# Axial Angular Contact Roller Bearings

## High load carrying capacity with very small cross sections

# Foreword

Axial ball bearings and axial cylindrical roller bearings are suitable for supporting high axial loads. However, these bearings should not be loaded in a radial direction and, on account of their cross section, require a relatively large radial installation space in the adjacent construction. Furthermore, single direction designs only support axial loads in one direction.

Yet applications frequently call for compact, load-bearing and rigid solutions, which can reliably support combined loads and moments with one bearing arrangement.

**Very small cross section with maximum load carrying capacity**

With axial angular contact roller bearings AXS, the Schaeffler Group Industrial has developed a bearing series with a high load bearing capacity and a particularly small cross section. The design layout, cylindrical rollers (line contact at the contact surfaces) and contact angle of 45° or 60° provide for high axial load ratings and very good rigidity values.

Arranged in pairs, combined loads are also possible in addition to high axial loads in both directions.

For high tilting rigidity values, the bearings can be fitted in an O arrangement.  Where necessary, the bearings can be preloaded to give freedom from axial clearance using an adjusting nut.

Due to the specific bearing features, standard axial angular contact ball bearings can even be replaced with the more compact axial angular contact roller bearings in certain cases.

**Compact and economical**

The new bearing series stands for compact, light and economical bearing arrangements with high axial, radial and tilting moment loading.

It fulfils the demands for the smallest possible installation space with a simultaneously high load carrying capacity and level of rigidity and therefore supports the requirement for bearing arrangements with a reduced installation space and a high level of performance.

**Other products
Radial and axial needle roller and cage assemblies**

The range of axial angular contact ball bearings is supplemented by radial and axial needle roller and cage assemblies produced by bending flat cages of series BF.

They are principally suitable for bearing arrangements with large shaft diameters. Due to their design, it is possible to produce cages of any diameter required.
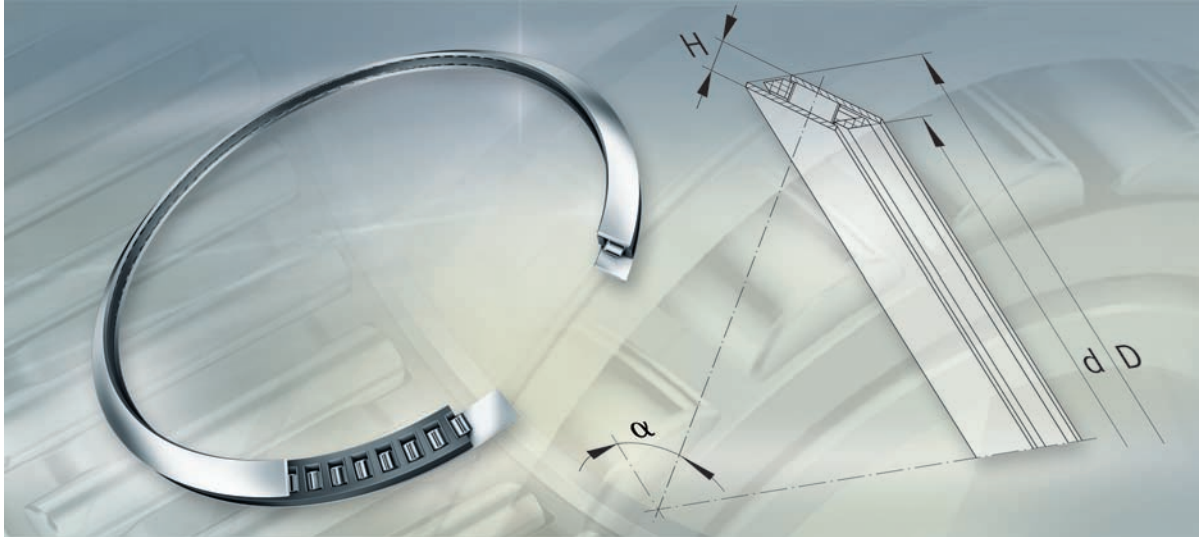
The needle roller and cage assemblies and the associated axial bearing washers are described in TPI 203, Radial and axial needle roller and cage assemblies, axial bearing washers.

