

MOTION & CONTROL™

**NSK**

# POCKET GUIDE MAINTENANCE OF BEARINGS



# Content

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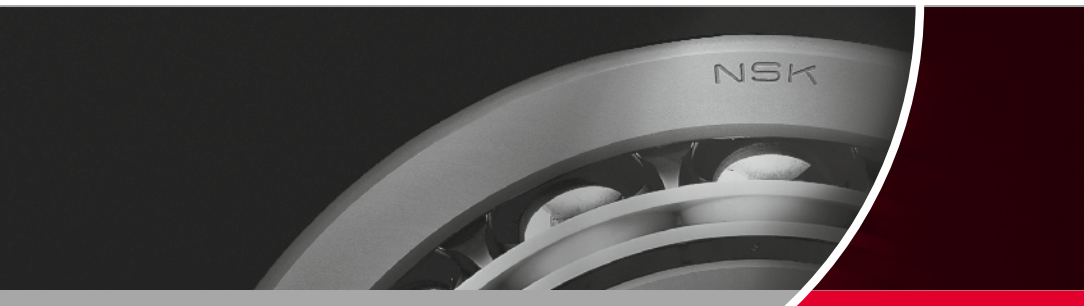
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## General and maintenance dedicated section

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# About NSK

As one of the world's leading manufacturers of rolling bearings, linear technology components and steering systems, we can be found on almost every continent – with production facilities, sales offices and technology centres – because our customers appreciate short decision-making channels, prompt deliveries and local service.

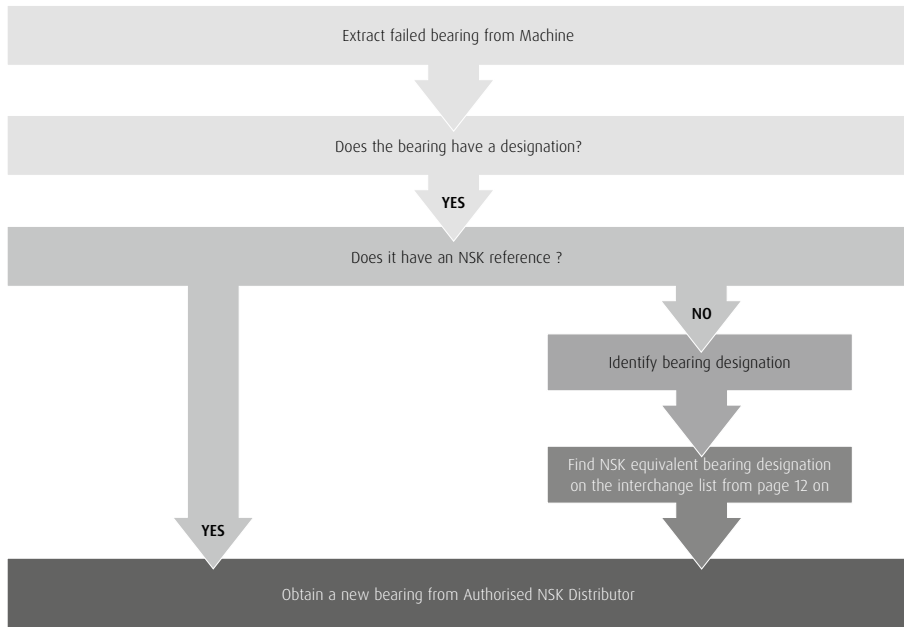


## **The NSK company**

NSK commenced operations as the first Japanese manufacturer of rolling bearings back in 1916. Ever since, we have been continuously expanding and improving not only our product portfolio but also our range of services for various industrial sectors. In this context, we develop technologies in the fields of rolling bearings, linear systems, components for the automotive industry and mechatronic systems. Our research and production facilities in Europe, Americas and Asia are linked together in a global technology network. Here we concentrate not only on the development of new technologies, but also on the continuous optimisation of quality – at every process stage.

Among other things, our research activities include product design, simulation applications using a variety of analytical systems and the development of different steels and lubricants for rolling bearings.

# How to order a replacement Bearing





NO

Determine basic bearing type i.e.: ball, roller, using sketches on following page

Measure basic dimensions: Bore (d), Outside diameter (D), Width (B)

Obtain NSK Designation by using "selection by dimension" pages (Bearing Replacement Guide) or consult Authorised NSK Distributor

Quote NSK Designation to Authorised NSK Distributor

Obtain a new bearing from Authorised NSK Distributor

# Basic Bearing Types



Single Row Deep Groove Ball Bearing



Single Row Angular contact Ball Bearing



Double Row Angular contact Ball Bearing



Double Row Self-Aligning Ball Bearing



Single Row Cylindrical Roller Bearing



Double Row Spherical Roller Bearing



Single Row Tapered Roller Bearing



Single Row Thrust Ball Bearing

If the failed bearing is not on this page, please consult your Authorised NSK Distributor or NSK direct.



# Standard Bearings – Interchange

Bearing Type	Manufacturer				
	FAG	SKF	SNR	NTN	NSK
<b>Single row Deep Groove Ball Bearings   600-6000-6200-6300-6400 Series</b>					
1 or 2 shields	ZR/2ZR	Z/ZZ	Z/ZZ	Z/ZZ	Z/ZZ
1 or 2 contact seals	RSR/2RSR	RS1/2RS1	E/EE	LU/LLU	DU/DDU
1 or 2 non contact seals	RSD/2RSD	RZ/2RZ		LB/LLB	V/VV
Groove without / with Snap ring	N/NR	N/NR	N/NR	N/NR	N/NR
Radial Internal Clearance (if different from normal CN clearance)	C2/C3 etc.	C2/C3 etc.	J20/J30 etc.	C2/C3 etc.	C2/C3 etc.
<b>Double row Deep Groove Ball Bearings   4200-4300 Series</b>					
Polyamide Cage		TN9	Blank		TNG
Without Filling Slots		A	A		B
Radial Internal Clearance (if different from normal CN clearance)		C2/C3 etc.	J20/J30 etc.		C2/C3 etc.
<b>Single row Angular Contact Ball Bearings (standard range )   7000-7200-7300-7400 Series</b>					
Contact Angle 40°	B	B	B	B	B
Extra Capacity		E			EA
Polyamide Cage	TVP	P	A	T2	T85
Steel Cage		J		J	W
Machined Brass Cage	MP	M	M	L1	Blank
Universal Mounting	UA / UO	CB/G	G	G	G, SU

Bearing Type	Manufacturer				
	FAG	SKF	SNR	NTN	NSK
<b>Double row Angular Contact Ball Bearings   3200-3300-5200-5300 Series</b>					
Contact Angle 32° and 35° with Filling Slots	Blank	Blank	A	Blank	Blank
Contact Angle 25° and 32° without Filling Slots	B	A	B		B
Polyamide Cage	TVH/TVP	TN9	G15		TNG
Steel Cage	Blank	Blank	Blank	Blank	Blank
Machined Brass Cage	M/MA	M	M	Blank	
1 or 2 shields	ZR/ZZR	Z/ZZ			Z/ZZ
1 or 2 contact seals	RSR/2RSR	RS/2RS			RSR/2RSR
Radial Internal Clearance (if different from normal CN clearance)	C2/C3 etc.	C2/C3 etc.	J20/J30 etc.	C2/C3 etc.	C2/C3 etc.
<b>Double row Self-Aligning Ball Bearings   1200-1300-2200-2300-100-11200   11300-11500 Series</b>					
Steel Cage		Blank	Blank	Blank	Blank
Polyamide Cage	TV	TN, TN9	G15	Blank	TNG
Machined Brass Cage	M	M	M	M	M
2 contact Seals	2RS	2RS1	EE		2RS
Extra Capacity		E			E
Radial Internal Clearance (if different from normal CN clearance)	C2/C3 etc.	C2/C3 etc.	J20/J30 etc.	C2/C3 etc.	C2/C3 etc.
Tapered Bore 1:12	K	K	K	K	K


