

1. Features of LDK Ball Bearing Units

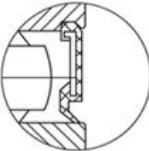


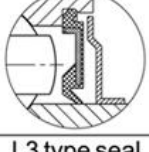
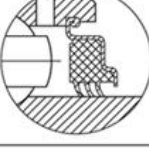

LDK ball bearing units consist of inserts and housings, based on the methods of mounting the units to shafts, they can be divided into four types: the setscrew locking type, the adapter sleeve locking type, the eccentric locking collar type and the concentric locking collar type.

The housings have five types: Cast grey or ductile iron housings, pressed steel housings, thermoplastic housings, stainless steel housings and Zinc alloy die casting housings.

Spherical outside surface self-aligning ball bearing units are compact in design with perfect sealing devices. All LDK ball bearing units have contact-type seals at both sides. The seals will vary according to the different types of bearings. By selecting the sealing devices, which is most suitable to the application and working condition, long bearing life can be guaranteed.

Sealing Devices:

Table 1.

<p>J type seal</p> 	<p>Synthetic rubber is baked to the core piece. It is inserted into the groove of the outer ring and then fitted on the inner ring outer diameter, thus it has low friction, high property in oil resistance and good mechanical stability.</p>
<p>H type seal</p> 	<p>This consists of a pressed steel seal with a vulcanized synthetic rubber sealing lip baked inside. The seal forms a tiny clearance with the outer diameter of the inner ring, thus can provide efficient protection against the dust, sand or other contaminants.</p>
<p>SL type seal</p> 	<p>Oil seal is fixed in the outer ring inner diameter groove, and the slinger is set at the inner ring outer surface. In addition, the simultaneous revolution with inner ring generates the wind pressure for dust-proof property. This constitutes the ideal labyrinth, so effective dust-proof property can be guaranteed.</p>
<p>TJ type seal</p> 	<p>The new design of "Step" slinger not only reinforces the rigidity of slinger but also increase the interior space between slinger and seal. This lead to less friction between slinger and seal when bearing facing pressure and therefore enable the bearing having a better sealing performance than "flat" slinger design.</p>
<p>L3 type seal</p> 	<p>This type consists of a metal cap and synthetic rubber seal, which are baked together to form a single seal. Seal lips have enough tightening allowance. In addition, the lip layers are of triple construction and outside matters, such as dust, water, etc., are shut out. This sealing system shows its outstanding function under bad conditions.</p>
<p>F type seal</p> 	<p>This type encloses a synthetic rubber washer between two metal caps. Due to the three pieces design with protective outer shroud, the sealing is excellent.</p>

2. Ball Bearing Inserts

The spherical outside ball bearing inserts are sealed at both sides. The internal structure dimensions, chromium bearing steel balls and retainers are same as those of the deep groove ball bearings.

2.1 Material of Bearing Rings and Balls.

LDK'S insert ball bearings are available with material of Chromium steel and stainless steel.

2.1.1 Gcr15 Chromium Bearing inserts

The bearing rings and balls are made of GCr15 chromium bearing steel of which the chemical composition are shown in table 2.

Table 2. (%)

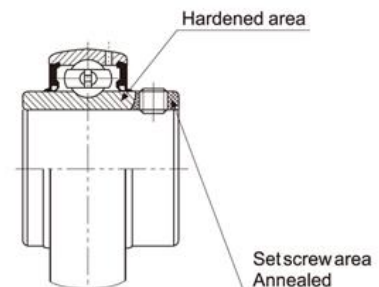
C	Cr	Si	Mn	S	P
0.95-1.05	1.40-1.50	0.15-0.35	0.25-0.45	≤ 0.025	≤ 0.025

The rockwell hardness for bearing rings are HRC59-65, for balls are HRC61-66, with high wear resistance and contact fatigue strength. For the inner ring of the setscrews type bearings, the hardness of the setscrews hole zone on the extended ends are less than HRC50 after annealing (CSB, SER, SB, CSB series).

The inner rings of setscrews type bearings are special heat treated by the induction heating method. Therefore, the raceway of the inner ring is hardened completely through the ring, while the setscrews hole zone on the extended ends of the inner rings are softened (as indicated in drawing).

The bearings have two hardened setscrews with threads which are installed in the soft extension of the inner ring, thread contact is thereby attained for maximum holding power, since they can be sufficiently tightened without causing inner ring cracking.

This special heat treatment ensures the most efficient bearing performance and prevents the setscrews from loosening during operation.



2.1.2 Material of Stainless Steel Bearing Inserts

The bearing rings and balls are made of SUS440 equivalent stainless steel of which the chemical composition are shown in table 3.

Table 3.

Material	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	Ni+Cu
G95Cr18	0.90~1.00	≤0.80	≤0.80	≤0.035	≤0.030	17~19.00	-	≤0.03	≤0.25	≤0.50
G102Cr18Mo	0.95~1.10	≤0.80	≤0.80	≤0.035	≤0.030	16~18.00	0.40~0.70	≤0.03	≤0.25	≤0.50
G65Cr14Mo	0.60~0.70	≤0.80	≤0.80	≤0.035	≤0.030	13~15.00	0.50~0.80	≤0.03	≤0.25	≤0.50

For material of components of stainless steel insert bearings, please see table 4.

Table 4.

DESCRIPTION	MATERIAALS
INNER & OUT RINGS	G95Cr18,G102Cr18Mo,G65Cr14Mo
BALLS	G95Cr18,G102Cr18Mo,G65Cr14Mo
SETScrew	SUS304
RETAINER	SUS304
SLINGER & FRAME	SUS304+Silicone Rubber Seal
GREASE (please check with us for details)	H1 approved food grease or Industry grease
OPERATING TEPERATURE	-20C°~ +120C°

2.2 Bearings Tolerances

2.2.1 Outer Rings Tolerances

The outer rings tolerances, which are shown in Table 5, are the same as those for deep groove bearings.

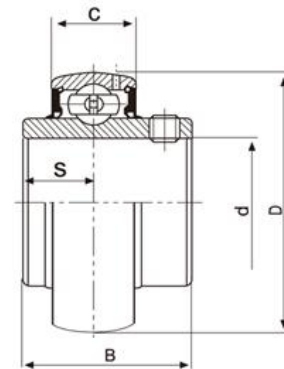
Table 5. Outer rings tolerances (μ m)

D (mm)		ΔDmp		Kea
over	incl.	high	low	max.
30	50	0	-11	20
50	80	0	-13	25
80	120	0	-15	35
120	150	0	-18	40
150	180	0	-25	45
180	250	0	-30	50
250	315	0	-35	60

Notes:(1) ΔDmp = the deviation of a single plane mean
outside diameter of the outer ring.

(2) Kea = Radial runout of assembled bearing outer ring.

(3) D = Nominal outer ring outside diameter.



2.2.2 Inner Rings Tolerances

The inner rings tolerances are different from those of deep groove bearings. The values are shown in Table 6 and Table 7.

