1. Construction

The **NTN** bearing unit is a combination of a radial ball bearing, seal, and a housing of high-grade cast iron or pressed steel, which comes in various shapes.

The outer surface of the bearing and the internal surface of the housing are spherical, so that the unit is self-aligning.

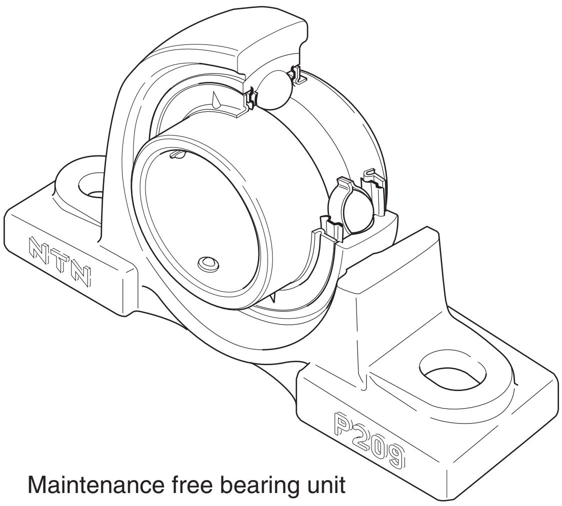
The inside construction of the ball bearing for the unit is such that steel balls and retainers of the same type as in series 62 and 63 of the **NTN** deep groove ball bearing are used. A duplex seal consisting of a combination of an oil-proof synthetic rubber seal and a slinger, unique to **NTN**, is provided on both sides.

Depending on the type, the following methods of fitting to the shaft are employed:

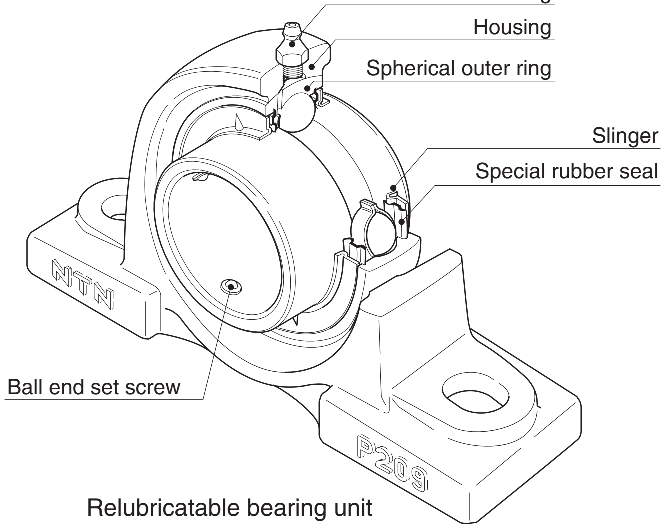
(1) The inner ring is fastened onto the shaft in two places by set screws.

(2) The inner ring has a tapered bore and is fitted to the shaft by means of an adapter.

(3) In the eccentric locking collar system the inner ring is fastened to the shaft by means of eccentric grooves provided at the side of the inner ring and on the collar.

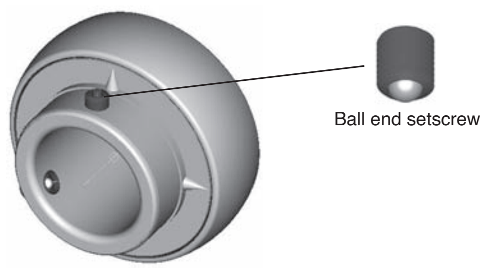


Maintenance free bearing unit

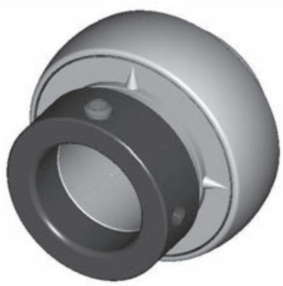


Relubricatable bearing unit

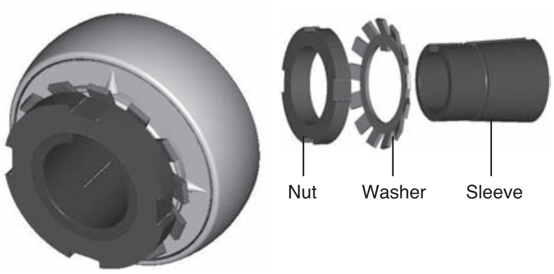
■Mounting system for bearing unit (Please refer to P56 ～ P59 for Mounting bearing unit on the shaft)



General application
Set screw system



Achieves a tighter fit to the shaft, but only for use in single direction rotation applications.
Eccentric locking collar system



Application required rotational accuracy.
Adapter system

Application required rotational accuracy.
Tight fitting system

2. Design Features and Advantages

2.1 Maintenance free type

The **NTN** Maintenance free bearing unit contains a high-grade lithium-based grease, good for use over a long period, which is ideally suited to sealed-type bearings. Also provided is an excellent sealing device, unique to **NTN**, which prevents any leakage of grease or penetration of dust and water from outside.

It is designed so that the rotation of the shaft causes the sealed-in grease to circulate through the inside space, effectively providing maximum lubrication. The lubrication effect is maintained over a long period with no need for replenishment of grease.

To summarize the advantages of the **NTN** maintenance free bearing unit:

(1) As an adequate amount of good quality grease is sealed in at the time of manufacture, there is no need for replenishment. This means savings in terms of time and maintenance costs.

(2) Since there is no need for any regreasing facilities, such as piping, a more compact design is possible.

(3) The sealed-in design eliminates the possibility of grease leakage, which could lead to stained products.

2.2 Relubricatable type

The **NTN** relubricatable type bearing unit has an advantage over other simillar units being so designed as to permit regreasing even in the case of misalignment of 2˚ to the right or left. The hole through which the grease fitting is mounted usually causes structural weakening of the housing.

However, as a result of extensive testing, in the **NTN** bearing unit the hole is positioned so as to minimize this adverse effect. In addition, the regreasing groove has been designed to minimize weakening of the housing.

While the **NTN** maintenance free type bearing unit is satisfactory for use under normal operating conditions in-doors, in the following circumstances it is necessary to use the relubricatable type bearing unit:

(1) Cases where the temperature of the bearing rises above 100˚C, 212˚F:

(2) Cases where there is excessive dust, but space does not permit using a bearing unit with a cover.

(3) Cases where the bearing unit is constantly exposed to splashes of water or any other liquid, but space does not permit using a bearing unit with a cover.

(4) Cases in which the humidity is very high, and the machine in which the bearing unit is used is run only intermittently.

(5) Cases involving a heavy load of which the C_r/P_r value is about 10 or below, and the speed is 10 rpm or below, or the movement is oscillatory.

(6) Cases where the number of revolutions is relatively high and the noise problem has to be considered; for example, when the bearing is used with the fan of an air conditioner.

2.3 Special sealing feature

2.3.1 Standard bearing units

The sealing device of the ball bearing for the **NTN** bearing unit is a combination of a heat-resistant and oil-proof synthetic rubber seal and a slinger of an exclusive **NTN** design.

The seal, which is fixed in the outer ring, is steelreinforced, and its lip, in contact with the inner ring, is designed to minimize frictional torque.

The slinger is fixed to the inner ring of the bearing with which it rotates. There is a small clearance between its periphery and the outer ring.

These two types of seals on both sides of the bearing prevent grease leakage, and foreign matter is prevented from entering the bearing from outside.

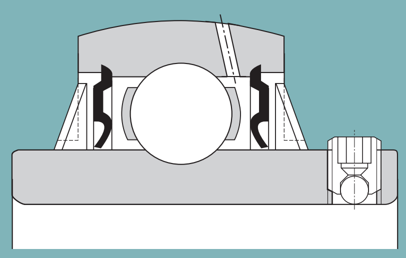


Fig. 2.1

2.3.2 Bearing units with covers

The **NTN** bearing unit with a cover consists of a standard bearing unit and an outside covering for extra protection against dust. Special consideration has been given to its design with respect to dust-proofing.

Sealing devices are provided in both the bearing and the housing, so that units of this type operate satisfactorily even in such adverse environments as flour mills, steel mills, foundries, galvanizing plants and chemical plants, where excessive dust is produced and/or liquids are used. They are also eminently suitable for outdoor environments where dust and rain are inevitable, and in heavy industrial machinery such as construction and transportation equipment.

The rubber seal of the cover contacts with the shaft by its two lips, as shown in **Fig. 2.2** and **2.3**. By filling the groove between the two lips with grease, an excellent sealing effect is obtained and, at the same time, the contacting portions of the lips are lubricated. Furthermore, the groove is so designed that when the shaft is inclined the rubber seal can move in the radial direction.

When bearing units are exposed to splashes of water rather than to dust, a drain hole (5 to 8 mm, 0.2 to 0.3 inches in diameter) is provided at the bottom of the cover, and grease should be applied to the side of the bearing itself instead of into the cover.

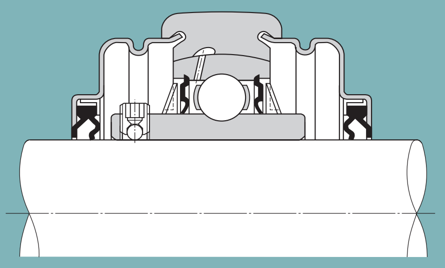


Fig. 2.2 Pressed steel cover

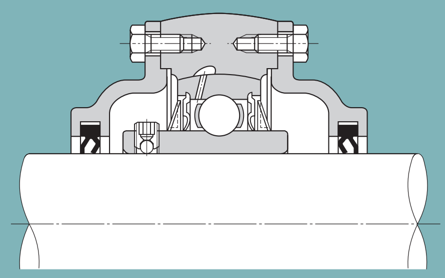


Fig. 2.3 Cast iron cover

2.4 Secure fitting

Fastening the bearing to the shaft is effected by tightening the ball-end set screw, situated on the inner ring. This is a unique **NTN** feature which prevents loosening, even if the bearing is subjected to intense vibrations and shocks.

2.5 Self-aligning

With the **NTN** bearing unit, the outer surface of the ball bearing and the inner surface of the housing are spherical, thus this bearing unit has self-aligning characteristic. Any misalignment of axis that may arise from poor workmanship on the shaft or errors in fitting will be properly adjusted.

2.6 Higher rated load capacity

The bearing used in the unit is of the same internal construction as those in **NTN** bearing series 62 and 63, and is capable of accommodating axial load as well as radial load, or composite load. The rated load capacity of this bearing is considerably higher than that of the corresponding self-aligning ball bearings used for standard plummer blocks.

2.7 Light weight yet strong housing

Housings for **NTN** bearing units come in various shapes. They consist of either high-grade cast iron, one-piece casting, or of precision finished pressed steel, the latter being lighter in weight. In either case, they are practically designed to combine lightness with maximum strength.

2.8 Easy mounting

The **NTN** bearing unit is an integrated unit consisting of a bearing and a housing.

As the bearing is prelubricated at manufacture with the correct amount of high-grade lithium base, it can be mounted on the shaft just as it is. It is sufficient to carry out a short test run after mounting.

2.9 Accurate fitting of the housing

In order to simplify the fitting of the pillow block and flange type bearing units, the housings are provided with a seat for a dowel pin, which may be utilized as needed.

2.10 Bearing replaceability

The bearing used in the **NTN** bearing unit is replaceable. In the event of bearing failure, a new bearing can be fitted to the existing housing.

3. Material

3.1 Raceway and rolling element materials

Materials with high hardness and appropriate toughness are used for the inner rings, outer rings and balls of the insert bearings since large compression forces and repetitive stresses are applied to a small contact. In general Cold-rolled steel is used for the cages. For special applications, stainless steel is also available for use in the insert bearings.

3.2 Housing materials

The most common materials used in **NTN** bearing unit housings are cast iron or steel plate, with cast iron being the standard.

For special applications, materials such as spheroidal graphite iron, structural steel, stainless steel cast iron or plastic resin are also available for use in the housings. The chemical resistance properties of glass-fiber reinforced resin are shown in **Table 3.5**.

3.2.1 Cast iron housing

NTN uses gray cast iron as the standard material for cast iron housings.

Among metallic materials cast iron has a high damping capacity, which is an ideal characteristic for mechanical components. This means cast iron, exhibits superior performance when absorbing vibration, compared with other materials. Additionally cast iron is suitable for high temperatures of up to 300C˚.

3.2.2 Steel plate housing

Cold-rolled steel sheet or hot-rolled mild steel sheet is used for steel plate housings.

Table 3.1 JIS G 5501 Mechanical properties of gray iron product

Code of material	Mechanical properties of separately casted test piece material	
	Tensile strength N/mm^2	Brinell hardness HB
FC200	Min. 200	Max. 232

Table 3.2 JIS G 5502 Mechanical properties of nodular graphite cast iron

Code of material	Mechanical properties of separately casted test piece material			
	Tensile strength N/mm^2	0.2% Proof stress N/mm^2	Elongation %	(Reference) Hardness HB
FCD450-10	Min. 450	Min. 280	Min. 10	140 - 210

Table 3.3 JIS G 3101 Mechanical properties of general structural rolled steel

Code of material	Mechanical properties			
	Steel thickness mm	Yield point or Proof stress N/mm^2	Tensile strength N/mm^2	Elongation % Test piece in ( )
SS400	Over 16 Incl. 40	Min. 235	400 - 510	21 (No. 1A)
	Over 40 Incl. 100	Min. 215		23 (No. 4)
	Over 100	Min. 205		

Table 3.4 JIS G 5152 Mechanical properties of stainless cast steel product

Code of material	Mechanical properties of separately casted test piece material			
	Tensile strength N/mm^2	0.2% Proof stress N/mm^2	Elongation %	Hardness HB
SCS13	Min. 440	Min. 185	Min. 30	Max. 183

Table 3.5 Water and chemical resistance of glass fiber reinforcing resin housing (PBT)

	Chemicals	Temperature ℃	Deterioration ratio[1] % Number of days soaked 30 days	90 days		Chemicals	Temperature ℃	Deterioration ratio[1] % Number of days soaked 30 days	90 days
Acid	Hydrochloric acid, 10%	23	89	85	Organic solven	Ethyl alcohol	23	99	96
	Sulfuric acid, 36%	23	97	97		Methyl alcohol	23	91	82
		60	84	60		Isopropyl alcohol	23	100	100
	Acetic acid 10%	23	88	88		Acetone	23	86	74
Alkaline	Potassium hydroacid, 5%	23	88	10		Methyl Ethyl Keton	23	90	80
	Sodium hydroacid, 10%	23	※	※		Ethyl acetate	23	96	86
	Ammonia hydroacid, 10%	23	96	87		Methylene chloride	23	54	54
Oil	Motor oil	23	100	100		ethylene grycole	23	100	100
	Brake oil	23	100	100	Sodium	Zinc chrolide 10%	23	97	94
	Gasoline (Regular)	23	100	100		Calcium chrolide 10%	23	98	98
		60	93	90		Sodium chrolide 5%	23	97	97

Remarks 1) Deterioration (%) is the strength after test divided by the strength before test.
The ※ symbol indicates that results could not be measured as the test piece dissolved.
Remarks 2) The values listed in the table are not guaranteed as they are the result of soaking without operating stresses on the sample. Because this strength data is general, it does not apply under all operating conditions. Actual housing strength will vary depending on the type and concentration of liquid, temperature, load, etc.

Table 3.6 Anti-Corrosion capability

NTN recommends ratings of ◎ to ○ for optimum corrosion resistance.

◎ ○ △ ▲ ×
excellent ←——→ poor

Materials \ Condition	Atmosphere: Dry	Atmosphere: Wet	Water: Natural water	Water: Sodium water	Acid: Nitric acid	Acid: Sulfuric acid	Acid: Hydrochloric acid
Martensite stainless steel SUS440C, SUS410	○	△	△	▲	▲	×	×
Austenite stainless steel SUS304, SCS13	◎	◎	◎	○	◎	○	△
Polyester plastics	◎	◎	◎	◎	▲	○	○
Polypropylene, polyethylene	◎	◎	◎	◎	○	○	○
High carbon steel SUJ2	△	▲	▲	×	×	×	×
Carbon steel, Cast iron	▲	×	×	×	×	×	×

Remarks: This data is obtained by observation of the surface conditions of materials.
Note that these anti-corrosion capabilities are altered by anti-corrosion surface treatment.
Not recommended for use in liquid.

4. Bearing unit part numbering

4.1 Bearing unit part numbering

NTN Bearing unit part numbers are in accordance with the Japanese Industrial Standard JIS. The code for the bearing type, housing type, diameter series and bore diameter are expressed from left to right within the part number.

Example 1

UC P 2 05

- Bore diameter code
- Diameter series
- Housing type code
- Bearing type code

Example 2

S - UK F 2 05 ; H2305X

- Adapter number code for unit
- Bore diameter code
- Diameter series
- Housing type code
- Bearing type code
- Cover code

4.2 Insert bearing part numbering

The part number for the insert bearing matches the part number for the bearing unit.

Example

UC 2 05 D1

- Supplementary code
- Bore diameter code
- Diameter series
- Bearing type code

Each bearing unit can take any number of different ball bearing inserts. The available insert types are shown in Fig. 4.3(1)-4.3(9).

4.3 Housing part numbering

Housing part numbers are expressed by the housing type code, the bearing outer diameter series code and the bore diameter codes of the insert bearing that would be used for the unit.

The available housings are shown in Table 4.3(1)-4.3(9).

Example

P 2 05 D1

- Supplementary code
- Bore diameter code
- Diameter series
- Housing type code

4.4 Supplemental codes

Typical supplementary codes added after the Bearing unit part number are shown below.

Table 4.1 Supplementary code in front of basic designation

Item	Supplementary code	Content
Cover	5	Inner diameter of cover : 5mm lager than bearing bore
	10	Inner diameter of cover : 10mm lager than bearing bore
	15	Inner diameter of cover : 15mm lager than bearing bore
	15	Inner diameter of cover : 20mm lager than bearing bore

Table 4.2 Examples of supplementary codes

Item	Supplementary code	Content
Housing	F	No recess in bottom, nor mounting bolt holes
	F1	No recess in bottom, but mounting bolt holes
	F2	No mounting bolt holes
	F7	No recess on the mounting bolt holes, but mounting bolt holes
For heat resistance and cold resistance	HT2	Heat resistance
	CT1	Cold resistance
Housing material	N1	Spheroidal graphite cast iron (FCD450)
Lubrication method	No code	Maintenance free type
	D1	Relubricatable type
Bearing seal	No code	Standard nitrile rubber seal
	U	Non-contact shield plate
	LLJ	Triple lip seal
Set screw	No code	Ball end set screw (Except for stainless bearing)
	W3	Cup point
	W4	Double point
	W5	Round head dog point set screw (With one piece)
	W6	Round head key bolt (With one piece)

Example 1

UC P 2 05 D1 LLJ

- Bearing seal code
- Relubricatable type
- Bore diameter code
- Diameter series
- Housing type code
- Bearing type code

Example 2

UC F 2 05 HT2 D1 W5

- Bearing set screw code
- Relubricatable type
- Heat resistance code
- Bore diameter code
- Diameter series
- Housing type code
- Bearing type code

Bearing specifications for heat resistance and cold resistance are shown on **Table 4.3**.

Table 4.3 Bearing specifications for heat resistance and cold resistance

Item	Code	Operating range (˚C)	Grease	Bearing seal	Bearing clearance
Heat resistance	HT2	Room temp. ～180˚C	Li soap＋ Silicone oil	Non-contact shield plate	C4
Cold resistance	CT1	－50˚C ～Room temp.	Li soap＋ Silicone oil	Non-contact shield plate	CN

Table 4.4 Recommended specifications (Frequent use conditions, except for general)

Operating condition	Bearing	Housing	Cover	Notes
Heat resistance (more than 100˚C)	Heat resistance bearing (Code : HT2)	—	— (It is possible to mount the cover, if necessary)	Refer to **table 9.1** for grease.
Cold resistance (less than -15˚C)	Cold resistance bearing (Code : CT1)			
Corrosion resistance	Stainless	Stainless		Refer to P7～P8 about detail.
	Stainless	Resin		
Light-load	—	Steel plate		Refer to P14～P15 for material characteristics.
Heavy-load		Ductile cast iron		
Impact and heavy load		Rolled steel		
The measures to prevent contamination (The specification depends on the surrounding environment)	Triple lip seal (Please refer P10)	—	Cast iron cover	—
			Steel plate cover	

※There are specifications expecting above table. For further details, consult **NTN**.

4.5 Special specifications

Following special specifications are supported individually and are not standard specification. For further details, consult **NTN.**

4.5.1 High temperature

The standard heat resistance bearing (Code:HT2) can be used up to MAX. 180˚C and up to **NTN**. 200˚C with special grease. In addition, NTN has a special heat resistance bearing for MAX. 250˚C. For further details, consult **NTN.**

4.5.2 Surface treatment

In order to improve rust preventive, **NTN** has also designed special corrosion resistant bearing unit features. In addition, **NTN** can paint housings with various colors and paints. For further details, consult **NTN.**

4.5.3 Special parts

(1) Parts

NTN can also supply special grease fittings outside of the standard grease fitting offering. Please refer to P44. In addition, **NTN** has grease fittings with tapered pipe thread for centralized lubrication. Please refer to the attached table (P529).

(2) Plug

If the application does not require the relubrication feature on the housing, the customer can use a plug, **NTN** can supply housing plugs in resin or steel materials. Please refer to the attached table (P529).

(3) Parts for higher seal performance.

NTN has designed seals that achieve a higher sealing performance. For example, the rotary shaft lip-type seal, the packing and so on.

