Bearing numbering system

RETAINER

STEEL RIBBON TYPE :	J
STEEL CROWN TYPE :	W
NYLON CROWN TYPE :	TW
STEEL RIVET TYPE :	RJ
FULL COMPLEMENT :	V
THRUST FM TYPE :	TP(SUS304)
THRUST F TYPE :	TD(C3604)

SEALS AND SHIELDS

TEFLON SEAL WITH SNAP RING :	TTS
STEEL SHIELD WITH SNAP RING :	ZZS
PRESSED STEEL SHIELD :	ZZ
CONTACT RUBBER SEAL :	2RS
NON-CONTACT RUBBER SEAL :	2RU

MATERIAL

HIGH CARBON CHROMIUM STEEL
SAE 52100、SUJ2、100Cr6·····NO SYMBOL

STAINLESS STEEL
AISI440C、SUS440C、X102CrMo17
KS440(ACD34)、X65Cr13

STANDARD METRIC ·····H
MR、MF、MT AND INCH SERIES ··S

RADIAL CLEARANCE

STANDARD :	C2、C0(CN)、C3、C4、C5
MINIATURE :	MC1 0~5 μm
	MC2 3~8 μm
	MC3 5~10 μm
	MC4 8~13 μm
	MC5 13~20 μm
	MC6 20~28 μm

Ex.1			686		J	ZZ	MC3		SRL
Ex.2		F	608		TW	2RS	MC4	P6	SRL
Ex.3		MR	52		W	ZZ	MC2	P5	AF2
Ex.4	S	MF	128		W	TTS	MC3	P6	SRL
Ex.5	S	ER	1458		W	ZZS	C0	A3	SRL
Ex.6			6205	H	RJ	2RS	C3		AV2
Ex.7		F	6706	H	W	2RU	C0		SRL
Ex.8	S	R	144		J	ZZS	MC4	A5P	AF2
Ex.9		R	10		RJ	ZZ	C2		AV2
Ex.10		F	3-8M	H	TP				AF2

BEARING TYPE

INCH:	R
INCH WITH FLANGE:	FR
INCH WITH EXTENDED INNER RING:	RW
INCH WITH EXTENDED INNER RING AND FLANGE:	FRW
METRIC STANDARD:	NO SYMBOL
METRIC WITH FLANGE:	F
SPECIAL METRIC:	MR
SPECIAL METRIC WITH FLANGE:	MF

TOLERANCE CLASSES

ABEC1:	NO SYMBOL
ABEC3:	A3
ABEC5:	A5
ABEC7:	A7
ABEC5P:	A5P
ABEC7P:	A7P
ISO CLASS0:	NO SYMBOL
ISO CLASS6:	P6
ISO CLASS5:	P5
ISO CLASS4:	P4

LUBRICATION

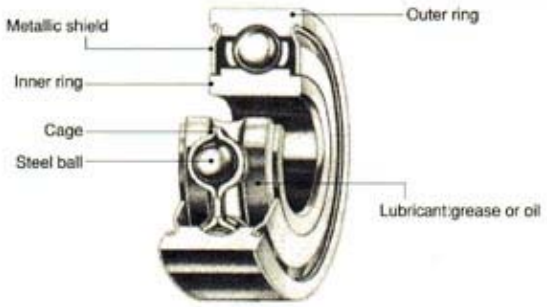
EX. GREASE	CODE
MULTEMP SRL:	SRL
ALVANIA NO.2:	AV2
BEACON 325:	B32
RPM GREASE SRI2:	SRI2
MOLYKOTE 44M:	M4M
KRYTOX 240AC:	K24
ISOFLEX SUPER LDS18:	SL8

EX. OIL	CODE
AERO SHELL FLUID 12:	AF2
WINDSOR LUBE L-245X:	WL2
ANTIRUST P2100:	002

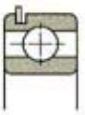
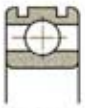
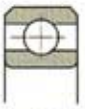
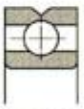
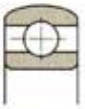
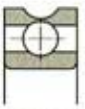
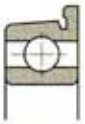
BEARING PART NO.

Design and characteristics of radial ball bearings

STRUCTURE OF BEARING



DESIGN OF BEARING

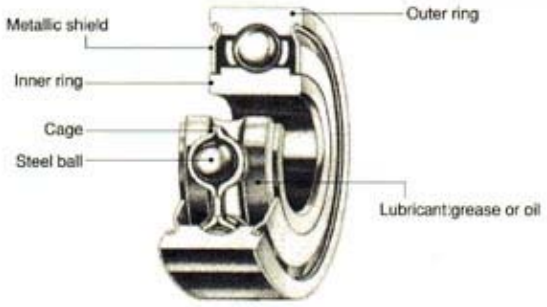
 standard	 extended inner ring	 (V) full complement of balls	 (N) with snap ring groove	 (NR) with snap ring groove and snap ring	 (F) with flanged outer ring
 examples of special designs	 examples of special designs	 examples of special designs	 examples of special designs	 examples of special designs	 examples of special designs

CHARACTERISTICS OF BEARINGS

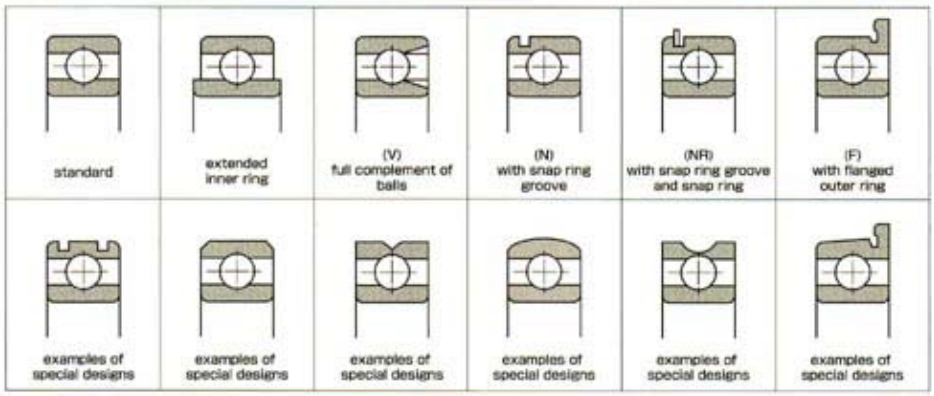
LOAD	Single row radial ball bearings with balls separated by a cage can support radial loads, axial loads and tilting moments. A full complement V-type ball bearing can support only radial loads and some low axial loads.
SPEED	Maximum permissible speeds for ball bearings are mainly related to the bearing design and size, cage type, bearing internal clearance, method and type of lubrication, manufacturing accuracy, sealing methods and loads.
TORQUE AND NOISE LEVEL	Single row radial ball bearings are precision components and have low torque and noise levels.
INCLINATION OF INNER/OUTER RINGS	Shaft and housing seats with poor accuracy, fitting errors and shaft bending might cause inclination between the inner and outer rings although the internal clearance of the bearing will permit this to a certain extent. Generally, the maximum permissible inclination between the inner and outer, rings is approximately 1 in 300.
TOUGHNESS	Bearings under load deform elastically at the contact point between the rolling element and bearing ring. This in influenced by the bearing type, size, form and load.
INSTALLATION AND REMOVAL	The single row radial ball bearing is a non-separable bearing. Therefore, shafts and housings should be so designed to enable bearing inspection and replacement when necessary.
AXIAL LOCATION	Improved axial location is obtation with NR and F type bearings.

Design and characteristics of radial ball bearings

STRUCTURE OF BEARING



DESIGN OF BEARING



CHARACTERISTICS OF BEARINGS

LOAD	Single row radial ball bearings with balls separated by a cage can support radial loads, axial loads and tilting moments. A full complement V-type ball bearing can support only radial loads and some low axial loads.
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AXIAL LOCATION	Improved axial location is obtation with NR and F type bearings.

Bearing material

Standard material for rings and balls is a vacuum degassed high carbon chromium steel allowing for high efficiency, low torque, low noise level and long bearing life. For bearings requiring anti-corrosion or heat-resistance properties, martensitic stainless steel is used.

CHEMICAL COMPOSITION OF BEARING MATERIALS

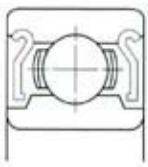
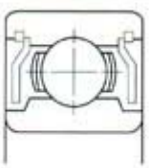
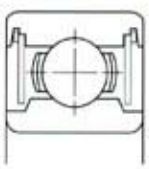
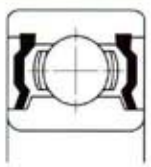
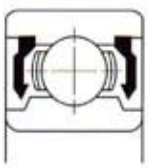
MATERIAL	SYMBOL	CHEMICAL COMPOSITION (Wt%)							EQUIVALENT	HARDNESS (HRC)
		C	Si	Mn	P	S	Cr	Mo		
HIGH CARBON CHROMIUM STEEL	SUJ2	0.95~1.10	0.15~0.35	≦0.50	≦0.025	≦0.025	1.30~1.60	≦0.08	SAE52100,100Cr6, ASTM52100, BS535A99,1.3505	60~64
STAINLESS STEEL	SUS440C	0.95~1.20	≦1.00	≦1.00	≦0.040	≦0.030	16.0~18.0	≦0.75	AISI440C, X102CrMo17, X105CrMo17, 1.4125, 1.3543	58~62
	KS440 (ACD34)	0.60~0.75	≦1.00	≦1.00	≦0.030	≦0.020	11.5~13.0	≦0.30	X65Cr13, 1.4037	58~62

Type and characteristics of cages, shields and seals

CAGES

 W : ONE-PIECE STEEL CROWN TYPE	 J : TWO-PIECES STEEL RIBBON TYPE	 RJ : TWO-PIECES STEEL RIVET TYPE	 TW : ONE-PIECE NYLON CROWN TYPE	 V : FULL COMPLEMENT OF BALLS
The stainless steel pressed cage is inner ring guided. It shows excellent performance in low torque, low speed applications.	Consists of two mating steel pressings, the cover side and the finger side. Usually guided by the rolling elements and designed to reduce frictional torque.	The RJ type cage is suitable for larger bearings with a high load carrying capacity. The two pieces are riveted together and are strong enough to withstand higher levels of vibration and acceleration. The cage is guided by the balls and reduces frictional torque.	Moulded nylon cage. Reduces the fluctuation in running torque. Suitable for high speeds. Guided by the rolling elements. NYLON CAGE operating temperature range:from -30 to +120℃	This type of bearing has no cage but maximum possible number of balls. Due to the fact that the inner and outer ring have a filling slot, the axial load carrying capacity of this bearing type is low. This type of bearing is suitable for high radial load, low speed applications.

