HRP Training Aid: Bearings

DESCRIPTION — ECCN

DESCRIPTION	ECCN
Ball bearings, precision hardened steel and tungsten carbide	1C999.a
Ball bearings, radial	2A101
Bearings (anti-friction) and bearing systems	2A101
Bearings, ball and solid roller	2A001.a
Bearings, (e.g., ball, roller, wheel) for ground vehicles	0A606.y.5
Bearings, high precision/temperature/special	2A001
Bearings, magnetic (active)*	2A001.c
Magnetic bearings (suspension)*	2A001.c

*See HRP training aid "Magnets, Magnetic Metals, Magnetic Components and Systems" for magnetic bearings controlled under Export Control Classification Number (ECCN) 2A001.c.

DEFINITIONS AND KEY TERMS

Bearing: A mechanical component used to reduce friction and to maintain clearance between stationary and rotating parts. Bearings are classified as plain journal bearings or antifriction bearings.

Plain journal: The simplest type of bearing, comprising just a bearing surface and no rolling elements. A lubricant, such as oil, grease, or graphite, is used between the surfaces.

Antifriction bearing: A bearing that contains moving elements to provide a low-friction support surface for rotating or sliding surfaces. Antifriction bearings are commonly made with hardened rolling elements (balls and rollers) and races (raceways).

Ring: The annular part of a radial rolling bearing that incorporates one or more raceways.

Rolling element: Ball or roller that rolls between raceways.

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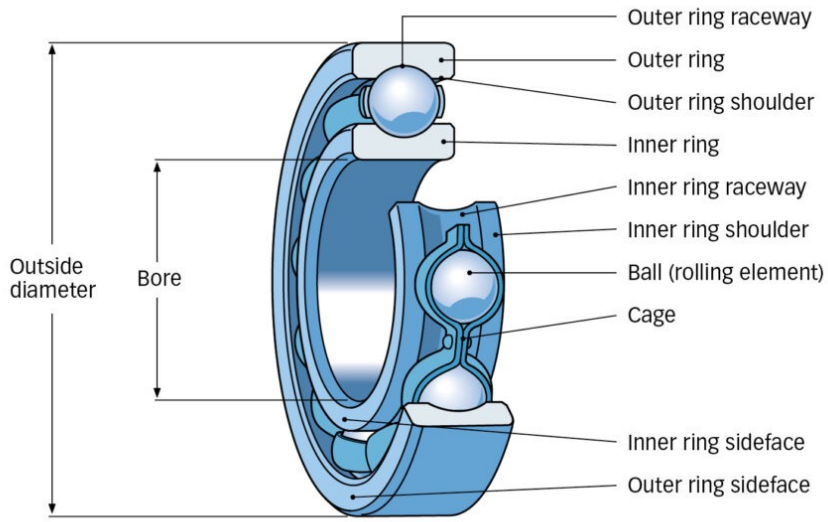
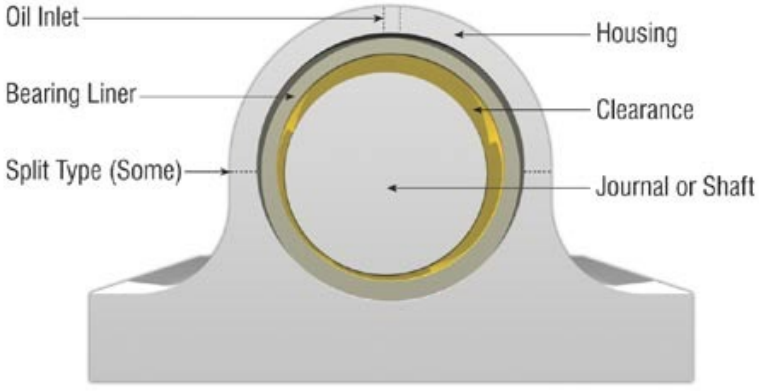
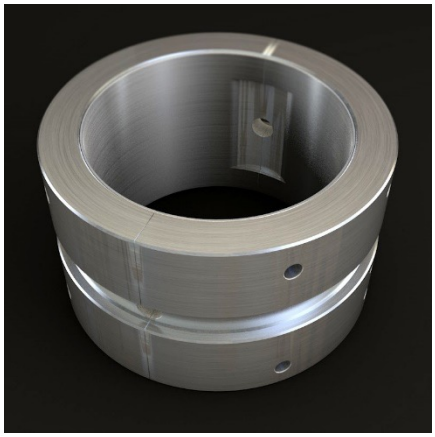
Bearing Terminology

