



FAG



Axial Angular Contact Roller Bearings

High load carrying capacity with very small cross sections

SCHAEFFLER GROUP
INDUSTRIAL

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.

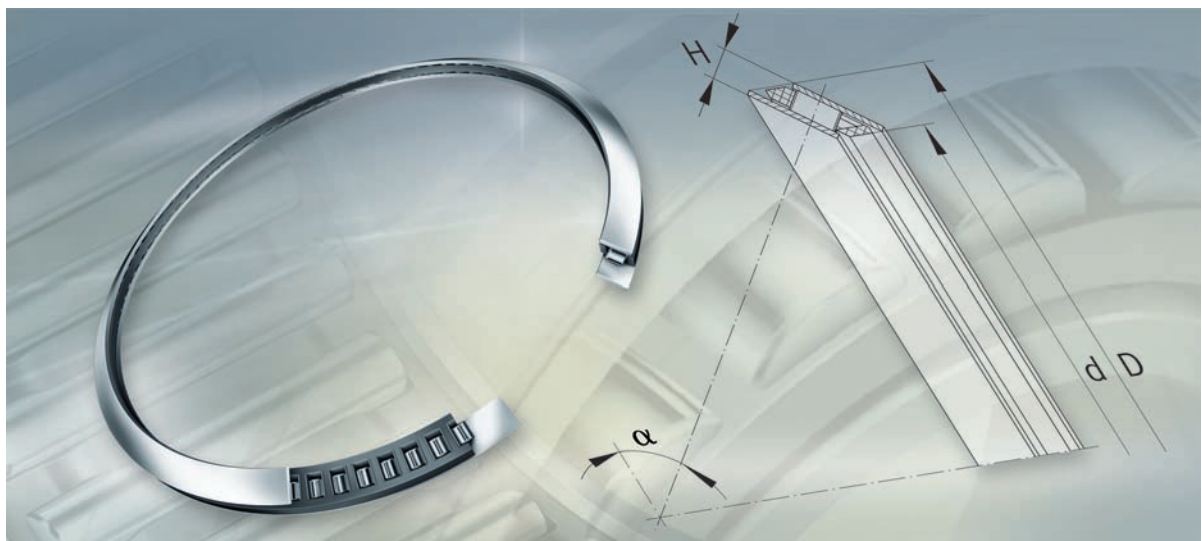
The needle roller and cage assemblies and the associated axial bearing washers are described in TPI 203, Radial and axial needle roller and cage assemblies, axial bearing washers.

Axial angular contact roller bearings

	Page
Axial angular contact roller bearings	4
Applications	10
Other products	18



FAG



Axial angular contact roller bearings

Axial angular contact roller bearings

	Page
Product overview	Axial angular contact roller bearings 6
Features	Load carrying capacity 7
	Operating temperature 7
	Applications 7
Design and safety guidelines	Dynamic load carrying capacity and life..... 8
	Basic rating life 8
	Static load safety factor 10
	Design of adjacent parts 11
	Preload 11
	Lubrication 11
Dimension tables	Axial angular contact roller bearings 12

Product overview 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:

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

$$L_{10h} = \frac{16666}{n} \cdot \left(\frac{C}{P} \right)^p$$

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 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 α_o	$F_r/F_a <^{1)}$	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 α_o	$F_r/F_a <^1)$	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.

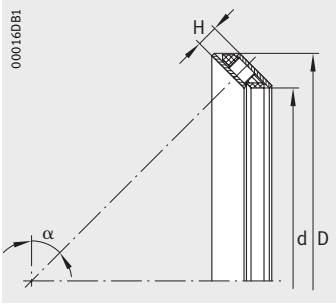
During adjustment, the units should be rotated several times, loosened again and then finally tightened.

Lubrication

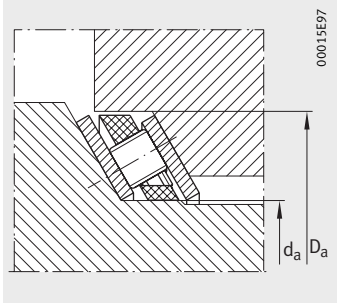
The bearing sets should be sufficiently greased prior to operation. Please contact Schaeffler for information on grease quantities.

A relubrication option should be provided for dynamic applications.

