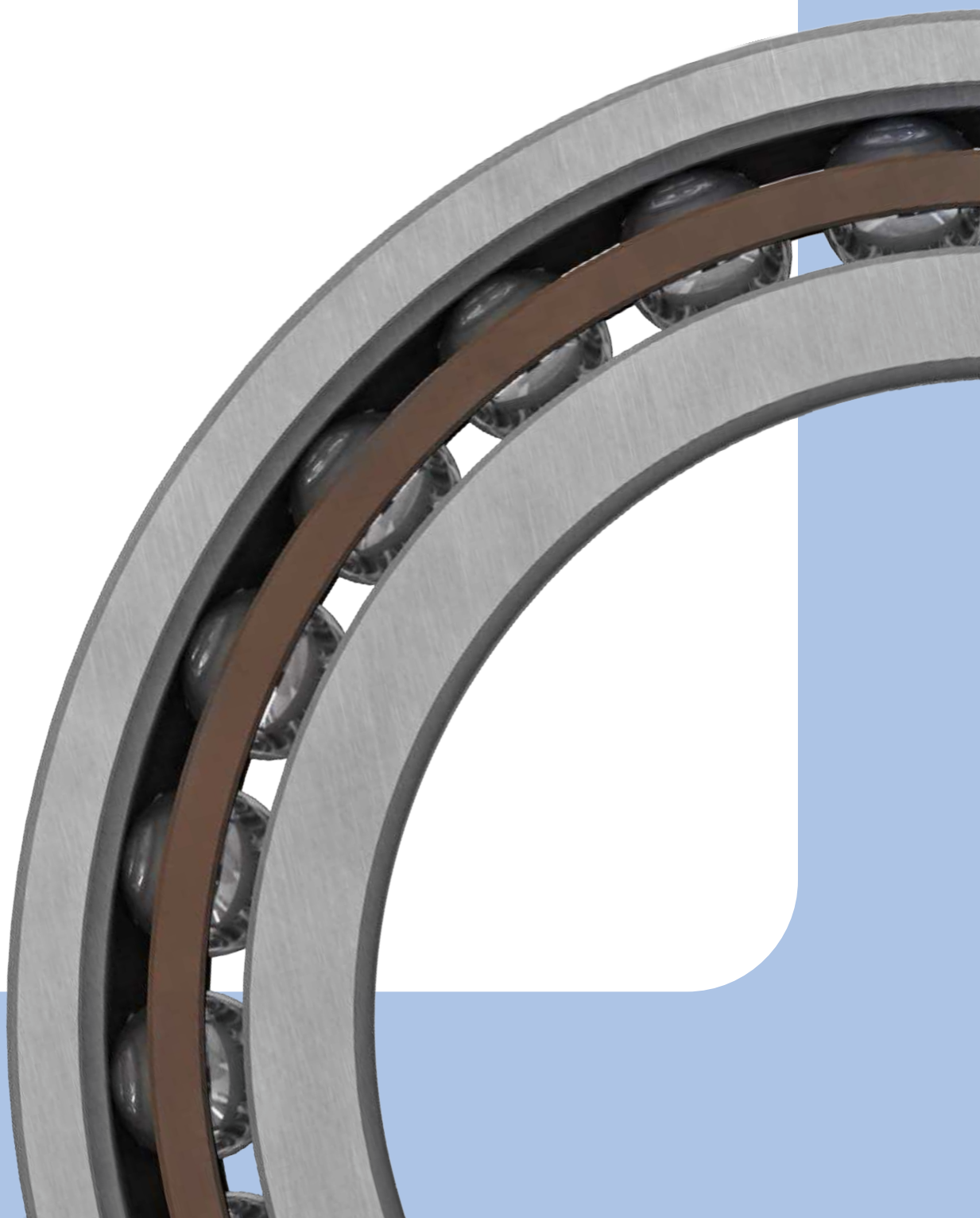
Super-precision angular contact ball bearings: High-speed, E design

719 .. E *(VEB)* and 70 .. E *(VEX)* series



Contents

SKF super-precision angular contact ball bearings in the 719 .. E *(VEB)* and 70 .. E *(VEX)* 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, as well as low noise and vibration levels are just some of the performance challenges.

To meet the ever-increasing performance requirements of high-speed precision applications, SKF has developed super-precision bearings in the 719 .. E *(VEB)* [1] and 70 .. E *(VEX)* series. Compared to high-speed B design bearings, high-speed E design bearings have a higher speed capability and they can accommodate heavier loads. This desirable combination makes bearings in the 719 .. E *(VEB)* and 70 .. E *(VEX)* series an excellent choice for demanding applications.

The bearings are characterized by:

- very high speed capability
- high degree of stiffness
- relatively high load carrying capacity
- extended bearing service life
- low heat generation
- compact cross section

Bearings in the 719 .. E *(VEB)* and 70 .. E *(VEX)* series provide high reliability and superior accuracy for applications such as high-speed machining centres, milling machines, internal grinding machines, and woodworking machines.

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

The assortment

The new, super-precision bearings in the 719 .. E *(VEB)* and 70 .. E *(VEX)* series are available in an extended range as follows:

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

Bearings in both series are manufactured to two tolerance classes and are available with three contact angles, two ball materials and two ring materials. Those suitable for universal matching or mounting in sets are produced to various preload classes, to meet almost all application requirements in terms of speed and rigidity. Matched bearing sets with a special preload can be supplied on request. Bearing variants for direct oil lubrication are available.

Bearings in the 719 .. E *(VEB)* and 70 .. E *(VEX)* series, like all angular contact ball bearings, are nearly always adjusted against a second bearing to balance the counterforces. To accommodate heavier loads and axial loads in both directions, the bearings are used in sets consisting typically of up to four bearings.

High-speed, E design bearings

Super-precision single row angular contact ball bearings in the 719 .. E *(VEB)* and 70 .. E *(VEX)* series are designed for very high operational speeds.

Features and benefits of SKF super-precision angular contact ball bearings: High-speed, E design

Features
- Open osculation
- High number of relatively large balls
- P4A or PA9A tolerance classes
- Optimized chamfer design
- ISO 19 and ISO 10 dimension series
- Optimized phenolic resin cage
- High-nitrogen stainless steel rings (NitroMax variant)
- Non-contact seals (sealed variant)
- Ready-to-mount (sealed variant)
- Relubrication-free (sealed variant)
- Lubrication features (direct oil lubrication variants)
- Asymmetrical inner and outer rings

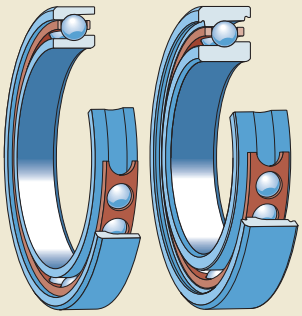
Benefits
- Very high speed capability
- Relatively high load carrying capacity, high degree of rigidity
- Superior running accuracy, short running-in time
- Facilitated mounting
- Compact cross sections
- Improved behaviour at high speeds
- Extended bearing service life, superior corrosion resistance
- Prevent entry of contaminants, high-speed capability
- Reduced mounting time
- Reduced maintenance
- Optimized oil lubrication
- Accommodate radial loads and axial loads in one direction, good permeability for lubrication

Features of E design bearings include:

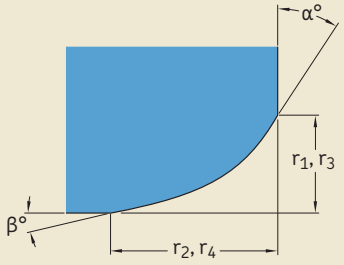
- asymmetrical inner and outer rings
- a high number of relatively large balls
- an optimized lightweight cage with optimized guiding clearance
- an optimized chamfer design
- an open osculation

The asymmetrical bearing rings enable the bearings to accommodate radial loads and axial loads in one direction. The bearings have a high number of relatively large balls for increased load carrying capacity. The bearings have an outer ring shoulder-guided cage made of fabric reinforced phenolic resin, designed to enable good lubricant supply to the ball/raceway contact areas. The guiding clearance between the cage and the outer ring is optimized for improved behaviour at high speeds. Depending on the series and size, the shape of some of the chamfers on the inner and outer rings is optimized for improved mounting accuracy. As a result, mounting is not only facilitated, but there is also less risk of damage to associated components. The open osculation of E design bearings enables very high speed capability.

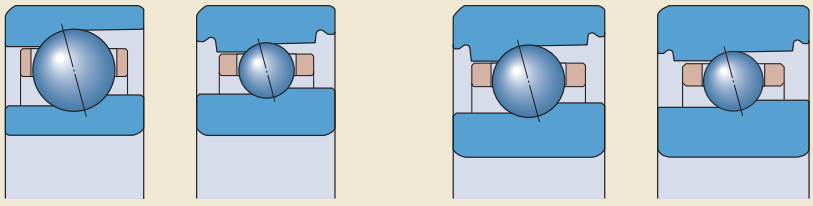
Open bearings in the 70 .. E *(VEX)* series with a bore diameter d ≥ 10 mm typically have seal grooves in the outer rings.



E design bearings accommodate very high speeds and relatively high loads.



Optimized design of the bearing ring chamfers facilitates mounting.



High-speed E design bearings can accommodate higher speeds and heavier loads, compared to high-speed B design bearings.

Bearing series

The assortment of super-precision bearings presented in this brochure includes two ISO dimension series:

- the extremely light 19 series
- the light 10 series

Bearings in both these series are suitable for very high operational speeds and where there is tight radial mounting space.

Bearing variants

Based on the operating conditions in precision applications, bearing requirements can vary. As a result, there are many variants of SKF super-precision angular contact ball bearings in the 719 .. E *(VEB)* and 70 .. E *(VEX)* series to choose from.

Contact angles

Standard bearings are manufactured with the following contact angles:

- a 15° contact angle, designation suffix CE *(1)*
- a 25° contact angle, designation suffix ACE *(3)*

Bearings with an 18° contact angle, designation suffix FE *(2)*, are available on request.

With three contact angles to choose from, designers can optimize their application based on axial load, speed and rigidity requirements. A larger contact angle provides a higher degree of axial stiffness and a higher axial load carrying capacity. However, this reduces speed capability.

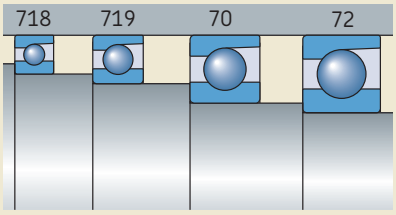
Ball materials

Standard bearings are available with:

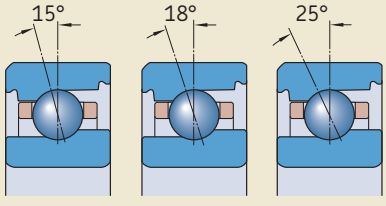
- steel balls, no designation suffix
- ceramic (bearing grade silicon nitride) balls, designation suffix HC *(/NS)*

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 comparably sized 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 bearing and grease service life.

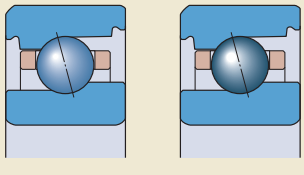
Series comparison
When increased system rigidity is required, bearings in the 719 series accommodate a larger shaft diameter for a given outside diameter, compared to bearings in the 70 series.



Three contact angles accommodate different axial load, speed and rigidity requirements.



The bearings are available in an all-steel and hybrid variant.



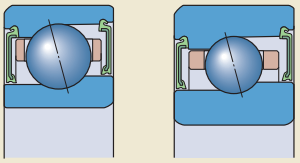
Sealed bearings

Bearings in most sizes can be supplied with an integral seal fitted on both sides and filled with premium grease. The seal forms an extremely narrow gap with the cylindrical surface of the inner ring shoulder.

When compared to bearing arrangements with open bearings and external seals, those with sealed bearings provide a number of advantages including:

- extended bearing service life
- reduced need for maintenance
- reduced inventory
- reduced risk of lubricant contamination during mounting and operation

Sealed bearings are identified by the designation prefix S *(suffix /S)*.



S719 E *(VEB /S)*

S70 E *(VEX /S)*

Most sizes are available in a sealed variant

Bearings made from NitroMax steel

Bearings in the 719 .. E *(VEB)* and 70 .. E *(VEX)* series can be supplied with rings made from NitroMax steel. NitroMax is a new generation high-nitrogen stainless steel with superior corrosion resistance, enhanced fatigue strength and a high degree of impact toughness. This ultra-clean steel can extend bearing service life in applications under good (full-film) as well as critical (thin-film) lubrication conditions.

Standard bearings made from NitroMax steel are supplied with ceramic balls. The combined properties of the NitroMax steel rings and ceramic balls greatly improve bearing performance, enabling these bearings to run several times longer than conventional hybrid bearings.

Sealed hybrid bearings made from NitroMax steel are identified by the designation prefix SV *(suffix /S/XN)*.

Open bearings for direct oil lubrication

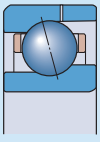
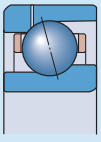
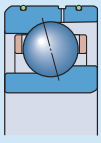
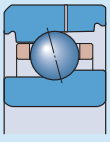
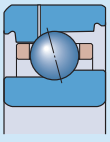
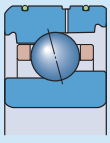
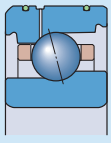
To accommodate direct oil lubrication, the outer ring of open bearings can be manufactured with two lubrication holes. Additional features are available, depending on the bearing series and size.

Single bearings and matched bearing sets

Bearings in 719 .. E *(VEB)* and 70 .. E *(VEX)* series are available, standard, as:

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

Bearing variants for direct oil lubrication

Description	Bearing variant for open bearings in the series 719 .. E *(VEB)*			70 .. E *(VEX)*			
							
Designation suffix	H *(H)*	H1 *(H1)*	L *(GH)*	H *(H)*	H1 *(H1)*	L *(GH)*	L1 *(G1)*
Bore diameter range d [mm]	8 to 35	40 to 120	20 to 120	6 to 17[1)]	20 to 120	20 to 120	20 to 120
Lubrication features	Two lubrication holes in the outer ring		Annular groove and two lubrication holes in the outer ring	Two lubrication holes in the outer ring		Annular groove and two lubrication holes in the outer ring	
Sealing features	None		Two annular grooves in the outer ring fitted with O-rings	None		Two annular grooves in the outer ring fitted with O-rings	

[1)] Bearings in the 70 .. E *(VEX)* series with a bore diameter d = 6 to 9 mm do not have seal grooves in the outer ring, as shown in the illustration above.

Applications

Machine tool applications, such as high-speed milling machines, machining centres and grinding machines, require high positioning accuracy and low levels of heat generation. The ability of bearings in the 719 .. E *(VEB)* and 70 .. E *(VEX)* series to meet these requirements and still provide a high degree of rigidity at very high operational speeds, makes them an excellent solution for these and similar applications.

In the highly contaminated environment of a machine tool spindle, one of the primary causes of premature bearing failure is the ingress of solid contaminants and/or cutting fluid into the bearing cavity. To eliminate this problem, sealed bearings in the S719 .. E *(VEB .. /S)* and S70 .. E *(VEX .. /S)* series are an excellent solution.

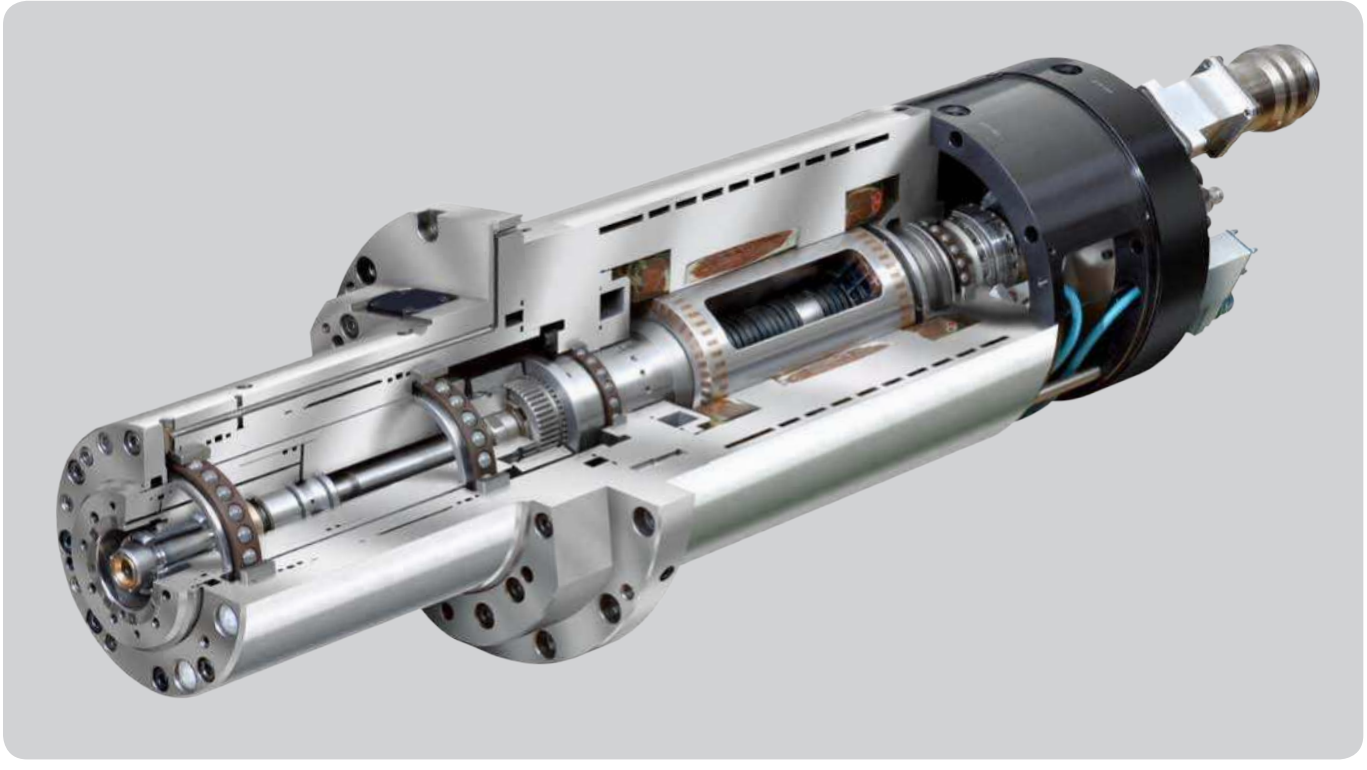
Where maximum speeds are required, bearing variants for direct oil lubrication combined with ceramic balls provide optimum performance.

Applications
- High-speed machining centres (horizontal and vertical)
- High-speed milling machines
- High-speed internal grinding machines
- High-speed spindles for PCB drilling
- Turbomolecular pumps
- Woodworking machines

Requirements
- High-speed capability
- High positioning accuracy
- High degree of system rigidity
- Low energy consumption
- Long service life
- Facilitated mounting
- Increased machine uptime
- High power density for compact designs
- Effective sealing against contaminants

Solution

SKF super-precision angular contact ball bearings in the 719 .. E (VEB) and 70 .. E (VEX) series



Bearing arrangement design

Bearing arrangements using SKF super-precision angular contact ball bearings in the 719 .. E *(VEB)* and 70 .. E *(VEX)* series 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**.

Single bearings

Bearings in the 719 .. E *(VEB)* and 70 .. E *(VEX)* series are available as single (stand-alone) bearings or single, universally matchable bearings. When ordering single bearings, indicate the number of individual bearings required.

Single bearings

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

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

Single, 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 are identified by the designation suffix G *(U)*.

Bearing sets

Bearings in the 719 .. E *(VEB)* and 70 .. E *(VEX)* series are available as matched bearing sets or as sets of universally matchable bearings. 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 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 bearing arrangements and six preload classes for asymmetrical bearing 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

Table 1

Example of the ordering possibilities for a three-bearing arrangement

Design criteria	What to order	Bearing designation[1)]	Order example
Bearing arrangement is not known	Three single, universally matchable bearings	70 .. EG../P4A *(VEX .. 7CE .. U..)*	3 x 7014 CEGA/P4A *(3 x VEX 70 7CE1 UL)*
Bearing arrangement is not known and improved load distribution is desirable	A set of three universally matchable bearings	70 .. E/P4ATG.. *(VEX .. 7CE .. TU..)*	1 x 7014 CE/P4ATGA *(1 x VEX 70 7CE1 TUL)*
Bearing arrangement is known and maximum rigidity is required	Three bearings in a matched set	70 .. E/P4AT.. *(VEX .. 7CE .. T..)*	1 x 7014 CE/P4ATBTA *(1 x VEX 70 7CE1 TD17,5DaN)*
Bearing arrangement is known and maximum speed is required	Three bearings in a matched set	70 .. E/P4AT.. *(VEX .. 7CE .. T..)*	1 x 7014 CE/P4ATBTL *(1 x VEX 70 7CE1 TDL)*

[1)] For additional information about designations, refer to **table 17** on **pages 32** and **33**.

