	6.6	11.4	11.2	0.2
	14	5	5	0.2	605	1 130	6.6	6.9	12.4	12.2	0.2
	16	5	5	0.3	625	1 470	7.0	7.5	14.0	13.8	0.3
	19	6	6	0.3	635	2 220	7.0	8.5	17.0	16.5	0.3
6	13	3.5	5	0.15	686	920	7.2	7.4	11.8	11.7	0.15
	15	5	5	0.2	696	1 470	7.6	7.9	13.4	13.3	0.2
	17	6	6	0.3	606	1 920	8.0	8.2	15.0	14.8	0.3
	19	6	6	0.3	626	2 220	8.0	8.5	17.0	16.5	0.3
	22	7	7	0.3	636	2 800	8.0	10.5	20.0	19.0	0.3
7	14	3.5	5	0.15	687	1 000	8.2	8.5	12.8	12.7	0.15
	17	5	5	0.3	697	1 370	9.0	10.2	15.0	14.8	0.3
	19	6	6	0.3	607	2 220	9.0	9.1	17.0	16.5	0.3
	22	7	7	0.3	627	2 800	9.0	10.5	20.0	19.0	0.3
	26	9	9	0.3	637	3 900	9.0	12.8	24.0	22.8	0.3
8	16	4	5	0.2	688	1 370	9.6	10.2	14.4	14.2	0.2
	19	6	6	0.3	698	1 900	10.0	10.0	17.0	16.5	0.3
	22	7	7	0.3	608	2 800	10.0	10.5	20.0	19.0	0.3
	24	8	8	0.3	628	2 850	10.0	12.0	22.0	20.5	0.3
	28	9	9	0.3	638	3 900	10.0	12.8	26.0	22.8	0.3
9	17	4	5	0.2	689	1 130	10.6	11.5	15.4	15.2	0.2
	20	6	6	0.3	699	1 460	11.0	12.0	18.0	17.2	0.3
	24	7	7	0.3	609	2 850	11.0	12.0	22.8	20.5	0.3
	26	8	8	0.6	629	3 900	11.0	12.8	24.0	22.8	0.3
	30	10	10	0.6	639	4 350	13.0	16.1	26.0	25.6	0.6
9.525	22.225	5.558	7.142	0.4	R6	2 830	12.6	11.9	19.2	20.0	0.4

Remarks Load rating *C_H*—load ratings of stainless steel bearings. Used to calculate an limiting load *P* of SPACEA™ bearing from *P/C_H*.
This value cannot be applied to calculation of rolling fatigue life of bearings with solid lubrication and coated bearings.

* Some open type SPACEA bearings have the same standard width as shielded type bearings



