GGB Bearing Technology

GGB’s history as the global leader in plain bearing technologies dates back more than 115 years, beginning with the founding of Glacier Antifriction Metal Company in 1899. GGB introduced the industry-leading DU® bearing in 1956 and the DX® bearing in 1965. Since that time, 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 with the highest safety standards in the industry.

- **Safety:** GGB’s deep-rooted culture of safety places a relentless focus on creating a secure, healthy work environment for all. A core value of GGB, safety is critically essential at all levels of business in order to achieve our goal of having the safest employees in the industry.

- **Excellence:** A world-class organization is built by fostering excellence throughout the company in all positions and functional areas. Our world-class manufacturing plants are certified in quality and excellence in the industry according to ISO 9001, TS 16949, ISO 14001, ISO 50001 and OHSAS 18001, allowing us to access the industry’s best practices while aligning our quality management system with global standards.

- **Respect:** We believe that respect is consistent with the growth of individuals and groups. Our teams work together with mutual respect regardless of background, nationality or function, embracing the diversity of people and learning from one another.

The GGB Advantage

With a global manufacturing footprint, including cutting edge R&D facilities, flexible production platforms and extensive customer support networks, GGB offers unmatched technical expertise combined with razor sharp responsiveness and customized solutions.

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.**

Quality/Certification

Our world-class manufacturing plants in the United States, Brazil, China, Germany, France and Slovakia and are **CERTIFIED IN QUALITY AND EXCELLENCE IN THE INDUSTRY** according to ISO 9001, TS 16949, ISO 14001, ISO 50001 and OHSAS 18001. This allows us to access the industry’s best practices while aligning our quality management system with global standards.

**DTS10™ Metal-Polymer Bearings for Lubricated Applications**

Customers with high expectations turn to GGB for innovative and application-specific plain bearing technology and solutions. The recent development of DTS10™ metal-polymer bearings illustrates GGB’s commitment to advancing the technology of metal-polymer PTFE bearings for hydro-dynamic lubricated applications. DTS10™ bearings deliver superior friction and wear properties, providing customers with advanced solutions that precisely meet their unique needs.

Featuring a uniquely engineered PTFE overlay, the DTS10™ bearing is the first polymer-lined material for lubricated conditions to not allow for metal exposure after machining. Providing low friction and excellent wear and fatigue resistance, DTS10™ improves the overall energy efficiency and increases the service life of high precision assemblies. DTS10™ provides the precision of a bi-metallic bearing and the high performance of an engineered metal-polymer bearing. **Here are some of the benefits of the DTS10™ bearing:**

- Excellent fatigue resistance
- High resistance against cavitation & flow erosion
- Excellent chemical resistance
- Good wear resistance
- Low friction
- High load capacity
- Promotes elastohydrodynamic performance benefits
- Good temperature range
- Machinable to obtain almost perfect bearing form
- RoHS compliant (lead-free)

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**Fig. 1: DTS10™ Microsection before machining**

- Sliding layer PTFE + additives
- Porous bronze sinter
- Steel backing

**Fig. 2: DTS10™ Microsection after machining**

- Sliding layer PTFE + additives
- Porous bronze sinter
- Steel backing
Applications

The DTS10™ is a PTFE-based metal-polymer bearing that is excellent for mixed-film and hydrodynamic lubricated applications. It is the first such bearing designed to be machined for tight tolerance control. Featuring excellent wear resistance and low friction as well as strong chemical, cavitation and flow erosion resistance, the DTS10™ is well suited for demanding applications. With all its great attributes, the DTS10™ bearing provides additional user benefits such as greater tolerance toward foreign particulates and reduces noise and vibration.

Below are a few of the applications for which the DTS10™ was designed.

