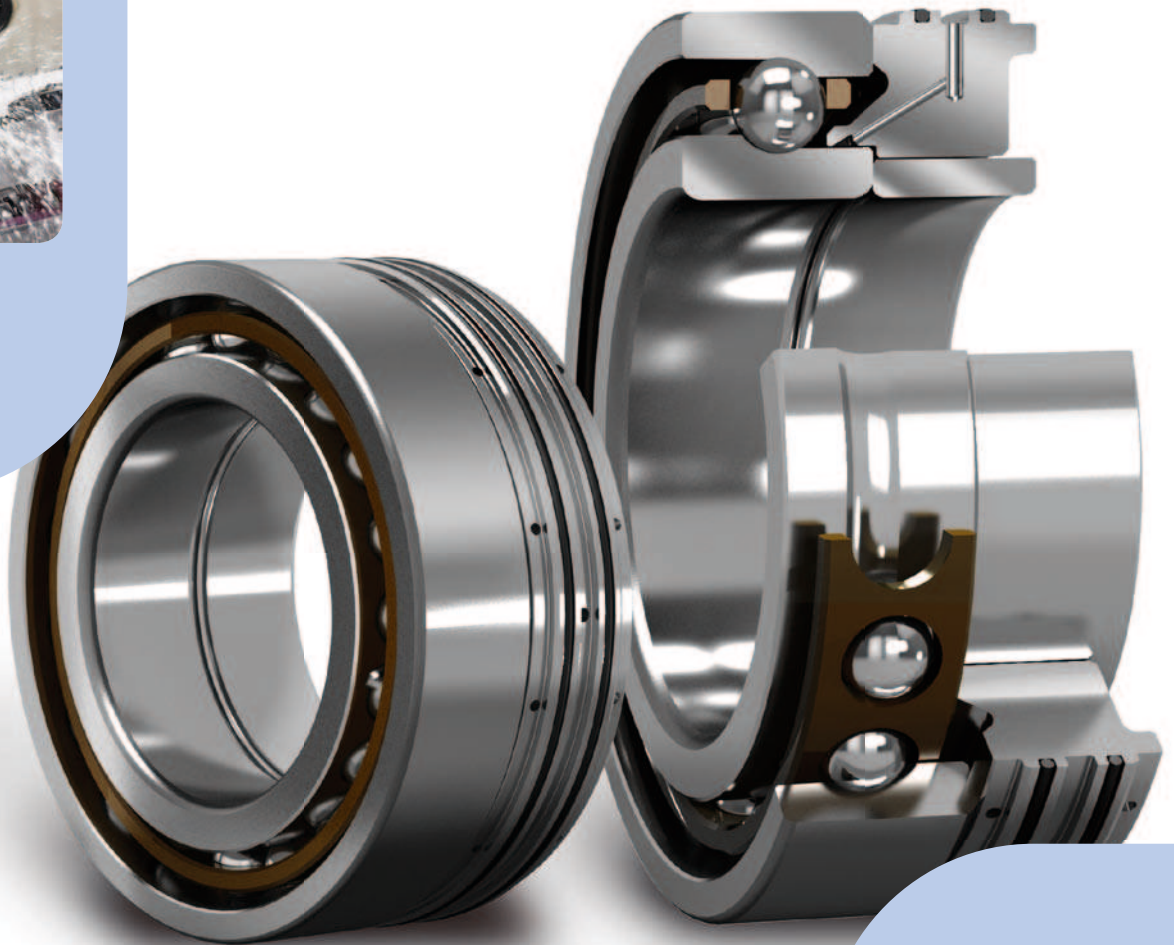


SKF Super-precision Bearing Lubrication Unit

Improved reliability, profitability and
reduced environmental impact



Benefit your business and the environ

To meet the ever-growing performance requirements of high-speed precision applications, SKF has developed the new Super-precision Bearing Lubrication Unit for use with oil-air lubrication in high-speed applications. This system can not only simplify new spindle designs but can also improve the performance of existing designs.

This highly effective solution improves lubricant flow and reduces frictional heating in the bearings, enabling them to operate at speeds up to approximately 2.5-3 million $n \cdot d_m$. By reducing the operating temperatures and improving oil-air flow, oil consumption and noise levels can also be reduced.

Advantages of oil-air lubrication

The rotational speed at which a bearing reaches its operating temperature limit depends primarily on the heat generated in the bearing (frictional heat) and the amount of heat that can be transferred away from the bearing. One way to reduce frictional heat, particularly in bearings, is to be sure that the correct quantity of the appropriate lubricant reaches all necessary components.