1) Tolerances for cylindrical bore bearing inner rings

Table 6. Cylindrical bore inner rings tolerances (μ m)

d (mm)		Δdmp		Kia	ΔBs	
over	incl.	high	low	max.	high	low
10	18	+15	0	12	0	-120
18	30	+18	0	15	0	-120
30	50	+21	0	18	0	-120
50	80	+24	0	22	0	-150
80	120	+28	0	28	0	-200
120	180	+33	0	35	0	-250

Notes: (1) d = Nominal bore diameter

(2) Δdmp = The deviation of a single plane mean bore diameter of the inner rings

(3) Kia = Radial runout of assembled bearing inner ring

(4) ΔBs = The deviation of a single width of inner ring

2) Tapered Bore Inner Rings Tolerances

Table 7. Tolerances on inner rings of tapered bore bearings (μm)

d (mm)		Δdmp		$\Delta\text{d}_{1\text{mp}}-\Delta\text{dmp}$	
over	incl.	high	low	max.	min.
10	18	+27	0	+18	0
18	30	+33	0	+21	0
30	50	+39	0	+25	0
50	80	+46	0	+30	0
80	120	+54	0	+35	0
120	150	+63	0	+40	0

Notes: (1) d = Nominal bore diameter

(2) d_1 = Theoretical diameter of larger end of tapered bore

d_1 is obtained by following formula:

$$d_1 = d + 0.083333 B$$

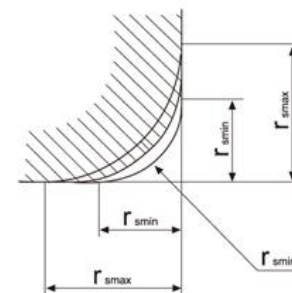
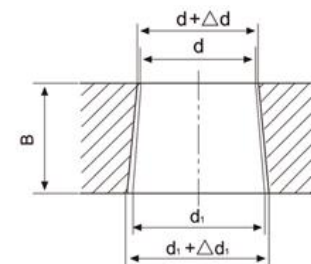
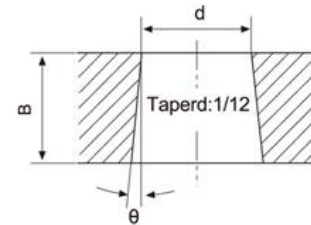
(3) B^1 = Nominal inner ring width

(4) θ = The nominal taper angle = $2^\circ 23' 9.4'' = 2.38594^\circ$

(5) Δdmp = Variation of tolerance of average bore diameter in plane at theoretical small end of tapered bore.

(6) $\Delta\text{d}_{1\text{mp}}$ = Variation of tolerance of average bore diameter in plane at theoretical large end of tapered bore.

(7) $\Delta\text{d}_{1\text{mp}}-\Delta\text{dmp}$ = Variation of tolerance of average bore diameter in planes between theoretical small and large end of tapered bore.



2.2.3 Chamfer Dimensions for Inner Ring

Table 8. Chamfer dimension limits (mm)

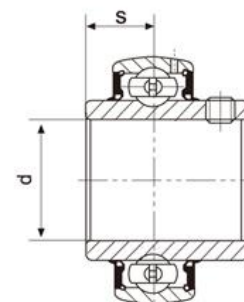
Nominal chamfer dimension r(min)	Radial direction	Axial direction	Chamfer Radius of Shaft r_s (max.)
	max.	max.	
1	1.5	3	1
1.5	2.3	4	1.5
2	3	4.5	2
2.5	3.8	6	2.5
3	5	8	3

2.2.4 Tolerances for Distance "S" From Center Line of Outer Ring to Side of Inner Ring

Tolerances for distance "S" between the radial plane passing through center of spherical surface of outer ring and a side of inner ring are shown in table 9.

Table 9. (μm)

Nominal bore diameter d(mm)		Deviation ΔS
over	incl.	
--	50	± 200
50	80	± 250
80	120	± 300



2.3 Radial Internal Clearance of Bearings

The radial internal clearance for the spherical outside surface ball bearings is usually greater than that of the same sizes of deep groove ball bearings. The clearance for the cylindrical bore bearings is shown in Table 10, While the clearance for the tapered bore bearings is shown in Table 11.

table 10. Radial internal clearance of cylindrical bore bearings (μm)

Nominal bore diameter d (mm)		Clearance (with setscrews or eccentric locking collars)					
		C2		Basic group		C3	
>	-	min.	max.	min.	max.	min.	max.
10	18	3	18	10	25	18	33
18	24	5	20	12	28	20	36
24	30	5	20	12	28	23	41
30	40	6	20	13	33	28	46
40	50	6	23	14	36	30	51
50	65	8	28	18	43	38	61
65	80	10	30	20	51	46	71
80	100	12	36	24	58	53	84
100	120	15	41	28	66	61	97
120	140	18	48	33	81	71	114

Table 11. Radial internal clearance of tapered bore bearings (μm)

Nominal bore diameter d (mm)		Clearance with tapered bore (UK200, UK300)					
		C2		Basic group		C3	
>	-	min.	max.	min.	max.	min.	max.
10	18	10	25	18	33	25	45
18	24	12	28	20	36	28	48
24	30	12	28	23	41	30	53
30	40	13	33	28	46	40	64
40	50	14	36	30	51	45	73
50	65	18	43	38	61	55	90
65	80	20	51	46	71	65	105
80	100	24	58	53	84	75	120
100	120	28	66	61	97	90	140
120	140	33	81	71	114	105	160

Notes: When the internal clearance of a bearing is measured, deformation occurs under loading, Therefore, to obtain the measuring value clearance, add the below correction clearance (see table12)to the radial clearance above.

table 12.

Bore dia. d (mm)		Measuring load	Radial clearance correction amount (μm)		
>	-		C ₂	Normal	C ₃
10	18	25	4	4	5
18	30	50	5	5	6
30	50	50	4	4	5
50	80	100	6	7	7
80	100	150	8	8	9

3. Bearing Housings

LDK's bearing housings are available with Cast grey iron, Cast ductile iron, Stainless steel, Thermoplastic, Stamped steel and Zinc Alloy.

3.1 Material of Housings

3.1.1 Material for Cast Iron Housings

The material for cast iron housing is HT200 (grey iron) and QT400/QT450 (ductile iron) of which the mechanical properties are shown in Table 13.

Table 13-(1).

No.	Major wall thickness of casting piece (mm)	Strain minimum stress σ _b min (σ _b /Mpa)	Hardness (HBS)
HT200	>2.5-10	220	157-236
	>10-20	195	148-222
	>20-30	170	134-200
	>30-50	160	128-192

Table 13-(2).

No.	Tensile strength (σ _b /Mpa)	Yield strength (σ _{0.2} /Mpa)	Hardness (HBS)
	min		For reference
QT400	400	250	130-180
QT450	450	310	160-210

3.1.2 Material of Stainless Steel Housings

The material for Stainless Steel Housing is SUS304 Stainless steel of which the chemical composition are shown in following table 14.

Table 14.

(%)

C	Si	Mn	P	S	Cr	Ni
≤0.07	≤1.00	≤2.00	≤0.035	≤0.030	17.00~19.00	8.00~11.00

3.1.3 Material of Zinc Alloy Housings

Zinc Alloy Die Casting

3.1.4 Material of Thermoplastic housings

The material for thermoplastic housing is mainly reinforced PBT or PA polymer. PP polymer is used for end covers.

3.1.5 Material of stamped steel

Cold rolled steel sheet, Surface with electroplating treatment.

3.2 Tolerances on spherical inside diameter of housing

Table 15. Tolerances on spherical inside diameter of housing (μm)

Nominal spherical inside diameter (mm)		H7		J7		K7	
		Dam		Dam		Dam	
Over	Incl.	High	Low	High	Low	High	Low
30	50	25	0	14	-11	7	-18
50	80	30	0	18	-12	9	-21
80	120	35	0	22	-13	10	-25
120	180	40	0	26	-14	12	-28
180	250	46	0	30	-16	13	-33
250	315	52	0	36	-16	16	-36

Notes

- Dam = (Damax + Damin) / 2
 Damax_Da maximum measured value of Da.
 Damin_Da minimum measured value of Da.
- Dimensional tolerances for spherical inside diameter of housing are classified into H7 clearance fit, K7 for interference fit and J7 for intermediate fit between H7 and K7.
- When H7 fit is applied, the self-aligning bearings are equipped with locking-pins.

3.2.1 The fits between inserts and the housings

Under normal conditions, the fit between insert and housing, which can be supplied by us, is listed as follows:

Table 16.

