HQW

SPINDLE BEARINGS


KIEL
HAMBURG
SCHWERIN
BREMEN
BERLIN
HANOVER
MAGDEBURG
DORTMUND
LEIPZIG
COLOGNE
ERFURT
FRANKFURT/MAIN
WIESBADEN
MAINZ
HQW
WÜRZBURG
SAARBRÜCKEN
NUREMBERG
STUTTGART
AUGSBURG
MUNICH
A7
HQW
KÜRNACH
WÜRZBURG
A3
A3
A7

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HQW - MADE IN GERMANY

HQW Precision is a premium brand – 'Made in Germany'. As a premium supplier, we manufacture high-end bearings and assemblies with an excellent price-performance-ratio, tailormade to the demands and requirements of our customers. It is important to us that our customers are supplied with products of consistent quality, which is reflected in our adherence to the highest quality standards. Working in close partnership with our customers we are also able to offer a full range of engineering support services.

SPINDLE BALL BEARINGS FROM HQW

HQW specialises in the production of stainless steel spindle ball bearings which are manufactured to the highest tolerance standards. The HQW product range covers bearings with an inner diameter from 3mm to 25mm. These bearings are specially designed to offer an exceptionally long lifetime, extreme corrosion resistance and suitability for the highest operating speeds. As product quality is of utmost importance, the use of a Class 7 cleanroom is an integral part of our manufacturing process. Our flexible approach in manufacturing combined with a large stock of different product types enables us to fully meet the demands of our customers at all times.

QUALITY

As a premium 'Made in Germany' manufacturer, we place the utmost importance on the quality of our production processes. The tolerances for size, geometry and running accuracy of our spindle bearings fully comply with international ISO 492 and national DIN 620 standards, as well as American ABEC tolerance classes. Our bearings are fitted with balls which meet the highest tolerance standards, 'Grade 5' as a minimum, and our spindle bearings are manufactured up to ABEC9 (P2). Our site in Kürnach near Würzburg, Germany, is certified to ISO 9001:2015 for quality and process management. We are fully committed to maintaining the highest levels of cleanliness in all areas of the manufacturing process. After assembly in a Class 7 cleanroom our bearings are subjected to 100% noise testing to ensure that our customers always receive bearings which meet the best noise standard for their application. The net result is a high precision product with a long operating life.

ENGINEERING SUPPORT

HQW is a global development and service partner for its customers throughout the world. In addition to offering expert technical advice, HQW has at its disposal a range of state-of the-art laboratory equipment and test rigs which are used for bearing analysis and testing.

As well as basic bearing analysis our team of bearing specialists also offer the following:

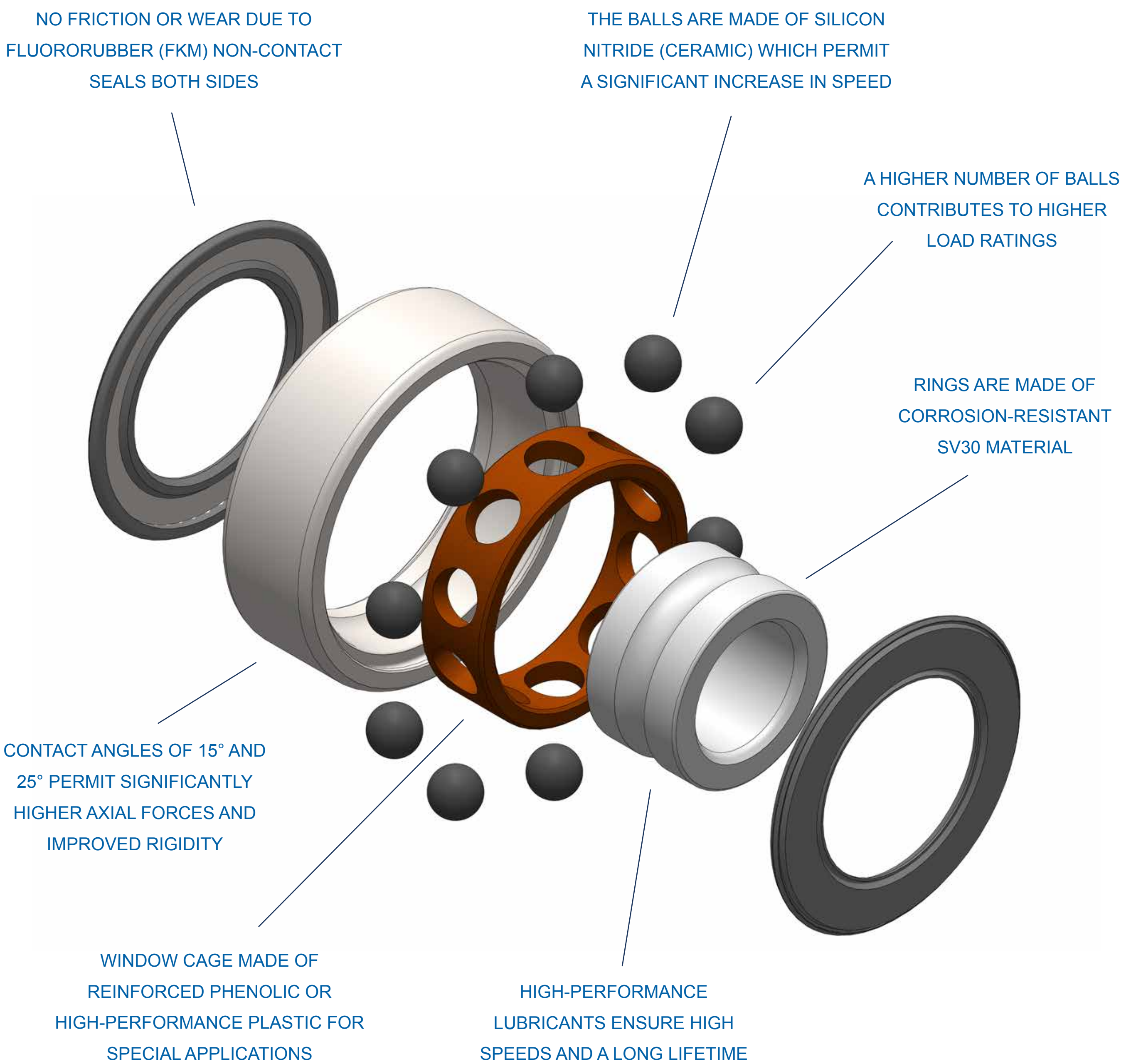
- Bearing lifetime calculations and evaluation of kinematics.
- Rigidity and preload design.
- Thermal inspection.
- Shaft calculation.
- Lubricant recommendation.

Services offered by our laboratory:

- Bearing damage analysis.
- Grease analysis.
- Dimensional check.
- Friction measurement.

SPINDLE BEARINGS

Spindle bearings are single row angular contact ball bearings which support thrust loads in one direction and are often used in machine tool spindles. At very high speeds, spindle bearings can simultaneously absorb high radial forces and single direction axial forces. Spindle bearings have one open shoulder on the outer ring as standard. This design permits the use of a higher number of balls and a window cage which maximises the bearing's load rating. Spindle bearings are preloaded, making the entire system free of clearance. In terms of design, running accuracy and the materials used, spindle bearings are designed for the highest speeds and highest load ratings.



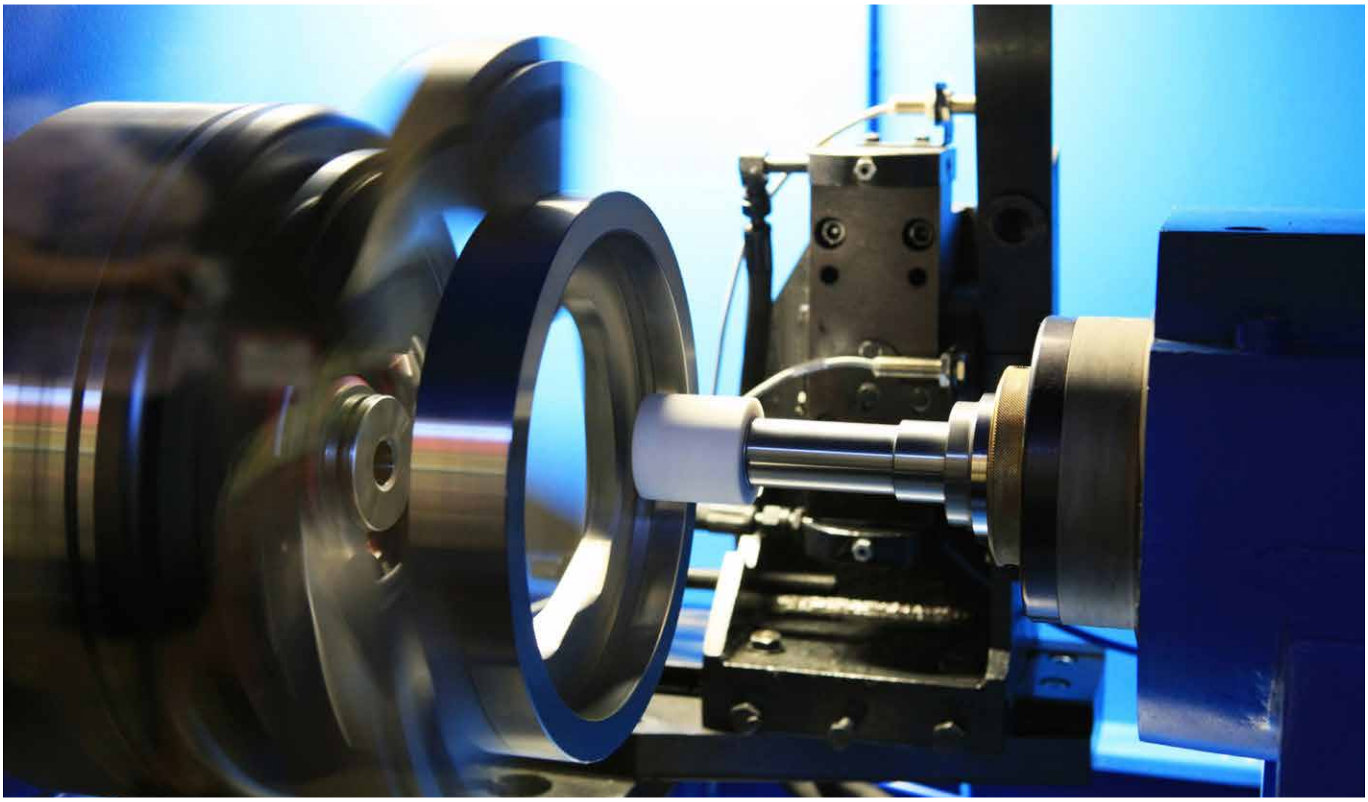
APPLICATIONS

The most common application for spindle bearings is in machine tool spindles from which the term "spindle bearing" is derived. The bearing has to be capable of handling the particularly demanding operating conditions of the spindle and, as such, has to be specially designed for the application. Depending on the size and type of material being machined by the spindle, the bearing has to cope with a variety of machine speeds, offering maintenance-free and reliable performance within the given design envelope.

The image below shows a modern grinding motor spindle, which reaches speeds of up to 180,000rpm. Running accuracy and quietness are key requirements in this application. These are met by ensuring that all rotating components are very finely balanced and that the bearings meet the highest quality standards. HQW spindle bearings meet these requirements down to the last micron.

Our spindle bearings are used in the most diverse applications: Whether it be motorised spindles or belt driven mechanical spindles, HQW spindle bearings are used in a wide variety of applications and always ensure optimum performance.

A further use for HQW spindle bearings is in rotary unions for machine tool spindles. These supply cooling liquids through the rotating spindle shaft at pressures of up to 150 bar and at high operating speeds. This places extreme demands on the bearing in terms of high speed and increased axial loads.



MATERIALS AND COMPONENTS

A spindle bearing is a special design of single row angular contact ball bearing, consisting of an inner ring, an outer ring, a window cage and optional seals. The components of the bearing design may vary according to the application. Please consult our bearing specialists for your particular requirements.

RINGS

HQW spindle bearing rings are manufactured in the material X30CrMoN15-1 (HQW designation: SV30) as standard. This highly-refined stainless steel has a very fine grain structure which enhances its mechanical properties. The composition of the material is shown in the table below. For comparison purposes, the stainless steel X65Cr13 and the standard bearing steel 100Cr6 are also indicated; these can also be specified as required.

Designation			Material composition							
Material	DIN	HQW	Cr	C	Si	Mn	P	S	Mo	N
X30CrMoN15-1	1.4108	SV30	14,0-16,0	0,25-0,35	--	--	--	--	0,85-1,10	0,30-0,40
X65Cr13	1.4037	S	12,50-14,50	0,43-0,50	≤ 1,00	≤ 1,00	≤ 0,040	≤ 0,030	--	--
100Cr6	1.3505	--	1,35-1,60	0,93-1,05	0,15-0,35	0,25-0,45	≤ 0,025	≤ 0,025	--	--

ADVANTAGES OF SV30

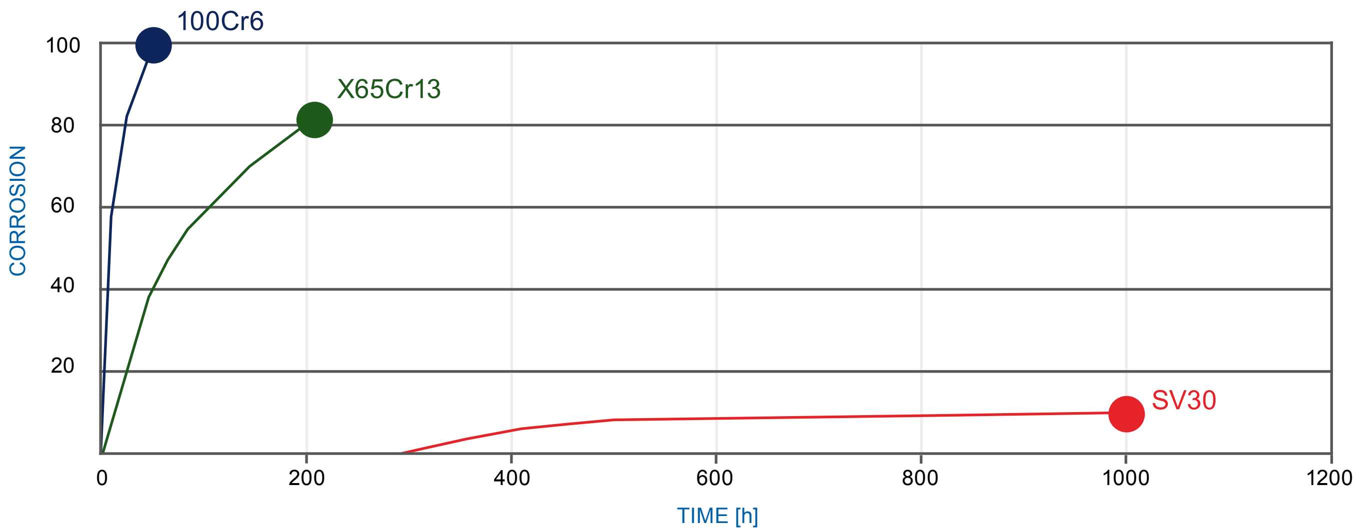
- Longer lifetime in comparison to conventional materials.
- Maximum corrosion resistance.
- Improved mechanical properties due to very fine structure.
- Quiet running.
- High temperature resistance of up to 300°C.
- High chemical resistance.