Many high speed applications can be lubricated with grease. However, as speeds and the resulting frictional heat increase, grease is typically replaced with an oil lubrication system.

Very high-speed applications generally require a precise lubricant delivery system: the precise amount of oil required to adequately lubricate the bearing is continuously delivered by the oil-air lubrication system, thus minimizing friction and operating temperature.

Oil-air lubrication system provides the following advantages:

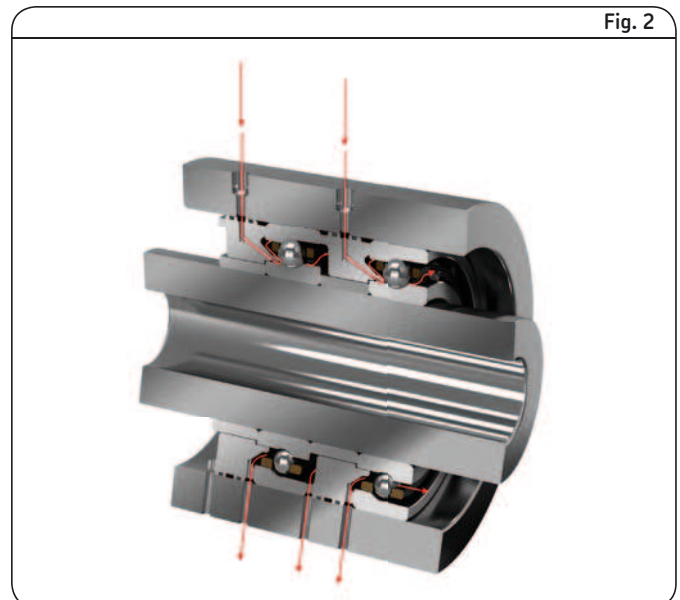
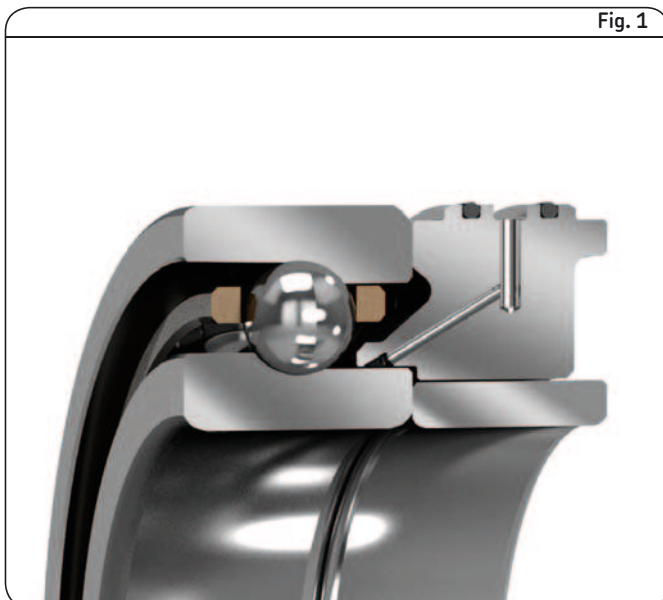
- increases the bearing attainable speed
- reduces friction torque and energy consumption
- reduces environmental impact
- reduces lubricant consumption
- maximizes the effectiveness of the lubricant
- positive pressure within the housing virtually eliminates the ingress of contaminants.

SKF's optimized design

An SKF Super-precision Bearing Lubrication Unit consists of a precision-ground steel spacer ring, a precision oil-air distribution ring and a super-precision angular contact ball bearing (→ **fig. 1**). Two O-rings on the outside surface of the oil-air distribution ring separate the inlet channel from outlet channels drilled into the housing.

The oil, transported by the flow of the compressed air (oil and air are not mixed), spirals along the feed lines and creeps toward the circumferential groove in the middle of the oil-air distribution ring and then into the inlet nozzle (→ **fig. 2**). The design of the nozzle further accelerates the oil flow directly to the contact surfaces inside the bearing.

The inlet channel design allows an increase of the air flow speed. Three outlet channels in the spindle housing, which are larger than the inlet, enable air to flow freely from the bearing and the housing.