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, sets of universally matchable bearings are identified by the designation suffix G *(U)*, but their positions in the designation differ (→ **table 1**).

Type of arrangement

Universally matchable bearings and matched bearing sets can be arranged in various configurations depending on the stiffness, rigidity and load requirements of the application. The possible configurations 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

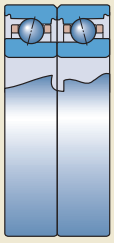
In a face-to-face bearing arrangement, the load lines converge toward the bearing axis. Axial loads acting in both directions can be accommodated, but only by one bearing or bearing set in one direction each. Face-to-face arrangements are less suitable to accommodate tilting moments.

Tandem bearing arrangement

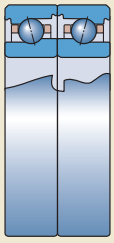
The axial load carrying capacity of a bearing arrangement can be increased by adding bearings mounted in tandem. In a tandem bearing arrangement, the load lines are parallel so that radial and axial loads are shared equally by the bearings in the set. The bearing set can only accommodate axial loads 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.

Fig. 1

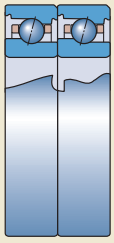
Bearing sets with 2 bearings



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

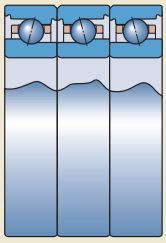


Face-to-face arrangement
Designation suffix DF *(FF)*

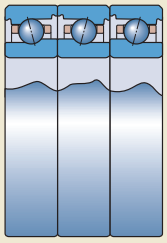


Tandem arrangement
Designation suffix DT *(T)*

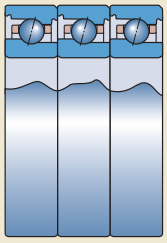
Bearing sets with 3 bearings



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

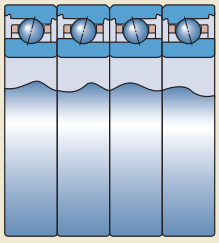


Face-to-face and tandem arrangement
Designation suffix TFT *(TF)*

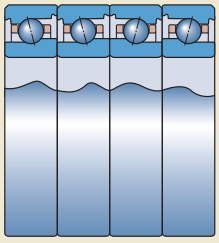


Tandem arrangement
Designation suffix TT *(3T)*

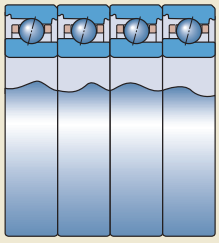
Bearing sets with 4 bearings



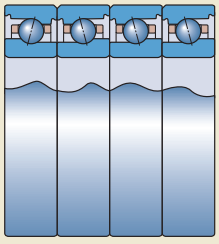
Tandem back-to-back arrangement
Designation suffix QBC *(TDT)*



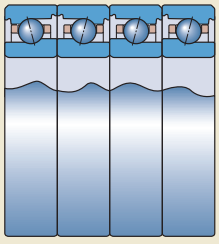
Tandem face-to-face arrangement
Designation suffix QFC *(TFT)*



Tandem arrangement
Designation suffix QT *(4T)*



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

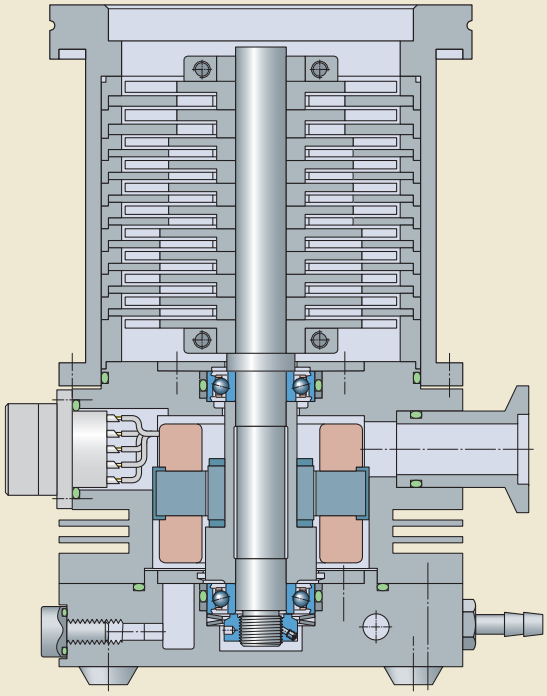


Face-to-face and tandem arrangement
Designation suffix QFT *(3TF)*

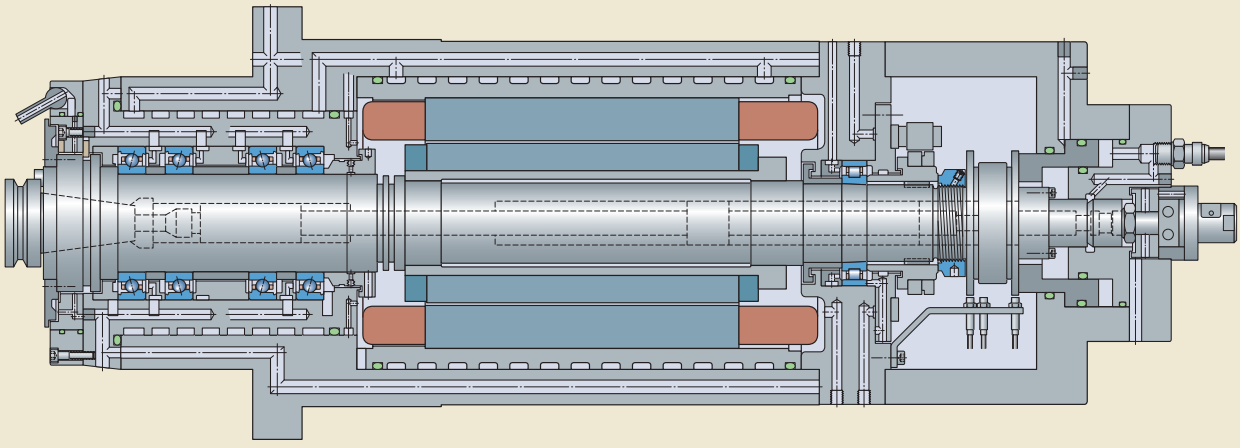
Application examples

Super-precision angular contact ball bearings are common in, but not limited to, machine tool spindles. Depending on the type of machine tool and its intended purpose, spindles may require different bearing arrangements.

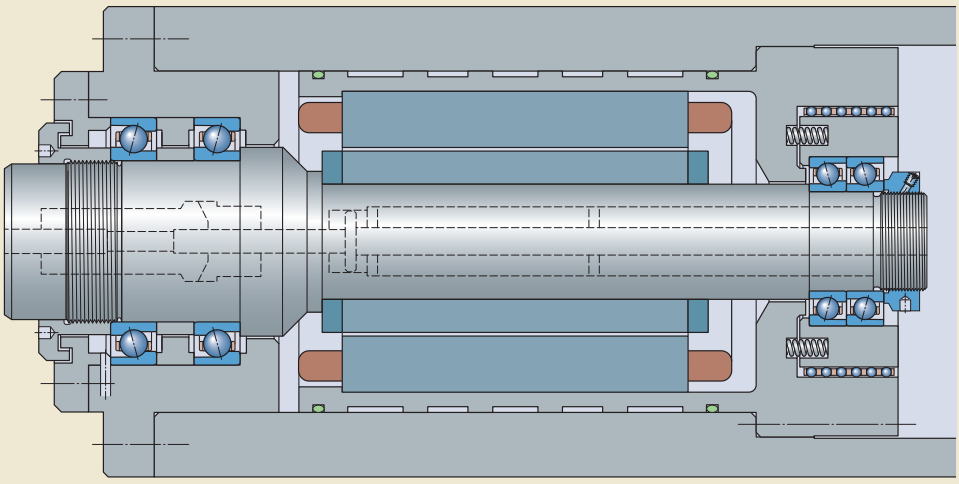
When very high operational speeds are required, as is the case for high-speed machining centres, milling operations and grinding applications, there is typically a compromise between rigidity and load carrying capacity. For many of these applications, there is an optimal bearing arrangement using bearings in the 719 .. E *(VEB)* and 70 .. E *(VEX)* series to provide the best possible combination of rigidity, load carrying capacity, heat generation and bearing service life. These bearings also enable the design of compact bearing arrangements, which is beneficial where radial space is limited.



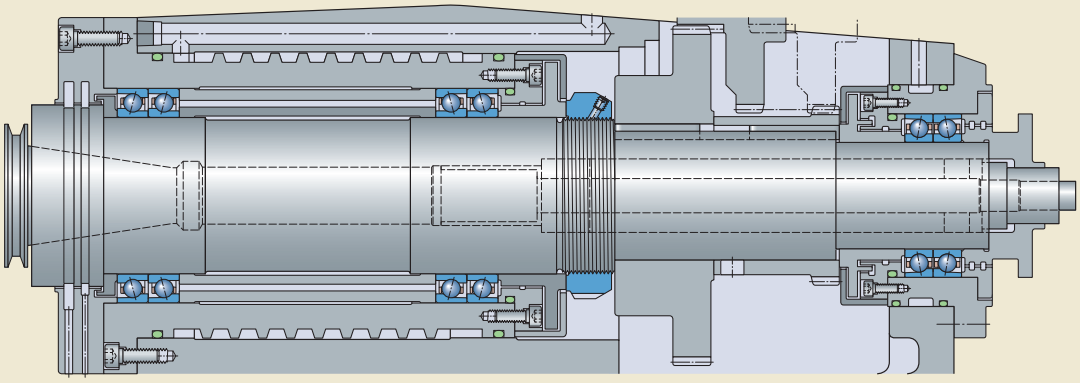
Turbomolecular pump
In turbomolecular pumps, high-speed capability, low vibration levels and long service life are stringent operational requirements. This grease-lubricated pump uses two hybrid super-precision angular contact ball bearings, arranged face-to-face, e.g. 7002 CE/HCP4A (VEX 15 /NS 7CE1). The rotor shaft bearings are preloaded with spring washers.



Electro-spindle in a horizontal machining centre
Machining centres typically operate at high speeds, under relatively high loads. In this spindle, the tool end has a matched set of four super-precision angular contact ball bearings mounted in a tandem back-to-back arrangement, e.g. 7014 CE/P4AQBCA (VEX 70 7CE1 TDTA), separated by a set of precision-matched spacer rings. Each bearing is lubricated with oil-air via a separate nozzle. A super-precision single row cylindrical roller bearing, e.g. N 1011 KPHA/SP, is at the non-tool end.



Electro-spindle for an internal grinding machine
A high-speed internal grinding machine requires a high degree of system rigidity. Often, radial space is limited. This spindle has two tandem pairs of super-precision angular contact ball bearings, mounted in a back-to-back arrangement, e.g. 71912 CE/P4ADT (VEB 60 7CE1 T) and 71908 CE/P4ADT (VEB 40 7CE1 T). The bearings at the non-tool end are preloaded with springs.



Horizontal machining centre
This spindle, which operates at very high speeds, uses a matched set of four super-precision angular contact ball bearings mounted in a tandem back-to-back arrangement, e.g. 71922 CE/P4AQBCA (VEB 110 7CE1 TDTL), separated by a set of precision-matched spacer rings. The non-tool end has a matched set of high-precision angular contact ball bearings mounted back-to-back, e.g. 7015 CD/P4ADBB (EX 75 7CE1 DDM).

Lubrication

Heat resulting from friction is a constant threat to production equipment. One way to reduce heat and the wear associated with friction, particularly in bearings, is to be sure that the correct quantity of the appropriate lubricant reaches all necessary parts.

Grease lubrication

Open bearings

In most applications with open bearings in the 719 .. E *(VEB)* and 70 .. E *(VEX)* series, grease with a mineral base oil and lithium thickener is suitable. These greases, which adhere well to the bearing surfaces, can accommodate operating temperatures ranging from –30 to +100 °C. For bearing arrangements that operate at very high speeds and temperatures, and where long service life is required, the use of grease based on a synthetic oil, e.g. the diester oil based grease SKF LGLT 2, has been proven effective.

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 series and 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 for open bearings can be estimated by

$$G = K\, G_{ref}$$

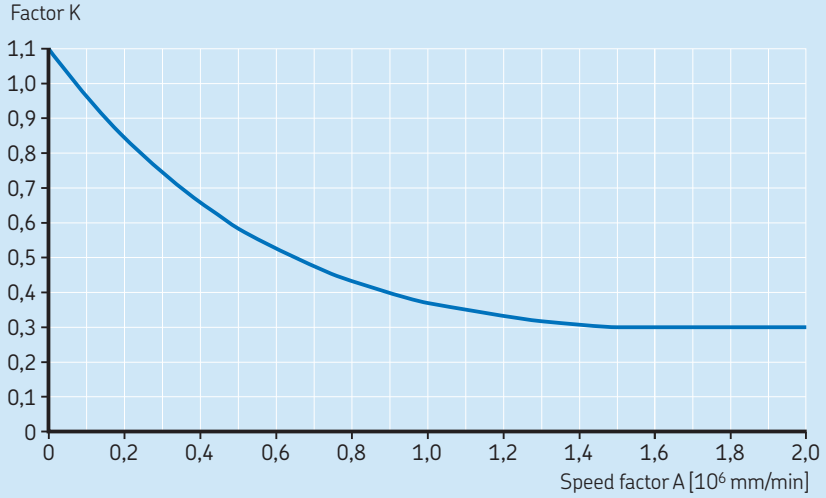
where
G = initial grease fill [cm³]
K = a calculation factor dependent on the speed factor A (→ **diagram 1**)
G_{ref} = reference grease quantity (→ **table 1**) [cm³]

Sealed bearings

Sealed bearings in the S719 .. E *(VEB .. /S)* and S70 .. E *(VEX .. /S)* series are filled with a high-grade, low viscosity grease that fills approximately 15% of the free space in the bearing. The bearings are relubrication-free under normal operating conditions.

Diagram 1

Factor K for initial grease fill (estimated)



The grease is characterized by:

- high-speed capability
- excellent ageing resistance
- very good rust inhibiting properties

The technical specifications of the grease are provided in **table 2**.

Running-in of open and sealed, grease lubricated bearings

A grease lubricated super-precision bearing 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. For open bearings, 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 (→ *Adjusting preload with spacer rings*, **page 23**).

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** on **page 16**).

Super-precision bearings can typically operate with a minimum quantity of lubricant when properly run-in, enabling the lowest frictional moment and temperature to be achieved. Grease that collects on each side of the bearing acts as a reservoir, enabling oil to bleed into the raceway to provide effective 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. For additional information about running-in

procedures, refer to the *SKF Interactive Engineering Catalogue* available online at www.skf.com.

Oil lubrication

Oil lubrication is recommended for open bearings in the 719 .. E *(VEB)* and 70 .. E *(VEX)* series where very high speeds preclude the use of grease as a lubricant.

Oil-air lubrication method

In some precision applications, the very 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 injector. Most designs include special spacers that incorporate the oil nozzles.

Guidelines for the quantity of oil to be supplied to each bearing for very 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 (→ **fig. 1**), where it is delivered to the bearings. The oil nozzles should be positioned correctly (→ **table 3** on **page 16**) to make sure that the oil is 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 pre-

Table 1

Reference grease quantity for initial grease fill estimation

Bearing Bore diameter d	Size	**Reference grease quantity**[1] for open bearings in the series 719 .. E *(VEB)* G_{ref}	70 .. E *(VEX)*
mm	–	cm³	
6	**6**	–	0,09
7	**7**	–	0,11
8	**8**	0,09	0,17
9	**9**	0,09	0,19
10	**00**	0,1	0,28
12	**01**	0,1	0,31
15	**02**	0,2	0,5
17	**03**	0,2	0,68
20	**04**	0,5	1,1
25	**05**	0,6	1,3
30	**06**	0,6	1,7
35	**07**	0,8	2,4
40	**08**	1,4	2,8
45	**09**	1,5	3,4
50	**10**	1,7	4,1
55	**11**	2,3	5
60	**12**	2,5	5,3
65	**13**	2,6	6,2
70	**14**	4,3	8,2
75	**15**	4,5	8,6
80	**16**	4,8	12
85	**17**	6,7	12
90	**18**	7	14
95	**19**	7,3	17
100	**20**	10	17
110	**22**	11	23
120	**24**	15	28

[1] Refers to a 30% filling grade.

Fig. 1

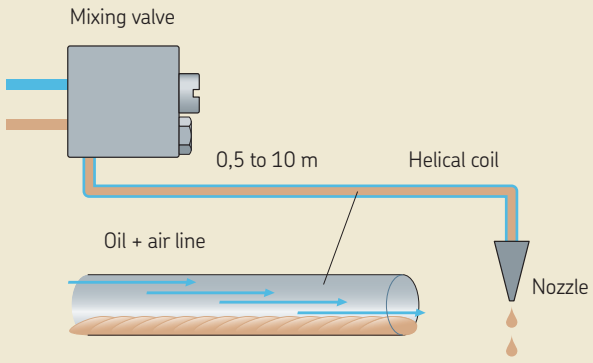


Table 2

Technical specifications of the grease in sealed bearings

Properties	**Grease specification**
Thickener	Special lithium soap
Base oil type	Ester/PAO
NLGI consistency class	2
Temperature range	
[°C]	–40 to +120
[°F]	–40 to +250
Kinematic viscosity [mm²/s]	
at 40 °C	25
at 100 °C	6

vents particles > 5 µm from reaching the bearings should also be incorporated.

Direct oil lubrication

For very high operational speeds, the injection of small amounts of oil-air into the bearing is beneficial. With this method, lubricant dispersion is prevented, as the lubricant is supplied directly and safely to the ball/raceway contact areas through the outer ring. As a result, lubricant consumption is minimized and bearing performance is improved.

There are three bearing variants in the 719 .. E *(VEB)* series and four bearing variants in the 70 .. E *(VEX)* series for direct oil lubrication (→ *Bearing variants*, **page 6**). The positions of the lubrication and sealing features in these bearings are provided in **table 4**.

To select the most appropriate variant for direct oil lubrication, keep the following in mind:

- Bearings with an annular groove in the outer ring that coincides with the two lubrication holes enable a more reliable supply of lubricant through the outer ring, compared to those without an annular groove.
- Bearings with lubrication holes manufactured on the thicker bearing shoulder side enable the lubricant to be supplied very close to the ball/raceway contact areas. These bearings can therefore be used to achieve maximum speeds.
- To prevent lubricant leakage between the bearing outside diameter and the housing bore, bearings fitted with O-rings in the outer ring are an excellent solution as no additional machining is required. When bearings without this sealing feature are used, SKF recommends machining the housing bore and incorporating O-rings into the bearing arrangement design (→ **fig. 2**).