- External gear pump and motors
- Scroll compressors
- Radial piston motors
- Oil Pumps
- Powertrain and industrial gearboxes
- Semi-hermetic and hermetic reciprocating compressors
- Hydraulic Cylinders
- Small Engines
The DTS10™ metal-polymer bearing contains three layers. The sliding layer is a thick (0.1mm) PTFE and filler overlay, which is impregnated into a porous bronze inner structure. The bronze center layer is sintered to a steel backing for mechanical strength.

Available Forms

Available as cylindrical bushes, thrust washers, flanged washers, slide plates, half bearings and special shapes.

Cylindrical bushes are available in sizes ranging from 8mm - 300mm. All formats are considered made to order items.

Material Structure

The DTS10™ metal-polymer bearing contains three layers. The sliding layer is a thick (0.1mm) PTFE and filler overlay, which is impregnated into a porous bronze inner structure. The bronze center layer is sintered to a steel backing for mechanical strength.

Lubricated Bearing Properties

<table>
<thead>
<tr>
<th>Bearing Properties</th>
<th>Imperial Units</th>
<th>Imperial Value</th>
<th>Metric Units</th>
<th>Metric Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum load, p</td>
<td>psi</td>
<td>20 000</td>
<td>N/mm²</td>
<td>140</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>°F</td>
<td>-328</td>
<td>°C</td>
<td>-200</td>
</tr>
<tr>
<td>Min</td>
<td>°F</td>
<td>536</td>
<td>°C</td>
<td>280</td>
</tr>
<tr>
<td>Max</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluid Lubricated</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum sliding speed, U</td>
<td>fpm</td>
<td>2 000*</td>
<td>m/s</td>
<td>10*</td>
</tr>
<tr>
<td>Maximum pU factor</td>
<td>psi x fpm</td>
<td>2 860 000*</td>
<td>N/mm² x m/s</td>
<td>100*</td>
</tr>
<tr>
<td>Coefficient of friction</td>
<td></td>
<td>0.01 - 0.08</td>
<td></td>
<td>0.01 - 0.08</td>
</tr>
<tr>
<td>Recommendations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shaft surface roughness, Ra</td>
<td>μm</td>
<td>&lt; 2 - 8*</td>
<td>μm</td>
<td>&lt; 0.05 - 0.2*</td>
</tr>
<tr>
<td>Shaft surface hardness</td>
<td>HB</td>
<td>&gt; 200</td>
<td>HB</td>
<td>&gt; 200</td>
</tr>
</tbody>
</table>

*Depending on Hydro-Dynamic Conditions
Bearing Performance

Relative Lubricated Wear Resistance

Composed of a unique combination of PTFE and fillers, the unique sliding layer composition of DTS10™ enhances its wear resistance over a wide range of operating conditions. The chart below summarizes the relative lubricated wear resistance of DTS10™ in comparison with GGB’s DP4™ and DP31™ products.

```markdown
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bearing diameter</td>
<td>20 mm</td>
</tr>
<tr>
<td>Bearing length</td>
<td>15 mm</td>
</tr>
<tr>
<td>Mean diametral clearance</td>
<td>0.07 mm</td>
</tr>
<tr>
<td>Speed</td>
<td>0.11 m/s</td>
</tr>
<tr>
<td>Lubricant</td>
<td>ISO VG46 hydraulic oil</td>
</tr>
<tr>
<td>Temperature</td>
<td>ambient</td>
</tr>
</tbody>
</table>
```

Relative Cavitation Resistance

As a result of its proprietary manufacturing process, the DTS10™ sliding layer far exceeds industry standards of cavitation resistance, making it an excellent choice for fluid power applications such as high-power pumps and motors.

```markdown
Amplitude...0.047 mm
Frequency....20 kHz
Test duration...6 minutes
Coupling medium...water
Temperature....ambient
```
Relative Hydrofatigue Resistance

The excellent hydrofatigue resistance of DTS10™ products makes them an ideal choice for applications with cyclic or rotating loads.

