MachLine®:
the perfect solution
for your machine tools

machline®

SNR

Industry

SNR

machline®

Our expertise made available for your machine tools

Contents

Precision, speed, quality: the best of all worlds

SNR's engineers, through their partnership in ambitious projects such as Ariane 5 and the Airbus A380, have been working for forty years to meet the toughest technical challenges, with extremely high quality requirements. They have drawn on all their expertise to satisfy strict specifications and to operate in extraordinary speed and temperature conditions.

On the basis of its experience in these conditions, SNR can now offer you the very best of its know-how for your machine tools.

This is our manufacturing philosophy, and our MachLine bearings are the result. "Programmed" to guarantee you outstanding precision, performance and long life.

SNR is part of the history of bearings... and is building their future

SNR is a major player on the European and worldwide stage, and has consistently remained committed to innovation in product design and manufacturing. Its process management operations compliment a sales presence in more than 200 countries.
However, SNR is also closely associated with the development of mechatronics. The company was in the vanguard of mechatronics pioneers, developing a specific competence working with customers in the three major markets of automotive, aerospace and industry.

Precision benefits from good organization

Very high precision bearings such as MachLine are designed, manufactured and tested by our aeronautics division which by its very nature, must have a “zero tolerance” organizational structure, when it comes to defects.

Quality: the safest bearings... and the most environmentally friendly

MachLine bearings comply with the most stringent standards in terms of manufacturing quality and environmental protection, with ISO 9001-V2000, EN 9100 and ISO 14001 accreditation.

machine

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Everything there is to know about MachLine®

How have machine tool-specific requirements been accounted for in SNR's R&D? What product families make up the MachLine range? What are their general characteristics? Find the answers to these questions and more over the next few pages...

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MachLine®: meeting every challenge for machine tool spindles

Faster, cleaner, longer lasting: today's bearings need to be adapted to the reality of machining in today's world. High speed machining, reduction of downtime, greater rigidity and integrated sealing…
Machines are achieving ever increasing performance levels requiring productivity and environmental considerations to be considered.
The MachLine range has specific solutions for all these points.

The challenge of reliability

The MachLine range offers a selection of new innovative products so that you no longer have to choose between machining speed and load capacity. In addition, precision self-locking nuts are offered to ensure proper assembly. These products enhance the "standard" high precision ranges which are still available and displayed in this catalog:

- ***MachLine High Precision: Standard***
- ***MachLine ML: High Speed***
- ***MachLine CH: Hybrid***
- ***MachLine MLE: Sealed bearings***
- ***MachLine N: HNS***
- ***Precision self-locking nuts***

The challenge of speed

Machining time is money. The quicker a machine works, the more productive it is. To achieve higher performance, bearings must be able to accomodate extremely high speeds – and this is why the ML range was designed.

The challenge of simplicity

A user's life is made easier if no periodic greasing is required: the MLE range of sealed bearings are lubricated for life.

Enhanced performance with ceramic balls:

x 3 ***times longer life***
+30% ***faster***
+10% ***more rigid***

All MachLine range bearings are manufactured with a radial run-out whose precision meets ISO2 (ABEC 9) standards (Precision P4S).

SNR R&D: high performance for your machine tools

The research that SNR has put into the MachLine range covers all performance-related areas, from materials to bearing geometry and complementary functions.

- Steel:

Defects due to steel quality are extremely rare on MachLine bearings because SNR uses total procurement management and traceability systems for its products throughout the world. This guarantees high purity, the secret for long bearing life.

- Lubrication and sealing:

SNR has developed "life-long" lubrication solutions, including LubSolid, which is a solution specially designed for certain industrial applications. It has been one of SNR's major research areas for MachLine, in order to allow high speeds, improve sealing and thus protect the mechanical environment.

- Defect simulation:

In this area, SNR's test center is particularly effective and has many years of experience. MachLine has undergone a vast array of tests and undergone numerous simulations and in-depth vibratory analysis.

- Research into bearing instrumentation:

The future of machine tools is in microelectronics, magnetism and machine-based firmware and this is why SNR's R&D department is continuing to carry out research into upgrades for MachLine products in the area of mechatronics.

- Contribution of fundamental and applied research:

As with all of SNR's ranges, MachLine has benefited from the company's active participation in European research programs, along with the largest worldwide steel manufacturers and major university research centers.

Medium-sized balls, providing a better balance between maximum speed and load capacity.

2.2 million N.Dm: extremely high speeds have been achieved with the ML range.

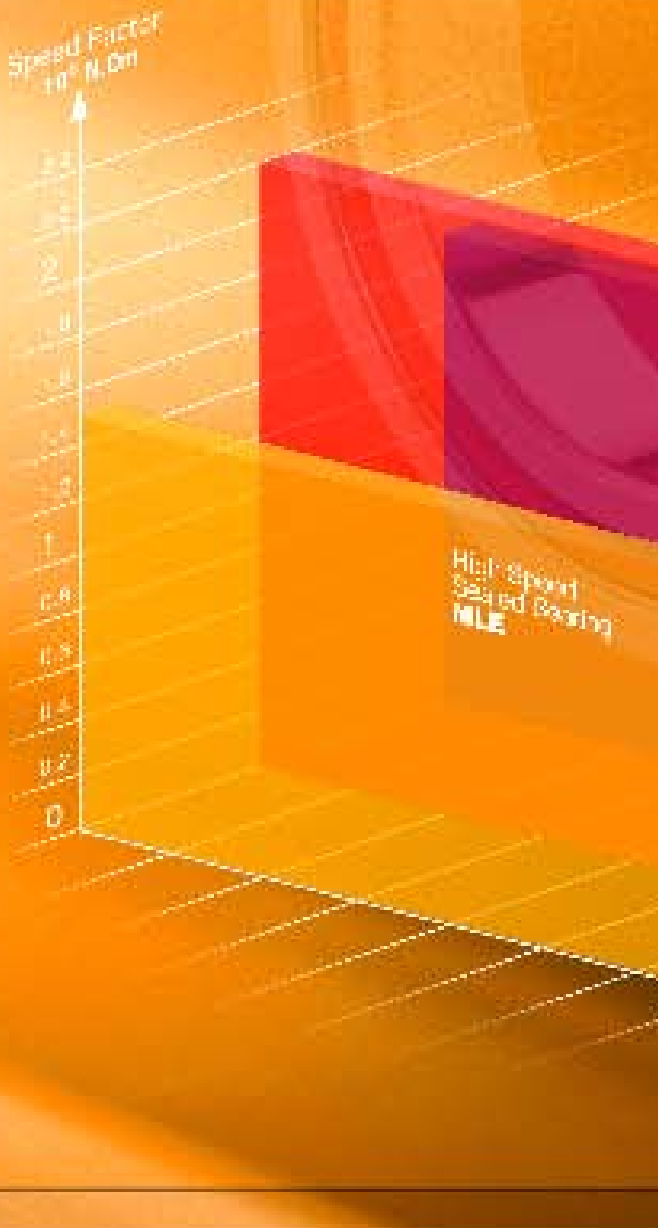
MachLine®: a vast array of solutions

HIGH PRECISION

- SNR series 71900V and 7000V, with excellent performance data to balance the need for speed, rigidity, capacity and precision.
- Series 7200G1, specially designed to meet specifications set by applications with large, predominantly axial loads.
- Variations according to contact angle (C for 15° and H for 25°) and preload (light, medium or heavy).

HYBRID, CERAMIC BALLS **CH**

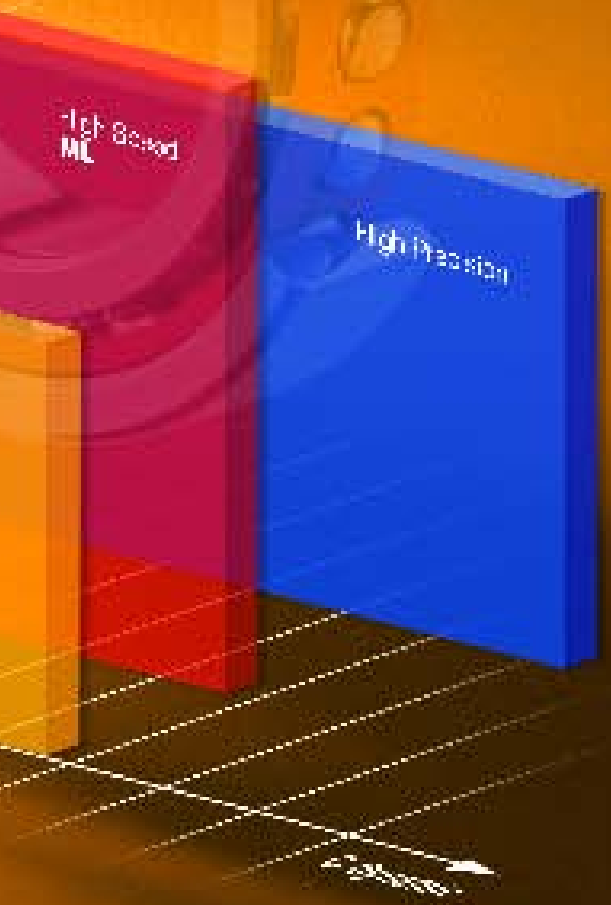
- Possible variation for all ranges, all series and all dimensions with Silicon Nitride balls and steel rings, combining the best qualities of the two materials.
- Reduced operating temperature and increased top speed. Reduced lubrication requirements as compared to a “conventional steel" bearing.
- Increased rigidity and longer life.



Manufacturing standard:

Whatever the machine tool application, there is a perfect MachLine solution.

MachLine range operating domain for a bearing with same bore diameter



HIGH SPEED **ML**

Speed
+ 30 %

- Family made up of series 71900 and 7000, designed and developed by SNR to meet the increasingly stringent requirements in high speed mechanization.
- Specially designed geometry: reduction in ball diameter, increase in number of balls and optimization of cage guidance on outer ring.
- Different variations according to contact angle (C for 17° and H for 25°) and preload.

HIGH SPEED SEALED BEARING **MLE**

Non-contact sealing

- When oil lubrication is not required and grease lubrication is sufficient, SNR has a technically appropriate solution which is also economically attractive – the MLE family of bearings, series 71900 and 7000.
- With nitrile rubber seals on the outer ring, not in contact with the inner ring, the same top speed can be attained as with an open bearing lubricated with grease.
- Variations according to contact angle (C for 17° and H for 25°) and preload.

Manufacturing precision 4S as standard (ISO 2, ABEC 9, for all rotation dynamic characteristics and ISO 4, ABEC 7, for all others).

machine

MachLine®: a vast array of solutions

HNS bearings: N

This bearing is a direct result of SNR's aeronautical know-how and its performance data for machine tools are remarkable:

- Increased rotation speeds,
- Better fatigue resistance,
- More reliable even when poorly lubricated,
- Longer life,
- Corrosion resistant.

Characteristics:
Bearings made of stainless martensitic steel with nitrogen (material used in aeronautics).
- Rings made of XD15N.
- Ceramic balls.

Precision self-locking nuts

Available in narrow or wide gauge, with a choice of 2 or 4 locking inserts, using blind holes or slots, the SNR range of precision self-locking nuts covers all requirements on the market.

These products are vital:
- for all precision bearing assemblies,
- when a set of bearings need a guaranteed preload, which can be maintained over time,
- for high axial loads.

General technical details

Each application has its own specific speed and load requirements, with a significant impact on geometry, material or lubrication. Over the next few pages, our engineers give you all the information necessary to make the optimum choice of bearings and how to install them correctly.

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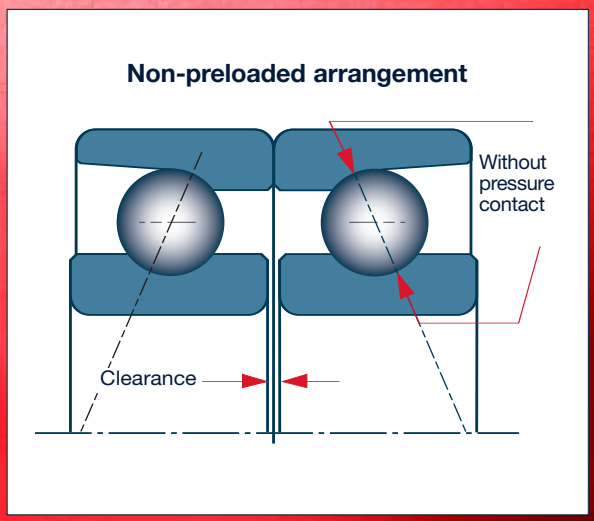
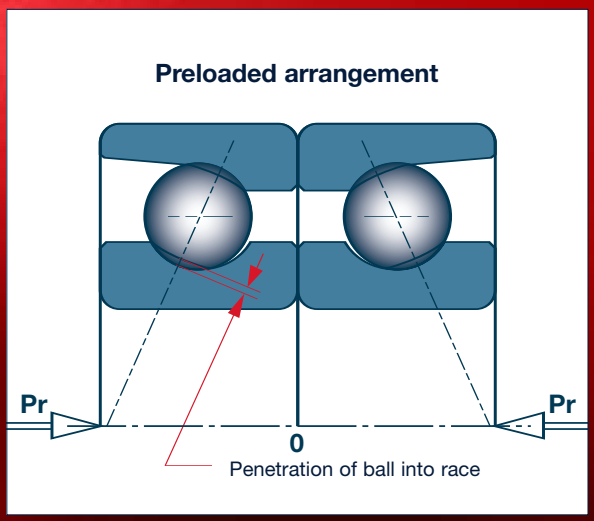
Preload: a direct effect on the application

Preload and preloading

Preload is an important characteristic for any assembly as it is used to achieve a defined, managed rigidity. It also has a direct influence on the load capacity and allowable rotational speed.

Preloading an assembly consists of applying a permanent axial load by abutting the faces of the bearings in the assembly. This load will lead to an elastic deformation between balls and raceway and will create a contact pressure between the components.



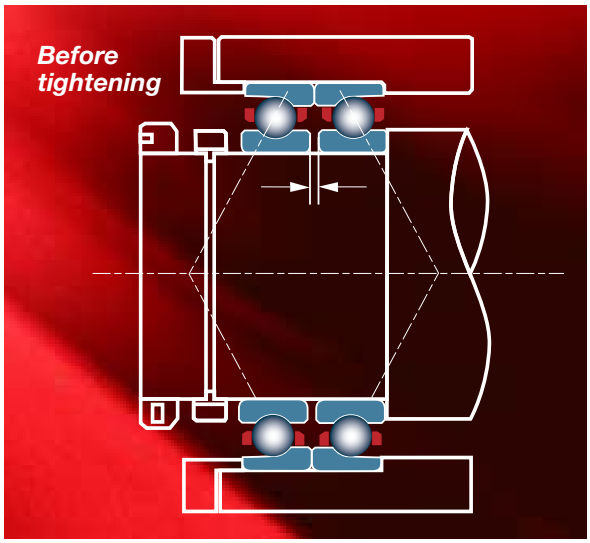


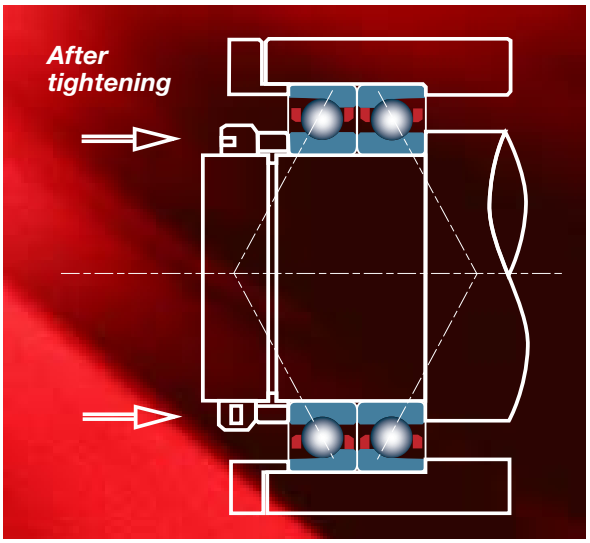
Example: assembly 7014HVDBJ84
Clearance: 0,012 mm
Preload: Pr = 1100 N (247 lbf)
Deflection: 0,0025 mm
Contact pressure:
- inner ring: 960 N/mm² (139,400 psi)
- outer ring: 840 N/mm² (121,800 psi)

The axial load is known as preload (Pr).

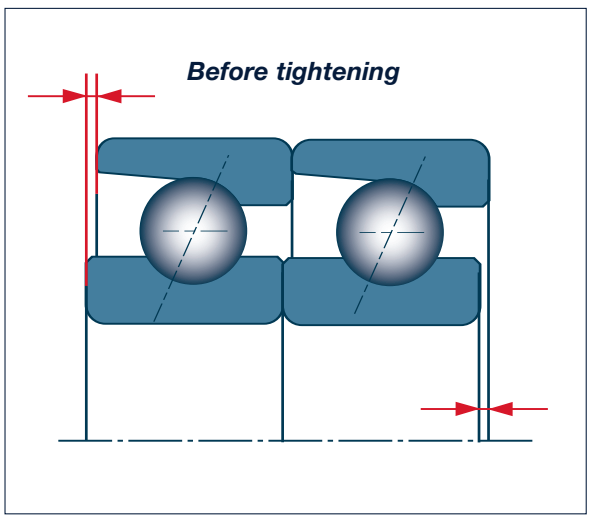
Two methods for application

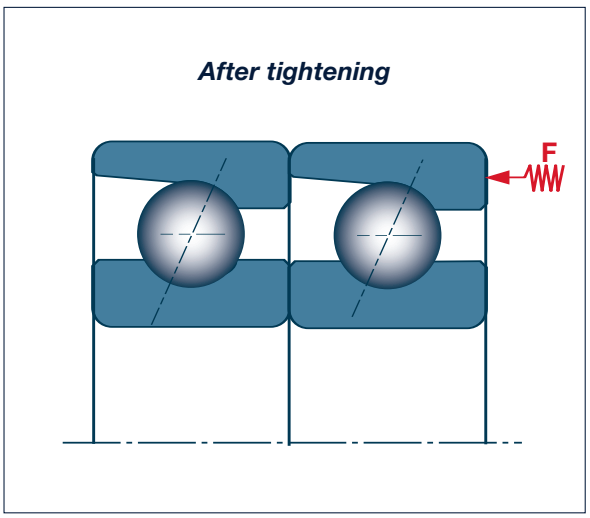
Preloading by tightening faces of bearings in an assembly





Preloading using calibrated springs





Definition of symbols

Pr	Preload	P	Equivalent dynamic load
a	Distance between the 2 spacers (µm)	C	Basic dynamic load
K	Deflection constant (µm (daN)$^{-2/3}$)	P_0	Equivalent static load
Pr_i	Initial preload (daN)	C_0	Basic static load
Pr_s	Preload required (daN)	N	Rotation speed (rpm)
PE	Equilibrium preload for an assembly	L_{10}	Nominal service life (hr)
CD	Separation load	f_s	Safety factor
Fa	Axial load	L_{na}	Corrected service life (hr)
Fr	Radial load	N.Dm	Speed factor

Preload: parameters to take into account

Preload levels

SNR has defined 3 preload levels which correspond to a level of contact pressure suitable for operating conditions:

- **Light preload (code 7):**
  High-speed, light load applications.
- **Medium preload (code 8):**
  Best balance between speed and load.
- **Heavy preload (code 9):**
  Large load, reduced speed applications.
- SNR can supply specific **preloads on request (code X)** to meet spindle operation optimization requirements.

Should a specific preload be required, it can be achieved using bearings preloaded as standard assembled with different length spacers.
The following formula is used to calculate the space required between two spacers to alter the bearing assembly preload:

$$a = 2K(Pr_i^{2/3} - Pr_s^{2/3})$$

a: difference in length between the 2 spacers (µm)
K: deflection constant (see page 44)
Pr_i: initial preload (daN)
Pr_s: preload required (daN)

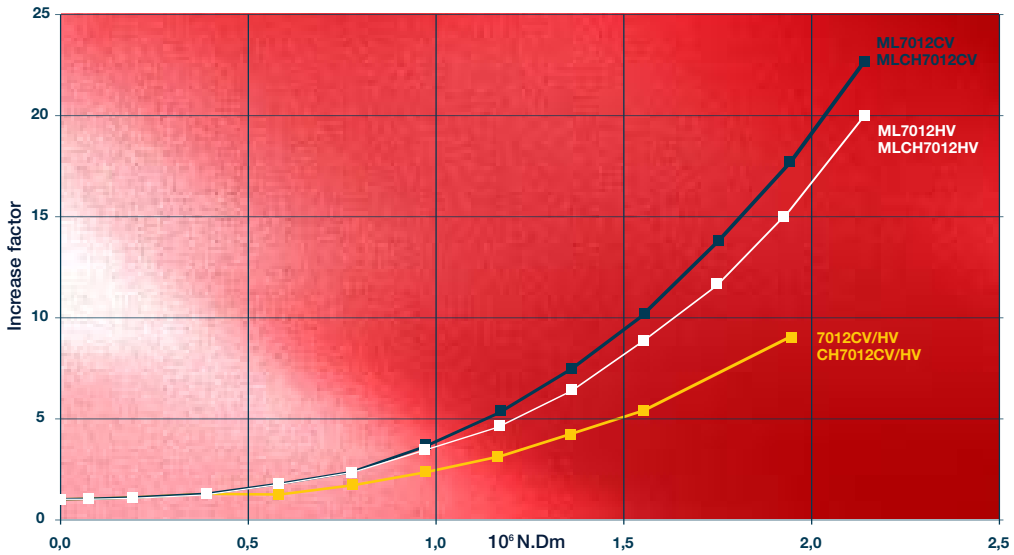
See also page 15, axial deflection of an angular contact ball bearing.

Factors influencing preload

The following factors can influence the preload value:

- **assembly interference** (fits),
- **rotation speed,**
- **temperature,** possibly associated with shaft and housing materials,
- **geometry of the surrounding parts.**

Make sure these parameters are fully taken into account when a spindle is designed. Contact SNR's design office for any further information. They are always prepared to share their expertise in this area.

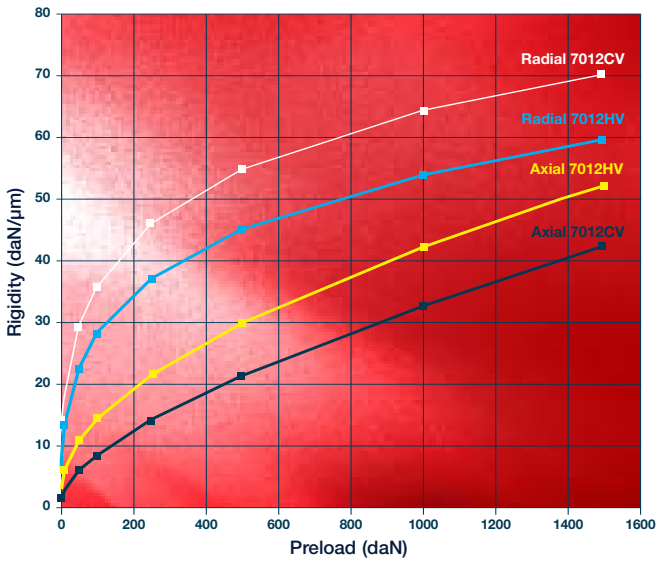


Preload increase factor according to rotation speed: comparison between 7012 and ML7012 bearings, versions with steel or ceramic balls.

