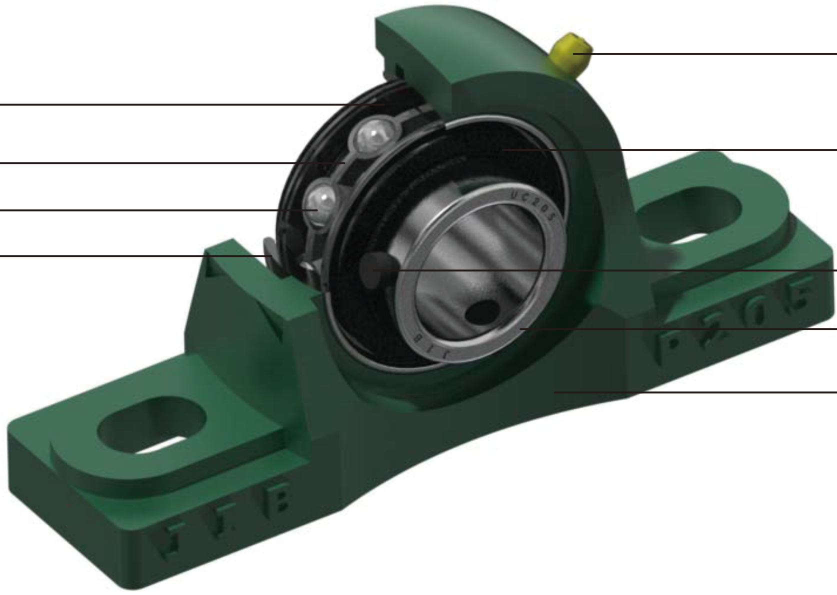
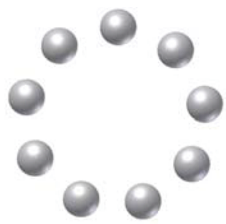
# A. Technical section

# 1. Design and features

## 1.1 Design




[Fig.1.1] Design of ball bearing units

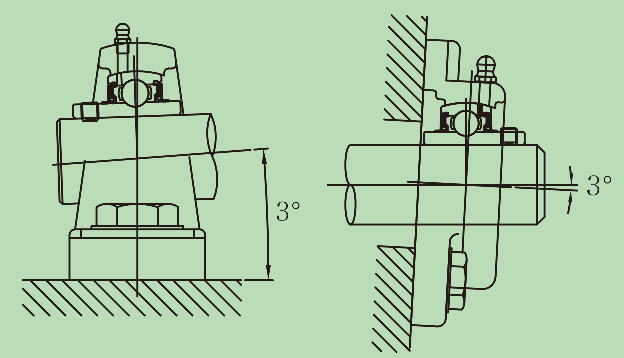
| Outer ring | Inner ring | Ball |
|---|---|---|
|  |  |  |
| **Cage** | **Seal** | **Slinger** |
|  |  |  |

## 1.2 Features

Ball bearing units are comprised of grease sealed deep groove ball bearings and housings in various forms. They are available in a wide range of applications because installation, exchange and lubrication of them are simple.

### 1) Self alignment

The most important feature of ball bearing units is the self-alignment which is accomplished by the spherical shape of the outer diameter of the bearing and the concave shape of the inner diameter of the housing into which they fit. It allows the bearing unit to adjust automatically for shaft deviation and reduces abnormal bearing load.




[Fig.1.2]

### 2) Simplicity of installation

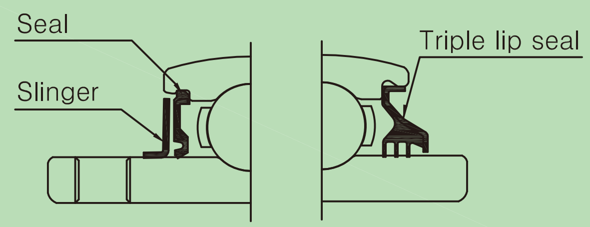
Since ball bearing units have the ability to self-align, they can be easily and firmly mounted onto the shaft with two set screws, an eccentric locking collar or an adapter sleeve.

### 3) Superior load carrying capacity

The internal structure of bearings is equivalent to the deep groove ball bearings of the 6200, 6300 series and has high load-carrying capacities for radial and thrust loads.

### 4) Excellent sealing performance and convenient maintenance

The labyrinth is achieved by attaching seal to the outer ring and attaching slinger to the inner ring. It efficiently prevents grease from leaking out of the interior of the bearing and protects entering of contaminants such as dust and moisture from outside at the same time. It is very convenient for the maintenance because bearings are prelubricated at the factory and do not require additional greasing. JIB has developed the triple lip seal and the double protection method to provide excellent protection even in the severest environment.




[Fig.1.3]

### 5) Compatibility

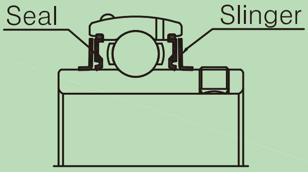
The bearing and the housing of the unit are compatible with each other therefore the bearing or the housing can be exchanged if required.

## 1.3 Sealing

The bearing can be quickly destroyed if contaminants enter the internal moving parts of the bearing or if the lubricating grease is allowed to leak out of the bearing. So, seals have the dual purpose of retaining the lubricant within the bearing and preventing contaminants entering to extend the bearing life. Sealing types are distinguished from non-contact seals and contact seals. Since friction does not occur in non-contact seals except for the lubricant friction, they may be used in high and maximum speed applications. Relatively speaking, contact seals are more efficient for the sealing performance in low speed applications.
Therefore, the sealing type should be carefully chosen to match the purpose and the operating condition.

### 1) Standard seal type(LS)

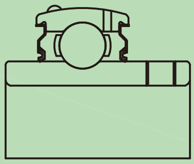
This is the most popular sealing method applied to general JIB bearings. The labyrinth is achieved by attaching seal to the outer ring and attaching slinger to the inner ring as shown in [Fig.1.4]. It efficiently prevents grease from leaking out of the interior of the bearing and prevents entering of contaminants such as dust and moisture from outside simultaneously.



[Fig.1.4] LS type

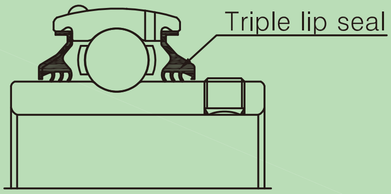
### 2) Simple seal type(L)

The special synthetic rubber is fixed to the stamped steel shield which is attached to the outer ring. There are low friction because the lip of the seal contacts the inner ring of the bearing with optimal tension. This type can provide the safe operation for extended periods in normal operating conditions. It is generally applied to SA, SB and SC bearings.[Fig. 1.5]


[Fig.1.5] L type

### 3) Triple lip seal type(L3)

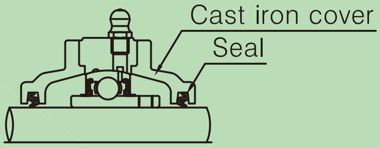
The triple lip seal type has a special seal structure made of synthetic rubber which is attached to a stamped steel shield. The combined piece is attached to the outer ring of the bearing. During operation, the spaces between the lips are filled with grease to provide lubrication and protection at the same time. This type provides an excellent protection against dust and moisture.



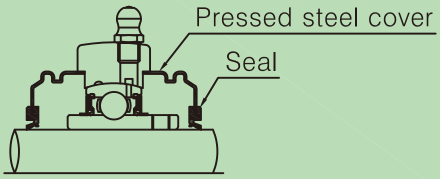
[Fig.1.6] L3 type

### 4) Double protection : units with cover (GC,GCD,C,CD)

The double protection method is made by attaching additional external covers to the housing. There are two types. Both are available in open and closed design. The covers adding second layer help to ensure the contaminants will not reach the bearing, so it is the best way of protection.



[Fig.1.7] Cast iron cover(GC,GCD)



[Fig.1.8] Pressed steel cover(C,CD)

# 2. Product overview

## 2.1 Type of units

### Pillow block type

#### Pillow block type unit

- Mounting with UC, UK, HC bearing
- Multidirectional installation
- High load capacity

**UCP** 2 – B01 X – B02 3 – B03


**UKP** 2 – B04 X – B05 3 – B06

**HCP** 2 – B07

#### Pillow block A type unit

- Mounting with UC bearing
- Installation on machine having narrow space
- Using two-bolt hole on the housing bottom surface for installation

**UCPA** 2 – B08

#### Pillow block H type unit

- Mounting with UC bearing
- Suitable for machine with high height of axis center

**UCPH** 2 – B09

Pillow block L type unit

**SALP** 2 – B10

**SBLP** 2 – B10

- Mounting with SA, SB bearing
- Installation on machine having narrow space
- Small and light pillow block type housing

## Square flange type

Square flange type unit

**UCF** 2 – B11 X – B12 3 – B13

**UKF** 2 – B14 X – B15 3 – B16

- Mounting with UC, UK, HC bearing
- Installation on the side surface of machine

Square flange S type unit

**UCFS** 3 – B17

**UKFS** 3 – B18

- Mounting with UC, UK, HC bearing
- Installation on the side surface of machine
- High positional accuracy for installation (Spigot joint machining on the bottom surface)

## Oval flange type

Oval flange type unit

**UCFL** 2 – B19 X – B20 3 – B21

**UKFL** 2 – B22 X – B23 3 – B24

- Mounting with UC, UK bearing
- Installation on the side surface of machine

## UCFA 2 – B25

### Oval flange A type unit

- Mounting with UC bearing
- Suitable for machine needed positional adjustment of axis center

## UCFB 2 – B26

### Oval flange B type unit

- Mounting with UC bearing
- Installation on machine having narrow space

## SALF 2 – B27

## SBLF 2 – B27

### Oval flange L type unit

- Mounting with SA, SB bearing
- Installation on the side surface of machine
- Small and light oval flange type housing

## Round flange type

## UCFC 2 – B28 X – B29

## UKFC 2 – B30 X – B31

### Round flange type unit

- Mounting with UC, UK bearing
- Installation on the side surface of machine
- High positional accuracy for installation (Spigot joint machining on the bottom surface)

## Round flange C type unit

- Mounting with SA, SB bearing
- Installation on the side surface of machine
- High positional accuracy for installation (Spigot joint machining on the bottom surface)

**SAFCC** 2 - B32

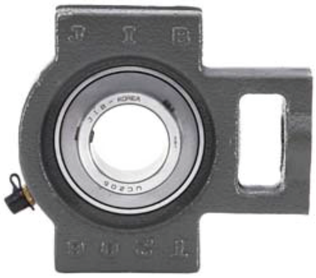
**SBFCC** 2 - B33

# Take-up type

## Take-up type unit

- Mounting with UC, UK bearing
- Suitable for machine needed tension adjustment

**UCT** 2 - B34 X - B35 3 - B36



**UKT** 2 - B37 X - B38 3 - B39

# Other types

## Cartridge type unit

- Mounting with UC, UK bearing
- Available to use as a floating unit (When there is expansion or contraction depending on temperature change)

**UCC** 2 - B40 X - B41 3 - B42

**UKC** 2 - B43 X - B44 3 - B45

## Hanger type unit

- Mounting with UC bearing
- Parallel pipe threads hole machining on the housing mounting surface
- Hanging a unit to machine for use

**UCHA** 2 - B46

## Pressed steel type

### Pressed steel Pillow block type unit

- Mounting with SA, SB bearing
- Pressed steel housing

**SAPP** 2 – B47

**SBPP** 2 – B47

### Pressed steel Oval flange type unit

- Mounting with SA, SB bearing
- Pressed steel housing

**SAPFL** 2 – B48

**SBPFL** 2 – B48

### Pressed steel Round flange type unit

- Mounting with SA, SB bearing
- Pressed steel housing

**SAPF** 2 – B49

**SBPF** 2 – B49

# 2.2 Type of bearings

## Set screw type

(fixing with two set screws of 120°)

### UC

2 – C01
X – C02
3 – C03

- Cylindrical bore bearing
- Sealing method : LS type
- Available to resupply grease

### UR

2 – C04

- Cylindrical inner and outer ring
- Sealing method : LS type
- Same dynamic/static load carrying capacity with UC
- Available to use a bearing alone when mounting

### SB

2 – C05

### CSB

2 – C05

- Bearing with relatively narrow width than UC
- Sealing method : L type
- Same dynamic/static load carrying capacity with UC(201~212)

### SER

2 – C06

- Cylindrical inner and outer ring
- Sealing method : LS type
- Same dynamic/static load carrying capacity with UC
- Available to resupply grease
- Available to use a bearing alone when mounting
- Available to mount a snap ring on the outer ring of bearing

## Eccentric locking collar type

### HC 2 – C07

### CHC 2 – C07

- Cylindrical bore bearing
- Sealing method : LS type
- Same dynamic/static load carrying capacity with UC
- Available to resupply grease
- CHC type : Cylindrical outer ring

### SA 2 – C08

### CSA 2 – C08

- Cylindrical bore bearing
- Sealing method : L type
- Same dynamic/static load carrying capacity with UC(201~212).
- Bearing with relatively narrow width than UC
- CSA type : Cylindrical outer ring

## Adapter type

### UK 2 – C09 X – C10 3 – C11

- Tapered bore bearing
- Sealing method : LS type
- Same dynamic/static load carrying capacity with UC
- Available to resupply grease

## Tight fit type

### SC 2 – C12

- Cylindrical bore bearing
- Sealing method : L type
- Same dynamic/static load carrying capacity with UC(201~212)
- Identical dimensions with ball bearings of the 6200 series

## 2.3 Stainless series

Bearing material : Stainless(KS-STS440C)
Housing material : Stainless(KS-SSC13)

### Unit

Stainless series
Pillow block type

**SUCP** 2 – D01

- Mounting with SUC bearing
- Multidirectional installation
- High load capacity

Stainless series
Square flange type

**SUCF** 2 – D02

- Mounting with SUC bearing
- Installation on the side surface of machine

Stainless series
Oval flange type

**SUCFL** 2 – D03

- Mounting with SUC bearing
- Installation on the side surface of machine

Stainless series
Take–up type

**SUCT** 2 – D04

- Mounting with SUC bearing
- Suitable for machine needed tension adjustment

## Bearing

Stainless series
Set screw type

**SUC** 2 – D05

- Cylindrical bore bearing
- Sealing method : LS type
- Same dynamic/static load carryin capacity with UC
- Available to resupply grease
- Identical dimensions with UC

## 2.4 Clean series

Bearing material : Bearing steel(KS-STB2)
Stainless(KS-STS440C)
Housing material : Zinc alloys die castings(KS-ZDC2)

### Unit

Clean series
Pillow block type

- Mounting with USA, USB, USC bearing
- Bearing material : Bearing steel (KS-STB2)
- Housing plating : Zinc plating

**USAP** 0 – E01

**USBP** 0 – E01

**USCP** 0 – E01

Stainless clean series
Pillow block type

- Mouting with MUSA, MUSB bearing
- Bearing material : Stainless
  (KS-STS440C)
- Housing plating : Chromium plating

## MUSAP 0 – E01

## MUSBP 0 – E01

Clean series
Oval flange type

- Mouting with USA, USB, USC bearing
- Bearing material : Bearing steel
  (KS-STB2)
- Housing plating : Zinc plating

## USAFL 0 – E02

## USBFL 0 – E02

## USCFL 0 – E02

Stainless clean series
Oval flange type

- Mounting with MUSA, MUSB bearing
- Bearing material : Stainless
  (KS-STS440C)
- Housing plating : Chromium plating

## MUSAFL 0 – E02

## MUSBFL 0 – E02

## Bearing

### Clean/ Stainless clean series
### Set screw type

**USB** 0 – E03

**MUSB** 0 – E03

- Cylindrical bore bearing
- Sealing method : L type
- USB material : Bearing steel(KS-STB2)
- MUSB material : Stainless(KS-STS440C)

### Clean/ Stainless clean series
### Eccentric locking collar type

**USA** 0 – E04

**MUSA** 0 – E04

- Cylindrical bore bearing
- Sealing method : L type
- USA material :Bearing steel(KS-STB2)
- MUSA material : Stainless(KS-STS440C)

### Clean series
### Tight fit type

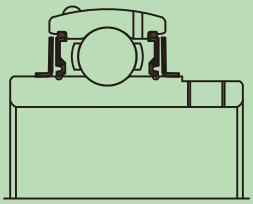
**USC** 0 – E05

- Cylindrical bore bearing
- Sealing method : L type

## 2.5 Units for special uses

### 1) Units for blowers(JIB Classification J5)

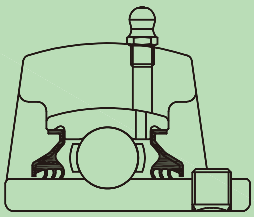
Ball bearing units for blowers must not generate large amounts of heat, vibration or noise at high rotation speed. JIB manufactures units for blowers with the best technology and design. Therefore, units for blowers made by JIB are the best products with the highest quality in surface roughness, orbital shape and rotation accuracy.



[Fig. 2.1] Units for blowers

### 2) Units with triple lip seal(JIB Classification L3)

It is a product that applies triple lip seal to the bearings. It is more suitable to use under extreme environmental conditions because it provides more excellent effect to prevent the entering of dust and moisture than the general seal type.



[Fig. 2.2] Units with triple lip seal

### 3) Units for anti-oxidation and anti-corrosion (JIB Classification M1)

This unit is suitable for anti-oxidation and anti-corrosion by coating the standard bearing with alkali black layer. UC, SA and SB bearings are generally applied, and other bearings can be applied on demand.(Product on demand)[Fig.2.3]

[Fig.2.3] Black-oxide treated bearing

### 4) Cold resistant and heat resistant units (JIB Classification EN1, EN2)

The operating temperature of ball bearing units depends on

① lubricating grease
② rubber material of seals
③ the radial internal clearance of the bearing

The normal operating temperature range for JIB ball bearing units is from -20℃ to 100℃. Cold resistant or heat resistant units should be used in low or high temperature environments outside the normal operating temperature range.
JIB manufactures the following standardized cold and heat resistant units shown in [Table 2.1].

