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



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The SKF brand now stands for more than ever before, and means more to you as a valued customer.

While SKF maintains its leadership as the hallmark of quality bearings throughout the world, new dimensions in technical advances, product support and services have evolved SKF into a truly solutions-oriented supplier, creating greater value for customers.

These solutions encompass ways to bring greater productivity to customers, not only with breakthrough application-specific products, but also through leading-edge design simulation tools and consultancy services, plant asset efficiency maintenance programmes, and the industry's most advanced supply management techniques.

The SKF brand still stands for the very best in rolling bearings, but it now stands for much more.

SKF – the knowledge engineering company

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SKF-SNFA 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 and SNFA joined their precision bearing expertise to develop 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-SNFA 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-SNFA 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-SNFA 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-SNFA 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.

Fig. 1

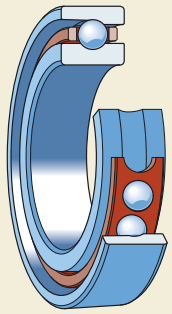


Fig. 2

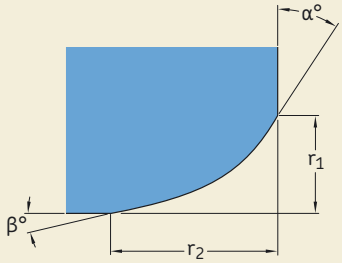


Fig. 3

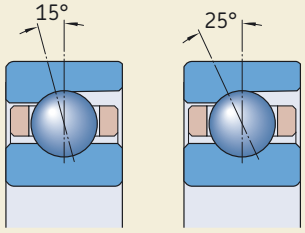
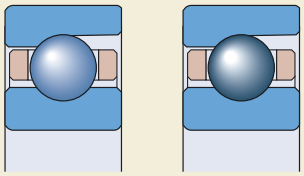


Fig. 4



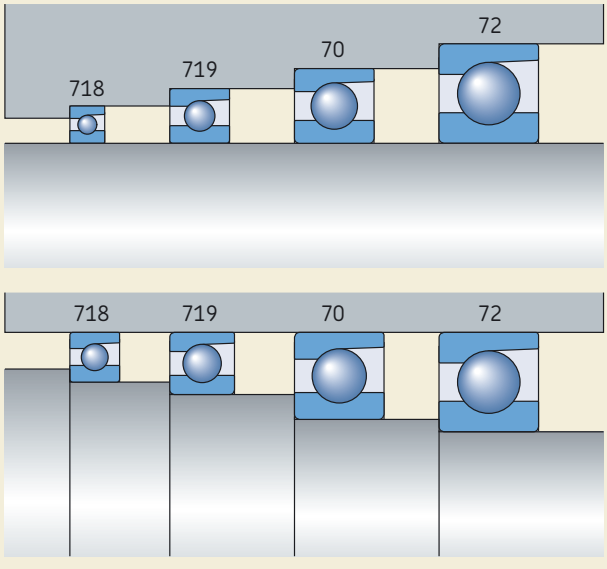
Single bearings and matched bearing sets

SKF-SNFA 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

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-SNFA 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

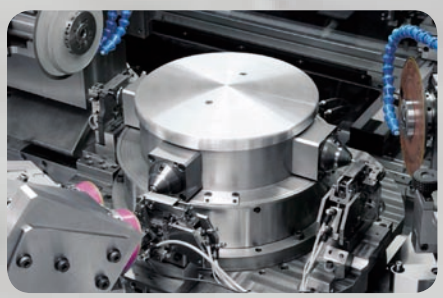
- High positioning accuracy
- Reliable positioning repeatability
- Low energy consumption
- Long service life
- Easy mounting
- Increased machine uptime
- High power density for compact designs

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-SNFA 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-SNFA 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-SNFA 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

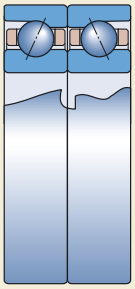
Example of the ordering possibilities for a three bearing arrangement with light preload

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..TD..*)	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..TD..*)	1 × 71810 CD/P4TBTL (*1 × SEA50 7CE1 TDL*)

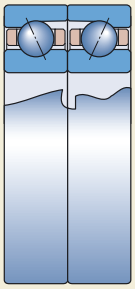
[1)] For additional information about designations, refer to **table 15** on **pages 28** and **29**.

Fig. 1

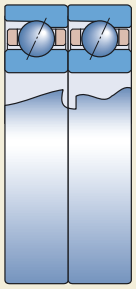
Bearing sets with 2 bearings



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

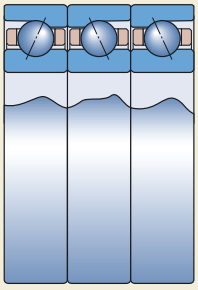


Face-to-face arrangement
Designation suffix DF (*FF*)

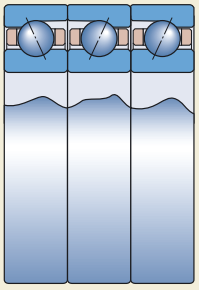


Tandem arrangement
Designation suffix DT (*T*)

