MOTION & CONTROL

NSK

SPACEA™

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

Introduction

As technology has moved forward in various industries such as liquid crystals and semiconductors in recent years, it has become imperative to develop products that meet every one of our customers' needs.

NSK Motion and Control products reflect our corporate commitment to being environmentally responsible. While we improve the functionality and performance of various industrial machines with our unique core technologies—including clean technology, surface treatment technology, lubrication technology, precision guiding technology, and precision machining technology—our products also save energy and help preserve the environment.

NSK's bearings, ball screws and NSK linear guides, for special environments, were launched in 1998 as the SPACEA™ Series. We have since focused on technological development and introduced various products, such as the world's first titanium alloy bearings and linear guides. In order to respond quickly to our customers' needs, we have also expanded our inventory lineup and established a system that enables delivery of products within one month.

As a result, our products have been used extensively in a wide variety of industries, such as liquid crystals, semiconductors, food, medicine, steel, and chemicals, earning exemplary reputations.

NSK is a comprehensive manufacturer that provides not only bearings but also precision products. This new catalog was compiled for customers to use NSK's products, including bearings and precision products, in special environments with optimal specifications and under optimum conditions.

This comprehensive catalog was made for easy selection of a wide range of SPACEA products, with newly added content related to the SPACEA™ Series, including product dimensions/accuracy, lubricants and materials.

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.

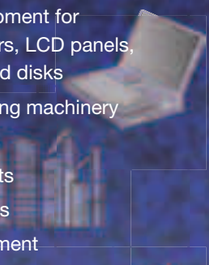
Application: Sanitary environments
- Food processing machinery
- Medical instrument

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™

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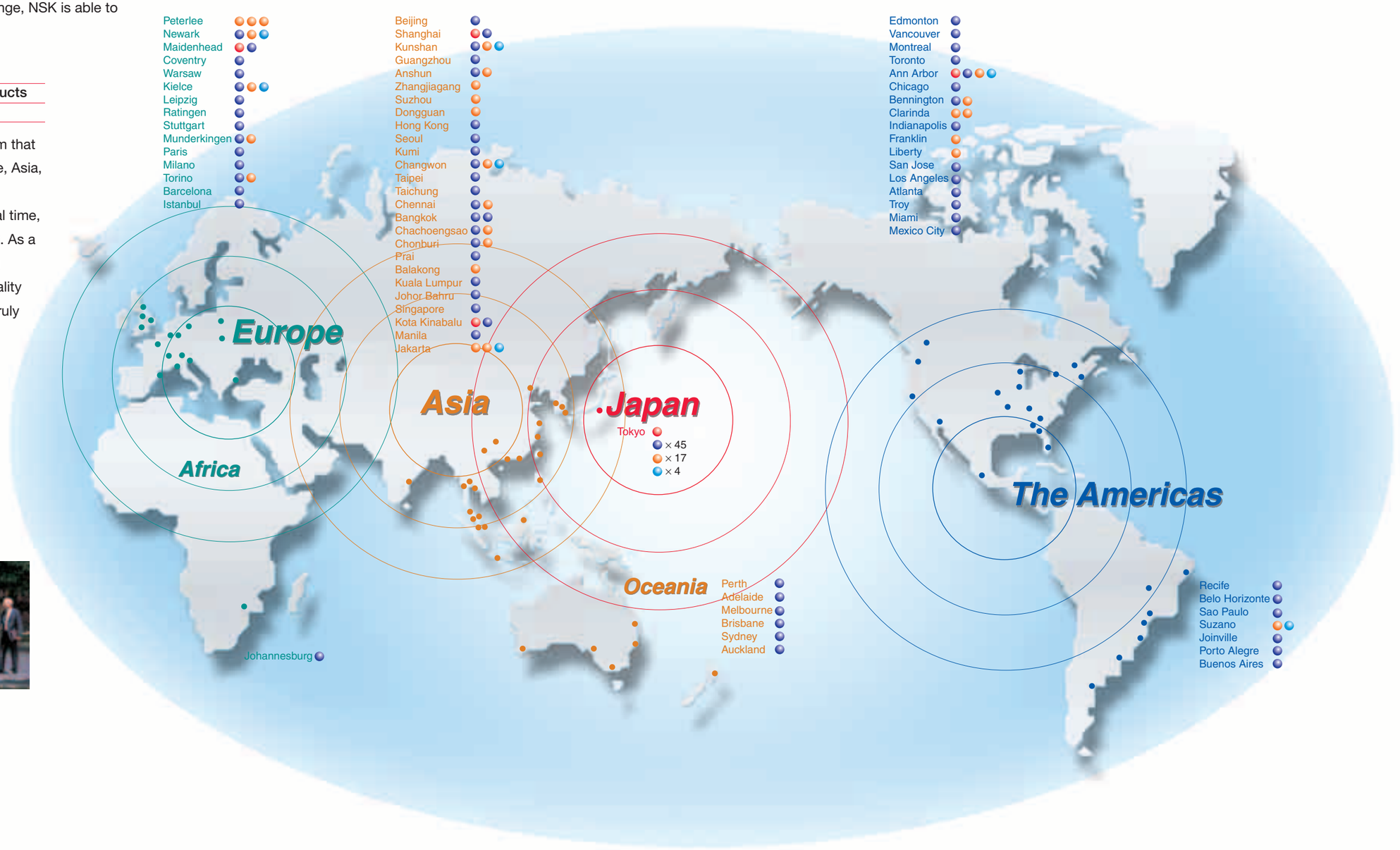
NSK *Global Network*

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.



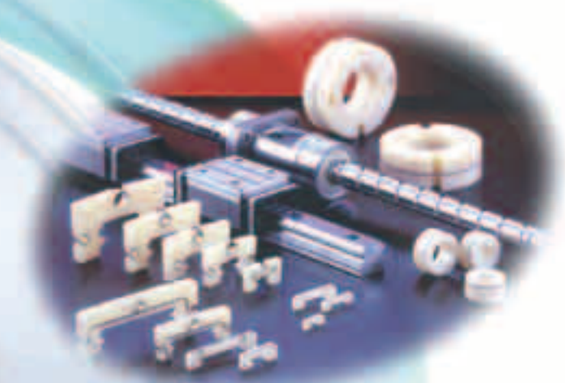
NSK *Research and Development*

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.

Titanium alloy bearings



NSK K1™ Seal (molded-oil)

Bearing Technology Center (Japan)

European Technology Centre (England)

American Technology Center (USA)

Test rig for bearings for vacuum conditions

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

- **Materials technology**

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

- **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, non-magnetic requirement and dust-contaminated environments.
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 12–15.

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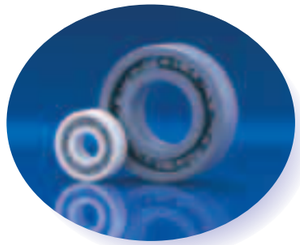
SPACEA™ Series Bearings

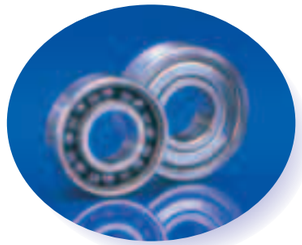
Inventory

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



All-ceramic bearings



YS high-temperature bearings with spacer joints

● Corrosion resistant
- High corrosion-resistant, non-magnetic stainless steel ESA bearings
- All-ceramic bearings (oxide-based ceramics)
- All-ceramic bearings (carbide-based ceramics)

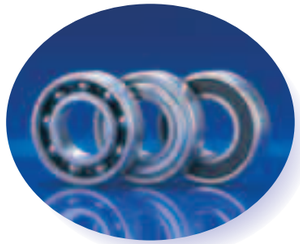
● Clean
- DL2 clean grease-packed bearings
- Clean lubricant V-DFO bearings
- Bearings with self-lubricating fluororesin cages
- YS bearings with MoS_2 self-lubricating cage

● 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
- All-ceramic bearings (oxide-based ceramics)

Corrosive environments

● Water environments
- Stainless steel bearings
- Molded-Oil™ bearings
- Hybrid bearings
- Corrosion-resistant coated bearings (Nickel coating)



Stainless steel bearings

● Alkali and weak acid environments
- 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)

Aqua-Bearing™—
high corrosion-resistant resin bearings

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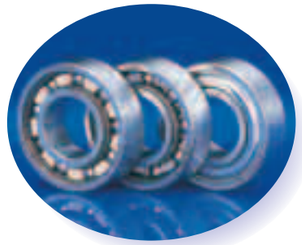
SPACEA™ Se ries Bearings

Clean environments

● Normal atmosphere, room temperature
- LG2/LGU clean grease-packed bearings

● Normal atmosphere, high-temperature/ vacuum, medium-temperature
- DL2 clean grease-packed bearings

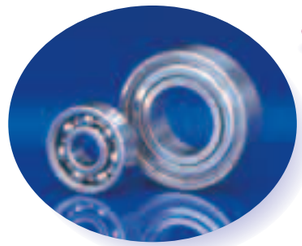
● Vacuum, high-temperature
- YS bearings with MoS_2 self-lubricating cage
- Bearings with self-lubricating fluororesin cages
- Clean lubricant V-DFO bearings



Bearings with self-lubricating fluororesin cages

SJ high-temperature bearings with solid lubrication

High-temperature environments

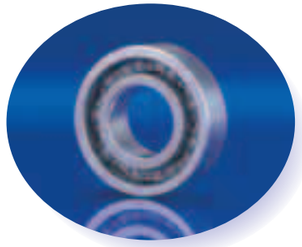


Clean lubricant V-DFO bearings

● 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



Completely non-magnetic titanium alloy bearings

● 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

Dust-contaminated environments

Molded-Oil™ bearings

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

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)
Vacuum	Corrosion-resistance	Reactive gas	High corrosion-resistant, non-magnetic stainless steel ESA bearings	Normal atmosphere, ≤10^{-4}, ≤10^{-8} Pa	≤50℃	100–1000	≤20 000	≤2%	Low → High	P24–27	P38–39	ESA □□□□
			All-ceramic bearings (oxide-based ceramics)	≤10^{-6} Pa	≤150℃		≤20 000	≤5%		P29	P40–41	□□□□ SZ1GSN14T36
			All-ceramic bearings (carbide-based ceramics)		≤200℃						P44–45	□□□□ SR1GT36
	Clean	Vacuum, medium-temperature (for conveyors)	DL2 clean grease-packed bearings	See the Scope of Applications of Bearings for Clean Environments on P14. *a*		100–1000	≤50 000	≤5%	Low → High	P24–27	P48–49	□□□□ LZZ—H DL2
		Vacuum, high-temperature (for conveyors, coating processes)	Bearings with self-lubricating fluororesin cages (T3 specification)	≤10^{-6} Pa	≤200℃						P50–51	□□□□ LZZ—HT3
			Clean lubricant V-DFO bearings	See the Scope of Applications of Bearings for Clean Environments on P14. *b*		10	≤20 000	≤2%			P52–53	□□□□ LZZ—HFD
			Bearings with self-lubricating YS fluororesin cages	≤10^{-7} Pa	≤200℃	100		See the Scope of Applications of Bearings for Clean Environments on P15. *c*			P54–55	□□□□ LZZC3—HMST4
	High-temperature	Up to 400℃	SJ high-temperature bearings with solid lubrication	≤10^{-8} Pa	≤400℃		≤20 000	≤5%	Low → High	P24–27	P60–61	U—□□□□ S4MLSJ01ZZ
		Up to 350℃	YS high-temperature bearings with spacer joints		≤350℃			See the Scope of Applications of High-Temperature Bearings on P15. *d*			P58–59	□□□□ LZZC4—HMSS2
	Non-magnetic	Non-magnetic (relative permeability 1.01 or less)	High corrosion-resistant, non-magnetic stainless steel ESA bearings	≤10^{-6} Pa	≤50℃		≤20 000	≤2%	Low → High	P24–27	P38–39	ESA □□□□
		Completely non-magnetic (relative permeability 1.001 or less)	Completely non-magnetic titanium alloy bearings		≤200℃			≤1%		—	P62–63	□□□□ L—TT3
			All-ceramic bearings (oxide-based ceramics)		≤150℃			≤5%		P29	P40–41	□□□□ SZ1GSN14T36
Corrosive	Water	High-humidity environments	Stainless steel bearings		≤80℃	100–1000	≤150 000	≤5%	Low → High	P24–27	P30–31	□□□□ —H—····✻MA
		Water spray, immersed	Molded-Oil™ bearings					Minimum required load 1%			P32–33	□□□□ L11—H—20
			Hybrid bearings		≤200℃		≤20 000	≤2%			P34–35	□□□□ LZZ—YT3
		Immersed, de-ionized water	Corrosion-resistant coated bearings (Nickel coating)								P36–37	□□□□ LZZCG—YNIT3
		Weak acid and alkali environments	High corrosion-resistant, non-magnetic stainless steel ESA bearings	≤10^{-6} Pa	≤50℃		≤20 000	≤2%	Low → High		P38–39	ESA □□□□
			All-ceramic bearings (oxide-based ceramics) Strong acid and reactive gas environments		≤150℃			≤5%		P29	P40–41	□□□□ SZ1GSN14T36
		Strong acid and reactive gas environments	Aqua-Bearing™—high corrosion-resistant resin bearings		≤40℃			≤1%		P28	P42–43	□□□□ L—PT3 (—QT3)
			All-ceramic bearings (carbide-based ceramics)	≤10^{-6} Pa	≤200℃		≤20 000	≤5%		P29	P44–45	□□□□ SR1GT36

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

Remarks 1. See the SPACEA™ Bearing Dimension Table on P24–27 for the C_H value.
2. C_H is not applicable for calculating rolling fatigue of solid lubrication bearings or coated bearings.

(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

SPACEA™

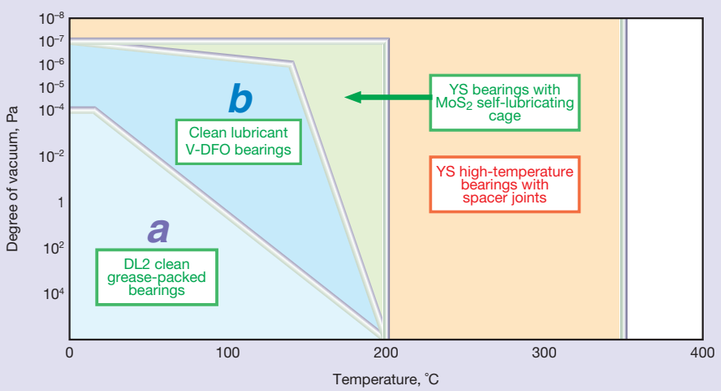
① Operating environment		Product name	② Operating conditions: Degree of vacuum Pa — Normal atmosphere	≤10^{-4}	≤10^{-8}	Operating temperature ℃ — ≤100	≤200	≤300	≤400	Cleanliness(1) — 100–1000	100	10	Limiting rotational speed $d_m n$(2) — ≤20,000	≤50,000	≤150,000	Limiting load P/C_H(3) — ≤1%	≤2%	≤5%	③ Price comparison	③ Availability	④ ·Specifications ·Operating instructions ·Technical data	⑤ Bearing number for inquiry(4)
Clean	Normal atmosphere, room temperature (for clean rooms)	LG2/LGU clean grease-packed bearings	●			70℃ (LG2) 120℃ (LGU)				●			50,000			5%			Low	P24–27	P46–47	□□□□ LZZ−H LG2 (LGU)
	Normal atmosphere, high-temperature/vacuum, medium-temperature (for conveyors)	DL2 clean grease-packed bearings	See the Scope of Applications of Bearings for Clean Environments (below) a																		P48–49	□□□□ LZZ−H DL2
	Normal atmosphere, high-temperature (for conveyors, coating processes)	Bearings with self-lubricating fluororesin cages (T3 specification)	10^{-6} Pa			200℃						●				2%					P50–51	□□□□ LZZ−HT3
		Clean lubricant V-DFO bearings	See the Scope of Applications of Bearings for Clean Environments (below) b										20,000								P52–53	□□□□ LZZ−HFD
		YS bearings with MoS_2 self-lubricating cages	10^{-7} Pa			200℃					●					See the Scope of Applications of Bearings for Clean Environments (below) c			High		P54–55	□□□□ LZZC3−HMST4
High-temperature	For use in normal atmosphere only, up to 230°C	High-temperature KPM grease-packed bearings	●			230℃							50,000			5%			Low	P24–27	P56–57	□□□□ LZZ−H KPM
	From normal atmosphere up to 10^{-8} Pa, up to 400°C	SJ high-temperature bearings with solid lubrication	10^{-8} Pa			400℃							20,000			5%					P60–61	U−□□□□ S4MLSJ01ZZ
	From normal atmosphere up to 10^{-8} Pa, up to 350°C	YS high-temperature bearings with spacer joints				350℃										See the Scope of Applications of High-Temperature Bearings (below) d			High		P58–59	□□□□ LZZC4−HMSS2
Non-magnetic	Non-magnetic (relative permeability 1.01 or less)	High corrosion-resistant, non-magnetic stainless steel ESA bearings				50℃										2%			Low	P24–27	P38–39	ESA □□□□
	Completely non-magnetic (relative permeability 1.001 or less)	Completely non-magnetic titanium alloy bearings	10^{-6} Pa			200℃							20,000			1%				—	P62–63	□□□□ L−TT3
		All-ceramic bearings (oxide-based ceramics)				150℃										5%			High	P29	P40–41	□□□□ SZ1GSN14T36
Dust-contaminated	Dust, wood waste, etc.	Molded-Oil™ bearings	●			80℃							150,000			Minimum required load 1%			—	P65	P64–65	□□□□ 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

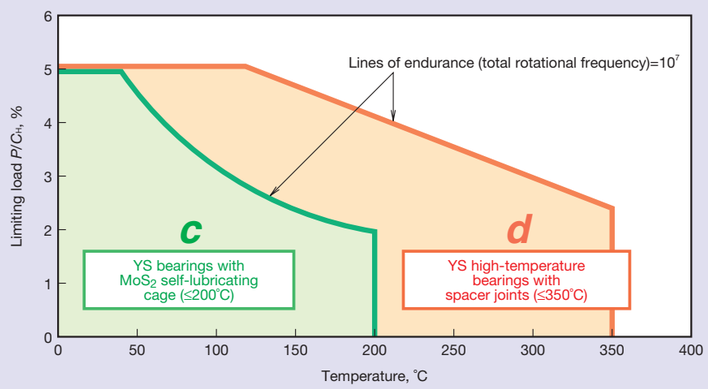
Remarks 1. See the SPACEA™ Bearing Dimension Table on P24–27 for the C_H value.
2. C_H is not applicable for calculating rolling fatigue of solid lubrication bearings or coated bearings.

(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

● Scope of Applications of Bearings for Clean Environments



● Scope of Applications of High-Temperature Bearings

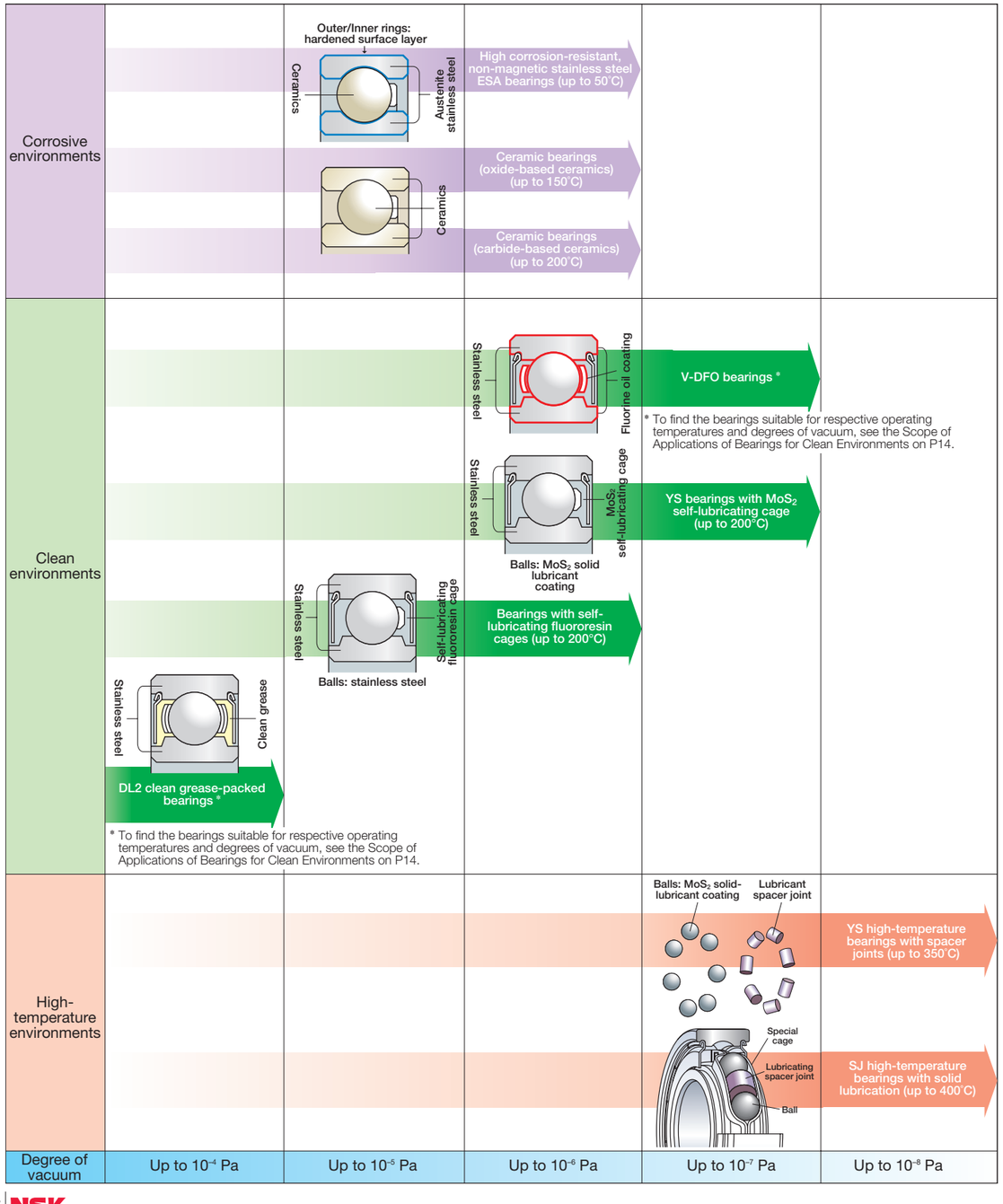


SPACEA™ Bearings Listed by Operating Environment

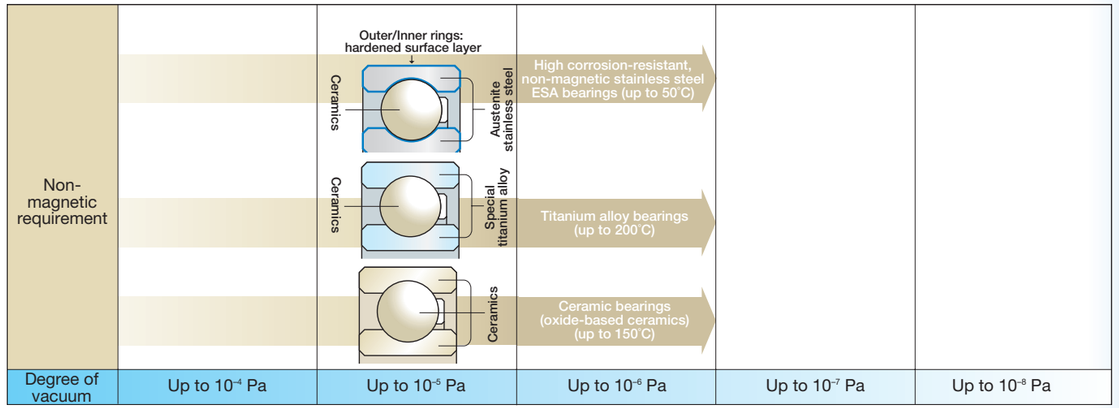
SPACEA™

Bearings for vacuum environments

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



* To find the bearings suitable for respective operating temperatures and degrees of vacuum, see the Scope of Applications of Bearings for Clean Environments on P14.



Specifications of Bearings for Vacuum Environments

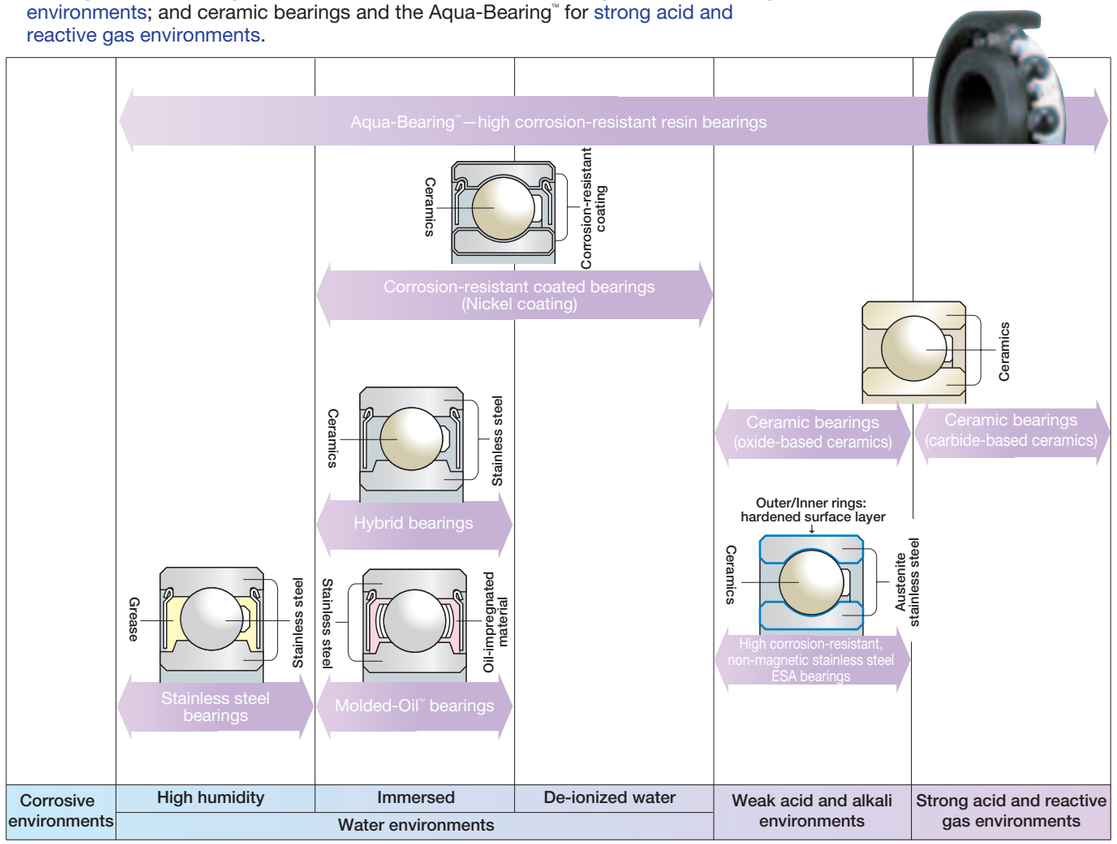
Operating environment		Product name	Structure	Specifications: Inner ring/ Outer ring	Balls	Cage	Shields	Seals	Lubricant	Bearing number for inquiry
Corrosion resistance	Reactive gas	High corrosion-resistant, non-magnetic stainless steel ESA bearings	Open Type only	Austenite stainless steel and hardened surface layer	Ceramics	Fluororesin	—	—	Solid lubrication (fluororesin)	ESA □□□□
		All-ceramic bearings (oxide-based ceramics)		Ceramics						□□□□ SZ1GSN14T36
		All-ceramic bearings (carbide-based ceramics)								□□□□ SR1GT36
Clean	Vacuum, medium-temperature (for conveyors)	DL2 clean grease-packed bearings	Shielded Type	Stainless steel	Stainless steel	Stainless steel	Stainless steel	—	Fluorine clean grease	□□□□ LZZ-H DL2
	Vacuum, high-temperature (for conveyors/ coating processes)	Bearings with self-lubricating fluororesin cages		Stainless steel	Stainless steel	Fluororesin			Solid lubricant (fluororesin)	□□□□ LZZ-HT3
		Clean lubricant V-DFO bearings		Stainless steel and fluorine oil coating	Stainless steel and fluorine oil coating	Stainless steel and fluorine oil coating			Fluorine oil coating V-DFO	□□□□ LZZ-HFD
		YS bearings with MoS_2 self-lubricating cages		Stainless steel	Stainless steel and MoS_2 solid lubricant coating	MoS_2 solid lubrication			MoS_2 solid lubrication	□□□□ LZZC3-HMST4
High-temperature	Up to 350˚C	YS high-temperature bearings with spacer joints	Shielded Type	Stainless steel	Stainless steel and MoS_2 solid lubricant coating	Lubrication spacer joints	Stainless steel	—	MoS_2 solid lubrication	□□□□ LZZC4-HMSS2
	Up to 450˚C	SJ high-temperature bearings with solid lubrication				Corrugated stainless steel and lubrication spacer joints				U-□□□□ S4MLSJ01ZZ
Non-magnetic	Non-magnetic (relative permeability 1.01 or less)	High corrosion-resistant, non-magnetic stainless steel ESA bearings	Open Type only	Austenite stainless steel and hardened surface layer	Ceramics	Fluororesin	—	—	Solid lubrication (fluororesin)	ESA □□□□
	Completely no-magnetic (relative permeability 1.001 or less)	Completely non-magnetic titanium alloy bearings		Special titanium alloy						□□□□ L-TT3
		All-ceramic bearings (oxide-based ceramics)		Ceramics						□□□□ SZ1GSN14T36

SPACEA™ Bearings Listed by Operating Environment

SPACEA™

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 and ESA bearings for weak acid and alkali environments; and ceramic bearings and the Aqua-Bearing™ for strong acid and reactive gas environments.



