

High-Precision Ball Bearings

Spindle Ball Bearings



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Our company

As a global corporation with more than 500 employees, GRW is headquartered in Rimpfing near Würzburg with assembly facilities in Prachatic (Czech Republic) and two direct sales office 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 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 condition 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.

GRW quality: Internationally certified DIN EN ISO 9001

GRW is an international enterprise specialising in 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.

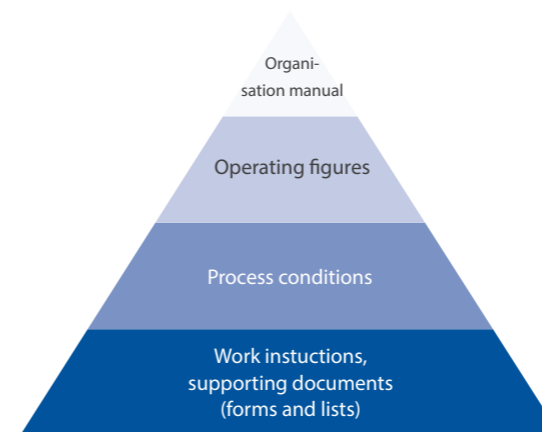
Our integrated management system is based on DIN EN ISO 9001:2008 and is certified in four specific areas:

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 checklists, forms)



