MOTION & CONTROL™

NSK

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 Guides® 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.

SPACEA™

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 Guides® that can be applied to demanding operating environments.

Application: Sanitary environments
- Food processing machinery
- Medical instrument

Application: Dust-contaminated environments
- Food processing machinery
- Woodworking machinery
- Tire buffs
- Welding lines
- Graphite processing machinery
- Laser machinery

Application: Non-magnetic requirement
- Electron beam rendering devices
- Electron beam aligners
- Inspection equipment

Application: Vacuum environments
- Production machinery for semiconductors, LCD panels, PDPs, and hard disks
- Vacuum evaporation devices
- Vacuum robots
- Space exploration equipment

Application: Corrosive environments
- Cleaning equipment for semiconductors, LCD panels, PDPs, and hard disks
- Food processing machinery
- Conveyors
- Chemical plants
- Plating facilities
- Etching equipment

Application: Clean environments
- Transporters in clean rooms
- Production machinery for semiconductors and LCD panels, and conveyors in machinery
- Hard disk production machinery
- Solar cell production machinery

Application: High-temperature environments
- Kilns
- High-temperature conveyors
- Semiconductor production machinery
- Kiln cars

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

SPACEA™

Table of Contents

NSK *Global Network*

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.

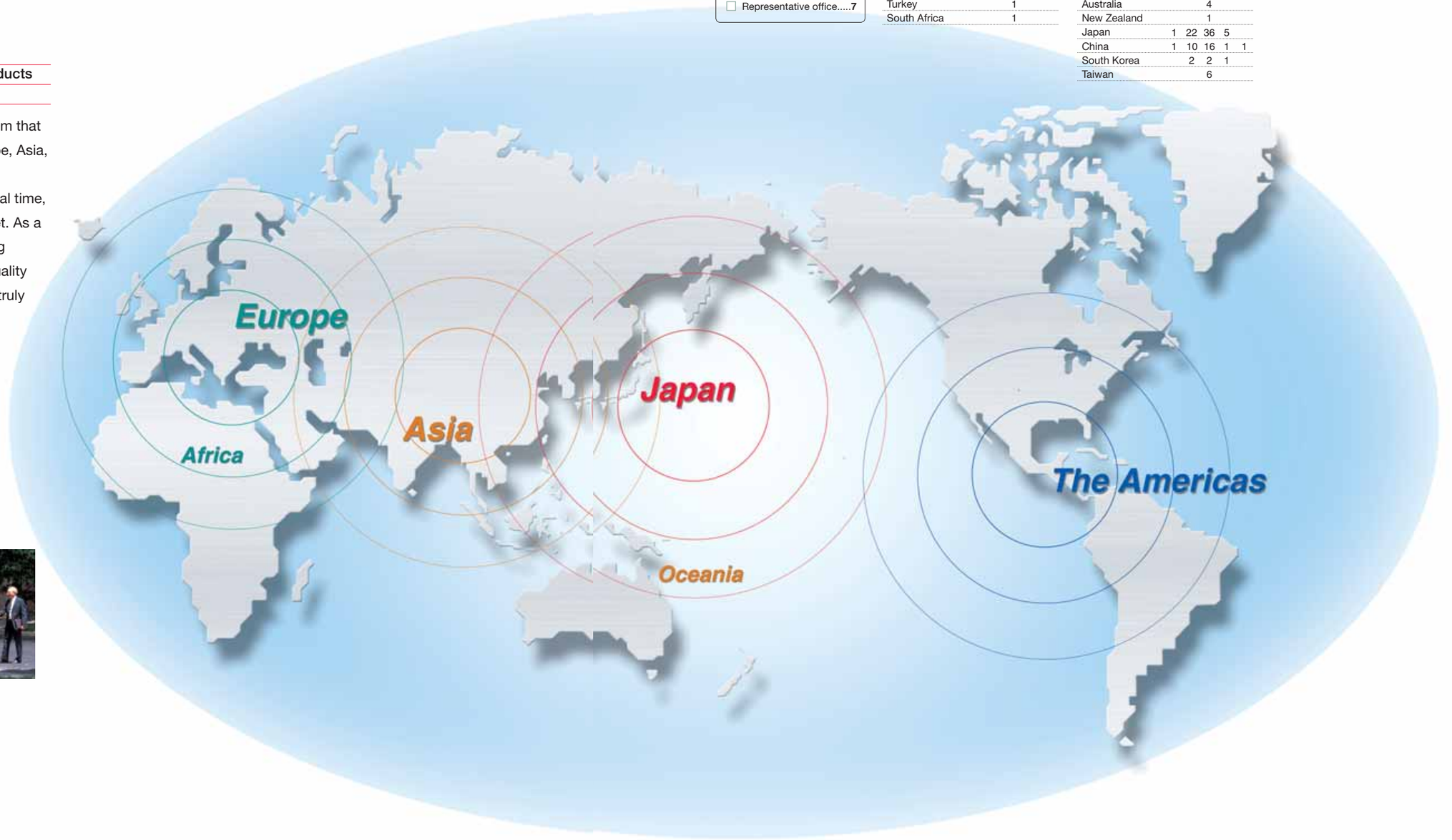
NSK has established a communication system that links the major markets of the world in Europe, Asia, Japan, and the Americas. We use this highly developed system to share information, in real time, related to changes and trends in each market. As a result, we can react quickly to meet changing customer 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.....**63**
- Sales office.....**113**
- Technical office.....**13**
- Representative office.....**7**

EUROPE/AFRICA	●	■	■	□	□
U.K.	1	5	2	1	
Germany		1	3	1	2
France			1		
Italy		1	2		
Spain			1		
Poland		4	3	1	1
Norway					1
Turkey			1		
South Africa			1		

ASIA/OCEANIA	●	■	■	□	□
Thailand	1	2	3	1	
Singapore			2		
Indonesia		3	2		
Malaysia		2	4		
Philippines					1
Vietnam			1		1
India	1	3	5		
Australia			4		
New Zealand			1		
Japan	1	22	36	5	
China	1	10	16	1	1
South Korea		2	2	1	
Taiwan			6		

THE AMERICAS	●	■	■	□	□
U.S.A.	1	7	6	1	
Canada			3		
Mexico			1		
Brazil		1	5	1	
Peru			1		
Argentina			1		

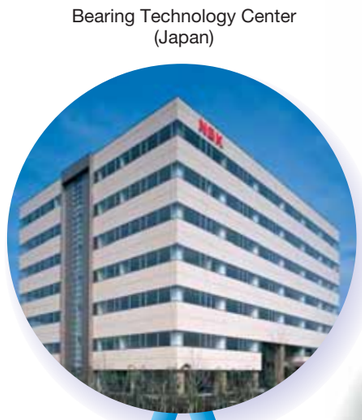


NSK *Research and Development*

SPACEA™

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.



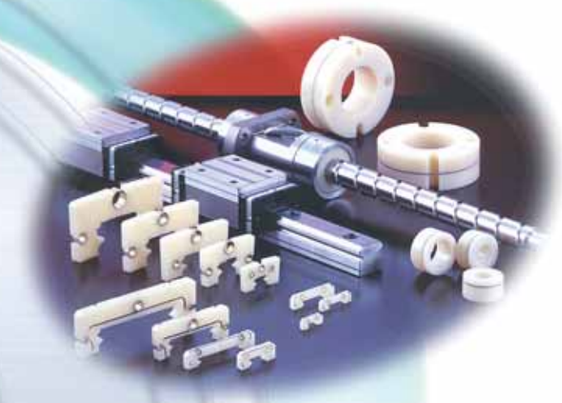
Bearing Technology Center
(Japan)

European Technology Centre
(England)

American Technology Center
(USA)

Titanium alloy bearings

Test rig for bearings for vacuum conditions



Lubrication Unit "NSK K1™"

SPACEA™ Series bearings

SPACEA™ Series bearings, ball screws and NSK Linear Guides™ 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

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, 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

SPACEA™ Series Bearings

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.

Vacuum environments

- **Clean**
  - DL2 clean grease-packed bearings
  - Clean lubricant DFO bearings
  - YS bearings with MoS_2 self-lubricating cage
- **High-temperature**
  - YS high-temperature bearings with spacer joints
  - SJ high-temperature bearings with solid lubrication
- **Non-magnetic**
  - High corrosion-resistant, non-magnetic stainless ESA bearings
  - Completely non-magnetic titanium alloy bearings

YS high-temperature bearings with spacer joints

Corrosive environments

- **Water environments**
  - Stainless steel bearings
  - Molded-Oil™ bearings
  - Hybrid bearings
  - Corrosion-resistant coated bearings (Nickel coating)
- **Alkali and weak acid environments**
  - High corrosion-resistant, high hardness stainless steel ESZ bearings
  - High corrosion-resistant, non-magnetic stainless steel ESA bearings
  - All-ceramic bearings (oxide-based ceramics)
- **Strong acid and reactive gas environments**
  - Aqua-Bearing™—high corrosion-resistant resin bearings
  - All-ceramic bearings (carbide-based ceramics)

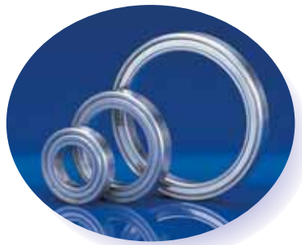
Stainless steel bearings

Aqua-Bearing™—
high corrosion-resistant resin bearings

SPACEA™ Series Bearings

Clean environments

- **Normal atmosphere, room temperature**
  - LG2/LGU clean grease-packed bearings
- **Normal atmosphere, high-temperature/ vacuum, medium-temperature**
  - DL2 clean grease-packed bearings
- **Vacuum, high-temperature**
  - YS bearings with MoS_2 self-lubricating cage
  - Clean lubricant DFO bearings



Clean grease-packed bearings

Clean lubricant DFO bearings

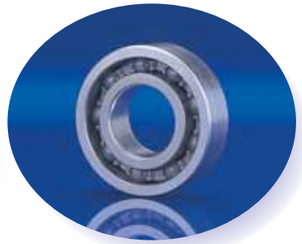
SJ high-temperature bearings with solid lubrication

High-temperature environments

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

Non-magnetic requirement

- **Non-magnetic (relative permeability 1.01 or less)**
  - High corrosion-resistant, non-magnetic stainless steel ESA bearings
- **Completely non-magnetic (relative permeability 1.001 or less)**
  - Completely non-magnetic titanium alloy bearings
  - All-ceramic bearings



Completely non-magnetic titanium alloy bearings

Dust-contaminated environments

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

Molded-Oil™ bearings

SPACEA™ Bearing Selection Guide-I

SPACEA™

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

① Select the group of bearings appropriate for your operating environment and application. → ② Find the bearings that suit your operating conditions. → ③ Select the bearing most appropriate in terms of availability and price. → ④ Follow the operating instructions that are provided. → ⑤ Determine the bearing number for making your inquiry.

① Operating environment			Product name	② Operating conditions: Degree of vacuum Pa (Normal atmosphere / ≤10^{-4} / ≤10^{-8})	② Operating conditions: Operating temperature ℃ (≤100 / ≤200 / ≤300 / ≤400)	② Operating conditions: Cleanliness[1] (100–1 000 / 100 / 10)	② Operating conditions: Limiting rotational speed $d_m n$[2] (≤20 000 / ≤50 000 / ≤150 000)	② Operating conditions: Limiting load P/C_H[3] (≤1% / ≤2% / ≤5%)	③ Price comparison	③ Availability	④ ·Specifications ·Operating instructions ·Technical data	⑤ Bearing number for inquiry[4]
Vacuum	Clean	Classification of air cleanliness: Class 100–1 000.	DL2 clean grease-packed bearings	10^{-4} Pa	200℃	●	50 000	5%	Low	Page A26	Page A53–A54	□□□□ LZZ–H DL2
		Classification of air cleanliness: Class 10–100.	Clean lubricant E-DFO bearings		150℃			5%		Page A27	Page A55–A56	□□□□ LZZ–HFD4
			Clean lubricant V-DFO bearings	10^{-7} Pa	200℃	●	20 000	2%				□□□□ LZZ–HFD
			Bearings with self-lubricating YS fluororesin cages		200℃	●		For details, please refer to page A57.		Page A28	Page A57–A58	□□□□ LZZ–HMST4
	High-temperature	Up to 400℃	SJ high-temperature bearings with solid lubrication	10^{-8} Pa	400℃		20 000	For details, please refer to page A63.	Low	Page A30	Page A63–A64	U–□□□□ –H–SJ
		Up to 350℃	YS high-temperature bearings with spacer joints	10^{-8} Pa	350℃			For details, please refer to page A61.		Page A28	Page A61–A62	□□□□ LZZ–HMSS2
	Non-magnetic	Non-magnetic (relative permeability 1.01 or less)	High corrosion-resistant, non-magnetic stainless steel ESA bearings	10^{-6} Pa	150℃		20 000	2%	Low	Page A23	Page A43–A44	ESA □□□□
		Completely non-magnetic (relative permeability 1.001 or less)	Completely non-magnetic titanium alloy bearings					1%		–	Page A65–A66	□□□□ L–T
Corrosive	Water	High-humidity environments	Stainless steel bearings		80℃		150 000	5%	Low	Page A15–A18	Page A31–A32	□□□□ –H–····✻MA
		Water spray, immersed	Molded-Oil™ bearings	●	60℃		For details, please refer to page A35.	1 to 5%		Page A20	Page A35–A36	□□□□ L11–H–DDU
			Hybrid bearings		150℃		20 000	2%		Page A21	Page A37–A38	□□□□ LZZ–YT3
		Water, sterilization liquid	Corrosion-resistant coated bearings (Nickel coating)								Page A39–A40	□□□□ LZZ–YNIT3
	Weak acid and alkali environments		High corrosion-resistant, high hardness stainless steel ESZ bearings	●				2%		Page A22	Page A41–A42	ESZ □□□□
			High corrosion-resistant, non-magnetic stainless steel ESA bearings	10^{-6} Pa	150℃		20 000			Page A23	Page A43–A44	ESA □□□□
			All-ceramic bearings (oxide-based ceramics) Strong acid and reactive gas environments	●				5%	High		Page A45–A46	□□□□ SZ1
	Strong acid and reactive gas environments		Aqua-Bearing™—high corrosion-resistant resin bearings	●	100℃			1%	Low	Page A24	Page A47–A48	□□□□ L–PT3 (–QT3)
			All-ceramic bearings (carbide-based ceramics)		150℃		20 000	5%	High	–	Page A49–A50	□□□□ SR1

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 10^7 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.)
(4) The bearing number for inquiry can be used as a reference before finalizing the specifications. The number will enable NSK to identify the summarized specifications of your bearing and provide you with a price estimate. A formal bearing number will be provided after the specifications are finalized. □□□□……represents the basic bearing number

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

B SPACEA Bearing Selection Guide-Ⅱ

SPACEA™

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

① Select the group of bearings appropriate for your operating environment and application. → ② Find the bearings that suit your operating conditions. → ③ Select the bearing most appropriate in terms of availability and price. → ④ Follow the operating instructions that are provided. → ⑤ Determine the bearing number for making your inquiry.

① Operating environment		Product name	② Operating conditions: Degree of vacuum Pa			② Operating conditions: Operating temperature ℃				② Operating conditions: Cleanliness[1]			② Operating conditions: Limiting rotational speed $d_m n$[2]			② Operating conditions: Limiting load P/C_H[3]			③ Price comparison	③ Availability	④ ·Specifications ·Operating instructions ·Technical data	⑤ Bearing number for inquiry[4]
			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 clean grease-packed bearings	●			70℃ (LG2) 120℃ (LGU)				●				50 000				5%	Low	Page A25–A26	Page A51–A52	□□□□ –H–ZZ LG2 □□□□ LZZ–H LG2 (LGU)
	From normal atmoshere up to vacuum	DL2 clean grease-packed bearings	10^{-4} Pa			200℃		For details, please refer to page A53.													Page A53–A54	□□□□ LZZ–H DL2
	Low outgas and low particle emissions	Clean lubricant E-DFO bearings				150℃		For details, please refer to page A56.				●					5%			Page A27	Page A55–A56	□□□□ LZZ–HFD4
		Clean lubricant V-DFO bearings	10^{-7} Pa			200℃							20 000				2%					□□□□ LZZ–HFD
		YS bearings with MoS_2 self-lubricating cages				200℃					●					For details, please refer to page A57.			High	Page A28	Page A57–A58	□□□□ LZZ–HMST4
High-temperature	For use in normal atmosphere only, up to 230°C	High-temperature KPM grease-packed bearings	●			230℃								50 000			5%		Low	Page A29	Page A59–A60	□□□□ LZZ (C3) –H KPM
	From normal atmosphere up to 10^{-8} Pa, up to 400℃	SJ high-temperature bearings with solid lubrication	10^{-8} Pa			400℃							20 000			For details, please refer to page A63.				Page A30	Page A63–A64	U–□□□□ –H–SJ
	From normal atmosphere up to 10^{-8} Pa, up to 350℃	YS high-temperature bearings with spacer joints		10^{-8} Pa		350℃										For details, please refer to page A61.			High	Page A28	Page A61–A62	□□□□ LZZ–HMSS2
Non-magnetic	Non-magnetic (relative permeability 1.01 or less)	High corrosion-resistant, non-magnetic stainless steel ESA bearings	10^{-6} Pa			150℃							20 000			2%			Low	Page A23	Page A43–A44	ESA □□□□
	Completely non-magnetic (relative permeability 1.001 or less)	Completely non-magnetic titanium alloy bearings														1%				–	Page A65–A66	□□□□ L–T
		All-ceramic bearings (oxide-based ceramics)	●															5%	High	Page A23	Page A45–A46	□□□□ SZ1
Dust-contaminated	Dust, wood waste, etc.	Molded-Oil™ bearings	●			60℃							For details, please refer to page A67.				1 to 5%		–	Page A68	Page A67–A68	□□□□ L11DDU

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.)
(4) The bearing number for inquiry can be used as a reference before finalizing the specifications. The number will enable NSK to identify the summarized specifications of your bearing and provide you with a price estimate. A formal bearing number will be provided after the specifications are finalized. □□□□……represents the basic bearing number

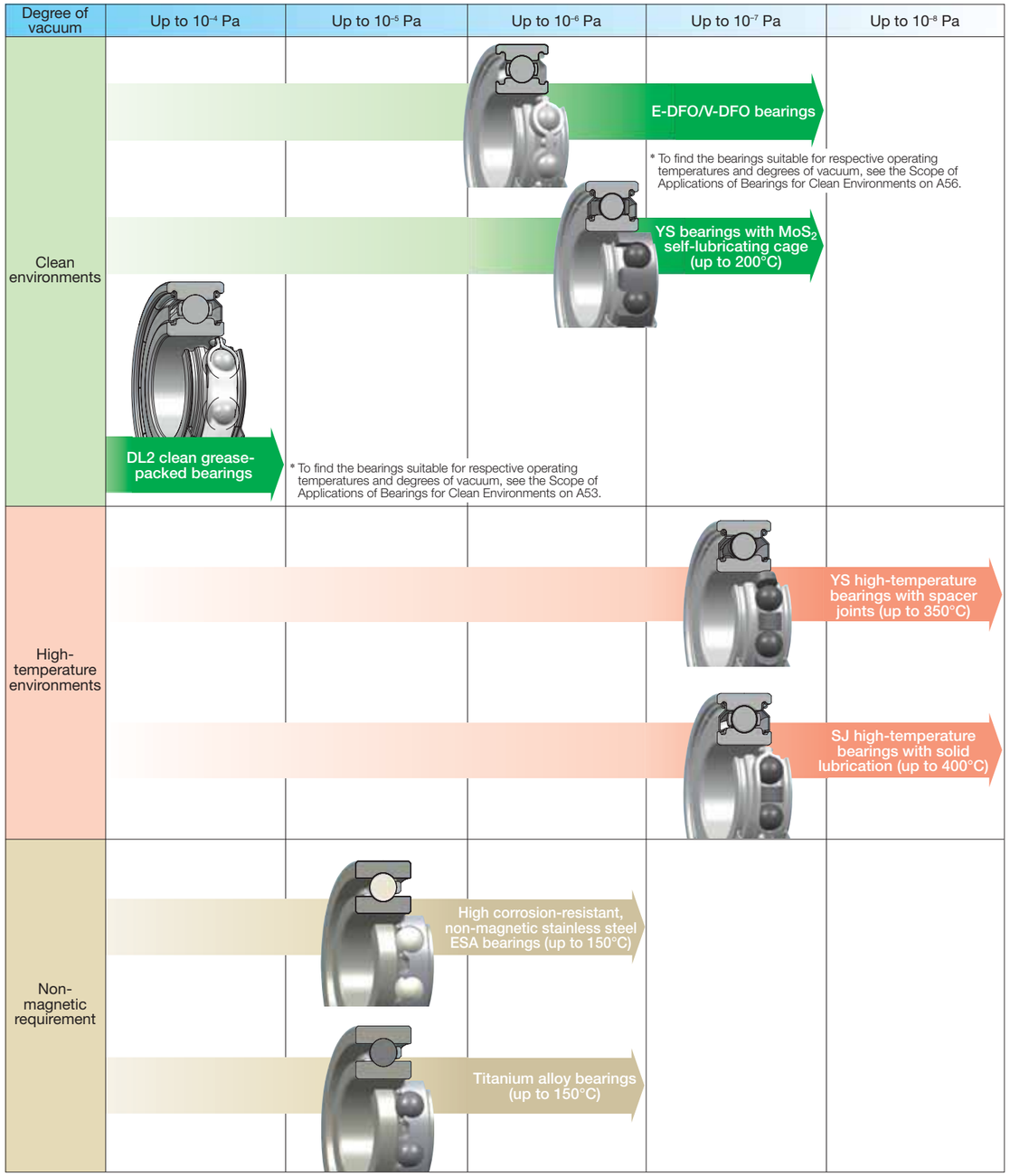
Remarks: Please consult NSK about a unidentified point about beaing specification.

SPACEA™ Bearings Listed by Operating Environment

SPACEA™

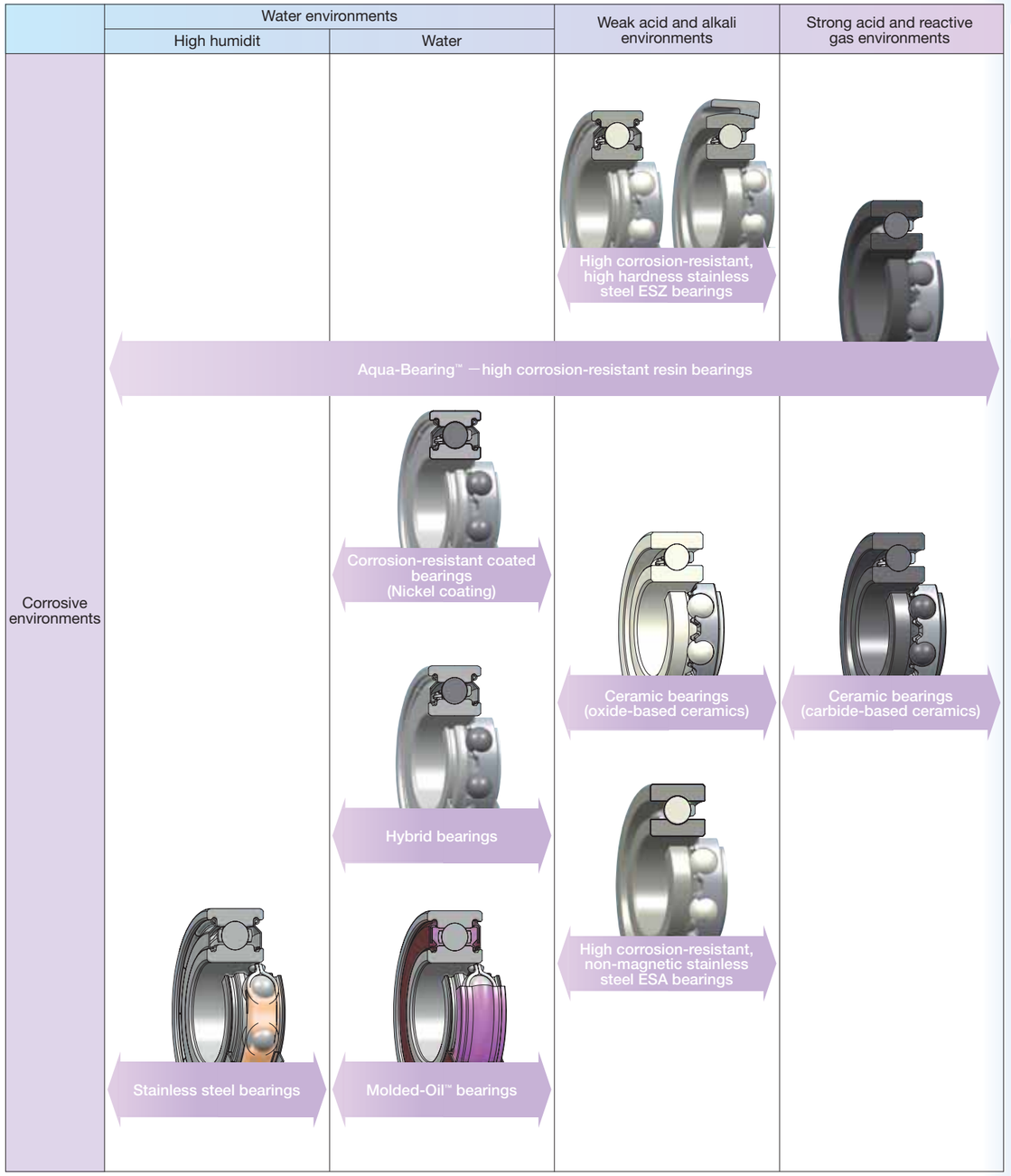
Bearings for vacuum environments

- Bearings for vacuum environments are base products of the NSK SPACEA™ Series for special environments, which also includes bearings suitable for operating environments such as clean, high-temperature environments, and non-magnetic requirement.



Bearings for corrosive environments

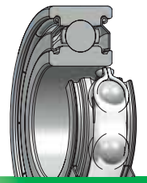
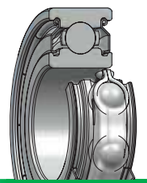
- High corrosion-resistant bearings are applicable in corrosive environments such as water, weak acid and alkali, and strong acid and reactive gas.
- High corrosion-resistant bearings include stainless steel bearings, Molded-Oil™ bearings, and corrosion-resistant coated bearings (Nickel coating) for water environments; ceramic bearings, ESA bearings and ESZ bearings for weak acid and alkali environments; and ceramic bearings and the Aqua-Bearing™ for strong acid and reactive gas environments.



SPACEA™ Bearings Listed by Operating Environment

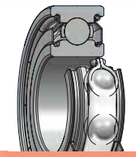
Bearings for clean environments

- Bearings for clean environments consist of clean grease-packed bearings, solid lubrication bearings, and clean lubricant DFO bearings.
- Clean grease-packed bearings are classified into bearings exclusively for use in normal atmosphere and bearings for vacuum environments. The solid lubrication bearings include MoS_2 solid lubricant or solid lubricant (fluororesin). The MoS_2 lubricant features long life; the fluorine lubricant, cleanliness.
- The clean lubricant E-DFO/V-DFO bearings represent a new concept in clean bearings, offering both long life and cleanliness.

Cleanliness	Class 100-1 000	Class 100-compliant	Class 10-compliant
Low outgas and particle emissions	 YS bearing with MoS_2 self-lubricating cage	E-DFO/V-DFO bearings	
From normal atmosphere up to vacuum	 DL2 clean grease-packed bearing		
For use in normal atmosphere only	 LG2/LGU clean grease-packed bearing		

Bearings for high-temperature environments

- Bearings for high-temperature environments consist of high-temperature, grease-packed bearings and MoS_2 solid-lubrication bearings.
- The high-temperature, grease-packed bearings are made exclusively for use under normal atmospheric pressure conditions in high-temperature environments (up to 230°C). They are packed with the NSK long-life fluorine grease, KPM, which has a life span five times as long as that of commercially available fluorine grease.
- For use in high-temperature, vacuum environments, SJ/YS high-temperature bearings with solid lubrication are recommended.

Operating temperature	Up to 230°C	Up to 350°C	Up to 400°C
Normal atmosphere	 KPM grease-packed bearings	 SJ high-temperature bearings with solid lubrication (Atmospheric pressure: up to 10^{-6} Pa)	
Vacuum	 YS high-temperature bearings with spacer joints (up to 10^{-6} Pa)		

Bearings for non-magnetic requirement

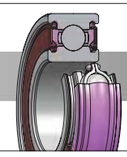
- Bearings for non-magnetic requirement are classified into non-magnetic (relative permeability 1.01 or less) bearings and completely non-magnetic (relative permeability 1.001 or less) bearings. Both bearings are harder and more resistant to corrosion than conventional stainless steel or beryllium-copper alloys.

Non-magnetic level	Non-magnetic (relative permeability 1.01 or less)	Completely non-magnetic (relative permeability 1.001 or less)
Normal atmosphere		 Ceramic bearings (carbide-based ceramics)
From normal atmosphere up to vacuum	 High corrosion-resistant, non-magnetic stainless steel ESA bearings	 Titanium alloy bearings

Bearings for dust-contaminated environments

- For dust-contaminated environments, bearing steel Molded-Oil™ bearings are recommended. These bearings are more economical than stainless steel Molded-Oil™ bearings.

  Note: Stainless steel Molded-Oil™ bearings are recommended for corrosive environments.

