

12 Needle roller thrust bearings

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Designs and variants

SKF needle roller thrust bearings are fitted with a form-stable cage to reliably retain and guide a large number of needle rollers. The very small diameter deviation of the rollers within one assembly enables these bearings to accommodate heavy axial loads and shock loads. The ends of the rollers are relieved slightly to modify the line contact between the raceways and rollers. This prevents stress peaks at the roller ends to extend bearing service life.

Needle roller thrust bearings provide a high degree of stiffness within a minimum axial space. In applications where the faces of adjacent machine components can serve as raceways, needle roller thrust bearings take up no more space than a conventional thrust washer. SKF supplies needle roller thrust bearings in two designs (→ **fig. 1**):

- needle roller and cage thrust assemblies, AXK series
- needle roller thrust bearings with a centring flange, AXW series (→ **fig. 3**)

In applications where adjacent components cannot serve as raceways, the assemblies can be combined with bearing washers in different series (→ *Bearing washers*, **page 1060**).

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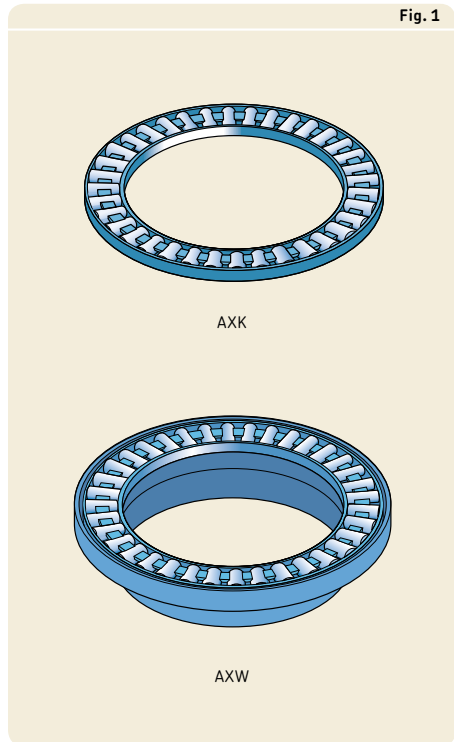
Needle roller and cage thrust assemblies

SKF needle roller and cage thrust assemblies in the AXK series (→ **fig. 1**) are available for shaft diameters ranging from 4 to 160 mm. They can be combined with washers in the LS, AS, GS 811 or WS 811 series (→ *Bearing washers*, **page 1060**) in applications where adjacent components cannot serve as raceways. These thrust assemblies can accommodate axial loads in one direction only.

Double direction bearings

Double direction needle roller thrust bearings can accommodate axial loads in both directions. They can be created by combining two needle roller and cage thrust assemblies and two bearing washers with an intermediate washer. Depending on the design, an intermediate washer can be shaft or housing centred (→ **fig. 2**).

Fig. 1



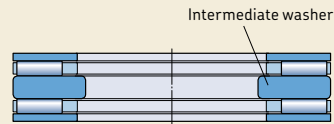
Intermediate washers must have the same hardness and surface finish as bearing washers. SKF does not supply intermediate washers, but provides material specifications and dimensional data on request.

For additional information, refer to *Design of bearing arrangements* (→ **page 1068**).

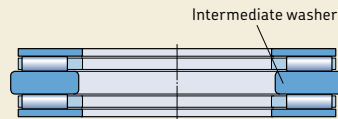
Needle roller thrust bearings with a centring flange

SKF needle roller thrust bearings in the AXW series (→ **fig. 3**) consist of a needle roller and cage thrust assembly and a thrust washer with a centring flange. The flange facilitates mounting and accurately centres the housing washer radially (→ **figs. 4 and 5, page 1060**). These thrust assemblies, which accommodate axial loads in one direction only, are available for shaft diameters ranging from 10 to 50 mm.

