# Mounting and dismounting

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Mounting and dismounting

General information

To provide proper bearing performance and prevent premature failure, skill and cleanliness when mounting ball and roller bearings are necessary.

As precision components, rolling bearings should be handled carefully when mounting. It is also important to choose the correct method of mounting and to use the correct tools for the job. The comprehensive SKF range of maintenance products includes mechanical and hydraulic tools and heating equipment as well as other products for mounting and maintenance. This full line of products will facilitate and speed the work, giving professional results. Brief information can be found in the section “Maintenance and lubrication products”, starting on page 1069.

To realize maximum bearing service life, a bearing must be installed correctly – which often is more difficult than it appears, especially where large size bearings are concerned. To be sure that bearings are mounted and maintained properly, SKF offers seminars and hands-on training courses as part of the SKF Reliability Systems concept. Installation and maintenance assistance may also be available from your local SKF company.

The information provided in the following section is quite general and is intended primarily to indicate what must be considered by machine and equipment designers in order to facilitate bearing mounting and dismounting. More detailed descriptions of the actual mounting and dismounting procedures can be found in the publication “SKF Bearing Maintenance Handbook” which is available through your local SKF representative on request, or online at www.skf.com-mount or www.aptitudexchange.com.

Where to mount

Bearings should be installed in a dry, dust-free room away from metalworking or other machines producing swarf and dust. When bearings have to be mounted in an unprotected area, which is often the case with large bearings, steps need to be taken to protect the bearing and mounting position from contamination by dust, dirt and moisture until installation has been completed. This can be done by covering or wrapping bearings, machine components etc. with waxed paper or foil.

Preparations for mounting and dismounting

Before mounting, all the necessary parts, tools, equipment and data need to be at hand. It is also recommended that any drawings or instructions be studied to determine the correct order in which to assemble the various components.

Housings, shafts, seals and other components of the bearing arrangement need to be checked to make sure that they are clean, particularly any threaded holes, leads or grooves where remnants of previous machining operations might have collected. The unmachined surfaces of cast housings need to be free of core sand and any burrs need to be removed.

The dimensional and form accuracy of all components of the bearing arrangement needs to be checked. The bearings will only perform satisfactorily if the associated components have the requisite accuracy and if the prescribed tolerances are adhered to. The diameter of cylindrical shaft and housing seatings are usually checked using a stirrup or internal gauge at two cross-sections and in four directions (fig. 1). Tapered bearing seatings are checked using ring gauges, special taper gauges or sine bars.

It is advisable to keep a record of the measurements. When measuring it is important that the components being measured and the measuring instruments have approximately the same temperature. This means that it is necessary to leave the components and measuring equipment together in the same place sufficiently long for them to reach the same temperature. This is particularly important where large bearings and their associated components, which are correspondingly large and heavy, are concerned.

The bearings need to be left in their original packages until immediately before mounting so
that they will not be exposed to any contaminants, especially dirt. Normally, the preservative with which new bearings are coated before leaving the factory does not need to be removed; it is only necessary to wipe off the outside cylindrical surface and bore. If, however, the bearing is to be grease lubricated and used at very high or very low temperatures, or if the grease is not compatible with the preservative, it is necessary to wash and carefully dry the bearing. This is to avoid any detrimental effect on the lubricating properties of the grease.

Bearings should be washed and dried before mounting if there is a risk that they have become contaminated because of improper handling (damaged packaging etc.).

When taken from its original packaging, any bearing that is covered by a relatively thick, greasy layer of preservative should also be washed and dried. This might be the case for some large bearings with an outside diameter larger than 420 mm. Suitable agents for washing rolling bearings include white spirit and paraffin.

Bearings that are supplied ready greased and which have integral seals or shields on both sides should not be washed before mounting.
Mounting and dismounting

Bearing handling

It is generally a good idea to use gloves as well as carrying and lifting tools, which have been specially designed for mounting and dismounting bearings. This will save not only time and money but the work will also be less tiring, less risky and less injurious to health.

