TIMKEN

TIMKEN® TAPERED ROLLER BEARING CATALOG

ABOUT THE TIMKEN COMPANY

The leading authority on tapered roller bearings, Timken today applies its deep knowledge of metallurgy, tribology and mechanical power transmission across a variety of bearings and related systems to improve reliability and efficiency of machinery and equipment all around the world. Timken (NYSE: TKR; www.timken.com) engineers, manufactures and markets bearings, gear drives, belts, chain and related products, and offers a spectrum of powertrain rebuild and repair services.

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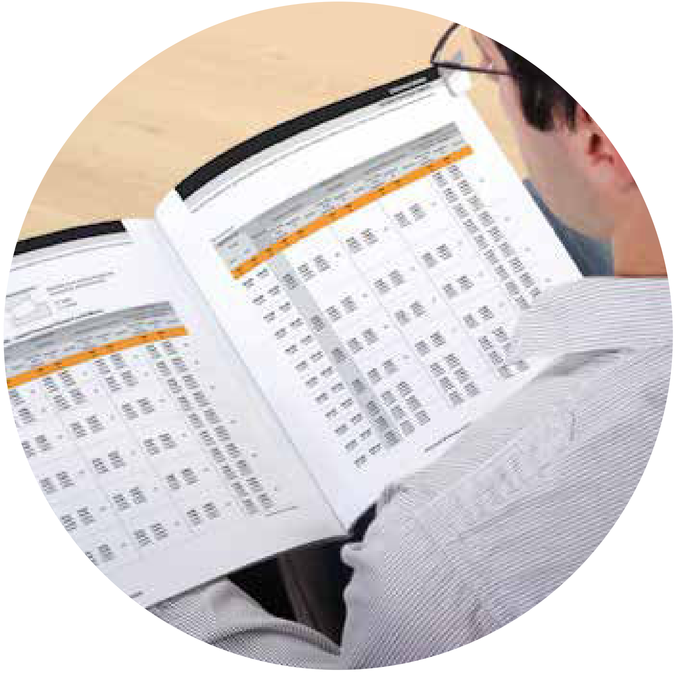
TAPERED ROLLER BEARING CATALOG INDEX

TIMKEN® TAPERED ROLLER BEARINGS - RELIABILITY, VERSATILITY, CHOICE

Demanding applications call for reliable solutions. Improve your equipment's performance and reduce your downtime and maintenance costs by turning to Timken tapered roller bearings. When you purchase a Timken bearing, you're investing in a product that's designed with you in mind.



Reliability. Expert craftsmanship, well-equipped production facilities and an ongoing investment in technology ensure our products are synonymous with quality and reliability. Our tapered roller bearings stand up to extreme situations, including high-corrosive, high-temperature, vacuum or low-lubrication environments.

Versatility. Use Timken tapered roller bearings to help your equipment excel when it faces combined radial and thrust loads. Our bearings are uniquely designed to manage both types of loads on rotating shafts and in housings.

Choice. From single- to double- to four-row configurations to thrust, choose from nearly 26,000 product combinations to find the right bearing for your application.

DESIGN FEATURES

Each tapered roller bearing contains four interdependent components: the cone (inner ring), the cup (outer ring), tapered rollers (rolling elements) and the cage (roller retainer).

Tapered angles allow our bearings to efficiently control a combination of radial and thrust loads. The steeper the outer ring angle, the greater ability the bearing has to handle thrust loads. To provide a true rolling motion of the rollers on the raceways, the extensions of the raceways and the tapered surfaces of the rollers come together at a common point, the apex, on the axis of rotation.

HOW TO USE THIS CATALOG

We designed this catalog to help you find the Timken bearings best suited to your equipment needs and specifications.

The product tables list many of the bearing types that are specifically used in thrust positions. For other bearing types, please refer to the respective Timken product catalog reference.

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 engineer to learn more about our complete line for the special needs of your application.

This publication contains dimensions, tolerances and load ratings, as well as engineering sections describing mounting and fitting practices for shafts and housings, internal clearances, materials and other bearing features. It provides valuable assistance in the initial consideration of the type and characteristics of the bearings that may best suit your particular needs.

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.

SHELF LIFE AND STORAGE OF GREASE-LUBRICATED BEARINGS AND COMPONENTS

To help you get the most value from our products, Timken provides guidelines for the shelf life of grease-lubricated ball and roller bearings, components and assemblies. Shelf life information is based on Timken and industry test data and experience.

SHELF LIFE

Shelf life should be distinguished from lubricated bearing/component design life as follows:

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.

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

European REACH compliance

Timken lubricants, greases and similar products sold in standalone containers or delivery systems are subject to the European REACH (Registration, Evaluation, Authorization and Restriction of CHemicals) directive. For import into the European Union, Timken can sell and provide only those lubricants and greases that are registered with ECHA (European CHemical Agency). For further information, please contact your Timken engineer.

STORAGE

Timken suggests the following storage guidelines for our finished products (bearings, components and assemblies, 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.
- 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 and the surfaces should be dry.
- 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.

Due to the fact that Timken is not familiar with your particular storage conditions, we strongly suggest following these guidelines. However, you may be required by circumstances or applicable government requirements to adhere to stricter storage requirements.

Most bearing components typically ship protected with a corrosion-preventive compound that is not a lubricant. These components may be used in oil-lubricated applications without removal of the corrosion-preventive compound. When using some specialized grease lubrications, we advise you to remove the corrosion-preventive compound before packing the bearing components with suitable grease.

Be careful in selecting lubrication, however, since different lubricants are often incompatible.

When you receive a bearing shipment, do not remove products from their packaging until they are ready for mounting so they do not become corroded or contaminated.

Store bearings and bearing housings in an appropriate atmosphere so they remain protected for the intended period.

⚠ WARNING
Failure to observe the following warnings could create a risk of death or serious injury.

Never spin a bearing with compressed air.
The components may be forcefully expelled.

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

Warnings for this product line are in this catalog and posted on http://www.timken.com/en-us/products/warnings/Pages/default.aspx

This information is not intended to substitute for the specific recommendations of your equipment suppliers.

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

DISCLAIMER

This catalog is provided solely to give you analysis tools and data to assist you in your product selection. Product performance is affected by many factors beyond the control of Timken. Therefore, you must validate the suitability and feasibility of all product selections.

Timken products are sold subject to Timken terms and conditions of sale, which include our limited warranty and remedy. You can find these at http://www.timken.com/en-us/purchase/Pages/TermsandConditionsofSale.aspx.

Please consult with your Timken engineer for more information and assistance. Every reasonable effort has been made to ensure the accuracy of the information in this writing, but no liability is accepted for errors, omissions or for any other reason.

ENGINEERING

The following topics are covered within this engineering section:

- Tapered roller bearing design types.
- Cage design types.
- Fitting practice and mounting recommendations.
- Lubrication recommendations.

This engineering section is not intended to be comprehensive, but does serve as a useful guide in tapered roller bearing selection.

To view the complete engineering catalog, please visit www.timken.com. To order the catalog, please contact your Timken engineer and request a copy of the Timken Engineering Manual, order number 10424.

To view more Timken catalogs, go to www.timken.com/catalogs for interactive versions, or to download a catalog app for your smart phone or mobile device scan the QR code or go to timkencatalogs.squawqr.com.

TAPERED ROLLER BEARINGS TYPES AND CAGES

SINGLE-ROW BEARINGS

TS - SINGLE-ROW

This is the basic and the most widely used type of tapered roller bearing. It consists of the inner-ring assembly and the outer ring. It is usually fitted as one of an opposing pair. During equipment assembly, single-row bearings can be “set” to the required clearance (endplay) or preload condition to optimize performance.

Fig. 1. Single-row TS bearing.

TSF - SINGLE-ROW, WITH FLANGED OUTER RING

The TSF type is a variation on the basic single-row bearing. TSF bearings have a flanged outer ring to facilitate axial location and accurately aligned seats in a through-bored housing.

Fig. 2. Single-row TSF bearing with flanged outer ring.

DOUBLE-ROW BEARINGS

TDO - DOUBLE OUTER RING

This has a one-piece (double) outer ring and two single inner rings. It is usually supplied complete with an inner-ring spacer as a pre-set assembly. This configuration gives a wide effective bearing spread and is frequently chosen for applications where overturning moments are a significant load component. TDO bearings can be used in fixed (locating) positions or allowed to float in the housing bore, for example, to compensate for shaft expansion. TDOCD outer rings also are available in most sizes. These outer rings have holes in the O.D. that permit the use of pins to prevent outer ring rotation in the housing.

Fig. 3. Double-row TDO bearing.

TDI - DOUBLE INNER RING

TDIT - DOUBLE INNER RING WITH TAPERED BORE

Both comprise a one-piece (double) inner ring and two single outer rings. They are usually supplied complete with an outer-ring spacer as a pre-set assembly. TDI and TDIT bearings can be used at fixed (locating) positions on rotating shaft applications. For rotating housing applications, the double inner ring of type TDI can be used to float on the stationary shaft. Type TDIT has a tapered bore to facilitate removal when an interference fit is essential, yet regular removal is required.

TDI **TDIT**

Fig. 4. Double-row, double-inner-ring bearings.

TNA - NON-ADJUSTABLE

TNASW - NON-ADJUSTABLE WITH LUBRICANT SLOTS

TNASWE - NON-ADJUSTABLE WITH LUBRICANT SLOTS AND EXTENDED BACK FACE RIB

These three bearing types are similar to the TDO with a one-piece (double) outer ring and two single inner rings. The inner-ring front faces are extended so they abut, eliminating the need for a separate inner-ring spacer. Supplied with a built-in clearance to give a standard setting range, these bearings provide a solution for many fixed or floating bearing applications where optimum simplicity of assembly is required.

Types TNASW and TNASWE are variations having chamfers and slots on the front face of the inner ring to provide lubrication through the shaft. Type TNASWE have extended back face ribs on the inner rings which are ground on the O.D. to allow for the use of a seal or stamped closure. These designs are typically used on stationary shaft applications.

Fig. 5. Double-row, non-adjustable bearings.

SPACER ASSEMBLIES

Any two single-row bearings (type TS) can be supplied as a double-row, pre-set, ready-to-fit assembly by the addition of spacers, machined to pre-determined dimensions and tolerances.

Spacer assemblies are provided in two types: "2S" and "SR". This concept can be applied to produce custom-made double-row bearings to suit specific applications. In addition to providing a bearing that automatically gives a pre-determined setting at assembly without the need for a manual setting, it is possible to modify the assembly width to suit an application, simply by varying the spacer widths.

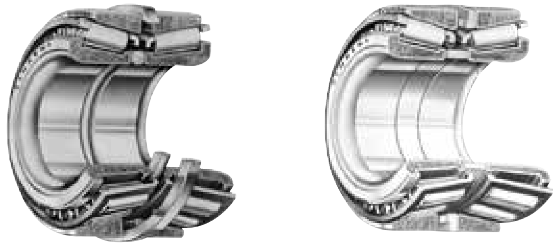


Fig. 6. Spacer assemblies.

2S - TWO SINGLE-ROW ASSEMBLY

Often referred to as snap-ring assemblies, type 2S consist of two basic single-row bearings (type TS). They are supplied complete with inner-ring and outer-ring spacers to give a pre-determined bearing setting when assembled. Type 2S have a specified setting range to suit the duty of the application. They have an inner-ring spacer and a snap-ring, which also serves as the outer-ring spacer, to give axial location in a through-bored housing.

SR - SET-RIGHT™ ASSEMBLY

Type SR are made to a standard setting range, based on Timken's SET-RIGHT™ automated setting technique suitable for most industrial applications. They have two spacers and an optional snap-ring that may be used for axial location. Because both types are made up of popular sizes of single-row bearings, they provide a low-cost option for many applications.

There are two basic mounting arrangements for spacer assemblies.

- **Type 2TS-IM (indirect mounting)**
  These consist of two single-row bearings with an inner-ring and outer-ring spacer. In some applications, the outer-ring spacer is replaced by a shoulder in the bearing housing.
- **Type 2TS-DM (direct mounting)**
  These consist of two single-row bearings, with inner rings abutting and an outer-ring spacer. They are generally used at fixed (locating) positions on rotating shaft applications.

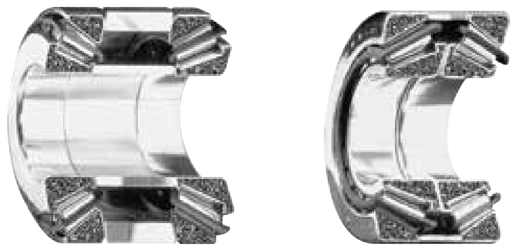


Fig. 7. Basic spacer assemblies.

TAPERED ROLLER BEARING CAGES

STAMPED-STEEL CAGES

The most common type of cage used for tapered roller bearings is the stamped-steel cage. These cages are mass produced from low-carbon sheet steel using a series of cutting, forming and punching operations. These cages can be used in high temperature and harsh lubricant environments.

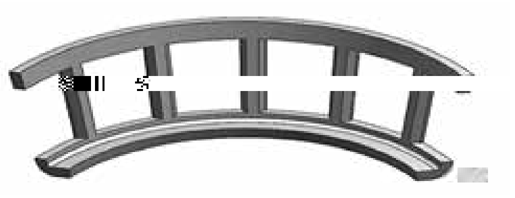


Fig. 8. Stamped-steel cage.

POLYMER CAGES

Cages for tapered roller bearings made of polymer material are used primarily for pre-greased and sealed package designs. The most common polymer materials used are Nylon thermoplastics with glass reinforcement. Polymer cages can be mass produced in large quantities and offer more design flexibility than stamped-steel types. Polymer cages are lightweight and easy to assemble. In some instances, increased bearing rating can be achieved by allowing one or two extra rollers in the bearing complement. Care should be exercised when using aggressive lubricants with EP (extreme-pressure) additives in combination with elevated temperatures greater than 107° C (225° F).

MACHINED CAGES

Machined cages for tapered roller bearings are robust in design and are suited for high-speed and high-load applications. Machined cages use alloy steels and are produced through milling and broaching operations. Assembly does not require a close-in operation and rollers can be retained using nibs or staking. Oil holes also can be easily added for extra lubrication for demanding applications. Some designs are silver plated for special applications.

PIN-TYPE CAGES

Tapered roller bearing pin-type cages retain the rolling elements by the use of a pin located through an axial hole in the center of the roller. Pin-type cages for tapered roller bearings consist of two rings with roller pins attached by screw threads at one end and welding at the other end. These types of cages are primarily used for larger tapered roller bearing designs (greater than 400 mm [15.7480 in.] O.D.). Pin-type cages are machined out of steel and typically allow for an increased number of rolling elements. Pin-type cages are restricted to low-speed applications (less than 20 m/sec [4000 ft/min] rib speed).

METRIC SYSTEM TOLERANCES

Tapered bearings are manufactured to a number of specifications with each having classes that define tolerances on dimensions such as bore, O.D., width and runout. Metric bearings have been manufactured to corresponding standard negative tolerances.

Boundary dimension tolerances for tapered roller bearing usage are listed in the following tables. These tolerances are provided for use in selecting bearings for general applications in conjunction with the bearing mounting and fitting practices offered in later sections.

The following table summarizes the different specifications and classes for tapered roller bearings.

TABLE 1. BEARING SPECIFICATIONS AND CLASSES

System	Specification	Bearing Type	Standard Bearing Class		Precision Bearing Class			
Metric	Timken	Tapered Roller Bearings	K	N	C	B	A	AA
	ISO/DIN	All Bearing Types	P0	P6	P5	P4	P2	-
	ABMA	Tapered Roller Bearings	K	N	C	B	A	-
Inch	Timken	Tapered Roller Bearings	4	2	3	0	00	000
	ABMA	Tapered Roller Bearings	4	2	3	0	00	-

DETERMINATION OF APPLIED LOADS AND BEARING ANALYSIS

SUMMARY OF SYMBOLS USED TO DETERMINE APPLIED LOADS AND BEARING ANALYSIS

Symbol	Description	Units (Metric/Inch System)
a	Axial Distance from Inner Ring Backface to Effective Load Center	mm, in.
a_1	Reliability Life Factor	unitless
a_2	Material Life Factor	unitless
a_3	Operating Condition Life Factor	unitless
a_{3d}	Debris Life Factor	unitless
a_{3k}	Load Zone Life Factor	unitless
a_{3l}	Lubrication Life Factor	unitless
a_{3p}	Low-Load Life Factor	unitless
a_e	Effective Bearing Spread	mm, in.
A, B, …	Bearing Position (used as subscripts)	unitless
B	Outer Ring Width	mm, in.
B_1	Inner Ring Width	mm, in.
b	Tooth Length	mm, in.
c_1, c_2	Linear Distance (positive or negative).	mm, in.
C	Basic Dynamic Radial Load Rating of a Double-Row Bearing for an L_{10} of One Million Revolutions	N, lbf
C_{a90}	Basic Dynamic Thrust Load Rating of a Single-Row Bearing for an L_{10} of 90 Million Revolutions or 3000 Hours at 500 RPM	N, lbf
C_o	Basic Static Radial Load Rating	N, lbf
C_{oa}	Basic Static Axial Load Rating	N, lbf
C_{90}	Basic Dynamic Radial Load Rating of a Single-Row Bearing for an L_{10} of 90 Million Revolutions	N, lbf
$C_{90(2)}$	Basic Dynamic Radial Load Rating of a Double-Row Bearing for an L_{10} of 90 Million Revolutions	N, lbf
C_a	Basic Dynamic Axial Load Rating	N, lbf
C_g	Geometry Factor (used in a_{3l} equation)	unitless
C_l	Load Factor (used in a_{3l} equation)	unitless
C_j	Load Zone Factor (used in a_{3l} equation)	unitless
C_s	Speed Factor (used in a_{3l} equation)	unitless
C_v	Viscosity Factor (used in a_{3l} equation)	unitless
C_{gr}	Grease Lubrication Factor (used in a_{3l} equation)	unitless
Cp	Specific Heat of Lubricant	J/(Kg - °C), BTU/(lbf - °F)
C_t	Basic Thrust Dynamic Load Rating	N, lbf
d	Bearing Bore Diameter	mm, in.
d	Ball Diameter	mm, in.
d_1	Spherical Diameter	mm, in.
d_a	Shaft Shoulder Diameter	mm, in.
d_0	Mean Inner Ring Diameter	mm, in.
dc	Distance Between Gear Centers	mm, in.
dm	Mean Bearing Diameter	mm, in.
d_{si}	Shaft Inside Diameter	mm, in.
D	Bearing Outside Diameter	mm, in.
D_0	Tapered Roller Bearing Outer Ring Mean Raceway Diameter	mm, in.
Dh	Housing Outside Diameter	mm, in.
Dm	Mean Diameter or Effective Working Diameter of a Sprocket, Pulley, Wheel or Tire	mm, in.
Dm	Tapered Roller Mean Large Rib Diameter	mm, in.
Dm_G	Mean or Effective Working Diameter of the Gear	mm, in.
Dm_P	Effective Working Diameter of the Pinion	mm, in.
Dm_W	Effective Working Diameter of the Worm	mm, in.
Dp_G	Pitch Diameter of the Gear	mm, in.
Dp_P	Pitch Diameter of the Pinion	mm, in.
Dp_W	Pitch Diameter of the Worm	mm, in.
e	Life Exponent	unitless
e	Limiting Value of F_a/F_r for the Applicability of Different Values of Factors X and Y	unitless
E	Free Endplay	mm, in.
f	Lubricant Flow Rate	L/min, U.S. pt/min
f_0	Viscous Dependent Torque Coefficient	unitless
f_1	Load Dependent Torque Coefficient	unitless
f_b	Belt or Chain Pull	N, lbf
f_n	Speed Factor	unitless
f_2	Combined Load Factor	unitless
f_3	Combined Load Factor	unitless
F	General Term for Force	N, lbf
F_1, F_2, …, F_n	Magnitudes of Applied Force During a Loading Cycle	N, lbf
F_a	Applied Thrust (Axial) Load	N, lbf
F_{ai}	Induced Thrust (Axial) Load Due to Radial Loading	N, lbf
F_{ac}	Induced Thrust (Axial) Load Due to Centrifugal Loading	N, lbf
F_{aG}	Thrust Force on Gear	N, lbf
F_{aP}	Thrust Force on Pinion	N, lbf
F_{aW}	Thrust Force on Worm	N, lbf
F_{az}	Allowable Axial Load	N, lbf
F_b	Belt or Chain Pull	N, lbf
F_β	Load Term for Torque Equation	N, lbf
Fc	Centrifugal Force	N, lbf
F_r	Applied Radial Load	N, lbf
F_{rh}	Resultant Horizontal Force	N, lbf
F_{RS}	Resultant Separating Force	N, lbf
F_{RV}	Resultant Vertical Force	N, lbf
F_S	Separating Force on Gear	N, lbf
F_{SG}	Separating Force on Gear	N, lbf
F_{SP}	Separating Force on Pinion	N, lbf
F_{SW}	Separating Force on Worm	N, lbf
F_t	Tangential Force	N, lbf
F_{te}	Tractive Effort on Vehicle Wheels	N, lbf
F_{tG}	Tangential Force on Gear	N, lbf
F_{tP}	Tangential Force on Pinion	N, lbf
F_{tW}	Tangential Force on Worm	N, lbf
F_W	Force of Unbalance	N, lbf
F_{WB}	Weighted Average Load	N, lbf
G	Gear (used as subscript)	unitless
G_1	Geometry Factor from Bearing Data Tables	unitless
G_2	Geometry Factor from Bearing Data Tables	unitless
H	Power	kW, hp
H_s	Housing Shoulder Inner Diameter	mm, in.
HFs	Static Load Rating Adjustment Factor for Raceway Hardness	unitless
i	Number of Rows of Rollers in a Bearing	unitless

Symbol	Description	Units (Metric/Inch System)
i_B	Number of Bearing Rows Taking Load	unitless
k	Centrifugal Force Constant	lbf/RPM^2
k_1	Bearing Torque Constant	unitless
k_4, k_5, k_6	Dimensional Factor to Calculate Heat Generation	unitless
K	Tapered Roller Bearing K-factor; ratio of basic dynamic radial load rating to basic dynamic thrust rating in a single-row bearing	unitless
K	Ball Bearing Constant Based on Geometry	
K_1, K_2	Super Precision K-Factors	unitless
K_{ea}	Radial Runout of Outer Ring Assembly	mm, in.
K_o	Outer Ring Contour Radius Expressed as a Decimal Fraction of the Ball Diameter	decimal fraction
K_i	Inner Ring Contour Radius Expressed as a Decimal Fraction of the Ball Diameter	decimal fraction
Kia	Radial Runout of Inner Ring Assembly	mm, in.
K_N	K-factor for Bearing #n	unitless
K_T	Relative Thrust Load Factor – Ball Bearings	unitless
L_H	Lead – Axial Advance of a Helix for One Complete Revolution	mm, in.
L	Distance Between Bearing Geometric Center Lines	mm, in.
L_{10}	Bearing Life	revolutions or hours
L_f	Life Factor	unitless
m	Gearing Ratio	unitless
M	Bearing Operating Torque	N-m, N-mm, lb.-in.
M_0	Moment	N-m, N-mm, lb.-in.
n	Bearing Operating Speed or General Term for Speed	rot/min, RPM
$n_1, n_2, \ldots, n_n$	Rotation Speeds During a Loading Cycle	rot/min, RPM
N_A	Reference Speed	rot/min, RPM
n_G	Gear Operating Speed	rot/min, RPM
n_P	Pinion Operating Speed	rot/min, RPM
n_W	Worm Operating Speed	rot/min, RPM
N_c	Number of Rotations of the Ball and Cage Assembly	unitless
N_i	Number of Rotations of the Inner Ring	unitless
N_G	Number of Teeth in the Gear	unitless
N_P	Number of Teeth in the Pinion	unitless
N_S	Number of Teeth in the Sprocket	unitless
N_f	Speed Factor	unitless
P	Pinion (used as subscript)	unitless
P_o	Static Equivalent Load	N, lbf
P_{oa}	Static Equivalent Thrust (Axial)	N, lbf
P_{or}	Static Equivalent Radial Load	N, lbf
P_a	Dynamic Equivalent Axial Load	N, lbf
P_r	Dynamic Equivalent Radial Load	N, lbf
P_{eq}	Equivalent Dynamic Load	N, lbf
Q	Generated Heat or Heat Dissipation Rate	W, BTU/min
Q_{gen}	Generated Heat	W, BTU/min
Q_{oil}	Heat Dissipated by a Circulating Oil System	W, BTU/min
r	Radius to Center of Mass	mm, in.
R	Percent Reliability, Used in the Calculation of the a_1 Factor	unitless
RIC	Radial Internal Clearance	mm, in.

Symbol	Description	Units (Metric/Inch System)
S	Shaft Diameter	mm, in.
s	Shaft (used as subscript)	unitless
S_d	Inner Ring Reference Face Runout	mm, in.
S_D	Outside Cylindrical Surface Runout	mm, in.
S_{ea}	Axial Runout of Outer Ring Assembly	mm, in.
S_{ia}	Axial Runout of Inner Ring Assembly	mm, in.
$t_1, t_2, \ldots, t_N$	Fractions of Time During a Loading Cycle	unitless
T	Applied Thrust (Axial) Load	N, lbf
T_E	Equivalent Thrust Load	N, lbf
v	Vertical (used as subscript)	unitless
V	Linear Velocity or Speed	km/h, mph
V_{BS}	Inner Ring Width Variation	mm, in.
V_{CS}	Outer Ring Width Variation	mm, in.
Vr	Rubbing, Surface or Tapered Roller Bearing Rib Velocity	m/s, fpm
W	Worm (used as subscript)	unitless
X	Dynamic Radial Load Factor	unitless
X_0	Static Radial Load Factor	unitless
Y, Y_1, Y_2, ...	Dynamic Thrust (Axial) Load Factor	unitless
Y_0	Static Thrust (Axial) Load Factor	unitless
Z	Number of Rolling Elements	unitless
α_T	Coefficient of Linear Expansion	mm/mm/°C, in./in./°F
α_o	Tapered Roller Bearing Half Included Outer Ring Raceway Angle	deg.
α	Ball Bearing Nominal Contact Angle	deg.
ΔT	Temperature Difference Between Shaft/Inner Ring/Rollers and Housing/Outer Ring	°C, °F
Δ_{Bs}	Inner Ring Width Deviation	mm, in.
Δ_{Cs}	Outer Ring Width Deviation	mm, in.
Δ_{dmp}	Deviation of Mean Bore Diameter in a Single Plane	mm, in.
Δ_{Dmp}	Deviation of Mean Outside Diameter in a Single Plane	mm, in.
δs	Interference Fit of Inner Ring on Shaft	mm, in.
δh	Interference Fit of Outer Ring in Housing	mm, in.
η	Efficiency, Decimal Fraction	
θ_1, θ_2, θ_3	Gear Mesh Angles Relative to the Reference Plane	deg., rad
θi, θo	Oil Inlet or Outlet Temperature	°C, °F
λ	Worm Gear Lead Angle	deg.
μ	Coefficient of Friction	unitless
μ	Lubricant Dynamic Viscosity	cP
v	Lubricant Kinematic Viscosity	cSt
σ_o	Approximate Maximum Contact Stress	MPa, psi
Φ_G	Normal Tooth Pressure Angle for the Gear	deg.
Φ_P	Normal Tooth Pressure Angle for the Pinion	deg.
Ψ_G	Helix (Helical) or Spiral Angle for the Gear	deg.
Ψ_P	Helix (Helical) or Spiral Angle for the Pinion	deg.
ρ	Lubricant Density	kg/m^3, lb./ft^3
Υ_G	Bevel Gearing – Gear Pitch Angle	deg.
	Hypoid Gearing – Gear Root Angle	deg.
Υ_P	Bevel Gearing – Pinion Pitch Angle	deg.
	Hypoid Gearing – Pinion Face Angle	deg.

METRIC SYSTEM BEARINGS (ISO AND J PREFIX PARTS)

Timken manufactures metric system bearings to six tolerance classes. Classes K and N are often referred to as standard classes. Class N has more closely controlled width tolerances than K. Classes C, B, A and AA are precision classes. These tolerances lie within those currently specified in ISO 492 with the exception of a small number of dimensions indicated in the tables. The differences normally have an insignificant effect on the mounting and performance of tapered roller bearings.

