



Needle Roller Bearings

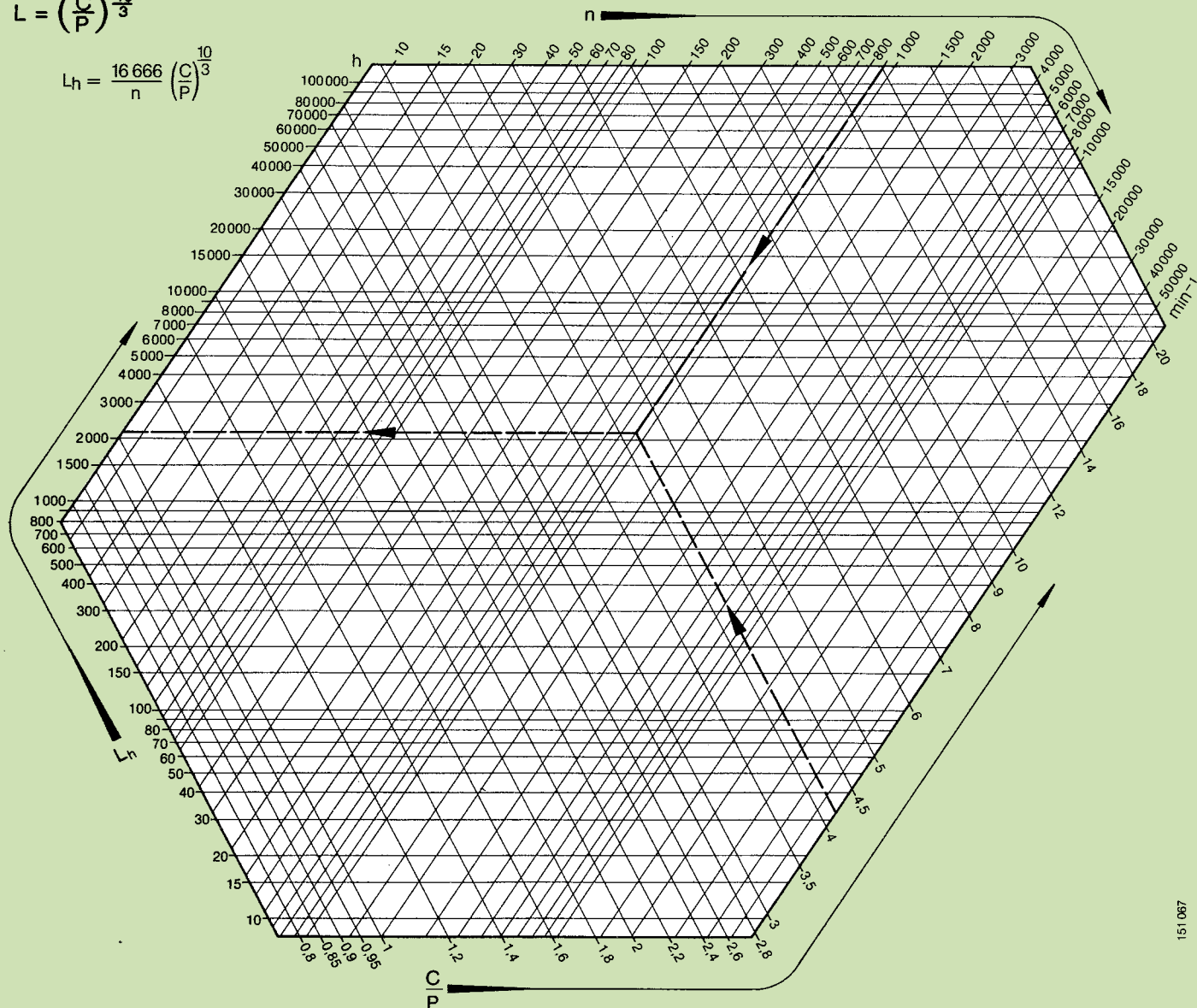
Catalog 352



Nomogram for fatigue life calculation of needle roller bearings

$$L = \left(\frac{C}{P}\right)^{\frac{10}{3}}$$

$$L_h = \frac{16\,666}{n} \left(\frac{C}{P}\right)^{\frac{10}{3}}$$



Calculation Example:

given are:

C = 1700 lbf

P = 415 lbf

n = 900 rpm

for $\frac{C}{P} = 4.2$ and $n = 900$ rpm; read

$L_h = 2200$ hrs

Please refer to page 14 for explanations concerning load ratings and life.



Catalog 352

INTRODUCTION

This catalog offers a wide range of standard, inch type needle roller bearings and components. Besides complete dimensional details, mounting recommendations, load ratings and limiting speeds are also provided to the user.

The section entitled "Technical Data" addresses essential questions concerning design and calculations of bearing applications. Additional engineering assistance is available through our network of sales engineers.

For information on the broad line of INA metric needle roller bearings and INA linear motion bearings, two separate catalogs are available upon request.

Due to continuous bearing developments, we reserve the right to introduce design changes and improvements at any time. We also advise our customers to check with our sales department on the availability of the products listed herein, since they may not always be available. All pages of this catalog have been carefully checked. However, INA will not assume responsibility for possible errors.

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Fort Mill, South Carolina 29715

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Product Survey

Page	Designation	Description
42	BCE	Shell bearings, cage guided, closed end, standard series
42	BCE...P	Shell bearings, cage guided, closed end, one seal, standard series
42	BCH	Shell bearings, cage guided, closed end, heavy series
42	BCH...P	Shell bearings, cage guided, closed end, one seal, heavy series
77	C	Unit cages
104	CF	Stud type cam followers, full complement
104	CF...PP	Stud type cam followers, full complement, sealed
104	CF...SK	Stud type cam followers, full complement, hexagonal socket
104	CF...Y	Stud type cam followers, full complement, crowned outside diameter
104	CFC	Stud type cam followers, cage guided
104	CFC...PP	Stud type cam followers, cage guided, sealed
104	CFC...SK	Stud type cam followers, cage guided, hexagonal socket
104	CFC...Y	Stud type cam followers, cage guided, crowned outside diameter
104	CFCE	Stud type cam followers, cage guided, eccentric collar
104	CFCE...PP	Stud type cam followers, cage guided, eccentric collar, sealed
104	CFCE...SK	Stud type cam followers, cage guided, eccentric collar, hexagonal socket
104	CFE	Stud type cam followers, full complement, eccentric collar
104	CFE...PP	Stud type cam followers, full complement, eccentric collar, sealed
104	CFE...SK	Stud type cam followers, full complement, eccentric collar, hexagonal socket
42	CSN	Shell bearings, full complement, grease retained, closed end, standard series
42	CSNH	Shell bearings, full complement, grease retained, closed end, heavy series
42	CS	Shell bearings, full complement, mechanically retained, closed end, standard series
42	CSH	Shell bearings, full complement, mechanically retained, closed end, heavy series
112	HFZ	Roller clutches
112	HFLZ	Roller clutches with bearing assembly
86	NCS	Precision ground needle bearings
92	PI	Inner rings

Page	Designation	Description
98	RF	Yoke type cam followers, full complement
98	RF...PP	Yoke type cam followers, full complement, sealed
98	RF...Y	Yoke type cam followers, full complement, crowned outside diameter
98	RFC	Yoke type cam followers, cage guided
98	RFC...PP	Yoke type cam followers, cage guided, sealed
98	RFC...Y	Yoke type cam followers, cage guided, crowned outside diameter
42	S	Shell bearings, full complement, mechanically retained, open end, standard series
42	SCE	Shell bearings, cage guided, open end, standard series
42	SCE...PP	Shell bearings, cage guided, open end, one seal, standard series
42	SCE...PP	Shell bearings, cage guided, open end, two seals, standard series
42	SCE...TN	Shell bearings, cage guided, plastic cage
42	SCH	Shell bearings, cage guided, open end, heavy series
42	SCH...P	Shell bearings, cage guided, open end, one seal, heavy series
42	SCH...PP	Shell bearings, cage guided, open end, two seals, heavy series
42	SH	Shell bearings, full complement, mechanically retained, open end, heavy series
42	SI	Inner rings for shell bearings
42	SN	Shell bearings, full complement, grease retained, open end, standard series
42	SNH	Shell bearings, full complement, grease retained, open end, heavy series
82	TC	Thrust cages
82	TWA	Thrust washers
82	TWB	Thrust washers
82	TWC	Thrust washers
82	TWD	Thrust washers
107	VD	Closing plugs

Suffixes

Suffixes complete the bearing designation and explain in detail the bearing design. If several suffixes apply to one bearing, they should be added in the order shown herein. Please note that not all bearings listed in the dimension tables are available in special executions. Most suffixes are not marked on the bearing.

A, B, C, E

The meaning of these symbols is not determined in detail. They are used as required to indicate different internal design features for bearings with the same boundary dimensions. In general, their use is of limited duration to avoid confusion during an interim period. In certain cases, however, they are used for the permanent identification of bearings of the same type and external dimensions, but with differences in internal design features.

F

integral reversed seal on one side

FF

integral reversed seals on both sides

P

integral seal on one side

PF

integral seals on both sides, one seal reversed

PN

nitrile rubber seal on one side

PP

integral seals on both sides

PPN

nitrile rubber seal on both sides

PPR

polyester elastomer seal on both sides

PR

polyester elastomer seal on one side

G

extra precision (applies to full complement shell bearings of series S only)

AS. . .

oil hole(s) in outer race

A figure is added to indicate the number of lubrication holes. If more than one is specified, they are equally spaced around the circumference.

Example:

SCE 2012 AS1 = Shell bearing

SCE 2012 with one lubrication hole in the drawn cup.

Y

crowned outside diameter of stud and yoke type cam followers if the standard design is a cylindrical outside diameter

SK

stud type cam follower with hexagonal socket

TN

plastic cage

Examples of INA part numbers

Shell bearings

Example	SCE 108	SCE	10	8
Explanation		cage guided, open end	shaft dia. in .16ths	width in 16ths

Thrust bearings

Example	TC 815	TC	8	15
Explanation		thrust cage	shaft dia. in 16ths	housing dia. in 16ths

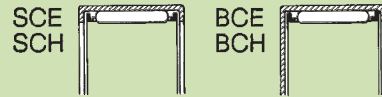
Cam followers

Example	CF 16	CF	16
Explanation		stud type cam follower	outside dia. in 16ths



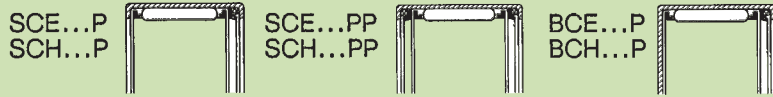
Technical data

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Shell bearings
cage guided

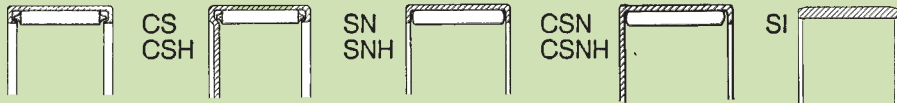
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Sealed shell bearings
cage guided

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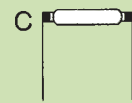
S
SH



Shell bearings
full complement
Inner rings
for shell bearings

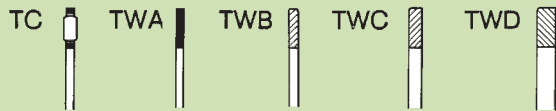
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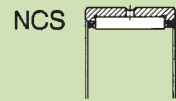
Unit cages

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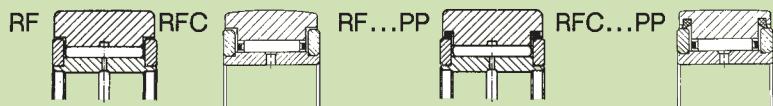
Precision ground bearings

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Inner rings

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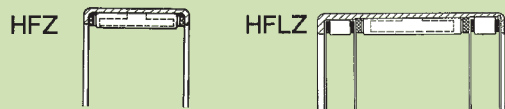
Yoke type cam followers

98



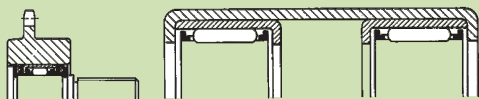
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1 Symbols and Units of Measurements

Unless otherwise specified in the text, the values indicated in the section "Technical Data" have the following symbols, units of measurements and meaning:

AA	μin	Arithmetic average surface finish value
C	lbf	Basic dynamic load rating
C _H	lbf	Effective dynamic load rating for reduced hardness
C _T	lbf	Effective dynamic load rating for high temperature
C _W	lbf	Effective dynamic load rating for yoke and stud type cam followers
C ₀	lbf	Basic static load rating
C _{0H}	lbf	Effective static load rating for reduced hardness
C _{0W}	lbf	Effective static load rating for yoke and stud type cam followers
C/P	—	Dynamic load ratio
d	in	Shaft diameter or bore diameter of the inner ring
d _M	in	Mean bearing diameter (d + D)/2
D _W	in	Rolling element diameter
D	in	Bore diameter of housing or outside diameter of outer ring
E	in	Raceway diameter of outer ring
E _{ht}	in	Effective hardness depth of case hardened raceways related to a reference hardness of 550 HV (RC 52)
E _W	in	Outer enveloping circle diameter
f	—	Coefficient of friction
f _H , f _{H0}	—	Dynamic or static hardness factor
f _T	—	Temperature factor
F	in	Raceway diameter of inner ring
F	lbf	Force, bearing load
F _a , F _r	lbf	Axial or radial bearing load
F ₀	lbf	Maximum load on radial or thrust bearings
F _W	in	Inner enveloping circle diameter
i	—	Number of rows of rolling elements

K_L	-	Bearing factor for calculation of relubrication interval
K_P	-	Load factor for calculation of relubrication interval
K_R	-	Oscillation factors for calculation of relubrication interval
K_T	-	Temperature factor for calculation of relubrication interval
K_U	-	Environmental factor for calculation of relubrication interval
L	10^6 rev	Basic life of a bearing in millions of revolutions
L_h	hrs	Basic life in operating hours
L_{na}	10^6 rev	Adjusted bearing life
L_w	in	Rolling element length
M_R	lb-in	Friction moment
n	rpm	Operating speed or equivalent speed
$n_{g \text{ oil}}$	rpm	Limiting speed for oil lubricated bearings
$n_{g \text{ grease}}$	rpm	Limiting speed for grease lubricated bearings
n_{osz}	min^{-1}	Frequency of oscillating or reciprocating motion
N_R	hp	Frictional power
p	-	Life exponent
p_H	psi	Hertzian pressure in rolling contact area
P	lbf	Equivalent dynamic bearing load
q	%	Duration of a particular operating condition as a percentage of the total operating cycle
Q	qt/min	Oil flow rate

r_s	in	Radius, corner chamfer
R_{ht}	in	Effective hardness depth of surface hardened raceways related to 80% of the lower limit of the surface hardness
R_m	psi	Tensile strength
$R_{p0.2}$	psi	Yield point (0.2-limit)
Δs	μin	Change in radial internal clearance
S_0	-	Static load safety factor
t	s, min, hrs	Time
Δt	s, min, hrs	Time period
t_f	hrs	Basic relubrication interval
t_{fR}	hrs	Relubrication interval
T	s, min, hrs	Duration of time period for periodically changing loads or speeds, or total running time for constant operating conditions
U	μin	Theoretical difference in size of mating surfaces with an interference fit
v	ft/sec	Mean circumferential speed
α	$^{\circ}\text{F}^{-1}$	Linear coefficient of thermal expansion
v	$^{\circ}\text{F}$	Temperature
Δv	$^{\circ}\text{F}$	Temperature difference
γ	$^{\circ}$	Oscillation amplitude (half the angle of oscillation)
ν	cst	Kinematic viscosity of the lubricating oil at bearing operating temperature
ν_E	cst	Kinematic viscosity of the lubricating oil prior to entering the bearing
ν_1	cst	Required viscosity of the lubricating oil (recommended operating viscosity)

2 Load Carrying Capacity and Life

The selection of the bearing size depends on the requirements in terms of load capacity, life and reliability in operation. For the calculation of bearing life, the basic load ratings are used as a measure of the load carrying capacity of a roller bearing, whereby the basic dynamic load rating applies to rotating bearings (dynamic load), and the basic static load rating applies to bearings where a rotary motion does not occur or occurs only infrequently (static load).

The basic load ratings and calculation methods shown in this catalog are based on DIN/ISO 281 and the recommendations for ISO 76. The ratings are adjusted to take into account the general practices based on the state-of-the-art of today's rolling bearings.

2.1 Dynamic Load Carrying Capacity and Life

The dynamic load carrying capacity of a rolling bearing is determined by the fatigue strength of the material. The life is defined as the duration up to fatigue failure and depends on the load and speed of the bearing as well as on the statistical probability of the first appearance of failure. The terms basic dynamic load rating and basic life (calculated life), are used for describing the dynamic load carrying capacity.

2.1.1 Basic Life Calculation

The basic life is calculated as follows:

$$L = \left(\frac{C}{P}\right)^p \quad (1)$$

$$L_h = \frac{16666}{n} \cdot \left(\frac{C}{P}\right)^p \quad (2)$$

L 10^6 revolutions
basic life in millions of revolutions, which 90% of a sufficiently large group of identical bearings will reach or exceed, before the first indication of material fatigue occurs.

L_h hrs
basic life in operating hours corresponding to the definition of L

C lbf
dynamic load rating. For radial bearings, C is that load

of constant magnitude and direction, under which a sufficiently large group of identical bearings reaches the life of one million revolutions. In the case of thrust bearings, C is an axial load acting concentrically, under which a sufficiently large quantity of identical bearings reaches one million revolutions of the shaft or housing (see also section 2.3)

P lbf
equivalent bearing load for radial or thrust bearings (see section 3)

p —
equivalent life exponent $p=10/3$ for needle and cylindrical roller bearings; $p=3$ for ball bearings

n rpm
operating speed (see section 3)

Roller bearings with a load ratio, C/P , over 15 are considered lightly loaded, between 6 and 15 as medium loaded and those below 6 are heavily loaded. For applications where the C/P is below 6, consult INA Engineering for suitability of bearing.

If the operating speed n is constant, the life L_h , in terms of operating hours according to equation (2), can be obtained from the applicable nomogram (see inside cover).

Adjusted Bearing Life

DIN/ISO 281 part 1 contains an expanded life equation for exceptional cases, in which additional influences besides load, speed or operational frequency are considered during the life calculation:

$$L_{na} = a_1 \cdot a_2 \cdot a_3 \cdot L \quad (3)$$

L_{na} 10^6 revolutions
adjusted life in millions of revolutions, where n indicates the probability of deviation from 90% (100- n)%

L 10^6 revolutions
life, see equation (1)

a_1 —
 factor for reliability other than 90%

a_2 —
 material factor

a_3 —
 factor for operating conditions, especially for lubrication conditions.

Under normal conditions $a_1 = a_2 = a_3 = 1$, so equation (3) is identical to equation (1).

For determination of the adjustment factors, it is necessary that all operating conditions (individual loading conditions, influence of misalignment, bearing temperature, etc.) are exactly known. If this is the case, the adjustment factors can be determined, based on special guidelines, by the INA Engineering Department and then substituted into equation (3).

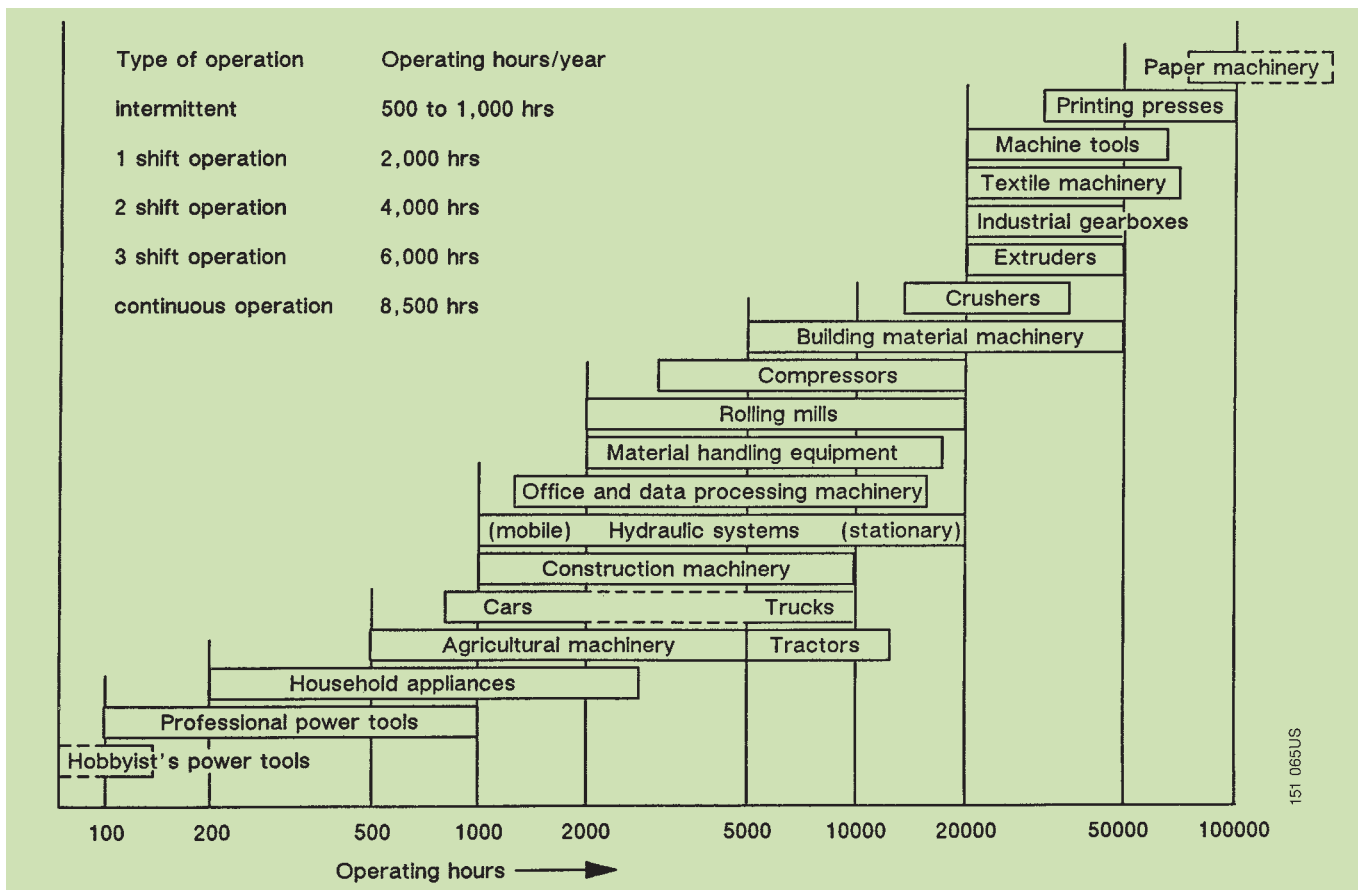


Figure 1 • Approximate values for the basic life of rolling bearings

2.1.2 Required Basic Life

With the aid of the life equations according to section 2.1.1, the correct bearing size can be selected, if the required life is known from the conditions of the machine operation and the requirements on the operating reliability. If data concerning the required life is not available, approximate values can be obtained from figure 1.

2.1.3 Service Life

The service life is the life actually reached by a roller bearing, which can deviate from the calculated life. For instance, misalignment between shaft and housing, contamination of the bearings, too high operating temperatures or insufficient lubrication may cause premature failure due to wear or fatigue.

Unfavorable operating conditions such as oscillating bearing motion with very small angles of oscillation, or vibrations of the bearings while not rotating, may also cause premature bearing failure due to brinelling.

Considering the multitude of applications and operating conditions, the service life of bearings cannot be exactly determined. The safest way to estimate the service life, now as before, is by comparison with similar applications.

2.2 Static Load Carrying Capacity

The static load carrying capacity is limited by the permanent deformation of the rolling elements and raceways, which is still considered permissible with the regard to the noise level during subsequent bearing operation. This definition of permissible permanent deformation leads to the term static load rating. The measure of static load rating is defined by the static load safety factor.

2.2.1 Static Load Safety Factor

The static load safety factor indicates the safety against the permissible permanent deformation in the bearing and is defined as follows:

$$S_0 = C_0 / F_0 \quad (4)$$

S_0 —
static load safety factor

C_0 lbf
basic static load rating. In radial bearings, C_0 is the load in the radial direction and in thrust bearings the concentrically acting axial load, for which the Hertzian pressure between the rolling elements and the raceways at the most highly loaded position in the bearing reaches the value 580,000 psi (4000 N/mm²). This load causes, under normal contact conditions, a permanent total deformation of 1/10,000 of the rolling element diameter.

F_0 lbf
maximum load of the radial or thrust bearings

2.2.2 Required Static Load Safety Factor

The guideline values shown in table 1 are recommended for the static load safety factor.

Table 1 • Recommended static load safety factor

Application	S_0
Quiet, vibration free operation with low demands for smooth running; bearings with only slight rotational movement.	≥ 1
Normal operation with higher demands for smoother running	≥ 2
Operation with distinct shock loads	≥ 3
Bearing arrangements with high demands for accuracy and smooth running	≥ 4

For shell bearings, the value $S_0 \geq 3$ should be used.

2.3 Influences on the Load Carrying Capacity

The basic load ratings shown in this catalog are valid for a hardness of 670 to 840 HV (RC 58 to 65) for raceways and rolling elements with a fine grain material structure which is characteristic for rolling bearing components.

2.3.1 Influence of the Raceway Hardness

If a raceway has a hardness less than 670 HV, (RC 58) the load rating decreases to the lower value C_H or C_{0H} . This is taken into account by the following corrective equations:

Dynamic Load Rating

$$C_H = f_H \cdot C \quad (5)$$

Static Load Rating

$$C_{0H} = f_{H0} \cdot C_0 \quad (6)$$

C_H, C_{0H} lbf
effective dynamic or static load rating

f_H, f_{H0} —
dynamic or static hardness factor according to figure 2

C, C_0 lbf
basic dynamic or static load rating

The hardness factors apply only for high quality bearing steel or steel with similar composition (see section 8.1.1) with corresponding purity and structure. In other cases, for example with cast iron and nonferrous metals, these values are not applicable.

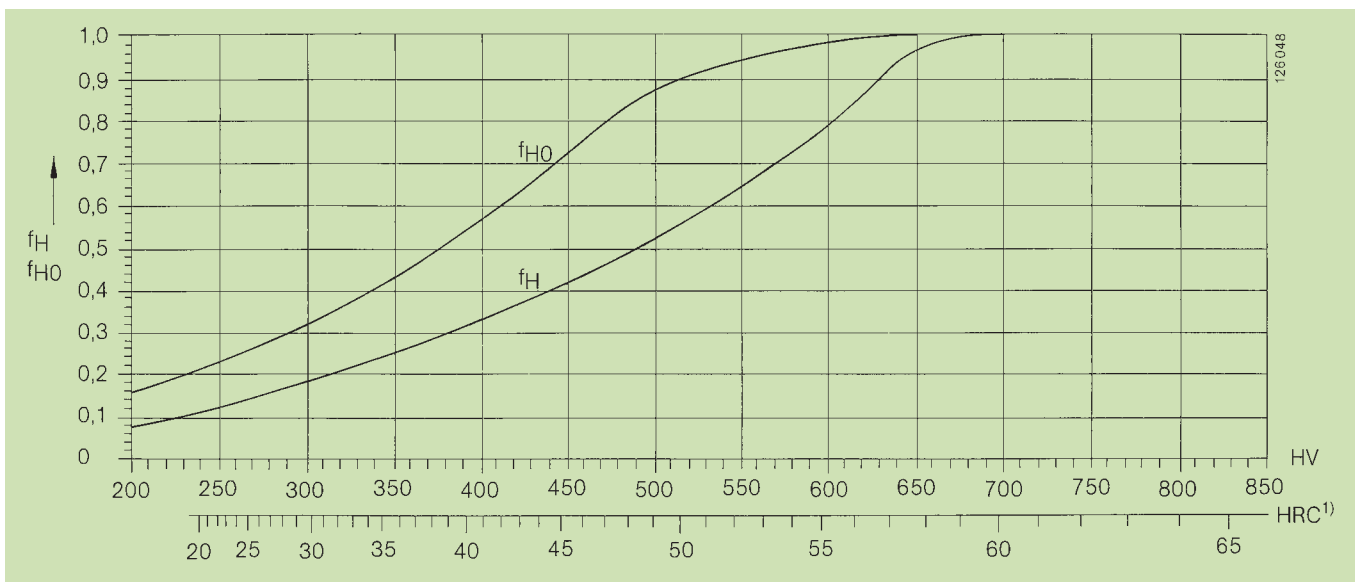


Figure 2 • Determination of hardness factor f_H or f_{H0}

1) Converted per DIN 50 150

2.3.2 Influence of the Bearing Temperature

INA anti-friction bearings can be used, generally, up to +250°F (+120°C), and for brief periods, up to peak temperatures of +300°F (+150°C).

Higher operating temperatures cause permanent structural changes in the bearing components, which entail a hardness reduction of the material as well as dimensional changes.

The reduction of the dynamic load carrying capacity due to the reduction in hardness is taken into account by the following equation:

$$C_T = f_T \cdot C \tag{7}$$

C_T lbf
effective dynamic load rating

f_T —
temperature factor according to figure 3

C lbf
dynamic load rating

The static load carrying capacity is insignificantly

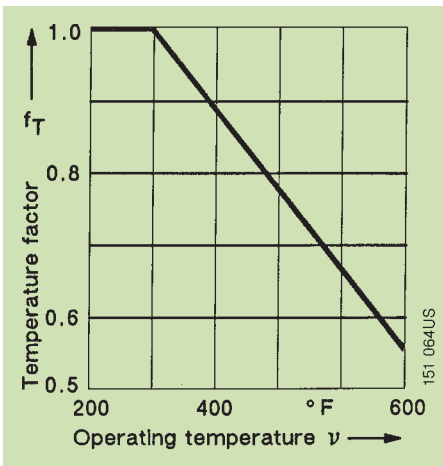


Figure 3 • Temperature factor f_T

affected by the decrease in hardness. Therefore, it can be neglected for temperatures up to 570°F (300°C).

2.3.3 Influence of Misalignment

Misalignment between bearing raceways can cause uneven load distribution along the length of the rolling elements effecting the bearings function and operating life. The misalignment is a result of deflections of the shaft and housing under load combined with manufacturing inaccuracies.

Load factors due to misalignment can be calculated and are a function of load, clearance, internal bearing design, angle of the shaft relative to the housing, and relative direction of the misalignment to the load. Maximum values of misalignment as a function of bearing width and type it will cause no significant reduction in operating life are shown in table 2. These are based on a bearing operating with a dynamic load ratio (C/P) greater than or equal to six, static load ratio (C₀/P) as shown in table 1 and normal operating clearances.

In applications where misalignment or radial clearance exceed or the load ratio is below the recommended values, please contact INA engineering for a review of the application and determination of the static and dynamic capacity adjustment factors.

Table 2 • Maximum misalignment values

Bearing width				Misalignment – in/in (mm/mm)	
over		to		cage guided	full complement
inch	mm	inch	mm		
–	–	1.00	25.4	.0015	.0010
1.00	25.4	2.00	50.8	.0010	.0005
2.00	50.8	–	–	.0005	.0005

3 Equivalent Bearing Load

The life equations (1) and (2) of section 2.1.1 are based on constant bearing load P and speed n. However, these conditions are not fulfilled in many cases. Therefore equivalent operating values must be established, which have the same effect on the life as the actual loads and speeds.

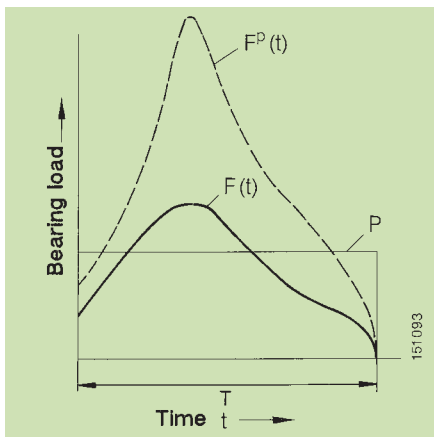


Figure 4 • Equivalent bearing load according to equation (12)

3.1 Varying Bearing Speed

3.1.1 General Calculation of the Equivalent Speed

In the case of a bearing speed $n(t)$ which varies with the time with the time t over a time period T , the average speed to be used for the life equation (2) is calculated as follows:

$$n = \frac{1}{T_0} \int_0^T n(t) dt \quad (8)$$

3.1.2 Bearing Speed Varying in Steps

If the bearing speed n_i varies in steps over a time period T , the equation (8) can be replaced by the simpler summation formula over z time periods Δt_i , whereby $q_i = (\Delta t_i/T) \cdot 100$ is the duration in % of each speed step.

$$n = \frac{q_1 \cdot n_1 + q_2 \cdot n_2 + \dots + q_z \cdot n_z}{100} \quad (9)$$

3.1.3 Oscillating Bearing Motion

For oscillating bearing motion the equivalent speed for use in the life equation (2) is determined according to following equations:

$$n = n_{osc} \cdot \frac{\gamma}{90^\circ} \quad (10)$$

n rpm
equivalent speed

n_{osc} min⁻¹
frequency of oscillating motion

γ °
oscillation amplitude (half the oscillation angle)

If the oscillating amplitudes are smaller than the angle between the rolling elements, equation (10) is no longer applicable and the danger of false brinelling has to be considered (see section 2.1.3).

3.2 Varying Bearing Load and Constant Speed

3.2.1 General Calculation of the Equivalent Bearing Load

If a bearing load varies with time, over a time period T , in a well defined function $F(t)$, then the following relation for the equivalent load results from the life formula:

$$P = \sqrt[p]{\frac{1}{T} \int_0^T F^p(t) dt} \quad (11)$$

Since equation (11) is based on the life formula according to equation (1), $p = 10/3$ applies to needle and cylindrical roller bearings and $p = 3$ to ball bearings.

3.2.2 Periodically Varying Bearing Load

Even with periodically varying loads, the calculation of the equivalent bearing load still follows equation (11). However, for many practical applications, the equivalent bearing load can easily be determined by means of load factors according to figure 5:

$$P = V_1 \cdot F_{\max} + V_2 \cdot F_{\min} \quad (12)$$

P lbf
equivalent bearing load

F_{\max} lbf
maximum load during the load cycle

F_{\min} lbf
minimum load during the cycle

V_1, V_2 —
load factors (see figure 5)

3.2.3 Bearing Load Varying in Steps

If the bearing load F_i varies in steps over a time period T , the equation (11) can be replaced by the simpler summation formula over z time periods Δ^t_i , whereby $q_i = (\Delta^t_i/T) \cdot 100$ is the duration in % of each step:

$$P = \sqrt[p]{\frac{q_1 \cdot F_1^p + q_2 \cdot F_2^p + \dots + q_z \cdot F_z^p}{100}} \quad (13)$$

3.3 Varying Speed and Load

3.3.1 General Calculation of the Equivalent Loads

If speed and bearing load during time period T are defined time functions $n(t)$ and $F(t)$, then the equivalent speed is determined according to equation (8), and the equivalent bearing load is obtained from the following equation:

$$P = \sqrt[p]{\frac{\int_0^T n(t) \cdot F^p(t) dt}{\int_0^T n(t) dt}} \quad (14)$$

3.3.2 Speed and Bearing Load Varying in Steps

If the speeds n_i and loads F_i vary in steps during time period T , equation (9) can be used for determining the equivalent speed. The equivalent bearing load is obtained from the summation formula over the z time period Δt_i derived from equation (14); whereby $q_i = (\Delta t_i/T) \cdot 100$ is the duration in % of each step:

$$P = \sqrt{\frac{q_1 \cdot n_1 \cdot F_1^p + \dots + q_z \cdot n_z \cdot F_z^p}{q_1 \cdot n_1 + \dots + q_z \cdot n_z}} \quad (15)$$

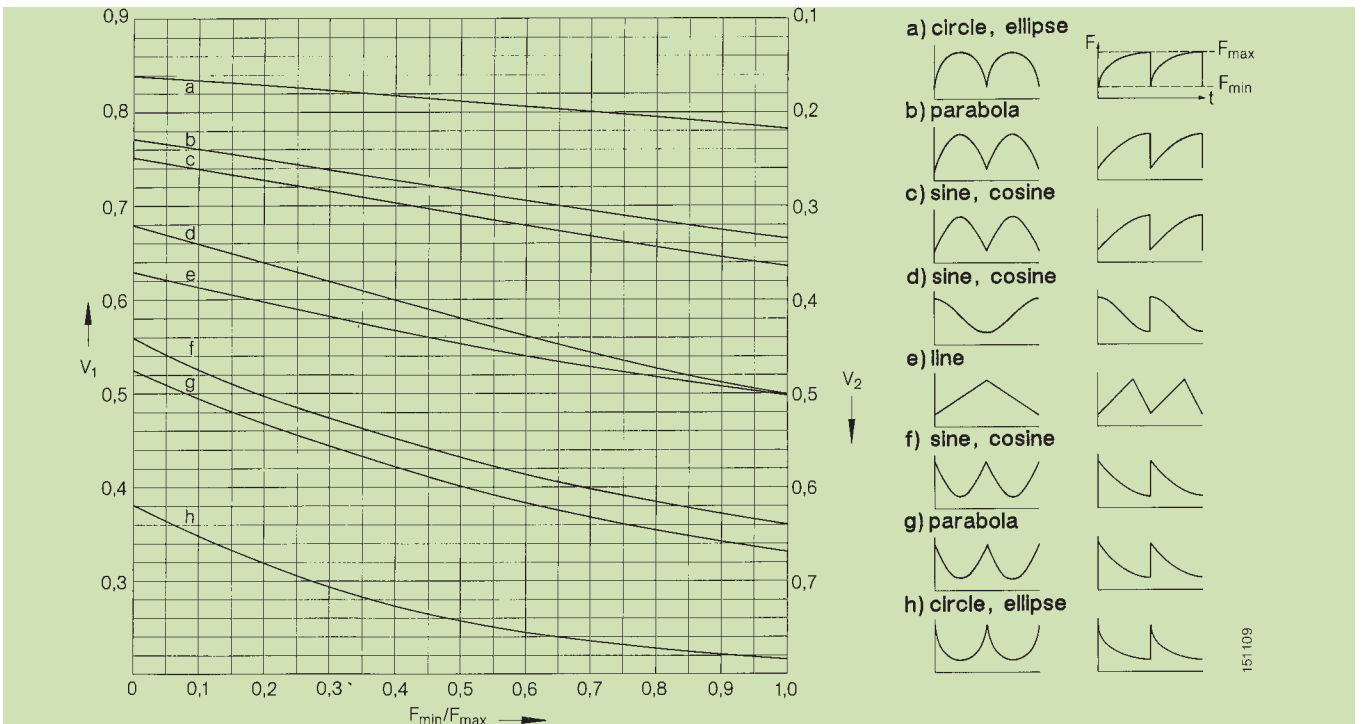


Figure 5 • Load factors for various load cycles

4 Friction and Temperature Generation

The total friction and therefore the increase in bearing temperature is comprised of several segments:

Friction component	Influencing entity
Rolling friction	Magnitude of load
Sliding friction of the rolling elements and cage	Magnitude and direction of load; speed and lubricating conditions; run-in conditions
Fluid friction (resistance to flow)	Design and speed of bearing; type, quantity and operating viscosity of the lubricant
Seal friction	Design and preload of the seal

Due to the variety of influencing entities, it is only possible to calculate the approximate frictional moment and thus the frictional power for a constant operating condition.

For new rolling bearings and during starting, higher friction than the values given below should be expected.

Excess amounts of lubricant, lubricants with high viscosity and seals also cause an increase of friction. The fluid friction in over lubricated bearings increases substantially with the speed. This results in a higher frictional power during operation than with correct amounts of lubricants. The optimum operating conditions are achieved with a quantity of lubricant that leads to the smallest possible temperature increase in the bearing.

The frictional power N_R calculated according to equations (17) or (19) is converted into heat at the contact surfaces in the rolling bearing and in the lubricant. The heat must be dissipated from the bearing, but the exact determination of the heat flow is difficult. The most important influencing factors are:

- Heat dissipation by temperature gradient between the bearing and housing or shaft.

The temperature gradient results from the design and the possible cooling of the housing or the shaft. External heat sources must be considered. Assessments of these relationships is usually possible by comparison with similar operating bearing arrangements.

- Heat dissipation by lubricant

When using grease lubrication, removal of the heat from the bearing by the lubricant is not possible. When using oil lubrication, a portion of the heat can be removed with the oil. The most effective heat

removal method is using recirculating oil lubrication with additional oil cooling. With this the bearing temperatures can be controlled within certain limits.

4.1 Approximate Calculation of Friction

For normal operating conditions with medium loading ($C/P \approx 10$) and speed ($n \leq 2/3 n_g$) along with the correct amount of lubricant, the summation of the friction components is determined with sufficient accuracy by the coefficient of friction f . The friction in rolling bearings can be determined with the following questions:

$$M_R = f \cdot F \cdot \frac{d_M}{2} \quad (16)$$

$$N_R = M_R \cdot \frac{n}{63000} \quad (17)$$

M_R lb-n
friction moment

f —
friction coefficient (see figure 6)

F lbf
radial load in radial bearings or axial load in thrust bearings

d_M in
mean bearing diameter $(d + D)/2$

N_R hp
frictional power

n rpm
rotational speed

Values for the friction coefficient f as a function of the load ratio C/P can be taken from figure 6 on page 24. Deviations occur predominantly due to the influence of fluid friction, which can be determined by the viscosity and amount of lubricant.

When grease lubrication is used, the consistency and the base oil viscosity determine the fluidity of the grease. A freshly greased bearing tends to cause higher friction moments. If the grease is distributed well within the bearing as in the case of oil lubrication, lower values than shown in figure 6 can be used.

4.2 Detailed Calculation of Friction

A more accurate calculation of friction is possible if the type and method of lubrication and the viscosity of the oil at bearing temperature or inlet temperature are known in addition to the speed and load. The total friction moment M_R can then be calculated from the dependent and independent bearing load components of the friction moment as follows:

$$M_R = M_0 + M_1 \quad (18)$$

$$N_R = M_R \cdot \frac{n}{63000} \quad (19)$$

M_0 lb-n
load-independent friction moment caused by fluid friction

M_1 lb-n
load-dependent friction moment caused by rolling friction

N_R hp
frictional power

n rpm
rotational speed

The friction moment components are calculated using the following equations:

$$M_0 = f_0 \cdot 1.4 \cdot (v_E \cdot n)^{2/3} \cdot d_M^3 \cdot 10^{-5} \quad (20)$$

for $v_E \cdot n \geq 2000$

$$M_0 = f_0 \cdot 2.3 \cdot d_M^3 \cdot 10^{-3} \quad (21)$$

for $v_E \cdot n < 2000$

$$M_1 = f_1 \cdot F \cdot \frac{d_M}{2} \quad (22)$$

f_0 —
factor for independent friction moment according to table 2

f_1 —
factor for load dependent friction moment according to table 2

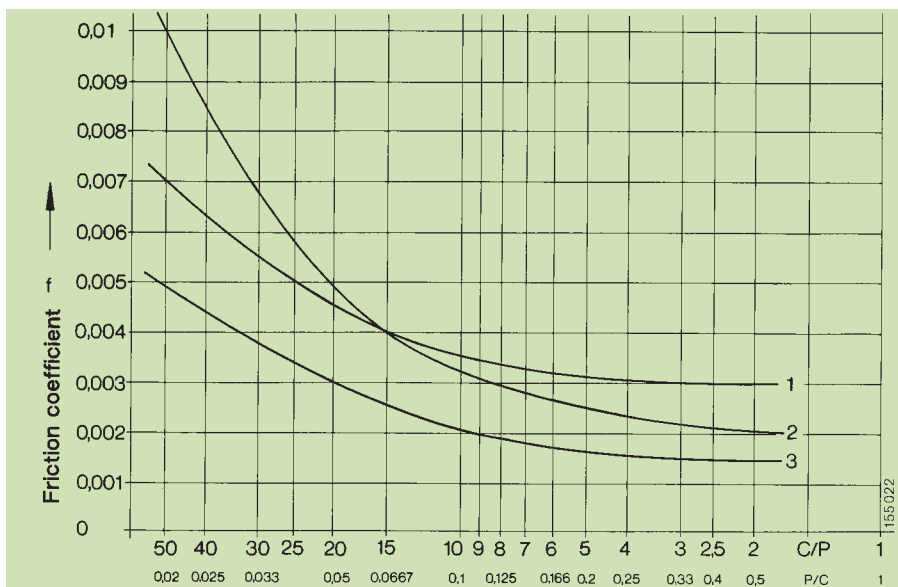
F lbf
radial load in radial bearings, axial load in thrust bearings

v_E cst
kinematic viscosity of the lubricant at oil slump temperature or at oil inlet temperature recirculating oil lubrication. For grease lubrication the viscosity of the base oil is the influencing factor.

The values in table 3 can vary significantly. The values given for oil mist and grease lubrication apply for marginal lubricant supply. In the case of oil bath lubrication, it is assumed that the oil level reaches to the middle of the lowest rolling element. Large deviations are possible in the case of recirculating oil lubrication and are a function of the quantity of oil passing through the bearing.

	f_0			f_1
	oil mist grease	oil bath	oil recir- culating	
Radial- needle bearings with cage	2	5	6	0.0015
Thrust- needle bearings	-	3	4	0.003

Table 3 • Bearing factors f_0 and f_1



1. Thrust needle roller bearings
2. Needle roller bearings with cage
3. Cylindrical roller bearings, full complement

Figure 6 • Friction coefficient f under mean operating conditions and operating viscosity of the lubricant of about 30 cst

5 Limiting Speeds

The maximum rotational speed for roller bearings is determined by the permissible operating temperature. The limiting speed is therefore dependent on the bearing design, size and loading, as well as the type of lubricant and cooling conditions (heat dissipation by conduction, radiation, convection and special cooling methods). The limiting speeds shown in the bearing tables are guides values. They are valid for oil lubrication with a load ratio C/P more than 15 and assume correct operating clearance, careful installation, and constant operating conditions.