SHIELD , SEAL

 ZZ : PRESSED STEEL SHIELD	 ZZS : STEEL SHIELD WITH SNAP RING	 TTS : TEFLON SEAL WITH SNAP RING	 2RS : CONTACT RUBBER SEAL	 2RU : NON-CONTACT RUBBER SEAL
Non-contact shield pressed into outer ring. Very little grease leakage and low ingress of contaminants.	Non-contact shield retained in outer ring. Low ingress of contaminants. Mainly used for smaller or narrower bearings.	Teflon seal reinforced with glass fibre is retained in outer ring by snap ring. Low ingress of contaminants. Mainly used for smaller or narrower bearings. Seal can flex to accommodate intenal pressure changes. TEFLON SEAL operating temperature range:from -100 to +260℃	Rubber seal fitted into outer ring. Light contact with inner ring, retains grease and prevents ingress of extenal contaminants. NBR SEAL operating temperature range:from -40 to +120℃ FKM(VITON)SEAL operating temperature range:from -30 to +230℃	Non-contact rubber seal fitted into outer ring, still provides effective sealing. NBR SEAL operating temperature range:from -40 to +120℃ FKM(VITON)SEAL operating temperature range:from -50 to +230℃

Type and characteristics of cages, shields and seals

CAGES

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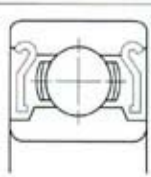
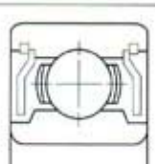
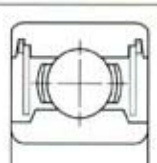
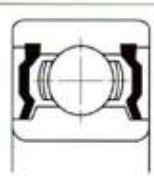
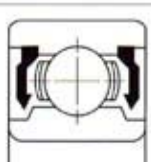
SHIELD , SEAL

 ZZ : PRESSED STEEL SHIELD	 ZZS : STEEL SHIELD WITH SNAP RING	 TTS : TEFLON SEAL WITH SNAP RING	 2RS : CONTACT RUBBER SEAL	 2RU : NON-CONTACT RUBBER SEAL
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Tolerance, class, chamfer dimension of bearings

TOLERANCES OF INNER RING AND OUTER RING WIDTH (ISO)

d (mm)		Δ_{dmp}				Δ_{ds}		V_{dp}										V_{dmp}			
		P0		P6	P5	P4		P0			P6			P5		P4					
							P4	Diameter series			Diameter series			Diameter series		Diameter series		P0	P6	P5	P4
							0,2,3	7,8,9	0	2,3	7,8,9	0	2,3	7,8,9	0,2,3	7,8,9	0,2,3				
Over	Incl.	Upper	Lower	Lower	Lower	Lower	Upper Lower	Max.			Max.			Max.		Max.		Max.	Max.	Max.	Max.
0.6(1)	2.5	0	−8	−7	−5	−4	0 −4	10	8	6	9	7	5	5	4	4	3	6	5	3	2
2.5	10	0	−8	−7	−5	−4	0 −4	10	8	6	9	7	5	5	4	4	3	6	5	3	2
10	18	0	−8	−7	−5	−4	0 −4	10	8	6	9	7	5	5	4	4	3	6	5	3	2
18	30	0	−10	−8	−6	−5	0 −5	13	10	8	10	8	6	6	5	5	4	8	6	3	2.5
30	50	0	−12	−10	−8	−6	0 −6	15	12	9	13	10	8	8	6	6	5	9	8	4	3

Remarks1: The upper value of the bore diameter in this table is not applicable when the distance from the bearing ring face is less than 1.2 times the chamfer dimension r smax
Remarks2: According to the revision of ANSI/ABMA Std.20-1996 ,the classes ABEC1 • ABEC3 • ABEC5 • ABEC7 are equivalent to CLASS0•CLASS6•CLASS5•CLASS4.

TOLERANCES OF OUTER RING (ISO)

D (mm)		Δ_{Dmp}					Δ_{Ds}		V_{Dp}(2)										V_{Dmp}(2)			
		P0		P6	P5	P4	P4		P0				P6			P5		P4				
									Open			Seal Shield	Open		Seal Shield	Open		Open		P0	P6	P5	P4
							Diameter series		Diameter series				Diameter series			Diameter series		Diameter series					
							0,2,3		7,8,9	0	2,3	2,3	7,8,9	0	2,3	2,3	7,8,9	0,2,3	7,8,9	0,2,3				
Over	Incl.	Upper	Lower	Lower	Lower	Lower	Upper	Lower	Max.				Max.				Max.		Max.		Max.	Max.	Max.	Max.
2.5(1)	6	0	−8	−7	−5	−4	0	−4	10	8	6	10	9	7	5	9	5	4	4	3	6	5	3	2
6	18	0	−8	−7	−5	−4	0	−4	10	8	6	10	9	7	5	9	5	4	4	3	6	5	3	2
18	30	0	−9	−8	−6	−5	0	−5	12	9	7	12	10	8	6	10	6	5	5	4	7	6	3	2.5
30	50	0	−11	−9	−7	−6	0	−6	14	11	8	16	11	9	7	13	7	5	6	5	8	7	4	3
50	80	0	−13	−11	−9	−7	0	−7	16	13	10	20	14	11	8	16	9	7	7	5	10	8	5	3.5

Remarks1: The lower value of the outside diameter in this table is not applicable when the distance from the bearing ring face is less than 1.2 times the chamfer dimension r smax
Remarks2: According to the revision of ANSI/ABMA Std.20-1996,the classes ABEC1•ABEC3•ABEC5•ABEC7 are equivalent to CLASS0•CLASS6•CLASS5•CLASS4.

TOLERANCES OF INNER RING AND OUTER RING WIDTH(ABMA)

Unit μm

d (mm)		Δ_{dmp}		Δ_{ds}		V_{dp}	V_{dmp}	$\Delta_{Bs}(\Delta_{Cs})$		V_{Bs}		K_{ia}		S_{ia}		S_d	
		ABEC 5P ABEC 7P		ABEC 5P ABEC 7P		ABEC 5P ABEC 7P	ABEC 5P ABEC 7P	Single bearing ABEC 5P ABEC 7P		ABEC 5P	ABEC 7P	ABEC 5P	ABEC 7P	ABEC 5P	ABEC 7P	ABEC 5P	ABEC 7P
Over	Incl.	Upper	Lower	Upper	Lower	Max.	Max.	Upper	Lower	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.
—	10	0	−5	0	−5	2.5	2.5	0	−25	5	2.5	3.5	2.5	7	3	7	3
10	18	0	−5	0	−5	2.5	2.5	0	−25	5	2.5	3.5	2.5	7	3	7	3
18	30	0	−5	0	−5	2.5	2.5	0	−25	5	2.5	3.5	2.5	7	3	7	3

Remarks1: ABEC5P and ABEC7P are the tolerance classes for hign precision bearings.

LIMIT TOLERANCE VALUES (METRIC) OF CHAMFER DIMENSIONS OF RADIAL BEARINGS

Unit:mm

r_{smin}	d(mm)		r_{smax}		r_{amax}
	Over	Incl.	Radial	Axial	
0.05	-	-	0.10	0.20	0.05
0.08	-	-	0.16	0.30	0.08
0.10	-	-	0.20	0.40	0.10
0.15	-	-	0.30	0.60	0.15
0.20	-	-	0.50	0.80	0.20
0.30	-	40	0.60	1.00	0.30
0.30	40	-	0.80	1.00	0.30
0.60	-	40	1.00	2.00	0.60
0.60	40	-	1.30	2.00	0.60
1.00	-	50	1.50	3.00	1.00
1.00	50	-	1.90	3.00	1.00
1.10	-	120	2.00	3.50	1.00
1.10	120	-	2.50	4.00	1.00
1.50	-	120	2.30	4.00	1.50
1.50	120	-	3.00	5.00	1.50

d : Nominal bore diameter
Δ_{dmp} : Single plane mean bore diameter deviation
Δ_{ds} : Deviation of a single bore diameter
V_{dp} : Bore diameter variation in a single radial plane
V_{dmp} : Mean bore diameter variation
$\Delta_{Bs}(\Delta_{Cs})$: Deviation of the single inner and outer ring width from the nommal dimension
$V_{Bs}(V_{Cs})$: Variation Of the inner and outer ring width
K_{ia} : Radial runout of assembled bearing inner ring
S_d : Face runout with bore
S_{ia} : Assembled bearing inner ring face runout with raceway

D : Nominal outside diameter
Δ_{Dmp} : Single plane mean outside diameter deviation
Δ_{Ds} : Deviation of a single outside diameter

V_{Dp} : Outside diameter variation in a single radial plane
V_{Dmp} : Mean outside diameter variation
K_{ea} : Radial runout of assembled bearing outer ring
S_o : Variation of outside surface generatrix inclination with face
S_{ea} : Assembled bearing outer ring face runout with raceway
V_{Cs} : Variation of the outer ring width
Δ_{Bs} : Flange outside diameter deviation
Δ_{Cs} : Flange width deviation

r_{smin} : Smallest permissible single chamfer dimension(minimum limit)
d : Nominal bore diameter
r_{smax} : Largest permissible single chamfer dimension(maximum limit)
r_{amax} : Largest permissible single shaft and housing fillet radius

Note(1) : The value of r_{smax} in axial direction of bearing with nominal width of under 2mm is the same as the one in radial direction

Unit μm

ΔB_s (ΔC_s) (2)			V_{Bs} (V_{Cs}) (2)				K_{ia}				S_d		S_{ia}		d (mm)	
Single bearing			Inner/outer ring		Inne ring		P0	P6	P5	P4	P5	P4	P5	P4		
P0 P6		P5 P4	P0	P6	P5	P4										
Upper	Lower	Lower	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Over	Incl.
0	− 40	− 40	12	12	5	2.5	10	5	4	2.5	7	3	7	3	0.6 (1)	2.5
0	−120	− 40	15	15	5	2.5	10	6	4	2.5	7	3	7	3	2.5	10
0	−120	− 80	20	20	5	2.5	10	7	4	2.5	7	3	7	3	10	18
0	−120	−120	20	20	5	2.5	13	8	4	3	8	4	8	4	18	30
0	−120	−120	20	20	5	3	15	10	5	4	8	4	8	4	30	50

Note (1) : 0.6mm is included in this classification.
Note (2) : The inner ring width variation is the same for the outer ring of the same bearing size.CLASS5 and CLASS4 referring to outer ring only.

Unit μm

K_{ea}				S_D		S_{ea}		V_{Cs} (3)		D (mm)		Flanged type				d (mm)		Flanged type			
												ΔD_{fs}						ΔC_{fs}			
P0	P6	P5	P4	P5	P4	P5	P4	P5	P4			P0 P6		P5 P4				P0 P6		P5 P4	
Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Over	Incl.	Upper	Lower	Upper	Lower	Over	Incl.	Upper	Lower	Upper	Lower
15	8	5	3	8	4	8	5	5	2.5	−	10	+220	−36	0	−36	0.6	2.5	0	−40	0	−40
15	8	5	3	8	4	8	5	5	2.5	10	18	+270	−43	0	−43	2.5	10	0	−120	0	−40
15	9	6	4	8	4	8	5	5	2.5	18	30	+330	−52	0	−52	10	18	0	−120	0	−80
20	10	7	5	8	4	8	5	5	2.5	30	50	+390	−62	0	−62	18	30	0	−120	0	−120
25	13	8	5	8	4	10	5	6	3	50	80	+460	−74	0	−74	30	50	0	−120	0	−120

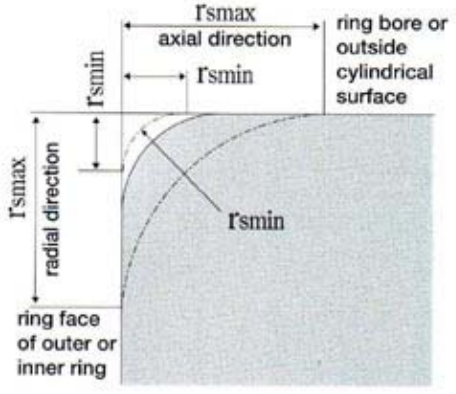
Note (1) : Size 2.5mm is included in this classification.
Note (2) : Applicable without locating snap ring.
Note (3) : The outer ring width variations for CLASS0 and CLASS6 are the same as for the inner ring of the same bearing size.

TOLERANCES OF OUTER RING (ABMA)

Unit μm

D (mm)		ΔD_{mp}			ΔD_D						V_{Dp},V_{Dmp}		ΔB_s (ΔC_s)		V_{Cs} (1)		S_D		K_{ea}		S_{ea}		Flanged type					
					Open			Seal,Shield			ABEC 5P,7P		Single bearing										ΔD_{fs}		ΔC_{fs} (1)		S_{ea1} (2)	
		ABEC 5P,7P	ABEC 5P	ABEC 7P	ABEC 5P,7P	ABEC 5P	ABEC 7P	ABEC 5P,7P	ABEC 5P	ABEC 7P	Open	Seal Shield	ABEC 5P ABEC 7P		ABEC 5P	ABEC 7P	ABEC 5P	ABEC 7P	ABEC 5P	ABEC 7P	ABEC 5P	ABEC 7P	ABEC 5P		ABEC 5P		ABEC	ABEC
																						ABEC 7P		ABEC 7P		5P	7P
Over	Incl.	Upper	Lower	Lower	Upper	Lower	Lower	Upper	Lower	Lower	Max.	Max.	Upper	Lower	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Upper	Lower	Upper	Lower	Max.	Max.
−	18	0	−5	−5	0	−5	−5	+1	−6	−6	2.5	5	0	−25	5	2.5	8	4	5	3.5	8	5	0	-25	0	-51	7.5	5
18	30	0	−6	−5	0	−6	−5	+1	−7	−6	2.5	5	0	−25	5	2.5	8	4	6	4	8	5	0	-25	0	-51	7.5	5
30	50	0	−6	−5	0	−6	−5	+1	−7	−6	2.5	5	0	−25	5	2.5	8	4	6	4	8	5	0	-25	0	-51	7.5	5

Note (1) : Applies to flange width variation of flanged bearing.
Note (2) : Applies to flange back face.



r's min=smallest permissible single chamfer dimension (minimum limit)
r's max=largest permissible single chamfer dimension (maximum limit)
r'a max=largest permissible single shaft and housing fillet radius

NOTE: The exact shape of the chamfer surface is not specified, but its contour in an axial plane shall not be allowed to project beyond the imaginary circular arc, of radius r'smin , tangential to the ring face and the bore or outside cylindrical surface of the ring (see figure).