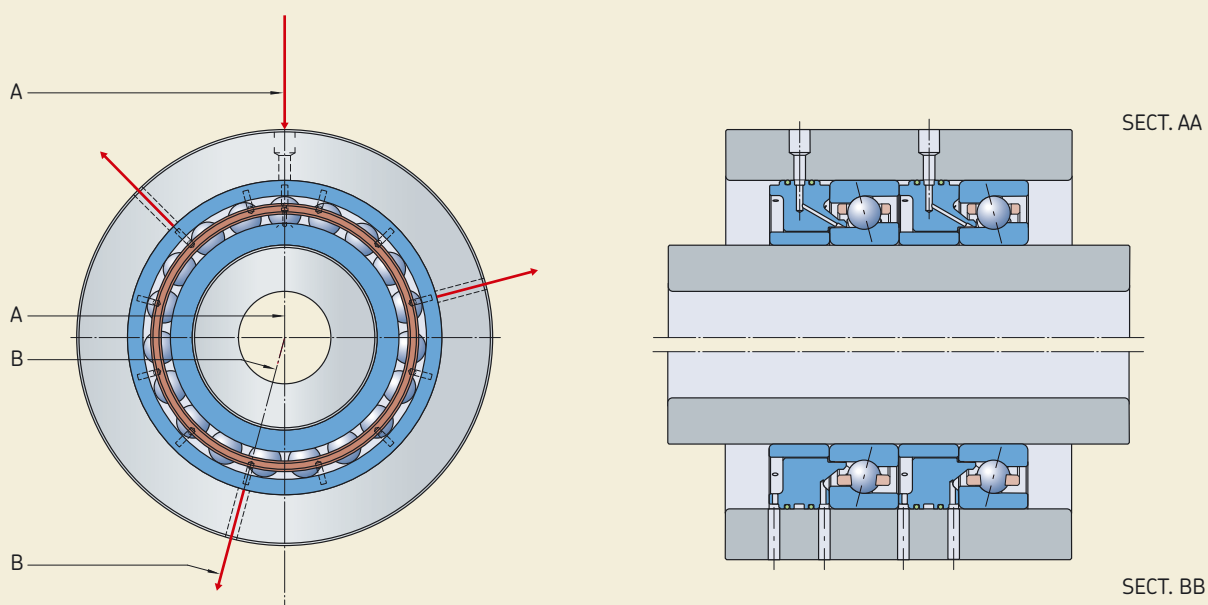
Lower operating temperatures

SKF compared the temperature rise of the SKF Super-precision Bearing Lubrication Unit to other commonly used alternatives (→ **diagram 1** on **page 6**).

The high-speed test results showed that the SKF Super-precision Bearing Lubrication Unit was able to reduce operating temperatures by 10 to 15 %.

Reduced noise levels

Reducing noise levels is one of the challenges for machine tool and other precision applications. The test results showed that the design of the SKF Super-precision Bearing Lubrication Unit substantially reduces noise levels (→ **diagram 2** on **page 6**).



Example of bearing arrangement

Improved performance and reliability

As a result of SKF's precise placement of the oil-air nozzle relative to the bearing, the cooling effect from the compressed air is optimized. This can stabilize operational preload within the bearing, further reduce frictional heat and maximize the effectiveness of the lubricant. The result: bearings can attain and even exceed their attainable speeds.

Safe, simple mounting

The SKF Super-precision Bearing Lubrication Unit is safe and simple to mount. Unlike other systems, there is no need to align the angular position of the lubrication unit with the inlet channel when assembling the spindle.

Another advantage is that O-ring grooves in the spindle housing are not necessary. This not only simplifies the spindle design but reduces machining costs.

Reduced lubricant consumption

The design of the nozzle and its positive contribution to the oil-air delivery system maximizes the effect of the lubricant. Therefore, less lubricant is needed to effectively lubricate the bearing.

Environmentally friendly

SKF Super-precision Bearing Lubrication Unit reduces the acoustic pollution decreasing the noise level. It also reduces the consumption of oil (allowing energy saving), resulting in a cleaner working environment.

Customer benefits

- Improved lubrication conditions
- Low noise levels
- Higher attainable speed
- Improved reliability
- Reduced oil consumption
- Reduced environmental impact
- Safe, easy assembly



Applications

SKF Super-precision Bearing Lubrication Units can extend bearing service life and allow increased operating speeds for high speed applications such as machining centres, milling machines, internal grinding machines and spindles for printed circuit boards drilling.

The unit works on high-speed spindles, with an air-oil lubrication system, in horizontal and vertical position.

The assortment

An SKF Super-precision Lubrication Unit consists of a set of precision-matched spacer rings and a super-precision high-speed single row angular contact ball bearing in the 70 .. E series (ISO 10 dimension series) with either a 15 or 18° contact angle.