● Standard Bearings

Bore diameter <i>d</i> (mm)	Outside diameter <i>D</i> (mm)	Width of Open/ Shielded Type <i>B</i> (mm)	Chamfer dimension (minimum) <i>r</i> (mm)	Basic bearing number	Load rating <i>C_H</i> (reference value) (N)	Abutment and fillet dimensions (mm)			
						<i>d_a</i>		<i>D_a</i>	<i>r_a</i>
						Minimum	Maximum	Maximum	Maximum
10	19	5	0.3	6800	1 460	12	12	17	0.3
	22	6	0.3	6900	2 290	12	12.5	20	0.3
	26	8	0.3	6000	3 900	12	13	24	0.3
	30	9	0.6	6200	4 350	14	16	26	0.6
	35	11	0.6	6300	6 900	14	16.5	31	0.6
12	21	5	0.3	6801	1 630	14	14	19	0.3
	24	6	0.3	6901	2 460	14	14.5	22	0.3
	28	8	0.3	6001	4 350	14	15.5	26	0.3
	32	10	0.6	6201	5 800	16	17	28	0.6
	37	12	1	6301	8 250	17	18	32	1
15	24	5	0.3	6802	1 760	17	17	22	0.3
	28	7	0.3	6902	3 700	17	17	26	0.3
	32	9	0.3	6002	4 750	17	19	30	0.3
	35	11	0.6	6202	6 500	19	20.5	31	0.6
	42	13	1	6302	9 700	20	22.5	37	1
17	26	5	0.3	6803	2 240	19	19	24	0.3
	30	7	0.3	6903	3 900	19	19.5	28	0.3
	35	10	0.3	6003	5 100	19	21.5	33	0.3
	40	12	0.6	6203	8 150	21	23.5	36	0.6
	47	14	1	6303	11 600	22	25.5	42	1
20	32	7	0.3	6804	3 400	22	22	30	0.3
	37	9	0.3	6904	5 400	22	24	35	0.3
	42	12	0.6	6004	7 950	24	25.5	38	0.6
	47	14	1	6204	10 900	25	26.5	42	1
	52	15	1.1	6304	13 500	26.5	28	45.5	1
25	37	7	0.3	6805	3 800	27	27	35	0.3
	42	9	0.3	6905	5 950	27	28.5	40	0.3
	47	12	0.6	6005	8 550	29	30	43	0.6
	52	15	1	6205	11 900	30	32	47	1
30	55	13	1	6006	11 300	35	36.5	50	1
	62	16	1	6206	16 500	35	38.5	57	1
35	62	14	1	6007	13 600	40	41.5	57	1
	72	17	1.1	6207	21 800	41.5	44.5	65.5	1
40	68	15	1	6008	14 200	45	47.5	63	1
	80	18	1.1	6208	24 800	46.5	50.5	73.5	1
45	75	16	1	6009	17 800	50	53.5	70	1

Remarks Load rating *C_H*—load ratings of stainless steel bearings. Used to calculate an limiting load *P* of SPACEA™ bearing from *P/C_H*.
This value cannot be applied to calculation of rolling fatigue life of bearings with solid lubrication and coated bearings.