If care is taken in selecting the lubricant, cooling method and design of adjacent parts along with the use of higher precision bearings, then the limiting speed can be exceeded.

The limiting speed values in the tables must be reduced to 60% if grease lubrication is used, except where noted differently. The values should also be reduced if a load ratio C/P less than 15 is used. In addition, for proper functioning of a high speed roller bearing, a minimum load is required to prevent sliding of the rolling elements, increased noise and premature failure of the bearing.

6 Lubrication and Maintenance

Proper lubrication and regular maintenance are important prerequisites for a long service life of rolling bearings. The required quantity of lubricant in a rolling bearing is small, however, sufficient lubricant must be present at all contact surfaces. Only then can the lubricant fulfill its required task (provide a supporting lubricant film, reduce wear, prevent corrosion, provide dampening, dissipate heat, etc.).

The type of lubricant as well as the required amount of lubricant depends on the bearing design, the design of the surrounding structures, the method of lubrication and the operating conditions.

Grease or oil lubrication is suitable for rolling bearings. There is no exact method for determining which lubrication method is best in all applications. The decision as to which method is used should be based on technological and economic considerations. The type of method of lubrication should therefore be considered at the design stage.

The operation of rolling bearings with unblended mineral oils is normally acceptable. The compatibility of blended lubricants based on mineral oils or synthetic oils with plastics and nonferrous metals should be verified.

The following data for oil and grease and lubrication is based on test results and practical experience. They are valid for continuous operation and, if not stated otherwise, for medium loads and operation without sliding.

6.1 Grease Lubrication

Rolling bearing greases must comply with the requirements according to DIN 51818, lubricating grease parts 1 through 4. Lubricating greases with solid lubricants are only suitable in limited cases. Cooling of the bearing cannot be achieved with grease lubrication. The calculation of the frictional power (see section 4) determines whether special cooling measures are necessary to reduce bearing temperature. Normally, bearing temperature should not exceed 160°F (70°C).

6.1.1 Lubricating Greases

The following should be considered in selection of lubricating greases:

Operating Temperature Range

The operating temperature range of a lubricating grease should exceed lower and upper operating temperature by at least 35°F (20°C).

Type of Lubricating Grease

The operating characteristics of a lubricating grease are determined by the thickener and the base oil. Data sheets from the grease manufacturer should be consulted.

Consistency

Recommended greases for lubrication of rolling bearings are lubricating greases in NLGI classes 1, 2 and 3 meeting DIN 51818.

Roller bearing units with vertical or oblique axes of rotation and for applications as sealing greases, lubricating greases with higher consistency (e.g. NLGI 3) should be used.

Speed Factor $n \cdot d_M$

For high speed applications or for low start-up torque, lubricating greases with high speed factors are recommended. For slowly rotating roller bearings, lubricating greases with low speed factors should be used. The dynamic behavior of lubricating greases generally does not depend on consistency, for example with NLGI class 2 lubricating greases, the allowable speed factor can be between $0.8 \cdot 10^4$ to $4 \cdot 10^4$ in/min ($0.2 \cdot 10^6$ and $1.0 \cdot 10^6$ mm/min).

Water Resistance

The resistance of lubricating grease against water is determined according to DIN 51807. The corrosion protection properties are tested according to DIN 51802.

Lithium based greases show good corrosion protection and in general are water resistant up to 195°F (90°C).

Sodium based greases can absorb small amounts of water (for instance, condensation) and thus offer corrosion protection, but they decompose in the presence of greater amounts of water.

Calcium based greases are water insoluble.

Pressure Properties

The use of lubricating greases with EP additives (no solid lubricants) and high base oil viscosity (ISO VG 150 and higher) is recommended in applications with load ratio $C/P < 10$ as well as in full complement radial roller bearings and for thrust roller bearings.

Silicon lubricating greases can only be used in cases of low loads ($C/P > 30$).

6.1.2 Relubrication Intervals

The relubrication intervals for roller bearings depends on the degree of oxidation and the workability of the lubricating grease (i.e. operating temperature, speed, bearing load, quantity of grease and environmental influences). Thus, the necessary relubrication intervals can vary widely.

The relubrication interval is the operating time after which the lubricating grease in the rolling bearing is used up so much that it has to be replaced. The most economical relubrication interval as well as the amount of relubricating grease required for relubrication can only be determined for the operating condition since the effective influence

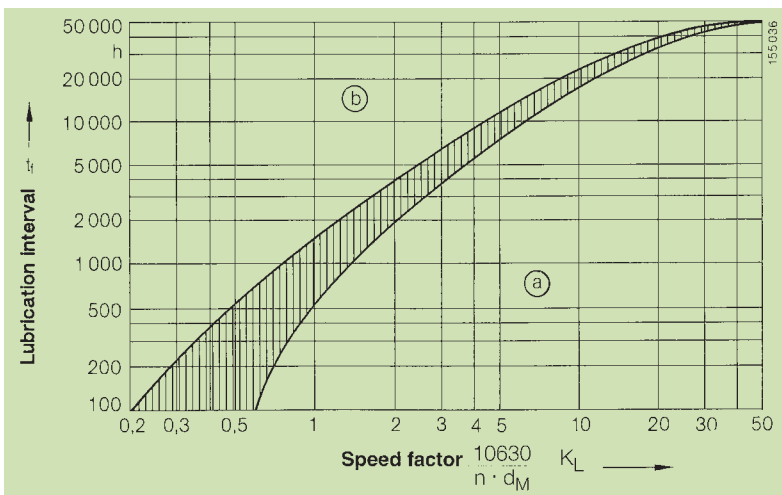


Figure 7 • Determination of basic lubrication interval t_f

Bearing design	K_L
Unit cages, needle bearings	1.0
Shell bearings	0.8
Cam followers with cage	0.6
Cam followers full complement	0.25
Thrust bearings with cooling provisions	0.25
Thrust bearings	0.1

a relubrication feasible
b new greasing necessary

of each individual case cannot be exactly determined. To verify the calculated relubrication intervals, especially in the high temperature range, and observation period should be extended over at least three to four relubrication intervals.

Due to natural aging of lubrication greases based on mineral oils, their service life is limited to three to five years.

The guide value t_{fR} for the relubrication interval can be calculated with the aid of the following equation:

$$t_{fR} = \frac{t_f}{K_T \cdot K_P \cdot K_R \cdot K_U} \quad \text{hrs}$$

guide value for the relubrication interval in hours

$$t_f = \text{basic lubrication interval in hours}$$

K_T, K_P, K_R, K_U —
correction factors for temperature, load, oscillation and environment

The guide value for the basic lubrication interval t_f is determined from figure 7 on page 27 as a function of the bearing design.

Temperature factor K_T takes into account the reduction of the relubrication interval for bearing temperatures above $+160^\circ\text{F}$ ($+70^\circ\text{C}$). This can be obtained from figure 8. Due to the differences in the composition

- a Lithium based greases on mineral oil basis
- b Gel and complex greases based on mineral oil

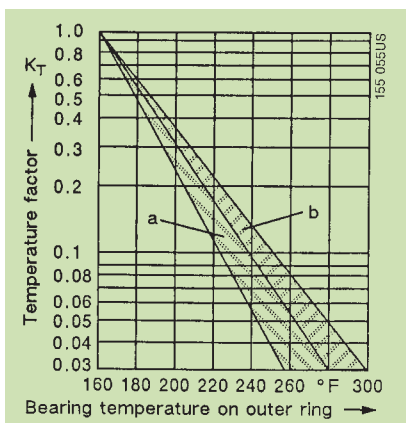


Figure 8 • Temperature factor K_T

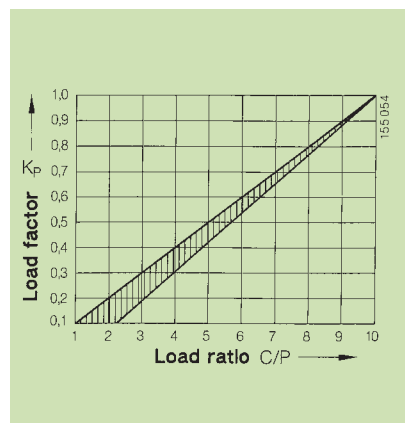


Figure 9 • Load factor K_P

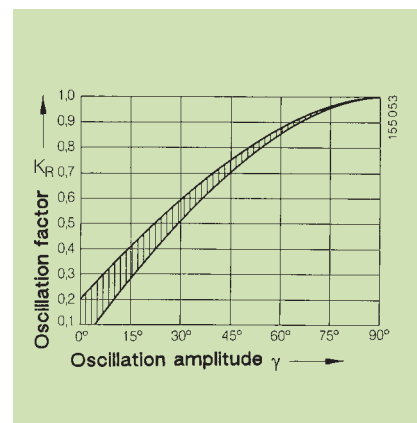


Figure 10 • Oscillation factor K_R

of high temperature greases (thickener and type of bases) no generally applicable correction factor can be assigned for temperatures above $+300^\circ\text{F}$ ($+150^\circ\text{C}$).

Load factor K_P considers the increased loading of the lubricating grease under increased bearing loads. It can be determined from figure 9 as a function of the load ratio C/P .

Oscillation factor K_R per figure 10 can be used to determine the lubricating interval in cases of oscillating motion of the bearing.

Shorter lubricating intervals are used to reduce false brinelling.

Environmental fact K_U takes into account the effects of the environment such as humidity, shaking forces, vibration (causes for false brinelling), and impact loads which represent an additional loading for the lubricating grease. This can be taken from table 4.

Extreme environmental influences such as the presence of large quantities of water, aggressive media, heavy contamination or nuclear radiation are not covered by the environmental factor K_U .

Table 4 • Environmental factor K_U

Environmental influences	K_U
minor	1.0
medium	0.8
strong	0.5

Relubrication should be carried out with the bearing rotating and at operating temperature in order to achieve better grease distribution. The grease feed lines and the lubrication holes in the housing or shaft should be short and lead directly to the lubrication hole on the bearing. If several bearings are mounted together on a shaft, each bearing should have a separate grease feed.

With thrust bearings, the lubricant must be fed from the inside and the feed holes must not be directly under the cage bore.

The quantity of grease used during relubrication depends on the operating conditions can be 20 to 80% of the initial grease fill. If in doubt, fill until fresh grease is purged through the seals. Care should be taken to ensure that the old grease can exit without hindrance.

After mounting, all bearings should be regreased. This ensures proper function of the relubrication system and that all supply holes and lines are filled with grease for corrosion protection. If the bearing temperatures are above $+300^{\circ}\text{F}$ ($+150^{\circ}\text{C}$), the bearings must be regreased before they have cooled down or before they have stopped.

6.2 Oil Lubrication

The advantages of oil lubrication are good lubricant distribution and resulting clean contact areas. It is commonly used when the adjacent machine elements are already supplied with oil or if heat has to be removed from the bearing. Doped and undoped lubricating oils of mineral oil or synthetic oil bases are suitable for bearing lubrication. Doped oils can tolerate constant temperatures of approximately $+265^{\circ}\text{F}$ ($+130^{\circ}\text{C}$) and synthetic oils up to $+390^{\circ}\text{F}$ ($+200^{\circ}\text{C}$).

6.2.1 Lubricating Oils

Determination of Viscosity

A sufficient lubricating film in the rolling contacts of bearings can only develop if the lubricating oil has a minimum viscosity (required viscosity ν_1) at operating temperature.

Guide values for ν_1 can be obtained from figure 11 as a function of the speed factor which also considers the influence bearing load and design. Both the laws of EHD theory and practical experience concerning the entire lubricating condition in bearings are considered in the selection of viscosity.

The effect of operating viscosity ν , which differs from the required viscosity ν_1 on the basic life can be determined according to section 2.1.1.

The required viscosity ν_1 should be related to a nominal viscosity of ISO VG 10 to 680 (mean viscosity according to DIN 51519).

When selecting the viscosity, the lowest operating temperature must also be considered since an increase in viscosity reduces the flow of lubricating oils and thus the power loss increases.

Pressure Properties

In case of high loads ($C/P < 10$) or if the required viscosity ν_1 according to figure 11 is not reached, lubricating oils with additives to increase the pressure characteristics (type P according to DIN 51502) are recommended. Silicon oils can only be used for very low loads ($C/P > 30$).

6.2.2 Lubrication Systems

Oil bath lubrication is suitable for radial bearings operating under rotational speed values $n \cdot d_M \leq 200,000$. The lowest rolling element should be immersed in oil up to its center. The required oil level for higher speed operation can only be determined by trials. Oil levels can only be checked only when the bearing is stationary. There should be plenty of oil in the housing, otherwise oil changes will be necessary at fairly short intervals.

In case of oil bath lubrication for thrust bearings, the oil level should be such that the bore of the thrust cage is

at least partly covered with oil. The pumping effect of the thrust cage can cause oil circulation.

Drip feed lubrication is suitable high speed radial bearings with a lubrication hole in the outer ring. Excess oil must be allowed to flow away from the bearing unrestricted. For full complement bearings, a small amount of oil should be retained in the bearing. The required oil quantity depends on the bearing size, design, speed, and load (oil quantity 3 to 50 drops/min per rolling element raceway; 1 drop weighs approximately .0009 oz / 0.025 g).

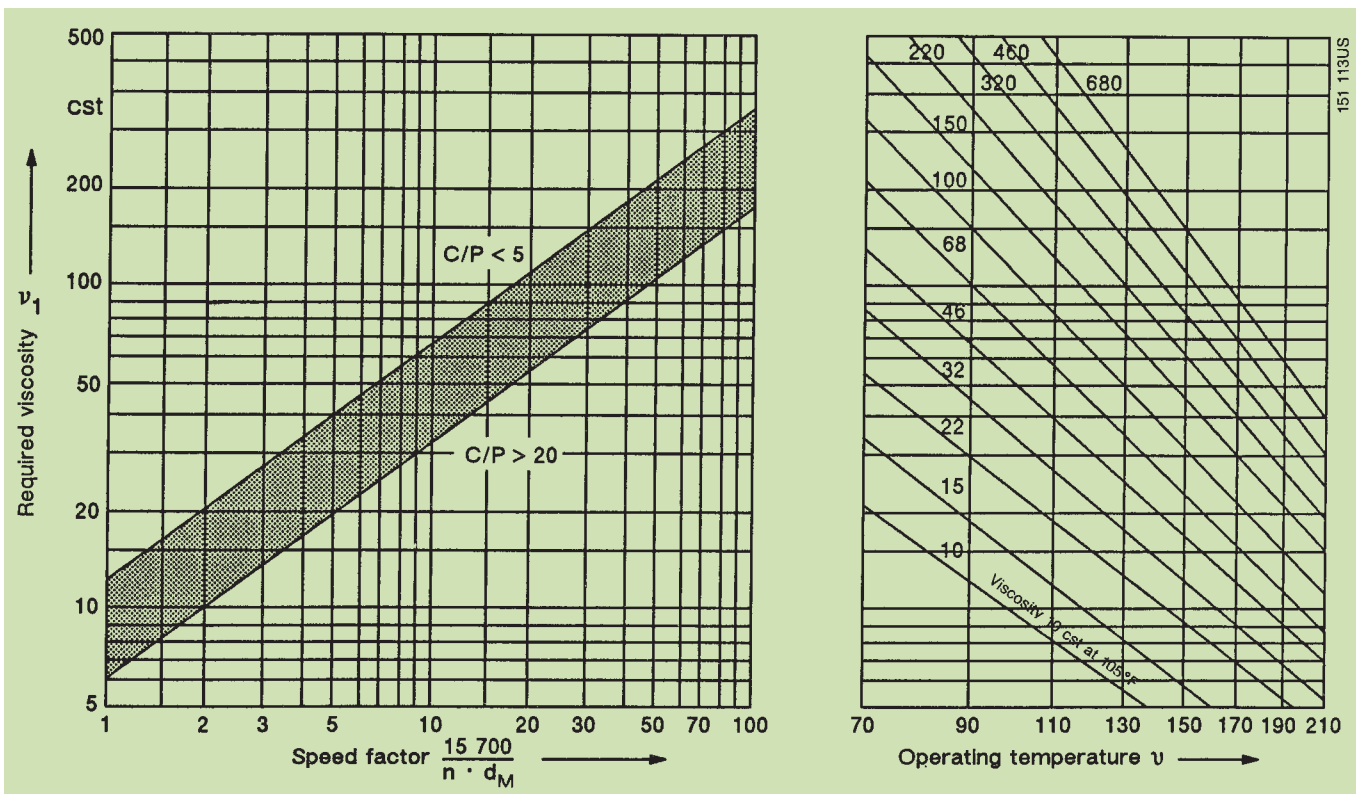


Figure 11 • Determination of required viscosity v_1

Recirculating oil lubrication is useful for the heat dissipation in bearings operating at high temperatures and when there is a risk of contamination, because this method offers the possibility to filter and cool the oil. The oil must be able to flow out without pressure in order to avoid any oil build-up which could cause additional heating due to pumping. The cross sections of the oil outlets must be significantly larger than those of the oil inlets. To avoid high oil pressure, lubricating holes in the housings or the shafts should be aligned with those of the bearing. If this is not possible, then oil grooves, cavities, etc. of large enough volume should be provided.

In thrust bearings, the oil must always be fed from the inside to the outside. The oil feed opening should not

be directly under the cage bore. The necessary oil quantities can be taken from figure 12.

Oil mist and pneumatic oil lubrication are methods of feeding the lubricating oil to the bearing by means of clean, compressed air which is free from water. The air has little cooling effect, but the pressure protects the bearing arrangement from the entry of contaminants. These lubrication methods are particularly suitable for bearings operating at high speeds and under light loads. The necessary data for designing such a lubrication system should be taken from the literature provided by the manufacturer of the equipment. Under certain conditions, thrust bearings can also be lubricated by oil mist or pneumatic oil lubrication. In such cases, INA Engineering should be consulted for advice.

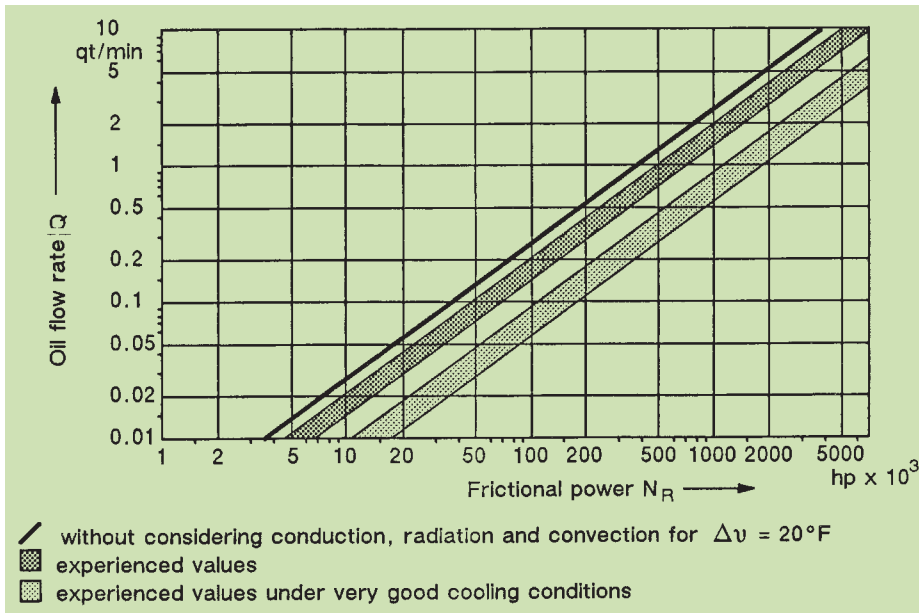


Figure 12 • Guide values for oil amount t required for lubrication and cooling

7 Radial Internal Clearance and Operating Clearance

The proper function of a roller bearing depends to a large degree on proper operating clearance which is a result of the clearance in the unmounted bearing and the change due to the effect of fit and temperature.

7.1 Radial Internal Clearance

The radial internal clearance of a rolling bearing is defined as the amount by which the inner ring can be moved in the radial direction from one extremity to the other in relation to the outer ring before mounting.

The nominal radial internal clearance of INA needle roller bearings is designed such that in combination with the shaft and housing fits shown in the dimension tables, the proper operating clearance for normal operating conditions results.

All special mounting and operating conditions, such as tighter fits or the bearing rings, extreme operating temperatures or mounting in or on nonferrous housings or shafts require a radial internal clearance other than normal. Please consult INA Engineering for proper shaft and housing recommendations and bearing selection.

7.2 Operating Clearance

The operating clearance of a rolling bearing is defined as the amount by which the shaft can be moved in the radial direction in relation to the outer ring of the mounted bearing without load. The operating clearance results from the radial internal clearance and the reduction ΔS , which is caused by interference fits and thermal expansion.

$$\Delta S = \Delta S_p + \Delta S_T \quad (24)$$

The reduction due to interference fit ΔS_p is calculated using the equation (25), and the reduction due to thermal expansion ΔS_T by equation (26). Care must be taken that the proper sign (+ or -) is used for ΔS_T .

Normal operating clearance

Normal operating clearances are obtained if the recommended shaft and housing fits are used and if not exposed to extreme operating temperatures.

Operating clearance smaller than normal

A smaller operating clearance than normally obtained should only be used in special cases, for example, in precision arrangements for machine tools and measuring equipment, or applications with alternating load or high shock loads in order to minimize their effect.

Operating clearance larger than normal

Larger operating clearance than normal is required for rolling bearings operating at high speeds and high temperatures as well as in cases of misalignment and shaft deflection.

7.2.1 Influence of Fits on the Operating Clearance

The reduction of radial internal clearance ΔS_p in a mounted bearing due to the fit results from the expansion of the inner ring Δd and the contraction of the outer ring ΔD .

$$\Delta S_p = \Delta d + \Delta D \quad (25)$$

Experience has shown that it is useful to determine the theoretical interference U between the bearing and shaft or housing from either the mean value or from the maximum limits reduced by 1/3 of their value. The amount by which the surfaces are smoothed during assembly must be subtracted from the interference. Average values for the dimensional change can be approximated from table 5.

In case of very thin walled housings and nonferrous housings, the effective interference cannot be reliably calculated. It is advisable to determine reduction of the radial internal clearance by sizing trials.

7.2.2 Influence of Temperature on the Operating Clearance

A relatively large temperature gradient between inner and outer ring of a radial bearing creates a considerable change in the operating clearance. This can sometimes be enough to endanger the proper functioning of the bearing. For a linear coefficient of thermal expansion for steel $\alpha = 6.1 \cdot 10^{-6} / ^\circ\text{F}$ ($1.1 \cdot 10^{-5} / ^\circ\text{C}$) and a temperature difference Δv between the inner ring and outer ring, the change in radial clearance is:

$$\Delta S_T \approx \alpha \cdot d_M \cdot \Delta v \quad (26)$$

The temperature difference Δv between inner and outer rings can result in a reduction or increase of the operating clearance. Δv must therefore be used in equation (26) with the correct mathematical sign.

Δv is positive if the inner ring is warmer than the outer ring — reduction in operating clearance; Δv is negative if the outer ring is warmer than the inner ring — increase in operating clearance.

Table 5 • Diameter changes caused by fits

	Needle bearings
Expansion of the inner ring when using a solid shaft	$\Delta d \approx 0.9 \cdot U \cdot \frac{d}{F}$
Contraction of the outer ring	$\Delta D \approx 0.8 \cdot U \cdot \frac{E}{D}$

8 Design of Bearing Arrangements

8.1 Design of Bearing Raceways

In order to achieve space saving bearing arrangements with the highest possible rigidity and load carrying capacity, certain series of INA roller bearings are used without bearing rings so that the rolling elements roll directly on the shaft or on the housing bore. This applies, for example to unit cages, precision ground bearings, shell bearings and shell type roller clutches. The following recommendations should be used when designing the raceways.

8.1.1 Materials for Raceways

When selecting the material for rolling bearing raceways, it is important to have a surface hardness of 670 to 840 HV (RC 58 to 65), a sufficient case depth and a degree of purity equal to that of common high grade steels in order to obtain full load carrying capacity. The following materials are suitable for rolling element bearing raceways:

Through-hardening Steels

For example 51100, 52100. In special cases, surface hardening of these steels is feasible.

Case Hardening Steels

In addition to hardenability, the core strength should also be considered when selecting the material. When case hardening, a fine grain structure should be

obtained and the effective hardness depth maintained in accordance with equation (27).

Steels for Flame or Induction Hardening

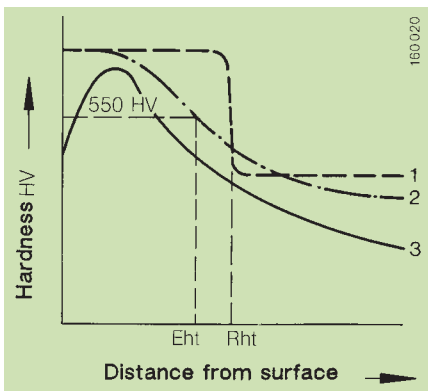
When flame or induction hardening, only those areas of the machine components which are used as raceways need to be hardened. The main precondition for the selection of material is again hardenability. Quenched and tempered material is preferable.

8.1.2 Hardness Depth

It is essential in case hardened, flame hardened, or induction hardened raceways to ensure that in addition to a surface hardness of 670 to 840 HV (RC 58 to 65), sufficient hardness depth h_t is achieved (for case hardening, $depth = E_{ht}$, for flame or induction hardening, $surface\ hardness\ depth = R_{ht}$). The case depth of a hardened surface is defined as that point on the hardness gradient where the referenced hardness of 550 HV (RC 52) or 80% of the lower limit of the surface hardness is still present.

Typical hardness curves are schematically shown in figure 13, where the required hardness is a result converting the principle stress into Vickers hardness.

The required minimum hardness depth depends basically on the rolling element diameter, load on the bearing, core strength and the heat treatment method.



- 1 Flame or induction hardening
- 2 Case hardening
- 3 Required hardness

Figure 13 • Case depth E_{ht} or R_{ht}

The hardness depth of bearing races, which are loaded up to the static capacity C_0 (Hertzian pressure = 580,000 psi/4000 Nmm²) can be determined from the following equations:

Case hardening:

$$E_{ht} \geq 0.078 \cdot D_w \quad (27)$$

Flame or induction hardening:

$$R_{ht} \geq 20300 \cdot D_w / R_{p0.2} \quad (28)$$

E_{ht} in
case hardening depth

R_{ht} in
surface hardening depth

D_w in
rolling element diameter

$R_{p0.2}$ psi
0.2 yield limit of the material core.

In case of smaller loads, then $\bar{P} = C_0$ and in case of $D_w > .4''$ (10 mm), smaller hardness depths than according to equations (27) and (28) can be permitted after careful investigation.

After finish grinding, the hardness depth should be at least .012" (0.3 mm).

8.1.3 Raceway Design

The surface quality of the raceway should be selected according to the operating requirements of the bearing. For full utilization of the load carrying capacity of the bearing, the raceway should have a maximum roughness of 8 $\mu\text{in AA}$ ($R_a 0.2 \mu\text{m}$). For less severe requirements, a roughness up to 32 $\mu\text{in AA}$ ($R_a 0.8 \mu\text{m}$) is permissible. For maximum smoothness of running and noise should be ground to have minimum waviness or, if possible, honed.

The tolerance for the shaft and housing for unit cages and shell bearings can be obtained from the dimension tables in their respective sections. The out-of-roundness should not be greater than 25% of the diameter tolerance and the taper should not exceed 50% of the diameter tolerance.

When using unit cages, the width of the outer raceway should be such that after deduction of the chamfers and/or radii, sufficient guiding surfaces for the cage are available over its total width.

8.3 Radial Location of Roller Bearings

The following influences should be taken into account in determining the proper mounting of roller bearings:

• Rotational Conditions

Rotational condition refers to the motion of the respective bearing ring in relation to the load direction.

Circumferential load is present if either the bearing ring rotates and the load is stationary, or the bearing ring is stationary and the load rotates. Under circumferential load, the bearing ring may creep if the shaft or housing fits is too loose. This must be prevented by sufficiently tight fits. The higher the load and the larger the ring diameter, the tighter the fit which has to be selected.

Point load is present if either the bearing ring and the load are stationary or the bearing ring and load rotate at the same speed. With point load a looser fit can be selected since there is less risk of the bearing ring creeping.

Indeterminate load direction is present when the load direction varies in irregular or oscillating manner, or shock loads and vibrations are present. Under these rotational conditions, relatively tight fits must be selected for both bearing rings.

- **Type and Magnitude of the Loading**

The higher the loading during circumferential or alternating load, the tighter the fit should be.

- **Temperature Conditions**

(see section 7.2.2)

- **Material and Design of the Mating Parts**

(see section 8.1)

The tolerance values given for housings in the dimensions tables, apply to steel and cast iron housings. The shaft dimensions given in the inner ring sections apply to solid shafts.

When using light metal housings or hollow shafts, tighter bearing fits should be selected.

8.2.1 Mounting Tolerances

Good radial location and uniform support of the bearing rings over their periphery and widths are of great

importance for proper operation and long service life of roller bearings. The selection of the mounting tolerances should therefore be performed with special care.

8.3 Axial Location of Roller Bearings

Normally both rings of needle roller bearings should be axially located in order to prevent lateral creep. This is not necessary if a sufficiently tight interference fit is used (i.e. shell type needle roller bearings, figure 14).

Unit cages must in all cases be axially located (see figures 15, 16).

8.3.1 Design of the Lateral Guiding Surfaces

The lateral guiding surfaces for unit cages (figures 15, 16) should be fine tuned and free of burrs. For high speeds, it is recommended that the adjacent faces be hardened and ground. When using locking or snap rings, an additional washer should be inserted (figure 15).

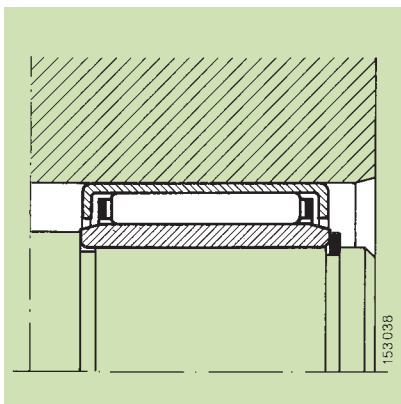


Figure 14

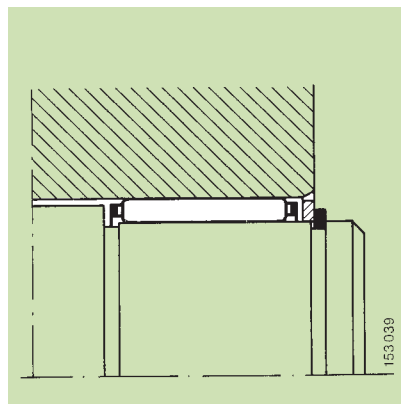


Figure 15

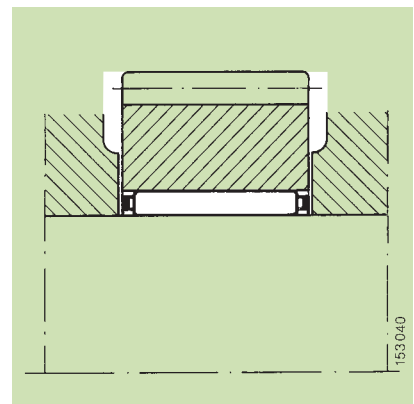


Figure 16

8.3.2 Axial Location of Bearing Rings

Bearing rings are often mounted in such a way that on one side they butt against the shoulder on the shaft or housing. The shoulders must be sufficiently high and square to the bearing axis. They should be machined in one operation together with the seating surface for the bearing ring.

The transition from the seating surface to the adjacent shoulder is generally accomplished by using a fillet radius or an undercut to ensure that the bearing ring butts over its entire circumference. A simple method of securing inner and outer rings can be achieved with snap rings (figures 14, 17).

8.4 Sealing of Roller Bearings

The reliability of the operation and service life of all roller bearings depends to a large extent on how effectively they are sealed against entry of contaminants and moisture as well as against loss of lubricant. The selection of the most suitable type of seal has to depend on each individual application.

8.4.1 Non-contact Seals

Non-contact seals are used in cases where seal friction is undesirable because of high circumferential speeds, absence of seal wear is a requirement, or where high temperatures are present. Seals with narrow gaps

have a very good sealing effect on grease. They are also suitable for sealing against oil, although they must be designed to return the oil (shaft grooves, slingers, spiral grooves, figure 19).

Simple gap seals should have a gap of .004 to .008" (0.1 to 0.2mm) and be as long as the available space permits. The sealing effect can be improved by grooves. (figure 18).

Labyrinth seals (figure 20) could be considered in cases of high requirements on the sealing effect. The radial gaps must not be so small as to cause pumping. The seals can be improved by filling the gaps with sealing grease, which typically is the same grease used for lubrication of the bearing, or at least a grease with the same soap base. In cases where the lubricating grease is not compatible with the media being sealed out, a special sealing grease should be used and a separating chamber be provided to prevent the sealing grease from entering the bearing.

8.4.2 Contact Seals

Contact seals are typically more effective than non-contact seals. The sealing element is under pressure against the sealing surface. This causes frictional heat which limits the permissible circumferential speed. The higher initial friction soon decreases during running. The sealing surface must be lubricated to avoid wear.

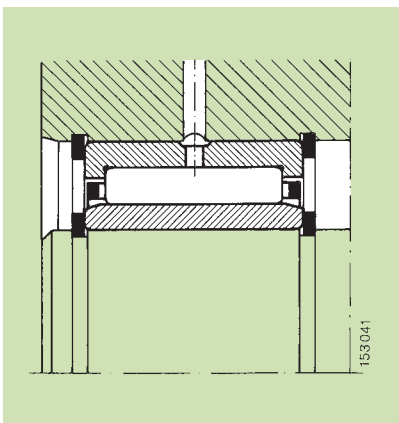


Figure 17

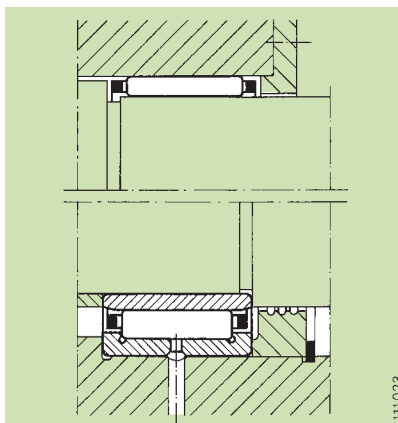


Figure 18

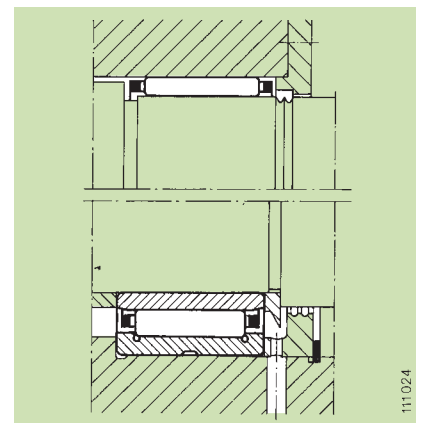


Figure 19

Lip seals (figures 21 to 24) can be used for oil or grease lubrication and are suitable for circumferential speeds up to 40 ft/sec (12 m/s). If purging of the lubricant from the bearing is to be avoided, the sealing lip has to face toward the inside. Assembly with the sealing lip facing the outside protects the bearing arrangement against contaminants.

Garter spring seals like those shown in figure 24, have proven successful in sealing of rolling bearings.

Sealed INA shell type roller bearings contain contact lip seals (figure 21), which eliminate the need for additional axial space in the bearing arrangement for sealing. These integral seals are suitable for sealing pressure free arrangements under normal operating conditions, provide good protection for the bearing against contamination and the loss of lubricant. During relubrication, they allow the purging of used grease.

Mounting instructions for contact seals

The raceways for the seals must be free from marks. A roughness of 8 to 32 $\mu\text{in AA}$ ($R_a 0.2$ to $R_a 0.8 \mu\text{m}$) is recommended. The surface hardness should be at least 450 HV (RC 45) and for circumferential speeds above 12 ft./sec (4 m/s), at least 600 HV (RC 55). The end of the raceway for the contact seals must be rounded or chamfered to prevent damage of the sealing lip during assembly.

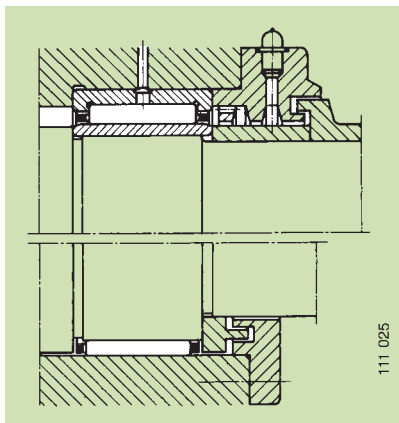


Figure 20

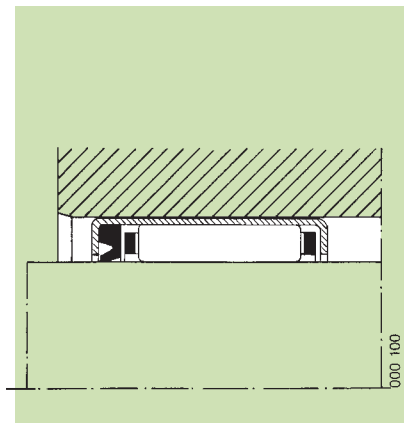


Figure 21

Greasing of the sealed lip and raceway prior to mounting prevents dry running during break-in. If several seals are mounted in tandem or if double lip seals are used, the free space between them should be filled with grease.

If the primary purpose is to prevent leakage of lubricant from the bearing, the seal lip should be mounted facing towards the bearing. A seal lip facing away from the bearing prevents entrance of contaminants and allows the used grease to be purged during regreasing.

Lip seals should be pressed into the housing bore with the aid of a pressing arbor to ensure a square and concentric fit. If the raceway has a sharp corner, a mounting sleeve should be used. It should have a slightly larger diameter than the diameter of the seal raceway and also a long lead chamfer (approximately 15°).

INA inner rings series PI and SI have rolling bearing raceways of very low roughness. The surface is well suited as the raceway for lip seals. The lead chamfers on the corners prevent damage to the sealing lip during assembly.

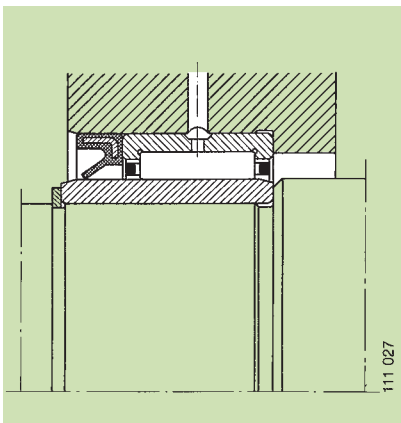


Figure 22

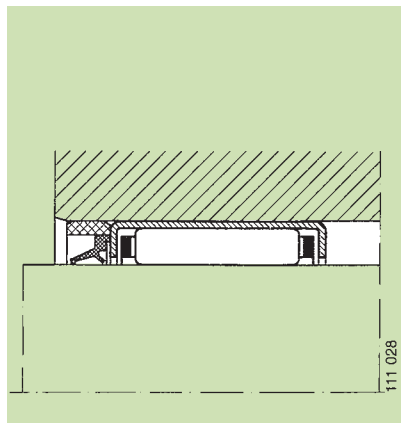


Figure 23

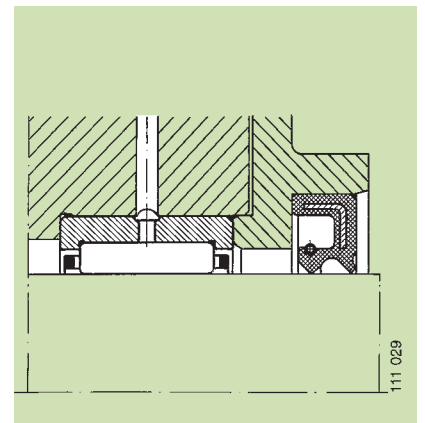


Figure 24

9 Mounting and Dismantling

INA rolling bearings are a precision product. Therefore, they require very careful handling before and during assembly. Trouble-free operation depends largely on the care exercised during assembly.

9.1 Storage

Rolling bearings should be stored in a dry, clean room with as constant a temperature as possible and a relative humidity not higher than 65%. INA rolling bearings are supplied in a preserved condition (anti-corrosive agent on an oil base, or a dry preservative with VCI paper) and should therefore not be removed from the original package until immediately before assembly.

After a few rolling bearings are taken from a multi-piece package with dry preservatives, the package must be closed immediately, since the protective vapor phase of the VCI paper can only be maintained in the closed package. The bearings which were removed must be greased or oiled immediately.

The storage period of greased and sealed bearings should, even in case of proper storage, not exceed three years. Changes in the grease resulting from long storage or unfavorable atmospheric conditions can make it necessary to clean and regrease the bearings before mounting.

9.2 Cleaning

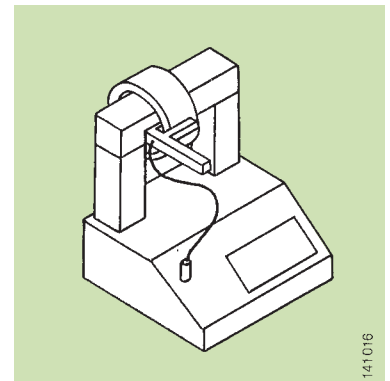
The anti-corrosive preservative used for oil preserved INA roller bearings is compatible with mineral oil base greases and lubricating oils and can be mixed with these. Normally, no special treatment is necessary before mounting. However, washing of the bearings may become necessary if synthetic lubricants or high or low temperature lubricants are to be used, if the operating temperature will be higher than +195°F (+90°C), or if contamination has taken place.

The following cleaning media can be used for degreasing and washing the bearings:

Inorganic cleaning media in the form of aqueous alkaline solutions. The temperature of the bath should be approximately +160 to +175°F (+70 to +80°C). The parts must remain in the bath until they reach the temperature of the bath. After that, they should be immersed in a dewatering bath. Alkaline solutions are not suitable for bearings with aluminum cages.

Organic cleaning media such as acid and water-free kerosene and naphtha (not gasoline) are also well suited as washing media.

Chlorinated hydrocarbons are not recommended as washing media since they increase the risk of corrosion. At least two baths should be available for preliminary and final cleaning. After washing, the bearings must be greased or oiled immediately.



Induction heater *INAtherm*®

9.3 Mounting

The assembly area should be as dust free as possible. Contamination has a detrimental effect on the operation and service life of rolling bearings. For mounting, housing bore and shaft should be checked for dimensional and geometrical accuracy as well as cleanliness.

The best method to mount the bearing ring is with a suitable device on a press (figure 25).

If a press is not available, mounting can also be achieved with light taps on the mounting sleeve. Under no circumstances should the mounting force be directed through the rolling elements!

The mounting of inner and outer rings is made easier if the seating surfaces are lightly lubricated with the oil or grease lubricant and are designed with a lead chamfer of 10 to 15°.

The easiest way to mount inner rings, particularly for a tight fit on a shaft, is to heat them first. This can be accomplished with an INA induction heater *INAtherm*® or an oil bath or heating oven at approximately +175°F (+80°C).

Freezing of the bearings for easier mounting into the housing is not recommended since moisture due to condensation may lead to corrosion in the bearing seats.

Special instructions regarding mounting are given in the technical explanation of the various bearing types.

After the bearing is mounted and supplied with lubricant, a functional test of the assembly is recommended.

9.4 Dismantling

The ability to dismantle a roller bearing must be taken into account during the design of the bearing arrangement. If the bearing rings are mounted with a tight interference fit, grooves should be provided in the shaft or in the housing to allow the removal of the rings by means of an extraction device (figure 26).

If the bearing is to be reused, direct impact on the bearing ring should be avoided during this handling, and dismantling forces should not be applied to the rolling elements. Afterwards, the bearing should be carefully cleaned, preferably in a disassembled condition (see also section 9.2).

