GGB

# DP4®, DP10 and DP11

## METAL-POLYMER SELF-LUBRICATING LEAD FREE BEARING SOLUTIONS

# GGB

GGB began in 1899 as Glacier Antifriction Metal Company, producing plain bearings and introducing many successful new products to the market, including internationally recognized polymer materials. Over the past 120 years, our company has continued forming strategic partnerships, continuously expanding into a global network of manufacturing facilities, increasing production capabilities and resources to become who we are today: world leaders in tribological innovation.

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 with the highest safety standards in the industry.

# 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 OHSAS 18001. 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.

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# 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.

## GLOBAL FOOTPRINT

Our global presence and local logistics networks ensure our customers receive only the highest quality bearing solutions, in a timely manner and with extensive engineering support.

**We don't just make products, we build partnerships. That's the GGB Advantage.**

# 1 Introduction

This brochure describes the range of selflubricated PTFE based metal-polymer plain bearings specifically developed by GGB for use in dry applications. PTFE based metal-polymer plain bearings are used extensively in a diverse range of industrial and automotive applications, where potentially they can:

- offer environmentally friendly dry running operation (as opposed to grease or oil lubricated)
- improve friction and wear performance (relative to conventional bronze, steel and bimetal bearings)
- reduce equipment / operating costs and improve performance (when replacing rolling element bearings)

These GGB plain bearing materials give excellent performance in a wide range of loads, speeds and temperatures; with or without external lubrication.

GGB's longest serving product, DU®, was developed as a self-lubricated dry bearing more than 50 years ago, when it quickly became established as a worldwide industry standard.

However, due to the lead content in the DU® overlay, GGB has developed a new range of lead free self-lubricated materials capable of meeting the most stringent performance requirements.

Each new material complies with the following European Parliament legislation:

- End of Life vehicles directive 2000/53/EC concerning the elimination of hazardous materials in the construction of passenger vehicles and light trucks (the EVL directive).
- Directive 2002/95/EC concerning the restriction of the use of certain hazardous substances in electrical and electronic equipment (the RoHS regulations).

Although designed for dry operation, these PTFE based materials can also perform exceptionally well in fluid lubricated conditions. For example, both DP4® and DP10 are particularly suited to marginally lubricated conditions, and DP4® performs well in oil lubricated heavy duty hydraulic applications.

# 2 Structure and Composition

GGB's PTFE based metal-polymer materials are composed of three bonded layers: a steel backing and a porous bronze interlayer, impregnated and overlaid with a bearing surface consisting of PTFE (polytetrafluoroethylene) and fillers.

The steel backing provides mechanical strength while the bronze sinter layer provides a strong mechanical bond for the filled PTFE bearing lining.

The PTFE-based bearing surface exhibits very low friction properties, and the different filler packages (indicated below) give each product its unique set of physical characteristics, for example, superior wear resistance.

DP4® can also be supplied with a bronze backing, (referred to as DP4-B) when improved corrosion resistance or antimagnetic properties are required.

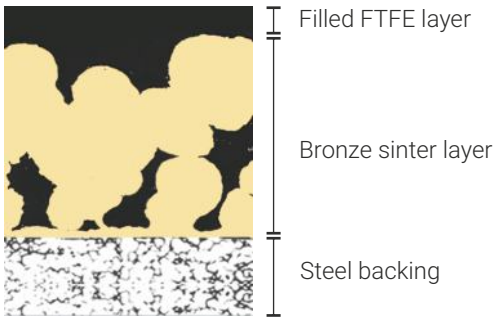


Figure 1: DP4 microsection

## 2.1 MATERIAL BEARING LAYER COMPOSITION

| MATERIAL | DP4® | DP10 | DP11 |
|---|---|---|---|
| Bearing Lining Composition | PTFE + Fillers | PTFE + Solid lubricant | PTFE + Solid lubricant + Fillers |

Table 1: Material bearin layer composition

## 2.2 BASIC FORMS

### Standard Components

Standard products are manufactured according to international, national and internal standards. Standard products are produced in the following forms:

– Cylindrical Bushes – Flanged Bushes – Thrust Washers – Flanged Washers – Strip Material

Figure 2: Standard stock products

### Availability

| | | |
|---|---|---|
| **DP4®** | Cylindrical, flanged bushes, thrust and flanged washers and strip | – ex stock |
| **DP4-B** | Cylindrical, flanged bushes and strip<br>Thrust and flanged washers | – ex stock<br>– made to order |
| **DP10** | All forms | – made to order |
| **DP11** | All forms | – made to order |

### Non-Standard Components

Non-Standard products are manufactured to requirements and may for example include the following forms:

– Modified standard parts (notches, oil grooves, etc.) – Stampings and deep drawn parts – Special shapes

Figure 3: Non-Standard products made to order

# 3 Properties

## 3.1 PHYSICAL AND MECHANICAL PROPERTIES

| BEARING PROPERTIES | | UNITS | DP4® | DP4-B | DP10 | DP11 |
|---|---|---|---|---|---|---|
| **Physical Properties** | | | | | | |
| Coefficient of linear thermal expansion | Parallel to the surface<br>Normal to the surface | $10^{-6}$/K<br>$10^{-6}$/K | 11<br>30 | 18<br>36 | 11<br>30 | 11<br>30 |
| Operating temperature | Min<br>Max | °C<br>°C | - 200<br>280 | - 200<br>280 | - 200<br>280 | - 200<br>280 |
| **Mechanical Properties** | | | | | | |
| Compressive yield strength | | $N/mm^2$ | 350 | 300 | 350 | 350 |
| Maximum load, p | Static<br>Dynamic | $N/mm^2$<br>$N/mm^2$ | 250<br>140 | 140<br>140 | 250<br>140 | 250<br>140 |
| **Bearing Properties - Dry** | | | | | | |
| Maximum sliding speed, U | | m/s | 2,5 | 2,5 | 2,5 | 2,5 |
| Maximum pU factor | | $N/mm^2$ x m/s | 1,0 | 1,0 | 1,0 | 1,0 |
| Recommended mating surface hardness | | HB | > 200 | > 200 | > 200 | > 200 |
| Recommended mating surface finish $R_a$ | | mm | 0,4 ± 0,1 | 0,4 ± 0,1 | 0,4 ± 0,1 | 0,4 ± 0,1 |

Table 2: Physical and Mechanical Properties

# 4 Bearing Performance

Each application, depending on the equip-ment design, usage and operating conditions (load, speed, type of movement, temperature, etc.), places individual demands on the bearing.

GGB undertook an extensive test program in order to determine each material's dry wear performance, while operating with different types of movement.

The three different types of movement are: – Continuous rotation – Low frequency oscillation – High frequency oscillation

Additionally, friction values for each material were measured under low and high speed dry running conditions. Finally, the material's resistance to bore burnishing (bore calibration) was also validated.

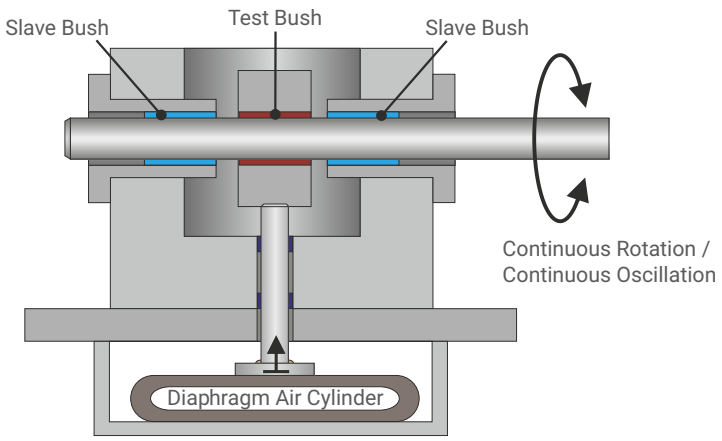



Figure 4: GGB Jupiter test rig

## 4.1 CONTINUOUS ROTATION

Under continuous rotation according to the GGB test conditions, the relative dry wear performance of each material see Fig.5.