[Table 2.1] Cold resistant and heat resistant units

| Section | | Cold resistant | Heat resistant | Clean room |
|---|---|---|---|---|
| JIB-Classification | | EN1 | EN2 | EN2-C |
| Operating temperature range | | -30°C ~ +180°C | | -30°C ~ +220°C |
| Lubricating grease (Temperature range) | | Super lube-Synco (-43℃~232℃) | | Carbaflo -Fuchs (-35℃~280℃) |
| Material of seal (Temperature range) | | Fluorine-FKM (-25℃~220℃) | | |
| Sealing method | | LS type | | |
| Clear-ance | UC | CN | C4 | C4 |
| | UK | C3 | C5 | C5 |

### 5) Ductile iron and steel castings units (JIB Classification FCD, SC)

Strength of ductile iron and steel castings is stronger than gray cast irons. Ductile iron(GCD450) unit provides a good combination of rigidity and fracture resistance, and it is suitable for the conditions with severe vibration. Steel castings(SC450) provides the best durability in extremely difficult operating environments.

[Table 2.2] Ductile iron and steel castings

| Section | Gray cast irons | Ductile iron | Steel casting |
|---|---|---|---|
| JIB Classification | - | FCD | SC |
| Material | KS-GC200 | KS-GCD450 | KS-SC450 |
| Yielding point (N/mm²) | - | 280 or more | 225 or more |
| Tensile strength (N/mm²) | 200 or more | 450 or more | 450 or more |
| Elongation(%) | - | 10 or more | 19 or more |
| Hardness(HB) | 223 or less | 140~210 | - |

# 3. Nomenclature

## 3.1 Bearing model code

The bearing model code describes the bearing type and basic dimensions, it is written in the order of the type code, the diameter code and the bore diameter code.[Table 3.1]

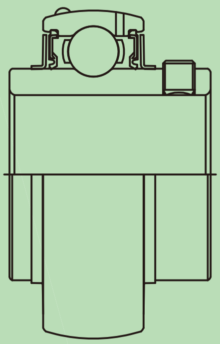
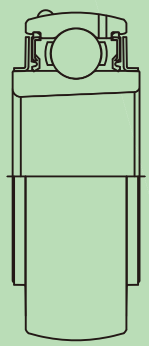
Ex.1) UC 3 08
- 08 — Bore diameter code(40 mm)
- 3 — Diameter code
- UC — Type code(Cylindrical bore)

Ex.2) SA 2 05-16 EN2
- EN2 — Heat resistant
- 05-16 — Bore diameter(1 inch)
- 2 — Diameter code
- SA — Type code(Cylindrical bore)

Ex.3) S UC 2 10
- 10 — Bore diameter code(50 mm)
- 2 — Diameter code
- UC — Type code(Cylindrical bore)
- S — Type code(Stainless series)

Ex.4) U SA 0 01
- 01 — Bore diameter code(12 mm)
- 0 — Diameter code
- SA — Type code(Cylindrical bore)
- U — Type code(Clean series)

[Table 3.1] Bore diameter code

| Bearing type | Bearing diameter code | Bearing bore diameter code | | | |
|---|---|---|---|---|---|
| | | mm | | inch | |
| | | Bore diameter code | Bore diameter | Bore diameter code | Bore diameter |
| | | 8 | 8 | | |
| | 0 | 00 | 10 | | |
| | | 01 | 12 | 01− 8 | 1/2 |
|  | 2 | 02 | 15 | 02−10 | 5/8 |
| | | 03 | 17 | | |
| | | 04 | 20 | 04−12 | 3/4 |
| | | 05 | 25 | 05−14 | 7/8 |
| | | | | 05−16 | 1 |
| | | 06 | 30 | 06−18 | 1 1/8 |
| | | 07 | 35 | 07−20 | 1 1/4 |
| | | | | 07−22 | 1 3/8 |
| | X | 08 | 40 | 08−24 | 1 1/2 |
| Cylindrical bore (Except UK type bearing) | | 09 | 45 | 09−26 | 1 5/8 |
| | | | | 09−28 | 1 3/4 |
| | | 10 | 50 | 10−32 | 2 |
| | | 11 | 55 | 11−35 | 2 3/16 |
| | | 12 | 60 | 12−36 | 2 1/4 |
| | | | | 12−39 | 2 7/16 |
| | | 13 | 65 | 13−40 | 2 1/2 |
| | | 14 | 70 | 14−44 | 2 3/4 |
| | | 15 | 75 | 15−48 | 3 |
|  | 3 | 16 | 80 | | |
| | | 17 | 85 | 17−52 | 3 1/4 |
| | | 18 | 90 | 18−56 | 3 1/2 |
| | | 19 | 95 | 19−60 | 3 3/4 |
| | | 20 | 100 | 20−64 | 4 |
| | | 21 | 105 | | |
| Tapered bore (UK type bearing) | | 22 | 110 | | |
| | | 24 | 120 | | |
| | | 26 | 130 | 26−82 | 5 1/8 |
| | | 28 | 140 | 28−88 | 5 1/2 |

## 3.2 Housing model code

The housing code is written in the order of the housing type code, the diameter code and the bore diameter code of the applicable bearing.

Ex.1) P 2 08

- 08 — Bore diameter code of applicable bearing
- 2 — Diameter code
- P — Type code(Pillow type)

Ex.2) S F 2 08

- 08 — Bore diameter code of applicable bearing
- 2 — Diameter code
- F — Type code(Square flange type)
- S — Type code(Stainless series)

## 3.3 Ball bearing unit model code

The ball bearing unit model code comprises the bearing model code and the housing model code.[Table 3.2]

Ex.1)
UC P 2 06 EN2

- EN2 — Heat resistant
- 06 — Bore diameter code(30 mm)
- 2 — Diameter code
- P — Housing type code(Pillow type)
- UC — Bearing type code(Cylindrical bore)

Ex.2)
UK FL 3 10

- 10 — Bore diameter code(50 mm)
- 3 — Diameter code
- FL — Housing type code(Oval flange type)
- UK — Bearing type code(Tapered bore)

Ex.3)
U SA P 0 06

- 06 — Bore diameter code(30 mm)
- 0 — Diameter code
- P — Housing type code(Pillow type)
- SA — Bearing type code(Cylindrical bore)
- U — Unit type code(Clean series)

Ex.4)
MU SB FL 0 04

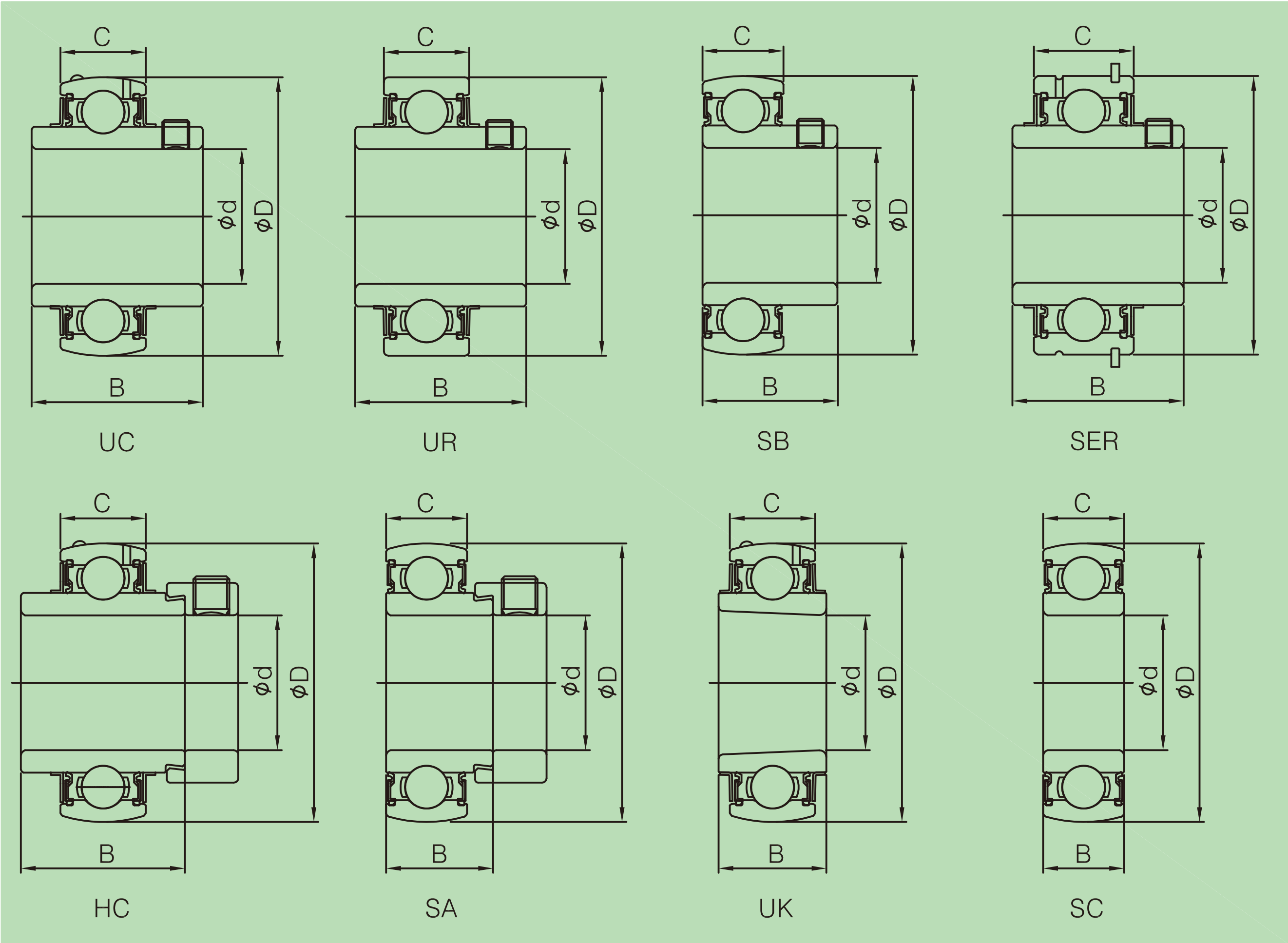
- 04 — Bore diameter code(20 mm)
- 0 — Diameter code
- FL — Housing type code(Oval flange type)
- SB — Bearing type code(Cylindrical bore)
- MU — Unit type code(Stainless clean series)

[Table 3.2] Example of ball bearing unit code

| Type | Model code | | | Type code | | Diameter code | Bore diameter code | Shaft diameter (mm) | Fixing to shaft |
|---|---|---|---|---|---|---|---|---|---|
| | Unit | Bearing | Housing | Bearing | Housing | | | | |
| Pillow (P) | UCP205 | UC205 | P205 | UC | P | 2 | 05 | 25 | Set screws |
| | HCP208 | HC208 | P208 | HC | P | 2 | 08 | 40 | Self-locking collar |
| | UKP206 | UK206 | P206 | UK | P | 2 | 06 | 30 | Adapter |
| Square flange (F) | UCF308 | UC308 | F308 | UC | F | 3 | 08 | 40 | Set screws |
| Square flange S (FS) | UCFS307 | UC307 | FS307 | UC | FS | 3 | 07 | 35 | Set screws |
| Oval flange (FL) | SAFL204 | SA204 | FL204 | SA | FL | 2 | 04 | 20 | Self-locking collar |
| Round flange (FC) | UCFCX17 | UCX17 | FCX17 | UC | FC | X | 17 | 85 | Set screws |
| Take-up (T) | UCT212 | UC212 | T212 | UC | T | 2 | 12 | 60 | Set screws |
| | UKT310 | UK310 | T310 | UK | T | 3 | 10 | 50 | Adapter |
| Cartridge (C) | UCC215 | UC215 | C215 | UC | C | 2 | 15 | 75 | Set screws |

# 4. Accuracy

Tolerances of JIB ball bearing units conform to KS B ISO 9628(bearing) and KS B ISO 3228(housing).




## 4.1 Tolerances of bearings

[Table 4.1] Tolerances of inner ring

(unit : 0.001mm)

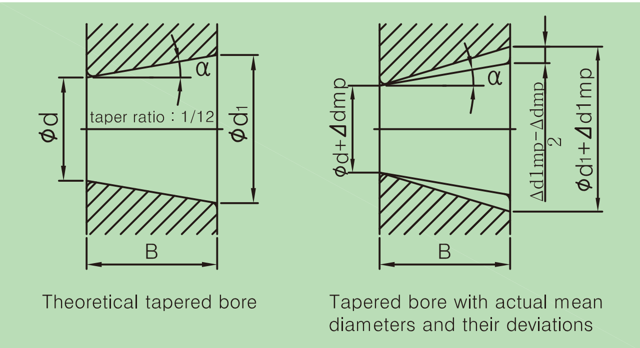
| Nominal bore diameter, ϕd(mm) | | Cylindrical bore diameter: UC, UR, SB, SER, HC, SA, SUC, USA, USB | | | Cylindrical bore diameter: SC, USC | | | Width (ΔBs) | | $K_{ia}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Δdmp | | Vdp | Δdmp | | Vdp | | | others | SC |
| over | incl. | high | low | max | high | low | max | high | low | max | |
| – | 10 | +15 | 0 | 10 | 0 | −8 | 6 | 0 | −120 | 10 | 6 |
| 10 | 18 | +15 | 0 | 10 | 0 | −8 | 6 | 0 | −120 | 15 | 7 |
| 18 | 31.75 | +18 | 0 | 12 | 0 | −10 | 8 | 0 | −120 | 18 | 8 |
| 31.75 | 50.80 | +21 | 0 | 14 | 0 | −12 | 9 | 0 | −120 | 20 | 10 |
| 50.80 | 80 | +24 | 0 | 16 | 0 | −15 | 11 | 0 | −150 | 25 | 10 |
| 80 | 120 | +28 | 0 | 19 | | | | 0 | −200 | 30 | |
| 120 | 180 | +33 | 0 | 22 | | | | 0 | −250 | 35 | |

Remark :
Δdmp : Single plane mean bore diameter deviation,
Vdp : Single radial plane bore diameter variation,
ΔBs : Single inner ring width deviation,
Kia : Radial runout of assembled bearing inner ring

[Table 4.2] Tolerances of tapered bore diameter

(unit : 0.001mm)

| Nominal bore diameter, ϕd(mm) | | Δdmp | | Δd1mp−Δdmp | |
|---|---|---|---|---|---|
| over | incl. | high | low | high | low |
| 18 | 30 | +33 | 0 | +21 | 0 |
| 30 | 50 | +39 | 0 | +25 | 0 |
| 50 | 80 | +46 | 0 | +30 | 0 |
| 80 | 120 | +54 | 0 | +35 | 0 |
| 120 | 180 | +63 | 0 | +40 | 0 |




Remark :

① Taper tolerance is defined as tolerance of ($\Delta d_1mp - \Delta dmp$)

② $d_1$ : Standard diameter at theoretical large end of tapered bore $d_1$ = d+ 1/12B

③ Δdmp : Deviation of tolerance of average bore diameter in plane at theoretical small end of tapered bore

④ $\Delta d_1$ mp : Deviation of tolerance of average bore diameter in plane at theoretical large end of tapered bore

⑤ B : Norminal inner ring width

⑥ α : 1/12 of taper angle of tapered bore

α = 2°23'9.4" = 2.38594° = 0.041643 rad

[Table 4.3] Tolerances of bore diameter of bearings for blowers(J5)

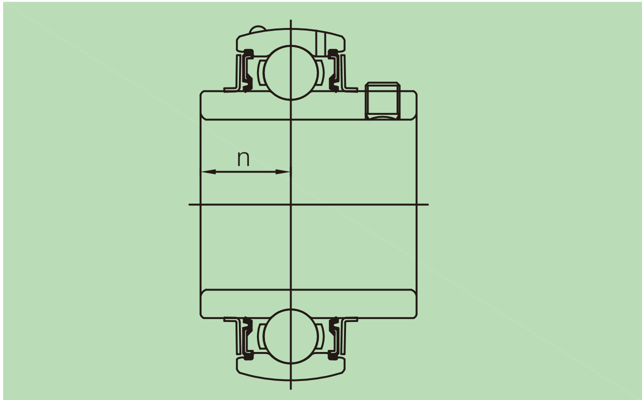
(unit : 0.001mm)

| Nominal bore diameter ϕd(mm) | | Δdmp | |
|---|---|---|---|
| over | incl. | high | low |
| 10 | 18 | +13 | 0 |
| 18 | 30 | +13 | 0 |
| 30 | 50 | +13 | 0 |
| 50 | 80 | +15 | 0 |
| 80 | 120 | +18 | 0 |
| 120 | 180 | +23 | 0 |

[Table 4.4] Tolerances of n

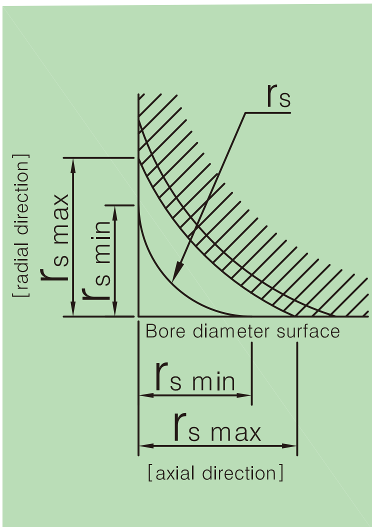
(unit : 0.001mm)

| Nominal bore diameter, ϕd(mm) | | n | |
|---|---|---|---|
| over | incl. | high | low |
| | 50 | +200 | −200 |
| 50 | 80 | +250 | −250 |
| 80 | 120 | +300 | −300 |
| 120 | | +350 | −350 |




[Table 4.5] Permissible value of filet dimensions (Inner ring of bearing with cylindrical bore)

(unit : mm)




| $r_{s\ min}$ | $r_{s\ max}$ | |
|---|---|---|
| | Radial direction | Axial direction |
| 0.3 | 0.6 | 1 |
| 0.6 | 1 | 2 |
| 1 | 1.5 | 3 |
| 1.1 | 2 | 3.5 |
| 1.5 | 2.3 | 4 |
| 2 | 3 | 4.5 |
| 2.1 | 4 | 6.5 |
| 2.5 | 3.8 | 6 |
| 3 | 5 | 8 |
| 4 | 6.5 | 9 |
| 5 | 8 | 10 |

Remark :

The exact shape of the chamfer surface is not specified, its contour in an axial plane should not be allowed to project beyond the imaginary circular arc, of radius "$r_{s\ min}$", tangential to the ring surface and the bore or outside cylindrical surface of the ring.