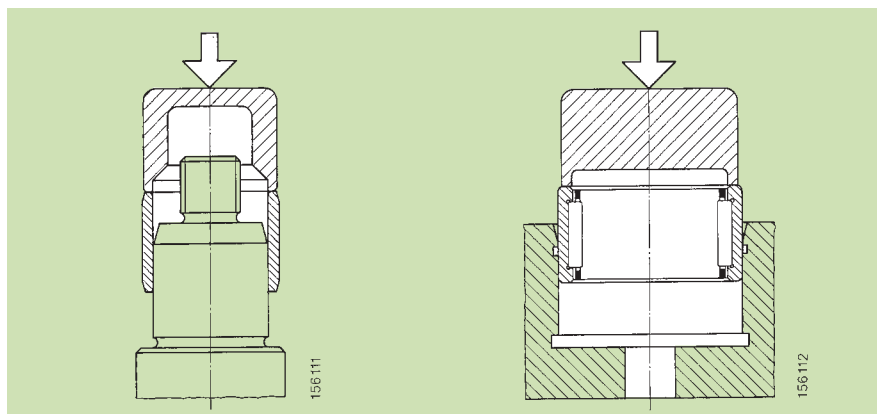


Figure 25 • Mounting of bearing rings

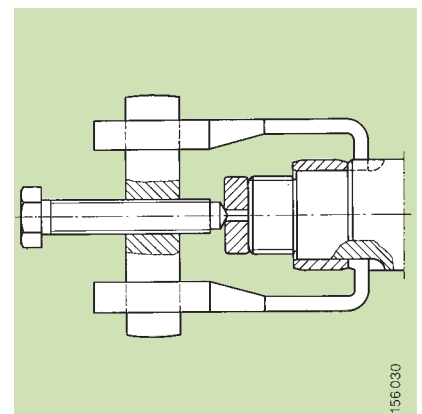
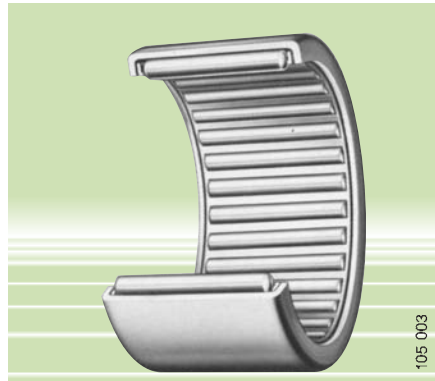


Figure 26 • Extraction device for bearing rings

Shell Bearings

with open and closed end
with and without seals



Series SCE, SCH



Series BCE, BCH

INA shell bearings have a very small radial section. They have a drawn cup or outer race or shell with cage guided needle rollers or a full complement of needle rollers.

These characteristics allow for a lower priced bearing arrangement with high load capacity. For full utilization of the load carrying capacity, the thin-walled cups must be rigidly supported. The bearings are pressed into the housing bore and normally require no further axial location.

The most economical way to use shell bearings is directly on hardened and ground shafts. When it is not practical to harden and grind the shaft, the bearings can be combined with inner rings of series SI or PI. The inner rings should be ordered separately by the part numbers shown in the dimension tables. See page 92 for further information on inner rings series PI.

Standard shell bearings are offered in two basic designs to fit the same shaft diameter. The heavy series is designed for applications where the loading conditions are too great for the standard series.

These bearings are characterized by a larger cross section and incorporate needle rollers with larger diameter.

A complete line of metric cage guided INA shell bearings is also available.

INA Shell Bearings, cage guided, see pages 48 to 57

These bearings consist of thin-walled drawn cups, cages and needle rollers which together form an integral unit. The cage assemblies ensure efficient performance even at high speeds. Long relubrication intervals can be scheduled due to large grease reservoirs.

Series • INA shell bearings are available in the following designs:	
Series	Description
SCE SCH	standard open end, cage guided needle rollers heavy duty open end, cage guided needle rollers
BCE BCH	standard closed end, cage guided needle rollers heavy duty closed end, cage guided needle rollers
SCE . . .P SCH . . .P	standard open end, cage guided needle rollers, one seal heavy duty open end, cage guided needle rollers, one seal
BCE . . .P BCH . . .P	standard closed end, cage guided needle rollers, one seal heavy duty closed end, cage guided needle rollers, one seal
SCE . . .PP SCH . . .PP	standard open end, cage guided needle rollers, two seals heavy duty open end, cage guided needle rollers, two seals
S SH	standard open end, mechanically retained needle rollers heavy duty open end, mechanically retained needle rollers
CS CSH	standard closed end, mechanically retained needle rollers heavy duty closed end, mechanically retained needle rollers
SN SNH	standard open end, grease retained needle rollers heavy duty open end, grease retained needle rollers
CSN CSNH	standard closed end, grease retained needle rollers heavy duty closed end, grease retained needle rollers

Cage guided shell bearings are available in open end designs for most applications, and with a closed end on the shell for applications where the shaft does not protrude beyond the bearing. The closed end serves as a seal for one side of the bearing and can also take light thrust loads in some applications.



Series SCE. .PP, SCH. .PP



Series S, SH



Series SN, SNH

INA Sealed Shell Bearings, cage guided, see pages 58 to 61

INA sealed shell bearings are provided with lip seals which under normal operating conditions protect the bearings against contamination and prevent leakage of grease. They are generally supplied grease filled. The lubricant is a high quality lithium base grease which is suitable for a temperature range of -25 to $+250^{\circ}\text{F}$ (-30 to $+120^{\circ}\text{C}$). Due to large grease reservoirs in the bearings, long relubrication intervals can be scheduled.

Compared with bearings with separate seals, INA sealed shell bearings offer lower initial cost, as well as lower storage and assembly costs since only one part is involved instead of two or three. This means simplified maintenance and replacement. It may also permit less costly housings since no counterbore is needed to hold a separate seal. Another advantage is that the seal is shrouded by the end of the shell to protect it from damage.

Sealed shell bearings are supplied at the discretion of INA with either polyester elastomer or nitrile rubber seals depending upon availability. If your application specifically requires one of these materials contact the INA Engineering Department. For specific applications, other seal materials such as polyacrylic and fluoro rubber are available. Please contact INA for design, price and availability for specific seal materials.

Sealed bearings are also available on special order with the seal lips facing inward to better retain the lubricant, suffix F or FF.

INA Shell Bearings, full complement, mechanically retained, see pages 62 to 67

These bearings feature thin-walled drawn cups, and trunnion-end rollers retained by inward curled flanges on the shells. This results in high load carrying bearings with small radial cross sections. They are best suited for moderate speed applications. Since they have excellent resistance to fretting, they are ideal for oscillating applications. They are more sensitive to misalignment, and have a somewhat higher coefficient

of friction than the INA cage guided shell bearings shown on pages 48 to 57.

INA Shell Bearings, full complement, grease retained, see pages 68 to 71

These bearings have drawn outer races and a full complement of needle rollers retained by a special tacky grease. They offer maximum load carrying capacity in a small space at minimum cost. The special lubricant is used to retain the rollers for shipment and installation. Once in operation, the grease loses its tackiness and allows the rollers to fall out when the shaft is removed for maintenance. This factor should be considered in the application of these bearings. Because of the special lubricant required to retain the rollers, the normal variety of lubricants available in other series is not available in this series.

INA Inner Rings for shell bearings

see pages 72 to 75

In applications where shafts cannot be hardened and ground to raceway quality, INA inner rings are an economical design solution.

INA inner rings of series SI are hardened and precision machined. The tolerance of the raceway diameter "F" is determined so that a normal operating clearance is achieved when used with shell bearings.

To ease assembly, the inner rings have lead chamfers. The rings are wider than the nominal width of the bearing with which they are used. This allows axial clamping of the inner ring while still leaving sufficient clearance for the bearing to rotate.

Recommended shaft diameters for mounting inner rings are specified for either press or slip fits. Normally, the inner ring must be press fitted if it rotates relative to the load.

Table 1 • Mounting Recommendations

Housing material	Shaft tolerance ¹⁾		Housing tolerance ²⁾	
	inch	mm	inch	mm
Steel	+0.0000 -0.0005	+0.000 -0.013	+0.0005 -0.0005	+0.013 -0.013
Powdered Metal	+0.0000 -0.0005	+0.000 -0.013	see table 2	
Aluminum, Magnesium, Plastic	+0.0000 -0.0005	+0.000 -0.013	see table 2	

¹⁾ Shaft Diameter
 3/16" / 4.762 mm and smaller
 +0.0000" / +0.000 mm
 -0.0003" / -0.008 mm
 Shaft Diameter
 2" / 50.80 mm and over
 +0.0000" / +0.000 mm
 -0.0006" / -0.015 mm

²⁾ Applies to housing larger than
 .3438" / 8.731 mm
 Consult with INA Engineering for smaller sizes.

Table 2 • Housing Recommendations

Housing bore diameter				Housing bore limits for			
inch		mm		Powdered metal		Aluminum, Magnesium, Plastic	
over	incl.	over	incl.	inch	mm	inch	mm
.3438	.7500	8.731	19.050	+0.0003 -0.0007	+0.008 -0.018	+0.0001 -0.0009	+0.002 -0.023
.7500	1.1875	19.050	30.162	+0.0002 -0.0008	+0.005 -0.020	+0.0000 -0.0010	+0.000 -0.025
1.1875	2.0000	30.162	50.800	+0.0001 -0.0009	+0.020 -0.023	-0.0002 -0.0012	-0.005 -0.030
2.0000	3.0000	50.800	76.200	+0.0000 -0.0010	+0.000 -0.025	-0.0003 -0.0012	-0.008 -0.030
3.0000	-	76.200	-	+0.0000 -0.0010	+0.000 -0.025	-0.0006 -0.0016	-0.015 -0.041

Mounting Tolerances

The unique design of the drawn shell outer race requires support of the bearing housing for proper functioning. The shell outside diameter is made oversize to assure a press fit in the recommended housing bore. This press fit serves two purposes. First, it provides axial retention for the bearing, eliminating a need for housing shoulders or retaining rings. If shoulders are required close to the bearing, enough axial clearance must be provided to prevent crushing the shell during installation.

Second, since the thin shell is subject to distortion during heat treatment, the bearing must be pressed into a round housing to give it proper size and roughness. The interference fit serves to maintain proper raceway geometry.

Housing tolerances shown in the dimension tables are for relatively heavy section steel or cast iron housings. When thin section housings are used, it is usually necessary to determine proper housing bores by trial. Consult the INA Engineering Department for further details. If the recommended housing and shaft tolerances listed in the dimension tables are maintained, a normal operating clearance results.

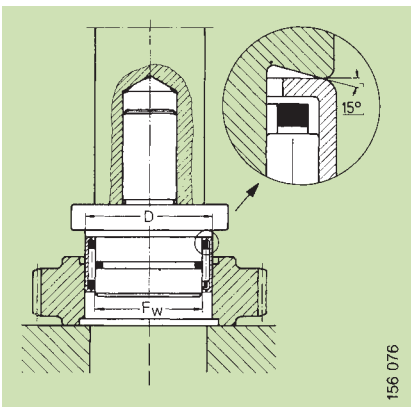


Figure 1

$D = 0.010''/0.25mm$ less than housing bore diameter
 $F_w = 0.003''/0.08mm$ less than shaft race diameter

Non-ferrous housing recommendations for shell bearings are shown in table 1.

Installation

INA shell bearings should be installed with the aid of a press and an arbor (figure 1) which has a shoulder to push against the bearing face. It is recommended that pressure be applied to the stamped end of the bearing shell, since the unstamped end is thinner and more susceptible to damage.

A rubber O-ring in the groove of the arbor is used to lightly grip the rollers and hold the bearing on the arbor. This simplifies mounting of the bearing on production lines. Mounting should be carried out using a press to prevent tilting of the bearing.

INA shell bearings which are installed without provision for relubrication must be sufficiently greased prior to installation.

Inspection Procedures

Dimensional inspection of shell type bearings is not possible in the unmounted condition because the thin shell may become out-of-round during production. It is only when they are pressed into a housing bore with the recommended tolerance limits that the bearings attain the geometrical accuracy which is essential to their correct functioning. The dimensional inspection can be carried out as follows:

1. Press bearing into a ring gage (wall thickness $\geq 0.750''/19.05mm$) with a bore diameter as shown in table 3 for standard or table 4 for extra precision shell bearings.
2. The under the roller diameter is inspected by using a plug gage for closed end bearings or a tapered arbor for open end shell bearings.

Additional information in section "Technical Data"

Page	Description
14	Load carrying capacity and life
26	Lubrication and maintenance
34	Design of bearing arrangements
6	Suffixes

Table 3 • Inspection dimensions for standard shell bearings

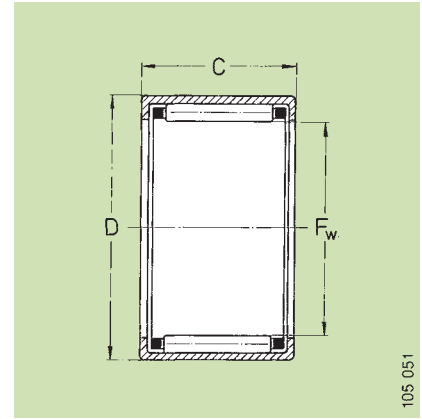
Bearing series SCE/BCE SCH/BCH S/CS SH/CSH SN/CSN	Nom inside diameter		Actual ring gauge bore				Under the roller diameter limits			
	F_w		standard series		heavy series		Inch		mm	
	Inch	mm	Inch	mm	Inch	mm	min	max	min	max
2 X	.1250	3.175	.2505	6.363	-	-	.1258	.1268	3.195	3.221
2 1/2 X	.1562	3.969	.2817	7.155	-	-	.1571	.1581	3.990	4.016
3 X	.1875	4.762	.3437	8.730	-	-	.1883	.1893	4.783	4.808
4 X	.2500	6.350	.4380	11.125	-	-	.2515	.2525	6.388	6.414
5 X	.3125	7.938	.5005	12.713	.5630	14.300	.3140	.3150	7.976	8.001
6 XX	.3750	9.525	.5630	14.300	.6255	15.888	.3765	.3775	9.563	9.588
7 XX	.4375	11.112	.6255	15.888	.6880	17.475	.4390	.4400	11.151	11.176
8 XX	.5000	12.700	.6880	17.475	.7505	19.063	.5015	.5025	12.738	12.764
9 XX	.5625	14.288	.7505	19.063	.8130	20.650	.5640	.5650	14.326	14.351
10 XX	.6250	15.875	.8130	20.650	.8755	22.238	.6265	.6275	15.913	15.938
11 XX	.6875	17.462	.8755	22.238	.9380	23.825	.6890	.6900	17.501	17.526
12 XX	.7500	19.050	.9995	25.387	1.0620	26.975	.7505	.7515	19.063	19.088
13 XX	.8125	20.638	1.0620	26.975	1.1245	28.562	.8130	.8140	20.650	20.676
14 XX	.8750	22.225	1.1245	28.562	1.1870	30.150	.8755	.8765	22.238	22.263
16 XX	1.0000	25.400	1.2495	31.737	1.3120	33.325	1.0005	1.0015	25.413	25.438
17 XX	1.0625	26.988	1.3120	33.325	-	-	1.0630	1.0640	27.000	27.026
18 XX	1.1250	28.575	1.3745	34.912	1.4995	38.087	1.1255	1.1265	28.588	28.613
20 XX	1.2500	31.750	1.4995	38.087	1.6245	41.262	1.2505	1.2515	31.763	31.788
21 XX	1.3125	33.338	1.6245	41.262	-	-	1.3130	1.3140	33.350	33.376
22 XX	1.3750	34.925	1.6245	41.262	1.7495	44.437	1.3755	1.3766	34.938	34.966
24 XX	1.5000	38.100	1.8745	47.612	-	-	1.5005	1.5017	38.113	38.143
26 XX	1.6250	41.275	1.9995	50.787	-	-	1.6255	1.6267	41.288	41.318
28 XX	1.7500	44.450	2.1245	53.962	-	-	1.7505	1.7518	44.463	44.496
30 XX	1.8750	47.625	2.2495	57.137	-	-	1.8755	1.8768	47.638	47.671
32 XX	2.0000	50.800	2.3745	60.312	-	-	2.0006	2.0019	50.815	50.848
36 XX	2.2500	57.150	2.6245	66.662	-	-	2.2506	2.2521	57.165	57.203
42 XX	2.6250	66.675	2.9995	76.187	-	-	2.6260	2.6275	66.700	66.738
44 XX	2.7500	69.850	3.1245	79.362	-	-	2.7510	2.7525	69.875	69.914
56 XX	3.5000	88.900	3.9995	101.587	-	-	3.5010	3.5025	88.925	88.964



Shell Bearings

cage guided

Series SCE, SCH
BCE, BCH

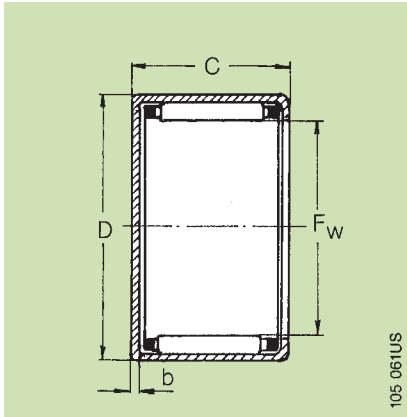


Series SCE, SCH

Dimension Table · Dimensions in inch and mm

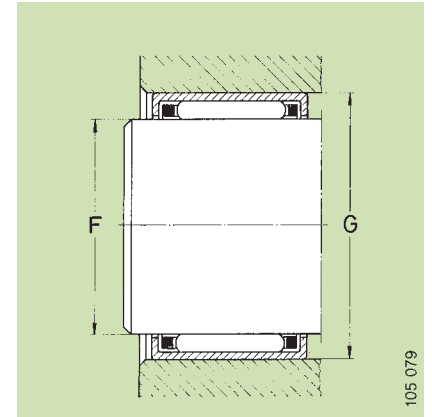
Shaft Dia. nom inch	Part Number open end	Part Number closed end	Bearing Dimensions							
			Inside Diameter ¹⁾ F_w		Outside Diameter D		Width C		End Recess b	
			nom inch	mm	nom inch	mm	$+0.000$ -0.010 inch	$+0.00$ -0.25 mm	max inch	max mm
$\frac{1}{8}$	SCE 24 TN	BCE 24 TN	.1250	3.175	.2500	6.350	.250	6.35	.03	0.8
$\frac{5}{32}$	SCE 2 1/2 4 TN	BCE 2 1/2 4 TN	.1562	3.969	.2812	7.144	.250	6.35	.03	0.8
	SCE 2 1/2 5 TN	BCE 2 1/2 5 TN	.1562	3.969	.2812	7.144	.312	7.94	.03	0.8
$\frac{3}{16}$	SCE 34 TN	BCE 34 TN	.1875	4.762	.3438	8.731	.250	6.35	.03	0.8
	SCE 36 TN	BCE 36 TN	.1875	4.762	.3438	8.731	.375	9.52	.03	0.8
$\frac{1}{4}$	SCE 44	BCE 44	.2500	6.350	.4375	11.112	.250	6.35	.04	1.0
	SCE 45	BCE 45	.2500	6.350	.4375	11.112	.312	7.94	.04	1.0
	SCE 47	BCE 47	.2500	6.350	.4375	11.112	.438	11.11	.04	1.0
$\frac{5}{16}$	SCE 55	BCE 55	.3125	7.938	.5000	12.700	.312	7.94	.04	1.0
	SCE 57	BCE 57	.3125	7.938	.5000	12.700	.438	11.11	.04	1.0
	SCE 59	BCE 59	.3125	7.938	.5000	12.700	.562	14.29	.04	1.0
	SCH 57	BCH 57	.3125	7.938	.5625	14.288	.438	11.11	.04	1.1
$\frac{3}{8}$	SCE 65	BCE 65	.3750	9.525	.5625	14.288	.312	7.94	.04	1.0
	SCE 66	BCE 66	.3750	9.525	.5625	14.288	.375	9.52	.04	1.0
	SCE 67	BCE 67	.3750	9.525	.5625	14.288	.438	11.11	.04	1.0
	SCE 68	BCE 68	.3750	9.525	.5625	14.288	.500	12.70	.04	1.0
	SCE 69	BCE 69	.3750	9.525	.5625	14.288	.562	14.29	.04	1.0
	SCE 610	BCE 610	.3750	9.525	.5625	14.288	.625	15.88	.04	1.0
	SCH 68	BCH 68	.3750	9.525	.6250	15.875	.500	12.70	.04	1.1
$\frac{7}{16}$	SCE 78	BCE 78	.4375	11.112	.6250	15.875	.500	12.70	.04	1.0
	SCE 710	BCE 710	.4375	11.112	.6250	15.875	.625	15.88	.04	1.0
	SCH 78	BCH 78	.4375	11.112	.6875	17.462	.500	12.70	.04	1.1

¹⁾ Inspection dimensions are listed on page 46, table 3.



Series BCE, BCH

105 061US



Mounting dimensions

105 079

Load Ratings in lbf		Limiting Speed 2)	Mounting Dimensions in inch and mm								Matching Inner Ring Number order separate
dynamic C	static C ₀		Shaft Diameter 3)				Housing Diameter 3)				
			F		G		F		G		
		rpm	inch	mm	inch	mm	inch	mm	inch	mm	
			max	min	max	min	min	max	min	max	
240	165	48000	.1250	.1247	3.175	3.167	.2500	.2505	6.350	6.363	-
275	204	44000	.1563	.1560	3.970	3.961	.2812	.2817	7.142	7.155	-
300	230	44000	.1563	.1560	3.970	3.961	.2812	.2817	7.142	7.155	-
400	305	40000	.1875	.1872	4.762	4.755	.3432	.3437	8.717	8.730	-
620	530	40000	.1875	.1872	4.762	4.755	.3432	.3437	8.717	8.730	-
360	260	35000	.2500	.2495	6.350	6.337	.4370	.4380	11.100	11.125	-
570	470	35000	.2500	.2495	6.350	6.337	.4370	.4380	11.100	11.125	-
920	870	35000	.2500	.2495	6.350	6.337	.4370	.4380	11.100	11.125	-
650	590	29000	.3125	.3120	7.938	7.925	.4995	.5005	12.687	12.713	-
1060	1090	29000	.3125	.3120	7.938	7.925	.4995	.5005	12.687	12.713	-
1340	1480	29000	.3125	.3120	7.938	7.925	.4995	.5005	12.687	12.713	-
1070	930	27000	.3125	.3120	7.938	7.925	.5620	.5630	14.275	14.300	-
650	610	25000	.3750	.3745	9.525	9.512	.5620	.5630	14.275	14.300	-
870	890	25000	.3750	.3745	9.525	9.512	.5620	.5630	14.275	14.300	-
980	1030	25000	.3750	.3745	9.525	9.512	.5620	.5630	14.275	14.300	-
1300	1490	25000	.3750	.3745	9.525	9.512	.5620	.5630	14.275	14.300	-
1510	1800	25000	.3750	.3745	9.525	9.512	.5620	.5630	14.275	14.300	-
1660	2040	25000	.3750	.3745	9.525	9.512	.5620	.5630	14.275	14.300	-
1590	1590	24000	.3750	.3745	9.525	9.512	.6245	.6255	15.862	15.888	-
1430	1760	22000	.4375	.4370	11.112	11.100	.6245	.6255	15.862	15.888	-
1830	2410	22000	.4375	.4370	11.112	11.100	.6245	.6255	15.862	15.888	-
1760	1840	21000	.4375	.4370	11.112	11.100	.6870	.6880	17.450	17.475	-

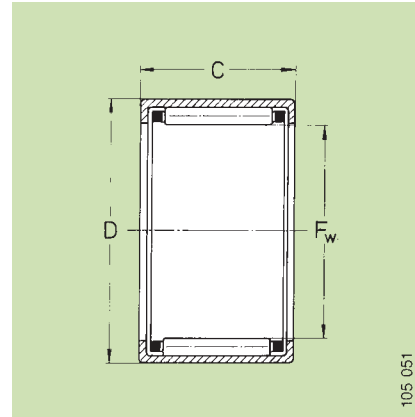
2) Limiting speeds shown apply for oil lubrication. With grease lubrication 60% of the given values are permissible.

3) For non-ferrous housing recommendations refer to page 44, table 1.

Shell Bearings

cage guided

Series SCE, SCH
BCE, BCH

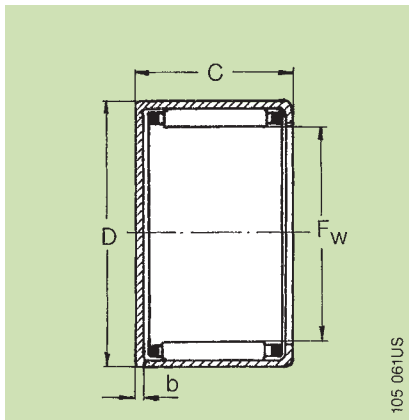


Series SCE, SCH

Dimension Table • Dimensions in inch and mm

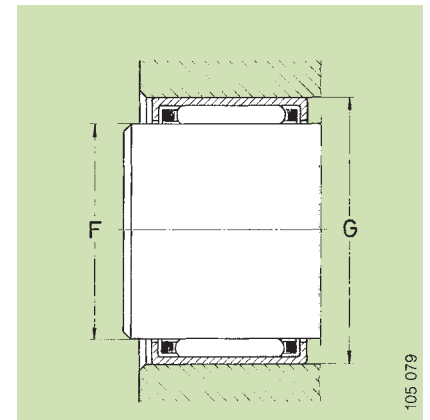
Shaft Dia. nom inch	Part Number open end	Part Number closed end	Bearing Dimensions							
			Inside Diameter ¹⁾ F _w nom		Outside Diameter D nom		Width C		End Recess b max	
			inch	mm	inch	mm	$\begin{matrix} +0.000 \\ -0.010 \end{matrix}$ inch	$\begin{matrix} +0.00 \\ -0.25 \end{matrix}$ mm	inch	mm
1/2	SCE 85	BCE 85	.5000	12.700	.6875	17.462	.312	7.94	.04	1.0
	SCE 86	BCE 86	.5000	12.700	.6875	17.462	.375	9.52	.04	1.0
	SCE 87	BCE 87	.5000	12.700	.6875	17.462	.438	11.11	.04	1.0
	SCE 88	BCE 88	.5000	12.700	.6875	17.462	.500	12.70	.04	1.0
	SCE 810	BCE 810	.5000	12.700	.6875	17.462	.625	15.88	.04	1.0
	SCE 812	BCE 812	.5000	12.700	.6875	17.462	.750	19.05	.04	1.0
	SCH 87	BCH 87	.5000	12.700	.7500	19.050	.438	11.11	.04	1.1
	SCH 88	BCH 88	.5000	12.700	.7500	19.050	.500	12.70	.04	1.1
	SCH 810	BCH 810	.5000	12.700	.7500	19.050	.625	15.88	.04	1.1
9/16	SCE 95	BCE 95	.5625	14.288	.7500	19.050	.312	7.94	.04	1.0
	SCE 96	BCE 96	.5625	14.288	.7500	19.050	.375	9.52	.04	1.0
	SCE 97	BCE 97	.5625	14.288	.7500	19.050	.438	11.11	.04	1.0
	SCE 98	BCE 98	.5625	14.288	.7500	19.050	.500	12.70	.04	1.0
	SCE 910	BCE 910	.5625	14.288	.7500	19.050	.625	15.88	.04	1.0
	SCE 912	BCE 912	.5625	14.288	.7500	19.050	.750	19.05	.04	1.0
	SCH 98	BCH 98	.5625	14.288	.8125	20.638	.500	12.70	.04	1.1
	SCH 912	BCH 912	.5625	14.288	.8125	20.638	.750	19.05	.04	1.1
5/8	SCE 105	BCE 105	.6250	15.875	.8125	20.638	.312	7.94	.04	1.0
	SCE 107	BCE 107	.6250	15.875	.8125	20.638	.438	11.11	.04	1.0
	SCE 107 ^{1/2}	BCE 107 ^{1/2}	.6250	15.875	.8125	20.638	.469	11.91	.04	1.0
	SCE 108	BCE 108	.6250	15.875	.8125	20.638	.500	12.70	.04	1.0
	SCE 1010	BCE 1010	.6250	15.875	.8125	20.638	.625	15.88	.04	1.0
	SCE 1012	BCE 1012	.6250	15.875	.8125	20.638	.750	19.05	.04	1.0
	SCH 108	BCH 108	.6250	15.875	.8750	22.225	.500	12.70	.04	1.1
	SCH 1010	BCH 1010	.6250	15.875	.8750	22.225	.625	15.88	.04	1.1
	SCH 1012	BCH 1012	.6250	15.875	.8750	22.225	.750	19.05	.04	1.1
	SCH 1016	BCH 1016	.6250	15.875	.8750	22.225	1.000	25.40	.04	1.1

¹⁾ Inspection dimensions are listed on page 46, table 3.



Series BCE, BCH

105 061 US



Mounting dimensions

105 079

Load Ratings in lbf		Limiting Speed 2) rpm	Mounting Dimensions in Inch and mm								Matching Inner Ring Number 4) order separate
dynamic C	static C ₀		Shaft Diameter 3)				Housing Diameter 3)				
			F		G		inch		mm		
			max	min	max	min	min	max	min	max	
820	890	19000	.5000	.4995	12.700	12.687	.6870	.6880	17.450	17.475	-
1040	1210	19000	.5000	.4995	12.700	12.687	.6870	.6880	17.450	17.475	-
1330	1660	19000	.5000	.4995	12.700	12.687	.6870	.6880	17.450	17.475	-
1550	2030	19000	.5000	.4995	12.700	12.687	.6870	.6880	17.450	17.475	SI 050808
1980	2750	19000	.5000	.4995	12.700	12.687	.6870	.6880	17.450	17.475	SI 050810
2230	3200	19000	.5000	.4995	12.700	12.687	.6870	.6880	17.450	17.475	-
1650	1760	19000	.5000	.4995	12.700	12.687	.7495	.7505	19.037	19.063	-
1910	2120	19000	.5000	.4995	12.700	12.687	.7495	.7505	19.037	19.063	SI 050808
2360	2800	19000	.5000	.4995	12.700	12.687	.7495	.7505	19.037	19.063	-
2850	3500	19000	.5000	.4995	12.700	12.687	.7495	.7505	19.037	19.063	-
910	1060	18000	.5625	.5620	14.288	14.275	.7495	.7505	19.037	19.063	-
1160	1440	18000	.5625	.5620	14.288	14.275	.7495	.7505	19.037	19.063	-
1480	1980	18000	.5625	.5620	14.288	14.275	.7495	.7505	19.037	19.063	-
1730	2420	18000	.5625	.5620	14.288	14.275	.7495	.7505	19.037	19.063	SI 060908
2120	3150	18000	.5625	.5620	14.288	14.275	.7495	.7505	19.037	19.063	-
2410	3700	18000	.5625	.5620	14.288	14.275	.7495	.7505	19.037	19.063	SI 060912
2050	2380	17000	.5625	.5620	14.288	14.275	.8120	.8130	20.625	20.650	SI 060908
3250	4300	17000	.5625	.5620	14.288	14.275	.8120	.8130	20.625	20.650	SI 060912
970	1180	16000	.6250	.6245	15.875	15.862	.8120	.8130	20.625	20.650	-
1480	2100	16000	.6250	.6245	15.875	15.862	.8120	.8130	20.625	20.650	-
1600	2320	16000	.6250	.6245	15.875	15.862	.8120	.8130	20.625	20.650	-
1830	2700	16000	.6250	.6245	15.875	15.862	.8120	.8130	20.625	20.650	SI 061008
2330	3650	16000	.6250	.6245	15.875	15.862	.8120	.8130	20.625	20.650	SI 061010
2700	4450	16000	.6250	.6245	15.875	15.862	.8120	.8130	20.625	20.650	SI 061012
2250	2750	15000	.6250	.6245	15.875	15.862	.8745	.8755	22.212	22.238	SI 061008
2850	3750	15000	.6250	.6245	15.875	15.862	.8745	.8755	22.212	22.238	-
3300	4500	15000	.6250	.6245	15.875	15.862	.8745	.8755	22.212	22.238	SI 061012
4300	6300	15000	.6250	.6245	15.875	15.862	.8745	.8755	22.212	22.238	-

2) Limiting speeds shown apply for oil lubrication. With grease lubrication 60% of the given values are permissible.

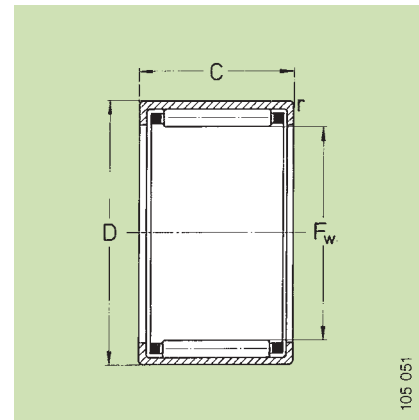
3) For non-ferrous housing recommendations refer to page 44, table 1.

4) Dimensions are listed on pages 72 to 75.

Shell Bearings

cage guided

Series SCE, SCH
BCE, BCH

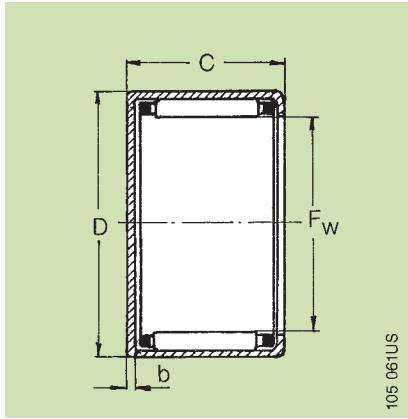


Series SCE, SCH

Dimension Table • Dimensions in inch and mm

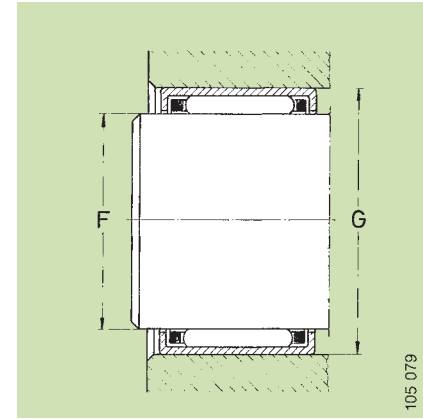
Shaft Dia. nom inch	Part Number open end	Part Number closed end	Bearing Dimensions							
			Inside Diameter ¹⁾ F_w		Outside Diameter D		Width C		End Recess b max	
			nom inch	mm	nom inch	mm	$+0.000$ -0.010 inch	$+0.00$ -0.25 mm	inch	mm
1 ¹ / ₁₆	SCE 116	BCE 116	.6875	17.462	.8750	22.225	.375	9.52	.04	1.0
	SCE 118	BCE 118	.6875	17.462	.8750	22.225	.500	12.70	.04	1.0
	SCE 1110	BCE 1110	.6875	17.462	.8750	22.225	.625	15.88	.04	1.0
	SCE 1112	BCE 1112	.6875	17.462	.8750	22.225	.750	19.05	.04	1.0
	SCH 117	BCH 117	.6875	17.462	.9375	23.812	.438	11.11	.04	1.1
	SCH 1110	BCH 1110	.6875	17.462	.9375	23.812	.625	15.88	.04	1.1
3 ⁴ / ₄	SCE 126	BCE 126	.7500	19.050	1.0000	25.400	.375	9.52	.04	1.0
	SCE 128	BCE 128	.7500	19.050	1.0000	25.400	.500	12.70	.04	1.0
	SCE 1210	BCE 1210	.7500	19.050	1.0000	25.400	.625	15.88	.04	1.0
	SCE 1212	BCE 1212	.7500	19.050	1.0000	25.400	.750	19.05	.04	1.0
	SCH 1212	BCH 1212	.7500	19.050	1.0625	26.988	.750	19.05	.04	1.1
1 ³ / ₁₆	SCE 136	BCE 136	.8125	20.638	1.0625	26.988	.375	9.52	.04	1.0
	SCE 138	BCE 138	.8125	20.638	1.0625	26.988	.500	12.70	.04	1.0
	SCE 1312	BCE 1312	.8125	20.638	1.0625	26.988	.750	19.05	.04	1.0
	SCE 1314	BCE 1314	.8125	20.638	1.0625	26.988	.875	22.22	.04	1.0
	SCH 1312	BCH 1312	.8125	20.638	1.1250	28.575	.750	19.05	.05	1.3
7 ⁸ / ₈	SCE 146	BCE 146	.8750	22.225	1.1250	28.575	.375	9.52	.04	1.1
	SCE 148	BCE 148	.8750	22.225	1.1250	28.575	.500	12.70	.04	1.1
	SCE 1412	BCE 1412	.8750	22.225	1.1250	28.575	.750	19.05	.04	1.1
	SCE 1416	BCE 1416	.8750	22.225	1.1250	28.575	1.000	25.40	.04	1.1
	SCH 1410	BCH 1410	.8750	22.225	1.1875	30.162	.625	15.88	.05	1.3
	SCH 1412	BCH 1412	.8750	22.225	1.1875	30.162	.750	19.05	.05	1.3
1 ⁵ / ₁₆	SCE 1516	BCE 1516	.9375	23.812	1.1875	30.162	1.000	25.40	.04	1.1

¹⁾ Inspection dimensions are listed on page 46, table 3.



Series BCE, BCH

105 061US



Mounting dimensions

105 079

Load Ratings in lbf		Limiting Speed 2) rpm	Mounting Dimensions in inch and mm								Matching Inner Ring Number 4) order separate
dynamic C	static C ₀		Shaft Diameter 3)				Housing Diameter 3)				
			F		G		F		G		
			inch	mm	inch	mm	inch	mm	inch	mm	
			max	min	max	min	min	max	min	max	
1290	1770	15000	.6875	.6870	17.462	17.450	.8745	.8755	22.212	22.238	-
1930	2950	15000	.6875	.6870	17.462	17.450	.8745	.8755	22.212	22.238	-
2460	4050	15000	.6875	.6870	17.462	17.450	.8745	.8755	22.212	22.238	-
2800	4750	15000	.6875	.6870	17.462	17.450	.8745	.8755	22.212	22.238	-
1900	2260	14000	.6875	.6870	17.462	17.450	.9370	.9380	23.800	23.825	-
2900	3850	14000	.6875	.6870	17.462	17.450	.9370	.9380	23.800	23.825	-
3550	5100	14000	.6875	.6870	17.462	17.450	.9370	.9380	23.800	23.825	-
1600	1860	13000	.7500	.7495	19.050	19.037	.9995	1.0005	25.387	25.413	-
2210	2800	13000	.7500	.7495	19.050	19.037	.9995	1.0005	25.387	25.413	SI 081208
2850	3950	13000	.7500	.7495	19.050	19.037	.9995	1.0005	25.387	25.413	SI 081210
3450	5000	13000	.7500	.7495	19.050	19.037	.9995	1.0005	25.387	25.413	SI 081212
4150	5300	13000	.7500	.7495	19.050	19.037	1.0620	1.0630	26.975	27.000	SI 081212
1590	1880	12000	.8125	.8120	20.638	20.625	1.0620	1.0630	26.975	27.000	-
2420	3200	12000	.8125	.8120	20.638	20.625	1.0620	1.0630	26.975	27.000	-
3600	5300	12000	.8125	.8120	20.638	20.625	1.0620	1.0630	26.975	27.000	-
4150	6500	12000	.8125	.8120	20.638	20.625	1.0620	1.0630	26.975	27.000	-
4350	6000	12000	.8125	.8120	20.638	20.625	1.1245	1.1255	28.562	28.588	-
1850	2400	11000	.8750	.8745	22.225	22.212	1.1245	1.1255	28.562	28.588	SI 101406
2500	3550	11000	.8750	.8745	22.225	22.212	1.1245	1.1255	28.562	28.588	SI 101408
3800	6100	11000	.8750	.8745	22.225	22.212	1.1245	1.1255	28.562	28.588	SI 101412
4950	8500	11000	.8750	.8745	22.225	22.212	1.1245	1.1255	28.562	28.588	SI 101416
3650	4800	11000	.8750	.8745	22.225	22.212	1.1870	1.1880	30.150	30.175	-
4400	6100	11000	.8750	.8745	22.225	22.212	1.1870	1.1880	30.150	30.175	SI 101412
5800	8600	11000	.8750	.8745	22.225	22.212	1.1870	1.1880	30.150	30.175	SI 101416
5400	9700	11000	.9375	.9370	23.812	23.800	1.1870	1.1880	30.150	30.175	-

2) Limiting speeds shown apply for oil lubrication. With grease lubrication 60% of the given values are permissible.

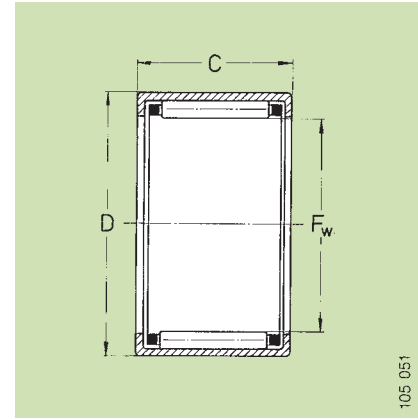
3) For non-ferrous housing recommendations refer to page 44, table 1.

4) Dimensions are listed on pages 72 to 75.

Shell Bearings

cage guided

Series SCE, SCH
BCE, BCH



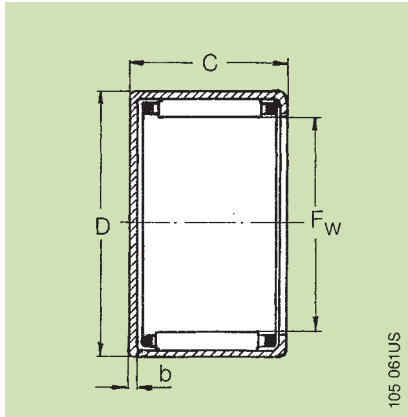
Series SCE, SCH

Dimension Table • Dimensions in inch and mm

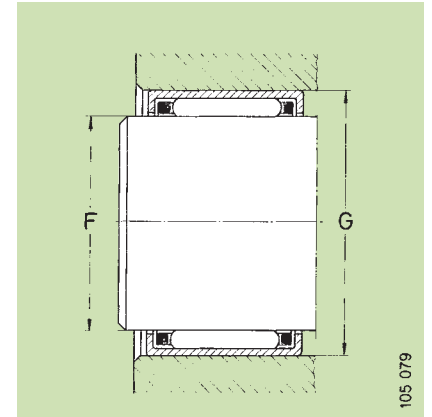
Shaft Dia. nom inch	Part Number open end	Part Number closed end	Bearing Dimensions							
			Inside Diameter ¹⁾ F _w		Outside Diameter D		Width C		End Recess b	
			nom inch	mm	nom inch	mm	+0.000 -0.010 inch	+0.00 -0.25 mm	max inch	mm
1	SCE 167	BCE 167	1.0000	25.400	1.2500	31.750	.438	11.11	.04	1.1
	SCE 168	BCE 168	1.0000	25.400	1.2500	31.750	.500	12.70	.04	1.1
	SCE 1612	BCE 1612	1.0000	25.400	1.2500	31.750	.750	19.05	.04	1.1
	SCE 1616	BCE 1616	1.0000	25.400	1.2500	31.750	1.000	25.40	.04	1.1
	SCH 168	BCH 168	1.0000	25.400	1.3125	33.338	.500	12.70	.05	1.3
	SCH 1610	BCH 1610	1.0000	25.400	1.3125	33.338	.625	15.88	.05	1.3
	SCH 1612	BCH 1612	1.0000	25.400	1.3125	33.338	.750	19.05	.05	1.3
	SCH 1616	BCH 1616	1.0000	25.400	1.3125	33.338	1.000	25.40	.05	1.3
	SCH 1620	BCH 1620	1.0000	25.400	1.3125	33.338	1.250	31.75	.05	1.3
SCH 1624 °	BCH 1624	1.0000	25.400	1.3125	33.338	1.500	38.10	.05	1.3	
1 1/8	SCE 186	BCE 186	1.1250	28.575	1.3750	34.925	.375	9.52	.04	1.1
	SCE 188	BCE 188	1.1250	28.575	1.3750	34.925	.500	12.70	.04	1.1
	SCE 1812	BCE 1812	1.1250	28.575	1.3750	34.925	.750	19.05	.04	1.1
	SCE 1814	BCE 1814	1.1250	28.575	1.3750	34.925	.875	22.22	.04	1.1
	SCE 1816	BCE 1816	1.1250	28.575	1.3750	34.925	1.000	25.40	.04	1.1
	SCH 1810	BCH 1810	1.1250	28.575	1.5000	38.100	.625	15.88	.05	1.3
	SCH 1812	BCH 1812	1.1250	28.575	1.5000	38.100	.750	19.05	.05	1.3
	SCH 1816	BCH 1816	1.1250	28.575	1.5000	38.100	1.000	25.40	.05	1.3
	SCH 1818	BCH 1818	1.1250	28.575	1.5000	38.100	1.125	28.58	.05	1.3
SCH 1820	BCH 1820	1.1250	28.575	1.5000	38.100	1.250	31.75	.05	1.3	
1 3/16	SCE 1916	BCE 1916	1.1875	30.162	1.5000	38.100	1.000	25.40	.04	1.1
1 1/4	SCE 208	BCE 208	1.2500	31.750	1.5000	38.100	.500	12.70	.04	1.1
	SCE 2010	BCE 2010	1.2500	31.750	1.5000	38.100	.625	15.88	.04	1.1
	SCE 2012	BCE 2012	1.2500	31.750	1.5000	38.100	.750	19.05	.04	1.1
	SCE 2016	BCE 2016	1.2500	31.750	1.5000	38.100	1.000	25.40	.04	1.1
	SCE 2020	BCE 2020	1.2500	31.750	1.5000	38.100	1.250	31.75	.04	1.1
	SCH 208	BCH 208	1.2500	31.750	1.6250	41.275	.500	12.70	.06	1.4
	SCH 2012	BCH 2012	1.2500	31.750	1.6250	41.275	.750	19.05	.06	1.4
	SCH 2016	BCH 2016	1.2500	31.750	1.6250	41.275	1.000	25.40	.06	1.4
	SCH 2020	BCH 2020	1.2500	31.750	1.6250	41.275	1.250	31.75	.06	1.4

¹⁾ Inspection dimensions are listed on page 46, table 3.

