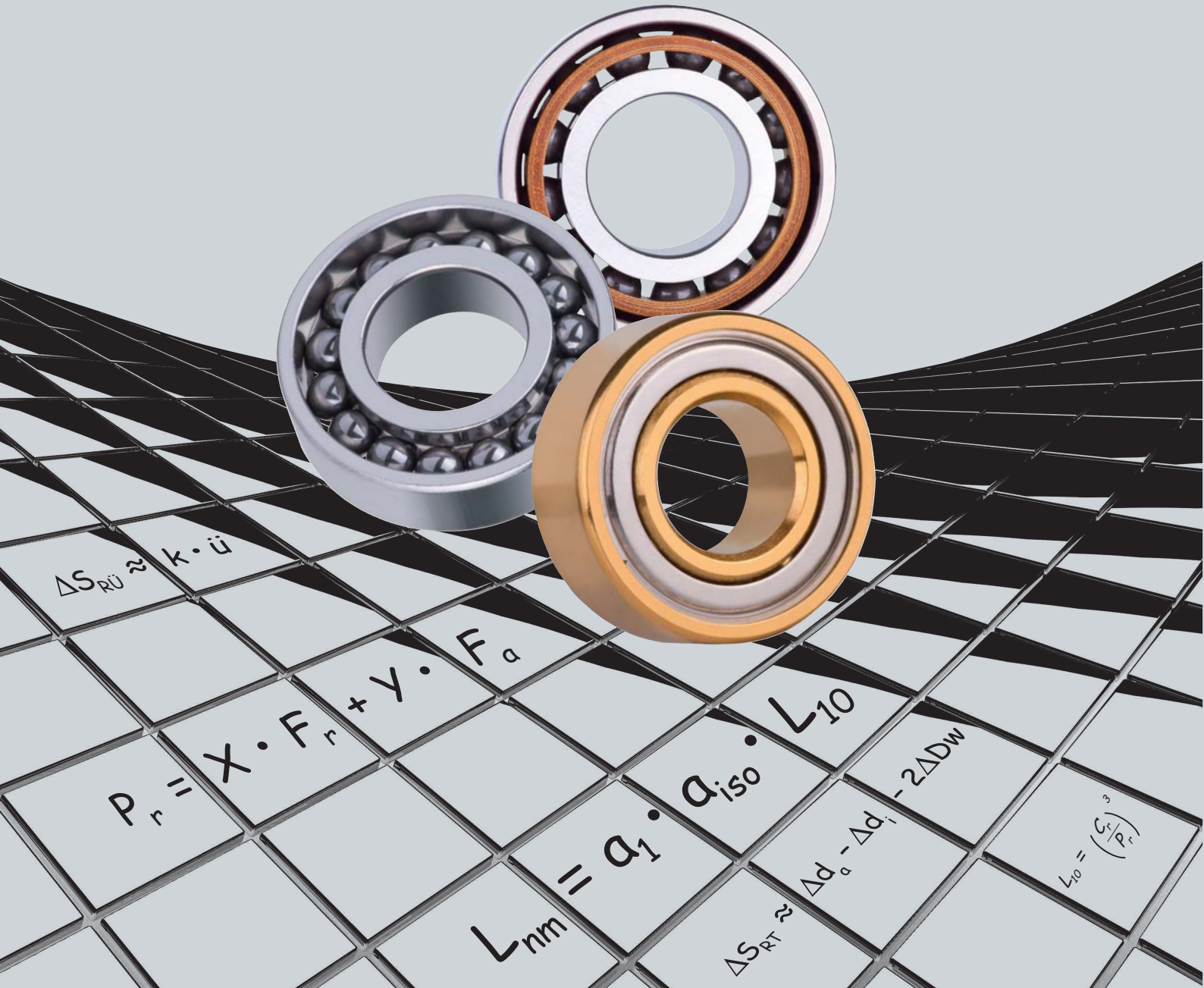
GRW

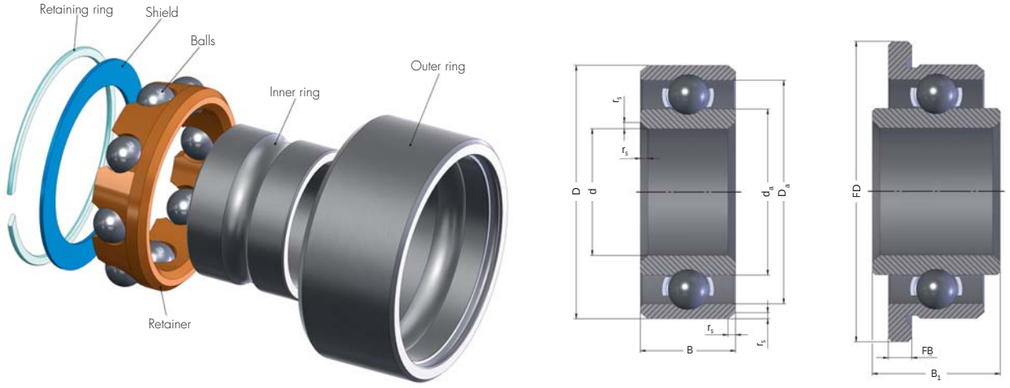
HIGH-PRECISION BALL BEARINGS

High-Precision Ball Bearings

Product Catalogue



Designation system of radial ball bearings – metric / inch



-	-	LE	625	-	P...	C...
HY	SS	F	3/16	-Z	ABEC...	K...
ZO	SV	E	625/603938	-2Z		D...
	S			-RZ		
	SA			-RS		
	N			-VZ		
	NZ			-VS		
				-TS		
- Steel balls HY Ceramic balls made from Si_3N_4 ZO Ceramic balls made from ZrO_2	- 100Cr6 SS X65Cr13 SV X30CrMoN15-1 S 440C SA Antimagnetic material Combination balls N Full ceramic bearings (balls, IR, AR) of silicon nitride NZ Full ceramic bearings (balls, IR, AR) made from zirconium oxide Further materials available on request	LE Bearing unit F Flange E Extended inner ring	625 Metric 3/16 Inch 625/XXXXXX Acc. to drawing	- Open ball bearings -Z Single shield -2Z Double shield -RZ Single Perbunan rubber shield, non-contact -RS Single Perbunan rubber contact seal -VZ Single Viton shield, non-contact -VS Single Viton contact seal -TS Single Teflon® contact seal	Standard tolerance grade **P0** or **ABEC1** not marked **P** tolerance grade for metric bearings in **P6**, **P5**, **P4** and **P2** **ABEC** tolerance grade for inch bearings in **ABEC3**, **ABEC5** etc. Special tolerance grades: **ABEC9P**, **P4A**, **P4S**,...	*Metric deep groove radial bearings* - Standard clearance **C2** Narrower than standard **C3** Slightly increased radial clearance **C4** Increased radial clearance **C5** Strongly increased radial clearance The exact values depend on the bearing dimensions, see capter "The classification of radial clearance". Defined radial clearance: f.e. **C1/5** 1 to 5 µm **C4/8** 4 to 8 µm **C10/15** 10 to 15 µm **C14/20** 14 to 20 µm *Inch deep groove radial bearings* Defined radial clearance: f.e. **K02** 0 to .0002" **K13** .0001" to .0003" **K46** .0004" to .0006" **K58** .0005" to .0008" **D** Followed a by number indicates contract angle *Spindle ball bearings* C Contact angle 15° E Contact angle 25°

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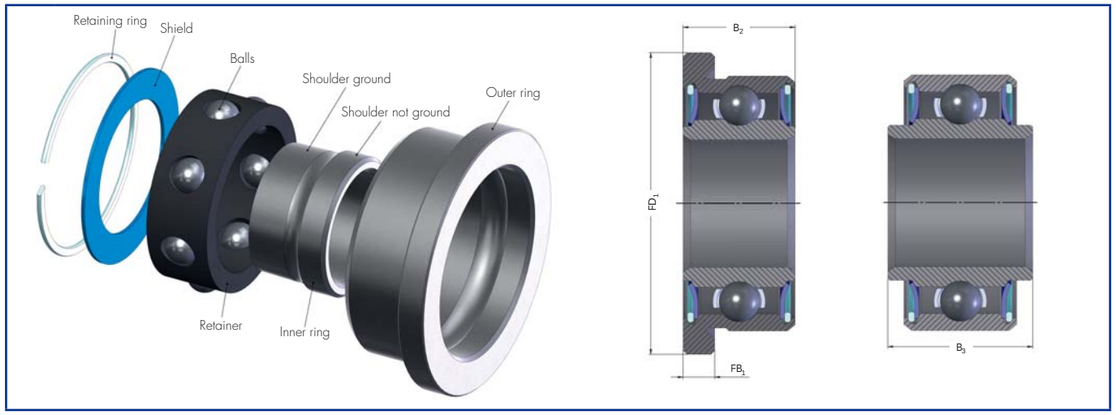
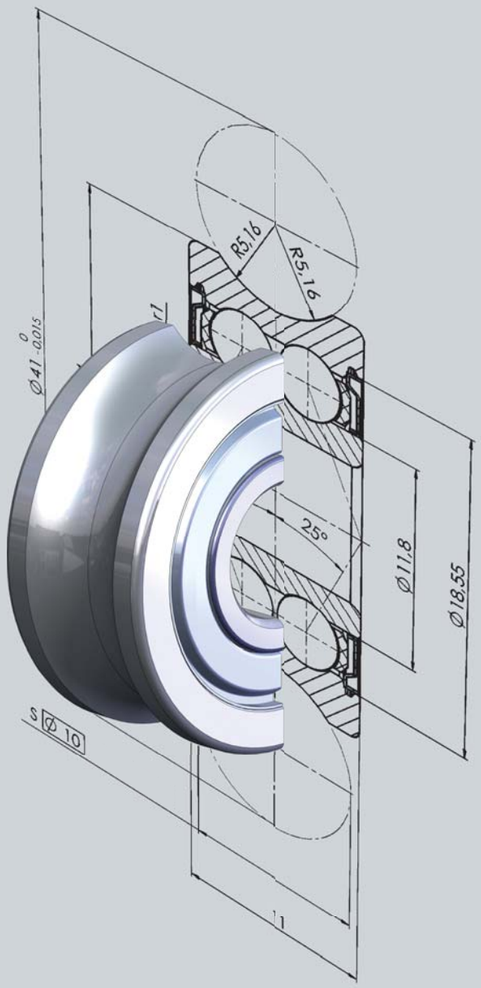
Designation system of radial ball bearings – metric / inch



GPR	X	-1	/...	E	–	G...
GPA	XB	-2	L	J	...%	L...
R(...)	XD	-3	M	J1	... MG	L299
	X4	-4	S	TXHB		B...
	X4B			T19HB		
	X4D			AC1TA		
GPR Noise test (standard 100%) **GPA** Axial vibration test **R(...)** Followed by a number indicates starting torque with standard load, max. 16 µNm	**X** Bore and outside diameter graded in 2 classes **XB** Bore graded in 2 classes **XD** Outside diameter graded in 2 classes **X4** Bore and outside diameter graded in 4 classes **X4B** Bore graded in 4 classes **X4D** Outside diameter graded in 4 classes	**-1** Back to back (O-arrangement) **-2** Face to face (X-arrangement) **-3** Tandem **-4** Universally paired *Example: Deep groove radial bearings: -1/5 (= O-arrangement with 5 N preload)* Example: Spindle ball bearings: UM (= universally matched pairs, medium preload)	**/...** Preload value in [N] Preload for spindle ball bearings ... L light M medium S strong Preload other than L, M, S possible	*Deep groove radial bearings* **E** 2-pc. steel retainer **J** 2-pc. stainl. steel retainer **J1** 2-pc. stainl. steel retainer Teflon®-laminated **TXHB** Machined one-piece snap retainer, X stands for a number and defines the material **T19HB** Machined synthetic snap retainer made from PAI-PTFE-cg Other retainer variants see chapter "Retainers for miniature ball bearings" *Full complement ball bearing* VAC1 Outer ring shoulder ground *Spindle ball bearings* **AC1** Outer ring shoulder ground **AC2** Inner ring shoulder ground **AC** Only in connection with solid retainer or full-complement Example: AC1TA Machined solid retainer made from fabric-reinforced phenolic resin	**–** No data Standard quantity **...%** Lubricant quantity in % of the free space only for lubricated bearings) **...MG** Lubricant quantities specified in mg or indication of quantity range e.g. 10–15 % or 6–10 MG	**G...** Grease **L...** Oil **L299** dry bearing **B...** Special treatment



HIGH-PRECISION BALL BEARINGS

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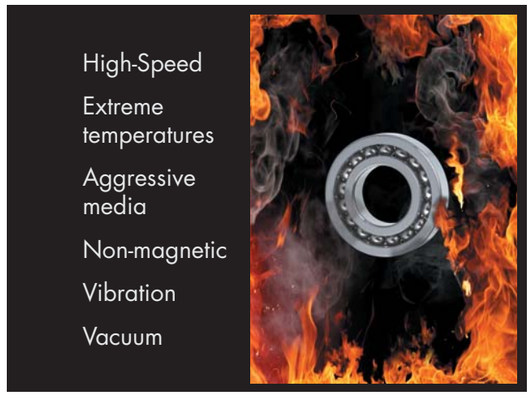


Our company

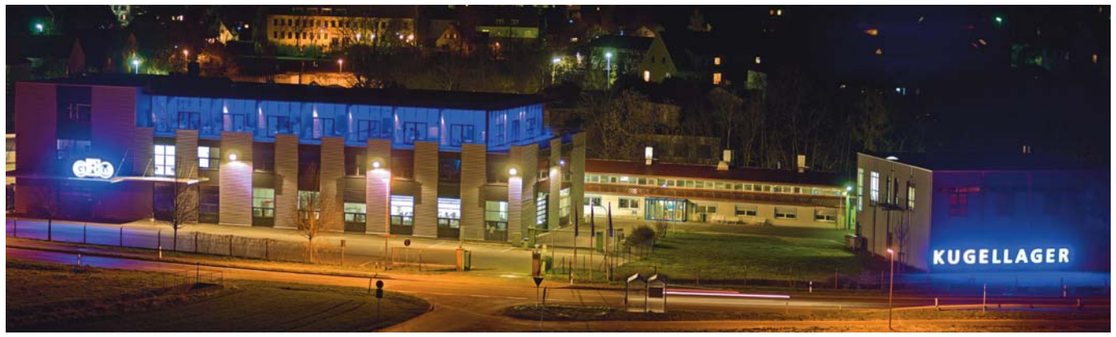
As a global corporation with more than 500 employees, GRW is headquartered in Rimpar near Würzburg with assembly facilities in Prachatice (Czech Republic) and two offices in the USA.

GRW is the premier developer and manufacturer of miniature precision ball bearings, assemblies and accessory parts utilizing state of the art equipment and manufacturing processes. We specialise in the production of high precision, small, miniature and instrument bearings as well as spindle bearings and bearing units. GRW also welcomes the opportunity to design, develop and produce customised applications using customer specifications.

Our radial ball bearings range in bores from 1 mm to 35 mm with outer diameters from 3 mm to 47 mm meeting any need from low to high volume standard applications.

GRW bearings are produced in both metric and inch dimensions making them truly applicable to any customer in the world. Whether your application requires high or low quantities or customised specifications, you can always rely upon GRW to meet any requirement or challenge.

GRW complies with the highly recognised standard ISO certification, DIN EN ISO 9001:2008 for quality in process and performance.



Headquarter and production site at Rimpar

HIGH-PRECISION BALL BEARINGS

Preface

"Miniature precision meets extreme demands"

GRW high-precision ball bearings are used in measurement and control technologies, medical & dental technologies, vacuum applications, electric motors, and high-tech aerospace industries.

This GRW Product Catalog provides extensive detail on our products for standard industry solutions and customised systems to meet our customers' most demanding challenges.

Our new program, **EXTREME**, is designed for applications that go far beyond the standard product solution. In fact, GRW products are optimised to our **EXTREME** standards. Which means we not only meet but also surpass your specifications for longer life, higher speed and load ratings and do so with incredibly dependable customer service.

See page 79 to 83 of this product catalogue for details on this new program.

We can do even better – just challenge us.
Our sales engineers will be happy to advise you.
We are looking forward to your call:
+49 (0) 93 65/819 - 440

Customized solutions
since 1942.

1942
Foundation of the company in Würzburg

1958
Purchase and construction of the factory in Rimpar (Buildings I and II)

1962
First cleanroom for ball bearings assembly in Rimpar

1987
Extension of the Rimpar site by buildings III and IV

1996
Purchase and building of the production site in the Czech Republic

1998
Restructuring of the establishment in the Czech Republic

2001
Reorganisation of the corporate strategy in terms of in-house production and cooperative production

2003
Foundation of the company GRW USA

2009
Relocation of administration to the new administrative building at the headquarters in Rimpar

2013
Construction of the new production site in the Czech Republic and opening of a new sales office on the East Coast of the USA

1942 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2013

Materials for rings and balls

Our ball bearings are manufactured by using technological advancements in steel production and heat treatment. Our ball bearings are made of chrome steel (100Cr6), stainless steel (X65Cr13), or high corrosion-resistant steel (X30CrMoN 15-1). It is now possible to achieve comparable load ratings for all these steel types.

Ceramic balls, e.g. hybrid ball bearings, can be used in all versions as required by your application.

Hybrid ball bearings

GRW hybrid, or ceramic, ball bearings are made of one of the steels mentioned above as well as silicon nitride (Si_3N_4) or zirconium oxide (ZrO_2), that offers specific benefits.

They are used most commonly in dental handpieces, spindle bearings and vacuum pumps to extend speed limits or increase bearing stiffness.

Using GRW Si_3N_4 ceramic balls reduces static load rating by 30%, while dynamic load rating remains unaffected.

The low affinity to other materials allows a particularly low adhesive wear. As a result, hybrid or ceramic bearings show an extended lifetime when used in mixed-friction applications.

Materials for rings and balls

Prefix	Unit	–	SS	SV	HY	ZO
DIN		100Cr6	X65Cr13	X30CrMoN 15-1	Si_3N_4	ZrO_2
DIN		1.3505	1.4037	1.4108		
SAE		52100				
Properties						
Density	[g/cm³]	7.81	7.7	7.7	3.2	6.0
Hardness	[HRC]	> 60	> 58	> 58	> 75	> 69
E module	[GPa]	212	220	223	320	200
Expansion coefficient	[x 10^{-6} °C]	11.0	10.5	10.4	3.0	10.5
Corrosion resistance	[–]	limited	good	very good	very good	good
Electrical conductivity	[–]	Conductor	Conductor	Conductor	Insulator	Insulator
Magnetism	[–]	magnetic	magnetic	magnetic	non magnetic [1]	non magnetic

[1] May contain magnetic parts for production technology reasons

Our sales engineers will gladly inform you about the chemical resistance of the materials.
Subject to change due to technical improvement.

Closures

Integrated ball bearing shields and seals provide two vital purposes: to prevent dirt and foreign particles from infiltration and to prevent lubricants from leaking out.

Non-contact shields

Together with the shoulder of the inner ring, the closure creates a narrow gap. Similar to open ball bearings, this closure neither increases running friction nor limits the maximum permissible speed because the shields do not touch the inner ring. This is sufficient for most applications. Shields prevent contamination with dirt particles but cannot achieve a hermetic seal.

Metal shields Z

For the majority of our bearings, shields are stamped from corrosion-resistant steel. They are fastened to the outer ring by means of a circlip and can thus be removed. Bearings can also be fitted with pressed-in shields made from a deep drawn steel sheet; these shields cannot be removed.

RZ/VZ non contact rubber shield

The RZ closure is made of synthetic buna N rubber with a steel support shield and can be used at temperatures from –30 °C to +120 °C.

The VZ closure is made of synthetic Viton fluoroelastomer with steel support shield and can be used at temperatures from –20 °C to +230 °C.

Both shield types are secured by snap fit.

Contact seals

This type of seal touches the shoulder of the inner ring, causing an increase in start up and running torque.

Teflon® seals can be used at working temperatures of –240 °C to +300 °C. The friction is lower than for rubber seals due to the low friction combination (PTFE/steel) and the low contact force of the sealing lip.

Teflon® seal TS

The TS seal is made of a glass-fiber reinforced Teflon® sheet that is fastened in the outer ring by means of a circlip.

TS seals are universally resistant to chemicals. Bearings using TS seals are normally made of corrosion-resistant steel. In appropriately large quantities, TS seals can also be made available for chrome steel bearings.

RS/VS seals

The RS seal is made of synthetic buna N rubber with a steel support shield and can be used at temperatures from –30 °C to +120 °C.

The VS seal is made of synthetic Viton fluoroelastomer with a steel support shield and can be used at temperatures from –20 °C to +230 °C.

Both seal types are secured by snap fit.

Custom Shields and Seals

GRW can also manufacture custom accessories and combinations of different shields and seals to meet your specifications.

For improved sealing effect between steel shields and outer ring GRW offers a special laminated shield.

In this context we would like to point out that certain lubricants cannot be used with all closures. Please consult our sales engineers about difficult applications.

Retainers for miniature ball bearings

Retainers are vital for efficient operation of ball bearings. They keep the balls separated and evenly spaced, ensuring a uniform distribution of load there by reducing heat thus enhancing the life expectancy of the bearing.

The retainer guides the balls in the load-free zone and prevents the balls from dropping out of separable bearings. Using our customised designs and materials, retainers can be manufactured to meet any application. We recommend usage of two-part ribbon retainer for the majority of applications.

In this context we would like to point out that certain lubricants cannot be used with all retainers.

See the following list for our range of different retainers:

GRW retainer designation	Illustration	Description/ material	Scope of application / purpose
E **J** **J1**		Two-piece retainer made from – steel sheet (E) – stainless steel sheet (J) – stainless steel sheet, Teflon®-laminated (J1)	Standard retainer for deep groove radial bearings. For stainless ball bearings: retainer always made from stainless steel sheet. To avoid torque peaks as far as possible, this retainer can also be mounted in a loosely closed condition.
		Retainer closing types: – without additional sign = standard – F = retainer tightly closed – L = retainer loosely closed	
JH		One-piece snap-type retainer made of stainless steel	For deep groove radial bearings. Used primarily for small ball bearings and low to medium speeds.
TNH		One-piece molded synthetic snap retainer	For deep groove radial bearings in medium speed range with good running and torque characteristics. Working temperature from –30°C to +80 °C, short term up to +100 °C.
TN9H		One-piece molded synthetic snap retainer made from glass fiber reinforced plastic	For deep groove radial bearings in a speed range above that of the TNH retainer. Working temperature from –30°C to +120 °C, short term up to +180 °C.
THA **THB**		Machined one-piece snap retainer made from fiber-reinforced phenolic resin. A = outer ring guided B = guided on inner ring	For deep groove radial bearings with very high speeds. High rigidity and emergency running properties. Working temperature from –50°C to +130°C. Can be impregnated with oil.
TXHA **TXHB**		Machined one-piece snap retainer made from a special material. X stands for a number and defines the material. A = outer ring guided B = guided on inner ring	For deep groove radial bearing with very high speeds. High rigidity and emergency running properties. Working temperature, depending on the material, up to +250°C or even +300°C.

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GRW retainer designation	Illustration	Description/ material	Scope of application / purpose
L1T **L2T**		L1T = outer ring separable, guided on inner ring L2T =inner ring separable, outer ring guided	For separable angular contact ball bearings/spindle ball bearings with highest speeds. High rigidity. Working temperature from –50 °C to +130 °C. Can be impregnated with oil.
L1TX **L2T**X		L1TX = outer ring separable, guided on inner ring L2TX = inner ring separable, outer ring guided X stands for a number and defines the material.	For separable angular contact ball bearings/spindle ball bearings with highest speeds. High rigidity and emergency running properties. Working temperature, depending on the material, up to +250 °C or even +300 °C.
TA/TB		Machined one-piece solid retainer made from fiber-reinforced phenolic resin. A = outer ring guided B = guided on inner ring Only together with AC types. Cannot be disassembled.	For angular contact ball bearings/ spindle ball bearings with highest speeds. High rigidity and emergency running properties. Working temperature from –50 °C to +130 °C. Can be impregnated with oil.
TXA/TXB **AC2TXA/TXB**		Machined one-piece solid retainer made from a special material. X stands for a number and defines the material. A = outer ring guided B = guided on inner ring Only together with AC types. Cannot be disassembled.	For angular contact ball bearings/ spindle ball bearings with highest speeds. High rigidity and emergency running properties. Working temperature, depending on the material, up to +250 °C or even +300 °C.
VAC1 **VAC2**		Full complement ball bearing, without retainer, cannot be disassembled. VAC1 = one shoulder relieved on outer ring VAC2 = one shoulder relieved on inner ring Outer ring or inner ring shoulder ground on one side.	Used for medium speeds, high radial loads and high axial loads in one direction.
VF		Full complement ball bearing, without retainer, cannot be disassembled, with filling slot for inserting the balls.	Used for medium speeds and high radial loads.

As not every retainer is available for all sizes of ball bearings, please contact us for additional information. On request, we will also gladly recommend other ball bearing and retainer designs as well as retainer materials for special requirements.

GRW offers some of the highest performance synthetic materials including **Vespel®, Torlon®, PEEK, PTFE** and **Meldin®** as well as various metallic materials and phenolic resins.

In addition to using proven materials, GRW, in close cooperation with its customers and suppliers, is constantly developing new options or enhancing existing variations. As a result, GRW is the sole owner of some exclusive licenses and patents for using specifically developed retainer materials such as **PAI-PTFE-cg**.

Lubricants

Why do bearings need lubricants?

Miniature ball bearings are perfect for high stress environments, but require special lubricants to minimise wear in order to increase operational life, performance, and safety of the product.

GRW lubricants provide permanent lubrication to minimise sliding friction between balls, rings and retainer. This prevents excessive wear and thermal overheating, protecting balls and raceway from micro-welding and thereby extending operational life while reducing running noise. The application determines the best type of lubrication to use.

Grease Lubrication

Thanks to its ability to dispense a lubricating film over time, grease lubricants offer an additional advantage when being used in maintenance-free applications.

Most of GRW bearings are grease-lubricated, with approximately 300 different greases to select from. The standard recommended amount of grease (lubricant quantity) is one-third (33%) of the remaining free space in the bearing. Grease quantities deviating from this standard are indicated in the bearing part number just before the type of lubricant, preferably in percent or alternatively in milligrams.

Furthermore, our customers can choose other special treatments for grease applications, for example a dispersion or a thin defined layer of grease. Here the designation system differentiates between DF (thin film), MF (medium film) and SF (strong film).

Oil lubrication

Oil is primarily used in applications where a minimal torque is required. In particular, high speed spindle bearings are typically lubricated with high performance oils.

When compared to grease lubrication, oil lubrication sometimes uses a dispersion of oil and a solvent achieving a better distribution of oil throughout the bearing.

With more than 100 special oils to choose from, GRW can help you to select the oil that perfectly matches your application. If no special lubrication is needed, all of our bearings whether open or shielded, are preserved with light instrument oil when they leave our factory.

Proper Lubrication Practices

At GRW all bearings are lubricated during final assembly under clean-room conditions. Since dust particles can cling to the oiled or greased bearings, it is important that the customer maintains a high standard of cleanliness in his application. In addition we recommend using a clean-room for removal of the bearings from their package and during assembly.

With greased bearings, the specified quantity of lubricant, accurate to milligrams, is injected directly into specified locations of the miniature ball bearing. Usually the lubricant is injected from only one side: however it is also possible to lubricate each bearing from both sides for better distribution.

For lubrication with standard oils, the oil is poured over the bearing which is then spun. Alternatively, a specified oil quantity can be directly injected into the bearing.

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Solid Lubricants

Non-lubricated bearings may be used in certain applications and are also available from GRW. These non-lubricated bearings are typically required for ultra-high vacuum (UHV) temperature extremes and for applications in aviation and aerospace. Here the operating conditions go beyond the functional limits of oil and grease lubricants. The use of a bearing without a protective lubricant will negatively impact its tribological system; however lubrication with solids is a viable alternative.

GRW offers its customers a variety of different dry film coatings. Applying thin layers of precious metals, graphite or Wolfratherm® (MoS_2) provides protection and lubrication for the bearing.

For oil or grease lubricated bearings, this process ensures reliable performance in case of lubricant deprivation (emergency running conditions). In GRW's part numbering system the surface treatment of bearing components is indicated by a "B", followed by a four-digit number code indicating the type of surface treatment.

Custom treatments

In addition to varying lubricants and surface treatments GRW can custom treat bearing components to improve tribological behaviour. For example, the phenolic retainer can be vacuum-impregnated with oil (up to 5% by weight).

The benefit of a vacuum-impregnated retainer is its ability to release small amounts of lubricant continually during operation. This process improves the general lubrication performance and ensures emergency running properties in lube deprived situations.

Lubricants in medical applications

Sterilisation (autoclaving) is mandatory for the correct use and maintenance of medical instruments according to the guidelines of the Robert-Koch Institute. This applies to the hygienic treatment of surgical devices and dental turbines that depend on miniature ball bearings.

GRW's stainless steel and retainer materials can easily withstand sterilisation in an autoclave subjected to superheated steam, where most lubricants do not survive. Combined with the extreme high speed stresses of dental turbines, these lubricants are required to provide exceptional surface adhesion and sterilisation resistance.

GRW bearings utilize a range of lubricants that are resistant to the sterilisation process. This makes them well suitable for dental and surgical devices and results in longer life under these extreme environmental conditions.

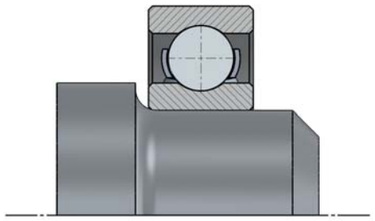
Shaft and housing shoulders

Certain design and assembly factors are critical for optimum performance of bearings. For instance, shaft and housing shoulders should accurately allow axial load to be transferred to the inner and outer ring without permitting the rings to tilt in opposite directions.

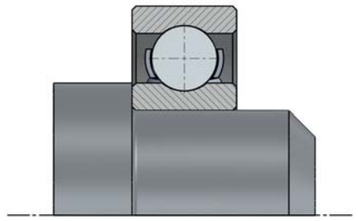
The associated dimension tables provide limits for the largest ($d_{a\ max}$) and the smallest ($d_{a\ min}$) permissible shoulder diameter for the inner ring and the largest permissible shoulder diameter for the outer ring ($D_{a\ max}$).

Please note the following considerations:

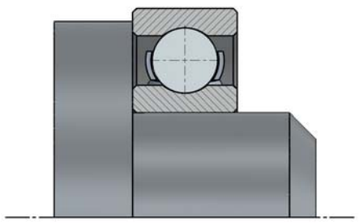
- The housing shoulder diameter for the outer ring must always be smaller than ($D_{a\ max}$) and the shaft shoulder diameter at the inner ring must not be smaller than ($d_{a\ min}$).
- The corner radius between fit and shoulder must not be larger than the corner clearance ($r_{s\ min}$) of the bearing. Here an undercut is preferable to a corner radius. The edge radii of the bearing are not designed as a locating surface for the bearing in any way.
- The axial runout of the mating surfaces should not be bigger than the maximum axial runout of the bearing used. Otherwise the function of the bearing will be compromised.



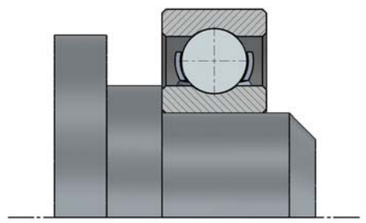
Wrong, Shaft radius bigger $r_{s\ min}$



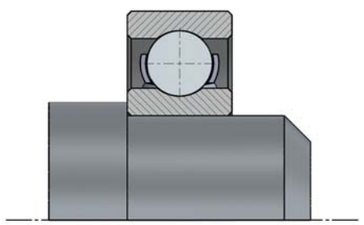
Right, Shaft radius smaller than $r_{s\ min}$



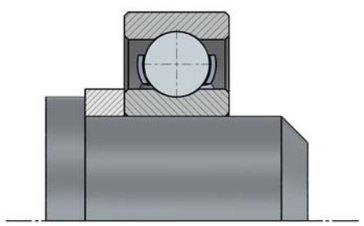
Wrong, Shaft collar bigger $d_{a\ max}$



Right, Shaft collar with shoulder



Wrong, Shaft collar smaller $d_{a\ min}$



Right, Support ring in place

Note: Similar examples apply to bearing housings.