Fig. 2

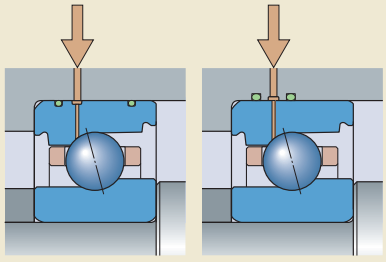


Diagram 2

Graphic representation of a running-in procedure

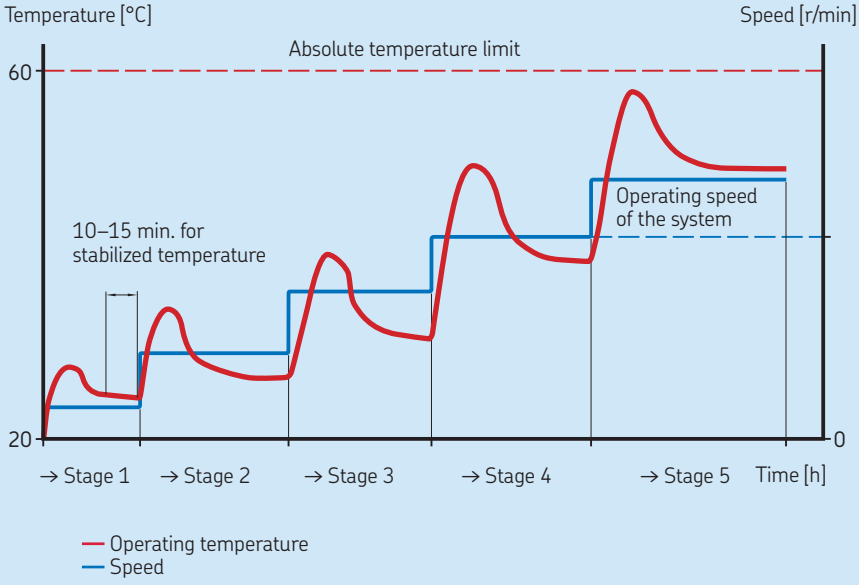
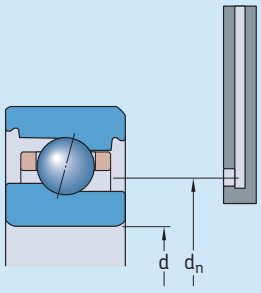


Table 3

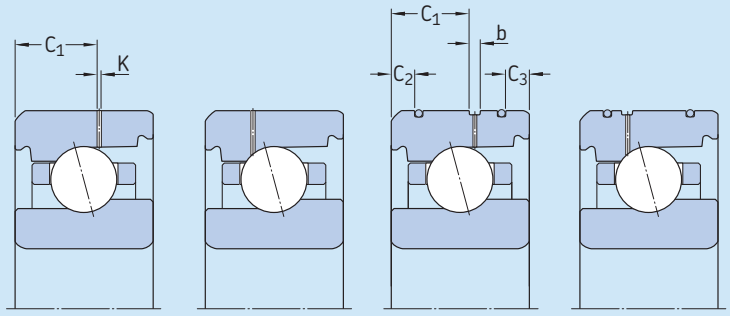
Oil nozzle position for oil-air lubrication



Bearing Bore diameter d	Size	Oil nozzle position for open bearings in the series 719 .. E *(VEB)* d_n	70 .. E *(VEX)*
mm	–	mm	
6	**6**	–	10,1
7	**7**	–	11,4
8	**8**	12,2	13,3
9	**9**	13,3	14,8
10	**00**	14,8	16,5
12	**01**	16,8	18,5
15	**02**	20	21,9
17	**03**	22	24,1
20	**04**	26,7	28,1
25	**05**	31,8	33,1
30	**06**	36,8	39,9
35	**07**	43	45,6
40	**08**	48	51,6
45	**09**	54,2	57,6
50	**10**	58,4	62,3
55	**11**	64,6	69,6
60	**12**	69,6	74,6
65	**13**	74,5	79,3
70	**14**	81,5	86,5
75	**15**	86,5	91,5
80	**16**	91,5	98,5
85	**17**	98,6	103,5
90	**18**	103,5	111
95	**19**	108,5	115,4
100	**20**	115,4	120,4
110	**22**	125,4	135,4
120	**24**	137,4	144,9

Table 4

Dimensions for direct oil lubrication



Bearing Bore diameter	Size	Dimensions of bearings in the 719 .. E (VEB) series for variant with designation suffix								of bearings in the 70 .. E (VEX) series for variant with designation suffix											
		H (H)		H1 (H1)		L (GH)				H (H)		H1 (H1)		L (GH)				L1 (G1)			
		C_1	K	C_1	K	C_1	C_2	C_3	b	C_1	K	C_1	K	C_1	C_2	C_3	b	C_1	C_2	C_3	b
mm	–	mm								mm											
6	**6**	–	–	–	–	–	–	–	–	3,65	0,5	–	–	–	–	–	–	–	–	–	–
7	**7**	–	–	–	–	–	–	–	–	3,65	0,5	–	–	–	–	–	–	–	–	–	–
8	**8**	3,65	0,5	–	–	–	–	–	–	4,25	0,5	–	–	–	–	–	–	–	–	–	–
9	**9**	3,65	0,5	–	–	–	–	–	–	4,25	0,5	–	–	–	–	–	–	–	–	–	–
10	**00**	3,65	0,5	–	–	–	–	–	–	4,75	0,5	–	–	–	–	–	–	–	–	–	–
12	**01**	3,65	0,5	–	–	–	–	–	–	4,9	0,5	–	–	–	–	–	–	–	–	–	–
15	**02**	4,3	0,5	–	–	–	–	–	–	5,35	0,5	–	–	–	–	–	–	–	–	–	–
17	**03**	4,35	0,5	–	–	–	–	–	–	6,05	0,5	–	–	–	–	–	–	–	–	–	–
20	**04**	5,45	0,5	–	–	4,6	1,4	0,9	1,5	–	–	3,67	0,5	5,9	1,8	1,9	1,9	3,2	1,45	1,9	1,4
25	**05**	5,45	0,5	–	–	4,6	1,4	0,9	1,5	–	–	3,72	0,5	5,9	1,8	1,9	2,1	3,2	1,45	1,9	1,4
30	**06**	5,45	0,5	–	–	4,6	1,4	0,9	1,5	–	–	4,23	0,5	6,5	2,3	2,6	1,8	3,7	1,95	2,6	1,4
35	**07**	6,15	0,5	–	–	5,1	1,8	1,2	1,6	–	–	4,52	0,5	7,3	2,2	2,8	1,7	4	2,2	2,8	1,4
40	**08**	–	–	3,75	0,5	5,9	1,8	1,8	2	–	–	5,03	0,5	7,8	2,5	3	1,7	4,5	2,5	3	1,4
45	**09**	–	–	3,75	0,5	5,9	2,3	1,8	2	–	–	5,53	0,5	8,6	3	3	1,7	5	3	3	1,4
50	**10**	–	–	3,53	0,5	5,9	2,3	1,8	2,2	–	–	5,32	0,5	8,6	2,7	3	1,7	4,7	2,7	3	1,6
55	**11**	–	–	3,83	0,5	6,5	2,5	2	2,2	–	–	6,3	0,5	9	3,4	3,4	2,4	5,65	3,4	3,4	1,6
60	**12**	–	–	3,83	0,5	6,5	2,5	2	2,2	–	–	6,3	0,5	9	3,4	3,4	2,4	5,65	3,4	3,4	1,6
65	**13**	–	–	3,83	0,5	6,5	2,5	2	2,2	–	–	5,92	0,5	9,7	3,3	3,3	1,9	5,3	3,3	3,3	1,6
70	**14**	–	–	4,9	0,5	8,6	2,8	2,8	2	–	–	6,7	0,5	10,9	3,4	3,4	1,9	6,05	3,4	3,4	1,6
75	**15**	–	–	4,9	0,5	8,6	2,8	2,8	2	–	–	6,73	0,5	10,9	3,4	3,4	1,8	6,1	3,4	3,4	1,6
80	**16**	–	–	4,9	0,5	8,6	2,8	2,8	2	–	–	7,27	0,5	11,1	3,8	3,8	2,8	6,5	3,8	3,8	1,8
85	**17**	–	–	5,48	0,5	9,3	3	3	2,6	–	–	7,27	0,5	11,1	3,8	3,8	2,8	6,5	3,8	3,8	1,8
90	**18**	–	–	5,48	0,5	9,3	3	3	2,6	–	–	8,33	0,5	13,2	4,3	4,3	2,6	7,6	4,3	4,3	1,8
95	**19**	–	–	5,48	0,5	9,3	3	3	2,6	–	–	7,81	0,5	13,4	4,3	4,3	2,2	7,1	4,3	4,3	1,8
100	**20**	–	–	6,05	0,5	10,9	3	3,3	2,3	–	–	7,82	0,5	13,4	4	4	2,2	7,1	4	4	1,8
110	**22**	–	–	5,78	0,5	10,9	3,5	3	2,3	–	–	9,84	0,5	15,1	5,4	5,4	2,6	9,05	5,4	5,4	1,8
120	**24**	–	–	6,31	0,5	11,9	4,2	3,6	2,6	–	–	9,38	0,5	15	5,4	5,4	2,8	8,6	5,4	5,4	1,8

Bearing data – general

Boundary dimensions

The principal dimensions of SKF super-precision angular contact ball bearings are in accordance with ISO 15:2011:

- Boundary dimensions for bearings in the 719 .. E *(VEB)* series are in accordance with ISO dimension series 19.
- Boundary dimensions for bearings in the 70 .. E *(VEX)* series are in accordance with ISO dimension series 10.

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.

For bearings in the 719 .. E *(VEB)* series, the values for the chamfers on the non-thrust side of the inner ring up to a bore diameter d = 30 mm, thrust side of the inner ring, and thrust side of the outer ring are in accordance with ISO 15:2011. The values for the chamfers on the non-thrust side of the inner ring for a bore diameter d > 30 mm are smaller than those in accordance with ISO 15:2011. The values for the chamfers on the non-thrust side of the outer ring are in accordance with ISO 12044:1995.

For bearings in the 70 .. E *(VEX)* series, the values for the chamfers on the inner ring and thrust side of the outer ring are in accordance with ISO 15:2011. The values for the chamfers on the non-thrust side of the outer ring are in accordance with ISO 12044:1995.

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

Table 1

Class P4A 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	1,5	1	0	–40	0	–250	1,5	1,5	1,5	1,5
10	**18**	0	–4	0	–4	1,5	1	0	–80	0	–250	1,5	1,5	1,5	1,5
18	**30**	0	–5	0	–5	1,5	1	0	–120	0	–250	1,5	2,5	1,5	2,5
30	**50**	0	–6	0	–6	1,5	1	0	–120	0	–250	1,5	2,5	1,5	2,5
50	**80**	0	–7	0	–7	2	1,5	0	–150	0	–250	1,5	2,5	1,5	2,5
80	**120**	0	–8	0	–8	2,5	1,5	0	–200	0	–380	2,5	2,5	2,5	2,5
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					max	max	max	max
mm		µm		µm		µm	µm					µm	µm	µm	µm
10	**18**	0	–4	0	–4	1,5	1	Values are identical to those for the				1,5	1,5	1,5	1,5
18	**30**	0	–5	0	–5	2	1,5	inner ring of the same bearing				1,5	1,5	1,5	1,5
30	**50**	0	–6	0	–6	2	1,5	(Δ_{Bs}, Δ_{B1s})				1,5	2,5	1,5	2,5
50	**80**	0	–7	0	–7	2	1,5					1,5	4	1,5	4
80	**120**	0	–8	0	–8	2,5	1,5					2,5	5	2,5	5
120	**150**	0	–9	0	–9	4	1,5					2,5	5	2,5	5
150	**180**	0	–10	0	–10	6	3					4	6	4	6

Tolerances

Bearings in the 719 .. E *(VEB)* and 70 .. E *(VEX)* series are manufactured, standard, to P4A tolerance class. On request, bearings can be supplied to the higher precision PA9A tolerance class.

The tolerance values are listed as follows:

- P4A (better than ABEC 7) tolerance class in **table 1**
- PA9A (better than ABEC 9) tolerance class in **table 2**

The tolerance symbols used in these tables are listed together with their definitions in **table 3**, on **page 20**.

Bearing preload

A single super-precision angular contact ball bearing does not have any preload. Preload can only be obtained when one bearing is placed against another to provide location in the opposite direction.

Preload in sets of universally matchable bearings and matched bearing sets prior to mounting

Universally matchable bearings and matched bearing sets are manufactured so that when the bearings are placed against each other, prior to mounting, a certain preload will result.

To meet the varying requirements with regard to rotational speed and rigidity, bearings in the 719 .. E *(VEB)* and 70 .. E *(VEX)* series are produced to different preload classes.

In applications where a maximum degree of rigidity is required, one of the following preload classes should be selected:

- class A *(L)*, light preload
- class B *(M)*, moderate preload
- class C *(F)*, 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 bearing series, 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 4** on **page 21**.

Bearing sets in the A, B or C preload class, consisting of three or four bearings, will have a heavier preload than sets with two bearings in the A, B or C preload class. The preload for these bearing sets is obtained by multiplying the values listed in **table 4** on **page 21** 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

Table 2

Class PA9A tolerances

Inner ring d over	incl.	Δ_{dmp} high	low	Δ_{ds} high	low	V_{dp} max	V_{dmp} max	Δ_{Bs} high	low	Δ_{B1s} high	low	V_{Bs} max	K_{ia} max	S_d max	S_{ia} max
mm		µm		µm		µm	µm	µm		µm		µm	µm	µm	µm
2,5	**10**	0	–2,5	0	–2,5	1,5	1	0	–40	0	–250	1,5	1,5	1,5	1,5
10	**18**	0	–2,5	0	–2,5	1,5	1	0	–80	0	–250	1,5	1,5	1,5	1,5
18	**30**	0	–2,5	0	–2,5	1,5	1	0	–120	0	–250	1,5	2,5	1,5	2,5
30	**50**	0	–2,5	0	–2,5	1,5	1	0	–120	0	–250	1,5	2,5	1,5	2,5
50	**80**	0	–4	0	–4	2	1,5	0	–150	0	–250	1,5	2,5	1,5	2,5
80	**120**	0	–5	0	–5	2,5	1,5	0	–200	0	–380	2,5	2,5	2,5	2,5

Outer ring D over	incl.	Δ_{Dmp} high	low	Δ_{Ds} high	low	V_{Dp} max	V_{Dmp} max	Δ_{Cs},Δ_{C1s}	V_{Cs} max	K_{ea} max	S_D max	S_{ea} max
mm		µm		µm		µm	µm		µm	µm	µm	µm
10	**18**	0	–2,5	0	–2,5	1,5	1	Values are identical to those for the inner ring of the same bearing (Δ_{Bs}, Δ_{B1s})	1,5	1,5	1,5	1,5
18	**30**	0	–4	0	–4	2	1,5		1,5	1,5	1,5	1,5
30	**50**	0	–4	0	–4	2	1,5		1,5	2,5	1,5	2,5
50	**80**	0	–4	0	–4	2	1,5		1,5	4	1,5	4
80	**120**	0	–5	0	–5	2,5	1,5		2,5	5	2,5	5
120	**150**	0	–5	0	–5	2,5	1,5		2,5	5	2,5	5
150	**180**	0	–7	0	–7	4	3		2,5	5	2,5	5

In applications where maximum operational speeds are required, one of the following preload classes should be selected:

- 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

As indicated, 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.

Bearing sets in the L, M or F preload class, consisting of three or four bearings, have the same preload as sets with two bearings in the A, B or C preload class.

Therefore, the preload for matched bearing sets that are asymmetrical i.e. for TBT *(TD)*, TFT *(TF)*, QBT *(3TD)* and QFT *(3TF)* arrangements, can be obtained directly from **table 4**.

An example of the various preload possibilities for the bearing 7014 CE/P4A is provided in **table 5** on **page 22**.

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

Preload in mounted bearing sets

After mounting, sets of universally matchable bearings and matched bearing sets can have a heavier preload than the built-in preload, predetermined during manufacture. The increase in preload depends mainly on the actual tolerances for the bearing seats on the shaft and in the housing bore. An increase in preload can also be caused by deviations from the geometrical form of associated components such as cylindricity, perpendicularity or concentricity of the bearing seats.

During operation, an increase in preload can also be caused by:

Table 3

Tolerance symbols

Tolerance symbol	Definition
	Bore diameter
d	Nominal bore diameter
d_s	Single bore diameter
d_{mp}	Mean bore diameter; arithmetical mean of the largest and smallest single bore diameters in one plane
Δ_{ds}	Deviation of a single bore diameter from the nominal ($\Delta_{ds} = d_s - d$)
Δ_{dmp}	Deviation of the mean bore diameter from the nominal ($\Delta_{dmp} = d_{mp} - d$)
V_{dp}	Bore diameter variation; difference between the largest and smallest single bore diameters in one plane
V_{dmp}	Mean bore diameter variation; difference between the largest and smallest mean bore diameter
	Outside diameter
D	Nominal outside diameter
D_s	Single outside diameter
D_{mp}	Mean outside diameter; arithmetical mean of the largest and smallest single outside diameters in one plane
Δ_{Ds}	Deviation of a single outside diameter from the nominal ($\Delta_{Ds} = D_s - D$)
Δ_{Dmp}	Deviation of the mean outside diameter from the nominal ($\Delta_{Dmp} = D_{mp} - D$)
V_{Dp}	Outside diameter variation; difference between the largest and smallest single outside diameters in one plane
V_{Dmp}	Mean outside diameter variation; difference between the largest and smallest mean outside diameter

Tolerance symbol	Definition
	Width
B, C	Nominal width of inner ring and outer ring, respectively
B_s, C_s	Single width of inner ring and outer ring, respectively
B_{1s}, C_{1s}	Single width of inner ring and outer ring, respectively, of a bearing belonging to a matched set
Δ_{Bs}, Δ_{Cs}	Deviation of single inner ring width or single outer ring width from the nominal ($\Delta_{Bs} = B_s - B$; $\Delta_{Cs} = C_s - C$)
$\Delta_{B1s}, \Delta_{C1s}$	Deviation of single inner ring width or single outer ring width of a bearing belonging to a matched set from the nominal (not valid for universally matchable bearings) ($\Delta_{B1s} = B_{1s} - B$; $\Delta_{C1s} = C_{1s} - C$)
V_{Bs}, V_{Cs}	Ring width variation; difference between the largest and smallest single widths of inner ring and of outer ring, respectively
	Running accuracy
K_{ia}, K_{ea}	Radial runout of inner ring and outer ring, respectively, of assembled bearing
S_d	Side face runout with reference to bore (of inner ring)
S_D	Outside inclination variation; variation in inclination of outside cylindrical surface to outer ring side face
S_{ia}, S_{ea}	Axial runout of inner ring and outer ring, respectively, of assembled bearing

- the rotational speed of the shaft, for constant position arrangements
- temperature gradients between the inner ring, outer ring and balls
- different coefficient of thermal expansion for the shaft and housing materials compared to the bearing steel

If the bearings are mounted with zero interference 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]

$G_{A,B,C}$ = built-in preload in the bearing set, prior to mounting (→ **table 4**) [N]

f = a bearing factor dependent on the bearing series and size (→ **table 6** on **page 22**)

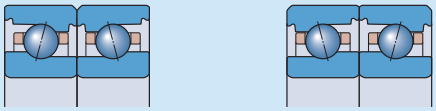
f_1 = a correction factor dependent on the contact angle (→ **table 7** on **page 23**)

f_2 = a correction factor dependent on the preload class (→ **table 7** on **page 23**)

f_{HC} = a correction factor for hybrid bearings (→ **table 7** on **page 23**)

Table 4

Axial preload of 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[1)] 719 CE *(VEB CE1)* 719 CE/HC *(VEB /NS CE1)* for preload class			719 ACE *(VEB CE3)* 719 ACE/HC *(VEB /NS CE3)* for preload class			70 CE *(VEX CE1)* 70 CE/HC *(VEX /NS CE1)* for preload class			70 ACE *(VEX CE3)* 70 ACE/HC *(VEX /NS CE3)* for preload class		
d		A	B	C	A	B	C	A	B	C	A	B	C
mm	–	N											
6	**6**	–	–	–	–	–	–	10	25	50	14	41	82
7	**7**	–	–	–	–	–	–	10	30	60	17	50	100
8	**8**	9	27	55	15	46	91	15	35	75	20	60	120
9	**9**	11	32	64	17	50	100	15	40	80	23	65	130
10	**00**	11	32	65	17	50	100	15	48	95	26	80	160
12	**01**	11	34	68	18	55	110	17	53	110	28	85	170
15	**02**	17	51	102	28	84	170	25	70	140	38	115	230
17	**03**	18	54	108	29	87	175	30	90	185	50	150	300
20	**04**	26	79	157	42	130	250	40	120	235	64	193	390
25	**05**	28	85	170	45	140	270	45	130	260	70	210	430
30	**06**	30	90	180	48	145	290	50	150	300	80	240	480
35	**07**	41	125	250	66	200	400	60	180	370	100	300	590
40	**08**	52	157	315	84	250	505	65	200	390	105	310	630
45	**09**	55	166	331	88	265	529	70	210	410	110	330	660
50	**10**	69	210	410	110	330	660	85	250	500	130	400	800
55	**11**	83	250	500	133	400	800	90	270	540	140	430	860
60	**12**	87	262	523	139	418	836	92	275	550	150	440	870
65	**13**	89	266	532	142	425	850	110	330	650	170	520	1 040
70	**14**	120	360	710	190	570	1 130	130	380	760	200	610	1 220
75	**15**	120	361	722	192	577	1 150	140	420	840	220	670	1 340
80	**16**	123	370	740	195	590	1 170	180	550	1 090	280	850	1 700
85	**17**	160	479	957	255	765	1 529	185	560	1 110	290	890	1 780
90	**18**	163	488	977	260	780	1 560	190	580	1 150	300	920	1 840
95	**19**	166	500	995	265	795	1 590	230	700	1 400	380	1 130	2 270
100	**20**	208	624	1 250	332	996	1 990	240	720	1 440	390	1 150	2 310
110	**22**	220	650	1 300	340	1 030	2 070	250	760	1 520	400	1 210	2 420
120	**24**	250	760	1 530	410	1 220	2 440	310	930	1 850	490	1 480	2 950

[1)] Data is also applicable to sealed bearings. Data for bearings with an 18° contact angle is available on request.