[Table 4.6] Tolerances of outer ring

(unit : 0.001mm)

| Nominal outer diameter, ϕD(mm) | | ΔDmp | | Kea |
|---|---|---|---|---|
| over | Incl. | high | low | max |
| 30 | 50 | 0 | −11 | 20 |
| 50 | 80 | 0 | −13 | 25 |
| 80 | 120 | 0 | −15 | 35 |
| 120 | 150 | 0 | −18 | 40 |
| 150 | 180 | 0 | −25 | 45 |
| 180 | 250 | 0 | −30 | 50 |
| 250 | 315 | 0 | −35 | 60 |

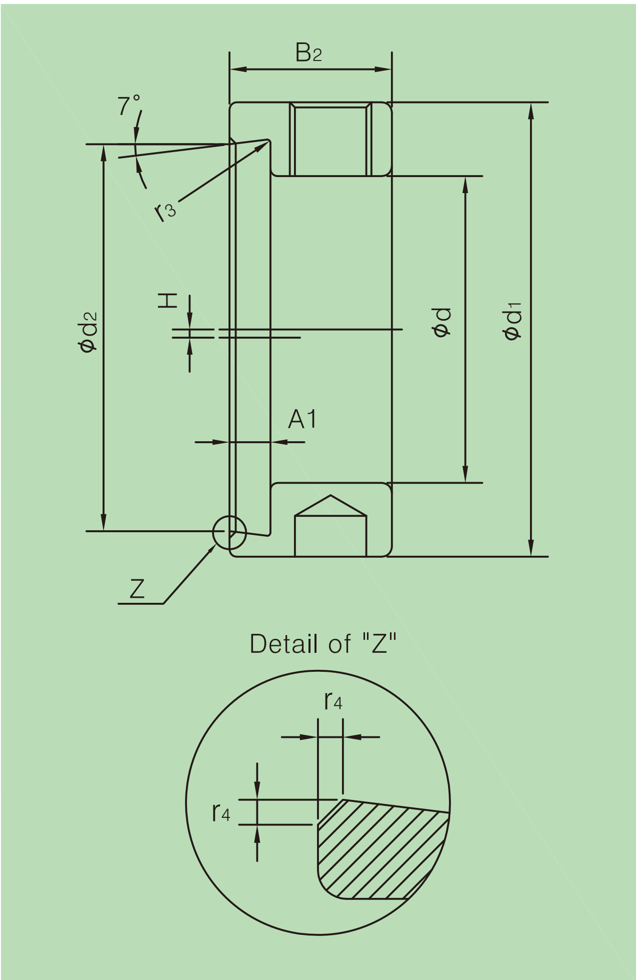
Remark :

① ΔDmp : Single plane mean outer diameter deviation

② Kea : Radial runout of assembled bearing outer ring

## 4.2 Tolerances of eccentric locking collars

Tolerances of JIB eccentric locking collars conform to KS B 2049, please refer to the table as follows.




[Table 4.7] Eccentric locking collars

(unit : mm)

| Collar code | Size | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | ϕd | ϕd1 max. | ϕd2 | B2 | H | A1 | r3 max. | r4 min. |
| ES201 | 12 | 28.6 | 22.1 | 13.5 | 0.8 | 4 | 0.3 | 0.8 |
| ES202 | 15 | 28.6 | 22.1 | 13.5 | 0.8 | 4 | 0.3 | 0.8 |
| ES203 | 17 | 28.6 | 22.1 | 13.5 | 0.8 | 4 | 0.3 | 0.8 |
| E201 | 12 | 28.6 | 21.6 | 13.5 | 0.8 | 4 | 0.3 | 0.8 |
| E202 | 15 | 28.6 | 21.6 | 13.5 | 0.8 | 4 | 0.3 | 0.8 |
| E203 | 17 | 28.6 | 21.6 | 13.5 | 0.8 | 4 | 0.3 | 0.8 |
| E204 | 20 | 33.3 | 26.6 | 13.5 | 0.8 | 4 | 0.3 | 0.8 |
| E205 | 25 | 38.1 | 31.6 | 13.5 | 0.8 | 4 | 0.3 | 0.8 |
| E206 | 30 | 44.5 | 37.9 | 15.9 | 0.8 | 4 | 0.3 | 0.8 |
| E207 | 35 | 55.6 | 44.7 | 17.5 | 0.8 | 4 | 0.3 | 0.8 |
| E208 | 40 | 60.3 | 49.4 | 18.3 | 1.6 | 4.8 | 0.3 | 1.2 |
| E209 | 45 | 63.5 | 54.4 | 18.3 | 1.6 | 4.8 | 0.3 | 1.2 |
| E210 | 50 | 69.9 | 60.0 | 18.3 | 1.6 | 4.8 | 0.3 | 1.2 |
| E211 | 55 | 76.2 | 66.9 | 20.7 | 1.6 | 4.8 | 0.3 | 1.2 |
| E212 | 60 | 84.2 | 73.5 | 22.3 | 1.6 | 6.4 | 0.3 | 1.6 |

Remark :

Collar code ES201~203 is for SA bearing.

[Table 4.8] Tolerances of eccentric locking collar

(unit : mm)

| Nominal bore diameter, ϕd | | ϕd | | $\phi d_2$ | | H | |
|---|---|---|---|---|---|---|---|
| over | Incl. | high | low | high | low | high | low |
| 10 | 36.512 | +0.250 | +0.025 | +0.3 | 0 | +0.1 | −0.1 |
| 36.512 | 55.562 | +0.300 | +0.025 | +0.4 | 0 | +0.1 | −0.1 |
| 55.562 | 61.912 | +0.300 | +0.025 | +0.4 | 0 | +0.1 | −0.1 |

## 4.3 Radial internal clearance

The radial internal clearance of bearings has a strong influence on the operating condition of the bearing such as bearing life, noise, vibration, and heat generation. Therefore, it must be taken into consideration when selecting a bearing. The radial internal clearance of JIB bearings conforms to KS B ISO 5753(Rolling bearing-Radial internal clearance).

The normal clearance indicated CN applies to JIB bearings with cylindrical bore in general. The radial clearance can be adjusted to C3 if the bearing has a tapered inner ring bore considering expansion of the inner ring because it is pressed onto the tapered sleeve. The clearance C2 reduces noise and vibration in high speed application, so it is used in units for blowers.

[Table 4.9] Radial internal clearance of bearings

(unit:0.001mm)

| Nominal bore diameter, ϕd(mm) | | Internal clearance | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | C2 | | CN(normal) | | C3 | | C4 | | C5 | |
| over | incl. | min | max | min | max | min | max | min | max | min | max |
| 6 | 10 | 0 | 7 | 2 | 13 | 8 | 23 | 14 | 29 | 20 | 37 |
| 10 | 18 | 0 | 9 | 3 | 18 | 11 | 25 | 18 | 33 | 25 | 45 |
| 18 | 24 | 0 | 10 | 5 | 20 | 13 | 28 | 20 | 36 | 28 | 48 |
| 24 | 30 | 1 | 11 | 5 | 20 | 13 | 28 | 23 | 41 | 30 | 53 |
| 30 | 40 | 1 | 11 | 6 | 20 | 15 | 33 | 28 | 46 | 40 | 64 |
| 40 | 50 | 1 | 11 | 6 | 23 | 18 | 36 | 30 | 51 | 45 | 73 |
| 50 | 65 | 1 | 15 | 8 | 28 | 23 | 43 | 38 | 61 | 55 | 90 |
| 65 | 80 | 1 | 15 | 10 | 30 | 25 | 51 | 46 | 71 | 65 | 105 |
| 80 | 100 | 1 | 18 | 12 | 36 | 30 | 58 | 53 | 84 | 75 | 120 |
| 100 | 120 | 2 | 20 | 15 | 41 | 36 | 66 | 61 | 97 | 90 | 140 |
| 120 | 140 | 2 | 23 | 18 | 48 | 41 | 81 | 71 | 114 | 105 | 160 |

Remark :

① Values of radial internal clearance are measured at temperature of 20℃ without any external forces acting on any parts of the the bearing.

② [Table 4.10] is correction rate which revises the radial clearance increasing rate by measured load.

[Table 4.10] Correction of clearance

(unit:0.001mm)

| Nominal bore diameter, ϕd(mm) | | Measured load | | Correction of clearance | | | | |
|---|---|---|---|---|---|---|---|---|
| over | incl. | N | Kgf | C2 | CN(normal) | C3 | C4 | C5 |
| 2.5 | 18 | 24.5 | 2.5 | 3~4 | 4 | 4 | 4 | 4 |
| 18 | 50 | 49 | 5 | 4~5 | 5 | 6 | 6 | 6 |
| 50 | 280 | 147 | 15 | 6~8 | 8 | 9 | 9 | 9 |

## 4.4 Tolerances of housings

Tolerance classes of spherical bore diameter of the housing are shown as below [Table 4.11]. The standard tolerance of JIB ball bearing units is a class H7.

[Table 4.11] Tolerance classes of spherical bore diameter of housings

(unit : 0.001mm)

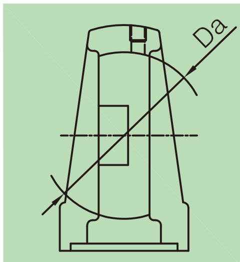
| Nominal spherical bore diameter, Da(mm) | | H7 ΔDamp | | J7 ΔDamp | | K7 ΔDamp | |
|---|---|---|---|---|---|---|---|
| over | incl. | high | low | high | low | high | low |
| 30 | 50 | +25 | 0 | +14 | −11 | +7 | −18 |
| 50 | 80 | +30 | 0 | +18 | −12 | +9 | −21 |
| 80 | 120 | +35 | 0 | +22 | −13 | +10 | −25 |
| 120 | 180 | +40 | 0 | +26 | −14 | +12 | −28 |
| 180 | 250 | +46 | 0 | +30 | −16 | +13 | −33 |
| 250 | 315 | +52 | 0 | +36 | −16 | +16 | −36 |

Remark :

ΔDamp is calculated by the equation where,

ΔDamp = (Da max+ Da min)/2

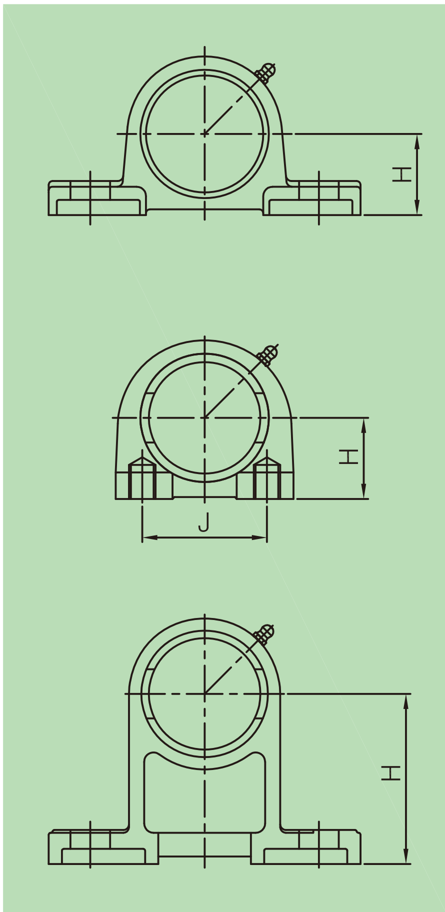
Da max and Da min is maximum and minimum measurement of Da.




[Table 4.12] Tolerances of pillow block type housings(P, PA, LP, PH)

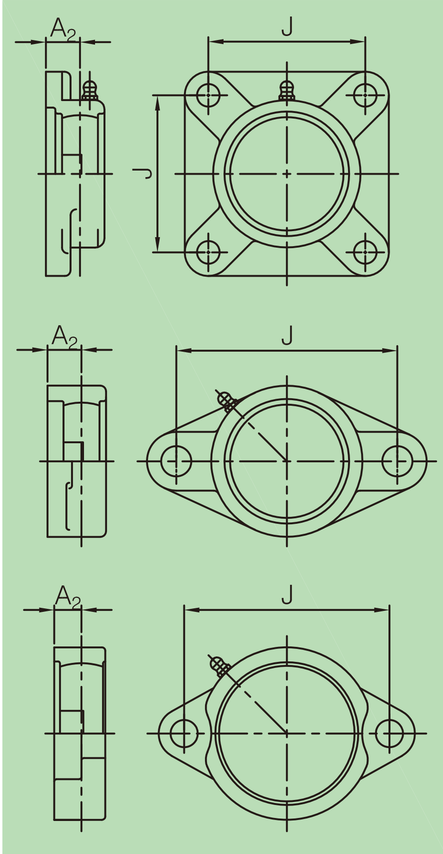
(unit : 0.001mm)

| Housing code | | | H | J(PA) |
|---|---|---|---|---|
| 203 | | | ±150 | ±500 |
| 204 | | | | |
| 205 | 305 | X05 | | |
| 206 | 306 | X06 | | |
| 207 | 307 | X07 | | |
| 208 | 308 | X08 | | |
| 209 | 309 | X09 | | |
| 210 | 310 | X10 | | |
| 211 | 311 | X11 | ±200 | ±700 |
| 212 | 312 | X12 | | |
| 213 | 313 | X13 | | |
| 214 | 314 | X14 | | |
| 215 | 315 | X15 | | |
| 216 | 316 | X16 | | |
| 217 | 317 | X17 | | |
| 218 | 318 | X18 | | |
| | 319 | − | ±300 | |
| | 320 | X20 | | |
| | 321 | | | |
| | 322 | | | |
| | 324 | | | |
| | 326 | | | |
| | 328 | | | |



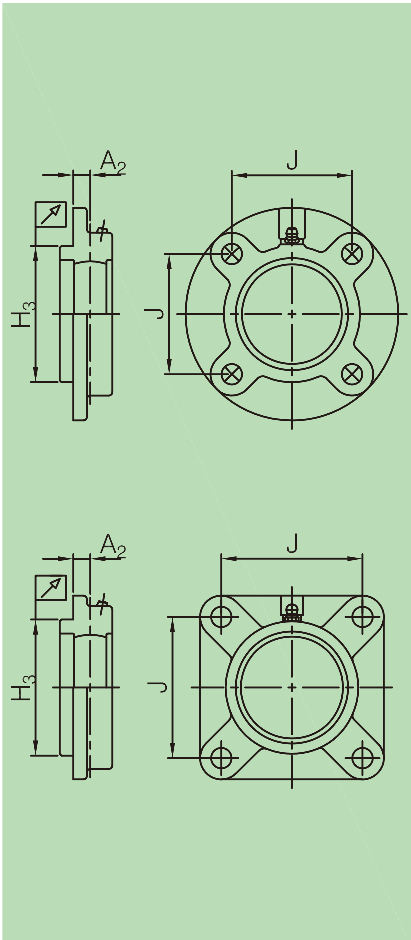
[Table 4.13] Tolerances of flange type housings(F, FL, LF) (unit : 0.001mm)

<table>
<tr><th colspan="3">Housing code</th><th>A2</th><th>J</th></tr>
<tr><td>203<br>204<br>205<br>206<br>207<br>208<br>209<br>210</td><td>305<br>306<br>307<br>308<br>309<br>310</td><td>X05<br>X06<br>X07<br>X08<br>X09<br>X10</td><td>±500</td><td>±700</td></tr>
<tr><td>211<br>212<br>213<br>214<br>215<br>216<br>217<br>218</td><td>311<br>312<br>313<br>314<br>315<br>316<br>317<br>318</td><td>X11<br>X12<br>X13<br>X14<br>X15<br>X16<br>X17<br>X18</td><td rowspan="2">±800</td><td rowspan="2">±1000</td></tr>
<tr><td></td><td>319<br>320<br>321<br>322<br>324<br>326<br>328</td><td>–<br>X20</td></tr>
</table>



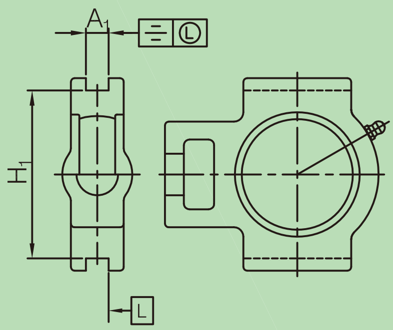

[Table 4.14] Tolerances of spigot joint flange type housings(FC, FS) (unit : 0.001mm)

