

SKF

SKF NEXT-GENERATION SUPER-PRECISION ANGULAR CONTACT BALL BEARINGS

Engineered for high speeds, high stiffness, and low heat generation of spindles for high-performance machining





Keep pace with BT40 machine tool spindles

BT40 spindles, as one of the mainstream interfaces on modern CNC machine tools (particularly machining centers), are evolving towards higher efficiency, higher precision, higher reliability, and higher intelligent capability.

High speed and high rigidity

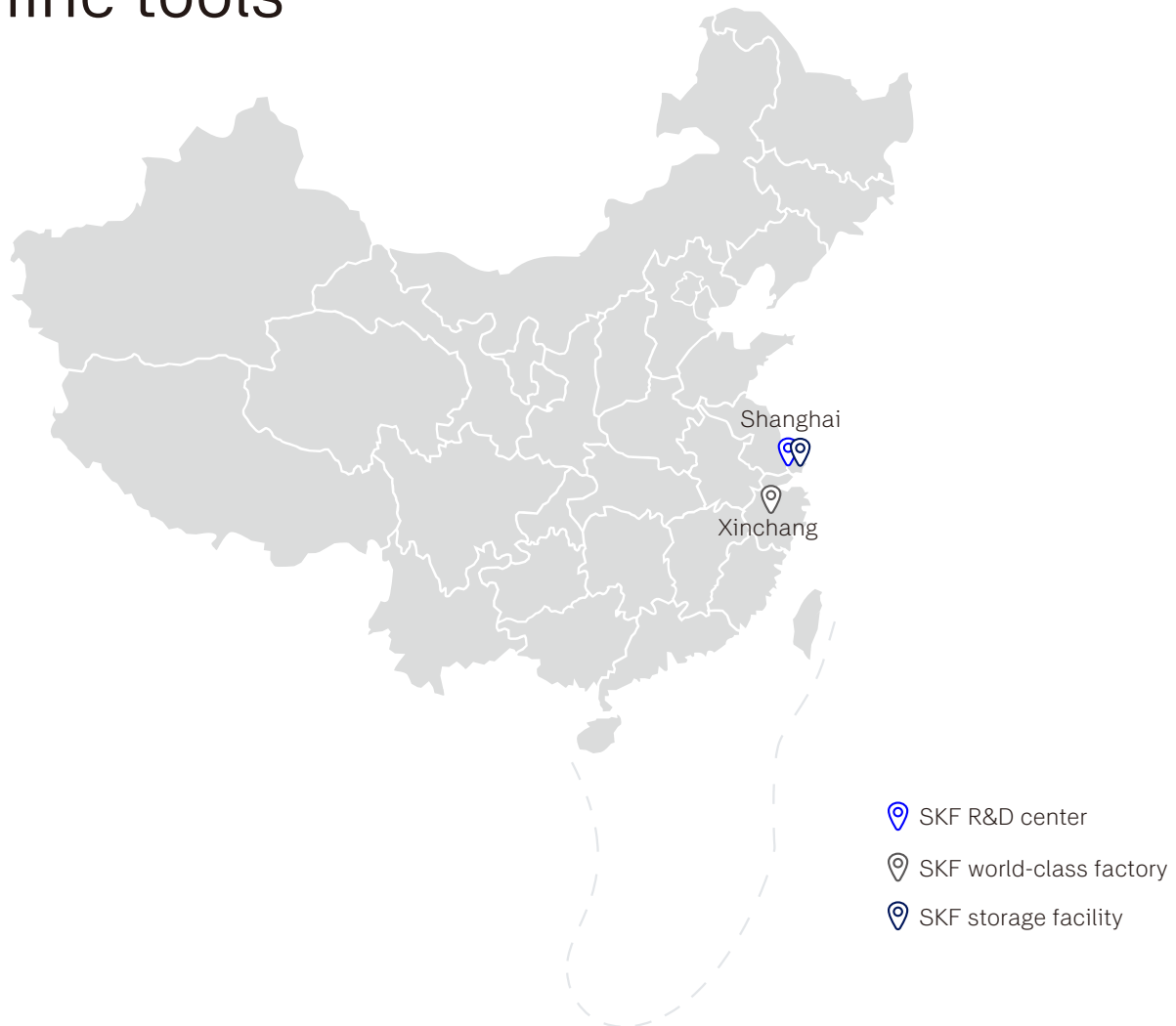
Today, machine tool spindles are running faster and faster. The speed of standard BT40 spindles can reach 15,000 rpm, while for some high-end models, the speed is even higher in order to meet the demands for high-speed cutting and efficient machining.