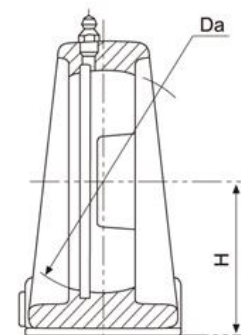
Housings No.	201-209 305-309 X05-X09	210-220 310-328 X10-X20
The fits between inserts and the housings	H7 J7	J7

If not specified, J7 fit will be standard fit for LDK mounted ball bearing units. If other fit or starting torque requirement is required, please check with our sales.

3.2.2 Tolerances for Pillow Block Housings Center Height

Table 17. (mm)

Housings NO.			Deviations ΔH	
Pillow Block	Pedestal Base Pillow Block	Tap Base Pillow Block	High	Low
P201-P210 P305-P310 AK201-AK210 PE201-PE210 PX05-PX09 LP201-LP208	PH201-PH210	PA201-PA210 PG201-PG210 PW201-PW210 PA201A-PA210A	+0.15	-0.15
P211-P218 PE211-PE215 P311-P319 AK211-AK215 PX10-PX17	PH211-PH212	PA211-PA212	+0.20	-0.20
P220 P320-P328			+0.30	-0.30



3.2.3 Tolerances for Flange Type Housings

Tolerances for Flange Type Housings are shown in Table 18.

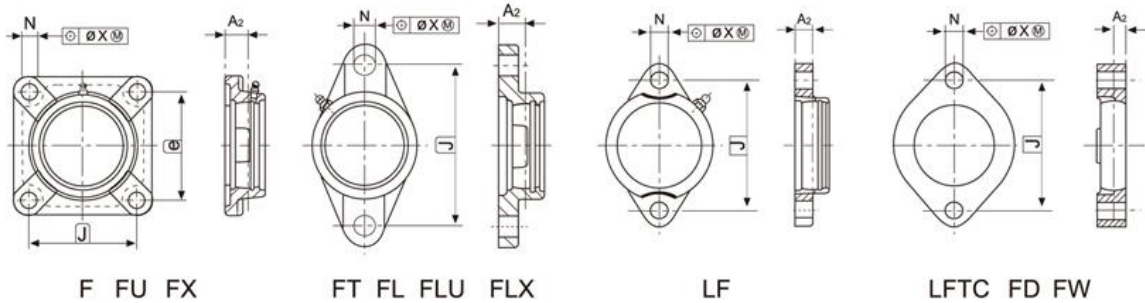


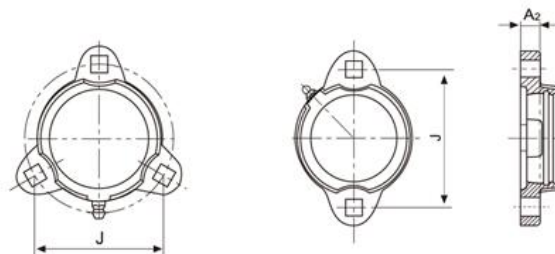
Table 18.

(mm)

Housing No.							Deviations ΔA_2		Tolerances of position for mouting bolt holes
F, FU	F, FL	FL, FT, FLU	FX, FLX	LF	LFTC	FD, FW	high	low	$X \leq$
203	--	203	--	203	203	203	+0.52	-0.52	0.6
204	--	204	--	204	204				
205	305	205	X05	205	205				
206	306	206	X06	206	206				
207	307	207	X07	207	207	207	+0.52	-0.52	0.8
208	308	208	X08	208	208				
209	309	209	X09						
210	310	210	X10						
211	311	211	X11				+0.62	-0.62	0.8
212	312	212	X12						
213	313	213	X13						
214	314	214	X14						
215	315	215	X15						
216	316	216	X16						
217	317	217	X17						
218	318	218	X18						
--	319	--	--				+0.62	-0.62	1.0
	320		X20						
	322								
	324								
	326								
	328								

3.2.4 PFTD, FCT

*Re-lub. Type PFTD, FCT Housings Available too.



(mm)

Housing NO.		Deviations ΔA_2		Tolerances of position for mouting bolt holes
PFTD	FCT	High	Low	ΔJ
203-206	203-206	+0.52	-0.52	± 0.70
207	207			± 0.80

3.2.5 Tolerances for flange cartridge type housings

Tolerances for flange cartridge type housings are shown in Table 19.

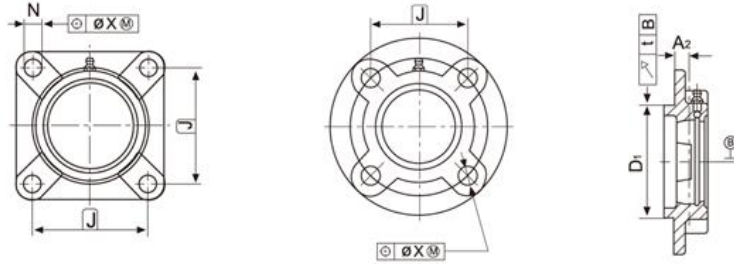


Table 19.

(mm)

Housing No.		Deviations ΔA_2		Deviations ΔD_1		Radial runout of spigot joint	Tolerances of position for mouting bolt holes
FC	FS	high	low	high	low	$t \leq$	$X \leq$
203 204 205 206	305 306	+0.52	-0.52	0	-0.046	0.20	0.60
207 208 209 210	307 308 309 310			0	-0.054		
211 212 213 214 215 216 217	311 312 313 314 315 316 317	+0.62	-0.62	0	-0.063	0.30	0.80
218	318	+0.62	-0.62	0	-0.072	0.30	0.80
	319 320 322 324 326 328	+0.62	-0.62	0	-0.072	0.40	1.00

3.2.6 Tolerances for special type flange units

Tolerances for special type flange units are shown in Table 20.

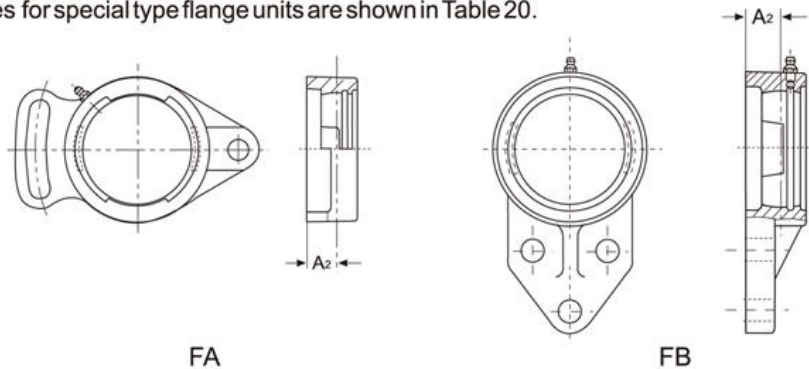


Table 20.

(mm)

Housings No.		Deviations ΔA_2	
FA	FB	High	Low
203-210	203-210	+0.52	-0.52
211-213	211-213	+0.62	-0.62

3.2.7 Tolerances for Cartridge Type Housings

Tolerances for Cartridge Type Housings are shown in Table 21.

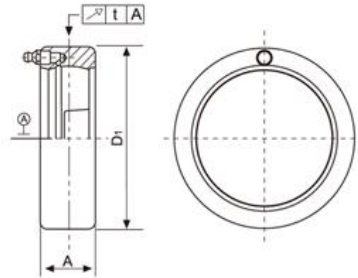


Table 21. (mm)

Housing No.		Deviation of outside diameter ΔL				Radial runout of spigot joint $t \leq$	Deviation ΔA	
		C200		C300			high	low
C	C	high	low	high	low		high	low
203-205	305	0	-0.030	0	-0.035	0.20	+0.20	-0.20
206-208	306-308		-0.035		-0.040			
209-210	309-310		-0.040		-0.046	0.30	+0.25	-0.25
211-213	311-314		-0.046		-0.052			
	315-318		-0.052			0.40	+0.30	-0.30
	319							
	320-322							
	324-328							

3.2.8 Tolerances for Take-up Type Housings

Tolerances for Take-up type housings are shown in Table 22.

