CATALOGO

BOCCOLE

ERNESTO RAAB SRL

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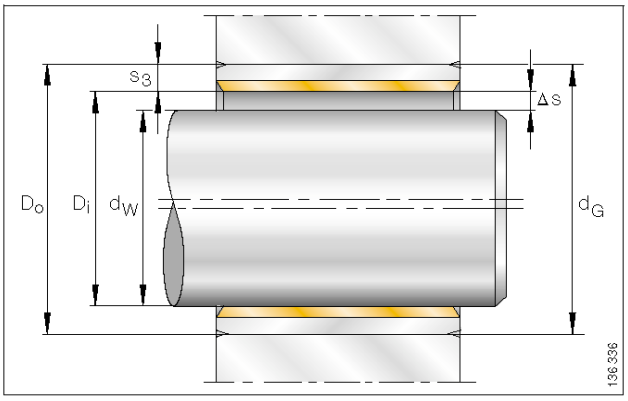
Internal clearance and mounting tolerances

Metric sizes

Bush diameter		Internal clearance Δs			
		SF-1		SF-2	
Di mm	Do mm	ΔSmin mm	ΔSmax mm	ΔSmin mm	ΔSmax mm
2	3,5	0,000	0,054	-	-
3	4,5				
4	5,5		0,056		
5	7		0,077		
6	8				
7	9	0,003	0,083		
8	10			0,040	
10	12		0,086		
12	14	0,006	0,092		
13	15			-	
14	16			0,040	
15	17				
16	18				
18	20		0,095		
20	23	0,010	0,112	0,050	
22	25				
24	27				
25	28				
28	32		0,126	0,060	
30	34				
32	36	0,015	0,135		
35	39				
40	44				
45	50		0,155	0,080	
50	55		0,160		
55	60	0,020	0,170		
60	65				
65	70			-	
70	75			0,080	
75	80				
80	85		0,201	0,100	
85	90		0,209	-	

Bush diameter		Internal clearance Δs			
		SF-1		SF-2	
Di mm	Do mm	ΔSmin mm	ΔSmax mm	ΔSmin mm	ΔSmax mm
90	95	0,020	0,209	0,100	0,319
95	100			-	-
100	105			0,100	0,319
105	110			-	-
110	115				
115	120				
120	125	0,070	0,264		
125	130		0,273		
130	135				
135	140				
140	145				
150	155				
160	165				
180	185		0,279		
200	205		0,288		
220	225				
250	255		0,294		
300	305		0,303		



Theoretical internal clearance ΔS

Maintenance-free plain bearing material

primary for dry running

BUSHES SF - 1

pv_{max}	=	1,8	N/mm² * m/s
pv_{temp}	=	3,6	N/mm² * m/s
$p_{max\ s}$	=	250	N/mm²
$p_{max\ d}$	=	56	N/mm²
V_{max}	=	2	m/s
ϑ	=	-200	°C to +280°C

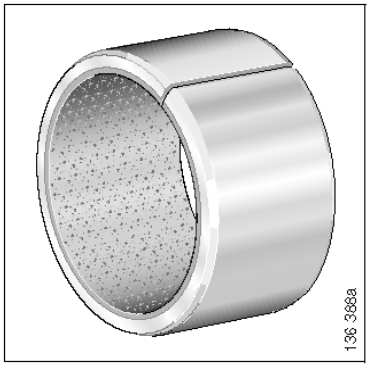
Low-maintenance plain bearing material

lubrication required

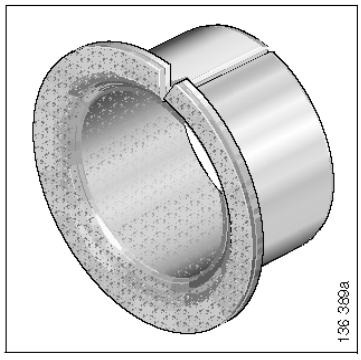
BUSHES SF - 2

pv_{max}	=	3,0	N/mm² * m/s
$p_{max\ s}$	=	250	N/mm²
$p_{max\ d}$	=	70	N/mm²
V_{max}	=	3	m/s
ϑ	=	-40	°C to +110°C
ϑ_{max}	=	up to +140°C for short periods	