SV30 APPLICATIONS

- Machine tool spindles.
- Medical technology.
- Vacuum technology.
- Aerospace.
- Measurement and control technology.
- Food and beverage industry.

CORROSION RESISTANCE

The graph below illustrates the degree of corrosion over time for the high-performance material SV30, compared with traditional bearing steels 100Cr6 and X65Cr13.



100Cr6
after 50 h

X65Cr13
after 200 h

SV30
after 1000 h

This high corrosion resistance is also clearly shown on the test rings shown above, which have been subjected to salt spray test according to DIN EN ISO 9227:2012 in our in-house test chamber. During testing, the concentration of the salt solution, the temperature, the pressure, and the pH value are all maintained at a constant level. The duration of the test is determined by the corrosion rate of the test rings. The salt spray test of standard bearing steel 100Cr6 therefore, was stopped after 50 hours due to high levels of corrosion. Thanks to its higher chrome content, X65Cr13 stainless steel will corrode at a much slower pace. If your application demands a particularly low corrosion rate we would recommend the use of SV30 steel, which showed only slight signs of corrosion after 1,000 hours of salt spray testing.

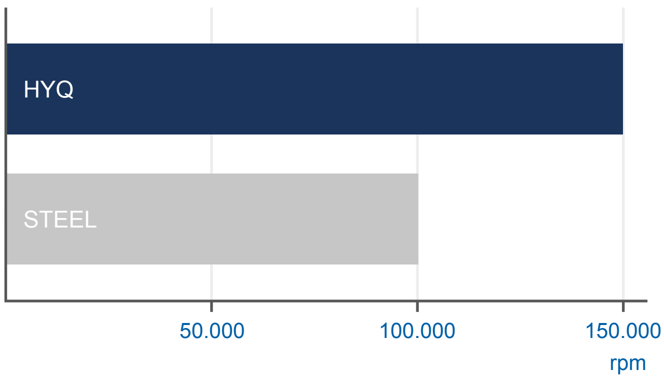
BALLS

The balls used in HQW's spindle bearings are usually made of stainless steel (X65Cr13). However, for particularly arduous applications many of our bearings are fitted with ceramic balls made from silicon nitride (Si_3N_4). Only balls of grade 3 and 5 are used for HQW spindle bearings. These classes comply with the highest tolerances in terms of size, roundness and roughness.

HYBRID SPINDLE BEARINGS

HQW hybrid spindle bearings are used to meet the requirements of particularly demanding applications. The inner ring and outer ring are made of stainless steel whilst the balls are ceramic (silicon nitride). Hybrid spindle bearings can be recognised by the letters "HYQ" in their part number. By using hybrid bearings, attainable speeds can be increased by up to 50%, as seen in the figure below. A significantly higher lifetime can be achieved in applications where there is insufficient lubrication. Please consult our bearing specialists for more information on how hybrid bearings could improve performance in your particular application.

LIMITTING SPEED FOR HQW HYBRID SPINDLE BEARINGS (ILLUSTRATIVE)



ADVANTAGES OF HYBRID BEARINGS

- Significantly higher lifetime and grease service life.
- Increase in running speeds by up to 50%.
- Higher media and corrosion resistance.
- Electrically non-conductive.
- Non-magnetic balls.
- Continued operation even with insufficient lubrication.
- Lower friction coefficient.
- Lower heat generation.

CAGES

Cages in spindle bearings are an essential part of bearing performance, which is why we choose to custom machine them at our site in Kürnach, Germany. The cage separates the balls to prevent them coming into contact, thus ensuring an even load distribution within the bearing. HQW spindle bearings have a window cage made of fabric reinforced phenolic as standard.

If required, cages can also be produced from high-performance plastics such as PEEK or Torlon®. These materials are used on account of their low weight, their corrosion resistance and low friction. The low friction properties result in reduced wear and less heat generation, which make the bearings more suited to higher speeds whilst prolonging grease service life. Plastics are therefore particularly suitable as cage materials for bearings used in machine tool spindles.

ADVANTAGES OF MACHINED WINDOW CAGES COMPARED WITH MOLDED AND STEEL CAGES

- High precision.
- Larger choice of materials.
- Flexible designs which can be manufactured quickly.
- Economic production of small to medium batches.
- Longer lifetime.
- High speeds.

Cage types	Short designation	Cage type	Features
	TA TB	Machine-made single-piece window cage made of fabric-reinforced phenolic resin. (A = outer ring guided, B = inner ring guided)	• Oil impregnation possible. • Suitable for spindle ball bearings with high accuracy. • Very high speeds. • High strength. • Good low lubricant running characteristics.
	TxA TxB	Machine-made single-piece window cage made of high-performance plastic (PEEK, Torlon®, etc.). (A = outer ring guided, B = inner ring guided, x = material)	• For spindle bearings with very high speeds. • High strength. • Best low lubricant running characteristics. • Also suitable for high-temperature applications (operating temperature of Torlon® up to 260°C).

LUBRICATION

The main task of a lubricant is to form a hydrodynamic lubricating film between the rolling element and the raceway, thereby preventing direct contact between the friction surfaces of the individual components.

Other tasks of the lubricating film are:

- Reduction of friction.
- Minimisation of wear.
- Corrosion protection.
- Heat dissipation from the bearing.

The type of lubricant is selected according to the application whilst taking into account specific customer requirements. Around 300 different greases and oils are available for this purpose. The different types of lubrication are highlighted below. In addition, we can offer special finishing of the spindle bearing itself or its individual components. This could include, for example, vacuum impregnation of the cage, special coating of the rings and dispersion greasing.

GREASE LUBRICATION

Grease lubrication is characterised as oil, bound by a thickener which is continuously dispensed to the contact point during the lifetime. Sealed HQW spindle bearings are lubricated with a high-performance grease for the entire lifetime, making an external lubrication system unnecessary. Attainable running speeds are generally lower compared with oil lubrication.

ADVANTAGES OF SEALED HQW SPINDLE BEARINGS WITH GREASE LUBRICATION

- Lifetime lubrication.
- Maintenance-free.
- No external lubrication system required.
- Optimal grease quantity.
- Use of a high-performance lubricant (speed factor $n \cdot d_m$ = 2,000,000).

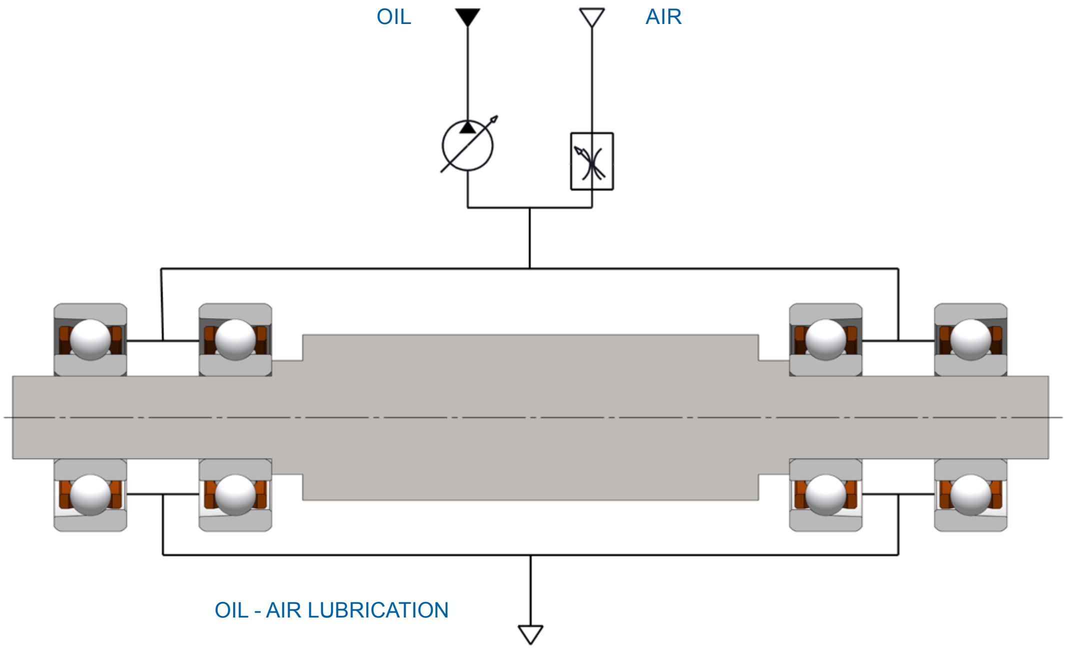
Based on the operating conditions, a suitable lubricant must be selected to achieve the required speed limits, temperatures and friction values. As standard, sealed HQW spindle bearings use a high-performance special grease, based on synthetic oil and polyurea thickener. The grease exhibits optimal performance during tests at speed factors of two million $n \cdot d_m$. Bearing run-in occurs much faster and the starting torque is greatly reduced.

OIL LUBRICATION

Oil lubrication can offer advantages when compared with grease lubrication, particularly in the case of spindle bearings rotating at high speed. Open HQW spindle bearings are supplied oil lubricated as standard. In contrast to lifetime lubrication as described above, if loss lubrication is intended, the bearing must be lubricated regularly with exactly the right amount of lubricant in order to achieve the expected bearing life. The relubrication interval may vary widely - from every two years to a continuous supply. The optimisation of relubrication intervals and lubricant quantity can have a significant cost-saving effect for the end user. If regular relubrication of the bearings is necessary, an external oil-air lubrication system can be integrated into the system.

ADVANTAGES OF OIL LUBRICATION

- Highest speeds possible.
- Low frictional torque.
- Low friction.
- Targeted supply of lubricant into the raceways.



This type of lubrication – illustrated above and often used in modern machine tool spindles – is called oil-air lubrication or oil minimum quantity lubrication (MQL). In this process, an oil film is formed in front of the spindle and conveyed to the bearing. Ideally, each bearing has its own oil-air supply. With oil-air lubrication exceptionally high speeds can be achieved. It offers the further advantage of heat dissipation from the bearing.

DESIGNS OF SPINDLE BEARINGS

Open and sealed spindle bearings can be easily distinguished by their design. It is also possible to specify whether the inner ring or outer ring is produced with one shoulder removed.

OPEN DESIGN

Open spindle bearings make optimum use of the internal space by allowing large balls and a window cage. This results in maximum load carrying capacities and therefore maximum bearing life. This open design is recommended for oil lubrication, as it allows relubrication using spacers. No dirt must be permitted to enter the bearing and continuous relubrication should be used.

OPEN DESIGN

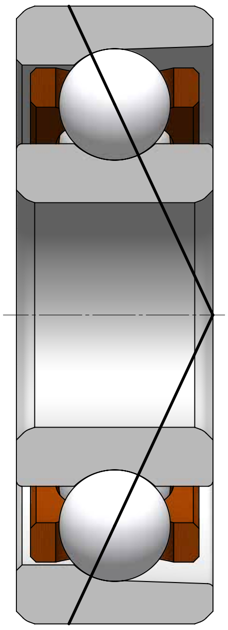
SEALED DESIGN

Sealed HQW spindle bearings generally have non-contact seals on both sides, which ensure improved protection against contaminants, such as dust, which could damage the internals of the bearing. This design also restricts the leakage of lubricant out of the bearing. The use of seals is recommended for applications where lifetime grease lubrication is a requirement. Since these are non-contact seals there is no negative effect on friction or speed ratings. HQW seals are made of fluororubber which can withstand peak temperatures of 230°C. The material possesses a very high resistance to grease and mineral oil. Further advantages of the sealed design include ease of handling and trouble-free installation, making it particularly suitable where bearings are being replaced.

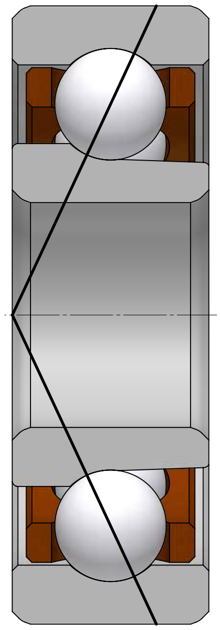
SEALED DESIGN

SPECIAL DESIGN ACI

As a general rule, spindle bearings have the open shoulder on the outer ring (ACO). However, for some special applications the open shoulder can be positioned on the inner ring (ACI) (e.g. dismountable bearings).



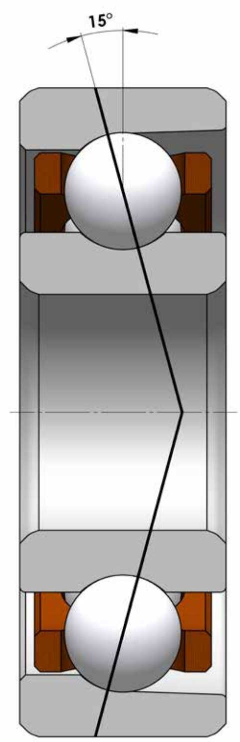
ACO



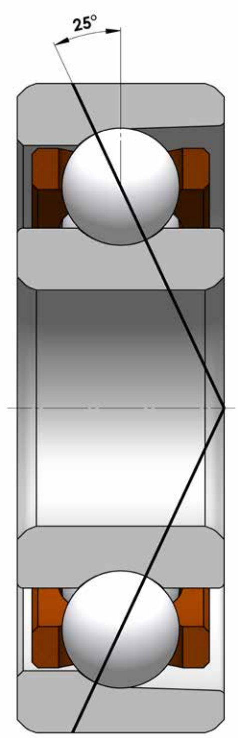
ACI

CONTACT ANGLE

The load is transmitted from the shaft via contact angle (α) to the inner ring, then via the balls to the outer ring. To ensure an even load on all bearings within a system, they should all have the same contact angle. HQW spindle bearings are available with a contact angle of 15° or 25°. The larger the angle, the higher the axial forces that can be absorbed. Conversely, bearings with a smaller contact angle are able to operate at higher speed.