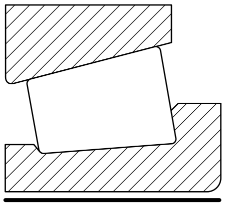


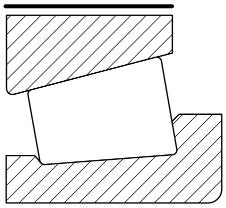
TABLE 2. TAPERED ROLLER BEARING TOLERANCES – INNER RING BORE (Metric)

Bearing Types	Bore		Standard Bearing Class				Precision Bearing Class							
			K		N		C		B		A		AA	
	Over	Incl.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	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.
	10.000 0.3937	**18.000** 0.7087	**0.000** 0.0000	**-0.012** -0.00047	**0.000** 0.0000	**-0.012** -0.00047	**0.000** 0.0000	**-0.007** -0.0002	**0.000** 0.0000	**-0.005** -0.0001	**0.000** 0.0000	**-0.005** -0.0001	**0.000** 0.0000	**-0.005** -0.0001
	18.000 0.7087	**30.000** 1.1811	**0.000** 0.0000	**-0.012** -0.0005	**0.000** 0.0000	**-0.012** -0.0005	**0.000** 0.0000	**-0.008** -0.0003	**0.000** 0.0000	**-0.006** -0.0002	**0.000** 0.0000	**-0.006** -0.0002	**0.000** 0.0000	**-0.006** -0.0002
	30.000 1.1811	**50.000** 1.9685	**0.000** 0.0000	**-0.012** -0.0005	**0.000** 0.0000	**-0.012** -0.0005	**0.000** 0.0000	**-0.010** -0.0004	**0.000** 0.0000	**-0.008** -0.0003	**0.000** 0.0000	**-0.008** -0.0003	**0.000** 0.0000	**-0.008** -0.0003
	50.000 1.9685	**80.000** 3.1496	**0.000** 0.0000	**-0.015** -0.0006	**0.000** 0.0000	**-0.015** -0.0006	**0.000** 0.0000	**-0.012** -0.0005	**0.000** 0.0000	**-0.009** -0.0004	**0.000** 0.0000	**-0.008** -0.0003	**0.000** 0.0000	**-0.008** -0.0003
	80.000 3.1496	**120.000** 4.7244	**0.000** 0.0000	**-0.020** -0.00079	**0.000** 0.0000	**-0.020** -0.00079	**0.000** 0.0000	**-0.015** -0.0006	**0.000** 0.0000	**-0.010** -0.0004	**0.000** 0.0000	**-0.008** -0.0003	**0.000** 0.0000	**-0.008** -0.0003
	120.000 4.7244	**180.000** 7.0886	**0.000** 0.0000	**-0.025** -0.00098	**0.000** 0.0000	**-0.025** -0.00098	**0.000** 0.0000	**-0.018** -0.0007	**0.000** 0.0000	**-0.013** -0.0005	**0.000** 0.0000	**-0.008** -0.0003	**0.000** 0.0000	**-0.008** -0.0003
	180.000 7.0866	**250.000** 9.8425	**0.000** 0.0000	**-0.030** -0.0012	**0.000** 0.0000	**-0.030** -0.0012	**0.000** 0.0000	**-0.022** -0.0009	**0.000** 0.0000	**-0.015** -0.0006	**0.000** 0.0000	**-0.008** -0.0003	**0.000** 0.0000	**-0.008** -0.0003
	250.000 9.8425	**265.000** 10.4331	**0.000** 0.0000	**-0.035** -0.0014	**0.000** 0.0000	**-0.035** -0.0014	**0.000** 0.0000	**-0.022** -0.0009	**0.000** 0.0000	**-0.015** -0.0006	**0.000** 0.0000	**-0.008** -0.0003	**0.000** 0.0000	**-0.008** -0.0003
TS TSF SR[1]	**265.000** 10.4331	**315.000** 12.4016	**0.000** 0.0000	**-0.035** -0.0014	**0.000** 0.0000	**-0.035** -0.0014	**0.000** 0.0000	**-0.022** -0.0009	**0.000** 0.0000	**-0.015** -0.0006	**0.000** 0.0000	**-0.008** -0.0003	**0.000** 0.0000	**-0.008** -0.0003
	315.000 12.4016	**400.000** 15.7480	**0.000** 0.0000	**-0.040** -0.0016	**0.000** 0.0000	**-0.040** -0.0016	**0.000** 0.0000	**-0.025** -0.0010	– –	– –	– –	– –	– –	– –
	400.000 15.7480	**500.000** 19.6850	**0.000** 0.0000	**-0.045** -0.0018	**0.000** 0.0000	**-0.045** -0.0018	**0.000** 0.0000	**-0.025** -0.0010	– –	– –	– –	– –	– –	– –
	500.000 19.6850	**630.000** 24.8031	**0.000** 0.0000	**-0.050** -0.0020	**0.000** 0.0000	**-0.050** -0.0020	**0.000** 0.0000	**-0.030** -0.0012	– –	– –	– –	– –	– –	– –
	630.000 24.8031	**800.000** 31.4961	**0.000** 0.0000	**-0.080** -0.0031	– –	– –	**0.000** 0.0000	**-0.040** -0.0014	– –	– –	– –	– –	– –	– –
	800.000 31.4961	**1000.000** 39.3701	**0.000** 0.0000	**-0.100** -0.0040	– –	– –	**0.000** 0.0000	**-0.050** -0.0020	– –	– –	– –	– –	– –	– –
	1000.000 39.3701	**1200.000** 47.2441	**0.000** 0.0000	**-0.130** -0.0051	– –	– –	**0.000** 0.0000	**-0.060** -0.0024	– –	– –	– –	– –	– –	– –
	1200.000 47.2441	**1600.000** 62.9921	**0.000** 0.0000	**-0.150** -0.0065	– –	– –	**0.000** 0.0000	**-0.080** -0.0031	– –	– –	– –	– –	– –	– –
	1600.000 62.9921	**2000.000** 78.7402	**0.000** 0.0000	**-0.200** -0.0079	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –
	2000.000 78.7402	– –	**0.000** 0.0000	**-0.250** -0.0098	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –

[1]SR assemblies are manufactured to tolerance class N only.

TABLE 3. TAPERED ROLLER BEARING TOLERANCES – OUTER RING OUTSIDE DIAMETER (Metric)

Bearing Type	O.D.		Standard Bearing Class				Precision Bearing Class							
			K		N		C		B		A		AA	
	Over	Incl.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	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.
TS TSF SR[(1)]	**10.000** 0.3937	**18.000** 0.7087	**0.000** 0.0000	- -	- -		- -	- -	- -	- -	**0.000** 0.0000	**-0.008** -0.0003	**0.000** 0.0000	**-0.008** -0.0003
	18.000 0.7087	**30.000** 1.1811	**0.000** 0.0000	**-0.012** -0.00047	**0.000** 0.0000	**-0.012** -0.00047	**0.000** 0.0000	**-0.008** -0.0003	**0.000** 0.0000	**-0.0006** -0.0002	**0.000** 0.0000	**-0.008** -0.0003	**0.000** 0.0000	**-0.008** -0.0003
	30.000 1.1811	**50.000** 1.9685	**0.000** 0.0000	**-0.014** -0.0005	**0.000** 0.0000	**-0.014** -0.0005	**0.000** 0.0000	**-0.009** -0.0004	**0.000** 0.0000	**-0.007** -0.0003	**0.000** 0.0000	**-0.008** -0.0003	**0.000** 0.0000	**-0.008** -0.0003
	50.000 1.9685	**80.000** 3.1496	**0.000** 0.0000	**-0.016** -0.0006	**0.000** 0.0000	**-0.016** -0.0006	**0.000** 0.0000	**-0.011** -0.0004	**0.000** 0.0000	**-0.009** -0.0004	**0.000** 0.0000	**-0.008** -0.0003	**0.000** 0.0000	**-0.008** -0.0003
	80.000 3.1496	**120.000** 4.7244	**0.000** 0.0000	**-0.018** -0.0007	**0.000** 0.0000	**-0.018** -0.0007	**0.000** 0.0000	**-0.013** -0.0005	**0.000** 0.0000	**-0.010** -0.0004	**0.000** 0.0000	**-0.008** -0.0003	**0.000** 0.0000	**-0.008** -0.0003
	120.000 4.7244	**150.000** 5.9055	**0.000** 0.0000	**-0.020** -0.00079	**0.000** 0.0000	**-0.020** -0.00079	**0.000** 0.0000	**-0.015** -0.0006	**0.000** 0.0000	**-0.011** -0.0004	**0.000** 0.0000	**-0.008** -0.0003	**0.000** 0.0000	**-0.008** -0.0003
	150.000 5.9055	**180.000** 7.0866	**0.000** 0.0000	**-0.025** -0.00098	**0.000** 0.0000	**-0.025** -0.00098	**0.000** 0.0000	**-0.018** -0.0007	**0.000** 0.0000	**-0.013** -0.0005	**0.000** 0.0000	**-0.008** -0.0003	**0.000** 0.0000	**-0.008** -0.0003
	180.000 7.0866	**250.000** 9.8425	**0.000** 0.0000	**-0.030** -0.0012	**0.000** 0.0000	**-0.030** -0.0012	**0.000** 0.0000	**-0.020** -0.0008	**0.000** 0.0000	**-0.015** -0.0006	**0.000** 0.0000	**-0.008** -0.0003	**0.000** 0.0000	**-0.008** -0.0003
	250.000 9.8425	**265.000** 10.4331	**0.000** 0.0000	**-0.035** -0.0014	**0.000** 0.0000	**-0.035** -0.0014	**0.000** 0.0000	**-0.025** -0.0010	**0.000** 0.0000	**-0.018** -0.0007	**0.000** 0.0000	**-0.008** -0.0003	**0.000** 0.0000	**-0.008** -0.0003
	265.000 10.4331	**315.000** 12.4016	**0.000** 0.0000	**-0.035** -0.0014	**0.000** 0.0000	**-0.035** -0.0014	**0.000** 0.0000	**-0.025** -0.0010	**0.000** 0.0000	**-0.018** -0.0007	**0.000** 0.0000	**-0.008** -0.0003	**0.000** 0.0000	**-0.008** -0.0003
	315.000 12.4016	**400.000** 15.7480	**0.000** 0.0000	**-0.040** -0.0016	**0.000** 0.0000	**-0.040** -0.0016	**0.000** 0.0000	**-0.028** -0.0011	**0.000** 0.0000	**-0.020** -0.0008	– –	– –	– –	– –
	400.000 15.7480	**500.000** 19.6850	**0.000** 0.0000	**-0.045** -0.0018	**0.000** 0.0000	**-0.045** -0.0018	**0.000** 0.0000	**-0.030** -0.0012	– –	– –	– –	– –	– –	– –
	500.000 19.6850	**630.000** 24.8031	**0.000** 0.0000	**-0.050** -0.0020	**0.000** 0.0000	**-0.050** -0.0020	**0.000** 0.0000	**-0.035** -0.0014	– –	– –	– –	– –	– –	– –
	630.000 24.8031	**800.000** 31.4961	**0.000** 0.0000	**-0.075** -0.0030	– –	– –	**0.000** 0.0000	**-0.040** *0.0016	– –	– –	– –	– –	– –	– –
	800.000 31.4961	**1000.000** 39.3701	**0.000** 0.0000	**-0.100** -0.0040	– –	– –	**0.000** 0.0000	**-0.050** -0.0020	– –	– –	– –	– –	– –	– –
	1000.000 39.3701	**1200.000** 47.2441	**0.000** 0.0000	**-0.130** -0.0051	– –	– –	**0.000** 0.0000	**-0.060** -0.0024	– –	– –	– –	– –	– –	– –
	1200.000 **47.2441**	**1600.000** **62.9921**	**0.000** **0.0000**	**-0.165** **-0.0065**	– –	– –	**0.000** 0.0000	**-0.080** -0.0031	– –	– –	– –	– –	– –	– –
	1600.000 62.9921	**2000.000** 78.7402	**0.000** 0.0000	**-0.200** -0.0079	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –
	2000.000 78.7402	– –	**0.000** 0.0000	**-0.250** -0.0098	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –



[(1)]SR assemblies are manufactured to tolerance class N only.

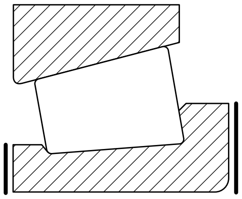


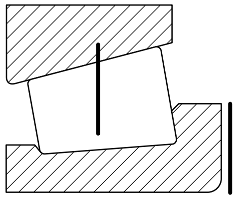
TABLE 4. TAPERED ROLLER BEARING TOLERANCES – INNER RING WIDTH (Metric)

Bearing Types	Bore		Standard Bearing Class				Precision Bearing Class							
			K		N		C		B		A		AA	
	Over	Incl.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	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.
TS TSF	**10.000** 0.3937	**50.000** 1.9685	**0.000** 0.0000	**-0.100** -0.0040	**0.000** 0.0000	**-0.050** -0.0020	**0.000** 0.0000	**-0.200** -0.0079	**0.000** 0.0000	**-0.200** -0.0079	**0.000** 0.0000	**-0.200** -0.0079	**0.000** 0.0000	**-0.200** -0.0079
	50.000 1.9685	**120.000** 4.7244	**0.000** 0.0000	**-0.150** -0.0059	**0.000** 0.0000	**-0.050** -0.0020	**0.000** 0.0000	**-0.300** -0.0118	**0.000** 0.0000	**-0.300** -0.0118	**0.000** 0.0000	**-0.300** -0.0118	**0.000** 0.0000	**-0.300** -0.0118
	120.000 4.7244	**180.000** 7.0866	**0.000** 0.0000	**-0.200** -0.0079	**0.000** 0.0000	**-0.050** -0.0020	**0.000** 0.0000	**-0.300** -0.0118	**0.000** 0.0000	**-0.300** -0.0118	**0.000** 0.0000	**-0.300** -0.0118	**0.000** 0.0000	**-0.300** -0.0118
	180.000 7.0866	**250.000** 9.8425	**0.000** 0.0000	**-0.200** -0.0079	**0.000** 0.0000	**-0.050** -0.0020	**0.000** 0.0000	**-0.350** -0.0138	**0.000** 0.0000	**-0.350** -0.0138	**0.000** 0.0000	**-0.350** -0.0138	**0.000** 0.0000	**-0.350** -0.0138
	250.000 **9.8425**	**265.000** **10.4331**	**0.000** **0.0000**	**-0.200** **-0.0079**	**0.000** **0.0000**	**-0.050** **-0.0020**	**0.000** **0.0000**	**-0.350** **-0.0138**	**0.000** **0.0000**	**-0.350** **-0.0138**	**0.000** **0.0000**	**-0.350** **-0.0138**	**0.000** **0.0000**	**-0.350** **-0.0138**
	265.000 10.4331	**315.000** 12.4016	**0.000** 0.0000	**-0.200** -0.0079	**0.000** 0.0000	**-0.050** -0.0020	**0.000** 0.0000	**-0.350** -0.0138	**0.000** 0.0000	**-0.350** -0.0138	**0.000** 0.0000	**-0.350** -0.0138	**0.000** 0.0000	**-0.350** -0.0138
	315.000 12.4016	**500.000** 19.6850	**0.000** 0.0000	**-0.250** -0.0098	**0.000** 0.0000	**-0.050** -0.0020	**0.000** 0.0000	**-0.350** -0.0138	– –	– –	– –	– –	– –	– –
	500.000 19.6850	**630.000** 24.8031	**0.000** 0.0000	**-0.250** -0.0098	**0.000** 0.0000	**-0.350** -0.0138	**0.000** 0.0000	**-0.350** -0.0138	– –	– –	– –	– –	– –	– –
	630.000 24.8031	**1200.000** 47.2441	**0.000** 0.0000	**-0.300** -0.0118	– –	– –	**0.000** 0.0000	**-0.350** -0.0138	– –	– –	– –	– –	– –	– –
	1200.000 47.2441	**1600.000** 62.9921	**0.000** 0.0000	**-0.350** -0.0138	– –	– –	**0.000** 0.0000	**-0.350** -0.0138	– –	– –	– –	– –	– –	– –
	1600.000 62.9921	– –	**0.000** 0.0000	**-0.350** -0.0138	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –

TABLE 5. TAPERED ROLLER BEARING TOLERANCES – INNER RING STAND (Metric)

Bearing Types	Bore		Standard Bearing Class				Precision Bearing Class							
			K		N		C		B		A		AA	
	Over	Incl.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	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.
TS TSF	**10.000** 0.3937	**80.000** 3.1496	**+0.100** +0.0039	**0.000** 0.0000	**+0.050** +0.0020	**0.000** 0.0000	**+0.100** +0.0039	**-0.100** -0.0039						
	80.000 3.1496	**120.000** 4.7244	**+0.100** +0.0039	**-0.100** -0.0039	**+0.050** +0.0020	**0.000** 0.0000	**+0.100** +0.0039	**-0.100** -0.0039						
	120.000 4.7244	**180.000** 7.0866	**+0.150** +0.0059	**-0.150** -0.0059	**+0.050** +0.0020	**0.000** 0.0000	**+0.100** +0.0039	**-0.100** -0.0039			(1)	(1)	(1)	(1)
	180.000 7.0866	**250.000** 9.8425	**+0.150** +0.0059	**-0.150** -0.0059	**+0.050** +0.0020	**0.000** 0.0000	**+0.100** +0.0039	**-0.150** -0.0059	(1)	(1)				
	250.000 9.8425	**265.000** 10.4331	**+0.150** +0.0059	**-0.150** -0.0059	**+0.100** +0.0039	**0.000** 0.0000	**+0.100** +0.0039	**-0.150** -0.0059						
	265.000 10.4331	**315.000** 12.4016	**+0.150** +0.0059	**-0.150** -0.0059	**+0.100** +0.0039	**0.000** 0.0000	**+0.100** +0.0039	**-0.150** -0.0059			– –	– –	– –	– –
	315.000 12.4016	**400.000** 15.7480	**+0.200** +0.0079	**-0.200** -0.0079	**+0.100** +0.0039	**0.000** 0.0000	**+0.150** +0.0059	**-0.150** -0.0059	– –	– –	– –	– –	– –	– –
	400.000 15.7480	– –	(1)	(1)	(1)	(1)	(1)	(1)	– –	– –	– –	– –	– –	– –

(1)These sizes manufactured as matched assemblies only.



Inner Ring Stand. Inner Ring stand is a measure of the variation in Inner Ring raceway size, taper and roller diameter. This is checked by measuring the axial location of the reference surface of a master outer ring or other type gauge with respect to the reference Inner Ring face.

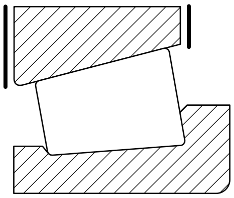


TABLE 6. TAPERED ROLLER BEARING TOLERANCES – OUTER RING WIDTH (Metric)

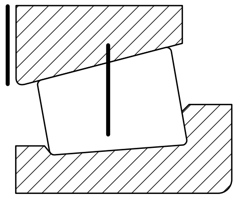
Bearing Types	O.D.		Standard Bearing Class				Precision Bearing Class							
			K		N		C		B		A		AA	
	Over	Incl.	Max.	Min.[1]	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.
TS TSF	**10.000** 0.3937	**80.000** 3.1496	**0.000** 0.0000	**-0.150** -0.0059	**0.000** 0.0000	**-0.100** -0.0040	**0.000** 0.0000	**-0.150** -0.0059	**0.000** 0.0000	**-0.150** -0.0059	**0.000** 0.0000	**-0.150** -0.0059	**0.000** 0.0000	**-0.150** -0.0059
	80.000 3.1496	**150.000** 5.9055	**0.000** 0.0000	**-0.200** -0.0079	**0.000** 0.0000	**-0.100** -0.0040	**0.000** 0.0000	**-0.200** -0.0079	**0.000** 0.0000	**-0.200** -0.0079	**0.000** 0.0000	**-0.200** -0.0079	**0.000** 0.0000	**-0.200** -0.0079
	150.000 5.9055	**180.000** 7.0866	**0.000** 0.0000	**-0.200** -0.0079	**0.000** 0.0000	**-0.100** -0.0040	**0.000** 0.0000	**-0.250** -0.0098	**0.000** 0.0000	**-0.250** -0.0098	**0.000** 0.0000	**-0.250** -0.0098	**0.000** 0.0000	**-0.250** -0.0098
	180.000 7.0866	**250.000** 9.8425	**0.000** 0.0000	**-0.250** -0.0098	**0.000** 0.0000	**-0.100** -0.0040	**0.000** 0.0000	**-0.250** -0.0098	**0.000** 0.0000	**-0.250** -0.0098	**0.000** 0.0000	**-0.250** -0.0098	**0.000** 0.0000	**-0.250** -0.0098
	250.000 **9.8425**	**265.000** **10.4331**	**0.000** **0.0000**	**-0.250** **-0.0098**	**0.000** **0.0000**	**-0.100** **-0.0040**	**0.000** **0.0000**	**-0.300** **-0.0118**	**0.000** **0.0000**	**-0.300** **-0.0118**	**0.000** **0.0000**	**-0.300** **-0.0118**	**0.000** **0.0000**	**-0.300** **-0.0118**
	265.000 10.4331	**315.000** 12.4016	**0.000** 0.0000	**-0.250** -0.0098	**0.000** 0.0000	**-0.100** -0.0040	**0.000** 0.0000	**-0.300** -0.0118	**0.000** 0.0000	**-0.300** -0.0118	**0.000** 0.0000	**-0.300** -0.0118	**0.000** 0.0000	**-0.300** -0.0118
	315.000 12.4016	**400.000** 15.7480	**0.000** 0.0000	**-0.250** -0.0098	**0.000** 0.0000	**-0.100** -0.0040	**0.000** 0.0000	**-0.300** -0.0118	**0.000** 0.0000	**-0.300** -0.0118	– –	– –	– –	– –
	400.000 15.7480	**500.000** 19.6850	**0.000** 0.0000	**-0.300** -0.0118	**0.000** 0.0000	**-0.100** -0.0040	**0.000** 0.0000	**-0.350** -0.0138	– –	– –	– –	– –	– –	– –
	500.000 19.6850	**800.000** 31.4961	**0.000** 0.0000	**-0.300** -0.0118	**0.000** 0.0000	**-0.100** -0.0040	**0.000** 0.0000	**-0.350** -0.0138	– –	– –	– –	– –	– –	– –
	800.000 31.4961	**1200.000** 47.2441	**0.000** 0.0000	**-0.350** -0.0138	– –	– –	**0.000** 0.0000	**-0.400** -0.0157	– –	– –	– –	– –	– –	– –
	1200.000 47.2441	**1600.000** 62.9921	**0.000** 0.0000	**-0.400** -0.0157	– –	– –	**0.000** 0.0000	**-0.400** -0.0157	– –	– –	– –	– –	– –	– –
	1600.000 62.9921	– –	**0.000** 0.0000	**-0.400** -0.0157	– –	– –	**–** –	**–** –	– –	– –	– –	– –	– –	– –

[1]These differ slightly from tolerances in ISO 492. These differences normally have an insignificant effect on the mounting and performance of tapered roller bearings. The 30000 series ISO bearings also are available with the above parameter according to ISO 492.

TABLE 7. TAPERED ROLLER BEARING TOLERANCES – OUTER RING STAND (Metric)

Bearing Types	O.D.		Standard Bearing Class				Precision Bearing Class							
			K		N		C		B		A		AA	
	Over	Incl.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	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.
TS TSF(1)	**10.000** 0.3937	**18.000** 0.7087	**+0.100** +0.0039	**0.000** 0.0000	**+0.050** +0.0020	**0.000** 0.0000	**+0.100** +0.0039	**-0.100** -0.0039						
	18.000 0.7087	**80.000** 3.1496	**+0.100** +0.0039	**0.000** 0.0000	**+0.050** +0.0020	**0.000** 0.0000	**+0.100** +0.0039	**-0.100** -0.0039						
	80.000 3.1496	**120.000** 4.7244	**+0.100** +0.0039	**-0.100** -0.0039	**+0.050** +0.0020	**0.000** 0.0000	**+0.100** +0.0039	**-0.100** -0.0039			(2)	(2)	(2)	(2)
	120.000 4.7244	**265.000** 10.4331	**+0.200** +0.0079	**-0.100** -0.0039	**+0.100** +0.0039	**0.000** 0.0000	**+0.100** +0.0039	**-0.150** -0.0059	(2)	(2)				
	265.000 10.4331	**315.000** 12.4016	**+0.200** +0.0079	**-0.100** -0.0039	**+0.100** +0.0039	**0.000** 0.0000	**+0.100** +0.0039	**-0.150** -0.0059						
	315.000 12.4016	**400.000** 15.7480	**+0.200** +0.0079	**-0.200** -0.0079	**+0.100** +0.0039	**0.000** 0.0000	**+0.100** +0.0039	**-0.150** -0.0059			– –	– –	– –	– –
	315.000 12.4016	**400.000** 15.7480	**+0.200** +0.0079	**-0.200** -0.0079	**+0.100** +0.0040	**0.000** 0.0000	**+0.150** +0.0059	**-0.150** -0.0059	– –	– –	– –	– –	– –	– –
	400.000 15.7480	– –	(2)	(2)	(2)	(2)	(2)	(2)	– –	– –	– –	– –	– –	– –

(1)Stand for flanged outer ring is measured from flange backface (seating face).
(2)These sizes manufactured as matched assemblies only.



Outer Ring Stand. Outer ring stand is a measure of the variation in outer ring I.D. size and taper. This is checked by measuring the axial location of the reference surface of a master plug or other type gauge with respect to the reference face of the outer ring.

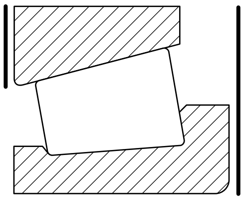


TABLE 8. TAPERED ROLLER BEARING TOLERANCES – OVERALL BEARING WIDTH (Metric)

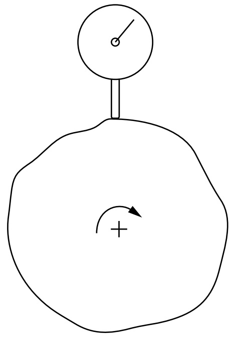
Bearing Types	Bore		Standard Bearing Class				Precision Bearing Class							
			K		N		C		B		A		AA	
	Over	Incl.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
TS TSF[1]	**10.000** 0.3937	**80.000** 3.1496	**+0.200** +0.0078	**0.000** 0.0000	**+0.100** +0.0039	**0.000** 0.0000	**+0.200** +0.0078	**-0.200** -0.0078	**+0.200** +0.0078	**-0.200** -0.0078	**+0.200** +0.0078	**-0.200** -0.0078	**+0.200** +0.0078	**-0.200** -0.0078
	80.000 3.1496	**120.000** 4.7244	**+0.200** +0.0078	**-0.200** -0.0078	**+0.100** +0.0039	**0.000** 0.0000	**+0.200** +0.0078	**-0.200** -0.0078	**+0.200** +0.0078	**-0.200** -0.0078	**+0.200** +0.0078	**-0.200** -0.0078	**+0.200** +0.0078	**-0.200** -0.0078
	120.000 4.7244	**180.000** 7.0866	**+0.350** +0.0137	**-0.250** -0.0098	**+0.150** +0.0059	**0.000** 0.0000	**+0.350** +0.0137	**-0.250** -0.0098	**+0.200** +0.0078	**-0.250** -0.0098	**+0.200** +0.0078	**-0.250** -0.0098	**+0.200** +0.0078	**-0.250** -0.0098
	180.000 7.0866	**250.000** 9.8425	**+0.350** +0.0137	**-0.250** -0.0098	**+0.150** +0.0059	**0.000** 0.0000	**+0.350** +0.0137	**-0.250** -0.0098	**+0.200** +0.0078	**-0.300** -0.0118	**+0.200** +0.0078	**-0.300** -0.0118	**+0.200** +0.0078	**-0.300** -0.0118
	250.000 9.8425	**265.000** 10.4331	**+0.350** +0.0137	**-0.250** -0.0098	**+0.200** +0.0078	**0.000** 0.0000	**+0.350** +0.0137	**-0.300** -0.0118	**+0.200** +0.0078	**-0.300** -0.0118	**+0.200** +0.0078	**-0.300** -0.0118	**+0.200** +0.0078	**-0.300** -0.0118
	265.000 10.4331	**315.000** 12.4016	**+0.350** +0.0137	**-0.250** -0.0098	**+0.200** +0.0078	**0.000** 0.0000	**+0.350** +0.0137	**-0.300** -0.0118	**+0.200** +0.0078	**-0.300** -0.0118	**+0.200** +0.0078	**-0.300** -0.0118	**+0.200** +0.0078	**-0.300** -0.0118
	315.000 12.4016	**500.000** 19.6850	**+0.400** +0.0157	**-0.400** -0.0157	**+0.200** +0.0078	**0.000** 0.0000	**+0.350** +0.0137	**-0.300** -0.0118	– –	– –	– –	– –	– –	– –
	500.000 19.6850	**800.000** 31.4961	**+0.400** +0.0157	**-0.400** -0.0157	– –	– –	**+0.350** +0.0137	**-0.400** -0.0157	– –	– –	– –	– –	– –	– –
	800.000 31.4961	**1000.000** 39.3701	**+0.450** +0.0177	**-0.450** -0.0177	– –	– –	**+0.350** +0.0137	**-0.400** -0.0157	– –	– –	– –	– –	– –	– –
	1000.000 39.3701	**1200.000** 47.2441	**+0.450** +0.0177	**-0.450** -0.0177	– –	– –	**+0.350** +0.0137	**-0.450** -0.0177	– –	– –	– –	– –	– –	– –
	1200.000 47.2441	**1600.000** 62.9921	**+0.450** +0.0177	**-0.450** -0.0177	– –	– –	**+0.350** +0.0137	**-0.500** -0.0196	– –	– –	– –	– –	– –	– –
	1600.000 62.9921		**+0.450** +0.0177	**-0.450** -0.0177	– –	– –	– –	– –	– –	– –	– –	– –	– –	– –
SR[2]	**180.000** 7.0866	**250.000** 9.8425	**0.000** 0.0000	**-0.200** -0.0079	**0.000** 0.0000	**-0.050** -0.0020	**0.000** 0.0000	**-0.350** -0.0138	**0.000** 0.0000	**-0.350** -0.0138	**0.000** 0.0000	**-0.350** -0.0138	**0.000** 0.0000	**-0.350** -0.0138

(1)For bearing type TSF, the tolerance applies to the dimension T_1. Refer to the TSF data in this catalog.
(2)SR assemblies are manufactured to tolerance class N only.

TABLE 9. TAPERED ROLLER BEARING TOLERANCES – RADIAL RUNOUT (Metric)

Bearing Types	O.D.		Standard Bearing Class		Precision Bearing Class			
	Over	Incl.	K	N	C	B	A	AA
	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.
TS TSF SR[1]	10.000 0.3937	18.000 0.7087	– –	– –	– –	– –	0.002 0.00008	0.001 0.00004
	18.000 0.7087	30.000 1.1811	0.018 0.0007	0.018 0.0007	0.005 0.0002	0.003 0.0001	0.002 0.00008	0.001 0.00004
	30.000 1.1811	50.000 1.9685	0.020 0.0008	0.020 0.0008	0.006 0.0002	0.003 0.0001	0.002 0.00008	0.001 0.00004
	50.000 1.9685	80.000 3.1496	0.025 0.0010	0.025 0.0010	0.006 0.0002	0.004 0.0002	0.002 0.00008	0.001 0.00004
	80.000 3.1496	120.000 4.7244	0.035 0.0014	0.035 0.0014	0.006 0.0002	0.004 0.0002	0.002 0.00008	0.001 0.00004
	120.000 4.7244	150.000 5.9055	0.040 0.0016	0.040 0.0016	0.007 0.0003	0.004 0.0002	0.002 0.00008	0.001 0.00004
	150.000 5.9055	180.000 7.0866	0.045 0.0018	0.045 0.0018	0.008 0.0003	0.004 0.0002	0.002 0.00008	0.001 0.00004
	180.000 7.0866	250.000 9.8425	0.050 0.0020	0.050 0.0020	0.010 0.0004	0.005 0.0002	0.002 0.00008	0.001 0.00004
	250.000 9.8425	265.000 10.4331	0.060 0.0024	0.060 0.0024	0.011 0.0004	0.005 0.0002	0.002 0.00008	0.001 0.00004
	265.000 10.4331	315.000 12.4016	0.060 0.0024	0.060 0.0024	0.011 0.0004	0.005 0.0002	0.002 0.00008	0.001 0.00004
	315.000 12.4016	400.000 15.7480	0.070 0.0028	0.070 0.0028	0.013 0.0005	0.005 0.0002	– –	– –
	400.000 15.7480	500.000 19.6850	0.080 0.0031	0.080 0.0031	– –	– –	– –	– –
	500.000 19.6850	630.000 24.8031	0.100 0.0039	– –	– –	– –	– –	– –
	630.000 24.8031	800.000 31.4961	0.120 0.0047	– –	– –	– –	– –	– –
	800.000 31.4961	1000.000 39.3701	0.140 0.0055	– –	– –	– –	– –	– –
	1000.000 39.3701	1200.000 47.2441	0.160 0.0063	– –	– –	– –	– –	– –
	1200.000 47.2441	1600.000 62.9921	0.180 0.0071	– –	– –	– –	– –	– –
	1600.000 62.9921	2000.000 78.7402	0.200 0.0079	– –	– –	– –	– –	– –
	2000.000 78.7402	– –	0.200 0.0079	– –	– –	– –	– –	– –

[1]SR assemblies are manufactured to tolerance class N only.