4.5.4 Grease

NTN can change the grease to something other than standard to meet application and environmental conditions upon special request. Please refer to **Table 9.1**.

Table 4.5 (1) Cast iron pillow block type units

Housing Type Material : Cast Iron	Cover	Bearing Type: UC	UEL / REL	UK	AS / AR	AEL / JEL	CS
Pillow Block	–	UCP	UELP RELP	UKP	ASP ARP	AELP JELP	–
	Steel	S(M)-UCP	–	S(M)-UKP	S(M)-ASP S(M)-ARP	–	–
	Cast Iron	C(M)-UCP	–	C(M)-UKP	C(M)-ASP C(M)-ARP	–	–
Thick Pillow Block	–	UCIP	UELIP RELIP	UKIP	–	–	–
	Steel	S(M)-UCIP	–	S(M)-UKIP	–	–	–
	Cast Iron	C(M)-UCIP	–	C(M)-UKIP	–	–	–
High-Center Pillow Block	–	UCHP	UELHP RELHP	UKHP	ASHP ARHP	AELHP JELHP	–
	Steel	S(M)-UCHP	–	S(M)-UKHP	S(M)-ASHP S(M)-ARHP	–	–
Narrow Pillow Block	–	UCUP	UELUP RELUP	UKUP	ASUP ARUP	AELUP JELUP	–
	Steel	S(M)-UCUP	–	S(M)-UKUP	S(M)-ASUP S(M)-ARUP	–	–
Light Pillow Block	–	–	–	–	ASPB ARPB	AELPB JELPB	CSPB
Pillow Block Low-Center	–	UCPL	UELPL RELPL	UKPL	ASPL ARPL	AELPL JELPL	–

Remarks 1. The codes "S-" and "C-" at the head of the type codes indicate steel plate covered bearing units and cast iron covered bearing units, respectively.
2. Single-sided closed covered bearing units made of steel and cast iron are also available. These bearing units are identified with the codes "SM-"(steel plate) and "CM-"(cast iron) at the head of the type codes, respectively.
3. "UC" type stainless steel bearings are also available. For further details, consult **NTN** (Stainless Series Bearing unit)

Table 4.5 (2) Cast iron flange type units

Housing Type Material : Cast Iron		Cover	Bearing Type					
			UC	UEL REL	UK	AS AR	AEL JEL	CS
Square Flange		–	UCF	UELF RELF	UKF	ASF ARF	AELF JELF	–
		Steel	S(M)-UCF	–	S(M)-UKF	S(M)-ASF S(M)-ARF	–	–
		Cast Iron	C(M)-UCF	–	C(M)-UKF	C(M)-ASF C(M)-ARF	–	–
Square Flange W/Spigot Joint		–	UCFS	UELFS	UKFS	–	–	–
		Cast Iron	C(M)-UCFS	–	C(M)-UKFS	–	–	–
Round Flange W/Spigot Joint		–	UCFC	UELFC RELFC	UKFC	ASFC ARFC	AELFC JELFC	–
		Steel	S(M)-UCFC	–	S(M)-UKFC	S(M)-ASFC S(M)-ARFC	–	–
		Cast Iron	C(M)-UCFC	–	C(M)-UKFC	C(M)-ASFC C(M)-ARFC	–	–
Rhombus Flange		–	UCFL	UELFL RELFL	UKFL	ASFL ARFL	AELFL JELFL	–
		Steel	S(M)-UCFL	–	S(M)-UKFL	S(M)-ASFL S(M)-ARFL	–	–
		Cast Iron	C(M)-UCFL	–	C(M)-UKFL	C(M)-ASFL C(M)-ARFL	–	–
Square Flange		–	UCFU	UELFU RELFU	UKFU	ASFU ARFU	AELFU JELFU	–
Rhombus Flange		–	UCFLU	UELFLU RELFLU	UKFLU	ASFLU ARFLU	AELFLU JELFLU	–
Modified Rhombus Flange		–	UCFA	UELFA RELFA	UKFA	ASFA ARFA	AELFA JELFA	–
		Steel	S(M)-UCFA	–	S(M)-UKFA	S(M)-ASFA S(M)-ARFA	–	–
Light Rhombus Flange		–	–	–	–	ASFB ARFB	AELFB JELFB	CSFB
Light Rhombus Flange		–	–	–	–	ASFD ARFD	AELFD JELFD	–
Modified Flange		–	UCFH	UELFH RELFH	UKFH	ASFH ARFH	AELFH JELFH	–

Remarks 1. The codes "S-" and "C-" at the head of the type codes indicate steel plate covered bearing units and cast iron covered bearing units, respectively.
2. Single-sided closed covered bearing units made of steel and cast iron are also available.
These bearing units are identified with the codes "SM-"(steel plate) and "CM-"(cast iron) at the head of the type codes, respectively.
3. "UC" type stainless steel bearings are also available. For further details, consult **NTN** (Stainless Series Bearing unit)

Table 4.5 (3) Other cast iron units

Housing Type Material : Cast Iron		Cover	Bearing Type					
			UC	UEL REL	UK	AS AR	AEL JEL	CS
Take-up		–	UCT	UELT RELT	UKT	AST ART	AELT JELT	–
		Steel	S(M)-UCT	–	S(M)-UKT	S(M)-AST S(M)-ART	–	–
		Cast Iron	C(M)-UCT	–	C(M)-UKT	C(M)-AST C(M)-ART	–	–
Cartridge		–	UCC	UELC RELC	UKC	ASC ARC	AELC JELC	–
Hanger		–	UCHB	UELHB RELHB	UKHB	ASHB ARHB	AELHB JELHB	–

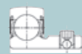
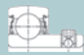
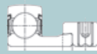
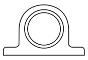
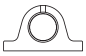
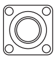
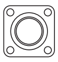
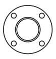
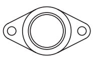
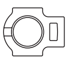
Remarks 1. The codes "S-" and "C-" at the head of the type codes indicate steel plate covered bearing units and cast iron covered bearing units, respectively.
2. Single-sided closed covered bearing units made of steel and cast iron are also available.
These bearing units are identified with the codes "SM-"(steel plate) and "CM-"(cast iron) at the head of the type codes, respectively.
3. "UC" type stainless steel bearings are also available. For further details, consult **NTN** (Stainless Series Bearing unit)

Table 4.5 (4) Bearing units with ductile cast iron housing (Ductile series)

Housing Type Material : Spheroidal Graphite Cast Iron		Cover	Bearing Type					
			UC	UEL REL	UK	AS AR	AEL JEL	CS
Pillow Block		–	UCPE	UELPE RELPE	UKPE	ASPE ARPE	AELPE JELPE	–
Rhombus Flange		–	UCFE	UELFE RELFE	UKFE	ASFE ARFE	AELFE JELFE	–

Remarks 1. "UC" type stainless steel bearings are also available. For further details, consult **NTN** (Stainless Series Bearing unit).

Table 4.5 (5) Bearing units steel series

Housing Type Material : General Structural Rolled Steel		Cover	Bearing Type					
			 UC	 UEL  REL	 UK	 AS  AR	 AEL  JEL	 CS
Pillow Block		–	UCPG	UELPG RELPG	UKPG	ASPG ARPG	AELPG JELPG	–
		Steel	S(M)-UCPG	–	S(M)-UKPG	S(M)-ASPG S(M)-ARPG	–	–
		Cast Iron	C(M)-UCPG	–	C(M)-UKPG	C(M)-ASPG C(M)-ARPG	–	–
Thick Pillow Block		–	UCIPG	UELIPG RELIPG	UKIPG	–	–	–
		Steel	S(M)-UCIPG	–	S(M)-UKIPG	–	–	–
		Cast Iron	C(M)-UCIPG	–	C(M)-UKIPG	–	–	–
Square Flange		–	UCFG	UELFG RELFG	UKFG	ASFG ARFG	AELFG JELFG	–
		Steel	S(M)-UCFG	–	S(M)-UKFG	S(M)-ASFG S(M)-ARFG	–	–
		Cast Iron	C(M)-UCFG	–	C(M)-UKFG	C(M)-ASFG C(M)-ARFG	–	–
Square Flange W/Spigot Joint		–	UCFSG	UELFSG	UKFSG	–	–	–
		Cast Iron	C(M)-UCFSG	–	C(M)-UKFSG	–	–	–
Round Flange W/Spigot Joint		–	UCFCG	UELFCG RELFCG	UKFCG	ASFCG ARFCG	AELFCG JELFCG	–
		Steel	S(M)-UCFCG	–	S(M)-UKFCG	S(M)-ASFCG S(M)-ARFCG	–	–
		Cast Iron	C(M)-UCFCG	–	C(M)-UKFCG	C(M)-ASFCG C(M)-ARFCG	–	–
Rhombus Flange		–	UCFLG	UELFLG RELFLG	UKFLG	ASFLG ARFLG	AELFLG JELFLG	–
		Steel	S(M)-UCFLG	–	S(M)-UKFLG	S(M)-ASFLG S(M)-ARFLG	–	–
		Cast Iron	C(M)-UCFLG	–	C(M)-UKFLG	C(M)-ASFLG C(M)-ARFLG	–	–
Take-up		–	UCTG	UELTG RELTG	UKTG	ASTG ARTG	AELTG JELTG	–
		Steel	S(M)-UCTG	–	S(M)-UKTG	S(M)-ASTG S(M)-ARTG	–	–
		Cast Iron	C(M)-UCTG	–	C(M)-UKTG	C(M)-ASTG C(M)-ARTG	–	–

Remarks 1. The codes "S-" and "C-" at the head of the type codes indicate steel plate covered bearing units and cast iron covered bearing units, respectively.
2. Single-sided closed covered bearing units made of steel and cast iron are also available.
3. "UC" type stainless steel bearings are also available. For further details, consult **NTN** (Stainless Series Bearing unit)

Table 4.5 (6) Bearing units stainless series

Housing Type Material : Stainless Steel	Cover	UC	UEL / REL	UK	AS / AR	AEL / JEL	CS
Pillow Block	—	F-UCPM	—	—	—	—	—
	Stainless steel	F-FS(M)-UCPM					
Rhombus Flange	—	F-UCFM	—	—	—	—	—
	Stainless steel	F-FS(M)-UCFM					

Table 4.5 (7) Bearing units plastic housing series

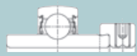
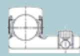
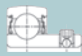
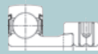
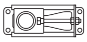
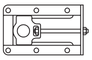
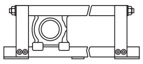
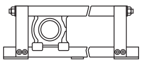
Housing Type Material : Glass Fiber Reinforcing Resin	Cover	UC	UEL / REL	UK	AS / AR	AEL / JEL	CS
Pillow Block	—	F-UCPR	—	—	—	—	—
	Resin	F-RM-UCPR	—	—	—	—	—
Rhombus Flange	—	F-UCFLR	—	—	—	—	—
	Resin	F-RM-UCFLR	—	—	—	—	—

Remarks 1.The code "RM-" at the head of the type codes indicates single-side closed resin covered unit.

Table 4.5 (8) Steel plate units

Housing Type Material : Steel Plate	Cover	UC	UEL / REL	UK	AS / AR	AEL / JEL	CS
Pillow Block	—	—	—	—	ASPP	AELPP	CSPP
Pillow Block W/Rubber Ring	—	—	—	—	ASRPP	AELRPP	CSRPP
Round Flange	—	—	—	—	ASPF	AELPF	CSPF
Round Flange W/Rubber Ring	—	—	—	—	ASRPF	AELRPF	CSRPF
Rhombus Flange	—	—	—	—	ASPFL	AELPFL	CSPFL
Rhombus Flange W/Rubber Ring	—	—	—	—	ASRPFL	AELRPFL	CSRPFL

Table 4.5 (9) Stretcher units

		Cover	Bearing Type				
			 UC	 UEL  REL	 UK	 AS  AR	 AEL  JEL
Mini Type		—	—	—	—	ASPT	AELPT
Angle Steel Frame Type		—	UCT-00	UELT-00 RELT-00	UKT-00	AST-00 ART-00	AELT-00 JELT-00
		Steel	S(M)-UCT-00	—	S(M)-UKT-00	S(M)-AST-00 S(M)-ART-00	—
		Cast Iron	C(M)-UCT-00	—	C(M)-UKT-00	C(M)-AST-00 C(M)-ART-00	—
Light Channel Steel Frame Type		—	UCL-00	UELL-00 RELL-00	UKL-00	ASL-00 ARL-00	AELL-00 JELL-00
		Steel	S(M)-UCL-00	—	S(M)-UKL-00	S(M)-ASL-00 S(M)-ARL-00	—
		Cast Iron	C(M)-UCL-00	—	C(M)-UKL-00	C(M)-ASL-00 C(M)-ARL-00	—
Channel Steel Frame Type		—	UCM-00	UELM-00 RELM-00	UKM-00	ASM-00 ARM-00	AELM-00 JELM-00
		Steel	S(M)-UCM-00	—	S(M)-UKM-00	S(M)-ASM-00 S(M)-ARM-00	—
		Cast Iron	C(M)-UCM-00	—	C(M)-UKM-00	C(M)-ASM-00 C(M)-ARM-00	—

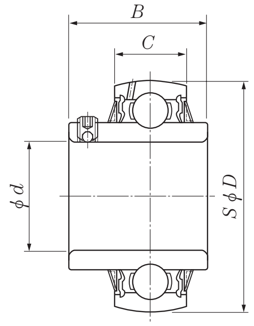
Remarks 1. The codes "S-" and "C-" at the head of the type codes indicate steel plate covered bearing units and cast iron covered bearing units, respectively.
2. Single-sided closed covered bearing units made of steel and cast iron are also available.
These bearing units are identified with the codes "SM-"(steel plate) and "CM-"(cast iron) at the head of the type codes, respectively.
3. "UC" type stainless steel bearings are also available. For further details, consult **NTN** (Stainless Series Bearing unit)

5. Tolerance

The tolerances of the **NTN** bearing units are in accordance with the following JIS specifications : JIS B 1558. 1559.

5.1 Tolerances of ball bearings for the unit

The tolerances of ball bearings used in the unit are shown in the following tables, 5.1 to 5.4.



Set screw type

Table 5.1 (1) Cylindrical bore (UC, UCS, AS, ASS, UEL, UELS, AEL, AELS) Unit: μm/0.0001 inch

Nominal bore diameter d				Cylindrical bore					Radial runout K_{ia} (reference)
				Bore diameter			Width		
over		incl.		dmp Deviations		V_{dp} Variations	B_s, C_s Deviations (reference)		
mm	inch	mm	inch	high	low	max.	high	low	(max)
10	0.3937	18	0.7087	+15 + 6	0 0	10 4	0 0	−120 − 47	15 6
18	0.7087	31.750	1.2500	+18 + 7	0 0	12 5	0 0	−120 − 47	18 7
31.750	1.2500	50.800	2.0000	+21 + 8	0 0	14 6	0 0	−120 − 47	20 8
50.800	2.0000	80	3.1496	+24 + 9	0 0	16 6	0 0	−150 − 59	25 10
80	3.1496	120	4.7244	+28 +11	0 0	19 7	0 0	−200 − 79	30 12
120	4.7244	180	7.0866	+33 +13	0 0	22 9	0 0	−250 − 98	35 14

Note: Symbols
dmp: Mean bore diameter deviation V_{dp}: Bore diameter variation
B_s: Inner ring width deviation
C_s: Outer ring width deviation

Table 5.1 (2) Cylindrical bore (AR, ARS, JEL, JELS, REL, RELS) Unit: μm/0.0001 inch

Nominal bore diameter d				Cylindrical bore					Radial runout K_{ia} (reference)
				Bore diameter			Width		
over		incl.		dmp Deviations		V_{dp} Variations	B_s, C_s Deviations (reference)		
mm	inch	mm	inch	high	low	max.	high	low	(max)
10	0.3937	18	0.7087	+13 + 5	0 0	6 2	0 0	−120 − 47	15 6
18	0.7087	31.750	1.2500	+13 + 5	0 0	6 2	0 0	−120 − 47	18 7
31.750	1.2500	50.800	2.0000	+13 + 5	0 0	6 2	0 0	−120 − 47	20 8
50.800	2.0000	80	3.1496	+15 + 6	0 0	8 3	0 0	−150 − 59	25 10

Table 5.1 (3) Cylindrical bore (CS) Unit: μm/0.0001 inch

Nominal bore diameter d				Cylindrical bore					Radial runout K_{ia}
				Bore diameter			Width		
over		incl.		dmp Deviations		V_{dp} Variations	B_s, C_s Deviations (reference)		(reference)
mm	inch	mm	inch	high	low	max.	high	low	max.
10	0.3937	18	0.7087	0 0	−8 −3	10 4	0 0	−120 −47	15 6
18	0.7087	31.75	1.2500	0 0	−10 −4	12 5	0 0	−120 −47	18 7
31.75	1.2500	50.8	2.0000	0 0	−12 −5	14 6	0 0	−120 −47	20 8
50.8	2.0000	80	3.1496	0 0	−15 −6	16 6	0 0	−150 −59	25 10

Table 5.2 Tapered bore (UK, UKS) Unit: μm/0.0001 inch

Nominal bore diameter d				dmp Deviations		$d_{1mp} - dmp$		V_{dp}[1)]
over		incl.						
mm	inch	mm	inch	high	low	high	low	max.
18	0.7087	30	1.1811	+33 +13	0 0	+21 +8	0 0	13 5
30	1.1811	50	1.9685	+39 +15	0 0	+25 +10	0 0	16 6
50	1.9685	80	3.1496	+46 +18	0 0	+30 +12	0 0	19 7
80	3.1496	120	4.7244	+54 +21	0 0	+35 +14	0 0	22 9
120	4.7244	180	7.0866	+63 +25	0 0	+40 +16	0 0	40 16

1) Applies to all radial flat planes of inner ring tapered bore.
Note: 1. To be applied for tapered bore of 1/12.
2. Symbols of quantity or values

d_1: Basic diameter at the theoretical large end of the tapered bore
$d_1 = d + \frac{1}{12}B$

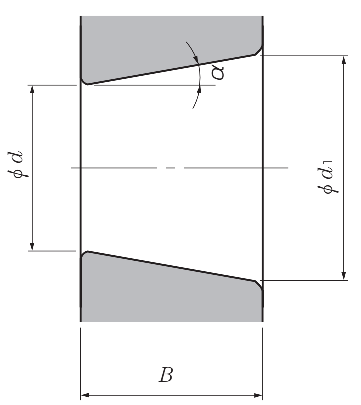
dmp: Dimensional difference of the average bore diameter within the flat surface at the theoretical small-end of the tapered bore

d_{1mp}: Dimensional difference of the average bore diameter within the flat surface at the theoretical large-end of the tapered bore

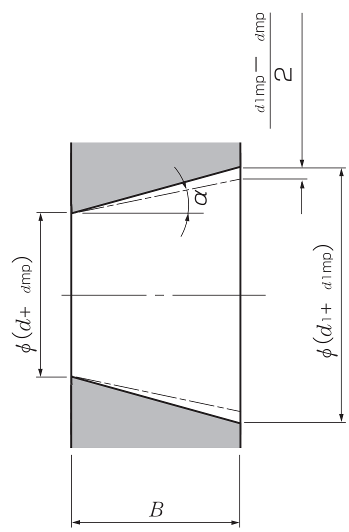
V_{dp}: Unevenness of the bore diameter with the flat surface

B : Nominal width of inner ring

α : Half of the tapered bore's nominal taper angle
α =2°23'9.4"
=2.385 94°
=0.041 643rad



Theoretical tapered bore

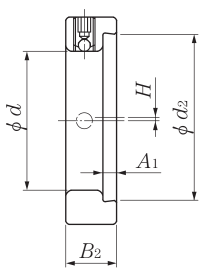


Tapered bore having dimensional difference of the average bore diameter within the flat surface

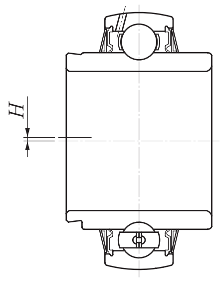
Table 5.3 Outer ring Unit: μm/0.0001 inch

Nominal outside diameter D				Mean outside diameter deviation Δ_{Dm}		Radial runout K_{ea} (reference)
over		incl.				
mm	inch	mm	inch	high	low	max.
18	0.7087	30	1.1811	0 0	− 9 − 4	15 6
30	1.1811	50	1.9685	0 0	−11 − 4	20 8
50	1.9685	80	3.1496	0 0	−13 − 5	25 10
80	3.1496	120	4.7244	0 0	−15 − 6	35 14
120	4.7244	150	5.9055	0 0	−18 − 7	40 16
150	5.9055	180	7.0866	0 0	−25 −10	45 18
180	7.0866	250	9.8425	0 0	−30 −12	50 20
250	9.8425	315	12.4016	0 0	−35 −14	60 24

Note: 1) The low deviation of outside diameter Δ_{Dm} does not apply within the distance of 1/4 the width of the outer ring from the side.