16. Tolerances for Shaft Diameters

Diameter classification (mm)		Single-plane mean-bore diameter deviation (Class 0) Δdmp	d6	e6	f6	g5	g6	h5	h6	h7	h8	h9	h10	js5	js6
over	incl.														
3	6	0 - 8	- 30 - 38	- 20 - 28	- 10 - 18	- 4 - 9	- 4 - 12	0 - 5	0 - 8	0 - 12	0 - 18	0 - 30	0 - 48	± 2.5	± 4
6	10	0 - 8	- 40 - 49	- 25 - 34	- 13 - 22	- 5 - 11	- 5 - 14	0 - 6	0 - 9	0 - 15	0 - 22	0 - 36	0 - 58	± 3	± 4.5
10	18	0 - 8	- 50 - 61	- 32 - 43	- 16 - 27	- 6 - 14	- 6 - 17	0 - 8	0 - 11	0 - 18	0 - 27	0 - 43	0 - 70	± 4	± 5.5
18	30	0 - 10	- 65 - 78	- 40 - 53	- 20 - 33	- 7 - 16	- 7 - 20	0 - 9	0 - 13	0 - 21	0 - 33	0 - 52	0 - 84	± 4.5	± 6.5
30	50	0 - 12	- 80 - 96	- 50 - 66	- 25 - 41	- 9 - 20	- 9 - 25	0 - 11	0 - 16	0 - 25	0 - 39	0 - 62	0 - 100	± 5.5	± 8
50	80	0 - 15	- 100 - 119	- 60 - 79	- 30 - 49	- 10 - 23	- 10 - 29	0 - 13	0 - 19	0 - 30	0 - 46	0 - 74	0 - 120	± 6.5	± 9.5
80	120	0 - 20	- 120 - 142	- 72 - 94	- 36 - 58	- 12 - 27	- 12 - 34	0 - 15	0 - 22	0 - 35	0 - 54	0 - 87	0 - 140	± 7.5	± 11
120	180	0 - 25	- 145 - 170	- 85 - 110	- 43 - 68	- 14 - 32	- 14 - 39	0 - 18	0 - 25	0 - 40	0 - 63	0 - 100	0 - 160	± 9	± 12.5
180	250	0 - 30	- 170 - 199	- 100 - 129	- 50 - 79	- 15 - 35	- 15 - 44	0 - 20	0 - 29	0 - 46	0 - 72	0 - 115	0 - 185	± 10	± 14.5
250	315	0 - 35	- 190 - 222	- 110 - 142	- 56 - 88	- 17 - 40	- 17 - 49	0 - 23	0 - 32	0 - 52	0 - 81	0 - 130	0 - 210	± 11.5	± 16
315	400	0 - 40	- 210 - 246	- 125 - 161	- 62 - 98	- 18 - 43	- 18 - 54	0 - 25	0 - 36	0 - 57	0 - 89	0 - 140	0 - 230	± 12.5	± 18
400	500	0 - 45	- 230 - 270	- 135 - 175	- 68 - 108	- 20 - 47	- 20 - 60	0 - 27	0 - 40	0 - 63	0 - 97	0 - 155	0 - 250	± 13.5	± 20
500	630	0 - 50	- 260 - 304	- 145 - 189	- 76 - 120	-	- 22 - 66	-	0 - 44	0 - 70	0 - 110	0 - 175	0 - 280	-	± 22
630	800	0 - 75	- 290 - 340	- 160 - 210	- 80 - 130	-	- 24 - 74	-	0 - 50	0 - 80	0 - 125	0 - 200	0 - 320	-	± 25
800	1 000	0 - 100	- 320 - 376	- 170 - 226	- 86 - 142	-	- 26 - 82	-	0 - 56	0 - 90	0 - 140	0 - 230	0 - 360	-	± 28
1 000	1 250	0 - 125	- 350 - 416	- 195 - 261	- 98 - 164	-	- 28 - 94	-	0 - 66	0 - 105	0 - 165	0 - 260	0 - 420	-	± 33
1 250	1 600	0 - 160	- 390 - 468	- 220 - 298	- 110 - 188	-	- 30 - 108	-	0 - 78	0 - 125	0 - 195	0 - 310	0 - 500	-	± 39
1 600	2 000	0 - 200	- 430 - 522	- 240 - 332	- 120 - 212	-	- 32 - 124	-	0 - 92	0 - 150	0 - 230	0 - 370	0 - 600	-	± 46