α = 15°



α = 25°

NOMENCLATURE

Ball material	-	X65Cr13
	HYQ	Si_3N_4
Ring material	SV	X30CrMoN15-1
	S	X65Cr13
Basic symbol		Dimensions according to ISO 15
Contact angle α	C	15°
	AC	25°
Internal geometry	d	Deviating inner ring Ø (e. g. d3)
	D	Deviating outer ring Ø (e. g. D7)
	W	Deviating width (e. g. W4)
Seal	-	Without seal
	FvLLB	Both sides, non-contact FPM (fluoroelastomer)
Version	ACO	1 shoulder on outer ring
	ACI	1 shoulder on inner ring
Cage	A = outer ring guided, B = inner ring guided	
	TA TB	Phenolic resin
	TxA TxB	High-performance special plastic such as: PEEK, Torlon®
	W	No cage, full complement
Accuracy	P4 P4S P2	According to DIN 620
	A7 A9	ABEC7 and/or ABEC9 (Annular Bearing Engineering Committee)
Specific calibration	X	Sorting according to chart

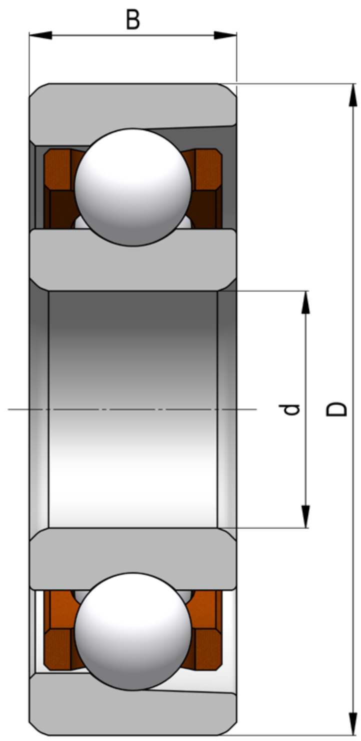
			D	
			0/-2,5	-2,5/-5
		Code	1	2
d	0/-2,5	1	11	12
			x	
	-2,5/-5	2	21	22

Example: Code 11 (= bore Ø 0/-2,5µm, outer Ø 0/-2,5µm)
Further tolerance groups possible.

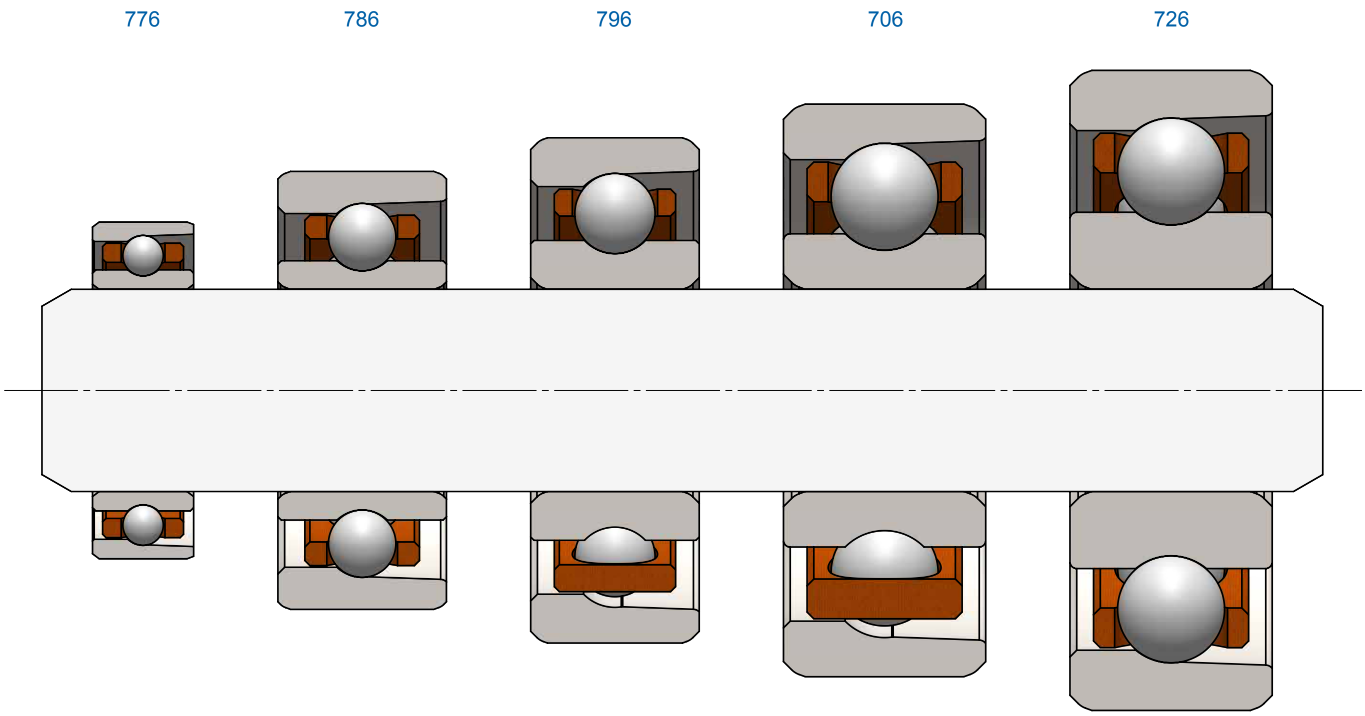
Type of pairing	U	Universal
	DB	Back-to-back arrangement
	DF	Face-to-face arrangement
	DT	Tandem arrangement
Preload	L	Light
	M	Medium
	S	Heavy
Noise test	EQ	Best noise level
Lubrication	L39-15	High-performance lubricant
	15-20%	Lubrication proportion of the existing free volume

DIMENSION SERIES

The illustration on the right shows how the HQW bearing part number is derived from the bearing's components, tolerance classes and design. The following tables indicate the dimensions, the dynamic and static load rating and the limiting speed for the various designs. The illustration to the right shows the areas which are referred to by the abbreviations d, D and B. Our bearing specialists are there to support you in selecting the optimum bearing for your application.



The following figure shows the different dimension series with a fixed bore diameter of 6mm.



HQW type			Dimensions			Contact angle	Load ratings		*Limiting speed	
							Dynamic	Static		
			d [mm]	D [mm]	B [mm]	α [°]	C [N]	C_0 [N]	Oil [min-1]	Grease [min-1]
723	open	SV723 C TA	3	10	4	15	505	158	273000	220000
723	open	HYQ SV723 C TA	3	10	4	15	505	110	394000	273000
723	open	SV723 AC TA	3	10	4	25	485	106	228000	182000
723	open	HYQ SV723 AC TA	3	10	4	25	485	106	334000	235000
723	sealed	SV723 C FvLLB TA	3	10	4	15	505	157	273000	220000
723	sealed	HYQ SV723 C FvLLB TA	3	10	4	15	505	110	394000	273000
723	sealed	SV723 AC FvLLB TA	3	10	4	25	485	151	228000	182000
723	sealed	HYQ SV723 AC FvLLB TA	3	10	4	25	485	106	334000	235000
774	open	SV774 C T4A	4	7	2	15	231	71	331000	267000
774	open	HYO SV774 C T4A	4	7	2	15	231	50	478000	331000
774	open	SV774 AC T4A	4	7	2	25	221	68	276000	221000
774	open	HYQ SV774 AC T4A	4	7	2	25	221	47	404000	285000
724	open	SV724 C TA	4	13	5	15	1340	525	212000	171000
724	open	HYQ SV724 C TA	4	13	5	15	1340	365	306000	212000
724	open	SV724 AC TA	4	13	5	25	1290	505	177000	142000
724	open	HYQ SV724 AC TA	4	13	5	25	1290	355	259000	183000
724	sealed	SV724 C FvLLB TA	4	13	5	15	1340	525	212000	171000
724	sealed	HYQ SV724 C FvLLB TA	4	13	5	15	1340	365	306000	212000
724	sealed	SV724 AC FvLLB TA	4	13	5	25	1290	505	177000	142000
724	sealed	HYQ SV724 AC FvLLB TA	4	13	5	25	1290	355	259000	183000
734	open	SV734 C TA	4	16	5	15	1640	725	167000	135000
734	open	HYQ SV734 C TA	4	16	5	15	1640	505	241000	167000
734	open	SV734 AC TA	4	16	5	25	1570	695	139000	112000
734	open	HYQ SV734 AC TA	4	16	5	25	1570	485	204000	144000
734	sealed	SV734 C FvLLB TA	4	16	5	15	1640	725	167000	135000
734	sealed	HYQ SV734 C FvLLB TA	4	16	5	15	1640	505	241000	167000
734	sealed	SV734 AC FvLLB TA	4	16	5	25	1570	695	139000	112000
734	sealed	HYQ SV734 AC FvLLB TA	4	16	5	25	1570	485	204000	144000
785	open	SV785 C TA	5	11	3	15	630	232	225000	182000
785	open	HYQ SV785 C TA	5	11	3	15	630	162	325000	225000
785	open	SV785 AC TA	5	11	3	25	605	222	188000	150000
785	open	HYQ SV785 AC TA	5	11	3	25	605	155	275000	194000
725	open	SV725 C TA	5	16	5	15	1640	725	167000	135000
725	open	HYQ SV725 C TA	5	16	5	15	1640	505	241000	167000
725	open	SV725 AC TA	5	16	5	25	1570	695	139000	112000
725	open	HYQ SV725 AC TA	5	16	5	25	1570	485	204000	144000
725	sealed	SV725 C FvLLB TA	5	16	5	15	1640	725	167000	135000
725	sealed	HYQ SV725 C FvLLB TA	5	16	5	15	1640	505	241000	167000
725	sealed	SV725 AC FvLLB TA	5	16	5	25	1570	695	139000	112000
725	sealed	HYQ SV725 AC FvLLB TA	5	16	5	25	1570	485	204000	144000

	Preload F_{va} / axial rigidity c_a / lifting force K_{aE}								
	Light (L)			Medium (M)			Heavy (S)		
	F_{va} [N]	c_a [N/µm]	K_{aE} [N]	F_{va} [N]	c_a [N/µm]	K_{aE} [N]	F_{va} [N]	c_a [N/µm]	K_{aE} [N]
	3	1,3	7	8	2,0	24	16	2,6	50
	3	1,5	7	8	2,2	24	16	2,9	50
	3	2,8	6	8	4,1	21	15	5,2	43
	3	3,1	6	8	4,6	21	15	5,9	43
	3	1,3	7	8	2,0	24	16	2,6	50
	3	1,5	7	8	2,2	24	16	2,9	50
	3	2,8	6	8	4,1	21	15	5,2	43
	3	3,1	6	8	4,6	21	15	5,9	43
	2	0,9	3	4	1,4	11	7	1,8	23
	2	1,0	3	4	1,6	10	7	2,0	22
	2	2,0	3	4	2,9	9	7	3,7	19
	2	2,3	3	4	3,3	9	7	4,2	19
	7	2,3	21	21	3,5	65	41	4,7	140
	7	2,6	20	21	3,9	65	41	5,2	140
	7	4,8	18	20	7,1	55	39	9,1	110
	7	5,4	18	20	8,0	55	39	10,2	110
	7	2,3	21	21	3,5	65	41	4,7	140
	7	2,6	20	21	3,9	65	41	5,2	140
	7	4,8	18	20	7,1	55	39	9,1	110
	7	5,4	18	20	8,0	55	39	10,2	110
	9	2,8	25	25	4,3	85	50	5,8	180
	9	3,1	25	25	4,7	80	50	6,4	170
	8	5,8	22	24	8,5	70	48	11,0	140
	8	6,5	22	24	9,6	70	48	12,3	140
	9	2,8	25	25	4,3	85	50	5,8	180
	9	3,1	25	25	4,7	80	50	6,4	170
	8	5,8	22	24	8,5	70	48	11,0	140
	8	6,5	22	24	9,6	70	48	12,3	140
	4	1,7	9	10	2,6	30	19	3,5	65
	4	1,9	9	10	2,9	30	19	3,9	60
	4	3,7	8	10	5,4	26	19	7,0	50
	4	4,2	8	10	6,1	26	19	7,8	50
	9	2,8	25	25	4,3	85	50	5,8	180
	9	3,1	25	25	4,7	80	50	6,4	170
	8	5,8	22	24	8,5	70	48	11,0	140
	8	6,5	22	24	9,6	70	48	12,3	140
	9	2,8	25	25	4,3	85	50	5,8	180
	9	3,1	25	25	4,7	80	50	6,4	170
	8	5,8	22	24	8,5	70	48	11,0	140
	8	6,5	22	24	9,6	70	48	12,3	140

*Ask our application engineers for more information.

		HQW type	Dimensions d [mm]	D [mm]	B [mm]	Contact angle α [°]	Load ratings Dynamic C [N]	Static C_0 [N]	*Limiting speed Oil [min-1]	Grease [min-1]
735	open	SV735 C TA	5	19	6	15	2710	1220	139000	112000
735	open	HYQ SV735 C TA	5	19	6	15	2710	860	200000	139000
735	open	SV735 AC TA	5	19	6	25	2620	1180	116000	93000
735	open	HYQ SV735 AC TA	5	19	6	25	2620	825	170000	120000
735	sealed	SV735 C FvLLB TA	5	19	6	15	1950	945	163000	128000
735	sealed	HYQ SV735 C FvLLB TA	5	19	6	15	1950	660	232000	155000
735	sealed	SV735 AC FvLLB TA	5	19	6	25	1870	905	136000	109000
735	sealed	HYQ SV735 AC FvLLB TA	5	19	6	25	1870	630	197000	136000
776	open	SV776 C TA	6	10	3	15	380	145	225000	182000
776	open	HYQ SV776 C TA	6	10	3	15	380	102	325000	225000
776	open	SV776 AC TA	6	10	3	25	360	138	188000	150000
776	open	HYQ SV776 AC TA	6	10	3	25	360	97	275000	194000
786	open	SV786 C TA	6	13	3,5	15	1220	535	186000	150000
786	open	HYQ SV786 C TA	6	13	3,5	15	1220	375	269000	186000
786	open	SV786 AC TA	6	13	3,5	25	1170	515	155000	124000
786	open	HYQ SV786 AC TA	6	13	3,5	25	1170	360	227000	160000
786	sealed	SV786 C FvLLB TA	6	13	5	15	935	345	198000	160000
786	sealed	HYQ SV786 C FvLLB TA	6	13	5	15	935	240	286000	198000
786	sealed	SV786 AC FvLLB TA	6	13	5	25	895	330	165000	132000
786	sealed	HYQ SV786 AC FvLLB TA	6	13	5	25	895	230	242000	171000
796	open	SV796 C TA	6	15	5	15	1470	645	172000	139000
796	open	HYQ SV796 C TA	6	15	5	15	1470	450	248000	172000
796	open	SV796 AC TA	6	15	5	25	1400	620	143000	115000
796	open	HYQ SV796 AC TA	6	15	5	25	1400	435	210000	148000
796	sealed	SV796 C FvLLB TA	6	15	5	15	1470	645	172000	139000
796	sealed	HYQ SV796 C FvLLB TA	6	15	5	15	1470	450	248000	172000
796	sealed	SV796 AC FvLLB TA	6	15	5	25	1400	620	143000	115000
796	sealed	HYQ SV796 AC FvLLB TA	6	15	5	25	1400	435	210000	148000
706	open	SV706 C TA	6	17	6	15	2550	1090	157000	127000
706	open	HYQ SV706 C TA	6	17	6	15	2550	765	227000	157000
706	open	SV706 AC TA	6	17	6	25	2470	1050	131000	105000
706	open	HYQ SV706 AC TA	6	17	6	25	2470	740	192000	135000
706	sealed	SV706 C FvLLB TA	6	17	6	15	2550	1090	157000	127000
706	sealed	HYQ SV706 C FvLLB TA	6	17	6	15	2550	765	227000	157000
706	sealed	SV706 AC FvLLB TA	6	17	6	25	2470	1050	131000	105000
706	sealed	HYQ SV706 AC FvLLB TA	6	17	6	25	2470	740	192000	135000

