GGB DP4®, DP10™ and DP11™

Metal-Polymer Self-Lubricating Lead Free Bearing Solutions

The Global Leader
in High Performance Bearing Solutions

GGB
BEARING TECHNOLOGY

an EnPro Industries company

Quality

All the products described in this brochure are manufactured under DIN EN ISO 9001, ISO/TS 16949 and ISO 14001 approved quality management systems.

Brazil

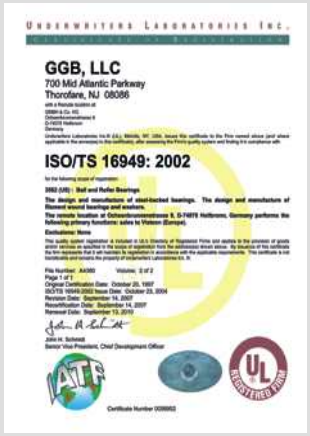
China

France

Germany

Slovakia

USA



All certificates are available for download on our website **www.ggbearings.com**.

Content

1 Introduction

This brochure describes the range of self-lubricated 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.

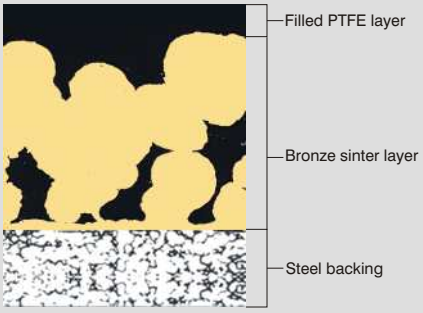
2 Structure and Composition

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 DP4B™) when improved corrosion resistance or anti-magnetic properties are required.



2.1 Material Bearing Layer Compositions

Material	DP4™	DP10™	DP11™
Bearing Lining Composition	PTFE + Fillers	PTFE + Solid lubricant	PTFE + Solid lubricant + Fillers

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 and flanged wrapped bushes
- Thrust and flanged washers
- Strip material


Cylindrical bushes


Flanged bushes


Thrust washers


Flanged washers


Strips

Availability

DP4™	Cylindrical, flanged bushes, thrust and flanged washers and strip	- ex stock
DP4B™	Cylindrical, flanged bushes and strip	- ex stock
	Thrust and flanged washers	- 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

3 Properties

3.1 Physical and Mechanical Properties

Physical Properties	Units	DP4™	DP4B™	DP10™	DP11™
Coefficient of thermal expansion: - parallel to surface - normal to surface	$1/10^6$ K	 11 30	 18 36	 11 30	 11 30
Maximum operating temperature T_{max}	°C	+280	+280	+280	+280
Minimum operating temperature T_{min}	°C	-200	-200	-200	-200
Mechanical Properties					
Compressive yield strength	MPa	350	300	350	350
Maximum load $\bar{p}$ - static / dynamic	MPa	250 / 140	140 / 140	250 / 140	250 / 140
Bearing Properties - Dry					
Maximum sliding speed v	m/s	2.5	2.5	2.5	2.5
Maximum $\bar{p}v$ factor	MPa 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	µm	0.4 ± 0.1	0.4 ± 0.1	0.4 ± 0.1	0.4 ± 0.1

4 Bearing Performance

Each application, depending on the equipment 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:

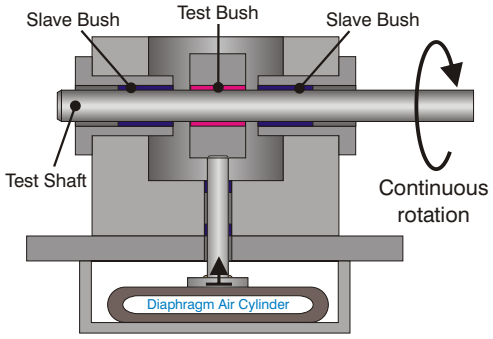
- Continuous rotation
- Low frequency oscillation
- High frequency oscillation

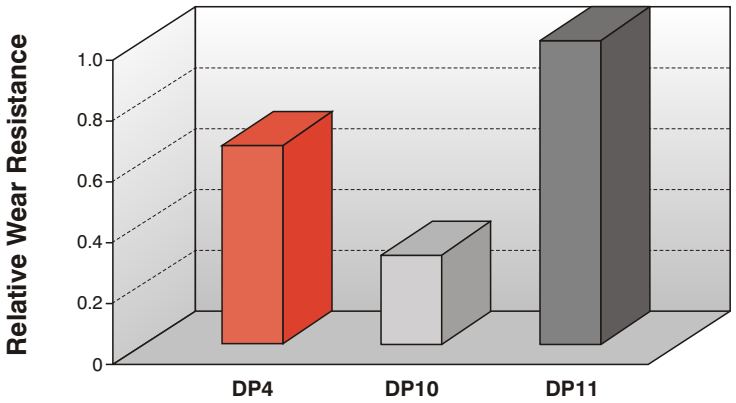
Additionally, friction values for each material were measured under low and high speed dry running conditions.