Eccentric locking collar



Eccentric locking collar type

Table 5.4 Eccentric locking collar Unit: mm/inch

Nominal bore diameter d				Bore diameter deviation Δ_{ds}		Small bore diameter of eccentric surface deviation Δ_{d2s}		Eccentricity deviation Δ_{Hs}		Collar width deviation Δ_{B2s}		Collar eccentric surface width deviation Δ_{A1s}	
over		incl.											
mm	inch	mm	inch	high	low	high	low	high	low	high	low	high	low
10	0.3937	36.512	1.4375	+0.250 +0.010	+0.025 +0.001	+0.3 +0.012	0 0	+0.1 +0.004	−0.1 −0.004	+0.270 +0.011	−0.270 −0.011	0 0	−0.180 −0.007
36.512	1.4375	55.562	2.1875	+0.300 +0.012	+0.025 +0.001	+0.4 +0.016	0 0	+0.1 +0.004	−0.1 −0.004	+0.330 +0.013	−0.330 −0.013	0 0	−0.180 −0.007
55.562	2.1875	61.912	2.4375	+0.300 +0.012	+0.025 +0.001	+0.4 +0.016	0 0	+0.1 +0.004	−0.1 −0.004	+0.330 +0.013	−0.330 −0.013	0 0	−0.220 −0.009

5.2 Tolerances of housings

Table 5.5 Spherical bore diameter of housings

Unit: μm/0.0001 inch

Nominal spherical bore diameter D_a				D_a Deviations Δ_{Dam}					
over		incl.		Tolerance class H7		Tolerance class J7		Tolerance class K7	
mm	inch	mm	inch	high	low	high	low	high	low
30	1.1811	50	1.9685	+25 +10	0 0	+14 + 6	−11 − 4	+ 7 + 3	−18 − 7
50	1.9685	80	3.1496	+30 +12	0 0	+18 + 7	−12 − 5	+ 9 + 4	−21 − 8
80	3.1496	120	4.7244	+35 +14	0 0	+22 + 9	−13 − 5	−	−
120	4.7244	180	7.0866	+40 +16	0 0	+26 +10	−14 − 6	−	−
180	7.0866	250	9.8425	+46 +18	0 0	+30 +12	−16 − 6	−	−
250	9.8425	315	12.4016	+52 +20	0 0	+36 +14	−16 − 6	−	−

Note: 1) Symbols Δ_{Dam}: Mean spherical bore diameter deviation
2) Dimensional tolerances for spherical bore diameter of housing are classified as H7 for clearance fit, and J7 for intermediate fit.
3) The housing bore diameter for a spherical OD bearing insert would use the following fit;
Housing bore diameter ≦ 52mm : K7 fit
52mm < Housing bore diameter ≦180mm : J7 fit
Housing bore diameter > 180mm : H7 fit

Table 5.6 (1) Pillow block housings

Unit: mm/inch

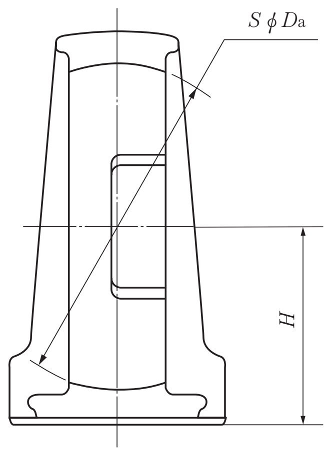
Housing numbers			H Deviations Δ_{Hs}
P, IP, HP, UP PB, PM, PL PE, PG, IPG	P, IP PG, IPG	P	
201 203 204 205 206 207 208 209 210	− − − 305 306 307 308 309 310	− − − X05 X06 X07 X08 X09 X10	±0.15 ±0.006
211 212 213 214 215 216 217 218	311 312 313 314 315 316 317 318	X11 X12 X13 X14 X15 X16 X17 X18	±0.2 ±0.008
− − − − − − −	319 320 321 322 324 326 328	− X20 − − − − −	±0.3 ±0.012

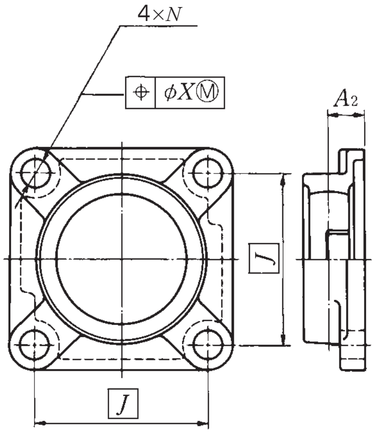
Note: 1) H is height of the shaft center line.
2) This table can be applied for bearing units with dust covers.

Table 5.6 (2) Pillow block resin housings

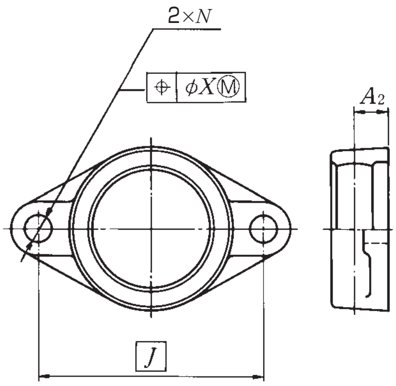
Unit: mm/inch

Housing numbers	H Deviations Δ_{Hs}
PR204 PR205 PR206 PR207 PR208	±0.25 ±0.010

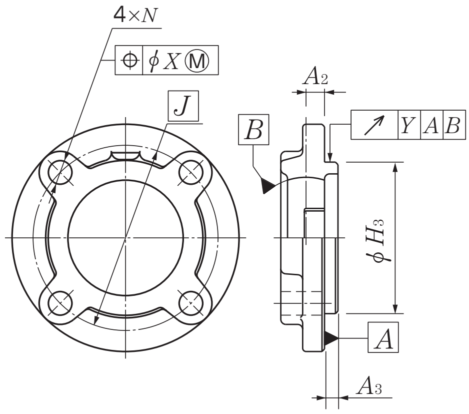




(F, FU, FS, FG, FSG)



(FL, FLU, FB, FM, FD, FLG)



(FC, FCG)

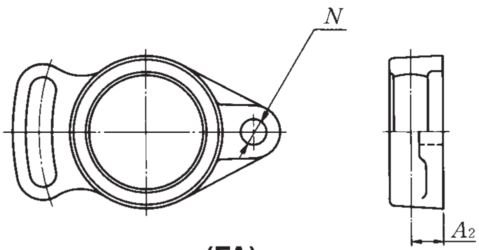
Table 5.7 (1) Flange unit housings Unit: mm/inch

<table>
<tr><th colspan="3">Housing numbers</th><th rowspan="3">Location tolerance of bolt hole</th><th rowspan="3">A_2 Deviations A_{2s}</th><th colspan="6">H_3 Deviations</th><th rowspan="3">Radial runout of spigot joint is (max.)</th><th colspan="2" rowspan="2">A_3 Deviations</th></tr>
<tr><th rowspan="2">F, FU, FC
FL, FLU
FB, FM, FD
FG, FCG, FLG</th><th rowspan="2">F, FL, FS
FG, FLG
FSG</th><th rowspan="2">F, FC, FL</th><th colspan="2">FC2, FCG2</th><th colspan="2">FS3, FSG3</th><th colspan="2">FCX</th></tr>
<tr><th>high</th><th>low</th><th>high</th><th>low</th><th>high</th><th>low</th><th>high</th><th>low</th></tr>
<tr><td>201</td><td>–</td><td>–</td><td rowspan="8">0.7
0.028</td><td rowspan="8">±0.5
±0.020</td><td rowspan="4">0
0</td><td rowspan="4">-0.046
-0.0018</td><td rowspan="2">—</td><td rowspan="2">—</td><td rowspan="2">—</td><td rowspan="2">—</td><td rowspan="8">0.2
0.008</td><td rowspan="8">0
0</td><td rowspan="8">-0.6
-0.024</td></tr>
<tr><td>204</td><td>–</td><td>–</td></tr>
<tr><td>205</td><td>305</td><td>X05</td><td>0
0</td><td>-0.046
-0.0018</td><td>0
0</td><td>-0.046
-0.0018</td></tr>
<tr><td>206</td><td>306</td><td>X06</td><td rowspan="3">0
0</td><td rowspan="3">-0.054
-0.0021</td><td rowspan="5">0
0</td><td rowspan="5">-0.054
-0.0021</td></tr>
<tr><td>207</td><td>307</td><td>X07</td><td rowspan="4">0
0</td><td rowspan="4">-0.054
-0.0021</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
0</td><td rowspan="5">-0.063
-0.0025</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">1
0.039</td><td rowspan="15">±0.8
±0.032</td><td rowspan="7">0
0</td><td rowspan="7">-0.063
-0.0025</td><td rowspan="5">0
0</td><td rowspan="5">-0.063
-0.0025</td><td rowspan="8">0.3
0.012</td><td rowspan="8">0
0</td><td rowspan="8">-1.0
-0.039</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
0</td><td rowspan="6">-0.072
-0.0028</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
0</td><td rowspan="5">-0.072
-0.0028</td></tr>
<tr><td>217</td><td>317</td><td>X17</td></tr>
<tr><td>218</td><td>318</td><td>X18</td><td>0
0</td><td>-0.072
-0.0028</td></tr>
<tr><td>–</td><td>319</td><td>–</td><td rowspan="7">—</td><td rowspan="7">—</td><td rowspan="7">0.4
0.016</td><td rowspan="7">0
0</td><td rowspan="7">-1.5
-0.059</td></tr>
<tr><td>–</td><td>320</td><td>X20</td><td rowspan="3">0
0</td><td rowspan="3">-0.081
-0.0032</td></tr>
<tr><td>–</td><td>321</td><td>–</td><td rowspan="5">—</td><td rowspan="5">—</td></tr>
<tr><td>–</td><td>322</td><td>–</td></tr>
<tr><td>–</td><td>324</td><td>–</td><td rowspan="3">0
0</td><td rowspan="3">-0.089
-0.0035</td></tr>
<tr><td>–</td><td>326</td><td>–</td></tr>
<tr><td>–</td><td>328</td><td>–</td></tr>
</table>

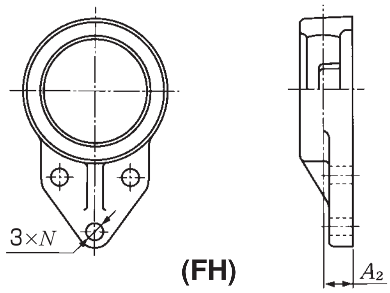
Note: 1) J is the bolt hole's center line dimension, and P,C,D. A_2 is distance between the center line of spherical bore diameter of the housing and mounting surfaces, and H_3 is outside diameter of the spigot joint.
2) Radial runout of spigot joint is applied for flange units with spigot joints.
3) This table can be applied for bearing units with dust covers.
4) Recomended hole tolerance for the spigot joint is H8.

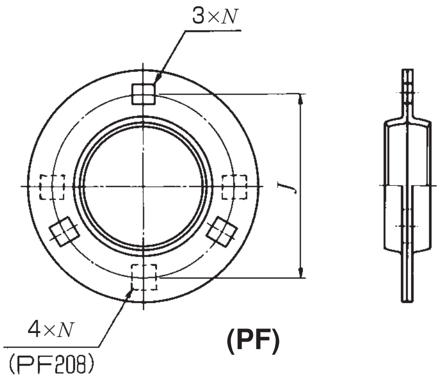
Table 5.7 (2) Flange unit housings (diameter of bolt hole) Unit: mm/inch

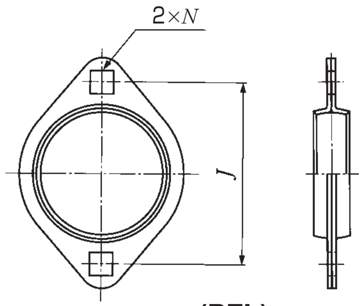
<table>
<tr><th rowspan="3">Housing type</th><th colspan="4">Nominal bore diameter N</th><th colspan="2" rowspan="2">N Deviatiors N_s</th></tr>
<tr><th colspan="2">over</th><th colspan="2">incl.</th></tr>
<tr><th>mm</th><th>inch</th><th>mm</th><th>inch</th><th>mm</th><th>inch</th></tr>
<tr><td rowspan="2">F, FL, FC, FS, FB, FD
FA, FH, FU, FLU, FM
FG, FLG, FCG, FSG</td><td>–</td><td>–</td><td>30</td><td>1.1811</td><td>±0.2</td><td>±0.008</td></tr>
<tr><td>30</td><td>1.1811</td><td>51</td><td>2.008</td><td>±0.3</td><td>±0.012</td></tr>
</table>



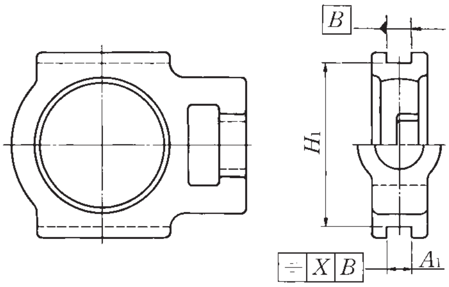
(FA)



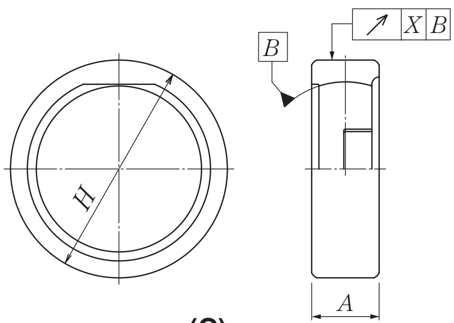




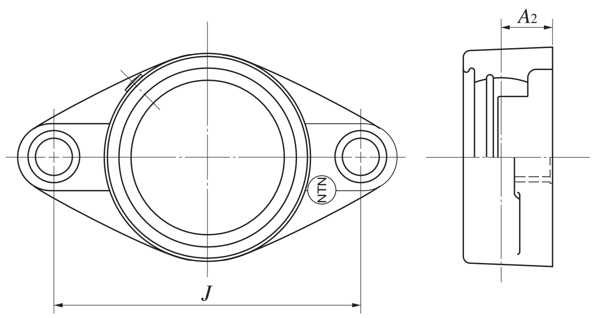
(PFL)



(T, TG)



(C)



(FLR)

Table 5.8 (1) Flanged units housings (FH, FA, PF, PFL) Unit: mm/inch

Housing numbers	A_2 Deviations A_{2s}	Housing numbers	J Deviations J_s	N Deviations N_s
—	±0.5 ±0.020	PF203	±0.4 ±0.016	±0.25 ±0.010
FH, FA204		PF204		
FH, FA205		PF205		
FH, FA206		PF206		
FH, FA207		PF207		
FH, FA208		PF208		
FH, FA209		PFL203		
FH, FA210		PFL204		
		PFL205		
FA211	±0.8 ±0.032	PFL206		
		PFL207		

Note: 1) A_2 is distance between the center line of spherical bore diameter of housings.
2) J is the bolt hole's center line dimension.

Table 5.8 (2) Flanged units housings (FLR) Unit: mm/inch

Housing numbers	J Deviations J_s	A_2 Deviations A_{2s}
FLR204	±0.7 ±0.028	±0.5 ±0.020
FLR205		
FLR206		
FLR207		
FLR208		

Table 5.9 Take-up unit housings (T, TG) Unit: mm/inch

<table>
<tr><th colspan="3">Housing numbers</th><th rowspan="2">A_1 Deviations A_{1s}</th><th colspan="2">H_1 Deviations H_{1s}</th><th rowspan="2">Parallelism of guide</th></tr>
<tr><th>T, TG</th><th>T, TG</th><th>T</th><th>high</th><th>low</th></tr>
<tr><td>204</td><td>—</td><td>—</td><td rowspan="7">+0.2
0
+0.008
0</td><td rowspan="7">0
0</td><td rowspan="7">−0.5
−0.020</td><td rowspan="7">0.5
0.020</td></tr>
<tr><td>205</td><td>305</td><td>X05</td></tr>
<tr><td>206</td><td>306</td><td>X06</td></tr>
<tr><td>207</td><td>307</td><td>X07</td></tr>
<tr><td>208</td><td>308</td><td>X08</td></tr>
<tr><td>209</td><td>309</td><td>X09</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">+0.3
0
+0.012
0</td><td rowspan="15">0
0</td><td rowspan="15">−0.8
−0.032</td><td rowspan="8">0.6
0.024</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></tr>
<tr><td>215</td><td>315</td><td>X15</td></tr>
<tr><td>216</td><td>316</td><td>X16</td></tr>
<tr><td>217</td><td>317</td><td>X17</td></tr>
<tr><td>—</td><td>318</td><td>—</td></tr>
<tr><td>—</td><td>319</td><td>—</td><td rowspan="4">0.7
0.028</td></tr>
<tr><td>—</td><td>320</td><td>—</td></tr>
<tr><td>—</td><td>321</td><td>—</td></tr>
<tr><td>—</td><td>322</td><td>—</td></tr>
<tr><td>—</td><td>324</td><td>—</td><td rowspan="3">0.8
0.032</td></tr>
<tr><td>—</td><td>326</td><td>—</td></tr>
<tr><td>—</td><td>328</td><td>—</td></tr>
</table>

Note: 1) A_1 is the width of guide rail grooves.
2) H_1 is the maximum span of guide rail grooves.
3) This table can be applied for bearing units with dust covers.

Table 5.10 Cartridge unit housings (C) Unit: mm/inch

<table>
<tr><th colspan="3" rowspan="3">Housing numbers</th><th colspan="6">H Deviations H_s</th><th rowspan="3">Radial runout of outside surface</th><th rowspan="3">A Deviations A_s</th></tr>
<tr><th colspan="2">C2</th><th colspan="2">C3</th><th colspan="2">CX</th></tr>
<tr><th>high</th><th>low</th><th>high</th><th>low</th><th>high</th><th>low</th></tr>
<tr><td>C204</td><td>—</td><td>—</td><td>0
0</td><td>−0.030
−0.0012</td><td>—</td><td>—</td><td>—</td><td>—</td><td rowspan="7">0.2
0.008</td><td rowspan="7">±0.2
±0.008</td></tr>
<tr><td>C205</td><td>C305</td><td>CX05</td><td rowspan="6">0
0</td><td rowspan="6">−0.035
−0.0014</td><td rowspan="4">0
0</td><td rowspan="4">−0.035
−0.0014</td><td rowspan="4">0
0</td><td rowspan="4">−0.035
−0.0014</td></tr>
<tr><td>C206</td><td>C306</td><td>CX06</td></tr>
<tr><td>C207</td><td>C307</td><td>CX07</td></tr>
<tr><td>C208</td><td>C308</td><td>CX08</td></tr>
<tr><td>C209</td><td>C309</td><td>CX09</td><td rowspan="6">0
0</td><td rowspan="6">−0.040
−0.0016</td><td rowspan="4">0
0</td><td rowspan="4">−0.040
−0.0016</td></tr>
<tr><td>C210</td><td>C310</td><td>CX10</td></tr>
<tr><td>C211</td><td>C311</td><td>CX11</td><td rowspan="3">0
0</td><td rowspan="3">−0.040
−0.0016</td><td rowspan="8">0.3
0.012</td><td rowspan="15">±0.3
±0.012</td></tr>
<tr><td>C212</td><td>C312</td><td>CX12</td></tr>
<tr><td>C213</td><td>C313</td><td>—</td><td rowspan="13">—</td><td rowspan="13">—</td></tr>
<tr><td>—</td><td>C314</td><td>—</td><td rowspan="12">—</td><td rowspan="12">—</td></tr>
<tr><td>—</td><td>C315</td><td>—</td><td rowspan="5">0
0</td><td rowspan="5">−0.046
−0.0018</td></tr>
<tr><td>—</td><td>C316</td><td>—</td></tr>
<tr><td>—</td><td>C317</td><td>—</td></tr>
<tr><td>—</td><td>C318</td><td>—</td></tr>
<tr><td>—</td><td>C319</td><td>—</td><td rowspan="7">0.4
0.016</td></tr>
<tr><td>—</td><td>C320</td><td>—</td><td rowspan="3">0
0</td><td rowspan="3">−0.052
−0.0020</td></tr>
<tr><td>—</td><td>C321</td><td>—</td></tr>
<tr><td>—</td><td>C322</td><td>—</td></tr>
<tr><td>—</td><td>C324</td><td>—</td><td rowspan="3">0
0</td><td rowspan="3">−0.057
−0.0022</td></tr>
<tr><td>—</td><td>C326</td><td>—</td></tr>
<tr><td>—</td><td>C328</td><td>—</td></tr>
</table>

Note: 1) H is the outside diameter of cartridge housings.
2) A is width of cartridge housings.

5.3 Bearing internal clearance

5.3.1 Bearing internal clearance

Bearing internal clearance (initial clearance) is the amount of internal clearance a bearing has before being installed on a shaft or in a housing.

As shown in **Fig. 5.1**, when either the inner ring or the outer ring is fixed and the other ring is free to move, displacement can take place in either an axial or radial direction. This amount of displacement (radially or axially) is termed the internal clearance and, depending on the direction, is called the radial internal clearance or the axial internal clearance.

When the internal clearance of a bearing is measured, a slight measurement load is applied to the raceway so the internal clearance may be measured accurately. However, at this time, a slight amount of elastic deformation of the bearing occurs under the measurement load, and the clearance measurement value (measured clearance) is slightly larger than the true clearance. This discrepancy between the true bearing clearance and the increased amount due to the elastic deformation must be compensated for. These compensation values are given in **Table 5.11.**

The internal clearance values for each bearing class are shown in **Tables 5.13**.

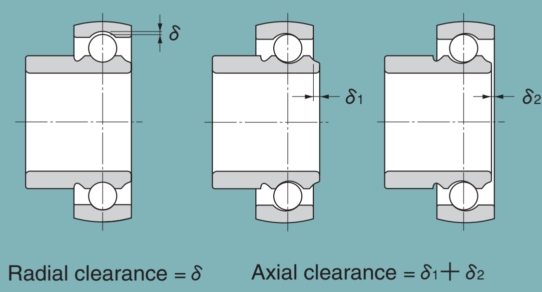


Fig.5.1 Internal clearance

Table 5.11 Adjustment of radial internal clearance based on measured load

Unit : μm

Nominal bore diameter d (mm)		Measuring load (N)	Radial clearance increase				
over	incl.		C2	CN	C3	C4	C5
10	18	24.5	3~4	4	4	4	4
18	50	49	4~5	5	6	6	6
50	200	147	6~8	8	9	9	9

5.3.2 Internal clearance selection

The internal clearance of a bearing under operating conditions (effective clearance) is usually smaller than the same bearing's initial clearance before being installed and operated. This is due to several factors including bearing fit, the difference in temperature between the inner and outer rings, etc. As a bearing's operating clearance has an effect on bearing life, heat generation, vibration, noise, etc.; care must be taken in selecting the most suitable operating clearance.

