

Super-precision angular contact ball bearings: 718 (SEA) series



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SKF super-precision angular contact ball bearings in the 718 (*SEA*) series

Machine tools and other precision applications require superior bearing performance. Extended speed capability, a high degree of running accuracy, high system rigidity, low heat generation, and low noise and vibration levels are just some of the performance challenges.

To meet the ever-increasing performance requirements of precision applications, SKF has developed a new generation of super-precision bearings. The new design super-precision angular contact ball bearings in the 718 (*SEA*)¹⁾ series are characterized by:

- high-speed capability
- high stiffness
- extended fatigue life
- easy mounting
- compact cross section

SKF super-precision angular contact ball bearings in the 718 (*SEA*) series provide optimum performance in applications where there is a need for high reliability and superior accuracy. The bearings are particularly suitable for machine tool applications, multi-spindle drilling heads, robotic arms and measuring devices.



¹⁾ Where applicable, designations in parentheses and italics refer to the corresponding SNFA equivalent.

The assortment

SKF super-precision angular contact ball bearings in the 718 (SEA) series are available standard as all-steel bearings and hybrid bearings. Both can accommodate shaft diameters ranging from 10 to 160 mm and are available with two contact angles.

Bearings in the 718 (SEA) series, like all angular contact ball bearings, are nearly always adjusted against a second bearing or used in sets to accommodate axial loads. Bearings suitable for mounting in sets are available in various preload classes. Matched bearing sets with a different preload can be supplied on request.

The design

SKF super-precision single row angular contact ball bearings in the 718 (SEA) series (→ **fig. 1**) are characterized by a symmetric inner ring and a non-symmetric outer ring, which enable the bearing to accommodate radial loads, and axial loads in one direction.

Some of the features of bearings in the 718 (SEA) series include:

- 15° and 25° contact angles
- a maximum number of balls
- a lightweight phenolic resin cage
- an optimized chamfer design

With two contact angles to choose from, designers can optimize their application based on axial load carrying capacity, speed capability and rigidity. Each bearing has the largest possible number of balls to provide the highest possible load carrying capacity.

The outer ring shoulder-guided cage is designed to enable sufficient lubricant to be supplied to the ball/raceway contact areas. The shape of the corner radius of the inner and outer rings (→ **fig. 2**) has been optimized for improved mounting accuracy. As a result, mounting is not only easier but there is also less risk of damage to associated components.

Bearing variants

Based on the operating conditions in precision applications, bearing requirements can vary. As a result, there are four variants of SKF super-precision angular contact ball bearings in the 718 (SEA) series to choose from.



Contact angles

Bearings in the 718 (SEA) series are produced as standard with (→ **fig. 3**):

- a 15° contact angle, designation suffix CD (1)
- a 25° contact angle, designation suffix ACD (3)

Bearings with a 25° contact angle are used primarily in applications requiring high axial rigidity or high axial load carrying capacity.

Ball materials

Standard bearings in the 718 (SEA) series are available with (→ **fig. 4**):

- steel balls, no designation suffix
- ceramic (silicon nitride) balls, designation suffix HC (NS)

As ceramic balls are considerably lighter and harder than steel balls, hybrid bearings can provide a higher degree of rigidity and run considerably faster than comparable all-steel bearings. The lower weight of the ceramic balls reduces the centrifugal forces within the bearing and generates less heat. Lower centrifugal forces are particularly important in machine tool applications where there are frequent rapid starts and stops. Less heat generated by the bearing means less energy consumption and longer lubricant service life.

Single bearings and matched bearing sets

SKF super-precision angular contact ball bearings in the 718 (SEA) series are available as:

- single, standard bearings
- single, universally matchable bearings
- matched bearing sets
- sets of universally matchable bearings

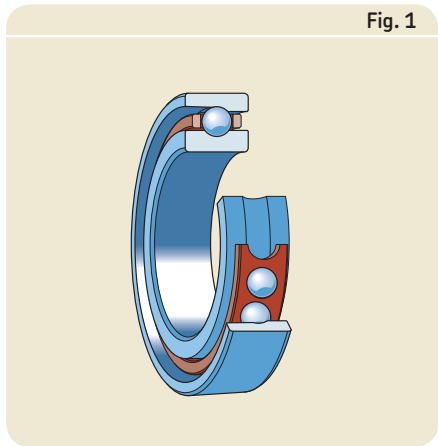


Fig. 1

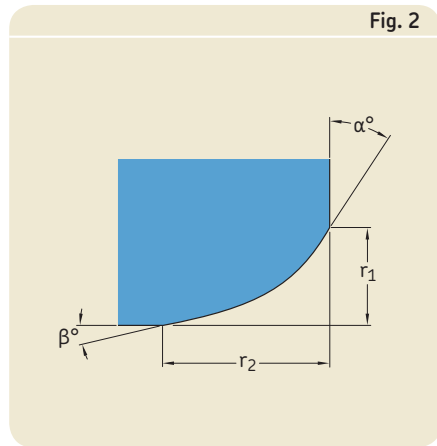


Fig. 2

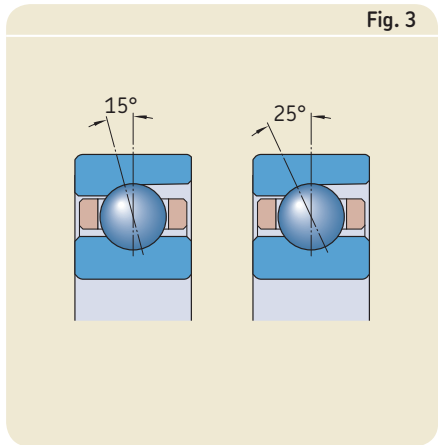


Fig. 3

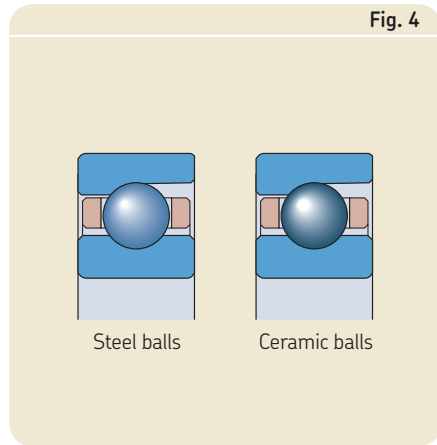


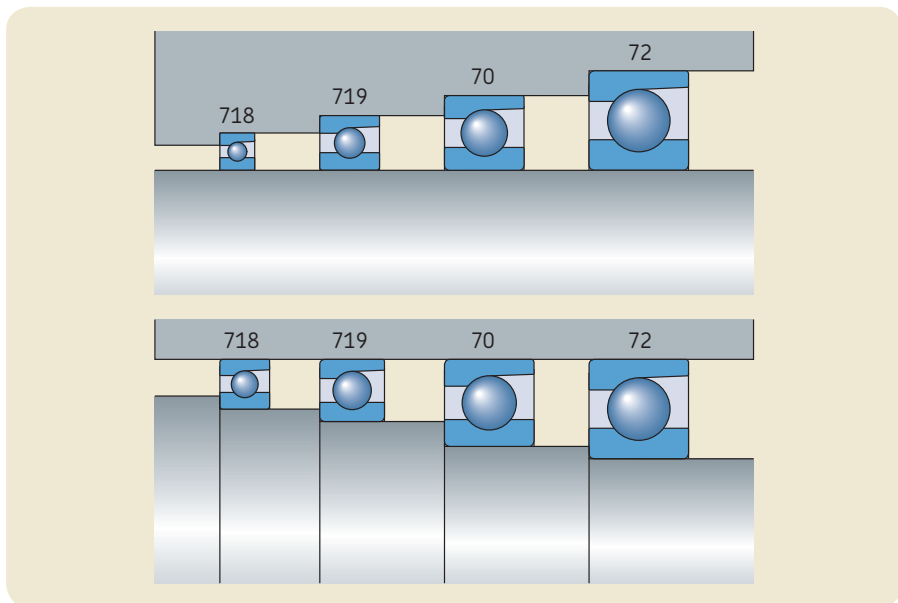
Fig. 4

Steel balls

Ceramic balls

Series comparison

Bearings in the 718 (SEA) series differ from high-precision angular contact ball bearings in other series mainly by their smaller cross section. For a given outside diameter, bearings in the 718 (SEA) series accommodate the largest shaft diameter and together with a larger number of small balls, rigidity is increased.



Applications

The assortment of SKF super-precision angular contact ball bearings in the 718 (SEA) series offers solutions for a variety of applications. Their ability to provide a high degree of rigidity and accommodate high speeds with extremely low runout can offer a variety of benefits to different applications.

By using the SKF logistics system, the bearings are available worldwide.

Applications

- Machine tools
- Robotics
- Printing
- Measuring systems
- Racing car wheels

Requirements

- High positioning accuracy
- Reliable positioning repeatability
- Low energy consumption
- Long service life
- Easy mounting
- Increased machine uptime
- High power density for compact designs

Solution





Bearing selection

Bearing selection is paramount when dealing with applications that require a high degree of accuracy at high speeds. The four variants of SKF super-precision angular contact ball bearings in the 718 (SEA) series are well suited to accommodate the conditions dictated by these applications.

The main criteria when selecting bearings in the 718 (SEA) series are:

- precision
- rigidity
- speed
- load

Precision

When dealing with rolling bearings, precision is described by tolerance classes for running and dimensional accuracy.

When selecting bearings in the 718 (SEA) series, the following should be considered:

- All bearing variants are manufactured to P4 (ABEC 7) tolerance class as standard.
- All bearing variants can be manufactured to the higher precision P2 (ABEC 9) tolerance class on request.

Rigidity

In precision applications, the rigidity of the bearing arrangement is extremely important, as the magnitude of elastic deformation under load determines the productivity and accuracy of the equipment. Although bearing stiffness contributes to system rigidity, there are other influencing factors such as the number and position of the bearings.

When selecting bearings in the 718 (SEA) series, the following should be considered:

- Silicon nitride balls provide a higher degree of stiffness than steel balls.
- A larger contact angle provides a higher degree of axial stiffness.
- Bearings mounted in a back-to-back arrangement provide the highest degree of rigidity.

- For matched bearing sets that are asymmetrical, preload classes A, B or C are preferred.

Speed

High-speed applications require cool running, low-friction bearings like angular contact ball bearings in the 718 (SEA) series.

When selecting bearings in this series, the following should be considered:

- In general, bearings lubricated with oil can operate at higher speeds than grease lubricated bearings.
- The attainable speeds of oil lubricated bearings vary, depending on the oil lubrication method.
- Hybrid bearings can operate at higher speeds than comparably sized all-steel bearings.
- With a larger contact angle, speed capability is decreased.
- For matched bearing sets that are asymmetrical, preload classes L, M or F are preferred.

Load

In high-speed precision applications, the load carrying capacity of a bearing is typically less important than in general engineering applications. Angular contact ball bearings can accommodate radial and axial loads acting simultaneously. When these combined loads exist, the direction of the load also plays an important role in the selection process.

When selecting bearings in the 718 (SEA) series, the following should be considered:

- A larger contact angle results in a higher axial load carrying capacity.
- The axial load carrying capacity of a bearing arrangement can be increased by adding bearings in tandem.



Bearing arrangement design

Bearing arrangements can be designed using single bearings or bearing sets. An example of the ordering possibilities for a three bearing arrangement is provided in **table 1** on **page 10**.

Single bearings

Single SKF super-precision angular contact ball bearings in the 718 (*SEA*) series are available as standard bearings or universally matchable bearings. When ordering single bearings, indicate the number of individual bearings required.

Standard bearings

Standard bearings are intended for arrangements where only one bearing is used in each bearing position.

Although the widths of the bearing rings in standard bearings are made to very tight tolerances, these bearings are not suitable for mounting immediately adjacent to each other.

Universally matchable bearings

Universally matchable bearings are specifically manufactured so that when mounted in random order, but immediately adjacent to each other, a given preload and/or even load distribution is obtained without the use of shims or similar devices. These bearings can be mounted in random order for any desired bearing arrangement.

Single, universally matchable bearings are available in three preload classes and carry the designation suffix G (*U*).

Bearing sets

SKF super-precision angular contact ball bearings in the 718 (*SEA*) series are available as matched bearing sets or as sets of universally matchable bearings. For bearing arrangements that are asymmetrical, matched bearing sets provide a greater number of possibilities for accommodating rigidity and speed requirements.

When ordering bearing sets, indicate the number of bearing sets required (the number of individual bearings per set is specified in the designation).

Matched bearing sets

Bearings can be supplied as a complete bearing set consisting typically of two, three or four bearings. The bearings are matched to each other during production so that when mounted immediately adjacent to each other in a specified order, a given preload and/or even load distribution is obtained without the use of shims or similar devices. The bore and outside diameters of these bearings are matched to within a maximum of one-third of the applicable permitted diameter tolerance, resulting in an even better load distribution when mounted, compared to single, universally matchable bearings.

Matched bearing sets are available in three preload classes for symmetrical arrangements and six preload classes for asymmetrical arrangements.

Sets of universally matchable bearings

The bearings in these sets can be mounted in random order for any desired bearing arrangement. The bore and outside diameters of universally matchable bearings in a set are matched to within a maximum of one-third of the applicable permitted diameter tolerance, resulting in an even better load distribution when mounted, compared to single, universally matchable bearings.

Sets of universally matchable bearings are available in three preload classes. Like single, universally matchable bearings, such sets carry the designation suffix G (*U*) but their positions in the designation differ (→ **table 1**, **page 10**).

Type of arrangement

Universally matchable bearings and matched bearing sets can be arranged in various combinations depending on the stiffness and axial load requirements. The possible combinations are shown in **fig. 1**, including the designation suffixes applicable to matched bearing sets.

Back-to-back bearing arrangement

In a back-to-back bearing arrangement, the load lines diverge toward the bearing axis. Axial loads acting in both directions can be accommodated, but only by one bearing or bearing set in one direction each. Bearings mounted back-to-back provide a relatively rigid bearing arrangement that can also accommodate tilting moments.

Face-to-face bearing arrangement

In a face-to-face bearing arrangement, the load lines converge toward the bearing axis. Axial loads acting in both directions can be accommodated, but only by one bearing or bearing set in one direction each. Face-to-face arrangements are not as rigid as back-to-back arrangements and are less able to accommodate tilting moments.

Tandem bearing arrangement

In a tandem bearing arrangement, the load lines are parallel so that radial and axial loads are shared equally by the bearings in the set. The bearing set can only accommodate axial loads acting in one direction. If axial loads act in the opposite direction, or if combined loads are present, additional bearing(s) adjusted against the tandem arrangement should be added.

