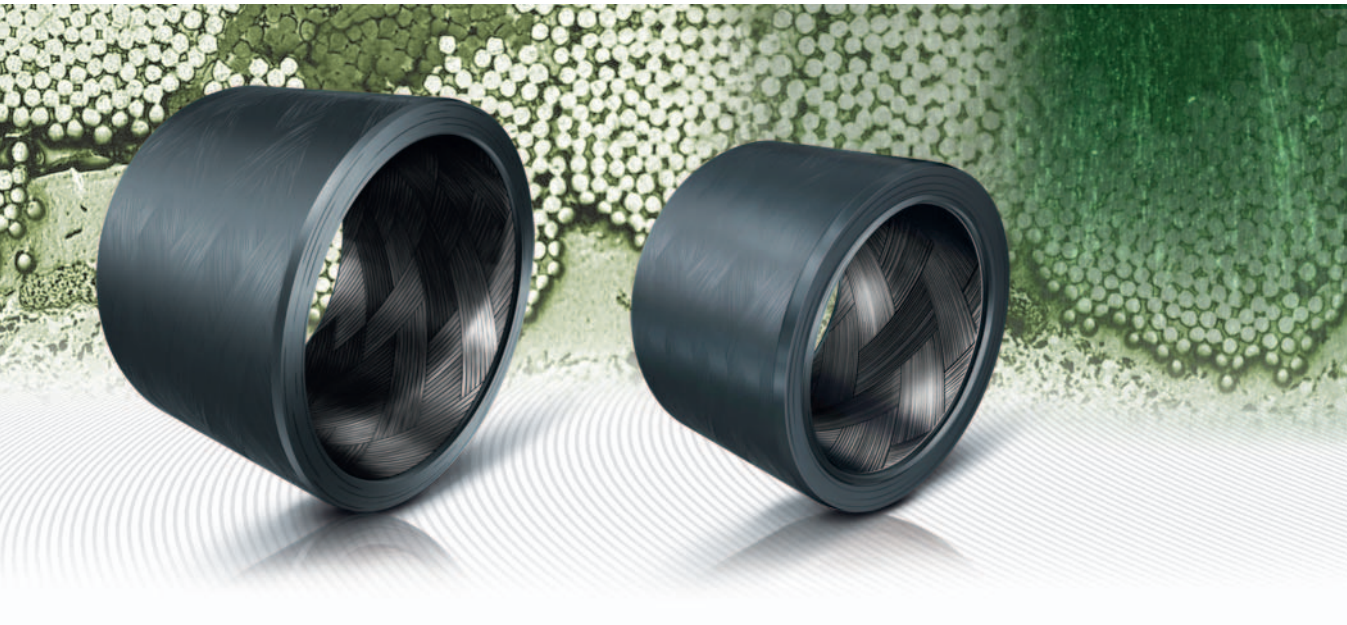


Plain Bearings with ELGOTEX®

Maintenance-free, wear-resistant

SCHAEFFLER

Foreword

Maintenance-free and environmentally-friendly

Bearing positions subjected to high loads, such as those in construction machinery, conveying equipment, transportation vehicles or agricultural machinery are normally fitted with solid-section plain bearings lubricated with grease or oil. ELGOTEX® filament wound bushes are particularly suitable as an environmentally-friendly and maintenance-free bearing type for replacing steel or bronze bearings requiring maintenance. The main dimensions are based on DIN ISO 4379.

High performance and wear-resistant

The maintenance-free filament wound bushes are particularly suitable for applications with dry running in which heavy loads and strong vibrations occur. Due to the material pairing used, they are maintenance-free for the whole of the operating life.

Due to the filament composite material, they are non-metallic and thus resistant to numerous media. They have low mass and and have a low coefficient of friction. The performance capability of the bearings is higher than that of metal/polymer composite plain bearings and lower than that of ELGOGLIDE® plain bushes, see table, page 2.

Water-resistant

For use in water, Schaeffler has developed the sliding material ELGOTEX®-WA. The performance capability in salt water has been certified in accordance with specification MCM-0112 from Germanischer Lloyd. This approval is valid for application as rudder carrier bearings, shaft bearings, pintle bearings and bearings for stabilisers.

Current level of technology

Technical Product Information TPI 194 describes the core range of ELGOTEX® filament wound bushes. The data represent the current level of technology and manufacture as of April 2014.
They reflect not only progress in bearing arrangement technology but also the experience gathered from numerous applications.

Any information in previous publications that does not concur with the data in this TPI is therefore invalid.

Foreword

Overview of available plain bushes

In addition to ELGOTEX® filament wound bushes, Schaeffler supplies other plain bushes for various requirements, *Figure 1* and table.

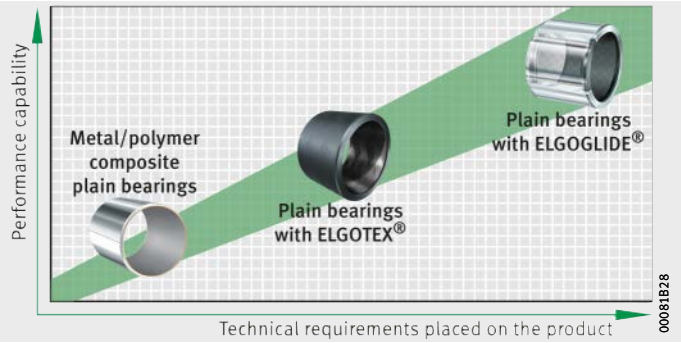
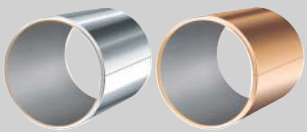
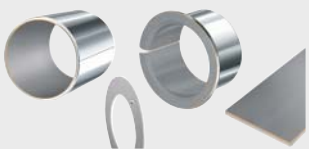
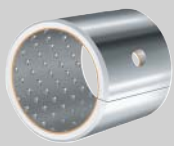
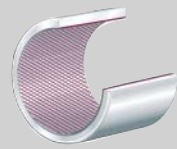
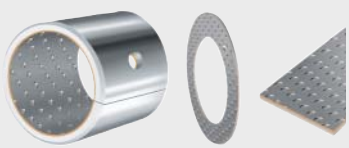
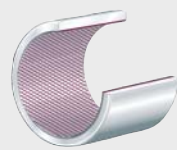


Figure 1
Product spectrum

Comparison of technical data

Plain bearing		Metal/polymer composite plain bearings E40, E40-B 
Type of maintenance		Maintenance-free
Permissible specific bearing load	Static	250 N/mm²
	Dynamic	140 N/mm²
Permissible sliding velocity		2,5 m/s
Maximum permissible pv value in continuous operation		1,8 N/mm² · m/s
Permissible operating temperature		–200 °C to +280 °C
Coefficient of friction		0,03 to 0,25
Dry running		✔
Grease and oil lubrication		–
Hydrodynamic operation		✔
Increased corrosion resistance		E40-B ■ E40 ❑
Use in water		E40-B ❑
Integrated sealing possible		–
Standard designs		EGB, EGF, EGW, EGS 

✔ Possible
■ Standard design
❑ Optional

Metal/polymer composite plain bearings E50	ELGOTEX®	ELGOGLIDE®
		
Low-maintenance	Maintenance-free	Maintenance-free
140 N/mm²	200 N/mm² [1]	500 N/mm² [2]
70 N/mm²	140 N/mm²	300 N/mm²
2,5 m/s	0,18 m/s	0,3 m/s
3 N/mm² · m/s	2,8 N/mm² · m/s	7 N/mm² · m/s
–40 °C to +110 °C	–20 °C to +130 °C	–50 °C to +150 °C
0,02 to 0,2	0,03 to 0,2	0,02 to 0,2
–	✔	✔
✔	–	–
–	–	–
❑	■	❑
–	❑	–
–	❑	❑
EGB, EGW, EGS	ZWB	ZGB
		

[1] For static loads of more than 180 N/mm², the design of ELGOTEX® filament wound bushes must be checked by the Schaeffler engineering service.

[2] Standard bushes have a static load carrying capacity of 300 N/mm².
If a material of higher strength is used for the steel support body, this value can be increased to 500 N/mm².

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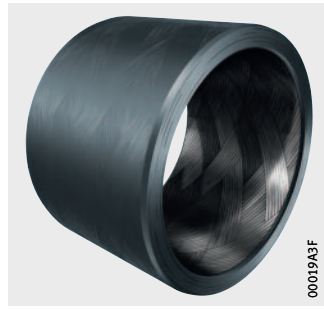
Product overview ELGOTEX® filament wound bushes, maintenance-free

Bushes

Open design

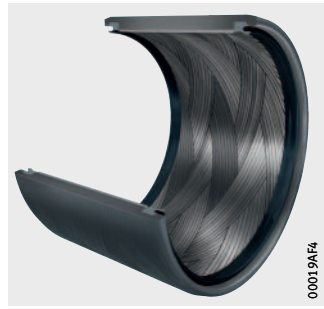
ZWB



With lip seals

Available by agreement

ZWB..-2RS



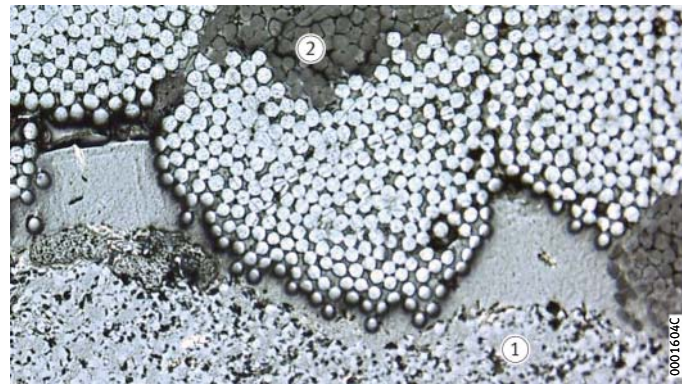
ELGOTEX® filament wound bushes, maintenance-free

Features

The radial dry plain bearings have a sliding layer made from ELGOTEX® and a twin layer structure, *Figure 1*:

- The outer layer (the backing) ensures the strength of the bush. It comprises continuous glass fibres that are additionally stabilised by means of a specific winding angle, giving an increase in strength. The fibres are bound in epoxy resin.
- The inner layer (sliding layer), contains a polymer/PTFE yarn that is embedded together with fillers and solid lubricants in a resin matrix.

