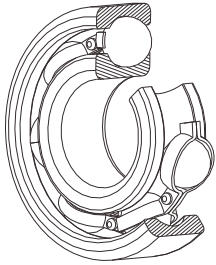


### 1.3 Characteristics

#### 1) Single-row deep groove ball bearing



Single-row deep groove ball bearings are the most common bearings, because they adopt various seals, shields and snap ring devices.

The bearing raceway is made into arc shape a little larger than the radius of the ball. The contact between ball and raceway is point contact (Ellipse contact when loaded).

Deep groove ball bearing mostly take radial load, and can also take certain axial load. The dimension ranges and forms of these bearings are various. Their friction torque is small, mostly suited where high speed rotation, low noise and low vibration are required. Such as: precision instruments, low-noise motors, automobiles, motorcycles and general machines, etc. They are the most common bearings in the mechanical industry. According to their outer diameters, bearings fall into:

- a) Miniature bearing:  $D \leq 26\text{mm}$ ;
- b) Small size bearing:  $28\text{mm} < D \leq 55\text{mm}$ ;
- c) Mid-small size bearings:  $60\text{mm} \leq D < 115\text{mm}$ ;
- d) Mid-large size bearings:  $120\text{mm} < D \leq 190\text{mm}$ ;
- e) Large size bearings:  $200\text{mm} \leq D < 430\text{mm}$ ;
- f) Extra-large size bearing:  $D > 430\text{mm}$ .

Cages are generally made of pressed steel (sheet), and nylon cages are also widely used.

Deep groove ball bearings with seals or shields have been standardized. An amount of lubricating grease has been filled in bearings in advance.

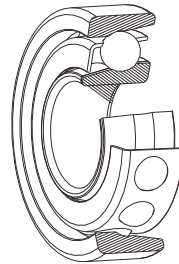
#### Main Applications

Automobiles: rear wheels, transmissions and electrical devices.

Electrical: general motor and household electrical appliances.

Others: meters, internal combustion engines, construction machines, railway vehicles, handling machinery, agricultural machine and various industrial machine.

#### 2) Angular contact ball bearing

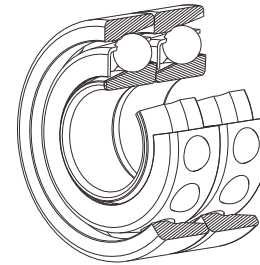


Angular contact ball bearings can take radial load and axial load at the same time, but single row angular contact ball bearings can only take axial load in single direction, therefore, they are often used in pairs. The matched angular contact ball bearing with adjusted clearance is the most convenient. The contact angles between steel balls and the inner ring/outer ring are  $15^\circ$ ,  $25^\circ$  and  $40^\circ$ . The larger the contact angle is, the larger the axial load capacity is. The smaller the contact angle is, the better it is for high speed rotation. General high precision and high speed bearings often adopt the contact angle of  $15^\circ$ .

The materials of cages are different including brass, synthetic resin, etc, depending on working conditions.

Main application: machine tool spindles, high frequency motors, centrifugal separators, compact car front wheels, differential pinion shafts.

#### 3) Matched pair bearing



Matched pair bearings are arranged by combining two or more radial bearings in pairs. Generally the same type of radial-thrust ball bearings or tapered roller bearings are paired in most situation:

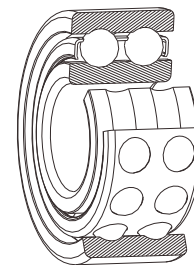
Face-to-face arrangement (DF type) can take radial load and in double direction axial load.

Back-to-back arrangement (DB type), can take radial load and double direction axial load.

Tandem arrangement (DT type) are used where the axial load in one direction is large.

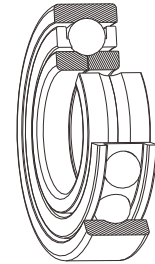
Main application: oil pumps, air compressors, various transmissions, etc.

#### 4) Double-row angular contact ball bearing



Double-row angular contact ball bearings are basically two single-row angular contact ball bearings mounted back-to-back except that they have only one inner ring and one outer ring, each have two raceways. So bearings with this kind of structure can take the thrust load from two directions.

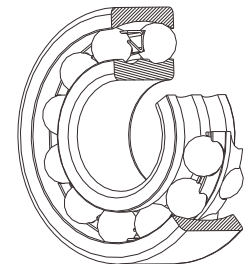
#### 5) Four-point contact ball bearing



Four-point contact ball bearings are single row radial-thrust ball bearings whose inner rings are divided into two parts by the radial plane through the central axis, and the inner ring and outer ring are separable. This bearing can form a contact angle ( $\alpha$ ) when bearing take axial load from any direction, therefore the ring and the ball are always keeping contact at two points of either line. Single bearing take axial load in two directions. One bearing can substitute for face-to-face or back-to-back angular contact ball bearings.

Materials of cages are mainly: made of copper or alloy steel.