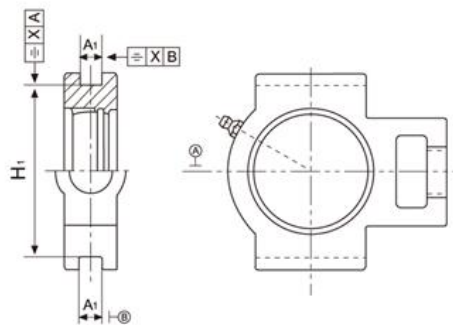


Table 22. (mm)

Housings No.				Deviations ΔA_1		Deviations ΔH_1		Parallelism of sliding slot
T200	ST200	TX	T300	high	low	high	low	$X \leq$
203-210	203-210	05-09	305-310	+0.5	-0.25	+0.25	-0.25	0.50
211-218	211-218	10-17	311-318	+1.0	-0.25	+0.25	-0.25	0.60
			319-322	+1.0	-0.25	+0.25	-0.25	0.70
			324-328	+1.0	-0.25	+0.25	-0.25	0.80

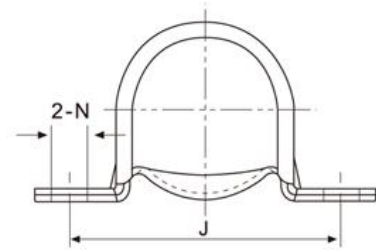
3.3 Pressed Steel Housings

3.3.1 Tolerances for Pressed Steel Pillow Block Type Housings

Tolerances for pressed steel pillow block type housings are shown in Table 23.

Table 23. (mm)

Housing No.	Deviation of mounting bolt hole distance ΔJ		Deviation of mounting bolt hole diameter ΔN	
	high	low	high	low
PP203	+0.40	-0.40	+0.50	-0.50
PP204				
PP205				
PP206				
PP207				
PP208				
PP209				



3.3.2 Tolerances for Pressed Round and Oval Flange Type Housings.

Tolerances for pressed steel round and oval flange type housings are shown in Table 24.

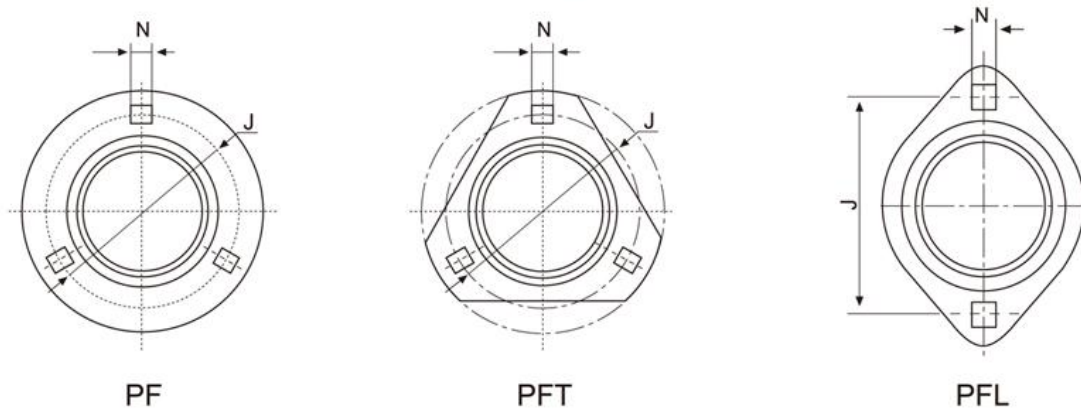


Table 24. (mm)

Housings No.	Tolerances of position for mounting bolt holes ΔJ		Deviation of length of square for mounting bolt holes ΔN	
	high	low	high	low
PF203 PF203 PFL203	+0.40	-0.40	+0.25	-0.25
PF204 PF204 PFL204				
PF205 PF205 PFL205				
PF206 PF206 PFL206				
PF207 PF207 PFL207				
PF208 PF208 PFL208				
PF209				
PF210				
PF211				
PF212				

4. Selection of Ball Bearing Units

The bearing size is usually selected according to the required bearing life and reliability under a specified type of load charged on the bearing.

The load applied to the bearing operating under a static or slow oscillating and rotating ($n < 10\text{r/min}$) condition is defined as static load, while the load applied to the bearing operating under a speedy rotating ($n > 10\text{r/min}$) condition is defined as dynamic load.

The load capacity of the bearing is expressed by the basic dynamic load rating and basic static load rating which is shown in the bearing table. (B120~B141)

Usually, the important factor of the selection of a rolling bearing is life calculation, which refers to fatigue life of the bearing. When bearing is under proper usage- appropriate load capacity, correct installation, good lubrication, the fatigue flake of rolling surface caused by alternating contact stress is the main element of bearing failure and this damage to the bearing can not be avoided completely.

Due to different application of each machinery and different requirement of the bearing, bearing could only be required to keep a certain kind of performance level during a specified period. After some time of working, factors like increased noise & vibration, declined precision caused by wear, grease aging will result in bearing failure or can not satisfy the requirement of the machine. These type of life before bearing failure are called noise life, wear life and grease life.

Besides life, bearing failure may occur for the reason of burning, breakage, crack, seal failure etc which should be regarded as bearing malfunction. Bearing malfunction occurs because of improper selection of bearing, poor design of machinery, improper installation & usage and maintenance mistake which should be distinguished from bearing life.

4.1 Basic Load Rating and Life

Basic dynamic load rating: The basic dynamic load rating is defined as the constant load applied to a bearings with stationary outer rings that the inner rings can endure for a rating life of one million revolutions (10^6 rev.).

Life: The life of a rolling bearing is defined as the total number of revolutions which the bearing is capable of enduring before the first evidence of fatigue flaking develops on any one of the rings or rolling elements.

Reliability: The reliability is the percentage of the bearing of a group of apparently identical bearings operating under identical conditions which can expect to attain or exceed a certain defined life. The reliability of an individual bearing is the probability of the bearing to attain or exceed a defined life.

Basic rating life L_{10} : For a group of apparently identical rolling bearings operating under identical conditions, the basic rating life is defined as the total number of revolutions that 90% of the bearings can be expected to complete or exceed.

The basic rating life L_{10} estimation for ball bearings with different speeds and ratios is shown in page A27~A28.

4.2 Bearings Selection According to Basic Dynamic Load Rating

4.2.1 Basic Rating Life

The fatigue rating of deep groove ball bearings is calculated by following formula:

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

$$\text{or } \frac{C_r}{P_r} = L_{10}^{1/3}$$

Where L_{10} = basic rating life (10^6 r)

C_r = basic dynamic load rating (N)

P_r = equivalent dynamic bearing load (N)

The basic dynamic load rating C is a hypothetical constant load with a fixed direction under which the bearing can attain a basic rating life of one million revolutions. For radial bearing, the load refers to the radial load.

The equivalent dynamic bearing load P is a constant load with a fixed direction under which the bearing life is identical to that of the bearing operating under actual load.