Due to the combination of filaments and resin matrix, the bushes are suited in preference for dry-running applications, see table, page 8.



① Backing
② Sliding layer

Figure 1
Microsection
of an ELGOTEX® filament wound bush

Resistance of the plain bearing material

The filament wound bushes are non-metallic and thus substantially resistant to media. For use in water, we recommend the sliding material ELGOTEX®-WA, see page 32.

For special environmental conditions, please consult the Schaeffler engineering service.

ELGOTEX® filament wound bushes, maintenance-free

Technical data for ELGOTEX®

Maintenance-free ELGOTEX® filament wound bushes have the following mechanical and physical characteristics, see table.

ELGOTEX® filament wound bushes are intended for dry running. They achieve their maximum operating life under these conditions.

Slight settling of the material occurs during running-in.

In underwater use, there is a considerable reduction in the rating life. In this case, the coefficient of friction may increase significantly.

In the production of ELGOTEX® filament wound bushes, defects (pores) and fraying may occur in the PTFE due to the production process. These cannot be prevented by technological measures and do not represent any impairment of the function.

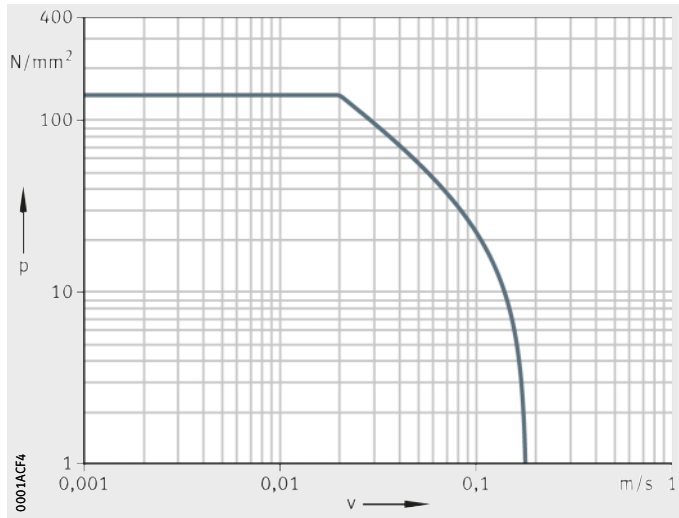
Characteristics of ELGOTEX®

Characteristic			
Maximum pv value[1]		pv	2,8 N/mm² · m/s
Permissible specific bearing load[2]	Static	p_{max}	200 N/mm²
	Rotary, oscillating		140 N/mm²
Permissible sliding velocity		v	0,18 m/s
Permissible operating temperature		ϑ	–20 °C to +130 °C
Coefficient of friction		μ	0,03 to 0,2
Operating life behaviour with:			
Dry running			+++
Grease and oil lubrication			+
Media lubrication, water lubrication			+

Definition of the symbols:
+++ Very good
+ Adequate

[1] The maximum permissible bearing load as function of velocity is determined by means of pv diagrams, *Figure 2*, page 9.

[2] For static loads of more than 180 N/mm², the design of ELGOTEX® filament wound bushes must be checked by the Schaeffler engineering service. For loads at or over this range, we alternatively recommend the use of ELGOGLIDE® plain bushes, see page 2.



p = specific bearing load
v = sliding velocity

Figure 2
pv diagram

Availability

Available designs: see dimension tables. The main dimensions are based on DIN ISO 4379.

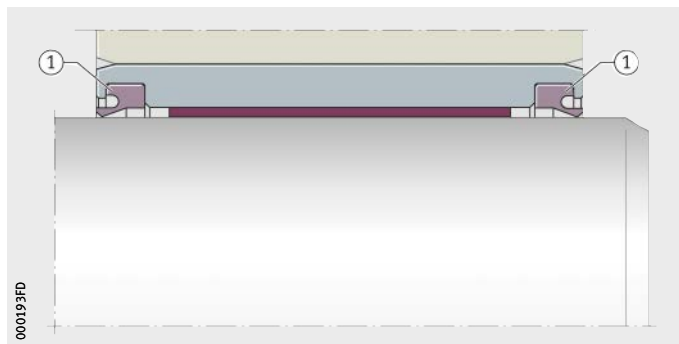
ELGOTEX® filament wound bushes with special dimensions up to an outside diameter D_o = 1 200 mm, special tolerance classes or in the form of segment bearings are possible and may be available by agreement from Schaeffler.

Sealing

Standard plain bushes without a suffix are not sealed. These can, however, be combined with separate external seals in order to prevent the ingress of contamination and moisture, see page 24.

Integrated seals RS or 2RS

ELGOTEX® filament wound bushes are available by agreement on one side with lip seals RS or on both sides with lip seals 2RS, *Figure 3*. The sealing rings used are made from NBR and are designed for temperature ranges from –30 °C to +100 °C. For short periods, temperatures up to a maximum of +130 °C are permissible.



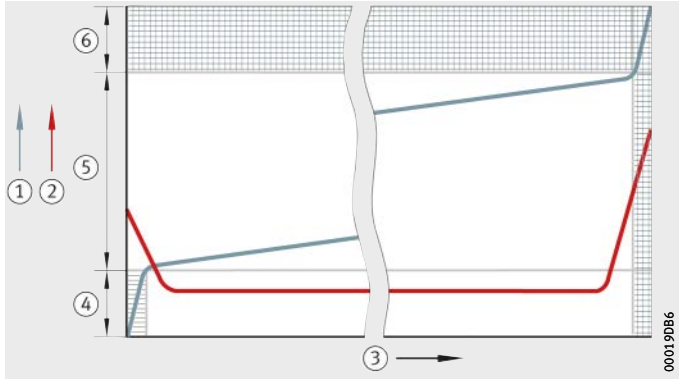
① Seal 2RS

Figure 3
Integrated seals
for plain bushes with ELGOTEX®

Friction and wear curve

The wear curve for maintenance-free plain bearings is divided into the running-in phase, main wear phase and failure phase, *Figure 4*. The main wear phase is approximately linear in character.

The friction curve of maintenance-free plain bearings shows a characteristic pattern in the three phases, *Figure 4*.



① Wear
② Friction
③ Rating life
④ Running-in phase
⑤ Main wear phase
⑥ Failure phase

Figure 4
Friction and wear curve

Lubrication

During the running-in phase, PTFE particles are transferred from the sliding layer to the mating surface.
As a result, the small roughness features of the shaft surface are filled in. It is only once this tribologically smooth surface is produced in conjunction with the detached PTFE particles that the bearings can achieve a long operating life.

Maintenance-free ELGOTEX® filament wound bushes do not have relubrication facilities and must not be lubricated.

Any lubrication of maintenance-free ELGOTEX® filament wound bushes after running-in will impair the smoothing effect necessary and will considerably reduce the operating life of the bearings.

Design and safety guidelines

Do not use plain bearings for movement involving spatial alignment. Skewing of the shaft gives a considerable reduction in the operating life of the bushes.

Influences on the rating life

Calculation of the basic rating life applies to plain bearings that perform rotary, swivel or linear motion.

The significant factors for a long rating life are the pv value and the design of the mating surface.

The ambient temperature, heat dissipation via the shaft, bearing and housing as well as the operating duration have a fundamental influence on the operating temperature and thus on the rating life.

Extraordinary factors

The following parameters are not taken into consideration in rating life calculation and may in certain circumstances have a very considerable influence on the operating life:

- corrosion of the adjacent construction
- contamination
- humidity
- vibrations
- shocks.

Rating life calculation is valid for dry running. A detailed description of rating life calculation is given in Catalogue HG 1, Plain Bearings.

Operating life

The operating life is the life actually achieved by a plain bearing. It may deviate from the calculated basic rating life.

ELGOTEX® filament wound bushes, maintenance-free

Basic rating life

Due to the large number of influences, the calculated basic rating life is a guide value. Under very low bearing loads or very low sliding velocities, this can therefore lead to unrealistic values.

Calculation of the rating life is only advisable within the permissible loads for plain bearing materials, see table.

Scope of validity of rating life calculation

Sliding layer	pv value[1]		Specific load[2]			Sliding velocity	Temperature	
	p		p			v	ϑ	
	N/mm² · m/s		N/mm²			m/s	°C	
	from	to	min.	max.		max.	from	to
				Constant	Variable			
ELGOTEX®	0,005	2,8	1	140	140	0,18	–20	+130

[1] The maximum permissible bearing load as function of velocity is determined by means of pv diagrams, *Figure 2*, page 9.

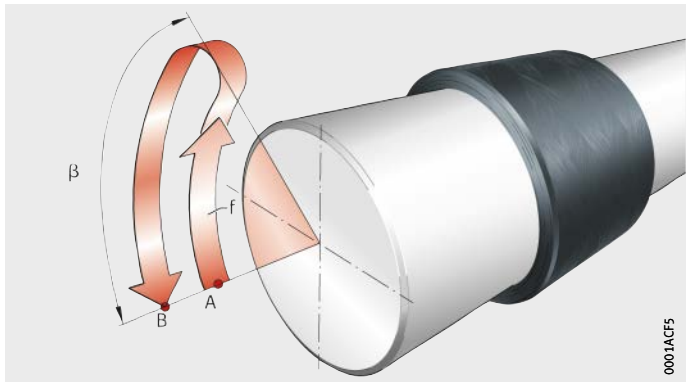
[2] In the case of values lower than 1 N/mm², calculation of the basic rating life must be carried out using the value p = 1 N/mm².