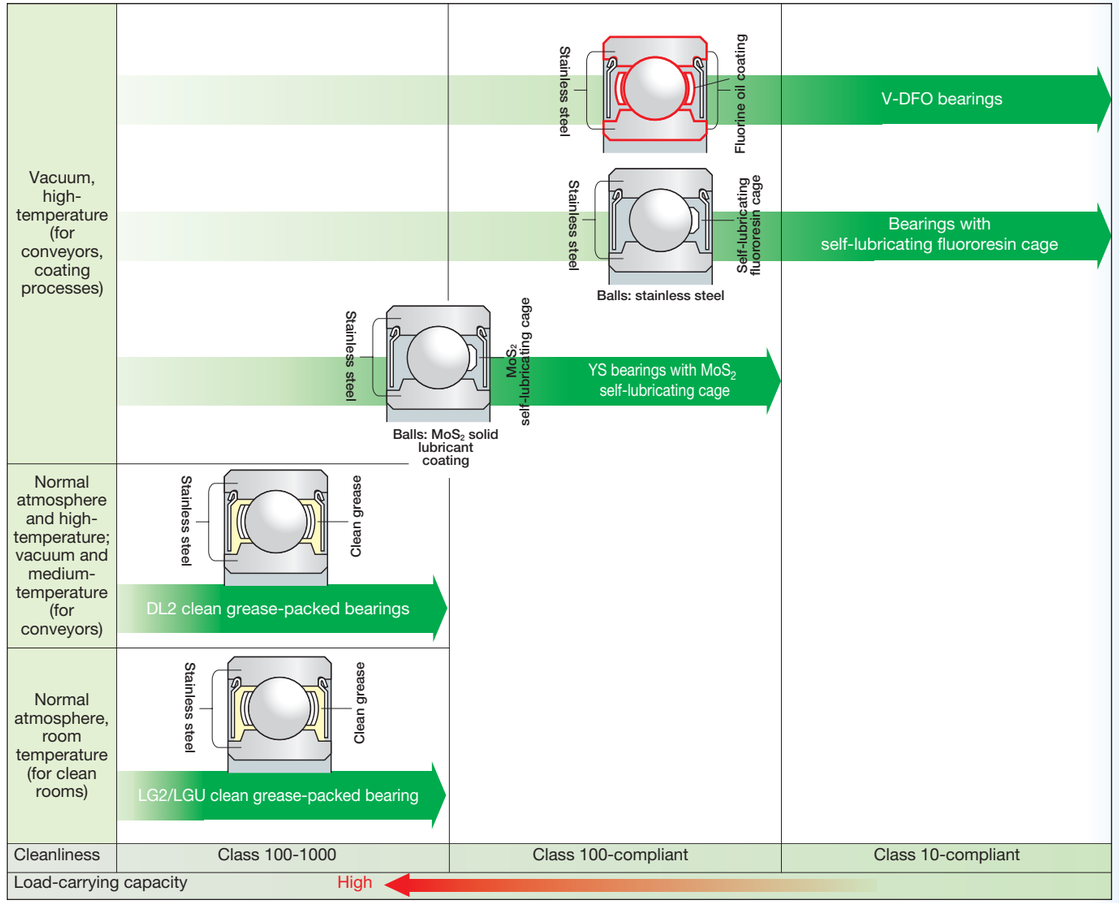
Specifications of Bearings for Corrosive Environments

Operating environment		Product name	Structure	Specifications: Inner ring/Outer ring	Balls	Cage	Shields	Seals	Lubricant/Surface treatment	Bearing number for inquiry
Water environments	High-humidity environments	Stainless steel bearings	Open Type, Shielded Type, Sealed Type	Stainless steel	Stainless steel	Stainless steel or resin	Stainless steel	Nitrile rubber	Grease (1)	□□□□-H-···※MA
	Water spray, immersed	Molded-Oil™ bearings				Stainless steel			Molded-oil™	□□□□ L11-H-20
		Hybrid bearings	Open Type, Shielded Type	Stainless steel	Ceramics	Fluororesin	Stainless steel	—	Solid lubricant (fluororesin)	□□□□ LZZ-YT3
	Immersed, de-ionized water	Corrosion-resistant coated bearings (Nickel coating)	Shielded Type	Stainless steel and nickel-alloy coating						□□□□ LZZCG-YNIT3
Weak acid and alkali environments		High corrosion-resistant, non-magnetic stainless steel ESA bearings	Open Type only	Austenite stainless steel and hardened surface layer	Ceramics	Fluororesin	—	—	Solid lubricant (Fluororesin)	ESA □□□□
		All-ceramic bearings (oxide-based ceramics)		Ceramics						□□□□ SZ1GSN14T36
Strong acid and reactive gas environments		Aqua-Bearing™—high corrosion-resistant resin bearings	Open Type only	Fluororesin	Ceramics	Fluororesin	—	—	Solid lubricant (fluororesin)	□□□□ L-PT3 (-QT3)
		All-ceramic bearings (carbide-based ceramics)		Ceramics						□□□□ SR1GT3

Note (1) Open Type bearings are not grease-packed.

Bearings for clean environments

- Bearings for clean environments consist of clean grease-packed bearings, solid lubrication bearings, and clean lubricant V-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 V-DFO bearings represent a new concept in clean bearings, offering both long life and cleanliness.



Specifications of Bearings for Clean Environments

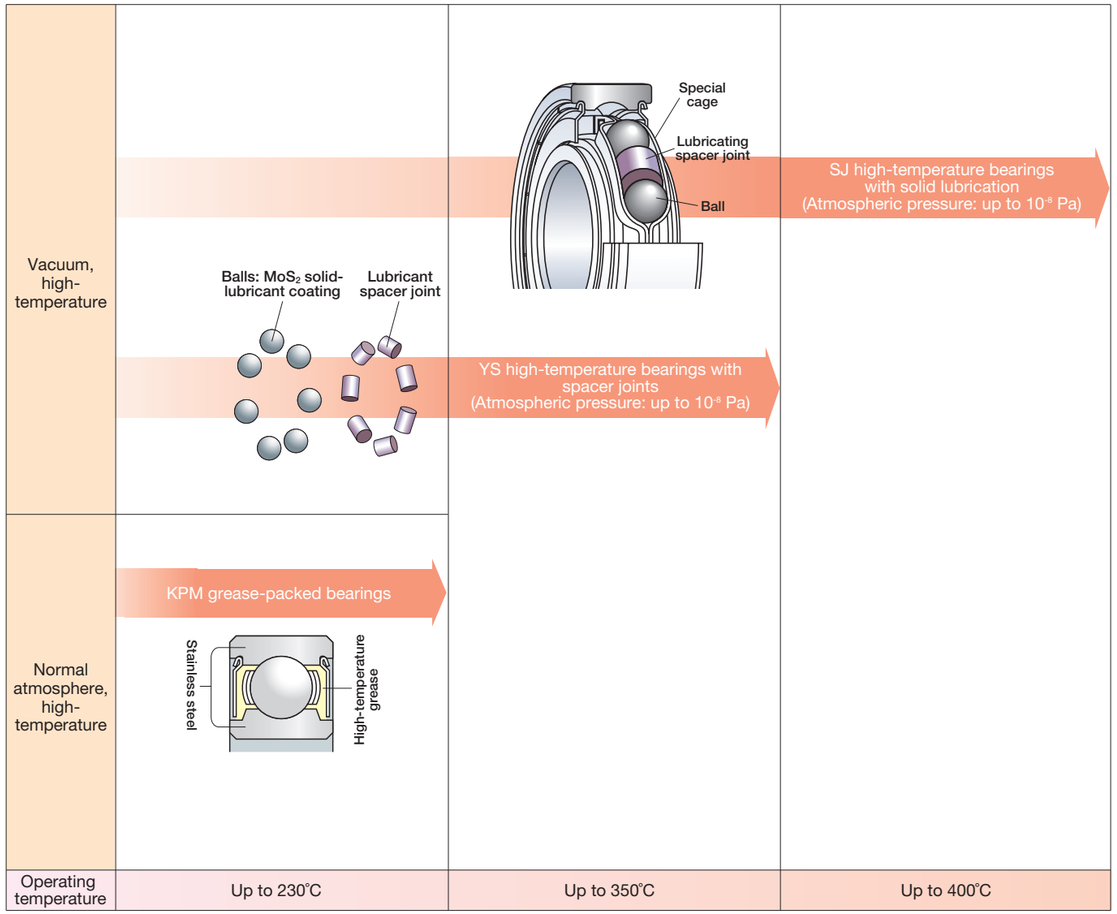
Operating environment	Product name	Structure	Specifications: Inner ring/Outer ring	Balls	Cage	Shields	Seals	Lubricant	Bearing number for inquiry
Normal atmosphere, room temperature (for clean rooms)	LG2/LGU clean grease-packed bearings	Shielded Type	Stainless steel	Stainless steel	Stainless steel or resin	Stainless steel	—	Clean grease	□□□□ LZZ-HLG2 (LGU)
Normal atmosphere, high-temperature/vacuum, medium-temperature (for conveyors)	DL2 clean grease-packed bearings				Stainless steel			Clean grease	□□□□ LZZ-HDL2
Vacuum, high-temperature (for conveyors, coating processes)	Bearings with self-lubricating fluororesin cages (T3 specification)	Shielded Type	Stainless steel	Stainless steel	Fluororesin	Stainless steel	—	Solid lubricant (fluororesin)	□□□□ LZZ-HT3
	Clean lubricant V-DFO bearings		Stainless steel and fluorine oil coating	Stainless steel and fluorine oil coating	Stainless steel and fluorine oil coating			Fluorine oil coating V-DFO	□□□□ LZZ-HFD
	YS bearings with MoS_2 self-lubricating cage		Stainless steel	Stainless steel and MoS_2 solid lubricant coating	Self-lubricating MoS_2 solid lubricant			MoS_2 solid lubrication	□□□□ LZZC3-HMST4

SPACEA™ Bearings Listed by Operating Environment

SPACEA™

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.

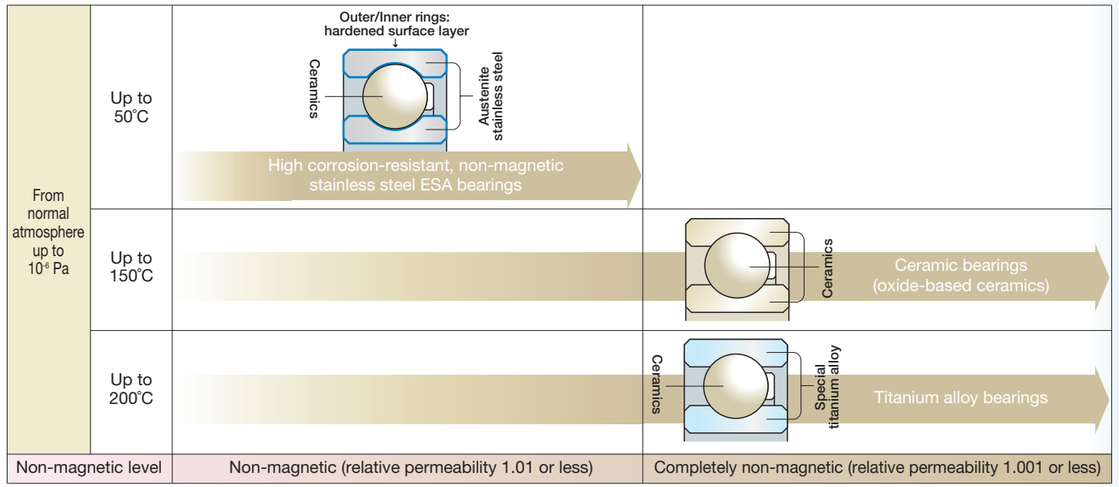


Specifications of Bearings for High-Temperature Environments

Operating environment	Product name	Structure	Specifications					Lubricant/ Surface treatment	Bearing number for inquiry
			Inner ring/ Outer ring	Balls	Cage	Shields	Seals		
For use in normal atmosphere only, up to 230°C	High-temperature KPM grease-packed bearings	Shielded Type	Stainless steel	Stainless steel	Stainless steel	Stainless steel	—	Fluorine grease	□□□□ LZZ-H KPM
From normal atmosphere up to 10^{-8} Pa, up to 350°C	YS high-temperature bearings with spacer joints			Stainless steel and MoS_2 coating	Lubrication spacer joints			MoS_2 solid lubricant	□□□□ LZZC4-HMSS2
From normal atmosphere up to 10^{-8} Pa, up to 400°C	SJ high-temperature bearings with solid lubrication				Corrugated stainless steel and lubrication spacer joints				U-□□□□ S4MLSJ01ZZ

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.



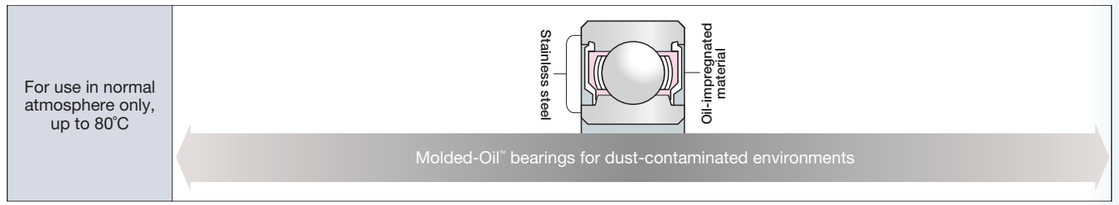
Specifications of Bearings for Non-magnetic Requirement

Operating environment	Product name	Structure	Specifications					Lubricant	Bearing number for inquiry
			Inner ring/ Outer ring	Ball	Cages	Shield	Seal		
Non-magnetic (relative permeability 1.01 or less)	High corrosion-resistant, non-magnetic stainless steel ESA bearings	Open Type only	Austenite stainless steel and hardened surface layer	Stainless steel	Fluororesin	—	—	Solid lubricant (fluororesin)	ESA □□□□
Completely non-magnetic (relative permeability 1.001 or less)	Completely non-magnetic titanium alloy bearings		Special titanium alloy						□□□□ L-TT3
	All-ceramic bearings (oxide-based ceramics)		Ceramics						□□□□ SZ1GSN14T36

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.



Specifications of Bearings for Dust-contaminated Environments

Operating environment	Product name	Structure	Specifications					Lubricant/ Surface treatment	Bearing number for inquiry
			Inner ring/ Outer ring	Balls	Cage	Shields	Seals		
Dust or wood waste	Molded-Oil™ bearings (bearing steel)	Sealed Type	Bearings steel	Bearings steel	Soft steel	—	Nitrile rubber	Molded-oil™	□□□□ L11DDU

1. Stainless steel-based SPACEA™ Series Bearings

Accuracy of boundary dimensions and running accuracy (compliant with JIS0 standards)

Note: The dimensional tolerance of the bore and outside diameter for corrosive coating bearings may deviate from the JIS0 standard for coating thickness (maximum 4μm 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 bore diameter D (mm)		Single plane mean outside diameter deviation (Deviation of single bore 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

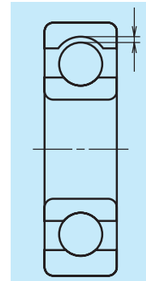
● Running accuracy

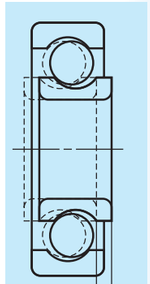
Unit: μm

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	MC1		MC2		MC3		MC4		MC5		MC6	
	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	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.

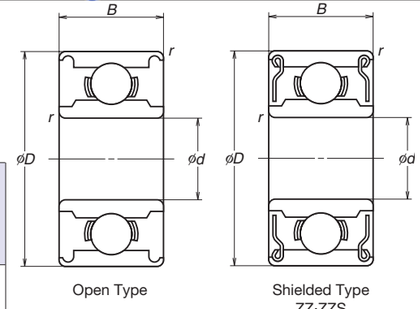
Dimensions, Accuracy and Availability of SPACEA™ Series Bearings

SPACEA™

1. Stainless steel-based SPACEA™ Series Bearings

Extra-small ball bearings

Product	Stainless steel bearings	Molded-Oil™ bearings	Hybrid bearings	Corrosion-resistant coated bearings (Nickel coating)	ESA bearings	Clean grease-packed bearings	YS bearings with MoS_2 self-lubricating cage	Bearings with self-lubricating fluororesin cages (T3 specification)		V-DFO bearings	High-temperature clean grease-packed bearings	YS high-temperature bearings with spacer joints	SJ high-temperature bearings with solid lubrication	Bore diameter *d* (mm)	Outside diameter *D* (mm)	Width Open Type, Shielded Type *B* (mm)	Chamfer dimension (min) *r* (mm)	Basic bearing number	Dynamic load rating, C_H (reference value) (N)
Bearing number for inquiry	□□□ –H– ···✻MA	□□□ L11–H–20	□□□ LZZCG–YT3	□□□ LZZCG –YNIT3	ESA □□□	□□□ LZZC3–H LG2 (LGU, DL2)	□□□ LZZC3– HMST4	□□□ LZZC3– HT3		□□□ LZZC3–HFD	□□□ LZZC3–H KPM	□□□ LZZC4– HMSS2	U–□□□ S4 MLSJ01ZZ						
Basic bearing number	NS7 grease	Molded-oil™	Solid lubricant	Solid lubricant		Clean grease	Solid lubricant			Fluorine oil coating	KPM grease	Solid lubricant							
684	○					○	◎			○	○			4	9	4	0.15	**684**	545
694	○					○	◎			○	○	○			11	4	0.15	**694**	815
604	●		○	○		○	◎	○		○	○	○			12	4	0.2	**604**	815
624	●					○	◎			○	○	○			13	5	0.2	**624**	1 110
634	○					○	○			○	○	○			16	5	0.3	**634**	1 470
685	○					○	◎			○	○			5	11	5	0.15	**685**	610
695	○					○	◎			○	○	○			13	4	0.2	**695**	915
605	●					◎	◎			○	◎	○			14	5	0.2	**605**	1 130
625	●		○	○		◎	◎	○		○	◎	○			16	5	0.3	**625**	1 470
635	○	○				○	○			○	○	○			19	6	0.3	**635**	2 220
686	●					○	◎			○	○	○		6	13	5	0.15	**686**	920
696	●		○	○		◎	◎	○		○	◎	○			15	5	0.2	**696**	1 470
606	●		○	○		◎	◎	○		○	◎	◎			17	6	0.3	**606**	1 920
626	●	○	○	○		◎	◎	○		○	◎	○			19	6	0.3	**626**	2 220
636	○	○				○	○			○	○	○			22	7	0.3	**636**	2 800
687	●					◎	◎			○	◎	○		7	14	5	0.15	**687**	1 000
697	●		○	○		◎	◎	○		○	◎	○			17	5	0.3	**697**	1 370
607	●	○	○	○		◎	◎	○		○	◎	◎			19	6	0.3	**607**	2 220
627	●	○	○	○		◎	◎	○		○	◎	○			22	7	0.3	**627**	2 800
637	○	○													26	9	0.3	**637**	3 900
688	●		○	○		◎	◎	○		○	◎	◎		8	16	5	0.2	**688**	1 370
698	●	○	○	○		◎	◎	○		○	◎	◎			19	6	0.3	**698**	1 900
608	●	○	○	○	○	◎	◎	○		○	◎	◎	◎		22	7	0.3	**608**	2 800
628	●	○	○	○	○	◎	◎	○		○	◎	◎			24	8	0.3	**628**	2 850
638	○					○	○	○		○	○	○			28	9	0.3	**638**	3 900
689	●		○	○		◎	◎	○		○	◎	◎		9	17	5	0.2	**689**	1 130
699	●	○	○	○		◎	◎	○		○	◎	◎			20	6	0.3	**699**	1 460
609	●	○	○	○	○	◎	◎	○		○	◎	◎			24	7	0.3	**609**	2 850
629	●	○	○	○	○	◎	◎	○		○	◎	◎			26	8	0.6	**629**	3 900
639	○	○													30	10	0.6	**639**	4 350
R6	○	○	○	○	○	◎	○	○		○	◎	○		9.525	22.225	7.142✻	0.4	**R6**	2 830



● Standard inventory items ◎ Rush items (within one month) ○ Production on demand Blank: TBA

Remarks For large orders of standard inventory items or rush items, delivery time may be adjusted.

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.

✻ For ESA bearing, standard width is 5.558mm.

Dimensions, Accuracy and Availability of SPACEA™ Series Bearings

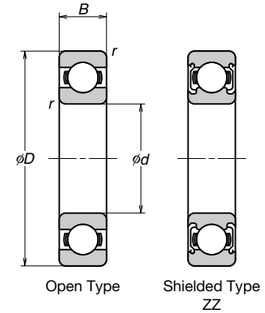
1. Stainless steel-based SPACEA™ Series Bearings

Standard bearings

*Standard inventory items for Molded-Oil™ bearings are Contact-Seal Type.

Product	Stainless steel bearings	Molded-Oil™ bearings*	Hybrid bearings	Corrosion-resistant coated bearings (Nickel coating)	ESA bearings	Clean grease-packed bearings	YS bearings with MoS_2 self-lubricating cage	Bearings with self-lubricating fluororesin cages (T3 specification)	V-DFO bearings	High-temperature clean grease-packed bearings	YS high-temperature bearings with spacer joints	SJ high-temperature bearings with solid lubrication
Bearing number for inquiry	□□□□ –H– ···✻MA	□□□□ L11–H–20	□□□□ LZZ–YT3	□□□□ LZZCG –YNIT3	ESA □□□□	□□□□ LZZ–H LG2 (LGU, DL2)	□□□□ LZZC3– HMST4	□□□□ LZZ– HT3	□□□□ LZZ–HFD	□□□□ LZZ–H KPM	□□□□ LZZC4– HMSS2	U–□□□□ S4 MLSJ01ZZ
Basic bearing number	NS7 grease	Molded-oil™	Solid lubricant	Solid lubricant		Clean grease	Solid lubricant		Fluorine oil coating	KPM grease	Solid lubricant	

Basic bearing number	Bore diameter d (mm)	Outside diameter D (mm)	Width Open Type, Shielded Type B (mm)	Chamfer dimension (min) r (mm)	Basic bearing number	Dynamic load rating, C_H (reference value) (N)
6800	10	19	5	0.3	6800	1 460
6900		22	6	0.3	6900	2 290
6000		26	8	0.3	6000	3 900
6200		30	9	0.6	6200	4 350
6300		35	11	0.6	6300	6 900
6801	12	21	5	0.3	6801	1 630
6901		24	6	0.3	6901	2 460
6001		28	8	0.3	6001	4 350
6201		32	10	0.6	6201	5 800
6301		37	12	1	6301	8 250
6802	15	24	5	0.3	6802	1 760
6902		28	7	0.3	6902	3 700
6002		32	9	0.3	6002	4 750
6202		35	11	0.6	6202	6 500
6302		42	13	1	6302	9 700
6803	17	26	5	0.3	6803	2 240
6903		30	7	0.3	6903	3 900
6003		35	10	0.3	6003	5 100
6203		40	12	0.6	6203	8 150
6303		47	14	1	6303	11 600
6804	20	32	7	0.3	6804	3 400
6904		37	9	0.3	6904	5 400
6004		42	12	0.6	6004	7 950
6204		47	14	1	6204	10 900
6304		52	15	1.1	6304	13 500
6805	25	37	7	0.3	6805	3 800
6905		42	9	0.3	6905	5 950
6005		47	12	0.6	6005	8 550
6205		52	15	1	6205	11 900
6006	30	55	13	1	6006	11 300
6206		62	16	1	6206	16 500
6007	35	62	14	1	6007	13 600
6207		72	17	1.1	6207	21 800
6008	40	68	15	1	6008	14 200
6208		80	18	1.1	6208	24 800
6009	45	75	16	1	6009	17 800



Open Type

Shielded Type ZZ

● Standard inventory items ◎ Rush items (within one month) ○ Production on demand Blank: TBA

Remarks For large orders of standard inventory items or rush items, delivery time may be adjusted.

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.

Dimensions, Accuracy and Availability of SPACEA™ Series Bearings

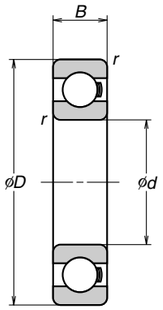
2. Aqua-Bearing™—high corrosion-resistant resin bearings

Ceramic ball bearings and Special glass ball bearings

Aqua-Bearing™		Bore diameter *d*		Outside diameter *D*		Width *B*		Chamfer dimension (reference value) *r* (mm)	Basic bearing number	Radial internal clearance (mm)
Ceramic ball	Special glass ball	Nominal size (mm)	Tolerance (mm)	Nominal size (mm)	Tolerance (mm)	Nominal size (mm)	Tolerance (mm)			
Bearing number for inquiry: □□□□ L–PT3 (–QT3)										
○		5	+0.05 0	16	0–0.05	5	0–0.12	0.3	**625**	0.04–0.12
○		6		15		5		0.2	**696**	
○				17		6		0.3	**606**	
○				19		6		0.3	**626**	
○		7		17		5		0.3	**697**	
○				19		6		0.3	**607**	
○	○			22		7		0.3	**627**	
○		8		16		4		0.2	**688**	
○	○			19		6		0.3	**698**	
○	○			22		7		0.3	**608**	
○	○			24		8		0.3	**628**	
○		9		20		6		0.3	**699**	
○	○			24		7		0.3	**609**	
○	○			26		8		0.6	**629**	
○	○	9.525		22.225		5.558		0.4	**R6**	
○		10		19		5		0.3	**6800**	
◎	◎			22		6		0.3	**6900**	
◎	◎			26		8		0.3	**6000**	
◎	◎			30		9		0.6	**6200**	
○		12		21		5		0.3	**6801**	
◎	◎			24		6		0.3	**6901**	
◎	◎			28		8		0.3	**6001**	
◎	◎			32		10		0.6	**6201**	
◎	◎	15		28		7		0.3	**6902**	
◎	◎			32		9		0.3	**6002**	
◎	◎			35		11		0.6	**6202**	
◎	◎	17		30		7		0.3	**6903**	
◎	◎			35		10		0.3	**6003**	
◎	◎			40		12		0.6	**6203**	
○		20		32		7		0.3	**6804**	
◎	◎			37		9		0.3	**6904**	
◎	◎			42		12		0.6	**6004**	
◎	◎			47		14		1	**6204**	
○		25		37		7		0.3	**6805**	
◎	◎			42		9		0.3	**6905**	
◎	◎			47		12		0.6	**6005**	
○				52		15		1	**6205**	

◎Rush items (within one month) ○Production on demand Blank: TBA

Remarks For large orders of rush items, delivery time may be adjusted.



Open Type

3. All-Ceramic Bearings

Oxide-based ceramic bearings and Carbide-based ceramic bearings

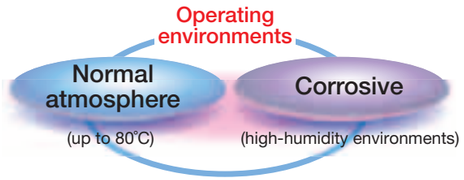
All-ceramic		Bore diameter *d*	Outside diameter *D*	Width *B*	Chamfer dimension (reference value) *r*	Basic bearing number
Oxide-based	Carbide-based	Nominal size (mm)	Nominal size (mm)	Nominal size (mm)	(mm)	
Bearing number for inquiry: □□□□ SZ1GSN14T36	□□□□ SR1GT36					
○		6	15	5	0.2	**696**
○		8	22	7	0.3	**608**
○		10	19	5	0.3	**6800**
○	○		26	8	0.3	**6000**
○	○		30	9	0.6	**6200**
○		12	21	5	0.3	**6801**
○			24	6	0.3	**6901**
○	○		28	8	0.3	**6001**
○	○		32	10	0.6	**6201**
○	○	15	32	9	0.3	**6002**
○	○		35	11	0.6	**6202**
○		17	35	10	0.3	**6003**
○	○	20	42	12	0.6	**6004**
○	○		47	14	1	**6204**
○	○	25	47	12	0.6	**6005**
○			52	15	1	**6205**
○	○	30	62	16	1	**6206**
○		35	62	14	1	**6007**
○			72	17	1.1	**6207**
○		40	68	15	1	**6008**
○		45	75	16	1.1	**6009**

○Production On Demand

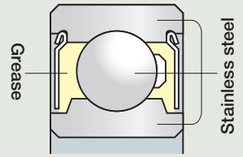
Remarks 1. Dimensional accuracy is compliant with the stainless steel bearings.
2. The standard of radial internal clearance for All-ceramic bearings is as follows;
Extra-small ball bearings/Miniature ball bearings: Lower limit of MC3 to upper limit of MC5
Normal size ball bearings: Lower limit of CN to upper limit of C4

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



Bearing number for inquiry: Basic bearing number –H–···✻MA

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

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

Operating Instructions and Notes

- Lubrication grease for standard inventory bearings is NS7 (lithium-based grease).
- For use in normal atmosphere only.
- Water-resistant grease-packed bearings are available.
- The scope of applications is shown in the table below.

Operating environment	Operating temperature	Limiting rotational speed	Limiting load
High-humidity environments	Up to 80°C	$d_m n$ = 150 000	5% of the stainless steel bearing load rating C_H

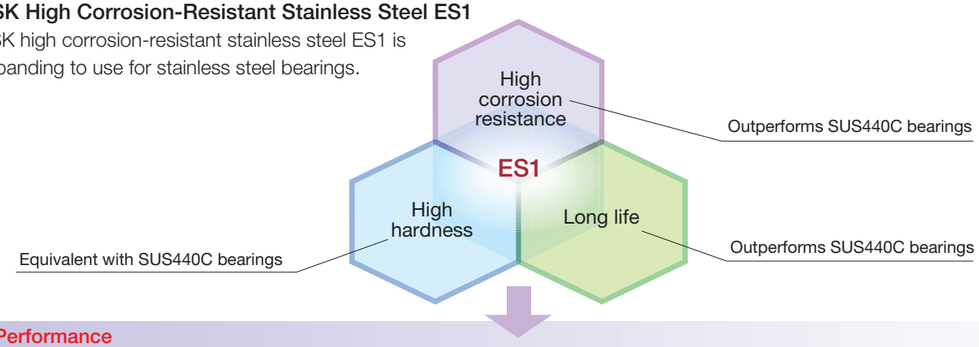
Remarks 1. $d_m n$ = (Bearing bore diameter, mm + Bearing outside diameter, mm) ÷ 2 × Rotational speed, rpm
2. The limiting load is calculated based on a bearing life of 10^7 rotations.
3. See the SPACEA™ Bearing Dimension Table on P24–27 for load rating C_H for stainless steel bearings.