Unit: μm

j5	j6	j7	k5	k6	k7	m5	m6	n6	p6	r6	r7	Diameter classification (mm)	
												over	incl.
+ 3 - 2	+ 6 - 2	+ 8 - 4	+ 6 + 1	+ 9 + 1	+ 13 + 1	+ 9 + 4	+ 12 + 4	+ 16 + 8	+ 20 + 12	+ 23 + 15	+ 27 + 15	3	6
+ 4 - 2	+ 7 - 2	+ 10 - 5	+ 7 + 1	+ 10 + 1	+ 16 + 1	+ 12 + 6	+ 15 + 6	+ 19 + 10	+ 24 + 15	+ 28 + 19	+ 34 + 19	6	10
+ 5 - 3	+ 8 - 3	+ 12 - 6	+ 9 + 1	+ 12 + 1	+ 19 + 1	+ 15 + 7	+ 18 + 7	+ 23 + 12	+ 29 + 18	+ 34 + 23	+ 41 + 23	10	18
+ 5 - 4	+ 9 - 4	+ 13 - 8	+ 11 + 2	+ 15 + 2	+ 23 + 2	+ 17 + 8	+ 21 + 8	+ 28 + 15	+ 35 + 22	+ 41 + 28	+ 49 + 28	18	30
+ 6 - 5	+ 11 - 5	+ 15 - 10	+ 13 + 2	+ 18 + 2	+ 27 + 2	+ 20 + 9	+ 25 + 9	+ 33 + 17	+ 42 + 26	+ 50 + 34	+ 59 + 34	30	50
+ 6 - 7	+ 12 - 7	+ 18 - 12	+ 15 + 2	+ 21 + 2	+ 32 + 2	+ 24 + 11	+ 30 + 11	+ 39 + 20	+ 51 + 32	+ 60 + 41	+ 71 + 41	50	65
										+ 62 + 43	+ 73 + 43	65	80
+ 6 - 9	+ 13 - 9	+ 20 - 15	+ 18 + 3	+ 25 + 3	+ 38 + 3	+ 28 + 13	+ 35 + 13	+ 45 + 23	+ 59 + 37	+ 73 + 51	+ 86 + 51	80	100
										+ 76 + 54	+ 89 + 54	100	120
+ 7 - 11	+ 14 - 11	+ 22 - 18	+ 21 + 3	+ 28 + 3	+ 43 + 3	+ 33 + 15	+ 40 + 15	+ 52 + 27	+ 68 + 43	+ 88 + 63	+ 103 + 63	120	140
										+ 90 + 65	+ 105 + 65	140	160
										+ 93 + 68	+ 108 + 68	160	180
										+ 106 + 77	+ 123 + 77	180	200
+ 7 - 13	+ 16 - 13	+ 25 - 21	+ 24 + 4	+ 33 + 4	+ 50 + 4	+ 37 + 17	+ 46 + 17	+ 60 + 31	+ 79 + 50	+ 109 + 80	+ 126 + 80	200	225
										+ 113 + 84	+ 130 + 84	225	250
+ 7 - 16	± 16	± 26	+ 27 + 4	+ 36 + 4	+ 56 + 4	+ 43 + 20	+ 52 + 20	+ 66 + 34	+ 88 + 56	+ 126 + 94	+ 146 + 94	250	280
										+ 130 + 98	+ 150 + 98	280	315
+ 7 - 18	± 18	+ 29 - 28	+ 29 + 4	+ 40 + 4	+ 61 + 4	+ 46 + 21	+ 57 + 21	+ 73 + 37	+ 98 + 62	+ 144 + 108	+ 165 + 108	315	355
										+ 150 + 114	+ 171 + 114	355	400
+ 7 - 20	± 20	+ 31 - 32	+ 32 + 5	+ 45 + 5	+ 68 + 5	+ 50 + 23	+ 63 + 23	+ 80 + 40	+ 108 + 68	+ 166 + 126	+ 189 + 126	400	450
										+ 172 + 132	+ 195 + 132	450	500
-	-	-	-	+ 44 0	+ 70 0	-	+ 70 + 26	+ 88 + 44	+ 122 + 78	+ 194 + 150	+ 220 + 150	500	560
										+ 199 + 155	+ 225 + 155	560	630
-	-	-	-	+ 50 0	+ 80 0	-	+ 80 + 30	+ 100 + 50	+ 138 + 88	+ 225 + 175	+ 255 + 175	630	710
										+ 235 + 185	+ 265 + 185	710	800
-	-	-	-	+ 56 0	+ 90 0	-	+ 90 + 34	+ 112 + 56	+ 156 + 100	+ 266 + 210	+ 300 + 210	800	900
										+ 276 + 220	+ 310 + 220	900	1 000
-	-	-	-	+ 66 0	+ 105 0	-	+ 106 + 40	+ 132 + 66	+ 186 + 120	+ 316 + 250	+ 355 + 250	1 000	1 120
										+ 326 + 260	+ 365 + 260	1 120	1 250
-	-	-	-	+ 78 0	+ 125 0	-	+ 126 + 48	+ 156 + 78	+ 218 + 140	+ 378 + 300	+ 425 + 300	1 250	1 400
										+ 408 + 330	+ 455 + 330	1 400	1 600
-	-	-	-	+ 92 0	+ 150 0	-	+ 150 + 58	+ 184 + 92	+ 262 + 170	+ 462 + 370	+ 520 + 370	1 600	1 800
										+ 492 + 400	+ 550 + 400	1 800	2 000

