

TIMKEN



Aerospace Design Guide for Precision Metric Ball and Cylindrical Roller Bearings

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INDEX

INTRODUCTION	2
BASIC DESIGN CONSIDERATIONS	
Bearing design	10
Construction selection	12
Size and chassis selection	13
Special designs	13
CYLINDRICAL ROLLER BEARINGS	
Basic construction types	14
Rollers	15
Cage options	15
Part numbers, dimensions and load ratings table	16
BALL BEARINGS	
Basic construction types	22
Cage options	23
Maximum capacity cage options	24
Seals and shields	24
Part numbers, dimensions and load ratings table	25
ENGINEERING DATA	
Tolerances	31
Inner ring tolerances	32
Outer ring tolerances	36
Non-destructive testing	40
Materials and operating temperatures	40
Radial play and contact angle	41
Radial play, ball bearings	43
Preloading	44
Bearing mounting practices	45
Dynamic load rating and life calculations	46
Static load ratings	49
Life adjustment factors	50
Considerations in bearing life prediction	51
Lubrication	51
ULTRA-HIGH-SPEED PERFORMANCE FEATURES	
Ultra-high-speed performance features	54
CONVERSION CHARTS	
Viscosity conversion table	55



TIMKEN. WHERE YOU TURN.

The world turns to Timken for innovation to move ahead of the competition. Our contributions to advancing work and living standards – through innovations surrounding friction management and power transmission – are invaluable. We have played a role in virtually all major technologies that have shaped our age, from automobile travel to artificial hearts. You'll find our products wherever you turn – on land, on sea and in space.

When customers turn to us, they are turning to a worldwide team. Because of our ability to help their products perform better, customers honor us with numerous awards each year.

Whether it is a wheel assembly for a family vehicle, bearings for a roller coaster, repair services for rail bearings or steel for an aircraft engine shaft, we supply the products and services that help keep the world turning.



FRICITION MANAGEMENT SOLUTIONS – A TOTAL SYSTEMS APPROACH

As needs change and advanced motion control systems evolve, Timken leverages its knowledge of friction management to offer a broad range of bearings, related products and integrated services to the marketplace. We supply quality products and services that extend beyond bearings to help all systems run smoothly.

We are committed to providing a wide array of friction management solutions. Customers can benefit by having Timken, a trusted name for more than 100 years, evaluate entire systems, not just individual components. This approach provides cost-effective solutions, while also helping customers to achieve specific objectives.



TECHNOLOGY THAT MOVES YOU

Today, major industries turn to Timken for our ability to influence the fundamentals of motion through the creation, transfer and control of power. We invest in people, attracting scholars, engineers and specialists from around the world. We invest in tools – computers, manufacturing equipment and state-of-the-art laboratories. We invest in the future by identifying new concepts that will help Timken and our customers make their mark for years to come. Innovation is one of our core values.

The return on our technology investment has grown exponentially. We help customers solve their immediate system issues, while developing the systems of tomorrow.

Our teams of engineers and scientists are dedicated to using everything they know about friction management and power transmission. They translate the scientific aspects of metallurgy, bearing operating characteristics, lubrication, torque, noise, heat-treatment, advanced processing concepts and application development into friction management solutions.

Because our teams are located at technology centers in North America, Europe and Asia – as well as in our manufacturing facilities and field offices on six continents – customers have access to ideas and resources that transform concepts into reality. Our technology focuses on products, materials, processes and emerging technology to create new solutions.





A BRAND YOU CAN TRUST

Timken has built a strong tradition of quality, technology and innovation. A long list of customer certifications provides solid evidence that our products have earned customer trust. As our founder, Henry Timken, said, "Don't set your name to anything you will ever have cause to be ashamed of."

From design to distribution, Timken gives customers expanded options and the security of knowing that each box contains an industry-tested product.

ABOUT THE TIMKEN COMPANY

The Timken Company is a diversified industrial manufacturer of innovative, highly engineered materials, products and power transmission systems. Timken's proprietary technologies reduce friction and enable machinery to operate more efficiently, powerfully and reliably, using less energy. With operations throughout the world, the company serves a wide range of mobile, industrial and aerospace customers.

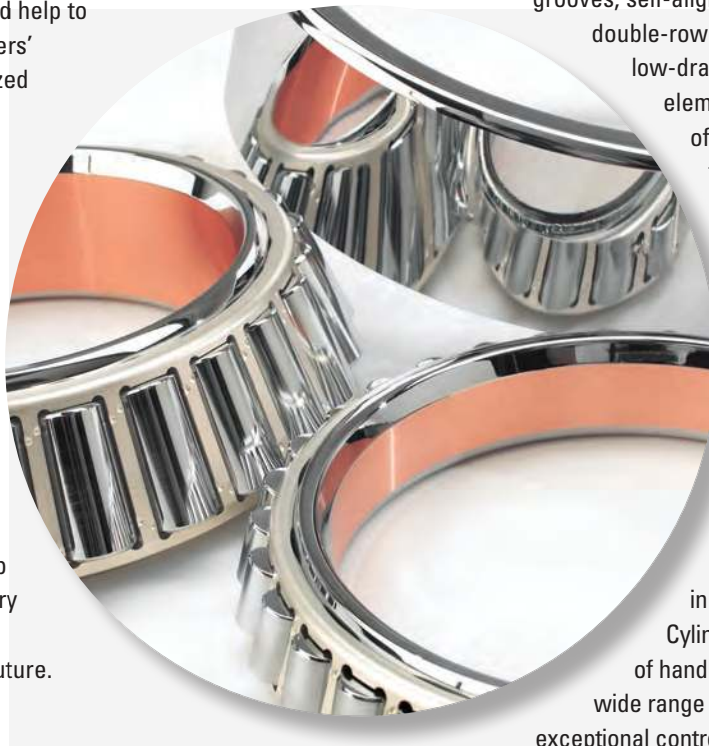
Timken has technical centers in North America, Europe and Asia and more than 100 years of engineering experience. Recognized by the Ethisphere Institute as among the 100 most ethical companies in the world in 2010, Timken has been listed on the New York Stock Exchange since 1922.

TIMKEN AEROSPACE SOLUTIONS

With rapidly expanding capabilities, Timken provides comprehensive life-cycle solutions and delivers unparalleled value for a growing number of aerospace power transmission systems. In addition to our global leadership position in aerospace bearings, we provide an increasing variety of products and services. These range from turbine engine components and gears to complete helicopter transmissions and services, which include part reconditioning and engine overhaul.

Customers around the world turn to Timken solutions for nearly every type of aerospace system – aircraft propulsion engines and auxiliary power units, gearboxes, helicopter transmissions, accessory subsystems, landing wheels, airframes and instrumentation. Our broad portfolio of products and services is known for consistent, critical performance and backed by stringent quality standards in the world.

We apply our advanced knowledge of friction management and power transmission to solve challenging motion-related problems and help to improve aerospace customers' performance. With specialized engineering and technical services, backed by significant ongoing investment in technology, we are a collaborator for design, testing and prototype development and continuing support. After more than 70 years as an aerospace innovator, Timken is well-equipped to supply the next-generation technologies needed to help keep commercial and military aircraft operating at peak performance well into the future.



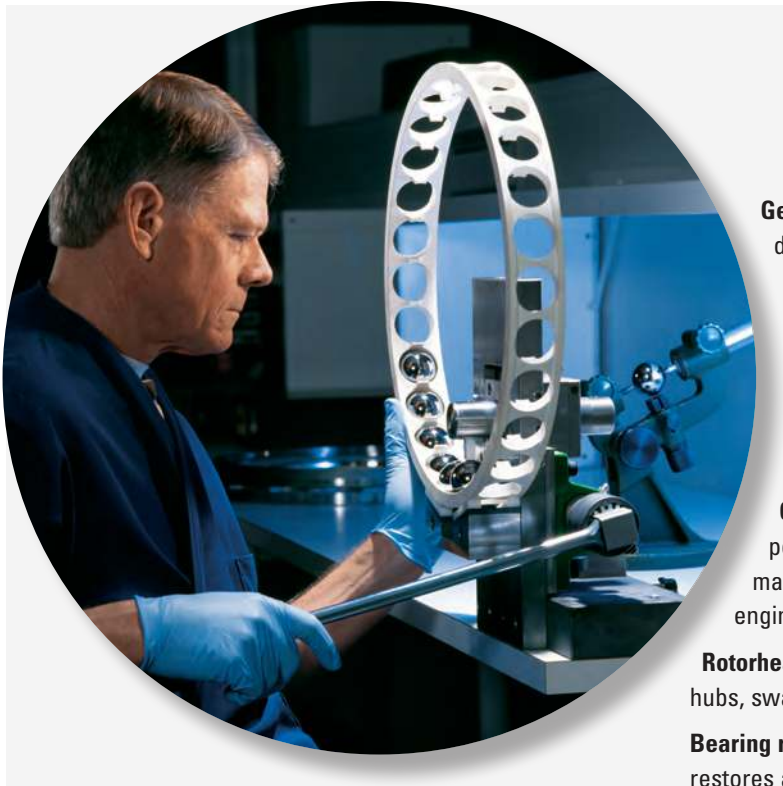
PRODUCT BREADTH

Timken® Aerospace bearings are designed to meet the performance requirements of critical flight systems. Most bearings are made from vacuum-melt 52100 or VIM-VAR M-50 steel and are normally manufactured to ANSI/ABMA tolerance class 5 (ISO class 5), with high-strength machined cages. Other special materials are available for performance enhancement, and our expertise extends not only to the development and application of new materials but also to the heat-treatment processes necessary for demanding aerospace environments. A range of stainless alloy steels also is available.

While most aerospace bearings are based on standard configurations, the unique requirements of each application tend to result in a final design that incorporates some special features. Timken has the capability to manufacture bearings of all types up to 600 mm (23.62 in.) outside diameter (O.D.). Special designs can simplify mounting and improve performance. This might include features such as puller grooves, self-aligning seats, flange mounts, double-row duplex assemblies, oil grooves, low-drag seals or ceramic rolling elements. We also can apply a range of special coatings and platings to help reduce friction and wear, extend life and improve performance.

Various Timken ball bearing configurations are specially designed to handle radial, axial, moment, reversible axial or combination loads, as single units or preloaded sets. Instrument and thin-section ball bearings are designed to provide superior performance in torque-sensitive applications.

Cylindrical roller bearings are capable of handling high radial loads and a wide range of application speeds through exceptional control of roller geometry.



Gears and associated components

deliver power transmission value with a range that includes housings and associated parts such as shafts, adapters, covers, supports and retainers.

Turbine engine components from airfoils (nozzles, blades and vanes) to housings, ducts and related components help keep aircraft engines operating at peak performance levels.

Gearboxes and transmissions meet the demanding performance requirements for helicopter engine nose, main, intermediate and tail transmissions, as well as engine accessory gearboxes.

Rotorhead assemblies serve critical dynamic functions with hubs, swashplates and miscellaneous rotorhead components.

Bearing repair, based on Timken's unique capabilities, restores a wide range of types and sizes to original specifications, offering significant savings over the cost of new replacements.

Component repair leverages Timken's core manufacturing strengths to return a wide range of parts to like-new condition for gas turbine engines and drivetrains.

Engine overhaul offers unmatched value for an increasing number of major aircraft platforms as part of our comprehensive lifecycle solutions.

Engineered surfaces improve wear and fatigue resistance for bearings and other components through a variety of applied treatments and finishes.

Frequently supplied with integral gears on their outer rings, spherical roller bearings are the preferred choice when operating conditions include heavy loads and difficulties with housing alignment or shaft deflection. Tapered roller bearings can withstand high accelerations and decelerations, heavy loads and a variety of temperature and environmental conditions. Aircraft landing wheel bearings are the standard in main and nose wheel assemblies for private, commercial and military planes.

As a Timken customer, you receive an uncompromising standard of quality across the broadest range of bearings and related products. Timken manufactures an extensive line of tapered, spherical, cylindrical and ball bearings, as well as mounted units, ideal for virtually every aerospace application. Our core products are complemented by an ever-growing line of friction management solutions including gears and transmissions, turbine engine components, replacement parts and overhaul services that help keep your aircraft flying.



ABOUT THIS DESIGN GUIDE

Timken offers an extensive range of bearings and accessories in both imperial and metric sizes. For your convenience, size ranges are indicated in millimeters and inches. Contact your Timken sales representative to learn more about our complete line for the special needs of your application.

USING THIS GUIDE

We are committed to providing our customers with maximum service and quality. This publication contains dimensions, tolerances and load ratings as well as an engineering section describing fitting practices for shafts and housings, internal clearances, materials and other bearing features. It can provide valuable assistance in the initial consideration of the type and characteristics of the bearing that may best suit your particular needs.

DESIGN GUIDE FEATURES

Dimensional and load rating data, within the various types and styles of bearings, is organized by size.

ISO and ANSI/ABMA, as used in this publication, refer to the International Organization for Standardization and the American National Standards Institute/American Bearing Manufacturers Association.

SPECIAL APPLICATIONS

Aerospace applications require some products made to special standards, and only original equipment manufacturers can determine if a particular bearing is suitable for use in their equipment.



WARNING

Failure to observe the following warnings could create a risk of serious injury.

Proper maintenance and handling practices are critical.
Always follow installation instructions and maintain proper lubrication.

Every reasonable effort has been made to ensure the accuracy of the information contained in this design guide, but no liability is accepted for errors, omissions or for any other reason.

NOTE

Product performance is affected by many factors beyond the control of Timken. Therefore, you must validate the suitability and feasibility of all designs and product selection. This guide is provided solely to give you, a customer of Timken or its parent or affiliates, analysis tools and data to assist you in your design. No warranty, expressed or implied, including any warranty of merchantability or fitness for a particular purpose, is made by Timken. Timken products and services are sold subject to a Limited Warranty. You can see your Timken representative for more information.



SHELF LIFE AND STORAGE OF GREASE-LUBRICATED BEARINGS AND COMPONENTS

Timken guidelines for the shelf life of grease-lubricated rolling bearings, components and assemblies are set forth below. Shelf life information is based on test data and experience. Shelf life should be distinguished from lubricated bearing/component design life as follows:

SHELF LIFE

Shelf life of the grease-lubricated bearing/component represents the period of time prior to use or installation. The shelf life is a portion of the anticipated aggregate design life. It is impossible to accurately predict design life due to variations in lubricant bleed rates, oil migration, operating conditions, installation conditions, temperature, humidity and extended storage.

The bearing shelf life is related primarily to the lubricant's ability to maintain the bearing's original manufactured radial internal clearance and freedom to rotate.

The component shelf life is related to the ability of the component to function as originally intended.

Shelf life values, available from Timken, represent a maximum limit – and assume adherence to the Timken suggested storage and handling guidelines. Deviations from Timken's storage and handling guidelines may reduce shelf life. Any specification or operating practice that defines a shorter shelf life should be used. Timken cannot anticipate the performance of the grease lubricant after the bearing or component is installed or placed in service.

TIMKEN IS NOT RESPONSIBLE FOR THE SHELF LIFE OF ANY BEARING/COMPONENT LUBRICATED BY ANOTHER PARTY.

STORAGE

Timken suggests the following storage guidelines for its finished products (bearings, components and assemblies, hereinafter referred to as "Products"):

- Unless directed otherwise by Timken, Products should be kept in their original packaging until they are ready to be placed into service.
- Do not remove or alter any labels or stencil markings on the packaging.
- Products should be stored in such a way that the packaging is not pierced, crushed or otherwise damaged.
- After a Product is removed from its packaging, it should be placed into service as soon as possible.

- When removing a Product that is not individually packaged from a bulk pack container, the container should be resealed immediately after the Product is removed.
- Do not use Product that has exceeded its shelf life as defined in Timken's shelf life guidelines statement.
- The storage area temperature should be maintained between 0° C (32° F) and 40° C (104° F); temperature fluctuations should be minimized.
- The relative humidity should be maintained below 60 percent.
- The storage area should be kept free from airborne contaminants such as, but not limited to: dust, dirt, harmful vapors, etc.
- The storage area should be isolated from undue vibration.
- Extreme conditions of any kind should be avoided.

Inasmuch as Timken is not familiar with a customer's particular storage conditions, these guidelines are strongly suggested. However, the customer may very well be required by circumstance or applicable government requirements to adhere to stricter storage requirements.

Most bearing types are typically shipped protected with a corrosion-preventive compound that is not a lubricant. Such bearings may be used in oil-lubricated applications without removal of the corrosion-preventive compound. When using some specialized grease lubrication, it is advisable to remove the corrosion-preventive compound before packing the bearings with suitable grease.

Some bearing types in this design guide are pre-packed with general purpose grease suitable for their normal application. Frequent replenishment of the grease may be necessary for optimum performance. Care must be exercised in lubricant selection, however, since different lubricants are often incompatible.

When specified by the customer, other bearings may be ordered pre-lubricated with suitable greases and oils.

Upon receipt of a bearing shipment, ensure that the bearings are not removed from their packaging until they are ready for mounting so that they do not become corroded or contaminated. Bearings should be stored in an appropriate atmosphere in order that they remain protected for the intended period.

Any questions concerning shelf life or storage should be directed to your local sales office.

BEARING DESIGN

FROM APPLICATION TO SPECIFICATION – A LOGICAL APPROACH

This design guide is prepared to help you choose the optimum bearing for your specific application. Too often, bearings are selected without a thorough analysis, resulting in poor performance, unexpected problems and reduced life. To help you avoid these and other issues, Timken developed a four-step procedure to summarize key concepts that should be considered when developing an aerospace bearing specification. The interrelationship of these concepts covers the entire field of bearing engineering.

Although this design guide answers many questions, others may require the assistance of an experienced Timken engineer. Furthermore, in unusual or state-of-the-art applications, the solution may require a carefully monitored test program. Bearing chassis sizes and load ratings listed in this guide can be modified and optimized to meet specific requirements including special features.

STEP 1: DETERMINE PERFORMANCE REQUIREMENTS

Simply stated, two basic performance requirements control everything that a bearing must do within an application. Every bearing must:

- 1) Provide a defined level of rotational freedom.
- 2) Provide a defined level of position control (from basic free movement to high-frequency movement or vibration).

It is important to determine the actual limits of these requirements since bearing life is simply how long the bearing is statistically expected to operate within these limits. Of course, limits vary significantly from one type of application to another, so detailed analysis must be established.

STEP 2: DETERMINE APPLICATION PARAMETERS

A number of application parameters govern performance. Although only a portion may be significant in any given application, meticulous review of each will help ensure that nothing important has been overlooked.

Performance application parameters can be categorized four ways:

- 1) Physical.
- 2) Operational.
- 3) Environmental.
- 4) Economic.

In any given application, many of these are fixed while others are variable and can be modified or controlled when necessary. Final selection is always involves a balance of these parameters.

Physical Parameters

These include:

- 1) Space available for the bearing or bearing systems.
- 2) Allowable weight for the bearing or bearing systems.
- 3) The shape, material and tolerance control of the housing and shaft.
- 4) The features integrated into the bearing to simplify mounting structures.
- 5) Operational temperature.

The more space and weight allowed for the bearing system, the more sophisticated and reliable it will be. However, added weight may be an expensive luxury unless absolutely necessary, as would be true of supplementary lubrication systems for high-speed turbine and accessory bearings. The housing and shaft design has a significant impact on ultimate bearing performance. The shaft should be a solid, perfectly round cylinder made from material absolutely compatible with the thermal coefficient of expansion of the bearing. The housing cross section should be uniform, giving full hoop support for the bearing. Both housing and shaft should have precision-machined shoulders or seats to ensure perfect alignment.

Final design selection is made by choosing the best set of features to meet the physical parameters of the application. Timken engineers can provide design assistance in choosing the best design features for the application.

Operational Parameters

- 1) **Speed** governs the number of load cycles the bearing experiences and is, therefore, related to life. Speed, in terms of a relative guide parameter called “dN” (inner ring bore in mm x RPM), also influences many other aspects of bearing operation. This includes lubricant flow patterns and film thickness, centrifugal rolling element loads, skidding, excessive heat generation and lubrication method.
- 2) **Loads** break down in three directions: radial, axial and moment. These, in turn, can be applied as constant, variable, vibratory or impact loading. The combination must be carefully considered for optimum bearing life and performance.

The environment is a fixed condition of the end product. However, the decision to protect or expose the bearing to the environment is a design option. Temperature, either ambient or internally generated, is a major consideration. The nature of the surrounding media, liquid or gas (for both materials and lubrication), may establish the need for seals, special corrosion protection or supplemental lubrication. Any special environments such as magnetic fields or radiation also should be considered for their design impact.

Total system cost should be carefully weighed. This is not just the cost of the bearing, but the total cost of bearing, mounting and replacement. Timken engineers can work with you on minimizing total system cost.

Reduced design life in a particular application occurs when there is sufficient performance degradation so that the bearing no longer meets the original requirements. There are fifteen commonly identified primary damage modes:

- A complete discussion of these failure modes is beyond the scope of this design guide. It is important to note that only classic fatigue and true load brinell have specific formulas that permit calculation of life or numerical limit. All of the others are experience factors that are a function of the specific application, where temperatures, lubrication, overload or contamination are contributors to decreased life.

Only after careful consideration of the foregoing should a specific bearing selection be made. In many cases, it is possible to select a size and type from this guide without defining restrictions on other characteristics. In more critical applications, specific design decisions and/or controls can be developed based on:

- If the analysis has been completed properly, the final design should function as intended. Reliability and life expectancy will be optimized with the best chance of avoiding damage. Timken Aerospace engineers are ready to provide assistance as necessary to achieve this goal.

Evaluation of the design criteria contained in the following chart will help you choose the optimum design construction. While no individual construction can satisfy all possible service functions, proper selection makes it possible to meet the most critical functions or conditions in each application. The chart rates each construction on a relative basis.



CODES: E = excellent S = satisfactory M = marginal N/A = not adequate or not available
(1) May be used with closely restraining housing fits and face clamping.

Table 1. Construction selector.

SIZE AND CHASSIS SELECTION

Timken Aerospace ball and roller bearings are offered in five basic boundary dimension series. These series, illustrated in Fig. 1 and listed in the dimension tables, include bearings ranging in size from 10 mm (0.3937 in.) bore to 600 mm (23.6220 in.) O.D. The 000 series (ANSI/ABMA 19 series) has become increasingly popular with the aircraft industry due to its very thin cross section and reduced weight. Timken also supplies bearings in the ultra-light 1800 series.

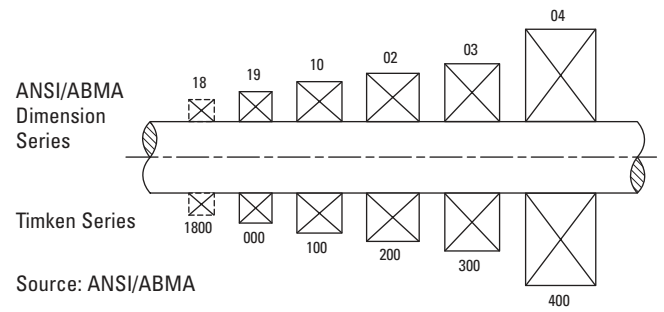


Fig. 1. ANSI/ABMA dimension series and Timken series.

SPECIAL DESIGNS

Many special designs can be made to simplify mounting and improve performance in complex engine assemblies.

A typical design would include bearings with puller grooves, self-aligning seats, flange mounts or double-row duplex assemblies. To speed delivery and reduce cost, all specialized bearings should be designed around standard bore, O.D. width or ball/roller complements as listed in the bearing specification tables.

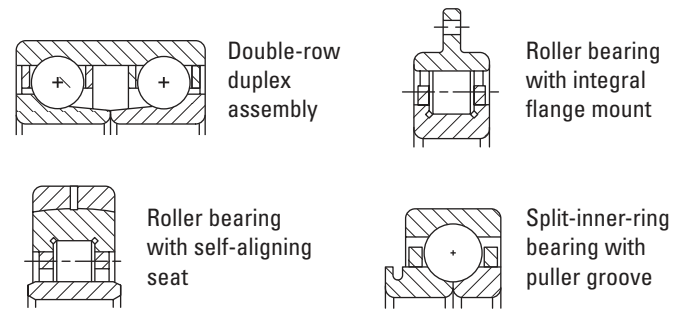


Fig. 2. Special designs.