Runout. Runout is a measure of rotational accuracy expressed by Total Indicator Reading (T.I.R.). Total displacement is measured by an instrument sensing against a moving surface, or moved with respect to a fixed surface. A radial runout measurement includes both roundness errors and the centering error of the surface that the instrument head senses against.

INCH SYSTEM TOLERANCES

Inch system bearings are manufactured to a number of tolerance classes. Classes 4 and 2 are often referred to as standard classes. Classes 3, 0, 00 and 000 are precision classes. Inch system bearings conform to ABMA standard 19.2.

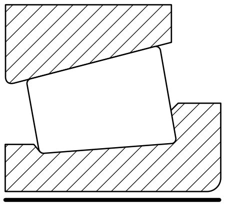


TABLE 10. TAPERED ROLLER BEARING TOLERANCES – INNER RING BORE (Inch)

Bearing Types	Bore		Standard Bearing Class				Precision Bearing Class							
			4		2		3		0		00		000	
	Over	Incl.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	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.
TS TSF TSL[(1)] TDI TDIT TDO TNA	**0.000** 0.0000	**76.200** 3.0000	**+0.013** +0.0005	**0.000** 0.0000	**+0.013** +0.0005	**0.000** 0.0000	**+0.013** +0.0005	**0.000** 0.0000	**+0.013** +0.0005	**0.000** 0.0000	**+0.008** +0.0003	**0.000** 0.0000	**+0.008** +0.0003	**0.000** 0.0000
	76.200 3.0000	**304.800** 12.0000	**+0.025** +0.0010	**0.000** 0.0000	**+0.025** +0.0010	**0.000** 0.0000	**+0.013** +0.0005	**0.000** 0.0000	**+0.013** +0.0005	**0.000** 0.0000	**+0.008** +0.0003	**0.000** 0.0000	**+0.008** +0.0003	**0.000** 0.0000
	304.800 12.0000	**609.600** 24.0000	– –	– –	**+0.051** +0.0020	**0.000** 0.0000	**+0.025** +0.0010	**0.000** 0.0000	– –	– –	– –	– –	– –	– –
	609.600 24.0000	**914.400** 36.0000	**+0.076** +0.0030	**0.000** 0.0000	– –	– –	**+0.038** +0.0015	**0.000** 0.0000	– –	– –	– –	– –	– –	– –
	914.400 36.0000	**1219.200** 48.0000	**+0.102** +0.0040	**0.000** 0.0000	– –	– –	**+0.051** +0.0020	**0.000** 0.0000	– –	– –	– –	– –	– –	– –
	1219.200 48.0000	– –	**+0.127** +0.0050	**0.000** 0.0000	– –	– –	**+0.076** +0.0030	**0.000** 0.0000	– –	– –	– –	– –	– –	– –

(1)For TSL bearings these are the normal tolerances of inner ring bore. However, bore size can be slightly reduced at large end due to tight fit assembly of the seal on the rib. This should not have any effect on the performance of the bearing.

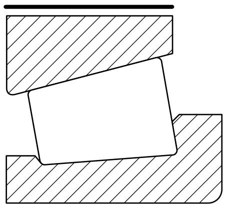


TABLE 11. TAPERED ROLLER BEARING TOLERANCES – OUTER RING OUTSIDE DIAMETER (Inch)

Bearing Types	O.D.		Standard Bearing Class				Precision Bearing Class							
			4		2		3		0		00		000	
	Over	Incl.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	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.
TS TSF TSL TDI TDIT TDO TNA TNASW TNASWE	**0.000** 0.0000	**304.800** 12.0000	**+0.025** +0.0010	**0.000** 0.0000	**+0.025** +0.0010	**0.000** 0.0000	**+0.013** +0.0005	**0.000** 0.0000	**+0.013** +0.0005	**0.000** 0.0000	**+0.008** +0.0003	**0.000** 0.0000	**+0.008** +0.0003	**0.000** 0.0000
	304.800 12.0000	**609.600** 24.0000	**+0.051** +0.0020	**0.000** 0.0000	**+0.051** +0.0020	**0.000** 0.0000	**+0.025** +0.0010	**0.000** 0.0000	**+0.013** +0.0005	**0.000** 0.0000	**+0.008** +0.0003	**0.000** 0.0000	**+0.008** +0.0003	**0.000** 0.0000
	609.600 24.0000	**914.400** 36.0000	**+0.076** +0.0030	**0.000** 0.0000	**+0.076** +0.0030	**0.000** 0.0000	**+0.038** +0.0015	**0.000** 0.0000	– –	– –	– –	– –	– –	– –
	914.400 36.0000	**1219.200** 48.0000	**+0.102** +0.0040	**0.000** 0.0000	– –	– –	**+0.051** +0.0020	**0.000** 0.0000	– –	– –	– –	– –	– –	– –
	1219.200 48.0000	– –	**+0.127** +0.0050	**0.000** 0.0000	– –	– –	**+0.076** +0.0030	**0.000** 0.0000	– –	– –	– –	– –	– –	– –

TABLE 12. TAPERED ROLLER BEARING TOLERANCES – OUTER RING FLANGE (Inch)

Bearing Types	O.D.		Standard Bearing Class				Precision Bearing Class							
			4		2		3		0		00		000	
	Over	Incl.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	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.
TSF	**0.000** 0.0000	**304.800** 12.0000	**+0.051** +0.0020	**0.000** 0.0000	**+0.052** +0.0020	**0.000** 0.0000	**+0.051** +0.0020	**0.000** 0.0000	**+0.051** +0.0020	**0.000** 0.0000	**+0.051** +0.0020	**0.000** 0.0000	**+0.051** +0.0020	**0.000** 0.0000
	304.800 12.0000	**609.600** 24.0000	**+0.076** +0.0030	**0.000** 0.0000	**+0.076** +0.0030	**0.000** 0.0000	**+0.076** +0.0030	**0.000** 0.0000	**+0.051** +0.0020	**0.000** 0.0000	**+0.051** +0.0020	**0.000** 0.0000	**+0.051** +0.0020	**0.000** 0.0000
	609.600 24.0000	**914.400** 36.0000	**+0.102** +0.0040	**0.000** 0.0000	**+0.102** +0.0040	**0.000** 0.0000	**+0.102** +0.0040	**0.000** 0.0000	– –	– –	– –	– –	– –	– –
	914.400 36.0000	– –	**+0.127** +0.0050	**0.000** 0.0000	– –	– –	**+0.127** +0.0050	**0.000** 0.0000	– –	– –	– –	– –	– –	– –

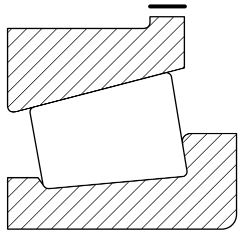


TABLE 13. TAPERED ROLLER BEARING TOLERANCES – INNER RING WIDTH (Inch)

Bearing Types	Bore		Standard Bearing Class				Precision Bearing Class							
			4		2		3		0		00		000	
	Over	Incl.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	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.
TS TSF TSL 2S TDI TDIT TDO	All Sizes		**+0.076** +0.0030	**-0.254** -0.0100	**+0.076** +0.0030	**-0.254** -0.0100	**+0.076** +0.0030	**-0.254** -0.0100	**+0.076** +0.0030	**-0.254** -0.0100	**+0.076** +0.0030	**-0.254** -0.0100	**+0.076** +0.0030	**-0.254** -0.0100

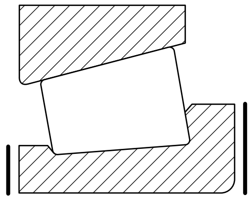


TABLE 14. TAPERED ROLLER BEARING TOLERANCES – OUTER RING WIDTH (Inch)

Bearing Types	O.D.		Standard Bearing Class				Precision Bearing Class							
			4		2		3		0		00		000	
	Over	Incl.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	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.
All Types	All Sizes		**+0.051** +0.0020	**-0.254** -0.0100	**+0.051** +0.0020	**-0.254** -0.0100	**+0.051** +0.0020	**-0.254** -0.0100	**+0.051** +0.0020	**-0.254** -0.0100	**+0.051** +0.0020	**-0.254** -0.0100	**+0.051** +0.0020	**-0.254** -0.0100

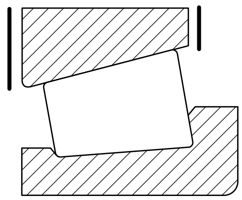
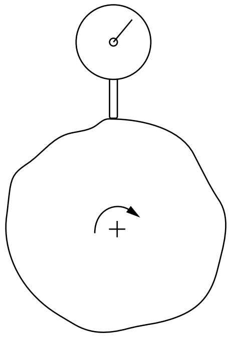


TABLE 17. TAPERED ROLLER BEARING TOLERANCES – RADIAL RUNOUT (Inch)

Bearing Types	O.D.		Standard Bearing Class		Precision Bearing Class			
	Over	Incl.	4	2	3	0	00	000
	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.
TS TSF TSL 2S TDI TDIT TDO TNA TNASW TNASWE	**0.000** 0.0000	**266.700** 10.5000	**0.051** 0.0020	**0.038** 0.0015	**0.008** 0.0003	**0.004** 0.00015	**0.002** 0.000075	**0.001** 0.000040
	266.700 10.5000	**304.800** 12.0000	**0.051** 0.0020	**0.038** 0.0015	**0.008** 0.0003	**0.004** 0.00015	**0.002** 0.000075	**0.001** 0.000040
	304.800 12.0000	**609.600** 24.0000	**0.051** 0.0020	**0.038** 0.0015	**0.018** 0.0007	– –	– –	– –
	609.600 24.0000	**914.400** 36.0000	**0.076** 0.0030	**0.051** 0.0020	**0.051** 0.0020	– –	– –	– –
	914.400 36.0000	– –	**0.076** 0.0030	– –	**0.076** 0.0030	– –	– –	– –



Runout. Runout is a measure of rotational accuracy expressed by Total Indicator Reading (T.I.R.). Total displacement is measured by an instrument sensing against a moving surface, or moved with respect to a fixed surface. A radial runout measurement includes both roundness errors and the centering error of the surface that the instrument head senses against.

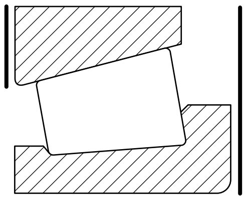
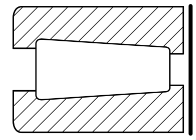


TABLE 18. TAPERED ROLLER BEARING TOLERANCES – OVERALL BEARING WIDTH (Inch)

Bearing Types	Bore		O.D.		Standard Bearing Class				Precision Bearing Class							
					4		2		3		0		00		000	
	Over	Incl.	Over	Incl.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	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.
TS TSF[1] TSL	**0.000** 0.0000	**101.600** 4.0000	– –	– –	**+0.203** +0.0080	**0.000** 0.0000	**+0.203** +0.0080	**0.000** 0.0000	**+0.203** +0.0080	**-0.203** -0.0080	**+0.203** +0.0080	**-0.203** -0.0080	**+0.203** +0.0080	**-0.203** -0.0080	**+0.203** +0.0080	**-0.203** -0.0080
	101.600 4.0000	**304.800** 12.0000	– –	– –	**+0.356** +0.0140	**-0.254** -0.0100	**+0.203** +0.0080	**0.000** 0.0000	**+0.203** +0.0080	**-0.203** -0.0080	**+0.203** +0.0080	**-0.203** -0.0080	**+0.203** +0.0080	**-0.203** -0.0080	**+0.203** +0.0080	**-0.203** -0.0080
	304.800 12.0000	**609.600** 24.0000	**0.000** 0.0000	**508.000** 20.0000	– –	– –	**+0.381** +0.0150	**-0.381** -0.0150	**+0.203** +0.0080	**-0.203** -0.0080	– –	– –	– –	– –	– –	– –
	304.800 12.0000	**609.600** 24.0000	**508.000** 20.0000	– –	– –	– –	**+0.381** +0.0150	**-0.381** -0.0150	**+0.381** +0.0150	**-0.381** -0.0150	– –	– –	– –	– –	– –	– –
	609.600 24.0000	– –	– –	– –	**+0.381** +0.0150	**-0.381** -0.0150	– –	– –	**+0.381** +0.0150	**-0.381** -0.0150	– –	– –	– –	– –	– –	– –
TNA TNASW TNASWE	**0.000** 0.0000	**127.000** 5.0000	– –	– –	– –	– –	**+0.254** +0.0100	**0.000** 0.0000	**+0.254** +0.0100	**0.000** 0.0000	– –	– –	– –	– –	– –	– –
	127.000 5.0000	– –	– –	– –	– –	– –	**+0.762** +0.0300	**0.000** 0.0000	**+0.762** +0.0300	**0.000** 0.0000	– –	– –	– –	– –	– –	– –
TDI TDIT TDO	**0.000** 0.0000	**101.600** 4.0000	– –	– –	**+0.406** +0.0160	**0.000** 0.0000	**+0.406** +0.0160	**0.000** 0.0000	**+0.406** +0.0160	**-0.406** -0.0160	**+0.406** +0.0160	**-0.406** -0.0160	**+0.406** +0.0160	**-0.406** -0.0160	**+0.406** +0.0160	**-0.406** -0.0160
	101.600 4.0000	**304.800** 12.0000	– –	– –	**+0.711** +0.0280	**-0.508** -0.0200	**+0.406** +0.0160	**-0.203** -0.0080	**+0.406** +0.0160	**-0.406** -0.0160	**+0.406** +0.0160	**-0.406** -0.0160	**+0.406** +0.0160	**-0.406** -0.0160	**+0.406** +0.0160	**-0.406** -0.0160
	304.800 12.0000	**609.600** 24.0000	**0.000** 0.0000	**508.000** 20.0000	– –	– –	**+0.762** +0.0300	**-0.762** -0.0300	**+0.406** +0.0160	**-0.406** -0.0160	– –	– –	– –	– –	– –	– –
	304.800 12.0000	**609.600** 24.0000	**508.000** 20.0000	– –	– –	– –	**+0.762** +0.0300	**-0.762** -0.0300	**+0.762** +0.0300	**-0.762** -0.0300	– –	– –	– –	– –	– –	– –
	609.600 24.0000	– –	– –	– –	**+0.762** +0.0300	**-0.762** -0.0300	– –	– –	**+0.762** +0.0300	**-0.762** -0.0300	– –	– –	– –	– –	– –	– –
2S	**0.000** 0.0000	**101.600** 4.0000	– –	– –	**+0.457** +0.0180	**-0.051** -0.0020	**+0.457** +0.0180	**-0.051** -0.0020	– –	– –	– –	– –	– –	– –	– –	– –

[1]For bearing type TSF, the tolerance applies to the dimension T_1. Refer to the TSF data tables in this catalog.

TABLE 19. THRUST TAPERED ROLLER BEARING TOLERANCES – BORE (Inch)



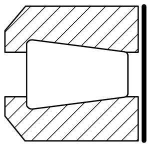
TTHD, TTHDFL, TTVS

TTHD, TTHDFL, TTVS

Bore		Bearing Class			
Range		Precision 2		Precision 3	
Over	Incl.	Over	Incl.	Max.	Min.
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
0.000 0.0000	**304.800** 12.0000	**+0.025** +0.0010	**0.000** 0.0000	**+0.013** +0.0005	**0.000** 0.0000
304.800 12.0000	**609.600** 24.0000	**+0.051** 0.0020	**0.000** 0.0000	**+0.025** +0.0010	**0.000** 0.0000
609.600 24.0000	**914.400** 36.0000	**+0.076** +0.0030	**0.000** 0.0000	**+0.038** +0.0015	**0.000** 0.0000
914.400 36.0000	**1219.200** 48.0000	**+0.102** +0.0040	**0.000** 0.0000	**+0.051** 0.0020	**0.000** 0.0000
1219.200 48.0000	– –	**+0.127** +0.0050	**0.000** 0.0000	**+0.076** +0.030	**0.000** 0.0000

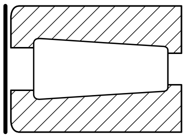
TTC, TTSP – CLASS 4

Bore		Deviation	
Range		Precision 4	
Over	Incl.	Over	Incl.
mm in.	**mm** in.	**mm** in.	**mm** in.
0.000 0.0000	**25.400** 1.0000	**+0.076** +0.0030	**-0.076** -0.0030
25.400 1.0000	**76.200** 3.0000	**+0.102** +0.0040	**-0.102** -0.0040
76.200 3.0000	– –	**+0.127** +0.0050	**-0.127** -0.0050



TTC, TTSP

TABLE 20. THRUST TAPERED ROLLER BEARING TOLERANCES – OUTSIDE DIAMETER (Inch)



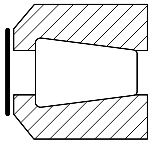
TTHD, TTHDFL, TTVS

TTHD, TTHDFL, TTVS

Outside Diameter		Bearing Class			
Range		Precision 2		Precision 3	
Over	Incl.	Over	Incl.	Max.	Min.
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
0.000 0.0000	**304.800** 12.0000	**+0.025** +0.0010	**0.000** 0.0000	**+0.013** +0.0005	**0.000** 0.0000
304.800 12.0000	**609.600** 24.0000	**+0.051** 0.0020	**0.000** 0.0000	**+0.025** +0.0010	**0.000** 0.0000
609.600 24.0000	**914.400** 36.0000	**+0.076** +0.0030	**0.000** 0.0000	**+0.038** +0.0015	**0.000** 0.0000

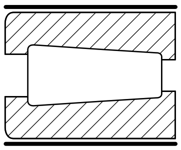
TTC, TTSP – CLASS 4

Outside Diameter		Deviation	
Range		Precision 4	
Over	Incl.	Over	Incl.
mm in.	**mm** in.	**mm** in.	**mm** in.
0.000 0.0000	**127.000** 5.0000	**+0.254** +0.0100	**0.000** 0.0000
127.000 5.0000	**203.200** 8.0000	**+0.381** +0.0150	**0.000** 0.0000
203.200 8.0000	– –	**+0508** +0.200	**0.000** 0.0000



TTC, TTSP

TABLE 21. THRUST TAPERED ROLLER BEARING TOLERANCES – WIDTH (Inch)



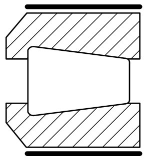
TTHDFL

TTHD, TTHDFL, TTVS

Width		Bearing Class			
Range		Precision 2		Precision 3	
Over	Incl.	Over	Incl.	Max.	Min.
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
All Sizes		**+0.381** +0.0150	**-0.381** -0.0150	**+0.203** +0.0080	**-0.203** -0.0080

TTC, TTSP – CLASS 4

Width		Deviation	
Range		Precision 4	
Over	Incl.	Over	Incl.
mm in.	**mm** in.	**mm** in.	**mm** in.
0.000 0.0000	**76.200** 3.0000	**+0.254** +0.0100	**-0.254** -0.0100
76.200 3.0000	**127.000** 5.0000	**+0.381** +0.0150	**-0.381** -0.0150
127.000 5.0000	– –	**+0508** +0.200	**-0.508** -0.0200



TTC, TTSP

TAPERED ROLLER BEARING MOUNTING, FITTING AND SETTING

MOUNTING

Tapered roller bearings are designed to take both radial and thrust loading. Under radial loads, a force is generated in the axial direction that must be counteracted. As a result, tapered roller bearings are normally adjusted against a second bearing. They can be mounted in either a direct or indirect mounting arrangement shown in fig. 9. For applications where a direct mounting arrangement is used and the outer ring is used to adjust the bearing setting, the outer ring is usually set in position by an outer-ring follower or mounted in an outer-ring carrier. See fig. 10.

For indirect mountings, bearing setting is typically achieved by clamping against one of the inner rings. Various designs, including locknuts, stakenuts and end plates as shown in fig. 11 can be used. For applications requiring precision-class bearings, a special precision nut can be used.

Backing shoulder diameters are listed for tapered roller bearings in the product data sections in this catalog.

FITTING PRACTICE

General industrial application fitting practice standards for inner rings and outer rings are shown in the tables starting on page 32. These tables apply to solid or heavy-sectioned steel shafts, heavy-sectioned ferrous housings and normal operating conditions. To use the tables, it is necessary to determine if the member is rotating or stationary, the magnitude, direction and type of loading, and the shaft finish.

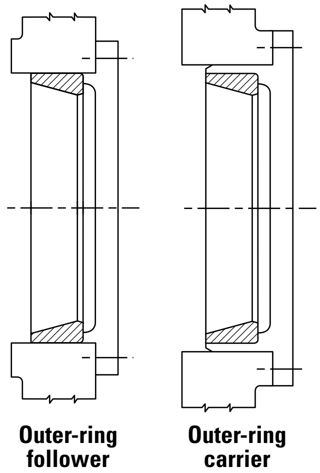


Fig. 10. Bearing setting devices - direct mounting.

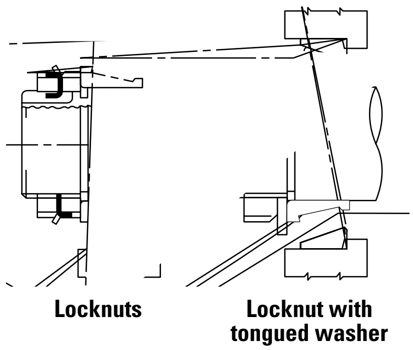


Fig. 11. Bearing setting devices – indirect mounting.

Certain table fits may not be adequate for light shaft and housing sections, shafts other than steel, nonferrous housings, critical operation conditions such as high speed, unusual thermal or loading conditions or a combination thereof. Also, assembly procedures and the means and ease of obtaining the bearing setting may require special fits. In these cases, experience should be used as a guideline or your Timken engineer should be consulted for review and suggestions.

Rotating inner rings generally should be applied with an interference fit. In special cases, loose fits may be considered if it has been determined by test or experience they will perform satisfactorily. The term "rotating inner ring" describes a condition in which the inner ring rotates relative to the load. This may occur with a rotating inner ring under a stationary load or a stationary inner ring with a rotating load. Loose fits will permit the inner rings to creep and wear the shaft and the backing shoulder. This may result in excessive bearing looseness and possible bearing and shaft damage.

Stationary inner ring fitting practice depends on the application. Under conditions of high speed, heavy loads or shock, interference fits using heavy-duty fitting practices should be used. With inner rings mounted on unground shafts subjected to moderate loads (no shock) and moderate speeds, a metal-to-metal or near zero average fit is used. In sheave and wheel applications using unground shafts, or in cases using ground shafts with moderate loads (no shock), a minimum fit near zero to a maximum looseness that varies with the inner ring bore size is suggested. In stationary inner ring applications requiring hardened and ground spindles, a slightly looser fit may be satisfactory. Special fits also may be necessary on installations such as multiple sheave crane blocks.

Rotating outer ring applications where the outer ring rotates relative to the load should always use an interference fit.

Stationary, non-adjustable and fixed single-row outer ring applications should be applied with a tight fit wherever practical. Generally, adjustable fits may be used where the bearing setup is obtained by sliding the outer ring axially in the housing bore. However, in certain heavy-duty, high-load applications, tight fits are necessary to prevent pounding and plastic deformation of the housing. Tightly fitted outer rings mounted in carriers can be used. Tight fits should always be used when the load rotates relative to the outer ring.

To permit through-boring when the outside diameters of single-row bearings mounted at each end of a shaft are equal, and one is adjustable and the other fixed, it is suggested that the same adjustable fit be used at both ends. However, tight fits should be used if outer rings are backed against snap rings to prevent excessive dishing of snap rings, groove wear and possible loss of ring retention. Only outer rings with a maximum housing fillet radius requirement of 1.3 mm (0.05 in.) or less should be considered for a snap ring backing.

Double-row stationary double outer rings are generally mounted with loose fits to permit assembly and disassembly. The loose fit also permits float when a floating bearing is mounted in conjunction with an axially fixed bearing on the other end of the shaft.

Fitting practice tables 22-32 on pages 32-46, have been prepared for both metric and inch dimensions.

For the inch system bearings, classes 4 and 2 (standard) have been included.

The metric system bearings that have been included are: classes K and N (metric system standard bearings).

Fit effect[1]

Solid shaft/heavy section housing

Setting Reduction/Width Increase for Single Inner Ring

$$= 0.5\left(\frac{K}{0.39}\right)\left(\frac{d}{d_o}\right)\delta_S$$

Setting Reduction/Width Increase for Single Outer Ring

$$= 0.5\left(\frac{K}{0.39}\right)\left(\frac{D_o}{D}\right)\delta_H$$

Hollow shaft/thin-wall section

Shaft Reduction/Width Increase for Single Inner Ring

$$= 0.5\left(\frac{K}{0.39}\right)\left(\frac{d}{d_o}\right)\left[\frac{1-\left(\frac{d_{si}}{d}\right)^2}{1-\left(\frac{d_{si}}{d_o}\right)^2}\right]\delta_S$$

Shaft Reduction/Width Increase for Single Outer Ring

$$= 0.5\left(\frac{K}{0.39}\right)\left(\frac{D_o}{D}\right)\left[\frac{1-\left(\frac{D}{D_H}\right)^2}{1-\left(\frac{D_o}{D_H}\right)^2}\right]\delta_H$$

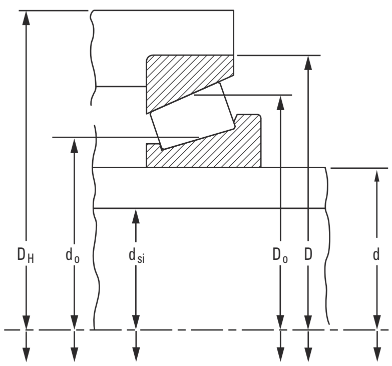


Fig. 15. Dimensional parameters affecting fit and temperature effects on setting.

(1)These equations apply only to ferrous shaft and housing.

SETTING

Setting is defined as the axial clearance between roller and raceway. Establishing the setting at the time of assembly is an inherent advantage of tapered roller bearings. They can be set to provide optimum performance in almost any application. Fig. 13 gives an example of the relationship between fatigue life and bearing setting. Unlike some types of anti-friction bearings, tapered roller bearings do not rely strictly on housing or shaft fits to obtain a certain bearing setting. One ring can be moved axially relative to the other to obtain the desired bearing setting.

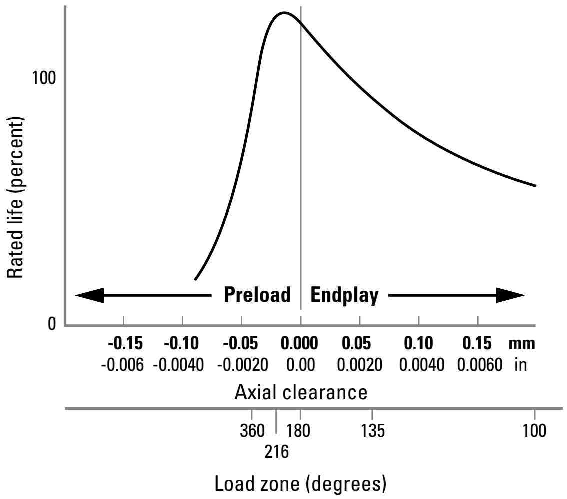


Fig. 13. Typical life vs. setting curve.

At assembly, the conditions of bearing setting are defined as:

- **Endplay (EP) –** An axial clearance between rollers and raceways producing a measurable axial shaft movement when a small axial force is applied – first in one direction then in the other, while oscillating or rotating the shaft. See fig. 14.
- **Preload (PL) –** An axial interference between rollers and raceways such that there is no measurable axial shaft movement when a small axial force is applied – in both directions – while oscillating or rotating the shaft.
- **Line-to-line –** A zero setting condition: the transitional point between endplay and preload.

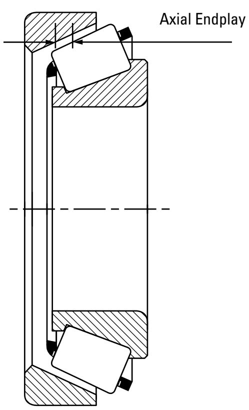


Fig. 14. Internal clearance – endplay.

Bearing setting obtained during initial assembly and adjustment is the cold or ambient bearing setting, and is established before the equipment is subjected to service.

Bearing setting during operation is known as the operating bearing setting, and is a result of changes in the ambient bearing setting due to thermal expansion and deflections encountered during service.

The ambient bearing setting necessary to produce the optimum operating bearing setting varies with the application. Application experience or testing generally determines optimum settings. Frequently, however, the exact relationship of ambient to operating bearing setting is unknown and an educated estimate has to be made. To determine a suggested ambient bearing setting for a specific application, contact your Timken engineer.

Generally, the ideal operating bearing setting is near zero to maximize bearing life (fig. 13). Most bearings are set with endplay at assembly to reach the desired near-zero setting at operating temperature.

There is an ideal bearing setting value for every application. To achieve this condition, the bearing setting must take into account deflection under load (radial + axial) as well as thermal expansions and material used.

1. Standard mounting

Operating setting = mounted setting ± temperature effect + deflection

2. Pre-set assemblies

Mounted EP or PL = bench EP or bench PL – effect of fits

Operating setting = mounted EP or PL (MEP or MPL) + deflection ± temperature effect

The temperature and fit effects will depend upon the type of mounting, bearing geometry and size, shaft and housing sizes, and material as defined in the following sections. Dimensional parameters affecting bearing setting are noted in fig. 15.