For use in normal atmosphere only, up to 60°C	 Molded-Oil™ bearings for dust-contaminated environments

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 corrosive coating 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 d (mm)		Single plane mean bore diameter deviation (Deviation of single bore diameter) Δ_{dmp}		Mean bore diameter variation (Out-of-roundness) V_{dp}				Mean bore diameter variation (Cylindricity) V_{dmp}
				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 D (mm)		Single plane mean outside diameter deviation (Deviation of single outside diameter) ΔD_{mp}		Mean outside diameter variation (Out-of-roundness) VD_p				Mean outside diameter variation (Cylindricity) V_{dmp}
				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 d (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

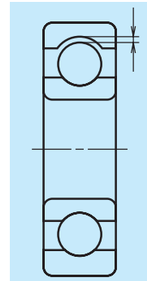
● Running accuracy

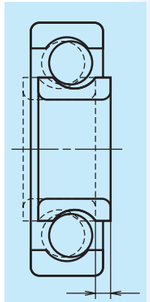
Unit: μm

Nominal bearing bore diameter d (mm)		Radial runout of assembled bearing inner ring k_{ia}		Radial runout of assembled bearing outer ring k_{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 clearance


Axial clearance

● Radial internal clearance of nominal bearing bore diameter

Unit: μm

Nominal bearing bore diameter d (mm)		Clearance									
		C2		CN		C3		C4		C5	
Over	Incl	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
10 only		0	7	2	13	8	23	14	29	20	37
10	**18**	0	9	3	18	11	25	18	33	25	45
18	**24**	0	10	5	20	13	28	20	36	28	48
24	**30**	1	11	5	20	13	28	23	41	30	53
30	**40**	1	11	6	20	15	33	28	46	40	64
40	**50**	1	11	6	23	18	36	30	51	45	73

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 d (mm)		Measuring load (N)	Clearance compensation value				
Over	Incl		C2	CN	C3	C4	C5
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.

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

Bearings Specifications Technical data A31–A32 pages

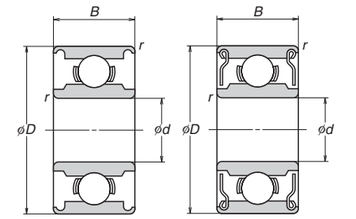
Stocked as standard inventory items

● Bearing number for inquiry[1]

Open Type: Basic bearing number -H-✻MA

Shielded Type: Basic bearing number -H-ZZ✻MA NS7

Rubber Sealed Type: Basic bearing number -H-DD✻MA NS7



Open Type (example) Shielded Type (example)
Rubber Sealed Type (example)

Boundary dimensions				Basic bearing number[2]	Dynamic load rating, C_H (reference value) (N)	Availability			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)			Open	Shielded	Rubber sealed		
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
	7	3.5	0.15	**602**	328	●	●		10 000	16
2.5	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
	8	4	0.15	**602X**	469	●	●		10 000	23
3	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
	13	5	0.2	**633**	1 100	●	●		10 000	55
4	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
	16	5	0.3	**634**	1 140	●	●	●	10 000	56
5	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
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
	22	7	0.3	**636**	2 800	●	●	●	10 000	140
7	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
	22	7	0.3	**627**	2 800	●	●	●	10 000	140
8	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
	24	8	0.3	✻ **628**	2 850	●	●	●	9 370	140
	28	9	0.3	**638**	3 890	●	●	●	8 330	190
9	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
	30	10	0.6	**639**	4 350	●	●		7 690	210
9.525	22.225	7.142	0.4	**R6**	2 830		●	●	9 440	140
10	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
	30	9	0.6	✻ **6200**	4 350	●	●	●	7 500	210
12	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.[4] Blank entry indicates non-stock items.

Notes (1) The actual bearing number of delivered products may include additional symbols or codes for NSK purposes.
(2) 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.
(3) The limiting load is a pure radial load that has been calculated based on a bearing life of 10^7 rotations.
(4) Orders placed for large quantities of 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 A14 for further details.

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

Bearings Specifications Technical data A31–A32 pages

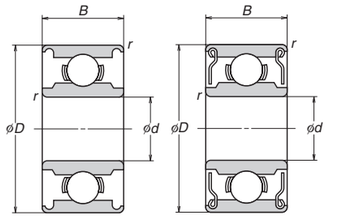
Stocked as standard inventory items

● Bearing number for inquiry[1]

Open Type: Basic bearing number -H-✻MA

Shielded Type: Basic bearing number -H-ZZ✻MA NS7

Rubber Sealed Type: Basic bearing number -H-DD✻MA NS7



Open Type (example) Shielded Type (example)
Rubber Sealed Type (example)

Boundary dimensions				Basic bearing number[2]	Dynamic load rating, C_H (reference value) (N)	Availability			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)			Open	Shielded	Rubber sealed		
15	21	4	0.2	**6702**	797	●	●	●	8 330	40
	24	5	0.3	✻ **6802**	1 760	●	●	●	7 690	88
	28	7	0.3	✻ **6902**	3 700	●	●	●	6 970	180
	32	9	0.3	✻ **6002**	4 750	●	●	●	6 380	230
	35	11	0.6	✻ **6202**	6 500	●	●	●	6 000	320
17	23	4	0.2	**6703**	849	●	●	●	7 500	42
	26	5	0.3	✻ **6803**	2 240	●	●	●	6 970	110
	30	7	0.3	✻ **6903**	3 900	●	●	●	6 380	190
	35	10	0.3	✻ **6003**	5 100	●	●	●	5 760	250
	40	12	0.6	✻ **6203**	8 150	●	●	●	5 260	400
20	27	4	0.2	**6704**	885	●	●	●	6 380	44
	32	7	0.3	✻ **6804**	3 400	●	●	●	5 760	170
	37	9	0.3	✻ **6904**	5 400	●	●	●	5 260	270
	42	12	0.6	✻ **6004**	7 950	●	●	●	4 830	390
	47	14	1	✻ **6204**	10 900	●	●	●	4 470	540
25	32	4	0.2	**6705**	931	●		●	5 260	47
	37	7	0.3	✻ **6805**	3 800	●	●	●	4 830	190
	42	9	0.3	✻ **6905**	5 950	●	●	●	4 470	290
	47	12	0.6	✻ **6005**	8 550	●	●	●	4 160	420
	52	15	1	✻ **6205**	11 900	●	●	●	3 890	590
30	37	4	0.2	**6706**	969	●		●	4 470	48
	55	13	1	✻ **6006**	11 300	●	●	●	3 520	560
	62	16	1	✻ **6206**	16 500	●	●	●	3 260	820
35	44	5	0.3	**6707**	1 590	●		●	3 790	79
	62	14	1	✻ **6007**	13 600	●	●	●	3 090	680
	72	17	1.1	✻ **6207**	21 800	●	●	●	2 800	1 090
40	50	6	0.3	**6708**	2 140	●		●	3 330	100
	68	15	1	✻ **6008**	14 200	●	●	●	2 770	710
	80	18	1.1	✻ **6208**	24 800	●	●	●	2 500	1 240
45	75	16	1	✻ **6009**	17 800		●	●	2 500	890
	85	19	1.1	✻ **6209**	26 600		●	●	2 300	1 330
50	80	16	1	✻ **6010**	18 500		●	●	2 300	920
	90	20	1.1	✻ **6210**	29 800		●	●	2 140	1 490
55	90	18	1.1	✻ **6011**	24 000		●	●	2 060	1 200
	100	21	1.5	✻ **6211**	37 000		●	●	1 930	1 850
60	95	18	1.1	✻ **6012**	25 000		●	●	1 930	1 250
	110	22	1.5	✻ **6212**	44 500		●	●	1 760	2 220

Symbol of availability: ● Stocked as standard inventory items.[4] Blank entry indicates non-stock items.

Notes (1) The actual bearing number of delivered products may include additional symbols or codes for NSK purposes.
(2) 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.
(3) The limiting load is a pure radial load that has been calculated based on a bearing life of 10^7 rotations.
(4) Orders placed for large quantities of 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 A14 for further details.

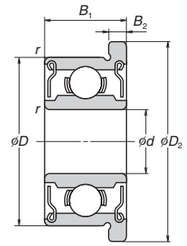
1-2. Stainless steel bearings (with flanged outer ring)

Bearings Specifications Technical data A31–A32 pages

Stocked as standard inventory items

● Bearing number for inquiry[1]

Basic bearing number -H-ZZ✻MA NS7



Boundary dimensions						Basic bearing number	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_1 (mm)	Flanged Outside diameter D_2 (mm)	Flanged Width B_2 (mm)	Chamfer dimension (min.) r (mm)					
1.5	4	2	5	0.6	0.05	**F681X**	96	●	10 000	4
	5	2.6	6.5	0.8	0.15	**F691X**	202	●	10 000	10
	6	3	7.5	0.8	0.15	**F601X**	281	●	10 000	14
2	5	2.3	6.1	0.6	0.08	**F682**	144	●	10 000	7
	5	2.5	6.2	0.6	0.1	**MF52**	144	●	10 000	7
	6	3	7.5	0.8	0.15	**F692**	281	●	10 000	14
	7	3	8.2	0.6	0.15	**MF72**	328	●	10 000	16
	7	3.5	8.5	0.9	0.15	**F602**	328	●	10 000	16
2.5	6	2.6	7.1	0.8	0.08	**F682X**	177	●	10 000	8
	7	3.5	8.5	0.9	0.15	**F692X**	328	●	10 000	16
	8	4	9.5	0.9	0.15	**F602X**	469	●	10 000	23
3	6	2.5	7.2	0.6	0.1	**MF63**	177	●	10 000	8
	7	3	8.1	0.8	0.1	**F683**	265	●	10 000	13
	8	4	9.5	0.9	0.15	**F693**	475	●	10 000	23
	9	4	10.6	0.8	0.15	**MF93**	486	●	10 000	24
	9	5	10.5	1	0.15	**F603**	486	●	10 000	24
	10	4	11.5	1	0.1	**F623**	538	●	10 000	26
4	7	2.5	8.2	0.6	0.1	**MF74**	217	●	10 000	10
	8	3	9.2	0.6	0.1	**MF84**	336	●	10 000	16
	9	4	10.3	1	0.1	**F684**	545	●	10 000	27
	10	4	11.6	0.8	0.15	**MF104**	604	●	10 000	30
	11	4	12.5	1	0.15	**F694**	815	●	10 000	40
	12	4	13.5	1	0.2	**F604**	815	●	10 000	40
	13	5	15	1	0.2	**F624**	1 110	●	10 000	55
	16	5	18	1	0.3	**F634**	1 140	●	10 000	56
5	8	2.5	9.2	0.6	0.1	**MF85**	185	●	10 000	9
	9	3	10.2	0.6	0.15	**MF95**	367	●	10 000	18
	10	4	11.6	0.8	0.15	**MF105**	367	●	10 000	18
	11	5	12.5	1	0.15	**F685**	609	●	10 000	30
	13	4	15	1	0.2	**F695**	916	●	10 000	45
	14	5	16	1	0.2	**F605**	1 130	●	10 000	56
	16	5	18	1	0.3	**F625**	1 470	●	10 000	73
	19	6	22	1.5	0.3	**F635**	1 990	●	10 000	99
6	10	3	11.2	0.6	0.1	**MF106**	423	●	10 000	21
	12	4	13.6	0.8	0.15	**MF126**	608	●	10 000	30
	13	5	15	1.1	0.15	**F686**	920	●	10 000	46
	15	5	17	1.2	0.2	**F696**	1 140	●	10 000	56
	17	6	19	1.2	0.3	**F606**	1 920	●	10 000	96
	19	6	22	1.5	0.3	**F626**	1 990	●	10 000	99
7	11	3	12.2	0.6	0.1	**MF117**	388	●	10 000	19
	13	4	14.6	0.8	0.15	**MF137**	460	●	10 000	23
	14	5	16	1.1	0.15	**F687**	1 000	●	10 000	50
	17	5	19	1.2	0.3	**F697**	1 370	●	10 000	68
	19	6	22	1.5	0.3	**F607**	1 990	●	10 000	99
	22	7	25	1.5	0.3	**F627**	2 800	●	10 000	140
8	12	3.5	13.6	0.8	0.1	**MF128**	463	●	10 000	23
	14	4	15.6	0.8	0.15	**MF148**	696	●	10 000	34
	16	5	18	1.1	0.2	**F688**	1 070	●	10 000	53
	19	6	22	1.5	0.3	**F698**	1 900	●	10 000	95
	22	7	25	1.5	0.3	**F608**	2 800	●	10 000	140
9	17	5	19	1.1	0.2	**F689**	1 130	●	10 000	56
	20	6	23	1.5	0.3	**F699**	2 100	●	10 000	100
10	19	5	21	1	0.3	**F6800**	1 460	●	10 000	73

Symbol of availability: ● Stocked as standard inventory items.[3]

Notes (1) The actual bearing number of delivered products may include additional symbols or codes for NSK purposes.
(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 large quantities of standard inventory items may incur some delay in actual delivery. Furthermore, products shipped from Japan may incur additional delays.

Remarks: 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 A14 for further details.

2. Stainless steel Angular Contact Ball Bearings

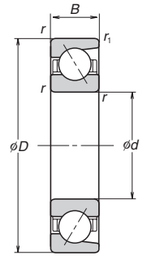
Bearings Specifications Technical data A33 pages

Stocked as standard inventory items

● Bearing number for inquiry[1]

For use in Normal atmosphere and Clean environments: Basic bearing number **-H-**

For use in Vacuum, Clean and High-temperature environments: Basic bearing number **-H-U264**



Boundary dimensions					Basic bearing number[2]	Dynamic load rating, C_H (reference value) (N)	Availability		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)	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.[4]

Notes (1) The actual bearing number of delivered products may include additional symbols or codes for NSK purposes.
(2) 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.
(3) The limiting load is a pure radial load that has been calculated based on a bearing life of 10^7 rotations.
(4) Orders placed for large quantities of 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.

3. Stainless steel Self-Aligning Ball Bearings

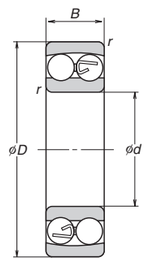
Bearings Specifications Technical data A34 pages

Stocked as standard inventory items

● Bearing number for inquiry[1]

Basic bearing number **-H-**

Boundary dimensions				Basic bearing number[2]	Dynamic load rating, C_H (reference value) (N)	Availability	Limiting speeds (reference value) (min^{-1})	Limiting load[3] (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.[4]

Notes (1) The actual bearing number of delivered products may include additional symbols or codes for NSK purposes.
(2) 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.
(3) The limiting load is a pure radial load that has been calculated based on a bearing life of 10^7 rotations.
(4) Orders placed for large quantities of 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. Molded-Oil™ bearings

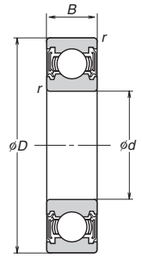
Bearings Specifications Technical data A35–A36 pages

Stocked as standard inventory items

● Bearing number for inquiry[1]

Basic bearing number **L11-H-DDU**

Boundary dimensions				Basic bearing number[2]	Availability	Limiting speeds[3] (reference value) (min^{-1})	Limiting load[4] (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	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.[5]

Notes (1) The actual bearing number of delivered products may include additional symbols or codes for NSK purposes.
(2) 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.
(3) 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.)
(4) The limiting load is a pure radial load that has been calculated based on a bearing life of 10^7 rotations.
(5) Orders placed for large quantities of standard inventory items may incur some delay in actual delivery. Furthermore, products shipped from Japan may incur additional delays.

Remarks: The radial internal clearance for the bearings on this page is CN. See the radial internal clearance tables on page A14 for further details.

5. Hybrid bearings

Bearings Specifications Technical data A37–A38 pages

Items available on short lead times

● Bearing number for inquiry[1]

Basic bearing number **LZZ-YT3**

Dimensions, Accuracy and Availability of bearings refer to the following Clause 6.

6. Corrosion-resistant coated bearings (Nickel coating)

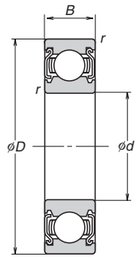
Bearings Specifications Technical data A39–A40 pages

Items available on short lead times

● Bearing number for inquiry[1]

Basic bearing number **LZZ-YNIT3**

Boundary dimensions				Basic bearing number[2]	Availability		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)		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: ◎ Items available on short lead times.[4]

Notes (1) The actual bearing number of delivered products may include additional symbols or codes for NSK purposes.

(2) 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.

(3) The limiting load is a pure radial load that has been calculated based on a bearing life of 10^7 rotations.

(4) Orders placed for large quantities of items that are available on short lead times may incur some delay in actual delivery. Furthermore, products shipped from Japan may incur additional delays.

Remarks: 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 A14 for further details.

7. High Corrosion-Resistant, High Hardness Stainless Steel ESZ Bearings

Deep groove ball bearings

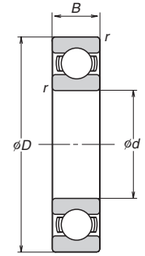
Bearings Specifications Technical data A41–A42 pages

Available on a production-by-order basis

● Bearing number for inquiry[1]

ESZ Basic bearing number

Boundary dimensions				Basic bearing number	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)				
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



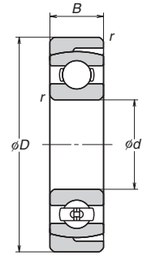
See the "Symbol of Availability," "Notes," and "Remarks" below the following bearing nomenclature for "Bearings with an Aligning Housing Ring."

Deep groove ball bearings with aligning housing rings

● Bearing number for inquiry[1]

ESZ Basic bearing number

Boundary dimensions				Basic bearing number	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)				
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

Notes (1) The actual bearing number of delivered products may include additional symbols or codes for NSK purposes.

(2) The limiting load is a pure radial load that has been calculated based on a bearing life of 10^7 rotations.

Remarks: The radial internal clearance for the bearings on this page is C3. See the radial internal clearance tables on page A14 for further details.

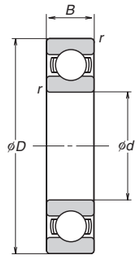
8. High corrosion-resistant, non-magnetic stainless steel ESA bearings

● Bearing number for inquiry[1]

Bearings Specifications Technical data A43–A44 pages

Items available on short lead times

ESA Basic bearing number



Boundary dimensions				Basic bearing number	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)				
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
	62	16	1	**6206**	◎	430	330

Symbol of availability: ◎ Items available on short lead times.[3]

Notes (1) The actual bearing number of delivered products may include additional symbols or codes for NSK purposes.
(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 large quantities of items that are available on short lead times may incur some delay in actual delivery. Furthermore, products shipped from Japan may incur additional delays.

Remarks: 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 A14 for further details.

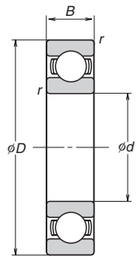
9. All-Ceramic Bearings (Oxide-based ceramic)

Bearings Specifications Technical data A45–A46 pages

● Bearing number for inquiry[1]

Items available on short lead times

Basic bearing number **SZ1**



Boundary dimensions				Basic bearing number	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)				
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: ◎ Items available on short lead times.[3]

Notes (1) The actual bearing number of delivered products may include additional symbols or codes for NSK purposes.
(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 large quantities of items that are available on short lead times may incur some delay in actual delivery. Furthermore, products shipped from Japan may incur additional delays.

Remarks: 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 A14 for further details.

10. Aqua-Bearing™-High Corrosion-Resisitant Resin Bearings

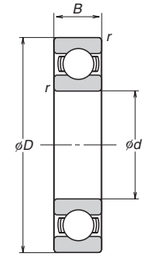
● Bearing number for inquiry[1]

Ceramic balls: Basic bearing number **L-PT3**

Special glass balls: Basic bearing number **L-QT3**

Bearings Specifications Technical data A47–A48 pages

Items available on short lead times



Boundary dimensions[2]				Basic bearing number	Availability		Limiting speeds (reference value) (min⁻¹)	Limiting load[3] (reference value) (N)	Radial internal clearance (mm)
Bore diameter *d* (mm)	Outside diameter *D* (mm)	Width *B* (mm)	Chamfer dimension (min.) *r* (mm)		Ceramics	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	
	40	12	0.6	**6203**	◎	◎	700	81	
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: ◎ Items available on short lead times.[4]

Notes (1) The actual bearing number of delivered products may include additional symbols or codes for NSK purposes.
(2) Tolerances: bore diameter: 0 mm to +0.05 mm; outer diameter: −0.05 mm to 0 mm
(3) The limiting load is a pure radial load that has been calculated based on a bearing life of 10^7 rotations.
(4) Orders placed for large quantities of items that are available on short lead times may incur some delay in actual delivery. Furthermore, products shipped from Japan may incur additional delays.

11. High Corrosion-Resisitant All-Ceramic Bearings (Carbide-based ceramic)

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

Bearings Specifications Technical data A49–A50 pages

Available on a production-by-order basis

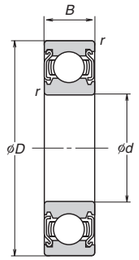
12-1. LG2 Clean Grease-Packed Bearings (For use in normal atmosphere only)

Bearings Specifications Technical data A51–A52 pages

Stocked as standard inventory items

● Bearing number for inquiry[1]

Basic bearing number **-H-ZZ LG2**



Boundary dimensions				Basic bearing number	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)				
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
	13	5	0.2	**624**	●	1 000	55
5	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	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
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	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	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	42	9	0.3	**6905**	●	1 000	290
	47	12	0.6	**6005**	●	1 000	420
	52	15	1	**6205**	●	1 000	590

Symbol of availability: ● Stocked as standard inventory items.[3]

Notes (1) The actual bearing number of delivered products may include additional symbols or codes for NSK purposes.
(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 large quantities of standard inventory items may incur some delay in actual delivery. Furthermore, products shipped from Japan may incur additional delays.

Remarks: 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 A14 for further details.

12-2. LG2/LGU Grease-Packed Bearings (For use in normal atmosphere only)

● Bearing number for inquiry[1]

Bearings Specifications Technical data A51–A52 pages

Items available on short lead times

Basic bearing number **LZZ-H LG2 (LGU)**

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

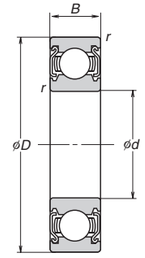
13. DL2 Clean Grease-Packed Bearings (From normal atmosphere up to vacuum)

● Bearing number for inquiry[1]

Bearings Specifications Technical data A53–A54 pages

Items available on short lead times

Basic bearing number **LZZ-H DL2**



Boundary dimensions				Basic bearing number	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)				
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**	◎	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

Symbol of availability: ◎ Items available on short lead times.[3]

Notes
(1) The actual bearing number of delivered products may include additional symbols or codes for NSK purposes.
(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 large quantities of items that are available on short lead times may incur some delay in actual delivery. Furthermore, products shipped from Japan may incur additional delays.

Remarks:
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 A14 for further details.

14. Clean Lubricant DFO Bearings

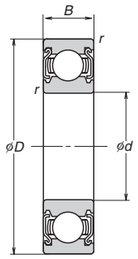
Bearings Specifications Technical data A55–A56 pages

Items available on short lead times

● Bearing number for inquiry[1]

E-DFO Beaarings: Basic bearing number **LZZ-HFD4**

V-DFO Beaarings: Basic bearing number **LZZ-HFD**



Boundary dimensions				Basic bearing number	E-DFO Beaarings			V-DFO Beaarings		
Bore diameter *d* (mm)	Outside diameter *D* (mm)	Width *B* (mm)	Chamfer dimension (min.) *r* (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

Symbol of availability: ◎ Items available on short lead times.[3]

Notes (1) The actual bearing number of delivered products may include additional symbols or codes for NSK purposes.
(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 large quantities of items that are available on short lead times may incur some delay in actual delivery. Furthermore, products shipped from Japan may incur additional delays.

Remarks: 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 A14 for further details.

15. YS Bearings with MoS_2 Self-Lubricating Cages

Bearings Specifications Technical data A57–A58 pages

Items available on short lead times

● Bearing number for inquiry[1]

Basic bearing number **LZZ-HMST4** Dimensions, Accuracy and Availability of bearings refer to the following Clause 17.

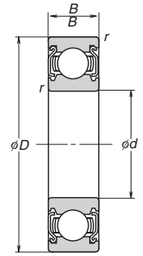
17. YS High-Temperature Bearings with Spacer Joints

Bearings Specifications Technical data A61–A62 pages

Items available on short lead times

● Bearing number for inquiry[1]

Basic bearing number **LZZ-HMSS2**



Boundary dimensions				Basic bearing number[2]	YS Bearings with MoS_2 Self-Lubricating Cages	YS High-Temperature Bearings with Spacer Joints	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	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
	17	5	0.3	**697**	◎		1 000	27
	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
9.525	22.225	7.142	0.4	**R6**	◎	○	1 000	56
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	42	7	0.3	**6806**	◎	◎	550	80
	47	9	0.3	**6906**	◎	◎	510	120
	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

Symbol of availability: ◎ Items available on short lead times.[4]
○ Available on a production-by-order basis. Blank entry indicates non-stock items.

Notes
(1) The actual bearing number of delivered products may include additional symbols or codes for NSK purposes.
(2) 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.
(3) The limiting load is a pure radial load that has been calculated based on a bearing life of 10^7 rotations.
(4) Orders placed for large quantities of items that are available on short lead times may incur some delay in actual delivery. Furthermore, products shipped from Japan may incur additional delays.

Remarks:
The radial internal clearances for the bearings on this page are listed below. See the radial internal clearance tables on page A14 for further details.
Bearings with a self-lubricating cage:
Bore diameters smaller than 10 mm: 0.008 mm to 0.023 mm.
Bore diameters of 10 mm or larger: C3
Bearing with spacer joints:
Bore diameters smaller than 10 mm: 0.014 mm to 0.029 mm.
Bore diameters of 10 mm or larger: C4

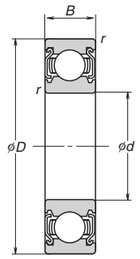
16. High-Temperature Grease-Packed Bearings (For use in normal atmosphere only)

● Bearing number for inquiry[1]

Bearings Specifications Technical data A59–A60 pages

Items available on short lead times

Basic bearing number **LZZ(C3)-H KPM**



Boundary dimensions				Basic bearing number[2]	Availability	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**	◎	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**	◎ (C3)	1 000	210
	32	10	0.6	**6201**	◎ (C3)	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**	◎ (C3)	1 000	230
	35	11	0.6	**6202**	◎ (C3)	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**	◎ (C3)	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**	◎ (C3)	1 000	390
	47	14	1	**6204**	◎ (C3)	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**	◎ (C3)	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

Symbol of availability: ◎ Items available on short lead times.[4]

Notes

(1) The actual bearing number of delivered products may include additional symbols or codes for NSK purposes.

(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. However, some of these bearings may also have a radial internal clearance of C3, which is indicated as so with parentheses in the "Availability" column. See the radial internal clearance tables on page A14 for further details.

(3) The limiting load is a pure radial load that has been calculated based on a bearing life of 10^7 rotations.

(4) Orders placed for large quantities of items that are available on short lead times may incur some delay in actual delivery. Furthermore, products shipped from Japan may incur additional delays.

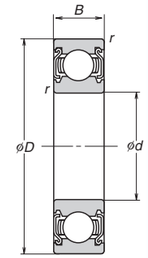
18. SJ High-Temperature bearings with solid lubrication

● Bearing number for inquiry[1]

Bearings Specifications Technical data A63–A64 pages

Items available on short lead times

U- Basic bearing number -H-SJ



Boundary dimensions				Basic bearing number[2]	Availability	Limiting speeds (reference value) (min⁻¹)	Limiting load[3] (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	0.020~0.080
10	26	8	0.3	✻ **6000**	◎	1 000	78	0.020~0.080
	30	9	0.6	✻ **6200**	◎	1 000	87	
12	28	8	0.3	✻ **6001**	◎	1 000	87	0.025~0.090
	32	10	0.6	✻ **6201**	◎	900	110	
15	32	9	0.3	✻ **6002**	◎	850	95	0.025~0.090
	35	11	0.6	✻ **6202**	◎	800	130	
17	35	10	0.3	✻ **6003**	◎	760	100	0.025~0.090
	40	12	0.6	✻ **6203**	◎	700	160	
20	42	12	0.6	✻ **6004**	◎	640	150	0.028~0.096
	47	14	1	✻ **6204**	◎	590	210	
30	55	13	1	✻ **6006**	◎	470	220	0.030~0.106

Symbol of availability: ◎ Items available on short lead times.[4]

Notes (1) The actual bearing number of delivered products may include additional symbols or codes for NSK purposes.

(2) 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.

(3) The limiting load is a pure radial load that has been calculated based on a bearing life of 10^7 rotations.

(4) Orders placed for large quantities of items that are available on short lead times may incur some delay in actual delivery. Furthermore, products shipped from Japan may incur additional delays.