17. Tolerances for Housing Bore Diameters

Diameter classification (mm)		Single-plane mean-outside diameter deviation (Class 0) ΔDmp	E6	F6	F7	G6	G7	H6	H7	H8	J6	J7	JS6	JS7
over	incl.													
10	18	0 - 8	+ 43 + 32	+ 27 + 16	+ 34 + 16	+ 17 + 6	+ 24 + 6	+ 11 0	+ 18 0	+ 27 0	+ 6 - 5	+10 - 8	± 5.5	± 9
18	30	0 - 9	+ 53 + 40	+ 33 + 20	+ 41 + 20	+ 20 + 7	+ 28 + 7	+ 13 0	+ 21 0	+ 33 0	+ 8 - 5	+12 - 9	± 6.5	±10.5
30	50	0 - 11	+ 66 + 50	+ 41 + 25	+ 50 + 25	+ 25 + 9	+ 34 + 9	+ 16 0	+ 25 0	+ 39 0	+10 - 6	+14 -11	± 8	±12.5
50	80	0 - 13	+ 79 + 60	+ 49 + 30	+ 60 + 30	+ 29 + 10	+ 40 + 10	+ 19 0	+ 30 0	+ 46 0	+13 - 6	+18 -12	± 9.5	±15
80	120	0 - 15	+ 94 + 72	+ 58 + 36	+ 71 + 36	+ 34 + 12	+ 47 + 12	+ 22 0	+ 35 0	+ 54 0	+16 - 6	+22 -13	± 11	±17.5
120 150	150 180	0 - 18 0 - 25	+110 + 85	+ 68 + 43	+ 83 + 43	+ 39 + 14	+ 54 + 14	+ 25 0	+ 40 0	+ 63 0	+18 - 7	+26 -14	± 12.5	±20
180	250	0 - 30	+129 +100	+ 79 + 50	+ 96 + 50	+ 44 + 15	+ 61 + 15	+ 29 0	+ 46 0	+ 72 0	+22 - 7	+30 -16	± 14.5	±23
250	315	0 - 35	+142 +110	+ 88 + 56	+108 + 56	+ 49 + 17	+ 69 + 17	+ 32 0	+ 52 0	+ 81 0	+25 - 7	+36 -16	± 16	±26
315	400	0 - 40	+161 +125	+ 98 + 62	+119 + 62	+ 54 + 18	+ 75 + 18	+ 36 0	+ 57 0	+ 89 0	+29 - 7	+39 -18	± 18	±28.5
400	500	0 - 45	+175 +135	+108 + 68	+131 + 68	+ 60 + 20	+ 83 + 20	+ 40 0	+ 63 0	+ 97 0	+33 - 7	+43 -20	± 20	±31.5
500	630	0 - 50	+189 +145	+120 + 76	+146 + 76	+ 66 + 22	+ 92 + 22	+ 44 0	+ 70 0	+110 0	—	—	± 22	±35
630	800	0 - 75	+210 +160	+130 + 80	+160 + 80	+ 74 + 24	+104 + 24	+ 50 0	+ 80 0	+125 0	—	—	± 25	±40
800	1 000	0 -100	+226 +170	+142 + 86	+176 + 86	+ 82 + 26	+116 + 26	+ 56 0	+ 90 0	+140 0	—	—	± 28	±45
1 000	1 250	0 -125	+261 +195	+164 + 98	+203 + 98	+ 94 + 28	+133 + 28	+ 66 0	+105 0	+165 0	—	—	± 33	±52.5
1 250	1 600	0 -160	+298 +220	+188 +110	+235 +110	+108 + 30	+155 + 30	+ 78 0	+125 0	+195 0	—	—	± 39	±62.5
1 600	2 000	0 -200	+332 +240	+212 +120	+270 +120	+124 + 32	+182 + 32	+ 92 0	+150 0	+230 0	—	—	± 46	±75
2 000	2 500	0 -250	+370 +260	+240 +130	+305 +130	+144 + 34	+209 + 34	+110 0	+175 0	+280 0	—	—	± 55	±87.5