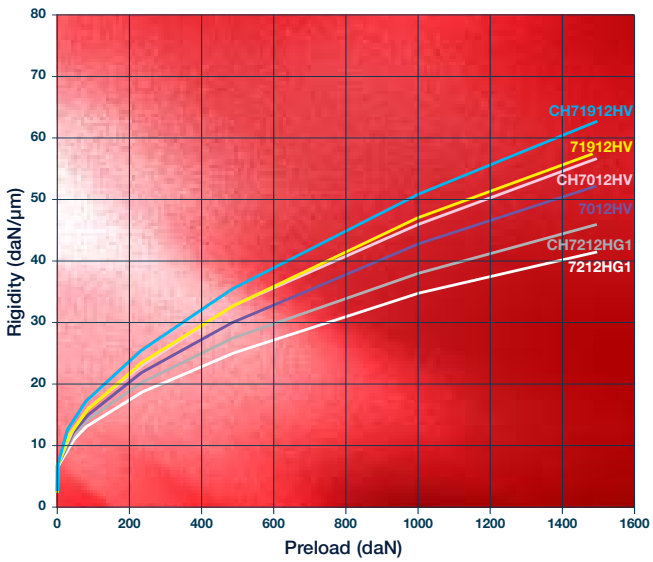
Rigidity and axial deflection

Rigidity as a function of preload

Example: a 7012 bearing assembled in DB



Comparison of rigidity by series

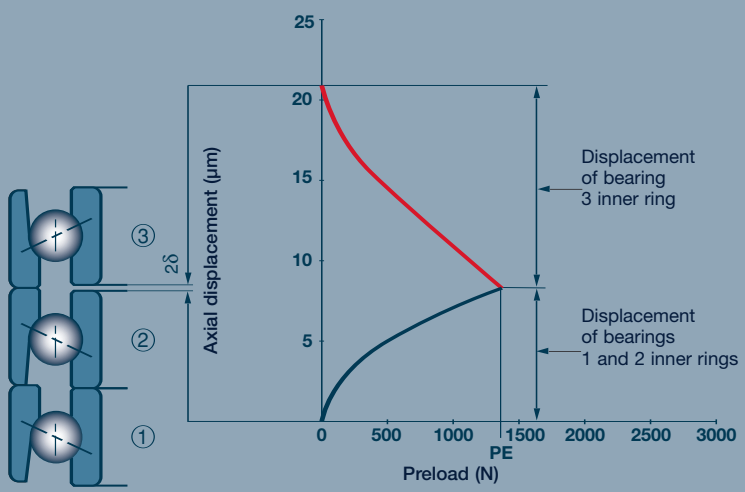


The rigidity is given by the preload. As preload increases, rigidity also increases in a non-linear manner.

Axial deflection of an angular contact ball bearing

When a bearing is subject to an axial load **Fa in daN**, one of the rings undergoes axial displacement with respect to the other, with a value δa: $\delta a = K(Fa)^{2/3}$

K is the axial deflection constant for each bearing and its value is given in the preload table (see page 44).



Preload application:

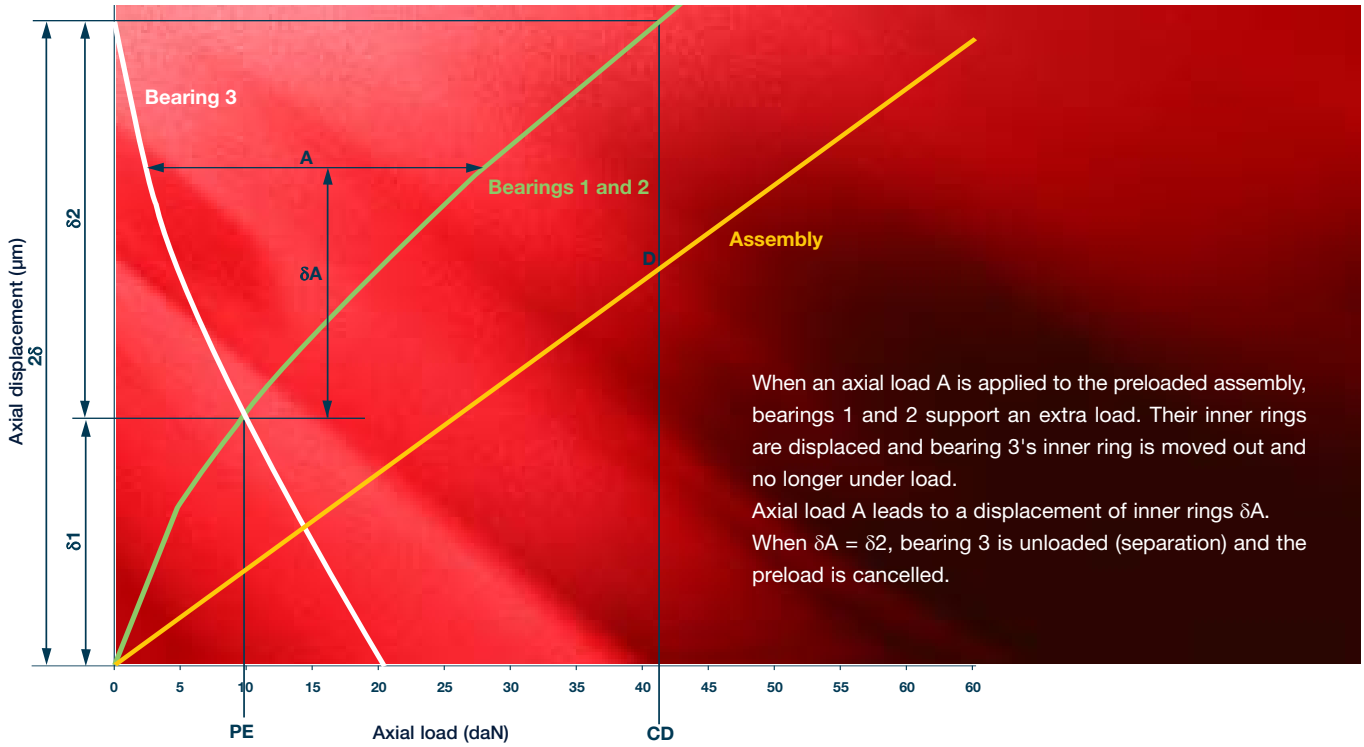
For instance, let us take an assembly, Q16, with preload **Pr** on its bearings. There is a gap of **2δ** between the inner rings of bearings 2 and 3 prior to preloading.

$$2\delta = 2K(Pr)^{2/3}$$

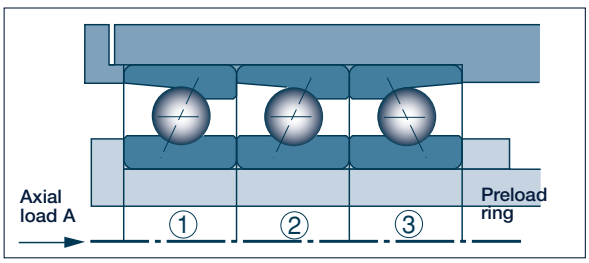
If the inner rings are abutted such as to close the gap **2δ**, the displacement is shown in the diagram opposite. The equilibrium preload for the assembly equals **PE** when clearance **2δ** is eliminated.

Influence of an external axial load

Axial deflection graph for assembly Q16



When an axial load A is applied to the preloaded assembly, bearings 1 and 2 support an extra load. Their inner rings are displaced and bearing 3's inner ring is moved out and no longer under load.
Axial load A leads to a displacement of inner rings δA.
When δA = δ2, bearing 3 is unloaded (separation) and the preload is cancelled.



Characteristics

- **Axial displacement:** until preload is cancelled, this is equal to δ2. With the initial approximation, it is defined by the line OD. Beyond point D, the curve represents the bearings supporting axial load A: in the above examples, bearings 1 and 2.
- **Axial rigidity:** until the preload is cancelled, mean rigidity is equal to CD/δ2.
- **Detachment load CD:** this is the axial load that leads to the separation of the bearing(s) in opposition: in the above example, bearing 3.

Characteristic values for equilibrium preload PE and detachment load CD

Assembly	PE	CD
DB - DF	Pr	2.83 Pr
Q16	1.36 Pr	5.66 Pr
Q21	2 Pr	5.66 Pr

Pr: preload

Our engineers can send you the characteristic curves for any assembly on request.
The axial and radial rigidity values for preloaded bearings are given on page 44.

Speed correction factors

Each bearing can only rotate up to a certain speed known as its limit speed. A bearing's limit speed depends on its design, lubrication method and the thermal level tolerated at this speed. If any of these parameters are altered, the limit speed is altered.

According to assembly

When bearings are put together in an assembly, the limit speed of the single bearing must be adjusted according to the assembly and the preload.

The limit speed for a single bearing is defined on page 41. For MachLine hybrid bearings, this value should be increased by 30 % (see page 31).

According to preload

Preload is selected from three suggested levels: *light, medium and heavy*. The level should be selected according to the spindle's maximum speed, the desired rigidity and the detachment load.

Speed correction*

After the above selections have been made, it is important to ensure that they can reach the required maximum spindle speed.

* This factor is given for information to help in design. If a spindle is to be used continuously close to its limit speed, the thermal level reached should be checked to ensure that it is compatible with the required precision.

For other types of assembly, please contact SNR.

Assembly	Preload		
	Light	Medium	Heavy
DT	0.90	0.80	0.65
DB	0.80	0.70	0.55
DF	0.75	0.65	0.40
Q16	0.70	0.60	0.35
Q21	0.65	0.55	0.30

Any non-compliance with the requisite geometric tolerances detracts from the assembly's maximum speed and thus from correct spindle operation.

Spindle design: simplified calculation method

Bearing pre-design

This must be checked and optimized either by using the simplified and/or corrected calculation method with the bearing service life method, or by using an application-specific software design package.

Required service life

The bearing service life on a spindle is linked to the loss of machining precision (dimensional precision, vibrations) or to abnormal heating.
This loss of precision is due to deterioration of race-way surfaces and balls due to wear, contamination, oxidation or lubricant deterioration (oil or grease).

The corresponding service life cannot be directly calculated. The only possible calculation is for service life L_{10} linked to material fatigue. Experience has shown that to give suitable spindle dimensions, service life L_{10} should be of the order of 20,000 hours.

Simplified calculation method

This most simple method, recommended by the **ISO 281 standard** is used to calculate the nominal service life reached by 90 % of bearings working under a dynamic load.

The simplified calculation method shown opposite is based on material fatigue as cause of failure.

Equivalent dynamic load

The torque and drive loads must be distributed over each bearing by using the normal methods of mechanical engineering.

- **Axial load:** This is to be distributed uniformly over each bearing supporting this load. If “m” bearings support this load:

  Fa = A / m

  A = axial load applied to main bearing.

- **Radial load:** This is to be distributed uniformly to each bearing making up the main bearing. If there are « n » bearings making up the main bearing, the radial load applied to each bearing will be:

  Fr = R / n ^{0,9}

  R: radial load applied to main bearing

- **Calculating the equivalent dynamic load:**

  P = X Fr + Y Fa

Coefficients **X** and **Y** are described in the table opposite. To define them, calculate the ratio **Fa/Co** and read the value for **e** and calculate **Fa/Fr** and compare it to **e**.

Co is the basic static radial load.

If the load varies between different machining types, the weighted equivalent radial load calculated is as follows:

$$P = (t_1P_1^3 + t_2P_2^3 + ... + t_iP_i^3)^{1/3}$$

t_i = usage rate
P_i = corresponding equivalent load

	Fa/Co	e	Fa/Fr ≤ e		Fa/Fr > e	
			X	Y	X	Y
	0.015	0.38	1	0	0.44	1.47
	0.029	0.40	1	0	0.44	1.40
	0.058	0.43	1	0	0.44	1.30
	0.087	0.46	1	0	0.44	1.23
15°	0.12	0.47	1	0	0.44	1.19
	0.17	0.50	1	0	0.44	1.12
	0.29	0.55	1	0	0.44	1.02
	0.44	0.56	1	0	0.44	1.00
	0.58	0.56	1	0	0.44	1.00
25°	-	0.68	1	0	0.41	0.87

Nominal service life

Life in hours: $L_{10} = (C/P)^3 . 10^6/60N$

C: dynamic basic load (see page 41)
Co: basic static radial load (see page 41)
N: rotation speed of the rotating ring in rpm

The life of the bearings on the spindle is calculated to be the service life of the bearing supporting the greatest load.

Spindle design: simplified and corrected calculation method

Equivalent static load

Should a bearing be subject to combined static loads, the equivalent static load needs to be calculated to compare it with the bearing's static load capacity.

- Calculating the equivalent static load:

Po = Xo Fr + Yo Fa

Coefficients **Xo** and **Yo** are given in the table opposite. To define them, the ratio **Fa/Fr.**

A bearing's static load capacity is given as a reference value rather than an accurate limit that should not be exceeded. It is useful to take it into account, for instance, in assessing the influence of punctual loads such as those generated by tool release or bar advance systems.

	Fa/Fr	Xo	Yo
15°	≤1.09	1	0
	>1.09	0.50	0.46
25°	≤1.31	1	0
	>1.31	0.50	0.38

- Basic static capacity for a bearing Co: This is defined in **ISO 76 standard** as the radial load that generates a Hertz pressure of 4,200 MPa at the most highly loaded point of contact (rotating body and raceway).

Safety factor: f_s = i Co / Po

i: Number of bearings
Co: Basic static load of bearing
Po: Equivalent static load

In principle, the minimum values for the safety factor f_s:

- 2.5 to 3 for spindles in general
- 1 to 1.5 for a short-term axial load.

Corrected calculation method

The **ISO 281 standard** gives a corrected nominal service life formula L_{na} which is expressed as a function of the basic nominal service life L_{10}: $L_{na} = a_1.a_2.a_3.L_{10}$

- Coefficient a_1

Coefficient used to correct a calculation for a reliability value other than 90 %. This factor is given in the table below:

Life	Reliability	Probability of failure	a_1
L_{10}	90%	10	1.00
L_5	95%	5	0.62
L_4	96%	4	0.53
L_3	97%	3	0.44
L_2	98%	2	0.33
L_1	99%	1	0.21

- Coefficient a_2

Coefficient for correcting calculation according to material and internal geometry.

For certain applications, a bearing may be manufactured from a special steel other than conventional steel, or have a non-standard internal geometry. These selections can give a much greater service life than that of a standard bearing.

In this case, a coefficient a_2 which is greater than 1 is applied. This coefficient is calculated according to experimental results obtained in SNR's research and testing centers.

Material	a_2
100Cr6	1
XD15N	2.8

- Coefficient a_3

Coefficient for correcting calculations according to operating conditions: contamination, lubrication, temperature... **Please note that coefficients a_2 and a_3 are not independent.**

- Coefficient a_{3pol}

Contamination can reduce service life, depending on its type and the level at which the rotating parts are loaded.

In most cases, a spindle bearing operates in maximum cleanliness conditions, **and coefficient a_{3pol} will thus equal 1.**

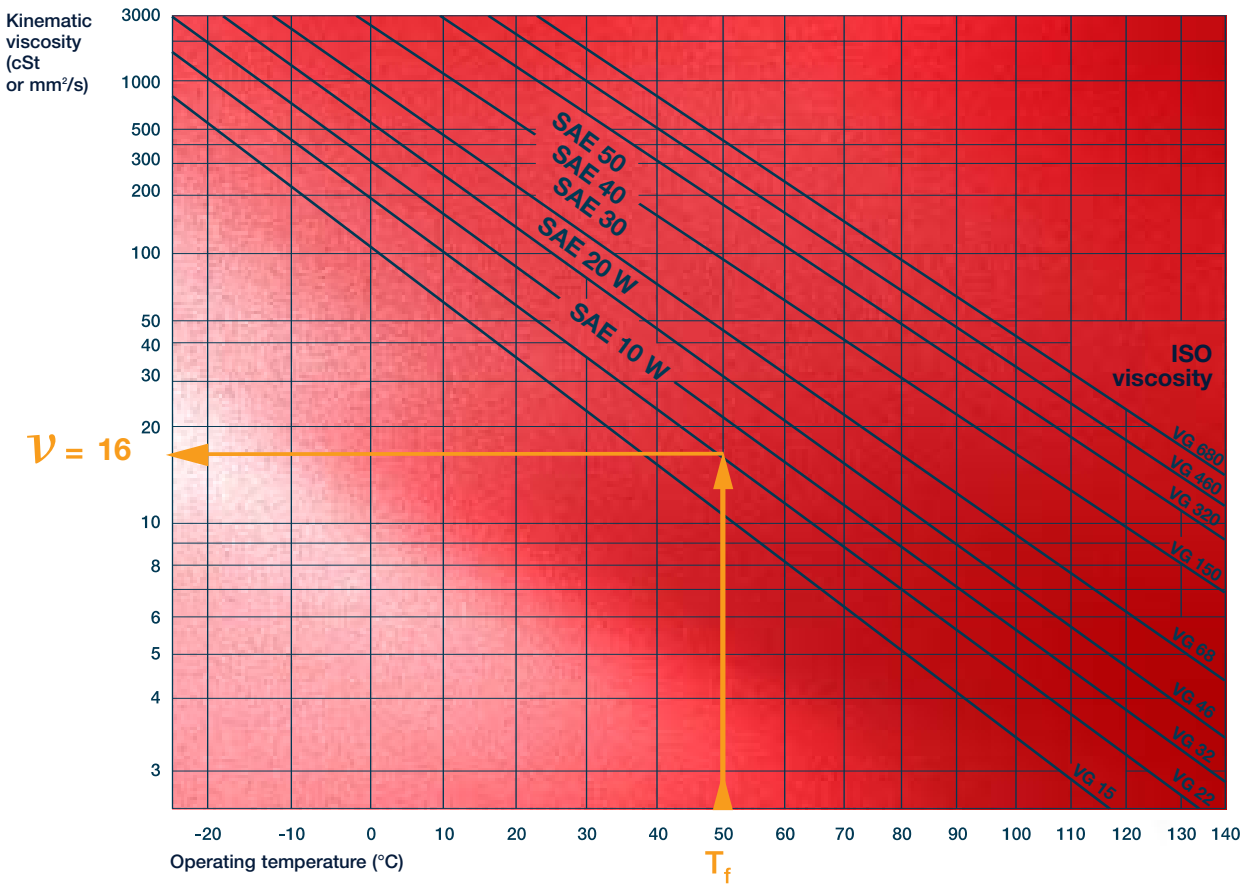
For other types of applications which are less well protected, coefficient a_{3pol} can have the following values:

Filtration	a_{3pol}
< 3 µm	1
5 µm	0.95
10 µm	0.90

- Coefficient a_{3lub}

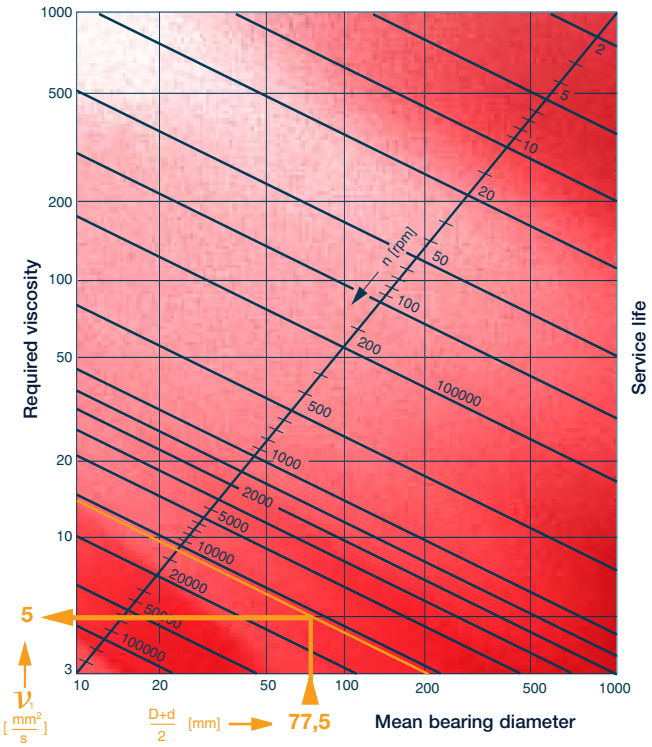
Bearing service life is influenced by the efficiency of lubrication, which, amongst other things, is characterized by the oil film thickness. Elasto-hydrodynamic theory shows that this latter value depends almost entirely on oil viscosity and speed. The graphs below can be used to determine coefficient a_{3lub}.

Graph 1: viscosity-temperature



Spindle design: corrected calculation method

Graph 2: required viscosity



Example

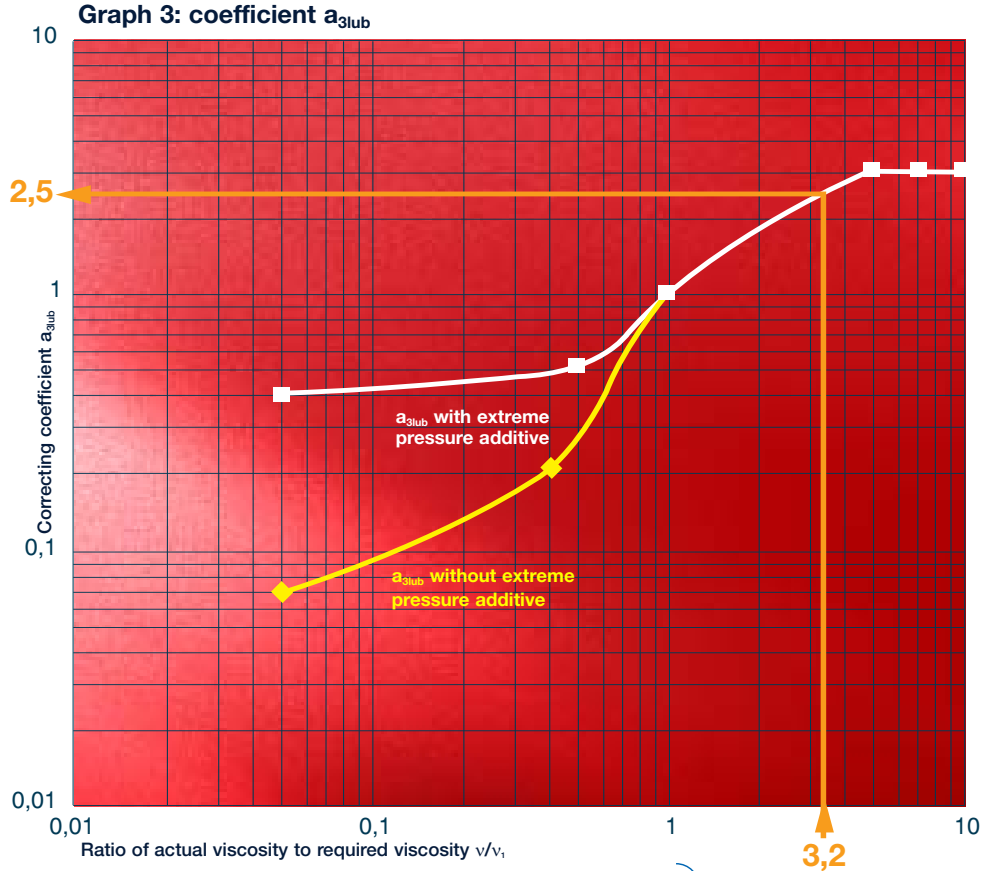
Bearing 7012CV at 13,000 rpm lubricated with VG22 oil and operating at 122°F.