Effective internal clearance:

The internal clearance differential between the initial clearance and the operating (effective) clearance (the amount of clearance reduction caused by interference fits, or clearance variation due to the temperature difference between the inner and outer rings) can be calculated by the following formula:

$$\delta_{eff} = \delta_o - (\delta_f + \delta_t) \quad \cdots\cdots (5.1)$$

where,

δ_{eff}: Effective internal clearance, mm

δ_o: Bearing internal clearance, mm

δ_f: Reduced amount of clearance due to interference, mm

δ_t: Reduced amount of clearance due to temperature differential of inner and outer rings, mm

Reduced clearance due to interference:

When bearings are installed with interference fits on shafts and in housings, the inner ring will expand and the outer ring will contract; thus reducing the bearings' internal clearance. The amount of expansion or contraction varies depending on the shape of the bearing, the shape of the shaft or housing, dimensions of the respective parts, and the type of materials used. The differential can range from approximately 70% to 90% of the effective interference.

$$\delta_f = (0.70 \sim 0.90) \cdot \Delta_{deff} \quad \cdots\cdots (5.2)$$

where,

δ_f: Reduced amount of clearance due to interference, mm

Δ_{deff}: Effective interference, mm

Reduced internal clearance due to inner/outer ring temperature difference:

During operation, normally the outer ring will be from 5° to 10°C cooler than the inner ring or rotating parts. However, if the cooling effect of the housing is large, the shaft is connected to a heat source, or a heated substance is conducted through the hollow shaft; the temperature difference between the two rings can be even greater. The amount of internal clearance is thus further reduced by the differential expansion of the two rings.

$$\delta_t = \alpha \cdot \Delta_T \cdot D_o \quad \cdots\cdots (5.3)$$

where,
δ_t : Amount of reduced clearance due to heat differential, mm
α : Bearing steel linear expansion coefficient 12.5 x 10^{-6}/°C
ΔT : Inner/outer ring temperature differential, °C
D_o : Outer ring raceway diameter, mm

Outer ring raceway diameter, D_o, values can be approximated by using formula 8.4.
For ball bearings,

$$D_o = 0.20\ (d + 4.0D) \quad \cdots\cdots (5.4)$$

where,
d : Bearing bore diameter, mm
D : Bearing outside diameter, mm

5.3.3 Bearing internal clearance selection standards

Theoretically, in regard to bearing life, the optimum operating internal clearance for any bearing would be a slight negative clearance after the bearing had reached normal operating temperature.

Unfortunately, under actual operating conditions, maintaining such optimum tolerances is often difficult at best. Due to various fluctuating operating conditions this slight minus clearance can quickly become a large minus, greatly lowering the life of the bearing and causing excessive heat to be generated. Therefore, an initial internal clearance which will result in a slightly greater than negative internal operating clearance should be selected.

Under normal operating conditions (e.g. normal load, fit, speed, temperature, etc.), a standard internal clearance will give a very satisfactory operating clearance.

Table 5.12 lists non-standard clearance recommendations for various applications and operating conditions.

Table 5.12 Examples of applications where bearing clearances other than normal clearance are used

Operating conditions	Appilcations	Selected clearance
Shaft is heated and housing is cooled.	Conveyor of casting machine	C5
Shaft or inner ring is heated.	Annealing pit, Drying pit, Curing pit	C4
Allows for shaft deflection and fitting errors.	Disc harrows	C4
	Combines	C3
Tight-fitted for both inner and outer rings.	Large blowers	C3

Table 5.13 (1) Cylindrical bore bearings (Series X is based on internal structure.)

Unit: μm/0.0001 inch

Nominal bore diameter *d*				Radial internal clearance																			
				C2				CN				C3				C4				C5			
over		incl.		min.		max.		min.		max.		min.		max.		min.		max.		min.		max.	
mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch
6	0.2362	10	0.3937	0	0	7	3	2	0.8	13	5	8	3	23	9	14	6	29	11	20	8	37	15
10	0.3937	18	0.7087	0	0	9	4	3	1	18	7	11	4	25	10	18	7	33	13	25	10	45	18
18	0.7087	24	0.9449	0	0	10	4	5	2	20	8	13	5	28	11	20	8	36	14	28	11	48	19
24	0.9449	30	1.1811	1	0	11	4	5	2	20	8	13	5	28	11	23	9	41	16	30	12	53	21
30	1.1811	40	1.5748	1	0	11	4	6	2	20	8	15	6	33	13	28	11	46	18	40	16	64	25
40	1.5748	50	1.9685	1	0	11	4	6	2	23	9	18	7	36	14	30	12	51	20	45	18	73	29
50	1.9685	65	2.5591	1	0	15	6	8	3	28	11	23	9	43	17	38	15	61	24	55	22	90	35
65	2.5591	80	3.1496	1	0	15	6	10	4	30	12	25	10	51	20	46	18	71	28	65	26	105	41
80	3.1496	100	3.9370	1	0	18	7	12	5	36	14	30	12	58	23	53	21	84	33	75	30	120	47
100	3.9370	120	4.7244	2	1	20	8	15	6	41	16	36	14	66	26	61	24	97	38	90	35	140	55
120	4.7244	140	5.5118	2	1	23	9	18	7	48	19	41	16	81	32	71	28	114	45	105	41	160	63

Note :Heat-resistant bearings with suffix HT2 have C4 clearances.

Table 5.13 (2) Tapered bore bearings (Series X is based on internal structure.)

Unit: μm/0.0001 inch

Nominal bore diameter *d*				Radial internal clearance															
				C2				CN				C3				C4			
over		incl.		min.		max.		min.		max.		min.		max.		min.		max.	
mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch
24	0.9449	30	1.1811	5	2	20	8	13	5	28	11	23	9	41	16	30	12	53	21
30	1.1811	40	1.5748	6	2	20	8	15	6	33	13	28	11	46	18	40	16	54	25
40	1.5748	50	1.9685	6	2	23	9	18	7	36	14	30	12	51	20	45	18	73	29
50	1.9685	65	2.5591	8	3	28	11	23	9	43	17	38	15	61	24	55	22	90	35
65	2.5591	80	3.1496	10	4	30	12	25	10	51	20	46	18	71	28	65	26	105	41
80	3.1496	100	3.9370	12	5	36	14	30	12	58	23	53	21	84	33	75	30	120	47
100	3.9370	120	4.7244	15	6	41	16	36	14	66	26	61	24	97	38	90	35	140	55
120	4.7244	140	5.5118	18	7	48	19	41	16	81	32	71	28	114	45	105	41	160	63

Note :Heat-resistant bearings with suffix HT2 have C4 clearances.

6. Basic Load Rating and Life

6.1 Bearing life

Even in bearings operating under normal conditions, the surfaces of the raceway and rolling elements are constantly being subjected to repeated compressive stresses which cause flaking of these surfaces to occur. This flaking is due to material fatigue and will eventually cause the bearings to fail. The effective life of a bearing is usually defined in terms of the total number of revolutions a bearing can undergo before flaking of either the raceway surface or the rolling element surfaces occurs.

Other causes of bearing failure are often attributed to problems such as seizing, abrasions, cracking, chipping, gnawing, rust, etc. However, these so called "causes" of bearing failure are usually themselves caused by improper installation, insufficient or improper lubrication, faulty sealing or inaccurate bearing selection. Since the above mentioned "causes" of bearing failure can be avoided by taking the proper precautions, and are not simply caused by material fatigue, they are considered separately from the flaking aspect.

6.2 Basic rating life and basic dynamic load rating

A group of seemingly identical bearings when subjected to identical load and operating conditions will exhibit a wide diversity in their durability.

This "life" disparity can be accounted for by the difference in the fatigue of the bearing material itself. This disparity is considered statistically when calculating bearing life, and the basic rating life is defined as follows.

The basic rating life is based on a 90% statistical model which is expressed as the total number of revolutions 90% of the bearings, in an identical group of bearings subjected to identical operating conditions, will attain or surpass before flaking due to material fatigue occurs. For bearings operating at fixed constant speeds, the basic rating life (90% reliability) is expressed in the total number of hours of operation.

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. The basic dynamic load ratings given in the bearing tables of this catalog are for bearings constructed of **NTN** standard bearing materials, using standard manufacturing techniques. Please consult **NTN** for basic load ratings of bearings constructed of special materials or using special manufacturing techniques.

The relationship between the basic rated life, the basic dynamic load rating and the bearing load is given in formula (6.1).

$$L_{10} = \left(\frac{C_r}{P_r}\right)^3 \quad \cdots\cdots \quad (6.1)$$

where,

L_{10}: Basic rating life 10^6 revolutions

C_r: Basic dynamic load rating, N, lbf

P_r: Equivalent dynamic load, N, lbf

The basic rated life can also be expressed in terms of hours of operation (revolution), and is calculated as shown in formula (6.2).

$$L_{10h} = 500 f_h^3 \quad \cdots\cdots \quad (6.2)$$

$$f_h = f_n \frac{C_r}{P_r} \quad \cdots\cdots \quad (6.3)$$

$$f_n = \left(\frac{33.3}{n}\right)^{1/3} \quad \cdots\cdots \quad (6.4)$$

where,

L_{10h}: Basic rating life, h

f_h: Life factor

f_n: Speed factor

n: Rotational speed, min^{-1}

Formula (6.2) can also be expressed as shown in formula (6.5).

$$L_{10h} = \frac{10^6}{60n}\left(\frac{C_r}{P_r}\right)^3 \quad \cdots\cdots \quad (6.5)$$

The relation between rotational speed n and speed factor f_n as well as the relation between the basic rated life L_{10h} and the life factor f_h is shown in **Fig. 6.1**.

When several bearings are incorporated in machines or equipment as complete units, all the bearings in the unit are considered as a whole when computing bearing life (see formula 6.6). The total bearing life of the unit is a life rating based on the viable lifetime of the unit before even one of the bearings fails due to rolling contact fatigue.

$$L = \frac{1}{\left(\frac{1}{L_1^{1.1}} + \frac{1}{L_2^{1.1}} + \cdots\cdots + \frac{1}{L_n^{1.1}}\right)^{1/1.1}} \cdots \quad (6.6)$$

where,
L : Total life of the whole bearing assembly h
L_1, $L_2 \cdots L_n$: Rated life of bearings 1, 2, $\cdots n$, h

In the case where load and the number of revolutions change at regulated intervals, after finding the rated life $L_1, L_2, \cdots, L_n$ under conditions of n_1 , p_1 : n_2 , p_2 : n_n , p_n; the built-in life L_m can be given by the formula (6.7).

$$L_1 = \frac{10^6}{60 n_1} \left(\frac{C_r}{P_1} \right)^3$$

$$L_2 = \frac{10^6}{60 n_2} \left(\frac{C_r}{P_2} \right)^3$$

$$\vdots$$

$$L_n = \frac{10^6}{60 n_n} \left(\frac{C_r}{P_n} \right)^3$$

$$L_m = \left(\frac{\phi_1}{L_1} + \frac{\phi_2}{L_2} + \cdots\cdots \frac{\phi_n}{L_n} \right)^{-1} \cdots\cdots\cdots\cdots \quad (6.7)$$

where,
$L_1, L_2, \cdots, L_n$: Rated life under condition 1, 2, $\cdots n$, h
$n_1, n_2, \cdots, n_n$: Number of revolutions under condition 1, 2, $\cdots n$, min^{-1}
$P_1, P_2, \cdots, P_n$: Equivalent load under condition 1, 2, $\cdots n$,N, lbf
$\phi_1, \phi_2, \cdots, \phi_n$: Ratio of condition 1, 2, $\cdots n$, accounting for the total operating time
L_m : Built-in life, h

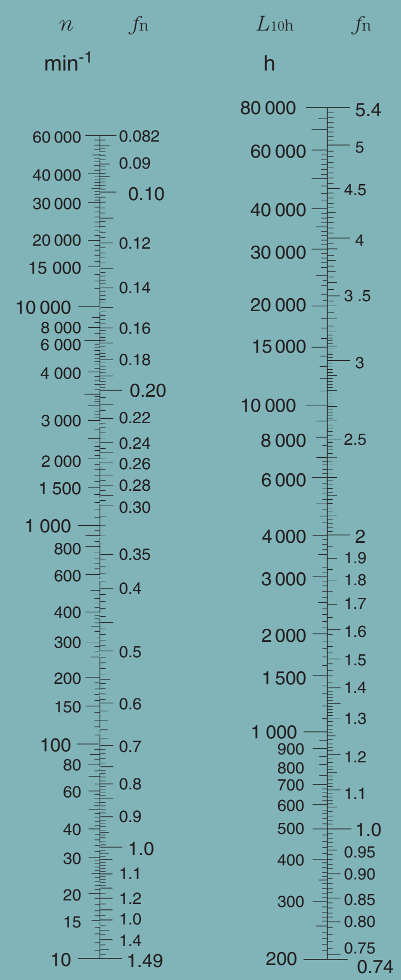


Fig. 6.1 Bearing life rating scale

Table 6.1 Rating life for applications

Service classification	Machine application	Life time L_n
Machines used occasionally	Door mechanisms, Garage shutter	500
Equipment for short period or intermittent serviceinterruption permissible	Household appliances, Electric hand tools, Agricultural machines, Lifting tackles in shops	4 000～ 8 000
Intermittent service machines-high reliability	Power-Station auxiliary equipment, Elevators, Conveyors, Deck cranes	8 000～ 14 000
Machines used for 8 hours a day, but not always in full operation	Ore wagon axles, Important gear units	14 000～ 20 000
Machines fully used for 8 hours	Blowers, General machinery in shops, Continuous operation cranes	20 000～ 30 000
Machines continuously used for 24 hours a day	Compressors, Pumps	50 000～ 60 000
Machines continuously used for 24 hours a day with maximum reliability	Power-station equipment, Water-supply equipment for urban areas, Mine ventilators	100 000～200 000

6.3 Machine applications and requisite life

When selecting a bearing, it is essential that the requisite life of the bearing be established in relation to the operating conditions. The requisite life of the bearing is usually determined by the type of machine the bearing is to be used in, and duration of service and operational reliability requirements. A general guide to these requisite life criteria is shown in **Table 6.1**. When determining bearing size, the fatigue life of the bearing is an important factor; however, besides bearing life, the strength and rigidity of the shaft and housing must also be taken into consideration.

6.4 Adjusted life rating factor based on ISO281:1990

The basic bearing life rating (90% reliability factor) can be calculated through the formulas mentioned earlier in Section 6.2. However, in some applications a bearing life factor of over 90% reliability may be required. To meet these requirements, bearing life can be lengthened by the use of specially improved bearing materials or special construction techniques. Moreover, according to elastohydrodynamic lubrication theory, it is clear that the bearing operating conditions (lubrication, temperature, speed, etc.) all exert an effect on bearing life. All these adjustment factors are taken into consideration when calculating bearing life, and using the life adjustment factor as prescribed in ISO 281, the adjusted bearing life can be arrived at.

$$L_{na} = a_1\, a_2\, a_3 \left(\frac{C}{P}\right)^3 \quad \text{(6.8)}$$

where,

L_{na} : Adjusted rating life in millions of revolutions (10^6)

a_1 : Reliability factor

a_2 : Bearing characteristics factor

a_3 : Operating conditions factor

6.4.1 Reliability factor a_1

The values for the reliability adjustment factor a_1 (for a reliability factor higher than 90%) can be found in **Table 6.2**.

6.4.2 Bearing characteristics factor a_2

The life of a bearing is affected by the material type and quality as well as the manufacturing process. In this regard, the life is adjusted by the use of an a_2 factor.

The basic dynamic load ratings listed in the catalog are based on **NTN**'s standard material and process, therefore, the adjustment factor $a_2 = 1$. When special materials or processes are used the adjustment factor a_2 can be larger than 1.

NTN bearings can generally be used up to 120˚C. If bearings are operated at a higher temperature, the bearing must be specially heat treated (stabilized) so that inadmissible dimensional change does not occur due to micro-structure change. This special heat treatment might cause the reduction of bearing life because of a hardness change.

Table 6.2 Reliability factor a_1

Reliability %	L_n	Reliability factor a_1
90	L_{10}	1.00
95	L_5	0.62
96	L_4	0.53
97	L_3	0.44
98	L_2	0.33
99	L_1	0.21

6.4.3 Operating conditions factor a_3

Operating conditions factor a_3 is used to compensate for when lubrication condition worsens due to rise in temperature or rotational speed, lubricant deteriorates, or becomes contaminated with foreign matter.

Generally speaking, when lubricating conditions are satisfactory, the a_3 factor has a value of one; and when lubricating conditions are exceptionally favorable, and all other operating conditions are normal, a_3 can have a value greater than one.

However, when lubricating conditions are particularly unfavorable and the oil film formation on the contact surfaces of the raceway and rolling elements is insufficient, the value of a_3 becomes less than one. This insufficient oil film formation can be caused, for example, by the lubricating oil viscosity being too low for the operating temperature (below 13 mm^2/s for ball bearings) ; or by exceptionally low rotational speed (n min^{-1} X d_p mm less than 10000). For bearings used under special operating conditions, please consult **NTN**.

● Bearing operating temperature is too high

If bearing operating temperature is too high, the raceway becomes softened, thereby shortening life.

Life is adjusted by multiplying by the values given in **fig.6.2** as the operating condition factor according to operating temperature. This however does not apply to bearings that have been treated to stabilize dimensions.

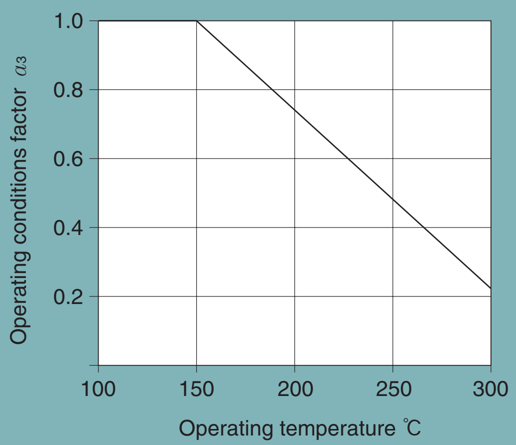


Fig. 6.2 Operating conditions factor according to operating temperature

6.5 Basic static load rating

When stationary rolling bearings are subjected to static loads, they suffer from partial permanent deformation of the contact surfaces at the contact point between the rolling elements and the raceway. The amount of deformity increases as the load increases, and if this increase in load exceeds certain limits, the subsequent smooth operation of the bearing is impaired.

It has been found through experience that a permanent deformity of 0.0001 times the diameter of the rolling element, occurring at the most heavily stressed contact point between the raceway and the rolling elements, can be tolerated without any impairment in running efficiency.

The basic rated static load refers to a fixed static load limit at which a specified amount of permanent deformation occurs. It applies to pure radial loads for radial bearings. The maximum applied load values for contact stress occurring at the rolling element and raceway contact points are given below.

For ball bearings (for bearing unit) : 4200 Mpa.

6.6 Allowable static equivalent load

Generally the static equivalent load which can be permitted (see section 7.3) is limited by the basic static rated load as stated in Section 6.5. However, depending on requirements regarding friction and smooth operation, these limits may be greater or lesser than the basic static rated load.

In the following formula (6.9) and **Table 6.4** the safety factor S_o can be determined considering the maximum static equivalent load.

$$S_o = \frac{C_o}{P_{o\max}} \quad \cdots\cdots (6.9)$$

where,

S_o : Safety factor

C_o: Basic static load rating, N, lbf

$P_{o\max}$: Maximum static equivalent load, N, lbf

Table 6.4 Minimum safety factor values S_o

Operating conditions	Ball bearings
High rotational accuracy demand	2
Normal rotating accuracy demand (Universal application)	1
Slight rotational accuracy deterioration permitted (Low speed, heavy loading, etc.)	0.5

Note :1) When vibration and/or shock loads are present, a load factor based on the shock load needs to be included in the $P_{o\max}$ value.

7. Loads

7.1 Load acting on the bearing

It is very rare that the load on a bearing can be obtained by a simple calculation. Loads applied to the bearing generally include the weight of the rotating element itself, the load produced by the working of the machine, and the load resulting from transmission of power by the belt and gearwheel. Such loads include the radial load, which works on the bearing at right angles to its axis, and the thrust load, which works on the bearing parallel to its axis. These can work either singly or in combination. In addition, the operation of a machine inevitably produces a varying degree of vibrations and shocks. To take this into account, the theoretical value of a load is multiplied by a safety factor that has been derived from past experience. This is known as the "load factor".

Load acting on the bearing =
Load factor f_w × Calculated load

Table 7.1 below shows the generally accepted load factors f_w which correspond to the degree of shock to which the machine is subjected.

7.1.1 Load applied to the bearing by power transmission

The force working on the shaft when power is transmitted by belts, chains or gearwheels is obtained, in general, by the following formula:

$$T = 9\,550\,\frac{H}{n}\ ,\ 84\,500\,\frac{H}{n} \quad \cdots\cdots\cdots\cdots \quad (7.1)$$

$$K_t = \frac{T}{r} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (7.2)$$

where,
T : Torque, N·m, lbf·inch.
H : Transmission power, kW
n : Rotational speed, min^{-1}
K_t : Transmission force (effective transmission force of belt or chain; tangential force of gearwheel), N, lbf
r: effective radius of belt pulley, sprocket wheel or gearwheel, m, inch

Accordingly, the load actually applied to the shaft by the transmission force can be obtained by the following formula:

$$\text{Actual load} = \text{Factor} \times K_t \quad \cdots\cdots\cdots\cdots \quad (7.3)$$

Different factors are adopted according to the transmission system in use. These will be dealt with in the following paragraphs.