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 P24–27)

NSK High Corrosion-Resistant Stainless Steel ES1

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



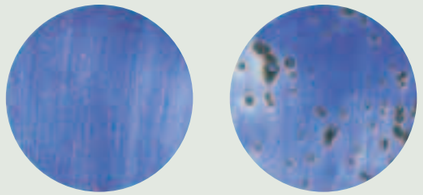
Performance

Material	Hardness, HRC	Corrosion resistance	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

● 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)

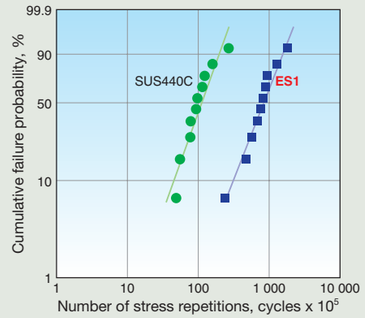


Salt spray test (JISZ2371)
Test solution: 5% NaCl solution
Test time: 1 hour
Temperature: 35°C

● Immersion rolling fatigue life

Outperforms SUS440C in durability

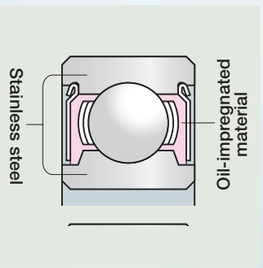
Test bearings: 51305
Balls: Ceramics
Speed: 1 000 rpm
Load: 980N



2. Molded-Oil™ Bearings

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

Product Specifications



Bearing number for inquiry | Basic bearing number | L11–H–20

Structure	Open Type, Shielded Type, Sealed Type	
Specifications	Outer/Inner rings	Martensite stainless steel
	Balls	Martensite stainless steel
	Cage	Corrugated stainless steel
	Lubricant	Molded-oil™
	Shields	Austenite stainless steel
	Seals	Nitrile rubber

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

Operating Instructions and Notes

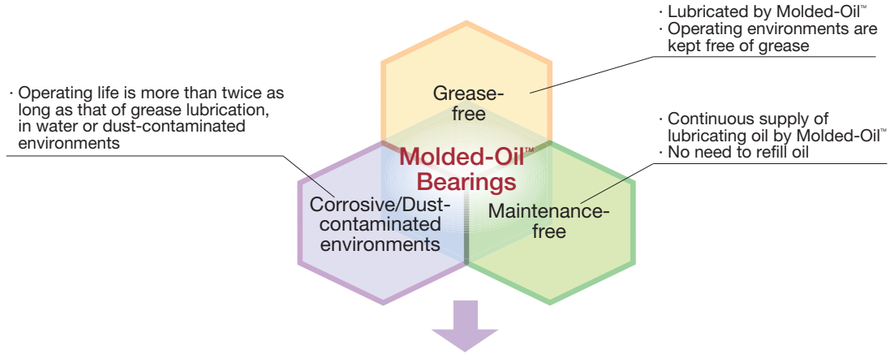
- Molded-Oil™ bearings should not be exposed to degreasing liquids such as organic solvents.
- Molded-Oil™ melts at a temperature of 120°C. The bearings must not be heated over 100°C, especially during shrink fitting.
- A radial load is required for the bearings to properly rotate. The minimum radial load recommended for maintaining proper rotation is at least 1% of the basic dynamic load rating.
- For use in normal atmosphere only.
- The scope of applications is shown in the table below.

Operating environment	Operating temperature	Limiting rotational speed	Limiting load
Water spray, water immersion	Up to 80˚C	$d_m n$ = 150 000	Between 1% and 5%, inclusive, of the stainless steel bearing load rating C_H

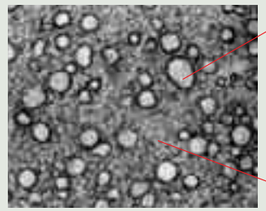
Remarks 1. $d_m n$ = (Bearing bore diameter, mm + Bearing outside diameter, mm) ÷ 2 × Rotational speed, rpm
2. The limiting load is calculated based on a bearing life of 10^7 rotations.
3. See the SPACEA™ Bearing Dimension Table on P24–27 for load rating C_H for stainless steel bearings.

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 P24–27)



Performance

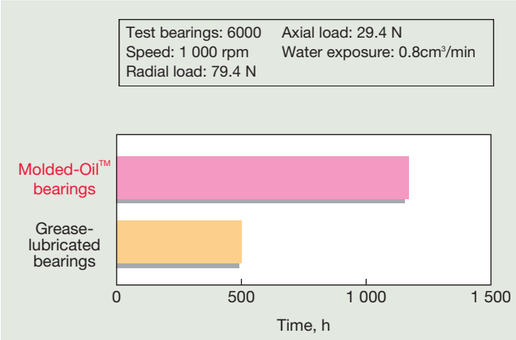


Portion containing high proportion of polyolefin
Polyolefin is used for packaging food in supermarkets, replacing dioxin-generating vinyl chloride.

Portion containing high proportion of lubricating oil
The lubricating oil is mineral oil-based.

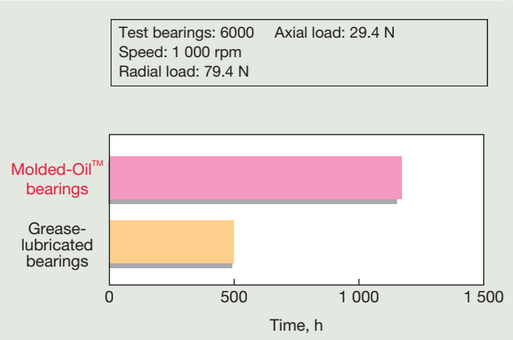
● Durability under wet conditions

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



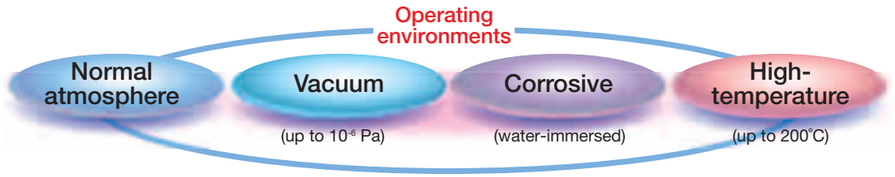
● Durability in water-immersed conditions

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

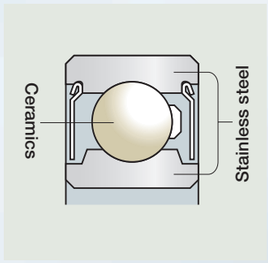


3. Hybrid Bearings

Hybrid bearings, combining ceramic balls and fluororesin self-lubricating cages, are suitable for corrosive environments from normal atmosphere up to vacuum.



Product Specifications



Bearing number for inquiry: Basic bearing number LZZ–YT3

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-immersed environments such as food processing and fishery equipment

Operating Instructions and Notes

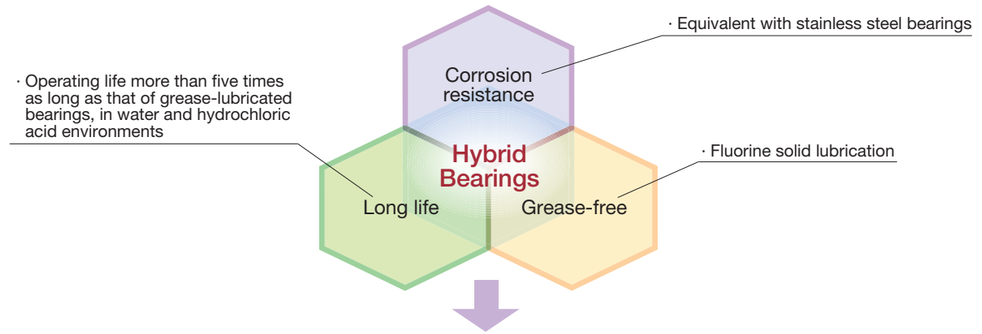
- The scope of applications is shown in the table below.
- The standard of radial internal clearance for Hybrid bearings, is as follows; Normal size ball bearings: CN clearance, Extra-small ball bearings: Lower limit of MC3 to upper limit of MC4.

Operating environment	Operating temperature	Limiting rotational speed	Limiting load
Water, grease-free environments	Up to 200°C	$d_m n$ = 20 000	2% of the stainless steel bearing load rating C_H

Remarks 1. $d_m n$ = (Bearing bore diameter, mm + Bearing outside diameter, mm) ÷ 2 × Rotational speed, rpm
2. The limiting load is calculated based on a bearing life of 10^7 rotations.
3. See the SPACEA™ Bearing Dimension Table on P24–27 for load rating C_H for stainless steel bearings.

Features

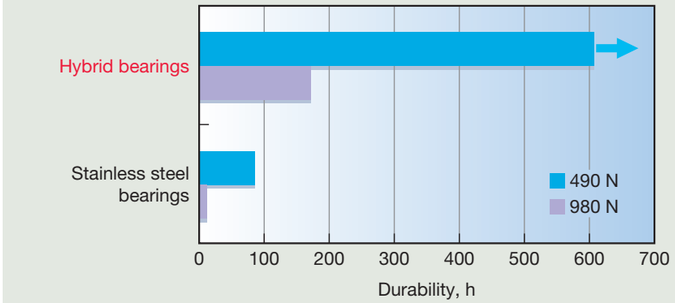
- Grease-free, fluorine solid lubricant
- Operating life more than five times as long as that of stainless steel bearings, in water-immersed environments
- Applicable from normal atmosphere up to 10^{-6} Pa



Performance

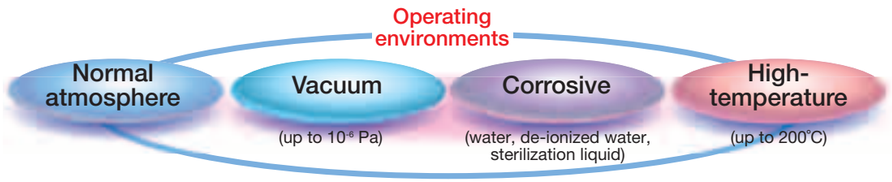
● Durability in water-immersed environments

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

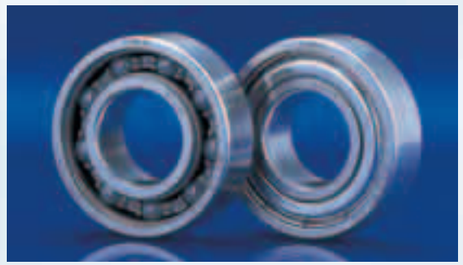


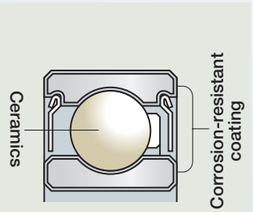
4. Corrosion-Resistant Coated Bearings (Nickel coating)

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 or high temperature.



Product Specifications





Bearing number for inquiry: Basic bearing number — LZZCG–YNIT3

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

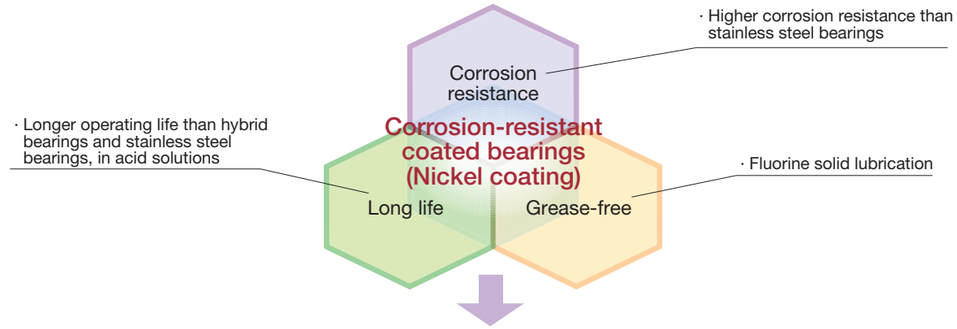
- Corrosion-resistant coated bearings (Nickel coating) should be used with a light load range to protect the coating.
- The dimensional tolerance of the bore and outside diameter for corrosion-resistant coated bearings may deviate from the JIS0 standard for coating thickness (maximum 4 μm in diameter).
- The standard of radial internal clearance CG is as follows; Normal size ball bearings: Lower limit of CN to upper limit of C3, Extra-small ball bearings: Lower limit of MC3 to upper limit of MC6.
- The scope of applications is shown in the table below.

Operating environment	Operating temperature	Limiting rotational speed	Limiting load
Water, de-ionized water, sterilization liquid	Up to 200°C	$d_m n$ = 20 000	2% of the stainless steel bearing load rating C_H

Remarks 1. $d_m n$ = (Bearing bore diameter, mm + Bearing outside diameter, mm) ÷ 2 × Rotational speed, rpm
2. The limiting load is calculated based on a bearing life of 10^7 rotations.
3. See the SPACEA™ Bearing Dimension Table on P24–27 for load rating C_H for stainless steel bearings.

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
- Applicable from normal atmosphere up to 10^{-6} Pa



Performance

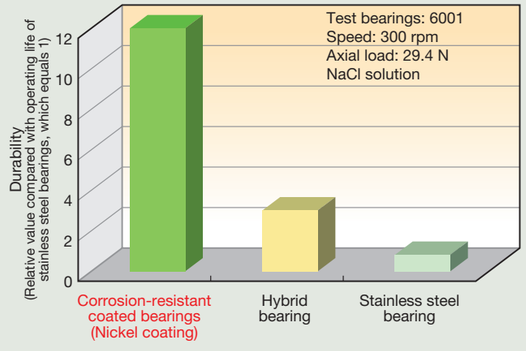
Immersed in a sodium hypochlorite solution
Concentration: 150 ppm

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.

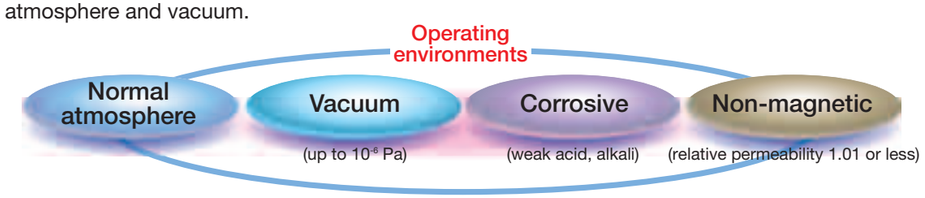


● Durability in NaCl solution

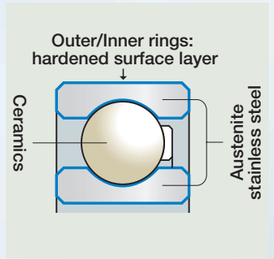
In NaCl solution, corrosion-resistant coated bearings (Nickel coating) have an operating life more than four times as long as that of hybrid bearings, and more than 12 times as long as that of stainless steel bearings.

5. 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



Bearing number for inquiry ESA Basic bearing number

Structure	Open Type only	
Specifications	Outer/Inner rings	Austenite stainless steel and hardened surface layer
	Balls	Silicon nitride ceramics
	Cage	Fluororesin
	Lubricant	Fluorine solid lubricant

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

Operating Instructions and Notes

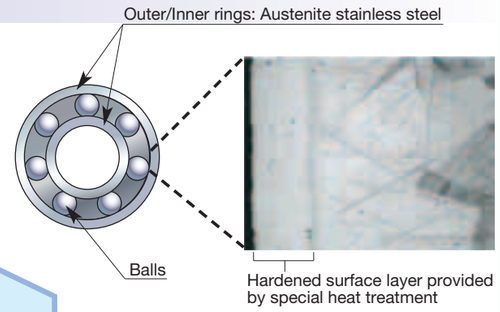
- For use with a light load.
- Relative permeability (μ) should be 1.01 or less. For completely non-magnetic requirement, titanium alloy bearings are recommended.
- The standard of radial internal clearance for ESA bearings is as follows; Normal size ball bearings: Lower limit of CN to upper limit of C4, Extra-small ball bearings: Lower limit of MC3 to upper limit of MC5.
- It is possible to use higher temperature in below, but it is necessary to design specially, so please contact NSK.
- The scope of applications is shown in the table below.

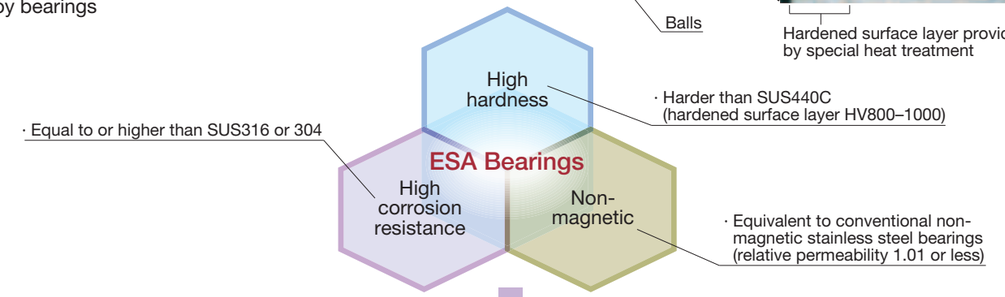
Operating environment	Operating temperature	Limiting rotational speed	Limiting load
Corrosive (chemical, weak acid, alkali), non-magnetic	Up to 50℃	$d_m n$ = 20 000	2% of the stainless steel bearing load rating C_H

Remarks 1. $d_m n$ = (Bearing bore diameter, mm + Bearing outside diameter, mm) ÷ 2 × Rotational speed, rpm
2. The limiting load is calculated based on a bearing life of 10^7 rotations.
3. See the SPACEA™ Bearing Dimension Table on P24–27 for load rating C_H for stainless steel bearings.

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
- More economical than completely non-magnetic titanium alloy bearings





Performance

Comparison with conventional materials

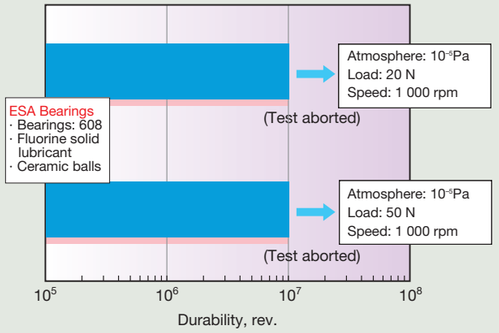
Material	Hardness (HV) (1)	Relative permeability	Corrosion resistance	Features
ESA	800–1 000 (2)	1.01 or less	◎	NSK-developed steel
SUS440C	670	Ferromagnetic body	△	Ordinary stainless steel
Non-magnetic stainless steel	450	1.01 or less	△	Due to its properties, it is difficult to machine, requiring advanced processing technology
Beryllium-copper alloy	320–400	1.001 or less	○	Apt to oxidize and hard to handle; the oxidation by-product is harmful
Silicon nitride	1 500	1.001 or less	◎	Due to its properties, it is difficult to machine, requiring advanced processing technology; high cost

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

Notes (1) Indicated in HV hardness for comparison
(2) Hardened surface layer

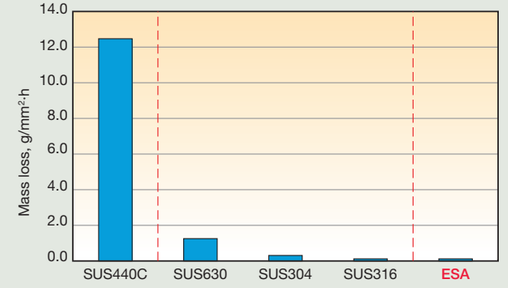
Durability in water-immersed conditions

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



Results of 2.5 mol/ℓ sulfuric acid immersion test

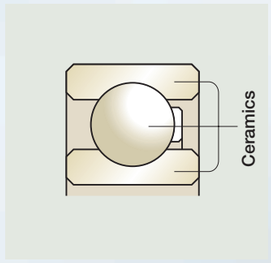
Corrosion resistance is equivalent with SUS316, 304



6. 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 up to vacuum.

Product Specifications



Bearing number for inquiry | Basic bearing number: SZ1GSN14T36

Structure		Open Type only
Specifications	Outer/Inner rings	Oxide-based ceramics (or silicon nitride)
	Balls	Silicon nitride ceramics
	Cage	Fluororesin
	Lubricant	Fluorine solid lubricant

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

Operating Instructions and Notes

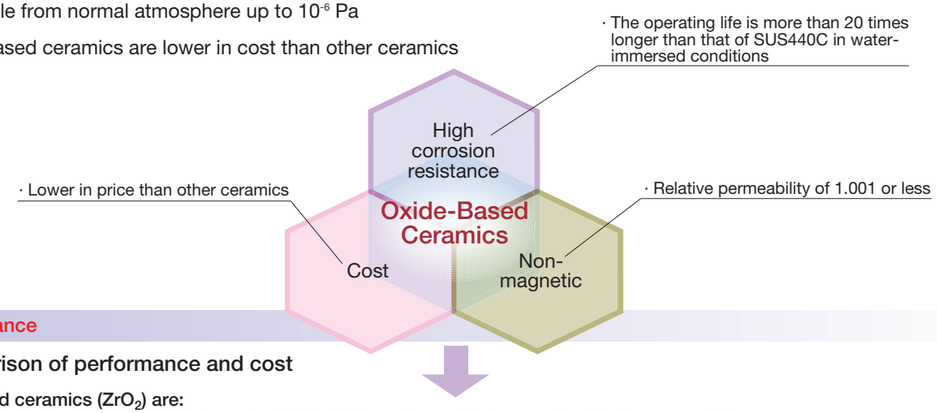
- Ceramics is a fragile material. Please observe the following precautions.
  - ☆Do not drop or strike the bearing.
  - ☆Allow for sufficient clearance when installing the bearing.
  - ☆Do not strike the bearing with a hammer or other tool when installing the bearing to a shaft or axle box.
- Silicon nitride-based ceramics may be recommended for specific high-temperature and heavy-load conditions.
- The scope of applications is shown in the table below.

Operating environment	Operating temperature	Limiting rotational speed	Limiting load
Corrosive (alkali, weak acid), non-magnetic	Up to 200°C	$d_m n$ = 20 000	5% of the stainless steel bearing load rating C_H

Remarks 1. $d_m n$ = (Bearing bore diameter, mm + Bearing outside diameter, mm) ÷ 2 × Rotational speed, rpm
2. The limiting load is calculated based on a bearing life of 10^7 rotations.
3. See the SPACEA™ Bearing Dimension Table on P24–27 for load rating C_H for stainless steel bearings.

Features

- Grease-free, fluorine solid lubricant
- Higher corrosion resistance and longer life than conventional stainless steel bearings and hybrid bearings (more than five times longer in water environments)
- Non-magnetic property outperforms conventional non-magnetic bearings
- Applicable from normal atmosphere up to 10^{-6} Pa
- 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

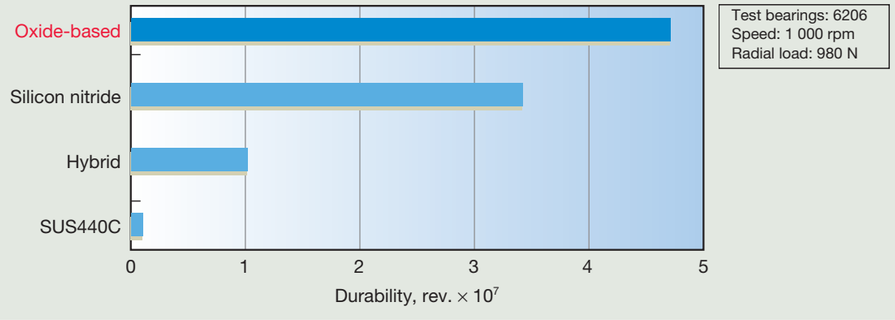
- Oxide-based ceramics ····· ZrO_2
- Carbide-based ceramics ····· SiC
- Silicon nitride ceramics ····· Si_3N_4

Evaluation item		Ceramics		Stainless steel
		Oxide-based	Silicon nitride	SUS440C
Corrosion resistance	Sulfuric acid 0.5 mol/ℓ (room temperature)	○	△	×
	Sulfuric acid 0.5 mol/ℓ (150°C)	△	△	×
	Fluoric acid 1 mol/ℓ (room temperature)	△	△	×
Relative permeability		1.001 or less	1.001 or less	Ferromagnetic body
Cost		Standard	High	Low

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

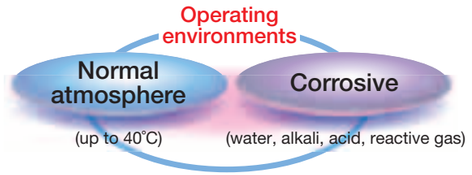
● Durability in water-immersed conditions

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

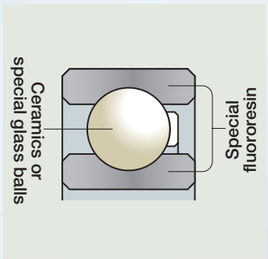


7. Aqua-Bearing™—High Corrosion-Resistant Resin Bearings

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



Bearing number for inquiry: Basic bearing number — L–PT3 (QT3)

P: Ceramics
Q: Special glass balls

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

Applications: Cleaning equipment for semiconductors/liquid crystals/hard disks, metal plating equipment, etching equipment, food processing machinery

Operating Instructions and Notes

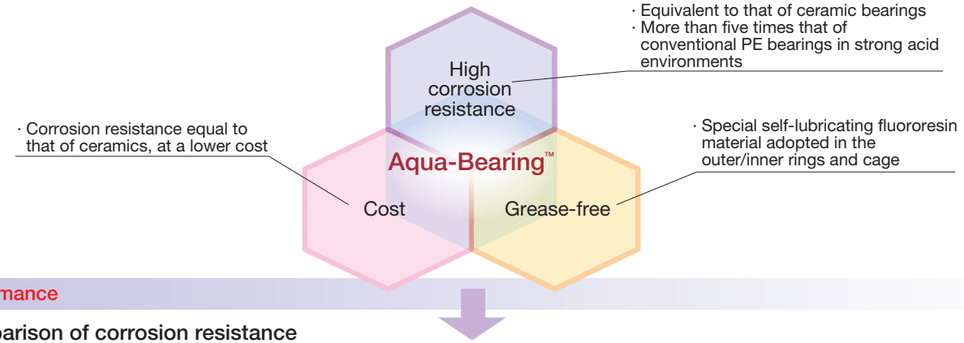
- Tolerances for bore and outside diameters and the internal clearance of the bearings deviate from specifications for standard bearings. (Refer to the Bearing Dimension Table on P28 for more detail).
- For bearings used in fluoric acid or organic solvent environments, please contact NSK.
- It is possible to use at temperatures higher than 40°C, but it is necessary to pay attention to fitting, so please contact NSK.
- For use in normal atmosphere only.
- The scope of applications is shown in the table below.

Operating environment	Operating temperature	Limiting rotational speed	Limiting load
Water, alkali, strong acid, reactive gas	Up to 40°C	$d_m n$ = 20 000	1% of the stainless steel bearing load rating C_H

Remarks 1. $d_m n$ = (Bearing bore diameter, mm + Bearing outside diameter, mm) ÷ 2 × Rotational speed, rpm
2. The limiting load is calculated based on a bearing life of 10^7 rotations.
3. See the SPACEA™ Bearing Dimension Table on P24–27 for load rating C_H for stainless steel bearings.

Features

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



Performance

Comparison of corrosion resistance

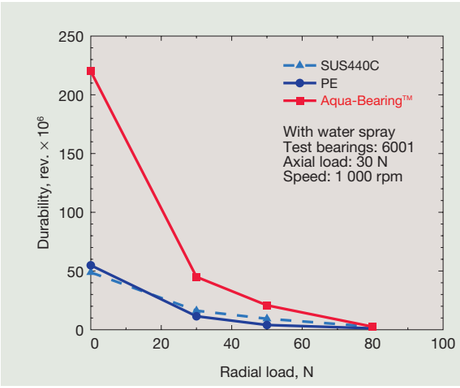
Corrosion resistance equal to that of ceramics

	Aqua-Bearing™	PE	PPS	Ceramics
Strong sulfuric acid	◎	△	△	◎
Hydrochloric acid	◎	◎	◎	◎
Aqua regalis	◎	△	×	◎
15% Acetic acid	◎	△	△	◎
70% Aqua fortis	◎	×	×	◎
40% Chromic acid	◎	×	△	◎
Halogen gas	◎	×	◎	◎

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

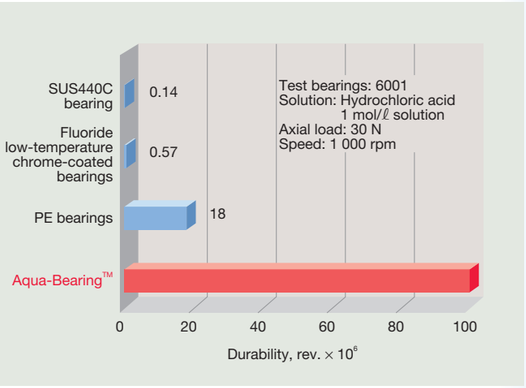
Results of water-spray durability tests

Remarkable durability can be observed under light-load conditions. Application recommended is under 1% of the stainless steel bearing's load rating C_H or less.



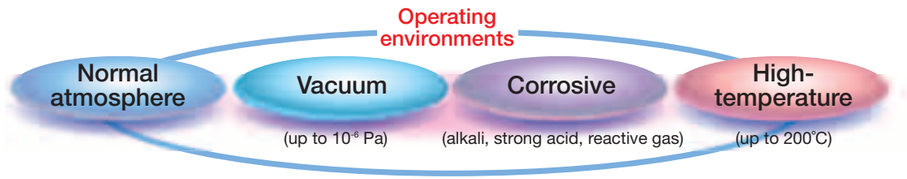
Results of durability tests in strong acid solution

Durability is more than 1 000 times that of SUS440C bearings, and more than five times that of conventional PE bearings.