#### 6) Self-aligning ball bearing



Inner ring has two raceways, the raceway of outer ring is spherical surface, and the spherical surface's center of curvature coincide with the bearing axis. Inner ring, ball and cage can deflect freely to the some extent around the bearing center. Outer ring raceway is a spherical surface, has self-aligning

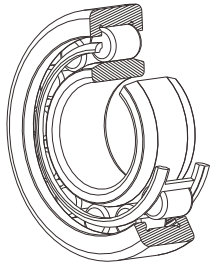
capacity, and can correct the axle center deviation caused by the deflection of axle or housing, or misalignment by itself.

It is able to correct the misalignment of the axle and bearing housing. With seal and one-shot lubrication design, it is applicable in the working conditions where maintenance is not available. The self-aligning ball bearings mounted in the adapter sleeves and bearing housings can supply customers with economical bearing service.

There are two structures of self-aligning ball bearings, cylindrical bore and tapered bore. The materials of cages include steel, synthetic resin, etc.

Main application: textile machinery drive shaft, etc.

### 7) Cylindrical roller bearing



Cylindrical roller and raceway are line contact. The loading capacity is large. They mostly take radial load. The friction between the rolling element and ring rib is small. They are applied to where high rotation speed is required. The inner ring and outer ring of this bearing are separable. According to whether the ring has a rib, they can fall into the following categories:

Single row: NU, NJ, NUP, N, NF  
Double row: NNU, NN

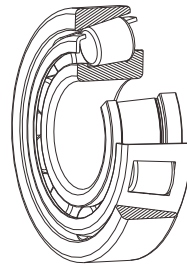
Applied to take heavy load and impact load, as well as high speed rotation. N type and NU type can move in the axial direction, can adjust to the changes of the relative position of axle and housing

caused by thermal expansion or mounting error and are most suited for free end. NJ type and NF type can take a certain degree of axial load in single direction ; NUP type can take a certain degree of axial load in two-direction , and the inner or outer ring is separable; the rigidity of NNU type and NN type against radial load is strong, furthermore they are convenient for handling. Mostly used to machine tool spindles.

Adopted cages mainly include: pressed steel cage (Z shape), copper alloy cut cages, pin cages, and molded synthetic resin cages.

Main application: medium and high-capacity motors, generators, internal combustion engines, gas turbines, machine tool spindles, reduction gear, handling machinery, and various of industrial machinery.

### 8) Tapered roller bearing



This type of bearings is equipped with conical rollers, which are guided by a back-to-back rib on the cone. The apexes of each circular conical surface of the inner ring raceway, outer ring raceway and the roller rolling surface meet at one point on the center line of the bearing. Single-row bearings can take radial load and axial load single direction , double row bearings can take radial load and axial load from two-direction , and are applied to where heavy load and impact load is required.

According to different angles ( $\alpha$ ), they fall into three types, normal angle, medium angle and steep angle. The larger the contact angle is, the larger the axial load capacity is.

Outer ring is separable and easy to assemble. During installation and application, the axial clearance and radial clearance can be regulated, and interference mounting can also be adopted.

Similar with angular contact ball bearings, generally two bearings are used in pairs. In this condition, required clearance can be achieved by adjusting the position of same inner rings or outer rings to axial direction.

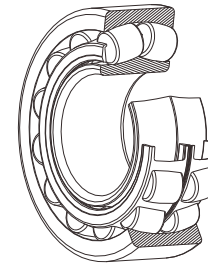
Adopted cages mainly include: steel sheet pressed cages, synthetic resin molded cages and pin cages.

Main application:

Automobile: front wheel, rear wheel, transmission, differential pinion shaft.

Machine tool spindles, construction machinery, agricultural machinery, gear reduction device, rolling mill assembly and reduction device.

### 9) Spherical roller bearing



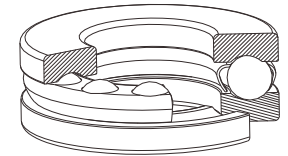
Spherical rollers are equipped between the spherical raceway of outer rings and two raceways of inner rings. Since the center of curvature of the outer ring raceway coincides with the bearing center, and has self-aligning ability, the axle center deflection caused by axle or housing deflection or misalignment can be correct automatically without excessive force to the bearing.

Spherical roller bearings can take, not only heavy radial loads, but also some axial loads in either direction. They have excellent radial load-carrying capacity and are suitable for use where there are heavy or impact loads. Some bearings have tapered bores and maybe mounted on tapered shaft or cylindrical shaft using adapters or withdrawal sleeves.

Adopted cages mainly include: pressed steel sheet cage, cut copper alloy cages, pin cages, and molded synthetic resin formed cages.

Main application: paper manufacturing machinery , reduction device, railway vehicle axle, rolling mill gearbox, rolling mill roller , crusher, vibration griddle, printing machinery, woodworking machinery, and various industrial reducer.

### 10) Single direction thrust ball bearing



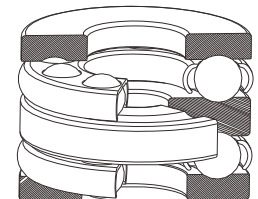
Composed of a washer like bearing ring with raceway, ball and cage. The ring attached to the shaft called shaft washer , and attached to the housing is called housing washer. Single direction bearing can take axial load in single direction , double direction bearing can take two-direction axial load (Neither can take radial load).