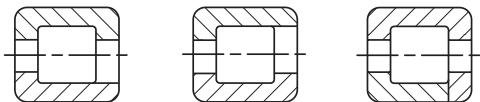
CYLINDRICAL ROLLER BEARINGS

BASIC CONSTRUCTION TYPES

Aerospace roller bearings are designed to meet the needs of high-speed operations. Careful attention to roller configuration, cage design, guide flange finish and contour and material stability can help you achieve roller end wear and improve life at high speeds.

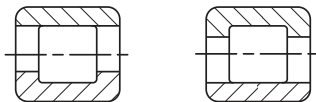
Conventionally designed roller bearings in standard 52100 or VIM-VAR M-50 steel are normally manufactured to class 5 tolerances with high-strength machined cages. Any of at least seven ring configurations may be selected, depending on the application. All types (except RAA) provide precision control of the roller for operation over a wide speed range with precision-ground, double-ribbed guide flanges on one ring. Generally, the guide flange diameters are ground to close tolerances to offer a riding surface for cage-to-land clearance control.

RF RJ RT



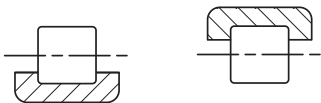
For applications requiring axial position control or limited axial capabilities in one direction, type RF is most frequently used. Under light loads, type RF is less prone to skidding. Under higher loads at higher speeds, type RJ is easier to lubricate with an oil jet onto the inner raceway. Type RT is similar, but can support a reversing or indeterminate thrust load.

RU RN



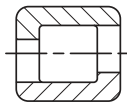
These full-floating configurations allow limited axial motion during operation. Type RU is easier to lubricate under heavy loads. Type RN is less prone to slip or skid under lighter or varying loads at high speeds.

RUS RNH



These configurations are used in integral designs where the rollers run directly on a hardened and ground shaft or housing. Nominal matching shaft and housing diameters are shown in the specification tables. Performance characteristics are similar to types RU and RN.

RAA



Single-ribbed inner and outer rings are a lower-cost version of type RF for use at low speeds or under oscillating conditions. This design generally has only guide flanges to accept some axial load in one direction (with well-lubricated guide flanges).

Fig. 3. Cylindrical roller bearing types.

ROLLERS

Rollers in all sizes over 3.5 mm (0.1378 in.) are contoured by crown blending for uniform stress distribution under load. The length is closely matched for uniform minimum clearance within the guide flanges to ensure optimum tracking at all speeds. All rollers listed in the specification tables have the preferred equal length-to-diameter ratio. These “square” rollers have superior ability to accept thrust and misalignment. Where theoretical capacity is critical and when load conditions and O.D. restrictions dictate, rollers of length-to-diameter ratio greater than 1 can be supplied.

CAGE OPTIONS

Following selection of the basic bearing construction, choosing the proper cage material results in the optimum bearing for the application. With the exception of the full roller complement, all cage options are one-piece designs with precision-machined pockets, piloted on the double-ribbed ring and are non-separable from the double-ribbed ring. Rollers are usually retained through a Timken-proprietary formed-tab design, although special designs may require the use of other retention methods.

Cage Code	Material and Type	Design	Temp. Limit	Speed Limit dN 10 ⁶	Description
F	Full roller complement, no cage		Same as bearing material	0.3	Use primarily at low speeds under high radial loads. Provides the maximum possible static load capacity. Also use to reduce cost where a cage is not required.
B	Machined brass		190° C	1.0	Use in heavily loaded transmission and accessory applications. Excellent strength and wear performance.
			375° F		
Z	AMS 4616 silicon-iron-bronze		260° C	1.5	Similar to brass with better strength and wear-resistant. Frequently used in combination with VIM-VAR M-50 rings where temperatures exceed the 177° C (350° F) limit for 52100 steel.
			500° F		
H	Machined and hardened AMS 6415 alloy steel silver-plated		480° C	3.0	Silver-plated to enhance run-in, wear life and to provide continuity after lubricant loss. VIM-VAR M-50 bearings with silver-plated steel cages are the first choice of the turbine industry for critical performance mainshaft and powertrain bearings.
			900° F		

Table 2. Cage options.

PART NUMBERS, DIMENSIONS AND LOAD RATINGS TABLE

Timken Size Code	Boundary Dimensions									Load Ratings		
	d	D	W	Mounting Shoulder Diameter		R	Nominal Roller Path Diameter		Roller		C _r	C _{or}
	Bore	Outside Diameter	Width	A	S	Radius			No.	Diameter x Length	Dynamic Radial Capacity	Static Radial Capacity
				Min. Shaft	Max. Housing							
				mm in.	mm in.		mm in.	mm in.				
000	10 0.3937	22 0.8661	6 0.2362	12.014 0.473	19.964 0.786	0.3 0.012	12.500 0.4921	19.500 0.7677	10	3.5 x 3.5 0.1378 x 0.1378	4790 1080	3480 782
100	10 0.3937	26 1.0236	8 0.3150	12.421 0.489	23.571 0.928	0.3 0.012	13.000 0.5118	23.000 0.9055	8	5 x 5 0.1969 x 0.1969	7950 1790	5580 1250
200	10 0.3937	30 1.1811	9 0.3543	14.021 0.552	25.984 1.023	0.6 0.024	15.000 0.5906	25.000 0.9843	8	5 x 5 0.1969 x 0.1969	8100 1820	5800 1300
300	10 0.3937	35 1.3780	11 0.4331	14.453 0.569	30.556 1.203	0.6 0.024	17.000 0.6693	30.000 1.1811	8	6.5 x 6.5 0.2559 x 0.2559	12700 2860	9240 2080
001	12 0.4724	24 0.9449	6 0.2362	14.021 0.552	21.996 0.866	0.3 0.012	14.676 0.5778	21.676 0.8534	10	3.5 x 3.5 0.1378 x 0.1378	4820 1080	3590 808
101	12 0.4724	28 1.1024	8 0.3150	14.326 0.564	25.679 1.011	0.3 0.012	15.000 0.5906	25.000 0.9843	8	5 x 5 0.1969 x 0.1969	8100 1820	5800 1300
201	12 0.4724	32 1.2598	10 0.3937	15.697 0.618	28.296 1.114	0.6 0.024	16.000 0.6299	28.000 1.1024	8	6 x 6 0.2362 x 0.2362	11400 2560	8280 1860
301	12 0.4724	37 1.4567	12 0.4724	17.043 0.671	32.029 1.261	1 0.039	18.034 0.7100	32.034 1.2612	8	7 x 7 0.2756 x 0.2756	14700 3300	10800 2430
002	15 0.5906	28 1.1024	7 0.2756	17.043 0.671	25.959 1.022	0.3 0.012	18.000 0.7087	25.000 0.9843	14	3.5 x 3.5 0.1378 x 0.1378	6180 1390	5220 1170
102	15 0.5906	32 1.2598	9 0.3543	17.424 0.686	29.591 1.165	0.3 0.012	18.750 0.7382	28.750 1.1319	10	5 x 5 0.1969 x 0.1969	9750 2190	7630 1710
202	15 0.5906	35 1.3780	11 0.4331	18.542 0.730	31.471 1.239	0.6 0.024	19.000 0.7480	31.000 1.2205	10	6 x 6 0.2362 x 0.2362	13800 3090	10800 2430
302	15 0.5906	42 1.6535	13 0.5118	20.218 0.796	36.906 1.453	1 0.039	20.900 0.8228	36.900 1.4528	8	8 x 8 0.3150 x 0.3150	19100 4300	14400 3240
003	17 0.6693	30 1.1811	7 0.2756	19.025 0.749	27.991 1.102	0.3 0.012	20.000 0.7874	27.000 1.0630	14	3.5 x 3.5 0.1378 x 0.1378	6150 1380	5300 1190
103	17 0.6693	35 1.3780	10 0.3937	19.380 0.763	32.614 1.284	0.3 0.012	21.250 0.8366	31.250 1.2303	12	5 x 5 0.1969 x 0.1969	11200 2520	9380 2110
203	17 0.6693	40 1.5748	12 0.4724	20.701 0.815	36.297 1.429	0.6 0.024	22.324 0.8789	35.324 1.3907	10	6.5 x 6.5 0.2559 x 0.2559	15500 3480	12400 2780
303	17 0.6693	47 1.8504	14 0.5512	22.327 0.879	41.681 1.641	1 0.039	23.451 0.9233	41.451 1.6319	8	9 x 9 0.3543 x 0.3543	24100 5410	18500 4160
403	17 0.6693	62 2.4409	17 0.6693	24.028 0.946	54.966 2.164	1 0.039	28.500 1.1220	50.500 1.9882	8	11 x 11 0.4331 x 0.4331	34200 7680	26900 6050
004	20 0.7874	37 1.4567	9 0.3543	22.200 0.874	34.798 1.370	0.3 0.012	23.749 0.9350	33.749 1.3287	14	5 x 5 0.1969 x 0.1969	12600 2830	11200 2510
104	20 0.7874	42 1.6535	12 0.4724	23.546 0.927	38.456 1.514	0.6 0.024	24.000 0.9449	38.000 1.4961	10	7 x 7 0.2756 x 0.2756	17900 4030	14500 3260
204	20 0.7874	47 1.8504	14 0.5512	24.689 0.972	42.291 1.665	1 0.039	25.900 1.0197	41.900 1.6496	10	8 x 8 0.3150 x 0.3150	23200 5220	19100 4280
304	20 0.7874	52 2.0472	15 0.5906	25.197 0.992	46.812 1.843	1 0.039	26.000 1.0236	46.000 1.8110	8	10 x 10 0.3937 x 0.3937	29500 6630	23100 5190
404	20 0.7874	72 2.8346	19 0.7480	27.026 1.064	64.973 2.558	1 0.039	34.000 1.3386	58.000 2.2834	8	12 x 12 0.4724 x 0.4724	41000 9220	33200 7460
005	25 0.9843	42 1.6535	9 0.3543	27.178 1.070	39.827 1.568	0.3 0.012	29.017 1.1424	39.017 1.5361	16	5 x 5 0.1969 x 0.1969	13800 3100	13200 2960
105	25 0.9843	47 1.8504	12 0.4724	28.651 1.128	43.332 1.706	0.6 0.024	29.000 1.1417	43.000 1.6929	12	7 x 7 0.2756 x 0.2756	20700 4660	18100 4070
205	25 0.9843	52 2.0472	15 0.5906	29.616 1.166	47.396 1.866	1 0.039	30.482 1.2000	46.482 1.8300	12	8 x 8 0.3150 x 0.3150	26900 6040	23700 5330
305	25 0.9843	62 2.4409	17 0.6693	30.607 1.205	56.388 2.220	1 0.039	33.564 1.3214	55.564 2.1876	10	11 x 11 0.4331 x 0.4331	41200 9270	35100 7890
405	25 0.9843	80 3.1496	21 0.8268	33.096 1.303	71.907 2.831	1.5 0.059	39.500 1.5551	65.500 2.5787	10	13 x 13 0.5118 x 0.5118	57100 12800	50000 11300

R = maximum shaft or housing fillet radius that bearing corner will clear.

C_r = ANSI/ABMA dynamic radial load rating (33⅓ RPM for 500 hours and 90 percent survival, equivalent to 1000000 inner ring revolutions).C_{or} = ANSI/ABMA static radial load rating.

continued on next page

PART NUMBERS, DIMENSIONS AND LOAD RATINGS TABLE *continued*

Timken Size Code	Boundary Dimensions									Load Ratings		
	d	D	W	Mounting Shoulder Diameter		R	Nominal Roller Path Diameter		Roller		C _r	C _{or}
	Bore	Outside Diameter	Width			Radius			No.	Diameter x Length	Dynamic Radial Capacity	Static Radial Capacity
				A	S							
				Min. Shaft	Max. Housing		Inner	Outer				
	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.		mm in.	Newtons lbs.	Newtons lbs.
006	30 1.1811	47 1.8504	9 0.3543	32.207 1.268	44.806 1.764	0.3 0.012	33.749 1.3287	43.749 1.7224	18	5 x 5 0.1965 x 0.1969	14900 3350	15100 3400
106	30 1.1811	55 2.1654	13 0.5118	34.544 1.360	50.470 1.987	1 0.039	35.850 1.4114	49.850 1.9626	14	7 x 7 0.2756 x 0.2756	23200 5220	22000 4940
206	30 1.1811	62 2.4409	16 0.6299	34.900 1.374	57.099 2.248	1 0.039	37.020 1.4575	57.020 2.2449	12	10 x 10 0.3937 x 0.3937	41400 9310	37800 8490
306	30 1.1811	72 2.8346	19 0.7480	35.890 1.413	66.091 2.602	1 0.039	38.651 1.5217	64.651 2.5453	10	13 x 13 0.5118 x 0.5118	56900 12800	49800 11200
406	30 1.1811	90 3.5433	23 0.9055	38.100 1.500	81.915 3.225	1.5 0.059	46.000 1.8110	74.000 2.9134	10	14 x 14 0.5512 x 0.5512	66400 14900	59600 13400
007	35 1.3780	55 2.1654	10 0.3937	38.354 1.510	51.664 2.034	0.6 0.024	39.300 1.5472	51.300 2.0197	18	6 x 6 0.2362 x 0.2362	21300 4790	22200 5000
107	35 1.3780	62 2.4409	14 0.5512	39.624 1.560	57.379 2.259	1 0.039	40.900 1.6102	56.900 2.2402	14	8 x 8 0.3150 x 0.3150	30200 6790	29200 6570
207	35 1.3780	72 2.8346	17 0.6693	40.361 1.589	66.624 2.623	1 0.039	43.050 1.6949	65.050 2.5610	12	11 x 11 0.4331 x 0.4331	48100 10800	44500 10000
307	35 1.3780	80 3.1496	21 0.8268	42.748 1.683	72.238 2.844	1.5 0.059	43.500 1.7126	71.500 2.8150	10	14 x 14 0.5512 x 0.5512	66100 14900	58900 13200
407	35 1.3780	100 3.9370	25 0.9843	43.104 1.697	91.923 3.619	1.5 0.059	52.500 2.0669	82.500 3.2481	10	15 x 15 0.5906 x 0.5906	76300 17100	70000 15700
008	40 1.5748	62 2.4409	12 0.4724	43.358 1.707	58.649 2.309	0.6 0.024	44.000 1.7323	58.000 2.2835	18	7 x 7 0.2756 x 0.2756	27700 6230	29100 6540
108	40 1.5748	68 2.6772	15 0.5906	44.577 1.755	63.424 2.497	1 0.039	45.000 1.7717	63.000 2.4803	14	9 x 9 0.3543 x 0.3543	38000 8540	37400 8400
208	40 1.5748	80 3.1496	18 0.7087	45.542 1.793	74.447 2.931	1 0.039	48.600 1.9134	72.600 2.8583	12	12 x 12 0.4724 x 0.4724	57100 12800	54000 12100
308	40 1.5748	90 3.5433	23 0.9055	48.133 1.895	81.864 3.223	1.5 0.059	49.800 1.9606	81.800 3.2205	10	16 x 16 0.6299 x 0.6299	85600 19200	77900 17500
408	40 1.5748	110 4.3307	27 1.0630	50.495 1.988	99.517 3.918	2 0.079	58.000 2.2835	92.000 3.6221	10	17 x 17 0.6693 x 0.6693	93100 20900	86000 19300
009	45 1.7717	68 2.6772	12 0.4724	48.590 1.913	64.414 2.536	0.6 0.024	49.500 1.9488	63.500 2.5000	20	7 x 7 0.2756 x 0.2756	29700 6680	32800 7380
109	45 1.7717	75 2.9528	16 0.6299	49.759 1.959	70.231 2.765	1 0.039	51.450 2.0256	69.450 2.7342	16	9 x 9 0.3543 x 0.3543	41800 9390	43600 9800
209	45 1.7717	85 3.3465	19 0.7480	50.419 1.985	79.578 3.133	1 0.039	52.650 2.0728	78.650 3.0965	12	13 x 13 0.5118 x 0.5118	66700 15000	64000 14400
309	45 1.7717	100 3.9370	25 0.9843	53.001 2.087	91.999 3.622	1.5 0.059	55.500 2.1850	89.500 3.5236	10	17 x 17 0.6693 x 0.6693	92900 20900	85100 19100
409	45 1.7717	120 4.7244	29 1.1417	55.499 2.185	109.499 4.311	2 0.079	64.500 2.5394	100.500 3.9568	12	18 x 18 0.7087 x 0.7087	120000 27000	118000 26500
010	50 1.9685	72 2.8346	12 0.4724	53.569 2.109	68.453 2.695	0.6 0.024	54.000 2.1260	68.000 2.6772	20	7 x 7 0.2756 x 0.2756	29400 6620	33200 7460
110	50 1.9685	80 3.1496	16 0.6299	54.788 2.157	75.209 2.961	1 0.039	56.449 2.2224	74.449 2.9311	18	9 x 9 0.3543 x 0.3543	45300 10200	49700 11200
210	50 1.9685	90 3.5433	20 0.7874	55.372 2.180	84.633 3.332	1 0.039	57.650 2.2697	83.650 3.2933	14	13 x 13 0.5118 x 0.5118	75000 16900	76000 17100
310	50 1.9685	110 4.3307	27 1.0630	59.715 2.351	100.279 3.948	2 0.079	61.950 2.4390	99.950 3.9350	10	19 x 19 0.7480 x 0.7480	115000 25900	108000 24300
410	50 1.9685	130 5.1181	31 1.2205	63.957 2.518	116.053 4.569	2 0.079	71.000 2.7953	109.000 4.2913	12	19 x 19 0.7480 x 0.7480	134000 30000	133000 30000
011	55 2.1654	80 3.1496	13 0.5118	60.071 2.365	74.930 2.950	1 0.039	60.850 2.3957	74.850 2.9468	24	7 x 7 0.2756 x 0.2756	33200 7470	40300 9070
111	55 2.1654	90 3.5433	18 0.7087	60.909 2.398	84.099 3.311	1 0.039	62.049 2.4429	84.049 3.3090	16	11 x 11 0.4331 x 0.4331	59400 13300	63300 14200
211	55 2.1654	100 3.9370	21 0.8268	62.128 2.446	92.888 3.657	1.5 0.059	63.500 2.5000	91.500 3.6024	14	14 x 14 0.5512 x 0.5512	86600 19500	89200 20100
311	55 2.1654	120 4.7244	29 1.1417	64.973 2.558	110.033 4.332	2 0.079	69.449 2.7342	107.449 4.2303	12	19 x 19 0.7480 x 0.7480	133000 30000	133000 29900
411	55 2.1654	140 5.5118	33 1.2992	68.961 2.715	126.035 4.962	2 0.079	77.500 3.0512	117.500 4.6260	12	20 x 20 0.7874 x 0.7874	148000 33200	150000 33700

R = maximum shaft or housing fillet radius that bearing corner will clear.

C_r = ANSI/ABMA dynamic radial load rating (33⅓ RPM for 500 hours and 90 percent survival, equivalent to 1000000 inner ring revolutions).

C_{or} = ANSI/ABMA static radial load rating.

Timken Size Code	Boundary Dimensions									Load Ratings		
	d	D	W	Mounting Shoulder Diameter		R	Nominal Roller Path Diameter		Roller		C _r	C _{or}
	Bore	Outside Diameter	Width			Radius			No.	Diameter x Length	Dynamic Radial Capacity	Static Radial Capacity
				A	S							
				Min. Shaft	Max. Housing		Inner	Outer				
	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.		mm in.	Newtons lbs.	Newtons lbs.
012	60 2.3622	85 3.3465	13 0.5118	65.024 2.560	79.959 3.148	1 0.039	65.723 2.5875	79.723 3.1387	24	7 x 7 0.2756 x 0.2756	32900 7390	40700 9140
112	60 2.3622	95 3.7402	18 0.7087	65.837 2.592	89.154 3.510	1 0.039	66.500 2.6181	88.500 3.4842	18	11 x 11 0.4331 x 0.4331	64600 14500	72000 16200
212	60 2.3622	110 4.3307	22 0.8661	67.259 2.648	102.743 4.045	1.5 0.059	69.800 2.7480	101.800 4.0079	14	16 x 16 0.6299 x 0.6299	112000 25200	117000 26400
312	60 2.3622	130 5.1181	31 1.2205	70.231 2.765	119.786 4.716	2 0.079	75.000 2.9528	115.000 4.5276	12	20 x 20 0.7874 x 0.7874	148000 33200	149000 33500
412	60 2.3622	150 5.9055	35 1.3780	73.965 2.912	136.042 5.356	2 0.079	83.000 3.2678	127.000 5.0000	12	22 x 22 0.8661 x 0.8661	178000 39900	182000 41000
013	65 2.5591	90 3.5433	13 0.5118	69.977 2.755	85.014 3.347	1 0.039	70.500 2.7756	84.500 3.3268	26	7 x 7 0.2756 x 0.2756	34600 7770	44300 9970
113	65 2.5591	100 3.9370	18 0.7087	70.790 2.787	94.209 3.709	1 0.039	71.500 2.8150	93.500 3.6811	18	11 x 11 0.4331 x 0.4331	64200 14400	72700 16300
213	65 2.5591	120 4.7244	23 0.9055	72.593 2.858	112.420 4.426	1.5 0.059	77.299 3.0433	109.299 4.3031	14	16 x 16 0.6299 x 0.6299	112000 25200	119000 26900
313	65 2.5591	140 5.5118	33 1.2992	74.905 2.949	130.099 5.122	2 0.079	81.600 3.2126	125.600 4.9449	12	22 x 22 0.8661 x 0.8661	178000 39900	182000 40900
413	65 2.5591	160 6.2992	37 1.4587	78.969 3.109	146.050 5.750	2 0.079	89.500 3.5237	135.500 5.3347	12	23 x 23 0.9055 x 0.9055	194000 43600	202000 45300
014	70 2.7559	100 3.9370	16 0.6299	75.260 2.963	94.742 3.730	1 0.039	76.449 3.0098	94.449 3.7185	24	9 x 9 0.3543 x 0.3543	54400 12200	68800 15500
114	70 2.7559	110 4.3307	20 0.7874	76.048 2.994	103.937 4.092	1 0.039	77.000 3.0315	103.000 4.0551	18	13 x 13 0.5118 x 0.5118	89600 20100	102000 23000
214	70 2.7559	125 4.9213	24 0.9449	77.572 3.054	117.424 4.623	1.5 0.059	80.500 3.1693	114.500 4.5079	14	17 x 17 0.6693 x 0.6693	121000 27200	129000 28900
314	70 2.7559	150 5.9055	35 1.3780	81.153 3.195	138.836 5.466	2 0.079	87.200 3.4331	135.200 5.3228	12	24 x 24 0.9449 x 0.9449	210000 47200	217000 48900
414	70 2.7559	180 7.0866	42 1.6535	87.503 3.445	162.484 6.397	2.5 0.098	99.000 3.8977	151.000 5.9449	12	26 x 26 1.0236 x 1.0236	239000 53700	251000 56400
015	75 2.9528	105 4.1339	16 0.6299	80.289 3.161	99.720 3.926	1 0.039	81.000 3.1890	99.000 3.8976	24	9 x 9 0.3543 x 0.3543	54100 12200	69200 15500
115	75 2.9528	115 4.5276	20 0.7874	81.026 3.190	108.966 4.290	1 0.039	82.000 3.2283	108.000 4.2520	18	13 x 13 0.5118 x 0.5118	89200 20100	103000 23200
215	75 2.9528	130 5.1181	25 0.9843	82.550 3.250	122.428 4.820	1.5 0.059	84.500 3.3268	120.500 4.7441	14	18 x 18 0.7087 x 0.7087	135000 30400	145000 32600
315	75 2.9528	160 6.2992	37 1.4567	86.436 3.403	148.565 5.849	2 0.079	92.800 3.6535	144.800 5.7008	12	26 x 26 1.0236 x 1.0236	238000 53500	247000 55600
415	75 2.9528	190 7.4803	45 1.7717	92.507 3.642	172.491 6.791	2.5 0.098	104.501 4.1142	160.501 6.3190	12	28 x 28 1.1024 x 1.1024	276000 62000	292000 65700
016	80 3.1496	110 4.3307	16 0.6299	85.242 3.356	104.750 4.124	1 0.039	86.000 3.3858	104.000 4.0945	26	9 x 9 0.3543 x 0.3543	56900 12800	75400 16900
116	80 3.1496	125 4.9213	22 0.8661	86.081 3.389	118.923 4.682	1 0.039	89.500 3.5236	115.500 4.5472	20	13 x 13 0.5118 x 0.5118	95900 21500	116000 26100
216	80 3.1496	140 5.5118	26 1.0236	89.383 3.519	130.607 5.142	2 0.079	92.000 3.6220	128.000 5.0394	16	18 x 18 0.7087 x 0.7087	149000 33600	168000 37800
316	80 3.1496	170 6.6929	39 1.5354	91.719 3.611	158.293 6.232	2 0.079	99.368 3.9121	155.368 6.1169	12	28 x 28 1.1024 x 1.1024	275000 61800	289000 65000
416	80 3.1496	200 7.8740	48 1.8898	97.511 3.839	182.499 7.185	2.5 0.098	110.000 4.3307	170.000 6.6929	12	30 x 30 1.1811 x 1.1811	315000 70800	337000 75700
017	85 3.3465	120 4.7244	18 0.7087	90.703 3.571	114.300 4.500	1 0.039	92.049 3.6240	114.049 4.4901	24	11 x 11 0.4331 x 0.4331	77500 17400	99900 22500
117	85 3.3465	130 5.1181	22 0.8661	91.262 3.593	123.749 4.872	1 0.039	93.500 3.6811	121.500 4.7835	20	14 x 14 0.5512 x 0.5512	111000 24900	135000 30400
217	85 3.3465	150 5.9055	28 1.1024	94.513 3.721	140.487 5.531	2 0.079	98.499 3.8779	138.499 5.4527	14	20 x 20 0.7874 x 0.7874	166000 37300	183000 41100
317	85 3.3465	180 7.0866	41 1.6142	98.450 3.876	166.548 6.557	2.5 0.098	104.500 4.1142	160.500 6.3189	12	28 x 28 1.1024 x 1.1024	276000 62000	292000 65700
417	85 3.3465	210 8.2677	52 2.0472	107.772 4.243	187.249 7.372	3 0.118	115.500 4.5473	179.500 7.0669	12	32 x 32 1.2598 x 1.2598	356000 80100	384000 86400

R = maximum shaft or housing fillet radius that bearing corner will clear.