Bushes maintenance-free: SF - 1 low-maintenance: SF - 2



Flanged bushes maintenanc free: SF - 1



conversion factors
Surface roughness
ISO tolerances

Conversion factors

Dimensions	1	mm	0,039	in
		in	25,400	mm
	0,001	mm	0,00004	in
		in	0,025	mm
Mass	1	g	0,0022	lbs
		lb	453,600	g
Force	1	N	0,225	lbf
		lbf	4,450	N
Temperature	°F =	$\frac{9 \times °C}{5} + 32$	°C =	$\frac{5}{9}(F° - 32)$
	- 200	°C	- 328	F°
	- 40	°C	- 40	F°
	+ 110	°C	+ 230	F°
	+ 140	°C	+ 284	F°
	+ 280	°C	+ 536	F°
Speed	1	m / s	196,848 fpm = 3,281 ft/s	
	2	m / s	394,000	fpm
	3	m / s	590,000	fpm
	1	ft / s	0,3048	m/s
Torque	1	Nmm	0,0009	in * lbf
		in * lbf	113	Nmm
		Nmm	8,850	
		in * lbf		
Pressure	1	N / mm² = 1 Mpa		
	250	N / mm²		
	1	psi		
pv value	1,8	N/mm² * m / s		
	3,0	N/mm² * m/s		
	3,6	N/mm² * m/s		

Surface roughness

R_a µm	AA and CLA µinch	R_t µm	R_z µm	RMS µinch	Surface symbols
0,20	8,00	1,0	1,0	8,96	▽▽▽▽
0,25	10,00	-	-	11,20	
0,30	12,00	1,5	1,6	13,44	
0,32	13,00	-	-	14,56	
0,40	16,00	2,0	2,0	17,92	▽▽▽
0,50	20,00	2,5	2,5	22,40	
0,63	25,00	3,0	3,0	28,00	
0,80	32,00	4,0	4,0	35,84	
1,00	40,00	-	-	44,80	▽▽
1,20	48,00	6,3	6,3	53,76	

ISO tolerances for shafts

Designation	Normal devi.	Nominal dimension range in mm									
		over 3	6	10	18	30	50	80	120	180	250
		incl 6	10	18	30	50	80	120	180	250	315
		Deviations in µm									
f 7	upper	-10	-13	-16	-20	-25	-30	-36	-43	-50	-56
	lower	-22	-28	-34	-41	-50	-60	-71	-83	-96	-108
h 6	upper	0	0	0	0	0	0	0	0	0	0
	lower	- 8	- 9	-11	-13	-16	-19	-22	-25	-29	-32
h 7	upper	0	0	0	0	0	0	0	0	0	0
	lower	-12	-15	-18	-21	-25	-30	-35	-40	-46	-52
h 8	upper	0	0	0	0	0	0	0	0	0	0
	lower	-18	-22	-27	-33	-39	-46	-54	-63	-72	-81

ISO tolerances for holes

Designation	Normal devi.	Nominal dimension range in mm									
		over 3	6	10	18	30	50	80	120	180	250
		incl 6	10	18	30	50	80	120	180	250	315
		Deviations in µm									
g 7	upper	+16	+20	+24	+28	+34	+40	+47	+54	+61	+69
	lower	+ 4	+ 5	+ 6	+ 7	+ 9	+10	+12	+14	+15	+17
h 6	upper	+ 8	+ 9	+11	+13	+16	+19	+22	+25	+29	+32
	lower	0	0	0	0	0	0	0	0	0	0
h 7	upper	+12	+15	+18	+21	+25	+30	+35	+40	+46	+52
	lower	0	0	0	0	0	0	0	0	0	0
h 8	upper	+18	+22	+27	+33	+39	+46	+54	+63	+72	+81
	lower	0	0	0	0	0	0	0	0	0	0
j 7	upper	+6	+ 8	+10	+12	+14	+18	+22	+26	+30	+36
	lower	-6	- 7	- 8	- 9	-11	-12	-13	-14	-16	-16

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Conversion to DIN ISO 3457

DIN 1494, which has been applicable up to now, specifies the deviations for outside diameters up to $D_0 \leq 180$ mm, and DIN ISO 3457 additionally specifies them for $D_0 < 180$ mm.

The deviations for the outside diameters up to D_0 therefore correspond to the specifications in Table 8 or to DIN ISO 3457 for the transitional period.