Specially designed for pure thrust load, can take axial load both in single direction and double direction .The spherical seat washer can also compensate the influence of misalignment. Since the bearings are separable, it is easy for mounting.

Pressed cages mainly include: steel sheet adopted cage, copper alloy or phenolic resin cut cages, synthetic resin molded cages.

Main application: automobile steering pin, machine tool spindles.

### 11) Double direction thrust ball bearing



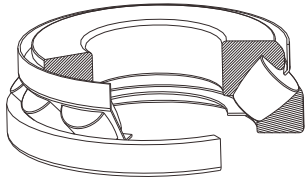
Different from single thrust bearings, double direction thrust ball bearings can take two-direction axial load.

Can compensate the influence of misalignment. Since the bearings are separable, it is easy for mounting.

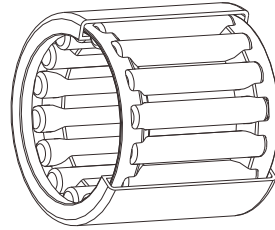
When in service, in order to alleviate the influence caused by mounting error, etc., thrust ball bearings with self-aligning seat washers can also be mounted on the outer ring.

Small size bearings mainly adopt steel sheet pressed cage; large bearings adopt machined cage.

## 12) Spherical Thrust roller bearing



## 13) Needle roller bearing



Needle roller bearings contain a great many long and thin needle rollers whose length is 3 ~ 10 times longer than their diameters. The structure is compact, the outer diameter and the inscribed circle diameter of the bearing is small, so the radial load capacity is high.

Needle roller bearings mainly include the following types:

Needle roller bearings with pressed outer ring which is made of special steel sheet; Needle roller bearings with solid outer ring which is made of cut rings; Cage and roller components without rings and needle roller bearings for gyror wheels.

Besides the above-mentioned, there are also other types with or without inner rings or cages.

The cages of needle roller bearings are mainly pressed steel sheet cages.

Rollers of these bearings are barrel-shaped. Since the raceway in the housing washer is spherical, they are self-aligning. Barrel-shaped roller are arranged slantwise, therefore the deflection of the axle is permitted. Axial load capacity is very large, and can take some radial load as well as axial load. Generally adopt oil lubrication while used.

Adopted cages mainly include: copper alloy cut cage.

These bearings are mainly used in hydraulic generator, vertical type motor, vessel propeller shaft, tower crane, extruder, etc.

## 2 Boundary dimension and basic number of rolling bearings

### 2.1 Boundary dimension

The main dimension of bearings refer to the inner diameter ( $d$ ), outer diameter ( $D$ ), width ( $B$ ) or height ( $H$ ) and chamfer size ( $r$ ), etc., which are required when mounting the bearings onto the axle or into the housing. See Figure 2.1 ~ 2.3.

For the main dimension series, the International Standardization Organization (ISO) has established international standards (ISO 15, ISO 355 and ISO 104) to ensure the exchangeability and economical efficiency internationally. Corresponding specifications have been made for the main size of radial bearings, tapered roller bearings and thrust

bearings, i.e. the inner diameter, outer diameter, width and chamfer size of bearings have been serialized and standardized. The standards of China also adopt the standard specifications of ISO. The corresponding standard numbers are GB/T273.1, GB/T273.2 and GB/T273.3. The assembling chamfer standard is GB/T274.

The dimension including inner diameter and diameter series, and width (or height series). See Figure 2.4-2.5

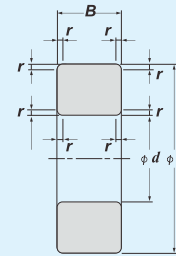


Fig. 2.1 Radial bearing (excluding tapered roller bearing)

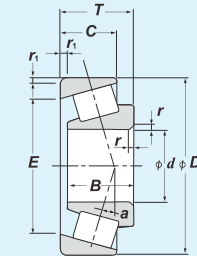


Fig. 2.2 Tapered roller bearing

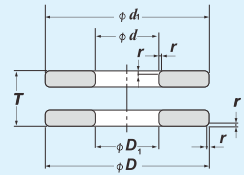


Fig. 2.3 Single direction thrust bearing

Table 2.1 Dimension series

	Dimension series				Reference figure
	Diameter series (outside dimension)		Width series (width)	Height series (height)	
Radial bearing (excluding tapered roller bearing)	No.	7,8,9,0,1,2,3,4	8, 0, 1, 2, 3, 4, 5, 6	—	Figure 2.4
	Dimension	Small $\longleftrightarrow$ Large	Small $\longleftrightarrow$ Large		
Tapered roller bearing	No.	9,0,1,2,3	0, 1, 2, 3	—	—
	Dimension	Small $\longleftrightarrow$ Large	Small $\longleftrightarrow$ Large		
Thrust Bearing	No.	0,1,2,3,4	—	7, 9, 1, 2	Figure 2.5
	Dimension	Small $\longleftrightarrow$ Large		Small $\longleftrightarrow$ Large	