# Standard Bearings – Interchange

Bearing Type	Manufacturer				
	FAG	SKF	SNR	NTN	NSK
<b>Ball Thrust Bearings, Single and Double Direction</b>   51100/200/300/400 - 52200/300/400   53200/300/400 - 54200/300/400 Series					
Steel Cage	Blank	Blank	Blank	Blank	Blank
Machined Brass Cage	M, MP	Blank		Blank	M
With Seat Washer	U	U		U	U
<b>Duplex Contact Ball Bearings</b>   QJ200 - QJ300 Series					
Polyamide Cage	TVP	TN, TN9			
Machined Brass Cage	MPA	Blank	MA	Blank	Blank
Radial Internal Clearance (if different from normal CN clearance)	C2/C3 etc.	C2/C3 etc.	J20/J30 etc.	C2/C3 etc.	C2/C3 etc.
<b>Single row cylindrical Roller Bearings</b>   N, NU, NUP, NJ / 200-300-400   N, NU, NUP, NJ / 1000-2200-2300 Series					
Polyamide Cage	TVP2	P	G15	Blank	T, T7
Steel Cage	Blank	J	Blank	Blank	W
Machined Brass Cage	M, M1	M	M	Blank	M
Extra Capacity	E	EC	E	E	E
Radial Internal Clearance (if different from normal CN clearance)	C2/C3 etc.	C2/C3 etc.	J20/J30 etc.	C2/C3 etc.	C2/C3 etc.
<b>Single row tapered Roller Bearings</b>   30200/300-31300-32000/200/300   33000/200 Series					
Steel Cage	Blank	Blank	Blank	Blank	Blank
Extra Capacity	Blank	Blank	A, V		prefix HR




Bearing Type	Manufacturer				
	FAG	SKF	SNR	NTN	NSK
<b>Double row Spherical Roller Bearings</b>   21300-22200-22300-23000-23100   23200-23900-24000-24100 Series					
Polyamide Cage	TVPB				H
Steel Cage	Blank	Blank	A	J	C, CD, EA, J
Machined Brass Cage	M, MA, MB	ECA, ECAC	M, MB	L1	M, MB, CAM
Extra Capacity	E	E, Explorer	E	E	Blank, E
Radial Internal Clearance (if different from normal CN clearance)	C2/C3 etc.	C2/C3 etc.	J20/J30 etc.	C2/C3 etc.	C2/C3 etc.
Tapered Bore 1:12	K	K	K	K	K
Tapered Bore 1:30	K30	K30	K30	K30	K30
Lubrication groove & holes	Blank, S	W33	B33	D1	E4,W33
Heat Stabilized to 200°C	Blank	Blank	Blank	Blank	Blank, S11
Vibrating Equipment Applications	T41A	A15, VA405	F800, F801	UAVS1	U15VS, VB
<b>Spherical Thrust Roller Bearings</b>   29300-29400 Series					
Steel Cage	Blank	Blank			E
Machined Brass Cage	MB	Blank		Blank	M
Extra Capacity	E	E			Blank

The list identifies the bearing series only. The user should check the relevant table to verify the characteristics and dimensions, and select the exact designation. The list is given in good faith, but no responsibility can be accepted for errors or omissions.




# Mounted Units – Interchange

Mounted Units Type	Manufacturer					
	SKF	INA	NTN	ASAHI	NSK	RHP
	SY-TF / SYJ-TF	RASEY	UCP200	UCP200	UCP200	NP
			UCPX00	UCPX00	UCPX00	MP
	SY-WF / SYJ-WF	RASE	UEL200	UGP200	UEL200	NP-DEC
	SY-FM / SYJ-FM	PASE	AEL200	UHP200		NP-EC
	SY-RM / SYJ-RM	PASEY	ASP200	BP200		NP-A
	FY-TF / FYJ-TF	RCJY	UCF200	UCF200	UCF200	SF
			UCFX00	UCFX00	UCFX00	MSF
	FY-WF / FYJ-WF	RCJ	UEL200	UGF200	UEL200	SF-DEC
	FY-FM / FYJ-FM	PCJ	AEL200	UHF200		SF-EC
	FY-RM / FYJ-RM	PCJY	ASF200	BF200		SF-A
	FYTB-TF / FYTJ-TF	RCJTY	UCFL200	UCFL200	UCFL200	SFT
			UCFLX00	UCFLX00	UCFLX00	MSFT
	FYTB-WF / FYTJ-WF	RCJT	UELFL200	UGFL200	UELFL200	SFT-DEC
	FYTB-FM / FYTJ-FM	PCJT	AELFL200	UHFL200		SFT-EC
	FYTB-RM / FYTJ-RM	PCJTY	ASFL200	BFL200		SFT-A



Mounted Units Type	Manufacturer					
	SKF	INA	NTN	ASAHI	NSK	RHP
	FYC-TF	RMEY	UCFC200	UCFC200	UCFC200	FC
			UCFCX00	UCFCX00	UCFCX00	MFC
	FYC-WM	RME	UELFC200	UGFC200	UELFC200	FC-DEC
	FYC-FM	PME	AELFC200	FHFC200		FC-EC
	FYC-RM	PMEY	ASFC200	BFC200		FC-A
		FLCTE	AELFD200	FHLCTE200	AELFD200	LFTC-EC
			ASFD200	BLCTE200	ASFD200	LFTC-A
	SYF-TF / SYFJ-TF	RSHEY	UCUP200	UCPA200	UCUP200	SNP
	SYF-WF / SYFJ-WF	RSHE				SNP-DEC
	SYF-FM / SYFJ-FM	PSHE				SNP-EC
	SYF-RM / SYFJ-RM	PSHEY				SNP-A







# Mounted Units – Interchange






Mounted Units Type	Manufacturer					
	SKF	INA	NTN	ASAHI	NSK	RHP
			UCFH200	UCFK200	UCFH200	
	TU-TF / TUJ-TF	RTUEY	UCT200	UCT200	UCT200	ST
			UCTX00		UCTX00	MST
	TU-WF / TUJ-WF	RTUE	UELT200	UGT200	UELT200	ST-DEC
	TU-FM / TUJ-FM	PTUE	AELT200	FHT200		ST-EC
	TU-RM / TUJ-RM	PTUEY	AST200	BT200		ST-A
		RHEY	UCHB200	UCEH200	UCHB200	SCH / SCHB
		RHE	UELHB200			SCH / SCHB-DEC
		PHE	AELHB200			SCH / SCHB-EC
		PHEY	ASHB200			SCH / SCHB-A

The list identifies the bearing series only. The user should check the relevant table to verify the characteristics and dimensions, and select the exact designation. The list is given in good faith, but no responsibility can be accepted for errors or omissions.

Mounted Units Type	Manufacturer					
	SKF	INA	NTN	ASAHI	NSK	RHP
	P-TF					LPB
	P-WF					LPB-DEC
	P-FM	PB	AELPP200	UHPP200	AELPP200	LPB-EC
	P-RM	PBY	ASPP200	BPP200	ASPP200	LPB-A
	PF-TF	RRY				SLFE
	PF-WF	RR				SLFE-DEC
	PF-FM	RA	AELPF200	FHPF200	AELPF200	SLFE-EC
	PF-RM	RAY	ASPF200	BPF200	ASPF200	SLFE-A
	PFT-TF	RRTY				SLFL
	PFT-WF	RRT				SLFL-DEC
	PFT-FM	RAT	AELPFL200	FHPFL200	AELPFL200	SLFL-EC
	PFT-RM	RATY	ASPFL200	BPFL200	ASPFL200	SLFL-A
	PFD-TF					SLFT
	PFD-WF	RRTR				SLFT-DEC
	PFD-FM	RATR				SLFT-EC
	PFD-RM	RATRY				SLFT-A

# Mounted Units Inserts – Interchange

Bearing Type	Manufacturer					
	SKF	INA	NTN	ASAHI	NSK	RHP
	YAR-2F	GYE-KRRB	UC200	UC200	UC200	1000G
			UC200/LIII		UC200/LIII	T1000G
	YAR2-2RF					1000GFS
	YAT2	GAY-NPPB	AS200	B200	AS200	1200G
	YET2	GRAE-NPPB	AEL200	KH200+ER	AEL200	1200ECG
	YEL2-2F	GE-KRRB	UEL200	UG200+ER	UEL200	1000DECG

Bearing Type	Manufacturer					
	SKF	INA	NTN	ASAHI	NSK	RHP
		GE-KPPB3				T1000DECG
						1000DECGFS
	YSA2-2FK	GSH-RRB	UK200	UK200	UK200	1000KG
	1726200-2RS	2-NPPB	CS200LLU	CS200ZZ	CS200LLU	1726200-2RS
			UC300	UC300	UC300	

The list identifies the bearing series only. The user should check the relevant table to verify the characteristics and dimensions, and select the exact designation. The list is given in good faith, but no responsibility can be accepted for errors or omissions.