19. Completely Non-Magnetic Titanium Alloy Bearings

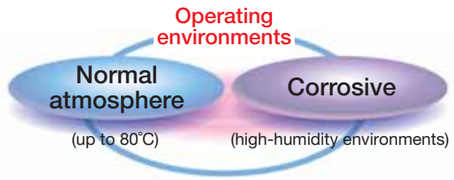
Bearings Specifications Technical data A65–A66 pages

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

Available on a production-by-order basis

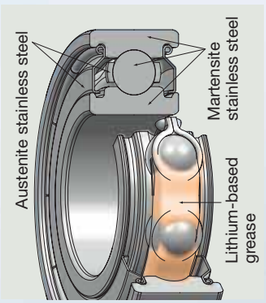
1. Stainless Steel Bearings

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

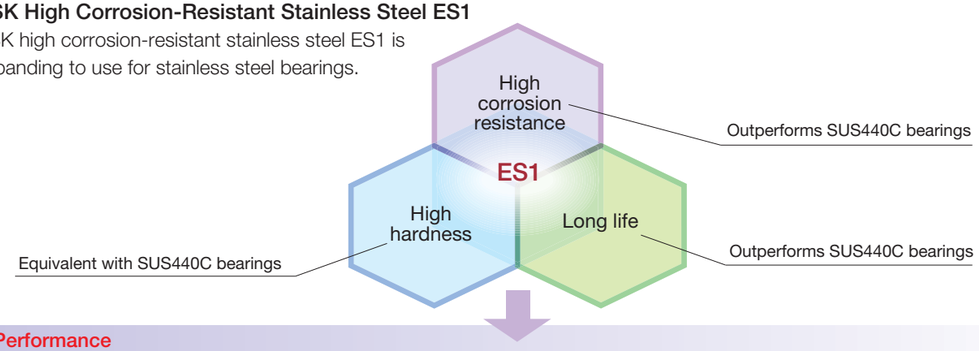
- For use in normal atmospheric conditions only.
- Bearings stocked as standard inventory items are prepacked with NS7 (lithium-based) grease.
- Bearing should not be unpacked until immediately before mounting.
- See the tables of SPACEA™ bearing nomenclature on pages A15 through A18 for the limiting 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 A15–A18)

NSK High Corrosion-Resistant Stainless Steel ES1

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



Performance

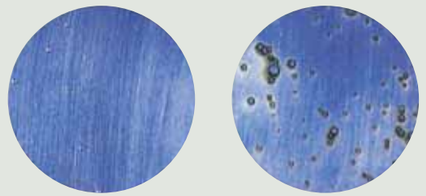
Material	Hardness, HRC	Corrosion resistance(1)	Features
NSK high corrosion-resistant stainless steel ES1	58–62	○	NSK-developed steel
Martensite stainless steel SUS440C	58–62	△	Ordinary stainless steel
Bearing steel SUJ2	60–64	×	Ordinary steel for bearings

Note (1) Comparative assessment between three kinds of materials

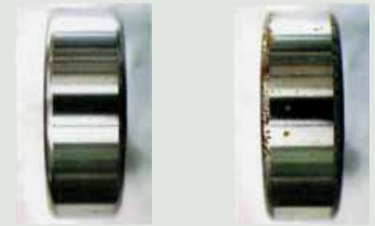
● Corrosion resistance of ES1

Outperforms SUS440C in corrosion resistance

Test sample: ϕ18 × 10 mm
(#800 emery paper, passivated)
Test solution: 5% NaCl solution
Immersion time: 8 hours (room temperature)



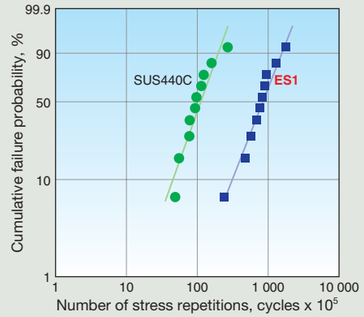
Salt spray test (JIS Z 2371)
Test solution: 5% NaCl solution
Test time: 1 hour
Temperature: 35˚C



● Immersion rolling fatigue life

Outperforms SUS440C in durability

Test bearings: 51305
Balls: Ceramics
Speed: 1 000 min^{-1}
Load: 980N



2. Stainless Steel Angular Contact Ball Bearings

Standard inventory

For use in Normal atmosphere and Clean environments

For use in Vacuum, Clean and High-temperature environments

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 up to 230°C.

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 A19 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.

3. Stainless Steel Self-Aligning Ball Bearings

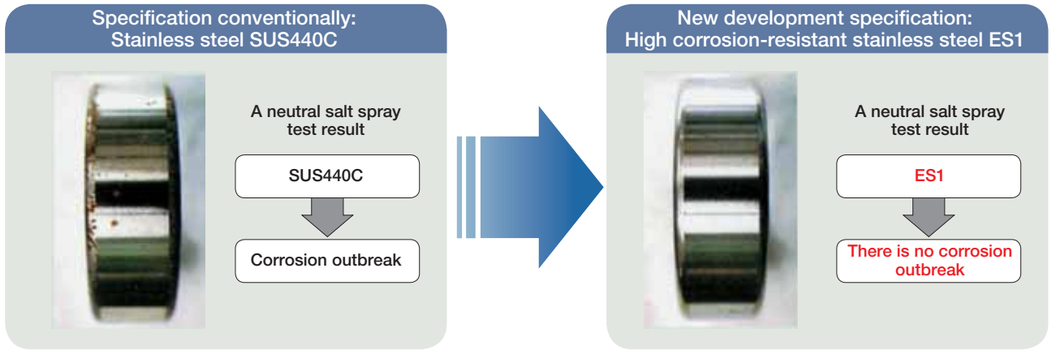
Standard inventory

For use in High corrosion-resistant stainless steel ES1

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

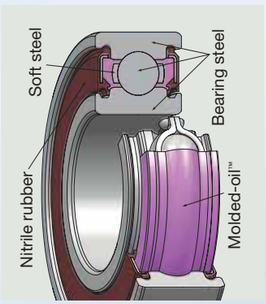
- Bearing should not be unpacked until immediately before mounting.
- Apply a coating of grease most appropriate for the bearing after cleaning the bearings and removing the anti-corrosion agent.
- See the tables of SPACEA™ bearing nomenclature on page A19 for the limiting loads and limiting rotational 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. Molded-Oil™ 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.

Product Specifications

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™
	Seals/Shields	Nitrile rubber/Austenite stainless steel

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

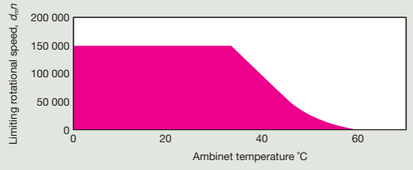
Operating Instructions and Notes

- 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

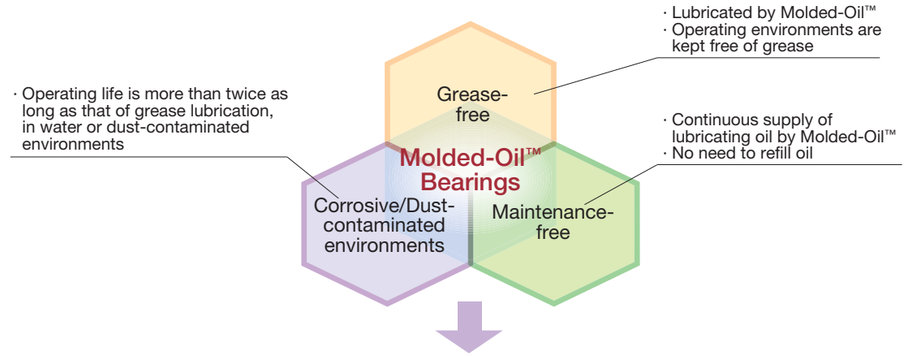
Applied load	Between 1% and 5%, inclusive, of the stainless steel bearing load rating C_H <Load more than 1% is necessary.>
Limiting rotational speed, $d_m n$(1)	150 000 <In the case of more than 35 degrees, please refer to chart below.>

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

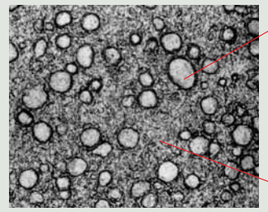


Features

- 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 A20)



Performance



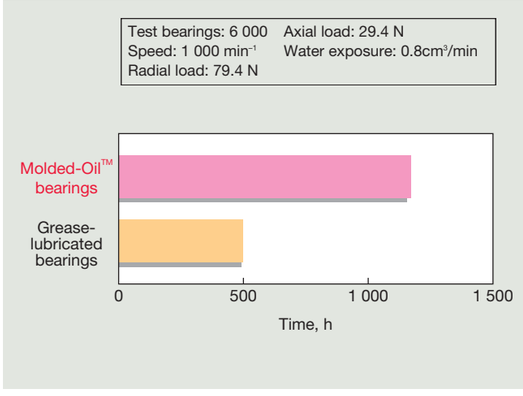
Close-up of Molded-Oil™ — 100 µm

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
The lubricating oil is mineral oil-based.

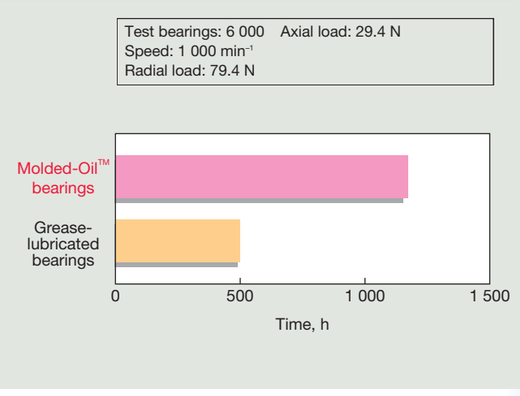
● Durability under wet conditions

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



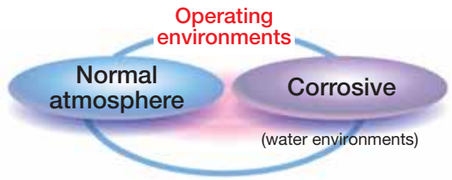
● Durability in water-immersed conditions

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



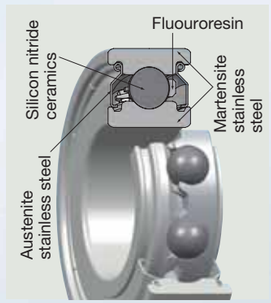
5. Hybrid Bearings

Hybrid bearings, combining ceramic balls and fluororesin self-lubricating cages, are suitable for corrosive environments from 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

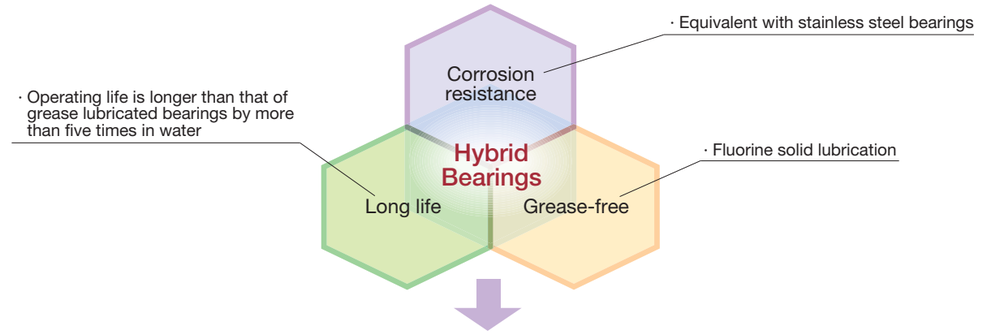
Applications: Devices and conveyor lines used in water-spray and water environments such as food processing and fishery equipment

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

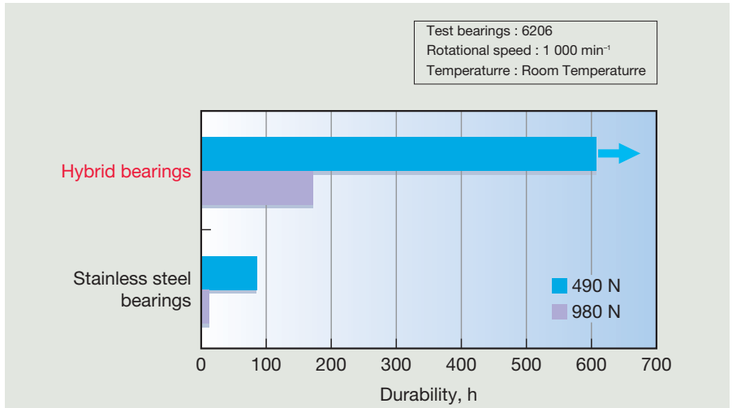
- Grease-free, fluorine solid lubricant
- Operating life more than five times as long as that of stainless steel bearings, in water-immersed environments



Performance

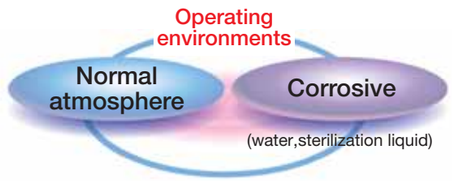
● Durability in water-immersed environments

Hybrid bearings have an operating life more than five times as long as that of stainless steel bearings.



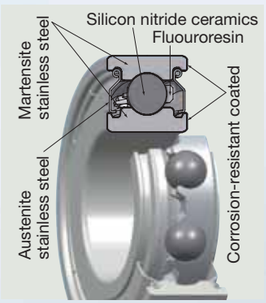
6. Corrosion-Resistant Coated Bearings (Nickel coating)

Corrosion-resistant coated bearings (Nickel coating) are coated with a nickel coating on the outer and inner rings to enhance corrosion resistance and durability, and are suitable for corrosive environments such as 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

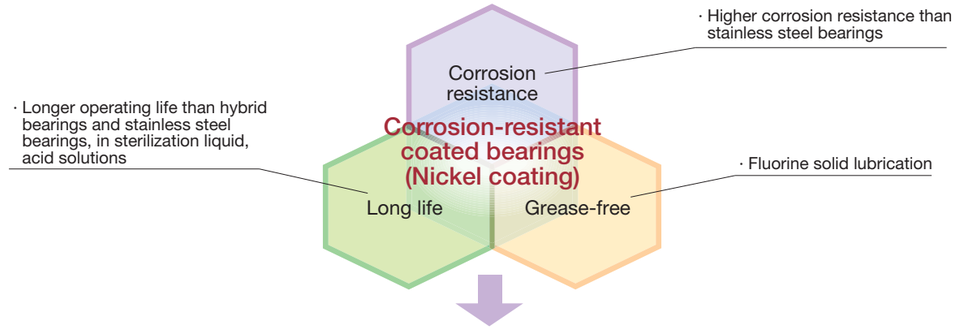
Applications: Semiconductor/FPD/HD cleaning equipment, etching equipment, food processing machinery, various conveyor lines

Operating Instructions and Notes

- Bearing should not be unpacked until immediately before mounting.
- See the tables of SPACEA™ bearing nomenclature on page 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.
- 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

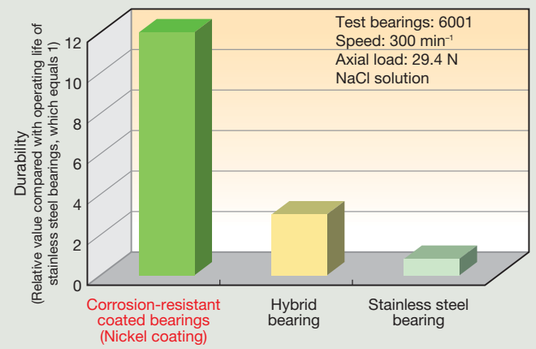
Immersed in a sodium hypochlorite solution
Concentration: 150 ppm

Stainless steel bearing SUS440C

Corrosion-resistant coated bearings (Nickel coating)

● Corrosion resistance in sodium hypochlorite solution

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

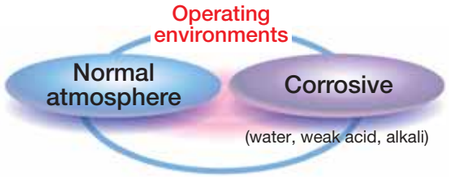


● Durability in NaCl solution

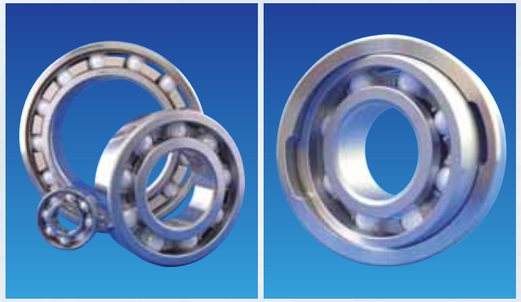
In NaCl solution, corrosion-resistant coated bearings (Nickel coating) have an operating life more than four times as long as that of hybrid bearings, and more than 12 times as long as that of stainless steel bearings.

7. High corrosion-Resistant, high hardness stainless steel ESZ Bearings

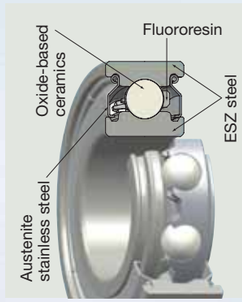
Highly corrosion-resistant, high-hardness stainless steel bearings offering corrosion resistance on a par with SUS630 bearing steel, and offering a higher degree of hardness by than 30 % in comparison with SUS630.
The bearings are suitable for corrosive environment operating under atmospheric conditions.



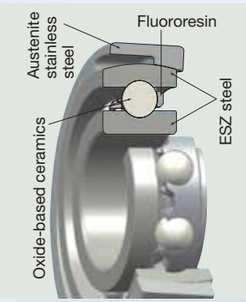
Product Specifications



Representative structure



Representative structure with aligning housing rings



Structure		Deep groove ball bearings	Deep groove ball bearings with aligning housing rings
		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 rings	—	Austenite stainless steel

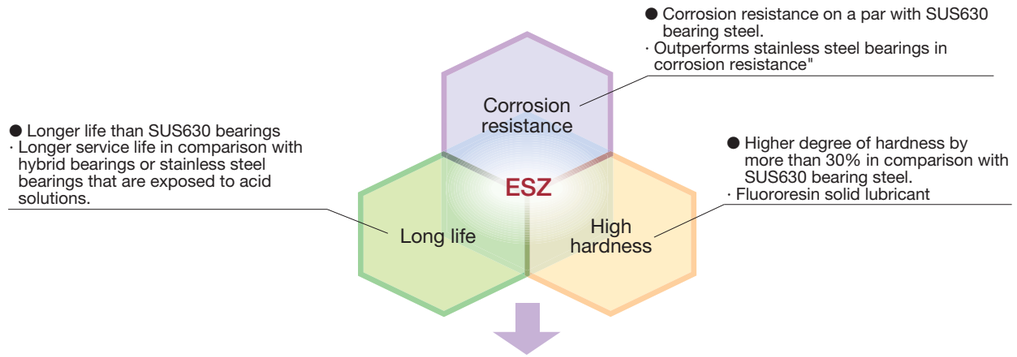
Applications: High function film conveyor, cleaning equipment, food processing machinery, various conveyor lines

Operating Instructions and Notes

- Bearing should not be unpacked until immediately before mounting.
- See the tables of SPACEA™ bearing nomenclature on page A22 for the limiting loads and limiting rotational speeds.
- C3 is the standard radial internal clearance.
- When bearings with aligning housing rings are used under radial loads, move the phase between the slot 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

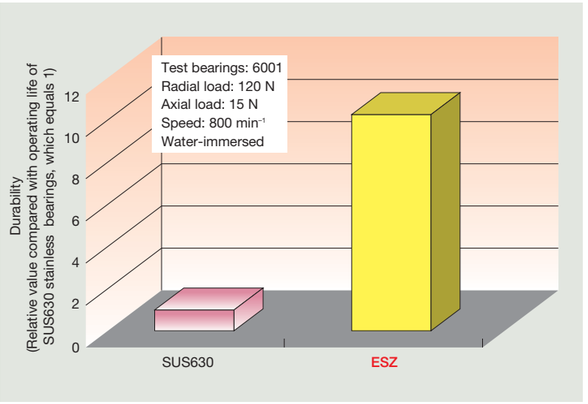
- Product lineup includes standard deep groove ball bearings and deep groove ball bearings with aligning housing rings.
- Corrosion resistance on a par with SUS630 bearing steel. Able to withstand exposure to sodium hypochlorite solutions.
- Hardness increased by more than 30 % in comparison with SUS630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



Performance

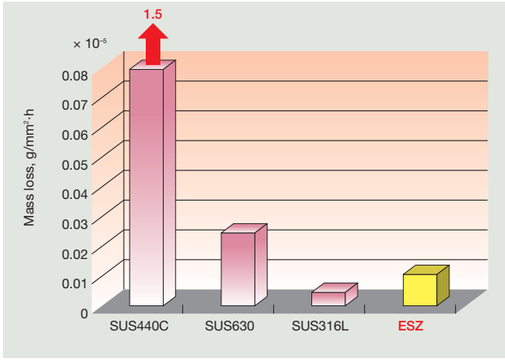
● Durability in water-immersed conditions

Longer life than SUS630 bearings



● Results of 5% sulfuric acid immersion test

Equal to or higher than SUS630

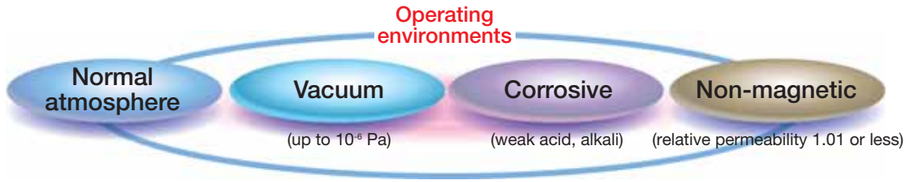


● Results of sodium hypochlorite solution immersion test

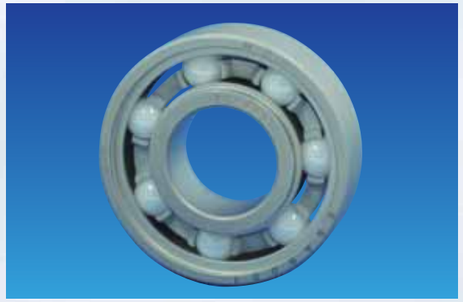
(Density: 120 ppm; photograph 120 hours after operation)

8. High Corrosion-Resistant, Non-Magnetic Stainless Steel ESA Bearings

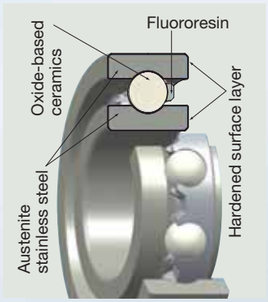
ESA Bearings, combining austenite stainless steel and hardened surface layers, possess high hardness, corrosion resistance and non-magnetic properties, and are suitable for corrosive environments and non-magnetic requirement in normal atmosphere and vacuum.



Product Specifications



Representative structure



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

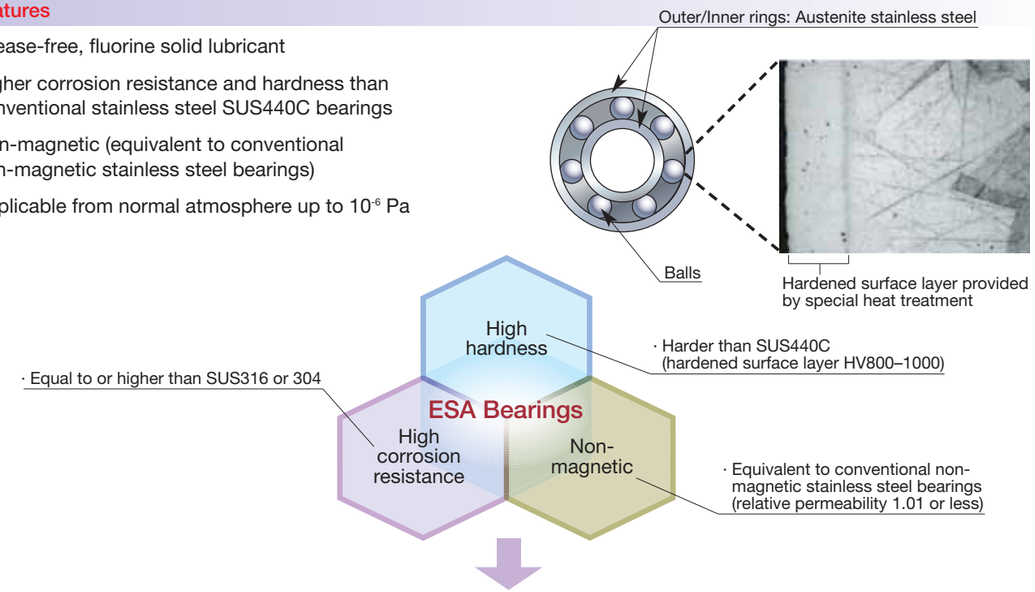
Applications: Corrosive environments: Cleaning equipment (except for etching equipment)
Non-magnetic requirement: Electron beam drawing devices, electron beam exposure equipment, testers

Operating Instructions and Notes

- Bearing should not be unpacked until immediately before mounting.
- See the tables of SPACEA™ bearing nomenclature on page A23 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 A23.
- 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 bearings
- Non-magnetic (equivalent to conventional non-magnetic stainless steel bearings)
- Applicable from normal atmosphere up to 10^{-6} Pa



Performance

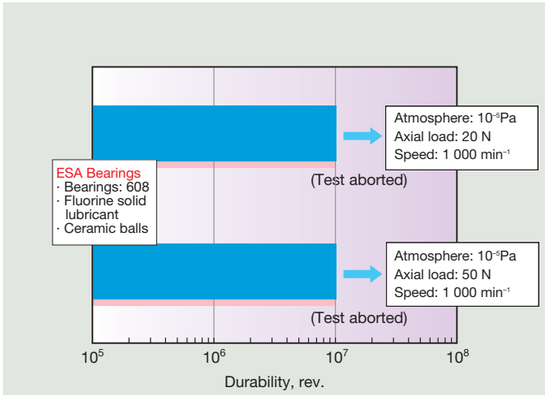
Comparison with conventional materials

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 body	△	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

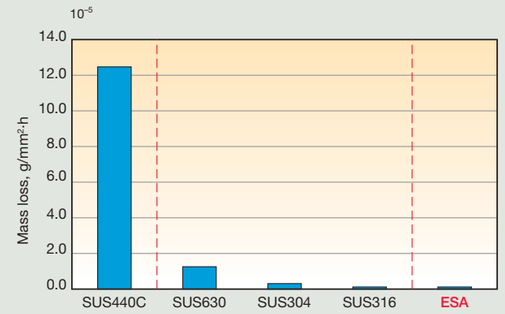
Durability in water-immersed conditions

ESA bearings have durability of more than 10^7 rotations.



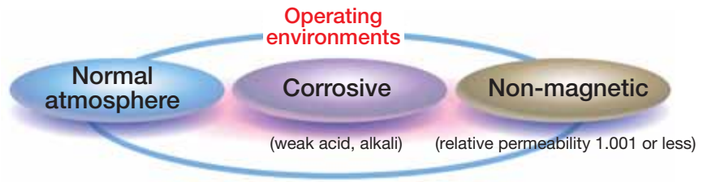
Results of 20% sulfuric acid immersion test

Corrosion resistance is equivalent with SUS316, 304



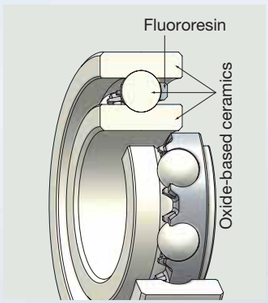
9. All-Ceramic Bearings (Oxide-based ceramics)

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



Product Specifications

Representative structure



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

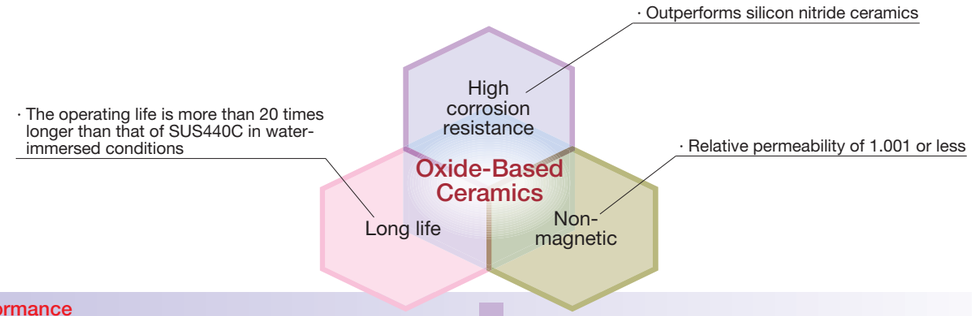
Applications: Corrosive environments: Semiconductor production machinery, chemical processing equipment, metal plating equipment
Non-magnetic requirement: Electron beam drawing devices, electron beam exposure equipment, testers

Operating Instructions and Notes

- Bearing should not be unpacked until immediately before mounting.
- See the tables of SPACEA™ bearing nomenclature on page A23 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 A23.
- 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

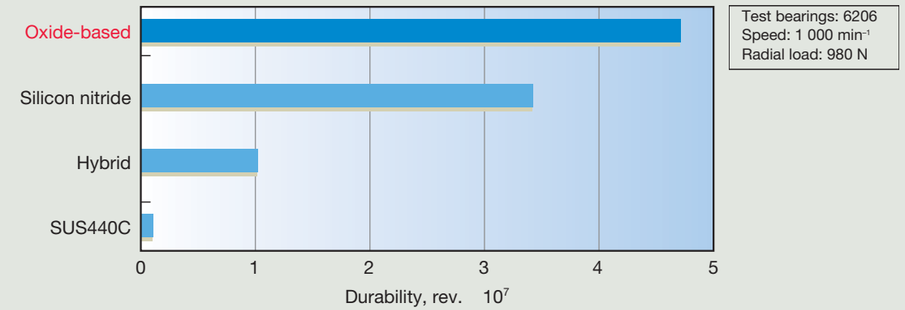
Oxide-based ceramics (ZrO_2) are:
☆More corrosion-resistant than stainless steel SUS440C or silicon nitride ceramics (Si_3N_4)
☆Lower in price than other ceramics

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		Standard	High	Low

Corrosion resistance evaluation ○: Slightly corroded △: Partially corroded ×: Corroded

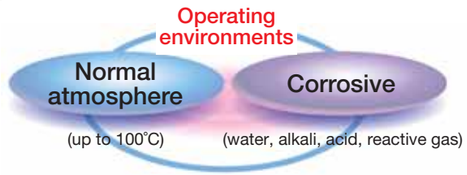
● Durability in water-immersed conditions

Oxide-based ceramics (ZrO_2) are 20 times more durable than SUS440C under water-immersed conditions.

