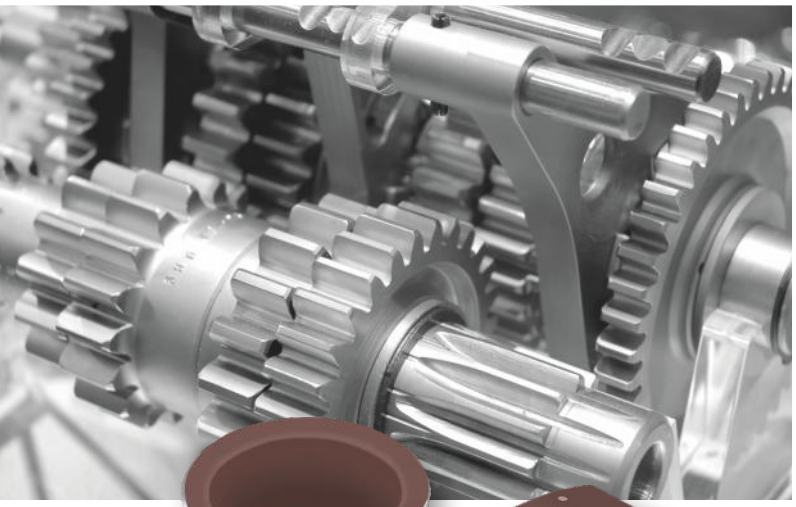
GGB
BY TIMKEN



GGB DP31

METAL-POLYMER BEARING SOLUTIONS FOR LUBRICATED APPLICATIONS

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.

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 critical at all levels of business in order to achieve ourgoal of having the safest employees in the industry.

EXCELLENCE

A world-class organization is built by fostering excellence throughout the company, across all roles. Our world-class manufacturing plants are certified in quality and excellence in the industry according to ISO 9001, IATF 16949, ISO 14001 and ISO 45001, allowing us to access the industry's best practices while aligning our quality management system with global standards.
For a complete listing of our certifications, please visit our website:
https://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 GGB DP31 PTFE based metal-polymer plain bearing material which has been developed to provide enhanced performance under lubricated conditions in industrial and automotive applications such as hydraulic pumps and motors, fuel injection pumps, power steering pumps, compressors, hydraulic cylinders, shock absorbers and McPherson struts.

DP31 complies with the EU directives 2002/96/EG (End of Life directive on electric and electronic devices), 2002/95/EG (Constraint of certain hazardous materials in electric and electronic devices) and End of Life Vehicles directive (2000/53/EC) on the elimination of hazardous materials in the construction of passenger cars and light trucks.

2 Structure and Composition

DP31 is a composite material consisting of steel backing to which is sintered a porous bronze interlayer impregnated and overlaid with a bearing layer of PTFE with fluoro-polymer and other fillers.

The PTFE bearing layer uses a proprietary formulation and process method specifically developed to provide enhanced bearing performance under lubricated conditions.

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

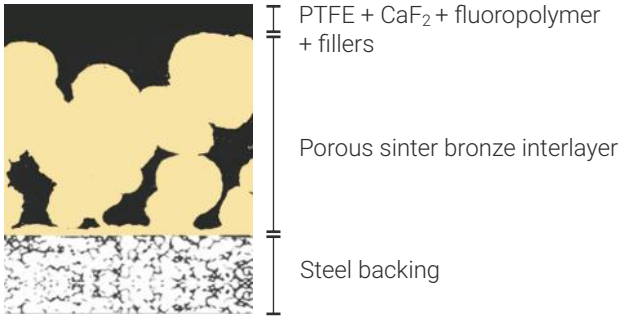


Figure 1: DP31 microsection

2.1 BASIC FORMS

Standard Components

These products are manufactured to International, National or GGB standards. The following components are standard stock products:

- Cylindrical Bushes
- Flanged Bushes
- Strip Material

Figure 2: Standard stock products

Non-Standard Components

These products are manufactured to customer's requirements and include:

- Thrust Washers
- Flanged Washers
- Special Parts

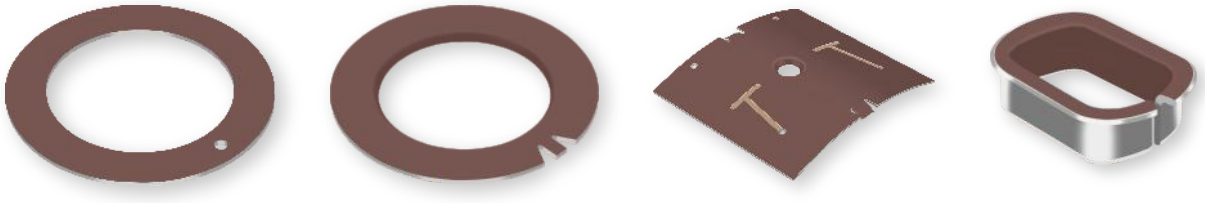


Figure 3: Non-standard products

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

3 Properties

3.1 PHYSICAL AND MECHANICAL PROPERTIES

BEARING PROPERTIES		IMPERIAL UNITS	IMPERIAL VALUE	METRIC UNITS	METRIC VALUE
General					
Maximum load, p	Static Dynamic	psi psi	36 000 20 000	N/mm^2 N/mm^2	250 140
Operating temperature	Min Max	°F °F	- 328 536	°C °C	- 200 280
Coefficient of linear thermal expansion	Parallel to the surface Normal to the surface	10^{-6}/F 10^{-6}/F	6 17	10^{-6}/K 10^{-6}/K	11 30
Oil Lubricated					
Maximum sliding speed, U		fpm	2 000	m/s	10.0
Maximum pU factor		psi x fpm	286 000	N/mm^2 x m/s	10.0
Coefficient of friction			0.01 - 0.05		0.01 - 0.05
Recommendations					
Shaft surface roughness, Ra	Lubricated	µin	≤ 2 - 16*	µm	≤ 0.05 - 0.4*
Shaft surface hardness	Unhardened acceptable, improved bearing life	HB	> 200	HB	> 200

Table 1: Physical and Mechanical Properties

* Depending on operating conditions

3.2 LUBRICATED FRICTION

A low and constant static and dynamic friction is generally desirable in most applications. However, actual friction values depend on the many design and operating factors that influence the lubrication conditions.

Friction is lowest under full hydrodynamic conditions and increases as the generated lubricant films decrease through the mixed film to boundary conditions. DP31 does not show any stick-slip effects.

3.3 CHEMICAL PROPERTIES

The following provides an indication of the chemical resistance of DP31 to various common lubricant media.

It is recommended that the chemical resistance is confirmed by testing if possible.

MEDIUM	°C	RATING
Paraffin	20	+
Gasoline	20	+
Kerosene	20	+
Diesel fuel	20	+
Mineral oil	70	+
HFA-ISO46 high water fluid	70	+
HFC-water glycol	70	+
HFD-phosphate ester	70	+
Water	20	o
Sea water	20	-

Table 2 Chemical resistance of DP31

\+ **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

4 Bearing Performance

Each application places particular demands on the bearing material properties required for satisfactory performance, depending on the equipment design, usage, lubrication and operating conditions.

The following describes the major perfor- mance factors required for satisfactory operation in lubricated applications and indicates the relative performance of DP31 compared with GGB DU® and DP4 for each of the factors.

4.1 BOUNDARY LUBRICATED WEAR RESISTANCE

For a long service life, a low wear rate is necessary, particularly under severe mixed film or boundary lubricated conditions where the generated lubricant films are of the same order or less than the surface roughness of the mating surface.

The wear resistance under steady load oil immersed boundary lubrication conditions has been evaluated using the test rig shown in Figure 4. The test conditions are given in Table 3.

