

SKF

SKF spherical plain bearings and rod ends



Contents

Made by SKF® stands for excellence. It symbolises our consistent endeavour to achieve total quality in everything we do. For those who use our products, “Made by SKF” implies three main benefits.

Reliability – thanks to modern, efficient products, based on our worldwide application know-how, optimised materials, forward-looking designs and the most advanced production techniques.

Cost effectiveness – resulting from the favourable ratio between our product quality plus service facilities, and the purchase price of the product.

Market lead – which you can achieve by taking advantage of our products and services. Increased operating time and reduced down-time, as well as improved output and product quality are the key to a successful partnership.



1 Product information	4
Where self-alignment is called for	4
When flexibility pays	6
An incomparable range	9
Multi-purpose performance	12
2 Recommendations	16
Selection of bearing size	16
Load ratings	16
Service life	17
Load	18
Equivalent dynamic bearing load.....	18
Equivalent static bearing load.....	20
Permissible loads for rod ends	20
Requisite bearing size.....	21
Specific bearing load	21
Mean sliding velocity	21
Basic rating service life	24
Sliding contact surface combinations requiring maintenance: steel-on-steel and steel-on-bronze.....	24
Maintenance-free sliding contact surface combination steel/sinter bronze composite	26
Maintenance-free sliding contact surface combination steel/PTFE fabric.....	27
Maintenance-free sliding contact surface combination steel/PTFE composite	28
Variable load and sliding velocity.....	29
Calculation examples	30
Friction	35
Application of bearings	36
Radial location of bearings.....	36
Axial location of bearings	40
Sealing	43
Designing the bearing arrangement for easy mounting and dismantling.....	46
Lubrication	48
Spherical plain bearings requiring maintenance	48
Maintenance-free spherical plain bearings	48
Rod ends requiring maintenance	50
Maintenance-free rod ends	50
Maintenance.....	51
Mounting	52
Spherical plain bearings	52
Rod ends.....	54
Dismounting	55
Spherical plain bearings	55
Rod ends.....	55

3 Product data	57
Radial spherical plain bearings requiring maintenance	58
General	58
Steel-on-steel spherical plain bearings	62
with metric dimensions	62
with inch dimensions	66
with extended inner ring	70
Maintenance-free radial spherical plain bearings	72
General	72
Bearings with sliding contact surface combination	
steel/sinter bronze composite	76
steel/PTFE fabric	78
steel/PTFE composite	82
Angular contact spherical plain bearings	86
General	86
Maintenance-free bearings with sliding contact surface combination steel/PTFE composite	90
Spherical plain thrust bearings	92
General	92
Maintenance-free bearings with sliding contact surface combination steel/PTFE composite	94
Rod ends requiring maintenance	96
General	96
Steel-on-steel rod ends	
with female thread	100
with female thread for hydraulic cylinders	102
with male thread	104
with cylindrical section welding shank	106
with rectangular section welding shank	108
Steel-on-bronze rod ends	
with female thread	110
with male thread	112
Maintenance-free rod ends	114
General	114
Rod ends	
with female thread, steel/sinter bronze composite	118
with male thread, steel/sinter bronze composite	120
with female thread, steel/PTFE fabric	122
with male thread, steel/PTFE fabric	124
with female thread, steel/PTFE composite	126
with male thread, steel/PTFE composite	128
Special solutions and related products	130
Plain bearings for road vehicles	130
Plain bearings for rail vehicles	130
Spherical plain bearings and rod ends for airframe applications	131
Dry sliding bushings and flanged bushings	132
Dry sliding thrust washers and strip	133
The SKF Group – a worldwide organisation	134

Product information	4	1
Recommendations	16	2
Product data	57	3
Radial spherical plain bearings requiring maintenance	58	3.1
Maintenance-free radial spherical plain bearings	72	3.2
Angular contact spherical plain bearings	86	3.3
Spherical plain thrust bearings	92	3.4
Rod ends requiring maintenance	96	3.5
Maintenance-free rod ends	114	3.6
Special solutions and related products	130	3.7

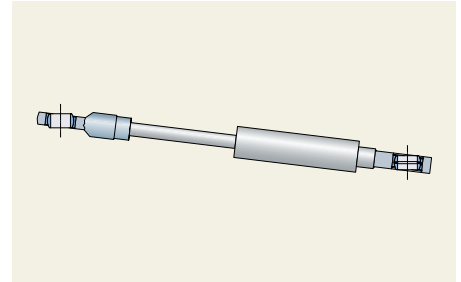
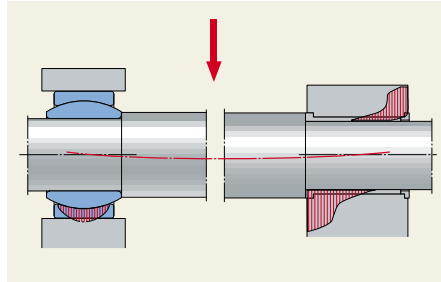
Where self-alignment is called for

Spherical plain bearings

Spherical plain bearings are standardised, ready-to-mount mechanical components which are self-aligning and enable multi-directional alignment movements to be made. The inner ring has a sphered convex outside diameter and the outer ring a correspondingly sphered but concave inside surface (→ fig 1). The forces acting on the bearing may be static or may occur when the bearing makes oscillating or recurrent tilting and slewing movements at relatively low speeds.

The advantages inherent in the design of spherical plain bearings mean that in practice

- errors of alignment or angular misalignment are without influence
- the deformation of surrounding components in operation has no effect
- edge stresses and excessive stressing of adjacent components cannot occur
- the operational reliability of light-weight constructions is enhanced
- reasonably wide manufacturing tolerances allow the use of cost-favourable welded constructions



Operational reliability is high even when a design is made more compact – edge stresses and overloading will not occur

Alignment errors are not a problem

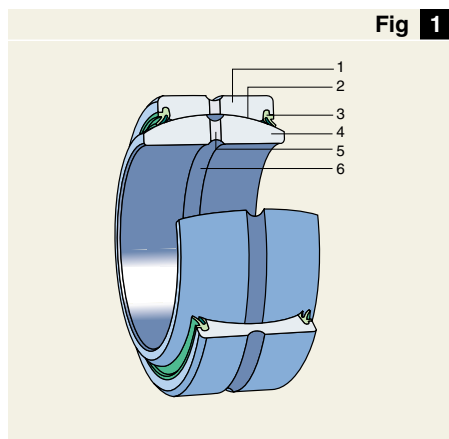
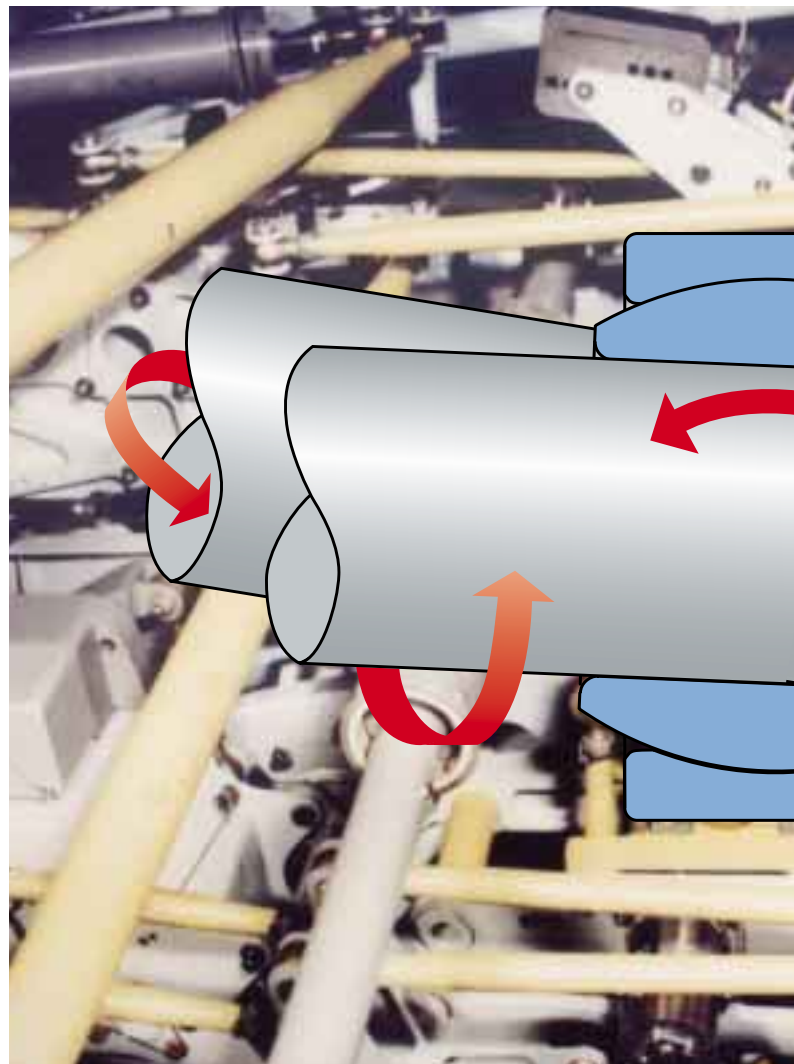
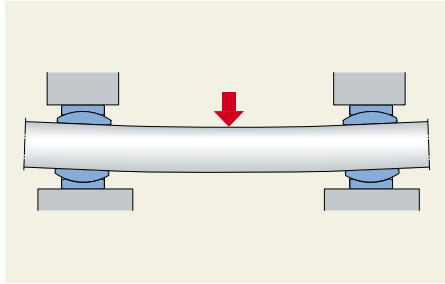


Fig 1

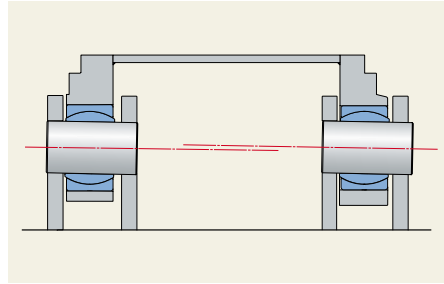
Spherical plain bearing

- 1 Outer ring
- 2 Sliding contact surfaces
- 3 Seal
- 4 Inner ring
- 5 Lubrication hole
- 6 Lubrication groove





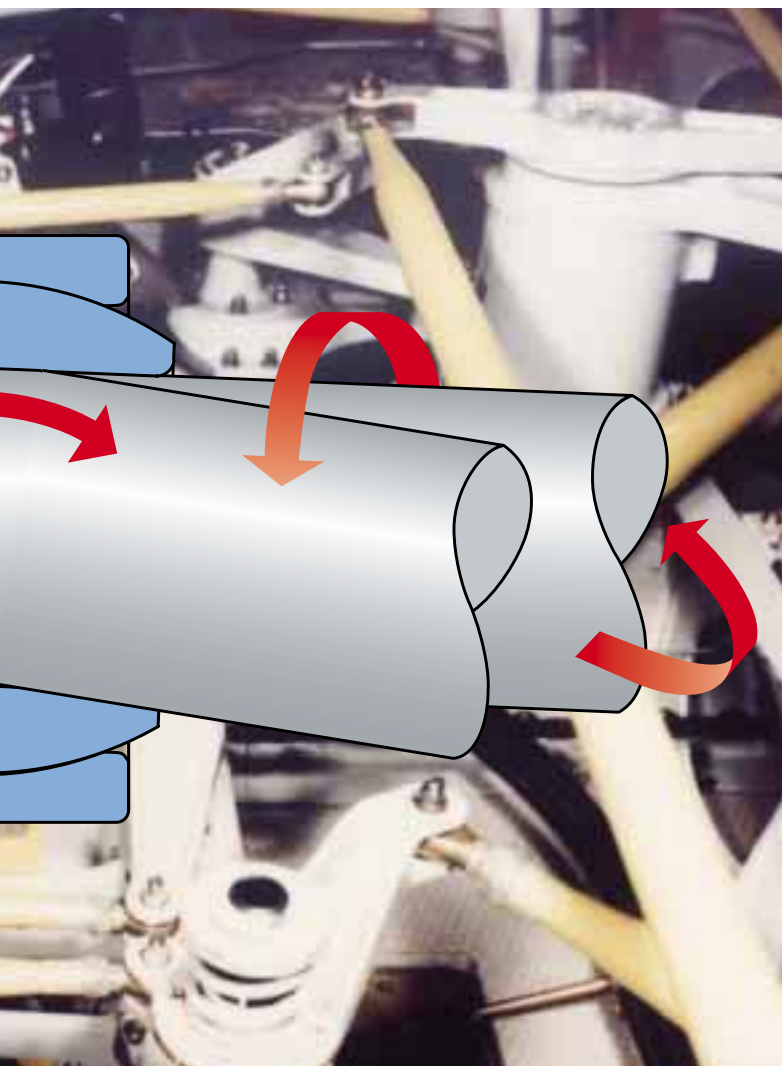
Deformations caused in operation have no influence



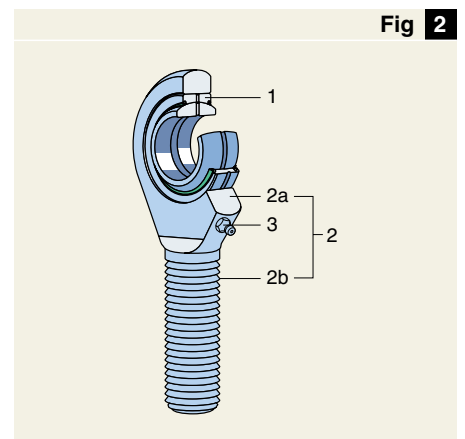
Wide manufacturing tolerances are permitted = cost-favourable welded constructions

Rod ends

Rod ends are spherical plain bearing units which consist of a bearing housed in an eye-shaped head with integral shank: the rod end housing (→ fig 2). They are used primarily on the ends of piston rods or together with hydraulic as well as pneumatic cylinders to join the cylinder to associated components.



- Rod end**
- 1 Spherical plain bearing
- 2 Rod end
- 2a Rod end housing (eye)
- 2b Rod end shank
- 3 Lubrication nipple



When flexibility pays

SKF spherical plain bearings and rod ends should be the first choice for total design economy. They are state-of-the-art products available from stock in a wide range of designs, dimension series and sizes.

Whether a really large bearing is required, or a small maintenance-free rod end – both are available from SKF and offer:

- long service life.
- simple maintenance and
- high operational reliability.

Easy replaceability is also assured as all SKF spherical plain bearings and rod ends are standardised products. Their worldwide availability goes without saying – thanks to the global SKF sales organisation.

It is not just total economy considerations which point to SKF spherical plain bearings and rod ends but also their unparalleled design characteristics. Some of the advantages are outlined in the following.

Ripe, well-proven designs

SKF spherical plain bearings and rod ends offer the performance to meet application demands. The designs, materials and manufacturing quality have been selected for long service lives and reliability. “Fit and forget” is a philosophy embraced by SKF.

Easily maintainable sliding contacts for heavy loads

SKF steel-on-steel spherical plain bearings have high-strength sliding contact surfaces of carbon chromium (rolling bearing) steel which are phosphated and treated with a special running-in lubricant. Their prime areas of use are where

- high static loads and
- high alternating loads and
- high-frequency alignment or oscillating movements occur.

They are also relatively insensitive to contamination and high temperatures. These advantages come at a price – in this case the need for maintenance.

However, to relieve this burden, lubrication holes and grooves are provided in both the inner and outer rings of all bearings – with the exception of a few small sizes – to facilitate relubrication. To further enhance lubrication, all bearings having a bore diameter of 150 mm and above incorporate the “multi-groove system” in the sliding surface of the outer ring.

SKF steel-on-bronze rod ends also require maintenance, although requirements are less stringent than for steel-on-steel rod ends, as the emergency running properties are better.

The multi-groove system

With the multi-groove system SKF has the answer to the problem of lubricant starvation in steel-on-steel bearings, which is otherwise prevalent where the bearings have to perform minor alignment movements under very heavy, constant direction loads. The multi-groove system

- improves lubricant supply to the loaded zone,
- enlarges the lubricant reservoir in the bearing,
- enables relubrication under load,
- permits extended relubrication intervals and
- provides space for wear particles and contaminants to be deposited

All in all the system improves lubricant distribution in the heavily loaded zone and thus extends the service life and/or maintenance intervals.



Radial spherical plain bearing



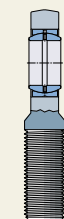
Angular contact spherical plain bearing



Spherical plain thrust bearing



Rod end with female thread



Rod end with male thread



Rod end with welding shank

Design features

Page 4

Page 57

Maintenance-free, long-life sliding contact surfaces

All freedom, as also freedom from maintenance, has a price. In this case a one-off cost – the purchase price. Once installed, maintenance-free spherical plain bearings and rod ends, more than make up for the slightly higher initial price as maintenance costs would be many times higher than the price difference, but maintenance is not required, or is kept within very narrow limits. In order to offer freedom from maintenance in the greatest number of applications SKF produces spherical plain bearings and rod ends with different sliding contact surface combinations (partly size-dependent):

- steel/sinter bronze composite,
- steel/PTFE fabric and
- steel/PTFE composite.

In the first two combinations, the steel is hard chromium plated.

The self-lubricating dry sliding materials of the maintenance-free sliding contacts are not as strong as steel and consequently deform more under load. This makes these bearings more sensitive to alternating or “hammering” loads so that steel-on-steel bearings should be used under such conditions. The types of duty for which the maintenance-free bearings and rod ends are designed are where

- loads may be heavy and are of constant direction,
- friction should be low and also constant, and
- relubrication is impossible or undesirable.



Maintenance-free, long-life sliding contact surfaces

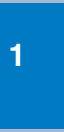
Sinter bronze composite



PTFE fabric



PTFE composite



Design features

Page 16

Page 57

Free choice of materials

There is a free choice of materials. Normally SKF bearings of rolling bearing steel are always the right answer, but in difficult environmental conditions SKF maintenance-free stainless steel bearings may be preferable, or the SKF Application Engineering Service should be contacted for other options. With SKF products it is not necessary to be limited or make compromises.

With or without seals

SKF also provides a choice where seals are concerned. The most popular sizes of standard bearings are available both with and without seals. Sealed bearings provide opportunities to solve many sealing problems simply by using standard bearings, saving space and above all expense. The double lip seal integral with the face of the outer ring efficiently protects the sliding contact surfaces from contaminants in normal environments. If environmental conditions are difficult, the SKF high-performance seals of the LS design should be considered (→ page 42). The operational reliability of the bearing arrangement will be much enhanced – a benefit for original equipment manufacturers as well as their customers.

Wide operating temperature range

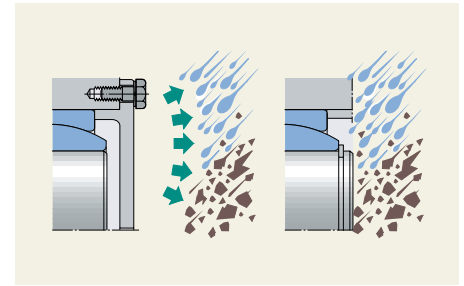
Nothing is impossible. This will become apparent to anyone who thinks they have a temperature problem. Using SKF spherical plain bearings and rod ends will solve almost all problems as nothing in the range from –50 to +300 °C is impossible.

Minimal maintenance

“Fit and forget” often applies to SKF spherical plain bearings and rod ends – but not always. Because many bearing arrangements are subjected to such heavy loads and difficult environmental influences that they cry out for maintenance. With SKF bearings the cries are perhaps not the loudest. Why? Because there are five different sliding contact surface combinations and because sealed bearings are also available from SKF. As if this were not enough, SKF also supplies appropriate lubricants and virtually all types of seal.

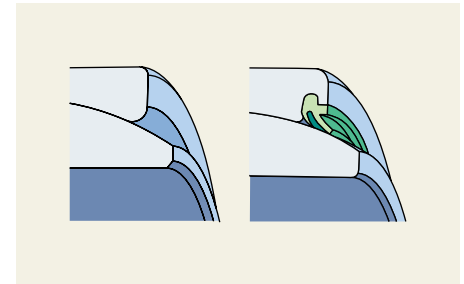
Exhaustive range

The SKF range starts with bearings having a 4 mm bore and the rod end range covers almost all normal requirements. More information will be found in the following section.



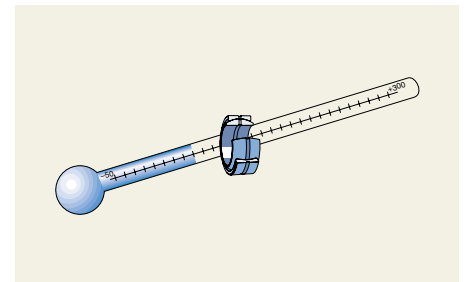
Free choice of materials

Bearings of rolling bearing steel for normal conditions and, for difficult surroundings, bearings of stainless steel



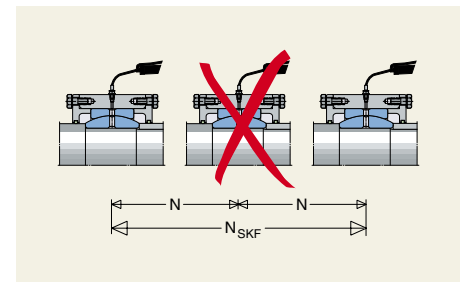
With or without seals

Many sealing problems can be solved economically and in a space-saving manner using sealed bearings which dominate the SKF range



Wide permissible operating temperature range

Open steel-on-steel spherical plain bearings can operate at temperatures from –50 to +300 °C



Minimum maintenance

The multi-groove system dramatically extends maintenance intervals for steel-on-steel spherical plain bearings

An incomparable range

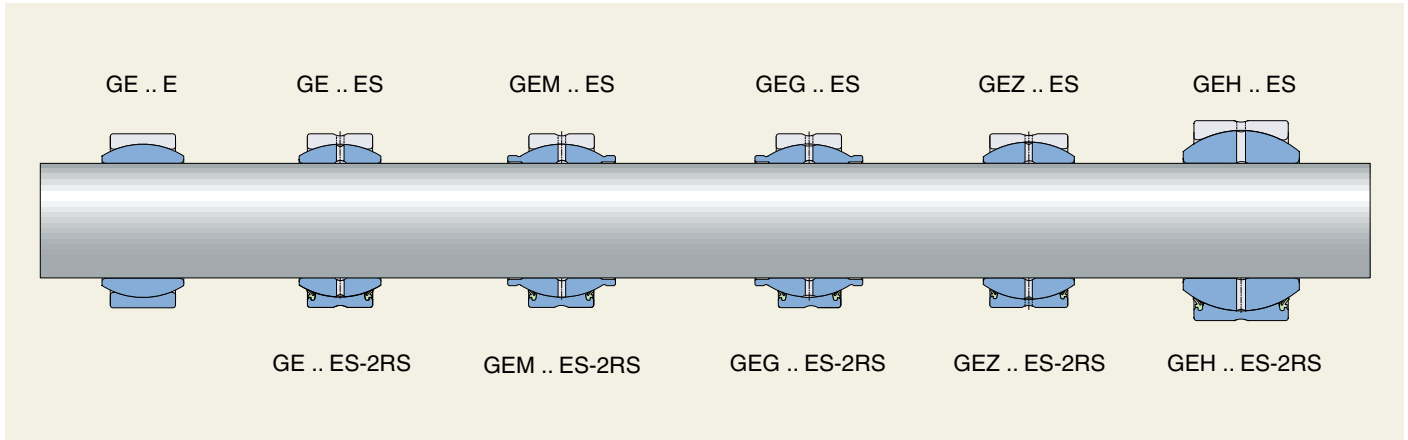
1



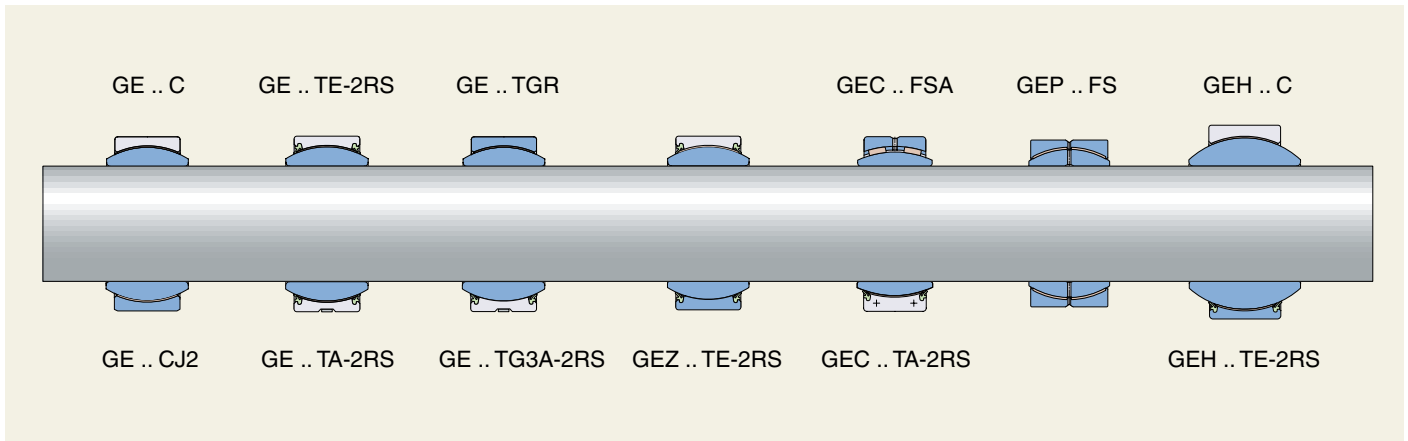
All the products shown here belong to the SKF standard range.

- Radial spherical plain bearings requiring maintenance
- Maintenance-free spherical plain bearings
- Angular contact spherical plain bearings
- Spherical plain thrust bearings
- Steel-on-steel rod ends requiring maintenance
- Steel-on-bronze rod ends requiring maintenance
- Maintenance-free rod ends

If the standard range is inadequate, SKF will produce special bearings, provided quantities permit manufacturing economy. The design will be specially tailored to meet particular application demands. Nothing is too much trouble.

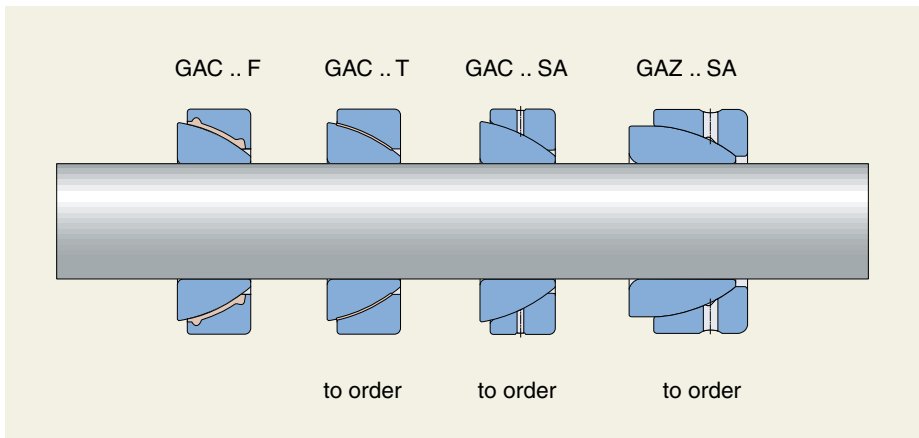


Radial spherical plain bearings requiring maintenance

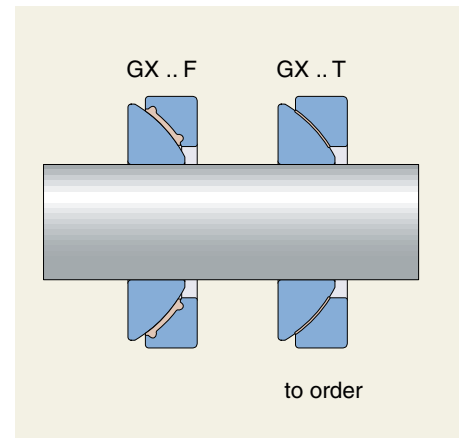


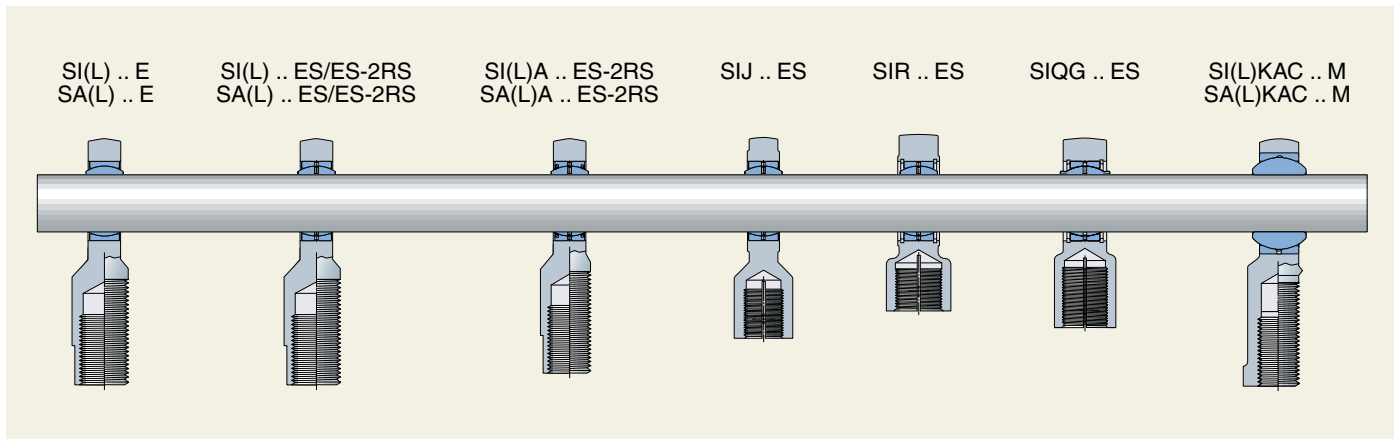
Maintenance-free radial spherical plain bearings

Angular contact spherical plain bearings



Spherical plain thrust bearings

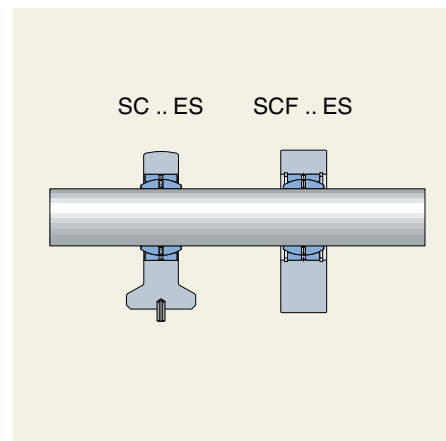




Rod ends with threaded shank requiring maintenance

Designation suffix	Dry sliding surface
C	sinter bronze composite
F	PTFE composite
T	PTFE fabric, embedded in phenolic or epoxy resin

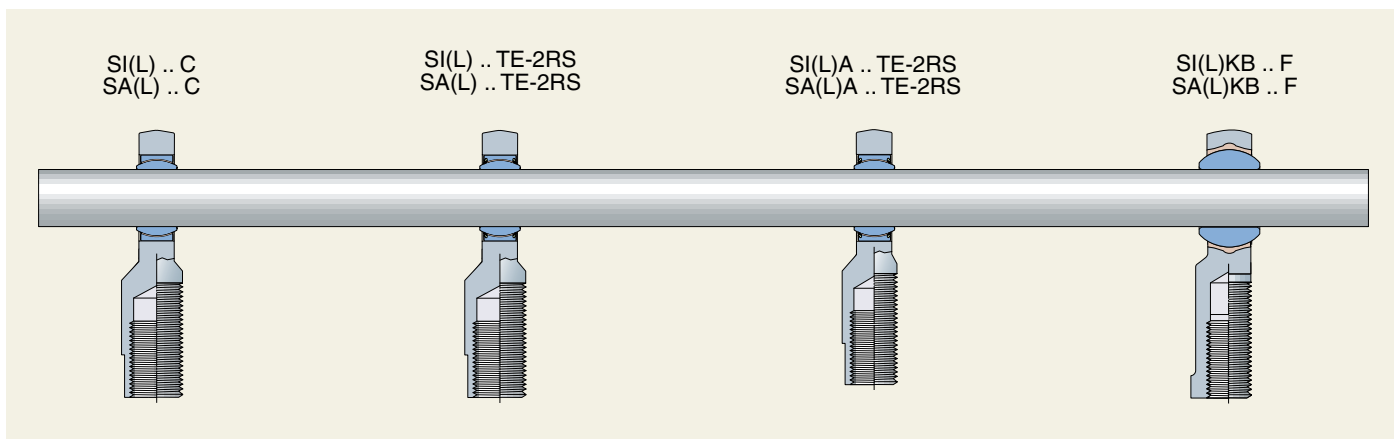
For detailed information on these materials, see [page 72](#)



Rod ends with welding shank requiring maintenance

Maintenance-free rod ends with threaded shank

Identification of maintenance-free sliding contact surface combinations



Multi-purpose performance

Long life, high reliability, minimum maintenance and a representative product range are strong arguments for SKF spherical plain bearings and rod ends. As this benefits the user as well as the operator, a wide range of applications in almost all sectors of industry has evolved. Typical uses for spherical plain bearings and rod ends requiring maintenance are found in

- the steel construction industry,
- cranes,
- fork lift trucks,
- hydraulic cylinders,
- stabilisers,
- mineral processing equipment,
- rolling mill equipment and
- linkages of all kinds in construction and earth-moving machines and equipment.

Application areas where maintenance-free spherical plain bearings and rod ends are used include

- conveyors,
- industrial robots,
- textile and printing machinery,
- switching levers,
- packaging as well as food and beverage treatment machines, and last but not least
- the many uses in segment gates, barrages and similar installations.

SKF spherical plain bearings and rod ends are in use around the world. Some well-proven applications are shown in the following as examples.

Suspended roof

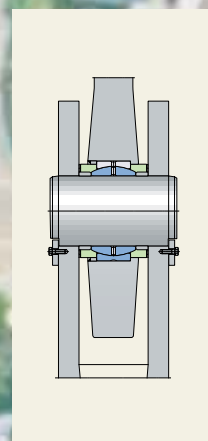
SKF steel-on-steel spherical plain bearings have been in service in an unusual, but world-renowned application for almost 30 years – the roof of the Olympia Stadium in Munich. Although this type of bearing requires maintenance, none has been given to these particular bearings.

The roof is constructed of a number of prestressed steel ropes in a network. At the torque-free nodal points of the network 225 completely normal SKF steel-on-steel spherical plain bearings having bore diameters from 160 to 300 mm do their duty. The nodes are statically loaded but must allow occasional oscillations of the roof construction.

What better proof could there be for staying power, robustness and longevity?



Nodal point of suspended roof construction



Articulated pendulum joint of a wheel loader

Three SKF steel-on-steel spherical plain bearings with the multi-groove lubrication system are used for the bearing arrangement of the articulated pendulum joint of this wheel loader. Two of the bearings ensure the articulation. The third bearing together with a cylindrical sliding bushing in the pendulum joint serves to compensate for uneven ground so that the driven wheels adhere well to the surface.

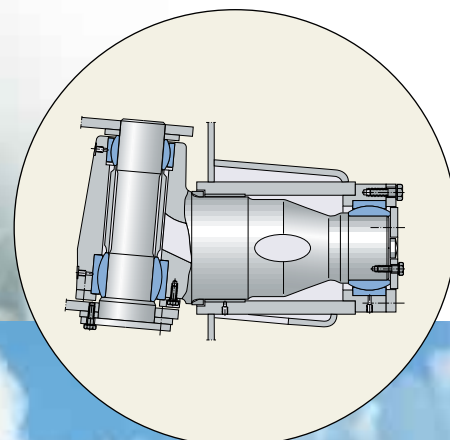
The multi-groove lubrication system of SKF spherical plain bearings improves the transport of lubricant to the loaded zone and also enlarges the lubricant reservoir in the bearing.

Problems which occurred previously if relubrication intervals were neglected so that lubricant starvation arose have thus been solved.

Heavy-duty performance at no extra cost provides much extended service lives in spite of long maintenance intervals.



Articulated pendulum joint of a wheel loader

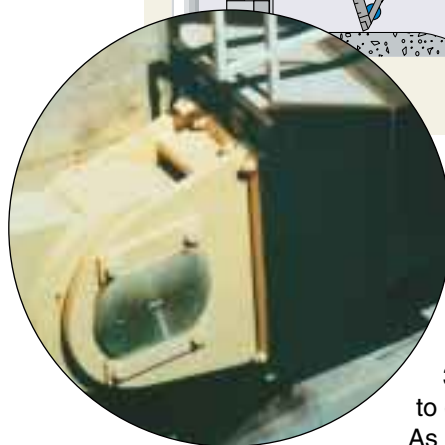
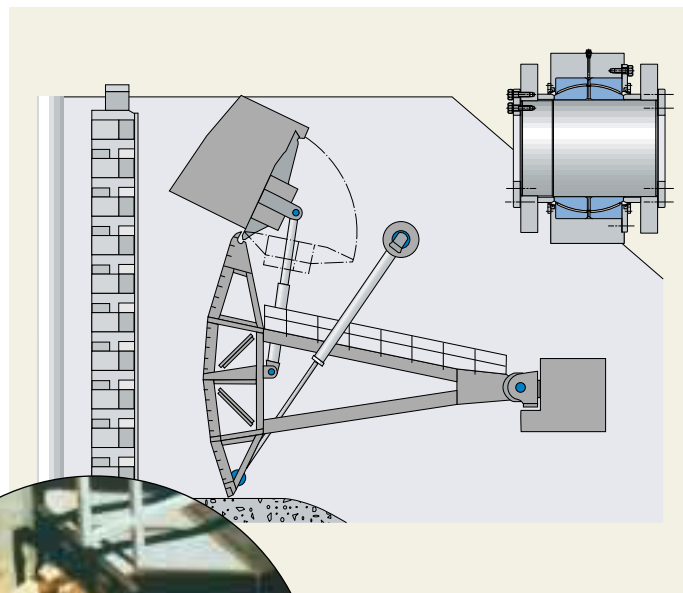


Truck twin-axle supports

The purpose of the bearing arrangement of a truck twin-axle support is to ensure an even load distribution between the two axles on bumpy roads or off highway. This means that the arrangement is subjected to heavy loads and, depending on the road/off-highway conditions, heavy shocks and highly frequent alignment movements. The bearings are hidden behind the tyres and are difficult to access. It goes without saying that any sudden bearing damage calling for immediate repairs wherever the vehicle happens to be must be avoided at all costs.

A pair of SKF angular contact spherical plain bearings mounted back-to-back ensure that such emergencies will not occur. They can withstand all the rigours of truck duty, are simple to install and also to maintain.

Dam gate



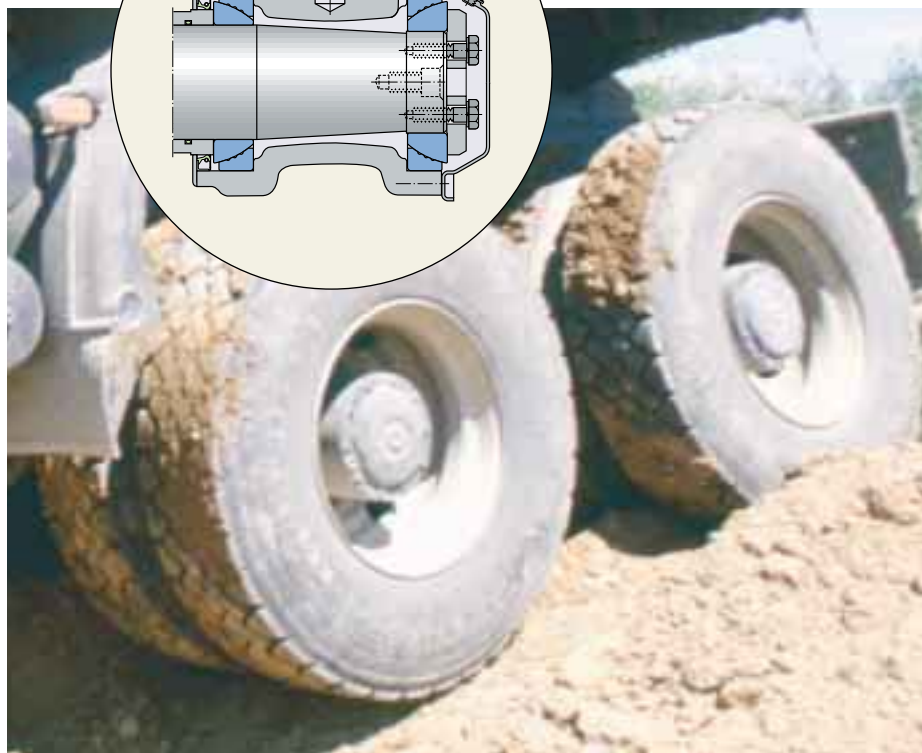
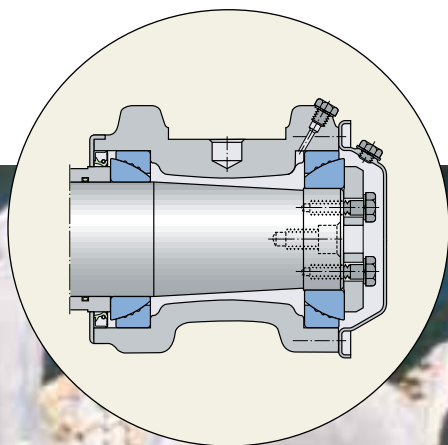
Dam gates

Segment gates for dam barges are the home of large-size SKF maintenance-free spherical plain bearings. The reference list is long – over 3 000 applications being included to date.

As main bearings, they compensate for non-alignment of their seatings, alterations in length as a result of temperature changes, elastic deformation of the dam gates as well as changes caused by settling of the foundations. They cope with the heavy radial loads caused by the water pressure as well as axial loads arising from the inclined position of the support arms.

SKF bearings not only serve as heavily loaded bearings under static conditions; they also serve in the frequently operated linkage attachments of the lifting and plunger cylinders as well as the flaps.

Truck twin-axle support

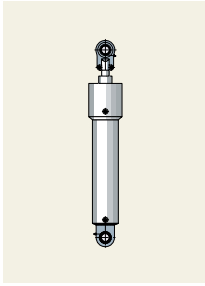


Hydraulic and pneumatic cylinders

SKF steel-on-steel and steel-on-bronze rod ends come into their own here.

They act as the link between the cylinder and its attachments. They are able to transmit high mechanical forces.

Hydraulic cylinders (e.g. to DIN 24336) are often fitted with steel-on-steel rod ends with female thread (compressible) at one end and steel-on-steel rod ends with welding shank at the other. Such hydraulic cylinders are found in all types of construction equipment, agricultural machinery, lifting equipment and shutters, recycling depot presses as well as other heavily loaded maneuvering equipment.



Where pneumatic cylinders for working pressures up to some 1 MPa are concerned, steel-on-bronze rod ends are mainly used as well as maintenance-free rod ends at the piston rod end and at the other end SKF rod ends with welding shank are employed.

Newspaper conveyor

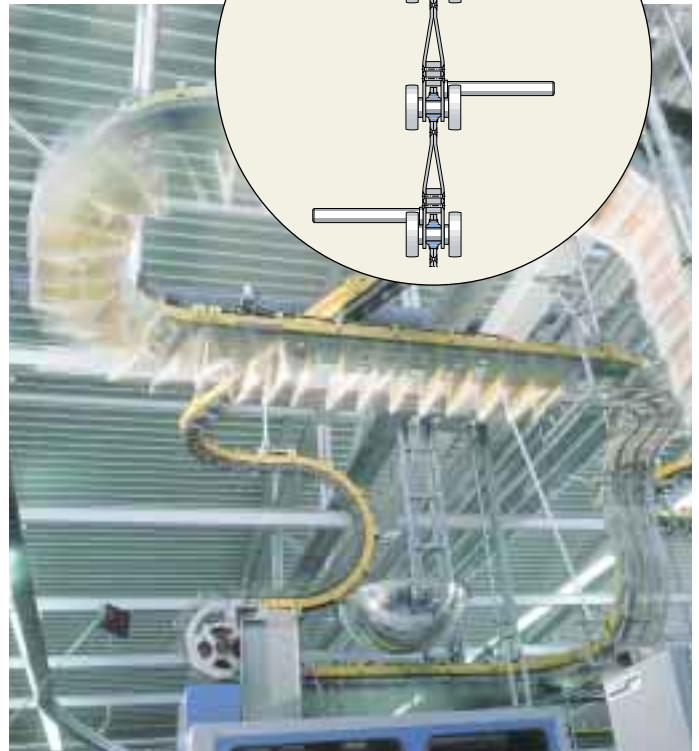
Speed is all-important when producing newspapers, not only in the printing but also in their transportation. The conveyor system from the printing press to the distribution point is therefore important if the newspapers are to come out on time.

The endless conveyor chain is one such system. It consists of a multitude of links which together provide the flexibility required. In the example shown more than 1 000 SKF maintenance-free spherical plain bearings GEH 10 C are used. They have been in daily service without any maintenance whatsoever for many years now.

Hydraulic and pneumatic cylinders



Newspaper conveyor



Selection of bearing size

Load ratings

There is no standardised method for determining the load ratings of spherical plain bearings and rod ends, nor is there any standardised definition. As different manufacturers define load ratings differently, it is not possible to compare the load ratings of bearings produced by one manufacturer with those published by another manufacturer.