Table 5

Example of the (light) preload possibilities for an arrangement with a matched set of 7014 CE *(VEX 70 CE1)* bearings

Number of bearings	Arrangement	Preload of a matched set, prior to mounting for maximum rigidity Designation suffix	Preload	for maximum speed Designation suffix	Preload
		–	N	–	N
2	Back-to-back	DBA *(DDL)*	130	–	–
	Face-to-face	DFA *(FFL)*	130	–	–
3	Back-to-back and tandem	TBTA *(TD17,5DaN)*	175,5	TBTL *(TDL)*	130
	Face-to-face and tandem	TFTA *(TF17,5DaN)*	175,5	TFTL *(TFL)*	130
4	Tandem back-to-back	QBCA *(TDTL)*	260	–	–
	Tandem face-to-face	QFCA *(TFTL)*	260	–	–
	Back-to-back and tandem	QBTA *(3TD20,8DaN)*	208	QBTL *(3TDL)*	130
	Face-to-face and tandem	QFTA *(3TF20,8DaN)*	208	QFTL *(3TFL)*	130

Note: For symmetrical arrangements, preload class A = preload class L e.g. the designation suffix DBL does not exist.

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

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.

Fig. 1

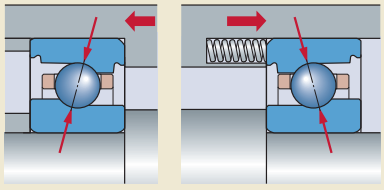


Table 6

Bearing factor f for calculating the preload in mounted bearing sets

Bearing Bore diameter d	Size	Bearing factor f for bearings in the series[1] 719 .. E *(VEB)*	70 .. E *(VEX)*
mm	–	–	
6	**6**	–	1,02
7	**7**	–	1,02
8	**8**	1,02	1,02
9	**9**	1,03	1,02
10	**00**	1,03	1,03
12	**01**	1,04	1,02
15	**02**	1,04	1,03
17	**03**	1,05	1,04
20	**04**	1,04	1,04
25	**05**	1,06	1,05
30	**06**	1,08	1,05
35	**07**	1,05	1,06
40	**08**	1,05	1,06
45	**09**	1,09	1,06
50	**10**	1,15	1,08
55	**11**	1,16	1,07
60	**12**	1,13	1,08
65	**13**	1,19	1,09
70	**14**	1,14	1,09
75	**15**	1,16	1,1
80	**16**	1,19	1,1
85	**17**	1,16	1,11
90	**18**	1,19	1,1
95	**19**	1,18	1,11
100	**20**	1,18	1,12
110	**22**	1,20	1,1
120	**24**	1,18	1,12

[1] Data is also applicable to sealed bearings.

Preload by axial displacement

Rigidity and precise axial guidance are critical parameters in bearing arrangements, especially when alternating axial forces occur. As a result, 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 series, contact angle and ball material, preload increases considerably with rotational speed.

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

Adjusting preload with spacer rings

By placing precision-matched spacer rings between two bearings, it is possible to increase or decrease preload. Precision spacer rings can also be used to:

- increase system rigidity
- create a sufficiently large grease reservoir between two bearings
- create a space for oil-air lubrication nozzles

It is possible to adjust preload in a bearing set, by grinding the side face of the inner or outer spacer ring. **Table 8** 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 9** on **page 24**.

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 2 µm.

Effect of rotational speed on preload

Using strain gauges, SKF has determined that there is a marked increase in preload at very high speeds. This is mainly attributable to the heavy centrifugal forces on the balls causing them to change their position within the bearing. When compared to an all-steel bearing, a hybrid bearing can attain much higher rotational speeds without significantly increasing preload. This is a due to the lower mass of the balls.

Table 7

Correction factors for calculating the preload in mounted bearing sets

Bearing series[1)]	Correction factors				
	f_1	f_2 for preload class			f_{HC}
		A	B	C	
719 CE *(VEB CE1)*	1	1	1,04	1,08	1
719 ACE *(VEB CE3)*	0,99	1	1,04	1,07	1
719 CE/HC *(VEB /NS CE1)*	1	1	1,05	1,09	1,01
719 ACE/HC *(VEB /NS CE3)*	0,98	1	1,04	1,08	1,01
70 CE *(VEX CE1)*	1	1	1,03	1,05	1
70 ACE *(VEX CE3)*	0,99	1	1,03	1,06	1
70 CE/HC *(VEX /NS CE1)*	1	1	1,03	1,05	1,01
70 ACE/HC *(VEX /NS CE3)*	0,99	1	1,03	1,06	1,01

[1)] Data is also applicable to sealed bearings. Data for bearings with an 18° contact angle is available on request.

Table 8

Guidelines for spacer ring modification

Preload change of a bearing set	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

Bearing axial stiffness

Axial stiffness depends on the deformation of the bearing under load and can be expressed as a ratio of the load to bearing resilience. However, since the relation between resilience and load is not linear, only guideline values can be provided (→ **table 10**). These values apply to mounted bearing pairs under static conditions and subjected to moderate loads.

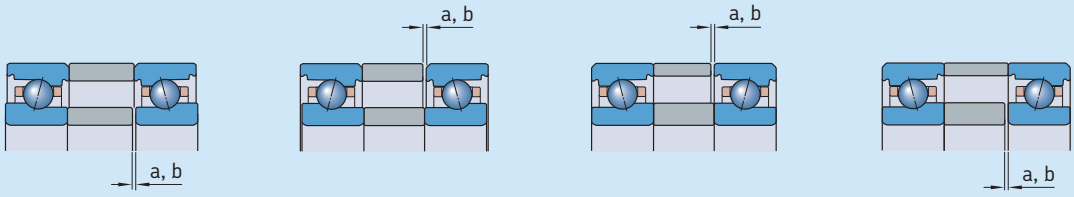
Exact values can be calculated using advanced computer methods. For additional information, contact the SKF application engineering service.

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 10** 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

Table 9

Guideline values for spacer ring width reduction



Increasing the preload (back-to-back arrangement) | Decreasing the preload (back-to-back arrangement) | Increasing the preload (face-to-face arrangement) | Decreasing the preload (face-to-face arrangement)

Bearing Bore diameter	Size	**Requisite spacer ring width reduction** for bearings in the series[1)]							
		719 CE *(VEB CE1)*		719 ACE *(VEB CE3)*		70 CE *(VEX CE1)*		70 ACE *(VEX CE3)*	
d		a	b	a	b	a	b	a	b
mm	–	µm							
6	**6**	–	–	–	–	6	7	5	5
7	**7**	–	–	–	–	8	8	5	6
8	**8**	7	8	5	5	8	10	6	6
9	**9**	7	8	5	5	8	10	6	6
10	**00**	7	8	5	5	9	10	6	6
12	**01**	7	8	5	5	9	10	6	6
15	**02**	8	9	6	6	9	10	6	11
17	**03**	9	9	6	6	11	12	7	11
20	**04**	10	10	7	7	13	13	8	11
25	**05**	10	10	7	7	13	13	8	11
30	**06**	10	10	7	7	13	13	8	11
35	**07**	11	11	7	8	13	15	9	11
40	**08**	12	13	8	9	13	15	9	11
45	**09**	12	13	8	9	13	15	9	11
50	**10**	14	14	9	10	14	15	9	11
55	**11**	15	16	9	11	14	15	9	11
60	**12**	15	16	9	11	14	15	9	11
65	**13**	15	16	9	11	15	16	10	11
70	**14**	17	19	11	12	16	17	10	11
75	**15**	17	19	11	13	16	17	10	11
80	**16**	17	19	11	13	18	19	12	13
85	**17**	20	22	13	14	18	19	12	13
90	**18**	20	22	13	14	18	19	12	13
95	**19**	20	22	13	15	20	22	13	15
100	**20**	22	25	14	16	20	22	13	15
110	**22**	22	25	14	16	20	22	13	15
120	**24**	25	28	16	18	22	24	14	16

[1)] Data is also applicable to sealed bearings. Data for bearings with an 18° contact angle is available on request.

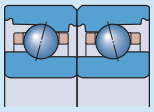
Matched bearing sets that are asymmetrical can be produced to the additional preload classes L, M or F (→ *Preload in sets of universally matchable bearings and matched bearing sets prior to mounting*, **page 19**). The axial stiffness for these bearing sets can be calculated by multiplying the values listed in **table 10** by the following factors:

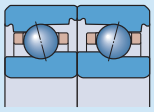
- 1,25 for TBT *(TD)* and TFT *(TF)* arrangements
- 1,45 for QBT *(3TD)* and QFT *(3TF)* arrangements

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 10

Static axial stiffness for bearing pairs arranged back-to-back or face-to-face





Bearing Bore diameter	Size	**Static axial stiffness** of all-steel bearings in the series[1]											
		719 CE *(VEB CE1)* for preload class			719 ACE *(VEB CE3)* for preload class			70 CE *(VEX CE1)* for preload class			70 ACE *(VEX CE3)* for preload class		
d		A	B	C	A	B	C	A	B	C	A	B	C
mm	–	N/µm											
6	**6**	–	–	–	–	–	–	8	12	16	19	28	37
7	**7**	–	–	–	–	–	–	8	13	18	21	31	41
8	**8**	8	13	18	21	32	41	10	14	20	23	34	45
9	**9**	10	16	21	25	37	48	11	16	22	26	38	50
10	**00**	10	16	22	25	37	48	12	19	26	31	47	61
12	**01**	11	17	23	27	41	53	13	21	30	34	50	66
15	**02**	13	21	29	34	51	66	16	25	34	40	59	66
17	**03**	14	23	31	35	55	71	18	28	39	46	68	89
20	**04**	18	28	39	47	69	88	21	32	44	52	78	102
25	**05**	20	32	44	51	77	100	24	37	50	59	89	117
30	**06**	23	35	49	55	85	111	28	44	60	71	105	138
35	**07**	28	43	59	69	104	136	31	49	67	79	119	154
40	**08**	32	49	67	78	117	153	34	54	73	87	129	169
45	**09**	34	53	73	85	127	166	38	59	79	94	140	183
50	**10**	38	61	83	96	145	190	42	65	88	104	156	204
55	**11**	42	67	92	105	160	210	46	72	98	116	174	226
60	**12**	47	73	100	115	173	228	48	75	101	122	180	235
65	**13**	47	76	105	120	181	238	53	83	112	132	198	259
70	**14**	52	83	113	131	197	258	57	88	120	143	215	280
75	**15**	54	86	118	137	205	269	65	102	140	161	243	318
80	**16**	56	89	123	141	214	281	72	114	157	178	268	352
85	**17**	63	99	136	157	237	311	75	118	163	186	281	369
90	**18**	65	102	141	164	247	324	79	125	171	196	297	389
95	**19**	68	107	147	170	256	338	84	133	184	212	319	420
100	**20**	73	116	160	187	280	367	88	138	191	220	330	435
110	**22**	80	126	174	199	301	397	94	149	204	237	356	466
120	**24**	82	129	179	207	312	411	104	164	225	259	391	512

[1] Data is also applicable to sealed bearings. Data for bearings with an 18° contact angle is available on request.

Fitting and clamping bearing rings

Super-precision angular contact ball 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, for precision lock nuts or end cap bolts, must be sufficient to prevent relative movement of adjacent components, maintain the position of the bearings without deformation, and minimize material fatigue.

Calculating the tightening torque M_t

It is difficult to accurately calculate the tightening torque M_t for a precision lock nut or the bolts in an end cap. The following formulas can be used to do the calculations, but the results should be verified during operation.

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

$$P_a = F_s + (N_{cp}F_c) + G_{A,B,C}$$

The tightening torque for a precision lock nut is

$$M_t = K\,P_a$$
$$= K\,[F_s + (N_{cp}F_c) + G_{A,B,C}]$$

The tightening torque for end cap bolts is

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

$$M_t = \frac{K\,[F_s + (N_{cp}F_c) + G_{A,B,C}]}{N_b}$$

where

M_t = tightening torque [Nmm]
P_a = axial clamping force [N]
F_s = minimum axial clamping force (→ **table 11**) [N]
F_c = axial fitting force (→ **table 11**) [N]
$G_{A,B,C}$ = built-in bearing preload, prior to mounting (→ **table 4** on **page 21**) [N]
N_{cp} = the number of preloaded bearings
N_b = the number of end cap bolts
K = a calculation factor dependent on the thread (→ **table 12**)

Fig. 2

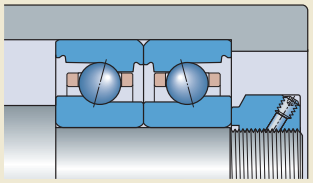


Table 11

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

Bearing Bore diameter d	Size	**Minimum axial clamping force** for bearings in the series[1] 719 .. E *(VEB)* F_s	70 .. E *(VEX)*	**Axial fitting force** for bearings in the series[1] 719 .. E *(VEB)* F_c	70 .. E *(VEX)*
mm	–	N		N	
6	**6**	–	260	–	430
7	**7**	–	310	–	410
8	**8**	330	450	280	490
9	**9**	400	600	280	490
10	**00**	500	650	280	550
12	**01**	600	700	280	470
15	**02**	650	1 000	280	490
17	**03**	750	1 000	280	490
20	**04**	1 300	1 600	400	650
25	**05**	1 600	1 800	340	500
30	**06**	1 900	2 500	300	550
35	**07**	2 600	3 300	440	750
40	**08**	3 100	4 100	500	750
45	**09**	3 800	4 500	480	750
50	**10**	3 100	5 000	380	650
55	**11**	4 100	6 000	430	800
60	**12**	4 500	6 500	400	750
65	**13**	4 800	7 000	370	700
70	**14**	6 500	8 500	500	800
75	**15**	6 500	9 000	480	750
80	**16**	7 000	11 000	650	1 200
85	**17**	9 000	11 000	900	1 400
90	**18**	9 500	16 000	850	1 700
95	**19**	10 000	14 000	850	1 500
100	**20**	12 000	15 000	1 000	1 400
110	**22**	13 000	20 000	900	1 800
120	**24**	16 000	22 000	1 200	1 900

[1] Data is also applicable to sealed bearings.

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 **table 13**.

Table 12

Factor K for calculating the tightening torque

Nominal thread diameter[1]	**Factor K** for precision lock nuts	end cap bolts
–	–	
M 4	–	0,8
M 5	–	1
M 6	–	1,2
M 8	–	1,6
M 10	1,4	2
M 12	1,6	2,4
M 14	1,9	2,7
M 15	2	2,9
M 16	2,1	3,1
M 17	2,2	–
M 20	2,6	–
M 25	3,2	–
M 30	3,9	–
M 35	4,5	–
M 40	5,1	–
M 45	5,8	–
M 50	6,4	–
M 55	7	–
M 60	7,6	–
M 65	8,1	–
M 70	9	–
M 75	9,6	–
M 80	10	–
M 85	11	–
M 90	11	–
M 95	12	–
M 100	12	–
M 105	13	–
M 110	14	–
M 120	15	–

[1] Applicable for fine threads only

Equivalent bearing loads

When determining the equivalent bearing load for preloaded bearings, 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 approximated using 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]
$G_{A,B,C}$ = built-in preload of the bearing pair, prior to mounting (→ **table 4** on **page 21**) [N]
G_m = preload in the mounted bearing pair (→ *Preload in mounted bearing sets*, **page 20**) [N]
K_a = external axial force acting on a single bearing [N]

Table 13

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

Equivalent dynamic bearing load

For single bearings and bearings paired in tandem

$P = F_r$ for $F_a/F_r \leq e$
$P = XF_r + YF_a$ for $F_a/F_r > e$

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

$P = F_r + Y_1F_a$ for $F_a/F_r \leq e$
$P = XF_r + Y_2F_a$ 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 14** and **15**. For bearings with a 15° contact angle, the factors also depend on the relationship f_0F_a/C_0 where f_0 is the calculation factor and C_0 is the basic static load rating, both of which are listed in the product tables.

Table 14

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 CE *(1)*				
≤ 0,178	0,38	0,44	1,47	0,46
0,357	0,4	0,44	1,4	0,46
0,714	0,43	0,44	1,3	0,46
1,07	0,46	0,44	1,23	0,46
1,43	0,47	0,44	1,19	0,46
2,14	0,5	0,44	1,12	0,46
3,57	0,55	0,44	1,02	0,46
≥ 5,35	0,56	0,44	1	0,46
For 25° contact angle designation suffix ACE *(3)*				
–	0,68	0,41	0,87	0,38

Note: Data for bearings with an 18° contact angle is available on request.

Table 15

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 CE *(1)*					
≤ 0,178	0,38	0,72	1,65	2,39	0,92
0,357	0,4	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	0,92
1,43	0,47	0,72	1,34	1,93	0,92
2,14	0,5	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 ACE *(3)*					
–	0,68	0,67	0,92	1,41	0,76

Note: Data for bearings with an 18° contact angle is available on request.

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 14** and **15**.

Attainable speeds

The attainable speeds listed in the product tables should be regarded as guideline values. They are valid for single bearings under light load ($P \leq 0{,}05\ C$) that are lightly preloaded with springs. In addition, good heat dissipation from the bearing arrangement is a prerequisite. As there is no friction generated at the seal lip, the attainable speed of a sealed bearing is equivalent to a comparably sized open bearing.

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 sealed bearings or open bearings with good lubricating grease that has a low consistency and low viscosity. Sealed bearings in the S719 .. E *(VEB .. /S)* and S70 .. E *(VEX .. /S)* series are designed for high-speed operation i.e. for a speed factor A up to approximately 2 000 000 mm/min.

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 16**.

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

Cage

Bearings in the 719 .. E *(VEB)* and 70 .. E *(VEX)* series have a one-piece outer ring shoulder-guided cage made of fabric reinforced phenolic resin (→ **fig. 3**) that can withstand temperatures up to 120 °C.

Seals

The integral seals in sealed S719 .. E *(VEB .. /S)* and S70 .. E *(VEX .. /S)* series bearings are designed for a speed factor A up to approximately 2 000 000 mm/min. The permissible operating temperature range of the seals is –25 to +100 °C and up to 120 °C for brief periods.

Materials

The rings and balls of all-steel bearings in the 719 .. E *(VEB)* and 70 .. E *(VEX)* 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. The rings of sealed hybrid bearings, designation prefix SV *(suffix /S/XN)*, are made from NitroMax, a high-nitrogen stainless steel.

The integral seals in sealed bearings are made of an oil-and wear-resistant acrylonitrile-butadiene rubber (NBR) and are reinforced with sheet steel. The O-rings of bearings for direct oil lubrication with a designation suffix L *(GH)* and L1 *(G1)*, are also made of acrylonitrile-butadiene rubber.

Heat treatment

All SKF super-precision bearings 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 wear-resistance.

Fig. 3

C

Table 16

Speed reduction factors for bearing sets

Number of bearings	Arrangement	Designation suffix for matched sets	Speed reduction factor for preload class					
			A	L	B	M	C	F
2	Back-to-back	DB *(DD)*	0,8	–	0,65	–	0,4	–
	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 bearing in the 719 .. E *(VEB)* and 70 .. E *(VEX)* series has various markings on the external surfaces of the rings (→ **fig. 4**):

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

Sealed bearings are marked in a similar way.

"V-shaped" marking

A "V-shaped" marking on the outside surface of the outer rings of matched bearing sets indicates how the bearings should be mounted to obtain the proper preload in the set. The marking also indicates how the bearing set should be mounted in relation to the axial load. The "V-shaped" marking should point in the direction in which the axial load will act on the inner ring (→ **fig. 5**). In applications where there are axial loads in both directions, the "V-shaped" marking should point toward the greater of the two loads.