<table>
<tr><th colspan="3" rowspan="3">Housing code</th><th rowspan="3">J</th><th rowspan="3">A2</th><th rowspan="3">Radial runout of spigot joint (Max)</th><th colspan="6">H3</th></tr>
<tr><th colspan="2">FC2</th><th colspan="2">FCX</th><th colspan="2">FS3</th></tr>
<tr><th>high</th><th>low</th><th>high</th><th>low</th><th>high</th><th>low</th></tr>
<tr><td>204</td><td></td><td></td><td rowspan="7">±700</td><td rowspan="7">±500</td><td rowspan="7">200</td><td rowspan="3">0</td><td rowspan="3">−46</td><td></td><td></td><td></td><td></td></tr>
<tr><td>205</td><td>305</td><td>X05</td><td>0</td><td>−46</td><td>0</td><td>−46</td></tr>
<tr><td>206</td><td>306</td><td>X06</td><td rowspan="5">0</td><td rowspan="5">−54</td><td rowspan="3">0</td><td rowspan="3">−54</td></tr>
<tr><td>207</td><td>307</td><td>X07</td><td rowspan="4">0</td><td rowspan="4">−54</td></tr>
<tr><td>208</td><td>308</td><td>X08</td></tr>
<tr><td>209</td><td>309</td><td>X09</td><td rowspan="5">0</td><td rowspan="5">−63</td></tr>
<tr><td>210</td><td>310</td><td>X10</td></tr>
<tr><td>211</td><td>311</td><td>X11</td><td rowspan="15">±1000</td><td rowspan="15">±800</td><td rowspan="8">300</td><td rowspan="8">0</td><td rowspan="7">−63</td><td rowspan="5">0</td><td rowspan="5">−63</td></tr>
<tr><td>212</td><td>312</td><td>X12</td></tr>
<tr><td>213</td><td>313</td><td>X13</td></tr>
<tr><td>214</td><td>314</td><td>X14</td><td rowspan="6">0</td><td rowspan="6">−72</td></tr>
<tr><td>215</td><td>315</td><td>X15</td></tr>
<tr><td>216</td><td>316</td><td>X16</td><td rowspan="5">0</td><td rowspan="5">−72</td></tr>
<tr><td>217</td><td>317</td><td>X17</td></tr>
<tr><td>218</td><td>318</td><td>X18</td><td>−72</td></tr>
<tr><td rowspan="7"></td><td>319</td><td>–</td><td rowspan="7">400</td><td rowspan="7"></td><td rowspan="7"></td></tr>
<tr><td>320</td><td>X20</td><td rowspan="3">0</td><td rowspan="3">−81</td></tr>
<tr><td>321</td><td></td><td rowspan="5"></td><td rowspan="5"></td></tr>
<tr><td>322</td><td></td></tr>
<tr><td>324</td><td></td><td rowspan="3">0</td><td rowspan="3">−89</td></tr>
<tr><td>326</td><td></td></tr>
<tr><td>328</td><td></td></tr>
</table>



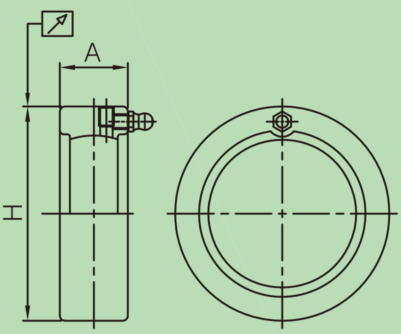
[Table 4.15] Tolerances of take-up type housings(T) (unit : 0.001mm)

| Housing code | | | $A_1$ high | $A_1$ low | $H_1$ high | $H_1$ low | Parallelism of guide rail (Max) |
|---|---|---|---|---|---|---|---|
| 204 | | | +200 | 0 | 0 | −500 | 500 |
| 205 | 305 | X05 | | | | | |
| 206 | 306 | X06 | | | | | |
| 207 | 307 | X07 | | | | | |
| 208 | 308 | X08 | | | | | |
| 209 | 309 | X09 | | | | | |
| 210 | 310 | X10 | | | | | |
| 211 | 311 | X11 | +300 | 0 | 0 | −800 | 600 |
| 212 | 312 | X12 | | | | | |
| 213 | 313 | X13 | | | | | |
| 214 | 314 | X14 | | | | | |
| 215 | 315 | X15 | | | | | |
| 216 | 316 | X16 | | | | | |
| 217 | 317 | X17 | | | | | |
| 218 | 318 | X18 | | | | | |
| | 319 | – | | | | | 700 |
| | 320 | X20 | | | | | |
| | 321 | | | | | | |
| | 322 | | | | | | |
| | 324 | | | | | | 800 |
| | 326 | | | | | | |
| | 328 | | | | | | |




[Table 4.16] Tolerances of cartridge type housings(C) (unit : 0.001mm)

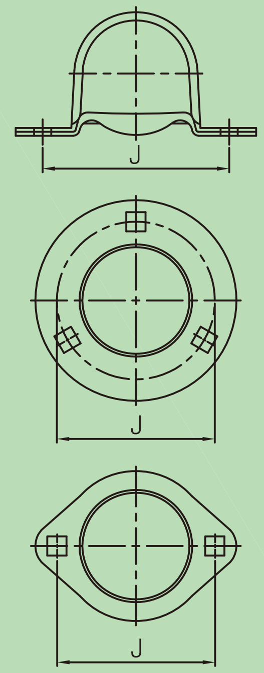
| Housing code | | | H 2 high | H 2 low | H 3 high | H 3 low | H X high | H X low | A | Outer diameter runout(Max) |
|---|---|---|---|---|---|---|---|---|---|---|
| 204 | | | 0 | −30 | | | | | ±200 | 200 |
| 205 | 305 | X05 | | | 0 | −35 | 0 | −35 | | |
| 206 | 306 | X06 | 0 | −35 | | | | | | |
| 207 | 307 | X07 | | | | | | | | |
| 208 | 308 | X08 | | | | | | | | |
| 209 | 309 | X09 | | | 0 | −40 | 0 | −40 | | |
| 210 | 310 | X10 | | | | | | | | |
| 211 | 311 | X11 | 0 | −40 | | | | | ±300 | 300 |
| 212 | 312 | X12 | | | | | | | | |
| 213 | 313 | X13 | | | | | | | | |
| 214 | 314 | X14 | | | | | | | | |
| 215 | 315 | X15 | | | 0 | −46 | | | | |
| 216 | 316 | X16 | | | | | | | | |
| 217 | 317 | X17 | | | | | | | | |
| 218 | 318 | X18 | | | | | | | | |
| | 319 | – | | | | | | | | 400 |
| | 320 | X20 | | | 0 | −52 | | | | |
| | 321 | | | | | | | | | |
| | 322 | | | | | | | | | |
| | 324 | | | | 0 | −57 | | | | |
| | 326 | | | | | | | | | |
| | 328 | | | | | | | | | |



[Table 4.17] Tolerances of pillow (pressed steel) type housings(PP)

(unit : 0.001mm)

| Housing code | J |
|---|---|
| PP 203 | ±400 |
| PP 204 | |
| PP 205 | |
| PP 206 | |
| PP 207 | |




[Table 4.18] Tolerances of flange (pressed steel) type housings(PF,PFL)

(unit : 0.001mm)

| Housing code | | J |
|---|---|---|
| PF | PFL | |
| 203 | | ±400 |
| 204 | | |
| 205 | | |
| 206 | | |
| 207 | | |

[Table 4.19] Other standard dimensional tolerances not specified

| Standard number | Standard description |
|---|---|
| KS B ISO 2768-1 (KS B 0412) | General tolerances-Part 1<br>Tolerances for linear and angular dimensions without individual tolerance indications |
| KS B 0250 | Casting - System of dimensional tolerances and machining allowances |
| KS B 0413 | General dimensional tolerances for parts formed by press working from sheet metal |

Remark :

Other standard dimensional tolerances of cutting, casting or press working portions not specified in this catalog follow KS standards.

# 5. Materials

## 5.1 Bearing materials

The bearing material for the orbital races and the ball must meet the following requirements.

① Force against rolling fatigue and repeated stress

② High strength with high hardness number, elasticity and yield point

③ Good internal wear resistance

④ High resistance against shock loads

In general, the bearings is made of the high carbon chrome bearing steel. Among the various high carbon chromium steels, the most widely used one is the KS-STB2 which is also used by JIB producing bearings.

[Table 5.1] Chemical composition of high carbon chromium bearing steel(KS D 3525)

| Code | | STB2 | STB3 |
|---|---|---|---|
| Chemical composition(%) | C | 0.95~1.10 | 0.95~1.10 |
| | Si | 0.15~0.35 | 0.40~0.70 |
| | Mn | under 0.50 | 0.09~1.15 |
| | P | under 0.025 | under 0.025 |
| | S | under 0.025 | under 0.025 |
| | Cr | 1.30~1.60 | 0.90~1.20 |
| | Mo | under 0.08 | under 0.08 |

Remark :

KS STB2 and STB3 is equivalent to JIS SUJ2 and SUJ3 respectively

[Table 5.2] Chemical composition of stainless steel (KS D 3706)

| Code | | Stainless steel for bearing | |
|---|---|---|---|
| Chemical composition(%) | C | 0.95~1.20 | Martensite stainless steel (equivalent to KS-STS440C) |
| | Si | under 1.00 | |
| | Mn | under 1.00 | |
| | P | under 0.040 | |
| | S | under 0.030 | |
| | Cr | 16.00~18.00 | |
| | Mo | under 0.75 | |

## 5.2 Housing materials

Gray cast irons, cold rolled steel sheet, zinc alloys die castings are used for housing material. Ductile iron, steel castings and stainless steel are used according to the purpose. The most common material is Class 3(GC200) of Gray cast irons from KS D 4301, it is widely used for machine parts because the vibration absorbing capacity is greater than other materials.

[Table 5.3] Mechanical properties of housing material

| Type code | Designation | Yielding point (N/mm²) | Tensile strength (N/mm²) | Elong-ation (%) | Hard-ness (HB) |
|---|---|---|---|---|---|
| GC200 | Gray cast irons | | 200 or more | | 223 or less |
| GCD450 | Ductile iron | 280 or more | 450 or more | 10 or more | 140~210 |
| SC450 | Steel castings | 225 or more | 450 or more | 19 or more | |
| SPCC | Cold rolled steel sheet | | 270 or more | 34 or more | |
| SSC13 | Stainless steel | 185 | 440 | 30 or more | 183 or less |
| ZDC 2 | Zinc alloys die castings | | 285 | 10 | 82 |

[Table 5.4] Chemical composition of housing material

| Type code | Chemical composition (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | C | Si | Mn | P | S | Ni | Cr | Mg |
| GC200 | 3.2~3.8 | 1.4~2.2 | 0.4~0.6 | 0.5 or less | 0.1 or less | | | |
| GCD450 | 2.5 or more | 2.7 or less | 0.4 or less | 0.08 or less | 0.02 or less | | | 0.09 or less |
| SC450 | 0.35 or less | | 0.5~2.00 | 0.04 or less | 0.04 or less | | | |
| SPCC | 0.12 or less | | 0.50 or less | 0.04 or less | 0.045 or less | | | |
| SSC13 | 0.08 or less | 2.00 or less | 2.00 or less | 0.04 or less | 0.04 or less | 8.00~11.00 | 18.00~21.00 | |

[Table 5.5] Chemical composition of zinc alloys die castings(KS D 6005)

| Type code | Chemical composition (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Al | Cu | Mg | Fe | Zn | Pb | Cd | Sn |
| ZDC2 | 3.5~4.3 | 0.25 under | 0.25~0.06 | 0.1 under | re-mains | 0.005 under | 0.004 under | 0.003 under |

## 5.3 Materials of other components

The materials for components of ball bearing units are listed in [Table 5.6].

[Table 5.6] Materials of other components

| Component | Material | Type code | Standard code |
|---|---|---|---|
| Ball (rolling element) | High carbon chromium bearing steel | STB2 | KS D 3525 |
| Ball (rolling element) | Stainless steel | STS440C | KS D 3692 |
| Cage | Cold rolled steel sheet | SPCC | KS D 3512 |
| Cage | Stainless steel | STS304 | KS D 3706 |
| Seal (standard type) | Nitrile rubber | NBR | |
| Seal (EN1,EN2,EN2-C type) | Fluorocarbon rubber | FKM | |
| Slinger | Cold rolled steel sheet | SPCC | KS D 3512 |
| Slinger | Stainless steel | STS304 | KS D 3706 |
| Cast iron cover | Gray cast irons | GC200 | KS D 4301 |
| Pressed steel cover | Cold rolled steel sheet | SPCC | KS D 3512 |
| Set screw (standard type) | Chrome molybdenum steel | SCM435 | KS D 3867 |
| Set screw | Stainless steel bar | STS304 | KS D 3692 |
| Eccentric locking collar | Carbon steels for machine structural use | SM25C | KS D 3752 |
| Adapter sleeve | Carbon steels for machine structural use | SM25C | KS D 3752 |
| Lock nut | Carbon steels for machine structural use | SM25C | KS D 3752 |
| Lock washer | Cold rolled steel sheet | SPCC | KS D 3512 |
| Grease nipple (standard type) | Brass bar | C3604BE | KS D 5101 |
| Grease nipple | Stainless steel | STS304 | KS D 3692 |

# 6. Life

## 6.1 Rating life

Even if bearings are used in normal conditions, they are unable to be used due to flaking after some period.

Flaking phenomenon commonly occurs because of the following reasons.

① Increasing of vibration

② Grease deterioration

③ Repeatedly applied stress on raceway or rolling elements

④ Declining accuracy by general wear

The total number of rotations or duration until the bearing becomes unavailable is called bearing life.

The basic rating life defines as the total number of rotations or total rotation time, which 90% of a group of bearings under identical rotating conditions can be operated without flaking by rolling fatigue.

## 6.2 Calculation of basic rating life

Bearing life depends on the following factors such as its own load capacities, actual applied loads and other factors for instance, operating temperature etc. The formula of basic rating life is shown as below.

### 1) Calculation of basic rating life Ⅰ

$$L_{10} = \left(\frac{Cr}{Pr}\right)^3 \quad (10^6 \text{ revolution}) \qquad \text{[Formula 6.1]}$$

Where,

$L_{10}$ : Basic rating life($10^6$ revolution)

Cr : Basic dynamic load rating(kgf, N)

Pr : Dynamic equivalent radial load (kgf, N : see[Formula 7.2])

### 2) Calculation of basic rating life Ⅱ

If the speed is constant, it is often preferable to calculate the life expressed in operating hour, using the following equation.

$$L_{10\,h} = L_{10} \times \left(\frac{10^6}{60 \cdot n}\right) \quad \text{(hour)} \qquad \text{[Formula 6.2]}$$

$$L_{10h} = \left(\frac{Cr}{Pr}\right)^3 \times \left(\frac{10^6}{60 \cdot n}\right) \quad \text{(hour)} \qquad \text{[Formula 6.3]}$$

Where,

$L_{10h}$ : Basic rating life(hr)

n : Rotation speed(rpm)

### 3) Calculation of basic rating life Ⅲ(simple formula)

The approximate value of the basic rating life can be calculated by using the life factor(fh) and the speed factor(fn) in [Table 6.1].

$$L_{10h} = 500\, fh^3 \qquad \text{[Formula 6.4]}$$

$$fh = \left(\frac{Cr}{Pr}\right) \times fn \qquad \text{[Formula 6.5]}$$

$$fn = \left(\frac{10^6}{500 \times 60n}\right)^{1/3} = \left(\frac{33.3}{n}\right)^{1/3} \qquad \text{[Formula 6.6]}$$

Where,

fh : Life factor

fn : Speed factor

[Table 6.1] Speed factor($f_n$) / Rating life($L_{10}$,$L_{10h}$) and Life factor($f_h$)

| n (rpm) | $f_n$ | n (rpm) | $f_n$ | Cr/P or fh | $L_{10}$ ($10^6$rev) | $L_{10h}$ (h) | Cr/P or fh | $L_{10}$ ($10^6$rev) | $L_{10h}$ (h) |
|---|---|---|---|---|---|---|---|---|---|
| 10 | 1.49 | 110 | 0.672 | 0.70 | 0.34 | 170 | 2.85 | 23.1 | 11600 |
| 11 | 1.45 | 120 | 0.652 | 0.75 | 0.42 | 210 | 2.90 | 24.4 | 12200 |
| 12 | 1.41 | 130 | 0.635 | 0.80 | 0.51 | 255 | 2.95 | 25.7 | 12800 |
| 13 | 1.37 | 140 | 0.620 | 0.85 | 0.61 | 305 | 3.00 | 27.0 | 13500 |
| 14 | 1.34 | 150 | 0.606 | 0.90 | 0.73 | 365 | 3.05 | 28.4 | 14200 |
| 15 | 1.30 | 160 | 0.593 | 0.95 | 0.86 | 430 | 3.10 | 29.8 | 14900 |
| 16 | 1.28 | 170 | 0.581 | 1.00 | 1.00 | 500 | 3.15 | 31.2 | 15600 |
| 17 | 1.25 | 180 | 0.570 | 1.05 | 1.16 | 580 | 3.20 | 32.8 | 16400 |
| 18 | 1.23 | 190 | 0.560 | 1.10 | 1.33 | 665 | 3.25 | 34.3 | 17200 |
| 19 | 1.21 | 200 | 0.550 | 1.15 | 1.52 | 760 | 3.30 | 35.9 | 18000 |
| 20 | 1.19 | 220 | 0.533 | 1.20 | 1.73 | 865 | 3.35 | 37.6 | 18800 |
| 21 | 1.17 | 240 | 0.518 | 1.25 | 1.95 | 975 | 3.40 | 39.3 | 19600 |
| 22 | 1.15 | 260 | 0.504 | 1.30 | 2.20 | 1100 | 3.45 | 41.1 | 20600 |
| 23 | 1.13 | 280 | 0.492 | 1.35 | 2.46 | 1230 | 3.50 | 42.9 | 21400 |
| 24 | 1.12 | 300 | 0.481 | 1.40 | 2.74 | 1370 | 3.55 | 44.7 | 22400 |
| 25 | 1.10 | 320 | 0.471 | 1.45 | 3.05 | 1520 | 3.60 | 46.6 | 23300 |
| 26 | 1.09 | 340 | 0.461 | 1.50 | 3.38 | 1690 | 3.65 | 48.6 | 24300 |
| 27 | 1.07 | 360 | 0.452 | 1.55 | 3.72 | 1860 | 3.70 | 50.6 | 25300 |
| 28 | 1.06 | 380 | 0.444 | 1.60 | 4.10 | 2050 | 3.75 | 52.7 | 26400 |
| 29 | 1.05 | 400 | 0.437 | 1.65 | 4.49 | 2240 | 3.80 | 54.9 | 27400 |
| 30 | 1.04 | 420 | 0.430 | 1.70 | 4.91 | 2460 | 3.85 | 57.1 | 28600 |
| 31 | 1.02 | 440 | 0.423 | 1.75 | 5.36 | 2680 | 3.90 | 59.3 | 29600 |
| 32 | 1.01 | 460 | 0.417 | 1.80 | 5.83 | 2920 | 3.95 | 61.6 | 30800 |
| 33.3 | 1.00 | 480 | 0.411 | 1.85 | 6.33 | 3160 | 4.00 | 64.0 | 32000 |
| 34 | 0.993 | 500 | 0.405 | 1.90 | 6.86 | 3430 | 4.05 | 66.4 | 33200 |
| 36 | 0.975 | 550 | 0.393 | 1.95 | 7.41 | 3700 | 4.10 | 68.9 | 34400 |
| 38 | 0.957 | 600 | 0.382 | 2.00 | 8.00 | 4000 | 4.15 | 71.5 | 35800 |
| 40 | 0.941 | 650 | 0.372 | 2.05 | 8.62 | 4310 | 4.20 | 74.1 | 37000 |
| 42 | 0.926 | 700 | 0.362 | 2.10 | 9.26 | 4630 | 4.25 | 76.8 | 38400 |
| 44 | 0.912 | 750 | 0.354 | 2.15 | 9.94 | 4970 | 4.30 | 79.5 | 39800 |
| 46 | 0.898 | 800 | 0.347 | 2.20 | 10.6 | 5300 | 4.35 | 82.3 | 41200 |
| 48 | 0.886 | 850 | 0.340 | 2.25 | 11.4 | 5700 | 4.40 | 85.2 | 42600 |
| 50 | 0.874 | 900 | 0.333 | 2.30 | 12.2 | 6100 | 4.45 | 88.1 | 44000 |
| 55 | 0.846 | 950 | 0.327 | 2.35 | 13.0 | 6500 | 4.50 | 91.1 | 45600 |
| 60 | 0.822 | 1000 | 0.322 | 2.40 | 13.8 | 6900 | 4.55 | 94.2 | 47100 |
| 65 | 0.800 | 2000 | 0.255 | 2.45 | 14.7 | 7350 | 4.60 | 97.3 | 48600 |
| 70 | 0.871 | 4000 | 0.203 | 2.50 | 15.6 | 7800 | 4.65 | 100 | 50000 |
| 75 | 0.763 | 6000 | 0.177 | 2.55 | 16.6 | 8300 | 4.70 | 104 | 52000 |
| 80 | 0.747 | 8000 | 0.161 | 2.60 | 17.6 | 8800 | 4.75 | 107 | 53500 |
| 85 | 0.732 | 10000 | 0.149 | 2.65 | 18.6 | 9300 | 4.80 | 110 | 55000 |
| 90 | 0.718 | 20000 | 0.119 | 2.70 | 19.7 | 9850 | 4.85 | 114 | 57000 |
| 95 | 0.705 | 40000 | 0.094 | 2.75 | 20.8 | 10400 | 4.90 | 118 | 59000 |
| 100 | 0.693 | 80000 | 0.075 | 2.80 | 22.0 | 11000 | 4.95 | 121 | 60500 |