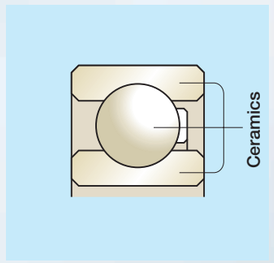


8. High Corrosion-Resistant All-Ceramic Bearings (Carbide-based ceramics)

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 up to vacuum.



Product Specifications



Bearing number for inquiry: Basic bearing number SR1GT36

Structure	Open Type only	
Specifications	Outer/Inner rings	Carbide-based ceramics
	Balls	Carbide-based ceramics (or alumina)
	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

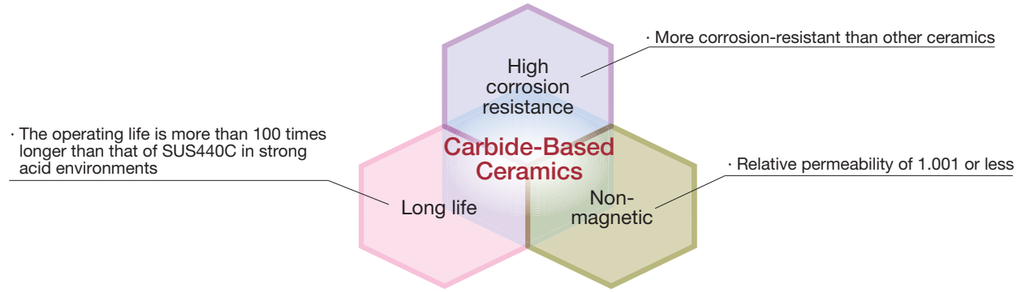
- Ceramics are fragile materials. Please observe the following precautions.
  - ☆Do not drop or strike the bearing.
  - ☆Allow for sufficient clearance when installing the bearing.
  - ☆Do not strike the bearing with a hammer or other tool when installing the bearing to a shaft or axle box.
- The scope of applications is shown in the table below.

Operating environment	Operating temperature	Limiting rotational speed	Limiting load
Strong acid, alkali, and reactive gas environments	Up to 200°C	$d_m n$ = 20 000	5% of the stainless steel bearing load rating C_H

Remarks 1. $d_m n$ = (Bearing bore diameter, mm + Bearing outside diameter, mm) ÷ 2 × Rotational speed, rpm
2. The limiting load is calculated based on a bearing life of 10^7 rotations.
3. See the SPACEA™ Bearing Dimension Table on P24–27 for load rating C_H for stainless steel bearings.

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
- Applicable from normal atmosphere up to 10^{-6} Pa



Performance

Comparison of performance and cost

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

- Oxide-based ceramics ····· ZrO_2
- Carbide-based ceramics ····· SiC
- Silicon nitride ceramics ····· Si_3N_4

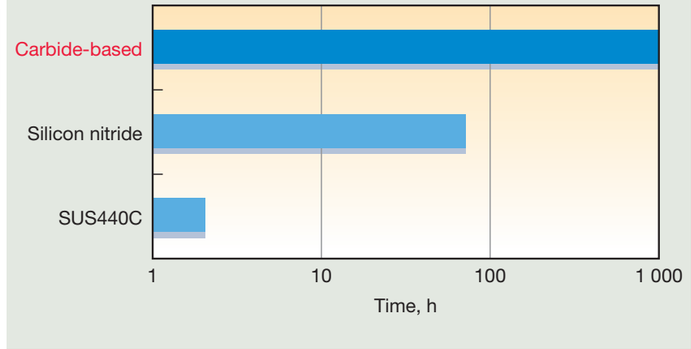
Evaluation item		Ceramics		Stainless steel
		Carbide-based	Silicon nitride	SUS440C
Corrosion resistance	Sulfuric acid 0.5 mol/ℓ (room temperature)	◎	△	×
	Sulfuric acid 0.5 mol/ℓ (150°C)	◎	△	×
	Fluoric acid 1 mol/ℓ (room temperature)	◎	△	×
Relative permeability		1.001 or less	1.001 or less	Ferromagnetic body
Cost		High	High	Low

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

Durability in strong acid

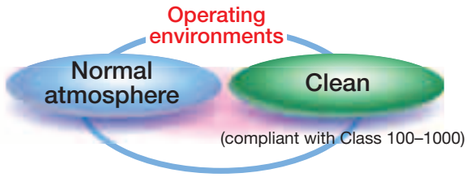
Carbide-based ceramics (SiC) are 100 times more durable than stainless steel bearings SUS440C.

Test bearings: 6206
Speed: 1 000 rpm
Radial load: 980 N
10% Sulfuric acid solution
Room temperature

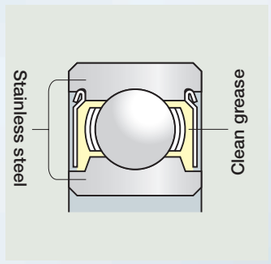


9. LG2/LGU Grease-Packed Bearings (For use in normal atmosphere only)

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



Product Specifications



Bearing number for inquiry: Basic bearing number — LZZ–H LG2 (LGU) (LG2: LG2 grease, LGU: LGU grease)

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

Applications: Equipment in clean rooms

Operating Instructions and Notes

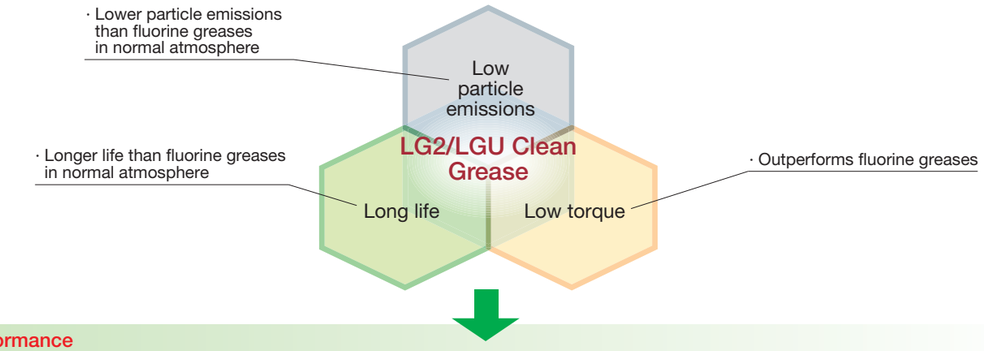
- LG2/LGU greases are for use in normal atmosphere only.
- The scope of applications is shown in the table below.

	Normal atmosphere, vacuum	Cleanliness	Operating temperature	Limiting rotational speed	Limiting load
LG2 grease	For use in normal atmosphere only	Class 100–1000	Up to 70°C	$d_m n$ = 50 000	5% of the stainless steel bearing load rating C_H
LGU grease			Up to 120°C		

Remarks 1. Cleanliness may vary depending on operating conditions, surrounding structures and other factors
2. $d_m n$ = (Bearing bore diameter, mm + Bearing outside diameter, mm) ÷ 2 × Rotational speed, rpm
3. The limiting load is calculated based on a bearing life of 10^7 rotations.
4. See the SPACEA™ Bearing Dimension Table on P24–27 for load rating C_H for stainless steel bearings

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

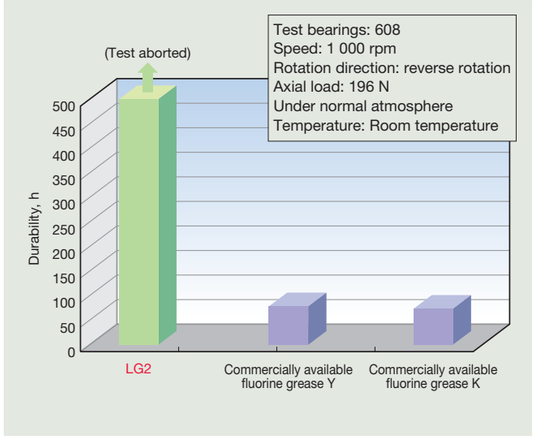
Properties of Grease

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)	30	94.8
Consistency	207	209
Maximum operating temperature, °C	up to 70	up to 120

LGU grease is free of metallic elements

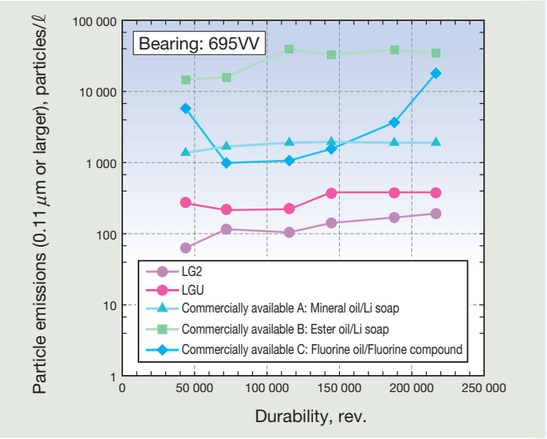
Results of durability tests in normal atmosphere

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



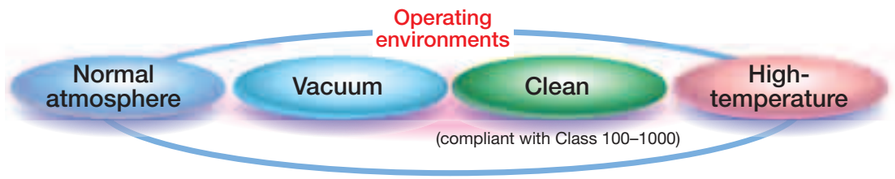
Results of particle emission tests in normal atmosphere

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

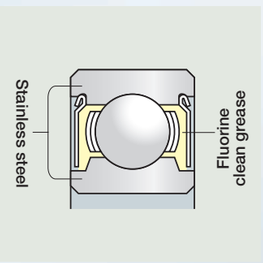


10. DL2 Clean Grease-Packed Bearings (From normal atmosphere up to vacuum)

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



Product Specifications



Bearing number for inquiry | Basic bearing number | LZZ–H DL2

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

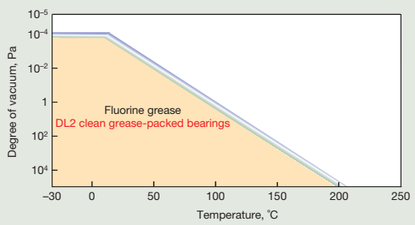
Applications: Liquid crystal and semiconductor manufacturing equipment, hard disk manufacturing equipment

Operating Instructions and Notes

● The scope of applications is shown in the table below.

Cleanliness	Normal atmosphere, vacuum	Operating temperature	Limiting rotational speed	Limiting load
Class 100–1000	See the Scope of Applications (right)		$d_m n$ = 50 000	5% of the stainless steel bearing load rating C_H

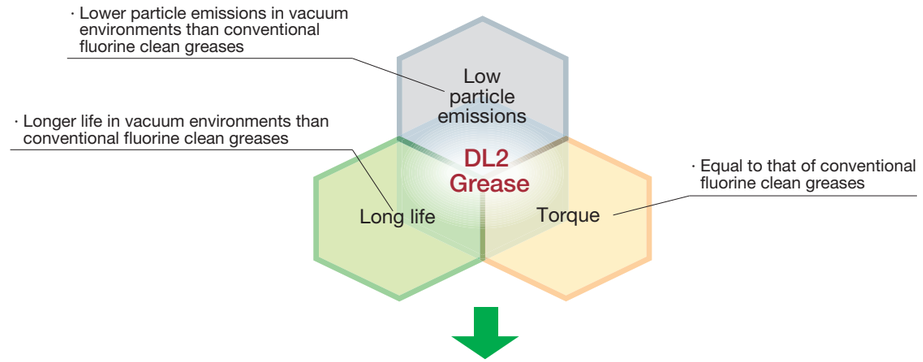
● Scope of Applications



Remarks 1. Cleanliness may vary depending on operating conditions, surrounding structures and other factors
2. $d_m n$ = (Bearing bore diameter, mm + Bearing outside diameter, mm) ÷ 2 × Rotational speed, rpm
3. The limiting load is calculated based on a bearing life of 10^7 rotations.
4. See the SPACEA™ Bearing Dimension Table on P24–27 for load rating C_H for stainless steel bearings

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



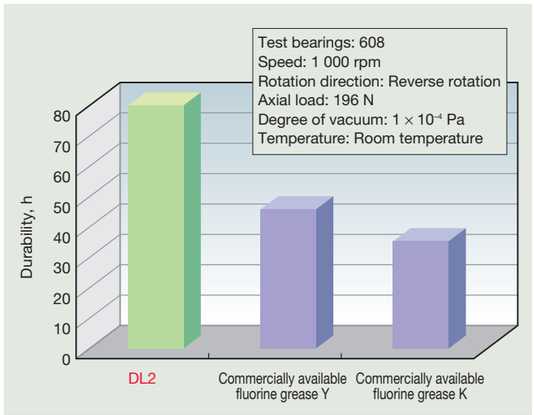
Performance

● 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

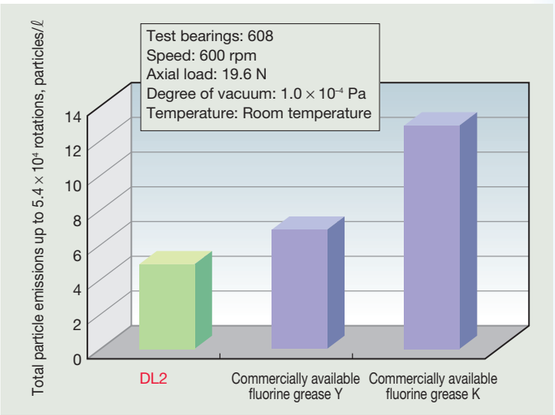
● Results of durability tests in vacuum

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



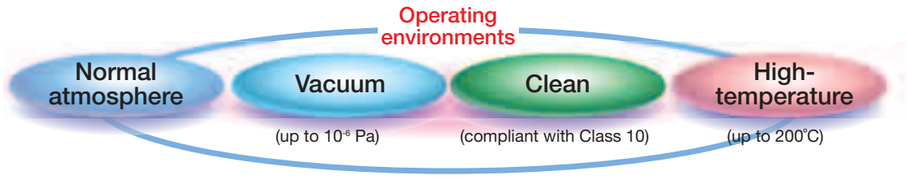
● Results of particle emission tests in vacuum

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

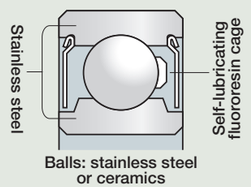


11. Bearings with Self-Lubricating Fluororesin Cages

These bearings have stainless steel or ceramic balls and self-lubricating fluororesin cages that provide for low particle emissions, and are suitable for clean environments from normal atmosphere up to vacuum.



Product Specifications



Bearing number for inquiry: Basic bearing number LZZ–HT3

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

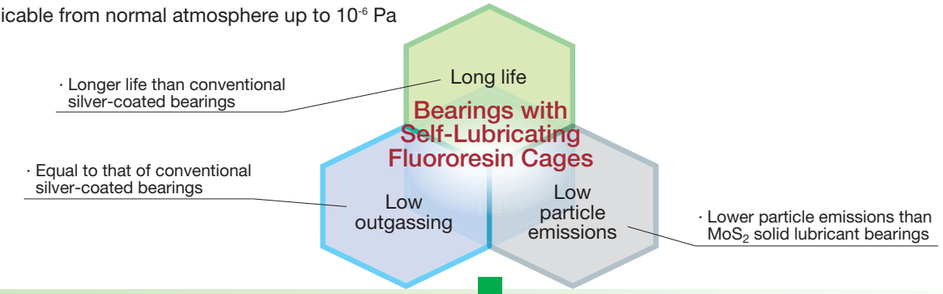
- While bearings with a self-lubricating cage can be used under the same operating conditions as grease-packed bearings, the latter have a longer operating life and are recommended wherever grease lubrication is indicated.
- The limiting load of these fluorine-lubricated bearings is lower when used as a substitute for YS bearings for vacuum environments (with MoS_2-based lubrication).
- The scope of applications is shown in the table below.

Normal atmosphere, vacuum	Cleanliness	Operating temperature	Limiting rotational speed	Limiting load
Atmosphere up to 10^{-6} Pa	Compliant with Class 10	Up to 200°C	$d_m n$ = 20 000	2% of the stainless steel bearing load rating C_H

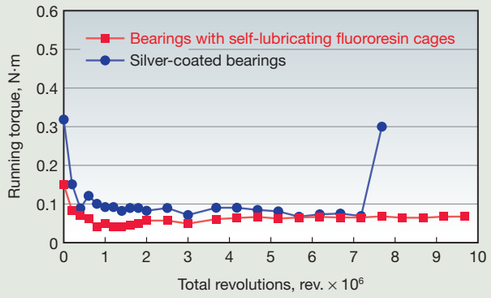
Remarks 1. Cleanliness may vary depending on operating conditions, surrounding structures and other factors
2. $d_m n$ = (Bearing bore diameter, mm + Bearing outside diameter, mm) ÷ 2 × Rotational speed, rpm
3. The limiting load is calculated based on a bearing life of 10^7 rotations.
4. See the SPACEA™ Bearing Dimension Table on P24–27 for load rating C_H for stainless steel bearings

Features

- Grease-free, fluorine solid lubrication
- More suitable in vacuum and at higher temperatures than fluorine clean grease
- Lower particle emissions than MoS_2 solid lubricant bearings
- Applicable in environments for which lubricants containing metallic elements such as MoS_2 are not suitable
- Applicable from normal atmosphere up to 10^{-6} Pa



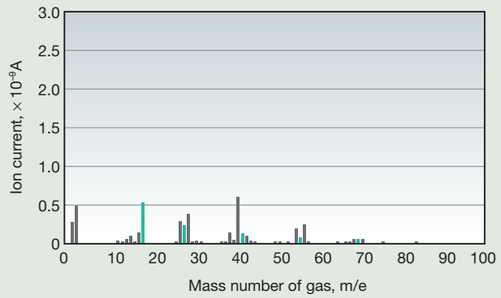
Performance



● Durability in vacuum environments

Longer life than conventional silver-coated bearings.

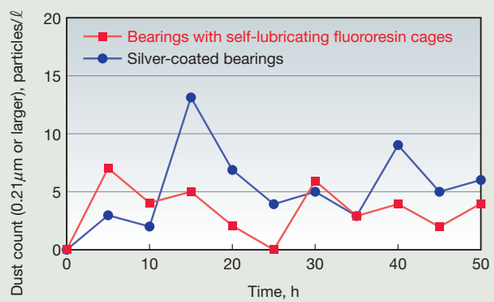
Test bearings: 6002
Speed: 500 rpm
Axial load: 40 N
Degree of vacuum: 1.0×10^{-4} Pa
Temperature: Room temperature



● Outgassing characteristics in vacuum environments

Longer life than conventional silver-coated bearings.

Test bearings: 6002
Degree of vacuum: 4.2×10^{-6} Pa
Temperature: 200°C



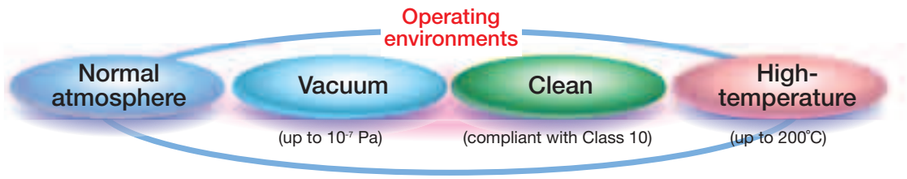
● Particle emissions in vacuum environments

Outperforms conventional silver-coated bearings (Significant deterioration of silver coating particles was not found).

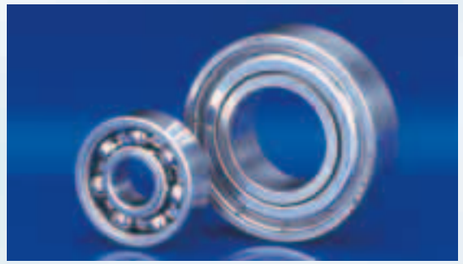
Test bearings: 608
Speed: 600 rpm
Axial load: 10 N
Degree of vacuum: 1.0×10^{-4} Pa
Temperature: Room temperature

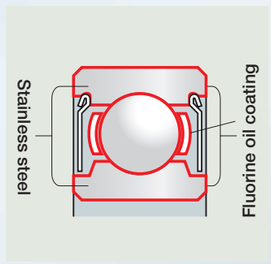
12. Clean Lubricant V-DFO Bearings

V-DFO bearings feature a new innovation: a fluorine oil coating is applied to inner/outer rings, balls and cage to deliver cleanliness and long life. These bearings are suitable for use in clean environments from normal atmosphere up to vacuum.



Product Specifications





Bearing number for inquiry | Basic bearing number | LZZ–HFD

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

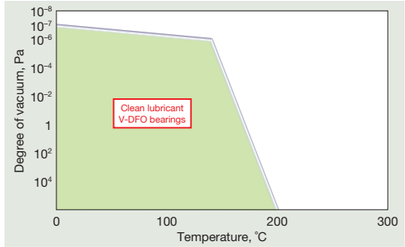
Applications: Liquid crystal and semiconductor manufacturing equipment, hard disk manufacturing equipment, solar cell manufacturing equipment, robots for vacuum environments

Operating Instructions and Notes

- Open the de-aeration package of the bearing immediately before use.
- Store the bearing in a desiccator. Do not apply anti-rust oil or use anti-tarnish paper to the bearing.
- Do not degrease to clean or apply new lubricant to the bearing.
- The scope of applications is shown in the table below.

Cleanliness	Normal atmosphere, vacuum	Operating temperature	Limiting rotational speed	Limiting load
Class 100–1000	See the Scope of Applications (right)		$d_m n$ = 20 000	2% of the stainless steel bearing load rating C_H

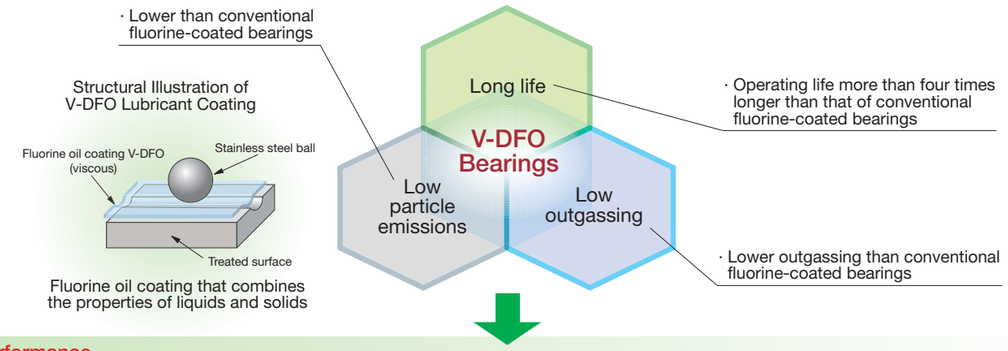
Scope of Applications



Remarks 1. Cleanliness may vary depending on operating conditions, surrounding structures and other factors
2. $d_m n$ = (Bearing bore diameter, mm + Bearing outside diameter, mm) ÷ 2 × Rotational speed, rpm
3. The limiting load is calculated based on a bearing life of 10^7 rotations.
4. See the SPACEA™ Bearing Dimension Table on P24–27 for load rating C_H for stainless steel bearings

Features

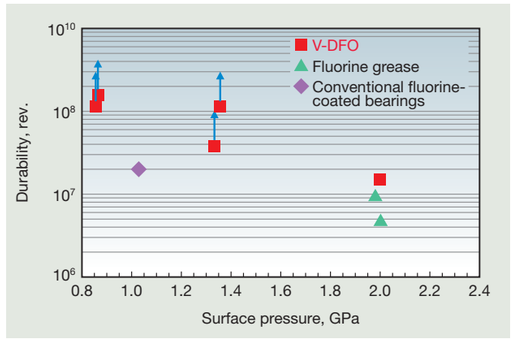
- Operating life more than four times longer than conventional fluorine-coated bearings
- Lower particle emissions and outgassing than MoS_2 solid lubricated bearings
- Applicable in environments for which lubricants containing metallic elements such as MoS_2 are not suitable
- Applicable from normal atmosphere up to 10^{-7} Pa (room temperature), although the degree of vacuum in which the bearings can be used varies according to the operating temperature



Performance

Durability in vacuum environments

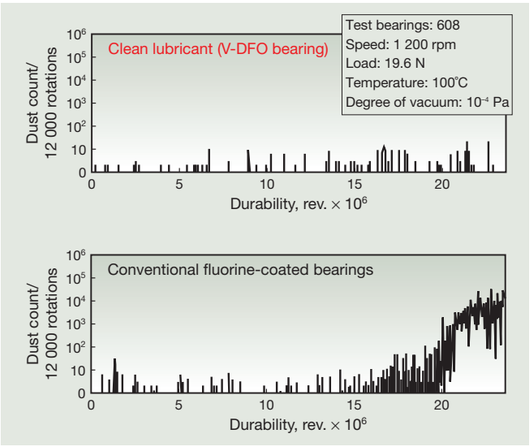
Over four times more durable than conventional fluorine-coated bearings



Test conditions
Test bearings: 608
Speed: 1 000 rpm
Degree of vacuum: 2×10^{-5} Pa

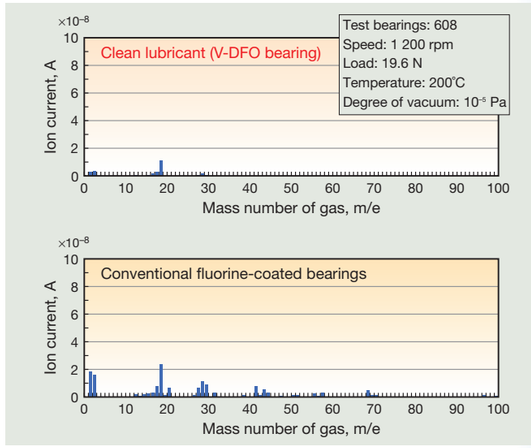
Particle emissions characteristics (0.21 μm or larger)

Superior to conventional fluorine-coated bearings



Outgassing characteristics in high-temperature environments

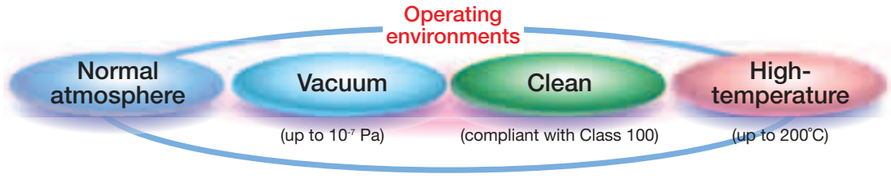
In high-temperature environments, harmful outgassing is virtually zero, in contrast to conventional fluorine-coated bearings



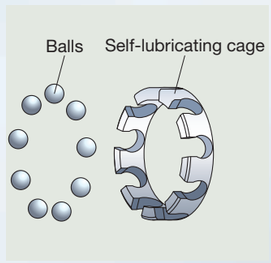
13. YS Bearings with MoS_2 Self-Lubricating Cages

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



Bearing number for inquiry | Basic bearing number | LZZC3–HMST4

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

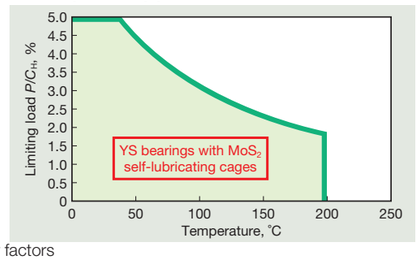
Applications: Vapor deposition equipment, sputtering equipment, etching equipment, vacuum pumps

Operating Instructions and Notes

- YS bearings use a MoS_2 solid lubricant. A fluorine-based bearing is recommended for environments where MoS_2 is not suitable.
- The internal radial clearance of Extra-small ball bearings of YS bearings with self-lubricating cages is 8 to 23 μm.
- The scope of applications is shown in the table below.