Life and load rating

BEARING LIFE

When bearings rotate, the inner and outer rings and rolling elements are constantly loaded. This produces material fatigue and eventually bearing failure. The total number of revolutions before a failure occurs is called the basic rating life.
Life of individual bearings varies considerably, even if they are of the same size, same material, same heat treatment and are under the same operating conditions.
Statistically, the total number of revolutions reached or exceeded by 90% of a sufficiently large group of apparently identical bearings before the first evidence of material fatigue occurs is called the basic rating life.

BASIC DYNAMIC LOAD RATING"Cr"

The basic dynamic load rating of a bearing with rotating inner ring and stationary outer ring is that load of constant magnitude and size which a sufficiently large group of apparently identical bearings can endure for a basic rating life of one million revolutions.
Radial bearings take central load. Values given for Cr in the dimension tables of this catalogue are for standard high chromium steel. 85% of the chromium steel values should be used for stainless steel.

LIFE FORMULA

The equation for the basic rating life for dynamically loaded ball bearings is as follows:

$$L_{10}=(Cr/P)^3(\times 10^6 \text{Revolutions}),\ L_{10}h=16667/n\cdot(Cr/P)^3(\text{Hours})$$

whereby:
L_{10}=BASIC RATING LIFE
Cr=BASIC DYNAMIC LOAD RATING(N)
n=R.P.M.(REVOLUTIONS PER MINUTE)
$L_{10}h$=BASIC RATING LIFE IN OPERATING HOURS
P=EQUIVALENT LOAD(N)

EXAMPLES OF RATING LIFE $L_{10}h$ VALUES USED:

OPERATING CONDITIONS	BASIC RATING LIFE $L_{10}h$
Infrequent operation.	500
Short or intermittent operation. Failure has little effect on function.	4,000~8,000
Intermittent operation. Failure has significant effect on function.	8,000~12,000
8 hours of non-continuous operation.	12,000~20,000
8 hours of continuous operation.	20,000~30,000
24 hours continuous operation.	40,000~60,000
24 hours of guaranteed trouble-free operation.	100,000~200,000

ADJUSTED LIFE FORMULA

The above life formula is for general use. In cases where a reliability of over 90% is required and where influences apart from load and speed or operating frequency should be taken into account for the rating life, ISO 281, 1990 gives an extended life formula:

$$Lna=a_1 \times a_2 \times a_3 \times (Cr/P)^3 \times 10^6 \text{ (Revolutions)}$$

whereby:
Lna=Adjusted rating life in millions with a reliability of (100-n)% (n=the reliability rate)
Cr=BASIC DYNAMIC LOAD RATING(N)
P=EQUIVALENT DYNAMIC LOAD(N)
a_1=Factor for a reliability other than 90%
a_2=Factor for non-conventional materials
a_3=Factor for non-conventional operating conditions, in particular lubrication

(1) RELIABILITY FACTOR a_1

When a reliability of over 90% is required, the corresponding factor should be selected from the following table.

●RELIABILITY FACTOR a_1

Reliability	90	91	92	93	94	95	96	97	98	99	(99.6)	(99.9)
a1	1.00	0.92	0.84	0.77	0.64	0.62	0.53	0.44	0.33	0.21	(0.10)	(0.037)

(2) MATERIAL FACTOR a_2

Improvement in manufacturing techniques for raw material and for heat treatment of components have led to an extended fatigue life for bearings.
Our standard bearing material is a superior quality of vacuum degassed steel leading to an extended life for bearings.
The basic load ratings given in this catalogue have been established by taking this longer life into consideration. This gives an increase in the operating life in hours of a factor of 2.2 and a factor of 1.3 for the load carrying capacity. The material factor a_2=1.

(3) OPERATING CONDITIONS FACTOR a_3

This is an adjustment factor to meet non-conventional operating conditions for lubrication, temperature and load.
Under good lubrication conditions with a permanent oil film between rolling elements and rings, the factor a_3=1.
In unfavourable conditions ($d_m \cdot n \leqq 10{,}000$), a factor $a_3 < 1$ must be selected. d_m = mean bearing diameter = (D+d)/2 , n = operating speed.
At temperatures above 120℃, greater dimensional changes occur and the material hardness deteriorates which affects the bearing life.
The operating factor f_t for temperature can be taken from the following table:

●OPERATING TEMPERATURE AND LIFE COMPENSATION FACTOR f_t

BEARING TEMPERATURE (℃)	120	150	175	200	225	250	275	300
TEMPERATURE FACTOR (f_t)	1.00	0.90	0.85	0.75	0.65	0.60	0.52	0.45

Heat stabilized bearings, where the dimensions are stable above 120℃, are available on request.

BASIC STATIC LOAD RATING "Cor"

The Basic Static Load Rating applies to bearings where rotating motion does not occur or occurs only infrequently.
The Basic Load Ratings and calculation methods in this catalogue are based on methods described in ISO 281 and on ISO Recommendations NR.76, taking into account the current level of bearing technology.
Excessive static load causes brinelling at the contact point between the rolling element and raceway.
As a standard of permissible static load, the basic load rating Cor for radial bearings is specified as follows:
Maximum contact pressure at the contact point between rolling element and bearing ring to be 4200 MPa and total permanent deformation of the bearing of appr. 1/10000th of the rolling element's diameter.
Basic Static Load Rating for stainless steel is 80% of that for standard bearing steel.

EQUIVALENT DYNAMIC BEARING LOAD "P"

Load conditions on bearings are usually a combination of radial and axial loads. In order to establish the equivalent radial load with definite force and direction we use the following formula:

●RADIAL LOAD FACTOR AND AXIAL LOAD FACTOR

Fa/(ZD²)	e	Fa/Fr≦e		Fa/Fr>e	
		X	Y	X	Y
0.172	0.19	1	0	0.56	2.30
0.345	0.22	1	0	0.56	1.99
0.689	0.26	1	0	0.56	1.71
1.03	0.28	1	0	0.56	1.55
1.38	0.30	1	0	0.56	1.45
2.07	0.34	1	0	0.56	1.31
3.45	0.38	1	0	0.56	1.15
5.17	0.42	1	0	0.56	1.04
6.89	0.44	1	0	0.56	1.00

P=XFr+YFa(N)

Fr=RADIAL LOAD(N)
Fa=AXIAL LOAD(N)

X=RADIAL LOAD FACTOR
Y=AXIAL LOAD FACTOR
D=BALL DIAMETER(mm)

EQUIVALENT STATIC RADIAL LOAD "Po"

For ball bearings subject to both radial and axial loads, the static radial load with definite force and direction is called the Equivalent Static Radial Load.
The higher value from the two formula shown below should be used.

Po=0.6×Fr+0.5×Fa(N), Po=Fr(N)

SAFETY MODULUS"fs"

Permissible equivalent static load depends on basic static load rating.
But using limit of bearing charge by using condition. Accordingly we use safety modulus which is experimental value.

fs=Cor/Po

fs=SAFETY MODULUS
Cor=BASIC STATIC LOAD RATING(N)
Po=EQUIVALENT STATIC RADIAL LOAD(N)

USING CONDITION	fs
NORMAL OPERATION	1.0
SHOCK LOAD	1.5
SILENT AND HIGH ACCURATE ROTATION	2.0

Fitting of bearings

THE IMPORTANCE OF CORRECT FITTING

A bearing can only perform to its full capacity when it is correctly fitted on the shaft and in the housing. Insufficient interference on fitting surfaces could cause bearing rings to creep in a circumferential direction. Once this happens, considerable wear occurs on the fitting surface and both shaft and housing are damaged. Furthermore, abrasive particles may enter the bearing causing vibration, excessive heat and damage to raceways. It is therefore necessary to provide bearing rings under rotating load with an adequate interference fit to prevent creep. When using thin-type bearings under low load, the bearings should be fastened by a nut. Statically loaded bearings generally do not need to be fitted with an interference fit. Only when subject to a high degree of vibration do both inner and outer rings require fitting with an interference fit.

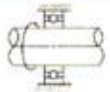
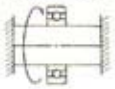
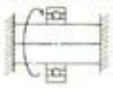
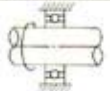
●FITTING OF BEARING AND SHAFT

CONDITION (STEEL SHAFT)		SHAFT BORE DIAMETER	SHAFT TOLERANCE CLASS	
			THIN TYPE	OTHERS
INNER RING ROTATING LOAD OR INDETERMINATE LOAD DIRECTION	LIGHT LOAD<= 0.06Cr OR FLUCTUATING LOAD	10≦d≦18 18≦d≦30 30≦d≦50	h5 h5 h5	js5 js5 js5
	STANDARD LOAD=0.06~ 0.12Cr	10≦d≦18 18≦d≦30 30≦d≦50	js5 js5 js5	j5 k5 k5
OUTER RING ROTATING LOAD	NECESSARY FOR INNER RING TURNING EASILY AROUND SHAFT	ALL BORE DIAMETERS	g5	g6
	UNNECESSARY FOR INNER RING TURNING EASILY AROUND SHAFT	ALL BORE DIAMETERS	h5	h6

●FITTING OF BEARING AND HOUSING

CONDITION (ONE-PIECE HOUSING)		AXIAL DIRECTIONAL MOVEMENT OF OUTER RING	TOLERANCE CLASS OF SHAFT HOUSING SEATS	
			THIN TYPE	OTHERS
INNER RING ROTATING LOAD	VARYING LOADS	EASY TO MOVE	H6	H7
	LIGHT OR STANDARD LOAD	EASY TO MOVE	H7	H8
	HIGH TEMPERATURE OF INNER RING AND SHAFT	EASY TO MOVE	G6	G7
	LIGHT OR STANDARD LOAD PRECISE ROTATION	AS A RULE, IMPOSSIBLE TO MOVE	K5	K6
		POSSIBLE TO MOVE	JS6	J6
	QUIET OPERATION	EASY TO MOVE	H6	H6
INDETERMINATE LOAD DIRECTION	LIGHT OR STANDARD LOAD	IN GENERAL, POSSIBLE TO MOVE	JS6	J7
	STANDARD OR HEAVY LOAD	AS A RULE, IMPOSSIBLE TO MOVE	K5	K7
	LARGE SHOCK LOAD	IMPOSSIBLE TO MOVE	M5	M7
	LIGHT OR FLUCTUATING LOAD	IMPOSSIBLE TO MOVE	M5	M7
OUTER RING ROTATING LOAD	STANDARD OR HEAVY LOAD	IMPOSSIBLE TO MOVE	N5	N7
	THIN-TYPE HOUSING SEATS HEAVY LOAD OR LARGE SHOCK LOAD	IMPOSSIBLE TO MOVE	P6	P7

●CHARACTERISTICS OF LOAD AND FITTING

ROTATING RING	LOAD	LOAD CONDITION	FITTING
 INNER RING	 STATIC	INNER RING ROTATING LOAD	INTERFERENCE FIT FOR INNER RING
 OUTER RING	 ROTATING	OUTER RING STATIC LOAD	CLEARANCE FIT FOR OUTER RING
 OUTER RING	 STATIC	OUTER RING ROTATING LOAD	CLEARANCE FIT FOR INNER RING
 INNER RING	 ROTATING	INNER RING STATIC LOAD	INTERFERENCE FIT FOR OUTER RING
IN THE CASE OF FLUCTUATING LOAD DIRECTION OR UNBALANCED LOAD	ROTATING OR STATIC	INDETERMINATE LOAD DIRECTION	INTERFERENCE FIT FOR INNER AND OUTER RING

CALCULATIONS OF FITS

(1) FITTING PRESSURE AND DIMENSIONAL CHANGES OF INNER AND OUTER RING

The right fit for each application is established taking various conditions into consideration such as load, speed, temperature, mounting dismounting of the bearing. The interference fit should be greater than normal in thin housings, housings of soft material or on hollow shafts.