## 6.3 Adjusted rating life

The basic rating life($L_{10}$) of bearing is calculated according to equation mentioned in [Formula 6.2]. According to purpose, however, when it needs more than 90% reliability, it can be calculated by using the reliability factor($a_1$) from the following equation.

$$L_n = a_1 * L_{10} \quad (10^6 \text{ revolution}) \quad \text{[Formula 6.7]}$$

The basic rating life is computed, assuming that normal bearing materials are used, and that normal conditions (mounting, lubrication, vibration are good and without extreme load or operating temperature) are provided. But, if the bearing made of special materials or made for special conditions adjusted rating life($L_{10a}$) is needed. The Following equation using the life adjustment factors of both material factor($a_2$) and operating condition factor ($a_3$) can be applied.

$$L_{10a} = a_2 * a_3 * L_{10} \ (10^6 \text{ revolution}) \quad \text{[Formula 6.8]}$$

The adjusted rating life($L_{na}$) for the bearing requiring all the adjustments can be obtained using the following equation.

$$L_{na} = a_1 * a_2 * a_3 * L_{10} \quad (10^6 \text{ revolution}) \quad \text{[Formula 6.9]}$$

However, if bearing dimensions are selected by using the adjusted rating life($L_{na}$) larger than $L_{10}$, the variables other than life, such as permissible deformation and hardness of shaft or housing, etc, have to be taken into consideration.

### 1) Reliability factor($a_1$)

The adjusted rating life for a reliability is calculated in accordance with [Formula 6.7], the value of reliability factor($a_1$) is in [Table 6.2] as follows.

[Table 6.2] Reliability factor($a_1$)

| Reliability,% | 90 | 95 | 96 | 97 | 98 | 99 |
|---|---|---|---|---|---|---|
| Ln | L10 | L5 | L4 | L3 | L2 | L1 |
| $a_1$ | 1.00 | 0.62 | 0.53 | 0.44 | 0.33 | 0.21 |

### 2) Bearing material factor($a_2$)

The bearing life is affected by the material quality and manufacturing process. In this case, the bearing life is adjusted using bearing material factor($a_2$). JIB ball bearings are based on standard material and process, therefore, the adjustment factor for material is treated as ($a_2$=1). However, for bearings made of special materials to extend fatigue life, the bearing material factor is treated as ($a_2$ >1).

### 3) Operating condition factor($a_3$)

The operating condition factor($a_3$) is used to adjust the bearing life influenced by operating conditions, specially, fatigue life by lubricating condition. It can be performed with ($a_3$=1) under normal condition where there is no incline between inner and outer ring and where rolling elements are sufficiently separated from raceway by lubricant.

In the following cases, the operating condition factor is treated as $a_3$<1.

- When kinematic viscosity of lubricant is too low. For ball bearings, below 13㎟/s(1㎟/s=1cSt)
- When rotation speed is too slow.
- When operating temperature of bearing is too high.
- When any foreign material or moisture is mixed with lubricant.
- When load distribution is abnormal.

[Table 6.3] Operating condition factor $a_3$ based on operating temperatures

| Operation temperatures(°C) | 150 | 200 | 250 | 300 |
|---|---|---|---|---|
| $a_3$ | 1 | 0.73 | 0.42 | 0.22 |

## 6.4 Operating machines and required life

When selecting a bearing, it is not economical to choose a bearing with unnecessarily longer life than required. Because it usually means a bigger than needed. In other words, a bearing life should not be a sole factor in selecting the bearing, strength, rigidity, and dimension of shaft to be considered. Please refer to the following tables to find out fatigue life factor and required life time.

[ Table 6.4] Fatigue life factor(fh) and applications

| Operating condition and period | Fatigue life factor(fh) | | | | |
|---|---|---|---|---|---|
| | ~ 2 | 2 ~ 3 | 3 ~ 4 | 4 ~ 6 | 6 ~ |
| Used occasionally or only for short period | - Small motors for home appliances like vacuum cleaners and washing machines<br>- Hand power tools | - Agricultural equipment | | | |
| Used occasionally or only for short period but reliability is important | | - Motors for home heaters and air conditioner<br>- Construction equipment | - Conveyors<br>- Elevators cable sheaves | | |
| Used intermittently for relatively long period | - Rolling mill roll necks | - Small motors<br>- Deck cranes<br>- General cargo cranes<br>- Pinion stands<br>- Passenger cars | - Machine tools<br>- Factory motors<br>- Vibrating screens<br>- Crushers | - Crane sheaves<br>- Compressors<br>- Specialized transmissions | |
| Used for more than 8 hours a day | | - Escalator | - Centrifuge separators<br>- Air conditioning equipment<br>- Blowers<br>- Woodworking machines<br>- Axle boxes on railway rolling stock | - Locomotive axle boxes<br>- Press flywheels<br>- Railway traction motors<br>- Mine hoists | - Paper making machines |
| Used continuously and high reliability is important | | | | | - Waterworks pumps<br>- Electric power stations<br>- Mine draining pumps |

[ Table 6.5 ] Required life time($L_{10h}$) for applications

| Operating condition and period | Required life time($L_{10h}$) | | | | |
|---|---|---|---|---|---|
| | ~ 4,000 | 4,000 ~ 12,000 | 12,000 ~ 30,000 | 30,000 ~ 60,000 | 60,000 ~ |
| Used occasionally or only for short period | - Small motors for home appliances like vacuum cleaners and washing machines<br>- Hand power tools | - Agricultural equipment | | | |
| Used occasionally or only for short period but reliability is important | - Medical instrument | - Motors for home heaters and air conditioner<br>- Construction equipment<br>- Elevators<br>- Conveyors | - Crane sheaves | | |
| Used intermittently for relatively long period | - Passenger cars<br>- Cart(two sheeled) | - Small motors<br>- Deck cranes<br>- General cargo cranes<br>- Pinion stands<br>- Passenger cars | - Machine tools<br>- Factory motors<br>- Crushers | - Specialized transmissions<br>- Rubber, plastic calender rolls | |
| Used for more than 8 hours a day | | - Escalator<br>- Rolling mill conveyor rollers<br>- Centrifuge separators | - Air conditioning equipment<br>- Compressors<br>- Pumps<br>- Large motors | - Locomotive axle boxes<br>- Press flywheels<br>- Mine hoists | - Paper making machines<br>- Propulsion system for ships |
| Used continuously and high reliability is important | | | | | - Waterworks pumps<br>- Electric power stations<br>- Mine draining pumps |

# 7. Loads rating of bearing

## 7.1 Dynamic load rating

### 1) Basic dynamic load rating(Cr)

The basic dynamic load rating is an expression of the load capacity of a bearing based on a constant load which the bearing can sustain for one million revolutions(the basic life rating). For radial bearings this rating applies to pure radial loads, and for thrust bearings it refers to pure axial loads. JIB bearings conform to ISO 281-1 and KS B 2019 to calculate the basic dynamic load rating(Cr). It is shown in the dimension tables.

◈ Adjusted basic load rating due to temperature

If the bearing is operated at high temperature above 120℃, the load carrying capacity of the bearing is reduced because the degree of hardness of it is dropped. In turn, the rating life is decreased and thus the basic dynamic load rating should be adjusted and calculated in high temperature conditions.

$$C_t = f_t \times C_r \qquad \text{[Formula 7.1]}$$

Where,
$C_t$ : Basic dynamic load rating at adjusted operating temperature(kgf, N)
$f_t$ : Temperature coefficient[Table 7.1]
$C_r$ : Basic dynamic load rating(kgf, N)

[Table 7.1] Temperature coefficient($f_t$)

| Bearing temperature(°C) | 125 | 150 | 175 | 200 | 250 |
|---|---|---|---|---|---|
| Temperature coefficient ($f_t$) | 1 | 1 | 0.95 | 0.90 | 0.75 |

### 2) Dynamic equivalent radial load(Pr)

The load applied to a bearing is usually combined with radial and axial loads. In this case, the actual load acting on a bearing can not be directly applied to the bearing life calculating equation. Therefore it is necessary to convert the radial and axial loads into a single radial load value to calculate the bearing life. This load is called as the dynamic equivalent radial load. It is shown as below.

$$Pr = XFr + YFa \qquad \text{[Formula 7.2]}$$

Where,
Pr : Dynamic equivalent radial load(kgf, N)
Fr : Radial load(kgf, N)
Fa : Axial load(kgf, N)
X : Radial load factor
Y : Axial load factor

[Table 7.2] The values of radial load factor(X) and axial load factor(Y)

| $\frac{Fa}{Cor}$ | e | Fa/Fr ≦ e | | Fa/Fr > e | |
|---|---|---|---|---|---|
| | | X | Y | X | Y |
| 0.014 | 0.19 | 1 | 0 | 0.56 | 2.30 |
| 0.025 | 0.22 | | | | 1.99 |
| 0.056 | 0.26 | | | | 1.71 |
| 0.084 | 0.28 | | | | 1.55 |
| 0.110 | 0.30 | | | | 1.45 |
| 0.170 | 0.34 | | | | 1.31 |
| 0.280 | 0.38 | | | | 1.15 |
| 0.420 | 0.42 | | | | 1.04 |
| 0.560 | 0.44 | | | | 1.00 |

When selecting a bearing, Pr should not exceed 0.5 x Cr. Normally load condition of bearing is Pr/Cr ≤ 0.15, minimum load condition of bearing is Pr/Cr ≥ 0.05.

### 3) Calculation of loads applied to bearings

To compute the values of loads applied to a bearing, the weight of rolling element, transmission power by gear or belt and load generated by the machines have to be calculated. Some of these loads are theoretically calculable, but the others are difficult to obtain. So, various coefficients empirically obtained have to be utilized.

#### (1) Load factor($f_w$)

The actual load($f_w$) on a bearing is usually greater than the calculated value because of vibration and shock. Therefore, it is determined by multiplying the calculated load with load factors($f_w$).

$$F_r = F_{rc} \cdot f_w \qquad \text{[Formula 7.3]}$$

Where,

$F_r$ : Actual applied load(kgf, N)

$F_{rc}$ : Theoretically calculated load(kgf, N)

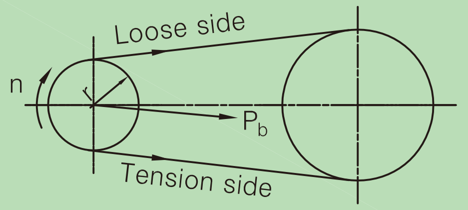
$f_w$ : Load factor(see Table 7.3 )

[Table 7.3] Load factor($f_w$)

| Load condition | $f_w$ | Applications |
|---|---|---|
| Smooth operation with no shocks | 1.0~1.2 | Electrical machines, compressed air machines |
| Normal operation | 1.2~1.5 | Power transmission, metallic machines, building machines, moving machines |
| Operation with frequent vibrations and shocks | 1.5~3.0 | Construction machines, rolling machines, agricultural machines |

#### (2) Loads applied to belt or chain

Load applied to pulley or sprocket, when power is transmitted by belt or chain, is as follows.




[Fig.7.1] Forces applied to belt or chain

$$M = 97400\ H/n \qquad \text{(kgf.cm)} \qquad \text{[Formula 7.4]}$$

$$P_b = M/r \qquad \text{(kgf)} \qquad \text{[Formula 7.5]}$$

where,

M : Torque applied to pulley or sprocket(kgf·cm)

H : Transmission power(kW)

$P_b$ : Force applied to chain or belt(kgf)

n : Rotation speed(rpm)

r : Effective radius of pulley or sprocket(cm)

In the case of a belt transmission, belt factor($f_b$) corresponding to initial tension should be multiplied as following equation.

$$F_r = f_b \cdot P_b \qquad \text{(kgf)} \qquad \text{[Formula 7.6]}$$

[Table 7.4] Belt, chain factor($f_b$)

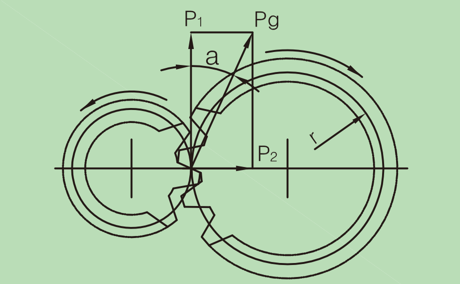
| Belt, chain type | $f_b$ |
|---|---|
| gear belt | 1.3 ~ 2.0 |
| V belt | 2.0 ~ 2.5 |
| plane belt (with tension pulley) | 2.5 ~ 3.0 |
| silk belt | 4.0 ~ 5.0 |
| chain | 1.2 ~ 1.5 |

Here, if vibration or impact is accompanied during operation, multiply by the load factor($f_w$) and the belt factor($f_b$) to obtain the actual load as following equation.

$$F_r = f_w \cdot f_b \cdot P_b \qquad \text{(kgf)} \qquad \text{[Formula 7.7]}$$

#### (3) Load applied to gear

The calculation methods for gear load vary depending on the type of gears. The following method applies for the simplest type of spur gear.




[Fig.7.2] Resultant forces applied to gear

$M = 97400\ H/n$ (kgf.cm) [Formula 7.8]

$P_1 = M/r$ (kgf) [Formula 7.9]

$P_2 = P_1 \cdot \tan\alpha$ (kgf) [Formula 7.10]

$Pg = \sqrt{P_1^2 + P_2^2} = \frac{P_1}{\cos\alpha}$ (kgf) [Formula 7.11]

where,

M : Torque applied to gear(kgf.cm)

H : Transmission power(kW)

$P_1$ : Tangential force of gear(kgf)

$P_2$ : Radial force of gear(kgf)

$P_g$ : Resultant force applied to gear(kgf)

n : Rotation speed(rpm)

r : Pitch circle radius of driven gear(cm)

The actual applied load on the bearing must be calculated by multiplying the gear factor($f_g$), listed in [Table 7.5]. The gear factor is based on the teeth angle and the overall quality of the gear.

$F_r = f_g \cdot P_g$ (kgf) [Formula 7.12]

[Table 7.5] Gear factor($f_g$)

| Gear type | $f_g$ |
|---|---|
| Precision gear (Both pitch and dimension error are less than 0.02mm) | 1.0 ~ 1.1 |
| Regular gear (Both pitch and dimension error are from 0.02 to 0.1mm) | 1.1 ~ 1.3 |

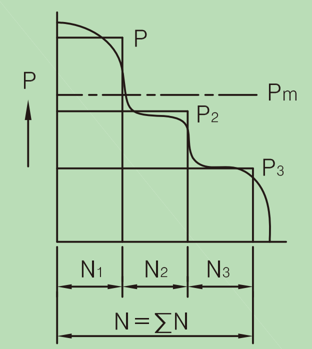
Here, if vibration or impact is accompanied during operation, multiply by the load factor(fw) and the gear factor(fg) to obtain the actual load as following equation.

$F_r = f_w \cdot f_g \cdot P_g$ (kgf) [Formula 7.13]

### (4) Average dynamic equivalent radial load of fluctuating load

Loads applied to a bearing usually fluctuate in various ways. In this case, bearing life can be calculated by mean load.

