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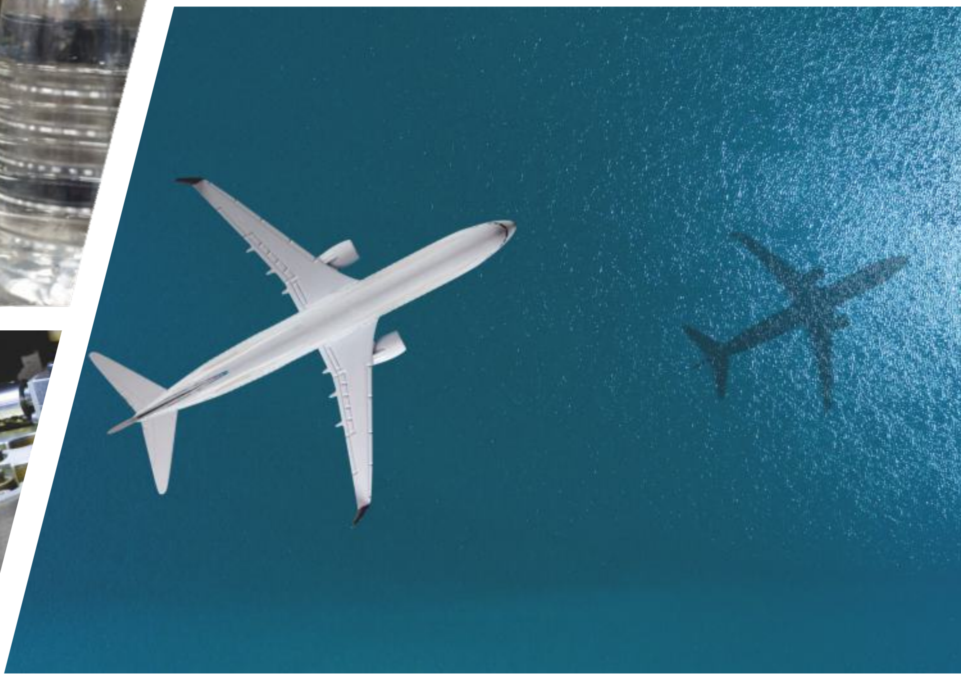
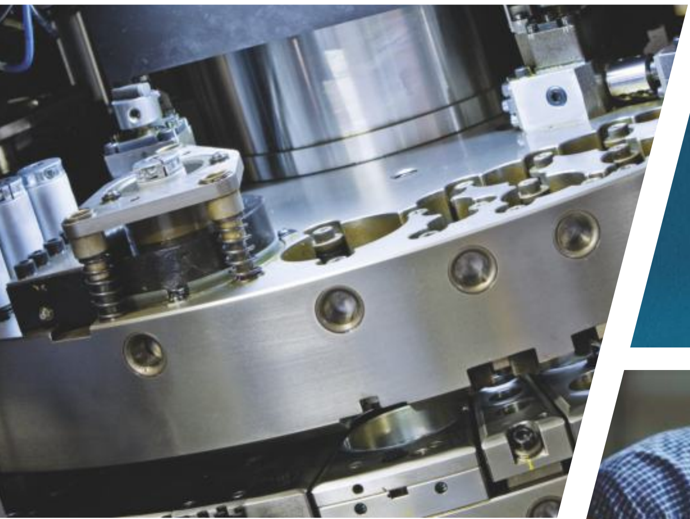




GGB DU® and DU-B

METAL-POLYMER SELF-LUBRICATING BEARING SOLUTIONS

PUSHING BOUNDARIES TO CO-CREATE A HIGHER QUALITY OF LIFE

GGB helps create a world of motion with minimal frictional loss through plain bearing and surface engineering technologies. With R&D, testing and production facilities in the United States, Germany, France, Brazil, Slovakia and China, GGB partners with customers worldwide on customized tribological design solutions that are efficient and environmentally sustainable. GGB's engineers bring their expertise and passion for tribology to a wide range of industries, including automotive, aerospace and industrial manufacturing. To learn more about tribology for surface engineering from GGB, visit www.ggbearings.com/en.

Our products are used in tens of thousands of critical applications every day on our planet. It is always our goal to provide superior, high-quality solutions for our customers' needs, no matter where those demands take our products. From space vehicles to golf carts and virtually everything in between; we offer the industry's most extensive range of high performance, maintenance-free bearing solutions for a multitude of applications:

- Aerospace
- Agricultural
- Automotive
- Construction
- E-Mobility
- Energy
- Fluid Power
- Industrial
- Medical
- Mining
- Oil & Gas
- Primary Metals
- Railway
- Recreation

The GGB Advantage

LOWER SYSTEM COST

GGB bearings reduce shaft costs by eliminating the need for hardening and machining grease paths. Their compact, one-piece construction provides space and weight savings and simplifies assembly.

LOW-FRICTION, HIGH WEAR RESISTANCE

Low coefficients of friction eliminate the need for lubrication, while providing smooth operation, reducing wear and extending service life. Low-friction also eliminates the effects of stick-slip or “stiction” during start up.

MAINTENANCE-FREE

GGB bearings are self-lubricating, making them ideal for applications requiring long bearing life without continuous maintenance, as well as operating conditions with inadequate or no lubrication.

ENVIRONMENTAL

Greaseless, lead-free GGB bearings comply with increasingly stringent environmental regulations such as the EU RoHS directive restricting the use of hazardous substances in certain types of electrical and electronic equipment.

CUSTOMER SUPPORT

GGB’s flexible production platform and extensive supply network assure quick turnaround and timely deliveries. In addition, we offer local applications engineering and technical support.

The Highest Standards in Quality

SAFETY

Our deep-rooted culture of safety places a relentless focus on creating a secure, healthy work environment for all. As one of our core values, safety is essential for us to achieve our goal of having the safest employees in the industry.

EXCELLENCE

Our world-class manufacturing plants in the United States, Brazil, China, Germany, France and Slovakia are certified in quality and excellence according to ISO 9001, IATF 16949, ISO 14001 and ISO 45001. This allows us to access the industry’s best practices while aligning our management system with global standards.

For a complete listing of our certifications, please visit our website: **www.ggbearings.com/en/certificates**

RESPECT

Our teams work together with mutual respect regardless of background, nationality, or function, embracing the diversity of people and learning from one another - after all, with respect comes both individual and group growth.

GGB Who We Are

GGB'S HISTORY AS THE GLOBAL LEADER IN PLAIN BEARING TECHNOLOGIES DATES BACK MORE THAN 120 YEARS.

Beginning with the founding of Glacier Antifriction Metal Company in 1899 and later introducing the industry-leading DU® bearing in 1965, GGB has continued to create innovative technologies and solutions that improve safety, performance, and profitability in a wide range of markets. Today, our products can be found everywhere - from scientific vessels at the bottom of the ocean to racecars speeding down the tarmac to jumbo jets slicing through the sky to the Curiosity rover exploring the surface of Mars.

Throughout our history, safety, excellence, and respect have formed the foundational values for the entire GGB family. They are of paramount importance as we seek to maximize personal possibility, achieve excellence, and establish open, creative work environments

Table of Contents

Table of Contents

1 Introduction

The purpose of this handbook is to provide comprehensive technical information on the characteristics of DU® and DU-B bearings. The information given permits designers to establish the correct size of bearing required and the expected life and performance. GGB Research and Development services are available to assist with unusual design problems.

Complete information on the range of DU® and DU-B standard stock products is given together with details of other DU® and DU-B products.

GGB is continually refining and extending its experimental and theoretical knowledge and, therefore, when using this brochure it is always worth-while to contact the Company should additional information be required.

As it is impossible to cover all conditions of operation which arise in practice, customers are advised to carry out prototype testing wherever possible.

1.1 APPLICATIONS

DU® and DU-B are suitable for

- rotating,
- oscillating,
- reciprocating and
- sliding movements.

Also available are DU® and DU-B related material compositions for specific applications, for example when increased corrosion resistance of the bearing material is required due to

- when improved corrosion resistance is required
- in the case of more stringent requirements as a result of environmental regulations
- when there is a tendency to fretting corrosion.

1.2 CHARACTERISTICS AND ADVANTAGES

- DU® and DU-B require no lubrication
- Provides maintenance free operation
- DU® and DU-B have a high pU capability
- DU® and DU-B exhibit low wear rate
- Seizure resistant
- Suitable for temperatures from -200 to +280 °C
- High static and dynamic load capacity
- Good frictional properties with negligible stick-slip
- Resists solvents
- No water absorption and therefore dimensionally stable
- DU® and DU-B are electrically conductive and show no electrostatic effects
- DU® and DU-B have good embedability and are tolerant of dusty environments
- Compact and light
- DU® and DU-B bearings are prefinished and require no machining after assembly

1.3 BASIC FORMS AVAILABLE

Standard Components available from Stock.

These products are manufactured to international, national or GGB standard designs.

Metric and Imperial Sizes

– Cylindrical Bushes – Flanged Bushes* – Thrust Washers – Flanged Washers* – Strip Material * Metric sizes only

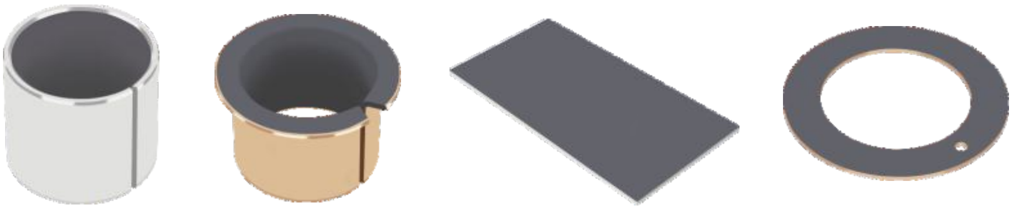


Fig. 1: Standard Components

Non-Standard Components not available from Stock.

These products are manufactured to customers' requirements with or without GGB recommendations, and include for example:

– Modified Standard Components – Half Bearings – Flat Components – Deep Drawn Parts – Pressings – Stampings

Fig. 2: Non-Standard Components

1.4 MATERIALS

MATERIAL	BACKING	BEARING LINING	OPERASTING TEMPERATURE [°C]		MAXIMUM LOAD p_{lim} [Nmm²]
DU®	Steel	PTFE+Lead	min -200	max +280	250
DU-B	Bronze	PTFE+Lead	min -200	max +280	140

Table 1: Characteristics of DU and DU-B

2 Material

2.1 STRUCTURE

DU®

DU® and DU-B take advantage of the outstanding dry bearing properties of Polytetrafluoroethylene (PTFE) and combines them with strength, stability and good wear resistance, excellent heat conductivity and low thermal expansion.

DU® consists of three bonded layers: a steel backing strip and a porous bronze matrix, impregnated and overlaid with the PTFE/lead bearing material.

Fig. 3: DU Microsection

DU-B

DU-B also consists of three layers, with a bronze backing replacing the steel backing strip. The structure is otherwise the same as that of DU®.

The bronze backing provides a high corrosion resistance, anti magnetic properties and a good thermal conductivity.

Fig. 4: DU-B Microsection

2.2 DRY WEAR MECHANISM

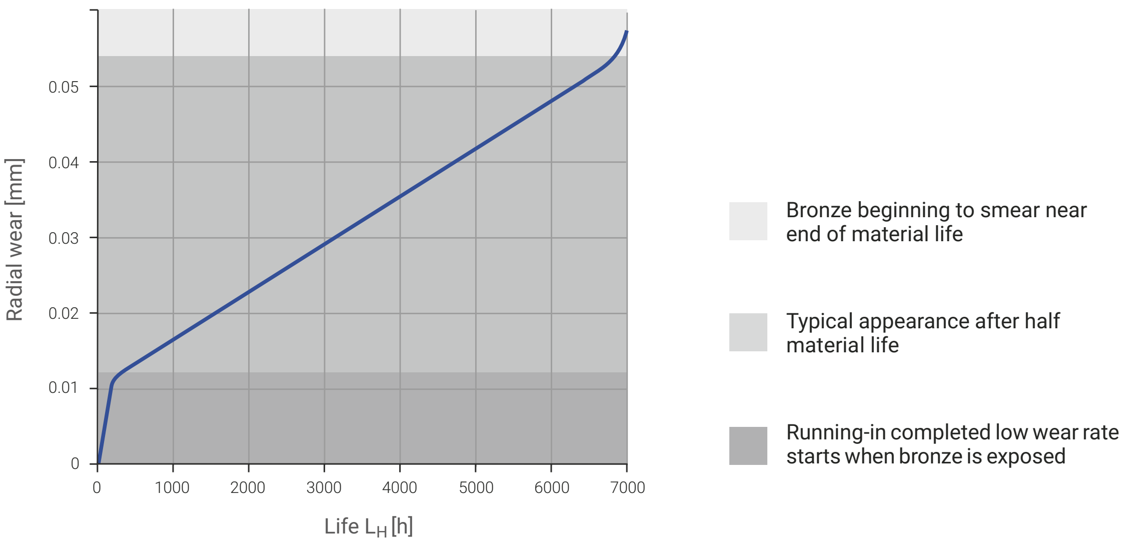


Fig. 5: Effect of wear on the DU bearing surface under dry operating conditions.

2 Material

Running-in

During normal operation, a DU® bearing quickly beds in and the PTFE/lead overlay material removed during this period, typically 0,015 mm, is transferred to the mating surface and forms a physically bonded lubricant film.

The rubbing surface of the bearing often acquires a grey-green colour and the bronze matrix can be seen exposed over about 10 % of the bearing surface. Any excess of the PTFE/lead surface layer will be shed as fine feathery particles.

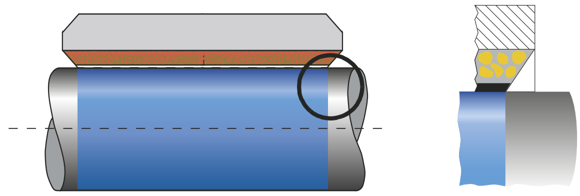


Fig. 6: Running-in

After 50 % of Useful Life

Following the running-in period the wear rate reduces to a minimum and the percentage of bronze exposed gradually increases.

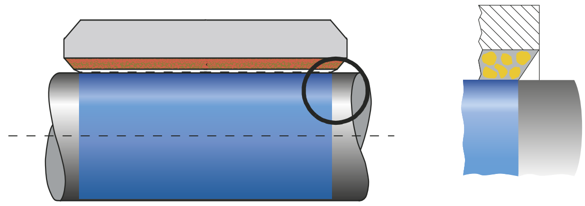


Fig. 7: After 50 % of useful life

End of Useful Life

After an extended period of operation the wear rate increases as the component approaches the end of its useful life as a self-lubricating bearing. At this stage at least 70 % of the bearing surface will be exposed bronze, and approximately 0,06 mm wear will have occurred.

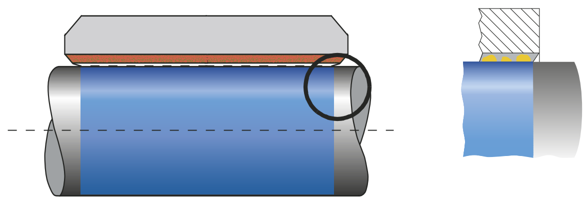


Fig. 8: End of useful life

Wear of Mating Surfaces

There is no measurable wear of mating surfaces made from recommended materials unless a DU® bearing is operated beyond its useful life or becomes contaminated with abrasive dirt.

2.3 PHYSICAL, MECHANICAL AND ELECTRICAL PROPERTIES

BEARING PROPERTIES		SYMBOL	UNIT	VALUE DU®	VALUE DU-B	COMMENTS
PHYSICAL PROPERTIES						
Thermal conductivity		λ	W/mK	40	60	after running-in
Coefficient of linear thermal expansion	parallel to surface normal to service	α_1 α_2	10^{-6}/K	11 30	18 36	measured on strip 1,9 mm thick
Operating temperature		T_{max} T_{min}	°C	+280 - 200	+280 - 200	
MECHANICAL PROPERTIES						
Compressive yield strength		σ_C	N/mm²	350	300	measured on disc Ø 25 mm x 2,44 mm thick
Maximum load	static dynamic	$p_{sta.max}$ $p_{dyn.max}$	N/mm²	250 140	140 140	
ELECTRICAL PROPERTIES						
Surface resistance		R_{OB}	Ω	1 - 10	1 - 12	depends on applied pressure and contact area
NUCLEAR RADIATION RESISTANCE						
Maximum thermal neutron dose		D_{Nth}	nvt	2×10^{15}	2×10^{15}	nvt = thermal neutron flux
Maximum gamma ray dose		D_{γ}	Gy = J/kg	10^6	10^6	1 Gray = 1J/kg

Table 2: Properties of of DU and DU-B

2 Material

2.4 CHEMICAL PROPERTIES

The following table provides an indication of the chemical resistance of DU® and DU-B to various chemical media. It is recommended that the chemical resistance is confirmed by testing if possible.

CHEMICAL	%	°C	DU®	DU-B
STRONG ACIDS				
Hydrochloric Acid	5	20	-	-
Nitric Acid	5	20	-	-
Sulfuric Acid	5	20	-	-
WEAK ACIDS				
Acetic Acid	5	20	-	o
Formic Acid	5	20	-	o
BASES				
Ammonia	10	20	o	-
Sodium Hydroxide	5	20	o	o

CHEMICAL	°C	DU®	DU-B
SOLVENTS			
Acetone	20	+	+
Carbon Tetrachloride	20	+	+
LUBRICANTS AND FUELS			
Paraffin	20	+	+
Gasolene	20	+	+
Kerosene	20	+	+
Diesel Fuel	20	+	+
Mineral Oil	70	o	o
HFA-ISO46 High Water Fluid	70	o	o
HFC-Water-Glycol	70	-	-
HFD-Phosphate Ester	70	o	o
Water	20	o	+
Sea Water	20	-	o

Table 3: Chemical Resistance of DU and DU-B

+ Satisfactory: Corrosion damage is unlikely to occur

o Acceptable: Some corrosion damage may occur but this will not be sufficient to impair either the structural integrity or the tribological performance of the material

\- Unsatisfactory: Corrosion damage will occur and is likely to affect either the structural integrity and/or the tribological performance of the material

Electrochemical Corrosion

DU-B should not be used in conjunction with aluminium housings due to the risk of electrochemical corrosion in the presence of water or moisture.

2.5 FRICTIONAL PROPERTIES

DU® bearings show negligible 'stick-slip' and provide smooth sliding between adjacent surfaces. The coefficient of friction of DU® depends upon:

- The specific load p [N/mm²]
- The sliding speed U [m/s]
- The roughness of the mating running surface Ra [µm]
- The bearing temperature T [°C].

A typical relationship is shown in Fig. 9, which can be used as a guide to establish the actual friction under clean, dry conditions after running in.

Exact values may vary by ± 20 % depending on operating conditions.

Before running in, the friction may be up to 50 % higher. With frequent starts and stops, the static coefficient of friction is approximately equal to, or even slightly less than the dynamic coefficient of friction.