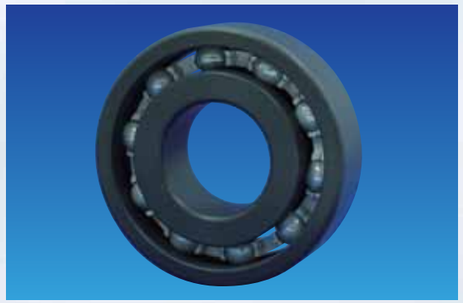


10. Aqua-Bearing™—High Corrosion-Resistant Resin Bearings

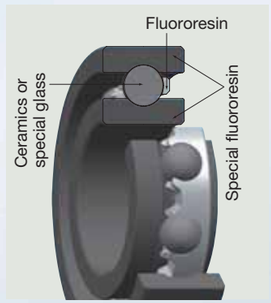
Aqua-Bearing™ features a special fluororesin for outer/inner rings and cages equipped to meet a broad range of applications in water, alkali and strong acid environments. Aqua-Bearing™ is suitable for corrosive environments exclusively in normal atmosphere.



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

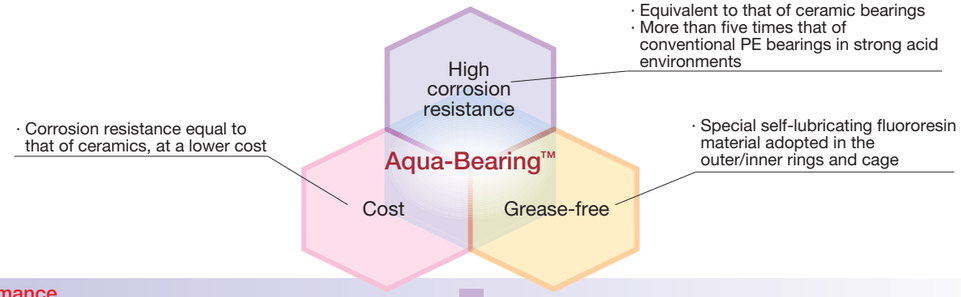
Applications: Corrosive environments: Semiconductor production machinery, chemical processing equipment, metal plating equipment
Non-magnetic requirement: Electron beam drawing devices, electron beam exposure equipment, testers

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 A24 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 A24.
- Please note that the bearing fit is large due to the linear expansion coefficient of the special fluororesin material ($\alpha = 1.7 \times 10^{-4}$/°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

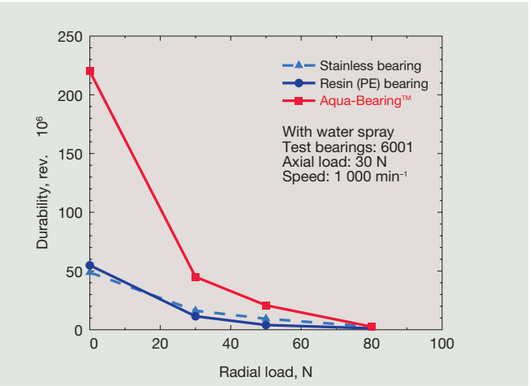
Corrosion resistance equal to or higher than all-ceramic bearings (oxide-base)

	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

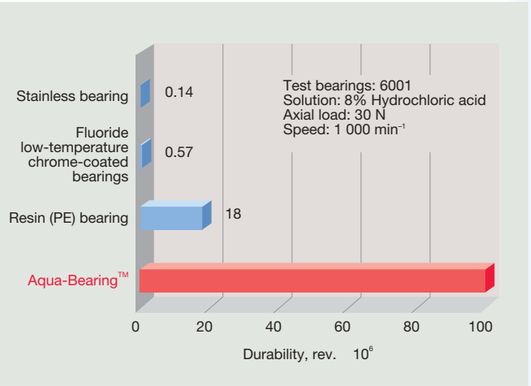
● Results of water-spray durability tests

Remarkable durability can be observed under light-load conditions.



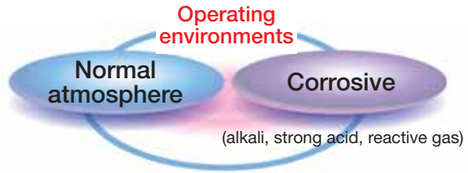
● Results of durability tests in strong acid solution

Durability is higher than that of SUS440C bearings and conventional resin bearings by, respectively, more than 1 000 times and five times.



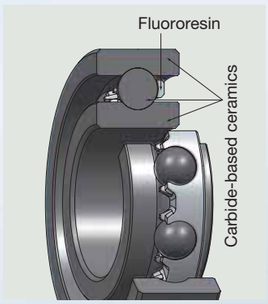
11. High Corrosion-Resistant All-Ceramic Bearings (Carbide-based ceramics)

With ceramic outer/inner rings and balls, all-ceramic bearings have self-lubricating fluororesin cages and are suitable for highly corrosive environments from normal atmosphere.



Product Specifications

Representative structure



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

Applications: Film cleaning systems, liquid crystal/semiconductor production machinery, chemical processing equipment, metal plating equipment

Operating Instructions and Notes

- 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.
- 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 ranging from the lower limit of CN to the upper limit of C3.
- 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.

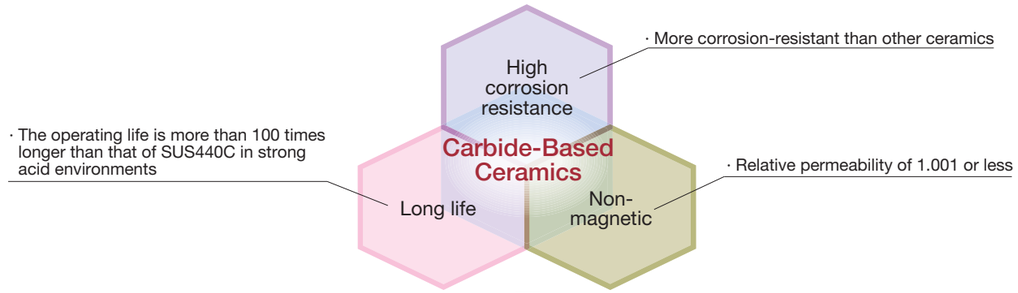
The scope of high corrosion-resistant all-ceramic bearings

Limiting load	5% 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
- Higher corrosion resistance than other types of ceramics
- Over 100 times more durable than stainless steel bearings under strong acidic environments



Performance

Comparison of performance and cost

Carbide-based ceramics (SiC) are more corrosion-resistant than other ceramics.

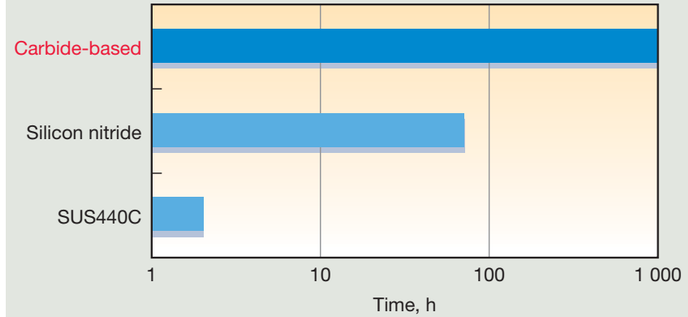
Evaluation item		Ceramics			Stainless steel
		Carbide-based	Oxide-based	Silicon nitride	SUS440C
Corrosion resistance	3% Sulfuric acid (room temperature)	◎	○	△	×
	8% Hydrochloric acid (room temperature)	◎	○	△	×
	5% Fluoric acid (room temperature)	◎	△	△	×
Relative permeability		1.001 or less	1.001 or less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

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

Durability in strong acid

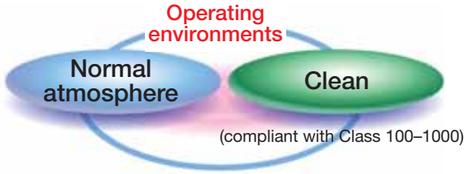
Carbide-based ceramics (SiC) are 100 times more durable than stainless steel bearings SUS440C.

Test bearings: 6206
Speed: 1 000 min^{-1}
Radial load: 980 N
10% Sulfuric acid solution
Room temperature



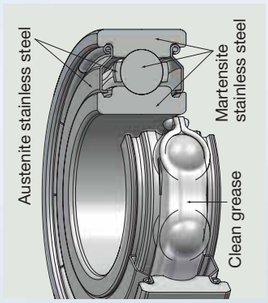
12. LG2/LGU Grease-Packed Bearings (For use in normal atmosphere only)

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

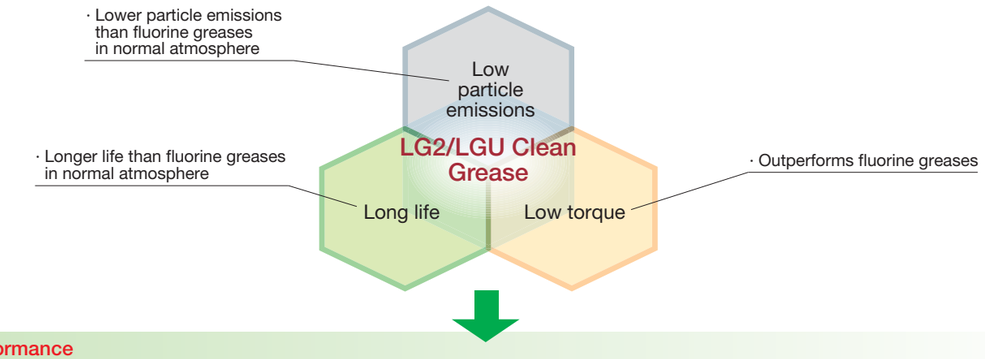
Applications: Equipment in clean rooms

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 A25 and A26 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

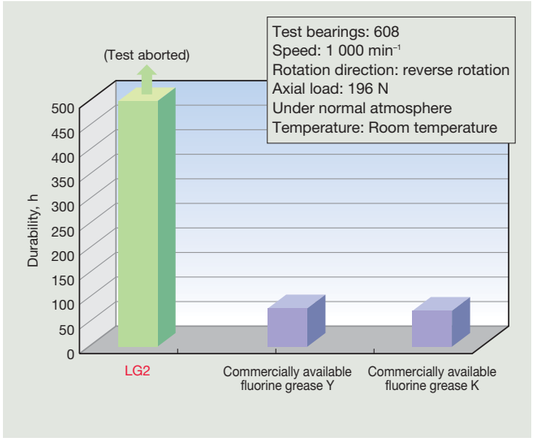
Properties of Grease

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 (mm^2/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

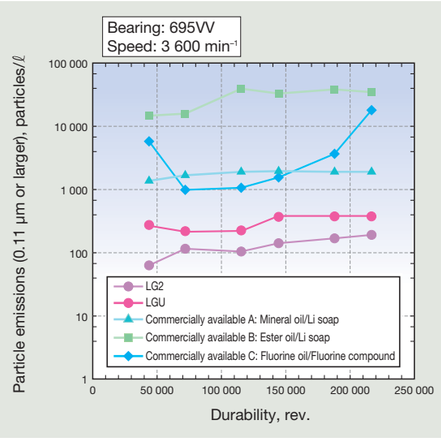
Results of durability tests in normal atmosphere

LG2/LGU grease has a longer life than any other grease in normal atmosphere.



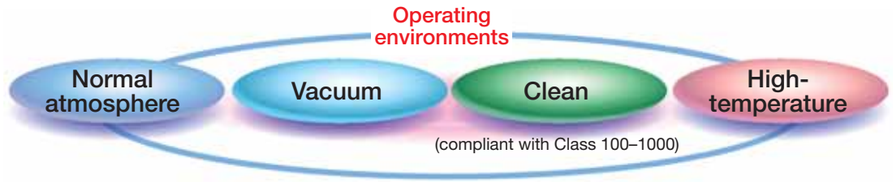
Results of particle emission tests in normal atmosphere

LG2/LGU grease are lowest in particle emissions in normal atmosphere.



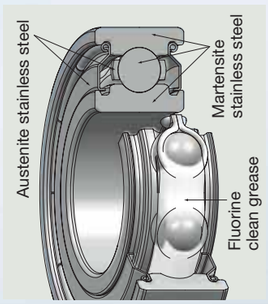
13. DL2 Clean Grease-Packed Bearings (From normal atmosphere up to vacuum)

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



Product Specifications

Representative structure

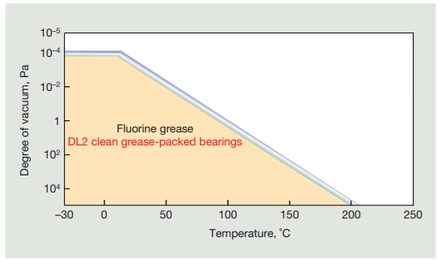


Structure		Shielded Type
Specifications	Outer/Inner rings	Martensite stainless steel
	Balls	Martensite stainless steel
	Cage	Stainless steel
	Lubricant	DL2 clean grease
	Shields	Austenite stainless steel

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

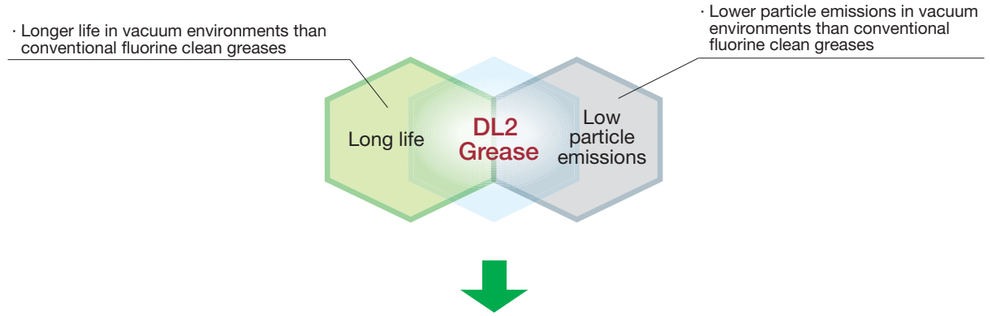
Operating Instructions and Notes

- 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 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

- 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



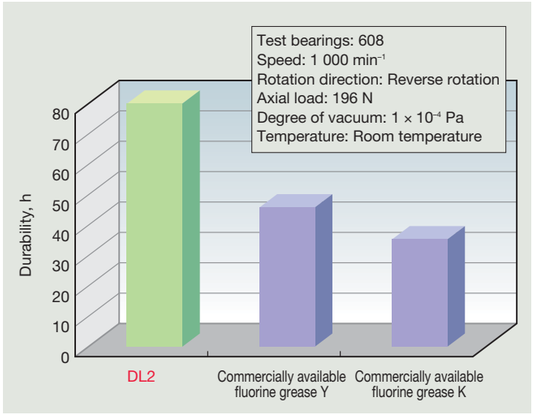
Performance

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

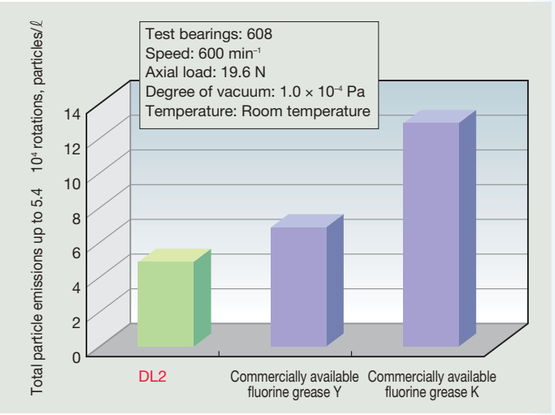
Results of durability tests in vacuum

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



Results of particle emission tests in vacuum

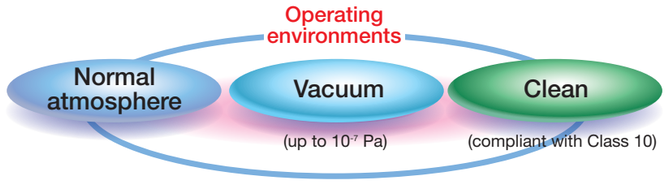
DL2 clean grease is lowest in particle emissions in vacuum environments.



14. Clean Lubricant DFO Bearings (E-DFO, V-DFO)

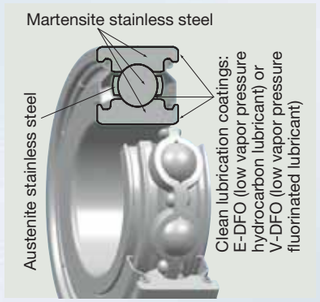
Newly developed specification DFO bearings that take advantage of clean lubrication coatings: V-DFO and E-DFO. The V-DFO specification uses low vapor pressure fluorinated lubricant while the E-DFO specification uses a low vapor pressure hydrocarbon lubricant. Both specifications are applied to the inner 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

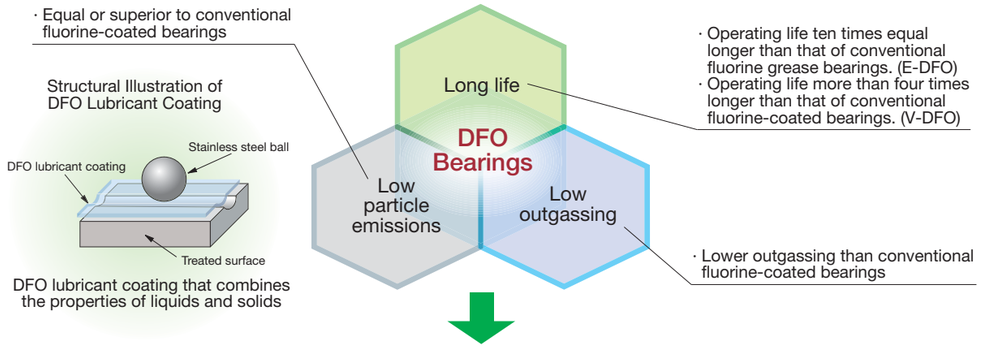
Applications: Liquid crystal and semiconductor manufacturing equipment, hard disk manufacturing equipment, solar cell manufacturing equipment, robots for vacuum environments

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 A27 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 MoS_2 solid lubricated bearings
- Applicable in environments for which lubricants containing metallic elements such as MoS_2 are not suitable
- Applicable from normal atmosphere up to vacum 10^{-7} Pa (room temperature), although the degree of vacuum in which the bearings can be used varies according to the operating temperature



Performance

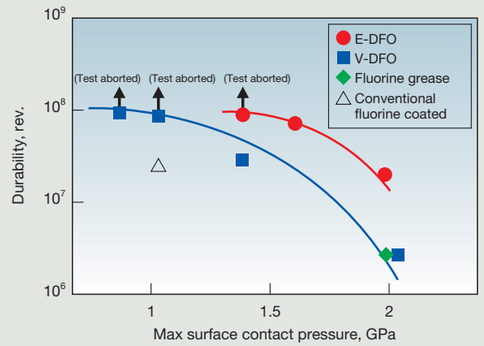
Comparison of operating environments for clean lubrication coatings E-DFO and V-DFO:

Conditions	E-DFO	V-DFO
Corrosive gas	×	○
Vacuum	◎ (up to 150°C)	○ (up to 150°C)
Normal atmospher	◎ (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.

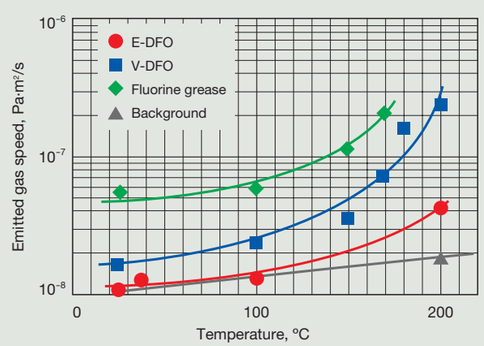
Test conditions
Test bearings: 708
Speed: 3 000 min^{-1}
Degree of vacuum: 2×10^{-4} Pa



Outgassing characteristics under high-temperature conditions

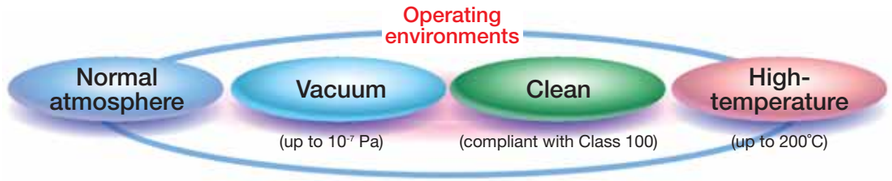
Excellent outgassing characteristics

Test conditions
Test bearings: 608
Degree of vacuum: 8×10^{-4} Pa



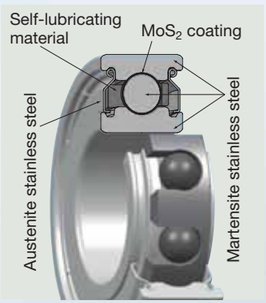
15. YS Bearings with MoS_2 Self-Lubricating Cages

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



Product Specifications

Representative structure

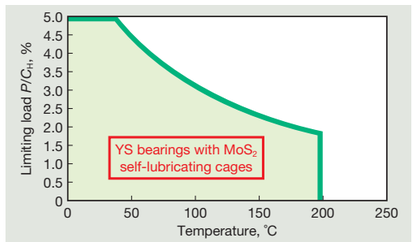


Structure		Shielded Type
Specifications	Outer/Inner rings	Martensite stainless steel
	Balls	Martensite stainless steel and MoS_2 coating
	Cage	Self-lubricating cage
	Lubricant	MoS_2 solid lubricant
	Shields	Austenite stainless steel

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

Operating Instructions and Notes

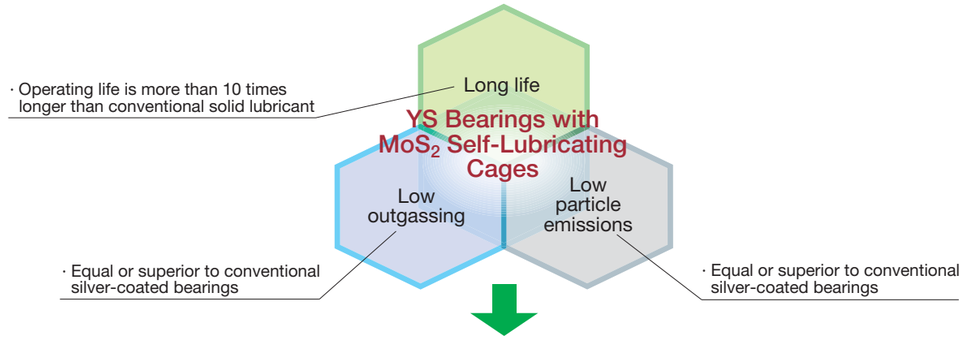
- Bearing should not be unpacked until immediately before mounting.
- Avoid storing the bearing for an overly extended or lengthy amount of time.
- Avoid exposure to any oil or moisture.
- The scope of application (limiting load, temperature) is listed in the table to the right.
- See the tables of SPACEA™ bearing nomenclature on page 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.



- 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

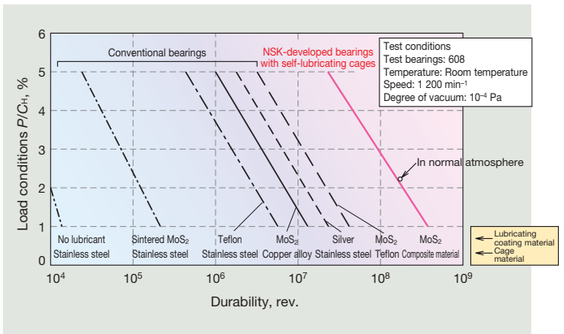
- Utilizes newly developed, long-life MoS_2 self-lubricating cages
- Operating life is longer than that of conventional high-temperature solid-lubricant bearings by more than 10 times (Life is presumable)
- Particle emissions and outgassing are as low as that of conventional silver-coated bearings
- Applicable from normal atmosphere up to vacuum 10^{-7} Pa



Performance

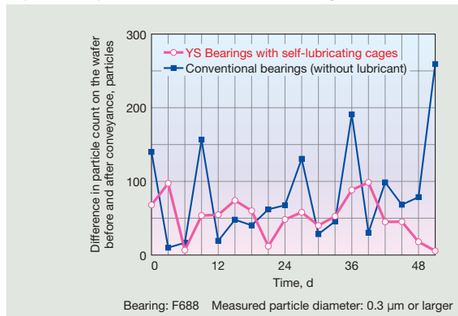
● Durability

Over ten times more durable than conventional bearings for vacuum environments



● Particle emissions evaluation in actual line of vacuum robots for wafer conveyance

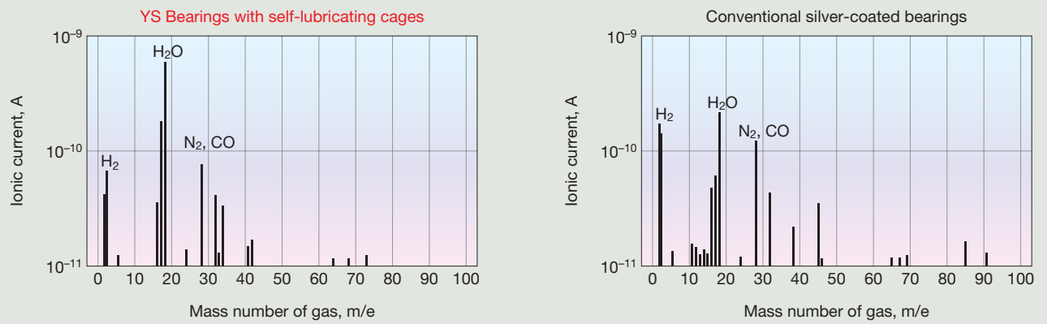
Equal or superior to conventional bearings for vacuum environments



Bearing: F688 Measured particle diameter: 0.3 μm or larger

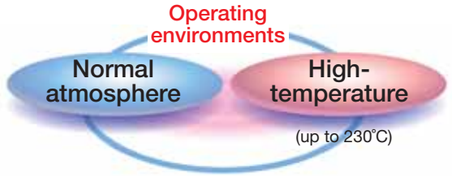
● Outgassing characteristics

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



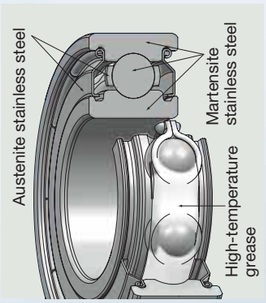
16. High-Temperature Grease-Packed Bearings (For use in normal atmosphere only)

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

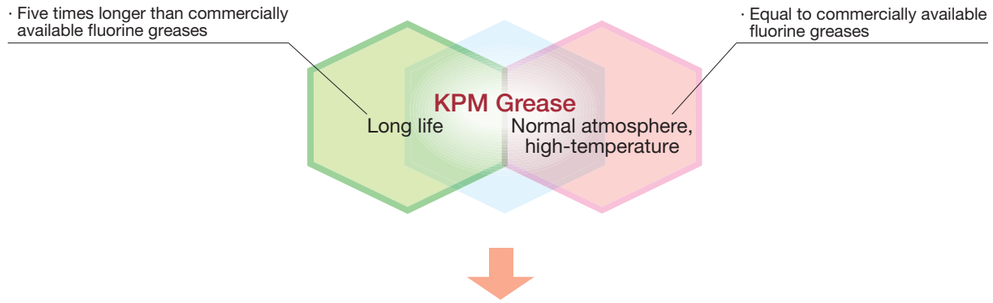
Applications: Copying machines, kilns, high-temperature conveyance equipment, other equipment for high-temperature environments

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 A29 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

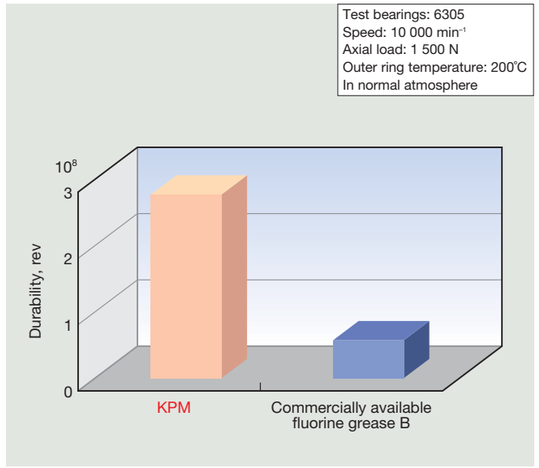
Properties of Grease

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

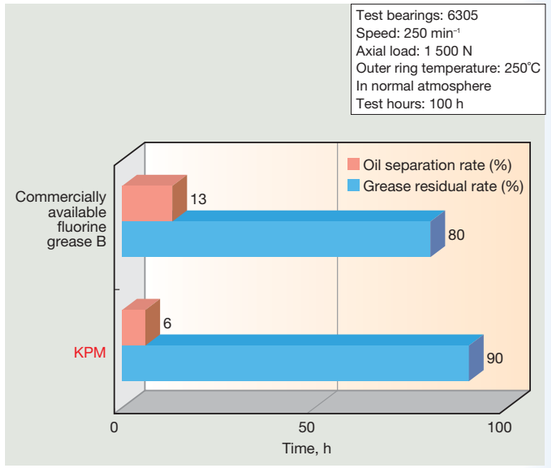
Durability

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



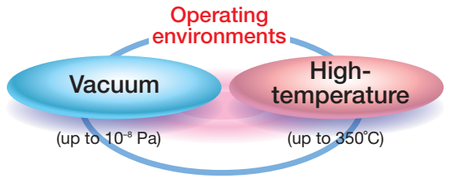
Oil separation and grease residual rates