Unit: μm

Diameter classification (mm)			K5	K6	K7	M5	M6	M7	N5	N6	N7	P6	P7	Diameter classification (mm)	
over	incl.													over	incl.
10	18		+ 2 - 6	+ 2 - 9	+ 6 - 12	- 4 -12	- 4 - 15	0 - 18	- 9 -17	- 9 - 20	- 5 - 23	- 15 - 26	- 11 - 29	10	18
18	30		+ 1 - 8	+ 2 - 11	+ 6 - 15	- 5 -14	- 4 - 17	0 - 21	-12 -21	- 11 - 24	- 7 - 28	- 18 - 31	- 14 - 35	18	30
30	50		+ 2 - 9	+ 3 - 13	+ 7 - 18	- 5 -16	- 4 - 20	0 - 25	-13 -24	- 12 - 28	- 8 - 33	- 21 - 37	- 17 - 42	30	50
50	80		+ 3 -10	+ 4 - 15	+ 9 - 21	- 6 -19	- 5 - 24	0 - 30	-15 -28	- 14 - 33	- 9 - 39	- 26 - 45	- 21 - 51	50	80
80	120		+ 2 -13	+ 4 - 18	+ 10 - 25	- 8 -23	- 6 - 28	0 - 35	-18 -33	- 16 - 38	- 10 - 45	- 30 - 52	- 24 - 59	80	120
120	180		+ 3 -15	+ 4 - 21	+ 12 - 28	- 9 -27	- 8 - 33	0 - 40	-21 -39	- 20 - 45	- 12 - 52	- 36 - 61	- 28 - 68	120	180
180	250		+ 2 -18	+ 5 - 24	+ 13 - 33	-11 -31	- 8 - 37	0 - 46	-25 -45	- 22 - 51	- 14 - 60	- 41 - 70	- 33 - 79	180	250
250	316		+ 3 -20	+ 5 - 27	+ 16 - 36	-13 -36	- 9 - 41	0 - 52	-27 -50	- 25 - 57	- 14 - 66	- 47 - 79	- 36 - 88	250	316
315	400		+ 3 -22	+ 7 - 29	+ 17 - 40	-14 -39	- 10 - 46	0 - 57	-30 -55	- 26 - 62	- 16 - 73	- 51 - 87	- 41 - 98	315	400
400	500		+ 2 -25	+ 8 - 32	+ 18 - 45	-16 -43	- 10 - 50	0 - 63	-33 -60	- 27 - 67	- 17 - 80	- 55 - 95	- 45 -108	400	500
500	630		—	0 - 44	0 - 70	—	- 26 - 70	- 26 - 96	—	- 44 - 88	- 44 -114	- 78 -122	- 78 -148	500	630
630	800		—	0 - 50	0 - 80	—	- 30 - 80	- 30 -110	—	- 50 -100	- 50 -130	- 88 -138	- 88 -168	630	800
800	1 000		—	0 - 56	0 - 90	—	- 34 - 90	- 34 -124	—	- 56 -112	- 56 -146	-100 -156	-100 -190	800	1 000
1 000	1 250		—	0 - 66	0 -105	—	- 40 -106	- 40 -145	—	- 66 -132	- 66 -171	-120 -186	-120 -225	1 000	1 250
1 250	1 600		—	0 - 78	0 -125	—	- 48 -126	- 48 -173	—	- 78 -156	- 78 -203	-140 -218	-140 -265	1 250	1 600
1 600	2 000		—	0 - 92	0 -150	—	- 58 -150	- 58 -208	—	- 92 -184	- 92 -242	-170 -262	-170 -320	1 600	2 000
2 000	2 500		—	0 -110	0 -175	—	- 68 -178	- 68 -243	—	-110 -220	-110 -285	-195 -305	-195 -370	2 000	2 500