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## Technical section

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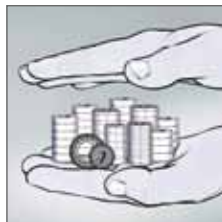
# Care and maintenance

## How to handle bearings

Rolling Bearings are high precision machine parts and need to be handled carefully.



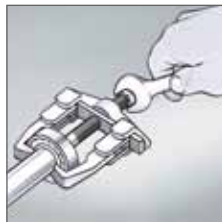
**Keep Bearings  
And Surroundings  
Clean!**



**Handle  
With Care!**



**Protect Bearings  
From Corrosion!**



**Use  
Proper Tools!**



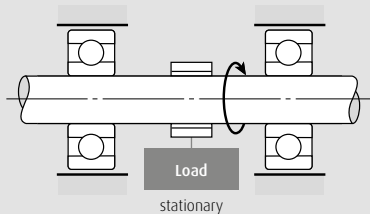
In the case of a rolling bearing with the inner ring fitted to the shaft with insufficient interference, a harmful circumferential slipping may occur between the inner ring and shaft. This slipping of the inner ring, which is called „creep“, results in a circumferential displacement of the ring relative to the shaft if the interference fit is not sufficiently tight. When creep occurs, the fitted surfaces become abraded, causing wear and considerable damage to the shaft.

It is important to prevent creep by having sufficient interference to firmly secure

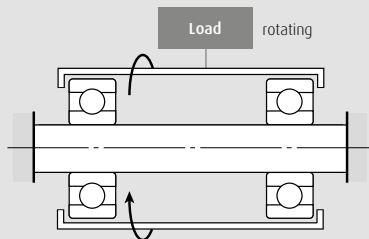
that ring which rotates to either shaft or housing. Creep cannot always be eliminated using only axial tightening throughout the bearing ring faces. Generally, it is not necessary, however, to provide interference for rings subjected only to stationary loads. Fits are sometimes made without any interference for either the inner or outer ring, to accommodate certain operating conditions, or to facilitate mounting and dismounting. In this case, to prevent damage to the fitting surfaces due to creep, lubrication or other applicable methods should be considered.

# Loading conditions and fits

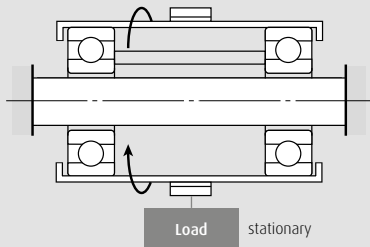
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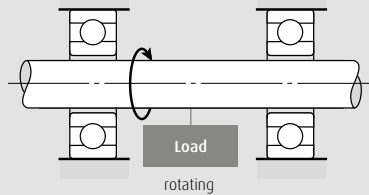
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3



4



Load Application	Bearing Operation		Load Conditions	Fits	
	Inner Ring	Outer Ring		Inner Ring	Outer Ring
<b>1. Load stationary</b>	Rotating	Stationary	Rotating Inner Ring Load	Tight Fit	Loose Fit
<b>2. Load rotating</b>	Stationary	Rotating	Stationary Outer Ring Load		
<b>3. Load stationary</b>	Stationary	Rotating	Rotating Outer Ring Load	Loose Fit	Tight Fit
<b>4. Load rotating</b>	Rotating	Stationary	Stationary Inner Ring Load		
Direction of load indeterminate due to variation of direction or unbalanced load	Rotating or Stationary	Rotating or Stationary	Direction of Load Indeterminate	Tight Fit	Tight Fit

# Fits between Radial Bearings and Housing Bores

Load Conditions			Examples	Tolerances for Housing Bores	Axial Displacement of Outer Ring	Remarks
Solid Housing	Rotating Outer Ring Load	Heavy loads on bearing in thin-walled housing or heavy shock loads	Automotive wheel hubs (Roller bearings), crane travelling wheels	P7	Impossible	-
		Normal or heavy loads	Automotive wheel hubs (Ball bearing), vibrating screens	N7		
		Light or variable loads	Conveyor rollers, rope sheaves, tension pulleys	M7		
	Direction of Load Indeterminate	Heavy shock loads	Traction motors		K7	Impossible
		Normal or heavy loads	Pumps, crankshaft, main bearings, medium and large motors			
		Normal or light loads		J57 (J7)	Possible	Axial displacement of outer ring is necessary
Solid or Split Housing	Rotating Inner Ring Load	Loads of all kinds	General bearing applications, railway axleboxes	H7	Easily Possible	-
		Normal or high loads	Plummer blocks	H8		
		High temperature rise of inner ring through shaft	Paper dryers	G7		

Load Conditions		Examples	Tolerances for Housing Bores	Axial Displacement of Outer Ring	Remarks	
Solid Housings	Rotating Inner Ring Load	Accurate running desirable under normal or light loads	Grinding spindle rear ball bearings, high-speed centrifugal compressor free bearings	J56 (J6)	Possible	For heavy loads, interference fit tighter than K is used. When high accuracy is required, very strict tolerances should be used for fitting
	Direction of Load Indeterminate		Grinding spindle front ball bearings, high-speed centrifugal compressor fixed bearings	K6	Impossible	
	Rotating Inner Ring Load	Accurate running and high rigidity desirable under variable loads	Cylindrical roller bearings for machine tool main spindle	M6 or N6	Impossible	
		Minimal noise is required	Electrical home appliances	H6	Easily Possible	

# Fits between Radial Bearings and Shafts

Load conditions	Examples	
<b>Radial Bearings with cylindrical bores</b>		
Rotating Outer Ring Load	Easy axial displacement of inner ring on shaft desirable	Wheels on stationary axles
	Easy axial displacement of inner ring on shaft unnecessary	Tension pulleys rope sheaves
Rotating Inner Load or Direction of Load Indeterminate	Light loads or variable Loads ( $< 0.06 C_r$ )	Electrical home appliances, pumps, blowers, transport vehicles, precision machinery, machine tools
	Normal loads ( $0.06$ to $0.13 C_r$ )	General bearing applications, medium and large motors, turbines, pumps, engine main bearings, gears, woodworking machine

Ball bearings	Shaft Diameter (mm)		Tolerance of shaft	Remarks
	Cylindrical roller bearings, tapered roller bearings	Spherical roller bearings		
<b>Radial Bearings with cylindrical bores</b>				
All Shaft Diameters			g6	Use g5 and h5 where accuracy is required. In case of large bearings, f6 can be used to allow easy axial movement
			h6	
≤18	-	-	js5	-
18-100	≤40	-	js6 (j6)	
100-200	40-140	-	k6	
-	140-200	-	m6	
≤18	-	-	js5-6 (j5-6)	k6 and m6 can be used for single-row tapered roller bearings and single-row angular contact ball bearings instead of k5 and m5
18-100	≤40	≤40	k5-6	
100-140	40-100	40-65	m5-6	
140-200	100-140	65-100	m6	
200-280	140-200	100-140	n6	
-	200-400	140-280	p6	
-	-	280-500	r6	
-	-	> 500	r7	