Fig. 2

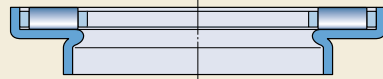


Shaft centred bearing



Housing centred bearing

Fig. 3



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Combined needle roller bearing arrangements

To accommodate combined radial and axial loads, needle roller thrust bearings in the AXW series can be combined with the following radial needle roller bearings:

- drawn cup needle roller bearings with a closed end or with open ends (→ **fig. 4**)
- needle roller bearings with machined rings (→ **fig. 5**)

These arrangements provide a cost-effective and compact solution for combined loads.

Bearing washers

SKF supplies bearing washers in different designs and series. The following series can be combined with needle roller thrust bearings:

- LS series universal washers
- AS series thin universal washers
- 811 series shaft and housing washers

Bearing washers are required in applications where adjacent machine components cannot serve as raceways.

Appropriate washers are listed in the product tables and must be ordered separately, due to the number of possible combinations.

Fig. 4

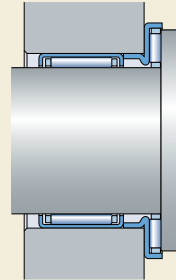
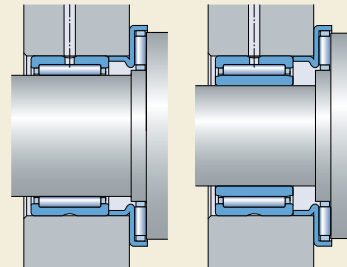


Fig. 5



Without an inner ring

With an inner ring

LS series universal washers

LS series universal washers (→ **fig. 6**) are made of hardened carbon chromium bearing steel. They can be used as shaft or housing washers for needle roller thrust bearings in the AXK series and as housing washers for bearings in the AXW series. LS series washers are available for shaft diameters ranging from 6 to 160 mm. The raceway surface is ground, while all other surfaces are turned. These washers are used for applications where accurate centring of the washers is not necessary or where slow speeds are involved. The washer face opposite the side with the chamfers is the raceway surface and should face the rollers.

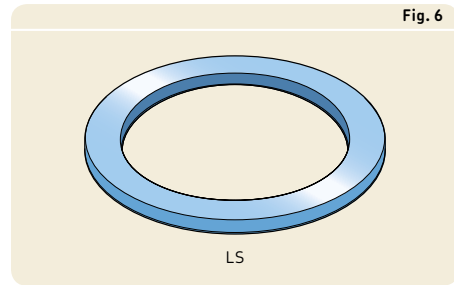


Fig. 6

AS series thin universal washers

AS series thin universal washers (→ **fig. 7**) are 1 mm thick, made of spring steel and hardened. They can be used as shaft or housing washers for needle roller thrust bearings in the AXK series and as housing washers for bearings in the AXW series. AS series washers are available for shaft diameters ranging from 4 to 160 mm. Both faces are polished and can be used as raceways. If adjacent machine components are not hardened, but have adequate stiffness and the running accuracy requirements are moderate, AS series thin universal washers can be used to provide a cost-effective bearing solution.

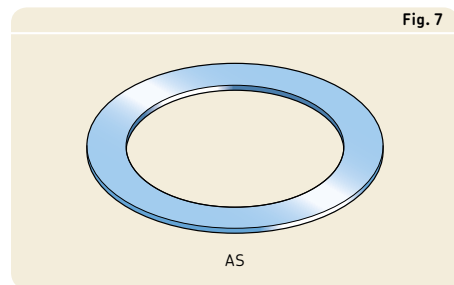


Fig. 7

811 series shaft and housing washers

Shaft and housing washers are used primarily with cylindrical roller and cage thrust assemblies. However, 811 series shaft washers (prefix WS) and housing washers (prefix GS) can also be combined with needle roller and cage thrust assemblies. These washers can be used in high-speed applications where accurate centring of the bearing washers is required.

For additional information about these washers, refer to *Cylindrical roller thrust bearings* (→ **page 1037**).

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Cages

Depending on their series and size, SKF needle roller thrust bearings are fitted with one of the cages shown in **table 1**. Bearings in the AXW series are fitted exclusively with steel cages.

The lubricants generally used for rolling bearings do not have a detrimental effect on cage properties. However, some synthetic oils and greases with a synthetic oil base and lubricants containing a high proportion of EP additives, when used at high temperatures, can have a detrimental effect on polyamide cages. For additional information about the suitability of cages, refer to *Cages* (→ **page 37**) and *Cage materials* (→ **page 152**).