For these reasons, the use of heat and oil resistant gloves is recommended when handling hot or oily bearings. These gloves should have a durable outside and a soft non-allergenic inside, as, for example, SKF TMBA gloves.

Heated and/or larger or heavier bearings often cause problems because they cannot be handled in a safe and efficient manner by one or two persons. Satisfactory arrangements for carrying and lifting these bearings can be made on site in a workshop. The bearing handling tool TMMH from SKF (→ fig. 2) is one such arrangement, which solves most of the problems and facilitates handling, mounting and dismounting bearings on shafts.

If large, heavy bearings are to be moved or held in position using lifting tackle, they should not be suspended at a single point, but a steel band or fabric belt should be used (→ fig. 3). A spring between the hook of the lifting tackle and the belt facilitates positioning the bearing when it is to be pushed onto a shaft.

To ease lifting, large bearings can be provided on request with threaded holes in the ring side faces to accommodate eye bolts. The hole size is limited by the ring thickness. It is therefore only permissible to lift the bearing itself or the individual ring by the bolts. Make also sure that the eye bolts are only subjected to load in the direction of the shank axis (→ fig. 4). If the load is to be applied at an angle, suitable adjustable attachments are required.

When mounting a large housing over a bearing that is already in position on a shaft it is advisable to provide three-point suspension for the housing, and for the length of one sling to be adjustable. This enables the housing bore to be exactly aligned with the bearing.
Mounting

Depending on the bearing type and size, mechanical, thermal or hydraulic methods are used for mounting. In all cases it is important that the bearing rings, cages and rolling elements or seals do not receive direct blows and that the mounting force must never be directed through the rolling elements.

Some parts may be mounted with a loose fit. To avoid any fretting corrosion between the mating surfaces, it is recommended to apply a thin layer of SKF anti-fretting agent LGAF 3 E.

Mounting bearings with a cylindrical bore

With non-separable bearings, the ring that is to have the tighter fit should generally be mounted first. The seating surface should be lightly oiled with thin oil before mounting.

Cold mounting

If the fit is not too tight, small bearings may be driven into position by applying light hammer blows to a sleeve placed against the bearing ring face. The blows should be evenly distributed around the ring to prevent the bearing from tilting or skewing. The use of a mounting dolly instead of a sleeve enables the mounting force to be applied centrally (→ fig. 5).

If a non-separable bearing is to be pressed onto the shaft and into the housing bore at the same time, the mounting force has to be applied equally to both rings and the abutment surfaces of the mounting tool must lie in the same plane. In this case a bearing fitting tool should be used, where an impact ring abuts the side faces of the inner and outer rings and the sleeve enables the mounting forces to be applied centrally (→ fig. 6).

With self-aligning bearings, the use of an intermediate mounting ring prevents the outer ring from tilting and swivelling when the bearing with shaft is introduced into the housing bore (→ fig. 7). It should be remembered that the balls of some sizes of self-aligning ball bearings protrude from the side faces of the bearing, so that the intermediate mounting ring should be recessed in order not to damage the balls. Large numbers of bearings are generally mounted using mechanical or hydraulic presses.
Mounting and dismounting

With separable bearings, the inner ring can be mounted independently of the outer ring, which simplifies mounting, particularly where both rings are to have an interference fit. When installing the shaft, with the inner ring already in position, into the housing containing the outer ring, make sure that they are correctly aligned to avoid scoring the raceways and rolling elements. When mounting cylindrical and needle roller bearings with an inner ring without flanges or a flange at one side, SKF recommends using a mounting sleeve (→ fig. 8). The outside diameter of the sleeve should be equal to the raceway diameter F of the inner ring and should be machined to a d10 tolerance.

Hot mounting
It is generally not possible to mount larger bearings in the cold state, as the force required to mount a bearing increases very considerably with increasing bearing size. The bearings, the inner rings or the housings (e.g. hubs) are therefore heated prior to mounting.