Normal atmosphere, vacuum	Cleanliness	Operating temperature	Limiting rotational speed	Limiting load
From normal atmosphere up to 10^{-7} Pa	Class 100-compliant	up to 200°C	$d_m n$ = 20 000	See the Scope of Applications (right)

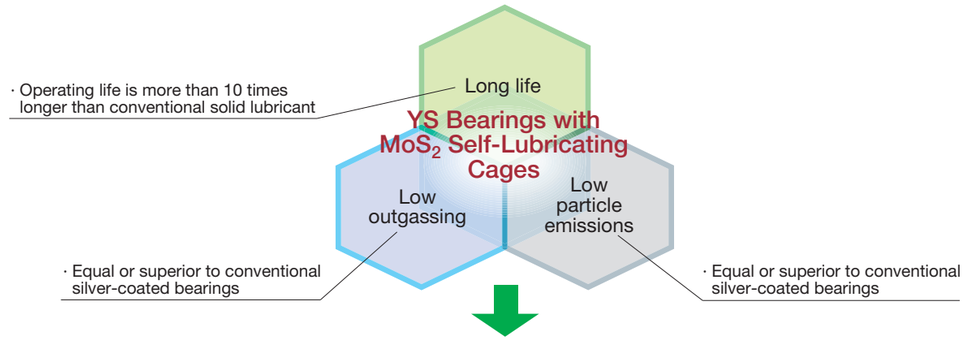
● Scope of Applications



Remarks 1. Cleanliness may vary depending on operating conditions, surrounding structures and other factors
2. $d_m n$ = (Bearing bore diameter, mm + Bearing outside diameter, mm) ÷ 2 × Rotational speed, rpm
3. The limiting load is calculated based on a bearing life of 10^7 rotations.
4. See the SPACEA™ Bearing Dimension Table on P24–27 for load rating C_H for stainless steel bearings

Features

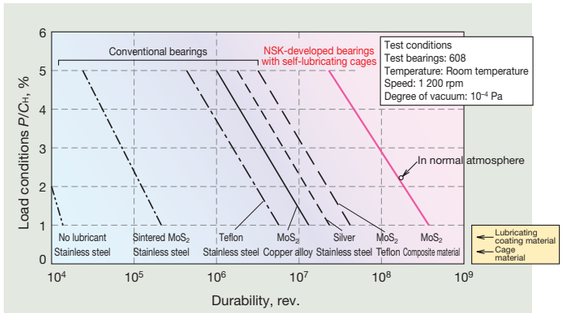
- Utilizes newly developed, long-life MoS_2 self-lubricating cages
- Operating life is more than 10 times longer than that of conventional solid-lubricant bearings
- Particle emissions and outgassing are as low as that of conventional silver-coated bearings
- Applicable from normal atmosphere up to 10^{-7}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



Performance

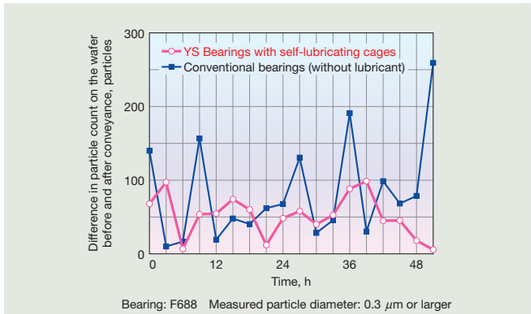
● Durability

Over ten times more durable than conventional bearings for vacuum environments



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

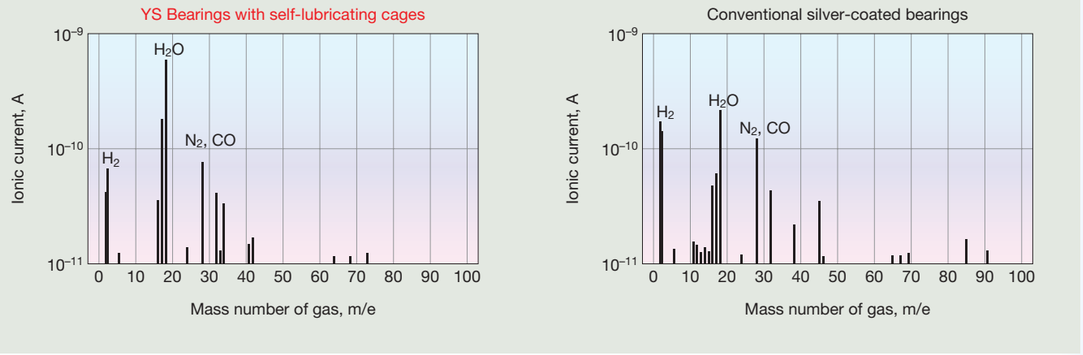
Equal or superior to conventional bearings for vacuum environments



Bearing: F688 Measured particle diameter: 0.3 μm or larger

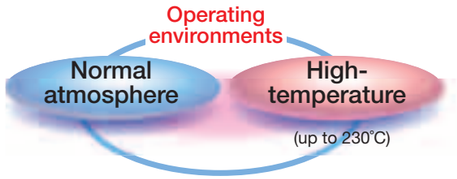
● Outgassing characteristics

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

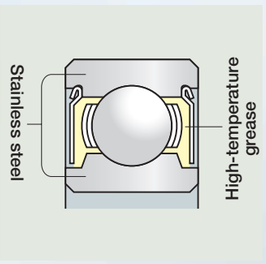


14. High-Temperature Grease-Packed Bearings (For use in normal atmosphere only)

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



Product Specifications



Bearing number for inquiry: Basic bearing number — LZZ–H KPM

Structure		Shielded Type
Specifications	Outer/Inner rings	Martensite stainless steel
	Balls	Martensite stainless steel
	Cage	Corrugated 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

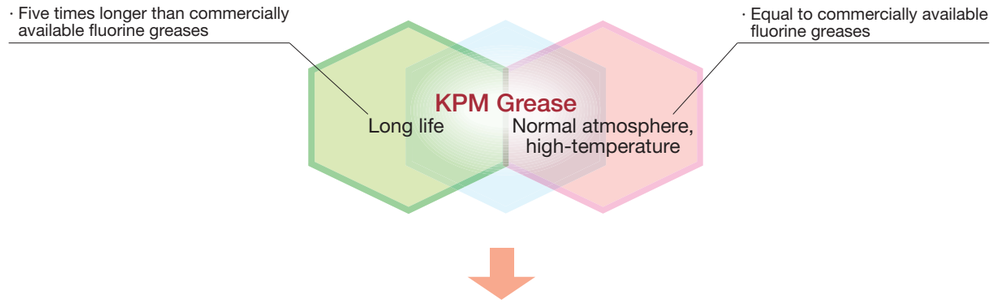
- KPM is a high-temperature, long-life grease for use in normal atmosphere only.
- For higher-temperature or vacuum environments, solid lubricant bearings are recommended.
- Not applicable in clean environments.
- The scope of applications is shown in the table below.

Normal atmosphere, vacuum	Operating temperature	Limiting rotational speed	Limiting load
For use in normal atmosphere only	Up to 230°C	$d_m n$ = 50 000	5% of the stainless steel bearing load rating C_H

Remarks 1. $d_m n$ = (Bearing bore diameter, mm + Bearing outside diameter, mm) ÷ 2 × Rotational speed, rpm
2. The limiting load is calculated based on a bearing life of 10^7 rotations.
3. See the SPACEA™ Bearing Dimension Table on P24–27 for load rating C_H for stainless steel bearings

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

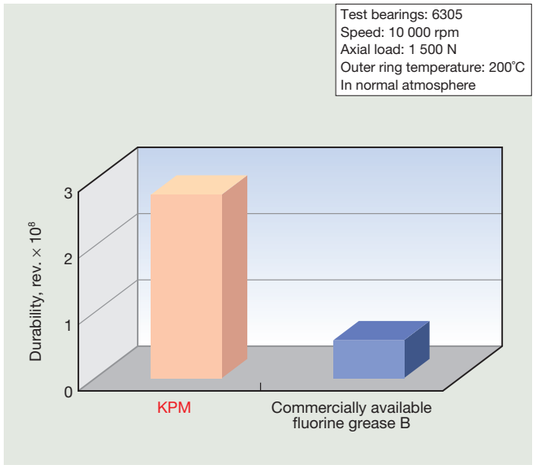
Properties of Grease

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)	380	390
Consistency	280	280
Maximum operating temperature, °C	230	230

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

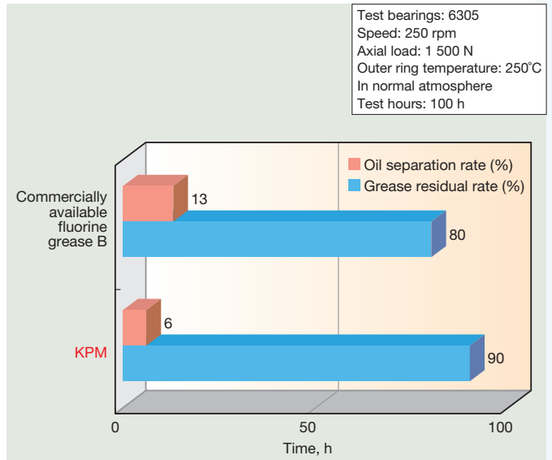
Durability

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



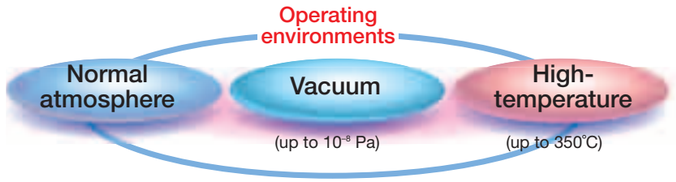
Oil separation and grease residual rates

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

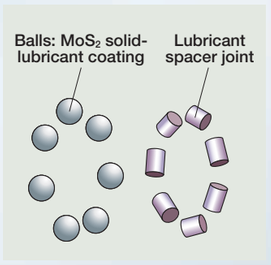


15. YS High-Temperature Bearings with Spacer Joints

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



Bearing number for inquiry: Basic bearing number — LZZC4–H**MSS2**

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

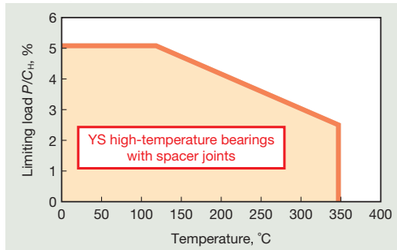
Applications: Ion implantation equipment, sputtering equipment, vacuum vapor deposition equipment, high-temperature conveying equipment

Operating Instructions and Notes

- Due to notch on one side of the inner and outer rings, the high-temperature bearings with spacer joints must be installed in a certain direction when used on the vertical axis. (For details, see the instruction manual that accompanies the product.)
- The internal radial clearance of Extra-small ball bearings of YS high-temperature bearings with spacer joints is 14 to 29 μm.
- The scope of applications is shown in the table below.

Normal atmosphere, vacuum	Operating temperature	Limiting rotational speed	Limiting load
Normal atmosphere up to 10^{-8} Pa	Up to 350°C	$d_m n$ = 20 000	See the Scope of Applications (right)

Scope of Applications

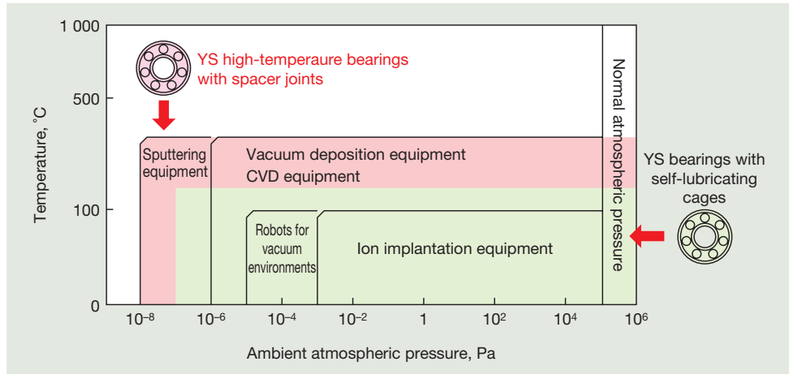


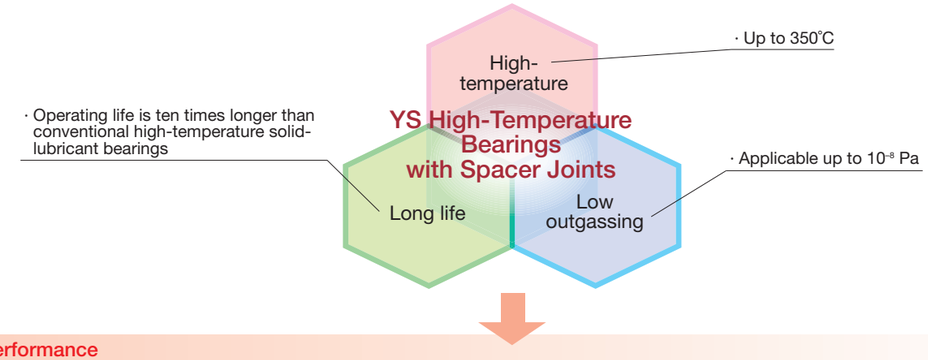
Remarks 1. $d_m n$ = (Bearing bore diameter, mm + Bearing outside diameter, mm) ÷ 2 × Rotational speed, rpm
2. The limiting load is calculated based on a bearing life of 10^7 rotations.
3. See the SPACEA™ Bearing Dimension Table on P24–27 for load rating C_H for stainless steel bearings

Features

- Grease-free, MoS_2 solid lubrication
- Applicable from normal atmosphere up to 10^{-8} Pa and temperatures up to 350°C
- Operating life is more than ten times longer than conventional high-temperature, solid-lubricant bearings

Applications of bearings for semiconductor production equipment

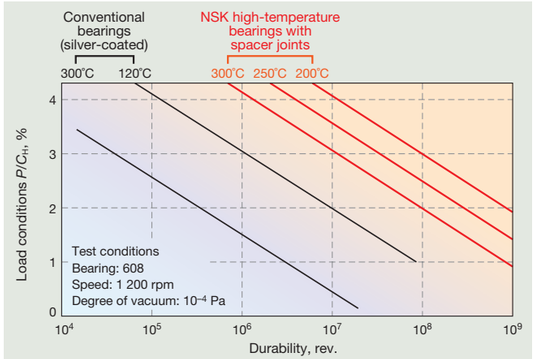




Performance

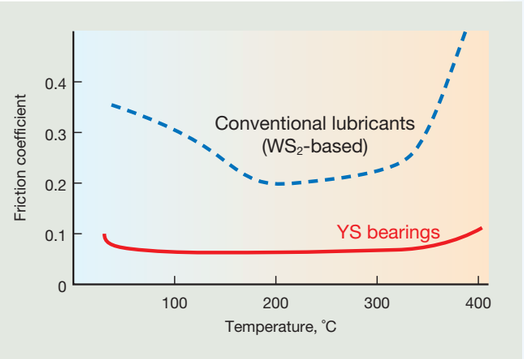
Durability

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



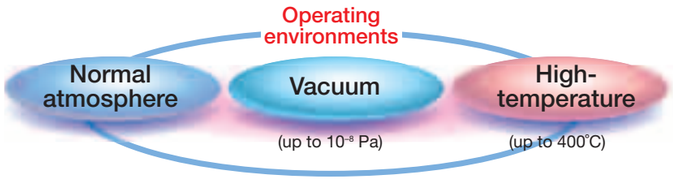
Friction coefficient

The friction coefficient is 60% to 75% lower than that of conventional high-temperature solid lubricants, which results in longer operating life.

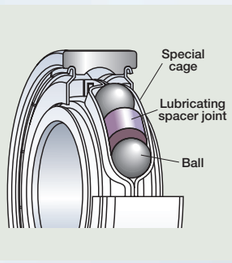


16. SJ High-Temperature Bearings with Solid Lubrication

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



Bearing number for inquiry U- [Basic bearing number] S4MLSJ01ZZ

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

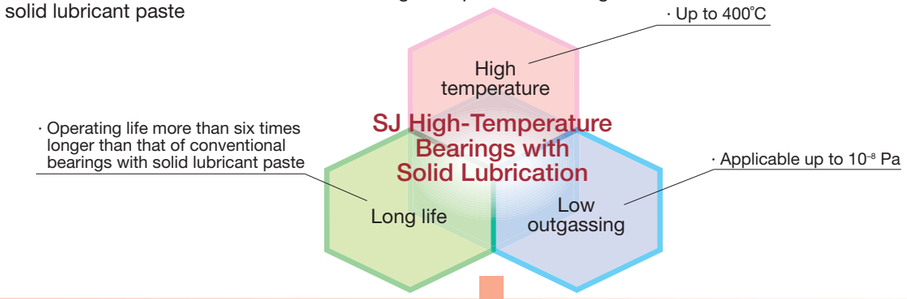
- Applicable at high temperatures in normal atmosphere, vacuum environments.
- The standard of radial internal clearance for SJ high-temperature bearings with solid lubrication is as follows; Normal size ball bearings: Lower limit of C5 to twice as large as upper limit of C5, Extra-small ball bearings: 20 to 80 μm.
- The scope of applications is shown in the table below.

Normal atmosphere, vacuum	Operating temperature	Limiting rotational speed	Limiting load
From normal atmosphere up to 10^{-8} Pa	Up to 400°C	$d_m n$ = 20 000	5% of the stainless steel bearing load rating C_H

Remarks 1. $d_m n$ = (Bearing bore diameter, mm + Bearing outside diameter, mm) ÷ 2 × Rotational speed, rpm
2. The limiting load is calculated based on a bearing life of 10^7 rotations.
3. See the SPACEA™ Bearing Dimension Table on P24–27 for load rating C_H for stainless steel bearings

Features

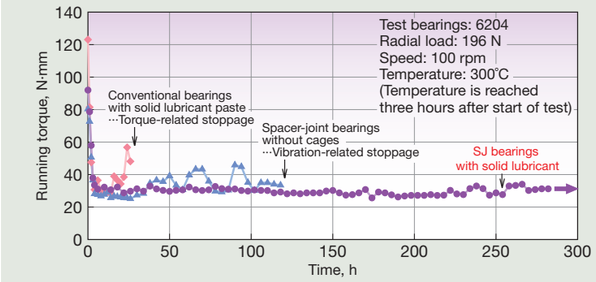
- Grease-free, MoS_2 solid lubricant
- Applicable from normal atmosphere up to 10^{-8} Pa and temperatures up to 400°C
- “Peapod” structure provides excellent torque stability and long life
- Over six times more durable than conventional high-temperature bearings with solid lubricant paste



Performance

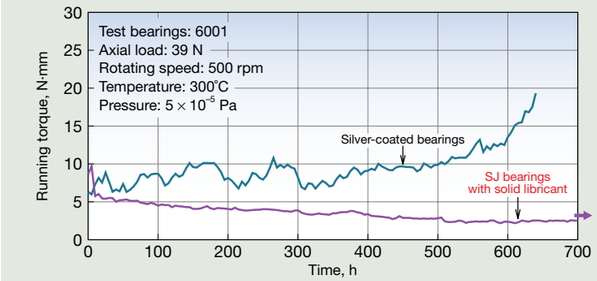
Durability

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.



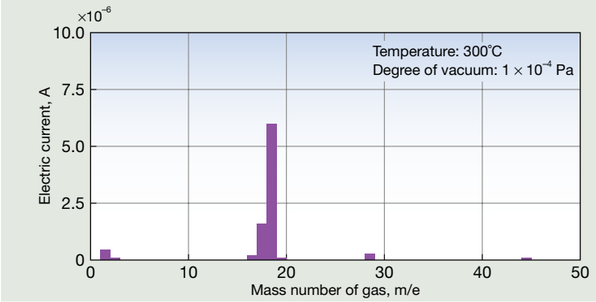
Durability of bearings in vacuum conditions

Outperforms silver-coated bearings in durability and torque stability.



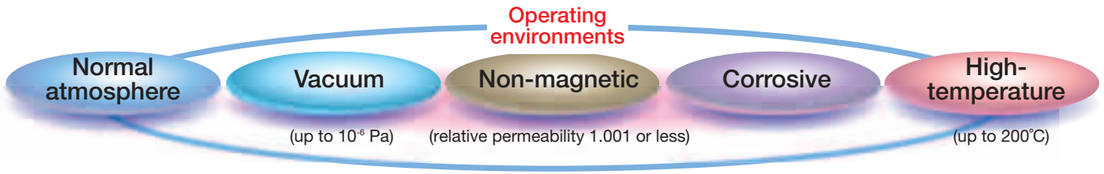
Outgassing in vacuum conditions

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



17. 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

Bearing number for inquiry: Basic bearing number L–TT3

Structure		
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

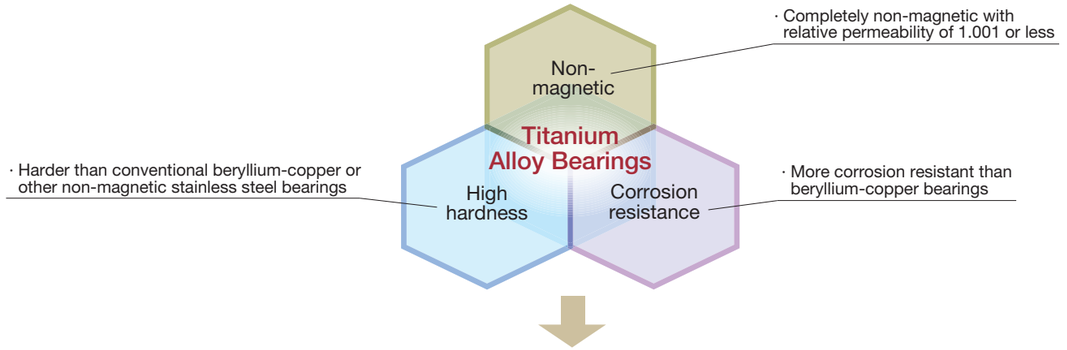
- For light loads only.
- Applicable in corrosive environments.
- Electrically conductive bearings are also available.
- The scope of applications is shown in the table below.

Normal atmosphere, vacuum	Operating temperature	Limiting rotational speed	Limiting load
From normal atmosphere up to 10^{-6} Pa	Up to 200°C	$d_m n$ = 20 000	1% of the stainless steel bearing load rating C_H

Remarks 1. $d_m n$ = (Bearing bore diameter, mm + Bearing outside diameter, mm) ÷ 2 × Rotational speed, rpm
2. The limiting load is calculated based on a bearing life of 10^7 rotations.
3. See the SPACEA™ Bearing Dimension Table on P24–27 for load rating C_H for stainless steel bearings

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 10^{-6} Pa



Performance

Comparison with conventional bearings

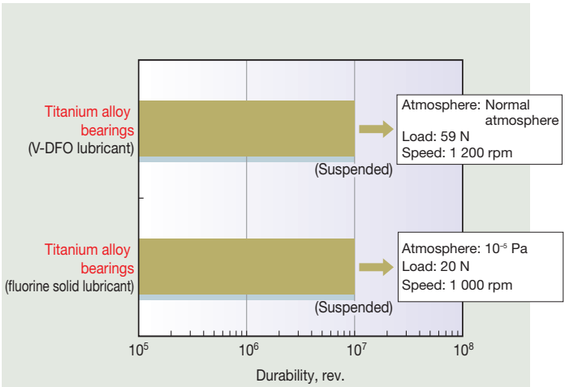
Material	Hardness (HV) (1)	Relative permeability	Corrosion resistance	Features
Special titanium alloy	450-500	1.001 or less	◎	NSK-developed material
SUS440C	670	Ferromagnetic	△	Commercially available stainless steel
Non-magnetic stainless steel	450	1.01 or less	△	Due to its properties, it is difficult 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

Note (1) Indicated in HV hardness for comparison

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

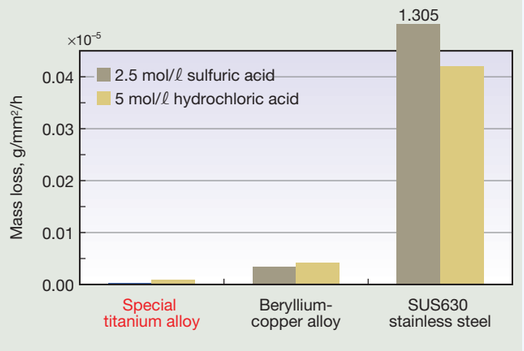
Durability

Titanium alloy bearings have an operating life of more than 10^7 rotations



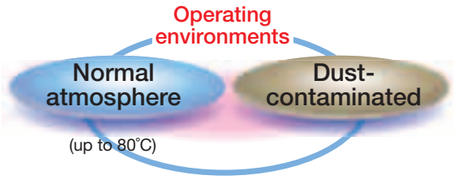
Results of corrosion resistance test

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

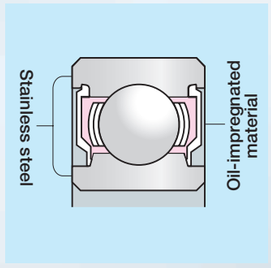


18. Molded-Oil™ Bearings for Dust-Contaminated Environments

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



Bearing number for inquiry | Basic bearing number — L11DDU

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

- Stainless steel Molded-Oil™ bearings are recommended for use in corrosive environments (See P32–33).
- Do not expose to degreasing liquids such as organic solvents.
- Because the oil-impregnated solid lubricant melts at 120°C, bearings should be shrink-fitted at temperatures of 100°C or lower.
- To rotate bearings properly, operate the bearing under a radial load of 1% or more of the basic dynamic load rating.
- For use in normal atmosphere only.
- The scope of applications is shown in the table below.

Operating environment	Operating temperature	Limiting rotational speed	Limiting load
Dust, wood waste, etc.	Up to 80˚C	$d_m n$ = 15 000	Between 1% and 5%, inclusive, of the stainless steel bearing load rating C_H

Remarks 1. $d_m n$ = (Bearing bore diameter, mm + Bearing outside diameter, mm) ÷ 2 × Rotational speed, rpm
2. The limiting load is calculated based on a bearing life of 10^7 rotations.
3. See the SPACEA™ Bearing Dimension Table on P24–27 for load rating C_H for stainless steel bearings

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)

Availability	Bore diameter *d* (mm)	Outside diameter *D* (mm)	Width *B* (mm)	Basic bearing number
○	5	19	6	**635**
○	6	19	6	**626**
○		22	7	**636**
○	7	19	6	**607**
○		22	7	**627**
○		26	9	**637**
○	8	19	6	**698**
○		22	7	**608**
○		24	8	**628**
○		28	9	**638**
○	9	20	6	**699**
○		24	7	**609**
○		26	8	**629**
○		30	10	**639**
○	9.525	22.225	7.142	**R6**
○	10	19	5	**6800**
○		22	6	**6900**
○		26	8	**6000**
●		30	9	**6200**
○		35	11	**6300**
○	12	21	5	**6801**
●		24	6	**6901**
●		28	8	**6001**
●		32	10	**6201**
○		37	12	**6301**
○	15	24	5	**6802**
●		28	7	**6902**
●		32	9	**6002**
●		35	11	**6202**
○		42	13	**6302**

Availability	Bore diameter *d* (mm)	Outside diameter *D* (mm)	Width *B* (mm)	Basic bearing number
○	17	26	5	**6803**
○		30	7	**6903**
●		35	10	**6003**
●		40	12	**6203**
○		47	14	**6303**
○	20	32	7	**6804**
○		37	9	**6904**
●		42	12	**6004**
●		47	14	**6204**
○		52	15	**6304**
○	25	37	7	**6805**
○		42	9	**6905**
●		47	12	**6005**
●		52	15	**6205**
●		62	17	**6305**
●	30	55	13	**6006**
●		62	16	**6206**
●		72	19	**6306**
●	35	62	14	**6007**
●		72	19	**6207**
●		80	21	**6307**
●	40	68	15	**6008**
●		80	18	**6208**
●		90	23	**6308**
●	45	75	16	**6009**
●		85	19	**6209**
●		100	25	**6309**
●	50	80	16	**6010**
●		90	20	**6210**
●		110	27	**6310**

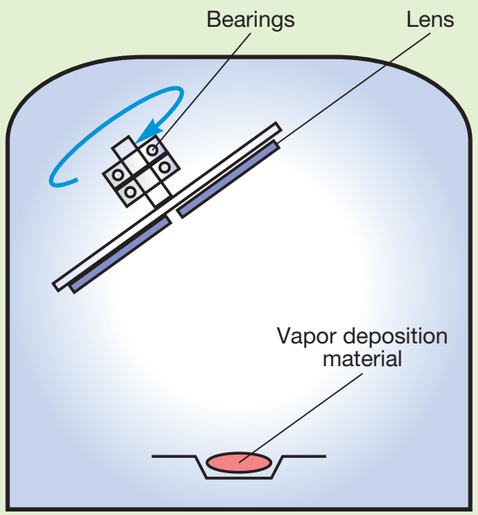
● Standard inventory items ○ Production on demand

Remarks For large orders of standard inventory items, delivery time may be adjusted.