[°] Double row design



Series BCE, BCH



Mounting dimensions

Load Ratings in lbf		Limiting Speed ²⁾ rpm	Mounting Dimensions in inch and mm								Matching Inner Ring Number ⁴⁾ order separate
dynamic C	static C ₀		Shaft Diameter ³⁾ F				Housing Diameter ³⁾ G				
			inch		mm		inch		mm		
			max	min	max	min	min	max	min	max	
2380	3400	10000	1.0000	.9995	25.400	25.387	1.2495	1.2505	31.737	31.763	-
2850	4300	10000	1.0000	.9995	25.400	25.387	1.2495	1.2505	31.737	31.763	SI 121608
4050	6800	10000	1.0000	.9995	25.400	25.387	1.2495	1.2505	31.737	31.763	SI 121612
5600	10200	10000	1.0000	.9995	25.400	25.387	1.2495	1.2505	31.737	31.763	SI 121616
2950	3750	10000	1.0000	.9995	25.400	25.387	1.3120	1.3130	33.325	33.350	-
3750	5100	10000	1.0000	.9995	25.400	25.387	1.3120	1.3130	33.325	33.350	-
4500	6400	10000	1.0000	.9995	25.400	25.387	1.3120	1.3130	33.325	33.350	SI 121612
6500	10400	10000	1.0000	.9995	25.400	25.387	1.3120	1.3130	33.325	33.350	SI 121616
7300	12100	10000	1.0000	.9995	25.400	25.387	1.3120	1.3130	33.325	33.350	SI 121620
7700	12900	10000	1.0000	.9995	25.400	25.387	1.3120	1.3130	33.325	33.350	-
1870	2600	9000	1.1250	1.1245	28.575	28.562	1.3745	1.3755	34.912	34.938	-
2900	4550	9000	1.1250	1.1245	28.575	28.562	1.3745	1.3755	34.912	34.938	SI 141808
4250	7500	9000	1.1250	1.1245	28.575	28.562	1.3745	1.3755	34.912	34.938	SI 141812
4950	9100	9000	1.1250	1.1245	28.575	28.562	1.3745	1.3755	34.912	34.938	-
5800	11100	9000	1.1250	1.1245	28.575	28.562	1.3745	1.3755	34.912	34.938	SI 141816
4900	6500	8500	1.1250	1.1245	28.575	28.562	1.4995	1.5005	38.087	38.113	-
5700	7800	8500	1.1250	1.1245	28.575	28.562	1.4995	1.5005	38.087	38.113	SI 141812
7100	10600	8500	1.1250	1.1245	28.575	28.562	1.4995	1.5005	38.087	38.113	SI 141816
8000	12300	8500	1.1250	1.1245	28.575	28.562	1.4995	1.5005	38.087	38.113	-
9200	14600	8500	1.1250	1.1245	28.575	28.562	1.4995	1.5005	38.087	38.113	SI 141820
7400	12900	8500	1.1875	1.1870	30.162	30.150	1.4995	1.5005	38.087	38.113	-
3000	4950	8000	1.2500	1.2495	31.750	31.737	1.4995	1.5005	38.087	38.113	-
3700	6500	8000	1.2500	1.2495	31.750	31.737	1.4995	1.5005	38.087	38.113	-
4750	8900	8000	1.2500	1.2495	31.750	31.737	1.4995	1.5005	38.087	38.113	SI 162012
6100	12300	8000	1.2500	1.2495	31.750	31.737	1.4995	1.5005	38.087	38.113	SI 162016
7500	16100	8000	1.2500	1.2495	31.750	31.737	1.4995	1.5005	38.087	38.113	SI 162020
3700	4700	8000	1.2500	1.2495	31.750	31.737	1.6245	1.6255	41.262	41.288	-
6100	8900	8000	1.2500	1.2495	31.750	31.737	1.6245	1.6255	41.262	41.288	SI 162012
8100	12900	8000	1.2500	1.2495	31.750	31.737	1.6245	1.6255	41.262	41.288	SI 162016
9800	16400	8000	1.2500	1.2495	31.750	31.737	1.6245	1.6255	41.262	41.288	SI 162020

2) Limiting speeds shown apply for oil lubrication. With grease lubrication 60% of the given values are permissible.

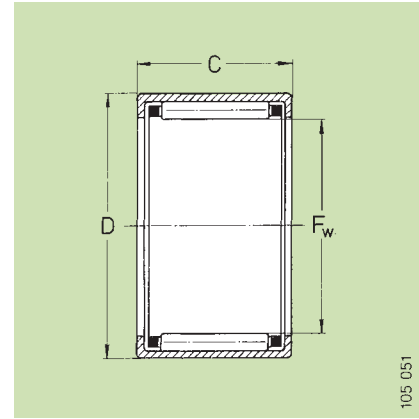
3) For non-ferrous housing recommendations refer to page 44, table 1.

4) Dimensions are listed on pages 72 to 75.

Shell Bearings

cage guided

Series SCE, SCH
BCE, BCH

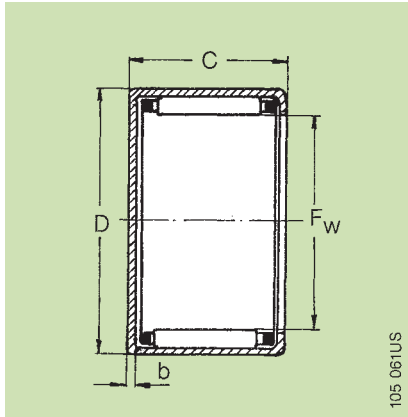


Series SCE, SCH

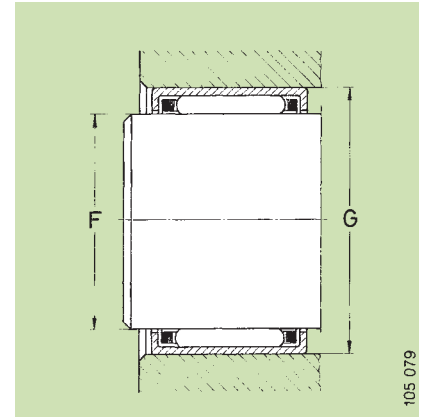
Dimension Table • Dimensions in inch and mm

Shaft Dia.	Part Number open end	Part Number closed end	Bearing Dimensions							
			Inside Diameter ¹⁾		Outside Diameter		Width		End Recess b	
			F_w nom		D nom		C		max	
nom inch		inch	mm	inch	mm	$+0.000$ -0.010 inch	$+0.00$ -0.25 mm	inch	mm	
1 ⁵ / ₁₆	SCE 2110	BCE 2110	1.3125	33.338	1.6250	41.275	.625	15.88	.04	1.1
	SCE 2120	BCE 2120	1.3125	33.338	1.6250	41.275	1.250	31.75	.04	1.1
1 ³ / ₈	SCE 228	BCE 228	1.3750	34.925	1.6250	41.275	.500	12.70	.04	1.1
	SCE 2212	BCE 2212	1.3750	34.925	1.6250	41.275	.750	19.05	.04	1.1
	SCE 2216	BCE 2216	1.3750	34.925	1.6250	41.275	1.000	25.40	.04	1.1
	SCE 2220	BCE 2220	1.3750	34.925	1.6250	41.275	1.250	31.75	.04	1.1
	SCH 228	BCH 228	1.3750	34.925	1.7500	44.450	.500	12.70	.06	1.4
	SCH 2212	BCH 2212	1.3750	34.925	1.7500	44.450	.750	19.05	.06	1.4
	SCH 2216	BCH 2216	1.3750	34.925	1.7500	44.450	1.000	25.40	.06	1.4
1 ¹ / ₂	SCE 248	BCE 248	1.5000	38.100	1.8750	47.625	.500	12.70	.06	1.4
	SCE 2410	BCE 2410	1.5000	38.100	1.8750	47.625	.625	15.88	.06	1.4
	SCE 2412	BCE 2412	1.5000	38.100	1.8750	47.625	.750	19.05	.06	1.4
	SCE 2414	BCE 2414	1.5000	38.100	1.8750	47.625	.875	22.22	.06	1.4
	SCE 2416	BCE 2416	1.5000	38.100	1.8750	47.625	1.000	25.40	.06	1.4
	SCE 2420	BCE 2420	1.5000	38.100	1.8750	47.625	1.250	31.75	.06	1.4
1 ⁵ / ₈	SCE 2610	BCE 2610	1.6250	41.275	2.0000	50.800	.625	15.88	.06	1.4
	SCE 2620	BCE 2620	1.6250	41.275	2.0000	50.800	1.250	31.75	.06	1.4
1 ³ / ₄	SCE 2812	BCE 2812	1.7500	44.450	2.1250	53.975	.750	19.05	.06	1.4
	SCE 2816	BCE 2816	1.7500	44.450	2.1250	53.975	1.000	25.40	.06	1.4
	SCE 2824	BCE 2824	1.7500	44.450	2.1250	53.975	1.500	38.10	.06	1.4
2	SCE 328	BCE 328	2.0000	50.800	2.3750	60.325	.500	12.70	.06	1.4
	SCE 3210	BCE 3210	2.0000	50.800	2.3750	60.325	.625	15.88	.06	1.4
	SCE 3216	BCE 3216	2.0000	50.800	2.3750	60.325	1.000	25.40	.06	1.4
	SCE 3220	BCE 3220	2.0000	50.800	2.3750	60.325	1.250	31.75	.06	1.4
2 ¹ / ₈	SCE 3416	BCE 3416	2.1250	53.975	2.5000	63.500	1.000	25.40	.06	1.4
2 ¹ / ₄	SCE 3612	BCE 3612	2.2500	57.150	2.6250	66.675	.750	19.05	.06	1.4
	SCE 3616	BCE 3616	2.2500	57.150	2.6250	66.675	1.000	25.40	.06	1.4
2 ³ / ₄	SCE 4412	BCE 4412	2.7500	69.850	3.1250	79.375	.750	19.05	.06	1.4
3 ¹ / ₂	SCE 5612	BCE 5612	3.5000	88.900	4.0000	101.600	.750	19.05	.06	1.4

¹⁾ Inspection dimensions are listed on page 46, table 3.



Series BCE, BCH



Mounting dimensions

Load Ratings in lbf		Limiting Speed 2) rpm	Mounting Dimensions in inch and mm								Matching Inner Ring Number 4) order separate
dynamic C	static C ₀		Shaft Diameter 3)				Housing Diameter 3)				
			F		G		inch		mm		
			max	min	max	min	min	max	min	max	
4750	7600	7500	1.3125	1.3120	33.338	33.325	1.6245	1.6255	41.262	41.288	-
10000	19600	7500	1.3125	1.3120	33.338	33.325	1.6245	1.6255	41.262	41.288	-
3050	5300	7500	1.3750	1.3745	34.925	34.912	1.6245	1.6255	41.262	41.288	SI 182208
4800	9600	7500	1.3750	1.3745	34.925	34.912	1.6245	1.6255	41.262	41.288	SI 182212
6200	13300	7500	1.3750	1.3745	34.925	34.912	1.6245	1.6255	41.262	41.288	SI 182216
7600	17300	7500	1.3750	1.3745	34.925	34.912	1.6245	1.6255	41.262	41.288	SI 182220
4050	5400	7000	1.3750	1.3745	34.925	34.912	1.7495	1.7505	44.437	44.463	SI 182208
6600	10100	7000	1.3750	1.3745	34.925	34.912	1.7495	1.7505	44.437	44.463	SI 182212
8800	14700	7000	1.3750	1.3745	34.925	34.912	1.7495	1.7505	44.437	44.463	SI 182216
4200	5800	6500	1.5000	1.4995	38.100	38.087	1.8745	1.8755	47.612	47.638	-
5500	8300	6500	1.5000	1.4995	38.100	38.087	1.8745	1.8755	47.612	47.638	-
6800	10900	6500	1.5000	1.4995	38.100	38.087	1.8745	1.8755	47.612	47.638	-
8100	13500	6500	1.5000	1.4995	38.100	38.087	1.8745	1.8755	47.612	47.638	-
8700	14900	6500	1.5000	1.4995	38.100	38.087	1.8745	1.8755	47.612	47.638	SI 202416
10600	19200	6500	1.5000	1.4995	38.100	38.087	1.8745	1.8755	47.612	47.638	SI 202420
5700	8900	6000	1.6250	1.6245	41.275	41.262	1.9995	2.0005	50.787	50.813	SI 222610
11400	21900	6000	1.6250	1.6245	41.275	41.262	1.9995	2.0005	50.787	50.813	SI 222620
7100	12300	6000	1.7500	1.7495	44.450	44.437	2.1245	2.1255	53.962	53.988	SI 242812
9300	17000	6000	1.7500	1.7495	44.450	44.437	2.1245	2.1255	53.962	53.988	SI 242816
14000	29000	6000	1.7500	1.7495	44.450	44.437	2.1245	2.1255	53.962	53.988	SI 232824
4900	7900	5000	2.0000	1.9994	50.800	50.785	2.3745	2.3755	60.312	60.338	-
6400	11200	5000	2.0000	1.9994	50.800	50.785	2.3745	2.3755	60.312	60.338	-
9300	17900	5000	2.0000	1.9994	50.800	50.785	2.3745	2.3755	60.312	60.338	SI 273216
12400	26000	5000	2.0000	1.9994	50.800	50.785	2.3745	2.3755	60.312	60.338	SI 273220
11200	23200	4900	2.1250	2.1244	53.975	53.960	2.4995	2.5005	63.487	63.513	-
8400	16200	4600	2.2500	2.2494	57.150	57.135	2.6245	2.6255	66.662	66.688	-
11300	24000	4600	2.2500	2.2494	57.150	57.135	2.6245	2.6255	66.662	66.688	-
8800	18300	3800	2.7500	2.7494	69.850	69.835	3.1245	3.1255	79.362	79.388	-
11900	23200	3000	3.5000	3.4994	88.900	88.885	3.9995	4.0005	101.587	101.613	-

2) Limiting speeds shown apply for oil lubrication. With grease lubrication 60% of the given values are permissible.

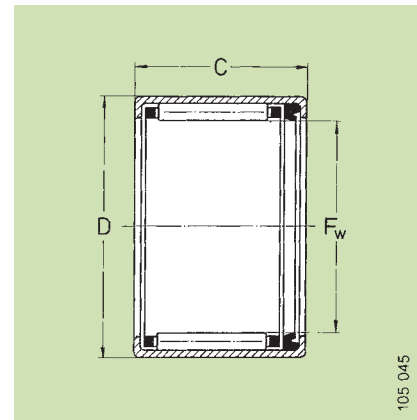
3) For non-ferrous housing recommendations refer to page 44, table 1.

4) Dimensions are listed on pages 72 to 75.

Sealed Shell Bearings

cage guided

Series SCE...P, SCH...P
SCE...PP, SCH...PP
BCE...P, BCH...P

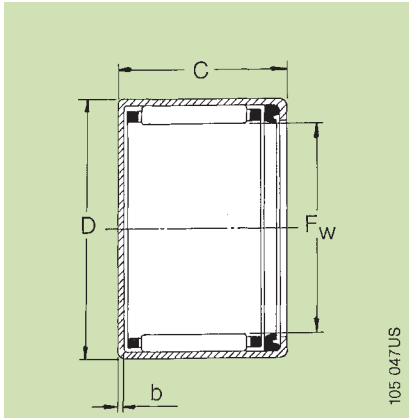


Series SCE...P, SCH...P

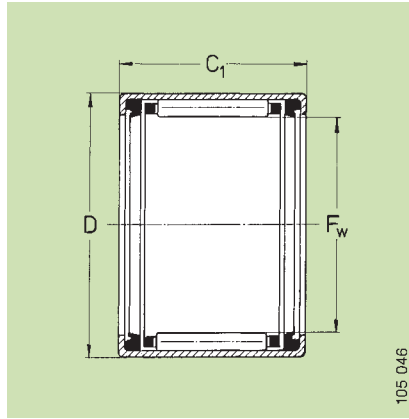
Dimension Table • Dimensions in inch and mm

Shaft Dia. nom inch	Part Number			Bearing Dimensions									
	one seal open end	one seal closed end	two seals open end	Inside Diameter F_w ¹⁾ nom		Outside Diameter D nom		Width one seal C		Width two seals C ₁		End Recess b max	
				inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
1/4	SCE 45 P	BCE 45 P	SCE 46 PP	.2500	6.350	.4375	11.112	.312	7.94	.375	9.52	.04	1.0
	SCE 46 P	BCE 46 P	SCE 47 PP	.2500	6.350	.4375	11.112	.375	9.52	.438	11.11	.04	1.0
	SCE 48 P	BCE 48 P	SCE 49 PP	.2500	6.350	.4375	11.112	.500	12.70	.562	14.29	.04	1.0
5/16	SCE 56 P	BCE 56 P	SCE 57 PP	.3125	7.938	.5000	12.700	.375	9.52	.438	11.11	.04	1.0
	SCE 58 P	BCE 58 P	SCE 59 PP	.3125	7.938	.5000	12.700	.500	12.70	.562	14.29	.04	1.0
3/8	SCE 66 P	BCE 66 P	SCE 67 PP	.3750	9.525	.5625	14.288	.375	9.52	.438	11.11	.04	1.0
	SCE 67 P	BCE 67 P	SCE 68 PP	.3750	9.525	.5625	14.288	.438	11.11	.500	12.70	.04	1.0
	SCE 69 P	BCE 69 P	SCE 610 PP	.3750	9.525	.5625	14.288	.562	14.29	.625	15.88	.04	1.0
7/16	SCH 79 P	BCH 79 P	SCH 710 PP	.4375	11.112	.6875	17.462	.562	14.29	.625	15.88	.04	1.1
1/2	SCE 86 P	BCE 86 P	SCE 87 PP	.5000	12.700	.6875	17.462	.375	9.52	.438	11.11	.04	1.0
	SCE 87 P	BCE 87 P	SCE 88 PP	.5000	12.700	.6875	17.462	.438	11.11	.500	12.70	.04	1.0
	SCE 88 P	BCE 88 P	SCE 89 PP	.5000	12.700	.6875	17.462	.500	12.70	.562	14.29	.04	1.0
	SCE 89 P	BCE 89 P	SCE 810 PP	.5000	12.700	.6875	17.462	.562	14.29	.625	15.88	.04	1.0
	SCE 811 P	BCE 811 P	SCE 812 PP	.5000	12.700	.6875	17.462	.688	17.46	.750	19.05	.04	1.0
	SCE 813 P	BCE 813 P	SCE 814 PP	.5000	12.700	.6875	17.462	.812	20.64	.875	22.22	.04	1.0
	SCH 813 P	BCH 813 P	SCH 814 PP	.5000	12.700	.7500	19.050	.812	20.64	.875	22.22	.04	1.1
9/16	SCE 96 P	BCE 96 P	SCE 97 PP	.5625	14.288	.7500	19.050	.375	9.52	.438	11.11	.04	1.0
	SCE 97 P	BCE 97 P	SCE 98 PP	.5625	14.288	.7500	19.050	.438	11.11	.500	12.70	.04	1.0
	SCE 98 P	BCE 98 P	SCE 99 PP	.5625	14.288	.7500	19.050	.500	12.70	.562	14.29	.04	1.0
	SCE 99 P	BCE 99 P	SCE 910 PP	.5625	14.288	.7500	19.050	.562	14.29	.625	15.88	.04	1.0
	SCE 911 P	BCE 911 P	SCE 912 PP	.5625	14.288	.7500	19.050	.688	17.46	.750	19.05	.04	1.0
	SCH 913 P	BCH 913 P	SCH 914 PP	.5625	14.288	.8125	20.638	.812	20.64	.875	22.22	.04	1.1
5/8	SCE 108 P	BCE 108 P	SCE 109 PP	.6250	15.875	.8125	20.638	.500	12.70	.562	14.29	.04	1.0
	SCE 109 P	BCE 109 P	SCE 1010 PP	.6250	15.875	.8125	20.638	.562	14.29	.625	15.88	.04	1.0
	SCE 1011 P	BCE 1011 P	SCE 1012 PP	.6250	15.875	.8125	20.638	.688	17.46	.750	19.05	.04	1.0
	SCE 1013 P	BCE 1013 P	SCE 1014 PP	.6250	15.875	.8125	20.638	.812	20.64	.875	22.22	.04	1.0

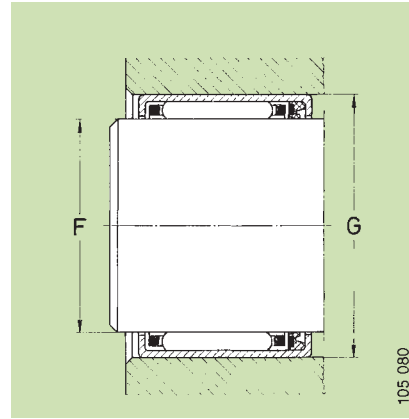
¹⁾ Inspection dimensions are listed on page 46, table 3.



Series BCE...P, BCH...P



Series SCE...PP, SCH...PP



Mounting dimensions

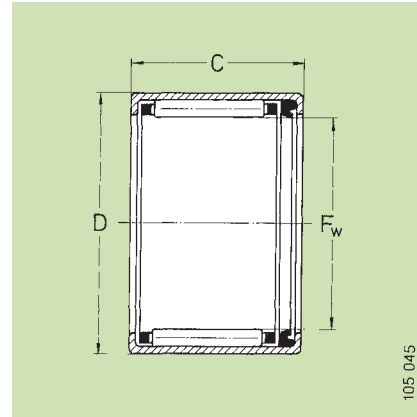
Load Ratings in lbf		Limiting Speed 2)	Mounting Dimensions in inch and mm								Matching Inner Ring Number 4)	
dynamic C	static C ₀		Shaft Diameter ³⁾				Housing Diameter ³⁾				one seal	two seals
			F		G							
		rpm	inch max	inch min	mm max	mm min	inch min	inch max	mm min	mm max		
360	260	35000	.2500	.2495	6.350	6.337	.4370	.4380	11.100	11.125	-	-
570	470	35000	.2500	.2495	6.350	6.337	.4370	.4380	11.100	11.125	-	-
920	870	35000	.2500	.2495	6.350	6.337	.4370	.4380	11.100	11.125	-	-
650	590	29000	.3125	.3120	7.938	7.925	.4995	.5005	12.687	12.713	-	-
1060	1090	29000	.3125	.3120	7.938	7.925	.4995	.5005	12.687	12.713	-	-
650	610	25000	.3750	.3745	9.525	9.512	.5620	.5630	14.275	14.300	-	-
870	890	25000	.3750	.3745	9.525	9.512	.5620	.5630	14.275	14.300	-	-
1300	1490	25000	.3750	.3745	9.525	9.512	.5620	.5630	14.275	14.300	-	-
1760	1840	21000	.4375	.4370	11.112	11.100	.6870	.6880	17.450	17.475	-	-
820	890	19000	.5000	.4995	12.700	12.687	.6870	.6880	17.450	17.475	-	-
1040	1210	19000	.5000	.4995	12.700	12.687	.6870	.6880	17.450	17.475	-	SI 050808
1330	1660	19000	.5000	.4995	12.700	12.687	.6870	.6880	17.450	17.475	SI 050808	-
1550	2030	19000	.5000	.4995	12.700	12.687	.6870	.6880	17.450	17.475	-	SI 050810
1980	2750	19000	.5000	.4995	12.700	12.687	.6870	.6880	17.450	17.475	-	-
2230	3200	19000	.5000	.4995	12.700	12.687	.6870	.6880	17.450	17.475	-	-
2850	3500	19000	.5000	.4995	12.700	12.687	.7495	.7505	19.037	19.063	-	-
910	1060	18000	.5625	.5620	14.288	14.275	.7495	.7505	19.037	19.063	-	-
1160	1440	18000	.5625	.5620	14.288	14.275	.7495	.7505	19.037	19.063	-	SI 060908
1480	1980	18000	.5625	.5620	14.288	14.275	.7495	.7505	19.037	19.063	SI 060908	-
1730	2420	18000	.5625	.5620	14.288	14.275	.7495	.7505	19.037	19.063	-	-
2120	3150	18000	.5625	.5620	14.288	14.275	.7495	.7505	19.037	19.063	-	SI 060912
3250	4300	17000	.5625	.5620	14.288	14.275	.8120	.8130	20.625	20.650	-	-
1560	2200	16000	.6250	.6245	15.875	15.862	.8120	.8130	20.625	20.650	SI 061008	-
1830	2700	16000	.6250	.6245	15.875	15.862	.8120	.8130	20.625	20.650	-	SI 061010
2330	3650	16000	.6250	.6245	15.875	15.862	.8120	.8130	20.625	20.650	-	SI 061012
2700	4450	16000	.6250	.6245	15.875	15.862	.8120	.8130	20.625	20.650	-	-

2) Limiting speeds shown apply for grease lubrication.
 3) For non-ferrous housing recommendations refer to page 44, table 1.
 4) Dimensions are listed on pages 72 to 75.

Sealed Shell Bearings

cage guided

Series SCE...P, SCH...P
SCE...PP, SCH...PP
BCE...P, BCH...P

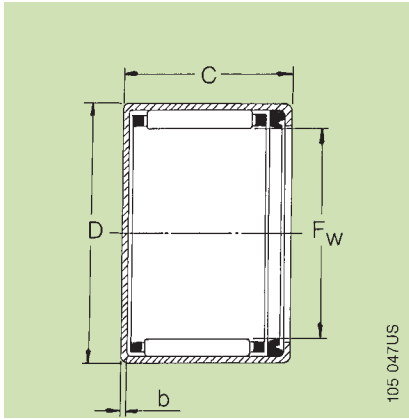


Series SCE...P, SCH...P

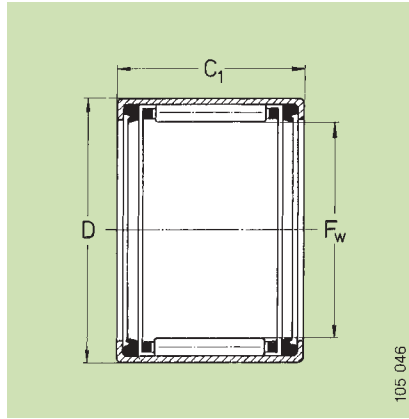
Dimension Table • Dimensions in inch and mm

Shaft Dia. nom inch	Part Number			Bearing Dimensions									
	one seal open end	one seal closed end	two seals open end	Inside Diameter $F_w^{1)}$ nom		Outside Diameter D nom		Width one seal C		Width two seals C_1		End Recess b max	
				inch	mm	inch	mm	+0.000 -0.010 inch	+0.00 -0.25 mm	+0.000 -0.010 inch	+0.00 -0.25 mm	inch	mm
3/4	SCE 127 P	BCE 128 P	SCE 128 PP	.7500	19.050	1.0000	25.400	.438	11.11	.500	12.70	.04	1.0
	SCE 129 P	BCE 129 P	SCE 1210 PP	.7500	19.050	1.0000	25.400	.562	14.29	.625	15.88	.04	1.0
	SCE 1211 P	BCE 1211 P	SCE 1212 PP	.7500	19.050	1.0000	25.400	.688	17.46	.750	19.05	.04	1.0
	SCE 1213 P	BCE 1213 P	SCE 1214 PP	.7500	19.050	1.0000	25.400	.812	20.64	.875	22.22	.04	1.0
7/8	SCE 147 P	BCE 147 P	SCE 148 PP	.8750	22.225	1.1250	28.575	.438	11.11	.500	12.70	.04	1.1
	SCE 149 P	BCE 149 P	SCE 1410 PP	.8750	22.225	1.1250	28.575	.562	14.29	.625	15.88	.04	1.1
	SCE 1417 P	BCE 1417 P	SCE 1418 PP	.8750	22.225	1.1250	28.575	1.062	26.99	1.125	28.58	.04	1.1
	SCH1413 P	BCH1413 P	SCH 1414 PP	.8750	22.225	1.1875	30.162	.812	20.64	.875	22.22	.05	1.3
1	SCE 1610 P	BCE 1610 P	SCE 1612 PP	1.0000	25.400	1.2500	31.750	.625	15.88	.750	19.05	.04	1.1
	SCE 1614 P	BCE 1614 P	SCE 1616 PP	1.0000	25.400	1.2500	31.750	.875	22.22	1.000	25.40	.04	1.1
	SCH1614 P	BCH1614 P	SCH 1616 PP	1.0000	25.400	1.3125	33.338	.875	22.22	1.000	25.40	.05	1.3
1 1/8	SCE 1810 P	BCE 1810 P	SCE 1812 PP	1.1250	28.575	1.3750	34.925	.625	15.88	.750	19.05	.04	1.1
	SCE 1812 P	BCE 1812 P	SCE 1814 PP	1.1250	28.575	1.3750	34.925	.750	19.05	.875	22.22	.04	1.1
	SCE 1814 P	BCE 1814 P	SCE 1816 PP	1.1250	28.575	1.3750	34.925	.875	22.22	1.000	25.40	.04	1.1
1 1/4	SCE 2010 P	BCE 2010 P	SCE 2012 PP	1.2500	31.750	1.5000	38.100	.625	15.88	.750	19.05	.04	1.1
	SCE 2014 P	BCE 2014 P	SCE 2016 PP	1.2500	31.750	1.5000	38.100	.875	22.22	1.000	25.40	.04	1.1
	SCE 2018 P	BCE 2018 P	SCE 2020 PP	1.2500	31.750	1.5000	38.100	1.125	28.58	1.250	31.75	.04	1.1
	SCH2018 P	BCH2018 P	SCH 2020 PP	1.2500	31.750	1.6250	41.275	1.125	28.58	1.250	31.75	.06	1.4
1 3/8	SCE 2210 P	BCE 2210 P	SCE 2212 PP	1.3750	34.925	1.6250	41.275	.625	15.88	.750	19.05	.04	1.1
	SCE 2214 P	BCE 2214 P	SCE 2216 PP	1.3750	34.925	1.6250	41.275	.875	22.22	1.000	25.40	.04	1.1
	SCE 2218 P	BCE 2218 P	SCE 2220 PP	1.3750	34.925	1.6250	41.275	1.125	28.58	1.250	31.75	.04	1.1
1 1/2	SCE 2410 P	BCE 2410 P	SCE 2412 PP	1.5000	38.100	1.8750	47.625	.625	15.88	.750	19.05	.06	1.4
	SCE 2412 P	BCE 2412 P	SCE 2414 PP	1.5000	38.100	1.8750	47.625	.750	19.05	.875	22.22	.06	1.4
	SCE 2414 P	BCE 2414 P	SCE 2416 PP	1.5000	38.100	1.8750	47.625	.875	22.22	1.000	25.40	.06	1.4
	SCE 2416 P	BCE 2416 P	SCE 2418 PP	1.5000	38.100	1.8750	47.625	1.000	25.40	1.125	28.58	.06	1.4
	SCE 2418 P	BCE 2418 P	SCE 2420 PP	1.5000	38.100	1.8750	47.625	1.125	28.58	1.250	31.75	.06	1.4
	SCE 2422 P	BCE 2422 P	SCE 2424 PP	1.5000	38.100	1.8750	47.625	1.375	34.92	1.500	38.10	.06	1.4

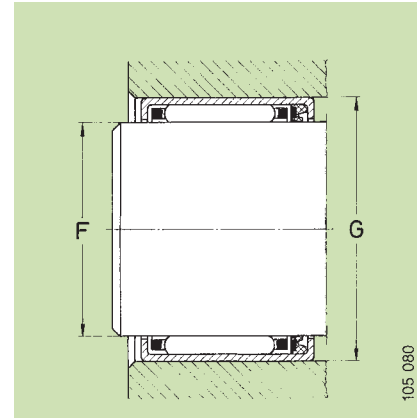
¹⁾ Inspection dimensions are listed on page 46, table 3.



Series BCE...P, BCH...P



Series SCE...PP, SCH...PP



Mounting dimensions

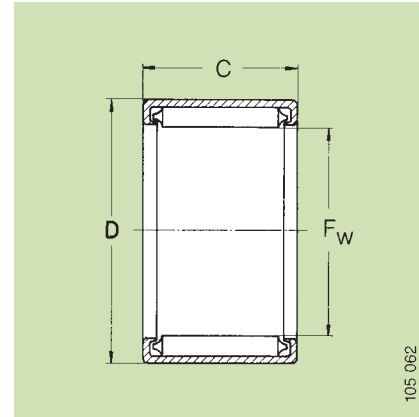
Load Ratings in lbf		Limiting Speed 2)	Mounting Dimensions in inch and mm								Matching Inner Ring Number 4)	
dynamic C	static C ₀		Shaft Diameter ³⁾				Housing Diameter ³⁾				one_seal	two seals
			F		G							
		rpm	inch	mm	inch	mm	inch	mm				
			max	min	max	min	min	max	min	max		
1600	1860	13000	.7500	.7495	19.050	19.037	.9995	1.0005	25.387	25.413	-	SI 081208
2210	2800	13000	.7500	.7495	19.050	19.037	.9995	1.0005	25.387	25.413	-	SI 081210
2850	3950	13000	.7500	.7495	19.050	19.037	.9995	1.0005	25.387	25.413	-	SI 081212
3450	5000	13000	.7500	.7495	19.050	19.037	.9995	1.0005	25.387	25.413	-	-
1850	2400	11000	.8750	.8745	22.225	22.212	1.1245	1.1255	28.562	28.588	-	SI 101408
2500	3550	11000	.8750	.8745	22.225	22.212	1.1245	1.1255	28.562	28.588	-	-
4950	8500	11000	.8750	.8745	22.225	22.212	1.1245	1.1255	28.562	28.588	-	-
4350	6000	11000	.8750	.8745	22.225	22.212	1.1870	1.1880	30.150	30.175	-	-
2850	4300	10000	1.0000	.9995	25.400	25.387	1.2495	1.2505	31.737	31.763	-	SI 121612
4050	6800	10000	1.0000	.9995	25.400	25.387	1.2495	1.2505	31.737	31.763	-	SI 121616
4500	6400	10000	1.0000	.9995	25.400	25.387	1.3120	1.3130	33.325	33.350	-	SI 121616
2900	4550	9000	1.1250	1.1245	28.575	28.562	1.3745	1.3755	34.912	34.938	-	SI 141812
3400	5600	9000	1.1250	1.1245	28.575	28.562	1.3745	1.3755	34.912	34.938	SI 141812	-
4250	7500	9000	1.1250	1.1245	28.575	28.562	1.3745	1.3755	34.912	34.938	-	SI 141816
3000	4950	8000	1.2500	1.2495	31.750	31.737	1.4995	1.5005	38.087	38.113	-	SI 162012
4750	8900	8000	1.2500	1.2495	31.750	31.737	1.4995	1.5005	38.087	38.113	-	SI 162016
6100	12300	8000	1.2500	1.2495	31.750	31.737	1.4995	1.5005	38.087	38.113	-	SI 162020
8200	13100	8000	1.2500	1.2495	31.750	31.737	1.6245	1.6255	41.262	41.288	-	SI 162020
3050	5300	7500	1.3750	1.3745	34.925	34.912	1.6245	1.6255	41.262	41.288	-	SI 182212
4800	9600	7500	1.3750	1.3745	34.925	34.912	1.6245	1.6255	41.262	41.288	-	SI 182216
6200	13300	7500	1.3750	1.3745	34.925	34.912	1.6245	1.6255	41.262	41.288	-	SI 182220
4200	5800	6500	1.5000	1.4995	38.100	38.087	1.8745	1.8755	47.612	47.638	-	-
5500	8300	6500	1.5000	1.4995	38.100	38.087	1.8745	1.8755	47.612	47.638	-	-
6800	10900	6500	1.5000	1.4995	38.100	38.087	1.8745	1.8755	47.612	47.638	-	SI 202416
8100	13500	6500	1.5000	1.4995	38.100	38.087	1.8745	1.8755	47.612	47.638	SI 202416	-
8700	14900	6500	1.5000	1.4995	38.100	38.087	1.8745	1.8755	47.612	47.638	-	SI 202420
10600	19200	6500	1.5000	1.4995	38.100	38.087	1.8745	1.8755	47.612	47.638	-	-

2) Limiting speeds shown apply for grease lubrication.
 3) For non-ferrous housing recommendations refer to page 44, table 1.
 4) Dimensions are listed on pages 72 to 75.

Shell Bearings

full complement
mechanically retained

Series S, SH
CS, CSH

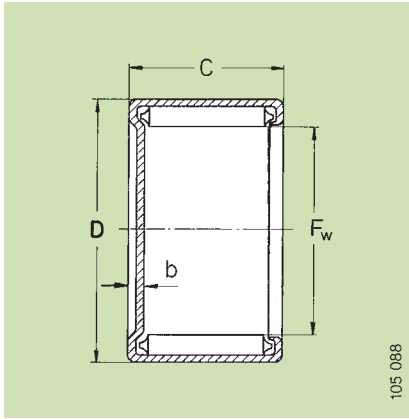


Series S, SH

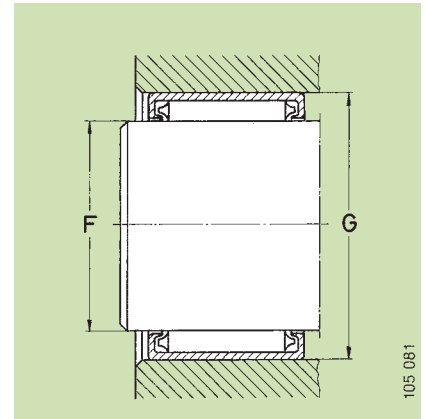
Dimension Table • Dimensions in inch and mm

Shaft Dia. nom inch	Part Number open end	Part Number closed end	Bearing Dimensions							
			Inside Diameter ¹⁾ F _w		Outside Diameter D		Width C		End Recess b	
			inch	mm	inch	mm	^{+0.000} -0.010 inch	^{+0.00} -0.25 mm	max inch	max mm
3/16	S 34	CS 34	.1875	4.762	.3438	8.731	.250	6.35	.07	1.7
	S 36	CS 36	.1875	4.762	.3438	8.731	.375	9.52	.07	1.7
1/4	S 44	CS 44	.2500	6.350	.4375	11.112	.250	6.35	.08	2.0
	S 45	CS 45	.2500	6.350	.4375	11.112	.312	7.94	.08	2.0
	S 47	CS 47	.2500	6.350	.4375	11.112	.438	11.11	.08	2.0
5/16	S 55	CS 55	.3125	7.938	.5000	12.700	.312	7.94	.08	2.0
	S 57	CS 57	.3125	7.938	.5000	12.700	.438	11.11	.08	2.0
	S 59	CS 59	.3125	7.938	.5000	12.700	.562	14.29	.08	2.0
	SH 59	CSH 59	.3125	7.938	.5625	14.288	.562	14.29	.09	2.4
3/8	S 65	CS 65	.3750	9.525	.5625	14.288	.312	7.94	.08	2.0
	S 66	CS 66	.3750	9.525	.5625	14.288	.375	9.52	.08	2.0
	S 68	CS 68	.3750	9.525	.5625	14.288	.500	12.70	.08	2.0
	S 610	CS 610	.3750	9.525	.5625	14.288	.625	15.88	.08	2.0
	SH 68	CSH 68	.3750	9.525	.6250	15.875	.500	12.70	.09	2.4
7/16	S 78	CS 78	.4375	11.112	.6250	15.875	.500	12.70	.08	2.0
	S 710	CS 710	.4375	11.112	.6250	15.875	.625	15.88	.08	2.0
1/2	S 85	CS 85	.5000	12.700	.6875	17.462	.312	7.94	.08	2.0
	S 87	CS 87	.5000	12.700	.6875	17.462	.438	11.11	.08	2.0
	S 88	CS 88	.5000	12.700	.6875	17.462	.500	12.70	.08	2.0
	S 810	CS 810	.5000	12.700	.6875	17.462	.625	15.88	.08	2.0
	S 812	CS 812	.5000	12.700	.6875	17.462	.750	19.05	.08	2.0
	SH 812	CSH 812	.5000	12.700	.7500	19.050	.750	19.05	.09	2.4
9/16	S 97	CS 97	.5625	14.288	.7500	19.050	.438	11.11	.08	2.0
	S 98	CS 98	.5625	14.288	.7500	19.050	.500	12.70	.08	2.0
5/8	S 107	CS 107	.6250	15.875	.8125	20.638	.438	11.11	.08	2.0
	S 108	CS 108	.6250	15.875	.8125	20.638	.500	12.70	.08	2.0
	S 1012	CS 1012	.6250	15.875	.8125	20.638	.750	19.05	.08	2.0
	SH 108	CSH 108	.6250	15.875	.8750	22.225	.500	12.70	.09	2.4

¹⁾ Inspection dimensions are listed on page 46, table 3.



Series CS, CSH



Mounting dimensions

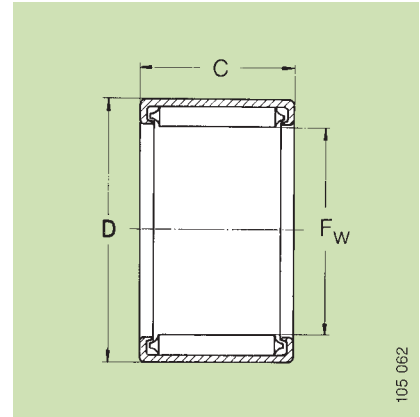
Load Ratings in lbf		Limiting Speed 2) rpm	Mounting Dimensions in inch and mm								Matching Inner Ring Number 4) order separate
dynamic C	static C ₀		Shaft Diameter 3)				Housing Diameter 3)				
			F		G		inch		mm		
			max	min	max	min	min	max	min	max	
540	530	19000	.1875	.1872	4.762	4.755	.3432	.3437	8.717	8.730	-
870	960	19000	.1875	.1872	4.762	4.755	.3432	.3437	8.717	8.730	-
590	580	15000	.2500	.2495	6.350	6.337	.4370	.4380	11.100	11.125	-
820	880	15000	.2500	.2495	6.350	6.337	.4370	.4380	11.100	11.125	-
1230	1490	15000	.2500	.2495	6.350	6.337	.4370	.4380	11.100	11.125	-
940	1100	12000	.3125	.3120	7.938	7.925	.4995	.5005	12.687	12.713	-
1420	1860	12000	.3125	.3120	7.938	7.925	.4995	.5005	12.687	12.713	-
1870	2650	12000	.3125	.3120	7.938	7.925	.4995	.5005	12.687	12.713	-
2000	2430	12000	.3125	.3120	7.938	7.925	.5620	.5630	14.275	14.300	-
1050	1320	11000	.3750	.3745	9.525	9.512	.5620	.5630	14.275	14.300	-
1310	1770	11000	.3750	.3745	9.525	9.512	.5620	.5630	14.275	14.300	-
1830	2700	11000	.3750	.3745	9.525	9.512	.5620	.5630	14.275	14.300	-
2300	3500	11000	.3750	.3745	9.525	9.512	.5620	.5630	14.275	14.300	-
2020	2550	10000	.3750	.3745	9.525	9.512	.6245	.6255	15.862	15.888	-
2000	3150	9500	.4375	.4370	11.112	11.100	.6245	.6255	15.862	15.888	-
2500	4250	9500	.4375	.4370	11.112	11.100	.6245	.6255	15.862	15.888	-
1240	1770	8500	.5000	.4995	12.700	12.687	.6870	.6880	17.450	17.475	-
1860	3000	8500	.5000	.4995	12.700	12.687	.6870	.6880	17.450	17.475	-
2160	3600	8500	.5000	.4995	12.700	12.687	.6870	.6880	17.450	17.475	SI 050808
2700	4850	8500	.5000	.4995	12.700	12.687	.6870	.6880	17.450	17.475	SI 050810
3250	6100	8500	.5000	.4995	12.700	12.687	.6870	.6880	17.450	17.475	-
3700	5800	8000	.5000	.4995	12.700	12.687	.7495	.7505	19.037	19.063	-
1980	3350	7500	.5625	.5620	14.288	14.275	.7495	.7505	19.037	19.063	-
2300	4050	7500	.5625	.5620	14.288	14.275	.7495	.7505	19.037	19.063	SI 060908
2100	3750	7000	.6250	.6245	15.875	15.862	.8120	.8130	20.625	20.650	-
2440	4500	7000	.6250	.6245	15.875	15.862	.8120	.8130	20.625	20.650	SI 061008
3650	7600	7000	.6250	.6245	15.875	15.862	.8120	.8130	20.625	20.650	SI 061012
2750	4200	6500	.6250	.6245	15.875	15.862	.8745	.8755	22.212	22.238	SI 061008

2) Limiting speeds shown apply for oil lubrication. With grease lubrication 60% of the given values are permissible.
 3) For non-ferrous housing recommendations refer to page 44, table 1.
 4) Dimensions are listed on pages 72 to 75.