After progressively longer periods of dwell under load (e.g. hours or days) the static coefficient of friction on the first movement may be between 1,5 and 3 times greater, particularly before running in. Friction increases at bearing temperatures below 0 °C. Where frictional characteristics are critical to a design they should be established by prototype testing.

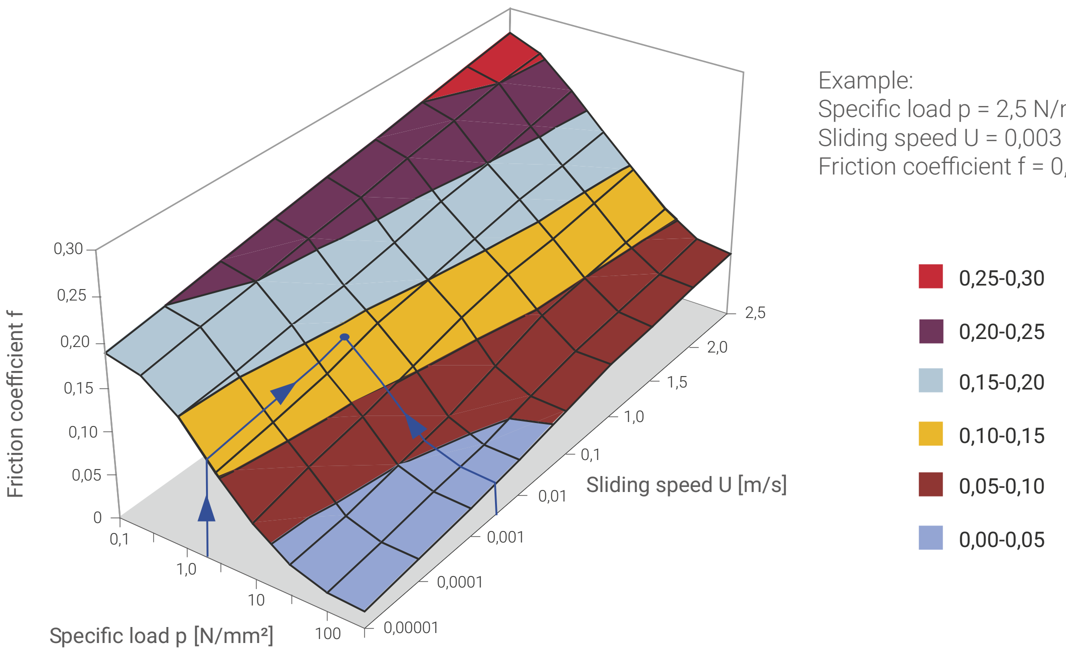


Fig. 9: Variation of friction coefficient f with specific load p and sliding speed U at temperature T = 25 °C

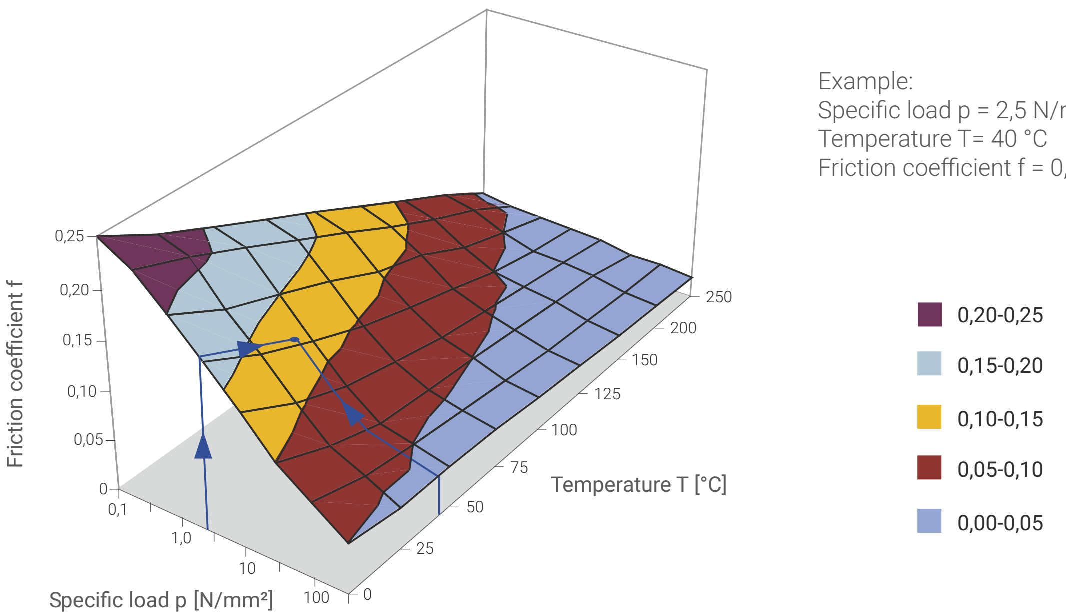


Fig. 10: Variation of friction coefficient f with specific load p and temperature T at sliding speed U = 0,01 m/s

3 Performance

3.1 DESIGN FACTORS

The main parameters when determining the size or calculating the service life for a DU® bearing are:

- Specific Load Limit p_{lim}
- pU Factor
- Mating surface roughness Ra
- Mating surface material
- Temperature T
- Other environmental factors e.g. housing design, dirt, lubricationtions.

Calculation

Two design procedures are provided as follows:

- SA bearing service life calculation based on the permitted bearing dimensions
- A calculation of the necessary bearing dimensions based on the required bearing service life

3.2 SPECIFIC LOAD p

For the purpose of assessing bearing performance the specific load p is defined as the working load divided by the projected area of the bearing and is expressed in N/mm².

Cylindrical Bush

(3.2.1) [N/mm²]

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

Thrust Washer

(3.2.2) [N/mm²]

$$p = \frac{4F}{\pi \cdot (D_o^2 - D_i^2)}$$

Flanged Bush (Axial Loading)

(3.2.3) [N/mm²]

$$p = \frac{F}{0{,}04 \cdot (D_{fl}^2 - D_i^2)}$$

Slideway

(3.2.4) [N/mm²]

$$p = \frac{F}{L \cdot W}$$

Permanent deformation of the DU® bearing lining may occur at specific loads above 140 N/mm² and under these conditions DU® should only be used with slow intermittent movements.

The permissible maximum load on a thrust washer is higher than that on the flange of a flanged bush, and under conditions of high axial loads a thrust washer should be specified.

3.3 SPECIFIC LOAD LIMIT p_{lim}

The maximum load which can be applied to a DU® bearing can be expressed in terms of the Specific Load Limit, which depends on the type of the loading. It is highest under steady loads. Conditions of dynamic load or oscillating movement which produce fatigue stress in the bearing result in a reduction in the permissible Specific Load Limit.

In general the specific load on a DU® bearing should not exceed the Specific Load Limits given in Table 4.

The values of Specific Load Limit specified in Table 4 assume good alignment between the bearing and mating surface (Fig. 29).

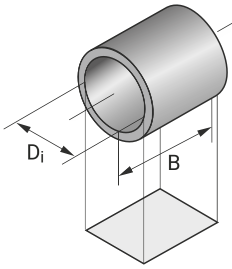


Fig. 11: Projected Area

Maximum Specific Load p_{lim}

TYPE OF LOADING / p_{lim} [Nmm²]										
Steady load - rotating movement p_{lim}	140									
Steady load - oscillating movement										
p_{lim}	140	140	115	95	85	80	60	44	30	20
Number of movement cycles Q	1000	2000	4000	6000	8000	10^4	10^5	10^6	10^7	10^8
Dynamic load - rotating or oscillating movement										
p_{lim}	60	60	50	46	42	40	30	22	15	10
Number of load cycles Q	1000	2000	4000	6000	8000	10^4	10^5	10^6	10^7	10^8

Table 4: Maximum specific load p_{lim}

3.4 SLIDING SPEED U

Speeds in excess of 2.5 m/s sometimes lead to overheating, and a running in procedure may be beneficial. This could consist of a series of short runs progressively increasing in duration from an initial run of a few seconds.

Continuous Rotation

Cylindrical Bush

(3.4.1) [m/s]

$$U = \frac{D_i \cdot \pi \cdot N}{60 \cdot 10^3}$$

Thrust Washer

(3.4.2) [m/s]

$$U = \frac{\frac{D_o + D_i}{2} \cdot \pi \cdot N}{60 \cdot 10^3}$$

Oscillating Movement

Cylindrical Bush

(3.4.3) [m/s]

$$U = \frac{D_i \cdot \pi}{60 \cdot 10^3} \cdot \frac{4\Phi \cdot N_{OSZ}}{360}$$

Thrust Washer

(3.4.4) [m/s]

$$U = \frac{\frac{D_o + D_i}{2} \cdot \pi}{60 \cdot 10^3} \cdot \frac{4\Phi \cdot N_{OSZ}}{360}$$

3 Performance

3.5 pU FACTOR

The useful operating life of a DU® bearing is governed by the pU factor, the product of the specific load p [N/mm²] and the sliding speed U [m/s].

For thrust washers and flanged bush thrust faces the rubbing velocity at the mean diameter is used.

pU factors up to 3.6 N/mm² x m/s can be accommodated for short periods, whilst for continuous rating.

pU factors up to 1.8 N/mm² x m/s can be used, depending upon the operating life required.

	DU	UNIT
p	140	N/mm²
U	2,5	m/s
pU continuous	1,8	N/mm² · m/s
pU intermittent	3,6	N/mm² · m/s

Table 5: Typical data p, U and pU

Calculation of pU Factor

(3.5.1) [N/mm² · m/s]

$$pU = p \cdot U$$

3.6 APPLICATON FACTORS

The following factors influence the bearing performance of DU and must be considered in calculating the required dimension or estimating the bearing life for a particular application.

Temperature

The useful life of a DU bearing depends upon the operating temperature.

Under dry running conditions frictional heat is generated at the rubbing surface of the bearing dependent on the pU condition. For a given pU factor the operating temperature of the bearing depends upon the temperature of the surrounding environment and the heat dissipation properties of the housing. Intermittent operation affects the heat dissipation from the assembly and hence the operating temperature of the bearing.

The effect of temperature on the operating life of DU bearings is indicated by the factor a_T shown in Table 6.

MODE OF OPERATION	NATURE OF HOUSING	TEMPERATURE OF BEARING ENVIRONMENT T_{amb} [°C] AND TEMPERATURE APPLICATION FACTOR a_T					
		[°C] 25	60	100	150	200	280
Dry continuous operation	Average heat dissipating qualities	1,0	0,8	0,6	0,4	0,2	0,1
Dry continuous operation	Light pressings or isolated housing with poor heat dissipating qualities	0,5	0,4	0,3	0,2	0,1	-
Dry continuous operation	Non-metallic housings with bad heat dissipating qualities	0,3	0,3	0,2	0,1	-	-
Dry intermittent operation (duration less than 2 min, followed by a longer dwell period)	Average heat dissipating qualities	2,0	1,6	1,2	0,8	0,4	0,2
Continuously immersed in water		2,0	1,5	0,6	-	-	-
Alternately immersed in water & dry		0,2	0,1	-	-	-	-
Continuously immersed in non lubricant liquids other than water		1,5	1,2	0,9	0,6	0,3	0,1
Continuously immersed in lubricant		3,0	2,5	2,0	1,5	-	-

Table 6: Temperature application factor a_T

Mating Surface

The effect of the mating surface material type on the operating life of DU® bearings is indicated by the mating surface factor a_M and the life correction constant a_L shown in Table 7.

MATERIAL	a_M	a_L
Steel and Cast Iron		
Carbon Steel	1	200
Carbon Manganese Steel	1	200
Alloy Steel	1	200
Case Hardened Steel	1	200
Nitrided Steel	1	200
Salt bath nitrocarburised	1	200
Stainless Steel (7-10 % Ni, 17-20 % Cr)	2	200
Sprayed Stainless Steel	1	200
Cast Iron (0,3 µm R_a)	1	200

MATERIAL	a_M	a_L
Plated Steel with min. Thickness of Plating 0,013 mm		
Cadmium	0,2	600
Hard Chrome	2,0	600
Lead	1,5	600
Nickel	0,2	600
Phosphated	0,2	300
Tin Nickel	1,2	600
Titanium Nitride	1,0	600
Tungsten Carbide Flame Plated	3,0	600
Zinc	0,2	600
Non Ferrous Metals		
Aluminium Alloys	0,4	200
Bronze and Copper Base Alloys	0,1-0,4	200
Hard Anodised Aluminium (0,025 mm thick)	3,0	600

Table 7: Mating surface factor a_M and life correction constant a_L

Note:

The factor values given assume a mating surface finish of ≤0.4 µm R_a

- A ground surface is preferred to fine turned
- Surfaces should be cleaned of abrasive particles after polishing
- Cast iron surfaces should be ground to <0,3 µm R_a
- The grinding cut should be in the same direction as the bearing motion relative to the shaft

Bearing Size

The running clearance of a DU® bearing increases with bearing diameter resulting in a proportionally smaller contact area between the shaft and bearing. This reduction in contact area has the effect of increasing the actual unit load and hence pU factor. The bearing size factor (Fig. 13) is used in the design calculations to allow for this effect. The bearing size factor is also applicable to thrust washers, where for other reasons, bearing diameter has an effect on performance.

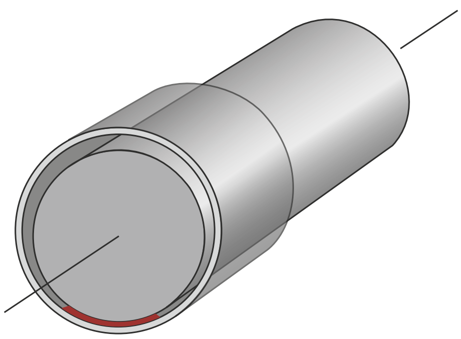


Figure 12: Contact area between bearing and shaft

3 Performance

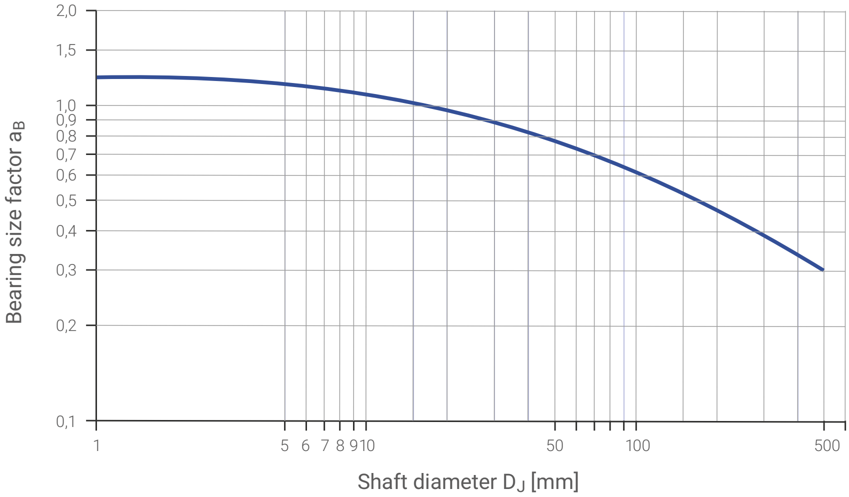


Fig. 13: Bearing size factor a_B

Bore Burnishing

Burnishing or machining the bore of a DU® bearing results in a reduction in the wear performance. The application factor a_C given in Table 8 is used in the design calculations to allow for this effect.

DEGREE OF SIZING		APPLICATION FACTOR a_C
BURNISHING	0,025 mm	0,8
Excess of burnishing tool diameter over	0,038 mm	0,6
mean bore size	0,050 mm	0,3
BORING	0,025 mm	0,6
Depth of cut	0,038 mm	0,3
	0,050 mm	0,1

Table 8: Bore burnishing or machining application factor a_C

Type of Load

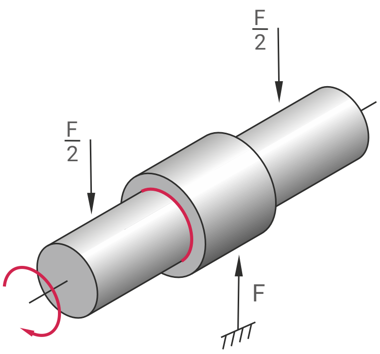


Fig. 14: Steady load, Bush stationary, Shaft rotating

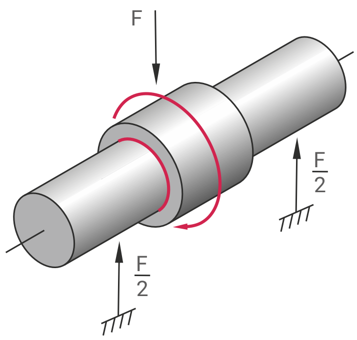


Fig. 15: Rotating load, Shaft stationary, Bush rotating

3.7 CALCULATION OF BEARING SIZE

In designing all bearings, the shaft diameter is usually determined by considerations of physical stability or stiffness and the main variable to be determined is the length of the bush or the land width of the thrust washer.

The formulae given below enable designers to calculate the length or width necessary to satisfy both the Specific Load Limit and the pU/Life relationship.

If it is found that the total length exceeds twice the diameter of the shaft, this indicates that the conditions envisaged are too severe for DU® material and consideration should be given to repositioning the bearings in order to reduce the load.

Calculation for Bushes

Bush Stationary, Shaft Rotating

(3.7.1) [mm]

$$B = \frac{F \cdot N \cdot (L_H + a_L)}{1{,}25 \cdot 10^7 \cdot a_T \cdot a_M \cdot a_B} + \frac{F}{p_{lim} \cdot D_i}$$

Bush Rotating, Shaft Stationary

(3.7.2) [mm]

$$B = \frac{F \cdot N \cdot (L_H + a_L)}{2{,}5 \cdot 10^7 \cdot a_T \cdot a_M \cdot a_B} + \frac{F}{p_{lim} \cdot D_i}$$

Calculation for Thrust Washers

(3.7.3) [mm]

$$D_o - D_i = \frac{F \cdot N \cdot (L_H + a_L)}{1{,}25 \cdot 10^7 \cdot a_T \cdot a_M \cdot a_B} + \sqrt{D_i^2 + \frac{1{,}3\,F}{p_{lim}}} - D_i$$

Calculation for Slideways

(3.7.4) [mm^2]

$$A = \frac{2{,}38 \cdot F \cdot U \cdot (L_H + a_L)}{10^3 \cdot a_T \cdot a_M} \cdot \frac{(L + L_S)}{L} + \frac{F}{p_{lim}}$$

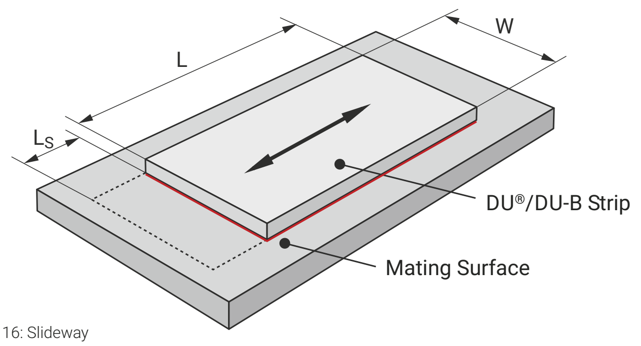


Fig. 16: Slideway

3 Performance

3.8 CALCULATION OF BEARING SERVICE LIFE

Where the size of a bearing is governed largely by the space available the following calculation can be used to determine whether its useful life will satisfy the requirements. If the calculated life is inadequate, a larger bearing should be considered.