# Axial angular contact roller bearings

# Axial angular contact roller bearings

# Axial angular contact roller bearings

**Axial angular contact roller bearing**

AXS



000157CB

# Axial angular contact roller bearings

| | |
|---|---|
| **Features** | Axial angular contact roller bearings AXS comprise thin, formed bearing rings, between which injection-moulded plastic cages and cylindrical rollers are arranged. The dimensions and tolerances of the rolling elements conform to DIN ISO 5 402-1. The modified line contact between the cylindrical rollers and raceways prevents damaging edge stresses. |
| | In contrast to comparable axial rolling bearings, series AXS has a particularly small cross section, whilst the load carrying capacity and tilting rigidity are very high in relation to the loaded installation space. Due to the small cross section of the bearing rings, radial section heights of just 7 mm to 10 mm can be achieved. This permits very compact bearing arrangements with a high load carrying capacity. |
| | Turned contact surfaces suffice for the bearing rings. As a result, the adjacent construction can be designed economically. |
| | The ready-to-fit machine elements are not self-retaining and are therefore very easy to assemble, as the individual parts can be fitted separately. |
| **Load carrying capacity** | The bearings can support radial loads and tilting moment loads in addition to axial loads. When fitted in pairs, even high loads are reliably supported. |
| **O or X arrangement** | Axial angular contact roller bearings are suitable for O and X arrangements. In the O arrangement, the cones and their apexes formed by the contact lines point outwards; in the X arrangement, the cones point inwards. |
| | The support base, in other words the distance between the apexes of the contact cones, is wider in the O arrangement than in the X arrangement. Bearing arrangements with the bearings in the O arrangement are particularly resistant to tilting. |
| **Contact angle** | In order to cater particularly well to the specific requirements of the complex application areas, series AXS is available with contact angles of 45° and 60°. The greater the contact angle, the higher the axial load to which the bearing can be subjected. |
| | Designs with a contact angle of 45° are particularly suitable for axial, radial and tilting moment loads and those with a contact angle of 60° for predominantly axial loads and tilting moments. |
| **Operating temperature** | The bearings are suitable for operating temperatures of −20 °C to +120 °C. |
| **Applications** | The new series has a wide application field. |
| | It is particularly suitable for: |

- combined loads (axial and radial) with simultaneously high exposure to tilting moments
- small axial and radial installation spaces
- swivelling operation
- low speeds.

# Axial angular contact roller bearings

**Design and
safety guidelines
Dynamic load carrying
capacity and life**

The fatigue behaviour of the material determines the dynamic load carrying capacity of a rolling bearing.

The dynamic load carrying capacity is described in terms of the basic dynamic load rating and the basic rating life $L_{10}$ or $L_{10h}$ in accordance with DIN ISO 281.

The fatigue life is dependent on:
- the load
- the operating speed
- the statistical probability of the first appearance of failure.

The dynamic load rating C ($C_a$, $C_r$) applies to rotating rolling bearings.

**Basic rating life**

The basic rating life $L_{10}$ and $L_{10h}$ is determined from:

$$L_{10} = \left(\frac{C}{P}\right)^p$$

$$L_{10h} = \frac{16\,666}{n} \cdot \left(\frac{C}{P}\right)^p$$

$L_{10}$            $10^6$ revolutions
The basic rating life in millions of revolutions is the life reached or exceeded by 90% of a sufficiently large group of apparently identical bearings before the first evidence of material fatigue develops

$L_{10h}$            h
The basic rating life as defined for $L_{10}$ but expressed in operating hours

C ($C_a$, $C_r$)          N
Basic dynamic axial or radial load rating, see dimension table

P                 N
Equivalent dynamic bearing load for combined load, see page 5

p                 –
Life exponent for roller bearings: $p = {}^{10}/_3$

n                 $\text{min}^{-1}$
Operating speed.

**Equivalent dynamic bearing load**

The equivalent dynamic bearing load P is a calculated value. This value is constant in size and direction; it is a radial load for radial bearings and an axial load for axial bearings.

P gives the same rating life as the combined load occurring in practice.

$$P = X \cdot F_r + Y \cdot F_a$$

$P$          N
Equivalent dynamic bearing load for combined load
$F_a$, $F_r$        N
Axial or radial dynamic bearing load
$X$          –
Calculation factor (radial load factor), see table
$Y$
Calculation factor (axial load factor), see table.

**Calculation factors**

| Axial angular contact roller bearing | Contact angle $\alpha$ ° | $F_r/F_a <$ [1] | Calculation factors | |
|---|---|---|---|---|
| | | | X | Y |
| AXS0816 | 45 | 0,67 | 1 | 1 |
| AXS1220 | 60 | 0,39 | 1,73 | 1 |
| AXS2034 | 60 | 0,39 | 1,73 | 1 |
| AXS3550 | 60 | 0,39 | 1,73 | 1 |
| AXS4558 | 45 | 0,67 | 1 | 1 |
| AXS6074 | 60 | 0,39 | 1,73 | 1 |
| AXS8599 | 60 | 0,39 | 1,73 | 1 |
| AXS100115 | 60 | 0,39 | 1,73 | 1 |
| AXS115129 | 60 | 0,39 | 1,73 | 1 |
| AXS120134 | 60 | 0,39 | 1,73 | 1 |
| AXS140154 | 60 | 0,39 | 1,73 | 1 |
| AXS145169 | 45 | 0,67 | 1 | 1 |
| AXS150164 | 60 | 0,39 | 1,73 | 1 |
| AXS160180 | 60 | 0,39 | 1,73 | 1 |
| AXS175200 | 45 | 0,67 | 1 | 1 |

[1] Where higher radial load is present, more detailed calculation is necessary.

# Axial angular contact roller bearings

**Static load safety factor**

In addition to dimensioning on the basis of the fatigue limit life, it is advisable to check the static load safety factor $S_0$.