	Preload F_{va} / axial rigidity c_a / lifting force K_{aE}								
	Light (L)			Medium (M)			Heavy (S)		
	F_{va} [N]	c_a [N/µm]	K_{aE} [N]	F_{va} [N]	c_a [N/µm]	K_{aE} [N]	F_{va} [N]	c_a [N/µm]	K_{aE} [N]
	14	4,1	43	41	6,4	140	85	8,8	310
	14	4,6	43	41	7,1	140	85	9,7	300
	14	8,6	38	40	12,7	110	80	16,4	240
	14	9,6	38	40	14,2	110	80	18,3	240
	10	3,7	31	30	5,8	100	60	8,0	230
	10	4,1	31	30	6,5	100	60	8,8	220
	10	7,6	27	29	9,4	85	60	14,7	170
	10	8,6	27	29	12,7	85	60	16,4	170
	2	1,4	5	6	2,1	18	12	2,7	38
	2	1,5	5	6	2,3	18	12	3,0	38
	2	3,0	5	6	4,3	15	11	5,5	32
	2	3,3	5	6	4,8	15	11	6,2	32
	7	2,8	20	19	4,4	65	37	6,0	140
	7	3,1	19	19	4,8	65	37	6,6	140
	6	5,7	17	18	8,5	50	36	11,0	110
	6	6,4	17	18	9,5	50	36	12,3	110
	5	2,1	14	15	3,1	46	29	4,2	95
	5	2,3	14	15	3,5	45	29	4,6	95
	5	4,4	12	14	6,5	39	27	8,3	80
	5	5,0	12	14	7,2	39	27	9,3	80
	8	2,6	23	23	3,9	75	45	5,3	160
	8	2,9	22	23	4,4	70	45	5,8	150
	7	5,4	20	21	7,9	60	42	10,2	120
	7	6,0	20	21	8,9	60	42	11,4	120
	8	2,6	23	23	3,9	75	45	5,3	160
	8	2,9	22	23	4,4	70	45	5,8	150
	7	5,4	20	21	7,9	60	42	10,2	120
	7	6,0	20	21	8,9	60	42	11,4	120
	13	3,8	41	39	6,1	130	80	8,3	300
	13	4,3	41	39	6,7	130	80	9,1	290
	13	8,0	36	38	11,8	110	75	15,3	230
	13	9,0	36	38	13,2	110	75	17,1	230
	13	3,8	41	39	6,1	130	80	8,3	300
	13	4,3	41	39	6,7	130	80	9,1	290
	13	8,0	36	38	11,8	110	75	15,3	230
	13	9,0	36	38	13,2	110	75	17,1	230

*Ask our application engineers for more information.

		HQW type	Dimensions d [mm]	D [mm]	B [mm]	Contact angle α [°]	Load ratings Dynamic C [N]	Static C_0 [N]	*Limiting speed Oil [min-1]	Grease [min-1]
726	open	SV726 C TA	6	19	6	15	2710	1220	139000	112000
		HYQ SV726 C TA	6	19	6	15	2710	860	200000	139000
		SV726 AC TA	6	19	6	25	2620	1180	116000	93000
		HYQ SV726 AC TA	6	19	6	25	2620	825	170000	120000
	sealed	SV726 C FvLLB TA	6	19	6	15	1950	945	163000	128000
		HYQ SV726 C FvLLB TA	6	19	6	15	1950	660	232000	155000
		SV726 AC FvLLB TA	6	19	6	25	1870	905	136000	109000
		HYQ SV726 AC FvLLB TA	6	19	6	25	1870	630	197000	136000
707	open	SV707 C TA	7	19	6	15	2710	1220	139000	112000
		HYQ SV707 C TA	7	19	6	15	2710	860	200000	139000
		SV707 AC TA	7	19	6	25	2620	1180	116000	93000
		HYQ SV707 AC TA	7	19	6	25	2620	825	170000	120000
	sealed	SV707 C FvLLB TA	7	19	6	15	1950	945	163000	128000
		HYQ SV707 C FvLLB TA	7	19	6	15	1950	660	232000	155000
		SV707 AC FvLLB TA	7	19	6	25	1870	905	136000	109000
		HYQ SV707 AC FvLLB TA	7	19	6	25	1870	630	197000	136000
727	open	SV727 C TA	7	22	7	15	3630	1590	120000	97000
		HYQ SV727 C TA	7	22	7	15	3630	1110	174000	120000
		SV727 AC TA	7	22	7	25	3510	1540	100000	80000
		HYQ SV727 AC TA	7	22	7	25	3510	1080	147000	104000
	sealed	SV727 C FvLLB TA	7	22	7	15	2830	1340	146000	115000
		HYQ SV727 C FvLLB TA	7	22	7	15	2830	935	209000	139000
		SV727 AC FvLLB TA	7	22	7	25	2710	1280	122000	98000
		HYQ SV727 AC FvLLB TA	7	22	7	25	2710	900	177000	122000
788	open	SV788 C TA	8	16	4	15	1830	840	150000	121000
		HYQ SV788 C TA	8	16	4	15	1830	585	217000	150000
		SV788 AC TA	8	16	4	25	1750	805	125000	100000
		HYQ SV788 AC TA	8	16	4	25	1750	560	184000	130000
	sealed	SV788 W4 C FvLLB TA	8	16	4	15	1450	740	181000	142000
		HYQ SV788 W4 C FvLLB TA	8	16	4	15	1450	515	258000	172000
		SV788 W4 AC FvLLB TA	8	16	4	25	1380	705	151000	121000
		HYQ SV788 W4 AC FvLLB TA	8	16	4	25	1380	495	219000	151000
798	open	SV798 C TA	8	19	6	15	2710	1220	139000	112000
		HYQ SV798 C TA	8	19	6	15	2710	860	200000	139000
		SV798 AC TA	8	19	6	25	2620	1180	116000	93000
		HYQ SV798 AC TA	8	19	6	25	2620	825	170000	120000
	sealed	SV798 C FvLLB TA	8	19	6	15	1950	945	163000	128000
		HYQ SV798 C FvLLB TA	8	19	6	15	1950	660	232000	155000
		SV798 AC FvLLB TA	8	19	6	25	1870	905	136000	109000
		HYQ SV798 AC FvLLB TA	8	19	6	25	1870	630	197000	136000

	Preload F_{va} / axial rigidity c_a / lifting force K_{aE}								
	Light (L)			Medium (M)			Heavy (S)		
	F_{va} [N]	c_a [N/µm]	K_{aE} [N]	F_{va} [N]	c_a [N/µm]	K_{aE} [N]	F_{va} [N]	c_a [N/µm]	K_{aE} [N]
	14	4,1	43	41	6,4	140	85	8,8	310
	14	4,6	43	41	7,1	140	85	9,7	300
	14	8,6	38	40	12,7	110	80	16,4	240
	14	9,6	38	40	14,2	110	80	18,3	240
	10	3,7	31	30	5,8	100	60	8,0	230
	10	4,1	31	30	6,5	100	60	8,8	220
	10	7,6	27	29	9,4	85	60	14,7	170
	10	8,6	27	29	12,7	85	60	16,4	170
	14	4,1	43	41	6,4	140	85	8,8	310
	14	4,6	43	41	7,1	140	85	9,7	300
	14	8,6	38	40	12,7	110	80	16,4	240
	14	9,6	38	40	14,2	110	80	18,3	240
	10	3,7	31	30	5,8	100	60	8,0	230
	10	4,1	31	30	6,5	100	60	8,8	220
	10	7,6	27	29	11,3	85	60	14,7	170
	10	8,6	27	29	12,7	85	60	16,4	170
	19	4,4	55	55	6,9	190	110	9,4	410
	19	5,0	55	55	7,7	180	110	10,4	400
	18	9,3	50	55	13,7	150	110	17,7	320
	18	10,4	50	55	15,4	150	110	19,8	320
	15	4,3	46	43	6,7	150	85	9,2	330
	15	4,8	45	43	7,5	150	85	10,1	320
	14	8,8	39	41	13,1	120	85	17,0	250
	14	9,9	39	41	14,6	120	85	18,9	250
	10	3,4	30	28	5,4	95	55	7,3	210
	10	3,8	29	28	6,0	95	55	8,1	210
	9	7,0	25	27	10,4	80	55	13,5	160
	9	7,9	25	27	11,7	75	55	15,1	160
	8	3,5	23	22	5,5	75	44	7,5	170
	8	3,9	23	22	6,1	75	44	8,2	160
	7	7,2	20	21	10,6	60	42	13,8	130
	7	8,1	20	21	11,9	60	42	15,4	120
	14	4,1	43	41	6,4	140	85	8,8	310
	14	4,6	43	41	7,1	140	85	9,7	300
	14	8,6	38	40	12,7	110	80	16,4	240
	14	9,6	38	40	14,2	110	80	18,3	240
	10	3,7	31	30	5,8	100	60	8,0	230
	10	4,1	31	30	6,5	100	60	8,8	220
	10	7,6	27	29	11,3	85	60	14,7	170
	10	8,6	27	29	12,7	85	60	16,4	170

*Ask our application engineers for more information.

		HQW type	Dimensions			Contact angle	Load ratings		*Limiting speed	
							Dynamic	Static		
			d [mm]	D [mm]	B [mm]	α [°]	C [N]	C_0 [N]	Oil [min^{-1}]	Grease [min^{-1}]
708	open	SV708 C TA	8	22	7	15	3630	1590	120000	97000
708	open	HYQ SV708 C TA	8	22	7	15	3630	1110	174000	120000
708	open	SV708 AC TA	8	22	7	25	3510	1540	100000	80000
708	open	HYQ SV708 AC TA	8	22	7	25	3510	1080	147000	104000
708	sealed	SV708 C FvLLB TA	8	22	7	15	2830	1340	146000	115000
708	sealed	HYQ SV708 C FvLLB TA	8	22	7	15	2830	935	209000	139000
708	sealed	SV708 AC FvLLB TA	8	22	7	25	2710	1280	122000	98000
708	sealed	HYQ SV708 AC FvLLB TA	8	22	7	25	2710	900	177000	122000
789	open	SV789 C TA	9	17	4	15	1950	945	139000	112000
789	open	HYQ SV789 C TA	9	17	4	15	1950	660	200000	139000
789	open	SV789 AC TA	9	17	4	25	1870	905	116000	93000
789	open	HYQ SV789 AC TA	9	17	4	25	1870	635	170000	120000
789	sealed	SV789 C FvLLB TA	9	17	4	15	1420	800	167000	131000
789	sealed	HYQ SV789 C FvLLB TA	9	17	4	15	1420	560	238000	159000
789	sealed	SV789 AC FvLLB TA	9	17	4	25	1350	745	139000	111000
789	sealed	HYQ SV789 AC FvLLB TA	9	17	4	25	1350	520	202000	139000
709	open	SV709 C TA	9	24	7	15	3670	1640	114000	92000
709	open	HYQ SV709 C TA	9	24	7	15	3670	1140	164000	114000
709	open	SV709 AC TA	9	24	7	25	3540	1580	95000	76000
709	open	HYQ SV709 AC TA	9	24	7	25	3540	1100	139000	98000
709	sealed	SV709 C FvLLB TA	9	24	7	15	3670	1640	114000	92000
709	sealed	HYQ SV709 C FvLLB TA	9	24	7	15	3670	1140	164000	114000
709	sealed	SV709 AC FvLLB TA	9	24	7	25	3540	1580	95000	76000
709	sealed	HYQ SV709 AC FvLLB TA	9	24	7	25	3540	1100	139000	98000
729	open	SV729 C TA	9	26	8	15	4880	2180	100000	81000
729	open	HYQ SV729 C TA	9	26	8	15	4880	1520	145000	100000
729	open	SV729 AC TA	9	26	8	25	4720	2110	84000	67000
729	open	HYQ SV729 AC TA	9	26	8	25	4720	1470	123000	87000
729	sealed	SV729 C FvLLB TA	9	26	8	15	3980	1890	121000	95000
729	sealed	HYQ SV729 C FvLLB TA	9	26	8	15	3980	1320	173000	115000
729	sealed	SV729 AC FvLLB TA	9	26	8	25	3820	1810	101000	81000
729	sealed	HYQ SV729 AC FvLLB TA	9	26	8	25	3820	1270	147000	101000
7800	open	SV7800 C TA	10	19	5	15	2070	1050	126000	102000
7800	open	HYQ SV7800 C TA	10	19	5	15	2070	740	182000	126000
7800	open	SV7800 AC TA	10	19	5	25	1970	1010	105000	84000
7800	open	HYQ SV7800 AC TA	10	19	5	25	1970	705	154000	109000
7800	sealed	SV7800 C FvLLB TA	10	19	5	15	1570	895	150000	118000
7800	sealed	HYQ SV7800 C FvLLB TA	10	19	5	15	1570	625	215000	143000
7800	sealed	SV7800 AC FvLLB TA	10	19	5	25	1490	850	125000	100000
7800	sealed	HYQ SV7800 AC FvLLB TA	10	19	5	25	1490	595	183000	125000

Preload F_{va} / axial rigidity c_a / lifting force K_{aE}								
Light (L)			Medium (M)			Heavy (S)		
F_{va} [N]	c_a [N/µm]	K_{aE} [N]	F_{va} [N]	c_a [N/µm]	K_{aE} [N]	F_{va} [N]	c_a [N/µm]	K_{aE} [N]
19	4,4	55	55	6,9	190	110	9,4	410
19	5,0	55	55	7,7	180	110	10,4	400
18	9,3	50	55	13,7	150	110	17,7	320
18	10,4	50	55	15,4	150	110	19,8	320
15	4,3	46	43	6,7	150	85	9,2	330
15	4,8	45	43	7,5	150	85	10,1	320
14	8,8	39	41	13,1	120	85	17,0	250
14	9,9	39	41	14,6	120	85	18,9	250
10	3,7	31	30	5,8	100	60	8,0	230
10	4,1	31	30	6,5	100	60	8,8	220
10	7,6	27	29	11,3	85	60	14,7	170
10	8,6	27	29	12,7	85	60	16,4	170
8	3,3	22	22	5,0	70	43	6,7	150
8	3,6	22	22	5,6	70	43	7,5	150
7	6,9	19	21	10,1	60	41	13,0	120
7	7,7	19	21	11,3	60	41	14,5	120
19	4,5	55	60	7,0	190	115	9,4	420
19	5,0	55	60	7,7	190	115	10,4	410
18	9,3	50	55	13,8	160	110	17,8	330
18	10,5	50	55	15,4	150	110	19,9	320
19	4,5	55	60	7,0	190	115	9,4	420
19	5,0	55	60	7,7	190	115	10,4	410
18	9,3	50	55	13,8	160	110	17,8	330
18	10,5	50	55	15,4	150	110	19,9	320
25	5,1	75	75	7,9	250	150	10,6	540
25	5,7	75	75	8,7	240	150	11,7	530
24	10,7	65	75	15,7	210	145	20,2	430
24	12,0	65	75	17,6	210	145	22,6	430
20	4,9	60	60	7,7	210	120	10,4	450
20	5,5	60	60	8,5	200	120	11,5	440
20	10,3	55	60	15,1	170	115	19,6	350
20	11,5	55	60	17,0	170	115	21,9	350
11	4,0	33	32	6,3	110	65	8,6	240
11	4,5	33	32	7,0	110	65	9,5	230
10	8,2	28	30	12,2	90	60	15,8	180
10	9,3	28	30	13,7	85	60	17,7	180
8	3,9	25	24	6,2	80	48	8,4	180
8	4,4	25	24	6,8	80	48	9,2	170
8	8,1	21	23	12,0	65	45	15,5	140
8	9,1	21	23	13,4	65	45	17,3	130

*Ask our application engineers for more information.