The spindle stiffness is also increasing. High-precision bearings and advanced lubrication technologies make it possible to maintain high rigidity and high precision at high speeds.

Less weight and higher thermal stability

With new materials and optimized structural design, spindles and machine tools are becoming lighter, posing more stringent requirements on the thermal stability and vibration characteristics of bearings.

SKF localization strategy for precision machine tools



Well-established, localized supply chain

SKF remains committed to offering accurate, stable lead times and cost-effective solutions by localized supply. Today, SKF has localized the full supply chain of precision bearings in China, from raw materials, manufacturing, to delivery. Backed by its uniform, strict manufacturing process management across the globe, SKF ensures consistent product quality and bearing performance. Whether you are an end user of machine tools or a spindle manufacturer, SKF can provide you with short lead times and complete products and services.

Professional R&D team

With its localized professional R&D team, SKF has developed precision bearings for BT40 spindles suitable for a wide range of applications. Also, we can quickly iterate and manufacture new products tailored to your specific needs and imminent challenges, helping your products stand above the competition.

Always at your side

From pre-sales support to after-sales service, SKF engineers stand ready to help you solve every problem in your bearing application. We offer detailed local technical consultations and product displays, and real-time condition monitoring and after-sales service during application. Backed by over 100 years of experience with bearings, SKF can help you tackle challenges with confidence.

Get all the benefits in one product



Higher speed requirements

12 000 r/min → 15 000 r/min

BT40 spindles have to operate at higher speeds when processing harder mold materials in order to achieve the required cutting speed. The intensifying demands for part surface finish and machining efficiency are driving a shift towards higher speeds and longer periods.



Higher thermal stability requirements

As the tools installed on a spindle machining a workpiece, the temperature rise within the spindle induces thermal deformation, causing dimensional alterations in the workpiece and compromising machining precision. Reducing heat generation and enhancing heat dissipation are critical requirements for controlling temperature rise in spindle and bearing systems.



Higher structural rigidity requirements

Forced vibrations occur in spindles because of material heterogeneity and external excitation sources. Enhanced dynamic stiffness of the spindle, i.e., higher natural frequencies, is essential for resisting deformation. While larger radial stiffness is typically required, enhanced axial stiffness is also imperative in drilling and milling operations in order to attain desirable machining precision under substantial axial loads.



Quiet running

The General Specifications for Metal-Cutting Machine Tools stipulate that the noise produced by a precision machine tool should not be louder than 85 dB(A). Irregular and intense impulsive noise can cause auditory discomfort to machine operators. It is a standard practice to subject machine tool spindles to no-load noise testing after they are assembled into machine tools.



Assembly fit and cleanliness

BT40 spindle bearings are typically arranged back-to-back. To improve the assembly efficiency and consistency of spindles, all spindle components within the same production batch must have higher interchangeability, which dictates the need for closer dimensional tolerances. This requirement extends to the bearing sets as well, meaning they should also have closer tolerances on their inside and outside diameter deviations.



Speed up to 15 000 r/min



Temperature rise $\leq 15\text{ }^{\circ}\text{C}$

 **Stiffness**
 $\geq 150 \text{ N}/\mu\text{m}$



 **Vibration acceleration**
 $\leq 0.4 \text{ g}$



Higher speed capability

Up to 15,000 r/min for hybrid bearings and 10,000 r/min for steel ball bearings

The higher speed capability of bearings is the result of optimized internal structural design, optimized cage structure and efficient lubrication. Optimized raceway design and cage structure can reduce friction, contributing to a stable running environment. Meanwhile, efficient lubrication reduces wear and enables high-speed operation.



Improved thermal stability

Temperature rise $\leq 15^\circ\text{C}$ for hybrid bearings and $\leq 18^\circ\text{C}$ for steel ball bearings

The thermal stability of bearings is optimized by high-quality heat treatment and efficient lubrication, which not only reduces deformation of bearings in service, but also improves heat generation under sliding friction. In addition, optimized lubrication design and cage structure further reduces the temperature rise and improves the thermal stability of bearings.