Deviations for the outside diameters

Table 8 - deviations for outside diameters D_0

Outside diameter for bush D_0	Deviations (Test A to DIN ISO 3457-2) SF 1 - 2	
	upper	lower
$D_0 \leq 10$	+ 0,055	+ 0,025
$10 < D_0 \leq 18$	+ 0,065	+ 0,030
$18 < D_0 \leq 30$	+ 0,075	+ 0,035
$30 < D_0 \leq 50$	+ 0,085	+ 0,045
$50 < D_0 \leq 80$	+ 0,100	+ 0,055
$80 < D_0 \leq 120$	+ 0,120	+ 0,070
$120 < D_0 \leq 180$	+ 0,170	+ 0,100
$180 < D_0 \leq 250$	+ 0,210	+ 0,130
$250 < D_0 \leq 305$	+ 0,260	+ 0,170

Wall thicknesses with tolerances

Table 9 - Wall thicknesses S_3 for bushes and flanged bushes SF - 1

Inside diameter D_i	Wall tickness S_3	Deviations SF - 1 to DIN ISO 3457-2 Table 3, series B	
		upper	lower
$D_i < 5$	0,75	0	- 0,020
	1	-	-
$5 \leq D_i < 20$	1	+ 0,005	- 0,020
$20 \leq D_i < 28$	1,5	+ 0,005	- 0,025
$28 \leq D_i < 45$	2	+ 0,005	- 0,030
$45 \leq D_i < 80$	2,5	+ 0,005	- 0,040
$80 \leq D_i < 120$	2,5	- 0,010	- 0,060
$120 \leq D_i$	2,5	- 0,035	- 0,085

Table 10 - Wall thicknesses S_3 for bushes SF - 2

Inside diameter D_i	Wall tickness S_3	Deviations SF - 2 to DIN ISO 3457-2 Table 3, series D	
		upper	lower
$8 \leq D_i < 20$	1	- 0,020	- 0,018
$20 \leq D_i < 28$	1,5	- 0,025	- 0,019
$28 \leq D_i < 45$	2	- 0,030	- 0,020
$45 \leq D_i < 80$	2,5	- 0,035	- 0,025
$80 \leq D_i$	2,5	- 0,040	- 0,030

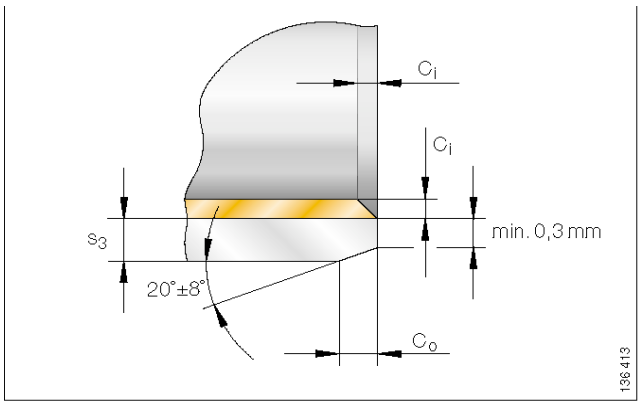
Chamfers and chamfer tolerances

Table 11 - Outer chamfer C_0 and inner edge break C_i (Figure) for bushes in metric sizes, to DIN ISO 3457-1, Table 2

Wall tickness S_3	Outer chamfer, machined without cutting (1 C_0	Inner edge break C_i	
		min	max
0,75	0,5 ± 0,3	0,1	0,4
1,00	0,6 ± 0,4	0,1	0,5
1,50	0,6 ± 0,4	0,1	0,7
2,00	1,0 ± 0,4	0,1	0,7
2,50	1,2 ± 0,4	0,2	1

