



Super Precision
Ball Bearings
Speciality Products



Table of Contents



Capabilities

| | |
|--------------------------------|---|
| Committed to Excellence | 4 |
| Speciality Products | 4 |
| Global Reach | 5 |
| Precision Standards | 5 |
| Beyond ABEC | 6 |
| Sizes and Configurations | 6 |
| Applications | 7 |
| Quality Management | 8 |
| Product Engineering | 9 |

Bearing Types

| | |
|--------------------------------|----|
| Deep Groove Bearings | 10 |
| Angular Contact Bearings | 11 |

Nomenclature

12-13

Product Tables

| | |
|--|-------|
| Deep Groove Instrument (Inch) | 14-17 |
| Deep Groove Instrument (Metric) | 18-19 |
| Deep Groove Flanged (Inch) | 20-21 |
| Deep Groove Thin Section (Inch) | 22-25 |
| Deep Groove Spindle and Turbine (Metric) | 26-31 |
| Angular Contact (Inch) | 32-33 |
| Angular Contact (Metric) | 34-39 |

Special Applications

| | |
|--|-------|
| Introduction and Capabilities | 41 |
| Vacuum Pumps | 42 |
| Emergency Touchdown/Auxiliary Bearings | 43 |
| Aviation and Defence – Auxiliary Equipment | 44-45 |
| Aviation and Defence – Instrumentation and Sensing | 46-47 |
| Aviation and Defence – Actuation Systems | 48-49 |
| Canning Industry | 50 |
| Nuclear Power | 51 |

Engineering

Bearing Selection

| | |
|--------------------------------------|-------|
| Selecting the Right Bearing | 56 |
| Operating Conditions | 56 |
| Bearing Types | 57 |
| Diameter Series | 58 |
| Sizes and Applications | 58 |
| Ceramic Hybrid Bearings | 60-61 |
| AMS5859 Bearings | 62 |
| Surface Engineering Technology | 63-64 |

| | |
|--|--------|
| Solid Lubrication | 64 |
| Bearing Cages | 65-69 |
| Bearing Closures | 70-71 |
| Attainable Speeds and Limiting Speed Factors | 72 |
| Internal Design Parameters | 73 |
| Ball Complement | 73 |
| Raceway Curvature | 73 |
| Radial Internal Clearance | 73-75 |
| Contact Angle | 76-77 |
| Axial Play | 78-79 |
| Ball Complement (Tables) | 80-82 |
| Preloading | 83-87 |
| Lubrication | 88-95 |
| Tolerances and Geometric Accuracy | 96-97 |
| Tolerance Tables | 98-101 |

Bearing Performance

| | |
|-------------------------------|---------|
| Bearing Life | 102 |
| Service Life | 102 |
| Bearing Capacity | 102-103 |
| Fatigue Life | 104-107 |
| Grease Life | 108 |
| Vibration | 109 |
| Yield Stiffness | 110 |
| Torque | 110 |
| Measurement and Testing | 110-111 |

Bearing Application

| | |
|--|---------|
| Mounting and Fitting | 112 |
| Shaft and Housing Fits | 113 |
| Fitting Practice | 113 |
| Fitting Notes | 114-115 |
| Shaft and Housing Size Determination | 115-116 |
| Maximum Fillet Radii | 116 |
| Shaft and Housing Shoulder Diameters | 117 |
| Abutment Tables | 118-126 |
| Random and Selective Fitting | 127 |
| Calibration | 127-128 |
| Maintaining Bearing Cleanliness | 129-130 |
| Handling Guidelines | 131 |
| Index | 132 |

Committed to Excellence

The Barden Corporation, located in Plymouth, UK, and HQW Precision, based in Kürnach near Würzburg in Germany, began a new era as 'Partners in Precision' in 2019 and together are now recognized as world leaders in the design and manufacture of super precision ball bearings.

For more than seven decades the Barden name has been synonymous with bearings of exceptional quality. Barden bearings are renowned worldwide for their high reliability and long operating life in challenging applications. HQW Precision started operations in 2010 and has rapidly built a global reputation for the design and manufacture of high precision, anti-friction bearings and components.

With a shared focus on technology, innovation and quality, these two market leaders manufacture many of the world's most complex and sophisticated precision bearing solutions.

Together they offer thousands of bearing variations that are used in virtually every sector of industry where there is the need to meet critical tolerances, high speeds and performance under demanding operating conditions. These include key components for the aerospace and defense sectors, vacuum pumps, food processing, robotics and medical equipment.

The success of the partnership is built on solid foundations of manufacturing and engineering design excellence, a highly skilled workforce and the ability to design bespoke engineered solutions for customers.