The static load safety factor indicates the security against impermissible permanent deformations in the bearing.

$$S_0 = \frac{C_0}{P_0}$$

$S_0$     –
Static load safety factor
$C_0$ ($C_{0a}$, $C_{0r}$)     N
Basic static axial or radial load rating, see dimension table
$P_0$     N
Equivalent static bearing load for axial bearings.

**Equivalent static load**

The equivalent static load $P_0$ is a calculated value. It corresponds to a concentric axial load in axial bearings.

$P_0$ induces the same load at the centre point of the most heavily loaded contact point between the rolling element and raceway as the combined load occurring in practice.

$$P_0 = X_0 \cdot F_{0r} + Y_0 \cdot F_{0a}$$

$P_0$     N
Equivalent static bearing load for combined load
$F_{0a}$, $F_{0r}$     N
Axial or radial static bearing load
$X_0$     –
Calculation factor (radial load factor), see table
$Y_0$
Calculation factor (axial load factor), see table.

**Calculation factors**

| Axial angular contact roller bearing | Contact angle $\alpha$ ° | $F_r/F_a <$ [1] | Calculation factors | |
|---|---|---|---|---|
| | | | $X_0$ | $Y_0$ |
| AXS0816 | 45 | 0,67 | 2,3 | 1 |
| AXS1220 | 60 | 0,39 | 3,98 | 1 |
| AXS2034 | 60 | 0,39 | 3,98 | 1 |
| AXS3550 | 60 | 0,39 | 3,98 | 1 |
| AXS4558 | 45 | 0,67 | 2,3 | 1 |
| AXS6074 | 60 | 0,39 | 3,98 | 1 |
| AXS8599 | 60 | 0,39 | 3,98 | 1 |
| AXS100115 | 60 | 0,39 | 3,98 | 1 |
| AXS115129 | 60 | 0,39 | 3,98 | 1 |
| AXS120134 | 60 | 0,39 | 3,98 | 1 |
| AXS140154 | 60 | 0,39 | 3,98 | 1 |
| AXS145169 | 45 | 0,67 | 2,3 | 1 |
| AXS150164 | 60 | 0,39 | 3,98 | 1 |
| AXS160180 | 60 | 0,39 | 3,98 | 1 |
| AXS175200 | 45 | 0,67 | 2,3 | 1 |

[1] Where higher radial load is present, more detailed calculation is necessary.

**Design of adjacent parts**

The bearing rings must be fully supported on their entire surface. They must be centred radially on the shaft or in the housing.

The transitions from the centring features to the supporting faces must be kept free. Corner radii should have a maximum radius of 0,2 mm.

Supporting faces for washers, threads and centring features are produced in a single clamping operation.

Do not centre adjacent parts using the thread; separate centring feature provided.

The angularity, roundness and surface quality of the shaft and housing are critical factors in the smooth running and load bearing capability of the bearings.

Angular deviations of the contact surfaces must not exceed $\pm 1,5'$.

Radial cage guidance surfaces should be precision machined.

**Preload**

Bearing clearance or preload should be adjusted using an adjusting nut with a fine-pitch thread. The nut must be secured against loosening.

Preload must be checked by means of a friction coefficient measurement.

During adjustment, the units should be rotated several times, loosened again and then finally tightened.

**Lubrication**

The bearing sets should be sufficiently greased prior to operation. Please contact Schaeffler for information on grease quantities.

A relubrication option should be provided for dynamic applications.