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 rpm
- Load: Up to 50 N

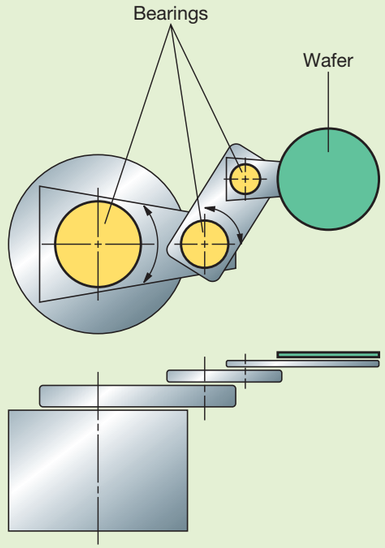
Conventional bearings

- 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

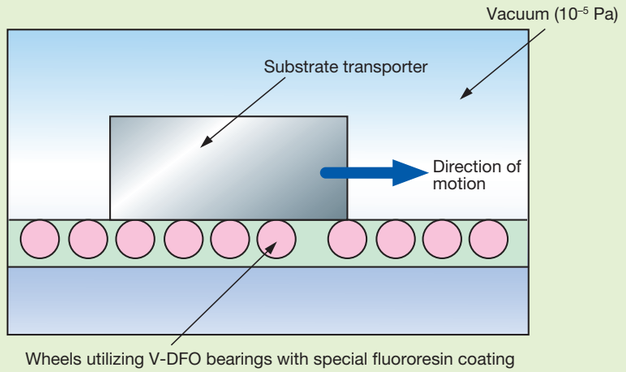
Conventional bearings

- 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 rpm
- Load: Up to 50 N

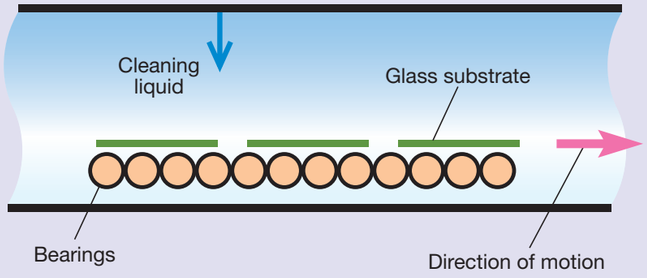
Conventional bearings

- 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 rpm
- Load: Light load

Conventional bearings

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

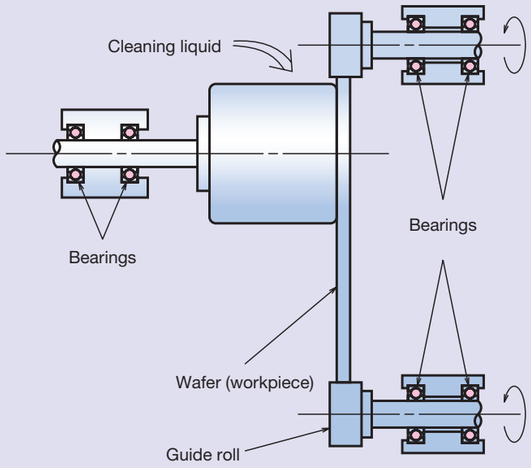
NSK SPACEA™ Series
Aqua-Bearing™— High Corrosion-Resistant Resin Bearings

- Operating life: More than 1 year

Applications of SPACEA™ Series Bearings

SPACEA™

Silicon Wafer Cleaning Equipment



Operating Conditions

Corrosive environments

- Cleaning liquid-spray environments
- Speed: Up to 100 rpm
- Load: Up to 50 N

Conventional bearings

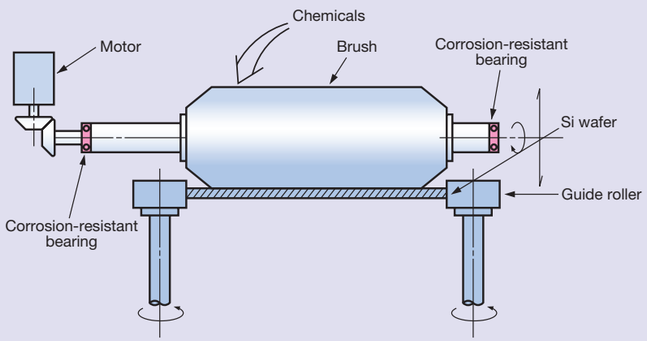
- Stainless steel bearing (degreased products 6000, 6001, 6901, etc.)
- Operating life: 2 weeks to 1 month

NSK SPACEA™ Series

Bearings with Fluororesin Self-Lubricating Cages

- Operating life: 2 to 3 months

Wafer Polishing Equipment (CMP Equipment)



Operating Conditions

Corrosive environments

- Cleaning liquid-spray environments
- Speed: Up to 30 rpm
- Load: Light load

Conventional bearings

- Stainless steel bearing (696, 6800, etc.)
- Operating life: 2 weeks to 1 month

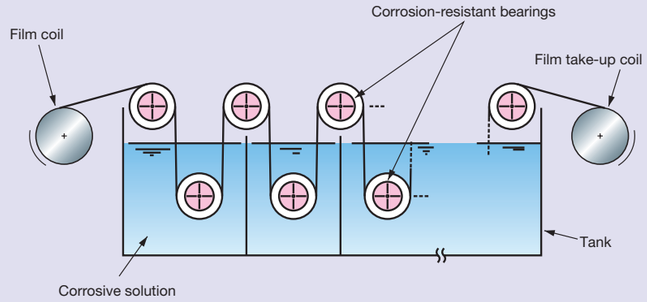
NSK SPACEA™ Series

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 rpm
- Load: Approx. 100 N
- Temperature: Approx. 80°C

Conventional bearings

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

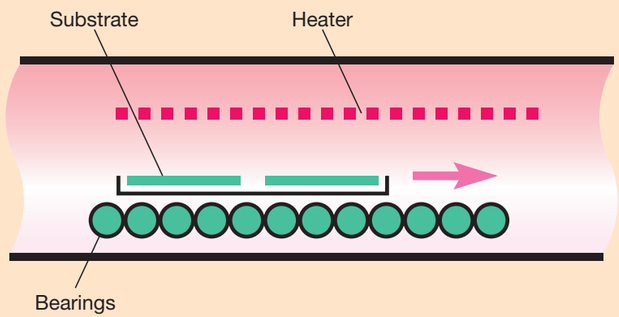
NSK SPACEA™ Series

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 rpm

Conventional bearings

- Stainless steel bearing (degreased products 6204, 6205, etc.)
- Operating life: 1 month

NSK SPACEA™ Series

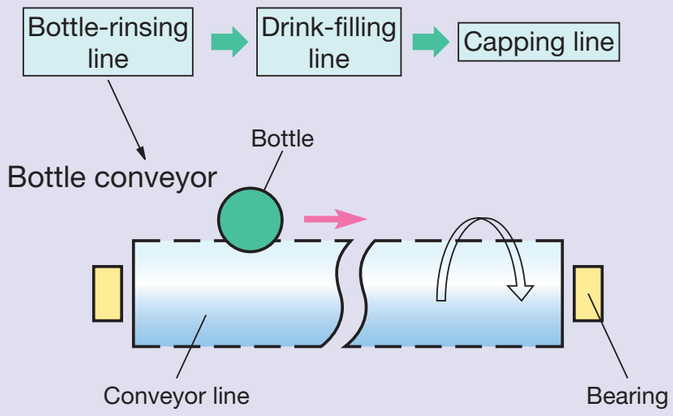
SJ High-Temperature Bearings with Solid Lubrication

- 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 rpm
- Load: Up to 50 N
- Temperature: Up to 80°C

Conventional bearings

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

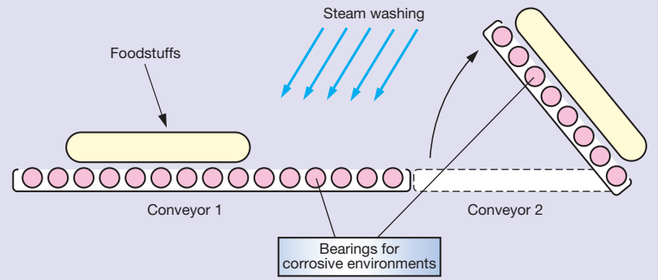
NSK SPACEA™ Series

Corrosion-Resistant Coated Bearings

(Balls: Ceramics)

- Operating life: More than 1 year

Raw Material Preparation Device



Operating Conditions

Corrosive environments

- Water spray, steam
- Speed: 10 to 1 000 rpm
- Temperature: Up to 80°C

Conventional bearings

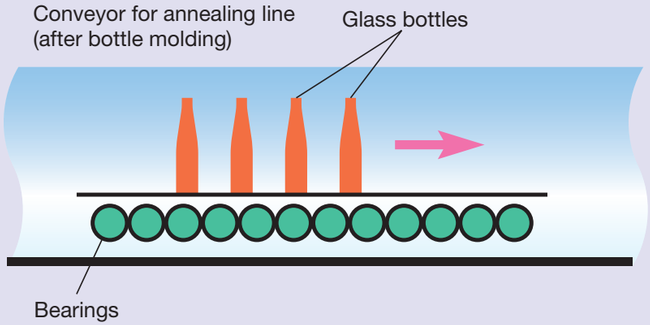
- Grease-packed stainless steel bearing

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 rpm

Conventional bearings

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

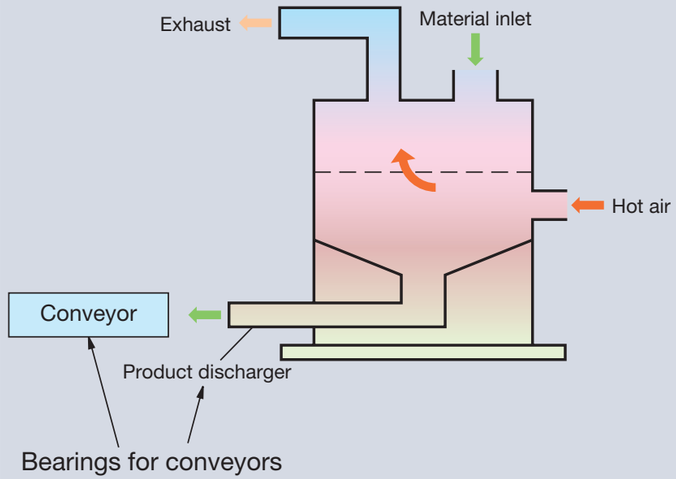
NSK SPACEA™ Series

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 80°C
- Speed: Up to 100 rpm

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, corrosive, clean, high-temperature, high-speed, sanitary, and dust-contaminated 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 76–77.

Table of Contents of SPACEA™ Series Ball Screws and NSK Linear Guides®

A Inventory ····· P74–75

B Selection Guide ····· P76–77

C Types and Specifications ····· P78–79

D Dimensions and Availability ····· P80–83

1. Ball Screws
2. Clean Support Unit
3. Linear Guides

E Specifications, Operating Instructions, and Technical Data ····· P84–101

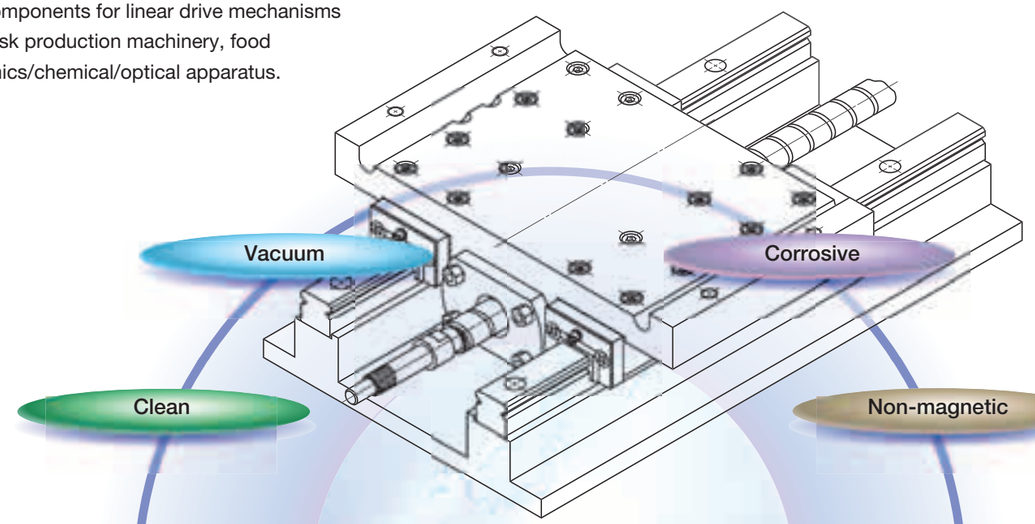
1. Corrosion-resistant Ball Screws and NSK Linear Guides® (Fluoride Low-temperature Chrome Coating) ····· P84–85
2. LG2/LGU Clean Greases ····· P86–87
3. NSK Clean Lubricant V-DFO ····· P88–89
4. Support Units for Clean Environments ····· P90–91
5. NSK K1™ Lubrication Unit for Food Processing and Medical Equipment Devices ····· P92–93
6. NSK High Performance Seals ····· P94–95
7. Ball Screws and NSK Linear Guides® for High-temperature Environments ····· P96–97
8. High-speed, Long-stroke Ball Screws (NDD Series Equipped with Vibration Damper) ····· P98–99
9. MF Series NSK Linear Guides® and Ball Screws ····· P100–101

F Applications of SPACEA™ Series Ball Screws and NSK Linear Guides® ····· P102–103

1. Semiconductor Manufacturing Equipment
2. LCD/Semiconductor Production Machinery

Product lineup listed by operating environment

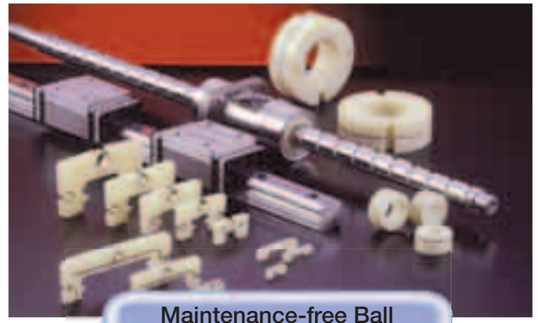
NSK's SPACEA™ series ball screws and NSK linear guides are the optimal components for linear drive mechanisms for demanding operating environments, such as semiconductor/FPD/hard disk production machinery, food processing machinery, medicine/cosmetic production machinery, and ceramics/chemical/optical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



Support units for special 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

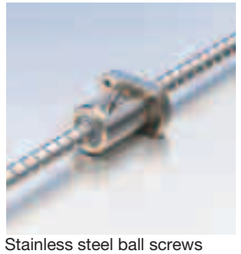
Ball screws for special environments

High-speed ball screws equipped with vibration damper

Corrosion-resistant coated ball screws

High dust-resistant ball screws

Ball screws equipped with NSK K1™ lubrication unit



Stainless steel ball screws

Non-magnetic ball screws

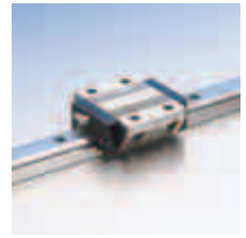
Clean greases

SPACEA™ Series Linear Guides

Linear guides for special environments

High dust-resistant linear guides

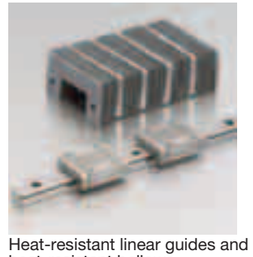
Linear guides equipped with NSK K1™ lubrication unit



Stainless steel linear guides

Corrosion-resistant coated linear guides

Linear guides for food processing



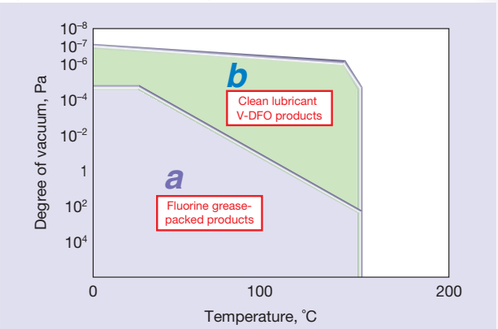
Heat-resistant linear guides and heat-resistant bellows

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

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 V-DFO products

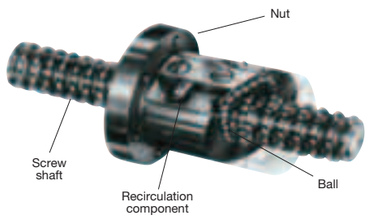


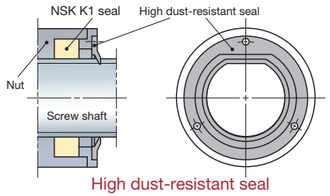
① Operating environment			Product name		② Operating conditions: Degree of vacuum Pa (Normal atmosphere / ≤10⁻⁴ / ≤10⁻⁸)	② Operating conditions: Temperature ˚C (≤100 / ≤200 / ≤300)	② Operating conditions: Cleanliness(1) (100–1 000 / ≤100 / ≤10)	② Operating conditions: Limiting rotational speed d·n value(2) (≤50 000 / ≤100 000 / ≤150 000)	② Operating conditions: Limiting speed of linear guide m/min (≤100 / ≤200 / ≤300)	③ Price comparison	③ Dimensions (availability)	④ Specifications · Operating instructions · Technical data
Vacuum	Clean	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	Ball screws (P80) Support units (P81) Linear guides (P82-83)	P84–85
		From normal atmosphere up to vacuum (up to 150˚C)	Clean lubricant V-DFO ball screws and linear guides		See the scope of applications for V-DFO products (upper right) b		●	≤70 000	≤100			P88–89
	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	Corrosion-resistant coated ball screws and linear guides	(Standard grease) (Standard seal)	●	≤80˚C		≤70 000	≤100	Low ▲ High		P84–85, P100–101
		Water-immersed, water-spray	Stainless steel ball screws and linear guides									
	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		P84–85
			Stainless steel ball screws and linear guides			≤150˚C						
From normal atmosphere up to vacuum, Clean	Normal atmosphere (room temperature)		LG2 clean grease-packed ball screws and linear guides		●	≤80˚C	●	≤70 000	≤100	Low ▲ High		P84–87, P100–101
			LGU clean grease-packed ball screws and linear guides			≤120˚C						
	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			P84–85
	From normal atmosphere up to vacuum (up to 150˚C)		Clean lubricant V-DFO ball screws and linear guides		See the scope of applications for V-DFO products (upper right) b		●					P88–89
Sanitary	Food processing environments		Ball screws and linear guides for food processing		●	≤80˚C		≤70 000	≤100	–		P92–93
Water- and dust-contaminated	Dust or wood chips		High dust-resistant, corrosion-resistant coated ball screws and linear guides		●	≤80˚C		≤70 000	≤100	Low ▲ High		P84–85, P94–95, P100–101
			High dust-resistant, stainless steel ball screws and linear guides									P94–95, P100–101
High-temperature	Normal atmosphere (up to 150˚C)		Heat-resistant ball screws and linear guides		●	≤150˚C		≤70 000	≤100	–		P96–97
High-speed	High-speed, normal atmosphere (room temperature)		High-speed, long-stroke ball screws and linear guides		●	≤80˚C		Critical speed extendable ≤100 000	≤300	–		P98–99
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)

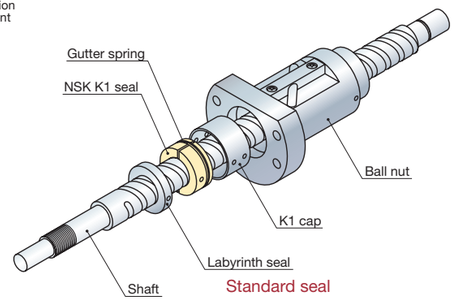
Types and Specifications of SPACEA™ Ball Screws and NSK Linear Guides® SPACEA™

SPACEA™ Series Ball Screws





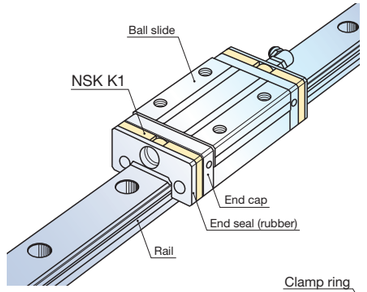
High dust-resistant seal

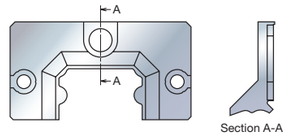


Standard seal

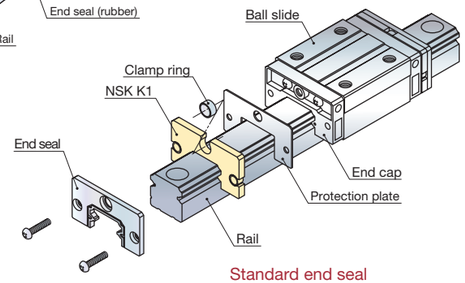
NSK K1™ lubrication unit

SPACEA™ NSK Linear Guides®





High dust-resistant end seal



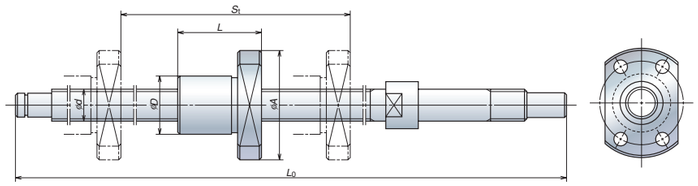
Standard end seal

NSK K1™ lubrication unit

Operating environment			Product name	Component specifications: Ball screw specifications / Linear guide specifications	Shaft, nut / Rail, ball slides	Ball	Recirculation components / End cap	Seal	Corrosion-resistant coating	Lubricant	· Specifications · Operating instructions · Technical data
Vacuum	Clean	From normal atmosphere up to vacuum (room temperature)	Fluorine grease-packed ball screws and linear guides	Martensite stainless steel	Martensite stainless steel	Austenite stainless steel	—	Fluoride low-temperature chrome plating	Fluorine grease	P84–85
		From normal atmosphere up to vacuum (up to 150°C)	Clean lubricant V-DFO ball screws and linear guides					—	V-DFO (+ DLC) or Molybdenum disulfide	P88–89
	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	P84-85, P100–101
		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	P84–85
			Stainless steel ball screws and linear guides	Martensite stainless steel	Martensite stainless steel					
Clean	Normal atmosphere (room temperature)		LG2 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	P84–87, P100–101
			LGU clean grease-packed ball screws and linear guides	Martensite stainless steel	Martensite stainless steel	Austenite stainless steel		Fluoride low-temperature chrome plating	LGU clean grease, NSK K1	
	From normal atmosphere up to vacuum (room temperature)		Fluorine grease-packed ball screws and linear guides				—	Fluoride low-temperature chrome plating	Fluorine grease	P84–85
	From normal atmosphere up to vacuum (up to 150°C)		Clean lubricant V-DFO ball screws and linear guides					—	V-DFO (+ DLC) or Molybdenum disulfide	P88–89
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 seal for food processing applications	P92–93
Water- and dust-contaminated	Dust or wood chips		High dust-resistant, corrosion-resistant coated ball screws and linear guides	Standard material	Standard material	Standard material	High dust-resistant seal	Fluoride low-temperature chrome plating	Standard grease + NSK K1	P84–85, P94–95, P100–101
			High dust-resistant and stainless steel ball screws and linear guides	Martensite stainless steel	Martensite stainless steel	Austenite stainless steel		—		P94–95, P100–101
High-temperature	Normal atmosphere (up to 150°C)		Heat-resistant ball screws and linear guides	Martensite stainless steel	Martensite stainless steel	Austenite stainless steel	(Heat-resistant seal)	—	Heat-resistant grease, Fluorine grease	P96–97
High-speed	High-speed, normal atmosphere (room temperature)		High-speed, long-stroke ball screws and linear guides	Standard material (ball screws: equipped with vibration damper)	Standard material	Standard material (linear guides: high-speed specification end cap)	Standard seal	—	Standard grease	P98–99
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; please consult NSK.

1. Dimensions of Ball Screws



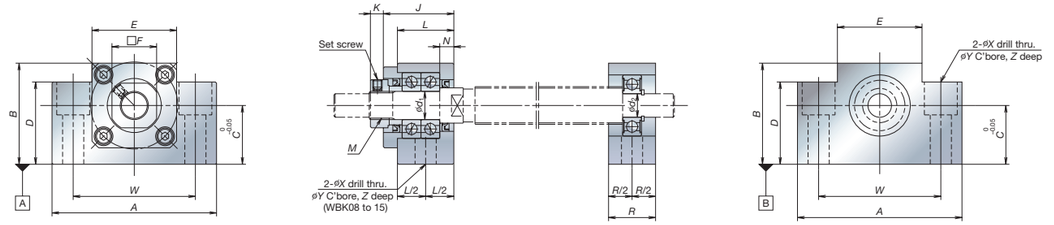
Series	Shaft diameter d	Lead	Effective turns of balls	Number of start	Nut outer diameter D	Flange outer diameter A	Nut length L	Maximum shaft length L_0max	Stroke S_1	Dynamic load rating (N)	Suitability for special environments (availability)						
											Clean	Vacuum	Corrosive	High-temperature	Water- and dust-contaminated	Sanitary	High-speed
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	○	○	○	○		○	○
	32	32	1.5 × 1	1	51	85	131	2 400		9 200	○	○	○	○	○	○	
		32	1.5 × 2	2	58	85	128	2 400		15 000	○	○	○	○	○	○	
		32	1.5 × 2	2	78	105	107	2 400		15 400	○	○	○	○			○
		20	3.5 × 2	2	78	120	142	2 400		48 500	○	○	○	○	○	○	
		10	2.5 × 2	1	82	124	193	3 000		42 500	○	○	○	○		○	
	36	20	2.5 × 4	2	96	138	186	3 000		69 500	○	○	○	○	○	○	
	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	1.5 × 1	1	64	106	155	3 000		15 100	○	○	○	○	○	○	
		40	1.5 × 2	2	73	114	154	3 000		24 700	○	○	○	○	○	○	
		40	1.5 × 2	2	100	133	136	3 000		24 600	○	○	○	○			○
	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	2	120	156	140	3 300		36 700	○	○	○	○			○
		50	1.5 × 1	1	80	126	161	3 500		22 500	○	○	○	○		○	
		50	1.5 × 2	2	80	126	167	3 500		36 800	○	○	○	○		○	
		50	1.5 × 2	2	120	156	158	3 500		36 700	○	○	○	○			○
		50	1.7×2	2	90	135	170	3 500		40 900	○	○	○	○	○	○	

●Standard stock items ○Production on demand

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	Availability
WBK08-01C	490	69 (M3)	8	14	23	7	—	4	M8 × 1	●
WBK10-01C	930	147 (M4)	10	17	30	5.5	24	6	M10 × 1	●
WBK12-01C	1 370	147 (M4)	12	19	30	5.5	24	6	M12 × 1	●
WBK15-01C	2 350	147 (M4)	15	22	31	12	25	5	M15 × 1	●

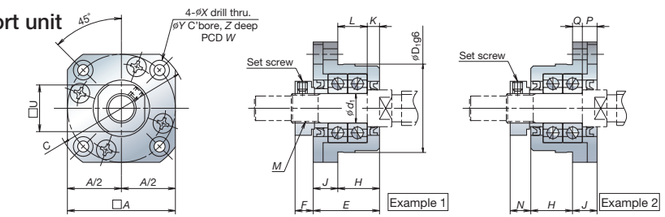
Unit: mm

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	Availability
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.

●Standard stock items

● Round type support unit



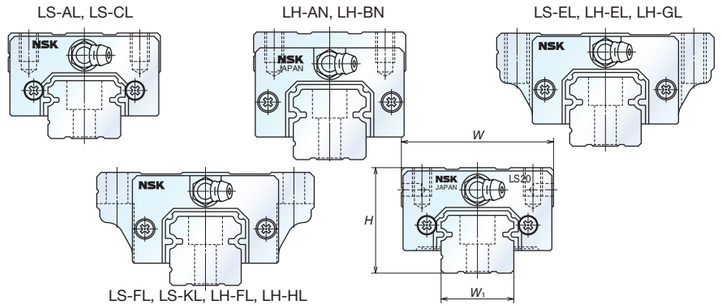
Unit: mm

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	Availability
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.

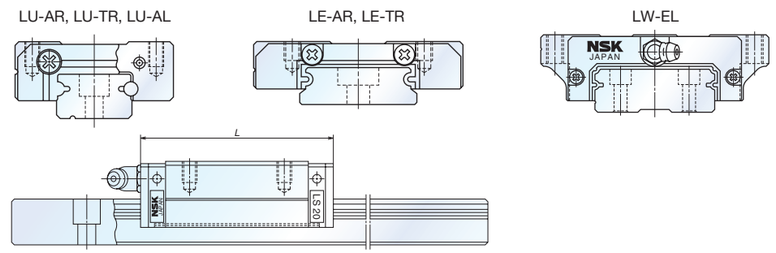
●Standard stock items

3. Dimensions of Linear Guides



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 seal								
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	16	10 800	◎				◎	
	LH15BN	28	34	74	84.6	16	14 600	◎				◎	
	LH15FL	24	47	55	65.6	16	10 800	◎				◎	
	LH15HL	24	47	74	84.6	16	14 600	◎				◎	
	LH15EL,EM	24	47	55	65.6	16	10 800	◎				◎	
	LH15GL,GM	24	47	74	84.6	16	14 600	◎				◎	
	LH20AN	30	44	69.8	80.4	20	17 400	◎	◎	◎	◎	◎	
	LH20BN	30	44	91.8	102.4	20	23 500	◎	◎	◎	◎	◎	
	LH20FL	30	63	69.8	80.4	20	17 400	◎	◎	◎	◎	◎	
	LH20HL	30	63	91.8	102.4	20	23 500	◎	◎	◎	◎	◎	
	LH20EL,EM	30	63	69.8	80.4	20	17 400	◎	◎	◎	◎	◎	
	LH20GL,GM	30	63	91.8	102.8	20	23 500	◎	◎	◎	◎	◎	
	LH25AN	40	48	79	90.6	23	25 600	◎	◎	◎	◎	◎	
	LH25BN	40	48	107	118.6	23	34 500	◎	◎	◎	◎	◎	
	LH25FL	36	70	79	90.6	23	25 600	◎	◎	◎	◎	◎	
	LH25HL	36	70	107	118.6	23	34 500	◎	◎	◎	◎	◎	
	LH25EL,EM	36	70	79	90.6	23	25 600	◎	◎	◎	◎	◎	
	LH25GL,GM	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	◎	◎	◎	◎	◎	
	LH30FL	42	90	98.6	110.6	28	35 500	◎	◎	◎	◎	◎	
	LH30HL	42	90	124.6	136.6	28	46 000	◎	◎	◎	◎	◎	
	LH30EL,EM	42	90	98.6	110.6	28	35 500	◎	◎	◎	◎	◎	
	LH30GL,GM	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	◎			◎	◎	◎
	LH35FL	48	100	109	122	34	47 500	◎			◎	◎	◎
	LH35HL	48	100	143	156	34	61 500	◎			◎	◎	◎
	LH35EL,EM	48	100	109	122	34	47 500	◎			◎	◎	◎
	LH35GL,GM	48	100	143	156	34	61 500	◎			◎	◎	◎
	LH45AN	70	86	139	154	45	81 000	◎			◎	◎	◎
	LH45BN	70	86	171	186	45	99 000	◎			◎	◎	◎
	LH45FL	60	120	139	154	45	81 000	◎			◎	◎	◎
	LH45HL	60	120	171	186	45	99 000	◎			◎	◎	◎
	LH45EL,EM	60	120	139	154	45	81 000	◎			◎	◎	◎
	LH45GL,GM	60	120	171	186	45	99 000	◎			◎	◎	◎
	LH55AN	80	100	163	178	53	119 000	◎			◎	◎	
	LH55BN	80	100	201	216	53	146 000	◎			◎	◎	
	LH55FL	70	140	163	178	53	119 000	◎			◎	◎	
	LH55HL	70	140	201	216	53	146 000	◎			◎	◎	
	LH55EL,EM	70	140	163	178	53	119 000	◎			◎	◎	
	LH55GL,GM	70	140	201	216	53	146 000	◎			◎	◎	

◎Rush items (within one month)



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	
				Standard	With NSK K1 seal								
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	◎				◎	
	PU12TR	13	27	35	42	12	2 830	◎				◎	
	PU15AL	16	32	43	51.2	15	5 550	◎				◎	
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	◎				◎	
	PE12AR	14	40	45	53	24	4 350	◎				◎	
	PE15AR	16	60	56.6	66.2	42	7 600	◎				◎	
LU	**LU05TL**	6	12	18	24.4	5	545	◎				◎	
	LU07AL	8	17	20.4	29.4	7	1 090	◎				◎	
	LU09AL	10	20	26.8	34.2	9	1 760	◎	◎	◎	◎	◎	
	LU09TL	10	20	26.8	34.2	9	1 760	◎	◎	◎	◎	◎	
	LU12AL	13	27	34	41	12	2 830	◎	◎	◎	◎	◎	
	LU12TL	13	27	34	41	12	2 830	◎	◎	◎	◎	◎	
	LU15AL	16	32	43.6	51.8	15	5 550	◎	◎	◎	◎	◎	
LE	**LE09AL**	12	30	39	46	18	3 000	◎	◎	◎		◎	
	LE09T	12	30	39	46	18	3 000	◎	◎	◎		◎	
	LE12A	14	40	44	52	24	4 350	◎	◎	◎	◎	◎	
	LE15AL	16	60	55	64.6	42	7 600	◎	◎	◎	◎	◎	
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	◎				◎	
LS	**LS15CL**	24	34	40.4	50	15	5 400	◎	◎	◎	◎	◎	
	LS15AL	24	34	56.8	66.4	15	8 350	◎	◎	◎	◎	◎	
	LS15KL	24	52	40.4	50	15	5 400	◎	◎	◎	◎	◎	
	LS15FL	24	52	56.8	66.4	15	8 350	◎	◎	◎	◎	◎	
	LS15EL,EM	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	◎	◎	◎	◎	◎	
	LS20KL	28	59	47.2	57.8	20	7 900	◎	◎	◎	◎	◎	
	LS20FL	28	59	65.2	75.8	20	11 700	◎	◎	◎	◎	◎	
	LS20EL,EM	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	◎	◎	◎	◎	◎	
	LS25KL	33	73	59.6	70.2	23	12 700	◎	◎	◎	◎	◎	
	LS25FL	33	73	81.6	92.2	23	18 800	◎	◎	◎	◎	◎	
	LS25EL,EM	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	◎	◎	◎	◎	◎	
	LS30KL	42	90	67.4	79.4	28	18 700	◎	◎	◎	◎	◎	
	LS30FL	42	90	96.4	108.4	28	28 800	◎	◎	◎	◎	◎	
	LS30EL,EM	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	◎				◎	
	LS35KL	48	100	77	90	34	26 000	◎				◎	
	LS35FL	48	100	108	121	34	40 000	◎				◎	
	LS35EL,EM	48	100	108	121	34	40 000	◎				◎	

◎Rush items (within one month)

1. Corrosion-resistant Ball Screws and NSK Linear Guides® (Fluoride Low-temperature Chrome Coating)

NSK linear guides and ball screws 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

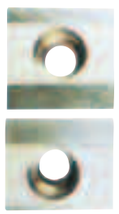
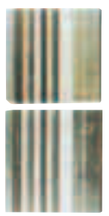
Electrolytic rust-resistant black plating + fluororesin coating

- 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.