Headquarter and production site at Rimpfing

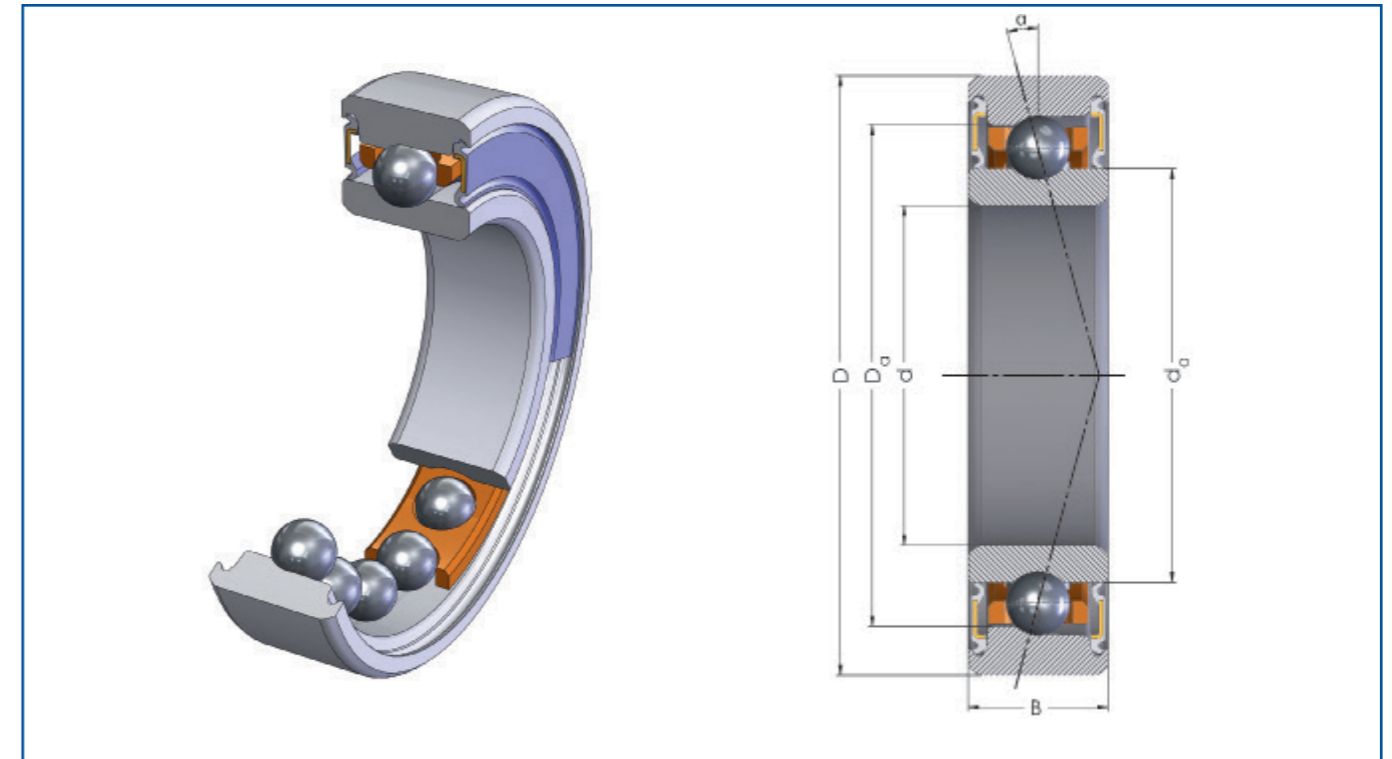
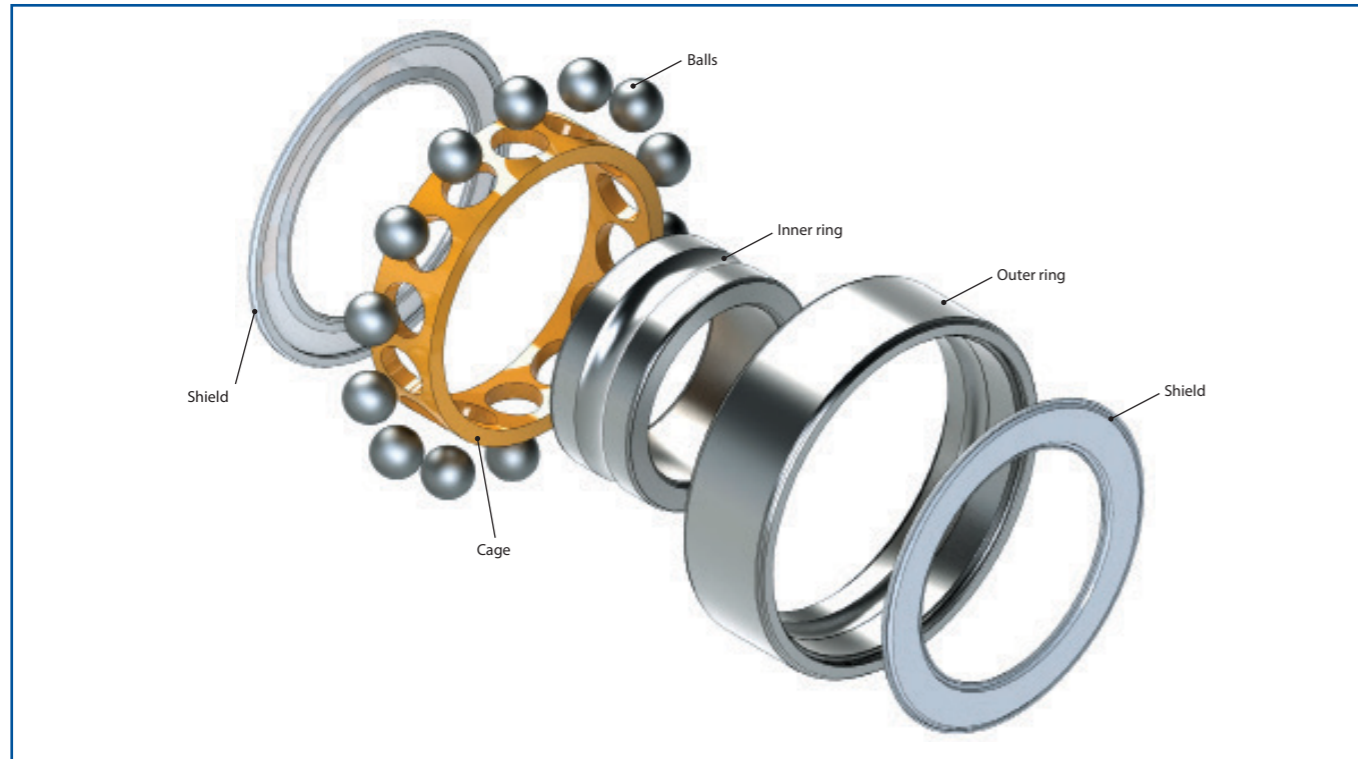
We can do even better - just challenge us.
Our sales engineers will be happy to advise you.
We are looking forward to your call: +49 (0) 93 65/819 - 482



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.