# Axial angular contact roller bearings
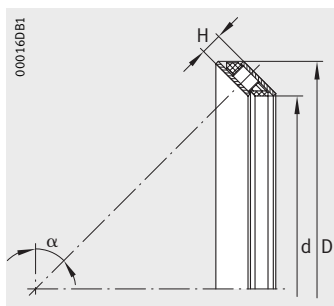


AXS
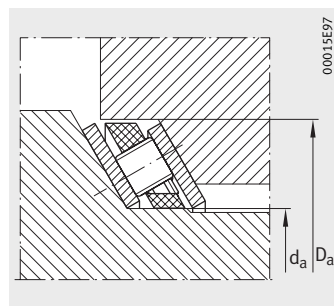


Centring of the bearing rings

**Dimension table** · Dimensions in mm

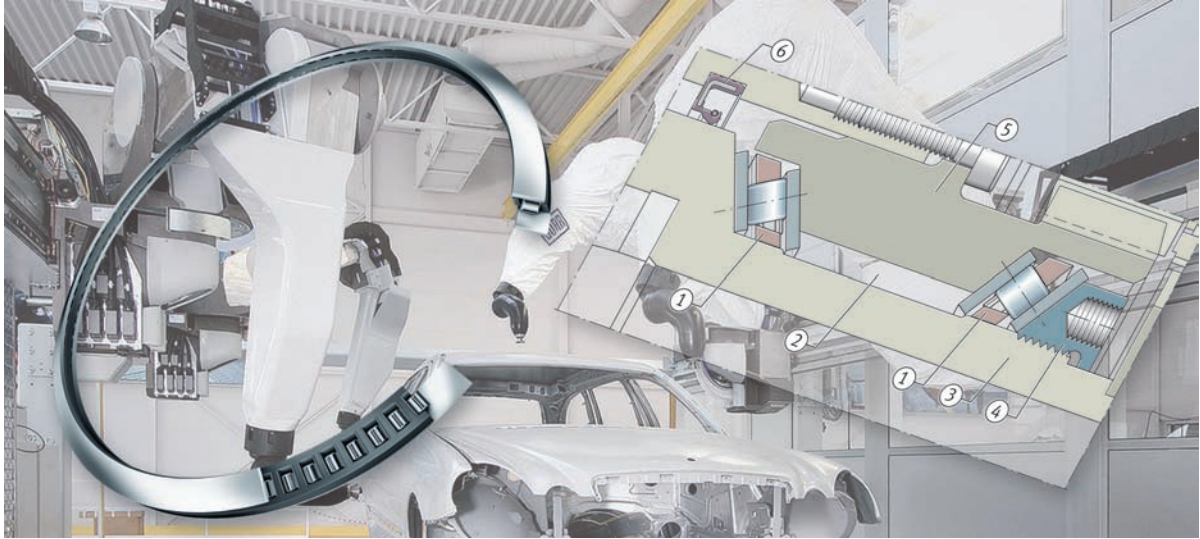| Designation[1] | Mass | Dimensions | | | Contact angle[2] | Centring of the bearing rings | | Basic load ratings | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | on the shaft | in the housing | dyn. | stat. | dyn. | stat. |
| | $m$ | $d$ | $D$ | $H$ | $\alpha$ | $d_a$ | $D_a$ | $C_a$ | $C_{0a}$ | $C_r$ | $C_{0r}$ |
| | $\approx$g | | | | ° | | | N | N | N | N |
| AXS0816 | 3 | **8** | 16 | $3\ ^{+0,26}_{+0,06}$ | 45 | $8\ ^{-0,05}_{-0,15}$ | $16,3^{+0,15}_{+0,05}$ | 3 600 | 6 300 | 1 510 | 1 270 |
| AXS1220 | 3 | **12** | 20 | $3\ ^{-0,24}_{-0,44}$ | 60 | $12,2^{-0,05}_{-0,15}$ | $20,2^{+0,15}_{+0,05}$ | 3 400 | 7 800 | [3] | [3] |
| AXS2034 | 16 | **20** | 34 | $5\ ^{-0,1}_{-0,2}$ | 60 | $20,2^{-0,05}_{-0,15}$ | $34,2^{+0,15}_{+0,05}$ | 9 800 | 25 000 | [3] | [3] |
| AXS3550 | 27 | **35** | 50 | $6\ ^{-0,1}_{-0,3}$ | 60 | $35,2^{-0,1}_{-0,2}$ | $49,2^{+0,2}_{+0,1}$ | 18 200 | 52 000 | [3] | [3] |
| AXS4558 | 35 | **45** | 58 | $6\ ^{-0,1}_{-0,3}$ | 45 | $45\ ^{-0,1}_{-0,2}$ | $58\ ^{+0,2}_{+0,1}$ | 18 200 | 56 000 | 7 600 | 11 200 |
| AXS6074 | 36 | **60** | 74 | $5\ _{-0,6}$ | 60 | $60\ ^{-0,1}_{-0,2}$ | $74\ ^{+0,2}_{+0,1}$ | 15 600 | 62 000 | [3] | [3] |
| AXS8599 | 60 | **85** | 99 | $6\ _{-0,5}$ | 60 | $85\ ^{-0,1}_{-0,2}$ | $99\ ^{+0,2}_{+0,1}$ | 26 500 | 109 000 | [3] | [3] |
| AXS100115 | 70 | **101** | 115 | $6\ _{-0,5}$ | 60 | $101,2^{-0,1}_{-0,2}$ | $114,8^{+0,2}_{+0,1}$ | 30 500 | 139 000 | [3] | [3] |
| AXS115129 | 65 | **115** | 129 | $5\ _{-0,5}$ | 60 | $115\ ^{-0,15}_{-0,25}$ | $129\ ^{+0,25}_{+0,15}$ | 21 600 | 115 000 | [3] | [3] |
| AXS120134 | 80 | **120** | 134 | $6\ _{-0,5}$ | 60 | $120\ ^{-0,15}_{-0,25}$ | $134\ ^{+0,25}_{+0,15}$ | 31 500 | 152 000 | [3] | [3] |
| AXS140154 | 90 | **140** | 154 | $6\ _{-0,3}$ | 60 | $140,2^{-0,15}_{-0,25}$ | $153,8^{+0,25}_{+0,15}$ | 36 000 | 190 000 | [3] | [3] |
| AXS145169 | 267 | **145** | 169 | $7,4^{+0,1}_{-0,4}$ | 45 | $145\ ^{-0,15}_{-0,25}$ | $169\ ^{+0,25}_{+0,15}$ | 76 000 | 400 000 | 31 500 | 80 000 |
| AXS150164 | 100 | **150** | 164 | $6\ _{-0,5}$ | 60 | $150\ ^{-0,15}_{-0,25}$ | $164\ ^{+0,25}_{+0,15}$ | 35 500 | 190 000 | [3] | [3] |
| AXS160180 | 168 | **160** | 180 | $6\ _{-0,2}$ | 60 | $160\ ^{-0,15}_{-0,25}$ | $180\ ^{+0,25}_{+0,15}$ | 68 000 | 405 000 | [3] | [3] |
| AXS175200 | 300 | **175** | 199 | $7,4^{+0,1}_{-0,4}$ | 45 | $175\ ^{-0,15}_{-0,25}$ | $199\ ^{+0,25}_{+0,15}$ | 84 000 | 480 000 | 34 500 | 96 000 |