**Typical applications include:**
Pulleys, sheaves, sprockets, wheels, axles, gears & gear shafts, crank shafts, office equipment, bank note handling machinery, packaging machinery, special purpose machinery, cranes 8 hoists, agricultural machinery, etc.

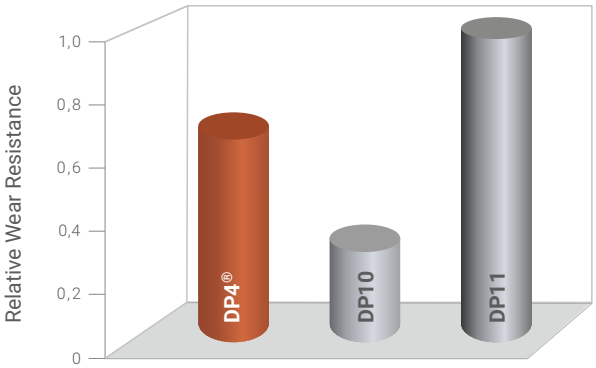



Figure 5: Relative wear resistance

**Test Conditions:**
- Specific load = 25 N/mm²
- Rotation speed = 0,04 m/s
- Life test

## 4.2 OSCILLATING MOVEMENT LOW FREQUENCY / HIGH AMPLITUDE

Under low frequency and high amplitude oscillating movement, according to the GGB test conditions, the relative dry wear performance of each material see Fig.6.

**Typical applications include:**
Pulleys, sheaves, sprockets, wheels, axles, gears & gear shafts, crank shafts, office equipment, bank note handling machinery, packaging machinery, special purpose machinery, cranes 8 hoists, agricultural machinery, etc.

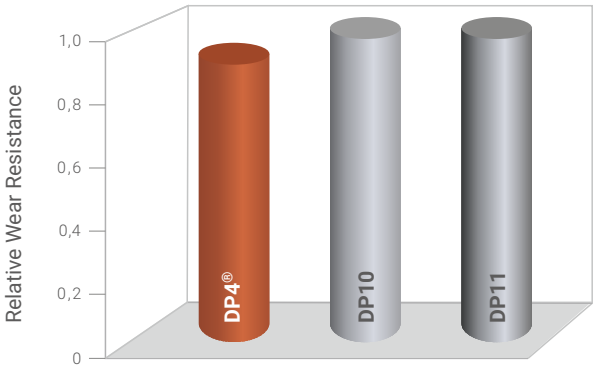



Figure 6: Relative wear resistance

**Test Conditions:**
- Specific load = 5 N/mm²
- Frequency = 1 Hz
- Angle = ±60°
- 40 Hours Operation

## 4.3 OSCILLATING MOVEMENT HIGH FREQUENCY / LOW AMPLITUDE

Under high frequency and low amplitude oscillating movement according to the GGB test conditions, the relative dry wear performance of each material see Fig.7.

**Typical applications include:**
Pulley dampers, belt tensioners, chain tensioners, twin mass flywheels, clutches, solenoids, textile machines, etc.