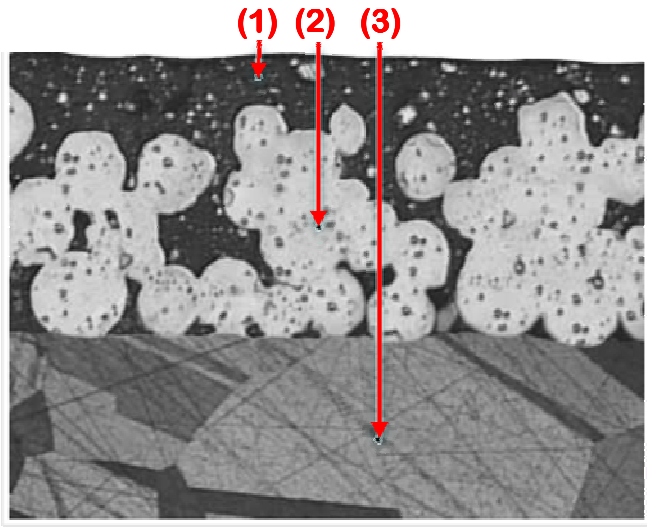
C_0 should be correspondingly larger for bushs with a bearing bore that must be machined to size. Chamfer deformation due to round bending is permissible.

(1 For a transitional period, bushes with differing chamfers can be supplied for wall ticknesses 2 mm and 2,5 mm.



Outher chamfer C_0 and inner edge break C_i for metric sizes

SF 1 plain bearing material, maintenance-free



Running-in layer (1):polytetrafluoroethylene (PTFE) and lead (Pb), 0,01mm to 0,03 mm thick

Silding layer (2): porous bronze layer filed with PTFE/Pb, 0,20 mm to 0,35mm thick

Bronze backing (3)

Technical data

Maximun pv value for dry running	continuos operation	pv	1,8	N / mm^2 * m / s
	for short periods	pv	3,6	
Permissible specific bearing load	static	p_{max}	250	N / mm^2
	very low sliding speed	p_{max}	140	
	rotating, oscillating	p_{max}	56	
Permissible sliding speed	dry running	V_{max}	2	m / s
	hydrodynamic operation	V_{max}	> 2	
Permissible operating temperature	-	ϑ	- 200 to + 280	° C
Coefficient of thermal expansion	steel backing	α_{St}	11 * 10^{-6}	K^{-1}
	bronze backing	α_{Bz}	17 * 10^{-6}	
Coefficient of thermal conducictivity	steel backing	γ_{St}	> 42	W (m* K)$^{-1}$
	bronze backing	γ_{Bz}	> 70	
Relative electrical resistance after running-in		$R_{rel\ min}$	> 70 Ω * cm^2	

Maintenance-free plain bearing material

primary for dry running

BUSHES SF - 1

pv_{max}	=	1,8	N/mm² * m/s
pv_{temp}	=	3,6	N/mm² * m/s
$p_{max\ s}$	=	250	N/mm²
$p_{max\ d}$	=	56	N/mm²
V_{max}	=	2	m/s
ϑ	=	-200	°C to +280°C

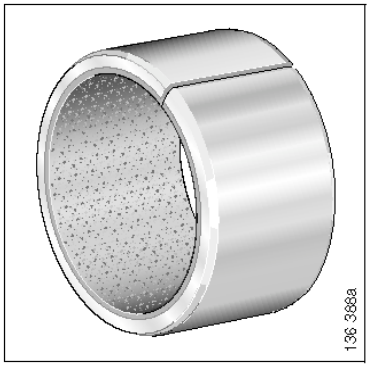
Low-maintenance plain bearing material

lubrication required

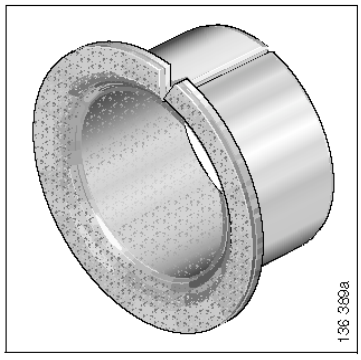
BUSHES SF - 2

pv_{max}	=	3,0	N/mm² * m/s
$p_{max\ s}$	=	250	N/mm²
$p_{max\ d}$	=	70	N/mm²
V_{max}	=	3	m/s
ϑ	=	-40	°C to +110°C
ϑ_{max}	=	up to +140°C for short periods	

