1. ISO Dimensional system and bearing numbers

1.1 ISO Dimensional system

The boundary dimensions of rolling bearings, namely, bore diameter, outside diameter, width, and chamfer dimensions have been standardized so that common dimensions can be adopted on a worldwide scale. In Japan, JIS (Japan Industrial Standard) adheres to the boundary dimensions established by ISO. ISO is a French acronym which is translated into English as the International Organization for Standardization. The ISO dimensional system specifies the following dimensions for rolling bearings: bore diameter, d, outside diameter, D, width, B, (or height, T) and chamfer dimension, r, and provides for the diameter to range from a bore size of 0.6 mm to an outside diameter of 2500 mm. In addition, a method to expand the range is laid out so that the bore diameter, d, (d>500 mm) is taken from the geometrical ratio standard R40.

When expanding the dimensional system, the equation for the outside diameter equals $D=d+f_D d^{0.9}$ and the width equals $B=f_B \cdot (D-d)/2$. Both of these are to be used for radial bearings. Dimensions of the width, B, if possible, should be taken from numerical sequence R80 of preferred numbers in JIS Z 8601. The values of factors f_D and f_B are respectively specified for the diameter series and width series in Table 1. Minimum chamfer dimension, $r_{s\ min}$, should be selected from ISO table and in principle be that value which is nearest to, but not larger than 7% of the bearing width, B, or of the sectional height $(D-d)/2$, whichever is the smaller. Rounding-off of fractions has been specified for the above dimensions.

The outside diameter can be obtained from the factor f_D in Table 1 and bore d. Incidentally, the diameter series symbols 9, 0, 2, 3 are used most often. The thickness between the bore and outside diameters is determined by the diameter series. The outside diameter series increases in the order of 7, 8, 9, 0, 1, 2, 3, and 4 (Fig. 1) while the bore size remains the same size. The diameter series are combined with the factor f_B and classified into a few different width series. The dimension series is composed of combinations of the width series and diameter series.

In the United States, many tapered roller bearings are expressed in the inch system rather than the metric system as specified by ISO. Japan and European countries use the metric system which is in accordance with ISO directives.

The expansion of thrust bearings series (single-direction with flat seats) is laid out in a similar manner as the radial bearings with the boundary dimensions as follows: outside diameter, $D=d+f_D d^{0.8}$, and height, $T=f_T \cdot (D-d)/2$. Minimum chamfer dimension, $r_{s\ min}$, should be selected from ISO table and in principle be that value which is nearest to, but not larger than 7% of the bearing height, T, or $(D-d)/2$, whichever is the smaller. Values for the factors f_D and f_T are as shown in Table 2.