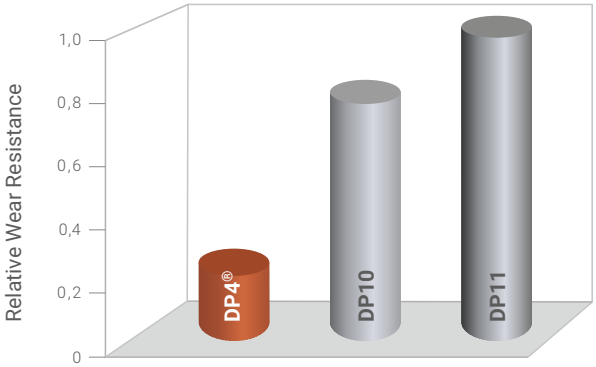



Figure 7: Relative wear resistance

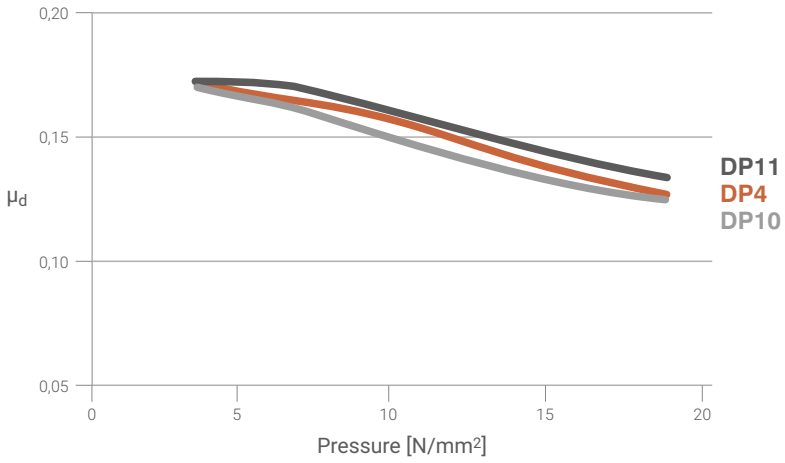
**Test Conditions:**
- Specific load = 5 N/mm²
- Frequency = 30 Hz
- Angle = ±3°
- Life test

# 4 Bearing Performance

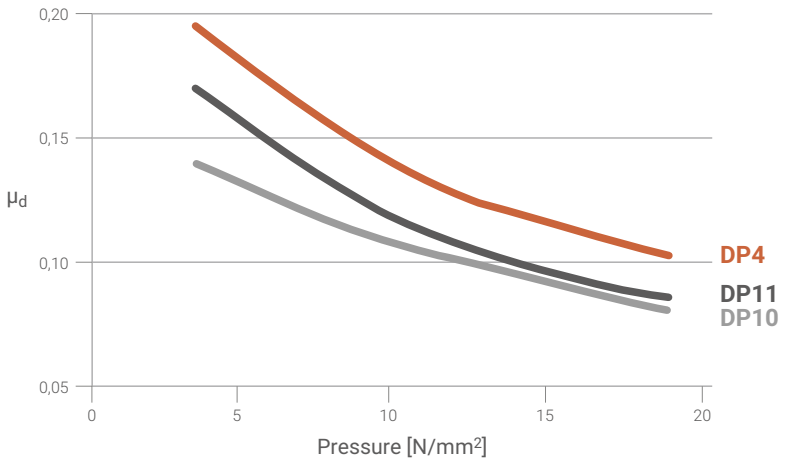
## 4.4 DRY FRICTION

A low level of friction is generally desirable in most dry bearing applications. An indication of dynamic friction coefficient under low and high speed dry conditions is indicated in the graphs below. None of the materials exhibited stick-slip effects.

Note that actual friction values in the final application will depend upon many design and operating factors. Consequently, if frictional characteristics are critical to an application, the actual values should be determined by testing.




**Dry friction under low speed conditions:**
— Speed = 0,05 m/s

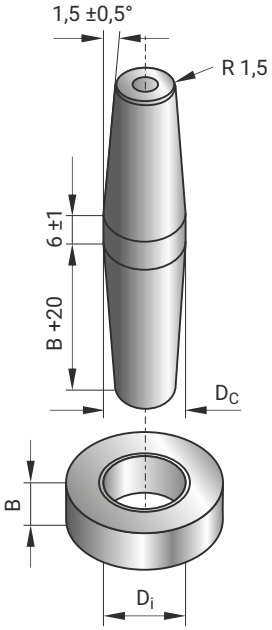



**Dry friction under high speed conditions:**
— Speed = 0,35 m/s

## 4.5 BUSH BURNISHING

Burnishing the bore of an assembled bush (calibration) reduces the variation of the inner diameter of the bush, which leads to a reduction in the clearance variation between the bush and the shaft (less play, lower noise, etc). The recommended burnishing tool design is shown in the illustration opposite.