Finally, the material's resistance to bore burnishing (bore calibration) was also validated.

4.1 Continuous Rotation

Under continuous rotation according to the GGB test conditions, the relative dry wear performance of each material is as follows:



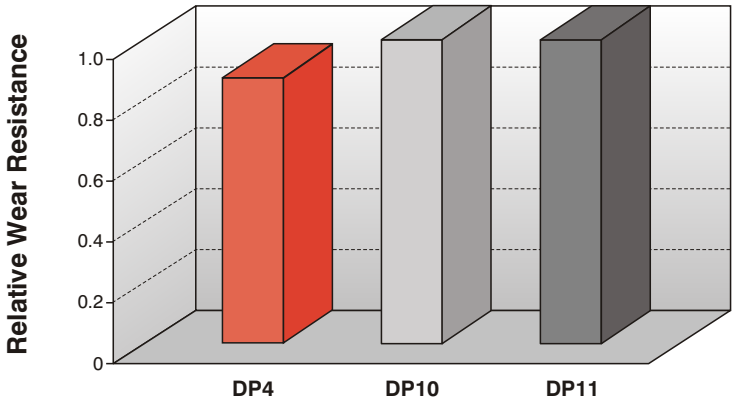


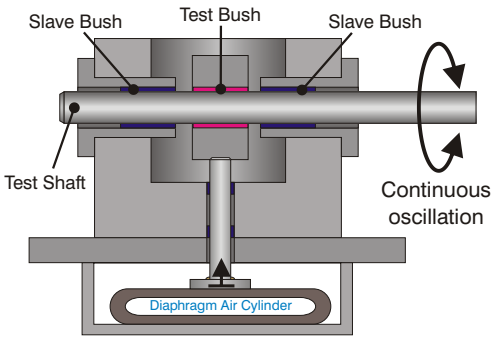
Test Conditions: Specific load = 25 MPa Rotation speed = 0.04 m/s Life test

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.

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 is as follows:



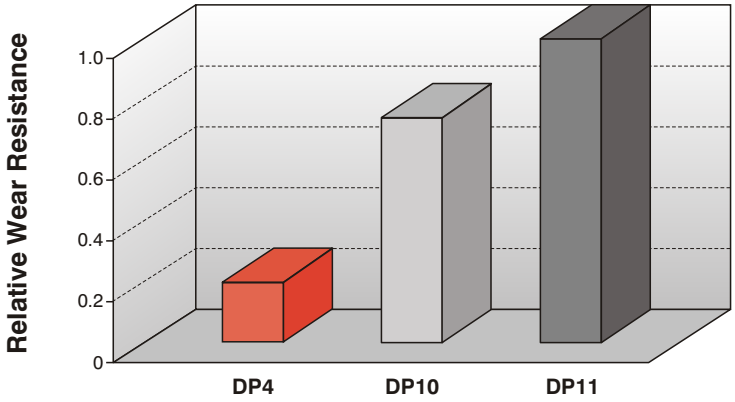


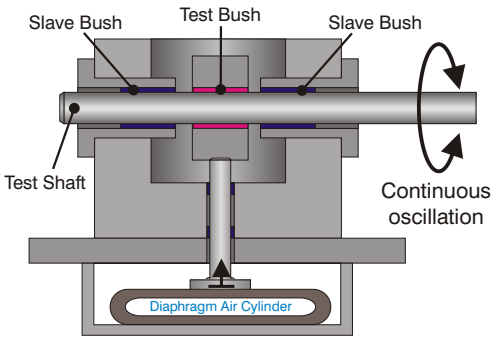
Test Conditions:
Specific load = 5 MPa Frequency = 1 Hz Angle = ±60° 40 Hours operation

Typical applications include:
Door, boot and bonnet hinges, furniture hinges, seat height adjuster mechanisms, linkages, cabriolet roof top pivot points, windscreen wipers, switchgear, solenoids, brakes, etc.