Units are available for shaft diameters ranging from 30 to 70 mm.

All-steel bearings and hybrid bearings, which have steel rings and balls made of bearing grade silicon nitride, are available. As silicon nitride (ceramic) balls are considerably lighter and harder than steel balls, hybrid bearings can provide a higher degree of rigidity and run considerably faster than comparably sized all-steel bearings.

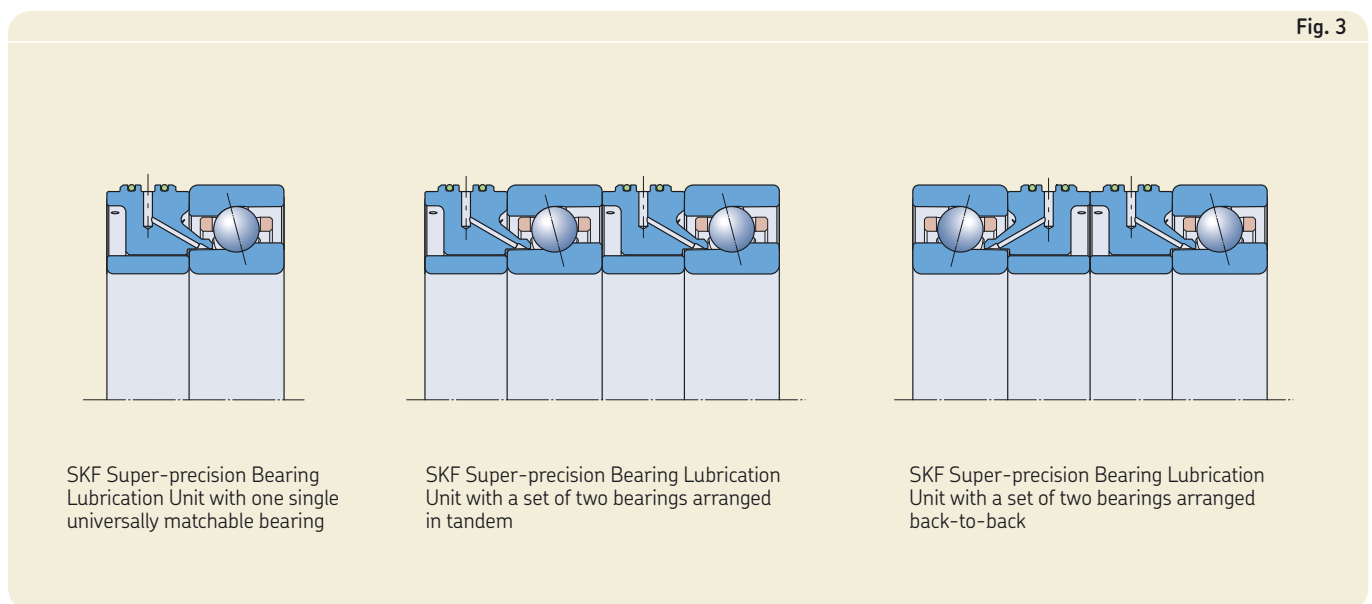
Unit arrangement design

SKF Super-precision Bearing Lubrication Units are designed exclusively for the following 70 .. E series bearing arrangements:

- single universally matchable bearing
- a set of two bearings arranged in tandem
- a set of two bearings arranged back-to-back

The possible configurations are shown in **fig. 3**.

Bearing arrangements can be of different types: single or tandem with spring preload, back-to-back with rigid preload.



Test results

High-speed tests were conducted to evaluate temperature rise versus speed and noise level.

Bearing types: hybrid super-precision angular contact ball bearings, high-speed E design, ISO 10 series, with a 15° contact angle in different executions