Calculation of the basic rating life

The basic rating life is calculated using the equations and diagrams presented and this is valid only for ELGOTEX® filament wound bushes.

Before calculating the rating life, the permissible loads must always be checked, see table.

The calculation method used for ELGOTEX® filament wound bushes cannot be carried over to other plain bearings. For calculation of other plain bearings from Schaeffler, see Catalogue HG 1, Plain Bearings.



β = swivel angle
A = start point
B = end point
f = swivel frequency (number of motions from A to B per minute)

Figure 5
Swivel angle and swivel frequency

Rating life equation for ELGOTEX® filament wound bushes

Rotary and swivel motion:

$$L_h = \frac{7\,000}{pv} \cdot f_p \cdot f_{pv^*} \cdot f_\vartheta \cdot f_R \cdot f_W \cdot f_A \cdot f_B \cdot f_\beta$$

Linear motion:

$$L_h = \frac{7\,000}{pv} \cdot f_p \cdot f_{pv^*} \cdot f_\vartheta \cdot f_R \cdot f_W \cdot f_A \cdot f_L$$

Specific bearing load

Bush:

$$p = \frac{F_r}{D_i \cdot B}$$

Sliding velocity

Bush, rotary motion:

$$v = \frac{D_i \cdot \pi \cdot n}{60 \cdot 10^3}$$

Bush, swivel motion, *Figure 5*, page 12:

$$v = \frac{D_i \cdot \pi}{60 \cdot 10^3} \cdot \frac{2 \cdot \beta \cdot f}{360^\circ}$$

Symbols, units and definitions

p	N/mm^2	Specific bearing load
F_r	N	Radial bearing load
D_i	mm	Inside diameter of bush
B	mm	Width of bearing
v	m/s	Sliding velocity
n	min^{-1}	Operating speed
β	°	Swivel angle, *Figure 5*
f	min^{-1}	Swivel frequency, *Figure 5*, page 12.

Specific frictional energy pv

The specific bearing load p and the sliding velocity v are in a reciprocal relationship. The product p · v gives the specific frictional energy pv and is an important key value for a plain bearing.

$$pv = p \cdot v$$

pv — $N/mm^2 \cdot m/s$
Specific frictional energy
p — N/mm^2
Specific bearing load
v — m/s
Sliding velocity.

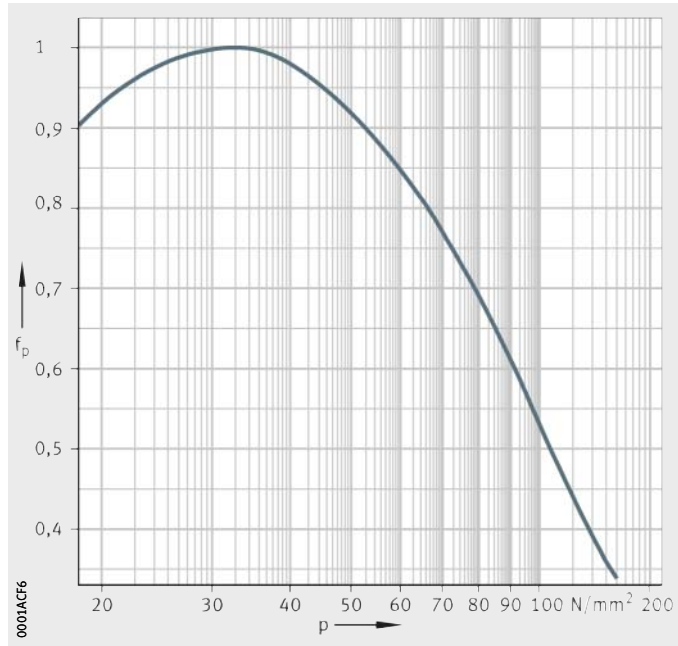
In the case of intermittent operation, the sliding velocity during one motion cycle must be used.

Correction factors

Calculation of the basic rating life requires numerous correction factors. These take account of influences due to the type of load, the specific bearing load, the material used, the sliding velocity, the temperature and the roughness depth of the mating surface. Linear motion is taken into consideration by means of a corresponding correction factor.

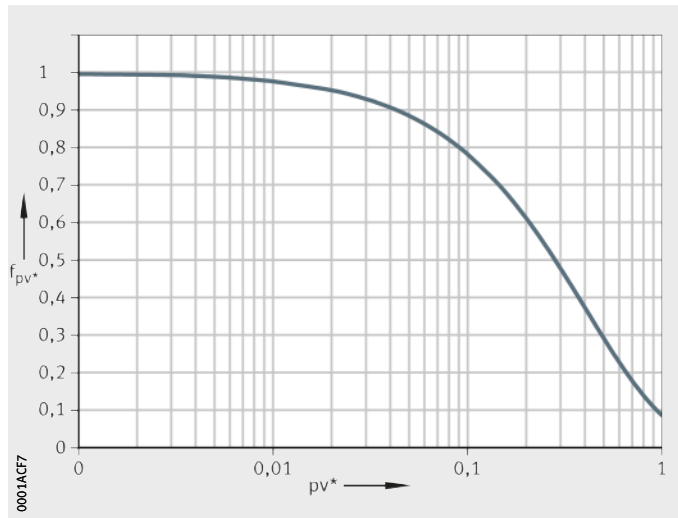
Symbols, units and definitions

L_h — h
Rating life of plain bearing
f_p — –
Correction factor for load, *Figure 6*, page 15
f_{pv*} — –
Correction factor for frictional energy for ELGOTEX®, *Figure 7*, page 15
f_ϑ — –
Correction factor for temperature, *Figure 8*, page 16
f_R — –
Correction factor for roughness depth, *Figure 9*, page 16
f_W — –
Correction factor for material, see table, page 17
f_A — –
Correction factor for condition of rotation, see page 17
f_B — –
Correction factor for width ratio, *Figure 11*, page 18
f_L — –
Correction factor for linear motion, see page 19
f_β — –
Correction factor for swivel and oscillation angle, *Figure 12*, page 18.



f_p = correction factor
p = specific bearing load, see page 13

Figure 6
Correction factor
for load, maintenance-free



f_{pv*} = correction factor
pv* = relative specific frictional energy,
see equation, page 16

Figure 7
Correction factor
for frictional energy

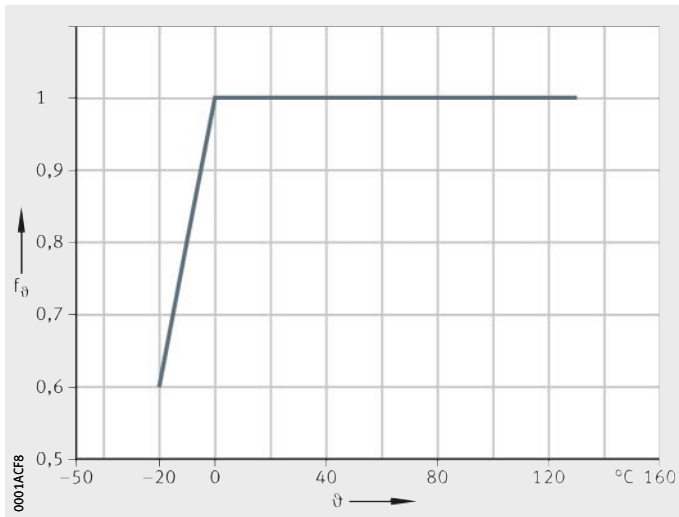
Relative specific frictional energy pv*

ELGOTEX®:

$$pv^* = v \cdot \left(60 + p^{1,25}\right) \cdot \frac{1}{10,8}$$

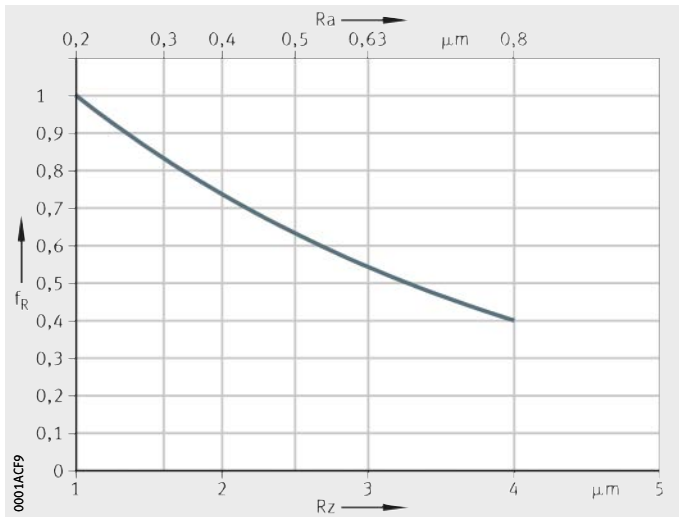
pv* –
Relative specific frictional energy
p N/mm²
Specific load, for calculation see page 13
v m/s
Sliding velocity, for calculation see page 13.