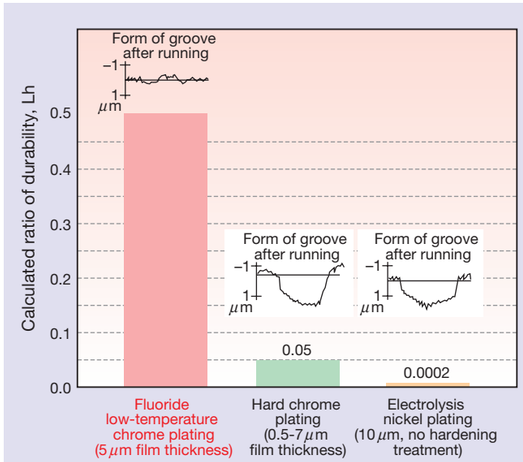
Note: Avoid using organic solvents, which may degrade the treatment's rust prevention properties.

● 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
Rust prevention — Test conditions: ● Testing machine: Dabaiespeck high-temperature and high-humidity vessel ● Temperature: 70°C ● Relative humidity: 95% ● Time: 96 hours						
Rust prevention — 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

● Surface treatment durability test results for linear guides



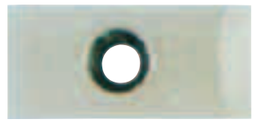
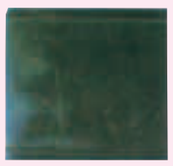
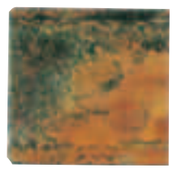
● Comprehensive evaluation

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

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

● Test results of corrosion resistance to chemical exposure

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

Fluoride low-temperature chrome plating	Soaking/Vapor	Hard chrome plating	No surface treatment
	24-hour soaking ← Nitric acid		
	24-hour soaking ← Hydrofluoric acid		
	72-hour vapor ← Hydrochloric cleansing liquid; $HCl : H_2O_2 : H_2O = 1 : 1 : 8$		
○	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, robot modules, megathrust 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	94.8	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

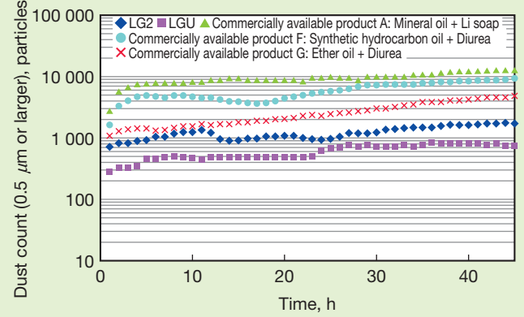
Characteristics	LG2/LGU	Fluorine grease	Ordinary grease
Dust	○	○/△	△/×
Torque	○	×	○/△
Durability	○	△/×	○
Rust prevention	○	△/×	○

○: Excellent △: Poor ×: Not recommended

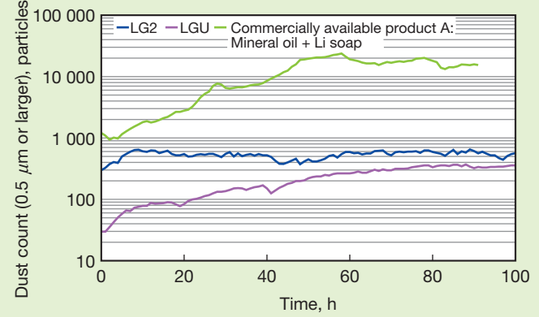
● Properties of grease

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

● Ball screws

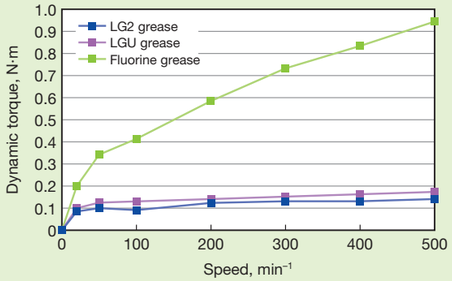


● Linear guides



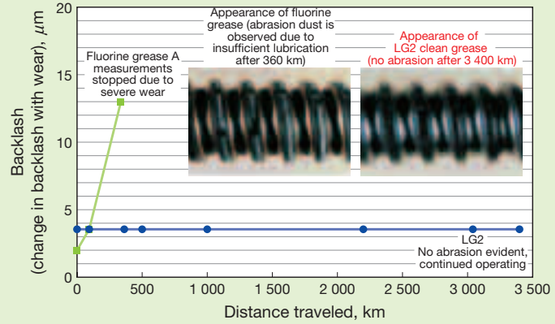
● Stable low-torque characteristics

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.

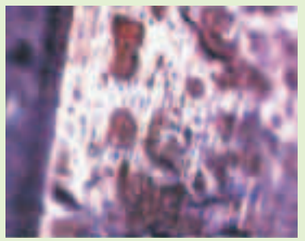


● Superior rust prevention

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

NSK clean grease

No rust



Fluorine grease

Rusting

3. NSK Clean Lubricant V-DFO

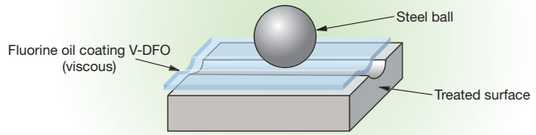
NSK clean lubricant V-DFO forms a fluorine film directly on raceway surfaces of ball screws and linear guides and balls, resulting in low particle emissions and outgassing, and a longer life than that of fluororesin coating in normal atmosphere up to vacuum conditions. These properties make V-DFO optimal for clean environments.
It is suitable for applications that must avoid contamination on wafers or lenses, such as semiconductor/LCD panel production machinery.

Features of NSK Clean Greases

- Lower particle emissions and superior outgassing properties compared to conventional fluororesin-coated products
- Over 10 times more durable than fluororesin-coated products

- Structural illustration of V-DFO lubricant coating

● Fluorine oil coating that exhibits the properties of liquids and solids



- Comprehensive evaluation

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

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

Notes:

V-DFO coating: V-DFO coating is a clear, colorless, fluorine-based, semi-dry coating that is viscous on the surface.

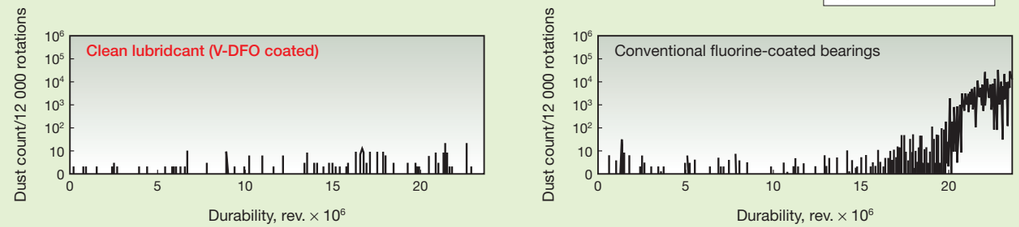
1. To open and handle the product: Open the package immediately before use in a clean space with the lowest possible humidity (less than 60%). Handle with gloves for clean rooms. Do not touch the product with bare hands.
2. To store: Store the product in a clean dry container such as a desiccator or 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: V-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: V-DFO coated ball screws and linear guides do not require additional lubricant. Do not use NSK K1 lubrication unit, which will degrade V-DFO's lubricating property.

- Superior particle emitting characteristics

- Measurement example with bearings (particle size of 0.21 μm or larger)

Outperforms conventional fluorine-coated bearings or fluorine grease-packed bearings.

Bearings tested: 608
Speed: 1 200 min^{-1}
Load: 19.6 N
Temperature: 100°C
Degree of vacuum: 10^{-4} Pa

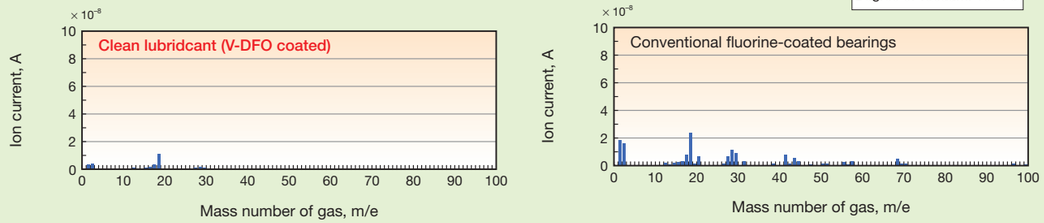


- Superior outgassing properties

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

Outperforms conventional fluorine-coated bearings.

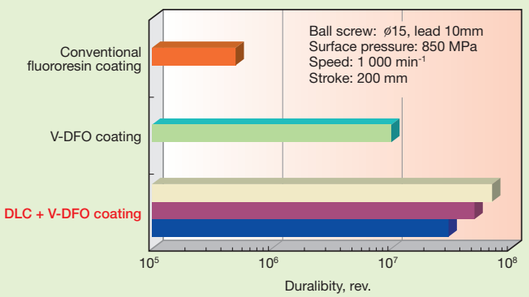
Bearings tested: 608
Speed: 1 200 min^{-1}
Load: 19.6 N
Temperature: 200°C
Degree of vacuum: 10^{-5} Pa



- Long life

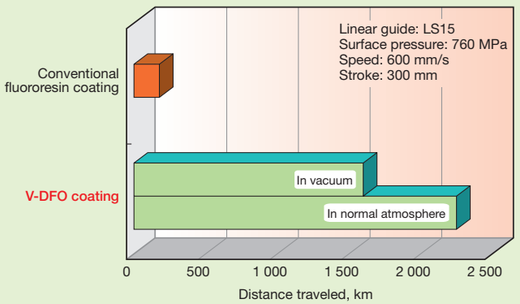
- Durability of ball screws

V-DFO coating extends operating life of ball screws: more than 10 times longer than conventional fluororesin coating, and even more when combined with DLC.



- Durability of linear guides

V-DFO coating extends operating life of linear guides: more than 10 times longer than conventional fluororesin coating.



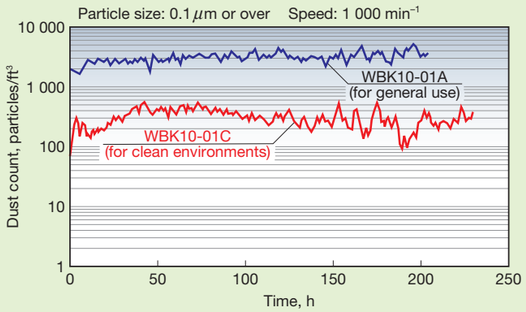
4. Support Units for Clean Environments

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.

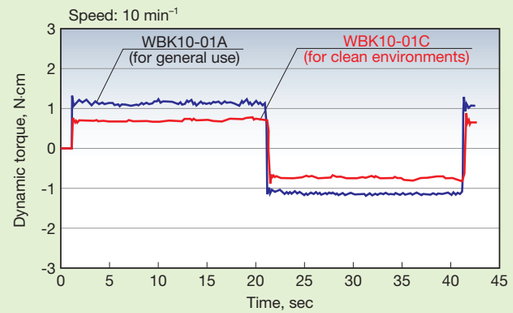
Features of Clean Support Unit

- **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**·····Fluoride low-temperature chrome coating and stainless steel are applied to components.

Low particle emitting characteristics



Low-torque characteristics



Coding of reference numbers

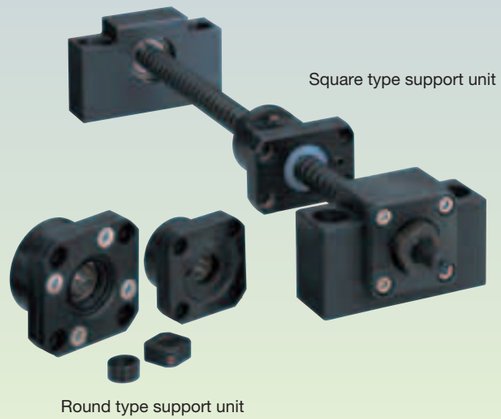
Example: **WBK 08 S - 01 A**

- Product code for support unit
- Nominal size code (internal bore of bearing)*
- Mounting code
  - No code: Fixed support unit
  - S: Simple support unit
  - SF: Simple support unit (for VFA)
  - R: Fixed support unit (support kit for miniature ball screws)
- 01: Square type, 11: Round type
- No code or A: For general use, C: For clean environments

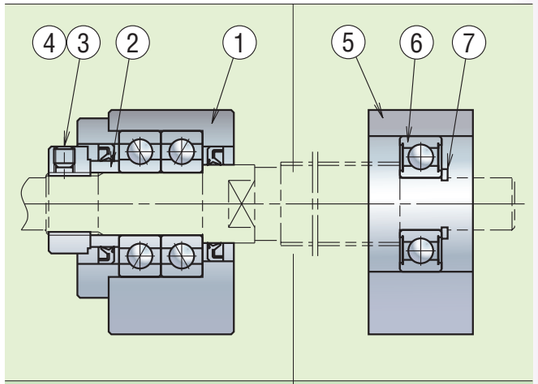
* For simple support units, please note that size codes of 12 or less do not represent internal bores of bearing.

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	Fluoride low-temperature chrome coating	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

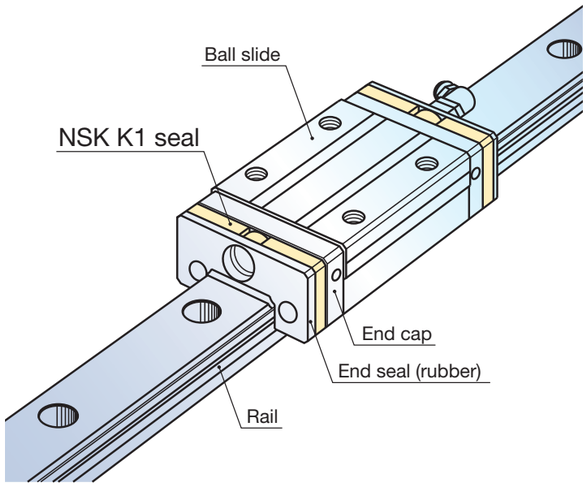
5. NSK K1™ Lubrication Unit for Food Processing Equipment and Medical Devices

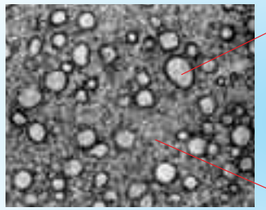
With an amazingly innovative lubricant seal, the NSK K1 lubrication unit, utilizing NSK K1 FDA-compliant material, provides reliability when used in food processing equipment and medical devices.
The newly developed porous synthetic resin contains abundant lubricant.
With the basic functions of highly praised NSK K1 for general industry (see pages 100–101), 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





Portion containing high proportion of polyolefin
Polyolefin is used for packaging food in supermarkets, replacing dioxin-generating vinyl chloride.

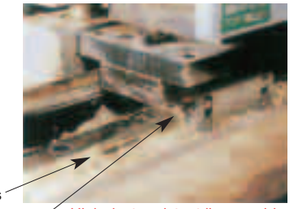
Portion containing high proportion of lubricating oil

Notes:
To maintain optimal performance of NSK K1 over a long time, please follow the instructions below:

1. Range of operating temperatures: Maximum operating temperature: 50°C
   Maximum instantaneous operating temperature: 80°C
2. Chemicals to avoid contact with: Organic solvent with degreasing properties, such as hexane and thinner
   Immersion in white kerosene or anti-corrosive oil (with white kerosene ingredients)

6. NSK High Performance Seals

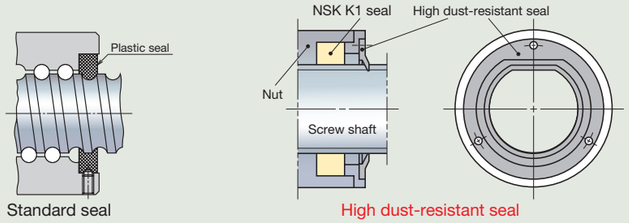
Examples of water- and particle-contaminated environments include atmospheres where dry powders such as wood flour, rubber crumb, graphite powder, ceramic powder and welding spatter exist. In recent years, demand for dust-resistant performance has increased, partly because protective equipment for machinery 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

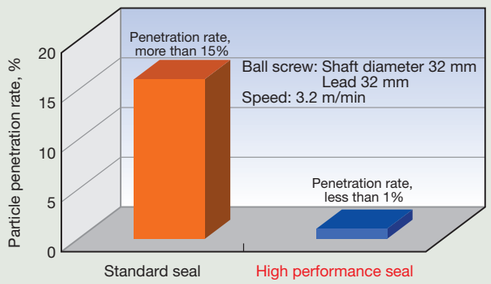


Note: Ball screws with high performance seals come standard with the NSK K1 lubrication unit, so the entire nut length is slightly longer than ball screws equipped with standard seals.

Performance of high dust-resistant ball screws

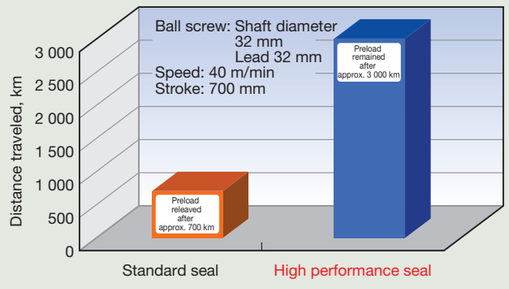
High dust-resistance

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.



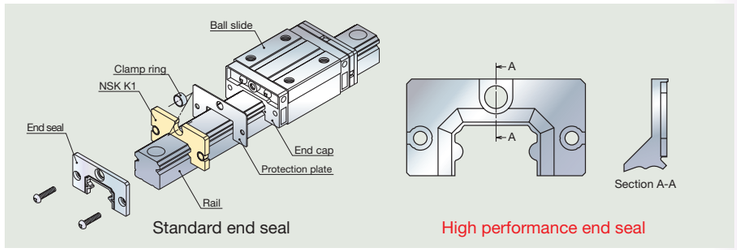
Long life

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

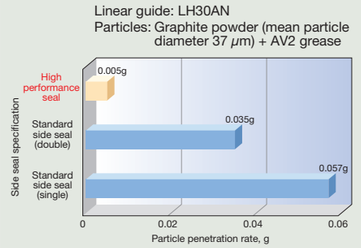


Note: Linear guides with extending seals also come standard with the NSK K1 lubrication unit, so the length of the ball slide is slightly longer than linear guides with standard seals. (See the table below for more details.)

Performance of high dust-resistant linear guides

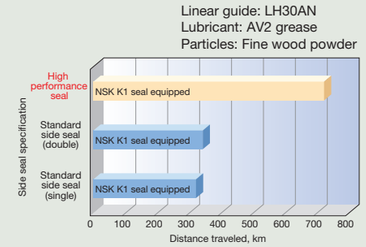
High dust-resistance

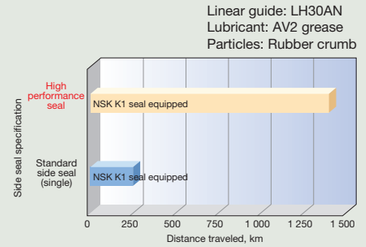
The particle penetration through high performance seals is less than 1/10 of the penetration through a standard end seal (single).



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.





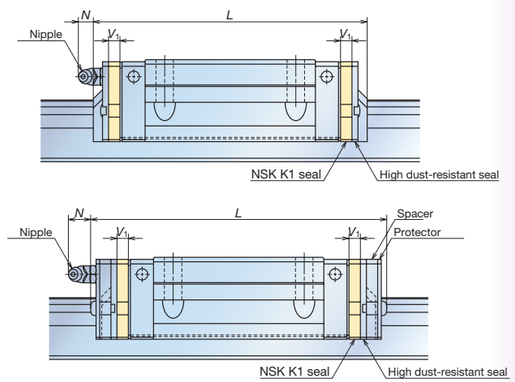
Specifications for high dust-resistant linear guides

Unit: mm

Model No.		Ball slide length L	Nipple extrusion N
LH20	AN/EL/FL/EM	87.4 (101.8)	11 (14)
	BN/GL/HL/GM	109.4 (123.8)	
LH25	AN/AL/EL/FL/EM	97.0 (104.4)	11 (14)
	BN/BL/GL/HL/GM	125.0 (132.4)	
LH30	AN/AL	104.4 (114.8)	10 (14)
	EL/FL/EM	117.4 (127.8)	
	BN/BL/GL/HL/GM	143.4 (153.8)	
LH35	AN/AL/EL/FL/EM	128.8 (139.2)	10 (14)
	BN/BL/GL/HL/GM	162.8 (173.2)	
LH45	AN/EL/FL/EM	161.4 (174.2)	11 (15)
	BN/GL/HL/GM	193.4 (206.2)	

Dimensions in parentheses are dimensions including the protector.

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



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

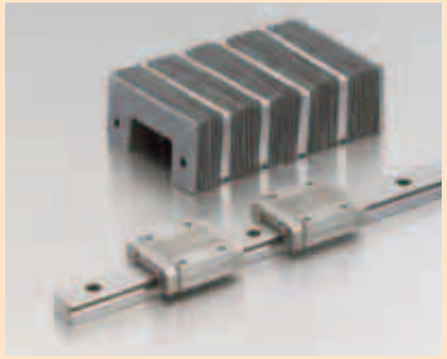
The scope of applications of NSK high-temperature linear guides is shown below.
Other series and model numbers not listed are also available upon request. Please contact NSK.

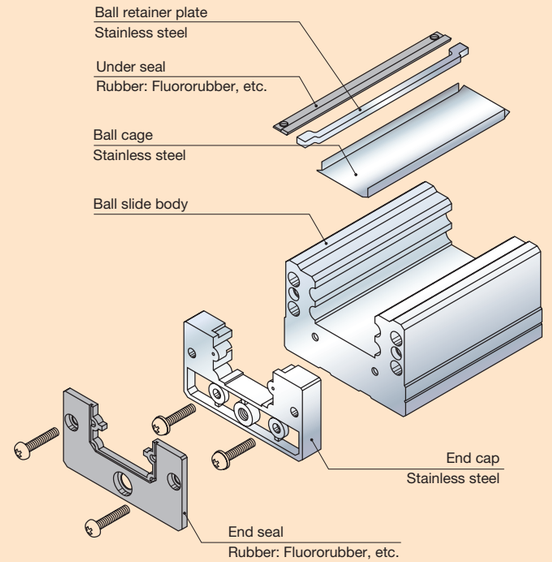
Applicable series	Size symbols*	
	Standard material specification	All-stainless steel specification (except for seals)
LH (high load capacity/aligning)	20, 25, 30, 35, 45, 55	20, 25, 30
LS (compact low type)	15, 20, 25, 30	15, 20, 25, 30
LW (broad type)	17, 21, 27	—
LU (miniature)	09, 12, 15	09, 12,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

Note: *Example of a basic symbol LH 20
Type Size symbol·····Indicates the rail width or assembly height.
For details, see NSK Catalog, Precision Machine Components (CAT. No.E3161)

● 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.


Heat-resistant linear guide and heat-resistant bellows



● Materials used in heat-resistant linear guide components

Linear guide component	Standard material specification	All-stainless steel specification
Rail, ball slide	Special high-carbon steel	Martensite stainless steel
Ball	SUJ2	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 of heat-resistant ball screw components

Ball screw component	Standard material specification	All-stainless steel specification
Shaft, nut	Special high-carbon steel	Martensite stainless steel
Ball	SUJ2	SUS440C
Recirculation components	Austenite stainless steel	

8. High-speed, Long-stroke Ball Screws (NDD Series Equipped with Vibration Damper)

For a long stroke ball screw, the desired rotation speed may not be achieved due to the constraint of critical speed, even with an acceptable *d·n* value. The NDD series ball screws equipped with a vibration damper for nut rolling are recommended for such cases.
The NDD series ball screws can be used up to a range well beyond the conventionally accepted critical speed.

Features of NDD Series Equipped with Vibration Damper

● Requires no allowance for critical speed

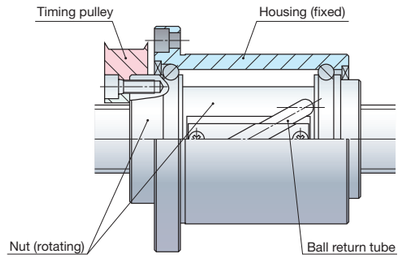
Conventional ball screws limited by critical speed require adjustments, such as an increased shaft diameter or an intermediate support. The NDD series requires no such measures.

● Dimension compatibility

Since the vibration damper is linked to the bore diameter section of a screw shaft, it does not change the outside dimension of the ball screw. Thus, the NDD series is compatible with the NDT series nut-rotating ball screws.

● Other

The NDD series offers the same capabilities as the NDT series, including multiple-nut driving, long-stroke and high-speed drive, easy installation and low inertia.

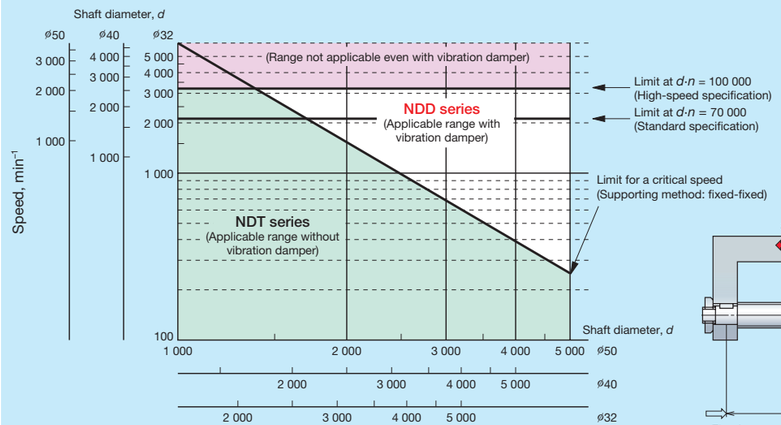


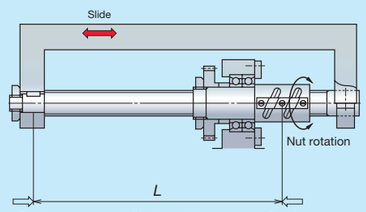
Structure of NDT series nut-rotating ball screws

Note: For the NDT series nut-rotating ball screws, see NSK Catalog, Precision Machine Components (CAT. No.E3161).

Notes:
1. The NDD series cannot be used at a *d·n* value exceeding 100 000. Please consult NSK.
2. Not applicable to shaft rotation for the NDD series. Please use for nut rotation only.

● Scope of applications of the NDD series



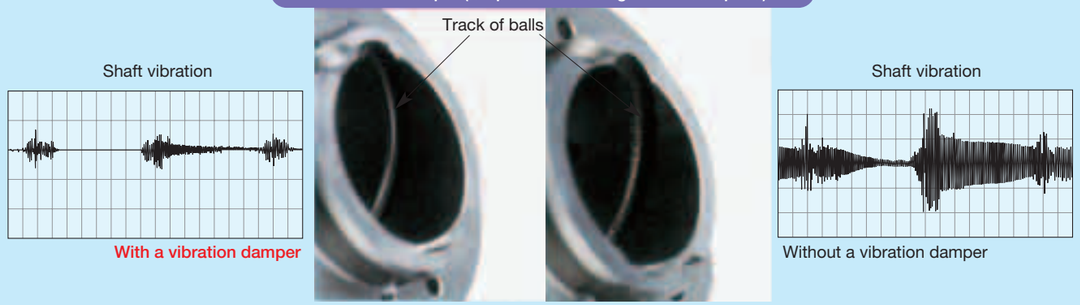


Supporting method:
example of fixed-fixed support

● Structure of the NDD series

- Features a hollow screw shaft with a vibration energy absorber (vibration damper) that enhances the screw shaft's dynamic rigidity and controls the vibration generated at critical speed. Patent pending.
- Same nut structure as the NDT series (nut-rotating ball screws).