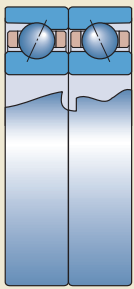
Table 1

Example of the ordering possibilities for a three bearing arrangement with light preload

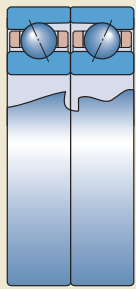
Design criteria	What to order	Designation ¹⁾	Order example
Bearing arrangement is not known	Three single, universally matchable bearings	718 ..DG../P4.. (SEA ..7 CE..U..)	3 × 71810 CDGA/P4 (3 × SEA50 7CE1 UL)
Bearing arrangement is not known and improved load distribution is desirable	A set of three universally matchable bearings	718 ..D/P4TG.. (SEA ..7 CE..TU..)	1 × 71810 CD/P4TGA (1 × SEA50 7CE1 TUL)
Bearing arrangement is known and high rigidity is required	Three bearings in a matched set	718 ..D/P4T.. (SEA ..7 CE..T..)	1 × 71810 CD/P4TBTA (1 × SEA50 7CE1 TD14,4DaN)
Bearing arrangement is known and high speed is required	Three bearings in a matched set	718 ..D/P4T.. (SEA ..7 CE..T..)	1 × 71810 CD/P4TBTL (1 × SEA50 7CE1 TDL)

¹⁾ For additional information about designations, refer to **table 15** on **pages 28** and **29**.

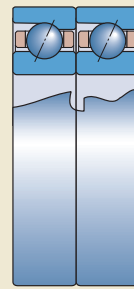
Bearing sets with 2 bearings



Back-to-back arrangement
Designation suffix DB (*DD*)

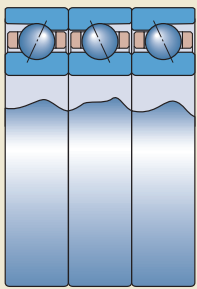


Face-to-face arrangement
Designation suffix DF (*FF*)

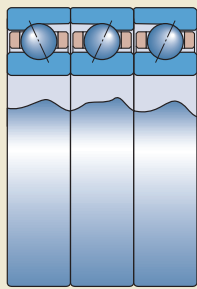


Tandem arrangement
Designation suffix DT (*T*)

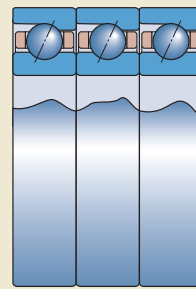
Bearing sets with 3 bearings



Back-to-back and tandem arrangement
Designation suffix TBT (*TD*)

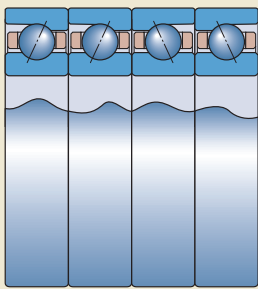


Face-to-face and tandem arrangement
Designation suffix TFT (*TF*)

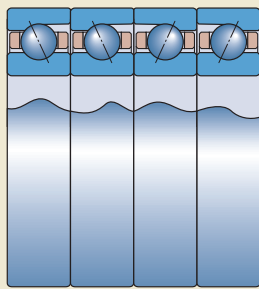


Tandem arrangement
Designation suffix TT (*3T*)

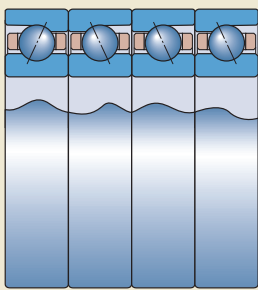
Bearing sets with 4 bearings



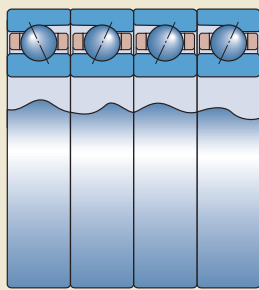
Tandem back-to-back arrangement
Designation suffix QBC (*TDT*)



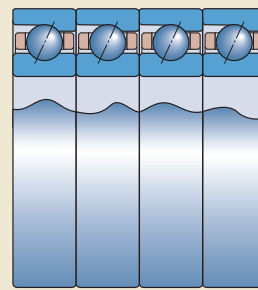
Tandem face-to-face arrangement
Designation suffix QFC (*TFT*)



Back-to-back and tandem arrangement
Designation suffix QBT (*3TD*)



Face-to-face and tandem arrangement
Designation suffix QFT (*3TF*)



Tandem arrangement
Designation suffix QT (*4T*)

Application examples

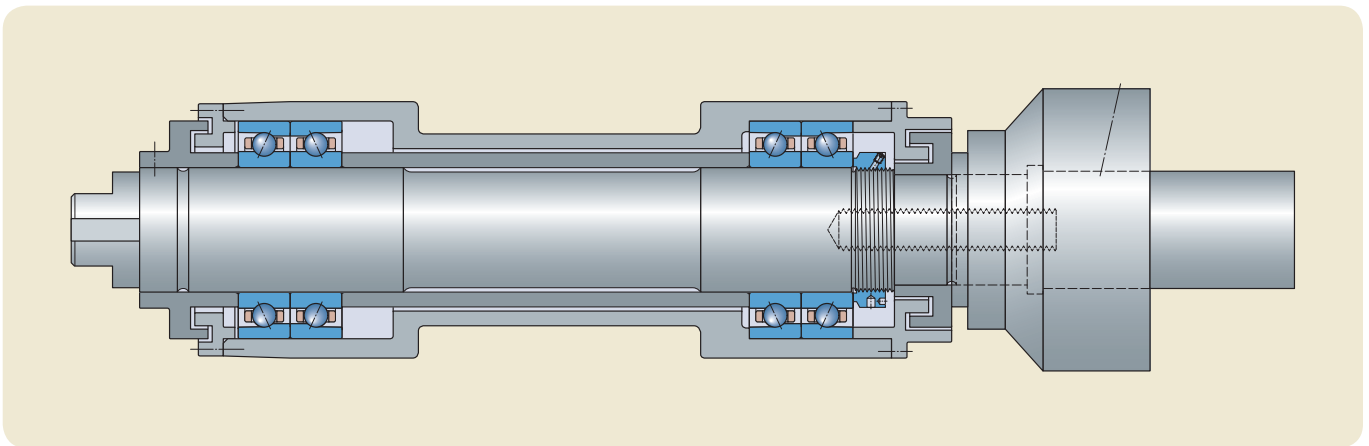
Super-precision angular contact ball bearings are common in, but not limited to, machine tool applications. Depending on the type of machine tool and its intended purpose, spindles may have different requirements regarding bearing arrangements. Lathe spindles, for example, are typically used to cut metals at relatively low speeds. Depth of cut and feed rates are usually pushed to the limit. A high degree of rigidity and high load carrying capacity are important operational requirements.

When higher speeds are demanded, as is the case for high-speed machining centres, milling operations and grinding applications, there is typically a compromise between rigidity and load carrying capacity. In these high-speed applications, controlling the heat generated by the bearings is an additional challenge.

For any precision application, there is an optimal arrangement to provide the best possible combination of rigidity, load carrying capacity, heat generation and bearing service life.

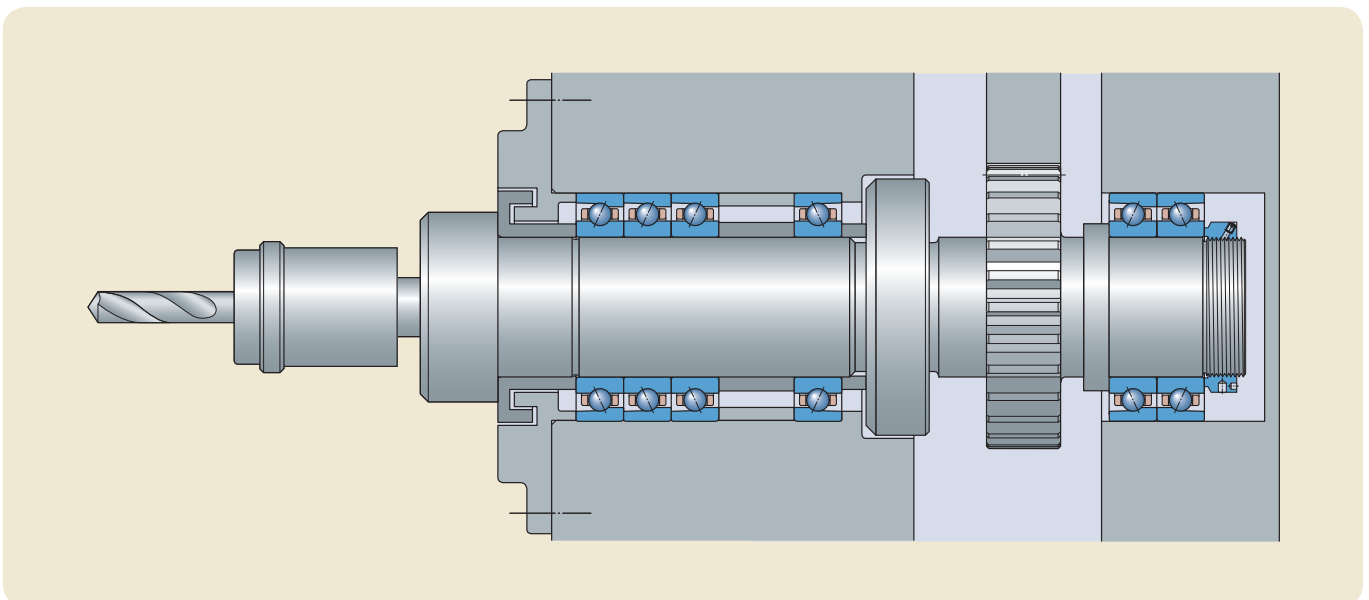
Tool holder sleeve

When space is limited and the loads are relatively light, two matched bearing sets of super-precision angular contact ball bearing pairs, e.g. 71801 ACD/P4DBB (SEA12 7CE3 DDM), are suitable.

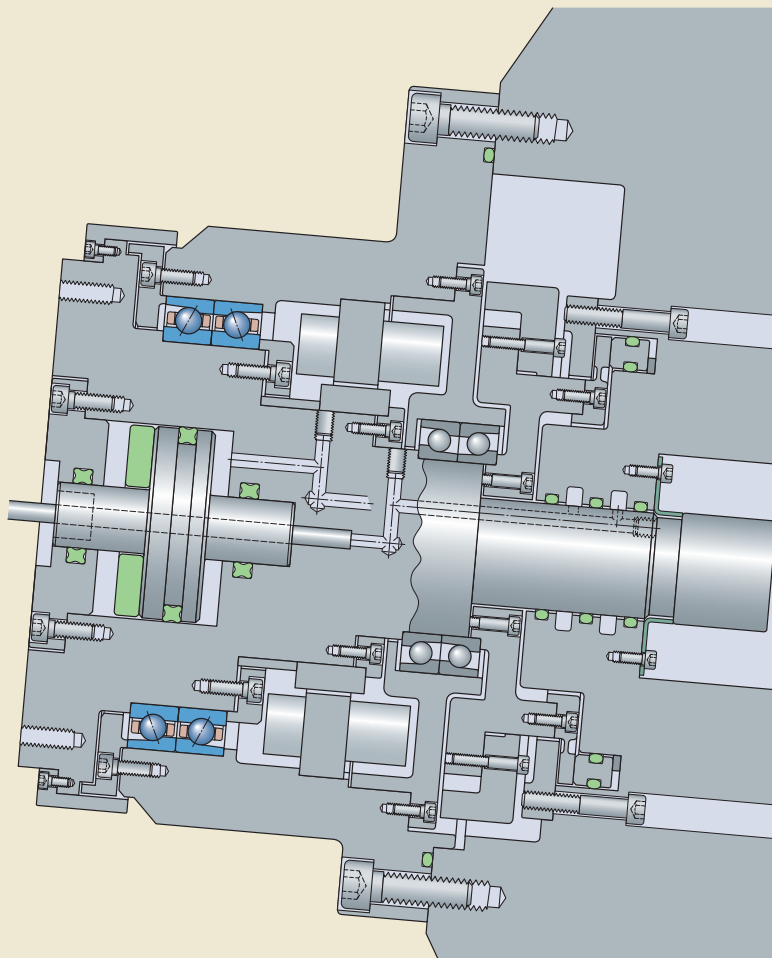


Multispindle drilling head

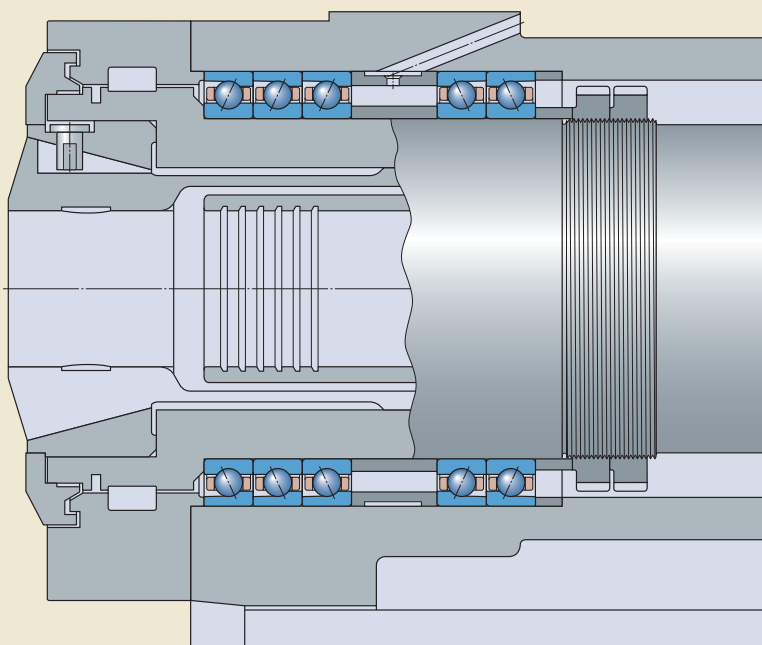
For multispindle drilling heads, where radial space is limited and axial rigidity is very important, super-precision angular contact ball bearings matched in a set of four bearings (arranged back-to-back and tandem), e.g. 71802 ACD/P4QBTA (SEA15 7CE3 3TD27,2DaN), incorporating a set of precision-matched spacer rings, can be used.



Grinding workhead
 In a grinding workhead, where rigidity is important and available space limited, a set of two super-precision angular contact ball bearings, e.g. 71824 ACD/P4DBB (SEA120 7CE3 DDM), are suitable.



Lathe spindle
 For lathe spindles with large bar diameter capacities, super-precision angular contact ball bearings matched as a set of five bearings, e.g. 71818 ACD/P4PBCB (SEA90 7CE3 3TDT45DaN), incorporating a set of precision-matched spacer rings, providing good rigidity, are used.