Belt transmission

When power is transmitted by belt, the effective transmission force working on the belt pulley is calculated by formula (7.2). The term "effective transmission force of the belt" refers to the difference in tension between the tensioned side and the loose side of the belt. Therefore, to obtain the load actually acting on the shaft through the medium of the belt pulley, it is necessary to multiply the effective transmission force by a factor which takes into account the type of belt and the initial tension. This is known as the "belt factor".

Table 7.1 Load factors f_w

Load conditions	f_w	Examples
Little or no shock	1 to 1.2	Machines tools, electric machines, etc.
Some degree of shock; machines with reciprocating parts	1.2 to 1.5	Vehicles, driving mechanism, metal-working machinery, steel-making machines, paper-making machinery, rubber mixing machines, hydraulic equipment, hoists, transportation machinery, power-transmission equipment, woodworking machines, printing machines, etc.
violent shocks	1.5 to 3	Agricultural machines, vibrator screens, ball and tube mills, etc.

In the case of power transmission by belts, gear wheels, etc., load factors adopted are somewhat different from the above.
Factors used for power transmission by belts, gearwheels and chains, respectively, are given in the following sections.

Table 7.2 Belt factors f_b

Belt type	f_b
V-belt	1.5 to 2.0
Timing belt	1.1 to 1.3
Flat belt (with tension pulley)	2.5 to 3.0
Flat belt	3.0 to 4.0

Note : In cases where the distance between shafts is short, the revolution speed is low, or where operating conditions are severe, the higher f_b values should be adopted.

Gear transmission

In the case of gear transmissions, the theoretical gear load can be calculated from the transmission force and the type of gear. With spur gears, only a radial load is involved; whereas, with helical gears and bevel gears, an additional axial load is present.

The simplest case is that of spur gears. In this instance, the tangential force K_t is obtained from the formula (7.2) and the radial force K_s can be obtained from the following formula:

$$K_s = K_t \cdot \tan\alpha \quad \cdots\cdots (7.4)$$

where,

α : is the pressure angle of the gear.

Accordingly, the theoretical composite force, K_r, working on the gear is obtained from the following formula:

$$K_r = \sqrt{K_t^2 + K_s^2} = K_t \cdot \sec\alpha \quad \cdots\cdots (7.5)$$

Therefore, to obtain the radial load actually working on the shaft, the theoretical composite force, as above, is multiplied by a factor in which the accuracy and the degree of precision of the gear is taken into account. This is called the "gear factor" and is represented by the symbol f_z. In **Table 7.3** is below, f_z values for spur wheels are given.

The gear factor is essentially almost the same as the previously described load factor, f_w. In some cases, however, vibrations and shocks are produced also by the machine of which the gear is a part. Here it is necessary to calculate the actual load working on the gear by further multiplying the gear load, as obtained above, by the load factor shown in **Table 7.1**, according to the degree of shock.

Table 7.3 Gear factors f_z

Gear	f_z
Precision gears (tolerance 0.02 mm 0.0008 inch max., for both pitch and shape)	1.05 to 1.1
Gears finished by ordinary machining work (tolerance 0.02 to 0.1 mm, 0.0008 to 0.0039 inch for both pitch and shape)	1.1 to 1.3

Chain transmission

When power is transmitted by chain, the effective transmission force working on the sprocket wheel is calculated by formula (7.2). To obtain the load actually working, the effective transmission force must be multiplied by the "chain factor", 1.2 to 1.5.

7.1.2 Distribution of the radial load

The load acting on the shaft is distributed to the bearings which support the shaft.

In **Fig. 7.1**, the load is applied to the shaft between two bearings; in **Fig. 7.2** the load is applied to the shaft outside the two bearings. In practice, however, most cases are combinations of **Fig. 7.1** and **7.2**, and the load is usually a composite load, that is to say, a combination of radial and axial loads. Therefore they are calculated by the methods described in the following sections.

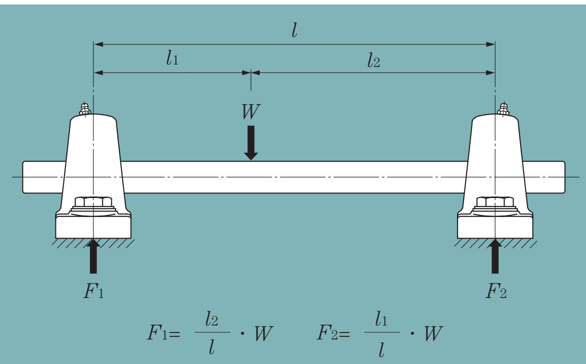


Fig. 7.1

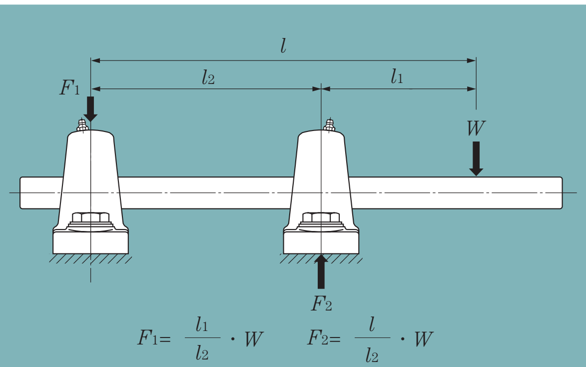


Fig. 7.2

7.2 Dynamic equivalent radial load

For ball bearings used in the **NTN** unit, the basic rated dynamic loads C_r mentioned in the table of dimensions are applicable only when the load is purely radial. In practice, however, bearings are usually subjected to a composite load. As the table of dimensions is not directly applicable here, it is necessary to convert the values of the radial and axial loads into a single radial load value that would have an effect on the life of bearing equivalent to that of the actual load applied. This is known as the "dynamic equivalent radial load", and from this the life of the ball bearings for the unit is the calculated. The dynamic equivalent radial load is calculated by the following formula:

$$P_r = X \cdot F_r + Y \cdot F_a \quad \cdots\cdots (7.6)$$

where,
P_r : Dynamic equivalent radial load, N, lbf
F_r : Actual radial load, N, lbf
F_a : Actual axial load, N, lbf
X : Radial load factor
Y : Axial load factor

Values of X and Y are shown in **Table 7.4** below.

Table 7.4 Dynamic equivalent radial load

$P_r = X \cdot F_r + Y \cdot F_a$

$\frac{f_o \cdot F_a}{C_{or}}$	e	$\frac{F_a}{F_r} \leqq e$		$\frac{F_a}{F_r} > e$	
		X	Y	X	Y
0.172	0.19	1	0	0.56	2.30
0.345	0.22				1.99
0.689	0.26				1.71
1.03	0.28				1.55
1.38	0.30				1.45
2.07	0.34				1.31
3.45	0.38				1.15
5.17	0.42				1.04
6.89	0.44				1.00

Note 1) The f_o factor for calculating equivalent radial load has been added to the dimensional tables in the catalog.
2) C_{or} is the basic static load rating. (See the table of dimensions.)
When the value of $\frac{f_o \cdot F_a}{C_{or}}$ or $\frac{F_a}{F_r}$ is not in conformity with those given in Table 7.4 above, find the value by interpolation.

7.3 Static equivalent radial load

In the case of a bearing which is stationary, rotates at a low speed of about 10 rpm, or makes slight oscillating movements, it is necessary to take into account the static equivalent radial load, which is the counterpart of the dynamic equivalent radial load of a rotating bearing. In this case, the following formula is used.

$$P_{or} = X_o \cdot F_r + Y_o \cdot F_a \quad \cdots\cdots (7.7)$$

where,
P_{or}: Static equivalent radial load, N, lbf
F_r : Actual radial load, N, lbf
F_a : Actual axial load, N, lbf
X_o : Static radial load factor
Y_o: Static axial load factor

With the ball bearings for the **NTN** unit, the values of X_o and Y_o are $X_o = 0.6$ $Y_o = 0.5$.

However when only radial load is involved, or when $F_a / F_r \leqq e$, the following values in used:

$X_o = 1 \qquad Y_o = 0$

Accordingly, the following equation holds.

$$P_{or} = F_r \quad \cdots\cdots (7.8)$$

8. Allowable Rotating Speed

The allowable speed while ensuring the safety and long life of ball bearings used in the unit is limited by their size, the circumferential speed at the point where the seal comes into contact, and the load acting on them. To indicate the allowable speed, it is customary to use the value of dn or $d_m n$ (d: bore diameter of the bearing; d_m: diameter of the pitch circle ≒ (I.D. + O.D.)/2, n: number of revolutions).

Problems connected with the lubrication of bearings are the generation of heat and seizures occurring at the sliding parts inside the bearing, in particular at the points where the ball is in contact with the cage, inner ring and outer rings. The contact pressure at the points where friction occurs on the cage is only slightly affected by the load acting on the bearing; the amount of heat generated there is approximately in proportion to the sliding velocity. Therefore, this sliding velocity serves as a yardstick to measure the limit of the rotating speed of the bearing. In the case of a bearing unit, however, there is another large factor that has to be taken into account – the circumferential speed at the part where the seal is in contact.

The UC type seal has an allowable speed of 10 m/s.

The graph in **Fig. 8.1** indicates the allowable.

The locking types configurations for bearing units are the set screw type insert and eccentric locking collar insert, and so on. Application conditions that include large clearance between the shaft and bearing, high speed operation, and so on, should be accounted for to avoid failure due to vibration, deformation or other modes. For those conditions, please refer to **Fig. 10.1** and **Fig. 10.5** to determine the appropriate fit condition. The allowable rotational speed can be calculated with the following equation:

UC(S),UK(S), UEL(S) type

n = 120000 /d

n = Allowable speed

d = Bearing bore

(For triple lip seal (LLJ) ; n = 36000/d.)

In cases where the application exceeds the allowable rotational speed, **NTN** recommends changing to a non-contact shield.

For further details, consult **NTN**.

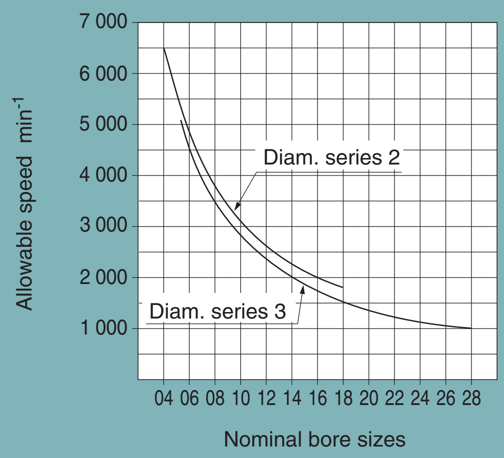


Fig.8.1

9. Lubrication

As bearings in **NTN** bearing units have sufficient grease sealed-in at the time of manufacture, there is no need for replenishment while in use. The amount of grease necessary for lubrication is, in general, very small. With the **NTN** bearing units, the amount of grease occupies about a half to a third of the space inside the bearing.

9.1 Life of grease

The life of grease is influenced by bearing type, dimensions, operating conditions, temperatures and conditions with or without ingress of dust, water and gas, and it is also greatly different depending on mineral oil of the raw material and soap base. **Fig. 9.2** is a diagram to calculate the grease life of **NTN** bearing units, which was prepared based on past results and experimental results at **NTN** with a view to safety. It is applicable where the bearing operating conditions are normal, and if type and bore of the bearing, and ratio of allowable rotational speed to the actual rotational speed are known, the grease life can be calculated as an example. The grease life calculated in this manner is not an absolute value but should be regarded as a certain guide including a large degree of safety. As the operating temperature is higher, the grease life becomes shorter obviously. Although it can not be simply described, the life obtained on **Fig. 9.2** is an approximate value for the operating temperature range of -15˚C to 100˚C.

9.2 Replenishment of grease

9.2.1 Sealed-in grease

NTN bearing units feature superior sealing device and contain proper amount of lithium soap-based grease which, being suitable for long term use, is ideal for sealed-type bearings. Relubrication, therefore, is unnecessary under most operating conditions. At high temperatures, or where there is exposure to water or excessive dust, the highest quality grease is essential. **Table 9.1** shows sealed-in grease brands for **NTN** relubrication-type bearing units. **Table 9.2** shows thermal solidification type grease brands. It is advisable to use **NTN** recommendation grease brand when replenishing grease.

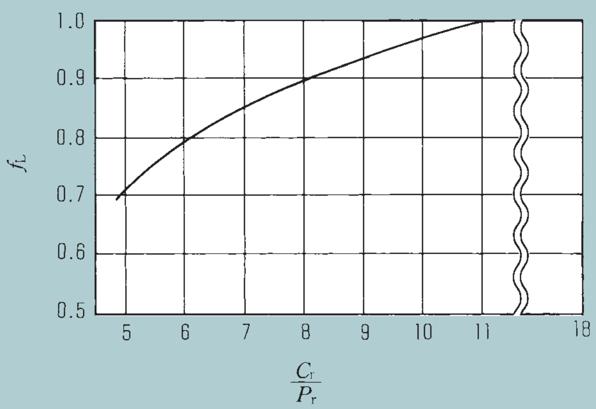
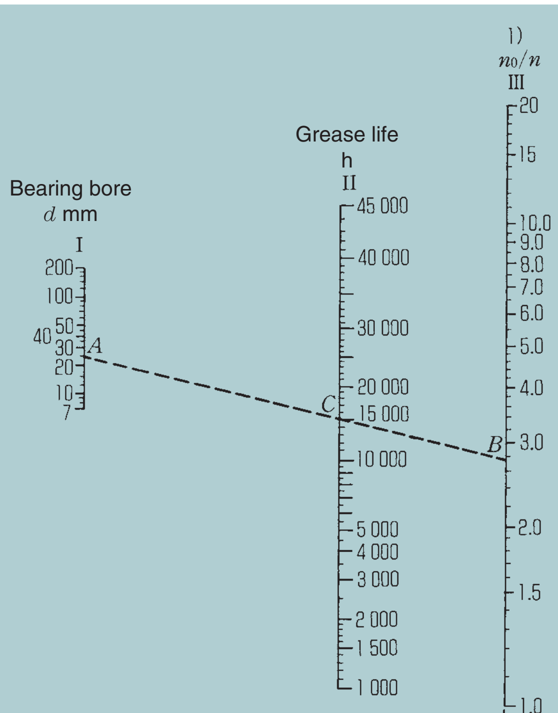


Fig.9.1 Adjustment factor f_L for bearing load



1) n: Rotational speed
$n_0 = f_L \cdot A_0/d$
For the insert bearing :
$A_0 = 250{,}000$

Fig.9.2

Example)
Grease life of UCP205 for radial load 1,000N and rotational speed 3,600min^{-1} is calculated as below;
At first, calculate n_0.
From Fig. 9.1, f_L= 1.00 for C_r/P_r= 14,000/1,000 = 14
A_0 = 250,000 for the insert bearing
Therefore,
$n_0 = f_L \cdot A_0/d$ = 1.00×250,000/25 = 10,000
n_0/n = 10,000/3,600 = 2.78

On Fig. 9.2, if the intersection point C was found connecting A for bearing bore d= 25 on vertical line I and B for n_0/n= 2.78 on vertical line III by a straight line, the grease life is 15,000 hrs.

Table 9.1 NTN relubrication-type sealed-in grease

Type of unit	Code	Operating temperature range ˚C ※1
Standard	—	-15 ～ +100
Heat-resistance	4M ※2	-40 ～ +180
Heat-resistance	LX23	-60 ～ +300
Cold-resistance	3L ※3	-50 ～ +120
Water-resistance	L588	-40 ～ + 120
Low-speed, Heavy-load, High-temperature	L666	-20 ～ +180
Low torque	5K	-40 ～ +150
General polylube	LP03	-20 ～ +80 (Constant use : +60˚C or less)
Food machinery	L791	-20 ～ +140
Polylube for food machinery	LP09	-10 ～ +100 (Constant use : +80˚C or less)

NTN also has the other grease options that may be available upon request.

Note ※1 : Operating temperature data described a catalog value of grease supplier.
※2 : Heat-resistance code "HT2" includes the use of "/4M" grease.
※3 : Cold-resistance code "CT1" includes the use of "/3L" grease.

9.2.2 Mixing of different kinds of grease

Whether or not different kinds of grease may be mixed usually depends on their thickeners. The commonly used criteria are shown in **Table 9.3**. Properties which are most susceptible to influences from mixing are viscosity, dropping point and penetration. Water and heat resisting properties as well as mechanical stability are also lowered. Therefore, when mixing in a grease which is different to that which is already in use, it is essential that thickener (soap base) and the base oil be of the same group.

Table 9.2 Mixing properties of grease

Soap base	Ca	Na	Al	Ba	Li
Ca	○	△	△	×	△
Na	△	○	△	×	×
Al	△	△	○	×	×
Ba	×	×	×	○	×
Li	△	△	×	×	○

○ Mixing will varies depending on properties of both greases.
△ Mixing may produce considerable variations of properties.
× Mixing will cause a drastic change of properties.

9.2.3 Relubrication frequency

Relubrication frequency varies with the kind and quality of grease used as well as the operation conditions. Therefore, it is difficult to establish a general rule, but under ordinary operating conditions, it is desirable that grease be replenished before one third (1/3) of its calculated life elapses. It is necessary, however, to take into consideration such factors as hardening of grease in the oil hole, making replenishment impossible; deterioration of grease while operation of the machine is suspended, and so forth.

In **Table 9.4** are shown standard relubrication frequencies. Irrespective of the calculated life of the grease, this list takes into consideration such factors as the rotational speed of the bearings, operating temperatures and environmental conditions, with a view to safety.

9.2.4 Re- greasing

The performance of a bearing is greatly influenced by the quantity of grease. In order to avoid over-filling, it is advisable to replenish the grease while the machine is in operation. Continue to insert grease until a little oozes out of from between the outer ring raceway and the periphery of the slinger, for optimum performance. Standard relubrication quantity is shown in **Table 9.5**. Relubrication pressure : 1- 3MPa {10 - 30kgf/cm^2}

Table 9.4 Relubrication quantity Unit g

Bearing number		Quant.	Bearing number	Quant.
UC201D1		1.1	UC305D1	2.0
UC202D1		1.1	UC306D1	3.0
UC203D1		1.1	UC307D1	4.3
UC204D1		1.1	UC308D1	5.5
UC205D1		1.3	UC309D1	7.5
UC206D1	UCX05D1	1.9	UC310D1	10.5
UC207D1	UCX06D1	2.7	UC311D1	13
UC208D1	UCX07D1	3.5	UC312D1	16.5
UC209D1	UCX08D1	4.1	UC313D1	20
UC210D1	UCX09D1	4.6	UC314D1	23.5
UC211D1	UCX10D1	6.0	UC315D1	27.5
UC212D1	UCX11D1	8.5	UC316D1	33
UC213D1	UCX12D1	10.5	UC317D1	38
UC214D1	UCX13D1	12	UC318D1	45
UC215D1	UCX14D1	13	UC319D1	50
UC216D1	UCX15D1	15.5	UC320D1	60
UC217D1	UCX16D1	16.5	UC321D1	70
UC218D1	UCX17D1	21	UC322D1	85
	UCX18D1	22.5	UC324D1	100
	UCX20D1	35.5	UC326D1	125
			UC328D1	150

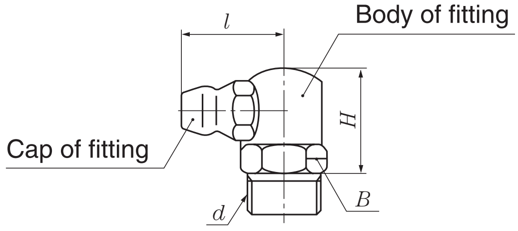
Note) Relubrication quantity of UK, UEL type is same as UC type

Table 9.3 Standard relubrication frequencies

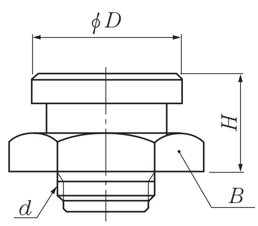
Type of bearing	Symbol	*dn* Value	Environmental conditions	Operating temperature ˚C	Relubrication interval	
					Hours	Period
Standard	D1	40 000 max	Ordinary	−15 to +80	1 500 to 3 000	6 to 12 mon.
Standard	D1	70 000 max	Ordinary	−15 to +80	1 000 to 2 000	3 to 6 mon.
Standard	D1	70 000 max	Ordinary	+80 to +100	500 to 700	1 mo.
Heat-resistant	HT2D1	70 000 max	Ordinary	+100 to +150	300 to 700	1 mo.
Heat-resistant	HT2D1	70 000 max	Ordinary	+150 to +180	100	1 wk.
Cold-resistant	CT1D1	70 000 max	Ordinary	−50 to +120	1 000 to 2 000	3 to 6 mo.
Standard	D1	70 000 max	Very dusty	−15 to +100	100 to 500	1 wk. to 1 mo.
Standard	D1	70 000 max	Exposed to water splashes	−15 to +100	30 to 100	1 day to 1 wk.

9.3 Grease fitting

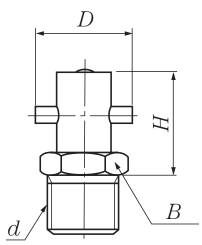
NTN bearing units are, as a general rule, provided with a grease fitting, as shown in **Table 9.6**, and a grease gun is used for regreasing. However, housing with pipe tapered thread for centralized greasing use as well as button-head and pin types are also available on demand.