# Fits between Radial Bearings and Shafts

Load conditions	Examples
<b>Radial Bearings with cylindrical bores</b>	
Rotating Inner Load or Direction of Load Indeterminate	Heavy loads or shock loads (> 0.13 Cr)  Railway axleboxes, industrial vehicles, traction motors, construction, equipment, crushers
Axial Loads Only	
<b>Radial Bearings with tapered bores and sleeves</b>	
All Types of Loading	General bearing applications, railway axleboxes
	Transmission shafts, woodworking spindles



Ball bearings	Shaft Diameter (mm)		Tolerance of shaft	Remarks
	Cylindrical roller bearings, tapered roller bearings	Spherical roller bearings		
<b>Radial Bearings with cylindrical bores</b>				
-	50~140	50~100	n6	Radial internal clearance greater than CN is necessary.
-	140~200	100~140	p6	
-	> 200	140~200	r6	
-	-	200~500	r7	
All Shaft Diameters			js6 (J6)	-
<b>Radial Bearings with tapered bores and sleeves</b>				
All Shaft Diameters			h9/IT5	IT5 and IT7 mean that the deviation of the shaft from its true geometric form, e.g. roundness and cylindricity should be within the tolerances of IT5 and IT7 respectively.
			h10/IT7	

# Tolerances for Shaft Diameters

Diameter Classification (mm)		Radial Bearing Bore Diameter (excluding tapered roller bearings)	d6	e6	f6	g5	g6	h5	h6	h7	h8	h9	h10	js5	js6	
over	incl.															
3	6	0 - 8	- 30 - 38	- 20 - 28	- 10 - 18	- 4 - 9	- 4 - 12	0 - 5	0 - 8	0 - 12	0 - 18	0 - 30	0 - 48	± 2.5	± 4	
6	10	0 - 8	- 40 - 49	- 25 - 34	- 13 - 22	- 5 - 11	- 5 - 14	0 - 6	0 - 9	0 - 15	0 - 22	0 - 36	0 - 58	± 3	± 4.5	
10	18	0 - 8	- 50 - 61	- 32 - 43	- 16 - 27	- 6 - 14	- 6 - 17	0 - 8	0 - 11	0 - 18	0 - 27	0 - 43	0 - 70	± 4	± 5.5	
18	30	0 - 10	- 65 - 78	- 40 - 53	- 20 - 33	- 7 - 16	- 7 - 20	0 - 9	0 - 13	0 - 21	0 - 33	0 - 52	0 - 84	± 4.5	± 6.5	
30	50	0 - 12	- 80 - 96	- 50 - 66	- 25 - 41	- 9 - 20	- 9 - 25	0 - 11	0 - 16	0 - 25	0 - 39	0 - 62	0 - 100	± 5.5	± 8	
50	80	0 - 15	- 100 - 119	- 60 - 79	- 30 - 49	- 10 - 23	- 10 - 29	0 - 13	0 - 19	0 - 30	0 - 46	0 - 74	0 - 120	± 6.5	± 9.5	
80	120	0 - 20	- 120 - 142	- 72 - 94	- 36 - 58	- 12 - 27	- 12 - 34	0 - 15	0 - 22	0 - 35	0 - 54	0 - 87	0 - 140	± 7.5	± 11	

									n6	p6			Diameter Classification (mm)	
	j5	j6	j7	k5	k6	k7	m5	m6			r6	r7	over	incl.
	+3 -2	+6 -2	+8 -4	+6 +1	+9 +1	+13 +1	+9 +4	+12 +4	+16 +8	+20 +12	+23 +15	+27 +15	3	6
	+4 -2	+7 -2	+10 -5	+7 +1	+10 +1	+16 +1	+12 +6	+15 +6	+19 +10	+24 +15	+28 +19	+34 +19	6	10
	+5 -3	+8 -3	+12 -6	+9 +1	+12 +1	+19 +1	+15 +7	+18 +7	+23 +12	+29 +18	+34 +23	+41 +23	10	18
	+5 -4	+9 -4	+13 -8	+11 +2	+15 +2	+23 +2	+17 +8	+21 +8	+28 +15	+35 +22	+41 +28	+49 +28	18	30
	+6 -5	+11 -5	+15 -10	+13 +2	+18 +2	+27 +2	+20 +9	+25 +9	+33 +17	+42 +26	+50 +34	+59 +34	30	50
	+6 -7	+12 -7	+18 -12	+15 +2	+21 +2	+32 +2	+24 +11	+30 +11	+39 +20	+51 +32	+60 +41 +62 +43	+71 +41 +73 +43	50	80
	+6 -9	+13 -9	+20 -15	+18 +3	+25 +3	+38 +3	+28 +13	+35 +13	+45 +23	+59 +37	+73 +51 +76 +54	+86 +51 +89 +54	80	120

# Tolerances for Shaft Diameters

Diameter Classification (mm)		Radial Bearing Bore Diameter (excluding tapered roller bearings)	d6	e6	f6	g5	g6	h5	h6	h7	h8	h9	h10	js5	js6
over	incl.														
120	180	0 - 25	- 145 - 170	- 85 - 110	- 43 - 68	- 14 - 32	- 14 - 39	0 - 18	0 - 25	0 - 40	0 - 63	0 - 100	0 - 160	± 9	± 12.5
180	250	0 - 30	- 170 - 199	- 100 - 129	- 50 - 79	- 15 - 35	- 15 - 44	0 - 20	0 - 29	0 - 46	0 - 72	0 - 115	0 - 185	± 10	± 14.5
250	315	0 - 35	- 190 - 222	- 110 - 142	- 56 - 88	- 17 - 40	- 17 - 49	0 - 23	0 - 32	0 - 52	0 - 81	0 - 130	0 - 210	± 11.5	± 16
315	400	0 - 40	- 210 - 246	- 125 - 161	- 62 - 98	- 18 - 43	- 18 - 54	0 - 25	0 - 36	0 - 57	0 - 89	0 - 140	0 - 230	± 12.5	± 18

	j5	j6	j7	k5	k6	k7	m5	m6	n6	p6	r6	r7	Diameter Classification (mm)			
													over	incl.		
													+ 88 + 63	+ 103 + 63	120	140
	+ 7 - 11	+ 14 - 11	+ 22 - 18	+ 21 + 3	+ 28 + 3	+ 43 + 3	+ 33 + 15	+ 40 + 15	+ 52 + 27	+ 68 + 43			+ 90 + 65	+ 105 + 65	140	160
													+ 93 + 68	+ 108 + 68	160	180
													+ 106 + 77	+ 123 + 77	180	200
	+ 7 - 13	+ 16 - 13	+ 25 - 21	+ 24 + 4	+ 33 + 4	+ 50 + 4	+ 37 + 17	+ 46 + 17	+ 60 + 31	+ 79 + 50			+ 109 + 80	+ 126 + 80	200	225
													+ 113 + 84	+ 130 + 84	225	250
	+ 7 - 16	± 16	± 26	+ 27 + 4	+ 36 + 4	+ 56 + 4	+ 43 + 20	+ 52 + 20	+ 66 + 34	+ 88 + 56			+ 126 + 94	+ 146 + 94	250	280
													+ 130 + 98	+ 150 + 98	280	315
	+ 7 - 18	± 18	+ 29 - 28	+ 29 + 4	+ 40 + 4	+ 61 + 4	+ 46 + 21	+ 57 + 21	+ 73 + 37	+ 98 + 62			+ 144 + 108	+ 165 + 108	315	355
													+ 150 + 114	+ 171 + 114	355	400