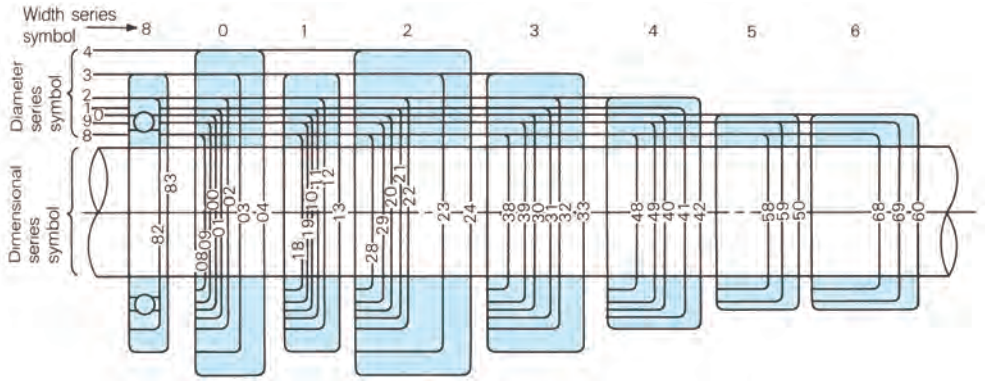


Fig. 1 Cross-sectional profiles of radial bearings by dimensional series

Table 1 f_D and f_B values of radial bearings

Diameter series	7	8	9	0	1	2	3	4
f_D	0.34	0.45	0.62	0.84	1.12	1.48	1.92	2.56

Width series	0	1	2	3	4	5	6	7
f_B	0.64	0.88	1.15	1.5	2.0	2.7	3.6	4.8

Table 2 f_D and f_T values for thrust bearings

Diameter series	0	1	2	3	4	5
f_D	0.36	0.72	1.20	1.84	2.68	3.80

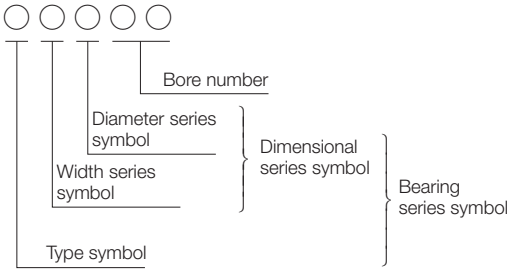
Height series	7	9	1
f_T	0.9	1.2	1.6

1.2 Formulation of bearing numbers

The rolling bearing is an important machine element and its boundary dimensions have been internationally standardized. International standardization of bearing numbers has been examined by ISO but not adopted. Now, manufacturers of various countries are using their own bearing numbers. Japanese manufacturers express the bearing number with 4 or 5 digits by a system which is mainly based on the SKF bearing numbers. The JIS has specified bearing numbers for some of the more commonly used bearings.

A bearing number is composed as follows.

The width series symbol and diameter series symbol are combined and called the dimensional series symbol. For radial bearings, the outside diameter increases with the diameter series symbols 7, 8, 9, 0, 1, 2, 3, and 4. Usually, 9, 0, 2, and 3 are the most frequently used. Width series symbols include 0, 1, 2, 3, 4, 5, and 6 and these are combined with the respective diameter series symbols. Among the width series symbols, 0, 1, 2, and 3 are the most frequently used. Width series symbols become wider in this ordering system to match the respective diameter series symbol.



For standard radial ball bearings, the width series symbol is omitted and the bearing number is expressed by 4 digits. Also, it is common practice to omit the width series symbol of the zero for cylindrical roller bearings.

For thrust bearings, there are various combinations between the diameter symbols and height symbols (thrust bearings use the term height symbol rather than width symbol).

The bore diameter symbol is a number which is 1/5 of the bore diameter dimension when bores are 20 mm or greater. For instance, if the bore diameter is 30 mm then the bore diameter symbol is 06. However, when the bore diameter dimension is less than 17 mm, then the bore diameter symbol is by common practice taken from Table 1. Although bearing numbers vary depending on the country, many manufacturers follow this rule when formulating bore symbols.

Numbers and letters are used to form symbols to designate a variety of types and sizes of bearings. For instance, cylindrical roller bearings use letters such as N, NU, NF, NJ and so forth to indicate various roller guide rib positions. The formulation of a bearing number is shown in Table 2.

Table 1

Bore No.	Bore diameter d (mm)
/0.6(1)	0.6
1	1
/1.5(1)	1.5
2	2
/2.5(1)	2.5
3	3
4	4
5	5
6	6
7	7
8	8
9	9
00	10
01	12
02	15
03	17

Notes
(1) NSK 0.6 mm bore bearing is not available. 1X and 2X are used for the NSK bearing number instead of /1.5 and /2.5 respectilely.

Table 2 Formulation of a bearing number

Bearing types		Sample brg	Type No.	Width or height(1) series No.	Dia. Series No.	Bore No.
Radial ball bearing	Single-row deep groove type	629	6	[0] omitted	2	9
		6010	6	[1] omitted	0	10
		6303	6	[0] omitted	3	03
	Single-row angular type	7215A	7	[0] omitted	2	15
	Double-row angular type	3206	3	[3] omitted	2	06
		5312	5	[3] omitted	3	12
	Double-row self-aligning type	1205	1	[0] omitted	2	05
		2211	2	[2] omitted	2	11
Radial roller bearing	Cylindrical roller	NU 1016	NU	1	0	16
		N 220	N	[0] omitted	2	20
		NU 2224	NU	2	2	24
		NN 3016	NN	3	0	16
	Tapered roller	30214	3	0	2	14
	Spherical roller	23034	2	3	0	34
Thrust ball bearing	Single-direction flat seats	51124	5	1	1	24
	Double-direction flat seats	52312	5	2	3	12
	Single-direction self-aligning seats	53318	5	3(2)	3	18
	Double-direction self-aligning seats	54213	5	4(2)	2	13
Thrust roller bearing	Spherical thrust roller	29230	2	9	2	30

Notes (1) Height symbol is used for thrust bearings instead of width.
(2) These express a type symbol rather than a height symbol.