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 is as follows:





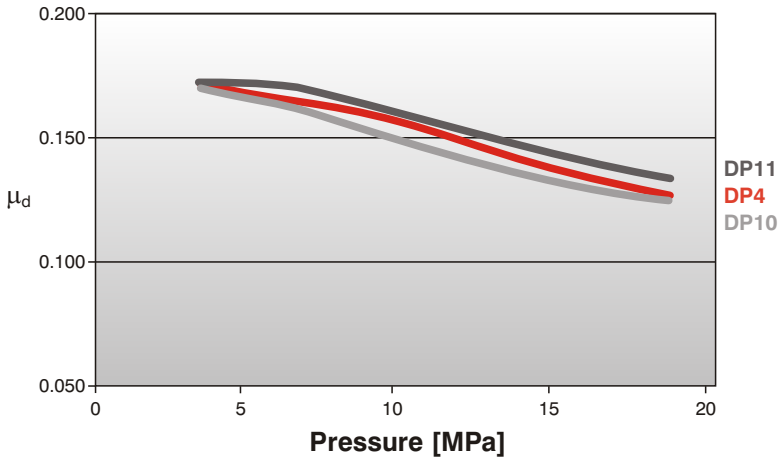
Test Conditions:
Specific load = 5 MPa Frequency = 30 Hz Angle = ±3° Life test

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

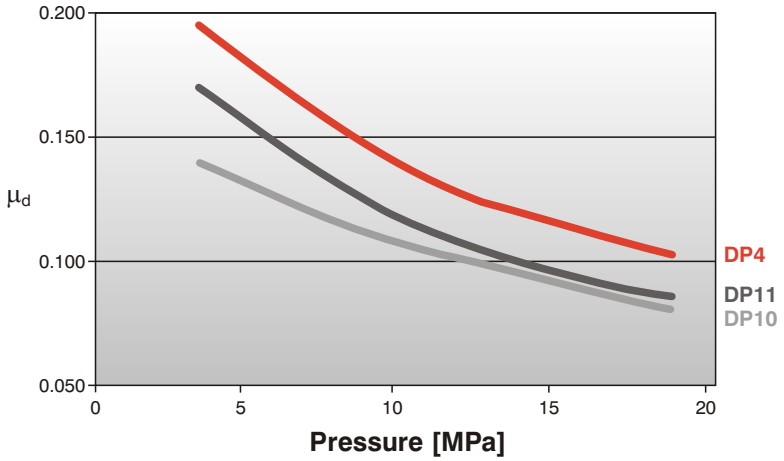
4.4 Dry Friction

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

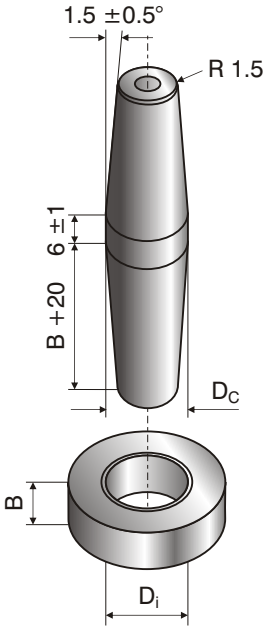


Dry friction under high speed conditions:
Speed: 0.35 m/s

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 0.150 mm. However the impact of burnishing on the bearing and on the assembly should be validated by trials.



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™					

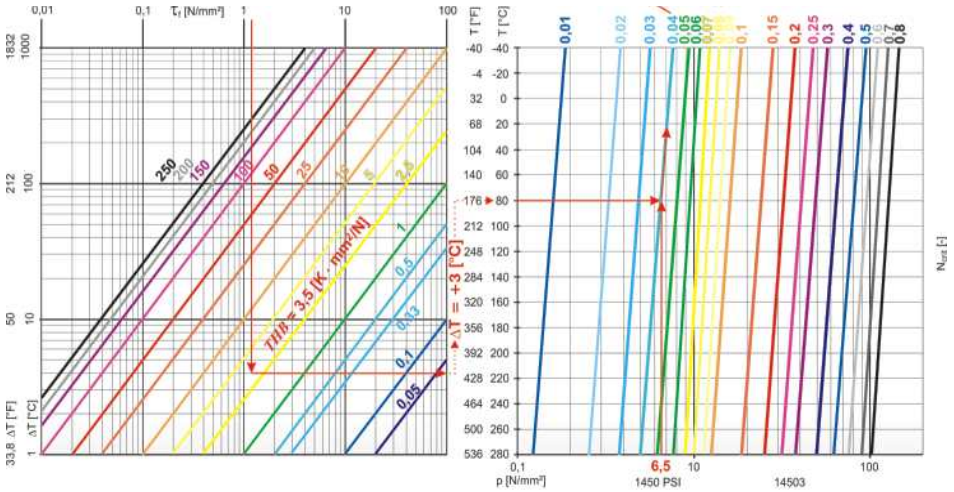
Ranking: Recommended | Good | Fair

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 Data Sheet for Bearing Design