Fit effect[(1)]

Solid shaft/heavy section housing

Setting Reduction/Width Increase for Single Inner Ring

$$= 0.5\left(\frac{K}{0.39}\right)\left(\frac{d}{d_o}\right)\delta_S$$

Setting Reduction/Width Increase for Single Outer Ring

$$= 0.5\left(\frac{K}{0.39}\right)\left(\frac{D}{D_o}\right)\delta_H$$

Hollow shaft/thin-wall section

Shaft Reduction/Width Increase for Single Inner Ring

$$= 0.5\left(\frac{K}{0.39}\right)\left(\frac{d}{d_o}\right)\left[\frac{1-\left(\frac{d_{si}}{d}\right)^2}{1-\left(\frac{d_{si}}{d_o}\right)^2}\right]\delta_S$$

Shaft Reduction/Width Increase for Single Outer Ring

$$= 0.5\left(\frac{K}{0.39}\right)\left(\frac{D_o}{D}\right)\left[\frac{1-\left(\frac{D}{D_H}\right)^2}{1-\left(\frac{D_o}{D_H}\right)^2}\right]\delta_H$$

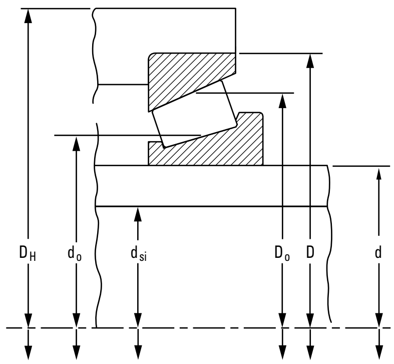


Fig. 15. Dimensional parameters affecting fit and temperature effects on setting.

(1)These equations apply only to ferrous shaft and housing.

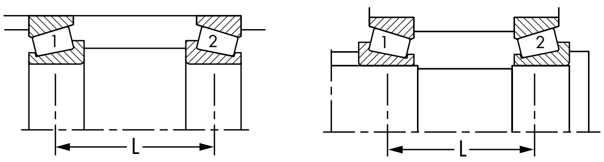
Temperature effect

Direct mounting - setting change due to temperature

$$= \alpha_T \Delta T \left[\left(\frac{K_1}{0.39}\right)\left(\frac{D_{o1}}{2}\right) + \left(\frac{K_2}{0.39}\right)\left(\frac{D_{o2}}{2}\right) + L \right]$$

Indirect mounting - setting change due to temperature

$$= \alpha_T \Delta T \left[\left(\frac{K_1}{0.39}\right)\left(\frac{D_{o1}}{2}\right) + \left(\frac{K_2}{0.39}\right)\left(\frac{D_{o2}}{2}\right) - L \right]$$



Direct mounting **Indirect mounting**

Fig. 16. Direct and indirect mounting.

Setting methods

Upper and lower limits of bearing setting values are determined by consideration of the following factors:

- Application type.
- Duty cycle/loading.
- Operational features of adjacent mechanical drive elements.
- Changes in bearing setting due to temperature differentials and deflections.
- Size of bearing and method of obtaining bearing setting.
- Lubrication method.
- Housing and shaft material.

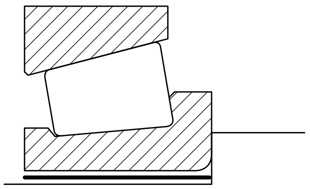
The setting value to be applied during assembly will depend on any changes that may occur during operation. In the absence of experience with bearings of similar size and operating conditions, a bearing setting range suggestion should be obtained from your Timken engineer.

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

FITTING PRACTICE TABLES

TAPERED ROLLER BEARINGS

INNER RING – Industrial Equipment Classes K and N (Metric)



Deviation from nominal (maximum) bearing bore and resultant fit.

T= Tight
L = Loose

TABLE 22. TAPERED ROLLER BEARINGS – INNER RING
Industrial Equipment Classes K and N (Metric)

Inner Ring Bore		Tolerance	Rotating Inner Ring			Rotating or Stationary Inner Ring		
Range			Ground Seat			Unground Seat or Ground Seat		
			Constant Loads With Moderate Shock			Heavy Loads, High Speed or Shock		
Over	Incl.		Inner Ring Seat Deviation	Resultant Fit	Symbol	Inner Ring Seat Deviation	Resultant Fit	Symbol
mm in.	mm in.	mm in.	mm in.	mm in.		mm in.	mm in.	
10.000 0.3937	**18.000** 0.7087	**-0.012** **0.000** -0.0005 0.0000	**+0.018** **+0.007** +0.0007 +0.0003	**0.030T** **0.007T** 0.0012T 0.0003T	m6	**+0.023** **+0.012** +0.0009 +0.0005	**0.035T** **0.012T** 0.0014T 0.0005T	n6
18.000 0.7087	**30.000** 1.1811	**-0.012** **0.000** -0.0005 0.0000	**+0.021** **+0.008** +0.0008 +0.0003	**0.033T** **0.008T** 0.0013T 0.0003T	m6	**+0.028** **+0.015** +0.0011 +0.0006	**0.040T** **0.015T** 0.0016T 0.0006T	n6
30.000 1.1811	**50.000** 1.9685	**-0.012** **0.000** -0.0005 0.0000	**+0.025** **+0.009** +0.0010 +0.0004	**0.037T** **0.009T** 0.0015T 0.0004T	m6	**+0.033** **+0.017** +0.0013 +0.0007	**0.045T** **0.017T** 0.0018T 0.0007T	n6
50.000 1.9685	**80.000** 3.1496	**-0.015** **0.000** -0.0006 0.0000	**+0.030** **+0.011** +0.0012 +0.0004	**0.045T** **0.011T** 0.0018T 0.0005T	m6	**+0.039** **+0.020** +0.0015 +0.0008	**0.054T** **0.020T** 0.0021T 0.0008T	n6
80.000 3.1496	**120.000** 4.7244	**-0.020** **0.000** -0.0008 0.0000	**+0.035** **+0.013** +0.0014 +0.0005	**0.055T** **0.013T** 0.0022T 0.0005T	m6	**+0.045** **+0.023** +0.0019 +0.0010	**0.065T** **0.023T** 0.0027T 0.0010T	n6
120.000 4.7244	**180.000** 7.0866	**-0.025** **0.000** -0.0010 0.0000	**+0.052** **+0.027** +0.0020 +0.0011	**0.077T** **0.027T** 0.0030T 0.0011T	n6	**+0.068** **+0.043** +0.0027 +0.0017	**0.093T** **0.043T** 0.0037T 0.0017T	p6
180.000 7.0866	**200.000** 7.8740	**-0.030** **0.000** -0.0012 0.0000	**+0.060** **+0.031** +0.0024 +0.0012	**0.090T** **0.031T** 0.0035T 0.0012T	n6	**+0.106** **+0.077** +0.0042 +0.0030	**0.136T** **0.077T** 0.0054T 0.0030T	r6
200.000 7.8740	**225.000** 8.8583					**+0.109** **+0.080** +0.0043 +0.0031	**0.139T** **0.080T** 0.0055T 0.0031T	
225.000 8.8583	**250.000** 9.8425					**+0.113** **+0.084** 0.0044 +0.0033	**0.143T** **0.084T** 0.0056T 0.0033T	
250.000 9.8425	**280.000** 11.0236	**-0.035** **0.000** -0.0014 0.0000	**+0.066** **+0.033** +0.0026 +0.0013	**0.101T** **0.033T** 0.0040T 0.0013T	n6	**+0.146** **+0.094** +0.0057 +0.0037	**0.181T** **0.094T** 0.0071T 0.0037T	r7
280.000 11.0236	**315.000** 12.4016					**+0.150** **+0.098** +0.0059 +0.0039	**0.185T** **0.098T** 0.0073T 0.0039T	

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

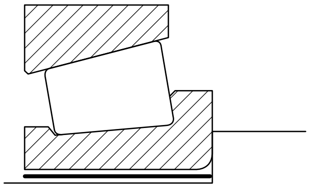
Stationary Inner Ring											
Unground Seat			Ground Seat			Unground Seat			Hardened and Ground Seat		
Moderate Loads, No Shock			Moderate Loads, No Shock			Sheaves, Wheels, Idlers			Wheel Spindles		
Inner Ring Seat Deviation	Resultant Fit	Symbol	Inner Ring Seat Deviation	Resultant Fit	Symbol	Inner Ring Seat Deviation	Resultant Fit	Symbol	Inner Ring Seat Deviation	Resultant Fit	Symbol
mm in.	**mm** in.		**mm** in.	**mm** in.		**mm** in.	**mm** in.		**mm** in.	**mm** in.	
0.000 **-0.011** 0.0000 -0.0004	**0.012T** **0.011L** 0.0005T 0.0004L	h6	**-0.006** **-0.017** -0.0002 -0.0007	**0.006T** **0.017L** 0.0002T 0.0007L	g6	**-0.006** **-0.017** -0.00025 -0.00065	**0.006T** **0.017L** -0.00025T 0.00065L	g6	**-0.016** **-0.027** -0.0006 -0.0011	**0.004L** **0.027L** 0.0002L 0.0011L	f6
0.000 **-0.013** 0.0000 -0.0005	**0.012T** **0.013L** 0.0005T 0.0005L	h6	**-0.007** **-0.020** -0.0003 -0.0008	**0.005T** **0.020L** 0.0002T 0.0008L	g6	**-0.007** **-0.020** -0.0003 -0.0008	**0.005T** **0.020L** 0.0002T 0.0008L	g6	**-0.020** **-0.033** -0.0008 -0.0013	**0.008L** **0.033L** 0.0003L 0.0013L	f6
0.000 **-0.016** 0.0000 -0.0006	**0.012T** **0.016L** 0.0005T 0.0006L	h6	**-0.009** **-0.025** -0.0004 -0.0010	**0.003T** **0.025L** 0.0001T 0.0010L	g6	**-0.009** **-0.025** -0.0004 -0.0010	**0.003T** **0.025L** 0.0001T 0.0010L	g6	**-0.025** **-0.041** -0.0010 -0.0016	**0.013L** **0.041L** 0.0005L 0.0016L	f6
0.000 **-0.019** 0.0000 -0.0007	**0.015T** **0.019L** 0.0006T 0.0007L	h6	**-0.010** **-0.029** -0.0004 -0.0011	**0.005T** **0.029L** 0.0002T 0.0011L	g6	**-0.010** **-0.029** -0.0004 -0.0011	**0.005T** **0.029L** 0.0002T 0.0011L	g6	**-0.030** **-0.049** -0.0012 -0.0019	**0.015L** **0.049L** 0.0006L 0.0019L	f6
0.000 **-0.022** 0.0000 -0.0009	**0.020T** **0.022L** 0.0008T 0.0009L	h6	**-0.012** **-0.034** -0.0005 -0.0014	**0.008T** **0.034L** 0.0003T 0.0014L	g6	**-0.012** **-0.034** -0.0005 -0.0014	**0.008T** **0.034L** 0.0003T 0.0014L	g6	**-0.036** **-0.058** -0.0014 -0.0023	**0.016L** **0.058L** 0.0006L 0.0023L	f6
0.000 **-0.025** 0.0000 -0.0010	**0.025T** **0.025L** 0.0010T 0.0010L	h6	**-0.014** **-0.039** -0.0006 -0.0016	**0.011T** **0.039L** 0.0004T 0.0016L	g6	**-0.014** **-0.039** -0.0006 -0.0016	**0.011T** **0.039** 0.0004T 0.0016L	g6	**-0.043** **-0.068** -0.0016 -0.0026	**0.018L** **0.068L** 0.0006L 0.0026L	f6
0.000 **-0.029** 0.0000 -0.0011	**0.030T** **0.029L** 0.0012T 0.0011L	h6	**-0.015** **-0.044** -0.0006 -0.0017	**0.015T** **0.044L** 0.0006T 0.0017L	g6	**-0.015** **-0.044** -0.0006 -0.0017	**0.015T** **0.044L** 0.0006T 0.0017L	g6	**-0.050** **-0.079** -0.0020 -0.0031	**0.020L** **0.079L** 0.0008L 0.0031L	f6
0.000 **-0.032** 0.0000 -0.0012	**0.035T** **0.032L** 0.0014T 0.0012L	h6	**-0.017** **-0.049** -0.0007 -0.0019	**0.018T** **0.049L** 0.0007T 0.0019L	g6	**-0.017** **-0.049** -0.0007 -0.0019	**0.018T** **0.049L** 0.0007T 0.0019L	g6	**-0.056** **-0.068** -0.0022 -0.0027	**0.021L** **0.088L** 0.0008L 0.0035L	f6

Continued on next page.

FITTING PRACTICE TABLES

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

INNER RING – Industrial Equipment Classes K and N (Metric)



Deviation from nominal (maximum) bearing bore and resultant fit.

T= Tight
L = Loose

Table 22 continued.

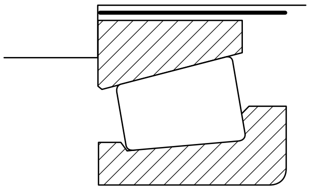
Inner Ring Bore			Rotating Inner Ring			Rotating or Stationary Inner Ring		
Range		Tolerance	Ground Seat			Unground Seat or Ground Seat		
			Constant Loads With Moderate Shock			Heavy Loads, High Speed or Shock		
Over	Incl.		Inner Ring Seat Deviation	Resultant Fit	Symbol	Inner Ring Seat Deviation	Resultant Fit	Symbol
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.		**mm** in.	**mm** in.	
315.000 12.4016	**355.000** 13.9764	**-0.040** **0.000** -0.0016 0.0000	**+0.073** **+0.037** +0.0029 +0.0015	**0.113T** **0.037T** 0.0044T 0.0015T	n6	**+0.165** **+0.108** +0.0065 +0.0043	**0.205T** **0.108T** 0.0081T 0.0043T	r7
355.000 13.9764	**400.000** 15.7480					**+0.171** **+0.114** +0.0067 +0.0045	**0.211T** **0.114T** 0.0083T 0.0045T	
400.000 15.7580	**450.000** 17.7165	**-0.045** **0.000** -0.0018 0.0000	**+0.080** **+0.040** +0.0031 +0.0016	**0.0125T** **0.040T** 0.0049T 0.0016T	n6	**+0.189** **+0.126** +0.0074 +0.0092	**0.234T** **0.126T** 0.0092T 0.0050T	r7
450.000 17.7165	**500.000** 19.6850					**+0.195** **+0.132** +0.0077 +0.0052	**0.240T** **0.132T** 0.0094T 0.0052T	
500.000 29.6850	**630.000** 24.8032	**-0.050** **0.000** -0.0020 0.0000	**+0.100** **+0.050** +0.0039 +0.0020	**0.150T** **0.050T** 0.0059T 0.0020T	–	**+0.200** **+0.125** +0.0079 +0.0049	**0.250T** **0.125T** 0.0098T 0.0049T	–
630.000 24.8032	**800.000** 31.4961	**-0.080** **0.000** -0.0031 0.0000	**+0.125** **+0.050** +0.0049 +0.0020	**0.205T** **0.050T** 0.0081T 0.0020T	–	**+0.225** **+0.150** +0.0089 +0.0059	**0.305T** **0.105T** 0.0102T 0.0041T	–
800.000 31.4961	**1000.000** 39.3701	**-0.100** **0.000** -0.0039 0.0000	**+0.150** **+0.050** +0.0059 +0.0020	**0.250T** **0.050T** 0.0098T 0.0020T	–	**+0.275** **+0.175** +0.0108 +0.0069	**0.375T** **0.175T** 0.0148T 0.0069T	–

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

Stationary Inner Ring											
Unground Seat			Ground Seat			Unground Seat			Hardened and Ground Seat		
Moderate Loads, No Shock			Moderate Loads, No Shock			Sheaves, Wheels, Idlers			Wheel Spindles		
Inner Ring Seat Deviation	Resultant Fit	Symbol	Inner Ring Seat Deviation	Resultant Fit	Symbol	Inner Ring Seat Deviation	Resultant Fit	Symbol	Inner Ring Seat Deviation	Resultant Fit	Symbol
mm in.	**mm** in.		**mm** in.	**mm** in.		**mm** in.	**mm** in.		**mm** in.	**mm** in.	
0.000 **-0.036** 0.0000 -0.0014	**0.040T** **0.036L** 0.0016T 0.0014L	h6	**-0.018** **-0.075** -0.0007 -0.0030	**0.022T** **0.075L** 0.0009T 0.0030L	g7	**-0.018** **-0.075** -0.0007 -0.0029	**0.022T** **0.075L** 0.0009T 0.0029L	g7	–	–	–
0.000 **-0.040** 0.0000 -0.0020	**0.045T** **0.040L** 0.0018T 0.0016L	h6	**-0.020** **-0.083** -0.0008 -0.0033	**0.025T** **0.083L** 0.0008T 0.0033L	g7	**-0.020** **-0.083** -0.0008 -0.0033	**0.025T** **0.083L** **0.0008T** 0.0033L	g7	–	–	–
0.000 **-0.050** 0.0000 -0.0020	**0.050T** **0.050L** 0.0020T 0.0020L	–	**-0.050** **-0.100** -0.0020 -0.0039	**0.000** **0.100L** 0.0000 0.0039L	–	**-0.050** **-0.100** -0.0020 -0.0039	**0.000** **0.100L** 0.0000 0.0039L	–	–	–	–
0.000 **-0.075** 0.0000 -0.0030	**0.080T** **0.075L** 0.0031T 0.0030L	–	**-0.080** **-0.150** -0.0031 -0.0059	**0.000** **0.150L** 0.0000 0.0059L	–	**-0.080** **-0.150** -0.0031 -0.0059	**0.000** **0.150L** 0.0000 0.0059L	–	–	–	–
0.000 **-0.100** 0.0000 -0.0039	**0.100T** **0.100L** 0.0039T 0.0039L	–	**-0.100** **-0.200** -0.0039 -0.0079	**0.000** **0.200L** 0.0000 0.0079L	–	**-0.100** **-0.200** -0.0039 -0.0079	**0.000** **0.200L** 0.0000 0.0079L	–	–	–	–

FITTING PRACTICE TABLES

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.



Deviation from nominal (maximum) bearing O.D. and resultant fit.

T= Tight
L = Loose

Outer Ring O.D.		Tolerance	Stationary Cup									Rotating Cup		
Range			Floating or Clamped			Adjustable			Nonadjustable or in Carriers			Nonadjustable or in Carriers or Sheaves - Clamped		
Over	Incl.		Outer Ring Seat Deviation	Resultant Fit	Symbol	Outer Ring Seat Deviation	Resultant Fit	Symbol	Outer Ring Seat Deviation	Resultant Fit	Symbol	Outer Ring Seat Deviation	Resultant Fit	Symbol
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.		**mm** in.	**mm** in.		**mm** in.	**mm** in.		**mm** in.	**mm** in.	
18.000 0.7087	**30.000** 1.1811	**0.000** **-0.012** 0.0000 -0.0005	**+0.007** **+0.028** +0.0003 +0.0011	**0.007L** **0.040L** 0.0003L 0.0016L	G7	**-0.009** **+0.012** -0.0004 +0.0005	**0.009T** **0.024L** 0.0004T 0.0009L	J7	**-0.035** **-0.014** -0.0014 -0.0005	**0.035T** **0.002T** 0.0014T 0.0001T	P7	**-0.041** **-0.020** -0.0016 -0.0009	**0.041T** **0.008T** 0.0016T 0.0003T	R7
30.000 1.1811	**50.000** 1.9685	**0.000** **-0.014** 0.0000 -0.0006	**+0.009** **+0.034** +0.0004 +0.0013	**0.009L** **0.048L** 0.0004L 0.0019L	G7	**-0.011** **+0.014** -0.0004 +0.0006	**0.011T** **0.028L** 0.0004T 0.0011L	J7	**-0.042** **-0.017** -0.0017 -0.0007	**0.042T** **0.003T** 0.0017T 0.0001T	P7	**-0.050** **-0.025** -0.0020 -0.0010	**0.050T** **0.011T** 0.0020T 0.0004T	R7
		0.000 **-0.016** 0.0000												

Continued on next page.

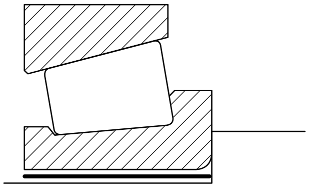
These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

Table 23 continued.

Outer Ring O.D.		Tolerance	Stationary Cup									Rotating Cup		
Range			Floating or Clamped			Adjustable			Nonadjustable or in Carriers			Nonadjustable or in Carriers or Sheaves - Clamped		
Over	Incl.		Outer Ring Seat Deviation	Resultant Fit	Symbol	Outer Ring Seat Deviation	Resultant Fit	Symbol	Outer Ring Seat Deviation	Resultant Fit	Symbol	Outer Ring Seat Deviation	Resultant Fit	Symbol
mm in.	mm in.	mm in.	mm in.	mm in.		mm in.	mm in.		mm in.	mm in.		mm in.	mm in.	
180.000 7.0866	**200.000** 7.8740											**-0.106** **-0.060** -0.0042 -0.0024	**0.106T** **0.030T** 0.0042T 0.0012T	
200.000 7.8740	**225.000** 8.8583	**0.000** **-0.030** 0.0000 -0.0012	**+0.015** **+0.061** +0.0006 +0.0024	**0.015L** **0.091L** 0.0006L 0.0036L	G7	**-0.016** **+0.030** -0.00076 +0.0012	**0.016T** **0.060L** 0.0006T 0.0024L	J7	**-0.079** **-0.033** -0.0031 -0.0014	**0.079T** **0.003T** 0.0031T 0.0001T	P7	**-0.109** **-0.063** -0.0043 -0.0025	**0.109T** **0.033T** 0.0043T 0.0013T	R7
225.000 8.8583	**250.000** 9.8425											**-0.113** **-0.067** -0.0044 -0.0026	**0.113T** **0.037T** 0.0044T 0.0015T	
250.000 9.8425	**280.000** 11.0236	**0.000** **-0.035** 0.0000 -0.0014	**+0.017** **+0.069** +0.0007 +0.0027	**0.017L** **0.104L** 0.0007L 0.0041L	G7	**-0.016** **+0.036** -0.0006 +0.0013	**0.016T** **0.071L** 0.0006T 0.0028L	J7	**-0.088** **-0.036** -0.0035 -0.0014	**0.088T** **0.001T** 0.0035T 0.0000	P7	**-0.126** **-0.074** -0.0050 -0.0029	**0.126T** **0.039T** 0.0050T 0.0015T	R7
280.000 11.0236	**315.000** 12.4016											**-0.130** **-0.078** -0.0051 -0.0031	**0.130T** **0.043T** 0.0051T 0.0017T	
315.000 12.4016	**355.000** 13.9764	**0.000** **-0.040** 0.0000 -0.0016	**+0.062** **+0.098** +0.0024 +0.0039	**0.062L** **0.138L** 0.0024L 0.0054L	F6	**-0.018** **+0.039** -0.0007 +0.0015	**0.018T** **0.079L** 0.0007T 0.0031L	J7	**-0.098** **-0.041** -0.0039 -0.0016	**0.098T** **0.001T** 0.0039T 0.0001T	P7	**-0.144** **-0.087** -0.0057 -0.0034	**0.144T** **0.047T** 0.0057T 0.0019T	R7
355.000 13.9764	**400.000** 15.7480											**-0.150** **-0.093** -0.0059 -0.0037	**0.150T** **0.053T** 0.0059T 0.0021T	
400.000 15.7480	**450.000** 17.7165	**0.000** **-0.045** 0.0000 -0.0018	**+0.068** **+0.095** +0.0027 +0.0037	**0.068L** **0.140L** 0.0027L 0.0055L	F5	**-0.020** **+0.043** -0.0008 +0.0017	**0.020T** **0.088L** 0.0008T 0.0035L	J7	**-0.108** **-0.045** -0.0043 -0.0018	**0.108T** **0.000** 0.0043T 0.0000	P7	**-0.166** **-0.103** -0.0065 -0.0041	**0.166T** **0.058T** 0.0065T 0.0023T	R7
450.000 17.7165	**500.000** 19.6850											**-0.172** **-0.109** -0.0068 -0.0043	**0.172T** **0.064T** 0.0068T 0.0025T	
500.000 19.6850	**630.000** 24.8032	**0.000** **-0.050** 0.0000 -0.0020	**+0.065** **+0.115** +0.0026 +0.0045	**0.065L** **0.165L** 0.0026L 0.0065L	–	**-0.022** **+0.046** -0.0009 +0.0018	**0.022T** **0.096L** 0.0009T 0.0038L	–	**-0.118** **-0.050** -0.0046 -0.0020	**0.118T** **0.000** 0.0046T 0.0000	–	**-0.190** **-0.120** -0.0075 -0.0047	**0.190T** **0.070T** 0.0075T 0.0028T	R7
630.000 24.8032	**800.000** 31.4961	**0.000** **-0.080** 0.0000 -0.0031	**+0.075** **+0.150** +0.0030 +0.0059	**0.075L** **0.225L** 0.0030L 0.0089L	–	**-0.025** **+0.050** -0.0098 +0.0020	**0.025T** **0.130L** 0.0098T 0.0051L	–	**-0.150** **-0.075** -0.0059 -0.0030	**0.150T** **0.000** 0.0059T 0.0000	–	–	–	R7
800.000 31.4961	**1000.000** 39.3701	**0.000** **-0.100** 0.0000 -0.0039	**+0.075** **+0.175** +0.0030 +0.0069	**0.075L** **0.275L** 0.0030L 0.0108L	–	**-0.025** **+0.075** -0.0098 +0.0030	**0.025T** **0.175L** 0.0098T 0.0069L	–	**-0.200** **-0.100** -0.0079 -0.0039	**0.200T** **0.000** 0.0079T 0.0000	–	–	–	R7

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

INNER RING – Industrial Equipment Classes 4 and 2 (Inch)



Deviation from nominal (minimum) bearing bore and resultant fit.

T= Tight
L = Loose

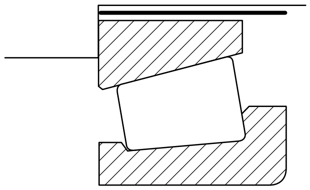
TABLE 24. TAPERED ROLLER BEARINGS – INNER RING – Industrial Equipment Classes 4 and 2 (Inch)

Inner Ring Bore		Tolerance[1]	Rotating Inner Ring		Rotating or Stationary Inner Ring		Stationary Inner Ring							
Range			Ground Seat		Unground or Ground Seat		Unground Seat		Ground Seat		Unground Seat		Hardened and Ground Seat	
			Constant Loads With Moderate Shock		Heavy Loads, or High Speed Or Shock		Moderate Loads, No Shock		Moderate Loads, No Shock		Sheaves, Wheels, Idlers		Wheel Spindles	
Over	Incl.		Inner Ring Seat Deviation	Resultant Fit	Inner Ring Seat Deviation	Resultant Fit	Inner Ring Seat Deviation	Resultant Fit	Inner Ring Seat Deviation	Resultant Fit	Inner Ring Seat Deviation	Resultant Fit	Inner Ring Seat Deviation	Resultant Fit
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.
0.000 0.0000	**76.200** 3.0000	**0.000** **+0.013** 0.0000 +0.0005	**+0.038**[2] **+0.026** +0.0015 +0.0010	**0.038T** **0.012T** 0.0015T 0.0005T	**+0.064** **+0.038** +0.0025 +0.0015	**0.064T** **0.025T** 0.0025T 0.0010T	**+0.013** **0.000** +0.0005T 0.0000	**0.013T** **0.013L** 0.0005T 0.0005L	**0.000** **-0.013** 0.0000 -0.0005	**0.000** **0.026L** 0.0000 0.0010L	**0.000** **-0.013** 0.0000 -0.0005	**0.000** **0.026L** 0.0000 0.0010L	**-0.005** **-0.018** -0.0002 -0.0007	**0.005L** **0.031L** 0.0002L 0.0012L
76.200 3.0000	**304.800** 12.0000	**0.000** **+0.025** 0.0000 +0.0010	**+0.064** **+0.038** +0.0025 +0.0015	**0.064T** **0.013T** 0.0025T 0.0005T			**+0.025** **0.000** +0.0010 0.0000	**0.025T** **0.025L** 0.0010T 0.0010L	**0.000** **-0.025** 0.0000 -0.0010	**0.000** **0.051L** 0.0000 0.0020L	**0.000** **-0.025** 0.0000 -0.0010	**0.000** **0.051L** 0.0000 0.0020L	**-0.005** **-0.031** -0.0002 -0.0012	**0.005L** **0.056L** 0.0002L 0.0022L
304.800 12.0000	**609.600** 24.0000	**0.000** **+0.051** 0.0000 +0.0020	**+0.127** **+0.076** +0.0050 +0.0030	**0.127T** **0.025T** 0.0050T 0.0010T	Use Average Tight Inner Ring Fit of 0.0005 mm/mm (0.0005in./in.) of Inner Ring Bore[3]		**+0.051** **0.000** +0.0020 0.0000	**0.051T** **0.051L** 0.0020T 0.0020L	**0.000** **-0.051** 0.0000 -0.0020	**0.000** **0.102L** 0.0000 0.0040L	**0.000** **-0.051** 0.0000 -0.0020	**0.000** **0.102L** 0.0000 0.0040L	–	–
609.600 24.0000	**914.400** 36.0000	**0.000** **+0.076** 0.0000 +0.0030	**+0.191** **+0.114** +0.0075 +0.0015T				**+0.076** **0.000** +0.0030 0.0000	**0.076T** **0.076L** 0.0030T 0.0030L	**0.000** **-0.076** 0.0000 -0.0030	**0.000** **0.152L** 0.0000 0.0060L	**0.000** **-0.076** 0.0000 -0.0030	**0.000** **0.152L** 0.0000 0.0060L	–	–

[1]Does not apply to TNASW and TNASWE type bearings.
[2]Example: If the minimum inner ring bore is 76.200 mm (3.0000 in.) the suggested shaft size = 76.238 mm (3.0015 in.) to 76.225 mm (3.0010 in.) for an inner ring fit of 0.038 mm (0.0015 in.) tight to 0.012 mm (0.0005 in.) tight.
[3]For inner ring bores between 76.200 mm (3.0000 in.) and 101.600 mm (4.0000 in.) use a minimum fit of 0.025 mm (0.0001 in.) tight.

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

OUTER RING – Industrial Equipment Classes 4 and 2 (Inch)



Deviation from nominal (minimum) bearing O.D. and resultant fit.