#### (a) Fluctuating stepped load




[Fig.7.3]

$$P_m = \sqrt[3]{\frac{P_1^3 n_1 t_1 + P_2^3 n_2 t_2 + \cdots + P_n^3 n_n t_n}{n_1 t_1 + n_2 t_2 + \cdots + n_n t_n}}$$ [Formula 7.14]

where,

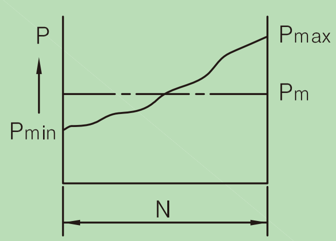
$P_m$ : Average dynamic equivalent radial load of fluctuating load(kgf, N)

Pn : Fluctuating load(kgf, N)

$n_n$ : Rotation speed(rpm)

$t_n$ : Operating time(hr)

#### (b) Linear fluctuating load




[Fig.7.4]

$$P_m \fallingdotseq \frac{P_{min} + 2P_{max}}{3}$$ [Formula 7.15]

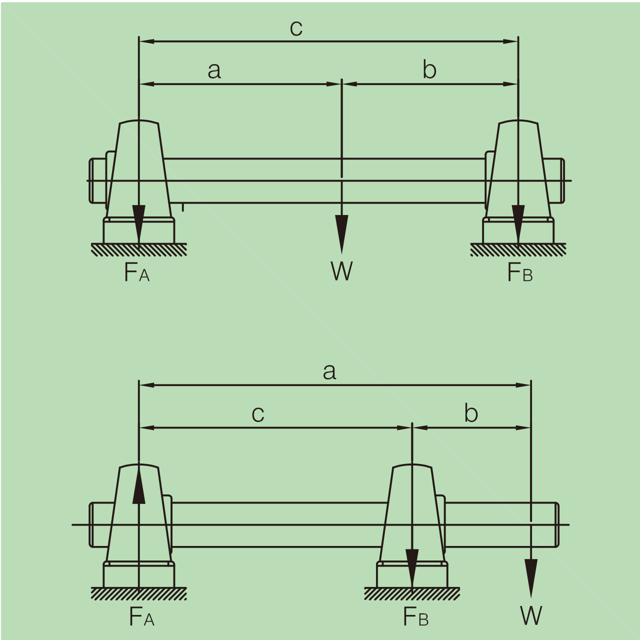
where,

$P_{min}$ : Minimum fluctuating load(kgf, N)

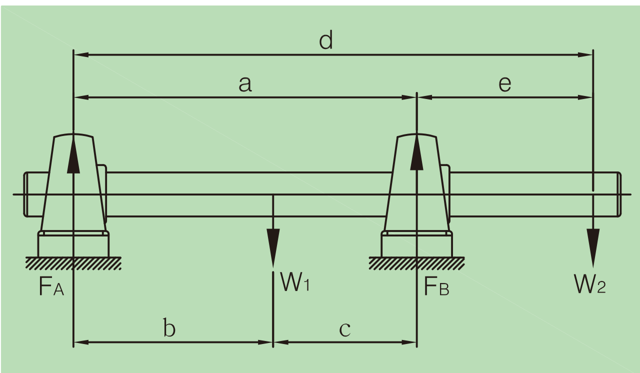
$P_{max}$ : Maximum fluctuating load(kgf, N)

### 4) Distribution of radial load

The load applied to the shaft is allocated to the bearings supporting the shaft. In the case of below drawings, radial loads applied to the bearing A and B are calculated by the following formula.




$$F_A = b/c \cdot W$$
$$F_B = a/c \cdot W \quad \text{[Formula 7.16]}$$




$$F_A = c/a \cdot W_1 - e/a \cdot W_2$$
$$F_B = b/a \cdot W_1 + d/a \cdot W_2 \quad \text{[Formula 7.17]}$$

## 7.2 Static load rating

### 1) Basic static load rating(Cor)

When an excessive load or impact load is applied to a bearing, permanent deformation on the contact surface between raceway and rolling element occurs. Basic static load rating(Cor) is the static load which responds to the calculated contact stress, at the contact center between the raceway and rolling elements which receive the maximum load.

- Maximum contact stress of radial ball bearing
: 4200(Mpa)

The total permanent deformation of rolling element and raceway caused by this contact stress will be approximately 1/10,000 of diameter of rolling element.

Basic static load rating(Cor) of JIB ball bearings is determined in accordance with ISO 76 and KS B 2020, it is shown in the dimension tables.

### 2) Static equivalent radial load(Po)

When the bearing is stationary or under extremely low speed, it is necessary to take into account the static equivalent radial load, which is the counter part of the dynamic equivalent radial load of a rotating bearing. In this case, the following formula is used.

$$Po = Xo \cdot Fr + Yo \cdot Fa \quad \text{(kgf)} \quad \text{[Formula 7.18]}$$

$$Po = Fr \quad \text{(kgf)} \quad \text{[Formula 7.19]}$$

where,
Po : Static equivalent radial load(kgf, N)
Fr : Actual radial load(kgf, N)
Fa : Actual thrust load(kgf, N)
Xo : Static radial factor
Yo : Static thrust factor

The most commonly used values of deep groove ball bearings are Xo=0.6 and Yo=0.5 .

### 3) Safety factor(fs)

The safety factor(fs) is calculated to check whether or not a bearing with appropriate static load rating(Cor) is selected.

$$fs = \frac{Cor}{Po} \quad (kgf) \qquad [Formula\ 7.20]$$

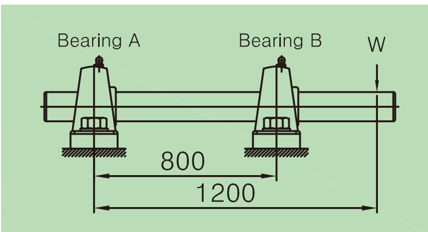
where,
fs : Safety factor
Po : Static equivalent radial load(kgf, N)
Cor : Basic static load rating(kgf, N)

[Table 7.6] Safety factor(fs)

| Operating condition | fs |
|---|---|
| High rotation accuracy is required | 1.5 ~ 2.5 |
| Operation with vibration and shock | 1.2 ~ 2.5 |
| Normal operation | 1.0 ~ 1.2 |
| Normal operation with small amount of permanent deformity | 0.3 ~ 1.0 |

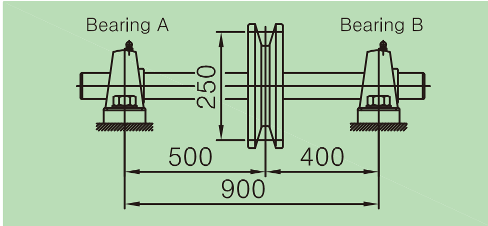
## 7.3 Calculation examples in selecting bearing

**Ex.1)** As shown in the drawing, radial load W=500kgf is applied to the shaft. What are the applied loads on bearing A and B?



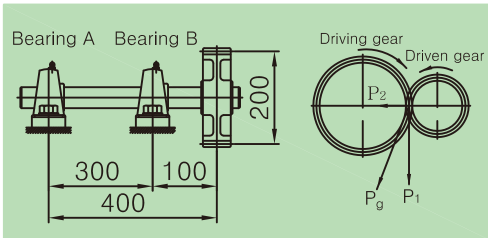

**Sol.)** $W_A$ = (1200-800)/800 x 500 = (-)250(kgf)
Remark : Negative load is the upward(↑) load
$W_B$ = 1200/800 x 500 = 750(kgf)

**Ex.2)** As shown in the drawing, the shaft is rotated by a V-belt with transmission power H=7.5KW, shaft speed n=500 rpm, and pulley pitch diameter d=250mm, what are the applied loads on bearing A and B?




**Sol.)** Rotating moment M = 97400 x H/n
= 97400 x 7.5/500 = 1461(kg.cm)
Force applied to belt or chain $P_b$ for the V-belt is,
$P_b$ = M/r = 1461/12.5 = 116.8(kgf)
Assuming that the belt factor $f_b$ = 1.2
and the load factor fw = 2.5,
the actual applied load F on the shaft is
F = 2.5 x 1.2 x 116.8 = 350.4(kgf)
Therefore, the actual applied loads on bearing A and B are $W_A$ = 400/900 x 350.4 = 155.7(kgf)
$W_B$ = 500/900 x 350.4 = 194.7(kgf)

**Ex.3)** As shown in the drawing, the shaft is rotated by a spur gear with transmission power H=5.5KW, shaft speed n=500rpm, pitch diameter d=200mm and teeth pressure angle α=14°30'. What are the applied loads on bearing A and B?




**Sol.)** Rotating moment M on the gear is
M = 97400 x H/n = 97400 x 5.5/500 = 1071.4(kg.cm)
Tangential force $P_1$ is
$P_1$ = M/r = 1071.4/10 = 107.1(kgf)
Perpendicular force $P_2$ is
$P_2 = P_1$ x tan a = 107.1 x tan 14°30' = 27.7(kgf)
Therefore, total applied load $P_g$ on the gear is

$$P_g = \sqrt{P_1^2 + P_2^2} = \sqrt{107.1^2 + 27.7^2} = 110.6(kgf)$$

Assuming that the gear factor $f_g$=1.2 and the load factor fw=1.3, the actual applied load F on the shaft is
F= 1.2 x 1.3 x 110.6 = 172.5(kg)
Therefore, the applied loads on bearing A and B are
$W_A$ = 100/300 x 172.5 = 57.5(kg)
$W_B$ = 400/300 x 172.5 = 230(kg)

**Ex.4)** What is the bearing life when UC313 is operated with radial load Fr=700Kgf, thrust load Fa=480Kgf and shaft speed n=1,200rpm? Assume ideal operating conditions.

[Refer to page C03] UC 313

| UC 313 | Cr | Cor |
|---|---|---|
| | 9270kgf | 5980kgf |

[Table 7.7] Radial factors (X) and thrust factor (Y)

| $\frac{Fa}{Cor}$ | e | Fa/Fr ≦ e | | Fa/Fr > e | |
|---|---|---|---|---|---|
| | | X | Y | X | Y |
| 0.084 | 0.28 | 1 | 0 | 0.56 | 1.55 |

**Sol.)** Fa/Cor = 480/5980 ≒ 0.08 ▶ e ≒ 0.28

Fa/Fr = 480/700 ≒ 0.68 ▶ 0.68 > 0.28

Radial factor X = 0.56

Thrust factor Y = 1.55

The applied equivalent radial load is Pr = XFr + YFa

Pr = 0.56 x 700 + 1.55 x 480 = 1136(kgf)

$$L_{10h} = \left(\frac{Cr}{Pr}\right)^3 \times \left(\frac{10^6}{60 \cdot n}\right) = \left(\frac{9270}{1136}\right)^3 \times \left(\frac{10^6}{60 \times 1200}\right)$$

= 7546(hr)

**Ex.5)** Which bearing should be selected when the operation life time should be greater than 6000hours at shaft speed of n=1200rpm and radial load of Fr = 500kgf?

**Sol.)** The life time factor of fh ≒ 2.29 can be determined from the bearing calculated life time table for $L_{10h}$ = 6000. The speed factor fn ≒ 0.3 is determined from shaft speed n = 1200(rpm).

Since the ratio C/P can be used to calculate,

Cr = fh/fn x Pr = 2.29/0.3 x 500 = 3816(kgf)

Unit diameter 211 or 308 can be selected with basic static load numbers of 4330 and 4070(kgf).

**Ex.6)** Which bearing should be selected when the ambient temperature is 150°C and axis to axis distance is 1200mm? The shaft material used is ϕ45 mild steel(SM20C material).

**Sol.)** First, select the heat resistant bearing that could be used at 150°C. Next, calculate the thermal shaft expansion at the temperature.

$\Delta\ell = \ell_0 \times \alpha(t - t_0)$

Here, $\ell_0$ = Axial distance at room temperature(mm)

α = Coefficient of linear expansion

(SM20C=$11.7 \times 10^{-6}$ /°C)

$t_0$ = Normal temperature(assume 20°C)

$t_1$ = Ambient temperature during operation

$\Delta\ell = 1200 \times 11.7 \times 10^{-6} \times (150-20) = 1.825$(mm)

The expansion is 1.825mm. There, refer to chapter 9.3 for installation of heat resistant bearing. The life time should be calculated with basic static load determined from the temperature factor(ft) in [Table 7.1].

**Ex.7)** Is it possible to guarantee 2 years bearing life when UC207 bearing unit is used 8 hours a day with radial load of 200kgf and shaft speed of 3200rpm?

**Sol.)** In the example, the maximum speed for high speed and load operation is 3800(rpm). The required guaranteed life time is 8 x 365 x 2=5760 hours. The calculated life time can be determined from the life time table with fn = $(33.3/n)^{1/3}$

fn ≒ 0.206,

Basic static load for UC207 Cor = 2570(kgf)

fh = fn x (Cr/Pr) = 0.206 x (2570/200) ≒ 2.7

$L_{10h} = 500 \times fh^3 = 500 \times 2.7^3$ ≒ 9841(hour)

Therefore, 2 years operation is guaranteed.

**Ex.8)** Which bearing should be selected when the radial load is 1000kgf, the speed is n=12rpm, the safety factor is fs=2.0 and operating life time required is 8000 hours?

**Sol.)** $Lh = 500 \cdot fh^3$ ▶ $fh = (8000/500)^{1/3} = 2.52$

$fn = (33.3/n)^{1/3} = (33.3/12)^{1/3} = 1.4$

here, fh=(Cr/Pr) x fn

therefore, Cr = Pr x fh/fn = 1000 x 2.52/1.4

= 1800(kgf)

Since UC200 series has Cr=3510(kgf), select UC210 series with Cor=2320(kgf).

# 8. Selection of units

## 8.1 Outline of selection

Ball bearing units are available in many types and specifications. To choose the most suitable unit for your application, many factors must be considered such as the structure of the machinery, the operating conditions and economics because the bearing life depends on the proper selection. Procedures for choosing the proper ball bearing unit are shown in [Table 8.1].

[Table 8.1] Procedures for the selection of proper ball bearing units

| Procedures of selection | Items to be examined | Operating conditions to be considered | Reference |
|---|---|---|---|
| 1. Selection of model | - Pillow type<br>- Flange type<br>- Take-up type<br>- Hanger type | - Structure of machinery<br>- Mounting space<br>- Mounting dimensions | - Product overview(A04) |
| 2. Selection of bore dia. and diameter code | - Bearing bore dia. : 8~140mm<br>- Diameter code : 0 , 2 , X , 3 | - Rating life of bearings required<br>- Load applied to bearings<br>- Rotating speed | - Life(A28)<br>- Load rating of bearing(A31)<br>- Maximum rotation speed (A38) |
| 3. Selection against environment | - L3 type<br>- Cover type<br>- Clean series<br>- Stainless steel series<br>- High-speed | - Dust, water leak<br>- Moisture, chemicals<br>- Rotating speed | - Sealing(A03)<br>- Product overview(A04)<br>- Maximum rotation speed (A38) |
| 4. Selection against temperature | - Heat resistant type<br>- Cold resistant type<br>- Measures against expansion and contraction of shaft<br>- Grease lubrication | - Bearing temperature | - Units for special uses(A16)<br>- Installation and use(A40)<br>- Grease lubrication(A45) |
| 5. Selection of locking mechanism | - Set screw<br>- Adapter<br>- Eccectric locking collar | - Rotating speed<br>- Load conditions<br>- Handling | - Installation to the shaft(A41) |
| 6. Selection of shaft | - Dimensional tolerance<br>- Use of shouldered shaft<br>- Provision of set screw for shaft<br>- Measures against expansion and contraction of shaft | - The structure of the machine<br>- Mounting space<br>- Mounting relationship dimension | - Installation and use(A40) |
| 7. Selection of strength of housing | - Cast iron<br>- Cast steel<br>- Steel plate | - Load conditions, load directions<br>- Presence of impact | - Housing materials(A27) |
| 8. Selection of lubrication | - Lubricating type<br>- Non-lubricating type<br>- Centralized lubricating type<br>- Greasing interval | - Environment, importance of machine<br>- Bearing temperature<br>- Grease life | - Installation and use (A41)<br>- Grease lubrication(A45) |
| 9. Selection of maintenance and inspection | - Periodic inspection<br>- Grease lubrication | - Environment, importance of machine<br>- Bearing temperature<br>- Grease life | - Installation and use (A41)<br>- Grease lubrication (A45) |

## 8.2 Maximum rotation speed

The bearing can be destroyed in excessive high speed operation because of the increase of heat generated by the friction between rolling elements and orbital raceway of rings or the agitate resistance of grease. The maximum rotation speed of bearings must, therefore, be considered to use bearings safely for a long time. Additionally, the increase of heat caused by the contact pressure of seals should also be considered because the standard type of JIB ball bearing units has seals and slingers. [Table 8.2] shows the maximum rotation speed of JIB standard type.

[Table 8.2] Maximum rotation speed of bearings

(Unit:rpm)

| Bearing code | Speed | Bearing code | Speed | Bearing code | Speed |
|---|---|---|---|---|---|
| UC201~204 | 6000 | | | | |
| UC205 | 5300 | UCX05 | 4500 | UC305 | 4800 |
| UC206 | 4500 | UCX06 | 3800 | UC306 | 4000 |
| UC207 | 3800 | UCX07 | 3400 | UC307 | 3600 |
| UC208 | 3400 | UCX08 | 3200 | UC308 | 3200 |
| UC209 | 3200 | UCX09 | 2900 | UC309 | 2800 |
| UC210 | 2900 | UCX10 | 2600 | UC310 | 2500 |
| UC211 | 2600 | UCX11 | 2400 | UC311 | 2400 |
| UC212 | 2400 | UCX12 | 2300 | UC312 | 2200 |
| UC213 | 2300 | UCX13 | 2200 | UC313 | 2000 |
| UC214 | 2200 | UCX14 | 2000 | UC314 | 1900 |
| UC215 | 2000 | UCX15 | 1800 | UC315 | 1700 |
| UC216 | 1800 | UCX16 | 1700 | UC316 | 1600 |
| UC217 | 1700 | UCX17 | 1600 | UC317 | 1500 |
| UC218 | 1600 | UCX18 | 1500 | UC318 | 1400 |
| | | UCX20 | 1300 | UC319 | 1350 |
| | | | | UC320 | 1300 |
| | | | | UC321 | 1200 |
| | | | | UC322 | 1150 |
| | | | | UC324 | 1100 |
| | | | | UC326 | 1000 |
| | | | | UC328 | 900 |

Remark :

1) For bearings with triple lip seal, the maximum speed is about 75% of values listed in the table.