C_r = ANSI/ABMA dynamic radial load rating (33½ RPM for 500 hours and 90 percent survival, equivalent to 1000000 inner ring revolutions).

C_{or} = ANSI/ABMA static radial load rating.

continued on next page

PART NUMBERS, DIMENSIONS AND LOAD RATINGS TABLE continued

Timken Size Code	Boundary Dimensions									Load Ratings		
	d	D	W	Mounting Shoulder Diameter		R	Nominal Roller Path Diameter		Roller		C _r	C _{or}
	Bore	Outside Diameter	Width			A					S	Dynamic Radial Capacity
				Min. Shaft	Max. Housing	Radius	Inner	Outer	No.	Diameter x Length		
											mm in.	
018	90	125	18	95.682	119.329	1	97.050	119.050	24	11 x 11	77000	100000
	3.5433	4.9213	0.7087	3.767	4.698	0.039	3.8209	4.6870		0.4331 x 0.4331	17300	22600
118	90	140	24	97.587	132.410	1.5	100.749	130.749	20	15 x 15	127000	157000
	3.5433	5.5118	0.9449	3.842	5.213	0.059	3.9665	5.1476		0.5906 x 0.5906	28500	35200
218	90	160	30	100.863	149.149	2	105.000	145.000	16	20 x 20	183000	211000
	3.5433	6.2992	1.1811	3.971	5.872	0.079	4.1339	5.7087		0.7874 x 0.7874	41200	47500
318	90	190	43	103.759	176.251	2.5	111.501	171.501	12	30 x 30	315000	338000
	3.5433	7.4803	1.6929	4.085	6.939	0.098	4.3898	6.7520		1.1811 x 1.1811	70800	75900
418	90	225	54	112.751	202.235	3	123.500	191.500	12	34 x 34	401000	437000
	3.5433	8.8583	2.1260	4.439	7.962	0.118	4.8622	7.5394		1.3386 x 1.3386	90100	98300
019	95	130	18	100.711	124.282	1	102.050	124.050	26	11 x 11	81200	109000
	3.7402	5.1181	0.7087	3.965	4.893	0.039	4.0177	4.8839		0.4331 x 0.4331	18300	24600
119	95	145	24	102.591	137.414	1.5	104.800	136.800	20	16 x 16	144000	179000
	3.7402	5.7087	0.9449	4.039	5.410	0.059	4.1260	5.3858		0.6299 x 0.6299	32300	40200
219	95	170	32	106.197	158.801	2	111.600	155.600	16	22 x 22	221000	257000
	3.7402	6.6929	1.2598	4.181	6.252	0.079	4.3937	6.1260		0.8661 x 0.8661	49600	57800
319	95	200	45	109.068	185.928	2.5	117.099	181.099	12	32 x 32	356000	386000
	3.7402	7.8740	1.7717	4.294	7.320	0.098	4.6102	7.1299		1.2598 x 1.2598	80100	86700
419	95	240	55	117.754	217.246	3	132.500	202.500	12	35 x 35	416000	456000
	3.7402	9.4488	2.1654	4.636	8.553	0.118	5.2165	7.9725		1.3780 x 1.3780	93400	103000
020	100	140	20	105.969	134.036	1	108.000	132.000	24	12 x 12	91100	121000
	3.9370	5.5118	0.7874	4.172	5.277	0.039	4.2520	5.1968		0.4724 x 0.4724	20500	27300
120	100	150	24	107.442	142.545	1.5	109.800	141.800	20	16 x 16	143000	180000
	3.9370	5.9055	0.9449	4.230	5.612	0.059	4.3228	5.5827		0.6299 x 0.6299	32200	40400
220	100	180	34	111.531	168.478	2	115.000	165.000	14	25 x 25	249000	279000
	3.9370	7.0866	1.3386	4.391	6.633	0.079	4.5275	6.4960		0.9843 x 0.9843	56000	62700
320	100	215	47	115.976	199.009	2.5	123.300	195.300	10	36 x 36	380000	395000
	3.9370	8.4646	1.8504	4.566	7.835	0.098	4.8543	7.6890		1.4173 x 1.4173	85500	88700
420	100	250	58	122.758	227.228	3	139.000	211.000	12	36 x 36	439000	486000
	3.9370	9.8424	2.2835	4.833	8.946	0.118	5.4724	8.3070		1.4173 x 1.4173	98800	109000
021	105	145	20	110.947	139.040	1	113.000	137.000	24	12 x 12	90500	122000
	4.1339	5.7087	0.7874	4.368	5.474	0.039	4.4488	5.3937		0.4724 x 0.4724	20300	27400
121	105	160	26	114.859	150.139	2	116.350	150.350	20	17 x 17	155000	194000
	4.1339	6.2992	1.0236	4.522	5.911	0.079	4.5807	5.9193		0.6693 x 0.6693	34800	43600
221	105	190	36	116.865	178.130	2	122.800	174.800	14	26 x 26	269000	305000
	4.1339	7.4803	1.4173	4.601	7.013	0.079	4.8346	6.8819		1.0236 x 1.0236	60400	68500
321	105	225	49	121.260	208.737	2.5	130.799	202.799	12	36 x 36	438000	480000
	4.1339	8.8583	1.9291	4.774	8.218	0.098	5.1496	7.9842		1.4173 x 1.4173	98500	108000
421	105	260	60	127.762	237.236	3	145.500	219.500	12	37 x 37	464000	517000
	4.1339	10.2362	2.3622	5.030	9.340	0.118	5.7284	8.6418		1.4567 x 1.4567	104000	116000
022	110	150	20	115.926	144.069	1	118.000	142.000	26	12 x 12	95500	132000
	4.3307	5.9055	0.7874	4.564	5.672	0.039	4.6457	5.5905		0.4724 x 0.4724	21500	29800
122	110	170	28	120.091	159.918	2	121.000	159.000	18	19 x 19	179000	219000
	4.3307	6.6929	1.1024	4.728	6.296	0.079	4.7638	6.2598		0.7480 x 0.7480	40200	49300
222	110	200	38	122.199	187.782	2	127.000	183.000	14	28 x 28	311000	354000
	4.3307	7.8740	1.4961	4.811	7.393	0.079	5.0000	7.2047		1.1024 x 1.1024	69800	79600
322	110	240	50	127.102	222.885	2.5	138.900	214.900	12	38 x 38	487000	539000
	4.3307	9.4480	1.9685	5.004	8.775	0.098	5.4685	8.4606		1.4961 x 1.4961	109000	121000
422	110	280	65	132.740	257.251	3	155.000	235.000	12	40 x 40	539000	608000
	4.3307	11.0236	2.5591	5.226	10.128	0.118	6.1024	9.2520		1.5748 x 1.5748	121000	137000
024	120	165	22	126.162	158.852	1	129.200	157.200	26	14 x 14	130000	182000
	4.7244	6.4961	0.8661	4.967	6.254	0.039	5.0866	6.1890		0.5512 x 0.5512	29300	41000
124	120	180	28	130.124	169.875	2	131.950	169.950	20	19 x 19	192000	247000
	4.7244	7.0866	1.1024	5.123	6.688	0.079	5.1949	6.6909		0.7480 x 0.7480	43200	55400
224	120	215	40	132.105	202.895	2	138.999	198.999	14	30 x 30	355000	411000
	4.7244	8.4646	1.5748	5.201	7.988	0.079	5.4724	7.8346		1.1811 x 1.1811	79800	92400
324	120	260	55	138.379	241.630	2.5	150.099	234.099	12	42 x 42	590000	662000
	4.7244	10.2362	2.1654	5.448	9.513	0.098	5.9094	9.2165		1.6535 x 1.6535	133000	149000
424	120	310	72	154.940	275.057	4	170.000	260.000	12	45 x 45	676000	774000
	4.7244	12.2047	2.8346	6.100	10.829	0.157	6.6929	10.2362		1.7717 x 1.7717	152000	174000

R = maximum shaft or housing fillet radius that bearing corner will clear.

C_r = ANSI/ABMA dynamic radial load rating (33⅓ RPM for 500 hours and 90 percent survival, equivalent to 1000000 inner ring revolutions).C_{or} = ANSI/ABMA static radial load rating.

Timken Size Code	Boundary Dimensions									Load Ratings		
	d	D	W	Mounting Shoulder Diameter		R	Nominal Roller Path Diameter		Roller		C _r	C _{or}
	Bore	Outside Diameter	Width			Radius			No.	Diameter x Length	Dynamic Radial Capacity	Static Radial Capacity
				A	S							
				Min. Shaft	Max. Housing		Inner	Outer				
	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.		mm in.	Newtons lbs.	Newtons lbs.
026	130	180	24	138.430	171.552	1.5	140.000	170.000	26	15 x 15	148000	211000
	5.1181	7.0866	0.9449	5.450	6.754	0.059	5.5118	6.6929		0.5906 x 0.5906	33400	47500
126	130	200	33	140.564	189.433	2	145.000	185.000	20	20 x 20	212000	276000
	5.1181	7.8740	1.2992	5.534	7.458	0.079	5.7087	7.2835		0.7874 x 0.7874	47600	62100
226	130	230	40	144.704	215.290	2.5	151.501	211.501	16	30 x 30	392000	477000
	5.1181	9.0551	1.5748	5.697	8.476	0.098	5.9646	8.3268		1.1811 x 1.1811	88000	107000
326	130	280	58	150.800	259.182	3	162.250	252.250	12	45 x 45	674000	766000
	5.1181	11.0236	2.2835	5.937	10.204	0.118	6.3878	9.9311		1.7717 x 1.7717	152000	172000
426	130	340	78	164.948	305.054	4	186.000	284.000	12	49 x 49	796000	925000
	5.1181	13.3858	3.0709	6.494	12.010	0.157	7.3229	11.1811		1.9291 x 1.9291	179000	208000
028	140	190	24	148.438	181.559	1.5	150.000	180.000	28	15 x 15	155000	229000
	5.5118	7.4803	0.9449	5.844	7.148	0.059	5.9055	7.0866		0.5906 x 0.5906	34900	51500
128	140	210	33	150.647	199.365	2	155.000	195.000	22	20 x 20	225000	306000
	5.5118	8.2677	1.2992	5.931	7.849	0.079	6.1024	7.6772		0.7874 x 0.7874	50700	68900
228	140	250	42	155.931	234.061	2.5	163.000	227.000	16	32 x 32	443000	547000
	5.5118	9.8425	1.6535	6.139	9.215	0.098	6.4173	8.9370		1.2598 x 1.2598	99700	123000
328	140	300	62	161.366	278.638	3	172.499	272.499	10	50 x 50	717000	788000
	5.5118	11.8110	2.4409	6.353	10.970	0.118	6.7913	10.7283		1.9685 x 1.9685	161000	177000
428	140	360	82	174.930	325.069	4	199.000	301.000	12	51 x 51	860000	1010000
	5.5118	14.1732	3.2283	6.887	12.798	0.157	7.8346	11.8504		2.0079 x 2.0079	193000	227000
030	150	210	28	159.944	200.050	2	163.000	197.000	28	17 x 17	191000	282000
	5.9055	8.2677	1.1024	6.297	7.876	0.079	6.4173	7.7559		0.6693 x 0.6693	43000	63400
130	150	225	35	161.519	213.487	2	167.005	211.005	22	22 x 22	272000	374000
	5.9055	8.8583	1.3780	6.359	8.405	0.079	6.5750	8.3072		0.8661 x 0.8661	61100	84000
230	150	270	45	166.649	253.340	2.5	174.000	246.000	14	36 x 36	494000	591000
	5.9055	10.6299	1.7717	6.561	9.974	0.098	6.8504	9.6850		1.4173 x 1.4173	111000	133000
032	160	220	28	169.875	210.134	2	172.000	208.000	28	18 x 18	214000	319000
	6.2992	8.6614	1.1024	6.688	8.273	0.079	6.7716	8.1890		0.7087 x 0.7087	48100	71600
132	160	240	38	172.110	227.889	2	176.000	224.000	22	24 x 24	323000	447000
	6.2992	9.4488	1.4961	6.776	8.972	0.079	6.9291	8.8189		0.9449 x 0.9449	72700	101000
232	160	290	48	177.470	272.542	2.5	189.000	261.000	16	36 x 36	545000	685000
	6.2992	11.4173	1.8898	6.987	10.730	0.098	7.4409	10.2756		1.4173 x 1.4173	122000	154000
034	170	230	28	179.908	220.091	2	182.900	218.900	28	18 x 18	212000	320000
	6.6929	9.0551	1.1024	7.083	8.665	0.079	7.2008	8.6181		0.7087 x 0.7087	47700	72000
134	170	260	42	182.677	247.320	2	189.000	241.000	22	26 x 26	367000	510000
	6.6929	10.2362	1.6535	7.192	9.737	0.079	7.4409	9.4882		1.0236 x 1.0236	82600	115000
036	180	250	33	190.475	239.522	2	195.000	235.000	28	20 x 20	262000	399000
	7.0866	9.8425	1.2992	7.499	9.430	0.079	7.6771	9.2519		0.7874 x 0.7874	58900	89800
136	180	280	46	192.634	267.360	2	200.000	260.000	20	30 x 30	455000	621000
	7.0866	11.0236	1.8110	7.584	10.526	0.079	7.8740	10.2362		1.1811 x 1.1811	102000	140000
038	190	260	33	200.406	249.580	2	205.000	245.000	28	20 x 20	260000	401000
	7.4803	10.2362	1.2992	7.890	9.826	0.079	8.0709	9.6456		0.7874 x 0.7874	58500	90200
138	190	290	46	202.895	277.114	2	208.000	272.000	20	32 x 32	517000	709000
	7.4803	11.4173	1.8110	7.988	10.910	0.079	8.1890	10.7086		1.2598 x 1.2598	116000	159000
040	200	280	38	211.887	268.097	2	216.000	264.000	26	24 x 24	357000	540000
	7.8740	11.0236	1.4961	8.342	10.555	0.079	8.5039	10.3937		0.9449 x 0.9449	80300	121000
044	220	300	38	231.800	288.188	2	236.000	284.000	28	24 x 24	372000	587000
	8.6614	11.8110	1.4961	9.126	11.346	0.079	9.2913	11.1811		0.9449 x 0.9449	83700	132000

R = maximum shaft or housing fillet radius that bearing corner will clear.

C_r = ANSI/ABMA dynamic radial load rating (33⅓ RPM for 500 hours and 90 percent survival, equivalent to 1000000 inner ring revolutions).

C_{or} = ANSI/ABMA static radial load rating.

BALL BEARINGS

BASIC CONSTRUCTION TYPES

Any of four basic ball bearing constructions in sizes ranging from 10 mm bore to 600 mm (0.3937 in. to 23.6220 in.) O.D. can be manufactured to meet the most demanding performance requirements.

Selection of the bearing construction best suited to the application must consider the relative importance of the various design functions as listed on page 12. The following general descriptions of each type will further assist in the proper selection.

HK Type

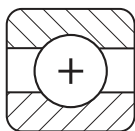
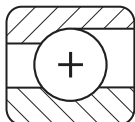


Fig. 5. Deep-groove (Conrad) design.

The conventional deep-groove (Conrad) bearing's versatile load capability allows it to handle radial, axial, moment, reversible axial or combination loading conditions. Cages – either a two-piece (riveted or welded) design or a one-piece, open-face crown design – while not having the ultimate strength and speed capability of a one-piece solid design – perform well in most applications. Where speeds and loads are severe, Timken Aerospace has developed high-strength deep-groove cage options. Seals and/or shields are readily adaptable to this series, particularly with high-strength, non-metallic molded crown cages.

HA Type



HJ Type

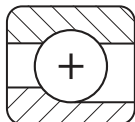


Fig. 6. Angular contact.

Conventional non-separable angular contact bearings with counterbored rings and one-piece, high-strength cages are used in preloaded and/or axially loaded applications. HJ type is especially suited to ultra-high speed applications. Two contact angle ranges are normally specified: 15 degree nominal for lightly preloaded radial applications; 25 degree nominal for heavy preloads and high external axial loads. Angular contact bearings may be supplied as duplex, triplex, etc., sets, which can be accurately preloaded to any specific level and with contact angles that can deviate from those normally specified.

HD Type

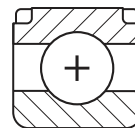


Fig. 7. Deep-groove fractured race.

The fractured outer ring design allows a maximum ball complement in a radial deep-groove bearing. This provides up to 56 percent greater dynamic load capacity and 280 percent longer design life over standard deep-groove types. One-piece, high-strength cages allow for higher speeds and loads while reducing the chance of cage damage. While HD bearings are used primarily for radial loads, high-strength 17-4PH stainless holding bands, pressed on ground shoulders, retain the fracture under moderate axial load at 1.0 speed limit dN 10⁶. Normal mounting procedures are used, except under severe axial loading or misalignment. Several stacked holding bands can be used to increase the holding power for loose-fit housings. In this case, observe special precaution to avoid displacement or opening of the fracture. Extensive experience has proven there is no advanced tendency to fatigue at the fracture under normal operation with a properly retained outer ring.

HT Type

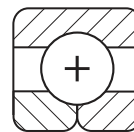


Fig. 8. Two-piece inner ring.

High-performance two piece inner ring bearings are typically used on high-speed shafts with reversing axial loads. Full deep-groove outer ring, one-piece high-strength cage and two extra-deep-groove inner ring halves provide the maximum level of reliability with full axial capacity in either direction. Simultaneous race grinding assures matching between the two inner ring halves, and a controlled offset may be specified to reduce endplay. The HT series can be readily disassembled for inspection of the race and ball components. Ball-retaining cages or a removable retaining clip – designed to hold inner halves together during normal handling – also are used. Operating contact angles are usually set between 25 degrees and 35 degrees, but develop final selections of detailed characteristics with your Timken engineer.

CAGE OPTIONS

Following the selection of the basic bearing construction, choosing the proper cage and ball complement results in the optimum bearing for the application. The ball bearing cage is critical to bearing performance. While its primary purpose is to separate the balls in the bearing assembly, it must be evaluated for each application as to:

- Performance at various speed levels.
- Compatibility with environmental conditions.
- Compatibility with lubricant systems.
- Cost and availability.

The tables below summarize cage options for metric ball bearings.

Cage Code	Material and Type	Design	Temp. Limit	Speed Limit dN 10 ⁶	Description
R	Laminated cotton phenolic; one-piece crown snap in		135° C	0.4	Specified for use with oil impregnation or where a lightweight, land-riding cage is required.
			275° F		
T	Stamped low-carbon steel; two-piece riveted		230° C	0.5	Use for low-speed, low-temperature accessory applications.
			450° F		
U	Phosphor bronze; stamped two-piece riveted; land piloted; with shaped pockets		190° C	1.0	Allows rapid acceleration with minimum inertia and maximum exposure to oil flow. Tooling available for limited number of sizes.
			375° F		
B	Precision-machined brass; two-piece riveted		190° C	1.0	Use for high speeds in aircraft accessories.
			375° F		
Z	AMS 4616 silicon-iron bronze; machined, two-piece riveted		260° C	1.5	Similar to brass with better strength and wear resistance. Frequently used in combination with VIM-VAR M-50 rings where temperatures exceed the 177° C (350° F) limit for 52100 steel.
			500° F		
H	Machined and hardened AMS 6414 or 6415 alloy steel; silver-plated; two-piece riveted		480° C	2.0	Use for ultra-high speeds in aircraft accessories. Silver-plating improves wear resistance under marginal lubrication. Normally used with M-50 rings and balls.
			900° F		

Table 5. Deep-groove bearing cage options. Deep-groove cages are two-piece or open-face crown designs.

SPECIAL CAGE OPTIONS

Conrad-design bearings utilizing precision machined cages can be provided with stepped interfaces and detents to meet the needs of applications that experience extreme operating conditions.

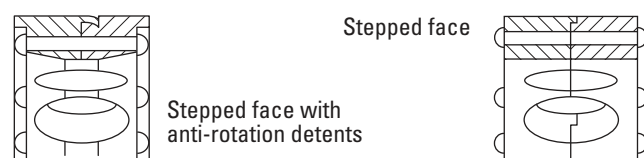


Fig.9. Special cage options.

MAXIMUM CAPACITY CAGE OPTIONS

With the exception of the special full ball complement or stamped-steel cage design, all cages for maximum-capacity ball bearings are one-piece machined designed for maximum strength and balance. They are normally designed to pilot on the outer land to optimize oil-jet lubrication of the inner ring. Outer-land piloting cages provide a self-balancing effect, since any wear improves balance.

Cage Code	Material and Type	Design	Temp. Limit	Speed Limit dN 10 ⁶	Description
F	Full ball complement		Same as bearing material	0.3	Use primarily at low speeds under high radial loads. Provides the maximum possible static and dynamic load capacity. Also use to reduce cost where a cage is not required. Should not be used under heavy combined or misaligned loads with continuous rotation, since the differential ball speeds will cause ball-to-ball scrubbing and a substantial reduction in life.
R	Laminated cotton machined phenolic; one-piece		135° C	1.0	Use on lightly loaded grease or oil-mist lubricated applications. May be vacuum impregnated to enhance life in "one shot" oiled or greased applications.
			275° F		
B	Precision-machined brass; drilled; one-piece		190° C	1.5	Use in heavily loaded transmission and accessory applications. Excellent strength and wear performance.
			375° F		
Z	AMS 4616 silicon-iron-bronze; machined; one-piece		260° C	2.0	Similar to brass with better strength and wear-resistance. Frequently used in combination with VIM-VAR M-50 rings where temperatures exceed the 177° C (350° F) limit for 52100 steel.
			500° F		
H	Machined and hardened AMS 6414 or 6415 alloy steel; silver-plated; one-piece		480° C	3.0	VIM-VAR M-50 bearings with silver-plated steel cages are first choice of the turbine industry for critical performance mainshaft and powertrain bearings. Steel is silver-plated to enhance run-in, wear life and to provide maximum continuity after lubricant loss.
			900° F		

Table 6. Maximum-capacity bearing cage options.