Table 1

Cages for needle roller thrust bearings

			
Material	Machined steel	Sheet steel	Glass fibre reinforced PA66
Suffix	-	-	TN

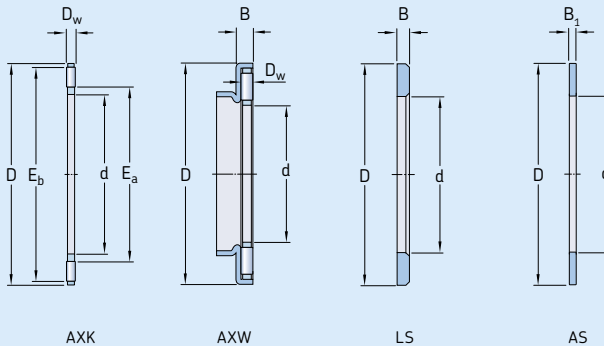
Bearing data

Dimension standards	Boundary dimensions: ISO 3031 (where standardized) Bearings in the AXW series are not standardized.
Tolerances	Tolerances, tolerance classes, standards (→ table 2, page 1064) Values (→ table 3, page 1065) Variation of gauge lot diameter of the rollers: ISO 3096, Grade 2
For additional information (→ page 132)	
Misalignment	Cannot tolerate any angular misalignment between shaft and housing or between shaft and axial support surfaces in the housing
Friction, starting torque, power loss	For calculations of the frictional moment, starting torque and power loss, contact the SKF application engineering service.
Defect frequencies	Defect frequencies can be calculated using the tools available online at skf.com/bearingcalculator .

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Table 2

Tolerances for needle roller thrust bearings



Bearing, component	Tolerance, tolerance class ¹⁾ , standard	
Dimensions		

Needle roller and cage thrust assemblies, AXK

Bore diameter	d	E12
Outside diameter	D	c13
Roller diameter	D_w	Grade 2, ISO 3096

Needle roller thrust bearings with a centring flange, AXW

Bore diameter	d	E12
Outside diameter	D	-
Thickness	B	0/-0,2 mm
Roller diameter	D_w	Grade 2, ISO 3096

Universal washers, LS

Bore diameter	d	E12
Outside diameter	D	a12
Thickness	B	h11
Axial run-out	s_i	Normal, ISO 199

Thin universal washers, AS

Bore diameter	d	E13
Outside diameter	D	e13
Thickness (1 mm)	B_1	±0,05 mm

¹⁾ All ISO tolerance classes are valid with the envelope requirement (such as H7(Ⓔ)) in accordance with ISO 14405-1.

Table 3

ISO tolerance classes

Nominal dimension		a12 ^(E) Deviations high low		c13 ^(E) Deviations high low		e13 ^(E) Deviations high low		h11 ^(E) Deviations high low		E12 ^(E) Deviations high low		E13 ^(E) Deviations high low	
over	incl.	μm		μm		μm		μm		μm		μm	
-	3	-	-	-	-	-	-	0	-60	-	-	-	-
3	6	-	-	-	-	-	-	0	-75	+140	+20	+200	+20
6	10	-	-	-	-	-	-	0	-90	+175	+25	+245	+25
10	18	-	-	-95	-365	-32	-302	-	-	+212	+32	+302	+32
18	30	-300	-510	-110	-440	-40	-370	-	-	+250	+40	+370	+40
30	40	-310	-560	-120	-510	-50	-440	-	-	+300	+50	+440	+50
40	50	-320	-570	-130	-520	-50	-440	-	-	+300	+50	+440	+50
50	65	-340	-640	-140	-600	-60	-520	-	-	+360	+60	+520	+60
65	80	-360	-660	-150	-610	-60	-520	-	-	+360	+60	+520	+60
80	100	-380	-730	-170	-710	-72	-612	-	-	+422	+72	+612	+72
100	120	-410	-760	-180	-720	-72	-612	-	-	+422	+72	+612	+72
120	140	-460	-860	-200	-830	-85	-715	-	-	+485	+85	+715	+85
140	160	-520	-920	-210	-840	-85	-715	-	-	+485	+85	+715	+85
160	180	-580	-980	-230	-860	-85	-715	-	-	-	-	-	-
180	200	-660	-1 120	-240	-960	-100	-820	-	-	-	-	-	-