Fig. 5

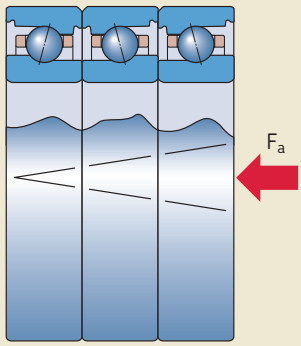
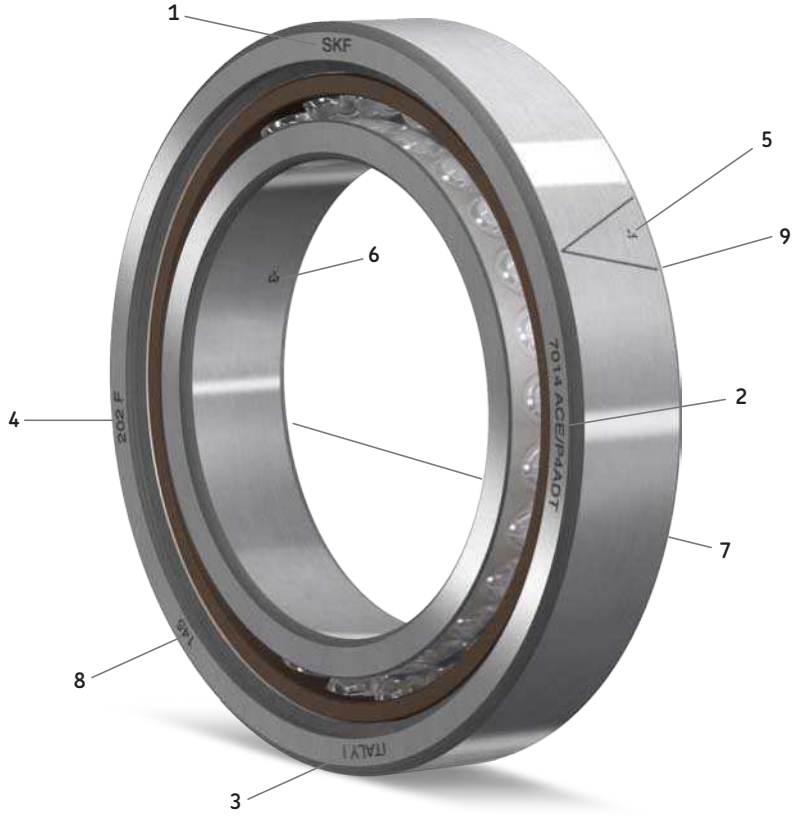


Fig. 4



Packaging

Super-precision bearings are distributed in new SKF illustrated boxes (→ **fig. 6**). An instruction sheet, with information about mounting bearing sets, is supplied in each box.

Designation system

The designations for SKF bearings in the 719 .. E *(VEB)* and 70 .. E *(VEX)* series are provided in **table 17** on **page 32** together with their definitions.

Fig. 6

C

Designation system for SKF super-precision angular contact ball bearings in the 719 .. E *(VEB)* and 70 .. E *(VEX)* series

	Variant prefix	Series	Size	Contact angle and design	Execution and preload (single bearing)		Ball material	Tolerance class	Lubrication feature	Arrange-ment	Preload
Single bearing: S7014 CEGB/PA9A	S	70	14	CE	GB	/		PA9A			
Matched bearing set: 71910 ACE/HCP4AH1QBCA		719	10	ACE		/	HC	P4A	H1	QBC	A

Variant (prefix)
– Open bearing (no designation prefix)
S Sealed bearing
V Bearing with NitroMax steel rings and bearing grade silicon nitride Si_3N_4 balls (hybrid bearings)

Bearing series
719 In accordance with ISO dimension series 19
70 In accordance with ISO dimension series 10

Bearing size
6 6 mm bore diameter[1)]
7 7 mm bore diameter[1)]
8 8 mm bore diameter
9 9 mm bore diameter
00 10 mm bore diameter
01 12 mm bore diameter
02 15 mm bore diameter
03 17 mm bore diameter
04 (x5) 20 mm bore diameter
to
24 (x5) 120 mm bore diameter

Contact angle and internal design
CE 15° contact angle, high-speed E design
FE 18° contact angle, high-speed E design
ACE 25° contact angle, high-speed E design

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

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

Ball material
– Carbon chromium steel (no designation suffix)
HC Bearing grade silicon nitride Si_3N_4 (hybrid bearings)

Tolerance class
P4A Dimensional accuracy in accordance with ISO tolerance class 4, running accuracy better than ISO tolerance class 4
PA9A Dimensional and running accuracy better than ABMA tolerance class ABEC 9

Lubrication feature
H Two lubrication holes in the outer ring for direct oil lubrication
H1 Two lubrication holes in the outer ring (optimized position) for direct oil lubrication
L Annular groove with two lubrication holes and two annular grooves fitted with O-rings in the outer ring for direct oil lubrication
L1 Annular groove with two lubrication holes and two annular grooves fitted with O-rings in the outer ring (optimized position) for direct oil lubrication

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

[1)] Bearings in the 719 .. E *(VEB)* series are only available for bore diameters starting at d = 8 mm.
[2)] For additional information, contact the SKF application engineering service.

Former SNFA designation system for super-precision angular contact ball bearings in the 719 .. E *(VEB)* and 70 .. E *(VEX)* series

	Series and design	Size	Variant	Tolerance class	Cage	Contact angle	Arrangement	Preload
Single bearing: VEX 70/S 9CE1 UM	VEX	70	/S	9	CE	1	U	M
Matched bearing set: VEB 50/NS/H1 7CE3 TDTL	VEB	50	/NS/H1	7	CE	3	TDT	L

Bearing series and internal design
VEB In accordance with ISO dimension series 19, high-speed VEB design
VEX In accordance with ISO dimension series 10, high-speed VEX design

Bearing size
6 6 mm bore diameter[1)]
to
120 120 mm bore diameter

Variant
– Open bearing (no designation suffix)
/S Sealed bearing
– Carbon chromium steel balls (no designation suffix)
/NS Bearing grade silicon nitride Si_3N_4 balls (hybrid bearings)
/XN Bearing with NitroMax steel rings and bearing grade silicon nitride Si_3N_4 balls (hybrid bearings)
H Two lubrication holes in the outer ring for direct oil lubrication
H1 Two lubrication holes in the outer ring (optimized position) for direct oil lubrication
GH Annular groove with two lubrication holes and two annular grooves fitted with O-rings in the outer ring for direct oil lubrication
G1 Annular groove with two lubrication holes and two annular grooves fitted with O-rings in the outer ring (optimized position) for direct oil lubrication

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

Cage
CE Fabric reinforced phenolic resin, outer ring centred

Contact angle
1 15° contact angle
2 18° contact angle
3 25° contact angle

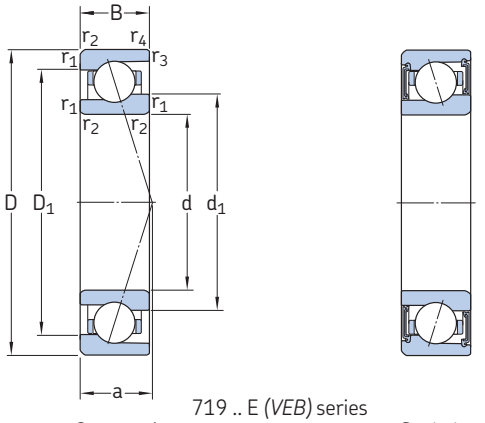
Single bearing – execution and preload
– Single bearing (no designation suffix)
UL Single, universally matchable, for light preload
UM Single, universally matchable, for moderate preload
UF Single, universally matchable, for heavy preload

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 (for symmetrical sets only)
M Moderate preload (for symmetrical sets only)
F Heavy preload (for symmetrical sets only)
..daN Special preload (for asymmetrical sets TD, TF, 3TD, 3TF and for special preload executions)[2)]

Super-precision angular contact ball bearings

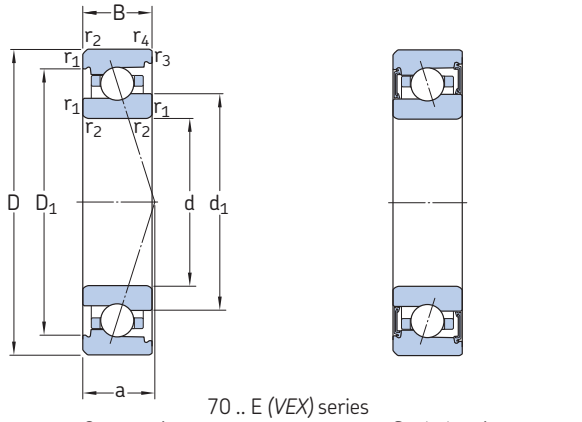
d **6 – 12** mm



719 .. E *(VEB)* series

Open variant

Sealed variant
for d = 20 to 120 mm



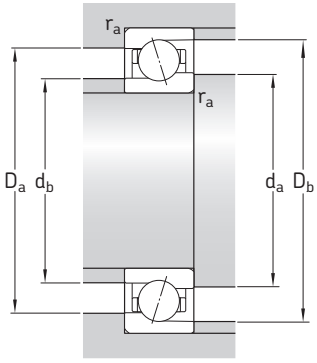
70 .. E *(VEX)* series

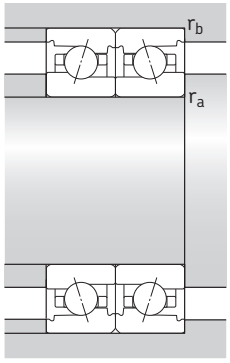
Open variant

Sealed variant
for d = 10 to 120 mm

Principal dimensions			Basic load ratings dynamic	static	Fatigue load limit	Calculation factor	Attainable speeds when lubricating with grease	oil-air[1]	Mass[1]	Designations of open bearings[2] SKF	SNFA
d	D	B	C	C_0	P_u	f_0					
mm			kN		kN	–	r/min		kg	–	
6	17	6	1,56	0,5	0,022	6,4	140 000	220 000	0,006	**706 CE/P4A**	**VEX 6 7CE1**
	17	6	1,56	0,5	0,022	6,4	170 000	260 000	0,005	**706 CE/HCP4A**	**VEX 6 /NS 7CE1**
	17	6	1,51	0,49	0,02	-	127 000	195 000	0,006	**706 ACE/P4A**	**VEX 6 7CE3**
	17	6	1,51	0,49	0,02	-	150 000	230 000	0,005	**706 ACE/HCP4A**	**VEX 6 /NS 7CE3**
7	19	6	1,95	0,64	0,027	6,5	127 000	190 000	0,007	**707 CE/P4A**	**VEX 7 7CE1**
	19	6	1,95	0,64	0,027	6,5	150 000	230 000	0,006	**707 CE/HCP4A**	**VEX 7 /NS 7CE1**
	19	6	1,86	0,62	0,026	-	112 000	175 000	0,007	**707 ACE/P4A**	**VEX 7 7CE3**
	19	6	1,86	0,62	0,026	-	133 000	205 000	0,006	**707 ACE/HCP4A**	**VEX 7 /NS 7CE3**
8	19	6	1,74	0,63	0,027	7,2	120 000	185 000	0,007	**719/8 CE/P4A**	**VEB 8 7CE1**
	19	6	1,74	0,63	0,027	7,2	145 000	220 000	0,006	**719/8 CE/HCP4A**	**VEB 8 /NS 7CE1**
	19	6	1,68	0,6	0,026	-	109 000	165 000	0,007	**719/8 ACE/P4A**	**VEB 8 7CE3**
	19	6	1,68	0,6	0,026	-	130 000	200 000	0,006	**719/8 ACE/HCP4A**	**VEB 8 /NS 7CE3**
	22	7	2,34	0,8	0,034	6,6	109 000	165 000	0,012	**708 CE/P4A**	**VEX 8 7CE1**
	22	7	2,34	0,8	0,034	6,6	130 000	200 000	0,011	**708 CE/HCP4A**	**VEX 8 /NS 7CE1**
	22	7	2,29	0,77	0,032	-	98 000	150 000	0,012	**708 ACE/P4A**	**VEX 8 7CE3**
	22	7	2,29	0,77	0,032	-	115 000	180 000	0,011	**708 ACE/HCP4A**	**VEX 8 /NS 7CE3**
9	20	6	2,03	0,8	0,034	7,4	109 000	165 000	0,008	**719/9 CE/P4A**	**VEB 9 7CE1**
	20	6	2,03	0,8	0,034	7,4	133 000	200 000	0,007	**719/9 CE/HCP4A**	**VEB 9 /NS 7CE1**
	20	6	1,95	0,77	0,032	-	100 000	150 000	0,008	**719/9 ACE/P4A**	**VEB 9 7CE3**
	20	6	1,95	0,77	0,032	-	120 000	180 000	0,007	**719/9 ACE/HCP4A**	**VEB 9 /NS 7CE3**
	24	7	2,6	0,93	0,04	6,8	98 000	150 000	0,014	**709 CE/P4A**	**VEX 9 7CE1**
	24	7	2,6	0,93	0,04	6,8	120 000	180 000	0,013	**709 CE/HCP4A**	**VEX 9 /NS 7CE1**
	24	7	2,51	0,9	0,038	-	90 000	137 000	0,014	**709 ACE/P4A**	**VEX 9 7CE3**
	24	7	2,51	0,9	0,038	-	106 000	165 000	0,013	**709 ACE/HCP4A**	**VEX 9 /NS 7CE3**
10	22	6	2,03	0,82	0,034	7,6	100 000	155 000	0,009	**71900 CE/P4A**	**VEB 10 7CE1**
	22	6	2,03	0,82	0,034	7,6	123 000	185 000	0,008	**71900 CE/HCP4A**	**VEB 10 /NS 7CE1**
	22	6	1,95	0,78	0,032	-	93 000	140 000	0,009	**71900 ACE/P4A**	**VEB 10 7CE3**
	22	6	1,95	0,78	0,032	-	109 000	165 000	0,008	**71900 ACE/HCP4A**	**VEB 10 /NS 7CE3**
	26	8	3,02	1,18	0,05	7,1	90 000	140 000	0,019	**7000 CE/P4A**	**VEX 10 7CE1**
	26	8	3,02	1,18	0,05	7,1	109 000	165 000	0,017	**7000 CE/HCP4A**	**VEX 10 /NS 7CE1**
	26	8	2,86	1,14	0,048	-	83 000	127 000	0,019	**7000 ACE/P4A**	**VEX 10 7CE3**
	26	8	2,86	1,14	0,048	-	98 000	150 000	0,017	**7000 ACE/HCP4A**	**VEX 10 /NS 7CE3**
12	24	6	2,12	0,92	0,039	7,8	90 000	137 000	0,010	**71901 CE/P4A**	**VEB 12 7CE1**
	24	6	2,12	0,92	0,039	7,8	109 000	165 000	0,009	**71901 CE/HCP4A**	**VEB 12 /NS 7CE1**
	24	6	2,03	0,87	0,036	-	83 000	123 000	0,010	**71901 ACE/P4A**	**VEB 12 7CE3**
	24	6	2,03	0,87	0,036	-	98 000	150 000	0,009	**71901 ACE/HCP4A**	**VEB 12 /NS 7CE3**
	28	8	3,19	1,34	0,057	7,3	80 000	127 000	0,021	**7001 CE/P4A**	**VEX 12 7CE1**
	28	8	3,19	1,34	0,057	7,3	98 000	150 000	0,019	**7001 CE/HCP4A**	**VEX 12 /NS 7CE1**
	28	8	3,07	1,27	0,054	-	73 000	112 000	0,021	**7001 ACE/P4A**	**VEX 12 7CE3**
	28	8	3,07	1,27	0,054	-	88 000	133 000	0,019	**7001 ACE/HCP4A**	**VEX 12 /NS 7CE3**

[1] Applicable to open bearings only
[2] For designations of sealed bearings and other variants, refer to **table 17** on **pages 32** and **33**.



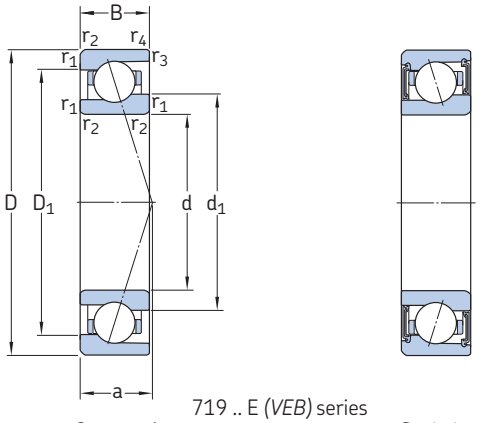


C

Dimensions						Abutment and fillet dimensions				
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
mm						mm				
6	9,2	13,9	0,3	0,15	5	8	15	15,6	0,3	0,15
	9,2	13,9	0,3	0,15	5	8	15	15,6	0,3	0,15
	9,2	13,9	0,3	0,15	6	8	15	15,6	0,3	0,15
	9,2	13,9	0,3	0,15	6	8	15	15,6	0,3	0,15
7	10,4	15,7	0,3	0,15	5	9	17	17,6	0,3	0,15
	10,4	15,7	0,3	0,15	5	9	17	17,6	0,3	0,15
	10,4	15,7	0,3	0,15	6	9	17	17,6	0,3	0,15
	10,4	15,7	0,3	0,15	6	9	17	17,6	0,3	0,15
8	11,3	15,7	0,3	0,15	5	10	17	17,6	0,3	0,15
	11,3	15,7	0,3	0,15	5	10	17	17,6	0,3	0,15
	11,3	15,7	0,3	0,15	7	10	17	17,6	0,3	0,15
	11,3	15,7	0,3	0,15	7	10	17	17,6	0,3	0,15
	12,1	17,9	0,3	0,15	6	10	20	20,6	0,3	0,15
	12,1	17,9	0,3	0,15	6	10	20	20,6	0,3	0,15
	12,1	17,9	0,3	0,15	7	10	20	20,6	0,3	0,15
	12,1	17,9	0,3	0,15	7	10	20	20,6	0,3	0,15
9	12,5	16,5	0,3	0,15	5	11	18	18,6	0,3	0,15
	12,5	16,5	0,3	0,15	5	11	18	18,6	0,3	0,15
	12,5	16,5	0,3	0,15	7	11	18	18,6	0,3	0,15
	12,5	16,5	0,3	0,15	7	11	18	18,6	0,3	0,15
	13,6	19,4	0,3	0,15	6	11	22	22,6	0,3	0,15
	13,6	19,4	0,3	0,15	6	11	22	22,6	0,3	0,15
	13,6	19,4	0,3	0,15	7	11	22	22,6	0,3	0,15
	13,6	19,4	0,3	0,15	7	11	22	22,6	0,3	0,15
10	14	17,9	0,3	0,15	5	12	20	20,6	0,3	0,15
	14	17,9	0,3	0,15	5	12	20	20,6	0,3	0,15
	14	17,9	0,3	0,15	7	12	20	20,6	0,3	0,15
	14	17,9	0,3	0,15	7	12	20	20,6	0,3	0,15
	15,6	22,4	0,3	0,3	6	12	24	24,6	0,3	0,15
	15,6	22,4	0,3	0,3	6	12	24	24,6	0,3	0,15
	15,6	22,4	0,3	0,3	8	12	24	24,6	0,3	0,15
	15,6	22,4	0,3	0,3	8	12	24	24,6	0,3	0,15
12	16	20	0,3	0,15	6	14	22	22,6	0,3	0,15
	16	20	0,3	0,15	6	14	22	22,6	0,3	0,15
	16	20	0,3	0,15	8	14	22	22,6	0,3	0,15
	16	20	0,3	0,15	8	14	22	22,6	0,3	0,15
	17,5	24,4	0,3	0,15	7	14	26	26,6	0,3	0,15
	17,5	24,4	0,3	0,15	7	14	26	26,6	0,3	0,15
	17,5	24,4	0,3	0,15	9	14	26	26,6	0,3	0,15
	17,5	24,4	0,3	0,15	9	14	26	26,6	0,3	0,15