Basic dynamic load rating

The basic dynamic load rating C is used, together with other influencing factors, to determine the basic rating service life of spherical plain bearings and rod ends. As a rule it represents the maximum load which a spherical plain bearing or rod end can sustain at room temperature when the sliding contact surfaces are in relative motion (\rightarrow fig 1). The maximum permissible load in any individual application should always be considered in rela-

tion to the desired service life. The basic dynamic load ratings quoted in the product tables are based on the specific load factor K (\rightarrow Table 4, page 21) and the effective projected sliding surface.

Basic static load rating

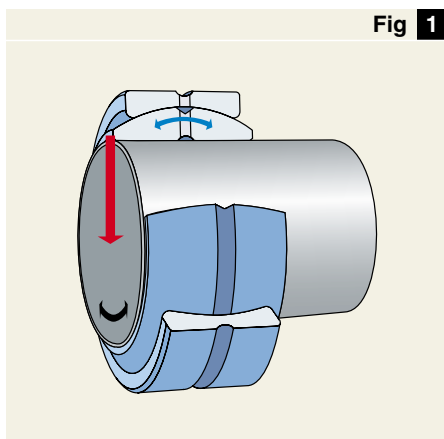
The basic static load rating C_0 represents the maximum permissible load which may be applied to a bearing when there is no relative movement of the sliding contact surfaces (\rightarrow fig 2).

For spherical plain bearings the basic static load rating represents the maximum load which the bearing can accommodate at room temperature without its performance being impaired as a result of inadmissible deformations, fracture or damage to the sliding contact surfaces. The basic static load ratings quoted for SKF spherical plain bearings are based on a specific static load factor K_0 (\rightarrow Table 4, page 21) and the effective projected sliding surface. It is assumed that the bearing is

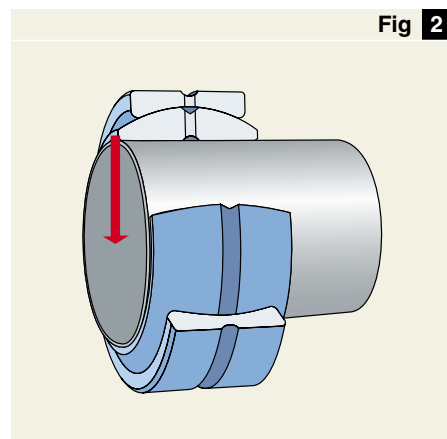
adequately supported by the associated components of the bearing arrangement. In order to fully exploit the static load rating of a spherical plain bearing it is generally necessary to use shafts and housings of high-strength materials. The basic static load rating must also be considered when bearings are dynamically loaded if they are also subjected to additional heavy shock loads. The total load in such cases must not exceed the basic static load rating.

For rod ends it is the strength of the eye-shaped head of the rod end (housing) at room temperature under a constant load acting in the direction of the shank axis which is the determining factor. The basic static load rating represents a safety factor of at least 1,2 relative to the tensile limit of the material of the rod end head under the above conditions.

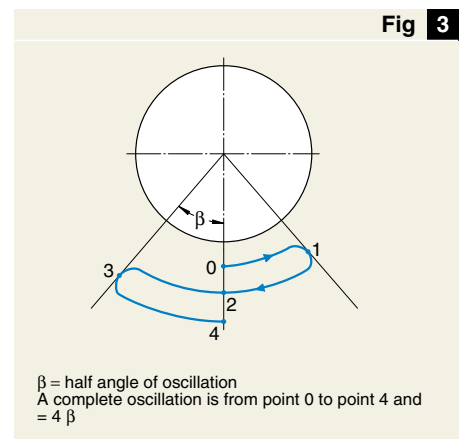
Dynamic bearing load



Static bearing load



Angle of oscillation



Service life

Spherical plain bearings belong to the category “dry sliding bearings”. In contrast to, say, hydrodynamic plain bearings, no lubricant film can form to fully separate the sliding surfaces. Therefore, under dynamic loads wear is naturally produced which enlarges the internal clearance.

The service life of a spherical plain bearing or rod end represents the operating period under test conditions which is ended when one of the criteria listed in **Table 1** for the end of service life is reached. The life is expressed either in operating hours or in the number of oscillating movements (→ **fig 3**). A distinction is made between the basic rating service life and the service life actually achieved.

The basic rating service life is a guideline value which will be attained or exceeded by the majority of a large number of apparently identical bearings under the same test conditions.

The service life actually achieved by apparently identical bearings under identical operating conditions has been found to differ. This has been found in laboratory tests but is also true in service, particularly as the service life depends on the actual operating conditions. These include not only the magnitude and type of load but also other factors such as contamination, corrosion, load and movement cycles of high frequency, and shock loads. These factors are difficult or even impossible to quantify.



Calculation of basic rating service life

By using the SKF Interactive Engineering Catalogue it is possible to perform all the necessary calculations for spherical plain bearing selection at the click of a mouse using the programs incorporated in the catalogue. The product data necessary for the calculations is automatically put in by selecting a spherical plain bearing or rod end from the product tables. It is then only necessary to fill in the fields for the operating data.

The SKF Interactive Engineering Catalogue is available as a CD-ROM from SKF or any SKF authorised dealer or distributor, or can be accessed online under www.skf.com.

Criteria for end of service life

Table 1

Sliding contact surface combination	Increase in bearing clearance	Coefficient of friction μ
–	mm	–
Steel-on-steel	> 0,004 d_k	0,20
Steel-on-bronze	> 0,004 d_k	0,25
Steel/sinter bronze composite		
constant direction load	0,2	0,20
alternating direction load	0,4	0,20
Steel/PTFE fabric		
constant direction load	0,3	0,20
alternating direction load	0,6	0,20
Steel/PTFE composite	design and size dependent	0,25

Load

When considering load, a distinction is made between:

- load direction
 - radial loads (→ **fig 4**)
 - axial loads (→ **fig 5**)
 - combined (axial and radial) loads (→ **fig 6**)
- the way in which the load acts
 - loads of constant direction (→ **fig 7**), i.e. the direction in which the load is applied does not change and the same part of the bearing (loaded zone) is always subjected to the load
 - alternating loads (→ **fig 8**), change direction so that loaded zones at opposite positions in the bearing are continuously loaded and unloaded
- the type of load
 - dynamic load is when sliding movement takes place in the loaded bearing
 - static load is when no movement takes place in the loaded bearing.

Equivalent dynamic bearing load

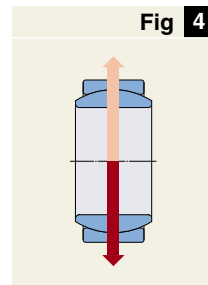
If the load acting on

- radial and angular contact spherical plain bearings is purely radial
- spherical plain thrust bearings is purely axial
- rod ends is purely radial and also in the direction of the shank axis

and is of constant magnitude, then the load can be directly inserted in the equation for the specific bearing load p (→ **page 21**). In all other cases it is necessary to calculate the equivalent dynamic bearing load P . If the load is not of constant magnitude, then the procedure given under “Variable load and sliding velocity” (→ **page 29**) should be followed.

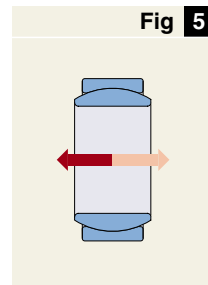
Radial load

Fig 4



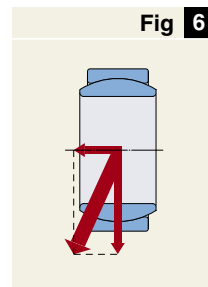
Axial load

Fig 5



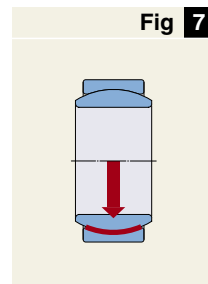
Combined load

Fig 6



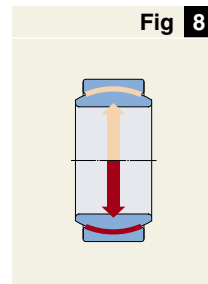
Constant direction load

Fig 7



Alternating direction load

Fig 8



Radial spherical plain bearings

Radial spherical plain bearings can accommodate a certain amount of axial load F_a in addition to the simultaneously acting radial load F_r (→ fig 6). When the resultant load is constant in magnitude, the equivalent dynamic bearing load can be obtained from

$$P = y F_r$$

where

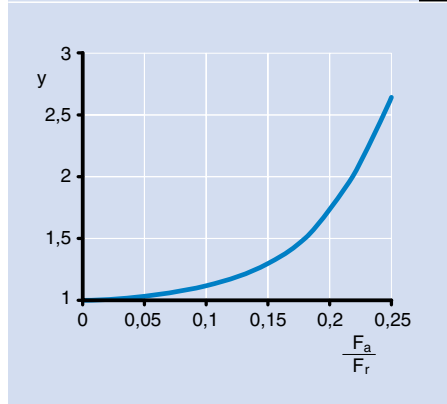
P = equivalent dynamic bearing load, N

F_r = radial component of the load, N

y = a factor which depends on the ratio of the axial to the radial load F_a/F_r

- for bearings requiring maintenance (→ Diagram 1)
- for maintenance-free bearings (→ Diagram 2)

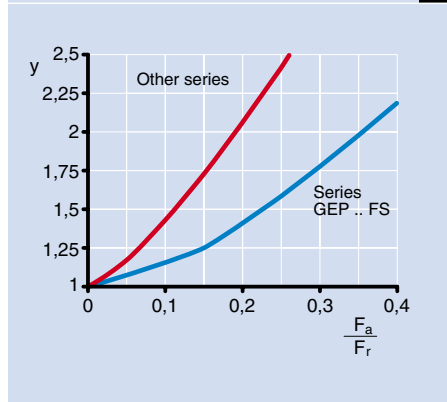
Diagram 1



Factor y for radial spherical plain bearings requiring maintenance

Factor y for maintenance-free radial spherical plain bearings

Diagram 2



Angular contact spherical plain bearings

When the resultant load (fig 9) is constant in magnitude, then

$$P = y F_r$$

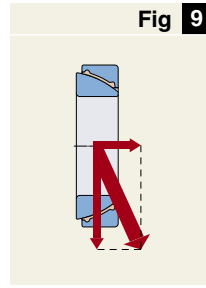
where

P = equivalent dynamic bearing load, N

F_r = radial component of the load, N

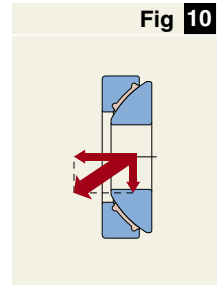
y = a factor which depends on the ratio of the axial to the radial load F_a/F_r (→ Diagram 3)

Fig 9



Angular contact spherical plain bearing under combined load

Fig 10



Spherical plain thrust bearing under combined load

Spherical plain thrust bearings

Spherical plain thrust bearings can carry a radial load F_r in addition to the axial load F_a . However, the radial load must not exceed 50 % of the simultaneously acting axial load (→ fig 10). When the resultant load is constant in magnitude, then

$$P = y F_a$$

where

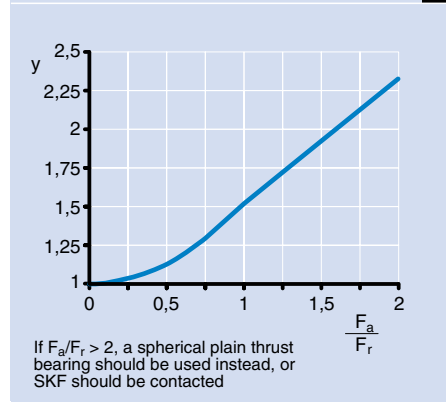
P = equivalent dynamic bearing load, N

F_a = axial component of the load, N

y = a factor depending on the ratio of the radial to the axial load F_r/F_a (→ Diagram 4)

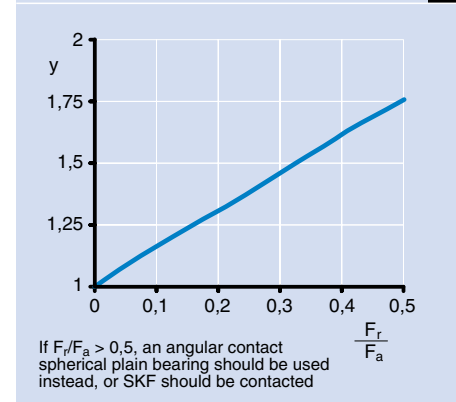
Factor y for angular contact spherical plain bearings

Diagram 3



Factor y for spherical plain thrust bearings

Diagram 4



Equivalent static bearing load

If spherical plain bearings and rod ends are subjected to load when stationary or making only slight alignment movements, then the permissible load is not limited by wear, but by the strength of the sliding contact layer or the strength of the rod end housing. If the actual load is a combined radial and axial load, then an equivalent static bearing load must be calculated. This can be done in a similar way to the calculation of the equivalent dynamic bearing load, for radial and angular contact spherical plain bearings using

$$P_0 = y F_r$$

and for spherical plain thrust bearings using

$$P_0 = y F_a$$

where

P_0 = equivalent static bearing load, N
 F_r = the radial component of the load, N

F_a = the axial component of the load, N

y = a factor which depends on the ratio F_a/F_r

- for radial bearings requiring maintenance (→ **Diagram 1**, **page 19**)
- for maintenance-free radial bearings (→ **Diagram 2**, **page 19**)
- for angular contact spherical plain bearings (→ **Diagram 3**, **page 19**)

and on the ratio F_r/F_a

- for spherical plain thrust bearings (→ **Diagram 4**, **page 19**)

Permissible loads for rod ends

Rod ends are primarily intended for the support of radial loads acting in the direction of the shank axis. If loads act at right angles to the shank axis (→ **fig 11**), the maximum permissible load will be reduced as additional bending stresses occur in the shank. When checking, consideration should also be paid to the rod end head (housing) material which differs depending on design and size.

The load directed at an angle or axially to the rod end (to the direction of the shank axis) should never exceed the value of $0,1 C_0$. If heavier loads are involved then a larger rod end should be chosen.

The maximum permissible load for a rod end in the direction of the shank axis can be calculated from

$$P_{perm} = C_0 b_2 b_6$$

where

P_{perm} = maximum permissible load, N

C_0 = static load rating, N

b_2 = temperature factor

- for rod ends requiring maintenance (→ **Table 5**, **page 24**)
- for maintenance-free rod ends with the sliding contact surface combination
 - steel/sinter bronze composite (→ **Diagram 16**, **page 26**)
 - steel/PTFE fabric (→ **Diagram 17**, **page 27**)
 - steel PTFE composite (→ **Diagram 18**, **page 28**)

b_6 = factor for the type of load (→ **Table 2**)

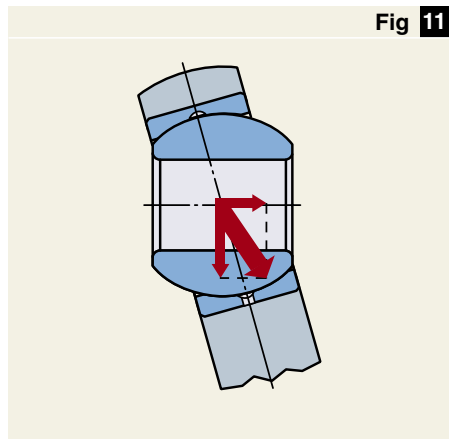

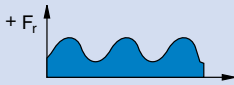
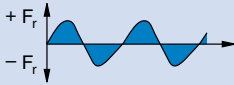


Fig 11

Rod end under combined load

Factor b_6 for rod end load type

Table 2	
Type of load (magnitude and direction)	Factor b_6
Constant 	1
Pulsating magnitude (single direction) 	0,5 (0,35)
Alternating direction, 	0,5 (0,35)

The values in brackets apply to rod ends with lubrication hole or nipple

Requisite bearing size

When determining the requisite size of bearing (or rod end), it is necessary to know the service life required for the particular application. This is dependent on the type of machine, the operating conditions and the demands regarding operational reliability.

As a first approximation the guideline values of the load ratio C/P given in **Table 3** can be used to obtain the requisite basic dynamic load rating C. A suitable bearing or rod end can then be selected from the product tables.

It should then be checked whether the chosen size can be used under the actual load and sliding velocity conditions using the appropriate diagram for the sliding contact surface combination from those shown on **pages 22 and 23** (**Diagrams 5 to 10** inclusive). The specific bearing load *p* and the sliding velocity *v* needed to perform this check can be calculated as explained in the following sections.

If, having checked the *p**v* diagram, it is found that the bearing or rod end can be used, then the basic rating ser-

vice life is calculated. If the calculated service life is shorter than the requisite service life, a larger bearing or rod end should be chosen and the calculation repeated.

If, on the other hand, the first check shows the *p**v* range is exceeded, a bearing having higher load carrying capacity should be chosen.

The bearing (or rod end) size is often dictated to a greater or lesser degree by the dimensions of the associated components. In such cases the *p**v* diagram should be consulted first to check that the product can be used.

Specific bearing load

The magnitude of the specific bearing load can be determined using

$$p = K \frac{P}{C}$$

where

p = specific bearing load, N/mm²
K = a specific load factor depending on the basic dynamic load rating (→ **Table 4**), N/mm²

P = equivalent dynamic bearing load, N
C = basic dynamic load rating, N

Mean sliding velocity

The mean sliding velocity for constant movement can be obtained from

$$v = 5,82 \times 10^{-7} d_m \beta f$$

where

v = mean sliding velocity, m/s
 When operation is intermittent (not continuous) the mean sliding velocity should be calculated for a cycle of operation

d_m = mean diameter of inner ring or shaft washer, mm
d_m = *d_k* for radial spherical plain bearings

d_m = 0,9 *d_k* for angular contact spherical plain bearings
d_m = 0,7 *d_k* for spherical plain thrust bearings

β = half the angle of oscillation (→ **fig 3**, **page 16**), degrees
 For rotation *β* = 90°

f = frequency of oscillation, min⁻¹, or rotational speed, r/min

For intermittent movement, the angle of oscillation is usually given per unit time. In this case the mean sliding velocity can be calculated using

$$v = 8,73 \times 10^{-6} d_m \frac{2 \beta}{t}$$

where

β = half the angle of oscillation, degrees
t = time taken to pass through 2 *β* (= whole angle of oscillation), s

Guideline values for C/P

Table 3	
Spherical plain bearings/rod ends with sliding contact surface combination	Load ratio C/P
Steel-on-steel	2
Steel-on-bronze	2
Steel/sinter bronze composite	1,6
Steel/PTFE fabric	1,75
Steel/PTFE composite	
GAC .. F	1,25
GX .. F	1,25
GEP .. FS	1,6
GEC .. FSA	1,6
Rod ends	1,25

Specific load factors

Table 4		
Sliding contact surface combination	Specific load factors	
	dyn. K	stat. K ₀
–	N/mm ²	
Steel-on-steel		
Metric sizes	100	500
Inch sizes	100	300
Steel-on-bronze	50	80
Steel/sinter bronze composite	100	250
Steel/PTFE fabric	150	300
Steel/PTFE composite		
GAC .. F	50	80
GX .. F	50	80
GEP .. FS	80	120
GEC .. FSA	80	120
Rod ends	50	80

Diagram 5

pv diagram for sliding contact surface combination steel-on-steel
See Note 1 for explanation of operating ranges

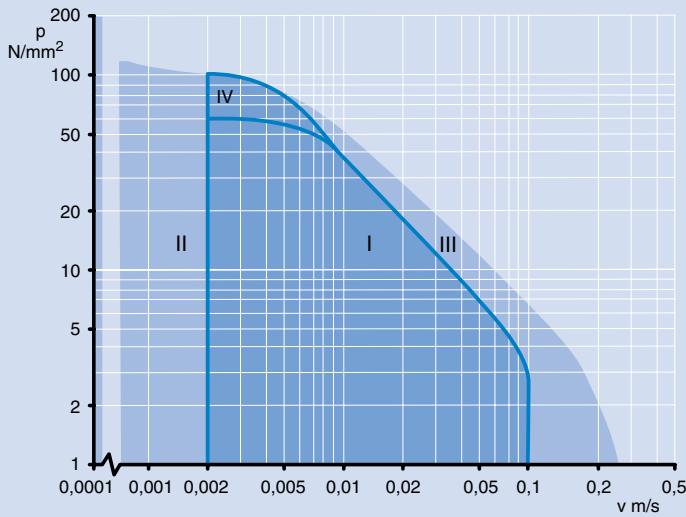


Diagram 6

pv diagram for sliding contact surface combination steel-on-bronze
See Note 1 for explanation of operating ranges

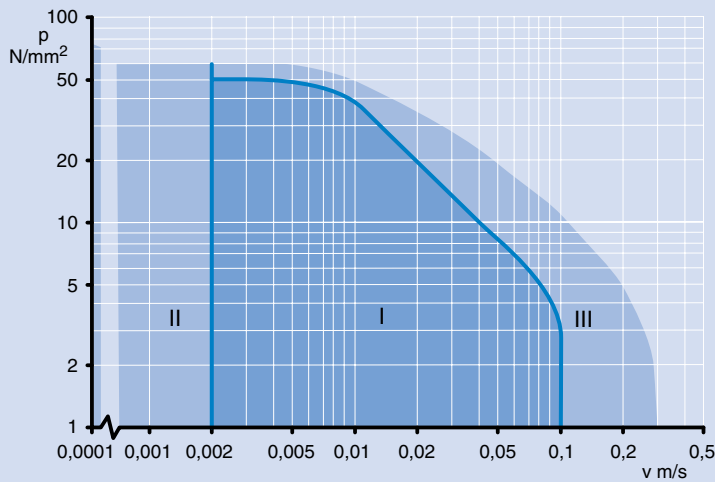
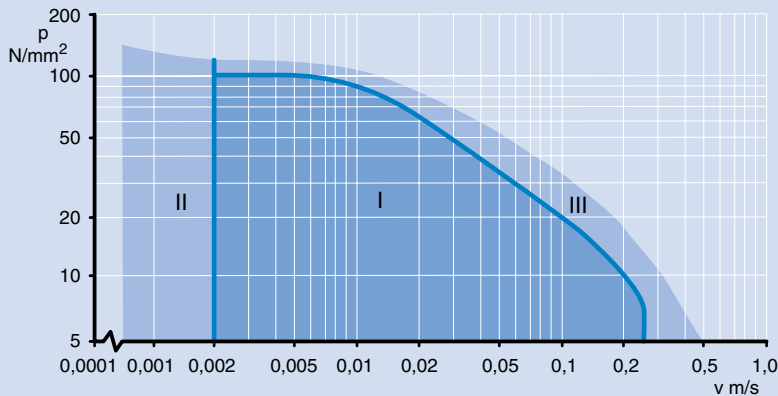


Diagram 7

pv diagram for sliding contact surface combination steel/sinter bronze composite
See Note 2 for explanation of operating ranges



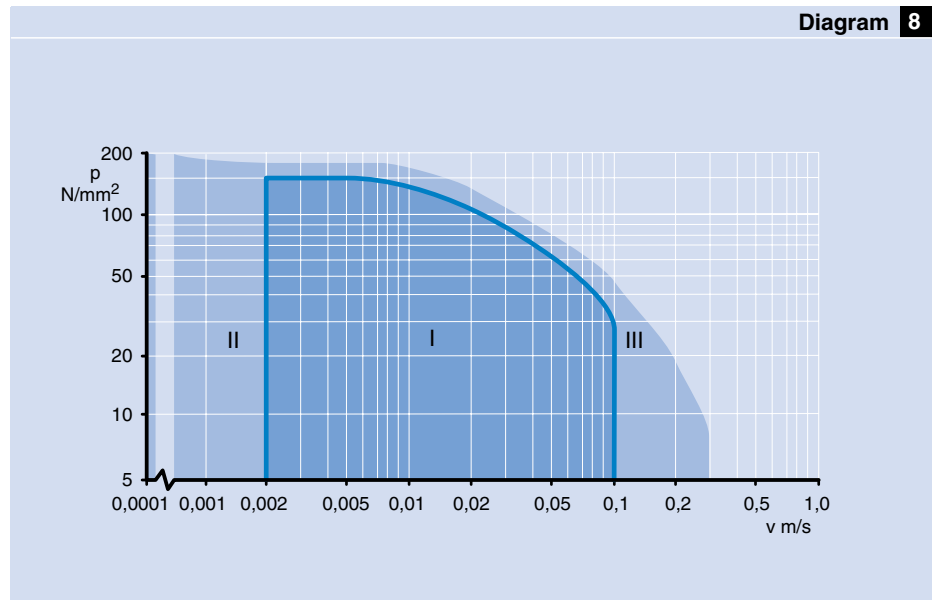
Note 1

pv operating ranges

- I Range where service life equation is valid
- II Quasi-static range; before using the service life equation, please contact SKF
- III Possible range of use, e.g. with very good lubrication; before using the service life equation, please contact SKF
- IV Extended range where service life equation is valid provided the load is exclusively alternating

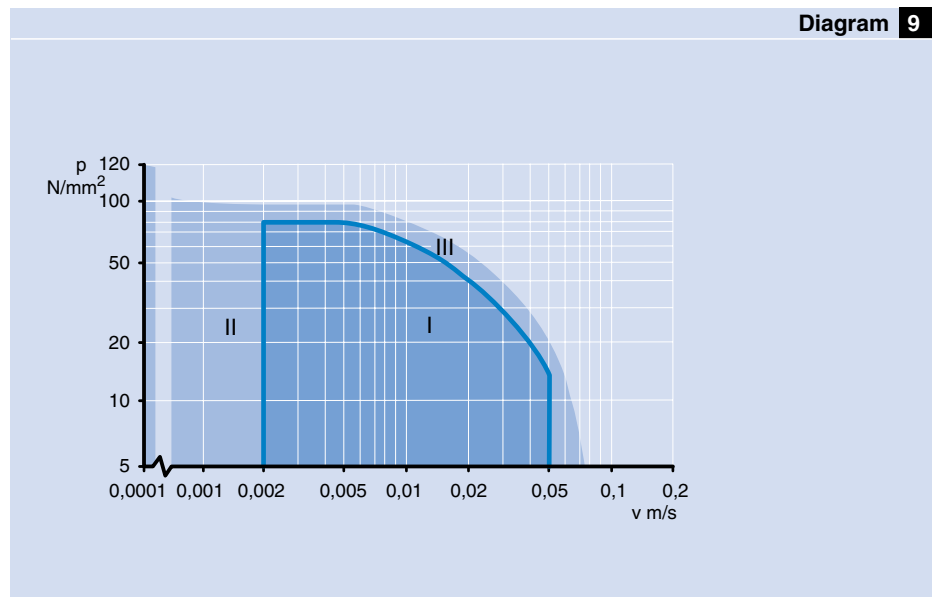
pv diagram for sliding contact surface combination steel/PTFE fabric
See Note 2 for explanation of operating ranges

Diagram 8



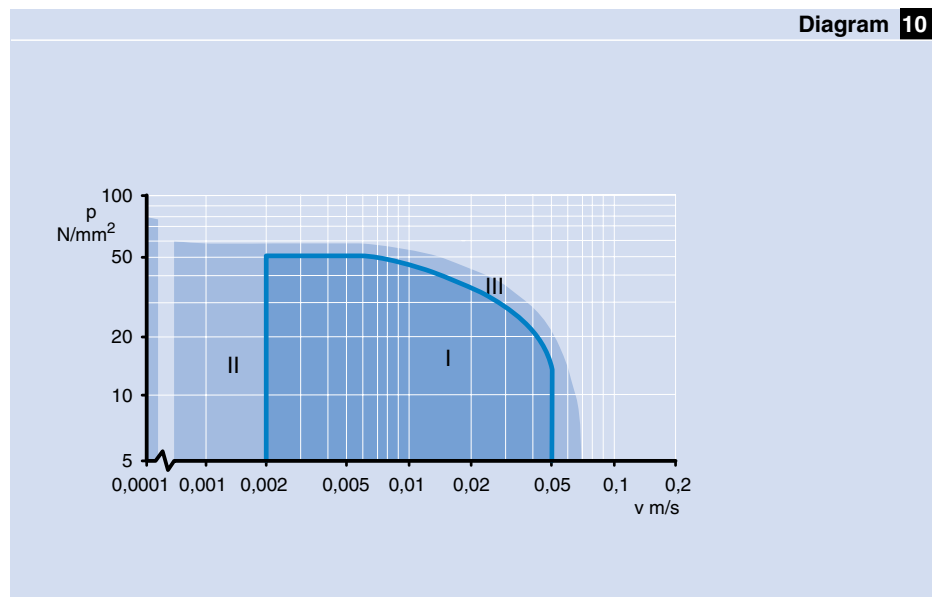
pv diagram for sliding contact surface combination steel/PTFE composite, FS and FSA designs
See Note 2 for explanation of operating ranges

Diagram 9



pv diagram for sliding contact surface combination steel/PTFE composite, F design
See Note 2 for explanation of operating ranges

Diagram 10



Note 2

pv operating ranges

- I Range where service life equation is valid
- II Quasi-static range; service life equation has limited validity, see under **“Basic rating service life”**
- III Possible range of use, e.g. with very good heat removal; before using the service life equation, please contact SKF

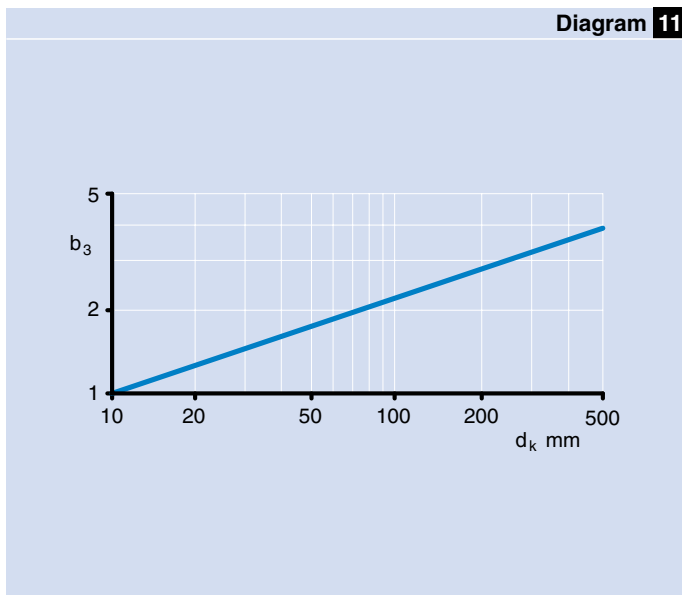
Temperature factor b_2

Table 5

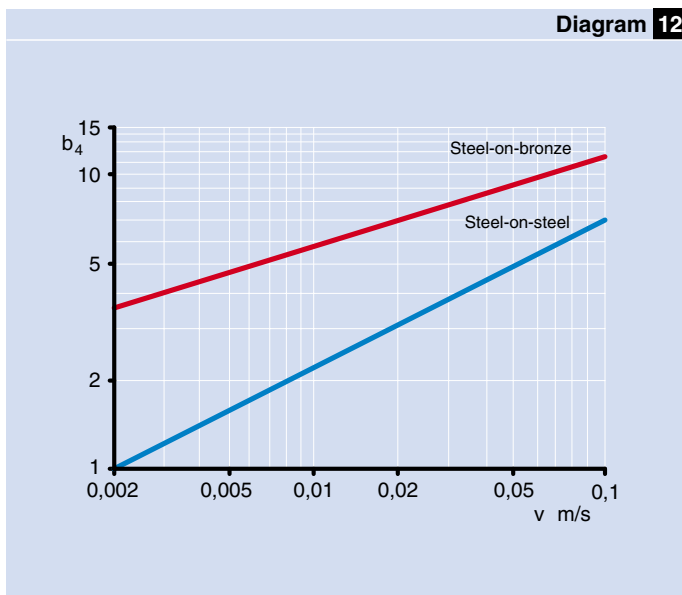
Operating temperature over		Temperature factor b_2
incl.		
°C		—
—	120	1,0
120	160	0,9
160	180	0,8
180	—	Please contact SKF

The following temperature limits must also be respected
 80 °C For bearings of series GEZ .. ES-2RS (polyurethane seals)
 130 °C For all other sealed bearings (polyester elastomer seals)
 120 °C Upper temperature limit for standard grease

Sliding factor b_3



Speed factor b_4



Basic rating service life

Sliding contact surface combinations requiring maintenance: steel-on-steel and steel-on-bronze

For the initial lubrication

$$G_h = b_1 b_2 b_3 b_4 b_5 \frac{330}{p^{2,5} v}$$

and when the product is regularly relubricated thereafter

$$G_{hN} = G_h f_\beta f_H$$

or

$$G_N = 60 f G_{hN}$$

where

G_h = service life for the initial lubrication, operating hours

G_{hN} = basic rating service life with regular relubrication, operating hours

G_N = basic rating service life with regular relubrication, number of oscillations

b_1 = load direction factor,
 $b_1 = 1$ for constant direction load

$b_1 = 2$ for alternating direction load

b_2 = temperature factor (→ Table 5)

b_3 = sliding factor (→ Diagram 11)

b_4 = velocity factor (→ Diagram 12)

b_5 = factor for angle of oscillation (→ Diagram 13), see also under “NB.”

f = frequency of oscillation, min^{-1}

f_β = factor depending on the angle of oscillation (→ Diagram 14), see also under “NB.”

f_H = factor depending on frequency of relubrication (→ Diagram 15)

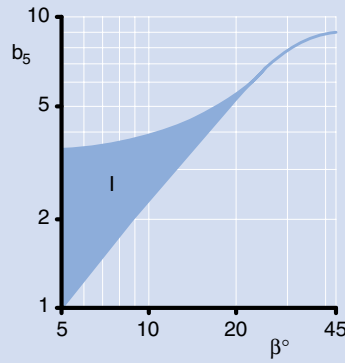
p = specific bearing load, N/mm^2
 (for values of $p < 10 \text{ N/mm}^2$ use $p = 10 \text{ N/mm}^2$)

v = mean sliding velocity, m/s

If the basic rating service life requirement is not met, then the relubrication interval N (→ Diagram 15) should be shortened, or a larger bearing or rod end should be chosen.

Diagram 13

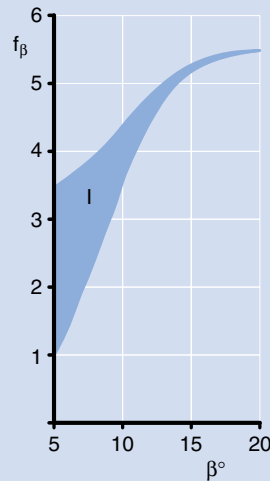
Angle of oscillation factor b_5



If $\beta < 5^\circ$, the value of b_5 for $\beta = 5^\circ$ should be used

Diagram 14

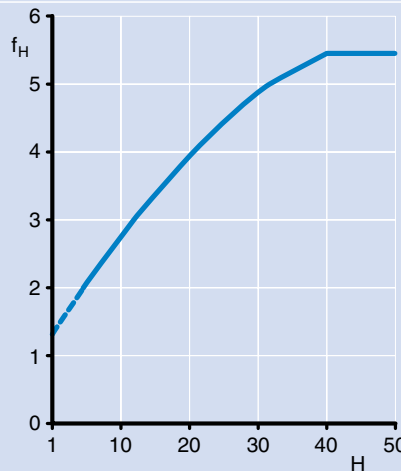
Multiplication factor f_β



If $\beta < 5^\circ$, half the value of f_β for $\beta = 5^\circ$ should be used

Diagram 15

Relubrication factor f_H



The frequency of relubrication H is defined as the ratio of the basic rating service life G_R to the relubrication interval N (in h), i.e. $H = G_R/N$; if $H < 5$, the values indicated by the broken line can be used

NB.

SKF steel-on-steel spherical plain bearings having an outside diameter of 150 mm and above are produced as standard with the multi-groove feature in the outer ring (→ page 6). The extra large grease reservoir in the bearing made possible by the multi-groove system is advantageous, particularly where the load is of constant direction, and enables the relubrication interval to be extended, and also the service life.

These advantages are considered in the calculation of the basic rating service life by the coloured regions in **Diagrams 13** and **14** for the factors for the angle of oscillation b_5 and f_β . Values of these two factors up to the upper limit of the coloured area may be used for bearings with the multi-groove system.

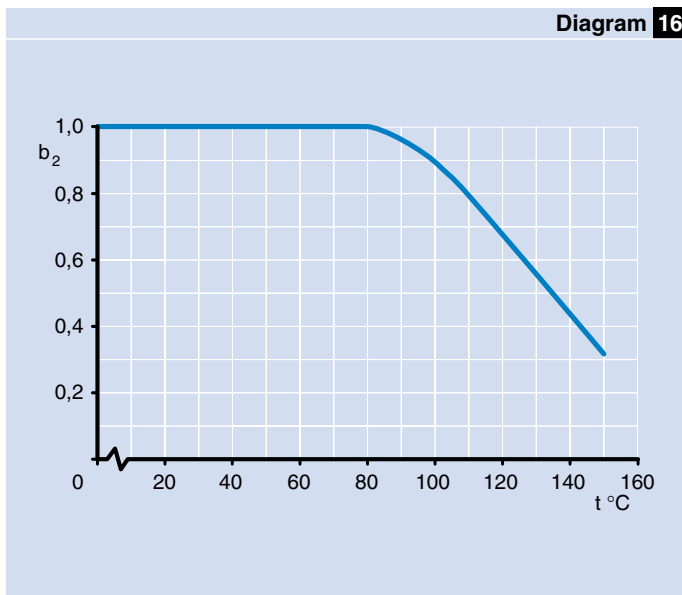
Load direction factor b_1 for sliding contact surface combination steel/sinter bronze composite

Table 6

Type of load	Factor b_1	Permissible specific bearing load ¹⁾
–	–	N/mm ²
Constant load²⁾ Single direction	1	–
Variable load Alternating direction or pulsating magnitude at a frequency up 0,5 Hz	0,4	40 to 60
over 0,5 up to 5 Hz	0,2	25 to 40

¹⁾ Inertia forces should also be taken into consideration
²⁾ For constant load, oscillating frequencies above 300 min⁻¹ and very short sliding distances, $b_1 = 1$ can no longer be used because of possible material fatigue; please contact SKF for guidance

Temperature factor b_2 for sliding contact surface combination steel/sinter bronze composite



Maintenance-free sliding contact surface combination steel/sinter bronze composite

$$G_h = b_1 b_2 \frac{1\,400}{p^{1,3} v}$$

or

$$G = 60 f G_h$$

where

- G = basic rating service life, number of oscillations
- G_h = basic rating service life, operating hours
- b_1 = load direction factor (→ **Table 6**)
- b_2 = temperature factor (→ **Diagram 16**)
- f = frequency of oscillation, min⁻¹
- p = specific bearing load, N/mm²
- v = mean sliding velocity, m/s

NB. Calculation of the service life considers the influence of the load and sliding velocity. Under very light loads and/or low sliding velocities, the equations will give relatively long service lives. However, the influence of environmental factors such as contamination, damp or moisture and corrosion increases in importance the longer the life so that deviations from the calculated life occur and in many cases the calculated life will not be attained.

Maintenance-free sliding contact surface combination steel/PTFE fabric

$$G_h = b_1 b_2 \frac{5\,500}{p^{1,3} v}$$

or

$$G = 60 f G_h$$

where

G = basic rating service life, number of oscillations

G_h = basic rating service life, operating hours

b₁ = load direction factor (→ Table 7)

b₂ = temperature factor (→ Diagram 17)

f = frequency of oscillation, min⁻¹

p = specific bearing load, N/mm²

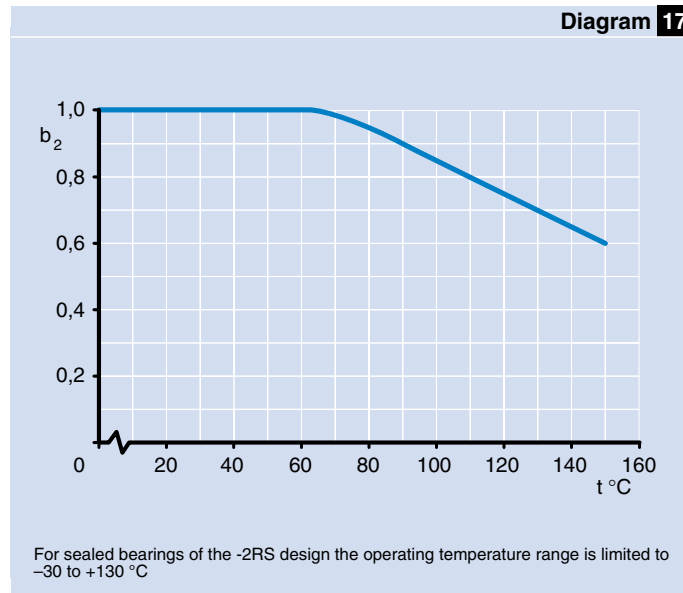
v = mean sliding velocity, m/s

Table 7

Type of load	Factor b ₁	Permissible specific bearing load ¹⁾
–	–	N/mm ²
Constant load²⁾ Single direction	1	–
Variable load Alternating direction or pulsating magnitude at a frequency up to 0,5 Hz	0,3	50 to 85
over 0,5 up to 5 Hz	0,1	30 to 50

¹⁾ Inertia forces should also be taken into consideration
²⁾ For constant load, oscillating frequencies above 300 min⁻¹ and very short sliding distances, b₁ = 1 can no longer be used because of possible material fatigue; please contact SKF for guidance

Load direction factor b₁ for sliding contact surface combination steel/PTFE fabric



Temperature factor b₂ for sliding contact surface combination steel/PTFE fabric

NB.

Calculation of the service life considers the influence of the load and sliding velocity. Under very light loads and/or low sliding velocities, the equations will give relatively long service lives. However, the influence of environmental factors such as contamination, damp or moisture and corrosion increases in importance the longer the life so that deviations from the calculated life occur and in many cases the calculated life will not be attained.

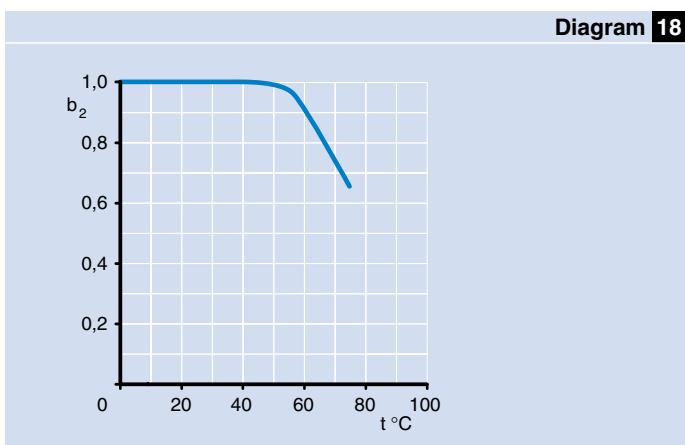
Load direction factor b_1 for sliding contact surface combination steel/PTFE composite

Table 8

Type of load	Factor b_1	Permissible specific bearing load ¹⁾
–	–	N/mm ²
Constant load²⁾ Single direction	1	–
Variable load Alternating direction or pulsating magnitude at a frequency up to 0,5 Hz over 0,5 up to 5 Hz	0,25 0,1	25 to 40 15 to 25

¹⁾ Inertia forces should also be taken into consideration.
²⁾ For constant load, oscillating frequencies above 300 min⁻¹ and very short sliding distances, $b_1 = 1$ can no longer be used because of possible material fatigue; please contact SKF for guidance

Temperature factor b_2 for sliding contact surface combination steel/PTFE composite



Sliding factor b_3 and constant K_M for sliding contact surface combination steel/PTFE composite

Table 9

Bearing type Series	Bore diameter d		Sliding factor b_3	Constant K_M
	Nominal	incl.		
–	mm	–	–	–
Radial bearings				
GEP .. FS	–	180	1	1 055
	180	440	1,15	1 055
GEC .. FSA	–	440	1,35	1 055
	440	–	1,15	1 055
Angular contact bearings¹⁾				
GAC .. F	–	60	1	480
	60	–	1,5	480
Thrust bearings				
GX .. F	–	60	1	670
	60	–	1,5	670
Rod ends			1	530

¹⁾ For preloaded bearings which cannot be re-adjusted, b_3 always = 1

Maintenance-free sliding contact surface combination steel/PTFE composite

$$G_h = b_1 b_2 b_3 \frac{K_M}{pv}$$

or

$$G = 60 f G_h$$

where

G = basic rating service life, number of oscillations

G_h = basic rating service life, operating hours

b_1 = load direction factor (→ Table 8)

b_2 = temperature factor (→ Diagram 18)

b_3 = sliding factor (→ Table 9)

K_M = material constant (→ Table 9)

f = frequency of oscillation, min⁻¹

p = specific bearing load, N/mm²

v = mean sliding velocity, m/s

NB.

1. The basic rating service life calculated using the above equation can be doubled by initial lubrication together with occasional relubrication, see under “Lubrication and maintenance”.

2. Calculation of the service life considers the influence of the load and sliding velocity. Under very light loads and/or low sliding velocities, the equations will give relatively long service lives. However, the influence of environmental factors such as contamination, damp or moisture and corrosion increases in importance the longer the life so that deviations from the calculated life occur and in many cases the calculated life will not be attained.