Series	Type	HQW type	Dimensions d [mm]	Dimensions D [mm]	Dimensions B [mm]	Contact angle α [°]	Load ratings Dynamic C [N]	Load ratings Static C_0 [N]	*Limiting speed Oil [min^{-1}]	*Limiting speed Grease [min^{-1}]
7900	open	SV7900 C TA	10	22	6	15	3030	1530	113000	91000
7900	open	HYQ SV7900 C TA	10	22	6	15	3030	1070	163000	113000
7900	open	SV7900 AC TA	10	22	6	25	2890	1460	94000	75000
7900	open	HYQ SV7900 AC TA	10	22	6	25	2890	1020	138000	97000
7900	sealed	SV7900 C FvLLB TA	10	22	6	15	2160	1180	135000	106000
7900	sealed	HYQ SV7900 C FvLLB TA	10	22	6	15	2160	825	193000	129000
7900	sealed	SV7900 AC FvLLB TA	10	22	6	25	2060	1120	113000	90000
7900	sealed	HYQ SV7900 AC FvLLB TA	10	22	6	25	2060	780	164000	113000
7000	open	SV7000 C TA	10	26	8	15	4880	2180	100000	81000
7000	open	HYQ SV7000 C TA	10	26	8	15	4880	1520	145000	100000
7000	open	SV7000 AC TA	10	26	8	25	4720	2110	84000	67000
7000	open	HYQ SV7000 AC TA	10	26	8	25	4720	1470	123000	87000
7000	sealed	SV7000 C FvLLB TA	10	26	8	15	3980	1890	121000	95000
7000	sealed	HYQ SV7000 C FvLLB TA	10	26	8	15	3980	1320	173000	115000
7000	sealed	SV7000 AC FvLLB TA	10	26	8	25	3820	1810	101000	81000
7000	sealed	HYQ SV7000 AC FvLLB TA	10	26	8	25	3820	1270	147000	101000
7200	open	SV7200 C TA	10	30	9	15	6250	3290	86000	69000
7200	open	HYQ SV7200 C TA	10	30	9	15	6250	2300	124000	86000
7200	open	SV7200 AC TA	10	30	9	25	6010	3160	72000	57000
7200	open	HYQ SV7200 AC TA	10	30	9	25	6010	2210	105000	74000
7200	sealed	SV7200 C FvLLB TA	10	30	9	15	6250	3290	86000	69000
7200	sealed	HYQ SV7200 C FvLLB TA	10	30	9	15	6250	2300	124000	86000
7200	sealed	SV7200 AC FvLLB TA	10	30	9	25	6010	3160	72000	57000
7200	sealed	HYQ SV7200 AC FvLLB TA	10	30	9	25	6010	2210	105000	74000
7801	open	SV7801 C TA	12	21	5	15	2260	1280	110000	88000
7801	open	HYQ SV7801 C TA	12	21	5	15	2260	900	158000	110000
7801	open	SV7801 AC TA	12	21	5	25	2150	1220	91000	73000
7801	open	HYQ SV7801 AC TA	12	21	5	25	2150	855	134000	94000
7801	sealed	SV7801 C FvLLB TA	12	21	5	15	1600	985	129000	101000
7801	sealed	HYQ SV7801 C FvLLB TA	12	21	5	15	1600	690	183000	122000
7801	sealed	SV7801 AC FvLLB TA	12	21	5	25	1520	935	107000	86000
7801	sealed	HYQ SV7801 AC FvLLB TA	12	21	5	25	1520	655	156000	107000
7901	open	SV7901 C TA	12	24	6	15	3200	1700	105000	85000
7901	open	HYQ SV7901 C TA	12	24	6	15	3200	1190	152000	105000
7901	open	SV7901 AC TA	12	24	6	25	3060	1630	88000	70000
7901	open	HYQ SV7901 AC TA	12	24	6	25	3060	1140	128000	91000
7901	sealed	SV7901 C FvLLB TA	12	24	6	15	2470	1470	126000	99000
7901	sealed	HYQ SV7901 C FvLLB TA	12	24	6	15	2470	1030	180000	120000
7901	sealed	SV7901 AC FvLLB TA	12	24	6	25	2340	1400	105000	84000
7901	sealed	HYQ SV7901 AC FvLLB TA	12	24	6	25	2340	980	153000	105000

Preload F_{va} / axial rigidity c_a / lifting force K_{aE}								
Light (L)			Medium (M)			Heavy (S)		
F_{va} [N]	c_a [N/μm]	K_{aE} [N]	F_{va} [N]	c_a [N/μm]	K_{aE} [N]	F_{va} [N]	c_a [N/μm]	K_{aE} [N]
16	4,7	49	46	7,3	160	95	10,0	350
16	5,2	48	46	8,1	160	95	11,0	340
15	9,6	42	44	14,2	130	90	18,4	270
15	10,8	42	44	15,9	130	90	20,6	270
11	4,3	35	33	6,7	110	65	9,1	250
11	4,8	34	33	7,4	110	65	10,1	240
11	8,8	30	31	13,1	90	65	16,9	190
11	9,9	30	31	14,6	90	65	18,9	190
25	5,1	75	75	7,9	250	150	10,6	540
25	5,7	75	75	8,7	240	150	11,7	530
24	10,7	65	75	15,7	210	145	20,2	430
24	12,0	65	75	17,6	210	145	22,6	430
20	4,9	60	60	7,7	210	120	10,4	450
20	5,5	60	60	8,5	200	120	11,5	440
20	10,3	55	60	15,1	170	115	19,6	350
20	11,5	55	60	17,0	170	115	21,9	350
32	6,8	100	95	10,6	330	190	14,4	720
32	7,5	100	95	11,7	330	190	15,9	710
31	14,0	85	95	20,7	270	185	26,8	560
31	15,7	85	95	23,2	270	185	30,0	560
32	6,8	100	95	10,6	330	190	14,4	720
32	7,5	100	95	11,7	330	190	15,9	710
31	14,0	85	95	20,7	270	185	26,8	560
31	15,7	85	95	23,2	270	185	30,0	560
12	4,5	36	34	7,1	120	70	9,7	260
12	5,1	36	34	7,9	110	70	10,7	250
11	9,4	31	33	13,9	95	65	18,0	200
11	10,6	31	33	15,6	95	65	20,1	200
8	4,1	25	24	6,4	85	48	8,8	180
8	4,6	25	24	7,1	80	48	9,6	180
8	8,5	22	23	12,6	65	46	16,2	140
8	9,5	22	23	14,1	65	46	18,2	140
16	5,0	50	48	7,9	170	100	10,8	370
16	5,6	50	48	8,7	160	100	11,8	360
16	10,4	44	46	15,4	130	95	19,9	280
16	11,6	44	46	17,2	130	95	22,2	280
13	5,1	39	38	8,0	130	75	10,9	280
13	5,7	39	38	8,9	120	75	12,0	280
12	10,6	34	36	15,6	100	75	20,2	220
12	11,9	34	36	17,5	100	75	22,6	210

*Ask our application engineers for more information.

		HQW type	Dimensions d [mm]	D [mm]	B [mm]	Contact angle α [°]	Load ratings Dynamic C [N]	Static C_0 [N]	*Limiting speed Oil [min^{-1}]	Grease [min^{-1}]
7001	open	SV7001 C TA	12	28	8	15	5670	2790	90000	73000
		HYQ SV7001 C TA	12	28	8	15	5670	1950	130000	90000
		SV7001 AC TA	12	28	8	25	5450	2690	75000	60000
		HYQ SV7001 AC TA	12	28	8	25	5450	1880	110000	78000
	sealed	SV7001 C FvLLB TA	12	28	8	15	4520	2410	102000	80000
		HYQ SV7001 C FvLLB TA	12	28	8	15	4520	1680	146000	97000
		SV7001 AC FvLLB TA	12	28	8	25	4320	2300	85000	68000
		HYQ SV7001 AC FvLLB TA	12	28	8	25	4320	1610	124000	85000
7201	open	SV7201 C TA	12	32	10	15	8720	4470	82000	66000
		HYQ SV7201 C TA	12	32	10	15	8720	3130	118000	82000
		SV7201 AC TA	12	32	10	25	8430	4320	68000	55000
		HYQ SV7201 AC TA	12	32	10	25	8430	3020	100000	70000
	sealed	SV7201 C FvLLB TA	12	32	10	15	8720	4470	82000	66000
		HYQ SV7201 C FvLLB TA	12	32	10	15	8720	3130	118000	82000
		SV7201 AC FvLLB TA	12	32	10	25	8430	4320	68000	55000
		HYQ SV7201 AC FvLLB TA	12	32	10	25	8430	3020	100000	70000
7802	open	SV7802 C TA	15	24	5	15	2530	1610	95000	77000
		HYQ SV7802 C TA	15	24	5	15	2530	1120	138000	95000
		SV7802 AC TA	15	24	5	25	2390	1530	80000	64000
		HYQ SV7802 AC TA	15	24	5	25	2390	1070	117000	82000
	sealed	SV7802 C FvLLB TA	15	24	5	15	2530	1610	95000	77000
		HYQ SV7802 C FvLLB TA	15	24	5	15	2530	1120	138000	95000
		SV7802 AC FvLLB TA	15	24	5	25	2390	1530	80000	64000
		HYQ SV7802 AC FvLLB TA	15	24	5	25	2390	1070	117000	82000
7902	open	SV7902 C TA	15	28	7	15	4520	2410	88000	71000
		HYQ SV7902 C TA	15	28	7	15	4520	1680	126000	88000
		SV7902 AC TA	15	28	7	25	4320	2300	73000	59000
		HYQ SV7902 AC TA	15	28	7	25	4320	1610	107000	76000
	sealed	SV7902 C FvLLB TA	15	28	7	15	4520	2410	88000	71000
		HYQ SV7902 C FvLLB TA	15	28	7	15	4520	1680	126000	88000
		SV7902 AC FvLLB TA	15	28	7	25	4320	2300	73000	59000
		HYQ SV7902 AC FvLLB TA	15	28	7	25	4320	1610	107000	76000
7002	open	SV7002 C TA	15	32	9	15	6400	3500	77000	62000
		HYQ SV7002 C TA	15	32	9	15	6400	2450	111000	77000
		SV7002 AC TA	15	32	9	25	6130	3350	64000	52000
		HYQ SV7002 AC TA	15	32	9	25	6130	2350	94000	66000
	sealed	SV7002 C FvLLB TA	15	32	9	15	5230	3100	92000	73000
		HYQ SV7002 C FvLLB TA	15	32	9	15	5230	2170	132000	88000
		SV7002 AC FvLLB TA	15	32	9	25	4980	2960	77000	62000
		HYQ SV7002 AC FvLLB TA	15	32	9	25	4980	2070	112000	77000

	Preload F_{va} / axial rigidity c_a / lifting force K_{aE}								
	Light (L)			Medium (M)			Heavy (S)		
	F_{va} [N]	c_a [N/µm]	K_{aE} [N]	F_{va} [N]	c_a [N/µm]	K_{aE} [N]	F_{va} [N]	c_a [N/µm]	K_{aE} [N]
	29	6,1	85	90	9,4	18	175	12,7	630
	29	6,8	85	90	10,4	280	175	14,0	620
	28	12,8	75	85	18,8	240	165	24,2	500
	28	14,4	75	85	21,1	240	165	27,1	500
	23	5,8	70	70	9,0	230	140	12,2	510
	23	6,4	70	70	10,0	230	140	13,4	500
	22	12,1	60	65	17,8	190	130	23,0	400
	22	13,6	60	65	20,0	190	130	25,7	390
	44	7,7	140	135	12,2	480	265	16,7	1060
	44	8,5	140	135	13,5	470	265	18,4	1030
	43	15,7	120	130	23,3	390	255	30,3	810
	43	17,6	120	130	26,1	380	255	33,9	800
	44	7,7	140	135	12,2	480	265	16,7	1060
	44	8,5	140	135	13,5	470	265	18,4	1030
	43	15,7	120	130	23,3	390	255	30,3	810
	43	17,6	120	130	26,1	380	255	33,9	800
	13	5,4	40	38	8,4	130	80	11,4	290
	13	6,0	40	38	9,3	130	80	12,5	280
	12	11,1	34	36	16,4	100	75	21,1	220
	12	12,4	34	36	18,3	100	75	23,6	220
	13	5,4	40	38	8,4	130	80	11,4	290
	13	6,0	40	38	9,3	130	80	12,5	280
	12	11,1	34	36	16,4	100	75	21,1	220
	12	12,4	34	36	18,3	100	75	23,6	220
	23	5,8	70	70	9,0	230	140	12,2	510
	23	6,4	70	70	10,0	230	140	13,4	500
	22	12,1	60	65	17,8	190	130	23,0	400
	22	13,6	60	65	20,0	190	130	25,7	390
	23	5,8	70	70	9,0	230	140	12,2	510
	23	6,4	70	70	10,0	230	140	13,4	500
	22	12,1	60	65	17,8	190	130	23,0	400
	22	13,6	60	65	20,0	190	130	25,7	390
	32	7,1	100	100	10,9	330	195	14,7	710
	32	7,9	95	100	12,1	320	195	16,2	690
	31	15,1	85	95	21,9	270	185	28,1	560
	31	16,7	85	95	24,5	270	185	31,5	560
	27	7,0	80	80	10,9	270	160	14,7	580
	27	7,8	80	80	12,1	260	160	16,2	570
	25	14,7	70	75	21,6	220	150	27,9	460
	25	16,5	70	75	24,2	220	150	31,2	450

*Ask our application engineers for more information.