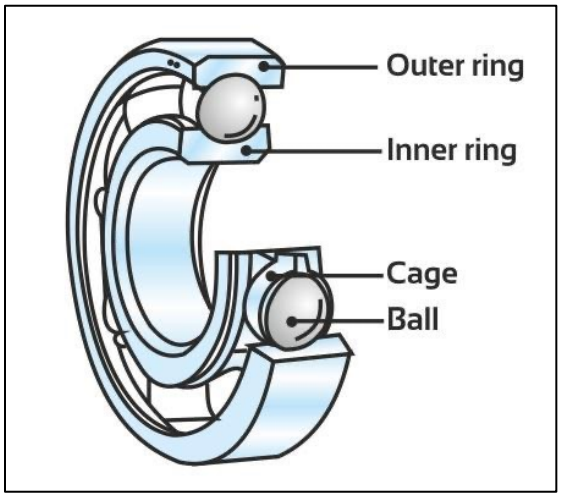


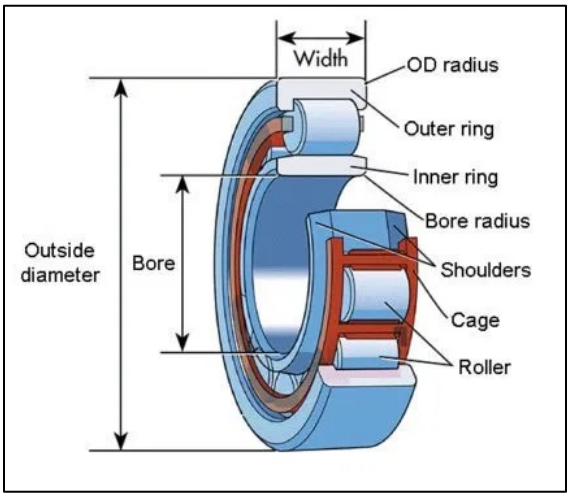
Plain Journal Bearings (not controlled)





Antifriction Bearings



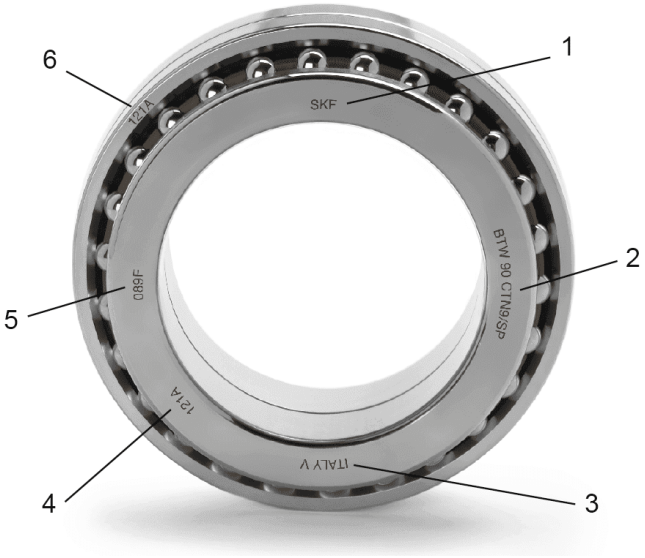


Ball Bearings

Roller Bearings

Markings

- Most bearings have markings that are laser stamped or engraved into them, but these markings can rub off over time.
- Use available markings to research additional bearing specs (e.g., tolerance class, materials of construction) from the manufacturer's websites.

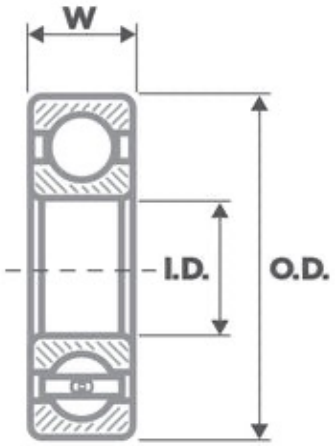


Markings on an SKF ball bearing

1. Manufacturer/trademark
2. Complete designation of the bearing
3. Country of manufacture
4. Date of manufacture, coded
5. Identification/serial number on the inner ring
6. Identification number on the outer ring

Bearing Measurements

- Bearings are measured in three ways: the inside diameter (ID), the outside diameter (OD), and the width (W). The ID is also known as the bore diameter.
- Use of a vernier caliper for accurate measurements is recommended.
- Imperial bearings are measured in inches, whereas metric bearings are measured in millimeters. Most bearing sizes are a full millimeter or inch measurement.
  - If the bearing is metric, then the measurement is a full millimeter(s) (e.g., 9 mm).
  - If the measurement is 9.5 mm, then it is likely a 3/8 in. imperial bearing.



Measuring ID

Measuring OD

Bearing Tolerance Classes

- Tolerance classes include standards for form, fit, function, and correlated running characteristics of bearings.
- During operation, an increase in temperature can cause bearings to expand, affecting boundary dimensions and running accuracy.
- The tolerances for the dimensions and running accuracy of bearings are specified in ISO 492/199/582 (“Accuracies of Rolling Bearings”).