Specific load p

Bushes

(3.8.1) [N/mm²]

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

Flanged Bushes

(3.8.2) [N/mm²]

$$p = \frac{F}{0{,}04 \cdot (D_{fl}^2 - D_i^2)}$$

Thrust Washers

(3.8.3) [N/mm²]

$$p = \frac{4F}{p \cdot (D_o^2 - D_i^2)}$$

High Load Factor a_E

(3.8.4) [-]

$$a_E = \frac{p_{lim} - p}{p_{lim}}$$

p_{lim} see Table 4, Page 15

If a_E is negative then the bearing is overloaded. Increase the bearing diameter and/or length.

Modified pU Factor

Bushes

(3.8.5) [N/mm² · m/s]

$$pU = \frac{5{,}25 \cdot 10^{-5} F \cdot N}{a_E \cdot B \cdot a_T \cdot a_M \cdot a_B}$$

Flanged Bushes

(3.8.6) [N/mm² · m/s]

$$pU = \frac{6{,}5 \cdot 10^{-4} F \cdot N}{a_E \cdot (D_{fl} - D_i) \cdot a_T \cdot a_M \cdot a_B}$$

Thrust Washers

(3.8.7) [N/mm² · m/s]

$$pU = \frac{3{,}34 \cdot 10^{-5} F \cdot N}{a_E \cdot (D_o - D_i) \cdot a_T \cdot a_M \cdot a_B}$$

For oscillating movement, calculate the average rotational speed.

(3.8.8) [1/min]

$$N = \frac{4\varphi \cdot N_{osz}}{360}$$

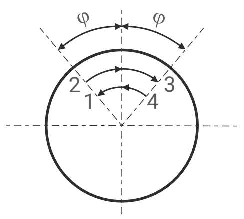


Figure 17: Oscillating cycle φ

Estimation of Bearing Life L_H

Bushes (Steady Load)

(3.8.9) [h]

$$L_H = \frac{615}{pU} - a_L$$

Bushes (Rotating Load)

(3.8.10) [h]

$$L_H = \frac{1230}{pU} - a_L$$

Flanged Bushes (Axial Load)

(3.8.11) [h]

$$L_H = \frac{410}{pU} - a_L$$

Thrust Washers

(3.8.12) [h]

$$L_H = \frac{410}{pU} - a_L$$

Bore Burnishing

If the DU® bush is bore burnished then this must be allowed for in estimating the bearing life by the application factor a_C (Table 8, Page 18).

Estimated Bearing Life

(3.8.13) [h]

$$L_H = L_H \cdot a_C$$

Slideways

Specific Load Factor

(3.8.14) [-]

$$a_{E1} = A - \frac{F}{p_{lim}}$$

If negative the bearing is overloaded and the bearing area should be increased.

Speed Temperature and Material Application Factors

(3.8.15) [-]

$$a_{E2} = \frac{420 \cdot a_T \cdot a_M}{F \cdot U}$$

Relative Contact Area Factor

(3.8.16) [-]

$$a_{E3} = \frac{A}{A_M}$$

Estimated Bearing Life

(3.8.17) [h]

$$L_H = a_{E1} \cdot a_{E2} \cdot a_{E3} - a_L$$

Estimated bearing lives greater than 4000 h are subject to error due to inaccuracies in the extrapolation of test data.

$Z_T = L_H \cdot N_{OSZ} \cdot 60$ (for oscillating movements - 3.8.18)

$Z_T = L_H \cdot C \cdot 60$ (for dynamic load - 3.8.19)

Check that Z_T is less than total number of cycles Q for the operating specific load p (Table 4, Page 15)

For oscillating movements or dynamic load: calculate estimated number of cycles Z_T.

If $Z_T < Q$, L_H will be limited by wear after Z_T cycles.

If $Z_T > Q$, L_H will be limited by fatigue after Z_T cycles.

3 Performance

3.9 CALCULATION OF BEARING

Cylindrical Bush

Given:			
Load Details	Steady Load Continuous Rotation	Inside Diameter D_i Length B	40 mm 30 mm
Shaft	Steel Unlubricated at 25°C	Bearing Load F Rotational Speed N	5.000 N 50 · 1/min

Calculation Constants and Application Factors		
Specific Load Limit p_{lim}	140 N/mm²	(Table 4, Page 15)
Temperature Application Factor a_T	1,0	(Table 6, Page 16)
Material Application Factor a_M	1,0	(Table 7, Page 17)
Bearing Size Factor a_B	0,85	(Fig. 13, Page 18)
Life Correction Constant a_L	200	(Table 7, Page 17)

Calculation	Ref	Value
Specific Load p [N/mm²]	(3.2.1) Page 14	$p = \frac{F}{D_i \cdot B} = \frac{5.000}{40 \cdot 30} = 4{,}17$
Sliding Speed U [m/s]	(3.4.1) Page 15	$U = \frac{D_i \cdot \pi \cdot N}{60 \cdot 10^3} = \frac{40 \cdot 3{,}14 \cdot 50}{60 \cdot 10^3} = 0{,}105$
pU Factor Calculate from Table 5, Page 16	(3.5.1) Page 16	$pU = p \cdot U = 4{,}17 \cdot 0{,}105 = 0{,}438$
High Load Factor a_E [-] must be > 0	(3.8.4) Page 20	$a_E = \frac{p_{lim} - p}{p_{lim}} = \frac{140 - 4{,}17}{140} = 0{,}97$
Modified pU Factor [N/mm² · m/s]	(3.8.5) Page 20	$pU = \frac{5{,}25 \cdot 10^{-5} F \cdot N}{a_E \cdot B \cdot a_T \cdot a_M \cdot a_B} = 0{,}53$
Life L_H [h]	(3.8.9) Page 21	$L_H = \frac{615}{pU} - a_L = \frac{615}{0{,}53} - 200 = 960$

Cylindrical Bush

Given:			
Load Details	Steady Load Continuous Rotation	Inside Diameter D_i Length B	30 mm 30 mm
Shaft	Steel Unlubricated at 25°C	Bearing Load F Rotational Speed N	25.000 N 15 · 1/min

Calculation Constants and Application Factors		
Specific Load Limit p_{lim}	60 N/mm²	(Table 4, Page 15)
Temperature Application Factor a_T	1,0	(Table 6, Page 16)
Material Application Factor a_M	1,0	(Table 7, Page 17)
Bearing Size Factor a_B	1,0	(Fig. 13, Page 18)
Life Correction Constant a_L	200	(Table 7, Page 17)

Calculation	Ref	Value
Specific Load p [N/mm²]	(3.2.1) Page 14	$p = \frac{F}{D_i \cdot B} = \frac{25.000}{40 \cdot 30} = 20{,}83$
Sliding Speed U [m/s]	(3.4.1) Page 15	$U = \frac{D_i \cdot \pi \cdot N}{60 \cdot 10^3} = \frac{30 \cdot 3{,}14 \cdot 15}{60 \cdot 10^3} = 0{,}024$
pU Factor Calculate from Table 5, Page 16	(3.5.1) Page 16	$pU = p \cdot U = 27{,}78 \cdot 0{,}024 = 0{,}669$
High Load Factor a_E [-] must be > 0	(3.8.4) Page 20	$a_E = \frac{p_{lim} - p}{p_{lim}} = \frac{60 - 27{,}78}{60} = 0{,}54$
Modified pU Factor [N/mm² · m/s]	(3.8.5) Page 20	$pU = \frac{5{,}25 \cdot 10^{-5} F \cdot N}{a_E \cdot B \cdot a_T \cdot a_M \cdot a_B} = 1{,}23$
Life L_H [h]	(3.8.9) Page 21	$L_H = \frac{615}{pU} - a_L = \frac{615}{1{,}23} - 200 = 300$
Calculate Total Load Cycles	Table 4 Page 15	$Z_T = 300 \cdot 60 \cdot 60 = 1{,}08 \cdot 10^6$
Q for 27,78 N/mm² = bearing will fatigue after 10^5 cycles (= 28h)		

Cylindrical Bush

Given:			
Load Details	Steady Load Continuous Rotation	Inside Diameter D_i Length B	50 mm 50 mm
Shaft	Steel Unlubricated at 100°C	Bearing Load F Rotational Speed N	10.000 N 50 · 1/min

Calculation Constants and Application Factors		
Specific Load Limit p_{lim}	60 N/mm²	(Table 4, Page 15)
Temperature Application Factor a_T	0,6	(Table 6, Page 16)
Material Application Factor a_M	1,0	(Table 7, Page 17)
Bearing Size Factor a_B	0,78	(Fig. 13, Page 18)
Life Correction Constant a_L	200	(Table 7, Page 17)

Calculation	Ref	Value
Specific Load p [N/mm²]	(3.2.1) Page 14	$p = \frac{F}{D_i \cdot B} = \frac{10.000}{50 \cdot 50} = 4{,}0$
Sliding Speed U [m/s]	(3.4.1) Page 15	$U = \frac{D_i \cdot \pi \cdot N}{60 \cdot 10^3} = \frac{50 \cdot 3{,}14 \cdot 50}{60 \cdot 10^3} = 0{,}131$
pU Factor Calculate from Table 5, Page 16	(3.5.1) Page 16	$pU = p \cdot U = 4{,}0 \cdot 0{,}131 = 0{,}542$
High Load Factor a_E [-] must be > 0	(3.8.4) Page 20	$a_E = \frac{p_{lim} - p}{p_{lim}} = \frac{60 - 4{,}17}{60} = 0{,}93$
Modified pU Factor [N/mm² · m/s]	(3.8.5) Page 20	$pU = \frac{5{,}25 \cdot 10^{-5} F \cdot N}{a_E \cdot B \cdot a_T \cdot a_M \cdot a_B} = 1{,}20$
Life L_H [h]	(3.8.9) Page 21	$L_H = \frac{1.230}{pU} - a_L = \frac{1.230}{1{,}20} - 200 = 825$

Cylindrical Bush

Given:			
Load Details	Steady Load Oscillating Movement	Inside Diameter D_i Length B	45 mm 40 mm
Shaft	Stainless Steel Unlubricated at 25°C Continuouis Operation	Bearing Load F Frequency C Amplitudes Φ	40.000 N 150 20°

Calculation Constants and Application Factors		
Specific Load Limit p_{lim}	140 N/mm²	(Table 4, Page 15)
Temperature Application Factor a_T	1,0	(Table 6, Page 16)
Material Application Factor a_M	2,0	(Table 7, Page 17)
Bearing Size Factor a_B	0,81	(Fig. 13, Page 18)
Life Correction Constant a_L	200	(Table 7, Page 17)

Calculation	Ref	Value
Specific Load p [N/mm²]	(3.2.1) Page 14	$p = \frac{F}{D_i \cdot B} = \frac{40.000}{45 \cdot 40} = 22{,}22$
Sliding Speed U [m/s]	(3.4.1) Page 15	$U = \frac{D_i \cdot \pi \cdot N}{60 \cdot 10^3} = \frac{45 \cdot 3{,}14 \cdot 33{,}33}{60 \cdot 10^3} = 0{,}078$
Average Speed N [1/min]	(3.8.8) Page 20	$N = \frac{4\Phi \cdot N_{osz}}{360} = \frac{4 \cdot 20 \cdot 150}{360} = 33{,}33$
pU Factor Calculate from Table 5, Page 16	(3.5.1) Page 16	$pU = p \cdot U = 22{,}22 \cdot 0{,}078 = 1{,}733$
High Load Factor a_E [-] must be > 0	(3.8.4) Page 20	$a_E = \frac{p_{lim} - p}{p_{lim}} = \frac{140 - 22{,}22}{140} = 0{,}84$
Modified pU Factor [N/mm² · m/s]	(3.8.5) Page 20	$pU = \frac{5{,}25 \cdot 10^{-5} F \cdot N}{a_E \cdot B \cdot a_T \cdot a_M \cdot a_B} = 1{,}29$
Life L_H [h]	(3.8.9) Page 21	$L_H = \frac{615}{pU} - a_L = \frac{615}{1{,}29} - 200 = 277$
Calculate Total Load Cycles	Table 4 Page 15	$Z_T = 277 \cdot 150 \cdot 60 = 2{,}5 \cdot 10^6$
Q for 22,22 N/mm² = 10^8 bearing o.k.!		

Thrust Washer

Given:			
Load Details	Axial Load Continuous Rotation	Outside Diameter D_o Inside Diameter D_i	62 mm 38 mm
Shaft	Steel Unlubricated at 25°C	Bearing Load F Rotational Speed N	6.500 N 60 · 1/min

Calculation Constants and Application Factors		
Specific Load Limit p_{lim}	140 N/mm²	(Table 4, Page 15)
Temperature Application Factor a_T	1,0	(Table 6, Page 16)
Material Application Factor a_M	1,0	(Table 7, Page 17)
Bearing Size Factor a_B	0,85	(Fig. 13, Page 18)
Life Correction Constant a_L	200	(Table 7, Page 17)

Calculation	Ref	Value
Specific Load p [N/mm²]	(3.8.3) Page 20	$p = \frac{4 \cdot 6.500}{3{,}14 \cdot (62^2 - 38^2)} = 3{,}45$
Sliding Speed U [m/s]	(3.4.2) Page 15	$U = \frac{\frac{(62 + 38)}{2} \cdot 3{,}14 \cdot 60}{60 \cdot 10^3} = 0{,}157$
pU Factor Calculate from Table 5, Page 16	(3.5.1) Page 16	$pU = p \cdot U = 3{,}45 \cdot 0{,}157 = 0{,}541$
High Load Factor a_E [-] must be > 0	(3.8.4) Page 20	$a_E = \frac{p_{lim} - p}{p_{lim}} = \frac{140 - 3{,}45}{140} = 0{,}98$
Modified pU Factor [N/mm² · m/s]	(3.8.7) Page 20	$pU = \frac{3{,}34 \cdot 10^{-5} \cdot 6.500 \cdot 60}{0{,}87 \cdot (62 - 38) \cdot 1 \cdot 1 \cdot 0{,}85} = 0{,}56$
Life L_H [h]	(3.8.12) Page 21	$L_H = \frac{410}{pU} - a_L = \frac{410}{0{,}65} - 200 = 431$

Flanged Bush

Given:			
Load Details	Axial Load Continuous Rotation	Flange Outside Ø D_{fl} Inside Diameter D_i	23 mm 15 mm
Shaft	Steel Unlubricated at 25°C	Bearing Load F Rotational Speed N	250 N 25 · 1/min

Calculation Constants and Application Factors		
Specific Load Limit p_{lim}	140 N/mm²	(Table 4, Page 15)
Temperature Application Factor a_T	1,0	(Table 6, Page 16)
Material Application Factor a_M	1,0	(Table 7, Page 17)
Bearing Size Factor a_B	1,0	(Fig. 13, Page 18)
Life Correction Constant a_L	200	(Table 7, Page 17)

Calculation	Ref	Value
Specific Load p [N/mm²]	(3.2.2) Page 14	$p = \frac{250}{0{,}04 \cdot (23^2 - 15^2)} = 20{,}55$
Sliding Speed U [m/s]	(3.4.2) Page 15	$U = \frac{\frac{(23 + 15)}{2} \cdot 3{,}14 \cdot 25}{60 \cdot 10^3} = 0{,}025$
pU Factor Calculate from Table 5, Page 16	(3.5.1) Page 16	$pU = p \cdot U = 20{,}55 \cdot 0{,}025 = 0{,}513$
High Load Factor a_E [-] must be > 0	(3.8.4) Page 20	$a_E = \frac{p_{lim} - p}{p_{lim}} = \frac{140 - 20.55}{140} = 0{,}85$
Modified pU Factor [N/mm² · m/s]	(3.8.6) Page 20	$pU = \frac{6{,}5 \cdot 10^{-5} \cdot 250 \cdot 50}{0{,}85 \cdot (23 - 15) \cdot 1 \cdot 1 \cdot 1} = 0{,}59$
Life L_H [h]	(3.8.11) Page 21	$L_H = \frac{410}{pU} - a_L = \frac{410}{0{,}59} - 200 = 495$

4 Lubrication

Although DU® was developed as a dry self lubricating bearing material, DU® also provides excellent performance in lubricated applications.

The following sections describe the basics of lubrication and provide guidance on the application of DU in such environments.

4.1 LUBRICANTS

DU® can be used with most fluids including:

- water
- lubricating oils
- engine oil
- turbine oil
- hydraulic fluid
- solvent
- refrigerants

In general, the fluid will be acceptable if it does not chemically attack the PTFE/lead overlay or the porous bronze interlayer. Where there is doubt about the suitability of a fluid, a simple test is to submerge a sample of DU® material in the fluid for two to three weeks at 15-20 °C above the operating temperature.

The following will usually indicate that the fluid is not suitable for use with DU®:

- A significant change in the thickness of the DU® material,
- a visible change in the bearing surface other than some discolouration or staining,
- a visible change in the microstructure of the bronze interlayer.

4.2 TRIBOLOGY

There are three modes of lubricated bearing operation which relate to the thickness of the developed lubricant film between the bearing and the mating surface.

These three modes of operation depend upon:

- Bearing dimensions
- Clearance
- Load
- Speed
- Lubricant Viscosity
- Lubricant Flow

Hydrodynamic lubrication

Characterised by:

- Complete separation of the shaft from the bearing by the lubricant film
- Very low friction and no wear of the bearing or shaft since there is no contact.
- Coefficients of friction of 0,001 to 0,01

Hydrodynamic conditions occur when:

(4.2.1) [N/mm²]

$$p \leq \frac{U \cdot \eta}{7{,}5} \cdot \frac{B}{D_i}$$

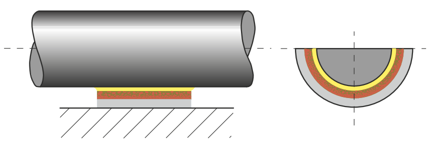


Figure 18: Hydrodynamic lubrication

Mixed Film Lubrication

Characterised by:

- Combination of hydrodynamic and boundary lubrication.
- Part of the load is carried by localised areas of self pressurised lubricant and the remainder supported by boundary lubrication.
- Friction and wear depend upon the degree of hydrodynamic support developed.
- DU® provides low friction and high wear resistance to support the boundary lubricated element of the load.