[1] Other dimensions by agreement.

[2] 60° for predominantly axial loads and tilting moments.

[3] Please request values.

# Applications

# Applications

# Ceiling mount

Ceiling mounts in operating theatres must reliably support an ever increasing number of heavier devices, whilst allowing the movable parts to swivel free from vibration and with low noise, even in strong magnetic fields, *Figure 1*. It is here that the classic mechanical components play a "supporting" role.
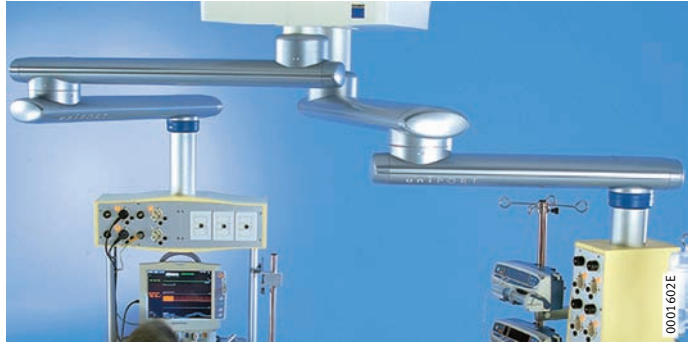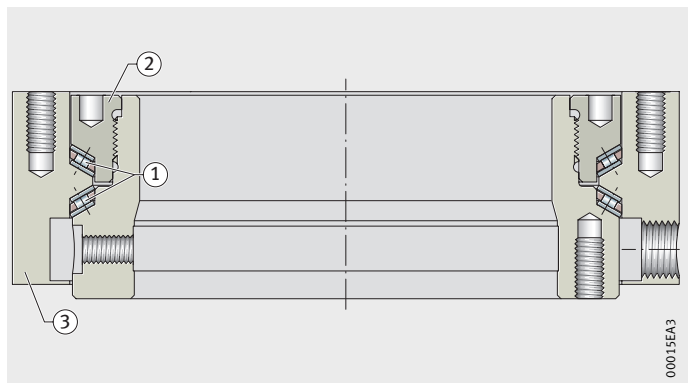


*Figure 1*
Ceiling mount

**Requirements**  The bearings must exhibit a high static load safety factor and tilting rigidity in the smallest possible installation space.
The inside diameter should be relatively large, to allow the supply lines and cables to pass through easily.

**Design solution**  The bearing arrangement comprises a complete unit with double direction axial angular contact roller bearings AXS, *Figure 2*. As a result of the O arrangement, cylindrical rollers and contact angle of 60°, the units have a high axial load carrying capacity and exhibit significant radial stiffness. The bearings are preloaded to give freedom from clearance using an adjusting nut. As a result, no extensive adjustment work is required during fitting.

The outer ring of the unit is screwed directly on to the end face of the adjacent construction by means of a fixing thread. The large inside diameter provides sufficient space for the supply lines and cables.

The bearings have an initial greasing using a special grease and can be relubricated if required.



① Axial angular contact roller bearing AXS in an O arrangement
② Adjusting nut
③ Outer ring

*Figure 2*
Bearing arrangement in a swivel arm

# Painting robots

Painting robots are used in the automatic surface coating of bodywork and the parts attached to it, *Figure 1*.
High-performance robots are available for coating components evenly and quickly.

*Figure 1*
Painting robots

**Requirements**
The most important part of the painting robot is the hand axis complete with paint sprayer. This hand axis should be light, compact, maintenance-free and easy to fit. It should also have sufficient space inside to accommodate the cable and hoses.

**Design solution**
The very small cross section of series AXS permits a compact design, *Figure 2*. The low weight of the bearings combined with a large diameter permits a light design with a high load carrying capacity and sufficient free space for the colour hoses.

The bearing clearance of the bearings used in an O arrangement is adjusted to a defined value with an adjusting nut.

These bearings are greased for life with special grease.
The bearing position is sealed by a rotary shaft seal.