1.3 Bearing numbers for tapered roller bearings (Inch system)

The **ABMA** (The American Bearing Manufacturers Association) standard specifies how to formulate the bearing number for tapered roller bearings in the inch system. The **ABMA** method of specifying bearing numbers is applicable to bearings with new designs. Bearing numbers for tapered roller bearings in the inch system, which have been widely used, will continue to be used and known by the same bearing numbers. Although **TIMKEN** uses **ABMA** bearing numbers to designate new bearing designs, many of its bearing numbers do not conform to **ABMA** rules.

A bearing number is composed as follows.

Load limit symbol	Contact angle number	Series number	Auxiliary number	Auxiliary symbol
AA	○	○○○	○○	AA

"A" indicates an alphabetical character.
"○" indicates a numerical digit.

Tapered roller bearings (Inch system)

The outer ring of a tapered roller bearing is called a "CUP" and the inner ring is a "CONE". A CONE ASSEMBLY consists of tapered rollers, cage and inner ring, though sometimes it is called a "CONE" instead of "CONE ASSEMBLY". Therefore, an inch-system tapered roller bearing consists of one CUP and one CONE (exactly speaking, one CONE ASSEMBLY). Each part is sold separately. Therefore, to obtain a complete set both parts must be ordered.

In the example of page 11, LM11949 is only a CONE. A complete inch-system tapered roller bearing is called a CONE/CUP and is specified by LM11949/LM11910 for this example.

LM 1 19 49

Load limit symbol
Terms such as light load, medium load, and heavy load and so forth are used for metric series bearings. The following symbols are used as load limiting symbols and are arranged from lighter to heavier: EL, LL, L, LM, M, HM, H, HH, EH, J, T
However, the last symbol "T" is reserved for thrust bearings only.

Contact angle number
The number expressing the contact angle is composed as follows.

Cup angle (contact angle × 2)	Number
0° to Less than 24°	1
24° to Less than 25°30'	2
25°30' to Less than 27°	3
27° to Less than 28°30'	4
28°30' to Less than 30°30'	5
30°30' to Less than 32°30'	6
32°30' to Less than 36°	7
36° to Less than 45°	8
Higher than 45° (Other than thrust bearings)	9

Auxiliary symbol
The auxiliary symbol is a suffix composed of 1 or 2 letters and used when the appearance or internal features are modified.
B Outer ring with flange
X Standard type, modified slightly
WA Inner ring with a slot at the back
Others Omitted

Auxiliary number
Excluding the auxiliary symbols, the last and second to last numbers are auxiliary numbers which are peculiar to the inner or outer ring of that bearing.
The numbers, 10 to 19, are used for outer rings with 10 used to label the bearing with the minimum outside diameter.
The numbers, 30 to 49, are used for inner rings with 49 used to label the inner ring with the largest bore diameter.

Series number
A series number is expressed by one, two, or three digits. The relationship with the largest bore diameter of that series is as follows.

Maximum bore diameter in series (mm (inch))		Series number
over	inch	
0	25.4 (1)	00 to 19
25.4 (1)	50.8 (2)	20 to 99 000 to 029
50.8 (2)	76.2 (3)	039 to 129
……(omitted)……		

1.4 Bearing numbers for miniature ball bearings

Ball bearings with outside diameters below 9 mm (or below 9.525 mm for bearings in the inch design) are called miniature ball bearings and are mainly used in VCRs, computer peripherals, various instruments, gyros, micromotors, etc. Ball bearings with outside diameters greater than or equal to 9 mm (greater than or equal to 9.525 mm for inch design bearings) and bore diameters less than 10 mm are called extra-small ball bearings.

As in general bearings, special capabilities of miniature ball bearings are expressed by descriptive symbols added after the basic bearing number. However, one distinction of miniature and extra-small ball bearings is that a clearance indicating symbol is always included and a torque symbol is often included even if the frictional torque is quite small.

NSK has established a clearance system for miniature and extra-small ball bearings with 6 gradations of clearance so that NSK can satisfy the clearance demands of its customers. The MC3 clearance is the normal clearance suitable for general bearings.