The requisite difference in temperature between the bearing ring and shaft or housing depends on the degree of interference and the diameter of the bearing seating. Bearings should not be heated to more than 125 °C as otherwise dimensional changes caused by alterations in the structure of the bearing material may occur. Bearings fitted with shields or seals should not be heated above 80 °C because of their grease fill or seal material.

When heating bearings, local overheating must be avoided. To heat bearings evenly, SKF electric induction heaters (→ fig. 9) are recommended. If hotplates are used, the bearing must be turned over a number of times. Hotplates should not be used for heating sealed bearings.

Bearing adjustment
The internal clearance of single row angular contact ball bearings and taper roller bearings is only established, in contrast to other radial bearings with cylindrical bore, when one bearing is adjusted against a second bearing. Usually these bearings are arranged in pairs either back-to-back or face-to-face, and one bearing ring is axially displaced until a given clearance or preload is attained. The choice of clearance or preload depends on the demands placed on the performance of the bearing arrangement and on the operating conditions. Additional information about bearing preloads can be found in the section “Bearing preload”, starting on page 206, so that the recommendations in the following refer only to the adjustment of internal
clearance in bearing arrangements with angular contact ball bearings and taper roller bearings.

The appropriate value for the clearance to be obtained when mounting is determined by the conditions when the bearing is under load and at the operating temperature. Depending on the size and arrangement of the bearings, the materials from which the shaft and housing are made and the distance between the two bearings, the initial clearance obtained on mounting may be smaller or larger in actual operation. If, for example, differential thermal expansion of inner and outer rings will cause a reduction in clearance during operation, the initial clearance must be sufficiently large so that distortion of the bearings and the detrimental consequences of this are avoided.

Since there is a definite relationship between the radial and axial internal clearance of angular contact ball bearings and taper roller bearings, it is sufficient to specify one value, generally the axial internal clearance. This specified value is then obtained, from a condition of zero clearance, by loosening or tightening a nut on the shaft or a threaded ring in the housing bore, or by inserting calibrated washers or shims between one of the bearing rings and its abutment. The actual methods used to adjust the clearance and measure the set clearance are determined by whether a few or many bearings are to be mounted.

One method is to check the set axial clearance, for example, of a hub bearing arrangement, using a dial gauge attached to the hub (→ fig. 10). It is important when adjusting taper roller bearings and measuring the clearance that the shaft, or housing, is turned through several revolutions in both directions to be sure that there is proper contact of the roller ends with the guide flange on the inner ring. If the contact is not correct, the measured result will be inaccurate and the desired adjustment will not be achieved.

**Mounting bearings with a tapered bore**

For bearings having a tapered bore, inner rings are always mounted with an interference fit. The degree of interference is not determined by the chosen shaft tolerance, as with bearings having a cylindrical bore, but by how far the bearing is driven up onto the tapered shaft seating, or onto the adapter or withdrawal sleeve. As the bearing is driven up the tapered seating, its radial internal clearance is reduced. This reduction can be measured to determine the degree of interference and the proper fit.

When mounting self-aligning ball bearings, CARB toroidal roller bearings, spherical roller bearings, as well as high-precision cylindrical roller bearings with tapered bore, either the reduction in radial internal clearance or the axial drive-up onto the tapered seating is determined and used as a measure of the degree of interference. Guideline values of clearance reduction and axial drive-up are provided in the text preceding the relevant product table sections.
Mounting and dismounting

Small bearings
Small bearings may be driven up onto a tapered seating using a nut. In the case of adapter sleeves the sleeve nut is used. Small withdrawal sleeves may be driven into the bearing bore using a nut. A hook or impact spanner can be used to tighten the nut. The seating surfaces of the shaft and sleeve should be lightly oiled with thin oil before mounting is started.