Super-precision angular contact ball bearings

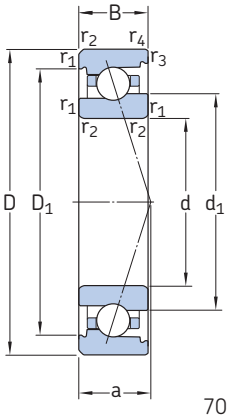
d **15 – 30** mm



719 .. E *(VEB)* series

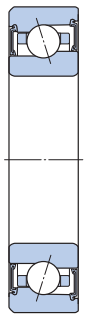
Open variant

Sealed variant
for d = 20 to 120 mm



70 .. E *(VEX)* series

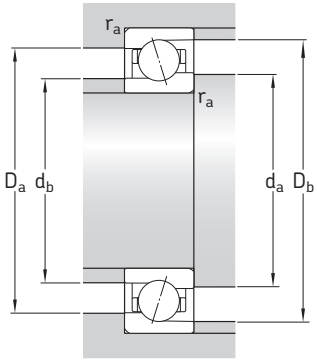
Open variant

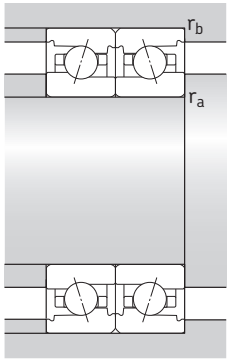


Sealed variant
for d = 10 to 120 mm

Principal dimensions			Basic load ratings dynamic	static	Fatigue load limit	Calculation factor	Attainable speeds when lubricating with grease	oil-air[1]	Mass[1]	Designations of open bearings[2] SKF	SNFA
d	D	B	C	C_0	P_u	f_0					
mm			kN		kN	–	r/min		kg	–	
15	28	7	3,19	1,4	0,06	7,7	75 000	115 000	0,015	**71902 CE/P4A**	**VEB 15 7CE1**
	28	7	3,19	1,4	0,06	7,7	90 000	140 000	0,013	**71902 CE/HCP4A**	**VEB 15 /NS 7CE1**
	28	7	3,02	1,34	0,057	-	68 000	106 000	0,015	**71902 ACE/P4A**	**VEB 15 7CE3**
	28	7	3,02	1,34	0,057	-	83 000	127 000	0,013	**71902 ACE/HCP4A**	**VEB 15 /NS 7CE3**
	32	9	4,42	1,93	0,08	7,3	68 000	106 000	0,028	**7002 CE/P4A**	**VEX 15 7CE1**
	32	9	4,42	1,93	0,08	7,3	83 000	127 000	0,025	**7002 CE/HCP4A**	**VEX 15 /NS 7CE1**
	32	9	4,23	1,83	0,078	-	63 000	95 000	0,028	**7002 ACE/P4A**	**VEX 15 7CE3**
	32	9	4,23	1,83	0,078	-	75 000	115 000	0,025	**7002 ACE/HCP4A**	**VEX 15 /NS 7CE3**
17	30	7	3,32	1,56	0,067	7,9	70 000	106 000	0,016	**71903 CE/P4A**	**VEB 17 7CE1**
	30	7	3,32	1,56	0,067	7,9	83 000	127 000	0,014	**71903 CE/HCP4A**	**VEB 17 /NS 7CE1**
	30	7	3,19	1,46	0,063	-	63 000	95 000	0,016	**71903 ACE/P4A**	**VEB 17 7CE3**
	30	7	3,19	1,46	0,063	-	75 000	115 000	0,014	**71903 ACE/HCP4A**	**VEB 17 /NS 7CE3**
	35	10	5,85	2,55	0,108	7,2	63 000	95 000	0,035	**7003 CE/P4A**	**VEX 17 7CE1**
	35	10	5,85	2,55	0,108	7,2	75 000	115 000	0,030	**7003 CE/HCP4A**	**VEX 17 /NS 7CE1**
	35	10	5,59	2,45	0,104	-	56 000	88 000	0,035	**7003 ACE/P4A**	**VEX 17 7CE3**
	35	10	5,59	2,45	0,104	-	68 000	103 000	0,030	**7003 ACE/HCP4A**	**VEX 17 /NS 7CE3**
20	37	9	4,88	2,4	0,102	7,8	56 000	88 000	0,036	**71904 CE/P4A**	**VEB 20 7CE1**
	37	9	4,88	2,4	0,102	7,8	68 000	106 000	0,032	**71904 CE/HCP4A**	**VEB 20 /NS 7CE1**
	37	9	4,68	2,28	0,098	-	52 000	78 000	0,036	**71904 ACE/P4A**	**VEB 20 7CE3**
	37	9	4,68	2,28	0,098	-	60 000	95 000	0,032	**71904 ACE/HCP4A**	**VEB 20 /NS 7CE3**
	42	12	7,41	3,35	0,143	7,2	54 000	83 000	0,064	**7004 CE/P4A**	**VEX 20 7CE1**
	42	12	7,41	3,35	0,143	7,2	65 000	100 000	0,056	**7004 CE/HCP4A**	**VEX 20 /NS 7CE1**
	42	12	7,15	3,25	0,137	-	48 000	75 000	0,064	**7004 ACE/P4A**	**VEX 20 7CE3**
	42	12	7,15	3,25	0,137	-	58 000	88 000	0,056	**7004 ACE/HCP4A**	**VEX 20 /NS 7CE3**
25	42	9	5,27	2,85	0,12	8,1	49 000	75 000	0,040	**71905 CE/P4A**	**VEB 25 7CE1**
	42	9	5,27	2,85	0,12	8,1	58 000	90 000	0,036	**71905 CE/HCP4A**	**VEB 25 /NS 7CE1**
	42	9	4,94	2,7	0,114	-	44 000	68 000	0,040	**71905 ACE/P4A**	**VEB 25 7CE3**
	42	9	4,94	2,7	0,114	-	52 000	83 000	0,036	**71905 ACE/HCP4A**	**VEB 25 /NS 7CE3**
	47	12	8,32	4,15	0,173	7,5	46 000	70 000	0,074	**7005 CE/P4A**	**VEX 25 7CE1**
	47	12	8,32	4,15	0,173	7,5	56 000	85 000	0,065	**7005 CE/HCP4A**	**VEX 25 /NS 7CE1**
	47	12	7,93	3,9	0,166	-	42 000	63 000	0,074	**7005 ACE/P4A**	**VEX 25 7CE3**
	47	12	7,93	3,9	0,166	-	50 000	75 000	0,065	**7005 ACE/HCP4A**	**VEX 25 /NS 7CE3**
30	47	9	5,59	3,25	0,14	8,3	41 000	63 000	0,050	**71906 CE/P4A**	**VEB 30 7CE1**
	47	9	5,59	3,25	0,14	8,3	49 000	75 000	0,045	**71906 CE/HCP4A**	**VEB 30 /NS 7CE1**
	47	9	5,27	3,1	0,132	-	37 000	58 000	0,050	**71906 ACE/P4A**	**VEB 30 7CE3**
	47	9	5,27	3,1	0,132	-	44 000	70 000	0,045	**71906 ACE/HCP4A**	**VEB 30 /NS 7CE3**
	55	13	9,36	5,2	0,22	7,9	39 000	60 000	0,11	**7006 CE/P4A**	**VEX 30 7CE1**
	55	13	9,36	5,2	0,22	7,9	47 000	73 000	0,10	**7006 CE/HCP4A**	**VEX 30 /NS 7CE1**
	55	13	8,84	5	0,212	-	35 000	54 000	0,11	**7006 ACE/P4A**	**VEX 30 7CE3**
	55	13	8,84	5	0,212	-	42 000	65 000	0,10	**7006 ACE/HCP4A**	**VEX 30 /NS 7CE3**

[1] Applicable to open bearings only
[2] For designations of sealed bearings and other variants, refer to **table 17** on **pages 32** and **33**.



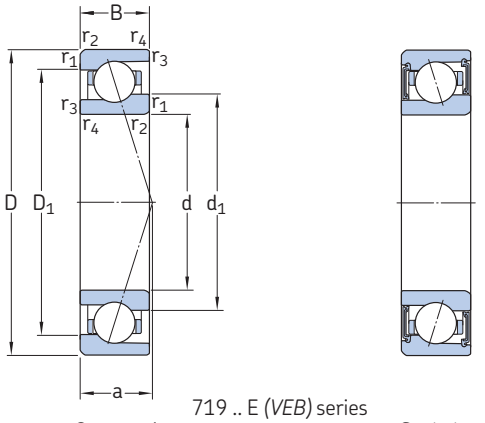


C

Dimensions						Abutment and fillet dimensions				
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
mm						mm				
15	19,1	23,9	0,3	0,15	7	17	26	26,6	0,3	0,15
	19,1	23,9	0,3	0,15	7	17	26	26,6	0,3	0,15
	19,1	23,9	0,3	0,15	9	17	26	26,6	0,3	0,15
	19,1	23,9	0,3	0,15	9	17	26	26,6	0,3	0,15
	20,7	28,8	0,3	0,15	8	17	30	30,6	0,3	0,15
	20,7	28,8	0,3	0,15	8	17	30	30,6	0,3	0,15
	20,7	28,8	0,3	0,15	10	17	30	30,6	0,3	0,15
	20,7	28,8	0,3	0,15	10	17	30	30,6	0,3	0,15
17	21,1	25,9	0,3	0,15	7	19	28	28,6	0,3	0,15
	21,1	25,9	0,3	0,15	7	19	28	28,6	0,3	0,15
	21,1	25,9	0,3	0,15	10	19	28	28,6	0,3	0,15
	21,1	25,9	0,3	0,15	10	19	28	28,6	0,3	0,15
	22,7	31,2	0,3	0,15	9	19	33	33,6	0,3	0,15
	22,7	31,2	0,3	0,15	9	19	33	33,6	0,3	0,15
	22,7	31,2	0,3	0,15	11	19	33	33,6	0,3	0,15
	22,7	31,2	0,3	0,15	11	19	33	33,6	0,3	0,15
20	25,7	31,5	0,3	0,15	9	22	35	35,6	0,3	0,15
	25,7	31,5	0,3	0,15	9	22	35	35,6	0,3	0,15
	25,7	31,5	0,3	0,15	12	22	35	35,6	0,3	0,15
	25,7	31,5	0,3	0,15	12	22	35	35,6	0,3	0,15
	26,6	36,5	0,6	0,3	10	22	40	39,6	0,6	0,3
	26,6	36,5	0,6	0,3	10	22	40	39,6	0,6	0,3
	26,6	36,5	0,6	0,3	13	22	40	39,6	0,6	0,3
	26,6	36,5	0,6	0,3	13	22	40	39,6	0,6	0,3
25	30,7	36,4	0,3	0,15	9	27	40	40,6	0,3	0,15
	30,7	36,4	0,3	0,15	9	27	40	40,6	0,3	0,15
	30,7	36,4	0,3	0,15	13	27	40	40,6	0,3	0,15
	30,7	36,4	0,3	0,15	13	27	40	40,6	0,3	0,15
	31,6	41,5	0,6	0,3	11	28,2	43,8	44,6	0,6	0,3
	31,6	41,5	0,6	0,3	11	28,2	43,8	44,6	0,6	0,3
	31,6	41,5	0,6	0,3	14	28,2	43,8	44,6	0,6	0,3
	31,6	41,5	0,6	0,3	14	28,2	43,8	44,6	0,6	0,3
30	35,8	41,4	0,3	0,15	10	32	45	45,6	0,3	0,15
	35,8	41,4	0,3	0,15	10	32	45	45,6	0,3	0,15
	35,8	41,4	0,3	0,15	14	32	45	45,6	0,3	0,15
	35,8	41,4	0,3	0,15	14	32	45	45,6	0,3	0,15
	38,2	48,1	1	0,6	12	34,6	50,4	50,8	1	0,6
	38,2	48,1	1	0,6	12	34,6	50,4	50,8	1	0,6
	38,2	48,1	1	0,6	16	34,6	50,4	50,8	1	0,6
	38,2	48,1	1	0,6	16	34,6	50,4	50,8	1	0,6

Super-precision angular contact ball bearings

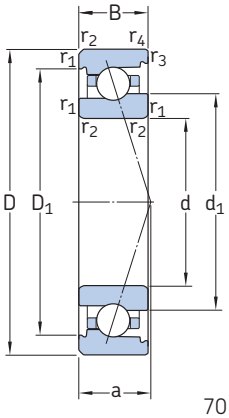
d **35 – 55** mm



719 .. E *(VEB)* series

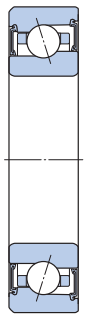
Open variant

Sealed variant
for d = 20 to 120 mm



70 .. E *(VEX)* series

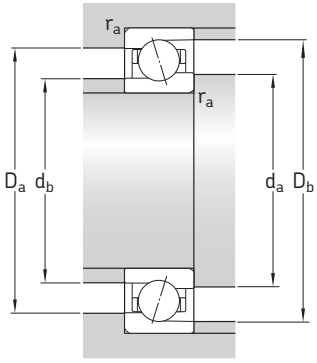
Open variant

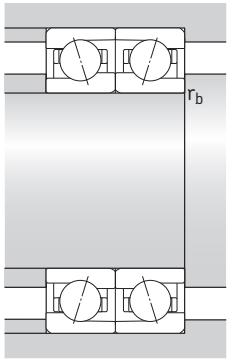


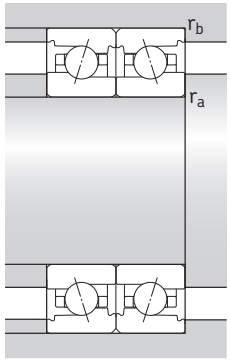
Sealed variant
for d = 10 to 120 mm

Principal dimensions			Basic load ratings dynamic	static	Fatigue load limit	Calculation factor	Attainable speeds when lubricating with grease	oil-air[1]	Mass[1]	Designations of open bearings[2] SKF	SNFA
d	D	B	C	C_0	P_u	f_0					
mm			kN		kN	–	r/min		kg	–	
35	55	10	7,61	4,75	0,2	8,3	36 000	54 000	0,075	**71907 CE/P4A**	**VEB 35 7CE1**
	55	10	7,61	4,75	0,2	8,3	43 000	65 000	0,067	**71907 CE/HCP4A**	**VEB 35 /NS 7CE1**
	55	10	7,28	4,5	0,19	-	32 000	50 000	0,075	**71907 ACE/P4A**	**VEB 35 7CE3**
	55	10	7,28	4,5	0,19	-	38 000	60 000	0,067	**71907 ACE/HCP4A**	**VEB 35 /NS 7CE3**
	62	14	11,4	6,55	0,28	7,9	34 000	50 000	0,15	**7007 CE/P4A**	**VEX 35 7CE1**
	62	14	11,4	6,55	0,28	7,9	40 000	63 000	0,13	**7007 CE/HCP4A**	**VEX 35 /NS 7CE1**
	62	14	11,1	6,3	0,265	-	31 000	46 000	0,15	**7007 ACE/P4A**	**VEX 35 7CE3**
	62	14	11,1	6,3	0,265	-	36 000	56 000	0,13	**7007 ACE/HCP4A**	**VEX 35 /NS 7CE3**
40	62	12	9,75	6,1	0,26	8,3	32 000	49 000	0,10	**71908 CE/P4A**	**VEB 40 7CE1**
	62	12	9,75	6,1	0,26	8,3	38 000	58 000	0,088	**71908 CE/HCP4A**	**VEB 40 /NS 7CE1**
	62	12	9,23	5,85	0,245	-	28 000	44 000	0,10	**71908 ACE/P4A**	**VEB 40 7CE3**
	62	12	9,23	5,85	0,245	-	34 000	52 000	0,088	**71908 ACE/HCP4A**	**VEB 40 /NS 7CE3**
	68	15	12,4	7,65	0,32	8,1	30 000	45 000	0,19	**7008 CE/P4A**	**VEX 40 7CE1**
	68	15	12,4	7,65	0,32	8,1	36 000	56 000	0,17	**7008 CE/HCP4A**	**VEX 40 /NS 7CE1**
	68	15	11,7	7,2	0,305	-	27 000	41 000	0,19	**7008 ACE/P4A**	**VEX 40 7CE3**
	68	15	11,7	7,2	0,305	-	32 000	50 000	0,17	**7008 ACE/HCP4A**	**VEX 40 /NS 7CE3**
45	68	12	10,1	6,95	0,29	8,4	29 000	44 000	0,13	**71909 CE/P4A**	**VEB 45 7CE1**
	68	12	10,1	6,95	0,29	8,4	34 000	52 000	0,12	**71909 CE/HCP4A**	**VEB 45 /NS 7CE1**
	68	12	9,75	6,55	0,275	-	25 000	39 000	0,13	**71909 ACE/P4A**	**VEB 45 7CE3**
	68	12	9,75	6,55	0,275	-	30 000	47 000	0,12	**71909 ACE/HCP4A**	**VEB 45 /NS 7CE3**
	75	16	13	8,5	0,36	8,2	27 000	41 000	0,24	**7009 CE/P4A**	**VEX 45 7CE1**
	75	16	13	8,5	0,36	8,2	32 000	50 000	0,22	**7009 CE/HCP4A**	**VEX 45 /NS 7CE1**
	75	16	12,1	8,15	0,345	-	24 000	37 000	0,24	**7009 ACE/P4A**	**VEX 45 7CE3**
	75	16	12,1	8,15	0,345	-	29 000	45 000	0,22	**7009 ACE/HCP4A**	**VEX 45 /NS 7CE3**
50	72	12	12,7	8,65	0,365	8,4	26 000	40 000	0,13	**71910 CE/P4A**	**VEB 50 7CE1**
	72	12	12,7	8,65	0,365	8,4	32 000	48 000	0,11	**71910 CE/HCP4A**	**VEB 50 /NS 7CE1**
	72	12	12,1	8,15	0,345	-	23 000	36 000	0,13	**71910 ACE/P4A**	**VEB 50 7CE3**
	72	12	12,1	8,15	0,345	-	28 000	43 000	0,11	**71910 ACE/HCP4A**	**VEB 50 /NS 7CE3**
	80	16	15,6	10,6	0,45	8,2	25 000	38 000	0,25	**7010 CE/P4A**	**VEX 50 7CE1**
	80	16	15,6	10,6	0,45	8,2	30 000	46 000	0,23	**7010 CE/HCP4A**	**VEX 50 /NS 7CE1**
	80	16	14,8	10	0,425	-	23 000	34 000	0,25	**7010 ACE/P4A**	**VEX 50 7CE3**
	80	16	14,8	10	0,425	-	27 000	41 000	0,23	**7010 ACE/HCP4A**	**VEX 50 /NS 7CE3**
55	80	13	15,3	10,6	0,455	8,4	24 000	36 000	0,17	**71911 CE/P4A**	**VEB 55 7CE1**
	80	13	15,3	10,6	0,455	8,4	28 000	43 000	0,14	**71911 CE/HCP4A**	**VEB 55 /NS 7CE1**
	80	13	14,6	10,2	0,43	-	21 000	32 000	0,17	**71911 ACE/P4A**	**VEB 55 7CE3**
	80	13	14,6	10,2	0,43	-	25 000	39 000	0,14	**71911 ACE/HCP4A**	**VEB 55 /NS 7CE3**
	90	18	16,8	12,2	0,52	8,4	22 000	34 000	0,39	**7011 CE/P4A**	**VEX 55 7CE1**
	90	18	16,8	12,2	0,52	8,4	25 000	39 000	0,36	**7011 CE/HCP4A**	**VEX 55 /NS 7CE1**
	90	18	15,9	11,6	0,49	-	19 000	30 000	0,39	**7011 ACE/P4A**	**VEX 55 7CE3**
	90	18	15,9	11,6	0,49	-	23 000	35 000	0,36	**7011 ACE/HCP4A**	**VEX 55 /NS 7CE3**

[1] Applicable to open bearings only
[2] For designations of sealed bearings and other variants, refer to **table 17** on **pages 32** and **33**.