Loads

	Needle roller thrust bearings	Symbols
<p>Minimum load</p> <p>For additional information (→ page 86)</p>	<p>$F_{am} = 0,0005 C_0$</p> <p>The weight of the components supported by the bearing, particularly when the shaft is vertical, together with external forces, generally exceed the requisite minimum load. If this is not the case, the bearing must be subjected to an additional axial load by using springs or a shaft nut.</p>	<p>C_0 = basic static load rating [kN] (→ product tables)</p> <p>F_a = axial load [kN]</p> <p>F_{am} = minimum axial load [kN]</p> <p>P = equivalent dynamic bearing load [kN]</p> <p>P_0 = equivalent static bearing load [kN]</p>
<p>Equivalent dynamic bearing load</p> <p>For additional information (→ page 85)</p>	<p>$P = F_a$</p>	
<p>Equivalent static bearing load</p> <p>For additional information (→ page 88)</p>	<p>$P_0 = F_a$</p>	

Temperature limits

The permissible operating temperature for needle roller thrust bearings can be limited by:

- the dimensional stability of the bearing washers and rollers
- the cage
- the lubricant

When temperatures outside the permissible range are expected, contact the SKF application engineering service.

Bearing washers and rollers

SKF needle roller thrust bearings undergo a special heat treatment. The bearings are heat stabilized up to at least 120 °C (250 °F).

Cages

Steel cages can be used at the same operating temperatures as the bearing washers and rollers. For temperature limits of polymer cages, refer to *Cage materials* (→ **page 152**).

Lubricants

Temperature limits for SKF greases are provided under *Lubrication* (→ **page 239**). When using lubricants not supplied by SKF, the temperature limits should be evaluated according to the SKF traffic light concept (→ **page 244**).

Permissible speed

The permissible speed can be estimated using the speed ratings listed in the product tables and applying the information provided under *Speeds* (→ **page 117**).

Design of bearing arrangements

Abutment dimensions

The support surfaces on shafts and in housings should be at right angles to the shaft or housing axis and should provide uninterrupted support over the entire washer face. The abutment diameter on the shaft should be $\leq E_a$ and in the housing $\geq E_b$. Values for E_a and E_b (\rightarrow **product tables**) take the movement and position of the roller set into consideration.

To provide satisfactory radial guidance for the individual thrust bearing components, suitable tolerance classes for shafts and housings are listed in **table 4**. Radial space between the shaft and washer bore is required for housing centred washers. Shaft centred washers require radial space between the washer and housing bore.

Needle roller and cage thrust assemblies in the AXW series are generally combined with drawn cup needle roller bearings (\rightarrow **fig. 4, page 1060**) or needle roller bearings with machined rings (\rightarrow **fig. 5, page 1060**). The same housing tolerance must be selected for the centring flange as for the radial bearing.

Needle roller and cage thrust assemblies are generally shaft centred, to reduce the circumferential speed at which the cage slides against the guiding surface. This is particularly important for higher speed applications. The guiding surface should be ground.

Raceways on shafts and in housings

If the load carrying capacity of a needle roller and cage thrust assembly is to be fully exploited, the raceways on the shaft or in the housing should have the same hardness, surface finish and axial run-out as a bearing washer.

The dimensions E_a and E_b (\rightarrow **product tables**) take displacement of the roller set into consideration and should be applied when designing raceways on shafts and in housings.