Bushes maintenance-free: SF - 1 low-maintenance: SF - 2



Flanged bushes maintenanc free: SF - 1



conversion factors
Surface roughness
ISO tolerances

Conversion factors

Dimensions	1	mm	0,039	in
		in	25,400	mm
	0,001	mm	0,00004	in
		in	0,025	mm
Mass	1	g	0,0022	lbs
		lb	453,600	g
Force	1	N	0,225	lbf
		lbf	4,450	N
Temperature	°F =	$\frac{9 \times °C}{5} + 32$	°C =	$\frac{5}{9}(F° - 32)$
	- 200	°C	- 328	F°
	- 40	°C	- 40	F°
	+ 110	°C	+ 230	F°
	+ 140	°C	+ 284	F°
	+ 280	°C	+ 536	F°
Speed	1	m / s	196,848 fpm = 3,281 ft/s	
	2	m / s	394,000	fpm
	3	m / s	590,000	fpm
	1	ft / s	0,3048	m/s
Torque	1	Nmm	0,0009	in * lbf
		in * lbf	113	Nmm
		Nmm	8,850	
		in * lbf		
Pressure	1	N / mm² = 1 Mpa		
	250	N / mm²		
	1	psi		
pv value	1,8	N/mm² * m / s		
	3,0	N/mm² * m/s		
	3,6	N/mm² * m/s		

Surface roughness

R_a µm	AA and CLA µinch	R_t µm	R_z µm	RMS µinch	Surface symbols
0,20	8,00	1,0	1,0	8,96	▽▽▽▽
0,25	10,00	-	-	11,20	
0,30	12,00	1,5	1,6	13,44	
0,32	13,00	-	-	14,56	
0,40	16,00	2,0	2,0	17,92	▽▽▽
0,50	20,00	2,5	2,5	22,40	
0,63	25,00	3,0	3,0	28,00	
0,80	32,00	4,0	4,0	35,84	
1,00	40,00	-	-	44,80	▽▽
1,20	48,00	6,3	6,3	53,76	

ISO tolerances for shafts

Designation	Normal devi.	Nominal dimension range in mm									
		over 3	6	10	18	30	50	80	120	180	250
		incl 6	10	18	30	50	80	120	180	250	315
		Deviations in µm									
f 7	upper	-10	-13	-16	-20	-25	-30	-36	-43	-50	-56
	lower	-22	-28	-34	-41	-50	-60	-71	-83	-96	-108
h 6	upper	0	0	0	0	0	0	0	0	0	0
	lower	- 8	- 9	-11	-13	-16	-19	-22	-25	-29	-32
h 7	upper	0	0	0	0	0	0	0	0	0	0
	lower	-12	-15	-18	-21	-25	-30	-35	-40	-46	-52
h 8	upper	0	0	0	0	0	0	0	0	0	0
	lower	-18	-22	-27	-33	-39	-46	-54	-63	-72	-81

ISO tolerances for holes

Designation	Normal devi.	Nominal dimension range in mm									
		over 3	6	10	18	30	50	80	120	180	250
		incl 6	10	18	30	50	80	120	180	250	315
		Deviations in µm									
g 7	upper	+16	+20	+24	+28	+34	+40	+47	+54	+61	+69
	lower	+ 4	+ 5	+ 6	+ 7	+ 9	+10	+12	+14	+15	+17
h 6	upper	+ 8	+ 9	+11	+13	+16	+19	+22	+25	+29	+32
	lower	0	0	0	0	0	0	0	0	0	0
h 7	upper	+12	+15	+18	+21	+25	+30	+35	+40	+46	+52
	lower	0	0	0	0	0	0	0	0	0	0
h 8	upper	+18	+22	+27	+33	+39	+46	+54	+63	+72	+81
	lower	0	0	0	0	0	0	0	0	0	0
j 7	upper	+6	+ 8	+10	+12	+14	+18	+22	+26	+30	+36
	lower	-6	- 7	- 8	- 9	-11	-12	-13	-14	-16	-16

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Conversion to DIN ISO 3457

DIN 1494, which has been applicable up to now, specifies the deviations for outside diameters up to $D_0 \leq 180$ mm, and DIN ISO 3457 additionally specifies them for $D_0 < 180$ mm.

The deviations for the outside diameters up to D_0 therefore correspond to the specifications in Table 8 or to DIN ISO 3457 for the transitional period.