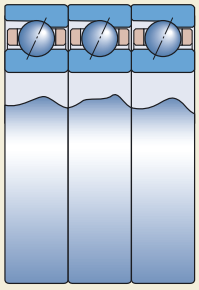
Bearing sets with 3 bearings



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

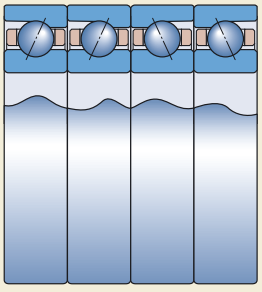


Face-to-face and tandem arrangement
Designation suffix TFT (*TF*)

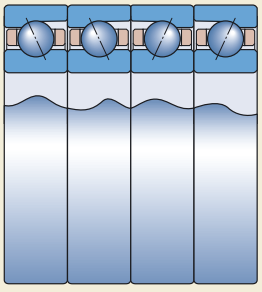


Tandem arrangement
Designation suffix TT (*3T*)

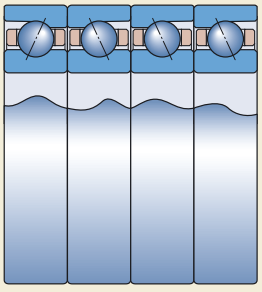
Bearing sets with 4 bearings



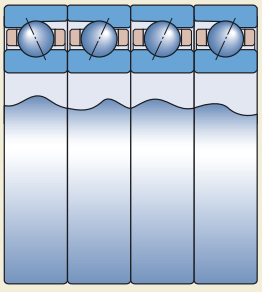
Tandem back-to-back arrangement
Designation suffix QBC (*TDT*)



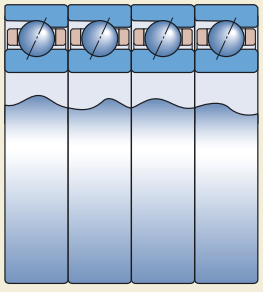
Tandem face-to-face arrangement
Designation suffix QFC (*TFT*)



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*)

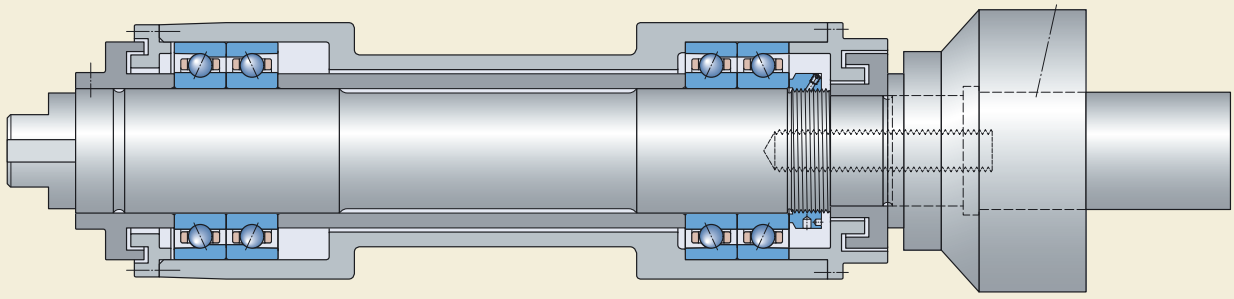
Application examples

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.

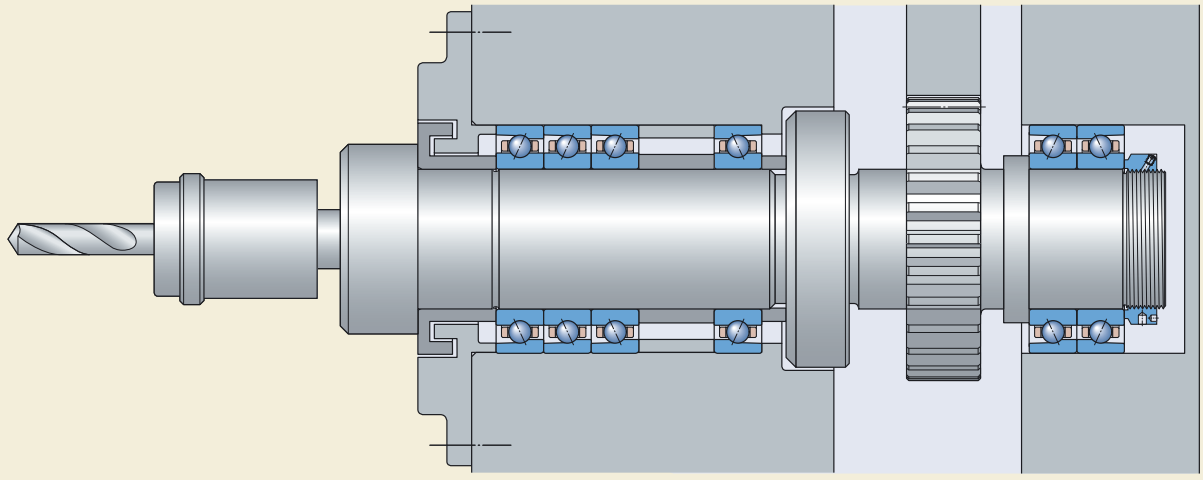
When higher speeds are demanded, as is the case for high-speed machining centres, milling operations and grinding applications, there is typically a compromise between rigidity and load carrying capacity. In these high-speed applications, controlling the heat generated by the bearings is an additional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