Graph 1: VG22 oil viscosity at 122°F is ν = 16 cSt

Graph 2: required viscosity for a 7012CV with mean diameter Dm = 77.5 mm at 13,000 rpm is: ν_1 = 5 cSt

Graph 3: coefficient a_{3lub} with viscosity ratio ν/ν_1 = 16/5 = 3.2 is a_{3lub} = 2.5

Graph 3: coefficient a_{3lub}



- Coefficient a_{3temp}

The operating temperature for bearing components is given in the table below:

Component	Max. temp.	Comment
Rings	302°F	-
Balls		
- steel	302°F	-
- ceramic	> 392°F	-
Cage		
- phenolic resin	212°F continuous 248°F peak temperature	Standard
- bronze	392°F	On request
- PEEK	248°F continuous 302°F peak temperature	On request
Seals	212°F continuous 248°F peak temperature	- -
Grease	248°F	-

For most machine tool spindle applications, coefficient a_{3temp} = 1 is used, as the operating temperature is well below 212°F.

For other, more exposed applications, coefficient **a_{3temp}** can have the following values:

Temperature	a_{3temp}
< 212°F	1
230°F	0.96
248°F	0.92
266°F	0.88
284°F	0.84
302°F	0.8

Infinite service life

In the area of materials development, we can define conditions under which bearings can have an infinite service life:

- Metal surfaces fully separated by a film of oil, giving a_{3lub} > 1.5.
- Extremely limited oil film contamination, giving a_{3pol} = 1.
- Load applied corresponds to Co/Po > 9, corresponding to Hertz pressure values lower than: 2,000 MPa for 100Cr6, 2,300 MPa for XD15N.

Spindle design: simulations

Design software

SNR's R&D department has developed design software for use in optimizing and checking spindle bearing dimensions. This software gives a fuller and more accurate simulation than the simplified or corrected methods. It provides a means to model the spindle and its bearings and to properly take load, rotation speed and lubrication into account. The software simulates the equilibrium state of a spindle rotating on bearings and subject to external loads.

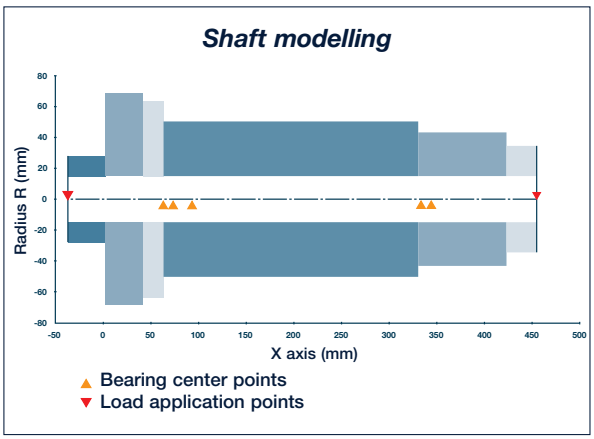
• **It determines:**

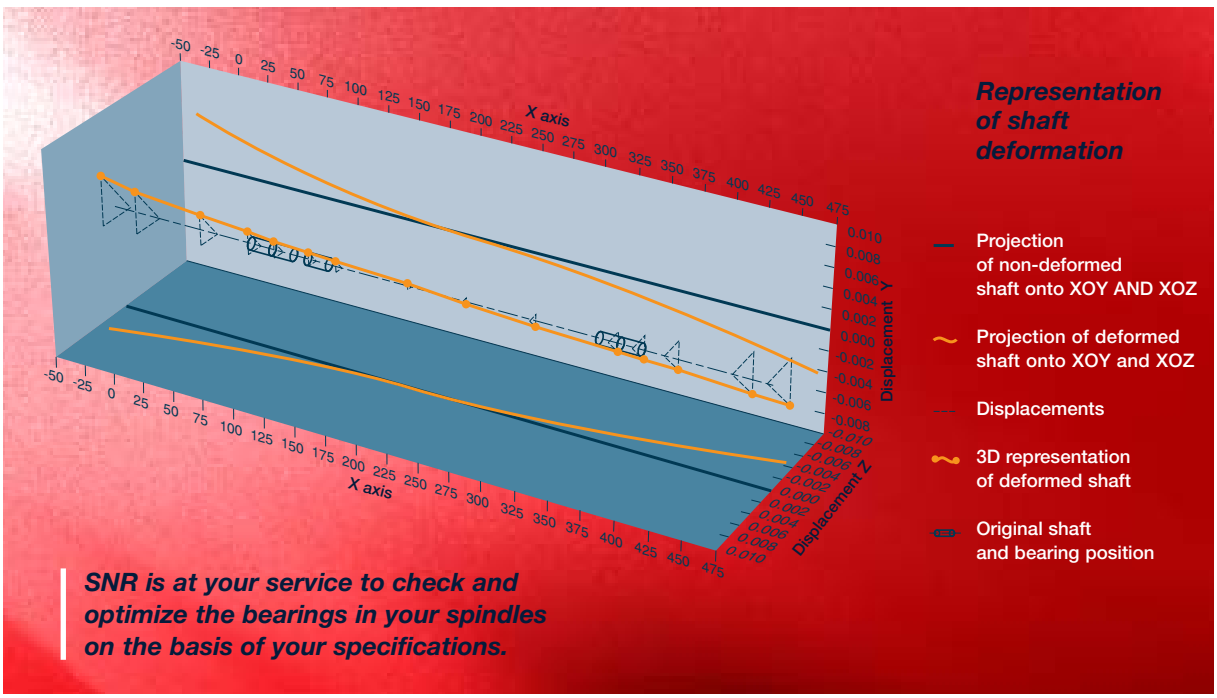
- **loads and the deflection** at the contact between balls and rings,
- **loads applied** to each bearing,
- **displacement of** inner and outer **rings,**
- **shaft deformation,**
- **axial and radial rigidity** at the selected reference point.

• **It calculates:**

- **the pressure values and dimensions of the elliptical contact surfaces,**
- **the service life** L_{10} of the bearings, based on the contact capacity,
- **the thickness of the lubricant film** (the service life is adjusted in the event of insufficient film thickness).

Graphic display of input data and SNR results





SNR is at your service to check and optimize the bearings in your spindles on the basis of your specifications.

Appropriate lubrication: the secret for long bearing life

Lubrication is an essential component of correct bearing function. It is used to avoid wear and seizure by placing an oil film between the rotating parts and the raceway. It also cools the bearing, by removing dissipated heat from the contacts and provides long-term corrosion protection for the bearing.

Selection of lubrication method

This is determined according to the maximum rotation speed and the loads, which determine the quantity of heat to be removed. It is thus inextricably linked to machine design.

- **Grease lubrication** is recommended when the maximum required speed allows and when the heat produced can be removed by conduction via the environment without leading to overheating (ΔT generally permitted 68°F to 77°F).
- **Oil lubrication** (using oil mist or oil-air) is recommended in other situations.

Oil lubrication

When the rotation speed exceeds the limit speed for grease lubrication, oil lubrication must be chosen. SNR recommends that a low-viscosity oil is selected in order to minimize heating effects - viscosity of the order of 20 cSt at 104°F (unless loads applied are very high).

- **Oil mist lubrication:** lubrication occurs by means of a gentle flow of oil sprayed into an air duct. Circulation of filtered dry air is used for cooling. For instance, for a 7016 bearing, the oil flow would be 50 mm^3/hr per bearing, and the air pressure 0.7 to 2 bar. Excess pressure generated in the spindle improves sealing.
- **Oil-air lubrication:** oil droplets are periodically introduced into an air duct. This system is cleaner and provides a good replacement for the oil mist system. Lubricant quantity can be better managed in this way.

Settings for 7016 bearing (example):

- **Oil flow:** 60 mm^3/hr for each bearing
- **Injection frequency:** 8 min.
- **Air pressure:** 1.0 to 2.5 bars.

- **Note:** settings are given for information and must be optimized to achieve the lowest possible thermal level.

- **Circulation channels:** the lubricant must be directed as close as possible to the bearing and introduced between the inner ring and the cage.

The oil inlet pitch diameter (D5) and the space between inner ring and cage (E) are defined on page 40.

Appropriate lubrication: the secret for long bearing life

Grease lubrication

SNR recommends its own SNR-LUB GV+ grease. It provides good resistance to high speeds and loads and enables a low operating torque value.

SNR-LUB GV+:

- **Base:** synthetic oil, lithium soap.
- **Additives:** antioxidant, anti-wear, anti-corrosion, extreme pressure.
- **Low viscosity: :** 15 cSt at 104°F
- **Operating temperature:** between -58°F and +248°F.

LUB GV+ grease is particularly recommended for applications with vertical shafts.

The volume of grease recommended by SNR is defined in the table opposite. Alter this volume according to the operating speed on the basis of the correcting coefficients below.

% limit speed	Correcting coefficient
< 35 %	1
35 % to 75 %	0.75
> 75 %	0.60

MachLine high speed range - ML

Mean volume of grease per bearing in cm³ - tolerance ± 10%

Bore code	Series 70	Series 719
00	0.1	0.1
01	0.2	0.1
02	0.3	0.1
03	0.3	0.1
04	0.6	0.3
05	0.8	0.4
06	1.0	0.5
07	1.4	0.6
08	1.7	1.0
09	2.2	1.1
10	2.4	1.1
11	4.4	2.3
12	4.6	2.6
13	5.2	2.7
14	6.7	4.3
15	7.1	4.6
16	9.3	4.8
17	9.6	6.5
18	12.9	6.8
19	12.8	7.0
20	13.5	9.6
21	18.3	-
22	22.1	10.3
24	23.5	13.3
26	34.8	17.5

Example: 7016 bearing to be used at 7,000 rpm (64 % of its limit speed with grease).
Grease volume to be used:
10 cm³ x 0.75 = 7.5 cm³

N.Dm = product of mean bearing diameter (mm) multiplied by rotation speed (rpm).
Grease application: see page 64.

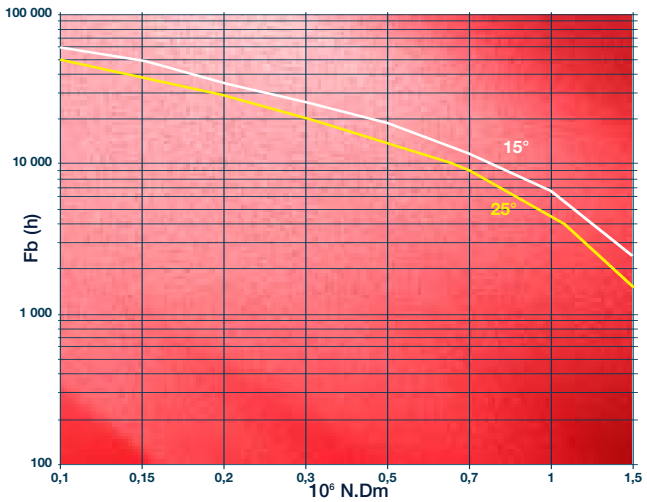
MachLine high precision range

Mean volume of grease per bearing in cm³ - tolerance ± 10%

Bore code	Series 70	Series 72	Series 719
00	0.3	0.4	0.2
01	0.4	0.5	0.2
02	0.5	0.6	0.3
03	0.6	0.8	0.3
04	1.0	1.3	0.5
05	1.2	1.7	0.6
06	1.6	2.3	0.7
07	2.0	3.3	1.0
08	2.5	3.5	1.5
09	3.2	5.3	1.6
10	3.4	6.2	1.7
11	4.7	7.5	2.2
12	5.0	9.2	2.3
13	5.3	11	2.5
14	7.5	13	4.2
15	7.8	14	4.3
16	10	16	4.5
17	11	21	6.3
18	14	26	6.5
19	15	-	7.3
20	16	38	9.7
21	19	-	10
22	24	52	10
24	25	63	14
26	40	-	19
28	42	-	20
30	51	-	30
32	64	-	31
34	83	-	32
36	107	-	50
38	110	-	52
40	140	-	74
44	190	-	80
48	-	-	86

Regreasing

- **Basic regreasing frequency:** the graph below can be used to determine the basic frequency in hours according to bearing type.



These values are given for information and must always be confirmed by testing.

- **Correcting regreasing frequency:** the basic frequency Fb must be corrected by coefficients given in the table below, according to particular spindle operating conditions, using the equation:

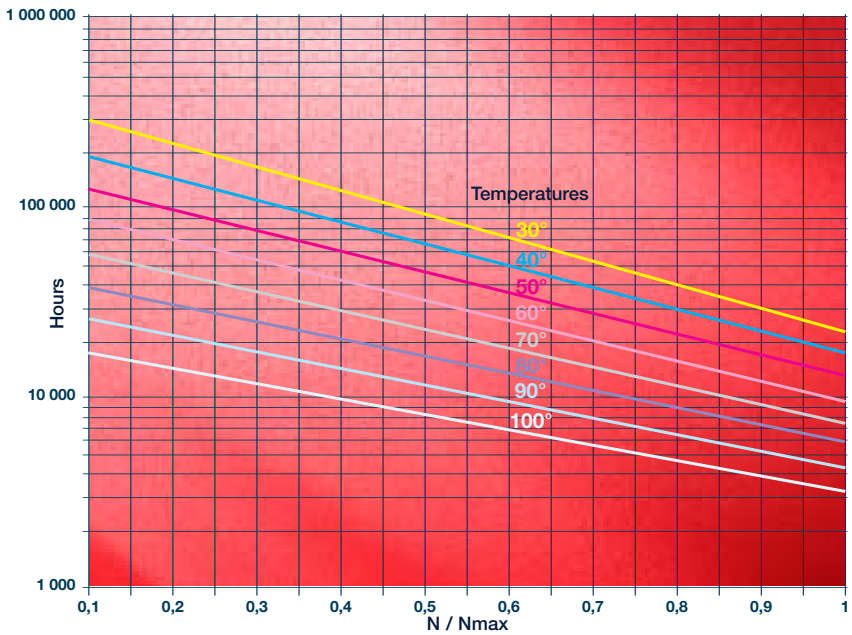
Fc = Fb.Te.Ta.Tt

Coef.	Conditions	Level	Coef. value
Te	**Environment**		
	- dust	Low	1
	- damp	Medium	0.8
	- condensation	High	0.5
Ta	**Application**		
	- vertical shaft	Low	1
	- vibrations	Medium	0.8
	- impacts	High	0.5
Tt	**Temperatures**	< 167°F	1
		167° to 185°F	0.8
		185° to 248°F	0.5

Grease life

Often spindle bearings are assembled such that the Hertz pressure values enable almost infinite resistance to fatigue. For this type of application, the grease life becomes an important factor in defining bearing service life.

Grease life is the period during which the grease will maintain its initial characteristics and lubricating power. For any given grease, it is mainly a function of the bearing rotation speed and its operating temperature.



N: bearing rotation speed
Nmax: bearing rotation limit speed
T: operating temperature (°C)

These values are given for information and must always be confirmed by testing.

MachLine® selection guide

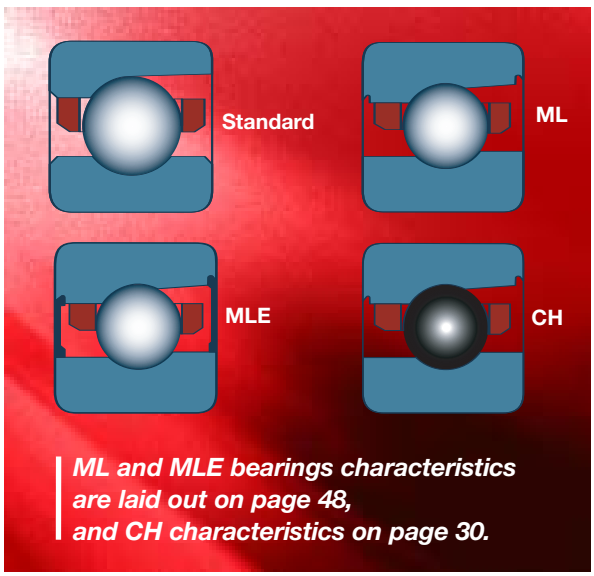
Our MachLine range has been designed for spindle applications for most machine tools: lathes, milling and drilling machines, center bores, grinders, high speed spindles, etc. Their capacity to support operating constraints - cutting and drive forces - and their high rotation speeds have been optimized for the following criteria: rotational accuracy, dimensional stability, geometrical micro and micro variations, rigidity, heat, vibration and service life.

Features of angular contact bearings

- Very high quality 100Cr6 steel rings and balls,
- Two contact angles: 15° and 25° (17° and 25° for MachLine ML and MLE range),
- Laminated resin cage centered on outer ring (Bronze or PEEK cage on request),
- Three preload grades (specific preloading on request),
- Standard precision P4S: ISO4 (ABEC 7) for dimensional characteristics and ISO2 (ABEC 9) for all dynamic characteristics. It is also possible to supply products with ISO 2 precision.

With our manufacturing know-how we can align the preloaded outer ring and inner ring with very high precision, guaranteeing offset of less than 2µm.
This non-standardized characteristic determines the preload value, which has a significant influence on spindle rigidity and behavior.

Comparison of internal geometry



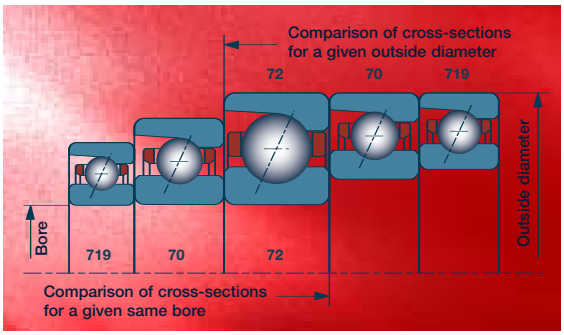
ML and MLE bearings characteristics are laid out on page 48, and CH characteristics on page 30.

- **MachLine High Speed – ML:** Speeds 30 % faster than the standard range are achieved using an increased number of balls with reduced diameter and improved cage guidance on the outer ring.

- **MachLine Sealed – MLE:** Performance values at speeds comparable to a standard bearing lubricated with oil are achieved with grease lubrication by using non-contact seals on ML range bearings.

- **MachLine Hybrid – CH:** Bearing performance can be further enhanced by using ceramic balls instead of steel balls.

Dimensions by series



Bearing series and version codes

Series	Version code
7000	V
71900	V
7200	G1

- **V version:** Series 71900 and 7000 are the best suited to high rotation speeds. They provide the best combination of speed, capacity, rigidity and precision characteristics.

- **G1 version:** The G1 version was specially designed to meet series 7200 specifications, which is designed to withstand predominantly major axial loads.

Version selection:
SNR offers several options for creating a bearing arrangement.

Features of versions on offer

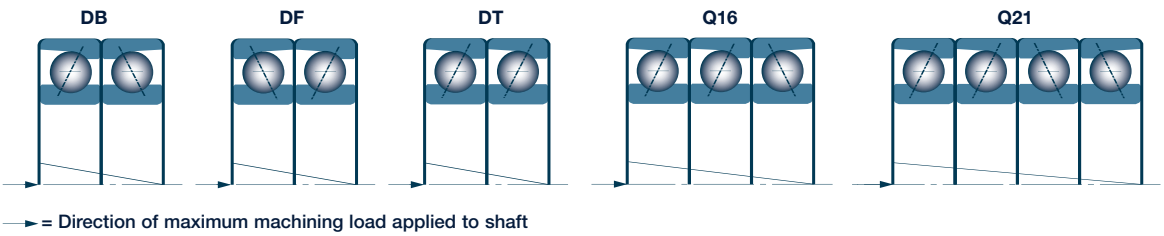
- **UNIVERSAL bearing, code U:** with the selected preload, the inner ring and outer ring surfaces of these bearings are on the same plane. All types of arrangements can be achieved with this bearing.

- **Arrangements of UNIVERSAL bearings, codes DU, TU, QU...:** Arrangement of several universal bearings whose outside diameters and bores are selected to ensure a tolerance range no more than half the ISO tolerance level.

- **Arrangements of MATCHED bearings, codes DB, DF, DT, Q16, Q21...:** These assemblies are matched by SNR and must not be re-arranged. They have the following characteristics:
- Matching preload values,
- Variation of outside diameter and bore values within a tolerance range no more than half the ISO standard tolerance,
- Assembly is identified with a “V” marked on the outside diameter of all bearings in an assembly.

These features, in particular the extremely precise preload values, mean that greater spindle precision can be achieved, with better rigidity and longer life.

Examples of identification codes for matched assemblies



Specific tolerances

Certain specific applications may require bearings with lower bore and outside diameter tolerances, values centered with respect to ISO 4 tolerance specifications. These bearings are identified with the letter R, as shown in the following coding example: 71912CVURJ74.

MachLine® CH - Hybrid: selecting a ceramic ball

The internal design of SNR series can greatly increase bearing performance and life with ceramic balls.

Ceramic properties

The ceramic used is a Silicone Nitride: Si_3N_4

- low density: 0.1156 lbs/in^3,
- low coefficient of thermal expansion,
- high modulus of elasticity: 45 x 10^6 psi,
- non-magnetic,
- low coefficient to friction,
- electrical insulator,
- low heat conductivity,
- corrosion-resistant.

Significant results

These physical properties make it possible to:

- **increase rotation speed at a given operating temperature,**
- **improve bearing rigidity,**
- **increase bearing life.**

All MachLine High Precision ranges, ML, MLE and 7000, 71900 and 7200 series are available as a hybrid version.

Performance values for MachLine CH - Hybrid

Increase in rotation speed:
+ 30%

The kinematics of SNR hybrid bearings generates less slipping and heating than steel ball bearings. At a given temperature, they can operate at approximately 30 % higher speeds than steel ball bearings.

Improved rigidity:
+ 10%

The fact that the modulus of elasticity of ceramics is higher than that of steel means that the rigidity of a hybrid bearing can be increased by approximately 10 % under a given preload.

In certain situations, the properties of "hybrid" bearings may allow grease lubrication where air-oil lubrication would otherwise be required due to the required rotation speed. This option provides economic advantages.

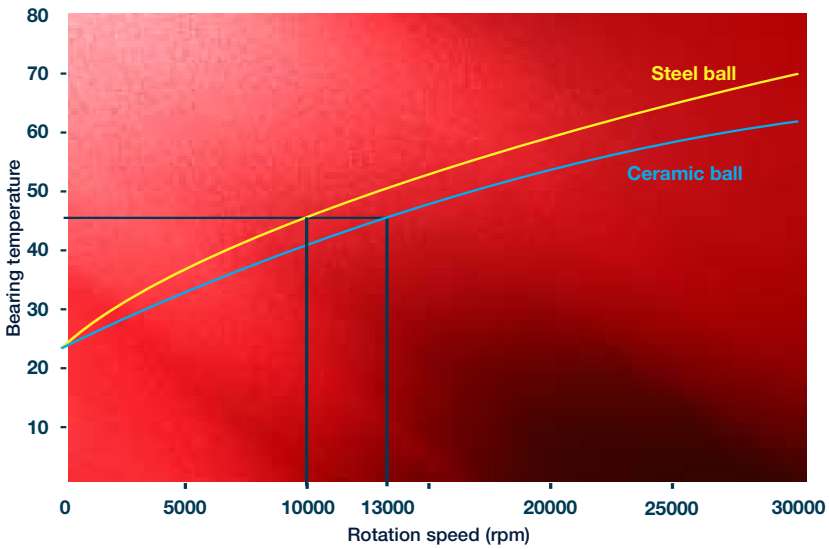
3 times longer life:
x 3

The lubrication and friction behavior of ceramics, in particular, their low friction coefficient and capacity to operate in reduced lubrication conditions, means that bearing raceways resist wear and damage much longer than with steel balls. The actual service life depends on operating conditions, but has been observed to be on the order of 2 or 3 times greater than steel ball bearings (under comparable operating conditions).