① Axial angular contact roller bearing AXS in an O arrangement
② Grease chamber
③ Shaft
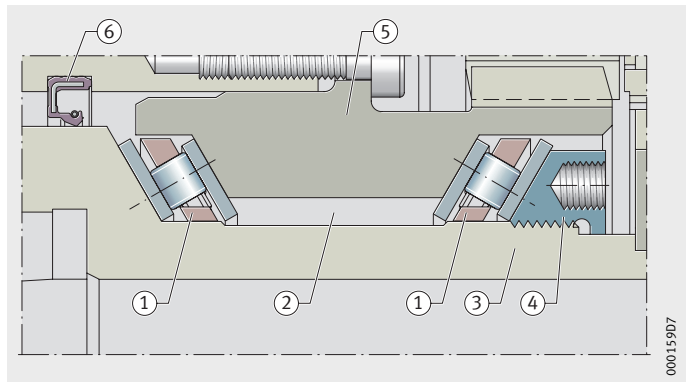④ Adjusting nut
⑤ Housing
⑥ Rotary shaft seal



*Figure 2*
Bearing arrangement in hand axis

# Bicycle arm

For mountain bikes, an inconsistent requirement applies at first glance: Significant damping comfort and lightweight design combined with high rigidity and freedom from clearance, *Figure 1*.



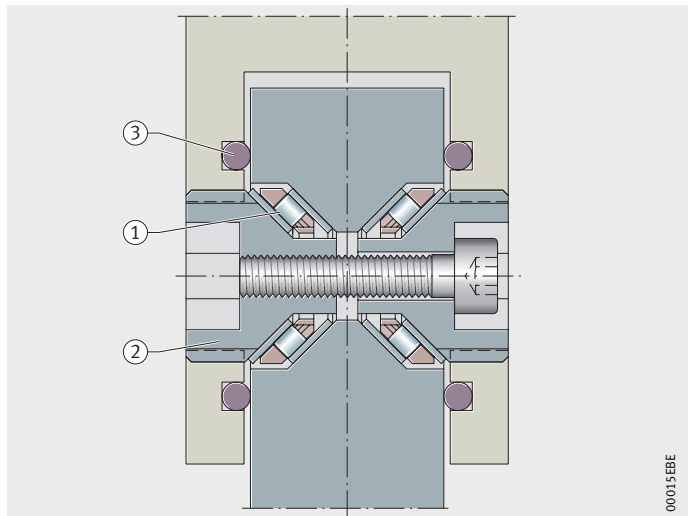*Figure 1*
Mountain bike

**Requirements**
Plain bearings and ball bearings in the rear construction cannot be adjusted to provide freedom from clearance. This, however, is at the expense of riding comfort. The bearing arrangement must therefore be adjustable to a defined value and reliably support the forces that occur as a result of exposure to the road surface and riding out of the saddle.

**Design solution**
The bearing units AXS comprise double direction axial angular contact roller bearings. As a result of the cylindrical rollers and the contact angle of 45° the units have a high axial and radial load carrying capacity and exhibit significant radial stiffness, *Figure 2*.

Using an adjusting nut, the bearing units can be preloaded to give freedom from clearance and readjusted if required.

The bearing arrangement has a relubrication facility and is protected against contamination by toroidal rings.



① Axial angular contact roller bearing AXS
② Adjusting nut
③ Toroidal ring

*Figure 2*
Bearing arrangement in a bicycle arm

# Computer tomograph

Computer tomography (CT) is a computer-based evaluation of X-ray images taken from various directions, which is used to generate a three-dimensional image. A table, complete with the object to be x-rayed, is moved through the device within seconds, *Figure 1*. The table drive is controlled by an electromechanical ball screw drive.



*Figure 1*
Computer tomograph

**Requirements**

Reliable volume production and smooth final fitting of the assembly is required in addition to function and cost-effectiveness.

The locating bearing in the roller-burnished screw drive is intended to permit a simple adjacent geometry and short assembly times. Reduced weight and installation space, as well as design improvements, are also desired.

**Design solution**

Axial angular contact roller bearings ZAXFM are greased and preloaded ex-works, *Figure 2*. The adjusting nut is already incorporated in the bearing unit.

Bearing rings and adjusting nuts are machined from high-strength aluminium, whilst axial roller and cage assemblies and bearing washers are produced using non-machining methods.

The shorter rolling bearing design offers a greater spindle stroke and just one machined contact surface. Compared with an isometric version from rolling bearing steel, the bearing weight is reduced by 60% due to the aluminium rings.