T= Tight
L = Loose

TABLE 25. TAPERED ROLLER BEARINGS – OUTER RING – Industrial Equipment Classes 4 and 2 (Inch)

Outer Ring O.D.		Tolerance	Stationary Outer Ring				Stationary Or Rotating Outer Ring		Rotating Outer Ring	
Range			Floating or Clamped		Adjustable		Non-adjustable or In Carriers, Sheaves - Clamped		Sheaves - Unclamped[1]	
Over	Incl.		Outer Ring Seat Deviation	Resultant Fit	Outer Ring Seat Deviation	Resultant Fit	Outer Ring Seat Deviation	Resultant Fit	Outer Ring Seat Deviation	Resultant Fit
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
0.000 0.0000	**76.200** 3.0000	**+0.025** **0.000** +0.0010 0.0000	**+0.050** **+0.076** +0.0020 +0.0030	**0.026L** **0.076L** 0.0010L 0.0030L	**0.000** **+0.025** 0.0000 +0.0010	**0.025T** **0.025L** 0.0010T 0.0010L	**-0.039** **-0.013** -0.0015 -0.0005	**0.064T** **0.013T** 0.0025T 0.0005T	**-0.077** **-0.051** -0.0030 -0.0020	**0.102T** **0.051T** 0.0040T 0.0020T
76.200 3.0000	**127.000** 5.0000	**+0.025** **0.000** +0.0010 0.0000	**+0.050** **+0.076** +0.0020 +0.0030	**0.026L** **0.076L** 0.0010L 0.0030L	**0.000** **+0.025** 0.0000 +0.0010	**0.025T** **0.025L** 0.0010T 0.0010L	**-0.051** **-0.025** -0.0020 -0.0010	**0.076T** **0.025T** 0.0030T 0.0010T	**-0.077** **-0.051** -0.0030 -0.0020	**0.102T** **0.051T** 0.0040T 0.0020T
127.000 5.0000	**304.800** 12.0000	**+0.025** **0.000** +0.0010 0.0000	**+0.050** **+0.076** +0.0020 +0.0030	**0.026L** **0.076L** 0.0010L 0.0030L	**0.000** **+0.051** 0.0000 +0.0020	**0.025T** **0.051L** 0.0010T 0.0020L	**-0.051** **-0.025** -0.0020 -0.0010	**0.076T** **0.025T** 0.0030T 0.0010T	**-0.077** **-0.051** -0.0030 -0.0020	**0.102T** **0.051T** 0.0040T 0.0020T
304.800 12.0000	**609.600** 24.0000	**+0.051** **0.000** +0.0020 0.0000	**+0.102** **+0.152** +0.0040 +0.0060	**0.051L** **0.152L** 0.0020L 0.0060L	**+0.026** **+0.076** +0.0010 +0.0030	**0.025T** **0.076L** 0.0010T 0.0030L	**-0.076** **-0.025** -0.0030 -0.0010	**0.127T** **0.025T** 0.0050T 0.0010T	**-0.102** **-0.051** -0.0040 -0.0020	**0.153T** **0.051T** 0.0060T 0.0020T
609.600 24.0000	**914.400** 36.0000	**+0.076** **0.000** +0.0030 0.0000	**+0.152** **+0.229** +0.0060 +0.0090	**0.076L** **0.229L** 0.0030L 0.0090L	**+0.051** **+0.127** +0.0020 +0.0050	**0.025T** **0.0127L** 0.0010T 0.0050L	**-0.102** **-0.025** -0.0040 -0.0010	**0.178T** **0.025T** 0.0070T 0.0010T	–	–

[1]Unclamped outer ring design is applicable only to sheaves with negligible fleet angle.

FITTING PRACTICE TABLES

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

INNER RING – Automotive Equipment Class 4 and 2 (Inch)

Deviation from nominal (minimum) bearing bore and resultant fit.

T= Tight
L = Loose

TABLE 26. TAPERED ROLLER BEARINGS – INNER RING
Automotive Equipment Classes 4 and 2 (Inch)

Inner Ring Bore		Tolerance	Shaft O.D.					
			Stationary Inner Ring		Rotating Inner Ring			
			Front Wheels Rear Wheel (Full-Floating Axles) Trailer Wheels		Rear Wheels (Semi-Floating Axles)		Rear Wheels (Unit-Bearing) (Semi-Floating Axles)	
			Non-adjustable					
Over	Incl.		Shaft O.D. Deviation	Resultant Fit	Shaft O.D. Deviation	Resultant Fit	Shaft O.D. Deviation	Resultant Fit
mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.	mm in.
0.000 0.0000	**76.200** 3.0000	**0.000** **+0.0013** 0.0000 +0.0005	**-0.005** **-0.018** -0.0002 -0.0007	**0.005L** **0.031L** 0.0002L 0.0012L	**+0.051** **+0.038** +0.0020 +0.0015	**0.051T** **0.025T** 0.0020T 0.0010T	**+0.056** **+0.038** +0.0022 +0.0015	**0.056T** **0.025T** 0.0022T 0.0010T
76.200 3.0000	**304.800** 12.0000	**0.000** **+0.0025** 0.0000 +0.0010	**-0.0013** **-0.038** -0.0050 -0.0015	**0.013L** **0.063L** 0.0005L 0.0025L	**+0.076** **+0.051** +0.0030 +0.0020	**0.076T** **0.026T** 0.0030T 0.0010T	–	–

OUTER RING – Automotive Equipment Classes 4 and 2 (Inch)

TABLE 27. TAPERED ROLLER BEARINGS – OUTER RING
Automotive Equipment Classes 4 and 2 (Inch)

Outer Ring O.D.		Tolerance	Housing Bore	
			Rotating Outer Ring	
			Front Wheels	Rear Wheels (Full-Floating Trailer Wheels)
			Non-adjustable	
Over	Incl.		Housing Bore Deviation	Resultant Fit
mm in.	mm in.	mm in.	mm in.	mm in.
0.000 0.0000	**76.200** 3.0000	**+0.025** **0.000** +0.0010 0.0000	**-0.051** **-0.013** -0.0020 -0.0005	**0.076T** **0.013T** 0.0030T 0.0005T
76.200 3.0000	**127.000** 5.0000	**+0.025** **0.000** +0.0010 0.0000	**-0.077** **-0.025** -0.0030 -0.0010	**0.102T** **0.025T** 0.0040T 0.0010T
127.000 5.0000	**304.800** 12.0000	**+0.025** **0.000** +0.0010 0.0000	**-0.077** **-0.025** -0.0030 -0.0010	**0.102T** **0.025T** 0.0040T 0.0010T

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

Shaft O.D.									
Rotating Inner Ring									
Pinion						Differential		Transaxles Transmissions Transfer Cases Cross Shafts	
Clamped		Collapsible Spacer		Non-adjustable		Non-adjustable		Non-adjustable	
Shaft O.D. Deviation	Resultant Fit	Shaft O.D. Deviation	Resultant Fit	Shaft O.D. Deviation	Resultant Fit	Shaft O.D. Deviation	Resultant Fit	Shaft O.D. Deviation	Resultant Fit
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
+0.025 **+0.013** +0.0010 +0.0005	**0.025T** **0.000** 0.0010T 0.0000	**+0.030** **+0.018** +0.0012 +0.0007	**0.030T** **0.005T** 0.0012T 0.0002T	**+0.051** **+0.038** +0.0020 +0.0015	**0.051T** **0.025T** 0.0020T 0.0010T	**+0.102** **+0.064** +0.0040 +0.0025	**0.102T** **0.051T** 0.0040T 0.0020T	**+0.038** **+0.025** +0.0015 +0.0010	**0.038T** **0.012T** 0.0015T 0.0005T
+0.038 **+0.013** +0.0015 +0.0005	**0.038T** **0.012T** 0.0015T 0.0005T	–	–	**+0.076** **+0.051** +0.0030 +0.0020	**0.076T** **0.026T** 0.0030T 0.0010T	**+0.102** **+0.076** +0.0040 +0.0025	**0.102T** **0.051T** 0.0040T 0.0020T	**+0.064** **+0.038** +0.0025 +0.0015	**0.064T** **0.013T** 0.0025T 0.0005T

Housing Bore							
Stationary Outer Ring							
Rear Wheels	(Semi-Floating Axles)	Differential	(Split Seat)	Transmissions	Transfer Cases Cross Shafts	Pinion (Solid Seat) Transmission	Differential Transaxles Transfer Cases
Adjustable (TS) Clamped (TSU)		Adjustable		Adjustable		Non-adjustable	
Housing Bore Deviation	Resultant Fit	Housing Bore Deviation	Resultant Fit	Housing Bore Deviation	Resultant Fit	Housing Bore Deviation	Resultant Fit
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.
+0.038 **+0.076** +0.0015 +0.0030	**0.013L** **0.076L** 0.0005L 0.0030L	**+0.025** **+0.051** +0.0010 +0.0020	**0.000** **0.051L** 0.0000 0.0020L	**0.000** **+0.025** 0.000 +0.0010	**0.025T** **0.025L** 0.0010T 0.0010L	**-0.038** **-0.013** -0.0015 -0.0005	**0.063T** **0.013T** 0.0025T 0.0005T
+0.038 **+0.076** +0.0015 +0.0030	**0.013L** **0.076L** 0.0005L 0.0030L	**+0.025** **+0.051** +0.0010 +0.0020	**0.000** **0.051L** 0.0000 0.0020L	**0.000** **+0.025** 0.0000 +0.0010	**0.025T** **0.025L** 0.0010T 0.0010L	**-0.051** **-0.025** -0.0020 -0.0010	**0.076T** **0.025T** 0.0030T 0.0010T
–	–	**0.000** **+0.051** 0.0000 +0.0020	**0.025T** **0.051L** 0.0010T 0.0020L	**0.000** **+0.051** 0.0000 +0.0020	**0.025T** **0.051L** 0.0010T 0.0020L	**-0.077** **-0.025** -0.0030 -0.0010	**0.102T** **0.025T** 0.0040T 0.0010T

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

INNER RING – Automotive Equipment Classes K and N (Metric)

TABLE 28. TAPERED ROLLER BEARINGS – INNER RING – Automotive Equipment Classes K and N (Metric)

Inner Ring Bore		Tolerance	Shaft O.D.								
			Stationary Inner Ring			Rotating Inner Ring					
			Front Wheels Rear Wheel (Full-Floating Axles) Trailer Wheels			Rear Wheels (Semi-Floating Axles)			Rear Wheels (Unit-Bearing) (Semi-Floating Axles)		
			Non-adjustable			Non-adjustable			Non-adjustable		
Over	Incl.		Shaft O.D. Deviation	Resultant Fit	Symbol	Shaft O.D. Deviation	Resultant Fit	Symbol	Shaft O.D. Deviation	Resultant Fit	Symbol
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.		**mm** in.	**mm** in.		**mm** in.	**mm** in.	
18.000 0.7087	**30.000** 1.1811	**-0.012** **0.000** -0.0005 0.0000	**-0.020** **-0.033** -0.0008 -0.0013	**0.008L** **0.033L** 0.0003L 0.0013L	f6	**+0.035** **+0.022** +0.0013 +0.0008	**0.047T** **0.022T** 0.0018T 0.0008T	p6	**+0.035** **+0.022** +0.0013 +0.0008	**0.047T** **0.022T** 0.0018T 0.0008T	p6
30.000 1.1811	**50.000** 1.9685	**-0.012** **0.000** -0.0005 0.0000	**-0.025** **-0.041** -0.0010 -0.0016	**0.013L** **0.041L** 0.0005L 0.0016L	f6	**+0.042** **+0.026** +0.0016 +0.0010	**0.054T** **0.026T** 0.0021T 0.0010T	p6	**+0.042** **+0.026** +0.0016 +0.0010	**0.054T** **0.026T** 0.0021T 0.0010T	p6
50.000 1.9685	**80.000** 3.1496	**-0.015** **0.000** -0.0006 0.0000	**-0.030** **-0.049** -0.0012 -0.0019	**0.015L** **0.049L** 0.0006L 0.0019L	f6	**+0.051** **+0.032** +0.0021 +0.0014	**0.066T** **0.032T** 0.0027T 0.0014T	p6	–	–	–
80.000 3.1496	**120.000** 4.7244	**-0.020** **0.000** -0.0008 0.0000	**-0.035** **-0.058** -0.0014 -0.0023	**0.016L** **0.058L** 0.0006L 0.0023L	f6	**+0.045** **+0.023** +0.0019 +0.0010	**0.065T** **0.023T** 0.0027T 0.0010T	n6	–	–	–
120.000 4.7244	**180.000** 7.0866	**-0.025** **0.000** -0.0010 0.0000	**-0.043** **-0.068** -0.0016 -0.0026	**0.018L** **0.068L** 0.0006L 0.0026L	f6	**+0.052** **+0.027** +0.0022 +0.0012	**0.077T** **0.029T** 0.0032T 0.0012T	n6	–	–	–

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

Shaft O.D.														
Rotating Inner Ring														
Pinion									Differential			Transaxles, Transmissions Transfer Cases, Cross Shafts		
Clamped			Collapsible Spacer			Non-adjustable			Non-adjustable			Non-adjustable		
Shaft O.D. Deviation	Resultant Fit	Symbol	Shaft O.D. Deviation	Resultant Fit	Symbol	Shaft O.D. Deviation	Resultant Fit	Symbol	Shaft O.D. Deviation	Resultant Fit	Symbol	Shaft O.D. Deviation	Resultant Fit	Symbol
mm in.	**mm** in.		**mm** in.	**mm** in.		**mm** in.	**mm** in.		**mm** in.	**mm** in.		**mm** in.	**mm** in.	
+0.015 **+0.002** +0.0006 +0.0001	**0.027T** **0.002T** 0.0011T 0.0001T	k6	**+0.015** **+0.002** +0.0006 +0.0001	**0.027T** **0.002T** 0.0011T 0.0001T	k6	**+0.035** **+0.022** +0.0013 +0.0009	**0.047T** **0.022T** 0.0018T 0.0009T	p6	**+0.056** **+0.035** +0.0022 +0.0014	**0.068T** **0.035T** 0.0027T 0.0014T		**+0.021** **+0.008** +0.0008 +0.0003	**0.033T** **0.008T** 0.0013T 0.0003T	m6
+0.018 **+0.002** +0.0007 +0.0001	**0.030T** **0.002T** 0.0012T 0.0001T	k6	**+0.018** **+0.002** +0.0007 +0.0001	**0.030T** **0.002T** 0.0012T 0.0001T	k6	**+0.042** **+0.026** +0.0016 +0.0010	**0.054T** **0.026T** 0.0021T 0.0010T	p6	**+0.068** **+0.043** +0.0028 +0.0018	**0.080T** **0.043T** 0.0033T 0.0018T		**+0.025** **+0.009** +0.0010 +0.0004	**0.037T** **0.009T** 0.0015T 0.0004T	m6
+0.021 **+0.002** +0.0008 -0.0001	**0.036T** **0.002T** 0.0014T 0.0001L	k6	**+0.021** **+0.002** +0.0008 +0.0001	**0.036T** **0.002T** 0.0014T 0.0001L	k6	**+0.051** **+0.032** +0.021 +0.014	**0.066T** **0.032T** 0.0027T 0.0014T	p6	**+0.0089** **+0.059** +0.0034 +0.0022	**0.104T** **0.059T** 0.0040T 0.0022T		**+0.030** **+0.011** +0.0012 +0.0004	**0.045T** **0.011T** 0.0018T 0.0004T	m6
+0.013 **-0.009** +0.0005 -0.0004	**0.033T** **0.009L** 0.0013T 0.0004L	j6	–	–	–	**+0.045** **+0.023** +0.0019 +0.0010	**0.065T** **0.023T** 0.0027T 0.0010T	n6	**+0.114** **+0.079** +0.0044 +0.0030	**0.134T** **0.079T** 0.0052T 0.0030T		**+0.035** **+0.013** +0.0014 +0.0005	**0.055T** **0.013T** 0.0022T 0.0005T	m6
+0.014 **-0.011** +0.0006 -0.0004	**0.039T** **0.011L** 0.0016T 0.0004L	j6	–	–	–	**+0.052** **+0.028** +0.0022 +0.0012	**0.077T** **0.029T** 0.0032T 0.0012T	n6	**+0.140** **+0.100** +0.0056 +0.0040	**0.165T** **0.100T** 0.0066T 0.0040T		**+0.040** **+0.015** +0.0016 +0.0006	**0.066T** **0.015T** 0.0026T 0.0006T	–

FITTING PRACTICE TABLES

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

OUTER RING – Automotive Equipment Classes K and N (Metric)

Deviation from nominal (maximum) bearing bore and resultant fit.

T= Tight
L = Loose

TABLE 29. TAPERED ROLLER BEARINGS – OUTER RING – Automotive Equipment Classes K and N (Metric)

Outer Ring O.D.		Tolerance	Housing Bore														
			Rotating Outer Ring			Stationary Outer Ring											
			Front Wheels Rear Wheels (Full-Floating Trailer Wheels)			Rear Wheels (Semi-Floating Axles)			Differential (Split Seat)			Transmissions Transfer Cases Cross Shafts			Pinion Differential (Solid Seat) Transaxles Transmission[(1)] Transfer Cases		
			Non-adjustable			Adjustable (TS) Clamped (TSU)			Adjustable			Adjustable			Non-adjustable		
Over	Incl.		Housing Bore Deviation	Resultant Fit	Symbol	Housing Bore Deviation	Resultant Fit	Symbol	Housing Bore Deviation	Resultant Fit	Symbol	Housing Bore Deviation	Resultant Fit	Symbol	Housing Bore Deviation	Resultant Fit	Symbol
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.	
30.000 1.1811	**50.000** 1.9685	**0.000** **-0.014** 0.0000 -0.0006	**-0.050** **-0.025** -0.0020 -0.0010	**0.050T** **0.011T** 0.0020T 0.0004T	R7	**+0.009** **+0.034** +0.0004 +0.0014	**0.009L** **0.048L** 0.0004L 0.0020L	G7	**0.000** **+0.025** 0.0000 +0.0010	**0.000** **0.039L** 0.0000 0.0016L	H7	**-0.013** **+0.003** -0.0005 +0.0001	**0.013T** **0.017L** 0.0005T 0.0007L	K6	**-0.050** **-0.025** -0.0020 -0.0010	**0.050T** **0.011T** 0.0020T 0.0004T	R7
50.000 1.9685	**65.000** 2.5591	**0.000** **-0.016** 0.0000 -0.0006	**-0.060** **-0.030** -0.0023 -0.0011	**0.060T** **0.014T** 0.0023T 0.0005T	R7	**+0.010** **+0.040** +0.0004 +0.0016	**0.010L** **0.056L** 0.0004L 0.0022L	G7	**0.000** **+0.030** 0.0000 +0.0012	**0.000** **0.046L** 0.0000 0.0018L	H7	**-0.015** **+0.004** -0.0006 +0.0001	**0.015T** **0.020L** 0.0006T 0.0007L	K6	**-0.060** **-0.030** -0.0023 -0.0011	**0.060** **0.014T** 0.0023T 0.0005T	R7
65.000 2.5591	**80.000** 3.1496	**0.000** **-0.016** 0.0000 -0.0006	**-0.062** **-0.032** -0.0023 -0.0011	**0.062T** **0.016T** 0.0023T 0.0005T											**-0.062** **-0.032** -0.0023 -0.0011	**0.062T** **0.016T** 0.0023T 0.0005T	
80.000 3.1496	**100.000** 3.9370	**0.000** **-0.018** 0.0000 -0.0007	**-0.073** **-0.038** -0.0029 -0.0015	**0.073T** **0.020T** 0.0029T 0.0008T	R7	**+0.012** **+0.047** +0.0005 +0.0029	**0.012L** **0.065L** 0.0005L 0.0026L	G7	**0.000** **+0.035** 0.0000 +0.0014	**0.000** **0.053L** 0.0000 0.0021L	H7	**-0.018** **+0.004** -0.0007 +0.0002	**0.018T** **0.022L** 0.0007T 0.0009L	K6	**-0.073** **-0.038** -0.0029 -0.0015	**0.073T** **0.020T** 0.0029T 0.0008T	R7
100.000 3.9370	**120.000** 4.7244	**0.000** **-0.018** 0.0000 -0.0007	**-0.076** **-0.041** -0.0029 -0.0015	**0.076T** **0.023T** 0.0029T 0.0008T											**-0.076** **-0.041** -0.0029 -0.0015	**0.076T** **0.023T** 0.0029T 0.0008T	
120.000 4.7244	**140.000** 5.5118	**0.000** **-0.020** 0.0000 -0.0008	**-0.088** **-0.048** -0.0035 -0.0019	**0.088T** **0.028T** 0.0035T 0.0011T	R7	**+0.014** **+0.054** +0.0006 +0.0022	**0.014L** **0.074L** 0.0006L 0.0030L	G7	**-0.014** **+0.026** -0.0006 +0.0010	**0.014T** **0.046L** 0.0006L 0.0018L	J7	**-0.021** **+0.004** -0.0008 +0.0002	**0.021T** **0.024L** 0.0008T 0.0010L	K6	**-0.088** **-0.048** -0.0035 -0.0019	**0.088T** **0.028T** 0.0035T 0.0011T	R7
140.000 5.5118	**150.000** 5.9055	**0.000** **-0.020** 0.0000 -0.0008	**-0.090** **-0.050** -0.0035 -0.0019	**0.090T** **0.030T** 0.0035T 0.0011T											**-0.090** **-0.050** -0.0035 -0.0019	**0.090T** **0.030T** 0.0035T 0.0011T	
150.000 5.9055	**160.000** 6.2992	**0.000** **-0.025** 0.0000 -0.0010	**-0.090** **-0.050** -0.0035 -0.0019	**0.090T** **0.025T** 0.0035T 0.0009T	R7	**+0.014** **+0.054** +0.0006 +0.0022	**0.014L** **0.079L** 0.0006L 0.0032L	G7	**-0.014** **+0.026** -0.0006 +0.0010	**0.014T** **0.051L** 0.0006T 0.0020L	J7	**-0.021** **+0.004** -0.0008 +0.0002	**0.021T** **0.029L** 0.0008T 0.0012L	K6	**-0.090** **-0.050** -0.0035 -0.0019	**0.090T** **0.025T** 0.0035T 0.0009T	R7
160.000 6.2992	**180.000** 7.0866	**0.000** **-0.025** 0.0000 -0.0010	**-0.093** **-0.053** -0.0035 -0.0019	**0.093T** **0.028T** 0.0035T 0.0009T											**-0.093** **-0.053** -0.0035 -0.0019	**0.093T** **0.028T** 0.0035T 0.0009T	

(1)Aluminum housings min. fit of 0.025 mm (0.001 in.) per inch of outer ring O.D. Magnesium housing min. fit of 0.038 mm (0.0015 in.) per inch of outer ring O.D.

Continued on next page.

These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

Table 29 continued.

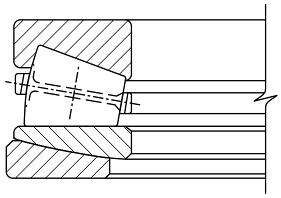
Housing Bore																	
Outer Ring O.D.		Tolerance	Rotating Outer Ring			Stationary Outer Ring											
			Front Wheels Rear Wheels (Full-Floating Trailer Wheels)			Rear Wheels (Semi-Floating Axles)			Differential (Split Seat)			Transmissions Transfer Cases Cross Shafts			Pinion Differential (Solid Seat) Transaxles Transmission[(1)] Transfer Cases		
			Non-adjustable			Adjustable (TS) Clamped (TSU)			Adjustable			Adjustable			Non-adjustable		
Over	Incl.		Housing Bore Deviation	Resultant Fit	Symbol	Housing Bore Deviation	Resultant Fit	Symbol	Housing Bore Deviation	Resultant Fit	Symbol	Housing Bore Deviation	Resultant Fit	Symbol	Housing Bore Deviation	Resultant Fit	Symbol
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.	
180.000 7.0866	**200.000** 7.8740	**0.000** **-0.030** 0.0000 -0.0012	**-0.106** **-0.060** -0.0042 -0.0024	**0.106T** **0.030T** 0.0042T 0.0012T											**-0.106** **-0.060** -0.0042 -0.0024	**0.106T** **0.030T** 0.0042T 0.0012T	
200.000 7.8740	**225.000** 8.8583	**0.000** **-0.030** 0.0000 -0.0012	**-0.109** **-0.063** -0.0042 -0.0024	**0.109T** **0.033T** 0.0042T 0.0012T	R7	–	–	–	**-0.016** **+0.030** -0.0007 +0.0011	**0.016T** **0.060L** 0.0007T 0.0023L	J7	**-0.016** **+0.030** -0.0007 +0.0011	**0.016T** **0.060L** 0.0007T 0.0023L	J7	**-0.109** **-0.063** -0.0042 -0.0024	**0.109T** **0.033T** 0.0042T 0.0012T	R7
225.000 8.8583	**250.000** 9.8425	**0.000** **-0.030** 0.0000 -0.0012	**-0.113** **-0.067** -0.0042 -0.0024	**0.113T** **0.037T** 0.0042T 0.0012T											**-0.113** **-0.067** -0.0042 -0.0024	**0.113T** **0.037T** 0.0042T 0.0012T	
250.000 9.8425	**280.000** 11.0236	**0.000** **-0.035** 0.0000 -0.0014	**-0.126** **-0.074** -0.0047 -0.0027	**0.126T** **0.039T** 0.0047T 0.0013T	R7	–	–	–	**-0.016** **+0.036** -0.0007 +0.0013	**0.016T** **0.071L** 0.0007T 0.0027L	J7	**-0.016** **+0.036** -0.0007 +0.0014	**0.016T** **0.071L** 0.0007T 0.0027L	J7	**-0.126** **-0.074** -0.0047 -0.0027	**0.126T** **0.039T** 0.0047T 0.0013T	R7
280.000 11.0236	**315.000** 12.4016	**0.000** **-0.035** 0.0000 -0.0014	**-0.130** **-0.078** -0.0047 -0.0027	**0.130T** **0.043T** 0.0047T 0.0013T											**-0.130** **-0.078** -0.0047 -0.0027	**0.130T** **0.043T** 0.0047T 0.0013T	

[(1)]Aluminum housings min. fit of 0.025 mm (0.001 in.) per inch of outer ring O.D. Magnesium housing min. fit of 0.038 mm (0.0015 in.) per inch of outer ring O.D.

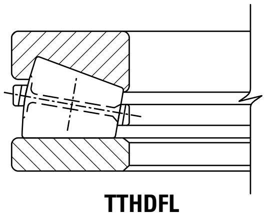
These charts are guidelines for specifying shaft and housing fits related to particular operating conditions. Please contact your Timken engineer for more information.

THRUST TAPERED ROLLER BEARINGS

Tolerances for housing bore and shaft diameters are shown as variance from nominal bearing dimension. When one ring is piloted by the housing, sufficient clearances must be allowed at the outside diameter of the other ring as well as at the bore of both rings to prevent cross-loading of the rollers. For most applications, this clearance is approximately 1⁄16 in. (1.588 mm, 0.0625 in.).



TTVS



TTHDFL

TABLE 30. THRUST TAPERED ROLLER BEARINGS TYPE TTVS AND TTHDFL – SHAFT DIAMETERS

Bearing Bore Nominal (Min.) Over	Bearing Bore Nominal (Min.) Incl.	Shaft Diameter Min.(1)
mm in.	**mm** in.	**mm** in.
0.000 0.0000	**304.800** 12.0000	**-0.051** -0.0020
304.800 12.0000	**508.000** 20.0000	**-0.051** -0.0020
508.000 20.0000	**711.200** 28.0000	**-0.076** -0.0030
711.200 28.0000	**1219.200** 48.0000	**-0.102** -0.0040
1219.200 48.0000	**1727.200** 68.0000	**-0.127** -0.0050

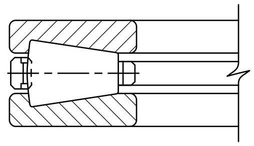
(1)Tolerance range is from +0 to value listed.

TABLE 31. THRUST TAPERED ROLLER BEARINGS TYPE TTVS AND TTHDFL – HOUSING DIAMETERS

Bearing Bore Nominal (Min.) Over	Bearing Bore Nominal (Min.) Incl.	Housing Bore Max.	Housing Bore Min.
mm in.	**mm** in.	**mm** in.	**mm** in.
161.925 6.3750	**265.113** 10.4375	**+0.060** +0.0025	**+0.025** +0.0010
265.113 10.3475	**317.500** 12.5000	**+0.076** +0.0030	**+0.025** +0.0010
317.500 12.5000	**482.600** 19.0000	**+0.102** +0.0040	**+0.051** +0.0020
482.600 19.0000	**603.250** 23.7500	**+0.113** +0.0045	**+0.051** +0.0020
603.250 23.7500	**711.200** 28.0000	**+0.152** +0.0060	**+0.076** +0.0030
711.200 28.0000	**838.200** 33.0000	**+0.178** +0.0070	**+0.076** +0.0030

TABLE 32. THRUST TAPERED ROLLER BEARINGS – TTHD BEARINGS – FITTING GUIDELINES

Bore		Rotating Ring						Stationary Ring	
		Class 2			Class 3			Class 2 and 3	
Over	Incl.	Tolerance	Shaft O.D. Deviation	Resultant Fit	Tolerance	Shaft O.D. Deviation	Resultant Fit		
mm in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.	**mm** in.		
0.000 0.0000	**304.800** 12.0000	**0.000** **+0.025** 0.0000 +0.0010	**+0.076** **+0.050** +0.0030 +0.0020	**0.076T** **0.025T** 0.0030T 0.0010T	**0.000** **+0.013** 0.0000 +0.0005	**+0.051** **+0.038** +0.0020 +0.0015	**0.051T** **0.025T** 0.0020T 0.0010T	All sizes	Provide a minimum radial clearance of 2.5 mm (0.1 in.) between ring bore and shaft O.D.
304.800 12.0000	**609.600** 24.0000	**0.000** **+0.051** 0.0000 +0.0020	**+0.152** **+0.102** +0.0060 +0.0040	**0.152T** **0.051T** 0.0060T 0.0020T	**0.000** **+0.025** 0.0000 +0.0010	**+0.102** **+0.076** +0.0040 +0.0030	**0.102T** **0.051T** 0.0040T 0.0020T		
609.600 24.0000	**914.400** 36.0000	**0.000** **+0.076** 0.0000 +0.0030	**+0.204** **+0.127** +0.0080 +0.0050	**0.204T** **0.051T** 0.0080T 0.0020T	**0.000** **+0.038** 0.0000 +0.0015	**+0.127** **+0.089** +0.0050 +0.0035	**0.127T** **0.051T** 0.0050T 0.0020T		
914.400 36.0000	**1219.200** 48.0000	**0.000** **+0.102** 0.0000 +0.0040	**+0.254** **+0.153** +0.0100 +0.0060	**0.254T** **0.051T** 0.0100T 0.0020T	**0.000** **+0.051** 0.0000 +0.0020	**+0.153** **+0.102** +0.0060 +0.0040	**0.153T** **0.051T** 0.0060T 0.0020T		
1219.200 48.0000		**0.000** **+0.127** 0.0000 +0.0050	**+0.305** **+0.178** +0.0120 +0.0070	**0.305T** **0.051T** 0.0120T 0.0020T	**0.000** **+0.076** 0.0000 +0.0030	**+0.204** **+0.127** +0.0080 +0.0050	**0.204T** **0.051T** 0.0080T 0.0020T		



TTHD

- Rotating ring O.D. must have a minimum radial clearance of 2.5 mm (0.1 in.).
- TTHD stationary ring O.D. must have a minimum loose fit of 0.25 to 0.37 mm (0.01 to 0.015 in.).
- TTHDFL ring when stationary may be loose fit on its O.D. (same as the TTHD) or may be 0.025 to 0.076 mm (0.001 to 0.003 in.) tight.