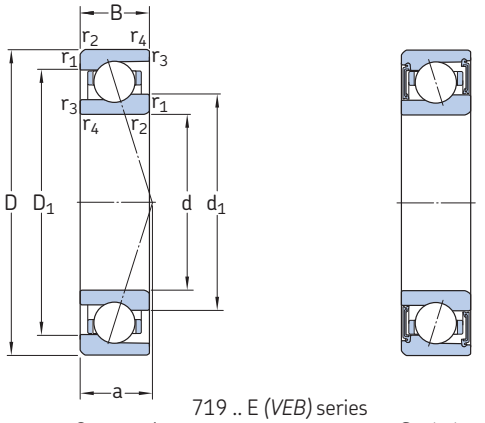


C

Dimensions						Abutment and fillet dimensions				
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
mm						mm				
35	41,7	48,3	0,6	0,3	11	38,2	51,8	52,6	0,6	0,3
	41,7	48,3	0,6	0,3	11	38,2	51,8	52,6	0,6	0,3
	41,7	48,3	0,6	0,3	16	38,2	51,8	52,6	0,6	0,3
	41,7	48,3	0,6	0,3	16	38,2	51,8	52,6	0,6	0,3
	43,7	54,9	1	0,6	14	39,6	57,4	57,8	1	0,6
	43,7	54,9	1	0,6	14	39,6	57,4	57,8	1	0,6
	43,7	54,9	1	0,6	18	39,6	57,4	57,8	1	0,6
	43,7	54,9	1	0,6	18	39,6	57,4	57,8	1	0,6
40	46,5	54,2	0,6	0,3	13	43,2	58,8	59,6	0,6	0,3
	46,5	54,2	0,6	0,3	13	43,2	58,8	59,6	0,6	0,3
	46,5	54,2	0,6	0,3	19	43,2	58,8	59,6	0,6	0,3
	46,5	54,2	0,6	0,3	19	43,2	58,8	59,6	0,6	0,3
	49,7	60,9	1	0,6	15	44,6	63,4	63,8	1	0,6
	49,7	60,9	1	0,6	15	44,6	63,4	63,8	1	0,6
	49,7	60,9	1	0,6	20	44,6	63,4	63,8	1	0,6
	49,7	60,9	1	0,6	20	44,6	63,4	63,8	1	0,6
45	52,7	60,3	0,6	0,3	14	43,2	64,8	65,6	0,6	0,3
	52,7	60,3	0,6	0,3	14	43,2	64,8	65,6	0,6	0,3
	52,7	60,3	0,6	0,3	20	43,2	64,8	65,6	0,6	0,3
	52,7	60,3	0,6	0,3	20	43,2	64,8	65,6	0,6	0,3
	55,7	66,9	1	0,6	16	49,6	70,4	70,8	1	0,6
	55,7	66,9	1	0,6	16	49,6	70,4	70,8	1	0,6
	55,7	66,9	1	0,6	22	49,6	70,4	70,8	1	0,6
	55,7	66,9	1	0,6	22	49,6	70,4	70,8	1	0,6
50	56,7	65,3	0,6	0,3	15	53,2	68,8	69,6	0,6	0,3
	56,7	65,3	0,6	0,3	15	53,2	68,8	69,6	0,6	0,3
	56,7	65,3	0,6	0,3	21	53,2	68,8	69,6	0,6	0,3
	56,7	65,3	0,6	0,3	21	53,2	68,8	69,6	0,6	0,3
	60,3	72,9	1	0,6	17	54,6	75,4	75,8	1	0,6
	60,3	72,9	1	0,6	17	54,6	75,4	75,8	1	0,6
	60,3	72,9	1	0,6	23	54,6	75,4	75,8	1	0,6
	60,3	72,9	1	0,6	23	54,6	75,4	75,8	1	0,6
55	62,8	72,3	1	0,3	16	59,6	75,4	77,6	1	0,3
	62,8	72,3	1	0,3	16	59,6	75,4	77,6	1	0,3
	62,8	72,3	1	0,3	23	59,6	75,4	77,6	1	0,3
	62,8	72,3	1	0,3	23	59,6	75,4	77,6	1	0,3
	67,7	80,4	1,1	0,6	19	61	84	85,8	1,1	0,6
	67,7	80,4	1,1	0,6	19	61	84	85,8	1,1	0,6
	67,7	80,4	1,1	0,6	26	61	84	85,8	1,1	0,6
	67,7	80,4	1,1	0,6	26	61	84	85,8	1,1	0,6

Super-precision angular contact ball bearings

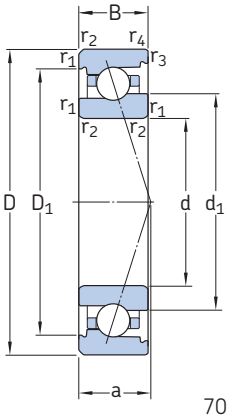
d **60 – 80** mm



719 .. E *(VEB)* series

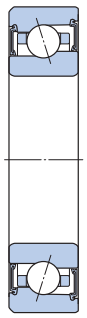
Open variant

Sealed variant
for d = 20 to 120 mm



70 .. E *(VEX)* series

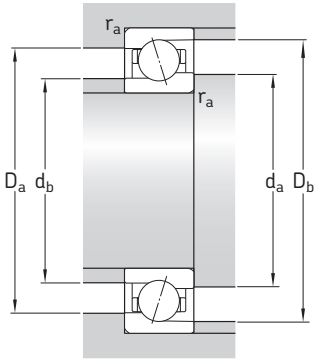
Open variant

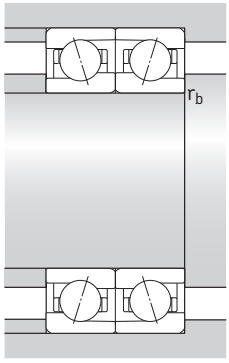


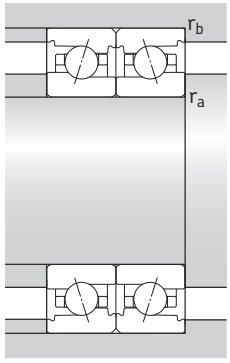
Sealed variant
for d = 10 to 120 mm

Principal dimensions			Basic load ratings dynamic	static	Fatigue load limit	Calculation factor	Attainable speeds when lubricating with grease	oil-air[1]	Mass[1]	Designations of open bearings[2] SKF	SNFA
d	D	B	C	C_0	P_u	f_0					
mm			kN		kN	–	r/min		kg	–	
60	85	13	16,3	11,8	0,5	8,5	22 000	34 000	0,19	**71912 CE/P4A**	**VEB 60 7CE1**
	85	13	16,3	11,8	0,5	8,5	26 000	40 000	0,16	**71912 CE/HCP4A**	**VEB 60 /NS 7CE1**
	85	13	15,3	11,2	0,475	-	19 500	30 000	0,19	**71912 ACE/P4A**	**VEB 60 7CE3**
	85	13	15,3	11,2	0,475	-	23 000	36 000	0,16	**71912 ACE/HCP4A**	**VEB 60 /NS 7CE3**
	95	18	17,2	12,9	0,54	8,5	20 000	31 000	0,42	**7012 CE/P4A**	**VEX 60 7CE1**
	95	18	17,2	12,9	0,54	8,5	24 000	37 000	0,39	**7012 CE/HCP4A**	**VEX 60 /NS 7CE1**
	95	18	16,3	12,2	0,52	-	18 000	28 000	0,42	**7012 ACE/P4A**	**VEX 60 7CE3**
	95	18	16,3	12,2	0,52	-	22 000	33 000	0,39	**7012 ACE/HCP4A**	**VEX 60 /NS 7CE3**
65	90	13	16,5	12,5	0,53	8,5	20 000	31 000	0,20	**71913 CE/P4A**	**VEB 65 7CE1**
	90	13	16,5	12,5	0,53	8,5	24 000	38 000	0,17	**71913 CE/HCP4A**	**VEB 65 /NS 7CE1**
	90	13	15,6	11,8	0,5	-	18 000	28 000	0,20	**71913 ACE/P4A**	**VEB 65 7CE3**
	90	13	15,6	11,8	0,5	-	22 000	34 000	0,17	**71913 ACE/HCP4A**	**VEB 65 /NS 7CE3**
	100	18	20,3	15,6	0,655	8,4	19 000	30 000	0,43	**7013 CE/P4A**	**VEX 65 7CE1**
	100	18	20,3	15,6	0,655	8,4	22 000	34 000	0,39	**7013 CE/HCP4A**	**VEX 65 /NS 7CE1**
	100	18	19,5	14,6	0,62	-	17 000	26 000	0,43	**7013 ACE/P4A**	**VEX 65 7CE3**
	100	18	19,5	14,6	0,62	-	20 000	31 000	0,39	**7013 ACE/HCP4A**	**VEX 65 /NS 7CE3**
70	100	16	22,1	16,3	0,68	8,4	18 500	28 000	0,32	**71914 CE/P4A**	**VEB 70 7CE1**
	100	16	22,1	16,3	0,68	8,4	22 000	34 000	0,27	**71914 CE/HCP4A**	**VEB 70 /NS 7CE1**
	100	16	20,8	15,3	0,655	-	16 500	26 000	0,32	**71914 ACE/P4A**	**VEB 70 7CE3**
	100	16	20,8	15,3	0,655	-	20 000	31 000	0,27	**71914 ACE/HCP4A**	**VEB 70 /NS 7CE3**
	110	20	23,8	18,3	0,780	8,4	17 000	27 000	0,61	**7014 CE/P4A**	**VEX 70 7CE1**
	110	20	23,8	18,3	0,780	8,4	20 500	32 000	0,56	**7014 CE/HCP4A**	**VEX 70 /NS 7CE1**
	110	20	22,5	17,3	0,735	-	15 500	24 000	0,61	**7014 ACE/P4A**	**VEX 70 7CE3**
	110	20	22,5	17,3	0,735	-	18 500	29 000	0,56	**7014 ACE/HCP4A**	**VEX 70 /NS 7CE3**
75	105	16	22,5	17	0,72	8,5	17 500	27 000	0,34	**71915 CE/P4A**	**VEB 75 7CE1**
	105	16	22,5	17	0,72	8,5	20 500	32 000	0,29	**71915 CE/HCP4A**	**VEB 75 /NS 7CE1**
	105	16	21,2	16,3	0,68	-	15 500	24 000	0,34	**71915 ACE/P4A**	**VEB 75 7CE3**
	105	16	21,2	16,3	0,68	-	18 500	29 000	0,29	**71915 ACE/HCP4A**	**VEB 75 /NS 7CE3**
	115	20	26	21,6	0,915	9,5	16 000	26 000	0,65	**7015 CE/P4A**	**VEX 75 7CE1**
	115	20	26	21,6	0,915	9,5	19 000	29 000	0,59	**7015 CE/HCP4A**	**VEX 75 /NS 7CE1**
	115	20	24,7	20,4	0,865	-	14 500	23 000	0,65	**7015 ACE/P4A**	**VEX 75 7CE3**
	115	20	24,7	20,4	0,865	-	17 000	27 000	0,59	**7015 ACE/HCP4A**	**VEX 75 /NS 7CE3**
80	110	16	22,5	18	0,75	8,6	16 500	25 000	0,36	**71916 CE/P4A**	**VEB 80 7CE1**
	110	16	22,5	18	0,75	8,6	19 000	30 000	0,31	**71916 CE/HCP4A**	**VEB 80 /NS 7CE1**
	110	16	21,2	17	0,71	-	14 500	22 000	0,36	**71916 ACE/P4A**	**VEB 80 7CE3**
	110	16	21,2	17	0,71	-	17 500	27 000	0,31	**71916 ACE/HCP4A**	**VEB 80 /NS 7CE3**
	125	22	33,8	28	1,18	9,4	15 000	24 000	0,86	**7016 CE/P4A**	**VEX 80 7CE1**
	125	22	33,8	28	1,18	9,4	17 500	27 000	0,77	**7016 CE/HCP4A**	**VEX 80 /NS 7CE1**
	125	22	32,5	26,5	1,12	-	13 700	21 000	0,86	**7016 ACE/P4A**	**VEX 80 7CE3**
	125	22	32,5	26,5	1,12	-	15 500	24 000	0,77	**7016 ACE/HCP4A**	**VEX 80 /NS 7CE3**

[1] Applicable to open bearings only
[2] For designations of sealed bearings and other variants, refer to **table 17** on **pages 32** and **33**.





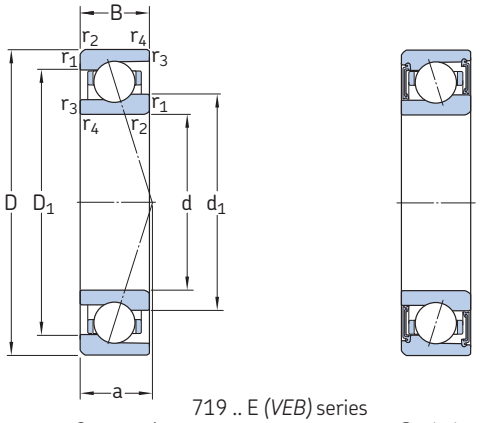


C

Dimensions						Abutment and fillet dimensions				
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
mm						mm				
60	67,8	77,3	1	0,3	17	64,6	80,4	82,6	1	0,3
	67,8	77,3	1	0,3	17	64,6	80,4	82,6	1	0,3
	67,8	77,3	1	0,3	25	64,6	80,4	82,6	1	0,3
	67,8	77,3	1	0,3	25	64,6	80,4	82,6	1	0,3
	72,7	85,4	1,1	0,6	19	66	89	90,8	1,1	0,6
	72,7	85,4	1,1	0,6	19	66	89	90,8	1,1	0,6
	72,7	85,4	1,1	0,6	27	66	89	90,8	1,1	0,6
	72,7	85,4	1,1	0,6	27	66	89	90,8	1,1	0,6
65	72,8	82,3	1	0,3	18	69,6	85,4	87,6	1	0,3
	72,8	82,3	1	0,3	18	69,6	85,4	87,6	1	0,3
	72,8	82,3	1	0,3	26	69,6	85,4	87,6	1	0,3
	72,8	82,3	1	0,3	26	69,6	85,4	87,6	1	0,3
	77,3	91,1	1,1	0,6	20	71	94	95,8	1,1	0,6
	77,3	91,1	1,1	0,6	20	71	94	95,8	1,1	0,6
	77,3	91,1	1,1	0,6	28	71	94	95,8	1,1	0,6
	77,3	91,1	1,1	0,6	28	71	94	95,8	1,1	0,6
70	79,3	90,5	1	0,3	20	74,6	95,4	97,6	1	0,3
	79,3	90,5	1	0,3	20	74,6	95,4	97,6	1	0,3
	79,3	90,5	1	0,3	29	74,6	95,4	97,6	1	0,3
	79,3	90,5	1	0,3	29	74,6	95,4	97,6	1	0,3
	84,3	98,6	1,1	0,6	22	76	104	105,8	1,1	0,6
	84,3	98,6	1,1	0,6	22	76	104	105,8	1,1	0,6
	84,3	98,6	1,1	0,6	31	76	104	105,8	1,1	0,6
	84,3	98,6	1,1	0,6	31	76	104	105,8	1,1	0,6
75	84,3	95,5	1	0,3	21	79,6	100	102,6	1	0,3
	84,3	95,5	1	0,3	21	79,6	100	102,6	1	0,3
	84,3	95,5	1	0,3	30	79,6	100	102,6	1	0,3
	84,3	95,5	1	0,3	30	79,6	100	102,6	1	0,3
	89,3	104,1	1,1	0,6	23	81	109	110,8	1,1	0,6
	89,3	104,1	1,1	0,6	23	81	109	110,8	1,1	0,6
	89,3	104,1	1,1	0,6	32	81	109	110,8	1,1	0,6
	89,3	104,1	1,1	0,6	32	81	109	110,8	1,1	0,6
80	89,3	100,52	1	0,3	22	84,6	105	107,6	1	0,3
	89,3	100,52	1	0,3	22	84,6	105	107,6	1	0,3
	89,3	100,52	1	0,3	32	84,6	105	107,6	1	0,3
	89,3	100,52	1	0,3	32	84,6	105	107,6	1	0,3
	95,8	112,6	1,1	0,6	25	86	119	120,8	1,1	0,6
	95,8	112,6	1,1	0,6	25	86	119	120,8	1,1	0,6
	95,8	112,6	1,1	0,6	35	86	119	120,8	1,1	0,6
	95,8	112,6	1,1	0,6	35	86	119	120,8	1,1	0,6

Super-precision angular contact ball bearings

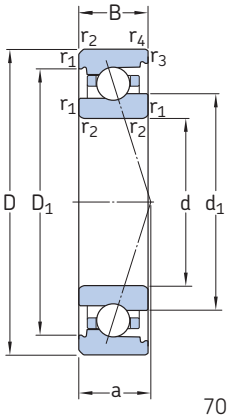
d **85 – 110** mm



719 .. E *(VEB)* series

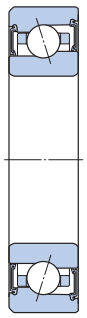
Open variant

Sealed variant
for d = 20 to 120 mm



70 .. E *(VEX)* series

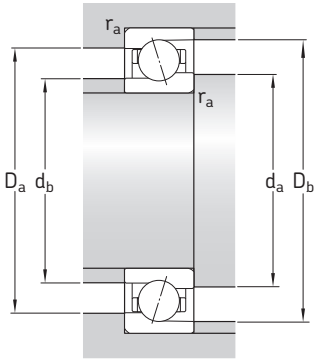
Open variant

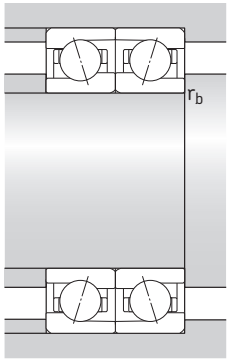


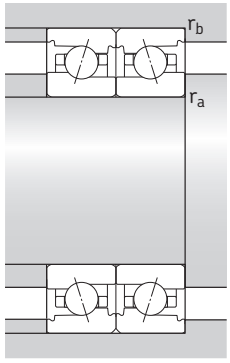
Sealed variant
for d = 10 to 120 mm

Principal dimensions			Basic load ratings		Fatigue load limit	Calculation factor	Attainable speeds when lubricating with		Mass[1]	Designations of open bearings[2]	
			dynamic	static			grease	oil-air[1]		SKF	SNFA
d	D	B	C	C_0	P_u	f_0					
mm			kN		kN	–	r/min		kg	–	
85	120	18	29,6	23,2	0,95	8,4	15 500	24 000	0,50	**71917 CE/P4A**	**VEB 85 7CE1**
	120	18	29,6	23,2	0,95	8,4	18 000	28 000	0,42	**71917 CE/HCP4A**	**VEB 85 /NS 7CE1**
	120	18	28,1	22	0,9	-	13 700	21 000	0,50	**71917 ACE/P4A**	**VEB 85 7CE3**
	120	18	28,1	22	0,9	-	16 500	25 000	0,42	**71917 ACE/HCP4A**	**VEB 85 /NS 7CE3**
	130	22	34,5	29	1,2	9,5	14 000	22 000	0,90	**7017 CE/P4A**	**VEX 85 7CE1**
	130	22	34,5	29	1,2	9,5	16 500	26 000	0,81	**7017 CE/HCP4A**	**VEX 85 /NS 7CE1**
	130	22	32,5	28	1,14	-	13 000	20 000	0,90	**7017 ACE/P4A**	**VEX 85 7CE3**
	130	22	32,5	28	1,14	-	15 000	23 000	0,81	**7017 ACE/HCP4A**	**VEX 85 /NS 7CE3**
90	125	18	30,2	24,5	0,965	8,5	14 500	22 000	0,54	**71918 CE/P4A**	**VEB 90 7CE1**
	125	18	30,2	24,5	0,965	8,5	17 000	27 000	0,46	**71918 CE/HCP4A**	**VEB 90 /NS 7CE1**
	125	18	28,6	23,2	0,915	-	13 000	20 000	0,54	**71918 ACE/P4A**	**VEB 90 7CE3**
	125	18	28,6	23,2	0,915	-	15 500	24 000	0,46	**71918 ACE/HCP4A**	**VEB 90 /NS 7CE3**
	140	24	35,8	32	1,27	9,6	13 300	21 000	1,20	**7018 CE/P4A**	**VEX 90 7CE1**
	140	24	35,8	32	1,27	9,6	15 500	24 000	1,10	**7018 CE/HCP4A**	**VEX 90 /NS 7CE1**
	140	24	33,8	30	1,2	-	12 000	19 000	1,20	**7018 ACE/P4A**	**VEX 90 7CE3**
	140	24	33,8	30	1,2	-	14 000	22 000	1,10	**7018 ACE/HCP4A**	**VEX 90 /NS 7CE3**
95	130	18	30,7	25,5	0,98	8,6	14 000	21 000	0,56	**71919 CE/P4A**	**VEB 95 7CE1**
	130	18	30,7	25,5	0,98	8,6	16 000	25 000	0,48	**71919 CE/HCP4A**	**VEB 95 /NS 7CE1**
	130	18	29,1	24	0,93	-	12 300	19 000	0,56	**71919 ACE/P4A**	**VEB 95 7CE3**
	130	18	29,1	24	0,93	-	15 000	23 000	0,48	**71919 ACE/HCP4A**	**VEB 95 /NS 7CE3**
	145	24	44,2	38	1,46	9,4	12 700	20 000	1,20	**7019 CE/P4A**	**VEX 95 7CE1**
	145	24	44,2	38	1,46	9,4	15 000	23 000	1,10	**7019 CE/HCP4A**	**VEX 95 /NS 7CE1**
	145	24	41,6	36	1,4	-	11 500	18 000	1,20	**7019 ACE/P4A**	**VEX 95 7CE3**
	145	24	41,6	36	1,4	-	13 300	20 500	1,10	**7019 ACE/HCP4A**	**VEX 95 /NS 7CE3**
100	140	20	39	31,5	1,2	8,5	13 300	20 500	0,77	**71920 CE/P4A**	**VEB 100 7CE1**
	140	20	39	31,5	1,2	8,5	15 500	24 000	0,65	**71920 CE/HCP4A**	**VEB 100 /NS 7CE1**
	140	20	36,4	30	1,14	-	11 500	18 000	0,77	**71920 ACE/P4A**	**VEB 100 7CE3**
	140	20	36,4	30	1,14	-	13 700	22 000	0,65	**71920 ACE/HCP4A**	**VEB 100 /NS 7CE3**
	150	24	44,9	40	1,5	9,5	12 300	19 000	1,35	**7020 CE/P4A**	**VEX 100 7CE1**
	150	24	44,9	40	1,5	9,5	14 500	22 000	1,10	**7020 CE/HCP4A**	**VEX 100 /NS 7CE1**
	150	24	42,3	38	1,43	-	11 200	17 500	1,25	**7020 ACE/P4A**	**VEX 100 7CE3**
	150	24	42,3	38	1,43	-	12 700	20 000	1,10	**7020 ACE/HCP4A**	**VEX 100 /NS 7CE3**
110	150	20	39,7	34,5	1,25	8,6	12 000	18 000	0,83	**71922 CE/P4A**	**VEB 110 7CE1**
	150	20	39,7	34,5	1,25	8,6	14 000	22 000	0,70	**71922 CE/HCP4A**	**VEB 110 /NS 7CE1**
	150	20	37,7	32,5	1,18	-	10 300	16 000	0,83	**71922 ACE/P4A**	**VEB 110 7CE3**
	150	20	37,7	32,5	1,18	-	12 300	19 000	0,70	**71922 ACE/HCP4A**	**VEB 110 /NS 7CE3**
	170	28	47,5	45	1,6	9,6	10 900	17 000	2,10	**7022 CE/P4A**	**VEX 110 7CE1**
	170	28	47,5	45	1,6	9,6	12 700	20 000	1,95	**7022 CE/HCP4A**	**VEX 110 /NS 7CE1**
	170	28	44,9	42,5	1,53	-	10 000	15 500	2,10	**7022 ACE/P4A**	**VEX 110 7CE3**
	170	28	44,9	42,5	1,53	-	11 500	17 500	1,95	**7022 ACE/HCP4A**	**VEX 110 /NS 7CE3**

[1] Applicable to open bearings only
[2] For designations of sealed bearings and other variants, refer to **table 17** on **pages 32** and **33**.