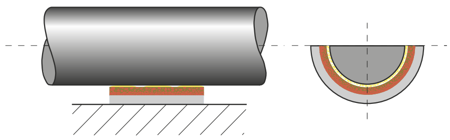


Figure 19: Mixed film lubrication

Boundary Lubrication

Characterised by:

- Rubbing of the shaft against the bearing with virtually no lubricant separating the two surfaces.
- Bearing material selection is critical to performance
- Shaft wear is likely due to contact between bearing and shaft.
- The excellent self lubricating properties of DU® material minimises wear under these conditions.
- The coefficient of friction with DU® is typically 0,02 to 0,06 under boundary lubrication conditions.

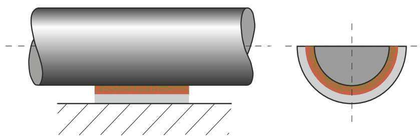


Figure 20: Boundary lubrication

4.3 CHARACTERISTICS OF LUBRICATED DU® BEARINGS

DU® is particularly effective in the most demanding of lubricated applications where full hydrodynamic operation cannot be maintained, for example:

- **High load conditions**

  In highly loaded applications operating under boundary or mixed film conditions DU® shows excellent wear resistance and low friction.

- **Start up and shut down under load**

  With insufficient speed to generate a hydrodynamic film the bearing will operate under boundary or mixed film conditions. DU® minimises wear and requires less start up torque than conventional metallic bearings.

- **Sparse lubrication**

  Many applications require the bearing to operate with less than the ideal lubricant supply, typically with splash or mist lubrication only. DU® provides excellent self lubricating properties.

- **Dry operation after running in water**

  If a DU® bearing is required to run dry after running in water under non hydrodynamic conditions then the wear resistance will be substantially reduced due to an increased amount of bedding in wear.

4.4 DESIGN GUIDANCE FOR LUBRICATED APPLICATIONS

Fig. 21 shows the three lubrication regimes discussed above. In order to use Fig. 21, using the formula on page 14 and page 15:

- Calculate the specific load p,
- Calculate the shaft surface speed U.

Using the viscosity temperature relationships presented in Table 9.

- Determine the lubricant viscosity in centipoise, of the lubricant.

If the operating temperature of the fluid is unknown, a provisional temperature of 25 °C above ambient can be used.

Area 1

The bearing will operate with boundary lubrication and pU factor will be the major determinant of bearing life. The DU® bearing performance can be calculated using the method given in Section 3, although the result will probably underestimate the bearing life

Area 2

The bearing will operate with mixed film lubrication and the pU factor is no longer a significant parameter in determining the bearing life. The DU® bearing performance will depend upon the nature of the fluid and the actual service conditions.

Area 3

The bearing will operate with hydrodynamic lubrication. The bearing wear will be determined only by the cleanliness of the lubricant and the frequency of start up and shut down.

Area 4

These are the most demanding operating conditions. The bearing is operated under either high speed or high bearing load to viscosity ratio, or a combination of both. These conditions may cause:

- excessive operating temperature and/or
- high wear rate.

The bearing performance may be improved by adding one or more grooves to the bearing and a shaft surface finish <0,05 µm Ra.

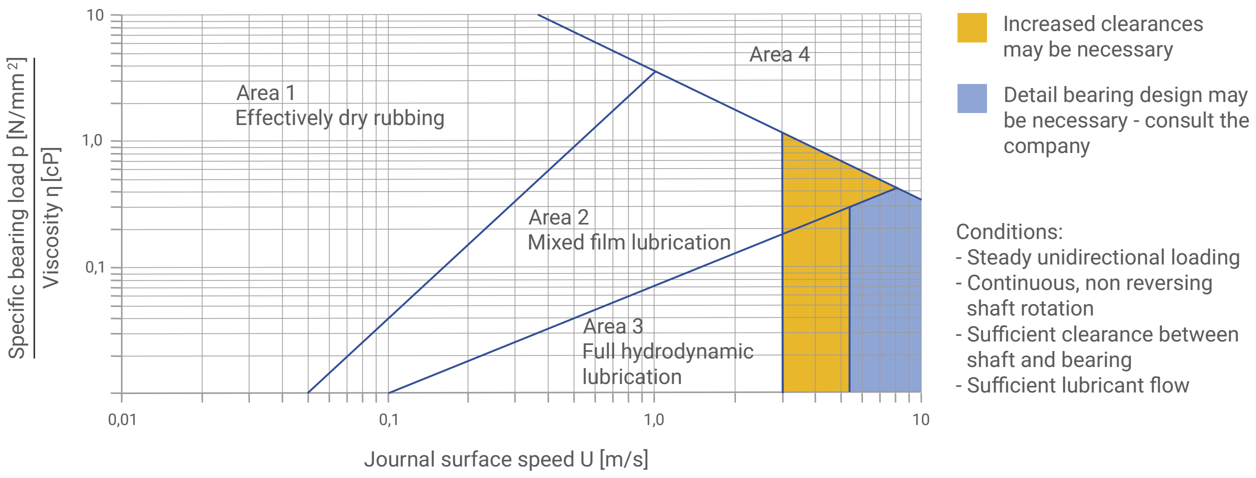


Fig. 21: Design guide for lubricated application

	VISCOSITY η [cP]														
Temperature [°C]	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140
Lubricant															
ISO VG 32	310	146	77	44	27	18	13	9,3	7,0	5,5	4,4	3,6	3,0	2,5	2,2
ISO VG 46	570	247	121	67	40	25	17	12	9,0	6,9	5,4	4,4	3,6	3,0	2,6
ISO VG 68	940	395	190	102	59	37	24	17	12	9,3	7,2	5,8	4,7	3,9	3,3
ISO VG 100	2110	780	335	164	89	52	33	22	15	11,3	8,6	6,7	5,3	4,3	3,6
ISO VG 150	3600	1290	540	255	134	77	48	31	21	15	11	8,8	7,0	5,6	4,6
Diesel oil	4,6	4,0	3,4	3,0	2,6	2,3	2,0	1,7	1,4	1,1	0,95				
Petrol	0,6	0,56	0,52	0,48	0,44	0,40	0,36	0,33	0,31						
Kerosene	2,0	1,7	1,5	1,3	1,1	0,95	0,85	0,75	0,65	0,60	0,55				
Water	1,79	1,30	1,0	0,84	0,69	0,55	0,48	0,41	0,34	0,32	0,28				

Table 9: Viscosity data

4.5 CLEARANCES FOR LUBRICATED OPERATION

The recommended shaft and housing diameters given for standard DU® bushes will provide sufficient clearance for applications operating with boundary lubrication.

For bearings operating with mixed film or hydrodynamic lubrication it may be necessary to improve the fluid flow through the bearing by reducing the recommended shaft diameter by approximately 0.1 %, particularly when the shaft surface speed exceeds 2,5 m/s.

4.6 MATING SURFACE FINISH FOR LUBRICATED OPERATION

- $R_a \leq 0,4$ µm boundary lubrication
- $R_a = 0,1 - 0,2$ µm mixed film or hydrodynamic conditions
- $R_a \leq 0,05$ µm for the most demanding operating conditions

4.7 GROOVING FOR LUBRICATED OPERATION

In demanding applications an axial oil groove will improve the performance of DU®. Fig. 22 shows the recommended form and location of a single groove with respect to the applied load and the bearing split. GGB can manufacture special DU® bearings with embossed or milled grooves on request.

4.8 GREASE LUBRICATION

DU® is not generally recommended for use with grease lubrication. In particular the following must be avoided:

- Dynamic loads - which can result in erosion of the PTFE/lead bearing surface.
- Greases with EP additives or fillers such as graphite or MoS_2 which can cause rapid wear of DU®.

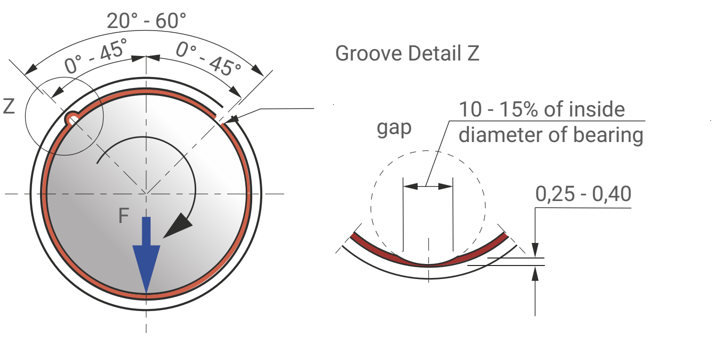


Fig. 22: Location of oil holes and grooves

5 Bearing Assembly

Dimensions and Tolerances

DU® bushes are prefinished in the bore, and except in very exceptional circumstances, must not be burnished, broached or otherwise modified. It is essential that the correct running clearance is used and that both the diameter of the shaft and the bore of the housing are finished to the limits given in the tables. Under dry running conditions any increase in the clearances given will result in a proportional reduction in performance.

If the bearing housing is unusually flexible the bush will not close in by the calculated amount and the running clearance will be more than the optimum. In these circumstances the housing should be bored slightly undersize or the journal diameter increased, the correct size being determined by experiment.

Where free running is essential, or where light loads (less than 0,1 N/mm²) prevail and the available torque is low, increased clearance is required and it is recommended that the shaft size quoted in the table be reduced by 0.025 mm.

5.1 ALLOWANCE FOR THERMAL EXPANSION

For operation in high temperature environments the clearance should be increased by the amounts indicated by Fig. 23 to compensate for the inward thermal expansion of the bearing lining.

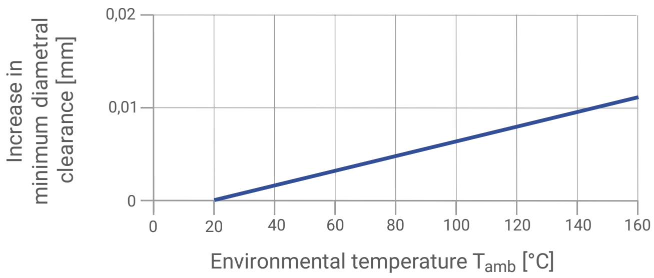


Fig. 23: Increase in diametral clearance

If the housing is non-ferrous then the bore should be reduced by the amounts given in Table 10, in order to give an increased interference fit to the bush, with a similar reduction in the journal diameter additional to that indicated by Fig. 23.

HOUSING MATERIAL	REDUCTION IN HOUSING DIAMETER PER 100°C RISE	REDUCTION IN SHAFT DIAMETER PER100°C RISE
Aluminium alloys	0,1 %	0,1 % + values from Fig. 23
Copper base alloys	0,05 %	0,05 % + values from Fig. 23
Steel and cast iron	–	values from Fig. 23
Zinc base alloys	0,15 %	0,15 % + values from Fig. 23

Table 10: Allowance for high temperature

5.2 TOLERANCES FOR MINIMUM CLEARANCE

Where it is required to keep the variation of assembled clearance to a minimum, closer tolerances can be specified towards the upper end of the journal tolerance and the lower end of the housing tolerance. If housings to H6 tolerance are used, then the journals should be finished to the following limits. The sizes in Table 11 give the following nominal clearance range.

D_i	D_J
< 25 mm	-0,019 to -0,029
> 25 mm < 50 mm	-0,021 to -0,035

Table 11: Shaft tolarances for use with H6 housings

D_i	D_J
10 mm	0,005 to 0,078
50 mm	0,005 to 0,130

Table 12: Clearance vs bearing diameter

Sizing

The burnishing or fine boring of the bore of an assembled DU® bush in order to achieve a smaller clearance tolerance is only permissible if a substantial reduction in performance is acceptable. Fig. 24 shows a recommended burnishing tool for the sizing of DU® bushes.

The coining section of the burnishing tool should be case hardened (case depth 0,6 - 1,2 mm, HRC 60±2) and polished ($R_Z \approx 1$ µm).

Note: Ball burnishing of DU® bushes is not recommended.

The values given in Table 13 indicate the dimensions of the burnishing tool required to give specific increases in the bearing bore diameter.

Exact values must be determined by test.

The reduction in bearing performance as a result of burnishing is allowed for in the bearing life calculation by the application factor a_C (Table 8, page 18).

ASSEMBLED BUSH INSIDE Ø	REQUIRED BUSH INSIDE Ø	REQUIRED BURNISHING TOOL Ø D_C
$D_{i,a}$	$D_{i,a}$ + 0,025	$D_{i,a}$ + 0,06
$D_{i,a}$	$D_{i,a}$ + 0,038	$D_{i,a}$ + 0,08
$D_{i,a}$	$D_{i,a}$ + 0,050	$D_{i,a}$ + 0,1

Table 13: Burnishing tool tolerances

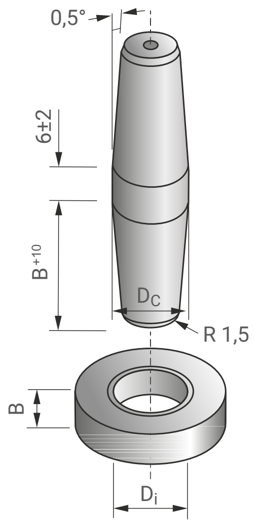


Fig. 24: Burnishing tool

5.3 COUNTERFACE DESIGN

The suitability of mating surface materials and recommendations of mating surface finish for use with DU® are discussed in detail on page 17.

DU® is normally used in conjunction with ferrous journals and thrust faces, but in damp or corrosive surroundings, particularly without the protection of oil or grease, stainless steel, hard chromium plated mild steel, or hard anodised aluminium is recommended. When plated mating surfaces are specified the plating should possess adequate strength and adhesion, particularly if the bearing is to operate with high fluctuating loads.

The shaft or thrust collar used in conjunction with the DU® bush or thrust washer must extend beyond the bearing surface in order to avoid cutting into it. The mating surface must also be free from grooves or flats, the end of the shaft should be given a lead-in chamfer and all sharp edges or projections which may damage the soft overlay of the DU® must be removed.

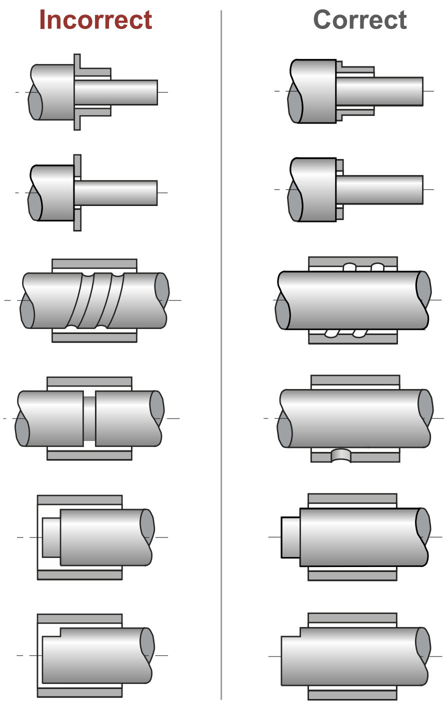


Fig. 25: Counterface Design

5 Bearing Assembly

5.4 INSTALLATION

Fitting of Cylindrical Bushes

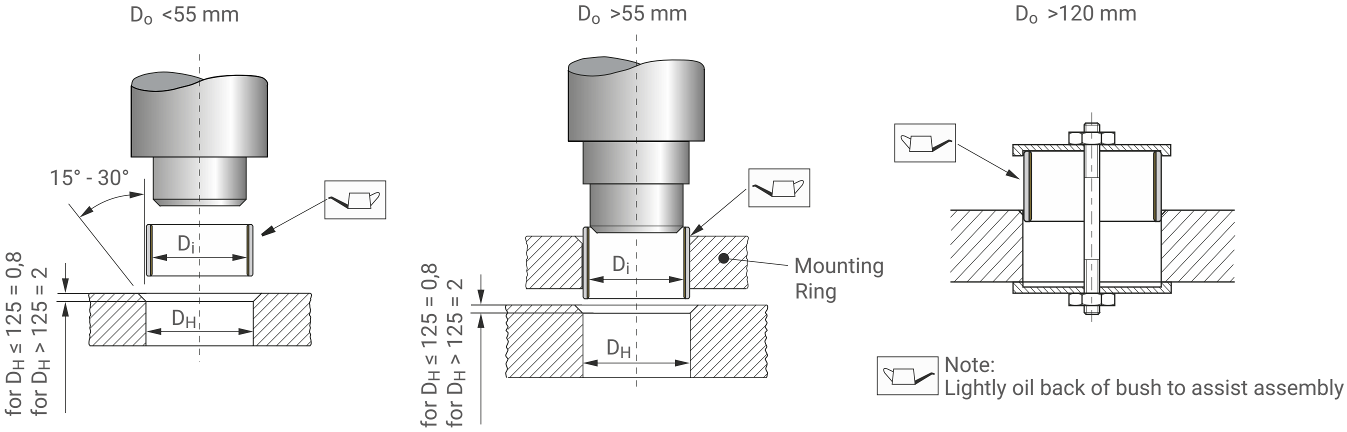


Fig. 26: Fitting of cylindrical bushes

Fitting of Flanged Bushes

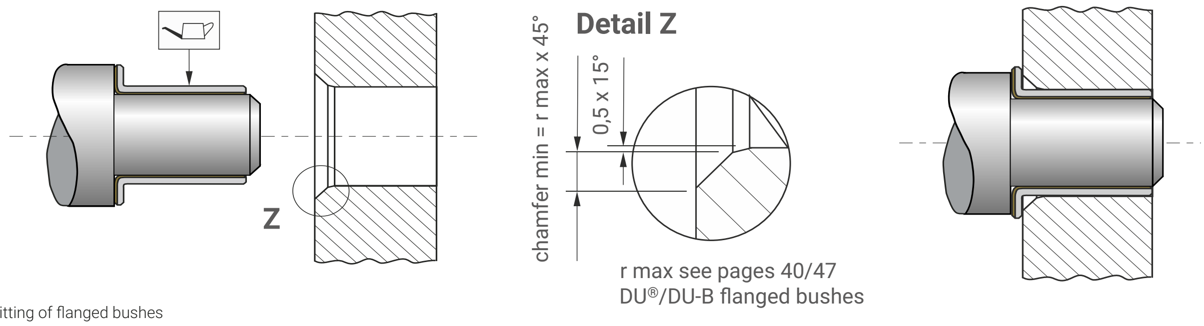


Fig. 27: Fitting of flanged bushes

Insertion Forces

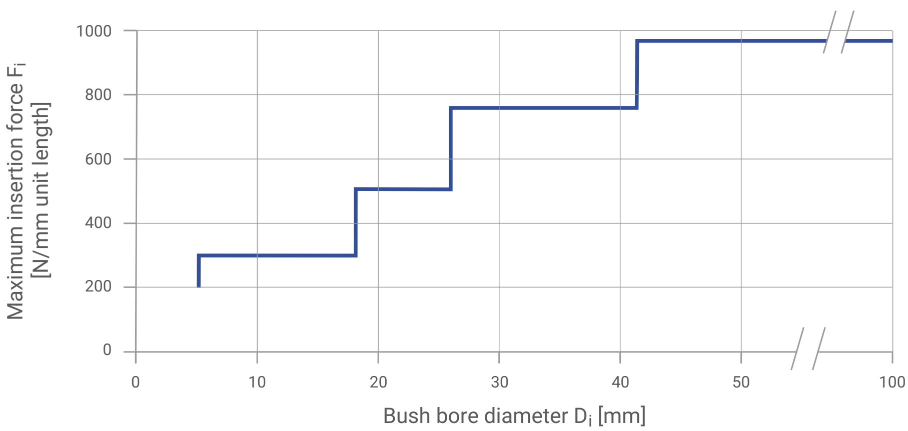


Fig. 28: Maximum Insertion Force F_i

Alignment

Accurate alignment is an important consideration for all bearing assemblies, but is particularly so for dry bearings because there is no lubricant to spread the load. With DU® bearings misalignment over the length of a bush (or pair of bushes), or over the diameter of a thrust washer should not exceed 0,020 mm as illustrated in Fig. 29.