GC type



Button type



Pin type

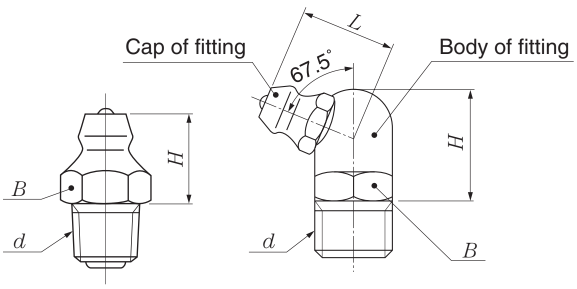
Table 9.5 Grease fitting types available for bearing units

Types of housing	NTN standard grease fitting types
Pillow type	GA type
Flange type	GA type
Take-up type	GB type
Hanger type	GA type
Cartridge type	GA type

Table 9.6 Housing series and nominal screw size of grease fitting

Nominal screw size d	Series 2	Series X	Series 3
¼-28 UNF	203-209	X05-X08	305-309
G⅛	210-215	X09-X14	310-315
G¼	216-218	X15-X20	316-328

Note:Screw size for the cartridge type is ¼ - 28 UNF.
That for C310D1 to C328D1 is G ⅛ (PF ⅛).



GA type **GB type**

GC type (90°)

NTN Designation	d	H mm	H inch	B mm	B inch	L mm	L inch
GC-¼-28UNF	¼-28UNF	10.5	0.413	8	0.315	10.5	0.413
GC-PF⅛	G⅛	14.25	0.561	10	0.394	13.5	0.531
GC-PF¼	G¼	15	0.591	14	0.551	13.5	0.531

Button type

NTN Designation	d	H mm	H inch	B mm	B inch	L mm	L inch
GF-¼-28UNF	¼-28UNF	10	0.394	17	0.669	15	0.591
GF-PF!/8	G⅛	10	0.394	17	0.669	15	0.591
GF-PF¼	G¼	10	0.394	17	0.669	15	0.591

Pin type

NTN Designation	d	H mm	H inch	B mm	B inch	L mm	L inch
GG-¼-28UNF	¼-28UNF	19	0.748	10	0.394	18	0.709
GG-PF⅛	G⅛	19	0.748	10	0.394	18	0.709
GG-PF¼	G¼	19	0.748	14	0.551	18	0.709

Table 9.7 Grease fitting dimensions

GA type (Vertical type)

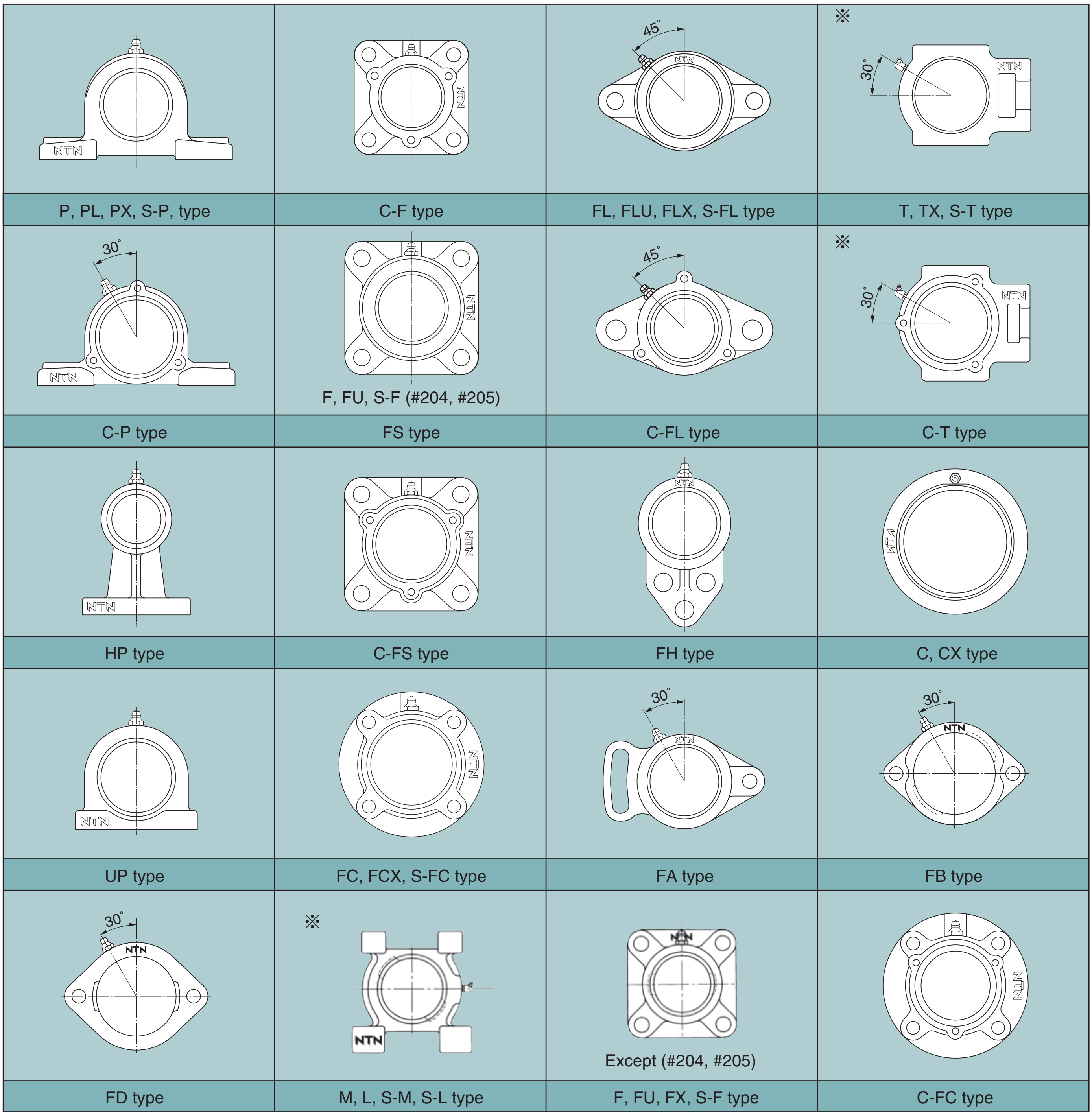
NTN Designation	d	H mm	H inch	B mm	B inch
GA-¼-28 UNF	¼-28 UNF	8.5	0.335	7	0.276
GA-PF⅛	G⅛	12	0.472	10	0.394
GA-PF¼	G¼	14	0.551	14	0.551

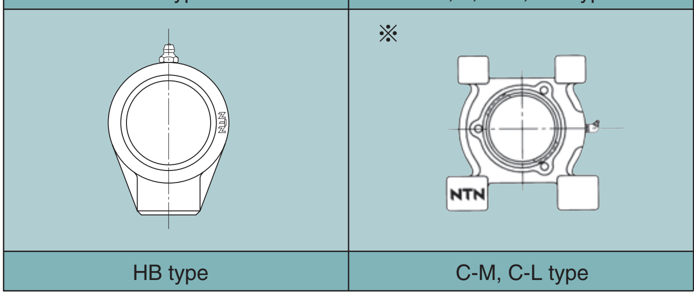
GB type (67.5°)

NTN Designation	d	H mm	H inch	L mm	L inch	B mm	B inch
GB-¼-28 UNF	¼-28 UNF	10.5	0.413	9.3	0.366	8	0.315
GB-PF⅛	G⅛	14.2	0.559	13.5	0.531	10	0.394
GB-PF¼	G¼	15	0.591	13.5	0.531	14	0.551

9.4 Standard location of the grease fitting

Standard location of grease fitting on the housing for the relubricatable bearing units of each type is illustrated below.





Note 1: Standard grease fitting type is GA. Item marked ※, however, have GB type as standard.
2: IPG, PE, PG, PM, PB and PR type are categorized as P type.
3: FM, FE, FLG and FLR type are categorized as FL type.
4: FG and FSG type are categorized as FS type.
5: FCG type is categorized as FC type.
6: TG type is categorized as T type.

10. Shaft Designs

Although the shafts used for **NTN** bearing units require no particularly high standards of accuracy, it is desirable that, as far as possible, they be free from bends and flaws.

10.1 Set screw system bearing units

With set screw system bearing units, under normal operating conditions the inner ring is usually fitted onto the shaft by means of a clearance fit to ensure convenience of assembly. In this case the values shown in **Fig. 10.1** are appropriate dimensional tolerances for the shaft.

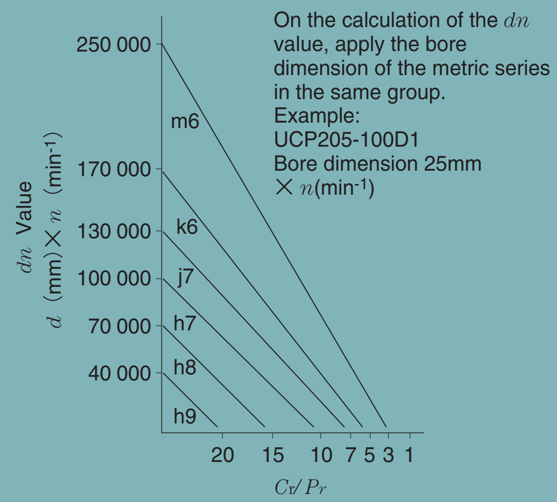


Fig. 10.1 Dimensional tolerance for the shaft for set screw system bearing units

Step shafts

Wherever there is a noticeably large axial load, a step shaft, as shown in **Fig. 10.2**, should, if practical, be used.

For bearing units with covers, it is recommended that the units shown in **Table 10.1** be used with shafts of the corresponding diameters, as shown in the same table.

NTN recommends the step shaft diameter of **Table 10.1**. In case of using a step shaft diameter smaller than shown in **Table 10.1**, **NTN** recommends the use of a spacer between the step shoulder and inner ring face.

NTN doesn't recommend the use of a step shaft with UK type bearing. If a step shaft is used with a UK type bearing, the step shoulder and the bearing can not contact each other. UK type bearing can't support axial load.

The values of the radii of the rounded corners of these shafts are shown in **Table 10.2.**

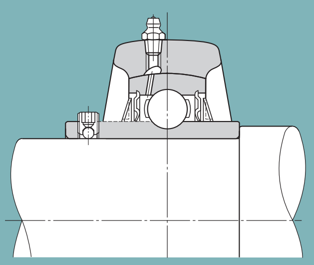


Fig.10.2

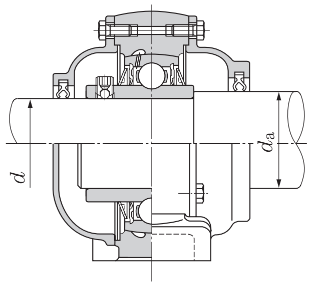


Table 10.1 Bearing units with covers (for use with step shafts) and shaft diameters

A) Metric series

Designation of units		d_a mm
10C-UCP206 to 10C-UCP218	10C-UCT208 to 10C-UCT217	d+10
10C-UCP305 to 10C-UCP311	10C-UCT305 to 10C-UCT311	d+10
15C-UCP312 to 15C-UCP324	15C-UCT312 to 15C-UCT324	d+15
20C-UCP326 to 20C-UCP328	20C-UCT326 to 20C-UCT328	d+20

Remarks : Designation of bearing units with blind covers.
Example : 10CM-UCP206D1

B) Inch series

Designation of units	d_a inch	Designation of units	d_a inch
ZnC-····206····	1½	ZnC-···305-···	1⅜
ZnC-···207-···	1¾	ZnC-···306-···	1½
ZnC-···208-···	1⅞	ZnC-···307-···	1¾
ZnC-···209-···	2	ZnC-···308-···	1⅞
ZnC-···210-···	2⅜	ZnC-···309-···	2⅛
ZnC-···211-···	2½	ZnC-···310-···	2⅜
ZnC-···212-···	2¾	ZnC-···311-···	2¾
ZnC-···213-···	3	ZnC-···312-···	3
ZnC-···214-···	3⅛	ZnC-···313-···	3⅛
ZnC-···215-···	3⅜	ZnC-···314-···	3¼
ZnC-···216-···	3½	ZnC-···315-···	3½
ZnC-···217-···	3¾	ZnC-···316-···	3¾
ZnC-···218-···	4	ZnC-···317-···	4
		ZnC-···318-···	4

Note :Designations for all units differ from the normal numbering system.
Example 1 Pillow type : ZnC-UCP206-101D1
ZnCM-UCP206-101D1
Example 2 Flange type : ZnC-UCF206-101D1
ZnC-UCFL206-101D1
Example 3 Take-up type : ZnC-UCT206-101D1
ZnCM-UCT206-101D1
n indicates serial number in designing from 1 onward.

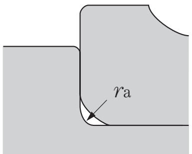


Table 10.2 Radii of the round corners of step shafts

Designation of bearings	r_{as} max. mm	inch	Designation of bearings	r_{as} max. mm	inch
UC201 to UC203	0.6	0.024	UC305 to UC306	1.5	0.059
UC204 to UC206	1	0.039	UC307 to UC309	2	0.079
UC207 to UC210	1.5	0.059	UC310 to UC311	2.5	0.098
UC211 to UC215	2	0.079	UC312 to UC316	2.5	0.098
UC216 to UC218	2.5	0.098	UC317 to UC324	3	0.118
			UC326 to UC328	4	0.157

Relief in the axial direction

Where several bearing units are fitted on the shaft, or where there is a great distance between two bearing units, one of the bearings is secured to the shaft as the "fixed-side bearing" and is subjected to both the axial and radial loads. The other is mounted on the shaft as the "free-side bearing" and is subjected only to radial load, compensating for expansion of the shaft due to a rise in temperature or for any errors in the distance between bearings that may have occurred during assembly.

If there is no free-side bearing, the bearings will be subjected to an abnormal axial load, which could cause premature breakdown.

Although it is desirable to use a cartridge-type bearing unit for the above purpose (**Fig. 10.3**), the following method is often employed. As illustrated in **Fig. 10.4 (a)** and **(b)**, a key way is cut in the shaft, to accommodate a special set screw.

However, when the shaft speed is high, the dog point set screw may wear because of intensive vibration caused by the clearance between the bearing bore and the shaft. For this reason the dog point set screw is not suitable for blower type and similar applications. Please consult with **NTN** for alternatives.

It is not suitable for applications such as blowers, please consult with **NTN**.

When relief is provided in the axial direction by the use of screwed bolts as above, the dimensional relationships applicable are as shown in **Tables 10.3 (a)** and **10.3 (b)** on the following pages.

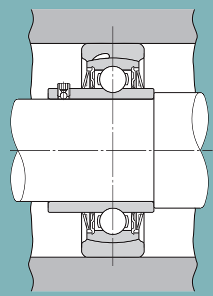


Fig.10.3

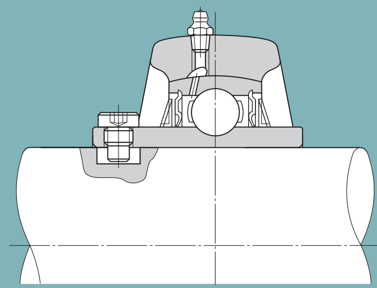


Fig.10.4 (a)

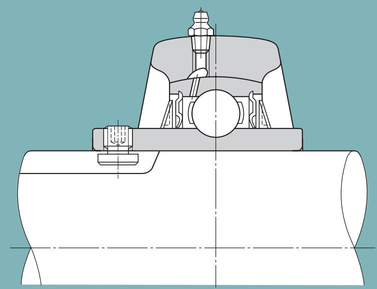


Fig.10.4 (b)

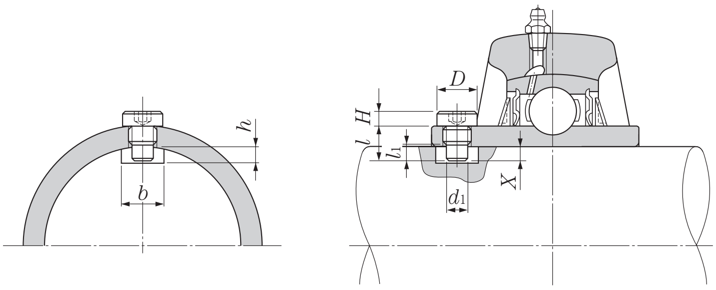


Table 10.3 (a) Screwed bolt system

A) Metric series, applied to metric bore size.

Designation of bearings	Key way Width b mm	Key way Depth h mm	Designation and size of bolts	d_1 mm	X mm	l mm	l_1 mm	D mm	H mm
UC201D1W5	3.5	3	S5W5×0.8×11	3.5	2.2	11	5	6	3
UC202D1W5	3.5	4.5	S5W5×0.8×11	3.5	3.7	11	5	6	3
UC203D1W5	3.5	5.5	S5W5×0.8×11	3.5	4.7	11	5	6	3
UC204D1W5	3.5	4.5	S5W5×0.8×8.5	3.5	3.7	8.5	5	6	3
UC205D1W5	3.5	5	S5W5×0.8×8.5	3.5	4.1	8.5	5	6	3
UC206D1W5	4	5.5	S5W6×0.75×10	4	4.6	10	5.9	8	3
UC207D1W5	4	5	S5W6×0.75×10	4	4.1	10	5.9	8	3
UC208D1W5	6	5.5	S5W8×1×11.5	6	5	11.5	5.5	10	3
UC209D1W5	6	6	S5W8×1×11.5	6	5.3	11.5	5.5	10	3
UC210D1W5	6	6	S5W8×1×11.5	6	5.3	11.5	5.5	10	3
UC211D1W5	6	5	S5W8×1×11.5	6	4.5	11.5	5.5	10	3
UC212D1W5	7	5.5	S5W10×1.25×13.5	7	5	13.5	6.5	12	3
UC213D1W5	7	5.5	S5W10×1.25×13.5	7	4.8	13.5	6.5	12	3
UC214D1W5	7	5.5	S5W10×1.25×13.5	7	5	13.5	6.5	12	3
UC215D1W5	7	5	S5W10×1.25×13.5	7	4.5	13.5	6.5	12	3
UC216D1W5	7	6.5	S5W10×1.25×15	7	6	15	7	12	3
UC217D1W5	9	6.5	S5W12×1.5×16.5	9	5.8	16.5	7	14	4
UC218D1W5	9	6.5	S5W12×1.5×16.5	9	5.7	16.5	7	14	4
UC305D1W5	4	6.5	S5W6×0.75×11.5	4	5.6	11.5	6	8	3
UC306D1W5	4	5	S5W6×0.75×11.5	4	4.1	11.5	6	8	3
UC307D1W5	6	5	S5W8×1×11.5	6	4.3	11.5	5.5	10	3
UC308D1W5	7	6	S5W10×1.25×13.5	7	5.5	13.5	6.5	12	3
UC309D1W5	7	6.5	S5W10×1.25×15	7	5.8	15	7	12	3
UC310D1W5	9	7	S5W12×1.5×16.5	9	6.2	16.5	7	14	4
UC311D1W5	9	6.5	S5W12×1.5×16.5	9	5.7	16.5	7	14	4
UC312D1W5	9	6	S5W12×1.5×16.5	9	5.2	16.5	7	14	4
UC313D1W5	9	7	S5W12×1.5×18	9	6.4	18	7.5	14	4
UC314D1W5	9	6.5	S5W12×1.5×18	9	5.6	18	7.5	14	4
UC315D1W5	10	7.5	S5W14×1.5×20	10	6.9	20	8.5	17	5
UC316D1W5	10	7	S5W14×1.5×20	10	6.1	20	8.5	17	5
UC317D1W5	12	9	S5W16×1.5×23	12	8.3	23	9	19	6
UC318D1W5	12	8.5	S5W16×1.5×23	12	7.6	23	9	19	6
UC319D1W5	12	7.5	S5W16×1.5×23	12	6.8	23	9	19	6
UC320D1W5	14	8	S5W18×1.5×25	14	7.2	25	9.5	22	7
UC321D1W5	14	7	S5W18×1.5×25	14	6.5	25	9.5	22	7
UC322D1W5	14	9	S5W18×1.5×29	14	8.2	29	10	22	7
UC324D1W5	14	7	S5W18×1.5×29	14	6.4	29	10	22	7
UC326D1W5	16	9.5	S5W20×1.5×33	16	8.9	33	11	24	7
UC328D1W5	16	8.5	S5W20×1.5×33	16	7.8	33	11	24	7

Remarks: The tolerance for the width (b) of the key way should preferably be set at the range of 0 to +0.2 mm.

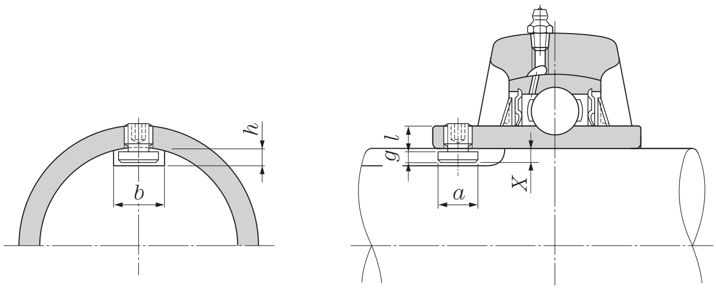


Table 10.3 (b) Key bolt system

A) Metric series, applied to metric bore size.