Shell Bearings

full complement
mechanically retained

Series S, SH
CS, CSH

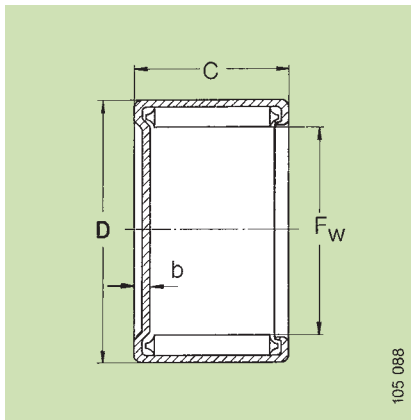


Series S, SH

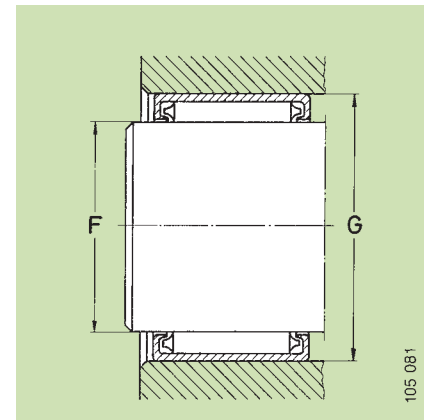
Dimension Table • Dimensions in inch and mm

Shaft Dia. nom inch	Part Number open end	Part Number closed end	Bearing Dimensions							
			Inside Diameter ¹⁾ F _w		Outside Diameter D		Width C		End Recess b max	
			inch	mm	inch	mm	$\begin{matrix} +0.000 \\ -0.010 \end{matrix}$ inch	$\begin{matrix} +0.00 \\ -0.25 \end{matrix}$ mm	inch	mm
1 ^{1/16}	S 116	CS 116	.6875	17.462	.8750	22.225	.375	9.52	.08	2.0
	S 118	CS 118	.6875	17.462	.8750	22.225	.500	12.70	.08	2.0
	S 1110	CS 1110	.6875	17.462	.8750	22.225	.625	15.88	.08	2.0
	S 1112	CS 1112	.6875	17.462	.8750	22.225	.750	19.05	.08	2.0
3/4	S 126	CS 126	.7500	19.050	1.0000	25.400	.375	9.52	.09	2.4
	S 128	CS 128	.7500	19.050	1.0000	25.400	.500	12.70	.09	2.4
	S 1210	CS 1210	.7500	19.050	1.0000	25.400	.625	15.88	.09	2.4
	S 1212	CS 1212	.7500	19.050	1.0000	25.400	.750	19.05	.09	2.4
1 ^{3/16}	S 1312	CS 1312	.8125	20.638	1.0625	26.988	.750	19.05	.09	2.4
	S 1316	CS 1316	.8125	20.638	1.0625	26.988	1.000	25.40	.09	2.4
7/8	S 146	CS 146	.8750	22.225	1.1250	28.575	.375	9.52	.10	2.5
	S 148	CS 148	.8750	22.225	1.1250	28.575	.500	12.70	.10	2.5
	S 1412	CS 1412	.8750	22.225	1.1250	28.575	.750	19.05	.10	2.5
	S 1416	CS 1416	.8750	22.225	1.1250	28.575	1.000	25.40	.10	2.5
1	S 168	CS 168	1.0000	25.400	1.2500	31.750	.500	12.70	.10	2.5
	S 1612	CS 1612	1.0000	25.400	1.2500	31.750	.750	19.05	.10	2.5
	S 1616	CS 1616	1.0000	25.400	1.2500	31.750	1.000	25.40	.10	2.5
	SH 1612	CSH 1612	1.0000	25.400	1.3125	33.338	.750	19.05	.11	2.7
1 ^{1/16}	S 1710	CS 1710	1.0625	26.988	1.3125	33.338	.625	15.88	.10	2.5
1 ^{1/8}	S 188	CS 188	1.1250	28.575	1.3750	34.925	.500	12.70	.10	2.5
	S 1812	CS 1812	1.1250	28.575	1.3750	34.925	.750	19.05	.10	2.5
	S 1816	CS 1816	1.1250	28.575	1.3750	34.925	1.000	25.40	.10	2.5
1 ^{1/4}	S 2012	CS 2012	1.2500	31.750	1.5000	38.100	.750	19.05	.10	2.5
	S 2016	CS 2016	1.2500	31.750	1.5000	38.100	1.000	25.40	.10	2.5
	S 2020	CS 2020	1.2500	31.750	1.5000	38.100	1.250	31.75	.10	2.5
	SH 2020	CSH 2020	1.2500	31.750	1.6250	41.275	1.250	31.75	.14	3.5

¹⁾ Inspection dimensions are listed on page 46, table 3.



Series CS, CSH



Mounting dimensions

Load Ratings in lbf		Limiting Speed ²⁾ rpm	Mounting Dimensions in inch and mm								Matching Inner Ring Number ⁴⁾ order separate
dynamic C	static C ₀		Shaft Diameter ³⁾ F				Housing Diameter ³⁾ G				
			inch		mm		inch		mm		
			max	min	max	min	min	max	min	max	
1840	3250	6500	.6875	.6870	17.462	17.450	.8745	.8755	22.212	22.238	-
2550	5000	6500	.6875	.6870	17.462	17.450	.8745	.8755	22.212	22.238	-
3200	6700	6500	.6875	.6870	17.462	17.450	.8745	.8755	22.212	22.238	-
3850	8400	6500	.6875	.6870	17.462	17.450	.8745	.8755	22.212	22.238	-
2190	3250	5500	.7500	.7495	19.050	19.037	.9995	1.0005	25.387	25.413	-
3200	5200	5500	.7500	.7495	19.050	19.037	.9995	1.0005	25.387	25.413	SI 081208
4000	7000	5500	.7500	.7495	19.050	19.037	.9995	1.0005	25.387	25.413	SI 081210
4800	8900	5500	.7500	.7495	19.050	19.037	.9995	1.0005	25.387	25.413	SI 081212
5000	9700	5000	.8125	.8120	20.638	20.625	1.0620	1.0630	26.975	27.000	-
6600	13700	5000	.8125	.8120	20.638	20.625	1.0620	1.0630	26.975	27.000	-
2310	3700	4900	.8750	.8745	22.225	22.212	1.1245	1.1255	28.562	28.588	SI 101406
3300	5900	4900	.8750	.8745	22.225	22.212	1.1245	1.1255	28.562	28.588	SI 101408
5100	10300	4900	.8750	.8745	22.225	22.212	1.1245	1.1255	28.562	28.588	SI 101412
6700	14600	4900	.8750	.8745	22.225	22.212	1.1245	1.1255	28.562	28.588	SI 101416
3600	6800	4300	1.0000	.9995	25.400	25.387	1.2495	1.2505	31.737	31.763	SI 121608
5500	11800	4300	1.0000	.9995	25.400	25.387	1.2495	1.2505	31.737	31.763	SI 121612
7300	16800	4300	1.0000	.9995	25.400	25.387	1.2495	1.2505	31.737	31.763	SI 121616
6100	11200	4200	1.0000	.9995	25.400	25.387	1.3120	1.3130	33.325	33.350	SI 121612
4750	9900	4100	1.0625	1.0620	26.988	26.975	1.3120	1.3130	33.325	33.350	-
3800	7600	3900	1.1250	1.1245	28.575	28.562	1.3745	1.3755	34.912	34.938	SI 141808
5900	13300	3900	1.1250	1.1245	28.575	28.562	1.3745	1.3755	34.912	34.938	SI 141812
7700	18900	3900	1.1250	1.1245	28.575	28.562	1.3745	1.3755	34.912	34.938	SI 141816
6200	14800	3500	1.2500	1.2495	31.750	31.737	1.4995	1.5005	38.087	38.113	SI 162012
8200	21000	3500	1.2500	1.2495	31.750	31.737	1.4995	1.5005	38.087	38.113	SI 162016
10000	27000	3500	1.2500	1.2495	31.750	31.737	1.4995	1.5005	38.087	38.113	SI 162020
12000	25000	3400	1.2500	1.2495	31.750	31.737	1.6245	1.6255	41.262	41.288	SI 162020

2) Limiting speeds shown apply for oil lubrication. With grease lubrication 60% of the given values are permissible.

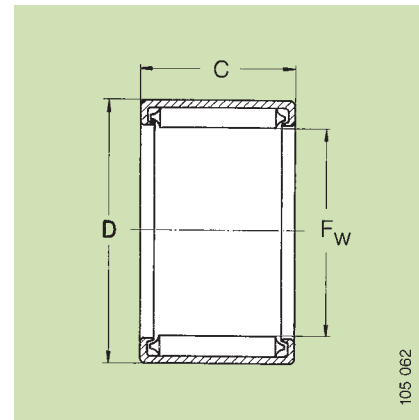
3) For non-ferrous housing recommendations refer to page 44, table 1.

4) Dimensions are listed on pages 72 to 75.

Shell Bearings

full complement
mechanically retained

Series S, SH
CS, CSH



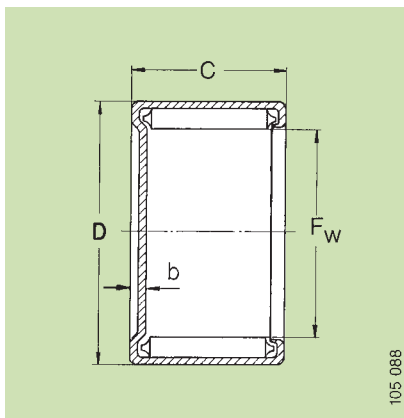
Series S, SH

105 062

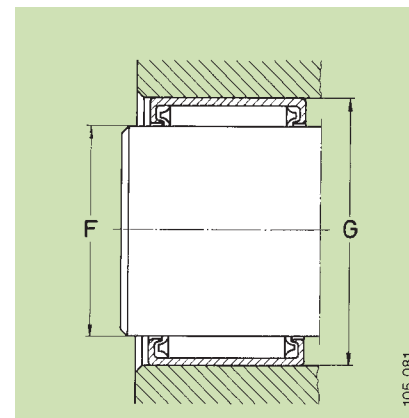
Dimension Table • Dimensions in inch and mm

Shaft Dia. nom inch	Part Number open end	Part Number closed end	Bearing Dimensions							
			Inside Diameter ¹⁾ F_w		Outside Diameter D		Width C		End Recess b	
			nom inch	mm	nom inch	mm	$+0.000$ -0.010 inch	$+0.00$ -0.25 mm	max inch	mm
1 ³ / ₈	S 228	CS 228	1.3750	34.925	1.6250	41.275	.500	12.70	.10	2.5
	S 2212	CS 2212	1.3750	34.925	1.6250	41.275	.750	19.05	.10	2.5
	S 2220	CS 2220	1.3750	34.925	1.6250	41.275	1.250	31.75	.10	2.5
	SH 2212	CSH2212	1.3750	34.925	1.7500	44.450	.750	19.05	.14	3.5
1 ¹ / ₂	S 248	CS 248	1.5000	38.100	1.8750	47.625	.500	12.70	.13	3.4
	S 2414	CS 2414	1.5000	38.100	1.8750	47.625	.875	22.22	.13	3.4
	S 2416	CS 2416	1.5000	38.100	1.8750	47.625	1.000	25.40	.13	3.4
	S 2420	CS 2420	1.5000	38.100	1.8750	47.625	1.250	31.75	.13	3.4
1 ⁵ / ₈	S 2610	CS 2610	1.6250	41.275	2.0000	50.800	.625	15.88	.13	3.4
1 ³ / ₄	S 2812	CS 2812	1.7500	44.450	2.1250	53.975	.750	19.05	.14	3.5
	S 2816	CS 2816	1.7500	44.450	2.1250	53.975	1.000	25.40	.14	3.5
	S 2824	CS 2824	1.7500	44.450	2.1250	53.975	1.500	38.10	.14	3.5
1 ⁷ / ₈	S 308	CS 308	1.8750	47.625	2.2500	57.150	.500	12.70	.14	3.5
	S 3010	CS 3010	1.8750	47.625	2.2500	57.150	.625	15.88	.14	3.5
	S 3012	CS 3012	1.8750	47.625	2.2500	57.150	.750	19.05	.14	3.5
	S 3016	CS 3016	1.8750	47.625	2.2500	57.150	1.000	25.40	.14	3.5
2	S 3216	CS 3216	2.0000	50.800	2.3750	60.325	1.000	25.40	.14	3.5
	S 3220	CS 3220	2.0000	50.800	2.3750	60.325	1.250	31.75	.14	3.5
2 ⁵ / ₈	S 4216	CS 4216	2.6250	66.675	3.0000	76.200	1.000	25.40	.14	3.5
3 ¹ / ₂	S 5612	CS 5612	3.5000	88.900	4.0000	101.600	.750	19.05	.14	3.5

¹⁾ Inspection dimensions are listed on page 46, table 3.



Series CS, CSH



Mounting dimensions

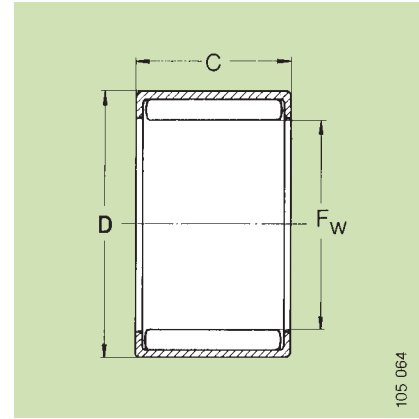
Load Ratings in lbf		Limiting Speed 2) rpm	Mounting Dimensions in inch and mm								Matching Inner Ring Number 4) order separate
dynamic C	static C ₀		Shaft Diameter 3)				Housing Diameter 3)				
			F		G		inch		mm		
			max	min	max	min	min	max	min	max	
4150	9200	3200	1.3750	1.3745	34.925	34.912	1.6245	1.6255	41.262	41.288	SI 182208
6400	16100	3200	1.3750	1.3745	34.925	34.912	1.6245	1.6255	41.262	41.288	SI 182212
10300	30000	3200	1.3750	1.3745	34.925	34.912	1.6245	1.6255	41.262	41.288	-
7500	13900	3100	1.3750	1.3745	34.925	34.912	1.7495	1.7505	44.437	44.463	SI 182212
4600	7700	2900	1.5000	1.4995	38.100	38.087	1.8745	1.8755	47.612	47.638	-
9300	18900	2900	1.5000	1.4995	38.100	38.087	1.8745	1.8755	47.612	47.638	-
10700	22700	2900	1.5000	1.4995	38.100	38.087	1.8745	1.8755	47.612	47.638	SI 202416
13400	30000	2900	1.5000	1.4995	38.100	38.087	1.8745	1.8755	47.612	47.638	SI 202420
6500	12400	2700	1.6250	1.6245	41.275	41.262	1.9995	2.0005	50.787	50.813	SI 222610
8400	17800	2500	1.7500	1.7495	44.450	44.437	2.1245	2.1255	53.962	53.988	SI 242812
11500	26500	2500	1.7500	1.7495	44.450	44.437	2.1245	2.1255	53.962	53.988	-
17000	44000	2500	1.7500	1.7495	44.450	44.437	2.1245	2.1255	53.962	53.988	-
5200	9600	2300	1.8750	1.8745	47.625	47.612	2.2495	2.2505	57.137	57.163	-
7100	14300	2300	1.8750	1.8745	47.625	47.612	2.2495	2.2505	57.137	57.163	-
8800	19100	2300	1.8750	1.8745	47.625	47.612	2.2495	2.2505	57.137	57.163	-
12000	28500	2300	1.8750	1.8745	47.625	47.612	2.2495	2.2505	57.137	57.163	-
12400	30500	2200	2.0000	1.9994	50.800	50.785	2.3745	2.3755	60.312	60.338	SI 273216
15500	40500	2200	2.0000	1.9994	50.800	50.785	2.3745	2.3755	60.312	60.338	SI 273220
14300	40000	1700	2.6250	2.6244	66.675	66.660	2.9995	3.0005	76.187	76.213	-
13900	33000	1300	3.5000	3.4994	88.900	88.885	3.9995	4.0005	101.587	101.613	-

2) Limiting speeds shown apply for oil lubrication. With grease lubrication 60% of the given values are permissible.
 3) For non-ferrous housing recommendations refer to page 44, table 1.
 4) Dimensions are listed on pages 72 to 75.

Shell Bearings

full complement
grease retained

Series SN, SNH
CSN, CSNH

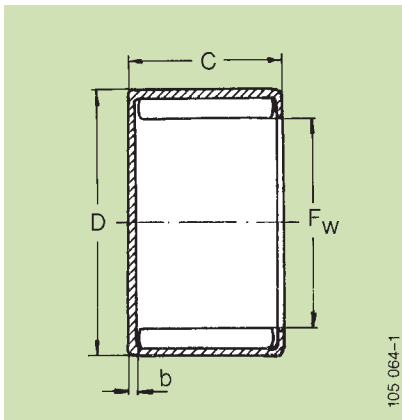


Series SN, SNH

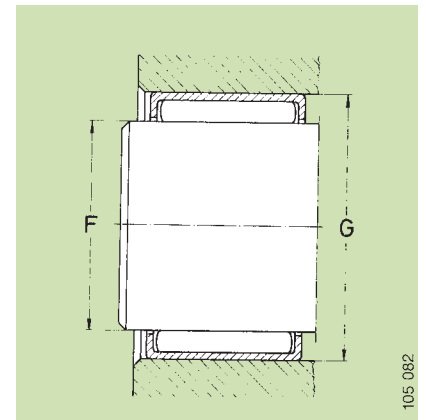
Dimension Table · Dimensions in inch and mm

Shaft Dia. nom inch	Part Number open end	Part Number closed end	Bearing Dimensions		Outside Diameter		Width		End Recess	
			Inside Diameter ¹⁾		D nom		C		b max	
			F_w nom		inch	mm	inch	mm	+0.000 -0.010 inch	+0.00 -0.25 mm
1/4	SN 45	CSN 45	.2500	6.350	.4375	11.112	.312	7.94	.04	1.0
	SN 55	CSN 55	.3125	7.938	.5000	12.700	.312	7.94	.04	1.0
5/16	SN 56	CSN 56	.3125	7.938	.5000	12.700	.375	9.52	.04	1.0
	SN 57	CSN 57	.3125	7.938	.5000	12.700	.438	11.11	.04	1.0
3/8	SN 64	CSN 64	.3750	9.525	.5625	14.288	.250	6.35	.04	1.0
	SN 65	CSN 65	.3750	9.525	.5625	14.288	.312	7.94	.04	1.0
	SN 66	CSN 66	.3750	9.525	.5625	14.288	.375	9.52	.04	1.0
	SN 67	CSN 67	.3750	9.525	.5625	14.288	.438	11.11	.04	1.0
	SN 68	CSN 68	.3750	9.525	.5625	14.288	.500	12.70	.04	1.0
	SN 610	CSN 610	.3750	9.525	.5625	14.288	.625	15.88	.04	1.0
7/16	SN 76	CSN 76	.4375	11.112	.6250	15.875	.375	9.52	.04	1.0
	SN 78	CSN 78	.4375	11.112	.6250	15.875	.500	12.70	.04	1.0
1/2	SN 85	CSN 85	.5000	12.700	.6875	17.462	.312	7.94	.04	1.0
	SN 86	CSN 86	.5000	12.700	.6875	17.462	.375	9.52	.04	1.0
	SN 88	CSN 88	.5000	12.700	.6875	17.462	.500	12.70	.04	1.0
	SN 810	CSN 810	.5000	12.700	.6875	17.462	.625	15.88	.04	1.0
	SN 812	CSN 812	.5000	12.700	.6875	17.462	.750	19.05	.04	1.0
	SNH 87	CSNH 87	.5000	12.700	.7500	19.050	.438	11.11	.04	1.0
9/16	SN 96	CSN 96	.5625	14.288	.7500	19.050	.375	9.52	.04	1.0
	SN 98	CSN 98	.5625	14.288	.7500	19.050	.500	12.70	.04	1.0
5/8	SN 108	CSN 108	.6250	15.875	.8125	20.638	.500	12.70	.04	1.0
11/16	SN 116	CSN 116	.6875	17.462	.8750	22.225	.375	9.52	.04	1.0
	SN 118	CSN 118	.6875	17.462	.8750	22.225	.500	12.70	.04	1.0
	SN 1112	CSN 1112	.6875	17.462	.8750	22.225	.750	19.05	.04	1.0
3/4	SN 128	CSN 128	.7500	19.050	1.0000	25.400	.500	12.70	.04	1.0
	SN 1210	CSN 1210	.7500	19.050	1.0000	25.400	.625	15.88	.04	1.0
	SN 1212	CSN 1212	.7500	19.050	1.0000	25.400	.750	19.05	.04	1.0

¹⁾ Inspection dimensions are listed on page 46, table 3.



Series CSN, CSNH



Mounting dimensions

Load Ratings in lbf		Limiting Speed 2)	Mounting Dimensions in inch and mm								Matching Inner Ring Number 4) order separate
dynamic	static		Shaft Diameter 3)				Housing Diameter 3)				
C	C ₀		F		G		inch		mm		
		rpm	max	min	max	min	min	max	min	max	
980	1110	13000	.2500	.2495	6.350	6.337	.4370	.4380	11.100	11.125	-
1120	1380	12000	.3125	.3120	7.938	7.925	.4995	.5005	12.687	12.713	-
1370	1790	12000	.3125	.3120	7.938	7.925	.4995	.5005	12.687	12.713	-
1620	2200	12000	.3125	.3120	7.938	7.925	.4995	.5005	12.687	12.713	-
880	1060	11000	.3750	.3745	9.525	9.512	.5620	.5630	14.275	14.300	-
1250	1660	11000	.3750	.3745	9.525	9.512	.5620	.5630	14.275	14.300	-
1500	2090	11000	.3750	.3745	9.525	9.512	.5620	.5630	14.275	14.300	-
1800	2650	11000	.3750	.3745	9.525	9.512	.5620	.5630	14.275	14.300	-
2030	3100	11000	.3750	.3745	9.525	9.512	.5620	.5630	14.275	14.300	-
2410	3850	11000	.3750	.3745	9.525	9.512	.5620	.5630	14.275	14.300	-
1650	2460	9500	.4375	.4370	11.112	11.100	.6245	.6255	15.862	15.888	-
2220	3600	9500	.4375	.4370	11.112	11.100	.6245	.6255	15.862	15.888	-
1480	2220	8500	.5000	.4995	12.700	12.687	.6870	.6880	17.450	17.475	-
1690	2650	8500	.5000	.4995	12.700	12.687	.6870	.6880	17.450	17.475	-
2390	4150	8500	.5000	.4995	12.700	12.687	.6870	.6880	17.450	17.475	SI 050808
2900	5300	8500	.5000	.4995	12.700	12.687	.6870	.6880	17.450	17.475	SI 050810
3450	6600	8500	.5000	.4995	12.700	12.687	.6870	.6880	17.450	17.475	-
2430	3350	8000	.5000	.4995	12.700	12.687	.7495	.7505	19.037	19.063	-
1910	2800	7500	.5625	.5620	14.288	14.275	.7495	.7505	19.037	19.063	-
2450	4400	7500	.5625	.5620	14.288	14.275	.7495	.7505	19.037	19.063	SI 060908
2700	5200	7000	.6250	.6245	15.875	15.862	.8120	.8130	20.625	20.650	SI 061008
2090	3850	6500	.6875	.6870	17.462	17.450	.8745	.8755	22.212	22.238	-
2850	5700	6500	.6875	.6870	17.462	17.450	.8745	.8755	22.212	22.238	-
4100	9100	6500	.6875	.6870	17.462	17.450	.8745	.8755	22.212	22.238	-
3400	5700	5500	.7500	.7495	19.050	19.037	.9995	1.0005	25.387	25.413	SI 081208
4350	7800	5500	.7500	.7495	19.050	19.037	.9995	1.0005	25.387	25.413	SI 081210
5200	9900	5500	.7500	.7495	19.050	19.037	.9995	1.0005	25.387	25.413	SI 081212

2) Limiting speeds shown apply for oil lubrication. With grease lubrication 60% of the given values are permissible.

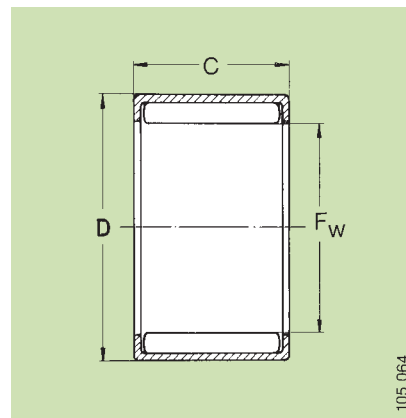
3) For non-ferrous housing recommendations refer to page 44, table 1.

4) Dimensions are listed on pages 72 to 75.

Shell Bearings

full complement
grease retained

Series SN, SNH
CSN, CSNH

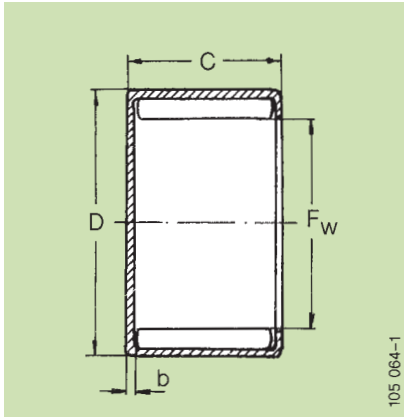


Series SN, SNH

Dimension Table • Dimensions in inch and mm

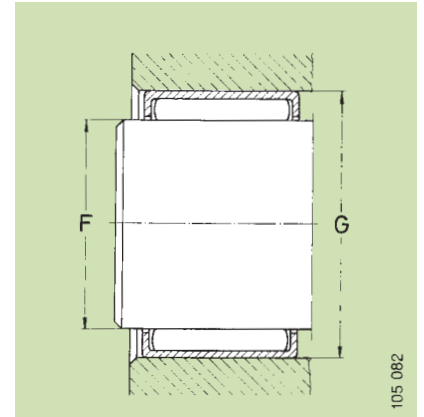
Shaft Dia. nom inch	Part Number open end	Part Number closed end	Bearing Dimensions		Outside Diameter		Width		End Recess	
			Inside Diameter ¹⁾		D nom		C		b max	
			F _w nom		inch	mm	inch	mm	+0.000 -0.010 inch	+0.00 -0.25 mm
7/8	SN 146	CSN 146	.8750	22.225	1.1250	28.575	.375	9.52	.04	1.1
	SN 148	CSN 148	.8750	22.225	1.1250	28.575	.500	12.70	.04	1.1
	SN 1412	CSN 1412	.8750	22.225	1.1250	28.575	.750	19.05	.04	1.1
	SN 1416	CSN 1416	.8750	22.225	1.1250	28.575	1.000	25.40	.04	1.1
1	SN 1612	CSN 1612	1.0000	25.400	1.2500	31.750	.750	19.05	.04	1.1
	SN 1616	CSN 1616	1.0000	25.400	1.2500	31.750	1.000	25.40	.04	1.1
1 1/8	SN 188	CSN 188	1.1250	28.575	1.3750	34.925	.500	12.70	.04	1.1
	SN 1812	CSN 1812	1.1250	28.575	1.3750	34.925	.750	19.05	.04	1.1
	SN 1816	CSN 1816	1.1250	28.575	1.3750	34.925	1.000	25.40	.04	1.1
1 1/4	SN 2012	CSN 2012	1.2500	31.750	1.5000	38.100	.750	19.05	.04	1.1
	SN 2016	CSN 2016	1.2500	31.750	1.5000	38.100	1.000	25.40	.04	1.1
1 3/8	SN 228	CSN 228	1.3750	34.925	1.6250	41.275	.500	12.70	.04	1.1
	SN 2212	CSN 2212	1.3750	34.925	1.6250	41.275	.750	19.05	.04	1.1
1 5/8	SN 2414	CSN 2414	1.5000	38.100	1.8750	47.625	.875	22.22	.06	1.4
	SN 2416	CSN 2416	1.5000	38.100	1.8750	47.625	1.000	25.40	.06	1.4
	SN 2420	CSN 2420	1.5000	38.100	1.8750	47.625	1.250	31.75	.06	1.4
	SN 2610	CSN 2610	1.6250	41.275	2.0000	50.800	.625	15.88	.06	1.4
1 3/4	SN 2812	CSN 2812	1.7500	44.450	2.1250	53.975	.750	19.05	.06	1.4
	SN 2816	CSN 2816	1.7500	44.450	2.1250	53.975	1.000	25.40	.06	1.4

¹⁾ Inspection dimensions are listed on page 46, table 3.



105 064-1

Series CSN, CSNH



105 082

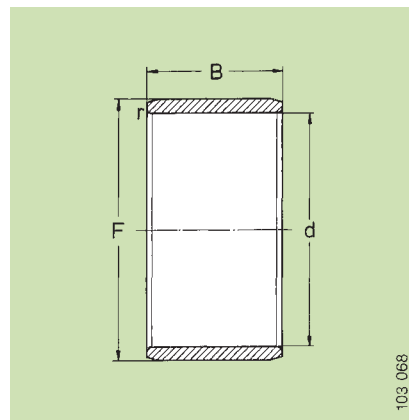
Mounting dimensions

Load Ratings in lbf		Limiting Speed 2)	Mounting Dimensions in inch and mm								Matching Inner Ring Number 4) order separate
dynamic	static		Shaft Diameter 3)				Housing Diameter 3)				
C	C ₀		F		G		inch		mm		
		rpm	inch	mm	inch	mm	min	max	min	max	
2650	4500	4900	.8750	.8745	22.225	22.212	1.1245	1.1255	28.562	28.588	SI 101406
3600	6500	4900	.8750	.8745	22.225	22.212	1.1245	1.1255	28.562	28.588	SI 101408
5300	10900	4900	.8750	.8745	22.225	22.212	1.1245	1.1255	28.562	28.588	SI 101412
6900	15300	4900	.8750	.8745	22.225	22.212	1.1245	1.1255	28.562	28.588	SI 101416
5800	12500	4300	1.0000	.9995	25.400	25.387	1.2495	1.2505	31.737	31.763	SI 121612
7500	17500	4300	1.0000	.9995	25.400	25.387	1.2495	1.2505	31.737	31.763	SI 121616
4150	8500	3900	1.1250	1.1245	28.575	28.562	1.3745	1.3755	34.912	34.938	SI 141808
6200	14100	3900	1.1250	1.1245	28.575	28.562	1.3745	1.3755	34.912	34.938	SI 141812
8000	19700	3900	1.1250	1.1245	28.575	28.562	1.3745	1.3755	34.912	34.938	SI 141816
6500	15700	3500	1.2500	1.2495	31.750	31.737	1.4995	1.5005	38.087	38.113	SI 162012
8500	21900	3500	1.2500	1.2495	31.750	31.737	1.4995	1.5005	38.087	38.113	SI 162016
4500	10300	3200	1.3750	1.3745	34.925	34.912	1.6245	1.6255	41.262	41.288	SI 182208
6700	17200	3200	1.3750	1.3745	34.925	34.912	1.6245	1.6255	41.262	41.288	SI 182212
10300	21500	2900	1.5000	1.4995	38.100	38.087	1.8745	1.8755	47.612	47.638	-
11700	25500	2900	1.5000	1.4995	38.100	38.087	1.8745	1.8755	47.612	47.638	SI 202416
14300	33000	2900	1.5000	1.4995	38.100	38.087	1.8745	1.8755	47.612	47.638	SI 202420
7700	15400	2700	1.6250	1.6245	41.275	41.262	1.9995	2.0005	50.787	50.813	SI 222610
9700	21400	2500	1.7500	1.7495	44.450	44.437	2.1245	2.1255	53.962	53.988	SI 242812
13800	29000	2500	1.7500	1.7995	44.450	44.437	2.1245	2.1255	53.962	53.988	SI 242816

- 2) Limiting speeds shown apply for oil lubrication. With grease lubrication 60% of the given values are permissible.
 3) For non-ferrous housing recommendations refer to page 44, table 1.
 4) Dimensions are listed on pages 72 to 75.

Inner Rings

Series SI

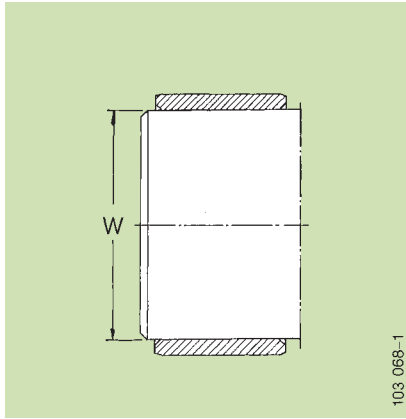


103 068

Series SI

Dimension Table • Dimensions in inch and mm

Shaft Dia.	Part Number	Mass approx. lbs.	Inner Ring Dimensions		Outer Diameter		Width	
			Inside Diameter		F		B	
			+0.0000 -0.0005 inch	+0.000 -0.013 mm	+0.0000 -0.0005 inch	+0.000 -0.013 mm	+0.015 +0.005 inch	+0.38 +0.13 mm
5/16	SI 050808	.02	.3125	7.938	.5000	12.700	.500	12.70
	SI 050810	.02	.3125	7.938	.5000	12.700	.625	15.88
3/8	SI 060908	.02	.3750	9.525	.5625	14.288	.500	12.70
	SI 060912	.03	.3750	9.525	.5625	14.288	.750	19.05
	SI 061008	.03	.3750	9.525	.6250	15.875	.500	12.70
	SI 061010	.03	.3750	9.525	.6250	15.875	.625	15.88
	SI 061012	.04	.3750	9.525	.6250	15.875	.750	19.05
	SI 081208	.03	.5000	12.700	.7500	19.050	.500	12.70
1/2	SI 081210	.04	.5000	12.700	.7500	19.050	.625	15.88
	SI 081212	.05	.5000	12.700	.7500	19.050	.750	19.05
	SI 101406	.03	.6250	15.875	.8750	22.225	.375	9.52
5/8	SI 101408	.04	.6250	15.875	.8750	22.225	.500	12.70
	SI 101412	.06	.6250	15.875	.8750	22.225	.750	19.05
	SI 101416	.08	.6250	15.875	.8750	22.225	1.000	25.40
	SI 121608	.05	.7500	19.050	1.0000	25.400	.500	12.70
3/4	SI 121612	.07	.7500	19.050	1.0000	25.400	.750	19.05
	SI 121616	.10	.7500	19.050	1.0000	25.400	1.000	25.40
	SI 121620	.14	.7500	19.050	1.0000	25.400	1.250	31.75
	SI 141808	.05	.8750	22.225	1.1250	28.575	.500	12.70
7/8	SI 141812	.08	.8750	22.225	1.1250	28.575	.750	19.05
	SI 141816	.11	.8750	22.225	1.1250	28.575	1.000	25.40
	SI 141820	.13	.8750	22.225	1.1250	28.575	1.250	31.75
	SI 151816	.11	.9375	23.813	1.1250	28.575	1.00	25.40
1	SI 162012	.09	1.0000	25.400	1.2500	31.750	.750	19.05
	SI 162016	.12	1.0000	25.400	1.2500	31.750	1.000	25.40
	SI 162020	.15	1.0000	25.400	1.2500	31.750	1.250	31.75
1 1/8	SI 182208	.07	1.1250	28.575	1.3750	34.925	.500	12.70
	SI 182212	.10	1.1250	28.575	1.3750	34.925	.750	19.05
	SI 182216	.13	1.1250	28.575	1.3750	34.925	1.000	25.40
	SI 182220	.17	1.1250	28.575	1.3750	34.925	1.250	31.75



103 068-1

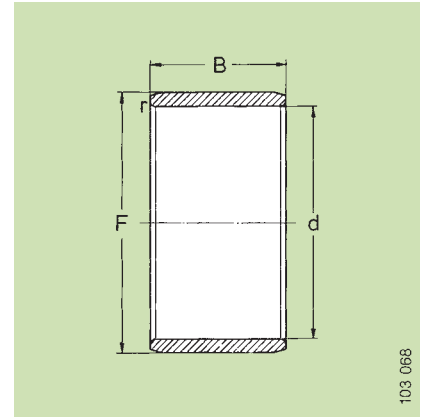
Mounting dimensions

Mounting Dimensions in inch and mm

Shaft Fillet		Shaft Diameter				Shaft Diameter			
r		W				W			
max		inch		mm		inch		mm	
inch	mm	max	min	max	min	min	max	min	max
.025	.064	.3126	.3121	7.940	7.927	.3122	.3117	7.930	7.917
.025	.064	.3126	.3121	7.940	7.927	.3122	.3117	7.930	7.917
.025	.064	.3751	.3746	9.528	9.515	.3747	.3742	9.517	9.505
.025	.064	.3751	.3746	9.528	9.515	.3747	.3742	9.517	9.505
.025	.064	.3751	.3746	9.528	9.515	.3747	.3742	9.517	9.505
.025	.064	.3751	.3746	9.528	9.515	.3747	.3742	9.517	9.505
.025	.064	.3751	.3746	9.528	9.515	.3747	.3742	9.517	9.505
.040	1.02	.5001	.4996	12.703	12.690	.4997	.4992	12.692	12.680
.040	1.02	.5001	.4996	12.703	12.690	.4997	.4992	12.692	12.680
.040	1.02	.5001	.4996	12.703	12.690	.4997	.4992	12.692	12.680
.040	1.02	.6251	.6246	15.878	15.865	.6247	.6242	15.867	15.855
.040	1.02	.6251	.6246	15.878	15.865	.6247	.6242	15.867	15.855
.040	1.02	.6251	.6246	15.878	15.865	.6247	.6242	15.867	15.855
.040	1.02	.6251	.6246	15.878	15.865	.6247	.6242	15.867	15.855
.040	1.02	.7501	.7496	19.053	19.040	.7497	.7492	19.042	19.030
.040	1.02	.7501	.7496	19.053	19.040	.7497	.7492	19.042	19.030
.040	1.02	.7501	.7496	19.053	19.040	.7497	.7492	19.042	19.030
.040	1.02	.7501	.7496	19.053	19.040	.7497	.7492	19.042	19.030
.040	1.02	.8751	.8746	22.228	22.215	.8747	.8742	22.217	22.205
.040	1.02	.8751	.8746	22.228	22.215	.8747	.8742	22.217	22.205
.040	1.02	.8751	.8746	22.228	22.215	.8747	.8742	22.217	22.205
.040	1.02	.8751	.8746	22.228	22.215	.8747	.8742	22.217	22.205
.040	1.02	.9376	.9371	23.815	23.802	.9372	.9367	23.805	23.792
.040	1.02	1.0001	.9996	25.403	25.390	.9997	.9992	25.392	25.380
.040	1.02	1.0001	.9996	25.403	25.390	.9997	.9992	25.392	25.380
.040	1.02	1.0001	.9996	25.403	25.390	.9997	.9992	25.392	25.380
.040	1.02	1.1251	1.1246	28.578	28.565	1.1247	1.1242	28.567	28.555
.040	1.02	1.1251	1.1246	28.578	28.565	1.1247	1.1242	28.567	28.555
.040	1.02	1.1251	1.1246	28.578	28.565	1.1247	1.1242	28.567	28.555
.040	1.02	1.1251	1.1246	28.578	28.565	1.1247	1.1242	28.567	28.555

Inner Rings

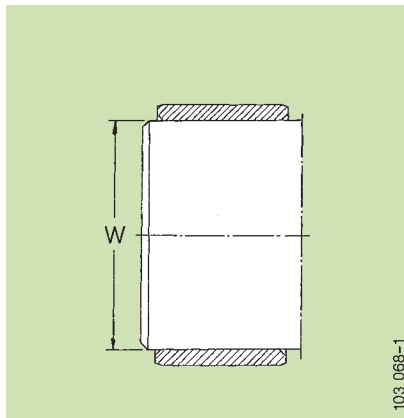
Series SI



Series SI

Dimension Table • Dimensions in inch and *mm*

Shaft Dia.	Part Number	Mass approx.	Inner Ring Dimensions		Outer Diameter		Width	
			Inside Diameter		F		B	
			+0.0000 -0.0005 inch	+0.000 -0.013 <i>mm</i>	+0.0000 -0.0005 inch	+0.000 -0.013 <i>mm</i>	+0.015 +0.005 inch	+0.38 +0.13 <i>mm</i>
1 ¹ / ₄	SI 202416	.15	1.2500	31.750	1.5000	38.100	1.000	25.40
	SI 202420	.19	1.2500	31.750	1.5000	38.100	1.250	31.75
1 ³ / ₈	SI 222610	.10	1.3750	34.925	1.6250	41.275	.625	15.88
	SI 222620	.20	1.3750	34.925	1.6250	41.275	1.250	31.75
1 ⁷ / ₁₆	SI 232816	.20	1.4375	36.512	1.7500	44.450	1.000	25.40
	SI 232824	.33	1.4375	36.512	1.7500	44.450	1.500	38.10
1 ¹ / ₂	SI 242812	.13	1.5000	38.100	1.7500	44.450	.750	19.05
	SI 242816	.18	1.5000	38.100	1.7500	44.450	1.000	25.40
1 ¹¹ / ₁₆	SI 273216	.24	1.6875	42.862	2.0000	50.800	1.000	25.40
	SI 273220	.31	1.6875	42.862	2.0000	50.800	1.250	31.75



Mounting dimensions

Mounting Dimensions in inch and *mm*

Shaft Fillet		Shaft Diameter press fit W				Shaft Diameter slip fit W			
r		inch		mm		inch		mm	
max		max	min	max	min	min	max	min	max
inch	mm								
.060	1.52	1.2501	1.2496	31.753	31.740	1.2497	1.2492	31.742	31.730
.060	1.52	1.2501	1.2496	31.753	31.740	1.2497	1.2492	31.742	31.730
.060	1.52	1.3751	1.3746	34.928	34.915	1.3747	1.3742	34.917	34.905
.060	1.52	1.3751	1.3746	34.928	34.915	1.3747	1.3742	34.917	34.905
.060	1.52	1.4376	1.4371	36.515	36.502	1.4372	1.4367	36.505	36.492
.060	1.52	1.4376	1.4371	36.515	36.502	1.4372	1.4367	36.505	36.492
.060	1.52	1.5001	1.4996	38.103	38.090	1.4997	1.4992	38.092	38.080
.060	1.52	1.5001	1.4996	38.103	38.090	1.4997	1.4992	38.092	38.080
.060	1.52	1.6876	1.6871	42.865	42.852	1.6872	1.6867	42.855	42.842
.060	1.52	1.6876	1.6871	42.865	42.852	1.6872	1.6867	42.855	42.842

Unit Cages



Series C

102 073

The INA unit cage is a self contained bearing assembly with precise, individually guided and retained needle rollers. It provides bearing arrangements with high load carrying capacity and stiffness with a low radial section. Large guidance areas ensure accurate guidance of the unit cages.

INA unit cages are suitable for applications where shaft and housing bores can be used as raceways.

The operating clearance is determined by the selection of the raceway diameter.

A very high degree of running accuracy can be achieved, depending upon the dimensional and geometric accuracy of the shaft and housing bore raceways.

A complete line of metric unit cages is also available.

Mounting Tolerances

Shafts and housings for unit cages must be steel and must be hardened and ground to serve as raceways. The recommended shaft and housing diameters shown

in the dimension tables provide adequate diametral clearance for most applications. However, for special conditions, such as high temperature operations, consult the INA Engineering Department.

To assure proper axial clearance, the minimum distance between the two locating side faces should be " B_c " $+0.008"/+0.20mm$.

Design of Adjacent Parts

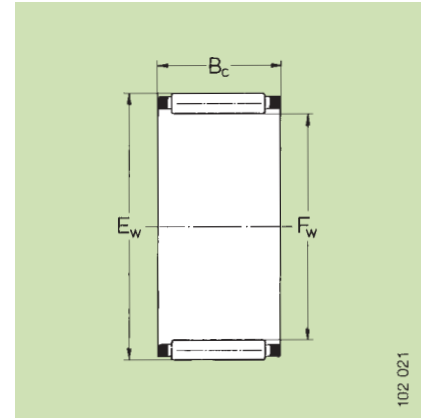
Further details regarding the design of the raceways and lateral guiding faces are given in section "Technical Data" on page 34.

Additional information in section "Technical Data"

Page	Description
14	Load carrying capacity and life
26	Lubrication and maintenance
34	Design of bearing arrangements
6	Suffixes

Unit Cages

Series C



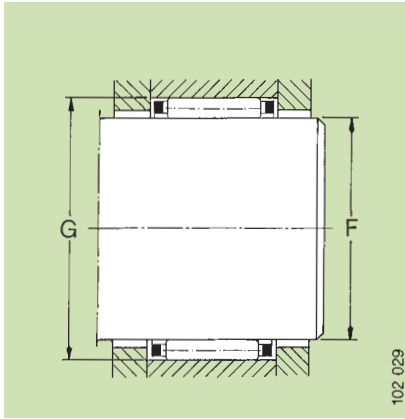
Series C

102 021

Dimension Table • Dimensions in inch and mm

Shaft Dia. nom inch	Part Number	Bearing Dimensions						Load Ratings in lbf		Limiting Speed 1) rpm
		Inside Diameter		Outside Diameter		Width		dynamic C	static C_0	
		F_w nom inch	F_w nom mm	E_w nom inch	E_w nom mm	B_c nom inch	B_c nom mm			
$\frac{3}{8}$	C 060806	.3750	9.525	.5000	12.700	.375	9.52	1100	1230	30000
$\frac{1}{2}$	C 081008	.5000	12.700	.6250	15.875	.500	12.70	1490	1960	26000
$\frac{9}{16}$	C 091108	.5625	14.288	.6875	17.462	.500	12.70	1630	2290	25000
	C 091110	.5625	14.288	.6875	17.462	.625	15.88	2190	3350	25000
$\frac{5}{8}$	C 101208	.6250	15.875	.7500	19.050	.500	12.70	1840	2800	24000
	C 101212	.6250	15.875	.7500	19.050	.750	19.05	2650	4400	24000
$\frac{11}{16}$	C 111308	.6875	17.462	.8125	20.638	.500	12.70	1840	2850	23000
$\frac{3}{4}$	C 121616	.7500	19.050	1.0000	25.400	1.000	25.40	5600	7800	21000
$\frac{13}{16}$	C 131608	.8125	20.638	1.0000	25.400	.500	12.70	2800	3950	21000
$\frac{7}{8}$	C 141816	.8750	22.225	1.1250	28.575	1.000	25.40	6500	9800	19000
	C 161908	1.0000	25.400	1.1875	30.162	.500	12.70	3050	4700	18000
	C 162112	1.0000	25.400	1.3125	33.338	.750	19.05	6400	8500	17000
1	C 162116	1.0000	25.400	1.3125	33.338	1.000	25.40	8200	11900	17000
	C 182416	1.1250	28.575	1.5000	38.100	1.000	25.40	9700	13400	15000
$1\frac{1}{8}$	C 182420	1.1250	28.575	1.5000	38.100	1.250	31.75	11700	17100	15000
	C 202612	1.2500	31.750	1.6250	41.275	.750	19.05	7700	10300	13000
$1\frac{1}{4}$	C 202616	1.2500	31.750	1.6250	41.275	1.000	25.40	10100	14600	13000
	C 202624	1.2500	31.750	1.6250	41.275	1.500	38.10	14300	22700	13000
$1\frac{3}{8}$	C 222820	1.3750	34.925	1.7500	44.450	1.250	31.75	12600	19900	12000
	C 243016	1.5000	38.100	1.8750	47.625	1.000	25.40	10800	16700	11000
$1\frac{1}{2}$	C 243020	1.5000	38.100	1.8750	47.625	1.250	31.75	13000	21300	11000
	C 243024	1.5000	38.100	1.8750	47.625	1.500	38.10	15300	26000	11000
$1\frac{3}{4}$	C 283416	1.7500	44.450	2.1250	53.975	1.000	25.40	11900	19800	10000
	C 283424	1.7500	44.450	2.1250	53.975	1.500	38.10	16900	31000	10000

1) Limiting speeds shown apply for oil lubrication. With grease lubrication 60% of the given values are permissible.