Load.................18 N/mm²
Speed................1.05 m/s
Lubricant.......oil ISO 680
Temperature........+120°C

Relative Friction and Seizure Resistance

As demonstrated in a friction and load test, DTS10™ bearings offer an excellent alternative to bimetallic bearings. The chart below compares the performance of PTFE based metal-polymer materials against leaded bronze, commonly used as the sliding layer in bimetal bearings.

In this incremental test, the load is increased with time and the friction and wear are recorded. As seen below, PTFE-based metal-polymer materials produce significantly lower friction over the entire range of loads, exhibiting excellent seizure resistance well past the point at which the leaded bronze product seized.
Machining

The PTFE copolymer lining of DTS10™ has excellent machinability characteristics, making it an ideal material for high precision applications. The benefit of machining the DTS10™ liner is that a controlled or precisely designed oil clearance can be achieved producing an almost perfect bearing form, which reduces inner diameter tolerances, initial bearing wear and noise. Dimensionally, the machined bore meets tolerance class 7 specifications with a surface finish in the range of 1.6 um Ra max, with geometric roundness below 10 um.

Class 7 Chart

<table>
<thead>
<tr>
<th>Ø RANGE</th>
<th>TOLERANCE</th>
<th>TOLERANCE CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 6.0   ≤ 10.0</td>
<td>± 0.015</td>
<td></td>
</tr>
<tr>
<td>&gt; 10.0  ≤ 18.0</td>
<td>± 0.018</td>
<td>0</td>
</tr>
<tr>
<td>&gt; 18.0  ≤ 30.0</td>
<td>± 0.021</td>
<td>0</td>
</tr>
<tr>
<td>&gt; 30.0  ≤ 50.0</td>
<td>± 0.025</td>
<td>0</td>
</tr>
<tr>
<td>&gt; 50.0  ≤ 80.0</td>
<td>± 0.030</td>
<td>0</td>
</tr>
<tr>
<td>&gt; 80.0  ≤ 120.0</td>
<td>± 0.035</td>
<td>0</td>
</tr>
</tbody>
</table>

Units (mm)

Machining Guidelines

The DTS10™ liner can be machined using three recommended methods: boring, milling and reaming. When machining DTS10™, it is recommended that no more than 0.05mm is removed from the lining thickness in order to ensure an ideal overlay anti-friction layer. Precise machine set-up and careful tool alignment are essential in obtaining good assembled roundness and cylindricity after machining.

- To avoid overheating and excessive wear on the tooling, lubrication is essential.
- Use a system to ensure that burrs/swarf will be removed (e.g. brush, air).
- Use polycrystalline diamond (PCD) or coated carbide (K20) tool material.

Please contact the GGB Application Engineering department should you have a specific need.
Boring

It is recommended to use inserts with wiper technology. The essential characteristics required in the single point turning tool is a nose radius of 0.2 mm – 0.4 mm, combined with a rake angle no greater than 15 degrees. Optimal cutting speeds are between 200 – 500 m/min. The feed rate should be in the range of 0.05 – 0.5 mm/rev. Satisfactory finishes can be obtained using PCD or coated carbide tool materials.

<table>
<thead>
<tr>
<th>Clearance angle</th>
<th>5 - 10°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rake angle</td>
<td>0 - 15°</td>
</tr>
<tr>
<td>Nose angle</td>
<td>35 - 55°</td>
</tr>
<tr>
<td>Nose radius</td>
<td>R = 0.20 - 0.40 mm</td>
</tr>
<tr>
<td>Speed</td>
<td>200 - 500 m/min</td>
</tr>
<tr>
<td>Feed Rate</td>
<td>0.05 - 0.50 mm/rev</td>
</tr>
</tbody>
</table>

Milling

For milling, it is recommended to use two edge millers. The characteristic required in the milling tool is a clearance angle of 5 -10 degrees. The rake angle should be no greater than 15 degrees. Optimal cutting speeds are between 200 – 500 m/min. The feed rate should be in the range of 0.05 – 0.1 mm/tooth.