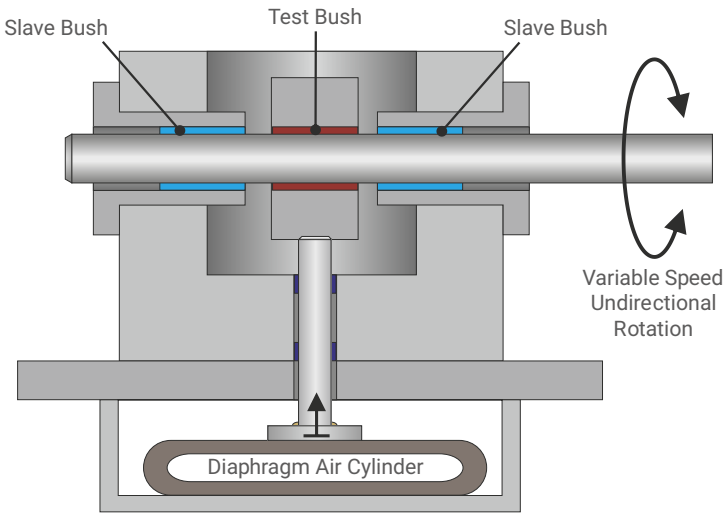


Figure 4: GGB Jupiter test rig

TEST CONDITIONS STEADY LOAD	
Bearing Diameter	20 mm
Bearing Length	15 mm
Mean Diametral Clearance	0.10 mm
Speed	0.11 m/s
p̄U (MPa x m/s)	2.8 4.2 5.6
Lubricant	ISO VG 46 hydraulic oil

Table 3: Test conditions - steady load

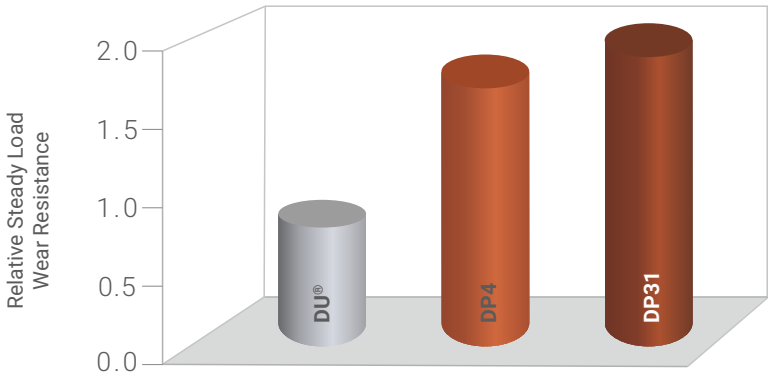


Figure 5: Relative steady load wear resistance

4.2 FATIGUE STRENGTH

Under dynamically loaded lubricated conditions the resulting cyclic pressure fluctuations generated in the lubricant film can result in fatigue damage of the PTFE bearing lining leading to a reduced service life.

Wear resistance and fatigue strength have been evaluated on bushings under rotating load conditions using the test rig shown in Figure 6. The test conditions are given in Table 4.

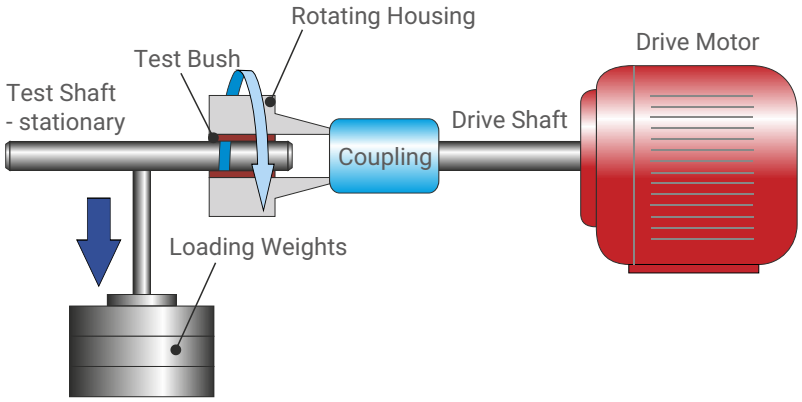


Figure 6: Bush wear / fatigue test rig

TEST CONDITIONS ROTATING BUSH - STATIONARY SHAFT	
Bearing Diameter	20 mm
Bearing Length	15 mm
Mean Diametral Clearance	0.10 mm
Load	13.8 MPa
p̄U	11 MPa x m/s

Table 4: Test conditions rotating bush - stationary shaft

Wear resistance and fatigue strength have also been evaluated on thrust washers under cyclic load conditions using the test rig shown in Fig. 7. The test conditions are given in Table 5.