102 029

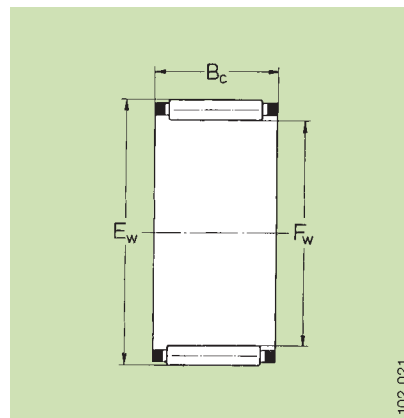
Mounting dimensions

Mounting Dimensions in inch and mm

Shaft Diameter					Housing Diameter				
F					G				
inch		mm			inch		mm		
max	min	max	min		min	max	min	max	
.3750	.3748	9.525	9.519		.5002	.5007	12.706	12.717	
.5000	.4997	12.700	12.692		.6252	.6257	15.881	15.892	
.5625	.5622	14.288	14.280		.6877	.6882	17.468	17.480	
.5625	.5622	14.288	14.280		.6877	.6882	17.468	17.480	
.6250	.6247	15.875	15.867		.7503	.7508	19.057	19.070	
.6250	.6247	15.875	15.867		.7503	.7508	19.057	19.070	
.6875	.6872	17.462	17.454		.8128	.8133	20.644	20.658	
.7500	.7496	19.050	19.041		1.0003	1.0008	25.407	25.420	
.8125	.8121	20.638	20.628		1.0003	1.0008	25.407	25.420	
.8750	.8746	22.225	22.216		1.1253	1.1258	28.582	28.595	
1.0000	.9996	25.400	25.391		1.1879	1.1885	30.172	30.188	
1.0000	.9996	25.400	25.391		1.3129	1.3135	33.346	33.362	
1.0000	.9996	25.400	25.391		1.3129	1.3135	33.346	33.362	
1.1250	1.1246	28.575	28.566		1.5004	1.5010	38.109	38.125	
1.1250	1.1246	28.575	28.566		1.5004	1.5010	38.109	38.125	
1.2500	1.2496	31.750	31.739		1.6254	1.6260	41.284	41.300	
1.2500	1.2496	31.750	31.739		1.6254	1.6260	41.284	41.300	
1.2500	1.2496	31.750	31.739		1.6254	1.6260	41.284	41.300	
1.3750	1.3746	34.925	34.914		1.7504	1.7510	44.459	44.475	
1.5000	1.4996	38.100	38.089		1.8754	1.8760	47.634	47.650	
1.5000	1.4996	38.100	38.089		1.8754	1.8760	47.634	47.650	
1.5000	1.4996	38.100	38.089		1.8754	1.8760	47.634	47.650	
1.7500	1.7496	44.450	44.439		2.1254	2.1261	53.985	54.004	
1.7500	1.7496	44.450	44.439		2.1254	2.1261	53.985	54.004	

Unit Cages

Series C



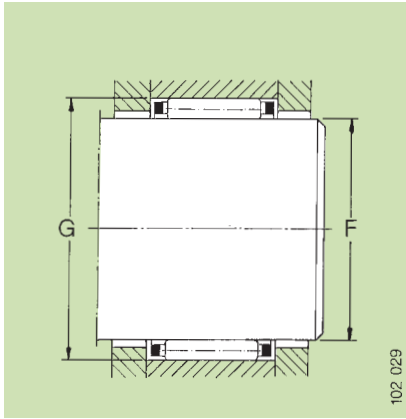
102 021

Series C

Dimension Table · Dimensions in inch and mm

Shaft Dia. nom inch	Part Number	Bearing Dimensions						Load Ratings in lbf		Limiting Speed 1) rpm
		Inside Diameter		Outside Diameter		Width		dynamic C	static C ₀	
		F _w nom		E _w nom		B _c				
inch	mm	inch	mm	$+0.000$ -0.015 inch	$+0.00$ -0.38 mm					
2	C 323816	2.0000	50.800	2.3750	60.325	1.000	25.40	12900	23000	9000
	C 323824	2.0000	50.800	2.3750	60.325	1.500	38.10	18300	36000	9000
2 1/16	C 333916	2.0625	52.388	2.4375	61.912	1.000	25.40	13200	24000	8500
2 1/8	C 344016	2.1250	53.975	2.5000	63.500	1.000	25.40	13200	24000	8500
	C 344024	2.1250	53.975	2.5000	63.500	1.500	38.10	18700	37500	8500
2 1/4	C 364216	2.2500	57.150	2.6250	66.675	1.000	25.40	10600	18500	8000
2 3/8	C 384424	2.3750	60.325	2.7500	69.850	1.500	38.10	19400	41000	7500
2 1/2	C 404616	2.5000	63.500	2.8750	73.025	1.000	25.40	14000	27000	7000
	C 404624	2.5000	63.500	2.8750	73.025	1.500	38.10	19800	42500	7000
2 3/4	C 445016	2.7500	69.850	3.1250	79.375	1.000	25.40	14500	29500	6500
3	C 485416	3.0000	76.200	3.3750	85.725	1.000	25.40	14900	31500	6000
	C 485424	3.0000	76.200	3.3750	85.725	1.500	38.10	21100	49000	6000
3 1/2	C 566216	3.5000	88.900	3.8750	98.425	1.000	25.40	15800	35500	5000
	C 566416	3.5000	88.900	4.0000	101.600	1.000	25.40	19800	39000	5000
	C 566424	3.5000	88.900	4.0000	101.600	1.500	38.10	25500	54000	5000
4	C 647216	4.0000	101.600	4.5000	114.300	1.000	25.40	20400	42500	4500
	C 647224	4.0000	101.600	4.5000	114.300	1.500	38.10	27500	62000	4500

1) Limiting speeds shown apply for oil lubrication. With grease lubrication 60% of the given values are permissible.



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Mounting dimensions

Mounting Dimensions in inch and mm

Shaft Diameter F					Housing Diameter G				
inch		mm			inch		mm		
max	min	max	min		min	max	min	max	
2.0000	1.9995	50.800	50.787		2.3754	2.3761	60.335	60.354	
2.0000	1.9995	50.800	50.787		2.3754	2.3761	60.335	60.354	
2.0625	2.0620	52.388	52.374		2.4379	2.4386	61.922	61.942	
2.1250	2.1245	53.975	53.962		2.5004	2.5011	63.510	63.529	
2.1250	2.1245	53.975	53.962		2.5004	2.5011	63.510	63.529	
2.2500	2.2495	57.150	57.137		2.6254	2.6261	66.685	66.704	
2.3750	2.3745	60.325	60.312		2.7504	2.7511	69.860	69.879	
2.5000	2.4995	63.500	63.487		2.8754	2.8761	73.035	73.054	
2.5000	2.4995	63.500	63.487		2.8754	2.8761	73.035	73.054	
2.7500	2.7495	69.850	69.837		3.1254	3.1261	79.385	79.404	
3.0000	2.9995	76.200	76.187		3.3755	3.3763	85.737	85.759	
3.0000	2.9995	76.200	76.187		3.3755	3.3763	85.737	85.759	
3.5000	3.4994	88.900	88.885		3.8755	3.8763	98.437	98.459	
3.5000	3.4994	88.900	88.885		4.0005	4.0013	101.612	101.634	
3.5000	3.4994	88.900	88.885		4.0005	4.0013	101.612	101.634	
4.0000	3.9994	101.600	101.585		4.5005	4.5013	114.312	114.334	
4.0000	3.9994	101.600	101.585		4.5005	4.5013	114.312	114.334	

Thrust Bearings

INA thrust bearings consist of thrust cages with needle rollers and thrust washers. The needle rollers are retained and accurately guided in a rigid thrust cage. Several combinations with various types of thrust washers are possible.

Within a **small space, high load carrying capacity** and **rigidity** of the bearing is achieved by using cylindrical rolling elements of high accuracy and with long contact surfaces. Thrust washers can be eliminated if the adjacent surfaces are suitable for raceways.

Extensive tests have shown that these bearings have very low coefficients of friction (see page 24, figure 6), in spite of the slight sliding effect of cylindrical rolling elements on a circular path.

The limiting speeds given in the dimension tables apply to oil lubrication with sufficient cooling of the oil. With grease lubrication, the limiting speeds are only about 25% of the values given in the tables. Higher speeds are permissible if adequate cooling is provided; please contact the INA Engineering Department.

A complete line of metric thrust bearings is also available.

INA Thrust Cages Series TC

The INA thrust cage is the basic component of the thrust needle roller bearings. The needle rollers are retained and guided in radially arranged pockets in a profiled, hardened steel strip cage.

The high accuracy of the needle rollers ensures uniform load distribution. It is preferable to guide INA thrust cages on the shaft. Even at high speeds, this results in relatively low circumferential speeds at the guiding surface. If guidance on the shaft is not possible, thrust cages can also be guided on their outside diameter.

Particularly space-saving bearing arrangements are achieved if the faces of the adjacent part are designed as raceways so that thrust washers can be dispensed with. If such a solution is not feasible, bearing arrange

ments with very low axial section height can be achieved with thrust washers of series TWA and TWB. These thrust washers must be fully supported. For other applications, combinations with thicker thrust washers, series TWC and TWD are also possible. INA thrust washers for use with INA thrust cages must be ordered separately.

INA Thrust Washer Series TWA and TWB

INA thrust washers of series TWA and TWB are punched from high-grade steel, through-hardened and polished. They are used if the adjacent machine part cannot be hardened but has sufficient rigidity and geometrical accuracy. The washers should be fully supported on their entire abutment surface. With appropriate centering they can be used either as housing locating or shaft locating washers.

INA Thrust Washers Series TWC and TWD

INA thrust washers of series TWC and TWD are thick washers made from bearing steel. The raceways are ground while the bore and outside diameter are machined. These washers can also be used as either housing locating or shaft locating washers when appropriate centering is provided.

Special Design

For applications where standard sizes cannot be used, INA thrust bearings can be supplied in special sizes and designs providing the quantities are large enough for economical production.

Mounting Tolerances

All tolerances for shaft and housings are listed in the dimension table.



Series TC

Mounting Guidelines

If the adjacent machine parts can be hardened and ground, INA thrust cages can be used without additional thrust washers. The raceway dimensions can be found in columns E_a and E_b in the dimension tables. The raceway surface must be square within $0.0005''/0.013mm$ with respect to the center line and flat within $0.0002''/0.005mm$ measured in any direction.

Further technical data for material selection and design of the raceways is given in the section "Technical Data".

If possible, thrust washers of series TWC and TWD should be supported over their entire abutment surface. However, small openings are permissible, e.g., for the supply of lubricant. The shoulders must be suffi-

ciently rigid, flat and square to the axis of rotation. They should extend at least to the middle of the rolling element raceway from either the outside or the inside diameter. On the other hand, INA thrust washers of series TWA and TWB must always be fully supported in order to prevent elastic deformation.

Additional information in section "Technical Data"

Page	Description
14	Load carrying capacity and life
26	Lubrication and maintenance
34	Design of bearing arrangements
6	Suffixes

Table 1 · Tolerances for inside diameter D_{C1} and outside diameter D_C of thrust cages Series TC

Needle Roller Dia.		Tolerance limits							
		Inside diameter				Outside diameter			
nom		inch		mm		inch		mm	
inch	mm	min	max	min	max	max	min	max	min
.0781	1.984	+0.002	+0.007	+0.05	+0.18	-.010	-.020	-0.25	-0.50
.1250	3.175	+0.002	+0.010	+0.05	+0.25	-.010	-.025	-0.25	-0.63

Table 2 · Tolerances for inside diameter d of thrust washers Series TWA, TWB, TWC and TWD

Nom inside diameter				Tolerance limits			
inch		mm		inch		mm	
over	incl.	over	incl.	min	max	min	max
.240	2.250	6.10	57.15	+0.002	+0.012	+0.05	+0.30
2.250	4.125	57.15	104.78	+0.002	+0.017	+0.05	+0.43

Table 3 · Tolerances for outside diameter D of thrust washers Series TWA, TWB, TWC and TWD

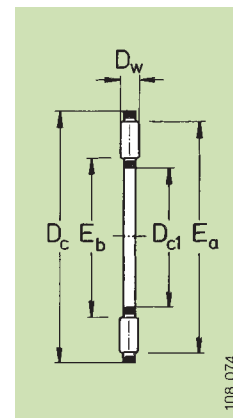
Nom outside diameter				Tolerance limits			
inch		mm		inch		mm	
over	incl.	over	incl.	max	min	max	min
.562	5.062	14.30	128.57	-.010	-.030	-0.25	-0.76

Thrust Bearings

Series TC

Thrust Washers

Series TWA, TWB, TWC, TWD



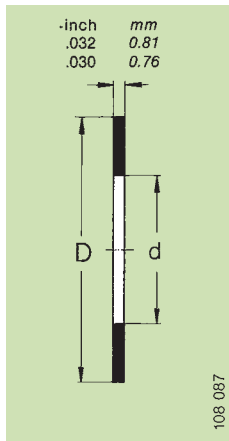
Series TC

Dimension Table • Dimensions in inch and mm

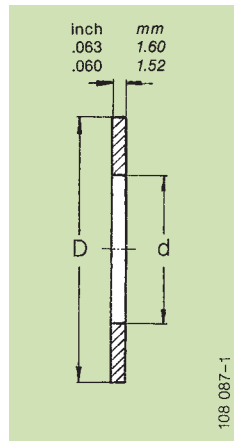
Shaft Dia. nom inch	Part Number	Bearing Dimensions						Load Ratings		Limiting Speed ²⁾ rpm	Mounting Dimensions			
		Inside Diameter ¹⁾ D_{c1} / d nom		Outside Diameter ¹⁾ D_c / D nom		Roller Diameter D_w $+0.0000$ -0.0002 inch $+0.000$ -0.005 mm		dynamic C	static C_0		I.D. Race E_b max		O.D. Race E_a min	
		inch	mm	inch	mm	inch	mm	lbf	lbf		inch	mm	inch	mm
$\frac{1}{4}$	TC 411	.250	6.35	.687	17.45	.0781	1.984	1370	3000	16000	.28	7.1	.62	15.7
$\frac{5}{16}$	TC 512	.312	7.94	.750	19.05	.0781	1.984	1560	3650	15000	.35	8.9	.68	17.3
$\frac{3}{8}$	TC 613	.375	9.52	.812	20.62	.0781	1.984	1620	4000	15000	.41	10.4	.75	19.0
$\frac{1}{2}$	TC 815	.500	12.70	.937	23.80	.0781	1.984	1920	5300	13000	.53	13.5	.89	22.6
$\frac{5}{8}$	TC 1018	.625	15.88	1.125	28.58	.0781	1.984	2170	6600	11000	.69	17.5	1.05	26.7
$\frac{3}{4}$	TC 1220	.750	19.05	1.250	31.75	.0781	1.984	2410	8000	9500	.81	20.6	1.17	29.7
$\frac{7}{8}$	TC 1423	.875	22.22	1.437	36.50	.0781	1.984	2900	10500	8500	.94	23.9	1.35	34.3
	TC 1427	.875	22.22	1.687	42.85	.0781	1.984	4400	18600	7500	.94	23.9	1.61	40.9
1	TC 1625	1.000	25.40	1.562	39.67	.0781	1.984	3150	12100	7500	1.07	27.2	1.48	37.6
$1 \frac{1}{8}$	TC 1828	1.125	28.58	1.750	44.45	.0781	1.984	3850	16300	6500	1.19	30.2	1.67	42.4
$1 \frac{3}{16}$	TC 1931	1.188	30.16	1.937	49.20	.0781	1.984	4500	20500	6000	1.25	31.8	1.85	47.0
$1 \frac{1}{4}$	TC 2031	1.250	31.75	1.937	49.20	.0781	1.984	4500	20500	6000	1.32	33.5	1.85	47.0
$1 \frac{3}{8}$	TC 2233	1.375	34.92	2.062	52.37	.0781	1.984	4600	21600	5500	1.44	36.6	1.98	50.3
$1 \frac{1}{2}$	TC 2435	1.500	38.10	2.187	55.55	.0781	1.984	4850	23700	5000	1.57	39.9	2.10	53.3
$1 \frac{3}{4}$	TC 2840	1.750	44.45	2.500	63.50	.0781	1.984	5600	30000	4500	1.82	46.2	2.41	61.2
2	TC 3244	2.000	50.80	2.750	69.85	.0781	1.984	5800	32500	4000	2.07	52.6	2.66	67.6
$2 \frac{1}{4}$	TC 3648	2.250	57.15	3.000	76.20	.0781	1.984	6000	35000	3600	2.32	58.9	2.91	73.9
$2 \frac{1}{2}$	TC 4052	2.500	63.50	3.250	82.55	.0781	1.984	6200	37500	3300	2.57	65.3	3.16	80.3
3	TC 4860	3.000	76.20	3.750	95.25	.0781	1.984	6600	42500	2800	3.07	78.0	3.66	93.0
$3 \frac{1}{4}$	TC 5266	3.250	82.55	4.125	104.78	.1250	3.175	10900	61000	2600	3.35	85.1	4.00	101.6
$4 \frac{1}{8}$	TC 6681	4.125	104.78	5.062	128.57	.1250	3.175	14200	92000	2100	4.22	107.2	4.95	125.7

1) For inside and outside diameter tolerances see table 1 on page 83.

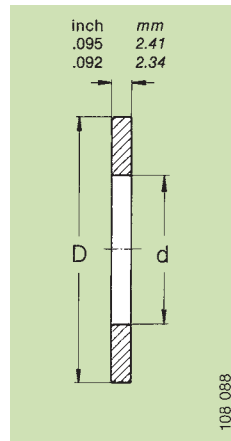
2) Limiting speeds shown apply for oil lubrication. With grease lubrication 25% of the given values are permissible.



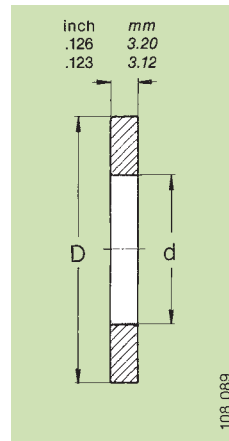
Series TWA



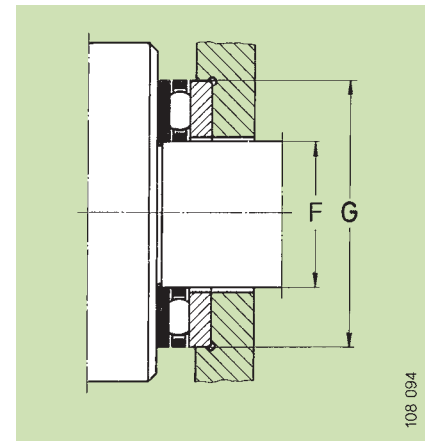
Series TWB



Series TWC



Series TWD



Mounting dimensions

Mounting Dimensions in inch and mm											Thrust ³⁾ Washer Designation	
Cage I.D. Guided Shaft Diameter F				Housing Diameter G		Cage O.D. Guided Housing Diameter G				Shaft Diameter F		
inch		mm		inch	mm	inch		mm		inch		mm
max	min	max	min	min	max	min	max	min	max	max		
.2500	.2470	6.350	6.274	.6870	17.450	.6810	.6850	17.297	17.399	.2420	6.147	411
.3125	.3095	7.938	7.861	.7500	19.050	.7440	.7480	18.898	18.999	.3045	7.734	512
.3750	.3720	9.525	9.449	.8120	20.625	.8060	.8100	20.472	20.574	.3670	9.322	613
.5000	.4970	12.700	12.624	.9370	23.800	.9310	.9350	23.647	23.749	.4920	12.497	815
.6250	.6220	15.875	15.799	1.1250	28.575	1.1190	1.1230	28.423	28.524	.6170	15.672	1018
.7500	.7470	19.050	18.974	1.2500	31.750	1.2440	1.2480	31.598	31.699	.7420	18.847	1220
.8750	.8720	22.225	22.149	1.4370	36.500	1.4310	1.4350	36.347	36.449	.8670	22.022	1423
.8750	.8720	22.225	22.149	1.6870	42.850	1.6810	1.6850	42.697	42.799	.8670	22.022	1427
1.0000	.9970	25.400	25.324	1.5620	39.675	1.5560	1.5600	39.522	39.624	.9920	25.197	1625
1.1250	1.1220	28.575	28.499	1.7500	44.450	1.7440	1.7480	44.298	44.399	1.1170	28.372	1828
1.1875	1.1845	30.162	30.086	1.9370	49.200	1.9310	1.9350	49.047	49.149	1.1795	29.959	1931
1.2500	1.2470	31.750	31.674	1.9370	49.200	1.9310	1.9350	49.047	49.149	1.2420	31.547	2031
1.3750	1.3720	34.925	34.849	2.0620	52.375	2.0560	2.0600	52.222	52.324	1.3670	34.722	2233
1.5000	1.4970	38.100	38.024	2.1870	55.550	2.1810	2.1850	55.397	55.499	1.4920	37.897	2435
1.7500	1.7470	44.450	44.374	2.5000	63.500	2.4940	2.4980	63.348	63.449	1.7420	44.247	2840
2.0000	1.9970	50.800	50.724	2.7500	69.850	2.7440	2.7480	69.698	69.799	1.9920	50.597	3244
2.2500	2.2470	57.150	57.074	3.0000	76.200	2.9940	2.9980	76.048	76.149	2.2420	56.947	3648
2.5000	2.4970	63.500	63.424	3.2500	82.550	3.2440	3.2480	82.398	82.499	2.4920	63.297	4052
3.0000	2.9970	76.200	76.124	3.7500	95.250	3.7440	3.7480	95.098	95.199	2.9920	75.997	4860
3.2500	3.2470	82.550	82.474	4.1250	104.775	4.1190	4.1230	104.623	104.724	3.2420	82.347	5266
4.1250	4.1220	104.775	104.699	5.0620	128.575	5.0560	5.0600	128.422	128.524	4.1170	104.572	6681

3) For thrust washer inside and outside diameter tolerances see tables 2 and 3 on page 83.

Precision Ground Bearings

Bearings of series NCS are high performance units with a through hardened and precision ground outer ring. They are designed for maximum roller length providing high load carrying capabilities and running accuracy.

The two integral shoulders on the outer race serve three purposes. They strengthen the outer ring permitting a thinner wall and a larger roller diameter for maximum load ratings. The shoulders locate the roller axially. They also provide a large guiding surface near the pitch diameter for the cage, preventing it from removing lubricant film from the raceways.

The rigid cage maintains accurate roller guidance even under adverse operating conditions. The precision rollers are crowned for optimum load distribution over their entire length.

The outer ring has a circumferential groove on its outside diameter and a radial oil hole to permit relubrication through the housing.

The bearing outside diameter tolerances are specified in table 1. The inside diameter tolerance limits in the unmounted condition are shown in table 2.

A complete line of metric precision ground bearings is also available.

Mounting

The most economical and best technical solution to the application of precision ground bearings is to harden and grind the shaft to be used as a raceway. The shaft is stronger, and since there are no inner ring tolerances to be considered, increased running accuracy is obtained. Consult the Technical Data on page 34 for details regarding shaft design. When it is not practical to harden and grind the shaft, inner rings are available

for use with NCS type bearings. These inner rings should be ordered separately by the part number shown in the dimension table. See page 94 for additional information on inner rings of series PI.

Normally the outer ring must be press fitted into the housing if it rotates relative to the load. The same is true of the inner ring, if one is used. If either ring is stationary with respect to the load, press-fitting is not required. Shaft and housing diameters are specified in the dimension table for both press fitted and slip fitted outer rings. If it should be necessary to press both fit both rings, care should be taken that adequate diametral clearance remains. Regardless of whether or not the bearings are press fitted, the inner and outer rings must be axially located on shafts or in housings by means of shoulders or snap rings.

Additional information in section "Technical Data"

Page	Description
14	Load carrying capacity and life
26	Lubrication and maintenance
32	Radial internal clearance and operating clearance
34	Design of bearing arrangements
6	Suffixes



Series NCS

Table 1 · Tolerances for inside diameter F_w

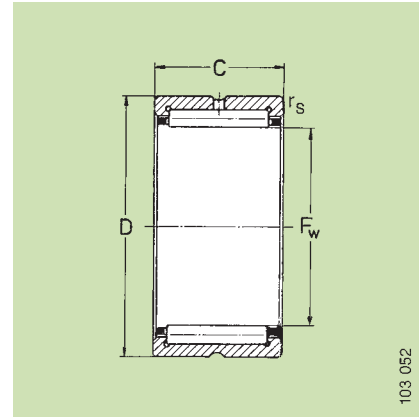
Nom inside diameter				Tolerance limits			
Inch		mm		Inch		mm	
over	incl.	over	incl.	min	max	min	max
.5000	.6250	12.700	15.875	+0.0008	+0.0017	+0.020	+0.043
.6250	1.1250	15.875	28.575	+0.0009	+0.0018	+0.023	+0.046
1.1250	1.6250	28.575	41.275	+0.0010	+0.0019	+0.025	+0.048
1.6250	1.8750	41.275	47.625	+0.0010	+0.0020	+0.025	+0.050
1.8750	2.7500	47.625	69.850	+0.0011	+0.0021	+0.028	+0.053
2.7500	3.0000	69.850	76.200	+0.0011	+0.0023	+0.028	+0.058
3.0000	4.0000	76.200	101.600	+0.0012	+0.0024	+0.030	+0.060
4.0000	4.5000	101.600	114.300	+0.0012	+0.0026	+0.030	+0.066
4.5000	6.0000	114.300	152.400	+0.0013	+0.0027	+0.033	+0.069

Table 2 · Tolerances for outside diameter D

Nom outside diameter				Tolerance limits			
Inch		mm		Inch		mm	
over	incl.	over	incl.	max	min	max	min
.7500	2.0000	19.050	50.800	+0	-.0005	+0	-0.013
2.0000	3.2500	50.800	82.550	+0	-.0006	+0	-0.015
3.2500	4.7500	82.550	120.650	+0	-.0008	+0	-0.020
4.7500	7.0000	120.650	177.800	+0	-.0010	+0	-0.025

Precision Ground Bearings

Series NCS

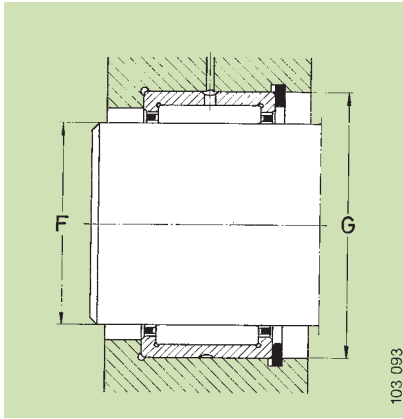


Series NCS

Dimension Table • Dimensions in inch and mm

Shaft Dia. nom inch	Part Number	Bearing Dimensions								Mass lbs	Load Ratings		Limiting Speed 2) rpm	Matching Inner Ring Number 3) order separate
		Inside Diameter F_w 1)		Outside Diameter D 1)		Width C		Corner Radius 4) r_s			dynamic C	static C_0		
		inch	mm	inch	mm	$+0.000$ -0.005 inch	$+0.00$ -0.13 mm	inch	mm		lbf	lbf		
5/8	NCS 1012	.6250	15.875	1.1250	28.575	.750	19.05	.025	0.64	.11	3700	3750	22000	PI 061012
	NCS 1016	.6250	15.875	1.1250	28.575	1.000	25.40	.025	0.64	.15	4750	5200	22000	-
3/4	NCS 1212	.7500	19.050	1.2500	31.750	.750	19.05	.040	1.02	.12	4600	5200	21000	PI 081212
	NCS 1216	.7500	19.050	1.2500	31.750	1.000	25.40	.040	1.02	.16	5900	7100	21000	PI 081216
7/8	NCS 1412	.8750	22.225	1.3750	34.925	.750	19.05	.040	1.02	.13	5100	6200	19000	PI 101412
	NCS 1416	.8750	22.225	1.3750	34.925	1.000	25.40	.040	1.02	.18	6600	8500	19000	PI 101416
15/16	NCS 1512	.9375	23.812	1.4375	36.512	.750	19.05	.040	1.02	.14	5400	6700	18000	-
1	NCS 1612	1.0000	25.400	1.5000	38.100	.750	19.05	.040	1.02	.15	5300	6800	17000	PI 121612
	NCS 1616	1.0000	25.400	1.5000	38.100	1.000	25.40	.040	1.02	.20	7200	10000	17000	PI 121616
1 1/8	NCS 1816	1.1250	28.575	1.6250	41.275	1.000	25.40	.040	1.02	.22	7100	10100	15000	PI 141816
	NCS 1820	1.1250	28.575	1.6250	41.275	1.250	31.75	.040	1.02	.28	10000	15700	15000	PI 141820
1 1/4	NCS 2012	1.2500	31.750	1.7500	44.450	.750	19.05	.040	1.02	.18	6000	8300	14000	PI 162012
	NCS 2016	1.2500	31.750	1.7500	44.450	1.000	25.40	.040	1.02	.24	7700	11500	14000	PI 162016
	NCS 2020	1.2500	31.750	1.7500	44.450	1.250	31.75	.040	1.02	.30	9900	15900	14000	PI 162020
1 3/8	NCS 2216	1.3750	34.925	1.8750	47.625	1.000	25.40	.040	1.02	.26	8200	12900	13000	PI 182216
	NCS 2220	1.3750	34.925	1.8750	47.625	1.250	31.75	.040	1.02	.33	11000	18800	13000	PI 182220
1 1/2	NCS 2416	1.5000	38.100	2.0625	52.388	1.000	25.40	.060	1.52	.34	8400	13700	12000	PI 202416
	NCS 2420	1.5000	38.100	2.0625	52.388	1.250	31.75	.060	1.52	.42	12600	20400	11000	PI 202420
1 5/8	NCS 2616	1.6250	41.275	2.1875	55.562	1.000	25.40	.060	1.52	.36	10500	16600	11000	PI 212616
	NCS 2620	1.6250	41.275	2.1875	55.562	1.250	31.75	.060	1.52	.46	11100	20000	11000	PI 222620
1 3/4	NCS 2816	1.7500	44.450	2.3125	58.738	1.000	25.40	.060	1.52	.39	9400	16500	10000	PI 242816
	NCS 2820	1.7500	44.450	2.3125	58.738	1.250	31.75	.060	1.52	.48	13300	22800	10000	PI 242820
1 7/8	NCS 3016	1.8750	47.625	2.4375	61.912	1.000	25.40	.060	1.52	.41	9600	17300	9500	PI 253016
	NCS 3020	1.8750	47.625	2.4375	61.912	1.250	31.75	.060	1.52	.51	12000	23000	9500	PI 253025

- 1) For inside and outside diameter tolerances see tables 1 and 2 on page 87.
- 2) Limiting speeds shown apply for oil lubrication. With grease lubrication 60% of the given values are permissible.
- 3) Additional sizes and dimensions are listed on pages 94 to 97.
- 4) Equals maximum housing fillet radius which the bearing corner will clear.



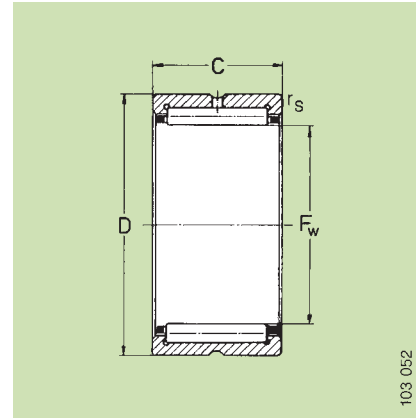
Mounting dimensions

Mounting Dimensions in inch and mm

Housing with slip fit						Housing with press fit									
Shaft Diameter F				Housing Diameter G				Shaft Diameter F				Housing Diameter G			
inch		mm		inch		mm		inch		mm		inch		mm	
max	min	max	min	min	max	min	max	max	min	max	min	min	max	min	max
.6250	.6246	15.875	15.864	1.1250	1.1258	28.575	28.596	.6244	.6239	15.859	15.848	1.1239	1.1247	28.547	28.568
.6250	.6246	15.875	15.864	1.1250	1.1258	28.575	28.596	.6244	.6239	15.859	15.848	1.1239	1.1247	28.547	28.568
.7500	.7495	19.050	19.037	1.2500	1.2510	31.750	31.775	.7492	.7487	19.030	19.017	1.2487	1.2497	31.717	31.742
.7500	.7495	19.050	19.037	1.2500	1.2510	31.750	31.775	.7492	.7487	19.030	19.017	1.2487	1.2497	31.717	31.742
.8750	.8745	22.225	22.212	1.3750	1.3760	34.925	34.950	.8742	.8737	22.205	22.192	1.3737	1.3747	34.892	34.917
.8750	.8745	22.225	22.212	1.3750	1.3760	34.925	34.950	.8742	.8737	22.205	22.192	1.3737	1.3747	34.892	34.917
.9375	.9370	23.812	23.800	1.4375	1.4385	36.512	36.538	.9367	.9362	23.792	23.780	1.4362	1.4372	36.480	36.504
1.0000	.9995	25.400	25.387	1.5000	1.5010	38.100	38.125	.9992	.9987	25.380	25.367	1.4987	1.4997	38.067	38.092
1.0000	.9995	25.400	25.387	1.5000	1.5010	38.100	38.125	.9992	.9987	25.380	25.367	1.4987	1.4997	38.067	38.092
1.1250	1.1245	28.575	28.562	1.6250	1.6260	41.275	41.300	1.1242	1.1237	28.555	28.542	1.6237	1.6247	41.242	41.267
1.1250	1.1245	28.575	28.562	1.6250	1.6260	41.275	41.300	1.1242	1.1237	28.555	28.542	1.6237	1.6247	41.242	41.267
1.2500	1.2494	31.750	31.734	1.7500	1.7510	44.450	44.475	1.2490	1.2484	31.725	31.709	1.7487	1.7497	44.417	44.442
1.2500	1.2494	31.750	31.734	1.7500	1.7510	44.450	44.475	1.2490	1.2484	31.725	31.709	1.7487	1.7497	44.417	44.442
1.2500	1.2494	31.750	31.734	1.7500	1.7510	44.450	44.475	1.2490	1.2484	31.725	31.709	1.7487	1.7497	44.417	44.442
1.3750	1.3744	34.925	34.909	1.8750	1.8760	47.625	47.650	1.3740	1.3734	34.900	34.884	1.8737	1.8747	47.592	47.617
1.3750	1.3744	34.925	34.909	1.8750	1.8760	47.625	47.650	1.3740	1.3734	34.900	34.884	1.8737	1.8747	47.592	47.617
1.5000	1.4994	38.100	38.084	2.0625	2.0637	52.388	52.418	1.4990	1.4984	38.075	38.059	2.0610	2.0621	52.348	52.378
1.5000	1.4994	38.100	38.084	2.0625	2.0637	52.388	52.418	1.4990	1.4984	38.075	38.059	2.0610	2.0621	52.348	52.378
1.6250	1.6244	41.275	41.259	2.1875	2.1887	55.562	55.592	1.6240	1.6234	41.250	41.234	2.1860	2.1871	55.524	55.554
1.6250	1.6244	41.275	41.259	2.1875	2.1887	55.562	55.592	1.6240	1.6234	41.250	41.234	2.1860	2.1871	55.524	55.554
1.7500	1.7494	44.450	44.434	2.3125	2.3137	58.738	58.768	1.7490	1.7484	44.425	44.409	2.3110	2.3121	58.698	58.728
1.7500	1.7494	44.450	44.434	2.3125	2.3137	58.738	58.768	1.7490	1.7484	44.425	44.409	2.3110	2.3121	58.698	58.728
1.8750	1.8744	47.625	47.609	2.4375	2.4387	61.912	61.942	1.8740	1.8734	47.600	47.584	2.4360	2.4371	61.874	61.904
1.8750	1.8744	47.625	47.609	2.4375	2.4387	61.912	61.942	1.8740	1.8734	47.600	47.584	2.4360	2.4371	61.874	61.904

Precision Ground Bearings

Series NCS



Series NCS

Dimension Table • Dimensions in inch and mm

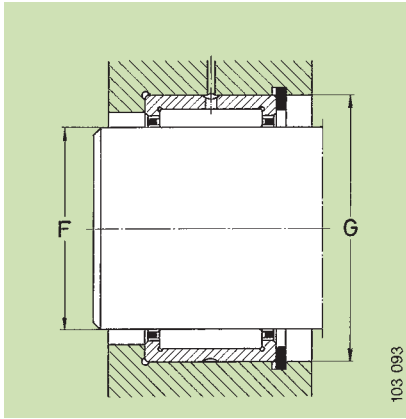
Shaft Dia. nom inch	Part Number	Bearing Dimensions								Mass lbs	Load Ratings		Limiting Speed 2) rpm	Matching Inner Ring Number 3) order separate
		Inside Diameter F_w ¹⁾ nom		Outside Diameter D ¹⁾ nom		Width C		Corner Radius 4) r_s min			dynamic C	static C_0		
		inch	mm	inch	mm	$+0.000$ -0.005 inch	$+0.00$ -0.13 mm	inch	mm		lbf	lbf		
2	NCS 3216	2.0000	50.800	2.5625	65.088	1.000	25.40	.060	1.52	.39	11400	18800	9000	PI 273216
	NCS 3220	2.0000	50.800	2.5625	65.088	1.250	31.75	.060	1.52	.50	14300	26500	9000	PI 273220
2 1/4	NCS 3624	2.2500	57.150	3.0000	76.200	1.500	38.10	.060	1.52	.93	18600	30500	7500	PI 283624
2 1/2	NCS 4024	2.5000	63.500	3.2500	82.550	1.500	38.10	.080	2.03	1.04	19800	34500	7000	PI 324024
2 3/4	NCS 4424	2.7500	69.850	3.5000	88.900	1.500	38.10	.080	2.03	1.11	22300	45000	6500	PI 364424
3	NCS 4824	3.0000	76.200	3.7500	95.250	1.500	38.10	.080	2.03	1.23	21900	41500	6000	PI 404824
3 1/4	NCS 5228	3.2500	82.550	4.2500	107.950	1.750	44.45	.080	2.03	2.12	29500	54000	5500	PI 445228
	NCS 5232	3.2500	82.550	4.2500	107.950	2.000	50.80	.080	2.03	2.43	33500	63000	5500	PI 445232
3 1/2	NCS 5632	3.5000	88.900	4.5000	114.300	2.000	50.80	.080	2.03	2.57	34500	67000	5000	PI 485632
4 1/4	NCS 6832	4.2500	107.950	5.2500	133.350	2.000	50.80	.100	2.54	2.91	44000	97000	4200	-
4 1/2	NCS 7240	4.5000	114.300	6.0000	152.400	2.500	63.50	.100	2.54	4.16	64000	115000	3800	-

1) For inside and outside diameter tolerances see tables 1 and 2 on page 87.

2) Limiting speeds shown apply for oil lubrication. With grease lubrication 60% of the given values are permissible.

3) Additional sizes and dimensions are listed on pages 94 to 97.

4) Equals maximum housing fillet radius which the bearing corner will clear.



Mounting dimensions

Mounting Dimensions in inch and *mm*

Housing with slip fit								Housing with press fit							
Shaft Diameter F				Housing Diameter G				Shaft Diameter F				Housing Diameter G			
inch		<i>mm</i>		inch		<i>mm</i>		inch		<i>mm</i>		inch		<i>mm</i>	
max	min	max	min	min	max	min	max	max	min	max	min	min	max	min	max
2.0000	1.9993	50.800	50.781	2.5625	2.5637	65.088	65.118	1.9988	1.9981	50.770	50.751	2.5610	2.5621	65.048	65.078
2.0000	1.9993	50.800	50.781	2.5625	2.5637	65.088	65.118	1.9988	1.9981	50.770	50.751	2.5610	2.5621	65.048	65.078
2.2500	2.2493	57.150	57.131	3.0000	3.0012	76.200	76.230	2.2488	2.2481	57.120	57.101	2.9985	2.9996	76.161	76.191
2.5000	2.4993	63.500	63.481	3.2500	3.2514	82.550	82.585	2.4988	2.4981	63.470	63.451	3.2482	3.2496	82.505	82.540
2.7500	2.7493	69.850	69.831	3.5000	3.5014	88.900	88.935	2.7488	2.7481	69.820	69.801	3.4982	3.4996	88.855	88.890
3.0000	2.9993	76.200	76.181	3.7500	3.7514	95.250	95.285	2.9988	2.9981	76.170	76.151	3.7482	3.7496	95.205	95.240
3.2500	3.2491	82.550	82.528	4.2500	4.2514	107.950	107.985	3.2486	3.2477	82.514	82.492	4.2482	4.2496	107.905	107.940
3.2500	3.2491	82.550	82.528	4.2500	4.2514	107.950	107.985	3.2486	3.2477	82.514	82.492	4.2482	4.2496	107.905	107.940
3.5000	3.4991	88.900	88.878	4.5000	4.5014	114.300	114.335	3.4986	3.4977	88.864	88.842	4.4982	4.4996	114.255	114.290
4.2500	4.2491	107.950	107.928	5.2500	5.2516	133.350	133.390	4.2486	4.2477	107.914	107.892	5.2480	5.2495	133.298	133.338
4.5000	4.4991	114.300	114.278	6.0000	6.0016	152.400	152.440	4.4986	4.4977	114.264	114.242	5.9980	5.9995	152.348	152.388

Inner Rings

In applications where shafts cannot be manufactured to raceway quality, INA inner rings permit a practical and economical design solution. If large axial movements are required on the shaft or if an additional seal is used, inner rings are available in wider designs.

INA inner rings of series PI are hardened and precision machined. The tolerance of the raceway diameter "F" is determined so that a normal operating clearance is achieved with needle roller bearings mounted.

Tolerances of the bore and raceway diameters are specified in tables 1 and 2.

INA also supplies inner rings in metric dimensions.

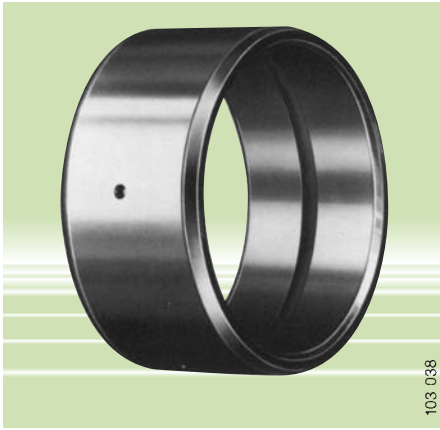
To ease assembly, inner rings have lead chamfers. A circumference groove on the inside diameter and a radial hole in the bore permit relubrication through the shaft. The rings are $.010"/0.25mm$ wider than the nominal width of the bearing with which they are used. This allows axial clamping of the inner ring while still leaving sufficient clearance for the bearing to rotate.

Mounting

Recommended shaft diameters for mounting inner rings are specified for either press or slip fits. Normally, the inner ring must be press fitted if it rotates relative to the load. With precision ground bearings the outer ring should be slip fitted to provide adequate clearance if the inner ring is to be press fitted. The radius (r) shown in the dimension tables is the maximum shaft fillet which the inner ring will clear.