Worldwide Sales Offices

P: Phone F: Fax ☆: Head Office

●Europe

United Kingdom:

NSK EUROPE LTD. (EUROPEAN HEADQUARTERS)

MAIDENHEAD Belmont Place, Belmont Road, Maidenhead, Berkshire SL6 6TB, U.K.
P: +44-1628-509-800 F: +44-1628-509-808

NSK UK LTD.

NEWARK Northern Road, Newark, Nottinghamshire NG24 2JF, U.K.
P: +44-1636-605-123 F: +44-1636-605-000

France:

NSK FRANCE S.A.S.

PARIS Quartier de l'Europe, 2 Rue Georges Guynemer, 78283 Guyancourt, France
P: +33-1-30-57-39-39 F: +33-1-30-57-00-01

Germany:

NSK DEUTSCHLAND GMBH

DUSSELDORF ☆ Harkortstrasse 15, D-40880 Ratingen, Germany
P: +49-2102-4810 F: +49-2102-4812-290

STUTTGART Liebknechtstrasse 33, D-70565 Stuttgart-Vaihingen, Germany
P: +49-711-79082-0 F: +49-711-79082-289

WOLFSBURG Tischlerstrasse 3, D-38440 Wolfsburg, Germany
P: +49-5361-27647-10 F: +49-5361-27647-70

Italy:

NSK ITALIA S.P.A.

MILANO Via Garibaldi 215, Garbagnate Milanese (Milano) 20024, Italy
P: +39-299-5191 F: +39-299-025778

Netherlands:

NSK EUROPEAN DISTRIBUTION CENTRE B.V.

TILBURG De Kroonstraat 38, 5048 AP Tilburg, Netherlands
P: +31-13-4647647 F: +31-13-4647648

Poland:

NSK REPRESENTATIVE OFFICE

WARSAW Ul. Migdalowa 4/73, 02-796, Warsaw, Poland
P: +48-22-645-1525 F: +48-22-645-1529

Russia:

NSK POLSKA SP. Z O.O.

SAINT-PETERSBURG Office I 703, Bldg 29, 18th Line of Vasilievskiy Ostrov, Saint-Petersburg, Russia, 199178
P: +7-812-332-5071 F: +7-812-332-5072

Spain:

NSK SPAIN S.A.

BARCELONA C/Tarragona, 161 Cuerpo Bajo, 2a Planta, 08014, Barcelona, Spain
P: +34-93-289-2763 F: +34-93-433-5776

Turkey:

NSK RULMANLARI ORTA DOGU TIC. LTD. STI.

ISTANBUL 19 Mayıs Mah. Ataturk Cad., Ulya Engin Is Merkezi No: 68 Kat. 6, P.K. : 34734,
Kozyatagi-Istanbul, Turkey
P: +90-216-477-7111 F: +90-216-477-7174

United Arab Emirates:

NSK BEARINGS GULF TRADING CO.

DUBAI JAFZA View 19, Floor 24 Office LB192402/3, PO Box 262163, DownTown Jebel Ali,
Dubai, UAE
P: +971-4-804-8207 F: +971-4-884-7227

●North and South America

United States of America:

NSK AMERICAS, INC. (AMERICAN HEADQUARTERS)

ANN ARBOR 4200 Goss Road, Ann Arbor, Michigan 48105, U.S.A.
P: +1-734-913-7500 F: +1-734-913-7511

NSK CORPORATION

ANN ARBOR 4200 Goss Road, Ann Arbor, Michigan 48105, U.S.A.
P: +1-734-913-7500 F: +1-734-913-7511

NSK PRECISION AMERICA, INC.