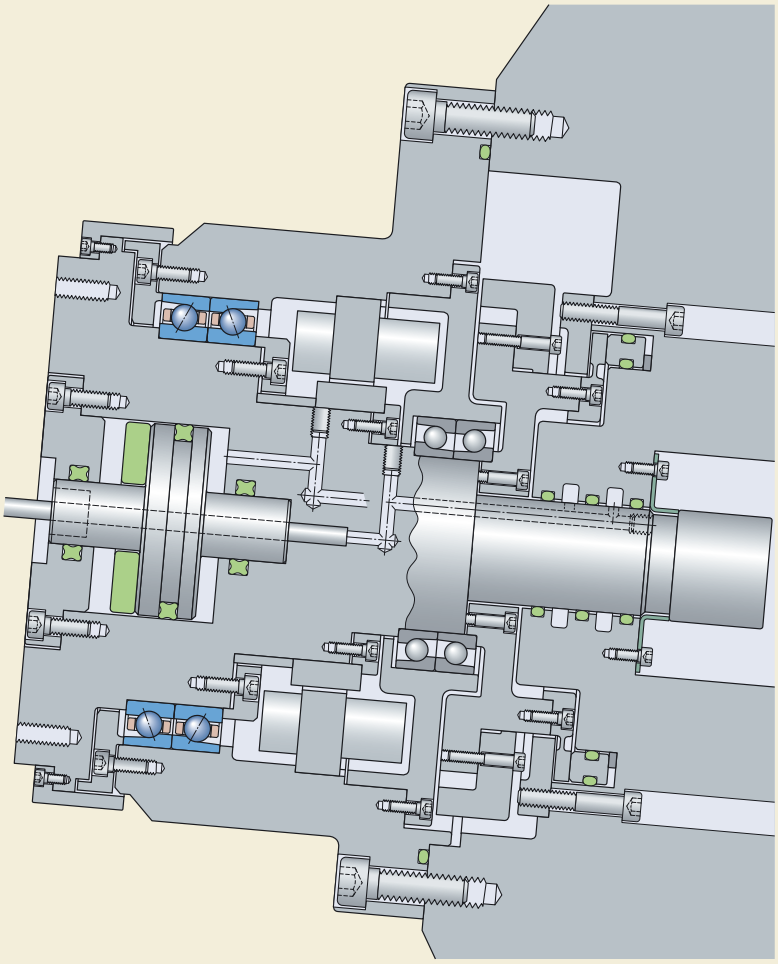
For any precision application, there is an optimal arrangement to provide the best possible combination of rigidity, load carrying capacity, heat generation and bearing service life.

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.

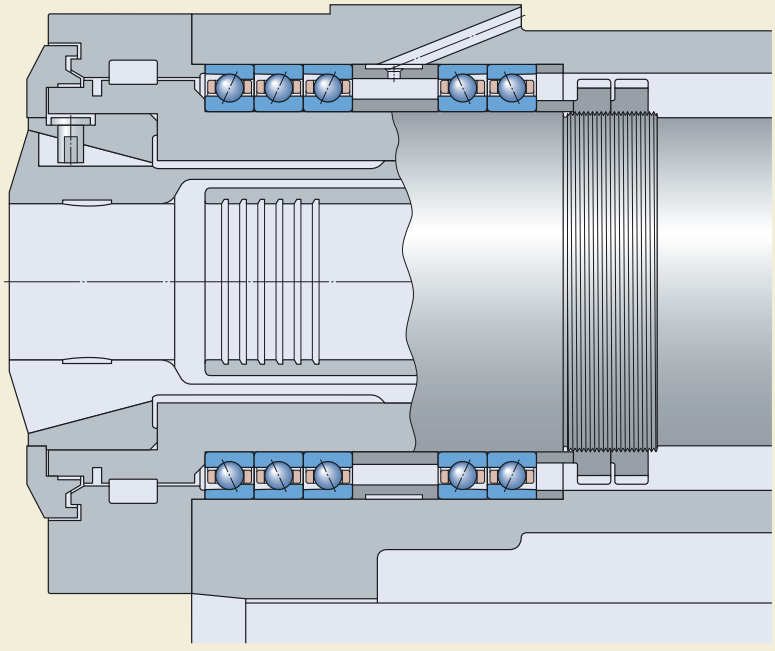


Multispindle drilling head
For multispindle drilling heads, where radial space is limited and axial rigidity is very important, super-precision angular contact ball bearings matched in a set of four bearings (arranged back-to-back and tandem), e.g. 71802 ACD/P4QBTA (SEA15 7CE3 3TD27,2DaN), incorporating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