An increasing pv or pv* value necessitates an increased level of heat dissipation. This must be ensured by means of the adjacent construction.



f_ϑ = correction factor
ϑ = temperature

Figure 8
Correction factor for temperature in maintenance-free bearings



f_R = correction factor
Rz, Ra = roughness depth

Figure 9
Correction factor for roughness depth

Correction factor f_W

If the following materials are used, a long rating life can be achieved, see table:

Mating surface material[1]	Layer thickness mm	Correction factor f_W
Steel[2]		
Nitrided	–	1
Corrosion-resistant	–	1
Hard chromium coating	≧ 0,013	1

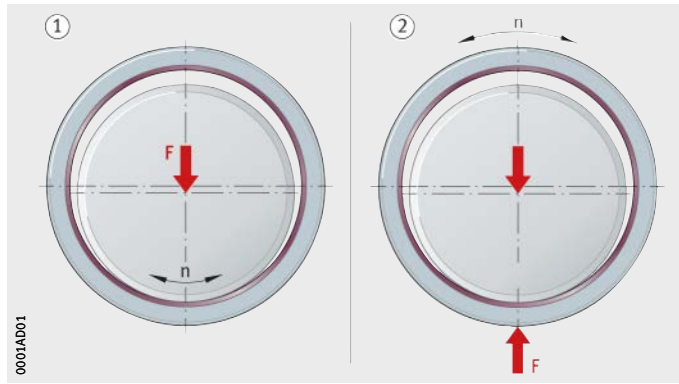
1) If materials other than those stated here are used for the shaft, this may have a deleterious effect on the rating life. Please contact us in this case.

2) For increased loads, the hardness of the steel when using ELGOTEX® should be at least 55 HRC.

Condition of rotation f_A

The correction factor f_A is dependent on the type of load, *Figure 10*:

- point load $f_A = 1$ (rotating shaft, stationary bush)
- circumferential load $f_A = 2$ (stationary shaft, rotating bush)
- linear motion $f_A = 1$.



F = load
n = speed

① Point load $f_A = 1$
② Circumferential load $f_A = 2$

Figure 10
Correction factor
for condition of rotation

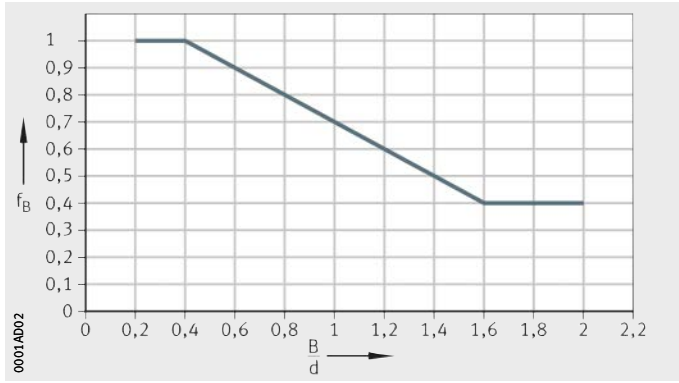
ELGOTEX® filament wound bushes, maintenance-free

Width ratio f_B and swivel angle f_β

In the case of maintenance-free plain bushes, the width ratio and the swivel angle are taken into consideration in rating life calculation, *Figure 11* and *Figure 12*.

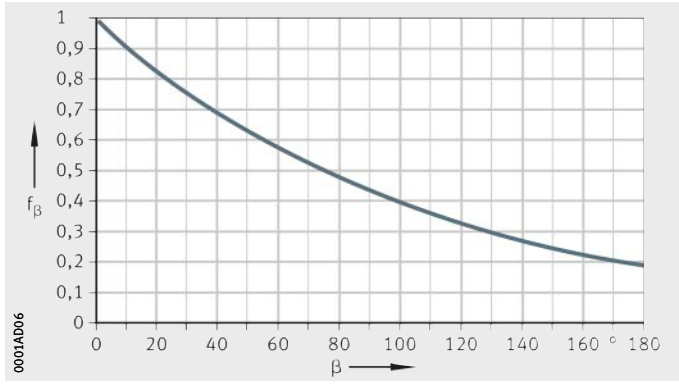
In the case of swivel angles ≧ 180° or rotation, the following applies:

- $f_\beta = 0{,}2$ for ELGOTEX®.



f_B = correction factor
B = width of bearing
d = inside diameter of bearing

Figure 11
Correction factor
for width ratio



f_β = correction factor
β = swivel angle, *Figure 5*, page 12

Figure 12
Correction factor
for swivel and oscillation angle

Linear motion f_L

The correction factor f_L is only necessary for linear motion, *Figure 13*.

In the case of linear motion, the stroke length should not exceed $H_{max} = 2,5 \cdot B$, *Figure 14*.

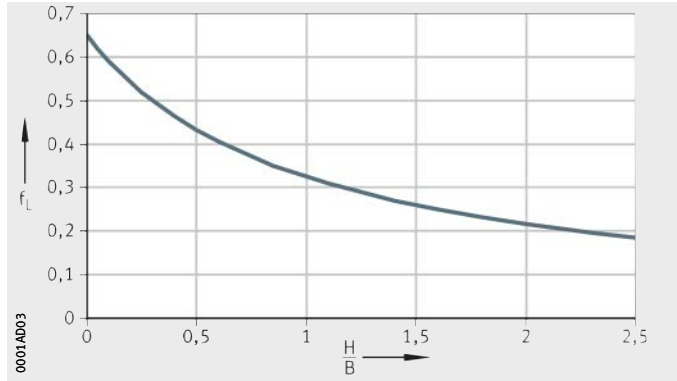
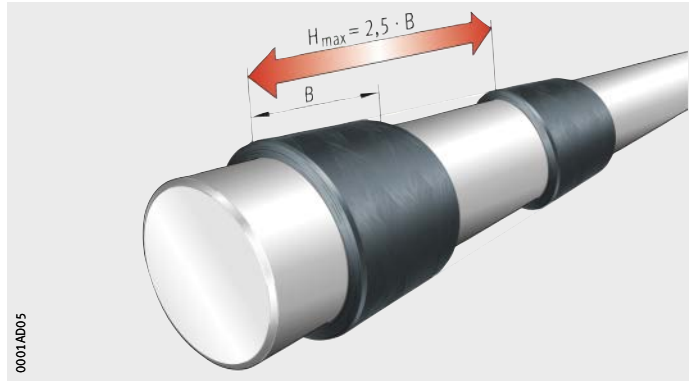


Figure 13
Correction factor for linear motion



H_{max} = maximum stroke length
B = width of bush

Figure 14
Maximum stroke length in linear motion

Calculation example for bush ZWB607060

The rating life of the bush is calculated on the basis of the sliding layer ELGOTEX®, see section Basic rating life, page 12.

Given data

The given data for calculation of the rating life are as follows:

- highly loaded pivots on an angled lever
- steel shaft (hard chromium coating, roughness depth 1,6)
- point load (rotating shaft, stationary bush).

Operating parameters

Bearing load	F_r	= 120 000 N
Swivel angle	β	= 30°
Swivel frequency	f	= 6 min^{-1}
Operating temperature	ϑ_{min}	= 0 °C
	ϑ_{max}	= +30 °C

Bearing data

ELGOTEX® bush		= ZWB607060
Basic dynamic load rating	C_r	= 504 000 N
Inside diameter	D_i	= 60 mm
Width of bush	B	= 60 mm
Sliding material		ELGOTEX®

Required

Bearing with the required rating life $L_h \geqq 15\,000$ h.

Checking of permissible loads

The validity of the permissible loads and sliding velocities must be checked, since useful rating life calculation is only possible within this range, see table, page 12.

Specific bearing load

The specific bearing load must be calculated and checked for validity, see table, page 12:

$$p = \frac{F_r}{D_i \cdot B}$$

$$p = \frac{120\,000}{60 \cdot 60} = 33{,}33\ N/mm^2$$

Sliding velocity in swivel motion

The sliding velocity must be calculated with the aid of the inside diameter D_i and the swivel angle β and checked for validity, see table, page 13, and table, page 12:

$$v = \frac{D_i \cdot \pi}{60 \cdot 10^3} \cdot \frac{2 \cdot \beta \cdot f}{360°}$$

$$v = \frac{60 \cdot \pi \cdot 2 \cdot 30° \cdot 6}{60 \cdot 10^3 \cdot 360°} = 3{,}1 \cdot 10^{-3}\ m/s$$

Specific frictional energy pv

The specific frictional energy pv must be checked for validity, see table, page 12.

$$pv = 33{,}33 \cdot 3{,}1 \cdot 10^{-3} = 0{,}10\ N/mm^2 \cdot m/s$$

Calculation of rating life

The values for the correction factors must be taken from the diagrams, see table and page 14.

Correction factors

Correction factor	Source	Value
Load f_p	*Figure 6*, page 15	0,99
Frictional energy f_{pv*} $pv^* = v \cdot \left(60 + p^{1,25}\right) \cdot \frac{1}{10,8}$ $pv^* = 3{,}1 \cdot 10^{-3} \cdot \left(60 + 33{,}33^{1,25}\right) \cdot \frac{1}{10,8} = 0{,}040$	Page 15	0,9
Temperature f_ϑ	*Figure 8*, page 16	1
Roughness depth f_R	*Figure 9*, page 16	0,82
Material f_W	Table, page 17	1
Condition of rotation f_A	Table, page 17	1
Width ratio f_B B/d = 1	*Figure 11*, page 18	0,7
Swivel angle f_β	*Figure 12*, page 18	0,75

Rating life L_h

The rating life is calculated as follows:

$$L_h = \frac{7\,000}{pv} \cdot f_p \cdot f_{pv*} \cdot f_\vartheta \cdot f_R \cdot f_W \cdot f_A \cdot f_B \cdot f_\beta$$

$$L_h = \frac{7\,000}{0{,}10} \cdot 0{,}99 \cdot 0{,}9 \cdot 1 \cdot 0{,}82 \cdot 1 \cdot 1 \cdot 0{,}7 \cdot 0{,}75 = 26\,850\ h$$

Result

The selected ELGOTEX® plain bush ZWB607060 fulfils the required rating life $L_h \geqq 15\,000$ h.