OPERATING TEMPERATURES

Bearings operate in a wide range of applications and environments. In most cases, bearing operating temperature is not an issue. Some applications, however, operate at extreme speeds or in extreme temperature environments. In these cases, care must be taken not to exceed the temperature limits of the bearing. Minimum temperature limits are primarily based on lubricant capability. Maximum temperature limits are most often based on material and/or lubricant constraints, but also may be based on accuracy requirements of the equipment that the bearings are built into. These constraints/limitations are discussed below.

BEARING MATERIAL LIMITATIONS

Standard bearing steels with a standard heat treatment cannot maintain a minimum hardness of 58 HRC much above 120° C (250° F).

Dimensional stability of Timken bearings is managed through the proper selection of an appropriate heat-treat process. Standard Timken tapered roller and ball bearings are dimensionally stabilized from -54° C (-65° F) up to 120° C (250° F), while standard spherical roller bearings are dimensionally stabilized up to 200° C (392° F) and standard cylindrical roller bearings are stabilized up to 150° C (302° F). Upon request, these bearings can be ordered to higher levels of stability as listed below. These designations are in agreement with DIN Standard 623.

TABLE 33.

Stability Designation	Maximum Operating Temperature	
	°C	°F
S0	**150**	302
S1	**200**	392
S2	**250**	482
S3	**300**	572
S4	**350**	662

With dimensionally stabilized product, there still may be some changes in dimensions during service as a result of microstructural transformations. These transformations include the continued tempering of martensite and decomposition of retained austenite. The magnitude of change depends on the operating temperature, the time at temperature and the composition and heat-treatment of the steel.

Temperatures exceeding the limits shown in table 33 require special high-temperature steel. Consult your Timken engineer for availability of specific part numbers for non-standard heat stability or high-temperature steel grades.

Suggested materials for use in balls, rings and rollers at various operating temperatures are listed in table 34. Also listed are chemical composition recommendations, hardness recommendations and dimensional stability information.

Operating temperature affects lubricant film thickness and setting, both of which directly influence bearing life. Extremely high temperatures can result in a reduced film thickness that can lead to asperity contact between contacting surfaces.

Operating temperature also can affect performance of cages, seals and shields, which in turn can affect bearing performance. Materials for these components and their operating temperature ranges are shown in table 35.

LUBRICATION LIMITATIONS

Starting torque in grease-lubricated applications typically increases significantly at cold temperatures. Starting torque is not primarily a function of the consistency or channel properties of the grease. Most often, it is a function of the rheological properties of the grease.

The high-temperature limit for greases is generally a function of the thermal and oxidation stability of the base oil in the grease and the effectiveness of the oxidation inhibitors.

See the LUBRICATION AND SEALS section on page 55 for more information on lubrication limitations.

EQUIPMENT REQUIREMENTS

The equipment designer must evaluate the effects of temperature on the performance of the equipment being designed. Precision machine tool spindles, for example, can be very sensitive to thermal expansions. For some spindles, it is important that the temperature rise over ambient be held to 20° C to 35° C (36° F to 45° F).

Most industrial equipment can operate at considerably higher temperatures. Thermal ratings on gear drives, for example, are based on 93° C (200° F). Equipment such as gas turbines operates continuously at temperatures above 100° C (212° F). Running at high temperatures for extended periods of time, however, may affect shaft and housing fits, if the shaft and housing are not machined and heat-treated properly.

Although bearings can operate satisfactorily up to 120° C (250° F), an upper temperature limit of 80° C to 95° C (176° F to 203° F) is more practical. Higher operating temperatures increase the risk of damage from transient temperature spikes. Prototype testing of the application can help define the operating temperature range and should be conducted if possible. It is the responsibility of the equipment designer to weigh all relevant factors and make the final determination of satisfactory operating temperature.

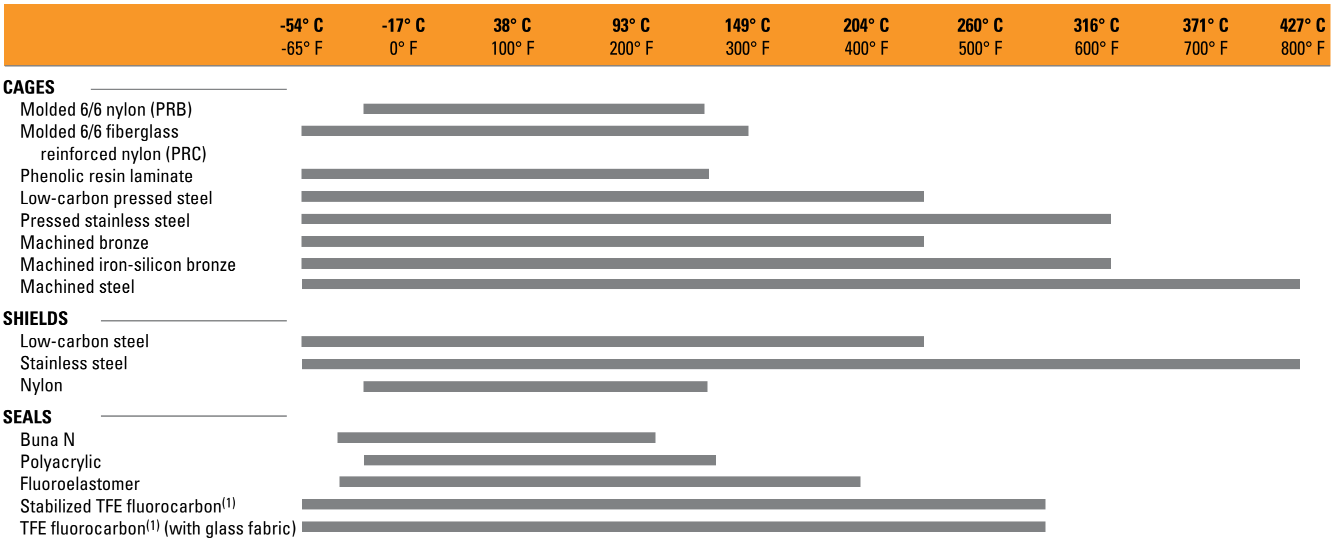
Tables 34 and 35 provide standard operating temperatures for common bearing component materials. They should be used for reference purposes only. Other bearing component materials are available on request. Contact your Timken engineer for more information.

TABLE 34. OPERATING TEMPERATURES FOR BEARING COMPONENT MATERIALS

Material	Approximate Chemical Analysis %	Temp. °F	Hard-ness HRC	-73° C -100° F	-54° C -65° F	-17° C 0° F	38° C 100° F	93° C 200° F	121° C 250° F	149° C 300° F	204° C 400° F	260° C 500° F	316° C 600° F	371° C 700° F	427° C 800° F
Low-alloy carbon-chromium bearing steels. 52100 and others per ASTM A295	1C 0.5–1.5Cr 0.35Mn	70	60		STANDARD DIMENSIONAL STABILIZATION <0.0001 in./in dimensional change in 2500 hours at 100° C (212° F). Good oxidation resistance.										
Low-alloy carbon-chromium bearing steels. 52100 and others per ASTM A295	1C 0.5–1.5Cr 0.35Mn	70 350 450	58 56 54	Heat stabilized per FS136, <0.0001in./in dimensional change in 2500 hours at 149° C (300° F). When given a stabilizing heat treatment, A295 steel is suitable for many applications in the 177°-232° C (350-450° F) range; however, it is not as dimensionally stable as it is at temperatures below 177° C (350° F). If utmost stability is required, use materials in the 316° C (600° F) group below.											
Deep-hardening steels for heavy sections per ASTM A485	1C 1–1.8Cr 1–1.5Mn .06Si	70 450 600	58 55 52	As heat-treated and tempered, it is stabilized, <0.0001 in./in dimensional change in 2500 hours at 149° C (300° F).											
Carburizing steels per ASTM A534 a) low alloy 4118, 8X19, 5019, 8620 (Ni-Moly grades) b) high nickel 3310	Ni-Moly: 0.2C, 0.4-2.0Mn, 0.3-0.8Cr, 0-2.0Ni, 0-0.3Mo .0.1C, 1.5Cr, 0.4Mn, 3.5Ni	70	58		Nickel-Moly grades of steel frequently used to achieve extra ductility in inner rings for locking device bearings. 3311 and others used for extra-thick-section rings.										
Corrosion-resistant 440C stainless steel per ASTM A756	1C 18Cr	70	58		Excellent corrosion resistance.										
Corrosion-resistant 440C stainless steel per ASTM A756	1C 18Cr	70 450 600	58 55 52	As heat stabilized for maximum hardness at high temperatures (FS238). Good oxidation resistance at higher temperatures. Note load capacity drops off more rapidly at higher temperatures than M50 shown below, which should be considered if loads are high, <0.0001 in./in dimensional change in 1200 hours.											
M-50 medium high speed	4Cr 4Mo 1V 0.8C	70 450 600	60 59 57	Suggested where stable high hardness at elevated temperature is required, <0.0001 in./in dimensional change in 1200 hours at 316° C (600° F).											

Note: Dimensional stability data shown above is the permanent metallurgical growth and/or shrinkage only. Thermal expansion effects are not included. For operating temperatures above 427° C (800° F), consult your Timken engineer.

TABLE 35. OPERATING TEMPERATURES FOR BEARING COMPONENT MATERIALS



(1)Limited life above these temperatures.

HEAT GENERATION AND DISSIPATION

Bearing operating temperature is dependent upon a number of factors, including heat generation of all contributing heat sources, heat flow rate between sources and the ability of the system to dissipate the heat. Heat sources include such things as bearings, seals, gears, clutches and oil supply. Heat dissipation is affected by many factors, including shaft and housing materials and designs, lubricant circulation and external environmental conditions. These and other factors are discussed in the following sections.

HEAT GENERATION

Under normal operating conditions, most of the torque and heat generated by the bearing is caused by the elastohydrodynamic losses at the roller/ring contacts.

Heat generation is the product of bearing torque and speed. The following equation is used to calculate the heat generated.

$$Q_{gen} = k_4 n M$$

If the bearing is tapered, the torque can be calculated using the following equation.

$$M = k_1 G_1 (n\mu)^{0.62} (P_{eq})^{0.3}$$

Where:

k_1 = bearing torque constant
= 2.56×10^{-6} for M in N-m
= 3.54×10^{-5} for M in lbf-in.

k_4 = 0.105 for Q_{gen} in W when M in N-m
= 6.73 x 10-4 for Q_{gen} in Btu/min when M in lbf-in.

HEAT DISSIPATION

The problem of determining the heat flow from a bearing in a specific application is rather complex. In general, it can be said that factors affecting the rate of heat dissipation include the following:

1. Temperature gradient from the bearing to the housing. This is affected by size configuration of the house and any external cooling such as fans, water cooling or fan action of the rotating components.
2. Temperature gradient from the bearing to the shaft. Any other heat sources, such as gears and additional bearings and their proximity to the bearing considered, will influence the temperature of the shaft.
3. The heat carried away by a circulating oil system.

To what extent nos. 1 and 2 can be controlled will depend on the application. The heat-dissipation modes include conduction through the system, convection along the inside and outside surfaces of the system, as well as radiation exchange to and from neighboring structures. In many applications, overall heat dissipation can be divided into two categories – heat removed by circulating oil and heat removed through the structure.

Heat dissipation by circulating oil

The amount of heat removed by the lubricant can be controlled more easily. In a splash lubrication system, cooling coils may be used to control the bulk oil temperature.

The amount of heat carried away in a circulating oil system by the lubricant can be approximated from the following equations.

$$Q_{oil} = k_6 C_p \rho f (\theta_o - \theta_i)$$

Where:

k_6 = 1.67×10^{-5} for Q_{oil} in W
= 1.67×10^{-2} for Q_{oil} in Btu/min

If the circulating lubricant is petroleum oil, the heat removed is further approximated by the following:

$$Q_{oil} = k_5 f (\theta_o - \theta_i)$$

The following factors apply to the heat generation and dissipation equations listed on this page.

Where:

k_5 = 28 for Q_{oil} in W when f in L/min and θ in °C
= 0.42 for Q_{oil} in Btu/min when f in U.S. pt/min and θ in °F

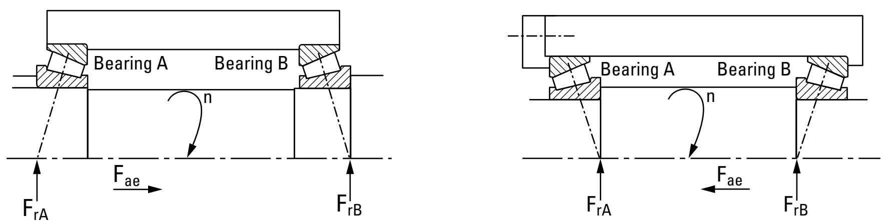
TORQUE

TAPERED ROLLER BEARINGS

RUNNING TORQUE-M

The rotational resistance of a rolling bearing depends on load, speed, lubrication conditions and internal bearing characteristics.

The following formulas yield approximations to values of bearing running torque. The formulas apply to bearings lubricated by oil. For bearings lubricated by grease or oil mist, torque is usually lower, although for grease lubrication this depends on amount and consistency of the grease. The formulas also assume the bearing running torque has stabilized after an initial period referred to as running-in.



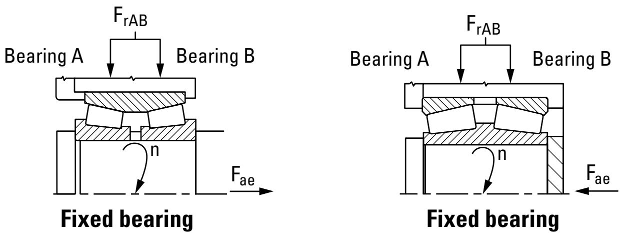
Design (external thrust, F_{ae}, onto bearing A)

Fig. 17. Single-row tapered roller bearing.

TABLE 36. VALUE APPROXIMATIONS OF BEARING RUNNING TORQUE

Thrust Condition	Net Bearing Thrust Load	
$\frac{0.47 F_{rA}}{K_A} \leq \frac{0.47 F_{rB}}{K_B} + F_{ae}$	$F_{aA} = \frac{0.47 F_{rB}}{K_B} + F_{ae}$ $F_{aB} = \frac{0.47 F_{rB}}{K_B}$	$M = k_1 G_1 (n\mu)^{0.62} \left(\frac{f_3 F_r}{K} \right)^{0.3}$ $n_{min} = \frac{k_2}{G_2\mu} \left(\frac{f_2 F_r}{K} \right)^{2/3}$
$\frac{0.47 F_{rA}}{K_A} > \frac{0.47 F_{rB}}{K_B} + F_{ae}$	$F_{aA} = \frac{0.47 F_{rA}}{K_A}$ $F_{aB} = \frac{0.47 F_{rA}}{K_A} - F_{ae}$	

The torque equations will be underestimated if operating speed, n, is less than n_{min}. For values of f_1 and f_2, refer to fig. 20 on page 53.



Design (external thrust, F_{ae}, onto bearing A)

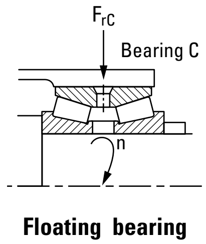
Fig. 18. Double-row tapered roller bearing.

TABLE 37. FIXED POSITION

Load Condition	Radial Load on Each Row F_r	
$F_{ae} > \frac{0.47\ F_{rAB}}{K_A}$	Bearing B is unloaded $F_{rA} = F_{rAB}$ $F_{aA} = F_{ae}$	$M = k_1\ G_1\ (n\mu)^{0.62} \left(\frac{f_3\ F_{rAB}}{K}\right)^{0.3}$ $n_{min} = \frac{k_2}{G_2\mu} \left(\frac{f_2\ F_{rAB}}{K}\right)^{2/3}$
$F_{ae} \leq \frac{0.47\ F_{rAB}}{K_A}$	$F_{rA} = \frac{F_{rAB}}{2} + 1.06\ K\ F_{ae}$ $F_{rB} = \frac{F_{rAB}}{2} - 1.06\ K\ F_{ae}$	$M = k_1\ G_1\ (n\mu)^{0.62} \left(\frac{0.060}{K}\right)^{0.3} (F_{rA}^{0.3} + F_{rB}^{0.3})$ $n_{minA} = \frac{k_2}{G_2\mu} \left(\frac{1.78F_{rA}}{K}\right)^{2/3}$; $n_{minB} = \frac{k_2}{G_2\mu} \left(\frac{1.78F_{rB}}{K}\right)^{2/3}$

$$M = 2\ k_1\ G_1\ (n\mu)^{0.62} \left(\frac{0.030\ F_{rC}}{K}\right)^{0.3}$$

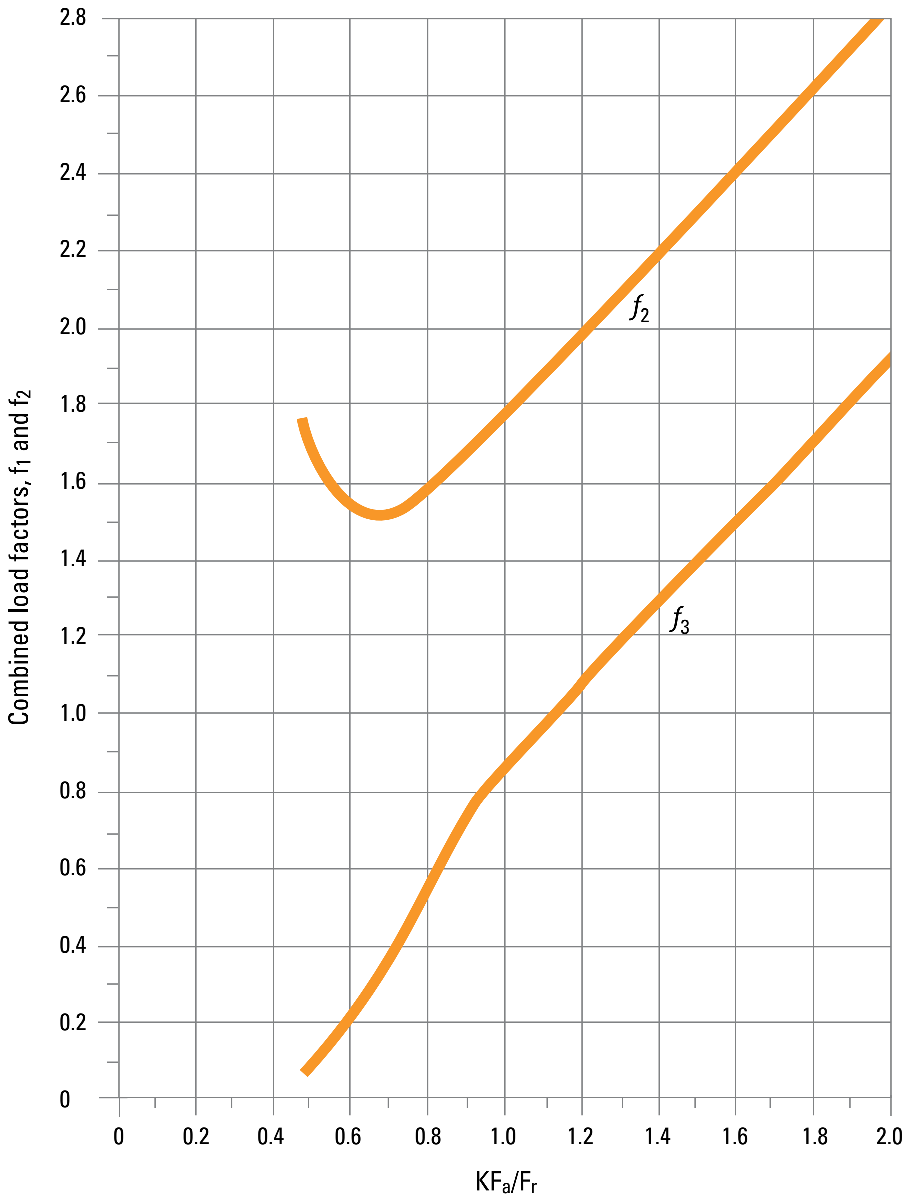
$$n_{min} = \frac{k_2}{G_2\mu} \left(\frac{0.890\ F_r}{K}\right)^{2/3}$$



The torque equations will be underestimated if operating speed, n, is less than n_{min}.
For values of f_1 and f_2, refer to fig. 20 on page 53.

Fig. 19. Floating position.

k_1 = 2.56×10^{-6} (metric) or 3.54×10^{-5} (inch)
k_2 = 625 (metric) or 1700 (inch)
μ = lubricant dynamic viscosity at operating temperature centipoise
For grease, use the base oil viscosity.
f_3 = combined load factor, see fig. 20 on page 53
f_2 = combined load factor, see fig. 20 on page 53



Load Condition	f_3 and f_2
$KF_a/F_r > 2.0$	$f_3 = KF_a/F_r$ $f_2 = f_3 + 0.8$
$0.47 \le KF_a/F_r \le 2.0$	Use graph above
$KF_a/F_r < 0.47$	$f_3 = 0.06$ $f_3 = 1.78$

Fig. 20. Determination of combined load factors f_3 and f_2.

LUBRICATION

To help maintain a bearing's antifriction characteristics, lubrication is needed to:

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

LUBRICATION

The wide range of bearing types and operating conditions precludes any simple, all-inclusive statement or guideline allowing the selection of the proper lubricant. At the design level, the first consideration is whether oil or grease is best for the particular operation. The advantages of oil and grease are outlined in the table below. When heat must be carried away from the bearing, oil must be used. It is almost always preferred for very high-speed applications.

TABLE 38. ADVANTAGES OF OIL AND GREASE

Oil	Grease
Carries heat away from the bearings	Simplifies seal design and acts as a sealant
Carries away moisture and particulate matter	Permits prelubrication of sealed or shielded bearings
Easily controlled lubrication	Generally requires less frequent lubrication

European REACH compliance

Timken-branded lubricants, greases and similar products sold in stand-alone containers or delivery systems are subject to the European REACH (**R**egistration, **E**valuation, **A**uthorization and Restriction of **CH**emicals) directive. For import into the European Union, Timken can sell and provide only those lubricants and greases that are registered with ECHA (**E**uropean **CH**emical **A**gency). For further information, please contact your Timken engineer.

OIL LUBRICATION

Oils used for bearing lubrication should be high-quality mineral oils or synthetic oils with similar properties. Selection of the proper type of oils depends on bearing speed, load, operating temperature and lubrication method. Some features and advantages of oil lubrication, in addition to the above are:

- Oil is a better lubricant for high speeds or high temperatures. It can be cooled to help reduce bearing temperature.
- It is easier to handle and control the amount of lubricant reaching the bearing. It is harder to retain in the bearing. Lubricant losses may be higher than with grease.
- Oil can be introduced to the bearing in many ways, such as drip-feed, wick-feed, pressurized circulating systems, oil bath or air-oil mist. Each is suited for certain types of applications.
- Oil is easier to keep clean for recirculating systems.

Oil may be introduced to the bearing housing in many ways. The most common systems are:

- **Oil bath.** The housing is designed to provide a sump through which the rolling elements of the bearing will pass. Generally, the oil level should be no higher than the center point of the lowest rolling element. If speed is high, lower oil levels should be used to reduce churning. Gages or controlled elevation drains are used to achieve and maintain the proper oil level.
- **Circulating system.** This system has the advantages of:
  - An adequate supply of oil for both cooling and lubrication.
  - Metered control of the quantity of oil delivered to each bearing.
  - Removal of contaminants and moisture from the bearing by flushing action.
  - Suitability for multiple bearing installations.
  - Large reservoir, which reduces deterioration. Increased lubricant life provides economical efficiency.
  - Incorporation of oil-filtering devices.
  - Positive control to deliver the lubricant where needed.
  - A typical circulating oil system consists of an oil reservoir, pump, piping and filter. A heat exchange may be required.
- **Oil-mist lubrication**. Oil-mist lubrication systems are used in high-speed, continuous-operation applications. This system permits close control of the amount of lubricant reaching the bearings. The oil may be metered, atomized by compressed air and mixed with air, or it may be picked up from a reservoir using a venturi effect. In either case, the air is filtered and supplied under sufficient pressure to assure adequate lubrication of the bearings. Control of this type of lubrication system is accomplished by monitoring the operating temperatures of the bearings being lubricated. The continuous passage of the pressurized air and oil through the labyrinth seals used in the system prevents the entrance of contaminants from the atmosphere to the system.

  The successful operation of this type of system is based upon the following factors:
  - Proper location of the lubricant entry ports in relation to the bearings being lubricated.
  - Avoidance of excessive pressure drops across void spaces within the system.
  - Proper air pressure and oil quantity ratio to suit the particular application.
  - Adequate exhaust of the air-oil mist after lubrication has been accomplished.

To ensure “wetting” of the bearings, and to prevent possible damage to the rolling elements and rings, it is imperative that the oil-mist system be turned on for several minutes before the equipment is started. The importance of “wetting” the bearing before starting cannot be overstated, and it also has particular significance for equipment that has been idled for extended periods of time.

Lubricating oils are commercially available in many forms for automotive, industrial, aircraft and other uses. Oils are classified as either petroleum types (refined from crude oil) or synthetic types (produced by chemical synthesis).

PETROLEUM OILS

Petroleum oils are made from a petroleum hydrocarbon derived from crude oil, with additives to improve certain properties. Petroleum oils are used for nearly all oil-lubricated applications of bearings.

SYNTHETIC OILS

Synthetic oils cover a broad range of categories and include polyalphaolefins, silicones, polyglycols and various esters. In general, synthetic oils are less prone to oxidation and can operate at extreme hot or cold temperatures. Physical properties, such as pressure-viscosity coefficients, tend to vary between oil types; use caution when making oil selections.

The polyalphaolefins (PAO) have a hydrocarbon chemistry that parallels petroleum oil both in chemical structures and pressure-viscosity coefficients. Therefore, PAO oil is mostly used in the oil-lubricated applications of bearings when severe temperature environments (hot and cold) are encountered or when extended lubricant life is required.

The silicone, ester and polyglycol oils have an oxygen-based chemistry that is structurally quite different from petroleum oils and PAO oils. This difference has a profound effect on its physical properties where pressure-viscosity coefficients can be lower compared to mineral and PAO oils. This means that these types of synthetic oils may actually generate a smaller elastohydrodynamic (EHD) film thickness than a mineral or PAO oil of equal viscosity at operating temperature. Reductions in bearing fatigue life and increases in bearing wear could result from this reduction of lubricant film thickness.

VISCOSITY

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 oil 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.

There are several classifications of oils based on viscosity grades. The most familiar are the Society of Automotive Engineers (SAE) classifications for automotive engine and gear oils. The American Society for Testing and Materials (ASTM) and the International Organization for Standardization (ISO) have adopted standard viscosity grades for industrial fluids. Fig. 21 shows the viscosity comparisons of ISO/ASTM with SAE classification systems at 40° C (104° F).

VISCOSITY CLASSIFICATION COMPARISON

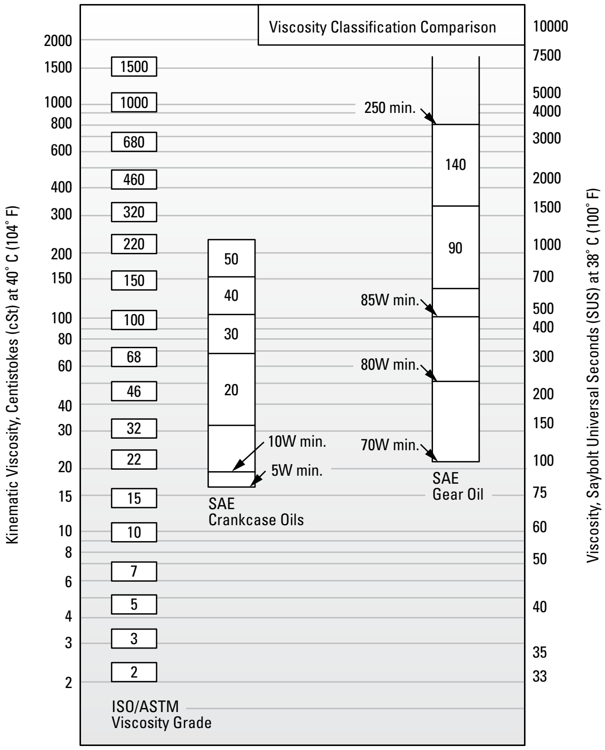


Fig. 21. Comparison between ISO/ASTM grades (ISO 3448/ASTM D2442) and SAE grades (SAE J 300-80 for crankcase oils, SAE J 306-81 for axle and manual transmission oils).

The ASTM/ISO viscosity grade system for industrial oils is depicted below.

ISO VISCOSITY SYSTEM

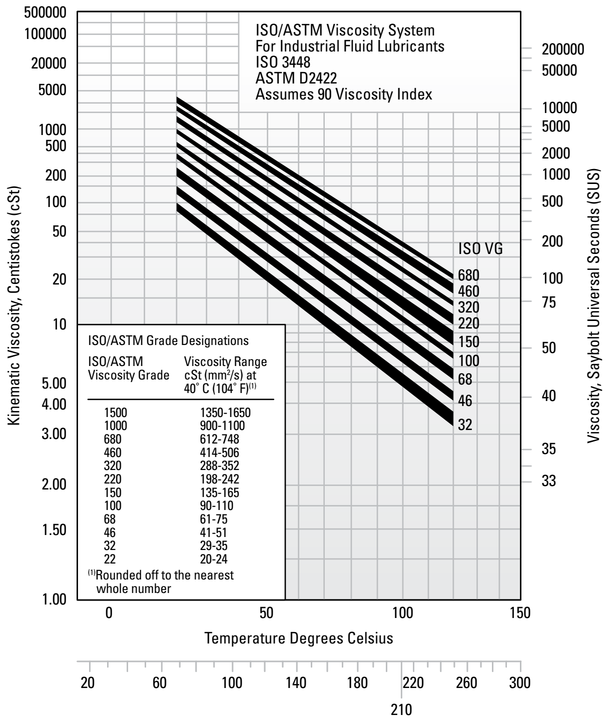


Fig. 22. Viscosity grade system for industrial oils.

TYPICAL BEARING LUBRICATION OILS

In this section, the properties and characteristics of lubricants for typical roller bearing applications are listed. These general characteristics are derived from successful performance in applications across all industries.