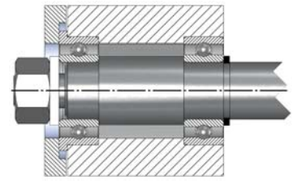
HIGH-PRECISION BALL BEARINGS

Special installation configurations

Flanged bearings

Using miniature and instrument bearings with a flange on the outer ring offers several advantages.

Stepped housing bores, which make it impossible or very difficult to maintain accurate alignment of both bearing fits, are no longer necessary. There is also no need for the use of circlips, which create manufacturing difficulties in small housing bores or thin-walled housings.

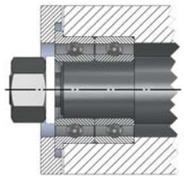


Proper installation, general

Flanged bearings assembled in narrow housings, such as gearboxes, are particularly effective and with paired bearings the use of a flanged bearing simplifies the correct assembly and alignment of the bearing.

Assembly in narrow housings

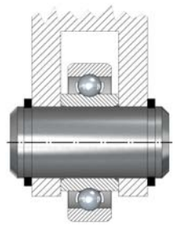
This allows the accurate axial positioning of the Duplex bearing pair.



Application of a Duplex bearing

Bearings with extended inner rings

Bearings with an extended inner ring simplify design and mounting of various assemblies. Shims, washers and other spacers are not necessary. Stepped shafts are also redundant.



Bearings with extended inner ring

Bearings with reinforced outer ring

Ball bearings whose outer rings are supported by a correct housing fit can face the highest loads. To increase the load capacity of a bearing which is not pressed into a housing, it takes advantage of a reinforced outer ring. These types of bearings can be used as "rollers".

Bearings with reinforced outer ring

Fitting tolerances

The fit of the bearing on the shaft and in the housing significantly affects the operational behavior of miniature ball bearings. When selecting fitting tolerances the following criteria should be considered:

Rotation conditions

Rings with circumferential load should have a tighter fit than rings with point load.

Circumferential load occurs when the ring is rotating and the load is static, or when the ring is static and the load is rotating.

Point load occurs when ring and load are both static, or when ring and load are both rotating in the same direction with equal speed. Please refer to the table "Shaft and housing fits by load type".

Running accuracy

The same high standards of accuracy and surface quality applicable to the bearings must be applied to the shaft and housing bore; refer to the overview "Accuracy of parts".

Loading

Higher loads require a tighter fit between the ball bearing, shaft and housing.

Temperature

There may be temperature differences between the bearing and mating components while the bearing is in operation, therefore dimensional changes caused by differential thermal expansion should be considered when selecting a bearing.

With miniature bearings it is very important to select the proper fit for the highest accuracy and reliability, hence only a close sliding or transition fit is generally required. All irregularities on the shaft or in the housing bore are directly transferred to the relatively thin(-walled) bearing rings.

To improve the fit it is possible to classify and sort the bore and outside diameters into groups (also refer to the chapter "Grading of bore and outside diameters"). The values shown in these tables "Shaft tolerances" and "Housing tolerances" are only valid for materials with the same expansion coefficient (11 x 10^{-6} 1/K). For different expansion coefficients, or when there are temperature differences between the bearing rings and the shaft or housing, a tolerance should be selected which ensures the appropriate fit at operating temperature.

Note: For certain environmental conditions an adhesive may be used to secure the bearing rings. Please contact our sales engineers for additional information.

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Recommended fittings

The recommended fits listed below assume mean tolerances obtained from performance test data.

Shaft tolerances

Ball bearing bore Quality → **Tolerance in µm** Tolerance in .0001 inch → Operating conditions	P0 **0/–8** 0/–3	P5 **0/–5** 0/–2	Grading **0/–2.5** 0/–1	 **–2.5/–5** –1/–2	Type of fit
Low load Medium speeds No oscillations	**–5/–13** –2/–5	**–5/–11** –2/–4	**–5/–8** –2/–3	**–8/–11** –3/–4	Slide fit
Low to medium loads Medium speeds Low oscillations	**0/–8** 0/–3	**0/–6** 0/–2.5	**0/–3** 0/–1.2	**–3/–6** –1.2/–2.5	Tight fit
High loads High speeds Oscillations at high frequency	**+4/–4** +1.6/–1.6	**+4/–2** +1.6/–1	**+4/+1** +1.6/+.4	**+1/–2** +.4/–1	Press fit

Subject to change due to technical improvement.

Housing tolerances

Ball bearing bore Quality → **Tolerance in µm** Tolerance in .0001 inch → Operating conditions	P0 **0/–8** 0/–3	P5 **0/–5** 0/–2	Grading **0/–2.5** 0/–1	 **–2.5/–5** –1/–2	Type of fit
Low load Medium speeds No oscillations	**+5/–3** +2/–1.2	**+5/–1** +2/–.4	**+5/+2** +2/+1	**+2/–1** +1/–.4	Slide fit
Low to medium loads Medium speeds Low oscillations	**0/–8** 0/–3	**0/–6** 0/–2.5	**0/–3** 0/–1.2	**–3/–6** –1.2/–2.5	Tight fit
High loads High speeds Oscillations at high frequency	**–4/–12** –1.6/–5	**–3/–9** –1.2/–3.5	**–3/–6** –1.2/–2.5	**–6/–9** –2.5/–3.5	Press fit

Subject to change due to technical improvement.

Note:

The information on this page applies to steel shafts and housings. If applicable, linear expansion coefficients of other materials (e.g. aluminium housings) must be taken into consideration for other operating temperatures.

For more information on grading, refer to the chapter "Grading of bore and outside diameters".

Load ratings and L-10 life

The static radial load rating C_{0r}

The basic static radial load rating (C_{0r}) applies to bearings which rotate at very slow speeds, which are subjected to slow oscillations or are stationary under load. Per DIN ISO 76, the basic static radial load rating is the static radial load corresponding to a calculated contact stress of 4200 N/mm² at the center of the contact ellipse of the most heavily loaded ball or raceway.

If the contact pressure exceeds this maximum permissible value, plastic deformation will occur affecting an efficient operation and the life of the bearing. The basic static radial load rating is the maximum allowable radial load for the bearing.

The basic static radial load rating for hybrid bearings with Si_3N_4 balls will be approximately 30 % lower than for steel ball bearings.

Static bearing capacity

Static loads including radial and axial components must be converted into the static equivalent radial load (P_r). The static bearing load capacity (P_r) is the static radial load which causes the same contact stress at the center of the contact ellipse of the most heavily loaded ball or raceway which occurs under actual load conditions. It is defined as follows:

$$P_r = X \cdot F_r + Y \cdot F_a$$

P_r : Static equivalent radial load [N]
X : 0.6
Y : 0.5
F_r : Biggest radial load occurring [N]
F_a : Biggest axial load occurring [N]
Where: $P_r = F_r$ if $P_r < F_r$

Basic dynamic radial load rating C_r

According to DIN ISO 281, the basic dynamic load rating (C_r) for radial ball bearings is the constant radial load at which a sufficiently large group of apparently identical bearings can endure one million revolutions before showing evidence of material fatigue.

Fatigue load limit C_u

The fatigue load limit (C_u) is defined as the radial load below which no material fatigue will occur. For ball bearings manufactured with commonly used high-quality materials, the fatigue load limit is reached at a contact stress of approx. 1500 N/mm².

The load ratings calculated in this Product Catalogue have been computed using a curvature of 52–53 % according to DIN ISO 281. Depending on the bearing geometries, the actual load ratings may differ.

Nominal life L_{10}

The "nominal life" (L_{10}) of a group of apparently identical ball bearings is the life in millions of revolutions, or number of hours, that 90 percent of the group will complete or exceed before the first evidence of material fatigue occurs. For a single bearing, (L_{10}) also refers to the life associated with 90 percent reliability.

This calculation per ISO DIN 281 assumes identical operating conditions including a constant lubrication film separating the ball complement from the raceway during the entire life of the bearing.

The L-10 life of miniature ball bearings is calculated as follows:

$$L_{10} = \left(\frac{C_r}{P_r}\right)^3$$

L_{10} : basic rating life for a reliability of 90 % [10^6 revolutions]
C_r : basic dynamic radial load rating [N]
P_r : dynamic equivalent radial load fatigue occurs.

Taking a constant speed for granted, the number of revolutions can also be expressed as L-10 life in hours (L_{10h}):

$$L_{10h} = \frac{10^6}{60 \cdot n} \cdot \left(\frac{C_r}{P_r}\right)^3$$

with

L_{10h}: basic rating life [h]
n : speed of the inner ring [min^{-1}]
C_r : basic dynamic radial load rating [N]
P_r : dynamic equivalent radial load [N]

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Extended modified rating life L_{nm}

In addition to the nominal life rating (L_{10}), DIN ISO 281 introduced an extended modified life rating (L_{nm}) and adds a life coefficient (a_1) as well as operating conditions (a_{ISO}). In application, life rating may be considerably higher or lower than the nominal L-10 life (L_{10}). The following correlation applies:

$$L_{nm} = a_1 \cdot a_{ISO} \cdot L_{10}$$

L_{nm} : extended modified rating life [10^6 revolutions]
a_1 : Rating life coefficient for a requisite reliability deviating from 90 %
a_{iso} : Rating life coefficient for consideration of operating conditions
L_{10} : basic rating life for a reliability of 90 % [10^6 revolutions]

Rating life coefficient for Reliability a_1 acc. DIN ISO 281

Reliability %	L_{nm}	a_1
90	L_{10m}	1
95	L_{5m}	0.64
96	L_{4m}	0.55
98	L_{3m}	0.47
98	L_{2m}	0.37
99	L_{1m}	0.25
99.2	$L_{0.8m}$	0.22
99.4	$L_{0.6m}$	0.19
99.6	$L_{0.4m}$	0.16
99.8	$L_{0.2m}$	0.12
99.9	$L_{0.1m}$	0.093
99.92	$L_{0.08m}$	0.087
99.94	$L_{0.06m}$	0.080
99.95	$L_{0.05m}$	0.077

The standardised calculation method for the life rating coefficient (a_{ISO}) takes the following factors into account:

- load on the bearing
- lubrication condition
- fatigue limit of the material
- geometry of the bearing
- internal stress of the bearing
- environmental conditions

Significance of the life rating for miniature ball bearings

All standardised methods for calculating the L-10 life assume that failure is attributable to material fatigue, this type of failure occurs very rarely in miniature ball bearings. Most miniature ball bearing malfunctions are usually attributed to contamination, retainer wear or lubricant failure. Therefore L-10 life is theoretical and merely a guide. When estimating the L-10 life of a miniature ball bearing, the exact environmental conditions of the application should be considered.

Limiting speeds

Various mechanical and kinematic factors impact the maximum operational speed of a bearing. The following factors can have an effect on the limiting speed:

- Retainer load
- Noise
- Rolling kinematics
- Lubrication
- Heat generated by friction and the environment
- Inner ring slippage and radial play reduction

Retainer loading

In miniature bearings the speed limitation can be determined among other factors by the retainer material and its design.

Practical experience has shown that machined synthetic retainers are better qualified for highest speeds. These retainers generate less imbalance at high speed because of their low mass and extreme accuracy by which they are manufactured. They are characterised by higher density and elasticity enabling them to face alternating forces generated from ball acceleration and deceleration.

With more than 40 different retainer materials, our product range offers an appropriate technical solution for nearly every application.

Heat

All bearing assemblies have a maximum operating temperature, which ultimately limits the bearing speed. This maximum temperature is not only defined by the bearings mechanical components but also by the temperature range of the lubricant. In general, the operating temperature achieved at a certain speed depends on the torque generated in the bearing and the assembly's ability to transfer heat to the environment.

This assumption is the basis for calculating the thermal reference speed as noted in DIN ISO 15312.

Thermal reference speed

The thermal reference speed (n_r) defines the speed of the inner ring at which a balance is achieved between the heat generated in the bearing by torque and the heat flow dissipated through shaft and housing.

For the standardised calculation method noted in DIN ISO 15312, the following conditions apply:

- Mean ambient temperature ϑ_{Ar} = +20 °C
- Static temperature at the outer ring ϑ_r = +70 °C
- Standard bearings without seals
- 5 % of the static load rating as pure radial load
- Lubricant: mineral oil with a kinematic viscosity of ν_r= 12 mm²/s at ϑ_r = +70 °C

Significance of the thermal reference speed

The calculation of the thermal reference speed is too general and does not take into consideration application specific conditions. As such the thermal reference speed is to be used merely as guideline value allowing for direct comparison of the different bearing sizes.

Significantly higher speeds can be achieved with special modifications of the components surrounding the bearing and of the bearing itself.

By using Si_3N_4 (ceramic) balls, a highly accurate synthetic retainer, a higher bearing tolerance grade and a high-performance lubricant, significantly higher speeds can be achieved.

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Elastic behaviour of deep groove radial bearings

With ball bearings two types of deformation have to be distinguished: axial and radial elastic deformation.

Axial elastic deformation

The axial elastic deformation of a ball bearing is the distance that the inner ring moves axially relative to the outer ring when the axial clearance of the ball bearing has been removed and an increasing axial load has been applied. This value does not increase linearly with increasing axial load; rather the contact ellipses between balls and raceways become larger as the load increases.

Radial elastic deformation

The radial elastic deformation is caused by a radial load component after radial clearance has been removed. Under otherwise identical conditions, with a small contact angle, the radial elastic deformation is considerably less than the axial elastic deformation. With increasing contact angle, the radial yield increases while the axial yield decreases until both values become roughly identical at approximately 35°.

Both types of deformation depend on the internal geometries of bearing, existing radial clearance and applied load.

Effect and application

A relatively large amount of yield can be reduced by using preloaded bearing pairs (see chapter "Duplexed bearings"). Preloading will result not only in a reduction of the elastic yield, resulting in increased stiffness, but also in a nearly linear relationship between loading and yield for a considerably wide range of applied loads.

For example: A ball bearing pair with a 10 N preload will maintain linearity up to approximately 30 N of applied axial load. Exceeding this load value will cause the balls to lose contact with the raceway transferring the load to one bearing.

The following formula provides an estimation of the axial preload:

$$Fv \approx Fa / 3$$

Fv : axial preload [N]

Fa : axial bearing load [N]

With a contact angle of 15° (C) the radial stiffness of bearing pairs is assumed to be approximately six times as high as the axial stiffness. With a contact angle of 25° (E) a factor of 2 is assumed.

Specific material properties always play an important role. In hybrid bearings using ceramic balls (e.g. Si_3N_4, ZrO_2) the material properties of the ceramic balls should be minded. Due to the lower elasticity of the ceramic material these bearings are stiffer than bearings assembled with steel balls. The stiffness of bearings using balls made of Si_3N_4 is about 30% higher than stiffness of bearings using steel balls.

Specific applications must consider the operating temperature which can affect the bearing clearances. Likewise, differing thermal expansion coefficients may play a decisive role in bearing material selection.

For further information, please contact your nearest GRW Sales Representative.

Relationship between radial play, axial play, contact angle and tilting angle

Radial play

Radial play has a minimal effect on the quality of a bearing; however, it does have a significant effect on its performance. For example, the bearing´s life rating, running noise, vibrations and thermal behavior all depend on the appropriate radial play. (See chapter: “Reduction in radial play”)

Radial play is the measurement of the total movement of one ring relative to the other in a plane perpendicular to the bearing axis. In selecting the appropriate radial play the fit of the bearing on the shaft and in the housing is of particular importance.

Larger than standard radial play (4 – 11 µm) should be selected if the ball bearing runs under axial preload and operates at high speeds, or if low torque is required.

Less than standard radial play should be specified if a radial load is applied or low noise is required.

Less than normal radial play is often specified to reduce the axial play in the application. When a very low axial play is required we recommend using duplexed bearings (see the chapter “Duplexed bearings”).

In deep groove bearings there is a definite correlation between radial and axial play that is controlled by the internal geometries. For the individual radial play groupings and their respective references, refer to the chapter on “Radial play classification”.

Axial play

The axial play is the measured value in which one bearing ring can move axially in relation to the other with no applied load.

Contact angle

In a load-free condition, the contact angle is called the ‘nominal contact angle’. The contact angle is the angle between a plane perpendicular to the ball bearing axis and a line joining the two points where the ball makes contact with the inner and outer raceways. The contact angle of a ball bearing is determined by its radial play, as well as its inner and outer track curvatures.

The contact angle under load is called the ‘operating contact angle’. Deformations of a defined size occur at the contact points between balls and raceways. The deep groove radial bearing is a relatively rigid bearing with a very small contact angle range. Here a highly accurate bearing alignment is of the utmost importance.

Tilting angle

The tilting angle of a bearing is the relative angle to which the inner and outer rings of a bearing can be tilted. The amount of tilting depends on the radial play and the internal geometries of the bearing.

Tilting of the rings should generally be avoided. Even small tilt angles of 2° or 3° may result in increased bearing noise and reduced life. It is critical to place close attention to machining tolerances of mating assembly components to assure proper bearing alignment.

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Calibration of bore and outside diameters

To guarantee a uniform fit of bearings on the shaft and in the housing, it is necessary to control diameter tolerances of the bearings. It is very difficult to control very small tolerances in a production run; therefore, sorting of the rings may be necessary. Only bearings in quality grades P5 and ABEC5 or better can be sorted into groups of 2.5 µm (.0001 inch) or 1.25 µm (.00005 inch). The diameters of shaft and housing must also be accurately measured and sorted to match.

For technical reasons it is not possible to supply bearings in only one specific tolerance group. This means that grading to X4, only 3 of 4 possible groups can be contained in the shipment lot, i.e. the final group distribution is subject to production machining variances.

The following symbols are used for the classification of graded ball bearings:

Classification of graded bearings

Grading	in classes of 2.5 µm or .0001 inch	in classes of 1.25 µm or .00005 inch	in classes of 1 µm or .00004 inch
Bore d and outside diam D	X	X4	X5
Bore d only	XB	X4B	X5B
Outside diam D only	XD	X4D	X5D

Example:
SS624 P5 GPR X4B J L001
X4B = bore graded in 4 groups of 1.25 µm.
The outside diameter is not graded.

Key to tolerance groups

				Outside diameter D												
	Tolerance field in **0.001 mm**			0/-2.5	-2.5/-5	0/-1.25	-1.25/-2.5	-2.5/-3.75	-3.75/-5	0/-1	-1/-2	-2/-3	-3/-4	-4/-5	not graded	
		Tolerance field in		0/-1	-1/-2	0/-.5	-.5/-1	-1/-1.5	-1.5/-2	0/-.4	-.4/-.8	-.8/-1.2	-1.2/-1.6	-1.6/-2		
		.0001 inch	Code	1	2	A	B	C	D	E	F	G	H	I		
Bore d	**0/-2.5**	**0/-1**	1	11	12										10	XB
	-2.5/-5	**-1/-2**	2	21	22										20	
	0/-1.25	**0/-.5**	A			AA	AB	AC	AD						A0	X4B
	-1.25/-2.5	**-.5/-1**	B			BA	BB	BC	BD						B0	
	-2.5/-3.75	**-1/-1.5**	C			CA	CB	CC	CD						C0	
	-3.75/-5	**-1.5/-2**	D			DA	DB	DC	DD						D0	
	0/-1	**0/-.4**	E							EE	EF	EG	EH	EI	E0	X5B
	-1/-2	**-.4/-.8**	F							FE	FF	FG	FH	FI	F0	
	-2/-3	**-.8/-1.2**	G							GE	GF	GG	GH	GI	G0	
	-3/-4	**-1.2/-1.6**	H							HE	HF	HG	HH	HI	H0	
	-4/-5	**-1.6/-2**	I							IE	IF	IG	IH	II	I0	
	not graded			01	02	0A	0B	0C	0D	0E	0F	0G	0H	0I	no Symbol	
				XD		X4D				X5D						

Different tolerance groups are defined by grading. On the package of the ball bearing, the relevant group is indicated by means of the following code:

Examples:

Code 21:
Bore-Ø –2.5/–5 µm
Outside-Ø 0/–2.5 µm

Code BC:
Bore-Ø –1.25/–2.5 µm
Outside-Ø –2.5/–3.75 µm

Code A0:
Bore-Ø 0/–1.25 µm
Outside-Ø not graded

Code 02:
Bore-Ø not graded
Outside-Ø –2.5/–5 µm

Method of group classification:

Bore diameter: The smallest measured diameter defines the class.

Outer diameter: The largest measured diameter defines the class.

Reduction in radial play

Ball bearing radial play can increase or decrease during operation due to external influences.

Increases in radial play can cause an increase in contact angle, which distorts the contact ellipse at the transition between raceway and shoulder. This "excessive edge loading" phenomenon may cause premature bearing failure.

In the worst case a reduction in radial play may cause excessive radial preloading of the bearing causing accelerated bearing wear and premature bearing failure.

The following factors have a direct influence on changes in radial play:

- Temperature gradients within the bearing or materials with different temperature coefficients.
- Shaft and housing fits.
- Speed related Centrifugal forces.

Reduction in radial play due to thermal expansion

Bearing clearances are set at an ambient temperature of +20 °C which excludes external loads except measuring loads. Frictional heat generation or temperature differentiation between inner and outer ring can very often cause unfavourable environments. The resulting differential expansions of inner ring and outer ring change the radial play. This factor has to be considered when designing the bearing.

$$\Delta S_{RT} \approx \Delta d_a - \Delta d_i - 2\Delta Dw$$

ΔS_{RT} : Change in radial play due to thermal expansion [µm]

Δd_a : Change in outer raceway diameter for temperature T [µm]

Δd_i : Change in inner raceway diameter for temperature T [µm]

ΔDw: Change in ball diameter for temperature T [µm]

The resultant diameter change caused by the temperature difference is to be calculated. (Reference: ambient temperature +20 °C):

For the outer ring: $\Delta d_a = d_{a0} \cdot \alpha \cdot \Delta T$

For the inner ring: $\Delta d_i = d_{i0} \cdot \alpha \cdot \Delta T$

For the balls: $\Delta Dw = Dw \cdot \alpha \cdot \Delta T$

d_{a0} : Raceway diameter of outer ring at +20 °C [mm]

d_{i0} : Raceway diameter of inner ring at +20 °C [mm]

Dw : Ball diameter at +20 °C [mm]

α : Linear expansion coefficient [K^{-1}] for
100Cr6 ... 11 · 10^{-6}
X65Cr13 ... 10.8 · 10^{-6}
X30CrMoN15-1 ... 10.8 · 10^{-6}
Si_3N_4 ... 3.2 · 10^{-6}
ZrO_2 ... 10.0 · 10^{-6}

ΔT : Temperature difference between temperature T and ambient temperature of +20 °C in [K]

Reduction in radial play due to interference fit

Interference fits cause a reduction in radial play and so the fitting tolerances should be chosen carefully. The reduction in radial play depends on the effective interference fit and the ring thickness ratio. These ratios can be calculated as follows:

$$\Delta S_{RÜ} \approx k \cdot ü$$

$\Delta S_{RÜ}$: Reduction in radial clearance due to interference fit [µm]

k : Factor given in the table on the next page, taking for granted that inner ring is pressed onto a complete shaft or outer ring is pressed into a stable, non-deformable housing.

ü : Largest interference fit [µm]

If interference fits are used on the shaft and on the housing, the total reduction in radial play is determined by adding both values.

k-factor for inner ring (IR) and outer ring (OR)

metric

Basic symbols	IR	AR	Basic symbols	IR	AR	Basic symbols	IR	AR
68/1,5/0003	0.4	0.8	694	0.7	0.8	699	0.7	0.8
681	0.6	0.8	604	0.6	0.8	609	0.7	0.8
691	0.5	0.8	624	0.6	0.8	629	0.6	0.8
68/1,5/0001	0.5	0.8	**634***	**0.5**	**0.8**	6800	0.8	0.9
68/1,5	0.8	0.8	675	0.9	0.9	6900	0.8	0.9
69/1,5	0.5	0.8	675/004	0.9	0.9	6000	0.7	0.8
682	0.7	0.8	694/1002	0.9	0.8	6901	0.8	0.9
682/005	0.7	0.8	685	0.8	0.8	6001	0.7	0.9
692/003	0.6	0.8	685/003	0.8	0.8	6001/003	0.7	0.9
692	0.6	0.8	695	0.7	0.8	6802	0.9	0.9
693/0001	0.5	0.9	605	0.6	0.8	6902	0.8	0.9
67/2,35	0.8	0.8	625	0.6	0.8	6002	0.8	0.9
68/2,35	0.8	0.9	635	0.5	0.8	6803	0.9	0.9
67/2,5	0.8	0.9	676/003	0.9	0.9	6903	0.8	0.9
68/2,5	0.7	0.9	695/1202	0.8	0.9	6003	0.8	0.9
69/2,5	0.6	0.9	686	0.8	0.9	6804	0.9	0.9
683/0001	0.6	0.9	696	0.7	0.8	6904	0.8	0.9
60/2,5	0.6	0.8	625/0002	0.7	0.8	6805	0.9	0.9
673	0.8	0.9	626	0.6	0.8			
683	0.8	0.9	688A/1322	0.8	0.9			
683/003	0.8	0.9	687	0.8	0.9			
693/003	0.7	0.9	697	0.7	0.8			
693	0.7	0.9	607	0.7	0.8			
683/8	0.8	0.8	627	0.6	0.8			
623	0.6	0.8	688A/142	0.9	0.8			
623/13	0.6	0.6	688	0.8	0.9			
633	0.5	0.8	688/003	0.8	0.9			
674	0.9	0.9	698	0.7	0.8			
684	0.8	0.9	608	0.7	0.8			
684/103	0.8	0.8	689	0.8	0.9			
684/10	0.8	0.8	689/003	0.8	0.9			

inch

Basic symbols	IR	AR
1016	0.7	0.8
1191	0.6	0.8
1397	0.6	0.8
5/64	0.6	0.8
2380	0.8	0.9
3/32	0.5	0.9
3175/0002	0.6	0.9
3175	0.8	0.9
1/8A	0.7	0.9
3175/6	0.8	0.6
1/8A/6	0.7	0.7
1/8B	0.6	0.9
3175/55	0.8	0.5
3175/6	0.8	0.6
3175/8	0.8	0.4
1/8B/083	0.6	0.6
3967	0.7	0.9
4763A	0.9	0.9
4763B	0.8	0.9
4763A/082	0.9	0.6
4763B/083	0.8	0.7
3/16	0.7	0.9
6350A	0.9	0.9
6350B	0.8	0.9
1/4A	0.7	0.8
1/4	0.6	0.8
7938	0.9	0.9
3/8	0.7	0.8
12700B	0.9	0.9
1/2	0.7	0.8
1/2/001	0.7	0.8

Subject to change due to technical improvement.

* For a detailed example, refer to page 22.

Reduction in radial play

Reduction in radial play due to centrifugal forces

At very high shaft speeds or inner ring rotation the centrifugal forces of the rotating parts increase. The load on the outer ring and the balls also increases and the inner ring expands. The expansion of the inner ring changes the fit of the shaft and bearing. The bearing may begin to slip on the shaft. In this situation, a tighter fit must be selected.

These types of deformations depend on bearing size, retainer, balls, materials used and inner geometry of the bearing.

Please contact our sales engineers to find out more about the reduction in radial play due to centrifugal forces.

Example:

The ball bearing SS634-2Z GPR J (d = 4 mm, D = 16 mm, Dw = 2.50 mm, material of rings and balls: X65Cr13) is to run in an application at 35,000 1/min. During the operating phase the temperature at the inner ring is +60 °C and at the outer ring +30 °C. The ball bearing is mounted on the shaft with a press fit j5 (+3/–2) and in the housing with a tight fit K5 (+2/–6).

Change in radial clearance due to thermal expansion:

Outer ring:

$d_{a0} \approx (d+D)/2 + Dw = (4+16)\,mm/2+2.50\,mm = 12.50\,mm$

$\Delta d_a \approx d_{a0} \cdot \alpha \cdot \Delta T = 12.50mm \cdot 10.8 \cdot 10^{-6}\,1/K \cdot 10\,K = 1.35\,\mu m$

Inner ring:

$d_{i0} \approx (d+D)/2 - Dw = (4+16)\,mm/2-2.50\,mm = 7.50\,mm$

$\Delta d_i \approx d_{i0} \cdot \alpha \cdot \Delta T = 7.50\,mm \cdot 10.8 \cdot 10^{-6}\,1/K \cdot 40\,K = 3.24\,\mu m$

Ball:

$Dw = 2.50\,mm$

$\Delta Dw \approx Dw \cdot \alpha \cdot \Delta T = 2.50\,mm \cdot 10.8 \cdot 10^{-6}\,1/K \cdot (10+40)\,K/2 \approx 0.68\,\mu m$

Change in radial clearance due to thermal expansion:

$\Delta S_{RT} \approx \Delta d_a - d_{i0} - 2\Delta Dw$

$\Delta S_{RT} \approx (1.35 - 3.24 - 2 \cdot 0.68)\,\mu m = -3.25\,\mu m$

The radial clearance is reduced due to the temperature difference between inner ring and outer ring by 3.25 µm.

Change in radial clearance due to interference fit:

Outer ring:

Outside diameter: 0/–8 µm

Housing diameter: +2/–6 µm

$\rightarrow ü = 6\,\mu m$

$\Delta S_{RÜa} \approx k \cdot ü$

$\Delta S_{RÜa} \approx 0.8 \cdot 6\,\mu m = 4.8\,\mu m$

Inner ring:

Bore: 0/–8 µm

Shaft: +3/–2 µm

$\rightarrow ü = 11\,\mu m$

$\Delta S_{RÜi} \approx k \cdot ü$

$\Delta S_{RÜi} \approx 0.5 \cdot 11\,\mu m = 5.5\,\mu m$

The radial clearance changes due to the interference fit by 4.8 µm + 5.5 µm = 10.3 µm

Total change of radial clearance due to thermal expansion and interference fit:

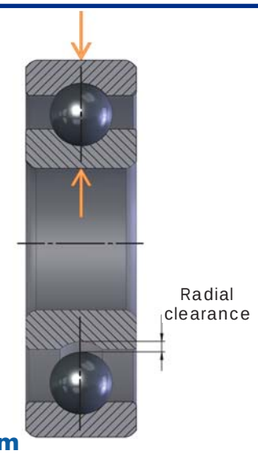
$\Delta S_R = \Delta S_{RT} + \Delta S_{RÜ}\,[\mu m]$

$\Delta S_R = 3.25\,\mu m + 10.3\,\mu m = 13.55\,\mu m$

This total reduction in radial clearance must be considered when selecting the radial clearance of the bearing.

HIGH-PRECISION BALL BEARINGS

Radial play classification



Radial bearing clearance for deep groove radial bearing

d	max 6 mm
C2	0 to 6 µm
CN	4 to 11 µm
C3	10 to 20 µm
C4	14 to 20 µm
C5	18 to 28 µm

d	more than 6 to 10 mm
C2	0 to 6 µm
CN	4 to 11 µm
C3	10 to 20 µm
C4	14 to 29 µm
C5	20 to 37 µm

d	more than 10 to 18 mm
C2	0 to 9 µm
CN	3 to 18 µm
C3	11 to 25 µm
C4	18 to 33 µm
C5	25 to 45 µm

d	more than 18 to 24 mm
C2	0 to 10 µm
CN	5 to 20 µm
C3	13 to 28 µm
C4	20 to 36 µm
C5	28 to 48 µm

d	more than 24 to 30 mm
C2	1 to 11 µm
CN	5 to 20 µm
C3	13 to 28 µm
C4	23 to 41 µm
C5	30 to 53 µm

d	more than 30 to 40 mm
C2	1 to 11 µm
CN	6 to 20 µm
C3	15 to 33 µm
C4	28 to 46 µm
C5	40 to 64 µm

d	more than 40 to 50 mm
C2	1 to 11 µm
CN	6 to 23 µm
C3	18 to 36 µm
C4	30 to 51 µm
C5	45 to 73 µm

The regular radial clearance is not indicated in the ball bearing numbering system.

Deviating radial clearance data metric system

C1/5	1 to 5 µm
C4/8	4 to 8 µm
C7/11	7 to 11 µm
C10/15	10 to 15 µm

Deviating radial clearance data inch system

K02	0″ to .0002″
K13	.0001″ to .0003″
K24	.0002″ to .0004″
K35	.0003″ to .0005″
K46	.0004″ to .0006″
K58	.0005″ to .0008″

The functional tests

There are different functional testings that can be performed by GRW. As a standard 100 % of our ball bearings are noise tested. The following tests are also available: axial vibration test, torque test, preload measurement.