The unit, which is only screw-mounted at the end face, improves the design of the linear actuator with its blue anodised outer ring.
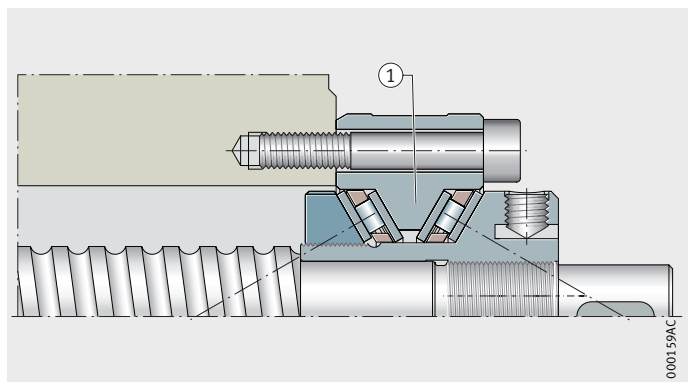


① Axial angular contact roller bearing ZAXFM in an O arrangement

*Figure 2*
Bearing arrangement in the ball screw drive

# Tracking systems for solar plants

As the largest energy source, the sun supplies an amount of energy which is approximately equivalent to 10 000 times the Earth's primary energy requirement each year.

One way of using the sun's energy is, for example, demonstrated by the so-called solar tower power plants, where hundreds of computer-controlled heliostats focus their light on one of the absorbers housed in a spire, *Figure 1*.

The concentration factor of the radiation reaches values of 1 000 and above. With its support, the radiation is converted into heat, which is drawn off in order to drive a generator via a conventional turbine by means of steam generation.



*Figure 1*
Solar plants

**Requirements**
Various tracking systems have been developed so that the mirrors of a heliostat can be tracked as accurately as possible.

The bearing arrangement in the azimuth and elevation axis is particularly important where the tracking systems are concerned.

**Design solution**

The solution is a twin-axis tracking system, which follows the sun at various angles, *Figure 2*. This guarantees that the radiation angle of the sun hits the collector in its entirety. Orientation towards the sun can increase the efficiency of the sun collectors by 30% to 40%.

The twin-axis tracking system is also used to increase the potential of a solar reflector as a converter in the heliostat system.

With their features, axial angular contact roller bearings of the series AXS permit compact, technically progressive and economical bearing arrangements for the azimuth and elevation axis.
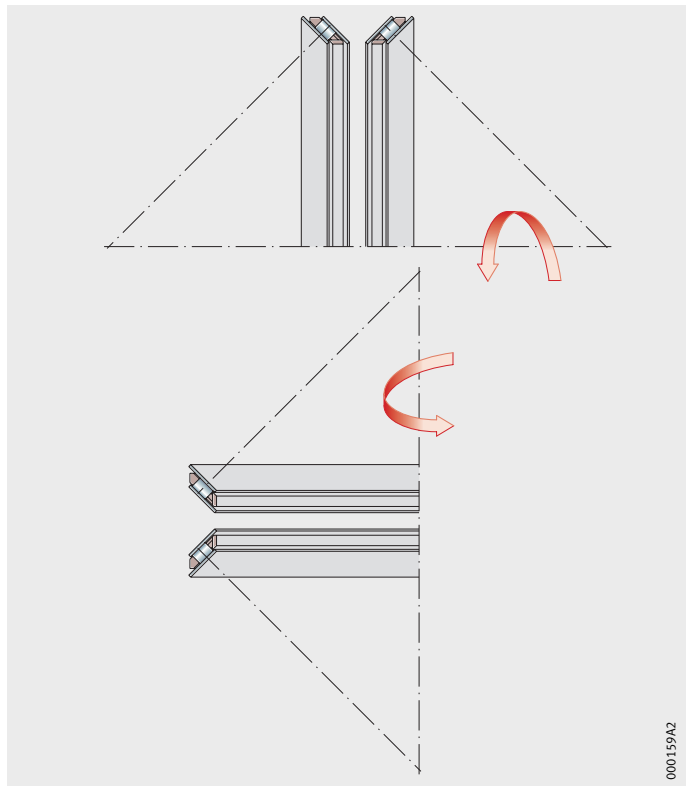


*Figure 2*
Installation postition
and function lines
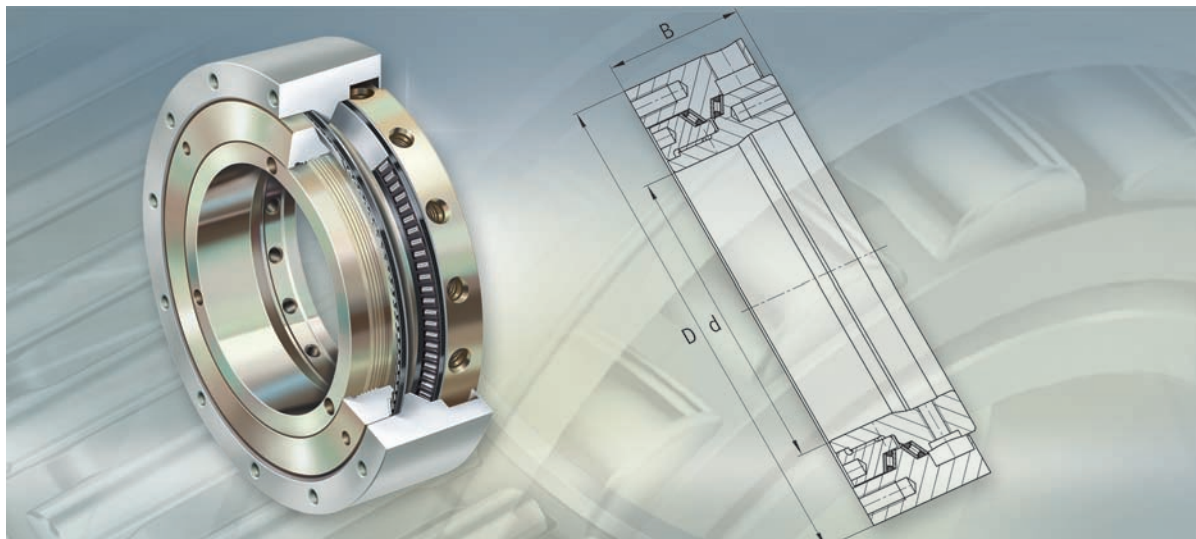
# Other products