General-purpose rust and oxidation lubricating oil

General-purpose rust and oxidation (R&O) inhibited oils are the most common type of industrial lubricant. They are used to lubricate Timken® bearings in all types of industrial applications where conditions requiring special considerations do not exist.

TABLE 39. SUGGESTED GENERAL PURPOSE R&O LUBRICATING OIL PROPERTIES

Properties	
Base stock	Solvent-refined, high-viscosity-index petroleum oil
Additives	Corrosion and oxidation inhibitors
Viscosity index	80 min.
Pour point	-10° C max. (14° F)
Viscosity grades	ISO/ASTM 32 through 220

Some low-speed and/or high-ambient-temperature applications require the higher viscosity grades. High-speed and/or low-temperature applications require the lower viscosity grades.

Industrial extreme-pressure (EP) gear oil

Extreme-pressure gear oils are used to lubricate Timken bearings in most types of heavily loaded industrial equipment. They should be capable of withstanding abnormal shock loads that are common in heavy-duty equipment.

TABLE 40. SUGGESTED INDUSTRIAL EP GEAR OIL PROPERTIES

Properties	
Base stock	Solvent-refined, high-viscosity-index petroleum oil
Additives	Corrosion and oxidation inhibitors Extreme-pressure (EP) additive(1) - 15.8 kg (35 lb.) min.
Viscosity index	80 min.
Pour point	-10° C max. (14° F)
Viscosity grades	ISO/ASTM 100, 150, 220, 320, 460

(1) ASTM D 2782

Industrial EP gear oils should be composed of a highly refined petroleum oil-based stock plus appropriate inhibitors and additives. They should not contain materials that are corrosive or abrasive to bearings. The inhibitors should provide long-term protection from oxidation and protect the bearing from corrosion in the presence of moisture. The oils should resist foaming in service and have good water-separation properties. An EP additive protects against scoring under boundary-lubrication conditions. The viscosity grades suggested represent a wide range. High-temperature and/or slow-speed applications generally require the higher viscosity grades. Low temperatures and/or high speeds require the use of lower viscosity grades.

GREASE LUBRICATION

Grease lubrication is generally applicable to low-to-moderate speed applications that have operating temperatures within the limits of the grease. There is no universal anti-friction bearing grease. Each grease has limiting properties and characteristics.

Greases consist of a base oil, a thickening agent and additives. Conventionally, bearing greases have consisted of petroleum base oils thickened to the desired consistency by some form of metallic soap. More recently synthetic base oils have been used with organic and inorganic thickeners. Table 41 summarizes the composition of typical lubricating greases.

TABLE 41. COMPOSITION OF GREASES

Base Oil		Thickening Agents		Additives		Lubricating Grease
Mineral oil Synthetic hydrocarbon Esters Perfluorinated oil Silicone	+	Soaps and complex soaps lithium, aluminum, barium, calcium Non-Soap (inorganic) microgel (clay), carbon black, silica-gel, PTFE Non-Soap (organic) Polyurea compounds	+	Rust inhibitors Dyes Tactifiers Metal deactivates Oxidation inhibitors Anti-wear EP	=	

Calcium- and aluminum-based greases have excellent water resistance and are used in industrial applications where water ingress is an issue. Lithium-based greases are multi-purpose and are used in industrial applications and wheel bearings.

Synthetic base oils such as esters, organic esters and silicones used with conventional thickeners and additives typically have higher maximum operating temperatures than petroleum-based greases. Synthetic greases can be designed to operate in temperatures from -73° C (-100° F) to 288° C (550° F).

Below are the general characteristics of common thickeners used with petroleum base oils.

TABLE 42. GENERAL CHARACTERISTICS OF THICKENERS USED WITH PETROLEUM BASE OILS

Thickener	Typical Dropping Point		Maximum Temperature		Typical Water Resistance
	°C	°F	°C	°F	
Lithium soap	**193**	380	**121**	250	Good
Lithium complex	**260+**	500+	**149**	300	Good
Aluminum complex	**249**	480	**149**	300	Excellent
Calcium sulfonate	**299**	570	**177**	350	Excellent
Polyurea	**260**	500	**149**	300	Good

Use of the thickeners in table 42 with synthetic hydrocarbon or ester base oils increases the maximum operating temperature by approximately 10° C (50° F).

Using polyurea as a thickener for lubricating fluids is one of the most significant lubrication developments in more than 30 years. Polyurea grease performance is outstanding in a wide range of bearing applications and, in a relatively short time, it has gained acceptance as a factory-packed lubricant for ball bearings.

LOW TEMPERATURES

Starting torque in a grease-lubricated bearing at low temperatures can be critical. Some greases may function adequately as long as the bearing is operating, but resistance to initial movement may be excessive. In certain smaller machines, starting may be impossible when very cold. Under such operating circumstances, greases containing low-temperature characteristic oils are generally required.

If the operating temperature range is wide, synthetic greases offer advantages. Synthetic greases are available to provide very low starting and running torque at temperatures as low as -73° C (-100° F). In certain instances, these greases perform better in this respect than oil.

An important point concerning lubricating greases is that the starting torque is not necessarily a function of the consistency or the channel properties of the grease. Starting torque is more a function of the individual rheological properties of a particular grease and is best evaluated by application experience.

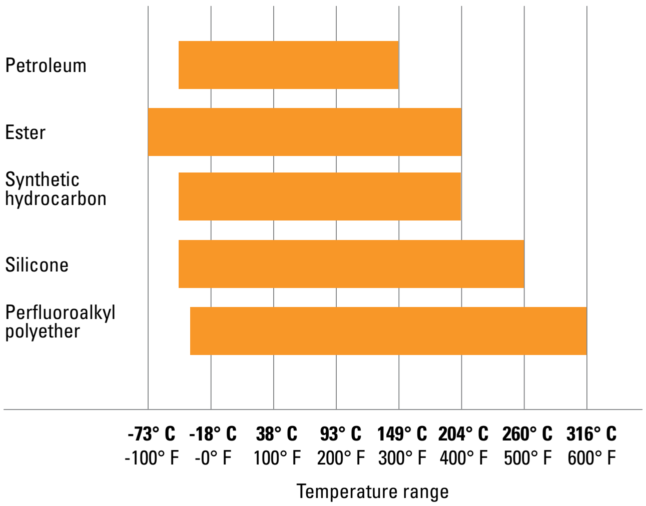
HIGH TEMPERATURES

The high temperature limit for lubricating greases is generally a function of the thermal and oxidation stability of the fluid and the effectiveness of the oxidation inhibitors. Grease temperature ranges are defined by both the dropping point of the grease thickener and composition of the base oil. Table 43 shows the temperature ranges of various base oils used in grease formulations.

A rule of thumb, developed from years of testing grease-lubricated bearings, indicates that grease life is halved for every 10° C (50° F) increase in temperature. For example, if a particular grease provides 2000 hours of life at 90° C (194° F), by raising the temperature to 100° C (212° F), reduction in life to approximately 1000 hours would result. On the other hand, 4000 hours could be expected by lowering the temperature to 80° C (176° F).

Thermal stability, oxidation resistance and temperature limitations must be considered when selecting greases for high-temperature applications. In non-relubricatable applications, highly refined mineral oils or chemically stable synthetic fluids are required as the oil component of greases for operation at temperatures above 121° C (250° F).

TABLE 43. TEMPERATURE RANGES FOR BASE OILS USED IN LUBRICATING GREASES



CONTAMINATION

Abrasive Particles

When roller bearings operate in a clean environment, the primary cause of damage is the eventual fatigue of the surfaces where rolling contact occurs. However, when particle contamination enters the bearing system, it is likely to cause damage such as bruising, which can shorten bearing life.

When dirt from the environment or metallic wear debris from some component in the application are allowed to contaminate the lubricant, wear can become the predominant cause of bearing damage. If bearing wear becomes significant, changes will occur to critical bearing dimensions that could adversely affect machine operation.

Bearings operating in a contaminated lubricant exhibit a higher initial rate of wear than those running in an uncontaminated lubricant. With no further contaminant ingress, this wear rate quickly diminishes. The contamination particles are reduced in size as they pass through the bearing contact area during normal operation.

Water

Water and moisture can be particularly conducive to bearing damage. Lubricating greases may provide a measure of protection from this contamination. Certain greases, such as calcium and aluminum-complex, are highly water-resistant.

Sodium-soap greases are water-soluble and should not be used in applications involving water.

Either dissolved or suspended water in lubricating oils can exert a detrimental influence on bearing fatigue life. Water can cause bearing etching that also can reduce bearing fatigue life. The exact mechanism by which water lowers fatigue life is not fully understood. It has been suggested that water enters micro-cracks in the bearing rings that are caused by repeated stress cycles. This leads to corrosion and hydrogen embrittlement in the micro-cracks, reducing the time required for these cracks to propagate to an unacceptable-sized spall.

Water-based fluids, such as water glycol and invert emulsions, also have shown a reduction in bearing fatigue life. Although water from these sources is not the same as contamination, the results support the previous discussion concerning water-contaminated lubricants.

GREASE SELECTION

The successful use of bearing grease depends on the physical and chemical properties of the lubricant as well as application and environmental conditions. Because the choice of grease for a particular bearing under certain service conditions is often difficult to make, you should consult with your lubricant supplier or equipment maker for specific questions about lubrication requirements for your application. You also can contact your Timken engineer for general lubrication guidelines for any application.

Grease must be carefully selected with regard to its consistency at operating temperature. It should not exhibit thickening, separation of oil, acid formation or hardening to any marked degree. It should be smooth, non-fibrous and entirely free from chemically active ingredients. Its dropping point should be considerably higher than the operating temperature.

Timken® application-specific lubricants were developed by leveraging our knowledge of tribology and anti-friction bearings, and how these two elements affect overall system performance. Timken lubricants help bearings and related components operate effectively in demanding industrial operations. High-temperature, anti-wear and water-resistant additives offer superior protection in challenging environments. Table 44 provides an overview of the Timken greases available for general applications. Contact your Timken engineer for a more detailed publication on Timken lubrication solutions.

TABLE 44. GREASE LUBRICATION SELECTION GUIDE

ENVIRONMENT		APPLICATION
High Wear • Moderate Loads Moderate Speeds Moderate Temperatures	Timken Premium All-Purpose Industrial Grease	Agriculture • Bushings/Ball Joints Truck and Auto Wheel Bearings Heavy-Duty Industrial
Extreme Heat • Heavy Loads High Sliding Wear Dirty Environments Slow Speeds • Shock Loading	Timken Construction and Off-Highway Grease	Agriculture/Mining • Cement Plants Construction/Off Road • Rock Quarry Earth-Moving Equipment Fleet Equipment • Heavy Industry Pivot Pins/Splined Shafts
Wet and Corrosive Conditions Quiet Environments • Light Loads Moderate to High Speeds Moderate Temperatures Light Load Moderate Water	Timken Ball Bearing Pillow Block Grease	Lightly Loaded Pillow Blocks Idler Pulleys • Oven Conveyors Electric Motors • Fans • Pumps Alternators • Generators
Corrosive Media • Extreme Heat Heavy Loads • Wet Conditions Slow to Moderate Speeds	Timken Mill Grease	Aluminum Mills • Paper Mills Steel Mills • Offshore Rigs Power Generation
Incidental Food Contact Hot and Cold Temperatures Moderate to High Speeds Medium Loads	Timken Food Safe Grease	Food and Beverage Industries Pharmaceuticals
Extreme Low and High Temperatures Severe Loads Corrosive Media Slow to Moderate Speeds	Timken Synthetic Industrial Grease	Wind Energy Main Bearing Pulp and Paper Machines General Heavy Industry Marine Applications Centralized Grease Systems
Moderate Speeds Light to Moderate Loads Moderate Temperatures Moderate Water	Timken Multi-Use Lithium Grease	General Industrial Applications Pins and Bushings • Track Rollers Water Pumps Plain and Anti-friction Bearings

This selection guide is not intended to replace the specifications by the equipment builder, who is responsible for its performance.

Many bearing applications require lubricants with special properties or lubricants formulated specifically for certain environments, such as:

- Friction oxidation (fretting corrosion).
- Chemical and solvent resistance.
- Food handling.
- Quiet running.
- Space and/or vacuum.
- Electrical conductivity.

For assistance with these or other areas requiring special lubricants, consult your Timken engineer.

GREASE USE GUIDELINES

It is important to use the proper amount of grease in the application. In typical industrial applications, the bearing cavity should be kept approximately one-third to one-half full. Less grease may result in the bearing being starved for lubrication. More grease may result in churning. Both conditions may result in excessive heat generation. As the grease temperature rises, viscosity decreases and the grease becomes thinner. This can reduce the lubricating effect and increase leakage of the grease from the bearing. It also may cause the grease components to separate, leading to a general breakdown of the lubricant properties. As the grease breaks down, bearing torque increases. In the case of excess grease resulting in churning, torque may also increase due to the resistance caused by the grease.

For best results, there should be ample space in the housing to allow room for excess grease to be thrown from the bearing. However, it is equally important that the grease be retained all around the bearing. If a large void exists between the bearings, grease closures should be used to prevent the grease from leaving the bearing area.

Only in low-speed applications may the housing be entirely filled with grease. This method of lubrication is a safeguard against the entry of foreign matter, where sealing provisions are inadequate for exclusion of contaminants or moisture.

During periods of non-operation, it is often wise to completely fill the housings with grease to protect the bearing surfaces. Prior to restarting operation, remove the excess grease and restore the proper level.

Applications utilizing grease lubrication should have a grease fitting and a vent at opposite ends of the housing near the top. A drain plug should be located near the bottom of the housing to allow the old grease to purge from the bearing.

Bearings should be relubricated at regular intervals to help prevent damage. Relubrication intervals are difficult to determine. If plant practice or experience with other applications is not available, consult your lubricant supplier.

Timken offers a range of lubricants to help bearings and related components operate effectively in demanding industrial operations. High-temperature, anti-wear and water-resistant additives offer greater protection in challenging environments. Timken also offers a line of single- and multi-point lubricators to simplify grease delivery.

Fig. 23. Grease can easily be packed by hand.

Fig. 24. Mechanical grease packer.

Grease application methods

Grease, in general, is easier to use than oil in industrial bearing lubrication applications. Most bearings that are initially packed with grease require periodic relubrication to operate efficiently.

Grease should be packed into the bearing so that it gets between the rolling elements – the rollers or balls. For tapered roller bearings, forcing grease through the bearing from the large end to the small end will ensure proper distribution.

Grease can be easily packed into small- and medium-size bearings by hand (fig. 23). In shops where bearings are frequently regreased, a mechanical grease packer that forces grease through the bearing under pressure may be appropriate (fig. 24). Regardless of the method, after packing the internal areas of the bearing, a small amount of grease also should be smeared on the outside of the rollers or balls.

The two primary considerations that determine the relubrication cycle are operating temperature and sealing efficiency. High-operating-temperature applications generally require more frequent regreasing. The less efficient the seals, the greater the grease loss and the more frequently grease must be added.

Grease should be added any time the amount in the bearing falls below the desired amount. The grease should be replaced when its lubrication properties have been reduced through contamination, high temperature, water, oxidation or any other factors. For additional information on appropriate regreasing cycles, consult with the equipment manufacturer or your Timken engineer.

Prelubricated bearings

Prelubricated shielded and sealed bearings are successfully used in applications where:

- Grease might be injurious to other parts of the mechanism.
- Cost and space limitations preclude the use of a grease-filled housing.
- Housings cannot be kept free of dirt and grit, water or other contaminants.
- Relubrication is impossible or would be a hazard to satisfactory use.

Prelubricated bearings are pre-packed with greases that have chemical and mechanical stability, and they have demonstrated long-life characteristics in rotating bearings. Greases are filtered several times to remove all harmful material, and they are accurately metered so that each bearing receives the proper amount of grease.

CONSISTENCY

Greases may vary in consistency from semi-fluids that are hardly thicker than a viscous oil to solid grades almost as hard as a soft wood.

Consistency is measured by a penetrometer in which a standard weighted cone is dropped into the grease. The distance the cone penetrates (measured in tenths of a millimeter in a specific time) is the penetration number.

The National Lubricating Grease Institute (NLGI) classification of grease consistency is shown below:

TABLE 45. NLGI CLASSIFICATIONS

NLGI Grease Grades	Penetration Number
0	355-385
1	310-340
2	265-295
3	220-250
4	175-205
5	130-160
6	85-115

Grease consistency is not fixed; it normally becomes softer when sheared or “worked.” In the laboratory, this “working” is accomplished by forcing a perforated plate up and down through a closed container of grease. This “working” does not compare with the violent shearing action that takes place in a bearing and does not necessarily correlate with actual performance.

TABLE 46. GREASE COMPATIBILITY CHART

- ■ = Best Choice
- ■ = Compatible
- ■ = Borderline
- ■ = Incompatible

	Aluminum Complex	Barium Complex	Calcium Stearate	Calcium 12 Hydroxy	Calcium Complex	Calcium Sulfonate	Clay Non-Soap	Lithium Stearate	Lithium 12 Hydroxy	Lithium Complex	Polyurea Conventional	Polyurea Shear Stable
Aluminum Complex	Best Choice	Incompatible	Incompatible	Compatible	Incompatible	Borderline	Incompatible	Incompatible	Incompatible	Compatible	Incompatible	Compatible
Timken Food Safe Grease	Best Choice	Incompatible	Incompatible	Compatible	Incompatible	Borderline	Incompatible	Incompatible	Incompatible	Compatible	Incompatible	Compatible
Barium Complex	Incompatible	Best Choice	Incompatible	Compatible	Incompatible	Compatible	Incompatible	Incompatible	Incompatible	Incompatible	Incompatible	Borderline
Calcium Stearate	Incompatible	Incompatible	Best Choice	Compatible	Incompatible	Compatible	Compatible	Compatible	Borderline	Compatible	Incompatible	Compatible
Calcium 12 Hydroxy	Compatible	Compatible	Compatible	Best Choice	Borderline	Borderline	Compatible	Compatible	Compatible	Compatible	Incompatible	Compatible
Calcium Complex	Incompatible	Incompatible	Incompatible	Borderline	Best Choice	Incompatible	Incompatible	Incompatible	Incompatible	Compatible	Compatible	Compatible
Calcium Sulfonate	Borderline	Compatible	Compatible	Borderline	Incompatible	Best Choice	Incompatible	Borderline	Borderline	Compatible	Incompatible	Compatible
Timken Construction and Off-Highway Grease	Borderline	Compatible	Compatible	Borderline	Incompatible	Best Choice	Incompatible	Borderline	Borderline	Compatible	Incompatible	Compatible
Timken Mill Grease	Borderline	Compatible	Compatible	Borderline	Incompatible	Best Choice	Incompatible	Borderline	Borderline	Compatible	Incompatible	Compatible
Clay Non-Soap	Incompatible	Incompatible	Compatible	Compatible	Incompatible	Incompatible	Best Choice	Incompatible	Incompatible	Incompatible	Incompatible	Borderline
Lithium Stearate	Incompatible	Incompatible	Compatible	Compatible	Incompatible	Borderline	Incompatible	Best Choice	Compatible	Compatible	Incompatible	Compatible
Lithium 12 Hydroxy	Incompatible	Incompatible	Borderline	Compatible	Incompatible	Borderline	Incompatible	Compatible	Best Choice	Compatible	Incompatible	Compatible
Timken Multi-Use	Incompatible	Incompatible	Borderline	Compatible	Incompatible	Borderline	Incompatible	Compatible	Best Choice	Compatible	Incompatible	Compatible
Lithium Complex	Compatible	Incompatible	Compatible	Compatible	Compatible	Compatible	Incompatible	Compatible	Compatible	Best Choice	Incompatible	Compatible
Timken All -Purpose Timken Synthetic	Compatible	Incompatible	Compatible	Compatible	Compatible	Compatible	Incompatible	Compatible	Compatible	Best Choice	Incompatible	Compatible
High Performance Roller Housed Unit Grease	Compatible	Incompatible	Compatible	Compatible	Compatible	Compatible	Incompatible	Compatible	Compatible	Best Choice	Incompatible	Compatible
Timken Premium All Purpose Industrial LC-2 Grease	Compatible	Incompatible	Compatible	Compatible	Compatible	Compatible	Incompatible	Compatible	Compatible	Best Choice	Incompatible	Compatible
Polyurea Conventional	Incompatible	Incompatible	Incompatible	Incompatible	Compatible	Incompatible	Incompatible	Incompatible	Incompatible	Incompatible	Best Choice	Compatible
Polyurea Shear Stable	Compatible	Borderline	Compatible	Compatible	Compatible	Compatible	Borderline	Compatible	Compatible	Compatible	Compatible	Best Choice
Timken Pillow Block	Compatible	Borderline	Compatible	Compatible	Compatible	Compatible	Borderline	Compatible	Compatible	Compatible	Compatible	Best Choice

TAPERED ROLLER BEARINGS

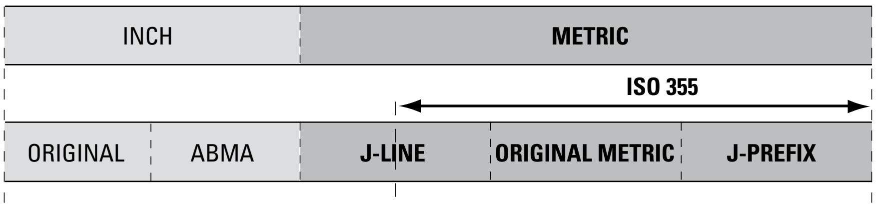
Timken offers the most extensive line of tapered roller bearings in the world. Tapered roller bearings consist of four interdependent components: the cone (inner ring), the cup (outer ring), the tapered rollers (rolling elements) and the cage (roller retainer). Tapered roller bearings are uniquely designed to manage both thrust and radial loads between a rotating and non-rotating member. The steeper the cup angle, the greater the ability of the bearing to handle thrust loads.

- **Sizes:** 8 mm (0.315 in.) bore to 3000 mm (118 in.) outside diameter (O.D.).
- **Industries:** Aerospace, agriculture, automotive, heavy truck, cement, aggregate, coal, oil and gas, construction, gear drives, machine tools, mining, paper, metals, rail and wind.
- **Features:** Available in single-, double- and four-row configurations. Refer to www.timken.com for four-row information. Customized designs and features are available upon request.
- **Benefits:** Enhanced performance in demanding applications.

PART-NUMBERING SYSTEMS FOR RADIAL TAPERED ROLLER BEARINGS

HOW TO IDENTIFY YOUR PART NUMBER

The part-numbering systems for single-row radial tapered roller bearings (type TS) are internationally recognized. Several part-numbering systems have been developed that can be classified according to metric or inch systems. Inch system bearings are normally assigned individual part numbers for the inner ring and for the outer ring, whereas ISO (metric) bearings are assigned a unique part number for the bearing assembly as a whole, which includes both inner and outer ring.



NOTE: ISO 355 is a dimensional plan for metric tapered roller bearings. See page 72 for more details on ISO 355.

Fig. 25. Part-numbering standards.

BEARING SERIES

In all the part-numbering systems, the term bearing series is used to describe bearings having the same basic internal geometry (e.g. roller size, inner-ring and outer-ring angles). Any inner ring (including roller set) can be matched with any outer ring within the same series providing that the same type of bearing is being used.

INCH PART-NUMBERING SYSTEMS

ORIGINAL INCH PART-NUMBERING SYSTEM

The original system developed by The Timken Company was based on a family of bearings designed around a common roller. Varying the number of rollers and the angle of the raceways allows different bearings to be designed for predominantly radial loads (shallow angle) or thrust loads (steep angle).

For example, all the tapered roller bearings in the 500 family use the same roller. However, the 595 Series has a steep angle and 24 rollers while the 525 Series has a shallow angle and 15 rollers.

Individual part numbers are assigned to the inner and outer rings. Although there are exceptions, the general rule is that the outer ring has a part number that is lower than that of the inner ring.

ABMA INCH PART-NUMBERING SYSTEM

The current inch part-numbering system was developed by the American Bearing Manufacturers Association (ABMA) to address the expansion in the number of new applications and tapered roller-bearing designs. This part-numbering system has become the international standard for inch-sized bearings.

The ABMA part-numbering system has been applied only to new bearing series designed after its introduction. Other part-numbering systems also are in use including those based on the original numbering system and proprietary part numbers for special bearings.

The ABMA part number is divided into five alphanumeric sections, which are described in fig. 26.

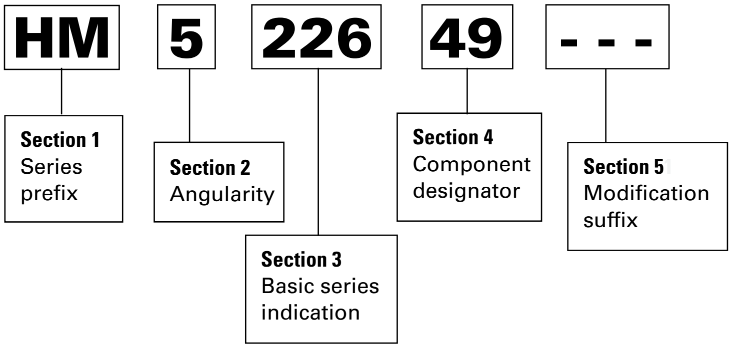


Fig. 26. ABMA inch part-numbering system nomenclature.

Section 1 - Series prefix

The series prefix consists of one or two letters that designate the duty class for which the bearing is designed. Additional prefix letters are available in table 49 on page 74.

TABLE 47. COMMON PREFIX LETTERS

Prefix	Class Designation	Prefix	Class Designation
EL	Extra light	HM	Heavy medium
LL	Lighter than light	H	Heavy
L	Light	HH	Heavier than heavy
LM	Light medium	EH	Extra heavy
M	Medium	T	Thrust only

Section 2 - Angularity designator

The first digit following the prefix represents the angle coding as determined by the included angle of the outer ring.

TABLE 48. ANGULARITY DESIGNATOR

Included Outer-Ring Angle	Code
0° to 23° 59′ 59.99 in.	1
24° to 25° 29′ 59.99 in.	2
25° 30′ to 26° 59′ 59.99 in.	3
27° to 28° 29′ 59.99 in.	4
28° 30′ to 30° 29′ 59.99 in.	5
30° 30′ to 32° 29′ 59.99 in.	6
32° 30′ to 35° 59′ 59.99 in.	7
36° to 44° 59′ 59.99 in.	8
45° and over; excluding thrust	9

Section 3 - Basic series indication

The two or three digits following the angularity designator are reserved for the basic series indication. Refer to ABMA standard 19.2 for more information.

Section 4 - Component designator

The last two numerical digits indicate the component number.

Section 5 - Modification suffix letters

The suffix may consist of one to three letters in pre-arranged combinations, indicating modifications in external form or internal arrangement. Table 49 on page 74 lists the most common prefix and suffix designations.

METRIC PART-NUMBERING SYSTEMS

J-LINE PART NUMBERS

Some ABMA (inch) part numbers are designed with metric envelope dimensions. The J prefix letter is used in conjunction with the ABMA part-numbering system to identify metric-dimensioned and toleranced inner rings and outer rings. The J-prefix is shown before the ABMA prefix letters. J-Line bearings are referred to as inch bearings in metric bore, O.D. and width.

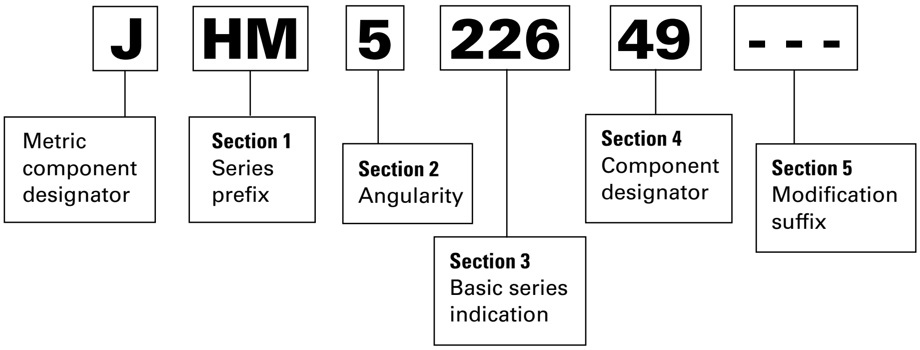


Fig. 27. J-Line part-numbering system nomenclature.

J-PREFIX

A range of metric bearings originally designed by The Timken Company also were included in the ISO 355 plan. These bearings are specifically application-oriented and are designed for optimum performance. Depending on application and type of load, thrust and/or radial, the bearing with the optimum angle and section can be selected. For example, pinion bearings have a steep angle, whereas bearings for machine tools are generally designed with a shallow angle and a light section. Fig. 29 demonstrates this feature for 55 mm (2.1654 in.) bore bearings.

These bearings also are identified with a J-prefix, which indicates a metric dimensioned and toleranced bearing.

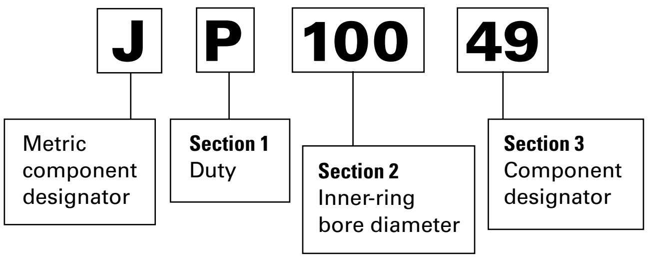


Fig. 28. J-prefix part-numbering system nomenclature.

Section 1 - Duty

Indicates application type:

C, D & F	=	general purpose
N	=	combination of general purpose and pinion
P	=	high speed
S & T	=	pinions
W	=	high axial loads

Section 2 - Inner-ring bore

The inner-ring bore metric diameter is included in the part-number designation of both the inner ring and outer rings.

Section 3 - Component designator

Same identification as in the ABMA part-numbering system.