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



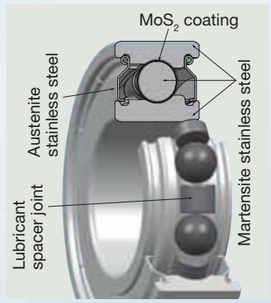
17. YS High-Temperature Bearings with Spacer Joints

YS high-temperature 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

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 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.
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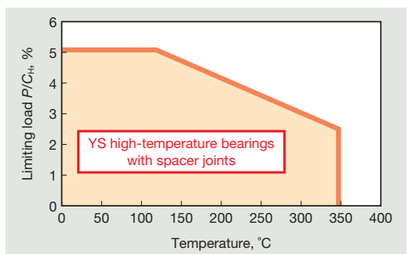
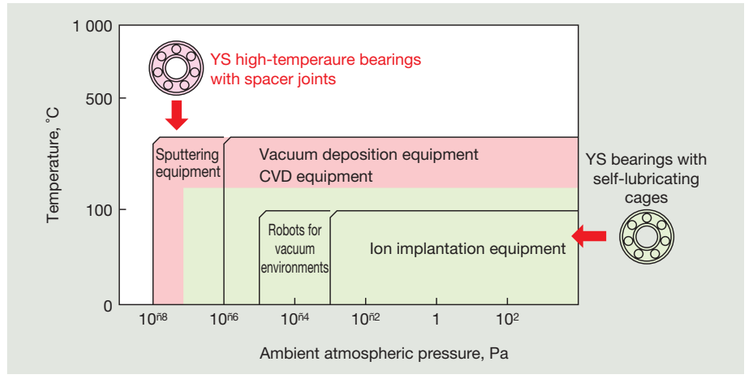
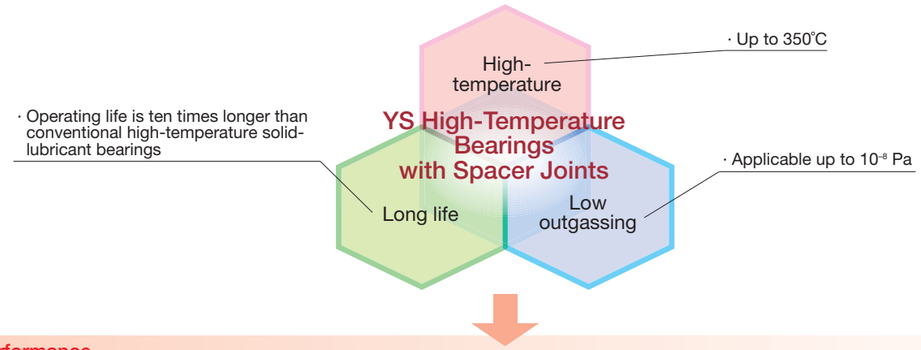


Features

- Grease-free, MoS_2 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 (Life is presumable)

Applications of bearings for semiconductor production equipment

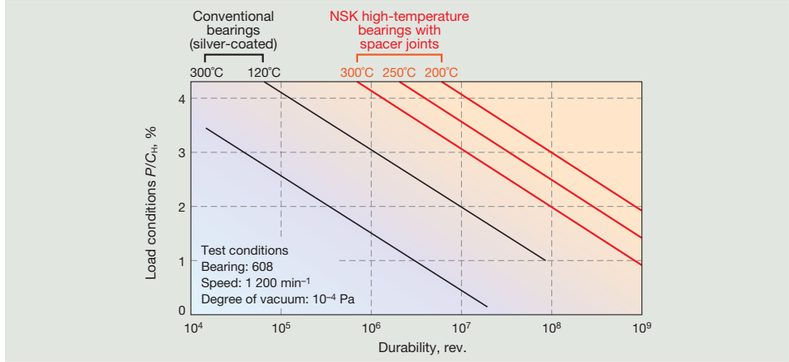




Performance

Durability

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

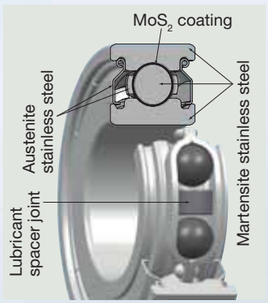


18. SJ High-Temperature Bearings with Solid Lubrication

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

Product Specifications

Representative structure

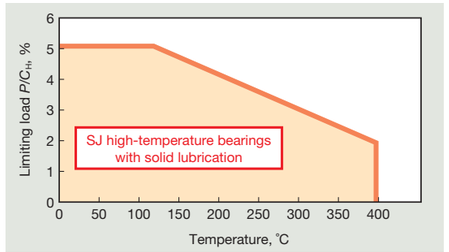


Structure		Shielded Type
Specifications	Outer/Inner rings	Martensite stainless steel
	Balls	Martensite stainless steel and MoS_2 coating
	Cage	Austenite stainless steel and lubricating spacer joints (sintered alloy)
	Lubricant	MoS_2 solid lubricant
	Shields	Austenite stainless steel

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

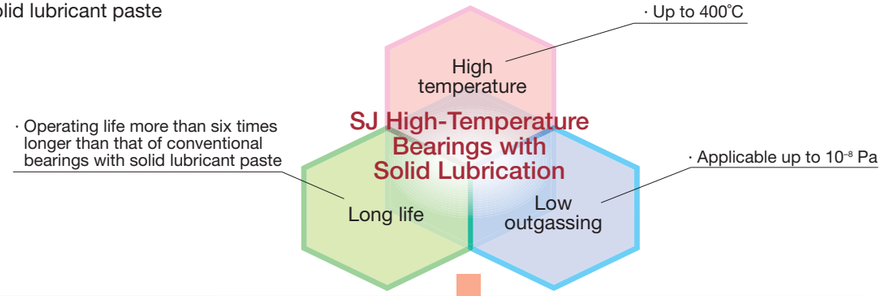
Operating Instructions and Notes

- 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 A30 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

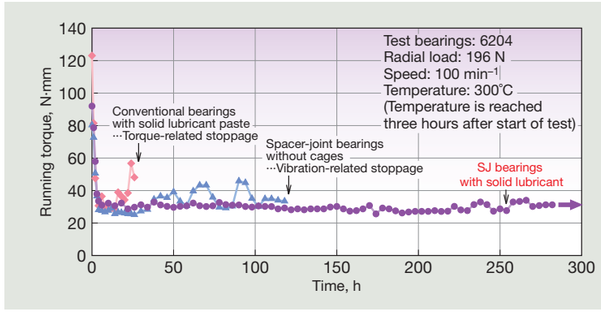
- Grease-free, MoS_2 solid lubricant
- Applicable from normal atmosphere up to vacuum 10^{-8} Pa and temperatures up to 400°C
- “Peapod” structure provides excellent torque stability and long life
- Over six times more durable than conventional high-temperature bearings with solid lubricant paste



Performance

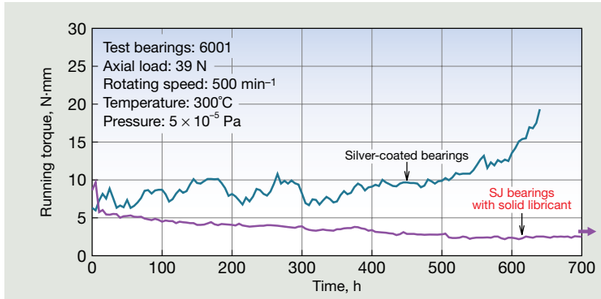
Durability

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.



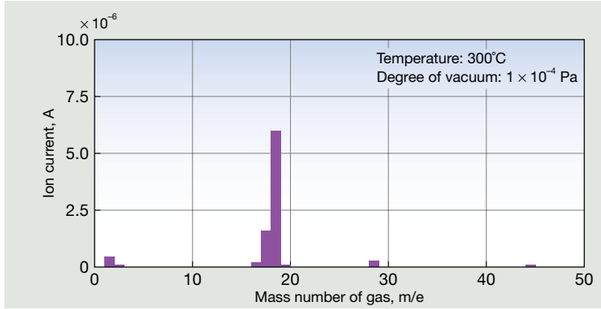
Durability of bearings in vacuum conditions

Outperforms silver-coated bearings in durability and torque stability.



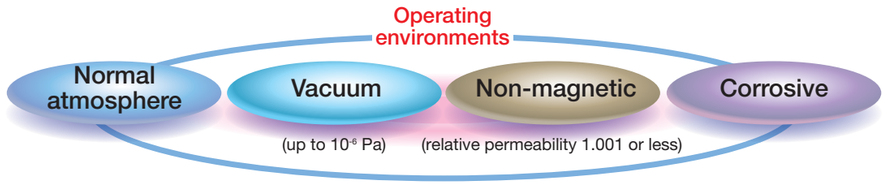
Outgassing in vacuum conditions

Solid lubricant spacer joints exhibit minimal outgassing in high-temperature, vacuum environments, easing pollution concerns.

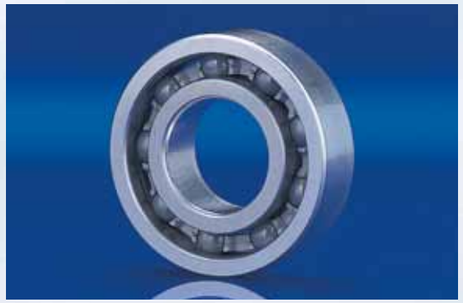


19. Completely Non-Magnetic Titanium Alloy Bearings

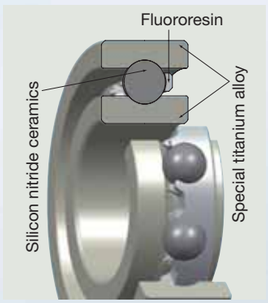
Titanium alloy bearings have special titanium alloy inner/outer rings and ceramic balls, making them completely non-magnetic (relative permeability 1.001 or less). These bearings are suitable for non-magnetic requirement from normal atmosphere up to vacuum.



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, testers

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.

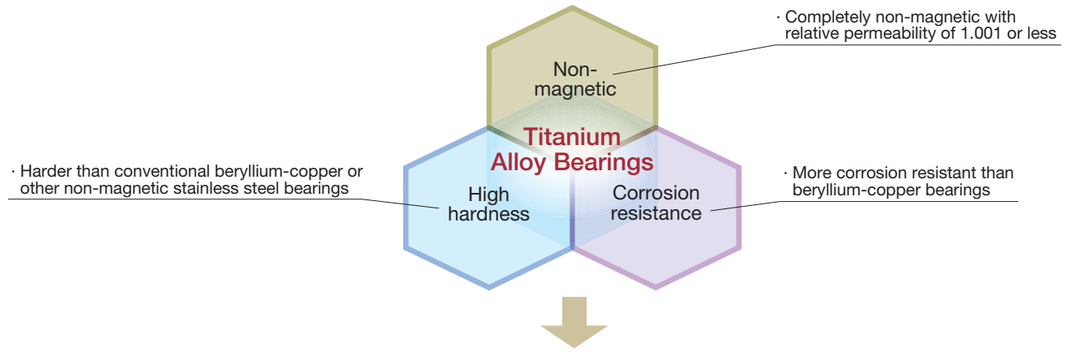
The scope Titanium alloy bearings

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 oxidation by-products such as beryllium in conventional beryllium-copper alloy
- Harder than conventional beryllium-copper alloy
- Applicable from normal atmosphere up to vacuum 10^{-6} Pa



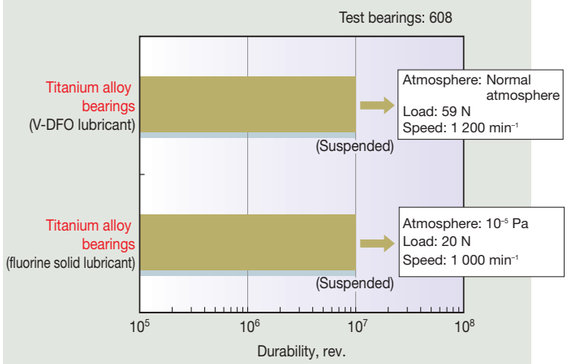
Performance

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

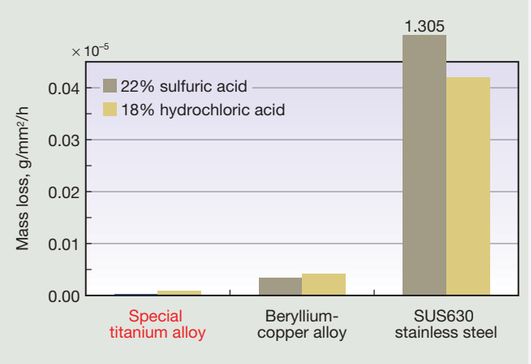
Notes (1) Indicated in HV hardness for comparison
(2) Comparative assessment between five kinds of materials

Durability



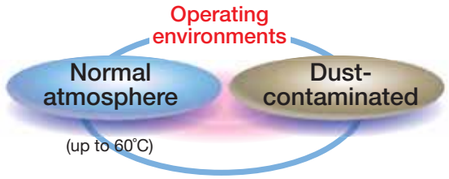
Results of corrosion resistance test

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



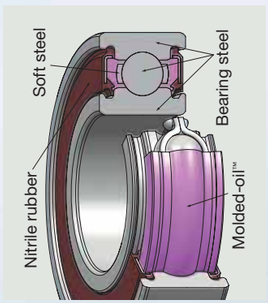
20. Molded-Oil™ Bearings for Dust-Contaminated Environments

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

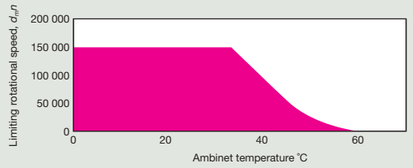
Operating Instructions and Notes

- 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™ "4. 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)

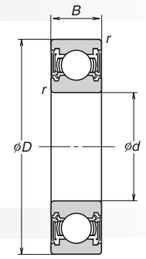


Table of Dimensions and Availability (Contact-seal Type)

● Bearing number for inquiry(1) Basic bearing number **L11DDU**

Boundary dimensions				Basic bearing number	Availability(2)	Limiting speeds (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)				
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

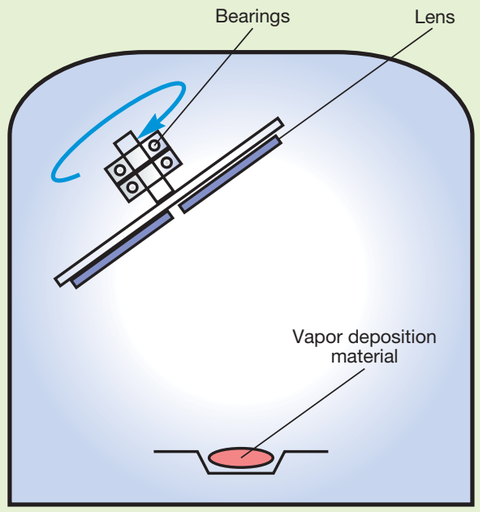
Symbol of availability: ● Stocked as standard inventory items.(4)

Notes (1) The actual bearing number of delivered products may include additional symbols or codes for NSK purposes.
(2) 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.)
(3) The limiting load is a pure radial load that has been calculated based on a bearing life of 10^7 rotations.
(4) Orders placed for large quantities of standard inventory items may incur some delay in actual delivery. Furthermore, products shipped from Japan may incur additional delays.

Applications of SPACEA™ Series Bearings

SPACEA™

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

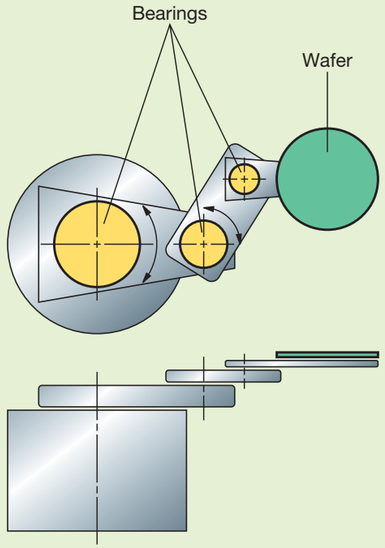
Conventional bearings

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

NSK SPACEA™ Series
YS High-Temperature Bearings with Spacer Joints

- Operating life: More than 1 year

Robots for Vacuum Environments



Operating Conditions

Vacuum/Clean environments

- Degree of vacuum: 10^{-4} Pa
- Max. temperature: 120°C
- Speed: Low-speed swing
- Load: Moment load

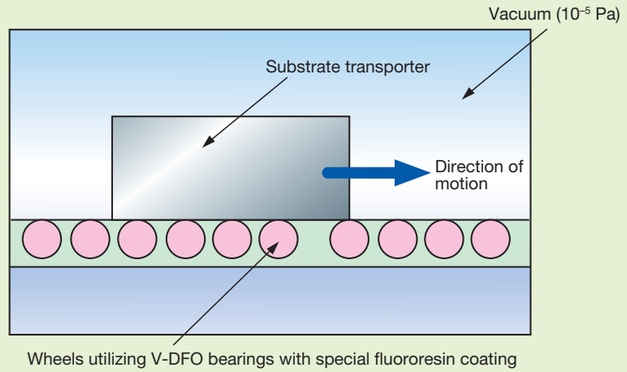
Conventional bearings

- 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

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

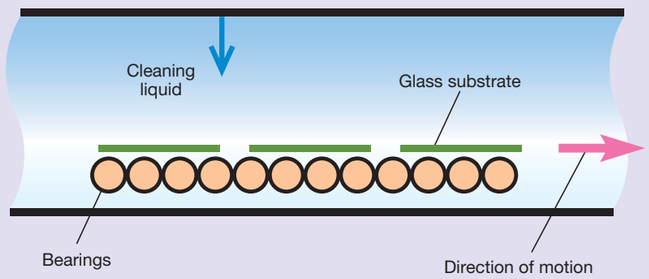
Conventional bearings

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

NSK SPACEA™ Series
Clean Lubricant V-DFO Bearings

- Operating life: 6 months

Liquid Crystal Cleaning Equipment



Operating Conditions

Corrosive environments

- Cleaning liquid-spray environments
- Speed: Up to 50 min^{-1}
- Load: Light load

Conventional bearings

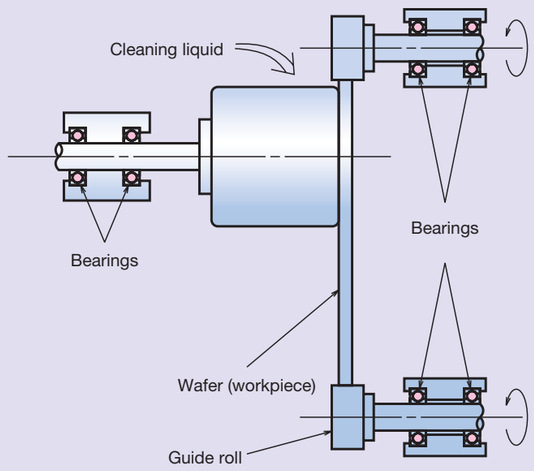
- Plain resin bearing
- Operating life: 2 to 3 months

NSK SPACEA™ Series
Aqua-Bearing™— High Corrosion-Resistant Resin Bearings

- Operating life: More than 1 year

Applications of SPACEA™ Series Bearings

Silicon Wafer Cleaning Equipment



Operating Conditions

Corrosive environments

- Cleaning liquid-spray environments
- Speed: Up to 100 min^{-1}
- Load: Up to 50 N

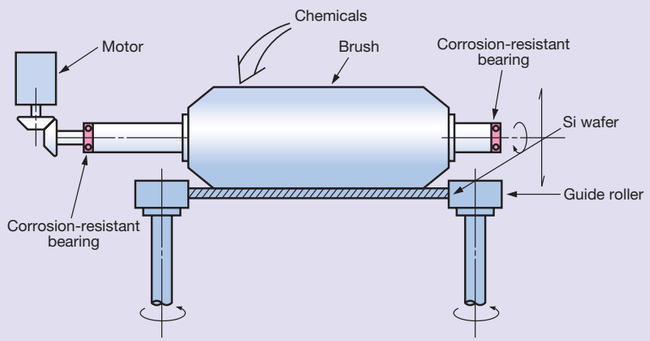
Conventional bearings

- 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

Wafer Polishing Equipment (CMP Equipment)



Operating Conditions

Corrosive environments

- Cleaning liquid-spray environments
- Speed: Up to 30 min^{-1}
- Load: Light load

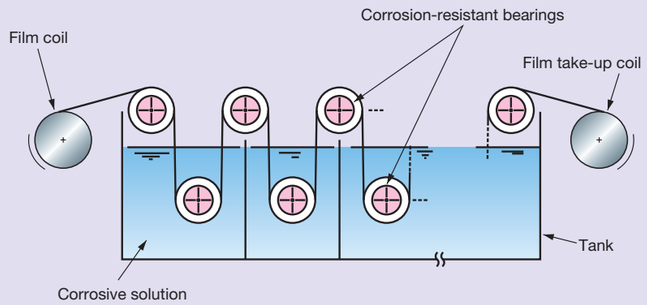
Conventional bearings

- Stainless steel bearing (6001, 6800, etc.)
- Operating life: 2 weeks to 1 month

NSK SPACEA™ Series
All-Ceramic Bearings
(Oxide-based ceramics)

- Operating life: More than 1 year

Cleaning Device



Operating Conditions

Corrosive environments

- Strong acid solution
- Speed: Up to 100 min^{-1}
- Load: Approx. 100 N
- Temperature: Approx. 80°C

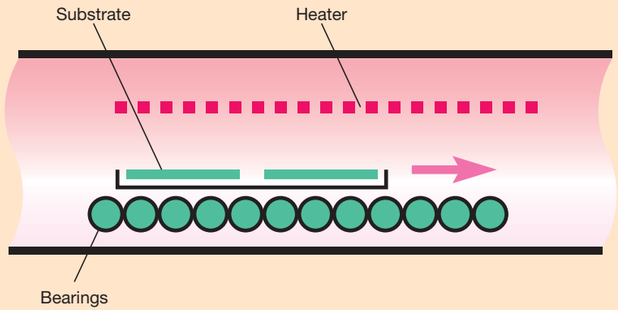
Conventional bearings

- All-ceramic bearing (silicon nitride 6204, 6206, etc.)
- Operating life: More than 1 year

NSK SPACEA™ Series
All-Ceramic Bearings
(Carbide-based ceramics)

- Operating life: More than 3 years

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

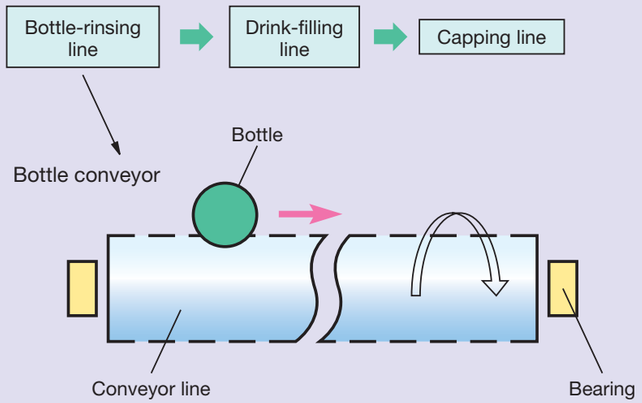
NSK SPACEA™ Series
SJ High-Temperature Bearings with Solid Lubrication

- Operating life: More than 1 year

Applications of SPACEA™ Series Bearings

SPACEA™

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

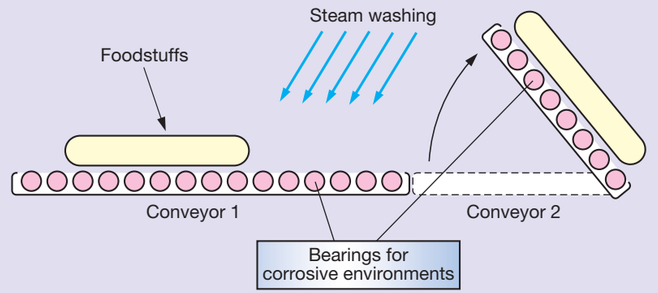
NSK SPACEA™ Series

Corrosion-Resistant Coated Bearings

(Balls: Ceramics)

- 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

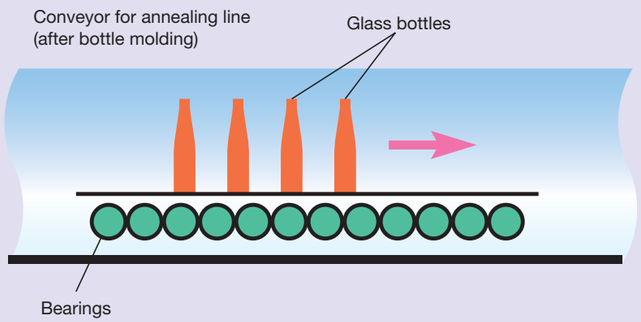
- Grease-packed stainless steel bearing

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

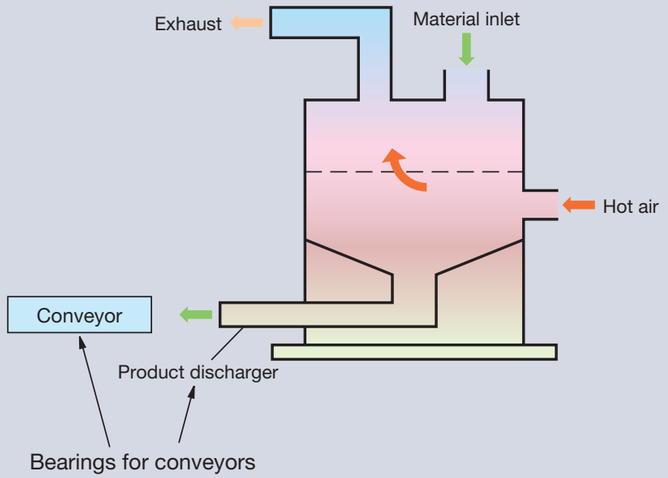
NSK SPACEA™ Series

Corrosion-Resistant Coated Bearings

(Balls: Ceramics)

- 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

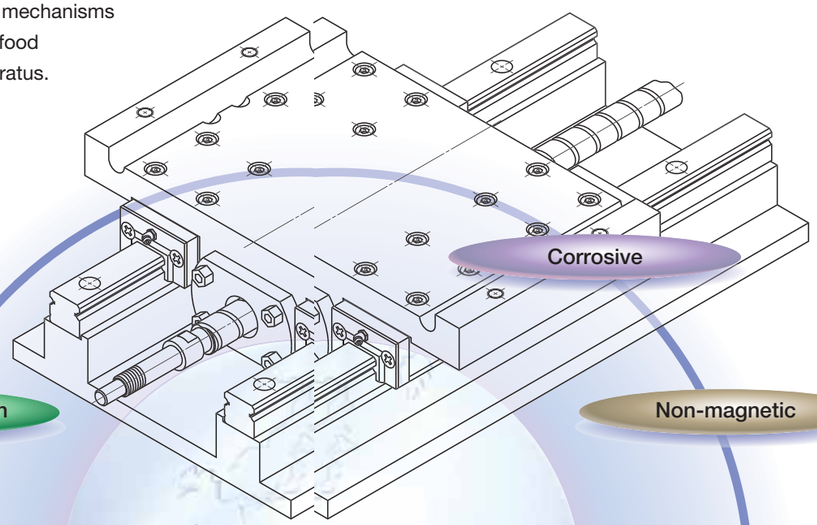
SPACEA™ Series—NSK Ball Screws and NSK Linear Guides for Special Environments—offers a wide array of products for special environments, including vacuum and clean, corrosive, sanitary, water-and dust-contaminated, high-temperature, and non magnetic environments. NSK's state-of-the-art technology creates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

Product lineup listed by operating environment

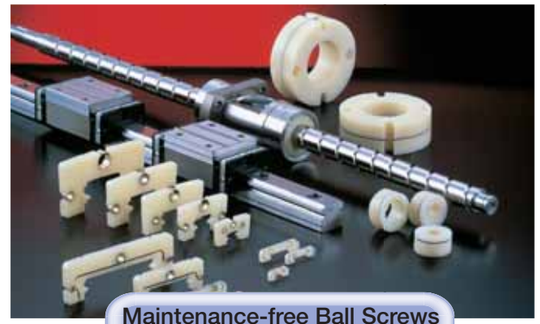
NSK's SPACEA™ series ball screws and NSK linear guides are the optimal components for linear drive mechanisms for demanding operating environments, such as semiconductor/FPD/hard disk production machinery, food processing machinery, medicine/cosmetic production machinery, and ceramics/chemical/optical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



Support units for clean environments

Support Units for Clean Environments

Ball screws and linear guides for special environments



Maintenance-free Ball Screws and Linear Guides

SPACEA™ Series Ball Screws

Ball screws for special environments

Ball screws equipped with high-performance seal

Ball screws equipped with NSK K1 lubrication unit

Stainless steel ball screws

Ball screws for corrosive environments

Non-magnetic ball screws

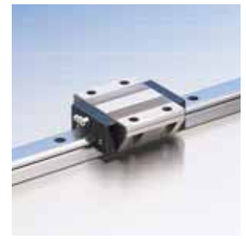
NSK Clean greases

SPACEA™ Series Linear Guides

Linear guides for special environments

Linear guides equipped with high-performance seal

Linear guides equipped with NSK K1 lubrication unit



Stainless steel linear guides

Linear guides for corrosive environments

Linear guides for food processing

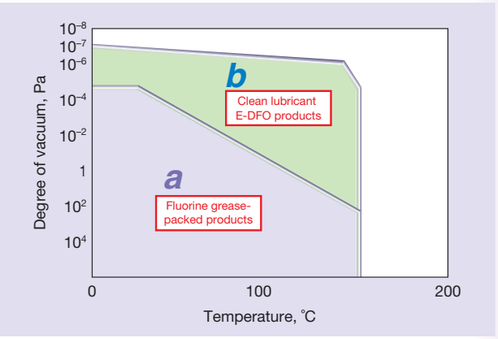
Linear guides for high-temperature and heat-resistant bellows

B SPACEA™ Series Ball Screws and NSK Linear Guides™ Selection Guide

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

① Select the group of products appropriate for your operating environment and application. → ② Find the product series that will meet your operating conditions. → ③ Select the product most appropriate in terms of availability and price. → ④ Follow the operating instructions that are provided.