For a bearing operating with a constant rotation speed, the basic rating life can be expressed in terms of operating hours:

$$L_{10h} = \frac{10^6}{60n} \left(\frac{C}{P} \right)^3$$

or

$$L_{10h} = \frac{10^6}{60n} L_{10}$$

$$= \frac{16666}{n} \left(\frac{C}{P} \right)^3$$

Where L_{10h} = basic rating life (h)

n = bearing operating speed of rotation (r/min)

For easier calculation, 500 hours as base of rating life is taken,

and the speed factor f_n and the life factor f_L is introduced:

$$f_n = \left(\frac{33\frac{1}{3}}{n} \right)^{1/3}$$

$$f_L = \left(\frac{L_{10h}}{500} \right)^{1/3}$$

In this way, the formula is simplified to

$$C = \frac{f_L}{f_n} P$$

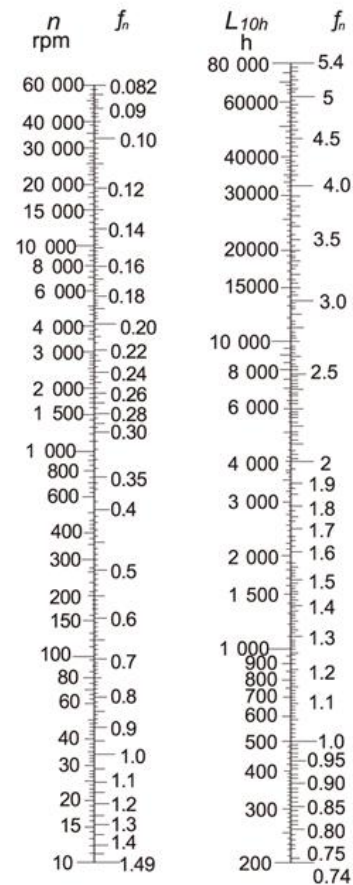


Fig.1

The values of f_n and f_L can be found in Fig. 1 by referring to the operation speed n and the anticipated bearing service life L_{10h} . Then, with the radial load (or the equivalent dynamic bearing load), the basic dynamic load rating can be determined. By this way, the bearing size can be determined according to the basic dynamic load rating value in the bearings Table. (B120~B141)

If the bearing operates under indeterminate loads and rotation speed, the following formula should be applied when calculating the bearing life:

$$P_m = \sqrt[3]{\frac{1}{N} \int_0^N P^3 dN}$$

Where P_m = mean equivalent dynamic bearing load (N)

P = equivalent dynamic bearing load (N)

N = total revolution numbers within one load changing cycle (r)

4.2.2 Anticipated Bearing Service Life

When selecting a bearing, one should usually predetermine an appropriate service life according to the relevant machine type, operating conditions and reliability requirement. Generally speaking, the anticipated bearing service life can be determined by referring to the maintenance period of a machine.

4.2.3 Calculation Method of Equivalent Dynamic Bearing Load P

The basic equivalent dynamic bearing load is determined under a hypothetical condition. When calculating the bearing life, the actual load has to be converted into equivalent dynamic bearing load which is in conformity with the load condition determining the equivalent dynamic load rating.

General equation for calculating the equivalent dynamic bearing load:

$$P = X F_r + Y F_a$$

Where P = equivalent dynamic bearing load (N)

F_r = actual radial load (N)

F_a = actual axial load (N)

X = radial factor

Y = axial factor

The values of X and Y are determined by the ratio between the applied axial load F_a and the basic static load rating C_0 . The axial load which the spherical outside surface bearings can carry is determined by the mounting method of the bearing on the shafts.

For the setscrews locking type or eccentric locking collar type bearings, if flexible shafts are applied and the setscrews are tightened enough (See Table 38 on page A25 for reference torque), the axial load F_a which the bearing can carry must not surpass 20% of the radial load F_r .

For the adapter sleeve locking type bearing, if the nuts are properly tightened, the axial load F_a can be maximum 15% to 20% of the radial load.

The values of radial and axial factors X and Y for spherical outside surface ball bearings can be obtained from the following table:

Table 25.

$\frac{F_a}{C_0}$	$\frac{F_a}{F_r} - e$ $P = F_r$		Clearance for group 2			Clearance for normal group			Clearance for group 3		
			$\frac{F_a}{F_r} > e$		e	$\frac{F_a}{F_r} > e$		e	$\frac{F_a}{F_r} > e$		e
			X	Y		X	Y		X	Y	
0.025	1	0	0.56	2.0	0.22	0.46	1.75	0.31	0.44	1.42	0.4
0.04	1	0	0.56	1.8	0.24	0.46	1.62	0.33	0.44	1.36	0.42
0.07	1	0	0.56	1.6	0.27	0.46	1.46	0.36	0.44	1.27	0.44
0.13	1	0	0.56	1.4	0.31	0.46	1.30	0.41	0.44	1.16	0.48
0.25	1	0	0.56	1.2	0.37	0.46	1.14	0.46	0.44	1.05	0.53

When twist load is applied to the bearings, the equivalent dynamic bearing load is calculated by:

$$P_m = f_m \cdot P$$

Where P_m = equivalent dynamic bearing load when considering twist load

f_m = twist load factor, which is defined as follows:

when the twist load is small: $f_m = 1.5$

when the twist load is big: $f_m = 2$

When shocking load is applied to the bearings, the equivalent dynamic bearing load can be calculated by the following equation:

$$P_d = f_d \cdot P$$

Where P_d = equivalent dynamic bearing load when considering shocking load

f_d = shocking load factor, which is defined as follows:

When no shocking load or minor shocking load is applied:

$$f_d = 1 \sim 1.2$$

When adequate shocking load is applied;

$$f_d = 1.2 \sim 1.8$$

4.3 Example of bearing size selection

One ball bearing is to operate at a rotation speed of 1000 r/min under only a radial load of $F_r = 3000$ N, with a basic rating life of at least 20000 hours, select the bearing size.

From the required rotation speed, it can be found that:

$$f_n = 0.322 \text{ (Fig 1 . shows about 0.32)}$$

From the required basic rating life (anticipated service life), at least 20000 hours, it can be found that:

$$f_n = 3.42 \text{ (Fig 1 . shows about 0.34)}$$

Under only a radial load, i. e.,

$$P = F_r = 3000(\text{N})$$

Therefore,

$$\begin{aligned} C &= \frac{f_n}{f_n} P \\ &= \frac{3.42}{0.322} \times 3000 = 31863(\text{N}) \end{aligned}$$

A simplified way to calculate the bearing life can be applied by using Fig 2.

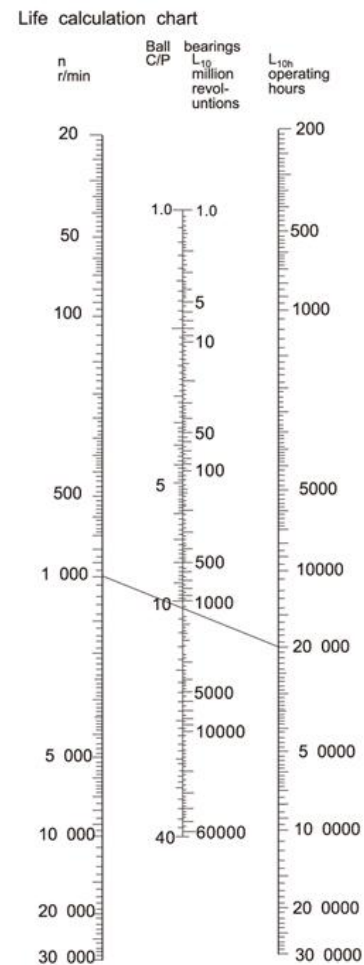


Fig.2

By connecting n (1000r/min) and the required basic rating life L_{10h} (20000 hours) with a straight line, it can be found that C/P value 10.6 , As known, $P = F_r = 3000(N)$, thus the required basic dynamic load rating is :

$$\begin{aligned}\frac{C}{P} &= 10.6 \\ C &= 10.6P \\ &= 10.6 \times 3000 = 31800 (N)\end{aligned}$$

In this way, we can select the bearing from the bearing table (Please refer to page B120-B141)

4.4 Adjusted Rating Life Equation

The basic rating life L_{10} calculated with the bearing life calculation formula can be applied to calculate the rating life of bearing made of ordinary bearings steel (i. e., bearing life with reliability of 90%.)