Lubrication:
Reduce costs

Lubricants used for 100Cr6 steel bearings can generally be used with ceramic ball bearings. Some applications may require a specific study to define the recommended lubricant.

Example for a CH7009CVDTJ04, spring preloaded to 550 N



Temperature as a function of rotation speed:
At a temperature of 113°F, the rotation speed goes from 10,000 rpm with steel balls to 13,000 rpm with ceramic balls.

MachLine® ML - High Speed: our solution for very high speeds

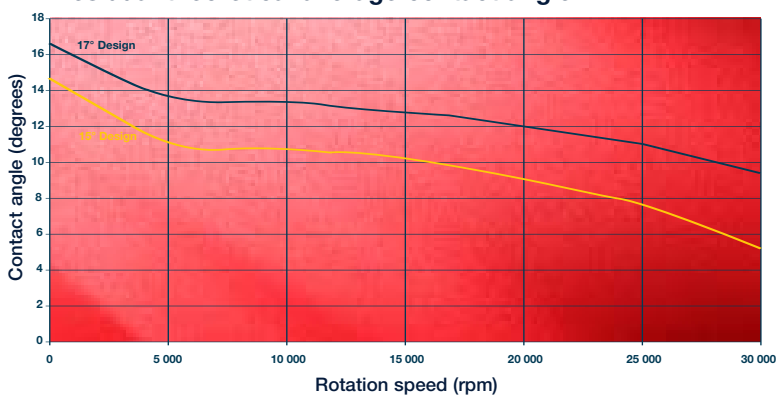
SNR has developed a range specifically designed to meet increasingly stringent requirements in applications using very high speed spindles.

Optimized design

The ML range is made up of series 7000 and 71900. The internal geometry of these bearings has been optimized to guarantee optimum behavior and operation at limit speeds:

- **Angle of contact 17° and 25°.**
- **Precision 4S.**
- **Phenolic resin cage with improved guidance.**
- **Design optimized for oil lubrication.**

Residual theoretical average contact angle



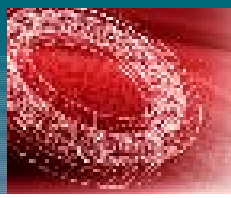
The graph opposite shows changes in the contact angle of a ML7011CVUJ74S according to rotation speed.
The advantage of a 17° design is that it maintains a larger contact angle at top speeds than a 15° design.

A « V » is marked on the outside diameter, in direction of the contact angle, to facilitate installation and creation of bearing arrangements.

Performance: reducing operating deformations

- Increase rotation speed, while maintaining a load capacity compatible with the service life target for high speed spindles.
- Speed coefficient on the order of 2.2×10^6 N.Dm.

These performance values have been made possible by using smaller balls and more of them. This design has the major advantage of increasing the ring cross-section, reducing operation deformations.



MachLine® MLE - Sealed: by definition, a cost-saving solution

Reduce maintenance costs

SNR has specially developed MLE bearings for machine tool spindles, a part of the trend for simplified mechanisms.

Conventional lubrication systems (oil mist, air-oil) **are no longer required with this type of bearing.** These methods are expensive, difficult to maintain and can cause critical functional failures for spindle use.

For grease-lubricated applications, the MLE **bearing means no more complex,** expensive sealing systems and regreasing operations.

Design and features

The design of these bearings is based on ML bearings, available in series 7000 and 71900:

- **Contact angle 17° and 25°.**
- **Precision 4S.**
- **Non-contact seals:** avoids over-heating linked to friction on seals.
- **Reduced clearance between seal lip and the shoulder of the inner ring:** limiting contaminant entry and avoiding grease leaks.
- Greased in factory by SNR, using optimum quantities of SNR-LUB GV+, recommended by our research and test center.
- Greased in clean room: avoiding contamination during assembly.

A single « V » is marked on the outside diameter to facilitate assembly and creating bearing arrangements.

Use of a MachLine High Speed ML bearing lubricated with SNR LUB GV+ grease can give the same performance values at high speed as a standard bearing lubricated with oil.

MachLine® HNS – N: for extreme conditions

SNR offers MachLine HNS for applications where the bearing is operating at extreme speed or load conditions. It was developed for the aviation and aerospace industries.

General features

This bearing has **stainless steel rings and ceramic balls.**
XD15N steel is a nitrogen-strengthened martensitic stainless steel, developed by SNR in partnership with Aubert & Duval. It is **highly corrosion-resistant and resistant to wear and surface damage.**

Performance of XD15N steel...

Its conventional manufacturing methods using ESR (Electro Slag Remelted) - and its highly machinable property make this a very high performance steel, with **excellent cleanliness**, guaranteeing greater fatigue resistance than conventional steel.

... and ceramic balls

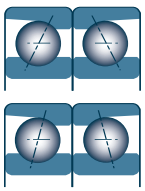
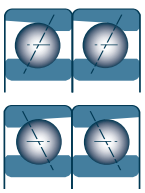
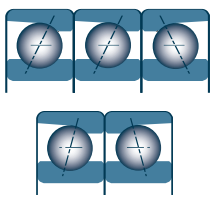
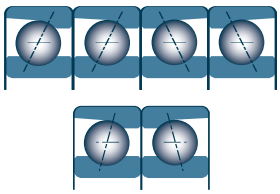
This bearing uses ceramic balls to give all the lubricant and wear advantages of ceramic-steel contact – high resistance to wear and deterioration (see page 31).

The SNR research and test center has established coefficient a_2 in calculating the corrected service life for XD15N – a value of 2.8 (see page 20).

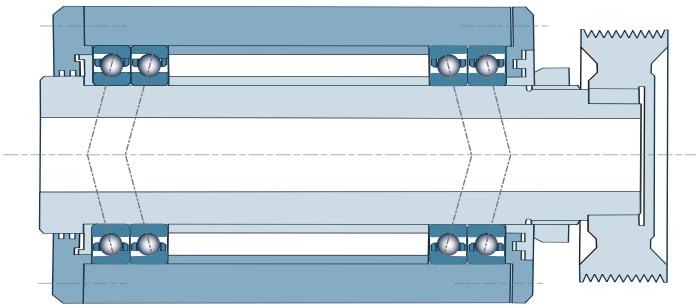
Spindle types and installation examples

Classification of spindle applications into broad areas

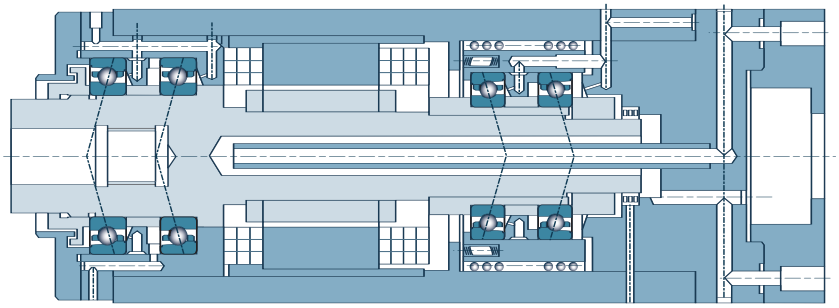
This classification gives the most usual configurations, but others are possible.

Number of bearings	Bearing	Arrangement	Field of application
4	Front Rear		**Light to medium loads – high speeds** Installed on boring, milling, drilling units and grinding spindles.
	Front Rear		**Light loads – very high speeds** Often installed on internal grinding spindles, spring preloaded.
5	Front Rear		**Heavy loads (single direction axial loads) - medium speeds** Very often installed on boring and milling machines, lathes and boring, milling and drilling units.
6	Front Rear		**Heavy loads – medium speeds** Useful when installed on assemblies where the axial load applies in both directions. For spindles on boring and milling machines, lathes and boring, milling and drilling units.

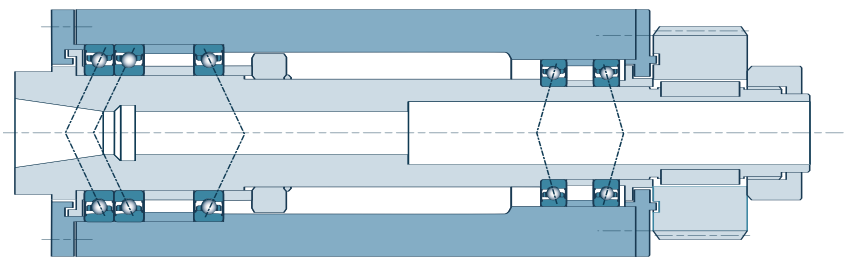
Spindle types and assembly examples



Example 1:
MachLine Standard bearings
Q21 arrangement

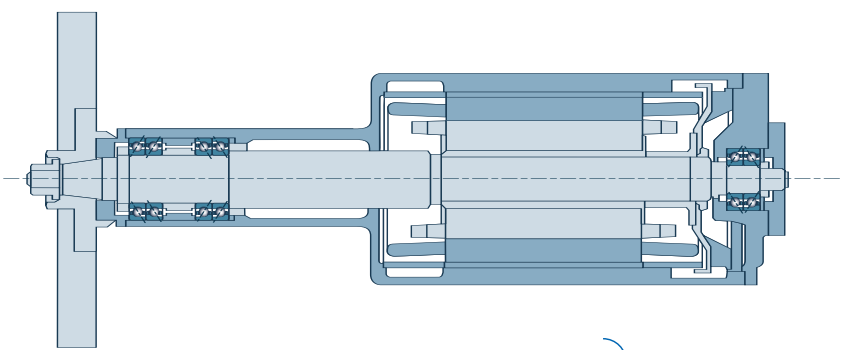


Example 2:
MachLine ML bearings
Front bearing: DT arrangement
Rear bearing: DT arrangement spring preloaded



Example 3:
MachLine MLE bearings
Front bearing: Q16 arrangement
Rear bearing: DB arrangement

Example 4:
MachLine MLE bearings
Front bearing: DB arrangement
Rear bearing: DB arrangement



Example 5:
MachLine Standard bearings
Front bearing: Q21 arrangement
Rear bearing: DB arrangement

MachLine®

range

To help in your choices, the section gives all part numbers, characteristics and tolerances for our range of bearings and precision self-locking nuts.
You are also provided with a whole range of operational information to facilitate your logistics and make easier to understand our symbol, marking and packaging code systems.

machline®

SNR

Symbol system for MachLine® bearings

12 — **Bore diameter**

Code	Dimensions
00	10 mm
01	12 mm
02	15 mm
03	17 mm
04 x 5	20 mm
05 x 5	25 mm
.... x 5	etc…

719 — **Series**

719 (ISO 19)
70 (ISO 10)
72 (ISO 02)

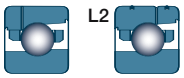
ML — **High Speed range**

CH

CH Hybrid bearing
N HNS bearing

***** — **Lubrication holes in outer ring**

(no code)
= Standard ring



V

V **High Precision bearings**
Series 719-70
Stratified phenolic cage guided by the outer ring

G1 **High load capacity bearing**
Serie 72
Stratified phenolic cage guided by the outer ring

J — Symbol preceding preload and precision functions

4S — **Tolerance classes**

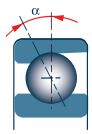
Code	Precision
4	P4S for standard
4S	P4S for ML and MLE
2	ISO 2 (ABEC 9)

ML	E	CH	719	12	C	V	*	U	*	J	7	4S	*

E — **Sealed bearing**

C — **Contact angle α**

Code	Stand.	ML
C	15°	17°
H	25°	25°

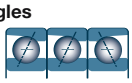


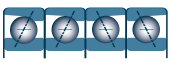
U — **Arrangement code**

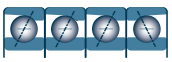
Universal bearing and arrangement of universal bearings

U Universal single bearing
DU Universal pair
TU Arrangement of 3 universal bearings
QU Arrangement of 4 universal bearings

Arrangement of paired bearings: identical contact angles

DB 
Q16 

DF 
Q21 

DT 
Q18 

Arrangement of paired bearings: different contact angles

Q34 
Q30 

***** — **Specials**

Example:
D = greased bearing

7 — **Preload**

Code	Designation
7	Light
8	Medium
9	Heavy
X	Special
0	Not defined

***** — **(empty)** standard bearing
R = classification of inner and outer diameter

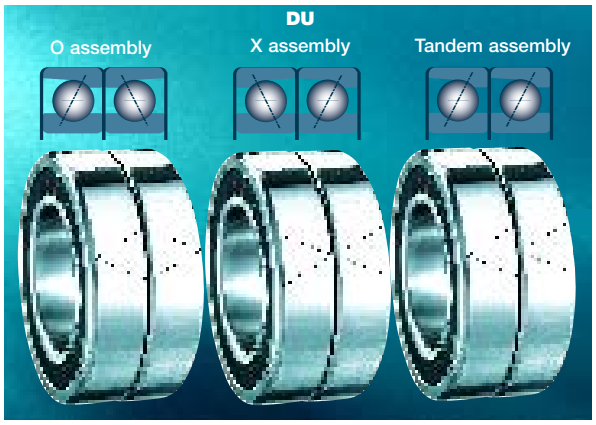
For other arrangements, consult SNR

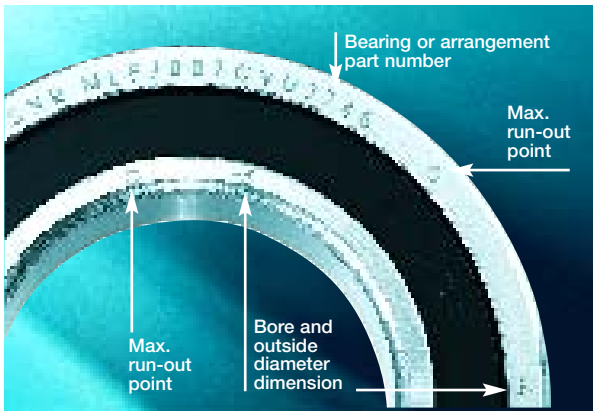
Packaging available from 2006

Marking and packaging

Marking

- **Universal bearings:** A single « V » is marked on the outside diameter to facilitate assembly. This identification is currently used for ML and MLE bearings and will be gradually incorporated into all ranges in 2006.
- **Matched bearing arrangements:** The « V » marked on the outside diameter shows the position of the bearings in the arrangement, enabling the assembly to be centered at installation (see installation recommendations). The registration number of the arrangement enables assemblies to be put back together if bearings get mixed up. The « V » of the arrangement is at 90° angle to the single « V » on the outside diameter.





Packaging

After being coated with an anti-oxidant, MachLine bearings are individually packed in a heat-sealed plastic bag. If the bearing is kept in its original packaging, long-term oxidation protection is guaranteed.

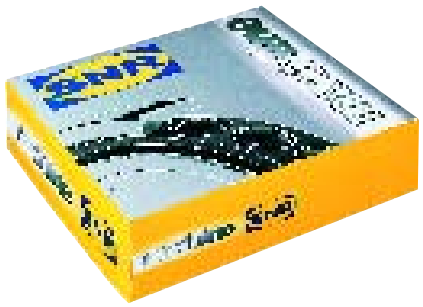
- **Universal bearings.** Information shown on package: bearing part number, packaging date, bore and outside diameter dimensions.
- **Matched bearing arrangements:** for bearing arrangements, boxes containing the bearings are bound with adhesive tape stating "Do not separate". Information shown on package: arrangement part number, packaging date, bore and outside diameter dimensions.

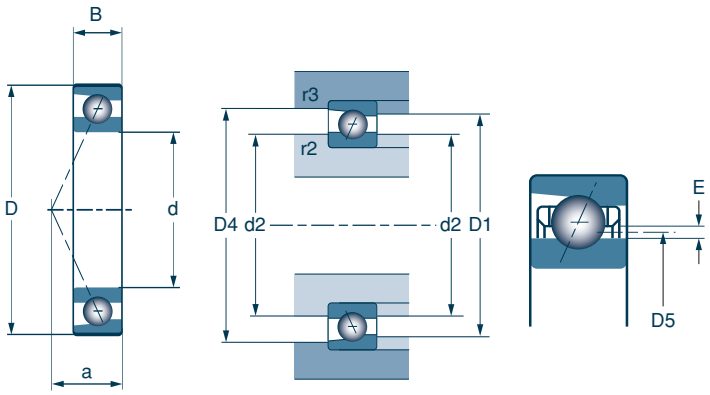
All SNR MachLine bearings have been given a holographic label with several security features as part of our ongoing fight against counterfeiting.

MachLine®: ranges
High Precision - Standard

Series 719 / 70 / 72

Dimensions			Weight	Series	Shoulders and fillets (mm)					Hole for lubrication		Balls	
d	D	B	lbs		D1	d2	D4	Max. r2	Max. r3	D5	E	Diam.	Nb
10	22	6	0.022	**71900**	17.8	13.6	18.8	0.3	0.1	14.7	1.10	3.175	11
	26	8	0.040	**7000**	21.4	14.7	22.7	0.3	0.1	16.5	1.85	4.762	10
	30	9	0.066	**7200**	24.5	16.0	25.5	0.6	0.3	18.2	2.25	5.556	10
12	24	6	0.024	**71901**	19.6	15.4	20.6	0.3	0.1	16.5	1.30	3.175	13
	28	8	0.044	**7001**	23.4	16.7	24.7	0.3	0.1	18.5	1.65	4.762	11
	32	10	0.082	**7201**	26.0	18.3	27.9	0.6	0.3	20.5	1.85	5.953	10
15	28	7	0.033	**71902**	24.3	18.7	25.4	0.3	0.1	20.0	1.40	3.969	13
	32	9	0.062	**7002**	26.9	20.2	28.2	0.3	0.1	22.0	1.65	4.762	13
	35	11	0.097	**7202**	29.0	21.1	31.3	0.6	0.3	23.3	2.10	5.953	11
17	30	7	0.037	**71903**	26.6	21.0	27.7	0.3	0.1	23.0	1.45	3.969	14
	35	10	0.082	**7003**	29.4	22.7	30.7	0.3	0.1	24.4	1.75	4.762	14
	40	12	0.143	**7203**	33.0	24.1	35.2	0.6	0.3	26.5	2.45	6.747	11
20	37	9	0.079	**71904**	31.9	25.1	33.2	0.3	0.15	26.8	1.78	4.762	15
	42	12	0.139	**7004**	35.5	26.6	37.3	0.6	0.3	29.0	2.40	6.350	13
	47	14	0.232	**7204**	38.6	28.5	41.4	1.0	0.3	31.3	2.80	7.938	11
25	42	9	0.090	**71905**	37.4	30.6	38.7	0.3	0.15	32.3	1.75	4.762	17
	47	12	0.168	**7005**	40.1	32.2	42.3	0.6	0.3	34.2	2.05	6.350	15
	52	15	0.282	**7205**	44.5	34.0	46.9	1.0	0.3	36.8	2.80	7.938	13
30	47	9	0.104	**71906**	41.9	35.1	43.2	0.3	0.15	36.8	1.73	4.762	18
	55	13	0.247	**7006**	47.0	38.1	49.5	1.0	0.3	40.4	2.35	7.144	16
	62	16	0.441	**7206**	52.1	40.4	55.4	1.0	0.3	43.5	3.15	9.525	13
35	55	10	0.165	**71907**	48.6	41.4	50.4	0.6	0.15	43.2	1.85	5.556	18
	62	14	0.331	**7007**	53.1	43.2	56.3	1.0	0.3	46.0	2.85	7.938	16
	72	17	0.639	**7207**	61.0	47.4	64.5	1.1	0.3	50.9	3.50	11.112	13
40	62	12	0.243	**71908**	55.2	46.8	57.2	0.6	0.15	49.0	2.18	6.350	19
	68	15	0.408	**7008**	59.0	49.2	61.8	1.0	0.3	51.8	2.55	7.938	18
	80	18	0.816	**7208**	67.6	52.8	71.8	1.1	0.6	56.9	4.05	11.906	13
45	68	12	0.282	**71909**	60.7	52.3	62.7	0.6	0.3	54.5	2.15	6.350	20
	75	16	0.525	**7009**	65.0	54.7	68.6	1.0	0.3	57.5	2.85	8.731	18
	85	19	0.917	**7209**	72.5	57.4	77.5	1.1	0.6	61.7	4.30	12.700	14
50	72	12	0.284	**71910**	65.2	56.8	67.2	0.6	0.3	58.9	2.13	6.350	21
	80	16	0.564	**7010**	70.0	59.7	73.6	1.0	0.3	62.5	2.80	8.731	19
	90	20	1.072	**7210**	76.9	62.5	82.7	1.1	0.6	66.7	4.20	12.700	15
55	80	13	0.399	**71911**	72.5	62.1	75.8	1.0	0.3	65.4	2.25	7.144	21
	90	18	0.860	**7011**	80.0	65.0	84.0	1.1	0.6	69.0	2.00	9.525	19
	100	21	1.367	**7211**	87.0	68.0	92.5	1.5	0.6	72.5	2.10	14.288	14
60	85	13	0.430	**71912**	77.5	67.1	80.8	1.0	0.3	70.4	2.25	7.144	23
	95	18	0.926	**7012**	85.0	70.0	89.0	1.1	0.6	73.8	2.00	9.525	21
	110	22	1.786	**7212**	95.0	75.0	101.5	1.5	0.6	79.5	2.30	15.875	14
65	90	13	0.463	**71913**	82.5	72.5	86.0	1.0	0.3	74.5	1.25	7.144	27
	100	18	0.970	**7013**	90.0	75.0	94.0	1.1	0.6	78.8	2.00	9.525	22
	120	23	2.514	**7213**	104.0	81.0	109.0	1.5	0.6	87.0	2.30	15.875	15
70	100	16	0.750	**71914**	91.0	79.0	95.0	1.0	0.3	81.5	1.50	8.731	24
	110	20	1.345	**7014**	98.5	81.5	103.0	1.1	0.6	85.8	2.50	11.112	21
	125	24	2.426	**7214**	109.0	86.0	116.0	1.5	0.6	91.4	2.60	17.462	14





Series 719 CV
70 CV / 72 CG1

Contact angle 15°

Series C	a (mm)	Basic load,values in lbf		Limit speed in rpm	
		C Dynamic	Co Static	Grease	Oil
71900CV	5	686	342	71,000	108,000
7000CV	6	1,283	619	60,000	95,000
7200CG1	7	1,688	833	53,000	82,000
71901CV	5	765	419	64,000	97,000
7001CV	7	1,395	720	54,000	85,000
7201CG1	8	1,935	968	48,000	74,000
71902CV	6	1,148	641	52,000	79,000
7002CV	8	1,575	900	46,000	72,000
7202CG1	9	2,115	1,125	42,000	65,000
71903CV	7	1,193	709	46,000	70,000
7003CV	8	1,665	1,001	41,000	65,000
7203CG1	10	2,610	1,440	37,000	58,000
71904CV	8	1,733	1,103	39,000	60,000
7004CV	10	2,655	1,598	35,000	55,000
7204CG1	11	3,510	2,003	32,000	49,000
71905CV	9	1,868	1,305	33,000	50,000
7005CV	11	2,925	1,935	30,000	47,000
7205CG1	13	3,960	2,498	27,000	42,000
71906CV	10	1,890	1,418	29,000	44,000
7006CV	12	3,758	2,633	25,000	40,000
7206CG1	14	5,490	3,578	23,000	35,000
71907CV	11	2,498	1,913	25,000	38,000
7007CV	13	4,725	3,488	23,000	35,000
7207CG1	16	7,313	4,883	20,000	31,000
71908CV	13	3,308	2,655	21,000	33,000
7008CV	15	4,860	3,780	21,000	33,000
7208CG1	17	8,213	5,625	18,500	29,500
71909CV	14	3,465	2,408	20,000	30,000
7009CV	16	6,165	4,320	19,000	28,000
7209CG1	18	10,328	6,728	16,500	26,000
71910CV	14	3,510	2,543	19,000	28,000
7010CV	17	6,345	4,545	18,000	26,000
7210CG1	19	10,800	7,335	15,500	24,500
71911CV	16	4,208	3,083	16,500	25,000
7011CV	19	6,863	5,850	16,000	24,000
7211CG1	21	11,925	9,000	14,500	21,500
71912CV	16	4,388	3,375	14,500	23,500
7012CV	19	7,313	6,638	15,000	23,000
7212CG1	22	14,625	11,025	12,500	19,500
71913CV	17	4,883	4,928	14,500	22,000
7013CV	20	7,425	6,975	14,000	21,000
7213CG1	24	15,075	12,150	11,500	17,500
71914CV	19	6,638	6,525	13,000	20,000
7014CV	22	9,675	9,000	13,000	20,000
7214CG1	25	17,325	13,500	11,000	16,500