# Tolerances for Housing Bore Diameters

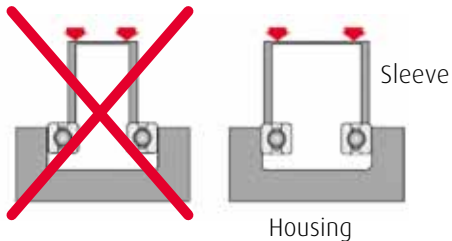
Diameter Classification (mm)		Radial Bearing Outside Deviation (excluding tapered roller bearings)	E6	F6	F7	G6	G7	H6	H7	H8	J6	J7	JS6	JS7	
over	incl.														
10	18	0 - 8	+ 43 + 32	+ 27 + 16	+ 34 + 16	+ 17 + 6	+ 24 + 6	+ 11 0	+ 18 0	+ 27 0	+ 6 - 5	+ 10 - 8	± 5.5	± 9	
18	30	0 - 9	+ 53 + 40	+ 33 + 20	+ 41 + 20	+ 20 + 7	+ 28 + 7	+ 13 0	+ 21 0	+ 33 0	+ 8 - 5	+ 12 - 9	± 6.5	± 10.5	
30	50	0 - 11	+ 66 + 50	+ 41 + 25	+ 50 + 25	+ 25 + 9	+ 34 + 9	+ 16 0	+ 25 0	+ 39 0	+ 10 - 6	+ 14 - 11	± 8	± 12.5	
50	80	0 - 13	+ 79 + 60	+ 49 + 30	+ 60 + 30	+ 29 + 10	+ 40 + 10	+ 19 0	+ 30 0	+ 46 0	+ 13 - 6	+ 18 - 12	± 9.5	± 15	
80	120	0 - 15	+ 94 + 72	+ 58 + 36	+ 71 + 36	+ 34 + 12	+ 47 + 12	+ 22 0	+ 35 0	+ 54 0	+ 16 - 6	+ 22 - 13	± 11	± 17.5	
120	150	0 18	+ 110	+ 68	+ 83	+ 39	+ 54	+ 25	+ 40	+ 63	+ 18	+ 26	± 12.5	± 20	
150	180	- 0 - 25	+ 85	+ 43	+ 43	+ 14	+ 14	0	0	0	- 7	- 14			
180	250	0 - 30	+ 129 + 100	+ 79 + 50	+ 96 + 50	+ 44 + 15	+ 61 + 15	+ 29 0	+ 46 0	+ 72 0	+ 22 - 7	+ 30 - 16	± 14.5	± 23	
250	315	0 - 35	+ 142 + 110	+ 88 + 56	+ 108 + 56	+ 49 + 17	+ 69 + 17	+ 32 0	+ 52 0	+ 81 0	+ 25 - 7	+ 36 - 16	± 16	± 26	

	K5	K6	K7	M5	M6	M7	N5	N6	N7	P6	P7	Diameter Classification (mm)	
												over	incl.
	+ 2 - 6	+ 2 - 9	+ 6 - 12	- 4 - 12	- 4 - 15	0 - 18	- 9 - 17	- 9 - 20	- 5 - 23	- 15 - 26	- 11 - 29	10	18
	+ 1 - 8	+ 2 - 11	+ 6 - 15	- 5 - 14	- 4 - 17	0 - 21	- 12 - 21	- 11 - 24	- 7 - 28	- 18 - 31	- 14 - 35	18	30
	+ 2 - 9	+ 3 - 13	+ 7 - 18	- 5 - 16	- 4 - 20	0 - 25	- 13 - 24	- 12 - 28	- 8 - 33	- 21 - 37	- 17 - 42	30	50
	+ 3 - 10	+ 4 - 15	+ 9 - 21	- 6 - 19	- 5 - 24	0 - 30	- 15 - 28	- 14 - 33	- 9 - 39	- 26 - 45	- 21 - 51	50	80
	+ 2 - 13	+ 4 - 8	+ 10 - 25	- 8 - 23	- 6 - 28	0 - 35	- 18 - 33	- 16 - 38	- 10 - 45	- 30 - 52	- 24 - 59	80	120
	+ 3 - 15	+ 4 - 21	+ 12 - 28	- 9 - 27	- 8 - 33	0 - 40	- 21 - 39	- 20 - 45	- 12 - 52	- 36 - 61	- 28 - 68	120	180
	+ 2 - 18	+ 5 - 24	+ 13 - 33	- 11 - 31	- 8 - 37	0 - 46	- 25 - 45	- 22 - 51	- 14 - 60	- 41 - 70	- 33 - 79	180	250
	+ 3 - 20	+ 5 - 27	+ 16 - 36	- 13 - 36	- 9 - 41	0 - 52	- 27 - 50	- 25 - 57	- 14 - 66	- 47 - 79	- 36 - 88	250	315

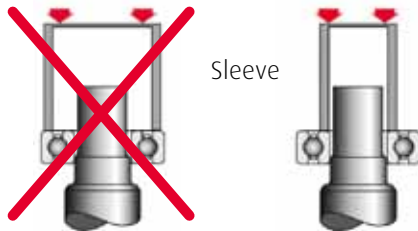
# Mounting of Cylindrical Bore Bearings with interference fit

Bearing rings should not be subjected to direct impact – use a tubular drift or hydraulic press! Always apply the mounting force to the correct ring!

**Fitting bearing into housing**

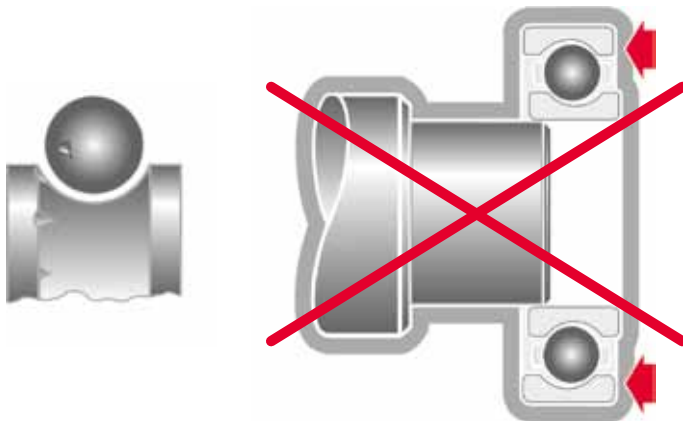


**Fitting bearing to shaft**



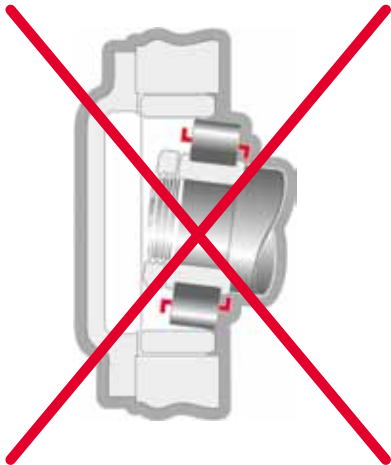


Damage can occur if the mounting force is applied to the incorrect ring during assembly. In particular, the balls or raceways may become indented, also known as “brinelling”.

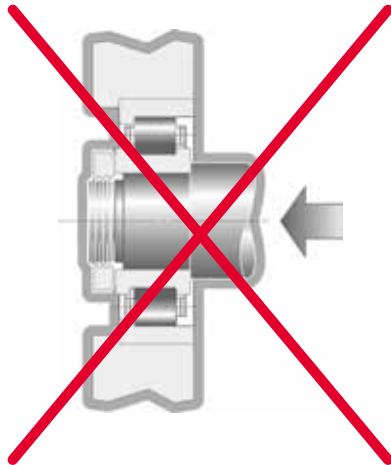


# Mounting of Cylindrical Roller Bearings

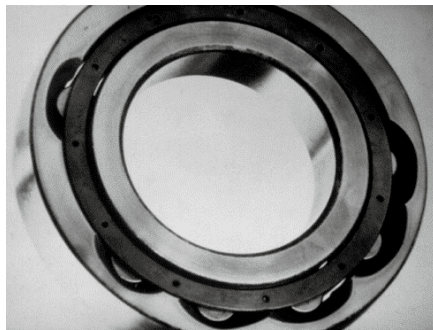
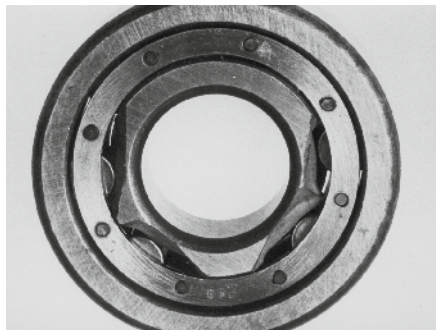
Ensure that the bearing is correctly aligned to the shaft/housing.