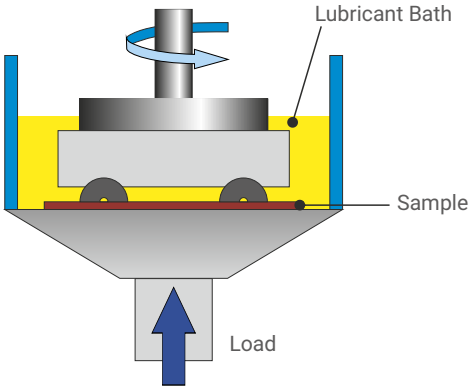


Figure 7: Falex thrust washer wear / fatigue test

FALEX THRUST WASHER WEAR / FATIGUE TEST	
p̄U	10.8 MPa x m/s
Temperature	100 C
Duration	6 hours

Table 5: Test conditions

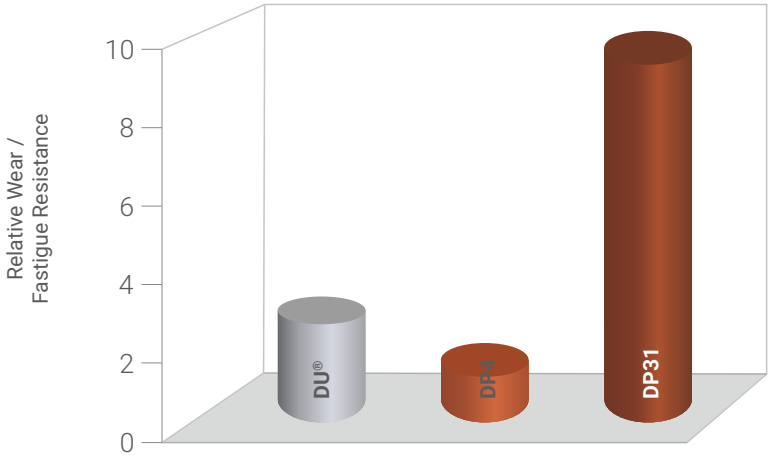


Figure 8: Relative wear / fatigue resistance

4.3 CAVITATION EROSION RESISTANCE

Under dynamically loaded lubricated conditions vapour cavities can be generated within the lubricant film, which subsequently collapse, causing damage to the PTFE bearing lining. This damage takes the form of localised removal of the PTFE and fillers across the bearing surface, leading to a reduced service life.

The test rig shown in Fig. 9 is designed to reproduce the cavitation erosion damage to the bearing lining of the test specimen.

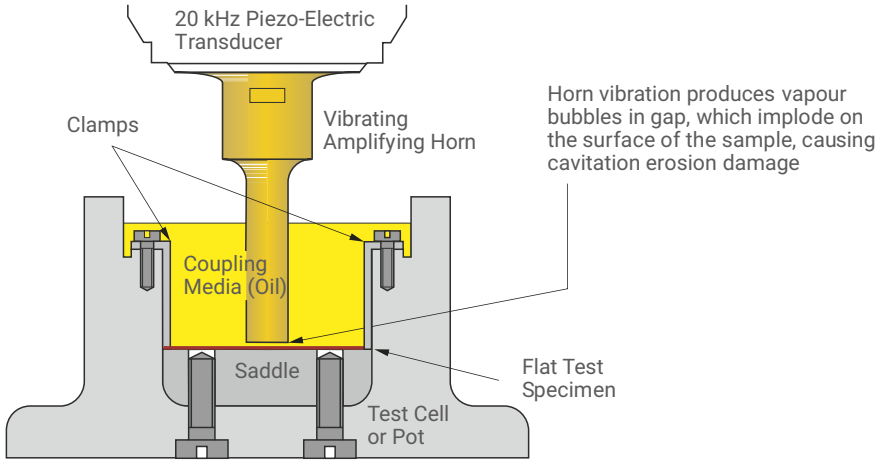


Figure 9: Principle of the cavitation erosion test rig

TEST CONDITIONS CAVITATION EROSION	
Amplitude	0.015 mm
Frequency	20 kHz
Test Duration	30 minutes
Coupling Medium	Water
Temperature	Ambient