These tests ensure the uniformity of the production run and compliance with customer requirements. All functional tests carried out by GRW take place in a class 10,000 clean room (ISO 14644-1).

The functional test method is always selected to simulate the intended use of the bearing.

Noise test GPR

In the GRW numbering system GPR designates 100% noise testing. Using highly sensitive noise testing equipment, the amplitude of the vibrations generated by the miniature bearings is measured at specified speed and frequencies. This method detects imperfections, such as ball or raceway failures and isolates their root cause.

The noise test is carried out in a class 10,000 clean room in accordance with ISO 14644-1. A Standard reference oil is used to eliminate the variable effects of different lubricants.

Axial vibration test GPA

GPA stands for noise testing in the axial direction. Similar to the GPR test, the axial vibrations measured by the GPA vibration meter identify the shape and surface properties of raceways and balls in the bearings.

GPA testing measures vibration noise in four distinct frequency ranges as compared to two frequency ranges for the GPR test. The amount of movement or 'peak to peak displacement' value is also recorded. The cumulative total of these distinct measurements provides a direct understanding of the ball bearing's running behaviour.

As with the GPR test, standard reference oil is used to eliminate the variable effects of different lubricants.

The GPA test is offered at an additional charge. If you require any further information, please contact a GRW sales representative.

Torque test

GRW uses different methods to measure starting and dynamic torque. The Asch testing device due to MIL-STD-206 provides very exact and reliable starting torque values. During this test the outer ring is driven and the inner ring is loaded relative to each bearing size. The standard axial loading of the inner ring is 75 g for ball bearings with an outer diameter of up to 10 mm. Ball bearings with a larger outer diameter (> 10 mm) are loaded with 400 g.

Since there is no universally accepted standard for torque measurement, the torques of identical bearings can only be compared if they have been measured under the same measuring conditions with the same measuring devices.

Table "Maximum starting torque in µNm" shows reference values for the maximum starting torque. These values apply for instrument ball bearings without seals, P5 or ABEC5 or better, which are lubricated with instrument oil having a low viscosity ≤ 14 mm^2/s at +40 °C. The values can be 10 to 40 times higher for ball bearings with grease lubrication.

Running or dynamic torque is the force required to keep a bearing in rotation. A special dynamic torque tester developed by GRW for this very purpose is available on request to measure the running torque at higher speeds.

Maximum starting torque in µNm

Basic symbols	Torque in [µNm]	Load in [g]	Basic symbols	Torque in [µNm]	Load in [g]	Basic symbols	Torque in [µNm]	Load in [g]
681	15	75	**695**	69	400	**1016**	15	75
691	15	75	**605**	69	400	**1191**	15	75
68/1,5	15	75	**625**	69	400	**1397**	15	75
69/1,5	15	75	**635**	76	400	**5/64**	15	75
682	15	75	**686**	69	400	**2380**	15	75
692	15	75	**696**	69	400	**3/32**	15	75
67/2,35	15	75	**626**	76	400	**3175**	15	75
68/2,35	15	75	**687**	69	400	**1/8A**	15	75
68/2,5	15	75	**697**	76	400	**1/8B**	16	75
69/2,5	15	75	**607**	76	400	**3967**	15	75
60/2,5	16	75	**627**	80	400	**4763A**	15	75
673	16	75	**688A**	52	400	**4763B**	16	75
683	16	75	**688**	76	400	**3/16**	52	400
693	16	75	**698**	76	400	**6350A**	15	75
623	16	75	**608**	80	400	**6350B**	52	400
674	16	75	**689**	76	400	**1/4A**	60	400
684	16	75	**699**	80	400	**1/4**	70	400
694	65	400	**609**	80	400	**7938**	52	400
604	65	400	**629**	100	400	**3/8**	95	400
624	69	400	**6800**	80	400			
634	69	400	**6900**	95	400			
675	65	400	**6000**	100	400			
685	65	400						

Comparison of measuring units

	1 µNm =	1 cmp =	1 oz.in. =	1 cNcm =
µNm	1	100	7200	100
cmp	0.01	1	72	1
oz.in.	0.000139	0.0139	1	0.0139
cNcm	0.01	1	72	1

Assembly of low-torque ball bearings

Shaft and housing fits and tolerances for low-torque bearings are particularly important. Shaft and housing tolerances need to be selected so that they result in a sliding fit. Please refer to the chapters "Fitting Tolerances" and, "Reduction in radial play".

Even a small misalignment of the inner or outer ring can result in increased bearing torque. Particular attention must be given to the exact alignment between shaft and housing bore as well as to the parallelism of the mating faces.

Extreme cleanliness of parts and assembly area is essential to produce a perfect low-torque bearing. Even tiniest contaminations of the ball bearings can cause torque peaks, which may be many times higher than the average torque level.

Preloading test

Another testing device specifically developed by GRW measures and records the preloading of duplexed bearings (following the "broken curve" method). This type of measurement is available on request.

HIGH-PRECISION BALL BEARINGS

Tolerance and runout tables – inner ring

GRW bearings conform to the applicable ISO (International Organization for Standardisation) and ABEC standards (Annular Bearing Engineering Committee). For metric size bearings, tolerances comply with ISO quality P0 to P2 (P2 = highest tolerance). For inch size bearings according to ABEC quality standards ABEC1 to ABEC9 (ABEC9 = highest tolerance).

GRW manufactures miniature ball bearings according to the highest quality standards for both inch and metric sizes.

GRW's sales engineers will be happy to help you choosing the suitable quality for your application, including tolerances of mating parts, such as shafts and housings, to create a bearing friendly environment.

Definition:		Diameter series	d [mm] above	d [mm] to	P0 [µm] max.	P0 [µm] min.	P6 [µm] max.	P6 [µm] min.	P5 [µm] max.	P5 [µm] min.	P4 [µm] max.	P4 [µm] min.	P2 [µm] max.	P2 [µm] min.	P5A [4] [µm] max.	P5A [4] [µm] min.	P4A [4] [µm] max.	P4A [4] [µm] min.	P4S [5] [µm] max.	P4S [5] [µm] min.		ABEC1 [.0001 inch] max.	ABEC1 [.0001 inch] min.	ABEC3 [.0001 inch] max.	ABEC3 [.0001 inch] min.	ABEC5 [.0001 inch] max.	ABEC5 [.0001 inch] min.	ABEC7 [.0001 inch] max.	ABEC7 [.0001 inch] min.	ABEC9 [.0001 inch] max.	ABEC9 [.0001 inch] min.	ABEC3P [.0001 inch] max.	ABEC3P [.0001 inch] min.	ABEC5P [.0001 inch] max.	ABEC5P [.0001 inch] min.	ABEC7P [.0001 inch] max.	ABEC7P [.0001 inch] min.	ABEC9P [.0001 inch] max.	ABEC9P [.0001 inch] min.	ABEC5T [6] [.0001 inch] max.	ABEC5T [6] [.0001 inch] min.
Single plane mean bore diameter deviation	Δdmp		0.6	18	0	-8	0	-7	0	-5	0	-4	0	-2.5	0	-5	0	-4	0	-4		0	-3	0	-3	0	-2	0	-1.5	0	-1	0	-2	0	-2	0	-2	0	-1	0	-2
			18	30	0	-10	0	-8	0	-6	0	-5	0	-2.5	0	-6	0	-5	0	-5		0	-4	0	-3	0	-2.5	0	-2	0	-1	0	-2	0	-2	0	-2	0	-1	0	-2
			30	50	0	-12	0	-10	0	-8	0	-6	0	-2.5					0	-6		0	-4.5	0	-4	0	-3	0	-2.5	0	-1									0	-3
Bore diameter variation in a single radial plane (out of roundness)	Vdsp	7/8/9	0.6	18	10		9		5		4		2.5		3		2.5		2.5														1		1		.5			
			18	30	13		10		6		5		2.5		3		2.5		2.5														1		1		.5			
			30	50	15		13		8		6		2.5						2.5																					
		0	0.6	18	8		7		4		3		2.5		3		2.5		2.5														1		1		.5			
			18	30	10		8		5		4		2.5		3		2.5		2.5														1		1		.5			
			30	50	12		10		6		5		2.5						2.5																					
		2/3	0.6	18	6		5		4		3		2.5		3		2.5		2.5														1		1		.5			
			18	30	8		6		5		4		2.5		3		2.5		2.5														1		1		.5			
			30	50	9		8		6		5		2.5						2.5																					
Mean bore diameter variation (conicity)	Vdmp		0.6	18	6		5		3		2		1.5		3		2		1.5														1		1		.5			
			18	30	8		6		3		2.5		1.5		3		2.5		1.5														1		1		.5			
			30	50	9		8		4		3		1.5						1.5																					
Variation of a single inner ring width from nominal dimension	ΔBs [1]		0.6	2.5	0	-40	0	-40	0	-40	0	-40	0	-40	0	-25	0	-25	0	-100																				
			0.6	10																		0	-50	0	-50	0	-16	0	-16	0	-16	0	-50	0	-10	0	-10	0	-10		
			2.5	10	0	-120	0	-120	0	-40	0	-40	0	-40	0	-25	0	-25	0	-100																				
			10	18	0	-120	0	-120	0	-80	0	-80	0	-80	0	-25	0	-25	0	-100		0	-50	0	-50	0	-32	0	-32	0	-32	0	-50	0	-10	0	-10	0	-10	0	-10
			18	30	0	-120	0	-120	0	-120	0	-120	0	-120	0	-25	0	-25	0	-120		0	-50	0	-50	0	-50	0	-50	0	-50	0	-50	0	-10	0	-10	0	-10	0	-10
			30	50	0	-120	0	-120	0	-120	0	-120	0	-120					0	-120		0	-50	0	-50	0	-50	0	-50	0	-50									0	-50
Variation in width of the inner ring	VBs		0.6	2.5	12		12		5		2.5		1.5						1.5																					
			0.6	10																		6		6		2		1		.5			2		1		.5		
			2.5	10	15		15		5		2.5		1.5		5		2.5		1.5																					
			10	18	20		20		5		2.5		1.5		5		2.5		1.5			8		8		2		1		.5			2		1		.5		2	
			18	30	20		20		5		2.5		1.5		5		2.5		1.5			8		8		2		1		.5			2		1		.5		2	
			30	50	20		20		5		3		1.5						1.5			8		8		2		1		.5									2	
Radial runout of inner ring in assembled bearing (dynamic imbalance)	Kia		0.6	2.5	10		5		4		2.5		1.5		3.5		2.5		1.5			3		2.5		1.5		1		.5		2	1.5		1		.5			
			2.5	10	10		6		4		2.5		1.5		3.5		2.5		1.5			3		2.5		1.5		1		.5		2	1.5		1		.5			
			10	18	10		7		4		2.5		1.5		3.5		2.5		1.5			4		3		1.5		1		.5		2	1.5		1		.5		2	
			18	30	13		8		4		3		2.5		3.5		3		2.5			5		3		1.5		1		1		2	1.5		1.5		1		2	
			30	50	15		10		5		4		2.5						2.5			6		4		2		1.5		1		3							
Face runout with bore (lateral runout)	Sd		0.6	18					7		3		1.5		7		3		1.5							3		1		.5		3	3		1		.5		3	
			18	30					8		4		1.5		8		4		1.5							3		1.5		.5		3	3		1.5		.5		3	
			30	50					8		4		1.5						1.5							3		1.5		.5		3							3	
Assembled bearing inner ring face runout with raceway (axial runout)	Sia		0.6	18					7		3		1.5		7		3		1.5							3		1		.5		3	3		1		.5		3	
			18	30					8		4		2.5		8		4		2.5							3		1.5		1		3	3		1.5		.5		3	
			30	50					8		4		2.5						2.5							3		1.5		1		3							3	

Subject to change due to technical improvement.

[1] Tolerance for matched bearings is 0/-200 µm
[2] Applicable before assembly of bearing and after removal of the inner and/ or outer circlips
[3] For flanged ball bearings the inner side of the flange
[4] For deep groove radial bearings only
[5] For spindle ball bearings only
[6] Nominal value for bores of 9 mm and bigger

HIGH-PRECISION BALL BEARINGS

Tolerance and runout tables – outer ring

Definition:		Diameter series	D [mm] above	to	P0 [µm] max.	min.	P6 [µm] max.	min.	P5 [µm] max.	min.	P4 [µm] max.	min.	P2 [µm] max.	min.	P5A (4) [µm] max.	min.	P4A (4) [µm] max.	min.	P4S (5) [µm] max.	min.	ABEC1 [.0001 inch] max.	min.	ABEC3 [.0001 inch] max.	min.	ABEC5 [.0001 inch] max.	min.	ABEC7 [.0001 inch] max.	min.	ABEC9 [.0001 inch] max.	min.	ABEC3P [.0001 inch] max.	min.	ABEC5P [.0001 inch] max.	min.	ABEC7P [.0001 inch] max.	min.	ABEC9P [.0001 inch] max.	min.	ABEC5T (6) [.0001 inch] max.	min.
Single plane mean outside diameter deviation	ΔDmp		2.5	18	0	-8	0	-7	0	-5	0	-4	0	-2.5	0	-5	0	-4	0	-4	0	-3	0	-3	0	-2	0	-2	0	-1	0	-3	0	-2	0	-2	0	-1		
			18	30	0	-9	0	-8	0	-6	0	-5	0	-4	0	-6	0	-5	0	-5	0	-4	0	-3	0	-2	0	-2	0	-1.5	0	-3	0	-2	0	-2	0	-1.5	0	-2
			30	50	0	-11	0	-9	0	-7	0	-6	0	-4	0	-7	0	-6	0	-6	0	-5	0	-4	0	-3	0	-2.5	0	-1.5	0	-3	0	-2	0	-2	0	-1.5	0	-4
			50	80	0	-13	0	-11	0	-9	0	-7	0	-4					0	-7	0	-5	0	-4.5	0	-3.5	0	-3	0	-1.5									0	-4
Outside diameter variation in a single radial plane (out of roundness)	VDsp (2)	7/8/9	2.5	18	10		9		5		4		2.5		3		2.5		2.5														1		1		.5			
			18	30	12		10		6		5		4		3		2.5		4														1		1		.8			
			30	50	14		11		7		6		4		3		2.5		4														1		1		.8			
			50	80	16		14		9		7		4						4																					
		0	2.5	18	8		7		4		3		2.5		3		2.5		2.5														1		1		.5			
			18	30	9		8		5		4		4		3		2.5		4														1		1		.8			
			30	50	11		9		5		5		4		3		2.5		4														1		1		.8			
			50	80	13		11		7		5		4						4																					
		2 / 3	2.5	18	6		5		4		3		2.5		3		2.5		2.5														1		1		.5			
			18	30	7		6		5		4		4		3		2.5		4														1		1		.8			
			30	50	8		7		5		5		4		3		2.5		4														1		1		.8			
			50	80	10		8		7		5		4						4																					
Mean outside diameter variation (conicity)	VDmp (2)		2.5	18	6		5		3		2		1.5		3		2		1.5														1		1		.5			
			18	30	7		6		3		2.5		2		3		2.5		2														1		1		.8			
			30	50	8		7		4		3		2		4		3		2														1		1		.8			
			50	80	10		8		5		3.5		2						2																					
Variation of a single outer ring width from nominal dimension	ΔCs (1)		2.5	18																																				
			18	30	identical with ΔBs for inner ring of the same bearing										0	-25	0	-25	0	-120	0	-50	0	-50	0	-50	0	-50	0	-50	0	-50	0	-10	0	-10	0	-10	0	-10
			30	50											0	-25	0	-25	0	-120	0	-50	0	-50	0	-50	0	-50	0	-50	0	-50	0	-10	0	-10	0	-10	0	-10
			50	80															0	-150	0	-60	0	-60	0	-60	0	-60	0	-60									0	-50
Variation in width	VCs		2.5	18																																				
			18	30	identical with VBs for inner ring of the same bearing										5		2.5		1.5		8		8		2		1		.5				2		1		.5		2	
			30	50											5		2.5		1.5		8		8		2		1		.5				2		1		.5		2	
			50	80															1.5		10		10		2.5		1		.5										2	
Radial runout of outer ring in assembled bearing (dynamic imbalance)	Kea		2.5	18	15		8		5		3		1.5		5		3		1.5		6		4		2		1.5		.5		4		2		1.5		.5		
			18	30	15		9		6		4		2.5		6		4		2.5		6		4		2		1.5		1		4		2		1.5		1		2
			30	50	20		10		7		5		2.5		7		5		2.5		8		4		3		2		1		4		2		2		1		3
			50	80	25		13		8		5		4						4		10		5		3		2		1.5										3	
Variation of outside surface generatrix inclination with face (3) (lateral runout)	SD		2.5	80					8		4		1.5		8		4		1.5						3		1.5		.5				3		1.5		.5		3	
Assembled bearing outer ring face flange back face rounout with raceway (axial runout)	Sea		2.5	18					8		5		1.5		8		5		1.5						3		2		.5				3		2		.5			
			18	30					8		5		2.5		8		5		2.5						3		2		1				3		2		1		3	
			30	50					8		5		2.5		8		5		2.5						3		2		1				3		2		1		3	
			50	80					10		5		4						4						5		2		1.5										4	
Assembled bearing outer ring face flange back face runout in the assembled bearing	Sea1		2.5	18					11		7		3		10		7																3		3					
			18	30					11		7		4		10		7																3		3					
			30	50					11		7		4		10		7																3		3					
			50	80					11		7																													
Variation of a single outside diameter of outer ring Flange diameter is used for positioning	ΔFD		2.5	10	0	-36	0	-36	0	-36	0	-36	0	-36	0	-25	0	-25													50	-20	0	-10	0	-10				
			10	18	0	-43	0	-43	0	-43	0	-43	0	-43	0	-25	0	-25													50	-20	0	-10	0	-10				
			18	30	0	-52	0	-52	0	-52	0	-52	0	-52	0	-25	0	-25													50	-20	0	-10	0	-10				
			30	50	0	-62	0	-62	0	-62	0	-62	0	-62	0	-25	0	-25													50	-20	0	-10	0	-10				
			50	80	0	-74	0	-74	0	-74	0	-74																												
Variation of a single width outer ring flange from nominal dimension	ΔFB		2.5	10	0	-120	0	-120	0	-40	0	-40	0	-40	0	-40	0	-40													0	-20	0	-20	0	-20				
			10	18	0	-120	0	-120	0	-80	0	-80	0	-80	0	-50	0	-50													0	-20	0	-20	0	-20				
			18	30	0	-120	0	-120	0	-120	0	-120	0	-120	0	-50	0	-50													0	-20	0	-20	0	-20				
			30	50	0	-120	0	-120	0	-120	0	-120	0	-120	0	-50	0	-50													0	-20	0	-20	0	-20				
			50	80	0	-120	0	-120	0	-120	0	-120																												

Subject to change due to technical improvement.

(1) Tolerance for matched bearings is 0/-200 µm
(2) Applicable before assembly of bearing and after removal of the inner and/ or outer circlips
(3) For flanged ball bearings the inner side of the flange
(4) For deep groove radial bearings only
(5) For spindle ball bearings only
(6) Nominal value for bores of 9 mm and bigger

Groove radial ball bearings – metric

GRW-designation	Main dimensions in **[mm]** [inch]		Bearing without closure in **[mm]** [inch]				Bearing with closure in **[mm]** [inch]				Chamfer in **[mm]** [inch]	Modification dimensions acc. to DIN 5418 **[mm]** [inch]		Load ratings acc. to DIN ISO [2] (max)		Closure variants [3]		Max. limiting speed [5] [mm^{-1}]	
			Width without closure	Width with extended inner ring without closure	Flange dimensions without closure		Width with extended inner ring with closure	Width with extended inner ring with closure	Flange dimensions with closure			Shaft diameter	Housing diameter						
Basic symbols	d	D	B	B_1	Flange diameter FD	Flange width FB	B_2	B_3	Flange diameter FD_1	Flange width FB_1	$r_{s\ min}$ [1]	$d_{a\ min}$	$D_{a\ max}$	C_r [N]	C_{0r} [N]	Shield [4]	Seal [4]	with closure or with shield	with seal
67/0,6	**0.60** .0236	**2.00** .0787	**0.80** .0315	–	–	–	–	–	–	–	**0.05** .002	**1.00** .039	**1.60** .063	27	7	–	–	170,000	–
68/1,5/0003	**0.80** .0315	**4.00** .1575	**2.00** .0787	–	**5.00** .1969	**0.60** .0236	**2.00** .0787	–	**5.00** .1969	**0.60** .0236	**0.05** .002	**1.20** .047	**3.60** .142	163	44	X	–	138,000	–
681	**1.00** .0394	**3.00** .1181	**1.00** .0394	–	–	–	**2.00** .0787	–	–	–	**0.05** .002	**1.40** .055	**2.60** .102	82	22	X	–	150,000	–
681/003	**1.00** .0394	**3.00** .1181	**2.00** .0787	–	–	–	**2.00** .0787	–	–	–	**0.05** .002	**1.40** .055	**2.60** .102	52	21	X	–	170,000	–
691	**1.00** .0394	**4.00** .1575	**1.60** .0630	–	–	–	**2.30** .0906	–	–	–	**0.10** .004	**1.60** .063	**3.40** .130	160	43	–	–	126,000	–
68/1,5/0001	**1.00** .0394	**4.00** .1575	–	–	–	–	**2.00** .0787	–	**5.00** .1969	**0.60** .0236	**0.05** .002	**1.40** .055	**3.60** .142	163	44	X	–	130,000	–
68/1,5/0011	**1.00** .0394	**4.00** .1575	**2.00** .0787	–	**5.00** .1969	**0.60** .0236	**2.00** .0787	–	–	–	**0.05** .002	**1.40** .055	**3.60** .142	163	44	X	–	130,000	–
68/1,5	**1.50** .0591	**4.00** .1575	**1.20** .0472	**2.00** .0787	**5.00** .1969	**0.40** .0157	**2.00** .0787	–	**5.00** .1969	**0.60** .0236	**0.05** .002	**1.90** .075	**3.60** .142	163	44	X	–	153,000	–
68/1,5A	**1.50** .0591	**4.00** .1575	– .0787	–	–	–	**2.00** .0787	–	**5.00** .1969	**0.60** .0236	**0.05** .002	**2.10** .083	**3.60** .142	112	33	X	–	120,000	–
69/1,5 [4]	**1.50** .0591	**5.00** .1969	**2.00** .0787	**2.80** .1102	**6.50** .2559	**0.60** .0236	**2.60** .1024	**3.40** .130	**6.50** .2559	**0.80** .0315	**0.15** .006	**2.30** .091	**4.20** .165	192	59	X	–	109,000	–
69/1,5/002	**1.50** .0591	**5.00** .1969	–	–	–	–	**2.00** .0787	–	**6.50** .2559	**0.60** .0236	**0.15** .006	**2.30** .091	**4.20** .165	192	59	X	–	93,000	–
60/1,5	**1.50** .0591	**6.00** .2362	**2.50** .0984	–	**7.50** .2953	**0.60** .0236	**3.00** .1181	–	**7.50** .2953	**0.80** .0315	**0.15** .006	**2.30** .091	**5.20** .205	330	98	X	–	90,000	–
672	**2.00** .0787	**4.00** .1575	**1.20** .0472	–	–	–	**2.00** .0787	–	–	–	**0.05** .002	**2.40** .094	**3.60** .142	124	40	X	–	104,000	–
682	**2.00** .0787	**5.0** .1969	**1.50** .0591	**2.30** .0906	**6.10** .2402	**0.50** .0197	**2.30** .0906	**3.10** .122	**6.10** .2402	**0.60** .0236	**0.08** .003	**2.50** .098	**4.50** .177	192	59	X	X	116,000	71,000
682/003	**2.00** .0787	**5.00** .1969	–	–	–	–	**2.50** .0984	–	**6.20** .2441	**0.60** .0236	**0.10** .004	**2.60** .102	**4.40** .173	169	50	X	–	100,000	–
682/005	**2.00** .0787	**5.00** .1969	**2.60** .1024	–	**6.50** .2559	**0.80** .0315	**2.60** .1024	–	**6.50** .2559	**0.80** .0315	**0.08** .003	**2.50** .098	**4.50** .177	192	59	X	–	105,000	–
692/003	**2.00** .0787	**6.00** .2362	**2.00** .0787	–	–	–	–	–	–	–	**0.15** .006	**2.80** .110	**5.20** .205	286	90	–	–	91,000	–
692	**2.00** .0787	**6.00** .2362	**2.30** .0906	**3.10** .1220	**7.50** .2953	**0.60** .0236	**2.30** .0906	**3.10** .122	**7.50** .2953	**0.60** .0236	**0.15** .006	**2.80** .110	**5.20** .205	286	90	X	X	91,000	65,000

Note:
[1] $r_{s\ min}$ = minimum single bearing chamfer or maximum permissible shaft or housing fillet radius.
[2] Other load ratings are possible due to different ball sets with use of a non-standard retainer.
[3] Different shields or seals available.
[4] Bearings also available with 1 or 2 shields/seals.
[5] Limiting speed also depends on seal material and the respective ball set.

- Ball bearings without shields or seals are also available with recesses.
- Please discuss your desired design in terms of flange, extended inner ring width, shield, seal, and material with our Technical Application Consultants to find out about availability.
- Subject to change due to technical improvement.

Groove radial ball bearings – metric

GRW-designation	Main dimensions in **[mm]** [inch]		Bearing without closure in **[mm]** [inch]				Bearing with closure in **[mm]** [inch]				Chamfer in **[mm]** [inch]	Modification dimensions acc. to DIN 5418 **[mm]** [inch]		Load ratings acc. to DIN ISO [2] (max)		Closure variants [3]		Max. limiting speed [5] [mm^{-1}]	
			Width without closure	Width with extended inner ring without closure	Flange dimensions without closure		Width with extended inner ring with closure	Width with extended inner ring with closure	Flange dimensions with closure			Shaft diameter	Housing diameter						
Basic symbols	d	D	B	B_1	Flange diameter FD	Flange width FB	B_2	B_3	Flange diameter FD_1	Flange width FB_1	$r_{s\ min}$ [1]	$d_{a\ min}$	$D_{a\ max}$	C_r [N]	C_{0r} [N]	Shield [4]	Seal [4]	with closure or with shield	with seal
692/005	**2.00** .0787	**6.00** .2362	**2.50** .0984	–	**7.20** .2835	**0.60** .0236	**2.50** .0984	–	–	–	**0.15** .006	**2.80** .110	**5.20** .205	330	99	X	–	90,000	–
692/004	**2.00** .0787	**6.00** .2362	**3.00** .1181	–	**7.50** .2953	**0.80** .0315	**3.00** .1181	–	**7.50** .2953	**0.80** .0315	**0.15** .006	**2.80** .110	**5.20** .205	330	99	X	–	95,000	–
683/0003	**2.00** .0787	**7.00** .2756	**3.00** .1181	–	**8.20** .3228	**0.60** .0236	**3.00** .1181	–	**8.20** .3228	**0.60** .0236	**0.15** .006	**2.80** .110	**6.20** .244	386	129	X	–	75,000	–
693/0001	**2.00** .0787	**8.00** .3150	**4.00** .1575	–	**9.50** .3740	**0.90** .0354	**4.00** .1575	–	**9.50** .3740	**0.90** .0354	**0.15** .006	**2.80** .150	**7.20** .283	644	215	X	–	67,000	–
67/2,35	**2.35** .0925	**5.00** .1969	**1.50** .0591	**2.30** .0906	**6.10** .2402	**0.50** .0197	**2.30** .0906	–	**6.10** .2402	**0.60** .0236	**0.08** .003	**2.50** .098	**4.50** .177	192	59	X	–	120,000	–
68/2,35	**2.35** .0925	**5.50** .2165	**2.00** .0787	–	–	–	–	–	–	–	**0.08** .003	**2.90** .114	**5.00** .197	286	90	–	–	91,000	–
67/2,5	**2.50** .0984	**5.00** .1969	**1.50** .0591	–	–	–	–	–	–	–	**0.08** .003	**2.90** .114	**4.60** .181	192	59	–	–	93,000	–
68/2,5	**2.50** .0984	**6.00** .2362	**1.80** .0709	**2.60** .1024	**7.10** .2795	**0.50** .0197	**2.60** .1024	**3.40** .1303	**7.10** .2795	**0.80** .0315	**0.08** .003	**3.00** .118	**5.50** .217	286	90	X	X	101,000	61,000
69/2,5/002	**2.50** .0984	**7.00** .2756	–	–	–	–	**2.50** .0984	–	–	–	**0.10** .004	**3.10** .122	**6.40** .252	177	58	X	–	75,000	–
69/2,5	**2.50** .0984	**7.00** .2756	**2.50** .0984	–	**8.50** .3346	**0.70** .0276	**3.50** .1307	–	**8.50** .3346	**0.90** .0354	**0.15** .006	**3.30** .130	**6.30** .248	432	149	X	X	87,000	53,000
683/0001	**2.50** .0984	**7.00** .2756	**2.00** .0787	–	**8.10** .3189	**0.50** .0197	**3.00** .1181	–	**8.10** .3189	**0.80** .0315	**0.10** .004	**3.60** .142	**6.40** .252	432	149	X	–	88,000	–
60/2,5	**2.50** .0984	**8.00** .3150	**2.80** .1102	**3.60** .1417	**9.50** .3740	**0.70** .0276	**2.80** .1102	**3.60** .1417	**9.50** .3740	**0.70** .0276	**0.15** .006	**3.30** .130	**7.20** .283	432	149	X	X	81,000	53,000
60/2,5/004	**2.50** .0984	**8.00** .3150	**4.00** .1575	–	**9.50** .3740	**0.90** .0354	**4.00** .1575	–	**9.50** .3740	**0.90** .0354	**0.15** .006	**3.30** .130	**7.20** .283	552	177	X	–	71,000	–
673	**3.00** .1181	**6.00** .2362	**2.00** .0787	–	**7.20** .2835	**0.60** .0236	**2.00** .0787	–	–	–	**0.08** .003	**3.60** .142	**5.40** .213	208	74	x	–	81,000	–
673/003	**3.00** .1181	**6.00** .2362	–	-	–	–	**2.50** .0984	-	**7.20** .2835	**0.60** .0236	**0.10** .004	**3.60** .142	**5.40** .213	208	74	X	–	80,000	–
683/63	**3.00** .1181	**7.00** .2751	**3.00** .1181	**3.80** .1496	–	–	**3.00** .1181	**3.80** .1496	–	–	**0.10** .004	**3.60** .142	**7.40** .291	432	149	X	X	80,000	50,000
683	**3.00** .1181	**7.00** .2756	**2.00** .0787	**2.80** .1102	**8.10** .3189	**0.50** .0197	**3.00** .1181	**3.80** .1496	**8.10** .3189	**0.80** .0315	**0.10** .004	**3.60** .142	**6.40** .252	432	149	X	X	90,000	53,000
683/8	**3.00** .1181	**8.00** .3150	**3.00** .1181	–	–	–	**3.00** .1181	**3.80** .1496	–	–	**0.10** .004	**3.60** .142	**7.40** .291	432	149	X	X	95,000	55,000

Note:
[1] $r_{s\ min}$ = minimum single bearing chamfer or maximum permissible shaft or housing fillet radius.
[2] Other load ratings are possible due to different ball sets with use of a non-standard retainer.
[3] Different shields or seals available.
[4] Bearings also available with 1 or 2 shields/seals.
[5] Limiting speed also depends on seal material and the respective ball set.

- Ball bearings without shields or seals are also available with recesses.
- Please discuss your desired design in terms of flange, extended inner ring width, shield, seal, and material with our Technical Application Consultants to find out about availability.
- Subject to change due to technical improvement.