Variable load and sliding velocity

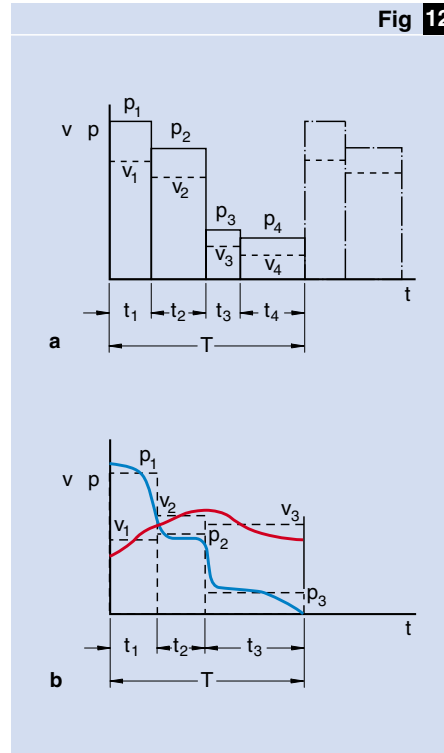
If, during operation, the load and/or the sliding velocity change it is first necessary to calculate individual service lives for the periods of constant load and sliding velocity, before the basic rating service life can be calculated. If the load and sliding velocity occur as shown by (a) in **fig 12** the individual lives can be calculated using the constant values of *p* and *v*. However, when the load and sliding velocity are not constant (b) in **fig 12**, it is first necessary to calculate the basic rating service life for the individual time periods using mean values of the load and the sliding velocity for the individual time periods. When this has been done, the total basic rating service life can be calculated using the following equation

$$G_h = \frac{1}{\frac{t_1}{T G_{h1}} + \frac{t_2}{T G_{h2}} + \frac{t_3}{T G_{h3}} + \dots}$$

where

- G_h = total basic rating service life, operating hours
- $t_1, t_2 \dots$ = time during which p_1 and v_1, p_2 and v_2 etc. pertain, h
- T = total duration of one cycle (= $t_1 + t_2 + t_3 + \dots$), h
- $G_{h1} \dots$ = individual values of service life for conditions p_1 and v_1, p_2 and v_2 etc., operating hours

Fig 12



Alternating load and variable sliding velocity

Calculation examples

The calculation examples shown in the following serve to illustrate the methods used to calculate the requisite bearing size or the basic rating service life for spherical plain bearings and rod ends.

Using the SKF Interactive Engineering Catalogue which incorporates programs to do these and many other calculations, results will be obtained quickly and accurately. Additionally, the programs can be run any number of times to enable the best possible solution to be obtained.

The SKF Interactive Engineering Catalogue is available as a CD-ROM from SKF or any SKF authorised dealer or distributor, or can be accessed online under www.skf.com.

Example 1

The torque support of a concrete transporter

Given:

Purely radial load (alternating direction): $F_r = 12\,000\text{ N}$

Half angle of oscillation: $\beta = 15^\circ$

(→ fig 3, page 16)

Frequency of oscillation: $f = 10\text{ min}^{-1}$
maximum operating temperature: $+80^\circ\text{C}$

Requirement:

A bearing which has a basic rating service life of 7 000 h.

As the load is alternating, a steel-on-steel spherical plain bearing is the appropriate choice. The intention is to relubricate the bearing after each 40 hours of operation.

If, for the first check, a guideline value of 2 is used for the load ratio C/P (→ Table 3, page 21), the required basic dynamic load rating C for the bearing is

$$C = 2 P = 24\,000\text{ N}$$

Bearing GE 20 ES having $C = 30\,000\text{ N}$ and a sphere diameter $d_k = 29\text{ mm}$ is chosen from the product table, page 62.

To be able to check the suitability of the bearing using the **pv diagram 5**, page 22, it is first necessary to calculate the specific bearing load using $K = 100$ from Table 4, page 21

$$p = K \frac{P}{C} = 100 \times \frac{12\,000}{30\,000} = 40\text{ N/mm}^2$$

and the sliding velocity v using $d_m = d_k = 29\text{ mm}$, $\beta = 15^\circ$ and $f = 10\text{ min}^{-1}$

$$\begin{aligned} v &= 5,82 \times 10^{-7} d_m \beta f \\ &= 5,82 \times 10^{-7} \times 29 \times 15 \times 10 \\ &= 0,0025\text{ m/s} \end{aligned}$$

These values for p and v lie within the permissible operating range I of the **pv diagram 5**, page 22, for steel-on-steel spherical plain bearings. To calculate the basic rating service life for initial lubrication, the values which apply are



$$\begin{aligned} b_1 &= 2 \text{ (alternating direction load)} \\ b_2 &= 1 \text{ (operating temperature } <120^\circ\text{C} \text{ from Table 5, page 24)} \\ b_3 &= 1,5 \text{ (from Diagram 11, page 24, for } d_k = 29\text{ mm)} \\ b_4 &= 1,1 \text{ (from Diagram 12, page 24, for } v = 0,0025\text{ m/s)} \\ b_5 &= 3,7 \text{ (from Diagram 13, page 25, for } \beta = 15^\circ) \\ p &= 40\text{ N/mm}^2 \\ v &= 0,0025\text{ m/s} \end{aligned}$$

Therefore

$$\begin{aligned} G_h &= b_1 b_2 b_3 b_4 b_5 \frac{330}{p^{2,5} v} \\ &= 2 \times 1 \times 1,1 \times 1,1 \times 3,7 \times \frac{330}{40^{2,5} \times 0,0025} \\ &\approx 160\text{ operating hours} \end{aligned}$$

The basic rating service life of the bearing which is to be relubricated regularly can now be calculated using

$$\begin{aligned} f_\beta &= 5,2 \text{ (from Diagram 14, page 25)} \\ f_H &= 1,8 \text{ (from Diagram 15, page 25, for a relubrication frequency } H = G_h/N = 160/40 = 4 \text{ with the relubrication interval of 40 h)} \end{aligned}$$

$$\begin{aligned} G_{hN} &= G_h f_\beta f_H = 160 \times 5,2 \times 1,8 \\ &\approx 1\,500\text{ operating hours} \end{aligned}$$

As this life is shorter than the required service life of 7 000 h, a larger bearing must be chosen and the calculations repeated.

Bearing GE 25 ES having $C = 48\,000$ N and $d_k = 35,5$ mm is chosen. The values for the specific bearing load

$$p = 100 \times \frac{12\,000}{48\,000} = 25 \text{ N/mm}^2$$

and the sliding velocity

$$v = 5,82 \times 10^{-7} \times 35,5 \times 15 \times 10 \\ = 0,0031 \text{ m/s}$$

lie within the permissible operating range I of the **pv diagram 6**, **page 22**. As before

$$b_1 = 2, b_2 = 1, b_5 = 3,7$$

and now

$$b_3 = 1,6 \text{ (from Diagram 11, page 24, for } d_k = 35,5 \text{ mm)}$$

$$b_4 = 1,3 \text{ (from Diagram 12, page 24, for } v = 0,0031 \text{ m/s)}$$

Therefore, the basic rating service life for initial lubrication

$$G_h = 2 \times 1 \times 1,6 \times 1,3 \times 3,7 \times \frac{330}{25^{2,5} \times 0,0031} \\ \approx 520 \text{ h}$$

With $f_\beta = 5,2$ (from **Diagram 14**, **page 25**) and $f_H = 3,1$ (from **Diagram 15**, **page 25** for $H = 520/40 = 13$) the basic rating service life for regular relubrication ($N = 40$ h) becomes

$$G_{hN} = 520 \times 5,2 \times 3,1 \\ \approx 8\,300 \text{ operating hours}$$

This larger bearing thus satisfies the service life requirement.

Example 2

The attachment of a shock absorber of an off-highway vehicle

Given:

Radial load: $F_r = 7\,000$ N

Axial load: $F_a = 700$ N

Half angle of oscillation: $\beta = 8^\circ$ (**fig 3**, **page 16**)

Frequency of oscillation: $f = 15 \text{ min}^{-1}$

Load frequency: 2–5 Hz

Maximum operating temperature: $+75^\circ\text{C}$

Required:

A bearing which will have a basic rating service life corresponding to a driven distance of 100 000 km at an average speed of 65 km/h without maintenance.

For design reasons, spherical plain bearing GE 20 C with the sliding contact surface combination steel/sinter bronze composite is proposed. From the bearing table, **page 76**, the basic dynamic load rating $C = 31\,500$ N and the sphere diameter $d_k = 29$ mm.

First the equivalent dynamic bearing load must be determined

$$F_a/F_r = 700/7\,000 = 0,1$$

which gives factor $y = 1,4$ from **Diagram 2**, **page 19**. The equivalent dynamic bearing load is thus

$$P = y F_r = 1,4 \times 7\,000 = 9\,800 \text{ N}$$

A first check of bearing size using the **pv diagram 7**, **page 22**, shows that the values for the specific bearing load ($K = 100$ from **Table 4**, **page 21**)

$$p = K \frac{P}{C} = 100 \times \frac{9\,800}{31\,500} = 31 \text{ N/mm}^2$$

and the sliding velocity ($d_m = d_k = 29$ mm)

$$v = 5,82 \times 10^{-7} d_m b f \\ = 5,82 \times 10^{-7} \times 29 \times 8 \times 15 \\ = 0,002 \text{ m/s}$$

so that this lies in the permissible operating range I of the **pv diagram**. Using



$b_1 = 0,2$ (from **Table 6**, **page 26**, for a load frequency over 0,5 Hz and $25 < p < 40 \text{ N/mm}^2$)

$b_2 = 1$ (from **Diagram 16**, **page 26**, for temperatures $< 80^\circ\text{C}$)

the basic rating service life for bearing GE 20 C with the sliding contact surface combination steel/sinter bronze composite is

$$G_h = b_1 b_2 \frac{1\,400}{p^{1,3} v} \\ = 0,2 \times 1 \times \frac{1\,400}{31^{1,3} \times 0,002} \\ \approx 1\,600 \text{ h}$$

This basic rating service life corresponds to a distance (at an average speed of 65 km/h) of $1\,600 \times 65 = 104\,000$ km.

Example 3

The 320-bar hydraulic cylinder of a fully automatic press for building industry waste

Given:

Radial load (constant direction):

Operation case	Load, F_r	Time period, t
I	300 000 N	10 %
II	180 000 N	40 %
III	120 000 N	50 %

The number of press cycles $n = 30$ per hour, and the movement between the end positions (90°) is made in 10 seconds (corresponds to a complete cycle duration of 20 s), i.e. $2\beta = 90^\circ$ degrees and $t = 10$ s. The operating temperature $< +50^\circ\text{C}$.

Required:

A maintenance-free spherical plain bearing with the sliding contact surface combination steel/PTFE fabric for a service life of 5 years for 70 h of operation per week.

Using a guideline value for the load ratio $C/P = 1,75$ (\rightarrow **Table 3**, **page 21**), and with $P = F_{rI}$ the required basic dynamic load rating

$$C = 1,75P = 1,75 \times 300\,000 = 525\,000 \text{ N}$$

From the product table, **page 78**, bearing GE 80 TE-2RS has a basic dynamic load rating $C = 570\,000$ N and a sphere diameter $d_k = d_m = 105$ mm is chosen.

First it is necessary to check that the operation cases I to III fall within the permissible range of the **pv diagram 8**, **page 23**.

The mean sliding velocity is the same for all three cases

$$v = 8,73 \times 10^{-6} \frac{d_m}{t}$$

$$= 8,73 \times 10^{-6} \times 105 \times 90/10$$

$$= 0,008 \text{ m/s}$$

The specific bearing load, $p = K(P/C)$, using $K = 150$ from **Table 4**, **page 21**, is



for case I

$$p_I = K \frac{P}{C} = 150 \times \frac{300\,000}{570\,000} \approx 79 \text{ N/mm}^2$$

for case II

$$p_{II} = K \frac{P}{C} = 150 \times \frac{180\,000}{570\,000} \approx 47 \text{ N/mm}^2$$

for case III

$$p_{III} = K \frac{P}{C} = 150 \times \frac{120\,000}{570\,000} \approx 32 \text{ N/mm}^2$$

The values for p_I , p_{II} , p_{III} and v are within the permissible range I of the **pv diagram 8**, **page 23**. Furthermore

$b_1 = 1$ (from **Table 7**, **page 27**, for constant load acting in constant direction)

$b_2 = 1$ (from **Diagram 17**, **page 27**, for operating temperatures $< +50^\circ\text{C}$)

Thus, the basic rating service life

$$G_h = b_1 b_2 \frac{5\,500}{p^{1,3} y}$$

for case I

$$G_{hI} = 1 \times 1 \times \frac{5\,500}{79^{1,3} \times 0,008}$$

$$\approx 2\,300 \text{ h}$$

for case II

$$G_{hII} = 1 \times 1 \times \frac{5\,500}{47^{1,3} \times 0,008}$$

$$\approx 4\,600 \text{ h}$$

for case III

$$G_{hIII} = 1 \times 1 \times \frac{5\,500}{32^{1,3} \times 0,008}$$

$$\approx 7\,500 \text{ h}$$

Using the calculated basic rating service lives of the three operation cases, the total basic rating life for continuous operation

$$G_h = \frac{1}{\frac{t_I}{T G_{hI}} + \frac{t_{II}}{T G_{hII}} + \frac{t_{III}}{T G_{hIII}}}$$

$$= \frac{1}{\frac{10}{100 \times 2\,300} + \frac{40}{100 \times 4\,600} + \frac{50}{100 \times 7\,500}}$$

$$\approx 5\,000 \text{ h}$$

for t_I , t_{II} etc. the percentages given in the operating data are inserted and for $T = t_I + t_{II} + t_{III} = 100\%$.

Continuous operation for 5 000 h corresponds to 3 cycles per minute or 180 cycles per hour to 900 000 press cycles. The required life corresponded to 525 000 press cycles, so that the proposed bearing is suitable.

Example 4

The linkages of a conveyor installation

Given:

Radial load of alternating direction:

$F_r = 5\,500\text{ N}$

Half angle of oscillation: $\beta = 15^\circ$

(→ fig 3, page 16)

Frequency of oscillation: $f = 25\text{ min}^{-1}$

Operating temperature: $\approx +70^\circ\text{C}$

Required:

A rod end that will provide a basic rating service life of 9 000 hours under conditions of alternating load.

As the load is alternating, a steel-on-steel rod end is appropriate, and it is to be relubricated after every 40 hours of operation. Using the guideline value for the load ratio $C/P = 2$ from Table 3, page 21, and as $P = F_r$, the requisite basic dynamic load rating will be

$$C = 2 P = 2 \cdot 5\,500 = 11\,000\text{ N.}$$

The rod end SI 15 ES with a basic dynamic load rating $C = 17\,000\text{ N}$ is selected (page 100). The basic static load rating $C_0 = 37\,500\text{ N}$ and the sphere diameter $d_k = 22\text{ mm}$.

The first check of size is made using the **pv diagram 5**, page 22, and with $K = 100$ (from Table 4, page 21)

$$p = K \frac{P}{C} = 100 \times \frac{5\,500}{17\,000} = 32\text{ N/mm}^2$$

and the mean sliding velocity ($d_m = d_k = 22\text{ mm}$)

$$\begin{aligned} v &= 5,82 \times 10^{-7} d_k \beta f \\ &= 5,82 \times 10^{-7} \times 22 \times 15 \times 25 \\ &= 0,0048\text{ m/s} \end{aligned}$$

p and v both lie within the permissible range I of the **pv diagram 5**, page 22.

Checking the permissible load on the rod end housing

$C_0 = 37\,500\text{ N}$

$b_2 = 1$ (from Table 5, page 24, for temperatures $< 120^\circ\text{C}$)

$b_6 = 0,35$ (from Table 2, page 20, for rod ends with lubrication hole)



$$\begin{aligned} P_{\text{perm}} &= C_0 b_2 b_6 \\ &= 37\,500 \times 1 \times 0,35 \\ &= 13\,125\text{ N} > P \end{aligned}$$

The following values of the factors are used to determine the basic rating service life for initial lubrication:

$$\begin{aligned} b_1 &= 2 \text{ (alternating load)} \\ b_2 &= 1 \text{ (for operating temperatures } < 120^\circ\text{C, from Table 5, page 24)} \\ b_3 &= 1,3 \text{ (from Diagram 11, page 24, for } d_k = 22\text{ mm)} \\ b_4 &= 1,6 \text{ (from Diagram 12, page 24, for } v = 0,0048\text{ m/s)} \\ b_5 &= 3,7 \text{ (from Diagram 13, page 25, for } \beta = 15^\circ) \\ p &= 32\text{ N/mm}^2 \\ v &= 0,0048\text{ m/s} \end{aligned}$$

Therefore

$$\begin{aligned} G_h &= b_1 b_2 b_3 b_4 b_5 \frac{330}{p^{2,5} v} \\ &= 2 \times 1 \times 1,3 \times 1,6 \times 3,7 \times \frac{330}{32^{2,5} \times 0,0048} \\ &\approx 180\text{ operating hours} \end{aligned}$$

The basic rating service life for regular relubrication ($N = 40\text{ h}$) with

$$\begin{aligned} f_\beta &= 5,2 \text{ (from Diagram 14, page 25) and} \\ f_H &= 2 \text{ (from Diagram 15, page 25, for } H = G_h/N = 180/40 = 4,5) \end{aligned}$$

$$G_{hN} = G_h f_\beta f_H = 180 \times 5,2 \times 2$$

$$\approx 1\,900\text{ operating hours}$$

The required basic rating service life of 9 000 h is not achieved by the rod end, so that a larger one has to be used.

Rod end SI 20 ES, with $C = 30\,000\text{ N}$, $C_0 = 57\,000\text{ N}$ and $d_k = 29\text{ mm}$ is selected and the calculation repeated.

The values for the specific bearing load

$$p = 100 \times \frac{5\,500}{30\,000} \approx 18\text{ N/mm}^2$$

and the mean sliding velocity ($d_m = d_k = 29\text{ mm}$)

$$v = 5,82 \times 10^{-7} \times 29 \times 15 \times 25 = 0,0063\text{ m/s}$$

both lie within the permissible range I. It is not necessary to check the permissible rod end housing load since the basic static load rating of the larger rod end is higher. Also, as before

$$b_1 = 2, b_2 = 1 \text{ and } b_5 = 3,7$$

whilst

$b_3 = 1,4$ (from Diagram 11, page 24, for $d_k = 29\text{ mm}$)

$b_4 = 1,8$ (from Diagram 12, page 24, for $v = 0,0063\text{ m/s}$)

so that

$$G_h = 2 \times 1 \times 1,4 \times 1,8 \times 3,7 \times \frac{330}{18^{2,5} \times 0,0063}$$

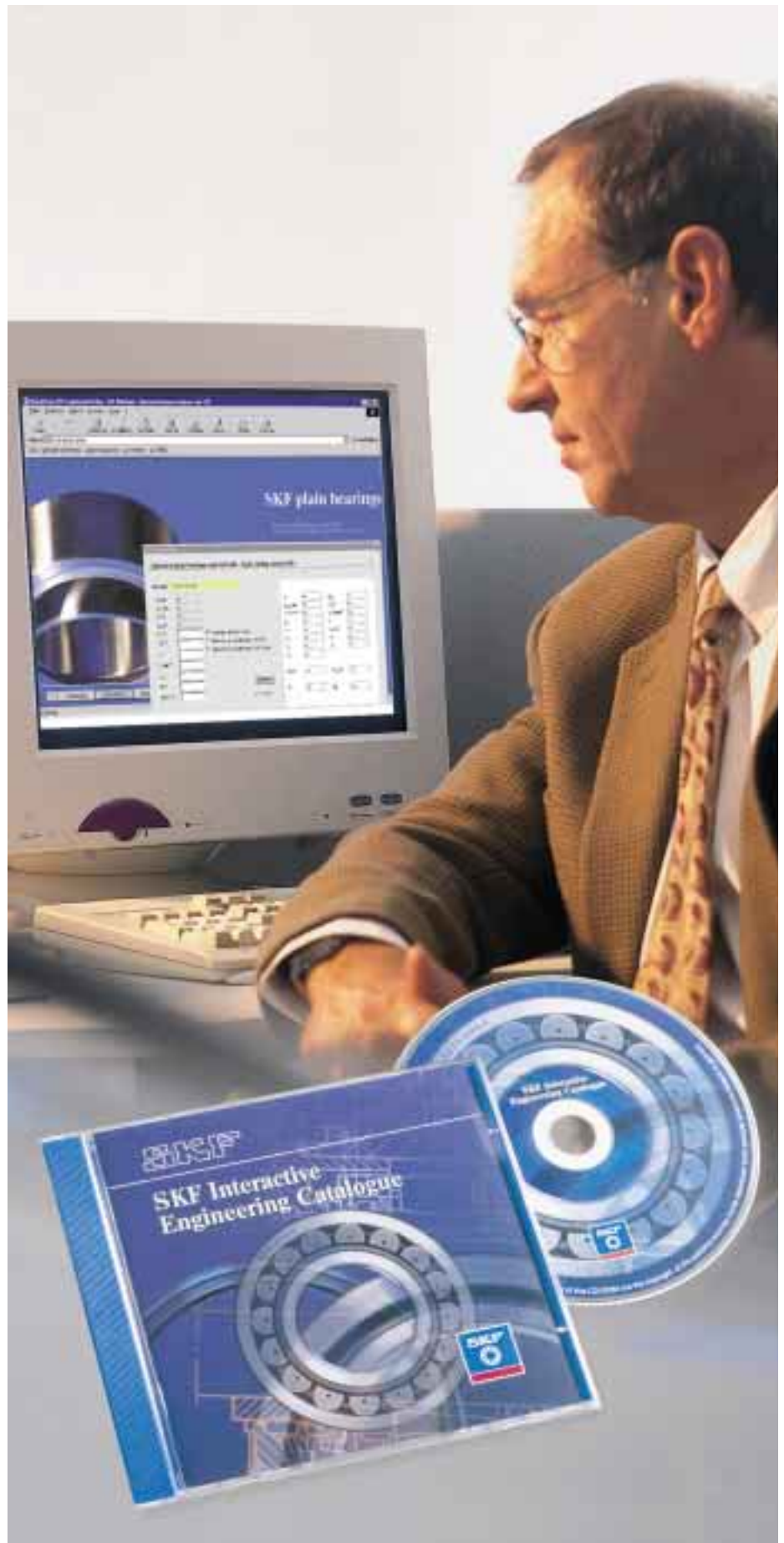
$$\approx 710\text{ operating hours}$$

With $f_\beta = 5,2$ (from Diagram 14, page 25) and $f_H = 3,7$ (from Diagram 15, page 25, for $H = 710/40 \approx 18$) the basic rating service life for regular relubrication ($N = 40\text{ h}$) becomes

$$G_{hN} = 710 \times 5,2 \times 3,7$$

$$\approx 13\,600\text{ operating hours}$$

Thus the larger rod end meets the service life requirements.



Calculation made easy

The calculations shown here have been programmed and incorporated in the SKF Interactive Engineering Catalogue. This makes the selection of bearing size effortless – just a few clicks of the mouse being all that is required.

Friction

The friction in a spherical plain bearing or rod end is primarily dependent on the sliding contact surface combination, the load and the sliding velocity. Because there are so many influencing factors which are not mutually independent it is not possible to quote exact values for the coefficient of friction. Under laboratory conditions, however, it is possible to record typical developments of the coefficient of friction for different sliding contact surface combinations. The friction during the running-in phase is higher than the value recorded during the subsequent test period. For example, for regularly relubricated steel-on-steel spherical plain bearings when a suitable lubricant containing molybdenum disulphide is used (e.g. the SKF grease LGHB 2). Guideline values for the coefficient of friction μ will be found in **Table 1**. They have been determined in laboratory trials.

The coefficient of friction for the maintenance-free sliding contact surface combinations steel/PTFE fabric and steel/sinter bronze composite decrease with increasing specific load.

At a constant specific load, friction will be reduced to the given minimum value as soon as the transfer of PTFE from the sliding layer to the opposing steel surface has been completed. The friction torque for a spherical plain bearing or rod end can be calculated using

$$M = 0,5 \times 10^{-3} \mu P d_m$$

where

M = friction torque, Nm

μ = coefficient of friction

(→ **Table 1**)

P = equivalent dynamic bearing load, N

d_m = mean bearing diameter, mm, for

$d_m = d_k$ for radial spherical plain bearings

$d_m = 0,9 d_k$ for angular contact spherical plain bearings

$d_m = 0,7 d_k$ for spherical plain thrust bearings

As operation progresses and as a result of negative influences (contamination, inadequate lubrication), even under very light loads, the maximum

values of the coefficient of friction quoted in the table may be approached or even exceeded if conditions are particularly unfavourable. In applications where friction is especially important, therefore, it is recommended that the maximum values of the coefficient of friction be used when determining the required power rating, for security reasons. For all bearings, which are operated under conditions of mixed or dry friction, there may be small differences between adhesive and sliding friction. Operation which is entirely free of stick-slip cannot be achieved. Experience has shown that stick-slip effects occur when the surrounding construction is "soft". In most applications, however, the effects are negligible.

Table 1

Sliding contact surface combination	Coefficient of friction μ	
	min	max
Steel-on-steel	0,08	0,20
Steel-on-bronze	0,10	0,25
Steel/sinter bronze composite	0,05	0,25
Steel/PTFE fabric	0,03	0,15
Steel/PTFE composite	0,05	0,20

Coefficients of friction for different sliding contact surface combinations (guideline values)

Application of bearings

Radial location of bearings

The inner and outer rings of spherical plain bearings must be radially secured (located) to the shaft and in the housing so that the sliding movements take place, as intended, in the bearing. Otherwise the rings may begin to creep or wander in or on their seatings in the circumferential direction under load.

Successful radial location is only usually achieved by using fits with sufficient interference. However, an interference fit cannot always be applied, e.g. if easy mounting and dismounting are desired, or if the bearing must be able to be displaced axially without restraint.

The appropriate fits are always determined by the operating conditions.

1. Type and magnitude of the load

The degree of interference must always suit the type and magnitude of the load, i.e. the heavier the load, and the higher the shock content, the heavier the interference required (→ **fig 1**).

- Under heavy loads, spherical plain bearings will deform elastically which may lead to a loosening of the fit and creeping of the ring on/in its seating.
- The strength of the associated components must be adequate to take up the loads and fully support the bearing.
- If the associated components deform, there is a risk that hardened bearing rings will break.
- Steel-on-steel spherical plain bearings require tighter fits than the maintenance-free bearings which have lower friction.

2. Bearing internal clearance

An interference fit will cause the

- inner ring to expand elastically, and the
- outer ring to be compressed elastically.

This reduces the original internal clearance in the bearing to the so-called operating clearance (→ **fig 2**). The clearance also depends on load and temperature.

The original internal clearance differs depending on the type and size of the bearing and has been selected so that if the recommended tolerances for the shaft and housing seatings are applied, an appropriate operational clearance (or preload) will be left in the bearing under normal operating conditions.

If interference fits are used for both bearing rings, or if the temperature conditions are unusual, it may be necessary to use a larger initial internal clearance than "Normal" for steel-on-steel bearings.

Relationship between load and requisite interference

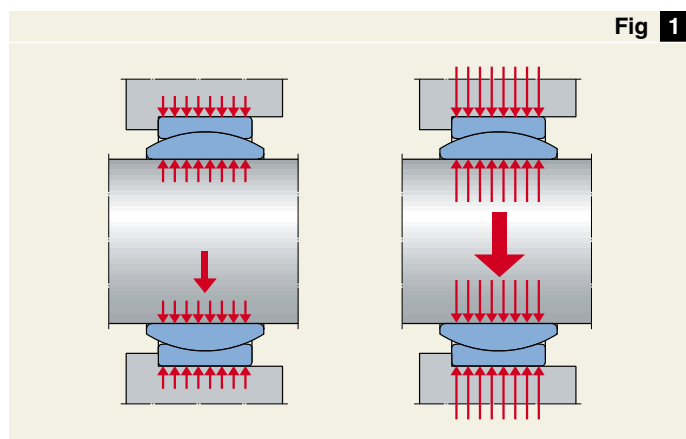


Fig 1

Operating clearance

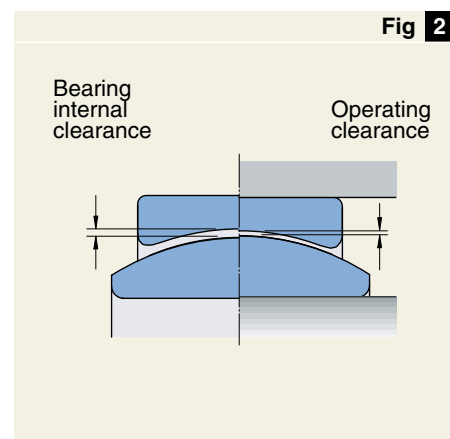


Fig 2

3. Temperature conditions

In operation, the bearings rings will normally have a higher temperature than their seatings. This means that

- the fit of the inner ring will loosen (→ fig 3) and
- the fit of the outer ring will become tighter, which may restrict any required axial displacement in the housing.

If there is a considerable temperature difference between inner and outer rings there will be a change in the operating clearance which must be considered when selecting the fits, so that a blockage of the bearing can be avoided.

4. Design of associated components

The design of the components providing the bearing seatings should not lead to irregular deformation (out-of-round) of the bearing (→ fig 4).

- Split housings are not suitable for interference fits.
- Thin-walled housings, light alloy housings and hollow shafts all call for a tighter fit to be used than for thick-walled steel or cast iron housings and solid shafts – and must have sufficient strength.
- Heavy loads and interference fits call for thick-walled one-piece steel or cast iron housings and solid steel shafts.

5. Axial displacement of non-locating bearings

A non-locating bearing, which is to provide radial support only, must always be able to be displaced axially (→ fig 5). This is normally achieved by selecting a loose fit for one of the bearing rings, generally the inner ring of spherical plain bearings. The reasons are

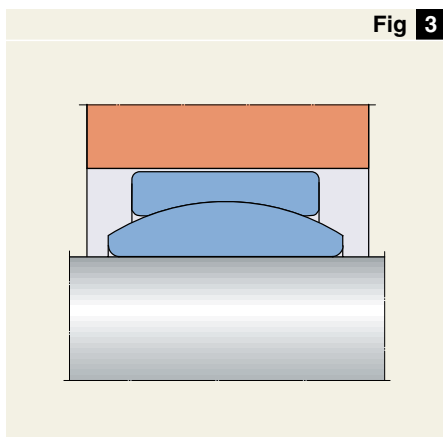
- the shaft seating can be easily and economically hardened and ground; this facilitates axial displacement. The hardness should be at least 50 HRC and the surface roughness R_z should be $\leq 10 \mu\text{m}$.
- the outer rings of most spherical plain bearings are axially fractured at one or two positions, or are radially split. This can hinder axial displacement or make it completely impossible.
- the housing bore should be protected against wear.

Surface finish of seatings

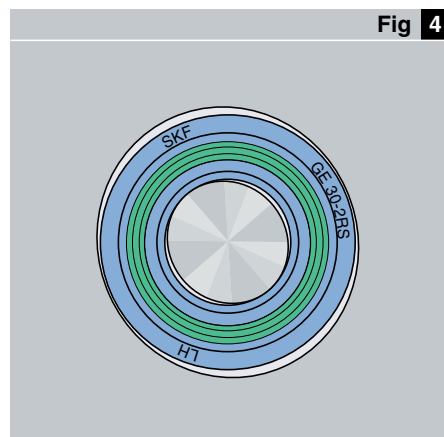
The recommended surface roughness to ISO 4288:1996 for the bearing seatings is

- for shaft seatings
 $R_z \leq 10 \mu\text{m}$
- for housing bore seatings
 $R_z \leq 16 \mu\text{m}$

Change of fit with temperature



Out-of-round bearing seating



Axial displacement

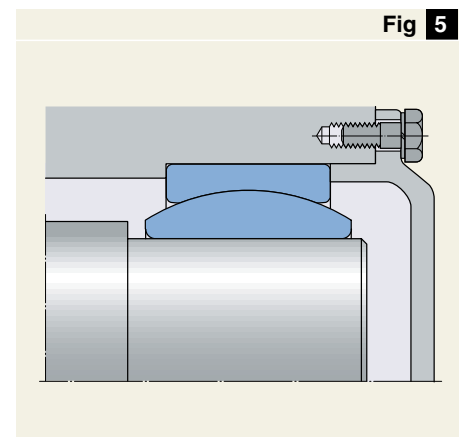


Table 1

Operating conditions	Tolerance Sliding contact surface steel-on-steel combination maintenance-free	
Radial bearings Loads of all kinds interference fit	m6 (n6) ¹⁾	k6
Loads of all kinds clearance or transition fit	h6 (hardened shaft)	h6 oder g6 (hardened shaft)
Angular contact bearings Loads of all kinds interference fit	m6 (n6)	m6
Thrust bearings Loads of all kinds interference fit	m6 (n6)	m6

The tolerances given in brackets may be chosen for very heavily loaded bearings. If chosen, it is necessary to check that the residual operating clearance is sufficient for correct performance of the bearing or whether a bearing with larger clearance must be used

¹⁾ These recommendations do not apply to bearings of series GEG which have a bore diameter tolerance to H7 and are normally mounted on shaft seatings machined to m7. If, for mounting reasons the shaft is machined to tolerance f7, it should be hardened as relative movements of the shaft with respect to the bearing bore will take place and wear may result

Shaft fits

Housing fits

Table 2

Operating conditions	Tolerance Sliding contact surface steel-on-steel combination maintenance-free	
Radial bearings Light loads, axial displacement required	H7	H7
Heavy loads	M7 (N7)	K7
Light alloy housings	N7	M7
Angular contact bearings Loads of all kinds, interference fit	M7 (N7)	M7
Loads of all kinds, can generally be displaced axially	J7	J7
Thrust bearings Purely axial loads Combined loads	H11 J7	H11 J7

The tolerances given in brackets may be chosen for very heavily loaded bearings. If chosen, it is necessary to check that the residual operating clearance of radial bearings is sufficient for correct performance of the bearing or whether a bearing with larger clearance must be used

Recommended fits

Only a limited number of ISO tolerance grades are appropriate to spherical plain bearings. Fig 6 shows schematically the relative positions of these in relation to the bore and outside diameters of the bearings. The recommended tolerances for

- the shaft seating are given in Table 1, and
- the housing bore in Table 2.

These recommendations are based on the considerations described above and have been confirmed in a wide variety of bearing applications.

The ISO tolerance limits are given in

- Table 3 for shafts, and
- Table 4 for housing bores.

To facilitate the calculation of the minimum and maximum values of the theoretical interference or clearance, the standardised bearing bore diameter deviations (Δ_{dmp}) and the bearing outside diameter deviations (Δ_{Dmp}) are given in the tables.

ISO shaft and housing tolerances

Fig 6

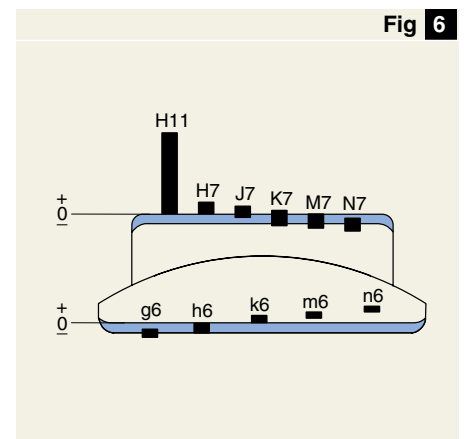


Table 3

Shaft Diameter		Bearing Bore diameter Δ_{dmp}		Shaft diameter tolerances									
Nominal over	incl.	min	max	g6 Deviations		h6		k6		m6		n6	
				high	low	high	low	high	low	high	low	high	low
mm		μm		μm									
3	6	-8	0	-4	-12	0	-8	+9	+1	+12	+4	+16	+8
6	10	-8	0	-5	-14	0	-9	+10	+1	+15	+6	+19	+10
10	18	-8	0	-6	-17	0	-11	+12	+1	+18	+7	+23	+12
18	30	-10	0	-7	-20	0	-13	+15	+2	+21	+8	+28	+15
30	50	-12	0	-9	-25	0	-16	+18	+2	+25	+9	+33	+17
50	80	-15	0	-10	-29	0	-19	+21	+2	+30	+11	+39	+20
80	120	-20	0	-12	-34	0	-22	+25	+3	+35	+13	+45	+23
120	180	-25	0	-14	-39	0	-25	+28	+3	+40	+15	+52	+27
180	250	-30	0	-15	-44	0	-29	+33	+4	+46	+17	+60	+31
250	315	-35	0	-17	-49	0	-32	+36	+4	+52	+20	+66	+34
315	400	-40	0	-18	-54	0	-36	+40	+4	+57	+21	+73	+37
400	500	-45	0	-20	-60	0	-40	+45	+5	+63	+23	+80	+40
500	630	-50	0	-22	-66	0	-44	+44	0	+70	+26	+88	+44
630	800	-75	0	-24	-74	0	-50	+50	0	+80	+30	+100	+50
800	1 000	-100	0	-26	-82	0	-56	+56	0	+90	+34	+112	+56
1 000	1 250	-125	0	-28	-94	0	-66	+66	0	+106	+40	+132	+66

ISO shaft limits

ISO housing limits

Table 4

Housing Bore diameter		Bearing Outside diameter Δ_{Dmp}		Housing bore tolerances											
Nominal over	incl.	max	min	H11 Deviations		H7		J7		K7		M7		N7	
				min	low	min	low	min	low	min	low	min	low	min	low
mm		μm		μm											
10	18	0	-8	0	+110	0	+18	-8	+10	-12	+6	-18	0	-23	-5
18	30	0	-9	0	+130	0	+21	-9	+12	-15	+6	-21	0	-28	-7
30	50	0	-11	0	+160	0	+25	-11	+14	-18	+7	-25	0	-33	-8
50	80	0	-13	0	+190	0	+30	-12	+18	-21	+9	-30	0	-39	-9
80	120	0	-15	0	+220	0	+35	-13	+22	-25	+10	-35	0	-45	-10
120	150	0	-18	0	+250	0	+40	-14	+26	-28	+12	-40	0	-52	-12
150	180	0	-25	0	+250	0	+40	-14	+26	-28	+12	-40	0	-52	-12
180	250	0	-30	0	+290	0	+46	-16	+30	-33	+13	-46	0	-60	-14
250	315	0	-35	0	+320	0	+52	-16	+36	-36	+16	-52	0	-66	-14
315	400	0	-40	0	+360	0	+57	-18	+39	-40	+17	-57	0	-73	-16
400	500	0	-45	0	+400	0	+63	-20	+43	-45	+18	-63	0	-80	-17
500	630	0	-50	0	+440	0	+70	-	-	-70	0	-96	-26	-114	-44
630	800	0	-75	0	+500	0	+80	-	-	-80	0	-110	-30	-130	-50
800	1 000	0	-100	0	+560	0	+90	-	-	-90	0	-124	-34	-146	-56
1 000	1 250	0	-125	0	+660	0	+105	-	-	-105	0	-145	-40	-171	-66
1 250	1 600	0	-160	0	+780	0	+125	-	-	-125	0	-173	-48	-203	-78
1 600	2 000	0	-200	0	+920	0	+150	-	-	-150	0	-208	-58	-242	-92

Axial location of bearings

An interference fit is not sufficient to axially locate a bearing ring. Normally a suitable axial securement is required.

The bearing rings of a locating bearing should be axially located at both sides. The bearing rings generally have an interference fit and are usually supported at one side by a shaft or housing shoulder. Inner rings are axially secured at the side opposite the shoulder by

- a plate screwed to the shaft end (→ **fig 7**), or
- a spacer sleeve between the ring and a neighbouring machine component (→ **fig 8**).

Outer rings are generally retained by the cover of the housing bore (→ **fig 7**).

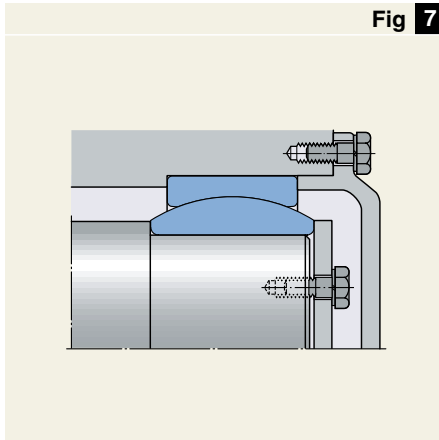
For non-locating bearings the outer ring (which normally has a tight fit) should be axially located; the inner ring must be free to move axially on the shaft (→ **fig 5**, page 37).

It should be observed that with bearings of series GEP (→ **fig 9**), which have a radially split outer ring, expansion forces will be produced under purely radial load; the axial components of these forces will act on the housing cover. The axial load acting on the cover may be as much as 30 % of the radial load. This must be taken into account when dimensioning the housing cover and selecting the size and number of the attachment screws.

If shaft and/or housing shoulders are undesirable because of manufacturing or assembly considerations, spacer sleeves or rings can be inserted between the bearing ring which is to be located and an adjacent machine component (→ **fig 10** and **11**).

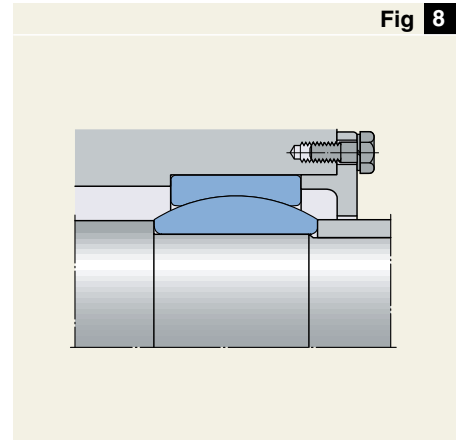
The axial location of non-separable bearings using retaining rings (→ **fig 10** and **11**) saves space and permits quick mounting and dismounting, as well as simplifying the machining of seatings. If larger axial forces have to be accommodated, a support ring (→ **fig 11**) should be arranged between the bearing ring and the retaining ring, so that the retaining ring is not subjected to excessive bending moments.

Fig 7



Using an end plate and cover to locate a bearing

Fig 8

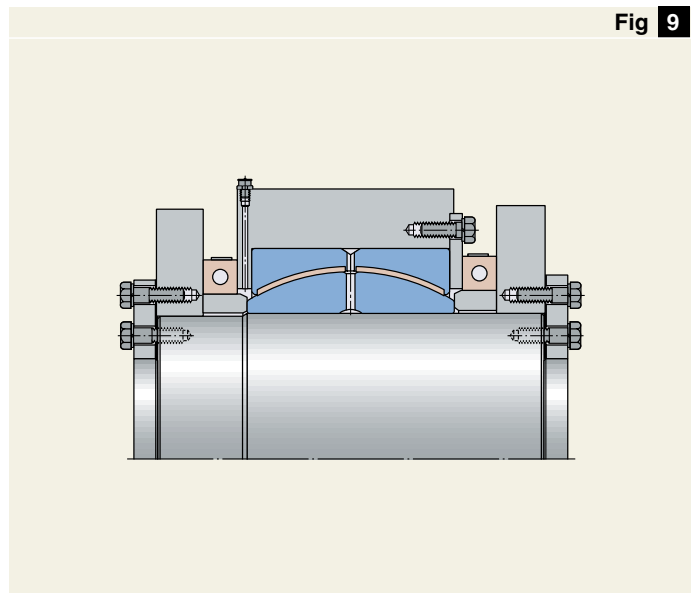


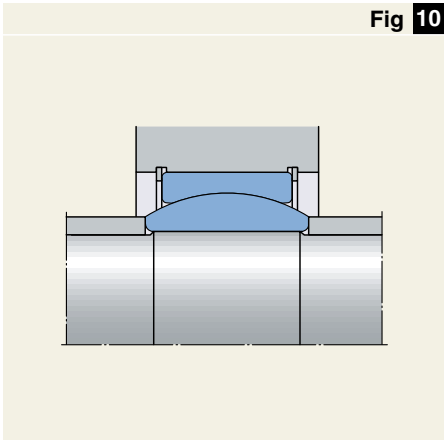
Using a spacer sleeve and cover to locate a bearing

For bearing location, the retaining rings used usually have constant radial width (also known as snap rings) to DIN 471:1981 or DIN 472:1981.

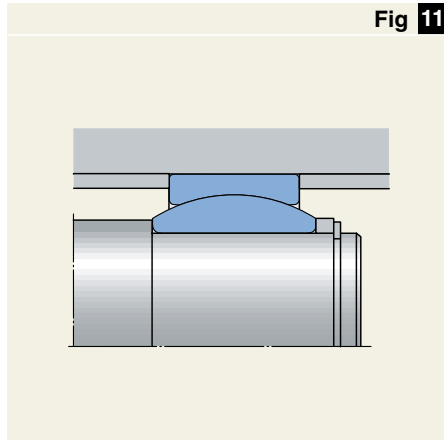
Locating a radially split bearing

Fig 9





Locating a bearing using snap rings in the housing and adjacent components on the shaft



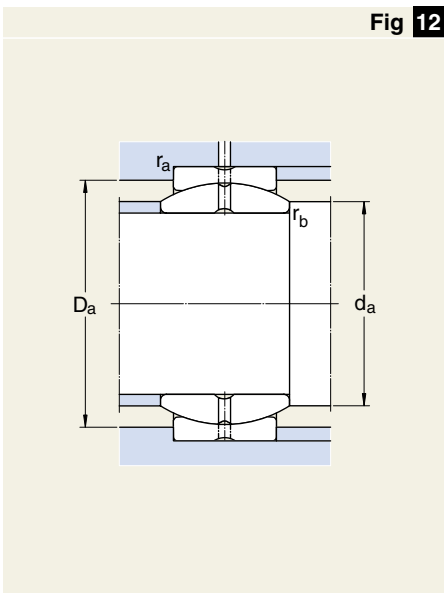
Locating a bearing using adjacent components in the housing

Abutment and fillet dimensions
The abutment and fillet dimensions should be such that

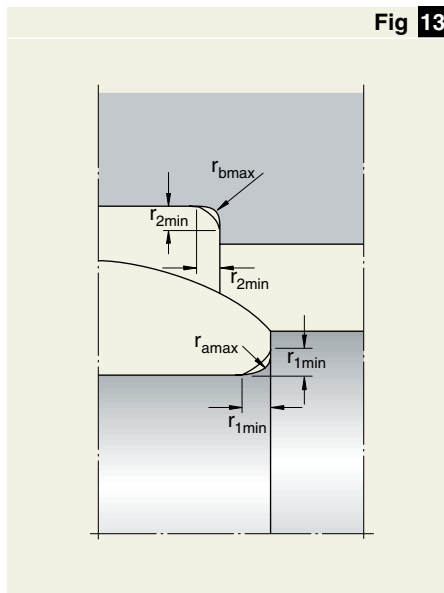
- a sufficiently large support surface is available for the bearing ring,
- moving parts of the bearing arrangement cannot foul stationary components, and
- the fillet radius should be smaller than the chamfer of the bearing.