Designation system of spindle ball bearings



Ball material	Material	Basic Symbol	Closure	Contact angle	Tolerance class
-	-	705	-	C	P4
HY	SS	7000	-Z	E	P4S
ZO	SV	795	-2Z	D = ... °	
		7900	-VZ		
		705B	-2VZ		
			-TZF		
			-2TZF		
- steel balls	- 100Cr6	70.. Series 10	- open ball bearing	C 15°	P4 acc. to DIN 620-2
HY ceramic balls made of Si ₃ N ₄	SS X65Cr13	79.. Series 19	-Z one metal shield	E 25°	P4S dimension accuracy P4, running accuracy P2, acc. to DIN 620-2
ZO ceramic balls made of ZrO ₂	SV X30CrMoN15-1 Standard	705B Modified internal design	-2Z two metal shields	other contact angles available on request, e.g. D = 20°	
			-VZ one Viton shield		
			-2VZ two Viton shields		
All Variants are non-contact closures					

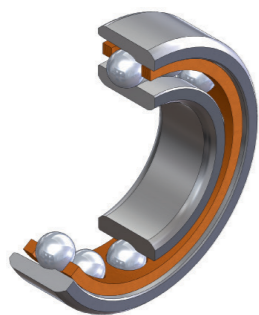
Retainer design	Diameter grading	Duplexing type	Preload value	Lubricant quantity	Lubricants
TA	-	-	-	-	-
TB	X	U	L	... %	L...
AC2TA	XB	DB	M		G...
L2TA	XD	DF	S		L299
	X4	DT	/X		
	X4B				
	X4D				
TA solid retainer made of fiber-reinforced phenolic resin guided by outer ring	- without diameter grading	-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

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 is shown by a "V" marking on the outer ring. GRW spindle ball bearings are suitable for applications requiring precision while carrying high load combined with high speed.

GRW spindle ball bearings are characterised by following properties:

- Manufactured quality of P4 (or ABEC7) or better.
- Rings mostly made of corrosion-resistant SV 30 high-grade steel (other materials on request).
- Steel or ceramic balls.
- Solid retainer made from fiber-reinforced phenolic resin or special materials, for special applications, speed, etc..
- 15° (C) or 25° (E) contact angles as standard.
- Optionally, bearings can be paired and ground to three pre-defined preload classes (L, M, S) or to a specific 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 or oil mist.

Shielded spindle ball bearings

- Non-contact shields do not cause any additional torque caused by the shields.
- Standard shields made of Viton (VZ) coupled with a stainless steel support shield offer excellent temperature and contamination 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 but sometimes different inner geometry.
- 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 to drop or to subject the bearing to any kind of impact loading.
- Spindle bearings are designed to withstand 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 of the bearing.
- Duplex bearings labeled (DB), (DF), or (DT) are always packed in pairs and can only be used as pair 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!

Duplex bearings

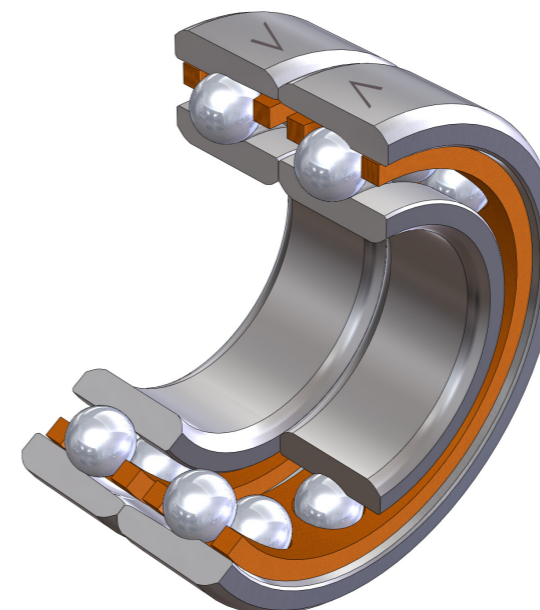
Duplex bearings are two matched bearings that provide following performance benefits:

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

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

Paired bearings processed this way are designed to be assembled in 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.



Spindle ball bearings:

Preload and contact angle are generally standardised for spindle bearings. GRW's standard contact angles are 15° (C) or 25° (E), preload is specified as light (L), medium (M) or heavy (S). If necessary, preload 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.

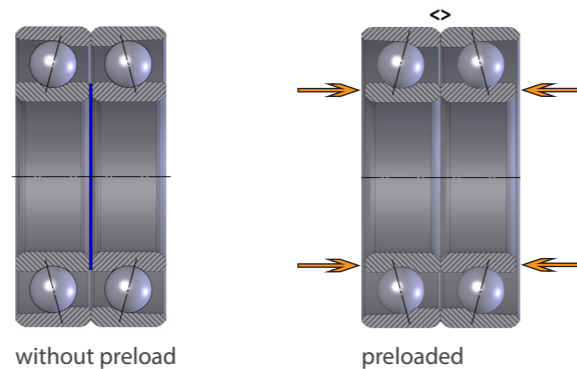
To achieve an identical fit for both bearings, Duplex bearings are sorted into two groups. The bore and outer diameters are packaged in pairs with bearings from the same group. To take full advantage of these duplexed pairs, they should also be mounted with calibrated shafts and housings (see the chapter "Calibration 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

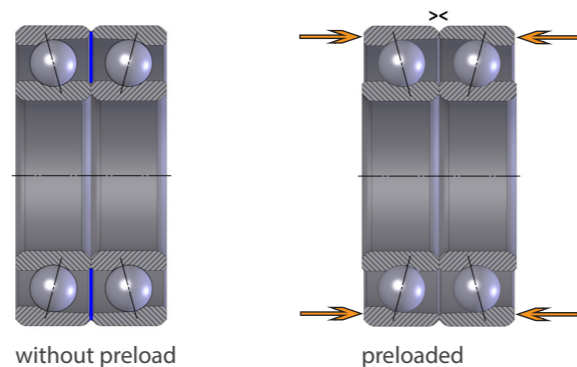
O (<>) arrangement: Back to back (designation DB)

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.



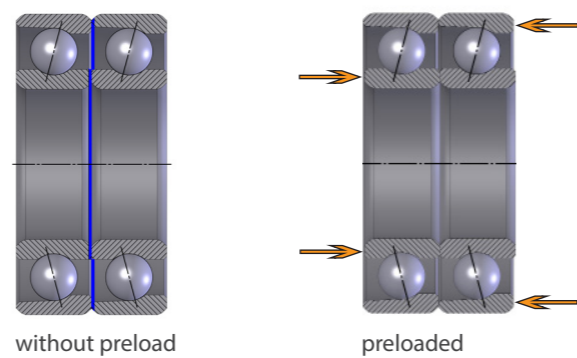
X (><) arrangement: Face to face (designation DF)

With this bearing configuration, the outer 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.