HIGH-PRECISION BALL BEARINGS

Groove radial ball bearings – metric

GRW-designation	Main dimensions in **[mm]** [inch]		Bearing without closure in **[mm]** [inch]				Bearing with closure in **[mm]** [inch]				Chamfer in **[mm]** [inch]	Modification dimensions acc. to DIN 5418 **[mm]** [inch]		Load ratings acc. to DIN ISO [2] (max)		Closure variants [3]		Max. limiting speed [5] [mm^{-1}]	
			Width without closure	Width with extended inner ring without closure	Flange dimensions without closure		Width with extended inner ring with closure	Width with extended inner ring with closure	Flange dimensions with closure			Shaft diameter	Housing diameter						
Basic symbols	d	D	B	B_1	Flange diameter FD	Flange width FB	B_2	B_3	Flange diameter FD_1	Flange width FB_1	$r_{s\ min}$ [1]	$d_{a\ min}$	$D_{a\ max}$	C_r [N]	C_{0r} [N]	Shield [4]	Seal [4]	with closure or with shield	with seal
683/003	**3.00** .1181	**7.00** .2756	**2.50** .0984	–	–	–	**2.50** .0984	–	–	–	**0.10** .004	**3.60** .142	**6.40** .252	432	149	X	–	93,000	–
693/003	**3.00** .1181	**8.00** .3150	**2.50** .0984	–	–	–	–	–	–	–	**0.15** .006	**3.80** .150	**7.20** .283	644	215	–	–	60,000	–
693 [4]	**3.00** .1181	**8.00** .3150	**3.00** .1181	**3.80** .1496	**9.50** .3740	**0.70** .0276	**4.00** .1575	**4.80** .1890	**9.50** .3740	**0.90** .0354	**0.15** .006	**3.80** .150	**7.20** .283	644	215	X	X	80,000	51,000
693/002	**3.00** .1181	**8.00** .3150	–	–	–	–	**3.00** .1181	–	–	–	**0.15** .006	**3.80** .150	**7.20** .283	395	141	X	–	67,000	–
603	**3.00** .1181	**9.00** .3543	**3.00** .1181	–	**10.50** .4134	**0.70** .0276	**5.00** .1969	–	**10.50** .4134	**1.00** .0394	**0.15** .006	**3.80** .150	**8.20** .323	571	189	X	–	67,000	–
603/003	**3.00** .1181	**9.00** .3543	–	–	–	–	**4.00** .1575	–	**10.60** .4173	**0.80** .0315	**0.20** .008	**4.40** .173	**7.60** .299	571	189	X	–	67,000	–
603/004	**3.00** .1181	**9.00** .3543	**2.50** .0984	–	**10.20** .4016	**0.60** .0236	–	–	–	–	**0.20** .008	**4.40** .173	**7.60** .299	571	189	–	–	67,000	–
623	**3.00** .1181	**10.00** .3937	**4.00** .1575	**4.80** .1890	**11.50** .4528	**1.00** .0394	**4.00** .1575	**4.80** .1890	**11.50** .4528	**1.00** .0394	**0.15** .006	**4.40** .173	**8.60** .339	725	265	X	X	65,000	44,000
623/13	**3.00** .1181	**13.00** .5118	**4.00** .1575	**4.80** .1890	–	–	**4.00** .1575	**4.80** .1890	–	–	**0.15** .006	**4.40** .173	**8.60** .339	725	265	X	X	70,000	46,000
633	**3.00** .1181	**13.00** .5118	**5.00** .1969	–	**15.00** .5906	**1.00** .0394	**5.00** .1969	–	**15.00** .5906	**1.00** .0394	**0.20** .008	**4.80** .1890	**11.20** .441	1339	488	X	–	55,000	–
693/0004	**3.30** .1299	**8.00** .3150	**4.00** .1575	–	**9.50** .3740	**0.90** .0354	**4.00** .1575	–	**9.50** .3740	**0.90** .0354	**0.15** .006	**4.10** .161	**7.20** .283	625	213	X	–	80,000	–
674/004	**4.00** .1575	**7.00** .2756	**1.60** .0630	–	–	–	**1.60** .063	–	–	–	**0.08** .003	**4.50** .177	**6.50** .256	337	129	–	–	60,000	–
674	**4.00** .1575	**7.00** .2756	**2.00** .0787	–	–	–	**2.00** .0787	–	–	–	**0.08** .003	**4.50** .177	**6.50** .256	345	130	X	–	67,000	–
674/003	**4.00** .1575	**7.00** .2756	**2.50** .0984	–	–	–	**2.50** .0984	–	**8.20** .3228	**0.60** .0236	**0.08** .003	**4.50** .177	**6.50** .256	255	108	X	–	67,000	–
693B/0021	**4.00** .1575	**8.00** .3150	**3.00** .1181	–	–	–	**3.00** .1181	–	–	–	**0.15** .006	**4.80** .189	**7.20** .283	380	127	X	–	72,000	–
684	**4.00** .1575	**9.00** .3543	**2.50** .0984	**3.30** .1299	**10.30** .4055	**0.60** .0236	**4.00** .1575	**4.80** .1890	**10.30** .4055	**1.00** .0394	**0.10** .004	**4.60** .181	**8.40** .331	658	226	X	X	62,000	45,000
684/103	**4.00** .1575	**10.00** .3937	**3.00** .1181	–	**11.50** .4528	**0.80** .0315	–	–	–	–	**0.10** .004	**4.60** .181	**9.40** .370	658	226	–	–	48,000	–
684/103	**4.00** .1575	**10.00** .3937	**3.00** .1181	–	**11.20** .4409	**0.60** .0236	–	–	–	–	**0.15** .006	**4.80** .189	**9.20** .362	711	272	–	–	56,000	–

Note:
[1] $r_{s\ min}$ = minimum single bearing chamfer or maximum permissible shaft or housing fillet radius.
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[3] Different shields or seals available.
[4] Bearings also available with 1 or 2 shields/seals.
[5] Limiting speed also depends on seal material and the respective ball set.

- Ball bearings without shields or seals are also available with recesses.
- Please discuss your desired design in terms of flange, extended inner ring width, shield, seal, and material with our Technical Application Consultants to find out about availability.
- Subject to change due to technical improvement.

Groove radial ball bearings – metric

GRW-designation	Main dimensions in **[mm]** [inch]		Bearing without closure in **[mm]** [inch]				Bearing with closure in **[mm]** [inch]				Chamfer in **[mm]** [inch]	Modification dimensions acc. to DIN 5418 **[mm]** [inch]		Load ratings acc. to DIN ISO [2] (max)		Closure variants [3]		Max. limiting speed [5] [mm^{-1}]	
			Width without closure	Width with extended inner ring without closure	Flange dimensions without closure		Width with extended inner ring with closure	Width with extended inner ring with closure	Flange dimensions with closure			Shaft diameter	Housing diameter						
Basic symbols	d	D	B	B_1	Flange diameter FD	Flange width FB	B_2	B_3	Flange diameter FD_1	Flange width FB_1	$r_{s\ min}$ [1]	$d_{a\ min}$	$D_{a\ max}$	C_r [N]	C_{0r} [N]	Shield [4]	Seal [4]	with closure or with shield	with seal
684/10	**4.00** .1575	**10.00** .3937	**4.00** .1575	**4.80** .1890	**11.50** .4528	**1.00** .0394	**4.00** .1575	**4.80** .1890	**11.50** .4528	**1.00** .0394	**0.10** .004	**4.60** .181	**9.40** .370	711	272	X	X	86,000	45,000
684/10 W8	**4.00** .1575	**10.00** .3937	**–**	**–**	**–**	**–**	**4.00** .1575	**–**	**11.60** .4567	**0.80** .0315	**0.15** .006	**4.80** .189	**9.20** .362	711	272	X	–	56,000	–
694	**4.00** .1575	**11.00** .4331	**4.00** .1575	**–**	**12.50** .4921	**1.00** .0394	**4.00** .1575	**–**	**12.50** .4921	**1.00** .0394	**0.15** .006	**4.80** .189	**10.20** .402	730	271	X	X	66,000	41,000
604	**4.00** .1575	**12.00** .4724	**4.00** .1575	**–**	**13.50** .5315	**1.00** .0394	**4.00** .1575	**–**	**13.50** .5315	**1.00** .0394	**0.20** .008	**5.40** .213	**10.60** .417	734	282	X	X	56,000	37,000
624	**4.00** .1575	**13.00** .5118	**5.00** .1969	**5.80** .2283	**15.00** .5906	**1.00** .0394	**5.00** .1969	**5.80** .2283	**15.00** .5906	**1.00** .0394	**0.20** .008	**5.80** .228	**11.20** .441	1339	488	X	X	52,000	28,000
694/133	**4.00** .1575	**13.00** .5118	**5.00** .1969	**–**	**–**	**–**	**5.00** .1969	**–**	**–**	**–**	**0.15** .006	**4.80** .189	**12.20** .480	730	271	X	X	65,000	53,000
624/16	**4.00** .1575	**16.00** .6299	**5.00** .1969	**5.80** .2283	**–**	**–**	**5.00** .1969	**5.80** .2283	**–**	**–**	**0.20** .008	**5.80** .228	**12.20** .480	1306	486	X	X	55,000	30,000
634	**4.00** .1575	**16.00** .6299	**5.00** .1969	**–**	**18.00** .7087	**1.00** .0394	**5.00** .1969	**–**	**18.00** .7087	**1.00** .0394	**0.30** .012	**6.40** .252	**13.60** .535	1730	670	X	X	44,000	43,000
624/17	**4.00** .1575	**17.00** .6693	**5.00** .1969	**5.80** .2283	**–**	**–**	**5.00** .1969	**5.80** .2283	**–**	**–**	**0.20** .008	**5.80** .228	**15.20** .598	1306	486	X	X	55,000	30,000
675	**5.00** .1969	**8.00** .3150	**2.00** .0787	**–**	**–**	**–**	**2.00** .0787	**–**	**–**	**–**	**0.08** .003	**5.50** .217	**7.50** .295	390	160	X	–	52,000	–
675/003	**5.00** .1969	**8.00** .3150	**2.50** .0984	**–**	**9.20** .3622	**0.60** .0236	**2.50** .0984	**–**	**–**	**–**	**0.10** .004	**5.60** .220	**7.50** .295	218	90	X	–	63,000	–
675/004	**5.00** .1969	**8.00** .3150	**3.00** .1181	**–**	**–**	**–**	**3.00** .1181	**–**	**–**	**–**	**0.08** .003	**5.40** .213	**7.60** .299	390	160	X	–	52,000	–
675/094	**5.00** .1969	**9.00** .3543	**3.00** .1181	**–**	**–**	**–**	**3.00** .1181	**–**	**10.20** .4016	**0.60** .0236	**0.15** .006	**5.40** .213	**8.60** .339	431	169	X	–	60,000	–
694A/1002	**5.00** .1969	**10.00** .3937	**4.00** .1575	**–**	**–**	**–**	**4.00** .1575	**–**	**11.20** .4409	**0.80** .0315	**0.15** .006	**5.50** .217	**8.80** .346	431	169	X	–	60,000	–
694/1002	**5.00** .1969	**10.00** .3937	**4.00** .1575	**–**	**–**	**–**	**4.00** .1575	**–**	**–**	**–**	**0.15** .006	**5.50** .217	**8.80** .346	730	271	X	–	66,000	–
694/1002 W1	**5.00** .1969	**10.00** .3937	**4.00** .1575	**–**	**11.60** .4567	**0.80** .0315	**4.00** .1575	**–**	**11.60** .4567	**0.80** .0315	**0.15** .006	**5.80** .228	**9.20** .362	431	169	X	–	60,000	–
685	**5.00** .1969	**11.00** .4331	**3.00** .1181	**–**	**12.50** .4921	**0.80** .0315	**5.00** .1969	**–**	**12.50** .4921	**1.00** .0394	**0.15** .006	**5.80** .228	**10.70** .421	734	282	X	X	71,000	37,000
685/003	**5.00** .1969	**11.00** .4331	**4.00** .1575	**–**	**12.50** .4921	**1.00** .0394	**4.00** .1575	**–**	**12.50** .4921	**1.00** .0394	**0.15** .006	**5.80** .228	**10.70** .421	734	282	X	–	62,000	–

Note:
[1] $r_{s\ min}$ = minimum single bearing chamfer or maximum permissible shaft or housing fillet radius.
[2] Other load ratings are possible due to different ball sets with use of a non-standard retainer.
[3] Different shields or seals available.
[4] Bearings also available with 1 or 2 shields/seals.
[5] Limiting speed also depends on seal material and the respective ball set.

- Ball bearings without shields or seals are also available with recesses.
- Please discuss your desired design in terms of flange, extended inner ring width, shield, seal, and material with our Technical Application Consultants to find out about availability.
- Subject to change due to technical improvement.

HIGH-PRECISION BALL BEARINGS

Groove radial ball bearings – metric

GRW-designation	Main dimensions in **[mm]** [inch]		Bearing without closure in **[mm]** [inch]				Bearing with closure in **[mm]** [inch]				Chamfer in **[mm]** [inch]	Modification dimensions acc. to DIN 5418 **[mm]** [inch]		Load ratings acc. to DIN ISO [2] (max)		Closure variants [3]		Max. limiting speed [5] [mm^{-1}]	
			Width without closure	Width with extended inner ring without closure	Flange dimensions without closure		Width with extended inner ring with closure	Width with extended inner ring with closure	Flange dimensions with closure			Shaft diameter	Housing diameter						
Basic symbols	d	D	B	B_1	Flange diameter FD	Flange width FB	B_2	B_3	Flange diameter FD_1	Flange width FB_1	$r_{s\ min}$ [1]	$d_{a\ min}$	$D_{a\ max}$	C_r [N]	C_{0r} [N]	Shield [4]	Seal [4]	with closure or with shield	with seal
695	**5.00** .1969	**13.00** .5118	**4.00** .1575	–	**15.00** .5906	**1.00** .0394	**4.00** .1575	–	**15.00** .5906	**1.00** .0394	**0.20** .008	**6.40** .252	**11.60** .457	1077	432	X	X	50,000	34,000
624/0003	**5.00** .1969	**13.00** .5118	**5.00** .1969	–	–	–	**5.00** .1969	–	**15.00** .5906	**1.00** .0394	**0.20** .008	**6.80** .268	**11.20** .441	1306	486	X	–	52,000	–
605	**5.00** .1969	**14.00** .5512	**5.00** .1969	–	**16.00** .6299	**1.00** .0394	**5.00** .1969	–	**16.00** .6299	**1.00** .0394	**0.20** .008	**6.40** .252	**12.60** .496	1329	507	X	X	50,000	33,000
625	**5.00** .1969	**16.00** .6299	**5.00** .1969	**5.80** .2283	**18.00** .7087	**1.00** .0394	**5.00** .1969	**5.80** .2283	**18.00** .7087	**1.00** .0394	**0.30** .012	**7.40** .291	**13.60** .535	1729	675	X	X	50,000	31,000
635	**5.00** .1969	**19.00** .7480	**6.00** .2362	–	**22.00** .8661	**1.50** .0591	**6.00** .2362	–	**22.00** .8661	**1.50** .0591	**0.30** .012	**7.40** .291	**16.60** .654	2522	1057	X	X	40,000	22,000
635/22	**5.00** .1969	**22.00** .8661	**6.00** .2362	**6.80** .2677	–	–	**6.00** .2362	**6.80** .2677	–	–	**0.60** .024	**7.40** .291	**19.60** .772	2458	1053	X	X	43,000	25,000
676	**6.00** .2362	**10.00** .3937	**2.50** .0984	–	**11.20** .4409	**0.60** .0236	–	–	–	–	**0.15** .006	**6.80** .268	**9.20** .362	500	216	–	–	35,000	–
676/003	**6.00** .2362	**10.00** .3937	**3.00** .1181	–	–	–	**3.00** .1181	–	–	–	**0.10** .004	**6.60** .26	**9.40** .370	503	215	X	–	46,000	–
676/003	**6.00** .2362	**10.00** .3937	–	–	–	–	**3.00** .1181	–	**11.20** .4409	**0.60** .0236	**0.15** .006	**6.80** .268	**9.20** .362	500	216	X	–	35,000	–
695/1232	**6.00** .2362	**12.00** .4724	**3.00** .1181	–	**13.20** .5197	**0.60** .0236	–	–	–	–	**0.20** .008	**7.40** .291	**10.60** .417	716	295	–	–	50,000	–
695/1202	**6.00** .2362	**12.00** .4724	**4.00** .1575	–	**13.60** .5354	**0.80** .0315	**4.00** .1575	–	**13.60** .5354	**0.80** .0315	**0.15** .006	**6.80** .268	**11.20** .441	851	366	X	X	49,000	28,000
686	**6.00** .2362	**13.00** .5118	**3.50** .1307	**4.30** .1693	**15.00** .5906	**1.00** .0394	**5.00** .1969	**5.80** .2283	**15.00** .5906	**1.10** .0433	**0.15** .006	**6.80** .268	**12.20** .48	1096	437	X	X	55,000	33,000
696	**6.00** .2362	**15.00** .5906	**5.00** .1969	–	**17.00** .6693	**1.20** .0472	**5.00** .1969	–	**17.00** .6693	**1.20** .0472	**0.20** .008	**7.40** .291	**13.60** .535	1340	523	X	X	46,000	45,000
625/0002	**6.00** .2362	**16.00** .6299	**5.00** .1969	–	**18.00** .7087	**1.00** .0394	**5.00** .1969	–	**18.00** .7087	**1.00** .0394	**0.15** .006	**8.40** .331	**13.60** .535	1646	663	X	–	41,000	–
606	**6.00** .2362	**17.00** .6693	**6.00** .2362	–	**19.00** .7480	**1.20** .0472	**6.00** .2362	–	**19.00** .7480	**1.20** .0472	**0.30** .012	**8.00** .315	**15.00** .591	2263	846	X	X	45,000	30,000
626	**6.00** .2362	**19.00** .7480	**6.00** .2362	–	**22.00** .8661	**1.50** .0591	**6.00** .2362	–	**22.00** .8661	**1.50** .0591	**0.30** .012	**8.40** .331	**16.60** .654	2522	1057	X	X	40,000	22,000
626/005	**6.00** .2362	**19.00** .7480	**8.00** .3150	–	–	–	**8.00** .3150	–	–	–	**0.30** .012	**8.40** .331	**16.60** .654	2522	1057	X	–	48,000	–
636	**6.00** .2362	**22.00** .8661	**7.00** .2756	–	–	–	**7.00** .2756	–	–	–	**0.30** .012	**8.40** .331	**19.60** .772	3333	1423	X	–	36,000	–

Note:
[1] $r_{s\ min}$ = minimum single bearing chamfer or maximum permissible shaft or housing fillet radius.
[2] Other load ratings are possible due to different ball sets with use of a non-standard retainer.
[3] Different shields or seals available.
[4] Bearings also available with 1 or 2 shields/seals.
[5] Limiting speed also depends on seal material and the respective ball set.

- Ball bearings without shields or seals are also available with recesses.
- Please discuss your desired design in terms of flange, extended inner ring width, shield, seal, and material with our Technical Application Consultants to find out about availability.
- Subject to change due to technical improvement.

Groove radial ball bearings – metric

GRW-designation	Main dimensions in **[mm]** [inch]		Bearing without closure in **[mm]** [inch]				Bearing with closure in **[mm]** [inch]				Chamfer in **[mm]** [inch]	Modification dimensions acc. to DIN 5418 **[mm]** [inch]		Load ratings acc. to DIN ISO [2] (max)		Closure variants [3]		Max. limiting speed [5] [mm^{-1}]	
			Width without closure	Width with extended inner ring without closure	Flange dimensions without closure		Width with extended inner ring with closure	Width with extended inner ring with closure	Flange dimensions with closure			Shaft diameter	Housing diameter						
Basic symbols	d	D	B	B_1	Flange diameter FD	Flange width FB	B_2	B_3	Flange diameter FD_1	Flange width FB_1	$r_{s\ min}$ [1]	$d_{a\ min}$	$D_{a\ max}$	C_r [N]	C_{0r} [N]	Shield [4]	Seal [4]	with closure or with shield	with seal
677	**7.00** .2756	**11.00** .4331	**2.50** .0984	–	**12.20** .4803	**0.60** .0236	–	–	–	–	**0.10** .004	**7.60** .299	**10.40** .409	461	206	–	–	50,000	–
677/003	**7.00** .2756	**11.00** .4331	**3.00** .1181	–	–	–	**3.00** .1181	–	**12.20** .4803	**0.60** .0236	**0.10** .004	**7.60** .299	**10.40** .409	461	206	X	–	50,000	–
688A/1322	**7.00** .2756	**13.00** .5118	**3.00** .1181	–	**14.20** .5591	**0.60** .0236	**4.00** .1575	–	**14.60** .5748	**0.80** .0315	**0.15** .006	**8.40** .331	**11.60** .457	541	276	X	X	48,000	30,000
688/1322	**7.00** .2756	**13.00** .5118	–	–	–	–	**4.00** .1575	–	–	–	**0.20** .008	**8.40** .331	**11.60** .457	335	152	X	–	35,000	–
687	**7.00** .2756	**14.00** .5512	**3.50** .1307	–	**16.00** .6299	**1.00** .0394	**5.00** .1969	–	**16.00** .6299	**1.10** .0433	**0.15** .006	**7.80** .307	**13.20** .520	1186	505	X	X	50,000	31,000
697	**7.00** .2756	**17.00** .6693	**5.00** .1969	–	**19.00** .7480	**1.20** .0472	**5.00** .1969	–	**19.00** .7480	**1.20** .0472	**0.30** .012	**9.00** .354	**15.00** .591	1795	776	X	X	39,000	28,000
607	**7.00** .2756	**19.00** .7480	**6.00** .2362	–	**22.00** .8661	**1.50** .0591	**6.00** .2362	–	**22.00** .8661	**1.50** .0591	**0.30** .012	**9.00** .350	**17.00** .669	3400	1057	X	X	43,000	22,000
627	**7.00** .2756	**22.00** .8661	**7.00** .2756	–	**25.00** .9843	**1.50** .0591	**7.00** .2756	–	**25.00** .9843	**1.50** .0591	**0.30** .012	**9.40** .370	**19.60** .772	3369	1363	X	X	35,000	21,000
627/28	**7.00** .2756	**28.00** 1.1024	**7.00** .2756	**7.80** .3071	–	–	**7.00** .2756	**7.80** .3071	–	–	**0.30** .012	**9.40** .370	**25.80** 1.016	3369	1363	X	–	40,000	–
678	**8.00** .3150	**12.00** .4724	**2.50** .0984	–	**13.20** .5197	**0.60** .0236	–	–	–	–	**0.10** .004	**8.60** .339	**11.40** .449	540	275	–	–	48,000	–
678/003	**8.00** .3150	**12.00** .4724	–	–	–	–	**3.50** .1307	–	**13.60** .5354	**0.80** .0315	**0.10** .004	**8.60** .339	**11.40** .449	540	275	X	–	48,000	–
688A/144	**8.00** .3150	**14.00** .5512	**3.50** .1307	–	**15.60** .6142	**0.80** .0315	–	–	–	–	**0.15** .006	**8.80** .346	**13.20** .520	817	386	–	–	45,000	–
688A/142	**8.00** .3150	**14.00** .5512	–	–	–	–	**4.00** .1575	–	**15.60** .6142	**0.80** .0315	**0.20** .008	**9.40** .370	**12.60** .496	817	386	X	–	47,000	–
688	**8.00** .3150	**16.00** .6299	**4.00** .1575	–	**18.00** .7087	**1.00** .0394	**6.00** .2362	–	**18.00** .7087	**1.30** .0512	**0.20** .008	**9.40** .370	**14.60** .575	1795	776	X	X	48,000	28,000
688/002	**8.00** .3150	**16.00** .6299	–	–	–	–	**4.00** .1575	–	–	–	**0.20** .008	**9.40** .370	**14.60** .575	1795	776	X	–	48,000	–
688/003	**8.00** .3150	**16.00** .6299	**5.00** .1969	–	**18.00** .7087	**1.10** .0433	**5.00** .1969	–	**18.00** .7087	**1.10** .0433	**0.20** .008	**9.40** .370	**14.60** .575	1795	776	X	X	43,000	28,000
698	**8.00** .3150	**19.00** .7480	**6.00** .2362	–	**22.00** .8661	**1.50** .0591	**6.00** .2362	–	**22.00** .8661	**1.50** .0591	**0.30** .012	**10.00** .394	**17.00** .669	2240	917	X	X	43,000	27,000
688/20	**8.00** .3150	**20.00** .7874	**4.00** .1575	**4.80** .1890	–	–	–	–	–	–	**0.20** .008	**9.40** .370	**18.60** .732	1795	776	–	–	45,000	–

Note:
[1] $r_{s\ min}$ = minimum single bearing chamfer or maximum permissible shaft or housing fillet radius.
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Groove radial ball bearings – metric

GRW-designation	Main dimensions in **[mm]** [inch]		Bearing without closure in **[mm]** [inch]				Bearing with closure in **[mm]** [inch]				Chamfer in **[mm]** [inch]	Modification dimensions acc. to DIN 5418 **[mm]** [inch]		Load ratings acc. to DIN ISO [2] (max)		Closure variants [3]		Max. limiting speed [5] [mm^{-1}]	
			Width without closure	Width with extended inner ring without closure	Flange dimensions without closure		Width with extended inner ring with closure	Width with extended inner ring with closure	Flange dimensions with closure			Shaft diameter	Housing diameter						
Basic symbols	d	D	B	B_1	Flange diameter FD	Flange width FB	B_2	B_3	Flange diameter FD_1	Flange width FB_1	$r_{s\ min}$ [1]	$d_{a\ min}$	$D_{a\ max}$	C_r [N]	C_{0r} [N]	Shield [4]	Seal [4]	with closure or with shield	with seal
608/003	**8.00** .3150	**22.00** .8661	**6.00** .2362	–	–	–	–	–	–	–	**0.30** .012	**10.00** .394	**20.00** .787	3369	1363	–	–	38,000	–
608	**8.00** .3150	**22.00** .8661	**7.00** .2756	–	**25.00** .9843	**1.50** .0591	**7.00** .2756	–	**25.00** .9843	**1.50** .0591	**0.30** .012	**10.00** .394	**20.00** .787	3369	1363	X	X	38,000	21,000
608/005	**8.00** .3150	**22.00** .8661	**10.00** .3937	–	–	–	**10.00** .3937	–	–	–	**0.30** .012	**10.00** .394	**20.00** .787	3369	1363	X	–	43,000	–
608/006	**8.00** .3150	**22.00** .8661	**10.31** .4059	–	–	–	**10.31** .4059	–	–	–	**0.30** .012	**10.00** .394	**20.00** .787	3369	1363	X	X	43,000	29,000
608/007	**8.00** .3150	**22.00** .8661	**11.00** .4331	–	–	–	**11.00** .4331	–	–	–	**0.30** .012	**10.00** .394	**20.00** .787	3369	1363	X	X	43,000	29,000
628	**8.00** .3150	**24.00** .9449	**8.00** .3150	–	–	–	**8.00** .3150	–	–	–	**0.30** .012	**10.40** .409	**21.60** .850	3360	1430	X	X	38,000	21,000
6000/0001	**8.00** .3150	**26.00** 1.0236	**8.00** .3150	–	–	–	**8.00** .3150	–	–	–	**0.30** .012	**10.40** .409	**24.00** .945	4698	1982	X	–	35,000	–
638	**8.00** .3150	**28.00** 1.1024	**9.00** .3543	–	–	–	**9.00** .3543	–	–	–	**0.30** .012	**10.40** .409	**25.60** 1.008	4563	1982	X	–	34,000	–
679	**9.00** .3543	**14.00** .5512	**3.00** .1181	–	**15.50** .6102	**0.80** .0315	–	–	–	–	**0.10** .004	**9.60** .378	**13.40** .528	919	468	–	–	42,000	–
679/003	**9.00** .3543	**14.00** .5512	**4.50** .1772	–	**15.50** .6102	**0.80** .0315	**4.50** .1772	–	**15.50** .6102	**0.80** .0315	**0.10** .004	**9.60** .378	**13.40** .528	919	468	X	X	42,000	25,000
689	**9.00** .3543	**17.00** .6693	**4.00** .1575	**4.80** .1890	**19.00** .7480	**1.00** .0394	**6.00** .2362	–	**19.00** .7480	**1.30** .0512	**0.20** .008	**10.40** .409	**15.60** .614	1798	797	X	X	44,000	27,000
689/003	**9.00** .3543	**17.00** .6693	**5.00** .1969	–	–	–	**5.00** .1969	–	–	–	**0.20** .008	**10.40** .409	**15.60** .614	1798	797	X	–	44,000	–
699	**9.00** .3543	**20.00** .7874	**6.00** .2362	**6.80** .2677	**23.00** .9055	**1.50** .0591	**6.00** .2362	**6.80** .2677	**23.00** .9055	**1.50** .0591	**0.30** .012	**11.00** .433	**18.00** .709	2467	1081	X	X	40,000	25,000
609	**9.00** .3543	**24.00** .9449	**7.00** .2756	–	**27.00** 1.0630	**1.50** .0591	**7.00** .2756	–	**27.00** 1.0630	**1.50** .0591	**0.30** .012	**11.00** .433	**22.00** .866	3435	1430	X	X	33,000	20,000
629	**9.00** .3543	**26.00** 1.0236	**8.00** .3150	**8.80** .3465	**28.00** 1.1024	**2.00** .0787	**8.00** .3150	**8.80** .3465	**28.00** 1.1024	**2.00** .0787	**0.30** .012	**11.40** .449	**23.60** .929	4698	1982	X	X	34,000	19,000
6700	**10.00** .3937	**15.00** .5906	**3.00** .1181	–	**16.50** .6496	**0.80** .0315	–	–	**16.50** .6496	**0.80** .0315	**0.15** .006	**10.80** .425	**14.20** .559	855	435	–	–	17,000	–
6700/003	**10.00** .3937	**15.00** .5906	**4.00** .1575	–	**16.50** .6496	**0.80** .0315	**4.00** .1575	–	**16.50** .6496	**0.80** .0315	**0.15** .006	**10.80** .425	**14.20** .559	855	435	X	X	17,000	10,000
6800 [4]	**10.00** .3937	**19.00** .7480	**5.00** .1969	**5.80** .2283	**21.00** .8268	**1.00** .0394	**7.00** .2756	**7.80** .3071	**21.00** .8268	**1.50** .0591	**0.30** .012	**12.00** .472	**17.00** .669	1922	915	X	X	42,000	25,000

Note:
[1] $r_{s\ min}$ = minimum single bearing chamfer or maximum permissible shaft or housing fillet radius.
[2] Other load ratings are possible due to different ball sets with use of a non-standard retainer.
[3] Different shields or seals available.
[4] Bearings also available with 1 or 2 shields/seals.
[5] Limiting speed also depends on seal material and the respective ball set.

- Ball bearings without shields or seals are also available with recesses.
- Please discuss your desired design in terms of flange, extended inner ring width, shield, seal, and material with our Technical Application Consultants to find out about availability.
- Subject to change due to technical improvement.