Superior bearing stiffness

The increased contact angle design with minimal dispersion enhances stiffness and improves stiffness consistency of the bearing. Optimized ball set design contributes to higher stiffness and uniform load distribution. Moreover, appropriate preload leads to optimum balance between higher stiffness and lower temperature rise, allowing the bearings to operate reliably.



Strict vibration and noise control

The P4B-class high-precision bearings can deliver higher running accuracy while significantly reducing vibration and noise. The cage design has been optimized to eliminate cage noise, so that the bearing can run smoothly with less vibration and noise.



Assembly fit

Consistent dimensional and running accuracy minimizes mounting errors and improves the operational accuracy. The load distribution is uniform, reducing local overloading and prolonging the service life of the bearing.

The bearing seal adopts a low friction design, and the outer ring deformation is minimized and the bearing precision is improved. The seal can effectively prevent the ingress of contaminants. Such design not only improves the efficiency but also extends the service life of the bearing.

Engineered for high-performance precision machining

The new-generation super-precision angular contact ball bearings feature innovative cage designs, which can enhance the speed capability while minimizing heat generation. Hence, the bearings can maintain reliable operation in various demanding applications.

Innovative cage structure

In most cases, the maximum speed of rolling bearings is limited by the lubrication conditions or cage design.

The SKF new generation of precision angular contact ball bearings incorporate innovative cage design and proprietary manufacturing process. These allow the bearings to withstand the most severe operating conditions. Moreover, different cage materials and designs are tailored to the operating characteristics of ceramic balls and steel balls during high-speed operation.

The optimized geometry of cage pockets significantly reduces the friction between pockets and rolling elements and the consequential heat generation. In addition, the optimum mass distribution minimizes cage deformation caused by centrifugal forces, thus improving the fatigue life of the cage.

Leveraging in-house simulation tools and test rigs, SKF has developed advanced cage design software in an effort to offer optimal cage designs. We take the Design of Experiments approach in material selection and pocket design, and achieved optimum trade-off between stiffness and elastic stability at high speeds, which has been fully verified through physical testing at various speeds.



Sealing solutions

Bearing seals prevent grease leakage and keep contaminants out. In high-speed operation, bearing seals play a critical role in preventing grease leakage. A precisely controlled clearance must be maintained between the seals and inner ring at all times to eliminate friction.

SKF's novel non-contact seals for the new-generation bearings are engineered specifically for excellent running performance at high speeds, ensuring that no additional friction occurs during operation.



From good to better

Better ceramic rolling elements

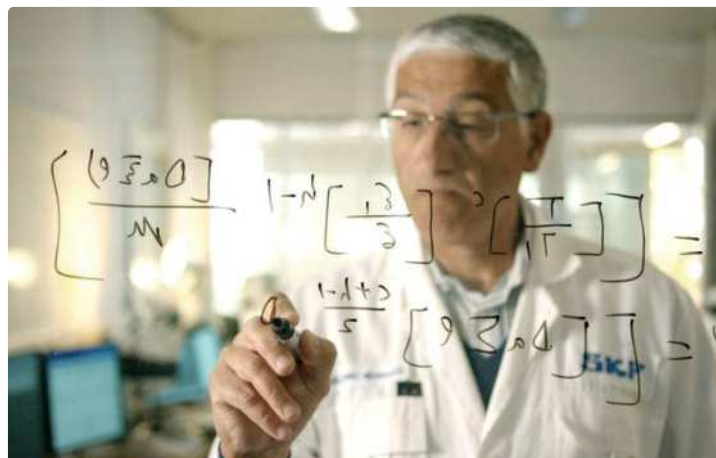
With a long presence in hybrid bearings, SKF possesses an experienced professional R&D team and excellent lean manufacturing capabilities. SKF tests its ceramic rolling elements on a 100% basis and follows evaluation criteria that are much stricter than the generally accepted standards to ensure excellent quality and zero defects of product delivery.