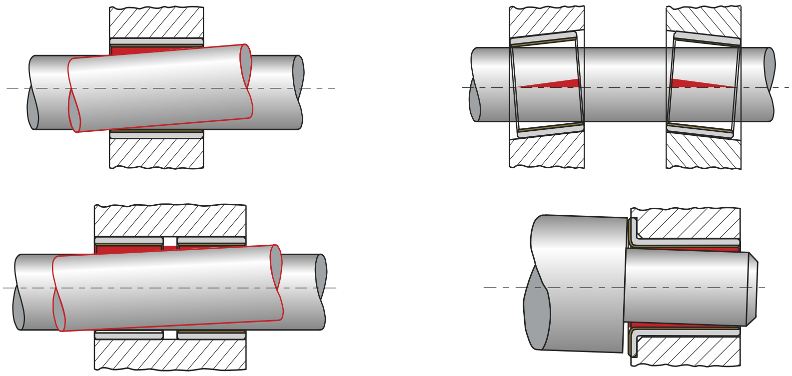


Fig. 29: Alignment

Sealing

While DU® can tolerate the ingress of some contaminant materials into the bearing without loss of performance, where there is the possibility of highly abrasive material entering the bearing, a suitable sealing arrangement, as illustrated in Fig. 30 should be provided.

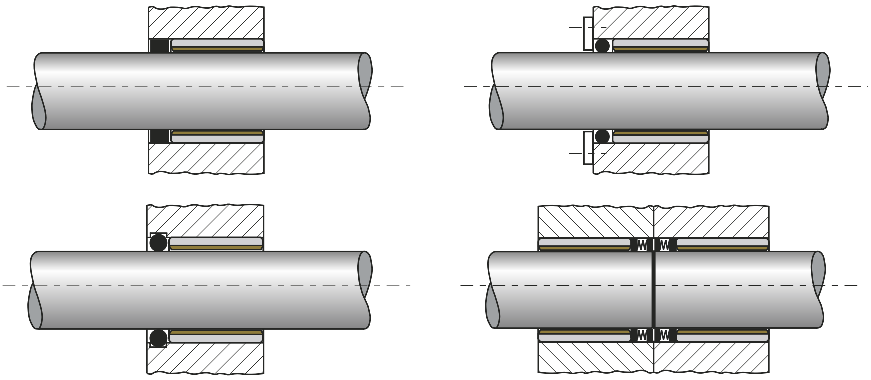


Fig. 30: Recommended sealing arrangements

5.5 AXIAL LOCATION

Where axial location is necessary, it is advisable to fit DU® thrust washers in conjunction with DU® bushes, even when the axial loads are low.

Fitting of Thrust Washers

DU® thrust washers should be located in a recess as shown in Fig. 31. The recess diameter should be 0.125 mm larger then the washer diameter and the depth as given in the product tables. If a recess is not possible one of the following methods may be used:

- Two dowel pins
- Two screws
- Adhesive
- Soldering

5 Bearing Assembly

Important Note

- Ensure the washer ID does not touch the shaft after assembly
- Ensure that the washer is mounted with the steel backing to the housing
- Dowels pins should be recessed 0,25 mm below the bearing surface
- Screws should be countersunk 0,25 mm below the bearing surface
- DU® must not be heated above 320 °C
- Contact adhesive manufacturers for guidance selection of suitable adhesives
- Protect the bearing surface to prevent contact with adhesive

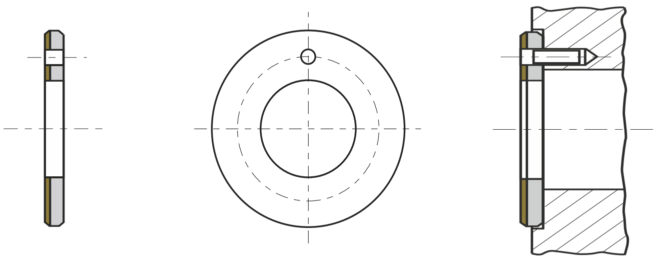


Fig. 31: Installation of Thrust-Washer

Grooves for Wear Debris Removal

Tests with thrust washers have demonstrated that for optimum dry wear performance at specific loads in excess of 35 N/mm², four wear debris removal grooves should be machined in the bearing surface as shown in Fig. 32.

Grooves in bushes have not been found to be beneficial in this respect.

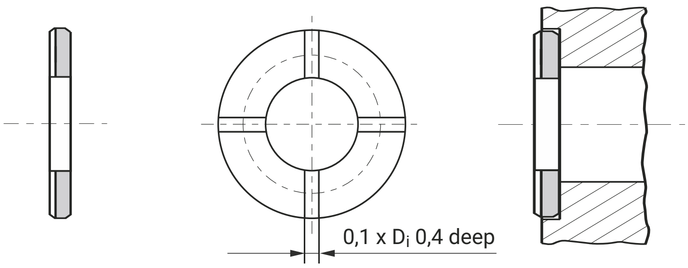


Fig. 32: Debris removal Grooves

Slideways

DU® strip material for use as slideway bearings should be installed using one of the following methods:

- Countersunk screws
- Adhesives
- Mechanical location as shown in Fig. 33

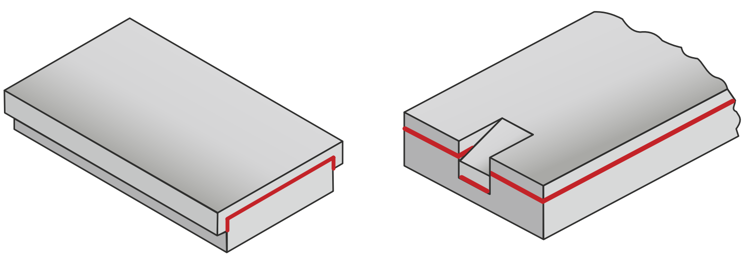


Fig. 33: Mechanical location of DU slideplates

6 Modification

6.1 CUTTING AND MACHINING

The modification of DU® bearing components requires no special procedures. In general it is more satisfactory to perform machining or drilling operations from the PTFE side in order to avoid burrs. When cutting is done from the steel side, the minimum cutting pressure should be used and care taken to ensure that any steel or bronze particles protruding into the remaining bearing material, and all burrs, are removed.

Drilling Oil Holes

Bushes should be adequately supported during the drilling operation to ensure that no distortion is caused by the drilling pressure.

Cutting Strip Material

DU® strip material may be cut to size by any one of the following methods.

Care must be taken to protect the bearing surface from damage and to ensure that no deformation of the strip occurs:

- Using side and face cutter, or slitting saw, with the strip held flat and securely on a horizontal milling machine.
- Cropping
- Guillotine (For widths less than 90 mm only)
- Water-jet cutting
- Laser cutting (see Health Warning)

6.2 ELECTROPLATING

DU® Components

In order to provide some protection in mildly corrosive environments the steel back and end faces of standard range DU® bearings are tin flashed.

If exposed to corrosive liquids further protection should be provided and in very corrosive conditions DU-B should be considered.

DU® can be electroplated with most of the conventional electroplating metals including the following:

- zinc ISO 2081-2
- cadmium ISO 2081-2
- nickel ISO 1456-8
- hard chromium ISO 1456-8

For the harder materials if the specified plating thickness exceeds approximately 5 μm then the housing diameter should be increased by twice the plating thickness in order to maintain the correct assembled bearing bore size.

With light deposits of materials such as cadmium, no special precautions are necessary. Harder materials such as nickel however, may strike through the PTFE/ lead surface layer of DU® and it is advisable to use an appropriate method of masking the bearing surface.

Where electrolytic attack is possible tests should be conducted to ensure that all the materials in the bearing environment are mutually compatible.

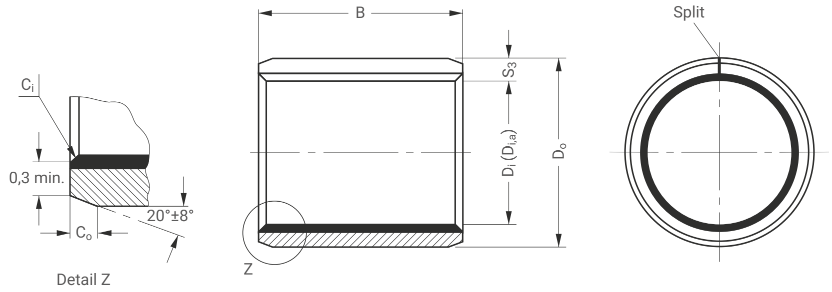
Mating Surfaces

DU® can be used against some plated materials as indicated on page 17.

Care should be taken to ensure that the recommended shaft sizes and surface finish are achieved after the plating process.

7 Standard Products

7.1 DU® CYLINDRICAL BUSHES



Dimensions and Tolerances according to ISO 3547 and GGB-Specifications

Outside C_o and Inside C_i Chamfers

WALL THICKNESS S_3	C_o (a) MACHINED /	ROLLED	C_i (b)
0,75	0,5 ± 0,3	0,5 ± 0,3	-0,1 to -0,4
1	0,6 ± 0,4	0,6 ± 0,4	-0,1 to -0,5
1,5	0,6 ± 0,4	0,6 ± 0,4	-0,1 to -0,7

WALL THICKNESS S_3	C_o (a) MACHINED /	ROLLED	C_i (b)
2	1,2 ± 0,4	1,0 ± 0,4	-0,1 to -0,7
2,5	1,8 ± 0,6	1,2 ± 0,4	-0,2 to -1,0

(a) = chamfer C_o machined or rolled at the opinion of the manufacturer
(b) = C_i can be a radius or a chamfer in accordance with ISO 13715

PART NO.	NOMINAL DIAMETER D_i	D_o	WALL THICKNESS S_3 max. min.	WIDTH B max. min.	SHAFT Ø D_J [h6, f7, h8]	max. min.	HOUSING Ø D_H [H6, H7]	max. min.	BUSH Ø $D_{i,a}$ ASSEMBLY IN H6/H7 HOUSING max. min.	CLEARANCE C_D max. min.
0203DU	2	3,5	0,750 0,730	3,25 2,75	h6	2,000 1,994	H6	3,508 3,500	2,048 2,000	0,054 0,000
0205DU				5,25 4,75						
0303DU	3	4,5		3,25 2,75		3,000 2,994		4,508 4,500	3,048 3,000	
0305DU				5,25 4,75						
0306DU				6,25 5,75						
0403DU	4	5,5		3,25 2,75		4,000 3,992		5,508 5,500	4,048 4,000	0,056 0,000
0404DU				4,25 3,75						
0406DU				6,25 5,75						
0410DU				10,25 9,75						
0505DU	5	7	1,005 0,980	5,25 4,75	f7	4,990 4,978	H7	7,015 7,000	5,055 4,990	0,077 0,000
0508DU				8,25 7,75						
0510DU				10,25 9,75						
0604DU	6	8		4,25 3,75		5,990 5,978		8,015 8,000	6,055 5,990	
0606DU				6,25 5,75						
0608DU				8,25 7,75						
0610DU				10,25 9,75						
0705DU	7	9		5,25 4,75		6,987 6,972		9,015 9,000	7,055 6,990	0,083 0,003
0710DU				10,25 9,75						

All dimensions in mm

PART NO.	NOMINAL DIAMETER D_i	NOMINAL DIAMETER D_o	WALL THICKNESS S_3 max. min.	WIDTH B max. min.	SHAFT Ø D_J [h6, f7, h8]	SHAFT Ø D_J [h6, f7, h8] max. min.	HOUSING Ø D_H [H6, H7]	HOUSING Ø D_H [H6, H7] max. min.	BUSH Ø $D_{i,a}$ ASSEMBLY IN H6/H7 HOUSING max. min.	CLEARANCE C_D max. min.
0806DU	8	10	1,005 0,980	6,25 5,75	f7	7,987 7,972	H7	10,015 10,000	8,055 7,990	0,083 0,003
0808DU				8,25 7,75						
0810DU				10,25 9,75						
0812DU				12,25 11,75						
1006DU	10	12		6,25 5,75		9,987 9,972		12,018 12,000	10,058 9,990	0,086 0,003
1008DU				8,25 7,75						
1010DU				10,25 9,75						
1012DU				12,25 11,75						
1015DU				15,25 14,75						
1020DU				20,25 19,75						
1208DU	12	14		8,25 7,75		11,984 11,966		14,018 14,000	12,058 11,990	0,092 0,006
1210DU				10,25 9,75						
1212DU				12,25 11,75						
1215DU				15,25 14,75						
1220DU				20,25 19,75						
1225DU				25,25 24,75						
1310DU	13	15		10,25 9,75		12,984 12,966		15,018 15,000	13,058 12,990	
1320DU				20,25 19,75						
1405DU	14	16		5,25 4,75		13,984 13,966		16,018 16,000	14,058 13,990	
1410DU				10,25 9,75						
1412DU				12,25 11,75						
1415DU				15,25 14,75						
1420DU				20,25 19,75						
1425DU				25,25 24,75						
1510DU	15	17		10,25 9,75		14,984 14,966		17,018 17,000	15,058 14,990	
1512DU				12,25 11,75						
1515DU				15,25 14,75						
1520DU				20,25 19,75						
1525DU				25,25 24,75						
1610DU	16	18		10,25 9,75		15,984 15,966		18,018 18,000	16,058 15,990	
1612DU				12,25 11,75						
1615DU				15,25 14,75						
1620DU				20,25 19,75						
1625DU				25,25 24,75						
1720DU	17	19		20,25 19,75		16,984 16,966		19,021 19,000	17,061 16,990	0,095 0,006

All dimensions in mm

7 Standard Products

PART NO.	NOMINAL DIAMETER D_i	NOMINAL DIAMETER D_o	WALL THICKNESS S_3 max. min.	WIDTH B max. min.	SHAFT Ø D_J [h6, f7, h8]	SHAFT Ø D_J max. min.	HOUSING Ø D_H [H6, H7]	HOUSING Ø D_H max. min.	BUSH Ø $D_{i,a}$ ASSEMBLY IN H6/H7 HOUSING max. min.	CLEARANCE C_D max. min.
1810DU	18	20	1,005 0,980	10,25 9,75	f7	17,984 17,966	H7	20,021 20,000	18,061 17,990	0,095 0,006
1815DU				15,25 14,75						
1820DU				20,25 19,75						
1825DU				25,25 24,75						
2010DU	20	23	1,505 1,475	10,25 9,75		19,980 19,959		23,021 23,000	20,071 19,990	0,112 0,010
2015DU				15,25 14,75						
2020DU				20,25 19,75						
2025DU				25,25 24,75						
2030DU				30,25 29,75						
2215DU	22	25		15,25 14,75		21,980 21,959		25,021 25,000	22,071 21,990	
2220DU				20,25 19,75						
2225DU				25,25 24,75						
2230DU				30,25 29,75						
2415DU	24	27		15,25 14,75		23,980 23,959		27,021 27,000	24,071 23,990	
2420DU				20,25 19,75						
2425DU				25,25 24,75						
2430DU				30,25 29,75						
2515DU	25	28		15,25 14,75		24,980 24,959		28,021 28,000	25,071 24,990	
2520DU				20,25 19,75						
2525DU				25,25 24,75						
2530DU				30,25 29,75						
2550DU				50,25 49,75						
2815DU	28	32	2,005 1,970	15,25 14,75		27,980 27,959		32,025 32,000	28,085 27,990	0,126 0,010
2820DU				20,25 19,75						
2825DU				25,25 24,75						
2830DU				30,25 29,75						
3010DU	30	34		10,25 9,75		29,980 29,959		34,025 34,000	30,085 29,990	
3015DU				15,25 14,75						
3020DU				20,25 19,75						
3025DU				25,25 24,75						
3030DU				30,25 29,75						
3040DU				40,25 39,75						
3220DU	32	36		20,25 19,75		31,975 31,950		36,025 36,000	32,085 31,990	0,135 0,015
3230DU				30,25 29,75						
3240DU				40,25 39,75						

All dimensions in mm

PART NO.	NOMINAL DIAMETER D_i	NOMINAL DIAMETER D_o	WALL THICKNESS s_3 max. min.	WIDTH B max. min.	SHAFT Ø D_J [h6, f7, h8]	SHAFT Ø D_J max. min.	HOUSING Ø D_H [H6, H7]	HOUSING Ø D_H max. min.	BUSH Ø $D_{i,a}$ ASSEMBLY IN H6/H7 HOUSING max. min.	CLEARANCE C_D max. min.
3520DU	35	39	2,005 1,970	20,25 19,75	f7	34,975 34,950	H7	39,025 39,000	35,085 34,990	0,135 0,015
3530DU				30,25 29,75						
3535DU				35,25 34,75						
3540DU				40,25 39,75						
3550DU				50,25 49,75						
3720DU	37	41		20,25 19,75		36,975 36,950		41,025 41,000	37,085 36,990	
4020DU	40	44		20,25 19,75		39,975 39,950		44,025 44,000	40,085 39,990	
4030DU				30,25 29,75						
4040DU				40,25 39,75						
4050DU				50,25 49,75						
4520DU	45	50	2,505 2,460	20,25 19,75		44,975 44,950		50,025 50,000	45,105 44,990	0,155 0,015
4530DU				30,25 29,75						
4540DU				40,25 39,75						
4545DU				45,25 44,75						
4550DU				50,25 49,75						
5020DU	50	55		20,25 19,75		49,975 49,950		55,030 55,000	50,110 49,990	0,160 0,015
5030DU				30,25 29,75						
5040DU				40,25 39,75						
5050DU				50,25 49,75						
5060DU				60,25 59,75						
5520DU	55	60		20,25 19,75		54,970 54,940		60,030 60,000	55,110 54,990	0,170 0,020
5525DU				25,25 24,75						
5530DU				30,25 29,75						
5540DU				40,25 39,75						
5550DU				50,25 49,75						
5555DU				55,25 54,75						
5560DU				60,25 59,75						
6020DU	60	65		20,25 19,75		59,970 59,940		65,030 65,000	60,110 59,990	0,170 0,020
6030DU				30,25 29,75						
6040DU				40,25 39,75						
6050DU				50,25 49,75						
6060DU				60,25 59,75						
6070DU				70,25 69,75						