GGB trials demonstrated that all three materials exhibited no removal of the bearing layer for diametric burnish interferences up to 0,15 mm. However the impact of burnishing on the bearing and on the assembly should be validated by trials.



# 5 Selection Guide

## 5.1 PRODUCT PERFORMANCE COMPARISON

Product selection may be simplified by using the following table which compares the relative strengths of each material.

For specific applications where bearing performance is of major importance, or where environmental or unusual operating conditions are present, prototype testing or test rig simulations are recommended,
to confirm satisfactory bearing design and performance.

| MATERIAL | CONTINUOUS ROTATION | LOW FREQUENCY OSCILLATION | HIGH FREQUENCY OSCILLATION | DRY FRICTION | BURNISH-ABILITY |
|---|---|---|---|---|---|
| DP4® | ● | ● | ● | ● | ● |
| DP10 | ● | ● | ● | ● | ● |
| DP11 | ● | ● | ● | ● | ● |

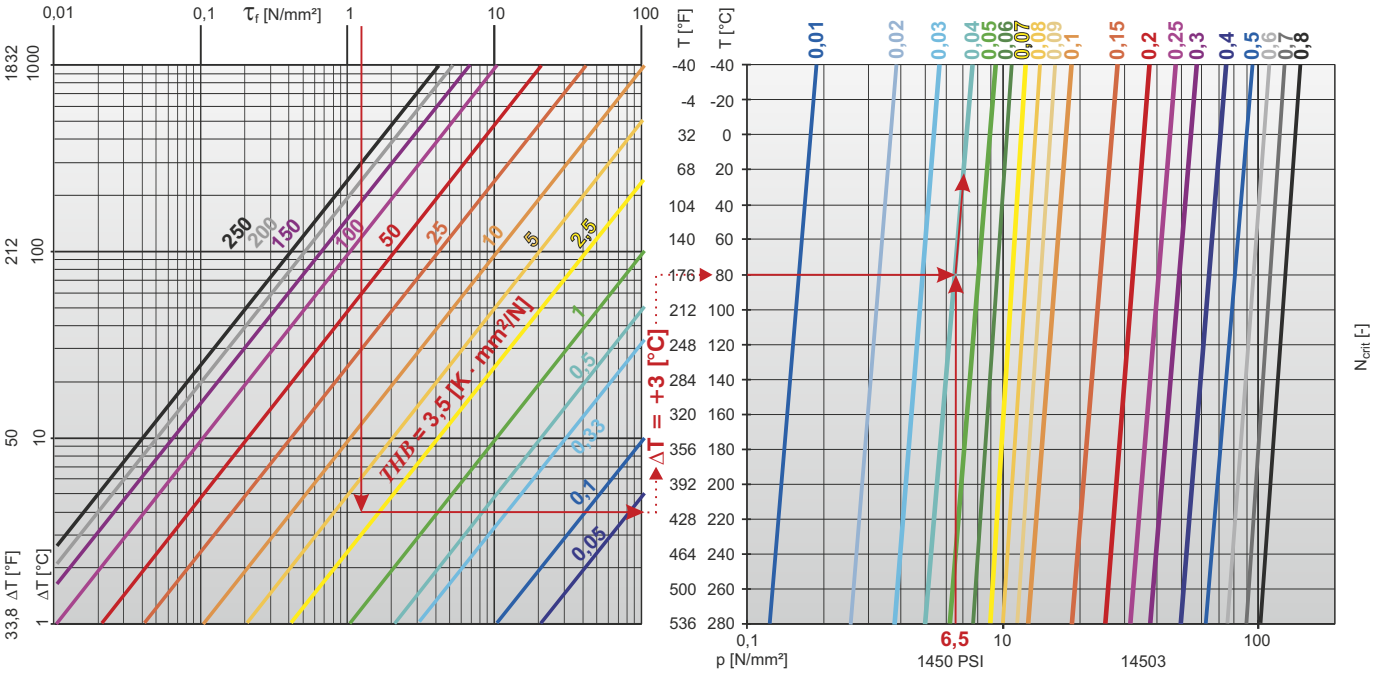
● Recommended ● Good ● Fair

## 5.2 CALCULATION OF GGB BEARING PERFORMANCE

For many years, GGB has carried out extensive plain bearing material testing on a variety of test rigs running under a range of different, but controlled operating conditions.