Axial angular contact roller bearings



AXS



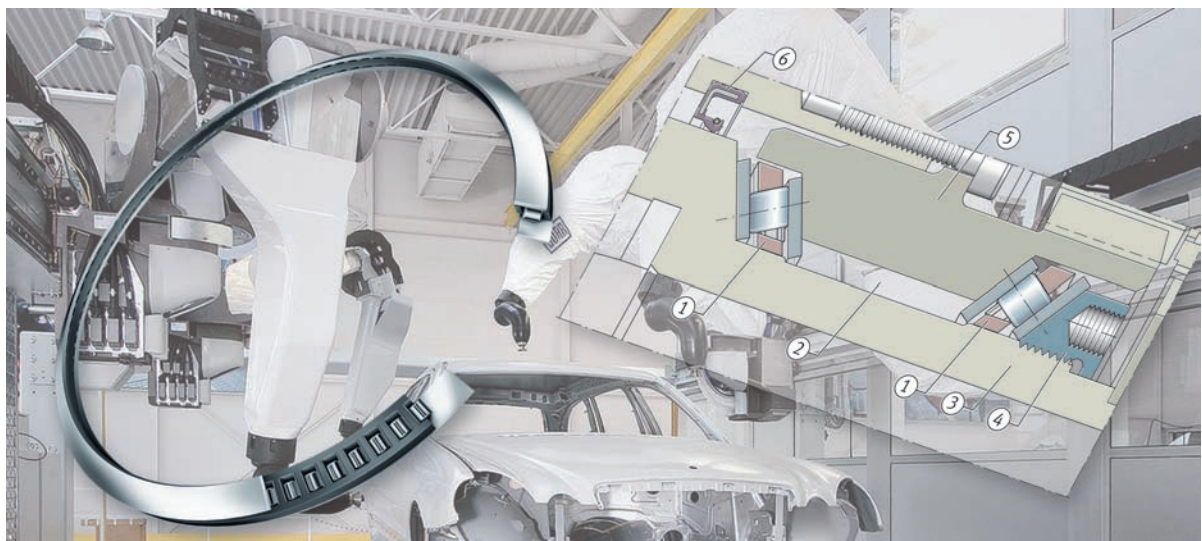
Centring of the bearing rings

Dimension table - Dimensions in mm											
Designation ¹⁾	Mass m ≈ g	Dimensions			Contact angle ²⁾ α °	Centring of the bearing rings		Basic load ratings			
		d	D	H		on the shaft d _a	in the housing D _a	dyn. C _a N	stat. C _{0a} N	dyn. C _r N	stat. C _{0r} 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.



FAG



Applications

Applications

	Page
Ceiling mount	
Requirements	12
Design solution	12
Painting robots	
Requirements	13
Design solution	13
Bicycle arm	
Requirements	14
Design solution	14
Computer tomograph	
Requirements	15
Design solution	15
Tracking systems for solar plants	
Requirements	16
Design solution	17