HIGH-PRECISION BALL BEARINGS

Groove radial ball bearings – metric

GRW-designation	Main dimensions in **[mm]** [inch]		Bearing without closure in **[mm]** [inch]				Bearing with closure in **[mm]** [inch]				Chamfer in **[mm]** [inch]	Modification dimensions acc. to DIN 5418 **[mm]** [inch]		Load ratings acc. to DIN ISO [2] (max)		Closure variants [3]		Max. limiting speed [5] [mm^{-1}]	
			Width without closure	Width with extended inner ring without closure	Flange dimensions without closure		Width with extended inner ring with closure	Width with extended inner ring with closure	Flange dimensions with closure			Shaft diameter	Housing diameter						
Basic symbols	d	D	B	B_1	Flange diameter FD	Flange width FB	B_2	B_3	Flange diameter FD_1	Flange width FB_1	$r_{s\ min}$ [1]	$d_{a\ min}$	$D_{a\ max}$	C_r [N]	C_{0r} [N]	Shield [4]	Seal [4]	with closure or with shield	with seal
6800/002	**10.00** .3937	**19.00** .7480	–	–	–	–	**5.00** .1969	–	**21.00** .8268	**1.00** .0394	**0.30** .012	**12.00** .472	**17.00** .669	1922	915	X	–	34,000	–
6800/003	**10.00** .3937	**19.00** .7480	**6.00** .2362	–	–	–	**6.00** .2362	–	–	–	**0.30** .012	**12.00** .472	**17.00** .669	1922	915	X	–	35,000	–
6800/202	**10.00** .3937	**20.00** .7874	–	–	–	–	**5.00** .1969	–	–	–	**0.30** .012	**12.00** .472	**18.00** .709	1922	915	X	–	34,000	–
6900	**10.00** .3937	**22.00** .8661	**6.00** .2362	–	**25.00** .9843	**1.50** .0591	**6.00** .2362	–	**25.00** .9843	**1.50** .0591	**0.30** .012	**12.00** .472	**20.00** .787	2695	1273	X	X	41,000	24,000
6000	**10.00** .3937	**26.00** 1.0236	**8.00** .3150	**8.80** .3465	**28.00** 1.1024	**2.00** .0787	**8.00** .3150	**8.80** .3465	**28.00** 1.1024	**2.00** .0787	**0.30** .012	**12.40** .488	**23.60** .929	4698	1982	X	X	35,000	19,000
6000/003	**10.00** .3937	**26.00** 1.0236	**10.00** .3937	–	–	–	**10.00** .3937	–	–	–	**0.30** .012	**12.40** .488	**23.60** .929	4149	1388	X	–	38,000	–
16100	**10.00** .3937	**28.00** 1.1024	**8.00** .3150	–	–	–	**8.00** .3150	–	–	–	**0.30** .012	**14.20** .559	**23.80** .937	4620	1960	X	–	37,000	–
6200	**10.00** .3937	**30.00** 1.1811	**9.00** .3543	–	–	–	**9.00** .3543	–	–	–	**0.60** .024	**14.20** .559	**25.80** 1.016	4340	1920	X	X	27,000	18,000
6300	**10.00** .3937	**35.00** 1.3780	**11.00** .4331	–	–	–	**11.00** .4331	–	–	–	**0.60** .024	**14.20** .559	**20.80** .819	6870	2750	X	X	27,000	18,000
6701	**12.00** .4724	**18.00** .7087	**4.00** .1575	–	**19.50** .7677	**0.80** .0315	**4.00** .1575	–	**19.50** .7677	**0.80** .0315	**0.20** .008	**13.40** .528	**16.60** .654	926	530	X	X	15,000	10,000
6801	**12.00** .4724	**21.00** .8268	**5.00** .1969	–	–	–	**5.00** .1969	–	–	–	**0.30** .012	**14.00** .551	**19.00** .748	1930	900	X	–	30,000	–
6801/003	**12.00** .4724	**21.00** .8268	**6.00** .2362	–	–	–	**6.00** .2362	–	–	–	**0.30** .012	**14.00** .551	**19.00** .748	1720	840	X	–	32,000	–
6801/004	**12.00** .4724	**21.00** .8268	**7.00** .2756	–	**23.00** .9055	**1.50** .0591	**7.00** .2756	–	**23.00** .9055	**1.50** .0591	**0.30** .012	**14.00** .551	**19.00** .748	1915	1041	X	X	39000	24,000
6901	**12.00** .4724	**24.00** .9449	**6.00** .2362	–	–	–	**6.00** .2362	–	–	–	**0.30** .012	**14.00** .551	**22.00** .866	2971	1460	X	–	32,000	–
16001	**12.00** .4724	**28.00** 1.1024	**7.00** .2756	–	–	–	**7.00** .2756	–	–	–	**0.30** .012	**14.00** .551	**26.00** 1.024	5100	2370	–	–	32,000	–
6001	**12.00** .4724	**28.00** 1.1024	**8.00** .3150	–	**30.00** 1.1811	**2.00** .0787	**8.00** .3150	–	**30.00** 1.1811	**2.00** .0787	**0.30** .012	**14.00** .551	**26.00** 1.024	5237	2370	X	X	31,000	17,000
6001/003	**12.00** .4724	**28.00** 1.1024	**11.00** .4331	–	–	–	**11.00** .4331	–	–	–	**0.30** .012	**14.00** .551	**26.00** 1.024	5237	2359	X	–	31,000	–
63001	**12.00** .4724	**28.00** 1.1024	**12.00** .4724	–	–	–	**12.00** .4724	–	–	–	**0.50** .020	**14.00** .551	**26.00** 1.024	5100	2370	X	X	30,000	16,000

Note:
[1] $r_{s\ min}$ = minimum single bearing chamfer or maximum permissible shaft or housing fillet radius.
[2] Other load ratings are possible due to different ball sets with use of a non-standard retainer.
[3] Different shields or seals available.
[4] Bearings also available with 1 or 2 shields/seals.
[5] Limiting speed also depends on seal material and the respective ball set.

- Ball bearings without shields or seals are also available with recesses.
- Please discuss your desired design in terms of flange, extended inner ring width, shield, seal, and material with our Technical Application Consultants to find out about availability.
- Subject to change due to technical improvement.

Groove radial ball bearings – metric

GRW-designation	Main dimensions in **[mm]** [inch]		Bearing without closure in **[mm]** [inch]				Bearing with closure in **[mm]** [inch]				Chamfer in **[mm]** [inch]	Modification dimensions acc. to DIN 5418 **[mm]** [inch]		Load ratings acc. to DIN ISO [2] (max)		Closure variants [3]		Max. limiting speed [5] [mm^{-1}]	
			Width without closure	Width with extended inner ring without closure	Flange dimensions without closure		Width with extended inner ring with closure	Width with extended inner ring with closure	Flange dimensions with closure			Shaft diameter	Housing diameter						
Basic symbols	d	D	B	B_1	Flange diameter FD	Flange width FB	B_2	B_3	Flange diameter FD_1	Flange width FB_1	$r_{s\ min}$ [1]	$d_{a\ min}$	$D_{a\ max}$	C_r [N]	C_{0r} [N]	Shield [4]	Seal [4]	with closure or with shield	with seal
16101	**12.00** .4724	**30.00** 1.1811	**8.00** .3150	–	–	–	**8.00** .3150	–	–	–	**0.50** .020	**14.40** .567	**27.60** 1.087	5070	2360	X	X	28,000	16,000
6201	**12.00** .4724	**32.00** 1.2598	**10.00** .3937	–	–	–	**10.00** .3937	–	–	–	**0.60** .024	**16.20** .638	**27.80** 1.094	5770	2450	X	X	26,000	15,000
62201	**12.00** .4724	**32.00** 1.2598	**14.00** .5512	–	–	–	**14.00** .5512	–	–	–	**0.60** .024	**16.20** .638	**27.80** 1.094	6890	3100	X	X	25,000	15,000
6301	**12.00** .4724	**37.00** 1.4567	**12.00** .4724	–	–	–	**12.00** .4724	–	–	–	**1.00** .039	**17.60** .693	**31.40** 1.236	8240	3360	X	X	25,000	14,000
62301	**12.00** .4724	**37.00** 1.4567	**17.00** .6693	–	–	–	**17.00** .6693	–	–	–	**1.00** .039	**17.60** .693	**31.40** 1.236	8240	3360	–	X	27,000	14,000
6702	**15.00** .5906	**21.00** .8268	**4.00** .1575	–	–	–	**4.00** .1575	–	–	–	**0.20** .008	**16.40** .646	**19.60** .772	937	582	X	X	13,000	9000
6802	**15.00** .5906	**24.00** .9449	**5.00** .1969	–	–	–	**5.00** .1969	–	–	–	**0.30** .012	**17.00** .669	**22.00** .866	2080	1100	X	X	25,000	15,000
6802/003	**15.00** .5906	**24.00** .9449	**7.00** .2756	– –	**26.00** 1.0236	**1.50** .0591	**7.00** .2756	– –	**26.00** 1.0236	**1.50** .0591	**0.30** .012	**17.00** .669	**22.00** .866	2073	1253	X	X	33,000	18,000
6902	**15.00** .5906	**28.00** 1.1024	**7.00** .2756	–	–	–	**7.00** .2756	–	–	–	**0.30** .012	**17.00** .669	**26.00** 1.024	4445	2268	X	X	24,000	16,000
16002	**15.00** .5906	**32.00** 1.2598	**8.00** .3150	–	–	–	**8.00** .3150	–	–	–	**0.50** .020	**17.00** .669	**30.00** 1.181	5600	2830	X	X	26,000	14,000
6002	**15.00** .5906	**32.00** 1.2598	**9.00** .3543	–	–	–	**9.00** .3543	–	–	–	**0.30** .012	**17.00** .669	**30.00** 1.181	5676	2819	X	–	25,000	–
6202	**15.00** .5906	**35.00** 1.3780	**11.00** .4331	–	–	–	**11.00** .4331	–	–	–	**0.60** .024	**19.20** .756	**30.80** 1.213	6490	3000	X	X	24,000	16,000
62202	**15.00** .5906	**35.00** 1.3780	**14.00** .5512	–	–	–	**14.00** .5512	–	–	–	**0.60** .024	**19.20** .756	**30.80** 1.213	7650	3750	X	X	23,000	13,000
6302	**15.00** .5906	**42.00** 1.6535	**13.00** .5118	–	–	–	**13.00** .5118	–	–	–	**1.50** .059	**24.00** .945	**33.00** 1.299	11400	5450	X	X	21,000	11,000
6703	**17.00** .6693	**23.00** .9055	**4.00** .1575	–	**24.50** .9646	**0.80** .0315	**4.00** .1575	–	**24.50** .9646	**0.80** .0315	**0.20** .008	**18.40** .724	**21.60** .850	1000	658	X	X	11,000	7,000
6803	**17.00** .6693	**26.00** 1.0236	**5.00** .1969	–	–	–	**5.00** .1969	–	–	–	**0.30** .012	**19.00** .748	**24.00** .945	2240	1270	X	–	22,000	–
6903	**17.00** .6693	**30.00** 1.1811	**7.00** .2756	–	–	–	**7.00** .2756	–	–	–	**0.30** .012	**19.00** .748	**28.00** 1.102	4723	2547	X	–	21,000	–
16003	**17.00** .6693	**35.00** 1.378	**8.00** .3150	–	–	–	**8.00** .3150	–	–	–	**0.30** .012	**19.00** .748	**33.00** 1.299	6000	3250	X	–	23,500	–

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Groove radial ball bearings – metric

GRW-designation	Main dimensions in **[mm]** [inch]		Bearing without closure in **[mm]** [inch]				Bearing with closure in **[mm]** [inch]				Chamfer in **[mm]** [inch]	Modification dimensions acc. to DIN 5418 **[mm]** [inch]		Load ratings acc. to DIN ISO [2] (max)		Closure variants [3]		Max. limiting speed [5] [mm^{-1}]	
			Width without closure	Width with extended inner ring without closure	Flange dimensions without closure		Width with extended inner ring with closure	Width with extended inner ring with closure	Flange dimensions with closure			Shaft diameter	Housing diameter						
Basic symbols	d	D	B	B_1	Flange diameter FD	Flange width FB	B_2	B_3	Flange diameter FD_1	Flange width FB_1	$r_{s\ min}$ [1]	$d_{a\ min}$	$D_{a\ max}$	C_r [N]	C_{0r} [N]	Shield [4]	Seal [4]	with closure or with shield	with seal
6003	**17.00** .6693	**35.00** 1.3780	**10.00** .3937	–	–	–	**10.00** .3937	–	–	–	**0.30** .012	**19.00** .748	**33.00** 1.299	5090	2630	X	X	23,000	18,000
6203	**17.00** .6693	**40.00** 1.5748	**12.00** .4724	–	–	–	**12.00** .4724	–	–	–	**0.60** .024	**21.20** .835	**35.80** 1.409	8130	3850	X	X	20,000	15,000
62203	**17.00** .6693	**40.00** 1.5748	**16.00** .6299	–	–	–	**16.00** .6299	–	–	–	**0.60** .024	**21.20** .835	**35.80** 1.409	9560	4750	X	–	21,000	–
6303	**17.00** .6693	**47.00** 1.8504	**14.00** .5512	–	–	–	**14.00** .5512	–	–	–	**1.00** .039	**22.60** .890	**41.40** 1.630	11550	5330	X	X	18,000	14,000
6704	**20.00** .7874	**27.00** 1.0630	**4.00** .1575	–	**28.50** 1.122	**0.80** .0315	**4.00** .1575	–	**28.50** 1.122	**0.80** .0315	**0.20** .008	**5.40** .213	**25.60** 1.008	1402	729	X	X	10,000	7,000
6804	**20.00** .7874	**32.00** 1.2598	**7.00** .2756	–	**35.00** 1.378	**1.50** .0591	**7.00** .2756	–	**35.00** 1.378	**1.50** .0591	**0.30** .012	**22.00** .866	**30.00** 1.181	4015	2462	X	X	25,000	13,000
6904	**20.00** .7874	**37.00** 1.4567	**9.00** .3543	–	**40.00** 1.5748	**2.00** .0787	**9.00** .3543	**2.00** .0787	**40.00** 1.5748	**2.00** .0787	**0.30** .012	**22.00** .866	**35.00** 1.378	6381	3682	X	X	23,000	12,000
16004	**20.00** .7874	**42.00** 1.6535	**8.00** .3150	-	-	-	**8.00** .3150	-	-	-	**0.30** .012	**22.00** .866	**40.00** 1.575	6940	4100	X	–	21,000	–
6004	**20.00** .7874	**42.00** 1.6535	**12.00** .4724	–	–	–	**12.00** .4724	–	–	–	**1.00** .039	**24.60** .969	**37.40** 1.472	7900	4250	X	X	21,000	11,000
6204	**20.00** .7874	**47.00** 1.8504	**14.00** .5512	–	–	–	**14.00** .5512	–	–	–	**1.00** .039	**25.60** 1.008	**41.40** 1.630	10910	5360	X	X	17,000	10,000
6705	**25.00** .9843	**32.00** 1.2598	**4.00** .1575	–	–	–	**4.00** .1575	–	**34.00** 1.3386	**1.00** .0394	**0.20** .008	**5.40** .213	**30.60** 1.205	1091	838	–	X	12,000	8,000
6805	**25.00** .9843	**37.00** 1.4567	**7.00** .2756	–	**40.00** 1.5748	**1.50** .0591	**7.00** .2756	–	**40.00** 1.5748	**1.50** .0591	**0.30** .012	**27.00** 1.063	**35.00** 1.378	4303	2932	X	–	21,000	–
6905	**25.00** .9843	**42.00** 1.6535	**9.00** .3543	–	**45.00** 1.7717	**2.00** .0787	**9.00** .3543	–	**45.00** 1.7717	**2.00** .0787	**0.30** .012	**27.00** 1.063	**40.00** 1.575	7001	4540	X	X	19,000	10,000
16005	**25.00** .9843	**47.00** 1.8504	**8.00** .3150	–	–	–	**8.00** .3150	–	–	–	**0.60** .024	**27.00** 1.063	**45.00** 1.772	8550	4690	X	–	17,000	–
6005	**25.00** .9843	**47.00** 1.8504	**12.00** .4724	–	–	–	**12.00** .4724	–	–	–	**0.60** .024	**28.20** 1.110	**43.80** 1.724	8550	4690	X	X	18,000	9,500
6706	**30.00** 1.1811	**37.00** 1.4567	**4.00** .1575	–	**39.00** 1.5354	**1.00** .0394	**4.00** .1575	–	**39.00** 1.5354	**1.00** .0394	**0.20** .008	**5.40** .213	**35.60** 1.402	1143	947	X	–	17,000	–
6806	**30.00** 1.1811	**42.00** 1.6535	**7.00** .2756	–	**45.00** 1.7717	**1.50** .0591	**7.00** .2756	–	**45.00** 1.7717	**1.50** .0591	**0.30** .012	**32.00** 1.260	**40.00** 1.575	4538	3402	X	X	18,000	9,000
6906	**30.00** 1.1811	**47.00** 1.8504	**9.00** .3543	–	**50.00** 1.9685	**2.00** .0787	**9.00** .3543	–	**50.00** 1.9685	**2.00** .0787	**0.30** .012	**32.00** 1.260	**45.00** 1.772	7242	5003	X	X	17,000	8,500

Note:
[1] $r_{s\ min}$ = minimum single bearing chamfer or maximum permissible shaft or housing fillet radius.
[2] Other load ratings are possible due to different ball sets with use of a non-standard retainer.
[3] Different shields or seals available.
[4] Bearings also available with 1 or 2 shields/seals.
[5] Limiting speed also depends on seal material and the respective ball set.

- Ball bearings without shields or seals are also available with recesses.
- Please discuss your desired design in terms of flange, extended inner ring width, shield, seal, and material with our Technical Application Consultants to find out about availability.
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HIGH-PRECISION BALL BEARINGS

Groove radial ball bearings – metric

GRW-designation	Main dimensions in **[mm]** [inch]		Bearing without closure in **[mm]** [inch]				Bearing with closure in **[mm]** [inch]				Chamfer in **[mm]** [inch]	Modification dimensions acc. to DIN 5418 **[mm]** [inch]		Load ratings acc. to DIN ISO [2] (max)		Closure variants [3]		Max. limiting speed [5] [mm^{-1}]	
			Width without closure	Width with extended inner ring without closure	Flange dimensions without closure		Width with extended inner ring with closure	Width with extended inner ring with closure	Flange dimensions with closure			Shaft diameter	Housing diameter						
Basic symbols	d	D	B	B_1	Flange diameter FD	Flange width FB	B_2	B_3	Flange diameter FD_1	Flange width FB_1	$r_{s\ min}$ [1]	$d_{a\ min}$	$D_{a\ max}$	C_r [N]	C_{0r} [N]	Shield [4]	Seal [4]	with closure or with shield	with seal
6807	**35.00** 1.3780	**47.00** 1.8504	**7.00** .2756	–	**50.00** 1.9685	**1.50** .0591	**7.00** .2756	–	**50.00** 1.9685	**1.50** .0591	**0.30** .012	**37.00** 1.457	**45.00** 1.772	4729	3821	X	X	16,000	8,000

Your Notes

Note:
[1] $r_{s\ min}$ = minimum single bearing chamfer or maximum permissible shaft or housing fillet radius.
[2] Other load ratings are possible due to different ball sets with use of a non-standard retainer.
[3] Different shields or seals available.
[4] Bearings also available with 1 or 2 shields/seals.
[5] Limiting speed also depends on seal material and the respective ball set.

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- Subject to change due to technical improvement.

Groove radial ball bearings – inch

GRW designation	Main dimensions in [mm] **[inch]**		Bearing without closure in [mm] **[inch]**				Bearing with closure in [mm] **[inch]**				Chamfer in [mm] **[inch]**	Modification dimensions acc. to ANSI/AFBMA Std. 12.2 in [mm] **[inch]**		Load ratings acc. to DIN ISO [2] (max)		Closure variants [3]		Max. limiting speed [5] [mm^{-1}]	
			Width without closure	Width with extended inner ring without closure	Flange dimensions without closure		Width with closure	Width with extended inner ring with closure	Flange dimensions with closure			Shaft diameter	Housing diameter						
Basic symobls	d	D	B	B_1	Flange diameter FD	Flange width FB	B_2	B_3	Flange diameter FD_1	Flange width FB_1	$r_{s\ min}$ [1]	$d_{a\ min}$	$D_{a\ max}$	C [N]	C_{0r} [N]	Shield[4]	Packing[4]	with closure or with shield	shield
1016	1.016 **.0400**	3.175 **.1250**	1.191 **.0469**	–	–	–	–	–	–	–	0.08 **.003**	1.50 **.059**	2.65 **.104**	106	28	–	–	150,000	–
1191	1.191 **.0469**	3.967 **.1562**	1.588 **.0625**	2.381 **.0937**	5.156 **.2030**	0.330 **.0130**	–	–	–	–	0.08 **.003**	1.80 **.071**	3.35 **.132**	163	44	–	–	129,000	–
1397	1.397 **.0550**	4.763 **.1875**	1.984 **.0781**	–	–	–	2.779 **.1094**	–	5.944 **.2340**	0.787 **.03100**	0.08 **.003**	2.00 **.079**	4.15 **.163**	239	67	X	–	114,000	–
5/64	1.984 **.0781**	6.350 **.2500**	2.380 **.0937**	3.175 **.1250**	7.518 **.2960**	0.584 **.0230**	3.571 **.1406**	4.366 **.1719**	7.518 **.2960**	0.787 **.0310**	0.08 **.003**	2.60 **.102**	5.75 **.226**	286	90	X	–	95000	–
2380	2.380 **.0937**	4.763 **.1875**	1.588 **.0625**	2.380 **.0937**	5.944 **.2340**	0.457 **.0180**	2.380 **.0937**	3.175 **.1250**	5.944 **.2340**	0.787 **.0310**	0.08 **.003**	2.90 **.114**	4.25 **.167**	192	59	X	–	94,000	–
3175/0002	2.380 **.0937**	6.350 **.2500**	2.779 **.1094**	–	7.518 **.2960**	0.787 **.0310**	2.779 **.1094**	–	7.518 **.2960**	0.787 **.0310**	0.08 **.003**	2.95 **.116**	5.75 **.226**	292	97	X	–	82,000	–
3/32	2.380 **.0937**	7.938 **.3125**	2.779 **.1094**	3.571 **.1406**	9.119 **.3590**	0.584 **.0230**	3.571 **.1406**	4.366 **.1719**	9.119 **.3590**	0.787 **.0310**	0.08 **.003**	3.10 **.122**	7.25 **.285**	644	215	X	X	62,000	51,000
3175/002	3.175 **.1250**	6.350 **.2500**	–	–	–	–	2.380 **.0937**	–	7.518 **.2960**	0.584 **.0230**	0.08 **.003**	3.75 **.148**	5.75 **.226**	311	109	X	–	80,000	–
3175	3.175 **.1250**	6.350 **.2500**	2.380 **.0937**	3.175 **.1250**	7.518 **.2960**	0.584 **.0230**	2.779 **.1094**	3.571 **.1406**	7.518 **.2960**	0.787 **.0310**	0.08 **.003**	3.75 **.148**	5.75 **.226**	292	97	X	X	80,000	53,000
3175A	3.175 **.1250**	6.350 **.2500**	2.380 **.0937**	–	7.518 **.2960**	0.584 **.0230**	2.779 **.1094**	–	7.518 **.2960**	0.787 **.0310**	0.08 **.003**	3.75 **.148**	5.75 **.226**	311	109	X	–	80,000	–
1/8A	3.175 **.1250**	7.938 **.3125**	2.779 **.1094**	3.571 **.1406**	9.119 **.3590**	0.584 **.0230**	3.571 **.1406**	4.366 **.1719**	9.119 **.3590**	0.787 **.0310**	0.08 **.003**	3.90 **.154**	7.20 **.283**	644	215	X	X	65,000	51,000
3175/061	3.175 **.1250**	9.525 **.3750**	2.779 **.1094**	–	–	–	2.779 **.1094**	–	–	–	0.08 **.003**	3.90 **.154**	8.80 **.346**	292	97	X	–	80,000	–
3175/6	3.175 **.1250**	9.525 **.3750**	–	–	–	–	2.779 **.1094**	–	–	–	0.08 **.003**	3.90 **.154**	8.80 **.346**	292	97	X	–	80,000	–
1/8A/6	3.175 **.1250**	9.525 **.3750**	–	–	–	–	3.571 **.1406**	4.366 **.1719**	10.719 **.4220**	0.787 **.0310**	0.08 **.003**	3.90 **.154**	8.80 **.346**	644	215	X	X	82,000	51,000
1/8B	3.175 **.1250**	9.525 **.3750**	3.967 **.1562**	4.763 **.1875**	11.176 **.4400**	0.762 **.0300**	3.967 **.1562**	4.763 **.1875**	11.176 **.4400**	0.762 **.0300**	0.30 **.012**	4.55 **.179**	8.25 **.325**	720	260	X	X	61,000	44,000
3175/552	3.175 **.1250**	10.414 **.4100**	–	–	–	–	2.380 **.0937**	–	–	–	0.08 **.003**	3.75 **.148**	8.40 **.331**	292	97	X	–	80,000	–
3175/8	3.175 **.1250**	12.700 **.5000**	–	–	–	–	2.779 **.1094**	3.571 **.1406**	–	–	0.08 **.003**	4.55 **.179**	11.35 **.447**	292	97	X	–	80,000	–
1/8B/083	3.175 **.1250**	12.700 **.5000**	4.366 **.1719**	–	–	–	4.366 **.1719**	–	–	–	0.30 **.012**	4.55 **.179**	11.35 **.447**	725	265	X	–	74,000	–

Note:
[1] $r_{s\ min}$ = minimum single bearing chamfer or maximum permissible shaft or housing fillet radius.
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[3] Different shields or seals available.
[4] Bearings also available with 1 or 2 shields/seals.
[5] Limiting speed also depends on seal material and the respective ball set.

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- Subject to change due to technical improvement.

Groove radial ball bearings – inch

GRW designation	Main dimensions in [mm] **[inch]**		Bearing without closure in [mm] **[inch]**				Bearing with closure in [mm] **[inch]**				Chamfer in [mm] **[inch]**	Modification dimensions acc. to ANSI/AFBMA Std. 12.2 in [mm] **[inch]**		Load ratings acc. to DIN ISO [2] (max)		Closure variants [3]		Max. limiting speed [5] [mm^{-1}]	
			Width without closure	Width with extended inner ring without closure	Flange dimensions without closure		Width with closure	Width with extended inner ring with closure	Flange dimensions with closure			Shaft diameter	Housing diameter						
Basic symobls	d	D	B	B_1	Flange diameter FD	Flange width FB	B_2	B_3	Flange diameter FD_1	Flange width FB_1	$r_{s\ min}$ [1]	$d_{a\ min}$	$D_{a\ max}$	C [N]	C_{0r} [N]	Shield[4]	Packing[4]	with closure or with shield	shield
3967/002	3.967 **.1562**	7.938 **.3125**	–	–	–	–	2.779 **.1094**	–	–	–	0.08 **.003**	4.55 **.179**	7.30 **.287**	391	165	X	–	65,000	–
3967	3.967 **.1562**	7.938 **.3125**	2.779 **.1094**	3.571 **.1406**	9.119 **.3590**	0.584 **.0230**	3.175 **.1250**	3.967 **.1562**	9.119 **.3590**	0.914 **.0360**	0.08 **.003**	4.55 **.179**	7.30 **.287**	391	165	X	X	68,000	42,000
4763A/002	4.763 **.1875**	7.938 **.3125**	–	–	–	–	2.779 **.1094**	–	–	–	0.08 **.003**	5.35 **.211**	7.30 **.287**	391	165	X	–	61,000	–
4763A	4.763 **.1875**	7.938 **.3125**	2.779 **.1094**	3.571 **.1406**	9.119 **.3590**	0.584 **.0230**	3.175 **.1250**	3.967 **.1562**	9.119 **.3590**	0.914 **.0360**	0.08 **.003**	5.35 **.211**	7.30 **.287**	391	165	X	X	65,000	42,000
4763A/062	4.763 **.1875**	9.525 **.3750**	2.779 **.1094**	–	–	–	2.779 **.1094**	–	–	–	0.08 **.003**	5.35 **.211**	7.30 **.287**	391	165	X	X	65,000	42,000
4763B	4.763 **.1875**	9.525 **.3750**	3.175 **.1250**	3.967 **.1562**	10.719 **.4220**	0.584 **.0230**	3.175 **.1250**	3.967 **.1562**	10.719 **.4220**	0.787 **.0310**	0.08 **.003**	5.50 **.217**	8.80 **.346**	730	271	X	X	56,000	41,000
4763A/082	4.763 **.1875**	12.700 **.5000**	–	–	–	–	2.779 **.1094**	3.571 **.1406**	–	–	0.08 **.003**	5.35 **.211**	8.80 **.346**	391	165	X	–	70,000	–
4763B/083	4.763 **.1875**	12.700 **.5000**	3.967 **.1562**	–	–	–	3.967 **.1562**	–	–	–	0.08 **.003**	6.20 **.244**	11.35 **.447**	730	271	X	–	56,000	–
3/16/002	4.763 **.1875**	12.700 **.5000**	–	–	–	–	3.967 **.1562**	–	–	–	0.30 **.012**	6.20 **.244**	11.35 **.447**	1339	488	X	–	50,000	–
3/16	4.763 **.1875**	12.700 **.5000**	3.967 **.1562**	4.763 **.1875**	14.351 **.5000**	1.067 **.0420**	4.978 **.1960**	5.771 **.2272**	14.351 **.5000**	1.067 **.0420**	0.30 **.012**	6.20 **.244**	11.35 **.447**	1339	488	X	X	50,000	37,000
4763B/084	4.763 **.1875**	12.700 **.5000**	2.779 **.1094**	-	-	-	5.558 **.2188**	-	-	-	0.30 **.012**	6.20 **.244**	11.35 **.447**	730	271	–	–	43,000	–
1/4A/0001	4.763 **.1875**	15.875 **.6250**	4.978 **.1960**	–	17.526 **.6900**	1.067 **.0420**	4.978 **.196**	–	17.526 **.6900**	1.067 **.0420**	0.30 **.012**	6.20 **.244**	14.35 **.565**	1651	670	X	X	41,000	31,000
6350A	6.350 **.2500**	9.525 **.3750**	3.175 **.1250**	3.967 **.1562**	10.719 **.4220**	0.584 **.02300**	3.175 **.1250**	3.967 **.1562**	10.719 **.4220**	0.914 **.0360**	0.08 **.003**	6.90 **.272**	8.95 **.352**	391	165	X	X	54,000	35,000
6350B	6.350 **.2500**	12.700 **.5000**	3.175 **.1250**	3.967 **.1562**	13.894 **.5000**	0.584 **.02300**	4.763 **.1875**	5.558 **.2188**	13.894 **.5000**	1.143 **.0450**	0.13 **.005**	7.20 **.283**	11.85 **.467**	730	271	X	X	38,000	33000
1/4A	6.350 **.2500**	15.875 **.6250**	4.978 **.1960**	5.771 **.2272**	17.526 **.6900**	1.067 **.0420**	4.978 **.1960**	5.771 **.2272**	17.526 **.6900**	1.067 **.0420**	0.30 **.012**	7.85 **.309**	14.35 **.565**	1651	670	X	X	43,000	31,000
1/4/002	6.350 **.2500**	19.050 **.7500**	–	–	–	–	5.558 **.2188**	–	–	–	0.41 **.016**	8.20 **.323**	17.20 **.677**	2522	1057	X	X	35,000	28,000
1/4	6.350 **.2500**	19.050 **.7500**	5.558 **.2188**	–	–	–	7.142 **.2812**	–	–	–	0.41 **.016**	8.20 **.323**	17.20 **.677**	2522	1057	X	X	35,000	28,000
7938	7.938 **.3125**	12.700 **.5000**	3.967 **.1562**	4.763 **.1875**	13.894 **.5000**	0.787 **.03100**	3.967 **.1562**	4.763 **.1875**	13.894 **.5000**	0.787 **.0310**	0.13 **.005**	8.80 **.346**	11.85 **.467**	539	279	X	X	45,000	30,000

Note:
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Groove radial ball bearings – inch

GRW designation	Main dimensions in [mm] **[inch]**		Bearing without closure in [mm] **[inch]**				Bearing with closure in [mm] **[inch]**				Chamfer in [mm] **[inch]**	Modification dimensions acc. to ANSI/AFBMA Std. 12.2 in [mm] **[inch]**		Load ratings acc. to DIN ISO [2] (max)		Closure variants [3]		Max. limiting speed [5] [mm^{-1}]	
			Width without closure	Width with extended inner ring without closure	Flange dimensions without closure		Width with closure	Width with extended inner ring with closure	Flange dimensions with closure			Shaft diameter	Housing diameter						
Basic symobls	d	D	B	B_1	Flange diameter FD	Flange width FB	B_2	B_3	Flange diameter FD_1	Flange width FB_1	$r_{s\ min}$ [1]	$d_{a\ min}$	$D_{a\ max}$	C [N]	C_{0r} [N]	Shield[4]	Packing[4]	with closure or with shield	shield
9525	9.525 **.3750**	15.875 **.6250**	3.967 **.1562**	–	–	–	3.967 **.1562**	–	–	–	0.25 **.010**	11.05 **.435**	14.35 **.565**	856	435	X	–	35,000	–
3/8/002	9.525 **.3750**	22.225 **.8750**	–	–	–	–	5.558 **.2188**	–	–	–	0.41 **.016**	11.45 **.451**	20.30 **.799**	2555	1129	X	–	30,000	–
3/8	9.525 **.3750**	22.225 **.8750**	5.558 **.2188**	–	24.613 **.9690**	1.575 **.0620**	7.142 **.2812**	–	24.613 **.9690**	1.575 **.0620**	0.41 **.016**	11.45 **.451**	20.30 **.799**	2555	1129	X	X	30,000	24,000
12700A/002	12.700 **.5000**	19.050 **.7500**	–	–	–	–	3.967 **.1562**	–	–	–	0.25 **.010**	14.20 **.500**	17.55 **.691**	918	542	X	X	28,000	20,000
12700B	12.700 **.5000**	22.225 **.8750**	7.142 **.2812**	–	–	–	7.142 **.2812**	–	–	–	0.41 **.016**	14.20 **.500**	20.30 **.799**	1972	1144	X	–	28,000	–
1/2	12.700 **.5000**	28.575 **1.1250**	6.350 **.2500**	–	31.115 **1.2250**	1.575 **.0620**	7.938 **.3125**	–	31.115 **1.2250**	1.575 **.0620**	0.41 **.016**	15.90 **.626**	26.05 **1.026**	5108	2413	X	X	32,000	21,000
15875A	15.875 **.6250**	22.225 **.8750**	3.967 **.1562**	–	–	–	3.967 **.1562**	–	–	–	0.25 **.010**	19.05 **.750**	20.30 **.799**	1133	801	X	–	25,000	–
5/8	15.875 **.6250**	34.925 **1.3750**	7.142 **.2812**	–	–	–	8.733 **.3438**	–	37.846 **1.4900**	1.745 **.0687**	0.80 **.031**	19.05 **.750**	31.75 **1.250**	5999	3265	X	–	25,000	–

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[3] Different shields or seals available.
[4] Bearings also available with 1 or 2 shields/seals.
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Spindle / angular contact bearings

Spindle bearings are single-row angular contact bearings with a nominal contact angle of 15° (C) or 25° (E). They can be subjected to both radial and (in one direction) axial loads. The direction of the axial load carrying capacity is shown by a "V" marking on the outer ring. GRW spindle ball bearings are suitable for applications requiring precision while carrying high loads combined with high speeds.