Series 719 HV
70 HV / 72 HG1

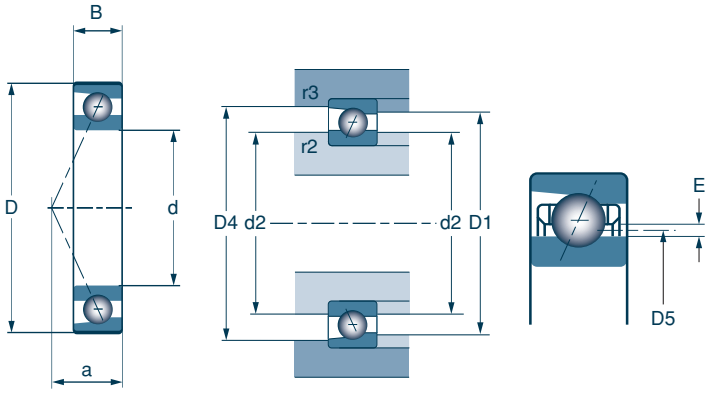
Contact angle 25°

Series H	a (mm)	Basic load values in lbf		Limit speed in rpm	
		C Dynamic	Co Static	Grease	Oil
71900HV	7	653	326	67,000	103,000
7000HV	8	1,238	596	53,000	82,000
7200HG1	9	1,620	799	46,000	72,000
71901HV	7	731	398	61,000	93,000
7001HV	9	1,350	686	48,000	72,000
7201HG1	10	1,868	945	42,000	65,000
71902HV	9	1,091	619	49,000	75,000
7002HV	10	1,508	866	42,000	62,000
7202HG1	11	2,048	1,091	37,000	57,000
71903HV	9	1,148	675	44,000	68,000
7003HV	11	1,575	956	37,000	56,000
7203HG1	13	2,520	1,395	32,000	50,000
71904HV	11	1,643	1,046	37,000	57,000
7004HV	13	2,543	1,530	31,000	47,000
7204HG1	15	3,375	1,913	28,000	43,000
71905HV	12	1,755	1,238	31,000	47,000
7005HV	14	2,790	1,845	26,000	40,000
7205HG1	16	3,803	2,385	24,000	37,000
71906HV	13	1,800	1,328	27,000	42,000
7006HV	16	3,578	2,520	22,000	34,000
7206HG1	19	5,265	3,420	20,000	31,000
71907HV	15	2,363	1,823	23,000	36,000
7007HV	18	4,500	3,330	21,000	31,000
7207HG1	21	6,975	4,658	17,000	27,000
71908HV	18	3,128	2,498	20,000	31,000
7008HV	20	4,613	3,600	20,000	30,000
7208HG1	23	7,875	5,423	16,500	25,500
71909HV	19	3,263	2,273	18,000	26,000
7009HV	22	5,850	4,073	18,000	24,000
7209HG1	25	9,855	6,413	15,000	22,500
71910HV	20	3,308	2,385	16,000	24,000
7010HV	23	5,985	4,343	14,500	22,000
7210HG1	26	10,283	6,930	13,500	20,500
71911HV	22	3,960	2,903	13,500	21,500
7011HV	26	6,525	5,603	14,000	22,000
7211HG1	29	11,475	8,550	12,500	19,500
71912HV	23	4,140	3,195	13,500	20,000
7012HV	27	6,863	6,300	14,000	21,000
7212HG1	31	13,950	10,575	11,000	17,500
71913HV	25	4,590	4,590	14,000	21,000
7013HV	28	7,088	6,638	13,000	19,000
7213HG1	33	14,400	11,700	10,000	16,500
71914HV	28	6,300	6,188	12,500	19,000
7014HV	31	9,113	8,438	12,500	19,000
7214HG1	35	16,425	12,825	9,700	15,000

MachLine®: ranges
High Precision - Standard

Series 719 / 70 / 72

Dimensions			Weight	Series	Shoulders and fillets (mm)					Hole for lubrication		Balls	
d	D	B	lbs		D1	d2	D4	Max. r2	Max. r3	D5	E	Diam.	Nb
75	105	16	0.794	**71915**	96.0	84.0	100.0	1.0	0.3	86.3	1.50	8.731	26
	115	20	1.433	**7015**	103.5	86.5	108.0	1.1	0.6	90.7	2.50	11.112	22
	130	25	2.646	**7215**	114.0	91.0	121.0	1.5	0.6	96.4	2.60	17.462	15
80	110	16	0.838	**71916**	101.0	89.0	105.0	1.0	0.3	91.2	1.50	8.731	27
	125	22	1.874	**7016**	112.0	93.0	117.5	1.1	0.6	98.0	3.50	13.494	20
	140	26	3.241	**7216**	122.5	97.5	130.0	2.0	1.0	103.4	2.80	19.050	15
85	120	18	1.213	**71917**	110.0	95.0	114.0	1.1	0.6	98.6	1.80	9.525	27
	130	22	1.985	**7017**	117.0	98.0	122.5	1.1	0.6	102.8	3.50	13.494	21
	150	28	3.991	**7217**	131.0	104.0	140.0	2.0	1.0	110.3	3.10	20.638	15
90	125	18	1.279	**71918**	115.0	100.0	119.0	1.1	0.6	103.5	1.80	9.525	29
	140	24	2.558	**7018**	125.5	104.5	131.5	1.5	0.6	110.0	3.80	15.081	20
	160	30	4.939	**7218**	139.0	111.0	149.0	2.0	1.0	117.2	3.30	22.225	15
95	130	18	1.301	**71919**	120.0	105.0	124.0	1.1	0.6	108.3	2.00	10.319	28
	145	24	2.668	**7019**	130.5	109.5	136.5	1.5	0.6	114.8	3.80	15.081	21
100	140	20	1.808	**71920**	128.5	111.5	133.5	1.1	0.6	115.6	2.10	11.112	28
	150	24	2.800	**7020**	135.5	114.5	141.5	1.5	0.6	119.7	3.80	15.081	22
	180	34	7.122	**7220**	155.5	124.5	167.0	2.1	1.1	131.0	3.80	25.400	14
105	145	20	1.896	**71921**	133.5	116.5	138.5	1.1	0.6	120.5	2.10	11.112	29
	160	26	3.550	**7021**	144.5	120.5	150.0	2.0	1.0	127.0	4.00	15.875	22
110	150	20	1.962	**71922**	138.5	121.5	143.5	1.1	0.6	125.5	2.10	11.112	30
	170	28	4.410	**7022**	153.0	127.0	160.0	2.0	1.0	134.0	4.50	17.462	21
	200	38	9.989	**7222**	172.5	137.5	185.5	2.1	1.1	145.0	4.30	28.575	14
120	165	22	2.624	**71924**	151.5	133.5	157.5	1.1	0.6	137.7	3.30	13.494	28
	180	28	4.741	**7024**	163.0	137.0	170.0	2.0	1.0	144.0	4.50	17.462	23
	215	40	12.348	**7224**	185.5	149.5	197.5	2.1	1.1	157.5	4.30	28.575	16
130	180	24	3.462	**71926**	165.0	145.0	172.0	1.5	0.6	149.8	3.70	15.081	27
	200	33	7.012	**7026**	179.5	150.5	189.0	2.0	1.0	158.0	5.30	20.638	21
140	190	24	3.704	**71928**	175.0	155.0	182.0	1.5	0.6	159.8	3.70	15.081	29
	210	33	7.541	**7028**	189.5	160.5	199.0	2.0	1.0	168.0	5.30	20.638	23
150	210	28	5.777	**71930**	192.5	167.5	199.0	2.0	1.0	174.0	4.10	16.669	29
	225	35	9.173	**7030**	203.0	172.0	213.0	2.1	1.0	180.0	5.70	22.225	23
160	220	28	6.086	**71932**	202.5	177.5	209.0	2.0	1.0	184.0	4.10	16.669	30
	240	38	11.312	**7032**	216.0	184.0	227.0	2.1	1.0	192.0	6.20	23.812	23
170	230	28	6.417	**71934**	212.5	187.5	219.0	2.0	1.0	194.0	4.10	16.669	32
	260	42	15.391	**7034**	232.5	197.5	246.0	2.1	1.1	206.4	6.60	25.400	23
180	250	33	9.393	**71936**	229.0	201.0	237.5	2.0	1.0	208.3	4.70	19.050	30
	280	46	19.845	**7036**	249.5	210.5	264.0	2.1	1.1	219.8	7.80	30.163	21
190	260	33	9.878	**71938**	239.0	211.0	247.5	2.0	1.0	218.3	4.70	19.050	32
	290	46	20.727	**7038**	259.5	220.5	274.0	2.1	1.1	229.8	7.80	30.163	22
200	280	38	13.583	**71940**	255.5	224.5	266.0	2.1	1.0	232.0	5.50	23.812	27
	310	51	26.791	**7040**	276.5	233.5	292.0	2.1	1.1	243.6	8.60	33.338	21
220	300	38	14.928	**71944**	275.5	244.5	286.0	2.1	1.0	252.0	5.50	22.225	31
	340	56	35.897	**7044**	304.0	256.0	321.0	3.0	1.1	268.6	8.60	33.338	23
240	320	38	16.030	**71948**	295.5	264.5	306.0	2.1	1.0	272.0	5.50	22.225	33



Series 719 CV
70 CV / 72 CG1

Contact angle 15°

Series C	a (mm)	Basic load values in lbf		Limit speed in rpm	
		C Dynamic	Co Static	Grease	Oil
71915CV	20	6,863	7,088	12,500	19,000
7015CV	23	9,900	9,450	12,000	19,000
7215CG1	26	18,000	14,625	10,000	16,000
71916CV	21	6,975	7,425	12,000	18,000
7016CV	25	13,275	12,375	11,000	17,000
7216CG1	28	21,150	17,550	9,400	15,000
71917CV	23	8,213	8,775	11,000	17,000
7017CV	25	13,725	13,275	10,500	16,000
7217CG1	30	24,300	20,475	8,700	14,000
71918CV	23	8,550	9,338	10,500	16,000
7018CV	27	16,425	15,525	10,000	15,000
7218CG1	32	27,900	23,625	8,100	12,500
71919CV	24	9,675	10,688	9,900	15,000
7019CV	28	16,650	16,425	9,700	14,500
71920CV	26	11,025	12,375	9,500	14,500
7020CV	29	17,100	17,325	9,300	14,000
7220CG1	36	33,750	28,575	7,200	11,000
71921CV	27	11,250	12,825	9,200	14,000
7021CV	31	18,900	19,350	8,800	13,500
71922CV	27	11,475	13,275	8,900	13,500
7022CV	33	21,825	22,050	8,300	12,500
7222CG1	40	39,825	36,000	6,300	9,700
71924CV	30	15,750	18,225	8,200	12,500
7024CV	34	22,950	24,525	7,700	11,500
7224CG1	42	43,425	42,075	5,700	8,700
71926CV	33	18,900	22,050	7,500	11,500
7026CV	39	29,475	30,825	7,000	10,500
71928CV	34	19,575	23,625	7,200	11,000
7028CV	40	31,050	34,200	6,600	10,000
71930CV	38	23,625	28,800	6,500	9,000
7030CV	43	35,550	39,600	6,200	9,300
71932CV	39	23,850	29,700	6,200	9,400
7032CV	46	40,275	45,450	5,800	8,800
71934CV	41	24,075	31,500	5,800	8,900
7034CV	50	45,000	51,750	5,400	8,100
71936CV	45	30,375	38,925	5,400	8,300
7036CV	54	54,900	65,250	5,000	7,600
71938CV	47	31,275	41,175	5,200	7,900
7038CV	55	56,250	68,625	4,800	7,300
71940CV	51	43,200	54,675	4,800	7,400
7040CV	60	63,000	79,875	4,500	6,900
71944CV	54	40,500	54,450	4,400	6,800
7044CV	66	66,375	88,875	4,100	6,200
71948CV	57	41,625	57,375	4,200	6,400

Series 719 HV
70 HV / 72 HG1

Contact angle 25°

Series H	a (mm)	Basic load values in lbf		Limit speed in rpm	
		C Dynamic	Co Static	Grease	Oil
71915HV	29	6,525	6,638	12,000	18,000
7015HV	32	9,338	9,000	11,000	17,000
7215HG1	36	17,100	13,950	9,100	14,500
71916HV	30	6,638	6,863	11,000	17,000
7016HV	35	12,600	11,925	10,500	16,000
7216HG1	39	20,025	16,650	8,500	13,000
71917HV	33	7,763	8,213	9,900	15,000
7017HV	36	13,050	12,600	9,900	15,000
7217HG1	41	23,175	19,350	7,800	12,000
71918HV	34	7,988	8,775	9,900	15,000
7018HV	39	15,525	14,850	9,200	14,000
7218HG1	44	26,550	22,500	7,300	11,000
71919HV	35	9,113	9,900	9,200	14,000
7019HV	40	15,975	15,525	8,900	13,500
71920HV	38	10,350	11,475	8,600	13,000
7020HV	41	16,200	16,425	8,600	13,000
7220HG1	50	32,175	27,225	6,400	9,800
71921HV	39	10,575	11,925	8,600	13,000
7021HV	44	17,775	18,225	7,900	12,000
71922HV	40	10,688	12,375	8,200	12,500
7022HV	47	20,700	20,925	7,600	11,500
7222HG1	55	38,025	34,425	5,600	8,700
71924HV	44	14,850	17,100	7,500	11,500
7024HV	49	21,600	23,175	6,900	10,500
7224HG1	59	41,400	40,050	5,100	7,800
71926HV	48	17,775	20,700	6,900	10,500
7026HV	55	27,900	29,250	6,500	9,800
71928HV	50	18,450	22,050	6,400	9,800
7028HV	57	29,250	32,400	6,100	9,200
71930HV	56	22,275	27,000	5,900	9,000
7030HV	61	33,525	37,575	5,700	8,600
71932HV	58	22,500	27,675	5,600	8,500
7032HV	66	38,025	42,975	5,300	8,100
71934HV	61	23,175	29,475	5,300	8,100
7034HV	71	42,525	49,050	5,000	7,500
71936HV	67	28,575	36,225	4,900	7,500
7036HV	77	51,975	61,875	4,600	7,000
71938HV	69	29,475	38,475	4,700	7,200
7038HV	79	53,325	65,250	4,400	6,700
71940HV	75	40,725	51,525	4,400	6,800
7040HV	85	59,625	75,375	4,200	6,300
71944HV	77	38,250	50,850	4,000	6,200
7044HV	93	63,000	84,375	3,700	5,700
71948HV	84	39,150	53,550	3,800	5,800

MachLine®: ranges
High Precision - Standard

Preload, axial and radial rigidity of DU DB DF arrangements

Symbol	Deflection constant	Preload (lbf)			Axial rigidity (lbf/µm)			Radial rigidity (lbf/µm)		
	K (1)	7	8	9	7	8	9	7	8	9
71900CV	2.58	3	9	17	3	5	7	16	23	28
7000CV	2.33	6	18	36	4	7	10	23	32	38
7200CG1	2.12	9	27	52	5	9	12	29	40	48
71900HV	1.25	5	16	32	7	11	15	15	21	26
7000HV	1.14	10	29	59	9	15	20	20	28	34
7200HG1	1.03	14	41	81	12	18	25	25	35	44
71901CV	2.31	3	10	19	3	5	8	20	27	33
7001CV	2.19	7	20	41	5	7	11	25	36	43
7201CG1	2.11	9	29	56	5	9	12	30	42	51
71901HV	1.12	6	17	34	8	13	17	18	25	30
7001HV	1.06	11	32	63	11	16	21	23	31	38
7201HG1	1.03	16	47	95	13	19	25	27	38	47
71902CV	2.18	5	16	32	4	7	9	24	34	41
7002CV	2.06	7	23	45	5	9	12	28	39	48
7202CG1	1.98	10	29	61	6	9	13	34	46	56
71902HV	1.05	8	25	50	10	15	20	21	30	37
7002HV	1.00	12	36	72	12	18	25	25	35	43
7202HG1	0.97	17	50	99	14	21	28	30	41	51
71903CV	2.08	6	17	34	5	7	10	26	36	45
7003CV	1.87	8	24	47	5	9	13	32	44	54
7203CG1	1.81	14	38	79	7	11	16	37	50	62
71903HV	1.00	9	27	54	11	16	22	23	32	40
7003HV	0.91	14	38	77	13	20	26	29	39	49
7203HG1	0.92	20	63	126	16	24	32	32	45	55
71904CV	1.79	8	25	50	6	10	14	33	47	58
7004CV	1.65	14	41	81	7	13	19	42	58	70
7204CG1	1.58	19	59	113	9	15	21	46	64	77
71904HV	0.87	12	38	77	14	21	28	29	42	52
7004HV	0.81	23	68	135	18	27	37	37	52	64
7204HG1	0.80	32	92	185	20	31	43	41	56	69
71905CV	1.64	9	27	54	7	11	15	38	53	65
7005CV	1.50	16	45	90	9	15	21	48	66	81
7205CG1	1.45	23	68	135	10	17	25	55	77	93
71905HV	0.80	14	41	81	16	24	31	33	47	58
7005HV	0.74	25	72	144	20	30	41	43	59	73
7205HG1	0.72	34	101	203	23	36	49	47	66	81
71906CV	1.59	9	27	54	7	11	16	40	55	68
7006CV	1.43	19	56	113	10	16	24	55	77	94
7206CG1	1.33	29	86	171	11	18	26	64	88	106
71906HV	0.77	14	43	86	16	25	33	34	50	61
7006HV	0.70	29	90	180	22	34	46	48	68	83
7206HG1	0.68	45	135	270	26	40	54	56	78	95
71907CV	1.45	12	37	74	8	14	19	47	66	81
7007CV	1.30	23	68	135	11	19	27	64	90	109
7207CG1	1.32	41	119	225	14	23	32	75	104	124
71907HV	0.70	20	59	117	20	30	40	43	59	73
7007HV	0.63	38	113	225	27	41	55	58	81	100
7207HG1	0.65	63	189	383	32	49	67	66	93	115

(1) Axial deflection constant in µm $(lbf)^{-2/3}$ 7 = light preload 8 = medium preload 9 = heavy preload

Symbol	Deflection constant	Preload (lbf)			Axial rigidity (lbf/µm)			Radial rigidity (lbf/µm)		
	K (1)	7	8	9	7	8	9	7	8	9
71908CV	1.29	17	52	104	10	17	25	59	82	100
7008CV	1.25	25	74	149	12	20	29	69	96	117
7208CG1	1.37	42	126	248	13	22	31	75	105	127
71908HV	0.63	27	81	162	25	38	51	52	73	90
7008HV	0.61	41	119	248	28	43	60	61	86	107
7208HG1	0.67	68	203	405	32	48	65	67	95	117
71909CV	1.20	18	52	104	11	18	25	61	85	105
7009CV	1.24	29	90	180	14	24	34	75	113	141
7209CG1	1.33	52	158	315	16	27	38	89	128	160
71909HV	0.59	27	81	162	26	39	52	54	76	95
7009HV	0.61	47	146	293	32	50	68	66	97	123
7209HG1	0.63	83	248	495	38	58	78	79	113	142
71910CV	1.13	18	52	104	11	18	26	63	87	108
7010CV	1.15	32	95	189	14	25	36	80	118	150
7210CG1	1.29	54	162	324	17	28	40	94	134	167
71910HV	0.55	27	83	167	27	41	54	56	79	99
7010HV	0.56	50	151	299	33	52	70	68	101	127
7210HG1	0.61	86	257	513	40	61	82	83	119	149
71911CV	1.08	20	63	126	12	20	27	83	111	138
7011CV	1.12	41	108	234	16	25	37	90	121	151
7211CG1	1.20	72	180	360	18	27	39	101	133	163
71911HV	0.53	34	99	198	29	43	58	73	99	122
7011HV	0.55	63	162	338	38	54	73	79	106	133
7211HG1	0.57	113	281	563	42	60	80	89	118	146
71912CV	1.03	23	68	135	13	21	30	90	120	150
7012CV	1.05	45	122	261	18	28	41	100	135	167
7212CG1	1.15	90	225	450	20	31	43	113	149	181
71912HV	0.50	34	104	207	31	47	62	80	107	133
7012HV	0.51	72	180	383	42	60	82	88	118	148
7212HG1	0.56	135	338	675	47	66	88	98	130	160
71913CV	0.97	34	90	194	17	27	41	97	131	163
7013CV	1.01	50	126	275	19	29	43	106	141	176
7213CG1	1.09	95	236	473	21	33	46	120	158	193
71913HV	0.48	54	135	284	41	59	80	86	115	144
7013HV	0.50	77	194	394	44	63	85	93	124	154
7213HG1	0.52	140	349	698	49	70	93	104	138	170
71914CV	0.98	45	117	252	19	29	44	106	140	176
7014CV	0.99	63	162	349	21	32	48	117	156	194
7214CG1	1.11	104	259	518	22	33	47	122	161	197
71914HV	0.48	70	180	369	44	64	86	93	125	156
7014HV	0.49	95	248	506	48	70	94	102	138	171
7214HG1	0.53	162	405	810	51	72	96	107	143	176
71915CV	0.93	50	131	275	21	32	47	115	154	191
7015CV	0.96	68	171	371	22	34	51	124	164	205
7215CG1	1.07	108	270	540	23	35	49	130	171	209
71915HV	0.46	77	194	405	48	69	94	101	135	169
7015HV	0.47	104	261	540	52	74	99	108	145	180
7215HG1	0.51	167	416	833	54	76	101	114	151	187