Designation of bearings	Key way Width b mm	Key way Depth h mm	Designation and size of bolts	a mm	X mm	g mm	l mm
UC201D1W6	6	4.5	S6W5×0.8×5-1	5.9	3.8	3	6
UC202D1W6	6	4.5	S6W5×0.8×5-1	5.9	3.6	3	6
UC203D1W6	6	4.5	S6W5×0.8×5-1	5.9	3.5	3	6
UC204D1W6	7	4.5	S6W5×0.8×5	6.9	3.8	3.2	6
UC205D1W6	7	4.5	S6W5×0.8×5	6.9	3.7	3.2	6
UC206D1W6	8	4.5	S6W6×0.75×6	7.9	3.7	3.2	7
UC207D1W6	8	4.5	S6W6×0.75×6	7.9	3.7	3.2	7
UC208D1W6	10	5	S6W8×1×7	9.9	4.2	3.6	8
UC209D1W6	10	5	S6W8×1×7	9.9	4.2	3.6	8
UC210D1W6	10	5	S6W8×1×7	9.9	4.1	3.6	8
UC211D1W6	10	5	S6W8×1×7	9.9	4	3.6	8
UC212D1W6	12	5.5	S6W10×1.25×9	11.9	4.6	4	10
UC213D1W6	12	5.5	S6W10×1.25×9	11.9	4.5	4	10
UC214D1W6	12	5.5	S6W10×1.25×9	11.9	4.5	4	10
UC215D1W6	12	5.5	S6W10×1.25×9	11.9	4.5	4	10
UC216D1W6	12	5.5	S6W10×1.25×9	11.9	4.4	4	10
UC217D1W6	14	6	S6W12×1.5×11	13.9	5.4	4.8	12
UC218D1W6	14	6	S6W12×1.5×11	13.9	5.3	4.8	12
UC305D1W6	8	4.5	S6W6×0.75×6	7.9	3.8	3.2	7
UC306D1W6	8	4.5	S6W6×0.75×6	7.9	3.7	3.2	7
UC307D1W6	10	5	S6W8×1×7	9.9	4.3	3.6	8
UC308D1W6	12	5.5	S6W10×1.25×9	11.9	4.9	4	10
UC309D1W6	12	5.5	S6W10×1.25×9	11.9	4.8	4	10
UC310D1W6	14	6.5	S6W12×1.5×11	13.9	5.8	4.8	12
UC311D1W6	14	6.5	S6W12×1.5×11	13.9	5.7	4.8	12
UC312D1W6	14	6.5	S6W12×1.5×11	13.9	5.6	4.8	12
UC313D1W6	14	6.5	S6W12×1.5×11	13.9	5.6	4.8	12
UC314D1W6	14	6.5	S6W12×1.5×11	13.9	5.5	4.8	12
UC315D1W6	16	7.5	S6W14×1.5×13	15.9	6.7	5.8	14
UC316D1W6	16	7.5	S6W14×1.5×13	15.9	6.6	5.8	14
UC317D1W6	18	8.5	S6W16×1.5×16	17.9	7.5	6.5	17
UC318D1W6	18	8	S6W16×1.5×16	17.9	7.4	6.5	17
UC319D1W6	18	8	S6W16×1.5×16	17.9	7.4	6.5	17
UC320D1W6	20	10.5	S6W18×1.5×18	19.9	9.5	8.5	19
UC321D1W6	20	10.5	S6W18×1.5×18	19.9	9.5	8.5	19
UC322D1W6	20	10	S6W18×1.5×18	19.9	9.4	8.5	19
UC324D1W6	20	10	S6W18×1.5×18	19.9	9.3	8.5	19
UC326D1W6	22	11	S6W20×1.5×25	21.9	10.4	9.5	26
UC328D1W6	22	11	S6W20×1.5×25	21.9	10.4	9.5	26

Note: The tolerance for the width (b) of the key way should preferably be set at the range of 0 to +0.2 mm.

10.2 Eccentric collar system

As in the case of the set screw system, it is usual under normal operating conditions to fit the inner ring onto the shaft by means of a clearance fit, for ease of assembly. **Fig. 10.5** shows the appropriate values of dimensional tolerances for the shaft.

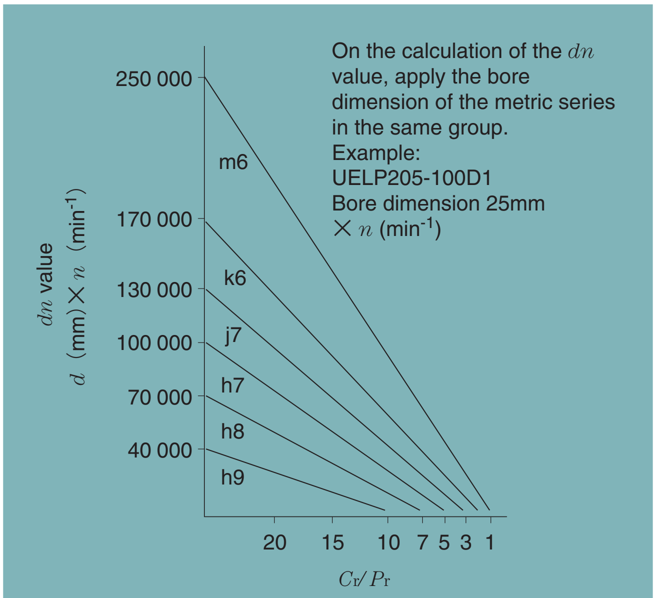


Fig 10.5 Dimensional tolerances for the shaft eccentric collar system bearing units

10.3 Adapter system bearing units

Since in the case of the adapter system, the bearing unit is fastened onto the shaft by means of a sleeve, for dimensional tolerances for the shaft, h9 is applicable under all operating conditions.

Note that it is not usable under a loose fit ≧ h9.

10.4 Mounting method of Take-up type unit

For the guide rail, adjusting bolt and nut of Take-up type unit, dimensions and machining accuracies indicated in **Table 10.4** are appropriate values.

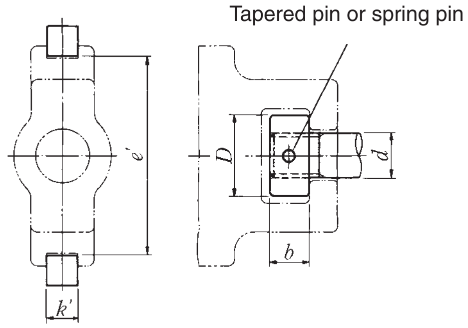


Table 10.4 Dimensions of guide rail, and bolt & nut

Unit: mm

Designation	Dimension and tolerance of guide rail e' Dimension	Tolerance	k'	Dimension of adjusting bolt & nut d	D	b
UCT201～UCT204	76.5	$^{+0.5}_{0}$	11	16	28	12
UCT205	76.5	$^{+0.5}_{0}$	11	16	28	12
UCT206	89.5	$^{+0.5}_{0}$	11	18	32	12
UCT207	89.5	$^{+0.5}_{0}$	11	18	32	12
UCT208	102.5	$^{+0.5}_{0}$	15	25	42	14
UCT209	102.5	$^{+0.5}_{0}$	15	25	42	14
UCT210	102.5	$^{+0.5}_{0}$	15	25	42	14
UCT211	130.5	$^{+0.8}_{0}$	20	30	55	20
UCT212	130.5	$^{+0.8}_{0}$	20	30	55	26
UCT213	151.5	$^{+0.8}_{0}$	24	36	60	26
UCT214	151.5	$^{+0.8}_{0}$	24	36	60	26
UCT215	151.5	$^{+0.8}_{0}$	24	36	60	26
UCT216	165.5	$^{+0.8}_{0}$	24	36	60	26
UCT217	173.5	$^{+1.0}_{0}$	28	42	60	30
UCT305	80.5	$^{+0.5}_{0}$	11	22	32	12
UCT306	90.5	$^{+0.5}_{0}$	15	24	36	14
UCT307	100.5	$^{+0.5}_{0}$	15	26	40	14
UCT308	112.5	$^{+0.5}_{0}$	17	28	45	16
UCT309	125.5	$^{+0.5}_{0}$	17	30	50	18
UCT310	140.5	$^{+0.5}_{0}$	19	32	55	20
UCT311	150.5	$^{+0.8}_{0}$	20	34	60	22
UCT312	160.5	$^{+0.8}_{0}$	20	36	65	24
UCT313	170.5	$^{+0.8}_{0}$	24	38	65	26
UCT314	180.5	$^{+0.8}_{0}$	24	40	70	28
UCT315	192.5	$^{+0.8}_{0}$	24	40	70	28
UCT316	204.5	$^{+0.8}_{0}$	28	46	80	34
UCT317	215	$^{+1.0}_{0}$	30	46	80	34
UCT318	229	$^{+1.0}_{0}$	30	50	90	38
UCT319	241	$^{+1.0}_{0}$	32	50	90	38
UCT320	261	$^{+1.0}_{0}$	32	50	95	40
UCT321	261	$^{+1.0}_{0}$	32	50	95	40
UCT322	286	$^{+1.0}_{0}$	34	55	100	44
UCT324	321	$^{+1.0}_{0}$	40	60	110	50
UCT326	351	$^{+1.5}_{0}$	46	65	115	55
UCT328	381	$^{+1.5}_{0}$	46	70	120	60

11. Handling of the Bearing Unit

11.1 Mounting of the housing

11.1.1 Pillow block type and flange type

Although an advantage of the **NTN** bearing unit is that it can be fitted easily and will function efficiently on any part of a machine, attention must be paid to the following points in order to ensure its normal service life.

1) The surface on which the housing is mounted must be sufficiently rigid.
2) The surface on which the housing is mounted should be as flat as possible (Flatness:0.05 max. The housing should set firmly in its position). Deformation of the housing caused by incorrect mounting will in turn cause deformation of the bearing, leading to its premature breakdown.
3) Angle error between housing mounting face and shaft is desirable to be within ±2˚ (±1˚ for outer ring narrow width type) from relationship with replenishment of grease. For unit with cover, the angle error is desirable to be as small as possible within±1˚ to ensure the sealing performance for the cover.

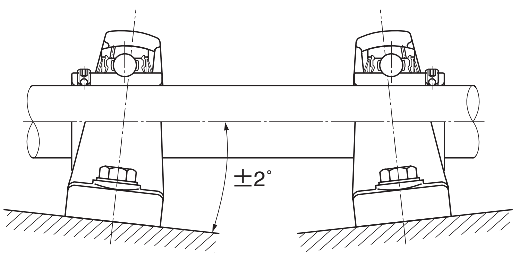


Fig. 11.1

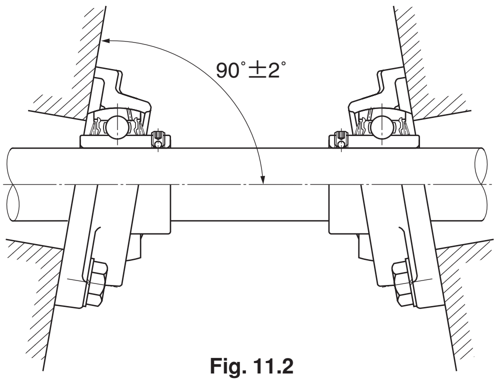


Fig. 11.2

4) Excessive tightening of the mounting bolts may cause the housing to deform. Tightening the bolts to the proper torque can avoid this issue. Also, **NTN** recommends using a washer with the bolt when mounting the housing as the bolt alone may cause damage to the housing.

Table 11.1 (1) Tightening torque of hexagon bolt (Reference value)

Except Resin Housing

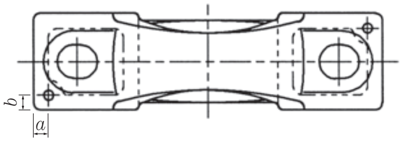
Bolt size	Tightening torques		Bolt size	Tightening torques	
	N·m	lbf·inch		N·m	lbf·inch
M5	1.8~3.0	16~27	M22	158~264	1400~2340
M6	3.0~5.1	27~45	M24	204~340	1800~3000
M8	7.3~12	65~106	M27	294~489	2600~4330
M10	14~24	124~212	M30	401~668	3550~5910
M12	25~41	221~363	M33	539~899	4770~7960
M14	39~66	345~584	M36	697~1160	6170~10300
M16	60~101	531~894	M39	893~1490	7900~13200
M18	84~141	743~1250	M42	1110~1850	9820~16400
M20	118~196	1040~1730	M45	1380~2300	12200~20400

Table 11.1 (2) Tightening torque of hexagon bolt (Reference value)

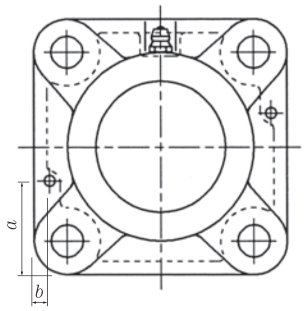
Resin Housing

Housing No.	Bolt size	Tightening torques		Housing No.	Bolt size	Tightening torques	
		N·m	lbf·inch			N·m	lbf·inch
PR204D1	M10	17.7	156	FLR204D1	M10	17.7	156
PR205D1	M10	24.5	217	FLR205D1	M10	24.5	217
PR206D1	M12	29.4	260	FLR206D1	M10	29.4	260
PR207D1	M12	35.3	312	FLR207D1	M12	35.3	312
PR208D1	M12	45.1	399	FLR208D1	M12	40.2	356

5) The pillow block type and flange type housings are provided with a seat for a dowel for accurate location. For the use of dowel pins, refer to **Table 11.2**.



P, C-P



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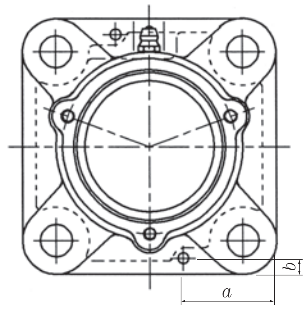
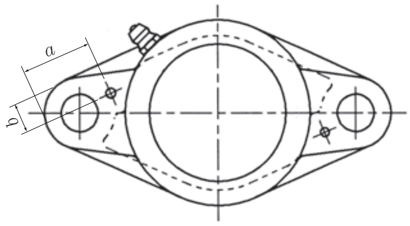


C-F

Table 11.2 Recommended dimensions of dowel pins

Designation of the housings		*a*		*b*		Recommended pin diameter	
		mm	inch	mm	inch	mm	inch
P203	—	5.5	0.216	5.5	0.216	3	0.118
P204	C-P204	5.5	0.216	5.5	0.216	3	0.118
P205	C-P205	5.5	0.216	5.5	0.216	3	0.118
P206	C-P206	5.5	0.216	5.5	0.216	3	0.118
P207	C-P207	5.5	0.216	5.5	0.216	3	0.118
P208	C-P208	7	0.276	7	0.276	5	0.197
P209	C-P209	7	0.276	7	0.276	5	0.197
P210	C-P210	7.5	0.295	7.5	0.295	5	0.197
P211	C-P211	7.5	0.295	7.5	0.295	5	0.197
P212	C-P212	9	0.354	9	0.354	7	0.276
P213	C-P213	9	0.354	9	0.354	7	0.276
P214	C-P214	9	0.354	9	0.354	7	0.276
P215	C-P215	9	0.354	9	0.354	7	0.276
P216	C-P216	10	0.394	10	0.394	7	0.276
P217	C-P217	12	0.472	12	0.472	10	0.394
P218	C-P218	12	0.472	12	0.472	10	0.394
P305	C-P305	8	0.315	8	0.315	4	0.157
P306	C-P306	8	0.315	8	0.315	4	0.157
P307	C-P307	10	0.394	10	0.394	5	0.197
P308	C-P308	10	0.394	10	0.394	5	0.197
P309	C-P309	10	0.394	10	0.394	5	0.197
P310	C-P310	12	0.472	12	0.472	6	0.236
P311	C-P311	12	0.472	12	0.472	6	0.236
P312	C-P312	14	0.551	14	0.551	6	0.236
P313	C-P313	14	0.551	14	0.551	6	0.236
P314	C-P314	14	0.551	14	0.551	6	0.236
P315	C-P315	17	0.669	17	0.669	8	0.315
P316	C-P316	17	0.669	17	0.669	8	0.315
P317	C-P317	17	0.669	17	0.669	8	0.315
P318	C-P318	17	0.669	17	0.669	8	0.315
P319	C-P319	17	0.669	17	0.669	8	0.315
P320	C-P320	17	0.669	17	0.669	8	0.315
P321	C-P321	17	0.669	17	0.669	8	0.315
P322	C-P322	19	0.748	19	0.748	10	0.394
P324	C-P324	19	0.748	19	0.748	10	0.394
P326	C-P326	23	0.906	23	0.906	12	0.472
P328	C-P328	23	0.906	23	0.906	12	0.472

Designation of the housings		*a*		*b*		Recommended pin diameter	
		mm	inch	mm	inch	mm	inch
F204	C-F204	33	1.229	6	0.236	4	0.157
F205	C-F205	35	1.378	6	0.236	4	0.157
F206	C-F206	35	1.378	6	0.236	4	0.157
F207	C-F207	38	1.496	7	0.276	5	0.197
F208	C-F208	40	1.575	8	0.315	5	0.197
F209	C-F209	43	1.693	8	0.315	5	0.197
F210	C-F210	49	1.929	8	0.315	5	0.197
F211	C-F211	49	1.929	8	0.315	5	0.197
F212	C-F212	49	1.929	8	0.315	5	0.197
F213	C-F213	52	2.047	9	0.354	6	0.236
F214	C-F214	52	2.047	9	0.354	6	0.236
F215	C-F215	52	2.047	9	0.354	6	0.236
F216	C-F216	55	2.165	12	0.472	6	0.236
F217	C-F217	55	2.165	12	0.472	6	0.236
F218	C-F218	61	2.402	14	0.551	6	0.236
F305	C-F305	35	1.378	6	0.236	4	0.157
F306	C-F306	40	1.575	6	0.236	4	0.157
F307	C-F307	47	1.805	8	0.315	5	0.197
F308	C-F308	48	1.890	8	0.315	5	0.197
F309	C-F309	48	1.890	8	0.315	5	0.197
F310	C-F310	48	1.890	8	0.315	5	0.197
F311	C-F311	51	2.008	10	0.394	5	0.197
F312	C-F312	51	2.008	10	0.394	5	0.197
F313	C-F313	57	2.244	10	0.394	6	0.236
F314	C-F314	61	2.402	10	0.394	6	0.236
F315	C-F315	65	2.559	8.5	0.335	6	0.236
F316	C-F316	65	2.559	8.5	0.335	6	0.236
F317	C-F317	70	2.756	9	0.354	6	0.236
F318	C-F318	80	3.150	10	0.394	8	0.315
F319	C-F319	80	3.150	10	0.394	8	0.315
F320	C-F320	80	3.150	10	0.394	8	0.315
F321	C-F321	80	3.150	10	0.394	8	0.315
F322	C-F322	90	3.543	10	0.394	8	0.315
F324	C-F324	90	3.543	13	0.512	10	0.394
F326	C-F326	100	3.937	13	0.512	10	0.394
F328	C-F328	108	4.252	13	0.512	10	0.394



FL

Designation of the housings	a mm	a inch	b mm	b inch	Recommended pin diameter mm	Recommended pin diameter inch
FL204	22	0.866	10	0.394	4	0.157
FL205	32	1.260	10	0.394	4	0.157
FL206	33	1.299	12	0.472	4	0.157
FL207	30	1.181	14	0.551	5	0.197
FL208	33	1.299	15	0.591	5	0.197
FL209	38	1.496	15	0.591	5	0.197
FL210	39	1.535	16	0.630	5	0.197
FL211	44	1.732	18	0.709	5	0.197
FL212	54	2.126	19	0.748	5	0.197
FL213	53	2.087	18	0.709	6	0.236
FL214	53	2.087	18	0.709	6	0.236
FL215	55	2.165	21	0.827	6	0.236
FL216	55	2.165	21	0.827	6	0.236
FL217	55	2.165	21	0.827	6	0.236
FL218	55	2.165	22	0.866	6	0.236
FL305	35	1.378	9	0.354	4	0.157
FL306	44	1.732	11	0.433	4	0.157
FL307	43	1.693	13	0.512	5	0.197
FL308	45	1.772	15	0.591	5	0.197
FL309	51	2.008	18	0.709	5	0.197
FL310	55	2.165	15	0.591	5	0.197
FL311	55	2.165	15	0.591	5	0.197
FL312	60	2.363	18	0.709	5	0.197
FL313	59	2.323	24	0.945	6	0.236
FL314	63	2.480	24	0.945	6	0.236
FL315	66	2.598	23	0.906	6	0.236
FL316	72	2.835	27	1.063	6	0.236
FL317	74	2.913	29	1.142	6	0.236
FL318	74	2.913	29	1.142	8	0.315
FL319	80	3.150	30	1.181	8	0.315
FL320	84	3.307	30	1.181	8	0.315
FL321	84	3.307	30	1.181	8	0.315
FL322	84	3.307	36	1.417	8	0.315
FL324	93	3.661	38	1.496	10	0.394
FL326	94	3.701	39	1.535	10	0.394
FL328	102	4.016	40	1.575	10	0.394

11.1.2 Cartridge type

The inside diameter of the housing into which a cartridge type unit is inserted should be H7 under general operating conditions. It should be so furnished as to permit the bearing unit to move freely in the axial direction.

11.2 Mounting the bearing unit on the shaft

11.2.1 Mounting of the set screw system unit

To mount the set screw system bearing unit on the shaft, it is sufficient to tighten the two set screws uniformly.

The construction of the **NTN** "Ball-End Set Screw" is illustrated in **Fig. 11.3** with the pin design that prevents it from becoming loose even when it is subjected to vibrations or impact loads.