Deviations for the outside diameters

Table 8 - deviations for outside diameters D_0

Outside diameter for bush D_0	Deviations (Test A to DIN ISO 3457-2) SF 1 - 2	
	upper	lower
$D_0 \leq 10$	+ 0,055	+ 0,025
$10 < D_0 \leq 18$	+ 0,065	+ 0,030
$18 < D_0 \leq 30$	+ 0,075	+ 0,035
$30 < D_0 \leq 50$	+ 0,085	+ 0,045
$50 < D_0 \leq 80$	+ 0,100	+ 0,055
$80 < D_0 \leq 120$	+ 0,120	+ 0,070
$120 < D_0 \leq 180$	+ 0,170	+ 0,100
$180 < D_0 \leq 250$	+ 0,210	+ 0,130
$250 < D_0 \leq 305$	+ 0,260	+ 0,170

Wall thicknesses with tolerances

Table 9 - Wall thicknesses S_3 for bushes and flanged bushes SF - 1

Inside diameter D_i	Wall tickness S_3	Deviations SF - 1 to DIN ISO 3457-2 Table 3, series B	
		upper	lower
$D_i < 5$	0,75	0	- 0,020
	1	-	-
$5 \leq D_i < 20$	1	+ 0,005	- 0,020
$20 \leq D_i < 28$	1,5	+ 0,005	- 0,025
$28 \leq D_i < 45$	2	+ 0,005	- 0,030
$45 \leq D_i < 80$	2,5	+ 0,005	- 0,040
$80 \leq D_i < 120$	2,5	- 0,010	- 0,060
$120 \leq D_i$	2,5	- 0,035	- 0,085

Table 10 - Wall thicknesses S_3 for bushes SF - 2

Inside diameter D_i	Wall tickness S_3	Deviations SF - 2 to DIN ISO 3457-2 Table 3, series D	
		upper	lower
$8 \leq D_i < 20$	1	- 0,020	- 0,018
$20 \leq D_i < 28$	1,5	- 0,025	- 0,019
$28 \leq D_i < 45$	2	- 0,030	- 0,020
$45 \leq D_i < 80$	2,5	- 0,035	- 0,025
$80 \leq D_i$	2,5	- 0,040	- 0,030

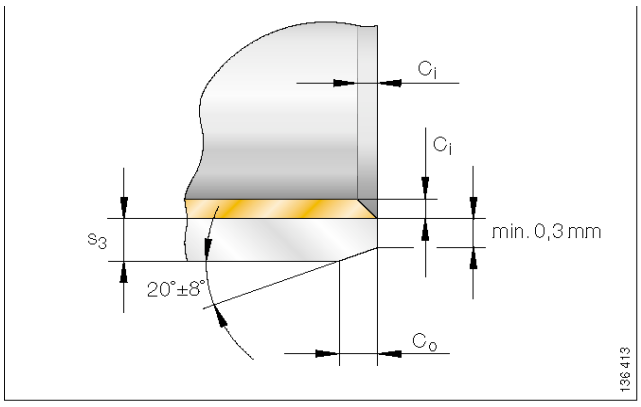
Chamfers and chamfer tolerances

Table 11 - Outer chamfer C_0 and inner edge break C_i (Figure) for bushes in metric sizes, to DIN ISO 3457-1, Table 2

Wall tickness S_3	Outer chamfer, machined without cutting (1 C_0	Inner edge break C_i	
		min	max
0,75	0,5 ± 0,3	0,1	0,4
1,00	0,6 ± 0,4	0,1	0,5
1,50	0,6 ± 0,4	0,1	0,7
2,00	1,0 ± 0,4	0,1	0,7
2,50	1,2 ± 0,4	0,2	1

C_0 should be correspondingly larger for bushs with a bearing bore that must be machined to size. Chamfer deformation due to round bending is permissible.

(1 For a transitional period, bushes with differing chamfers can be supplied for wall ticknesses 2 mm and 2,5 mm.