Avoid shock loading on the inner/outer ring ribs.



Fractured rings, due to shock loading during fitting



## Shrink fits

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Shrink fitting is often used to avoid the large force involved in press fitting large bearings. For shrink fitting, the bearings are first heated in oil, or in an induction heater, to expand them, then mounted and allowed to cool. This amount of expansion of the inner ring for various temperature differences and bearing sizes are shown in Fig. 1.

Some precautions should be considered when using shrink fits:

- › Do not heat bearings above 120°C
- › Put bearings on a wire netting or suspend them in the oil tank to prevent them from touching the tank bottom.
- › Heat bearing to a temperature 20 to 30°C higher than the lowest temperature required for mounting, because the inner ring will cool a little during mounting.

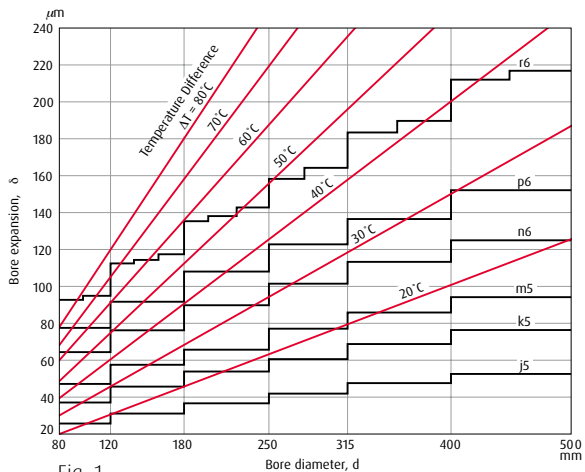
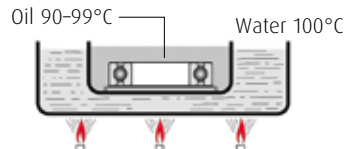


Fig. 1

## Heating bearing oil



## Induction heater



## Shrink fits

After mounting, the bearings will shrink in the axial direction as well as the radial direction while cooling. Therefore, while mounting, press the bearing firmly against the shaft shoulder to avoid excessive clearance between the bearing and the shoulder.





# Mounting of Spherical Roller Bearings

## on adapter sleeves

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1. With bearing on bench check clearance using the feeler gauges over the top of the rollers at the top of the bearing as shown in Fig. 1 and note the clearance.
2. Before mounting, smear the thread and the side face of the nut with a molybdenum disulphide paste or similar lubricant.
3. Smear the shaft and outside diameter of sleeve with a light oil.
4. Open the sleeve slightly by inserting and twisting a screw driver into the slit in the sleeve and position the sleeve on the shaft.
5. Slide bearing, lockwasher and locknut onto sleeve and tighten nut with a 'C' spanner until all slackness is removed.
6. Further tighten the nut until the clearance has been reduced by the amount shown in the chart on pages 54/55 but when the bearing is mounted on the shaft the clearance should be checked under the rollers at the bottom of the bearing as shown in Fig. 2.



7. Check the clearance has not been reduced below the minimum permissible residual clearance shown in the chart on pages 54/55 for the size and clearance of bearing.
8. Align one tab on the lock washer with a slot in the locknut and bend it into the slot, if no tabs line up with the slots slightly tighten the locknut until one lines up. **Never back off the nut to line up the tab with the slot.**
9. Check the bearing rotates freely without any binding.

# Mounting of Spherical Roller Bearings on adapter sleeves

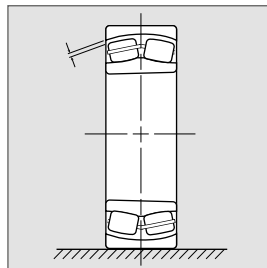
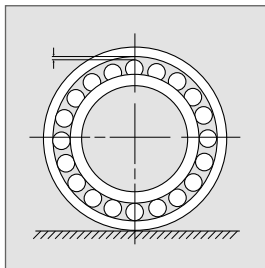
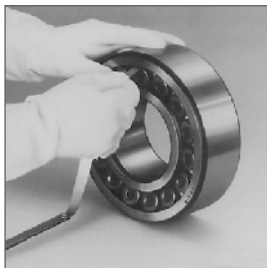


Fig. 1:  
Checking bearing clearance with bearing on bench.

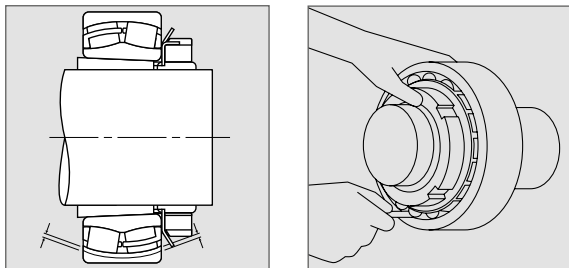


Fig. 2:  
Checking bearing clearance with bearing mounted on shaft.

# Mounting of Spherical Roller Bearings

## on an adapter sleeve using the Axial Drive-Up Method

---

1. Before mounting, smear the thread and the side face of the nut with a molybdenum disulphide paste or similar lubricant.
2. Smear the shaft and outside diameter of sleeve with a light oil.
3. Open the sleeve slightly by inserting and twisting a screwdriver into the slit in the sleeve and position the sleeve on the shaft.
4. Slide bearing, lockwasher and locknut onto sleeve and tighten nut with a 'C' spanner until all slackness is removed.
5. Measure dimension 'X' as shown in Fig. 3.
6. Tighten the nut and **decrease** dimension 'X' by the amount of axial drive-up shown in the chart on pages 54/55 for the correct size of bearing.
7. Check bearing clearance as shown on pages 50/51 to ensure the clearance is not less than the minimum permissible residual clearance shown in the chart on pages 54/55 for the size and clearance of bearing.

8. Align one tab on the lock washer with a slot in the locknut and bend it into the slot, if no tabs line up with the slots slightly tighten the locknut until one lines up. **Never back off the nut to line up the tab with the slot.**
9. Check the bearing rotates freely without binding.

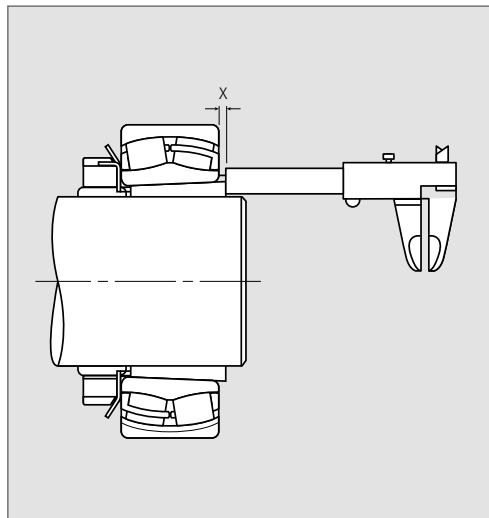


Fig. 3

# Mounting of Spherical Roller Bearings on an adapter sleeve (dimensions in mm) Taper 1:12

Bearing Bore Diameter mm		Initial Radial Internal Clearance						Reduction in Radial Clearance		Axial Drive-Up		Nominal tightening angle	Minimum Permissible Residual Clearance		
over	incl.	CN		C3		C4		min	max	min	max	nominal	CN	C3	C4
		min	max	min	max	min	max								
30	40	0.035	0.050	0.050	0.065	0.065	0.085	0.25	0.030	0.40	0.45	100°	0.010	0.25	0.035
40	50	0.045	0.060	0.060	0.080	0.080	0.100	0.030	0.035	0.45	0.55	120°	0.015	0.030	0.045
50	65	0.055	0.075	0.075	0.095	0.095	0.120	0.030	0.035	0.45	0.55	90°	0.025	0.035	0.060
65	80	0.070	0.095	0.095	0.120	0.120	0.150	0.040	0.040	0.60	0.70	120°	0.030	0.040	0.075
80	100	0.080	0.110	0.110	0.140	0.140	0.180	0.045	0.055	0.070	0.85	140°	0.035	0.050	0.085
100	120	0.100	0.135	0.135	0.170	0.170	0.220	0.050	0.060	0.75	0.90		0.045	0.065	0.110
120	140	0.120	0.160	0.160	0.200	0.200	0.260	0.060	0.070	0.90	1.10		0.055	0.080	0.130
140	160	0.130	0.180	0.180	0.230	0.230	0.300	0.065	0.080	1.00	1.30		0.060	0.100	0.150