As far as miniature and extra-small ball bearings are concerned, the ISO standards are applied to bearings in the metric design bearings and **ABMA** standards are applied to inch design bearings.

Miniature ball bearings are often required to have low frictional torque when used in machines. Therefore, torque standards have been established for low frictional torque. Torque symbols are used to indicate the classification of miniature bearings within the frictional standards.

The cage, seal, and shield symbols for miniature ball bearings are the same as those used for general bearings. The material symbol indicating stainless steel is an "S" and is added before the basic bearing number in both inch and metric designs for bearings of special dimensions. However, for metric stainless steel bearings of standard dimensions, an "h" is added after the basic bearing number. The figure below shows the arrangement and meaning and so forth of bearing symbols for miniature and extra-small ball bearings.

Table 1 Formulation of bearing numbers for miniature ball bearings.

Symbol	Contents
ZZS	Shield
ZZ	Shield

Symbol	Contents
J	Pressed-cage
W	Crown type cage
T	Non-metallic cage

Symbol	Contents
Omitted	Bearing steel (SUJ2)
h	Stainless steel (SUS440C)
S	Stainless steel (SUS440C)

Symbol	Radial clearance (μm)
MC1	0 ~ 5
MC2	3 ~ 8
MC3	5 ~ 10
MC4	8 ~ 13
MC5	13 ~ 20
MC6	20 ~ 28

ANSI/ABMA Std.		ISO Std.	
Symbol	Accuracy class	Symbol	Accuracy class
Omitted	ABEC1	Omitted	Class 0
3	ABEC3	P6	Class 6
5P	CLASS5P	P5	Class 5
7P	CLASS7P	P4	Class 4

Symbol	Contents
AF2	Aero-Shell Fluid 12
NS7	NS Hilube grease

Classification	Material symbol
Inch design bearings	S
Special metric design bearings	—
Standard metric design bearings	—
	—

Basic bearing number	Material symbol	Cage symbol	Seal/shield symbol	Clearance symbol	Accuracy symbol	Torque symbol	Lubricatdon symbol
FR133	—	J	ZZS	MC4	7P	L	AF2
MR74	—	W	ZZS	MC3	P5	—	NS7
692	h	J	ZZ	MC3	P5	—	NS7
602	—	J	ZZS	MC4	—	—	NS7

1.5 Auxiliary bearing symbols

Rolling bearings are provided with various capabilities to meet a variety of application demands and methods of use. These special capabilities are classified and indicated by auxiliary symbols attached after the basic bearing number. The entire system of basic and auxiliary symbols should be completely unified but this level of standardization has not been achieved.

Currently, manufacturers use a combination of their own symbols and specified symbols. The internal clearance symbols and accuracy symbols are two sets of symbols which are widely used and specified by JIS. The auxiliary symbols employed by NSK are listed in alphabetical order as follows.

Symbol	Contents	Example
A	Internal design differs from standard design	6307A HR32936JA
A(1)	Angular contact ball bearing with standard contact angle of α =30°	7215A
AH	Removable sleeve type symbol	AH3132
A5(1)	Angular contact ball bearing with standard contact angle of α =25°	7913A5
B	Cylindrical roller bearing: the allowance of roller inscribed circle diameter or circumscribed circle diameter does not comply with JIS standards	NU306B
	Inch series tapered roller bearing with flanged cup	779/772B
B(1)	Angular contact ball bearing with standard contact angle of α =40°	7310B
C(1)	Angular contact ball bearing with standard contact angle of α =15°	7205C
	Tapered roller bearing with contact angle of about 20°	HR32205C
CA	Spherical roller bearing with high load capacity (machined cage)	22324CA
CD	Spherical roller bearing with high load capacity (pressed cage)	22228CD
C1 C2 C3 C4 C5	C1 clearance (smaller than C2) C2 clearance (smaller than normal clearance) C3 clearance (larger than normal clearance) C4 clearance (larger than C3) C5 clearance (larger than C4)	6218C3
CC CC1 CC2 CC3 CC4 CC5	Normal matched clearance of cylindrical roller bearing C1 matched clearance of cylindrical roller bearing C2 matched clearance of cylindrical roller bearing C3 matched clearance of cylindrical roller bearing C4 matched clearance of cylindrical roller bearing C5 matched clearance of cylindrical roller bearing	N238CC2
CC9	Matched clearance of cylindrical roller bearing with tapered bore (smaller than CC1)	NN3017KCC9
CG15	Special radial clearance (indicates median clearance)	6022CG15
CM	Special clearances for general motors of single-row deep groove ball bearing and cylindrical roller bearing (matched)	NU312CM