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

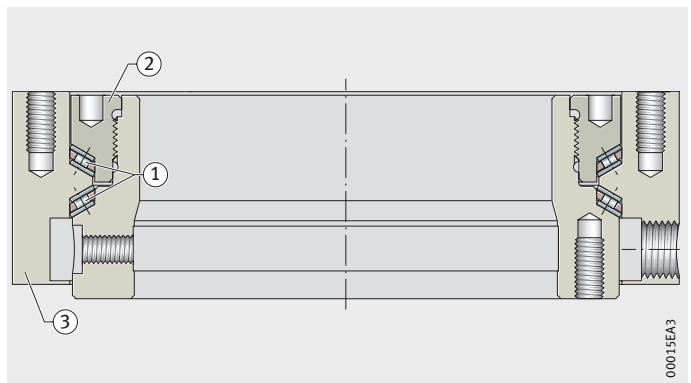


Figure 2
Bearing arrangement in a swivel arm

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

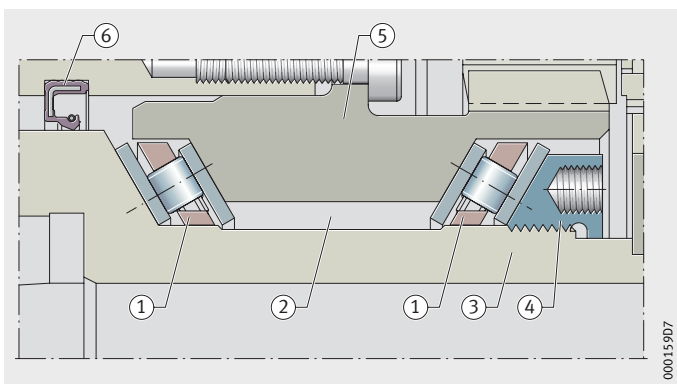


Figure 2
Bearing arrangement in hand axis

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

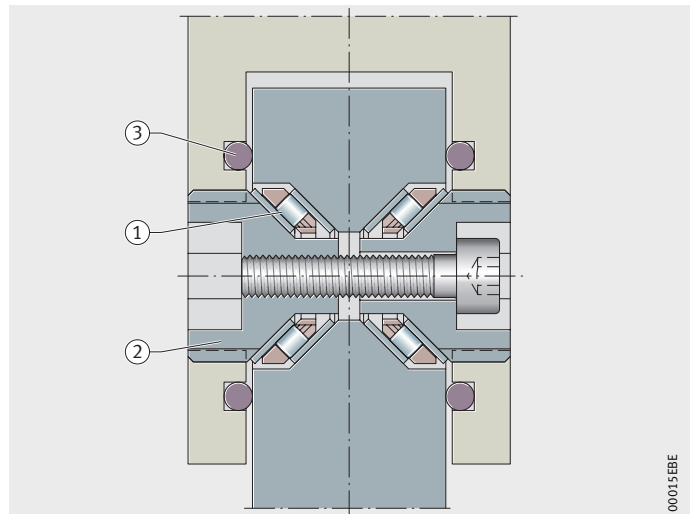
The bearing units AXS comprise double direction axial angular contact roller bearings. As a result of the cylindrical rollers and the contact angle of 45° the units have a high axial and radial load carrying capacity and exhibit significant radial stiffness, *Figure 2*.

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.

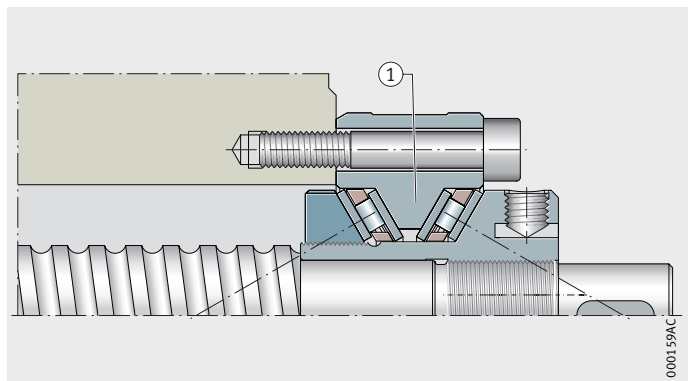
Design solution

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.