Additional information in section "Technical Data"

Page	Description
34	Design of bearing arrangements
40	Mounting and dismantling
6	Suffixes



Series PI

Table 1 • Tolerances for inside diameter d

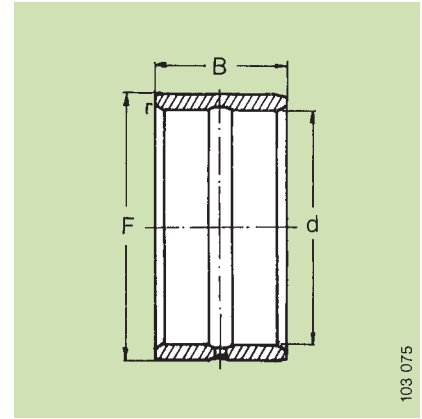
Nom inside diameter				Tolerance limits			
inch		mm		inch		mm	
over	incl.	over	incl.	max	min	max	min
.3000	.7500	7.620	19.050	+0	-.0004	+0	-0.010
.7500	1.7500	19.050	44.450	+0	-.0005	+0	-0.013
1.7500	3.0000	44.450	76.200	+0	-.0006	+0	-0.015

Table 2 • Tolerances for outside diameter F

Nom outside diameter				Tolerance limits			
inch		mm		inch		mm	
over	incl.	over	incl.	max	min	max	min
.4800	.6250	12.382	15.875	-.0005	-.0009	-0.013	-0.023
.6250	1.0000	15.875	25.400	-.0007	-.0012	-0.018	-0.030
1.0000	1.8750	24.400	46.625	-.0009	-.0015	-0.023	-0.036
1.8750	3.0000	47.625	76.200	-.0011	-.0018	-0.028	-0.046
3.0000	3.5000	76.200	88.900	-.0013	-.0022	-0.033	-0.056

Inner Rings

Series PI

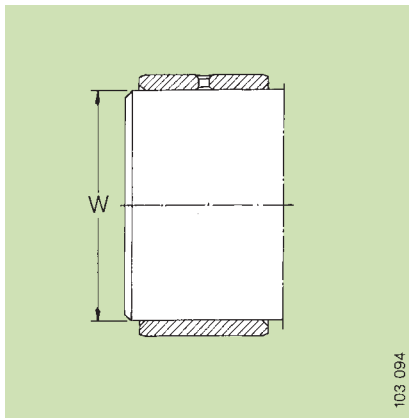


Series PI

Dimension Table • Dimensions in inch and mm

Shaft Dia. nom inch	Part Number	Mass approx. lbs	Inner Ring Dimensions					
			Inside Diameter ¹⁾ d nom		Outside Diameter ¹⁾ F nom		Width B	
			inch	mm	inch	mm	+0.010 +0.005 inch	+0.25 +0.13 mm
5/16	PI 050808	.02	.3125	7.938	.5000	12.700	.500	12.70
	PI 060908	.02	.3750	9.525	.5625	14.288	.500	12.70
3/8	PI 060912	.03	.3750	9.525	.5625	14.288	.750	19.05
	PI 061008	.03	.3750	9.525	.6250	15.875	.500	12.70
	PI 061012	.04	.3750	9.525	.6250	15.875	.750	19.05
1/2	PI 081208	.03	.5000	12.700	.7500	19.050	.500	12.70
	PI 081210	.04	.5000	12.700	.7500	19.050	.625	15.88
	PI 081212	.05	.5000	12.700	.7500	19.050	.750	19.05
	PI 081216	.07	.5000	12.700	.7500	19.050	1.000	25.40
5/8	PI 101406	.03	.6250	15.875	.8750	22.225	.375	9.52
	PI 101408	.04	.6250	15.875	.8750	22.225	.500	12.70
	PI 101412	.06	.6250	15.875	.8750	22.225	.750	19.05
	PI 101416	.08	.6250	15.875	.8750	22.225	1.000	25.40
3/4	PI 121608	.05	.7500	19.050	1.0000	25.400	.500	12.70
	PI 121612	.07	.7500	19.050	1.0000	25.400	.750	19.05
	PI 121616	.10	.7500	19.050	1.0000	25.400	1.000	25.40
	PI 121620	.14	.7500	19.050	1.0000	25.400	1.250	31.75
7/8	PI 141808	.05	.8750	22.225	1.1250	28.575	.500	12.70
	PI 141812	.08	.8750	22.225	1.1250	28.575	.750	19.05
	PI 141816	.11	.8750	22.225	1.1250	28.575	1.000	25.40
	PI 141820	.13	.8750	22.225	1.1250	28.575	1.250	31.75
1	PI 162012	.09	1.0000	25.400	1.2500	31.750	.750	19.05
	PI 162016	.12	1.0000	25.400	1.2500	31.750	1.000	25.40
	PI 162020	.15	1.0000	25.400	1.2500	31.750	1.250	31.75
1 1/8	PI 182208	.07	1.1250	28.575	1.3750	34.925	.500	12.70
	PI 182212	.10	1.1250	28.575	1.3750	34.925	.750	19.05
	PI 182216	.13	1.1250	28.575	1.3750	34.925	1.000	25.40
	PI 182220	.17	1.1250	28.575	1.3750	34.925	1.250	31.75

1) For inside and outside diameter tolerances see tables 1 and 2 on page 93.



103 094

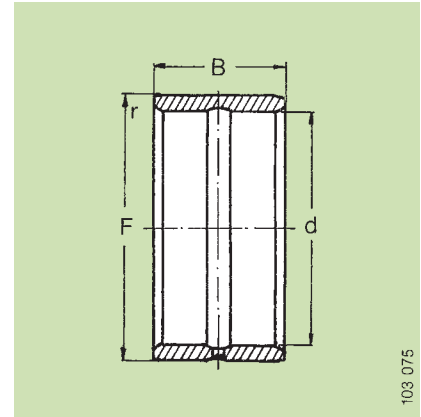
Mounting dimensions

Mounting Dimensions in inch and mm

Shaft Fillet		Shaft Diameter press fit				Shaft Diameter slip fit			
r		W		W		W		W	
max		inch		inch	mm	inch		inch	mm
inch	mm	max	min	max	min	min	max	min	max
.025	0.64	.3130	.3127	7.950	7.943	.3123	.3119	7.932	7.922
.025	0.64	.3755	.3752	9.538	9.530	.3748	.3744	9.520	9.510
.025	0.64	.3755	.3752	9.538	9.530	.3748	.3744	9.520	9.510
.025	0.64	.3755	.3752	9.538	9.530	.3748	.3744	9.520	9.510
.025	0.64	.3755	.3752	9.538	9.530	.3748	.3744	9.520	9.510
.040	1.02	.5006	.5003	12.715	12.708	.4998	.4993	12.695	12.682
.040	1.02	.5006	.5003	12.715	12.708	.4998	.4993	12.695	12.682
.040	1.02	.5006	.5003	12.715	12.708	.4998	.4993	12.695	12.682
.040	1.02	.5006	.5003	12.715	12.708	.4998	.4993	12.695	12.682
.040	1.02	.6256	.6253	15.890	15.883	.6248	.6243	15.870	15.857
.040	1.02	.6256	.6253	15.890	15.883	.6248	.6243	15.870	15.857
.040	1.02	.6256	.6253	15.890	15.883	.6248	.6243	15.870	15.857
.040	1.02	.6256	.6253	15.890	15.883	.6248	.6243	15.870	15.857
.040	1.02	.7507	.7503	19.068	19.058	.7497	.7492	19.042	19.030
.040	1.02	.7507	.7503	19.068	19.058	.7497	.7492	19.042	19.030
.040	1.02	.7507	.7503	19.068	19.058	.7497	.7492	19.042	19.030
.040	1.02	.7507	.7503	19.068	19.058	.7497	.7492	19.042	19.030
.040	1.02	.8757	.8753	22.243	22.233	.8747	.8742	22.217	22.205
.040	1.02	.8757	.8753	22.243	22.233	.8747	.8742	22.217	22.205
.040	1.02	.8757	.8753	22.243	22.233	.8747	.8742	22.217	22.205
.040	1.02	.8757	.8753	22.243	22.233	.8747	.8742	22.217	22.205
.040	1.02	1.0007	1.0003	25.418	25.408	.9997	.9992	25.392	25.380
.040	1.02	1.0007	1.0003	25.418	25.408	.9997	.9992	25.392	25.380
.040	1.02	1.0007	1.0003	25.418	25.408	.9997	.9992	25.392	25.380
.040	1.02	1.1257	1.1253	28.593	28.583	1.1247	1.1242	28.567	28.555
.040	1.02	1.1257	1.1253	28.593	28.583	1.1247	1.1242	28.567	28.555
.040	1.02	1.1257	1.1253	28.593	28.583	1.1247	1.1242	28.567	28.555
.040	1.02	1.1257	1.1253	28.593	28.583	1.1247	1.1242	28.567	28.555

Inner Rings

Series PI



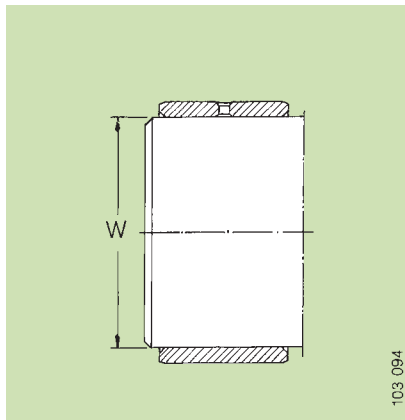
Series PI

103 075

Dimension Table • Dimensions in inch and mm

Shaft Dia. nom inch	Part Number	Mass approx. lbs	Inner Ring Dimensions					
			Inside Diameter ¹⁾ d nom		Outside Diameter ¹⁾ F nom		Width B	
			inch	mm	inch	mm	+0.010 +0.005 inch	+0.25 +0.13 mm
1 1/4	PI 202416	.15	1.2500	31.750	1.5000	38.100	1.000	25.40
	PI 202420	.19	1.2500	31.750	1.5000	38.100	1.250	31.75
1 5/16	PI 212616	.19	1.3125	33.338	1.6250	41.275	1.000	25.40
1 3/8	PI 222610	.10	1.3750	34.925	1.6250	41.275	.625	15.88
	PI 222620	.20	1.3750	34.925	1.6250	41.275	1.250	31.75
1 7/16	PI 232816	.22	1.4375	36.512	1.7500	44.450	1.000	25.40
	PI 232820	.27	1.4375	36.512	1.7500	44.450	1.250	31.75
	PI 232824	.33	1.4375	36.512	1.7500	44.450	1.500	38.10
1 1/2	PI 242812	.13	1.5000	38.100	1.7500	44.450	.750	19.05
	PI 242816	.18	1.5000	38.100	1.7500	44.450	1.000	25.40
	PI 242820	.21	1.5000	38.100	1.7500	44.450	1.250	31.75
1 9/16	PI 253016	.23	1.5625	39.688	1.8750	47.625	1.000	25.40
	PI 253020	.29	1.5625	39.688	1.8750	47.625	1.250	31.75
1 5/8	PI 263216	.26	1.6250	41.275	2.0000	50.800	1.000	25.40
1 11/16	PI 273216	.24	1.6875	42.862	2.0000	50.800	1.000	25.40
	PI 273220	.31	1.6875	42.862	2.0000	50.800	1.250	31.75
1 3/4	PI 283212	.16	1.7500	44.450	2.0000	50.800	.750	19.05
	PI 283624	.63	1.7500	44.450	2.2500	57.150	1.500	38.10
2	PI 324024	.72	2.0000	50.800	2.5000	63.500	1.500	38.10
2 1/4	PI 364424	.81	2.2500	57.150	2.7500	69.850	1.500	38.10
2 1/2	PI 404824	.89	2.5000	63.500	3.0000	76.200	1.500	38.10
2 3/4	PI 445228	1.12	2.7500	69.850	3.2500	82.550	1.750	44.45
	PI 445232	1.28	2.7500	69.850	3.2500	82.550	2.000	50.80
3	PI 485632	1.40	3.0000	76.200	3.5000	88.900	2.000	50.80

1) For inside and outside diameter tolerances see tables 1 and 2 on page 93.



Mounting dimensions

Mounting Dimensions in inch and *mm*

Shaft Fillet		Shaft Diameter press fit				Shaft Diameter slip fit			
r		W		W		W		W	
max		inch		inch	mm	inch		inch	mm
inch	mm	max	min	max	min	min	max	min	max
.060	1.52	1.2508	1.2504	31.770	31.760	1.2496	1.2490	31.740	31.725
.060	1.52	1.2508	1.2504	31.770	31.760	1.2496	1.2490	31.740	31.725
.060	1.52	1.3133	1.3129	33.358	33.348	1.3121	1.3115	33.327	33.312
.060	1.52	1.3758	1.3754	34.945	34.935	1.3746	1.3740	34.915	34.900
.060	1.52	1.3758	1.3754	34.945	34.935	1.3746	1.3740	34.915	34.900
.060	1.52	1.4383	1.4379	36.533	36.523	1.4371	1.4365	36.502	36.487
.060	1.52	1.4383	1.4379	36.533	36.523	1.4371	1.4365	36.502	36.487
.060	1.52	1.4383	1.4379	36.533	36.523	1.4371	1.4365	36.502	36.487
.060	1.52	1.5008	1.5004	38.120	38.110	1.4996	1.4990	38.090	38.075
.060	1.52	1.5008	1.5004	38.120	38.110	1.4996	1.4990	38.090	38.075
.060	1.52	1.5008	1.5004	38.120	38.110	1.4996	1.4990	38.090	38.075
.060	1.52	1.5633	1.5629	39.708	39.698	1.5621	1.5615	39.677	39.662
.060	1.52	1.5633	1.5629	39.708	39.698	1.5621	1.5615	39.677	39.662
.060	1.52	1.6258	1.6254	41.295	41.285	1.6246	1.6240	41.265	41.250
.060	1.52	1.6883	1.6879	42.883	42.873	1.6871	1.6865	42.852	42.837
.060	1.52	1.6883	1.6879	42.883	42.873	1.6871	1.6865	42.852	42.837
.060	2.03	1.7508	1.7504	44.470	44.460	1.7496	1.7490	44.440	44.425
.060	2.03	1.7508	1.7504	44.470	44.460	1.7496	1.7490	44.440	44.425
.080	2.03	2.0010	2.0004	50.825	50.810	1.9996	1.9938	50.790	50.643
.080	2.03	2.2510	2.2504	57.175	57.160	2.2496	2.2488	57.140	57.120
.080	2.03	2.2510	2.2504	57.175	57.160	2.4996	2.4988	63.490	63.470
.080	2.03	2.7510	2.7504	69.875	69.860	2.7496	2.7488	69.840	69.820
.080	2.03	2.7510	2.7504	69.875	69.860	2.7496	2.7488	69.840	69.820
.080	2.03	3.0010	3.0004	76.225	76.210	2.9996	2.9988	76.190	76.170

Yoke Type Cam Followers

The extensive range of INA yoke type cam followers comprises a variety of solutions suitable for all types of pressures rollers, eccentric rollers or valve rocker rollers.

INA cam followers have a heavy section outer ring with a straight roller profile. A crowned roller to overcome edge loading conditions is available upon request.

When a cam follower is rolling on a flat track or cam surface, the point load on the outer ring causes bending stresses not encountered in a housing mounted ring. A reduction in the effective load ratings results. Dynamic and static ratings C_W and C_{0W} which account for the added outer ring bending stresses are therefore less than those calculated by basic load rating formulas (C and C_0).

While basic load ratings are listed for comparison, the effective ratings C_W and C_{0W} must be used to calculate B-10 life and the static safety factor. For dynamic loads, the loading ratio must be not less than $C_W/P=1$.

A complete line of metric yoke type cam followers is also available.

INA Yoke Type Cam Followers RF and RF. .PP, see pages 100 to 103

Cam followers of series RF consist of an outer ring, inner ring and a full compliment of needle rollers.

Retaining washers are pressed onto both sides of the inner ring to form an integral unit with the other components.

In comparison with cage guided cam followers of series RFC, cam followers of the RF series are suitable for heavier loads, but at lower speeds. In addition, frequent lubrication is required. These cam followers are preferably used for bearing arrangements without suitable lateral guiding faces. Thrust loads occurring due to misalignment or skewing are taken by the thrust washers. It is recommended to support the washers axially to their outside diameter "d₁" listed in the dimension tables. If thrust loads occur, the cam followers must be axially located.

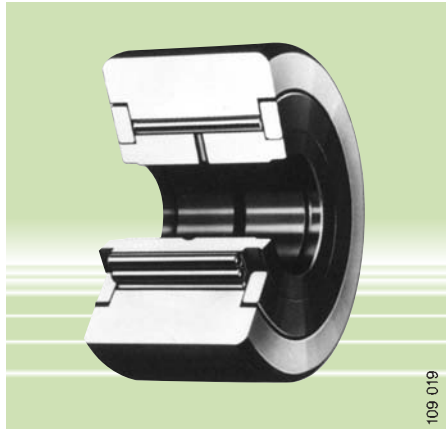
Cam followers of series RF are also available with seals (suffix "PP") and can be used for operating temperatures of -20 to +210°F (-30 to +100°C).

INA Yoke Type Cam Followers RFC and RFC. .PP, see pages 102 to 105

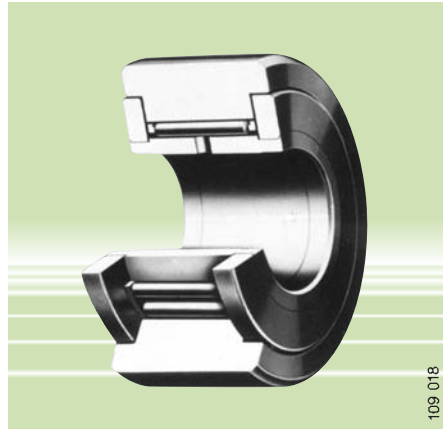
Series RFC and RFC. .PP are basically the same design as series RF, except that the needles are cage guided. Since large grease storage space is available, longer relubrication intervals can be scheduled. These cam followers are suitable for high loads at medium speeds.

Cam followers of series RFC are also available with seals (suffix "PP") and can be used for operating temperatures of -20 to +210°F (-30 to +100°C). For all other features, refer to series RF.

Series • INA yoke type cam followers are available in the following designs:	
Series	Description
RF RF...PP	with full complement of needle rollers, gap seals with contact seals
RFC RFC...PP	with cage guided needle rollers, gap seals with contact seals



Series RF



Series RFC

Standard Design

INA inch type cam followers are normally supplied with a straight cylindrical outside diameter. The bearing tolerances are specified in the dimension tables.

All INA cam followers are supplied prelubricated with a high-grade lithium base grease which is suitable for operating temperatures of -20 to $+250^{\circ}\text{F}$ (-30 to $+120^{\circ}\text{C}$). Temperature limits for the seals are stated with each series description. For re-lubrication, all inner rings are provided with lubrication grooves.

Special Design

INA cam followers are available with a crowned outside diameter to relieve edge loading of the rollers in applications where misalignment is a problem. When a crowned outside profile is required, add suffix "Y".

Mounting Tolerances

INA yoke type cam followers generally have a stationary load on the inner ring. We therefore recommend the shaft tolerances given in the dimension tables. A

press fit is recommended for heavily loaded applications, and the shaft should be hardened. On lightly loaded applications, a slip fit may be used on a soft shaft. If possible, the cam follower should be clamped axially to prevent movement on the shaft, or at least the axial clearance should be minimized.

Installation

INA yoke type cam followers must be mounted with the lubrication hole in the unloaded zone.

Additional information in section "Technical Data"

Page	Description
14	Load carrying capacity and life
26	Lubrication and maintenance
34	Design of bearing arrangements
6	Suffixes

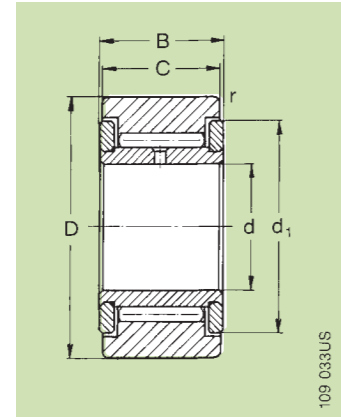




Yoke Type Cam Followers

cage guided and full complement
with and without seals

Series RF, RF...PP
RFC, RFC...PP



Series RF ¹⁾

Dimension Table • Dimensions in inch and mm

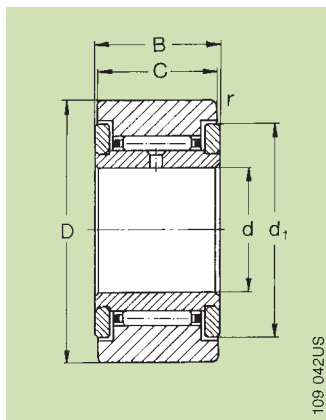
Roller Dia. nom inch	Part Number 1)	Cam Follower Dimensions											
		Inside Diameter d				Roller Dia. ²⁾ D		Roller Width C		Width B		Corner Radius r	
		inch		mm		inch	mm	inch	mm	inch	mm	inch	mm
3/4	RF 12	.2496	.2502	6.340	6.355	.7500	19.050	.500	12.70	.562	14.29	.020	0.5
	RFC 12	.2496	.2502	6.340	6.355	.7500	19.050	.500	12.70	.562	14.29	.020	0.5
7/8	RF 14	.2496	.2502	6.340	6.355	.8750	22.225	.500	12.70	.562	14.29	.039	1.0
	RFC 14	.2496	.2502	6.340	6.355	.8750	22.225	.500	12.70	.562	14.29	.039	1.0
1	RF 16	.3121	.3127	7.927	7.943	1.0000	25.400	.625	15.88	.687	17.46	.039	1.0
	RFC 16	.3121	.3127	7.927	7.943	1.0000	25.400	.625	15.88	.687	17.46	.039	1.0
1 1/8	RF 18	.3121	.3127	7.827	7.943	1.1250	28.575	.625	15.88	.687	17.46	.039	1.0
	RFC 18	.3121	.3127	7.827	7.943	1.1250	28.575	.625	15.88	.687	17.46	.039	1.0
1 1/4	RF 20	.3746	.3752	9.515	9.530	1.2500	31.750	.750	19.05	.812	20.64	.039	1.0
	RFC 20	.3746	.3752	9.515	9.530	1.2500	31.750	.750	19.05	.812	20.64	.039	1.0
1 3/8	RF 22	.3746	.3752	9.515	9.530	1.3750	34.925	.750	19.05	.812	20.64	.039	1.0
	RFC 22	.3746	.3752	9.515	9.530	1.3750	34.925	.750	19.05	.812	20.64	.039	1.0
1 1/2	RF 24	.4371	.4377	11.102	11.118	1.5000	38.100	.875	22.23	.937	23.81	.059	1.5
	RFC 24	.4371	.4377	11.102	11.118	1.5000	38.100	.875	22.23	.937	23.81	.059	1.5
1 5/8	RF 26	.4371	.4377	11.102	11.118	1.6250	41.275	.875	22.23	.937	23.81	.059	1.5
	RFC 26	.4371	.4377	11.102	11.118	1.6250	41.275	.875	22.23	.937	23.81	.059	1.5
1 3/4	RF 28	.4996	.5002	12.690	12.705	1.7500	44.450	1.000	25.40	1.062	26.99	.079	2.0
	RFC 28	.4996	.5002	12.690	12.705	1.7500	44.450	1.000	25.40	1.062	26.99	.079	2.0
1 7/8	RF 30	.4996	.5002	12.690	12.705	1.8750	47.625	1.000	25.40	1.062	26.99	.079	2.0
	RFC 30	.4996	.5002	12.690	12.705	1.8750	47.625	1.000	25.40	1.062	26.99	.079	2.0
2	RF 32	.6246	.6252	15.865	15.880	2.0000	50.800	1.250	31.75	1.312	33.34	.079	2.0
	RFC 32	.6246	.6252	15.865	15.880	2.0000	50.800	1.250	31.75	1.312	33.34	.079	2.0
2 1/4	RF 36	.6246	.6252	15.865	15.880	2.2500	57.150	1.250	31.75	1.312	33.34	.079	2.0
	RFC 36	.6246	.6252	15.865	15.880	2.2500	57.150	1.250	31.75	1.312	33.34	.079	2.0
2 1/2	RF 40	.7496	.7502	19.040	19.055	2.5000	63.500	1.500	38.10	1.562	39.69	.098	2.5
	RFC 40	.7496	.7502	19.040	19.055	2.5000	63.500	1.500	38.10	1.562	39.69	.098	2.5
2 3/4	RF 44	.7496	.7502	19.040	19.055	2.7500	69.850	1.500	38.10	1.562	39.69	.098	2.5
	RFC 44	.7496	.7502	19.040	19.055	2.7500	69.850	1.500	38.10	1.562	39.69	.098	2.5

1) For crowned outside diameter, add suffix "Y", e.g. RF 36 Y.

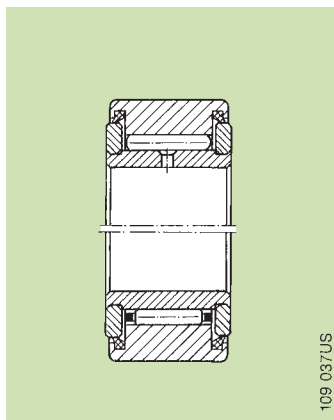
For sealed version, add suffix "PP", e.g. RF 36 PP.

2) For crowned roller outside diameter, a tolerance of 0 to -0.002" / 0 to -0.051mm applies.

Series RF...PP 1)



Series RFC 1)



Series RFC...PP 1)

Load Ratings in lbf				Limiting Speed 4)	Mounting Dimensions in inch and mm									
Basic		Track Roller 3)			Shaft Diameter								Clamping Diameter d ₁	
dyn. C	static C ₀	dyn. C _w	static C _{0w}		slip fit				press fit				min	
				rpm	inch max	inch min	mm max	mm min	inch max	inch min	mm max	mm min	inch	mm
1830	2900	1140	1650	6000	.2497	.2493	6.342	6.332	.2505	.2501	6.363	6.353	.500	12.7
950	1060	670	750	17000	.2497	.2493	6.342	6.332	.2505	.2501	6.363	6.353	.500	12.7
1830	2900	1420	2220	6000	.2497	.2493	6.342	6.332	.2505	.2501	6.363	6.353	.500	12.7
950	1060	820	960	17000	.2497	.2493	6.342	6.332	.2505	.2501	6.363	6.353	.500	12.7
2700	4300	1950	3000	5000	.3122	.3118	7.930	7.920	.3130	.3126	7.950	7.940	.594	15.1
1530	1780	1240	1480	13000	.3122	.3118	7.930	7.920	.3130	.3126	7.950	7.940	.594	15.1
2700	4300	2190	3550	5000	.3122	.3118	7.930	7.920	.3130	.3126	7.950	7.940	.594	15.1
1530	1780	1360	1700	13000	.3122	.3118	7.930	7.920	.3130	.3126	7.950	7.940	.594	15.1
4300	6300	3300	4800	4400	.3747	.3743	9.517	9.507	.3755	.3751	9.538	9.528	.750	19.1
2700	2950	2230	2550	10000	.3747	.3743	9.517	9.507	.3755	.3751	9.538	9.528	.750	19.1
4300	6300	3600	5400	4400	.3747	.3743	9.517	9.507	.3755	.3751	9.538	9.528	.750	19.1
2700	2950	2390	2850	10000	.3747	.3743	9.517	9.507	.3755	.3751	9.538	9.528	.750	19.1
5500	9100	4200	6900	3400	.4372	.4368	11.105	11.095	.4380	.4376	11.125	11.115	.891	22.6
3600	4550	3000	3950	7500	.4372	.4368	11.105	11.095	.4380	.4376	11.125	11.115	.891	22.6
5500	9100	4500	7700	3400	.4372	.4368	11.105	11.095	.4380	.4376	11.125	11.115	.891	22.6
3600	4550	3200	4300	7500	.4372	.4368	11.105	11.095	.4380	.4376	11.125	11.115	.891	22.6
6800	12800	5000	9000	2700	.4997	.4993	12.692	12.682	.5007	.5003	12.718	12.708	1.047	26.6
4450	6400	3550	5100	5000	.4997	.4993	12.692	12.682	.5007	.5003	12.718	12.708	1.047	26.6
6800	12800	5400	10000	2700	.4997	.4993	12.692	12.682	.5007	.5003	12.718	12.708	1.047	26.6
4450	6400	3750	5600	5000	.4997	.4993	12.692	12.682	.5007	.5003	12.718	12.708	1.047	26.6
10100	20000	7200	13700	2300	.6247	.6243	15.867	15.857	.6257	.6253	15.893	15.883	1.203	30.6
6900	10600	5400	8300	4100	.6247	.6243	15.867	15.857	.6257	.6253	15.893	15.883	1.203	30.6
10100	20000	8100	16400	2300	.6247	.6243	15.867	15.857	.6257	.6253	15.893	15.883	1.203	30.6
6900	10600	6000	9600	4100	.6247	.6243	15.867	15.857	.6257	.6253	15.893	15.883	1.203	30.6
13100	27000	10400	21300	2000	.7497	.7493	19.042	19.032	.7507	.7503	19.068	19.058	1.375	34.9
8700	13400	7400	11700	3300	.7497	.7493	19.042	19.032	.7507	.7503	19.068	19.058	1.375	34.9
13100	27000	11200	23400	2000	.7497	.7493	19.042	19.032	.7507	.7503	19.068	19.058	1.375	34.9
8700	13400	7800	12800	3300	.7497	.7493	19.042	19.032	.7507	.7503	19.068	19.058	1.375	34.9

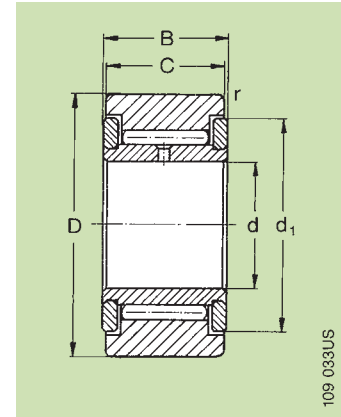
3) The basic load ratings C and C₀ apply if the bearing outer ring (with cylindrical outside surface) is mounted into a housing with standard bearing fit; when used as track roller, the load ratings C_w and C_{0w} apply.

4) Limiting speed shown is for grease lubrication. With oil lubrication, the speed can be increased by approx. 30% except for sealed executions.

Yoke Type Cam Followers

cage guided and full complement
with and without seals

Series RF, RF...PP
RFC, RFC...PP



Series RF 1)

Dimension Table • Dimensions in inch and mm

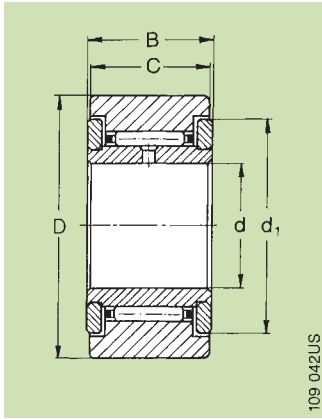
Roller Dia. nom inch	Part Number 1)	Cam Follower Dimensions											
		Inside Diameter d				Roller Dia. 2)		Roller Width C		Width B		Corner Radius r	
		inch		mm		inch	mm	inch	mm	inch	mm	inch	mm
3	RF 48	.9996	1.0002	25.390	25.405	3.0000	76.200	1.750	44.45	1.812	46.04	.118	3.0
	RFC 48	.9996	1.0002	25.390	25.405	3.0000	76.200	1.750	44.45	1.812	46.04	.118	3.0
3 1/4	RF 52	.9996	1.0002	25.390	25.405	3.2500	82.550	1.750	44.45	1.812	46.04	.118	3.0
	RFC 52	.9996	1.0002	25.390	25.405	3.2500	82.550	1.750	44.45	1.812	46.04	.118	3.0
3 1/2	RF 56	1.1246	1.1252	28.565	28.580	3.5000	88.900	2.000	50.80	2.062	52.39	.118	3.0
	RFC 56	1.1246	1.1252	28.565	28.580	3.5000	88.900	2.000	50.80	2.062	52.39	.118	3.0
4	RF 64	1.2496	1.2502	31.740	31.755	4.0000	101.600	2.250	57.15	2.312	58.74	.118	3.0
	RFC 64	1.2496	1.2502	31.740	31.755	4.0000	101.600	2.250	57.15	2.312	58.74	.118	3.0

1) For crowned outside diameter, add suffix "Y", e.g. RF 36 Y.

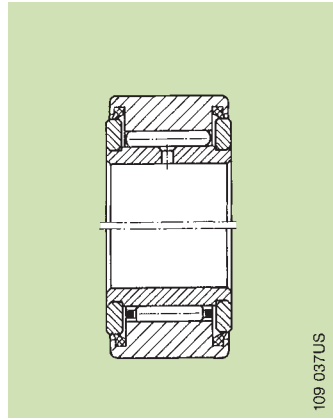
For sealed version, add suffix "PP", e.g. RF 36 PP.

2) For crowned roller outside diameter, a tolerance of 0 to -0.002" / 0 to -0.051mm applies.

Series RF...PP 1)



Series RFC 1)



Series RFC...PP 1)

Load Ratings in lbf				Limiting Speed 4)	Mounting Dimensions in Inch and mm									
Basic		Track Roller 3)			Shaft Diameter								Clamping Diameter d ₁	
dyn. C	static C ₀	dyn. C _w	static C _{0w}		slip fit				press fit				min	
				rpm	inch		mm		inch		mm		inch	mm
					max	min	max	min	max	min	max	min		
18200	39500	14300	31500	1600	.9996	.9991	25.390	25.377	1.0008	1.0003	25.420	25.408	1.750	44.5
12400	20900	10500	18300	2400	.9996	.9991	25.390	25.377	1.0008	1.0003	25.420	25.408	1.750	44.5
18200	39500	15200	34500	1600	.9996	.9991	25.390	25.377	1.0008	1.0003	25.420	25.408	1.750	44.5
12400	20900	11000	19500	2400	.9996	.9991	25.390	25.377	1.0008	1.0003	25.420	25.408	1.750	44.5
23200	52000	19000	43000	1400	1.1246	1.1241	28.565	28.552	1.1258	1.1253	28.595	28.583	1.922	48.8
15900	27500	13900	25000	2100	1.1246	1.1241	28.565	28.552	1.1258	1.1253	28.595	28.583	1.922	48.8
30000	67000	25000	58000	1300	1.2496	1.2491	31.740	31.727	1.2508	1.2503	31.770	31.758	2.281	57.9
20700	35500	18400	33000	1700	1.2496	1.2491	31.740	31.727	1.2508	1.2503	31.770	31.758	2.281	57.9

3) The basic load ratings C and C₀ apply if the bearing outer ring (with cylindrical outside surface) is mounted into a housing with standard bearing fit; when used as track roller, the load ratings C_w and C_{0w} apply.

4) Limiting speed shown is for grease lubrication. With oil lubrication, the speed can be increased by approx. 30% except for sealed executions.

Stud Type Cam Followers

INA stud type cam followers are ready to use track rollers. They consist of a thick section outer ring, a threaded stud which also provides the inner race, a cage and roller assembly or a full complement of rollers, and a retaining washer to hold the assembly together.

When a cam follower is rolling on a flat track or cam surface, the point load on the outer ring causes bending stresses not encountered in a housing mounted ring. A reduction in the effective load ratings results. Dynamic and static ratings C_W and C_{0W} which account for the added outer ring bending stresses are therefore less than those calculated by basic load rating formulas (C and C_0).

While basic load ratings are listed for comparison, the effective ratings C_W and C_{0W} must be used to calculate B-10 life and the static safety factor. For dynamic loads, the loading ratio must not be less than $C_W/P=1$.

A complete line of metric stud type cam followers is also available.

INA Stud Type Cam Followers CF and CF. . .PP, see pages 108 to 111

In the CF and CF. . .PP series with a full complement of needle rollers, the outer ring is axially guided between the stud flange and a press fitted thrust washer.

While heavier loads can be accommodated, the grease capacity and limiting speed are less than those of the caged version CFC. Care must be taken so that the maximum shock loads occurring do not exceed the values C_{0W} given in the dimension tables. In addition, frequent lubrication is required.

Cam followers of series CF are also available with seals (suffix "PP") and can be used for operating temperatures of -20 to +210°F (-30 to +100°C).

INA Stud Type Cam Followers FCF and CFC. . .PP, see pages 110 to 113

Series CFC and CFC. . .PP are dimensionally the same as series CF, except that the needle rollers are cage guided. The cage guided version is suitable for higher speed applications. Since large grease storage space is available, longer relubrication intervals can be achieved. Cam followers of series CFC are also available with seals (suffix "PP") and can be used for operating temperatures of -20 to +210°F (-30 to 100°C). For all other design features, refer to series CF.

Series		INA stud type cam followers are available in the following designs:
Series	Description	
CF CFE	with full complement of needle rollers, gap seals with eccentric collar	
CF...SK, CFE...SK CF...PP, CFE...PP	with hexagonal socket with contact seals	
CFC CFCE	with cage guided needle rollers, gap seals with eccentric collar	
CFC...SK, CFCE...SK CFC...PP, CFCE...PP	with hexagonal socket with contact seals	



Series CF



Series CFC



Series CF. . .PP

INA Stud Type Cam Followers with Hexagonal Socket

All INA stud cam followers can be supplied with a screw driver slot or a hexagonal socket in the face of the stud (figure 1). Add suffix "SK" to the part number for the hexagonal socket version, for example: CF 14 SK.

Relubrication provisions are made through the threaded part of the stud.

Table 1 • Socket wrench size

Part number suffix	Socket size inch
8-1	1/8
10-1	1/8
12	3/16
14	3/16
16	1/4
18	1/4
20	1/4
22	1/4
24	5/16
26	5/16
28	5/16
30	5/16
32	7/16
36	7/16
40	1/2
44	1/2
48	5/8
52	5/8
56	5/8
64	3/4

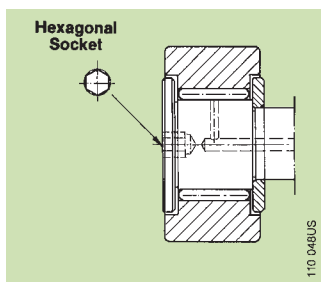


Figure 1

For proper socket wrench sizes, refer to table 1.

INA Stud Type Cam Followers with Eccentric Collar

All INA stud type cam followers are available with eccentric collars, add suffix "E" to the part number. They provide a radial adjustment of the outer ring by using the slot on the flanged side of the stud. The marking INA on the stud face indicates the highest point of the eccentric collar. Relubrication is possible through the stud from both ends. Eccentric collar dimensions are given in table 2.

Accessories

Closing plugs: The ends of the lubrication hole in the stud are counterbored to take standard press fitted lube fittings and a plug (figure 2) is supplied with the bearing to close the unused hole. The lube fittings are not supplied, but can be easily obtained from recognized suppliers.

Dimensions for the recommended installation arbor for the closing plug are listed in table 3.

Standard Design

All inch type cam followers are normally supplied with a **straight** cylindrical outside diameter. The bearing tolerances are specified in the dimension tables.

All INA cam followers are supplied prelubricated with a high grade lithium base grease. The operating temperature ranges from -20 to +250°F (-30 to +120°C). In all but the two smallest sizes a lubrication hole is drilled through the center of the stud. Cross holes are drilled from the inner raceway and from the unthreaded portion of the stud shank. The holes permit relubrication through either end of the stud or through the housing.

Special Design

INA cam followers can be supplied with a crowned outside profile to relieve edge loading of the rollers in applications where misalignment is a problem. The suffix "Y" should be added to the part number when a crowned outside diameter profile is required, for example: CF 24 Y.

Mounting

The stud mounting bore diameters shown in the tables are chosen to give a minimum clearance so that the stud is well supported. The edge of the housing which supports the stud shank should be kept as sharp as possible and free of burrs to obtain an optimum support surface. A chamfer of $.020''/0.50\text{mm} \times 45^\circ$ is permissible.

The thrust washer of the cam follower should be supported firmly by a flat shoulder. The shoulder diameter should meet at least the minimum dimension "d₂" listed in the dimension tables.

Avoid hammering on the shoulder of the stud. When installing with standard nuts, use the recommended tightening torque given in the dimension table. Based on this torque, the maximum load ratings C_{0W} listed in the dimension tables will apply. Self-locking nuts require a higher tightening torque.

The screw driver slot on the flanged end of the stud serves to prevent the stud from turning when the nut is tightened and to adjust the cam followers with an eccentric collar.

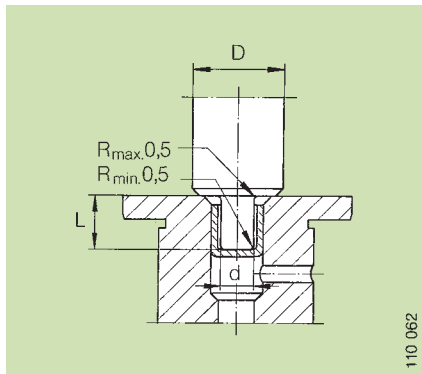
If possible, the lubrication hole in the inner raceway should be in the unloaded area. Its position is marked with the INA logo on the face. The second hole (M₁) in the stud on larger size cam followers can be used for locking pins or for relubrication.

Table 2 • Eccentric Collar Dimensions for Series CFE and CFCE

Size	Outside diameter d ₁		Width B ₃		Eccentricity e	
	+0.001 -0.001	+0.025 -0.025	+0.000 -0.010	+0.00 -0.25	Inch	mm
	inch	mm	inch	mm		
8-1	.250	6.350	.375	9.53	.010	0.25
10-1	.375	9.525	.437	11.10	.015	0.38
12	.500	12.700	.500	12.70	.015	0.38
14	.500	12.700	.500	12.70	.015	0.38
16	.625	15.875	.500	12.70	.030	0.76
18	.625	15.875	.500	12.70	.030	0.76
20	.687	17.450	.625	15.88	.030	0.76
22	.687	17.450	.625	15.88	.030	0.76
24	.875	22.225	.750	19.05	.030	0.76
26	.875	22.225	.750	19.05	.030	0.76
28	1.000	25.400	.875	22.23	.030	0.76
30	1.000	25.400	.875	22.23	.030	0.76
32	1.187	30.150	1.000	25.40	.030	0.76
36	1.187	30.150	1.000	25.40	.030	0.76
40	1.375	34.925	1.125	28.58	.030	0.76
44	1.375	34.925	1.125	28.58	.030	0.76
48	1.750	44.450	1.250	31.75	.060	1.52
52	1.750	44.450	1.250	31.75	.060	1.52
56	1.812	46.025	1.375	34.93	.060	1.52
64	2.000	50.800	2.000	50.80	.060	1.52

Table 3 · Closing Plugs

Plug number	Plug outside diameter		Arbor dimensions						for use with CF sizes
	nom		D		d		L		
	inch	mm	inch	mm	inch	mm	inch	mm	
VD 7 A	.126	3.2	.355	8.5	.094	2.4	.169	4.3	8-1 thru 10-1
VD 5 A	.189	4.8	.433	11.0	.138	3.5	.216	5.5	12 thru 44
VD 6 A	.252	6.4	.512	13.0	.201	5.1	.295	7.5	48 thru 64



**Additional information in section
“Technical Data”**

Page	Description
14	Load carrying capacity and life
26	Lubrication and maintenance
34	Design of bearing arrangements
6	Suffixes

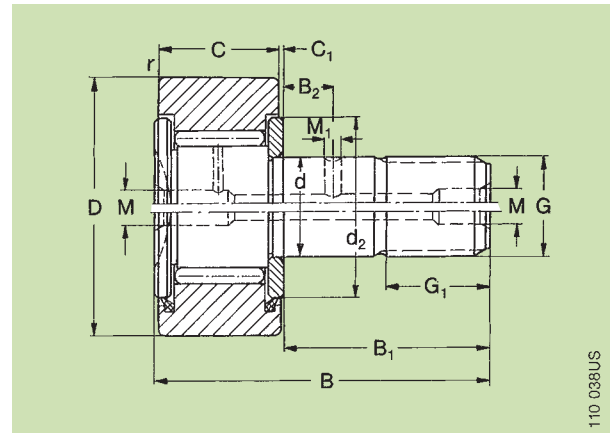
Figure 2

Stud Type Cam Followers

cage guided and full complement
with and without seals

Series CF, CF...PP, CFE, CFE...PP
CFC, CFC...PP, CFCE, CFCE...PP

Series CF¹⁾



110 038US

Series CF...PP¹⁾

Dimension Table • Dimensions in inch and mm

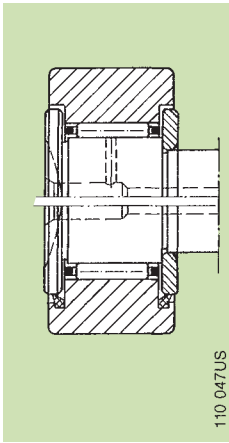
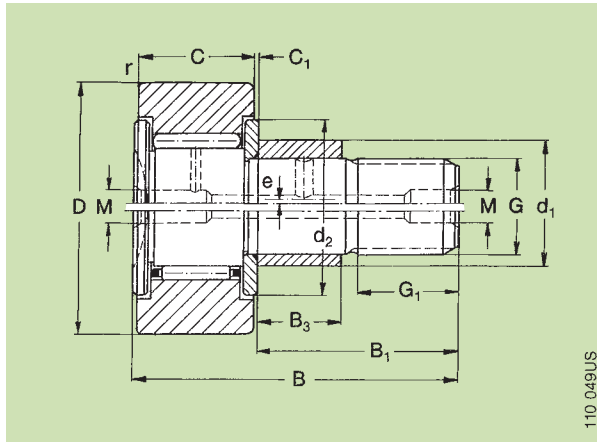
Roller Dia. nom inch	Part Number 1)	Part Number 1) 2) with eccentric collar	Cam Follower Dimensions													
			Roller Dia. ³⁾ D		Stud Dia. d		Roller Width C		Corner Radius r		Length B		Stud Length B ₁		Location B ₂	
			+0.0000 -0.0010 inch	+0.000 -0.025 mm	+0.0010 -0.0000 inch	+0.000 -0.025 mm	+0.000 -0.005 inch	+0.00 -0.13 mm	inch	mm	inch	mm	inch	mm	inch	mm
1/2	CF 8-1	CFE 8-1	.5000	12.700	.1900	4.826	.375	9.53	.012	0.3	1.031	26.2	.625	15.9	-	-
	CFC 8-1	CFCE 8-1	.5000	12.700	.1900	4.826	.375	9.53	.012	0.3	1.031	26.2	.625	15.9	-	-
5/8	CF 10-1	CFE 10-1	.6250	15.875	.2500	6.350	.438	11.13	.012	0.3	1.438	31.0	.750	19.0	-	-
	CFC 10-1	CFCE 10-1	.6250	15.875	.2500	6.350	.438	11.13	.012	0.3	1.438	31.0	.750	19.0	-	-
3/4	CF 12	CFE 12	.7500	19.050	.3750	9.525	.500	12.70	.020	0.5	1.406	35.7	.875	22.2	.250	6.4
	CFC 12	CFCE 12	.7500	19.050	.3750	9.525	.500	12.70	.020	0.5	1.406	35.7	.875	22.2	.250	6.4
7/8	CF 14	CFE 14	.8750	22.225	.3750	9.525	.500	12.70	.039	1.0	1.406	35.7	.875	22.2	.250	6.4
	CFC 14	CFCE 14	.8750	22.225	.3750	9.525	.500	12.70	.039	1.0	1.406	35.7	.875	22.2	.250	6.4
1	CF 16	CFE 16	1.0000	25.400	.4375	11.113	.625	15.88	.039	1.0	1.656	42.1	1.000	25.4	.250	6.4
	CFC 16	CFCE 16	1.0000	25.400	.4375	11.113	.625	15.88	.039	1.0	1.656	42.1	1.000	25.4	.250	6.4
1 1/8	CF 18	CFE 18	1.1250	28.575	.4375	11.113	.625	15.88	.039	1.0	1.656	42.1	1.000	25.4	.250	6.4
	CFC 18	CFCE 18	1.1250	28.575	.4375	11.113	.625	15.88	.039	1.0	1.656	42.1	1.000	25.4	.250	6.4
1 1/4	CF 20	CFE 20	1.2500	31.750	.5000	12.700	.750	19.05	.039	1.0	2.031	51.6	1.250	31.8	.312	7.9
	CFC 20	CFCE 20	1.2500	31.750	.5000	12.700	.750	19.05	.039	1.0	2.031	51.6	1.250	31.8	.312	7.9
1 3/8	CF 22	CFE 22	1.3750	34.925	.5000	12.700	.750	19.05	.039	1.0	2.031	51.6	1.250	31.8	.312	7.9
	CFC 22	CFCE 22	1.3750	34.925	.5000	12.700	.750	19.05	.039	1.0	2.031	51.6	1.250	31.8	.312	7.9
1 1/2	CF 24	CFE 24	1.5000	38.100	.6250	15.875	.875	22.23	.059	1.5	2.406	61.1	1.500	38.1	.375	9.5
	CFC 24	CFCE 24	1.5000	38.100	.6250	15.875	.875	22.23	.059	1.5	2.406	61.1	1.500	38.1	.375	9.5
1 5/8	CF 26	CFE 26	1.6250	41.275	.6250	15.875	.875	22.23	.059	1.5	2.406	61.1	1.500	38.1	.375	9.5
	CFC 26	CFCE 26	1.6250	41.275	.6250	15.875	.875	22.23	.059	1.5	2.406	61.1	1.500	38.1	.375	9.5

1) For crowned outside diameter, add suffix "Y", e.g. CF 36 Y.