Appropriate abutment dimensions (→ fig 12) are given for each bearing in the product tables. The transition from the bearing seating to the shaft or housing shoulder may be designed either as a fillet (→ fig 13) or an undercut (→ fig 14).

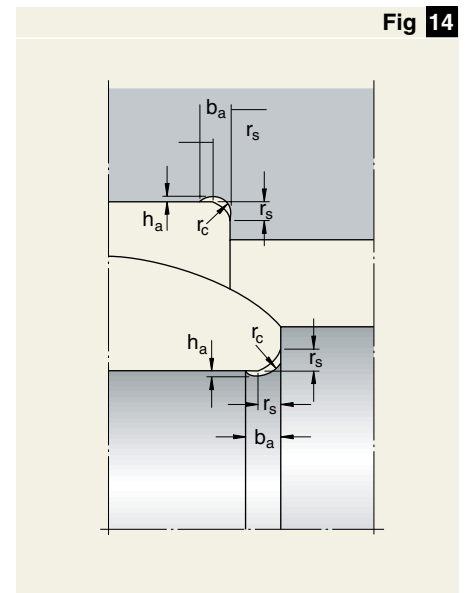
Recommended abutment and fillet dimensions



Fillet dimensions for shaft and housing shoulders



Undercut dimensions for shaft and housing shoulders



Fillets

Suitable dimensions for the fillet are given in the product tables and for the undercut in **Table 5**. The stress conditions in a stepped shaft are more favourable, the larger the fillet (rounding) of the transition to the shaft shoulder.

Rod ends

The inner rings of rod ends can, in the same way as bearings, be axially located by a shaft shoulder, a nut or a retaining ring.

Rod ends mounted on threaded rods or in extension tubes should be prevented from coming loose by an extra nut on the rod or the external thread of the rod end shank. The nut should be securely tightened against the support surface on the rod end housing or on the tube (→ **fig 15**).

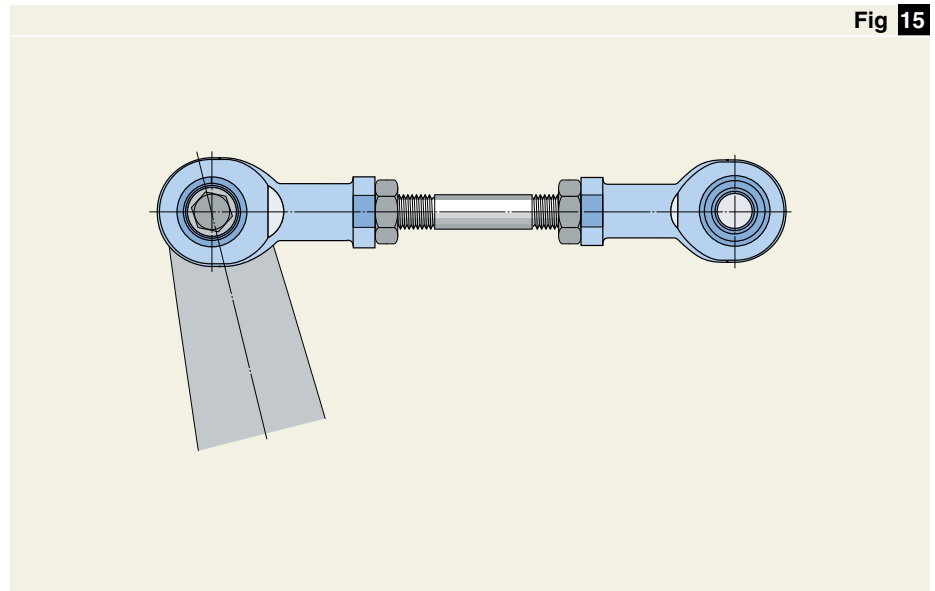
Relieved fillets

Table 5

Chamfer dimensions r_1, r_2 min	Fillet dimensions		
	b_a	h_a	r_c
mm	mm		
1	2	0,2	1,3
1,1	2,4	0,3	1,5
1,5	3,2	0,4	2
2	4	0,5	2,5
2,5	4	0,5	2,5
3	4,7	0,5	3
4	5,9	0,5	4
5	7,4	0,6	5
6	8,6	0,6	6
7,5	10	0,6	7

Attachment of rod ends

Fig 15



Sealing

Most bearing arrangements must be sealed to prevent external contamination and damp from entering the bearing. The efficiency of the sealing has a decisive influence on the service life of the bearing. In contrast to most other types of bearing, which only move in one plane, the alignment capabilities of the spherical plain bearings place extra demands on the sealing.

When selecting appropriate seals, many factors have to be considered including

- the permissible angle of tilt,
- the available space,
- the environmental conditions,
- the efficiency of the seal,
- the type of lubrication and the frequency of relubrication, and
- the justifiable cost.

Depending on the application, one or other of the above factors will outweigh the others. It is therefore not possible to establish general rules for sealing design. **Table 6**, pages 44 and 45, gives an overview of the possible seals, their design characteristics and suitability to meet different demands.

NB.

More detailed information concerning the radial shaft seals, V-ring seals and mechanical seals referred to in the table will be found in the SKF catalogue 4006 "CR seals" or the "SKF Interactive Engineering Catalogue" available as a CD-ROM or online under www.skf.com.

Sealing strips can also be supplied by SKF in felt (FS strips) or, for high temperatures, in aluminium-boron silicate material (FSB strips).



Table 6

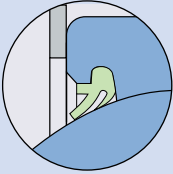

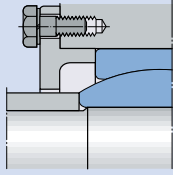
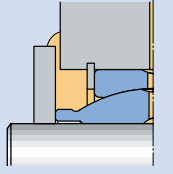
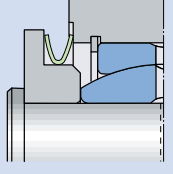
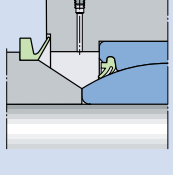
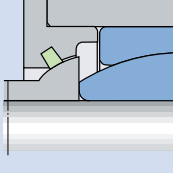
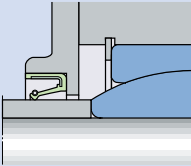
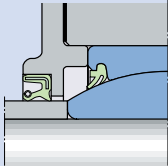
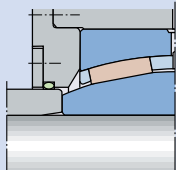
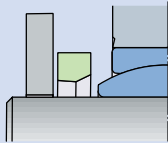
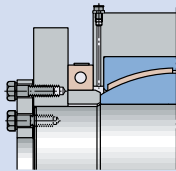
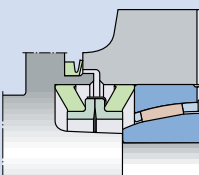
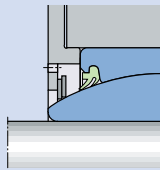
Seal	Illustration	Design characteristics	Suitability
Integral RS design		Double-lip rubbing seal of polyurethane (–20 to +80 °C) or polyelastomer (–30 to +130 °C)	<ul style="list-style-type: none"> ✓ for compact bearing arrangements, mainly indoors ✓ for cramped spaces ✓ for high sealing demands when combined with an outboard seal ✓ for long service life with minimum maintenance ✓ for bearings which are to rotate
Integral heavy duty LS design (to order)		Triple-lip rubbing seal of elastomer with steel backing (–25 to +120 °C)	<ul style="list-style-type: none"> ✓ for compact bearing arrangements ✓ for high sealing demands ✓ for long service life with minimum maintenance ✓ for rotating bearing arrangements ✓ for difficult operating conditions in the presence of sand or mud
Gap type		Simple and economic, no wear, simple mounting	<ul style="list-style-type: none"> ✓ for maintenance-free bearings ✓ for small angles of tilt ✓ for high temperatures ✓ for moderately dusty environments ✓ for bearings which are to rotate
Gap type with grease		Simple and efficient with periodic relubrication May pollute environment	<ul style="list-style-type: none"> ✓ for maintenance-free bearings and rod ends ✓ for small angles of tilt ✓ for rough conditions in the presence of sand, clay, slush etc.
V-shaped (commercially available)		Simple, lightly preloaded seal of polyurethane (–40 to +100 °C) Good wear strength and resistance to grease, oil and other environmental influences	<ul style="list-style-type: none"> ✓ for contaminant exclusion ✓ for angles of tilt up to 2° ✓ for bearing arrangements with shafts up to 300 mm diameter ✓ for bearings which are to rotate
V-Ring (commercially available)		Elastic seal which sits on shaft and rotates with it, axial sealing lip of nitrile rubber (–40 to +100 °C) or fluoro rubber (–40 to +200 °C) Good wear and chemical resistance	<ul style="list-style-type: none"> ✓ for contaminant exclusion ✓ for maintenance-free and grease-lubricated bearings ✓ for all shaft diameters ✓ for angles of tilt between 2 and 4° depending on size ✓ for bearings which are to rotate
Felt (commercially available)		Simple to install, good resistance to grease (–40 to +100 °C)	<ul style="list-style-type: none"> ✓ for dust and minor damp exclusion ✓ for grease retention ✓ for large angles of tilt ✓ for all sizes of bearing ✓ for bearings which are to rotate

Table 6

Seal	Illustration	Design characteristics	Suitability
Radial shaft (commercially available)		Steel reinforced (either externally or internally) elastomer with lip of nitrile rubber (-40 to +100 °C) or fluoro rubber (-40 to +200 °C) Good wear resistance, good resistance to grease, oil and other environmental influences	<ul style="list-style-type: none"> ✓ for contaminant exclusion ✓ for grease retention ✓ for oil retention ✓ for small angles of tilt ✓ for all sizes of bearing ✓ for bearings which are to rotate
Radial shaft with dust lip (commercially available)		Steel reinforced (either externally or internally) elastomer with lips of nitrile rubber (-40 to +100 °C) or fluoro rubber (-40 to +200 °C) Good wear resistance, good resistance to grease, oil and other environmental influences	<ul style="list-style-type: none"> ✓ for strong contaminant exclusion ✓ for oil retention ✓ for small angles of tilt ✓ for bearings up to approx. 300 mm bore ✓ for bearings which are to rotate
O-ring (commercially available)		Nitrile rubber (-30 to +100 °C) or fluoro rubber (-20 to +200 °C)	<ul style="list-style-type: none"> ✓ for reliable moisture exclusion ✓ for oil and grease retention ✓ for very small angles of tilt ✓ for slow oscillating movements
Profiled rubber (commercially available)		Polyurethane (-40 to +100 °C) Good wear resistance, good resistance to grease, oil and other environmental influences	<ul style="list-style-type: none"> ✓ for hermetically sealed bearing arrangements ✓ for small angles of tilt ✓ for slow oscillating movements; initial oiling or greasing of faces reduces friction
Profiled rubber with clamp and lock (commercially available)		Elastomer strip (-40 to +100 °C) Good wear resistance, good resistance to grease, oil and other environmental influences	<ul style="list-style-type: none"> ✓ for hermetically sealed bearing arrangements ✓ for slow oscillating movements; initial oiling or greasing of faces reduces friction ✓ for small angles of tilt
Mechanical seals (commercially available)		Stainless steel rings and cup springs of nitrile rubber (-40 to +100 °C) Good wear resistance, good resistance to grease, oil and other environmental influences	<ul style="list-style-type: none"> ✓ for contaminant exclusion ✓ for oil and grease retention ✓ for small angles of tilt ✓ for bearings which are to rotate
Spring steel washers (commercially available)		Labyrinth seals of sets of washers for high temperatures. Excellent wear resistance, good chemical resistance	<ul style="list-style-type: none"> ✓ for contaminant exclusion ✓ grease exit vents needed in housing cover if grease used ✓ for small angles of tilt ✓ for bearings which are to rotate

Designing the bearing arrangement for easy mounting and dismounting

To ease mounting, the shaft ends and housing bores should have a lead-in with an angle of between 10 and 20° (→ fig 16). This not only eases mounting but reduces the risk of damaging the mating surfaces by skewing of the bearing rings.

Particularly where large bearing arrangements are concerned, it is necessary to design the arrangement so that bearing mounting, and especially dismounting, are simplified or even made possible.

To facilitate subsequent removal of a bearing, it can be advantageous to

- * provide recesses in the shaft shoulder (→ fig 17), and
- * recesses or threaded holes in the housing bore (→ fig 18)

so that withdrawal tools can be used without difficulty.

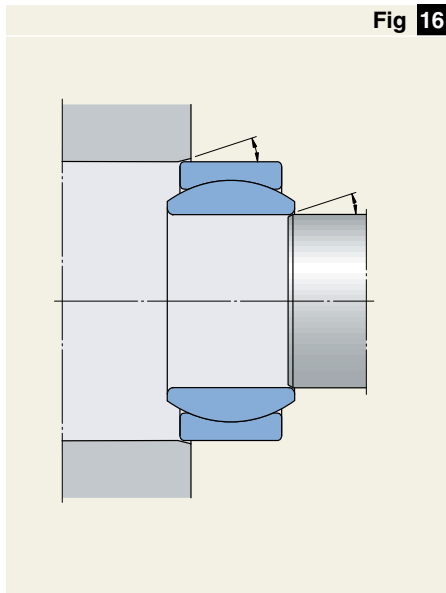
To dismount maintenance-free bearings having a bore diameter of some 80 mm and above, it is recommended that the oil injection method be used. This involves introducing oil under high pressure between the bearing inner ring and its shaft seating. This greatly reduces the force required to dismount the bearing and practically eliminates

any risk of damaging the bearing and seating.

In order to employ the oil injection method it is necessary to provide an oil supply duct in the shaft as well as an oil distributor groove in the seating (→ fig 19). The distance between this groove and the bearing side from which mounting and dismounting are to be performed should be approximately one third of the seating width. Recommended dimensions for the ducts and grooves as well as for the threads for the oil supply connection are given in **Tables 7** and **8**.

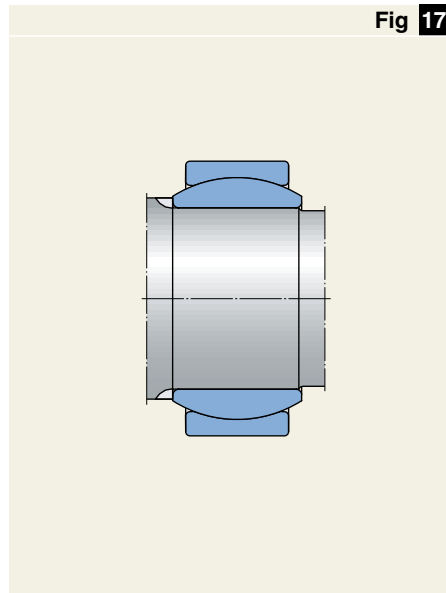
Chamfering shaft ends and housing bore entrances

Fig 16



Shaft shoulder with recess

Fig 17



Housing shoulder with threaded holes

Fig 18

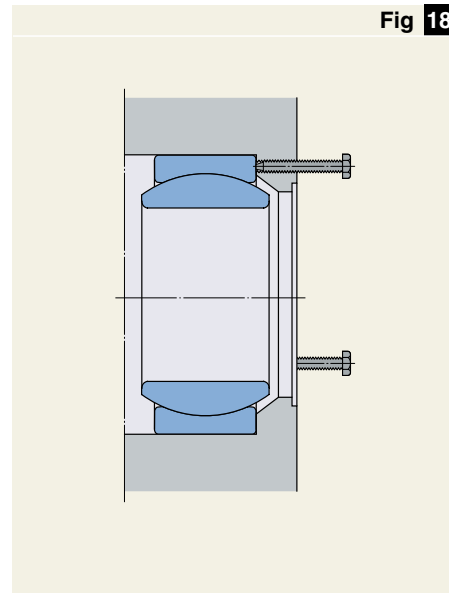
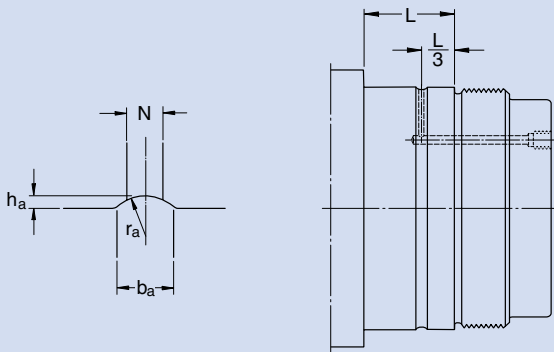


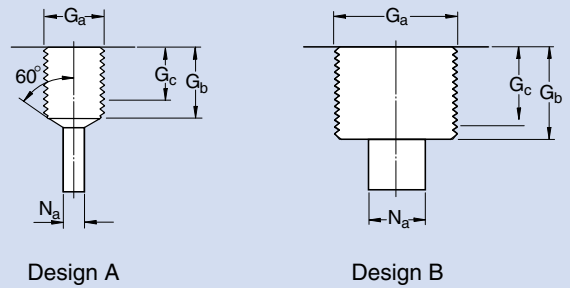
Table 7



Bearing seating diameter over incl.		Dimensions			
		b_a	h_a	r_a	N
mm		mm			
100	100	3	0,5	2,5	2,5
150	150	4	0,8	3	3
150	200	4	0,8	3	3
200	250	5	1	4	4
250	300	5	1	4	4
300	400	6	1,25	4,5	5
400	500	7	1,5	5	5
500	650	8	1,5	6	6
650	800	10	2	7	7
800	1 000	12	2,5	8	8

Oil ducts and distributor grooves

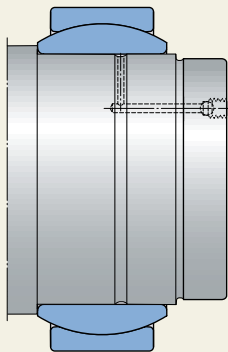
Table 8



Thread	Design	Dimensions		
		G_b	$G_c^{1)}$	$N_{a \max}$
mm		mm		
M6	A	10	8	3
R 1/8	A	12	10	3
R 1/4	A	15	12	5
R 3/8	B	15	12	8
R 1/2	B	18	14	8
R 3/4	B	20	16	8

Threaded holes for connection

Fig 19



Bearing seating with oil ducts and distributor grooves for easy dismantling

Lubrication

Spherical plain bearings requiring maintenance

Steel-on-steel spherical plain bearings must be maintained and lubricated to

- reduce friction,
- reduce wear,
- extend bearing life,
- protect against corrosion and
- prevent contamination by dirt or moisture.

The sliding contact surfaces are phosphated and treated with a “running-in” lubricant. This special surface treatment has a favourable influence on the running-in phase. In order to obtain the desired service life the bearings must be greased at the very latest before being taken into operation and must then be regularly relubricated.

It is therefore necessary when designing the bearing arrangement to ensure that it is possible to provide the bearing with an adequate supply of grease. This can be done by providing ducts in the housing and a grease nipple (→ fig 1) or in the shaft or pin

(→ fig 2) so that grease can be directly supplied to the bearing. To facilitate efficient lubrication in service, all SKF steel-on-steel spherical plain bearings (with the exception of the smallest bearings of the E and ESA designs) have an annular groove and lubrication holes in both inner and outer rings.

If the arrangement is appropriately designed, the bearing can be supplied with grease from the side. To compel grease to pass through the bearing it is necessary to prevent the grease from exiting the bearing arrangement from the same side as it is supplied and to provide a grease exit opening at the opposite side (→ fig 3). Where possible, the free space surrounding the bearing should be filled with grease.

It is recommended that the SKF grease LGHB 2 be used to lubricate steel-on-steel spherical plain bearings. This is a high-quality calcium sulpho-nate base grease. Its properties include

- excellent load carrying capacity,
- very good rust inhibition,
- very good resistance to ageing,

- good water resistance, and
- a wide operating temperature range of –20 to +150 °C.

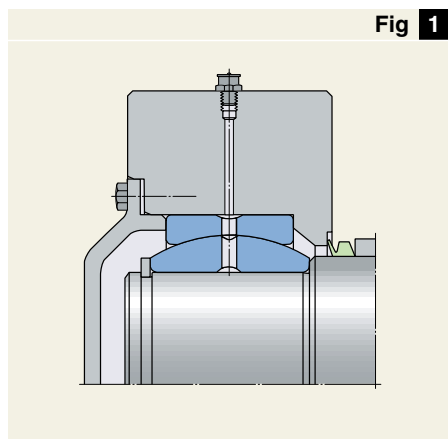
If operating temperatures are higher than this special grease should be used instead, and the SKF application engineering service should be contacted. More information on SKF greases will be found in **Table 1**.

Maintenance-free spherical plain bearings

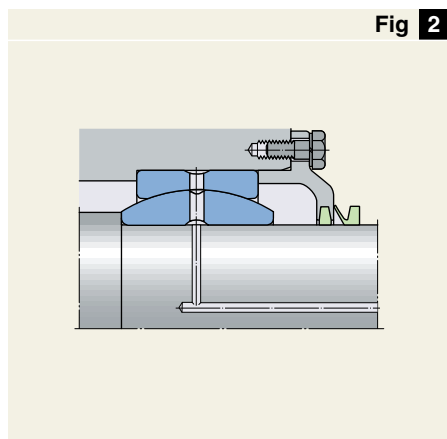
Sliding contact surface combinations steel/sinter bronze composite and steel/PTFE fabric

During the first period of operation of these bearings, a transfer of PTFE takes place from the dry sliding contact surface to the opposing surface of the inner ring. Any lubrication of the sliding contact surfaces would disturb this transfer and shorten bearing life. Therefore, lubrication of these bearings, or rod ends with the same sliding contact surface combinations, is not

Relubricating the bearing via the outer ring



Relubricating the bearing via the inner ring



Relubricating the bearing from the side

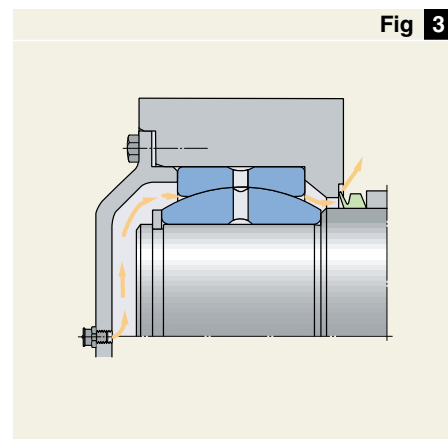


Table 1

Property	SKF greases (designation)			
	LGHB 2 for sliding contact surface combinations steel-on-steel	LGMT 3 steel-on-bronze	LGEP 2 steel/PTFE composite	LGGB 2 ¹⁾
Thickener	Calcium sulphionate complex soap	Lithium soap	Lithium soap	Lithium/calcium soap
Base oil	Mineral oil	Mineral oil	Mineral oil	Ester oil
Colour	Brown	Yellowish brown	Light brown	White
Operating temperature, °C (continuous operation)	-20 to +150	-30 to +120	-20 to +110	-40 to +120
Kinematic viscosity of base oil, mm²/s at +40 °C at +100 °C	400 to 450 26,5	120 to 130 12	200 16	110 13
Consistency (to NLGI Scale)	2	3	2	2

¹⁾ Biologically degradable grease for use in applications where strict ecological demands must be met and where lubrication cannot be dispensed with

Sliding contact surface combination steel/PTFE composite

An initial lubrication followed by occasional relubrication of steel/PTFE composite bearings can extend the service life by a factor of at least 2. The inner rings and shaft washers of such bearings are coated with lithium base grease before leaving the factory.

If operating conditions are such that protection against corrosion and enhanced sealing are required, the free space surrounding the bearing (→ fig 5) should be filled with the same grease as that used for bearing lubrication. The appropriate time to replenish or renew the grease in the bearing arrangement is determined by the operating conditions and the ageing of the grease.

Rust inhibiting, water-repellant lithium base greases of normal consistency should be used, for example, the SKF grease LGEP 2 (→ Table 1). On no account should greases containing molybdenum disulphide or other solid lubricants be used.

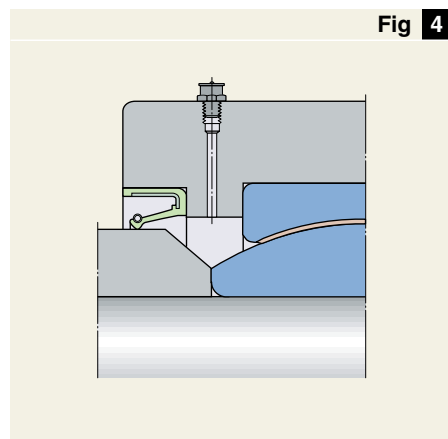
SKF lubricating greases

advisable and they have no relubrication facilities.

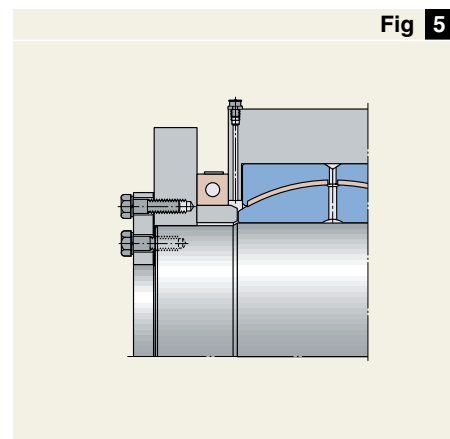
To provide protection against corrosion and to enhance sealing, the free space surrounding the bearing may, however, be filled with grease. If the bearing arrangement is as shown in fig 4 it is possible to introduce grease without the grease reaching the sliding

contact surfaces. Rust inhibiting, water-repellant lithium base greases of normal consistency should be used, for example, the SKF greases LGEP 2 or LGMT 3 (→ Table 1).

Grease supply to free space in the housing surrounding a steel/sinter bronze composite bearing



Grease supply to free space in housing surrounding a large steel/PTFE composite bearing



NB.

SKF spherical plain bearings, depending on their design are either completely or partially coated with an oily preservative or filled with grease. Skin contact should be avoided as these substances may give rise to irritation or allergic reactions.

Rod ends requiring maintenance

Rod ends with the sliding contact surface combinations steel-on-steel and steel-on-bronze require maintenance and must be lubricated. To facilitate this

- all SKF steel-on-steel rod ends can be relubricated via a lubrication hole or grease nipple in the rod end housing as well as via the inner ring (→ **fig 6**) with the exception of the small-sized rod ends of the E and ESA designs;
- all SKF steel-on-bronze rod ends can be relubricated via a lubrication hole or grease nipple in the rod end housing (→ **fig 7**).

The recommendations above for steel-on-steel spherical plain bearings also apply to steel-on-bronze rod ends.

These recommendations also apply to the steel-on-bronze rod ends of the SIKAC .. M and SAKAC .. M series where SKF grease LGMT 3 is recommended. It is, however, also possible to use lithium base greases of normal consistency without solid lubricant additives.

Maintenance-free rod ends

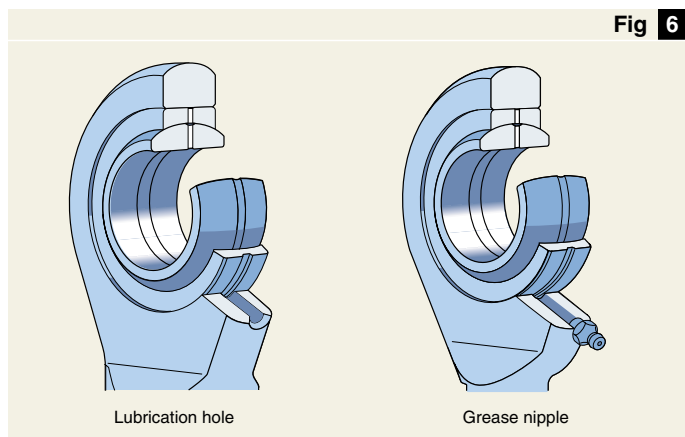
Rod ends with maintenance-free sliding contact surface combinations are generally to be used as dry sliding bearings, i.e. they should not be lubricated; the maintenance-free rod ends are without relubrication facilities.

However, the service life of steel/PTFE composite rod ends can be much extended by an initial application of grease followed by occasional relubrication. The inner ring is already coated with a lithium base grease before leaving the factory.

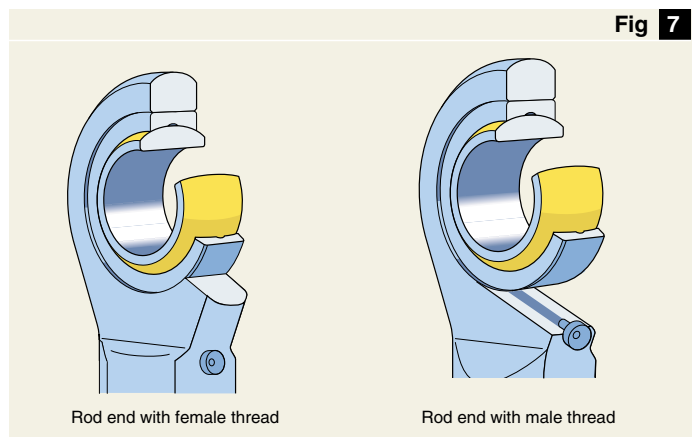
NB.

SKF rod ends, depending on their design are either completely or partially coated with an oily preservative or filled with grease. Skin contact should be avoided as these substances may give rise to irritation or allergic reactions.

Relubrication facilities for steel-on-steel rod ends



Relubrication facilities for steel-on-bronze rod ends



Maintenance

To obtain a long service life with spherical plain bearings and rod ends requiring maintenance, they must be relubricated. Used grease together with wear debris and any contamination should be removed from the contact zone and be replaced by fresh grease.

The relubrication interval should be determined when performing the bearing calculation. The frequency of relubrication is of decisive importance for the attainable service life and depends on many factors including

- the magnitude of the load,
- the type of load,
- the angle of oscillation,
- the frequency of oscillation,
- the operating temperature
- the sealing arrangement and
- other environmental conditions.

Long service lives can be attained when the following relubrication conditions are observed:

- the same grease is used as originally applied;
- the relubrication should be carried out at the operating temperature;
- the bearing should be relubricated before a long interruption in operation occurs, e.g. before construction machinery or agricultural equipment is laid up.

SKF has the correct greases for spherical plain bearings and rod ends, including the biologically degradable grease LGG 2

Relubrication of non-locating bearings

Non-locating bearings, where axial displacement takes place along the shaft or pin, should always be relubricated via the shaft and bearing inner ring (→ fig 2, page 46). By supplying lubricant in this way grease will also enter between the mating surfaces of inner ring and shaft seating. This reduces friction and consequently the axial forces produced when axial displacement takes place.

Storage

SKF spherical plain bearings and rod ends are treated with a preservative before they are packaged. They can, therefore, be stored in their original packages for several years. However, the relative humidity in the storeroom should not exceed 60 %.



Mounting

Spherical plain bearings

Skill and cleanliness when mounting are necessary if spherical plain bearings and rod ends are to perform correctly and not fail prematurely.

The bearings and rod ends should only be taken from their packages immediately before mounting so that they do not become contaminated. Any components which have possibly become dirty as a result of improper handling (damaged packaging etc.) should be wiped using a clean cloth.

The sliding contact surfaces of the bearings are matched to ensure favourable friction and wear characteristics. Any alteration of the sliding surfaces would shorten the service life so that the bearings must not be washed or come into contact with solvents, cleaners, oils or similar media.

The components associated with the bearings (housings, shafts or pins etc.) should be cleaned and any burrs removed. They should also be checked with regard to accuracy of dimensions and form before mounting is started.

Simultaneous mounting in housing and on shaft

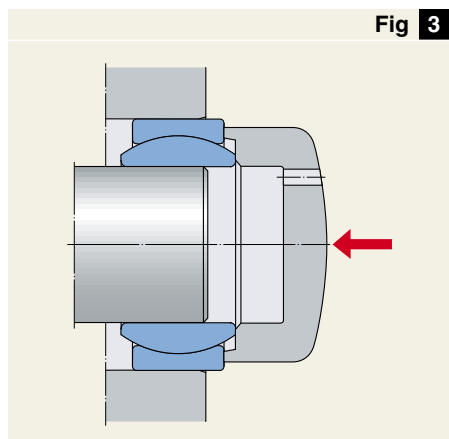


Fig 3

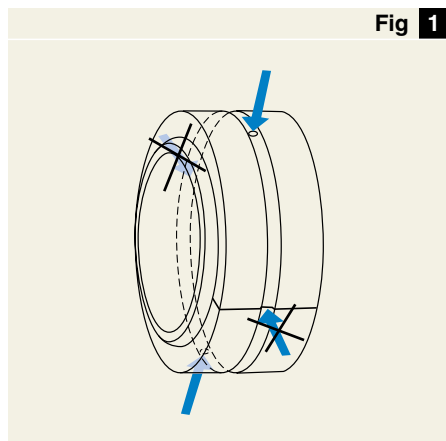


Fig 1

Plane of fracture or split and main direction of load

When mounting spherical plain bearings with a fractured or split outer ring it is essential that the joint be positioned at right angles to the main direction of load (fig 1) as otherwise the service life will be shortened, particularly under heavy loads.

Mounting using a press

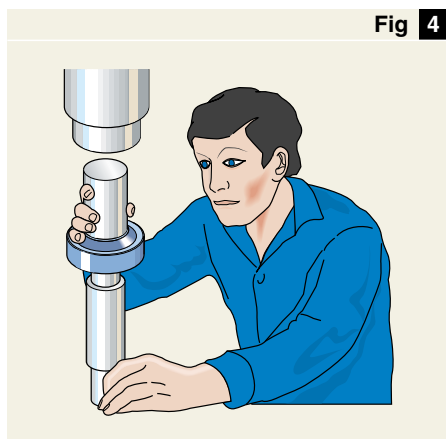


Fig 4

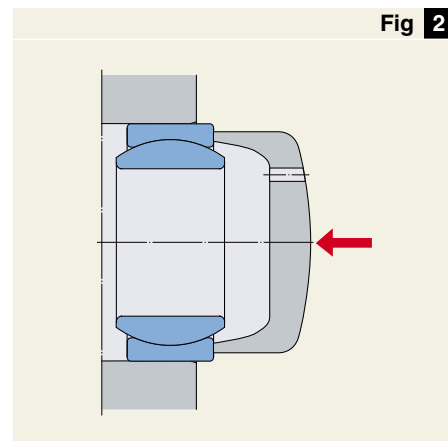


Fig 2

Mounting with the aid of a dolly

Never direct blows at the bearing rings

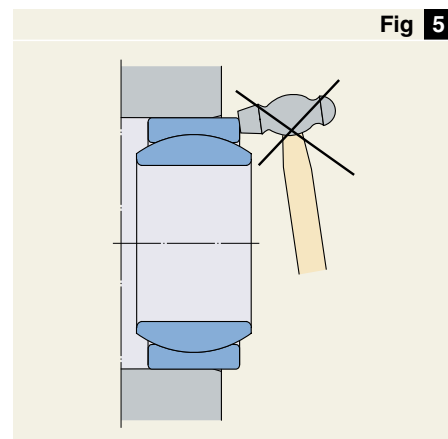


Fig 5

Mechanical mounting

The following tools are suitable for mounting spherical plain bearings

- a mounting dolly (→ fig 2) or length of tubing; the ring having an interference fit should generally be mounted first;
- a dolly having two abutment surfaces (→ fig 3) for mounting simultaneously on the shaft and in the housing;
- for larger numbers of bearings, suitable tools can be used in combination with a press (→ fig 4).

When mounting spherical plain bearings,

- on no account should blows be directed at the bearing rings themselves (→ fig 5); the use of a hammer and drift can also easily damage the rings;
- the mounting force should never be directed through the sliding contact surfaces (→ fig 6); this could
 - damage the sliding contact surfaces and/or
 - expand fractured or split bearing outer rings, which would cause an increase in the mounting force required.

Mounting using heat

Larger bearings cannot usually be mounted in the cold state as the force required increases sharply with increasing bearing size. Therefore, the bearing or housing should be heated before mounting (→ fig 7).

The requisite temperature difference between the bearing ring and shaft or housing bore depends on the seating diameter. Generally, a temperature of 60 to 80 °C above ambient is adequate to allow the rings to be easily mounted. The temperature to which a bearing can be heated also depends on the permissible temperature for the bearing which may be limited, for example, by the material of the seals.

NB.

Maintenance-free spherical plain bearings and rod ends having sliding contact surfaces containing PTFE should never be subjected to temperatures in excess of +280 °C. PTFE is completely inert below this temperature but at higher temperatures (from approx. 320 °C) it rapidly decomposes. The fluorine compounds released during this process are extremely toxic, even in small quantities. It should also be remembered that the material is dangerous to handle once it has been overheated even after it has cooled down again.

Never apply the mounting force via the sliding contact surfaces

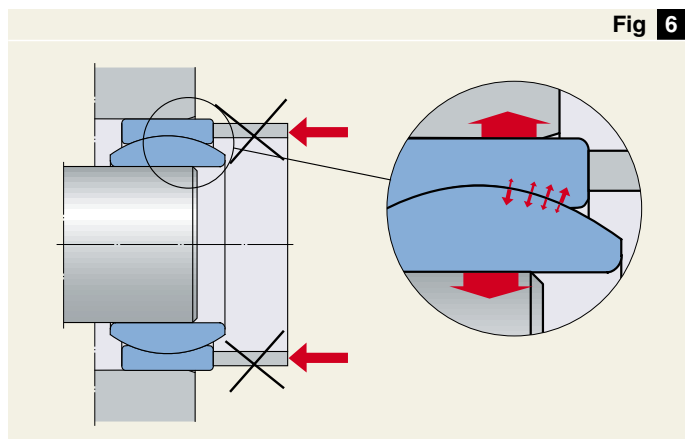


Fig 6

Mounting a heated bearing

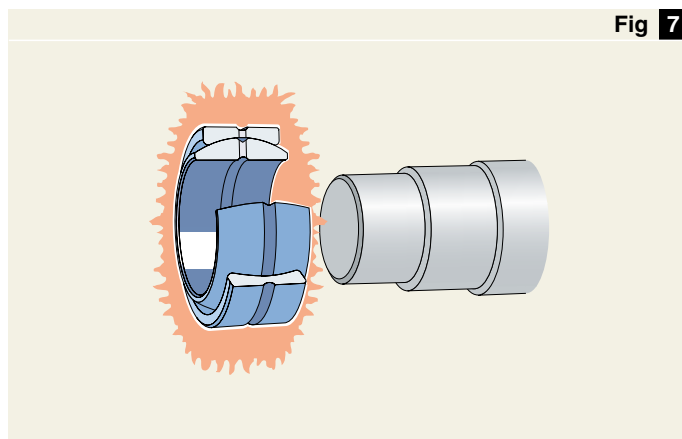


Fig 7

The use of SKF induction heaters has been found particularly beneficial (→ **fig 8**). They are equipped with integral protection against overheating and automatically demagnetise. The induced current flow serves to rapidly heat the bearing. The non-metallic components, such as seals or PTFE fabric remain cold as does the heater itself.

To ease the mounting of large bearings, particularly if they have been heated, it is possible to use slings and a hoist. Metal or textile slings placed around the outer ring can be used (→ **fig 9**). A spring between the hoist hook and the sling also facilitates bearing handling. Heat-resistant gloves should be worn when handling hot components.

Rod ends

Rod ends are fitted on the pins in the same way as spherical plain bearings. Slight heating will reduce the force required for mounting and reduce the danger of damaging associated components.

When attaching rod ends to threaded rods or in extension tubes (→ **fig 10**) a counter lock nut should be used on the rod or on the external thread of the rod end. It should be securely tightened against the abutment surface on the rod end or the tube.

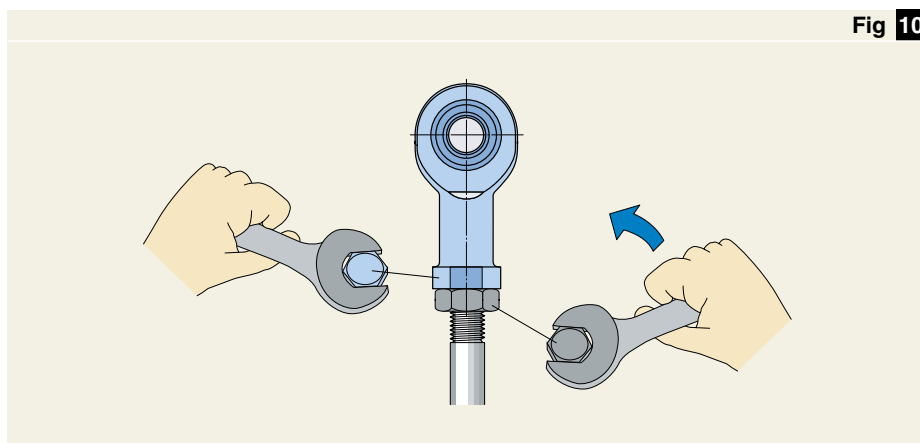


Fig 10

Securing a rod end

A bearing in position on an SKF induction heater

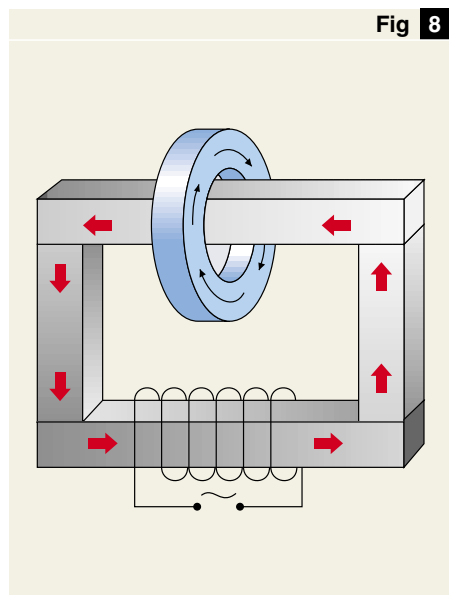


Fig 8

Mounting a large heated bearing

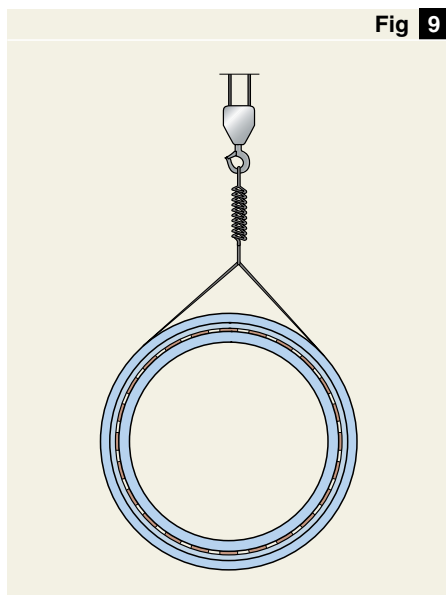


Fig 9

SKF has a comprehensive range of mechanical and hydraulic tools as well as heating equipment for bearing mounting and dismantling. Full details will be found in the SKF catalogue MP201 "SKF Tools, Measuring Equipment and Lubricants".

Dismounting

Spherical plain bearings

If the bearings are to be re-used after dismounting, the same care and attention are required as when mounting. The requisite withdrawal force should always be applied to the ring which is to be dismounted.

A mechanical puller (→ **fig 1**) can be used for removing small bearings from shafts. The claws are applied directly to the bearing inner ring or to a component immediately behind the bearing.

A suitable tool for difficult dismounting work is the SKF puller with adapter cup (→ **fig 2**). The two parts of the cup are clamped against each other using two bolts with nuts. It is possible to remove an inner ring abutting a shoulder in this way. As the cup engages behind the bearing inner ring, there will be no damage to the sliding contact surfaces or to the outer ring.

Especially where large bearings with an interference fit are concerned, dismounting is considerably facilitated if the SKF oil injection method is used (→ **fig 3**). In order to do this it is necessary to provide the necessary oil ducts and distributor grooves when designing the bearing arrangement (→ **page 46**).

Small bearings can be dismounted using a mounting dolly or a length of tubing applied to the outer ring. For larger bearings with an interference fit, a mechanical or hydraulic press can be used where possible.

It is also possible to dismount bearings from housing bores by quickly heating the bearing housing without heating the bearing outer ring to any extent.

Rod ends

To dismount rod ends the lock nut securing the shank should be loosened and, if possible, the rod end be unscrewed from its rod or tube. The rod end can then be removed from the pin in the same way as a bearing, e.g. using a puller.