All dimensions in mm

7 Standard Products

PART NO.	NOMINAL DIAMETER D_i	D_o	WALL THICKNESS S_3 max. min.	WIDTH B max. min.	SHAFT Ø D_J [h6, f7, h8]	max. min.	HOUSING Ø D_H [H6, H7]	max. min.	BUSH Ø $D_{i,a}$ ASSEMBLY IN H6/H7 HOUSING max. min.	CLEARANCE C_D max. min.
6530DU	65	70	2,505 2,460	30,25 29,75	f7	64,970 64,940	H7	70,030 70,000	65,110 64,990	0,170 0,020
6550DU				50,25 49,75						
6570DU				70,25 69,75						
7040DU	70	75		40,25 39,75		69,970 69,940		75,030 75,000	70,110 69,990	
7050DU				50,25 49,75						
7070DU				70,25 69,75						
7560DU	75	80		60,25 59,75		74,970 74,940		80,030 80,000	75,110 74,990	
7580DU				80,25 79,75						
8040DU	80	85	2,490 2,440	40,50 39,50	h8	80,000 79,946		85,035 85,000	80,155 80,020	0,209 0,020
8060DU				60,50 59,50						
8080DU				80,50 79,50						
80100DU				100,50 99,50						
8530DU	85	90		30,50 29,50		85,000 84,946		90,035 90,000	85,155 85,020	
8560DU				60,50 59,50						
85100DU				100,50 99,50						
9060DU	90	95		60,50 59,50		90,000 89,946		95,035 95,000	90,155 90,020	
90100DU				100,50 99,50						
9560DU	95	100		60,50 59,50		95,000 94,946		100,035 100,000	95,155 95,020	
95100DU				100,50 99,50						
10050DU	100	105		50,50 49,50		100,000 99,946		105,035 105,000	100,155 100,020	
10060DU				60,50 59,50						
100115DU				115,50 114,50						
10560DU	105	110		60,50 59,50		105,000 104,946		110,035 110,000	105,155 105,020	
105115DU				115,50 114,50						
11060DU	110	115		60,50 59,50		110,000 109,946		115,035 115,000	110,155 110,020	
110115DU				115,50 114,50						
11550DU	115	120		50,50 49,50		115,000 114,946		120,035 120,000	115,155 115,020	
11570DU				70,50 69,50						
12050DU	120	125	2,465 2,415	50,50 49,50		120,000 119,946		125,040 125,000	120,210 120,070	0,264 0,070
12060DU				60,50 59,50						
120100DU				100,50 99,50						
125100DU	125	130		100,50 99,50		125,000 124,937		130,040 130,000	125,210 125,070	0,273 0,070
13060DU	130	135		60,50 59,50		130,000 129,937		135,040 135,000	130,210 130,070	
130100DU				100,50 99,50						

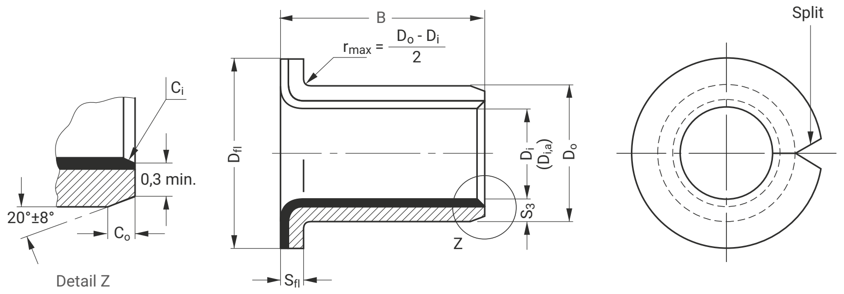
All dimensions in mm

PART NO.	NOMINAL DIAMETER D_i	NOMINAL DIAMETER D_o	WALL THICKNESS S_3 max. min.	WIDTH B max. min.		SHAFT Ø D_J [h6, f7, h8] max. min.		HOUSING Ø D_H [H6, H7] max. min.	BUSH Ø $D_{i,a}$ ASSEMBLY IN H6/H7 HOUSING max. min.	CLEARANCE C_D max. min.
13560DU	135	140	2,465 2,415	60,50 59,50	h8	135,000 134,937	H7	140,040 140,000	135,210 135,070	0,273 0,070
13580DU				80,50 79,50						
14060DU	140	145		60,50 59,50		140,000 139,937		145,040 145,000	140,210 140,070	
140100DU				100,50 99,50						
15060DU	150	155		60,50 59,50		150,000 149,937		155,040 155,000	150,210 150,070	
15080DU				80,50 79,50						
150100DU				100,50 99,50						
16080DU	160	165		80,50 79,50		160,000 159,937		165,040 165,000	160,210 160,070	
160100DU				100,50 99,50						
180100DU	180	185		100,50 99,50		180,000 179,937		185,046 185,000	180,216 180,070	0,279 0,070
200100DU	200	205				200,000 199,928		205,046 205,000	200,216 200,070	0,288 0,070
210100DU	210	215				210,000 209,928		215,046 215,000	210,216 210,070	
220100DU	220	225				220,000 219,928		225,046 225,000	220,216 220,070	
250100DU	250	255				250,000 249,928		255,052 255,000	250,222 250,070	0,294 0,070
300100DU	300	305				300,000 299,919		305,052 305,000	300,222 300,070	0,303 0,070

All dimensions in mm

7 Standard Products

7.2 DU® FLANGED BUSHES



Dimensions and Tolerances according to ISO 3547 and GGB-Specifications

Outside C_o and Inside C_i Chamfers

WALL THICKNESS S_3	C_o (a) MACHINED	/ ROLLED	C_i (b)
0,75	0,5 ± 0,3	0,5 ± 0,3	-0,1 to -0,4
1	0,6 ± 0,4	0,6 ± 0,4	-0,1 to -0,5
1,5	0,6 ± 0,4	0,6 ± 0,4	-0,1 to -0,7
2	1,2 ± 0,4	1,0 ± 0,4	-0,1 to -0,7
2,5	1,8 ± 0,6	1,2 ± 0,4	-0,2 to -1,0

(a) = chamfer C_o machined or rolled at the opinion of the manufacturer
(b) = C_i can be a radius or a chamfer in accordance with ISO 13715

PART NO.	NOMINAL DIAMETER D_i	D_o	WALL THICKNESS S_3 max. min.	FLANGE THICKN. S_{fl} max. min.	FLANGE Ø D_{fl} max. min.	WIDTH B max. min.	SHAFT Ø D_J [h6, f7, h8]	max. min.	HOUSING Ø D_H [H6, H7]	max. min.	BUSH Ø $D_{i,a}$ ASSEMBLY IN H6/H7 HOUSING max. min.	CLEARANCE C_D max. min.
BB0304DU	3	4,5	0,750 0,730	0,80 0,70	7,50 6,50	4,25 3,75	h6	3,000 2,994	H6	4,508 4,500	3,048 3,000	0,054 0,000
BB0404DU	4	5,5			9,50 8,50	4,25 3,75		4,000 3,992		5,508 4,500	4,048 4,000	0,056 0,000
BB0505DU	5	7	1,005 0,980	1,05 0,80	10,50 9,50	5,25 4,75	f7	4,990 4,978	H7	7,015 7,000	5,055 4,990	0,077 0,000
BB0604DU	6	8			12,50 11,50	4,25 3,75		5,990 5,978		8,015 8,000	6,055 5,990	0,077 0,000
BB0608DU						8,25 7,75						
BB0806DU	8	10			15,50 14,50	5,75 5,25		7,987 7,972		10,015 10,000	8,055 7,990	0,083 0,003
BB0808DU						7,75 7,25						
BB0810DU						9,75 9,25						
BB1007DU	10	12			18,50 17,50	7,25 6,75		9,987 9,972		12,018 12,000	10,058 9,990	0,086 0,003
BB1009DU						9,25 8,75						
BB1012DU						12,25 11,75						
BB1017DU						17,25 16,75						
BB1207DU	12	14			20,50 19,50	7,25 6,75		11,984 11,966		14,018 14,000	12,058 11,990	0,092 0,006
BB1209DU						9,25 8,75						
BB1212DU						12,25 11,75						
BB1217DU						17,25 16,75						
BB1412DU	14	16			22,50 21,50	12,25 11,75		13,984 13,966		16,018 16,000	14,058 13,990	
BB1417DU						17,25 16,75						

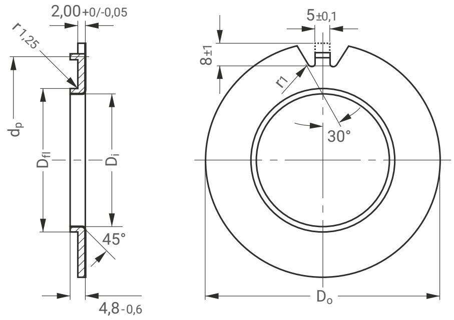
All dimensions in mm

PART NO.	NOMINAL DIAMETER D_i	NOMINAL DIAMETER D_o	WALL THICK-NESS S_3 max. min.	FLANGE THICKN. S_{fl} max. min.	FLANGE Ø D_{fl} max. min.	WIDTH B max. min.	SHAFT Ø D_J [h6, f7, h8]	SHAFT Ø max. min.	HOUSING Ø D_H [H6, H7]	HOUSING Ø max. min.	BUSH Ø $D_{i,a}$ ASSEMBLY IN H6/H7 HOUSING max. min.	CLEARANCE C_D max. min.
BB1509DU	15	17	1,005 0,980	1,05 0,80	23,50 22,50	9,25 8,75	f7	14,984 14,966	H7	17,018 17,000	15,058 14,990	0,092 0,006
BB1512DU						12,25 11,75						
BB1517DU						17,25 16,75						
BB1612DU	16	18			24,50 23,50	12,25 11,75		15,984 15,966		18,018 18,000	16,058 15,990	
BB1617DU						17,25 16,75						
BB1812DU	18	20			26,50 25,50	12,25 11,75		17,984 17,966		20,021 20,000	18,061 17,990	0,095 0,006
BB1817DU						17,25 16,75						
BB1822DU						22,25 21,75						
BB2012DU	20	23	1,505 1,475	1,60 1,30	30,50 29,50	11,75 11,25		19,980 19,959		23,021 23,000	20,071 19,990	0,112 0,010
BB2017DU						16,75 16,25						
BB2022DU						21,75 21,25						
BB2512DU	25	28			35,50 34,50	11,75 11,25		24,980 24,959		28,021 28,000	25,071 24,990	
BB2517DU						16,75 16,25						
BB2522DU						21,75 21,25						
BB3016DU	30	34	2,005 1,970	2,10 1,80	42,50 41,50	16,25 15,75		29,980 29,959		34,025 34,000	30,085 29,990	0,126 0,010
BB3026DU						26,25 25,75						
BB3516DU	35	39			47,50 46,50	16,25 15,75		34,975 34,950		39,025 39,000	35,085 34,990	0,135 0,015
BB3526DU						26,25 25,75						
BB4016DU	40	44			53,50 52,50	16,25 15,75		39,975 39,950		44,025 44,000	40,085 39,990	
BB4026DU						26,25 25,75						
BB4516DU	45	50	2,505 2,460	2,60 2,30	58,50 57,50	16,25 15,75		44,975 44,950		50,025 50,000	45,105 44,990	0,155 0,015
BB4526DU						26,25 25,75						

All dimensions in mm

7 Standard Products

7.3 DU® FLANGED WASHERS

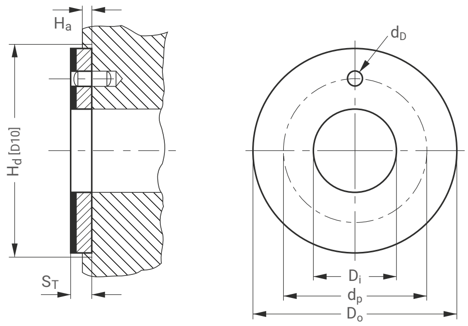


Dimensions and Tolerances according to ISO 3547 and GGB-Specifications

PART NO.	INSIDE DIAMETER D_i max. min.	OUTSIDE DIAMETER D_o max. min.	FLANGE Ø D_{fl} max. min.	LOCATION Ø d_P max. min.
BS40DU	40,7 40,2	75,0 74,5	44,00 43,90	65,0 64,5
BS50DU	51,5 51,0	85,0 84,5	55,00 54,88	75,0 74,5
BS60DU	61,5 61,0	95,0 94,5	65,00 64,88	85,0 84,5
BS70DU	71,5 71,0	110,0 109,5	75,00 74,88	100,0 99,5
BS80DU	81,5 81,0	120,0 119,5	85,00 84,86	110,0 109,5
BS90DU	91,5 91,0	130,0 129,5	95,00 94,86	120,0 119,5
BS100DU	101,5 101,0	140,0 139,5	105,00 104,86	130,0 129,5

All dimensions in mm

7.4 DU® THRUST WASHERS



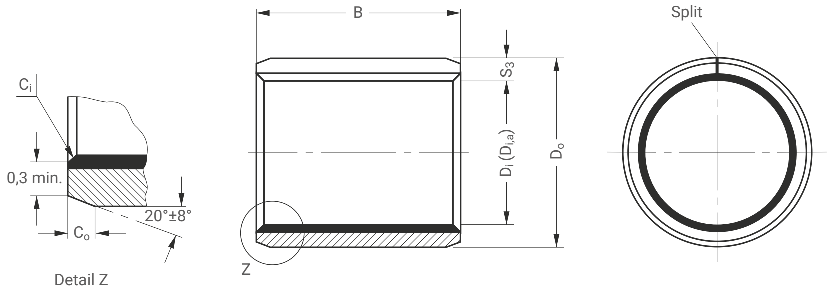
Dimensions and Tolerances according to ISO 3547 and GGB-Specifications

PART NO.	INSIDE DIAMETER D_i max.	INSIDE DIAMETER D_i min.	OUTSIDE DIAMETER D_o max.	OUTSIDE DIAMETER D_o min.	THICKNESS S_T max. / min.	DOWEL HOLE Ø d_D max. / min.	DOWEL HOLE PCD Ø d_P max. / min.	RECESS DEPTH H_a max. / min.
WC08DU	10,25	10,00	20,00	19,75	1,50 / 1,45	No Hole	No Hole	1,20 / 0,95
WC10DU	12,25	12,00	24,00	23,75		1,875 / 1,625	18,12 / 17,88	
WC12DU	14,25	14,00	26,00	25,75		2,375 / 2,125	20,12 / 19,88	
WC14DU	16,25	16,00	30,00	29,75			22,12 / 21,88	
WC16DU	18,25	18,00	32,00	31,75			25,12 / 24,88	
WC18DU	20,25	20,00	36,00	35,75		3,375 / 3,125	28,12 / 27,88	
WC20DU	22,25	22,00	38,00	37,75			30,12 / 29,88	
WC22DU	24,25	24,00	42,00	41,75			33,12 / 32,88	
WC24DU	26,25	26,00	44,00	43,75			35,12 / 34,88	
WC25DU	28,25	28,00	48,00	47,75		4,375 / 4,125	38,12 / 37,88	
WC30DU	32,25	32,00	54,00	53,75			43,12 / 42,88	
WC35DU	38,25	38,00	62,00	61,75			50,12 / 49,88	
WC40DU	42,25	42,00	66,00	65,75			54,12 / 53,88	
WC45DU	48,25	48,00	74,00	73,75	2,00 / 1,95		61,12 / 60,88	1,70 / 1,45
WC50DU	52,25	52,00	78,00	77,75			65,12 / 64,88	
WC60DU	62,25	62,00	90,00	89,75			76,12 / 75,88	

All dimensions in mm

7 Standard Products

7.5 DU-B CYLINDRICAL BUSHES



Dimensions and Tolerances according to ISO 3547 and GGB-Specifications

Outside C_o and Inside C_i Chamfers

WALL THICKNESS S_3	C_o (a) MACHINED /	ROLLED	C_i (b)
0,75	0,5 ± 0,3	0,5 ± 0,3	-0,1 to -0,4
1	0,6 ± 0,4	0,6 ± 0,4	-0,1 to -0,5
1,5	0,6 ± 0,4	0,6 ± 0,4	-0,1 to -0,7

WALL THICKNESS S_3	C_o (a) MACHINED /	ROLLED	C_i (b)
2	1,2 ± 0,4	1,0 ± 0,4	-0,1 to -0,7
2,5	1,8 ± 0,6	1,2 ± 0,4	-0,2 to -1,0

(a) = chamfer C_O machined or rolled at the opinion of the manufacturer
(b) = C_i can be a radius or a chamfer in accordance with ISO 13715

PART NO.	NOMINAL DIAMETER D_i	D_o	WALL THICKNESS S_3 max. min.	WIDTH B max. min.	SHAFT Ø D_J [h6, f7, h8]	max. min.	HOUSING Ø D_H [H6, H7]	max. min.	BUSH Ø $D_{i,a}$ ASSEMBLY IN H6/H7 HOUSING max. min.	CLEARANCE C_D max. min.
0203DUB	2	3,5	0,750 0,730	3,25 2,75	h6	2,000 1,994	H6	3,508 3,500	2,048 2,000	0,054 0,000
0205DUB				5,25 4,75						
0306DUB	3	4,5		6,25 5,75		3,000 2,994		4,508 4,500	3,048 3,000	
0404DUB	4	5,5		4,25 3,75		4,000 3,992		5,508 5,500	4,048 4,000	0,056 0,000
0406DUB				6,25 5,75						
0505DUB	5	7	1,005 0,980	5,25 4,75	f7	4,990 4,978	H7	7,015 7,000	5,055 4,990	0,077 0,000
0510DUB				10,25 9,75						
0606DUB	6	8		6,25 5,75		5,990 5,978		8,015 8,000	6,055 5,990	
0608DUB				8,25 7,75						
0610DUB				10,25 9,75						
0808DUB	8	10		8,25 7,75		7,987 7,972		10,015 10,000	8,055 7,990	0,083 0,003
0810DUB				10,25 9,75						
0812DUB				12,25 11,75						
1010DUB	10	12		10,25 9,75		9,987 9,972		12,018 12,000	10,058 9,990	0,086 0,003
1015DUB				15,25 14,75						
1208DUB	12	14		8,25 7,75		11,984 11,966		14,018 14,000	12,058 11,990	0,092 0,006
1210DUB				10,25 9,75						
1212DUB				12,25 11,75						
1215DUB				15,25 14,75						