# Other products
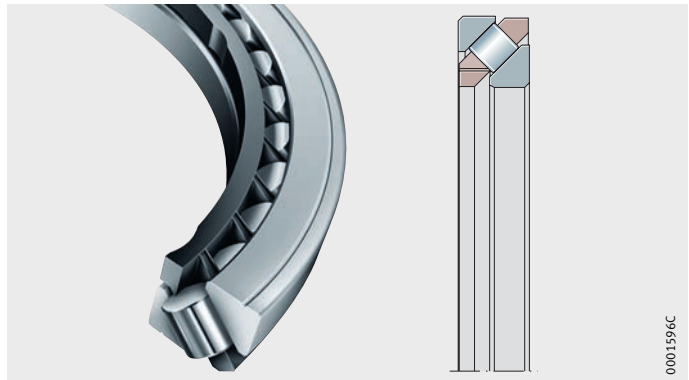
# Angular contact roller bearings

**Features**
Bearings of the series SGL are preferably used if high accuracy and rigidity is required in addition to a high load carrying capacity.

The particularly high precision of the SGL bearings is achieved by means of exact, machined, hardened and ground bearing rings with a triangular profile, *Figure 1*.

A roller and cage assembly from wear-resistant plastic is arranged between the bearing rings.

This results in very compact bearing arrangements with a high performance capacity.

The bearings correspond to dimension series 18 and are therefore interchangeable with series 718.

**SGL**

*Figure 1*
Angular contact roller bearing



**Applications**
Angular contact roller bearings SGL have long proven successful in many accuracy applications across a wide range of industries, in machine tools and in the field of robots and handling systems.

# Axial angular contact roller bearing as ready-to-fit unit

**Features**

This design corresponds to an AXS complete assembly, which is individually tailored to the customer's requirements.

These units comprise, *Figure 1*:

an outer and inner ring with fixing thread

an adjusting nut

double direction axial angular contact roller bearings in an O arrangement.

As a result of the O arrangement and the contact angle of 60°, the bearing units have a high load carrying capacity and exhibit significant radial stiffness.

Bearing rings and adjusting nuts are precision-turned parts from high-strength steel, whilst axial roller and cage assemblies and axial bearing washers are produced using non-machining methods.

On request, units are available with:

friction linings (strips, pads) for setting a minimum frictional resistance

stop systems (smaller and larger than 360°) to restrict travel

coatings (Corrotect®, powder coating).

**ZAXFM**

*Figure 1*
Axial angular contact roller bearing
as ready-to-fit unit



**Applications**

Axial angular contact roller bearings ZAXFM are particularly suitable for bearing arrangements:

in the handling and automation sector

in hoisting and conveying equipment

in packaging technology

in medical engineering

in general machine construction

in theatre and stage technology.

# Axial angular contact roller bearings with electromagnetic brake

**Features**

This design corresponds to an AXS-complete assembly with electromagnetic brake. The brake prevents the bearing unit from rotating in a currentless state.

These units comprise, *Figure 1*:

- an outer ring with fixing thread
- an inner ring with coil and pressure springs
- an adjusting nut with fixing thread
- an anchor plate with an axial movement facility
- a lining plate connected to the outer ring
- double direction axial angular contact roller bearings in an O arrangement

As a result of the O arrangement and the contact angle of 60°, the bearing units have a high load carrying capacity and exhibit significant radial stiffness.

Bearing rings and adjusting nuts are precision-turned parts from high-strength steel, whilst axial roller and cage assemblies and axial bearing washers are produced using non-machining methods.

**ZAXB**

*Figure 1*
Axial angular contact roller bearing with electromagnetic brake



**Brake function**

In a currentless state, the springs press the anchor plate against the brake lining, the unit decelerates.

When current is supplied, the electromagnet pulls the anchor plate against the springs and releases the brake lining so that the unit can rotate.

**Applications**

Axial angular contact roller bearings ZAXB are particularly suitable for applications:

- in the handling and automation sector
- in hoisting and conveying equipment
- in packaging technology
- in medical engineering
- in general machine construction
- in theatre and stage technology.