Removing a bearing with a clawed puller

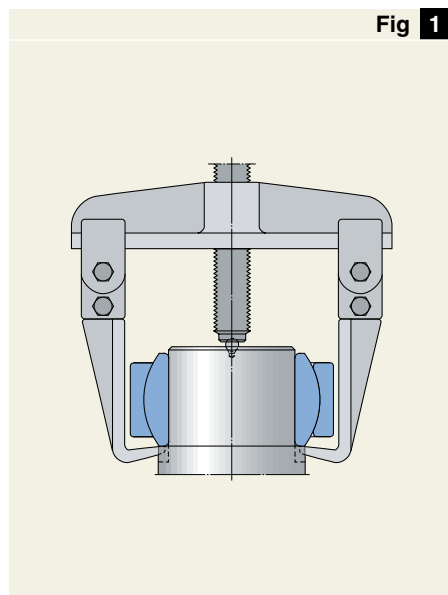


Fig 1

SKF puller

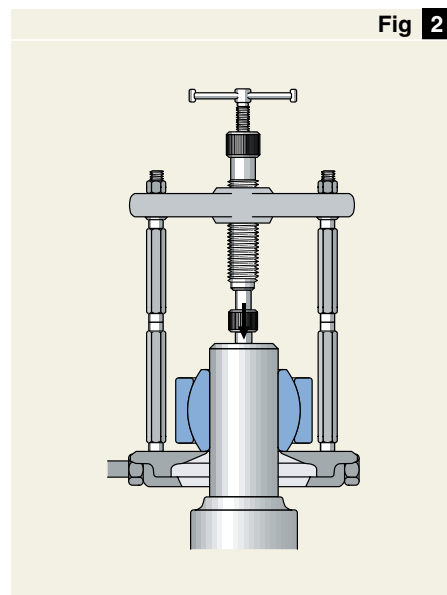


Fig 2

Dismounting a bearing using the SKF oil injection method

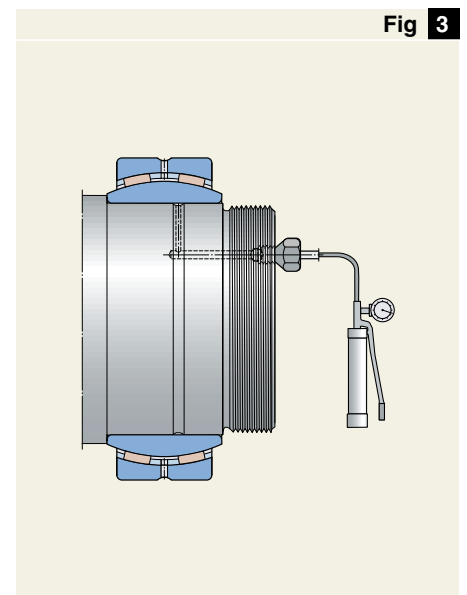


Fig 3



General

3 Product data 57

Radial spherical plain bearings

requiring maintenance.....	58
General	58
Steel-on-steel spherical plain bearings	
with metric dimensions	62
with inch dimensions	66
with extended inner ring	70

Maintenance-free radial spherical plain bearings 72

General	72
Bearings with sliding contact surface combination	
steel/sinter bronze composite	76
steel/PTFE fabric	78
steel/PTFE composite	82

Angular contact spherical plain bearings 86

General	86
Maintenance-free bearings with sliding contact surface combination steel/PTFE composite	90

Spherical plain thrust bearings..... 92

General	92
Maintenance-free bearings with sliding contact surface combination steel/PTFE composite.....	94

Rod ends requiring maintenance 96

General	96
Steel-on-steel rod ends	
with female thread	100
with female thread for hydraulic cylinders	102
with male thread	104
with cylindrical section welding shank	106
with rectangular section welding shank	108

Steel-on-bronze rod ends	
with female thread	110
with male thread	112

Maintenance-free rod ends..... 114

General	114
Rod ends	
with female thread, steel/sinter bronze composite	118
with male thread, steel/sinter bronze composite	120
with female thread, steel/PTFE fabric.....	122
with male thread, steel/PTFE fabric.....	124
with female thread, steel/PTFE composite	126
with male thread, steel/PTFE composite	128

Special solutions and related products 130

Plain bearings for road vehicles	130
Plain bearings for rail vehicles	130
Spherical plain bearings and rod ends for airframe applications	131
Dry sliding bushings and flanged bushings.....	132
Dry sliding thrust washers and strip	133

Radial spherical plain bearings requiring maintenance	58
--	-----------

Maintenance-free radial spherical plain bearings	72
---	-----------

Angular contact spherical plain bearings	86
---	-----------

Spherical plain thrust bearings	92
--	-----------

Rod ends requiring maintenance	96
---	-----------

Maintenance-free rod ends	114
--	------------

Special solutions and related products	130
---	------------

Radial spherical plain bearings requiring maintenance

The characteristic feature of the SKF steel-on-steel spherical plain bearings is the outer ring, which is intentionally fractured at a given point so that it can be sprung apart to enable the inner ring to be inserted (→ **fig 1**). The bearings are therefore non-separable and easy to handle.

The surfaces are manganese phosphated and the sliding contact surface also treated with a running-in lubricant. This makes the bearings wear resistant and easy to run-in. To facilitate effective lubrication, all bearings – except some small sizes – have an annular groove and two lubrication holes in both outer and inner rings. Additionally, bearings with an outside diameter of 150 mm and above also have the “multi-groove system” (→ **page 6**) in the outer ring sliding contact surface as standard (→ **fig 2**).



Dimensions

The dimensions of spherical plain bearings of series GE, GEH and GEG conform to ISO 12240-1:1998.

Bearings with cylindrical extensions to the inner ring, series GEM, have a non-standard inner ring width but otherwise have the dimensions of series GE bearings.

The dimensions of spherical plain bearings with inch dimensions, series GEZ, conform to the American Standard ANSI/ABMA Std. 22.2-1988.

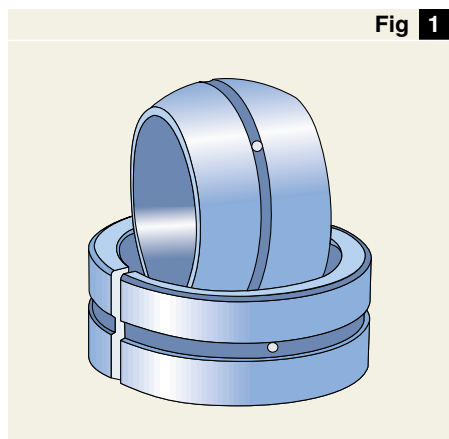
Tolerances

The tolerances to which metric radial spherical plain bearings are made are given in **Table 1** and those of inch-size bearings are given in **Table 2** on **page 60**. The values for the outer rings apply to rings before fracture and before surface treatment.

The tolerances are in accordance with ISO 12240-1:1998 (metric) and ANSI/ABMA Std. 22.2-1988 (inch-size bearings).

The symbols used in the tolerance tables are explained in the following.

d	nominal bore diameter
D_{dmp}	deviation of the mean bore diameter from the nominal
D	nominal outside diameter
Δ_{Dmp}	deviation of the mean outside diameter from the nominal
Δ_{Bs}	deviation of single inner ring width from the nominal
Δ_{Cs}	deviation of single outer ring width from the nominal

Insertion of inner ring into outer ring*Outer ring with multi-groove system in sliding contact surface*

*Tolerances of
metric bearings*

Table 1

Nominal diameter		Series GE, GEH, GEM Inner ring				Series GEG Inner ring				All series Outer ring			
d, D		Δ_{dmp}		Δ_{Bs}		Δ_{dmp}		Δ_{Bs}		Δ_{Dmp}		Δ_{Cs}	
over	incl.	high	low	high	low	high	low	high	low	high	low	high	low
mm		μm		μm		μm		μm		μm		μm	
	6	0	-8	0	-120	-	-	-	-	-	-	-	-
6	10	0	-8	0	-120	-	-	-	-	0	-8	0	-240
10	18	0	-8	0	-120	+18	0	0	-180	0	-8	0	-240
	18	0	-10	0	-120	+21	0	0	-210	0	-9	0	-240
30	50	0	-12	0	-120	+25	0	0	-250	0	-11	0	-240
50	80	0	-15	0	-150	+30	0	0	-300	0	-13	0	-300
	80	0	-20	0	-200	+35	0	0	-350	0	-15	0	-400
120	150	0	-25	0	-250	+40	0	0	-400	0	-18	0	-500
150	180	0	-25	0	-250	+40	0	0	-400	0	-25	0	-500
	180	0	-30	0	-300	+46	0	0	-460	0	-30	0	-600
250	315	0	-35	0	-350	-	-	-	-	0	-35	0	-700
315	400	-	-	-	-	-	-	-	-	0	-40	0	-800
	400	-	-	-	-	-	-	-	-	0	-45	0	-900
	500	-	-	-	-	-	-	-	-	0	-45	0	-900

*Tolerances of
inch-size bearings*

Table 2

Nominal diameter		Inner ring		Outer ring		Δ_{Dmp}		Δ_{Cs}	
d, D		Δ_{dmp}		Δ_{Bs}		Δ_{Dmp}		Δ_{Cs}	
over	incl.	high	low	high	low	high	low	high	low
mm		μm		μm		μm		μm	
	50,8	0	-13	0	-130	0	-13	0	-130
50,8	76,2	0	-15	0	-130	0	-15	0	-130
76,2	80,962	0	-20	0	-130	0	-15	0	-130
	80,962	0	-20	0	-130	0	-20	0	-130
120,65	152,4	0	-25	0	-130	0	-25	0	-130
152,4	177,8	-	-	-	-	0	-25	0	-130
	177,8	-	-	-	-	0	-30	0	-130
	222,25	-	-	-	-	0	-30	0	-130

Radial internal clearance

Steel-on-steel spherical plain bearings are produced with Normal radial internal clearance as standard; the actual values are shown in **Table 3**. The availability of bearings with radial internal clearance smaller than Normal, C2, or greater than Normal, C3, should be checked before ordering.

The clearance values for the metric bearings conform to ISO 12240-1:1998.

Materials

The inner and outer rings of SKF steel-on-steel radial spherical plain bearings are made of carbon chromium steel 100 Cr 6/1.3505, and are hardened, ground and phosphated. The sliding contact surfaces are treated with a running-in lubricant.

The double-lip rubbing seals of metric bearings of the 2RS design are made of polyester elastomer. Polyurethane is used for the seals of the inch-size bearings.

Permissible operating temperature range

Steel-on steel spherical plain bearings can be used in the temperature range of –50 to +300 °C, but their load carrying capacity will be reduced at temperatures above +150 °C.

The permissible range for sealed bearings of the 2RS design is limited by the operating temperature of the seal material to

- –30 to +130 °C for polyester elastomer (metric bearings), and
- –20 to +80 °C for polyurethane (inch-size bearings).

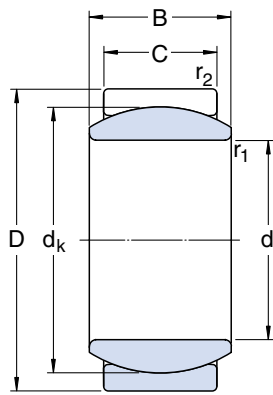
The operating temperature range for the actual grease used to lubricate the bearings must also be taken into consideration.

Table 3

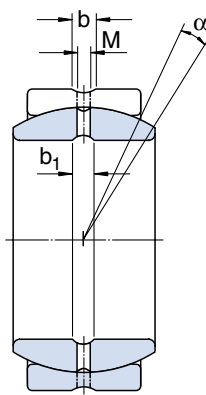
Bore diameter d		Radial internal clearance						
		C2		Normal		C3		
over	incl.	min	max	min	max	min	max	
mm		µm						
Metric bearings¹⁾								
	12		8	32	32	68	68	104
12	20		10	40	40	82	82	124
20	35		12	50	50	100	100	150
35	60		15	60	60	120	120	180
	60		18	72	72	142	142	212
60	90		18	85	85	165	165	245
90	140		18	100	100	192	192	284
140	200							
	200		18	110	110	214	214	318
200	240		18	125	125	239	239	353
240	300							
Inch-size bearings								
	15,875		15	75	50	150	150	200
15,875	50,800		25	105	80	180	180	260
	50,800		30	130	100	200	200	300
50,800	76,200		40	160	130	230	230	350
76,200	152,400							

¹⁾ Bearings of series GEH with bore diameter d = 20, 35, 60 and 90 mm have a radial internal clearance corresponding to the values quoted for the next larger diameter range

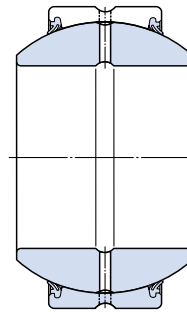
Radial internal clearance of steel-on-steel spherical plain bearings



GE .. E



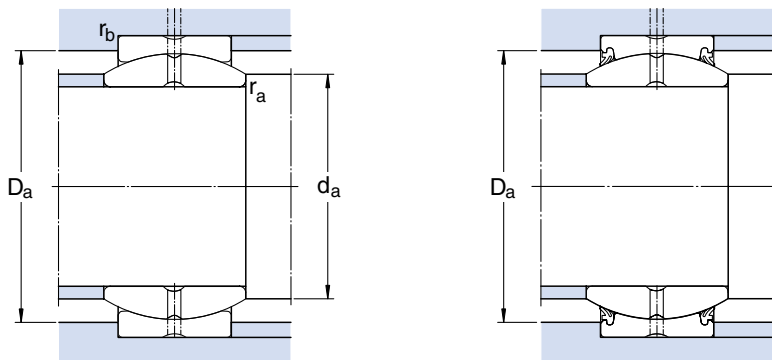
GE .. ES



GEH .. ES-2RS

Principal dimensions				Angle of tilt ¹⁾	Basic load ratings		Mass	Designation
d	D	B	C	α	dynamic	static		
				degrees	C	C ₀	kg	–
4	12	5	3	16	2 040	10 200	0,003	GE 4 E
5	14	6	4	13	3 400	17 000	0,004	GE 5 E
6	14	6	4	13	3 400	17 000	0,004	GE 6 E
8	16	8	5	15	5 500	27 500	0,008	GE 8 E
10	19	9	6	12	8 150	40 500	0,012	GE 10 E
12	22	10	7	10	10 800	54 000	0,017	GE 12 E
15	26	12	9	8	17 000	85 000	0,032	GE 15 ES
	26	12	9	8	17 000	85 000	0,032	GE 15 ES-2RS
17	30	14	10	10	21 200	106 000	0,050	GE 17 ES
	30	14	10	10	21 200	106 000	0,050	GE 17 ES-2RS
20	35	16	12	9	30 000	146 000	0,065	GE 20 ES
	35	16	12	9	30 000	146 000	0,065	GE 20 ES-2RS
	42	25	16	17	48 000	240 000	0,16	GEH 20 ES-2RS
25	42	20	16	7	48 000	240 000	0,12	GE 25 ES
	42	20	16	7	48 000	240 000	0,12	GE 25 ES-2RS
	47	28	18	17	62 000	310 000	0,20	GEH 25 ES-2RS
30	47	22	18	6	62 000	310 000	0,16	GE 30 ES
	47	22	18	6	62 000	310 000	0,16	GE 30 ES-2RS
	55	32	20	17	80 000	400 000	0,35	GEH 30 ES-2RS
35	55	25	20	6	80 000	400 000	0,23	GE 35 ES
	55	25	20	6	80 000	400 000	0,23	GE 35 ES-2RS
	62	35	22	15	100 000	500 000	0,47	GEH 35 ES-2RS
40	62	28	22	7	100 000	500 000	0,32	GE 40 ES
	62	28	22	6	100 000	500 000	0,32	GE 40 ES-2RS
	68	40	25	17	127 000	640 000	0,61	GEH 40 ES-2RS
45	68	32	25	7	127 000	640 000	0,46	GE 45 ES
	68	32	25	7	127 000	640 000	0,46	GE 45 ES-2RS
	75	43	28	14	156 000	780 000	0,80	GEH 45 ES-2RS
50	75	35	28	6	156 000	780 000	0,56	GE 50 ES
	75	35	28	6	156 000	780 000	0,56	GE 50 ES-2RS
	90	56	36	17	245 000	1 220 000	1,60	GEH 50 ES-2RS

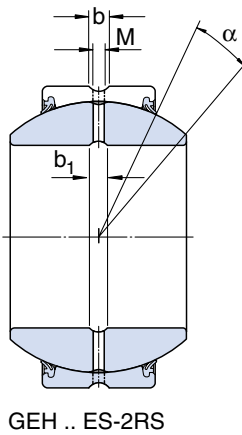
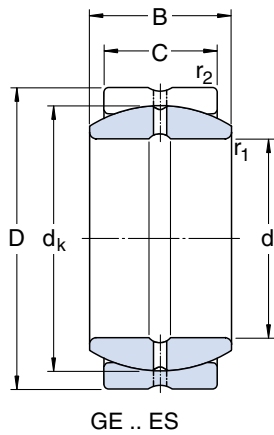
¹⁾ To fully utilise the angle of tilt, the shaft shoulder should not be made larger than $d_{a \max}$



Dimensions

Abutment and fillet dimensions

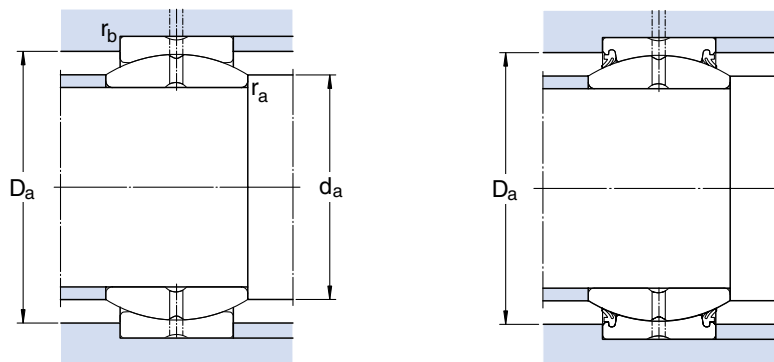
d	d _k	b	b ₁	M	r ₁ min	r ₂ min	d _a min	d _a max	D _a max	D _a min	r _a max	r _b max
mm							mm					
4	8	-	-	-	0,3	0,3	5,5	6,2	10,7	7,6	0,3	0,3
5	10	-	-	-	0,3	0,3	6,6	8	12,6	9,5	0,3	0,3
6	10	-	-	-	0,3	0,3	7,5	8	12,6	9,5	0,3	0,3
8	13	-	-	-	0,3	0,3	9,6	10,2	14,5	12,3	0,3	0,3
10	16	-	-	-	0,3	0,3	11,7	13,2	17,5	15,2	0,3	0,3
12	18	-	-	-	0,3	0,3	13,8	15	20,4	17,1	0,3	0,3
15	22	2,3	2,3	1,5	0,3	0,3	16,9	18,4	24,3	20,9	0,3	0,3
	22	2,3	2,3	1,5	0,3	0,3	16,9	18,4	24,3	22,8	0,3	0,3
17	25	2,3	2,3	1,5	0,3	0,3	19	20,7	28,3	23,7	0,3	0,3
	25	2,3	2,3	1,5	0,3	0,3	19	20,7	28,3	26	0,3	0,3
20	29	3,1	3,1	2	0,3	0,3	22,1	24,2	33,2	27,6	0,3	0,3
	29	3,1	3,1	2	0,3	0,3	22,1	24,2	33,2	30,9	0,3	0,3
	35,5	3,1	3,1	2	0,3	0,6	22,7	25,2	39,2	36,9	0,3	0,6
25	35,5	3,1	3,1	2	0,6	0,6	28,2	29,3	39,2	33,7	0,6	0,6
	35,5	3,1	3,1	2	0,6	0,6	28,2	29,3	39,2	36,9	0,6	0,6
	40,7	3,1	3,1	2	0,6	0,6	28,6	29,5	44	41,3	0,6	0,6
30	40,7	3,1	3,1	2	0,6	0,6	33,3	34,2	44	38,7	0,6	0,6
	40,7	3,1	3,1	2	0,6	0,6	33,3	34,2	44	41,3	0,6	0,6
	47	3,9	3,9	2,5	0,6	1	33,7	34,4	50,9	48,5	0,6	1
35	47	3,9	3,9	2,5	0,6	1	38,5	39,8	50,9	44,6	0,6	1
	47	3,9	3,9	2,5	0,6	1	38,5	39,8	50,9	48,5	0,6	1
	53	3,9	3,9	2,5	0,6	1	38,8	39,8	57,8	54,5	0,6	1
40	53	3,9	3,9	2,5	0,6	1	43,6	45	57,8	50,3	0,6	1
	53	3,9	3,9	2,5	0,6	1	43,6	45	57,8	54,5	0,6	1
	60	4,6	4,6	3	0,6	1	44,1	44,7	63,6	61	0,6	1
45	60	4,6	4,6	3	0,6	1	49,4	50,8	63,6	57	0,6	1
	60	4,6	4,6	3	0,6	1	49,4	50,8	63,6	61	0,6	1
	66	4,6	4,6	3	0,6	1	49,8	50,1	70,5	66,2	0,6	1
50	66	4,6	4,6	3	0,6	1	54,6	56	70,5	62,7	0,6	1
	66	4,6	4,6	3	0,6	1	54,6	56	70,5	66,2	0,6	1
	80	6,2	6,2	4	0,6	1	55,8	57,1	84,2	79,7	0,6	1



Principal dimensions				Angle of tilt ¹⁾	Basic load ratings		Mass	Designation ²⁾
d	D	B	C	α	C	C ₀		
mm				degrees	N		kg	–
60	90	44	36	6	245 000	1 220 000	1,10	GE 60 ES
	90	44	36	6	245 000	1 220 000	1,10	GE 60 ES-2RS
	105	63	40	17	315 000	1 560 000	2,40	GEH 60 ES-2RS
70	105	49	40	6	315 000	1 560 000	1,55	GE 70 ES
	105	49	40	6	315 000	1 560 000	1,55	GE 70 ES-2RS
	120	70	45	16	400 000	2 000 000	3,40	GEH 70 ES-2RS
80	120	55	45	6	400 000	2 000 000	2,30	GE 80 ES
	120	55	45	5	400 000	2 000 000	2,30	GE 80 ES-2RS
	130	75	50	14	490 000	2 450 000	4,10	GEH 80 ES-2RS
90	130	60	50	5	490 000	2 450 000	2,75	GE 90 ES
	130	60	50	5	490 000	2 450 000	2,75	GE 90 ES-2RS
	150	85	55	15	610 000	3 050 000	6,30	GEH 90 ES-2RS
100	150	70	55	7	610 000	3 050 000	4,40	GE 100 ES
	150	70	55	6	610 000	3 050 000	4,40	GE 100 ES-2RS
	160	85	55	13	655 000	3 250 000	6,80	GEH 100 ES-2RS
110	160	70	55	6	655 000	3 250 000	4,80	GE 110 ES
	160	70	55	6	655 000	3 250 000	4,80	GE 110 ES-2RS
	180	100	70	12	950 000	4 750 000	11,0	GEH 110 ES-2RS
120	180	85	70	6	950 000	4 750 000	8,25	GE 120 ES
	180	85	70	6	950 000	4 750 000	8,25	GE 120 ES-2RS
	210	115	70	16	1 080 000	5 400 000	15,0	GEH 120 ES-2RS
140	210	90	70	7	1 080 000	5 400 000	11,0	GE 140 ES
	210	90	70	7	1 080 000	5 400 000	11,0	GE 140 ES-2RS
160	230	105	80	8	1 370 000	6 800 000	14,0	GE 160 ES
	230	105	80	8	1 370 000	6 800 000	14,0	GE 160 ES-2RS
180	260	105	80	6	1 530 000	7 650 000	18,5	GE 180 ES
	260	105	80	6	1 530 000	7 650 000	18,5	GE 180 ES-2RS
200	290	130	100	7	2 120 000	10 600 000	28,0	GE 200 ES
	290	130	100	7	2 120 000	10 600 000	28,0	GE 200 ES-2RS
220	320	135	100	8	2 320 000	11 600 000	35,5	GE 220 ES-2RS
240	340	140	100	8	2 550 000	12 700 000	40,0	GE 240 ES-2RS
260	370	150	110	7	3 050 000	15 300 000	51,5	GE 260 ES-2RS
280	400	155	120	6	3 550 000	18 000 000	65,0	GE 280 ES-2RS
300	430	165	120	7	3 800 000	19 000 000	78,5	GE 300 ES-2RS

¹⁾ To fully utilise the angle of tilt, the shaft shoulder should not be made larger than $d_{a \max}$

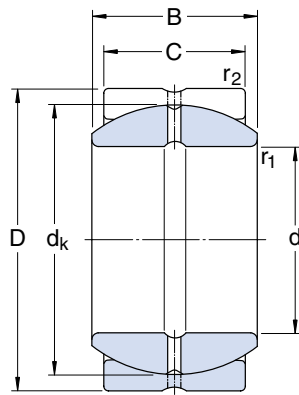
²⁾ Bearings with outside diameters ≥ 150 mm have the multi-groove lubrication system in the outer ring sliding contact surface as standard (\rightarrow page 6)



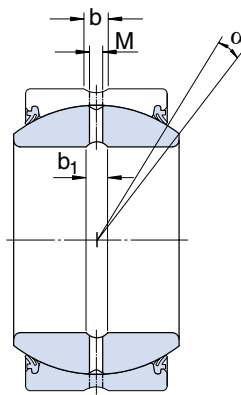
Dimensions

Abutment and fillet dimensions

d	d _k	b	b ₁	M	r ₁ min	r ₂ min	d _a min	d _a max	D _a max	D _a min	r _a max	r _b max
mm							mm					
60	80	6,2	6,2	4	1	1	66,4	66,8	84,2	76	1	1
	80	6,2	6,2	4	1	1	66,4	66,8	84,2	79,7	1	1
	92	7,7	7,7	4	1	1	67	67	99	92	1	1
70	92	7,7	7,7	4	1	1	76,7	77,9	99	87,4	1	1
	92	7,7	7,7	4	1	1	76,7	77,9	99	92	1	1
	105	7,7	7,7	4	1	1	77,5	78,3	113,8	104,4	1	1
80	105	7,7	7,7	4	1	1	87,1	89,4	113,8	99,7	1	1
	105	7,7	7,7	4	1	1	87,1	89,4	113,8	104,4	1	1
	115	9,5	9,5	5	1	1	87,2	87,2	123,5	112,9	1	1
90	115	9,5	9,5	5	1	1	97,4	98,1	123,5	109,3	1	1
	115	9,5	9,5	5	1	1	97,4	98,1	123,5	112,9	1	1
	130	11,3	11,3	5	1	1	98,2	98,4	143,2	131	1	1
100	130	11,3	11,3	5	1	1	107,8	109,5	143,2	123,5	1	1
	130	11,3	11,3	5	1	1	107,8	109,5	143,2	131	1	1
	140	11,5	11,5	5	1	1	108,1	111,2	153,3	141,5	1	1
110	140	11,5	11,5	5	1	1	118	121	153	133	1	1
	140	11,5	11,5	5	1	1	118	121	153	141,5	1	1
	160	13,5	13,5	6	1	1	119,5	124,5	172	157,5	1	1
120	160	13,5	13,5	6	1	1	129,5	135,5	172	152	1	1
	160	13,5	13,5	6	1	1	129,5	135,5	172	157,5	1	1
	180	13,5	13,5	6	1	1	130	138,5	202,5	180	1	1
140	180	13,5	13,5	6	1	1	149	155,5	202,5	171	1	1
	180	13,5	13,5	6	1	1	149	155,5	202,5	180	1	1
160	200	13,5	13,5	6	1	1	169,5	170	222	190	1	1
	200	13,5	13,5	6	1	1	169,5	170	222	197	1	1
180	225	13,5	13,5	6	1,1	1,1	191	199	250,5	214	1	1
	225	13,5	13,5	6	1,1	1,1	191	199	250,5	224,5	1	1
200	250	15,5	15,5	7	1,1	1,1	212,5	213,5	279,5	237,5	1	1
	250	15,5	15,5	7	1,1	1,1	212,5	213,5	279,5	244,5	1	1
220	275	15,5	15,5	7	1,1	1,1	232,5	239,5	309,5	271	1	1
240	300	15,5	15,5	7	1,1	1,1	252,5	265	329,5	298	1	1
260	325	15,5	15,5	7	1,1	1,1	273	288	359	321,5	1	1
280	350	15,5	15,5	7	1,1	1,1	294	313,5	388,5	344,5	1	1
300	375	15,5	15,5	7	1,1	1,1	314	336,5	418,5	371	1	1



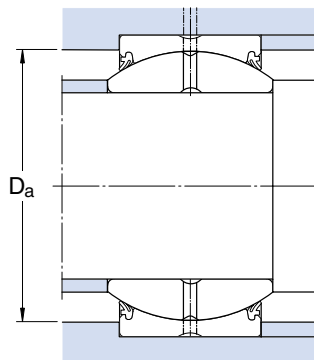
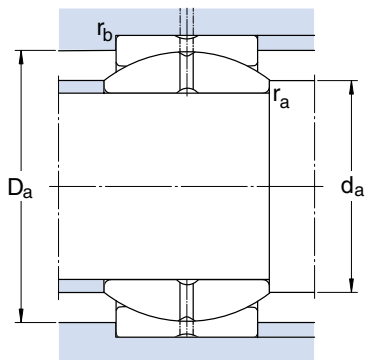
GEZ .. ES



GEZ .. ES-2RS

Principal dimensions				Angle of tilt ¹⁾	Basic load ratings		Mass	Designation
d	D	B	C		dynamic	static		
				α	C	C ₀		
mm/in				degrees	N		kg	–
12,700 0,5000	22,225 0,8750	11,100 0,4370	9,525 0,3750	6	14 000	41 500	0,020	GEZ 008 ES
15,875 0,6250	26,988 1,0625	13,894 0,5470	11,913 0,4690	6	21 600	65 500	0,035	GEZ 010 ES
19,050 0,7500	31,750 1,2500	16,662 0,6560	14,275 0,5620	6	31 500	93 000	0,055	GEZ 012 ES
22,225 0,8750	36,513 1,4375	19,431 0,7650	16,662 0,6560	6	42 500	127 000	0,085	GEZ 014 ES
25,400 1,0000	41,275 1,6250	22,225 0,8750	19,050 0,7500	6	56 000	166 000	0,12	GEZ 100 ES
	41,275 1,6250	22,225 0,8750	19,050 0,7500	6	56 000	166 000	0,12	GEZ 100 ES-2RS
31,750 1,2500	50,800 2,0000	27,762 1,0930	23,800 0,9370	6	86 500	260 000	0,23	GEZ 104 ES
	50,800 2,0000	27,762 1,0930	23,800 0,9370	6	86 500	260 000	0,23	GEZ 104 ES-2RS
34,925 1,3750	55,563 2,1875	30,150 1,1870	26,187 1,0310	5	104 000	310 000	0,35	GEZ 106 ES
	55,563 2,1875	30,150 1,1870	26,187 1,0310	5	104 000	310 000	0,35	GEZ 106 ES-2RS
38,100 1,5000	61,913 2,4375	33,325 1,3120	28,575 1,1250	6	125 000	375 000	0,42	GEZ 108 ES
	61,913 2,4375	33,325 1,3120	28,575 1,1250	6	125 000	375 000	0,42	GEZ 108 ES-2RS
44,450 1,7500	71,438 2,8125	38,887 1,5310	33,325 1,3120	6	170 000	510 000	0,64	GEZ 112 ES
	71,438 2,8125	38,887 1,5310	33,325 1,3120	6	170 000	510 000	0,64	GEZ 112 ES-2RS
50,800 2,0000	80,963 3,1875	44,450 1,7500	38,100 1,5000	6	224 000	670 000	0,93	GEZ 200 ES
	80,963 3,1875	44,450 1,7500	38,100 1,5000	6	224 000	670 000	0,93	GEZ 200 ES-2RS
57,150 2,2500	90,488 3,5625	50,013 1,9690	42,850 1,6870	6	280 000	850 000	1,30	GEZ 204 ES
	90,488 3,5625	50,013 1,9690	42,850 1,6870	6	280 000	850 000	1,30	GEZ 204 ES-2RS
63,500 2,5000	100,013 3,9375	55,550 2,1870	47,625 1,8750	6	345 000	1 040 000	1,85	GEZ 208 ES
	100,013 3,9375	55,550 2,1870	47,625 1,8750	6	345 000	1 040 000	1,85	GEZ 208 ES-2RS

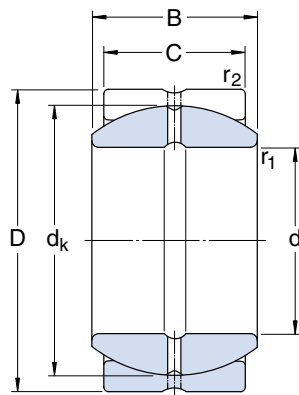
¹⁾ To fully utilise the angle of tilt, the shaft shoulder should not be made larger than d_{a max}



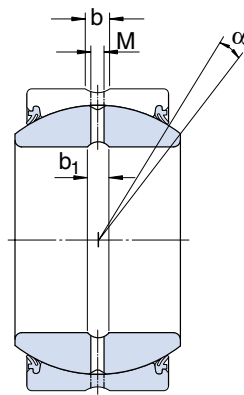
Dimensions

Abutment and fillet dimensions

d	d _k	b	b ₁	M	r ₁ min	r ₂ min	d _a min	d _a max	D _a max	D _a min	r _a max	r _b max
mm/in							mm/in					
12,700 0,5000	18,263 0,719	2,6 0,102	2,5 0,098	1,5 0,059	0,15 0,006	0,6 0,024	13,7 0,539	14,5 0,571	19,9 0,783	17,3 0,681	0,15 0,006	0,6 0,024
15,875 0,6250	22,835 0,899	3,2 0,126	3 0,118	2,5 0,098	0,15 0,006	1 0,039	17 0,669	18,1 0,713	23,6 0,929	21,7 0,854	0,15 0,006	1 0,039
19,050 0,7500	27,432 1,080	3,2 0,126	3 0,118	2,5 0,098	0,3 0,012	1 0,039	20,9 0,823	21,8 0,858	28,3 1,114	26,1 1,028	0,3 0,012	1 0,039
22,225 0,8750	31,953 1,258	3,2 0,126	3 0,118	2,5 0,098	0,3 0,012	1 0,039	24,2 0,953	25,4 1,000	33 1,299	30,4 1,197	0,3 0,012	1 0,039
25,400 1,0000	36,5 1,437	3,2 0,126	3 0,118	2,5 0,098	0,3 0,012	1 0,039	27,5 1,083	29 1,142	37,7 1,484	34,7 1,366	0,3 0,012	1 0,039
	36,5 1,437	3,2 0,126	3 0,118	2,5 0,098	0,3 0,012	1 0,039	27,5 1,083	29 1,142	37,7 1,484	35,2 1,386	0,3 0,012	1 0,039
31,750 1,2500	45,593 1,795	4,8 0,189	5 0,197	4 0,158	0,6 0,024	1 0,039	34,8 1,370	36,2 1,425	47 1,850	43,3 1,705	0,6 0,024	1 0,039
	45,593 1,795	4,8 0,189	5 0,197	4 0,158	0,6 0,024	1 0,039	34,8 1,370	36,2 1,425	47 1,850	44,8 1,764	0,6 0,024	1 0,039
34,925 1,3750	49,2 1,937	4,8 0,189	5 0,197	4 0,158	0,6 0,024	1 0,039	38,1 1,500	38,9 1,531	51,7 2,035	46,7 1,839	0,6 0,024	1 0,039
	49,2 1,937	4,8 0,189	5 0,197	4 0,158	0,6 0,024	1 0,039	38,1 1,500	38,9 1,531	51,7 2,035	47,1 1,854	0,6 0,024	1 0,039
38,100 1,5000	54,737 2,155	4,8 0,189	5 0,197	4 0,158	0,6 0,024	1 0,039	41,4 1,630	43,4 1,709	58 2,283	52 2,047	0,6 0,024	1 0,039
	54,737 2,155	4,8 0,189	5 0,197	4 0,158	0,6 0,024	1 0,039	41,4 1,630	43,4 1,709	58 2,283	52,3 2,059	0,6 0,024	1 0,039
44,450 1,7500	63,881 2,515	4,8 0,189	5 0,197	4 0,158	0,6 0,024	1 0,039	48,5 1,909	50,7 1,996	67,4 2,654	60,7 2,390	0,6 0,024	1 0,039
	63,881 2,515	4,8 0,189	5 0,197	4 0,158	0,6 0,024	1 0,039	48,5 1,909	50,7 1,996	67,4 2,654	61,3 2,413	0,6 0,024	1 0,039
50,800 2,0000	73,025 2,875	4,8 0,189	5 0,197	4 0,158	0,6 0,024	1 0,039	55,1 2,169	57,9 2,280	75,9 2,988	69,4 2,732	0,6 0,024	1 0,039
	73,025 2,875	4,8 0,189	5 0,197	4 0,158	0,6 0,024	1 0,039	55,1 2,169	57,9 2,280	75,9 2,988	69,1 2,720	0,6 0,024	1 0,039
57,150 2,2500	82,169 3,235	5,7 0,224	5 0,197	4 0,158	0,6 0,024	1 0,039	61,7 2,429	65,2 2,567	85,3 3,358	78,1 3,075	0,6 0,024	1 0,039
	82,169 3,235	5,7 0,224	5 0,197	4 0,158	0,6 0,024	1 0,039	61,7 2,429	65,2 2,567	85,3 3,358	79 3,110	0,6 0,024	1 0,039
63,500 2,5000	91,186 3,590	9 0,354	8 0,315	6,5 0,256	0,6 0,024	1 0,039	68,3 2,689	72,3 2,846	94,7 3,728	86,6 3,409	0,6 0,024	1 0,039
	91,186 3,590	9 0,354	8 0,315	6,5 0,256	0,6 0,024	1 0,039	68,3 2,689	72,3 2,846	94,7 3,728	87 3,425	0,6 0,024	1 0,039



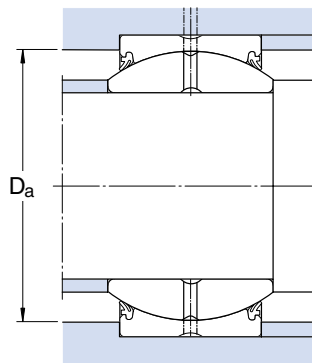
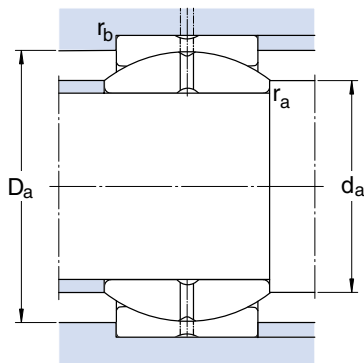
GEZ .. ES



GEZ .. ES-2RS

Principal dimensions				Angle of tilt ¹⁾	Basic load ratings		Mass	Designation
d	D	B	C	α	C	C ₀		
mm/in				degrees	N		kg	–
69,850 2,7500	111,125	61,112	52,375	6	425 000	1 270 000	2,40	GEZ 212 ES
	4,3750	2,4060	2,0620					
	111,125	61,112	52,375	6	425 000	1 270 000	2,40	GEZ 212 ES-2RS
	4,3750	2,4060	2,0620					
76,200 3,0000	120,650	66,675	57,150	6	500 000	1 500 000	3,10	GEZ 300 ES
	4,7500	2,6250	2,2500					
	120,650	66,675	57,150	6	500 000	1 500 000	3,10	GEZ 300 ES-2RS
	4,7500	2,6250	2,2500					
82,550 3,2500	130,175	72,238	61,900	6	585 000	1 760 000	3,80	GEZ 304 ES
	5,1250	2,8440	2,4370					
	130,175	72,238	61,900	6	585 000	1 760 000	3,80	GEZ 304 ES-2RS
	5,1250	2,8440	2,4370					
88,900 3,5000	139,700	77,775	66,675	6	680 000	2 040 000	4,80	GEZ 308 ES
	5,5000	3,0620	2,6250					
	139,700	77,775	66,675	6	680 000	2 040 000	4,80	GEZ 308 ES-2RS
	5,5000	3,0620	2,6250					
95,250 3,7500	149,225	83,337	71,425	6	780 000	2 360 000	5,80	GEZ 312 ES
	5,8750	3,2810	2,8120					
	149,225	83,337	71,425	6	780 000	2 360 000	5,80	GEZ 312 ES-2RS
	5,8750	3,2810	2,8120					
101,600 4,0000	158,750	88,900	76,200	6	900 000	2 650 000	7,00	GEZ 400 ES
	6,2500	3,5000	3,0000					
	158,750	88,900	76,200	6	900 000	2 650 000	7,00	GEZ 400 ES-2RS
	6,2500	3,5000	3,0000					
114,300 4,5000	177,800	100	85,725	6	1 120 000	3 400 000	9,80	GEZ 408 ES
	7,0000	3,9370	3,3750					
	177,800	100	85,725	6	1 120 000	3 400 000	9,80	GEZ 408 ES-2RS
	7,0000	3,9370	3,3750					
120,650 4,7500	187,325	105,562	90,475	6	1 250 000	3 750 000	11,5	GEZ 412 ES
	7,3750	4,1560	3,5620					
	187,325	105,562	90,475	6	1 250 000	3 750 000	11,5	GEZ 412 ES-2RS
	7,3750	4,1560	3,5620					
127 5,0000	196,850	111,125	95,250	6	1 400 000	4 150 000	13,5	GEZ 500 ES
	7,7500	4,3750	3,7500					
	196,850	111,125	95,250	6	1 400 000	4 150 000	13,5	GEZ 500 ES-2RS
	7,7500	4,3750	3,7500					
152,400 6,0000	222,250	120,650	104,775	5	1 730 000	5 200 000	17,5	GEZ 600 ES
	8,7500	4,7500	4,1250					
	222,250	120,650	104,775	5	1 730 000	5 200 000	17,5	GEZ 600 ES-2RS
	8,7500	4,7500	4,1250					

¹⁾ To fully utilise the angle of tilt, the shaft shoulder should not be made larger than $d_{a,max}$

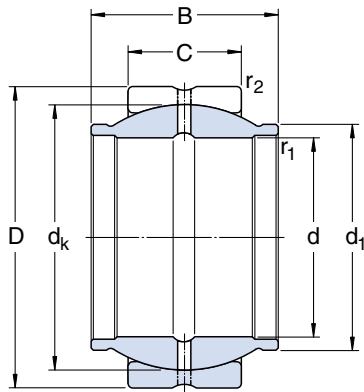


Dimensions

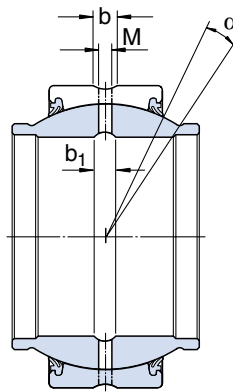
Abutment and fillet dimensions

d	dk	b	b ₁	M	r ₁ min	r ₂ min	d _a min	d _a max	D _a max	D _a min	r _a max	r _b max
mm/in							mm/in					
69,850	100,330	9	8	6,5	0,6	1	74,9	79,6	105,7	95,3	0,6	1
2,7500	3,950	0,354	0,315	0,256	0,024	0,039	2,949	3,134	4,161	3,752	0,024	0,039
	100,330	9	8	6,5	0,6	1	74,9	79,6	105,7	96	0,6	1
	3,950	0,354	0,315	0,256	0,024	0,039	2,949	3,134	4,161	3,780	0,024	0,039
76,200	109,525	9	8	6,5	0,6	1	81,4	86,9	115	104	0,6	1
3,0000	4,312	0,354	0,315	0,256	0,024	0,039	3,205	3,421	4,528	4,094	0,024	0,039
	109,525	9	8	6,5	0,6	1	81,4	86,9	115	104,8	0,6	1
	4,312	0,354	0,315	0,256	0,024	0,039	3,205	3,421	4,528	4,126	0,024	0,039
82,550	118,745	9,3	8	6,5	0,6	1	88	94,2	124,4	112,8	0,6	1
3,2500	4,675	0,366	0,315	0,256	0,024	0,039	3,465	3,709	4,898	4,441	0,024	0,039
	118,745	9,3	8	6,5	0,6	1	88	94,2	124,4	114,2	0,6	1
	4,675	0,366	0,315	0,256	0,024	0,039	3,465	3,709	4,898	4,496	0,024	0,039
88,900	128,016	10,5	8	6,5	0,6	1	94,6	101,7	133,8	121,6	0,6	1
3,5000	5,040	0,413	0,315	0,256	0,024	0,039	3,724	4,004	5,268	4,787	0,024	0,039
	128,016	10,5	8	6,5	0,6	1	94,6	101,7	133,8	122,8	0,6	1
	5,040	0,413	0,315	0,256	0,024	0,039	3,724	4,004	5,268	4,835	0,024	0,039
95,250	136,906	10,5	8	6,5	0,6	1	101,2	108,6	143,1	130,1	0,6	1
3,7500	5,390	0,413	0,315	0,256	0,024	0,039	3,984	4,276	5,634	5,122	0,024	0,039
	136,906	10,5	8	6,5	0,6	1	101,2	108,6	143,1	131,4	0,6	1
	5,390	0,413	0,315	0,256	0,024	0,039	3,984	4,276	5,634	5,173	0,024	0,039
101,600	146,050	10,5	10	8	0,6	1	108	115,5	152,5	139	0,6	1
4,0000	5,750	0,413	0,394	0,315	0,024	0,039	4,252	4,547	6,004	5,472	0,024	0,039
	146,050	10,5	10	8	0,6	1	108	115,5	152,5	139,5	0,6	1
	5,750	0,413	0,394	0,315	0,024	0,039	4,252	4,547	6,004	5,492	0,024	0,039
114,300	164,465	11	10	8	1	1,1	122,5	130,5	171	156,5	1	1
4,5000	6,475	0,433	0,394	0,315	0,039	0,043	4,823	5,138	6,732	6,161	0,039	0,039
	164,465	11	10	8	1	1,1	122,5	130,5	171	157	1	1
	6,475	0,433	0,394	0,315	0,039	0,043	4,823	5,138	6,732	6,181	0,039	0,039
120,650	173,355	11	10	8	1	1,1	129	137,5	179	165	1	1
4,7500	6,825	0,433	0,394	0,315	0,039	0,043	5,079	5,413	7,047	6,496	0,039	0,039
	173,355	11	10	8	1	1,1	129	137,5	179	166,5	1	1
	6,825	0,433	0,394	0,315	0,039	0,043	5,079	5,413	7,047	6,555	0,039	0,039
127	182,626	11	10	8	1	1,1	135,5	144,5	188,5	173,5	1	1
5,0000	7,190	0,433	0,394	0,315	0,039	0,043	5,335	5,689	7,421	6,831	0,039	0,039
	182,626	11	10	8	1	1,1	135,5	144,5	188,5	175,5	1	1
	7,190	0,433	0,394	0,315	0,039	0,043	5,335	5,689	7,421	6,909	0,039	0,039
152,400	207,162	15	11	8	1	1,1	161	168	213,5	197	1	1
6,0000	8,156	0,591	0,433	0,315	0,039	0,043	6,339	6,614	8,406	7,756	0,039	0,039
	207,162	15	11	8	1	1,1	161	168	213,5	197,5	1	1
	8,156	0,591	0,433	0,315	0,039	0,043	6,339	6,614	8,406	7,776	0,039	0,039