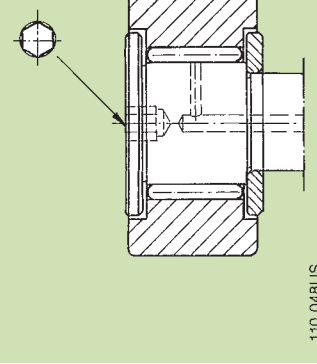
For sealed version, add suffix "PP", e.g. CF 36 PP.

2) For specific dimensions on the eccentric collar, see table 2 on page 108.

3) For crowned roller outside diameter, a tolerance of 0 to -0.002" / 0 to -0.051mm applies.

Series CFC¹⁾Series CFC...PP¹⁾Series CFE¹⁾Series CFE¹⁾

Hexagonal Socket

Series CF...SK⁷⁾

UNF Thread G	Thread Length G ₁ min inch mm		Lubrication Holes M nom inch mm M ₁ nom inch mm				Distance C ₁ nom inch mm		Load Ratings in lbf				Limiting Speed ⁵⁾ rpm	Mounting Dimensions in inch and mm						
									Basic		Track Roller			Stud Housing Diameter				Clamping Diameter d ₂		Clamp. Torque ⁶⁾ max lb. in.
									dyn. C	stat. C ₀	dyn. C _w ⁴⁾	stat. C _{0w}		min	max	min	max	min	max	
10-32	.250	6.4	.125	3.2	-	-	.031	0.8	850	1260	650	940	10000	.1900	.1905	4.826	4.839	.297	7.5	8
10-32	.250	6.4	.125	3.2	-	-	.031	0.8	405	415	345	380	25000	.1900	.1905	4.826	4.839	.297	7.5	8
1/4-28	.312	7.9	.125	3.2	-	-	.031	0.8	1080	1820	840	1410	9000	.2500	.2505	6.350	6.363	.359	9.1	19
1/4-28	.312	7.9	.125	3.2	-	-	.031	0.8	510	580	445	550	22000	.2500	.2505	6.350	6.363	.359	9.1	19
3/8-24	.375	9.5	.188	4.8	.125	3.2	.031	0.8	1830	2900	1140	1650	6000	.3750	.3755	9.525	9.538	.500	12.7	65
3/8-24	.375	9.5	.188	4.8	.125	3.2	.031	0.8	950	1060	670	750	17000	.3750	.3755	9.525	9.538	.500	12.7	65
3/8-24	.375	9.5	.188	4.8	.125	3.2	.031	0.8	1830	2900	1120	2220	6000	.3750	.3755	9.525	9.538	.500	12.7	65
3/8-24	.375	9.5	.188	4.8	.125	3.2	.031	0.8	950	1060	820	960	17000	.3750	.3755	9.525	9.538	.500	12.7	65
7/16-20	.500	12.7	.188	4.8	.125	3.2	.031	0.8	2700	4300	1950	3000	5000	.4375	.4380	11.113	11.125	.594	15.1	105
7/16-20	.500	12.7	.188	4.8	.125	3.2	.031	0.8	1530	1780	1240	1480	13000	.4375	.4380	11.113	11.125	.594	15.1	105
7/16-20	.500	12.7	.188	4.8	.125	3.2	.031	0.8	2700	4300	2190	3550	5000	.4375	.4380	11.113	11.125	.594	15.1	105
7/16-20	.500	12.7	.188	4.8	.125	3.2	.031	0.8	1530	1780	1360	1700	13000	.4375	.4380	11.113	11.125	.594	15.1	105
1/2-20	.625	15.9	.188	4.8	.125	3.2	.031	0.8	4300	6300	3300	4800	4400	.5000	.5005	12.700	12.713	.750	19.0	165
1/2-20	.625	15.9	.188	4.8	.125	3.2	.031	0.8	2700	2950	2230	2550	10000	.5000	.5005	12.700	12.713	.750	19.0	165
1/2-20	.625	15.9	.188	4.8	.125	3.2	.031	0.8	4300	6300	3600	5400	4400	.5000	.5005	12.700	12.713	.750	19.0	165
1/2-20	.625	15.9	.188	4.8	.125	3.2	.031	0.8	2700	2950	2390	2850	10000	.5000	.5005	12.700	12.713	.750	19.0	165
5/8-18	.750	19.0	.188	4.8	.125	3.2	.031	0.8	5500	9100	4200	6900	3400	.6250	.6255	15.875	15.888	.891	22.6	335
5/8-18	.750	19.0	.188	4.8	.125	3.2	.031	0.8	3600	4550	3000	3950	7500	.6250	.6255	15.875	15.888	.891	22.6	335
5/8-18	.750	19.0	.188	4.8	.125	3.2	.031	0.8	5500	9100	4500	7700	3400	.6250	.6255	15.875	15.888	.891	22.6	335
5/8-18	.750	19.0	.188	4.8	.125	3.2	.031	0.8	3600	4550	3200	4300	7500	.6250	.6255	15.875	15.888	.891	22.6	335

4) The basic load ratings C and C₀ apply if the bearing outer ring (with cylindrical outside surface) is mounted into a housing with standard bearing fit; when used as track roller, the load ratings C_w and C_{0w} apply.

5) Limiting speeds shown is for grease lubrication. With oil lubrication, the speed can be increased by approx. 30% except for sealed versions.

6) Clamping torque is based on lubricated threads. If threads are dry, double the values shown.

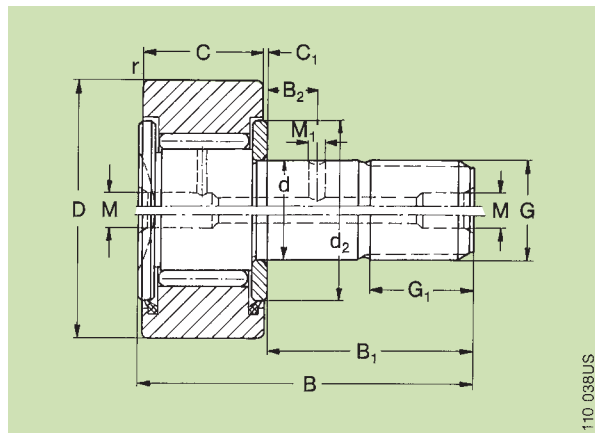
7) For hexagonal socket wrench sizes, see table 1 on page 105.

Stud Type Cam Followers

cage guided and full complement
with and without seals

Series CF, CF...PP, CFE, CFE...PP
CFC, CFC...PP, CFCE, CFCE...PP

Series CF¹⁾



110 038US

Series CF...PP¹⁾

Dimension Table • Dimensions in inch and mm

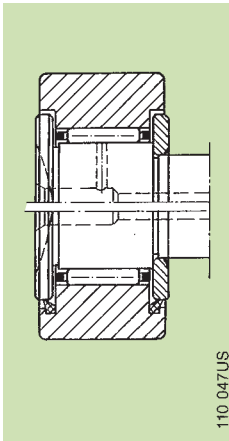
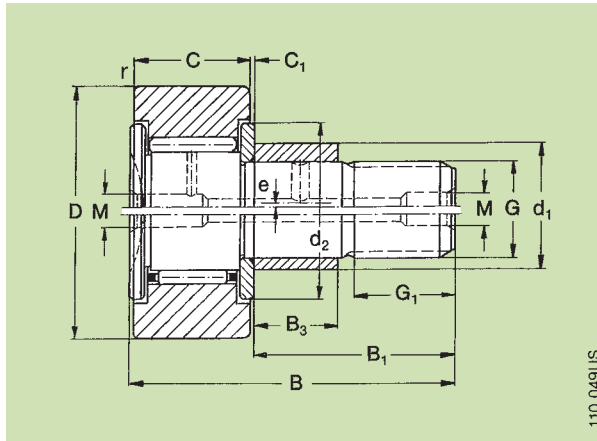
Roller Dia. nom inch	Part Number 1)	Part Number 1) 2) with eccentric collar	Cam Follower Dimensions													
			Roller Dia. ³⁾		Stud Dia.		Roller Width		Corner Radius r		Length B		Stud Length B ₁		Location B ₂	
			D +0.0000 -0.0010 inch	D +0.000 -0.025 mm	d +0.0010 -0.0000 inch	d +0.000 -0.025 mm	C +0.000 -0.005 inch	C +0.00 -0.13 mm	nom inch	nom mm	nom inch	nom mm	nom inch	nom mm	nom inch	nom mm
1 3/4	CF 28	CFE 28	1.7500	44.450	.7500	19.050	1.000	25.40	.079	2.0	2.781	70.6	1.750	44.4	.438	11.1
	CFC 28	CFCE 28	1.7500	44.450	.7500	19.050	1.000	25.40	.079	2.0	2.781	70.6	1.750	44.4	.438	11.1
1 7/8	CF 30	CFE 30	1.8750	47.625	.7500	19.050	1.000	25.40	.079	2.0	2.781	70.6	1.750	44.4	.438	11.1
	CFC 30	CFCE 30	1.8750	47.625	.7500	19.050	1.000	25.40	.079	2.0	2.781	70.6	1.750	44.4	.438	11.1
2	CF 32	CFE 32	2.0000	50.800	.8750	22.225	1.250	31.75	.079	2.0	3.281	83.3	2.000	50.8	.500	12.7
	CFC 32	CFCE 32	2.0000	50.800	.8750	22.225	1.250	31.75	.079	2.0	3.281	83.3	2.000	50.8	.500	12.7
2 1/4	CF 36	CFE 36	2.2500	57.150	.8750	22.225	1.250	31.75	.079	2.0	3.281	83.3	2.000	50.8	.500	12.7
	CFC 36	CFCE 36	2.2500	57.150	.8750	22.225	1.250	31.75	.079	2.0	3.281	83.3	2.000	50.8	.500	12.7
2 1/2	CF 40	CFE 40	2.5000	63.500	1.0000	25.400	1.500	38.10	.098	2.5	3.781	96.0	2.250	57.2	.562	14.3
	CFC 40	CFCE 40	2.5000	63.500	1.0000	25.400	1.500	38.10	.098	2.5	3.781	96.0	2.250	57.2	.562	14.3
2 3/4	CF 44	CFE 44	2.7500	69.850	1.0000	25.400	1.500	38.10	.098	2.5	3.781	96.0	2.250	57.2	.562	14.3
	CFC 44	CFCE 44	2.7500	69.850	1.0000	25.400	1.500	38.10	.098	2.5	3.781	96.0	2.250	57.2	.562	14.3
3	CF 48	CFE 48	3.0000	76.200	1.2500	31.750	1.750	44.45	.118	3.0	4.281	108.7	2.500	63.5	.625	15.9
	CFC 48	CFCE 48	3.0000	76.200	1.2500	31.750	1.750	44.45	.118	3.0	4.281	108.7	2.500	63.5	.625	15.9
3 1/4	CF 52	CFE 52	3.2500	82.550	1.2500	31.750	1.750	44.45	.118	3.0	4.281	108.7	2.500	63.5	.625	15.9
	CFC 52	CFCE 52	3.2500	82.550	1.2500	31.750	1.750	44.45	.118	3.0	4.281	108.7	2.500	63.5	.625	15.9
3 1/2	CF 56	CFE 56	3.5000	88.900	1.3750	34.925	2.000	50.80	.118	3.0	4.781	121.4	2.750	69.8	.688	17.5
	CFC 56	CFCE 56	3.5000	88.900	1.3750	34.925	2.000	50.80	.118	3.0	4.781	121.4	2.750	69.8	.688	17.5
4	CF 64	CFE 64	4.0000	101.600	1.5000	38.100	2.250	57.15	.118	3.0	5.781	146.8	3.500	88.9	.750	19.0
	CFC 64	CFCE 64	4.0000	101.600	1.5000	38.100	2.250	57.15	.118	3.0	5.781	146.8	3.500	88.9	.750	19.0

¹⁾ For crowned outside diameter, add suffix "Y", e.g. CF 36 Y.

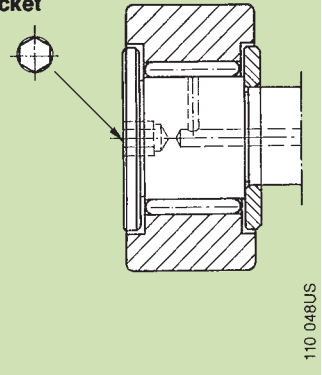
For sealed version, add suffix "PP", e.g. CF 36 PP.

²⁾ For specific dimensions on the eccentric collar, see table 2 on page 108.

³⁾ For crowned roller outside diameter, a tolerance of 0 to -0.002" / 0 to -0.051mm applies.

Series CFC¹⁾Series CFC...PP¹⁾Series CFE¹⁾Series CFCE¹⁾

Hexagonal Socket

Series CF...SK⁷⁾

UNF Thread G	Thread Length G ₁ min		Lubrication Holes				Distance C ₁		Load Ratings in lbf				Limiting Speed ⁵⁾ rpm	Mounting Dimensions in inch and mm						
									Basic		Track Roller			Stud Housing Diameter				Clamping Diameter d ₂		Clamp. Torque ⁶⁾ max lb.in.
									dyn. C	stat. C ₀	dyn. C _w ⁴⁾	stat. C _{0w}		min	max	min	max	min	max	
3/4-16	.875	22.2	.188	4.8	.125	3.2	.031	0.8	6800	12800	5000	9000	2700	.7500	.7505	19.050	19.063	1.047	26.6	600
3/4-16	.875	22.2	.188	4.8	.125	3.2	.031	0.8	4450	6400	3550	5100	5000	.7500	.7505	19.050	19.063	1.047	26.6	600
3/4-16	.875	22.2	.188	4.8	.125	3.2	.031	0.8	6800	12800	5400	10000	2700	.7500	.7505	19.050	19.063	1.047	26.6	600
3/4-16	.875	22.2	.188	4.8	.125	3.2	.031	0.8	4450	6400	3750	5600	5000	.7500	.7505	19.050	19.063	1.047	26.6	600
7/8-14	1.000	25.4	.188	4.8	.125	3.2	.031	0.8	10100	20000	7200	13700	2300	.8750	.8755	22.225	22.238	1.812	30.6	950
7/8-14	1.000	25.4	.188	4.8	.125	3.2	.031	0.8	6900	10600	5400	8300	4100	.8750	.8755	22.225	22.238	1.812	30.6	950
7/8-14	1.000	25.4	.188	4.8	.125	3.2	.031	0.8	10100	20000	8100	16400	2300	.8750	.8755	22.225	22.238	1.812	30.6	950
7/8-14	1.000	25.4	.188	4.8	.125	3.2	.031	0.8	6900	10600	6000	9600	4100	.8750	.8755	22.225	22.238	1.812	30.6	950
1-14 ⁸⁾	1.125	28.6	.188	4.8	.125	3.2	.031	0.8	13100	27000	10400	21300	2000	1.0000	1.0005	25.400	25.413	1.375	34.9	1450
1-14 ⁸⁾	1.125	28.6	.188	4.8	.125	3.2	.031	0.8	8700	13400	7400	11700	3300	1.0000	1.0005	25.400	25.413	1.375	34.9	1450
1-14 ⁸⁾	1.125	28.6	.188	4.8	.125	3.2	.031	0.8	13100	27000	11200	23400	2000	1.0000	1.0005	25.400	25.413	1.375	34.9	1450
1-14 ⁸⁾	1.125	28.6	.188	4.8	.125	3.2	.031	0.8	8700	13400	7800	12800	3300	1.0000	1.0005	25.400	25.413	1.375	34.9	1450
1 1/4-12	1.250	31.8	.250	6.4	.125	3.2	.031	0.8	18200	39500	14300	31500	1600	1.2500	1.2505	31.750	31.763	1.750	44.4	2250
1 1/4-12	1.250	31.8	.250	6.4	.125	3.2	.031	0.8	12400	20900	10500	18300	2400	1.2500	1.2505	31.750	31.763	1.750	44.4	2250
1 1/4-12	1.250	31.8	.250	6.4	.125	3.2	.031	0.8	18200	39500	15200	34500	1600	1.2500	1.2505	31.750	31.763	1.750	44.4	2250
1 1/4-12	1.250	31.8	.250	6.4	.125	3.2	.031	0.8	12400	20900	11000	19500	2400	1.2500	1.2505	31.750	31.763	1.750	44.4	2250
1 3/8-12	1.375	34.9	.250	6.4	.125	3.2	.031	0.8	23200	52000	19000	43000	1400	1.3750	1.3755	34.925	34.938	1.922	48.8	2750
1 3/8-12	1.375	34.9	.250	6.4	.125	3.2	.031	0.8	15900	27500	13900	25000	2100	1.3750	1.3755	34.925	34.938	1.922	48.8	2750
1 1/2-12	1.500	38.1	.250	6.4	.125	3.2	.031	0.8	30000	67000	25000	58000	1300	1.5000	1.5005	38.100	38.113	2.281	57.9	3050
1 1/2-12	1.500	38.1	.250	6.4	.125	3.2	.031	0.8	20700	35500	18400	33000	1700	1.5000	1.5005	38.100	38.113	2.281	57.9	3050

4) The basic load ratings C and C₀ apply if the bearing outer ring (with cylindrical outside surface) is mounted into a housing with standard bearing fit; when used as track roller, the load ratings C_w and C_{0w} apply.

5) Limiting speeds shown is for grease lubrication. With oil lubrication, the speed can be increased by approx. 30% except for sealed versions.

6) Clamping torque is based on lubricated threads. If threads are dry, double the values shown.

7) For hexagonal socket wrench sizes, see table 1 on page 105.

8) Sizes CF (C) (E) 40 and CF (C) (E) 44 have UNS instead of UNF thread.

Shell Type Roller Clutches

with and without bearing supports

INA shell type roller clutches have a small radial section equal in size to standard shell bearings. They transmit torque in one direction only allowing free wheeling in the opposite direction. They are used for indexing operations, backstopping and overrunning

A complete line of INA metric shell type roller clutches are also available.

INA Shell Type Roller Clutches, Series HFZ

Shell type roller clutches of series HFZ consist of a thin-walled drawn cup with ramps on the inside, a plastic cage with stainless steel springs and needle rollers. The ramp configuration is designed to minimize friction in the overrunning mode and backlash angle during engagement. The plastic cage ensures precise positioning and guiding of the needle rollers, which act as wedging elements.

The separate support needed to handle radial loads is best provided by placing INA shell bearings on each side or by utilizing a shell type roller clutch with integrated bearing supports, series HFLZ. If a support is needed on only one side, it should be placed in the loaded area.

If the boundary conditions do not allow the use of a roller clutch with sufficient torque capacity, two clutches can be mounted side by side.

INA Shell Type Roller Clutches, Series HFLZ

INA shell type roller clutches series HFLZ have two integral support bearings. The support bearings are arranged on either side of the clutch unit and handle radial loads. The support bearings consist of needle rollers retained by plastic cages.

The same design features as described for series HFZ apply for the clutch portion.

Torque Capacity

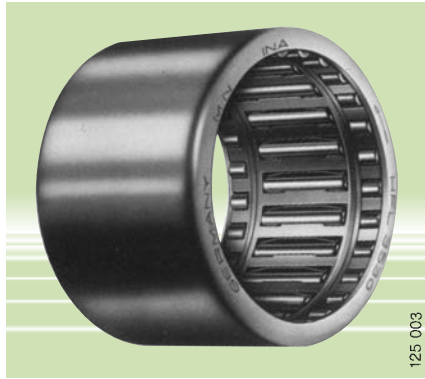
The maximum torque that can be transmitted, assuming that proper application recommendations are followed, depends largely on the configuration of shaft and housing (material, hardness, wall thickness). The stresses acting on the clutch can be supported only if sufficient housing strength is present.

The inertial moments must also be taken into account when evaluating the suitability of a clutch. Figure 1 shows the stresses on the housing and the minimum housing wall thickness for various torques. The amount of stress allowed should be lower than the strength of the housing material selected.

Series • INA shell type roller clutches are available in the following designs:	
Series	Description
HFZ	shell type roller clutch without bearing support
HFLZ	shell type roller clutch with integral bearing support



Series HF, HFZ



Series HFL, HFLZ

Examples

- S_{min} Minimum wall thickness required (inches)
- S_{eff} Actual wall thickness (inches)
- σ_v Equivalent stress (psi)
- % M_d Percentage of maximum rated torque

A given: Clutch HFZ 040708 Torque 90 % M_d
 Housing wall thickness .575" (14.6mm)
 from figure 1: Minimum wall thickness required to transmit the torque

$$S_{min} : .115" (2.92mm)$$

$$S_{min}/S_{eff} : 0.2$$

The stress on the housing is σ_v ;
 46000 psi (317 N/mm²)

B given: Clutch HFLZ 101416

Maximum allowable housing material stress
 40000 psi (275 N/mm²)

$$S_{min}/S_{eff} : 1$$

from figure 12: Minimum housing thickness:

$$S_{min} : .1" (2.5mm)$$

Maximum transmissible torque: 25 % M_d

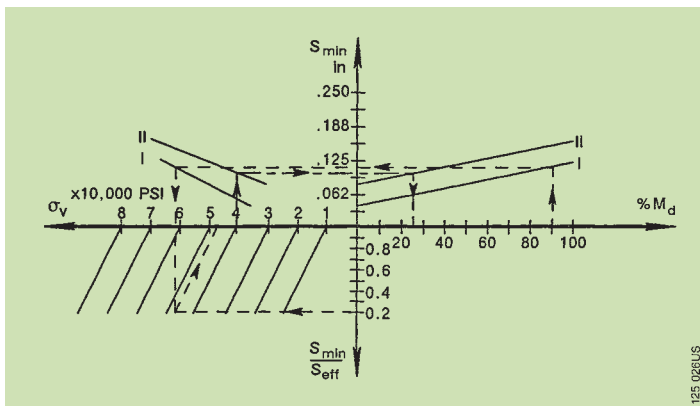
If the housing thickness can be increased so S_{min}/S_{eff} equals 0.5, then the new S_{min} is .125" (3.18mm) and the transmissible torque becomes 50% M_d for the same 40000 psi (275 N/mm²) max stress.

Indexing Frequency

Because of their low radial section height, INA shell type roller clutches have a very low moment of inertia. This combined with individually spring loaded needle rollers allows for high indexing frequencies. The driving torque should be transmitted through the shaft.

Indexing Accuracy

The needle rollers are retained individually to ensure continuous contact between shaft and ramps, thus allowing for a small reaction time which translates in high indexing accuracy. This accuracy depends not only on the indexing frequency, but also on the type of lubrication, the mounting fits, the elastic deformation of the housing and whether the system is driven through the shaft or the housing.



Curve I: HFZ 040708, HFZ 061008, HFLZ 061014

Curve II: HFZ 081208, HFZ 101410, HFZ 121610, HFLZ 081214, HFLZ 101416

Figure 1 • Minimum housing wall thickness as a function of torque

Friction

INA shell type roller clutches have a very low friction moment. Nominal values are shown in figure 2.

In the overrunning mode, the friction increases with increasing shaft speed. As the rotation speed of the outer ring increases, the clutch friction initially increases but then drops as a result of the centrifugal force, acting on the needle rollers. The limiting speed for this condition should not be exceeded since locking will no longer occur.

Mounting Tolerances

INA shell type roller clutches assume their final shape once assembled into the housing. No additional axial location is necessary. Housing tolerances shown in the dimension tables are for relatively heavy section steel or cast iron housings. For non-ferrous housing recommendations see table 1 and 2 on page 44.

A surface roughness of $32 \mu\text{in AA}$ ($R_a 0,8 \mu\text{m}$) should be maintained for the housing bore. The shaft raceway should be hardened and ground. A surface hardness of HV 670 to 840 (RC 58 to 65) is recommended. Proper clutch performance can only be guaranteed if recommended installation and mounting instructions are followed.

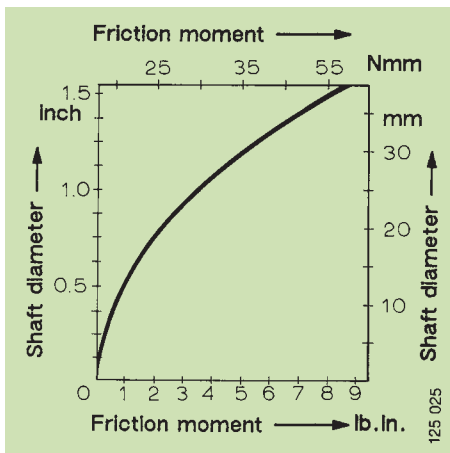


Figure 2 • Nominal friction moment of shell type roller clutches HFZ and HFLZ as a function of shaft diameter

Inspection

Roller clutches can only be inspected for proper operation when mounted in a ring gauge and tested with different shafts. The ring gauge should be through-hardened steel ring with a minimum wall thickness of $.75''$ (19.05 mm). The ring gauge bore and the shaft tolerances should conform to the limits listed in the dimension tables. A torque which is approximately 15% of the rated capacity should be used to verify engagement with the minimum shaft. Overrunning should still occur with the maximum shaft. The inspection dimensions for the bearing portion of roller clutches with integral bearing supports are shown in the dimension tables on page 119.

Temperatures

With suitable lubrication, INA shell type roller clutches can operate continuously in the temperature range of -20 to $+25^\circ\text{F}$ (-30 to $+120^\circ\text{C}$). For intermittent periods temperatures of up to $+300^\circ\text{F}$ ($+150^\circ\text{C}$) are permissible.

Lubrication

INA shell type roller clutches are suitable for either oil or grease lubrication, although oil lubrication is preferred. Oil levels should cover up to one third of the diameter of the clutch in the horizontal, non-operating condition. The oil viscosity should be no less than 15 centi-strokes at operating temperature. When using oil lubrication, the clutches should be ordered ungreased.

Grease lubrication is acceptable for most applications. INA shell type roller clutches are supplied prelubricated with a lithium based grease unless ordered otherwise. This grease will give satisfactory operation from +15°F to +160°F (+10°C to +70°C). The clutch is approximately 40% full of grease which is sufficient to protect the clutch without impeding the operation of the springs. Other greases may be required below 15°F (10°C), and/or for circumferential speeds above $0.7 \cdot n_g$. Oil lubrication is recommended for temperatures above +160°F (+70°C). Please consult the INA Engineering department for assistance on proper selection. To ensure proper distribution of the lubricant, the clutches should be relubricated or reoiled only when rotating.

Installation

For proper installation, the housing bore and shaft should be chamfered at an angle of approximately 15°. Shell type roller clutches should be pressed into the housing bore with an arbor that transmits the press-in force to the shell wall itself as shown in figure 3.

The diameter of the abutment shoulder D on the pressing arbor should be .008 to .012" (0.2 to 0.3mm) smaller than the housing bore diameter; the arbor diameter F_w should be .020" (.050mm) smaller than the shaft diameter. An O-ring on the pressing arbor serves to retain the bearing after it has been slid onto the arbor. This simplifies mounting of the bearings on production files. Mounting should be carried out using a press to prevent tilting of the clutch.

The clutches will lock when rotated in the direction of the arrow stamped on the end of the clutch. Care should be taken at the time of installation to properly orient the clutch for operation in the application. If the arrow of rotation is obscured for final assembly, some external marking should be used on the housing.

Additional information in section "Technical Data"

Page	Description
34	Design of bearing arrangements

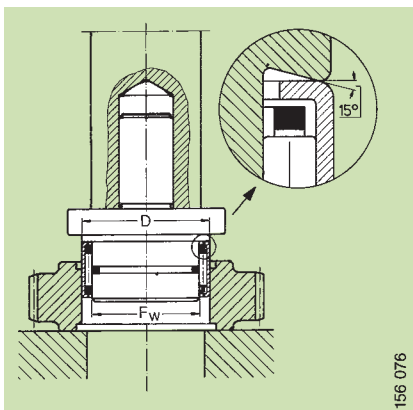
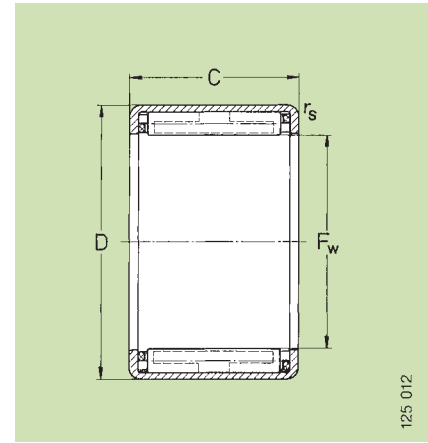


Figure 3 • INA press-in tool with a 15° chamfer relief

Shell Type Roller Clutches

Series HFZ without bearing supports
HFLZ with bearing supports



Series HFZ

125 012

Dimension Table • Dimensions in inch and mm

Shaft Dia. nom inch	Part Number	Roller Clutch Dimensions								Torque Rating Md lb. in.	Limiting Speed ³⁾	
		Inside Diameter F_w		Outside Diameter D		Width C		Corner Radius r_s			n rpm	n _A ⁴⁾ rpm
		nom inch	mm	nom inch	mm	+0.000 -0.010 inch	+0.00 -0.025 mm	min inch	mm			
1/4	HFZ 040708 ¹⁾	.2500	6.350	.4375	11.113	.500	12.70	.03	0.8	18.6	21000	12000
3/8	HFZ 061008	.3750	9.525	.6250	15.875	.500	12.70	.03	0.8	50.4	14000	12000
1/2	HFZ 081208	.5000	12.700	.7500	19.050	.500	12.70	.03	0.8	85.9	11000	9000
5/8	HFZ 101410	.6250	15.875	.8750	22.225	.625	15.88	.03	0.8	175.2	8500	5000
3/4	HFZ 121610 ²⁾	.7500	19.050	1.0000	25.400	.625	15.88	.03	0.8	247.8	7000	4400
1	HFZ 162110	1.000	25.400	1.313	33.35	.625	15.88	.03	0.8	442.5	5300	5000

Dimension Table • Dimensions in inch and mm

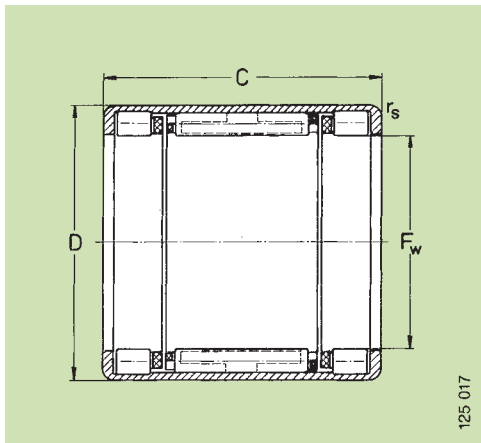
Shaft Dia. nom inch	Part Number	Roller Clutch Dimensions								Torque Rating Md lb. in.	Limiting Speed ³⁾		Load Ratings	
		Inside Diameter F_w		Outside Diameter D		Width C		Corner Radius r_s			n rpm	n _A ⁴⁾ rpm	dynamic	static
		nom inch	mm	nom inch	mm	+0.000 -0.008 inch	+0.00 -0.20 mm	min inch	mm				C lbf	C ₀ lbf
3/8	HFLZ 061014	.3750	9.525	.6250	15.875	.875	22.22	.03	0.8	50.4	14000	12000	1350	1240
1/2	HFLZ 081214	.5000	12.700	.7500	19.050	.875	22.22	.03	0.8	85.9	11000	9000	1720	1550
5/8	HFLZ 101416	.6250	15.875	.8750	22.225	1.000	25.40	.03	0.8	175.2	8500	5000	1720	1890

¹⁾ This size is also available with plastic springs, HFZ 040708 KF, for a maximum operating temperature of +60°C (+140°F)

²⁾ Check for availability

³⁾ Limiting speeds shown apply for grease and oil lubrication.

⁴⁾ Permissible speed with rotating outer ring.



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Series HFLZ

Clutch Inspection Data						Mounting Dimensions in inch and mm								Shell ⁶⁾ Bearing for Radial Load Support order separate
Ring Gauge Diameter		Locking Diameter		Overrunning Diameter		Shaft Diameter ⁵⁾ F				Housing Diameter ⁵⁾ G				
inch	mm	inch	mm	inch	mm	max	min	max	mm min	inch min	max	mm min	max	
.4380	11.125	.2495	6.337	.2513	6.383	.2500	.2495	6.350	6.337	.4370	.4380	11.100	11.125	SCE 44
.6255	15.888	.3745	9.512	.3763	9.558	.3750	.3745	9.525	9.512	.6245	.6255	15.862	15.888	SCH 68
.7505	19.063	.4995	12.687	.5013	12.733	.5000	.4995	12.700	12.687	.7495	.7505	19.037	19.063	SCH 87
.8755	22.238	.6245	15.862	.6263	15.908	.6250	.6245	15.875	15.862	.8745	.8755	22.212	22.238	SCH 108
.995	25.387	.7485	19.012	.7501	19.052	.7500	.7495	19.050	19.037	.9995	1.0005	25.387	25.413	SCH 126
1.3130	33.350	.9987	25.367	1.0013	25.433	1.000	.9987	25.400	25.367	1.312	1.313	33.325	33.350	SCH 168

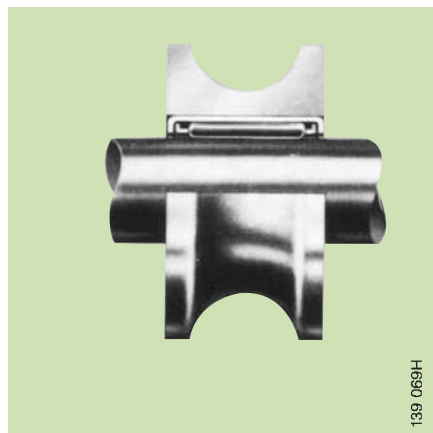
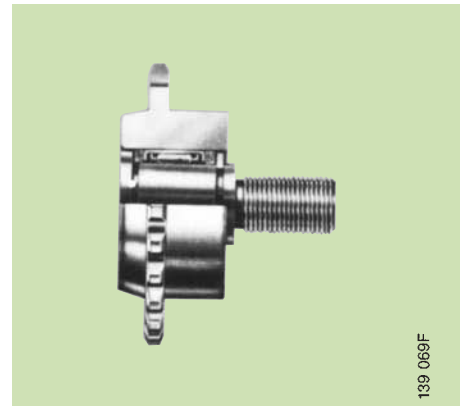
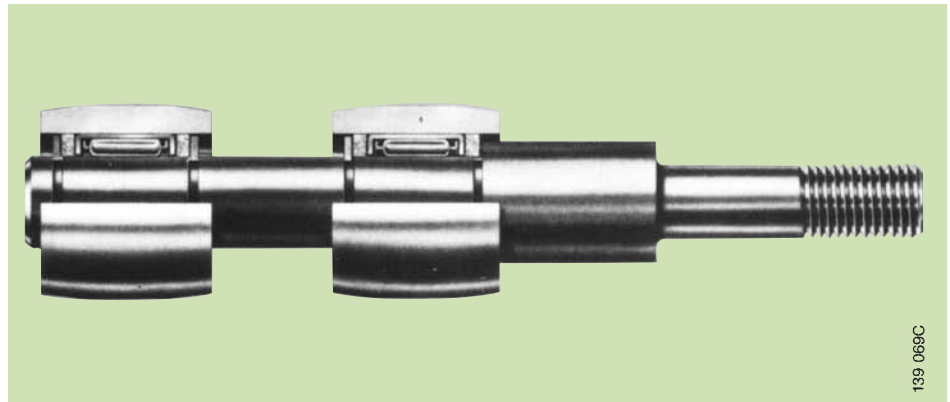
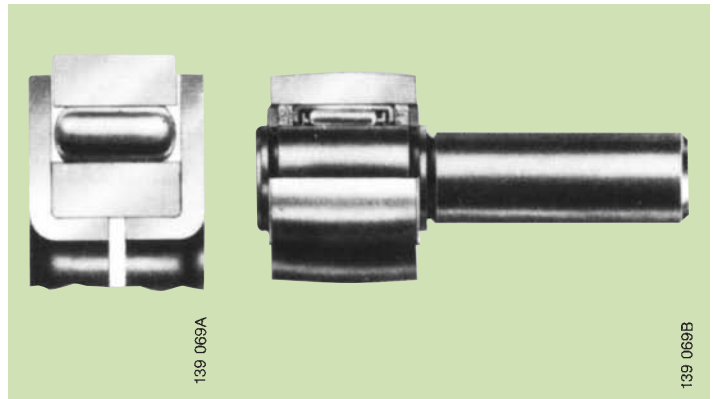
Clutch Inspection Data						Mounting Dimensions in inch and mm									
Ring Gauge Diameter		Locking Diameter		Overrunning Diameter and Bearing Go Plug		Bearing No Go Plug		Shaft Diameter ⁵⁾ F				Housing Diameter ⁵⁾ G			
inch	mm	inch	mm	inch	mm	inch	mm	max	min	max	mm min	inch min	max	mm min	max
.6255	15.888	.3745	9.512	.3761	9.553	.3775	9.588	.3750	.3745	9.525	9.512	.6245	.6255	15.862	15.888
.7505	19.063	.4995	12.687	.5011	12.728	.5025	12.764	.5000	.4995	12.700	12.687	.7495	.7505	19.037	19.063
.8755	22.238	.6245	15.862	.6261	15.903	.6275	15.938	.6250	.6245	15.875	15.862	.8745	.8755	22.212	22.238

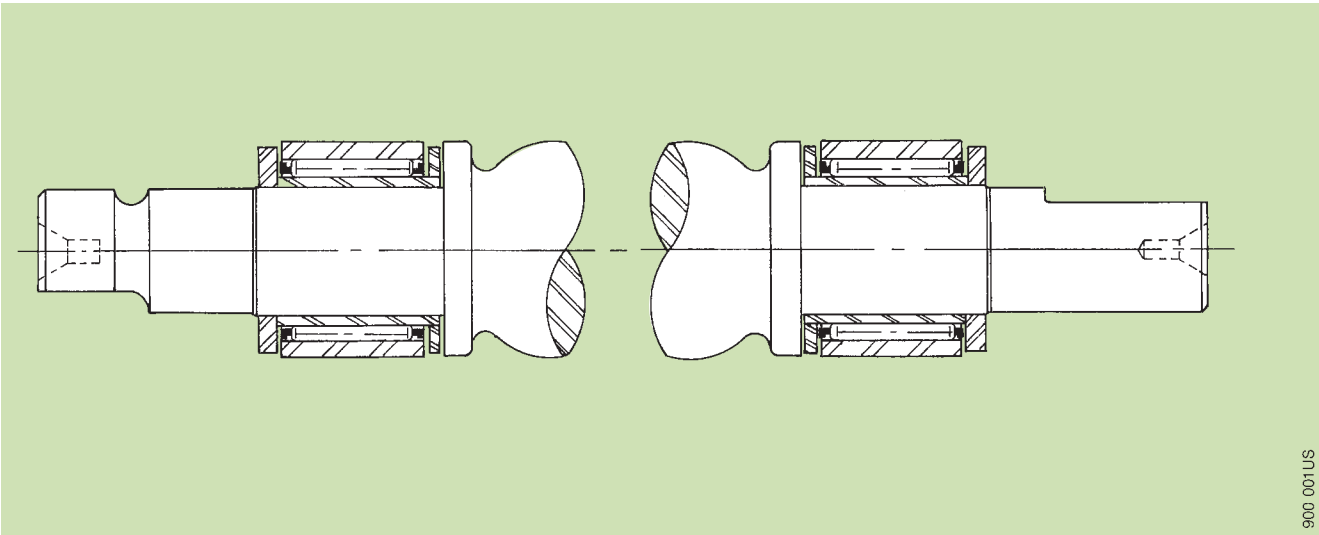
5) For non-ferrous housing recommendations refer to page 44, tables 1 and 2.
6) For additional sizes and sealed versions refer to pages 48 to 61.

Special INA products

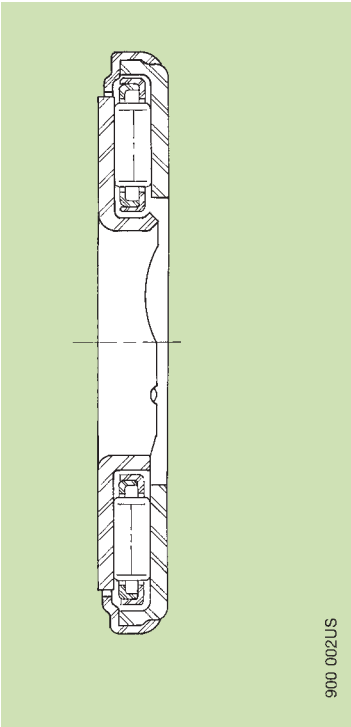
Rotating devices such as sprockets, pulleys and rollers are available from INA. Mounted or housed bearings are also available. A few typical arrangements are illustrated here.

Designed especially for the requirements of specific applications, they result in outstanding value at optimum cost. Consult INA for a value engineering analysis of your rotating devices.

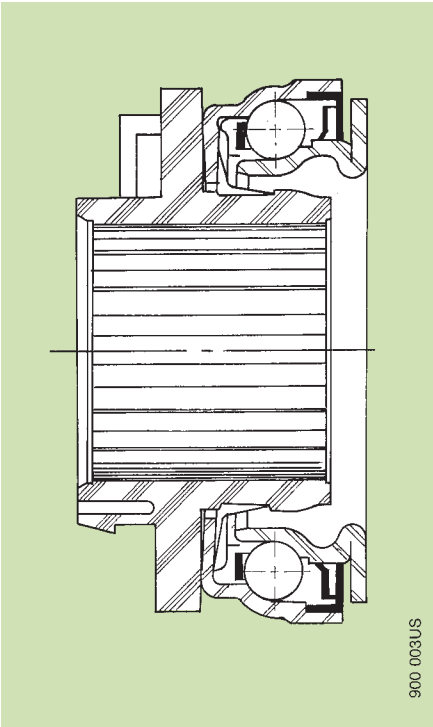




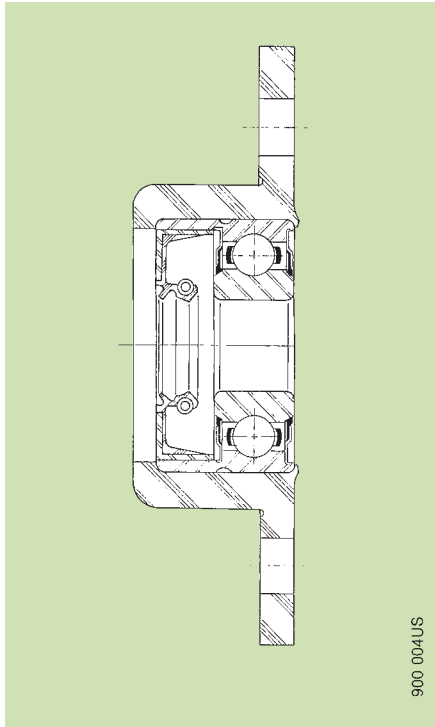
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