<table>
<thead>
<tr>
<th>Clearance angle</th>
<th>5 - 10°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rake angle</td>
<td>0 - 15°</td>
</tr>
<tr>
<td>Speed</td>
<td>200 - 500 m/min</td>
</tr>
<tr>
<td>Feed Rate</td>
<td>0.05 - 0.1 mm/tooth</td>
</tr>
</tbody>
</table>

Reaming

The reaming process utilizes multiple cutting edges and is an ideal method for enlarging or sizing the inner diameter of DTS10™ bushings. The essential characteristics required in the reaming tool are a 10-degree clearance or relief angle, and a tooling groove angle of 10 degrees. The benefits of reaming produces hole geometry and finish as close to perfection as theoretically possible.

<table>
<thead>
<tr>
<th>Clearance / relief angle</th>
<th>10°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rake angle</td>
<td>0°</td>
</tr>
<tr>
<td>Helix angle</td>
<td>10°</td>
</tr>
<tr>
<td>Speed</td>
<td>200-500 m/min</td>
</tr>
<tr>
<td>Feed Rate</td>
<td>0.05 - 0.10 mm/rev</td>
</tr>
</tbody>
</table>
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 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 the technical data without prior announcement.

Edition 2015 (This edition replaces earlier editions, which hereby lose their validity.)

RoHS - Restriction of Hazardous Substances

Declaration on lead contents of GGB products/compliance with EU law: It has been prohibited under Directive 2011/65/EU (restriction of the use of certain hazardous substances in electrical and electronic equipment; ROHS II 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 II Directive are exempted. According to Directive 2011/65/EU 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.

All products of GGB, with the exception of DU®, DU-B™, DB™, PICAL™2, SY™, GGB-CSM™115, GGB-CSM™118, GGB-CSM™124, GGB-CSM™125, GGB-CBM™311, GGB-CBM™312, GGB-CBM™321, GGB-CBM™322, GGB-CBM™341, GGB- CBM™342 und SP satisfy these requirements of 2011/65/EU from 08.06.2011 (ROHS II Directive). All products manufactured by GGB are also compliant with REACH Regulation (EC) No. 1 907/2006 of December 18, 2006."

Fabrication

At temperatures up to 250°C, the polytetrafluoroethylene (PTFE) present in the lining material is completely inert so that even on the rare occasions in which DP4™, DP4B™, 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®, DTS10™®, DU®, DX®, DP4™ and DP31™ are trademarks of GGB.
Bearing Application Data Sheet

Not sure which GGB part fits your application requirements? Go to ggbpartfinder.com to complete a Bearing Application Data Sheet online, and one of our GGB bearing specialists will reach out to you with recommended options that meet your application requirements.

You can also 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

DIMENSIONS (mm)

<table>
<thead>
<tr>
<th></th>
<th>Inside diameter</th>
<th>Outside diameter</th>
<th>Length</th>
<th>Flange diameter</th>
<th>Flange thickness</th>
<th>Wall thickness</th>
<th>Length of slideplate</th>
<th>Width of slideplate</th>
<th>Thickness of slideplate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shaft</td>
<td>D_s</td>
<td>D_o</td>
<td>B</td>
<td>S_f</td>
<td>B_f</td>
<td>S_t</td>
<td>L</td>
<td>W</td>
<td>S_s</td>
</tr>
</tbody>
</table>

FITs & TOLERANCES

<table>
<thead>
<tr>
<th></th>
<th>Shaft</th>
<th>Bearing housing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D_s</td>
<td>D_h</td>
</tr>
</tbody>
</table>

OPERATING ENVIRONMENT

- 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

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 ..........................................................
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700 Mid Atlantic Parkway
Thorofare, New Jersey, 08086 USA
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email: usa@ggbearings.com • www.ggbearings.com