Steel-on-steel spherical plain bearings with extended inner ring
d 12 – 200 mm



GEG .. ES

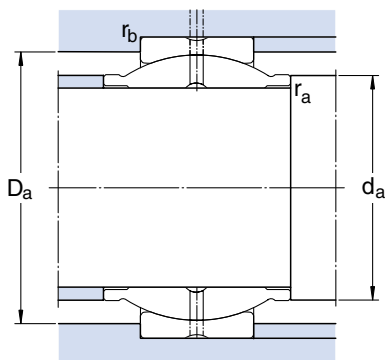


GEM .. ES-2RS

Principal dimensions				Angle of tilt	Basic load ratings		Mass	Designation ¹⁾
d	D	B	C	α	dynamic	static		
				degrees	C	C ₀	kg	–
12	22	12	7	4	10 800	54 000	0,020	GEG 12 ESA ²⁾
16	28	16	9	4	17 600	88 000	0,035	GEG 16 ES
20	35	20	12	4	30 000	146 000	0,070	GEG 20 ES
	35	24	12	6	30 000	146 000	0,073	GEM 20 ES-2RS
25	42	25	16	4	48 000	240 000	0,13	GEG 25 ES
	42	29	16	4	48 000	240 000	0,13	GEM 25 ES-2RS
30	47	30	18	4	62 000	310 000	0,17	GEM 30 ES-2RS
32	52	32	18	4	65 500	325 000	0,17	GEG 32 ES
35	55	35	20	4	80 000	400 000	0,25	GEM 35 ES-2RS
40	62	38	22	4	100 000	500 000	0,35	GEM 40 ES-2RS
	62	40	22	4	100 000	500 000	0,34	GEG 40 ES
45	68	40	25	4	127 000	640 000	0,49	GEM 45 ES-2RS
50	75	43	28	4	156 000	780 000	0,60	GEM 50 ES-2RS
	75	50	28	4	156 000	780 000	0,56	GEG 50 ES
60	90	54	36	3	245 000	1 220 000	1,15	GEM 60 ES-2RS
63	95	63	36	4	255 000	1 270 000	1,25	GEG 63 ES
70	105	65	40	4	315 000	1 560 000	1,65	GEM 70 ES-2RS
80	120	74	45	4	400 000	2 000 000	2,50	GEM 80 ES-2RS
	120	80	45	4	400 000	2 000 000	2,40	GEG 80 ES
100	150	100	55	4	610 000	3 050 000	4,80	GEG 100 ES
125	180	125	70	4	950 000	4 750 000	8,50	GEG 125 ES
160	230	160	80	4	1 370 000	6 800 000	16,5	GEG 160 ES
200	290	200	100	4	2 120 000	10 600 000	32,0	GEG 200 ES

¹⁾ Bearings with outside diameters ≥ 150 mm have the multi-groove lubrication system in the outer ring sliding contact surface as standard (\rightarrow page 6)

²⁾ Can only be relubricated via the outer ring



Dimensions

Abutment and fillet dimensions

d	d _k	d ₁	b	b ₁	M	r ₁ min	r ₂ min	d _a min	d _a max	D _a max	D _a min	r _a max	r _b max
mm								mm					
12	18	15,5	2,3	–	1,5	0,3	0,3	14,5	15,5	20,4	17,1	0,3	0,3
16	23	20	2,3	2,3	1,5	0,3	0,3	18,7	20	26,3	21,9	0,3	0,3
20	29	25	3,1	3,1	2	0,3	0,3	23,1	25	33,2	27,6	0,3	0,3
	29	24	3,1	3,1	2	0,3	0,3	23	24	33,2	30,9	0,3	0,3
25	35,5	30,5	3,1	3,1	2	0,6	0,6	29,2	30,5	39,2	33,7	0,6	0,6
	35,5	29	3,1	3,1	2	0,3	0,6	28,3	29	39,2	36,9	0,3	0,6
30	40,7	34	3,1	3,1	2	0,3	0,6	33,5	34	44	41,3	0,3	0,6
32	43	38	3,9	3,9	2,5	0,6	1	36,3	38	48,1	40,9	0,6	1
35	47	40	3,9	3,9	2,5	0,6	1	38,8	40	50,9	48,5	0,6	1
40	53	45	3,9	3,9	2,5	0,6	1	44	45	57,8	54,5	0,6	1
	53	46	3,9	3,9	2,5	0,6	1	44,8	46	57,8	50,3	0,6	1
45	60	52	4,6	4,6	3	0,6	1	49,6	52	63,6	61	0,6	1
50	66	57	4,6	4,6	3	0,6	1	54,8	57	70,5	66,2	0,6	1
	66	57	4,6	4,6	3	0,6	1	55,9	57	70,5	62,7	0,6	1
60	80	68	6,2	6,2	4	0,6	1	65,4	68	84,2	79,7	0,6	1
63	83	71,5	6,2	6,2	4	1	1	69,7	71,5	89,2	78,9	1	1
70	92	78	7,7	7,7	4	0,6	1	75,7	78	99	92	0,6	1
80	105	90	7,7	7,7	4	0,6	1	86,1	90	113,8	104,4	0,6	1
	105	91	7,7	7,7	4	1	1	88,7	91	113,8	99,7	1	1
100	130	113	11,3	11,3	5	1	1	110,1	113	143,2	123,5	1	1
125	160	138	13,5	13,5	6	1	1	136,5	138	172	152	1	1
160	200	177	13,5	13,5	6	1	1	172	177	222	190	1	1
200	250	221	15,5	15,5	7	1,1	1,1	213	221	279,5	237,5	1	1

Maintenance-free radial spherical plain bearings

SKF maintenance-free spherical plain bearings are produced in a variety of designs and a wide range of sizes. Three sliding contact surface combinations are available:

- steel/sinter bronze composite, suffix C
- steel/PTFE fabric, suffix T
- steel/PTFE composite, suffix F

The different designs of SKF maintenance-free spherical plain bearings are presented in **Matrix 1**. The designs used depend on size and series, the main differences being in the material or in the design of the outer ring.

Materials

The materials for inner ring, outer ring, sliding layer and, where applicable, for the double-lip rubbing seals, are listed in **Matrix 1**. The sliding contact surface of the inner rings of series GEC and GEP bearings are coated with a lithium base grease.

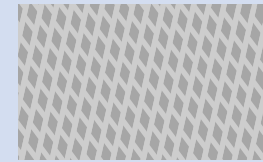
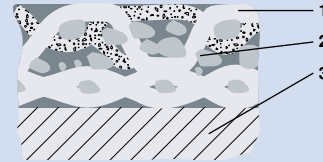


Sliding contact surface combination

Steel/sinter bronze composite

Steel/PTFE fabric

Steel/PTFE composite



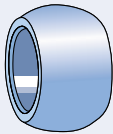
Liner

1 PTFE
2 Tin bronze
3 Copper layer
4 Sheet steel backing

1 PTFE/glass fibre fabric
2 Glass fibre fabric
3 Phenolic or epoxy resin

Glass fibre reinforced plastic containing PTFE

Inner ring



C and CJ2 designs

Carbon chromium steel 100 Cr 6/1.3505, hardened, ground, sliding surface hard chromium plated and polished.

TA and TE designs

Carbon chromium steel 100 Cr 6/1.3505, hardened, ground, sliding surface hard chromium plated and polished

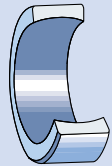
Series GEP and GEC

Carbon chromium steel 100 Cr 6/1.3505, hardened, ground, sliding surface of series GEP hard chromium plated

TGR and TG3A designs

Stainless steel X 46 Cr 13/1.4034, hardened, ground, sliding surface polished

Outer ring



C design

Sinter bronze composite moulded around the inner ring, with a butt joint

CJ2 design

Unhardened automatic steel with sliding sleeve of sinter bronze composite pressed around the inner ring, without a butt joint.

TA and TE designs

Carbon chromium steel 100 Cr 6/1.3505, hardened, ground
TA: split two-piece, held together by one or two steel bands
TE: fractured at one point

TG3A design

Stainless steel X 46 Cr 13/1.4034, hardened, ground, split two-piece, held together by one steel band

TGR design

d ≤ 17 mm: unhardened stainless steel X 22 CrNi 17/1.4057, pressed over the inner ring, no butt joint
d ≥ 20 mm: hardened stainless steel X 46 Cr 13/1.4034, hardened, ground, fractured at one position

Series GEP and GEC

Series GEP: unhardened heat treatable steel C35/1.0501, ground, radially split. A liner of glass fibre reinforced plastic containing PTFE is glued in position in each outer ring half.

Series GEC: Unhardened heat treatable steel C35/1.0501, ground. With sliding discs made of glass fibre reinforced plastic containing PTFE held by a cage made of unhardened steel C35/1.0501, which is pinned and screwed together with the outer ring.

Seals



To order

Bearings with designation suffix 2RS have double lip seals at both sides

None

Operating temperature range



Permissible: -50 to +180 °C
For short periods: to +280 °C

Reduced carrying capacity above 80 °C

Bearings without seals:
Permissible: -50 to +150 °C
Sealed bearings:
Permissible: -30 to +130 °C

Reduced carrying capacity above 60 °C for both sealed and unsealed bearings

Permissible: -40 to +75 °C
For short periods: to +110 °C

Reduced carrying capacity above 50 °C

Lubrication

To enhance sealing and protect against corrosion the free space in the housing may be filled with grease

The bearings must not be lubricated

Occasional relubrication is beneficial and extends service life

Dimensions

The dimensions of the maintenance-free spherical plain bearings conform to ISO 12240-1:1998.

Tolerances

The tolerances to which maintenance-free radial spherical plain bearings are made are given in **Table 1**; they are in accordance to ISO 12240/1:1998.

The symbols used are explained in the following.

- d nominal bore diameter
- Δ_{dmp} deviation of the mean bore diameter from the nominal
- D nominal outside diameter
- Δ_{Dmp} deviation of the mean outside diameter from the nominal
- Δ_{Bs} deviation of single inner ring width from the nominal
- Δ_{Cs} deviation of single outer ring width from the nominal

Radial internal clearance, preload

Maintenance free spherical plain bearings with a bore diameter up to and including 90 mm may have an internal clearance or a slight preload (negative clearance) because of their design. For these bearings, therefore, only the permissible maximum limit for bearing clearance is given in the table, and also only the permissible upper limit for the frictional moment depending on the preload in the circumferential direction under measuring load.

The radial internal clearance and the upper limit of the permissible frictional moment of bearings with the sliding contact surface combination steel/sinter bronze composite and steel/PTFE fabric are given in **Table 2**. The values for the clearance limits of bearings with the sliding contact surface combination steel/PTFE composite are listed in **Table 3**.

Table 1

Nominal diameter d, D		Inner ring				Outer ring			
		Δ_{dmp}		Δ_{Bs}		Δ_{Dmp}		Δ_{Cs}	
over	incl.	high	low	high	low	high	low	high	low
mm		μm		μm		μm		μm	
18	18	0	-8	0	-120	0	-8	0	-240
30	30	0	-10	0	-120	0	-9	0	-240
30	50	0	-12	0	-120	0	-11	0	-240
50	80	0	-15	0	-150	0	-13	0	-300
80	120	0	-20	0	-200	0	-15	0	-400
120	150	0	-25	0	-250	0	-18	0	-500
150	180	0	-25	0	-250	0	-25	0	-500
180	250	0	-30	0	-300	0	-30	0	-600
250	315	0	-35	0	-350	0	-35	0	-700
315	400	0	-40	0	-400	0	-40	0	-800
400	500	0	-45	0	-450	0	-45	0	-900
500	630	0	-50	0	-500	0	-50	0	-1 000
630	800	0	-75	0	-750	0	-75	0	-1 100
800	1 000	0	-100	0	-1 000	0	-100	0	-1 200
1 000	1 250	0	-125	0	-1 250	0	-125	0	-1 300
1 250	1 600	-	-	-	-	0	-160	0	-1 600
1 600	2 000	-	-	-	-	0	-200	0	-2 000

Tolerances of maintenance-free radial bearings

Permissible operating temperature range

The permissible operating temperature range of maintenance-free spherical plain bearings depends on the sliding contact surface combination and also on the polyester elastomer material of the seals (\rightarrow **Matrix 1**). However, if the load carrying capacity of the bearings is fully exploited the temperature range is narrowed. Under normal loads it is possible to operate at temperatures above the upper limit for brief periods.

Internal clearance and frictional moment of steel/sinter bronze composite and steel/PTFE fabric bearings

Maintenance-free radial spherical plain bearings

Table 2

Bore diameter		Series		GE .. TA, TE, TGR, TG3A		
d		GE .. C, CJ2		Internal clearance	Frictional moment	
over	incl.	Internal clearance max	Frictional moment max	min	max	max
mm		µm	Nm	µm		Nm
	12	28	0,15	–	32	1
12	17	35	0,25	–	40	1
17	20	35	0,25	–	40	1,5
	20	44	0,40	–	50	2
20	30	53	0,75	–	50	2,5
30	35	53	0,75	–	60	2,5
35	40					
	40	53	0,75	–	60	3,5
40	45	53	0,75	–	60	4
45	50	53	0,75	–	60	4,5
50	60					
	60	–	–	–	72	5
60	70	–	–	–	72	6
70	90	–	–	85	165	–
90	140					
	140	–	–	100	192	–
140	200	–	–	110	215	–
200	240	–	–	125	240	–
240	300					

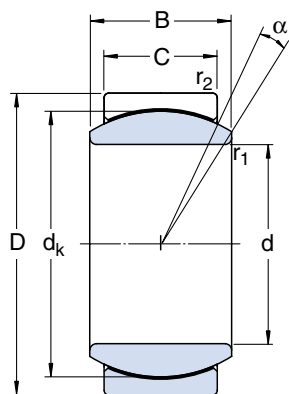
3.2

Internal clearance for steel/PTFE composite bearings

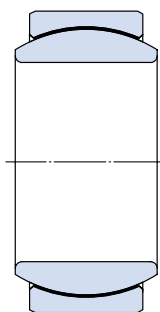
Table 3

Bore diameter		Radial internal clearance			
d		Series GEP		Series GEC	
over	incl.	min	max	min	max
mm		µm			
	90	85	285	–	–
90	120	100	355	–	–
120	220	110	365	–	–
220	240				
	240	110	380	–	–
240	280	135	415	–	–
280	300	135	490	135	600
300	360				
	360	135	490	135	630
360	380	135	510	135	630
380	400	145	540	145	640
400	480				
	480	145	570	145	640
480	500	160	610	160	670
500	600	160	640	160	670
600	630				
	630	170	670	170	690
630	750	170	670	170	760
750	800	170	700	170	760
	800	195	770	195	800
800	950	195	820	195	800
950	1 000	–	–	220	820
1 000	1 250				

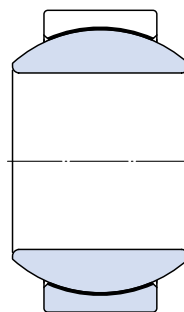
Maintenance-free spherical plain bearings with sliding contact surface combination steel/sinter bronze composite
d 4 – 60 mm



GE .. C



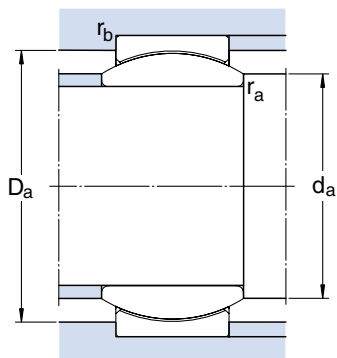
GE .. CJ2



GEH .. C

Principal dimensions				Angle of tilt ¹⁾ α	Basic load ratings		Mass	Designation
d	D	B	C		dynamic C	static C ₀		
mm				degrees	N		kg	–
4	12	5	3	16	2 160	5 400	0,003	GE 4 C
6	14	6	4	13	3 600	9 000	0,004	GE 6 C
8	16	8	5	15	5 850	14 600	0,008	GE 8 C
10	19	9	6	12	8 650	21 600	0,012	GE 10 C
	22	12	7	18	11 400	28 500	0,020	GEH 10 C
12	22	10	7	10	11 400	28 500	0,017	GE 12 C
	26	15	9	18	18 000	45 000	0,030	GEH 12 C
15	26	12	9	8	18 000	45 000	0,032	GE 15 C
	30	16	10	16	22 400	56 000	0,050	GEH 15 C
17	30	14	10	10	22 400	56 000	0,050	GE 17 C
	35	20	12	19	31 500	78 000	0,090	GEH 17 C
20	35	16	12	9	31 500	78 000	0,065	GE 20 C
	42	25	16	17	51 000	127 000	0,16	GEH 20 C
25	42	20	16	7	51 000	127 000	0,12	GE 25 C
	47	28	18	17	65 500	166 000	0,20	GEH 25 C
30	47	22	18	6	65 500	166 000	0,16	GE 30 C
35	55	25	20	6	85 000	212 000	0,23	GE 35 CJ2
40	62	28	22	7	104 000	260 000	0,32	GE 40 CJ2
45	68	32	25	7	134 000	340 000	0,46	GE 45 CJ2
50	75	35	28	6	166 000	415 000	0,56	GE 50 CJ2
60	90	44	36	6	260 000	655 000	1,10	GE 60 CJ2

¹⁾ To fully utilise the angle of tilt, the shaft shoulder should not be made larger than $d_{a\max}$

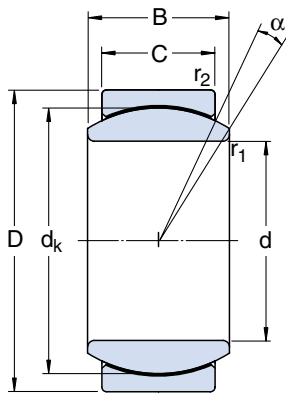


Dimensions

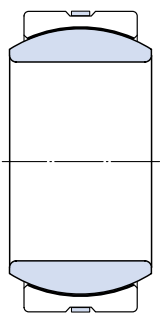
Abutment and fillet dimensions

d	d _k	r ₁ min	r ₂ min	d _a min	d _a max	D _a max	D _a min	r _a max	r _b max
mm									
4	8	0,3	0,3	5,4	6,2	10,7	7,6	0,3	0,3
6	10	0,3	0,3	7,4	8	12,7	9,5	0,3	0,3
8	13	0,3	0,3	9,4	10,2	14,6	12,3	0,3	0,3
10	16	0,3	0,3	11,5	13,2	17,6	15,2	0,3	0,3
	18	0,3	0,3	11,6	13,4	20,6	17,1	0,3	0,3
12	18	0,3	0,3	13,5	15	20,6	17,1	0,3	0,3
	22	0,3	0,3	13,7	16,1	24,5	20,9	0,3	0,3
15	22	0,3	0,3	16,6	18,4	24,5	20,9	0,3	0,3
	25	0,3	0,3	16,7	19,2	28,5	23,7	0,3	0,3
17	25	0,3	0,3	18,7	20,7	28,5	23,7	0,3	0,3
	29	0,3	0,3	18,9	21	33,4	27,6	0,3	0,3
20	29	0,3	0,3	21,8	24,2	33,4	27,6	0,3	0,3
	35,5	0,3	0,6	22,1	25,2	39,5	33,7	0,3	0,6
25	35,5	0,6	0,6	27,7	29,3	39,5	33,7	0,6	0,6
	40,7	0,6	0,6	27,9	29,5	44,4	38,7	0,6	0,6
30	40,7	0,6	0,6	32,8	34,2	44,4	38,7	0,6	0,6
35	47	0,6	1	37,9	39,8	51,4	44,7	0,6	1
40	53	0,6	1	42,9	45	58,3	50,4	0,6	1
45	60	0,6	1	48,7	50,8	64,2	57	0,6	1
50	66	0,6	1	53,9	56	71,1	62,7	0,6	1
60	80	1	1	65,4	66,8	85,8	76	1	1

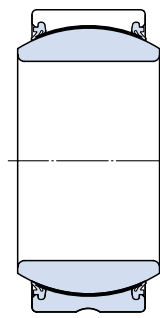
Maintenance-free spherical plain bearings with sliding contact surface combination steel/PTFE fabric
d 12 – 140 mm



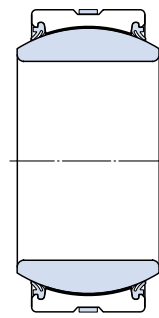
GE .. TGR



GE .. TG3A



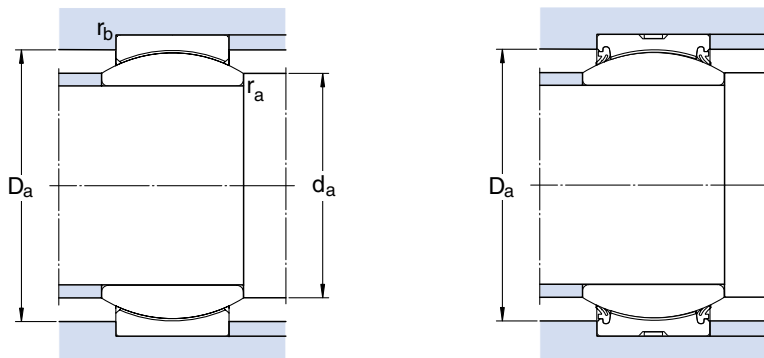
GE .. TE-2RS



GE .. T(G3)A-2RS

Principal dimensions				Angle of tilt ¹⁾	Basic load ratings		Mass	Designation
d	D	B	C		dynamic	static		
				α	C	C ₀		
mm				degrees	N		kg	–
12	22	10	7	10	15 000	30 000	0,017	GE 12 TGR
15	26	12	9	8	23 600	47 500	0,032	GE 15 TGR
17	30	14	10	10	30 000	60 000	0,050	GE 17 TGR
20	35	16	12	9	41 500	83 000	0,065	GE 20 TGR
25	42	20	16	7	68 000	137 000	0,12	GE 25 TGR
	42	20	16	7	68 000	137 000	0,12	GE 25 TE-2RS
30	47	22	18	6	88 000	176 000	0,16	GE 30 TGR
	47	22	18	6	88 000	176 000	0,16	GE 30 TE-2RS
35	55	25	20	6	112 000	224 000	0,23	GE 35 TGR
	55	25	20	6	112 000	224 000	0,23	GE 35 TE-2RS
40	62	28	22	7	140 000	280 000	0,32	GE 40 TGR
	62	28	22	6	140 000	280 000	0,32	GE 40 TE-2RS
45	68	32	25	7	180 000	360 000	0,46	GE 45 TGR
	68	32	25	7	180 000	360 000	0,46	GE 45 TE-2RS
50	75	35	28	6	220 000	440 000	0,56	GE 50 TGR
	75	35	28	6	220 000	440 000	0,56	GE 50 TE-2RS
60	90	44	36	6	345 000	695 000	1,10	GE 60 TGR
	90	44	36	6	345 000	695 000	1,10	GE 60 TE-2RS
70	105	49	40	6	440 000	880 000	1,55	GE 70 TG3A
	105	49	40	6	440 000	880 000	1,55	GE 70 TE-2RS
80	120	55	45	6	570 000	1 140 000	2,30	GE 80 TG3A
	120	55	45	5	570 000	1 140 000	2,30	GE 80 TE-2RS
90	130	60	50	5	695 000	1 370 000	2,75	GE 90 TG3A
	130	60	50	5	695 000	1 370 000	2,75	GE 90 TE-2RS
100	150	70	55	6	865 000	1 730 000	4,40	GE 100 TA-2RS
	150	70	55	6	865 000	1 730 000	4,40	GE 100 TG3A-2RS
110	160	70	55	6	930 000	1 860 000	4,80	GE 110 TA-2RS
	160	70	55	6	930 000	1 860 000	4,80	GE 110 TG3A-2RS
120	180	85	70	6	1 340 000	2 700 000	8,25	GE 120 TA-2RS
	180	85	70	6	1 340 000	2 700 000	8,25	GE 120 TG3A-2RS
140	210	90	70	7	1 500 000	3 000 000	11,0	GE 140 TA-2RS
	210	90	70	7	1 500 000	3 000 000	11,0	GE 140 TG3A-2RS

¹⁾ To fully utilise the angle of tilt, the shaft shoulder should not be made larger than $d_{a \max}$

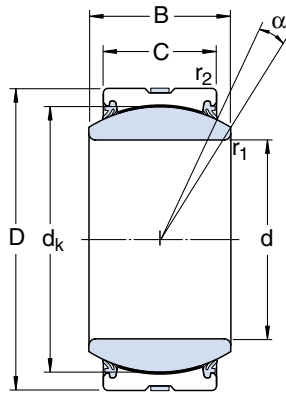


Dimensions

Abutment and fillet dimensions

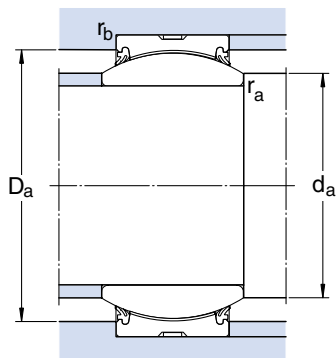
d	d_k	r_1 min	r_2 min	d_a min	d_a max	D_a max	D_a min	r_a max	r_b max
mm									
12	18	0,3	0,3	13,5	15	20,6	17,1	0,3	0,3
15	22	0,3	0,3	16,6	18,4	24,5	20,9	0,3	0,3
17	25	0,3	0,3	18,7	20,7	28,5	23,7	0,3	0,3
20	29	0,3	0,3	21,8	24,2	33,4	27,6	0,3	0,3
25	35,5	0,6	0,6	27,8	29,3	39,5	33,7	0,6	0,6
	35,5	0,6	0,6	27,8	29,3	39,5	36,9	0,6	0,6
30	40,7	0,6	0,6	32,8	34,2	44,4	38,7	0,6	0,6
	40,7	0,6	0,6	32,8	34,2	44,4	41,3	0,6	0,6
35	47	0,6	1	37,9	39,8	51,3	44,6	0,6	1
	47	0,6	1	37,9	39,8	51,3	48,5	0,6	1
40	53	0,6	1	43	45	58,3	50,3	0,6	1
	53	0,6	1	43	45	58,3	54,5	0,6	1
45	60	0,6	1	48,8	50,8	64,1	57	0,6	1
	60	0,6	1	48,8	50,8	64,1	61	0,6	1
50	66	0,6	1	53,9	56	71	62,7	0,6	1
	66	0,6	1	53,9	56	71	66,2	0,6	1
60	80	1	1	65,5	66,8	84,9	76	1	1
	80	1	1	65,5	66,8	84,9	79,7	1	1
70	92	1	1	75,6	77,9	99,8	87,4	1	1
	92	1	1	75,6	77,9	99,8	92	1	1
80	105	1	1	85,9	89,4	114,7	99,7	1	1
	105	1	1	85,9	89,4	114,7	104,4	1	1
90	115	1	1	96	98,1	124,5	109,3	1	1
	115	1	1	96	98,1	124,5	112,9	1	1
100	130	1	1	106,4	109,5	144,4	131	1	1
	130	1	1	106,4	109,5	144,4	131	1	1
110	140	1	1	116,5	121	154	141,5	1	1
	140	1	1	116,5	121	154	141,5	1	1
120	160	1	1	127,5	135,5	173,5	157,5	1	1
	160	1	1	127,5	135,5	173,5	157,5	1	1
140	180	1	1	147	155,5	203,5	180	1	1
	180	1	1	147	155,5	203,5	180	1	1

Maintenance-free spherical plain bearings with sliding contact surface combination steel/PTFE fabric
d 160 – 300 mm



Principal dimensions				Angle of tilt ¹⁾	Basic load ratings		Mass	Designation
d	D	B	C	α	dynamic	static		
				degrees	C	C ₀		
mm					N		kg	–
160	230	105	80	8	1 930 000	3 800 000	14,0	GE 160 TA-2RS
	230	105	80	8	1 930 000	3 800 000	14,0	GE 160 TG3A-2RS
180	260	105	80	6	2 160 000	4 300 000	18,5	GE 180 TA-2RS
	260	105	80	6	2 160 000	4 300 000	18,5	GE 180 TG3A-2RS
200	290	130	100	7	3 000 000	6 000 000	28,0	GE 200 TA-2RS
	290	130	100	7	3 000 000	6 000 000	28,0	GE 200 TG3A-2RS
220	320	135	100	8	3 350 000	6 550 000	35,5	GE 220 TA-2RS
240	340	140	100	8	3 600 000	7 200 000	40,0	GE 240 TA-2RS
260	370	150	110	7	4 300 000	8 650 000	51,5	GE 260 TA-2RS
280	400	155	120	6	5 000 000	10 000 000	65,0	GE 280 TA-2RS
300	430	165	120	7	5 400 000	10 800 000	78,5	GE 300 TA-2RS

¹⁾ To fully utilise the angle of tilt, the shaft shoulder should not be made larger than $d_{a\max}$



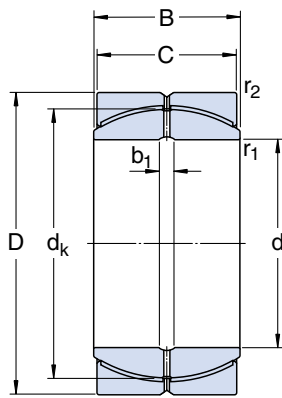
Dimensions

Abutment and fillet dimensions

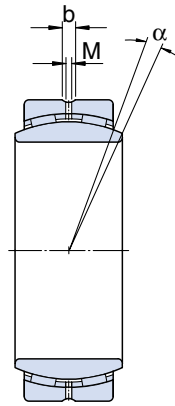
d	d _k	r ₁ min	r ₂ min	d _a min	d _a max	D _a max	D _a min	r _a max	r _b max
mm									
160	200	1	1	167,5	170	223,5	197	1	1
	200	1	1	167,5	170	223,5	197	1	1
180	225	1,1	1,1	189	199	252	224,5	1	1
	225	1,1	1,1	189	199	252	224,5	1	1
200	250	1,1	1,1	209,5	213,5	281,5	244,5	1	1
	250	1,1	1,1	209,5	213,5	281,5	244,5	1	1
220	275	1,1	1,1	229,5	239,5	311,5	271	1	1
240	300	1,1	1,1	249,5	265	331,5	298	1	1
260	325	1,1	1,1	270	288	361	321,5	1	1
280	350	1,1	1,1	290,5	313,5	391	344,5	1	1
300	375	1,1	1,1	310,5	336,5	421	371	1	1

3.2

Maintenance-free spherical plain bearings with sliding contact surface combination steel/PTFE composite
d 100 – 480 mm



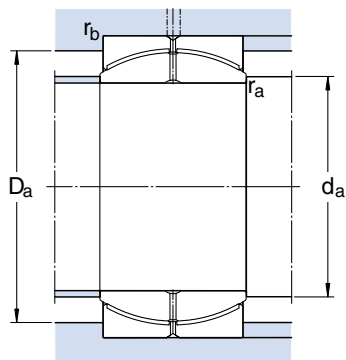
GEP .. FS



GEC .. FSA

Principal dimensions				Angle of tilt ¹⁾	Basic load ratings		Mass	Designation
d	D	B	C	α	dynamic	static		
				degrees	C	C ₀	kg	–
100	150	71	67	2	600 000	900 000	4,51	GEP 100 FS
110	160	78	74	2	720 000	1 080 000	5,35	GEP 110 FS
120	180	85	80	2	850 000	1 270 000	7,96	GEP 120 FS
140	210	100	95	2	1 200 000	1 800 000	13,0	GEP 140 FS
160	230	115	109	2	1 600 000	2 400 000	16,6	GEP 160 FS
180	260	128	122	2	2 080 000	3 100 000	24,4	GEP 180 FS
200	290	140	134	2	2 450 000	3 650 000	33,5	GEP 200 FS
220	320	155	148	2	3 050 000	4 550 000	45,8	GEP 220 FS
240	340	170	162	2	3 550 000	5 400 000	53,7	GEP 240 FS
260	370	185	175	2	4 250 000	6 400 000	69,5	GEP 260 FS
280	400	200	190	2	5 000 000	7 500 000	89,5	GEP 280 FS
300	430	212	200	2	5 600 000	8 300 000	110	GEP 300 FS
320	440	160	135	4	2 800 000	4 150 000	73,0	GEC 320 FSA
	460	230	218	2	6 400 000	9 650 000	135	GEP 320 FS
340	460	160	135	3	2 900 000	4 400 000	77,0	GEC 340 FSA
	480	243	230	2	7 100 000	10 800 000	150	GEP 340 FS
360	480	160	135	3	3 100 000	4 650 000	80,0	GEC 360 FSA
	520	258	243	2	8 150 000	12 200 000	200	GEP 360 FS
380	520	190	160	4	3 900 000	5 850 000	120	GEC 380 FSA
	540	272	258	2	9 150 000	13 700 000	220	GEP 380 FS
400	540	190	160	3	4 050 000	6 100 000	125	GEC 400 FSA
	580	280	265	2	9 650 000	14 600 000	275	GEP 400 FS
420	560	190	160	3	4 250 000	6 400 000	130	GEC 420 FSA
	600	300	280	2	10 600 000	16 000 000	300	GEP 420 FS
440	600	218	185	3	5 200 000	7 800 000	180	GEC 440 FSA
	630	315	300	2	12 200 000	18 600 000	360	GEP 440 FS
460	620	218	185	3	5 400 000	8 150 000	190	GEC 460 FSA
	650	325	308	2	12 900 000	19 600 000	380	GEP 460 FS
480	650	230	195	3	6 000 000	9 000 000	220	GEC 480 FSA
	680	340	320	2	14 300 000	21 200 000	435	GEP 480 FS

¹⁾ To fully utilise the angle of tilt, the shaft shoulder should not be made larger than $d_{a\max}$

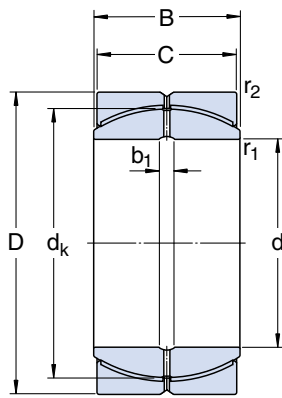


Dimensions

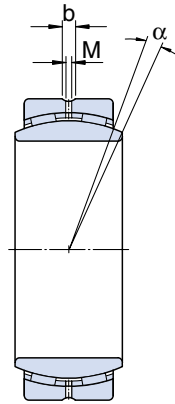
Abutment and fillet dimensions

d	d _k	b	b ₁	M	r ₁ min	r ₂ min	d _a min	d _a max	D _a max	D _a min	r _a max	r _b max
mm							mm					
100	135	7,5	7,5	4	1	1	106,7	114,8	141,9	125,6	1	1
110	145	7,5	7,5	4	1	1	117	122	151	135	1	1
120	160	7,5	7,5	4	1	1	127,5	135,5	171	149	1	1
140	185	7,5	7,5	4	1	1	148	155,5	200	172,5	1	1
160	210	7,5	7,5	4	1	1	169	175,5	218,5	195,5	1	1
180	240	7,5	7,5	4	1,1	1,1	191	203	246,5	223,5	1	1
200	260	11,5	11,5	5	1,1	1,1	211	219	276	242	1	1
220	290	13,5	13,5	6	1,1	1,1	232	245	304,5	270	1	1
240	310	13,5	13,5	6	1,1	1,1	252,5	259	323,5	288,5	1	1
260	340	15,5	15,5	7	1,1	1,1	273,5	285	352,5	316,5	1	1
280	370	15,5	15,5	7	1,1	1,1	294	311	381,5	344,5	1	1
300	390	15,5	15,5	7	1,1	1,1	314,5	327	411	363	1	1
320	380	21	–	8	1,1	3	327	344	427	381	1	3
	414	21	21	8	1,1	3	335	344	434	385	1	3
340	400	21	–	8	1,1	3	347	366	447	401	1	3
	434	21	21	8	1,1	3	356	359	453	404	1	3
360	420	21	–	8	1,1	3	367	388	467	421	1	3
	474	21	21	8	1,1	4	377	397	490	441	1	4
380	450	21	–	8	1,5	4	389	407	505	451	1,5	4
	494	21	21	8	1,5	4	398	412	508	460	1,5	4
400	470	21	–	8	1,5	4	409	429	525	471	1,5	4
	514	21	21	8	1,5	4	418	431	549	478	1,5	4
420	490	21	–	8	1,5	4	429	451	545	491	1,5	4
	534	21	21	8	1,5	4	439	441	568	497	1,5	4
440	520	27	–	10	1,5	4	449	472	584	521	1,5	4
	574	27	27	10	1,5	4	460	479	596	534	1,5	4
460	540	27	–	10	1,5	4	469	494	604	541	1,5	4
	593	27	27	10	1,5	5	481	496	612	552	1,5	5
480	565	27	–	10	2	5	491	516	631	566	2	5
	623	27	27	10	2	5	503	522	641	580	2	5

Maintenance-free spherical plain bearings with sliding contact surface combination steel/PTFE composite
d 500 – 1 250 mm



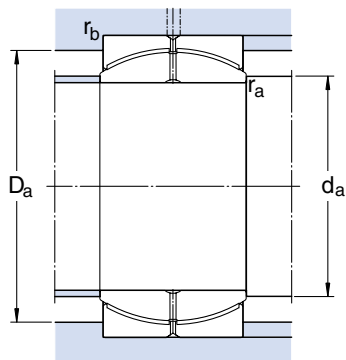
GEP .. FS



GEC .. FSA

Principal dimensions				Angle of tilt ¹⁾	Basic load ratings		Mass	Designation
d	D	B	C	α	dynamic	static		
				degrees	C	C ₀	kg	–
500	670	230	195	3	6 200 000	9 300 000	230	GEC 500 FSA
	710	355	335	2	15 300 000	23 200 000	500	GEP 500 FS
530	710	243	205	3	6 950 000	10 400 000	270	GEC 530 FSA
	750	375	355	2	17 000 000	25 500 000	585	GEP 530 FS
560	750	258	215	4	7 650 000	11 400 000	320	GEC 560 FSA
	800	400	380	2	19 600 000	29 000 000	730	GEP 560 FS
600	800	272	230	3	8 800 000	13 200 000	385	GEC 600 FSA
	850	425	400	2	22 000 000	33 500 000	860	GEP 600 FS
630	850	300	260	3	10 400 000	15 600 000	495	GEC 630 FSA
	900	450	425	2	24 500 000	37 500 000	1 040	GEP 630 FS
670	900	308	260	3	11 000 000	16 600 000	560	GEC 670 FSA
	950	475	450	2	27 500 000	41 500 000	1 210	GEP 670 FS
710	950	325	275	3	12 500 000	18 600 000	655	GEC 710 FSA
	1 000	500	475	2	31 000 000	46 500 000	1 400	GEP 710 FS
750	1 000	335	280	3	13 400 000	20 000 000	735	GEC 750 FSA
	1 060	530	500	2	34 500 000	52 000 000	1 670	GEP 750 FS
800	1 060	355	300	3	15 300 000	22 800 000	865	GEC 800 FSA
	1 120	565	530	2	39 000 000	58 500 000	1 940	GEP 800 FS
850	1 120	365	310	3	16 600 000	25 000 000	980	GEC 850 FSA
	1 220	600	565	2	45 000 000	67 000 000	2 600	GEP 850 FS
900	1 180	375	320	3	18 300 000	27 500 000	1 100	GEC 900 FSA
	1 250	635	600	2	49 000 000	73 500 000	2 690	GEP 900 FS
950	1 250	400	340	3	20 400 000	30 500 000	1 350	GEC 950 FSA
	1 360	670	635	2	56 000 000	85 000 000	3 620	GEP 950 FS
1 000	1 320	438	370	3	23 200 000	35 500 000	1 650	GEC 1000 FSA
	1 450	710	670	2	63 000 000	95 000 000	4 470	GEP 1000 FS
1 060	1 400	462	390	3	26 500 000	40 000 000	1 950	GEC 1060 FSA
1 120	1 460	462	390	3	28 000 000	41 500 000	2 050	GEC 1120 FSA
1 180	1 540	488	410	3	31 000 000	46 500 000	2 400	GEC 1180 FSA
1 250	1 630	515	435	3	34 500 000	52 000 000	2 850	GEC 1250 FSA

¹⁾ To fully utilise the angle of tilt, the shaft shoulder should not be made larger than $d_{a,max}$



Dimensions

Abutment and fillet dimensions

d	d _k	b	b ₁	M	r ₁ min	r ₂ min	d _a min	d _a max	D _a max	D _a min	r _a max	r _b max
mm							mm					
500	585	27	—	10 2	2	5	511	537	651	586	2	5
	643	27	27	10 2	2	5	523	536	670	598	2	5
530	620	27	—	10 2	2	5	541	570	691	621	2	5
	673	27	27	10 2	2	5	554	558	709	626	2	5
560	655	27	—	10 2	2	5	571	602	731	656	2	5
	723	27	27	10 2	2	5	585	602	758	673	2	5
600	700	27	—	10 2	2	5	611	645	781	701	2	5
	773	27	27	10 2	2	6	627	645	801	719	2	6
630	740	35	—	13 3	3	6	645	676	827	741	3	6
	813	35	35	13 3	3	6	661	677	850	757	3	6
670	785	35	—	13 3	3	6	685	722	877	786	3	6
	862	35	35	13 3	3	6	702	719	898	802	3	6
710	830	35	—	13 3	3	6	725	763	926	831	3	6
	912	35	35	13 3	3	6	743	762	946	849	3	6
750	875	35	—	13 3	3	6	766	808	976	876	3	6
	972	35	35	13 3	3	6	784	814	1 005	904	3	6
800	930	35	—	13 3	3	6	816	859	1 036	931	3	6
	1 022	35	35	13 3	3	6	836	851	1 062	951	3	6
850	985	35	—	13 3	3	6	866	914	1 096	986	3	6
	1 112	35	35	13 3	3	7,5	888	936	1 156	1 035	3	7,5
900	1 040	35	—	13 3	3	6	916	970	1 156	1 041	3	6
	1 142	35	35	13 3	3	7,5	938	949	1 183	1 063	3	7,5
950	1 100	40	—	15 4	4	7,5	968	1 024	1 221	1 101	4	7,5
	1 242	40	40	15 4	4	7,5	993	1 045	1 290	1 156	4	7,5
1 000	1 160	40	—	15 4	4	7,5	1 019	1 074	1 290	1 161	4	7,5
	1 312	40	40	15 4	4	7,5	1 045	1 103	1 378	1 221	4	7,5
1 060	1 240	40	—	15 4	4	7,5	1 079	1 150	1 370	1 241	4	7,5
1 120	1 310	40	—	15 4	4	7,5	1 139	1 225	1 430	1 311	4	7,5
1 180	1 380	40	—	15 4	4	7,5	1 199	1 290	1 510	1 381	4	7,5
1 250	1 460	40	—	15 4	4	7,5	1 270	1 366	1 600	1 461	4	7,5

Angular contact spherical plain bearings

The sphered sliding contact surfaces of angular contact spherical plain bearings are inclined at an angle to the bearing axis (→ **fig 1**). Consequently, the bearings are particularly suitable for the accommodation of combined (radial and axial) loads. Singly mounted angular contact bearings can only support axial loads acting in one direction. The bearings are of separable design, e.g. the rings may be mounted separately.



Dimensions

The boundary dimensions of SKF angular contact spherical plain bearings conform to ISO 12240-2:1998.

Tolerances

SKF angular contact spherical plain bearings are made to the tolerances specified in **Table 1**. The tolerances conform to ISO 12240-2:1998.

The symbols used in the tolerance table are explained in the following.