		HQW type	Dimensions d [mm]	D [mm]	B [mm]	Contact angle α [°]	Load ratings Dynamic C [N]	Static C_0 [N]	*Limiting speed Oil [min^{-1}]	Grease [min^{-1}]
7202	open	SV7202 C TA	15	35	11	15	9700	5060	72000	58000
		HYQ SV7202 C TA	15	35	11	15	9700	3540	104000	72000
		SV7202 AC TA	15	35	11	25	9360	4880	60000	48000
		HYQ SV7202 AC TA	15	35	11	25	9360	3410	88000	62000
	sealed	SV7202 C FvLLB TA	15	35	11	15	6410	3570	85000	67000
		HYQ SV7202 C FvLLB TA	15	35	11	15	6410	2490	122000	81000
		SV7202 AC FvLLB TA	15	35	11	25	6120	3410	71000	57000
		HYQ SV7202 AC FvLLB TA	15	35	11	25	6120	2380	103000	71000
7803	open	SV7803 C TA	17	26	5	15	2580	1740	86000	70000
		HYQ SV7803 C TA	17	26	5	15	2580	1210	125000	86000
		SV7803 AC TA	17	26	5	25	2440	1650	72000	58000
		HYQ SV7803 AC TA	17	26	5	25	2440	1150	106000	74000
	sealed	SV7803 C FvLLB TA	17	26	5	15	2580	1740	86000	70000
		HYQ SV7803 C FvLLB TA	17	26	5	15	2580	1210	125000	86000
		SV7803 AC FvLLB TA	17	26	5	25	2440	1650	72000	58000
		HYQ SV7803 AC FvLLB TA	17	26	5	25	2440	1150	106000	74000
7903	open	SV7903 C TA	17	30	7	15	4990	2920	77000	62000
		HYQ SV7903 C TA	17	30	7	15	4990	2040	111000	77000
		SV7903 AC TA	17	30	7	25	4750	2780	64000	51000
		HYQ SV7903 AC TA	17	30	7	25	4750	1950	94000	66000
	sealed	SV7903 C FvLLB TA	17	30	7	15	3780	2440	92000	72000
		HYQ SV7903 C FvLLB TA	17	30	7	15	3780	1710	131000	87000
		SV7903 AC FvLLB TA	17	30	7	25	3590	2320	77000	61000
		HYQ SV7903 AC FvLLB TA	17	30	7	25	3590	1620	111000	77000
7003	open	SV7003 C TA	17	35	10	15	6730	3890	70000	56000
		HYQ SV7003 C TA	17	35	10	15	6730	2720	100000	70000
		SV7003 AC TA	17	35	10	25	6410	3720	58000	47000
		HYQ SV7003 AC TA	17	35	10	25	6410	2600	85000	60000
	sealed	SV7003 C FvLLB TA	17	35	10	15	6730	3890	70000	56000
		HYQ SV7003 C FvLLB TA	17	35	10	15	6730	2720	100000	70000
		SV7003 AC FvLLB TA	17	35	10	25	6410	3720	58000	47000
		HYQ SV7003 AC FvLLB TA	17	35	10	25	6410	2600	85000	60000
7203	open	SV7203 C TA	17	40	12	15	11140	6450	63000	50000
		HYQ SV7203 C TA	17	40	12	15	11140	4510	90000	63000
		SV7203 AC TA	17	40	12	25	10680	6190	52000	42000
		HYQ SV7203 AC TA	17	40	12	25	10680	4330	76000	54000
	sealed	SV7203 C FvLLB TA	17	40	12	15	9180	5490	74000	58000
		HYQ SV7203 C FvLLB TA	17	40	12	15	9180	3840	106000	71000
		SV7203 AC FvLLB TA	17	40	12	25	8770	5250	62000	50000
		HYQ SV7203 AC FvLLB TA	17	40	12	25	8770	3670	90000	62000

Preload F_{va} / axial rigidity c_a / lifting force K_{aE}								
Light (L)			Medium (M)			Heavy (S)		
F_{va} [N]	c_a [N/µm]	K_{aE} [N]	F_{va} [N]	c_a [N/µm]	K_{aE} [N]	F_{va} [N]	c_a [N/µm]	K_{aE} [N]
49	8,0	150	150	12,6	510	295	17,1	1120
49	9,0	150	150	14,0	510	295	18,9	1100
47	16,8	130	145	24,8	420	285	32,0	880
47	18,8	130	145	27,8	420	285	35,8	870
33	7,1	100	100	10,9	330	195	14,7	710
33	7,9	100	100	12,1	320	195	16,2	690
31	14,9	85	95	21,9	270	185	28,1	560
31	16,7	85	95	24,5	270	185	31,5	560
13	5,6	41	39	8,7	130	80	11,8	290
13	6,2	41	39	9,7	130	80	13,1	290
13	11,6	35	37	17,1	110	75	22,1	220
13	13,0	35	37	19,2	100	75	24,7	220
13	5,6	41	39	8,7	130	80	11,8	290
13	6,2	41	39	9,7	130	80	13,1	290
13	11,6	35	37	17,1	110	75	22,1	220
13	13,0	35	37	19,2	100	75	24,7	220
25	6,6	75	75	10,2	260	150	13,8	560
25	7,4	75	75	11,4	250	150	15,3	550
24	13,8	65	75	20,3	210	145	26,2	440
24	15,5	65	75	22,8	210	145	29,3	430
19	6,4	60	60	10,0	200	115	13,6	430
19	7,1	60	60	11,1	190	115	15,0	430
18	13,2	50	55	19,6	160	110	25,3	330
18	14,9	50	55	21,9	160	110	28,3	330
34	7,5	100	105	11,6	340	205	15,6	740
34	8,4	100	105	12,9	340	205	17,3	730
33	15,8	90	100	23,3	280	195	30,0	590
33	17,8	90	100	26,1	280	195	33,6	580
34	7,5	100	105	11,6	340	205	15,6	740
34	8,4	100	105	12,9	340	205	17,3	730
33	15,8	90	100	23,3	280	195	30,0	590
33	17,8	90	100	26,1	280	195	33,6	580
60	9,5	170	170	14,9	590	335	20,2	1280
60	10,6	170	170	16,5	580	335	22,2	1250
55	19,8	150	165	29,2	480	325	37,8	1000
55	22,2	150	165	32,7	480	325	42,2	990
46	8,9	140	140	13,9	480	280	18,9	1050
46	10,0	140	140	15,5	470	280	20,8	1030
44	18,6	120	135	27,4	390	265	35,4	820
44	20,9	120	135	30,7	390	265	39,6	810

*Ask our application engineers for more information.

		HQW type	Dimensions d [mm]	Dimensions D [mm]	Dimensions B [mm]	Contact angle α [°]	Load ratings Dynamic C [N]	Load ratings Static C_0 [N]	*Limiting speed Oil [min^{-1}]	*Limiting speed Grease [min^{-1}]
7804	open	SV7804 C TA	20	32	7	15	4020	2820	70000	56000
		HYQ SV7804 C TA	20	32	7	15	4020	1970	100000	70000
		SV7804 AC TA	20	32	7	25	3800	2670	58000	47000
		HYQ SV7804 AC TA	20	32	7	25	3800	1870	85000	60000
	sealed	SV7804 C FvLLB TA	20	32	7	15	4020	2820	70000	56000
		HYQ SV7804 C FvLLB TA	20	32	7	15	4020	1970	100000	70000
		SV7804 AC FvLLB TA	20	32	7	25	3800	2670	58000	47000
		HYQ SV7804 AC FvLLB TA	20	32	7	25	3800	1870	85000	60000
7904	open	SV7904 C TA	20	37	9	15	6690	3990	64000	51000
		HYQ SV7904 C TA	20	37	9	15	6690	2790	92000	64000
		SV7904 AC TA	20	37	9	25	6370	3810	53000	43000
		HYQ SV7904 AC TA	20	37	9	25	6370	2660	78000	55000
	sealed	SV7904 C FvLLB TA	20	37	9	15	5580	3690	76000	60000
		HYQ SV7904 C FvLLB TA	20	37	9	15	5580	2580	108000	72000
		SV7904 AC FvLLB TA	20	37	9	25	5290	3510	63000	51000
		HYQ SV7904 AC FvLLB TA	20	37	9	25	5290	2450	92000	63000
7004	open	SV7004 C TA	20	42	12	15	11780	7150	59000	47000
		HYQ SV7004 C TA	20	42	12	15	11780	5010	84000	59000
		SV7004 AC TA	20	42	12	25	11280	6850	49000	39000
		HYQ SV7004 AC TA	20	42	12	25	11280	4800	71000	50000
	sealed	SV7004 C FvLLB TA	20	42	12	15	9640	6030	69000	55000
		HYQ SV7004 C FvLLB TA	20	42	12	15	9640	4220	99000	66000
		SV7004 AC FvLLB TA	20	42	12	25	9190	5760	58000	46000
		HYQ SV7004 AC FvLLB TA	20	42	12	25	9190	4030	84000	58000
7805	open	SV7805 C TA	25	37	7	15	5030	3820	59000	47000
		HYQ SV7805 C TA	25	37	7	15	5030	2670	84000	59000
		SV7805 AC TA	25	37	7	25	4750	3620	49000	39000
		HYQ SV7805 AC TA	25	37	7	25	4750	2530	71000	50000
	sealed	SV7805 C FvLLB TA	25	37	7	15	4180	3210	70000	55000
		HYQ SV7805 C FvLLB TA	25	37	7	15	4180	2250	99000	66000
		SV7805 AC FvLLB TA	25	37	7	25	3950	3040	58000	47000
		HYQ SV7805 AC FvLLB TA	25	37	7	25	3950	2130	84000	58000
7905	open	SV7905 C TA	25	42	9	15	7500	5040	54000	44000
		HYQ SV7905 C TA	25	42	9	15	7500	3520	78000	54000
		SV7905 AC TA	25	42	9	25	7110	4790	45000	36000
		HYQ SV7905 AC TA	25	42	9	25	7110	3350	66000	47000
	sealed	SV7905 C FvLLB TA	25	42	9	15	5660	4030	65000	51000
		HYQ SV7905 C FvLLB TA	25	42	9	15	5660	2820	92000	62000
		SV7905 AC FvLLB TA	25	42	9	25	5350	3830	54000	43000
		HYQ SV7905 AC FvLLB TA	25	42	9	25	5350	2680	78000	54000

Preload F_{va} / axial rigidity c_a / lifting force K_{aE}								
Light (L)			Medium (M)			Heavy (S)		
F_{va} [N]	c_a [N/µm]	K_{aE} [N]	F_{va} [N]	c_a [N/µm]	K_{aE} [N]	F_{va} [N]	c_a [N/µm]	K_{aE} [N]
21	7,0	60	65	11,0	210	125	14,9	460
21	7,8	60	65	12,2	200	125	16,4	450
19	14,6	55	60	21,5	170	115	27,8	350
19	16,4	55	60	24,1	170	115	31,1	350
21	7,0	60	65	11,0	210	125	14,9	460
21	7,8	60	65	12,2	200	125	16,4	450
19	14,6	55	60	21,5	170	115	27,8	350
19	16,4	55	60	24,1	170	115	31,1	350
34	7,5	100	105	11,6	340	205	15,6	730
34	8,4	100	105	12,9	330	205	17,2	720
32	15,8	90	100	23,3	280	195	29,9	580
32	17,8	90	100	26,1	280	195	33,5	580
28	7,8	85	85	12,0	280	170	16,2	620
28	8,7	85	85	13,4	280	170	17,9	610
27	16,3	75	80	23,9	230	160	30,8	480
27	18,3	75	80	26,8	230	160	34,5	480
60	10,2	180	180	15,9	620	355	21,6	1350
60	11,4	180	180	17,7	610	355	23,8	1320
60	21,2	160	170	31,4	510	340	40,5	1050
60	23,9	160	170	35,1	500	340	45,3	1040
49	9,5	150	145	14,9	510	290	20,1	1100
49	10,6	150	145	16,5	500	290	22,2	1080
46	19,8	130	140	29,3	410	280	37,8	860
46	22,3	130	140	32,8	410	280	42,2	850
26	8,3	80	80	12,9	260	155	17,5	570
26	9,3	75	80	14,4	250	155	19,3	550
24	17,3	65	75	25,5	210	145	32,9	440
24	19,5	65	75	28,6	210	145	36,8	430
21	7,6	65	65	11,9	220	130	16,0	470
21	8,5	65	65	13,2	210	130	17,7	460
20	15,8	55	60	23,3	170	120	30,1	360
20	17,8	55	60	26,2	170	120	33,7	360
38	8,9	110	115	13,6	380	225	18,3	820
38	9,9	110	115	15,2	370	225	20,2	800
36	18,7	100	110	27,4	310	215	35,2	650
36	21,0	100	110	30,8	310	215	39,4	640
29	8,1	85	85	12,5	290	170	16,8	620
29	9,0	85	85	13,9	280	170	18,6	610
27	17,0	75	85	24,9	240	165	32,1	490
27	19,1	75	85	28,0	230	165	35,9	490

*Ask our application engineers for more information.

		HQW type	Dimensions d [mm]	D [mm]	B [mm]	Contact angle α [°]	Load ratings Dynamic C [N]	Static C_0 [N]	*Limiting speed Oil [min-1]	Grease [min-1]
7806	open	SV7806 C TA	30	42	7	15	5210	4300	51000	41000
		HYQ SV7806 C TA	30	42	7	15	5210	3010	73000	51000
		SV7806 AC TA	30	42	7	25	4910	4070	42000	34000
		HYQ SV7806 AC TA	30	42	7	25	4910	2850	62000	44000
	sealed	SV7806 C FvLLB TA	30	42	7	15	4520	4110	59000	47000
		HYQ SV7806 C FvLLB TA	30	42	7	15	4520	2880	85000	57000
		SV7806 AC FvLLB TA	30	42	7	25	4250	3890	50000	40000
		HYQ SV7806 AC FvLLB TA	30	42	7	25	4250	2720	72000	50000

	Preload F_{va} / axial rigidity c_a / lifting force K_{aE}								
	Light (L)			Medium (M)			Heavy (S)		
	F_{va} [N]	c_a [N/µm]	K_{aE} [N]	F_{va} [N]	c_a [N/µm]	K_{aE} [N]	F_{va} [N]	c_a [N/µm]	K_{aE} [N]
	27	8,9	80	80	13,9	270	160	18,8	580
	27	10,0	80	80	15,4	260	160	20,7	570
	25	18,6	70	75	27,5	220	150	35,4	450
	25	20,9	70	75	30,8	210	150	39,6	450
	23	8,7	70	70	13,3	230	140	17,9	490
	23	9,7	70	70	14,8	220	140	19,8	480
	22	18,2	60	65	26,7	190	130	34,3	390
	22	20,4	60	65	29,9	180	130	38,4	380

*Ask our application engineers for more information.