GRW spindle ball bearings are characterised by the following properties:

- Manufactured quality of P4 (or ABEC7) or better.
- Rings generally made of corrosion-resistant SV 30 high-grade steel.
- Steel or ceramic balls.
- Solid retainer made from fiber-reinforced phenolic resin or special materials, for applications involving higher temperatures.
- 15° (C) or 25° (E) contact angles are standard.
- Optionally, bearings can be paired and ground to three pre-defined preload classes (L, M, S) or to a specific customer defined preload.
- Oil or grease lubrication.
- Open and shielded versions available.
- Cleanroom assembly, lubrication and packaging.

Open spindle ball bearings

- Standard configuration has large balls for optimum utilisation of bearing geometries and a solid retainer for higher bearing capacities.
- The outer ring has only one partial shoulder remaining. This partial shoulder is necessary to prevent the , bearing from separation.
- Solid outer ring guided retainer with a low profile cross-section is particularly well suited for oil injection lubrication.

Shielded spindle ball bearings

- Non-contact shields do not add any additional torque caused by the shields.
- Standard shields made of Viton (VZ) coupled with a stainless steel support shield offer excellent temperature and debris resistance.
- A very small, closely toleranced sealing gap provides protection against dust particles.
- GRW recommends using a grease lubricant for longer life and reliability.
- Dimensionally identical to non-shielded spindle bearings.
- This type of design often requires use of smaller balls that results in a lower load capacity but higher axial stiffness and speed limits (usually signified by an 'A', 'B', ... after the base type).
- Also available without shields for high-speed applications.

Handling

- GRW recommends to keep the bearing in its airtight packaging until it is ready for assembly.
- Extreme cleanliness during assembly is recommended.
- Avoid dropping or subjecting the bearing to any kind of impact loading.
- Spindle bearings are designed to handle axial loads in only one direction. This direction is identified by the "V" laser marking on the outer ring.
- Using the proper assembly tooling will prevent damage to the bearing.
- Duplex bearings labeled (DB), (DF), or (DT) are always packed in pairs and can only be used as pairs in the specified configuration.
- Universally matched Duplex bearings can be used in every combination of configurations, i.e. you can combine bearings from different packages or lots. These bearings may be assembled in any duplex arrangement.
- Prior to running bearings at high speed a run in period helps to distribute lubricant and is beneficial for the bearing!

HIGH-PRECISION BALL BEARINGS

Duplex bearings

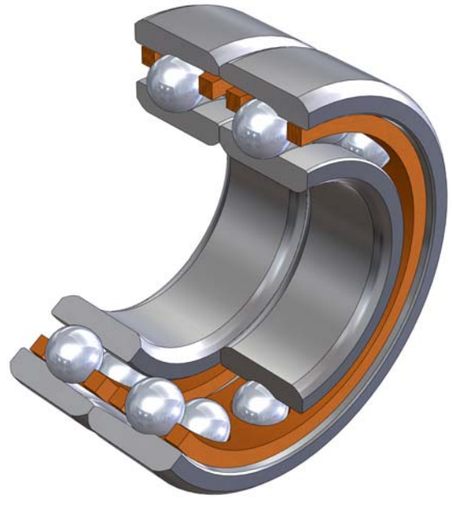
Duplex bearings are two matched bearings that provide the following performance benefits:

- Accurate bearing alignment in radial and axial directions including defined clearances and controlled stiffness.
- Increased system reliability.
- Higher load capacities.

Duplexing of these bearings is performed by loading each bearing with the specified preload and accurately grinding the inner and/or outer rings until the bearing faces of both rings are flush.

Paired bearings machined this way are designed to be assembled in the following configurations: back-to-back (DB), face-to-face (DF) or tandem (DT) and axially loaded to the specified or required force. Duplexed bearings are designed to provide the specified preload when the ground surfaces are accurately pressed together.

The ball bearings must be mounted according to the designation on the packaging labels or "V" markings on the outer rings.



Deep groove radial bearings:

For deep groove Duplex bearings the radial play is bigger than normal to facilitate the desired contact angle, rigidity and axial load capacity.

Unless otherwise specified, GRW grind duplex deep groove radial bearings to a preload of 5 N and a nominal contact angle of 15°. If necessary, preload and contact angles can be adjusted to a customer's unique operating requirements.

Spindle ball bearings:

Preload and the contact angle are generally standardised for spindle bearings. GRW's standard contact angles are 15° (C) or 25° (E), preloads are specified as light (L), medium (M) or strong (S). If necessary, preloads and contact angles can be customised to each customer's individual operating requirements.

By default, GRW uses for:	Deep groove radial bearings	Spindle bearings
Contact angle α	15° (C)	15° (C) or 25° (E)
Preload FV	5 N	L, M, S

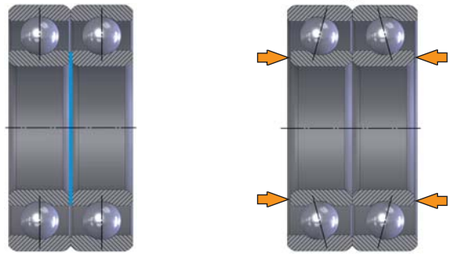
However, the preload should not be specified higher than necessary as this would result in an increase of start up and running torque, which in turn would directly affect the expected life of the bearing.

To achieve an identical fit for both bearings, Duplex bearings are sorted into two groups. The bore and outer diameters are packaged in pairs with bearings from the same group. To take full advantage of these duplexed pairs, they should also be mounted with calibrated shafts and housings (see the chapter "Grading of bore and outside diameters"). Bearing fits should be carefully selected because an interference fit on the inner or outer ring will change the preload.

Installation and configuration of duplexed bearings

O (<>) arrangement: Back to back (designation –1 and DB for spindle bearings)

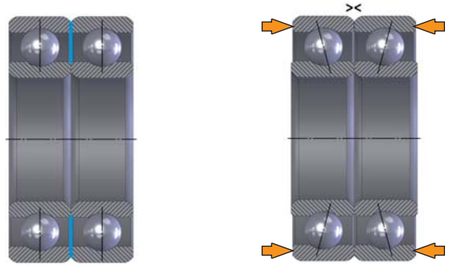
With this bearing configuration the inner rings are designed to be clamped together. The contact angle load path between the outer ring raceway, the ball and the inner ring curvature diverge, which results in maximum stability and stiffness against any moment loading. Radial and axial loads can be taken in both directions.



without preload *preloaded*

X (><) arrangement: Face to face (designation –2 and DF for spindle bearings)

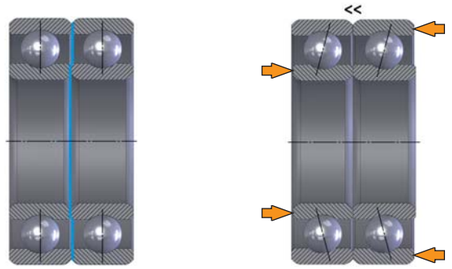
With this bearing configuration, the inner rings are designed to be clamped together. The load path converges resulting in less stability and a lower stiffness against moment loading. This design more easily compensates any misalignment of the assembly. Radial and axial loads can likewise be taken in both directions.



without preload *preloaded*

Tandem (>>) or (<<) arrangement (designation –3 and DT for spindle bearings)

Duplex bearings in O- and X- configurations are designed to accommodate axial loading in both directions. The tandem-mounted bearing design is capable of taking a significantly higher axial load, but only in one direction. With this type of bearing, preloading and control of axial play can only be achieved by preloading against another bearing.

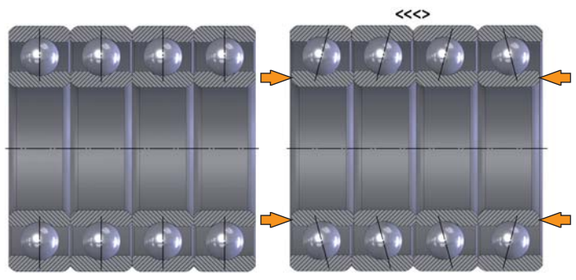


without preload *preloaded*

General: Bearings of these pairing types are packed in pairs or sets and must not be mixed

Universal Tandem arrangement (designation –4 and DT for spindle bearings).

Universally matched bearing pairs have a significant advantage compared to the duplexed designs described above. They are individually ground in such a way that they can be assembled in various pairing configurations, e.g. X, O, or tandem; without any loss in performance. With the same preload, these single bearings can be interchanged without any problems.

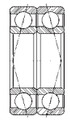
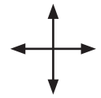
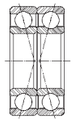
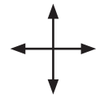
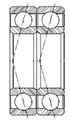
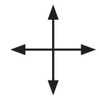
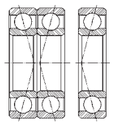
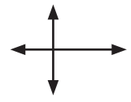


without preload *preloaded*

HIGH-PRECISION BALL BEARINGS

Bearing sets

When a higher stiffness is specified, multiple duplexed bearing configurations may be used together to get the desired results. Depending on the application, these bearing sets can be made up of universally paired bearings in X, O, or tandem configurations. The table below shows some examples of possible configurations in more detail.

	Usual designation	Mark/ arrangement	Permissible load direction	Rigidity
	O -arrangement –1 or DB	<>	 axial radial	axial radial rigidity against tilting torques
	X -arrangement –2 or DF	><	 axial radial	axial radial
	Tandem arrangement –3 or DT	<< or >>	radial and unilaterally axial	unilaterally radial
	Universal –4 or U	<<> Examples: >< or <> or >> or…	 axial radial	depending on the arrangement
	Set of bearings assembled from universally matched bearings	>< Examples: <>>		depending on the arrangement

Superduplex bearings

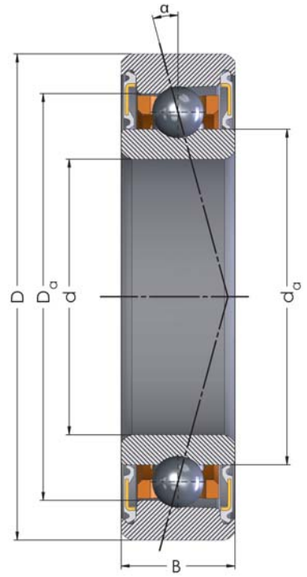
Superduplex bearings are double-row deep groove radial bearings or angular contact bearings where either the inner or outer rings are integral and the remaining rings are separate to allow assembly and correct preloading. (See also chapter "Special bearings" → Superduplex bearings or Extraduplex bearings).

For Superduplex bearings, the following configurations apply:

- **designation –5**
  O-configuration (<>)
  (corresponds to designation –1)
- **designation –6**
  X-configuration (><)
  (corresponds to designation –2)
- **designation –7**
  Tandem (corresponds to designation –3)

Designation system of spindle ball bearings

-	-	705	-	C	P4
HY	SS	7000	-Z	E	P4S
ZO	SV	795	-2Z	D = ... °	
		7900	-VZ		
		705**B**	-2VZ		
			-TZF		
			-2TZF		
- steel balls **HY** ceramic balls made of Si_3N_4 **ZO** ceramic balls made of ZrO_2	**-** 100Cr6 **SS** X65Cr13 **SV** X30CrMoN15-1 Standard	**70..** Series 10 **79..** Series 19 705**B** Modified internal design	**-** open ball bearing **-Z** one metal shield **-2Z** two metal shields **-VZ** **one Viton shield** **-2VZ** two Viton shields **-TZF** **one Teflon®shield** **-2TZF** two Teflon®shields All Variants are non-contact closures	**C** 15° **E** 25° other contact angles available on request, e.g. D = 20°	**P4** acc. to DIN 620-2 **P4S** dimension accuracy P4, running accuracy P2, acc. to DIN 620-2



TA	-	-	-	-	-
TB	X	U	L	... %	L...
AC2TA	XB	DB	M		G...
L2TA	XD	DF	S		L299
	X4	DT	/X		
	X4B				
	X4D				
TA solid retainer made of fiber-reinforced phenolic resin guided by outer ring **TB** same as TA, guided by inner ring **TXA** other retainer materials available on request **-TA** angular contact **-TB** shoulder on outer ring (standard) **AC2** angular contact shoulder on inner ring (standard) **L2TA** inner ring can be dismounted, solid retainer keeps the balls	**-** without diameter grading **X** bore and outside diameter graded in 2 classes **XB** bore graded in 2 classes **XD** outside diameter graded in 2 classes **X4** bore and outside diameter graded in 4 classes **X4B** bore graded in 4 classes **X4D** outside diameter graded in 4 classes	**-** single bearing not duplexed **U** universally duplexed **Bearing pair:** **DB** 2 bearings in O-arrangement **DF** 2 bearings in X-arrangement **DT** 2 bearings in Tandem arrangement	**-** without preload **L** light **M** medium **S** heavy/ strong **/X** preload value in [N] if other than L, M, S. Example: Spindle ball bearing U/10 (= universally paired with 10 N preload)	**-** Standard grease quantitiy 20 % of free bearing volume with closed spindle bearing **... %** adjusted lubricant quantity in [%] of free bearing volume	**-** open bearings are preserved with oil L001, closed bearings are greased with 20% grease G510 as a standard **L...** Oil **G...** Grease **L299** dry bearing

Spindle ball bearings

GRW designation	Main dimensions in **[mm]** [inch]			Load ratings acc. to DIN ISO		Ball set		Limiting speeds*		Preload		
Basic symbols	d	D	B	C_{0r} [N]	C_r [N]	Z	Dw **[mm]** [inch]	Oil [min^{-1}]	Grease [min^{-1}]	(L) light [N]	(M) medium [N]	(S) heavy [N]
AC bearings, open, metric												
SV723 C TA	**3.00** .1181	**10.00** .3937	**4.00** .1575	170	506	8	**1.588** .0625	254,000	209,000	5	8	16
HYSV723 C TA	**3.00** .1181	**10.00** .3937	**4.00** .1575	119	506	8	**1.588** .0625	373,000	269,000	5	8	16
SV774 C TA	**4.00** .1575	**7.00** .2756	**2.00** .0787	77	223	10	**1.000** .0394	309,000	255,000	5	7	10
HYSV774 C TA	**4.00** .1575	**7.00** .2756	**2.00** .0787	54	223	10	**1.000** .0394	455,000	327,000	5	7	10
SV724 C TA	**4.00** .1575	**13.00** .5118	**5.00** .1969	364	1037	8	**2.381** .0937	195,000	161,000	5	16	32
HYSV724 C TA	**4.00** .1575	**13.00** .5118	**5.00** .1969	255	1037	8	**2.381** .0937	287,000	206,000	5	16	32
SV734 C TA	**4.00** .1575	**16.00** .6299	**5.00** .1969	721	1594	9	**2.500** .0984	157,000	130,000	8	24	49
HYSV734 C TA	**4.00** .1575	**16.00** .6299	**5.00** .1969	504	1594	9	**2.500** .0984	231,000	167,000	8	24	49
SV725 C TA	**5.00** .1969	**16.00** .6299	**5.00** .1969	721	1594	9	**2.500** .0984	157,000	130,000	8	24	49
HYSV725 C TA	**5.00** .1969	**16.00** .6299	**5.00** .1969	504	1594	9	**2.500** .0984	231,000	167,000	8	24	49
SV735 C TA	**5.00** .1969	**19.00** .7480	**6.00** .2362	1277	2612	10	**3.175** .1250	127,000	105,000	13	40	80
HYSV735 C TA	**5.00** .1969	**19.00** .7480	**6.00** .2362	894	2612	10	**3.175** .1250	187,000	135,000	13	40	80
SV786 C TA	**6.00** .2362	**13.00** .5118	**3.50** .1378	354	895	10	**1.984** .0781	175,000	144,000	5	14	28
HYSV786 C TA	**6.00** .2362	**13** .5118	**3.50** .1378	247	895	10	**1.984** .0781	258,000	186,000	5	14	28
SV786 E TA	**6.00** .2362	**13.00** .5118	**3.50** .1378	332	856	10	**1.984** .0781	149,000	123,000	5	14	28
HYSV786 E TA	**6.00** .2362	**13.00** .5118	**3.50** .1378	232	856	10	**1.984** .0781	219,000	158,000	5	14	28
SV786/001 C TA	**6.00** .2362	**13.00** .5118	**5.00** .1969	354	895	10	**1.984** .0781	175,000	144,000	5	14	28
HYSV786/001 C TA	**6.00** .2362	**13.00** .5118	**5.00** .1969	247	895	10	**1.984** .0781	258,000	186,000	5	14	28
SV726 C TA	**6.00** .2362	**19.00** .7480	**6.00** .2362	1277	2612	10	**3.175** .1250	127,000	105,000	13	40	80
HYSV726 C TA	**6.00** .2362	**19.00** .7480	**6.00** .2362	894	2612	10	**3.175** .1250	187,000	135,000	13	40	80
SV707 C TA	**7.00** .2756	**19.00** .7480	**6.00** .2362	1277	2612	10	**3.175** .1250	127,000	105,000	13	40	80
HYSV707 C TA	**7.00** .2756	**19.00** .7480	**6.00** .2362	894	2612	10	**3.175** .1250	187,000	135,000	13	40	80
SV727 C TA	**7.00** .2756	**22.00** .8661	**7.00** .2756	1693	3511	9	**3.969** .1563	116,000	95,000	18	54	108
HYSV727 C TA	**7.00** .2756	**22.00** .8661	**7.00** .2756	1185	3511	9	**3.969** .1563	170,000	122,000	18	54	108
SV788 C TA	**8.00** .3150	**16.00** .6299	**4.00** .1575	569	1377	10	**2.500** .0984	142,000	117,000	7	21	42
HYSV788 C TA	**8.00** .3150	**16.00** .6299	**4.00** .1575	398	1377	10	**2.500** .0984	208,000	150,000	7	21	42
SV788 E TA	**8.00** .3150	**16.00** .6299	**4.00** .1575	534	1317	10	**2.500** .0984	120,000	99,000	7	21	42
HYSV788 E TA	**8.00** .3150	**16.00** .6299	**4.00** .1575	374	1317	10	**2.500** .0984	177,000	128,000	7	21	42
SV708 C TA	**8.00** .3150	**22.00** .8661	**7.00** .2756	1693	3511	9	**3.969** .1563	116,000	95,000	18	54	108
HYSV708 C TA	**8.00** .3150	**22.00** .8661	**7.00** .2756	1185	3511	9	**3.969** .1563	170,000	122,000	18	54	108
SV708 E TA	**8.00** .3150	**22.00** .8661	**7.00** .2756	1589	3358	9	**3.969** .1563	98,000	81,000	18	54	108
HYSV708 E TA	**8.00** .3150	**22.00** .8661	**7.00** .2756	1112	3358	9	**3.969** .1563	145,000	104,000	18	54	108
SV789 C TA	**9.00** .3543	**17.00** .6693	**4.00** .1575	642	1471	11	**2.500** .0984	131,000	108,000	8	23	45
HYSV789 C TA	**9.00** .3543	**17.00** .6693	**4.00** .1575	450	1471	11	**2.500** .0984	192,000	138,000	8	23	45
SV709 C TA	**9.00** .3543	**24.00** .9449	**7.00** .2756	1974	3844	10	**3.969** .1563	105,000	86,000	20	59	118
HYSV709 C TA	**9.00** .3543	**24.00** .9449	**7.00** .2756	1382	3844	10	**3.969** .1563	154,000	111,000	20	59	118
SV729 C TA	**9.00** .3543	**26.00** 1.0236	**8.00** .3150	2737	5137	10	**4.763** .1875	94,000	78,000	26	79	158
HYSV729 C TA	**9.00** .3543	**26.00** 1.0236	**8.00** .3150	1916	5137	10	**4.763** .1875	139,000	10,000	26	79	158
SV7800 C TA	**10.00** .3937	**19.00** .7480	**5.00** .1969	724	1556	12	**2.500** .0984	117,000	97,000	8	24	48
HYSV7800 C TA	**10.00** .3937	**19.00** .7480	**5.00** .1969	507	1556	12	**2.500** .0984	172,000	124,000	8	24	48
SV7800 E TA	**10.00** .3937	**19.00** .7480	**5.00** .1969	680	1488	12	**2.500** .0984	10,0000	82,000	8	24	48
HYSV7800 E TA	**10.00** .3937	**19.00** .7480	**5.00** .1969	476	1488	12	**2.500** .0984	147,000	106,000	8	24	48
SV7900 C TA	**10.00** .3937	**22.00** .8661	**6.00** .2362	1500	2824	11	**3.175** .1250	107,000	88,000	15	44	88
HYSV7900 C TA	**10.00** .3937	**22.00** .8661	**6.00** .2362	1050	2824	11	**3.175** .1250	157,000	113,000	15	44	88
SV7900A E TA	**10.00** .3937	**22.00** .8661	**6.00** .2362	1407	2700	11	**3.175** .1250	90,000	74,000	15	44	88
HYSV7900A E TA	**10.00** .3937	**22.00** .8661	**6.00** .2362	985	2700	11	**3.175** .1250	133,000	96,000	15	44	88
SV7000 C TA	**10.00** .3937	**26.00** 1.0236	**8.00** .3150	2737	5137	10	**4.763** .1875	94,000	78,000	26	79	158
HYSV7000 C TA	**10.00** .3937	**26.00** 1.0236	**8.00** .3150	1916	5137	10	**4.763** .1875	139,000	10,000	26	79	158

* The indicated speed limits are guide values for spring-loaded single bearings with low load; depending on the respective application, higher or lower speed limits may apply in practice.
** For use with oil lubrication, these bearings are also available without shields.
Subject to change due to technical improvement.

Spindle ball bearings

GRW designation	Main dimensions in **[mm]** [inch]			Load ratings acc. to DIN ISO		Ball set		Limiting speeds*		Preload		
Basic symbols	d	D	B	C_{0r} [N]	C_r [N]	Z	Dw **[mm]** [inch]	Oil [min^{-1}]	Grease [min^{-1}]	(L) light [N]	(M) medium [N]	(S) heavy [N]
AC bearings, open, metric												
SV7000 E TA	**10.00** .3937	**26.00** 1.0236	**8.00** .3150	2568	4913	10	**4.763** .1875	80,000	66,000	26	79	158
HYSV7000 E TA	**10.00** .3937	**26.00** 1.0236	**8.00** .3150	1798	4913	10	**4.763** .1875	118,000	85,000	26	79	158
SV7200 C TA	**10.00** .3937	**30.00** 1.1811	**9.00** .3543	3192	5597	11	**4.763** .1875	83,000	68,000	29	86	172
HYSV7200 C TA	**10.00** .3937	**30.00** 1.1811	**9.00** .3543	2235	5597	11	**4.763** .1875	122,000	88,000	29	86	172
SV7200 E TA	**10.00** .3937	**30.00** 1.1811	**9.00** .3543	2995	5353	11	**4.763** .1875	71,000	58,000	29	86	172
HYSV7200 E TA	**10.00** .3937	**30.00** 1.1811	**9.00** .3543	2097	5353	11	**4.763** .1875	104,000	75,000	29	86	172
SV7801 C TA	**12.00** .4724	**21.00** .8268	**5.00** .1969	794	1543	14	**2.381** .0937	103,000	84,000	8	24	48
HYSV7801 C TA	**12.00** .4724	**21.00** .8268	**5.00** .1969	556	1543	14	**2.381** .0937	151,000	109,000	8	24	48
SV7801 E TA	**12.00** .4724	**21.00** .8268	**5.00** .1969	745	1476	14	**2.381** .0937	87,000	72,000	8	24	48
HYSV7801 E TA	**12.00** .4724	**21.00** .8268	**5.00** .1969	521	1476	14	**2.381** .0937	128,000	92,000	8	24	48
SV7901 C TA	**12.00** .4724	**24.00** .9449	**6.00** .2362	1700	2992	12	**3.175** .1250	94,000	78,000	15	46	92
HYSV7901 C TA	**12.00** .4724	**24.00** .9449	**6.00** .2362	1190	2992	12	**3.175** .1250	139,000	10,000	15	46	92
SV7901 E TA	**12.00** .4724	**24.00** .9449	**6.00** .2362	1595	2861	12	**3.175** .1250	80,000	66,000	15	46	92
HYSV7901 E TA	**12.00** .4724	**24.00** .9449	**6.00** .2362	1117	2861	12	**3.175** .1250	118,000	85,000	15	46	92
SV7001 C TA	**12.00** .4724	**28.00** 1.1024	**8.00** .3150	2590	4423	12	**3.969** .1563	82,000	68,000	23	68	136
HYSV7001 C TA	**12.00** .4724	**28.00** 1.1024	**8.00** .3150	1813	4423	12	**3.969** .1563	121,000	87,000	23	68	136
SV7001 E TA	**12.00** .4724	**28.00** 1.1024	**8.00** .3150	2430	4230	12	**3.969** .1563	70,000	58,000	23	68	136
HYSV7001 E TA	**12.00** .4724	**28.00** 1.1024	**8.00** .3150	1701	4230	12	**3.969** .1563	103,000	74,000	23	68	136
SV7201C C TA	**12.00** .4724	**32.00** 1.2598	**10.00** .3937	3806	7652	9	**5.953** .2344	77,000	64,000	39	118	235
HYSV7201C C TA	**12.00** .4724	**32.00** 1.2598	**10.00** .3937	2664	7652	9	**5.953** .2344	114,000	82,000	39	118	235
SV7201C E TA	**12.00** .4724	**32.00** 1.2598	**10.00** .3937	3571	7318	9	**5.953** .2344	66,000	54,000	39	118	235
HYSV7201C E TA	**12.00** .4724	**32.00** 1.2598	**10.00** .3937	2500	7318	9	**5.953** .2344	97,000	70,000	39	118	235
SV7802 C TA	**15.00** .5906	**24.00** .9449	**5.00** .1969	1054	1784	18	**2.381** .0937	87,000	72,000	9	27	55
HYSV7802 C TA	**15.00** .5906	**24.00** .9449	**5.00** .1969	738	1784	18	**2.381** .0937	128,000	92,000	9	27	55
SV7802 E TA	**15.00** .5906	**24.00** .9449	**5.00** .1969	989	1706	18	**2.381** .0937	74,000	61,000	9	27	55
HYSV7802 E TA	**15.00** .5906	**24.00** .9449	**5.00** .1969	692	1706	18	**2.381** .0937	109,000	78,000	9	27	55
SV7902 C TA	**15.00** .5906	**28.00** 1.1024	**7.00** .2756	2841	4666	13	**3.969** .1563	79,000	65,000	24	72	143
HYSV7902 C TA	**15.00** .5906	**28.00** 1.1024	**7.00** .2756	1989	4666	13	**3.969** .1563	116,000	84,000	24	72	143
SV7902 E TA	**15.00** .5906	**28.00** 1.1024	**7.00** .2756	2665	4463	13	**3.969** .1563	67,000	55,000	24	72	143
HYSV7902 E TA	**15.00** .5906	**28.00** 1.1024	**7.00** .2756	1866	4463	13	**3.969** .1563	99,000	71,000	24	72	143
SV7002 C TA	**15.00** .5906	**32.00** 1.2598	**9.00** .3543	3970	6327	13	**4.763** .1875	72,000	60,000	32	97	194
HYSV7002 C TA	**15.00** .5906	**32.00** 1.2598	**9.00** .3543	2779	6327	13	**4.763** .1875	106,000	77,000	32	97	194
SV7002 E TA	**15.00** .5906	**32.00** 1.2598	**9.00** .3543	3725	6051	13	**4.763** .1875	62,000	51,000	32	97	194
HYSV7002 E TA	**15.00** .5906	**32.00** 1.2598	**9.00** .3543	2607	6051	13	**4.763** .1875	90,000	65,000	32	97	194
SV7202 C TA	**15.00** .5906	**35.00** 1.3780	**11.00** .4331	4090	6970	13	**4.763** .1875	97,000	63,000	30	60	120
SV7202 E TA	**15.00** .5906	**35.00** 1.3780	**11.00** .4331	3930	6650	13	**4.763** .1875	85,000	55,000	45	90	180
SV7803 C TA	**17.00** .6693	**26.00** 1.0236	**5.00** .1969	1071	1754	18	**2.381** .0937	79,000	65,000	9	27	54
HYSV7803 C TA	**17.00** .6693	**26.00** 1.0236	**5.00** .1969	750	1754	18	**2.381** .0937	116,000	84,000	9	27	54
SV7803 E TA	**17.00** .6693	**26.00** 1.0236	**5.00** .1969	1005	1677	18	**2.381** .0937	67,000	55,000	9	27	54
HYSV7803 E TA	**17.00** .6693	**26.00** 1.0236	**5.00** .1969	704	1677	18	**2.381** .0937	99,000	71,000	9	27	54
SV7903 C TA	**17.00** .6693	**30.00** 1.1811	**7.00** .2756	3137	4888	14	**3.969** .1563	72,000	6,0000	25	75	150
HYSV7903 C TA	**17.00** .6693	**30.00** 1.1811	**7.00** .2756	2196	4888	14	**3.969** .1563	106,000	77,000	25	75	150
SV7903 E TA	**17.00** .6693	**30.00** 1.1811	**7.00** .2756	2944	4675	14	**3.969** .1563	61,000	51,000	25	75	150
HYSV7903 E TA	**17.00** .6693	**30.00** 1.1811	**7.00** .2756	2061	4675	14	**3.969** .1563	90,000	65,000	25	75	150
SV7003 C TA	**17.00** .6693	**35.00** 1.3780	**10.00** .3937	4571	6817	14	**4.763** .1875	65,000	54,000	34	102	205
HYSV7003 C TA	**17.00** .6693	**35.00** 1.3780	**10.00** .3937	3200	6817	14	**4.763** .1875	96,000	69,000	34	102	205
SV7003 E TA	**17.00** .6693	**35.00** 1.3780	**10.00** .3937	4571	6817	14	**4.763** .1875	56,000	46,000	34	102	205
HYSV7003 E TA	**17.00** .6693	**35.00** 1.3780	**10.00** .3937	3200	6817	14	**4.763** .1875	82,000	59,000	34	102	205

* The indicated speed limits are guide values for spring-loaded single bearings with low load; depending on the respective application, higher or lower speed limits may apply in practice.
** For use with oil lubrication, these bearings are also available without shields.
Subject to change due to technical improvement.