- d nominal bore diameter
- D_{dmp} deviation of the mean bore diameter from the nominal
- D nominal outside diameter
- Δ_{Dmp} deviation of the mean outside diameter from the nominal
- Δ_{Bs} deviation of single inner ring width from the nominal
- Δ_{Cs} deviation of single outer ring width from the nominal
- Δ_{Ts} deviation of single bearing width (abutment width) from the nominal

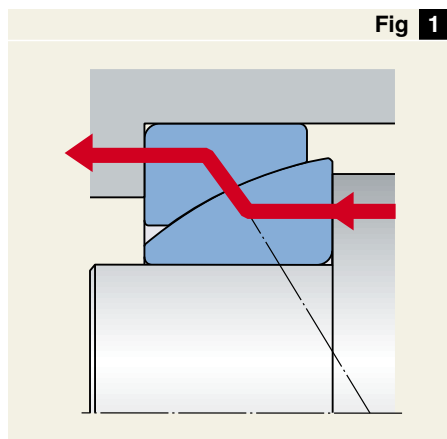
Table 1

Nominal diameter d, D		Inner ring				Outer ring				Total width	
		Δ_{dmp}		Δ_{Bs}		Δ_{Dmp}		Δ_{Cs}		Δ_{Ts}	
over	incl.	high	low	high	low	high	low	high	low	high	low
mm		μm		μm		μm		μm		μm	
18	50	0	-12	0	-240	0	-14	0	-240	+250	-400
50	80	0	-15	0	-300	0	-16	0	-300	+250	-500
80	120	0	-20	0	-400	0	-18	0	-400	+250	-600
120	150	-	-	-	-	0	-20	0	-500	-	-
150	180	-	-	-	-	0	-25	0	-500	-	-

Tolerances for angular contact spherical plain bearings

Load line through angular contact spherical plain bearing

Fig 1



Radial internal clearance, preload

Internal clearance in a single angular contact spherical plain bearing is only obtained after mounting and is dependent on adjustment against a second bearing, which provides axial location in the opposite direction.

Angular contact spherical plain bearings are generally mounted in pairs in a back-to-back or face-to-face arrangement; the bearings are adjusted against each other by axially displacing one bearing ring until a specific bearing load of 10 N/mm^2 is obtained. The preload prevents some of the elastic and plastic deformations, which would occur under load and after a short period of operation. When adjusting bearings for the first time in a new arrangement, the specific bearing load of 10 N/mm^2 is achieved when the frictional moment and the axial preload force lie in the ranges specified in **Table 2**.

Materials

The inner and outer rings of SKF angular contact spherical plain bearings are made of carbon chromium steel 100 Cr 6/1.3505, and are hardened and ground. The sliding surface of the inner ring is hard chromium plated and coated with a lithium base grease. The sliding layer of glass fibre reinforced plastic containing PTFE additives is injection moulded in the outer ring.

Permissible operating temperature range

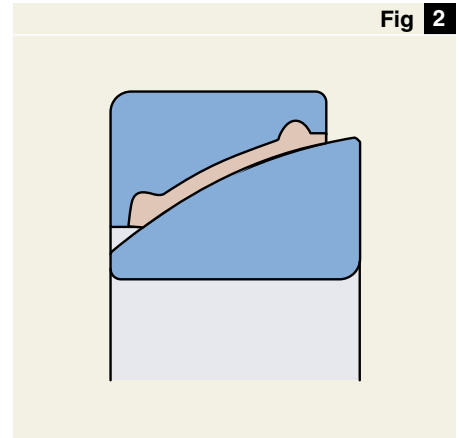
Spherical plain bearings with the sliding contact surface combination steel/PTFE composite can be used in the temperature range of -40 to $+75 \text{ }^\circ\text{C}$, although brief periods of operation up to $+110 \text{ }^\circ\text{C}$ are permitted. However, the load carrying capacity of the bearings will be reduced at temperatures above $+50 \text{ }^\circ\text{C}$.

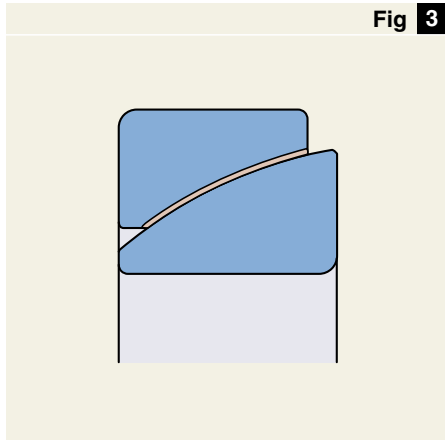
Table 2

Bearing	Frictional moment for 10 N/mm^2		Axial preload force for 10 N/mm^2
	min	max	
–	Nm		N
GAC 25 F	7	9	5 600
GAC 30 F	12	14	7 500
GAC 35 F	16	19	9 300
GAC 40 F	21	25	10 600
GAC 45 F	26	32	13 600
GAC 50 F	31	38	12 900
GAC 60 F	51	62	17 800
GAC 70 F	76	92	21 000
GAC 80 F	105	126	30 000
GAC 90 F	153	184	41 700
GAC 100 F	180	216	39 500
GAC 110 F	273	328	54 500
GAC 120 F	317	380	69 500

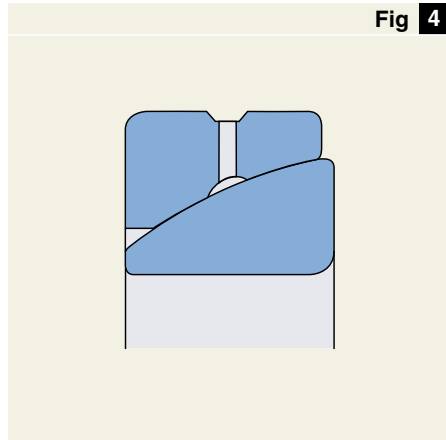
Frictional moment and axial preload force

Fig 2

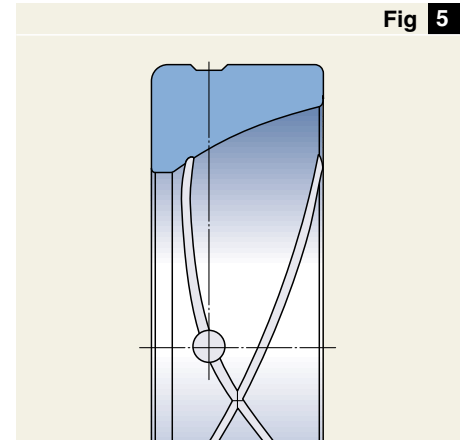
**Standard angular contact spherical plain bearing**



Maintenance-free bearing, sliding contact surface combination steel/PTFE fabric



Steel-on-steel bearing



Steel-on-steel bearing with "pendulum" grooves

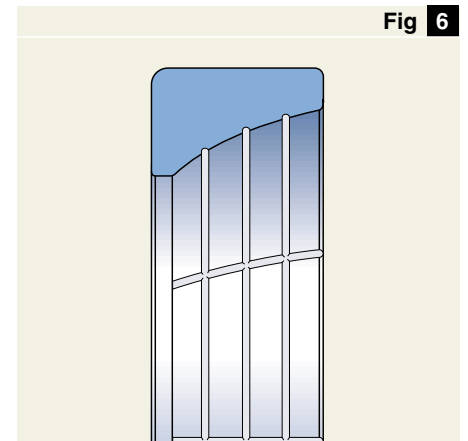
Special designs

Special operating conditions may call for angular contact spherical plain bearings with sliding contact surface combinations steel-on-steel or steel/PTFE fabric and, consequently, such bearings are also produced by SKF.

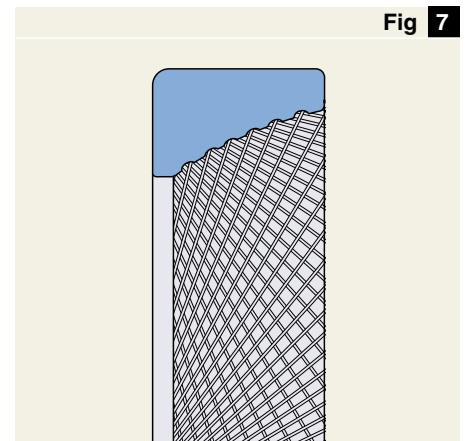
Bearings with sliding contact surface combination steel/PTFE fabric (→ fig 3) should be used when maintenance-free operation is specified and where the bearing arrangement is such that the presence of any lubricant is not permitted.

Steel-on-steel bearings (→ fig 4) are preferred where operating temperatures, loads or load frequencies are high or where shock loads occur. To ensure correct operation, steel-on-steel bearings must be provided with an adequate supply of lubricant. Depending on the lubricant the sliding surface of the outer ring may be equipped with various types of lubrication grooves (→ figs 5 to 7).

Inch-size steel-on-steel angular contact spherical plain bearings are also available to order.



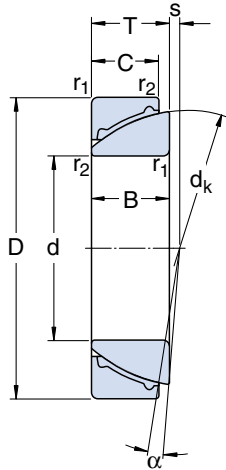
Steel-on-steel bearing with "waffle" grooves



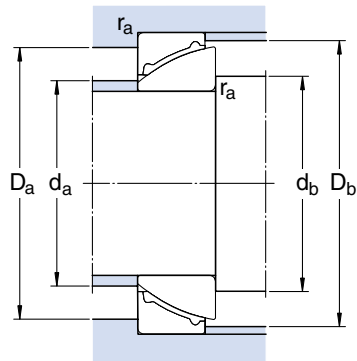
Steel-on-steel bearing with "diamond thread" grooves

3.3

Maintenance-free angular contact
spherical plain bearings with sliding
contact surface combination
steel/PTFE composite
d 25 – 120 mm



Principal dimensions			Angle of tilt	Basic load ratings		Mass	Designation
d	D	T	α	dynamic	static		
mm			degrees	C	C_0	kg	–
25	47	15	3,5	21 600	34 500	0,14	GAC 25 F
30	55	17	3,5	27 000	43 000	0,21	GAC 30 F
35	62	18	3,5	32 500	52 000	0,27	GAC 35 F
40	68	19	3,5	39 000	62 000	0,33	GAC 40 F
45	75	20	3	45 500	73 500	0,42	GAC 45 F
50	80	20	3	53 000	85 000	0,46	GAC 50 F
60	95	23	3	69 500	112 000	0,73	GAC 60 F
70	110	25	2,5	88 000	143 000	1,05	GAC 70 F
80	125	29	2,5	110 000	176 000	1,55	GAC 80 F
90	140	32	2,5	134 000	216 000	2,10	GAC 90 F
100	150	32	2	170 000	270 000	2,35	GAC 100 F
110	170	38	2	200 000	320 000	3,70	GAC 110 F
120	180	38	1,5	240 000	380 000	4,00	GAC 120 F



Dimensions

Abutment and fillet dimensions

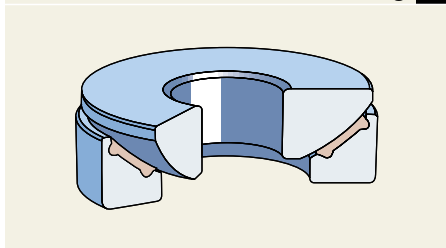
d	d _k	B	C	r ₁ min	r ₂ min	s	d _a max	d _b max	D _a min	D _b min	r _a max
mm							mm				
25	42	15	14	0,6	0,3	0,6	29	39	34	43	0,6
30	49,5	17	15	1	0,3	1,3	35	45	39	50,5	1
35	55,5	18	16	1	0,3	2,1	40	50	45	56,5	1
40	62	19	17	1	0,3	2,8	45	54	50	63	1
45	68,5	20	18	1	0,3	3,5	51	60	55	69	1
50	74	20	19	1	0,3	4,3	56	67	60	74,5	1
60	88,5	23	21	1,5	0,6	5,7	68	77	70	90	1,5
70	102	25	23	1,5	0,6	7,2	78	92	85	103	1,5
80	115	29	25,5	1,5	0,6	8,6	88	104	95	116	1,5
90	128,5	32	28	2	0,6	10,1	101	118	105	129	2
100	141	32	31	2	0,6	11,6	112	128	120	141	2
110	155	38	34	2,5	0,6	13	124	145	130	156	2,5
120	168	38	37	2,5	0,6	14,5	134	155	140	169	2,5

Spherical plain thrust bearings

Spherical plain thrust bearings have a sphered surface on the shaft washer and a hollow, correspondingly sphered surface in the housing washer (→ **fig 1**). They are primarily intended to carry axial loads but are also suitable for the accommodation of radial loads in addition to simultaneously acting axial loads. The radial load component of combined loads should not exceed 50 % of the simultaneously acting axial load. When radial loads are very heavy it may be advisable to combine thrust bearings with larger radial bearings of dimension series GE (→ **fig 2**).

Spherical plain thrust bearings are of separable design, e.g. the washers may be mounted separately.

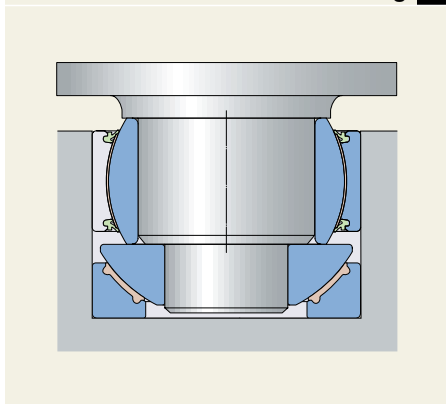
Fig 1



Standard spherical plain thrust bearing

Combination of radial and thrust bearings

Fig 2



Dimensions

The principal dimensions of SKF spherical plain thrust bearings conform to ISO 12240-3:1998.

Tolerances

SKF spherical plain thrust bearings are made to the tolerances specified in **Table 1**. The tolerances conform to ISO 12240-3:1998.

The symbols used in the tolerance table are explained in the following.

- d nominal bore diameter
- Δ_{dmp} deviation of the mean bore diameter from the nominal diameter
- D nominal outside diameter
- Δ_{Dmp} deviation of the mean outside diameter from the nominal diameter
- Δ_{Bs} deviation of single shaft washer width from the nominal
- Δ_{Cs} deviation of single housing washer width from the nominal
- Δ_{Ts} deviation of single height of thrust bearing from the nominal

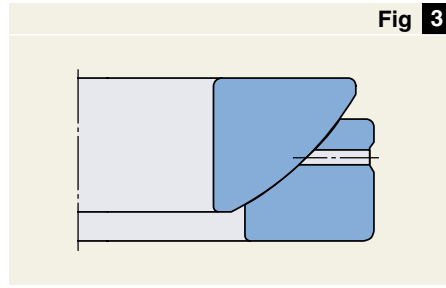
Materials

The shaft and housing washers of SKF spherical plain thrust bearings are made of carbon chromium steel 100 Cr 6/1.3505. They are hardened and ground. The sliding surface of the shaft washer is hard chromium plated and coated with a lithium base grease. The sliding layer of glass fibre reinforced plastic containing PTFE additives is injection moulded in the housing washer.

Permissible operating temperature range

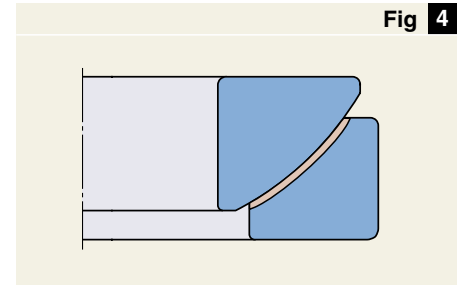
Spherical plain bearings with the sliding contact surface combination steel/PTFE composite can be used in the temperature range -40 to +75 °C, although brief periods of operation up to +110 °C are permitted. However, the load carrying capacity of the bearings will be reduced at temperatures above +50 °C.

Fig 3



Steel-on-steel spherical plain thrust bearing with lubrication hole and groove

Fig 4



Maintenance-free thrust bearing with sliding contact surface combination steel/PTFE fabric

Special designs

Special operating conditions may call for spherical plain thrust bearings with the sliding contact surface combinations steel-on-steel or steel/PTFE fabric and consequently they are produced to order by SKF.

Steel-on-steel bearings (→ fig 3) are preferred where operating temperatures, loads or load frequencies are high or where shock loads occur.

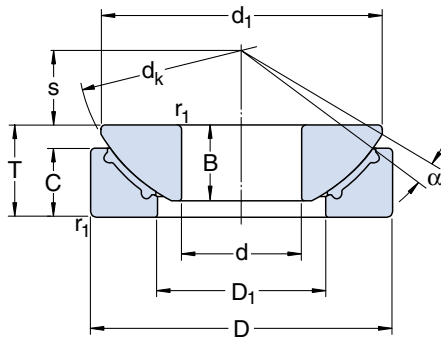
Bearings with the sliding contact surface steel/PTFE fabric (→ fig 4) should be used when maintenance-free operation is specified and where the bearing arrangement is such that the presence of any lubricant is not permitted.

Tolerances of spherical plain thrust bearings

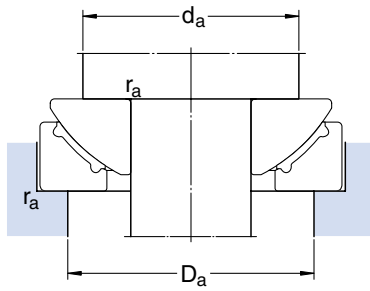
Table 1

Nominal diameter d, D		Shaft washer				Housing washer				Single height	
		Δ_{dmp}		Δ_{Bs}		Δ_{Dmp}		Δ_{Cs}		Δ_{Ts}	
over	incl.	high	low	high	low	high	low	high	low	high	low
mm		μm		μm		μm		μm		μm	
-	18	0	-8	0	-240	-	-	-	-	+250	-400
18	30	0	-10	0	-240	-	-	-	-	+250	-400
30	50	0	-12	0	-240	0	-11	0	-240	+250	-400
50	80	0	-15	0	-300	0	-13	0	-300	+250	-500
80	120	0	-20	0	-400	0	-15	0	-400	+250	-600
120	150	-	-	-	-	0	-18	0	-500	-	-
150	180	-	-	-	-	0	-25	0	-500	-	-
180	230	-	-	-	-	0	-30	0	-600	-	-

Maintenance-free spherical plain thrust bearings with sliding contact surface combination steel/PTFE composite
 d 17 – 120 mm



Principal dimensions			Angle of tilt	Basic load ratings		Mass	Designation
d	D	T	α	dynamic	static		
mm			degrees	C	C_0	kg	–
17	47	16	5	36 500	58 500	0,14	GX 17 F
20	55	20	5	46 500	73 500	0,25	GX 20 F
25	62	22,5	5	69 500	112 000	0,42	GX 25 F
30	75	26	5	95 000	153 000	0,61	GX 30 F
35	90	28	6	134 000	216 000	0,98	GX 35 F
40	105	32	6	173 000	275 000	1,50	GX 40 F
45	120	36,5	6	224 000	355 000	2,25	GX 45 F
50	130	42,5	6	275 000	440 000	3,15	GX 50 F
60	150	45	6	375 000	600 000	4,65	GX 60 F
70	160	50	5	475 000	750 000	5,40	GX 70 F
80	180	50	5	570 000	915 000	6,95	GX 80 F
100	210	59	5	735 000	1 180 000	11,0	GX 100 F
120	230	64	4	880 000	1 430 000	14,0	GX 120 F



Dimensions

Abutment and fillet dimensions

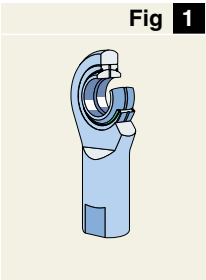
d	d _k	d ₁	D ₁	B	C	r ₁ min	s	d _a min	D _a max	r _a max
mm								mm		
17	52	43,5	27	11,8	11,2	0,6	11	34	37	0,6
20	60	50	31	14,5	13,8	1	12,5	40	44	1
25	68	58,5	34,5	16,5	16,7	1	14	45	47	1
30	82	70	42	19	19	1	17,5	56	59	1
35	98	84	50,5	22	20,7	1	22	66	71	1
40	114	97	59	27	21,5	1	24,5	78	84	1
45	128	110	67	31	25,5	1	27,5	89	97	1
50	139	120	70	33	30,5	1	30	98	105	1
60	160	140	84	37	34	1	35	109	120	1
70	176	153	94,5	42	36,5	1	35	121	125	1
80	197	172	107,5	43,5	38	1	42,5	135	145	1
100	222	198	127	51	46	1	45	155	170	1
120	250	220	145	53,5	50	1	52,5	170	190	1

Rod ends requiring maintenance

Steel-on-steel rod ends

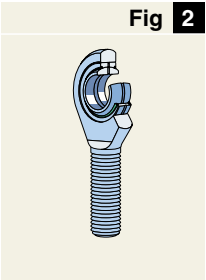
Steel-on-steel rod ends consist of a rod end housing and a normal steel-on-steel spherical plain bearing which is held in position axially in the housing. The rod ends are available with female thread (→ **fig 1**), male thread (→ **fig 2**) or with a welding shank (→ **fig 3**).

Fig 1



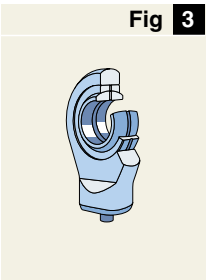
Rod end with female thread

Fig 2



Rod end with male thread

Fig 3



Rod end with welding shank



Steel-on-steel bronze rod ends

Steel-on-bronze rod ends consist of a rod end housing and a steel-on-bronze spherical plain bearing having an outer ring made of bronze. The bearing is held in position by staking at both sides of the outer ring. These rod ends are available with female or male thread.

Dimensions

The dimensions of SKF rod ends are standardised and correspond to the standards listed in **Table 1**. Rod ends identified by designation suffix VZ019 have a male thread which deviates from the ISO standard but conforms to the CETOP¹⁾ Recommendation RP 103 P.

The female and male threads of SKF rod ends correspond to ISO 965-1:1998.

Tolerances

The tolerances to which SKF rod ends are made conform to ISO 12240-4:1998. The tolerances for the steel-on-steel rod end inner rings are given in **Table 2** and those for steel-on-bronze rod end inner rings are given in **Table 3**.

The symbols used in these tables are defined in the following.

- d nominal bore diameter
 Δ_{dmp} deviation of the mean bore diameter from the nominal
 Δ_{Bs} deviation of single inner ring width from the nominal

Table 1

Series	Standards
SA(A) SI(A) SC	ISO 12240-4:1998
SCF SIJ	– ISO 8138:1991
SIR SIQG	– CETOP RP 88 H
SAKAC SIKAC SIKAC/VZ019	ISO 12240-4:1998 ISO 12240-4:1998 ISO 8139:1991, CETOP RP 103 P

Standards**Tolerances for steel-on-steel rod end inner rings**

Table 2

Bore diameter	Series SA(A), SI(A), SIJ, SIR, SC, SCF				Series SIQG			
	Δ_{dmp}		Δ_{Bs}		Δ_{dmp}		Δ_{Bs}	
over incl.	low	high	low	high	low	high	low	high
mm	μm		μm		μm		μm	
10 10	0	-8	0	-120	–	–	–	–
10 18	0	-8	0	-120	+18	0	0	-180
18 30	0	-10	0	-120	+21	0	0	-210
30 50	0	-12	0	-120	+25	0	0	-250
50 80	0	-15	0	-150	+30	0	0	-300
80 120	0	-20	0	-200	+35	0	0	-350
120 180	–	–	–	–	+40	0	0	-400
180 250	–	–	–	–	+46	0	0	-460

Tolerances for steel-on-bronze rod end inner rings

Table 3

Bore diameter	Series SIKAC, SAKAC			
	Δ_{dmp}		Δ_{Bs}	
over incl.	high	low	high	low
mm	μm		μm	
6 6	+12	0	0	-120
6 10	+15	0	0	-120
10 18	+18	0	0	-120
18 30	+21	0	0	-120

¹⁾ CETOP = Comité Européen des Transmissions Oléohydrauliques et Pneumatiques (European Committee for Hydraulic and Pneumatic Transmissions)

Table 4

Steel-on-steel rod ends				Steel-on-bronze rod ends			
Bore diameter		Radial internal clearance		Bore diameter		Radial internal clearance	
d over	incl.	Normal	max	d over	incl.	Normal	max
mm		µm		mm		µm	
12	12 20	16 20	68 82	6	6 10	5 7	50 60
20	35 60	25 30	100 120	10	18 30	8 10	75 90
60	90	36	142				
90	140	42	165				
140	240	50	192				

Radial internal clearance**Rod end housing materials**

Table 5

Series	Size	Material	Material No.
SA(A)	6 to 80	Heat treatable steel C45 zinc coated	1.0503
SI(A)	6 to 80	Heat treatable steel C45 zinc coated	1.0503
SC	25 to 80	Construction steel S 355 J2G3 (St 52-3 N)	1.0570
SCF	20 to 80	Construction steel S 355 J2G3 (St 52-3 N)	1.0570
SIQG	12 to 50	Heat treatable steel C45	1.0503
	63 to 200	Spheroidal graphite cast iron GGG40	–
SIJ	12 to 50	Heat treatable steel C45	1.0503
	60 to 100	Spheroidal graphite cast iron GGG40	–
SIR	20 to 50	Heat treatable steel C45	1.0503
	60 to 120	Spheroidal graphite cast iron GGG40	–
SAKAC	5 to 12	Automatic steel 9 SMnPb 28 K zinc coated and chromatised	1.0718
	14 to 30	Heat treatable steel C35 zinc coated and chromatised	1.0501
SIKAC	5 to 12	Automatic steel 9 SMnPb 28 K zinc coated and chromatised	1.0718
	14 to 30	Heat treatable steel C35 zinc coated and chromatised	1.0501

Radial internal clearance

The steel-on-steel rod ends have radial internal clearance corresponding to the Normal clearance values quoted in ISO 12240-4:1998 which are given in Table 4.

Materials

The materials used for the manufacture of SKF rod ends requiring maintenance are listed in Table 5.

Details of the materials used for the steel-on-steel spherical plain bearings incorporated in SKF rod ends will be found under the heading “Materials” on page 61.

The bearings incorporated in the steel-on-bronze rod ends have an outer ring of tin bronze. The inner ring is of carbon chromium steel and is hardened, ground and polished.

Permissible operating temperature range

The operating temperature range for the rod ends requiring maintenance depends on the rod end, the bearing incorporated in it, the bearing seals and the grease used for lubrication. The actual limits are given in Table 6.

NB.

The load carrying capacity of rod ends is reduced at temperatures above +100 °C. For temperatures below 0 °C, the fracture toughness of the rod end material must be taken into consideration.

Fatigue strength

In all applications where a rod end is subjected to loads which vary in magnitude or are alternating, or where the failure of a rod end would be dangerous, it is advisable to check that the selected rod end has a suitable fatigue strength.

Relubrication facilities

All SKF rod ends requiring maintenance, with the exception of steel-on-steel rod ends of series SA .. E and SI .. E and the steel-on-bronze rod ends of size 5 are provided with a grease nipple or hole in the rod end housing. The type and design of the relubrication facilities in the rod end housing are shown in **Table 7**.


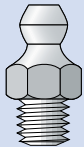

Table 6

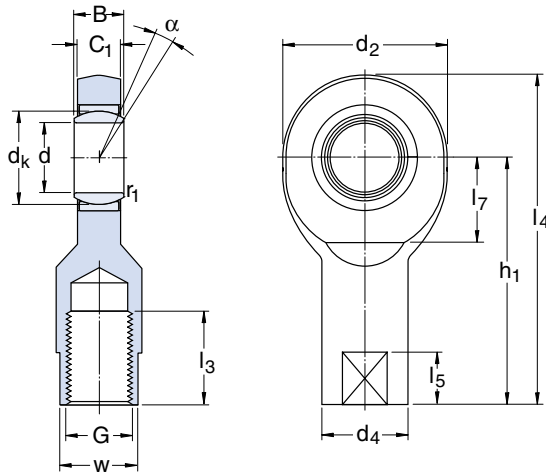
Series	Permissible operating temperature range ¹⁾		Reduced load carrying capacity from
	from	incl.	
–	°C		°C
Steel-on-steel			
SA .. E(S)	–50	+300	+100
SA(A) .. ES-2RS	–30	+130	+100
SI .. E(S)	–50	+300	+100
SI(A) .. ES-2RS	–30	+130	+100
SIQG .. ES	–50	+300	+100
SIJ .. ES	–50	+300	+100
SIR .. ES	–50	+300	+100
SC .. ES	–50	+300	+100
SCF .. ES	–50	+300	+100
Steel-on-bronze			
SAKAC .. M	–30	+180	+100
SIKAC .. M(VZ019)	–30	+180	+100

¹⁾ NB. The permissible operating temperature range of the grease used should not be exceeded

Permissible operating temperature range**Relubrication facilities**

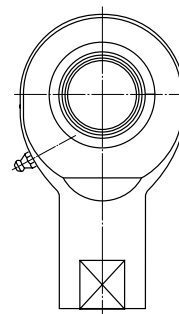
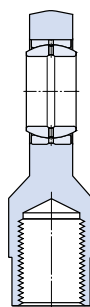
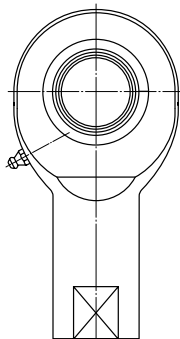
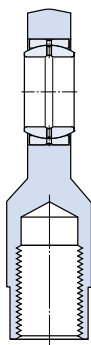
Table 7

Series	Size	Grease nipple to DIN/ISO	Design
SA .. ES SI .. ES SIJ .. ES	15 .. 20 15 .. 20 16 .. 20	Lubrication hole 2,5 mm diameter	
SA(A) .. ES-2RS SI(A) .. ES-2RS SIJ .. ES SIR .. ES SIQG .. ES SC .. ES SCF .. ES	25 .. 80 25 .. 80 25 .. 100 25 .. 120 12 .. 200 25 .. 80 20 .. 80	Lubrication nipple to DIN 71412:1987, Form A ISO 3799:1976	
SAKAC .. M SIKAC .. M	6 .. 30 6 .. 30	Lubrication nipple to DIN 3405:1986 Form D	



SI .. E

Principal dimensions						Angle of tilt	Basic load ratings		Mass	Designations	
d	d ₂ max	G 6H	B	C ₁ max	h ₁	α	C	C ₀		Rod end with right-hand thread	left-hand thread
mm						degrees	N		kg	–	
6	22	M 6	6	4,5	30	13	3 400	8 150	0,023	SI 6 E	SIL 6 E
8	25	M 8	8	6,5	36	15	5 500	12 900	0,036	SI 8 E	SIL 8 E
10	30	M 10	9	7,5	43	12	8 150	19 000	0,065	SI 10 E	SIL 10 E
12	35	M 12	10	8,5	50	10	10 800	25 500	0,11	SI 12 E	SIL 12 E
15	41	M 14	12	10,5	61	8	17 000	37 500	0,18	SI 15 ES	SIL 15 ES
17	47	M 16	14	11,5	67	10	21 200	44 000	0,25	SI 17 ES	SIL 17 ES
20	54	M 20×1,5	16	13,5	77	9	30 000	57 000	0,36	SI 20 ES	SIL 20 ES
25	65	M 24×2	20	18	94	7	48 000	90 000	0,65	SI 25 ES	SIL 25 ES
30	75	M 30×2	22	20	110	6	62 000	116 000	1,00	SI 30 ES	SIL 30 ES
35	84	M 36×3	25	22	130	6	80 000	134 000	1,40	SI 35 ES-2RS	SIL 35 ES-2RS
40	94	M 39×3	28	24	142	6	100 000	166 000	2,20	SIA 40 ES-2RS	SILA 40 ES-2RS
	94	M 42×3	28	24	145	6	100 000	166 000	2,30	SI 40 ES-2RS	SIL 40 ES-2RS
45	104	M 42×3	32	28	145	7	127 000	224 000	2,90	SIA 45 ES-2RS	SILA 45 ES-2RS
	104	M 45×3	32	28	165	7	127 000	224 000	3,20	SI 45 ES-2RS	SIL 45 ES-2RS
50	114	M 45×3	35	31	160	6	156 000	270 000	4,10	SIA 50 ES-2RS	SILA 50 ES-2RS
	114	M 52×3	35	31	195	6	156 000	270 000	4,50	SI 50 ES-2RS	SIL 50 ES-2RS
60	137	M 52×3	44	39	175	6	245 000	400 000	6,30	SIA 60 ES-2RS	SILA 60 ES-2RS
	137	M 60×4	44	39	225	6	245 000	400 000	7,10	SI 60 ES-2RS	SIL 60 ES-2RS
70	162	M 56×4	49	43	200	6	315 000	530 000	9,50	SIA 70 ES-2RS	SILA 70 ES-2RS
	162	M 72×4	49	43	265	6	315 000	530 000	10,5	SI 70 ES-2RS	SIL 70 ES-2RS
80	182	M 64×4	55	48	230	5	400 000	655 000	15,0	SIA 80 ES-2RS	SILA 80 ES-2RS
	182	M 80×4	55	48	295	5	400 000	655 000	19,0	SI 80 ES-2RS	SIL 80 ES-2RS



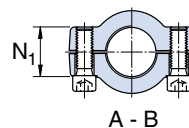
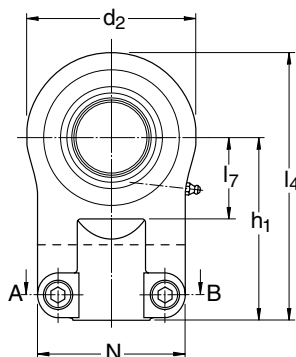
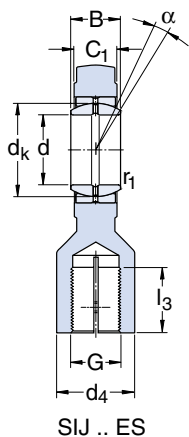
SI .. ES

SIA .. ES-2RS

Dimensions

d	d _k	d ₄ ≈	l ₃ min	l ₄ max	l ₅ ≈	l ₇ min	r ₁ min	w h14
mm								
6	10	11	11	43	8	10	0,3	9
8	13	13	15	50	9	11	0,3	11
10	16	16	15	60	11	13	0,3	14
12	18	19	18	69	12	17	0,3	17
15	22	22	21	83	14	19	0,3	19
17	25	25	24	92	15	22	0,3	22
20	29	28	30	106	16	24	0,3	24
25	35,5	35	36	128	18	30	0,6	30
30	40,7	42	45	149	19	34	0,6	36
35	47	49	60	174	25	40	0,6	41
40	53	58	65	191	25	46	0,6	50
	53	58	65	194	25	46	0,6	50
45	60	65	65	199	30	50	0,6	55
	60	65	65	219	30	50	0,6	55
50	66	70	68	219	30	58	0,6	60
	66	70	68	254	30	58	0,6	60
60	80	82	70	246	35	73	1	70
	80	82	70	296	35	73	1	70
70	92	92	80	284	40	85	1	80
	92	92	80	349	40	85	1	80
80	105	105	85	324	45	98	1	90
	105	105	85	389	45	98	1	90

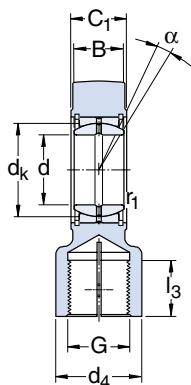
3.5



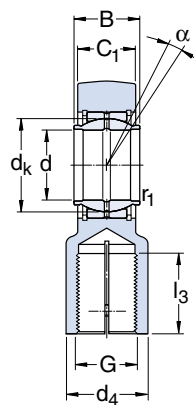
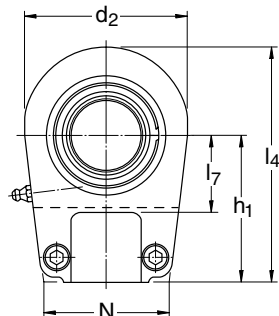
Principal dimensions

d	d ₂ max	G 6H	B	C ₁ max	h ₁	Angle of tilt	Basic load ratings		Mass	Designations Rod end with right-hand thread	left-hand thread ¹⁾
						α	C	C ₀			
mm						degrees	N		kg	–	
12	40	M 10×1,25	10	8	42	3	10 800	21 200	0,14	SIJ 12 E SIQG 12 ESA	SILJ 12 E SILQG 12 ESA
	33	M 12×1,5	12	11	38	4	10 800	22 000	0,11		
16	45	M 12×1,25	14	11	48	3	21 200	23 500	0,25	SIJ 16 ES SIQG 16 ES	SILJ 16 ES SILQG 16 ES
	41	M 14×1,5	16	15	44	4	17 600	32 500	0,21		
20	55	M 14×1,5	16	13	58	3	30 000	51 000	0,40	SIJ 20 ES SIQG 20 ES	SILJ 20 ES SILQG 20 ES
	50	M 16×1,5	20	19	52	4	30 000	43 000	0,40		
25	65	M 16×1,5	20	17	68	3	48 000	73 500	0,68	SIJ 25 ES SIR 25 ES SIQG 25 ES	SILJ 25 ES SILR 25 ES SILQG 25 ES
	58	M 16×1,5	20	23,5	50	7	48 000	52 000	0,49		
	62	M 20×1,5	25	23	65	4	48 000	69 500	0,66		
30	80	M 20×1,5	22	19	85	3	62 000	112 000	1,35	SIJ 30 ES SIR 30 ES	SILJ 30 ES SILR 30 ES
	66	M 22×1,5	22	28,5	60	6	62 000	78 000	0,77		
32	76	M 27×2	32	29	80	4	65 500	100 000	1,20	SIQG 32 ES	SILQG 32 ES
35	80	M 28×1,5	25	30,5	70	6	80 000	118 000	1,20	SIR 35 ES	SILR 35 ES
40	100	M 27×2	28	23	105	3	100 000	146 000	2,40	SIJ 40 ES SIR 40 ES SIQG 40 ES	SILJ 40 ES SILR 40 ES SILQG 40 ES
	96	M 35×1,5	28	35,5	85	7	100 000	200 000	2,10		
	97	M 33×2	40	34	97	4	100 000	176 000	2,00		
50	122	M 33×2	35	30	130	3	156 000	216 000	3,80	SIJ 50 ES SIR 50 ES SIQG 50 ES	SILJ 50 ES SILR 50 ES SILQG 50 ES
	118	M 45×1,5	35	40,5	105	6	156 000	280 000	3,60		
	118	M 42×2	50	42	120	4	156 000	270 000	3,50		
60	160	M 42×2	44	38	150	3	245 000	405 000	8,50	SIJ 60 ES SIR 60 ES	SILJ 60 ES SILR 60 ES
	132	M 58×1,5	44	50,5	130	6	245 000	325 000	6,00		
63	142	M 48×2	63	55	140	4	255 000	375 000	6,80	SIQG 63 ES	SILQG 63 ES
70	157	M 65×1,5	49	55,5	150	6	315 000	450 000	9,40	SIR 70 ES	SILR 70 ES
80	205	M 48×2	55	47	185	3	400 000	610 000	14,5	SIJ 80 ES SIR 80 ES SIQG 80 ES	SILJ 80 ES SILR 80 ES SILQG 80 ES
	179	M 80×2	55	60,5	170	6	400 000	560 000	13,0		
	180	M 64×3	80	69	180	4	400 000	600 000	14,5		
100	240	M 64×3	70	57	240	3	610 000	780 000	29,5	SIJ 100 ES SIR 100 ES SIQG 100 ES	SILJ 100 ES SILR 100 ES SILQG 100 ES
	233	M 110×2	70	70,5	235	7	610 000	950 000	30,0		
	224	M 80×3	100	87	210	4	610 000	930 000	28,0		
120	342	M 130×3	85	90,5	310	6	950 000	2 450 000	84,0	SIR 120 ES	SILR 120 ES
125	290	M 100×3	125	105	260	4	950 000	1 430 000	43,0	SIQG 125 ES	SILQG 125 ES
160	346	M 125×4	160	132	310	4	1 370 000	2 200 000	80,0	SIQG 160 ES	SILQG 160 ES
200	460	M 160×4	200	164	390	4	2 120 000	3 400 000	165	SIQG 200 ES	SILQG 200 ES

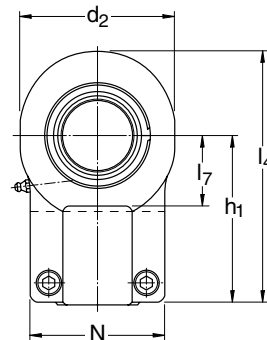
¹⁾ Please check availability of rod ends with left-hand thread



SIR .. ES



SIQG .. ES

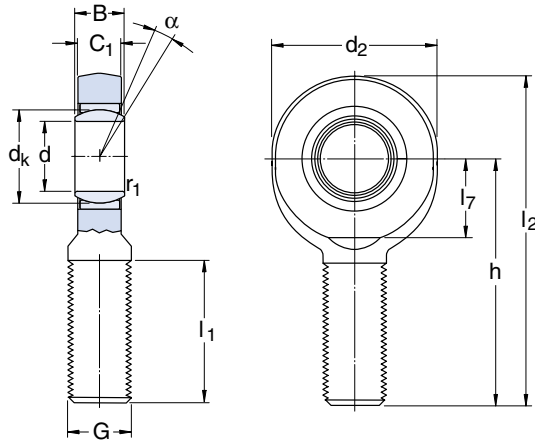


Dimensions

Cylinder screw
with internal hexagon
(ISO 4762:1998)
Size Tightening
torque

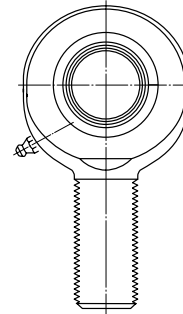
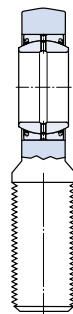
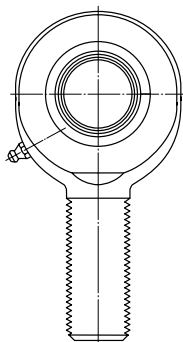
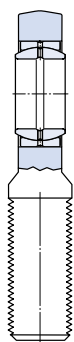
d	dk	d4 max	l3 min	l4 max	l7 min	N max	N1 max	r1 min	Size	Tightening torque
mm									–	Nm
12	18	17	15	62	16	40	13	0,3	M 6	9,5
	18	17	17	55,5	13	33	11	0,3	M 5	5,5
16	25	21	17	70,5	20	45	13	0,3	M 6	9,5
	23	22,5	19	64,5	18	41	17	0,3	M 6	9,5
20	29	25	19	85,5	25	55	17	0,3	M 8	23
	29	26,5	23	77,5	21	48	21	0,3	M 8	23
25	35,5	30	23	100,5	30	62	17	0,6	M 8	23
	35,5	26,5	17	81	27	46	22	0,6	M 8	23
	35,5	32	29	97	26	55	21	0,6	M 8	23
30	40,7	36	29	125	35	80	19	0,6	M 10	46
	40,7	34	23	95	29	50	27	0,6	M 8	23
32	43	40	37	120	31	67	24	0,6	M 10	46
35	47	42	29	113	37	66	29	0,6	M 10	46
40	53	45	37	155	45	90	23	0,6	M 10	46
	53	51	36	136	44	76	34	0,6	M 10	46
	53	49	46	147	40	81	28	0,6	M 10	46
50	66	55	46	192,5	58	105	30	0,6	M 12	79
	66	63,5	46	169	54	90	38	0,6	M 12	79
	66	60,5	57	181	49	97	34	0,6	M 12	79
60	80	68	57	230	68	134	38	1	M 16	195
	80	77,5	59	201	64	120	47	1	M 16	195
63	83	72,5	64	213	61	116	40	1	M 16	195
70	92	89	66	234	74	130	52	1	M 16	195
80	105	90	64	287,5	92	156	47	1	M 20	390
	105	109	81	267	79	160	57	1	M 20	390
	105	93	86	272	77	150	50	1	M 20	390
100	130	110	86	360	116	190	57	1	M 24	670
	130	142	111	362	103	200	67	1	M 24	670
	130	114	96	324	97	180	65	1	M 24	670
120	160	177	135	491	138	257	86	1	M 24	670
125	160	139	113	407	118	202	75	1	M 24	670
160	200	170	126	490	148	252	85	1	M 24	670
200	250	221	161	623	193	323	106	1,1	M 30	1 350

3.5



SA .. E

Principal dimensions						Angle of tilt	Basic load ratings		Mass	Designations	
d	d ₂ max	G 6g	B	C ₁ max	h	α	C	C ₀		Rod end with right-hand thread	left-hand thread
mm						degrees	N		kg	–	
6	22	M 6	6	4,5	36	13	3 400	8 150	0,017	SA 6 E	SAL 6 E
8	25	M 8	8	6,5	42	15	5 500	12 900	0,029	SA 8 E	SAL 8 E
10	30	M 10	9	7,5	48	12	8 150	18 300	0,053	SA 10 E	SAL 10 E
12	35	M 12	10	8,5	54	10	10 800	24 500	0,078	SA 12 E	SAL 12 E
15	41	M 14	12	10,5	63	8	17 000	28 000	0,13	SA 15 ES	SAL 15 ES
17	47	M 16	14	11,5	69	10	21 200	31 000	0,19	SA 17 ES	SAL 17 ES
20	54	M 20×1,5	16	13,5	78	9	30 000	42 500	0,32	SA 20 ES	SAL 20 ES
25	65	M 24×2	20	18	94	7	48 000	78 000	0,53	SA 25 ES	SAL 25 ES
30	75	M 30×2	22	20	110	6	62 000	81 500	0,90	SA 30 ES	SAL 30 ES
35	84	M 36×3	25	22	130	6	80 000	110 000	1,30	SA 35 ES-2RS	SAL 35 ES-2RS
40	94	M 39×3	28	24	150	6	100 000	140 000	1,85	SAA 40 ES-2RS	SALA 40 ES-2RS
	94	M 42×3	28	24	145	6	100 000	140 000	1,90	SA 40 ES-2RS	SAL 40 ES-2RS
45	104	M 42×3	32	28	163	7	127 000	200 000	2,45	SAA 45 ES-2RS	SALA 45 ES-2RS
	104	M 45×3	32	28	165	7	127 000	200 000	2,55	SA 45 ES-2RS	SAL 45 ES-2RS
50	114	M 45×3	35	31	185	6	156 000	245 000	3,30	SAA 50 ES-2RS	SALA 50 ES-2RS
	114	M 52×3	35	31	195	6	156 000	245 000	3,90	SA 50 ES-2RS	SAL 50 ES-2RS
60	137	M 52×3	44	39	210	6	245 000	360 000	5,70	SAA 60 ES-2RS	SALA 60 ES-2RS
	137	M 60×4	44	39	225	6	245 000	360 000	6,25	SA 60 ES-2RS	SAL 60 ES-2RS
70	162	M 56×4	49	43	235	6	315 000	490 000	7,90	SAA 70 ES-2RS	SALA 70 ES-2RS
	162	M 72×4	49	43	265	6	315 000	490 000	10,0	SA 70 ES-2RS	SAL 70 ES-2RS
80	182	M 64×4	55	48	270	5	400 000	585 000	12,0	SAA 80 ES-2RS	SALA 80 ES-2RS
	182	M 80×4	55	48	295	5	400 000	585 000	14,5	SA 80 ES-2RS	SAL 80 ES-2RS