Durability comparison test between screw shafts with and without a vibration damper (at speeds exceeding the critical speed)



● Accuracy grade and axial play

Same as the NDT series

● Axial play

Unit: mm

Axial play code	Z	T	S
Axial play	0	0.005	0.020

● Combination of accuracy and play

Accuracy grade	C3	C5	Ct7
Axial play	Z, T, S	Z, T, S	S

● Limiting rotational speed

- The *d·n* value* is same as the NDT series
- Requires no allowance for critical speed

Standard specification	*d·n* ≤ 70 000
High-speed specification**	*d·n* ≤ 100 000

Notes: * *d·n* value
(*d*: Shaft diameter of ball screws, mm × Rotational speed, min⁻¹)
** High-speed specification products are designed to order. Please contact NSK.

Reference: Limiting Speed of NSK Linear Guides®

By changing materials for end caps, the recirculation components, NSK linear guides respond to a wide range of high-speed applications. The speed guidelines of high-speed specification products are shown in the table below. Although maximum speeds will vary by series and model number, this table lists the maximum speed of each model number.

Note: For any required maximum speed exceeding 100 m/min, please notify NSK.

Specification of linear guide end caps	Limiting maximum speed by model number, m/min
Standard end cap	All model numbers: 100
High-speed specification end cap	Up to 35***: 300 45–55: 200 Up to 65: 150

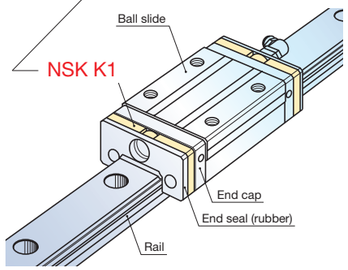
Note: *** Rail width symbol

9. MF Series NSK Linear Guides® and Ball Screws

NSK has developed the maintenance-free MF series linear guides and ball screws with the newly-developed NSK K1 lubrication unit. (NSK K1 lubrication unit for sanitary environments is also available. See pages 92–93.)

Features of MF Series NSK Linear Guides®

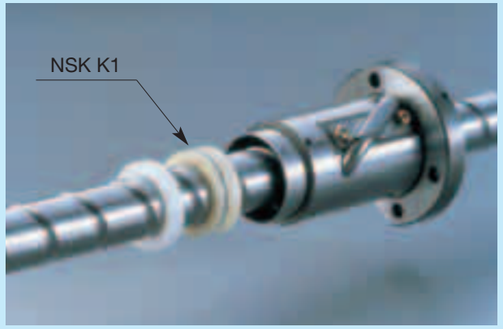
- **NSK linear guides equipped with the NSK K1 lubrication unit enhances lubrication.**
- **The newly developed porous synthetic resin contains ample lubricant to ensure extended maintenance-free performance.**
- **Easy installation: mounts to the inside of the standard-end seal (rubber).**



Notes:
To maintain optimal performance of NSK K1 for extended use, please follow the instructions below:

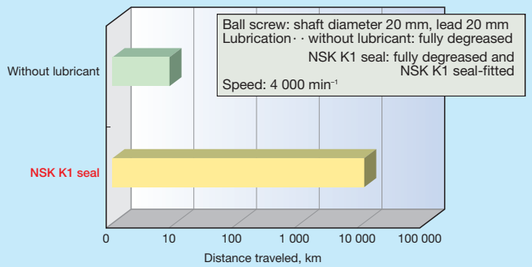
1. Range of operating temperatures··Maximum operating temperature: 50°C
   Maximum instantaneous operating temperature: 80°C
2. Chemicals to avoid contact with····Organic solvents with degreasing properties, such as hexane and immersion in white kerosene thinner or anti-corrosive oil (containing white kerosene)

Features of MF Series Ball Screws



Durability tests without lubricant

The linear guide without lubricant was damaged after operating over a distance of 8.6 km, but the MF series (equipped with NSK K1 seal) operated for more than 10 000 km.



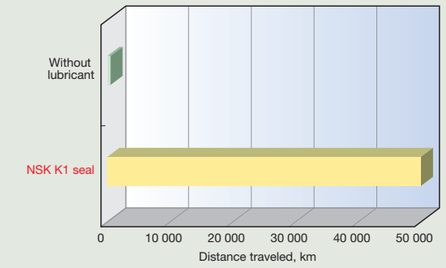
Note: The range of operating temperatures and chemicals to avoid contact with are the same as for the aforementioned linear guides.

Performance of the MF Series NSK Linear Guides

Durability test without lubricant

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

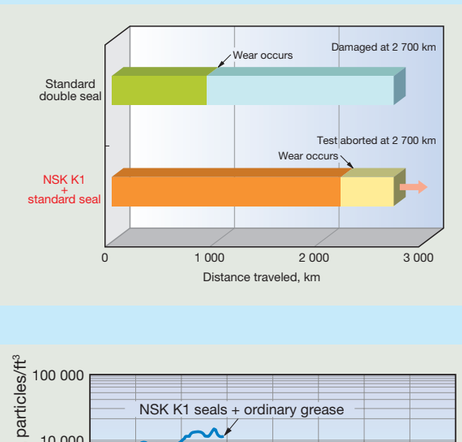
Conditions
Linear guide: LH30AN (preload Z1)
Lubrication· · without lubricant: fully degreased
NSK K1 seal: fully degreased and NSK K1 seal-fitted
Speed: 60 m/min



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 MF series linear guide equipped with NSK K1 seal showed only 1/3 as much wear as the standard linear guides, confirming the seal's significant lubricating efficacy.

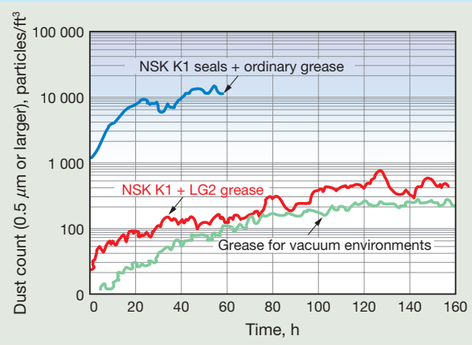
Conditions
Linear guide: LS30 stainless steel (preload Z1)
Water immersion: Run once a week for 24 hours, fully immersed in water
Lubrication: Full grease-packing for food processing machinery
Speed: 24 m/min



Dust characteristics

The combination of NSK K1 seals 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 seals with oils and chemicals

The table at right shows the results of a test in which NSK K1 seals were immersed in chemicals and oils at 40°C. NSK K1 seals 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.

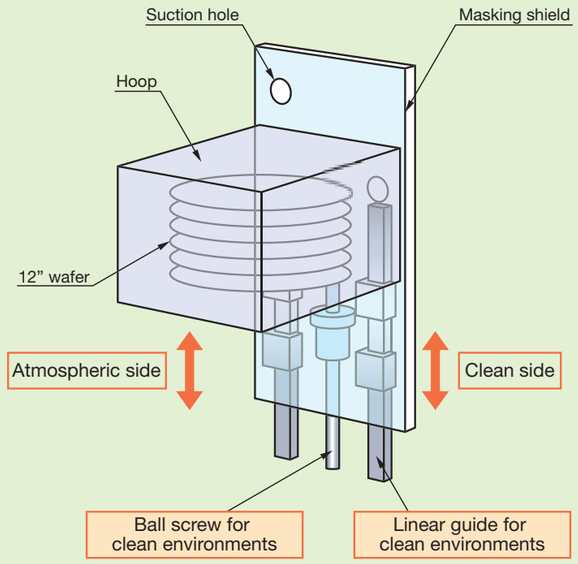
Chemicals/Oil	Compatibility
Cutting lubricants (water-based, oil-based)	A
Grease (mineral oil-based, ester-based)	A
Rust preventives (without solvents)	A
Rust preventives (with solvents)	B
White kerosene	B
Hexane	C

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

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

1. Semiconductor Manufacturing Equipment

Wafer Conveyor



Operating Conditions

Clean environments

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

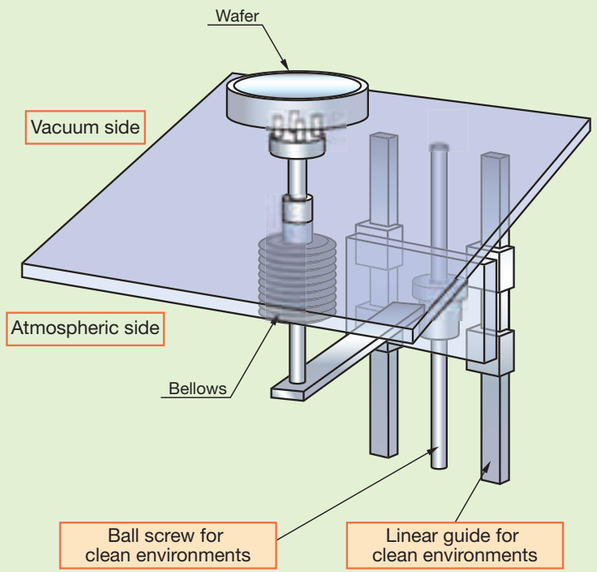
Feature

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

NSK SPACEA Series
Ball screws and NSK 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

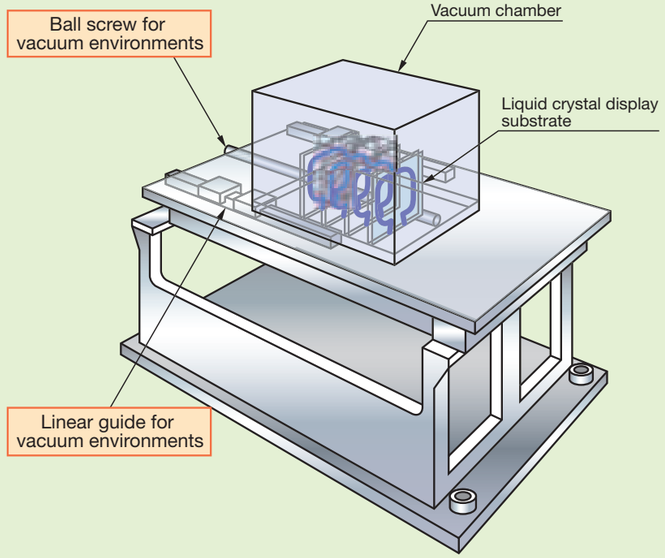
- Change from a commercially available vacuum grease to NSK clean grease

NSK SPACEA Series
Ball screws and NSK linear guides for clean environments

- Reduces costs and maintenance

2. LCD/Semiconductor Production Machinery

Liquid Crystal Filling Machine



Operating Conditions

Vacuum/Clean environments

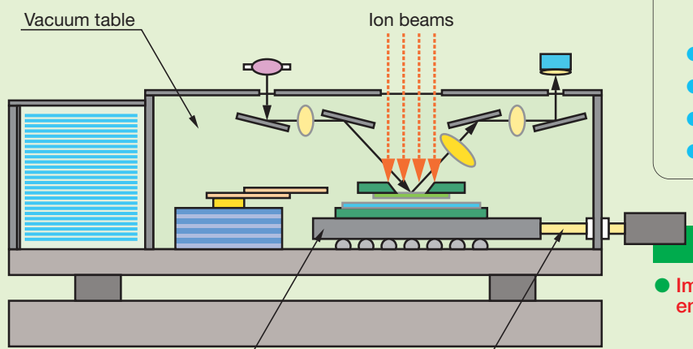
- Degree of vacuum: 10^{-1} Pa
- Temperature: 100–150°C
- Speed: 10 m/min
- Load: Minimal

Feature

- Heat-resistant

NSK SPACEA Series
Ball screws and NSK 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 V-DFO lubrication

NSK SPACEA Series
Ball screws and NSK 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

Physical Properties of Materials, Unit Conversion Tables ····· P106–127

1. Properties of SPACEA™ Series Greases
2. Characteristics of Representative Solid Lubricants
3. Characteristics of Metallic Materials
4. Characteristics of Ceramic Materials
5. Physical Properties of Plastic Materials
6. Properties of Commercially Available Fluorine Greases (Krytox)
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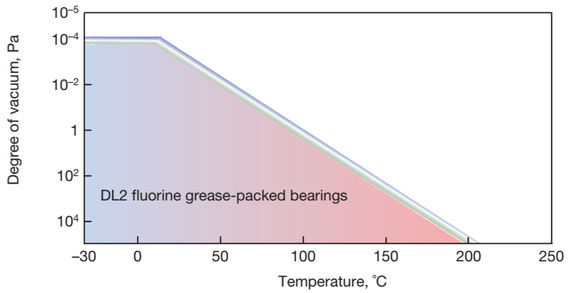
1. Properties of SPACEA™ Series Greases

Operating environment	Grease	Normal atmosphere, vacuum	Maximum operating temperature ˚C	Cleanliness (1)	Base oil	Thickener	Kinematic viscosity mm²/s, 40˚C	Consistency
Normal atmosphere, clean	LG2	Normal atmosphere	70	Class 100–1000	Mineral oil and synthetic hydrocarbon oil	Lithium soap	30	207
	LGU		120		Synthetic hydrocarbon oil	Diurea	94.8	209
From normal atmosphere up to vacuum, clean	DL2	See the Scope of Applications of DL2 Grease-Packed Bearings below.			Fluorine oil	PTFE	200	280
Water	AS2	Normal atmosphere	110	—	Mineral oil	Lithium soap	140	277
Normal atmosphere, high-temperature	KPM		230	—	Fluorine oil	PTFE	380	280
Cryogenic	D3L	—	-60 (Minimum operating temperature)	—	Silicone oil	Lithium soap	75	300
Radioactive	MRG	—	—	—	Synthetic hydrocarbon oil	Bentonite	120	130

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: Normal atmosphere	Maximum operating temperature ˚C: Vacuum	Coefficient of friction: Normal atmosphere	Coefficient of friction: Vacuum	Particle emissions	Outgassing
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

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

Application	Metallic material	Thermal expansion coefficient $\times 10^{-6}$ / ˚C	Young's modulus GPa	Hardness (1) HV	Relative permeability	Corrosion resistance
General application Radiation-resistant	Bearing steel SUJ2	12.5	208	700–800	Ferromagnetic	×
Corrosive, Clean, Vacuum, High-temperature, Low-temperature	High corrosion-resistant stainless steel ES1	10.8	206	650–750		△/○
	Martensite stainless steel SUS440C	10.1	200	670		△
	Austenite stainless steel SUS304	16.3	193	160	1.04 or less	○
	Precipitation-hardened stainless steel SUS630	10.8	200	290–380	Ferromagnetic	○
Non-magnetic, Corrosive	High corrosion-resistant, non-magnetic stainless steel ESA	16.0	193	800–1 000 (Hardened surface layer)	1.01 or less	○
	Completely non-magnetic titanium alloy	9.0	90	450–500	1.001 or less	◎
(Comparative material)	Non-magnetic stainless steel	17.0	195	450	1.01 or less	△
	Beryllium-copper alloy	16.3	135	320–400	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.

Operating environment	Plastic	Classification(1)	Elasticity coefficient GPa	Strength GPa	Density g/cm³	Tm(2) ˚C	Heat distortion temperature(3) ˚C
High-temperature, Clean, Vacuum	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)
Corrosive	Polyvinylidene fluoride (PVDF)	M, C	1.6	0.045	1.76	170	90 (150)
	Tetrafluoroethylene-ethylene copolymer (ETFE)	M, C	0.88–1.37	0.04–0.046	1.7–1.76	260	74 (104)
(Comparative material)	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)

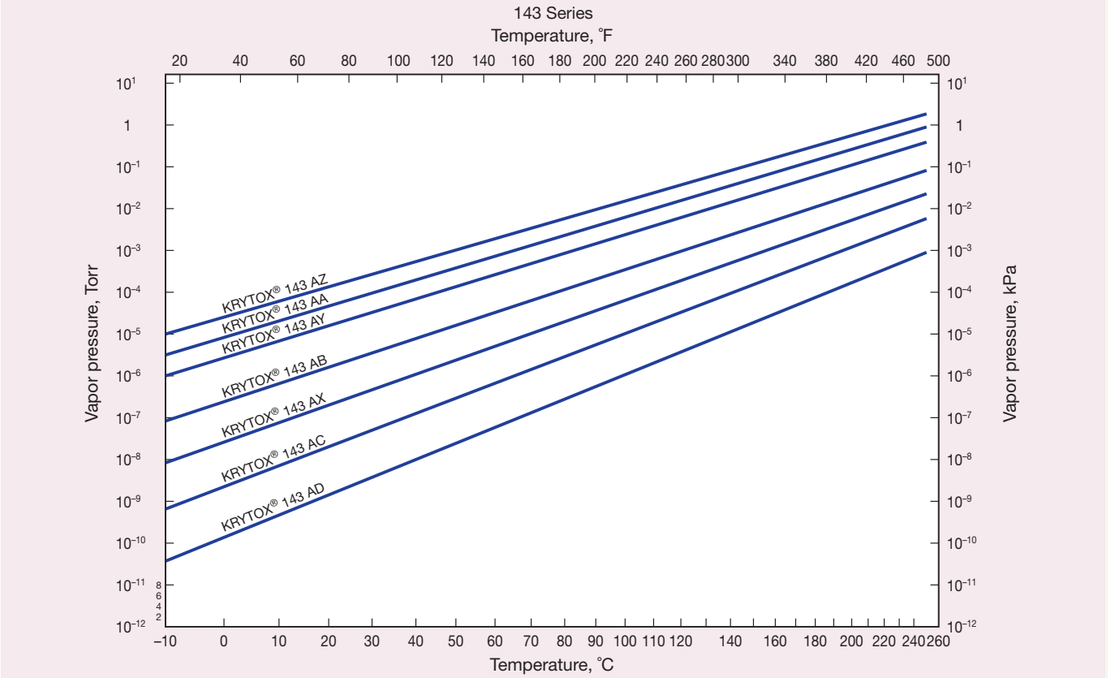
● Krytox oil (Dupont)

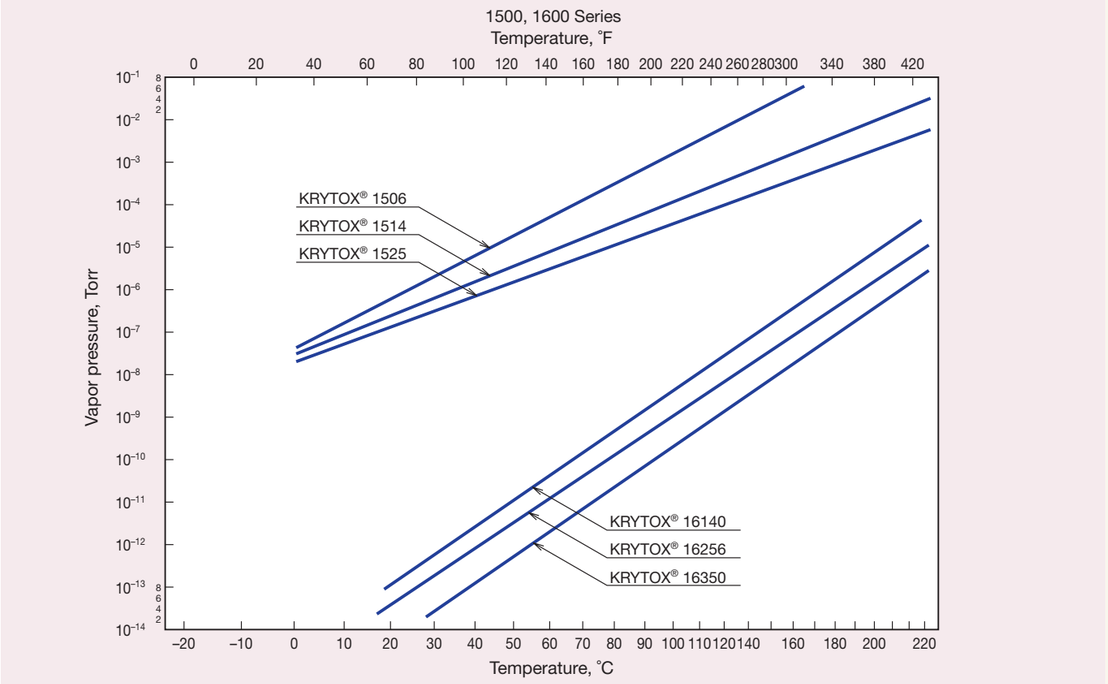
Product		Average molecular weight	Kinematic viscosity mm²/s 20℃	38℃	50℃	100℃	Viscosity index	Pour point ℃	Vapor pressure (Knudsen number) Pa 20℃	38℃	100℃	260℃	Amount of evaporation, mass % (Temperature, 22 hours)	Density g/cm³ (0℃)	Range of operating temperatures
143 Series	AZ	1 850	40	18	—	3.3 (99℃)	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)

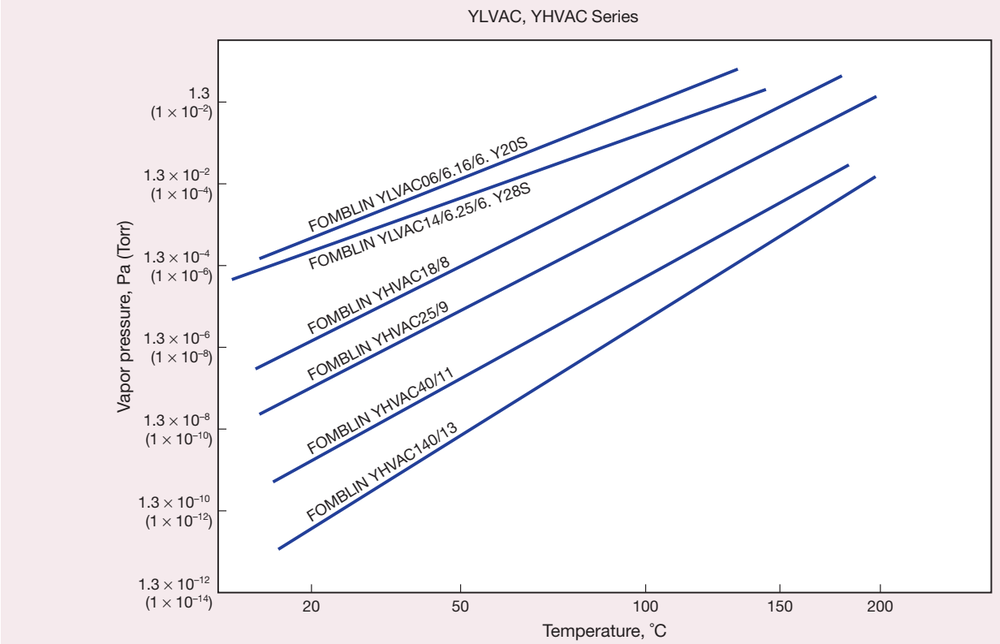
● Fomblin oil (Solvay Solexis)

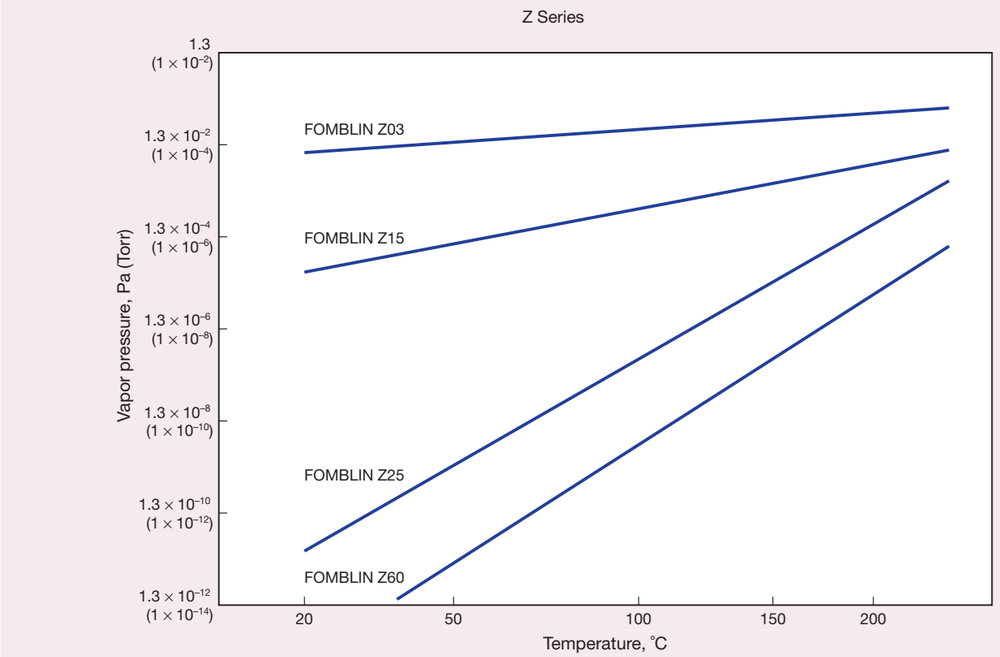
Product		Average molecular weight	Kinematic viscosity mm²/s			Viscosity index	Pour point ℃	Vapor pressure (Knudsen number) Pa		Amount of evaporation, mass % (Temperature, 22 hours)	Density g/cm³ (20℃)
			20℃	40℃	100℃			20℃	100℃		
Y Series	Y04	1 500	38	15	3.2	60	–58	—	—	20 (120℃)	1.87
	Y06	1 800	60	22	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 (25℃)	Additive	Range of operating temperatures
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)

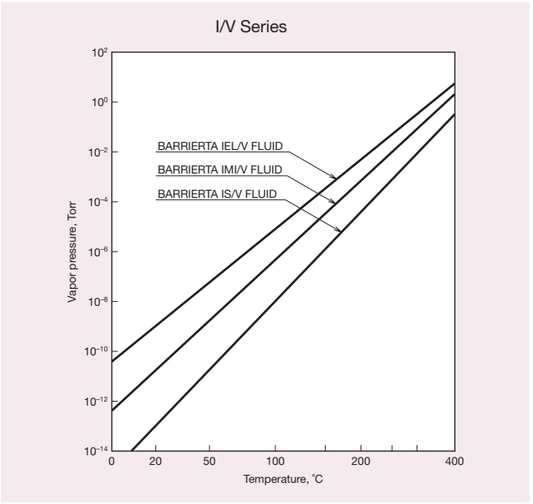
● Barrierta oil (NOK Clüber)

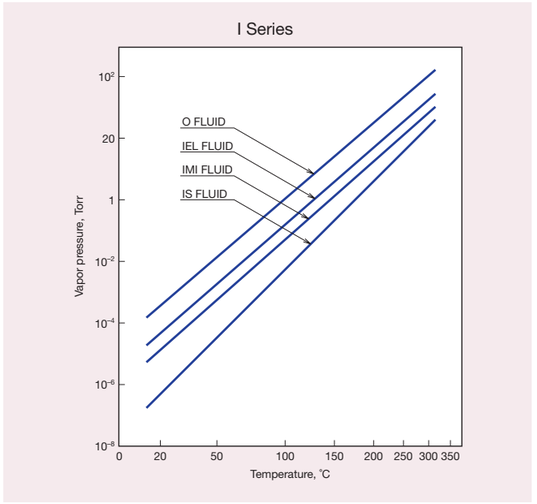
I Series	I/V Series	Average molecular weight	Kinematic viscosity mm²/s		Viscosity index	Pour point ˚C	Vapor pressure (Knudsen number) Pa (20˚C)	Density g/cm³ (20˚C)
			20˚C	40˚C				
O		2 100	65	25	72	–60	—	1.88
	IEL/V	—	140	65	200	–70	1×10^{-7}	1.87
IEL		3 500	280	95	130	–45	—	1.90
IMI		4 500	550	180	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





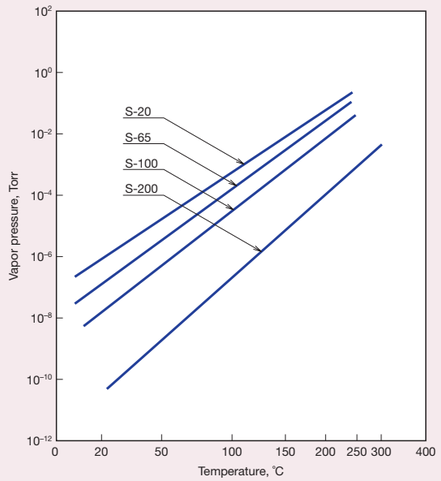
● Demnum oil (Daikin)

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	$1/(9.80665\times10^3)$
			Dyne	dyn	10^3
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	$1/(9.80665\times10^4)$
			Kilogram per square millimeter	kgf/mm^2	$1/(9.80665\times10^6)$

● 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	$1/(9.80665\times10^3)$
			Millimeter mercury	mmHg	$760/(1.01325\times10^5)$
			Torr	Torr	$760/(1.01325\times10^5)$
			Bar	bar	10^{-5}
			Atmospheric pressure	atm	$1/(1.01325\times10^5)$
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	$1/(3.6\times10^6)$
			Metric horsepower-hour	PS·h	$=3.77672\times10^{-7}$
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	24.034	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

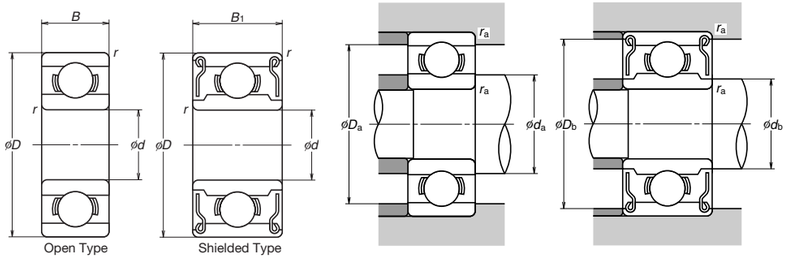
14. Hardness Conversion Table

( ): 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

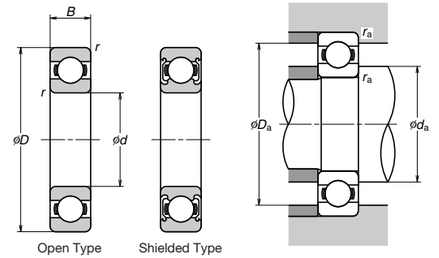
15. Dimensions of Shoulder and Fillet



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

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

MEMO

Specification Inquiry for SPACEA™ Series

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. Manufacturer unknown 2. Other company's model No. (Name of manufacturer:)	
	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 ( ) rpm Max ( ) rpm	
	Bearing load	Radial (N) Axial (N) Other load information ( )	
Comments			

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