Diagram 1

Factor K for initial grease fill estimation

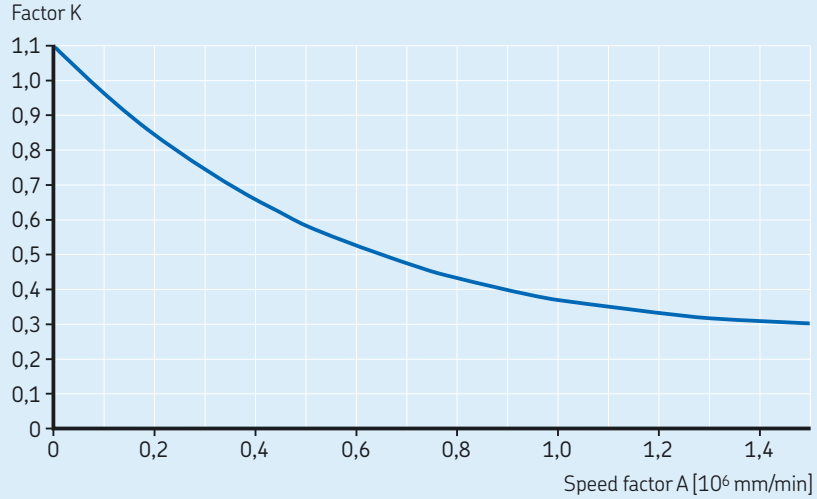


Table 1

Reference grease quantity for initial grease fill estimation

Bearing Bore diameter d	Size	**Reference grease quantity**[1] G_{ref}
mm	–	cm³
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.

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:

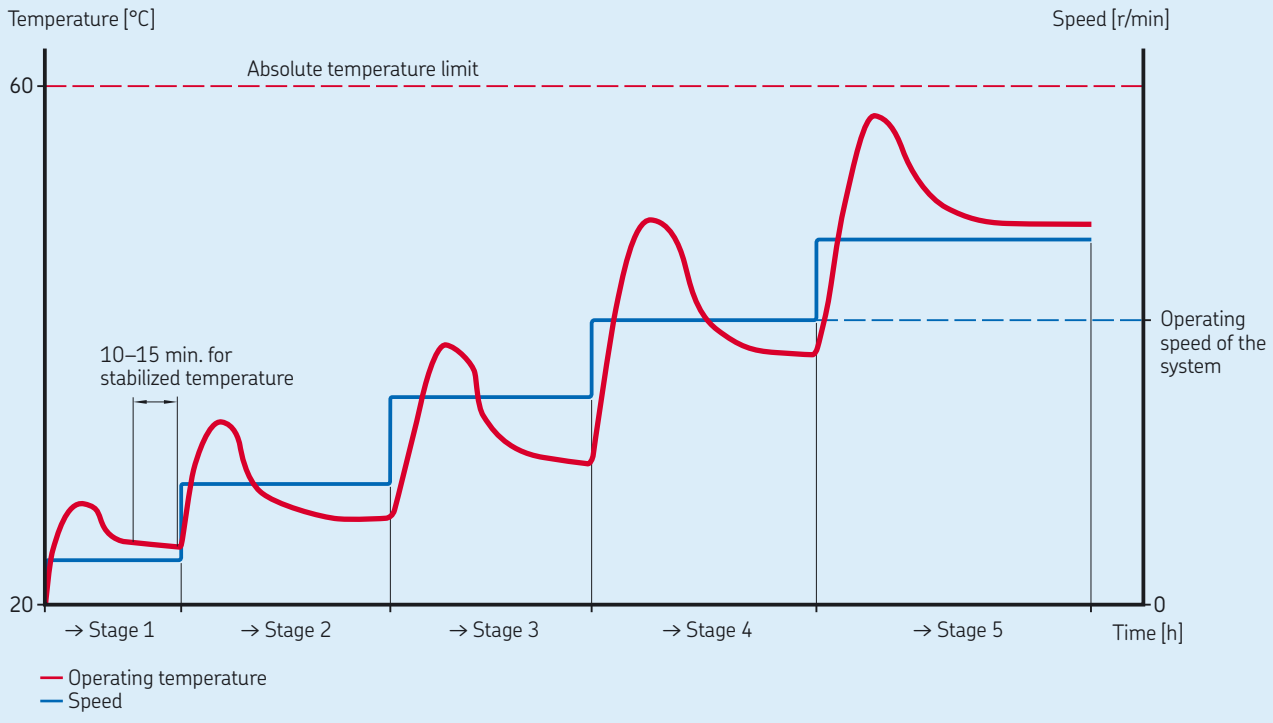
1. Select a low starting speed and a relatively small speed increment interval.
2. Decide on an absolute temperature limit, usually 60 to 65 °C. It is advisable to set the equipment with limit switches that will stop the equipment if the temperature rise exceeds the set limit.
3. Start operation at the 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 = oil flow rate [mm³/h]

d_m = bearing mean diameter

$= 0{,}5\ (d + D)$ [mm]

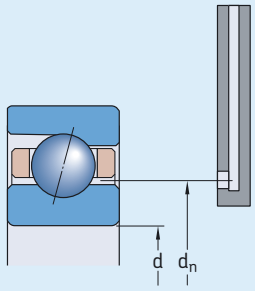
The calculated oil flow rate should be verified during operation and adjusted depending on the resulting temperatures.

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-SNFA super-precision angular contact ball bearings in the 718 (*SEA*) series for Dimension Series 18 are in accordance with ISO 15:1998.

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 15:1998; 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-SNFA 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 d		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	–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 D		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	–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**.

Table 2

Class P2 (ABEC 9) tolerances

Inner ring															
d		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															
D		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 cylindricity, 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**)

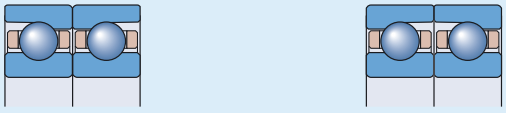
f_2 = a correction factor dependent on the preload class (→ **table 5, page 20**)

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		
d		A	B	C	A	B	C
mm	–	N					
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	1960	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.