MachLine®: ranges
High Precision - Standard

Preload, axial and radial rigidity of DU DB DF arrangements

Symbol	Deflection constant	Preload (lbf)			Axial rigidity (lbf/µm)			Radial rigidity (lbf/µm)		
	K (1)	7	8	9	7	8	9	7	8	9
71916CV	0.91	50	135	288	21	34	50	118	160	199
7016CV	0.97	86	225	484	24	37	55	134	180	224
7216CG1	1.03	131	326	653	25	38	54	142	188	230
71916HV	0.45	81	203	416	50	72	97	106	141	176
7016HV	0.47	135	338	709	56	80	109	119	158	198
7216HG1	0.50	198	495	990	59	83	110	124	165	204
71917CV	0.88	63	162	349	24	37	54	132	175	218
7017CV	0.93	90	239	506	25	39	58	141	189	235
7217CG1	1.01	149	371	743	27	41	58	153	201	246
71917HV	0.43	95	243	506	54	79	106	115	154	193
7017HV	0.46	140	360	743	59	85	114	124	167	208
7217HG1	0.49	225	563	1,125	63	89	118	133	177	218
71918CV	0.84	68	171	371	25	39	58	141	187	234
7018CV	0.93	108	284	608	27	42	62	151	202	251
7218CG1	1.00	171	428	855	29	44	62	164	216	265
71918HV	0.41	104	261	540	59	84	114	124	166	206
7018HV	0.45	167	428	889	63	90	122	132	177	221
7218HG1	0.47	261	653	1,305	68	96	127	143	191	235
71919CV	0.84	72	194	416	26	41	61	145	196	244
7019CV	0.90	113	297	630	28	44	64	158	212	263
71919HV	0.41	117	293	608	62	88	119	130	173	216
7019HV	0.44	176	450	934	66	95	128	139	187	233
71920CV	0.82	86	225	484	28	44	65	157	211	263
7020CV	0.87	117	315	664	29	46	68	165	222	276
7220CG1	0.99	207	518	1,035	31	47	66	174	230	282
71920HV	0.40	135	338	709	66	94	128	139	186	232
7020HV	0.43	185	473	979	69	99	134	146	196	244
7220HG1	0.48	315	788	1,575	72	102	135	152	203	250
71921CV	0.80	90	234	495	29	46	67	164	219	271
7021CV	0.86	131	349	743	31	49	72	174	234	291
71921HV	0.39	140	360	731	68	99	133	144	194	241
7021HV	0.42	207	529	1,091	73	105	142	154	207	257
71922CV	0.78	95	243	720	31	47	70	170	227	281
7022CV	0.86	153	405	855	33	51	75	183	246	305
7222CG1	0.96	243	608	1,215	34	51	71	192	253	310
71922HV	0.38	144	371	765	71	102	138	149	201	250
7022HV	0.42	239	608	1,260	77	110	149	161	216	270
7222HG1	0.46	374	934	1,868	79	112	148	167	223	276
71924CV	0.77	126	329	698	34	53	78	191	255	317
7024CV	0.80	167	439	945	36	56	83	200	269	335
7224CG1	0.89	257	641	1,283	37	56	78	214	283	347
71924HV	0.37	198	495	1,035	80	114	155	169	225	281
7024HV	0.39	261	675	1,384	84	121	163	177	238	296
7224HG1	0.42	387	968	1,935	87	123	162	185	248	306

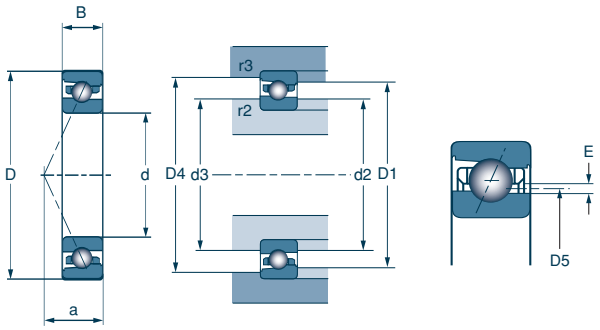
(1) Axial deflection constant in µm $(lbf)^{-2/3}$ 7 = light preload 8 = medium preload 9 = heavy preload

Symbol	Deflection constant	Preload (lbf)			Axial rigidity (lbf/µm)			Radial rigidity (lbf/µm)		
	K (1)	7	8	9	7	8	9	7	8	9
71926CV	0.76	149	394	844	37	57	85	205	275	342
7026CV	0.81	212	551	1,181	38	60	88	216	289	359
71926HV	0.37	234	596	1,238	86	123	167	181	243	303
7026HV	0.40	333	844	1,744	90	123	175	191	255	318
71928CV	0.72	162	428	900	40	62	90	221	296	367
7028CV	0.76	234	608	1,305	42	66	97	237	317	395
71928HV	0.35	257	653	1,339	93	133	180	196	262	326
7028HV	0.37	371	934	1,924	100	142	192	210	281	349
71930CV	0.70	198	518	1,091	44	68	100	244	326	404
7030CV	0.74	270	709	1,508	45	71	104	255	342	425
71930HV	0.34	311	788	1,631	102	147	198	216	289	360
7030HV	0.36	428	1,091	2,228	107	153	207	226	302	376
71932CV	0.68	207	540	1,148	45	71	104	253	339	420
7032CV	0.73	311	810	1,721	49	76	111	273	366	454
71932HV	0.33	324	821	1,699	106	152	206	224	299	373
7032HV	0.36	484	1,238	2,621	114	164	221	241	323	403
71934CV	0.65	221	574	1,215	48	75	110	270	361	448
7034CV	0.71	349	923	1,958	52	81	119	290	390	484
71934HV	0.32	349	878	1,823	114	162	220	239	320	399
7034HV	0.35	551	1,406	2,914	122	175	236	257	345	430
71936CV	0.65	270	709	1,496	52	81	119	289	387	480
7036CV	0.71	450	1,159	2,464	56	87	127	315	420	522
71936HV	0.32	416	1,080	2,216	121	174	235	254	343	426
7036HV	0.35	698	1,789	3,679	131	189	254	277	372	463
71938CV	0.62	288	754	1,586	55	86	126	309	413	511
7038CV	0.69	473	1,226	2,588	59	91	133	331	441	547
71938HV	0.31	450	1,148	2,374	129	186	251	272	365	455
7038HV	0.34	743	1,879	3,870	138	198	267	292	390	486
71940CV	0.65	371	979	2,048	58	90	132	323	433	536
7040CV	0.69	540	1,418	3,004	62	96	140	347	464	576
71940HV	0.32	585	1,485	3,060	136	194	265	286	383	477
7040HV	0.34	855	2,171	4,478	145	208	281	306	411	511
71944CV	0.61	383	990	2,093	63	97	143	350	466	578
7044CV	0.65	608	1,620	3,465	68	107	158	383	515	640
71944HV	0.30	596	1,519	3,116	146	210	283	308	414	514
7044HV	0.32	956	2,453	5,063	160	231	312	338	454	565
71948CV	0.58	405	1,058	2,250	67	104	153	372	497	617
71948HV	0.28	641	1,631	3,353	157	225	303	329	441	549

MachLine®: ranges
High Speed and Sealed - ML & MLE

Series 719 / 70

Dimensions			Weight	Series		Shoulders and fillets (mm)						Hole for lubrication		Balls	
d	D	B	lbs			D1	d2	d3	D4	r2	r3	D5	E	Diam.	Nb
10	22	6	0.022	**ML**	**71900**	17.2	13.3	13.6	17.8	0.3	0.1	14.4	1.05	2.381	14
	26	8	0.040	**ML**	**7000**	19.5	14.2	14.7	20.1	0.3	0.1	15.7	1.53	3.175	11
12	24	6	0.024	**ML**	**71901**	19.0	15.1	15.4	19.6	0.3	0.1	16.2	1.05	2.381	14
	28	8	0.044	**ML**	**7001**	21.5	16.2	16.7	22.1	0.3	0.1	17.7	1.58	3.175	13
15	28	7	0.033	**ML**	**71902**	23.3	18.3	18.7	23.7	0.3	0.1	19.7	1.35	2.778	16
	32	9	0.062	**ML**	**7002**	25.7	19.4	20.2	26.8	0.3	0.1	21.3	1.85	3.969	13
17	30	7	0.037	**ML**	**71903**	25.6	20.6	21.0	26.0	0.3	0.1	22.0	1.35	2.778	18
	35	10	0.082	**ML**	**7003**	28.4	22.0	22.7	29.5	0.3	0.1	23.9	1.85	3.969	15
20	37	9	0.079	**ML**	**71904**	30.7	24.5	25.1	31.8	0.3	0.2	26.3	1.75	3.969	16
	42	12	0.139	**ML**	**7004**	34.3	25.3	26.6	35.7	0.6	0.3	27.9	2.63	5.556	14
25	42	9	0.090	**ML**	**71905**	36.2	30.0	30.6	37.3	0.3	0.2	31.8	1.75	3.969	19
	47	12	0.168	**ML**	**7005**	39.9	30.9	32.2	41.3	0.6	0.3	33.5	2.63	5.556	17
30	47	9	0.104	**ML**	**71906**	40.7	34.5	35.1	41.8	0.3	0.2	36.2	1.73	3.969	22
	55	13	0.247	**ML**	**7006**	45.8	36.8	38.1	47.2	1.0	0.3	39.4	2.63	5.556	20
35	55	10	0.165	**ML**	**71907**	47.1	40.8	41.4	48.2	0.6	0.2	42.7	1.90	3.969	26
	62	14	0.329	**ML**	**7007**	51.5	41.5	43.2	53.6	1.0	0.3	44.6	3.10	6.350	20
40	62	12	0.240	**ML**	**71908**	53.1	45.3	46.8	54.4	0.6	0.2	47.6	2.25	4.762	25
	68	15	0.408	**ML**	**7008**	57.5	47.5	49.2	59.6	1.0	0.3	50.5	3.00	6.350	22
45	68	12	0.282	**ML**	**71909**	58.6	50.8	52.3	59.9	0.6	0.3	53.0	2.23	4.762	28
	75	16	0.525	**ML**	**7009**	63.0	53.0	54.7	65.0	1.0	0.3	56.1	3.05	6.350	22
50	72	12	0.284	**ML**	**71910**	63.1	55.3	56.8	64.4	0.6	0.3	57.5	2.23	4.762	30
	80	16	0.564	**ML**	**7010**	68.0	58.0	59.7	70.0	1.0	0.3	61.0	3.00	6.350	25
55	80	13	0.390	**ML**	**71911**	73.8	60.5	62.2	76.0	1.0	0.3	64.3	2.50	5.556	30
	90	18	0.873	**ML**	**7011**	79.5	65.5	66.5	83.5	1.1	0.6	69.5	1.70	7.938	22
60	85	13	0.419	**ML**	**71912**	78.8	65.6	67.1	81.0	1.0	0.3	69.3	2.50	5.556	32
	95	18	0.939	**ML**	**7012**	84.5	70.5	71.5	88.5	1.1	0.6	74.4	1.67	7.938	24
65	90	13	0.445	**ML**	**71913**	83.5	70.5	72.5	86.5	1.0	0.3	75.0	1.25	6.350	29
	100	18	0.981	**ML**	**7013**	89.5	74.0	76.5	93.5	1.1	0.6	79.4	1.67	7.938	26
70	100	16	0.728	**ML**	**71914**	92.0	76.5	79.0	95.5	1.0	0.3	81.9	1.63	7.938	26
	110	20	1.378	**ML**	**7014**	98.0	81.5	83.0	102.5	1.1	0.6	86.4	2.07	9.525	24
75	105	16	0.770	**ML**	**71915**	97.0	81.5	84.0	100.5	1.0	0.3	86.9	1.63	7.938	28
	115	20	1.451	**ML**	**7015**	103.0	86.5	88.0	107.5	1.1	0.6	91.4	2.07	9.525	25
80	110	16	0.816	**ML**	**71916**	102.0	86.5	89.0	105.5	1.0	0.3	91.9	1.63	7.938	30
	125	22	1.927	**ML**	**7016**	111.5	93.0	94.5	116.5	1.1	0.6	98.4	2.49	11.113	23
85	120	18	1.180	**ML**	**71917**	110.0	93.0	96.0	114.0	1.1	0.6	99.2	1.94	8.731	29
	130	22	2.044	**ML**	**7017**	116.5	98.5	99.5	121.5	1.1	0.6	103.4	2.49	11.113	25
90	125	18	1.239	**ML**	**71918**	115.0	98.5	101.0	119.0	1.1	0.6	104.2	1.94	8.731	31
	140	24	2.628	**ML**	**7018**	124.5	103.0	106.5	130.0	1.5	0.6	110.5	2.64	11.906	25
95	130	18	1.303	**ML**	**71919**	120.0	103.5	106.0	124.0	1.1	0.6	109.2	1.94	8.731	32
	145	24	2.785	**ML**	**7019**	129.5	109.5	111.5	135.0	1.5	0.6	115.5	2.64	11.906	26
100	140	20	1.755	**ML**	**71920**	128.5	109.5	112.5	133.0	1.1	0.6	115.9	2.02	10.319	29
	150	24	2.895	**ML**	**7020**	134.5	114.5	116.5	140.0	1.5	0.6	120.5	2.61	11.906	27
105	160	26	3.532	**ML**	**7021**	143.0	119.0	123.0	149.0	2.0	1.0	127.5	3.02	13.494	25
110	150	20	1.914	**ML**	**71922**	138.5	119.5	122.5	143.0	1.1	0.6	125.9	1.98	10.319	32
	170	28	4.452	**ML**	**7022**	150.5	126.0	130.0	149.0	2.0	1.0	134.7	3.23	14.288	25
120	165	22	2.655	**ML**	**71924**	151.5	131.0	134.5	156.5	1.1	6.0	138.1	2.18	11.113	33
	180	28	4.778	**ML**	**7024**	160.5	136.0	140.0	167.5	2.0	1.0	144.7	3.23	14.288	27
130	180	24	3.466	**ML**	**71926**	165.0	142.0	146.0	170.5	1.5	0.6	150.0	2.56	12.700	31
	200	33	7.290	**ML**	**7026**	177.0	148.5	154.0	185.0	2.0	1.0	158.9	3.84	16.669	26



Series 719 CV
70 CV

Contact angle 17°

Series C	a (mm)	Basic load values in lbf		Limit speed in rpm	
		C Dynamic	Co Static	Grease	Oil
ML 71900 C	5	322	680	101,500	135,000
ML 7000 C	6	459	681	94,000	125,000
ML 71901 C	5	335	683	90,000	120,000
ML 7001 C	7	513	684	82,500	110,000
ML 71902 C	6	457	686	75,000	100,000
ML 7002 C	8	776	687	69,000	92,000
ML 71903 C	7	488	689	67,500	90,000
ML 7003 C	8	844	690	61,500	82,000
ML 71904 C	8	878	692	56,500	75,000
ML 7004 C	10	1,474	693	52,500	70,000
ML 71905 C	9	968	695	47,500	63,000
ML 7005 C	11	1,676	696	44,500	59,000
ML 71906 C	10	1,046	698	41,500	55,000
ML 7006 C	12	1,868	699	37,500	50,000
ML 71907 C	11	1,148	701	35,500	47,000
ML 7007 C	13	2,363	702	33,000	44,000
ML 71908 C	13	1,564	704	31,500	42,000
ML 7008 C	15	2,475	705	29,500	39,000
ML 71909 C	14	1,654	707	28,500	38,000
ML 7009 C	16	2,453	708	27,000	36,000
ML 71910 C	14	1,710	710	26,500	35,000
ML 7010 C	17	2,633	711	25,000	33,000
ML 71911 C	16	2,273	713	21,000	31,000
ML 7011 C	19	5,243	714	22,000	30,500
ML 71912 C	16	2,340	716	18,000	29,500
ML 7012 C	19	5,490	717	19,000	28,500
ML 71913 C	17	3,960	719	19,000	30,500
ML 7013 C	20	5,738	720	18,000	27,000
ML 71914 C	19	5,625	722	17,000	27,000
ML 7014 C	22	7,650	723	16,500	25,000
ML 71915 C	20	5,850	725	16,500	26,000
ML 7015 C	23	7,763	726	15,500	23,750
ML 71916 C	21	6,075	728	15,500	24,500
ML 7016 C	25	9,900	729	14,000	21,500
ML 71917 C	23	7,088	731	14,500	22,500
ML 7017 C	26	10,350	732	13,500	20,500
ML 71918 C	23	7,313	734	13,500	21,000
ML 7018 C	28	11,700	735	12,500	19,100
ML 71919 C	24	7,425	737	12,700	20,000
ML 7019 C	28	11,925	738	12,000	18,400
ML 71920 C	26	9,563	740	11,700	18,500
ML 7020 C	29	12,150	741	11,500	18,000
ML 7021 C	31	14,625	743	10,500	16,500
ML 71922 C	28	10,013	745	10,500	17,000
ML 7022 C	33	16,200	746	10,000	15,800
ML 71924 C	30	11,700	748	9,500	15,500
ML 7024 C	34	16,875	749	9,000	14,000
ML 71926 C	33	14,400	751	8,500	14,000
ML 7026 C	39	21,825	752	8,000	12,500

Series 719 HV
70 HV

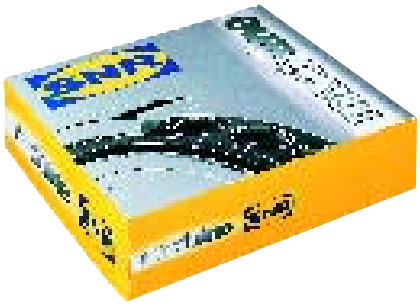
Contact angle 25°

Series H	a (mm)	Basic load values in lbf		Limit speed in rpm	
		C Dynamic	Co Static	Grease	Oil
ML 71900 H	7	306	680	94,000	125,000
ML 7000 H	8	439	681	82,500	110,000
ML 71901 H	7	317	683	82,500	110,000
ML 7001 H	9	491	684	75,000	100,000
ML 71902 H	9	434	686	67,500	90,000
ML 7002 H	10	743	687	62,500	83,000
ML 71903 H	9	464	689	61,500	82,000
ML 7003 H	11	810	690	55,500	74,000
ML 71904 H	11	833	692	51,000	68,000
ML 7004 H	13	1,418	693	47,500	63,000
ML 71905 H	12	923	695	43,000	57,000
ML 7005 H	14	1,598	696	40,000	53,000
ML 71906 H	13	990	698	37,500	50,000
ML 7006 H	16	1,755	699	34,500	46,000
ML 71907 H	15	1,080	701	32,500	43,000
ML 7007 H	18	2,250	702	30,000	40,000
ML 71908 H	18	1,474	704	28,500	38,000
ML 7008 H	20	2,363	705	27,000	36,000
ML 71909 H	19	1,564	707	25,500	34,000
ML 7009 H	22	2,318	708	24,000	32,000
ML 71910 H	20	1,609	710	24,000	32,000
ML 7010 H	23	2,498	711	22,500	30,000
ML 71911 H	22	2,160	713	18,000	28,500
ML 7011 H	26	4,950	714	19,000	27,000
ML 71912 H	24	2,205	716	17,500	26,500
ML 7012 H	27	5,175	717	17,000	25,500
ML 71913 H	25	3,735	719	17,500	26,000
ML 7013 H	28	5,378	720	16,000	24,500
ML 71914 H	28	5,333	722	15,000	23,500
ML 7014 H	31	7,200	723	15,000	21,800
ML 71915 H	29	5,535	725	14,000	21,700
ML 7015 H	32	7,313	726	13,500	21,000
ML 71916 H	30	5,738	728	13,700	21,000
ML 7016 H	35	9,338	729	12,500	19,000
ML 71917 H	33	6,638	731	12,500	20,000
ML 7017 H	36	9,788	732	11,500	18,500
ML 71918 H	34	6,863	734	11,700	18,700
ML 7018 H	39	11,025	735	10,500	17,200
ML 71919 H	35	6,975	737	11,000	17,700
ML 7019 H	40	11,250	738	10,000	16,500
ML 71920 H	38	9,000	740	10,500	16,700
ML 7020 H	41	11,475	741	9,500	15,900
ML 7021 H	44	13,725	743	9,000	14,900
ML 71922 H	41	9,450	745	9,300	14,700
ML 7022 H	47	15,300	746	8,500	13,900
ML 71924 H	44	11,025	748	8,600	13,500
ML 7024 H	49	15,750	749	8,000	12,500
ML 71926 H	48	13,500	751	7,500	11,500
ML 7026 H	55	20,700	752	7,000	10,500

MachLine®: ranges High Speed and Sealed - ML & MLE

Preload, axial and radial rigidity of DU DB DF arrangements

Symbol	Deflection constant	Preload (lbf)			Axial rigidity (lbf/µm)			Radial rigidity (lbf/µm)		
	K (1)	7	8	9	7	8	9	7	8	9
ML 71900 C	2.58	2	5	10	3	4	6	13	19	24
ML 7000 C	2.33	2	7	14	3	4	6	14	20	24
ML 71900 H	1.25	2	8	16	6	8	11	12	8	22
ML 7000 H	1.14	4	11	23	6	9	11	13	18	23
ML 71901 C	2.31	2	5	10	3	4	6	14	20	25
ML 7001 C	2.19	2	8	16	3	5	7	16	23	29
ML 71901 H	1.12	3	8	16	6	9	11	13	19	23
ML 7001 H	1.06	4	12	25	7	10	13	15	21	27
ML 71902 C	2.18	2	7	14	3	5	7	17	24	30
ML 7002 C	2.06	4	11	23	4	6	8	20	28	35
ML 71902 H	1.05	4	11	23	7	11	14	16	23	29
ML 7002 H	1.00	7	18	36	9	12	16	19	26	33
ML 71903 C	2.08	2	8	15	4	6	8	19	27	33
ML 7003 C	1.87	4	12	25	5	7	9	23	32	40
ML 71903 H	1.00	4	11	23	8	14	15	18	25	31
ML 7003 H	0.91	7	20	41	9	14	18	21	30	38
ML 71904 C	1.79	5	14	27	5	7	10	24	34	43
ML 7004 C	1.65	8	23	45	6	9	12	30	42	52
ML 71904 H	0.87	7	20	41	10	15	19	22	32	39
ML 7004 H	0.81	11	36	72	12	18	24	27	39	49
ML 71905 C	1.64	5	15	29	6	9	11	28	40	49
ML 7005 C	1.50	8	25	50	7	11	14	34	49	61
ML 71905 H	0.80	8	23	45	12	17	22	26	37	46
ML 7005 H	0.74	14	41	81	15	22	28	32	46	58
ML 71906 C	1.59	5	16	32	6	10	13	31	45	56
ML 7006 C	1.43	9	27	56	8	12	16	40	56	71
ML 71906 H	0.77	8	25	50	13	20	25	29	42	52
ML 7006 H	0.70	15	45	88	17	25	32	37	54	66
ML 71907 C	1.45	6	18	34	7	11	14	36	52	64
ML 7007 C	1.30	11	36	72	9	14	18	45	65	81
ML 71907 H	0.70	9	27	54	15	22	29	34	48	60
ML 7007 H	0.63	18	56	113	19	28	36	42	60	75
ML 71908 C	1.29	8	23	47	8	12	17	42	59	74
ML 7008 C	1.25	12	36	74	10	15	20	49	69	87
ML 71908 H	0.63	12	36	74	17	25	33	39	55	69
ML 7008 H	0.61	20	59	117	21	30	39	46	65	81
ML 71909 C	1.20	8	25	50	9	14	18	45	65	81
ML 7009 C	1.22	12	36	74	10	15	20	49	69	87
ML 71909 H	0.59	14	38	79	19	28	36	43	60	76
ML 7009 H	0.60	20	59	117	21	30	39	46	65	81
ML 71910 C	1.13	9	25	52	10	14	19	49	68	86
ML 7010 C	1.14	14	41	79	11	17	22	55	79	97
ML 71910 H	0.55	14	41	81	20	30	38	45	65	80
ML 7010 H	0.56	20	63	126	23	34	44	50	73	91
ML 71911 C	1.06	11	34	68	11	17	22	57	80	100
ML 7011 C	1.15	16	52	106	11	18	23	57	83	104
ML 71911 H	0.59	18	54	108	23	35	45	51	74	93
ML 7011 H	0.64	27	83	167	24	36	47	54	77	97
ML 71912 C	1.01	11	36	70	12	18	23	61	86	106
ML 7012 C	1.08	18	57	114	12	19	25	62	90	113
ML 71912 H	0.57	18	54	110	25	36	47	54	80	99
ML 7012 H	0.60	29	89	180	26	39	51	59	84	105