All dimensions in mm

PART NO.	NOMINAL DIAMETER D_i	NOMINAL DIAMETER D_o	WALL THICKNESS S_3 max. min.	WIDTH B max. min.	SHAFT Ø D_J [h6, f7, h8] max. min.		HOUSING Ø D_H [H6, H7] max. min.		BUSH Ø $D_{i,a}$ ASSEMBLY IN H6/H7 HOUSING max. min.	CLEARANCE C_D max. min.
1410DUB	14	16	1,005 0,980	10,25 9,75	f7	13,984 13,966	H7	16,018 16,000	14,058 13,990	0,092 0,006
1415DUB				15,25 14,75						
1420DUB				20,25 19,75						
1515DUB	15	17		15,25 14,75		14,984 14,966		17,018 17,000	15,058 14,990	
1525DUB				25,25 24,75						
1615DUB	16	18		15,25 14,75		15,984 15,966		18,018 18,000	16,058 15,990	
1625DUB				25,25 24,75						
1820DUB	18	20		20,25 19,75		17,984 17,966		20,021 20,000	18,061 17,990	0,095 0,006
1825DUB				25,25 24,75						
2015DUB	20	23	1,505 1,475	15,25 14,75		19,980 19,959		23,021 23,000	20,071 19,990	0,112 0,010
2020DUB				20,25 19,75						
2025DUB				25,25 24,75						
2030DUB				30,25 29,75						
2215DUB	22	25		15,25 14,75		21,980 21,959		25,021 25,000	22,071 21,990	
2220DUB				20,25 19,75						
2225DUB				25,25 24,75						
2515DUB	25	28		15,25 14,75		24,980 24,959		28,021 28,000	25,071 24,990	
2525DUB				25,25 24,75						
2830DUB	28	32	2,005 1,970	30,25 29,75		27,980 27,959		32,025 32,000	28,085 27,990	0,126 0,010
3020DUB	30	34		20,25 19,75		29,980 29,959		34,025 34,000	30,085 29,990	
3030DUB				30,25 29,75						
3040DUB				40,25 39,75						
3520DUB	35	39		20,25 19,75		34,975 34,950		39,025 39,000	35,085 34,990	0,135 0,015
3530DUB				30,25 29,75						
4030DUB	40	44		30,25 29,75		39,975 39,950		44,025 44,000	40,085 39,990	
4050DUB				50,25 49,75						
4530DUB	45	50	2,505 2,460	30,25 29,75		44,975 44,950		50,025 50,000	45,105 44,990	0,155 0,015
4550DUB				50,25 49,75						
5040DUB	50	55		40,25 39,75		49,975 49,950		55,030 55,000	50,110 49,990	0,160 0,015
5060DUB				60,25 59,75						
5540DUB	55	60		40,25 39,75		54,970 54,940		60,030 60,000	55,110 54,990	0,170 0,020
6040DUB	60	65		40,25 39,75		59,970 59,940		65,030 65,000	60,110 59,990	
6050DUB				50,25 49,75						
6060DUB				60,25 59,75						
6070DUB				70,25 69,75						
6570DUB	65	70		70,25 69,75		64,970 64,940		70,030 70,000	65,110 64,990	

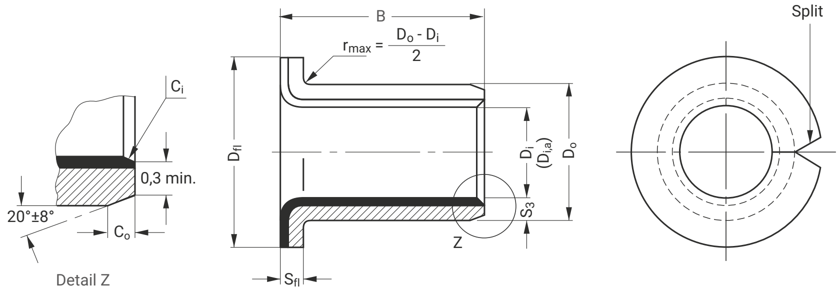
All dimensions in mm

7 Standard Products

PART NO.	NOMINAL DIAMETER D_i	NOMINAL DIAMETER D_O	WALL THICKNESS s_3 max. min.	WIDTH B max. min.	SHAFT Ø D_J [h6, f7, h8]	SHAFT Ø D_J max. min.	HOUSING Ø D_H [H6, H7]	HOUSING Ø D_H max. min.	BUSH Ø $D_{i,a}$ ASSEMBLY IN H6/H7 HOUSING max. min.	CLEARANCE C_D max. min.
7050DUB	70	75	2,505 2,460	50,25 49,75	f7	69,970 69,940	H7	75,030 75,000	70,110 69,990	0,170 0,020
7070DUB	70	75	2,505 2,460	70,25 69,75	f7	69,970 69,940	H7	75,030 75,000	70,110 69,990	0,170 0,020
7580DUB	75	80	2,505 2,460	80,25 79,75	f7	74,970 74,940	H7	80,030 80,000	75,110 74,990	0,170 0,020
8060DUB	80	85	2,490 2,440	60,50 59,50	h8	80,000 79,946	H7	85,035 85,000	80,155 80,020	0,201 0,020
80100DUB	80	85	2,490 2,440	100,50 99,50	h8	80,000 79,946	H7	85,035 85,000	80,155 80,020	0,201 0,020
85100DUB	85	90	2,490 2,440	100,50 99,50	h8	85,000 84,946	H7	90,035 90,000	85,155 85,020	0,209 0,020
9060DUB	90	95	2,490 2,440	60,50 59,50	h8	90,000 89,946	H7	95,035 95,000	90,155 90,020	0,209 0,020
90100DUB	90	95	2,490 2,440	100,50 99,50	h8	90,000 89,946	H7	95,035 95,000	90,155 90,020	0,209 0,020
95100DUB	95	100	2,490 2,440	100,50 99,50	h8	95,000 94,946	H7	100,035 100,000	95,155 95,020	0,209 0,020
10060DUB	100	105	2,490 2,440	60,50 59,50	h8	100,000 99,946	H7	105,035 105,000	100,155 100,020	0,209 0,020
100115DUB	100	105	2,490 2,440	115,50 114,50	h8	100,000 99,946	H7	105,035 105,000	100,155 100,020	0,209 0,020
105115DUB	105	110	2,490 2,440	115,50 114,50	h8	105,000 104,946	H7	110,035 110,000	105,155 105,020	0,209 0,020
110115DUB	110	115	2,490 2,440	115,50 114,50	h8	110,000 109,946	H7	115,035 115,000	115,155 115,020	0,209 0,020

All dimensions in mm

7.6 DU-B FLANGED BUSHES



Dimensions and Tolerances according to ISO 3547 and GGB-Specifications

Outside C_o and Inside C_i Chamfers

WALL THICKNESS S_3	C_o (a) MACHINED	/ ROLLED	C_i (b)
0,75	0,5 ± 0,3	0,5 ± 0,3	-0,1 to -0,4
1	0,6 ± 0,4	0,6 ± 0,4	-0,1 to -0,5
1,5	0,6 ± 0,4	0,6 ± 0,4	-0,1 to -0,7

WALL THICKNESS S_3	C_o (a) MACHINED	/ ROLLED	C_i (b)
2	1,2 ± 0,4	1,0 ± 0,4	-0,1 to -0,7
2,5	1,8 ± 0,6	1,2 ± 0,4	-0,2 to -1,0

(a) = chamfer C_O machined or rolled at the opinion of the manufacturer
(b) = C_i can be a radius or a chamfer in accordance with ISO 13715

PART NO.	NOMINAL DIAMETER D_i	D_o	WALL THICKNESS S_3 max. min.	FLANGE THICKN. S_{fl} max. min.	FLANGE Ø D_{fl} max. min.	WIDTH B max. min.	SHAFT Ø D_J [h6, f7, h8]	max. min.	HOUSING Ø D_H [H6, H7]	max. min.	BUSH Ø $D_{i,a}$ ASSEMBLY IN H6/H7 HOUSING max. min.	CLEARANCE C_D max. min.
BB0304DUB	3	4,5	0,750 0,730	0,80 0,70	7,50 6,50	4,25 3,75	h6	3,000 2,994	H6	4,508 4,500	3,048 3,000	0,054 0,000
BB0404DUB	4	5,5			9,50 8,50	4,25 3,75		4,000 3,992		5,508 4,500	4,048 4,000	0,056 0,000
BB0505DUB	5	7	1,005 0,980	1,05 0,80	10,50 9,50	5,25 4,75	f7	4,990 4,978	H7	7,015 7,000	5,055 4,990	0,077 0,000
BB0604DUB	6	8			12,50 11,50	4,25 3,75		5,990 5,978		8,015 8,000	6,055 5,990	0,077 0,000
BB0608DUB						8,25 7,75						
BB0806DUB	8	10			15,50 14,50	5,75 5,25		7,987 7,972		10,015 10,000	8,055 7,990	0,083 0,003
BB0810DUB						9,75 9,25						
BB1007DUB	10	12			18,50 17,50	7,25 6,75		9,987 9,972		12,018 12,000	10,058 9,990	0,086 0,003
BB1012DUB						12,25 11,75						
BB1207DUB	12	14			20,50 19,50	7,25 6,75		11,984 11,966		14,018 14,000	12,058 11,990	0,092 0,006
BB1209DUB						9,25 8,75						
BB1212DUB						12,25 11,75						
BB1417DUB	14	16			22,50 21,50	17,25 16,75		13,984 13,966		16,018 16,000	14,058 13,990	
BB1512DUB	15	17			23,50 22,50	12,25 11,75		14,984 14,966		17,018 17,000	15,058 14,990	
BB1517DUB						17,25 16,75						
BB1612DUB	16	18			24,50 23,50	12,25 11,75		15,984 15,966		18,018 18,000	16,058 15,990	
BB1617DUB						17,25 16,75						

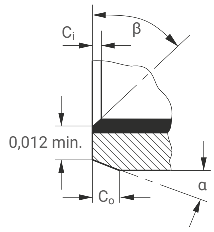
All dimensions in mm

7 Standard Products

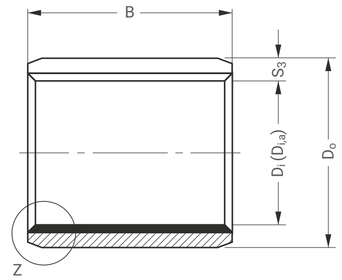
PART NO.	NOMINAL DIAMETER D_i	D_o	WALL THICKNESS S_3 max. min.	FLANGE THICKN. S_{fl} max. min.	FLANGE Ø D_{fl} max. min.	WIDTH B max. min.	SHAFT Ø D_J [h6, f7, h8] max. min.		HOUSING Ø D_H [H6, H7] max. min.		BUSH Ø $D_{i,a}$ ASSEMBLY IN H6/H7 HOUSING max. min.	CLEARANCE C_D max. min.
BB1812DUB	18	20	1,005 0,980	1,05 0,80	26,50 25,50	12,25 11,75	f7	17,984 17,966	H7	20,021 20,000	18,061 17,990	0,095 0,006
BB1822DUB						22,25 21,75						
BB2012DUB	20	23	1,505 1,475	1,60 1,30	30,50 29,50	11,75 11,25		19,980 19,959		23,021 23,000	20,071 19,990	0,112 0,010
BB2017DUB						16,75 16,25						
BB2512DUB	25	28			35,50 34,50	11,75 11,25		24,980 24,959		28,021 28,000	25,071 24,990	
BB2522DUB						21,75 21,25						
BB3016DUB	30	34	2,005 1,970	2,10 1,80	42,50 41,50	16,25 15,75		29,980 29,959		34,025 34,000	30,085 29,990	0,126 0,010
BB3026DUB						26,25 25,75						
BB3526DUB	35	39			47,50 46,50	26,25 25,75		34,975 34,950		39,025 39,000	35,085 34,990	0,135 0,015
BB4026DUB	40	44			53,50 52,50	26,25 25,75		39,975 39,950		44,025 44,000	40,085 39,990	0,135 0,015
BB4526DUB	45	50	2,505 2,460	2,60 2,30	58,50 57,50	26,25 25,75		44,975 44,950		50,025 50,000	45,105 44,990	0,155 0,015

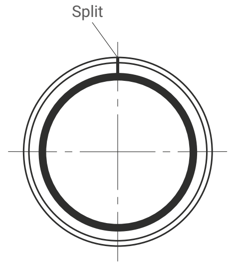
All dimensions in mm

7.7 DU® CYLINDRICAL BUSHES - INCH SIZES



Detail Z





Outside C_o and Inside C_i Chamfers

D_i	C_o	α	C_i	β
1/8" - 5/16	0,008" - 0,024	30°-4	0,004" - 0,012	30°-45°
3/8" - 11/16	0,020" - 0,040	20°-3	0,005" - 0,025	40°-55°
3/4" - 7	0,020" - 0,040	15°-25	0,005" - 0,025	40°-50°

PART NO.	NOMINAL DIAMETER D_i	D_o	B	WALL THICKNESS S_3 max. min.	WIDTH B max. min.	SHAFT Ø D_J max. min.	HOUSING Ø D_H max. min.	BUSH Ø $D_{i,a}$ ASSEMBLY IN D_H HOUSING max. min.	CLEARANCE C_D max. min.
02DU02	1/8	3/16	1/8	0,0315 0,0305	0,1350 0,1150	0,1243 0,1236	0,1878 0,1873	0,1268 0,1243	0,0032 0,0000
02DU03			3/16		0,1975 0,1775				
025DU025	5/32	7/32	5/32		0,16625 0,14265	0,1554 0,1547	0,2191 0,2186	0,1581 0,1556	0,0034 0,0002
025DU04			1/4		0,2600 0,2400				
03DU03	3/16	1/4	3/16		0,1975 0,1775	0,1865 0,1858	0,2503 0,2497	0,1893 0,1867	0,0035 0,0002
03DU04			1/4		0,2600 0,2400				
03DU06			3/8		0,3850 0,3650				
04DU04	1/4	5/16	1/4		0,2600 0,2400	0,2490 0,2481	0,3128 0,3122	0,2518 0,2492	0,0037 0,0002
04DU06			3/8		0,3850 0,3650				
05DU06	5/16	3/8	3/8		0,3850 0,3650	0,3115 0,3106	0,3753 0,3747	0,3143 0,3117	
05DU08			1/2		0,5100 0,4900				
06DU06	3/8	15/32	3/8	0,0471 0,0461	0,3850 0,3650	0,3740 0,3731	0,4691 0,4684	0,3769 0,3742	0,0038 0,0002
06DU08			1/2		0,5100 0,4900				
06DU12			3/4		0,7600 0,7400				
07DU08	7/16	17/32	1/2		0,5100 0,4900	0,4365 0,4355	0,5316 0,5309	0,4394 0,4367	0,0039 0,0002
07DU12			3/4		0,7600 0,7400				
08DU06	1/2	19/32	3/8		0,3850 0,3650	0,4990 0,4980	0,5941 0,5934	0,5019 0,4992	0,0039 0,0002
08DU08			1/2		0,5100 0,4900				
08DU10			5/8		0,6350 0,6150				
08DU14			7/8		0,8850 0,8650				
09DU08	9/16	21/32	1/2		0,5100 0,4900	0,5615 0,5605	0,6566 0,6559	0,5644 0,5617	
09DU12			3/4		0,7600 0,7400				

All dimensions in inches

7 Standard Products

PART NO.	NOMINAL DIAMETER D_i	NOMINAL DIAMETER D_O	NOMINAL DIAMETER B	WALL THICKNESS S_3 max. min.	WIDTH B max. min.	SHAFT Ø D_J max. min.	HOUSING Ø D_H max. min.	BUSH Ø $D_{i,a}$ ASSEMBLY IN D_H HOUSING max. min.	CLEARANCE C_D max. min.
10DU08	5/8	23/32	1/2	0,0471 0,0461	0,5100 0,4900	0,6240 0,6230	0,7192 0,7184	0,6270 0,6242	0,0040 0,0002
10DU10			5/8		0,6350 0,6150				
10DU12			3/4		0,7600 0,7400				
10DU14			7/8		0,8850 0,8650				
11DU14	11/16	25/32			0,8850 0,8650	0,6865 0,6855	0,7817 0,7809	0,6895 0,6867	
12DU08	3/4	7/8	1/2	0,0627 0,0615	0,5100 0,4900	0,7491 0,7479	0,8755 0,8747	0,7525 0,7493	0,0046 0,0002
12DU12			3/4		0,7600 0,7400				
12DU16			1		1,0100 0,9900				
14DU12	7/8	1	3/4		0,7600 0,7400	0,8741 0,8729	1,0005 0,9997	0,8775 0,8743	
14DU14			7/8		0,8850 0,8650				
14DU16			1		1,0100 0,9900				
16DU12	1	1 1/8	3/4		0,7600 0,7400	0,9991 0,9979	1,1256 1,1246	1,0026 0,9992	0,0047 0,0001
16DU16			1		1,0100 0,9900				
16DU24			1 1/2		1,5100 1,4900				
18DU12	1 1/8	1 9/32	3/4	0,0784 0,0770	0,7600 0,7400	1,1238 1,1226	1,2818 1,2808	1,1278 1,1240	0,0052 0,0002
18DU16			1		1,0100 0,9900				
20DU12	1 1/4	1 13/32	3/4		0,7600 0,7400	1,2488 1,2472	1,4068 1,4058	1,2528 1,2490	0,0056 0,0002
20DU16			1		1,0100 0,9900				
20DU20			1 1/4		1,2600 1,2400				
20DU28			1 3/4		1,7600 1,7400				
22DU16	1 3/8	1 17/32	1		1,0100 0,9900	1,3738 1,3722	1,5318 1,5308	1,3778 1,3740	
22DU22			1 3/8		1,3850 1,3650				
22DU28			1 3/4		1,7600 1,7400				
24DU16	1 1/2	1 21/32	1		1,0100 0,9900	1,4988 1,4972	1,6568 1,6558	1,5028 1,4990	
24DU20			1 1/4		1,2600 1,2400				
24DU24			1 1/2		1,5100 1,4900				
24DU32			2		2,0100 1,9900				
26DU16	1 5/8	1 25/32	1		1,0100 0,9900	1,6238 1,6222	1,7818 1,7808	1,6278 1,6240	0,0056 0,0002
26DU24			1 1/2		1,5100 1,4900				
28DU16	1 3/4	1 15/16	1	0,0941 0,0923	1,0100 0,9900	1,7487 1,7471	1,9381 1,9371	1,7535 1,7489	0,0064 0,0002
28DU24			1 1/2		1,5100 1,4900				
28DU28			1 3/4		1,7600 1,7400				
28DU32			2		2,0100 1,9900				