Design of bearing arrangements

The guidelines on the design of bearing arrangements as well as mounting and dismounting must be observed.

Adjacent construction

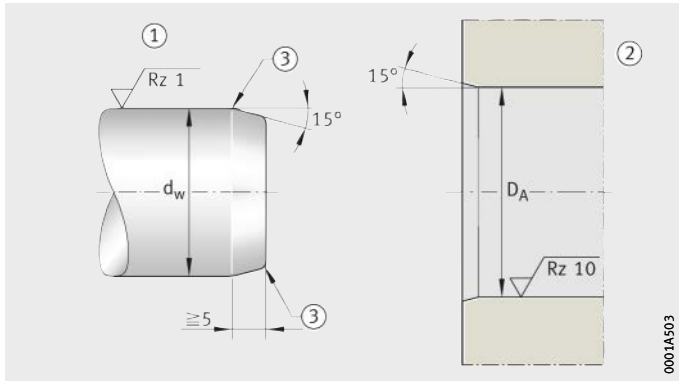
The shaft and housing bore should be produced as specified *Figure 15*. For the shaft, a roughness Rz 1 is recommended. Higher roughness values will reduce the operating life of plain bushes. A roughness higher than Rz 4 must be avoided.

For optimum conditions, the shaft should be hardened. For increased loads, the hardness of the steel should be at least 55 HRC. Lower hardness values may reduce the rating life.

If the full volume of the sliding layer is to be used, the raceway on the shaft must be hard, smooth and resistant to corrosion.

Mounting tolerances

Adjacent component	Sliding layer ELGOTEX®
Shaft	h7
Housing bore	H7



d_w, D_A = recommended mounting tolerances, see table

① Shaft
② Housing bore
③ Rounded

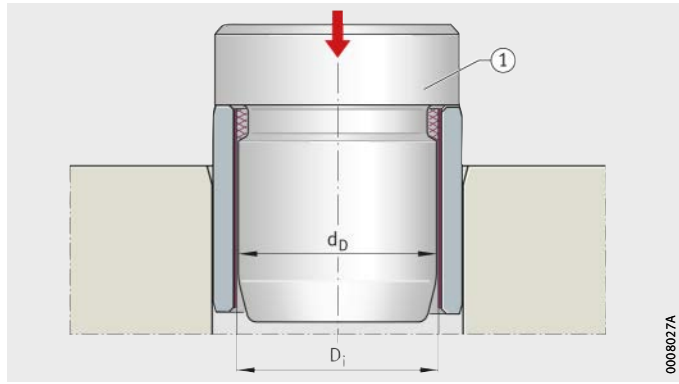
Figure 15
Design of adjacent components

Mounting

Plain bushes should be pressed in using a fitting mandrel, *Figure 16*.

The chamfer on the mandrel must have rounded transitions or rounding of the end.

Sharp transitions on the entry side of the shaft and mandrel will damage the sliding layer during mounting and reduce the operating life of the plain bearings.



① Fitting mandrel
$d_D = D_i$ – 0,3 mm to 0,5 mm

Figure 16
Mounting using a fitting mandrel

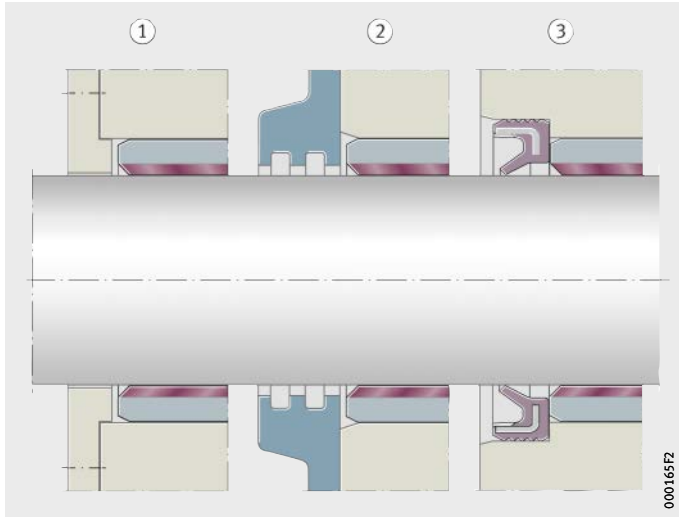
Seals in the adjacent construction

Possibilities for sealing the bearing position in the adjacent construction are as follows, *Figure 17*:

- a modified adjacent construction
- gap seals
- rotary shaft seals.

The suitability of the sealing arrangement must be agreed in consultation with the seal manufacturer.

If the seal is designed with additional outer seals, it must be borne in mind that the bearing clearance will increase due to the wear of the sliding layer. Plain bushes with ELGOTEX® are not lubricated. Grease must be prevented from leaving a seal and coming into contact with these sliding layers.



① Protection by adjacent construction
② Gap seal
③ Shaft seal

Figure 17
Seals for protection of the bearing position

Theoretical bearing clearance of ELGOTEX® filament wound bushes

The bushes are pressed as standard into a housing with the tolerance H7. This provides radial and axial location.
Due to the contraction of the inside diameter, there is a change in the tolerance of the inside diameter of the bush after pressing in, see table, page 26.

Expansion of the housing bore is not taken into consideration in calculation of the bearing clearance.

Depending on the selected shaft fit, there is a theoretical bearing clearance, see equations:

$$\Delta s_{max} = D_{i\,max} - d_{W\,min}$$

$$\Delta s_{min} = D_{i\,min} - d_{W\,max}$$

Δs_{max} mm
Maximum bearing clearance

Δs_{min} mm
Minimum bearing clearance

$D_{i\,max}$ mm
Maximum inside diameter of bush after pressing in, see table, page 26

$D_{i\,min}$ mm
Minimum inside diameter of bush after pressing in, see table, page 26

$d_{W\,min}$ mm
Minimum shaft diameter

$d_{W\,max}$ mm
Maximum shaft diameter.

ELGOTEX® filament wound bushes, maintenance-free

Theoretical bearing clearance after pressing-in

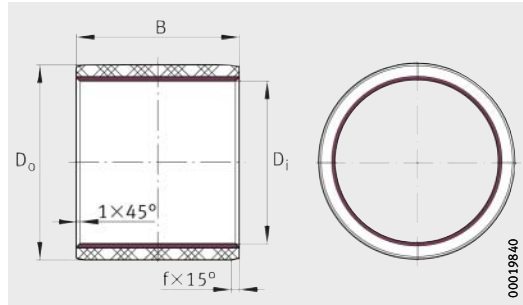
For a housing tolerance H7 and the recommended shaft tolerance h7, the minimum and maximum theoretical clearances for the standard dimensions are stated, see table. The data do not take account of any possible expansion of the housing bore.

Theoretical bearing clearance for metric sizes

Diameter of bush		Inside diameter after pressing-in		Bearing clearance for tolerance H7/h7	
D_i	D_o	$D_{i\,min}$	$D_{i\,max}$	Δs_{min}	Δs_{max}
mm	mm	mm	mm	mm	mm
20	24	20,042	20,18	0,042	0,201
25	30	25,042	25,18	0,042	0,201
28	34	28,028	28,176	0,028	0,197
30	36	30,028	30,176	0,028	0,197
35	41	35,038	35,202	0,038	0,227
40	48	40,038	40,202	0,038	0,227
45	53	45,031	45,207	0,031	0,232
50	58	50,031	50,207	0,031	0,232
55	63	55,041	55,237	0,041	0,267
60	70	60,035	60,231	0,035	0,261
65	75	65,035	65,231	0,035	0,261
70	80	70,045	70,241	0,045	0,271
75	85	75,025	75,234	0,025	0,264
80	90	80,025	80,234	0,025	0,264
85	95	85,045	85,274	0,045	0,309
90	105	90,037	90,266	0,037	0,301
95	110	95,037	95,266	0,037	0,301
100	115	100,037	100,266	0,037	0,301
105	120	105,047	105,276	0,047	0,311
110	125	110,025	110,268	0,025	0,303
120	135	120,025	120,268	0,025	0,303
130	145	130,037	130,3	0,037	0,34
140	155	140,037	140,3	0,037	0,34
150	165	150,039	150,302	0,039	0,342
160	180	160,039	160,302	0,039	0,342
170	190	170,036	170,314	0,036	0,354
180	200	180,036	180,314	0,036	0,354
190	210	190,038	190,341	0,038	0,387
200	220	200,038	200,341	0,038	0,387

ELGOTEX® filament wound bushes

Maintenance-free
DIN ISO 4379[1)]