Speciality Products

The Speciality Product line is comprised largely of radial, single and double row, angular contact (separable and non-separable) and deep groove, super precision ball bearings. All products in the range typically meet, and usually surpass, ABEC7 (ISO P4) standards as a minimum with ABEC 9 (ISO P9) also available, while full traceability back to raw materials can also be provided. The product range also includes large and small diameter thin section ball bearings. Produced in standard cross sections and configurations, these bearings can be customised to meet the unique needs of each application.

Super precision bearings come in inch or metric dimensions with diameters ranging from 4mm (5/32") OD up to 180mm (7") OD. Larger sizes can be produced on request.

A variety of seals, shields and metallic/non-metallic cage designs are available to meet most requirements. Many bearings operate comfortably at speeds reaching 2 million dN (bore in mm x RPM), or above.



Global Reach

Originally founded in the USA in 1942 and specializing in precision instrument bearings, The Barden Corporation has since built an enviable reputation for producing some of the world's most precise bearings. The partnership with HQW Precision has served to enhance both capabilities and reputation.

As Partners in Precision the companies now boast state-of-the-art facilities at manufacturing plants in Würzburg, Germany and Plymouth, UK, both of which are equipped with some of the world's most sophisticated machine tools, production equipment and inspection systems. As suppliers to blue chip companies across the globe, quality is of the utmost importance throughout the organisation. Stringent standards are applied to every element of the business, from the customer interface and design, through to production, packaging and delivery.

Precision Standards

Precision ball bearings are manufactured to tolerance standards defined by the Annular Bearing Engineering Committee (ABEC) of the American Bearing manufacturers Association (ABMA). These standards are accepted by the American National Standards Institute (ANSI) and can be seen as

broadly equivalent standards for the International Organisation for Standardisation (ISO). ABEC standards define tolerances for several major bearing dimensions and characteristics, which are divided into envelope dimensions (bore, OD and width) and bearing geometry. Bores and OD's may be calibrated for greater mounting flexibility.

| ABEC Standard | ISO Standard | M&I ABEC Standard | M&I ISO Standard |
|---------------|--------------|-------------------|------------------|
| 1 | P0 | | |
| 3 | P6 | 3P | P6 |
| 5 | P5 | 5P | P5A |
| 7 | P4 | 7P | P4A |
| 9 | P2 | 9P | P2 |

The product range encompasses specialist product lines, including large and small diameter thin section bearings, spindle and turbine bearings, turbomolecular pump and machine tool bearings. While general purpose bearings for these ranges are manufactured to ABEC 1 through to ABEC 9 standards commercially, Barden bearings of these types meet or exceed ABEC 7 geometric standards.

Additionally, the 'miniature and instrument' product range is produced in equivalent classes with added refinements designated by suffixes, and are comparable to ABEC 7 or above.

Beyond ABEC

ABEC classes are primarily concerned with bearing tolerances and while very helpful in categorising precision, there are many other factors that affect the suitability of a bearing to its application. Total bearing quality and 'fitness for purpose' in critical applications is of major importance and Barden often maintains closer tolerances than specified. There are several factors affecting bearing performance and life which are not covered by ABEC standards and these are addressed during the design and manufacture of all Barden bearings.

For example, ABEC criteria does not include functional testing of assembled bearings, yet this measure can be extremely important. Barden applies self-established standards, using proprietary tests and measuring equipment to ensure the delivery of quiet, smooth-running bearings that will perform exceptionally well.

Bearing design is also omitted from ABEC classification but can make the difference between success and failure in bearing use. Barden offers a flexible and innovative design service for this purpose, which takes into account all the factors likely to impact on an application. As such, a Barden bearing may have specific low torque characteristics for a gyro gimbal, extra stiffness for a textile spindle, or extremely high reliability for an aerospace accessory application. Because ball quality affects the running smoothness of a bearing, Barden uses both steel and ceramic balls produced to its own exacting specifications for ball geometry, finish and size control.

Sizes

Barden's super precision bearings are available in metric or inch dimensions, with diameters ranging from 1.5mm (0.06") bore diameter to 180mm (7") OD, and can be categorised as either 'miniature and instrument' or 'spindle and turbine'. This categorisation is primarily related to size, however the application can sometimes be used to classify the bearing.

Configurations

Barden manufactures deep groove and angular contact (eg Cronidur 30 and similar) bearings, available with a wide variety of seals, shields, speciality lubricants, metallic and non-metallic cage designs and calibration options. Thanks to an innovative design service, Barden products can incorporate bespoke design features, such as direct lubricant injection slots, fixings and flanges. Flanged bearings are especially useful in through-bored housings. The inboard side of the flange provides an accurate positioning surface for bearing alignment, eliminating a need for housing shoulders or shoulder rings.