BEARING PRELOAD

Spindle bearings are angular contact ball bearings which are matched and mounted with preload.

The preload ensures:

- Even loading of the balls.
- Improved rolling of the balls (spin/roll ratio).
- Higher bearing rigidity and zero play.
- Faster speeds.

In most cases, two types of preload are sufficient – spring preload and rigid preload. In individual cases, hydraulic preload is used. This uses hydraulic pressure to set the preload during operation, depending on the speed of the bearing.

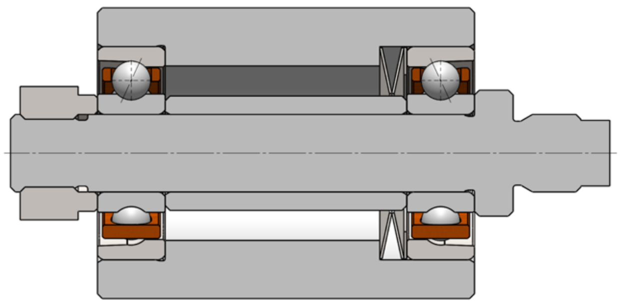
SPRING PRELOAD

Springs are the simplest method for bearing preload. These are typically coil springs, disc springs, wave and finger spring washers which load the non-rotating ring of the bearing, typically the outer ring. The selected ring must fit the shaft and/or housing under all operating conditions (temperatures, high centrifugal forces, etc.).

The advantage of a spring preload, compared with a rigid preload, is that it provides a constant preload on account of its lower sensitivity to different thermal expansions. Ball or sliding bushes can be used to avoid misalignment from occurring at high speeds.

Properties:

- Resistant to different thermal expansions between shaft and housing.
- Suitable for the highest speeds.
- Continuous preload, even with changes of temperature or speed.
- Limited axial rigidity against the preload force (e.g. tensile forces).



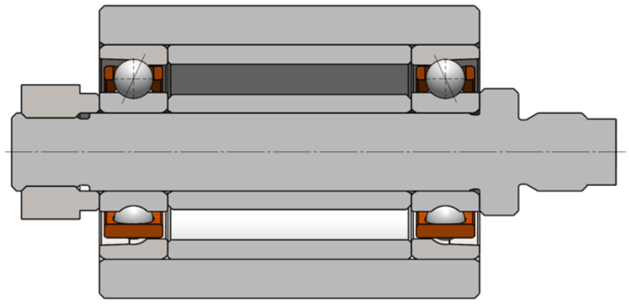
RIGID PRELOAD WITH PAIRED BEARINGS

The design of a rigid bearing arrangement is less complex, as there is no loose bearing to consider or any allowance made for the sliding movement of the bearing. Mounting of the bearing is also significantly easier. The preload can be determined using paired bearings (see chapter “Paired Spindle Bearings”). These must only be preloaded in sets.

Properties:

- Significantly higher rigidity in both axial directions compared with spring preload.
- Fewer design constraints as preload is already integrated in the system.
- Easier to mount.
- Lower maximum speeds due to higher sensitivity to thermal expansion.

The preload force should be determined depending on the desired performance. An excessive preload will lead to increased heating of the bearing, which makes it unsuitable for high speeds and will reduce the lifetime. An insufficient preload can lead to a slipping movement (sliding) between ball and raceway during operation, which reduces the bearing life. A specific minimum bearing preload is thus required.The preload classes L, M or S can be found in the spindle bearing tables.



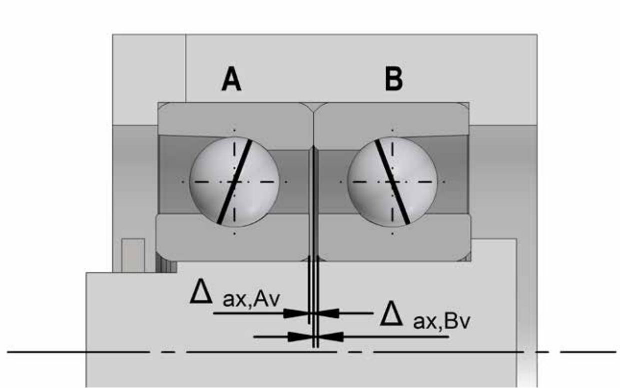
SPEED REDUCTION WITH RIGID BEARING ARRANGEMENT

The high rigidity in these systems, compared with spring adjustment, means that it is not possible to compensate for expansion caused by temperature differences or centrifugal forces to the same extent. With the rigid bearing arrangement, maximum speeds can deviate from the values indicated in the table. Our bearing specialists are on hand to provide technical advice.

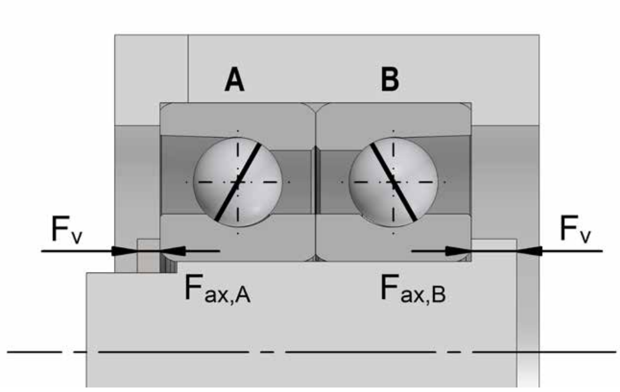
LIFTING FORCE

Lifting force is an important consideration in the design of the bearing. If high axial forces on the shaft are expected, it is important to check the ratio of axial force to lifting force. If the axial force exceeds the lifting force, this may lead to increased noise and vibration, and therefore a reduced lifetime. The lifting forces are indicated in the bearing tables on p.18. Lifting force can be explained using the following example of a back-to-back arrangement.

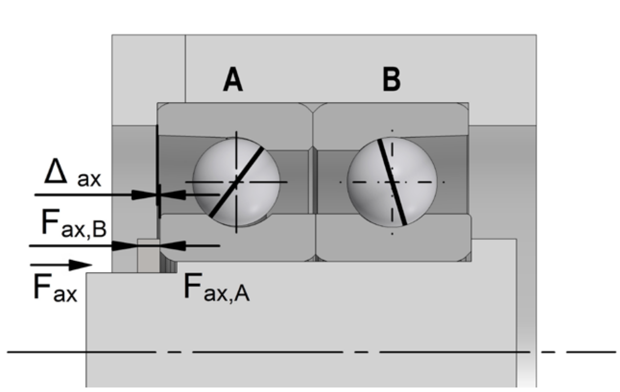
Step 1: Two spindle bearings are pressed on a shaft next to each other in back-to-back arrangement. Depending on the type and the desired preload of the spindle bearing, this results in a defined gap ($\Delta_{ax,Av} = \Delta_{ax,Bv}$) between the two plane surfaces in a force-free state.



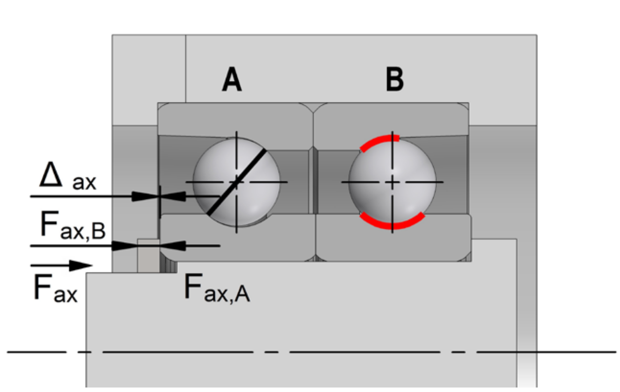
Step 2: Using a lock nut, the spindle bearings are preloaded against each other ($F_V = F_{ax,A} = F_{ax,B}$) with the preload force F_V (L, M or S), until the gap is closed. The operating contact angle is enlarged compared with the nominal contact angle due to the elastic deformation of the rings.



Step 3: As soon as an axial force F_{ax} puts pressure on the shaft, the shaft is moved in the direction of the axial force F_{ax} by δ_{ax}. As a result, the inner preload forces relocate, causing bearing A to absorb a higher force and reducing the force in bearing B. The contact angle will increase in bearing A and decrease in bearing B.



Step 4: If the axial force F_{ax} affecting the shaft exceeds the lifting force, the balls of bearing B become load free. Bearing A will absorb the complete force $F_{ax} = F_{ax,A}$. At high speeds, in particular, this may lead to increased vibration and noise, and thus to a reduced lifetime.



PAIRED SPINDLE BEARINGS

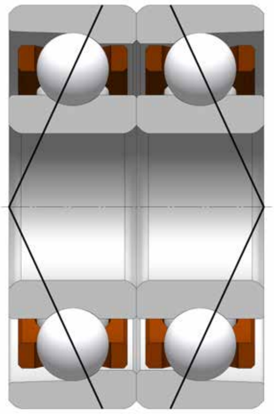
With rigid bearing preload, adjusted bearing pairs in back-to-back, face-to-face or tandem arrangement offer an effective, economic and technical solution for a variety of applications.

Back-to-back arrangement (DB): The contact lines form an O. The back-to-back arrangement is distinguished by a broad support base and high rigidity against tilting moments. The axial force is absorbed in both directions.

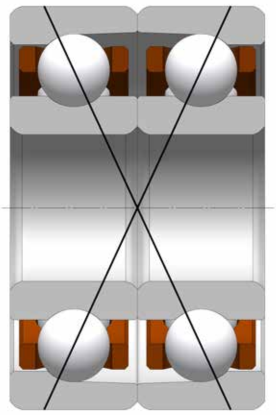
Face-to-face arrangement (DF): The pressure lines form an X. This bearing arrangement is less sensitive to misalignment than the back-to-back arrangement, but does however, have less tilting rigidity. The axial force is absorbed in both directions.

Tandem arrangement (DT): In this bearing arrangement, the contact lines are arranged in parallel. The axial load capacity is twice that of a single bearing, but only in one direction. That is why this bearing pair must be adjusted against another bearing or bearing pair.

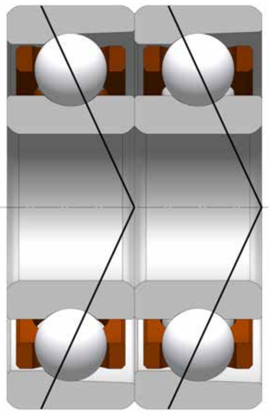
Universal design (U): Universal bearings can be paired in any arrangement listed above. It must be noted here that the bearings require the same preload.



BACK-TO-BACK ARRANGEMENT (DB)



FACE-TO-FACE ARRANGEMENT (DF)



TANDEM ARRANGEMENT (DT)

ADVANTAGES OF THE UNIVERSAL DESIGN

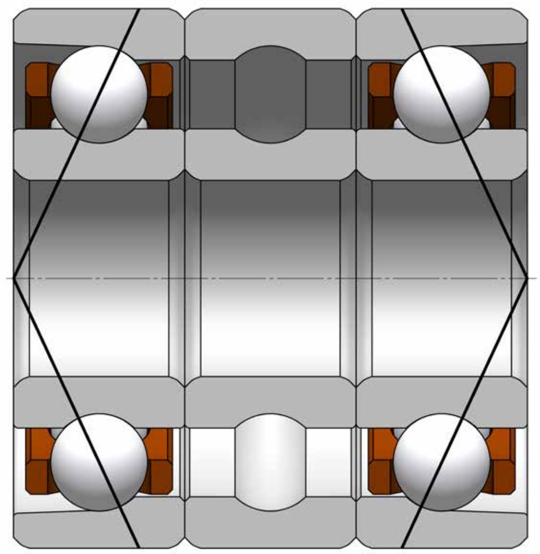
- Single bearings are interchangeable at identical preload force.
- Can be flexibly installed in X, O or tandem arrangement, also with spring preload.
- Reduction of product diversity leading to better forecasting of demand.
- Advantages in handling, as no specific positioning of the bearing pairs is required.

SPACERS

The width of the spacers should not be smaller than the width of the bearings. For paired bearings, both rings should be surface-ground in one processing step to ensure the same width. We are happy to offer you suitable spacers for your specific application.

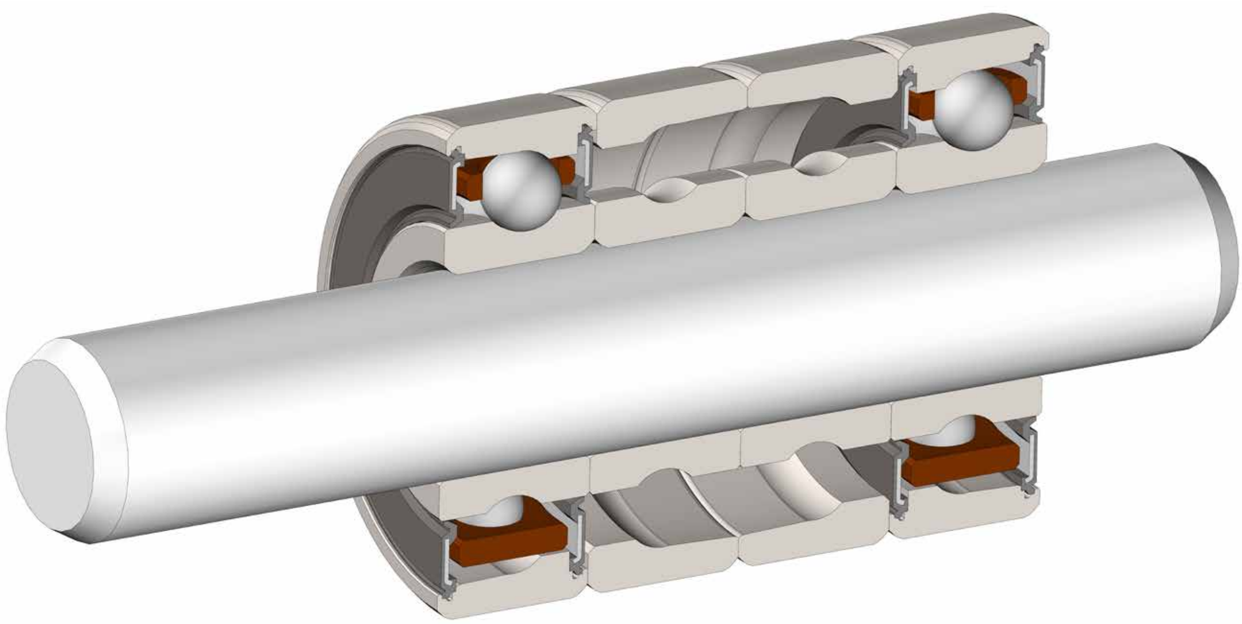
TECHNICAL ADVANTAGES OF PAIRED BEARINGS FITTED WITH SPACERS

- Larger clamping surface gives higher permissible moment load.
- Improved heat dissipation from the bearing.
- Easier implementation of the oil-air supply.