ZWB

Dimension table · Dimensions in mm

Designation	Mass	Dimensions				Basic load ratings	
	m	D_i	D_o	B	f	dyn. C_r	stat. C_{0r}[2)]
	≈g	C10	s8	h13		N	N
ZWB202415	4	$\mathbf{20}^{+0,194}_{+0,11}$	$24^{+0,068}_{+0,035}$	$15_{-0,27}$	1,5±0,5	42 000	60 000
ZWB202420	5	$\mathbf{20}^{+0,194}_{+0,11}$	$24^{+0,068}_{+0,035}$	$20_{-0,33}$	1,5±0,5	56 000	80 000
ZWB202430	7	$\mathbf{20}^{+0,194}_{+0,11}$	$24^{+0,068}_{+0,035}$	$30_{-0,33}$	1,5±0,5	84 000	120 000
ZWB253020	8	$\mathbf{25}^{+0,194}_{+0,11}$	$30^{+0,068}_{+0,035}$	$20_{-0,33}$	1,5±0,5	70 000	100 000
ZWB253030	12	$\mathbf{25}^{+0,194}_{+0,11}$	$30^{+0,068}_{+0,035}$	$30_{-0,33}$	1,5±0,5	105 000	150 000
ZWB253040	16	$\mathbf{25}^{+0,194}_{+0,11}$	$30^{+0,068}_{+0,035}$	$40_{-0,39}$	1,5±0,5	140 000	200 000
ZWB283420	11	$\mathbf{28}^{+0,194}_{+0,11}$	$34^{+0,082}_{+0,043}$	$20_{-0,33}$	1,5±0,5	78 400	112 000
ZWB283430	16	$\mathbf{28}^{+0,194}_{+0,11}$	$34^{+0,082}_{+0,043}$	$30_{-0,33}$	1,5±0,5	118 000	168 000
ZWB283440	21	$\mathbf{28}^{+0,194}_{+0,11}$	$34^{+0,082}_{+0,043}$	$40_{-0,39}$	1,5±0,5	157 000	224 000
ZWB303620	11	$\mathbf{30}^{+0,194}_{+0,11}$	$36^{+0,082}_{+0,043}$	$20_{-0,33}$	1,5±0,5	84 000	120 000
ZWB303630	17	$\mathbf{30}^{+0,194}_{+0,11}$	$36^{+0,082}_{+0,043}$	$30_{-0,33}$	1,5±0,5	126 000	180 000
ZWB303640	22	$\mathbf{30}^{+0,194}_{+0,11}$	$36^{+0,082}_{+0,043}$	$40_{-0,39}$	1,5±0,5	168 000	240 000
ZWB354130	19	$\mathbf{35}^{+0,22}_{+0,12}$	$41^{+0,082}_{+0,043}$	$30_{-0,33}$	1,5±0,5	147 000	210 000
ZWB354140	26	$\mathbf{35}^{+0,22}_{+0,12}$	$41^{+0,082}_{+0,043}$	$40_{-0,39}$	1,5±0,5	196 000	280 000
ZWB354150	32	$\mathbf{35}^{+0,22}_{+0,12}$	$41^{+0,082}_{+0,043}$	$50_{-0,39}$	1,5±0,5	245 000	350 000
ZWB404830	30	$\mathbf{40}^{+0,22}_{+0,12}$	$48^{+0,082}_{+0,043}$	$30_{-0,33}$	2 ±0,7	168 000	240 000
ZWB404840	40	$\mathbf{40}^{+0,22}_{+0,12}$	$48^{+0,082}_{+0,043}$	$40_{-0,39}$	2 ±0,7	224 000	320 000
ZWB404860	60	$\mathbf{40}^{+0,22}_{+0,12}$	$48^{+0,082}_{+0,043}$	$60_{-0,46}$	2 ±0,7	336 000	480 000
ZWB455330	33	$\mathbf{45}^{+0,23}_{+0,13}$	$53^{+0,099}_{+0,053}$	$30_{-0,33}$	2 ±0,7	189 000	270 000
ZWB455340	44	$\mathbf{45}^{+0,23}_{+0,13}$	$53^{+0,099}_{+0,053}$	$40_{-0,39}$	2 ±0,7	252 000	360 000
ZWB455360	66	$\mathbf{45}^{+0,23}_{+0,13}$	$53^{+0,099}_{+0,053}$	$60_{-0,46}$	2 ±0,7	378 000	540 000
ZWB505840	49	$\mathbf{50}^{+0,23}_{+0,13}$	$58^{+0,099}_{+0,053}$	$40_{-0,39}$	2 ±0,7	280 000	400 000
ZWB505850	61	$\mathbf{50}^{+0,23}_{+0,13}$	$58^{+0,099}_{+0,053}$	$50_{-0,39}$	2 ±0,7	350 000	500 000
ZWB505860	73	$\mathbf{50}^{+0,23}_{+0,13}$	$58^{+0,099}_{+0,053}$	$60_{-0,46}$	2 ±0,7	420 000	600 000

Recommended mounting tolerances, see page 25.

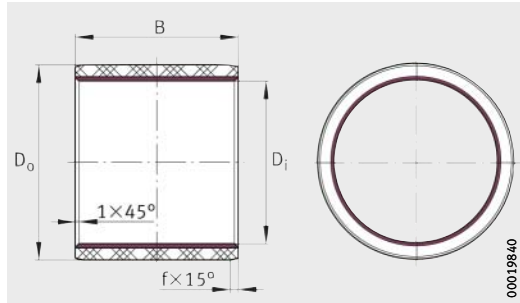
Filament wound bushes with special dimensions up to an outside diameter of 1 200 mm, special tolerances and seals are available by agreement.

1) Reference only to the nominal value of dimensions D_i, D_o and B.

2) For static loads of more than 180 N/mm², the design of ELGOTEX® filament wound bushes must be checked by the Schaeffler engineering service.
For loads at or over this range, we alternatively recommend the use of ELGOGLIDE® plain bushes, see page 2.

ELGOTEX® filament wound bushes

Maintenance-free
DIN ISO 4379[1)]



ZWB

Dimension table (continued) · Dimensions in mm

Designation	Mass	Dimensions				Basic load ratings	
	m	D_i	D_o	B	f	dyn. C_r	stat. C_{0r}[2)]
	≈g	C10	s8	h13		N	N
ZWB556340	53	$\mathbf{55}^{+0,26}_{+0,14}$	$63^{+0,099}_{+0,053}$	$40_{-0,39}$	2±0,7	308 000	440 000
ZWB556350	67	$\mathbf{55}^{+0,26}_{+0,14}$	$63^{+0,099}_{+0,053}$	$50_{-0,39}$	2±0,7	385 000	550 000
ZWB556370	93	$\mathbf{55}^{+0,26}_{+0,14}$	$63^{+0,099}_{+0,053}$	$70_{-0,46}$	2±0,7	539 000	770 000
ZWB607040	74	$\mathbf{60}^{+0,26}_{+0,14}$	$70^{+0,105}_{+0,059}$	$40_{-0,39}$	2±0,7	336 000	480 000
ZWB607060	110	$\mathbf{60}^{+0,26}_{+0,14}$	$70^{+0,105}_{+0,059}$	$60_{-0,46}$	2±0,7	504 000	720 000
ZWB607080	147	$\mathbf{60}^{+0,26}_{+0,14}$	$70^{+0,105}_{+0,059}$	$80_{-0,46}$	2±0,7	672 000	960 000
ZWB657550	99	$\mathbf{65}^{+0,26}_{+0,14}$	$75^{+0,105}_{+0,059}$	$50_{-0,39}$	2±0,7	455 000	650 000
ZWB657560	119	$\mathbf{65}^{+0,26}_{+0,14}$	$75^{+0,105}_{+0,059}$	$60_{-0,46}$	2±0,7	546 000	780 000
ZWB657580	158	$\mathbf{65}^{+0,26}_{+0,14}$	$75^{+0,105}_{+0,059}$	$80_{-0,46}$	2±0,7	728 000	1 040 000
ZWB708050	106	$\mathbf{70}^{+0,27}_{+0,15}$	$80^{+0,105}_{+0,059}$	$50_{-0,39}$	3±1	490 000	700 000
ZWB708070	148	$\mathbf{70}^{+0,27}_{+0,15}$	$80^{+0,105}_{+0,059}$	$70_{-0,46}$	3±1	686 000	980 000
ZWB708090	191	$\mathbf{70}^{+0,27}_{+0,15}$	$80^{+0,105}_{+0,059}$	$90_{-0,54}$	3±1	882 000	1 260 000
ZWB758550	113	$\mathbf{75}^{+0,27}_{+0,15}$	$85^{+0,125}_{+0,071}$	$50_{-0,39}$	3±1	525 000	750 000
ZWB758570	158	$\mathbf{75}^{+0,27}_{+0,15}$	$85^{+0,125}_{+0,071}$	$70_{-0,46}$	3±1	735 000	1 050 000
ZWB758590	204	$\mathbf{75}^{+0,27}_{+0,15}$	$85^{+0,125}_{+0,071}$	$90_{-0,54}$	3±1	945 000	1 350 000
ZWB809060	144	$\mathbf{80}^{+0,27}_{+0,15}$	$90^{+0,125}_{+0,071}$	$60_{-0,46}$	3±1	672 000	960 000
ZWB809080	192	$\mathbf{80}^{+0,27}_{+0,15}$	$90^{+0,125}_{+0,071}$	$80_{-0,46}$	3±1	896 000	1 280 000
ZWB8090100	240	$\mathbf{80}^{+0,27}_{+0,15}$	$90^{+0,125}_{+0,071}$	$100_{-0,54}$	3±1	1 120 000	1 600 000
ZWB859560	153	$\mathbf{85}^{+0,31}_{+0,17}$	$95^{+0,125}_{+0,071}$	$60_{-0,46}$	3±1	714 000	1 020 000
ZWB859580	204	$\mathbf{85}^{+0,31}_{+0,17}$	$95^{+0,125}_{+0,071}$	$80_{-0,46}$	3±1	952 000	1 360 000
ZWB8595100	254	$\mathbf{85}^{+0,31}_{+0,17}$	$95^{+0,125}_{+0,071}$	$100_{-0,54}$	3±1	1 190 000	1 700 000

Recommended mounting tolerances, see page 25.

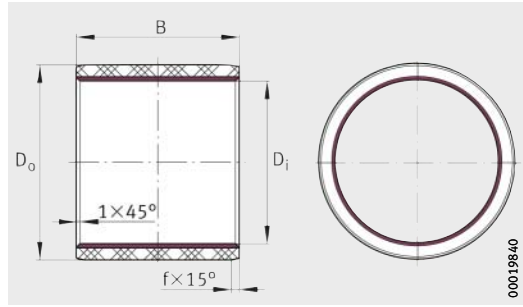
Filament wound bushes with special dimensions up to an outside diameter of 1 200 mm, special tolerances and seals are available by agreement.