Tandem-arrangement (designation DT)

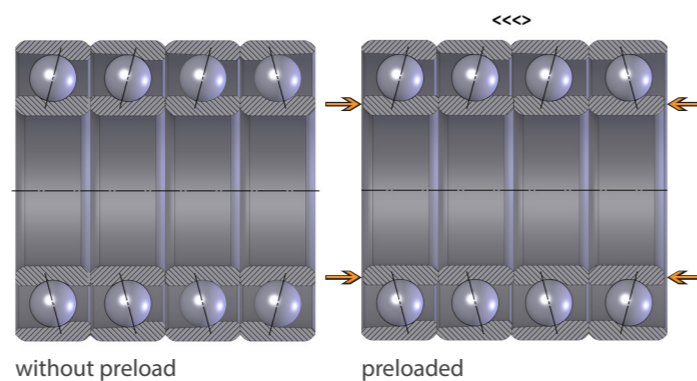
The tandem-mounted bearing design is capable of taking a significantly higher axial load, but only in one direction. With this type of bearing, preloading and control of axial play can only be achieved by preloading against another bearing.



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

Universal (designation U)

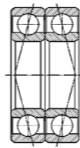
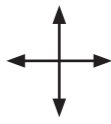
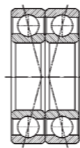
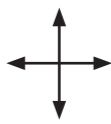
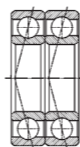
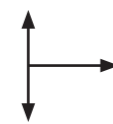
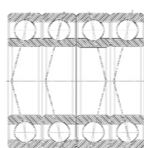
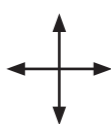
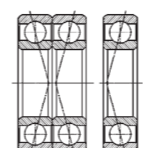
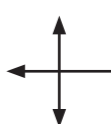
Universally matched bearing pairs have a significant advantage compared to the duplexed designs described above. They are individually ground in such a way that they can be assembled in various pairing configurations, e.g. X, O, or tandem; without any loss in performance. With the same preload, these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



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 DB	<>	 axial radial	axial radial rigidity against tilting torques
	X-arrangement DF	><	 axial radial	axial radial
	Tandem arrangement DT	<< or >>	 radial and unilaterally axial	unilaterally axial radial
	Universal U	<<>> Examples: >< or <> or >> or <<	 axial radial	depending on the arrangement
	Set of bearings assembled from universally matched bearings	>><< Examples: <>>>	 axial radial	depending on the arrangement

Calibration of bore and outside diameters

To guarantee a uniform fit of bearings on the shaft and in the housing, it is imperative 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 diameter D	X	X4	X5
Bore d only	XB	X4B	X5B
Outside diameter D only	XD	X4D	X5D

Examples:

SV724 C P4 TA X4B UL L001

X4B = bore graded in 4 groups of 1,25 µm.

The outside diameter is not graded.

Key to tolerance groups

Tolerance field in 0,001 mm	Outside diameter D												not graded			
	Tolerance field in .0001 inch															
	Code	1	2	A	B	C	D	E	F	G	H	I				
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:	Code BC:	Code A0:	Code 02:
Bore-Ø -2,5/-5 µm	Bore-Ø -1,25/-2,5 µm	Bore-Ø 0/-1,25 µm	Bore-Ø not graded
Outside-Ø 0/-2,5 µm	Outside-Ø -2,5/-3,75 µm	Outside-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.

Packaging

Correct packaging protects bearings from contamination, corrosion and damage during transport and storage. We recommend the package to open just prior to mounting and to use bearings with opened packages as soon as possible.

Spindle bearing Packaging CP1P

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

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.



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, please mind:

- 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. Usage of gloves, finger cots, and tweezers are recommended.
- Assembly location has to be clean and bright. All mating parts also have to be clean. A hard surface is preferred.
- When mounting a ball bearing, the assembly force must not be applied over 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 a 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.



Removal from package

Service

External and In-house training

- GRW modular system
- GRW designation system
- Principles of ball bearing design
- Handling of miniature ball bearings



Customized labels

- Integration of your logo
- Special packaging
- Customized designation system



Lubrication service

- First-time lubrication
- Re-lubrication
- Lubrication change
- Determination of lubrication weight



Laboratory service

- General analytics
- Lubricant analysis
- Surface treatment
- Condensation and salt spray test (DIN ISO 9227)
- Chemical deburring
- Examinations by microscope, spectroscopy and various analysis



Handling of miniature ball bearings

- Tutorial



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