2) For bearings with additional external cover, the maximum speed is about 80% of the values listed in the table.

3) It applies when bearing operating temperature is under 100°C.

4) It applies when maximum load applied to a bearing is $Pr/Cr \leq 0.15$ and minimum load applied to a bearing is $Pr/Cr \geq 0.05$.

5) It applies when "$dmp \times n \leq 30 \times 10^4$ considering features and life of grease JIB uses.

Pitch circle diameter : $dmp=(D+d)/2$, Rotation speed : n, Lubrication constant : $30 \times 10^4$

## 8.3 Relational table between load and rotation speed

In the table below [Table 8.3], the load and the speed for each ball bearing type are outlined and summarized for your reference based on 500 hours, theoretical rating life, of JIB unit ball bearings.

Refer to [Formula 6.1], [Formula 6.3]

$$L_{10} = \left(\frac{Cr}{Pr}\right)^3 \quad (10^6 \text{ revolution}) \quad \text{[Formula 6.1]}$$

$$L_{10h} = \left(\frac{Cr}{Pr}\right)^3 \times \left(\frac{10^6}{60 \cdot n}\right) \quad (\text{hour}) \quad \text{[Formula 6.3]}$$

[Table 8.3] Relational table between load and rotation speed(200, X00 type)

| Bearing code | | | | | | | Rotation speed(rpm) and load(kgf) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| UC2 | UK2 | UCX | SER2 | HC2 | SA2 | SB2 | 33⅓ | 50 | 100 | 250 | 500 | 750 | 1000 | 1200 | 1500 | 2000 | 2400 | 3600 | 5000 | rpm |
| – | – | – | – | – | ~203 | ~203 | 960 | 840 | 670 | 490 | 390 | 340 | 310 | 290 | 270 | 250 | 230 | 200 | 180 | load (kg) |
| 204 | – | – | ~204 | 204 | 204 | 204 | 1280 | 1120 | 890 | 650 | 520 | 450 | 410 | 390 | 360 | 330 | 310 | 270 | 240 | |
| 205 | 205 | – | 205 | 205 | 205 | 205 | 1400 | 1220 | 970 | 720 | 570 | 500 | 450 | 420 | 390 | 360 | 340 | 290 | 260 | |
| 206 | 206 | X05 | 206 | 206 | 206 | 206 | 1950 | 1700 | 1350 | 1000 | 790 | 690 | 630 | 590 | 550 | 500 | 470 | 410 | – | |
| 207 | 207 | X06 | 207 | 207 | 207 | 207 | 2570 | 2250 | 1780 | 1310 | 1040 | 910 | 830 | 780 | 720 | 660 | 620 | 540 | – | |
| 208 | 208 | X07 | 208 | 208 | 208 | 208 | 2910 | 2540 | 2020 | 1490 | 1180 | 1030 | 940 | 880 | 820 | 740 | 700 | – | – | |
| 209 | 209 | X08 | 209 | 209 | 209 | 209 | 3200 | 2800 | 2220 | 1630 | 1300 | 1130 | 1030 | 970 | 900 | 820 | 770 | – | – | |
| 210 | 210 | X09 | 210 | 210 | 210 | 210 | 3150 | 3070 | 2430 | 1790 | 1420 | 1240 | 1130 | 1060 | 990 | 900 | 840 | – | – | |
| 211 | 211 | X10 | 211 | 211 | 211 | 211 | 4330 | 3780 | 3000 | 2210 | 1760 | 1530 | 1390 | 1310 | 1220 | 1110 | 1040 | – | – | |
| 212 | 212 | X11 | 212 | 212 | 212 | 212 | 5240 | 4580 | 3630 | 2680 | 2120 | 1860 | 1690 | 1590 | 1470 | 1340 | – | – | – | |
| 213 | 213 | X12 | – | – | – | – | 5720 | 5000 | 3970 | 2920 | 2320 | 2030 | 1840 | 1730 | 1610 | 1460 | – | – | – | |
| 214 | – | X13 | – | – | – | – | 6220 | 5430 | 4310 | 3180 | 2520 | 2200 | 2000 | 1880 | 1750 | 1590 | – | – | – | |
| 215 | 215 | X14 | – | – | – | – | 6740 | 5890 | 4670 | 3440 | 2730 | 2390 | 2170 | 2040 | 1890 | 1720 | – | – | – | |
| 216 | 216 | X15 | – | – | – | – | 7260 | 6340 | 5030 | 3710 | 2940 | 2570 | 2340 | 2200 | 2040 | – | – | – | – | |
| 217 | 217 | X16 | – | – | – | – | 8390 | 7330 | 5820 | 4290 | 3400 | 2970 | 2700 | 2540 | 2360 | – | – | – | – | |
| 218 | 218 | X17 | – | – | – | – | 9600 | 8390 | 6660 | 4900 | 3890 | 3400 | 3090 | 2910 | 2700 | – | – | – | – | |
| – | – | X18 | – | – | – | – | 10900 | 9520 | 7560 | 5560 | 4420 | 3860 | 3500 | 3300 | 3060 | – | – | – | – | |
| – | – | X20 | – | – | – | – | 13300 | 11600 | 9220 | 6780 | 5390 | 4710 | 4280 | 4030 | – | – | – | – | – | |

[Table 8.4] Relational table between load and rotation speed(300 type)

| Bearing code | | Rotation speed(rpm) and load(kgf) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| UC3 | UK3 | 33⅓ | 50 | 100 | 250 | 500 | 750 | 1000 | 1200 | 1500 | 2000 | 2400 | 3600 | 5000 | rpm |
| 305 | 305 | 2100 | 1830 | 1460 | 1070 | 850 | 740 | 680 | 640 | 590 | 540 | 500 | 440 | – | load (kg) |
| 306 | 306 | 2660 | 2320 | 1840 | 1360 | 1080 | 940 | 860 | 810 | 750 | 680 | 640 | 560 | – | |
| 307 | 307 | 3330 | 2910 | 2310 | 1700 | 1350 | 1180 | 1070 | 1010 | 940 | 850 | 800 | 700 | – | |
| 308 | 308 | 4070 | 3560 | 2820 | 2080 | 1650 | 1440 | 1310 | 1230 | 1140 | 1040 | 980 | – | – | |
| 309 | 309 | 3890 | 4270 | 3390 | 2500 | 1980 | 1730 | 1570 | 1480 | 1370 | 1250 | 1180 | – | – | |
| 310 | 310 | 6200 | 5420 | 4300 | 3170 | 2510 | 2200 | 2000 | 1880 | 1740 | 1580 | 1490 | – | – | |
| 311 | 311 | 7160 | 6250 | 4960 | 3660 | 2900 | 2540 | 2300 | 2170 | 2010 | 1830 | 1720 | – | – | |
| 312 | 312 | 8180 | 7150 | 5670 | 4180 | 3320 | 2900 | 2630 | 2480 | 2300 | 2090 | 1970 | – | – | |
| 313 | 313 | 9270 | 8100 | 6430 | 4740 | 3760 | 3280 | 2980 | 2810 | 2610 | 2370 | – | – | – | |
| 314 | – | 10400 | 9090 | 7210 | 5310 | 4220 | 3680 | 3350 | 3150 | 2920 | – | – | – | – | |
| 315 | 315 | 11300 | 9870 | 7830 | 5770 | 4580 | 4000 | 3640 | 3420 | 3180 | – | – | – | – | |
| 316 | 316 | 12300 | 10750 | 8530 | 6280 | 4990 | 4360 | 3960 | 3730 | 3460 | – | – | – | – | |
| 317 | 317 | 13300 | 11620 | 9220 | 6790 | 5390 | 4710 | 4280 | 4030 | – | – | – | – | – | |
| 318 | 318 | 14300 | 12490 | 9920 | 7310 | 5800 | 5070 | 4600 | 4330 | – | – | – | – | – | |
| 319 | 319 | 15300 | 13370 | 10610 | 7820 | 6200 | 5420 | 4920 | 4630 | – | – | – | – | – | |
| 320 | 320 | 17300 | 15110 | 12000 | 8840 | 7010 | 6130 | 5570 | – | – | – | – | – | – | |
| 321 | – | 18400 | 16070 | 12760 | 9400 | 7460 | 6520 | 5920 | – | – | – | – | – | – | |
| 322 | 322 | 20500 | 17190 | 14210 | 10470 | 8310 | 7260 | 6600 | – | – | – | – | – | – | |
| 324 | 324 | 20700 | 18080 | 14350 | 10580 | 8390 | 7330 | – | – | – | – | – | – | – | |
| 326 | 326 | 22900 | 20000 | 15880 | 11700 | 9290 | 8110 | – | – | – | – | – | – | – | |
| 328 | 328 | 25300 | 22100 | 17540 | 12930 | 10260 | 8960 | – | – | – | – | – | – | – | |

# 9. Installation and use

## 9.1 Selection of shaft

The proper selection of a shaft is very important for optimal performance of ball bearing units.

① Tolerances in [Table 9.1] should be used for cylindrical bore type bearings which are mounted onto the shaft with set screws. The tolerance class h8 and h7 are applied to normal conditions, h6 and j6 to relatively high speed applications.
② Tolerances in [Table 9.1] can also be used as the basis for tapered bore type bearings. Since the mounting onto the shaft is firmly secured with a nut, using the tolerance class h9 in [Table 9.2] is also permissible.
③ Tolerances in [Table 9.3] should be used for high load and impact load conditions to prevent loosening bolts caused by vibrations.
④ Tolerances in [Table 9.4] should be used for blowers and high-speed bearings. In this case, precision in bearing and shaft is required.

[Table 9.1] Tolerances of shaft for cylindrical bore type bearings with set screws

| Shaft outside diameter (mm) | | Tolerance (0.001mm) | | | |
|---|---|---|---|---|---|
| | | dn≤60000 | dn≤100000 | dn≤120000 | dn>120000 |
| over | incl. | h8 | h7 | h6 | j6 |
| 10 | 18 | 0~ −27 | 0~ −18 | 0~ −11 | +8~ −3 |
| 18 | 30 | 0~ −33 | 0~ −21 | 0~ −13 | +9~ −4 |
| 30 | 50 | 0~ −39 | 0~ −25 | 0~ −16 | +11~ −5 |
| 50 | 80 | 0~ −46 | 0~ −30 | 0~ −19 | +12~ −7 |
| 80 | 120 | 0~ −54 | 0~ −35 | 0~ −22 | +13~ −9 |
| 120 | 180 | 0~ −63 | 0~ −40 | 0~ −25 | +14~ −11 |

Remark :
dn = bearing bore diameter, d(mm) × rotation speed, n(rpm)

[Table 9.2] Tolerances of shaft for tapered bore type bearings with adapter

| Shaft outside diameter (mm) | | Tolerance (0.001mm) | Tolerance of roundness (0.001mm) (Max) |
|---|---|---|---|
| over | incl. | h9 | |
| 18 | 30 | 0~ −33 | 13 |
| 30 | 50 | 0~ −39 | 17 |
| 50 | 80 | 0~ −46 | 20 |
| 80 | 120 | 0~ −54 | 23 |
| 120 | 180 | 0~ −63 | 31 |

[Table 9.3] Tolerances of shaft for cylindrical bore type bearings with set screws (High load and impact load)

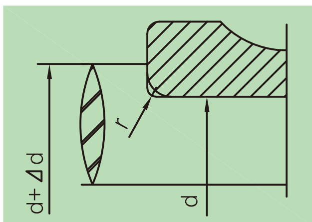
| Shaft outside diameter (mm) | | Tolerance(0.001mm) | | |
|---|---|---|---|---|
| over | incl. | m6 | m7 | m8 |
| 10 | 18 | +18 ~ +7 | +19 ~ +1 | +12 ~ +1 |
| 18 | 30 | +21 ~ +8 | +23 ~ +2 | +15 ~ +2 |
| 30 | 50 | +25 ~ +9 | +27 ~ +2 | +18 ~ +2 |
| 50 | 80 | +30 ~ +11 | +32 ~ +2 | +21 ~ +2 |
| 80 | 120 | +35 ~ +13 | +38 ~ +3 | +25 ~ +3 |
| 120 | 180 | +40 ~ +15 | +43 ~ +3 | +28 ~ +3 |

[Tabel 9.4] Tolerances of shaft for blowers

| Shaft outside diameter (mm) | | Tolerance(0.001mm) | |
|---|---|---|---|
| over | incl. | h5 | j5 |
| 10 | 18 | 0 ~ −8 | +5 ~ −3 |
| 18 | 30 | 0 ~ −9 | +6 ~ −4 |
| 30 | 50 | 0 ~ −11 | +6 ~ −5 |
| 50 | 80 | 0 ~ −13 | +6 ~ −7 |
| 80 | 120 | 0 ~ −15 | +6 ~ −9 |
| 120 | 180 | 0 ~ −18 | +7 ~ −11 |

[Table 9.5] Values of "r" and shaft diameter of shouldered shaft.

| Bearing code | r (Max) | Δd (Min) | Bearing code | r (Max) | Δd (Min) |
|---|---|---|---|---|---|
| UC201~203 | 0.6 | 5 | UC216~218<br>UCX16~X18<br>UC310~311 | 2.0 | 10 |
| UC204~206<br>UCX05~X06 | 1.0 | 6 | UCX20<br>UC312~316 | 2.0 | 12 |
| UC207~210<br>UCX07~X10<br>UC305~306 | 1.0 | 7 | UC317~324 | 2.5 | 14 |
| UC211~215<br>UCX11~X15<br>UC307~309 | 1.5 | 9 | | | |



## 9.2 Operating temperature

### 1) Operating temperature range

The operating temperature range of ball bearing units is based on the allowable temperature of the grease and the seal. The operating temperature range of normal ball bearing units is from approximately -20℃ to 100℃. In order to operate this out of range, proper grease type must be used for the intended operating temperature. Also the sealing type and the radial clearance must take into account for proper operation.

### 2) Bearing temperature rise

The temperature rise of bearing is affected by the internal frictional heat in bearing rotation, by the deterioration caused by the agitate resistance of grease and by heat surrounding the housing, the shaft and the machine. In most cases, the bearing temperature rises sharply during initial operation, under normal operating conditions, then decreases slowly until it reaches a stable condition and then remains thermal equilibrium state. However, if bearing temperature is typically higher 30℃ to 35℃ than ambient temperature, it has high possibility that there is something wrong with operating conditions or bearing itself.

### 3) Temperature difference and radial internal clearance

In general, the temperature of the inner ring and rolling elements is higher than the outer ring. The temperature difference between inner and outer ring is especially large when the shaft gets heat and the housing gets cold. Its difference makes reduction of the radial internal clearance of the bearing. Thus, when the temperature difference is expected to be large, internal clearance C3 and C4 should be considered. The reduction of radial internal clearance due to the temperature difference can be calculated by the following formula.

$$\delta t \fallingdotseq 12.5 \times 10^{-6}\ t\ \left(\frac{4D+d}{5}\right) \qquad \text{[Formula 9.1]}$$

t : Temperature difference between the inner and the outer ring(℃)
d : Inner ring bore diameter(mm)
D : Outer ring outside diameter(mm)

The axial clearance can also be insufficient when the bearing units are mounted far apart along the shaft. In this case, the axial expansion and ball bearing axial clearance must be carefully matched for proper operation. The shaft expansion, $\Delta\ell$, can be calculated by the following equation.

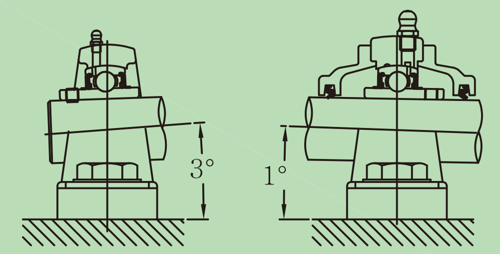
$$\Delta \ell = \alpha \cdot \Delta t \cdot \ell \qquad \text{[Formula 9.2]}$$

α : Coefficient of linear expansion(1/°C)
(coefficient of linear expansion bearing steel : $12.5\text{x}10^{-6}$)
t : Temperature difference(°C)
ℓ : Distance between units(mm)

## 9.3 Installation of ball bearing units

### 1) Allowable aligning angle

The bearing units should be mounted within 3˚ of the bearing locking angle. The operation of the bearing is not affected if the angle between the base of the unit and the shaft axis is greater than 3˚. But, there is a possibility that the grease will not be properly resupplied. If the unit is used with an additional cover, the locking angle should be less than 1˚ for proper operation.



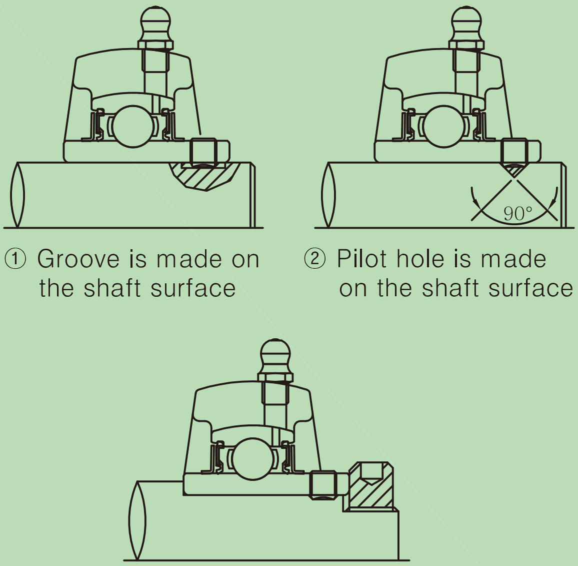
[Fig.9.1] Shaft mounting angle

### 2) Installation to the shaft

#### (1) Installation of units with set screws

The unit is simply mounted to the shaft with two hexagonal screws located 120˚ apart on the inner ring of the bearing. If the unit is mounted in the environment where it is exposed to impact or vibration, or if the shaft is rotated bidirectionally, or if rotation is started and stopped frequently, then one of the following solutions are recommended. [Fig.9.2]

① Grind the surface of the shaft to make a groove.
② Drill hole on the surface of the shaft.
③ Use a shouldered shaft with a nut.