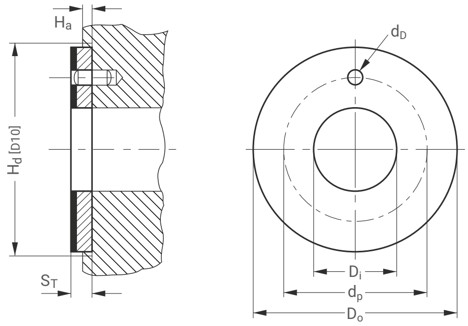
All dimensions in inches

PART NO.	NOMINAL DIAMETER D_i	D_o	B	WALL THICKNESS S_3 max. min.	WIDTH B max. min.	SHAFT Ø D_J max. min.	HOUSING Ø D_H max. min.	BUSH Ø $D_{i,a}$ ASSEMBLY IN D_H HOUSING max. min.	CLEARANCE C_D max. min.
30DU16	1 7/8	2 1/16	1	0,0941 0,0923	1,0100 0,9900	1,8737 1,8721	2,0633 2,0621	1,8787 1,8739	0,0066 0,0002
30DU30			1 7/8		1,8850 1,8650				
30DU36			2 1/4		2,2600 2,2400				
32DU16	2	2 3/16	1		1,0100 0,9900	1,9987 1,9969	2,1883 2,1871	2,0037 1,9989	0,0068 0,0002
32DU24			1 1/2		1,5100 1,4900				
32DU32			2		2,0100 1,9900				
32DU40			2 1/2		2,5100 2,4900				
36DU32	2 1/4	2 7/16	2	0,0928 0,0902	2,0100 1,4900	2,2507 2,2489	2,4377 2,4365	2,2573 2,2509	0,0084 0,0002
36DU36			2 1/4		2,2600 2,2400				
36DU40			2 1/2		2,5100 2,4900				
36DU48			3		3,0100 2,9900				
40DU32	2 1/2	2 11/16	2		2,0100 1,9900	2,5011 2,4993	2,6881 2,6869	2,5077 2,5013	
40DU40			2 1/2		2,5100 2,4900				
40DU48			3		3,0100 2,9900				
40DU56			3 1/2		3,5100 3,4900				
44DU32	2 3/4	2 15/16	2		2,0100 1,9900	2,7500 2,7482	2,9370 2,9358	2,7566 2,7502	
44DU40			2 1/2		2,5100 2,4900				
44DU48			3		3,0100 2,9900				
44DU56			3 1/2		3,5100 3,4900				
48DU32	3	3 3/16	2 1/2		2,5100 2,4900	3,0000 2,9982	3,1872 3,1858	3,0068 3,0002	0,0086 0,0002
48DU48			3		3,0100 2,9900				
48DU60			3 3/4		3,7600 3,7400				
56DU40	3 1/2	3 11/16	2 1/2		2,5100 2,4900	3,5000 3,4978	3,6872 3,6858	3,5068 3,5002	0,0090 0,0002
56DU48			3		3,0100 2,9900				
56DU60			3 3/4		3,7600 3,7400				
64DU48	4	4 3/16	3		3,0100 2,9900	4,0000 3,9978	4,1872 4,1858	4,0068 4,0002	0,0090 0,0002
64DU60			3 3/4		3,7600 3,7400				
64DU76			4 3/4		4,7600 4,7400				
80DU48	5	5 3/16	3		3,0100 2,9900	4,9986 4,9961	5,1860 5,1844	5,0056 4,9988	0,0095 0,0002
80DU60			3 3/4		3,7600 3,7400				
96DU48	6	6 3/16	3		3,0100 2,9900	6,0000 5,9975	6,1874 6,1858	6,0070 6,0002	
96DU60			3 3/4		3,7600 3,7400				
112DU60	7	7 3/16	3 3/4		3,7600 3,7400	6,9954 6,9929	7,1830 7,1812	7,0026 6,9956	0,0097 0,0002

All dimensions in inches

7 Standard Products

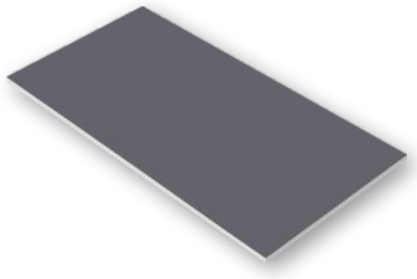
7.8 DU® THRUST WASHERS - INCH SIZES

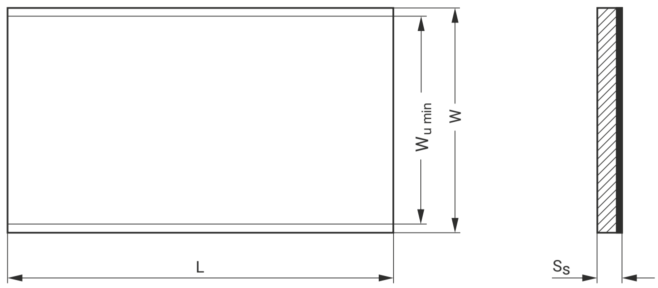


<table>
<tr><th rowspan="2">PART NO.</th><th colspan="2">INSIDE DIAMETER
D_i</th><th colspan="2">OUTSIDE DIAMETER
D_o</th><th>THICKNESS
S_T</th><th colspan="2">DOWEL HOLE</th><th>RECESS DEPTH
H_a</th></tr>
<tr><th>max.</th><th>min.</th><th>max.</th><th>min.</th><th>max.
min.</th><th>Ø d_D
max.
min.</th><th>PCD Ø d_P
max.
min.</th><th>max.
min.</th></tr>
<tr><td>DU06</td><td>0,510</td><td>0,500</td><td>0,875</td><td>0,865</td><td rowspan="14">0,063
0,061</td><td rowspan="2">0,077
0,067</td><td>0,692
0,682</td><td rowspan="14">0,050
0,040</td></tr>
<tr><td>DU07</td><td>0,572</td><td>0,562</td><td>1,000</td><td>0,990</td><td>0,786
0,776</td></tr>
<tr><td>DU08</td><td>0,635</td><td>0,625</td><td>1,125</td><td>1,115</td><td rowspan="4">0,109
0,099</td><td>0,880
0,870</td></tr>
<tr><td>DU09</td><td>0,697</td><td>0,687</td><td>1,187</td><td>1,177</td><td>0,942
0,932</td></tr>
<tr><td>DU10</td><td>0,760</td><td>0,750</td><td>1,250</td><td>1,240</td><td>1,005
0,995</td></tr>
<tr><td>DU11</td><td>0,822</td><td>0,812</td><td>1,375</td><td>1,365</td><td>1,099
1,089</td></tr>
<tr><td>DU12</td><td>0,885</td><td>0,875</td><td>1,500</td><td>1,490</td><td rowspan="2">0,140
0,130</td><td>1,192
1,182</td></tr>
<tr><td>DU14</td><td>1,010</td><td>1,000</td><td>1,750</td><td>1,740</td><td>1,380
1,370</td></tr>
<tr><td>DU16</td><td>1,135</td><td>1,125</td><td>2,000</td><td>1,990</td><td rowspan="3">0,171
0,161</td><td>1,567
1,557</td></tr>
<tr><td>DU18</td><td>1,260</td><td>1,250</td><td>2,125</td><td>2,115</td><td>1,692
1,682</td></tr>
<tr><td>DU20</td><td>1,385</td><td>1,375</td><td>2,250</td><td>2,240</td><td>1,817
1,807</td></tr>
<tr><td>DU22</td><td>1,510</td><td>1,500</td><td>2,500</td><td>2,490</td><td rowspan="6">0,202
0,192</td><td>2,005
1,995</td></tr>
<tr><td>DU24</td><td>1,635</td><td>1,625</td><td>2,625</td><td>2,615</td><td>2,130
2,120</td></tr>
<tr><td>DU26</td><td>1,760</td><td>1,750</td><td>2,750</td><td>2,740</td><td>2,255
2,245</td></tr>
<tr><td>DU28</td><td>2,010</td><td>2,000</td><td>3,000</td><td>2,990</td><td rowspan="3">0,093
0,091</td><td>2,505
2,495</td><td rowspan="3">0,080
0,070</td></tr>
<tr><td>DU30</td><td>2,135</td><td>2,125</td><td>3,125</td><td>3,115</td><td>2,630
2,620</td></tr>
<tr><td>DU32</td><td>2,260</td><td>2,250</td><td>3,250</td><td>3,240</td><td>2,755
2,745</td></tr>
</table>

All dimensions in inches

7.9 DU® STRIP





PART NO.	LENGTH L max. min.	TOTAL WIDTH W	USABLE WIDTH $W_{U\ min}$	THICKNESS S_S max. min.
S07190DU	503 500	200	190	0,74 0,70
S10190DU				1,01 0,97
S15240DU		254	240	1,52 1,48
S20240DU				2,00 1,96
S25240DU				2,50 2,46
S30240DU				3,06 3,02

All dimensions in mm

7.10 DU-B STRIP

PART NO.	LENGTH L max. min.	TOTAL WIDTH W	USABLE WIDTH $W_{U\ min}$	THICKNESS S_S max. min.
S07085DUB	503 500	95	85	0,74 0,70
S10180DUB		193	180	1,01 0,97
S15180DUB				1,52 1,48
S20180DUB				2,00 1,96
S25180DUB				2,50 2,46

All dimensions in mm

7.11 DU® STRIP - INCH SIZES

DU® Strip inch sizes are available as Non-Standard products, on request.

8 Test Methods

8.1 MEASUREMENT OF WRAPPED BUSHES

It is not possible to accurately measure the external and internal diameters of a wrapped bush in the free condition. In its free state a wrapped bush will not be perfectly cylindrical and the butt joint may be open. When correctly installed in a housing the butt joint will be tightly closed and the bush will conform to the housing. For this reason the external diameter and internal diameter of a wrapped bush can only be checked with special gauges and test equipment.

The checking methods are defined in ISO 3547 Parts 1 to 7.

Test A of ISO 3547 Part 2

Checking the external diameter in a test machine with checking blocks and adjusting mandrel.

TEST A OF ISO 3547 PART 2 ON 2015DU	
Checking block and setting mandrel $d_{ch,1}$	23,062 mm
Test force F_{ch}	4500 N
Limits for Δz	0 and -0,065 mm
Bush Outside diameter D_o	23,035 to 23,075 mm

Table 14 : Test A of ISO 3547 Part 2

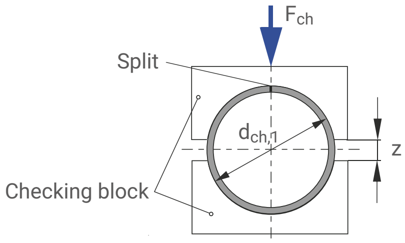


Fig.34 : Test A, data for drawing

Test B (alternatively to Test A)

Check external diameter with GO and NO GO ring gauges.

Test C

Checking the internal diameter of a bush pressed into a ring gauge, which nominal diameter corresponds to the dimension specified in table 6 of ISO 3547 Part 2 (Example D_i = 20 mm).

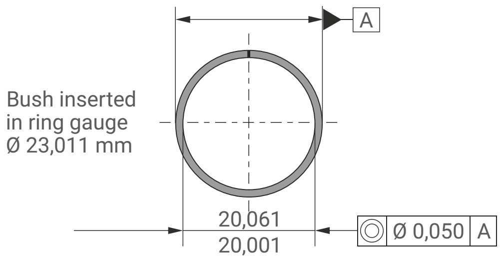


Fig.35 : Test C, data for drawing

Measurement of Wall Thickness (alternatively to Test C)

The wall thickness is measured at one, two or three positions axially according to the bearing dimensions.

B [mm]	X [mm]	MEASUREMENT POSITION
≤15	B/2	1
>15 ≤50	4	2
>50 ≤90	6 and B/2	3
>90	8 and B/2	3

Table 15 : Measurement position

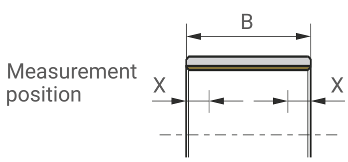


Fig.36 : Test C, measurement position

Test D

Check external diameter by precision measuring tape.

FORMULA SYMBOLS AND DESIGNATIONS

SYMBOL	UNIT	DESIGNATION
A	mm^2	Surface area of DU® bearing
A_M	mm^2	Surface area of mating surface in contact with DU® bearing (slideway)
a_B	-	Bearing size factor
a_C	-	Application factor for bore burnishing or machining
a_E	-	High load factor
a_{E1}	-	Specific load factor (slideways)
a_{E2}	-	Speed, temperature and material factor (slideways)
a_{E3}	-	Relative contact area factor (slideways)
a_L	-	Life correction constant
a_M	-	Mating surface material factor
a_T	-	Temperature application factor
B	mm	Nominal bush length
C	1/min	Dynamic load frequency
C_D	mm	Installed diametrical clearance
C_i	mm	ID chamfer length
C_o	mm	OD chamfer length
C_T	-	Total number of dynamic load cycles
D_C	mm	Diameter of burnishing tool
D_{fl}	mm	Nominal bush flange OD
D_H	mm	Housing Diameter
D_i	mm	Nominal bush and thrust washer ID
$D_{i,a}$	mm	Bush ID when assembled in housing
D_J	mm	Shaft diameter
D_{Nth}	nvt	Max. thermal neutron dose
D_o	mm	Nominal bush and thrust washer OD
D_Y	Gy	Max. Gamma radiation dose
$d_{ch,1}$	mm	Checking block diameter
d_D	mm	Dowel hole diameter
d_L	mm	Oil hole diameter
d_p	mm	Pitch circle diameter for dowel hole
F	N	Bearing load
F_{ch}	N	Test force
F_i	N	Insertion force
f	-	Friction

SYMBOL	UNIT	DESIGNATION
H_a	mm	Depth of housing recess (e.g. for thrust washers)
H_d	mm	Diameter of housing recess (e.g. for thrust washers)
L	mm	Strip length
L_H	h	Bearing service life
L_S	mm	Length of stroke (slideway)
N	1/min	Rotational speed
N_{osz}	1/min	Oscillating movement frequency
p	N/mm^2	Specific load
p_{lim}	N/mm^2	Specific load limit
$p_{sta,max}$	N/mm^2	Maximum static load
$p_{dyn,max}$	N/mm^2	Maximum dynamic load
Q	-	Permissible number of cycles
R_a	µm	Surface roughness (DIN 4768, ISO/DIN 4287/1)
R_{OB}	Ω	Electrical resistance
s_3	mm	Bush wall thickness
s_{fl}	mm	Flange thickness
s_S	mm	Strip thickness
s_T	mm	Thrust washer thickness
T	°C	Temperature
T_{amb}	°C	Ambient temperature
T_{max}	°C	Maximum temperature
T_{min}	°C	Minimum temperature
U	m/s	Sliding speed
W	mm	Strip width
$W_{U\,min}$	mm	Minimum usable strip width
Z_T	-	Total number of cycles
α_1	$1/10^6K$	Coefficient of linear thermal expansion parallel to surface
α_2	$1/10^6K$	Coefficient of linear thermal expansion normal to surface
σ_c	N/mm^2	Compressive yield strength
λ	W/mK	Thermal conductivity
φ	°	Angular displacement
η	Ns/mm^2	Dynamic viscosity

9 Bearing Application Data Sheet

GGB BY TIMKEN

Not sure which GGB part fits your application requirements?
Please complete the form below and share it with your GGB sales person or distributor representative.

DATA FOR BEARING DESIGN CALCULATION

Application: ____

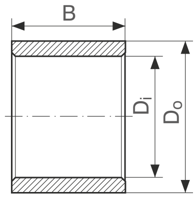
____

Project/No.: ____________________ Quantity: __________ ☐ New Design ☐ Existing Design

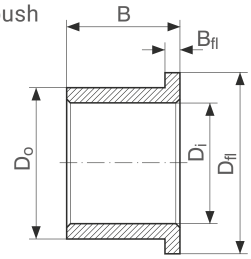
☐ Steady load ☐ Rotating load ☐ Rotational movement ☐ Oscillating movement ☐ Linear movement

BEARING TYPE

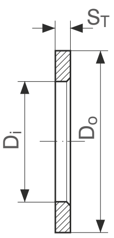
☐ Cylindrical bush



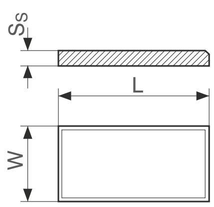
☐ Flanged bush



☐ Thrust washer



☐ Slideplate



☐ Special parts (sketch)

DIMENSIONS [MM]

Inside diameter	D_i	
Outside diameter	D_o	
Length	B	
Flange Diameter	D_{fl}	
Flange thickness	B_{fl}	
Wall thickness	S_T	
Length of slideplate	L	
Width of slideplate	W	
Thickness of slideplate	S_S	

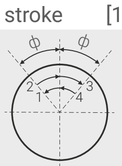
LOAD

☐ Static load
☐ Dynamic load

Axial load F	[N]	
Radial load F	[N]	

MOVEMENT

Rotational speed	N [1/min]	
Speed	U [m/s]	
Length of stroke	L_S [mm]	
Frequency of stroke	[1/min]	
Oscillating cycle	ϕ [°]	
Osc. frequence	N_{osz} [1/min]	



MATING SURFACE

Material		
Hardness	HB/HRC	
Surface finish	Ra [µm]	

FITS & TOLERANCES

Shaft	D_J	
Bearing housing	D_H	

OPERATING ENVIRONMENT

Ambient temperature	T_{amb}[°]	
Bearing housing material		

☐ Housing with good heating transfer properties
☐ Light pressing or insulated housing with poor heat transfer properties
☐ Non metal housing with poor heat transfer properties
☐ Alternate operation in water and dry

LUBRICATION

☐ Dry
☐ Continuous lubrication
☐ Process fluid lubrication
☐ Initial lubrication only
☐ Hydrodynamic conditions

Process fluid		
Lubricant		
Dynamic viscosity	η[mPas]	

SERVICE HOURS PER DAY

Continuous operation	
Intermittent operation	
Operating time	
Days per year	

SERVICE LIFE

Required service life	L_H [h]	

CUSTOMER INFORMATION

Company ____

Street ____

City / State / Province / Post Code ______________________________

Telephone ____________________ Fax ____________________

Name ____

Email Address ____________________ Date ____________________

Product Information

GGB assures the products described in this document have no manufacturing errors or material deficiencies.

The details set out in this document are registered to assist in assessing material suitability for intended use. They have been developed from our own investigations as well as generally accessible publications. They do not represent any assurance for the properties themselves.

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Products are subject to continual development. GGB retains the right to make specification amendments or improvements to technical data without prior announcement. Edition 2023 (this edition replaces earlier editions which hereby lose their validity).

STATEMENT REGARDING LEAD CONTENT IN GGB PRODUCTS & EU DIRECTIVE COMPLIANCE

GGB is committed to adhering to all U.S., European, and international standards and regulations with regard to lead content. Wehave established internal processes that monitor any changes to existing standards and regulations, and we work collaborativelywith customers and distributors to ensure all requirements are strictly followed. This includes RoHS and REACH guidelines.

GGB makes it a top priority to operate in an environmentally conscious and safe manner. We follow numerous industry best practices and are committed to meeting or exceeding a variety of internationally recognized standards for emissions control and workplace safety.

Each of our global locations has management systems in place that adhere to IATF 16949, ISO 9001, ISO 14001, ISO 45001, and AS9100D/EN9100 quality regulations.

All of our certificates can be found here: **https://www.ggbearings.com/en/certificates**. A detailed explanation of our commitment to REACH and RoHS directives can be found at **https://www.ggbearings.com/en/who-we-are/quality-and-environment**.



PUSHING BOUNDARIES TO CO-CREATE
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