Table 6: Cavitation erosion test conditions

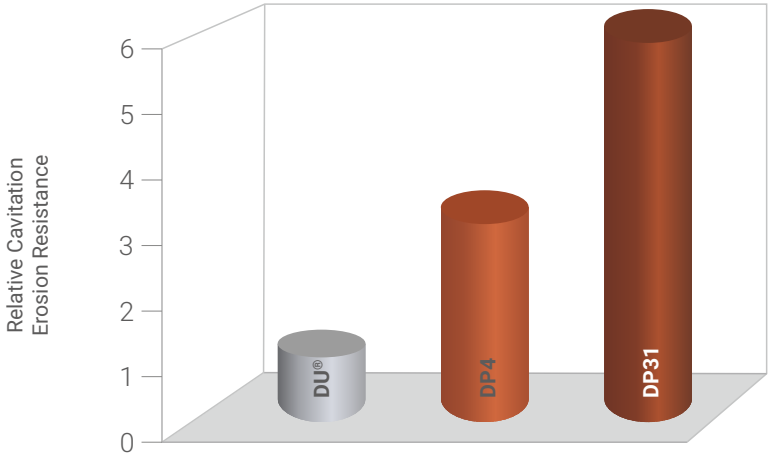
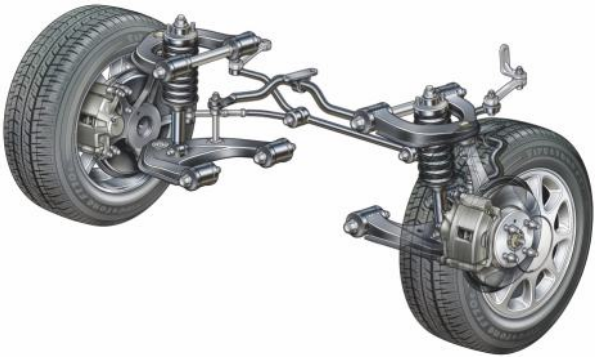


Figure 10: Relative wear / fatigue resistance

5 APPLICATIONS

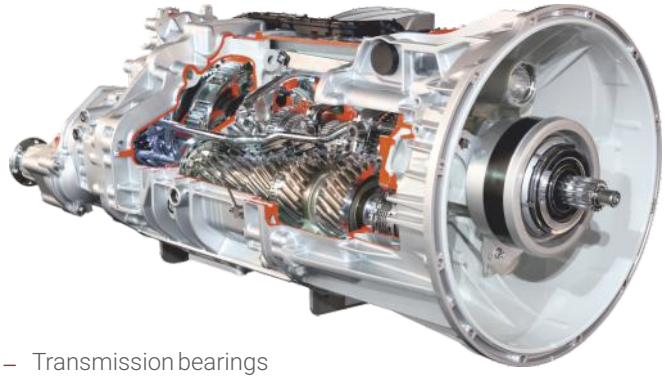
DP31 has been developed to provide enhanced performance under the most demanding marginally lubricated operating conditions.

Typical applications include:



- McPherson struts and shock absorbers
- Hydraulic cylinders

- Hydraulic pumps and motors
- Fuel injection pumps
- Power steering pumps
- Compressors
- Engine valve-train bearings



- Transmission bearings

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 2023 (this edition replaces earlier editions which hereby lose their validity).

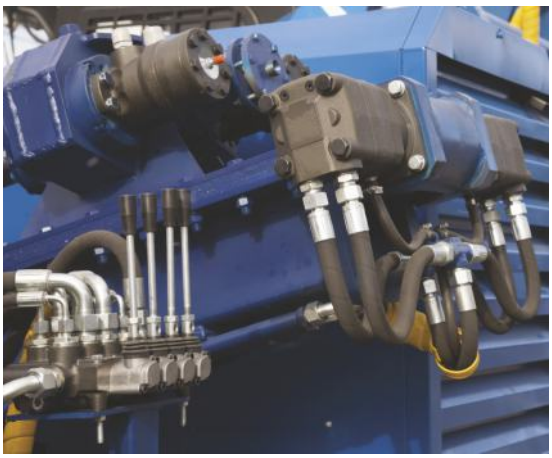
STATEMENT REGARDING LEAD CONTENT IN GGB PRODUCTS & EU DIRECTIVE COMPLIANCE

GGB is committed to adhering to all U.S., European, and international standards and regulations with regard to lead content. We have established internal processes that monitor any changes to existing standards and regulations, and we work collaboratively with 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 A HIGHER QUALITY OF LIFE

GGB NORTH AMERICA

P.O. Box 189 | 700 Mid Atlantic Parkway
USA | Thorofare, New Jersey, 08086
Tel: +1 856 848 3200
www.ggbearings.com

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