SKF GBLM for more accurate selection and life prediction of bearings

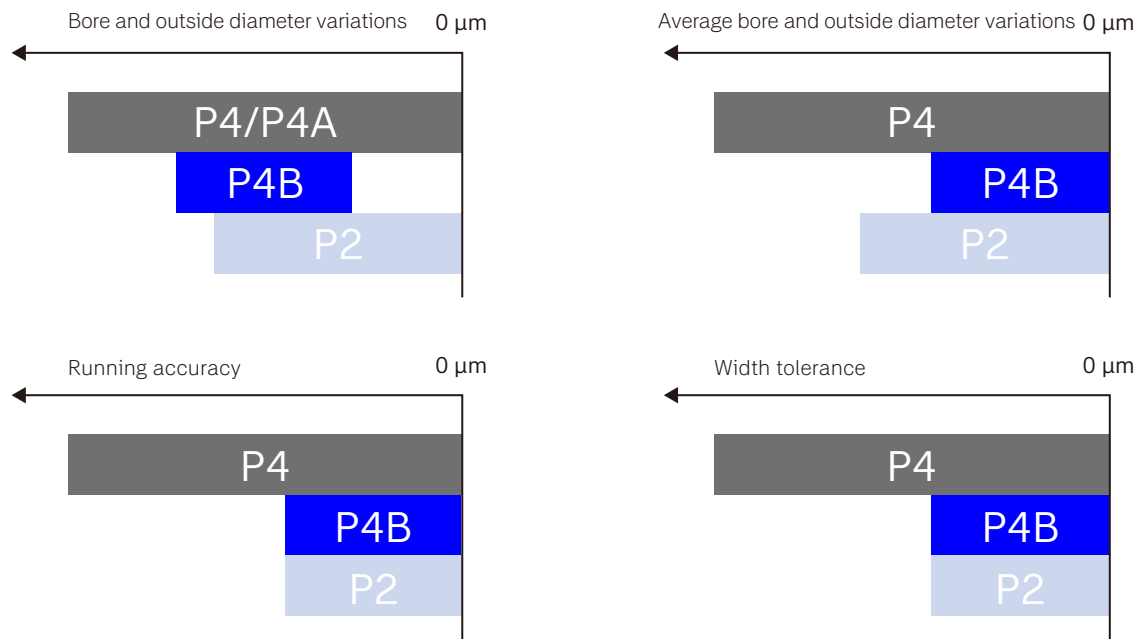
The failure causes of hybrid bearings are different from those of conventional steel bearings. Therefore, it would be extremely inaccurate to calculate the life of hybrid bearings using the typical rating life models, adversely affecting the bearing selection and life prediction by customers.

By virtue of its extensive experience in tribology and tests, SKF has created and improved the first rating life model that can predict the life of hybrid bearings realistically—SKF Generalized Bearing Life Model (GBLM). The model is intended to cope with today's demanding applications and more extensive product characteristics. By contacting our professional engineers, you will get access to detailed selection analysis and accurate life prediction, enabling you to confidently select the right product for your application.



Tailored to more severe challenges

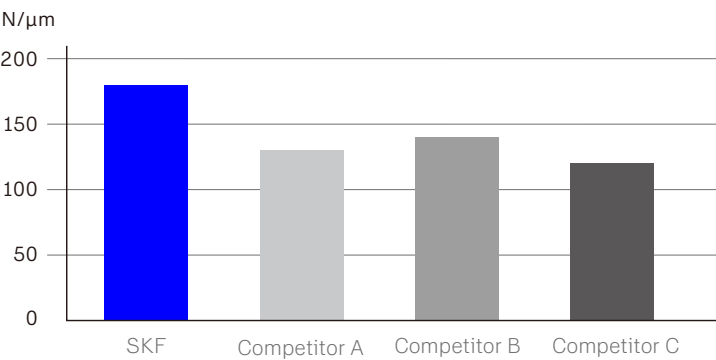
Enhanced precision



The relentless pursuit of machining efficiency improvement by machine tool users imposes new demands on bearing design and manufacturing. To ensure bearings deliver excellent performance during long periods of high-speed operation, SKF has redefined the precision classes for bearings. The P4B tolerance class, better than P4, is introduced, with certain precision metrics even exceeding the P2 tolerance class.