(2) LOAD OF INTERFERENCE

The interference fit of shaft and inner ring decreases under radial load. The decrease in fit of shaft and inner ring is calculated by the following formula:
The higher value from the two formula shown below should be used.

$$\Delta dF = 0.08 \times \sqrt{d/B \cdot Fr} \times 10^{-3} \ (mm)$$
$$\Delta dF = 0.02 \times Fr/B \times 10^{-3} (mm)$$

(3) INFLUENCE OF TEMPERATURE ON BEARINGS, SHAFTS AND HOUSINGS

Each inner ring, outer ring or rolling element of a bearing rotating under load generates heat which will affect the interference fits of the shaft and the housing. Assuming a temperature difference within the bearing and the housing of ΔT(C), that of the mating surface of the shaft and of the bearing is (0.10~0.15)ΔT.
Consequently, ΔdT, the decrease of the inner ring interference fit due to temperature change, is calculated from the following formula:

$$\Delta dT = (0.10 \sim 0.15) \times \Delta T \cdot a \cdot d \fallingdotseq 0.0015 \times \Delta T \cdot d \times 10^{-3} (mm)$$

ΔdT : DECREASE OF INTERFERENCE DUE TO TEMPERATURE DIFFERENCE(mm)

ΔT : TEMPERATURE DIFFERENCE BETWEEN BEARING AND SURROUNDING HOUSING(℃)

a : COEFFICIENT OF THERMAL EXPANSION FOR BEARING STEEL $\fallingdotseq 12.5 \times 10^{-6}$(l/℃)

COEFFICIENT OF THERMAL EXPANSION FOR STAINLESS STEEL $\fallingdotseq 10.3 \times 10^{-6}$(l/℃)

d : NOMINAL BORE DIAMETER OF BEARING(mm)

It should also be noted that fit can increase due to temperature changes.

(4) EFFECTIVE INTERFERENCE, SURFACE ROUGHNESS AND ACCURACY

The surface roughness is smoothed during fitting and the effective interference becomes smaller than the theoretical interference. The surface roughness quality of a mating surface has an influence on how much this theoretical interference decreases. Effective interference can usually be calculated as follows:

Ground Shaft : $\Delta d = d/(d+2) \cdot \Delta da$(mm)
Turned Shaft : $\Delta d = d/(d+3) \cdot \Delta da$(mm)
Δd : EFFECTIVE INTERFERENCE(mm)
Δda : THEORETICAL INTERFERENCE(mm)
d : NOMINAL BORE DIAMETER OF BEARING(mm)

By combining these factors, the theoretical interference fit required for inner ring and shaft where the inner ring is subjected to rotating load is calculated as follows:

$$\Delta da \geqq (\Delta dF + \Delta dT)\ ((d+3)/d \text{ or } (d+2)/d) \text{ (mm)}$$

Normally, shaft and housing seats have to meet the accuracy and roughness requirements as given below.

●ACCURACY AND ROUGHNESS OF SHAFT AND HOUSING SEATS

	SHAFT	HOUSING
ROUNDNESS	BELOW 50% OF SHAFT DIAMETER TOLERANCE	BELOW 50% OF HOUSING BORE DIAMETER TOLERANCE
CYLINDRICITY	BELOW 50% OF SHAFT DIAMETER TOLERANCE WITHIN BEARING WIDTH	BELOW 50% OF HOUSING BORE DIAMETER TOLERANCE WITHIN BEARING WIDTH
SQUARENESS	≦3/1000(0.17°)	
ROUGHNESS OF MATING SURFACE	Rmax 3.2	Rmax 6.3

Mounting bearings with extra tight or light interference fits can lead to early bearing failure. In order to ensure safe operating conditions the tolerance variations of shaft seats, housing bores and bearing bore and outside diameter need to be reduced.
We recommend the tolerance zones are divided into two bands and selective assembly is applied. Bearings sorted into two tolerance bands for inner and outer rings are available on request. These bearings are marked as follows:

●SELECTIVE CLASSIFICATION OF OUTER AND BORE DIAMETER TOLERANCES AND INDICATION MARK

TOLERANCE OF BORE DIAMETER / TOLERANCES OF OUTER DIAMETER	MARK	0~-D/2	-D/2~-D	0~-D
		1	2	0
0~-d/2	1	C11	C12	C10
-d/2~-d	2	C21	C22	C20
0~-d	0	C01	C02	

ZC3 (C11, C12, C21, C22) ZC1 (C12, C10, C22, C20) ZC2 (C01, C02)

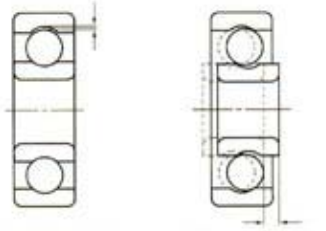
NOTE: 1.THIS IS APPLIED TO BOTH BEARINGS OF ABEC 5P AND P5.
2.UPON YOUR REQUEST, PLEASE SPECIFY THE MARK LISTED BELOW.
ZC1.... 2 SELECTIVE CLASSIFICATIONS FOR BORE DIAMETER TOLERANCE (0~-d/2、-d/2~-d)
1 SELECTIVE CLASSIFICATION FOR OUTER DIAMETER TOLERANCE (0~-D)
ZC2.... 1 SELECTIVE CLASSIFICATION FOR BORE DIAMETER TOLERANCE (0~-d)
2 SELECTIVE CLASSIFICATIONS FOR OUTER DIAMETER TOLERANCE (0~-D/2、-D/2~-D)
ZC3.... 4 SELECTIVE CLASSIFICATIONS FOR BOTH BORE AND OUTER DIAMETER TOLERANCE (0~-d/2~、-d/2~-d,0~-D/2~、-D/2~-D)
D.... MINIMUM VALUE OF OUTER DIAMETER TOLERANCE
d.... MINIMUM VALUE OF BORE DIAMETER TOLERANCE

Internal clearance

INTERNAL CLEARANCE AND STANDARD VALUES

Internal clearance is the play between outer ring, inner ring and rolling element. Generally, the amount of up and down movement of the outer ring with respect to the fixed inner ring is called the radial internal clearance and its right and left movement the axial internal clearance. Bearing internal clearance in operation is an important factor that has a significant influence on other factors such as noise, vibration, heat and fatigue life. Radial ball bearings are usually classified by their internal radial clearance. When measuring the internal clearance, the bearing is subjected to a standard load in order to ensure full contact between all bearing components. Under such a load, the measured value is larger than the actual value stated for radial clearance; this is due to elastic deformation. The difference is compensated by the factors given in the tables below.

BEARING INTERNAL CLEARANCE



RADIAL INTERNAL CLEARANCE

AXIAL INTERNAL CLEARANCE

●RADIAL INTERNAL CLEARANCE OF SMALL AND MINIATURE BEARINGS

Unit μm

CLEARANCE SYMBOL		MC1	MC2	MC3	MC4	MC5	MC6
CLEARANCE	min	0	3	5	8	13	20
	max	5	8	10	13	20	28

NOTE: 1.STANDARD CLEARANCE IS MC3.
2.FOR MEASURING CLEARANCE, OFFSET BY COMPENSATION FACTOR LISTED BELOW.

Unit μm

CLEARANCE SYMBOL	MC1	MC2	MC3	MC4	MC5	MC6
COMPENSATION FACTOR	1	1	1	1	2	2

MEASURING LOAD IS AS FOLLOWS.
MINIATURE BEARINGS 2.5N (0.25kgf)
SMALL BEARINGS 4.4N (0.45kgf)

●RADIAL INTERNAL CLEARANCE OF STANDARD RADIAL BALL BEARINGS

Unit μm

NOMINAL BORE DIAMETER d(mm)		CLEARANCE									
		C2		CN(C0)		C3		C4		C5	
OVER	INCL.	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
10(ONLY)		0	7	2	13	8	23	14	29	20	37
10	18	0	9	3	18	11	25	18	33	25	45
18	24	0	10	5	20	13	28	20	36	28	48
24	30	1	11	5	20	13	28	23	41	30	53
30	40	1	11	6	20	15	33	28	46	40	64
40	50	1	11	6	23	18	36	30	51	45	73

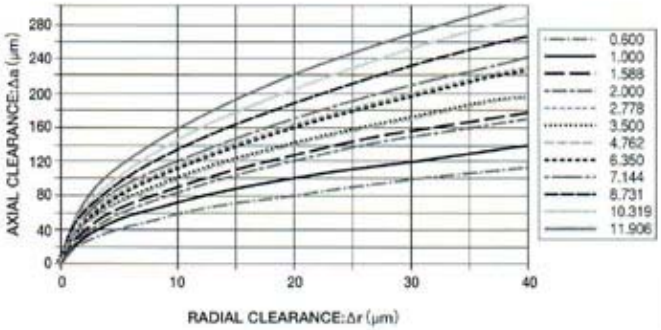
NOTE: 1.FOR MEASURING CLEARANCE, OFFSET BY COMPENSATION FACTOR LISTED BELOW.

Unit μm

BORE DIAMETER OF NOMINAL BEARING d(mm)		MEASURING LOAD	COMPENSATION FACTOR				
OVER	INCL.	N (kgf)	C2	CN (C0)	C3	C4	C5
10(INCLUDED)	18	24.5 (2.5)	3~4	4	4	4	4
18	50	49 (5)	4~5	6	6	6	6

RELATIONSHIP BETWEEN RADIAL INTERNAL CLEARANCE AND AXIAL INTERNAL CLEARANCE

The axial internal clearance is established from the ball diameter, outer and inner ring raceway radius and the radial internal clearance. Usually it is about 10 times the value of the internal radial clearance. Selection of a small internal radial clearance or an extra large interference fit in order to reduce the internal axial clearance after mounting is not recommended.



$$\Delta a = 2\sqrt{\Delta r(r_o + r - Da)} \quad (mm)$$

Δa:AXIAL INTERNAL CLEARANCE(mm)
r_o:OUTER RING RACEWAY RADIUS(mm)
Da:BALL DIAMETER(mm)
Δr:RADIAL INTERNAL CLEARANCE(mm)
r:INNER RING RACEWAY RADIUS(mm)

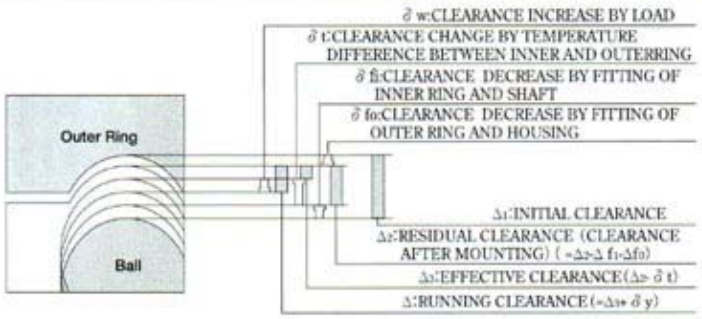
SELECTION OF BEARING CLEARANCE

Theoretically, maximum bearing life is with very slight preload. However, even a slight increase in this theoretical preload can have a considerably detrimental effect on the bearing life. Positive clearance should therefore be selected. MC3 is usually used for miniature or small bearings, standard clearance for general bearings and the clearance for thin section bearings should never be greater than "standard".