Due to more and more of machinery products demanding higher reliability and better quality steel , GB/T6391-1995 (equalling to ISO281:1990) suggested an adjusted rating life calculation equation , i. e.,

$$L_{na} = a_1 \cdot a_2 \cdot a_3 \cdot L_{10}$$

For the deep groove ball bearings:

$$L_{na} = a_1 \cdot a_2 \cdot a_3 \left(\frac{C}{P} \right)^3$$

Where L_{na} = under specified material and lubricating conditions , bearing life with (100-n)% no breaking probability (i.e. reliability)

a_1 = life adjustment factor for reliability (Table 26.)

a_2 = life adjustment factor for materials (Table 27.)

a_3 = life adjustment factor for operating conditions (Table 28.)

Table 26. Life adjustment factors for reliability a_1

Reliability%	90	95	96	97	98	99
L_n	L_{10}	L_5	L_4	L_3	L_2	L_1
a_1	1	0.62	0.53	0.44	0.33	0.21

Table 27. Life adjustment factors for materials a_2

Normal chromium bearing steel	$a_2=1$
Special smelted bearing steel- vacuum degassed bearing steel ($a < 31$)	$a_2>1$
When material hardness lowered by high frequency tempering	$a_2<1$

Table 28. Life adjustment factors for operating conditions a_3

When under normal operating conditions, i. e. : Properly mounted; sufficiently lubricated; Without outside matters intrusion.	$a_3=1$
When under operating temperature, the ball bearing lubricating grease viscosity is lower than $13\text{mm}^2/\text{s}$. The bearing operating under lower speed $D_{pw} \cdot n < 10000 (\text{mm} \cdot \text{r}/\text{min})$. D_{pw} = pitch circle diameter of rolling elements.	$a_3<1$

5. Lubrication and Operating Temperature

5.1 Lubricants

The industry lithium based N0.2 lubricating grease defined in GB7324 "Lithium based lubricant grease" is filled in the spherical outside surface ball bearings during manufacturing. Its physical and chemical properties are shown in table 29.

Table 29.

Density (1/10mm)	Without operation	265~295
Dropping point (°C)		≥175
Mechanical impurities (pc/cm ³)	10-25 μm 25-75 μm 75-125 μm above 125 μm	Within 5000 Within 3000 Within 500 0

5.2 Operating Temperature.

The bearings usually operate below the temperature of 120 °C (the measuring temperature of the outer ring is 100 °C). Grease life reduction has to be taken into account when the bearings continue to operate at a temperature above 70 °C. The lowest operating temperature should not be lower than -20 °C.

For higher or lower temperature application , please consult us for further information.

5.3 Relubricate Period

Under normal operating condition, the grease should conform to the life of the bearings. Relubricatable type bearing units must be periodically greased to assure long life.

The greasing interval is dependent on the bearing running speed, operating temperatures and ambient conditions.

The following table shows the standard relubrication period.

Table 30.

dn Value	Cleanliness	Temperature		Greasing interval
		°C	°F	
40,000 and below	Clean	-15~65 Up to 65~100	+5~150 Up to 150~210	6 to 12 months 2 to 6 months
Up to 40,00 ~70,000 and below	Clean	-15~65 Up to 65~100	+5~150 Up to 150~210	2 to 6 months 1 month
Any dn value	Dirty	Up to 65 Over 65	Up to 150 Over 150	1 week. to 1 month 1 day to 2 weeks.
Any dn value	Very Dirty	Any temp	Any temp	1 day to 2 weeks.
Any dn value	Exposed to water splashes	Any temp	Any temp	Every day

5.4 Grease Fittings

The grease nipples supplied by LDK bearing units are classified as A type (straight), B type (type 45°) and C type (type 90°) made of brass, A3 steel. Grease nipple types for LDK standard bearing units are given in table 31. The availability of the grease nipple dimensions and designation to each type are M6x1, M8x1, M10x1, 1/4-28UNF, NPT 1/8 and G1/8, as given in table 32. If any other grease fitting is required, the customers are required to specify dimensions and designations.

Table 31. Grease nipple types for LDK standard bearing units

Housings No.	Grease fitting type and dimension
203~210 305~309 X05~X09	A Type, M6x1
211~218 310~320 X10~X20	A Type, M8x1
322-328	A Type, M10x1

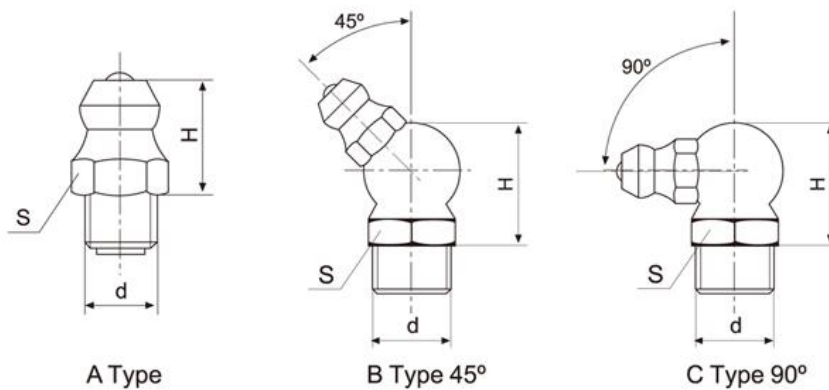


Table 32. Grease nipple dimensions and designations of applicable bearing units

Grease fitting Type	d	H(mm)	S(mm)
A type	M6x1	8	7
	M8x1	9	10
	M10x1	10	11
	1/4-28UNF	8	7
	G1/8	10	11
	NPT1/8	10	11
B type 45°	M6x1	15	10
	M8x1	15	10
	1/4-28UNF	15	10
	G1/8	15	11
C type 90°	M6x1	15	10
	M8x1	15	10
	1/4-28UNF	15	10
	G1/8	15	11

6. Limiting Speed

The limiting speed of the ball bearing units are mainly determined by the fit between the bearings and the shafts. Under normal conditions, the fit for the setscrews type and eccentric locking collar type bearing unit is h7. h8 or h9 fit is applied when with light load and slow speed, while tighter fit j7 is applied when with heavy load and high speed. The shaft applied to the adapter sleeve bearing is h9 class, with IT5 class tolerances.

The speed ratings for ball bearing UD200(-2RS) series are the same as deep groove ball bearings which are shown in Table 33.

The limiting speeds for the ball bearing units with different fits are shown in Table 33.

Table 33. Limiting Speed (r/min)

d (mm)	200 Series				300 Series				CS200-2RS
	Shaft Tolerances				Shaft Tolerances				
	j7(h9/IT5)	h7	h8	h9	j7(h9/IT5)	h7	h8	h9	
12	6700	5300	3800	1400	--	--	--	--	--
15	6700	5300	3800	1400	--	--	--	--	11000
17	6700	5300	3800	1400	--	--	--	--	10000
20	6000	4800	3400	1200	--	--	--	--	9000
25	5600	4000	3000	1000	5000	3600	2600	900	8000
30	4500	3400	2400	850	4300	3000	2200	800	6700
35	4000	3000	2000	750	3800	2800	2000	700	6000
40	3600	2600	1900	670	3400	2400	1700	630	5600
45	3200	2400	1700	600	3000	2200	1500	560	5000
50	3000	2200	1600	560	2600	2000	1400	500	4800
55	2600	2000	1400	500	2400	1800	1300	450	--
60	2400	1800	1200	450	2200	1700	1100	430	--
65	2200	1700	1100	430	2000	1500	1100	400	--
70	2200	1600	1100	400	1900	1400	1000	360	--
75	2000	1500	1000	380	1800	1300	900	340	--
80	1900	1400	950	340	1700	1200	850	320	--
85	1800	1300	900	320	1600	1100	800	300	--
90	1700	1200	800	300	1500	1100	750	280	--
95	--	--	--	--	1400	1000	700	260	--
100	--	--	--	--	1300	950	670	240	--
105	--	--	--	--	1200	900	630	220	--
110	--	--	--	--	1200	800	600	200	--
120	--	--	--	--	1100	750	530	190	--
130	--	--	--	--	1000	670	480	180	--
140	--	--	--	--	900	600	430	160	--

Note: The h9/IT5 column fit for adapter sleeve type ball bearing units, and the rest j7 ~ h9 column fit for the setscrews type and eccentric locking collar type ball bearing units.