Using the data from these tests, in addition to the various graphs and guides shown above and published for its other materials,
GGB has been able to develop advanced programs that enable GGB engineers to undertake more detailed predictions of bearing performance and bearing material selection according to the unique operating conditions of each specific application.

This service is available by completing the enclosed Data Sheet for Bearing Design and by contacting your local GGB representative.



# 6 Bearing Application Data Sheet

Please complete the form below and share it with your GGB sales engineer or send it to: **germany@ggbearings.com**

## DATA FOR BEARING DESIGN CALCULATION

Application: _____

_____

Project/No.: _____ Quantity: _____ ☐ New Design ☐ Existing Design

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

### DIMENSIONS [MM]

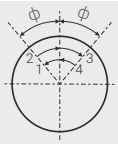
| | | |
|---|---|---|
| Inside diameter | $D_i$ | |
| Outside diameter | $D_o$ | |
| Length | B | |
| Flange Diameter | $D_{fl}$ | |
| Flange thickness | $B_{fl}$ | |
| Wall thickness | $S_T$ | |
| Length of slideplate | L | |
| Width of slideplate | W | |
| Thickness of slideplate | $S_S$ | |

### 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

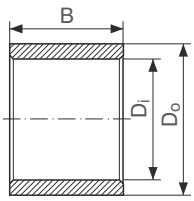
| | | |
|---|---|---|
| Continuous operation | | |
| Intermittent operation | | |
| Operating time | | |
| Days per year | | |

### SERVICE LIFE

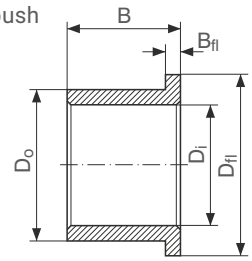
| | | |
|---|---|---|
| Required service life | $L_H$ [h] | |

### BEARING TYPE

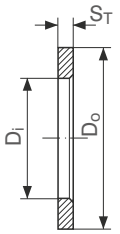
☐ Cylindrical bush



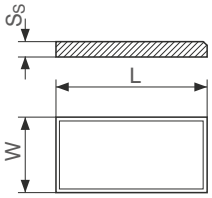

☐ Flanged bush




☐ Thrust washer




☐ Slideplate




☐ Special parts (sketch)

### CUSTOMER INFORMATION

Company _____

Street _____

City / State / Province / Post Code _____

Telephone _____ Fax _____

Name _____

Email Address _____ Date _____

# 7 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.

Unless expressly declared in writing, GGB gives no warranty that the products described are suited for any particular purpose or specific operating circumstances. GGB accepts no liability for any losses, damages, or costs however they may arise through direct or indirect use of these products.

GGB's sales and delivery terms and conditions, included as an integral part of quotations, stock and price lists, apply absolutely to all business conducted by GGB. Copies can be made available on request.

Products are subject to continual development. GGB retains the right to make specification amendments or improvements to technical data without prior announcement. Edition 2022 (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, OHSAS 18001, 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**.

## HEALTH HAZARD - WARNING

### Fabrication

At temperatures up to 250 °C the polytetrafluroethylene (PTFE) present in the lining material is completely inert so that even on the rare occasions in which DP4®, DP4-B, DP10 or DP11 bushes are drilled or sized after assembly there is no danger in boring or burnishing.

At higher temperatures however, small quantities of toxic fumes can be produced and the direct inhalation of these can cause an influenza type of illness which may not appear for some hours but which subsides without after-effects in 24-48 hours.

Such fumes can arise from PTFE particles picked up on the end of a cigarette. Therefore smoking should be prohibited where DP4®, DP4-B, DP10 or DP11 are being machined.

# PUSHING BOUNDARIES TO CO-CREATE A HIGHER QUALITY OF LIFE


**GGB HEILBRONN GMBH**

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https://www.ggbearings.com/de



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