●SELECTION OF RADIAL INTERNAL CLEARANCE

Operating Condition	Clearance
Clearance fit for inner and outer ring. Low axial load. No axial load carrying requirement. Select bearing with reduced radial clearance. Lower vibration and noise. Low speeds.	MC1, MC2, C2
Lower frictional torque. Standard axial load. Average axial load carrying requirements. Slight interference fit for inner ring. Clearance fit for outer ring. Average/low speeds.	MC3, MC4, CN(C0)
Extremely low frictional torque. High axial load. High axial load carrying requirements. Heavy interfence fit to support high loads or shock loads. Large temperature gradient from inner ring to outer ring. High degree of shaft deflection.	MC5, MC6, C3, C4, C5

CALCULATION OF CLEARANCE



(1) RUNNING CLEARANCE

Running clearance is the resultant clearance after load, temperature difference and fitting are taken into consideration.

$$\Delta = \Delta_3 - (\partial t + \partial f) + \partial w \ (mm)$$

(2) CLEARANCE REDUCTION BY TEMPERATURE DIFFERENCE BETWEEN INNER AND OUTER RING

In a bearing, the highest temperature is generated in the rolling element followed by the inner ring, with the outer ring having the lowest temperature. Since it is impossible to measure the temperature of a rolling element, in practice, the temperature of the inner ring is used.

$$\partial t \fallingdotseq a \times \Delta T \times Do \ (mm)$$

(3) CLEARANCE REDUCTION BY FITTING

When a bearing is fitted onto a shaft or into a housing with an interference fit, the internal clearance of the bearing reduces.

$$\partial f = \partial fi + \partial fo =$$
$$\Delta db \times d/db \times ((1-(do/d)^2))/(1-(do/db)^2)) +$$
$$\Delta Da \times Da/D \times ((1-(D/Dh)^2)/(1-(Da/Dh)^2)) \quad (mm)$$

(4) CLEARANCE INCREASE BY LOAD

Load on a bearing deforms it elastically and increases the internal clearance.

$$\partial w = C \times ((5 \times Fr)/(Z \times \cos \alpha))^{(2/3)} \times (1/dw)^{(1/3)} \quad (mm)$$

The initial contact angle α_o is calculated from the following two formulae:

$$\cos \alpha_o / \cos \alpha = 1 + C/(2 \times m-1) \times (Fa/(9.8 \times Z \times Dw^2 \times \sin \alpha)^{(2/3)}$$
$$1-\cos \alpha_o = \Delta r/(2 \times DW \times (2 \times m-1))$$

SYMBOLS

ΔT : TEMPERATURE DIFFERENCE BETWEEN INNER AND OUTER RING	**m** : OSCULATION
Do : OUTER RING RACEWAY DIAMETER	Z : NUMBER OF BALLS
Δdb : CLEARANCE OF INNER RING ON SHAFT	Dw : BALL DIAMETER
do : BORE DIAMETER OF HOLLOW SHAFT	α : CONTACT ANGLE
Dn : OUTSIDE DIAMETER OF HOUSING SEAT	α_o : INITIAL CONTACT ANGLE
ΔDa : CLEARANCE OF OUTER RING IN HOUSING	Fa : AXIAL LOAD
db : AVERAGE OUTSIDE DIAMETER OF INNER RING	Fr : RADIAL LOAD
Da : AVERAGE OUTSIDE DIAMETER OF OUTER RING	Δr : RADIAL INTERNAL CLEARANCE
a : COEFFICENT OF THERMAL EXPANSION FOR BEARING STEEL	C : MATERIAL ELASTICITY FACTOR

General Bearing	C=0.00218	m=0.525
Instrument Bearing	C=0.00267	m=0.560

Lubrication

OBJECT OF LUBRICATION

The lubrication method and the lubricant have a direct effect on the bearing life; the most suitable lubrication must therefore be selected for each application. Effects of lubrication are described as follows:

(1) DECREASE OF FRICTION AND ABRASION

It decreases rolling friction between the raceway and the rolling elements, sliding friction between rolling element and cage and sliding friction of guide surface between the cage and the bearing ring.

(2) REDUCTION OF HEAT GENERATION

It dissipates heat generated inside the bearing as well as heat conducted from the outside thus preventing overheating of the bearing and deterioration of the lubricant.

(3) PROTECTION FROM CORROSION AND CONTAMINANTS

It prevents corrosion of rolling elements, bearing rings and cages and also prevents the ingress of contaminants and moisture into the bearing.

REQUIRED CHARACTERISTICS OF THE LUBRICANT

(1) LOW FRICTION AND ABRASION

(2) HIGH STABILITY AGAINST HEAT, GOOD THERMAL CONDUCTIVITY

(3) STRONG OIL FILM

(4) NON-CORROSIVE

(5) PROVIDE A GOOD BARRIER AGAINST DUST AND MOISTURE

(6) MAINTAIN A STABLE VISCOSITY

STANDARD LUBRICANT

Lubricant	Brand	EZO CODE	Manufacturer	MIL STANDARD	Operating Temperature(℃)	specific gravity
STD.GREASE	MULTEMP SRL	SRL	Kyodo Yushi		-40~+150	0.93
	ALVANIA 2S	AV2	Shell OIL Co.		-25~+120	0.92
STD. OIL	AERO SHELL FLUID 12	AF2	Shell OIL Co.	MIL-PRF-6085D	-50~+205	0.93

LUBRICATION METHOD

There are two types of lubricant: oil or grease. It is important to select the correct lubricant and lubrication method for each application and its conditions.

●LUBRICATING OIL AND GREASE

	LUBRICATING OIL	LUBRICATING GREASE
ROTATING SPEED	LOW・MEDIUM・HIGH SPEED	LOW・MEDIUM SPEED
LUBRICANT EFFICIENCY	EXCELLENT	GOOD
COOLING EFFECT	GOOD	NONE
TORQUE	COMPARATIVELY LOW	COMPARATIVELY HIGH
LUBRICANT LIFE	LONG	COMPARATIVELY SHORT
LUBRICANT REPLACEMENT	EASY	DIFFICULT
LUBRICANT LEAKAGE	SHOULD NOT BE USED WHERE OIL LEAKAGE IS UNACCEPTABLE	LITTLE GREASE LEAKAGE
IMPURITIES FILTRATION	EASY	DIFFICULT
SEALING EQUIPMENT	COMPLEX	SIMPLE

●GREASE FILLING VOLUME

SYMBOL	FILLING VOLUME(%)	OPERATING CONDITION	
		SPEED	LOAD
M	70±10	LOW	HEAVY
S	50±10	LOW	MEDIUM
G	40±10	MEDIUM	MEDIUM
L	30±10	MEDIUM	MEDIUM
Q	25±5	MEDIUM	MEDIUM
K	20±5	HIGH	LIGHT
X	10±5	HIGH	LIGHT

NOTE: LIGHT LOAD (≦0.06Cr)
STANDARD LOAD (≦0.12Cr)

●CRITERIA FOR LUBRICATING OIL SELECTION

OPERATING TEMPERATURE OF BEARING (℃)	dn	ISO VISCOSITY GRADE OF LUBRICATING OIL(VG)	
		MEDIUM LOAD	HEAVY LOAD/SHOCK LOAD
-30~0	UP TO PERMISSIBLE ROTATING SPEED	15,22,32	32,46
0~+60	UP TO 15000	32,46,68	100
	15000~80000	32,46	68
	80000~150000	22,32	32
	150000~500000	10	22,32
+60~+100	UP TO 15000	150	220
	15000~80000	100	150
	80000~150000	68	100,150
	150000~500000	32	68
+100~+150	UP TO PERMISSIBLE ROTATING SPEED	320	

NOTE: 1.IF HEAVY LOADS OCCUR AT LOW SPEEDS, A HIGHER VISCOSITY LUBRICATING OIL SHOULD BE USED.
2.THIS TABLE IS FOR OIL BATH LUBRICATION SYSTEM AND RECIRCULATING OIL SYSTEMS.
3.dn = BEARING BORE DIAMETER d(mm) × ROTATING SPEED n(r.p.m)

●COMMON OIL BRANDS AND EFFICIENCY

Manufacturer	Brand	Code	Lubricant Base	Flash Point (℃)	Viscosity (m^2/s)	Operating Temperature (℃)	Approved Standard
Shell Oil Co.	Aero Shell Fluid 31	AF1	Diester	237	14.33 (40℃)	-40~+204	MIL-PRF-83282D
	Aero Shell Fluid 12	AF2	Diester	220	8.9 (54.4℃)	-50~+205	MIL-PRF-6085D
	Aero Shell Fluid 3	AF3	Mineral	155	10.0 (38℃)	-47~+115	MIL-PRF-7870C
Anderson Oil Co.	Windsor Lube L-245X	WL2	Diester	215	14.0 (38℃)	-55~+175	MIL-PRF-6085D
Dupont,E.I.	Krytox 143AZ	KAZ	Fluorinated	-	12.4 (40℃)	-54~+149	-
Kluber Lub.	Isoflex PDB38	PD8	Diester	210	12.0 (40℃)	-55~+100	-
Anderol Co.	Anderol 402	A42	Diester	227	12.4 (40℃)	-54~+177	MIL-PRF-6085D
Nippon Oil Corp.	Antirust P2100	002	Mineral	166	13.0 (40℃)	-20~+115	VV-L-800c

●COMMON GREASE BRANDS AND EFFICIENCY

Manufacturer	Brand	Code	Thickening Agent	Lubricant Base	Drop Point (℃)	Cone Penetration: Worked (60 strokes)	Operating Temperature (℃)	Approved Standard
Shell Oil Co.	Alvania 1S	AV1	Lithium	Mineral	182	323	-35~+120	-
	Alvania 2S	AV2	Lithium	Mineral	185	275	-25~+120	-
	Alvania 3S	AV3	Lithium	Mineral	185	242	-20~+135	-
	Alvania RLQ	RLQ	Lithium	Mineral	195	275	-30~+120	-
	Aero Shell NO.7	AG7	Microgel	Diester	260	296	-73~+149	MIL-PRF-83282D
	Aero Shell NO.14	AG4	Calsium	Diester	148	273	-54~+93	MIL-G-25537C
	Aero Shell NO.15	AG5	Fluorotelomer	Silicone	260	290	-73~+232	MIL-G-25013E
	Aero Shell NO.16	AG6	Microgel	Polyester,Mineral	260	308	-54~+204	MIL-G-25760A
	Aero Shell NO.17	AG8	Microgel	Diester	260	295	-73~+149	MIL-G-21164D
	Aero Shell NO.22	AG2	Microgel	Synthetic Hydorocarbon	260	275	-65~+204	MIL-PRF-81322F
	Alvania EP2	AE2	Lithium	Mineral	184	284	-20~+110	-
	Retinax CL2	RXA	Lithium	Mineral	181	284	-15~+130	-
	Shell Cassida HDS2	HS2	Aluminum Complex	PAO	240	280	-30~+120	NSF(USDA)H1
	Shell Cassida RLS2	RL2	Aluminum Complex	PAO	240	275	-35~+120	NSF(USDA)H1
Kyodo Yushi	Multemp PS NO.2	PS2	Lithium	Diester,Mineral	190	275	-55~+130	-
	Multemp SRL	SRL	Lithium	Diester,Mineral	191	245	-40~+150	-
Kluber Lub.	Staburags NBU12	NB2	Barium	Mineral	220	270	-35~+150	NSF(USDA)H2
	Staburags NBU12/300KP	NB3	Barium	Mineral	220	300	-35~+150	-
	Staburags NBU8 EP	NB8	Barium	Mineral	220	280	-35~+150	NSF(USDA)H2
	Isoflex NBU15	NB5	Barium	Diester,Mineral	200	280	-40~+130	MIL-G-25760A
	Isoflex TOPAS NB52	B52	Barium	Synthetic Hydorocarbon	220	280	-60~+160	-
	Isoflex Alltime SL2	AS2	Lithium	Diester	180	280	-70~+150	-
	Isoflex LDS18 Special A	L8A	Lithium	Diester	190	280	-60~+130	MIL-G-23827B
	Isoflex Super LDS18	SL8	Lithium	Diester	190	280	-60~+130	MIL-G-7118A
	Isoflex PDB38 CX2000	PDC	Lithium	Synthetic	-	-	-70~+120	-
	Barielta IEL	IEL	PTFE	Fluorinated	-	280	-35~+220	-
	Barielta IEL/V	IEV	PTFE	Fluorinated	-	280	-65~+200	-
	Barielta IMI	IMI	PTFE	Fluorinated	-	280	-50~+220	-
	Barielta IMI/V	IMV	PTFE	Fluorinated	-	280	-50~+220	-
	Barielta L55/2	L55	PTFE	Fluorinated	-	280	-35~+260	NSF(USDA)H2
	Barielta IS	BS1	PTFE	Fluorinated	-	280	-35~+260	-
Dow Corning Co.	Molykote 33M	M3M	Lithium	Silicone	200	260	-70~+180	-
	Molykote 33L	M3L	Lithium	Silicone	200	300	-70~+180	-
	Molykote 44M	M4M	Lithium	Silicone	210	260	-40~+200	-
	Molykote BR2 Plus	BR2	Lithium	Mineral	180	280	-30~+150	-
	Molykote FS3451	F35	PTFE	Fluorinated	232	310	-40~+200	-
Dupont,E.I.	Krytox 240AC	K24	PFPE	Fluorinated	-	282	-35~+288	MIL-G-27617
	Krytox 240AZ	K2Z	PFPE	Fluorinated	-	285	-54~+149	MIL-G-27617
Esso Standard	Beacon325	B32	Lithium	Diester	190	274	-60~+120	-
	Temptex N3	TX3	Lithium Complex	Mineral	260	230	-30~+160	-
Mobil Oil Co.	Mobil NO.28	MG2	Bentnite	Synthetic Hydorocarbon	262	280	-62~+204	MIL-G-81322E
	Mobilux EP2	MGE	Lithium	Mineral	202	280	-30~+130	-
Caltex	Chevron RPM Grease SRI-2	SRI2	Lithium	Mineral	243	280	-30~+175	-
Nippon Grease Co.	Nig Ace W	NAW	Diurea	Synthetic	268	256	-30~+150	-
Shinetsu Chemical Co.	Silicolube G40M	G40	Lithium	Silicone	210	260	-30~+200	MIL-L-15719A