Symbol	Deflection constant	Preload (lbf)			Axial rigidity (lbf/µm)			Radial rigidity (lbf/µm)		
	K (1)	7	8	9	7	8	9	7	8	9
ML 71913 C	1.03	14	42	83	12	18	24	60	86	107
ML 7013 C	1.03	19	61	123	13	21	27	67	98	122
ML 71913 H	0.57	20	65	130	24	37	48	54	80	99
ML 7013 H	0.57	32	97	194	28	42	55	63	91	114
ML 71914 C	1.04	21	60	119	14	20	27	69	97	121
ML 7014 C	1.03	26	81	162	15	23	30	75	108	135
ML 71914 H	0.57	29	60	185	28	42	54	62	90	112
ML 7014 H	0.57	43	129	261	32	47	61	70	101	127
ML 71915 C	0.98	22	63	127	15	22	29	74	104	129
ML 7015 C	0.99	27	85	170	16	24	32	78	113	140
ML 71915 H	0.54	31	99	199	30	45	58	66	97	121
ML 7015 H	0.55	45	133	270	33	49	63	74	105	132
ML 71916 C	0.94	23	68	135	16	23	31	79	111	138
ML 7016 C	1.00	34	107	214	17	26	34	84	121	151
ML 71916 H	0.52	33	106	212	32	48	62	71	103	129
ML 7016 H	0.56	57	169	338	36	52	68	79	113	141
ML 71917 C	0.90	28	79	158	17	25	33	84	118	147
ML 7017 C	0.94	37	116	232	18	28	37	91	132	164
ML 71917 H	0.52	39	124	248	34	51	66	76	110	137
ML 7017 H	0.52	61	182	365	38	57	74	86	123	153
ML 71918 C	0.89	29	84	168	18	27	35	90	126	157
ML 7018 C	0.92	41	128	261	19	29	39	97	140	175
ML 71918 H	0.50	42	132	265	36	54	70	81	117	147
ML 7018 H	0.51	71	208	423	41	61	79	92	131	165
ML 71919 C	0.87	30	87	173	18	27	36	93	130	162
ML 7019 C	0.90	44	137	275	20	31	41	101	146	182
ML 71919 H	0.48	43	136	271	37	56	72	83	121	151
ML 7019 H	0.50	73	216	439	43	63	82	96	136	171
ML 71920 C	0.87	39	111	221	20	30	39	100	140	174
ML 7020 C	0.88	45	141	284	21	32	43	105	152	189
ML 71920 H	0.48	55	173	347	40	60	78	90	130	162
ML 7020 H	0.49	76	226	452	45	66	85	99	142	177
ML 7021 C	0.89	54	171	342	22	34	45	110	160	199
ML 7021 H	0.49	90	270	540	47	69	90	104	149	186
ML 71922 C	0.83	43	122	243	22	33	43	110	154	192
ML 7022 C	0.87	60	182	371	23	35	47	116	167	209
ML 71922 H	0.46	61	190	381	44	66	86	99	143	179
ML 7022 H	0.48	101	299	608	50	73	95	110	157	197
ML 71924 C	0.79	51	145	290	24	36	48	122	171	213
ML 7024 C	0.83	65	199	410	25	38	51	126	181	227
ML 71924 H	0.44	72	225	450	49	73	95	110	158	198
ML 7024 H	0.46	108	324	648	53	79	102	119	170	212
ML 71926 C	0.78	63	178	356	26	39	51	131	184	228
ML 7026 C	0.81	84	263	540	28	43	58	141	204	255
ML 71926 H	0.43	90	279	558	53	79	102	118	171	213
ML 7026 H	0.45	142	423	855	60	88	115	134	191	239

(1) Axial deflection constant in µm $(lbf)^{-2/3}$ 7 = light preload 8 = medium preload 9 = heavy preload

Precision self-locking nuts

It is highly recommended that precision self-locking nuts are used whenever MachLine bearings are installed. They can be used to preload a bearing assembly and ensure the preload is maintained over time. When used with large axial loads, the assembly can be reliably positioned to last.

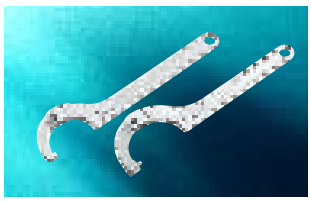
Features

- High strength steel (1,000 N/mm²) throughout the range, protected by finish rolling (apart from back face and threads).
- Squareness < 2 µm between back face / bore.
- Metric thread with tolerance 5H (as per ISO 965/1).
- Narrow or wide series.
- Locking via blind holes or slots.
- Nuts locked with 2 or 4 bronze inserts.

Installation precautions

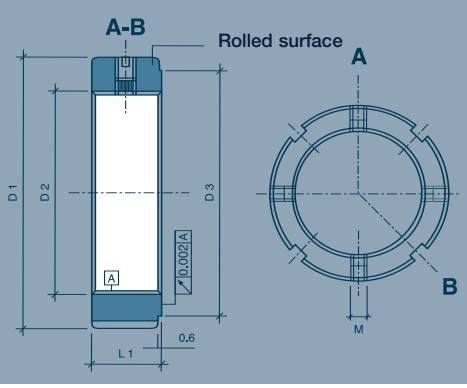
As with bearings, wait until the last moment to remove nuts from packaging to avoid contamination risks. Place them on the rolled face. Once the nut has been tightened with a wrench (DIN 1810A and DIN 1810B), tighten the insert fastening screws with an Allen key (4 insert series: tighten gradually in a cross formation).

You are advised to replace nuts each time bearings are replaced.

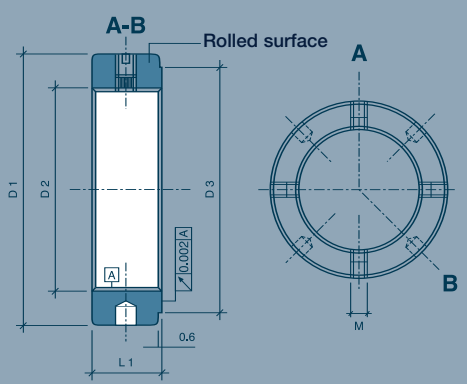


SNR offers a full range of wrenches which are solid, secure and easy to use. The 5 dimensions of our wrenches are sufficient to replace the equivalent of 15 conventional fixed models. For more information, visit: www.snr-bearings.com or contact your SNR technician.

Series with slots



Series with blind holes



Series	Number of inserts	Slots	Blind holes
Narrow	2	B	TB
	4	BR	TBR
Wide	2	BP	TBP
	4	BPR	TBPR

Dimensions and part numbers

Nuts type B and TB

Threads	P/N		Weight	Dimensions				Locking screw	Nuts		
D2	–	–	–	D1	L1	D3	M	Mbl	Far	Ma	Md
–	–	–	kg	mm	mm	mm	mm	N.m	kN	N.m	N.m
M8 x 0.75	**B 8/0.75**	–	0.01	16	8	11	M4	1	27	4	26
M12 x 1	**B 12/1**	–	0.015	22	8	18	M4	1	47	8	31
M15 x 1	**B 15/1**	–	0.02	25	8	21	M4	1	65	10	32
M17 x 1	**B 17/1**	–	0.03	28	10	24	M5	3	100	15	32
M20 x 1	**B 20/1**	**TB 20/1**	0.04	32	10	28	M5	4-5	140	18	39
M20 x 1.5	**B 20/1.5**	**TB 20/1.5**	0.04	32	10	28	M5	4-5	126	18	39
M25 x 1.5	**B 25**	**TB 25**	0.06	38	12	33	M5	4-5	198	25	56
M30 x 1.5	**B 30**	**TB 30**	0.08	45	12	40	M5	4-5	240	32	63
M35 x 1.5	**B 35**	**TB 35**	0.11	52	12	47	M5	4-5	263	40	72
M40 x 1.5	**B 40**	**TB 40**	0.15	58	14	52	M6	8-10	290	55	97
M45 x 1.5	**B 45**	**TB 45**	0.18	65	14	59	M6	8-10	322	65	115
M50 x 1.5	**B 50**	**TB 50**	0.20	70	14	64	M6	8-10	351	85	132
M55 x 2	**B 55**	**TB 55**	0.25	75	16	68	M8	16-18	378	95	148
M60 x 2	**B 60**	**TB 60**	0.27	80	16	73	M8	16-18	405	100	186
M65 x 2	**B 65**	**TB 65**	0.28	85	16	78	M8	16-18	431	120	196
M70 x 2	**B 70**	**TB 70**	0.38	92	18	85	M8	16-18	468	130	228
M75 x 2	**B 75**	**TB 75**	0.42	98	18	90	M8	16-18	497	150	255
M80 x 2	**B 80**	**TB 80**	0.49	105	18	95	M8	16-18	527	160	291
M85 x 2	**B 85**	**TB 85**	0.52	110	18	100	M8	16-18	558	190	315
M90 x 2	**B 90**	**TB 90**	0.75	120	20	110	M8	16-18	603	200	369
M95 x 2	**B 95**	**TB 95**	0.78	125	20	115	M8	16-18	637	220	391
M100 x 2	**B 100**	**TB 100**	0.82	130	20	120	M8	16-18	688	250	432

Nuts type BP and TBP

Threads	P/N		Weight	Dimensions				Locking screw	Nuts		
D2	–	–	–	D1	L1	D3	M	Mbl	Far	Ma	Md
–	–	–	kg	mm	mm	mm	mm	N.m	kN	N.m	N.m
M20 x 1	**BP 20/1**	**TBP 20/1**	0.12	38	20	28	M5	4-5	255	18	39
M20 x 1.5	**BP 20/1.5**	**TBP 20/1.5**	0.12	38	20	28	M5	4-5	225	18	39
M25 x 1.5	**BP 25**	**TBP 25**	0.17	45	20	33	M6	8-10	405	25	56
M30 x 1.5	**BP 30**	**TBP 30**	0.24	52	22	40	M6	8-10	491	32	63
M35 x 1.5	**BP 35**	**TBP 35**	0.28	58	22	47	M6	8-10	560	40	72
M40 x 1.5	**BP 40**	**TBP 40**	0.29	62	22	52	M8	16-18	585	55	97
M45 x 1.5	**BP 45**	**TBP 45**	0.37	68	24	59	M8	16-18	641	65	115
M50 x 1.5	**BP 50**	**TBP 50**	0.46	75	25	64	M8	16-18	706	85	132
M55 x 2	**BP 55**	**TBP 55**	0.92	88	32	68	M8	16-18	940	95	148
M60 x 2	**BP 60**	**TBP 60**	1.14	98	32	73	M8	16-18	1,070	100	186
M65 x 2	**BP 65**	**TBP 65**	1.29	105	32	78	M8	16-18	1,155	120	196
M70 x 2	**BP 70**	**TBP 70**	1.49	110	35	85	M8	16-18	1,230	130	228
M75 x 2	**BP 75**	**TBP 75**	2.25	125	38	90	M10	30-32	1,300	150	255
M80 x 2	**BP 80**	**TBP 80**	2.97	140	38	95	M10	30-32	1,420	160	291
M85 x 2	**BP 85**	**TBP 85**	3.44	150	38	100	M10	30-32	1,510	190	315
M90 x 2	**BP 90**	**TBP 90**	3.59	155	38	110	M10	30-32	1,596	200	369
M95 x 2	**BP 95**	**TBP 95**	3.73	160	38	115	M10	30-32	1,656	220	391
M100 x 2	**BP 100**	**TBP 100**	3.70	160	40	120	M10	30-32	1,780	250	432

Far: Axial breaking load (corresponds to thread failure). In operation, a nut should support less than 75 % of axial breaking load **Far** specified for this nut / **Ma:** Nut installation torque / **Md**: Nut untightening torque (installed with corresponding torques **Ma** and **Mbl**) / **Mbl:** Insert tightening torque / **D1**: Outside diameter / **D3**: Back face diameter / **L1**: Width

Precision self-locking nuts

Dimensions and part numbers

Nuts type BR and TBR

Threads	P/N		Weight	Dimensions				Locking screw	Nuts		
D2	–	–	–	D1	L1	D3	M	Mbl	Far	Ma	Md
–	–	–	kg	mm	mm	mm	mm	N.m	kN	N.m	N.m
M25 x 1.5	**BR 25**	**TBR 25**	0.06	38	12	33	M5	3-4	198	25	85
M30 x 1.5	**BR 30**	**TBR 30**	0.08	45	12	40	M5	3-4	240	32	96
M35 x 1.5	**BR 35**	**TBR 35**	0.11	52	12	47	M5	3-4	263	40	107
M40 x 1.5	**BR 40**	**TBR 40**	0.15	58	14	52	M6	6-8	290	55	127
M45 x 1.5	**BR 45**	**TBR 45**	0.18	65	14	59	M6	6-8	322	65	149
M50 x 1.5	**BR 50**	**TBR 50**	0.20	70	14	64	M6	6-8	351	85	180
M55 x 2	**BR 55**	**TBR 55**	0.25	75	16	68	M8	12-14	378	95	206
M60 x 2	**BR 60**	**TBR 60**	0.27	80	16	73	M8	12-14	405	100	255
M65 x 2	**BR 65**	**TBR 65**	0.28	85	16	78	M8	12-14	431	120	277
M70 x 2	**BR 70**	**TBR 70**	0.38	92	18	85	M8	12-14	468	130	304
M75 x 2	**BR 75**	**TBR 75**	0.42	98	18	90	M8	12-14	497	150	357
M80 x 2	**BR 80**	**TBR 80**	0.49	105	18	95	M8	12-14	527	160	396
M85 x 2	**BR 85**	**TBR 85**	0.52	110	18	100	M8	12-14	558	190	444
M90 x 2	**BR 90**	**TBR 90**	0.75	120	20	110	M8	12-14	603	200	501
M95 x 2	**BR 95**	**TBR 95**	0.78	125	20	115	M8	12-14	637	220	550
M100 x 2	**BR 100**	**TBR 100**	0.82	130	20	120	M8	12-14	688	250	603

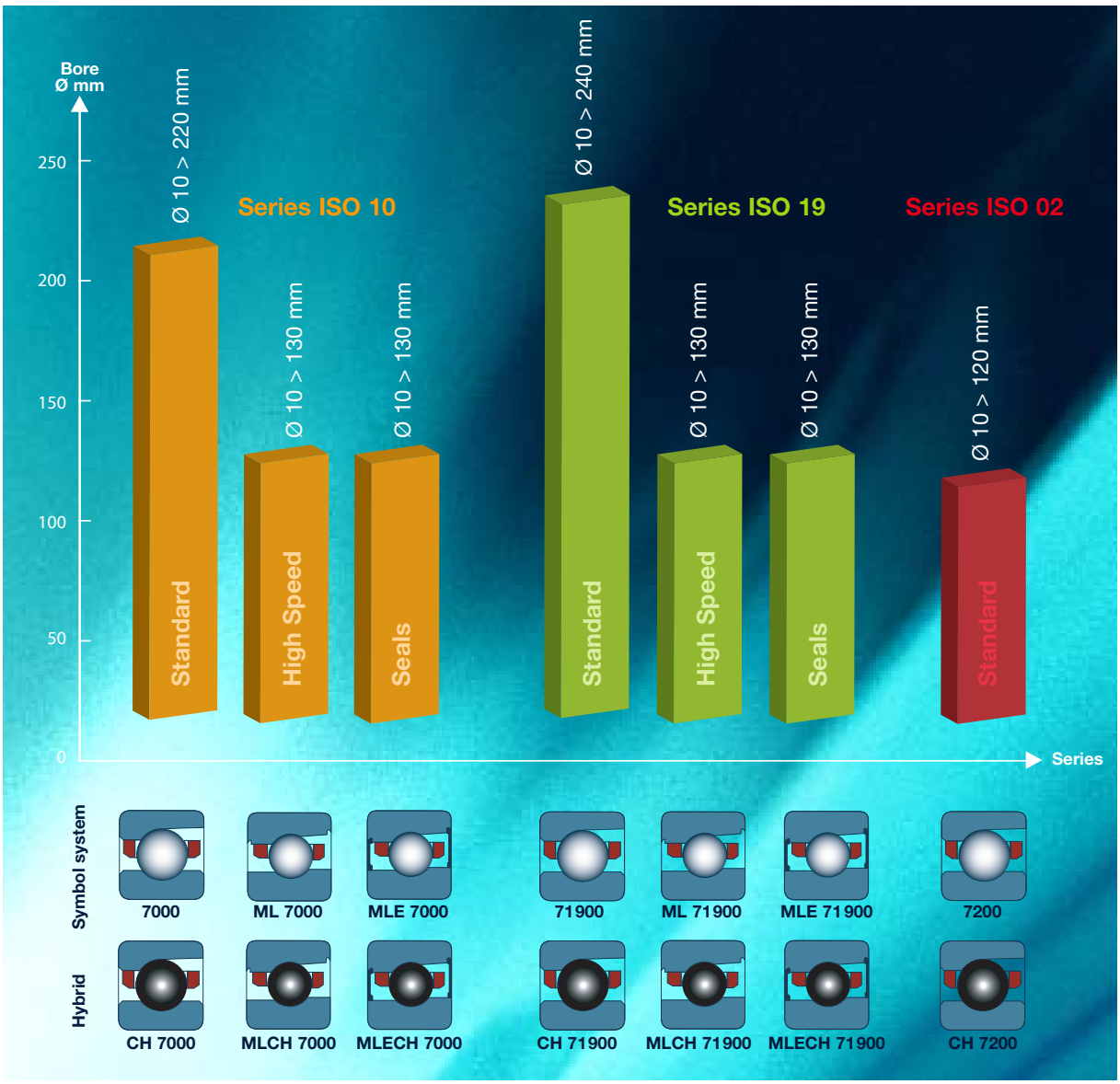
Nuts type BPR and TBPR

Threads	P/N		Weight	Dimensions				Locking screw	Nuts		
D2	–	–	–	D1	L1	D3	M	Mbl	Far	Ma	Md
–	–	–	kg	mm	mm	mm	mm	N.m	kN	N.m	N.m
M20 x 1	**BPR 20/1**	**TBPR 20/1**	0.12	38	20	28	M5	3-4	255	18	56
M20 x 1.5	**BPR 20/1.5**	**TBPR 20/1.5**	0.12	38	20	28	M5	3-4	225	18	56
M25 x 1.5	**BPR 25**	**TBPR 25**	0.17	45	20	33	M6	6-8	405	25	85
M30 x 1.5	**BPR 30**	**TBPR 30**	0.24	52	22	40	M6	6-8	491	32	96
M35 x 1.5	**BPR 35**	**TBPR 35**	0.28	58	22	47	M6	6-8	560	40	107
M40 x 1.5	**BPR 40**	**TBPR 40**	0.29	62	22	52	M8	12-14	585	55	127
M45 x 1.5	**BPR 45**	**TBPR 45**	0.37	68	24	59	M8	12-14	641	65	149
M50 x 1.5	**BPR 50**	**TBPR 50**	0.46	75	25	64	M8	12-14	706	85	180
M55 x 2	**BPR 55**	**TBPR 55**	0.92	88	32	68	M8	12-14	940	95	206
M60 x 2	**BPR 60**	**TBPR 60**	1.14	98	32	73	M8	12-14	1,070	100	255
M65 x 2	**BPR 65**	**TBPR 65**	1.29	105	32	78	M8	12-14	1,155	120	277
M70 x 2	**BPR 70**	**TBPR 70**	1.49	110	35	85	M8	12-14	1,230	130	304
M75 x 2	**BPR 75**	**TBPR 75**	2.25	125	38	90	M10	24-26	1,300	150	357
M80 x 2	**BPR 80**	**TBPR 80**	2.97	140	38	95	M10	24-26	1,420	160	396
M85 x 2	**BPR 85**	**TBPR 85**	3.44	150	38	100	M10	24-26	1,510	190	444
M90 x 2	**BPR 90**	**TBPR 90**	3.59	155	38	110	M10	24-26	1,596	200	501
M95 x 2	**BPR 95**	**TBPR 95**	3.73	160	38	115	M10	24-26	1,656	220	550
M100 x 2	**BPR 100**	**TBPR 100**	3.70	160	40	120	M10	24-26	1,780	250	603

Far: Axial breaking load (corresponds to thread failure). In operation, a nut should support less than 75 % of axial breaking load **Far** specified for this nut / **Ma:** Nut installation torque / **Md**: Nut untightening torque (installed with corresponding torques **Ma** and **Mbl**) / **Mbl:** Insert tightening torque / **D1**: Outside diameter / **D3**: Back face diameter / **L1**: Width

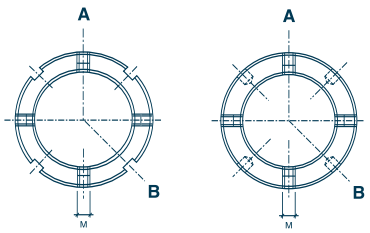
Summary of ranges: find the appropriate SNR solution

MachLine range



Range of precision nuts

Series	Number of inserts	Slots	Blind holes	Application	Bore
Narrow	2	B	-	Normal use	8 to 100
		-	TB		20 to 100
	4	BR	TBR	Medium load: maximum flatness required	25 to 100
Wide	2	BP	TBP	High loads	20 to 100
	4	BPR	TBPR	Very high loads: maximum flatness required	20 to 100



Specific nuts can be manufactured on request (diameter, number of inserts, etc.)

Tolerances and precision classes

Ring tolerance

Spindle precision in rotation has a direct influence on machining precision. SNR manufactures bearings in very high precision class P4S and super precision class ISO 2.