SEALS AND SHIELDS

Deep-groove construction bearings and some angular contact bearings can be supplied with various types of seals or shields. The choice of seal/shield configuration and material depends on the bearing type and specific application conditions. Shields are used when low torque is important or when excessive heat generation is a concern; however, some degree of grease leakage must be tolerable and the environment relatively clean. Seals have better resistance to contamination and less grease loss, but, conversely, increase torque and heat generation. Typically, molded types of closures are of either Buna N or Viton® and cut-washer types of Teflon® or glass-reinforced Teflon. Stamped-metal shields may be either low-carbon or stainless steel.

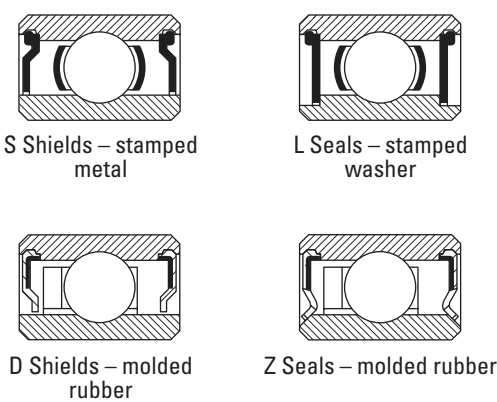


Fig. 10. Seal and shield configurations.

PART NUMBERS, DIMENSIONS AND LOAD RATINGS TABLE

BALL BEARING SPECIFICATIONS

To develop a complete bearing part number:

- 1) Select **MATERIALS AND OPERATING TEMPERATURES** prefix (see page 40).
- 2) Select **CONSTRUCTION TYPE**, plus **CAGE**, plus **SEAL** prefixes.

Cages		HK	HA/HJ	HD	HT
		Deep Groove	Angular Contact	Fractured Ring	Two-Piece Inner Ring
		Construction Types			
Full ball complement	F		HAF, HJF	HDF	HTF
Machined phenolic	R	HKR	HAR, HJR	HDR	HTR
Stamped steel	T	HKT			
Stamped brass	U	HKU			
Machined brass	B	HKB	HAB, HJB	HDB	HTB
Si-Fe bronze	Z	HKZ	HAZ, HJZ	HDZ	HTZ
Silver-plated steel	H	HKH	HAH, HJH	HDH	HTH

Shields and Seals		HK	HK
		One Side	Two Sides
		Construction Types	
Shield - stamped steel	S	HK * S	HK * SS
Shield - molded rubber	D	HK * D	HK * DD
Seal - stamped washer	L	HK * L	HK * LL
Seal - molded rubber	Z	HK * Z	HK * ZZ

* = Cage selection from above

Table 7. Ball bearing specifications.

- 3) Select basic bearing **TIMKEN SIZE CODE**. (See tables on pages 26-30.)
- 4) Add suffixes for **TOLERANCE** code (see pages 31-39), **RADIAL PLAY** code (see pages 41-43), **PRELOAD** code (see page 44) and **LUBRICATION** code (see pages 51-53). If any codes are omitted, standard values are applied.
For complex assemblies, Timken substitutes a dash number (in lieu of suffixes) to cover all special features.

Examples	3HAH 104 P5(4)DB 10/20	HDB 306-91	26HKTZZ 108-183
Material	3 = 440C stainless steel	Air-melt 52100 steel	CEVM 52100 steel
Construction	HA = angular contact	HD = fractured ring type	HK = deep groove
Cage	H = silver-plated steel	B = machined brass	T = stamped steel
Seals/Shields	(none)	(none)	ZZ = (2) molded-rubber seals
Size	104	306	108
Dash Number	(not used, standard part)	-91 = special features detailed under "dash" 91 code	-183 = special features detailed under "dash" 183 code
Tolerance	Timken P5 = ABEC 5	(not used, dash # part)	(not used, dash # part)
Radial Play	(4) = range 4 clearance	(not used, dash # part)	(not used, dash # part)
Preload	DB10/20 = DB 10 lbs. min to 20 lbs. max	(not used, dash # part)	(not used, dash # part)
Lubrication	No code shown = standard dip	(not used, dash # part)	(not used, dash # part)

Table 8. Ball bearing part number examples.

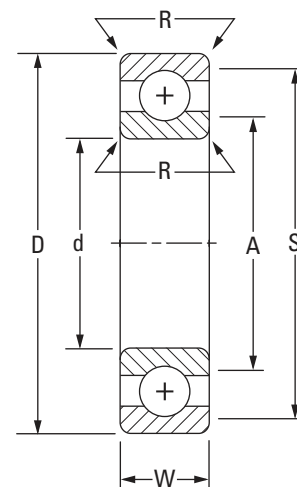


Fig. 11. Ball bearing dimensional features.

PART NUMBERS, DIMENSIONS AND LOAD RATINGS TABLE

Timken Size Code	Boundary Dimensions							Load Ratings					
	d	D	W	Mounting Shoulder Diameter		R	Ball Diameter	Max. Capacity Types HA, HD, HT, HJ			CONRAD Type HK		
	Bore	Outside Diameter	Width	A	S	Radius		Balls No. ⁽³⁾	C _r	C _{or}	Balls No. ⁽³⁾	C _r	C _{or}
				Min. Shaft	Max. Housing				Dynamic Radial Capacity	Static Radial Capacity		Dynamic Radial Capacity	Static Radial Capacity
				mm in.	mm in.				mm in.	mm in.		mm in.	mm in.
000	10	22	6	12.014	19.964	0.3	3.572	11	3790	1900	8	3060	1370
	0.3937	0.8661	0.2362	0.473	0.786	0.012	³ / ₆₄		852	427		688	307
100	10	26	8	12.421	23.571 ⁽¹⁾	0.3	4.763	10	5850	2860	7	4580	1970
	0.3937	1.0236	0.3150	0.489	0.928 ⁽¹⁾	0.012	³ / ₁₆		1310	644		1030	443
200	10	30	9	14.021	25.984	0.6	6.350	9	8690	4150	6	6550	2720
	0.3937	1.1811	0.3543	0.552	1.023	0.024	¹ / ₄		1950	933		1470	612
300	10	35	11	14.453	30.556	0.6	7.144	9	10900	5350	6	8100	3440
	0.3937	1.3780	0.4331	0.569	1.203	0.024	⁹ / ₃₂		2440	1200		1820	774
001	12	24	6	14.021	21.996	0.3	3.572	13	4260	2350	9	3330	1610
	0.4724	0.9449	0.2362	0.552	0.866	0.012	⁹ / ₆₄		959	528		749	362
101	12	28	8	14.326	25.679	0.3	4.763	11	6310	3260	8	5140	2440
	0.4724	1.1024	0.3150	0.564	1.011	0.012	³ / ₁₆		1420	734		1160	549
201	12	32	10	15.697	28.296	0.6	5.953	10	8690	4410	7	6900	3150
	0.4724	1.2598	0.3937	0.618	1.114	0.024	¹⁵ / ₆₄		1950	991		1550	708
301	12	37	12	17.043	32.029	1	7.938	8	11800	5650	6	9710	4190
	0.4724	1.4567	0.4724	0.671	1.261	0.039	³ / ₁₆		2660	1270		2180	941
002	15	28	7	17.043	25.959	0.3	3.969	14	5410	3170	10	4320	2250
	0.5906	1.1024	0.2756	0.671	1.022	0.012	³ / ₃₂		1220	712		972	506
102	15	32	9	17.424	29.591 ⁽¹⁾	0.3	5.556	11	8320	4440	8	6730	3220
	0.5906	1.2598	0.3543	0.686	1.165 ⁽¹⁾	0.012	⁷ / ₃₂		1870	997		1510	725
202	15	35	11	18.542	31.471	0.6	5.953	11	9430	5090	8	7620	3690
	0.5906	1.3780	0.4331	0.730	1.239	0.024	¹⁵ / ₆₄		2120	1140		1710	830
302	15	42	13	20.218	36.906	1	8.731	9	15500	7950	6	11800	5240
	0.5906	1.6535	0.5118	0.796	1.453	0.039	¹¹ / ₃₂		3500	1790		2650	1180
003	17	30	7	19.025	27.991	0.3	3.969	15	5650	3470	11	4600	2550
	0.6693	1.1811	0.2756	0.749	1.102	0.012	³ / ₃₂		1270	781		1030	573
103	17	35	10	19.380	32.614 ⁽²⁾	0.3	5.556	12	8920	5060	8	6810	3360
	0.6693	1.3780	0.3937	0.763	1.284 ⁽²⁾	0.012	⁷ / ₃₂		2010	1140		1530	756
203	17	40	12	20.701	36.297	0.6	7.144	10	12200	6520	8	10500	5210
	0.6693	1.5748	0.4724	0.815	1.429	0.024	³ / ₃₂		2740	1470		2360	1170
303	17	47	14	22.327	41.681	1	9.525	9	18300	9550	6	13900	6340
	0.6693	1.8504	0.5512	0.879	1.641	0.039	³ / ₈		4120	2150		3130	1430
403	17	62	17	27.635	51.359	1	12.700	8	27500	14400	6	22700	10800
	0.6693	2.4409	0.6693	1.088	2.022	0.039	¹ / ₂		6180	3230		5100	2430
004	20	37	9	22.200	34.798 ⁽¹⁾	0.3	4.763	16	8180	5390	11	6380	3680
	0.7874	1.4567	0.3543	0.874	1.370 ⁽¹⁾	0.012	³ / ₁₆		1840	1210		1430	827
104	20	42	12	23.546	38.456 ⁽¹⁾	0.6	6.350	13	12000	7240	9	9380	5030
	0.7874	1.6535	0.4724	0.927	1.514 ⁽¹⁾	0.024	¹ / ₄		2690	1630		2110	1130
204	20	47	14	24.689	42.291	1	7.938	11	15800	9040	8	12800	6580
	0.7874	1.8504	0.5512	0.972	1.665	0.039	³ / ₁₆		3550	2030		2880	1480
304	20	52	15	25.197	46.812	1	9.525	10	20300	11400	7	15900	7880
	0.7874	2.0472	0.5906	0.992	1.843	0.039	³ / ₈		4570	2560		3590	1770
404	20	72	19	30.632	61.366	1	14.288	7	31500	16300	6	28700	14100
	0.7874	2.8346	0.7480	1.206	2.416	0.039	³ / ₁₆		7080	3660		6460	3180
005	25	42	9	27.178	39.827	0.3	4.763	19	9040	6630	13	7030	4520
	0.9843	1.6535	0.3543	1.070	1.568	0.012	³ / ₁₆		2030	1490		1580	1020
105	25	47	12	28.651	43.332 ⁽¹⁾	0.6	7.144	14	15600	10000	9	11600	6440
	0.9843	1.8504	0.4724	1.128	1.706 ⁽¹⁾	0.024	⁵ / ₃₂		3500	2260		2610	1450
205	25	52	15	29.616	47.396	1	7.938	13	17900	11300	9	14000	7830
	0.9843	2.0472	0.5906	1.166	1.866	0.039	⁵ / ₁₆		4030	2540		3150	1760
305	25	62	17	30.607	56.388	1	11.113	11	28600	17200	7	21200	10900
	0.9843	2.4409	0.6693	1.205	2.220	0.039	⁷ / ₁₆		6440	3860		4770	2450
405	25	80	21	37.262	67.742	1.5	16.669	8	45100	25000	6	37200	18700
	0.9843	3.1496	0.8268	1.467	2.667	0.059	²¹ / ₃₂		10100	5630		8370	4210

⁽¹⁾ Reduce by 0.635 mm (0.025 in.) for fractured race HD bearings.

⁽²⁾ Reduce by 1.270 mm (0.050 in.) for fractured race HD bearings.

⁽³⁾ Ball complement is normally one less than the number listed when non-metallic cages or separable HT and HJ bearings with modified cages for ball retention are specified.

R = maximum shaft or housing fillet radius that bearing corner will clear.

C_r = ANSI/ABMA dynamic radial load rating (33⅓ RPM for 500 hours and 90 percent survival, equivalent to 1000000 inner ring revolutions).

C_{or} = ANSI/ABMA static radial load rating.

Timken Size Code	Boundary Dimensions							Load Ratings					
	d	D	W	Mounting Shoulder Diameter		R	Ball Diameter	Max. Capacity Types HA, HD, HT, HJ			CONRAD Type HK		
	Bore	Outside Diameter	Width	A	S	Radius		Balls No. ⁽³⁾	C _r	C _{or}	Balls No. ⁽³⁾	C _r	C _{or}
				Min. Shaft	Max. Housing				Dynamic Radial Capacity	Static Radial Capacity		Dynamic Radial Capacity	Static Radial Capacity
				mm in.	mm in.				mm in.	mm in.		mm in.	Newtons lbs.
006	30	47	9	32.207	44.806 ⁽²⁾	0.3	4.763	21	9490	7520	14	7240	5010
	1.1811	1.8504	0.3543	1.268	1.764 ⁽²⁾	0.012	³ / ₁₆		2130	1690		1630	1130
106	30	55	13	34.544	50.470	1	7.144	17	17700	12900	11	13200	8270
	1.1811	2.1654	0.5118	1.360	1.987	0.039	⁵ / ₃₂		3970	2890		2980	1860
206	30	62	16	34.900	57.099	1	9.525	13	24900	16300	9	19500	11300
	1.1811	2.4409	0.6299	1.374	2.248	0.039	³ / ₈		5590	3660		4370	2530
306	30	72	19	35.890	66.091	1	12.700	11	36600	22700	7	27100	14500
	1.1811	2.8346	0.7480	1.413	2.602	0.039	¹ / ₂		8220	5110		6090	3250
406	30	90	23	42.240	77.749	1.5	17.463	9	54700	32300	7	46300	25100
	1.1811	3.5433	0.9055	1.663	3.061	0.059	¹¹ / ₁₆		12300	7270		10400	5650
007	35	55	10	38.354	51.664 ⁽¹⁾	0.6	6.350	19	15200	11800	13	11800	8060
	1.3780	2.1654	0.3937	1.510	2.034 ⁽¹⁾	0.024	¹ / ₄		3410	2650		2650	1810
107	35	62	14	39.624	57.379	1	7.938	17	21400	15900	11	16000	10300
	1.3780	2.4409	0.5512	1.560	2.259	0.039	⁵ / ₁₆		4800	3570		3590	2310
207	35	72	17	40.361	66.624	1	11.906	12	35100	23000	8	26700	15200
	1.3780	2.8346	0.6693	1.589	2.623	0.039	¹⁵ / ₃₂		7890	5160		6010	3420
307	35	80	21	42.748	72.238	1.5	14.288	11	45300	28800	7	33500	18300
	1.3780	3.1496	0.8268	1.683	2.844	0.059	⁹ / ₁₆		10200	6480		7530	4120
407	35	100	25	47.244	87.757	1.5	18.256	10	64900	41000	7	51200	28700
	1.3780	3.9370	0.9843	1.860	3.455	0.059	²³ / ₃₂		14600	9220		11500	6440
008	40	62	12	43.358	58.649 ⁽¹⁾	0.6	6.350	22	16400	14000	14	12200	8890
	1.5748	2.4409	0.4724	1.707	2.309 ⁽¹⁾	0.024	¹ / ₄		3690	3150		2740	2000
108	40	68	15	44.577	63.424	1	7.938	19	22800	18300	12	16800	11500
	1.5748	2.6772	0.5906	1.755	2.497	0.039	⁵ / ₁₆		5130	4110		3770	2590
208	40	80	18	45.542	74.447	1	11.906	15	41000	30000	9	29100	17900
	1.5748	3.1496	0.7087	1.793	2.931	0.039	¹⁵ / ₃₂		9210	6750		6550	4020
308	40	90	23	48.133	81.864	1.5	15.875	12	58300	39400	7	48000	29300
	1.5748	3.5433	0.9055	1.895	3.223	0.059	⁵ / ₈		13100	8870		10800	6580
408	40	110	27	55.880	94.107	2	19.844	10	75800	48800	7	52200	30100
	1.5748	4.3307	1.0630	2.200	3.705	0.079	²⁵ / ₃₂		17000	11000		11700	6770
009	45	68	12	48.590	64.414 ⁽¹⁾	0.6	6.350	24	17100	15600	16	13100	10300
	1.7717	2.6772	0.4724	1.913	2.536 ⁽¹⁾	0.024	¹ / ₄		3840	3500		2940	2330
109	45	75	16	49.759	70.231	1	8.731	20	27900	23400	12	19900	14000
	1.7717	2.9528	0.6299	1.959	2.765	0.039	¹¹ / ₃₂		6270	5270		4470	3140
209	45	85	19	50.419	79.578	1	12.700	14	43900	31800	9	32700	20400
	1.7717	3.3465	0.7480	1.985	3.133	0.039	¹ / ₂		9880	7160		7360	4590
309	45	100	25	53.001	91.999	1.5	17.463	11	65400	43700	8	52800	31700
	1.7717	3.9370	0.9843	2.087	3.622	0.059	¹¹ / ₁₆		14700	9830		11900	7120
409	45	120	29	60.884	104.115	2	20.638	11	87600	60000	8	70900	43600
	1.7717	4.7244	1.1417	2.397	4.099	0.079	¹³ / ₁₆		19700	13500		15900	9800
010	50	72	12	53.569	68.453 ⁽¹⁾	0.6	6.350	26	17800	17100	17	13400	11200
	1.9685	2.8346	0.4724	2.109	2.695 ⁽¹⁾	0.024	¹ / ₄		4000	3840		3010	2510
110	50	80	16	54.788	75.209	1	9.525	19	31700	26300	12	23300	16600
	1.9685	3.1496	0.6299	2.157	2.961	0.039	³ / ₈		7120	5910		5240	3730
210	50	90	20	55.372	84.633	1	12.700	15	46000	34800	10	35100	23200
	1.9685	3.5433	0.7874	2.180	3.332	0.039	¹ / ₂		10300	7820		7890	5210
310	50	110	27	59.715	100.279	2	19.050	11	76500	52200	8	61800	37800
	1.9685	4.3307	1.0630	2.351	3.948	0.079	³ / ₄		17200	11700		13900	8500
410	50	130	31	71.145	108.864	2	21.431	11	94500	65900	8	76400	47900
	1.9685	5.1181	1.2205	2.801	4.286	0.079	²⁷ / ₃₂		21200	14800		17200	10800
011	55	80	13	60.071	74.930	1	7.938	24	25800	24100	15	18900	15100
	2.1654	3.1496	0.5118	2.365	2.950	0.039	⁵ / ₁₆		5790	5430		4240	3390
111	55	90	18	60.909	84.099	1	11.113	18	40500	33600	12	30900	22400
	2.1654	3.5433	0.7087	2.398	3.311	0.039	⁷ / ₁₆		9100	7550		6940	5030
211	55	100	21	62.128	92.888	1.5	14.288	15	56800	43900	10	43400	29200
	2.1654	3.9370	0.8268	2.446	3.657	0.059	⁹ / ₁₆		12800	9870		9750	6560
311	55	120	29	64.973	110.033	2	20.638	11	88400	61300	8	71500	44500
	2.1654	4.7244	1.1417	2.558	4.332	0.079	¹³ / ₁₆		19900	13800		16100	10000
411	55	140	33	76.149	118.872	2	22.225	12	107000	78600	8	82000	52400
	2.1654	5.5118	1.2992	2.998	4.680	0.079	⁷ / ₈		24200	17700		18400	11800

⁽¹⁾ Reduce by 0.635 mm (0.025 in.) for fractured race HD bearings.

⁽²⁾ Reduce by 1.270 mm (0.050 in.) for fractured race HD bearings.

⁽³⁾ Ball complement is normally one less than the number listed when non-metallic cages or separable HT and HJ bearings with modified cages for ball retention are specified.

R = maximum shaft or housing fillet radius that bearing corner will clear.

C_r = ANSI/ABMA dynamic radial load rating (33 1/3 RPM for 500 hours and 90 percent survival, equivalent to 1000000 inner ring revolutions).

C_{or} = ANSI/ABMA static radial load rating.

continued on next page

PART NUMBERS, DIMENSIONS AND LOAD RATINGS TABLE continued

Timken Size Code	Boundary Dimensions							Load Ratings					
	d	D	W	Mounting Shoulder Diameter		R	Ball Diameter	Max. Capacity Types HA, HD, HT, HJ			CONRAD Type HK		
	Bore	Outside Diameter	Width	A	S	Balls No. ⁽³⁾		C _r Dynamic Radial Capacity	C _{or} Static Radial Capacity	Balls No. ⁽³⁾	C _r Dynamic Radial Capacity	C _{or} Static Radial Capacity	
				Min. Shaft	Max. Housing								
				mm in.	mm in.								mm in.
012	60	85	13	65.024	79.959	1	7.938	25	26200	25400	16	19400	16200
	2.3622	3.3465	0.5118	2.560	3.148	0.039	⅜		5890	5700		4370	3650
112	60	95	18	65.837	89.154	1	11.113	19	41600	36000	12	30700	22700
	2.3622	3.7402	0.7087	2.592	3.510	0.039	⅞		9360	8090		6890	5100
212	60	110	22	67.259	102.743	1.5	15.875	14	65700	50300	10	52500	35900
	2.3622	4.3307	0.8661	2.648	4.045	0.059	⅝		14800	11300		11800	8070
312	60	130	31	70.231	119.786	2	22.225	11	101000	71300	8	81800	51800
	2.3622	5.1181	1.2205	2.765	4.716	0.079	⅞		22700	16000		18400	11600
412	60	150	35	81.128	128.854	2	23.019	12	115000	86000	8	87700	57300
	2.3622	5.9055	1.3780	3.194	5.073	0.079	29/32		25800	19300		19700	12900
013	65	90	13	69.977	85.014	1	7.938	26	26500	26800	17	20000	17500
	2.5591	3.5433	0.5118	2.755	3.347	0.039	⅜		5950	6020		4490	3930
113	65	100	18	70.790	94.209	1	11.113	20	42800	38300	13	32100	24900
	2.5591	3.9370	0.7087	2.787	3.709	0.039	⅞		9610	8610		7210	5590
213	65	120	23	72.593	112.420	1.5	17.463	14	78000	60700	10	62300	42800
	2.5591	4.7244	0.9055	2.858	4.426	0.059	1 1/16		17500	13600		14000	9630
313	65	140	33	74.905	130.099	2	23.813	12	121000	89500	8	92700	59600
	2.5591	5.5118	1.2992	2.949	5.122	0.079	1 5/16		27300	20100		20800	13400
413	65	160	37	86.131	138.862	2	23.813	13	129000	101000	8	101000	69500
	2.5591	6.2992	1.4587	3.391	5.467	0.079	1 5/16		29000	22600		22700	15600
014	70	100	16	75.260	94.742	1	9.525	24	35400	35000	16	27100	23300
	2.7559	3.9370	0.6299	2.963	3.730	0.039	⅝		7970	7870		6090	5240
114	70	110	20	76.048	103.937	1	12.700	19	52900	47100	13	41000	32200
	2.7559	4.3307	0.7874	2.994	4.092	0.039	½		11900	10600		9230	7240
214	70	125	24	77.572	117.424	1.5	17.463	15	81500	66000	10	62200	44000
	2.7559	4.9213	0.9449	3.054	4.623	0.059	1 1/16		18300	14800		14000	9880
314	70	150	35	81.153	138.836	2	25.400	12	136000	102000	8	104000	68000
	2.7559	5.9055	1.3780	3.195	5.466	0.079	1		30700	22900		23400	15300
414	70	180	42	96.520	153.492	2.5	26.987	13	158000	129000	8	114000	79100
	2.7559	7.0866	1.6535	3.800	6.043	0.098	1 1/16		35500	28900		25700	17800
015	75	105	16	80.289	99.720	1	9.525	26	37000	38300	17	27900	25000
	2.9528	4.1339	0.6299	3.161	3.926	0.039	⅝		8330	8600		6270	5620
115	75	115	20	81.026	108.966	1	12.700	20	54300	50100	13	40700	32500
	2.9528	4.5276	0.7874	3.190	4.290	0.039	½		12200	11300		9160	7310
215	75	130	25	82.550	122.428	1.5	26.987	16	85000	71700	10	62100	44800
	2.9528	5.1181	0.9843	3.250	4.820	0.059	1 1/16		19100	16100		14000	10100
315	75	160	37	86.436	148.565	2	26.987	12	149000	115000	8	113000	76900
	2.9528	6.2992	1.4567	3.403	5.849	0.079	1 1/16		33400	25900		25500	17300
415	75	190	45	101.524	163.474	2.5	28.575	13	171000	144000	9	134000	99800
	2.9528	7.4803	1.7717	3.997	6.436	0.098	1 1/8		38400	32400		30100	22400
016	80	110	16	85.242	104.750	1	9.525	27	37500	40200	17	27600	25300
	3.1496	4.3307	0.6299	3.356	4.124	0.039	⅝		8440	9030		6200	5680
116	80	125	22	86.081	118.923	1	14.288	19	65200	59800	13	50700	40900
	3.1496	4.9213	0.8661	3.389	4.682	0.039	⅞		14700	13400		11400	9190
216	80	140	26	89.383	130.607	2	19.050	16	99400	85000	10	72700	53000
	3.1496	5.5118	1.0236	3.519	5.142	0.079	¾		22300	19100		16300	11900
316	80	170	39	91.719	158.293	2	28.575	12	161000	130000	8	123000	86500
	3.1496	6.6929	1.5354	3.611	6.232	0.079	1 1/8		36200	29100		27600	19400
416	80	200	48	106.528	173.482	2.5	30.162	13	184000	161000	9	144000	111000
	3.1496	7.8740	1.8898	4.194	6.830	0.098	1 1/16		41500	36200		32400	25000
017	85	120	18	90.703	114.300	1	11.113	25	47800	49900	16	35500	31900
	3.3465	4.7244	0.7087	3.571	4.500	0.039	⅞		10700	11200		7990	7170
117	85	130	22	91.262	123.749	1	14.288	20	67100	63400	13	50300	41200
	3.3465	5.1181	0.8661	3.593	4.872	0.039	⅞		15100	14300		11300	9270
217	85	150	28	94.513	140.487	2	20.638	15	110000	92800	10	84000	61800
	3.3465	5.9055	1.1024	3.721	5.531	0.079	1 3/16		24700	20900		18900	13900
317	85	180	41	98.450	166.802	2.5	28.575	13	171000	144000	8	124000	88700
	3.3465	7.0866	1.6142	3.876	6.567	0.098	1 1/8		38400	32400		27800	19900
417	85	210	52	119.456	175.539	3	31.750	13	198000	178000	9	155000	123000
	3.3465	8.2677	2.0472	4.703	6.911	0.118	1 1/4		44500	40100		34900	27700

⁽¹⁾ Reduce by 0.635 mm (0.025 in.) for fractured race HD bearings.⁽²⁾ Reduce by 1.270 mm (0.050 in.) for fractured race HD bearings.⁽³⁾ Ball complement is normally one less than the number listed when non-metallic cages or separable HT and HJ bearings with modified cages for ball retention are specified.