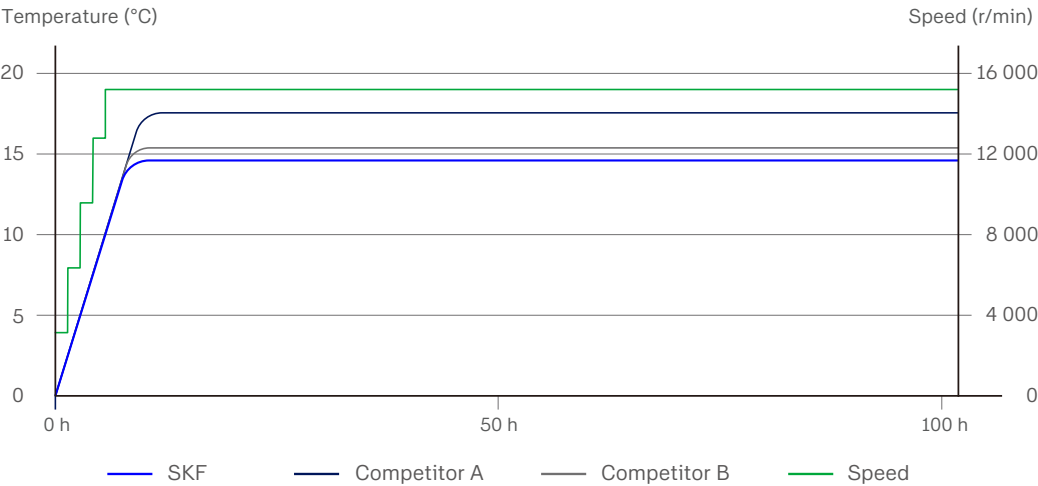
Superior bearing stiffness

The stiffness of bearings exerts a critical influence on both the machining precision and the service life of bearings. SKF's proprietary ball set configuration and contact angle design enhance bearing stiffness, with rigorously controlled contact angle dispersion improving the stiffness consistency.

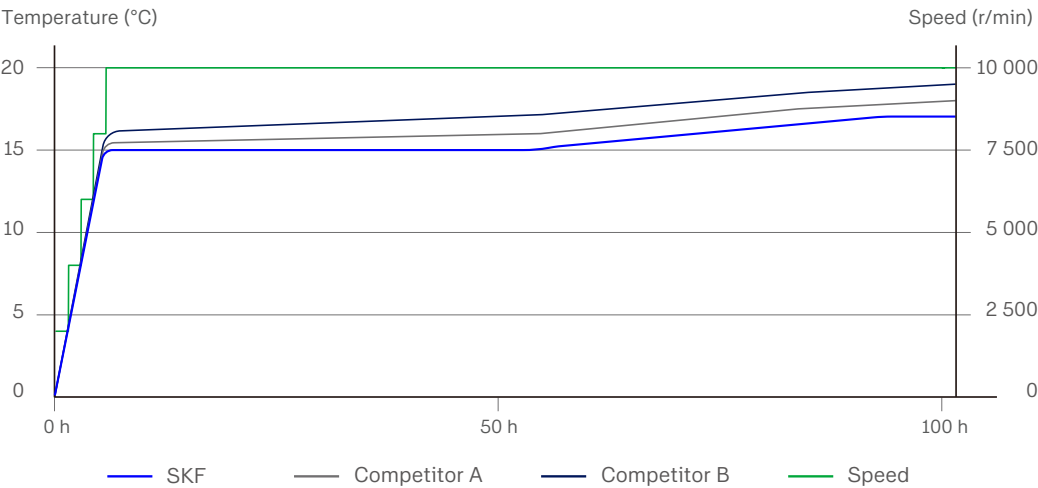


Temperature rise performance at high speeds

100-hour endurance test at 15 000 r/min



100-hour endurance test at 10 000 r/min



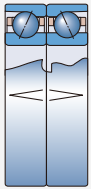
Benefiting from the optimized internal geometry and cage design, SKF's new-generation series can always meet customer requirements, as evidenced by the 15 000 rpm endurance test with ceramic balls and 10 000 rpm endurance test with steel balls. Also, it outperforms the competitors in thermal stability.

Tailored to more severe challenges

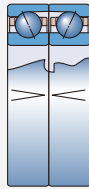
Bearing arrangements

Fig. 1

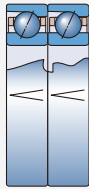
Bearing sets with two universally matchable bearings



Back-to-back arrangement



Face-to-face arrangement



Tandem arrangement

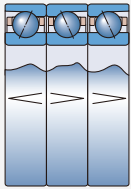
Bearing arrangements

SKF Silent Series super-precision angular contact ball bearings are available as single, universally matchable bearings.