Bearing Bore Diameter mm		Initial Radial Internal Clearance						Reduction in Radial Clearance		Axial Drive-Up		Nominal tightening angle	Minimum Permissible Residual Clearance		
over	incl.	CN		C3		C4		min	max	min	max	nominal	CN	C3	C4
		min	max	min	max	min	max								
160	180	0.140	0.200	0.200	0.260	0.260	0.340	0.070	0.090	1.10	1.40		0.070	0.110	0.170
180	200	0.160	0.220	0.220	0.290	0.290	0.370	0.080	0.100	1.30	1.60		0.070	0.110	0.190
200	225	0.180	0.250	0.250	0.320	0.320	0.410	0.090	0.110	1.40	1.70		0.080	0.130	0.210
225	250	0.200	0.270	0.270	0.350	0.350	0.450	0.100	0.120	1.60	1.90		0.090	0.140	0.230
250	280	0.220	0.300	0.300	0.390	0.390	0.490	0.110	0.140	1.70	2.20		0.100	0.150	0.250
280	315	0.240	0.330	0.330	0.430	0.430	0.540	0.120	0.150	1.90	2.40		0.110	0.160	0.280
315	355	0.270	0.360	0.360	0.470	0.470	0.590	0.140	0.170	2.20	2.70		0.120	0.180	0.300
355	400	0.300	0.400	0.400	0.520	0.520	0.650	0.150	0.190	2.40	3.00		0.130	0.200	0.330

# Mounting of Self-Aligning Ball Bearings

## on an adapter sleeve

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### Axial Drive-Up Method

1. Before mounting, smear the thread and the side face of the nut with a molybdenum disulphide paste or similar lubricant.
2. Smear the shaft and outside diameter of sleeve with a light oil.
3. Open the sleeve slightly by inserting and twisting a screw driver into the slit in the sleeve and position the sleeve on the shaft.
4. Slide bearing, lockwasher and locknut onto sleeve and tighten nut with a 'C' spanner until all slackness is removed.
5. Measure distance from end tapered sleeve to the face of locknut or to the face of the inner ring and note the dimension.



6. From the chart note the required “axial drive up” and tighten the locknut until the bearing has moved the required distance up the taper of the sleeve indicated by the reduction or increase in the measured distance originally noted. If the original dimension was from the end of the tapered sleeve to the face of the locknut then the dimension will increase but if the measurement was from the end of the tapered sleeve to the face of the inner ring the dimension will be reduced.
7. A self-aligning ball bearing with normal clearance when adjusted correctly should rotate freely but should have some resistance to swivelling.
8. Align one tab on the lock washer with a slot in the locknut and bend it into the slot, if no tabs line up with the slots slightly tighten the locknut until one lines up. **Never back off the nut to line up the tab with the slot.**

# Mounting of Self-Aligning Ball Bearings

## on an adapter sleeve

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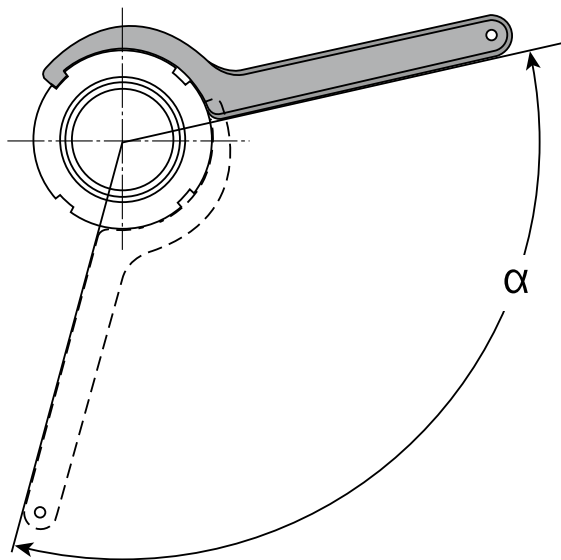
### Tightening Angle Method

1. Before mounting, smear the thread and the side face of the nut with a molybdenum disulphide paste or similar lubricant.
2. Smear the shaft and outside diameter of sleeve with a light oil.
3. Open the sleeve slightly by inserting and twisting a screw driver into the slit in the sleeve and position the sleeve on the shaft.
4. Slide bearing, lockwasher and locknut onto sleeve and tighten nut with a 'C' spanner until all slackness is removed.
5. Tighten locknut through the required angle  $\alpha$ , taken from chart, and then reposition the 'C' spanner to 180° from its original position and give it a sharp tap with the hammer to straighten the bearing on its seating.

6. A self-aligning ball bearing with normal clearance when adjusted correctly should rotate freely but should have some resistance to swivelling.
7. Align one tab on the lock washer with a slot in the locknut and bend it into the slot, if no tabs line up with the slots slightly tighten the locknut until one lines up.  
**Never back off the nut to line up the tab with the slot.**

# Mounting of Double Row Self-Aligning Ball Bearings with 1:12 Tapered Bores on to adapter sleeves

Bearing Bore Diameter mm		Tightening Angle ( $\alpha$ ) degrees	Approximate Axial Drive-Up mm
over	inclusive		
24	30	70	0.22
30	40	70	0.30
40	50	70	0.30
50	65	90	0.40
65	80	90	0.45
80	100	90	0.45
100	120	120	0.55
120	140	120	0.65
140	160	120	0.75



# Bearing Lubrication

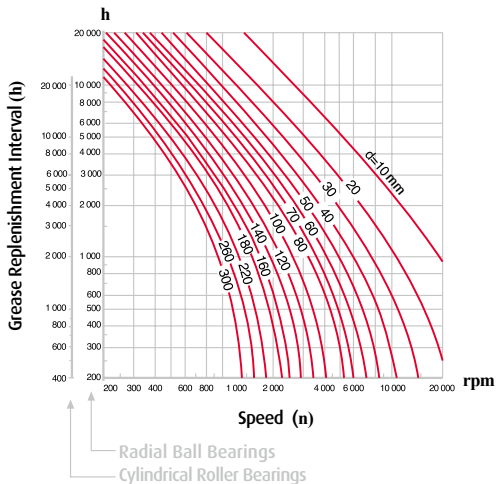
## Grease quantity

The quantity of grease in a bearing depends on the application, rotational speed of the bearing, characteristics of the selected grease, and the ambient temperature conditions. These factors are critical to satisfactory performance.

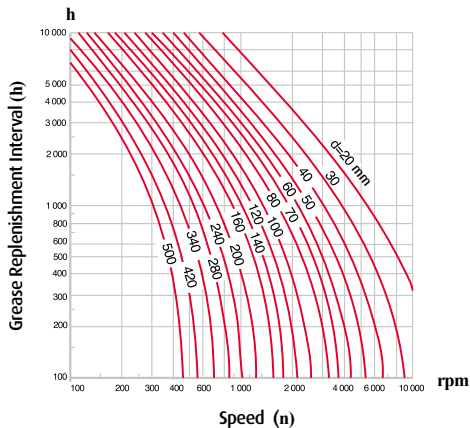
Quantity of grease for standard applications				Replenishment time interval (see graphs on following page)
Conditions	Quantity of Grease	Conditions	Quantity of Grease	Application Conditions
Speed is less than 50% of the bearing limiting speed	Between <b>1/3</b> & <b>2/3</b> of the free internal space	Speed is more than 50% of the bearing limiting speed	Between <b>1/3</b> & <b>1/2</b> of the free internal space	These graphs are applicable if the Bearing temperature is < 70°C. If the Bearing temperature exceeds 70°C, the replenishment time interval must be reduced by half for every 15°C temperature rise

Care should be taken to avoid excessive greasing as this will cause bearings to overheat.