Table 4

Bearing factor f for calculating the preload in mounted bearing sets

Bearing Bore diameter d	Size	**Bearing factor f** for all-steel bearings[1)]
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

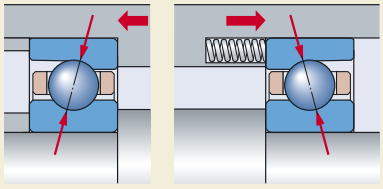
[1)] For hybrid bearings, f = 1.

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.

Fig. 1



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 5

Correction factors for calculating the preload in mounted bearing sets

Bearing series	**Correction factors** f_1	f_2 for preload class A	B	C	f_{HC}
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

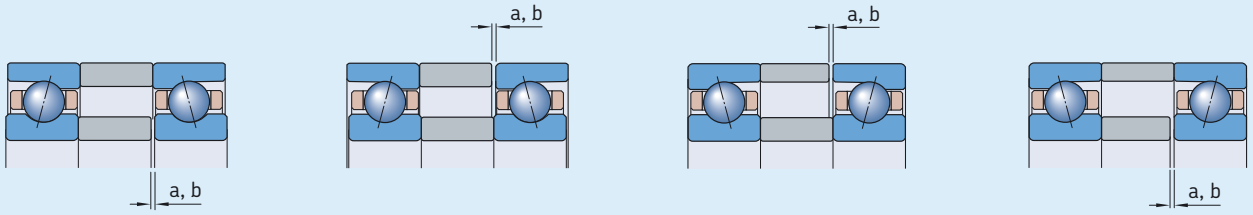
Guidelines for spacer ring modification

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

C

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*) a	 b	 718 CD (*SEA CE1*) a	 b
mm	–	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

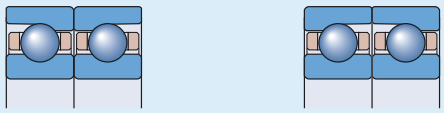
Matched bearing sets that are asymmetrical can be produced to the additional preload classes L, M or F (→ *Preload in bearings prior to mounting*, **page 18**). The axial stiffness for these bearing sets can be calculated by multiplying the values listed in **table 8** by the following factors:

- 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

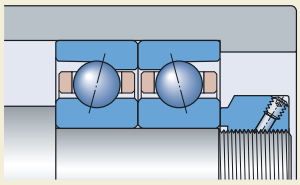


Table 9

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

Bearing Bore diameter	Size	**Minimum axial clamping force**	**Axial fitting force**
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 (→ **table 3**, **page 19**) [N]
G_m = preload in the mounted bearing pair (→ *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

$$P = F_r + Y_1F_a \quad \text{for } F_a/F_r \leq e$$
$$P = XF_r + Y_2F_a \quad \text{for } F_a/F_r > e$$

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_0F_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

$$P_0 = 0{,}5\ F_r + Y_0F_a$$

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

$$P_0 = F_r + Y_0F_a$$

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_0F_a/C_0	Calculation factors			
	e	X	Y	Y_0
For 15° contact angle designation suffix CD (*1*)				
≤ 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
≥ 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 ≤ 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-SNFA 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-SNFA 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.

Table 13

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

$2\ f_0F_a/C_0$	Calculation factors				
	e	X	Y_1	Y_2	Y_0
For 15° contact angle designation suffix CD (*1*)					
≤ 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
≥ 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 (*DD*)	0,80	–	0,65	–	0,40	–
	Face-to-face	DF (*FF*)	0,77	–	0,61	–	0,36	–
3	Back-to-back and tandem	TBT (*TD*)	0,69	0,72	0,49	0,58	0,25	0,36
	Face-to-face and tandem	TFT (*TF*)	0,63	0,66	0,42	0,49	0,17	0,24
4	Tandem back-to-back	QBC (*TDT*)	0,64	–	0,53	–	0,32	–
	Tandem face-to-face	QFC (*TFT*)	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-SNFA 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 from the mean outside diameter ΔD_m [µm]
6 Deviation from the mean bore diameter Δd_m [µm]
7 Thrust face mark (punched)
8 Serial number (bearing sets only)
9 "V-shaped" marking (matched bearing sets only)

The deviations from the mean outside and bore diameters are marked at the point of maximum wall thickness on their respective rings.