R = maximum shaft or housing fillet radius that bearing corner will clear.

C_r = ANSI/ABMA dynamic radial load rating (33⅓ RPM for 500 hours and 90 percent survival, equivalent to 1000000 inner ring revolutions).C_{or} = ANSI/ABMA static radial load rating.

Timken Size Code	Boundary Dimensions							Load Ratings					
	d	D	W	Mounting Shoulder Diameter		R	Ball Diameter	Max. Capacity Types HA, HD, HT, HJ			CONRAD Type HK		
	Bore	Outside Diameter	Width	A	S	Radius		Balls No. ⁽³⁾	C _r	C _{or}	Balls No. ⁽³⁾	C _r	C _{or}
				Min. Shaft	Max. Housing				Dynamic Radial Capacity	Static Radial Capacity		Dynamic Radial Capacity	Static Radial Capacity
				mm in.	mm in.				mm in.	mm in.		mm in.	mm in.
018	90	125	18	95.682	132.410	1	11.113	26	48600	52300	17	36600	34200
	3.5433	4.9213	0.7087	3.767	5.213	0.039	7/16		10900	11800		8240	7690
118	90	140	24	97.587	149.149	1.5	15.875	20	81500	77800	13	61200	50500
	3.5433	5.5118	0.9449	3.842	5.872	0.059	5/8		18300	17500		13700	11400
218	90	160	30	100.863	176.251	2	22.225	15	126000	107000	10	96000	71400
	3.5433	6.2992	1.1811	3.971	6.939	0.079	3/4		28300	24100		21600	16100
318	90	190	43	103.759	124.282	2.5	30.162	13	184000	161000	8	133000	98900
	3.5433	7.4803	1.6929	4.085	4.893	0.098	1 1/16		41500	36200		30000	22200
418	90	225	54	124.460	190.551	3	34.925	12	214000	197000	8	163000	131000
	3.5433	8.8583	2.1260	4.900	7.502	0.118	1 1/8		48100	44200		36700	29500
019	95	130	18	100.711	124.282	1	11.113	28	50600	56700	18	37700	36400
	3.7402	5.1181	0.7087	3.965	4.893	0.039	7/16		11400	12800		8480	8190
119	95	145	24	102.591	137.414	1.5	15.875	21	83700	82300	13	60800	50900
	3.7402	5.7087	0.9449	4.039	5.410	0.059	5/8		18800	18500		13700	11400
219	95	170	32	106.197	158.801	2	23.813	15	142000	122000	10	109000	81700
	3.7402	6.6929	1.2598	4.181	6.252	0.079	1 5/16		32000	27500		24400	18400
319	95	200	45	109.068	185.928	2.5	31.750	13	198000	178000	8	143000	110000
	3.7402	7.8740	1.7717	4.294	7.320	0.098	1 1/4		44500	40100		32200	24600
419	95	240	55	129.464	205.537	3	36.513	13	241000	235000	9	188000	162000
	3.7402	9.4488	2.1654	5.097	8.092	0.118	1 1/8		54100	52800		42400	36500
020	100	140	20	105.969	134.036	1	12.700	26	62200	68000	17	46800	44500
	3.9370	5.5118	0.7874	4.172	5.277	0.039	1/2		14000	15300		10500	9990
120	100	150	24	107.442	142.545	1.5	15.875	21	83200	83600	14	63500	55300
	3.9370	5.9055	0.9449	4.230	5.612	0.059	5/8		18700	18800		14300	12400
220	100	180	34	111.531	168.478	2	25.400	15	160000	139000	10	122000	92600
	3.9370	7.0866	1.3386	4.391	6.633	0.079	1		36000	31300		27500	20800
320	100	215	47	115.976	199.009	2.5	34.925	12	214000	197000	8	163000	131000
	3.9370	8.4646	1.8504	4.566	7.835	0.098	1 3/8		48200	44300		36700	29500
420	100	250	58	134.468	215.544	3	38.100	13	255000	256000	9	200000	177000
	3.9370	9.8424	2.2835	5.294	8.486	0.118	1 1/2		57400	57400		45000	39800
021	105	145	20	110.947	139.040	1	12.700	27	63300	71200	17	46400	44800
	4.1339	5.7087	0.7874	4.368	5.474	0.039	1/2		14200	16000		10400	10100
121	105	160	26	114.859	150.139	2	17.463	21	99300	99600	13	72100	61700
	4.1339	6.2992	1.0236	4.522	5.911	0.079	1 1/16		22300	22400		16200	13900
221	105	190	36	116.865	178.130	2	26.987	15	174000	157000	10	133000	104000
	4.1339	7.4803	1.4173	4.601	7.013	0.079	1 1/8		39200	35200		29900	23500
321	105	225	49	121.260	208.737	2.5	36.513	12	228000	215000	8	174000	143000
	4.1339	8.8583	1.9291	4.774	8.218	0.098	1 1/8		51200	48400		39100	32300
421	105	260	60	139.446	225.527	3	39.688	13	271000	278000	9	212000	192000
	4.1339	10.2362	2.3622	5.490	8.879	0.118	1 3/8		60800	62400		47600	43200
022	110	150	20	115.926	144.069	1	12.700	28	64300	74200	18	47800	47600
	4.3307	5.9055	0.7874	4.564	5.672	0.039	1/2		14400	16700		10800	10700
122	110	170	28	120.091	159.918	2	19.050	20	113000	112000	13	84700	73000
	4.3307	6.6929	1.1024	4.728	6.296	0.079	3/4		25400	25300		19100	16400
222	110	200	38	122.199	187.782	2	28.575	15	189000	176000	10	144000	117000
	4.3307	7.8740	1.4961	4.811	7.393	0.079	1 1/8		42400	39500		32400	26200
322	110	240	50	127.102	222.885	2.5	41.275	11	253000	245000	7	188000	156000
	4.3307	9.4480	1.9685	5.004	8.775	0.098	1 3/8		57000	55100		42200	35100
422	110	280	65	144.475	245.542	3	42.862	13	301000	322000	9	236000	223000
	4.3307	11.0236	2.5591	5.688	9.667	0.118	1 1/16		67700	72500		53000	50200
024	120	165	22	126.162	158.852	1	14.288	27	77900	90400	17	57200	56800
	4.7244	6.4961	0.8661	4.967	6.254	0.039	5/16		17500	20300		12900	12800
124	120	180	28	130.124	169.875	2	19.050	22	119000	125000	14	88200	79700
	4.7244	7.0866	1.1024	5.123	6.688	0.079	3/4		26800	28200		19800	17900
224	120	215	40	132.105	202.895	2	28.575	16	197000	192000	10	144000	120000
	4.7244	8.4646	1.5748	5.201	7.988	0.079	1 1/8		44200	43100		32300	26900
324	120	260	55	138.379	241.630	2.5	44.450	12	298000	311000	7	208000	181000
	4.7244	10.2362	2.1654	5.448	9.513	0.098	1 3/4		67100	69900		46800	40800
424	120	310	72	162.408	267.589	4	47.625	13	349000	396000	9	273000	274000
	4.7244	12.2047	2.8346	6.394	10.535	0.157	1 7/8		78400	89100		61400	61700

⁽¹⁾ Reduce by 0.635 mm (0.025 in.) for fractured race HD bearings.

⁽²⁾ Reduce by 1.270 mm (0.050 in.) for fractured race HD bearings.

⁽³⁾ Ball complement is normally one less than the number listed when non-metallic cages or separable HT and HJ bearings with modified cages for ball retention are specified.

R = maximum shaft or housing fillet radius that bearing corner will clear.

C_r = ANSI/ABMA dynamic radial load rating (33 1/3 RPM for 500 hours and 90 percent survival, equivalent to 1000000 inner ring revolutions).

C_{or} = ANSI/ABMA static radial load rating.

continued on next page

PART NUMBERS, DIMENSIONS AND LOAD RATINGS TABLE *continued*

Timken Size Code	Boundary Dimensions							Load Ratings					
	d	D	W	Mounting Shoulder Diameter		R	Ball Diameter	Max. Capacity Types HA, HD, HT, HJ			CONRAD Type HK		
	Bore	Outside Diameter	Width	A	S	Radius		Balls No. ⁽³⁾	C _r	C _{or}	Balls No. ⁽³⁾	C _r	C _{or}
				Min. Shaft	Max. Housing				Dynamic Radial Capacity	Static Radial Capacity		Dynamic Radial Capacity	Static Radial Capacity
				mm in.	mm in.				mm in.	mm in.		mm in.	mm in.
026	130	180	24	138.430	171.552	1.5	15.875	27	94500	111000	17	69500	69900
	5.1181	7.0866	0.9449	5.450	6.754	0.059	$\frac{5}{8}$		21300	25000		15600	15700
126	130	200	33	140.564	189.433	2	22.225	20	149000	153000	13	112000	99500
	5.1181	7.8740	1.2992	5.534	7.458	0.079	$\frac{7}{8}$		33500	34400		25100	22400
226	130	230	40	144.704	215.290	2.5	30.162	17	220000	229000	11	165000	147000
	5.1181	9.0551	1.5748	5.697	8.476	0.098	$1\frac{1}{16}$		49600	51500		37100	33200
326	130	280	58	150.800	259.182	3	47.625	12	329000	358000	7	230000	209000
	5.1181	11.0236	2.2835	5.937	10.204	0.118	$1\frac{1}{2}$		73900	80500		51600	46900
426	130	340	78	172.415	297.586	4	52.388	13	398000	478000	10	334000	368000
	5.1181	13.3858	3.0709	6.788	11.716	0.157	$2\frac{1}{16}$		89500	108000		75200	82700
028	140	190	24	148.438	181.559	1.5	15.875	29	97900	120000	18	71300	74500
	5.5118	7.4803	0.9449	5.844	7.148	0.059	$\frac{5}{8}$		22000	27000		16000	16700
128	140	210	33	150.647	199.365	2	22.225	22	157000	172000	14	116000	108000
	5.5118	8.2677	1.2992	5.931	7.849	0.079	$\frac{7}{8}$		35400	38600		26200	24400
228	140	250	42	155.931	234.061	2.5	33.337	16	244000	261000	10	178000	163000
	5.5118	9.8425	1.6535	6.139	9.215	0.098	$1\frac{1}{16}$		54900	58600		40100	36600
328	140	300	62	161.366	278.638	3	50.800	12	360000	408000	8	275000	272000
	5.5118	11.8110	2.4409	6.353	10.970	0.118	2		81000	91800		61800	61100
428	140	360	82	182.397	317.602	4	55.563	13	433000	539000	11	387000	456000
	5.5118	14.1732	3.2283	7.181	12.504	0.157	$2\frac{3}{16}$		97200	121000		87000	102000
030	150	210	28	159.944	200.050	2	19.050	26	129000	153000	16	93300	94100
	5.9055	8.2677	1.1024	6.297	7.876	0.079	$\frac{3}{4}$		29000	34400		21000	21200
130	150	225	35	161.519	213.487	2	22.225	23	160000	181000	15	121000	118000
	5.9055	8.8583	1.3780	6.359	8.405	0.079	$\frac{7}{8}$		36000	40700		27100	26500
230	150	270	45	166.649	253.340	2.5	36.513	16	277000	312000	10	203000	194000
	5.9055	10.6299	1.7717	6.561	9.974	0.098	$1\frac{1}{16}$		62400	70100		45600	43700
032	160	220	28	169.875	210.134	2	19.050	27	131000	161000	17	96100	101000
	6.2992	8.6614	1.1024	6.688	8.273	0.079	$\frac{3}{4}$		29400	36100		21600	22700
132	160	240	38	172.110	227.889	2	25.400	22	200000	223000	14	148000	142000
	6.2992	9.4488	1.4961	6.776	8.972	0.079	1		45000	50100		33300	31800
232	160	290	48	177.470	272.542	2.5	41.275	15	316000	367000	9	225000	220000
	6.2992	11.4173	1.8898	6.987	10.730	0.098	$1\frac{1}{2}$		71000	82500		50500	49300
034	170	230	28	179.908	220.091	2	19.050	29	136000	173000	18	98700	107000
	6.6929	9.0551	1.1024	7.083	8.665	0.079	$\frac{3}{4}$		30500	38900		22200	24100
134	170	260	42	182.677	247.320	2	28.575	21	230000	266000	13	167000	165000
	6.6929	10.2362	1.6535	7.192	9.737	0.079	$1\frac{1}{8}$		51700	59900		37600	37100
036	180	250	33	190.475	239.522	2	22.225	27	174000	218000	17	128000	137000
	7.0866	9.8425	1.2992	7.499	9.430	0.079	$\frac{7}{8}$		39000	48900		28700	30700
136	180	280	46	192.634	267.360	2	28.575	22	235000	283000	14	174000	180000
	7.0866	11.0236	1.8110	7.584	10.526	0.079	$1\frac{1}{8}$		52800	63700		39100	40500
038	190	260	33	200.406	249.580	2	22.225	28	176000	227000	17	126000	138000
	7.4803	10.2362	1.2992	7.890	9.826	0.079	$\frac{7}{8}$		39700	51000		28400	31000
138	190	290	46	202.895	277.114	2	30.162	22	254000	315000	14	188000	200000
	7.4803	11.4173	1.8110	7.988	10.910	0.079	$1\frac{1}{16}$		57100	70700		42200	45000
040	200	280	38	211.887	268.097	2	25.400	26	216000	272000	16	157000	167000
	7.8740	11.0236	1.4961	8.342	10.555	0.079	1		48700	61200		35200	37600
044	220	300	38	231.800	288.188	2	25.400	28	224000	297000	18	167000	191000
	8.6614	11.8110	1.4961	9.126	11.346	0.079	1		50300	66700		37500	42800

⁽¹⁾ Reduce by 0.635 mm (0.025 in.) for fractured race HD bearings.

⁽²⁾ Reduce by 1.270 mm (0.050 in.) for fractured race HD bearings.

⁽³⁾ Ball complement is normally one less than the number listed when non-metallic cages or separable HT and HJ bearings with modified cages for ball retention are specified.

R = maximum shaft or housing fillet radius that bearing corner will clear.

C_r = ANSI/ABMA dynamic radial load rating (33⅓ RPM for 500 hours and 90 percent survival, equivalent to 1000000 inner ring revolutions).

C_{or} = ANSI/ABMA static radial load rating.

TOLERANCES

All bearings described in this design guide can be manufactured to ISO "Normal," 6, 5, 4 (ANSI/ABMA 1, 3, 5 or 7) tolerances. Generally, ISO 5 (ANSI/ABMA 5) is the preferred tolerance class for high-reliability aircraft systems. ISO 4 and 2 (ANSI/ABMA classes 7 and 9) may be specified where closer mounting tolerances and runouts are essential for precise position control. Their performance is otherwise similar to ISO 5 (ANSI/ABMA class 5). ISO 4 (ANSI/ABMA class 7) is normally applied only to ball bearings, although roller bearings can be supplied. ISO 2 (ANSI/ABMA class 9) is applicable to ball bearings only.

ISO "Normal" and 6 (ANSI/ABMA 1 and 3) are generally used in industrial and less critical aircraft accessory applications. To facilitate selection, the tolerance charts on the following pages summarize mean bore, outside diameter, width tolerance and maximum radial runout of each ring for all classes. Please refer to ANSI/ABMA Standard 20 for a complete table of all dimensions.

ISO 492 is equivalent to ANSI/ABMA Standard 20.

HOW TO SPECIFY

ANSI/ABMA precision tolerance levels 1 through 9 are indicated in Timken Aerospace part numbers by the suffixes P1, P3, P5 or P9.

32 AEROSPACE DESIGN GUIDE

Bore Diameter		Bore 2pt Diametral Roundness, Max. 000 (1900) Diameter ⁽¹⁾					Bore 2pt Diametral Roundness, Max. 100 Diameter Series ⁽¹⁾					Bore 2pt Diametral Roundness, Max. 200, 300, 400 Diameter Series ⁽¹⁾				
		ISO and ANSI/ABMA Classes					ISO and ANSI/ABMA Classes					ISO and ANSI/ABMA Classes				
Over	Included	Normal	6	5	4	2	Normal	6	5	4	2	Normal	6	5	4	2
		1	3	5	7	9	1	3	5	7	9	1	3	5	7	9
mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.
2.5 0.0984	10 0.3937	0.010 0.0004	0.009 0.00035	0.005 0.0002	0.004 0.00015	0.0025 0.0001	0.008 0.0003	0.007 0.0003	0.004 0.00015	0.003 0.0001	0.0025 0.0001	0.006 0.00025	0.005 0.0002	0.004 0.00015	0.003 0.0001	0.0025 0.0001
10 0.3937	18 0.7087	0.010 0.0004	0.009 0.00035	0.005 0.0002	0.004 0.00015	0.0025 0.0001	0.008 0.0003	0.007 0.0003	0.004 0.00015	0.003 0.0001	0.0025 0.0001	0.006 0.00025	0.005 0.0002	0.004 0.00015	0.003 0.0001	0.0025 0.0001
18 0.7087	30 1.1811	0.013 0.0005	0.010 0.0004	0.006 0.00025	0.005 0.0002	0.0025 0.0001	0.010 0.0004	0.008 0.0003	0.005 0.0002	0.004 0.00015	0.0025 0.0001	0.008 0.0003	0.006 0.00025	0.005 0.0002	0.004 0.00015	0.0025 0.0001
30 1.1811	50 1.9685	0.015 0.0006	0.013 0.0005	0.008 0.0003	0.006 0.00025	0.0025 0.0001	0.012 0.00045	0.010 0.0004	0.006 0.00025	0.005 0.0002	0.0025 0.0001	0.009 0.00035	0.008 0.0003	0.006 0.00025	0.005 0.0002	0.0025 0.0001
50 1.9685	80 3.1496	0.019 0.00075	0.015 0.0006	0.009 0.00035	0.007 0.0003	0.004 0.00015	0.019 0.00075	0.015 0.0006	0.007 0.0003	0.005 0.0002	0.004 0.00015	0.011 0.00045	0.009 0.00035	0.007 0.0003	0.005 0.0002	0.004 0.00015
80 3.1496	120 4.7244	0.025 0.0010	0.019 0.00075	0.010 0.0004	0.008 0.0003	0.005 0.0002	0.025 0.0010	0.019 0.00075	0.008 0.0003	0.006 0.00025	0.005 0.0002	0.015 0.0006	0.011 0.00045	0.008 0.0003	0.006 0.00025	0.005 0.0002
120 4.7244	150 5.9055	0.031 0.0012	0.023 0.0009	0.013 0.0005	0.010 0.0004	0.007 0.0003	0.031 0.0012	0.023 0.0009	0.010 0.0004	0.008 0.0003	0.007 0.0003	0.019 0.00075	0.014 0.00055	0.010 0.0004	0.008 0.0003	0.007 0.0003
150 5.9055	180 7.0866	0.031 0.0012	0.023 0.0009	0.013 0.0005	0.010 0.0004	0.007 0.0003	0.031 0.0012	0.023 0.0009	0.010 0.0004	0.008 0.0003	0.007 0.0003	0.019 0.00075	0.014 0.00055	0.010 0.0004	0.008 0.0003	0.007 0.0003
180 7.0866	250 9.8425	0.038 0.0015	0.028 0.0011	0.015 0.0006	0.012 0.00045	0.008 0.0003	0.038 0.0015	0.028 0.0011	0.012 0.00045	0.009 0.00035	0.008 0.0003	0.023 0.0009	0.017 0.00065	0.012 0.00045	0.009 0.00035	0.008 0.0003
250 9.8425	315 12.4016	0.044 0.0017	0.031 0.0012	0.018 0.0007	- -	- -	0.044 0.0017	0.031 0.0012	0.014 0.00055	- -	- -	0.026 0.0010	0.019 0.00075	0.014 0.00055	- -	- -
315 12.4016	400 15.7480	0.050 0.0020	0.038 0.0015	0.023 0.0009	- -	- -	0.050 0.0020	0.038 0.0015	0.018 0.0007	- -	- -	0.030 0.0012	0.023 0.0009	0.018 0.0007	- -	- -
400 15.7480	500 19.6850	0.056 0.0022	0.044 0.0017	- -	- -	- -	0.056 0.0022	0.044 0.0017	- -	- -	- -	0.034 0.0013	0.026 0.0010	- -	- -	- -
500 19.6850	630 24.8031	0.063 0.0025	0.050 0.0020	- -	- -	- -	0.063 0.0025	0.050 0.0020	- -	- -	- -	0.038 0.0015	0.030 0.0012	- -	- -	- -
630 24.8031	800 31.4961	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -

⁽¹⁾ For ANSI/ABMA Classes 7 and 9 (ISO 4 and 2), no individual 2point readings outside the limits for mean diameter (pg. 34) are allowed.