Inner ring
Tolerances in µm

Bore (d) in mm		Exclusive	6	10	18	30	50	80	120	150	180
		Inclusive	10	18	30	50	80	120	150	180	250
Tolerances	**Symbol (1)**										
Tolerance on mean diameter	Δ dmp	ISO 4	0 -4	0 -4	0 -5	0 -6	0 -7	0 -8	0 -10	0 -10	0 -12
		ISO 2	0 -2.5	0 -2.5	0 -2.5	0 -2.5	0 -4	0 -5	0 -7	0 -7	0 -8
Roundness	Series 719 max. Vdp	ISO 4 ISO 2	4 2.5	4 2.5	5 2.5	6 2.5	7 4	8 5	10 7	10 7	12 8
	Series 70-72	ISO 4 ISO 2	3 2.5	3 2.5	4 2.5	5 2.5	5 4	6 5	8 7	8 7	9 8
Taper	max. Vdmp	ISO 4 ISO 2	2 1.5	2 1.5	2.5 1.5	3 1.5	3.5 2	4 2.5	5 3.5	5 3.5	6 4
Radial run-out	max. K_{ia}	ISO 4 ISO 2	2.5 1.5	2.5 1.5	3 2.5	4 2.5	4 2.5	5 2.5	6 2.5	6 5	8 5
Face run-out with respect to bore	max. S_d	ISO 4 ISO 2	3 1.5	3 1.5	4 1.5	4 1.5	5 1.5	5 2.5	6 2.5	6 4	7 5
Raceway run-out with respect to face	max. S_{ia}	ISO 4 ISO 2	3 1.5	3 1.5	4 2.5	4 2.5	5 2.5	5 2.5	7 2.5	7 5	8 5
Tolerance on bearing width	Δ Bs	ISO 4 ISO 2	0 -40	0 -80	0 -120	0 -120	0 -150	0 -200	0 -250	0 -250	0 -300
Alignment of faces	max. VBs	ISO 4 ISO 2	2.5 1.5	2.5 1.5	2.5 1.5	3 1.5	4 1.5	4 2.5	5 2.5	5 4	6 5

(1) Symbols for tolerances comply with standard ISO 492

Equivalence of precision standards

Quality	ISO	ABEC	DIN
High precision	4	7	P4
Very high precision P4S (SNR Standard)	2: dynamic 4: dimensional	9: dynamic 7: dimensional	P2: dynamic P4: dimensional
Super precision	2	9	P2

Outer ring
Tolerances in µm

Outside diameter (D) in mm											
	Exclusive	2.5	18	30	50	80	120	150	180	250	31
	Inclusive	18	30	50	80	120	150	180	250	315	400

Tolerances	Symbol (1)										
Tolerance on mean diameter	Δ Dmp	ISO 4	0 -4	0 -5	0 -6	0 -7	0 -8	0 -9	0 -10	0 -11	0 -13	0 -15
		ISO 2	0 -2.5	0 -4	0 -4	0 -4	0 -5	0 -5	0 -7	0 -8	0 -8	0 -10
Roundness	Series 719 max. VDp	ISO 4 ISO 2	4 2.5	5 4	6 4	7 4	8 5	9 5	10 7	11 8	13 8	15 10
	Series 70-72	ISO 4 ISO 2	3 2.5	4 4	5 4	5 4	6 5	7 5	8 7	8 8	10 8	11 10
Taper	max. VDmp	ISO 4 ISO 2	2 1.5	2.5 2	3 2	3.5 2	4 2.5	5 2.5	5 3.5	6 4	7 4	8 5
Radial run-out	max. K_{ea}	ISO 4 ISO 2	3 1.5	4 2.5	5 2.5	5 4	6 5	7 5	8 5	10 7	11 7	13 8
Face run-out with respect to bore	max. S_D	ISO 4 ISO 2	4 1.5	4 1.5	4 1.5	4 1.5	5 2.5	5 2.5	5 2.5	7 4	8 5	10 7
Raceway run-out with respect to face	max. S_{ea}	ISO 4 ISO 2	5 1.5	5 2.5	5 2.5	5 4	6 5	7 5	8 5	10 7	10 7	13 8
Tolerance on bearing width	Δ Cs	ISO 4 ISO 2	Identical values to those of the bearing inner ring									
Alignment of faces	max. VCs	ISO 4 ISO 2	2.5 1.5	2.5 1.5	2.5 1.5	3 1.5	4 2.5	5 2.5	5 2.5	7 4	7 5	8 7

(1) Symbols for tolerances comply with standard ISO 492

Tolerances and precision classes

Bearing seat tolerances

In order not to alter preloading or damage rotational accuracy, seats must be very close to bearing dimensions. In general, we recommend the fits specified below. When installing the bearings, we advise matching them with their seats to avoid assembling parts at the extremes of their tolerance limits, which can only lead to excessive clearance or tight fit.

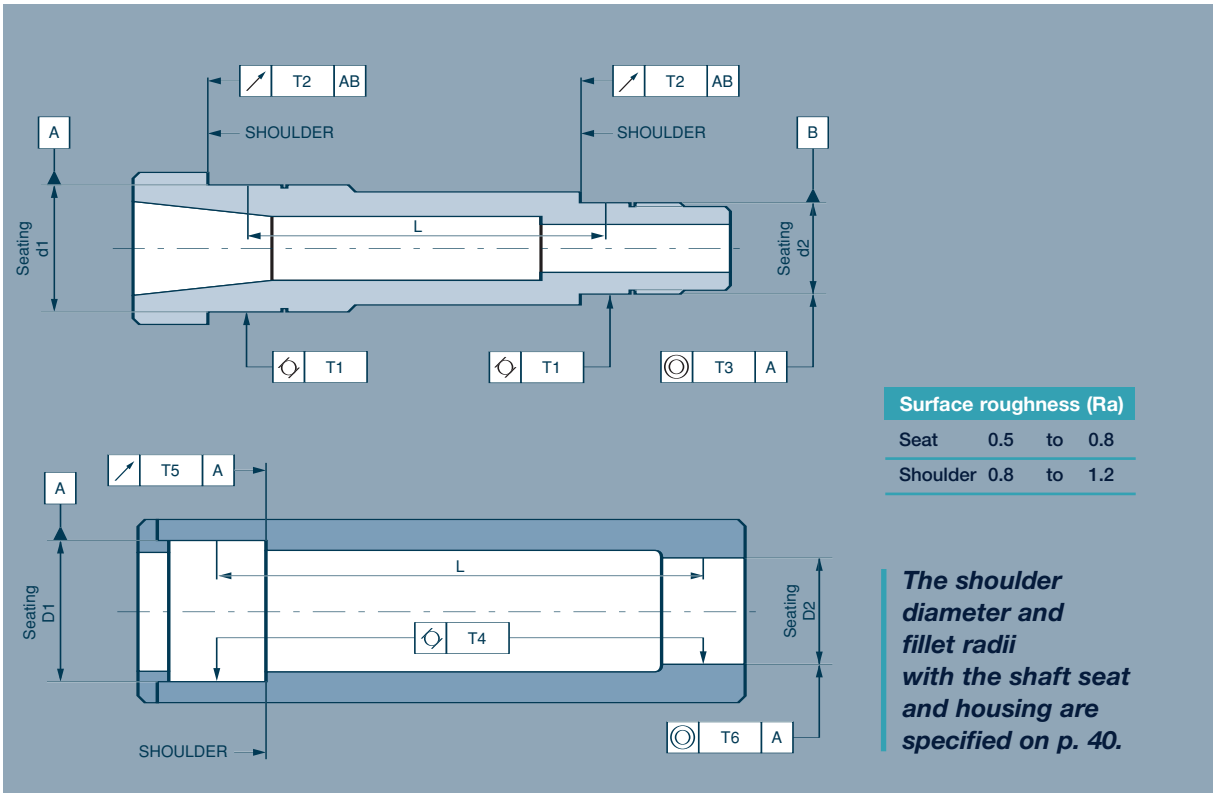
Tolerances in microns

Nominal diameter (mm)	Shaft			Housing					
	ISO4		ISO2	ISO4				ISO2	
				Fixed assembly		Floating assembly		Fixed assembly	Floating assembly
	h4 (1)	js4(2)	-	JS5(1)	K5(2)	H5(3)	Play (4)	JS4	-
10 to 18	0 -5	+3 -3	0 -4	- -	- -	- -	- -	- -	- -
> 18 to 30	0 -6	+3 -3	0 -4	+4 -4	+1 -8	+9 0	2 to 10	+3 -3	+8 +2
> 30 to 50	0 -7	+4 -4	0 -5	+5 -5	+2 -9	+11 0	3 to 11	+4 -4	+10 +2
> 50 to 80	0 -8	+4 -4	0 -5	+6 -6	+3 -10	+13 0	3 to 12	+4 -4	+11 +3
> 80 to 120	0 -10	+5 -5	0 -6	+7 -7	+2 -13	+15 0	5 to 15	+5 -5	+13 +3
> 120 to 180	0 -12	+6 -6	0 -8	+9 -9	+3 -15	+18 0	5 to 17	+6 -6	+16 +4
> 180 to 250	0 -14	+7 -7	0 -10	+10 -10	+2 -18	+20 0	7 to 22	+7 -7	+18 +4
> 250 to 315	- -	- -	- -	+11 -11	+3 -20	+23 0	7 to 27	+8 -8	+21 +5
> 315 to 400	- -	- -	- -	+12 -12	+3 -22	+25 0	7 to 30	+9 -9	+23 +5

(1) Light load C/P > 16, Medium load $10 \leq C/P \leq 16$
(2) Heavy load C/P < 10 or high speed applications (ML range)
(3) We recommend a tolerance, but the optimum fitting is obtained by matching the housing and bearings within the tolerance limits specified in column (4)

Shape and position tolerances for shoulders and seats

Spindle performance (rotational accuracy, heat level) depends to a large extent on the manufacturing quality of seats and their shoulders. To meet targets, these characteristics must be within the tolerances recommended by SNR.



Surface roughness (Ra)			
Seat	0.5	to	0.8
Shoulder	0.8	to	1.2

The shoulder diameter and fillet radii with the shaft seat and housing are specified on p. 40.

Maximum tolerances in microns

Nominal diameter of seat (mm)	Shaft						Housing					
	T1		T2		T3		T4		T5		T6	
	ISO 4	ISO 2	ISO 4	ISO 2	ISO 4	ISO 2	ISO 4	ISO 2	ISO 4	ISO 2	ISO 4	ISO 2
10 to 18	1.5	1	2	1.2	0.013L(1)	0.008L(1)	-	-	-	-	-	-
> 18 to 30	2	1	2.5	1.5	0.013L(1)	0.008L(1)	2	1.5	2.5	1.5	0.015L(1)	0.010L(1)
> 30 to 50	2	1.5	2.5	1.5	0.013L(1)	0.008L(1)	2.5	1.5	2.5	1.5	0.015L(1)	0.010L(1)
> 50 to 80	2.5	1.5	3	2	0.013L(1)	0.008L(1)	3	2	3	2	0.015L(1)	0.010L(1)
> 80 to 120	3	2	4	2.5	0.025L(1)	0.013L(1)	3.5	2.5	4	2.5	0.030L(1)	0.015L(1)
> 120 to 180	3.5	2	5	3.5	0.025L(1)	0.013L(1)	4.5	3	5	3.5	0.030L(1)	0.015L(1)
> 180 to 250	4	2.5	7	4.5	0.025L(1)	0.013L(1)	5	3.5	7	4.5	0.030L(1)	0.015L(1)
> 250 to 315	-	-	-	-	-	-	6	4	8	6	0.030L(1)	0.015L(1)
> 315 to 400	-	-	-	-	-	-	6	4.5	9	7	0.030L(1)	0.015L(1)

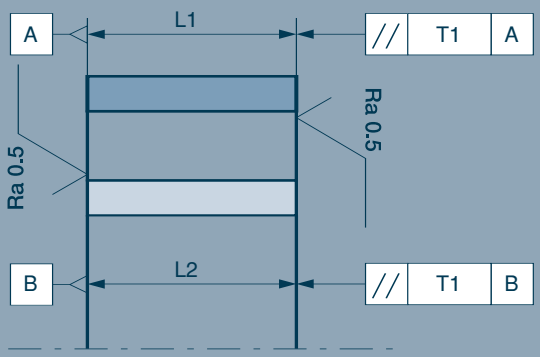
(1) L = distance between bearing units in mm

Tolerances and precision classes

Component tolerances - spacers and clamping nuts

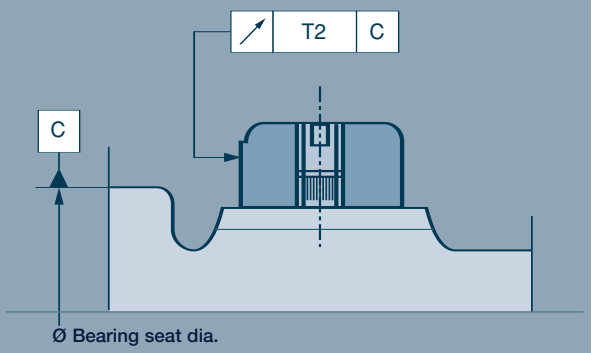
Rotational accuracy of the spindle also depends on manufacturing precision of spacers and nuts.

Spacers



Spacers must be rigid enough to avoid any bending during tightening. They should be no longer than 200 mm. Tolerances for their alignment and length differences are specified below.

Clamping nuts



Whether the nut is threaded or pressed on, its clamping face must be perpendicular to the bearing seat. The axial run-out tolerance of the face is specified below.

Maximum tolerances in microns

Nominal bore of spacer or nominal diameter of bearing seat (mm)	Spacer				Nut	
	T2		Difference in length between L1 and L2		T2	
	ISO4	ISO2	ISO4	ISO2	ISO4	ISO2
10 to 18	2	1	2	1	5	3
> 18 to 30	2	1	2	1	6	4
> 30 to 50	2	1	2	1	7	4
> 50 to 80	2	1	3	2	8	5
> 80 to 120	3	2	3	2	10	6
> 120 to 180	3	2	4	3	12	8
> 180 to 250	4	3	5	4	14	10

Maintenance and services

Maintenance is a major issue, particularly for heavily used components such as bearings. It has an influence on productivity, occupational health and safety, and the environment. Maintenance is a risk avoidance operation based most of all on human know-how. Our teams will talk you through their expertise over the course of this chapter…

machline®

SNR

Storage: rules to follow

Every SNR bearing undergoes a specific packaging process in order to ensure its original qualities are maintained during storage. Spindle results in the long-term will be dependent on the precautions taken on installation.

SNR packaging process and bearing protection

- Assembly is carried out in a dust-free air-conditioned environment.
- High covering power anti-oxidant protective oil is applied in a controlled atmosphere. This protection is compatible with all currently-used lubricants.
- The final protective elements are a heat-sealed protective bag and a packing box.

Normal storage conditions

- General cleanliness.
- Free of dust and corrosive atmospheric conditions.
- Recommended temperature: 64° to 68°F.
- Maximum relative humidity: 65 %. For exceptional climatic conditions, specific packaging will be necessary (e.g.: specific packaging for tropical countries).
- Do not store on wooden shelves.
- Keep at least 30 cm from ground, walls and heating pipework.
- Avoid exposure to the sun.
- Store boxes flat and do not stack to high.
- Lay out boxes so bearing part number is visible without handling.

Storage time

Thanks to their standard unit packaging, SNR bearings can have long storage times and the normal storage conditions.

The packaging must not be opened, altered or damaged.

Installation: rules to follow

General installation precautions

Spindle should be assembled in clean, well-lit area away from manufacturing sites, in order to avoid risk of contamination.
Do not remove bearings from their box until they are to be installed. Do not wash bearings under any circumstances.

The bearing must be stored in its original packaging and not opened until the time of use.

Pre-installation checks

Dimensions and tolerances of components making up the spindle must first be checked (see pages 58 to 60). All components must be carefully washed and dried before installation.

Bearing installation

Bearing seats must be coated with an anti-corrosive product. SNR recommends the use of an assembly paste.

Products used for bearing protection are compatible with all SNR-recommended lubricants.

Selection of outside diameter and bore dimensions

To obtain as uniform as possible preload and an external load distributed evenly as possible between all bearings in an arrangement, it is recommended that there should be almost identical interferences or clearances between these bearings and their supports (shaft and housing).

Outside diameter and bore dimensions are marked on the package and dimension selection need not involve removing bearing from box.

Installation: rules to follow

Lubrication

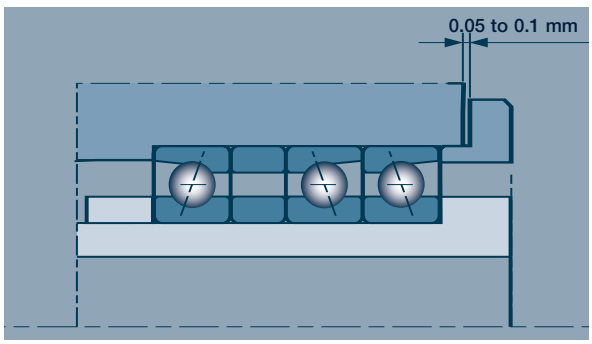
- Grease must be injected using a graduated syringe.
- SNR can supply pre-greased bearings (suffix D or sealed bearings MLE).
- For oil-based lubrication, inject some oil of the same type as used in the system. This precaution will avoid dry start-up which could seriously damage bearings.

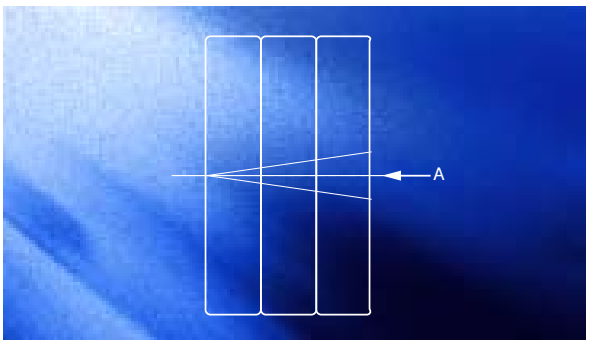
Define appropriate lubrication method: see page 25.
For grease lubrication, follow recommended volumes (page 26).

Bearing positioning

- **Universal bearings and pairs of universal bearings:** Pay attention to bearing position according to contact angles to obtain the desired assembly type. For MachLine ML and MLE, use the individual « V » marked on the outer rings.

- **Arrangement of matched bearings:**
  - An arrangement is inseparable and must not be mixed.
  - Find the « V » marked on the outside diameter of bearings in order to correctly position bearings in the arrangement.
  - Orientate the tip of « V » in the direction of preferential axial thrust A.





Installation

- **Heat-assisted fitting (expansion) is preferable to any other method.** If this is impossible, apply the pressure to the entire parameter of the ring to be fitted. Do not exert any pressure on the other ring because balls must never transmit a force-fitting load.
- **Fitting by impact (e.g. with a hammer) is strictly prohibited.**

Oppose defects

- Shaft and/or housing run-out with respect to bearing radial round out.
- Spacers.
- Line up inner ring high points.

Tightening

- Tighten sideplate screws gradually in a cross formation to avoid misaligning the outer ring in the housing.
- Measure radial run-out of spindle nose before and after locking to check that the shaft has not been deformed by tightening. The values should be identical.

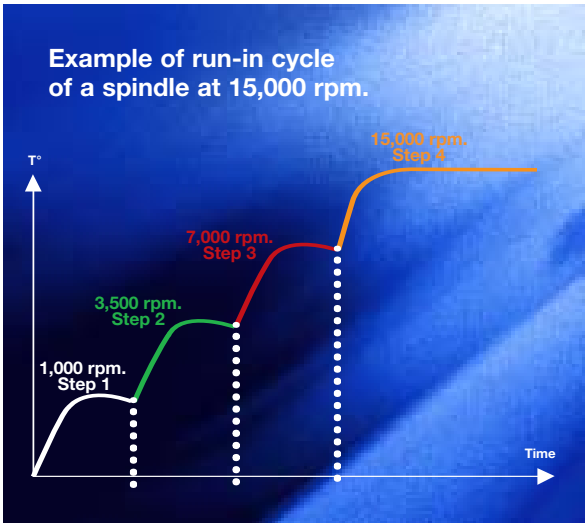
Balancing

After fitting bearings on shaft, it must be balanced to eliminate any unbalance which could affect correct spindle operation at high speed.

Installation: rules to follow

Run-in procedure

The run-in procedure has a considerable influence on the accuracy of spindle rotation and its service life. The procedure must be carried out in steps, depending on the spindle type and temperature rise. The rotation speed of the first step must be at a low enough N.Dm (of the order of 10^5) to be certain that the lubrication film is established.
Run-in time at each step depends on the time required for bearing temperature to stabilise. As soon as the temperature is stabilised, move on to next step.



Characteristic failures

Spalling failures due to material fatigue are extremely rare on MachLine spindle bearings.
Spindle failures are more characterized by deviation of a certain number of factors observed and measured on the manufactured components, which indicate the requirement for spindle maintenance.
These factors are:
- Difficulties in maintaining dimensions.
- Increasing geometrical defects such as circularity or radial run-out.
- Poor surface finish.
- Unusual surface condition (chatter marks, vibration, etc.).
- Abnormal noises in operation.

In 70 % of cases failures are linked to lubrication problems and in 10 % of cases, linked to the sealing system or a sudden impact between the part and the tool which can cause damage to spindle and bearings.

The bearing itself is rarely the cause of premature failure.

Vibratory analysis: an objective, all-round approach

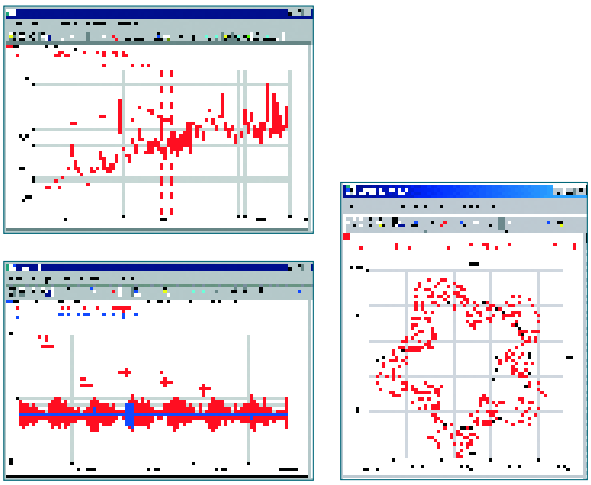
The whole mechanical environment must be taken into account for maintenance, as interactions between the bearing and other components give useful indications. This all-round approach, based on experience with many different applications, is nevertheless indissociable from objective figures and data, which guarantee neutral diagnostics. This is why SNR uses specialised partners.

SNR and 01dB Metravib

Our partnership with this company provides you with specialist expert services in vibratory analysis. Fixed or portable monitoring systems can be designed and implemented to enable predictive maintenance of machine tools.

Our vibratory analysis services can help you design:

- **Monitoring methods,**
- **Monitoring periodicity,**
- **The organisational structure to use,**
- **Results layout and technical-economical studies.**



These services are fitted to each individual case. They may involve work or longer-term contracts, and we will never offer more than you need.
For more information, contact your SNR technician.

Expert analysis, training: passing on our know-how

Expert analysis: investigate the causes

Our experts are at your service for prototype installations or post-operation bearing analysis.
For an optimum analysis, it is vital to:

- remove bearings extremely carefully (it is difficult to distinguish any defects due to working conditions from those due to careless removal).
- send bearings as they are (do not wash).
- record bearing position within the spindle.
- inform our services of the spindle installation operating conditions: speed, load, lubrication and an overall drawing of the spindle.

Characteristic frequencies

In order to monitor spindles in operation, SNR can provide characteristic frequencies for spindle bearing components on request.
This information is also available in the e-catalog: **www.snr-bearings.com/catalogue**
Nevertheless, due to the low deviation of recorded signals, interpreting results is delicate and must be carried out by an expert.

Training: customized services

SNR offers a full training program, written and delivered by our engineers and machine tool spindle bearing experts.
This training course is designed for sales teams wishing to improve their product knowledge or technical design teams, manufacturing and maintenance technicians. It aims to:

- Fully introduce the MachLine range,
- Help in selecting the technical solutions appropriate for your applications,
- Introduce spindle calculations,
- Present the key installation operation phases for a spindle bearing.

SNR is open 24 hours a day, 7 days a week.

Our catalogs are available on line for checking product availability in real-time and making on-line procurement and urgent orders. It's simple and easy and available 24 hours a day, 7 days a week. Go to **www.snr-bearings.com/catalogue** then click on "Catalogue Industry".

Go straight to www.snr-bearings.com and fill in the on-line form, or directly contact your usual SNR representative to take advantage of these services.

SNR: aeronautical precision made available for machine tools

SNR is a partner in major aeronautical and space programs such as the Airbus A380 or Ariane 5 and it has now transferred the experience and knowledge acquired in these fields to the area of machine tools. The MachLine range offers high precision bearings suited for extreme speed, sealing and reliability requirements.