Barden products are available in a range of materials to suit all applications, including SAE 52100 carbon chrome steel, AISI 440C, AISI M50 and AMS5898 (Cronidur 30), a high nitrogen steel originally developed for critical aerospace applications

Design innovation has led to the development of extra wide, or cartridge width, deep groove bearings which are available in Series 9000 for applications requiring extended operation without lubrication. These bearings offer more interior free volume and can therefore hold more grease. Furthermore, improved lubricant life in extreme or hostile environments and increased speedability can be offered through the use of ceramic balls. The benefits of hybrid bearings over traditional steel ball bearings are well known and all Barden products can be fitted with ceramic balls.

Applications

Complementing Barden's range of standard products are a range of re-engineered, modified and custom-designed bearings, created to customer specifications. Often designed around a particular application, these 'special' bearings offer users something new in terms of precision, size or configuration. Examples of Barden bearing applications include:

- ✦ Aviation & Defence Applications
 - ✦ Auxiliary Equipment
 - ✦ Instrumentation & Sensing
 - ✦ Actuation Systems
 - ✦ Space Applications
 - ✦ eVTOL
 - ✦ Air Mobility
- ✦ Vacuum Pumps
 - ✦ Turbomolecular Pumps
 - ✦ Dry Pumps
- ✦ Air Products
 - ✦ Touchdown Bearings
 - ✦ Cryo Pumps
 - ✦ Compressor
 - ✦ Fans
- ✦ Medical Equipment
- ✦ Nuclear Power
- ✦ Canning & Textile Industries
- ✦ High Speed Machine Tool Spindles



Vacuum pumps place severe demands on precision bearings, which must operate reliably under extreme conditions and meet long life requirements.



Commercial aviation applications include a wide variety of aircraft accessories and critical components, and comprise a large percentage of Barden's core business.



Barden super precision bearings used in space applications must meet stringent performance requirements with minimal lubrication.

Quality Management

Barden's Quality Management Systems are accredited to Aerospace Standards AS9100 and AS9120. These external certification controls are coupled with a planned flexibility which enables Barden to comply with specific requirements of individual customers through a system of bespoke quality levels and formal certification of our products.

Quality is fundamental to all Barden products and services. Total Quality is applied to every aspect of our business; from customer service, through design and procurement; and onto manufacturing, assembly and post-delivery support. We place strong emphasis on "quality planning" using preventive tools such as Failure Mode and Effects Analysis (FMEA) for our design and manufacturing processes.

Our Quality and Manufacturing Engineering staff determine and monitor the capabilities of our measurement systems and production machines respectively; thereby ensuring that manufacturing tolerances can be achieved. In-process machine control is facilitated using pre-control; and these statistical methods are employed as production tools to gain better and more consistent quality. We also provide continual investment in business improvement techniques such as Six-Sigma and lean manufacturing.

Each lot of parts or assembled bearings must conform to defined quality requirements before being allowed to move to the next operation. Barden's operators are certified through vigorous training and auditing to perform inspection operations during the manufacturing process.

Similarly, our "Approved Supplier" programme ensures that our suppliers are also in line with our expectations, consistently supplying us with quality products.

The Metrology Department of Barden's quality control organisation provides basic standards of reference, using many advanced types of instrumentation. All linear measurements are certified and traceable back to National Standards. Similarly, our Metallurgical and Chemical Laboratories provide routine verification of incoming bearing steel,



lubricants, cage material and other supplies. These laboratories work closely with external providers, universities and establishments to ensure continual development of our products and processes.

All these aspects are echoed in Barden's Quality Management principles of continual improvement; and customer satisfaction.

Product Engineering

Barden Product Engineering services are available to all customers and prospective users of Barden products. Our engineers and technicians have capabilities in every area of bearing design, application, testing and development. When bearing performance involving torque, vibration or stiffness is an issue, they can perform computational analysis of characteristics and requirements in order to determine a suitable bearing design.

If standard catalogue bearings lack the necessary characteristics for a particular application, our Product Engineering Department can design a special bearing to meet your requirement, whether this is a change of material for extreme environments, changes to the internal design or modified interface dimensions.

With over 70 years of specialisation in the field of precision ball bearings, Barden engineers can draw upon a wealth of technical information to aid in failure analysis or troubleshooting of performance problems. They can readily identify the contributing causes and recommend solutions to improve bearing performance or useful life.

With our dedicated team of experienced R&D engineers we concentrate on both product and process related development simultaneously. Working in a dedicated R&D area, we create and enhance both our world leading production processes and technologies, as well as the products we supply to our customers.

Our modern laboratory and testing facilities are utilised to conduct investigations into new materials, coatings, lubricants and bearing designs. They are the centre for Barden's work on identifying bearing related performance enhancement opportunities, conducting special environmental testing, lifetime and vibration analysis. Further capabilities include materials testing and analysis, scanning electron microscopy with EDX. Production chemistry as well as bearing lubrication is further developed.

If you have a particular problem that you would like Barden's engineers to review, please contact your local sales office.