Medium and large sized bearings
For larger bearings, considerably more force is required and

- SKF hydraulic nuts should be used and/or
- the oil injection method should be employed.

In either case, the mounting process will be considerably easier. The oil injection equipment required for both, operating the hydraulic nut as well as for applying the oil injection method, is available from SKF. Additional information about these products can be found in the section “Maintenance and lubrication products”, starting on page 1069.

When using an SKF hydraulic nut for mounting it has to be positioned onto a threaded section of the journal or onto the thread of the sleeve so that its annular piston abuts the inner ring of the bearing, a nut on the shaft, or a disc attached to the end of the shaft. Pumping oil into the hydraulic nut displaces the piston axially with the force needed for accurate and safe mounting. Mounting of a spherical roller bearing with the aid of a hydraulic nut on

- a tapered shaft seating is shown in fig. 11
- an adapter sleeve is shown in fig. 12
- a withdrawal sleeve is shown in fig. 13.

With the oil injection method, oil under high pressure is injected between the bearing and bearing seating to form an oil film. This oil film separates the mating surfaces and appreciably reduces the friction between them. This method is typically used when mounting bearings directly on tapered journals (→ fig. 14), but is also used to mount bearings on adapter and withdrawal sleeves that have been prepared for the oil injection method. A pump or oil injector produces the requisite pressure, the oil is injected between the mating surfaces via ducts and distributor grooves in the shaft or sleeve.
The necessary ducts and grooves in the shaft must be considered when designing the bearing arrangement. A spherical roller bearing mounted on a withdrawal sleeve with oil ducts is shown in fig. 15. The withdrawal sleeve is pressed into the bearing bore by injecting oil between the mating surfaces and tightening the screws in turn.

**Determination of the interference fit**

Bearings with a tapered bore are always mounted with an interference fit. The reduction in radial internal clearance, or the axial displacement of the inner ring on its tapered seating is used to determine and measure the degree of interference.

Different methods can be used to measure the degree of interference:

1. Measuring the clearance reduction with a feeler gauge.
2. Measuring the lock nut tightening angle.
3. Measuring the axial drive-up.
4. Measuring the inner ring expansion.

A brief description of these four different methods is provided in the following. More detailed information about these methods can be found in the relevant product sections.
Mounting and dismounting

**Measuring clearance reduction with a feeler gauge**
The method using feeler gauges for measuring the radial internal clearance before and after mounting bearings is applicable for medium and large-sized spherical and toroidal roller bearings. The clearance should preferably be measured between the outer ring and an unloaded roller (→ fig. 16).

**Measuring the lock nut tightening angle**
Measuring the lock nut tightening angle is a proven method to determine the correct degree of interference in small to medium-sized bearings on tapered seatings (→ fig. 17). Guideline values for the tightening angle $\alpha$ have been established, providing accurate positioning of the bearing on its tapered seating.

**Measuring the axial drive-up**
Mounting bearings with a tapered bore can be done by measuring the axial drive-up of the inner ring on its seating. Guideline values for the required axial drive-up are given in the text preceding the relevant product table sections.

However, a more suitable method is the “SKF Drive-up Method”. This mounting method provides a reliable and easy way to determine the degree of interference. The correct fit is achieved by controlling the axial displacement of the bearing from a predetermined position. The method incorporates the use of an SKF hydraulic nut fitted with a dial indicator, and a specially calibrated digital gauge mounted on a selected pump (→ fig. 18). Determined values of the requisite oil pressure and the axial displacement for the individual bearings provide accurate positioning of the bearings. These values can be found

- in the handbook “SKF Drive-up Method” on CD-ROM,
- in the “SKF Interactive Engineering Catalogue” online at www.skf.com or
- online at www.skf.com/mount.
Measuring the inner ring expansion

Measuring inner ring expansion is a simple and very accurate method to determine the correct position of large-size spherical and toroidal roller bearings on their seatings. For this kind of measurement the SensorMount® is available, using a sensor, integrated with the bearing inner ring, a dedicated hand-held indicator and common hydraulic mounting tools (→ fig. 19). Aspects such as bearing size, shaft smoothness, material or design – solid or hollow – do not need to be considered.