Company:

Project:

Application:

Date:

Existing Design ☐ New Design ☐

Quantity Annual

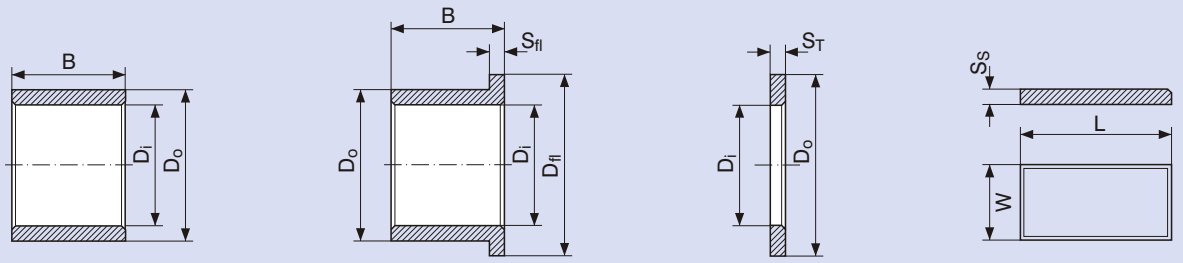
Contact name:

Tel.:

Fax:

Email:

Drawing attached YES NO



☐ Cylindrical bush ☐ Flanged bush ☐ Thrust washer ☐ Slideplate ☐ Special (sketch)

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

Dimensions in mm

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

Load

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

Movement

Rotational speed	N [1/min]	
Speed	v [ms]	
Length of stroke	L_S [mm]	
Frequency of stroke	[1/min]	
Oscillating angle	φ [°]	
Oscillating freq.	N_{OSZ} [1/min]	

Service hours per day

Continuous operation	[h]	
Intermittent operation	[h]	

Fits and tolerances

Housing (Ø, tolerance)	D_H	
Shaft (Ø, tolerance)	D_J	

Mating surface

Material		
Hardness	HB/HRC	
Surface finish	R_a [µm]	

Operating environment

Temperature - ambient	T_{amb}	
Temperature - min/max	T_{min}/T_{max}	

Housing material

Assembly with good heat transfer properties ☐

Assembly with poor heat transfer properties ☐

Dry operation ☐ With lubricant ☐

If grease, type with technical datasheet

If oil, type with technical datasheet

- Oil splash ☐
- Oil bath ☐
- Oil circulation ☐

Service life

Required service life L_H[h]

Product Information

GGB gives an assurance that 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 the material's suitability for the intended use. They have been developed from our own investigations as well as from 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 to 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 buisness 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 the technical data without prior announcement.

Edition 2010 (This edition replaces earlier editions which hereby lose their validity).

Declaration on lead contents of GGB products/compliance with EU law

Since July 1, 2006 it has been prohibited under Directive 2002/95/EC (restriction of the use of certain hazardous substances in electrical and electronic equipment; ROHS Directive) to put products on the market that contain lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE). Certain applications listed in the annex to the ROHS Directive are exempted. A maximum concentration value of 0.01% by weight and per homogeneous material, for cadmium and of 0.1% by weight and per homogeneous material, for lead, mercury, hexavalent chromium, PBB and PBDE shall be tolerated.

According to Directive 2000/53/EC on end-of life vehicles, since July 1, 2003 it has been prohibited to put on the market materials and components that contain lead, mercury, cadmium or hexavalent chromium. Due to an exceptional provision, lead-containing bearing shells and bushes could still be put on the market up until July 1, 2008. This general exception expired on July 1, 2008. A maximum concentration value of up to 0.1% by weight and per homogeneous material, for lead, hexavalent chromium and mercury shall be tolerated.

All products of GGB in this brochure, with the exception of DU, DUB, DB, SY and SP, satisfy these requirements of Directives 2002/95/EC (ROHS Directive) and 2000/53/EC (End-of-life Vehicle Directive).

All products manufactured by GGB are also compliant with REACH Regulation (EC) No. 1 907/2006 of December 18, 2006.

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.

GGB

BEARING TECHNOLOGY

an EnPro Industries company

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