Lubrication

The choice of the lubricant and lubrication method for a particular application depends primarily on the operating conditions, such as permissible temperature or speed, but may also be dictated by the lubrication of adjacent components e.g. gear wheels.

For an adequate lubricant film to be formed between the balls and raceways, only a very small amount of lubricant is required. Therefore, grease lubrication for precision bearing arrangements is becoming increasingly popular. With grease lubrication, the hydrodynamic friction losses are small and operating temperatures can be kept to a minimum. However, where speeds are very high, the bearings should be lubricated with oil as the service life of grease is too short under such conditions and oil provides the added benefit of cooling.

Grease lubrication

In most applications with super-precision angular contact ball bearings, grease with a mineral base oil and lithium thickener is suitable. These greases adhere well to the bearing surfaces and can be used where temperatures range from -30 to $+100$ °C. For bearing

arrangements that run at very high speeds and temperatures, and where long service life is required, the use of grease based on synthetic oil, e.g. the diester oil based grease SKF LGLT 2, has been proven effective.

Initial grease fill

In high-speed applications, less than 30% of the free space in the bearings should be filled with grease. The initial grease fill depends on the bearing size as well as the speed factor, which is

$$A = n d_m$$

where

A = speed factor [mm/min]

n = rotational speed [r/min]

d_m = bearing mean diameter
= $0,5 (d + D)$ [mm]

The initial grease fill can be estimated from

$$G = K G_{ref}$$

where

G = initial grease fill [cm³]

K = a calculation factor dependent on the speed factor A (→ **diagram 1**)

G_{ref} = reference grease quantity (→ **table 1**) [cm³]

Table 1

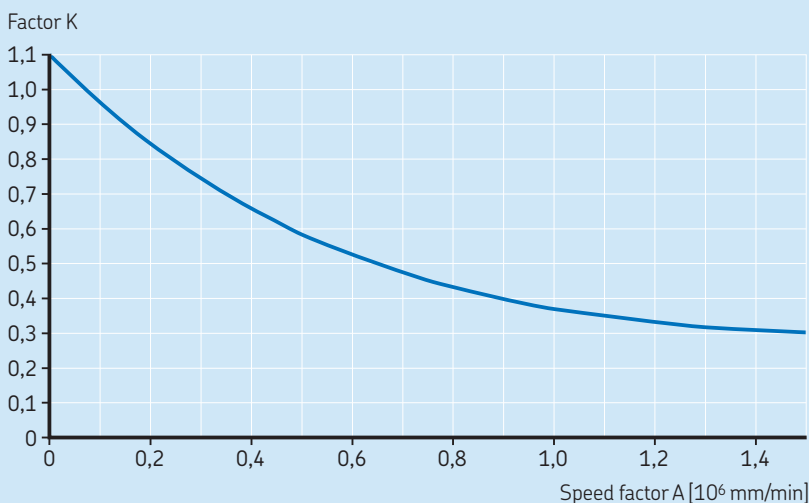
Reference grease quantity for initial grease fill estimation

Bearing Bore diameter d	Size	Reference grease quantity ¹⁾ G_{ref}
mm	–	cm ³
10	00	0,06
12	01	0,07
15	02	0,08
17	03	0,09
20	04	0,18
25	05	0,21
30	06	0,24
35	07	0,28
40	08	0,31
45	09	0,36
50	10	0,5
55	11	0,88
60	12	1,2
65	13	1,3
70	14	1,4
75	15	1,5
80	16	1,6
85	17	2,7
90	18	2,9
95	19	3,1
100	20	3,2
105	21	4
110	22	5,1
120	24	5,5
130	26	9,3
140	28	9,9
150	30	13
160	32	14

¹⁾ Refers to a 30% filling grade.

Diagram 1

Factor K for initial grease fill estimation



Running-in of grease lubricated bearings

A grease lubricated super-precision bearing in the 718 (SEA) series will initially run with a relatively high frictional moment. If the bearing is run at high speed without a running-in period, the temperature rise can be considerable. The relatively high frictional moment is due to the churning of the grease and it takes time for the excess grease to work its way out of the contact zone. This time period can be minimized by applying a small quantity of grease distributed evenly on both sides of the bearing during the assembly stage. Spacers between two adjacent bearings are also beneficial (→ *Individual adjustment of preload using spacer rings*, page 20).

The time required to stabilize the operating temperature depends on a number of factors – the type of grease, the initial grease fill, how the grease is applied to the bearings and the running-in procedure (→ **diagram 2**).

Super-precision bearings typically can operate with minimal lubricant quantity when properly run-in, enabling the lowest frictional moment and temperature to be

achieved. The grease that collects at the sides of the bearing will act as a reservoir and the oil will bleed into the raceways to provide efficient lubrication for a long time.

Running-in can be done in several ways. Wherever possible and regardless of the procedure chosen, running-in should involve operating the bearing in both a clockwise and anticlockwise direction.

The standard running-in procedure can be summarized as follows:

- 1 Select a low starting speed and a relatively small speed increment interval.
- 2 Decide on an absolute temperature limit, usually 60 to 65 °C. It is advisable to set the equipment with limit switches that will stop the equipment if the temperature rise exceeds the set limit.
- 3 Start operation at the chosen initial speed.
- 4 Monitor the temperature by taking measurements at the bearing outer ring position, avoiding peaks, and wait for it to stabilize. If the temperature reaches the limit, stop operation and allow the bearing to cool. Start again at the same speed and wait for the temperature to stabilize.

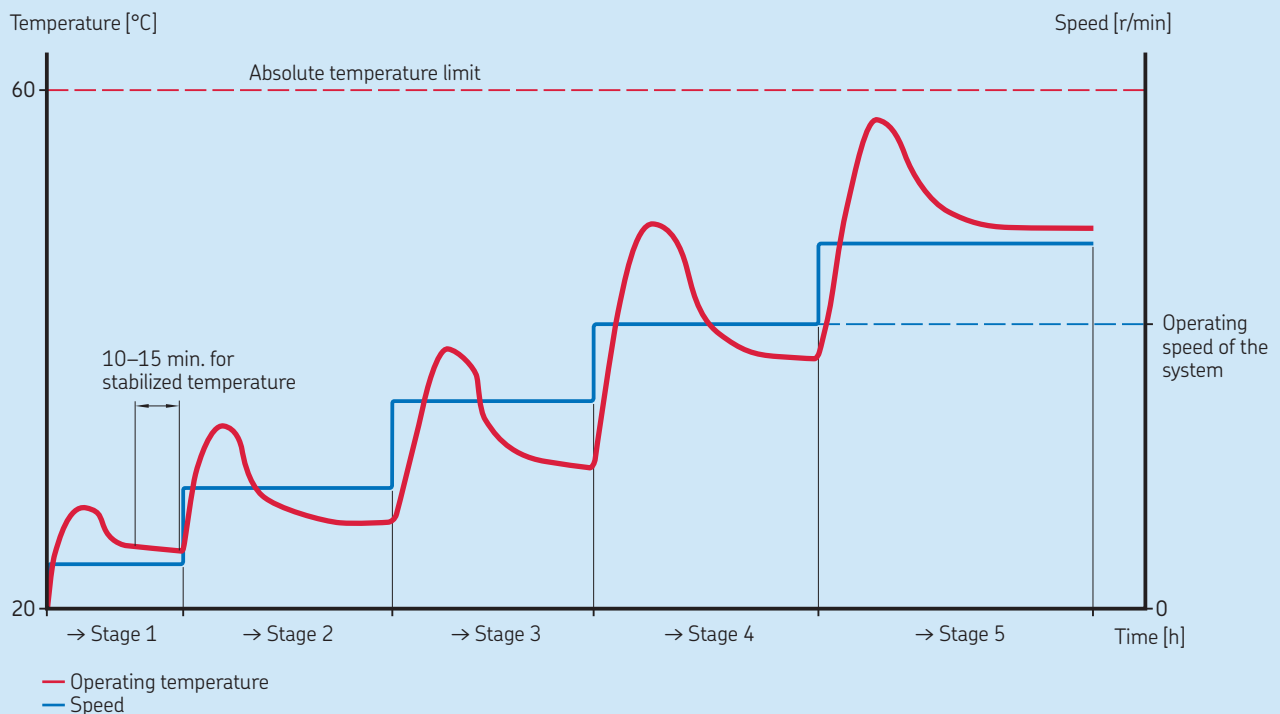
- 5 Increase the speed by one interval and repeat **step 4**.
- 6 Continue increasing the speed in intervals, allowing the temperature to stabilize below the limit at each stage. Proceed until this is achieved for one speed interval greater than the operating speed of the system. This results in a lower temperature rise during normal operation. The bearing is now properly run-in.

The standard running-in procedure is normally time-consuming and the total time for the running-in process could be as high as 8 to 10 hours.

The short running-in procedure reduces the number of stages. Although each stage may have to be repeated several times, each cycle is just a few minutes long, and the total time for this running-in process is substantially less than the standard procedure.

Diagram 2

Graphic representation of a running-in procedure



The main steps of the short running-in procedure can be summarized as follows:

- 1 Select a starting speed approximately 20 to 25% of the attainable speed and choose a relatively large speed increment interval.
- 2 Decide on an absolute temperature limit, usually 60 to 65 °C. It is advisable to set the equipment with limit switches that will stop the equipment if the temperature rise exceeds the limits set.
- 3 Start operation at the chosen initial speed.
- 4 Monitor the temperature by taking measurements at the bearing outer ring position until the temperature reaches the limit. Care should be taken as the temperature increase may be very rapid.
- 5 Stop operation and let the outer ring of the bearing cool down by 5 to 10 °C.
- 6 Start operation at the same speed a second time and monitor the temperature until the limit is reached again.
- 7 Repeat **steps 5 and 6** until the temperature stabilizes below the limit. When the temperature peak is lower than the alarm limit, the bearing is run-in at that particular speed.
- 8 Increase the speed by one interval and repeat **steps 4 to 7**.
- 9 Proceed until the bearing is running at one speed interval higher than the operating speed of the system. This results in a lower temperature rise during normal operation. The bearing is now properly run-in.

Oil lubrication

Oil lubrication is recommended for many applications, as the method of supply can be adapted to suit the operating conditions and design of the equipment.

Oil-air lubrication method

For typical arrangements with bearings in the 718 (SEA) series, the high operational speeds and requisite low operating temperatures generally require an oil-air lubrication system. With the oil-air method, also called the oil-spot method, accurately metered quantities of oil are directed at each individual bearing by compressed air. For bearings used in sets, each bearing is supplied by a separate oil injector. Most designs include spacers that incorporate the oil nozzles.

Guidelines for the quantity of oil to be supplied to each bearing for high-speed operation can be obtained from

$$Q = 1,3 d_m$$

where

$$Q = \text{oil flow rate [mm}^3/\text{h]}$$

$$d_m = \text{bearing mean diameter} \\ = 0,5 (d + D) [\text{mm}]$$

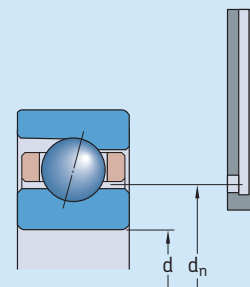
The calculated oil flow rate should be verified during operation and adjusted depending on the resulting temperatures.

Oil is supplied to the feed lines at given intervals by a metering unit. The oil coats the inside surface of the feed lines and “creeps” toward the nozzles, where it is delivered to the bearings. The oil nozzles should be positioned correctly (→ **table 2**) to make sure that the oil can be introduced into the contact area between the balls and raceways and to avoid interference with the cage.

High quality lubricating oils without EP additives are generally recommended for super-precision angular contact ball bearings. Oils with a viscosity of 40 to 100 mm²/s at 40 °C are typically used. A filter that prevents particles > 5 µm from reaching the bearings should also be incorporated.

Table 2

Oil nozzle positions for oil-air lubrication



Bearing Bore diameter d	Size	Oil nozzle position d _n
mm	–	mm
10	00	13,4
12	01	15,4
15	02	18,4
17	03	20,4
20	04	24,5
25	05	29,5
30	06	34,5
35	07	39,5
40	08	44,5
45	09	50,0
50	10	55,6
55	11	61,3
60	12	66,4
65	13	72,4
70	14	77,4
75	15	82,4
80	16	87,4
85	17	94,1
90	18	99,1
95	19	104,1
100	20	109,1
105	21	114,6
110	22	120,9
120	24	130,9
130	26	144,0
140	28	153,2
150	30	165,6
160	32	175,6

Bearing data – general

Dimensions

The boundary dimensions of SKF super-precision angular contact ball bearings in the 718 (SEA) series for dimension series 18 are in accordance with ISO 15:2011.

Chamfer dimensions

Minimum values for the chamfer dimensions in the radial direction (r_1, r_3) and the axial direction (r_2, r_4) are provided in the product tables. The values for the chamfers of the inner ring and thrust side of the outer ring are in accordance with ISO 15:2011; the values for the non-thrust side of the outer ring are not standardized.

The appropriate maximum chamfer limits are in accordance with ISO 582:1995.

Tolerances

SKF super-precision angular contact ball bearings in the 718 (SEA) series are made to P4 tolerance class, in accordance with ISO 492:2002, as standard. On request, bearings can be supplied to the higher precision P2 tolerance class.

The tolerance values are listed as follows:

- P4 (ABEC 7) tolerance class in **table 1**
- P2 (ABEC 9) tolerance class in **table 2** on **page 18**

Table 1

Class P4 (ABEC 7) tolerances

Inner ring		Δ_{dmp}		Δ_{ds}		V_{dp}	V_{dmp}	Δ_{Bs}		Δ_{B1s}		V_{Bs}	K_{ia}	S_d	S_{ia}
d	incl.	high	low	high	low	max	max	high	low	high	low	max	max	max	max
mm		μm		μm		μm	μm	μm		μm		μm	μm	μm	μm
2,5	10	0	-4	0	-4	4	2	0	-40	0	-250	2,5	2,5	3	3
10	18	0	-4	0	-4	4	2	0	-80	0	-250	2,5	2,5	3	3
18	30	0	-5	0	-5	5	2,5	0	-120	0	-250	2,5	3	4	4
30	50	0	-6	0	-6	6	3	0	-120	0	-250	3	4	4	4
50	80	0	-7	0	-7	7	3,5	0	-150	0	-250	4	4	5	5
80	120	0	-8	0	-8	8	4	0	-200	0	-380	4	5	5	5
120	150	0	-10	0	-10	10	5	0	-250	0	-380	5	6	6	7
150	180	0	-10	0	-10	10	5	0	-250	0	-380	5	6	6	7
Outer ring		Δ_{Dmp}		Δ_{Ds}		V_{Dp}	V_{Dmp}	Δ_{Cs}		Δ_{C1s}		V_{Cs}	K_{ea}	S_D	S_{ea}
D	incl.	high	low	high	low	max	max	high	low	high	low	max	max	max	max
mm		μm		μm		μm	μm	μm		μm		μm	μm	μm	μm
18	30	0	-5	0	-5	5	2,5	0	-120	0	-250	2,5	4	4	5
30	50	0	-6	0	-6	6	3	0	-120	0	-250	2,5	5	4	5
50	80	0	-7	0	-7	7	3,5	0	-150	0	-250	3	5	4	5
80	120	0	-8	0	-8	8	4	0	-200	0	-380	4	6	5	6
120	150	0	-9	0	-9	9	5	0	-250	0	-380	5	7	5	7
150	180	0	-10	0	-10	10	5	0	-250	0	-380	5	8	5	8
180	250	0	-11	0	-11	11	6	0	-300	0	-500	7	10	7	10

Bearing preload

Preload in bearings prior to mounting

To meet the varying requirements regarding rotational speed and rigidity, bearings in the 718 (SEA) series are produced to different preload classes. In applications where a high degree of rigidity is more important than a high operational speed, the following preload classes are available:

- class A, light preload
- class B, moderate preload
- class C, heavy preload

These preload classes are valid for:

- single, universally matchable bearings
- sets of universally matchable bearings
- all matched bearing sets

The preload level depends on the contact angle, the inner geometry and the size of the bearing and applies to bearing sets with two bearings arranged back-to-back or face-to-face as listed in **table 3**.