Maximum permissible bearing speed

Each bearing type has its own limiting speed. The theoretical speed that bearings can run at safely, even if heat generation by internal friction occurs, is called the maximum permissible speed.
The permissible speed is related to bearing type, type of cage, lubricant type, load and cooling conditions to which the bearing is subjected.
For contact rubber seals(2RS type), the permissible speeds are limited by the peripheral velocity of the seal lip. Normally, this is approximately 50 - 60% of that of non-contact rubber seals. If light contact rubber seals are required, this must be stipulated with the order.
If high loads occur, the permissible speed values must be reduced and the following supplementary factors applied, except under standard operating conditions(Cr/P<12, Fa/Fr>0.2)

●COMPENSATION FOR MAXIMUM PERMISSIBLE SPEED DEPENDENT ON LOAD RATIO

Cr/P	5	6	7	8	9	10	11	12
COMPENSATION FACTOR	0.72	0.79	0.85	0.90	0.93	0.96	0.98	1.00

●COMPENSATION FOR MAXIMUM PERMISSIBLE SPEED UNDER COMBINED AXIAL AND RADIAL LOAD

Fa/Fr	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00
COMPENSATION FACTOR	1.00	0.95	0.93	0.91	0.89	0.88	0.87	0.86

If the bearing operates at over 70% of the permissible speed value, a lubricant for high speed should be selected.
The values for the permissible speed are for applications with horizontal shafts and with appropriate lubrication. With vertical shafts, only 80% of the maximum speed value should be used. This is necessary due to the reduced cage guidance and reduced lubricant retention in this type of application.

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Frictional torque and temperature

FRICTIONAL TORQUE

Frictional torque of rolling bearings varies under changing load and lubrication conditions. When grease is used as a lubricant, the grease resistance must be added to the bearing frictional torque.
When adequate lubrication under normal loading conditions(Cr/P>12,Fa/Fr<0.2), the frictional torque of a bearing can be expressed as follows:

$M = \mu \cdot F \cdot d/2 (N \cdot mm)$	M:FRICTIONAL TORQUE(N·mm) F:BEARING LOAD (N) d:SHAFT DIAMETER(mm) μ:=0.0015 COEFFICIENT OF FRICTION

TEMPERATURE INCREASE

Friction and grease resistance can increase the bearing temperature. In the initial stages of operation, the internal bearing temperature rises rapidly: as the heat dissipates to the shaft and housing and the cooling effect of the lubricant begins to take effect, the temperature stabilizes. Constant high temperatures lead to a reduction in bearing clearance, a deterioration of the running accuracy and of the lubricant and thereby a reduction in bearing life. It is important to consider the effect of temperature increases when selecting the bearing.

Basic rules for selecting and handling of bearings

NOTES ON SELECTING

- The efficiency of thin type bearings can be greatly affected by the precision of shaft and housing seats. The accuracy of the surrounding structure must be such that it will not adversely affect the operation of the bearing. If you have any questions, in particular regarding series 670 and 680, please contact us.
- In applications with steel crown type cages (w type), where high acceleration, heavy loads, shock loads or vertical shafts occur or where oil is the only lubricant available, please contact us.
- Selection of fitting clearance and grease type requires a careful consideration of rotating speed, load conditions and temperature in order to prevent premature bearing failure.
- Full complement ball bearings are suitable for low speed and heavy radial load conditions. There is a danger of balls being pushed out of the bearing through the filling slot, even under light axial load. For this reason, full complement ball bearings are not suitable for supporting axial loads.

NOTES ON HANDLING

- The actual assembly area should be kept free from dust as any contamination has a detrimental effect on the operation and life of rolling bearings. If there is any doubt concerning the cleanliness of a bearing, it can be washed with a suitable agent and then relubricated.
- When fitting bearings, the fitting forces must not be transmitted via the rolling elements. If it is necessary to heat the bearing to facilitate fitting, the temperature should not exceed +120℃.

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- After assembly, the bearing should be rotated to check its correct operation. If the bearing does not appear to be functioning correctly, it should be re-examined to establish the cause of the malfunction.
- It is not advisable to mix oils and greases as this will affect the efficiency of the bearing.
- Bearings must be stored in a clean environment with stable temperature. They should be handled with care to avoid the possibility of corrosion and rusting.
- Lint-free cloth must be used to wipe shaft and housing seats to avoid the ingress of contaminants into the bearing.

Problem, Cause, Remedy

PROBLEM		CAUSE	REMEDY
Noise	High pitched metallic noise	Poor lubrication	Improve lubrication
		Clearance too small	Correct clearance
		Poor fitting	Investigate mounting method and seating
		Excessive load	Examine shaft and housing tolerances for closing effect
	Low pitched metallic noise	Brinelled raceway surface	Avoid shock loads
	Regular noise	Rust and damage	Check and replace seals and relubricate
		Flaking of raceway surface	Improve lubrication and check fitting, clearance and fixing method
	Irregular noise	Ingress of foreign matter	Check and replace seals and relubricate
		Excessive clearance	Correct clearance
		Damege and flaking of rolling element	Reduce loads and/or clearance
	Variable noise	Variable clearance due to temperature changes	Check fits taking housing material and temperature into consideration
		Damage to raceways	Improve lubrication and check fitting, clearance and fixing method
Heavy vibration		Flaking of raceway and rolling element	Improve lubrication and check fitting, clearance and fixing method
		Ingress of foreign matter	Check and replace seals and relubricate
		Excessive clearance	Correct clearance
		Poor location	Ensure abutment face and fitting diameter are perpendicular
Excessive heat generation		Clearance too small	Correct clearance
		Poor location	Ensure abutment face and fitting diameter are perpendicular
		Excessive load	Examine shaft and housing tolerances for closing effect
		Poor lubrication	Improve lubrication
		Creep	Maintain recommended shaft and housing fits
Lubrication failure		Too much grease	Use correct lubricant quantity
		Ingress of foreign matter	Check and replace seals and relubricate

Damage, Cause, Remedy

Incorrect handling of bearing can cause damage and shorten the life. The following list shows typical causes and suggested remedies.

PROBLEM	DAMAGE	CAUSE	REMEDY
Flaking	Flaking on one side of entire raceway	Excessive axial load by poor fitting or linear expansion	Use clearance fit on non-rotating bearing outer ring
	Flaking at rolling element pitch on raceways	Raceways brinelled during fitting	Careful fitting
		Corrosion during down time	Apply corrosion protective
	Premature flaking of raceway and rolling element surfaces	Excessive load	Check fitting Correct clearance Use correct lubricant quantity
		Clearance too small	
		Poor lubrication	
		Poor fitting	
		Corrosion	
	Flaking across the raceway	Poor fitting and eccentricity	Fitting and centering with care
		Shaft deflection	Use bearing with larger internal clearance
		Geometric inaccuracy of shaft and housing	Shaft and abutments to be square
	Flaking around raceway	Poor housing accuracy	Check geometric accuracy of housing bore
Indentations	Indentations on raceway at rolling element pitch	Shock loads during fitting or poor handling	Handling with care
		Excessive static load	Check static load
	Overrolling	Ingress of foreign matter	Ensure cleanliness of components and integrity of seals
Pick-up	Discolouration of raceway and rolling element surface	Excessive load	Check fitting
		Clearance too small	Correct clearance
	Softening of surfaces	Poor lubrication	Use correct lubricant quantity
		Poor fitting	Check fitting method
Electrical erosion	Raceway eroded at regular intervals	Arcing due to bearing conducting electricity	Ground the bearing. Insulate the bearing
Fracture	Raceway surface fracture	Excessive shock loads	Correct loading
		High interference fit	Proper fitting
		Increase of flaking and softening;welding of inner ring to shaft	Ensure correct geometry of shaft and housing
		Corner fillet radii too large	Correct fillet radii
	Rolling element fracture	Excessive shock loads	Correct loading
		Excessive internal clearance	Check fitting and clearance
	Cage fracture	Tilting moments	Fit with care
		High speed impulse and high acceleration	Ensure uniform rotation
		Incorrect lubrication	Check lubricant and lubrication method
		Ingress of foreign matter in bearing	Improve sealing
Skidding	Scoring of raceway and rolling element surfaces	Hard grease	Use soft grease
		High start-up acceleration	Control acceleration
Abrasion	Extreme abrasion of raceway, rolling element and cage	Ingress of foreign matter	Improve sealing Improve lubrication
		Corrosion	
		Poor lubrication	
	Creep	Loose fit	Correct tolerances and fitting
		Incorrectly fixed	Correct fixing
	Fretting corrosion	Small movements between surfaces	Increase interference fit
	False brinelling	Vibration in non-rotating bearing	Insulate bearing from vibration Use oil as lubricant Apply preload
		Small oscillations in application	
Corrosion	Rust inside bearing	Poor storage	Careful storage and handling
		Condensation	
	Rust on fitting surface	Fretting	Increase interference fit
		Fluctuating load	Use oil as lubricant
	Corrosion	Ingress of acid, alkali or gas	Check sealing
		Chemical reaction with lubricant	Use correct lubricant

〈Metric Series〉

●OPEN BEARINGS

EZO	KOYO	NMB	NSK	NTN
681	681	L-310	681	681
MR31	ML1003	L-310W51	MR31	–
691	691	R-410	691	691
MR41X	ML1204	R-412	MR41X	BC1.2-4
681X	68/1.5	L-415	681X	68/1.5
691X	69/1.5	R-515	691X	69/1.5
601X	ML1506	R-615	601X	60/1.5
672	–	–	672	672
682	682	L-520	682	682
MR52	ML2005	L-520W02	MR52	BC2-5
692	692	R-620	692	692
MR62	ML2006	R-620W02	MR62	BC2-6
MR72	ML2007	R-720Y52	MR72	BC2-7
602	602	R-720	602	602
682X	68/2.5	L-625	682X	68/2.5
692X	69/2.5	R-725	692X	69/2.5
MR82X	ML2508/1B	R-825Y52	MR82X	BC2.5-8
602X	ML2508	R-825	602X	60/2.5
MR63	ML3006	L-630	MR63	673
683	683	L-730	683	683
MR83	ML3008	R-830Y52	MR83	BC3-8
693	693	R-830	693	693
MR93	ML3009	R-930Y52	MR93	BC3-9
603	603	R-930	603	603
623	623	R-1030	623	623
633	633	–	633	633
MR74	ML4007	L-740	MR74	674
MR84	ML4008	L-840	MR84	BC4-8
684	684	L-940	684	684
MR104	ML4010	L-1040X2	MR104	BC4-10
694	694	R-1140	694	694
604	604	R-1240	604	604
624	624	R-1340	624	624
634	634	R-1640X4	634	634
MR85	ML5008	L-850	MR85	675
MR95	ML5009	L-950	MR95	BC5-9
MR105	ML5010	L-1050	MR105	BC5-10
685	685	L-1150	685	685
695	695	R-1350	695	695
605	605	R-1450	605	605
625	625	R-1650X4	625	625
635	635	R-1950	635	635
MR106	ML6010	L-1060	MR106	676
MR126	ML6012	L-1260	MR126	BC6-12
686	686	L-1360	686	686
696	696	R-1560	696	696
606	606	R-1760X2	606	606
626	626	R-1960	626	626
636	636	–	636	636
MR117	ML7011	L-1170	MR117	677
MR137	ML7013	L-1370	MR137	BC7-13
687	687	L-1470	687	687
697	697	–	697	697
607	607	R-1970	607	607
627	627	R-2270	627	627
637	637	–	637	637
MR128	ML8012	L-1280	MR128	678
MR148	ML8014	L-1480	MR148	BC8-14
688	688	L-1680	688	688
698	698	R-1980	698	698
608	608	R-2280	608	608
628	628	–	628	628
638	638	–	638	638
679	679	–	679	679
689	689	L-1790	689	689
699	699	L-2090	699	699
609	609	–	609	609
629	629	R-2690	629	629
639	639	–	639	639
6800	6800	L-1910W7	6800	6800
6900	6900	–	6900	6900
6000	6000	R-2610	6000	6000
6200	6200	–	6200	6200
6801	6801	–	6801	6801
6901	6901	–	6901	6901
6802	6802	–	6802	6802
6902	6902	–	6902	6902
6803	6803	–	6803	6803
6903	6903	–	6903	6903