● Scope of applications for fluorine grease-packed products and E-DFO products

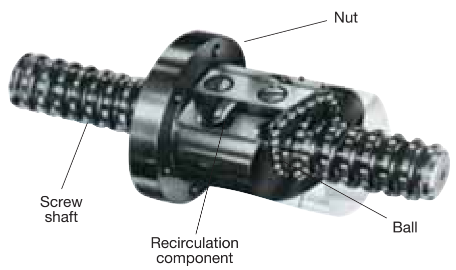


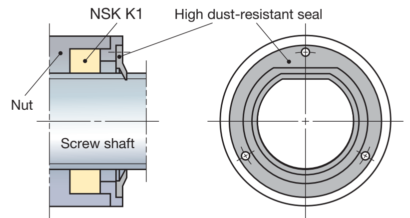
① Operating environment			Product name		② Operating conditions: Degree of vacuum Pa				② Operating conditions: Temperature ˚C			② Operating conditions: Cleanliness (1)			② Operating conditions: Limiting rotational speed *d*·*n* value (2)			② Operating conditions: Limiting speed of linear guide m/min			③ Price comparison	③ Dimensions (availability)	④ · Specifications · Operating instructions · Technical data
					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			Low ▲ High	Ball screws (B9)	B15–B16, B21–B23
			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) a							●			≤70 000			≤100			Low ▲ High		B13–B14
		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) b									●	≤70 000			≤100					B17–B18
	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^{-5} 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 ▲ High	Support units (B10)	B13–B14, B21–B22
		Water-immersed, water-spray	Ball screws and linear guides for corrosive environments																				
	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 ▲ High		B13–B14
			Stainless steel ball screws and linear guides						≤150˚C														
Sanitary	Food processing environments		Ball screws and linear guides for food processing		●				≤80˚C						≤70 000			≤100			–	Linear guides (B11–B12)	B23–B24
Water- and dust-contaminated	Dust or wood chips		Ball screws and linear guides, equipped with a high-performance seal		●				≤80˚C						≤70 000			≤100			Low ▲ High		B13–B14, B21–B22, B25–B26
High-temperature	Normal atmosphere (up to 150˚C)		Ball screws and linear guides for high-temperature environments		●				≤150˚C						≤70 000			≤100			–		B27–B28
Non-magnetic	From normal atmosphere up to vacuum		Non-magnetic stainless steel ball screws and linear guides		10^{-5} 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})

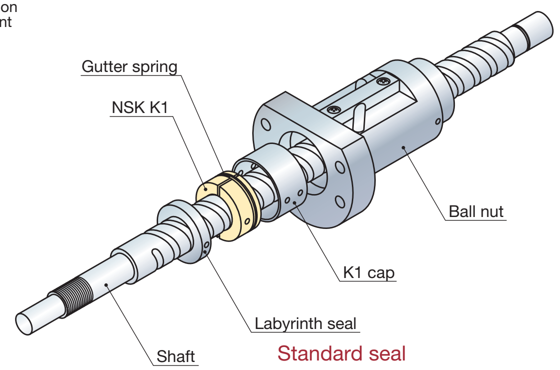
Types and Specifications of SPACEA™ Ball Screws and NSK Linear Guides™

SPACEA™ Series Ball Screws





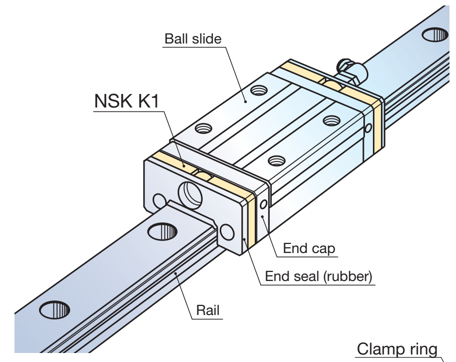
High dust-resistant seal

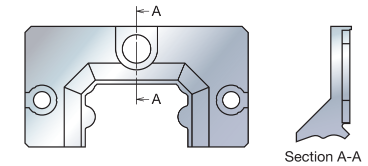


Standard seal

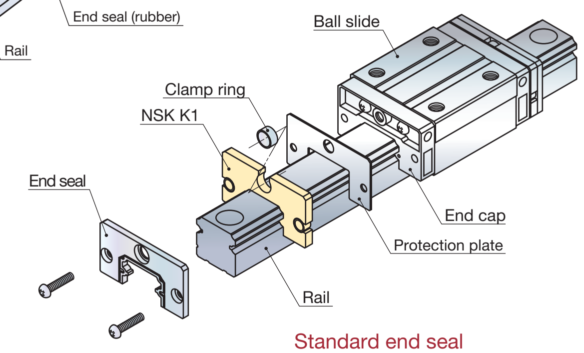
NSK K1 lubrication unit

SPACEA™ NSK Linear Guides™

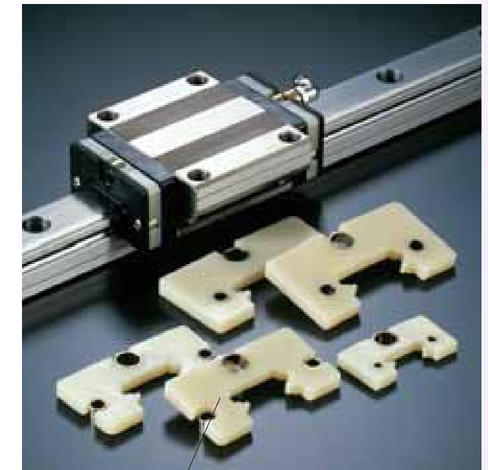




High dust-resistant end seal



Standard end seal

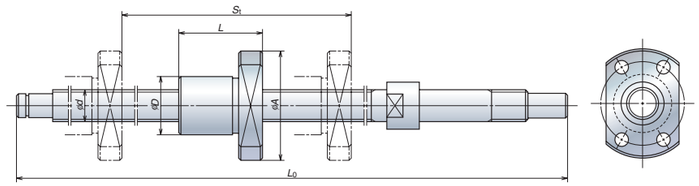


NSK K1 lubrication unit

Operating environment			Product name	Component specifications: Ball screw specifications: Shaft, nut / Linear guide specifications: Rail, ball slides		Ball	Recirculation components / End cap	Seal	Corrosion-resistant coating	Lubricant	· Specifications · Operating instructions · Technical data
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, B21–B22
				Martensite stainless steel		Martensite stainless steel	Austenite stainless steel			LGU clean grease, NSK K1	
	Vacuum	From normal atmosphere up to vacuum (room temperature)	Fluorine grease-packed ball screws and linear guides					—		Fluorine grease	B13–B14
		From normal atmosphere up to vacuum (up to 150˚C)	Clean lubricant E-DFO ball screws and linear guides						—	E-DFO (+ DLC) or Molybdenum disulfide	B17–B18
	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	—
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, B21–B22
		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	B23–B24
Water-and dust-contaminated	Dust or wood chips		Ball screws and linear guides, equipped with a high-performance seal	Standard material		Standard material	Standard material	High dust-resistant seal	Fluoride low-temperature chrome plating	Standard grease + NSK K1	B13–B14, B21–B22, B25–B26
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	(Heat-resistant seal)	—	Heat-resistant grease, Fluorine grease	B27–B28
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



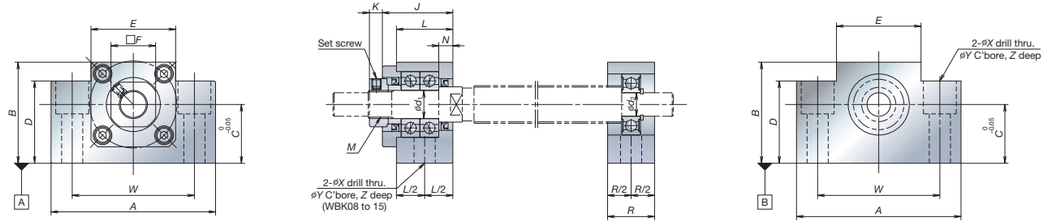
Series	Dimensions (mm)										Dynamic load rating	Suitability for special environments (availability)					
	Shaft diameter *d*	Lead	Effective turns of balls	Number of start	Nut outer diameter *D*	Flange outer diameter *A*	Nut length *L*	Maximum shaft length L_0*max*	Stroke S_t		(N)	Clean	Vacuum	Corrosive	High-temperature	Water- and 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	○		○			
		2	1 × 3	1	16	29	28	248	150		1 080	○		○			
	10	2	1 × 3	1	18	35	29	308	200		1 210	○		○			
		4	2.5 × 3	1	26	46	34	430	300		2 250	○		○			○
	12	2	1 × 3	1	20	37	29	380	250		1 360	○		○			○
		5	2.5 × 1	1	30	50	40	580	450		3 070	○		○			○
		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	○		○			○
		20	1.7 × 1	1	34	55	45	1 161	1 000		4 150	○		○			○
	16	2	1 × 4	1	25	44	40	461	300		2 870	○		○			○
	20	20	1.5 × 1	1	46	74	63	1 208	1 000		5 760	○		○			○
Production on demand	10	2	1 × 3	1	22	39	29	308			1 210	○	○	○	○		○
		4	2.5 × 1	1	26	46	34	430			2 250	○	○	○	○		○
	12	2	1 × 3	1	24	41	29	380			1 360	○	○	○	○		○
		5	2.5 × 1	1	30	50	40	580			3 070	○	○	○	○		○
		10	2.5 × 1	1	30	50	50	580			3 070	○	○	○	○		○
	15	10	2.5 × 1	1	34	57	51	1 161			5 780	○	○	○	○		○
		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	1.5 × 1	1	44	71	90	1 800			8 280	○	○	○	○		○
		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	○	○	○	○		○
		10	2.5 × 2	1	74	108	125	2 400			37 900	○	○	○	○		○
		20	2.5 × 1	1	78	105	107	2 400			14 700	○	○	○	○		
		25	2.5 × 1	1	78	105	120	2 400			14 700	○	○	○	○		
		32	1.5 × 1	1	51	85	109	2 400			9 450	○	○	○	○		○
		10	5.7 × 1	1	56	86	132	2 800			43 300	○				○	○
		16	4.7 × 1	1	56	86	150	2 800			36 700	○				○	○
		20	4.7 × 1	1	56	86	169	2 800			36 700	○				○	○
		32	1.7 × 2	2	56	86	122	2 800			25 000	○				○	○
	40	25	2.5 × 1	1	100	133	136	3 000			23 400	○	○	○	○		
		32	1.5 × 2	1	100	133	122	3 000			24 600	○	○	○	○		
		40	1.5 × 1	1	64	106	133	3 000			15 100	○	○	○	○		○
		40	1.7 × 2	2	70	100	144	3 800			33 600	○				○	○
	45	8	2.5 × 4	1	82	120	162	3 300			55 400	○	○	○	○		○
		10	2.5 × 2	1	88	132	117	3 300			44 300	○	○	○	○		○
	50	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	1.5 × 1	1	80	126	161	3 500			22 500	○	○	○	○		○
		50	1.5 × 2	2	120	156	158	3 500			36 700	○	○	○	○		
		50	1.7 × 2	2	82	118	164	3 500			37 300	○				○	○

○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

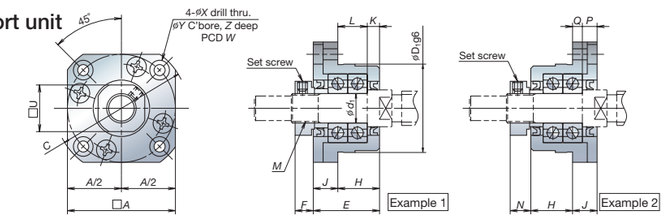
Fixed support side unit (square type)									
Reference No. (for use in clean environments)	Locknut tightening torque (reference) [N·cm]	Set screw tightening torque (reference) [N·cm]	d_1	*F*	*J*	*K*	*L*	*N*	*M*
WBK08-01C	230	69 (M3)	8	14	23	7	—	4	M8 × 1
WBK10-01C	280	147 (M4)	10	17	30	5.5	24	6	M10 × 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



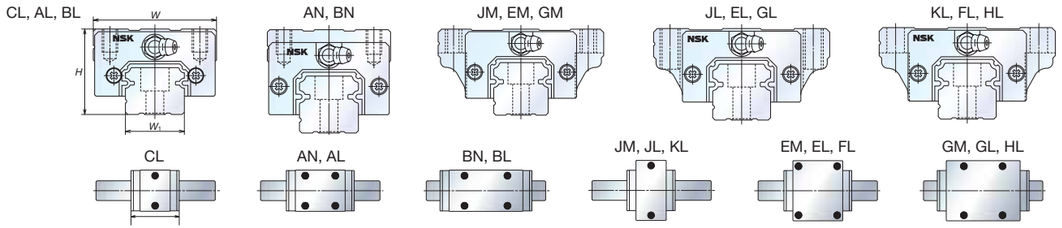
Unit: mm

Reference No. (for use in clean environments)	Fixed support side unit (round type)																	
	d_1	*A*	*C*	*U*	*W*	*X*	*Y*	*Z*	D_1	*E*	*F*	*H*	*J*	*K*	*L*	*N*	*P*	*Q*	*M*
WBK08-11C	8	35	43	14	35	3.4	6.5	4	28	23	7	14	9	4	10	8	5	4	M8 × 1
WBK10-11C	10	42	52	17	42	4.5	8	4	34	27	7.5	17	10	5	12	8.5	6	4	M10 × 1
WBK12-11C	12	44	54	19	44	4.5	8	4	36	27	7.5	17	10	5	12	8.5	6	4	M12 × 1
WBK15-11C	15	52	63	22	50	5.5	9.5	6	40	32	12	17	15	6	11	14	8	7	M15 × 1

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

3. Dimensions of Linear Guides

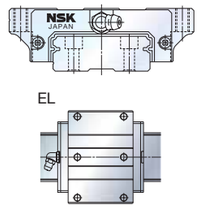
LH, VH, LS Series



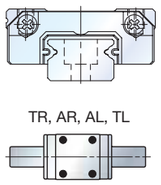
Series	Model No.	Dimensions (mm)						Suitability for special environments (availability)					
		Height H	Overall width W	Ball slide length		Rail width W_1	Dynamic load rating (N)	Clean	Vacuum	Corrosive	High-temperature	Sanitary	Water- and dust-contaminated
				Standard	With NSK K1								
LH	LH08AN	11	16	24	31	8	1 240	○		○			
	LH10AN	13	20	31	40	10	2 250	○		○			
	LH12AN	20	27	45	54	12	5 650	○		○		○	
	LH15AN	28	34	55	65.6	15	10 800	○		○		○	
	LH15BN	28	34	74	84.6	15	14 600	○		○		○	
	LH15EM, EL, FL	24	47	55	65.6	15	10 800	○		○		○	
	LH15GM, GL, HL	24	47	74	84.6	15	14 600	○		○		○	
	LH20AN	30	44	69.8	80.4	20	17 400	○	○	○	○	○	
	LH20BN	30	44	91.8	102.4	20	23 500	○	○	○	○	○	
	LH20EM, EL, FL	30	63	69.8	80.4	20	17 400	○	○	○	○	○	
	LH20GM, GL, HL	30	63	91.8	102.4	20	23 500	○	○	○	○	○	
	LH25AN	40	48	79	90.6	23	25 600	○	○	○	○	○	
	LH25BN	40	48	107	118.6	23	34 500	○	○	○	○	○	
	LH25AL	36	48	79	90.6	23	25 600	○	○	○	○	○	
	LH25BL	36	48	107	118.6	23	34 500	○	○	○	○	○	
	LH25EM, EL, FL	36	70	79	90.6	23	25 600	○	○	○	○	○	
	LH25GM, GL, HL	36	70	107	118.6	23	34 500	○	○	○	○	○	
	LH30AN	45	60	85.6	97.6	28	31 000	○	○	○	○	○	
	LH30BN	45	60	124.6	136.6	28	46 000	○	○	○	○	○	
	LH30AL	42	60	85.6	97.6	28	31 000	○	○	○	○	○	
	LH30BL	42	60	124.6	136.6	28	46 000	○	○	○	○	○	
	LH30EM, EL, FL	42	90	98.6	110.6	28	35 500	○	○	○	○	○	
	LH30GM, GL, HL	42	90	124.6	136.6	28	46 000	○	○	○	○	○	
	LH35AN	55	70	109	122	34	47 500	○		○	○	○	
	LH35BN	55	70	143	156	34	61 500	○		○	○	○	
	LH35AL	48	70	109	122	34	47 500	○		○	○	○	
	LH35BL	48	70	143	156	34	61 500	○		○	○	○	
	LH35EM, EL, FL	48	100	109	122	34	47 500	○		○	○	○	
	LH35GM, GL, HL	48	100	143	156	34	61 500	○		○	○	○	
	LH45AN	70	86	139	154	45	81 000	○		○	○		
	LH45BN	70	86	171	186	45	99 000	○		○	○		
	LH45AL	60	86	139	154	45	81 000	○		○	○		
	LH45BL	60	86	171	186	45	99 000	○		○	○		
	LH45EM, EL, FL	60	120	139	154	45	81 000	○		○	○		
	LH45GM, GL, HL	60	120	171	186	45	99 000	○		○	○		
	LH55AN	80	100	163	178	53	119 000	○		○			
	LH55BN	80	100	201	216	53	146 000	○		○			
	LH55AL	70	100	163	178	53	119 000	○		○			
	LH55BL	70	100	201	216	53	146 000	○		○			
	LH55EM, EL, FL	70	140	163	178	53	119 000	○		○			
	LH55GM, GL, HL	70	140	201	216	53	146 000	○		○			
	LH65AN	90	126	193	211	63	181 000	○		○			
	LH65BN	90	126	253	271	63	235 000	○		○			
	LH65EM, EL, FL	90	170	193	211	63	181 000	○		○			
	LH65GM, GL, HL	90	170	253	271	63	235 000	○		○			
VH	VH15AN	28	34	70.6		15	10 800	○		○			○
	VH15BN	28	34	89.6		15	14 600	○		○			○
	VH15EM, EL, FL	24	47	70.6		15	10 800	○		○			○
	VH15GM, GL, HL	24	47	89.6		15	14 600	○		○			○
	VH20AN	30	44	87.4		20	17 400	○		○			○
	VH20BN	30	44	109.4		20	23 500	○		○			○
	VH20EM, EL, FL	30	63	87.4		20	17 400	○		○			○
	VH20GM, GL, HL	30	63	109.4		20	23 500	○		○			○
	VH25AN	40	48	97		23	25 600	○		○			○
	VH25BN	40	48	125		23	34 500	○		○			○
	VH25AL	36	48	97		23	25 600	○		○			○
	VH25BL	36	48	125		23	34 500	○		○			○
	VH25EM, EL, FL	36	70	97		23	25 600	○		○			○
	VH25GM, GL, HL	36	70	125		23	34 500	○		○			○
	VH30AN	45	60	104.4		28	31 000	○		○			○
	VH30BN	45	60	143.4		28	46 000	○		○			○
	VH30AL	42	60	104.4		28	31 000	○		○			○
	VH30BL	42	60	143.4		28	46 000	○		○			○
	VH30EM, EL, FL	42	90	117.4		28	35 500	○		○			○
	VH30GM, GL, HL	42	90	143.4		28	46 000	○		○			○
	VH35AN	55	70	128.8		34	47 500	○		○			○
	VH35BN	55	70	162.8		34	61 500	○		○			○
	VH35AL	48	70	128.8		34	47 500	○		○			○
	VH35BL	48	70	162.8		34	61 500	○		○			○
	VH35EM, EL, FL	48	100	128.8		34	47 500	○		○			○
	VH35GM, GL, HL	48	100	162.8		34	61 500	○		○			○
	VH45AN	70	86	161.4		45	81 000	○		○			○
	VH45BN	70	86	193.4		45	99 000	○		○			○
	VH45AL	60	86	161.4		45	81 000	○		○			○
	VH45BL	60	86	193.4		45	99 000	○		○			○

○: Made-to-order (Blank: Consult NSK)

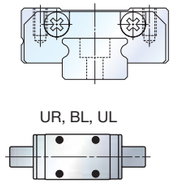
LW Series



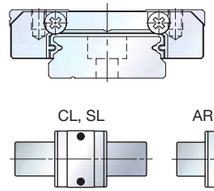
PU Series



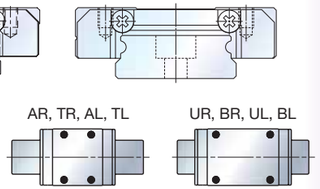
LU Series



PE Series



LE Series



Series	Model No.	Dimensions (mm)						Suitability for special environments (availability)					
		Height H	Overall width W	Ball slide length		Rail width W_1	Dynamic load rating (N)	Clean	Vacuum	Corrosive	High-temperature	Sanitary	Water- and dust-contaminated
				Standard	With NSK K1								
VH	VH45EM, EL, FL	60	120	161.4		45	81 000	○		○			○
	VH45GM, GL, HL	60	120	193.4		45	99 000	○		○			○
	VH55AN	80	100	185.4		53	119 000	○		○			○
	VH55BN	80	100	223.4		53	146 000	○		○			○
	VH55AL	70	100	185.4		53	119 000	○		○			○
	VH55BL	70	100	223.4		53	146 000	○		○			○
	VH55EM, EL, FL	70	140	185.4		53	119 000	○		○			○
	VH55GM, GL, HL	70	140	223.4		53	146 000	○		○			○
LS	LS15CL	24	34	40.4	50	15	5 400	○	○	○	○	○	
	LS15AL	24	34	56.8	66.4	15	8 350	○	○	○	○	○	
	LS15JM, JL, KL	24	52	40.4	50	15	5 400	○	○	○	○	○	
	LS15EM, EL, FL	24	52	56.8	66.4	15	8 350	○	○	○	○	○	
	LS20CL	28	42	47.2	57.8	20	7 900	○	○	○	○	○	
	LS20AL	28	42	65.2	75.8	20	11 700	○	○	○	○	○	
	LS20JM, JL, KL	28	59	47.2	57.8	20	7 900	○	○	○	○	○	
	LS20EM, EL, FL	28	59	65.2	75.8	20	11 700	○	○	○	○	○	
	LS25CL	33	48	59.6	70.2	23	12 700	○	○	○	○	○	
	LS25AL	33	48	81.6	92.2	23	18 800	○	○	○	○	○	
	LS25JM, JL, KL	33	73	59.6	70.2	23	12 700	○	○	○	○	○	
	LS25EM, EL, FL	33	73	81.6	92.2	23	18 800	○	○	○	○	○	
	LS30CL	42	60	67.4	79.4	28	18 700	○	○	○	○*	○	
	LS30AL	42	60	96.4	108.4	28	28 800	○	○	○	○*	○	
	LS30JM, JL, KL	42	90	67.4	79.4	28	18 700	○	○	○	○*	○	
	LS30EM, EL, FL	42	90	96.4	108.4	28	28 800	○	○	○	○*	○	
	LS35CL	48	70	77	90	34	26 000	○		○		○	
	LS35AL	48	70	108	121	34	40 000	○		○		○	
	LS35JM, JL, KL	48	100	77	90	34	26 000	○		○		○	
	LS35EM, EL, FL	48	100	108	121	34	40 000	○		○		○	
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	○		○		○	
	PU15BL	16	32	61	69.2	15	8 100	○		○		○	
LU	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	○	○	○	○*	○	
	LU15BL	16	32	61	69.2	15	8 100	○	○	○	○*	○	
PE	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	○		○		○	
	PE15BR	16	60	76	85.6	42	10 300	○		○		○	
LE	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	○	○	○	○	○	

*Seals are not applicable in high-temperature environments. Contact NSK for details.

○: Made-to-order (Blank: Consult NSK)

1. Corrosion-resistant Ball Screws and NSK Linear Guides™ (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 fluororesin 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

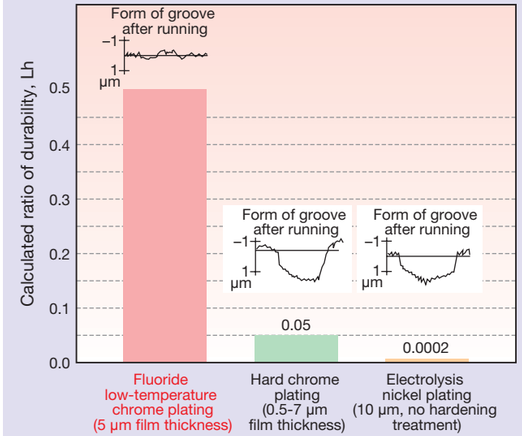
Electrolytic rust-resistant black plating + fluororesin coating

- Black plating: treated to form a stable thin film (1-2 µm), which is a form of black chrome galvanization
- Fluororesin 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.

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

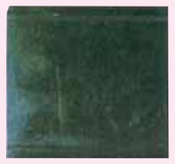
● Test results of corrosion resistance to humidity

Characteristics \ Sample			Fluoride low-temperature chrome plating	Hard chrome plating	Electrolysis nickel plating	SUS440C	Standard product
Rust prevention	Rust condition	Upper face	(Grinding) B	(Grinding) B	(Grinding) A	(Grinding) C	(Grinding) E
		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
	Test conditions ● Testing machine: Dabaiespeck high-temperature and high-humidity vessel ● Temperature: 70℃ ● Relative humidity: 95% ● Time: 96 hours						
	To/From the setting condition of temperature and humidity Rise time: 5 hours Fall 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

● 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 $HCl : H_2O_2 : H_2O = 1 : 1 : 8$		
○	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 (mm^2/s, 40°C)	30	100	270
Consistency	207	209	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

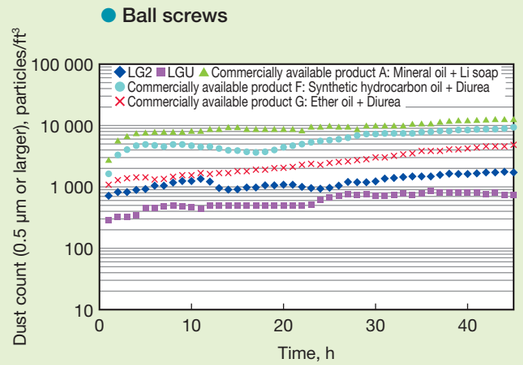
Characteristics	LG2/LGU	Fluorine grease	Ordinary grease
Low partide emission	○	○/△	△/×
Torque	○	×	○/△
Durability	○	△/×	○
Rust prevention	○	△/×	○

○: Excellent △: Poor ×: Not recommended

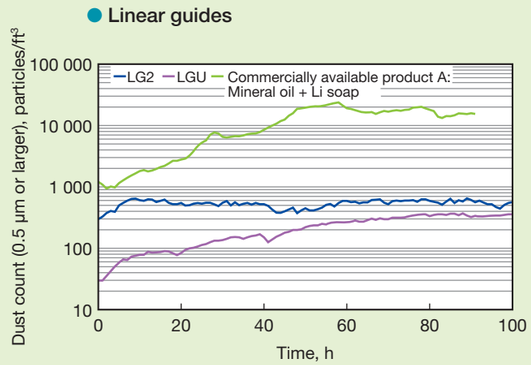
● Properties of grease

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

● Ball screws

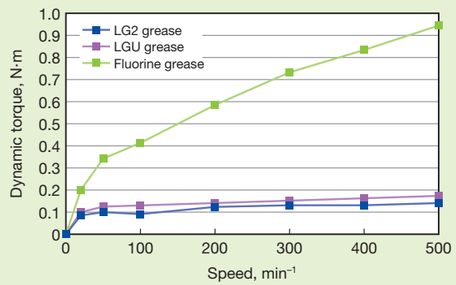


● Linear guides



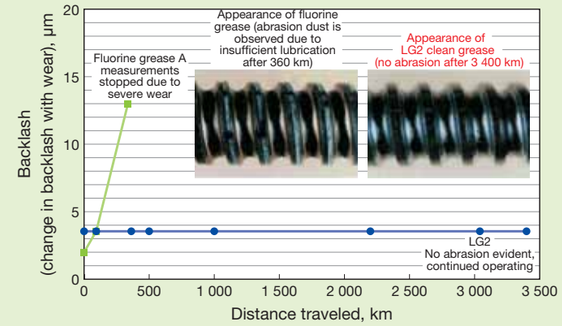
● Stable low-torque characteristics

LG2/LGU greases significantly reduce burden on motors running at high speeds: torque less than 20% of that of fluorine greases (ball screws, at 500 min^{-1}).



● Long life

LG2/LGU greases last over 10 times longer than fluorine greases, equivalent with ordinary greases, resulting in less maintenance downtime.

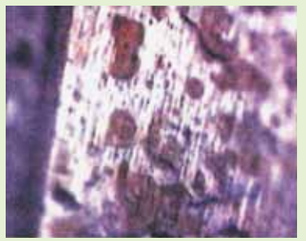


● Superior rust prevention

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

NSK clean grease

No rust



Fluorine grease

Rusting

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).

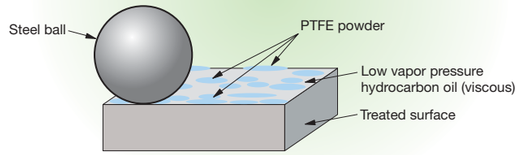
Features of Clean Lubricant E-DFO

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

● Low vapor pressure hydrocarbon oil coating that exhibits the properties of liquids and solids



● Retention intensity of lubricant coating increases due to the flake-shaped PTFE powder that has a large absorbed surface area of lubricant and retains a large quantity of 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.