BEARING INNER AND OUTER RING AS SPACER

The following illustration represents two spindle bearings which are preloaded against each other with a defined force. Two spacers provide a wide clamping surface. HQW also offers complete assemblies consisting of spindle bearings, spacers and shaft. Please ask our bearing specialists for more information.



SIZES, TOLERANCES AND GEOMETRIC ACCURACY

HQW spindle bearings are manufactured in compliance with the current ISO (International Organization for Standardization) or ABEC (Annular Bearing Engineering Committee) standards. ABEC1 corresponds with the lowest tolerance class and ABEC9 to the highest level of accuracy. Among the ISO standards, P0 corresponds to the standard accuracy and classes P6 to P2 indicate increasing accuracy. The following two tables represent tolerance values for both specifications. HQW produces spindle bearings to these tolerance classes as standard.

INNER RING TOLERANCES			d in mm		P4 / ABEC7		P2 / ABEC9		P4S		ABEC7P		ABEC9P	
			over	incl.	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower
Deviation of the bore diameter		Δ_{dmp} / Δ_{ds}	0,6	18	0	-4	0	-2,5	0	-4	0	-5	0	-2,5
			18	30	0	-5	0	-2,5	0	-5	0	-5	0	-2,5
			30	50	0	-6	0	-2,5	0	-6				
Variation of the bore diameter on a radial plane (roundness)	Diameter series 7 / 8 / 9	V_{dp}	0,6	18	4		2,5		2,5		2,5		1,5	
			18	30	5		2,5		2,5		2,5		1,5	
			30	50	6		2,5		2,5					
	0 / 1 / 2 / 3	V_{dp}	0,6	18	3		2,5		2,5		2,5		1,5	
			18	30	4		2,5		2,5		2,5		1,5	
			30	50	5		2,5		2,5					
Variation of the average bore diameter (conicity)		V_{dmp}	0,6	18	2		1,5		1,5		2,5		1,5	
			18	30	2,5		1,5		1,5		2,5		1,5	
			30	50	3		1,5		1,5					
Runout of the inner ring on the assembled bearing (radial runout)		K_{ia}	0,6	2,5	2,5		1,5		1,5		2,5		1,5	
			2,5	10	2,5		1,5		1,5		2,5		1,5	
			10	18	2,5		1,5		1,5		2,5		1,5	
			18	30	3		2,5		2,5		4		2,5	
			30	50	4		2,5		2,5					
Axial run-out of the face in relation to the borehole (sidestroke)		S_d	0,6	18	3		1,5		1,5		2,5		1,5	
			18	30	4		1,5		1,5		4		1,5	
			30	50	4		1,5		1,5					
Axial runout of the face, in relation to the course of the inner ring on the assembled bearing (axial stroke)		S_{ia}	0,6	18	3		1,5		1,5		2,5		1,5	
			18	30	4		2,5		2,5		4		1,5	
			30	50	4		2,5		2,5					
Deviation of a single inner ring width		Δ_{Bs}	0,6	2,5	0	-40	0	-40	0	-40	0	-25	0	-25
			2,5	10	0	-40	0	-40	0	-40	0	-25	0	-25
			10	18	0	-80	0	-80	0	-80	0	-25	0	-25
			18	30	0	-120	0	-120	0	-120	0	-25	0	-25
			30	50	0	-120	0	-120	0	-120				
Variation of the inner ring width		V_{Bs}	0,6	2,5	2,5		1,5		1,5		2,5		1,5	
			2,5	10	2,5		1,5		1,5		2,5		1,5	
			10	18	2,5		1,5		1,5		2,5		1,5	
			18	30	2,5		1,5		1,5		2,5		1,5	
			30	50	3		1,5		1,5					

All figures in µm.

OUTER RING TOLERANCES			D in mm		P4 / ABEC7		P2 / ABEC9		P4S		ABEC7P		ABEC9P	
			over	incl.	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower
Deviations of the outer diameter		Δ_{Dmp} / Δ_{Ds}	2,5	18	0	-4	0	-2,5	0	-4	0	-5	0	-2,5
			18	30	0	-5	0	-4	0	-5	0	-5	0	-4
			30	50	0	-6	0	-4	0	-6	0	-5	0	-4
			50	80	0	-7	0	-4	0	-7				
Variation of the outer diameter on a radial plane (roundness)	Diameter series 7 / 8 / 9	V_{Dp}	2,5	18	4		2,5		2,5		2,5		1,5	
			18	30	5		4		4		2,5		2	
			30	50	6		4		4		2,5		2	
			50	80	7		4		4					
	0 / 1 / 2 / 3	V_{Dp}	2,5	18	3		2,5		2,5		2,5		1,5	
			18	30	4		4		4		2,5		2	
			30	50	5		4		4		2,5		2	
			50	80	5		4		4					
Variation of the average outer diameter (conicity)		V_{Dmp}	2,5	18	2		1,5		1,5		2,5		1,5	
			18	30	2,5		2		2		2,5		2	
			30	50	3		2		2		2,5		2	
			50	80	3,5		2		2					
Runout of the outer ring on the assembled bearing (radial runout)		K_{ea}	2,5	18	3		1,5		1,5		4		1,5	
			18	30	4		2,5		2,5		4		2,5	
			30	50	5		2,5		2,5		5		2,5	
			50	80	5		4		4					
Variation of the inclination of the surface line, with regard to the referential side surface (sidestroke)		S_D	2,5	18	4		1,5		1,5		4		1,5	
			18	30	4		1,5		1,5		4		1,5	
			30	50	4		1,5		1,5		4		1,5	
			50	80	4		1,5		1,5		4		1,5	
Axial runout of the face in relation to the course of the outer ring on the assembled bearing (axial stroke)		S_{ea}	2,5	18	5		1,5		1,5		5		1,5	
			18	30	5		2,5		2,5		5		2,5	
			30	50	5		2,5		2,5		5		2,5	
			50	80	5		4		4					
Deviation of a single outer ring width		Δ_{Cs}	2,5	18	Identical with Δ_{Bs} for the inner ring of the same bearing.									
			18	30	0	-120	0	-120	0	-120	0	-25	0	-25
			30	50	0	-120	0	-120	0	-120	0	-25	0	-25
			50	80	0	-150	0	-150	0	-150				
Variation of the outer ring width		V_{Cs}	2,5	18	2,5		1,5		1,5					
			18	30	2,5		1,5		1,5		2,5		1,5	
			30	50	2,5		1,5		1,5		2,5		1,5	
			50	80	3		1,5		1,5					

All figures in µm.

SELECTION OF FIT

The efficiency of HQW spindle bearings is determined largely by the precision of the mating parts. The accuracy of the fit has a decisive impact on the selected bearing. High speeds will result in increased centrifugal forces, leading to expansion of the inner ring. This may result in the inner ring sliding on the shaft which causes fretting corrosion and vibration. To prevent this, a tighter fit should be selected. The fit can also be selected using tables “Shaft Tolerances” and “Housing Tolerances”.

SHAFT TOLERANCES		d in mm		P4 / ABEC7		P2 / ABEC9		P4S		ABEC7P		ABEC9P	
		over	incl.	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower
Deviation of the bore diameter	Δ_{dmp} / Δ_{ds}	0,6	18	0	-4	0	-2,5	0	-4	0	-5	0	-2,5
		18	30	0	-5	0	-2,5	0	-5	0	-5	0	-2,5
		30	50	0	-6	0	-2,5	0	-6				
Deviations of the shaft diameter	Operating conditions – Clearance: Little load, Medium speeds, No vibration	0,6	18	-5	-9	-4	-7	-5	-9	-6	-11	-4	-7
		18	30	-6	-11	-4	-7	-6	-11	-6	-11	-4	-7
		30	50	-7	-13	-4	-7	-7	-13				
	Operating conditions – Transfer: Medium load, Medium speed, Little vibration	0,6	18	0	-4	0	-3	0	-4	0	-5	0	-3
		18	30	0	-5	0	-3	0	-5	0	-5	0	-3
		30	50	0	-6	0	-3	0	-6				
	Operating conditions – Oversize: High load, High speeds, Large vibration	0,6	18	+5	+1	+4	+1	+5	+1	+6	+1	+4	+1
		18	30	+6	+1	+4	+1	+6	+1	+6	+1	+4	+1
		30	50	+7	+1	+4	+1	+7	+1				
Variation of the shaft diameter on a radial plane (roundness)	Diameter series 7 / 8 / 9	0,6	18	2		1,5		1,5		1,5		0,8	
		18	30	2,5		1,5		1,5		1,5		0,8	
		30	50	3		1,5		1,5					
	0 / 1 / 2 / 3	0,6	18	1,5		1,5		1,5		1,5		0,8	
		18	30	2		1,5		1,5		1,5		0,8	
		30	50	2,5		1,5		1,5					
Variation of the average shaft diameter (conicity)		0,6	18	1		0,8		0,8		1,5		0,8	
		18	30	1,5		0,8		0,8		1,5		0,8	
		30	50	1,5		0,8		0,8					
Variation of the average shaft diameter (conicity)		0,6	2,5	1,5		0,8		0,8		1,5		0,8	
		2,5	10	1,5		0,8		0,8		1,5		0,8	
		10	18	1,5		0,8		0,8		1,5		0,8	
		18	30	1,5		1,5		1,5		2		1,5	
		30	50	2		1,5		1,5					
Axial runout of the face in relation to the shaft		0,6	18	1,5		0,8		0,8		1,5		0,8	
		18	30	2		0,8		0,8		2		0,8	
		30	50	2		0,8		0,8					

Axial securing of the outer ring is required (tight fit).

All figures in µm.

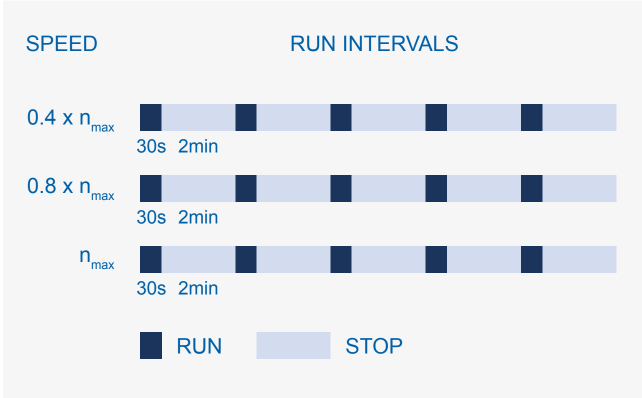
HOUSING TOLERANCES		D in mm		P4 / ABEC7		P2 / ABEC9		P4S		ABEC7P		ABEC9P	
		over	incl.	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower
Deviations of the outer diameter	Δ_{Dmp} / Δ_{Ds}	2,5	18	0	-4	0	-2,5	0	-4	0	-5	0	-2,5
		18	30	0	-5	0	-4	0	-5	0	-5	0	-4
		30	50	0	-6	0	-4	0	-6	0	-5	0	-4
		50	80	0	-7	0	-4	0	-7				
Deviations of the housing boreholes	Operating conditions – Clearance: Little load, Medium speeds, No vibration	2,5	18	+5	+1	+4	+1	+5	+1	+6	+1	+4	+1
		18	30	+6	+1	+5	+1	+6	+1	+6	+1	+5	+1
		30	50	+7	+1	+5	+1	+7	+1	+6	+1	+5	+1
		50	80	+8	+1	+5	+1	+8	+1				
	Operating conditions – Transfer: Medium load, Medium speeds, Little vibration	2,5	18	0	-4	0	-3	0	-4	0	-5	0	-3
		18	30	0	-5	0	-4	0	-5	0	-5	0	-4
		30	50	0	-6	0	-4	0	-6	0	-5	0	-4
		50	80	0	-7	0	-4	0	-7				
	Operating conditions – Oversize: High load, High speeds, Large vibration	2,5	18	-5	-9	-4	-7	-5	-9	-6	-11	-4	-7
		18	30	-6	-11	-5	-9	-6	-11	-6	-11	-5	-9
		30	50	-7	-13	-5	-9	-7	-13	-6	-11	-5	-9
		50	80	-8	-15	-5	-9	-8	-15				
Variation of the housing borehole on a radial plane (roundness)	Diameter series 7 / 8 / 9	2,5	18	2		1,5		1,5		1,5		0,8	
		18	30	2,5		2		2		1,5		1	
		30	50	3		2		2		1,5		1	
		50	80	3,5		2		2					
	0 / 1 / 2 / 3	2,5	18	1,5		1,5		1,5		1,5		0,8	
		18	30	2		2		2		1,5		1	
		30	50	2,5		2		2		1,5		1	
		50	80	2,5		2		2					
Variation of the average housing borehole (conicity)		2,5	18	1		0,8		0,8		1,5		0,8	
		18	30	1,5		1		1		1,5		1	
		30	50	1,5		1		1		1,5		1	
		50	80	2		1		1					
Runout of the housing borehole (concentricity)		2,5	18	1,5		0,8		0,8		2		0,8	
		18	30	2		1,5		1,5		2		1,5	
		30	50	2,5		1,5		1,5		2,5		1,5	
		50	80	2,5		2		2					
Axial runout of the face in relation to the housing borehole		2,5	18	2,5		0,8		0,8		2,5		0,8	
		18	30	2,5		1,5		1,5		2,5		1,5	
		30	50	2,5		1,5		1,5		2,5		1,5	
		50	80	2,5		2		2					

Axial securing of the outer ring is required (tight fit).

All figures in µm.

GREASE DISTRIBUTION

Before operation under load, spindle bearings with lifetime lubrication first need to be run in to distribute the grease. This ensures an even distribution of lubricant. The grease distribution is carried out at intervals with pauses at rest, so that the oil can flow back into the track. The procedure for grease distribution is as follows: Three process steps with increasing speeds ($0.4 \times n_{max}$; $0.8 \times n_{max}$; n_{max}) in relation to the maximum speed of the application, and five intervals composed of one 30-second run and a two-minute stop. The temperature must be observed and additional stops should be made if the temperature is too high. This grease distribution process is illustrated above. After the grease distribution, the spindle bearings can be operated under full load and at maximum speed.



GREASE DISTRIBUTION

HANDLING OF HQW SPINDLE BEARINGS

- Ensure that the workplace is extremely clean and only unpack the ball bearing shortly before assembling.
- Avoid knocks and any impact to the bearings.
- When greasing open spindle bearings, make sure that a suitable grease is used.
- For high speed applications a grease distribution run in is required.
- Bearing pairs in O, X or tandem arrangement (labelled with DB, DF or DT) are always shrink-wrapped in pairs and may only be installed with the delivered spindle bearing of the corresponding type; labelling is carried out by means of arrow symbols on the outer diameter (<>, ><, >>, <<).
- The marking indicates the load direction of the outer ring.
- The bearings with a multi-purpose design (UL, UM, US) are individually packed in foil and can be installed as required, e.g. with bearings from other batches. The load direction is indicated by arrow symbols on the outer ring.

NOTES

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