●FLANGED OPEN BEARINGS

EZO	KOYO	NMB	NSK	NTN
F681	F681	LF-310	F681	FL681
F691	F691	RF-410	F691	FL691
MF41X	OBF05	RF-412	MF41X	FLBC1.2-4
F681X	F68/1.5	RF-415	F681X	FL68/1.5
F691X	F69/1.5	RF515	F691X	FL69/1.5
F601X	MLF1506	RF-615	F601X	FL60/1.5
F682	F682	LF-520	F682	FL682
MF52	MLF2005	LF-520W02	MF52	–
F692	F692	RF-620	F692	FL692
MF62	MLF2006	RF-620W52	MF62	FLBC2-6
MF72	MLF2007	RF-720Y52	MF72	–
F602	F602	RF-720	F602	FL602
F682X	F68/2.5	LF-625	F682X	FL68/2.5
F682X	F69/2.5	RF-725	F682X	FL69/.25
MF82X	MLF2508/1B	RF-825Y52	MF82X	FLBC2.5-8
F602X	MLF2508	RF-825	F602X	FL60/2.5
MF63	MLF3006	LF-630	MF63	FL673
F683	F683	LF-730	F683	FL683
MF83	MLF3008	RF-830Y52	MF83	FLBC3-8
F693	F693	RF-830	F693	FL693
MF93	MLF3009	RF-930Y52	MF93	FLBC3-9
F603	F603	RF-930	F603	FL603
F623	F623	RF-1030	F623	FL623
MF74	MLF4007	LF-740	MF74	FL674
MF84	MLF4008	LF-840	MF84	FLBC4-8
F684	F684	LF-940	F684	FL684
MF104	MLF4010	LF-1040X2	MF104	FLBC4-10
F694	F694	RF-1140	F694	FL694
F604	F604	RF-1240	F604	FL604
F624	F624	RF-1340	F624	FL624
F634	F634	RF-1640	F634	FL634
MF85	MLF5008	LF-850	MF85	FL675
MF95	MLF5009	LF-950	MF95	FLBC5-9
MF105	MLF5010	LF-1050	MF105	FLBC5-10
F685	F685	LF-1150	F685	FL685
F695	F695	RF-1350	F695	FL695
F605	F605	RF-1450	F605	FL605
F625	F625	RF-1650X4	F625	FL625
F635	F635	RF-1950	F635	FL635
MF106	MLF6010	LF-1060	MF106	FL676
MF126	MLF6012	LF-1260	MF126	FLBC6-12
F686	F686	LF-1360	F686	FL686
F696	F696	RF-1560X2	F696	FL696
F606	F606	RF-1760X2	F606	FL606
F626	F626	RF-1960	F626	FL626
MF117	MLF7011	LF-1170	MF117	FL677
MF137	MLF7013	LF-1370	MF137	FLBC3-17
F687	F687	LF-1470	F687	FL687
F697	F697	–	F697	FL697
F607	F607	RF-1970	F607	FL607
F627	F627	RF-2270	F627	FL627
MF128	MLF8012	LF-1280	MF128	FL678
MF148	MLF8014	LF-1480	MF148	FLBC8-14
F688	F688	LF-1680	F688	FL688
F698	F698	RF-1980	F698	FL698
F608	F608	RF-2280	F608	FL608
F679	–	–	F679	FL679
F689	F689	LF-1790	F689	FL689
F699	F699	LF-2090	F699	FL699
F609	F609	–	F609	FL609
F6800	F6800	LF-1910	F6800	FL6800
F63800	F63800	LF-1910W7	F63800	FL63800
F6900	F6900	–	F6900	FL6900

●SHIELDED BEARINGS

EZO	KOYO	NMB	NSK	NTN
681XZZ	W68/1.5ZZ	L-415ZZ	681XZZ	W68/1.5ZZA
691XZZ	W69/1.5ZZ	R-515ZZ	691XZZ	W69/1.5ZZA
601XZZ	WML1506ZZ	R-615ZZ	601XZZ	W60/1.5ZZA
682ZZ	W682ZZ	L-520ZZ	682ZZ	W682ZZA
MR52ZZ	WML2005ZZ	L-520ZZW52	MR52ZZ	WBC2-5ZZA
692ZZ	W692ZZ	R-620ZZ	692ZZ	W692ZZA
MR62ZZ	WML2006ZZ	R-620ZZY52	MR62ZZ	WBC2-6ZZA
MR72ZZS	WML2007ZZ	R-720ZZY03	MR72ZZS	WBC2-7ZZA
602ZZS	W602ZZX	R-720ZZ	602ZZS	W602ZZA
682XZZ	W68/2.5ZZ	L-625ZZ	682XZZ	W68/2.5ZZA
692XZZ	W69/2.5ZZ	R-725ZZ	692XZZ	W69/2.5ZZA
602XZZ	WOB17ZZ	R-825ZZ	602XZZ	W60/2.5ZZA
MR63ZZS	WML3006ZZX	L-630ZZ	MR63ZZS	WA673ZZA
683ZZ	W683ZZ	L-730ZZ	683ZZ	WA683ZZA
MR83ZZ	WML3008ZZ	L-830ZZ	MR83ZZ	WBC3-8ZZA
693ZZ	W693ZZ	R-830ZZ	693ZZ	WA693ZZA
MR93ZZ	603/2BZZ	R-930ZZY04	MR93ZZ	WBC3-9ZZA
603ZZ	W603ZZ	R-930ZZ	603ZZ	W603ZZA
623ZZ	623ZZ	R-1030ZZ	623ZZ	623ZZA
633ZZ	633ZZ	R-1330ZZ	633ZZ	633ZZ
MR74ZZS	WML4007ZZX	L-740ZZ	MR74ZZS	WA674ZZA
MR84ZZ	WML4008ZZX	L-840ZZ	MR84ZZ	WBC4-8ZZA
684ZZ	W684ZZ	L-940ZZ	684ZZ	W684ZZA
MR104ZZ	WML4010ZZ	L-1040ZZ	MR104ZZ	WBC4-10ZZA
694ZZ	694ZZ	R-1140ZZ	694ZZ	694ZZA
604ZZ	604ZZ	R-1240ZZ	604ZZ	604ZZ
624ZZ	624ZZ	R-1340ZZ	624ZZ	624ZZ
634ZZ	634ZZ	R-1640ZZ	634ZZ	634ZZ
MR85ZZS	WML5008ZZX	L-850ZZ	MR85ZZS	WA675ZZA
MR95ZZS	WML5009ZZX	L-950ZZ	MR95ZZS	WBC5-9ZZA
MR105ZZ	WML5010ZZ	L-1050ZZ	MR105ZZ	WBC5-10ZZA
685ZZ	W685ZZ	L-1150ZZ	685ZZ	W685ZZA
695ZZ	695ZZ	R-1350ZZ	695ZZ	695ZZA
605ZZ	605ZZ	R-1450ZZ	605ZZ	605ZZ
625ZZ	625ZZ	R-1650ZZ	625ZZ	625ZZ
MR106ZZS	WML610ZZX	L-1060ZZ	MR106ZZS	WA676ZZA
MR126ZZ	WML6012ZZ	L-1260ZZ	MR126ZZ	WBC6-12ZZA
686ZZ	W686ZZ	L-1360ZZ	686ZZ	W686ZZA
696ZZ	696ZZ	R-1560ZZ	696ZZ	696ZZ
606ZZ	606ZZ	R-1760ZZ	606ZZ	606ZZ
626ZZ	626ZZ	R-1960ZZ	626ZZ	626ZZ
MR117ZZS	WML7011ZZX	L-1170ZZ	MR117ZZS	WA677ZZA
MR137ZZ	WML7013ZZ	L-1370ZZ	MR137ZZ	WBC7-13ZZA
687ZZ	W687ZZ	L-1470ZZ	687ZZ	W687ZZA
607ZZ	607ZZ	R-1970ZZ	607ZZ	607ZZ
627ZZ	627ZZ	R-2270ZZ	627ZZ	627ZZ
MR128ZZS	WML8012ZZX	L-1280ZZ	MR128ZZS	W678ZZA
MR148ZZ	WML8014ZZ	L-1480ZZ	MR148ZZ	WBC8-14ZZA
688ZZ	W688ZZ	L-1680ZZ	688ZZ	W688ZZ
608ZZ	608ZZ	R-2280ZZ	608ZZ	608ZZ
689ZZ	W689ZZ	L-1790ZZ	689ZZ	W689ZZ
699ZZ	699ZZ	L-2090ZZ	699ZZ	699ZZ
629ZZ	629ZZ	R-2690ZZ	629ZZ	629ZZ
6800ZZ	6800ZZ	L-1910ZZW5	6800ZZ	6800ZZ
63800ZZ	63800ZZ	L-1910ZZ	63800ZZ	63800ZZ
6900ZZ	6900ZZ	L-2210ZZ	6900ZZ	6900ZZ
6000ZZ	6000ZZ	R-2610ZZ	6000ZZ	6000ZZ
6200ZZ	6200ZZ	–	6200ZZ	6200ZZ
6801ZZ	6801ZZ	–	6801ZZ	6801ZZ
6901ZZ	6901ZZ	–	6901ZZ	6901ZZ
6802ZZ	6802ZZ	–	6802ZZ	6802ZZ
6902ZZ	6902ZZ	–	6902ZZ	6902ZZ
6803ZZ	6803ZZ	–	6803ZZ	6803ZZ
6903ZZ	6903ZZ	–	6903ZZ	6903ZZ