Bearing sets consisting of three or four bearings, and preloaded according to preload classes A, B and C, have a heavier preload than sets with two bearings. The preload for these bearing sets is obtained by multiplying the values listed in **table 3** by a factor of:

- 1,35 for TBT (TD) and TFT (TF) arrangements
- 1,6 for QBT (3TD) and QFT (3TF) arrangements
- 2 for QBC (TDT) and QFC (TFT) arrangements

In applications where a high operational speed is more important than a high degree of rigidity, the following additional preload classes are available:

- class L, reduced light preload for asymmetrical bearing sets
- class M, reduced moderate preload for asymmetrical bearing sets
- class F, reduced heavy preload for asymmetrical bearing sets

These preload classes are only available for matched bearing sets that are asymmetrical i.e. for TBT (TD), TFT (TF), QBT (3TD) and QFT (3TF) arrangements. In these cases, due to the higher speed capability and lower degree of rigidity, matched bearing sets consisting of three or four bearings have the same preload as sets with two bearings of similar preload class. The preload for matched bearing sets that are asymmetrical for TBT (TD), TFT (TF), QBT (3TD) and QFT (3TF) arrangements can therefore be obtained from **table 3**.

Bearing sets with a special preload can be supplied on request. These bearing sets are identified by the designation suffix G followed by a number. The number is the mean preload value of the set expressed in daN. Special preload is not applicable for sets of universally matchable bearings consisting of three or more bearings (suffixes TG and QG).

Table 2

Class P2 (ABEC 9) tolerances

Inner ring		Δ_{dmp}		Δ_{ds}		V_{dp}	V_{dmp}	Δ_{Bs}		Δ_{B1s}		V_{Bs}	K_{ia}	S_d	S_{ia}
over	incl.	high	low	high	low	max	max	high	low	high	low	max	max	max	max
mm		μm		μm		μm	μm	μm		μm		μm	μm	μm	μm
2,5	10	0	-2,5	0	-2,5	2,5	1,5	0	-40	0	-250	1,5	1,5	1,5	1,5
10	18	0	-2,5	0	-2,5	2,5	1,5	0	-80	0	-250	1,5	1,5	1,5	1,5
18	30	0	-2,5	0	-2,5	2,5	1,5	0	-120	0	-250	1,5	2,5	1,5	2,5
30	50	0	-2,5	0	-2,5	2,5	1,5	0	-120	0	-250	1,5	2,5	1,5	2,5
50	80	0	-4	0	-4	4	2	0	-150	0	-250	1,5	2,5	1,5	2,5
80	120	0	-5	0	-5	5	2,5	0	-200	0	-380	2,5	2,5	2,5	2,5
120	150	0	-7	0	-7	7	3,5	0	-250	0	-380	2,5	2,5	2,5	2,5
150	180	0	-7	0	-7	7	3,5	0	-250	0	-380	4	5	4	5
Outer ring		Δ_{Dmp}		Δ_{Ds}		V_{Dp}	V_{Dmp}	Δ_{Cs}		Δ_{C1s}		V_{Cs}	K_{ea}	S_D	S_{ea}
over	incl.	high	low	high	low	max	max	high	low	high	low	max	max	max	max
mm		μm		μm		μm	μm	μm		μm		μm	μm	μm	μm
18	30	0	-4	0	-4	4	2	0	-120	0	-250	1,5	2,5	1,5	2,5
30	50	0	-4	0	-4	4	2	0	-120	0	-250	1,5	2,5	1,5	2,5
50	80	0	-4	0	-4	4	2	0	-150	0	-250	1,5	4	1,5	4
80	120	0	-5	0	-5	5	2,5	0	-200	0	-380	2,5	5	2,5	5
120	150	0	-5	0	-5	5	2,5	0	-250	0	-380	2,5	5	2,5	5
150	180	0	-7	0	-7	7	3,5	0	-250	0	-380	2,5	5	2,5	5
180	250	0	-8	0	-8	8	4	0	-350	0	-500	4	7	4	7

Preload in mounted bearing sets

Universally matchable bearings and matched bearing sets have a heavier preload when mounted than when unmounted. The increase in preload depends mainly on:

- the actual tolerances for the bearing seats on the shaft and in the housing bore
- the rotational speed of the shaft, if the bearings are pressed against each other

An increase in preload can, among other things, also be caused by:

- temperature differences between the inner ring, outer ring and balls
- different coefficient of thermal expansion for the shaft and housing materials
- deviations from the geometrical form of associated components such as cylindricality, perpendicularity or concentricity of the bearing seats

If the bearings are mounted with the usual fits (js4 shaft tolerance and JS5 housing bore tolerance for bearings manufactured to P4 tolerance class) on a steel shaft and in a thick-walled steel or cast iron housing, preload can be determined with sufficient accuracy from

$$G_m = f f_1 f_2 f_{HC} G_{A,B,C}$$

where

G_m = preload in the mounted bearing set [N]

$G_{A,B,C}$ = preload in the bearing set prior to mounting (→ table 3) [N]

f = a bearing factor dependent on the bearing size (→ table 4, page 20)

f_1 = a correction factor dependent on the contact angle (→ table 5, page 20)

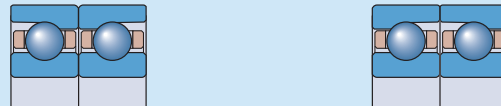
f_2 = a correction factor dependent on the preload class (→ table 5, page 20)

f_{HC} = a correction factor for hybrid bearings (→ table 5, page 20)

Considerably tighter fits may be necessary, for example for very high speed spindles, where the centrifugal forces can loosen the inner ring from its seat on the shaft. These bearing arrangements must be carefully evaluated.

Table 3

Axial preload of single, universally matchable bearings and matched bearing pairs prior to mounting, arranged back-to-back or face-to-face



Bearing Bore diameter	Size	Axial preload of bearings in the series 718 ACD (SEA CE3) 718 ACD/HC (SEA/NS CE3) for preload class			718 CD (SEA CE1) 718 CD/HC (SEA/NS CE1) for preload class		
		A	B	C	A	B	C
d	–	N					
mm							
10	00	16	48	100	10	30	60
12	01	17	53	105	11	33	66
15	02	19	58	115	12	36	72
17	03	20	60	120	12	37	75
20	04	32	100	200	20	60	120
25	05	35	105	210	22	66	132
30	06	37	110	220	23	70	140
35	07	39	115	230	25	75	150
40	08	40	120	240	26	78	155
45	09	41	125	250	27	80	160
50	10	60	180	360	40	120	240
55	11	87	260	520	55	165	330
60	12	114	340	680	70	210	420
65	13	115	345	690	71	215	430
70	14	117	350	700	73	220	440
75	15	120	360	720	76	225	450
80	16	123	370	740	78	235	470
85	17	183	550	1 100	115	345	690
90	18	184	555	1 110	116	350	700
95	19	186	560	1 120	117	355	710
100	20	190	570	1 140	120	360	720
105	21	200	600	1 200	130	390	780
110	22	260	800	1 600	160	500	1 000
120	24	280	850	1 700	180	550	1 100
130	26	325	980	1 960	210	620	1 230
140	28	380	1 140	2 280	240	720	1 440
150	30	430	1 300	2 590	270	820	1 630
160	32	450	1 350	2 690	280	850	1 700

Preload with constant force

In precision, high-speed applications, a constant and uniform preload is important. To maintain the proper preload, calibrated linear springs can be used between one bearing outer ring and its housing shoulder (→ **fig. 1**). With springs, the kinematic behaviour of the bearing will not influence preload under normal operating conditions. Note, however, that a spring loaded bearing arrangement has a lower degree of rigidity than an arrangement using axial displacement to set the preload.

Preload by axial displacement

Rigidity and precise axial guidance are critical parameters in bearing arrangements, especially when alternating axial forces occur. In these cases, the preload in the bearings is usually obtained by adjusting the bearing rings relative to each other in the axial direction. This preload method offers significant benefits in terms of system rigidity. However, depending on the bearing type and ball material, preload increases considerably with rotational speed.

Universally matchable bearings and matched bearing sets are manufactured to specifications so that when mounted properly they will attain their predetermined axial displacement and consequently the proper preload. With single standard bearings, precision-matched spacer rings must be used.

Individual adjustment of preload using spacer rings

It may be necessary to optimize the preload of a bearing set for certain operating conditions. By using spacer rings between the bearings, it is possible to increase or decrease preload. The use of spacer rings in angular contact ball bearing sets is also advantageous when:

- system rigidity should be increased
- nozzles for oil-air lubrication must be as close as possible to the bearing raceways
- sufficiently large space is needed for surplus grease in order to reduce heat generated by the bearings

By grinding the side face of the inner or outer spacer ring, the preload in the bearing set can be changed.

Table 6 provides information about which of the equal-width spacer ring side faces must be ground and what effect it will have. Guideline values for the requisite overall width reduction of the spacer rings are listed in **table 7**.

To achieve maximum bearing performance, the spacer rings must not deform under load. They should be made of high-grade steel that can be hardened to between 45 and 60 HRC. Particular importance must be given to the plane parallelism of the side face surfaces, where the permissible shape deviation must not exceed 1 to 2 µm.

Table 4

Bearing factor *f* for calculating the preload in mounted bearing sets

Bearing Bore diameter <i>d</i>	Size	Bearing factor <i>f</i>
mm	–	–
10	00	1,05
12	01	1,06
15	02	1,08
17	03	1,10
20	04	1,08
25	05	1,11
30	06	1,14
35	07	1,18
40	08	1,23
45	09	1,24
50	10	1,30
55	11	1,27
60	12	1,30
65	13	1,28
70	14	1,32
75	15	1,36
80	16	1,41
85	17	1,31
90	18	1,33
95	19	1,36
100	20	1,40
105	21	1,44
110	22	1,34
120	24	1,41
130	26	1,34
140	28	1,43
150	30	1,37
160	32	1,42

Fig. 1

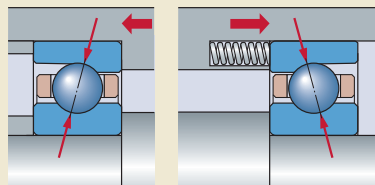


Table 5

Correction factors for calculating the preload in mounted bearing sets

Bearing series	Correction factors			<i>f_{HC}</i>	
	<i>f₁</i>	<i>f₂</i> for preload class			
		A	B	C	
718 CD (SEA CE1)	1	1	1,09	1,16	1
718 ACD (SEA CE3)	0,97	1	1,08	1,15	1
718 CD/HC (SEA/NS CE1)	1	1	1,10	1,18	1,02
718 ACD/HC (SEA/NS CE3)	0,97	1	1,09	1,17	1,02

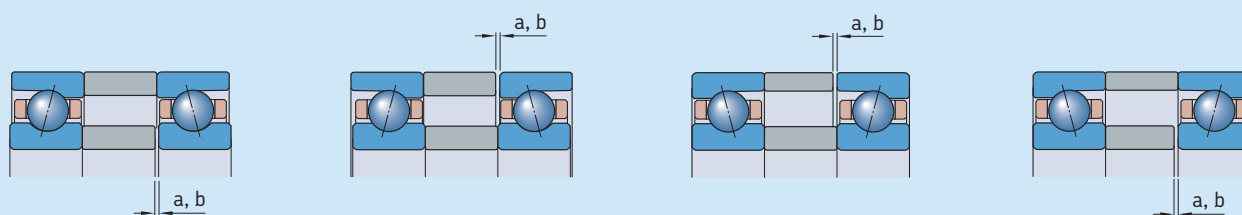
Table 6

Guidelines for spacer ring modification

Bearing set Preload change	Width reduction Value	Requisite spacer ring	
		between bearings arranged back-to-back	face-to-face
Increasing the preload			
from A to B	a	inner	outer
from B to C	b	inner	outer
from A to C	a + b	inner	outer
Decreasing the preload			
from B to A	a	outer	inner
from C to B	b	outer	inner
from C to A	a + b	outer	inner

Table 7

Guideline values for spacer ring width reduction



Bearing Bore diameter d	Size	Requisite spacer ring width reduction for bearings in the series			
		718 ACD (SEA CE3)		718 CD (SEA CE1)	
mm	–	a	b	a	b
µm					
10	00	4	4	5	5
12	01	4	4	5	5
15	02	4	4	5	5
17	03	4	4	5	5
20	04	4	5	6	6
25	05	4	5	6	6
30	06	4	5	6	6
35	07	4	5	6	6
40	08	4	5	6	6
45	09	4	5	6	6
50	10	5	6	8	8
55	11	6	7	9	9
60	12	7	8	10	11
65	13	7	8	10	11
70	14	7	8	10	11
75	15	7	8	10	11
80	16	7	8	10	11
85	17	9	10	13	13
90	18	9	10	13	14
95	19	9	10	13	14
100	20	9	10	13	14
105	21	9	10	14	14
110	22	10	12	16	16
120	24	11	12	16	17
130	26	11	12	16	17
140	28	12	14	18	20
150	30	13	14	19	20
160	32	13	15	19	20

Bearing axial stiffness

Axial stiffness depends on the deformation of the bearing under load and can be expressed as the ratio of the load to the bearing resilience. However, since the resilience of rolling bearings does not depend linearly on the load, axial stiffness is also load-dependent. Exact values of axial stiffness for bearings in the 718 (SEA) series for a given load can be calculated using advanced computer methods, but guideline values are listed in **table 8**. These values apply to mounted bearing sets under static conditions with two all-steel bearings arranged back-to-back or face-to-face and subjected to moderate loads.