Bearing sizes: shaft diameter 40 mm

Different arrangements tested

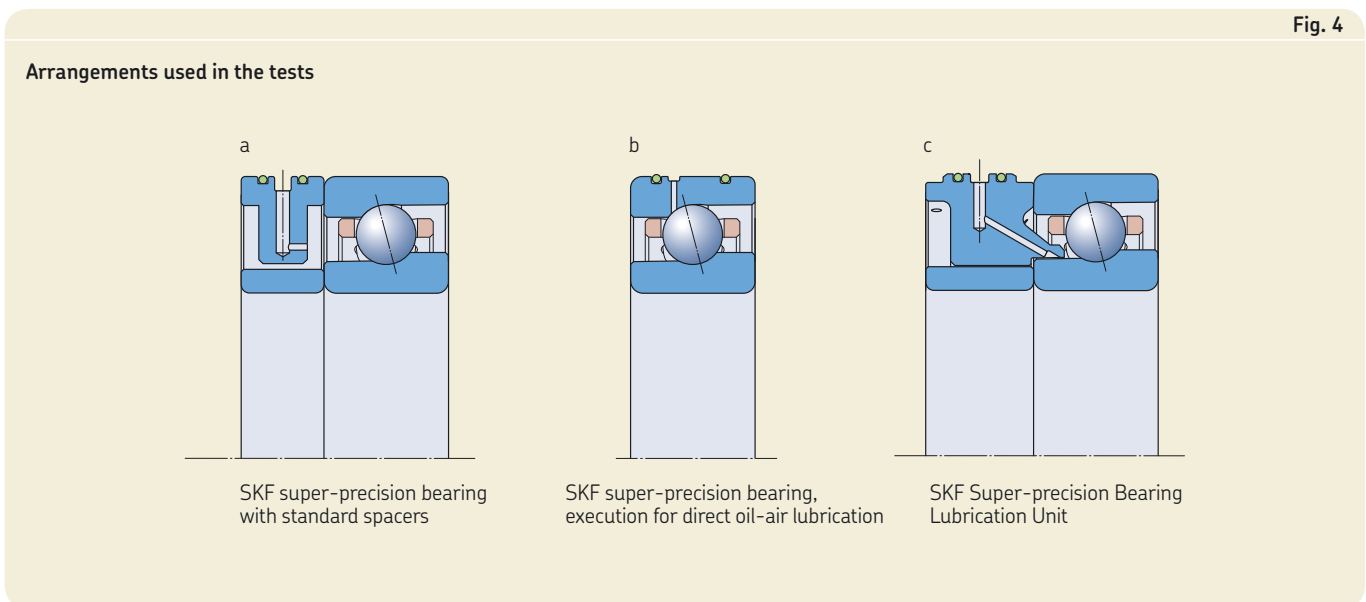
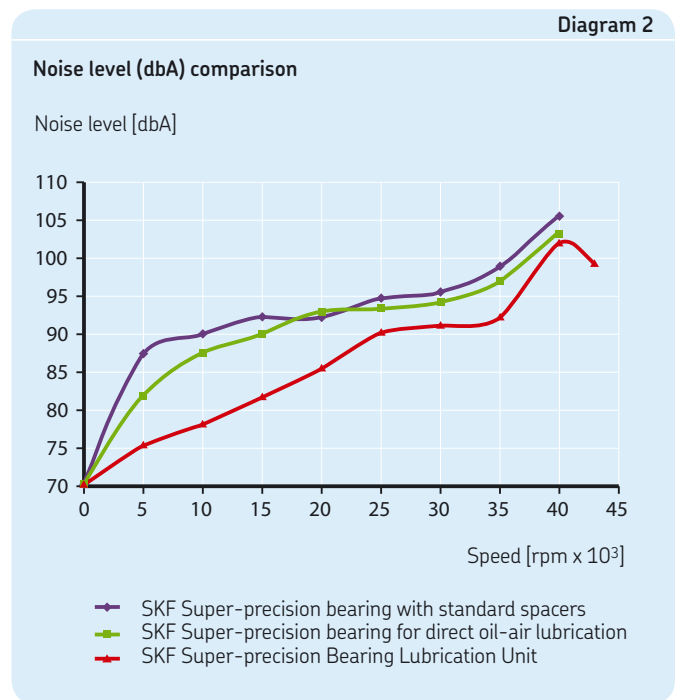
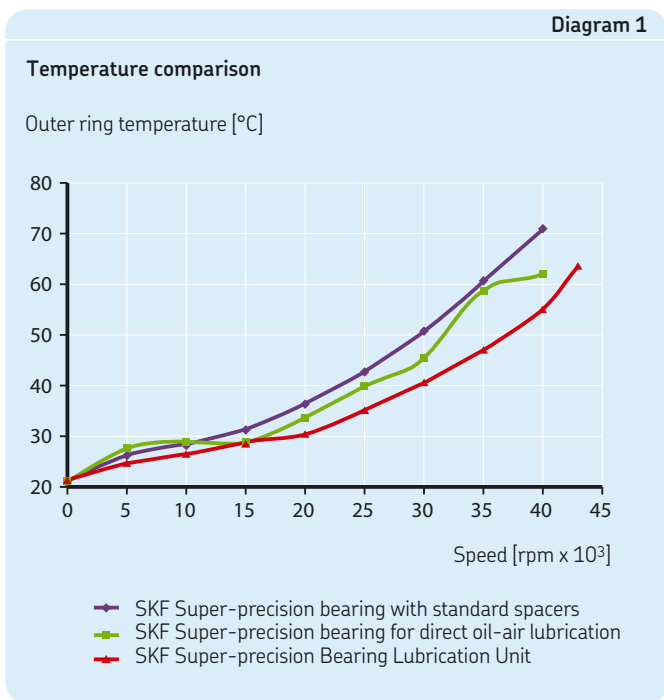
- sets of two bearings 7008 CEGA/HCP4AD8 (outer ring without seal grooves special execution, designation suffix D8), arranged back-to-back, mounted with spacer rings (→ fig. 4a);