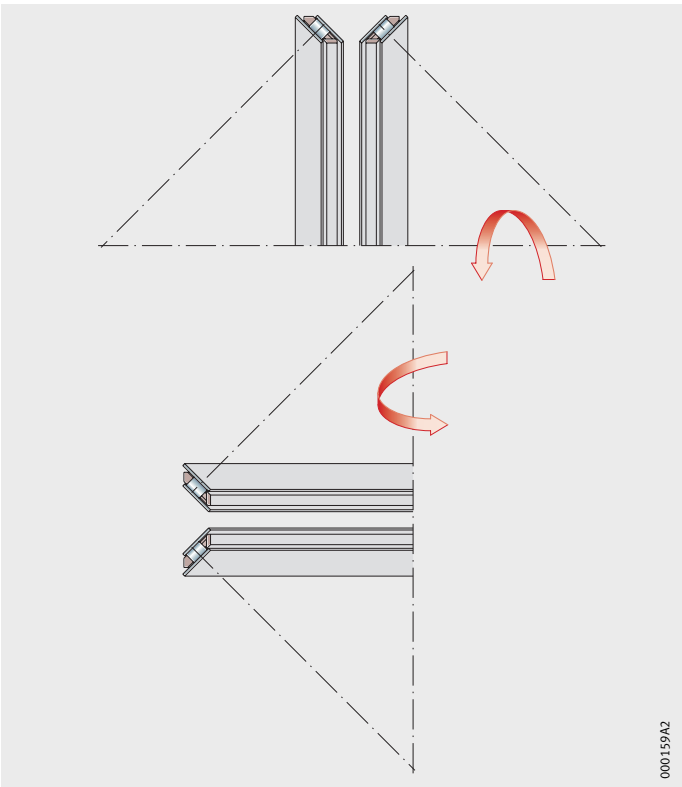
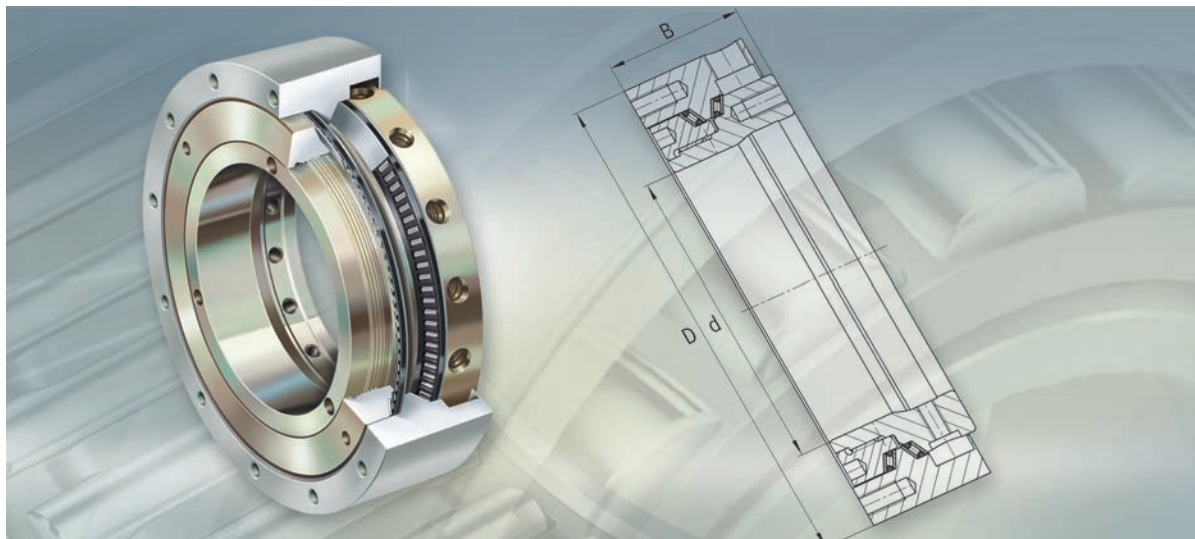


Figure 2
Installation position
and function lines

000159A2



FAG



Other products

Other products

		Page
Angular contact roller bearings	Features	20
	Applications	20
Axial angular contact roller bearing as ready-to-fit unit	Features	21
	Applications	21
Axial angular contact roller bearings with electromagnetic brake	Features	22
	Brake function	22
	Applications	22

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*.

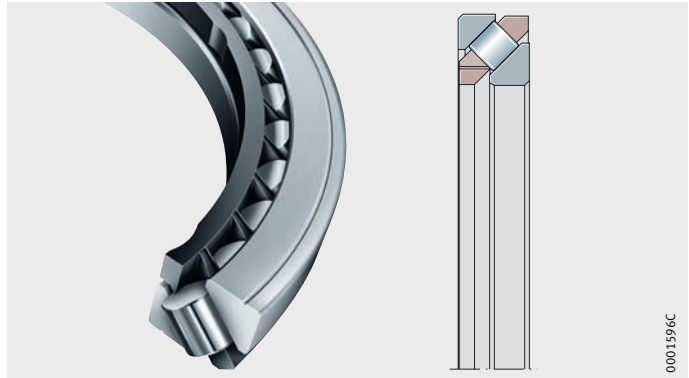
A roller and cage assembly from wear-resistant plastic is arranged between the bearing rings.

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.

**Schaeffler Technologies
GmbH & Co. KG**

Industriestraße 1–3
91074 Herzogenaurach (Germany)
Internet www.ina.com
E-Mail info@schaeffler.com

In Germany:

Phone 0180 5003872

Fax 0180 5003873

From other countries:

Phone +49 9132 82-0

Fax +49 9132 82-4950

**Schaeffler Technologies
GmbH & Co. KG**

Georg-Schäfer-Straße 30
97421 Schweinfurt (Germany)
Internet www.fag.com
E-Mail FAGinfo@schaeffler.com

In Germany:

Phone 0180 5003872

Fax 0180 5003873

From other countries:

Phone +49 9721 91-0

Fax +49 9721 91-3435

Every care has been taken to ensure the correctness of the information contained in this publication but no liability can be accepted for any errors or omissions. We reserve the right to make technical changes.

© Schaeffler Technologies GmbH & Co. KG

Issued: 2010, October

This publication or parts thereof may not be reproduced without our permission.

TPI 185 GB-D