Spindle ball bearings

GRW designation / Basic symbols	Main dimensions in **[mm]** [inch] d	D	B	Load ratings acc. to DIN ISO C_{0r} [N]	C_r [N]	Ball set Z	Dw **[mm]** [inch]	Limiting speeds* Oil [min⁻¹]	Grease [min⁻¹]	Preload (L) light [N]	(M) medium [N]	(S) heavy [N]
AC bearings, open, metric												
SV7203 C TA	**17.00** .6693	**40.00** 1.5748	**12.00** .4724	5090	8730	12	**5.556** .2187	85,000	55,000	35	70	140
SV7203 E TA	**17.00** .6693	**40.00** 1.5748	**12.00** .4724	4860	8340	12	**5.556** .2187	75,000	49,000	60	120	240
SV7804 C TA	**20.00** .7874	**32.00** 1.2598	**7.00** .2756	2772	3772	18	**3.175** .1250	65,000	54,000	19	58	115
HYSV7804 C TA	**20.00** .7874	**32.00** 1.2598	**7.00** .2756	1941	3772	18	**3.175** .1250	96,000	69,000	19	58	115
SV7804 E TA	**20.00** .7874	**32.00** 1.2598	**7.00** .2756	2870	3865	18	**3.175** .1250	56,000	46,000	19	58	115
HYSV7804 E TA	**20.00** .7874	**32.00** 1.2598	**7.00** .2756	2009	3772	18	**3.175** .1250	82,000	59,000	19	58	115
SV7904 C TA	**20.00** .7874	**37.00** 1.4567	**9.00** .3543	4854	7543	15	**4.763** .1875	6,0000	49,000	39	116	232
HYSV7904 C TA	**20.00** .7874	**37.00** 1.4567	**9.00** .3543	3398	7543	15	**4.763** .1875	88,000	63,000	39	116	232
SV7904 E TA	**20.00** .7874	**37.00** 1.4567	**9.00** .3543	4554	7214	15	**4.763** .1875	51,000	42,000	39	116	232
HYSV7904 E TA	**20.00** .7874	**37.00** 1.4567	**9.00** .3543	3188	7214	15	**4.763** .1875	75,000	54,000	39	116	232
SV7004 C TA	**20.00** .7874	**42.00** 1.6535	**12.00** .4724	6090	9660	14	**5.556** .2187	75,000	49,000	35	70	140
SV7004 E TA	**20.00** .7874	**42.00** 1.6535	**12.00** .4724	5810	9210	14	**5.556** .2187	66,000	43,000	55	110	220
SV7204 C TA	**20.00** .7874	**47.00** 1.8504	**14.00** .5512	7320	11700	13	**6.350** .2500	72,000	47,000	45	90	180
SV7204 E TA	**20.00** .7874	**47.00** 1.8504	**14.00** .5512	7010	11100	13	**6.350** .2500	63,000	41,000	70	140	280
SV7805 C TA	**25.00** .9843	**37.00** 1.4567	**7.00** .2756	2335	3397	19	**3.175** .1250	55,000	45,000	17	52	104
HYSV7805 C TA	**25.00** .9843	**37.00** 1.4567	**7.00** .2756	1634	3397	19	**3.175** .1250	81,000	58,000	17	52	104
SV7005 C TA	**25.00** .9843	**47.00** 1.8504	**12.00** .4724	6918	11769	12	**6.747** .2656	47,000	39,000	59	177	353
HYSV7005 C TA	**25.00** .9843	**47.00** 1.8504	**12.00** .4724	4843	11769	12	**6.747** .2656	69,000	5,0000	59	177	353
SV7005 E TA	**25.00** .9843	**47.00** 1.8504	**12.00** .4724	6890	9920	16	**5.556** .2187	57,000	37,000	55	110	220
(SV)7205 C TA	**25.00** .9843	**52.00** 2.0472	**15.00** .5906	8710	12800	15	**6.350** .2500	63,000	41,000	50	100	200
(SV)7205 E TA	**25.00** .9843	**52.00** 2.0472	**15.00** .5906	8330	12100	15	**6.350** .2500	55,000	36,000	80	160	320
(SV)7006 C TA	**30.00** 1.1811	**55.00** 2.1654	**13.00** .5118	9010	12100	17	**5.953** .2344	55,000	36,000	40	80	160
(SV)7006 E TA	**30.00** 1.1811	**55.00** 2.1654	**13.00** .5118	8560	11500	17	**5.953** .2344	48,000	31,000	65	130	260

GRW designation / Basic symbols	Main dimensions in **[mm]** [inch] d	D	B	Load ratings acc. to DIN ISO C_{0r} [N]	C_r [N]	Ball set Z	Dw **[mm]** [inch]	Limiting speeds* Oil [min⁻¹]	Grease [min⁻¹]	Preload (L) light [N]	(M) medium [N]	(S) heavy [N]
AC bearings, open, inch												
SV3/16 C TA	4.763 **.1875**	12.700 **.5,000**	3.967 **.1562**	312	913	8	2.381 **.0937**	195,000	161,000	5	14	28
HYSV3/16 C TA	4.763 **.1875**	12.700 **.5,000**	3.967 **.1562**	218	913	8	2.381 **.0937**	287,000	206,000	5	14	28
SV3/16 D TA	4.764 **.1876**	12.800 **.5039**	3.967 **.1562**	293	873	8	2.381 **.0937**	166,000	136,000	5	14	28
HYSV3/16 D TA	4.765 **.1876**	12.900 **.5079**	3.967 **.1562**	205	873	8	2.381 **.0937**	244,000	175,000	5	14	28
SV1/4A C TA	6.350 **.2500**	15.875 **.6250**	4.978 **.1960**	421	1114	9	2.500 **.0984**	153,000	126,000	6	17	34
HYSV1/4A C TA	6.350 **.2500**	15.875 **.6250**	4.978 **.1960**	295	1114	9	2.500 **.0984**	225,000	162,000	6	17	34
SV1/2/001 C TA	12.700 **.5,000**	28.575 **1.1250**	7.938 **.3125**	2063	4066	12	3.969 **.1563**	82,000	68,000	20	61	121
HYSV1/2/001 C TA	12.700 **.5,000**	28.575 **1.1250**	7.938 **.3125**	1444	4066	12	3.969 **.1563**	121,000	87,000	20	61	121
AC bearings. dismountable. metric and inch												
SV784 D L2T	**4.00** .1575	**9.00** .3543	**2.50** .0984	132	457	7	**1.588** .0625	242,000	199,000	5	8	15
HYSV784 D L2T	**4.00** .1575	**9.00** .3543	**2.50** .0984	94	457	7	**1.588** .0625	355,000	256,000	5	8	15
SV725 C L2T	**5.00** .1969	**16.00** .6299	**5.00** .1969	737	1626	9	**2.500** .0984	157,000	130,000	8	24	49
HYSV725 C L2T	**5.00** .1969	**16.00** .6299	**5.00** .1969	515	1626	9	**2.500** .0984	231,000	167,000	8	24	49
SV725 D L2T	**5.00** .1969	**16.00** .6299	**5.00** .1969	737	1626	9	**2.500** .0984	134,000	110,000	8	24	49
HYSV725 D L2T	**5.00** .1969	**16.00** .6299	**5.00** .1969	515	1626	9	**2.500** .0984	197,000	142,000	8	24	49
SV707 C L2T	**7.00** .2756	**19.00** .7480	**6.00** .2362	1183	2617	10	**3.175** .1250	127,000	105,000	13	40	80
HYSV707 C L2T	**7.00** .2756	**19.00** .7480	**6.00** .2362	828	2617	10	**3.175** .1250	187,000	135,000	13	40	80
SV7000 C L2T	**10.00** .3937	**26.00** 1.0236	**8.00** .3150	2550	4906	10	**4.763** .1875	94,000	78,000	28	85	170
HYSV7000 C L2T	**10.00** .3937	**26.00** 1.0236	**8.00** .3150	1785	4906	10	**4.763** .1875	139,000	10,000	28	85	170
SV1/8A D20 L2T	3.175 **.1250**	7.938 **.3125**	2.779 **.1094**	207	609	7	1.588 **.0625**	266,000	219,000	5	8	16
HYSV1/8A D20 L2T	3.175 **.1250**	7.938 **.3125**	2.779 **.1094**	144	609	7	1.588 **.0625**	392,000	282,000	5	8	16
SV1/8B D20 L2T	3.175 **.1250**	9.525 **.3750**	3.967 **.1562**	134	461	8	1.588 **.0625**	228,000	188,000	5	10	20
HYSV1/8B D20 L2T	3.175 **.1250**	9.525 **.3750**	3.967 **.1562**	95	461	8	1.588 **.0625**	336,000	242,000	5	10	20

* The indicated speed limits are guide values for spring-loaded single bearings with low load; depending on the respective application, higher or lower speed limits may apply in practice.
** For use with oil lubrication, these bearings are also available without shields.
Subject to change due to technical improvement.

Spindle ball bearings

GRW designation	Main dimensions in **[mm]** [inch]			Load ratings acc. to DIN ISO		Ball set		Limiting speeds*		Preload		
Basic symbols	d	D	B	C_{0r} [N]	C_r [N]	Z	Dw **[mm]** [inch]	Oil [min^{-1}]	Grease [min^{-1}]	(L) light [N]	(M) medium [N]	(S) heavy [N]
AC bearings, sealed, metric												
SV725A-2VZ C TA	**5.00** .1969	**16.00** .6299	**5.00** .1969	647	1305	12	**1.984** .0781	194,000**	155,000	7	20	40
HYSV725A-2VZ C TA	**5.00** .1969	**16.00** .6299	**5.00** .1969	453	1305	12	**1.984** .0781	290,000**	194,000	7	20	40
SV725A-2VZ E TA	**5.00** .1969	**16.00** .6299	**5.00** .1969	607	1248	12	**1.984** .0781	165,000**	132,000	7	20	40
SV788B-2VZ C TA	**8.00** .3150	**16.00** .6299	**4.00** .1575	723	1374	13	**1.984** .0781	174,000**	139,000	7	21	42
HYSV788B-2VZ C TA	**8.00** .3150	**16.00** .6299	**4.00** .1575	506	1374	13	**1.984** .0781	261,000**	174,000	7	21	42
SV708B-2VZ C TA	**8.00** .3150	**22.00** .8661	**7.00** .2756	1298	2625	10	**3.175** .1250	144,000**	115,000	13	40	80
HYSV708B-2VZ C TA	**8.00** .3150	**22.00** .8661	**7.00** .2756	909	2625	10	**3.175** .1250	216,000**	144,000	13	40	80
SV708B-2VZ E TA	**8.00** .3150	**22.00** .8661	**7.00** .2756	1218	2510	10	**3.175** .1250	122,000**	98,000	13	40	80
HYSV708B-2VZ E TA	**8.00** .3150	**22.00** .8661	**7.00** .2756	853	2510	10	**3.175** .1250	183,000**	122,000	13	40	80
SV709A-2VZ C TA	**9.00** .3543	**24.00** .9449	**7.00** .2756	1493	2822	11	**3.175** .1250	128,000**	102,000	14	43	86
HYSV709A-2VZ C TA	**9.00** .3543	**24.00** .9449	**7.00** .2756	1045	2822	11	**3.175** .1250	191,000**	128,000	14	43	86
SV7800A-2VZ C TA	**10.00** .3937	**19.00** .7480	**5.00** .1969	876	1487	15	**1.984** .0781	143,000**	114,000	8	23	46
HYSV7800A-2VZ C TA	**10.00** .3937	**19.00** .7480	**5.00** .1969	613	1487	15	**1.984** .0781	215,000**	143,000	8	23	46
SV7900B-2VZ C TA	**10.00** .3937	**22.00** .8661	**6.00** .2362	1173	2047	13	**2.500** .0984	128,000**	102,000	11	33	66
HYSV7900B-2VZ C TA	**10.00** .3937	**22.00** .8661	**6.00** .2362	821	2047	13	**2.500** .0984	192,000**	128,000	11	33	66
SV7000A-2VZ C TA	**10.00** .3937	**26.00** 1.0236	**8.00** .3150	2030	3879	10	**3.969** .1563	115,000**	92,000	20	60	120
SV7000A-2VZ E TA	**10.00** .3937	**26.00** 1.0236	**8.00** .3150	1905	3710	10	**3.969** .1563	98,000**	78,000	20	60	120
HYSV7000A-2VZ E TA	**10.00** .3937	**26.00** 1.0236	**8.00** .3150	1334	3710	10	**3.969** .1563	147,000**	98,000	20	60	120
SV7901A-2VZ C TA	**12.00** .4724	**24.00** .9449	**6.00** .2362	1478	2329	16	**2.500** .0984	115,000**	92,000	12	35	71
HYSV7901A-2VZ C TA	**12.00** .4724	**24.00** .9449	**6.00** .2362	1035	2329	16	**2.500** .0984	173,000**	115,000	12	35	71
SV7901A-2VZ E TA	**12.00** .4724	**24.00** .9449	**6.00** .2362	1387	2227	16	**2.500** .0984	98,000**	79,000	12	35	71
HYSV7901A-2VZ E TA	**12.00** .4724	**24.00** .9449	**6.00** .2362	971	2227	16	**2.500** .0984	147,000**	98,000	12	35	71
SV7001B-2VZ C TA	**12.00** .4724	**28.00** 1.1024	**8.00** .3150	2328	3603	16	**3.175** .1250	101,000**	80,000	18	55	111
HYSV7001B-2VZ C TA	**12.00** .4724	**28.00** 1.1024	**8.00** .3150	1141	3603	16	**3.175** .1250	151,000**	101,000	18	55	111
SV7001B-2VZ E TA	**12.00** .4724	**28.00** 1.1024	**8.00** .3150	2184	3446	16	**3.175** .1250	85,000**	68,000	18	55	111

HIGH-PRECISION BALL BEARINGS

GRW designation	Main dimensions in **[mm]** [inch]			Load ratings acc. to DIN ISO		Ball set		Limiting speeds*		Preload		
Basic symbols	d	D	B	C_{0r} [N]	C_r [N]	Z	Dw **[mm]** [inch]	Oil [min^{-1}]	Grease [min^{-1}]	(L) light [N]	(M) medium [N]	(S) heavy [N]
AC bearings, sealed, metric												
HYSV7001B-2VZ E TA	**12.00** .4724	**28.00** 1.1024	**8.00** .3150	1070	3446	16	**3.175** .1250	128,000**	85,000	18	55	111
SV7201B-2VZ E TA	**12.00** .4724	**32.00** 1.2598	**10.00** .3937	3034	5373	11	**4.763** .1875	80,000**	64,000	29	86	173
HYSV7201B-2VZ E TA	**12.00** .4724	**32.00** 1.2598	**10.00** .3937	1487	5373	11	**4.763** .1875	120,000**	80,000	29	86	173
SV7902A-2VZ C TA	**15.00** .5906	**28.00** 1.1024	**7.00** .2756	2359	3586	16	**3.175** .1250	95,000**	76,000	18	55	110
HYSV7902A-2VZ C TA	**15.00** .5906	**28.00** 1.1024	**7.00** .2756	1651	3586	16	**3.175** .1250	143,000**	95,000	18	55	110
SV7902A-2VZ E TA	**15.00** .5906	**28.00** 1.1024	**7.00** .2756	2213	3430	16	**3.175** .1250	81,000**	65,000	18	55	110
HYSV7902A-2VZ E TA	**15.00** .5906	**28.00** 1.1024	**7.00** .2756	1549	3430	16	**3.175** .1250	121,000**	81,000	18	55	110
SV7002A-2VZ C TA	**15.00** .5906	**32.00** 1.2598	**9.00** .3543	3337	5125	15	**3.969** .1563	87,000**	70,000	26	79	158
HYSV7002A-2VZ C TA	**15.00** .5906	**32.00** 1.2598	**9.00** .3543	2336	5125	15	**3.969** .1563	131,000**	87,000	26	79	158
SV7002A-2VZ E TA	**15.00** .5906	**32.00** 1.2598	**9.00** .3543	3131	4902	15	**3.969** .1563	74,000**	59,000	26	79	158
HYSV7002A-2VZ E TA	**15.00** .5906	**32.00** 1.2598	**9.00** .3543	2192	4902	15	**3.969** .1563	111,000**	74,000	26	79	158
SV7903A-2VZ C TA	**17.00** .6693	**30.00** 1.1811	**7.00** .2756	2402	3554	16	**3.175** .1250	88,000**	70,000	18	55	110
HYSV7903A-2VZ C TA	**17.00** .6693	**30.00** 1.1811	**7.00** .2756	1682	3554	16	**3.175** .1250	132,000**	88,000	18	55	110
SV7903A-2VZ E TA	**17.00** .6693	**30.00** 1.1811	**7.00** .2756	2254	3399	16	**3.175** .1250	75,000**	60,000	18	55	110
HYSV7903A-2VZ E TA	**17.00** .6693	**30.00** 1.1811	**7.00** .2756	1578	3399	16	**3.175** .1250	112,000**	75,000	18	55	110
SV7003-2VZ C TA	**17.00** .6693	**35.00** 1.3780	**10.00** .3937	4415	6654	14	**4.763** .1875	65,000**	54,000	34	102	205
HYSV7003-2VZ C TA	**17.00** .6693	**35.00** 1.3780	**10.00** .3937	3091	6654	14	**4.763** .1875	96,000**	69,000	34	102	205
SV7003-2VZ E TA	**17.00** .6693	**35.00** 1.3780	**10.00** .3937	4143	6363	14	**4.763** .1875	56,000**	46,000	34	102	205
HYSV7003-2VZ E TA	**17.00** .6693	**35.00** 1.3780	**10.00** .3937	2900	6363	14	**4.763** .1875	82,000**	59,000	34	102	205
SV7904A-2VZ C TA	**20.00** .7874	**37.00** 1.4567	**9.00** .3543	3868	5394	16	**3.969** .1563	70,000	56,000	27	81	162
HYSV7904A-2VZ C TA	**20.00** .7874	**37.00** 1.4567	**9.00** .3543	2708	5394	16	**3.969** .1563	105,000	70,000	27	81	162
SV7005A-2VZ C TA	**25.00** .9843	**47.00** 1.8504	**12.00** .4724	7909	10661	17	**5.556** .2187	56,000	44,000	53	160	320
HYSV7005A-2VZ C TA	**25.00** .9843	**47.00** 1.8504	**12.00** .4724	5536	10661	17	**5.556** .2187	83,000	56,000	53	160	320

* The indicated speed limits are guide values for spring-loaded single bearings with low load; depending on the respective application, higher or lower speed limits may apply in practice.

** For use with oil lubrication, these bearings are also available without shields.

Subject to change due to technical improvement.

Profiled rollers

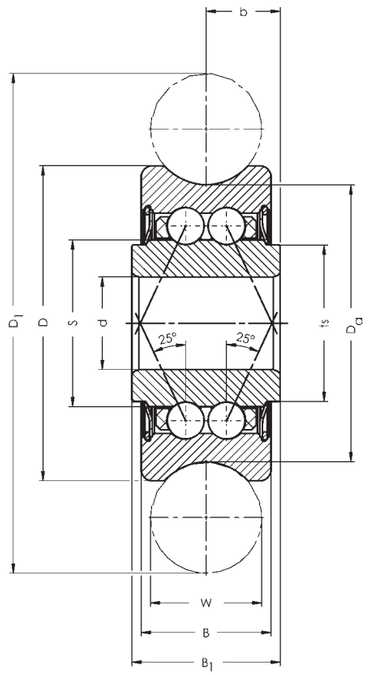
Profiled rollers are double-row ball bearings, which are able to accept axial loads in both directions, as well as high radial loads. Usually, the contact surface is shaped like a Gothic arch; contact surface and shaft touch each other in two zones.

On request, other contour surface designs are available (e.g. V groove, spherical outer ring, etc.).

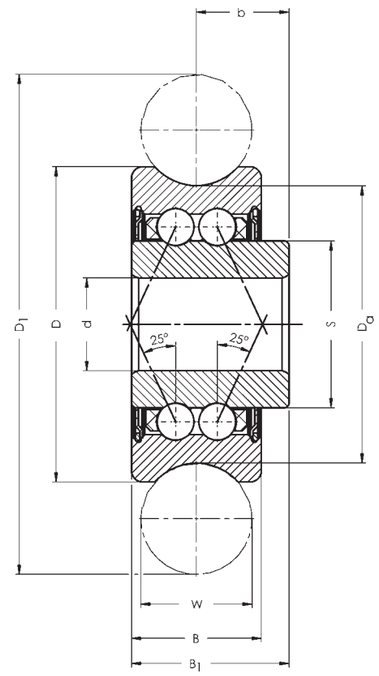
Inner and outer rings can be made of chrome steel 100Cr6 or corrosion-resistant chrome steels X65Cr13 or X30CrMoN 15-1. Balls can be made of chrome steel 100Cr6, X65Cr13 or ceramic.

GRW profiled rollers have non-contact shields. On request, contact seals (e.g. Teflon®, NBR) are available as an alternative. The rollers are lubricated for life and are also available with FDA-approved or autoclavable lubricants.

For further information please contact your nearest GRW Sales Representative.



Profile roller with inner ring extended on both sides



Profile roller with inner ring extended on one side

GRW designation	Drawing no.	d	D_a	D	D_1	W	B	B_1	b	S
687/603282-2RZ	604623	5	–	17	27	6	7	8	4	9
687/603282-2Z	603282	5	–	17	27	6	7	8	4	9
687/602057-2Z	602057	5	–	17	25	5	7	8.5	5	9
687/601938-2Z	601938	5	–	17	27	6	7	8.5	5	9
687/601935-2Z	602055	5	–	16	22	4	7	8.5	5	9
687/601935-2Z	601935	5	–	16	22	4	7	8.5	5	9
608/602030-2ZF	604976	8	–	24	34	6	11	11	5.5	11.8
608/602030-2ZF	602030	8	–	24	34	6	11	11	5.5	11.8
608/602024-2ZF	602024	8	–	24	37	8	11	12.5	7	11.8
608/601947-2ZF	602053	8	–	24	34	6	11	12.5	7	11.8
608/601947-2ZF	601947	8	–	24	34	6	11	12.5	7	11.8
6201/604947-2Z	604947	12	–	35	51.3	10	15.9	15.9	7.95	18.28

Subject to change due to technical improvement.

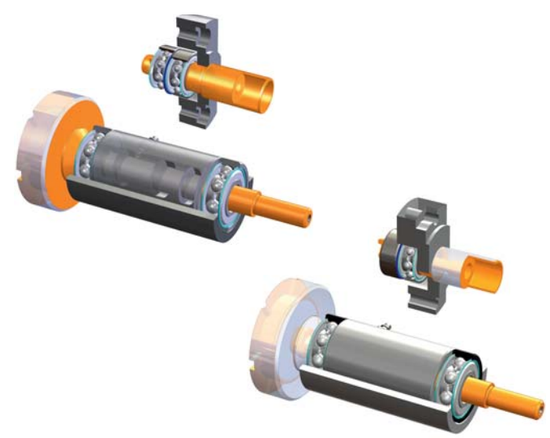
Bearing units

Bearing units are complete pre-mounted assemblies, comprising of at least one ball bearing, shaft or housing, optional spacers, shims or spring washers.

GRW assembles the components in bearing units primarily by using adhesives. Backlash free bearing units are produced cost effectively by precisely gluing the bearings under an axial pre-load. GRW has engineered special gluing equipment and techniques to ensure high accuracy and strength.

When using GRW bearing units, customers will profit by following benefits:

- Cost advantages by eliminating possibility of improper customer assembly.
- Pre-mounted units are easier to handle than single bearings, reducing stock control.
- At GRW the bearings are mounted in a clean room under optimum conditions.
- Depending on the customer's requirements, other functional elements may be integrated into the bearing units, for example springs and seals or moulded tyres.



Thin-section bearings

Thin-section bearings are bearings with very thin ring cross-sections (light ISO dimension series 67/68) or bearings of identical cross-sections, independent of their bore diameter (inch series: Extra Thin Series, Thin Series).

In addition to their small footprint and low weight, they are characterised by low torque and high rigidity.

Thin-section bearings are available in the following versions: open (standard), with closures, with an extended inner ring, with a flanged outer ring and as an angular contact or full-complement bearing at a maximum outside diameter of 40 mm.

The closures are available in -2Z and -2TS versions.

As standard, thin-section bearings are all ABEC5. Contact us regarding other available versions (e.g. Superduplex) ABEC7, and ABEC9.

GRW designation	d [mm]	d [inch]	D [mm]	D [inch]	B [mm]	B [inch]	$r_{s\ min}$ [mm]	$r_{s\ min}$ [inch]	$d_{a\ min}$ [mm]	$d_{a\ min}$ [inch]	$d_{a\ max}$ [mm]	$d_{a\ max}$ [inch]	$D_{a\ max}$ [mm]	$D_{a\ max}$ [inch]
15875A	**15.875**	.625	**22.225**	.875	**3.967**	.156	**0.25**	.010	**16.9**	.665	**17.9**	.705	**20.6**	.811
15875A-2Z	**15.875**	.625	**22.225**	.875	**4.978**	.196	**0.25**	.010	**16.9**	.665	**17.9**	.705	**20.6**	.811
15875A-2TS	**15.875**	.625	**22.225**	.875	**4.978**	.196	**0.25**	.010	**16.9**	.665	**17.2**	.677	**20.6**	.811
19050A	**19.050**	.750	**25.400**	1.000	**3.967**	.156	**0.25**	.010	**20.1**	.791	**21.1**	.831	**23.7**	.933
19050A-2Z	**19.050**	.750	**25.400**	1.000	**4.978**	.196	**0.25**	.010	**20.1**	.791	**21.1**	.831	**23.7**	.933
19050A-2Z	**19.050**	.750	**25.400**	1.000	**4.978**	.196	**0.25**	.010	**20.1**	.791	**20.4**	.803	**23.7**	.933
22225A	**22.225**	.875	**28.575**	1.125	**3.967**	.156	**0.25**	.010	**23.3**	.917	**24.3**	.957	**26.9**	1.059
22225A-2Z	**22.225**	.875	**28.575**	1.125	**4.978**	.196	**0.25**	.010	**23.3**	.917	**24.3**	.957	**26.9**	1.059
22225A-2TS	**22.225**	.875	**28.575**	1.125	**4.978**	.196	**0.25**	.010	**23.3**	.917	**23.6**	.929	**26.9**	1.059
26988A	**26.988**	1.063	**33.338**	1.313	**3.967**	.156	**0.25**	.010	**28.1**	1.106	**29.1**	1.146	**31.7**	1.248
26988A-2Z	**26.988**	1.063	**33.338**	1.313	**4.978**	.196	**0.25**	.010	**28.1**	1.106	**29.1**	1.146	**31.7**	1.248
26988-2TS	**26.988**	1.063	**33.338**	1.313	**4.978**	.196	**0.25**	.010	**28.1**	1.106	**28.4**	1.118	**31.7**	1.248
31750A	**31.750**	1.250	**38.100**	1.500	**3.967**	.156	**0.25**	.010	**32.8**	1.291	**33.8**	1.331	**36.4**	1.433
31750A-2Z	**31.750**	1.250	**38.100**	1.500	**4.978**	.196	**0.25**	.010	**32.8**	1.291	**33.8**	1.331	**36.4**	1.433
31750A-2TS	**31.750**	1.250	**38.100**	1.500	**4.978**	.196	**0.25**	.010	**32.8**	1.291	**33.1**	1.303	**36.4**	1.433
34925A	**34.925**	1.375	**41.275**	1.625	**3.967**	.156	**0.25**	.010	**36.0**	1.417	**37.0**	1.457	**39.5**	1.555
34925A-2Z	**34.925**	1.375	**41.275**	1.625	**4.978**	.196	**0.25**	.010	**36.0**	1.417	**37.0**	1.457	**39.5**	1.555
34925A-2TS	**34.925**	1.375	**41.275**	1.625	**4.978**	.196	**0.25**	.010	**36.0**	1.417	**36.3**	1.429	**39.5**	1.555

Subject to change due to technical improvement.

HIGH-PRECISION BALL BEARINGS

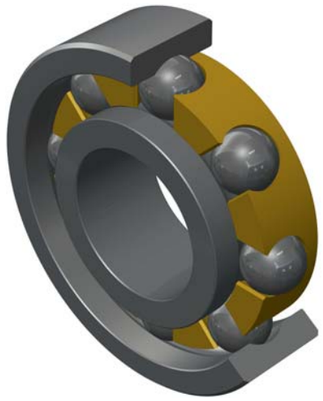
Hybrid and full ceramic ball bearings

Conventional ball bearings are limited when operating at high temperatures. in a vacuum. or in a corrosive environment. All ceramic bearings have proven to be ideally suited for these extreme applications.

Zirconium oxide (ZrO_2) and silicon nitride (Si_3N_4) are typical materials used in all ceramic bearings. which provide excellent corrosion and temperature resistance as well as other mechanical properties.

Material properties:

Properties	Unit	Si_3N_4 HY	ZrO_2 ZO
Density	g/cm³	3.2	6.05
Hardness	HRC	> 75	> 69
E module	GPa	320	200
Poisson coefficient		0.26	0.2
Linear expansion coefficient	$x10^{-6}\ K^{-1}$	2.9	10
Max. temperature	°C	800	600
Corrosion resistance		very good	good
Electrical conductivity		Insulator	Insulator



High chemical resistance

All ceramic ball bearings have specific advantages for applications with mixed-friction because they remain operative for a longer period of time than conventional steel bearings even in the case of lube deprivation.

Corrosion resistance

All ceramic bearings resist cold micro welding to other materials which allows for particularly low adhesive wear. Certain applications make use of conventional bearings almost impossible. For example: chemical resistance of all ceramic bearings to corrosive materials allows usage in chemical applications.

Thermal expansion

Full ceramic bearings will remain dimensionally stable even at high temperature fluctuations.

Non-magnetism and electrical insulation

The non-magnetic properties of the ceramic materials prevent interference with magnetic fields and the ceramic acts as an insulator preventing current flow.

Special ball bearings

GRW develops and produces a complete range of custom bearing options.

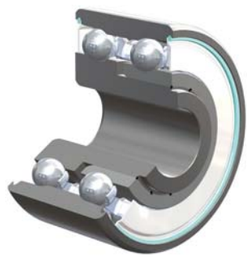
Superduplex bearings

Superduplex bearings are also known as double row deep-groove ball bearings or angular contact ball bearings featuring split inner or outer rings. One of the ring sets, either outer or inner, consists of a double row integral set of raceways.

Its compact design permits easy handling and assembly. The inner or outer split rings are paired according to customer specifications ensuring that GRW bearings will meet the required axial preload.

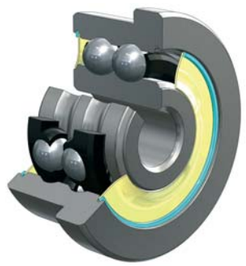
Extra-duplex bearings

Extra-duplex bearings are double-row deep groove radial bearings or angular contact ball bearings with a split inner or outer ring. One floating ring is accurately preloaded and then laser-welded in place. This style of bearing prevents radial offset or changes in axial preload during assembly.



Tandem-duplex bearings

Tandem-duplex bearings are designed with double-row deep-groove bearings. The raceways are extremely close to each other (in the micron range). These bearings are designed to handle both radial loads and axial loads in one direction by ensuring that the load is evenly distributed to all balls.



Bearings with custom outer geometries

GRW can produce single or double-row bearings with a spherical or grooved outer ring and also can provide moulded and plastic rubber types.

Integrated Shaft Bearings

Bearing and shaft can be combined to provide an integrated assembly. In this design the raceway is ground on the shaft and the bearing assembly is delivered completely assembled ready to use.

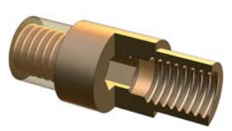
Customised outer geometries and moulded plastic or rubber tyres can be supplied upon request.

Bearing/ housing assemblies

For these special designs, the raceway of the outer ring is ground directly into the housing. Complex housings, flanges and threaded mounting holes maintain the tight tolerances necessary for proper installation.

Precision Components

GRW manufactures precision spacers and precision components that incorporate threads, steps, grooves, bores, etc. to tolerances in the micron (µ) range.



Coated bearings

Sometimes it is not possible to use conventional lubricants especially in applications that are exposed to extremely high or low temperatures, ultra high vacuum, or in close proximity to optical systems.

The solution in these cases may be special coatings of gold, silver, MoS_2 , or Teflon®. These thin layers act as a dry film lubricant. Development of this technology has made applications possible even at temperatures of –70 °C to +400 °C or in a high vacuum.

Protection against wear is also an advantage of using thin coated bearings. Raceways, bearing bores and/or outer surfaces can be thinly coated to meet each application's requirements. Possible uses for these types of coatings are rollers, paper cutting blade wheels, bearings used in chemical or food processing industries, and medical instruments.

As each coating can be applied by a variety of technologies, GRW will work with each customer to select the optimum coating process to meet the application requirements.

EXTREME

GRW goes EXTREME

GRW goes EXTREME – this is how our experts describe production beyond our standard product offerings: individually adapted, customised “tuning” of ball bearings for extreme applications.