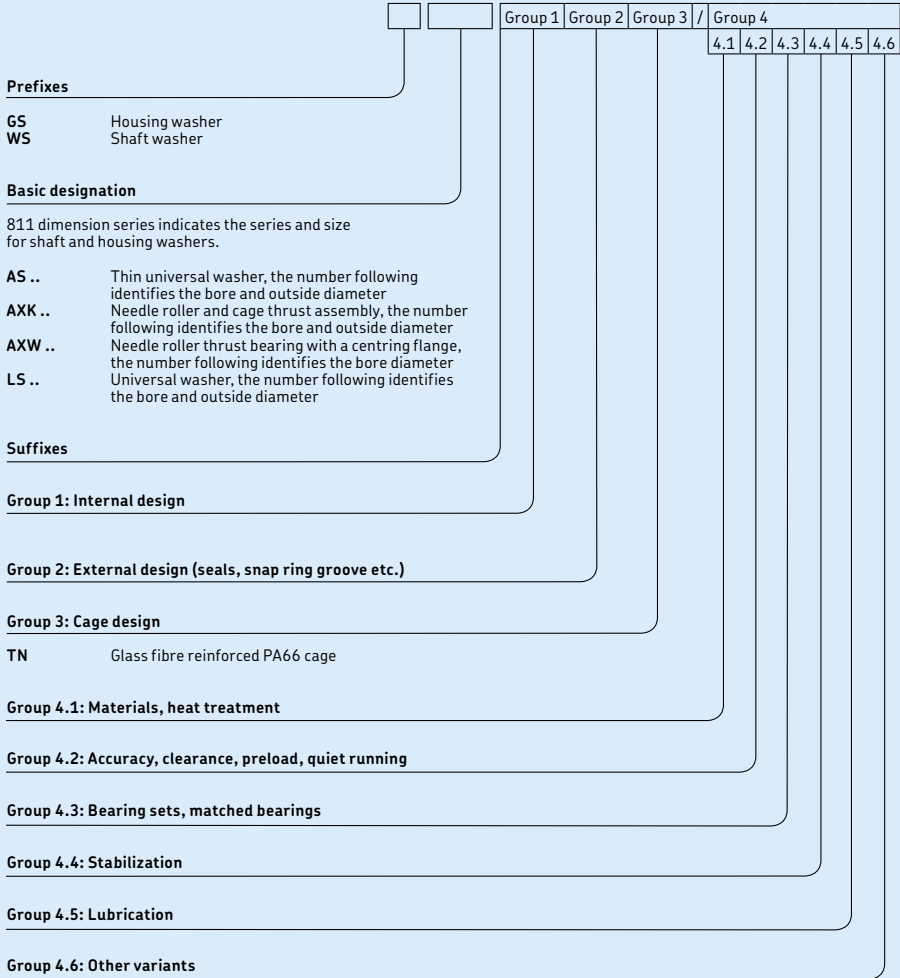
For additional information, refer to *Raceways on shafts and in housings* (\rightarrow **page 210**).

Table 4

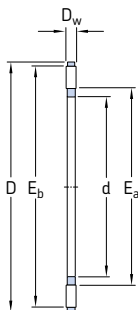
Shaft and housing tolerance classes			
Bearing component	Series	Tolerance class ¹⁾	
		Shaft centred	Housing centred
Needle roller and cage thrust assemblies	AXK	h8	–
Universal washers	LS	h8 radial space	radial space H9
Thin universal washers	AS	h8 radial space	radial space H9
Shaft washers	WS 811	h8	–
Housing washers	GS 811	–	H9

¹⁾ All ISO tolerance classes are valid with the envelope requirement (such as H7 $\text{\textcircled{E}}$) in accordance with ISO 14405-1.

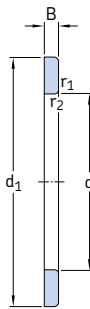
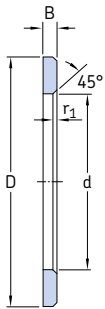
Designation system