Bore Diameter		Radial Runout, Max.					Axial Runout, Max.				
		ISO and ANSI/ABMA Classes					ISO and ANSI/ABMA Classes				
Over	Included	Normal	6	5	4	2	Normal	6	5	4	2
		1	3	5	7	9	1	3	5	7	9
mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.
2.5	10	0.010	0.006	0.004	0.0025	0.0015	0.020	0.015	0.007	0.003	0.0015
0.0984	0.3937	0.0004	0.00025	0.00015	0.0001	0.00005	0.0008	0.0006	0.0003	0.0001	0.00005
10	18	0.010	0.007	0.004	0.0025	0.0015	0.020	0.020	0.007	0.003	0.0015
0.3937	0.7087	0.0004	0.0003	0.00015	0.0001	0.00005	0.0008	0.0008	0.0003	0.0001	0.00005
18	30	0.013	0.008	0.004	0.003	0.0025	0.025	0.020	0.008	0.004	0.0025
0.7087	1.1811	0.0005	0.0003	0.00015	0.0001	0.0001	0.0010	0.0008	0.0003	0.00015	0.0001
30	50	0.015	0.010	0.005	0.004	0.0025	0.030	0.020	0.008	0.004	0.0025
1.1811	1.9685	0.0006	0.0004	0.0002	0.00015	0.0001	0.0012	0.0008	0.0003	0.00015	0.0001
50	80	0.020	0.010	0.005	0.004	0.0025	0.030	0.025	0.008	0.005	0.0025
1.9685	3.1496	0.0008	0.0004	0.0002	0.00015	0.0001	0.0012	0.0010	0.0003	0.0002	0.0001
80	120	0.025	0.013	0.006	0.005	0.0025	0.035	0.025	0.009	0.005	0.0025
3.1496	4.7244	0.0010	0.0005	0.00025	0.0002	0.0001	0.0014	0.0010	0.00035	0.0002	0.0001
120	150	0.030	0.018	0.008	0.006	0.0025	0.040	0.030	0.010	0.007	0.0025
4.7244	5.9055	0.0012	0.0007	0.0003	0.00025	0.0001	0.0016	0.0012	0.0004	0.0003	0.0001
150	180	0.030	0.018	0.008	0.006	0.005	0.040	0.030	0.010	0.007	0.005
5.9055	7.0866	0.0012	0.0007	0.0003	0.00025	0.0002	0.0016	0.0012	0.0004	0.0003	0.0002
180	250	0.040	0.020	0.010	0.008	0.005	0.045	0.035	0.013	0.008	0.005
7.0866	9.8425	0.0016	0.0008	0.0004	0.0003	0.0002	0.0018	0.0014	0.0005	0.0003	0.0002
250	315	0.050	0.025	0.013	-	-	0.055	0.040	0.015	-	-
9.8425	12.4016	0.0020	0.0010	0.0005	-	-	0.0022	0.0016	0.0006	-	-
315	400	0.060	0.030	0.015	-	-	0.065	0.045	0.020	-	-
12.4016	15.7480	0.0024	0.0012	0.0006	-	-	0.0026	0.0018	0.0008	-	-
400	500	0.065	0.035	-	-	-	0.075	0.050	-	-	-
15.7480	19.6850	0.0026	0.0014	-	-	-	0.0030	0.0020	-	-	-
500	630	0.070	0.040	-	-	-	0.090	0.055	-	-	-
19.6850	24.8031	0.0028	0.0016	-	-	-	0.0035	0.0022	-	-	-
630	800	0.080	-	-	-	-	0.100	-	-	-	-
24.8031	31.4961	0.0031	-	-	-	-	0.0039	-	-	-	-

Bore Diameter		Face to Bore Runout, Max.					Face Parallelism, Max.				
		ISO and ANSI/ABMA Classes					ISO and ANSI/ABMA Classes				
Over	Included	Normal	6	5	4	2	Normal	6	5	4	2
		1	3	5	7	9	1	3	5	7	9
mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.
2.5 0.0984	10 0.3937	NR	NR	0.007 0.0003	0.003 0.0001	0.0015 0.00005	0.015 0.0006	0.015 0.0006	0.005 0.0002	0.0025 0.0001	0.0015 0.00005
10 0.3937	18 0.7087	NR	NR	0.007 0.0003	0.003 0.0001	0.0015 0.00005	0.020 0.0008	0.020 0.0008	0.005 0.0002	0.0025 0.0001	0.0015 0.00005
18 0.7087	30 1.1811	NR	NR	0.008 0.0003	0.004 0.00015	0.0015 0.00005	0.020 0.0008	0.020 0.0008	0.005 0.0002	0.0025 0.0001	0.0015 0.00005
30 1.1811	50 1.9685	NR	NR	0.008 0.0003	0.004 0.00015	0.0015 0.00005	0.020 0.0008	0.020 0.0008	0.005 0.0002	0.003 0.0001	0.0015 0.00005
50 1.9685	80 3.1496	NR	NR	0.008 0.0003	0.005 0.0002	0.0015 0.00005	0.025 0.0010	0.025 0.0010	0.006 0.00025	0.004 0.00015	0.0015 0.00005
80 3.1496	120 4.7244	NR	NR	0.009 0.00035	0.005 0.0002	0.0025 0.0001	0.025 0.0010	0.025 0.0010	0.007 0.0003	0.004 0.00015	0.0025 0.0001
120 4.7244	150 5.9055	NR	NR	0.010 0.0004	0.006 0.00025	0.0025 0.0001	0.030 0.0012	0.030 0.0012	0.008 0.0003	0.005 0.0002	0.0025 0.0001
150 5.9055	180 7.0866	NR	NR	0.010 0.0004	0.006 0.00025	0.004 0.00015	0.030 0.0012	0.030 0.0012	0.008 0.0003	0.005 0.0002	0.004 0.00015
180 7.0866	250 9.8425	NR	NR	0.011 0.00045	0.007 0.0003	0.005 0.0002	0.030 0.0012	0.030 0.0012	0.010 0.0004	0.006 0.00025	0.005 0.0002
250 9.8425	315 12.4016	NR	NR	0.013 0.0005	- -	- -	0.035 0.0014	0.035 0.0014	0.013 0.0005	- -	- -
315 12.4016	400 15.7480	NR	NR	0.015 0.0006	- -	- -	0.040 0.0016	0.040 0.0016	0.015 0.0006	- -	- -
400 15.7480	500 19.6850	- -	- -	- -	- -	- -	0.050 0.0020	0.045 0.0018	- -	- -	- -
500 19.6850	630 24.8031	- -	- -	- -	- -	- -	0.060 0.0024	0.050 0.0020	- -	- -	- -
630 24.8031	800 31.4961	- -	- -	- -	- -	- -	0.070 0.0028	- -	- -	- -	- -

NR = no standardized requirement for this feature.

Identical to
inner ring
of same
bearing

Outside Diameter (O.D.)		O.D. 2pt Diametral Roundness, Max. 000 (1900) Diameter Series ⁽¹⁾					O.D. 2pt Diametral Roundness, Max. 100 Diameter Series ⁽¹⁾					O.D. 2pt Diametral Roundness, Max. 200, 300, 400 Diameter Series ⁽¹⁾				
		ISO Classes and ANSI/ABMA					ISO Classes and ANSI/ABMA					ISO and ANSI/ABMA Classes				
Over	Included	Normal	6	5	4	2	Normal	6	5	4	2	Normal	6	5	4	2
		1	3	5	7	9	1	3	5	7	9	1	3	5	7	9
mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.
18 0.7087	30 1.1811	0.012 0.00045	0.010 0.0004	0.006 0.00025	0.005 0.0002	0.004 0.00015	0.009 0.00035	0.008 0.0003	0.005 0.0002	0.004 0.00015	0.004 0.00015	0.007 0.0003	0.006 0.00025	0.005 0.0002	0.004 0.00015	0.004 0.00015
30 1.1811	50 1.9685	0.014 0.00055	0.011 0.00045	0.007 0.0003	0.006 0.00025	0.004 0.00015	0.011 0.00045	0.009 0.00035	0.005 0.0002	0.005 0.0002	0.004 0.00015	0.008 0.0003	0.007 0.0003	0.005 0.0002	0.005 0.0002	0.004 0.00015
50 1.9685	80 3.1496	0.016 0.00065	0.014 0.00055	0.009 0.00035	0.007 0.0003	0.004 0.00015	0.013 0.0005	0.011 0.00045	0.007 0.0003	0.005 0.0002	0.004 0.00015	0.010 0.0004	0.008 0.0003	0.007 0.0003	0.005 0.0002	0.004 0.00015
80 3.1496	120 4.7244	0.019 0.00075	0.016 0.00065	0.010 0.0004	0.008 0.0003	0.005 0.0002	0.019 0.00075	0.016 0.00065	0.008 0.0003	0.006 0.00025	0.005 0.0002	0.011 0.00045	0.010 0.0004	0.008 0.0003	0.006 0.00025	0.005 0.0002
120 4.7244	150 5.9055	0.023 0.0009	0.019 0.00075	0.011 0.00045	0.009 0.00035	0.005 0.0002	0.023 0.0009	0.019 0.00075	0.008 0.0003	0.007 0.0003	0.005 0.0002	0.014 0.00055	0.011 0.00045	0.008 0.0003	0.007 0.0003	0.005 0.0002
150 5.9055	180 7.0866	0.031 0.0012	0.023 0.0009	0.013 0.0005	0.010 0.0004	0.007 0.0003	0.031 0.0012	0.023 0.0009	0.010 0.0004	0.008 0.0003	0.007 0.0003	0.019 0.00075	0.014 0.00055	0.010 0.0004	0.008 0.0003	0.007 0.0003
180 7.0866	250 9.8425	0.038 0.0015	0.025 0.0010	0.015 0.0006	0.011 0.00045	0.008 0.0003	0.038 0.0015	0.025 0.0010	0.011 0.00045	0.008 0.0003	0.008 0.0003	0.023 0.0009	0.015 0.0006	0.011 0.00045	0.008 0.0003	0.008 0.0003
250 9.8425	315 12.4016	0.044 0.0017	0.031 0.0012	0.018 0.0007	0.013 0.0005	0.008 0.0003	0.044 0.0017	0.031 0.0012	0.014 0.00055	0.010 0.0004	0.008 0.0003	0.026 0.0010	0.019 0.00075	0.014 0.00055	0.010 0.0004	0.008 0.0003
315 12.4016	400 15.7480	0.050 0.0020	0.035 0.0014	0.020 0.0008	0.015 0.0006	0.010 0.0004	0.050 0.0020	0.035 0.0014	0.015 0.0006	0.011 0.00045	0.010 0.0004	0.030 0.0012	0.021 0.00085	0.015 0.0006	0.011 0.00045	0.010 0.0004
400 15.7480	500 19.6850	0.056 0.0022	0.041 0.0016	0.023 0.0009	-	-	0.056 0.0022	0.041 0.0016	0.017 0.00065	-	-	0.034 0.0013	0.025 0.0010	0.017 0.00065	-	-
500 19.6850	630 24.8032	0.063 0.0025	0.048 0.0019	0.028 0.0011	-	-	0.063 0.0025	0.048 0.0019	0.021 0.00085	-	-	0.038 0.0015	0.029 0.0011	0.021 0.00085	-	-
630 24.8032	800 31.4961	0.094 0.0037	0.056 0.0022	0.035 0.0014	-	-	0.094 0.0037	0.056 0.0022	0.026 0.0010	-	-	0.055 0.0022	0.034 0.0013	0.026 0.0010	-	-
800 31.4961	1000 39.3701	0.125 0.0049	0.075 0.0030	-	-	-	0.125 0.0049	0.075 0.0030	-	-	-	0.075 0.0030	0.045 0.0018	-	-	-

⁽¹⁾ For ANSI/ABMA Classes 7 and 9 (ISO 4 and 2), no individual 2point readings outside the limits for mean diameter (pg. 38) are allowed.

Outside Diameter (O.D.)		Radial Runout, Max.					Axial Runout, Max.				
		ISO and ANSI/ABMA Classes					ISO and ANSI/ABMA Classes				
Over	Included	Normal	6	5	4	2	Normal	6	5	4	2
		1	3	5	7	9	1	3	5	7	9
mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.
18	30	0.015	0.009	0.006	0.004	0.0025	0.025	0.015	0.008	0.005	0.0025
0.7087	1.1811	0.0006	0.00035	0.00025	0.00015	0.0001	0.0010	0.0006	0.0003	0.0002	0.0001
30	50	0.020	0.010	0.007	0.005	0.0025	0.030	0.020	0.008	0.005	0.0025
1.1811	1.9685	0.0008	0.0004	0.0003	0.0002	0.0001	0.0012	0.0008	0.0003	0.0002	0.0001
50	80	0.025	0.013	0.008	0.005	0.004	0.035	0.020	0.010	0.005	0.004
1.9685	3.1496	0.0010	0.0005	0.0003	0.0002	0.00015	0.0014	0.0008	0.0004	0.0002	0.00015
80	120	0.035	0.018	0.010	0.006	0.005	0.040	0.025	0.011	0.006	0.005
3.1496	4.7244	0.0014	0.0007	0.0004	0.00025	0.0002	0.0016	0.0010	0.00045	0.00025	0.0002
120	150	0.040	0.020	0.011	0.007	0.005	0.045	0.030	0.013	0.007	0.005
4.7244	5.9055	0.0016	0.0008	0.00045	0.0003	0.0002	0.0018	0.0012	0.0005	0.0003	0.0002
150	180	0.045	0.023	0.013	0.008	0.005	0.055	0.035	0.014	0.008	0.005
5.9055	7.0866	0.0018	0.0009	0.0005	0.0003	0.0002	0.0022	0.0014	0.00055	0.0003	0.0002
180	250	0.050	0.025	0.015	0.010	0.007	0.065	0.040	0.015	0.010	0.007
7.0866	9.8425	0.0020	0.0010	0.0006	0.0004	0.0003	0.0026	0.0016	0.0006	0.0004	0.0003
250	315	0.060	0.030	0.018	0.011	0.007	0.075	0.045	0.018	0.010	0.007
9.8425	12.4016	0.0024	0.0012	0.0007	0.00045	0.0003	0.0030	0.0018	0.0007	0.0004	0.0003
315	400	0.070	0.035	0.020	0.013	0.008	0.090	0.050	0.020	0.013	0.008
12.4016	15.7480	0.0028	0.0014	0.0008	0.0005	0.0003	0.0035	0.0020	0.0008	0.0005	0.0003
400	500	0.080	0.040	0.023	-	-	0.100	0.055	0.023	-	-
15.7480	19.6850	0.0031	0.0016	0.0009	-	-	0.0039	0.0022	0.0009	-	-
500	630	0.100	0.050	0.025	-	-	0.110	0.060	0.025	-	-
19.6850	24.8032	0.0039	0.0020	0.0010	-	-	0.0043	0.0024	0.0010	-	-
630	800	0.120	0.060	0.030	-	-	0.120	0.065	0.030	-	-
24.8032	31.4961	0.0047	0.0024	0.0012	-	-	0.0047	0.0026	0.0012	-	-
800	1000	0.140	0.075	-	-	-	0.125	0.070	-	-	-
31.4961	39.3701	0.0055	0.0030	-	-	-	0.0049	0.0028	-	-	-

Outside Diameter (O.D.)		O.D. to Face Runout, Max.					Face Parallelism, Max.				
		ISO and ANSI/ABMA Classes					ISO and ANSI/ABMA Classes				
Over	Included	Normal	6	5	4	2	Normal	6	5	4	2
		1	3	5	7	9	1	3	5	7	9
mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.
18 0.7087	30 1.1811	NR	NR	0.008 0.0003	0.004 0.00015	0.0015 0.00005	Identical to inner ring of same bearing		0.005 0.0002	0.0025 0.0001	0.0015 0.00005
30 1.1811	50 1.9685	NR	NR	0.008 0.0003	0.004 0.00015	0.0015 0.00005			0.005 0.0002	0.0025 0.0001	0.0015 0.00005
50 1.9685	80 3.1496	NR	NR	0.008 0.0003	0.004 0.00015	0.0015 0.00005			0.006 0.00025	0.003 0.0001	0.0015 0.00005
80 3.1496	120 4.7244	NR	NR	0.009 0.00035	0.005 0.0002	0.0025 0.0001			0.008 0.0003	0.004 0.00015	0.0025 0.0001
120 4.7244	150 5.9055	NR	NR	0.010 0.0004	0.005 0.0002	0.0025 0.0001			0.008 0.0003	0.005 0.0002	0.0025 0.0001
150 5.9055	180 7.0886	NR	NR	0.010 0.0004	0.005 0.0002	0.0025 0.0001			0.008 0.0003	0.005 0.0002	0.0025 0.0001
180 7.0866	250 9.8425	NR	NR	0.011 0.00045	0.007 0.0003	0.004 0.00015			0.010 0.0004	0.007 0.0003	0.004 0.00015
250 9.8425	315 12.4016	NR	NR	0.013 0.0005	0.008 0.0003	0.005 0.0002			0.011 0.00045	0.007 0.0003	0.005 0.0002
315 12.4016	400 15.7480	NR	NR	0.013 0.0005	0.010 0.0004	0.007 0.0003			0.013 0.0005	0.008 0.0003	0.007 0.0003
400 15.7480	500 19.6850	NR	NR	0.015 0.0006	- -	- -			0.015 0.0006	- -	- -
500 19.6850	630 24.8032	NR	NR	0.018 0.0007	- -	- -			0.018 0.0007	- -	- -
630 24.8032	800 31.4961	NR	NR	0.020 0.0008	- -	- -			0.020 0.0008	- -	- -
800 31.4961	1000 39.3701	- -	- -	- -	- -	- -			- -	- -	- -

NR = no standardized requirement for this feature.

NON-DESTRUCTIVE TESTING

In addition to the basic dimensional characteristics defined by ANSI/ABMA Standard 20, many aspects of quality and reliability assurance depend upon the integrity of the manufacturer as well as supplemental tests that are agreed upon in the final specification. Controls on finish, raceway waviness, lobing, roller-path flatness and many other minute variables are carefully defined as a function of tolerance level by Timken. Non-destructive testing techniques are used on a sample basis to help ensure reliability against cracks, material defects and grinding temper marks.

For critical bearings, 100-percent non-destructive testing using fluorescent penetrant, magnetic particle inspection, nital etch testing, Barkhausen noise testing or eddy current testing is available on a contract basis to help ensure reliability of all components.

MATERIALS AND OPERATING TEMPERATURES

STANDARD MATERIAL – HIGH CHROME 52100 BEARING STEEL (AMS 6440)

Unless otherwise indicated, all bearings listed in this design guide are manufactured from vacuum-degassed bearing-quality 52100 steel (AMS 6440). Rings and rolling elements are precision heat-treated to provide the uniform stable structure required for rolling bearings. ANSI/ABMA 3 (ISO class 6) and higher-precision bearings are stabilized typically with special tempers and sub-cooling cycles. This permits operating temperatures ranging from -54 to +177° C (-65° to +350° F) with a hardness of HRC 60 minimum on most standard configurations and HRC 58 minimum on more complex shapes or where higher temperature capability is required. Retained austenite is generally held to less than 4 percent.

SPECIAL MATERIALS

CEVM 52100 (AMS 6444) consumable electrode vacuum remelt improves reliability and fatigue life versus standard 52100. Timken generally recommends that, in an application critical enough to require CEVM 52100, the slight additional cost of VIM-VAR M-50 is more than justified by its many additional benefits.

VIM-VAR 52100 (AMS 6444) vacuum induction melt, followed by a vacuum arc remelt, further improves reliability and fatigue life. Hardness and heat-treatment are similar to other 52100 grades.

VIM-VAR M-50 HIGH-SPEED (AMS 6491)

Vacuum induction melt-vacuum arc remelt (VIM-VAR) M-50 has proven to be the most satisfactory advanced performance

material for demanding aircraft engine and accessory applications. VIM-VAR M-50 provides four specific areas of improved performance:

- 1) M-50 permits operation at or exposure to temperatures up to 427° C (800° F) with dimensional size change controlled within standard limits. Retained austenite is held to 3 percent maximum by the heat-treatment process.
- 2) M-50 provides extended fatigue life in temperature ranges above 204° C (400° F) common to many aircraft applications. It compensates for application conditions that may cause severe reduction in experienced life, e.g., rapid acceleration, marginal housing or shaft support, differential temperatures, misalignment and other unavoidable conditions.
- 3) M-50 extends life in “oil out” or marginal lubricant conditions. Under these conditions, surface temperatures immediately rise, causing surface tempering, deformation and seizure. Even after exposure to temperatures as high as 593° C (1100° F), M-50 will not soften significantly (compared to 260° C [500° F] for 52100), providing an extra margin of operable life.
- 4) M-50 moly-carbides provide greater hardness to reduce fretting and wear under slow-speed or oscillating conditions.

VIM-VAR M-50 NIL (AMS 6278)

A carburized case-hardened variation of M-50, VIM-VAR M-50 NIL (AMS 6278) provides improved fracture toughness due to its softer core. Other properties of conventional M-50, including high-temperature stability and rolling contact fatigue life, are maintained, with the exception of retained austenite, typically 6 percent max. Potential applications include ultra-high-speed (2.4 million dN and above) mainshaft and other applications limited by low fracture toughness.

440C STAINLESS STEEL (AMS 5880)

A 16-percent chromium steel common to miniature and instrument bearings, 440C stainless steel (AMS 5880) also is used in special metric bearings requiring corrosion resistance. Standard tempering and subcooling cycles provide capability for operation at temperatures up to 190° C (375° F). Optional high-temperature draw cycles allow operation at temperatures up to 425° C (800° F); however, this option reduces corrosion resistance. Typical applications include large instrument bearings, reactor control bearings, bearings immersed in jet fuel and lightly loaded high-temperature thrust-reverser controls.

Modified 440C alloys, similar to 440C, contain additional molybdenum to improve hot hardness at high tempering temperatures for applications requiring corrosion and oxidation resistance. In some applications, they provide the best features of both 440C and M-50; however, their high alloy content has led to unpredictable variations in experienced fatigue life. Examples of modified 440C is BG-42® (AMS 5749).

BG-42® (AMS 5749) VIM-VAR

A high-performance Cr-Mo-V alloy, BG-42 (AMS 5749) VIM-VAR is ideal for bearing applications where a hardenable martensitic stainless steel is needed for corrosion resistance, and has hot hardness better than 440C. It performs similarly to M-50, but with added properties described above. Multiple remelting enhances material cleanliness and provides a more reliable performance and fatigue life. It is suitable for use where application temperatures are up to 482° C (900° F).

PYROWEAR 675® (AMS 5930)

A carburizing grade of stainless steel, Pyrowear 675® (AMS 5930) is a corrosion-resistant steel developing a HRC 60 case with a tough ductile core. It has corrosion resistance equivalent to 440C steel.

CERAMIC ROLLING ELEMENTS

Ceramic balls and rollers (silicon nitride) are available for hybrid bearings. This high-performance ceramic has proved beneficial for certain high-temperature, high-corrosive environments. When corrosive environments, exceptionally non-typical bearing temperatures or very high speeds are anticipated in a design, it may be useful to apply a “hybrid” construction. Properly designed ring and cage materials can be mated with ceramic rolling elements – balls or rollers – to obtain the maximum benefits of each. Discuss these special applications with a Timken engineer for guidance.

HOW TO SPECIFY

To select material, choose one of the following as the prefix to the Timken part number:

None – 52100	34 – CEVM 440C
3 – 440C	35 – VIM-VAR M50 Nil
5 – VIM-VAR M50	58 – Pyrowear 675
25 – BG-42	
26 – CEVM 52100	

RADIAL PLAY AND CONTACT ANGLE

Radial play, or free internal clearance, is one of the most critical bearing design parameters. Contrary to a common misconception, it has nothing to do with quality or ANSI/ABMA or ISO tolerance level. In both ball and roller bearings, radial play is defined as the free radial displacement of the outer ring with respect to a fixed inner ring. In ball bearings, it directly affects and controls the operating contact angle and free axial or endplay. In some ball bearing applications, contact angle or endplay may be the controlling specification. In these cases, radial play is not designated, but is offered as a “reference.”

RADIAL PLAY SELECTION – HK, HD AND R TYPES

Ball bearings are normally manufactured to one of the five standard ranges shown in the chart on page 43. Unless otherwise specified, Timken HK (deep-groove) and HD (fractured outer ring) ball bearings and R-series roller bearings are supplied with Group N standard clearances. This standard range has excellent radial stability and load capacity. In ball bearings, Group N provides good resistance to cocking loads and a reasonable degree of axial location without preloading. It also allows for a light press fit on the inner ring for normal rotating shaft applications.

LOOSER FITS

Group 3 and Group 4 clearances may be specified in a bearing for a number of reasons:

- 1) To allow for a press fit on the outer ring and where necessary on both rings. Keep in mind that 50 percent to 75 percent of an interference fit is reflected in loss of radial play. Temperature extremes cause additional changes in radial play when dissimilar materials are used for shaft and housing materials.
- 2) To provide higher contact angles under axial loads, thereby reducing stress levels that increase fatigue life, reduce torque and help to improve operating efficiency.
- 3) To provide greater axial stability, particularly in preloaded bearings.
- 4) To allow greater static and dynamic misalignment.