With the new program EXTREME, GRW is trail blazing new paths.

EXTREME shows what we are planning to achieve with these products, and how we are reaching these goals. Ball bearings of the EXTREME series offer added value for almost all types of applications. Join us in the EXTREME world of GRW.

High-Speed

The EXTREME solution:

- Highest precision
- Ceramic balls
- Use of special retainers
- Optimum bearing design

Extreme heat up to +450 °C

The EXTREME solution:

- High-temperature chrome steels
- High-temperature retainers or full complement designs
- Dry-film lubricated designs

Resistance to aggressive media

Selecting the right material is paramount if you need the highest resistance to corrosion or when aggressive media is specified.

The EXTREME solution:

- Rings made of SV-30 or use corrosion resistant coatings
- Ceramic balls
- Acid and alkali-proof synthetic retainers

Non-magnetic solutions

GRW ball bearings with non-magnetic properties.

The EXTREME solution:

- Rings made from a cobalt-based alloy with a hardness of up to 59 HRC
- Ceramic balls
- Retainer made from a non-magnetic material

Easy solutions that can withstand the highest loads

The EXTREME solution:

- Optimum dimensioning of ball size and curvature
- For optimised load ratings and rigidity
- Multi-row bearing systems

Requirements in a vacuum

Ball bearing applications in space / in vacuum environments.

The EXTREME solution:

- Use of special materials
- Surface treatments
- Special lubrications

Resistance ensured down to absolute zero

The EXTREME solution:

- Special retainer materials
- Use of special lubricants
- Coatings

HIGH-PRECISION BALL BEARINGS

GRW's special product range EXTREME

Highest material quality

The GRW portfolio lists many different ring materials that can meet all special requirements in:

- Hardness,
- Rolling resistance,
- Corrosion resistance,
- Heat resistance and L-10 life,
- Non-magnetic requirements.

Perfect lubrication

100% performance in extreme applications requires extreme materials, absolute precision and cleanliness. For this reason, GRW relies on the experience of their engineers and technicians when selecting the materials – and on internal results from our own chemistry laboratory.

The correct lubricant is of high relevance. It has a major effect on:

- Bearing friction
- Running noise
- Limiting speeds
- L-10 life ratings

GRW's wide selection of high-quality greases and oils has the exacting solution for every extreme application. Our recommended lubricants are based upon manufacturer data as well as in house tests results obtained from our proprietary test facility. From lubricants for high-speed applications to lubricants that are resistant to aggressive sterilisation processes – GRW offers a customised solution tailored to your individual needs.

Special low-torque bearings

Special low-torque bearings in the field of measurement and control engineering operate reliably and precisely even when running dry.

These ball bearings meet the highest demands in bearing engineering:

- Minimum starting and dynamic torque
- Repeatable low friction torque

Retainers for practically any application

In addition to the standard retainer made from corrosion resistant steel, GRW has a range of widely different synthetic materials for selecting the suitable solution for each customer's specific application.

Patented know-how

GRW has proven expertise in the field of ball bearing retainers, supported by a number of patents.

Maximizing load ratings and limiting speeds

From the start, optimisation measures are considered for their potential to maximize the static and dynamic radial load ratings or limiting speeds of each ball bearing. Further optimisation measures are taken into account for internal geometries as well, i.e. pitch circle diameter, curvature, ball diameter and ball complement, material, tolerance and finally manufacturing technology of bearing components.

Turbine ball bearings by a factor of 5

Turbine ball bearings used in dental handpieces, utilise a new type of retainer material that achieves a factor of 5 increase in life compared to standard bearings equipped with retainers made from commercially available synthetics.

Manufacturers using ball bearings with the new retainer materials can offer their customers:

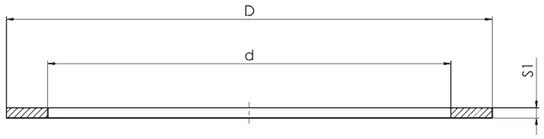
- Increased performance and fewer in-warranty returns
- improved durability despite improper handling of the device, e.g. improper oil maintenance.

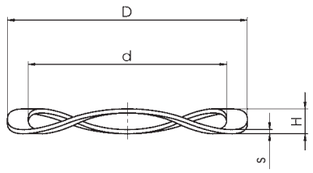
Tested quality

GRW's in-house test facility is the core element of their research and development. The suitability of a synthetic material is evaluated on their proprietary, fully automated equipment for properties such as wear and elasticity, additional functionality and life-testing allow them to optimise the performance of each ball bearing for individual customer's specific requirements.

For further information, please contact your nearest GRW sales representative.

Accessories





Shims AS

Shims are often used to balance the accumulation of tolerances (tolerance chains) and axial tolerances.

GRW spring washers are made of corrosion-resistant 1.4310 (AISI 301) spring wire. They are heat-treated, burr-free, and have an extremely fine surface finish.

Spring washers WF

Spring washers are used for defined axial preloading of bearings, particularly for miniature and small ball bearings. The manufacture of these spring washers includes cutting and punching processes. Through a subsequent finishing process they can be calibrated to provide highly accurate preload tolerances as required for special applications.

GRW spring washers are made of corrosion-resistant 1.4310 (AISI 301) spring wire. They are heat-treated, burr-free, and have an extremely fine surface finish. Our spring washers are designed with 3 waves ensuring even support of the bearing during axial preloading.

Dimensions [mm]					
Shims		Spring washers		for use in version	
d x D	s	(d x D x H x s)	Spring constant [N/mm]	for use on the shaft	for use in the housing
AS 1.55 x 2.50	0.15	–	–	68/1,5, 69/1,5	–
–	–	WF 1.60 x 2.90 x 0.40 x 0.06	50.0	–	–
–	–	WF 1.90 x 2.80 x 0.50 x 0.08	60.0	–	–
AS 2.00 x 4.30	0.10 0.16 0.20	–	–	–	–
AS 2.25 x 3.20	0.08 0.10	WF 2.15 x 3.10 x 0.50 x 0.08	54.9	682, 692, 5/64	–
AS 2.80 x 3.90	0.08 0.10	WF 2.70 x 3.80 x 0.50 x 0.08	52.0	60/2,5, 68/2,5, 69/2,5, 3/32	68/1,5, 691, 1191
AS 3.05 x 4.50	0.10 0.16 0.20	–	–	–	–
AS 3.30 x 4.40	0.08 0.10 0.12	WF 3.20 x 4.30 x 0.50 x 0.10	32.5	623, 683, 693, 1/8A, 1/8B, 3175,1/8A/6, 1/8B/083	–
AS 3.50 x 5.00	0.08	–	–	–	–
AS 3.80 x 4.90	0.08 0.10 0.12	WF 3.70 x 4.80 x 0.55 x 0.10	32.0	–	682, 69/1,5
AS 4.05 x 5.50	0.10 0.20	–	–	–	–
AS 4.30 x 5.85	0.10 0.12 0.15	WF 4.20 x 5.75 x 0.65 x 0.12	40.0	604, 624, 634, 684, 694, 3967	68/2,5, 692
AS 4.90 x 6.20	0.10 0.12 0.15	WF 4.80 x 6.10 x 0.60 x 0.12	37.0	3/16, 4763A, 4763B	5/64, 3175
AS 5.20 x 6.75	0.15	–	–	–	–
AS 5.30 x 6.85	0.10 0.12 0.15	WF 5.20 x 6.75 x 0.65 x 0.12	22.0	625, 635, 685, 695	683, 69/2,5
AS 5.50 x 8.50	0.40	–	–	–	–
AS 6.30 x 7.85	0.12 0.15 0.18	WF 6.20 x 7.75 x 0.70 x 0.15	38.0	626, 686, 696	60/2,5, 693, 3/32, 1/8A, 3967, 4763A
AS 6.70 x 9.40	0.10	–	–	–	–
AS 7.30 x 8.80	0.12 0.15 0.18	WF 7.20 x 8.70 x 0.90 x 0.15	28.5	607, 627, 687, 697	684
–	–	WF 7.20 x 12.00 x 1.55 x 0.13	41.8	607, 627	6350B, 7938, 1/8B/083
AS 8.30 x 9.80	0.10 0.15 0.18 0.20	WF 8.20 x 9.70 x 0.85 x 0.18	26.0	608, 688, 698, 7938	623
AS 9.30 x 10.80	0.15 0.18 0.20	WF 9.20 x 10.70 x 1.15 x 0.18	22.0	609, 629, 689, 699	685, 694
AS 10.30 x 11.80	0.18 0.20 0.22	WF 10.20 x 11.70 x 1.05 x 0.20	18.5	6000, 6800, 6900,3/8	604
–	–	WF 10.50 x 15.80 x 1.85 x 0.25	77.0	6000	625, 634
AS 11.30 x 12.80	0.18 0.20 0.22	WF 11.20 x 12.70 x 1.30 x 0.20	16.0	–	624, 686, 695
AS 12.30 x 13.80	0.20 0.22 0.25	WF 12.20 x 13.70 x 1.30 x 0.22	20.0	–	687
AS 13.30 x 14.80	0.20 0.22 0.25	WF 13.20 x 14.70 x 1.30 x 0.22	13.0	–	696
AS 14.35 x 15.80	0.22 0.25 0.30	WF 14.20 x 15.65 x 1.55 x 0.25	17.0	–	625, 634, 688, 1/4A
AS 15.35 x 16.80	0.22 0.25 0.30	WF 15.20 x 16.65 x 1.55 x 0.25	14.5	–	689, 697
AS 16.00 x 22.00	0.10 0.20	WF 15.80 x 21.80 x 1.60 x 0.20	10.0	–	3/8
AS 16.40 x 18.80	0.25 0.30 0.35	WF 16.20 x 18.55 x 2.15 x 0.30	28.5	–	607, 626, 635, 6800, 698, 1/4

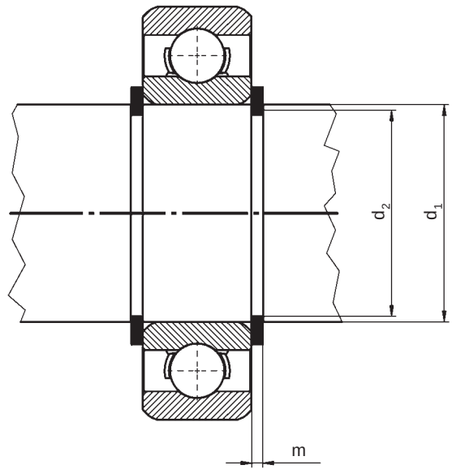
Material 1.4310 (AISI 301). Before planning on the use of shims and spring washers, please ask about the availability.
Subject to change due to technical improvement. Minimum quantity 100 pieces.

Accessories

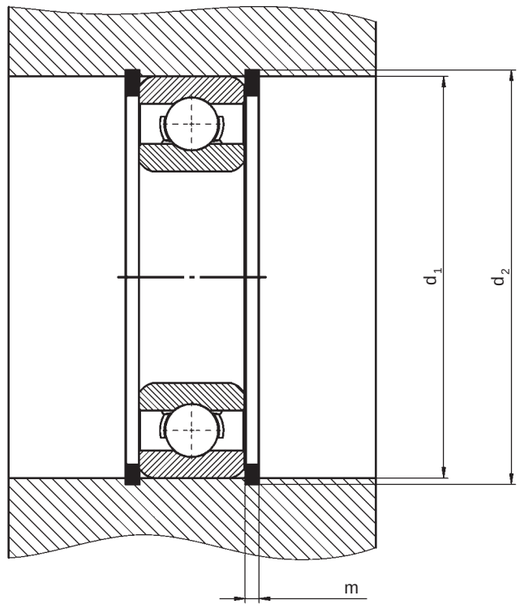
Retaining rings – (shaft circlips WSR, bore retaining rings BSR)

Retaining rings are precision engineered components that are designed to be applied on shafts or in bores providing a shoulder that accurately positions, locates and retains parts of an assembly. They are especially useful with small and evenly distributed axial and radial loads. It is important to ensure that the face of the retaining ring does not touch the edge radius of the bearing. If the face does touch the radial edge, we recommend that you use our shims in conjunction with our retaining rings.

GRW retaining rings are constructed from cold-drawn spring wire 1.4310 (AISI 301), which exhibits an extremely constant cross section. They are corrosion-resistant and free of any scale or burrs.

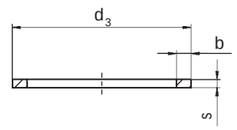


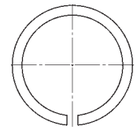
Assembly of a ball bearing with shaft circlips



Assembly of a ball bearing with bore circlips

HIGH-PRECISION BALL BEARINGS

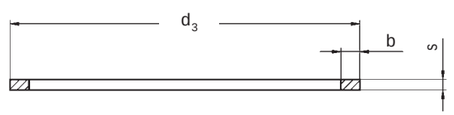


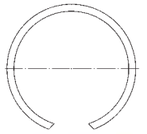


Shaft circlips

Type	Dimensions [mm]					
	Shaft	Split lock			Gro	
	d_1	d_3 max.	b ± 0.10	s ± 0.02	d_2 – 0.05	m + 0.03
WSR 3	3	2.60	0.50	0.30	2.70	0.33
WSR 4	4	3.60	0.50	0.30	3.70	0.33
WSR 5	5	4.50	0.70	0.40	4.60	0.44
WSR 6	6	5.45	0.70	0.40	5.60	0.44
WSR 7	7	6.45	0.70	0.40	6.60	0.44
WSR 8	8	7.35	0.90	0.50	7.50	0.55
WSR 9	9	8.30	0.90	0.50	8.50	0.55
WSR 10	10	9.25	0.90	0.50	9.50	0.55

Material 1.4310 (AISI 301). Subject to change due to technical improvement. Packaging unit 1000 pieces.





Bore circlips

Type	Dimensions [mm]					
	Shaft	Split lock			Gro	
	d_1	d_3 min.	b ± 0.10	s ± 0.02	d_2 – 0.05	m + 0.03
BSR 4	4	4.40	0.50	0.30	4.30	0.33
BSR 5	5	5.45	0.50	0.30	5.30	0.33
BSR 6	6	6.45	0.50	0.30	6.30	0.33
BSR 7	7	7.50	0.50	0.30	7.30	0.33
BSR 8	8	8.60	0.70	0.40	8.40	0.44
BSR 9	9	9.60	0.70	0.40	9.40	0.44
BSR 10	10	10.65	0.70	0.40	10.40	0.44
BSR 11	11	11.65	0.70	0.40	11.40	0.44
BSR 12	12	12.75	0.90	0.50	12.50	0.55
BSR 13	13	13.75	0.90	0.50	13.50	0.55
BSR 14	14	14.80	0.90	0.50	14.50	0.55
BSR 15	15	15.80	0.90	0.50	15.50	0.55
BSR 16	16	16.85	0.90	0.50	16.50	0.55
BSR 17	17	17.85	0.90	0.50	17.50	0.55
BSR 19	19	20.00	1.10	0.60	19.60	0.66

Material 1.4310 (AISI 301). Subject to change due to technical improvement. Packaging unit 1000 pieces.

Test engineering

Orakel III

Orakel III is an automated, stand-alone test module for performing cyclical loading tests on turbines and surgical handpieces. Quantifiable results are recorded while a LED continuously displays the current operating mode. The pneumatic load unit is calibrated and decelerates the test specimen with a force between 0.1 and 6 N at an accuracy of +/–0.1 N. An adjusting device allows continuous measurement of the test specimen.

While the magnetic speed sensor records speeds from 20,000 to 600,000 rpm, the instrument holder can be adjusted to any angle to accommodate all potential parameters. This module can be operated via a Windows PC (the PC is only required for operating purposes, the module tests independently).

Benefits:

- Up to 7,000 cycles can be executed without interruption.
- Uniform test processes can be exactly reproduced.
- The operation of the module only requires electric power and clean compressed air.
- Testing capacities can be expanded at any time by adding additional modules.
- Easy documentation: For each cycle, the measured speed is stored and can be written in a text file along with details of the completed testing time.
- Up to 10 modules can be controlled by one PC.

Note: Orakel III, the test module developed by GRW, is available for purchase. Contact us for price and availability!

Speedmaster

The GRW Speedmaster is a noncontact speed-measuring device especially designed for high RPM rotating instruments used in the dental industry.

It may also be used for other high-speed applications such as motors or high-frequency spindles.

Note: Speedmaster, developed by GRW, is available for purchase. Contact us for price and availability!

This instrument consists of: the basic measuring unit, AC adapter, speed sensor, permanent magnet, a hard metal test probe for clamping in the dental instrument, and a measuring stand to hold the speed sensor.

Measurement Principle

A test probe or a motor shaft is magnetised by means of the attached permanent magnet. The sensor is positioned 1 and 10 mm away from the magnetised shaft. When the shaft rotates, the weak magnetic field is recorded by the special GRW sensor, then amplified and displayed in rpm, revolutions per minute.

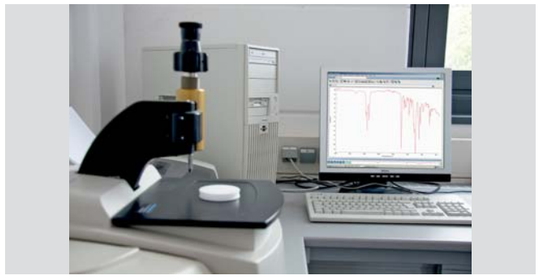
The non-contact measurement is designed for speeds from 20,000 to 600,000 min^{-1}.

The device has proven to be particularly useful in development and production as well as the repair of dental turbines and surgical handpieces.

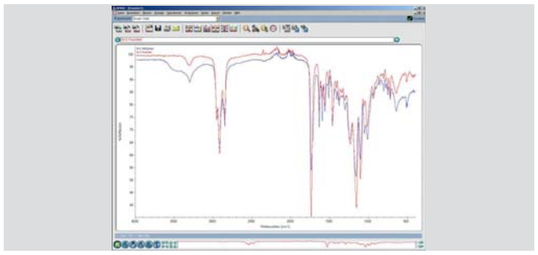
HIGH-PRECISION BALL BEARINGS

GRW laboratory services

By analysing and testing materials in their own laboratory, GRW ensures the quality and future development of their products. GRW engineers and chemists work continuously to improve the rating life and efficiency of their ball bearings. Customers benefit from flexible and cost-effective solutions developed in collaboration with their experienced GRW analyst´s and chemistry lab team using state-of-the-art technical equipment.



FTIR spectroscopy with ATR technology for non-destructive analysis of the quality composition of organic materials.



FTIR spectra make the difference visible e.g.: A grease with water entrainment and a changed base oil-thickener-ratio compared to a fresh grease.

GRW offers the following services:

General analytics, for example determination of
– pH
– Acid concentration
– Oil or preservative content
– Evaporation residue
– Nitrite levels

Lubricant analyses and contamination identification
– Dissolution and filitration
– Microscopy
– FTIR analysis

Surface treatments
– Gold plating
– Ultrasonic cleaning
– Hot and cold black-oxide-finishing
– Passivation of high-alloy steels

Medical hygiene treatments
– High-pressure steam sterilisation
– Thermal disinfection

Condensation and salt spray test

Chemical deburring
For natural fiber reinforced polymers

As part of our laboratory association, GRW offers you the following additional services:

SEM analysis (SEM) and energy-dispersive X-ray spectroscopy (EDX)

X-ray fluorescence analysis (RFA)

Detailed analysis by means of
Differential scanning calorimetry (DSC)

Thermogravimetry (TGA)

Please contact us to learn more about the GRW laboratory services.

Correct handling of GRW high-precision miniature bearings

GRW ball bearings are manufactured and packaged with extreme care to avoid contamination, corrosion, and other external influences on the bearings. When mounting the ball bearings, the following advice is recommended:

- Bearings should be stored in their original package in clean, dry rooms under constant temperature conditions.
- Bearings should only be removed from their original package shortly before they are mounted. The use of gloves, finger cots, and tweezers are recommended.
- Care should be taken that the assembly location is clean and well lit and that all other parts are equally clean. A hard surface is preferred.
- When mounting a ball bearing, the assembly force must not be applied to the balls. Suitable mounting tools must be used. Non-compliance with these instructions may easily result in damage of balls or raceways, for example ball indentations may occur in the raceway.
- If glued interfaces are used, ensure that any excess glue does not enter the bearing.
- Re-lubrication should only be carried out with a lubricant of the same type and purity.
- We recommend to have the bearings lubricated by GRW, as this is executed in the clean room shortly before packaging.
- Selective sorting of all mating parts will help to guarantee the proper fit of the bearing to the shaft or housing.
- We recommend a run-in process for grease-lubricated bearings prior to use at low speed to achieve optimum distribution of the lubricant.
- Electrical current running through the bearing should be avoided

Analysis of ball bearings

Based on over 70 years of expertise, GRW can provide ball bearing analysis to establish the root cause of failure or to estimate the remaining life of the ball bearing. For more information about bearing analysis, please contact your nearest GRW Sales Representative.

Valuable results can be achieved when bearings are disassembled and examined after a certain period of operation before failure has occurred. Marking of the bearing rings during disassembly can help to reproduce original assembly characteristics.

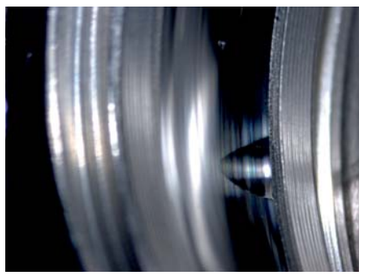
Removal from package

HIGH-PRECISION BALL BEARINGS

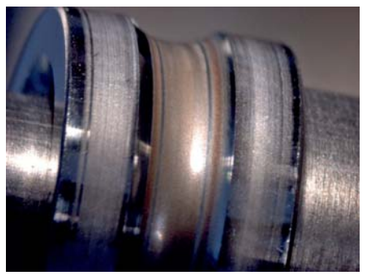
Installation on the shaft

Characteristics caused by improper handling

Defect characteristics	Possible cause											
	Contamination	Assembly	Assembly tools	Adhesive	Lubricant	Temperature	Speed	Load	Storage	Ambient media	Fitting/ contact	Design
Increasing running noise	x	x		x	x							x
Mounting problems			x								x	x
Bearing blocking	x	x		x		x	x	x		x	x	
Corrosion	x								x	x	x	
Coloration						x				x		
Breakage								x			x	



Ball indentation in raceway



Ball bearing in dry running

Indentations in raceway caused by particles

Packaging

Correct packaging protects bearings from contamination, corrosion and damage during transport and storage. We recommend that the package is opened just prior to mounting and that bearings from opened packages will be used as soon as possible. Each bearing package is labeled with the exact design specification and the respective product lot number, factory batch number, and the packaging date of the bearing.

Our Standard packaging options are as follows:

Strip Packaging “CP”

Our standard packaging contains ball bearings in one strip or pill pack, sealed individually in transparent synthetic film packets with a white backing. The quantity per strip depends on the outside diameter of the bearing.

Vacuum Packaging “LL”

Bearings are bulk packaged in a transparent synthetic film pack and sealed under vacuum. The quantity per vacuum pack depends on the size of the bearing or as specified by the customer.

Spindle bearing Packaging “CP1P”

Spindle bearings are sealed in a separate envelope marked “GRW” (CP1) and boxed individually (CP1P) to avoid damage.

Special Packaging

Packaging can be customised according to your specifications relative to the outside diameter of the respective bearing. GRW offers a wide range of packaging options, including placing the bearings on a metal stick, for automated assembly, and special aluminum envelopes.

HIGH-PRECISION BALL BEARINGS

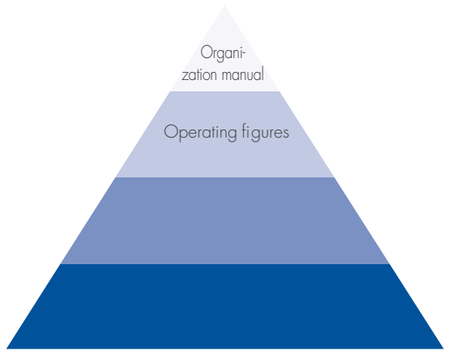
GRW quality: Internationally certified DIN EN ISO 9001

GRW is an international enterprise specialising in the development and production of high-precision miniature ball bearings. Ensuring our customers‘ complete satisfaction is our top priority. By continually improving our products and processes, we ensure the long- term success of our company.

To achieve these goals, we introduced a management system that evolves with the future requirements of each market. Our corporate strategy, based on growth and innovation, is the basis for a successful partnership with our customers and suppliers.

Our integrated management system is based on DIN EN ISO 9001:2008 and is certified in four specific areas:

1. Organisational Manual
2. Key Performance Indicators (KPI)
3. Process Definitions and defined Responsibilities
4. Process Control Documentation (work and test instructions) including supporting documents (e.g. quality check lists, forms)



The Organisational Manual includes a Management section addressing our customers, employees and suppliers. It contains our corporate principles and corporate policy. Special sections contain job descriptions and Key Performance Indicators. These critical areas of measurement contain the controlling documentation for organisational process and product quality as well as continuous improvement.

ZERTIFIKAT

Hiermit wird bescheinigt, dass

Gebr. Reinfurt GmbH & Co. KG
Hochpräzisionslager
Niederhofer Straße 105
97222 Rimpar
Deutschland

mit der weiteren Firma

Reinfurt-ČR k.s.
Průmyslová I/1366
38301 Prachatice
Tschechische Republik

ein **Qualitätsmanagementsystem** eingeführt hat und anwendet.

Geltungsbereich:
Entwicklung, Produktion und Vertrieb von Hochpräzisionskugellagern, Lagereinheiten und kundenspezifischen Sonderlagern

Durch ein Audit, dokumentiert in einem Bericht, wurde der Nachweis erbracht, dass das Managementsystem die Forderungen des folgenden Regelwerks erfüllt:

ISO 9001 : 2008

Zertifikat-Registrier-Nr. 283913 QM08
Zertifizierungsdatum 2012-12-15
Gültig bis 2015-12-14

TCA-ZM-02-90

DQS GmbH

Michael Drechsel
Geschäftsführer

Akkreditierte Stelle: DQS GmbH, August-Schanz-Straße 21, 60433 Frankfurt am Main

IQNet

THE INTERNATIONAL CERTIFICATION NETWORK

CERTIFICATE

IQNet and
DQS GmbH Deutsche Gesellschaft zur Zertifizierung von Managementsystemen
hereby certify that the company

Gebr. Reinfurt GmbH & Co. KG
Hochpräzisionslager
Niederhofer Straße 105
97222 Rimpar
Germany

Reinfurt-ČR k.s.
Průmyslová I/1366
38301 Prachatice
Czech Republic

with the following company

has implemented and maintains a **Quality Management System**.

Scope:
Development, production and sales of high precision ball bearings, bearing units and bearings according to customer specification

Through an audit, documented in a report, it was verified that the management system fulfills the requirements of the following standard:

ISO 9001 : 2008

Date of certification 2012-10-15
Valid until 2015-10-14

Registration Number: DE-283913 QM08

Michael Drechsel
Managing Director of DQS GmbH
President of IQNet

IQNet Partners*:
AENOR *Spain* AFNOR Certification *France* AIB-Vincotte International *Belgium* ANCE *Mexico* APCER *Portugal* CCC *Cyprus* CISQ *Italy* CQC *China* CQM *China* CQS *Czech Republic* Cro Cert *Croatia* DQS Holding GmbH *Germany* DS *Denmark* ELOT *Greece* FCAV *Brazil* FONDONORMA *Venezuela* ICONTEC *Colombia* IMNC *Mexico* INNORPI *Tunisia* Inspecta Certification *Finland* IRAM *Argentina* JQA *Japan* KFQ *Korea* MSZT *Hungary* Nemko AS *Norway* NSAI *Ireland* PCBC *Poland* Quality Austria *Austria* RR *Russia* SII *Israel* SIQ *Slovenia* SIRIM QAS International *Malaysia* SQS *Switzerland* SRAC *Romania* TEST St Petersburg *Russia* TSE *Turkey* YUQS *Serbia*
IQNet is represented in the USA by: AFNOR Certification, CISQ, DQS Holding GmbH and NSAI Inc.
* The list of IQNet partners is valid at the time of issue of this certificate. Updated information is available under www.iqnet-certification.com

HIGH-PRECISION BALL BEARINGS

Manufacturing in a nut shell

GRW high-precision ball bearings are used in a variety of industries and applications. Before they leave our factory they have passed several complex, manufacturing steps.

Their journey starts in the turning department where our high-precision turning machines produce bearing rings from a variety of steels used by GRW.

Turning department

Customized solutions since 1942.

After heat treatment, all critical dimensions and raceway geometries are precisely machined and ground to the micron (µ). Interim quality inspection is carried out in the measurement room.

Measurment room

Grinding department

Customized solutions since 1942.

Honing department

Honing is the last step before assembly. The finished, bearing rings run through a final process on machines co-developed by GRW for surface finishing of the raceways.

During the final assembly, finished components are sorted and selected to guarantee customer satisfaction and in some cases automated assembly can be used to assemble, lubricate and package bearings.

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About us:

GRW
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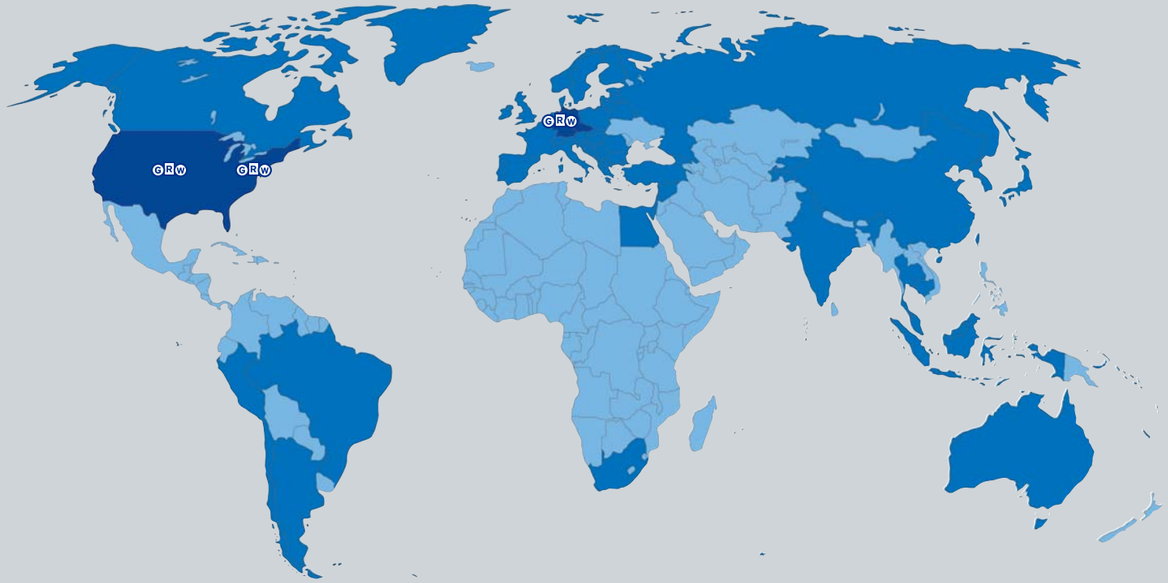
E-Mail: info@grw.de
Web: www.grw.de

Kommanditgesellschaft (Limited Partnership)
headquartered in Würzburg
Register Court: Würzburg HRA 467
Personally liable partner:
Verwaltungsgesellschaft Reinfurt mbH
headquartered in Würzburg
Register Court: Würzburg HRB 196
Sales tax ID: DE 811118985
Managing Director: Michael Ludwig, Harald Kroeger
For our current General Terms and Conditions,
please see: www.grw.de

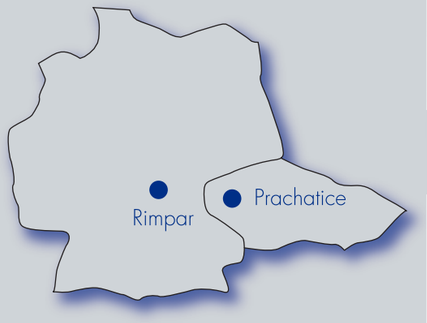
As of: 11/13

GRW
HIGH-PRECISION BALL BEARINGS



Sales office, Draper – Utah (USA)

Sales office, Richmond – Virgina (USA)



Headquarters & production, Rimpar (GER)

Production site, Prachatice (CZ)

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HOCHPRÄZISIONSKUGELLAGER

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