12.1 Needle roller and cage thrust assemblies and appropriate washers d 4 – 80 mm



Principal dimensions					Basic load ratings		Fatigue load limit P_u	Speed ratings		Mass	Designation
d	D	D_w	E_a	E_b	dynamic C	static C_0		Reference speed	Limiting speed		
mm					kN		kN	r/min	g	-	
4	14	2	5	13	4,15	8,3	0,95	7 500	15 000	0,7	AXK 0414 TN
5	15	2	6	14	4,5	9,5	1,08	6 700	14 000	0,8	AXK 0515 TN
6	19	2	7	18	6,3	16	1,86	6 000	12 000	1	AXK 0619 TN
8	21	2	9	20	7,2	20	2,32	5 600	11 000	2	AXK 0821 TN
10	24	2	12	23	8,5	26	3	5 300	10 000	3	AXK 1024
12	26	2	14	25	9,15	30	3,45	5 000	10 000	3	AXK 1226
15	28	2	17	27	10,4	37,5	4,3	4 800	9 500	4	AXK 1528
17	30	2	19	29	11	40,5	4,75	4 500	9 500	4	AXK 1730
20	35	2	22	34	12	47,5	5,6	4 300	8 500	5	AXK 2035
25	42	2	29	41	13,4	60	6,95	3 800	7 500	7	AXK 2542
30	47	2	34	46	15	72	8,3	3 600	7 000	8	AXK 3047
35	52	2	39	51	16,6	83	9,8	3 200	6 300	10	AXK 3552
40	60	3	45	58	25	114	13,7	2 800	5 600	16	AXK 4060
45	65	3	50	63	27	127	15,3	2 600	5 300	18	AXK 4565
50	70	3	55	68	28,5	143	17	2 400	5 000	20	AXK 5070
55	78	3	60	76	34,5	186	22,4	2 200	4 300	28	AXK 5578
60	85	3	65	83	37,5	232	28,5	2 200	4 300	33	AXK 6085
65	90	3	70	88	39	255	31	2 000	4 000	35	AXK 6590
70	95	4	74	93	49	255	31	1 800	3 600	60	AXK 7095
75	100	4	79	98	50	265	32,5	1 700	3 400	61	AXK 75100
80	105	4	84	103	51	280	34	1 700	3 400	63	AXK 80105



LS

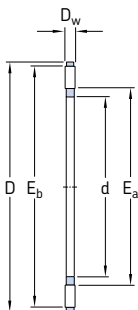
AS

WS 811

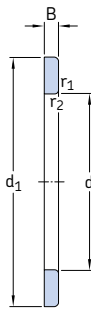
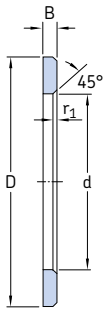
GS 811

Dimensions					Masses Washers		Designations		Thin universal washer	Shaft washer	Housing washer
d	d ₁	D	D ₁	B	r _{1,2} min.	LS, WS, GS	AS	Universal washer			
mm					g		-				
4	-	14	-	-	-	-	1	-	AS 0414	-	-
5	-	15	-	-	-	-	1	-	AS 0515	-	-
6	-	19	-	2,75	0,3	6	2	LS 0619	AS 0619	-	-
8	-	21	-	2,75	0,3	6	2	LS 0821	AS 0821	-	-
10	-	24	-	2,75	0,3	8	3	LS 1024	AS 1024	-	-
12	-	26	-	2,75	0,3	9	3	LS 1226	AS 1226	-	-
15	28	28	16	2,75	0,3	9	3	LS 1528	AS 1528	WS 81102	GS 81102
17	30	30	18	2,75	0,3	9	4	LS 1730	AS 1730	WS 81103	GS 81103
20	35	35	21	2,75	0,3	13	5	LS 2035	AS 2035	WS 81104	GS 81104
25	42	42	26	3	0,6	19	7	LS 2542	AS 2542	WS 81105	GS 81105
30	47	47	32	3	0,6	22	8	LS 3047	AS 3047	WS 81106	GS 81106
35	52	52	37	3,5	0,6	29	9	LS 3552	AS 3552	WS 81107	GS 81107
40	60	60	42	3,5	0,6	40	12	LS 4060	AS 4060	WS 81108	GS 81108
45	65	65	47	4	0,6	50	13	LS 4565	AS 4565	WS 81109	GS 81109
50	70	70	52	4	0,6	55	14	LS 5070	AS 5070	WS 81110	GS 81110
55	78	78	57	5	0,6	88	18	LS 5578	AS 5578	WS 81111	GS 81111
60	85	85	62	4,75	1	97	22	LS 6085	AS 6085	WS 81112	GS 81112
65	90	90	67	5,25	1	115	24	LS 6590	AS 6590	WS 81113	GS 81113
70	95	95	72	5,25	1	123	25	LS 7095	AS 7095	WS 81114	GS 81114
75	100	100	77	5,75	1	142	27	LS 75100	AS 75100	WS 81115	GS 81115
80	105	105	82	5,75	1	151	28	LS 80105	AS 80105	WS 81116	GS 81116