1. 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.
2. 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.
3. 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.
4. 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.
5. 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

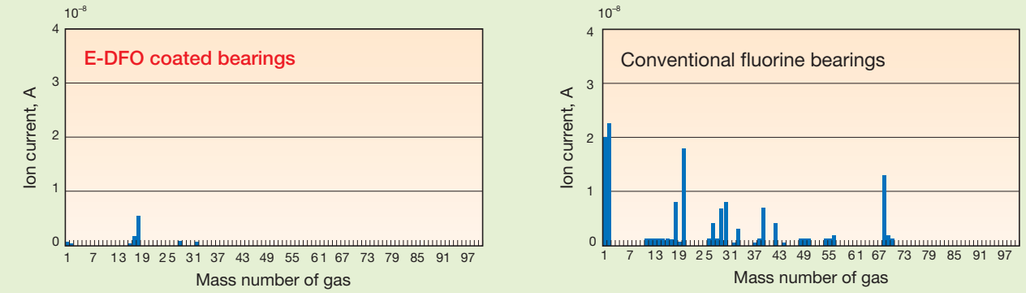
Lubricant	Performance			Compatible operating environment		
	Durability	Particle emissions	Outgassing	Operating environment	Ball screws	Linear guides
E-DFO	○	○	◎	Normal atmosphere, vacuum	●	●
Fluororesin	△	△	○	Normal atmosphere, vacuum	–	–
MoS_2	○	△/○	○	Normal atmosphere, vacuum	●	●
Commercially available fluorine grease	◎	◎	△	Normal atmosphere, vacuum	●	●

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

● Low outgassing properties

● Outgassing property in high-temperature environments (measurement example with bearings)

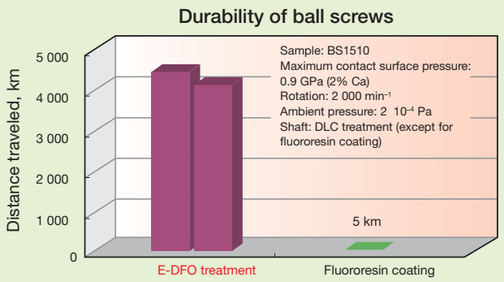
Outperforms conventional fluorine-coated bearings.



● Long life

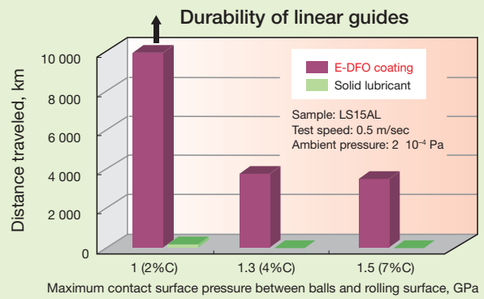
● Durability of ball screws

E-DFO coating extends operating life of ball screws compared to fluororesin coating.



● Durability of linear guides

E-DFO coating extends operating life of linear guides compared to solids lubricant.



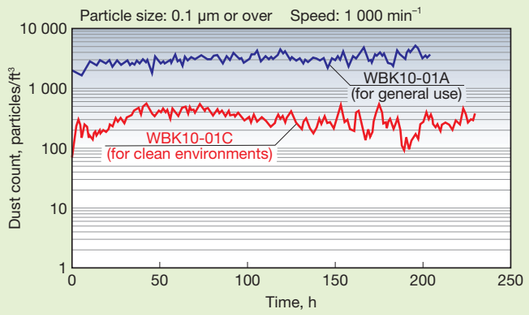
4. Support Units for Clean Environments

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.

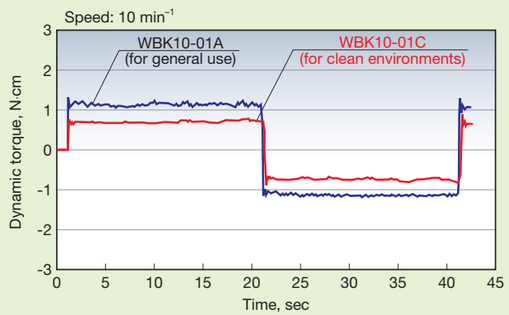
Features of Clean Support Unit

- **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

● Low particle emitting characteristics



● Low-torque characteristics



● Coding of reference numbers

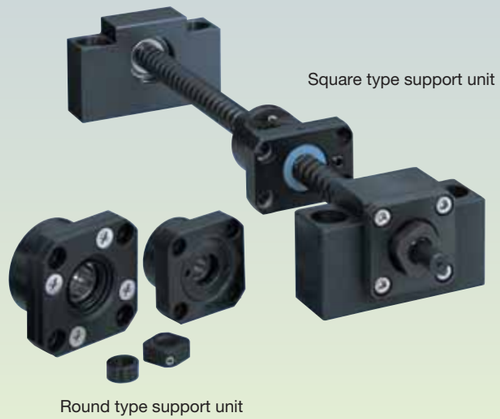
Example: **WBK 08 S - 01 C**

- WBK: Product code for support unit
- 08: Nominal size code (internal bore of bearing)*
- S: Mounting code — No code: Fixed support unit; S: Simple support unit
- 01: Square type; 11: Round type
- C: For clean environments

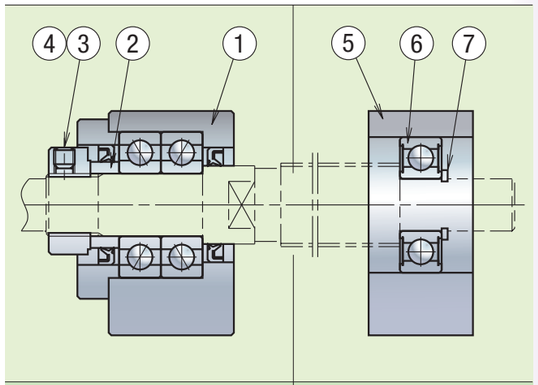
* For simple support units, please note that size codes of 12 or less do not represent internal bores of bearing.

● Structure

Support units



- 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.



Fixed support side		Simple support side	
Part No.	Name of part	Part No.	Name of part
①	Bearing housing	⑤	Bearing housing
②	Spacer	⑥	Bearing
③	Locknut	⑦	Snap ring
④	Set screw with set piece		

● 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

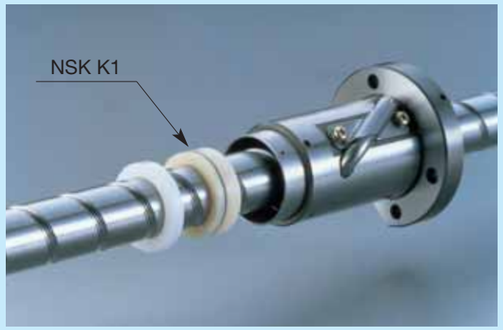
Fixed support side unit					Simple support side support unit		
Reference No.	Axial direction			Maximum starting torque (N·cm)	Reference No.	Bearing Reference No.	Radial direction
	Basic dynamic load rating C_a(N)	Load limit (N)	Stiffness (N/μm)				Basic dynamic load rating C (N)
WBK08-01C (square) **WBK08-11C** (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

5. Lubrication Unit "NSK K1™"

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

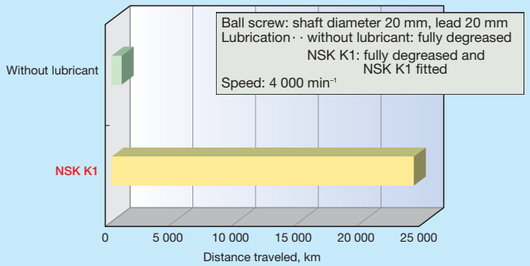
NSK has developed the maintenance-free ball screws and linear guides with the newly-developed NSK K1 lubrication unit. (NSK K1 lubrication unit for food processing equipment and medical devices is also available. See pages B23–B24.)

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.

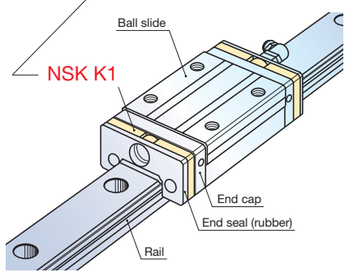
Features of NSK Linear Guides™

- **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:

1. Range of operating temperatures··Maximum operating temperature: 50°C
   Maximum instantaneous operating temperature: 80°C
2. 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)

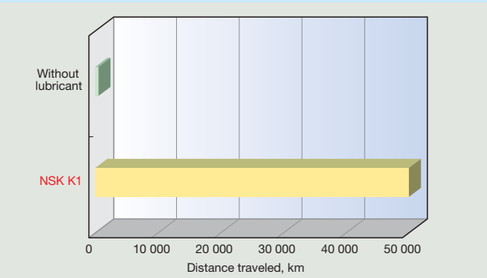


Performance of the NSK Linear Guides

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.

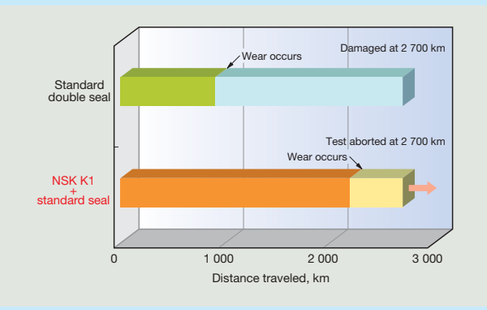
Conditions
Linear guide: LH30AN (preload Z1)
Lubrication · · without lubricant: fully degreased
NSK K1: fully degreased and NSK K1 fitted
Speed: 60 m/min



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.

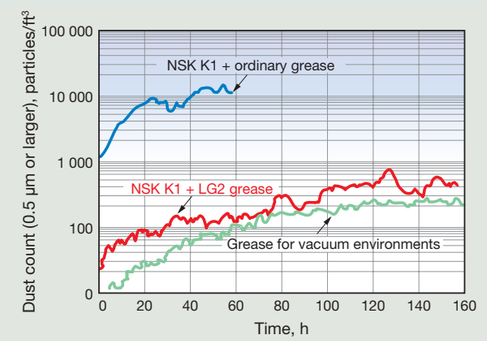
Conditions
Linear guide: LS30 stainless steel (preload Z1)
Water immersion: Run once a week for 24 hours, fully immersed in water
Lubrication: Full grease-packing for food processing machinery
Speed: 24 m/min



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

5. Lubrication Unit “NSK K1™”

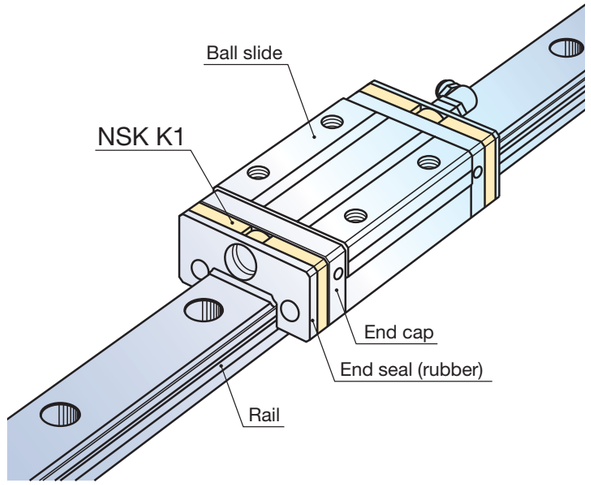
(2) Linear guides equipped with lubrication unit “NSK K1™” for food processing and medical equipment.

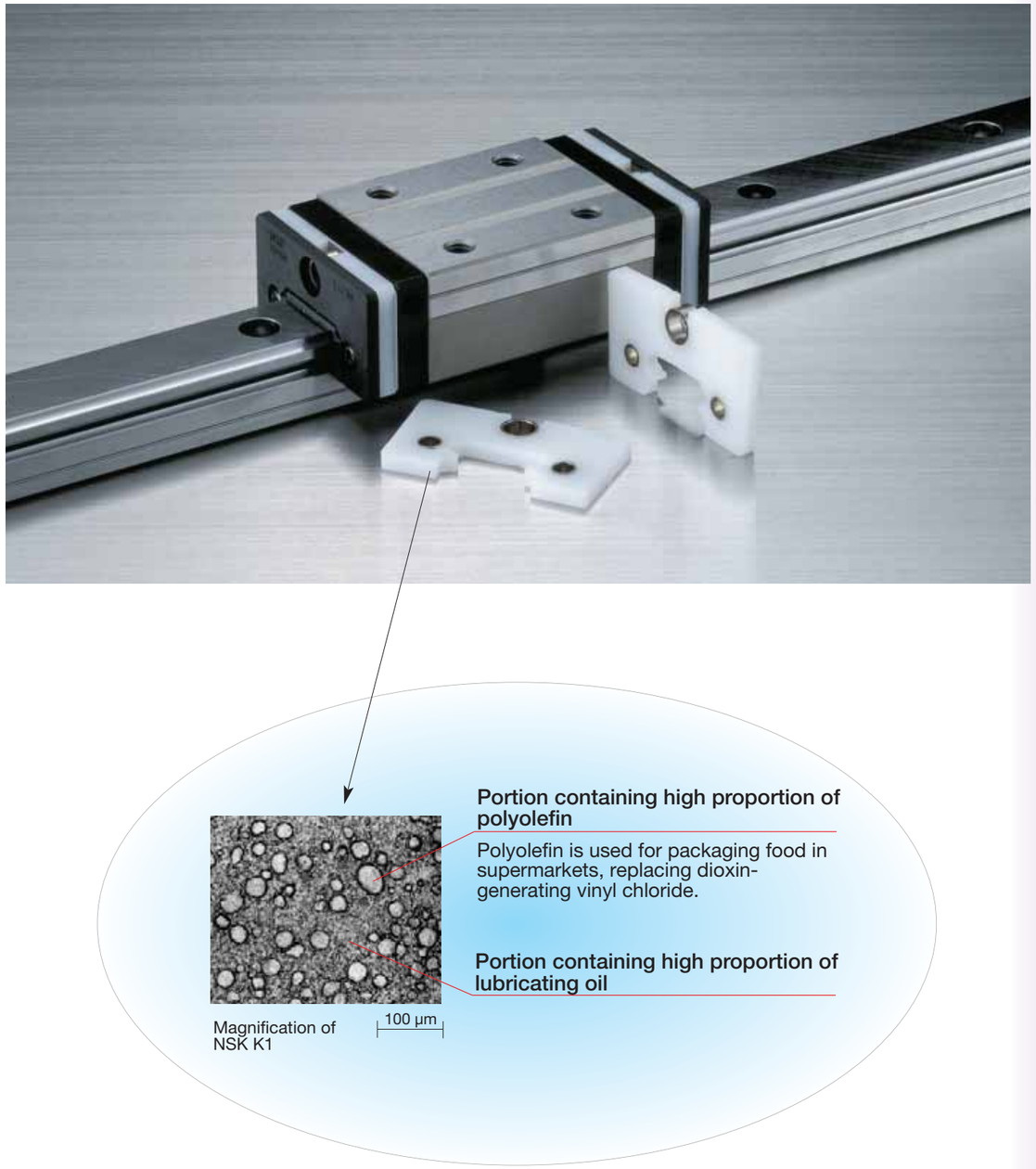
The NSK K1 lubrication unit for food processing and medical equipment is a phenomenal new material seal that is safe and secure. NSK K1 FDA-compliant material is used for the lubrication unit, so it is used without anxiety for food processing and medical equipment.
The newly developed porous synthetic resin contains abundant lubricant.
With the basic functions of highly praised NSK K1 for general industry (see pages B21–B22), 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℃
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)

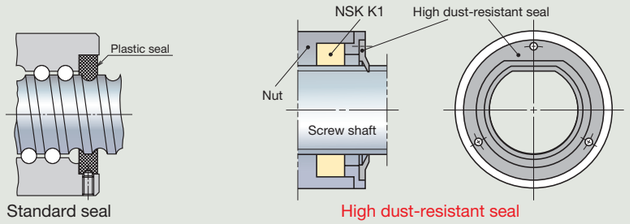
6. NSK High Performance Seals

Examples of water- and particle-contaminated environments include atmospheres where dry powders such as wood flour, rubber crumb, 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** · · · · · Forming the screw shaft into a special groove shape enhances sealing capacity
- **Long life** · · · · · · · · · · · · · · · · NSK K1 lubrication unit was adopted to both enhance dust-resistance and increase durability
- **Low torque design** · · · · · · · Designed to produce lower torque, the seal is formed into a lip shape and positioned close to the cross-section of the screw shaft

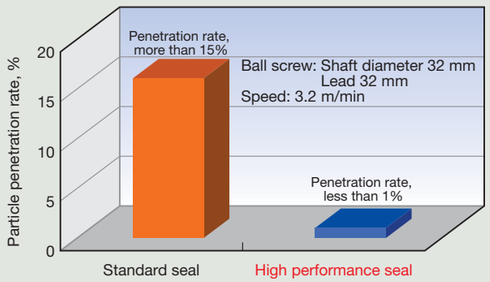


Note: Ball screws with high performance seals come standard with the NSK K1 lubrication unit, so the entire nut length is slightly longer than ball screws equipped with standard seals.

Performance of ball screws equipped with high-performance seals

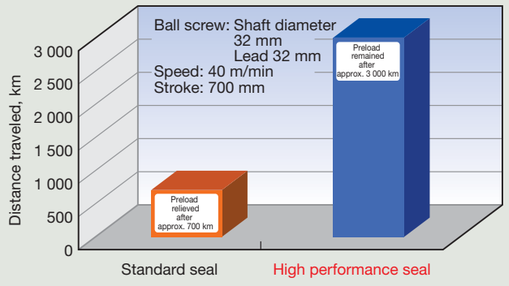
High dust-resistance

Powder finer than 30 µm in particle diameter, such as iron powder, was mixed with grease pasted on the screw shaft. After stroking the nut, particle penetration through the seal was measured.
Particle penetration through the high performance seal is less than 1/15 of the penetration through a standard seal.



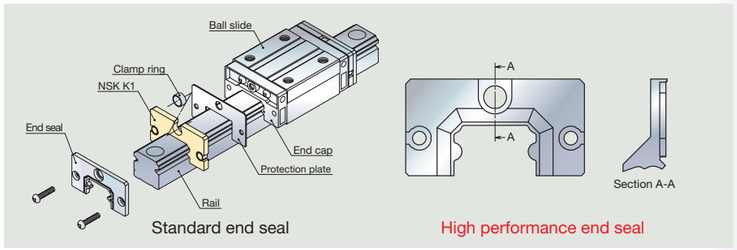
Long life

The durability of ball screws was tested by pasting a mixture of iron powder and a small amount of grease on the screw shaft at regular intervals. The ball screw equipped with the high performance seal functioned more than four times longer than ball screws equipped with standard seals.



Features of Linear Guides Equipped with High Performance Seals

- **High dust-resistance** · · · · · Sealed with three flanges 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 come 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.)

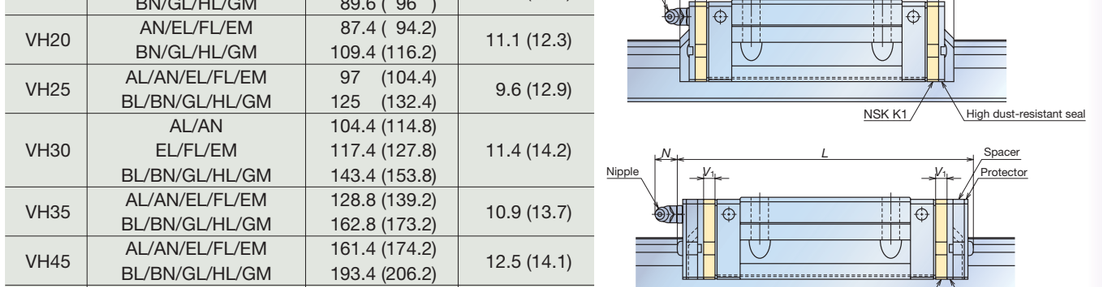
Performance of linear guides equipped with high-performance seals

High dust-resistance

The particle penetration through high performance seals 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 seals in a fine wood flour atmosphere to more than twice that of standard side seals, and more than five times longer in a rubber crumb atmosphere.



Specifications of linear guides equipped with high-performance seals

Unit: mm

Model No.		Ball slide length *L*	Nipple extrusion *N*
VH15	AN/EL/FL/EM	70.6 (77)	1 (8.2)
	BN/GL/HL/GM	89.6 (96)	
VH20	AN/EL/FL/EM	87.4 (94.2)	11.1 (12.3)
	BN/GL/HL/GM	109.4 (116.2)	
VH25	AL/AN/EL/FL/EM	97 (104.4)	9.6 (12.9)
	BL/BN/GL/HL/GM	125 (132.4)	
VH30	AL/AN	104.4 (114.8)	11.4 (14.2)
	EL/FL/EM	117.4 (127.8)	
	BL/BN/GL/HL/GM	143.4 (153.8)	
VH35	AL/AN/EL/FL/EM	128.8 (139.2)	10.9 (13.7)
	BL/BN/GL/HL/GM	162.8 (173.2)	
VH45	AL/AN/EL/FL/EM	161.4 (174.2)	12.5 (14.1)
	BL/BN/GL/HL/GM	193.4 (206.2)	
VH55	AL/AN/EL/FL/EM	185.4 (198.2)	12.5 (14.1)
	BL/BN/GL/HL/GM	223.4 (236.2)	

Dimensions in parentheses are dimensions including the protector.

Dimensions of the linear guide equipped with high performance seal and NSK K1

7. Ball Screws and NSK Linear Guides™ 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.

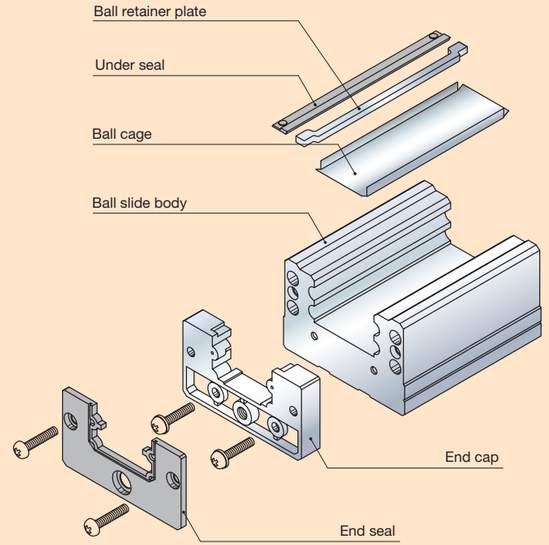
Applicable series	Size symbols*	
	Standard material specification	All-stainless steel specification (except for seals)
LH (high load capacity/aligning)	20, 25, 30, 35, 45, 55	20, 25, 30
LS (compact low type)	15, 20, 25, 30	15, 20, 25, 30
LW (broad type)	17, 21, 27	—
LU (miniature)	09, 12, 15	09, 12,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

Note: *Example of a basic symbol LH 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.

Linear guides for high-temperature and heat-resistant bellows



● 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

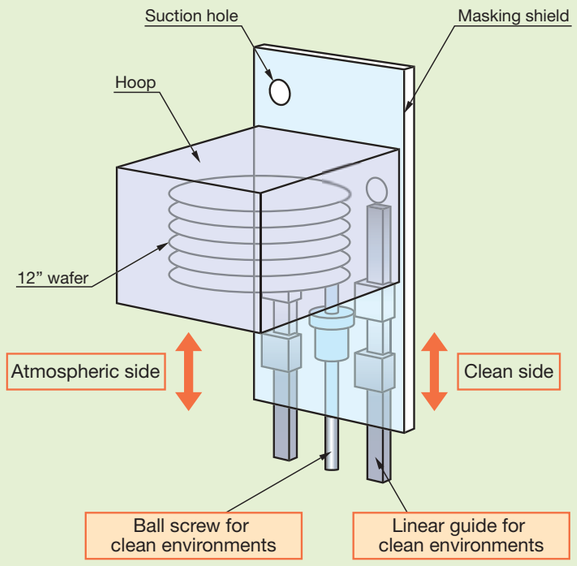
Ball screw component	Material specification
Shaft, nut	Martensite stainless steel
Ball	SUS440C
Recirculation components	Austenite stainless steel

Applications of SPACEA™ Series Ball Screws and NSK Linear Guides™

SPACEA™

1. Semiconductor Manufacturing Equipment

Wafer Conveyor



Operating Conditions

Clean environments

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

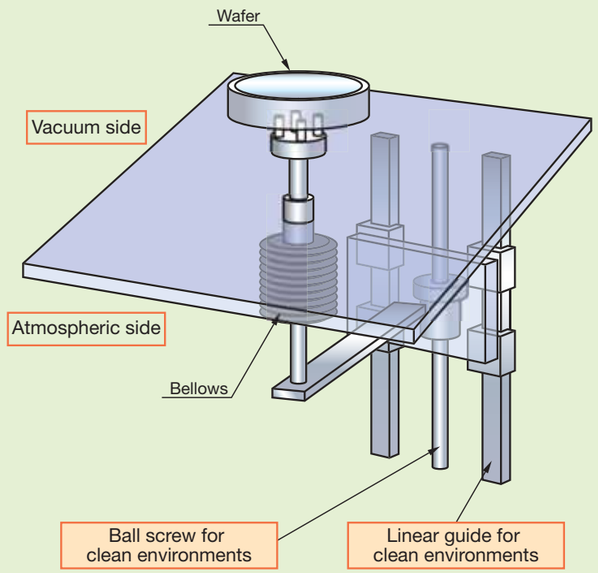
Feature

- 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

Wafer Lift



Operating Conditions

Clean environments

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

Feature

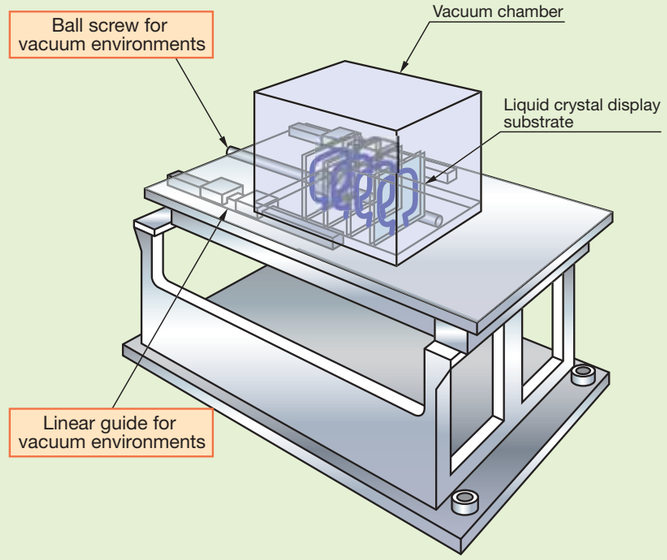
- Change from a commercially available vacuum grease to NSK clean grease

SPACEA™ Series
Ball screws and linear guides for clean environments

- Reduces costs and maintenance

2. LCD/Semiconductor Production Machinery

Liquid Crystal Filling Machine



Operating Conditions

Vacuum/Clean environments

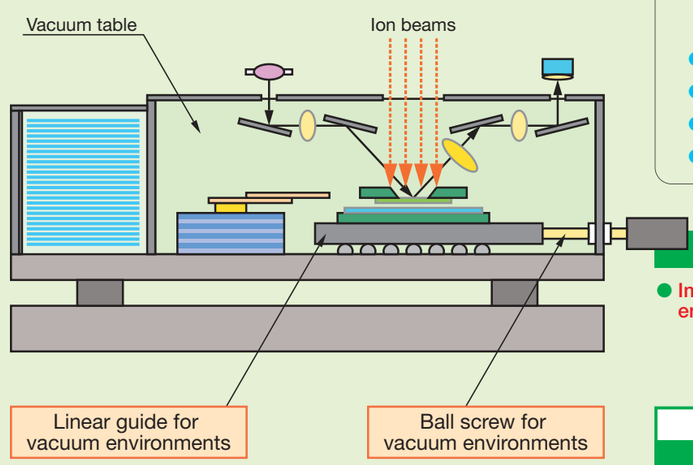
- Degree of vacuum: 10^{-1} Pa
- Temperature: 100–150°C
- Speed: 10 m/min
- Load: Minimal

Feature

- Heat-resistant

SPACEA™ Series
Ball screws and linear guides for vacuum environments

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 clean 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.