If the fit clearance between the inner ring and the shaft is very small, it is advisable, prior to fastening on the screw, to file off that part of the shaft at which the end of the set screw (ball) strikes, by approximately 0.2 to 0.5mm 0.01 to 0.02 inches, to flatten it , as illustrated in **Fig. 11.4**.

This will facilitate dismounting of the bearing from the shaft should it become necessary.

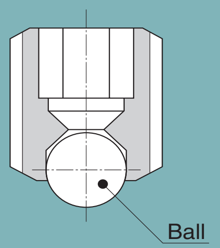


Fig. 11.3

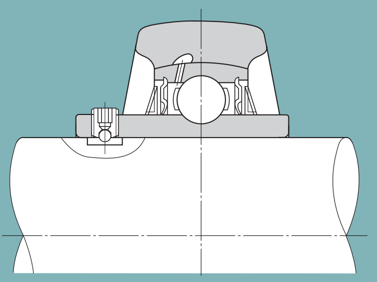


Fig. 11.4

The method of mounting the unit on the shaft is as follows:

1) Make certain that the end of the set screw is not protruding into the bore of the bearing.
2) Holding the unit at right angles to the shaft, insert the shaft into the bore of the bearing without twisting the bearing. Take care not to strike the slinger nor to subject the unit to any shock (**Fig. 11.5**).

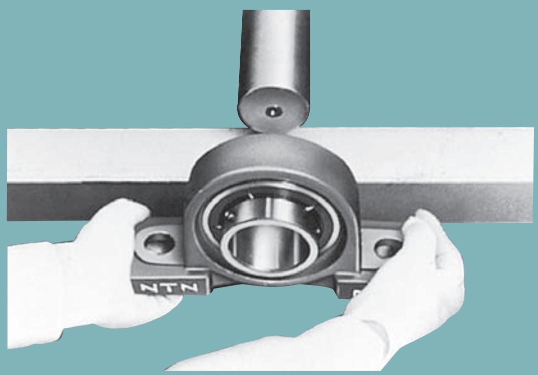


Fig. 11.5

3) Mount housing securely in position on the machine. For the hexagon bolt, tightening torque indicated in **Table 11.1** shall be recommended value.

4) Using tightening torque indicated in **Table 11.3** as a guide, tighten the two set-screws uniformly with a torque wrench (**Fig. 11.6**).

5) Periodic retightning must be done.

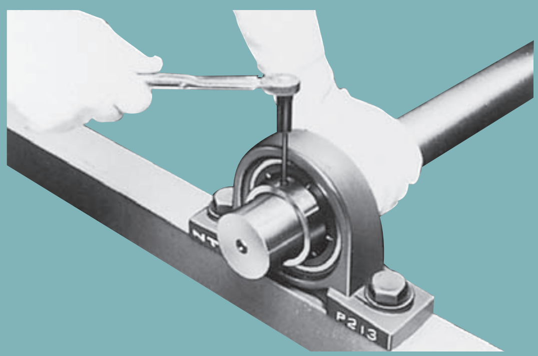


Fig. 11.6

Table 11.3 Recommended torques for tightening set screws

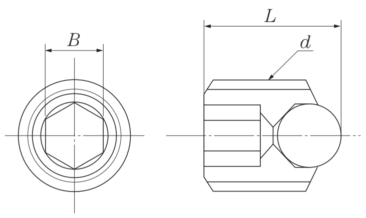
Designation of the bearings of applicable units			Designation of set screws		Tightening torques N·m {lbi} (Max)
			milimeter	inch	
AS201～203	—	—	MSS5	S8W4.826×32×7	3.4 {30}
UC201～205 AS204～205	—	—	MSS5	S8W4.826×32×7	3.9 {35}
UC206 AS206 AR201～206	—	UC305～306	MSS6	S8W1/4×28×8	4.9 {43}
UC207 AS207 AR207	UCX05	—	MSS6	S8W1/4×28×8	5.8 {51}
UC208～210 AS208～210 AR208～210	—	—	MSS8	S8W5/16×24×10	7.8 {69}
UC211	UCX06～X08	UC307	MSS8	S8W5/16×24×10	9.8 {87}
UC212	UCX09	—	MSS10	S8W3/8×24×12	16.6 {147}
UC213～215	—	UC308～309	MSS10	S8W3/8×24×12	19.6 {173}
UC216	UCX10	—	MSS10	S8W3/8×24×12	22.5 {199}
—	UCX11～X12	—	MSS10	S8W3/8×24×12	24.5 {217}
UC217～218	UCX13～X15	UC310～314	MSS12	S8W1/2×20×13	29.4 {260}
—	UCX16～X17	—	MSS12	S8W1/2×20×13	34.3 {304}
—	UCX18	UC315～316	MSS14	S8W9/16×18×15	34.3 {304}
—	UCX20	UC317～319	MSS16	S8W5/8×18×18	53.9 {477}
—	—	UC320～324	MSS18	S8W3/4×16×25	58.8 {520}
—	—	UC326～328	MSS20	—	78.4 {694}

How to securely fix the set screw

In the case that impact load is acting on the bearing unit and the unit is operated continuously under relatively high speed (dn = 30,000 and more) and low load (such as only belt tension), it is possible to securely fix the set screw on the shaft by adding the following method.

① After fixing the housing, hit the housing lightly with a wooden or plastic hummer before tightening the set screw. (To prevent “sticking” of the bearing and the shaft) → To be done between procedure 3) and 4).

② After the test run of the equipment, tighten the set screw further with specified torque as necessary.
→ To be done after procedure 4).



1) Standard ball end set screw (mm size)

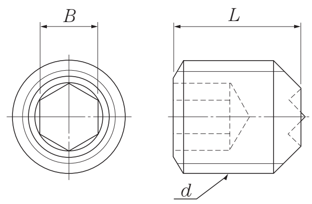
Units: mm

Part No.	d	L	B
MSS 5	M5×0.8	7	2.5
MSS 6	M6×0.75	8	3
MSS 8	M8×1.0	10	4
MSS10	M10×1.25	12	5
MSS12	M12×1.5	13	6
MSS14	M14×1.5	15	6
MSS16	M16×1.5	18	8
MSS18	M18×1.5	20	8
MSS20	M20×1.5	25	10

2) Standard ball end set screw (inch size)

Units: mm

Part No.	d	L	B
S8W 4.826×32×7	No.10-32UNF	7	2.381
S8W 1/4×28×8	1/4 -28UNF	8	3.175
S8W 5/16×24×10	5/16 -24UNF	10	3.969
S8W 3/8×24×12	3/8 -24UNF	12	4.762
S8W 1/2×20×13	1/2 -20UNF	13	6.350
S8W 9/16×18×15	9/16 -18UNF	15	6.350
S8W 5/8×18×18	5/8 -18UNF	18	7.938
S8W 3/4×16×25	3/4 -16UNF	25	9.525



3) Stainless set screw

Units: mm

Part No.	d	L	B	Designation of bearing of applicable units
F-S7W5x0.8x6	M5x0.8	6	2.5	F-UC204～205
F-S7W6x0.75x6.5	M6x0.75	6.5	3	F-UC206～207
F-S7W8x1x8-3	M8x1.0	8	4	F-UC208～210

11.2.2 Mounting the eccentric locking collar system unit

In this system, unlike the screw system, the shaft and inner ring are fastened together by fastening the eccentric collar in the direction of the rotation of the shaft. They are fastened together securely, and deformation of the inner ring seldom occurs. This system, however, is not recommended for applications where the direction of rotation is sometimes reversed.

Directions for mounting the unit are as follows :

1) Make certain that the frame in which the housing is to be mounted is suitable to the operating conditions with regard to rigidity, flatness, etc.
2) Make sure that the end of the shaft is not burred and that the end of the set screw in the eccentric collar is not protruding from the interior surface of the collar (**Fig. 11.7**).

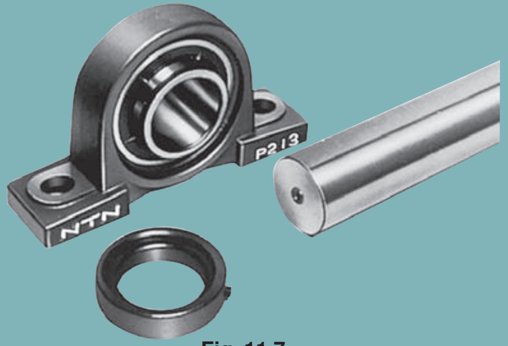


Fig. 11.7

3) Mount the housing of the unit securely onto the frame.
4) Determine the relative position of the unit and the shaft accurately so that the unit will not be subjected to any thrust, and then insert the eccentric collar (**Fig. 11.8**).

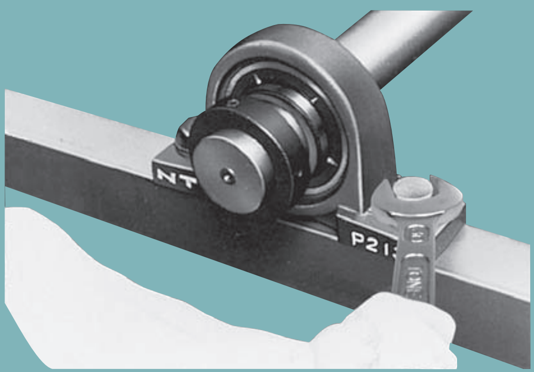


Fig. 11.8

5) Fit the eccentric circular ridge provided on the inner ring into the eccentric circular groove of the eccentric collar, and then provisionally tighten by turning the collar by hand in the direction of the shaft (**Fig. 11.9**).

Fig. 11.9

6) Insert a bar into the hole provided on the periphery of the eccentric collar and tap the bar so that the collar turns in the direction of rotation of the shaft (see **Fig. 11.10**).

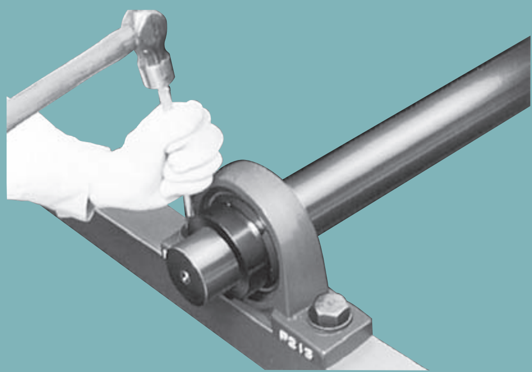


Fig. 11.10

7) Fasten the set screw of the eccentric collar onto the shaft. Recommended tightening torques are given in **Table 11.4**.

Table 11.4 Recommended torques for tightening set screws of the eccentric collar

Designation of the bearings of applicable units			Designation of set screws		Tightening torques N·m {lbi} (Max)
			milimeter	inch	
——	UEL204～205 AEL201～205	JEL201～205 REL201～205	MSS6	S8W1/4×28×8	7.8 {69}
UEL305～307	UEL206 AEL206	JEL206 REL206	MSS8	S8W5/16×24×10	9.8 {86}
——	UEL207 AEL207	JEL207 REL207	MSS10	S8W3/8×24×12	11.7 {104}
——	UEL208～210 AEL208～210	JEL208～210 REL208～210	MSS10	S8W3/8×24×12	15.6 {138}
——	UEL211 AEL211	JEL211 REL211	MSS10	S8W3/8×24×12	19.6 {173}
UEL308～312	UEL212～215 AEL212	JEL212 REL212	MSS10	S8W3/8×24×12	29.4 {206}
UEL313～314	——	——	MSS12	S8W1/2×20×13	34.3 {303}
UEL315～317	——	——	MSS16	S8W5/8×18×18	53.9 {477}
UEL318～322	——	——	MSS20	S8W3/4×16×25	78.4 {694}

11.2.3 Mounting of the adapter system unit

When an adapter system unit is used, there is no danger of the fit between the shaft and the inner ring working loose even if it is subjected to impact loads or vibration. Furthermore, straight shafts may be used under any operating conditions, except where there is a large axial load.

To mount the adapter system unit onto the shaft, the procedure is as follows:

1) Adjust the position of the sleeve so that the tapered part comes to about the center of the bearing. To facilitate the mounting of the sleeve onto the shaft, the opening in the sleeve can be widened using a screw-driver or similar implement. The sleeve should be positioned so that the nut is located on the opposite side from the pulley, etc., for easier handling (**Fig. 11.11**).

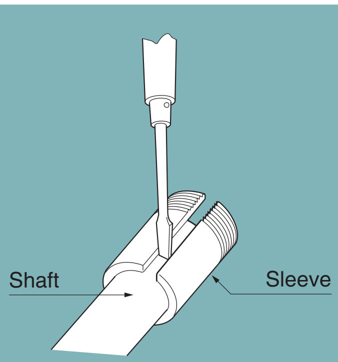


Fig. 11.11

2) Place the bearing unit with the tapered bore properly oriented on the sleeve and abut a cylindrical sleeve against the lock nut side face of the inner ring. Tap the adapter sleeve lightly over its entire periphery, as shown in **Fig. 11.12**, until a positive contact is made between the bearing and the sleeve.

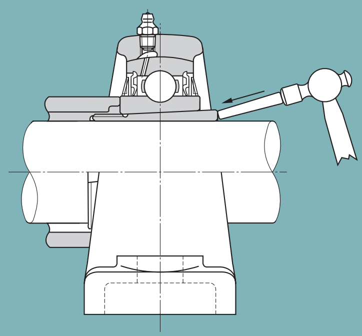


Fig. 11.12

3) Insert the washer and tighten the nut fully by hand.
4) Apply a jig (or screwdriver where no jig is available) to the notch of the nut and tap it with a hammer. Stop tapping after the nut has turned through from 60˚ to 90˚. Be careful not to strike the slinger.
Care should also be taken not to over-tighten the nut, as this will deform the inner ring, causing heat generation and seizure.
5) Bend up the tab on the rim of the washer, which is in line with the notch of the nut. This will prevent the nut from turning. The nut must not be turned backwards to bring the notch into line with the tab on the washer.
6) Mount the housing securely in position on the machine.

Table 11.5 Recommended torques for tightening adapter of UK type

Designation of the bearing	Tightning torque		Tightning torque + Angle N·m {lbi}※1
	N·m	{lbi}	
UK205	49	434	———
UK206	58.8	520	
UK207	78.4	694	58.4 {517}+60°
UK208	88.2	781	
UK209	108	956	
UK210	118	1044	
UK211	157	1390	
UK212	196	1735	
UK213	225	1991	
UK215	294	2602	
UK216	314	2779	
UK217	392	3469	58.4 {517}+90°
UK218	431	3815	
UK305	49	434	———
UK306	78.4	694	58.4 {517}+60°
UK307	98	867	
UK308	118	1044	
UK309	147	1301	58.4 {517}+90°
UK310	196	1735	
UK311	245	2168	
UK312	294	2602	
UK313	323	2859	
UK315	490	4337	
UK316	539	4770	
UK317	637	5638	58.4 {517}+120°
UK318	755	6682	
UK319	833	7372	
UK320	980	8673	
UK322	1372	12143	58.4 {517}+150°
UK324	1670	14780	
UK326	2250	19913	58.4 {517}+160°
UK328	2550	22569	

Note 1) These values are applied to the case of delivery state.
Note 2) Guideline values to be applied in the field work.

11.2.4 Mounting covered bearing units

For selection of the shaft, mounting the bearing onto the shaft and fitting the housing follow the same procedure as for standard bearing units. Furthermore, fitting the cover presents no special difficulty, with no need for special tools or jigs.

The procedure for mounting covered bearing units is as follows:

1) Remove the cover from the bearing unit. The steel cover can usually be removed easily by hand, but should there be any difficulty due to an over-tight fit, insert a screwdriver or similar tool in a twisting motion, as shown in **Fig. 11.13**.

Fig. 11.13

2) In order to augment the dust and waterproofing effects, completely fill the space between the two lips of the rubber seal incorporated in the cover with grease, and apply grease to the inside of the cover, filling about two-thirds of the space. Cup grease is commonly used for this purpose (**Fig. 11.14**).
3) First, pass one of the two grease-packed covers along the shaft, and then slide the bearing unit onto the shaft and fix the inner ring fast on the shaft before tightening the bolts holding the housing. Sometimes these steps are reversed for convenience of assembly. It is recommended that the end of the shaft be chamfered beforehand to avoid damaging the lips of the rubber seal.

Fig. 11.14

4) Next take the cover which has been passed along the shaft and press it into the housing as follows: Be careful not to strike the surface of the steel cover directly with a steel hammer but use a synthetic resin or wood block in between. Do not strike only in one place but tap the cover all the way round until it is firmly seated in the housing. (**Fig. 11.15**)
   The cast iron cover is fastened with three bolts.
5) Pack the second cover with grease as in step 2 and pass it along the shaft. In the case of a blind cover, the recess of the housing should be filled with grease (**Fig. 11.14**).
6) Fit the cover into the recess of the housing using the same procedure as detailed in Step 4) (**Fig. 11.16**).

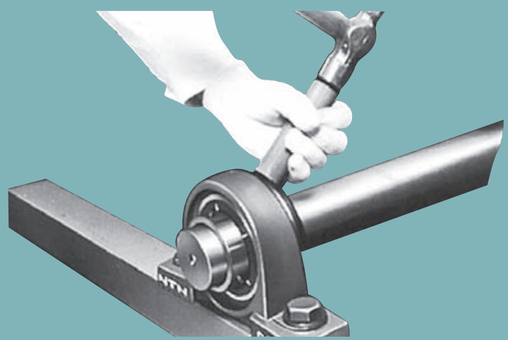


Fig. 11.15

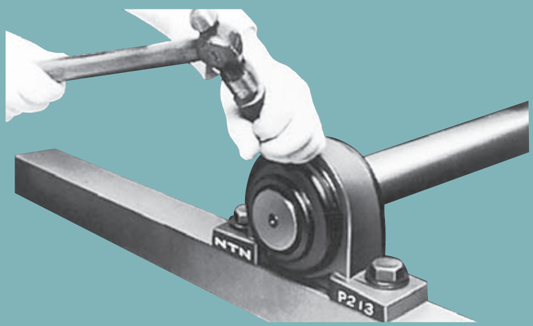
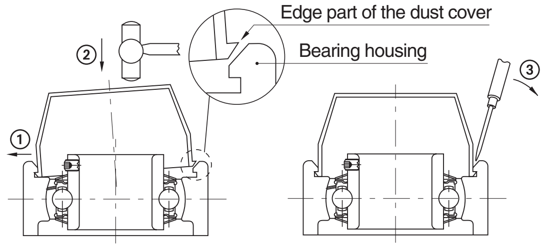


Fig. 11.16

11.2.5 Mounting resin covered bearing units

①Insert the edge of the dust cover in the housing's groove.
②Insert the other side of the dust cover in the opposite housing groove either by hand or with assistance of a plastic/rubber mallet/hammer.
③To remove the dust cover, pry the edge from the housing groove using a screw driver or similar tool.

※Note: frequent mounting/dismounting of the dust cover may damage the edge of the housing and is not recommended.



11.3 Running tests

After mounting the bearing unit, check that it has been done correctly.

First, turn the shaft or the rotor by hand to make certain that it rotates smoothly. If there is no irregularity, start up the machine. Run the machine at low speed under no load and gradually bring it up to full operating speed while checking that there are no abnormalities.

Some indications of abnormality or faulty assembly are as follows:

When the shaft is turned by hand a resistance or drag is felt, or the shaft appears to become heavy or light in turn. Or, if the machine is running under power, any abnormal noise, vibration or overheating is evident.

11.4 Inspection during operation

Although the **NTN** lubrication-free bearing unit does not require refilling with grease while in use, periodic inspections are necessary to ensure safe operation of the unit's most important parts. While the interval between inspections varies from case to case, according to the degree of importance and the rate of operation, it is usually some time between two weeks and a month.

Since the inside of the bearing can be examined only by removing the slinger, seal etc., the condition of the bearing should be judged by checking for the presence of vibration, noise, overheating of the housing, etc., while the machine is running.

11.5 Dismounting the bearing unit

If some abnormality makes it necessary to dismount the bearing unit from the shaft in order to replace it, the procedure used to mount the bearing is followed in reverse order. In this case, special care should be given to the following points:

1) Set screw system units:

If the set screw is protruding into the bore of the bearing when the unit is withdrawn from the shaft, it will damage the shaft. Therefore the screw should be turned back fully.

2) Adapter system units:

To remove an adapter system bearing unit from the shaft, raise the tab of the washer, turn the nut two or three turns back, and apply a metal block to the nut and tap it with a hammer. Do this all round the nut, until the sleeve can be moved (**Fig. 11.17**).

If the nut is turned back too far and the screws are only slightly engaged, tapping to remove it will eventually ruin the screws.

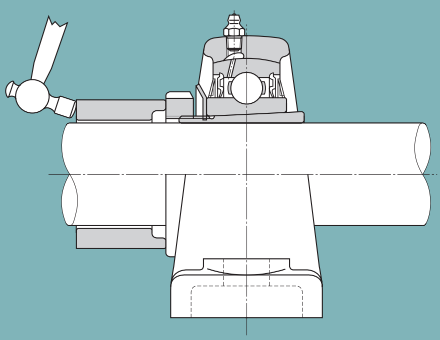


Fig. 11.17

11.6 Replacement of the bearing

If the bearing in the **NTN** bearing unit needs to be replaced, this can be carried out simply with a plummer block. There is no need to replace the housing, as it is reusable.

The bearing is changed using the following procedure: First, the set screw should be tightened as much as possible. Otherwise, there is a danger that it may catch in the housing when the bearing is tilted.

Next, insert the handle of a hammer or similar tool into the bore of the bearing and twist. Tilt the bearing through a full 90, and pull it in the direction of the notch on the housing to remove it. To install a new bearing in the housing, follow the same procedure in reverse.