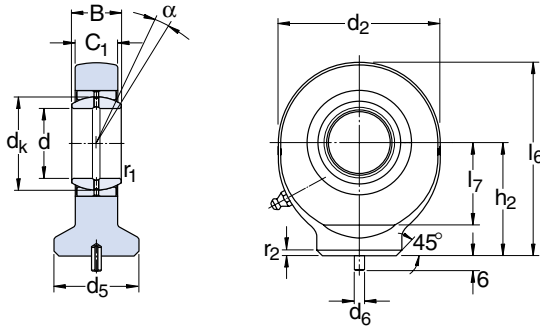
SA .. ES

SAA .. ES-2RS

Dimensions

d	d _k	l ₁ min	l ₂ max	l ₇ min	r ₁ min
mm					
6	10	16	49	10	0,3
8	13	21	56	11	0,3
10	16	26	65	13	0,3
12	18	28	73	17	0,3
15	22	34	85	19	0,3
17	25	36	94	22	0,3
20	29	43	107	24	0,3
25	35,5	53	128	30	0,6
30	40,7	65	149	34	0,6
35	47	82	174	40	0,6
40	53	86	199	46	0,6
	53	90	194	46	0,6
45	60	92	217	50	0,6
	60	95	219	50	0,6
50	66	104	244	58	0,6
	66	110	254	58	0,6
60	80	115	281	73	1
	80	120	296	73	1
70	92	125	319	85	1
	92	132	349	85	1
80	105	140	364	98	1
	105	147	389	98	1

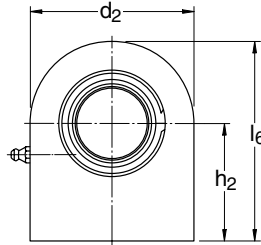
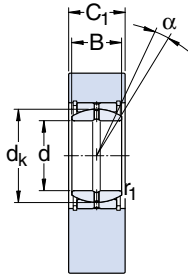
3.5



Principal dimensions					Angle of tilt	Basic load ratings		Mass	Designation
d	d _{2 max}	B	C _{1 max}	h ₂	α	C	C ₀		
mm					degrees	N		kg	–
20	54	16	13,5	38	9	30 000	46 500	0,20	SC 20 ES
25	65	20	18	45	7	48 000	73 500	0,45	SC 25 ES
30	75	22	20	51	6	62 000	96 500	0,65	SC 30 ES
35	84	25	22	61	6	80 000	112 000	1,00	SC 35 ES
40	94	28	24	69	7	100 000	134 000	1,30	SC 40 ES
45	104	32	28	77	7	127 000	180 000	1,90	SC 45 ES
50	114	35	31	88	6	156 000	220 000	2,50	SC 50 ES
60	137	44	39	100	6	245 000	335 000	4,60	SC 60 ES
70	162	49	43	115	6	315 000	455 000	6,80	SC 70 ES
80	182	55	48	141	6	400 000	550 000	9,70	SC 80 ES

Dimensions

d	d _k	d ₅ max	d ₆	l ₆ max	l ₇ min	r ₁ min	r ₂
mm							
20	29	29	4	66	24	0,3	2
25	35,5	35	4	78	30	0,6	3
30	40,7	42	4	89	34	0,6	3
35	47	49	4	104	40	0,6	3
40	53	54	4	118	46	0,6	4
45	60	60	6	132	50	0,6	4
50	66	64	6	150	58	0,6	4
60	80	72	6	173	73	1	4
70	92	82	6	199	85	1	5
80	105	97	6	237	98	1	5



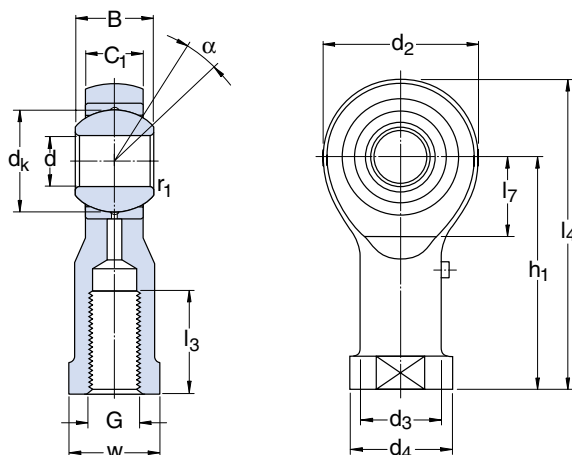
Principal dimensions					Angle of tilt α	Basic load ratings		Mass	Designations
d	d ₂ max	B	C ₁ max	h ₂ js13		dynamic C	static C ₀		
mm					degrees	N		kg	–
20	51,5	16	20	38	9	30 000	63 000	0,35	SCF 20 ES
25	56,5	20	24	45	7	48 000	65 500	0,53	SCF 25 ES
30	66,5	22	29	51	6	62 000	110 000	0,87	SCF 30 ES
35	85	25	31	61	6	80 000	183 000	1,55	SCF 35 ES
40	102	28	36,5	69	7	100 000	285 000	2,45	SCF 40 ES
45	112	32	41,5	77	7	127 000	360 000	3,40	SCF 45 ES
50	125,5	35	41,5	88	6	156 000	415 000	4,45	SCF 50 ES
60	142,5	44	51,5	100	6	245 000	530 000	7,00	SCF 60 ES
70	166,5	49	57	115	6	315 000	680 000	10,0	SCF 70 ES
80	182,5	55	62	141	6	400 000	750 000	15,0	SCF 80 ES

Dimensions

d	d _k	l ₆ max	r ₁ min
---	----------------	-----------------------	-----------------------

mm

20	29	64	0,3
25	35,5	73,5	0,6
30	40,7	85	0,6
35	47	103,5	0,6
40	53	120	0,6
45	60	133	0,6
50	66	151	0,6
60	80	171,5	1
70	92	198,5	1
80	105	232,5	1



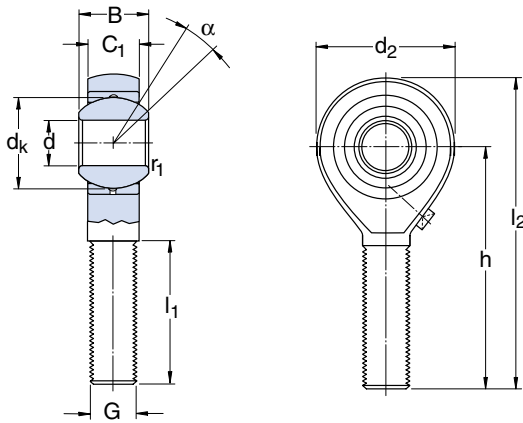
Principal dimensions

d	d ₂ max	G 6H	B	C ₁ max	h ₁	Angle of tilt	Basic load ratings		Mass	Designations	
						α	dynamic	static		Rod end with right-hand thread	left-hand thread
mm						degrees	N		kg	–	
5	19	M 5	8	6	27	13	3 250	5 400	0,017	SIKAC 5 M ¹⁾	SILKAC 5 M ¹⁾
6	21	M 6	9	6,75	30	13	4 300	5 400	0,025	SIKAC 6 M	SILKAC 6 M
8	25	M 8	12	9	36	14	7 200	9 150	0,043	SIKAC 8 M	SILKAC 8 M
10	29	M 10	14	10,5	43	13	10 000	12 200	0,072	SIKAC 10 M	SILKAC 10 M
	29	M 10×1,25	14	10,5	43	13	10 000	12 200	0,072	SIKAC 10 M/VZ019	–
12	33	M 12	16	12	50	13	13 400	14 000	0,11	SIKAC 12 M	SILKAC 12 M
	33	M 12×1,25	16	12	50	13	13 400	14 000	0,11	SIKAC 12 M/VZ019	–
14	37	M 14	19	13,5	57	16	17 000	20 400	0,16	SIKAC 14 M	SILKAC 14 M
16	43	M 16	21	15	64	15	21 600	29 000	0,22	SIKAC 16 M	SILKAC 16 M
	43	M 16×1,5	21	15	64	15	21 600	29 000	0,22	SIKAC 16 M/VZ019	–
18	47	M 18×1,5	23	16,5	71	15	26 000	35 500	0,30	SIKAC 18 M	SILKAC 18 M
20	51	M 20×1,5	25	18	77	14	31 500	35 500	0,40	SIKAC 20 M	SILKAC 20 M
22	55	M 22×1,5	28	20	84	15	38 000	45 000	0,50	SIKAC 22 M	SILKAC 22 M
25	61	M 24×2	31	22	94	15	47 500	53 000	0,65	SIKAC 25 M	SILKAC 25 M
30	71	M 30×2	37	25	110	17	64 000	69 500	1,15	SIKAC 30 M	SILKAC 30 M

¹⁾ Without lubrication nipple

Dimensions

d	d _k	d ₃ ≈	d ₄ max	l ₃ min	l ₄ max	l ₅ ≈	l ₇ min	r ₁ min	w h14
mm									
5	11,1	9	12	8	38	4	9	0,3	9
6	12,7	10	14	9	42	5	10	0,3	11
8	15,8	12,5	17	12	50	5	12	0,3	14
10	19	15	20	15	59	6,5	14	0,3	17
	19	15	20	15	59	6,5	14	0,3	17
12	22,2	17,5	23	18	68	6,5	16	0,3	19
	22,2	17,5	23	18	68	6,5	16	0,3	19
14	25,4	20	27	21	77	8	18	0,3	22
16	28,5	22	29	24	87	8	21	0,3	22
	28,5	22	29	24	87	8	21	0,3	22
18	31,7	25	32	27	96	10	23	0,3	27
20	34,9	27,5	37	30	105	10	25	0,3	30
22	38,1	30	40	33	114	12	27	0,3	32
25	42,8	33,5	44	36	127	12	30	0,3	36
30	50,8	40	52	45	148	15	35	0,3	41



Principal dimensions						Angle of tilt	Basic load ratings		Mass	Designations	
d	d ₂ max	G 6g	B	C ₁ max	h	α	C	C ₀		Rod end with right-hand thread	left-hand thread
mm						degrees	N		kg	–	
5	19	M 5	8	6	33	13	3 250	4 800	0,013	SAKAC 5 M ¹⁾	SALKAC 5 M ¹⁾
6	21	M 6	9	6,75	36	13	4 300	4 800	0,020	SAKAC 6 M	SALKAC 6 M
8	25	M 8	12	9	42	14	7 200	8 000	0,032	SAKAC 8 M	SALKAC 8 M
10	29	M 10	14	10,5	48	13	10 000	10 800	0,054	SAKAC 10 M	SALKAC 10 M
12	33	M 12	16	12	54	13	12 200	12 200	0,085	SAKAC 12 M	SALKAC 12 M
14	37	M 14	19	13,5	60	16	17 000	17 300	0,13	SAKAC 14 M	SALKAC 14 M
16	43	M 16	21	15	66	15	21 600	23 200	0,19	SAKAC 16 M	SALKAC 16 M
18	47	M 18×1,5	23	16,5	72	15	26 000	29 000	0,26	SAKAC 18 M	SALKAC 18 M
20	51	M 20×1,5	25	18	78	14	29 000	29 000	0,34	SAKAC 20 M	SALKAC 20 M
22	55	M 22×1,5	28	20	84	15	38 000	39 000	0,44	SAKAC 22 M	SALKAC 22 M
25	61	M 24×2	31	22	94	15	46 500	46 500	0,60	SAKAC 25 M	SALKAC 25 M
30	71	M 30×2	37	25	110	17	61 000	61 000	1,05	SAKAC 30 M	SALKAC 30 M

¹⁾ Without lubrication nipple

Dimensions

d	d _k	l ₁ min	l ₂ max	r ₁ min
---	----------------	-----------------------	-----------------------	-----------------------

mm

5	11,1	19	44	0,3
6	12,7	21	48	0,3
8	15,8	25	56	0,3
10	19	28	64	0,3
12	22,2	32	72	0,3
14	25,4	36	80	0,3
16	28,5	37	89	0,3
18	31,7	41	97	0,3
20	34,9	45	106	0,3
22	38,1	48	114	0,3
25	42,8	55	127	0,3
30	50,8	66	148	0,3

Maintenance-free rod ends

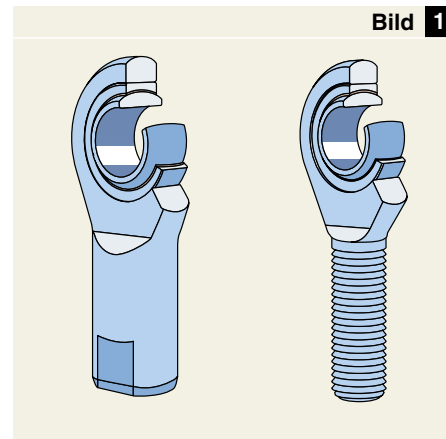


SKF maintenance-free rod ends are produced with three different sliding contact surface combinations.

The rod ends with the sliding contact surface combinations steel/sinter bronze composite (→ fig 1) and steel/PTFE fabric (→ fig 2) comprise a rod end housing and a standard spherical plain bearing, the outer ring of which is held in position axially.

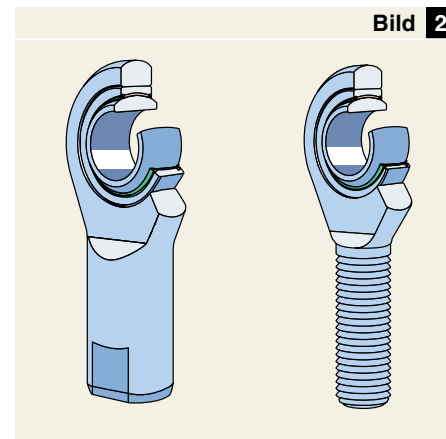
The rod ends with the sliding contact surface combination steel/PTFE composite (→ fig 3) consist of a rod end housing and a spherical plain bearing inner ring. Between the housing and the inner ring, a sliding layer of glass fibre reinforced plastic containing PTFE is injection moulded in situ.

Bild 1



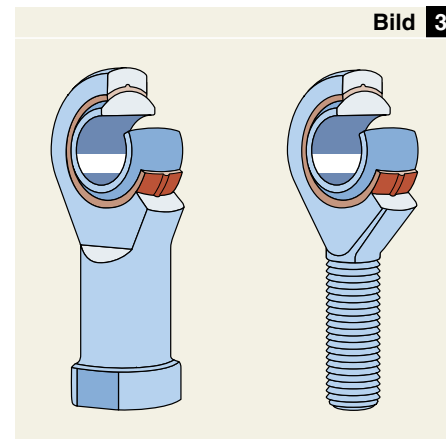
Maintenance-free rod end, steel/sinter bronze composite

Bild 2



Maintenance-free rod end, steel/PTFE fabric

Bild 3



Maintenance-free rod end, steel/PTFE composite

3.6

Dimensions

The dimensions of the maintenance-free rod ends conform to ISO 12240-4:1998. Those rod ends which carry the designation suffix /VZ019 have a thread which deviates from that specified in ISO 12240-4 but is in accordance with the CETOP¹⁾ recommendation RP 103 P and ISO 8139:1991.

The female and male threads of SKF rod ends are in accordance with ISO 965-1:1998.

Tolerances

The tolerances of SKF rod ends are in accordance with the tolerances specified in ISO 12240-4:1998. The actual tolerance values are given in **Table 1**.

The symbols used in **Table 1** are explained in the following.

- d nominal bore diameter
- Δ_{dmp} deviation of the mean bore diameter from the nominal
- Δ_{Bs} deviation of single inner ring width from the nominal

Internal clearance, preload

SKF maintenance-free rod ends, because of their design, have a radial internal clearance but may also have a light preload. Therefore, **Tables 2** and **3** show maximum values for the radial internal clearance as well as for the friction torque in the circumferential direction caused by preload.

Table 1

Bore diameter d	Series SA(A) and SI(A)		Series SAKB and SIKB					
	Δ_{dmp}		Δ_{Bs}		Δ_{dmp}		Δ_{Bs}	
over incl.	high	low	high	low	high	low	high	low
mm	μm		μm		μm		μm	
6	0	-8	0	-120	+12	0	0	-120
6 10	0	-8	0	-120	+15	0	0	-120
10 18	0	-8	0	-120	+18	0	0	-120
18 30	0	-10	0	-120	-	-	-	-
30 50	0	-12	0	-120	-	-	-	-
50 80	0	-15	0	-150	-	-	-	-

Tolerances for maintenance-free rod end inner rings

Table 2

Bore diameter d		Radial internal clearance	Friction torque
over	incl.	max	max
mm		μm	Nm
12	12	28	0,15
12	20	35	0,25
20	30	44	0,40
30	35	50	2,5
35	40	60	2,5
40	45	60	3,5
50	60	60	4
60	70	72	5

Radial internal clearance and friction torque for steel/sinter bronze composite and steel/PTFE fabric rod ends Series SA(A) and SI(A)

Table 3

Bore diameter d	Radial internal clearance	Friction torque
	max	max
mm	μm	Nm
5	50	0,20
6	50	0,25
8	50	0,30
10	75	0,40
12	75	0,50
14	75	0,60
16	75	0,70
18	85	0,80
20	100	1

Radial internal clearance and friction torque for steel/PTFE composite rod ends Series SAKB and SIKB

¹⁾ CETOP = Comité Européen des Transmissions Oléohydrauliques et Pneumatiques (European Committee for Hydraulic and Pneumatic Transmissions)

Rod end housing materials

Series	Size	Material	Material No.
SA(A) SI(A)	6 .. 70	Heat treatable steel C45 zinc coated	1.0503
SAKB	5 .. 12	Automatic steel 9 SMnPb 28 K zinc coated and chromatised	1.0718
SIKB	14 .. 20	Heat treatable steel C35 zinc coated and chromatised	1.0501

Materials

The materials used for the rod end housings of SKF maintenance-free rod ends are listed in Table 4. The right is reserved to make changes dictated by technical developments.

Details of the materials used for the maintenance-free spherical plain bearings incorporated in the rod ends will be found in **Matrix 1, page 73**.

The inner rings of rod ends with the sliding contact surface combination steel/PTFE composite are of bearing steel which is hardened and ground and the sliding contact surface is hard chromium plated. The sliding layer of these bearings consists of a glass fibre reinforced polymer containing PTFE.

Permissible operating temperature range

The permissible operating temperature range for SKF maintenance-free rod ends is governed by the rod end housing, the spherical plain bearing incorporated and the bearing seals. The ranges are given in **Table 5**.

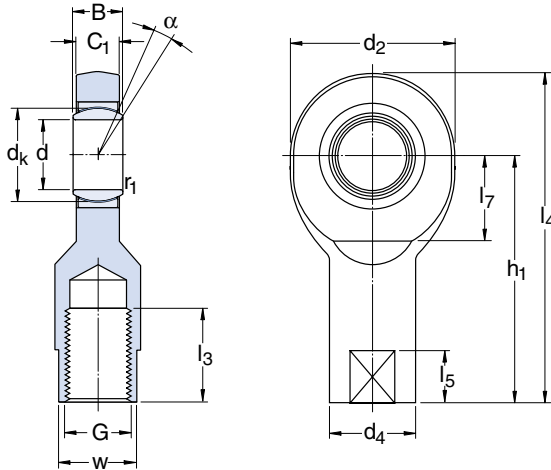
Fatigue strength

In applications where the rod end is subjected to loads of alternating magnitude or direction, or where rod end failure could be dangerous, it is necessary to check the fatigue strength of the rod end.

Permissible operating temperature range

Series	Permissible operating temperature range ¹⁾		Reduced load carrying capacity from
	from	incl.	
–	°C		°C
Steel/sinter bronze composite			
SA .. C SI .. C	–50	+150	+80
Steel/PTFE fabric			
SA(A) .. TE-2RS SI(A) .. TE-2RS	–30	+130	+60
Steel/PTFE composite			
SAKB .. F SIKB .. F SIKB .. F/VZ019	–40	+75	+50

Maintenance-free rod ends with female thread, sliding contact surface combination steel/sinter bronze composite
d 6 – 30 mm



Principal dimensions

Angle of tilt

Basic load ratings
dynamic static

Mass

Designations

d	d ₂ max	G 6H	B	C ₁ max	h ₁	α	C	C ₀	Mass	Designations Rod end with right-hand thread	Designations left-hand thread
mm						degrees	N		kg	–	
6	22	M 6	6	4,5	30	13	3 600	8 150	0,023	SI 6 C	SIL 6 C
8	25	M 8	8	6,5	36	15	5 850	12 900	0,036	SI 8 C	SIL 8 C
10	30	M 10	9	7,5	43	12	8 650	19 000	0,065	SI 10 C	SIL 10 C
12	35	M 12	10	8,5	50	10	11 400	25 500	0,11	SI 12 C	SIL 12 C
15	41	M 14	12	10,5	61	8	18 000	37 500	0,18	SI 15 C	SIL 15 C
17	47	M 16	14	11,5	67	10	22 400	46 500	0,25	SI 17 C	SIL 17 C
20	54	M 20×1,5	16	13,5	77	9	31 500	57 000	0,35	SI 20 C	SIL 20 C
25	65	M 24×2	20	18	94	7	51 000	90 000	0,65	SI 25 C	SIL 25 C
30	75	M 30×2	22	20	110	6	65 500	118 000	1,05	SI 30 C	SIL 30 C

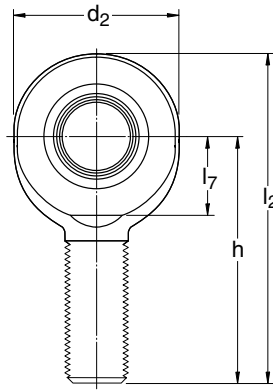
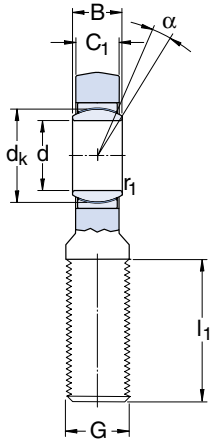
Dimensions

d	d _k	d ₄ ≈	l ₃ min	l ₄ max	l ₅ ≈	l ₇ min	r ₁ min	w h14
---	----------------	---------------------	-----------------------	-----------------------	---------------------	-----------------------	-----------------------	----------

mm

6	10	11	11	43	8	10	0,3	9
8	13	13	15	50	9	11	0,3	11
10	16	16	15	60	11	13	0,3	14
12	18	19	18	69	12	17	0,3	17
15	22	22	21	83	14	19	0,3	19
17	25	25	24	92	15	22	0,3	22
20	29	28	30	106	16	24	0,3	24
25	35,5	35	36	128	18	30	0,6	30
30	40,7	42	45	149	19	34	0,6	36

Maintenance-free rod ends with male thread, with sliding contact surface combination steel/sinter bronze composite
d 6 – 30 mm



Principal dimensions

Angle of tilt

Basic load rating
dynamic static

Mass

Designations
Rod end with right-hand thread left-hand thread

d	d ₂ max	G 6g	B	C ₁ max	h	α	C	C ₀	Mass	Designations Rod end with right-hand thread	Designations left-hand thread
mm						degrees	N		kg	–	
6	22	M 6	6	4,5	36	13	3 600	8 150	0,017	SA 6 C	SAL 6 C
8	25	M 8	8	6,5	42	15	5 850	12 900	0,030	SA 8 C	SAL 8 C
10	30	M 10	9	7,5	48	12	8 650	18 300	0,053	SA 10 C	SAL 10 C
12	35	M 12	10	8,5	54	10	11 400	24 500	0,078	SA 12 C	SAL 12 C
15	41	M 14	12	10,5	63	8	18 000	34 500	0,13	SA 15 C	SAL 15 C
17	47	M 16	14	11,5	69	10	22 400	42 500	0,19	SA 17 C	SAL 17 C
20	54	M 20×1,5	16	13,5	78	9	31 500	51 000	0,32	SA 20 C	SAL 20 C
25	65	M 24×2	20	18	94	7	51 000	78 000	0,57	SA 25 C	SAL 25 C
30	75	M 30×2	22	20	110	6	65 500	104 000	0,90	SA 30 C	SAL 30 C

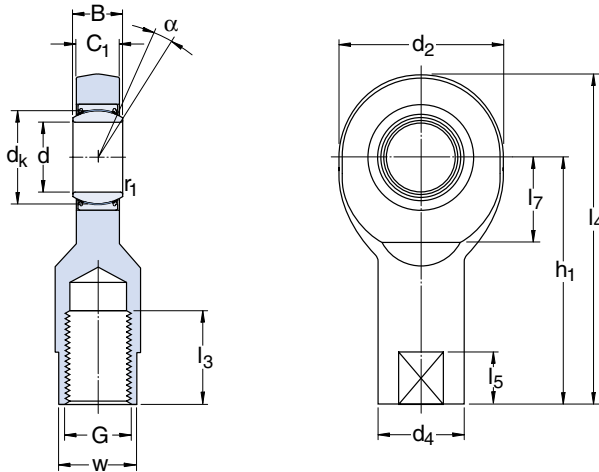
Dimensions

d	d _k	l ₁ min	l ₂ max	l ₇ min	r ₁ min
---	----------------	-----------------------	-----------------------	-----------------------	-----------------------

mm

6	10	16	49	10	0,3
8	13	21	56	11	0,3
10	16	26	65	13	0,3
12	18	28	73	17	0,3
15	22	34	85	19	0,3
17	25	36	94	22	0,3
20	29	43	107	24	0,3
25	35,5	53	128	30	0,6
30	40,7	65	149	34	0,6

Maintenance-free rod ends with female thread, sliding contact surface combination steel/PTFE fabric
d 35 – 70 mm



Principal dimensions

Angle of tilt

Basic load ratings
dynamic static

Mass

Designations

Rod end with right-hand thread

left-hand thread

d	d ₂ max	G 6H	B	C ₁ max	h ₁	α	C	C ₀	Mass	Designations Rod end with right-hand thread	left-hand thread
mm						degrees	N		kg	–	
35	84	M 36×3	25	22	130	6	112 000	134 000	1,40	SI 35 TE-2RS	SIL 35 TE-2RS
	94	M 39×3	28	24	142	6	140 000	166 000	2,20	SIA 40 TE-2RS	SILA 40 TE-2RS
40	94	M 42×3	28	24	145	6	140 000	166 000	2,30	SI 40 TE-2RS	SIL 40 TE-2RS
	104	M 45×3	32	28	165	7	180 000	224 000	2,90	SIA 45 TE-2RS	SILA 45 TE-2RS
45	104	M 42×3	32	28	145	7	180 000	224 000	3,20	SI 45 TE-2RS	SIL 45 TE-2RS
	114	M 45×3	35	31	160	6	220 000	270 000	4,10	SIA 50 TE-2RS	SILA 50 TE-2RS
50	114	M 52×3	35	31	195	6	220 000	270 000	4,50	SI 50 TE-2RS	SIL 50 TE-2RS
	137	M 52×3	44	39	175	6	345 000	400 000	6,30	SIA 60 TE-2RS	SILA 60 TE-2RS
60	137	M 60×4	44	39	225	6	345 000	400 000	7,10	SI 60 TE-2RS	SIL 60 TE-2RS
	162	M 72×4	49	43	265	6	440 000	530 000	10,5	SI 70 TE-2RS	SIL 70 TE-2RS

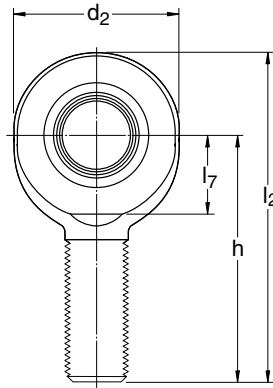
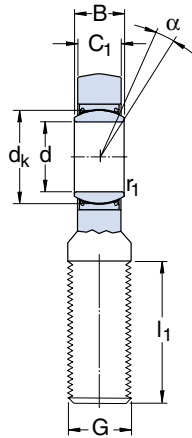
Dimensions

d	d _k	d ₄ ≈	l ₃ min	l ₄ max	l ₅ ≈	l ₇ min	r ₁ min	w h14
---	----------------	---------------------	-----------------------	-----------------------	---------------------	-----------------------	-----------------------	----------

mm

35	47	49	60	174	25	40	0,6	41
40	53	58	65	191	25	46	0,6	50
	53	58	65	194	25	46	0,6	50
45	60	65	65	199	30	50	0,6	55
	60	65	65	219	30	50	0,6	55
50	66	70	68	219	30	58	0,6	60
	66	70	68	254	30	58	0,6	60
60	80	82	70	246	35	73	1	70
	80	82	70	296	35	73	1	70
70	92	92	80	349	40	85	1	80

Maintenance-free rod ends with female thread, sliding contact surface combination steel/PTFE fabric
d 35 – 70 mm



Principal dimensions

d	d ₂ max	G 6g	B	C ₁ max	h	Angle of tilt	Basic load ratings		Mass	Designations	
						α	dynamic	static		Rod end with right-hand thread	left-hand thread
mm						degrees	N		kg	–	
35	84	M 36×3	25	22	130	6	112 000	120 000	1,30	SA 35 TE-2RS	SAL 35 TE-2RS
	6										
40	94	M 39×3	28	24	150	6	140 000	150 000	1,85	SAA 40 TE-2RS	SALA 40 TE-2RS
	94					M 42×3					
45	104	M 42×3	32	28	163	7	180 000	200 000	2,45	SAA 45 TE-2RS	SALA 45 TE-2RS
	104					M 45×3					
50	114	M 45×3	35	31	185	6	220 000	245 000	3,30	SAA 50 TE-2RS	SALA 50 TE-2RS
	114					M 52×3					
60	137	M 52×3	44	39	210	6	345 000	360 000	5,70	SAA 60 TE-2RS	SALA 60 TE-2RS
	137					M 60×4					
70	162	M 72×4	49	43	265	6	440 000	490 000	10,0	SA 70 TE-2RS	SAL 70 TE-2RS

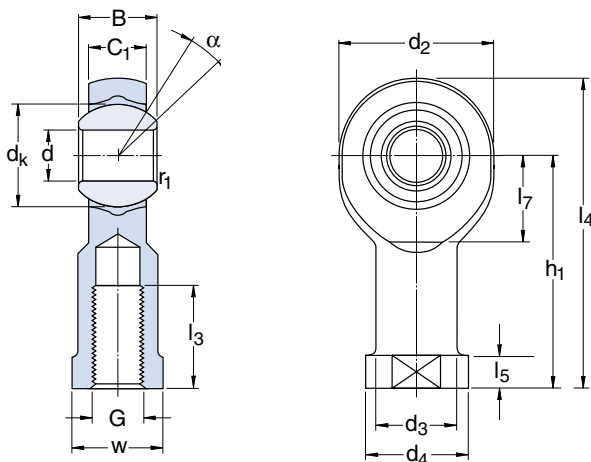
Dimensions

d	d _k	l ₁ min	l ₂ max	l ₇ min	r ₁ min
---	----------------	-----------------------	-----------------------	-----------------------	-----------------------

mm

35	47	82	174	40	0,6
40	53	86	199	46	0,6
	53	90	194	46	0,6
45	60	92	217	50	0,6
	60	95	219	50	0,6
50	66	104	244	58	0,6
	66	110	254	58	0,6
60	80	115	281	73	1
	80	120	296	73	1
70	92	132	349	85	1

Maintenance-free rod ends with female thread, sliding contact surface combination steel/PTFE composite
d 5 – 20 mm



Principal dimensions

Angle of tilt

Basic load ratings
dynamic static

Mass

Designations

Rod end with right-hand thread

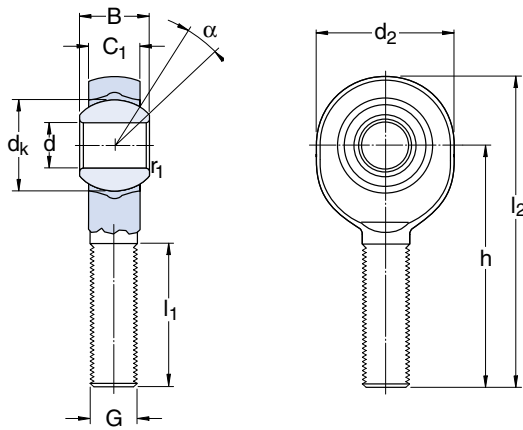
left-hand thread

d	d ₂ max	G 6H	B	C ₁ max	h ₁	α	C	C ₀	Mass	Designations Rod end with right-hand thread	left-hand thread
mm						degrees	N		kg	–	
5	19	M 5	8	6	27	13	3 250	5 300	0,019	SIKB 5 F	SILKB 5 F
6	21	M 6	9	6,75	30	13	4 250	6 800	0,028	SIKB 6 F	SILKB 6 F
8	25	M 8	12	9	36	14	7 100	11 400	0,047	SIKB 8 F	SILKB 8 F
10	29	M 10	14	10,5	43	13	9 800	14 300	0,079	SIKB 10 F	SILKB 10 F
	29	M 10×1,25	14	10,5	43	13	9 800	14 300	0,079	SIKB 10 F/VZ019	–
12	33	M 12	16	12	50	13	13 200	17 000	0,12	SIKB 12 F	SILKB 12 F
	33	M 12×1,25	16	12	50	13	13 200	17 000	0,12	SIKB 12 F/VZ019	–
14	37	M 14	19	13,5	57	16	17 000	27 500	0,16	SIKB 14 F	SILKB 14 F
16	43	M 16	21	15	64	15	21 400	34 500	0,23	SIKB 16 F	SILKB 16 F
	43	M 16×1,5	21	15	64	15	21 400	34 500	0,23	SIKB 16 F/VZ019	–
18	47	M 18×1,5	23	16,5	71	15	26 000	41 500	0,33	SIKB 18 F	SILKB 18 F
20	51	M 20×1,5	25	18	77	14	31 000	50 000	0,38	SIKB 20 F	SILKB 20 F

Dimensions

d	d _k	d ₃ ≈	d ₄ max	l ₃ min	l ₄ max	l ₅ ≈	l ₇ min	r ₁ min	w h14
mm									
5	11,1	9	12	8	37	4	9	0,3	9
6	12,7	10	14	9	41	5	10	0,3	11
8	15,8	12,5	17	12	49	5	12	0,3	14
10	19	15	20	15	58	6,5	14	0,3	17
	19	15	20	15	58	6,5	14	0,3	17
12	22,2	17,5	23	18	67	6,5	16	0,3	19
	22,2	17,5	23	18	67	6,5	16	0,3	19
14	25,4	20	27	21	76	8	18	0,3	22
16	28,5	22	29	24	86	8	21	0,3	22
	28,5	22	29	24	86	8	21	0,3	22
18	31,7	25	32	27	95	10	23	0,3	27
20	34,9	27,5	37	30	103	10	25	0,3	30

Maintenance-free rod ends with male thread, with sliding contact surface combination steel/PTFE composite
d 5 – 20 mm



Principal dimensions

Angle of tilt

Basic load ratings
dynamic static

Mass

Designations

d	d ₂ max	G 6g	B	C ₁ max	h	α	C	C ₀	Mass	Designations Rod end with right-hand thread	left-hand thread
mm						degrees	N		kg	–	
5	19	M 5	8	6	33	13	3 250	5 300	0,015	SAKB 5 F	SALKB 5 F
6	21	M 6	9	6,75	36	13	4 250	6 800	0,021	SAKB 6 F	SALKB 6 F
8	25	M 8	12	9	42	14	7 100	10 000	0,035	SAKB 8 F	SALKB 8 F
10	29	M 10	14	10,5	48	13	9 800	12 500	0,059	SAKB 10 F	SALKB 10 F
12	33	M 12	16	12	54	13	13 200	15 000	0,10	SAKB 12 F	SALKB 12 F
14	37	M 14	19	13,5	60	16	17 000	25 500	0,13	SAKB 14 F	SALKB 14 F
16	43	M 16	21	15	66	15	21 400	34 500	0,20	SAKB 16 F	SALKB 16 F
18	47	M 18x1,5	23	16,5	72	15	26 000	41 500	0,26	SAKB 18 F	SALKB 18 F
20	51	M 20x1,5	25	18	78	14	31 000	50 000	0,37	SAKB 20 F	SALKB 20 F

Dimensions

d	d _k	l ₁ min	l ₂ max	r ₁ min
---	----------------	-----------------------	-----------------------	-----------------------

mm

5	11,1	19	44	0,3
6	12,7	21	48	0,3
8	15,8	25	56	0,3
10	19	28	64	0,3
12	22,2	32	72	0,3
14	25,4	36	80	0,3
16	28,5	37	89	0,3
18	31,7	41	97	0,3
20	34,9	45	106	0,3

Special solutions and related SKF products

Plain bearings for road vehicles

Special applications such as the bearing arrangements for centring propeller shafts or gear shifts require special spherical plain bearings or bearing units. SKF has developed appropriate products in close cooperation with customers and manufactures them in large volumes.

Plain bearings for rail vehicles

The SKF plain bearing range for railway vehicles includes bogie swivel bearings for trams and heavy duty goods wagons as well as spherical plain bearings and rod ends for transverse stabilisers, tilting mechanisms etc.



Spherical plain bearings and rod ends for the aircraft industry

In the aircraft industry spherical plain bearings and rod ends take a prominent place as airframe bearings for the transmission of rotating, tilting and oscillating movements. The SKF specialist company for airframe products is SARMA, producing spherical plain bearings and rod ends for the suspension of engines and auxiliary equipment, as well those needed for use in undercarriages, spoilers, height and side rudders, wing flaps etc.

SARMA manufactures spherical plain bearings and rod ends in steel, stainless steel and composite materials in various sliding contact surface combinations: some requiring maintenance and some being maintenance-free.

Airframe control rods and structural rods of light alloy, steel, titanium and composite materials in a wide variety of designs are produced by SARMA for a multitude of applications in other fields as well as the aircraft industry.

Direct contact:

SARMA

1 avenue Marc Seguin

Parc Industriel de la Brassière

F-26241 Saint Vallier sur Rhône

Cedex

France

Telephone: +33 4 75 03 40 40

Fax: +33 4 75 30 40 00



Bushings and flanged bushings

Bushings and flanged bushings have been part of the SKF product range for more than thirty years and the most varied assortment is available from stock. A comprehensive range of materials is available including the following.

- **Solid bronze bushings**
The traditional robust bushings
- **Sintered bronze bushings**
These are impregnated with oil and can be operated at high speed
- **Wrapped bronze bushings**
The lubricant pockets allow them to function well even in dirty environments
- **PTFE composite bushings**
The low friction enables long periods of maintenance-free operation

- **POM composite bushings**
These require little maintenance even under arduous conditions
- **Stainless backed composite bushings**
These are appropriate for corrosive environments
- **PTFE/polyamide bushings**
The cost-favourable, maintenance-free bushings for light loads
- **Filament wound bushings**
The maintenance-free bushings for extreme conditions

Because of the great variety of SKF bushings they are to be found in all branches of industry irrespective of whether

- freedom from maintenance is required, or not;
- lubricants or other media are present, or not;

and where

- rotational, slewing or linear movement must be accommodated.

See brochure 4741 "SKF bushings", brochure 4413 "Composite dry sliding bearings – maintenance-free and space-saving" or CD-ROM "SKF Interactive Engineering Catalogue".



Thrust washers and strips

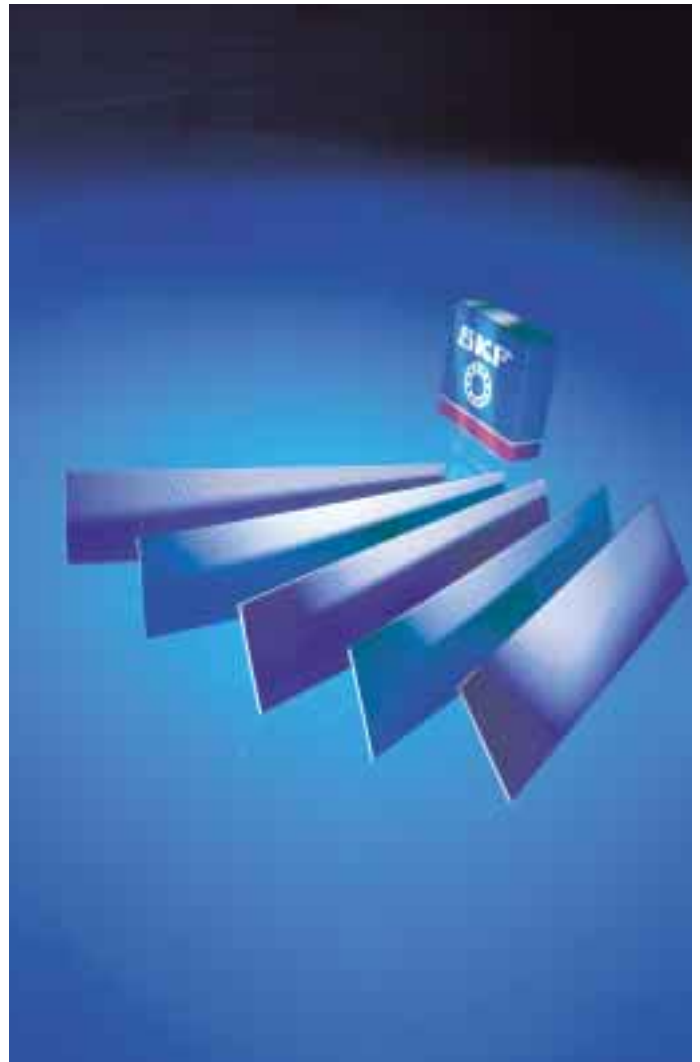
For thrust bearing arrangements which have to make oscillating or slow rotational movements, thrust washers are available made of two different triple layer composite materials:

- SKF thrust washers of B material (PTFE composite), and
- SKF thrust washers of M material (POM composite).

The thrust washers are primarily intended for applications where axial space is extremely limited and where freedom from maintenance is required or where lubricant starvation can occur.

SKF also supplies strip of the same triple layer composite materials – B and M. The strip can be bent, pressed or coined to form, for example, linear guides with flat, L-shaped or V-shaped profiles or many other dry sliding components.

See brochure 4413 “Composite dry sliding bearings – maintenance-free and space-saving” or CD-ROM “SKF Interactive Engineering Catalogue”.



The SKF group - a worldwide corporation

SKF is an international industrial Group operating in some 130 countries and is world leader in bearings.

The company was founded in 1907 following the invention of the self-aligning ball bearing by Sven Wingquist and, after only a few years, SKF began to expand all over the world.

Today, SKF has some 40 000 employees and around 80 manufacturing facilities spread throughout the world. An international sales network includes a large number of sales companies and some 7 000 distributors and retailers. Worldwide availability of SKF products is supported by a comprehensive technical advisory service.

The key to success has been a consistent emphasis on maintaining the highest quality of its products and services. Continuous investment in research and

development has also played a vital role, resulting in many examples of epoch-making innovations.

The business of the Group consists of bearings, seals, special steel and a comprehensive range of other high-tech industrial components. The experience gained in these various fields provides SKF with the essential knowledge and expertise required in order to provide the customers with the most advanced engineering products and efficient service.



SKF



The SKF Group is the first major bearing manufacturer to have been granted approval according to ISO 14001, the international standard for environmental management systems. The certificate is the most comprehensive of its kind and covers more than 60 SKF production units in 17 countries.



The SKF Engineering & Research Centre is situated just outside Utrecht in The Netherlands. In an area of 17 000 square metres (185 000 sq.ft) some 150 scientists, engineers and support staff are engaged in the further improvement of bearing performance. They are developing technologies aimed at achieving better materials, better designs, better lubricants and better seals – together leading to an even better understanding of the operation of a bearing in its application. This is also where the SKF Life Theory was evolved, enabling the design of bearings which are even more compact and offer even longer operational life.



SKF has developed the Channel concept in factories all over the world. This drastically reduces the lead time from raw material to end product as well as work in progress and finished goods in stock. The concept enables faster and smoother information flow, eliminates bottlenecks and bypasses unnecessary steps in production. The Channel team members have the knowledge and commitment needed to share the responsibility for fulfilling objectives in areas such as quality, delivery time, production flow etc.



SKF manufactures ball bearings, roller bearings and plain bearings. The smallest are just a few millimetres (a fraction of an inch) in diameter, the largest several metres. SKF also manufactures bearing and oil seals which prevent dirt from entering and lubricant from leaking out. SKF's subsidiaries CR and RFT S.p.A. are among the world's largest producers of seals.

© Copyright SKF 2000

The contents of this publication are the copyright of the publisher and may not be reproduced (even extracts) unless permission is granted. Every care has been taken to ensure the accuracy of the information contained in this publication but no liability can be accepted for any loss or damage whether direct, indirect or consequential arising out of the use of the information contained herein.

Publication **4407 E**

Printed in Sweden on environmentally friendly, chlorine-free paper (Multiart Silk) by SG idé & tryck ab.