[Fig.9.2] Improvement method for set screws tightening

[Table 9.6] Locking torque of bearing set screw

| Size of set screws | | Bearing code | Locking torque (kgf.cm) |
|---|---|---|---|
| mm | inch | | |
| M2.5x0.35 | | USB 08 | 3.5 |
| M3x0.35 | | USB000~001 | 8 |
| M4x0.35 | | USB002~003 | 15 |
| M5x0.5 | | USB004~006 | 30 |
| M5x0.8 | No.10-32 | UC201~205 | 30 |
| M6x0.75 | 1/4-28 | UC206~207<br>UCX05~X06<br>UC305~306 | 40 |
| M8x1.0 | 5/16-24 | UC208~211<br>UCX07~X10<br>UC307 | 90 |
| M10x1.25 | 3/8-24 | UC212<br>UCX11<br>UC308~309 | 180 |
| M12x1.5 | 7/16-20 | UC213~218<br>UCX12~X17<br>UC310~314 | 280 |
| M14x1.5 | 9/16-18 | UCX18<br>UC315~316 | 350 |
| M16x1.5 | 5/8-18 | UCX20<br>UC317~319 | 600 |
| M18x1.5 | 5/8-18 | UC320~324 | 650 |
| M20x1.5 | 3/4-16 | UC326~328 | 800 |

(2) Installation of units with an adapter sleeve

Adapter sleeve mounting method is used with bearing units that have a 1/12 tapered inner ring bore diameter. The adapter type ball bearing unit can be firmly secured to the shaft even when it is subjected to impact loads and severe vibrations.

Procedure for installation of the ball bearing unit with adapter sleeve is as follows.

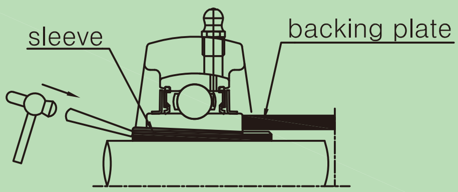
(1) Fit the sleeve to the shaft and move it to the installing position of the bearing

(2) For easy fitting of the sleeve to the shaft, expand its slot with a screw driver.


[Fig.9.3] Fit the sleeve to the shaft

(3) Fit the ball bearing unit (UK) to the sleeve. (with shaft)

(4) The sleeve is inserted into the tapered bore and then gently tap with wooden hammer. Be careful not to strike the slinger.




[Fig.9.4] Fit the sleeve to bearing with tapered bore

(5) Fit the washer and the lock nut to the sleeve, and tighten the lock nut with your hand and further tighten with hook spanner by 1/4 to 1/3 turn of the nut.

Remark :
If the lock nut is over tightened, the radial clearance inside the bearing is reduced which can then lead to excessive heat generation and burning of high load contact areas. Therefore, the nut should never be over tightened.

(6) The rim of the washer should be bent and placed in the groove on the lock nut. As for the tightening torque of the lock nut, see [Table 9.7]

Remark :
The lock nut must not be turned backwards to bring the groove into line with the rim on the washer.

[Table 9.7] Locking torque of adapter(kgf.cm)

| Bearing code | Locking torque | Bearing code | Locking torque |
|---|---|---|---|
| UK 205 | 180 | UK 305 | 250 |
| UK 206 | 280 | UK 306 | 400 |
| UK 207 | 380 | UK 307 | 600 |
| UK 208 | 480 | UK 308 | 750 |
| UK 209 | 580 | UK 309 | 1050 |
| UK 210 | 680 | UK 310 | 1350 |
| UK 211 | 900 | UK 311 | 1600 |
| UK 212 | 1200 | UK 312 | 1900 |
| UK 213 | 1400 | UK 313 | 2400 |
| UK 215 | 1600 | UK 315 | 3400 |
| UK 216 | 1900 | UK 316 | 3900 |
| UK 217 | 2200 | UK 317 | 4400 |
| UK 218 | 2600 | UK 318 | 5400 |
| | | UK 319 | 6400 |
| | | UK 320 | 8000 |
| | | UK 322 | 10000 |
| | | UK 324 | 13000 |
| | | UK 326 | 16000 |
| | | UK 328 | 18000 |

(3) Installation of units with an eccentric locking collar

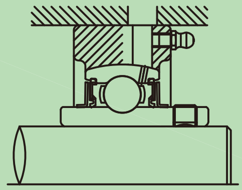
The eccentric locking collar method uses an eccentric locking collar on the outer circumference of the inner ring. This locking method is more simple to use than the bolt mounting method or the adapter sleeve mounting method because the rotating shaft is used to generate the shaft locking force. The self-locking feature of the collar works by converting the rotation of the shaft into a contact force between the eccentric collar, the inner race and the shaft.

## 3) High temperature applications

Heat resistant bearing units operating at high temperatures receive axial loading by the expansion of the shaft. In this situation, one side of the bearing unit should be firmly fixed to the locking surface and the other side of the bearing unit should be locked freely to absorb the expansion of the shaft as shown in [Fig.9.5], [Fig.9.6].

(1) Cartridge type

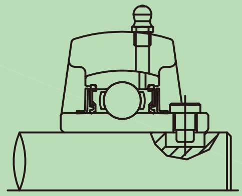
Use the rounded cartridge type unit so that the outer surface of the cartridge housing can move.



[Fig.9.5] Cartridge type

(2) Key type bolt

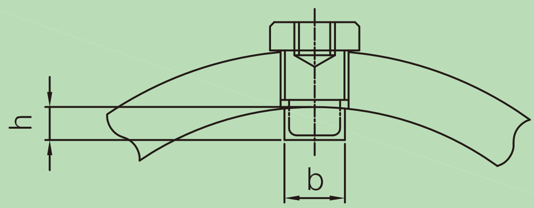
Make a key groove on the shaft and then lock key type bolt.



[Fig.9.6] Key type

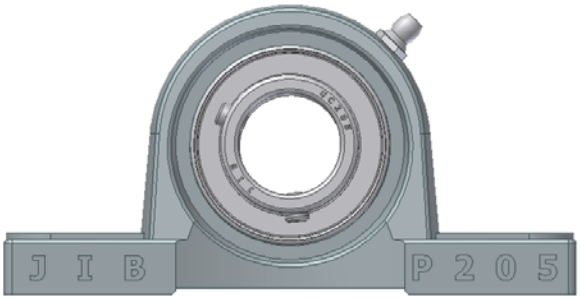
[Table 9.8] Dimensions of key groove(mm)

| Bearing code | Locking bolt code | h | b |
|---|---|---|---|
| UC201 ~ 205 | M5 x 0.8 | – | – |
| UC206 ~ 207 | M6 x 0.75 | 5 | 4 |
| UC208 ~ 211 | M8 x 1.0 | 6 | 6 |
| UC212 | M10 x 1.25 | 6.5 | 7 |
| UC213~218 | M12 x 1.5 | 8 | 9 |
| UCX05~06 | M6 x 0.75 | 5 | 4 |
| UCX07 ~ X10 | M8 x 1.0 | 5 | 6 |
| UCX11 | M10 x 1.25 | 6.5 | 7 |
| UCX12 ~ X17 | M12 x 1.5 | 7 | 9 |
| UCX18 | M14 x 1.5 | 7 | 10 |
| UCX20 | M16 x1.5 | 7 | 12 |
| UC305 ~ 306 | M6 x 0.75 | 5 | 4 |
| UC307 | M8 x 1.0 | 6 | 6 |
| UC308 ~ 309 | M10 x 1.25 | 6.5 | 7 |
| UC310 ~ 314 | M12 x 1.5 | 8 | 9 |
| UC315 ~ 316 | M14 x 1.5 | 8 | 10 |
| UC317 ~ 319 | M16 x 1.5 | 8 | 12 |
| UC320 ~ 324 | M18 x 1.5 | 8 | 13 |
| UC326 ~ 328 | M20 x 1.5 | 8 | 15 |

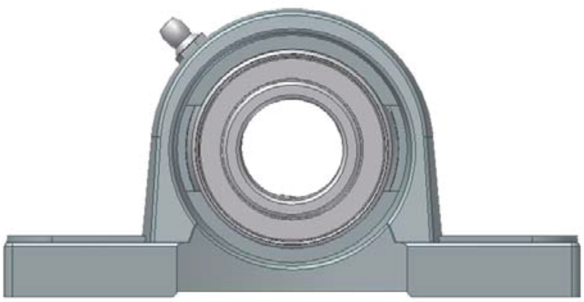


## 9.4 Replacement

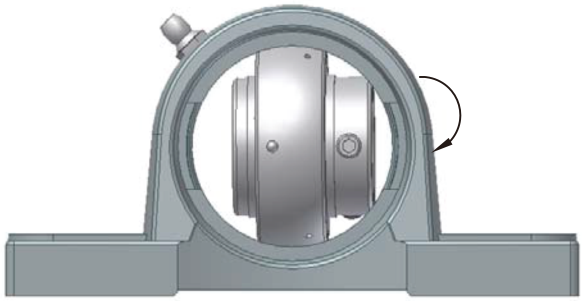
Bearings and housings of JIB ball bearing units are easily replaced each other. When the bearing is removed from the housing, rotate the bearing perpendicular to the housing bore as shown in [Fig.9.9]. Next, the bearing should be rotated to a position where the housing bore diameter assembly groove and the bearing width are equal as shown in [Fig.9.10]. Then, the bearing can be simply removed by pulling towards the assembly groove as shown in [Fig.9.11]. Assembly of the bearing unit is in the opposite order of disassembly.



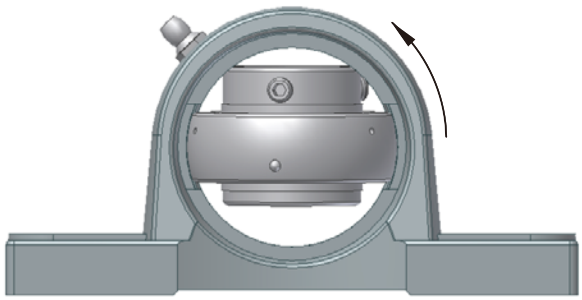

[Fig.9.7] Front of unit



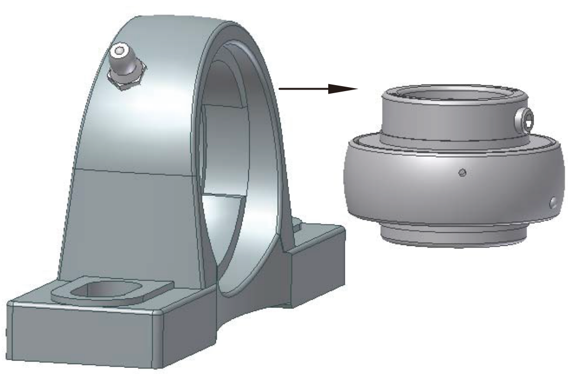
[Fig.9.8] Back of unit



① [Fig.9.9] Rotate the bearing perpendicular to the housing bore.



② [Fig.9.10] The bearing should be rotated to a position where the housing bore diameter assembly groove and the bearing width are equal.



③ [Fig.9.11] The bearing is removed from the housing

## 9.5 Grease Lubrication

### 1) Amount of grease

The inserted grease lubricates the internal parts of the bearing and the seal, and also protects against dust and moisture. The proper amount of grease is about 30% to 35% of the internal volume of the bearing. If the grease is over filled, it can cause excessive temperature increase due to agitate resistance. The standard amount of grease filled by JIB is listed in [Table 9.9].

[Table 9.9] Standard amount of grease prelubricated

| Bearing code | Supply amount(g) | Bearing code | Supply amount(g) |
|---|---|---|---|
| UC201 ~ 205 | 1.4 | UC305 | 3 |
| UC206 / UCX05 | 2.5 | UC306 | 4.5 |
| UC207 / UCX06 | 3 | UC307 | 6 |
| UC208 / UCX07 | 4 | UC308 | 9 |
| UC209 / UCX08 | 4.5 | UC309 | 11 |
| UC210 / UCX09 | 5.5 | UC310 | 14 |
| UC211 / UCX10 | 7 | UC311 | 17 |
| UC212 / UCX11 | 9 | UC312 | 21 |
| UC213 / UCX12 | 11 | UC313 | 26 |
| UC214 / UCX13 | 13 | UC314 | 33 |
| UC215 / UCX14 | 14 | UC315 | 37 |
| UC216 / UCX15 | 20 | UC316 | 46 |
| UC217 / UCX16 | 24 | UC317 | 51 |
| UC218 / UCX17 | 31 | UC318 | 63 |
| UCX18 | 40 | UC319 | 72 |
| UCX20 | 58 | UC320 | 90 |
| | | UC321 | 105 |
| | | UC322 | 130 |
| | | UC324 | 150 |
| | | UC326 | 190 |
| | | UC328 | 240 |

### 2) Grease resupply

When resupply grease, other grease type which is different from original one should not be used in principle. The proper resupply interval affects to the bearing and grease life. It is safe to regrease regularly under bad operating conditions or operating temperature over 100°C. [Table 9.10] shows resupply intervals and grease used when bearing operates 8 hours a day.

[Table 9.10] Relubrication intervals

| Bearing operating temperature (°C) | Relubrication intervals | | | | |
|---|---|---|---|---|---|
| | Good environmental condition | Dusty condition | High dust, moisture condition | Bearing | Grease |
| under 50 | – | 1 year | 4 months | Regular | EP2 |
| under 70 | 12 months | 4 months | 1 month | | |
| under 100 | 6 months | 2 months | 2 weeks | | |
| under 120 | 2 months | 2 weeks | 5 days | Heat resistant (EN2) | Super –lube |
| under 150 | 2 weeks | 5 days | 2 days | | |
| under 180 | 1 week | 2 days | 1day | | |
| under 200 | 3 days | 1 day | 1day | | |

Remark :
The greases listed in the table may be changed without notice to improve the quality.

### 3) Grease life

In normal operating conditions, the grease life of sealed bearings is determined by the following formula.

$$\log L = 4.73-(t-17.2) \times \{0.0104+(8.46 \cdot n)\times 10^{-7}\} - 0.03 \frac{n \cdot Fr^{1.5}}{C^{1.9}} \qquad \text{[Formula 9.3]}$$

where,
L : Average life of grease(hour)
T : Bearing operating temperature(℃)
n : Rotation speed(rpm)
Fr : Radial load(Kgf)
Cr : Basic dynamic load rating(Kgf)

### 4) Grease nipple

There are 3 different grease nipple types as shown in [Fig.9.12]. On demand, we supply the applicable fitting as shown in [Table 9.11]

[Fig.9.12] Nipple types

[Table 9.11] Nipple fitting threads

| Bearing code | Basic screw threads | Applicable screw threads |
|---|---|---|
| UC201 ~ 210<br>UCX05 ~ X09<br>UC305 ~ 308 | M6 x 1 | 1/4-28UNF |
| UC211 ~ 218<br>UCX10 ~ X20<br>UC309 ~ 328 | M6 x 1 | PT 1/8 |

## 9.6 Abnormal phenomena and causes

Abnormal phenomena and causes during operation of ball bearing units. [Table 9.12]

[Table 9.12] Abnormal phenomena and causes

| Phenomena | Causes |
|---|---|
| Excess friction torque (rotating) | 1) Reduction of the radial internal clearance due to tight assembly, overtightening of adapter<br>2) Overlap of seal and slinger due to physical shock during installation<br>3) Inaccurate alignment of bearings when more than 2 bearing units are installed on a single axis |
| Noise and vibration | 1) Breakdown of the race way due to improper handling or installation<br>2) Early stage of flaking or breakdown of the race way or the ball<br>3) Looseness of bearing mounting bolt<br>4) Looseness of housing mounting bolt<br>5) Bent shaft<br>6) Unbalanced load acting on the axis of the rotating machine<br>7) More than 3 units mounted on a single axis<br>8) Bad mounting surface, vibration of shaft axis<br>9) Too much clearance between the shaft and the bearing bore<br>10) Not enough strength on the mounting surface<br>11) Entrance of foreign contaminants into the bearing due to breakdown of sealing |
| Temperature rise | 1) Not enough the radial internal clearance of bearing<br>2) Operating above the maximum rotation speed<br>3) Overlap between seals and slingers due to installation shock<br>4) Too much axial loads due to the heat expansion of shaft<br>5) Early stage of breakdown of some bearing parts |

# 10. Precautions for handling

As the ball bearing unit is a precision part, the maintenance should be handled with care and plan. No matter how good quality and capability of the bearing is, the expected bearing life cannot be achieved without good maintenance practices. Bearing life is affected by operating environment and conditions as the followings thus, we hereby describe precautions for handling as below.

1) Maintain a clean assembly and disassembly area and use suitable tools.
2) Handle a bearing with clean and dry hands.
3) When resupplying grease, refer to the table of relubrication intervals. [Table 9.10]
4) When mounting a bearing onto the shaft, consider values of locking torque. [Refer to A42, 43]
   Excessive locking torque causes breakage of the set screw area on the bearing.
5) When mounting a unit, consider allowable aligning angle [Fig. 9.1]
6) When selecting a shaft, consider tolerances which fit with locking method and rotation speed.
   [Refer to A40]
7) When it needs replacement, use JIB products.
   In case of using other brand's product, bearing life can be shorten by reduction of bearing internal clearance because each company has different standard to manage tolerance of spherical bore diameter of housing. Also, grease leakage may occur because the grease groove of housing isn't corresponding.