12.1 Needle roller and cage thrust assemblies and appropriate washers d 85 – 160 mm



Principal dimensions					Basic load ratings		Fatigue load limit P_u	Speed ratings		Mass	Designation
d	D	D_w	E_a	E_b	dynamic C	static C_0		Reference speed	Limiting speed		
mm					kN		kN	r/min	g		-
85	110	4	89	108	52	290	35,5	1 700	3 400	67	AXK 85110
90	120	4	94	118	65,5	405	49	1 500	3 000	86	AXK 90120
100	135	4	105	133	76,5	560	65,5	1 400	2 800	104	AXK 100135
110	145	4	115	143	81,5	620	72	1 300	2 600	122	AXK 110145
120	155	4	125	153	86,5	680	76,5	1 300	2 600	131	AXK 120155
130	170	5	136	167	112	830	93	1 100	2 200	205	AXK 130170
140	180	5	146	177	116	900	96,5	1 000	2 000	219	AXK 140180
150	190	5	156	187	120	950	102	1 000	2 000	232	AXK 150190
160	200	5	166	197	125	1 000	106	950	1 900	246	AXK 160200



LS

AS

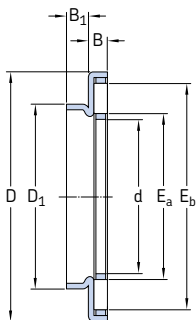
WS 811

GS 811

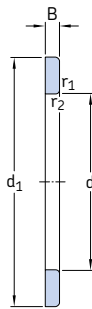
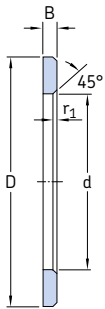
Dimensions					Masses Washers		Designations		Thin universal washer	Shaft washer	Housing washer
d	d ₁	D	D ₁	B	r _{1,2} min.	LS, WS, GS	AS	Universal washer			
mm					g		-				
85	110	110	87	5,75	1	159	29	LS 85110	AS 85110	WS 81117	GS 81117
90	120	120	92	6,5	1	234	39	LS 90120	AS 90120	WS 81118	GS 81118
100	135	135	102	7	1	350	50	LS 100135	AS 100135	WS 81120	GS 81120
110	145	145	112	7	1	385	55	LS 110145	AS 110145	WS 81122	GS 81122
120	155	155	122	7	1	415	59	LS 120155	AS 120155	WS 81124	GS 81124
130	170	170	132	9	1	663	65	LS 130170	AS 130170	WS 81126	GS 81126
140	178	180	142	9,5	1	749	79	LS 140180	AS 140180	WS 81128	GS 81128
150	188	190	152	9,5	1	796	84	LS 150190	AS 150190	WS 81130	GS 81130
160	198	200	162	9,5	1	842	89	LS 160200	AS 160200	WS 81132	GS 81132