Test running

After mounting a bearing, the prescribed lubricant is applied and a test run made so that noise and bearing temperature can be checked.

The test run should be carried out under partial load and – where there is a wide speed range – at slow or moderate speed. Under no circumstances should a rolling bearing be allowed to start up unloaded and accelerated to high speed, as there is a danger that the rolling elements would slide on the raceways and damage them, or that the cage would be subjected to inadmissible stresses. Reference should be made to the section “Minimum load” in the text preceding the relevant product table sections.

Any noise or vibration can be checked using an SKF electronic stethoscope. Normally, bearings produce an even “purring” noise. Whistling or screeching indicates inadequate lubrication. An uneven rumbling or hammering is due in most cases to the presence of contaminants in the bearing or to bearing damage caused during mounting.

An increase in bearing temperature immediately after start up is normal. For example, in the case of grease lubrication, the temperature will not drop until the grease has been evenly distributed in the bearing arrangement, after which an equilibrium temperature will be reached. Unusually high temperatures or constant peaking indicates that there is too much lubricant in the arrangement or that the bearing is radially or axially distorted. Other causes are that the associated components have not been correctly made or mounted, or that the seals have excessive friction.

During the test run, or immediately afterwards, the seals should be checked to see that they perform correctly and any lubrication equipment as well as the oil level of an oil bath should be checked. It may be necessary to sample the lubricant to determine whether the bearing arrangement is contaminated or components of the arrangement have become worn.
Dismounting

If bearings are to be used again after removal, the force used to dismount them must never be applied through the rolling elements.

With separable bearings, the ring with the rolling element and cage assembly can be removed independently of the other ring. With non-separable bearings, the ring having the looser fit should be withdrawn from its seating first. To dismount a bearing having an interference fit, the tools described in the following section may be used, the choice of tools will depend on bearing type, size and fit.

Dismounting bearings with a cylindrical bore

Cold dismounting
Small bearings may be removed from their seatings by applying light hammer blows via a suitable drift to the ring face, or preferably by using a puller. The claws of the puller should be placed around the side face of the ring to be removed, or an adjacent component (→ fig. 20), e.g. a labyrinth ring etc. Dismounting is made easier if

- provision is made for slots in the shaft and/or housing shoulders to take the claws of the puller, or
- tapped holes are provided in the housing shoulders to take withdrawal screws (→ fig. 21).

Larger bearings mounted with an interference fit generally require greater force to remove them, particularly if, after a long period of service, fretting corrosion has occurred. Use of the oil injection method considerably facilitates dismounting in such cases. This presupposes that the necessary oil supply ducts and distributor grooves have been designed into the arrangement (→ fig. 22).

Hot dismounting
Special induction heaters have been developed to dismount the inner rings of cylindrical roller bearings having no flanges or only one flange. They heat the inner ring rapidly without any appreciable heating of the shaft, so that the expanded inner ring can be removed easily. These electrical induction heaters (→ fig. 23)
have one or more coils energized by alternating current. It is necessary to demagnetize the inner rings after heating and removal. The use of electric withdrawal tools becomes economic when bearings of the same size are frequently mounted and dismounted.

When flangeless inner rings of cylindrical roller bearings, or those with only one flange, which have not to be removed frequently, or if larger sizes of inner rings (up to approximately 400 mm bore diameter) have to be dismounted, it is less costly and also easier to use a so-called thermo-withdrawal ring also referred to as a heating ring. This is a slotted ring, generally of light alloy, with handles (→ fig. 24).