FRANKLIN ☆ 3450 Bearing Drive, Franklin, Indiana 46131, U.S.A.
P: +1-317-738-5000 F: +1-317-738-5050

SAN JOSE 780 Montague Expressway, Suite 505, San Jose, California, 95131, U.S.A.
P: +1-408-944-9400 F: +1-408-944-9405

NSK LATIN AMERICA, INC.

MIAMI 3470 NW 82nd Avenue Suite 625, Miami FL 33122, U.S.A.
P: +1-305-477-0605 F: +1-305-477-0377

Canada:

NSK CANADA INC.

TORONTO ☆ 5585 McAdam Road, Mississauga, Ontario, Canada L4Z 1N4
P: +1-905-890-0740 F: +1-800-800-2788

MONTREAL 2150-32E Avenue Lachine, Quebec, Canada H8T 3H7
P: +1-514-633-1220 F: +1-800-800-2788

VANCOUVER 3353 Wayburne Drive, Burnaby, British Columbia, Canada V5G 4L4
P: +1-877-994-6675 F: +1-800-800-2788

Argentina:

NSK ARGENTINA SRL

BUENOS AIRES García del Río 2477 Piso 7 Oficina "A" (1429) Buenos Aires-Argentina
P: +54-11-4704-5100 F: +54-11-4704-0033

Brazil:

NSK BRASIL LTDA.

SAO PAULO ☆ Rua 13 de Maio, 1633-14th Andar-Bela Vista-CEP 01327-905 São Paulo, SP, Brazil
P: +55-11-3269-4786 F: +55-11-3269-4720

BELO HORIZONTE Rua Ceara 1431-4th andar-sala 405-Funcionarios Belo Horizonte-MG, Brazil
30150-311
P: +55-31-3274-2591 F: +55-31-3273-4408

JOINVILLE Rua Blumenau, 178-sala 910-Centro Joinville-SC, Brazil 89204-250
P: +55-47-3422-5445 F: +55-47-3422-2817

PORTO ALEGRE Av. Cristovão Colombo, 1694-sala 202-Floresta Porto Alegre-RS, Brazil 90560 001
P: +55-51-3222-1324 F: +55-51-3222-2599

RECIFE Av. Conselheiro Aguiar, 2738-6th andar-conj. 604-Boa Viagem Recife-PE, Brazil 51020-020
P: +55-81-3326-3781 F: +55-81-3326-5047

Peru:

NSK PERU S.A.C.

LIMA Av. Caminos del Inca 670, Ofic : # 402, Santiago del Surco, Lima, Perú
P: +51-1-652-3372 F: +51-1-638-0555

Mexico:

NSK RODAMIENTOS MEXICANA, S.A. DE C.V.

MEXICO CITY ☆ Av. Presidente Juarez No.2007 Lote 5, Col. San Jeronimo Tepetlalcaltco,
Tlalnepantla, Estado de Mexico, Mexico, C.P.54090
P: +52-55-3682-2900 F: +52-55-3682-2937

MONTERREY Av. Ricardo Margain 575, IOS Torre C, Suite 516, Parque Corporativo Santa
Engracia, San Pedro Garza Garcia, N.L. Mexico, C.P.66267
P: +52-81-8000-7300 F: +52-81-8000-7095

<As of December 2015>

For the latest information, please refer to the NSK website.

www.nsk.com

NSK Ltd. has a basic policy not to export any products or technology designated as controlled items by export-related laws. When exporting the products in this brochure, the laws of the exporting country must be observed. Specifications are subject to change without notice and without any obligation on the part of the manufacturer. Every care has been taken to ensure the accuracy of the data contained in this brochure, but no liability can be accepted for any loss or damage suffered through errors or omissions. We will gratefully acknowledge any additions or corrections.