"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

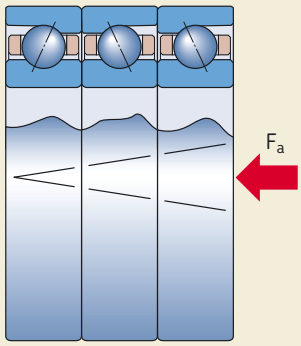
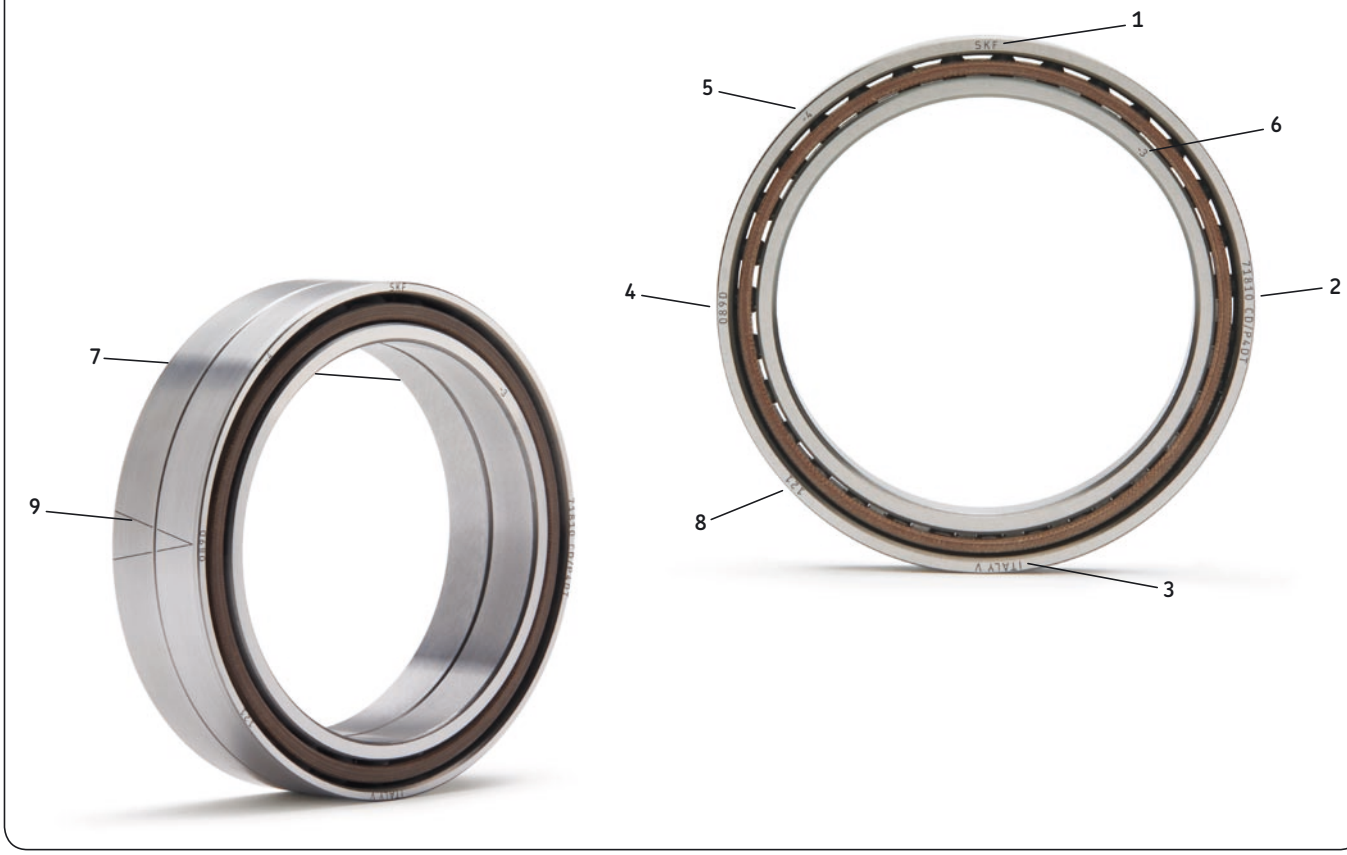


Fig. 4



Packaging

SKF-SNFA super-precision bearings are distributed in dual branded boxes (→ **fig. 6**). The boxes are marked with both the SKF and SNFA bearing designations. The box contains an instruction sheet with information about mounting bearing sets.

Designation system

The designation system for SKF-SNFA 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



Dual branded packaging for SKF-SNFA super-precision bearings

C

SKF designation system for SKF-SNFA 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	(×5) 20 mm bore diameter
to	
32	(×5) 160 mm bore diameter

Contact angle and internal design

CD	15° contact angle, basic design
ACD	25° contact angle, basic design

Single bearing

–	Standard (no designation suffix)
G_	Universally matchable with preload class

Cage

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

Ball material

–	Carbon chromium steel (no designation suffix)
HC	Bearing grade silicon nitride Si_3N_4 (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

Table 15

SNFA designation system for SKF-SNFA 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 Si_3N_4 (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

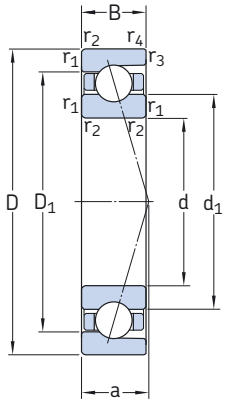
DD	Two bearings arranged back-to-back <>
FF	Two bearings arranged face-to-face ><
T	Two bearings arranged in tandem <<
DU	Two bearings for universal matching
TD	Three bearings arranged back-to-back and tandem <>>
TF	Three bearings arranged face-to-face and tandem >><
3T	Three bearings arranged in tandem <<<
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

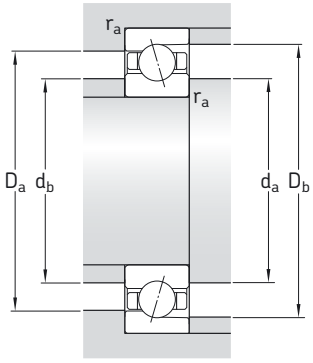
L	Light preload
M	Moderate preload
F	Heavy preload
..daN	Special preload