Bearing sets comprising three or four bearings can provide a higher degree of axial stiffness than sets with two bearings. The axial stiffness for these sets can be calculated by multiplying the values listed in **table 8** by a factor dependent on the bearing arrangement and preload class of the bearings. For bearing sets produced to preload classes A, B or C, the following factors apply:

- 1,45 for TBT (TD) and TFT (TF) arrangements
- 1,8 for QBT (3TD) and QFT (3TF) arrangements
- 2 for QBC (TDT) and QFC (TFT) arrangements

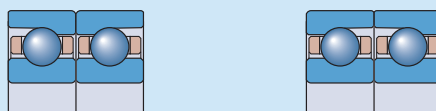
Matched bearing sets that are asymmetrical can be produced to the additional preload classes L, M or F (→ *Preload in bearings prior to mounting*, page 18). The axial stiffness for these bearing sets can be calculated by multiplying the values listed in **table 8** by the following factors:

- 1,25 for TBT (TD) and TFT (TF) arrangements
- 1,45 for QBT (3TD) and QFT (3TF) arrangements

For hybrid bearings, the axial stiffness can be calculated in the same way as for all-steel bearings. However, the calculated value should then be multiplied by a factor of 1,11 (for all arrangements and preload classes).

Table 8

Static axial stiffness for two bearings arranged back-to-back or face-to-face



Bearing Bore diameter d	Size	Axial stiffness of bearings in the series 718 ACD (SEA CE3) for preload class			718 CD (SEA CE1) for preload class		
		A	B	C	A	B	C
mm	–	N/μm					
10	00	30	47	65	13	22	32
12	01	34	54	72	15	25	37
15	02	40	63	85	17	30	43
17	03	43	67	90	18	31	45
20	04	52	83	112	22	38	55
25	05	60	95	128	26	44	64
30	06	69	106	144	29	49	72
35	07	76	119	161	32	56	82
40	08	83	130	178	36	61	90
45	09	87	139	189	38	65	95
50	10	107	168	231	47	81	119
55	11	124	195	268	53	91	135
60	12	141	222	306	59	103	152
65	13	144	227	312	61	105	155
70	14	152	241	332	65	112	166
75	15	162	257	355	69	119	177
80	16	171	274	379	74	128	191
85	17	189	296	406	79	137	202
90	18	194	307	420	82	142	210
95	19	200	316	436	85	147	218
100	20	211	335	462	90	156	231
105	21	220	353	488	96	167	250
110	22	236	377	518	99	173	256
120	24	262	417	576	112	196	291
130	26	278	439	603	119	202	296
140	28	306	489	675	130	226	336
150	30	323	512	702	136	236	346
160	32	352	556	764	147	256	379

Fitting and clamping of bearing rings

Bearings are typically located axially on shafts or in housings with either precision lock nuts (→ fig. 2) or end caps. These components require high geometrical precision and good mechanical strength to provide reliable locking.

The tightening torque M_t , obtained by tightening the precision lock nut or bolts in the end cap, must prevent relative movement of adjacent components, provide correct bearing positioning without deformation, and minimize material fatigue.

Calculating the tightening torque M_t

It is difficult to accurately calculate the tightening torque M_t . The following formulas can be used as guidelines, but should be verified during operation.

The axial clamping force for a precision lock nut or the bolts in an end cap is

$$P_a = F_s + (N_{cp}F_c) + G$$

The tightening torque for a precision lock nut is

$$M_t = K P_a \\ = K [F_s + (N_{cp}F_c) + G]$$

The tightening torque for the bolts in an end cap is

$$M_t = \frac{K P_a}{N_b}$$

$$M_t = \frac{K [F_s + (N_{cp}F_c) + G]}{N_b}$$

where

M_t = tightening torque [Nmm]

P_a = axial clamping force [N]

F_s = minimum axial clamping force (→ table 9) [N]

F_c = axial fitting force (→ table 9) [N]

G = bearing preload prior to mounting (→ table 3, page 19) [N]

N_{cp} = the number of preloaded bearings

N_b = the number of bolts in the end cap

K = a calculation factor dependent on the thread (→ table 10)

Fig. 2

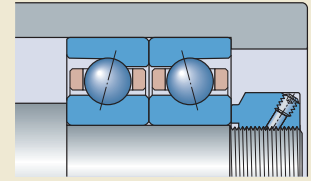


Table 9

Minimum axial clamping force and axial fitting force for precision lock nuts and end caps

Bearing Bore diameter	Size	Minimum axial clamping force F_s	Axial fitting force F_c
d		F_s	F_c
mm	–	N	
10	00	370	240
12	01	430	210
15	02	550	180
17	03	600	160
20	04	950	250
25	05	1 200	210
30	06	1 400	180
35	07	1 600	210
40	08	1 800	180
45	09	2 400	190
50	10	2 900	180
55	11	3 300	230
60	12	3 300	240
65	13	4 700	260
70	14	5 000	240
75	15	5 500	230
80	16	5 500	300
85	17	7 500	550
90	18	8 000	500
95	19	8 000	480
100	20	8 500	460
105	21	9 000	450
110	22	11 000	600
120	24	12 000	600
130	26	17 000	900
140	28	16 000	800
150	30	21 000	1 000
160	32	23 000	1 000

Table 10

Factor K for tightening torque calculation

Nominal thread diameter ¹⁾	Factor K for precision lock nuts	bolts in end caps
mm	–	
4	–	0,8
5	–	1,0
6	–	1,2
8	–	1,6
10	1,4	2,0
12	1,6	2,4
14	1,9	2,7
15	2,0	2,9
16	2,1	3,1
17	2,2	–
20	2,6	–
25	3,2	–
30	3,9	–
35	4,5	–
40	5,1	–
45	5,8	–
50	6,4	–
55	7,0	–
60	7,6	–
65	8,1	–
70	9,0	–
75	9,6	–
80	10,0	–
85	11,0	–
90	11,0	–
95	12,0	–
100	12,0	–
105	13,0	–
110	14,0	–
120	15,0	–
130	16,0	–
140	17,0	–
150	18,0	–
160	19,0	–

¹⁾ Applicable for fine threads only.

Load carrying capacity of bearing sets

The values listed in the product tables for the basic dynamic load rating C , the basic static load rating C_0 and the fatigue load limit P_u apply to single bearings. For bearing sets, the values for single bearings should be multiplied by a calculation factor according to the values listed in **table 11**.

Equivalent bearing loads

When determining the equivalent bearing load for preloaded bearings in the 718 (SEA) series, the preload must be taken into account. Depending on the operating conditions, the requisite axial component of the bearing load F_a for a bearing pair arranged back-to-back or face-to-face can be determined approximately from the following equations.

For bearing pairs under radial load and mounted with an interference fit

$$F_a = G_m$$

For bearing pairs under radial load and preloaded by springs

$$F_a = G_{A,B,C}$$

For bearing pairs under axial load and mounted with an interference fit

$$F_a = G_m + 0,67 K_a \quad \text{for } K_a \leq 3 G_m$$

$$F_a = K_a \quad \text{for } K_a > 3 G_m$$

For bearing pairs under axial load and preloaded by springs

$$F_a = G_{A,B,C} + K_a$$

where

- F_a = axial component of the load [N]
- $G_{A,B,C}$ = preload of a bearing pair prior to mounting (\rightarrow **table 3, page 19**) [N]
- G_m = preload in the mounted bearing pair (\rightarrow *Preload in mounted bearing sets, page 19*) [N]
- K_a = external axial force acting on a single bearing [N]

Equivalent dynamic bearing load

For single bearings and bearings paired in tandem

$$P = F_r \quad \text{for } F_a/F_r \leq e$$

$$P = XF_r + YF_a \quad \text{for } F_a/F_r > e$$

For bearing pairs, arranged back-to-back or face-to-face

$$P = F_r + Y_1 F_a \quad \text{for } F_a/F_r \leq e$$

$$P = XF_r + Y_2 F_a \quad \text{for } F_a/F_r > e$$

where

- P = equivalent dynamic load of the bearing set [kN]
- F_r = radial component of the load acting on the bearing set [kN]
- F_a = axial component of the load acting on the bearing set [kN]

The values for the calculation factors e , X , Y , Y_1 and Y_2 depend on the bearing contact angle and are listed in **tables 12** and **13**. For bearings with a 15° contact angle, the factors also depend on the relationship $f_0 F_a / C_0$ where f_0 and C_0 are the calculation factor and basic static load rating respectively, listed in the product table.

Equivalent static bearing load

For single bearings and bearings paired in tandem

$$P_0 = 0,5 F_r + Y_0 F_a$$

For bearing pairs, arranged back-to-back or face-to-face

$$P_0 = F_r + Y_0 F_a$$

where

- P_0 = equivalent static load of the bearing set [kN]
- F_r = radial component of the load acting on the bearing set [kN]
- F_a = axial component of the load acting on the bearing set [kN]

If $P_0 < F_r$, $P_0 = F_r$ should be used. The values for the calculation factor Y_0 depend on the bearing contact angle and are listed in **tables 12** and **13**.

Table 11

Calculation factors for load carrying capacities of bearing sets

Number of bearings	Calculation factor for		
	C	C_0	P_u
2	1,62	2	2
3	2,16	3	3
4	2,64	4	4

Table 12

Calculation factors for single bearings and bearings paired in tandem

$f_0 F_a / C_0$	Calculation factors			
	e	X	Y	Y_0
For 15° contact angle designation suffix CD (1)				
$\leq 0,178$	0,38	0,44	1,47	0,46
0,357	0,40	0,44	1,40	0,46
0,714	0,43	0,44	1,30	0,46
1,07	0,46	0,44	1,23	0,46
1,43	0,47	0,44	1,19	0,46
2,14	0,50	0,44	1,12	0,46
3,57	0,55	0,44	1,02	0,46
$\geq 5,35$	0,56	0,44	1,00	0,46
For 25° contact angle designation suffix ACD (3)				
–	0,68	0,41	0,87	0,38

Attainable speeds

The attainable speeds listed in the product tables should be regarded as guideline values. They are valid for single bearings under light load ($P \leq 0,05 C$) that are lightly preloaded using springs. In addition, good heat dissipation from the bearing arrangement is a prerequisite.

The values provided for oil lubrication apply to the oil-air lubrication method and should be reduced if other oil lubrication methods are used. The values provided for grease lubrication are maximum values that can be attained with good lubricating grease that has a low consistency and low viscosity.

If single bearings are adjusted against each other with heavier preload or if bearing sets are used, the attainable speeds listed in

the product tables should be reduced i.e. the values should be multiplied by a reduction factor. Values for this reduction factor, which depend on the bearing arrangement and preload class, are listed in **table 14**.

If the rotational speed obtained is not sufficient for the application, spacer rings in the bearing set can be used to significantly increase the speed capability.

Cages

SKF super-precision angular contact ball bearings in the 718 (*SEA*) series have a one-piece outer ring shoulder-guided cage made of fabric reinforced phenolic resin (→ **fig. 3**) that can be used up to 120 °C.

Materials

The rings and balls of all-steel angular contact ball bearings in the 718 (*SEA*) series are made from SKF Grade 3 steel, in accordance with ISO 683-17:1999. Balls of hybrid bearings are made of bearing grade silicon nitride Si_3N_4 .

Heat treatment

All SKF super-precision angular contact ball bearings in the 718 (*SEA*) series undergo a special heat treatment to achieve a good balance between hardness and dimensional stability. The hardness of the rings and rolling elements is optimized for low wear.

C

Table 13

Calculation factors for bearing pairs arranged back-to-back or face-to-face

$2 f_0 F_a / C_0$	Calculation factors				
	e	X	Y_1	Y_2	Y_0
For 15° contact angle designation suffix CD (1)					
$\leq 0,178$	0,38	0,72	1,65	2,39	0,92
0,357	0,40	0,72	1,57	2,28	0,92
0,714	0,43	0,72	1,46	2,11	0,92
1,07	0,46	0,72	1,38	2,00	0,92
1,43	0,47	0,72	1,34	1,93	0,92
2,14	0,50	0,72	1,26	1,82	0,92
3,57	0,55	0,72	1,14	1,66	0,92
$\geq 5,35$	0,56	0,72	1,12	1,63	0,92
For 25° contact angle designation suffix ACD (3)					
–	0,68	0,67	0,92	1,41	0,76

Fig. 3



Table 14

Speed reduction factors for bearing sets

Number of bearings	Arrangement	Designation suffix	Speed reduction factor for preload class					
			A	L	B	M	C	F
2	Back-to-back	DB (<i>DD</i>)	0,80	–	0,65	–	0,40	–
	Face-to-face	DF (<i>FF</i>)	0,77	–	0,61	–	0,36	–
3	Back-to-back and tandem	TBT (<i>TD</i>)	0,69	0,72	0,49	0,58	0,25	0,36
	Face-to-face and tandem	TFT (<i>TF</i>)	0,63	0,66	0,42	0,49	0,17	0,24
4	Tandem back-to-back	QBC (<i>TDT</i>)	0,64	–	0,53	–	0,32	–
	Tandem face-to-face	QFC (<i>TFT</i>)	0,62	–	0,48	–	0,27	–

Note: for spring-loaded tandem sets, designation suffix DT (*T*), a speed reduction factor of 0,9 should be applied.

Marking of bearings and bearing sets

Each SKF super-precision angular contact ball bearing in the 718 (SEA) series has various identifiers on the external surfaces of the rings (→ **fig. 4**):

- 1 SKF trademark
- 2 Complete designation of the bearing
- 3 Country of manufacture
- 4 Date of manufacture, coded
- 5 Deviation of the mean outside diameter ΔD_m [μm], and position of the maximum eccentricity of the outer ring
- 6 Deviation of the mean bore diameter Δd_m [μm], and position of the maximum eccentricity of the inner ring
- 7 Thrust face mark (punched)
- 8 Serial number (bearing sets only)
- 9 "V-shaped" marking (matched bearing sets only)

"V-shaped" marking

The additional identifier on bearings in matched bearing sets provides important information about the mounting sequence and load direction. This identifier, a "V-shaped" marking, is evident on the outside diameter of the outer rings and extends across all of the bearings in the matched bearing set (→ **fig. 5**).

The "V-shaped" marking coincides with the position of maximum ring wall thickness. The marking indicates how the bearings should be mounted to obtain the proper preload and it also points in the direction in which the main axial component of the load F_a will act on the inner rings.