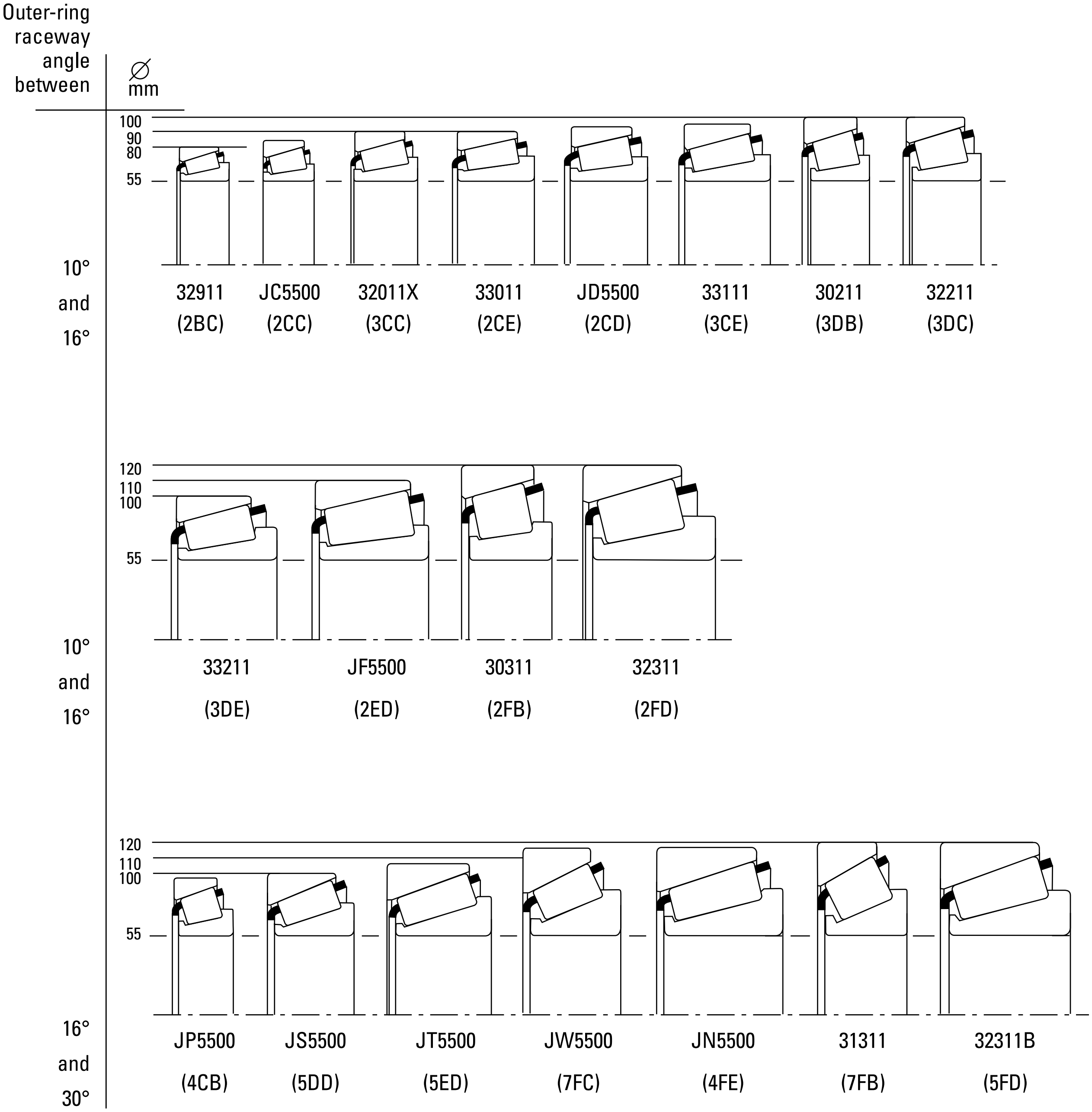


Fig. 29. Comparison of metric bearing designs for 55 mm (2.1654 in.) bore.

ORIGINAL METRIC (ISO) PART-NUMBERING SYSTEM

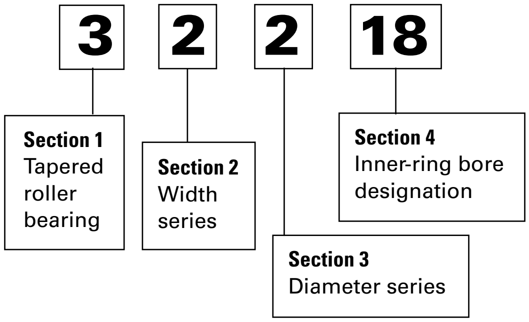


Fig. 30. Original ISO part-numbering system nomenclature.

The original metric part-numbering system for tapered roller bearings was based on the ISO 15 dimensional plan for radial bearings. A five-digit part number commencing with numeral 3 describes the bearing assembly (inner rings and outer rings).

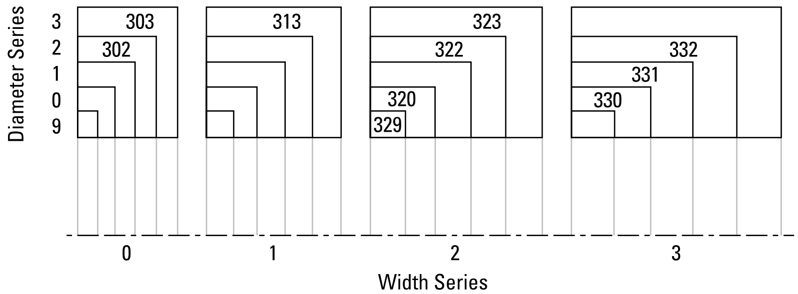


Fig. 31. Original ISO part-numbering system.

Section 1 - Symbol for bearing type

3 always applies to tapered roller bearings.

Section 2 - Width series

The bearing width is classified as 9 and 0 through 3 in increasing order of width.

Section 3 - Diameter series

The bearing section height is classified as 9 and 0 through 3 in increasing order of O.D. for a given bore size.

Section 4 - Inner-ring bore designation

The last two digits multiplied by five yield the inner-ring bore diameter in millimeters.

There are two exceptions to this rule:

1. Small bearings where: 02 = 15 mm
   03 = 17 mm
2. Where the last two digits are preceded by a forward slash (/), the last two digits show the actual bore size in millimeters. Examples:

   32218 = 90 mm bore
   30203 = 17 mm bore
   329/28 = 28 mm bore

ISO 355 PART NUMBERING

As dimensions given by the ISO 15 general plan were not found to be optimal for tapered roller bearings, ISO introduced a new numbering system for tapered roller bearings in ISO 355. The numbering system of ISO 355 uses three alphanumeric fields to define a dimension series. The bearing part number is then defined by adding the inner-ring diameter in mm after the dimension series. Although the original metric part numbers were assigned a new designation in the ISO 355 plan, the original part number is still used.

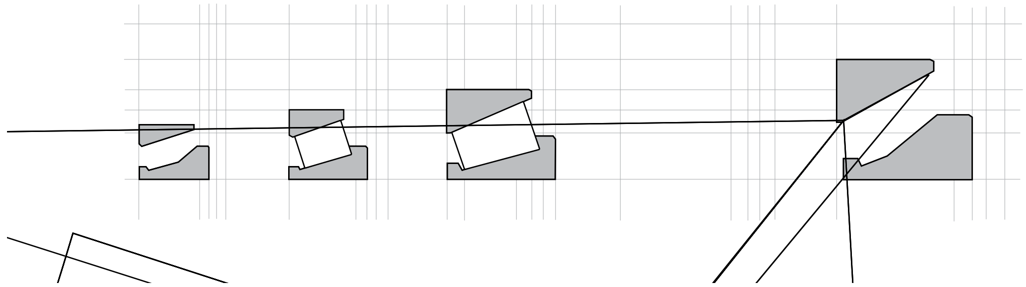


Fig. 32. ISO 355 part-numbering system.

BEARING ASSEMBLY NUMBERS

The nomenclature for a bearing assembly consists of the inner-ring part number followed by a five-digit alphanumeric code, e.g. LM48548-902A7. The assembly nomenclature describes the bill of material of the assembly.

An assembly number is assigned on receipt of the first order for new applications. It is very important for correct function of the bearing in a given application that the same assembly number is quoted for all subsequent orders. A Timken engineer should be consulted if additional information is required on the assembly number.

HISTORICAL PART-NUMBERING SYSTEMS

This historical nomenclature is for reference purposes only. Contact your Timken engineer with questions or for more information.

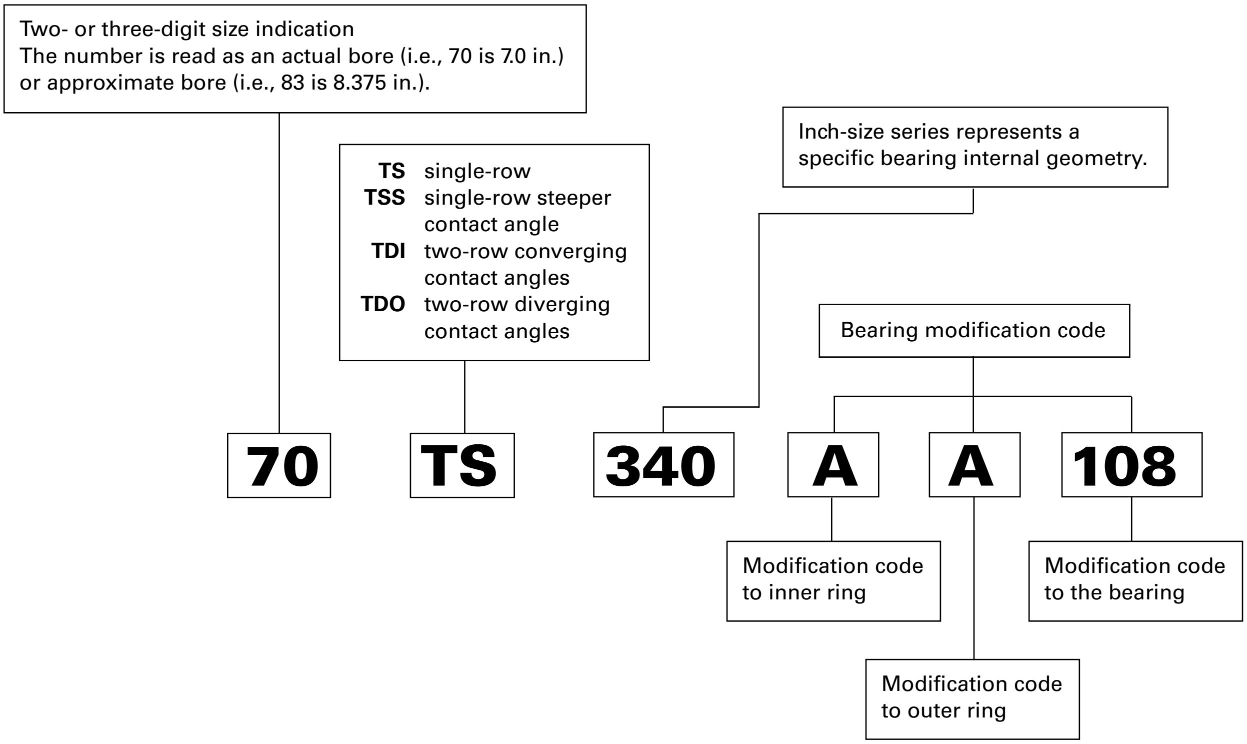


Fig. 33. Historical radial tapered roller bearing nomenclature.

For further explanation of prefix and suffix symbols or proprietary part numbers of special bearings, consult your Timken engineer.

PREFIXES AND SUFFIXES

The following are some of the symbols used by The Timken Company and prefixes and suffixes that are part of the ABMA part numbering standard:

TABLE 49. PREFIXES AND SUFFIXES

Prefix	Suffix	Inner Ring or Outer Ring	Explanation
A		Inner ring & outer ring	Standard basic series part number.
	A	Inner ring	Different radius from basic part number.
	A	Inner ring	Different bore from basic part number.
	A	Inner ring	Different complement of rollers.
	A	Outer ring	Different O.D. from basic part number.
	A	Outer ring	Different radius from basic part number.
	A	Outer ring	Different width from basic part number.
	AA	Inner ring & outer ring	Different bore, O.D., width or radius from basic part number.
	AB	Inner ring	Different bore, width or radius from basic part number, assembled with brass cage.
	AB	Outer ring	Flanged outer ring. Non-interchangeable with basic part number.
	AC	Inner ring	Different bore or radius, different internal geometry.
	AC	Outer ring	Different O.D., width or radius from basic part number.
	AD	Outer ring	Double outer ring. Non-interchangeable with basic part number.
	ADW	Inner ring	Double inner ring. Pilots and slots each end, holes in large rib.
	AH	Inner ring	Assembled with special cage, rollers, and/or internal geometry.
	AL	Inner ring	Assembled with DUO-FACE seal.
	ARB	Outer ring	Single outer ring with snap ring groove in O.D.
	AS	Inner ring & outer ring	Different bore, O.D., width, or radius from basic part number.
	ASB	Inner ring	Single inner ring, different bore or width from basic part number, assembled with brass cage.
	AV	Inner ring & outer ring	Made of special steel.
	AW	Inner ring & outer ring	Keyway or slotted inner ring or outer ring.
	AX	Inner ring & outer ring	Different bore, O.D., width, or radius from basic part number.
	AXB	Inner ring	Different bore, width, or radius from basic part number, assembled with brass cage.
	AXD	Outer ring	ISO outer ring - double outer ring without oil holes or groove.
	AXV	Inner ring & outer ring	Different O.D., width, or radius from basic part number. Made of special steel.
	AXX	Inner ring & outer ring	Different O.D., width, or radius from basic part number. Made of special steel.
	B	Outer ring	Flanged outer ring. Non-interchangeable with basic part number.
	B	Inner ring	Inner ring using brass cage.
	B	Inner ring & outer ring	ISO bearing with same boundary dimensions as basic part number, but with different internal geometry, steeper included outer-ring angle.
	BA	Outer ring	Flanged outer ring. Non-interchangeable with basic part number.
	BNA	Inner ring	ISO inner ring used in assemblies with two inner rings mated with double outer ring to form a double-row, non-adjusting bearing. Non-interchangeable with other inner rings having the same basic part numbers, which may vary in bore or width dimensions.
	BR	Outer ring	Single outer ring with groove in O.D. for snap ring.
	BS	Outer ring	Flanged outer ring. Non-interchangeable with basic part number.
	BW	Outer ring	Flanged outer ring with slot. Non-interchangeable with basic part number.
	BX	Outer ring	Flanged outer ring. Non-interchangeable with basic part number.
	BXX	Outer ring	Flanged single outer ring. Made of special steel.
	C	Inner ring	Single inner ring, envelope dimensions same as basic part number, different internal geometry.
	C	Outer ring	Dimensionally different from basic part number. Non-interchangeable.
	CA	Inner ring	Single inner ring, envelope dimensions same as basic part number, different internal geometry.
	CB	Inner ring	Single inner ring, dimensionally different from basic part number.
	CD	Outer ring	Double outer ring with oil holes and groove. One hole counterbored for locking pin.
	CE	Outer ring	Dimensionally different from basic part number. Non-interchangeable.
CN		Outer ring	Neoprene-cushioned outer ring.

Prefix	Suffix	Inner Ring or Outer Ring	Explanation
	CP	Inner ring & outer ring	Flash-chrome plated. Otherwise, interchangeable with basic part number.
	CP	Inner ring & outer ring	Envelope dimensions same as basic part number, different internal geometry, customized for performance.
	CR	Inner ring & outer ring	Ribbed outer-ring bearing series.
	CS	Inner ring & outer ring	Dimensionally different from basic part number. Non-interchangeable.
	CX	Inner ring	Dimensionally different from basic part number. Non-interchangeable.
	D	Inner ring & outer ring	Double inner ring or double outer ring. Non-interchangeable with basic part number.
	DA	Inner ring	Double inner ring. Non-interchangeable with inner rings having same basic part number.
	DA	Outer ring	Spherical O.D. double outer ring. Non-interchangeable with basic part number or other double outer rings having same basic numbers.
	DB	Outer ring	Double outer ring with flange. Non-interchangeable with basic part number or double outer rings having same basic numbers.
	DB	Inner ring	Double inner ring assembled with brass cages.
	DD	Inner ring & outer ring	Special long double inner ring or outer ring. Non-interchangeable with basic part number or other double parts having same basic numbers.
	DE	Inner ring & outer ring	Double inner ring or double outer ring having different dimensions or other characteristics from single and double parts identified with same basic part number.
	DF	Outer ring	Double outer ring with oil holes and groove. Snap ring groove on O.D.
	DG	Inner ring	Double inner ring with pressure-removal groove or helical groove in bore.
	DGA	Inner ring	Double inner ring with pressure-removal groove or helical groove in bore. Non-interchangeable with basic part number.
	DGE	Inner ring	Double inner ring with pressure-removal groove or helical groove in bore. Non-interchangeable with basic part number.
	DGH	Inner ring	Double inner ring with pressure-removal groove or helical groove in bore and with special cage, rollers, and/or internal geometry.
	DGW	Inner ring	Double inner ring with pressure-removal groove or helical groove in bore, and having face slots.
	DH	Inner ring	Double inner ring with special cage, rollers, and/or internal geometry.
	DP	Inner ring	Double inner ring with puller groove.
	DR	Outer ring	Double outer ring for ribbed outer-ring series. Non-interchangeable with single and double outer rings identified with same basic part number.
	DRB	Outer ring	Double outer ring with snap-ring groove.
	DS	Outer ring	Crowned O.D. double outer ring. Non-interchangeable with other outer rings having same basic part numbers.
	DT	Outer ring	Tapered O.D. double outer ring. Non-interchangeable with other outer rings having same basic part numbers.
	DV	Inner ring & outer ring	Double inner ring or double outer ring made of special steel.
	DVH	Inner ring	Double inner ring, special steel, and/or internal geometry.
	DW	Inner ring & outer ring	Double inner ring or double outer ring with keyway or slot. Non-interchangeable with inner rings or outer rings identified with same basic part numbers.
	DWA	Inner ring	Double inner ring with one end extended and with oil slots in extended end (asymmetrical).
	DWH	Inner ring	Double inner ring with oil slots, assembled with special cage, rollers, and/or internal geometry.
	DWV	Inner ring & outer ring	Double inner ring or double outer ring with keyway or slot. Non-interchangeable with inner rings or outer rings identified with same basic part numbers. Made of special steel.
DX		Inner ring & outer ring	DuraSpexx power rating series.
	DX	Outer ring	Adaptor for spherical or straight O.D. outer ring.
	DX	Outer ring	Threaded O.D. double outer ring. Non-interchangeable with outer rings identified with same basic part numbers.
	DXX	Inner ring & outer ring	Double inner ring or double outer ring made of special steel.
	E	Inner ring & outer ring	Inner rings or outer rings having special characteristics differing from and non-interchangeable with other inner rings or outer rings identified with the same basic part numbers.
	ED	Outer ring	Double outer rings. Non-interchangeable with other outer rings identified with same basic part numbers.
	EDC	Outer ring	Double outer rings, special hole in O.D. for locking pin.
EE		Inner ring	Large and small ribs - close-guided rollers. Non-interchangeable with other inner rings identified with same basic part numbers.
EH		Inner ring & outer ring	Extra-heavy series.

Prefix	Suffix	Inner Ring or Outer Ring	Explanation
EL		Inner ring & outer ring	Extra light series.
EX		Inner ring & outer ring	Experimental.
	EXX	Inner ring & outer ring	Inner rings or outer rings having special characteristics differing from and non-interchangable with other inner rings or outer rings identified with the same basic part numbers. Made of special steel.
	F	Inner ring	Assembled with polymer cage.
FL		Inner ring & outer ring	Free lateral series, no large or small ribs.
FX		Inner ring & outer ring	Factory identification number only.
	G	Inner ring	Cage groove in bore.
H		Inner ring & outer ring	Heavy series. Non-interchangeable with other inner rings and outer rings identified with same basic part numbers.
	H	Inner ring	Assembled with special cage, rollers, and/or internal geometry.
	HV	Inner ring	Assembled with special cage, rollers, and/or internal geometry. Made of special steel.
HH		Inner ring & outer ring	Heavy-heavy series. Non-interchangeable with other inner rings and outer rings identified with same basic part numbers.
HM		Inner ring & outer ring	Heavy-medium series. Non-interchangeable with other inner rings or outer rings identified with same basic part numbers.
	HP	Inner ring	Assembled with special cage and/or roller, different internal geometry. Customized for performance.
	HR	Outer ring	Special outer ring used in Hydra-Rib bearing.
J		Inner ring & outer ring	Used alone or with other prefix letters to indicate metric bore and/or O.D.
JC		Inner ring & outer ring	Metric series.
JD		Inner ring & outer ring	Metric series.
JE		Inner ring & outer ring	Metric series.
JF		Inner ring & outer ring	Metric series.
JG		Inner ring & outer ring	Metric series.
JN		Inner ring & outer ring	Metric series.
JP		Inner ring & outer ring	Metric series.
JR		Inner ring & outer ring	Metric series.
JRM		Inner ring & outer ring	Metric series, UNIPAC bearing.
JS		Inner ring & outer ring	Metric series.
JT		Inner ring & outer ring	Metric series.
JU		Inner ring & outer ring	Metric series.
JW		Inner ring & outer ring	Metric series.
K		Outer ring	Double outer ring with heavy section. May have unusual features such as flange, tapered O.D., etc.
K		Inner ring & outer ring	Through-hardened components, non-DIN 720 part numbers.
K		Miscellaneous	K prefix with five or six digits following also used for miscellaneous components (seals, bolts, filler rings, etc.).
	KP	Thrust bearing	Cadmium plated.
L		Inner ring & outer ring	Light series. Non-interchangeable with other inner rings and outer rings identified with same basic part numbers.
	L	Inner ring	Inner ring assembled with DUO-FACE seal.
	L	Outer ring	Loose rib. Part of unit-bearing.
	LA	Inner ring	Inner ring assembled with DUO-FACE-PLUS seal.
	LA, LB, LC, etc.	Seal	These suffixes are used on a basic DUO-FACE-PLUS seal number to identify the assembly resulting from the use of the seal with various inner rings in the series.
LL		Inner ring & outer ring	Light-light series.
LM		Inner ring & outer ring	Light-medium series.
M		Inner ring & outer ring	Medium series.
	M	Inner ring & outer ring	Through-hardened components, DIN 720 part numbers, IsoClass part numbers.
N		Inner ring	Bock- or Gilliam-type bearings.
NA	NA	Inner ring	Two inner rings mated with double outer ring to form double-row non-adjustable bearing. Non-interchangeable with other inner rings having same basic part numbers which may vary in bore, O.D., and width dimensions.
	NA	Outer ring	Etched electric pencil on double outer rings mated with two NA-type single inner rings to form double-row non-adjustable bearings.

Prefix	Suffix	Inner Ring or Outer Ring	Explanation
	NAV	Inner ring	NA inner ring made of special steel.
	NC	Outer ring	Cushioned outer ring (usually neoprene.)
	NI	Inner ring	Tapered or threaded bore.
NP		Inner ring & outer ring	Used with random numbers for product differentiation.
	NR	Inner ring	NA-type ribless inner ring for ribbed outer-ring series.
	NW	Inner ring	NA-type inner ring with slotted front face.
	NWV	Inner ring	NA-type inner ring with slotted front face. Made of special steel.
	NX	Inner ring	Lapped front face.
	P	Inner ring	Puller groove.
	P	Inner ring & outer ring	Customized for performance.
R		Inner ring & outer ring	Gilliam replacement series. Non-interchangeable with other inner rings and outer rings identified with same basic numbers.
	R	Inner ring & outer ring	Special feature bearing. Non-interchangeable with bearings having the same basic part numbers.
	R	Inner ring & outer ring	Bock-type bearing.
	R	Inner ring	Basic part number with polymer lubricant.
	RB	Outer ring	Snap ring on O.D.
RC		Inner ring & outer ring	Special ribbed outer-ring bearing.
	RN	Various	Used with random numbers, not to exceed six digits, for purchased items that are distributed by Timken.
	RR	Inner ring & outer ring	Relieved ring.
	S	Inner ring & outer ring	Special feature bearing. Non-interchangeable with bearings having same basic part numbers.
	SA	Inner ring & outer ring	Special feature bearing. Non-interchangeable with bearings having same basic part numbers.
	SB	Inner ring	Assembled with brass cage.
	SB	Outer ring	Flanged outer ring.
	SC	Inner ring	With square bore.
	SD	Inner ring & outer ring	Double inner ring with square bore or double outer ring.
	SH	Inner ring	Special feature bearing, with special cage, rollers, and/or internal geometry. Non-interchangeable with bearings having same basic part numbers.
	SL	Thrust bearing	Basic part number with polymer lubricant.
	SR	Inner ring	Different radius from basic part numbers.
	SW	Inner ring & outer ring	Slot or keyway. Non-interchangeable with bearings having same basic part numbers.
	SWB	Inner ring	Slot or keyway assembled with brass cage. Non-interchangeable with bearings having same basic part numbers.
	SWV	Inner ring	Slot or keyway made of special steel. Non-interchangeable with bearings having same basic part numbers.
	SX	Outer ring	Special feature bearing. Non-interchangeable with bearings having same basic part numbers.
T		Rings	Thrust bearing assemblies.
T		Outer rings	Double outer ring with heavy section. May have unusual feature such as flange, tapered O.D., etc.
	T	Inner ring	Tapered bore.
	T	Outer ring	Tapered O.D.
	TA	Inner ring	Tapered bore NA-type inner ring.
	TA	Outer ring	Tapered O.D.
	TB	Inner ring	Tapered-bore inner ring with brass cage.
TC		Rings	Thrust bearing assemblies.
	TC	Inner rings	Tapered bore.
	TD	Inner ring	Double with tapered bore.
	TDB	Inner ring	Double with tapered bore, assembled with brass cages.
	TDE	Inner ring	Double with tapered bore and extended rib.
	TDG	Inner ring	Double with tapered bore, pressure-removal groove or spiral groove in bore.
	TDGV	Inner ring	Double with tapered bore, pressure-removal groove or spiral groove in bore. Made of special steel.
	TDH	Inner ring	Double with tapered bore, special cage, rollers or internal geometry.
	TDL	Inner ring	Double with tapered bore, interlock feature.
	TDV	Inner ring	Double with tapered bore. Made of special steel.

Prefix	Suffix	Inner Ring or Outer Ring	Explanation
	TDW	Inner ring	Double with tapered bore and slots or keys.
	TDXX	Inner ring	Double with tapered bore. Made of special steel.
	TE	Inner ring	Single, tapered bore, extended large rib.
	TEV	Inner ring	Single, tapered bore, extended large rib. Made of special steel.
	TL	Inner ring	Tapered-bore with interlock feature.
	TLE	Inner ring	Tapered-bore with interlock feature and extended rib.
	TP	Inner ring	Tapered-bore inner ring with puller groove.
	TPE	Inner ring	Tapered-bore inner ring with puller groove, extended inner-ring large rib.
	TV	Inner ring & outer ring	Tapered-bore inner ring or outer ring O.D. Made of special steel.
	TW	Inner ring & outer ring	Tapered-bore inner ring or outer ring O.D. with slots or keys.
	TWE	Inner ring & outer ring	Tapered-bore inner ring or outer ring O.D. with locking keyway in front face, extended inner ring large rib or outer ring width.
	TXX	Inner ring	Tapered bore. Made of special steel.
U		Inner ring & outer ring	Basic series part number, unitized, self-contained.
	U	Inner ring & outer ring	Basic series part number, unitized, self-contained.
	US	Inner ring & outer ring	Special close stand.
V		Inner ring & outer ring	Special close stand.
	V	Inner ring & outer ring	Made of special steel.
	VC	Inner ring	Special internal geometry. Made of special steel.
	VH	Inner ring	Special cage, rollers, and/or internal geometry. Made of special steel.
	W	Inner ring & outer ring	Slot(s) or keyway(s).
	W	Thrust bearing	Oil holes in retainer.
	WA	Inner ring & outer ring	Slot(s) or keyway(s).
	WB	Inner ring	Slot(s) or keyway(s) with brass cage.
	WC	Inner ring & outer ring	Slot(s) or keyway(s).
	WD	Inner ring & outer ring	Double inner ring or outer ring with slot(s) or keyway(s).
	WE	Inner ring & outer ring	Extended face with slot(s) or keyway(s).
	WS	Inner ring & outer ring	Slot(s) or keyway(s).
WV		Inner ring & outer ring	Slot(s) or keyway(s). Made of special steel.
	WXX	Inner ring & outer ring	Slot(s) or keyway(s). Made of special steel.
X		Inner ring	ISO part number.
	X	Inner ring	Slot(s) or keyway(s).
	X	Inner ring & outer ring	Special feature bearing. Non-interchangeable with bearings having the same basic part number.
	X	Inner ring & outer ring	ISO bearing with same boundary dimensions as basic part number but with different internal geometry, yielding increased rating.
	XA	Inner ring & outer ring	Special feature bearing. Non-interchangeable with bearings having the same basic part number.
XAA		Inner ring	ISO single inner ring. Non-interchangeable with bearings having the same basic part number.
XAB		Inner ring	ISO single inner ring. Non-interchangeable with bearings having the same basic part number.
	XB	Inner ring	Different bore, width, or radius, from basic part number. Assembled with brass cage.
	XB	Outer ring	Special feature flanged outer ring. Non-interchangeable with bearings having the same basic part number.
XC		Inner ring & outer ring	Limited production bearings to which standard series part numbers have not been assigned.
	XD	Outer ring	Double outer ring, no oil holes or groove.
	XD	Inner ring	Double inner ring, different bore or width from basic part numbers.
	XD	Inner ring	Double inner ring, oil holes in large rib.
	XDXP	Outer ring	Double outer ring, no oil holes or groove, special material and process.
	XE	Outer ring	Different bore, width, or radius from basic part number.
XGA		Inner ring	ISO single inner ring. Non-interchangeable with bearings having the same basic part number.
XGB		Inner ring	ISO single inner ring. Non-interchangeable with bearings having the same basic part number.
	XP	Inner ring	Special steel and process.
XR		Inner ring & outer ring	Crossed roller bearings.
	XS	Inner ring & outer ring	Different bore, O.D., width, or radius from basic part number.

Prefix	Suffix	Inner Ring or Outer Ring	Explanation
	XV	Inner ring & outer ring	Special feature inner ring or outer ring made of special steel.
	XW	Inner ring	Slotted.
	XX	Inner ring & outer ring	Single inner ring or single outer ring. Made of special steel.
Y		Outer ring	ISO part number.
	YD	Outer ring	Double outer ring with oil holes, no groove.
	YDA	Outer ring	Double outer ring with oil holes, no groove. Non-interchangeable with bearings having the same basic part number.
	YDV	Outer ring	Double outer ring with oil holes, no groove. Made of special steel.
	YDW	Inner ring	Double outer ring with oil holes, no groove. Slots or keyways in faces.
YKA		Outer ring	ISO single outer ring. Non-interchangeable with bearings having the same basic part number.
YKB		Outer ring	ISO single outer ring. Non-interchangeable with bearings having the same basic part number.
YSA		Outer ring	ISO single outer ring. Non-interchangeable with bearings having the same basic part number.
	Z	Inner ring & outer ring	Close stand part.