1) Reference only to the nominal value of dimensions D_i, D_o and B.

2) For static loads of more than 180 N/mm², the design of ELGOTEX® filament wound bushes must be checked by the Schaeffler engineering service.
For loads at or over this range, we alternatively recommend the use of ELGOGLIDE® plain bushes, see page 2.

ELGOTEX® filament wound bushes

Maintenance-free
DIN ISO 4379[1)]



ZWB

Dimension table (continued) · Dimensions in mm

Designation	Mass	Dimensions				Basic load ratings	
	m	D_i	D_o	B	f	dyn. C_r	stat. C_{0r}[2)]
	≈g	C10	s8	h13		N	N
ZWB9010560	248	**90** $^{+0,31}_{+0,17}$	105 $^{+0,133}_{+0,079}$	60 $_{-0,46}$	3 ±1	756 000	1 080 000
ZWB9010580	331	**90** $^{+0,31}_{+0,17}$	105 $^{+0,133}_{+0,079}$	80 $_{-0,46}$	3 ±1	1 010 000	1 440 000
ZWB90105120	496	**90** $^{+0,31}_{+0,17}$	105 $^{+0,133}_{+0,079}$	120 $_{-0,54}$	3 ±1	1 510 000	2 160 000
ZWB9511060	261	**95** $^{+0,31}_{+0,17}$	110 $^{+0,133}_{+0,079}$	60 $_{-0,46}$	3 ±1	798 000	1 140 000
ZWB95110100	435	**95** $^{+0,31}_{+0,17}$	110 $^{+0,133}_{+0,079}$	100 $_{-0,54}$	3 ±1	1 330 000	1 900 000
ZWB95110120	522	**95** $^{+0,31}_{+0,17}$	110 $^{+0,133}_{+0,079}$	120 $_{-0,54}$	3 ±1	1 600 000	2 280 000
ZWB10011580	365	**100** $^{+0,31}_{+0,17}$	115 $^{+0,133}_{+0,079}$	80 $_{-0,46}$	3 ±1	1 120 000	1 600 000
ZWB100115100	456	**100** $^{+0,31}_{+0,17}$	115 $^{+0,133}_{+0,079}$	100 $_{-0,54}$	3 ±1	1 400 000	2 000 000
ZWB100115120	547	**100** $^{+0,31}_{+0,17}$	115 $^{+0,133}_{+0,079}$	120 $_{-0,54}$	3 ±1	1 680 000	2 400 000
ZWB10512080	382	**105** $^{+0,32}_{+0,18}$	120 $^{+0,133}_{+0,079}$	80 $_{-0,46}$	4 ±1	1 180 000	1 680 000
ZWB105120100	477	**105** $^{+0,32}_{+0,18}$	120 $^{+0,133}_{+0,079}$	100 $_{-0,54}$	4 ±1	1 470 000	2 100 000
ZWB105120120	573	**105** $^{+0,32}_{+0,18}$	120 $^{+0,133}_{+0,079}$	120 $_{-0,54}$	4 ±1	1 760 000	2 520 000
ZWB11012580	399	**110** $^{+0,32}_{+0,18}$	125 $^{+0,155}_{+0,092}$	80 $_{-0,46}$	4 ±1	1 230 000	1 760 000
ZWB110125100	498	**110** $^{+0,32}_{+0,18}$	125 $^{+0,155}_{+0,092}$	100 $_{-0,54}$	4 ±1	1 540 000	2 200 000
ZWB110125120	598	**110** $^{+0,32}_{+0,18}$	125 $^{+0,155}_{+0,092}$	120 $_{-0,54}$	4 ±1	1 850 000	2 640 000
ZWB120135100	541	**120** $^{+0,32}_{+0,18}$	135 $^{+0,155}_{+0,092}$	100 $_{-0,54}$	4 ±1	1 680 000	2 400 000
ZWB120135120	649	**120** $^{+0,32}_{+0,18}$	135 $^{+0,155}_{+0,092}$	120 $_{-0,54}$	4 ±1	2 020 000	2 880 000
ZWB120135150	811	**120** $^{+0,32}_{+0,18}$	135 $^{+0,155}_{+0,092}$	150 $_{-0,63}$	4 ±1	2 520 000	3 600 000
ZWB130145100	583	**130** $^{+0,36}_{+0,2}$	145 $^{+0,163}_{+0,1}$	100 $_{-0,54}$	4 ±1	1 820 000	2 600 000
ZWB130145120	700	**130** $^{+0,36}_{+0,2}$	145 $^{+0,163}_{+0,1}$	120 $_{-0,54}$	4 ±1	2 180 000	3 120 000
ZWB130145150	875	**130** $^{+0,36}_{+0,2}$	145 $^{+0,163}_{+0,1}$	150 $_{-0,63}$	4 ±1	2 730 000	3 900 000

Recommended mounting tolerances, see page 25.

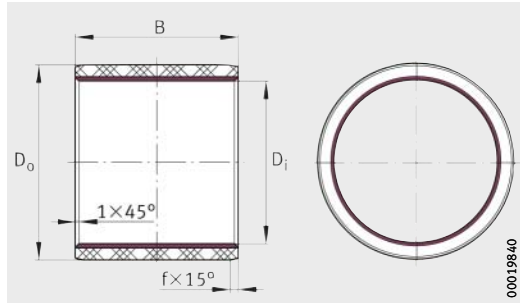
Filament wound bushes with special dimensions up to an outside diameter of 1 200 mm, special tolerances and seals are available by agreement.

1) Reference only to the nominal value of dimensions D_i, D_o and B.

2) For static loads of more than 180 N/mm², the design of ELGOTEX® filament wound bushes must be checked by the Schaeffler engineering service.
For loads at or over this range, we alternatively recommend the use of ELGOGLIDE® plain bushes, see page 2.

ELGOTEX® filament wound bushes

Maintenance-free
DIN ISO 4379[1)]



ZWB

Dimension table (continued) · Dimensions in mm

Designation	Mass	Dimensions				Basic load ratings	
	m	D_i	D_o	B	f	dyn. C_r	stat. C_{0r}[2)]
	≈g	C10	s8	h13		N	N
ZWB140155100	626	**140** $^{+0,36}_{+0,2}$	155 $^{+0,163}_{+0,1}$	100 $_{-0,54}$	4 ±1	1 960 000	2 800 000
ZWB140155150	938	**140** $^{+0,36}_{+0,2}$	155 $^{+0,163}_{+0,1}$	150 $_{-0,63}$	4 ±1	2 940 000	4 200 000
ZWB140155180	1 126	**140** $^{+0,36}_{+0,2}$	155 $^{+0,163}_{+0,1}$	180 $_{-0,63}$	4 ±1	3 530 000	5 040 000
ZWB150165120	802	**150** $^{+0,37}_{+0,21}$	165 $^{+0,171}_{+0,108}$	120 $_{-0,54}$	4 ±1	2 520 000	3 600 000
ZWB150165150	1 002	**150** $^{+0,37}_{+0,21}$	165 $^{+0,171}_{+0,108}$	150 $_{-0,63}$	4 ±1	3 150 000	4 500 000
ZWB150165180	1 202	**150** $^{+0,37}_{+0,21}$	165 $^{+0,171}_{+0,108}$	180 $_{-0,63}$	4 ±1	3 780 000	5 400 000
ZWB160180120	1 154	**160** $^{+0,37}_{+0,21}$	180 $^{+0,171}_{+0,108}$	120 $_{-0,54}$	4 ±1	2 690 000	3 840 000
ZWB160180150	1 442	**160** $^{+0,37}_{+0,21}$	180 $^{+0,171}_{+0,108}$	150 $_{-0,63}$	4 ±1	3 360 000	4 800 000
ZWB160180180	1 730	**160** $^{+0,37}_{+0,21}$	180 $^{+0,171}_{+0,108}$	180 $_{-0,63}$	4 ±1	4 030 000	5 760 000
ZWB170190120	1 221	**170** $^{+0,39}_{+0,23}$	190 $^{+0,194}_{+0,122}$	120 $_{-0,54}$	5 ±1	2 860 000	4 080 000
ZWB170190180	1 832	**170** $^{+0,39}_{+0,23}$	190 $^{+0,194}_{+0,122}$	180 $_{-0,63}$	5 ±1	4 280 000	6 120 000
ZWB170190200	2 036	**170** $^{+0,39}_{+0,23}$	190 $^{+0,194}_{+0,122}$	200 $_{-0,72}$	5 ±1	4 760 000	6 800 000
ZWB180200150	1 612	**180** $^{+0,39}_{+0,23}$	200 $^{+0,194}_{+0,122}$	150 $_{-0,63}$	5 ±1	3 780 000	5 400 000
ZWB180200180	1 934	**180** $^{+0,39}_{+0,23}$	200 $^{+0,194}_{+0,122}$	180 $_{-0,63}$	5 ±1	4 540 000	6 480 000
ZWB180200250	2 686	**180** $^{+0,39}_{+0,23}$	200 $^{+0,194}_{+0,122}$	250 $_{-0,72}$	5 ±1	6 300 000	9 000 000
ZWB190210150	1 696	**190** $^{+0,425}_{+0,24}$	210 $^{+0,202}_{+0,13}$	150 $_{-0,63}$	5 ±1	3 990 000	5 700 000
ZWB190210180	2 036	**190** $^{+0,425}_{+0,24}$	210 $^{+0,202}_{+0,13}$	180 $_{-0,63}$	5 ±1	4 790 000	6 840 000
ZWB190210250	2 827	**190** $^{+0,425}_{+0,24}$	210 $^{+0,202}_{+0,13}$	250 $_{-0,72}$	5 ±1	6 650 000	9 500 000
ZWB200220180	2 137	**200** $^{+0,425}_{+0,24}$	220 $^{+0,202}_{+0,13}$	180 $_{-0,63}$	5 ±1	5 040 000	7 200 000
ZWB200220200	2 375	**200** $^{+0,425}_{+0,24}$	220 $^{+0,202}_{+0,13}$	200 $_{-0,72}$	5 ±1	5 600 000	8 000 000
ZWB200220250	2 969	**200** $^{+0,425}_{+0,24}$	220 $^{+0,202}_{+0,13}$	250 $_{-0,72}$	5 ±1	7 000 000	10 000 000

Recommended mounting tolerances, see page 25.