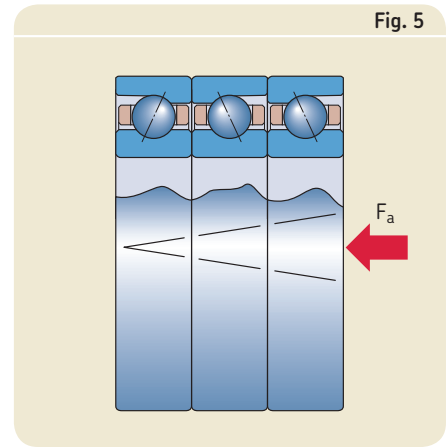


Fig. 5



Fig. 4

Packaging

SKF super-precision bearings are distributed in new SKF illustrated boxes (→ **fig. 6**). The box contains an instruction sheet with information about mounting bearing sets.

Designation system

The designation system for SKF super-precision angular contact ball bearings in the 718 (SEA) series is provided in **table 15** on **pages 28** and **29** together with the definitions.

Fig. 6



C

SKF designation system for SKF super-precision angular contact ball bearings in the 718 (SEA) series

Single bearing: 71830 CDGB/P2	718	30	CD	GB	/		P2		
	Series	Size	Contact angle	Execution (single bearings)		Ball material	Tolerance class	Arrangement	Preload
Matched bearing set: 71810 ACD/HCP4QBCA	718	10	ACD		/	HC	P4	QBC	A

Bearing series
718 In accordance with ISO dimension series 18

Bearing size
00 10 mm bore diameter
01 12 mm bore diameter
02 15 mm bore diameter
03 17 mm bore diameter
04 (x5) 20 mm bore diameter
to
32 (x5) 160 mm bore diameter

Contact angle and internal design
CD 15° contact angle, basic design
ACD 25° contact angle, basic design

Single bearing – execution and preload
– Single bearing (no designation suffix)
GA Single, universally matchable, for light preload
GB Single, universally matchable, for moderate preload
GC Single, universally matchable, for heavy preload

Cage
– Fabric reinforced phenolic resin, outer ring centred (no designation suffix)

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

Tolerance class
P4 Dimensional and running accuracy in accordance with ISO tolerance class 4
P2 Dimensional and running accuracy in accordance with ISO tolerance class 2

Bearing set arrangement
DB Two bearings arranged back-to-back <>
DF Two bearings arranged face-to-face ><
DT Two bearings arranged in tandem <<
DG Two bearings for universal matching
TBT Three bearings arranged back-to-back and tandem <>>
TFT Three bearings arranged face-to-face and tandem >><
TT Three bearings arranged in tandem <<<
TG Three bearings for universal matching
QBC Four bearings arranged tandem back-to-back <<>>
QFC Four bearings arranged tandem face-to-face >><<
QBT Four bearings arranged back-to-back and tandem <>>>
QFT Four bearings arranged face-to-face and tandem >><<<
QT Four bearings arranged in tandem <<<<
QG Four bearings for universal matching

Bearing set – preload
A Light preload
L Light preload (only for matched bearing sets in TBT, TFT, QBT and QFT arrangements)
B Moderate preload
M Moderate preload (only for matched bearing sets in TBT, TFT, QBT and QFT arrangements)
C Heavy preload
F Heavy preload (only for matched bearing sets in TBT, TFT, QBT and QFT arrangements)
G... Special preload, expressed in daN e.g. G240

Former SNFA designation system for super-precision angular contact ball bearings in the 718 (SEA) series

Single bearing: SEA150 9CE1 UM	SEA	150		9	CE	1	U	M
	Series	Size	Ball material	Tolerance class	Cage	Contact angle	Arrangement	Preload
Matched bearing set: SEA50 /NS 7CE3 TDTL	SEA	50	/NS	7	CE	3	TDT	L

Bearing series
SEA In accordance with ISO dimension series 18

Bearing size
10 10 mm bore diameter
to
160 160 mm bore diameter

Contact angle and internal design
1 15° contact angle, basic design
3 25° contact angle, basic design

Single bearing
– Standard (no designation suffix)
U_ Universally matchable with preload class

Cage
CE Fabric reinforced phenolic resin, outer ring centred

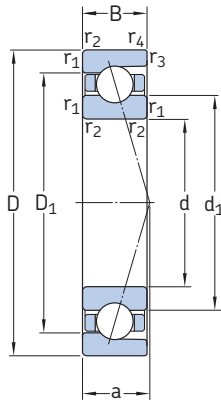
Ball material
– Carbon chromium steel (no designation suffix)
/NS Bearing grade silicon nitride Si₃N₄ (hybrid bearings)

Tolerance class
7 Dimensional and running accuracy in accordance with ABMA tolerance class ABEC 7
9 Dimensional and running accuracy in accordance with ABMA tolerance class ABEC 9

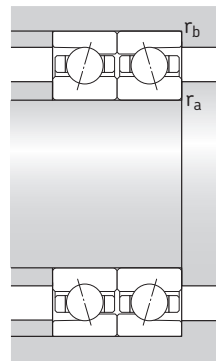
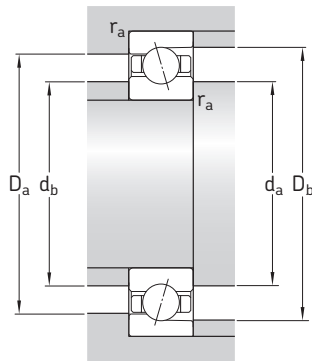
Bearing set arrangement
DD Two bearings arranged back-to-back <>
FF Two bearings arranged face-to-face >>
T Two bearings arranged in tandem <<
DU Two bearings for universal matching
TD Three bearings arranged back-to-back and tandem <>>
TF Three bearings arranged face-to-face and tandem >><<
3T Three bearings arranged in tandem <<<
TU Three bearings for universal matching
TDT Four bearings arranged tandem back-to-back <<>>
TFT Four bearings arranged tandem face-to-face >><<
3TD Four bearings arranged back-to-back and tandem <>>>
3TF Four bearings arranged face-to-face and tandem >><<<
4T Four bearings arranged in tandem <<<<
4U Four bearings for universal matching

Bearing set – preload
L Light preload
M Moderate preload
F Heavy preload
..daN Special preload

Super-precision angular contact ball bearings in the 718 (SEA) series
d 10 – 45 mm

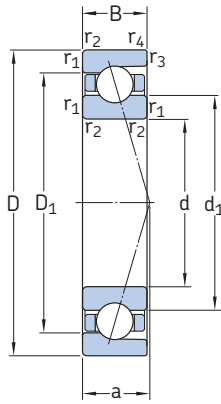


Principal dimensions			Basic load ratings		Fatigue load limit	Attainable speeds		Mass	Designations	SNFA
d	D	B	C	C ₀	P _u	when lubricating with grease oil-air			SKF	
mm			kN		kN	r/min		kg	–	
10	19	5	1,9	0,98	0,043	80 000	120 000	0,005	71800 CD/P4	SEA10 7CE1
	19	5	1,78	0,93	0,04	70 000	110 000	0,005	71800 ACD/P4	SEA10 7CE3
	19	5	1,9	0,98	0,043	95 000	150 000	0,005	71800 CD/HCP4	SEA10 /NS 7CE1
	19	5	1,78	0,93	0,04	85 000	130 000	0,005	71800 ACD/HCP4	SEA10 /NS 7CE3
12	21	5	2,08	1,18	0,05	70 000	110 000	0,006	71801 CD/P4	SEA12 7CE1
	21	5	1,95	1,12	0,048	63 000	95 000	0,006	71801 ACD/P4	SEA12 7CE3
	21	5	2,08	1,18	0,05	85 000	130 000	0,006	71801 CD/HCP4	SEA12 /NS 7CE1
	21	5	1,95	1,12	0,048	75 000	110 000	0,006	71801 ACD/HCP4	SEA12 /NS 7CE3
15	24	5	2,29	1,5	0,063	60 000	90 000	0,007	71802 CD/P4	SEA15 7CE1
	24	5	2,16	1,4	0,06	53 000	80 000	0,007	71802 ACD/P4	SEA15 7CE3
	24	5	2,29	1,5	0,063	70 000	110 000	0,006	71802 CD/HCP4	SEA15 /NS 7CE1
	24	5	2,16	1,4	0,06	63 000	100 000	0,006	71802 ACD/HCP4	SEA15 /NS 7CE3
17	26	5	2,34	1,6	0,068	53 000	85 000	0,01	71803 CD/P4	SEA17 7CE1
	26	5	2,21	1,53	0,064	48 000	75 000	0,01	71803 ACD/P4	SEA17 7CE3
	26	5	2,34	1,6	0,068	63 000	100 000	0,009	71803 CD/HCP4	SEA17 /NS 7CE1
	26	5	2,21	1,53	0,064	60 000	90 000	0,009	71803 ACD/HCP4	SEA17 /NS 7CE3
20	32	7	3,9	2,65	0,112	45 000	70 000	0,018	71804 CD/P4	SEA20 7CE1
	32	7	3,64	2,5	0,106	40 000	63 000	0,018	71804 ACD/P4	SEA20 7CE3
	32	7	3,9	2,65	0,112	53 000	80 000	0,017	71804 CD/HCP4	SEA20 /NS 7CE1
	32	7	3,64	2,5	0,106	48 000	75 000	0,017	71804 ACD/HCP4	SEA20 /NS 7CE3
25	37	7	4,16	3,2	0,137	38 000	56 000	0,021	71805 CD/P4	SEA25 7CE1
	37	7	3,9	3,05	0,129	34 000	53 000	0,021	71805 ACD/P4	SEA25 7CE3
	37	7	4,16	3,2	0,137	45 000	70 000	0,019	71805 CD/HCP4	SEA25 /NS 7CE1
	37	7	3,9	3,05	0,129	40 000	63 000	0,019	71805 ACD/HCP4	SEA25 /NS 7CE3
30	42	7	4,42	3,75	0,16	32 000	50 000	0,026	71806 CD/P4	SEA30 7CE1
	42	7	4,16	3,55	0,15	28 000	45 000	0,026	71806 ACD/P4	SEA30 7CE3
	42	7	4,42	3,75	0,16	38 000	60 000	0,024	71806 CD/HCP4	SEA30 /NS 7CE1
	42	7	4,16	3,55	0,15	34 000	53 000	0,024	71806 ACD/HCP4	SEA30 /NS 7CE3
35	47	7	4,62	4,3	0,183	28 000	43 000	0,028	71807 CD/P4	SEA35 7CE1
	47	7	4,36	4,05	0,173	26 000	40 000	0,028	71807 ACD/P4	SEA35 7CE3
	47	7	4,62	4,3	0,183	34 000	53 000	0,026	71807 CD/HCP4	SEA35 /NS 7CE1
	47	7	4,36	4,05	0,173	30 000	48 000	0,026	71807 ACD/HCP4	SEA35 /NS 7CE3
40	52	7	4,88	4,9	0,208	26 000	38 000	0,031	71808 CD/P4	SEA40 7CE1
	52	7	4,49	4,55	0,196	22 000	34 000	0,031	71808 ACD/P4	SEA40 7CE3
	52	7	4,88	4,9	0,208	30 000	45 000	0,029	71808 CD/HCP4	SEA40 /NS 7CE1
	52	7	4,49	4,55	0,196	28 000	43 000	0,029	71808 ACD/HCP4	SEA40 /NS 7CE3
45	58	7	4,88	5,3	0,224	22 000	34 000	0,039	71809 CD/P4	SEA45 7CE1
	58	7	4,62	5	0,212	20 000	30 000	0,039	71809 ACD/P4	SEA45 7CE3
	58	7	4,88	5,3	0,224	26 000	40 000	0,037	71809 CD/HCP4	SEA45 /NS 7CE1
	58	7	4,62	5	0,212	24 000	38 000	0,037	71809 ACD/HCP4	SEA45 /NS 7CE3

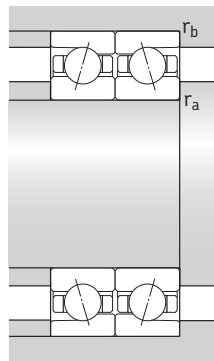
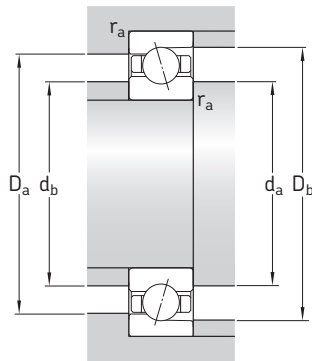


Dimensions						Abutment and fillet dimensions					Calculation factor
d	d ₁	D ₁	r _{1,2}	r _{3,4}	a	d _{a, d_b}	D _a	D _b	r _a	r _b	f ₀
mm	~	~	min	min		min	max	max	max	max	-
10	13,1	16,1	0,3	0,15	4,5	12	17	18,2	0,3	0,15	15
	13,1	16,1	0,3	0,15	5,9	12	17	18,2	0,3	0,15	-
	13,1	16,1	0,3	0,15	4,5	12	17	18,2	0,3	0,15	15
	13,1	16,1	0,3	0,15	5,9	12	17	18,2	0,3	0,15	-
12	15,1	18,1	0,3	0,15	4,7	14	19	20,2	0,3	0,15	15
	15,1	18,1	0,3	0,15	6,4	14	19	20,2	0,3	0,15	-
	15,1	18,1	0,3	0,15	4,7	14	19	20,2	0,3	0,15	15
	15,1	18,1	0,3	0,15	6,4	14	19	20,2	0,3	0,15	-
15	18,1	21,1	0,3	0,15	5,1	17	22	23,2	0,3	0,15	16
	18,1	21,1	0,3	0,15	7,1	17	22	23,2	0,3	0,15	-
	18,1	21,1	0,3	0,15	5,1	17	22	23,2	0,3	0,15	16
	18,1	21,1	0,3	0,15	7,1	17	22	23,2	0,3	0,15	-
17	20,1	23	0,3	0,15	5,4	19	24	25,2	0,3	0,15	16
	20,1	23	0,3	0,15	7,5	19	24	25,2	0,3	0,15	-
	20,1	23	0,3	0,15	5,4	19	24	25,2	0,3	0,15	16
	20,1	23	0,3	0,15	7,5	19	24	25,2	0,3	0,15	-
20	24,1	28,1	0,3	0,15	7	22	30	31,2	0,3	0,15	16
	24,1	28,1	0,3	0,15	9,6	22	30	31,2	0,3	0,15	-
	24,1	28,1	0,3	0,15	7	22	30	31,2	0,3	0,15	16
	24,1	28,1	0,3	0,15	9,6	22	30	31,2	0,3	0,15	-
25	29,1	33,1	0,3	0,15	7,7	27	35	36,2	0,3	0,15	16
	29,1	33,1	0,3	0,15	10,8	27	35	36,2	0,3	0,15	-
	29,1	33,1	0,3	0,15	7,7	27	35	36,2	0,3	0,15	16
	29,1	33,1	0,3	0,15	10,8	27	35	36,2	0,3	0,15	-
30	34,1	38,1	0,3	0,15	8,3	32	40	41,2	0,3	0,15	17
	34,1	38,1	0,3	0,15	11,9	32	40	41,2	0,3	0,15	-
	34,1	38,1	0,3	0,15	8,3	32	40	41,2	0,3	0,15	17
	34,1	38,1	0,3	0,15	11,9	32	40	41,2	0,3	0,15	-
35	39,1	43,1	0,3	0,15	9	37	45	46,2	0,3	0,15	17
	39,1	43,1	0,3	0,15	13,1	37	45	46,2	0,3	0,15	-
	39,1	43,1	0,3	0,15	9	37	45	46,2	0,3	0,15	17
	39,1	43,1	0,3	0,15	13,1	37	45	46,2	0,3	0,15	-
40	44,1	48,1	0,3	0,15	9,7	42	50	51,2	0,3	0,15	17
	44,1	48,1	0,3	0,15	14,3	42	50	51,2	0,3	0,15	-
	44,1	48,1	0,3	0,15	9,7	42	50	51,2	0,3	0,15	17
	44,1	48,1	0,3	0,15	14,3	42	50	51,2	0,3	0,15	-
45	49,6	53,6	0,3	0,15	10,4	47	56	57,2	0,3	0,15	17
	49,6	53,6	0,3	0,15	15,5	47	56	57,2	0,3	0,15	-
	49,6	53,6	0,3	0,15	10,4	47	56	57,2	0,3	0,15	17
	49,6	53,6	0,3	0,15	15,5	47	56	57,2	0,3	0,15	-