- sets of two bearings for direct oil-air lubrication 7008 CEGA/HCP4AD8L1 (outer ring without seal grooves special execution, designation suffix D8) arranged back-to-back (no need of spacer rings: lubrication holes in the outer ring (designation suffix L1) enable the oil-air mix to be supplied very close to the ball/raceway contact areas) (→ fig. 4b);
- new Super-precision Bearing Lubrication Unit including sets of two bearings 7008 CEGA/HCP4AD8 (outer ring without seal grooves special execution, designation suffix D8) arranged back-to-back (→ fig. 4c)

Spring preload: 30 daN

Lubrication: oil-air system, ISO VG32 oil, 70 mm³/h

Inlet air-oil pressure: 3 bar



Designation system

The first part of the designation identifies the unit, the contact angle and the cage of the bearing, the bearing series and the bore diameter.

The second part of the designation follows the standard bearing rules and defines the balls material, the precision, the arrangement, the preload and the special features.

The designations for SKF Super-precision Bearing Lubrication Unit are provided in **table 1** together with their definitions.

Table 1

Designation system for SKF Super-precision Bearing Lubrication Unit

SKF Super-precision Bearing Lubrication Unit including a single universally matchable bearing
BUCN 7006 GA/HC

BU	C	N	70	06	GA	/	HC	-	-	
Design	Contact angle	Cage	Series	Size	Execution and preload (single bearing)		Ball material	Tolerance class	Arrangement	Preload

SKF Super-precision Bearing Lubrication Unit including a matched pair of bearings in back to back configuration
BUCN 7006/HCDBA

BU	C	N	70	06	-	/	HC	-	DB	A
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SKF Super-precision Bearing Lubrication Unit internal design

BU Bearing unit
high-speed E design bearing
O-ring included

Contact angle

C 15° contact angle
F 18° contact angle

Cage

N Fabric reinforced phenolic resin, outer ring centred
T Glass fibre reinforced PEEK, outer ring centred

Bearing series

70 In accordance with ISO dimension series 10

Bearing size

06 (x5) 30 mm bore diameter
to
14 (x5) 70 mm bore diameter

Execution and preload (single bearing)

GA Single, universally matchable, for light preload
GB Single, universally matchable, for medium preload
GC Single, universally matchable, for heavy preload

Ball material

- Carbon chromium steel (no designation suffix)
HC Bearing grade silicon nitride Si3N4 (hybrid bearings)

Bearing tolerance class

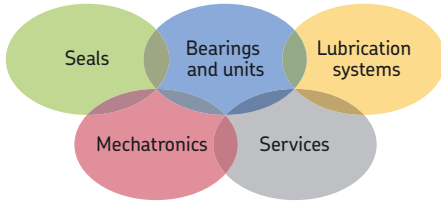
- Dimensional accuracy in accordance with ISO tolerance class 4, running accuracy better than ISO tolerance class 4 (no designation suffix)
PA9A Dimensional and running accuracy better than ABMA tolerance class ABEC 9

Bearing set – arrangement

DB Two bearings arranged back-to-back <>
DT Two bearings arranged in tandem <<

Bearing set – preload

A Light preload
B Medium preload
C Heavy preload
G... Special preload, expressed in daN e.g. G240



The Power of Knowledge Engineering

Drawing on five areas of competence and application-specific expertise amassed over more than 100 years, SKF brings innovative solutions to OEMs and production facilities in every major industry worldwide. These five competence areas include bearings and units, seals, lubrication systems, mechatronics (combining mechanics and electronics into intelligent systems), and a wide range of services, from 3-D computer modelling to advanced condition monitoring and reliability and asset management systems. A global presence provides SKF customers uniform quality standards and worldwide product availability.

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