Filament wound bushes with special dimensions up to an outside diameter of 1 200 mm, special tolerances and seals are available by agreement.

1) Reference only to the nominal value of dimensions D_i, D_o and B.

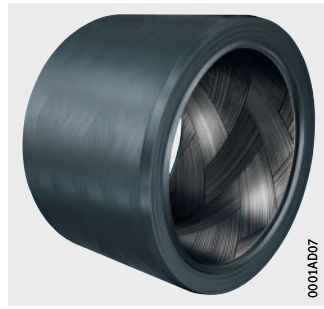
2) For static loads of more than 180 N/mm², the design of ELGOTEX® filament wound bushes must be checked by the Schaeffler engineering service.
For loads at or over this range, we alternatively recommend the use of ELGOGLIDE® plain bushes, see page 2.

ELGOTEX®-WA filament wound bushes, water-resistant

Bushes

Open design

ZWB..-WA

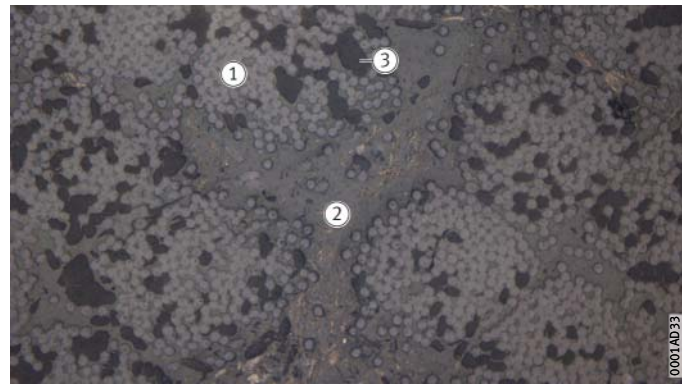


ELGOTEX®-WA filament wound bushes, water-resistant

Features

In contrast to the standard design of ELGOTEX®, ELGOTEX®-WA is specially developed for use in water as well as salt water and sea water. Shipbuilding is an important area of application. Furthermore, ELGOTEX®-WA is also highly suitable for use in marine engineering, hydromechanical steel structures and water power generation as well as in pumps and turbines.

The specific characteristic of ELGOTEX®-WA lies in the specific matching of fibre and matrix to the particular operating conditions. The inner sliding layer contains a polymer/PTFE sliding filament that is embedded together with fillers and solid lubricants in a resin matrix. This is hydrophobic and dimensionally stable. The backing, which is reinforced by means of glass fibre, ensures the necessary strength of the bush. The thickness of the sliding layer and backing layer is specifically designed in accordance with the requirements of the application and thus of the wear limit.



① Sliding filament
② Resin matrix
③ Fillers

Figure 1
Microsection of the sliding layer of an ELGOTEX®-WA filament wound bush

Availability

ELGOTEX®-WA filament wound bushes have the suffix WA.

ELGOTEX® filament wound bushes with special dimensions up to an outside diameter D_0 = 1 200 mm, special tolerance classes or in the form of segment bearings are possible and may be available by agreement from Schaeffler.

ELGOTEX®-WA filament wound bushes, water-resistant

Technical data for ELGOTEX®-WA

Maintenance-free ELGOTEX® filament wound bushes have the following mechanical and physical characteristics, see table.

Slight settling of the material occurs during running-in.

In the production of ELGOTEX®-WA filament wound bushes, defects (pores) and fraying may occur in the PTFE due to the production process. These cannot be prevented by technological measures and do not represent any impairment of the function.

For information on the rating life, please consult the Schaeffler engineering service.

Characteristics of ELGOTEX®-WA

Characteristic			
Maximum pv value[1]		pv	1,2 N/mm² · m/s
Permissible specific bearing load	Static	p_{max}	150 N/mm²
	Rotary, oscillating		50 N/mm²
Certified specific bearing load in accordance with MCM-0112			15 N/mm²
Permissible sliding velocity		v	0,024 m/s
Permissible operating temperature		ϑ	–20 °C to +130 °C
Coefficient of friction		μ	0,05 to 0,15
Operating life behaviour with:			
Dry running			+++
Grease and oil lubrication			+
Media lubrication, water lubrication			+++

Definition of the symbols:
+++ Very good
+ Adequate

[1] The maximum permissible bearing load as function of velocity is determined by means of pv diagrams, *Figure 2*.

p = specific bearing load
v = sliding velocity

Performance capability:
① Certified by GL in accordance with MCM-0112
② Proven in accordance with the requirements for certification to MCM-0112
③ Achievable performance capability

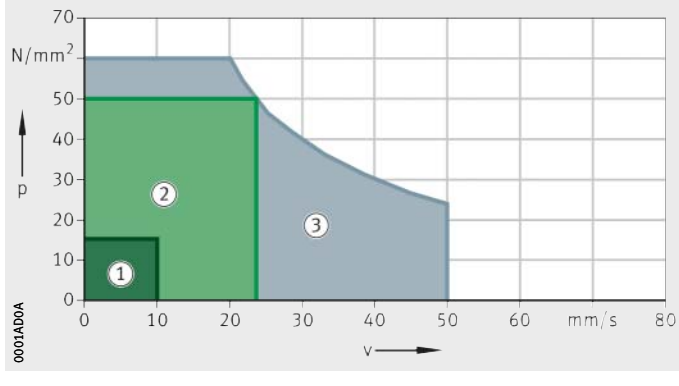


Figure 2
pv diagram

Certification

The rudder bearing is a safety-relevant component and must therefore be monitored by classification companies such as Lloyd, Lloyds Register, DNV or Germanischer Lloyd. For this reason, the bearing positions, the bearing itself and its design must be certified before mounting.

On the basis of a specification issued by Germanischer Lloyd, Schaeffler has completed a comprehensive programme of testing in this direction. This has fully demonstrated the functional capability of the plain bearings. For INA plain bearings with ELGOTEX®-WA, the performance capability in salt water has been certified in accordance with MCM-0112 from Germanischer Lloyd, *Figure 3* and *Figure 4*.

This approval is valid for:

- rudder carrier bearings
- shaft bearings
- pintle bearings
- bearings for stabilisers.

Schaeffler is the first manufacturer to receive approval from this classification company for a maximum specific bearing load on the plain bearing of 15 N/mm^2.

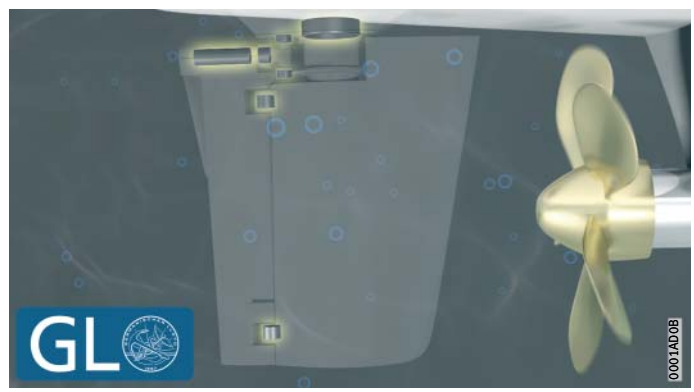


Figure 3
Application for rudder bearing

Figure 4
ELGOTEX® filament wound bush

ELGOTEX®-WA filament wound bushes, water-resistant

Ordering designation

Water-resistant ELGOTEX®-WA filament wound bushes are matched to the specific application. For available sizes, please place an enquiry with Schaeffler on the basis of the following ordering designation, *Figure 5*.

① Cylindrical filament wound bush
② Inside diameter
③ Outside diameter
④ Width of bush
⑤ Standard lip seal:
RS (on one side)
2RS (on both sides)
⑥ Design using ELGOTEX®-WA

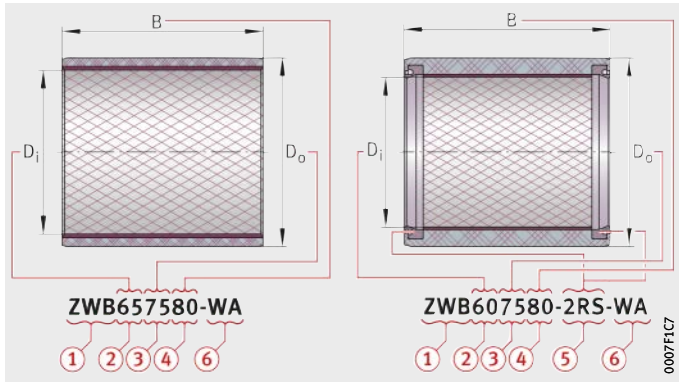


Figure 5
Structure of the designation

MATNR 036888524-0000 / TPI 194 / 01 / GB-D / 2014041 / Printed in Germany by bresler

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Issued: 2014, April

TPI 194 GB-D