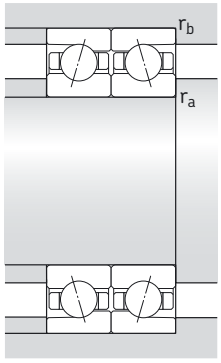
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Super-precision angular contact ball bearings in the 718 (*SEA*) series
d **10 – 45** mm



Principal dimensions			Basic load ratings dynamic	static	Fatigue load limit	Attainable speeds when lubricating with grease	oil-air	Mass	Designations SKF	SNFA
d	D	B	C	C_0	P_u					
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**

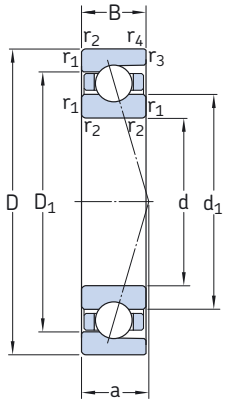




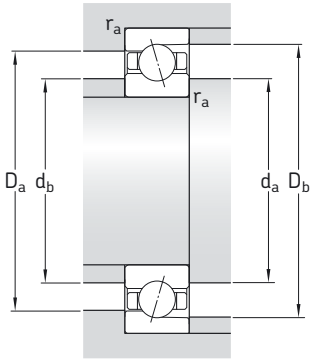
Dimensions						Abutment and fillet dimensions					Calculation factor
d	d_1 ~	D_1 ~	$r_{1,2}$ min	$r_{3,4}$ min	a	d_a, d_b min	D_a max	D_b max	r_a max	r_b max	f_0
mm						mm					–
10	13,1	16,1	0,3	0,15	4,5	12	17	18,2	0,3	0,15	15
	13,1	16,1	0,3	0,15	5,9	12	17	18,2	0,3	0,15	–
	13,1	16,1	0,3	0,15	4,5	12	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	–

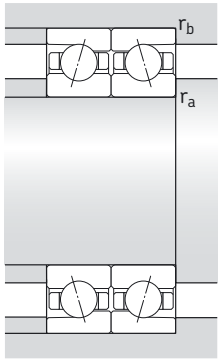
Super-precision angular contact ball bearings in the 718 (*SEA*) series

d **50 – 95** mm



Principal dimensions			Basic load ratings dynamic	static	Fatigue load limit	Attainable speeds when lubricating with grease	oil-air	Mass	Designations SKF	SNFA
d	D	B	C	C_0	P_u					
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**

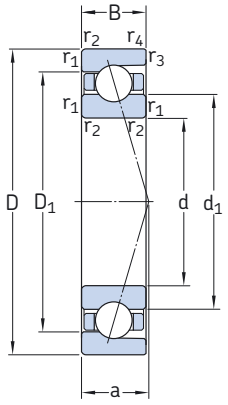




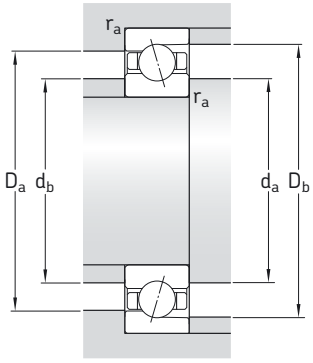
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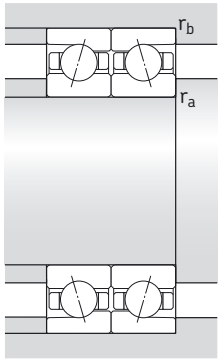
Dimensions						Abutment and fillet dimensions					Calculation factor
d	d_1 ~	D_1 ~	$r_{1,2}$ min	$r_{3,4}$ min	a	d_a, d_b min	D_a max	D_b max	r_a max	r_b max	f_0
mm						mm					–
50	55,1	60	0,3	0,15	11,2	52	63	64,2	0,3	0,15	17
	55,1	60	0,3	0,15	16,9	52	63	64,2	0,3	0,15	–
	55,1	60	0,3	0,15	11,2	52	63	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 dynamic	static	Fatigue load limit	Attainable speeds when lubricating with grease	oil-air	Mass	Designations SKF	SNFA
d	D	B	C	C_0	P_u					
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**





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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	–

Other SKF-SNFA super-precision bearings

In addition to the super-precision angular contact ball bearings presented in this brochure, the SKF-SNFA assortment includes super-precision angular contact thrust ball bearings for screw drives. The assortment comprises:

- single direction angular contact thrust ball bearings
- double direction angular contact thrust ball bearings
- cartridge units with a flanged housing

Single direction angular contact thrust ball bearings

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

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 with a flanged housing

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



Other precision bearings

For information about other precision bearings, refer to the SKF catalogue 6002 EN *High-precision bearings* and the SNFA General Catalogue.



SKF – the knowledge engineering company

From the company that invented the self-aligning ball bearing more than 100 years ago, SKF has evolved into a knowledge engineering company that is able to draw on five technology platforms to create unique solutions for its customers. These platforms include bearings, bearing units and seals, of course, but extend to other areas including: lubricants and lubrication systems, critical for long bearing life in many applications; mechatronics that combine mechanical and electronics knowledge into systems for more effective linear motion and sensorized solutions; and a full range of services, from design and logistics support to conditioning monitoring and reliability systems.