Super-precision angular contact ball bearings in the 718 (SEA) series
d 50 – 95 mm



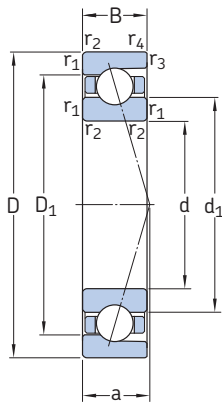
Principal dimensions			Basic load ratings		Fatigue load limit	Attainable speeds		Mass	Designations	SNFA
d	D	B	C	C ₀	P _u	when lubricating with grease oil-air			SKF	
mm			kN		kN	r/min		kg	–	
50	65	7	7,41	7,8	0,335	20 000	30 000	0,051	71810 CD/P4	SEA50 7CE1
	65	7	6,89	7,35	0,315	18 000	28 000	0,051	71810 ACD/P4	SEA50 7CE3
	65	7	7,41	7,8	0,335	24 000	36 000	0,046	71810 CD/HCP4	SEA50 /NS 7CE1
	65	7	6,89	7,35	0,315	22 000	34 000	0,046	71810 ACD/HCP4	SEA50 /NS 7CE3
55	72	9	10,1	10,8	0,455	18 000	28 000	0,081	71811 CD/P4	SEA55 7CE1
	72	9	9,56	10,2	0,43	16 000	24 000	0,081	71811 ACD/P4	SEA55 7CE3
	72	9	10,1	10,8	0,455	22 000	32 000	0,073	71811 CD/HCP4	SEA55 /NS 7CE1
	72	9	9,56	10,2	0,43	19 000	30 000	0,073	71811 ACD/HCP4	SEA55 /NS 7CE3
60	78	10	13,5	14,3	0,6	16 000	24 000	0,1	71812 CD/P4	SEA60 7CE1
	78	10	12,7	13,4	0,57	15 000	22 000	0,1	71812 ACD/P4	SEA60 7CE3
	78	10	13,5	14,3	0,6	19 000	30 000	0,088	71812 CD/HCP4	SEA60 /NS 7CE1
	78	10	12,7	13,4	0,57	18 000	26 000	0,088	71812 ACD/HCP4	SEA60 /NS 7CE3
65	85	10	13,5	14,6	0,63	15 000	22 000	0,126	71813 CD/P4	SEA65 7CE1
	85	10	12,7	14	0,585	13 000	20 000	0,126	71813 ACD/P4	SEA65 7CE3
	85	10	13,5	14,6	0,63	18 000	28 000	0,114	71813 CD/HCP4	SEA65 /NS 7CE1
	85	10	12,7	14	0,585	16 000	24 000	0,114	71813 ACD/HCP4	SEA65 /NS 7CE3
70	90	10	13,8	16	0,67	14 000	22 000	0,134	71814 CD/P4	SEA70 7CE1
	90	10	13	15	0,64	13 000	19 000	0,134	71814 ACD/P4	SEA70 7CE3
	90	10	13,8	16	0,67	17 000	26 000	0,121	71814 CD/HCP4	SEA70 /NS 7CE1
	90	10	13	15	0,64	15 000	24 000	0,121	71814 ACD/HCP4	SEA70 /NS 7CE3
75	95	10	14,3	17	0,72	13 000	20 000	0,142	71815 CD/P4	SEA75 7CE1
	95	10	13,3	16	0,68	12 000	18 000	0,142	71815 ACD/P4	SEA75 7CE3
	95	10	14,3	17	0,72	16 000	24 000	0,128	71815 CD/HCP4	SEA75 /NS 7CE1
	95	10	13,3	16	0,68	14 000	22 000	0,128	71815 ACD/HCP4	SEA75 /NS 7CE3
80	100	10	14,6	18,3	0,765	12 000	19 000	0,151	71816 CD/P4	SEA80 7CE1
	100	10	13,8	17	0,72	11 000	17 000	0,151	71816 ACD/P4	SEA80 7CE3
	100	10	14,6	18,3	0,765	15 000	22 000	0,136	71816 CD/HCP4	SEA80 /NS 7CE1
	100	10	13,8	17	0,72	13 000	20 000	0,136	71816 ACD/HCP4	SEA80 /NS 7CE3
85	110	13	21,6	25,5	1,08	11 000	17 000	0,266	71817 CD/P4	SEA85 7CE1
	110	13	20,3	24	1,02	10 000	16 000	0,266	71817 ACD/P4	SEA85 7CE3
	110	13	21,6	25,5	1,08	14 000	20 000	0,239	71817 CD/HCP4	SEA85 /NS 7CE1
	110	13	20,3	24	1,02	12 000	19 000	0,239	71817 ACD/HCP4	SEA85 /NS 7CE3
90	115	13	21,6	26,5	1,1	11 000	17 000	0,279	71818 CD/P4	SEA90 7CE1
	115	13	20,3	25	1,04	10 000	15 000	0,279	71818 ACD/P4	SEA90 7CE3
	115	13	21,6	26,5	1,1	13 000	20 000	0,251	71818 CD/HCP4	SEA90 /NS 7CE1
	115	13	20,3	25	1,04	12 000	18 000	0,251	71818 ACD/HCP4	SEA90 /NS 7CE3
95	120	13	22,1	27,5	1,12	10 000	16 000	0,292	71819 CD/P4	SEA95 7CE1
	120	13	20,8	25,5	1,06	9 500	14 000	0,292	71819 ACD/P4	SEA95 7CE3
	120	13	22,1	27,5	1,12	12 000	19 000	0,263	71819 CD/HCP4	SEA95 /NS 7CE1
	120	13	20,8	25,5	1,06	11 000	17 000	0,263	71819 ACD/HCP4	SEA95 /NS 7CE3



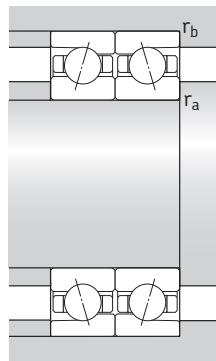
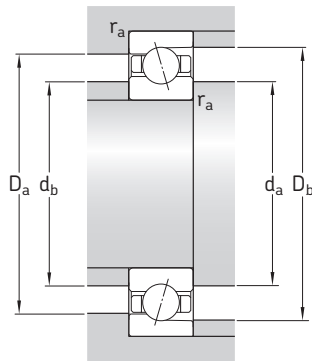
Dimensions						Abutment and fillet dimensions					Calculation factor
d	d ₁	D ₁	r _{1,2}	r _{3,4}	a	d _a , d _b	D _a	D _b	r _a	r _b	f ₀
mm	~	~	min	min		min	max	max	max	max	-
50	55,1	60	0,3	0,15	11,2	52	63	64,2	0,3	0,15	17
	55,1	60	0,3	0,15	16,9	52	63	64,2	0,3	0,15	-
	55,1	60	0,3	0,15	11,2	52	63	64,2	0,3	0,15	17
	55,1	60	0,3	0,15	16,9	52	63	64,2	0,3	0,15	-
55	60,7	66,5	0,3	0,15	13	57	70	71,2	0,3	0,15	17
	60,7	66,5	0,3	0,15	19,3	57	70	71,2	0,3	0,15	-
	60,7	66,5	0,3	0,15	13	57	70	71,2	0,3	0,15	17
	60,7	66,5	0,3	0,15	19,3	57	70	71,2	0,3	0,15	-
60	65,7	72,5	0,3	0,15	14,3	62	76	77,2	0,3	0,15	17
	65,7	72,5	0,3	0,15	21,1	62	76	77,2	0,3	0,15	-
	65,7	72,5	0,3	0,15	14,3	62	76	77,2	0,3	0,15	17
	65,7	72,5	0,3	0,15	21,1	62	76	77,2	0,3	0,15	-
65	71,7	78,5	0,6	0,3	15,1	68,2	81,8	83	0,6	0,3	17
	71,7	78,5	0,6	0,3	22,5	68,2	81,8	83	0,6	0,3	-
	71,7	78,5	0,6	0,3	15,1	68,2	81,8	83	0,6	0,3	17
	71,7	78,5	0,6	0,3	22,5	68,2	81,8	83	0,6	0,3	-
70	76,7	83,5	0,6	0,3	15,7	73,2	86,8	88	0,6	0,3	17
	76,7	83,5	0,6	0,3	23,7	73,2	86,8	88	0,6	0,3	-
	76,7	83,5	0,6	0,3	15,7	73,2	86,8	88	0,6	0,3	17
	76,7	83,5	0,6	0,3	23,7	73,2	86,8	88	0,6	0,3	-
75	81,7	88,5	0,6	0,3	16,4	78,2	91,8	93	0,6	0,3	17
	81,7	88,5	0,6	0,3	24,9	78,2	91,8	93	0,6	0,3	-
	81,7	88,5	0,6	0,3	16,4	78,2	91,8	93	0,6	0,3	17
	81,7	88,5	0,6	0,3	24,9	78,2	91,8	93	0,6	0,3	-
80	86,7	93,5	0,6	0,3	17,1	83,2	96,8	98	0,6	0,3	17
	86,7	93,5	0,6	0,3	26	83,2	96,8	98	0,6	0,3	-
	86,7	93,5	0,6	0,3	17,1	83,2	96,8	98	0,6	0,3	17
	86,7	93,5	0,6	0,3	26	83,2	96,8	98	0,6	0,3	-
85	93,2	102,1	1	0,3	19,6	89,6	105,4	108	1	0,3	17
	93,2	102,1	1	0,3	29,3	89,6	105,4	108	1	0,3	-
	93,2	102,1	1	0,3	19,6	89,6	105,4	108	1	0,3	17
	93,2	102,1	1	0,3	29,3	89,6	105,4	108	1	0,3	-
90	98,2	107,1	1	0,3	20,3	94,6	110,4	113	1	0,3	17
	98,2	107,1	1	0,3	30,5	94,6	110,4	113	1	0,3	-
	98,2	107,1	1	0,3	20,3	94,6	110,4	113	1	0,3	17
	98,2	107,1	1	0,3	30,5	94,6	110,4	113	1	0,3	-
95	103,2	112,1	1	0,3	20,9	99,6	115,4	118	1	0,3	17
	103,2	112,1	1	0,3	31,6	99,6	115,4	118	1	0,3	-
	103,2	112,1	1	0,3	20,9	99,6	115,4	118	1	0,3	17
	103,2	112,1	1	0,3	31,6	99,6	115,4	118	1	0,3	-

Super-precision angular contact ball bearings in the 718 (SEA) series

d 100 – 160 mm



Principal dimensions			Basic load ratings		Fatigue load limit	Attainable speeds		Mass	Designations	SNFA
d	D	B	C	C ₀	P _u	when lubricating with grease oil-air			SKF	
mm			kN		kN	r/min		kg	–	
100	125	13	22,5	29	1,16	9 000	14 000	0,31	71820 CD/P4	SEA100 7CE1
	125	13	21,2	27,5	1,1	8 500	13 000	0,31	71820 ACD/P4	SEA100 7CE3
	125	13	22,5	29	1,16	11 000	17 000	0,279	71820 CD/HCP4	SEA100 /NS 7CE1
	125	13	21,2	27,5	1,1	10 000	15 000	0,279	71820 ACD/HCP4	SEA100 /NS 7CE3
105	130	13	22,9	30	1,18	9 000	14 000	0,32	71821 CD/P4	SEA105 7CE1
	130	13	21,6	28,5	1,1	8 000	12 000	0,32	71821 ACD/P4	SEA105 7CE3
	130	13	22,9	30	1,18	11 000	16 000	0,289	71821 CD/HCP4	SEA105 /NS 7CE1
	130	13	21,6	28,5	1,1	9 500	15 000	0,289	71821 ACD/HCP4	SEA105 /NS 7CE3
110	140	16	31,9	40,5	1,53	8 000	13 000	0,505	71822 CD/P4	SEA110 7CE1
	140	16	30,2	38	1,46	7 500	12 000	0,505	71822 ACD/P4	SEA110 7CE3
	140	16	31,9	40,5	1,53	10 000	15 000	0,453	71822 CD/HCP4	SEA110 /NS 7CE1
	140	16	30,2	38	1,46	9 000	14 000	0,453	71822 ACD/HCP4	SEA110 /NS 7CE3
120	150	16	33,2	45	1,63	7 500	12 000	0,55	71824 CD/P4	SEA120 7CE1
	150	16	31,2	42,5	1,53	6 700	11 000	0,55	71824 ACD/P4	SEA120 7CE3
	150	16	33,2	45	1,63	9 000	14 000	0,493	71824 CD/HCP4	SEA120 /NS 7CE1
	150	16	31,2	42,5	1,53	8 000	13 000	0,493	71824 ACD/HCP4	SEA120 /NS 7CE3
130	165	18	39	53	1,86	7 000	11 000	0,77	71826 CD/P4	SEA130 7CE1
	165	18	36,4	50	1,76	6 300	9 500	0,77	71826 ACD/P4	SEA130 7CE3
	165	18	39	53	1,86	8 500	13 000	0,696	71826 CD/HCP4	SEA130 /NS 7CE1
	165	18	36,4	50	1,76	7 500	12 000	0,696	71826 ACD/HCP4	SEA130 /NS 7CE3
140	175	18	44,9	62	2,12	6 300	10 000	0,8	71828 CD/P4	SEA140 7CE1
	175	18	42,3	58,5	2	6 000	9 000	0,8	71828 ACD/P4	SEA140 7CE3
	175	18	44,9	62	2,12	8 000	12 000	0,705	71828 CD/HCP4	SEA140 /NS 7CE1
	175	18	42,3	58,5	2	7 000	11 000	0,705	71828 ACD/HCP4	SEA140 /NS 7CE3
150	190	20	52	72	2,36	6 000	9 000	1,1	71830 CD/P4	SEA150 7CE1
	190	20	48,8	68	2,2	5 300	8 500	1,1	71830 ACD/P4	SEA150 7CE3
	190	20	52	72	2,36	7 000	11 000	0,982	71830 CD/HCP4	SEA150 /NS 7CE1
	190	20	48,8	68	2,2	6 300	10 000	0,982	71830 ACD/HCP4	SEA150 /NS 7CE3
160	200	20	54	78	2,5	5 600	8 500	1,233	71832 CD/P4	SEA160 7CE1
	200	20	50,7	75	2,36	5 000	8 000	1,233	71832 ACD/P4	SEA160 7CE3
	200	20	54	78	2,5	6 700	10 000	1,105	71832 CD/HCP4	SEA160 /NS 7CE1
	200	20	50,7	75	2,36	6 000	9 500	1,105	71832 ACD/HCP4	SEA160 /NS 7CE3