7. Shaft Design

The ball bearing units are provided with two hexagonal setscrews 120° apart on one side of the inner rings. Under normal operating conditions, the inner rings are mounted on shafts by means of a loose fit to ensure convenience of installation. In this case, the dimensional accuracy of the shafts is shown in Table 34.

Table 34. Dimensional accuracy of the shafts to be used in the cylindrical bore bearings (Loose fit) (μ m)

Shaft Diameter (mm)		Deviation of tolerance in shaft									
		for lower speed		for medium speed		for rather high speed		for high speed			
		h9		h8		h7		j6		h6	
over	incl.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.
10	18	0	-43	0	-27	0	-18	+8	-3	0	-11
18	30	0	-52	0	-33	0	-21	+9	-4	0	-13
30	50	0	-62	0	-39	0	-25	+11	-5	0	-16
50	80	0	-74	0	-46	0	-30	+12	-7	0	-19
80	120	0	-87	0	-54	0	-35	+13	-9	0	-22

When the ball bearing units are used at a high speed or under heavy load, the inner rings of the ball bearings should be mounted to the shafts by means of a tight fit. As shown in Table 35.

Table 35. Dimensional accuracy of the shafts to be used in the cylindrical bore bearings (Tight fit) (μ m)

Shaft Diameter (mm)		Deviation of tolerance in shaft							
		for higher speed		for rather heavy load		for highest speed		for heavy load	
		m6		m7		n6		n7	
over	incl.	max.	min.	max.	min.	max.	min.	max.	min.
10	18	+18	+7	+25	+7	+23	+12	+30	+12
18	30	+21	+8	+29	+8	+28	+15	+36	+15
30	50	+25	+9	+34	+9	+33	+17	+42	+17
50	80	+30	+11	+41	+11	+39	+20	+50	+20
80	120	+35	+13	+48	+13	+45	+23	+58	+23

Some bearings can be installed to the shafts by means of adapter sleeves. In this method, the bearing bore is made of 1:12 taper and the corresponding tapered adapter sleeves are applied. This is a convenient method that can be used as the intermediate bearings of a long shaft. In this case, the dimensional accuracy of shafts is shown in Table 36.

Table 36. Dimensional accuracy of shafts to be used in tapered bore bearings (μm)

Shaft Diameter (mm)		Deviation of tolerance in shaft			
		for short shaft		for long shaft	
		h9		h10	
over	incl.	max.	min.	max.	min.
10	18	0	-43	0	-70
18	30	0	-52	0	-84
30	50	0	-62	0	-100
50	80	0	-74	0	-120
80	120	0	-87	0	-140

Most industrial fans operate at high speeds. The inner ring of the ball bearing units should be mounted to the shafts by means of h5 or j5 fit, As shown in table 37.

Table 37. Dimensional accuracy of shafts for HVAC industry (μm)

Shaft Diameter (mm)		Deviation of tolerance in shaft			
		h5		j5	
		max.	min.	max.	min.
over	incl.	max.	min.	max.	min.
18	30	0	-9	+5	-4
30	50	0	-11	+6	-5
50	80	0	-13	+6	-7
80	100	0	-15	+6	-9

8. Mounting of Bearings on Shafts

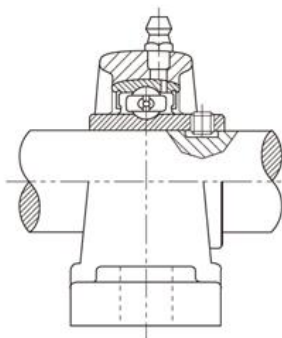
8.1 Setscrews Locking Type Bearings

There are two setscrews located at two places on one side of the wide inner ring 120° apart with which the bearings can be mounted to the shafts. When mounting the bearings to the shafts, the torque shown in the table 38 is recommended to tighten the setscrews to shafts.

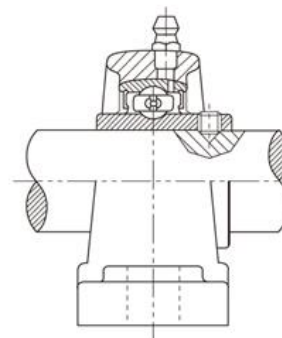
Table 38. Proper tightening torque of setscrews

Bearings No.		Setscrews (mm)	Tightening torque N•m(max)	Setscrews (in.)	Tightening torque 1bf•in(max)
UC201~UC203	SB201~SB204	M5X0.8	3.9	10-32UNF	32
UC204~UC206	UC305~UC306	M6X1	4.9	1/4-28UNF	43
UC207~UC209	UC307	M8X1	8.0	5/16-24UNF	70.5
UC210~UC213	UC308~UC309	M10X1.25	16.8	3/8-24UNF	148
UC214~UC218	UC310~UC314	M12X1.25	27.1	7/16-20UNF	235
	UC315~UC316	M14X1.5	34.3	1/2-20UNF	300
	UC317~UC319	M16X1.5	54.2	5/8-18UNF	478
	UC320~UC324	M18X1.5	58.0	5/8-18UNF	496
	UC326~UC328	M20X1.5	78.0		

In case of either the vibration is caused to the bearing: or 1) the alternating movement takes place, 2) the load applied to the bearings is large, 3) The shafts rotation speed is rapid, it is desired to provide with the filed seat or concave section at the part where the setscrews contact with the shafts. As shown in Fig. 3.



File the shaft surface where the setscrews are positioned



Make a concave section at the shaft surface where the setscrews are positioned

Fig. 3

8.2 Adapter Sleeves Locking Type Bearings

The inner ring bore of this type of bearings has a taper of 1 : 12. The sleeves are installed to an arbitrary position. After the shake proof washers are inserted, the correct nuts tightening condition can be obtained if they are tightened enough by hand and then rotated by 2/5 to 3/5 revolution with a spanner.

After tightening the nuts, bend the shake proof washers within the slots. Otherwise, the nuts may loosen and creep may happen between the shaft and sleeves.

8.3 Eccentric Locking Collar Type Bearings

The eccentric part of the collars mates with the inner rings of the bearings which is made eccentric with the collars. When locked to the shafts by hand in direction of the shafts rotation, the eccentric locking collars tighten automatically to the shafts by force of working radial loads. Then, lock the setscrews provided on the collar to fix the eccentric collars to the shafts.

8.4 Mounting Method of Housings

The desired installation order is: first install the housing, then the shaft and bearing. The bearing units can be easily installed, in principle, at any place. However, in order to have a long service life, it is desired that the mounting base is flat and rigid.

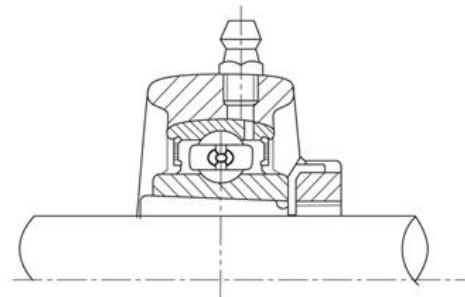


Fig.4.

The pillow block type and flange type housings are desired that the angle between the surface on which the housing is mounted and the shaft be maintained to a tolerance of $\pm 2^\circ$ (Fig. 5).