TIGHTER FITS

Group 2 clearance may be specified for a bearing slip-fit mounted in both the housing and on the shaft, and operating under straight radial loads. If cocking loads are unavoidable, Group 2 provides the greatest resistance and angular control. If preloading between two bearings is impractical, it also provides the most precise axial location.

RELATIONSHIP BETWEEN RADIAL PLAY, ENDPLAY AND CONTACT ANGLE (HK AND HD SERIES BALL BEARINGS)

The following graph provides the designer with the means to calculate the relationship between radial play, contact angle and endplay for Timken® bearings with standard inner and outer race curvatures. Since curvature significantly affects this relationship, any bearing with inverse curvature or reduced curvature for extra-high load capacity will have a different relationship. The values obtained with this graph are averages and should not be interpreted as acceptance or manufacturing limits.

RADIAL PLAY AND CONTACT ANGLE continued

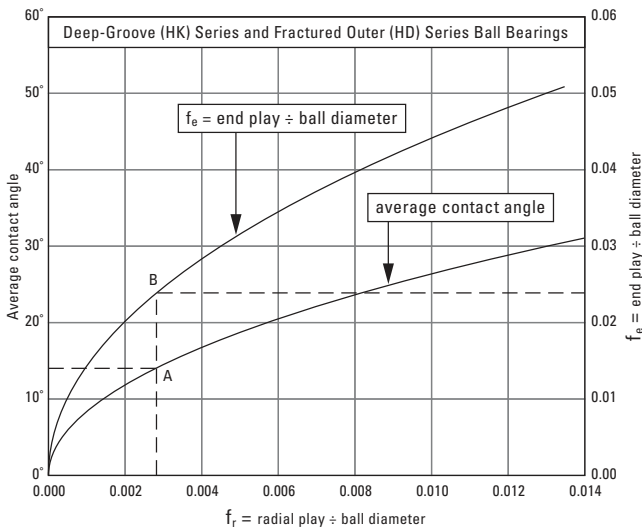


Fig. 12. Relationship between radial play, endplay and contact angle for any ball size.

EXAMPLE:

Determine the average contact angle and the average endplay on an HD 106 bearing with Group 3 (loose) internal clearance:

- 1) From table of dimensions (see Ball Bearing Specifications page 25) the ball diameter is found to be 3/32 inch (0.28125 inch).
- 2) From the chart on page 43, the internal clearance for group 3 for a 106 bearing is 0.0005 inch to 0.0011 inch.
- 3) The conditions for average internal clearance (0.0008 inch) or the extremes (0.0005 inch and 0.0011 inch) may be read off the graph above. First determine the value of fr.

fr = radial play / ball diameter = 0.0008 / 0.28125 = 0.00285

- 4) Extend a vertical line from fr = 0.00285 through curves labeled "Contact Angle" and "fe" to determine intersection points "A" and "B."
- 5) Extend horizontal line to left from "A" to determine average contact angle of 14 degrees.
- 6) To obtain endplay, extend horizontal line to right from point "B" to determine value; fe = 0.024.
Solve equation fe = endplay / ball diameter
endplay = ball diameter x fe = 0.28125 x 0.024 = 0.0067 inch

NOTE

An interference fit will reduce the internal clearance by approximately 50 percent to 75 percent of the amount of interference, giving operating conditions of a tighter internal fit-up. If interference fits are used, first determine the reduced internal clearance, then the contact angle or the average endplay of the bearing.

The graph also may be used to determine the required internal clearance range from predetermined axial play or contact angle values.

RADIAL PLAY SELECTION – HA/HJ AND HT TYPES

Angular contact (HA/HJ) ball bearings are normally manufactured to a contact angle tolerance rather than a specified radial play. The two standard contact angles are 15 degrees and 25 degrees; 15 degrees should be used for applications which, while predominantly axially loaded, have a significant radial load component, and 25 degrees should be used for high-axial-load applications.

Split-inner-ring (HT) series bearings are normally manufactured to a contact angle of 25 degrees or higher. Due to the special nature of these bearings, consult your Timken engineer or representative before specifying.

HOW TO SPECIFY:

To specify radial play or contact angle, choose one of the following alternatives and then add the suffix to the basic bearing part number. For standard Group N, the code may be omitted.

- 1) To specify a radial play range: Select the group code number from table on page 43. Example: "3" indicates Group 3.
- 2) To specify radial play: Express in ten thousandths (0.0001) of an inch x 10,000. Example: (5/15) indicates 0.0005/0.0015 radial play.
- 3) To specify contact angle code (HA/HJ-type angular contact bearings only): Use letter code in parentheses. Suffix (D) is equivalent to normal contact angle of 25 degrees.

Codes B and D are standard contact angles offered.

Code	Contact Angle Degrees
A	12
B	15
C	18
D	25
E	30

RADIAL PLAY, BALL BEARINGS

ISO and ANSI/ABMA Radial Play Groups											
Bore Diameter		Group 2		Group N		Group 3		Group 4		Group 5	
≥	≤	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.
6 0.2362	10 0.3937	0.000 0.0000	0.007 0.0003	0.002 0.0001	0.013 0.0005	0.008 0.0003	0.023 0.0009	0.014 0.0006	0.029 0.0011	0.020 0.0008	0.037 0.0015
10 0.3937	18 0.7087	0.000 0.0000	0.009 0.00035	0.003 0.0001	0.018 0.0007	0.011 0.00045	0.025 0.0010	0.018 0.0007	0.033 0.0013	0.025 0.0010	0.045 0.0018
18 0.7087	24 0.9449	0.000 0.0000	0.010 0.0004	0.005 0.0002	0.020 0.0008	0.013 0.0005	0.028 0.0011	0.020 0.0008	0.036 0.0014	0.028 0.0011	0.048 0.0019
24 0.9449	30 1.1811	0.001 0.00005	0.011 0.00045	0.005 0.0002	0.020 0.0008	0.013 0.0005	0.028 0.0011	0.023 0.0009	0.041 0.0016	0.030 0.0012	0.053 0.0021
30 1.1811	40 1.5748	0.001 0.00005	0.011 0.00045	0.006 0.00025	0.020 0.0008	0.015 0.0006	0.033 0.0013	0.028 0.0011	0.046 0.0018	0.040 0.0016	0.064 0.0025
40 1.5748	50 1.9685	0.001 0.00005	0.011 0.00045	0.006 0.00025	0.023 0.0009	0.018 0.0007	0.036 0.0014	0.030 0.0012	0.051 0.0020	0.045 0.0018	0.073 0.0029
50 1.9685	65 2.5591	0.001 0.00005	0.015 0.0006	0.008 0.0003	0.028 0.0011	0.023 0.0009	0.043 0.0017	0.038 0.0015	0.061 0.0024	0.055 0.0022	0.090 0.0035
65 2.5591	80 3.1496	0.001 0.00005	0.015 0.0006	0.010 0.0004	0.030 0.0012	0.025 0.0010	0.051 0.0020	0.046 0.0018	0.071 0.0028	0.065 0.0026	0.105 0.0041
80 3.1496	100 3.9370	0.001 0.00005	0.018 0.0007	0.012 0.00045	0.036 0.0014	0.030 0.0012	0.058 0.0023	0.053 0.0021	0.084 0.0033	0.075 0.0030	0.120 0.0047
100 3.9370	120 4.7244	0.002 0.0001	0.020 0.0008	0.015 0.0006	0.041 0.0016	0.036 0.0014	0.066 0.0026	0.061 0.0024	0.097 0.0038	0.090 0.0035	0.140 0.0055
120 4.7244	140 5.5118	0.002 0.0001	0.023 0.0009	0.018 0.0007	0.048 0.0019	0.041 0.0016	0.081 0.0032	0.071 0.0028	0.114 0.0045	0.105 0.0041	0.160 0.0063
140 5.5118	160 6.2992	0.002 0.0001	0.023 0.0009	0.018 0.0007	0.053 0.0021	0.046 0.0018	0.091 0.0036	0.081 0.0032	0.130 0.0051	0.120 0.0047	0.180 0.0071
160 6.2992	180 7.0866	0.002 0.0001	0.025 0.0010	0.020 0.0008	0.061 0.0024	0.053 0.0021	0.102 0.0040	0.091 0.0036	0.147 0.0058	0.135 0.0053	0.200 0.0079
180 7.0866	200 7.8740	0.002 0.0001	0.030 0.0012	0.025 0.0010	0.071 0.0028	0.063 0.0025	0.117 0.0046	0.107 0.0042	0.163 0.0064	0.150 0.0059	0.230 0.0091
200 7.8740	225 8.8583	0.002 0.0001	0.035 0.0014	0.025 0.0010	0.085 0.0033	0.075 0.0030	0.140 0.0055	0.125 0.0049	0.195 0.0077	0.175 0.0069	0.265 0.0104
225 8.8583	250 9.8425	0.002 0.0001	0.040 0.0016	0.030 0.0012	0.095 0.0037	0.085 0.0033	0.160 0.0063	0.145 0.0057	0.225 0.0089	0.205 0.0081	0.300 0.0118
250 9.8425	280 11.0236	0.002 0.0001	0.045 0.0018	0.035 0.0014	0.105 0.0041	0.090 0.0035	0.170 0.0067	0.155 0.0061	0.245 0.0096	0.225 0.0089	0.340 0.0134
280 11.0236	315 12.4016	0.002 0.0001	0.055 0.0022	0.040 0.0016	0.115 0.0045	0.100 0.0039	0.190 0.0075	0.175 0.0069	0.270 0.0106	0.245 0.0096	0.370 0.0146
315 12.4016	355 13.9764	0.003 0.0001	0.060 0.0024	0.045 0.0018	0.125 0.0049	0.110 0.0043	0.210 0.0083	0.195 0.0077	0.300 0.0118	0.275 0.0108	0.410 0.0161
355 13.9764	400 15.7480	0.003 0.0001	0.070 0.0028	0.055 0.0022	0.145 0.0057	0.130 0.0051	0.240 0.0094	0.225 0.0089	0.340 0.0134	0.315 0.0124	0.460 0.0181
400 15.7480	450 17.7165	0.003 0.0001	0.080 0.0031	0.060 0.0024	0.170 0.0067	0.150 0.0059	0.270 0.0106	0.250 0.0098	0.380 0.0150	0.350 0.0138	0.510 0.0201
450 17.7165	500 19.6850	0.003 0.0001	0.090 0.0035	0.070 0.0028	0.190 0.0075	0.170 0.0067	0.300 0.0118	0.280 0.0110	0.420 0.0165	0.390 0.0154	0.570 0.0224
500 19.6850	560 22.0472	0.010 0.0004	0.100 0.0039	0.080 0.0031	0.210 0.0083	0.190 0.0075	0.330 0.0130	0.310 0.0122	0.470 0.0185	0.440 0.0173	0.630 0.0248
560 22.0472	630 24.8031	0.010 0.0004	0.110 0.0043	0.090 0.0035	0.230 0.0091	0.210 0.0083	0.360 0.0142	0.340 0.0134	0.520 0.0205	0.490 0.0193	0.690 0.0272

PRELOADING

There are three basic reasons for preloading a ball bearing:

- 1) To define more precisely a shaft position by increasing bearing stiffness.
- 2) To keep the balls in contact with the race to prevent skidding and reduce noise.
- 3) To share a load, axial or radial, equally between two bearings.

PRELOADING METHODS

Conventional radial (HK) or angular contact (HA/HJ) ball bearings may be preloaded in an application using one of the following basic techniques:

- 1) Increase axial load to a predetermined torque range by using adjustable face clamping, for example a nut or screw.
- 2) Select a shim to create a predetermined torque value or axial deflection value under a reversing gage load.
- 3) Mount bearings with a preload spring, either between inner or outer rings or at one end of the assembly.
- 4) Use factory preloaded duplex pairs of bearings, which provide exact “built-in” preload when face-clamped in a DB, DF or DT configuration.

Where opposed single bearings are involved, two types of preload mounts are possible: DB (back-to-back) and DF (face-to-face). The type of mount is usually predicated on unit assembly considerations. DB mounts are most desirable where overturning moment loading is to be supported; DF mounts allow limited angular misalignment.

FACTORY-DUPLEXED PAIRS

Timken supplies pairs of radial bearings that have a precision-matched offset. When face-clamped together or against equal length spacers, a predetermined preload value is obtained. Duplex pairs are available in DB or DF configurations with preload values as selected for individual applications. To avoid unloading of either bearing in a two bearing DB or DF set, the minimum preload value should equal one-third of the applied axial load. The maximum preload limit should then be specified as at least one and a half times the minimum preload.

DT pairs, while not preloaded, are available matched to ensure equal sharing of axial load. DU pairs have offsets matched on both sides to allow use in any of the three configurations.

Matched sets of three or more bearings also are available.

ADVANTAGE OF EACH METHOD

DB – Provides excellent radial, axial and moment stability when there are no additional bearings on the shaft.

DF – Provides radial and axial stability and aligns readily with additional bearings mounted on the same shaft.

DT – Shares extra-high axial loads equally between two bearings. Does not provide stability unless further preloaded with additional bearings.

MARKING

Bearings of DB, DF and DT duplex sets have two axial lines forming a 30-degree included angle “V” etched across the outer rings of the pair (with the point of the “V” at the outer ring face to which the load is applied in the case of DT pairs).

HOW TO SPECIFY:

To specify preload, show preload type DB, DF, DT or DU and min./max. preload value desired.

Example: DB preload, 3.63 kg min. to 5.44 kg max.
(8 lbs. min. to 12 lbs. max.)

Specify as: DB 8/12.

Add this suffix to the standard part number.

ROLLER BEARINGS

Roller bearings may be radially preloaded by application of bi-lobe or tri-lobe geometry to the outer ring, through use of specialized grinding techniques. Consult Timken for advice and applicability.

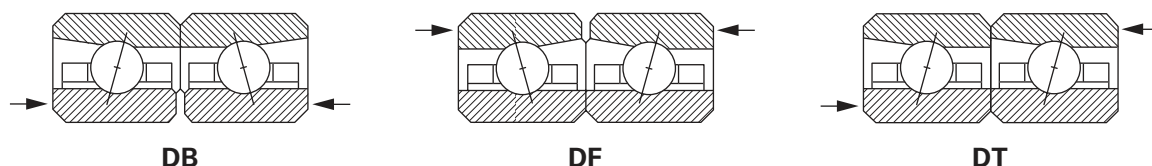


Fig. 13. Matched bearing pairs.

BEARING MOUNTING PRACTICES

Bearing fits are generally established based upon the application data such as loads, materials, temperatures and speeds. Every bearing must be properly fitted before it can meet its performance requirements. Preferably, housing and shaft tolerances should be selected in magnitudes approximately equal to the diameter tolerances of the bearing (see tolerance charts on pages 32-39). The normal fitting procedure is to press fit the ring that rotates relative to the applied radial load from bearing dimension is equal to (or matches) the shaft or housing dimension to tight. The ring stationary relative to the applied radial load is usually slip fitted from bearing dimension is equal to (or matches) the shaft or housing dimension to loose.

Heavier or out-of-balance loads may require tighter fits to avoid fretting damage to the housing or shaft. In these cases, additional radial play is required to compensate for the press fit.

Shaft and housing shoulders should be of adequate height to properly support the face of the bearing. See suggested minimum shaft and maximum housing dimensions in the bearing specification tables. Shoulders should be carefully machined to prevent misalignment and have a corner fillet radius not exceeding the radius dimension listed in the specifications.

It is always preferable to use shaft and housing materials with compatible coefficients of expansion with the bearing. Whenever this is impractical due to weight or other material consideration, use the adjacent chart to determine the possible degree of looseness or interference at temperature extremes. This additional looseness or tightness can be partially compensated for by adjusting fits and radial play.

EFFECT OF FITTING PRACTICE ON RADIAL PLAY AND PRELOAD

Keep in mind that 50 percent to 75 percent of the interference fit at any temperature extreme is reflected in loss of radial play. Press fits are even more significant in their effect on increasing preload in factory-duplexed fits. For example, with an HA 107 bearing having a 4.54 kg (10 lbs.) preload, a 0.0152 mm (0.0006 in.) press fit of the inner raceway on a solid steel shaft would increase the preload in excess of 45.36 kg (100 lbs.). To avoid excessive as-mounted preloads, pairs are either mounted with loose fits or specified as "matched and coded" on the bores and/or O.D.s so that a fit of 0.0025 mm (0.0001 in.) tight on the rotating member can be established. Contact Timken for specific application assistance.

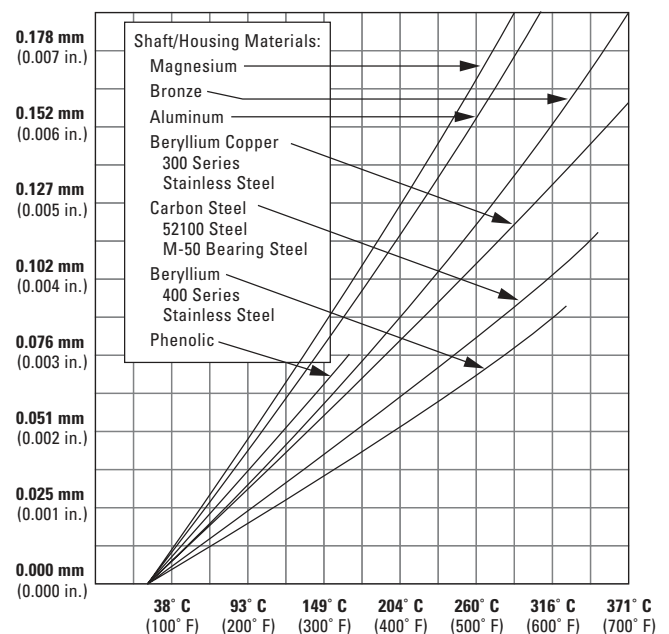


Fig. 14. Linear or diametral expansion in mm (inches) from 21° C (71° F).

To determine expansion or potential fit variation for dissimilar materials: multiply bore or O.D. diameter by the expansion for each material at the maximum temperature required. Contraction at temperatures below 21° C (71° F) is equal to the expansion for a comparable temperature differential above 21° C (71° F).

DYNAMIC LOAD RATING AND LIFE CALCULATIONS

The calculation methods in the following paragraphs yield approximate results only. In particular, they do not account for the effects of higher speeds or, for ball bearings, race curvature. More sophisticated, computer-based analyses are available by contacting Timken.

The dynamic load ratings for all ball and roller bearings described in this design guide (see bearing specification tables) are based on an average (L_{50}) life of 2500 hours or a minimum (L_{10}) life. The dynamic load rating, C_r , is defined as that constant stationary radial load which a rolling element bearing could theoretically endure for a basic rating life on one million revolutions. L_{10} life for an individual rolling bearing, or a group of apparently identical rolling bearings, operating under the same conditions, is the life associated with 90 percent reliability, with contemporary, commonly used material and manufacturing quality, and under conventional operating conditions. Reference: ANSI/ABMA Std. 9 and 11.

NOTE

The load rating is a calculation device only. Under actual operating conditions, a $\frac{C_r}{P}$ ratio of less than three or more than 10 should be avoided.

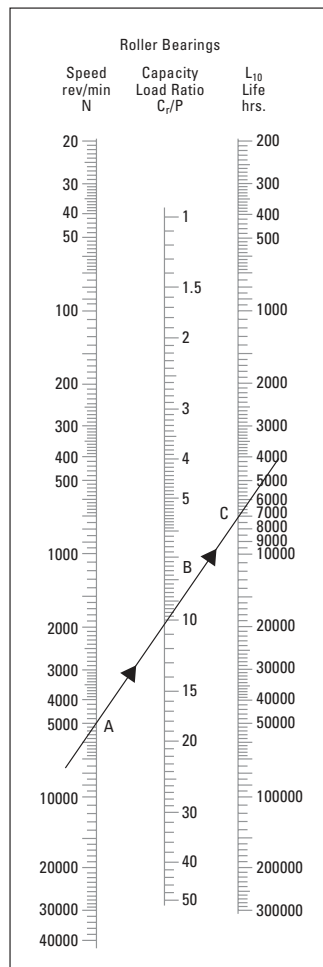
TO CALCULATE L_{10} RATING LIFE FOR OTHER LOADS AND SPEEDS:

Determine $\frac{C_r}{P}$

C_r = dynamic load rating (see bearing specification tables pages 17-21 and 26-30)

P = equivalent radial load (see page 48)

Enter the nomogram at N (the desired RPM). Draw a straight line through the $\frac{C_r}{P}$ value. The intersection point with the right hand line equals the L_{10} life.



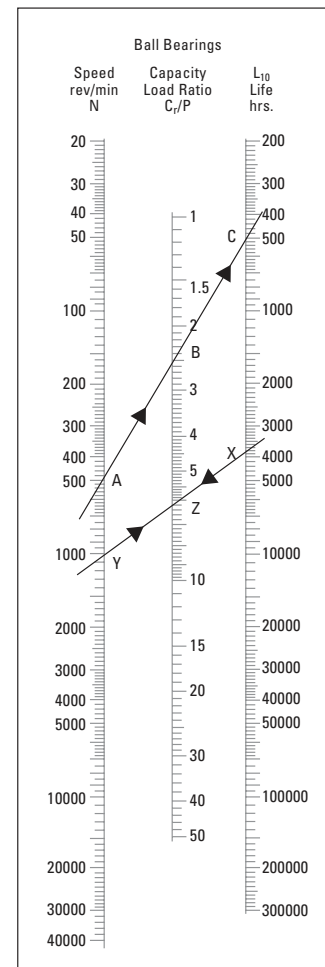
To find L_{10} life of a
ROLLER BEARING
given $N = 5000$ RPM (point A)
 $C_r/P = 10$ (point B)
then $L_{10} = 7300$ hours (point C)

To find L_{10} life of a
BALL BEARING
given $N = 500$ RPM (point A)
 $C_r/P = 2.45$ (point B)
then $L_{10} = 500$ hours (point C)

To find the size of a
BALL BEARING
given Shaft = 35 mm (1.3780 in.)
Load = 249.48 kg (550 lbs.)
 $L_{10} = 4000$ hours (point X)
Speed = 1000 RPM (point Y)
then $C_r/P = 6.3$ (point Z) and
 $C_r = 6.3 \times 550 = 3465$ lbs.

Select HKB 107 where
 $C_r = 3592$ lbs. and shaft
diameter is compatible.

Fig. 15. Nomogram examples.



TO SELECT A BEARING SIZE:

Knowing the required L_{10} life, RPM and load, the nomograms can be solved for $\frac{C_r}{P}$. Enter the nomogram at N RPM and draw a straight line to the L_{10} value. The intersection with the center line is the $\frac{C_r}{P}$ ratio. Multiply $\frac{C_r}{P}$ by P (equivalent load) and obtain C_r . Using this value, enter the C_r column in the bearing dimension and capacity tables and select a bearing with the proper capacity to suit the shaft and housing requirements.

ALTERNATE DIRECT CALCULATION METHOD

Roller Bearings

Cylindrical bearing L_{10} life

$$L_{10} = \frac{((C_r/P)^{10/3} \times 10^6)}{N \times 60}$$

Ball Bearings

Radial and angular contact bearing L_{10} life

$$L_{10} = \frac{((C_r/P)^3 \times 10^6)}{N \times 60}$$

Where:

- 1) L_{10} = rating life in hours
- 2) N = bearing speed in RPM
- 3) C_r = dynamic load rating (see Column C_r bearing specification table, pages 17-21 and 26-30)
- 4) P = equivalent radial load (see next page)

VARIABLE LOAD OR SPEED CALCULATION

Variable load and constant speed

$$P = \sqrt[X]{\frac{P_1^X f_1 + P_2^X f_2 + P_3^X f_3 + \dots + P_n^X f_n}{100}}$$

Variable load and variable speed

$$P = \sqrt[X]{\frac{P_1^X N_1 f_1 + P_2^X N_2 f_2 + P_3^X N_3 f_3 + \dots + P_n^X N_n f_n}{100 N_m}}$$

X = 3 for ball bearings, $^{10/3}$ for cylindrical roller bearings

N_m is the mean equivalent speed where:

$$N_m = \frac{N_1 f_1 + N_2 f_2 + N_3 f_3 + \dots + N_n f_n}{100}$$

where: P_1, P_2 , etc., equal each discrete radial load (lbs.)
 f_1, f_2 , etc., equal percent time when each load is applied. The sum of $f_1 + f_2 + f_3 + \dots + f_n$ must equal 100 exactly.