### Radial Ball Bearings / Cylindrical Roller Bearings



### Tapered Roller Bearings / Spherical Roller Bearings



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## Bearing Doctor Section

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# Causes and countermeasures for operating irregularities

Irregularities		Possible Causes	Countermeasures
Noise	Loud Metallic Sound	Abnormal load	Correction of fit, internal clearance, preload, position of housing shoulder, etc.
		Incorrect mounting	Correction of alignment of shaft and housing, accuracy of mounting method
		Insufficient or improper lubricant	Replenish lubricant or select proper lubricant.
		Squeaking noise	Replacement by low-noise bearings, selection of small clearance bearings
		Sliding of balls	Adjustment of preload, selection of small clearance bearings, or adoption of softer grease
		Contact of rotating parts	Correction of labyrinth seal, etc.
	Loud Regular Sound	Flaws, corrosion, or scratches on the raceways	Replacement of bearing, cleaning, improvement of seals, and usage of clean lubricant
		Brinelling	Replacement of bearing and careful handling
		Flaking on the raceways	Replacement of bearing
	Irregular Sound	Excessive clearance	Correction of fit and clearance and correction of preload
		Penetration by foreign particles	Replacement of bearing, cleaning, improvement of seals, and relubrication using clean lubricant
		Flaws or flaking on the ball surfaces	Replacement of bearing
		Excessive amount of lubricant	Reduce amount of lubricant, select stiffer grease

Irregularities	Possible Causes	Countermeasures
Abnormal Temperature Rise	Insufficient or improper lubricant	Replenish lubricant or select proper lubricant
	Abnormal load	Correction of fit, internal clearance, preload, position of housing shoulder
	Incorrect mounting	Correction of alignment of shaft and housing, accuracy of mounting, or mounting method
	Creep of fitted surfaces, excessive seal friction	Correction of seals, replacement of bearing, correction of fit or mounting
Vibration	Brinelling	Replacement of bearings and careful handling
	Flaking	Replacement of bearing.
	Incorrect mounting	Correction of squareness between shaft and housing shoulder or side of spacer
	Penetration by foreign particles	Replacement of bearing, cleaning, correction of seals
Leakage or Discoloration of Lubricant	Too much lubrication. Penetration by foreign particles or abrasion chips	Reduce amount of lubricant, select stiffer grease Replace bearing or lubricant Clean housing and adjacent parts

# Flaking

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**Location:**

Inner ring of a spherical roller bearing

**Symptom:**

Flaking of only one raceway over its entire circumference

**Cause:**

excessive axial load

**Countermeasure:**

Reconfirm the bearing application and check the load conditions



**Location:**

Rollers of a double-row cylindrical roller bearing

**Symptom:**

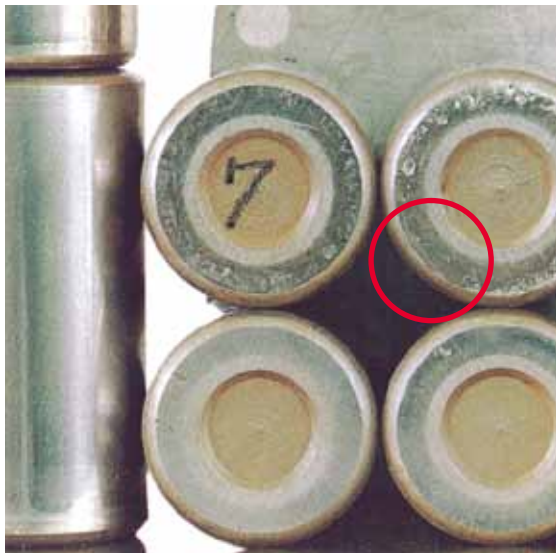
Scoring on the roller end face

**Cause:**

Poor lubrication and excessive axial load

**Countermeasure:**

Improve the lubricant and the lubrication method and check the load conditions



# Smearing

**Location:**

Outer ring of a cylindrical roller bearing

**Symptom:**

Smearing occurs circumferentially on raceway surface

**Cause:**

Insufficient radial load, roller slipping due to excessive grease filling

**Countermeasure:**

Improve the bearing clearance, improve the lubrication method, check load condition



**Location:**

Inner ring of a tapered roller bearing

**Symptom:**

Fracture occurs at the cone back face rib

**Cause:**

Large shock during mounting

**Countermeasure:**

Improve the mounting method  
(shrink fit, use of proper tools)



# Cracks

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**Location:**

Inner ring of a spherical roller bearing

**Symptom:**

Axial cracks occur on raceway surface

**Cause:**

Large fitting stress due to temperature difference between shaft and inner ring

**Countermeasure:**

Check the application and use NSK TL series bearings (special steel)





**Location:**

Cage of an angular contact ball bearing

**Symptom:**

Pocket pillar fractures in a cast iron machined cage

**Cause:**

Abnormal load action on cage due to misaligned mounting between inner and outer rings

**Countermeasure:**

Check the mounting method



# Denting

**Location:**

Inner ring of a tapered roller bearing

**Symptom:**

Small and large indentations occur over entire raceway surface

**Cause:**

Debris caught in the surface

**Countermeasure:**

Improve the sealing mechanism, filter the lubricating oil



**Location:**

Rolling element of a ball bearing

**Symptom:**

Pitting occurs on the rolling element surface

**Cause:**

Debris becomes caught in the lubricant

**Countermeasure:**

Improve the sealing mechanism,  
filter the lubricating oil



# Fretting

---

**Location:**

Inner ring of a deep groove ball bearing

**Symptom:**

Fretting occurs on the bore surface

**Cause:**

Vibration

**Countermeasure:**

Check the interference fit



**Location:**

Inner ring of a deep groove ball bearing

**Symptom:**

False brinelling occurs on the raceway

**Cause:**

Vibration from an external source while stationary

**Countermeasure:**

Secure the shaft and housing during transport, reduce the vibration by preloading, use a suitable lubricant



# Creep

---

**Location:**

Inner ring of a spherical roller bearing

**Symptom:**

Creep accompanied by scoring of bore surface

**Cause:**

Insufficient interference

**Countermeasure:**

Check the interference and prevent rotation



**Location:**

Inner ring of a spherical roller bearing

**Symptom:**

Raceway is discolored and melted. Worn particles from the cage were rolled and attached to the raceway

**Cause:**

Insufficient lubrication

**Countermeasure:**

Check the lubricant and lubrication method



# Electrical corrosion

---

**Location:**

Inner ring of a tapered roller bearing

**Symptom:**

Striped pattern of corrosion occurs on the raceway surface

**Cause:**

Electrical potential difference between inner and outer rings

**Countermeasure:**

Insulation of the bearing





**Location:**

Inner ring of a spherical roller bearing

**Symptom:**

Rust on raceway surface at roller pitch

**Cause:**

Entry of water into lubricant

**Countermeasure:**

Improve the sealing mechanism



# Mounting flaws

---

**Location:**

Inner ring of a cylindrical roller bearing

**Symptom:**

Axial scratches on raceway surface

**Cause:**

Inclination of inner and outer rings during mounting

**Countermeasure:**

Center the relative mating parts during mounting



**Location:**

Inner ring of a 4-point contact ball bearing

**Symptom:**

Bluish or purplish discoloration on raceway surface

**Cause:**

Heat generation due to poor lubrication

**Countermeasure:**

Improve the lubrication method



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