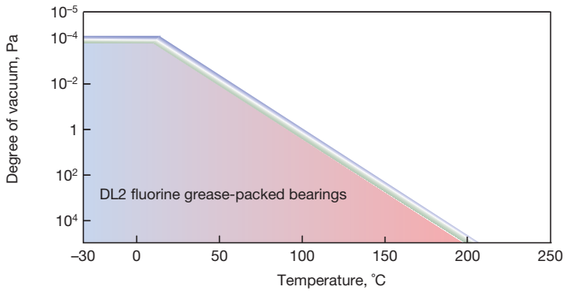
Appendices

Appendices

1. Properties of SPACEA™ Series Greases

Operating environment	Grease	Normal atmosphere, vacuum	Maximum operating temperature ˚C	Cleanliness[1]	Base oil	Thickener	Kinematic viscosity mm²/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

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



Scope of Applications of DL2 Fluorine Grease-Packed Bearings

2. Characteristics of Representative Solid Lubricants

◎: Excellent ○: Good △: Satisfactory

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 MoS_2	4.8	160.07	Hexagonal crystal system	8.33 (-60˚C)	350	650	0.006–0.25	0.001–0.2	△	○
Tungsten disulfide WS_2	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	10^{14}	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 $\times 10^{-6}$ / ˚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

◎: Excellent ○: Good △: Satisfactory ×: Unsatisfactory

Item	Unit	Highly reliable silicon nitride ceramics (Si_3N_4)	High corrosion-resistant carbide-based ceramics (SiC)	Low-cost oxide-based ceramics (ZrO_2)	Bearing steel
Density	g/cm³	3.23	3.14	5.9	7.8
Young's modulus	GPa	330	390	210	208
Fracture toughness	MPa · m$^{1/2}$	6.0	2.5	7.5	18
Hardness (HV)	—	1 500	≥2 000	1 300	700
Thermal expansion coefficient	$\times 10^{-6}$ / ˚C	2.8	4.3	10.5	12.5
Thermal conductivity	W / m · k	31	60	3	50
Bending strength	MPa	900	600	1 100	≥2 500
Rotating capability in water immersion	—	◎	△	○	×
Rotating capability in acid solvents	—	△	◎	○	×
Cost	—	High	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 MoS_2, 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 Greases (Krytox)

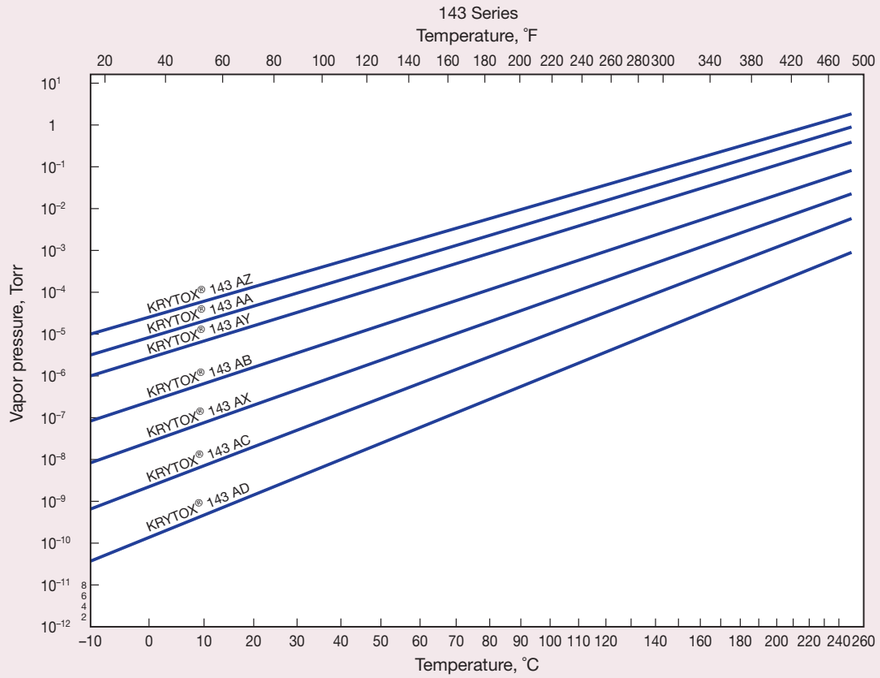
● Krytox oil (Dupont)

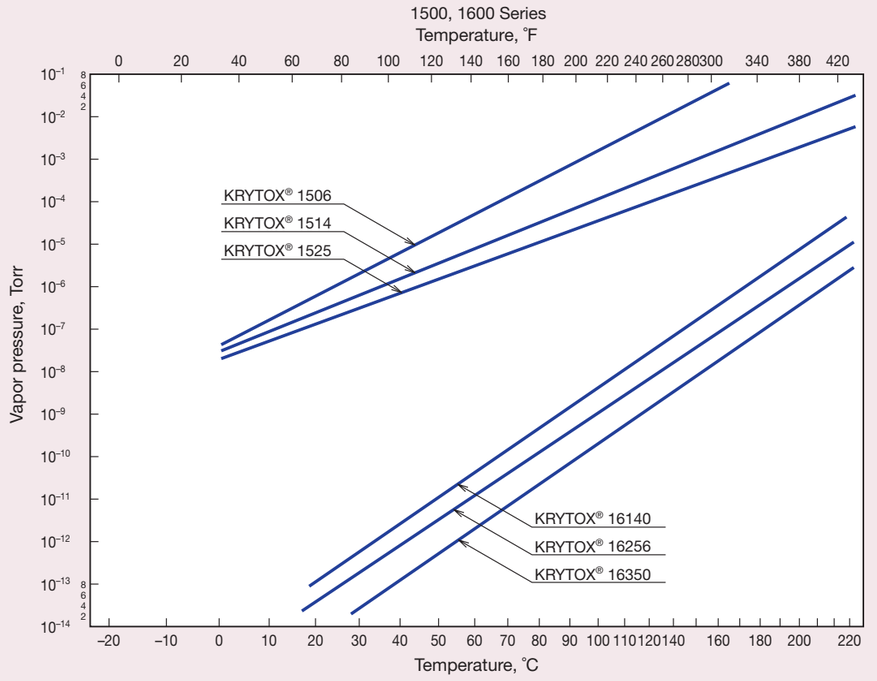
Product		Average molecular weight	Kinematic viscosity mm²/s 20℃	38℃	50℃	100℃	Viscosity index	Pour point ℃	Vapor pressure (Knudsen number) Pa 20℃	38℃	100℃	260℃	Amount of evaporation, mass % (Temperature, 22 hours)	Density g/cm³ (0℃)	Range of operating temperatures
143 Series	AZ	1 850	40	18	—	3.3 (99℃)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

● Krytox grease

Product	Base oil	Kinematic viscosity mm²/s (38℃)	Thickener	Consistency NLGI No.	Vapor pressure (Knudsen number) Pa 38℃	260℃	Oil separation rate mass % (204℃, 30h)	Amount of evaporation mass % (204℃, 6.5h)	Density g/cm³ (25℃)	Additive
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℃, 22h)	1.94	None
GPL204	GPL104	180 (20℃)	PTFE	—	—	—	6 (99℃)	—	—	None
GPL224	GPL104	180 (20℃)			—	—	6 (99℃)	—	—	Anti-rust agent
GPL207	GPL107	1 600 (20℃)			—	—	10	—	—	None
GPL227	GPL107	1 600 (20℃)			—	—	10	—	—	Anti-rust agent

● Vapor pressure of Krytox oil





7. Properties of Commercially Available Fluorine Greases (Fomblin)

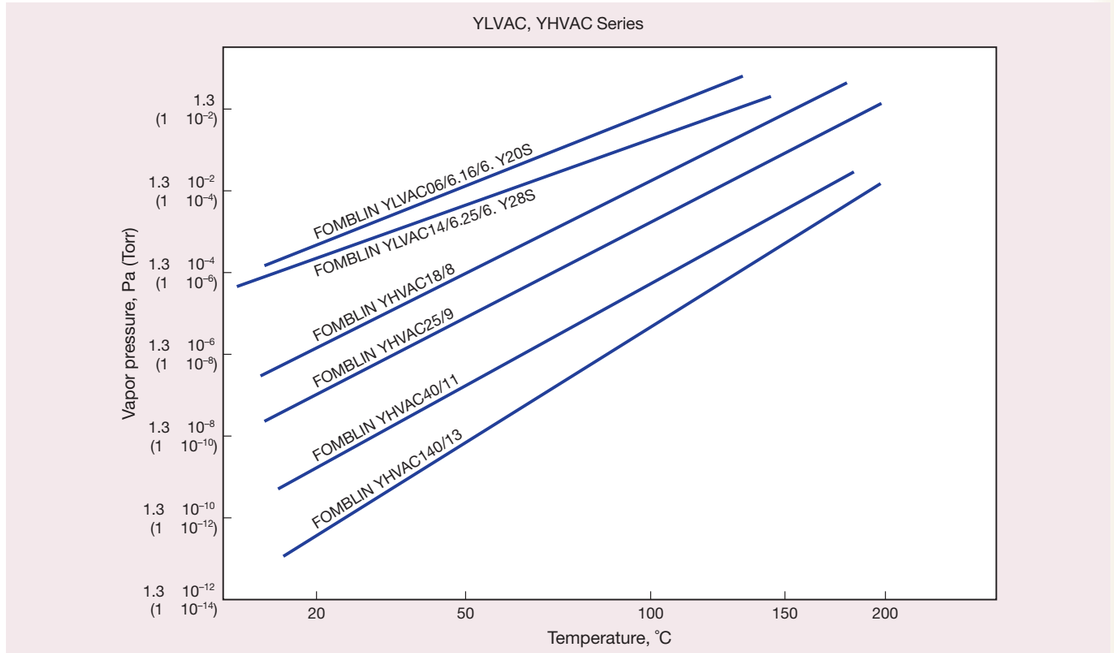
● Fomblin oil (Solvay Solexis)

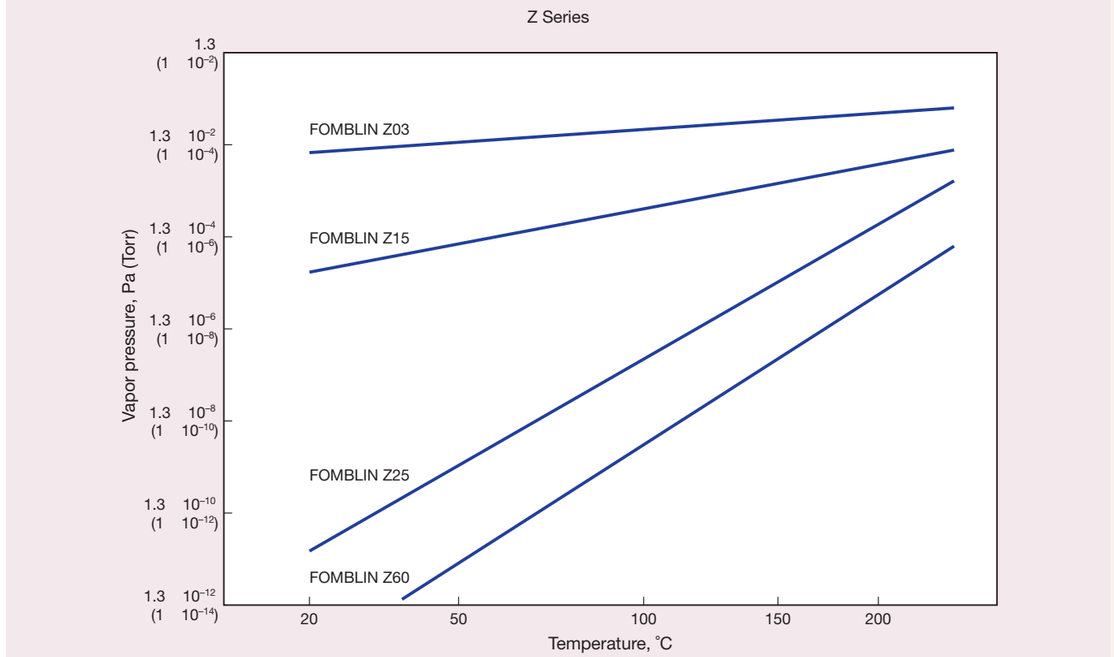
Product		Average molecular weight	Kinematic viscosity mm²/s			Viscosity index	Pour point ℃	Vapor pressure (Knudsen number) Pa		Amount of evaporation, mass % (Temperature, 22 hours)	Density g/cm³ (20℃)
			20℃	40℃	100℃			20℃	100℃		
Y Series	Y04	1 500	38	15	3.2	60	–58	—	—	20 (120℃)	1.87
	Y06	1 800	60	22	3.9	70	–50	—	—	6 (120℃)	1.88
	Y25	3 200	250	81	10.4	108	–35	—	—	15 (204℃)	1.90
	Y45	4 100	470	147	16.5	117	–30	—	—	1.7 (204℃)	1.91
	YR	6 250	1 200	345	33.0	135	–25	—	—	1.2 (204℃)	1.91
YLVAC Series	06/6	—	62 ± 6	—	—	—	–50	$\leq 5.2 \times 10^{-4}$	$\leq 9.1 \times 10^{-1}$	—	1.88
	14/6	—	140 ± 20	—	—	—	–45	$\leq 2.6 \times 10^{-4}$	$\leq 2.6 \times 10^{-1}$	—	1.89
	16/6	—	160 ± 15	—	—	—	–45	$\leq 6.5 \times 10^{-4}$	$\leq 9.1 \times 10^{-1}$	—	1.90
	25/6	—	270 ± 20	—	—	—	–35	$\leq 2.6 \times 10^{-4}$	$\leq 2.6 \times 10^{-1}$	—	1.90
YHVAC Series	18/8	—	180 ± 20	—	—	—	–42	$\leq 2.6 \times 10^{-6}$	$\leq 2.6 \times 10^{-2}$	—	1.89
	25/9	—	270 ± 20	—	—	—	–35	$\leq 2.6 \times 10^{-7}$	$\leq 2.6 \times 10^{-3}$	—	1.90
	40/11	—	450 ± 50	—	—	—	–32	$\leq 2.6 \times 10^{-9}$	$\leq 6.5 \times 10^{-5}$	—	1.91
	140/13	—	1 400 ± 200	—	—	—	–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℃)	1.82
	Z15	8 000	160	92	28	334	–80	—	—	1.2 (204℃)	1.84
	Z25	9 500	260	159	49	358	–75	—	—	0.4 (204℃)	1.85
	Z60	13 000	600	355	98	360	–63	—	—	0.2 (204℃)	1.85

● Fomblin grease

Product	Base oil	Thickener	Consistency NLGI No.	Oil separation rate mass % (204℃, 30h)	Amount of evaporation mass % (204℃, 6.5h)	Density g/cm³ (20℃)	Additive	Working temperature range ℃
OT20	Y Series	PTFE	2	—	—	1.91	None	–70/120
UT18	Y Series		2	—	—	1.94	None	–30/250
RT15	Y Series		2	7.7	0.5	1.95	None	–25/250
YRT/2	Y Series	PTFE	2	7.9	0.9	1.95	Anti-rust agent (solid)	–20/170
AR883	Y Series	PTFE	2	8.0	1.5	1.95	Anti-rust agent (liquid)	–20/170
AR855	Y Series		2	8.0	1.5	1.95	Anti-rust agent (liquid)	–20/250
YVAC1	HVAC140/13	PTFE	1	8.6	0.3	1.98	None	–25/250
YVAC2	HVAC140/13		2	8.0		1.98	None	–25/250
YVAC3	HVAC140/13		3	8.0	0.3	2.00	None	–25/250
ZLHT	Z Series	PTFE	2	6.6	2.8	1.95	None	–80/200
ZNF	Z Series		3	8.0	0.2	1.98	None	–60/220

● Vapor pressure of Fomblin oil





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

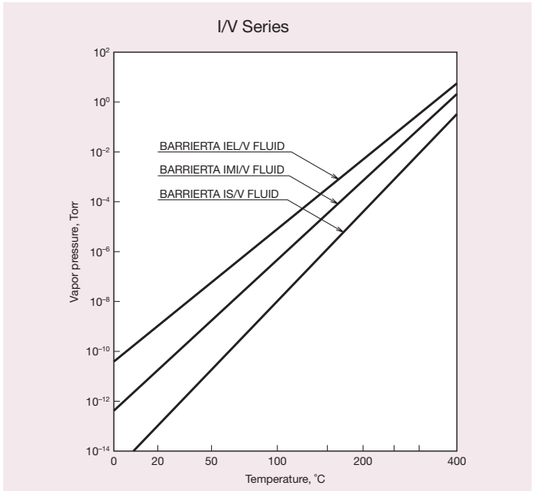
● Barrierta oil (NOK Clüber)

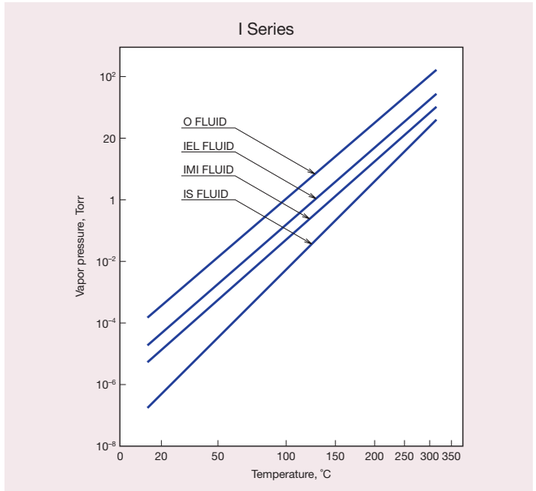
I Series	I/V Series	Average molecular weight	Kinematic viscosity mm²/s		Viscosity index	Pour point ˚C	Vapor pressure (Knudsen number) Pa (20˚C)	Density g/cm³ (20˚C)
			20˚C	40˚C				
O		2 100	65	25	72	–60	—	1.88
	IEL/V	—	140	65	200	–70	1×10^{-7}	1.87
IEL		3 500	280	95	130	–45	—	1.90
IMI		4 500	550	180	138	–40	—	1.90
	IMI/V	—	500	180	130	–37.5	2×10^{-9}	1.90
IS		7 500	1 400	390	140	–32	—	1.90
	IS/V	—	1 400	390	140	–30	1×10^{-11}	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
ISL/OX	O	25	PTFE	2	—	—	—	1.95	Anti-rust agent
IEL	IEL	95		2	4×10^{-5}	—	—	1.95	Anti-rust agent
IMI	IMI	180		2	7×10^{-6}	—	—	1.95	Anti-rust agent
IS	IS	390		2	3×10^{-7}	—	—	1.95	Anti-rust agent
L25/DL	IEL	95	PTFE	2	—	—	—	1.95	Anti-rust agent
L55/2	IS	390		2	3×10^{-7}	—	—	1.95	Anti-rust agent
IEL/V	IEL/V	65	PTFE	2	9×10^{-7}	7.0	0.2	1.95	Anti-rust agent
IMI/V	IMI/V	180		2	2×10^{-8}	7.0	0.2	1.95	Anti-rust agent
IS/V	IS/V	390		2	1×10^{-11}	7.0	0.1	1.95	None

● Vapor pressure of Barrierta oil





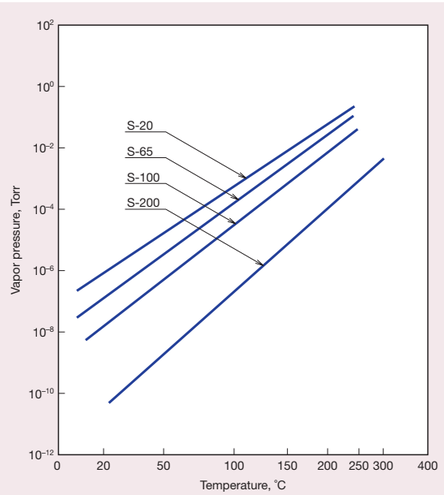
● Demnum oil (Daikin)

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

System of units \ Quantity	Length	Mass	Time	Temperature	Acceleration	Force	Stress	Pressure	Energy	Power
SI	m	kg	s	K, ℃	m/s^2	N	Pa	Pa	J	W
CGS	cm	g	s	℃	Gal	dyn	dyn/cm^2	dyn/cm^2	erg	erg/s
Engineering	m	$kgf·s^2/m$	s	℃	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	°	$180/\pi$
			Minute	′	$10\,800/\pi$
			Second		$648\,000/\pi$
Length	Meter	m	Micron	μ	10^6
			Angstrom	A	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	$1/(9.80665 \times 10^3)$
			Dyne	dyn	10^5
Torque and moment of force	Newton-meter	N·m	Kilogram-force-meter	kgf·m	1/9.80665
Strength	Pascal (Newton per square meter)	Pa (N/m^2)	Kilogram per square centimeter	kgf/cm^2	$1/(9.80665 \times 10^4)$
			Kilogram per square millimeter	kgf/mm^2	$1/(9.80665 \times 10^6)$

● 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_2O	$1/(9.80665 \times 10^3)$
			Millimeter mercury	mmHg	$760/(1.01325 \times 10^5)$
			Torr	Torr	$760/(1.01325 \times 10^5)$
			Bar	bar	10^{-5}
			Atmospheric pressure	atm	$1/(1.01325 \times 10^5)$
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	$1/(3.6 \times 10^6)$
			Metric horsepower-hour	PS·h	$= 3.77672 \times 10^{-7}$
Power	Watt (Joule per second)	W (J/s)	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, ℃	Degree	℃	(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	$4\pi/10^3$
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 TK to θ℃, $\theta = T - 273.15$. In the case of temperature difference, $\Delta T = \Delta\theta$, with ΔT and $\Delta\theta$ 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	233.459	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	17.482	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	372.256
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	71.014	96.441	121.641	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	200.022	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

1 = 25.4 mm

Inches		21	22	23	24	25	26	27	28	29	30
Fraction	Decimal number	mm									
0	0.0000	533.400	558.800	584.200	609.600	635.000	660.400	685.800	711.200	736.600	762.000
1/16	0.0625	534.988	560.388	585.788	611.188	636.588	661.988	687.388	712.788	738.188	763.588
1/8	0.1250	536.575	561.975	587.375	612.775	638.175	663.575	688.975	714.375	739.775	765.175
3/16	0.1875	538.162	563.562	588.962	614.362	639.762	665.162	690.562	715.962	741.362	766.762
1/4	0.2500	539.750	565.150	590.550	615.950	641.350	666.750	692.150	717.550	742.950	768.350
5/16	0.3125	541.338	566.738	592.138	617.538	642.938	668.338	693.738	719.138	744.538	769.938
3/8	0.3750	542.925	568.325	593.725	619.125	644.525	669.925	695.325	720.725	746.125	771.525
7/16	0.4375	544.512	569.912	595.312	620.712	646.112	671.512	696.912	722.312	747.712	773.112
1/2	0.5000	546.100	571.500	596.900	622.300	647.700	673.100	698.500	723.900	749.300	774.700
9/16	0.5625	547.688	573.088	598.488	623.488	649.288	674.688	700.088	725.488	750.888	776.288
5/8	0.6250	549.275	574.675	600.075	625.475	650.875	676.275	701.675	727.075	752.475	777.875
11/16	0.6875	550.862	576.262	601.662	627.062	652.462	677.862	703.262	728.662	754.062	779.462
3/4	0.7500	552.450	577.850	603.250	628.650	654.050	679.450	704.850	730.250	755.650	781.050
13/16	0.8125	554.038	579.438	604.838	630.238	655.638	681.038	706.438	731.838	757.238	782.638
7/8	0.8750	555.625	581.025	606.425	631.825	657.225	682.625	708.025	733.425	758.825	784.225
15/16	0.9375	557.212	582.612	608.012	633.412	658.812	684.212	709.612	735.012	760.412	785.812

1 = 25.4 mm

Inches		31	32	33	34	35	36	37	38	39	40
Fraction	Decimal number	mm									
0	0.0000	787.400	812.800	838.200	863.600	889.000	914.400	939.800	965.200	990.600	1016.000
1/16	0.0625	788.988	814.388	839.788	865.188	890.588	915.988	941.388	966.788	992.188	1017.588
1/8	0.1250	790.575	815.975	841.375	866.775	892.175	917.575	942.975	968.375	993.775	1019.175
3/16	0.1875	792.162	817.562	842.962	868.362	893.762	919.162	944.562	969.962	995.362	1020.762
1/4	0.2500	793.750	819.150	844.550	869.950	895.350	920.750	946.150	971.550	996.950	1022.350
5/16	0.3125	795.338	820.738	846.138	871.538	896.938	922.338	947.738	973.138	998.538	1023.938
3/8	0.3750	796.925	822.325	847.725	873.125	898.525	923.925	949.325	974.725	1000.125	1025.525
7/16	0.4375	798.512	823.912	849.312	874.712	900.112	925.512	950.912	976.312	1001.712	1027.112
1/2	0.5000	800.100	825.500	850.900	876.300	901.700	927.100	952.100	977.900	1003.300	1028.700
9/16	0.5625	801.688	827.088	852.488	877.888	903.288	928.688	954.088	979.488	1004.888	1030.288
5/8	0.6250	803.275	828.675	854.075	879.475	904.875	930.275	955.675	981.075	1006.475	1031.875
11/16	0.6875	804.862	830.262	855.662	881.062	906.462	931.862	957.262	982.662	1008.062	1033.462
3/4	0.7500	806.450	831.850	857.250	882.650	908.050	933.450	958.850	984.250	1009.650	1035.050
13/16	0.8125	808.038	833.438	858.838	884.238	909.638	935.038	960.438	985.838	1011.238	1036.638
7/8	0.8750	809.625	835.025	860.425	885.825	911.225	936.625	962.025	987.425	1012.825	1038.225
15/16	0.9375	811.212	836.612	862.012	887.412	912.812	938.212	963.621	989.012	1014.412	1039.812

13. Viscosity Conversion Table

Kinematic viscosity mm²/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

Kinematic viscosity mm²/s	Saybolt universal second SUS (seconds)		Redwood 1 second R (seconds)		Engler viscosity E (degrees)
	100°F	210°F	50°C	100°C	
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

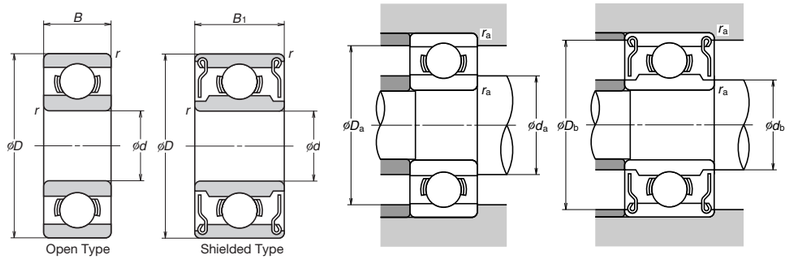
14. Hardness Conversion Table

( ): Reference

Rockwell C scale hardness (1 471N) (150 kgf)	Vickers hardness	Brinell hardness		Rockwell hardness		Shore hardness
		Standard ball	Tungsten carbide ball	A scale Load 588N (60 kgf) Brale indenter	B scale 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

Rockwell C scale hardness (1 471N) (150 kgf)	Vickers hardness	Brinell hardness		Rockwell hardness		Shore hardness
		Standard ball	Tungsten carbide ball	A scale Load 588N (60 kgf) Brale indenter	B scale Load 980.7N (100 kgf) 1.588 mm Ball (1/16 in)	
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

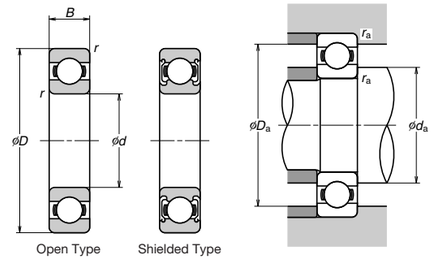


● Extra-Small Ball Bearings

Bore diameter d (mm)	Outside diameter D (mm)	Width		Chamfer dimension (minimum) r (mm)	Basic bearing number	Load rating C_H (reference value) (N)	Abutment and fillet dimensions (mm)				
		Open Type B (mm)	Shielded Type B_1 (mm)				d_a	d_b	D_a	D_b	r_a
							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 d (mm)	Outside diameter D (mm)	Width of Open/ Shielded Type B (mm)	Chamfer dimension (minimum) r (mm)	Basic bearing number	Load rating C_H (reference value) (N)	Abutment and fillet dimensions (mm)			
						d_a		D_a	r_a
						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

Unit: μm

Diameter classification (mm)		Single-plane mean-bore diameter deviation (Class 0) Δ_{dmp}	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

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
+ 7 −13	+16 −13	+25 −21	+24 + 4	+ 33 + 4	+ 50 + 4	+37 +17	+ 46 + 17	+ 60 + 31	+ 79 + 50	+106 + 77	+123 + 77	180	200
										+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

Unit: μm

Diameter classification (mm) over	incl.	Single-plane mean-outside diameter deviation (Class 0) ΔDmp	E6	F6	F7	G6	G7	H6	H7	H8	J6	J7	JS6	JS7
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

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

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SPACEA™

To request a specification inquiry, please fill out the following form and contact the nearest NSK office.

Name of company		Name	
Department		Phone	

Nominal bearing number, Dimensions	NSK bearing No.		
	Other company's model No.		
	Dimensions	Bore diameter × Outside diameter × Width (ϕ × ϕ × mm)	
Application	Type of machine (example: liquid crystal cleaning equipment, coating equipment for semiconductor, etc.) 1. New design 2. Experience in use with similar equipment 3. Maintenance		
Problems/ Issues	Current bearing	1. Name of manufacturer: ( ), Model: ( ) 2. Unknown	
	Specifications	1. Material	
		2. Lubricant	
	Bearing durability	(hours or months)	1. Poor lubrication 2. Particle emissions/outgassing 3. Rusting 4. Contamination with foreign particles 5. Lubricant leakage 6. Fracture 7. Abnormal noise 9. Poor rotation
	Required operating life	( ) hours or months	
	Details of problems/ issues		
Operating environment	Normal atmosphere, vacuum	1. Normal atmosphere 2. From normal atmosphere up to vacuum (degree of vacuum = Pa) 3. Vacuum (degree of vacuum = Pa)	
	Corrosion resistance	1. Water environment	1. High-humidity 2. Water-spray 3. Water-immersed 4. De-ionized water 5. Other ( )
		2. Corrosive liquids	Acid ( ) Alkali ( ) Other ( )
		3. Corrosive gases	F-based ( ) Cl-based ( ) Br-based ( ) Other ( )
	Cleanliness	1. Particle emissions (Class:) 2. Outgassing ( ) 3. Grease-free 4. No grease leakage 5. Other ( )	
	High temperature	Bearing temperature (˚C) Ambient temperature (˚C)	
	Non-magnetism	1. Non-magnetic (relative permeability 1.01 or less) 2. Completely non-magnetic (relative permeability 1.001 or less)	
Operating conditions	Speed	Normal ( ) min^{-1} Max ( ) min^{-1}	
	Bearing load	Radial (N) Axial (N) Other load information ( )	
Comments			

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