12.1

12.2 Needle roller thrust bearings with a centring flange and appropriate washers d 10 – 50 mm



Principal dimensions								Basic load ratings		Fatigue load limit P_u	Speed ratings		Mass	Designation
d	D	D_1	B	B_1	E_a	E_b	dynamic	static	Reference speed		Limiting speed			
mm								kN		kN	r/min		g	-
10	27	14	3,2	3	12	23	8,5	26	3	4 800	10 000	8,3	AXW 10	
12	29	16	3,2	3	14	25	9,15	30	3,45	4 800	9 500	9,1	AXW 12	
15	31	21	3,2	3,5	17	27	10,4	37,5	4,3	4 500	9 000	10	AXW 15	
17	33	23	3,2	3,5	19	29	11	40,5	4,75	4 500	9 000	11	AXW 17	
20	38	26	3,2	3,5	22	34	12	47,5	5,6	4 000	8 000	14	AXW 20	
25	45	32	3,2	4	29	41	13,4	60	6,95	3 600	7 500	20	AXW 25	
30	50	37	3,2	4	34	46	15	72	8,3	3 400	7 000	22	AXW 30	
35	55	42	3,2	4	39	51	16,6	83	9,8	3 200	6 300	27	AXW 35	
40	63	47	4,2	4	45	58	25	114	13,7	2 800	5 600	39	AXW 40	
45	68	52	4,2	4	50	63	27	127	15,3	2 600	5 000	43	AXW 45	
50	73	58	4,2	4,5	55	68	28,5	143	17	2 400	4 800	49	AXW 50	



LS

AS

WS 811

Dimensions				Masses Washers		Designations		
d	d ₁ , D	B	r _{1,2} min.	LS, WS, GS	AS	Universal washer	Thin universal washer	Shaft washer
mm				g		-		
10	24	2,75	0,3	8	3	LS 1024	AS 1024	-
12	26	2,75	0,3	9	3	LS 1226	AS 1226	-
15	28	2,75	0,3	9	3	LS 1528	AS 1528	WS 81102
17	30	2,75	0,3	9	4	LS 1730	AS 1730	WS 81103
20	35	2,75	0,3	13	5	LS 2035	AS 2035	WS 81104
25	42	3	0,6	19	7	LS 2542	AS 2542	WS 81105
30	47	3	0,6	22	8	LS 3047	AS 3047	WS 81106
35	52	3,5	0,6	29	9	LS 3552	AS 3552	WS 81107
40	60	3,5	0,6	40	12	LS 4060	AS 4060	WS 81108
45	65	4	0,6	50	13	LS 4565	AS 4565	WS 81109
50	70	4	0,6	55	14	LS 5070	AS 5070	WS 81110



13 Spherical roller thrust bearings

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13 Spherical roller thrust bearings

Designs

SKF spherical roller thrust bearings have specially designed raceways and accommodate a large number of asymmetrical rollers. The rollers have an optimum conformity with the washer raceways to optimize load distribution along the roller length. Therefore, they can accommodate relatively high speeds, heavy axial loads in one direction and heavy radial loads. The load is transmitted between the raceways at an angle to the bearing axis (→ **fig. 1**). Spherical roller thrust bearings are self-aligning and can accommodate misalignment of the shaft relative to the housing, which can be caused, for example, by shaft deflection.

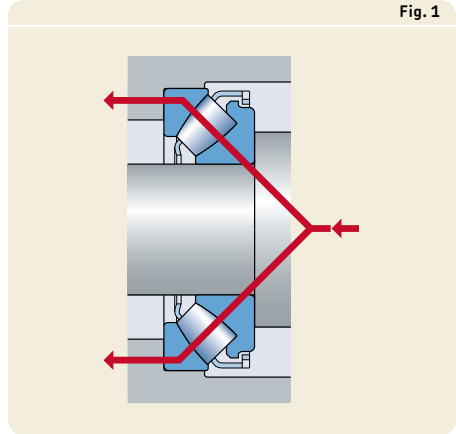


Fig. 1

Basic design bearings

Depending on their series and size, SKF spherical roller thrust bearings are manufactured to two basic designs: bearings with no designation suffix and E design bearings.

Bearings with no designation suffix (e.g. 29272) are fitted with a machined prong-type brass cage as standard (→ **fig. 2**). The cage is guided by a sleeve held in the shaft washer bore. The shaft washer, cage and rollers form a non-separable unit.

Bearings with an E designation suffix have larger rollers and an optimized internal design for increased load carrying capacity. E design bearings up to size 68 are fitted with a stamped window-type steel cage (→ **fig. 3**), which forms a non-separable unit with the shaft washer and rollers.

E design bearings from size 72 and larger are fitted with a machined prong-type cage. This type of cage is guided by a sleeve held in the shaft washer bore. The shaft washer, cage and rollers form a non-separable unit.

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Mounting instructions for individual bearings → skf.com/mount