The resulting value P is the equivalent mean load to be used for life calculation.

For ball bearings with combined radial and axial loads, first calculate the equivalent radial load for each condition per the preceding paragraph; then use those values to calculate the equivalent mean load.

DYNAMIC LOAD RATING AND LIFE CALCULATIONS *continued*

Example: A roller bearing has a variable load of 22.68 kg (50 lbs.) for 2 minutes, 11.34 kg (25 lbs.) for 3 minutes and 45.36 kg (100 lbs.) for 5 minutes.

The equivalent load with speed constant is:

$$P = \sqrt[10/3]{\frac{50^{10/3}(20) + 25^{10/3}(30) + 100^{10/3}(50)}{100}} \approx 82 \text{ lbs.}$$

In the given example, if speed also varies with load, 2000 RPM, 5000 RPM and 3000 RPM respectively, then:

$$N_m = \frac{2000(200) + 5000(30) + 3000(50)}{100} = 3400 \text{ RPM}$$

$$\text{lbs. } P = \sqrt[10/3]{\frac{50^{10/3}(2000)(20) + 25^{10/3}(5000)(30) + 100^{10/3}(3000)(50)}{100(3400)}} \approx 79$$

EQUIVALENT RADIAL LOAD (P)

In both rating life formulas below, the equivalent radial load (P) is the constant stationary radial load, which, if applied to a bearing with a rotating inner ring and stationary outer ring, would give the same life as the bearing would attain under actual conditions of load and rotation.

Roller Bearings

(cylindrical)

$$P = F_r$$

Ball Bearings:

$P = F_r$ (radial loads)

$$P = XF_r + YF_a$$

(radial and axial combined loads)

Check both formulas.

Use the larger value of P

as the equivalent radial load.

where:

- 1) F_r = calculated radial load
 - 2) F_a = calculated axial load
 - 3) $X = 0.50$ radial factor
 - 4) Y = axial factor
- } for ball bearings under combined loads

Y is a function of F_a/C_o (axial load divided by the radial static capacity) and the radial clearance factor, f_r .

where: $f_r = \frac{\text{average radial play in inches}}{\text{ball diameter in inches}}$

To determine the value of Y for single-row ball bearings, compute f_r and select the curve closest to this value in the chart to the right. Solve for F_a/C_o and determine Y using the selected curve.

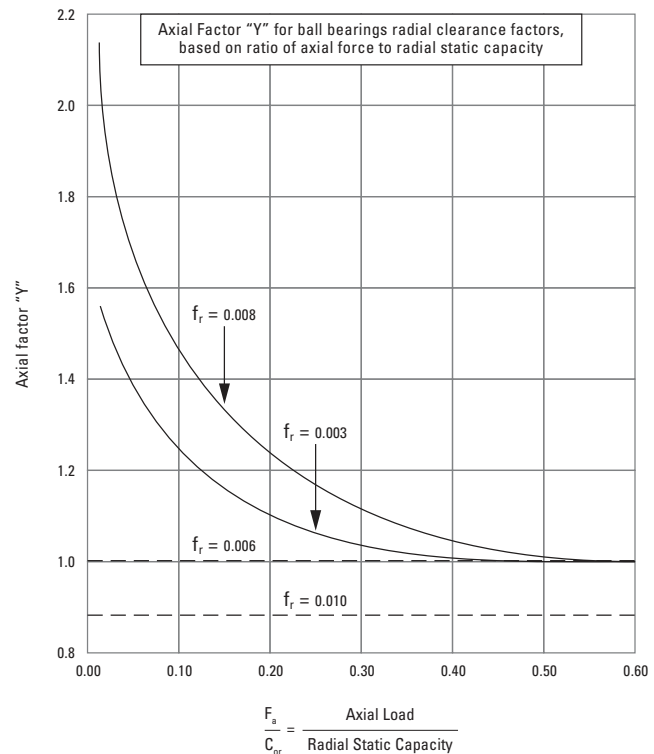


Fig. 16. Axial Factor Y

Use care to select bearings that are of sufficient size for the application. A bearing that appears to have adequate life may require a shaft so small that shaft deflection could lead to misalignment and fitting problems. A further analysis is sometimes required.

STATIC LOAD RATINGS

Ball and roller bearings loaded in a static (non-rotating) condition will experience some degree of permanent deformation at the ball-/roller-to-race contact. The static load rating is an indicator as to the magnitude of that deformation.

RATING DEFINITION

Radial static capacity, C_{0r} , is defined by ANSI/ABMA in terms of contact stress at the center of the most heavily loaded ball/roller.

- For ball bearings (except self-aligning types), the rating is based on 609KSI (4200 MPa) contact stress.
- For roller bearings, the rating is based on 580KSI (4000 MPa) contact stress.

These stresses correspond to a permanent deformation of 0.0025 mm/mm (0.0001 in./in.) of the ball or roller diameter. (Examples: a 25.4 mm [1 in.] ball or roller will have approximately 0.0025 mm [0.0001 in.] permanent deformation when loaded to C_{0r} . A 12.7 mm [0.5 in.] ball or roller will have approximately 0.0013 mm [0.00005 in.] permanent deformation). Experience has shown that most applications can tolerate this degree of permanent deformation without impairing subsequent operation.

Contact your Timken representative to discuss specific applications.

RADIALLY LOADED APPLICATIONS

For ball or cylindrical roller bearing applications subject to radial loading only, the applied load is applied directly to the C_{0r} rating.

AXIAL-LOADED OR COMBINED RADIAL-/AXIAL-LOADED APPLICATIONS

Ball Bearings

Ball bearings with combined radial and axial static loading or axial static loading only require the calculation of a static equivalent radial load, which is then applied against the C_{0r} rating. Contact your Timken representative for the applicable X_0 and Y_0 factors or see ANSI/ABMA Standard 9.

Static axial-loaded ball bearing applications may also be subject to other limitations.

- Depending on initial contact angle (radial play), groove depth and race curvature (conformity), truncation of the contact ellipse may be a limiting factor.
- Fractured-outer-ring bearings (HD series) may be limited by the ability of the holding wires to keep the fracture closed. Axial loads in excess of approximately 90.72 kg (200 lbs.), depending on bearing size, may tend to open the fracture, causing early damage. Where the housing fit can be maintained line-to-line to tight, the holding wires will no longer be the limiting factor and higher axial loads, equivalent to the HK configuration, may be applied.

Roller Bearings

Cylindrical roller bearings, depending on the ring configuration, are capable of supporting axial loads. Since the load is taken on the much larger roller end surfaces rather than on the normal contact surfaces, the C_{0r} rating does not apply; the static load is limited only by the structural strength of the ring guide flanges and their supporting shaft and housing shoulders.

CONSIDERATIONS IN BEARING LIFE PREDICTION

In all discussions of the calculated dynamic load rating and L_{10} life, the factor that determines bearing life is always considered to be subsurface origin fatigue spalling of the inner or outer raceway or rolling elements. Fatigue results from cyclic stress reversals on the rolling contact surfaces and is characterized by actual loss of metal. Initially, only the vibration level of the bearing increases, but more extensive damage may follow if operation is allowed to continue. The wear rate of the cage substantially increases and the ring or one of the rolling elements may fracture, causing a total lock-up. For this reason, magnetic chip detectors are used in many critical applications to highlight early stages of fatigue in gear or bearing components.

Other modes of damage that are not statistically predictable by the conventional ANSI/ABMA formulas can affect performance. Depending on the criticality of torque and noise level, they may result in a dramatically reduced design life long before the predicted life has been achieved.

These include:

- True load brinells caused by either radial or axial impacts in excess of the static rating. Results: roughness and noise.
- False brinells caused by vibration under static conditions with inadequate lubrication. Results: fretting corrosion on raceways and shorter life.
- Wear caused by loss of lubrication or introduction of abrasive particles (contamination). Results: premature spalling of raceways and rolling elements.
- Ball/roller skidding caused by rapid acceleration with inadequate load/preload. Results: flat spots, noisy bearings, overheating and early failures.
- Ring or ball fracture or cage fracture caused by improper mounting techniques or extreme loads. Results: fractured bearing elements and early failures.
- Rotational interference caused by debris, lubricant oxidation, loss of radial play due to improper fitting procedures, corrosion, etc. Results: early failures and overheating.

LUBRICATION

Selection of the lubricant type and the method of distribution are critical to achieve successful life. Lubrication has four basic purposes:

- 1) Minimize rolling resistance due to deformation of the rolling elements and raceway under load by separating the mating surfaces.
- 2) Minimize sliding friction occurring between rolling elements, raceways and cage.
- 3) Transfer heat (with oil lubrication).
- 4) Protect from corrosion and, with grease lubrication, from contaminant ingress.

The relative importance of each depends upon the application, particularly on the speed and load. Effect of speed on different bearings can be related by the dN value (bore diameter mm x RPM).

HIGH-SPEED APPLICATIONS (OVER 1 MILLION dN)

Lubrication of high-speed (more than 1 million dN) applications is most critical. Centrifugal force tends to throw lubricant from the heavily stressed inner raceway into the outer race. Lubricant accumulation creates additional drag and heat, causing slippage or wear on the inner raceway. In high-speed applications, the most effective means of lubrication uses one or more high-velocity jets of oil directed at the inner raceway contact area with adequate escape for used lubrication around the outer race shoulders. In some applications, this can be achieved by bringing oil through holes at critical locations in the inner race. If loads are not severe, air can be mixed with oil in a non-recirculating oil mist system. With mist lubrication, air provides the cooling and cleaning functions.

MEDIUM-SPEED APPLICATIONS (10000 TO 1 MILLION dN)

In the broad range of 10000 to 1 million dN, which encompasses most bearing applications, the lubricant's cooling function is less critical. A circulating or replenishment oil system is still preferable for optimum life, but a controlled quantity of grease may be used if temperatures are low. With above ambient temperatures, grease frequently deteriorates long before the predicted fatigue life of the bearing. Unless the bearings are periodically regreased with the proper amount of lubricant, early fatigue may result. New developments in high-temperature greases provide a partial solution to the problem.

Bearing fatigue life can be prolonged beyond that predicted in this design guide if full fluid film elastohydrodynamic lubrication is established at the contact surface. To achieve this, the fluid film thickness must be equal to or greater than contact surface finish or microgeometry variations at the most heavily loaded

LUBRICATION *continued*

contact area. Without full fluid separation, metal contact occurs, causing higher surface shear stress, possible wear and reduced life.

Fluid film separation is influenced by: 1) size, design and precision of the bearing; 2) speed; 3) applied load; and 4) viscosity characteristics of the oil at operating temperatures.

Most medium-speed bearings operating with high-quality mineral oils under average loads establish full fluid film separation. However, where low viscosity fluids or lubricants are required, fluid film may not be established, resulting in reduced life (e.g., hydraulic pumps and fuel control systems). Bearings operating in jet fuel yield less than 10 percent of normal life. Timken Aerospace computer programs utilizing the above variables are available to assist designers in determining adequacy of the lubricant. Then, design or application modifications can be reviewed to compensate for or accept potential life reductions.

Where fluid film cannot be maintained due to low speeds and high bearing loads, grease lubrication may prove advantageous. Extreme pressure additives in some greases provide good boundary lubrication and lubricity even though the viscosity characteristics of the oil provide marginal fluid film support.

The selection of oil viscosity for any bearing application requires consideration of several factors: load, speed, bearing setting, type of oil, and environmental factors. Since viscosity varies inversely with temperature, a viscosity value

must always be stated with the temperature at which it was determined. High viscosity oil is used for low-speed or high-ambient temperature applications. Low viscosity oil is used for high-speed or low-ambient temperature applications.

The measure of viscosity uses multiple units that depend upon the test method used in the evaluation. There are several viscosity terms, such as absolute, kinematic and apparent. The units used in most modern analysis programs are the kinematic viscosity expressed in centistokes (cs). It can be related to the absolute viscosity, expressed in centipoise (cp) by the oil density. The purpose of the lubrication, ideally, is to separate the moving elements in a bearing by developing a protective film, thereby avoiding metal-to-metal contact at the surface finish asperities.

Lubricants are temperature limited. Mineral oils may be utilized at temperatures not exceeding -40°C to 107°C (-40°F to 225°F).

Synthetic esters and di-esters may be utilized at temperatures not exceeding -54°C to 176°C (-65°F to 350°F).

Degradation of the lubrication film is most affected by oxidation and is accelerated at higher temperatures.

LUBRICATION FILTRATION

To obtain the greatest benefit from the lubrication supplied, it is important that the lubrication system is properly filtered. For oil lubrication in critical applications where speeds are moderate to high, use of a 3 to 5 micron filter is advised. Be aware that a hard particle greater than 2.5 to 7.5 microns (0.0001 to 0.0003 inches) can cause wear, scuffing and other surface distress. When grease is used, it also should be filtered prior to installation, since unfiltered grease may be highly contaminated. Filtering the grease with a 5 micron filter is recommended.

LOW-SPEED APPLICATIONS

Under slow speed or oscillating conditions, bearings no longer depend on fluid film separation, but operate with metal-to-metal contact. Wear is minimized by grease lubricants with high lubricity and extreme pressure additives providing effective "boundary layer" separation. Thin, dry-film coatings may be added to further improve wear resistance.

Standard lubrication

Most aircraft turbine and transmission bearings operate with supplemental replenishment lubricant systems. Therefore, unless otherwise specified, all open bearings with cages are supplied with a preservative coating meeting MIL-PRF-32033. Open bearings with nonmetallic cages are supplied with



a light oil preservative per MIL-PRF-6085. These are non-operating coatings rather than lubricants. They are, however, compatible with most lubricants and generally do not need to be removed prior to mounting.

Sealed bearings are normally lubricated with a controlled quantity of sodium soap grease. This provides excellent channeling characteristics, resulting in minimum torque and heat generation.

Special lubricants

Timken maintains an inventory of oils and greases for use in special applications exposed to extreme conditions of temperature, vacuum, moisture or radiation. Where initial lubrication must last the life of the bearing, grease is preferable to oil (except for instrument-type applications having sensitive torque requirements). The choice of grease is a function of oil and thickener type as well as the additive package to meet many special requirements.

HOW TO SPECIFY

The greases listed with the Timken lubricant code are typical of those frequently specified. The lubricant code should be identified when ordering the bearing. For a more complete list, consult your Timken representative.

Timken Lubrication Code	Brand Name	Manufacturers' Suggested Temp. Range	Comments
LY 263	Aeroshell 22	-65 to +204° C	Non-melting, inorganic thickener with synthetic hydrocarbon oil for excellent fatigue life over wide temperature ranges. General-purpose lubricant, meets MIL-PRF-81322.
		-85 to +400° F	
LY 708	Mobil 28	-65 to +177° C	Organic bentonite clay binder with synthetic hydrocarbon oil. Has EP additives. Meets MIL-PRF-81322.
		-85 to +350° F	
LY 240	Shell Darina E P 2	-30 to +175° C	Similar to LY 270 except uses non-melting, inorganic thickener to enhance high-temperature operation.
		-20 to +350° F	
LY 270	Shell Alvania E P 2	-30 to +149° C	Lithium soap, mineral oil, extreme pressure lubricant. Excellent water resistance for long design life under adverse operating conditions.
		-20 to +300° F	
LG 38	Exxon Andok B	-30 to +110° C	Long design life, sodium soap, mineral oil grease with excellent channeling characteristics for low torque after run in at all speeds. Limited operating temperature range.
		-20 to +225° F	
LY 189	Dupont Krytox 240 AC	-25 to +315° C	Teflon®-type thickener with fluorocarbon oil for maximum high-end temperatures. Chemically inert and insoluble in all fuels and most solvents. Premium price. Meets MIL-PRF-27617.
		-10 to +600° F	

Table 9. Timken lubrication codes.

ULTRA-HIGH-SPEED PERFORMANCE FEATURES

To operate successfully above 2 million dN speeds, specifically engineered designs have been developed through close cooperation between Timken and the bearing user. Lubrication flow pattern is one of the most important factors. Timken has the manufacturing technology to fabricate both ball and roller bearings in VIM-VAR M-50 steel with integral inner raceway lubrication. Two-piece inner ring mainshaft bearings with lubricant directed between the halves, and mainshaft roller bearings with lubrication holes in precision undercuts (adjacent to guide flanges and to the cage pilot surface) efficiently provide lubricant to critical locations. Both wear and fatigue life are improved while less oil is needed, resulting in higher efficiency and less heat generation.

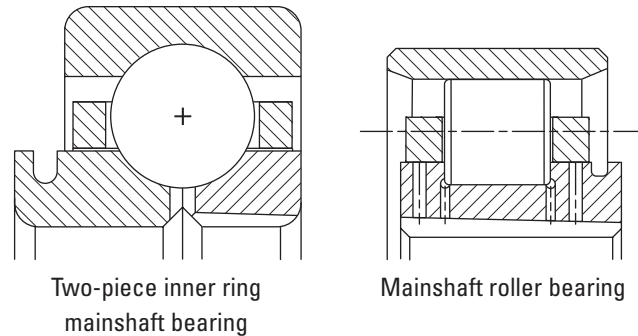


Fig. 17. Ultra-high-speed performance feature examples.

Where the application warrants:

- 1) Ultraprecise rollers can be manufactured by Timken with end squareness as low as 0.0013 mm (0.00005 in.) and corner radius runout as low as 0.0127 mm (0.0005 in.).
- 2) Slight roller end crown, low guide flange angles and reduced clearances can be combined to further improve roller tracking and permit even higher speeds.
- 3) Special roller crowns can be used to allow for greater misalignment.
- 4) The one-piece broached cage can be modified with relieved areas to improve lubrication and reduce wear.

The extensive use of VIM-VAR M-50 steel in many turbine and accessory positions testifies to its value as the preferred material for ultra-high-speed bearings.

In all cases where special designs are required, consult your Timken representative for assistance in selecting the necessary features.

VISCOSITY CONVERSION TABLE

SUS Saybolt	R ^o Redwood	E Engler	cSt Centistokes
sec.	sec.	deg.	mm ² /s
35	32.2	1.18	2.7
40	36.2	1.32	4.3
45	40.6	1.46	5.9
50	44.9	1.60	7.4
55	49.1	1.75	8.9
60	53.5	1.88	10.4
65	57.9	2.02	11.8
70	62.3	2.15	13.1
75	67.6	2.31	14.5
80	71.0	2.42	15.8
85	75.1	2.55	17.0
90	79.6	2.68	18.2
95	84.2	2.81	19.4
100	88.4	2.95	20.6
110	97.1	3.21	23.0
120	105.9	3.49	25.0
130	114.8	3.77	27.5
140	123.6	4.04	29.8
150	132.4	4.32	32.1
160	141.1	4.59	34.3
170	150.0	4.88	36.5
180	158.8	5.15	38.8
190	167.5	5.44	41.0
200	176.4	5.72	43.2
220	194.0	6.28	47.5
240	212	6.85	51.9
260	229	7.38	56.5
280	247	7.95	60.5
300	265	8.51	64.9
325	287	9.24	70.3
350	309	9.95	75.8
375	331	10.7	81.2
400	353	11.4	86.8
425	375	12.1	92.0

SUS Saybolt	R ^o Redwood	E Engler	cSt Centistokes
sec.	sec.	deg.	mm ² /s
450	397	12.8	97.4
475	419	13.5	103
500	441	14.2	108
550	485	15.6	119
600	529	17.0	130
650	573	18.5	141
700	617	19.9	152
750	661	21.3	163
800	705	22.7	173
850	749	24.2	184
900	793	25.6	195
950	837	27.0	206
1000	882	28.4	217
1200	1058	34.1	260
1400	1234	39.8	302
1600	1411	45.5	347
1800	1587	51	390
2000	1763	57	433
2500	2204	71	542
3000	2646	85	650
3500	3087	99	758
4000	3526	114	867
4500	3967	128	974
5000	4408	142	1082
5500	4849	156	1150
6000	5290	170	1300
6500	5730	185	1400
7000	6171	199	1510
7500	6612	213	1630
8000	7053	227	1740
8500	7494	242	1850
9000	7934	256	1960
9500	8375	270	2070
10000	8816	284	2200

To convert from	to	Multiply by	
Acceleration			
foot/second ²	meter/second ²	m/s ²	0.3048
inch/second ²	meter/second ²	m/s ²	0.0254
Area			
foot ²	meter ²	m ²	0.09290304
inch ²	meter ²	m ²	0.00064516
inch ²	millimeter ²	mm ²	645.16
yard ²	meter ²	m ²	0.836127
mile ² (U.S. statute)	meter ²	m ²	2589988
Bending Moment or Torque			
dyne-centimeter	newton-meter	N-m	0.0000001
kilogram-force-meter	newton-meter	N-m	9.806650
pound-force-inch	newton-meter	N-m	0.1129848
pound-force-foot	newton-meter	N-m	1.355818
Energy			
BTU (International Table)	joule	J	1055.056
foot-pound-force	joule	J	1.355818
kilowatt-hour	megajoule	MJ	3.6
Force			
kilogram-force	newton	N	9.806650
kilopound-force	newton	N	9.806650
pound-force (lbf avoirdupois)	newton	N	4.448222
Length			
fathom	meter	m	1.8288
foot	meter	m	0.3048
inch	millimeter	mm	25.4
microinch	micrometer	μm	0.0254
micron (μm)	millimeter	mm	0.0010
mile (U.S. statute)	meter	m	1609.344
yard	meter	m	0.9144
nautical mile (UK)	meter	m	1853.18
Mass			
kilogram-force-second ² /meter			
(mass)	kilogram	kg	9.806650
kilogram-mass	kilogram	kg	1.0
pound-mass (lbm avoirdupois)	kilogram	kg	0.4535924
ton (long, 2240 lbm)	kilogram	kg	1016.047
ton (short, 2000 lbm)	kilogram	kg	907.1847
tonn	kilogram	kg	1000.000

To convert from	to	Multiply by	
Power			
BTU (International Table)/hour	watt	W	0.293071
BTU (International Table)/minute	watt	W	17.58427
horsepower (550 ft lbf/s)	kilowatt	kW	0.745700
BTU (thermochemical)/minute	watt	W	17.57250
Pressure or Stress (Force/Area)			
newton/meter ²	pascal	Pa	1.0000
kilogram-force/centimeter ²	pascal	Pa	98066.50
kilogram-force/meter ²	pascal	Pa	9.806650
kilogram-force/millimeter ²	pascal	Pa	9806650
pound-force/foot ²	pascal	Pa	47.88026
pound-force/inch ² (psi)	megapascal	MPa	0.006894757
Temperature			
degree Celsius	kelvin	k	t _k = t _c + 273.15
degree Fahrenheit	kelvin	k	k = ⁵ ⁄ ₉ (t _f + 459.67)
degree Fahrenheit	Celsius	°C	t _c = ⁵ ⁄ ₉ (t _f - 32)
Velocity			
foot/minute	meter/second	m/s	0.00508
foot/second	meter/second	m/s	0.3048
inch/second	meter/second	m/s	0.0254
kilometer/hour	meter/second	m/s	0.27778
mile/hour (U.S. statute)	meter/second	m/s	0.44704
mile/hour (U.S. statute)	kilometer/hour	km/h	1.609344
Volume			
foot ³	meter ³	m ³	0.02831685
gallon (U.S. liquid)	liter	l	3.785412
liter	meter ³	m ³	0.001
inch ³	meter ³	m ³	0.00001638706
inch ³	centimeter ³	cm ³	16.38706
inch ³	millimeter ³	mm ³	16387.06
ounce (U.S. fluid)	centimeter ³	cm ³	29.57353
yard ³	meter ³	m ³	0.7645549

Алматы (7273)495-231
Ангарск (3955)60-70-56
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Ставрополь (8652)20-65-13
Сургут (3462)77-98-35
Сыктывкар (8212)25-95-17
Тамбов (4752)50-40-97
Тверь (4822)63-31-35

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