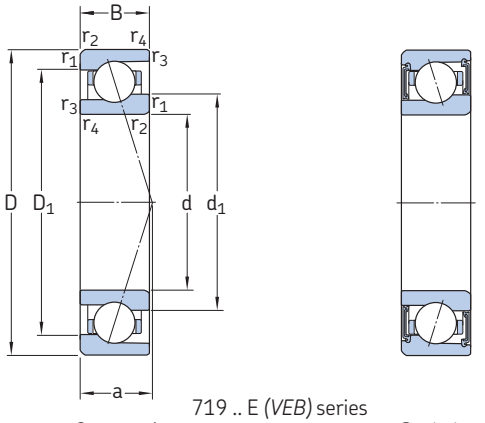


C

Dimensions						Abutment and fillet dimensions				
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
mm						mm				
85	96	109,22	1,1	0,6	23	91	114	115,8	1,1	0,6
	96	109,22	1,1	0,6	23	91	114	115,8	1,1	0,6
	96	109,22	1,1	0,6	34	91	114	115,8	1,1	0,6
	96	109,22	1,1	0,6	34	91	114	115,8	1,1	0,6
	100,8	117,6	1,1	0,6	26	91	124	125,8	1,1	0,6
	100,8	117,6	1,1	0,6	26	91	124	125,8	1,1	0,6
	100,8	117,6	1,1	0,6	36	91	124	125,8	1,1	0,6
	100,8	117,6	1,1	0,6	36	91	124	125,8	1,1	0,6
90	101	114,22	1,1	0,6	24	96	119	120,8	1,1	0,6
	101	114,22	1,1	0,6	24	96	119	120,8	1,1	0,6
	101	114,22	1,1	0,6	36	96	119	120,8	1,1	0,6
	101	114,22	1,1	0,6	36	96	119	120,8	1,1	0,6
	108,3	125,2	1,5	1	28	97	133	134,4	1,5	1
	108,3	125,2	1,5	1	28	97	133	134,4	1,5	1
	108,3	125,2	1,5	1	39	97	133	134,4	1,5	1
	108,3	125,2	1,5	1	39	97	133	134,4	1,5	1
95	106	119,22	1,1	0,6	25	101	124	125,8	1,1	0,6
	106	119,22	1,1	0,6	25	101	124	125,8	1,1	0,6
	106	119,22	1,1	0,6	37	101	124	125,8	1,1	0,6
	106	119,22	1,1	0,6	37	101	124	125,8	1,1	0,6
	112,4	131	1,5	1	28	102	138	139,4	1,5	1
	112,4	131	1,5	1	28	102	138	139,4	1,5	1
	112,4	131	1,5	1	40	102	138	139,4	1,5	1
	112,4	131	1,5	1	40	102	138	139,4	1,5	1
100	112,4	127,51	1,1	0,6	27	106	134	135,8	1,1	0,6
	112,4	127,51	1,1	0,6	27	106	134	135,8	1,1	0,6
	112,4	127,51	1,1	0,6	39	106	134	135,8	1,1	0,6
	112,4	127,51	1,1	0,6	39	106	134	135,8	1,1	0,6
	117,4	136	1,5	1	29	107	143	144,4	1,5	1
	117,4	136	1,5	1	29	107	143	144,4	1,5	1
	117,4	136	1,5	1	41	107	143	144,4	1,5	1
	117,4	136	1,5	1	41	107	143	144,4	1,5	1
110	122,4	137,51	1,1	0,6	29	111	139	145,8	1,1	0,6
	122,4	137,51	1,1	0,6	29	111	139	145,8	1,1	0,6
	122,4	137,51	1,1	0,6	43	111	139	145,8	1,1	0,6
	122,4	137,51	1,1	0,6	43	111	139	145,8	1,1	0,6
	132,4	152,2	2	1	33	118,8	161,2	164,4	2	1
	132,4	152,2	2	1	33	118,8	161,2	164,4	2	1
	132,4	152,2	2	1	47	118,8	161,2	164,4	2	1
	132,4	152,2	2	1	47	118,8	161,2	164,4	2	1

Super-precision angular contact ball bearings

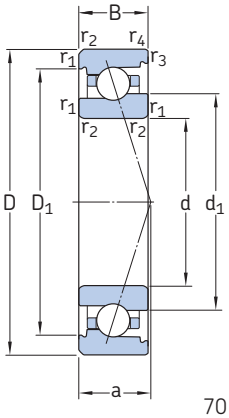
d **120** mm



719 .. E *(VEB)* series

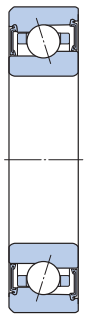
Open variant

Sealed variant
for d = 20 to 120 mm



70 .. E *(VEX)* series

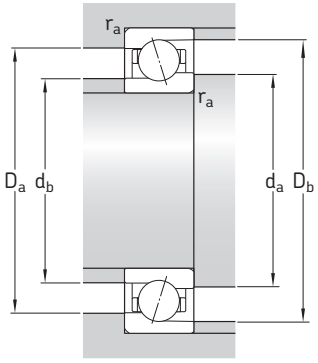
Open variant

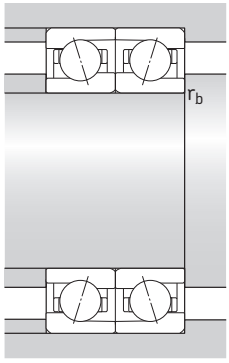


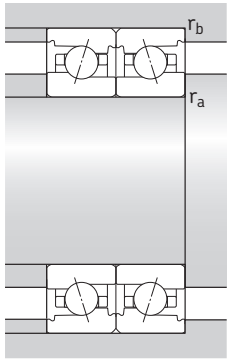
Sealed variant
for d = 10 to 120 mm

Principal dimensions			**Basic load ratings** dynamic	static	**Fatigue load limit**	**Calculation factor**	**Attainable speeds** when lubricating with grease	oil-air[1]	**Mass**[1]	**Designations of open bearings**[2] SKF	SNFA
d	D	B	C	C_0	P_u	f_0					
mm			kN		kN	–	r/min		kg	–	
120	165	22	47,5	40,5	1,4	8,5	11 200	16 000	1,10	**71924 CE/P4A**	**VEB 120 7CE1**
	165	22	47,5	40,5	1,4	8,5	12 700	19 000	0,93	**71924 CE/HCP4A**	**VEB 120 /NS 7CE1**
	165	22	44,9	38	1,32	-	9 500	15 000	1,10	**71924 ACE/P4A**	**VEB 120 7CE3**
	165	22	44,9	38	1,32	-	11 500	17 500	0,93	**71924 ACE/HCP4A**	**VEB 120 /NS 7CE3**
	180	28	57,2	55	1,9	9,6	9 300	14 500	2,20	**7024 CE/P4A**	**VEX 120 7CE1**
	180	28	57,2	55	1,9	9,6	11 200	17 500	1,95	**7024 CE/HCP4A**	**VEX 120 /NS 7CE1**
	180	28	54	52	1,8	-	8 300	13 000	2,20	**7024 ACE/P4A**	**VEX 120 7CE3**
	180	28	54	52	1,8	-	10 000	15 500	1,95	**7024 ACE/HCP4A**	**VEX 120 /NS 7CE3**

[1] Applicable to open bearings only
[2] For designations of sealed bearings and other variants, refer to **table 17** on **pages 32** and **33**.







C

Dimensions						Abutment and fillet dimensions				
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
mm						mm				
120	134	151,01	1,1	0,6	31	116	154	160,8	1,1	0,6
	134	151,01	1,1	0,6	31	116	154	160,8	1,1	0,6
	134	151,01	1,1	0,6	46	116	154	160,8	1,1	0,6
	134	151,01	1,1	0,6	46	116	154	160,8	1,1	0,6
	141,4	163,2	2	1	34	128,8	171,2	174,4	2	1
	141,4	163,2	2	1	34	128,8	171,2	174,4	2	1
	141,4	163,2	2	1	49	128,8	171,2	174,4	2	1
	141,4	163,2	2	1	49	128,8	171,2	174,4	2	1

Setting the highest standard for precision bearings

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

Table 1 on **page 48** and **49** provides an overview of the new assortment of SKF super-precision bearings.

Super-precision angular contact ball bearings

Bearings in the 718 *(SEA)* series

Bearings in the 718 *(SEA)* series provide optimum performance in applications where a low cross section and high degree of rigidity, speed and superior accuracy are critical design parameters. They are particularly suitable for machine tool applications, multi-spindle drilling heads, robotic arms, measuring devices, racing car wheels and other precision applications. The standard assortment accommodates shaft diameters ranging from 10 to 160 mm.

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

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

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

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

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

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

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

Bearings made from NitroMax steel

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

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

Super-precision cylindrical roller bearings

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

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

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

Super-precision double direction angular contact thrust ball bearings

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

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

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

Super-precision angular contact thrust ball bearings for screw drives

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

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

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

Super-precision axial-radial cylindrical roller bearings

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

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

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

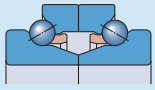
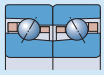
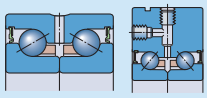
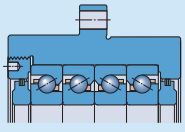
Table 1

Overview of SKF super-precision bearings

ISO dimension series	Bearing type and design *SKF publication[1,2]*		Variant		SKF assortment SKF bearings in the series
18	**Angular contact ball bearings: Basic design** *Super-precision angular contact ball bearings: 718 (SEA) series (Publication No. 06810)*		Open	All-steel Hybrid	718 .. D *(SEA)* 718 .. D/HC *(SEA /NS)*
19	**Angular contact ball bearings: High-speed, B design** *Super-precision angular contact ball bearings: High-speed, B design, sealed as standard (Publication No. 06939)*		Open Sealed	All-steel Hybrid All-steel Hybrid	719 .. B *(HB)* 719 .. B/HC *(HB /NS)* S719 .. B *(HB /S)* S719 .. B/HC *(HB /S/NS)*
	Angular contact ball bearings: High-speed, E design *Super-precision angular contact ball bearings: High-speed, E design (Publication No. 10112)*		Open Sealed	All-steel Hybrid All-steel Hybrid	719 .. E *(VEB)* 719 .. E/HC *(VEB /NS)* S719 .. E *(VEB /S)* S719 .. E/HC *(VEB /S/NS)*
	Angular contact ball bearings: High-capacity, basic design *Super-precision angular contact ball bearings: High-capacity 719 .. D (SEB) and 70 .. D (EX) series (Publication No. 10527)*		Open Sealed	All-steel Hybrid All-steel Hybrid	719 .. D *(SEB)* 719 .. D/HC *(SEB /NS)* S719 .. D *(SEB /S)* S719 .. D/HC *(SEB /S/NS)*
10	**Angular contact ball bearings: High-speed, B design** *Super-precision angular contact ball bearings: High-speed, B design, sealed as standard (Publication No. 06939)*		Open Sealed	All-steel Hybrid All-steel Hybrid	70 .. B *(HX)* 70 .. B/HC *(HX /NS)* S70 .. B *(HX /S)* S70 .. B/HC *(HX /S/NS)*
	Angular contact ball bearings: High-speed, E design *Super-precision angular contact ball bearings: High-speed, E design (Publication No. 10112)*		Open Sealed	All-steel Hybrid All-steel Hybrid	70 .. E *(VEX)* 70 .. E/HC *(VEX /NS)* S70 .. E *(VEX /S)* S70 .. E/HC *(VEX /S/NS)*
	Angular contact ball bearings: High-capacity, basic design *Super-precision angular contact ball bearings: High-capacity 719 .. D (SEB) and 70 .. D (EX) series (Publication No. 10527)*		Open Sealed	All-steel Hybrid All-steel Hybrid	70 .. D *(EX)* 70 .. D/HC *(EX /NS)* S70 .. D *(EX /S)* S70 .. D/HC *(EX /S/NS)*
02	**Angular contact ball bearings: High-capacity, basic design** *Super-precision angular contact ball bearings: High-capacity (Publication No. 06981)*		Open Sealed	All-steel Hybrid All-steel Hybrid	72 .. D *(E 200)* 72 .. D/HC *(E 200 /NS)* S72 .. D *(E 200 /S)* S72 .. D/HC *(E 200 /S/NS)*
49	**Double row cylindrical roller bearings: NNU design**		Open	All-steel	NNU 49 BK

[1] Where applicable, information can be found in the SKF publication *High-precision bearings* (Publication No. 6002).
[2] For additional information about super-precision angular contact ball bearings made from NitroMax steel, refer to the SKF publication *Extend bearing service life with NitroMax* (Publication No. 10126).

Overview of SKF super-precision bearings

ISO dimension series	Bearing type and design *SKF publication[1,2]*		Variant		SKF assortment SKF bearings in the series
10	**Single row cylindrical roller bearings: Basic design**		Open	All-steel Hybrid	N 10 KTN N 10 KTN/HC5
	Single row cylindrical roller bearings: High-speed design *Super-precision cylindrical roller bearings: High-speed (Publication No. 07016)*		Open	All-steel Hybrid	N 10 KPHA N 10 KPHA/HC5
30	**Double row cylindrical roller bearings: NN design**		Open	All-steel Hybrid	NN 30 KTN NN 30 KTN/HC5
– (Non-standardized)	**Angular contact thrust ball bearings: Double direction, basic design** *Super-precision double direction angular contact thrust ball bearings (Publication No. 10097)*		Open	All-steel Hybrid	BTW BTW /HC
	Angular contact thrust ball bearings: Double direction, high-speed design *Higher-speed capability with the new BTM bearing series design (Publication No. 12119)*		Open	All-steel Hybrid	BTM BTM /HC
02	**Angular contact thrust ball bearings: Single direction** *Super-precision angular contact thrust ball bearings for screw drives (Publication No. 06570)*		Open Sealed	All-steel All-steel	BSA 2 *(BS 200)* BSA 2 .. *(BS 200 ..)*
03	**Angular contact thrust ball bearings: Single direction** *Super-precision angular contact thrust ball bearings for screw drives (Publication No. 06570)*		Open Sealed	All-steel All-steel	BSA 3 *(BS 3)* BSA 3 .. *(BS 3 ..)*
– (Non-standardized)	**Angular contact thrust ball bearings: Single direction** *Super-precision angular contact thrust ball bearings for screw drives (Publication No. 06570)*		Open Sealed	All-steel All-steel	BSD *(BS ../)* BSD .. *(BS ..)*
	Angular contact thrust ball bearings: Double direction		Sealed	All-steel	BEAS *(BEAS)* BEAM *(BEAM)*
	Cartridge unit with angular contact thrust ball bearings		Sealed	All-steel	FBSA *(BSDU, BSQU)* –

[1] Where applicable, information can be found in the SKF publication *High-precision bearings* (Publication No. 6002).
[2] For additional information about super-precision angular contact ball bearings made from NitroMax steel, refer to the SKF publication *Extend bearing service life with NitroMax* (Publication No. 10126).

D

SKF – the knowledge engineering company

From one simple but inspired solution to a misalignment problem in a textile mill in Sweden, and fifteen employees in 1907, SKF has grown to become a global industrial knowledge leader.
Over the years we have built on our expertise in bearings, extending it to seals, mechatronics, services and lubrication systems. Our knowledge network includes 46 000 employees, 15 000 distributor partners, offices in more than 130 countries, and a growing number of SKF Solution Factory sites around the world.

Research and development

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

Meeting the toughest challenges

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

Working for a sustainable future

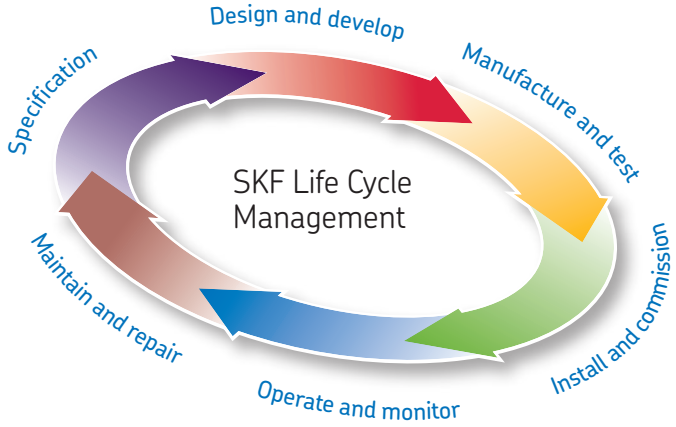
Since 2005, SKF has worked to reduce the negative environmental impact from our own operations and those of our suppliers. Our continuing technology development introduced the SKF BeyondZero portfolio of products and services which improve efficiency and reduce energy losses, as well as enable new technologies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

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

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

Our knowledge – your success

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



Working closely with you

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

Innovative solutions

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

Design optimization and verification

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

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

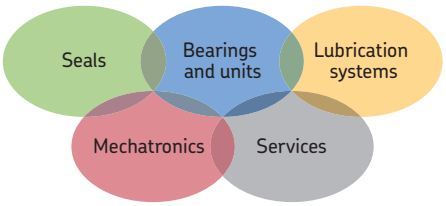
Machinery maintenance
Condition monitoring technologies and maintenance services from SKF can help minimize unplanned downtime, improve operational efficiency and reduce maintenance costs.

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

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

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

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



The Power of Knowledge Engineering

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

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This publication supersedes all information about SKF bearings in the 719 .. E and 70 .. E series in the SKF publication *High-precision bearings* (Publication No. 6002) and SNFA bearings in the VEB and VEX series in the *SNFA General Catalogue*.

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