When there are shields or seals on the bearing housing, the slanted angle which is the angle between the central line of bearing bore and the central line of bearing housing bore is required within $\pm 1^\circ$

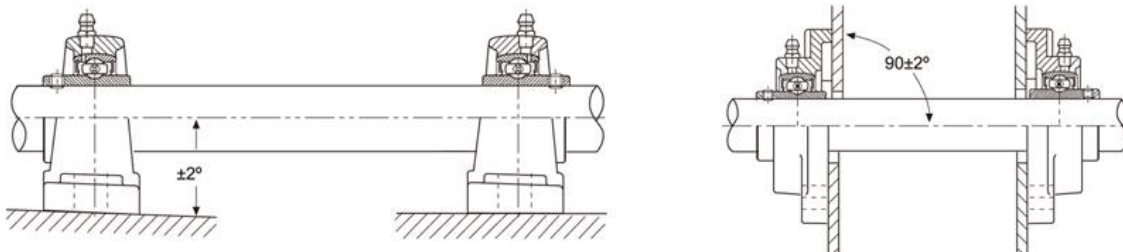


Fig.5.

8.5 Mounting Method of Take-up Units

The Take-up units are mounted on two parallel slides, bearing centers to be adjusted by adjustable bolts. The relevant parts dimensions are shown as Fig. 6. Mounting tolerances are shown in Table 39 and Table 40.

Table 39 . (mm)

Take-up No.	H' ±0.5	A'	d	D	N
T204	77	11	16	28	12
T205	77	11	16	28	12
T206	90	11	18	32	12
T207	90	11	18	32	12
T208	103	15	24	42	14
T209	103	15	24	42	14
T210	103	15	24	42	14
T211	131	20	30	56	20
T212	131	20	30	56	26
T213	152	24	36	60	26
T214	152	24	36	60	26
T215	152	24	36	60	26
T216	167	24	36	60	26
T217	175	28	42	65	30

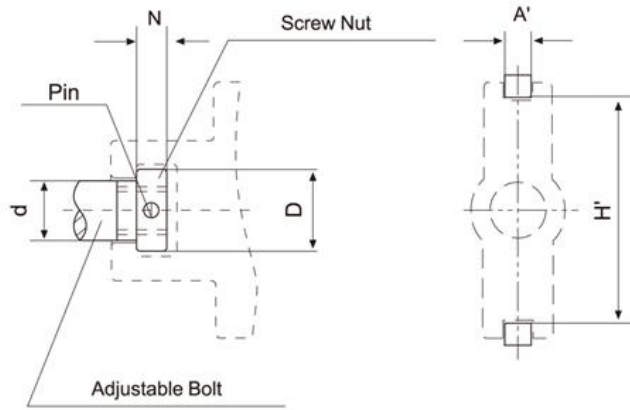


Table 40 . (mm)

Take-up No.	H' ±0.5	A'	d	D	N
ST204	77	12.5	16	28	12
ST205	77	12.5	16	28	12
ST206	90	12.5	18	32	12
ST207	90	12.5	18	32	12
ST208	103	16.5	24	42	14
ST209	103	16.5	24	42	14
ST210	103	16.5	24	42	14
ST211	131	25	30	56	20
ST212	131	25	30	56	26

Fig.6

9. Bearing Inserts - Life Estimation for Different $\frac{C_r}{P_r}$ Ratios.

Table 41.

L _{10h} (hours)	C _r /P _r when speed n= (r/min)															
	50	100	200	300	500	750	900	1000	1500	1800	2000	2500	3000	4000	5000	6000
500	1.14	1.45	1.82	2.08	2.47	2.82	3.00	3.11	3.56	3.78	3.91	4.22	4.48	4.93	5.32	5.65
1000	1.44	18.2	2.29	2.62	3.11	3.56	3.78	3.91	4.48	4.76	4.93	5.31	5.65	6.21	6.70	7.11
1500	1.65	2.08	2.62	3.00	3.56	4.08	4.31	4.48	5.13	5.45	5.65	6.10	6.46	7.11	7.65	8.15
2000	1.82	2.29	2.88	3.30	3.91	4.48	4.76	4.93	5.65	6.00	6.21	6.69	7.11	7.81	8.43	8.96
3000	2.08	2.62	3.30	3.78	4.48	5.13	5.42	5.65	6.46	6.85	7.11	7.66	8.14	8.96	9.65	10.3
5000	2.47	3.11	3.91	4.48	5.32	6.08	6.46	6.70	7.66	8.14	8.43	9.09	9.65	10.6	11.5	12.2
7500	2.82	3.56	4.48	5.13	6.06	6.96	7.37	7.66	8.77	9.32	9.65	10.4	11.1	12.2	13.1	13.9
10000	3.11	3.91	4.93	5.65	6.70	7.66	8.14	8.43	9.65	10.3	10.6	11.4	12.2	13.4	14.5	15.3
15000	3.56	4.48	5.65	6.46	7.66	8.77	9.28	9.65	11.1	11.7	12.2	13.1	13.9	15.3	16.5	17.5
20000	3.91	4.93	6.21	7.11	8.43	9.65	10.3	10.6	12.2	12.9	13.4	14.4	15.3	16.8	18.2	19.3
30000	4.48	5.65	7.11	8.14	9.65	11.1	11.7	12.2	13.9	14.8	15.3	16.5	17.5	19.3	20.8	22.1
40000	4.93	6.21	7.81	8.96	10.6	12.2	12.9	13.4	15.3	16.3	16.8	18.2	19.3	21.2	22.9	24.3
60000	5.65	7.11	8.96	10.3	12.2	13.9	14.8	15.3	17.5	18.6	19.3	20.8	22.1	24.3	26.2	27.8
80000	6.21	7.81	9.83	11.3	13.4	15.3	16.3	16.8	19.3	20.5	21.2	22.9	24.3	26.7	28.8	30.7

Life estimation for UC212 insert bearing with steady radial load $F_r = 3250 \text{ N}$ at a speed of 1500 r/min.

The dynamic load rating C_r of the inset bearing UC212 from page B120 is 47680 N.

Since the bearing is not subject to axial load, the equivalent load $P_r = F_r \times f_d = 3250 \text{ N} \times 1.2 = 3900 \text{ N}$ (When no shocking load or minor shocking load, shocking load factor $f_d = 1 \sim 1.2$)

Using the load ratio tables, an approximate life can be obtained by locating the nearest C_r/P_r value in the appropriate r/min column.

$$\text{Therefore for } C_r/P_r = \frac{47680}{3900} = 12.226$$

Under the $n = 1500 \text{ r/min}$ column, the nearest C_r/P_r value is 12.2 with give an approximate life of 20000 hours.

10. WARRANTY & DISCLAIMER

10.1 Warranty

LDK warrants that the products will be free from defects in material and workmanship for one year from date of sale. LDK makes no other warranty of any kind, express or implied. LDK shall have no obligation under the foregoing warranty where the defect is the result of improper or abnormal use, negligence, vehicle accident, improper or incorrect installation or maintenance, nor when the product has been repaired or altered in any way so as (in our judgment) to affect its performance. LDK's liability in the case of defective products subjects to the foregoing warranty shall be limited to the repair or replacement, at LDK's option, of the defective products. Except expressly provide herein, LDK shall have no liability (on account negligence or otherwise) for, or in connection with, defects or deficiencies in the products and in no event shall LDK be liable for any incidental, special or consequential damages or commercial loss (including loss revenue or profits) of buyer or any other person, arising out of the use, or inability to use the goods, or the failure or ineffectiveness of the goods.

10.2 DISCLAIMER

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WARNING

Since the manufacturer is unable to determine all applications in which a part may be placed, it's the user's responsibility to determine the suitability of the part of its intended use. This is especially true where safety is a factor. Incorrect application or installation may result in property damage, bodily injury, or death. For technical assistance, please check with us.