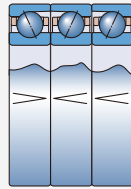
They are specifically manufactured so that, when mounted in a random order, but immediately adjacent to each other, preload within a predetermined range will result without the use of shims or similar devices.

The bearings have an optimized tolerance range on the bore and outside diameter, resulting in an improved load sharing across the bearings when mounted in sets (Fig. 1). This not only improves spindle efficiency, but means less time is spent during the validation and testing processes to select the appropriate bearings.

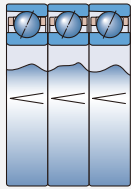
Bearing sets with three universally matchable bearings



Back-to-back and tandem arrangement

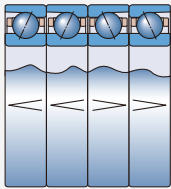


Face-to-face and tandem arrangement

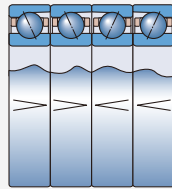


Tandem arrangement

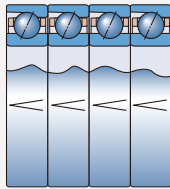
Bearing sets with four universally matchable bearings



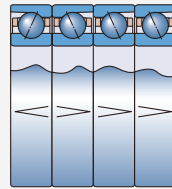
Tandem back-to-back arrangement



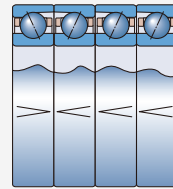
Tandem face-to-face arrangement



Tandem arrangement



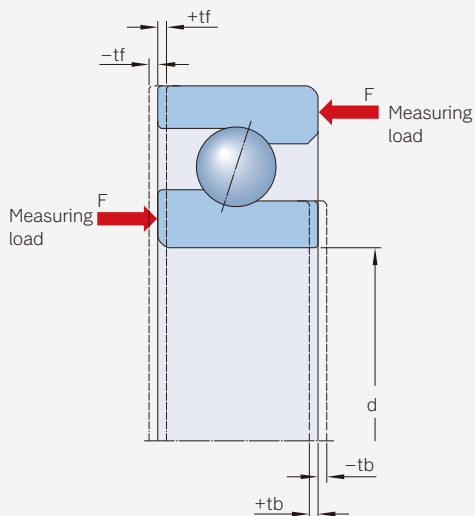
Back-to-back and tandem arrangement



Face-to-face and tandem arrangement

Stand-out value

Fig. 2



Stand-out value

An indication of stand-out value has recently been added to SKF single, universally matchable super-precision bearing markings and their package markings.

The stand-out value, where the stand-out of the back face t_b is practically equal to the stand-out of the front face t_f , defines the position of the side face of the inner ring with respect to the side face of the outer ring under measuring load F , which is equal to the preload class desired (Fig. 2). The values of t_b and t_f are close to zero when the measuring load is equivalent to the preload desired.

For back-to-back and face-to-face arrangements, bearings with the same stand-out value, but opposite signs, should be matched. For example, by combining bearings with stand-outs of -2 and $+2$, or -1 and $+1$, the sum of the stand-outs will be 0 . If different stand-outs are combined, for example, -1 and $+2$, the sum of the stand-outs will be $+1$, which will lead to slightly higher preload in the bearing set.

For tandem arrangements, bearings with the same stand-out value and the same negative or positive sign should be matched.

Designation system

Designation	Ring material	Rolling element material	Cage material
S7014 FEGAPNG / V058F1	SKF3	SKF3	Glass fiber reinforced PEEK
S7014 FEGA / HCGMM1V060	SKF3	SKFAC3 silicon nitride	Phenolic resin

Designation	S	7014	FE	GA	PNG	/	V058	F1
Seal								
Non-contact seal for high-speed applications								
Basic designation								
Bearing series		In accordance with ISO dimension series 10						
Bearing size		70 mm bore diameter						
Contact angle and design								
18° contact angle, high-capacity E design								
Execution								
Single, universally matchable bearing, light preload								
Cage								
Glass fiber reinforced PEEK cage								
Tolerance class and grease								
P4B								
L252 grease								
Grease fill								
Special grease fill								

Designation	S	7014	FE	GA	/	HC	GMM1	V060
Rolling element material								
Silicon nitride balls								
Grease and grease fill								
L252 grease, F1								
Tolerance class and cage								
P4B								
Phenolic resin cage for high-speed applications								



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