The above-mentioned heaters and heating rings are available from SKF. Additional information can be found in the section “Maintenance and lubrication products”, starting on page 1069.
Mounting and dismounting

Dismounting bearings with a tapered bore

Dismounting bearing on a tapered journal
Small and medium-sized bearings on a tapered journal can be dismounted using conventional pullers, which engage the inner ring (→ fig. 25). Preferably a self-centring puller should be used to avoid damage to the bearing seating. Bearings on tapered seatings normally loosen very quickly. Therefore, it is necessary to provide a stop of some kind, a lock nut for example, to prevent the bearing from being completely withdrawn from the shaft.

The dismounting of large bearings from tapered journals is greatly eased if the oil injection method is employed. After injecting pressurised oil between the mating surfaces, the bearing will separate suddenly from its seating. A stop must therefore be provided, for example, a shaft nut or end plate, to limit the axial movement of the bearing to somewhat more than the drive-up distance (→ fig. 26).
Dismounting bearing on an adapter sleeve
Small and medium-sized bearings on an adapter sleeve and smooth shafts can be dismounted by hammer blows directed to a drift (fig. 27) until the bearing becomes free. But first the sleeve nut has to be loosened a few turns.

Small and medium-sized bearings on an adapter sleeve and stepped shafts against a support ring can be dismounted by using a dolly abutting the sleeve nut, which has been released by a few turns (fig. 28).

Dismounting large bearings from an adapter sleeve with a hydraulic nut has proved easy to do. To use this technique however, the bearing must be mounted against a support ring (fig. 29). If the sleeves are provided with oil supply ducts and distributor grooves the dismounting becomes easier because the oil injection method can be employed.

Dismounting bearing on a withdrawal sleeve
When dismounting bearings on withdrawal sleeves, the axial locking device – a locking nut, end cover etc. – has to be removed.

Small and medium-sized bearings can be dismounted using a lock nut and a hook or impact spanner to free the bearing (fig. 30).
Mounting and dismounting

The preferred means of dismounting large bearings is by using a hydraulic nut. If the threaded section of the sleeve protrudes beyond the shaft end or shaft shoulder, a support ring having the greatest possible wall thickness should be inserted in the sleeve bore to prevent distortion and damage to the thread when the hydraulic pressure is applied. SKF recommends providing a stop behind the hydraulic nut, e.g. through an end plate at the shaft end (→ fig. 31). The use of a stop prevents the withdrawal sleeve together with the hydraulic nut from being completely withdrawn from the shaft if the sleeve would separate suddenly from its seating.

Withdrawal sleeves for large bearings are generally provided with distributor ducts and grooves for the oil injection method to save considerable time when mounting as well as dismounting large bearings (→ fig. 32).
Bearing storage

Bearings can be stored in their original packaging for many years, provided that the relative humidity in the storeroom does not exceed 60% and there are no great fluctuations in temperature. The storeroom should also be free of vibrations and shaking.

With sealed or shielded bearings it may be found that the lubricating properties of the grease with which they are filled may have deteriorated if the bearings have been stored for a long time. Bearings that are not stored in their original packaging should be well protected against corrosion and contamination.

Large rolling bearings should only be stored lying down, and preferably with support for the whole extent of the side faces of the rings. If kept in a standing position, the weight of the rings and rolling elements can give rise to permanent deformation because the rings are relatively thin-walled.

Inspection and cleaning

As with all other important machine components, ball and roller bearings must be frequently cleaned and examined. The intervals between such examinations depend entirely on the operating conditions.

If it is possible to ascertain the condition of the bearing during service, e.g. by listening to the sound of the bearing when it is running and measuring the temperature or examining the lubricant, then it is usually found sufficient if the bearings (rings, cage and rolling elements) and other parts of the bearing arrangement are thoroughly cleaned and inspected annually. Where the load is heavy, the frequency of inspection must be increased, e.g. rolling mill bearings are often inspected when the rolls are changed.

After the bearing components have been cleaned with a suitable solvent (white spirit, paraffin etc.) they should be oiled or greased immediately to prevent corrosion. This is particularly important for bearings in machines that are left to stand for considerable periods.