●FLANGED SHIELDED BEARINGS

EZO	KOYO	NMB	NSK	NTN
F681XZZ	WF68/1.5ZZ	LF-415ZZ	F681XZZ	FLW68/1.5ZZA
F691XZZ	WF69/1.5ZZ	RF-515ZZ	F691XZZ	FLW69/1.5ZZA
F601XZZ	WMLF1506ZZ	RF-615ZZ	F601XZZ	FLW60/1.5ZZA
F682ZZ	WF682ZZ	LF-520ZZ	F682ZZ	FLW682ZZA
MF52ZZ	WMLF2005ZZ	LF-520ZZW52	MF52ZZ	FLWBC2-5ZZA
F692ZZ	WF692ZZ	RF-620ZZ	F692ZZ	FLW692ZZA
MF62ZZ	WMLF2006ZZ	RF-620ZZY52	MF62ZZ	FLWBC2-6ZZA
MF72ZZS	WMLF2007ZZ	RF-720ZZY03	MF72ZZS	FLWBC2-7ZZA
F602ZZS	WF602ZZX	RF-720ZZ	F602ZZS	FLW602ZZA
F682XZZ	WF68/2.5ZZ	LF-625ZZ	F682XZZ	FLW68/2.5ZZA
F692XZZ	WF69/2.5ZZ	RF-725ZZ	F692XZZ	FLW69/2.5ZZA
F602XZZ	WMLF2508ZZ	RF-825ZZ	F602XZZ	FLW60/2.5ZZA
MF63ZZS	WMLF3006ZZX	LF-630ZZ	MF63ZZS	FLWA673ZZA
F683ZZ	WF683ZZ	LF-730ZZ	F683ZZ	FLW683ZZA
MF83ZZ	WMLF3008ZZ	LF-830ZZ	MF83ZZ	FLWBC3-8ZZA
F693ZZ	WF693ZZ	RF-830ZZ	F693ZZ	FLW693ZZA
MF93ZZ	F603/2BZZ	RF-930ZZY04	MF93ZZ	FLAWBC3-9ZZA
F603ZZ	WF603ZZ	RF-930ZZ	F603ZZ	FLW603ZZA
F623ZZ	F623ZZ	RF-1030ZZ	F623ZZ	FL623ZZA
F633ZZ	F633ZZ	RF-1330ZZ	F633ZZ	FL633ZZ
MF74ZZS	WMLF4007ZZX	LF-740ZZ	MF74ZZS	FLWA674ZZA
MF84ZZ	WMLF4008ZZX	LF-840ZZ	MF84ZZ	FLWBC4-8ZZA
F684ZZ	WF684ZZ	LF-940ZZ	F684ZZ	FLW684ZZA
MF104ZZ	WMLF4010ZZ	LF-1040ZZ	MF104ZZ	FLAWBC4-10ZZA
F694ZZ	F694ZZ	RF-1140ZZ	F694ZZ	FL694ZZA
F604ZZ	F604ZZ	RF-1240ZZ	F604ZZ	FL604ZZ
F624ZZ	F624ZZ	RF-1340ZZ	F624ZZ	FL624ZZ
F634ZZ	F634ZZ	RF-1640ZZ	F634ZZ	FL634ZZ
MF85ZZS	WMLF5008ZZX	LF-850ZZ	MF85ZZS	FLWA675ZZA
MF95ZZS	WMLF5009ZZX	LF-950ZZ	MF95ZZS	FLWBC5-9ZZA
MF105ZZ	WMLF5010ZZ	LF-1050ZZ	MF105ZZ	FLAWBC5-10ZZA
F685ZZ	WF685ZZ	LF-1150ZZ	F685ZZ	FLW685ZZA
F695ZZ	F695ZZ	RF-1350ZZ	F695ZZ	FL695ZZA
F605ZZ	F605ZZ	RF-1450ZZ	F605ZZ	FL605ZZ
F625ZZ	F625ZZ	RF-1650ZZ	F625ZZ	FL625ZZ
MF106ZZS	WMLF610ZZX	LF-1060ZZ	MF106ZZS	FLWA676ZZA
MF126ZZ	WMLF6012ZZ	LF-1260ZZ	MF126ZZ	FLAWBC6-12ZZA
F686ZZ	WF686ZZ	LF-1360ZZ	F686ZZ	FLW686ZZA
F696ZZ	F696ZZ	RF-1560ZZ	F696ZZ	FL696ZZ
F606ZZ	F606ZZ	RF-1760ZZ	F606ZZ	FL606ZZ
F626ZZ	F626ZZ	RF-1960ZZ	F626ZZ	FL626ZZ
MF117ZZS	WMLF7011ZZX	LF-1170ZZ	MF117ZZS	FLWA677ZZA
MF137ZZ	WMLF7013ZZ	LF-1370ZZ	MF137ZZ	FLAWBC7-13ZZA
F687ZZ	WF687ZZ	LF-1470ZZ	F687ZZ	FLW687ZZA
F607ZZ	F607ZZ	RF-1970ZZ	F607ZZ	FL607ZZ
F627ZZ	F627ZZ	RF-2270ZZ	F627ZZ	FL627ZZ
MF128ZZS	WMLF8012ZZX	LF-1280ZZ	MF128ZZS	FLAW678ZZA
MF148ZZ	WMLF8014ZZ	LF-1480ZZ	MF148ZZ	FLWBC8-14ZZA
F688ZZ	WF688ZZ	LF-1680ZZ	F688ZZ	FLW688ZZ
F608ZZ	F608ZZ	RF-2280ZZ	F608ZZ	FL608ZZ
F689ZZ	WF689ZZ	LF-1790ZZ	F689ZZ	FLW689ZZ
F699ZZ	F699ZZ	LF-2090ZZ	F699ZZ	FL699ZZ
F629ZZ	F629ZZ	RF-2690ZZ	F629ZZ	FL629ZZ
F6800ZZ	F6800ZZ	LF-1910ZZW5	F6800ZZ	FL6800ZZ
F63800ZZ	F63800ZZ	LF-1910ZZ	F63800ZZ	FL63800ZZ
F6900ZZ	F6900ZZ	LF-2210ZZ	F6900ZZ	FL6900ZZ

〈Inch Series〉

●OPEN BEARINGS

EZO	KOYO	NMB	NSK	NTN
R09	OB63	RI-2	R09	R01
R0	OB65	RI-2 1/2	R0	R0
R1	OB67	RI-3	R1	R1
R1-4	OB69	RI-4	R1-4	R1-4
R133	OB71	RI3332	R133	R133
R1-5	OB72	RI-5	R1-5	R1-5
R144	OB74	RI-418	R144	R144
R2-5	OB75	RI-518	R2-5	R2-5
R2-6	OB76	RI-618	R2-6	R2-6
R2	EE0	R-2	R2	R2
R2A	EE1/2	–	R2A	RA2
R155	OB79	RI-5532	R155	R155
R156	OB81	RI-5632	R156	R156
R166	OB82	RI-6632	R166	R166
R3	EE1	R-3	R3	R3
R168	OB87	RI-614	R168	R168
R188	OB88	RI-814	R188	R188
R4	EE11/2	R-4	R4	R4
R4A	EE2	RI-1214	R4A	RA4
R1810	OB92-1	RI-8516	R1810	R1810
R6	EE3	RI-1438	R6	R6
R8	–	RI-1812	R8	R8
R10	–	–	R10	R10
R12	–	–	R12	R12

●SHIELDED BEARINGS

EZO	KOYO	NMB	NSK	NTN
R0ZZ	WOB65ZZ	RI-2 1/2ZZ	R0ZZ	RA0ZZA
R1ZZ	WOB67ZZ	RI-3ZZ	R1ZZ	RA1ZZA
R1-4ZZS	WOB69ZZX	RI-4ZZ	R1-4ZZS	RA1-4ZZA
R133ZZS	WOB71ZZX	RI-3332ZZ	R133ZZS	RA133ZZA
R1-5ZZS	WOB72ZZX	RI-5ZZ	R1-5ZZS	RA1-5ZZA
R144ZZS	WOB74ZZX	RI-418ZZ	R144ZZS	RA144ZZA
R2-5ZZ	WOB75ZZ	RI-518ZZ	R2-5ZZ	RA2-5ZZA
R2-6ZZ	WOB76ZZ	RI-618ZZ	R2-6ZZ	RA2-6ZZA
R2ZZ	EE0ZZ	R-2ZZ	R2ZZ	R2ZZA
R2AZZ	EE1/2ZZ	–	R2AZZ	RA2ZZ
R155ZZS	WOB79ZZX	RI-5532ZZ	R155ZZS	RA155ZZA
R156ZZS	WOB81ZZ	RI-5632ZZ	R156ZZS	RA156ZZA
R166ZZ	WOB82ZZ	RI-6632ZZ	R166ZZ	R166ZZA
R3ZZ	EE1SZZ	R-3ZZ	R3ZZ	RA3ZZ
R168ZZS	OB87ZZX	RI-614ZZ	R168ZZS	R168ZZA
R188ZZ	WOB88ZZ	RI-814ZZ	R188ZZ	RA188ZZA
R4ZZ	EE11/2ZZ	R-4ZZ	R4ZZ	R4ZZ
R4AZZ	EE2ZZ	RI-1214ZZ	R4AZZ	RA4ZZ
R1810ZZS	OBF92ZZX	RI-8516ZZ	R1810ZZS	RA1810ZZA
R6ZZ	EE3SZZ	RI-1438ZZ	R6ZZ	R6ZZ
R8ZZ	–	RI-1812ZZ	R8ZZ	R8ZZ
R10ZZ	–	–	R10ZZ	R10ZZ
R12ZZ	–	–	R12ZZ	R12ZZ

●FLANGED OPEN BEARINGS

EZO	KOYO	NMB	NSK	NTN
FR0	OBF65	RIF-2 1/2	FR0	FLR0
FR1	OBF67	RIF-3	FR1	FLR1
FR1-4	OBF69	RIF-4	FR1-4	FLR1-4
FR133	OBF71	RIF-3332	FR133	FLR133
FR1-5	OBF72	RIF-5	FR1-5	FLR1-5
FR144	OBF74	RIF-418	FR144	FLR144
FR2-5	OBF75	RIF-518	FR2-5	FLR2-5
FR2-6	OBF76	RIF-618	FR2-6	FLR2-6
FR2	OBF77	RF-2	FR2	FLR2
FR155	OBF79	RIF-5532	FR155	FLR155
FR156	OBF81	RIF-5632	FR156	FLR156
FR166	OBF82	RIF-6632	FR166	FLR166
FR3	OBF84	RF-3	FR3	FLRA3
FR168	OBF87	RIF-614	FR168	FLR168
FR188	OBF88	RIF-814	FR188	FLR188
FR4	OBF89	RF-4	FR4	FLR4
FR1810	OBF92-1	RIF-8516	FR1810	FLR1810
FR6	OBF93	RIF-1438	FR6	FLR6
FR8	–	RIF-1812	FR8	FLR8
FR10	–	–	FR10	FLR10
FR12	–	–	FR12	FLR12

●FLANGED SHIELDED BEARINGS

EZO	KOYO	NMB	NSK	NTN
FR0ZZ	WOBF65ZZ	RIF-2 1/2ZZ	FR0ZZ	FLRA0ZZA
FR1ZZ	WOBF67ZZ	RIF-3ZZ	FR1ZZ	FLRA1ZZA
FR1-4ZZS	WOBF69ZZX	RIF-4ZZ	FR1-4ZZS	FLRA1-4ZZA
FR133ZZS	WOBF71ZZX	RIF-3332ZZ	FR133ZZS	FLRA133ZZA
FR1-5ZZS	WOBF72ZZX	RIF-5ZZ	FR1-5ZZS	FLRA1-5ZZA
FR144ZZS	WOBF74ZZX	RIF-418ZZ	FR144ZZS	FLRA144ZZA
FR2-5ZZ	WOBF75ZZ	RIF-518ZZ	FR2-5ZZ	FLRA2-5ZZA
FR2-6ZZ	WOBF76ZZ	RIF-618ZZ	FR2-6ZZ	FLRA2-6ZZA
FR2ZZ	OBF77ZZ	RF-2ZZ	FR2ZZ	FLR2ZZA
FR155ZZS	WOBF79ZZX	RIF-5532ZZ	FR155ZZS	FLRA155ZZA
FR156ZZS	WOBF81ZZ	RIF-5632ZZ	FR156ZZS	FLRA156ZZA
FR166ZZ	WOBF82ZZ	RIF-6632ZZ	FR166ZZ	FLAR166ZZA
FR3ZZ	OBF84ZZ	RF-3ZZ	FR3ZZ	FLRA3ZZ
FR168ZZS	OBF87ZZX	RIF-614ZZ	FR168ZZS	FLAR168ZZA
FR188ZZ	WOBF88ZZ	RIF-814ZZ	FR188ZZ	FLRA188ZZA
FR4ZZ	OBF89ZZ	RF-4ZZ	FR4ZZ	FLR4ZZ
FR1810ZZS	OBF92ZZX	RIF-8516ZZ	FR1810ZZS	FLRA1810ZZA
FR6ZZ	WOBF93ZZ	RIF-1438ZZ	FR6ZZ	FLR6ZZ
FR8ZZ	–	RIF-1812ZZ	FR8ZZ	FLR8ZZ
FR10ZZ	–	–	FR10ZZ	FLR10ZZ
FR12ZZ	–	–	FR12ZZ	FLR12ZZ