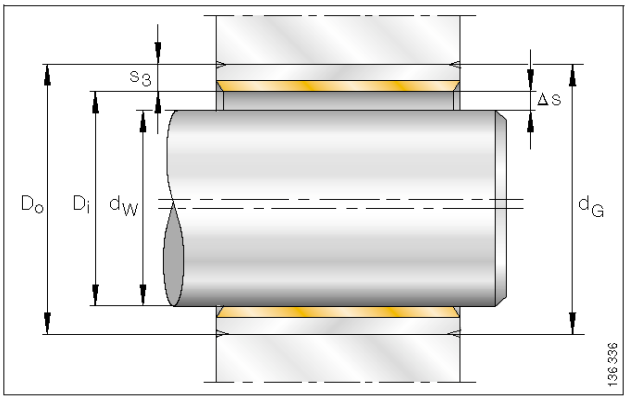
Outher chamfer C_0 and inner edge break C_i for metric sizes

Internal clearance and mounting tolerances

Metric sizes

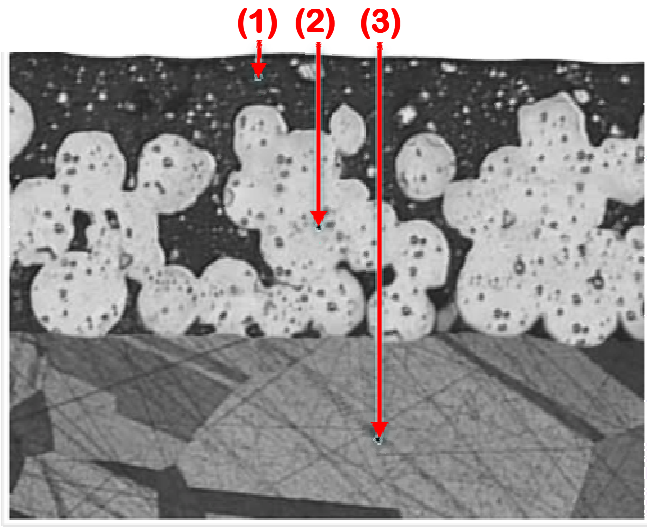
Bush diameter		Internal clearance Δs			
		SF-1		SF-2	
Di mm	Do mm	ΔSmin mm	ΔSmax mm	ΔSmin mm	ΔSmax mm
2	3,5	0,000	0,054	-	-
3	4,5				
4	5,5		0,056		
5	7		0,077		
6	8				
7	9	0,003	0,083		
8	10			0,040	
10	12		0,086		
12	14	0,006	0,092		
13	15			-	
14	16			0,040	
15	17				
16	18				
18	20		0,095		
20	23	0,010	0,112	0,050	
22	25				
24	27				
25	28				
28	32		0,126	0,060	
30	34				
32	36	0,015	0,135		
35	39				
40	44				
45	50		0,155	0,080	
50	55		0,160		
55	60	0,020	0,170		
60	65				
65	70			-	
70	75			0,080	
75	80				
80	85		0,201	0,100	
85	90		0,209	-	

Bush diameter		Internal clearance Δs			
		SF-1		SF-2	
Di mm	Do mm	ΔSmin mm	ΔSmax mm	ΔSmin mm	ΔSmax mm
90	95	0,020	0,209	0,100	0,319
95	100			-	-
100	105			0,100	0,319
105	110			-	-
110	115				
115	120				
120	125	0,070	0,264		
125	130		0,273		
130	135				
135	140				
140	145				
150	155				
160	165				
180	185		0,279		
200	205		0,288		
220	225				
250	255		0,294		
300	305		0,303		



Theoretical internal clearance ΔS

SF 1 plain bearing material, maintenance-free



Running-in layer (1):polytetrafluoroethylene (PTFE) and lead (Pb), 0,01mm to 0,03 mm thick

Silding layer (2): porous bronze layer filed with PTFE/Pb, 0,20 mm to 0,35mm thick

Bronze backing (3)

Technical data

Maximun pv value for dry running	continuos operation	pv	1,8	N / mm^2 * m / s
	for short periods	pv	3,6	
Permissible specific bearing load	static	p_{max}	250	N / mm^2
	very low sliding speed	p_{max}	140	
	rotating, oscillating	p_{max}	56	
Permissible sliding speed	dry running	V_{max}	2	m / s
	hydrodynamic operation	V_{max}	> 2	
Permissible operating temperature	-	ϑ	- 200 to + 280	° C
Coefficient of thermal expansion	steel backing	α_{St}	11 * 10^{-6}	K^{-1}
	bronze backing	α_{Bz}	17 * 10^{-6}	
Coefficient of thermal conducictivity	steel backing	γ_{St}	> 42	W (m* K)$^{-1}$
	bronze backing	γ_{Bz}	> 70	
Relative electrical resistance after running-in		$R_{rel\ min}$	> 70 Ω * cm^2	