Note (1) Part of the basic bearing number

Symbol	Contents	Example
D(1)	Tapered roller bearing with contact angle of about 28°	HR30305D
DU	A contact rubber seal on one side	6306DU
DDU	Contact rubber seals on both sides	6205DDU
DB	2-row combination (back-to-back combination) 	7208ADB
DBB	4-row combination 	7318ADBB
DBD	3-row combination 	7318ADBD
DBT	4-row combination 	7318ADBT
DBTD	5-row combination 	7318ADBTD
DF	2-row combination (front-to-front combination) 	7320ADF
DFD	3-row combination 	7320ADFD
DFF	4-row combination 	7320ADFF
DFT	4-row combination 	7320ADFT
DT	2-row combination (tandem combination) 	7320ADT
DTD	3-row combination 	7320ADTD
DTT	4-row combination 	7320ADTT

Symbol	Contents	Example
E	Bearing with notch or oil port	6214E
	High load capacity type cylindrical roller bearing	NU309ET
E4	Cylindrical roller bearing for sheave and spherical roller bearing with oil groove and oil holes in the outer ring	230/560 ME4
F	Steel machined cage	230/570F
g	Case hardened steel (SAE4320H, etc)	456g/454g
h	Stainless steel bearing rings and rolling elements	6203h
H	Adapter type symbol	H318X
	Radial and thrust spherical roller bearings of high load capacity	22210H 29418H
HJ	L-type loose collar type symbol	HJ210
HR (2)	High load capacity type tapered roller bearing	HR30308J
J	Tapered roller bearing with the outer ring raceway small end diameter and angle in conformity with ISO standards	HR30308J
	Pressed steel cage, 2 pieces	R6JZZ
K	Tapered inner ring bore (taper: 1:12)	1210K
	With outer ring spacer	30310DF+K
K30	Tapered inner ring bore (taper: 1:30)	24024CK30
KL	With inner and outer ring spacers (Figure just after KL is spacer width)	7310ADB+KL10
L	With inner ring spacer	30310DB+L
M	Copper alloy machined cage	6219M
MC3	Small size and miniature ball bearings of standard clearance	683MC3
N	With locating snap ring groove in outer ring	6310N
NR	Bearing with locating snap ring	6209NR
NRX	Locating snap ring of special dimension	6209NRX
NRZ	Pressed-steel shield on one side and locating snap ring on the same side (c.f. ZNR)	6207NRZ
PN0	Accuracy class of inch design tapered roller bearings, equivalent to Class 0	575/572PN0
PN3	Accuracy class of inch design tapered roller bearings, equivalent to Class 3	779/772BPN3

Note (2) HR is added before bearing type symbol.

Symbol	Contents		Example
S11	Heat stabilized for operation up to 200°C		22230CAMKE4 C3S11
T	Synthetic resin cage		7204CT
V	No cage		NA4905V
	A non-contact rubber seal on one side		6204V
VV	Non-contact rubber seals on both sides		6306VV
W	One-piece pressed-steel cage		NU210W
	Inch design tapered roller bearing with notch at bearing ring		456W/454
X	Bore or outside diameter or width modified less than 1 mm		6310X
	Shaft washer's outside diameter is smaller than housing washer's outside diameter		51130X
X26	Bearings with enhanced dimensional stability	Bearing operating temperature below 150°C	23032CD C3X26
X28		Operating temperature below 200°C	23032CD C4X28
X29		Operating temperature below 250°C	23032CD C4X29
Y	Pressed-brass cage		608Y
Z	A pressed-steel shield on one side		6203Z
ZN	A pressed-steel shield on one side and a locating-snap-ring groove on the other side		6208ZN
ZNR	A pressed-steel shield on one side and a locating-snap-ring on the other side (c.f. NRZ)		6208ZNR
ZZ	Pressed-steel shields on both sides		6208ZZ