Though the scope has broadened, SKF continues to maintain the world's leadership in the design, manufacture and marketing of rolling bearings, as well as complementary products such as radial seals. SKF also holds an increasingly important position in the market for linear motion products, high-precision aerospace bearings, machine tool spindles and plant maintenance services.

The SKF Group is globally certified to ISO 14001, the international standard for environmental management, as well as OHSAS 18001, the health and safety management standard. Individual divisions have been approved for quality certification in accordance with ISO 9001 and other customer specific requirements.

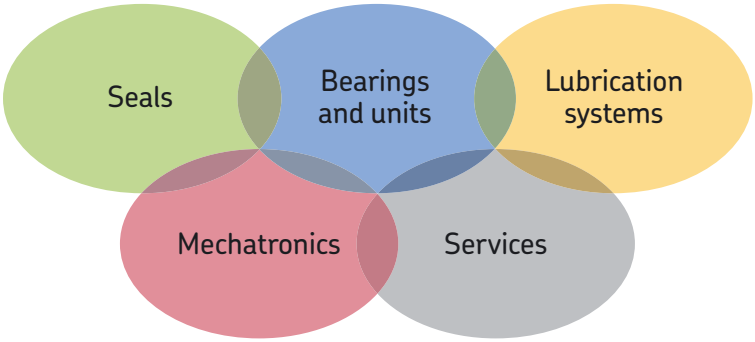
With over 100 manufacturing sites worldwide and sales companies in 70 countries, SKF is a truly international corporation. In addition, our distributors and dealers in some 15 000 locations around the world, an e-business marketplace and a global distribution system put SKF close to customers for the supply of both products and services. In essence, SKF solutions are available wherever and whenever customers need them. Overall, the SKF brand and the corporation are stronger than ever. As the knowledge engineering company, we stand ready to serve you with world-class product competencies, intellectual resources, and the vision to help you succeed.



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Evolving by-wire technology
SKF has a unique expertise in fast-growing by-wire technology, from fly-by-wire, to drive-by-wire, to work-by-wire. SKF pioneered practical fly-by-wire technology and is a close working partner with all aerospace industry leaders. As an example, virtually all aircraft of the Airbus design use SKF by-wire systems for cockpit flight control.

SKF is also a leader in automotive by-wire technology, and has partnered with automotive engineers to develop two concept cars, which employ SKF mechatronics for steering and braking. Further by-wire development has led SKF to produce an all-electric forklift truck, which uses mechatronics rather than hydraulics for all controls.







Harnessing wind power
The growing industry of wind-generated electric power provides a source of clean, green electricity. SKF is working closely with global industry leaders to develop efficient and trouble-free turbines, providing a wide range of large, highly specialized bearings and condition monitoring systems to extend equipment life of wind farms located in even the most remote and inhospitable environments.



Working in extreme environments
In frigid winters, especially in northern countries, extreme sub-zero temperatures can cause bearings in railway axleboxes to seize due to lubrication starvation. SKF created a new family of synthetic lubricants formulated to retain their lubrication viscosity even at these extreme temperatures. SKF knowledge enables manufacturers and end user customers to overcome the performance issues resulting from extreme temperatures, whether hot or cold. For example, SKF products are at work in diverse environments such as baking ovens and instant freezing in food processing plants.



Developing a cleaner cleaner
The electric motor and its bearings are the heart of many household appliances. SKF works closely with appliance manufacturers to improve their products' performance, cut costs, reduce weight, and reduce energy consumption. A recent example of this cooperation is a new generation of vacuum cleaners with substantially more suction. SKF knowledge in the area of small bearing technology is also applied to manufacturers of power tools and office equipment.



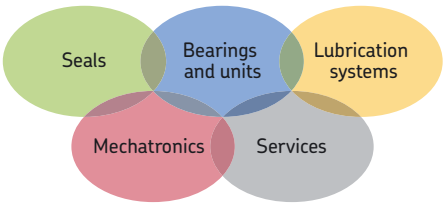
Maintaining a 350 km/h R&D lab
In addition to SKF's renowned research and development facilities in Europe and the United States, Formula One car racing provides a unique environment for SKF to push the limits of bearing technology. For over 50 years, SKF products, engineering and knowledge have helped make Scuderia Ferrari a formidable force in F1 racing. (The average racing Ferrari utilizes more than 150 SKF components.) Lessons learned here are applied to the products we provide to automakers and the aftermarket worldwide.



Delivering Asset Efficiency Optimization
Through SKF Reliability Systems, SKF provides a comprehensive range of asset efficiency products and services, from condition monitoring hardware and software to maintenance strategies, engineering assistance and machine reliability programmes. To optimize efficiency and boost productivity, some industrial facilities opt for an Integrated Maintenance Solution, in which SKF delivers all services under one fixed-fee, performance-based contract.



Planning for sustainable growth
By their very nature, bearings make a positive contribution to the natural environment, enabling machinery to operate more efficiently, consume less power, and require less lubrication. By raising the performance bar for our own products, SKF is enabling a new generation of high-efficiency products and equipment. With an eye to the future and the world we will leave to our children, the SKF Group policy on environment, health and safety, as well as the manufacturing techniques, are planned and implemented to help protect and preserve the earth's limited natural resources. We remain committed to sustainable, environmentally responsible growth.



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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