Dimensions						Abutment and fillet dimensions					Calculation factor
d	d ₁ ~	D ₁ ~	r _{1,2} min	r _{3,4} min	a	d _{a, d_b} min	D _a max	D _b max	r _a max	r _b max	f ₀
mm						mm					-
100	108,2	117	1	0,3	21,6	104,6	120,4	123	1	0,3	17
	108,2	117	1	0,3	32,8	104,6	120,4	123	1	0,3	-
	108,2	117	1	0,3	21,6	104,6	120,4	123	1	0,3	17
	108,2	117	1	0,3	32,8	104,6	120,4	123	1	0,3	-
105	113,2	122	1	0,3	22,3	109,6	125,4	128	1	0,3	17
	113,2	122	1	0,3	34	109,6	125,4	128	1	0,3	-
	113,2	122	1	0,3	22,3	109,6	125,4	128	1	0,3	17
	113,2	122	1	0,3	34	109,6	125,4	128	1	0,3	-
110	119,8	130,6	1	0,3	24,8	114,6	135,4	138	1	0,3	17
	119,8	130,6	1	0,3	37,2	114,6	135,4	138	1	0,3	-
	119,8	130,6	1	0,3	24,8	114,6	135,4	138	1	0,3	17
	119,8	130,6	1	0,3	37,2	114,6	135,4	138	1	0,3	-
120	129,8	140,6	1	0,3	26,1	124,6	145,4	148	1	0,3	17
	129,8	140,6	1	0,3	39,5	124,6	145,4	148	1	0,3	-
	129,8	140,6	1	0,3	26,1	124,6	145,4	148	1	0,3	17
	129,8	140,6	1	0,3	39,5	124,6	145,4	148	1	0,3	-
130	141,8	153,21	1,1	0,6	28,8	136	159	161,8	1,1	0,6	17
	141,8	153,21	1,1	0,6	43,5	136	159	161,8	1,1	0,6	-
	141,8	153,21	1,1	0,6	28,8	136	159	161,8	1,1	0,6	17
	141,8	153,21	1,1	0,6	43,5	136	159	161,8	1,1	0,6	-
140	151,3	163,71	1,1	0,6	30,2	146	169	171,8	1,1	0,6	17
	151,3	163,71	1,1	0,6	45,8	146	169	171,8	1,1	0,6	-
	151,3	163,71	1,1	0,6	30,2	146	169	171,8	1,1	0,6	17
	151,3	163,71	1,1	0,6	45,8	146	169	171,8	1,1	0,6	-
150	163,4	176,7	1,1	0,6	32,8	156	184	186,8	1,1	0,6	17
	163,4	176,7	1,1	0,6	49,7	156	184	186,8	1,1	0,6	-
	163,4	176,7	1,1	0,6	32,8	156	184	186,8	1,1	0,6	17
	163,4	176,7	1,1	0,6	49,7	156	184	186,8	1,1	0,6	-
160	173,4	186,7	1,1	0,6	34,2	166	194	196,8	1,1	0,6	17
	173,4	186,7	1,1	0,6	52,1	166	194	196,8	1,1	0,6	-
	173,4	186,7	1,1	0,6	34,2	166	194	196,8	1,1	0,6	17
	173,4	186,7	1,1	0,6	52,1	166	194	196,8	1,1	0,6	-

Setting the highest standard for precision bearings

SKF has developed and is continuing to develop a new, improved generation of super-precision bearings. The new assortment delivers improved accuracy and extended bearing service life when compared to previous designs.

Super-precision angular contact ball bearings

Bearings in the 719 .. D (SEB) and 70 .. D (EX) series

For applications where a high load carrying capacity is an additional operational requirement, SKF offers high-capacity bearings in the 719 .. D (SEB) and 70 .. D (EX) series. The ability of the new design super-precision bearings in these two series to accommodate heavy loads in applications where radial space is often limited, makes them an excellent choice for demanding applications. Open bearings in the 719 .. D (SEB) series accommodate shaft diameters ranging from 10 to 360 mm; sealed bearings from 10 to 150 mm.

Open bearings in the 70 .. D (EX) series accommodate shaft diameters ranging from 6 to 240 mm; sealed bearings from 10 to 150 mm.



Bearings in the 72 .. D (E 200) series

High-capacity bearings in the 72 .. D (E 200) series offer solutions to many bearing arrangement challenges. Their ability, among others, to provide a high degree of rigidity and accommodate heavy loads at relatively high speeds, is beneficial for a variety of applications. The extended range of bearings in this series now accommodates shaft diameters ranging from 7 to 140 mm. And, there is also a relubrication-free, sealed variant, available on request.



Bearings in the S719 .. B (HB .. /S) and S70 .. B (HX .. /S) series

High-speed sealed bearings in the S719 .. B (HB .. /S) and S70 .. B (HX .. /S) series can virtually eliminate the problem of premature bearing failures resulting from contamination. The standard assortment accommodates shaft diameters ranging from 30 to 120 mm. These relubrication-free bearings are particularly suitable for metal cutting and woodworking machines. The bearings are also available in an open variant.



Bearings in the 719 .. E (VEB) and 70 .. E (VEX) series

Compared to high-speed B design bearings, high-speed E design bearings have a higher speed capability and can accommodate heavier loads. This desirable combination makes these bearings an excellent choice for demanding applications.

Open bearings in the 719 .. E (VEB) series accommodate shaft diameters ranging from 8 to 120 mm; sealed bearings from 20 to 120 mm. Open bearings in the 70 .. E (VEX) series accommodate shaft diameters ranging from 6 to 120 mm; sealed bearings from 10 to 120 mm.

Bearings made from NitroMax steel

In extremely demanding applications such as high-speed machining centres and milling machines, bearings are frequently subjected to difficult operating conditions such as very high speeds, thin-film lubrication conditions, and contaminated and corrosive environments. To enable longer bearing service life and reduce the costs associated with downtime, SKF has developed a superior high-nitrogen steel.

The SKF assortment of super-precision angular contact ball bearings made from NitroMax steel have ceramic (bearing grade silicon nitride) rolling elements as standard.

Super-precision cylindrical roller bearings

SKF produces super-precision single row and double row cylindrical roller bearings. The characteristic features of these bearings are a low cross sectional height, high load carrying capacity, high rigidity and high-speed capability. They are therefore particularly well suited for machine tool spindles where the bearing arrangement must accommodate heavy radial loads and high speeds, while providing a high degree of stiffness.

Single row cylindrical roller bearings are produced in the N 10 series as basic design bearings and as high-speed design bearings. High-speed single row cylindrical roller bearings in the N 10 series are available with a tapered bore only and for shaft diameters ranging from 40 to 80 mm. Compared to previous high-speed design, they can accommodate a speed increase of up to 30% in grease lubricated applications and up to 15% in oil-air lubricated applications.

Double row cylindrical roller bearings are produced as standard in the NN design and NNU design.



Super-precision double direction angular contact thrust ball bearings

Double direction angular contact bearings, as their name implies, were developed by SKF to axially locate machine tool spindles in both directions.

The new optimized design of super-precision bearings in the BTW series consists of a set of two single row angular contact thrust ball bearings, arranged back-to-back. This configuration enables the bearings to accommodate axial loads in both directions while providing a high degree of system rigidity. These bearings can accommodate higher speeds compared to bearings in the former 2344(00) series. The bearings are available for shaft diameters ranging from 35 to 200 mm.

The redesigned high-speed BTM series accommodate higher speeds, anywhere from 6% to 12% depending on the size; minimize heat generation, even at higher speeds; provide high load carrying capacity and maintain a high degree of system rigidity. The range of BTM bearings series has been expanded to accommodate shaft diameters from 60 to 180 mm.



Super-precision angular contact thrust ball bearings for screw drives

Single direction angular contact thrust ball bearings in the BSA and BSD (BS) series are available for shaft diameters ranging from 12 to 75 mm. These bearings are characterized by superior axial stiffness and high axial load carrying capacity.

Double direction angular contact thrust ball bearings in the BEAS series have been developed for machine tool applications where space is tight and easy mounting is required. The bearings are available for shaft diameters ranging from 8 to 30 mm. Bearings in the BEAM series, which can accommodate shaft diameters ranging from 12 to 60 mm, can be bolt-mounted to an associated component.

Cartridge units are another solution for simple and quick mounting. Units in the FBSA (BSDU and BSQU) series incorporate SKF single direction angular contact thrust ball bearings and can accommodate shaft diameters ranging from 20 to 60 mm.

Super-precision axial-radial cylindrical roller bearings

SKF axial-radial cylindrical roller bearings are suitable for arrangements that have simultaneously acting (radial and axial) loads as well as moment loads.

Their internal design, together with close tolerance manufacturing processes, enable these bearings to attain better than P4 running accuracy.

Axial-radial cylindrical roller bearings are commonly used to support rotating tables, indexing tables and milling heads.



SKF – the knowledge engineering company

From one simple but inspired solution to a misalignment problem in a textile mill in Sweden, and fifteen employees in 1907, SKF has grown to become a global industrial knowledge leader.



Over the years we have built on our expertise in bearings, extending it to seals, mechatronics, services and lubrication systems. Our knowledge network includes 46 000 employees, 15 000 distributor partners, offices in more than 130 countries, and a growing number of SKF Solution Factory sites around the world.

Research and development

We have hands-on experience in over forty industries, based on our employees' knowledge of real life conditions. In addition our world-leading experts and university partners who pioneer advanced theoretical research and development in areas including tribology, condition monitoring, asset management and bearing life theory. Our ongoing commitment to research and development helps us keep our customers at the forefront of their industries.



Meeting the toughest challenges

Our network of knowledge and experience along with our understanding of how our core technologies can be combined helps us create innovative solutions that meet the toughest of challenges. We work closely with our customers throughout the asset life cycle, helping them to profitably and responsibly grow their businesses.

Working for a sustainable future

Since 2005, SKF has worked to reduce the negative environmental impact from our own operations and those of our suppliers. Our continuing technology development introduced the SKF BeyondZero portfolio of products and services which improve efficiency and reduce energy losses, as well as enable new technologies harnessing wind, solar and ocean power. This combined approach helps reduce the environmental impact both in our own operations and in our customers'.

SKF Solution Factory makes SKF knowledge and manufacturing expertise available locally, to provide unique solutions and services to our customers.

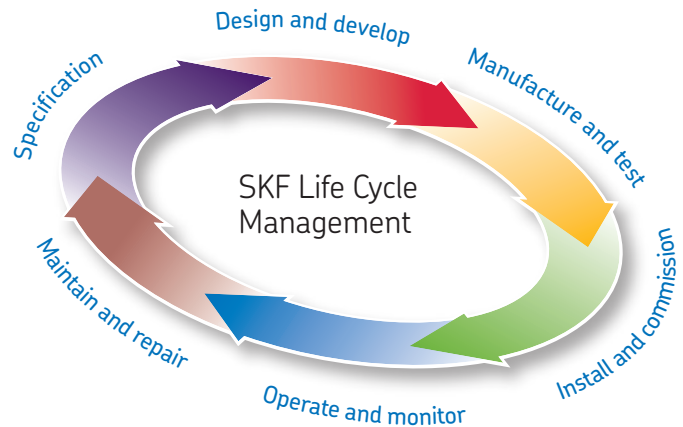


Working with SKF IT and logistics systems and application experts, SKF Authorized Distributors deliver a valuable mix of product and application knowledge to customers worldwide.



Our knowledge – your success

SKF Life Cycle Management is how we combine our technology platforms and advanced services, and apply them at each stage of the asset life cycle, to help our customers to be more successful, sustainable and profitable.



Working closely with you

Our objective is to help our customers improve productivity, minimize maintenance, achieve higher energy and resource efficiency, and optimize designs for long service life and reliability.



Bearings

SKF is the world leader in the design, development and manufacture of high performance rolling bearings, plain bearings, bearing units and housings.

Innovative solutions

Whether the application is linear or rotary or a combination of the two, SKF engineers can work with you at each stage of the asset life cycle to improve machine performance by looking at the entire application. This approach doesn't just focus on individual components like bearings or seals. It looks at the whole application to see how each component interacts with the next.



Machinery maintenance

Condition monitoring technologies and maintenance services from SKF can help minimize unplanned downtime, improve operational efficiency and reduce maintenance costs.

Design optimization and verification

SKF can work with you to optimize current or new designs with proprietary 3-D modeling software that can also be used as a virtual test rig to confirm the integrity of the design.



Sealing solutions

SKF offers standard seals and custom engineered sealing solutions to increase uptime, improve machine reliability, reduce friction and power losses, and extend lubricant life.



Mechatronics

SKF fly-by-wire systems for aircraft and drive-by-wire systems for off-road, agricultural and forklift applications replace heavy, grease or oil consuming mechanical and hydraulic systems.



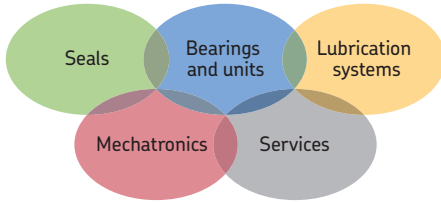
Lubrication solutions

From specialized lubricants to state-of-the-art lubrication systems and lubrication management services, lubrication solutions from SKF can help to reduce lubrication related downtime and lubricant consumption.



Actuation and motion control

With a wide assortment of products – from actuators and ball screws to profile rail guides – SKF can work with you to solve your most pressing linear system challenges.



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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