REFERENCE STANDARDS AND ORGANIZATIONS ASSOCIATED WITH BEARINGS

ABEC	Annular Bearings Engineers Committee (within the ABMA)
ABMA	American Bearing Manufactures Association
ANSI	American National Standards Institute, Inc.
BAS	The Japan Bearing Industrial Association Standard
BS	British Standards Institution
DIN	Deutsches Institut für Normung
ISO	International Organization for Standardization
JIS	Japanese Industrial Standards
NF	Association Francaise de Normalisation

Comparison of Tolerance Classes of Various National Standards

ABEC RATING	ISO 492	DIN 620
ABEC 1	normal class 6X	P0
ABEC 3	class 6	P6
ABEC 5	class 5	P5
Tolerance classes controlled under ECCN 2A001 and ECCN 2A101		
ABEC 7	class 4	P4
ABEC 9	class 2	P2

- For ABEC precision classes, the higher the ABEC number, the tighter the tolerance (i.e., higher precision) of the manufactured bearing.
  - From loose to tight: ABEC 1, ABEC 3, ABEC 5, ABEC 7, ABEC 9
- The ISO and DIN classes are opposites of the ABEC scale. The higher the number, the looser the tolerance (i.e., lower precision).
  - ISO 492 scale (from loose to tight): Class 6X, Class 6, Class 5, Class 4, Class 2
  - DIN 620 scale (from loose to tight): P0, P6, P5, P4, P2
- High-precision bearings (ABEC 7 and above) are manufactured with the strictest tolerances and allow dimensions to deviate by only microns.
  - Machine tooling technology has advanced such that manufacturers can routinely produce high-precision bearing classes.
  - **These high-precision classes are controlled under ECCN 2A001 and ECCN 2A101.**

HIGH-PRECISION BEARING APPLICATIONS AND TOLERANCE CLASSES

LNG pumps	**P5**
Measuring instruments	**P5**
Centrifugal separators	**P5, P4**
Jet engine spindles and accessories	**P5, P4**
Superchargers	**P5, P4**
Turbo molecular pump spindles	**P5, P4**
Machine tool spindles	**P5, P4, P2**
Computers, magnetic disk spindles	**P5, P4, P2**
Control equipment (synchronous motors servomotors, and gyro gimbals)	**P4**
Radar or parabola antenna slewing shafts	**P4**
Dental spindles	**P2**

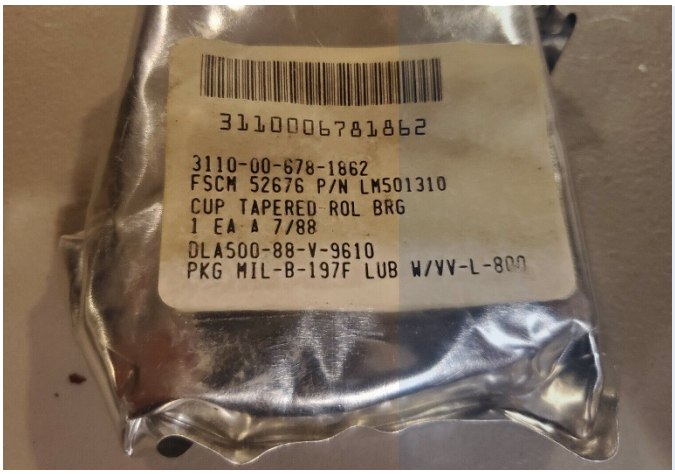
Appearance and Packaging

- Bearings have a metallic double-ring construction, are silver in color, have a smooth finish, and are sometimes polished.
- The balls are generally visible between the housing races, and the races rotate freely.
- Bearings are packaged either individually or as multiple units in plastic bags and cardboard boxes.
- Larger quantities are packaged and shipped in wooden crates.

Bearings for Ground Vehicles
ECCN 0A606.y.5

This ECCN controls exports to China, Russia, or Venezuela for regional stability reasons, and controlled exports include specific parts, components, accessories, and attachments specially designed for a defense article in U.S. Munitions List (USML) Category VII and not elsewhere specified on the USML or the Commerce Control List, including item y.5 as follows:

y.5. Bearings (e.g., ball, roller, wheel) for ground vehicles



A tapered roller bearing for military ground vehicle.

Note, the "MIL-B" marking on packaging.

Hardened Steel and Tungsten Carbide Ball Bearings
ECCN 1C999.a

This ECCN controls exports to China, Russia, or Venezuela for regional stability reasons, and controlled exports include specific parts, components, accessories, and attachments specially designed for a defense article in U.S. Munitions List (USML) Category VII and not elsewhere specified on the USML or the Commerce Control List, including item y.5 as follows:

a. Hardened steel and tungsten carbide precision ball bearings (≥3 mm diameter)

Ball Bearings and Solid Roller Bearings
ECCN 2A001.a

KEY POINTS

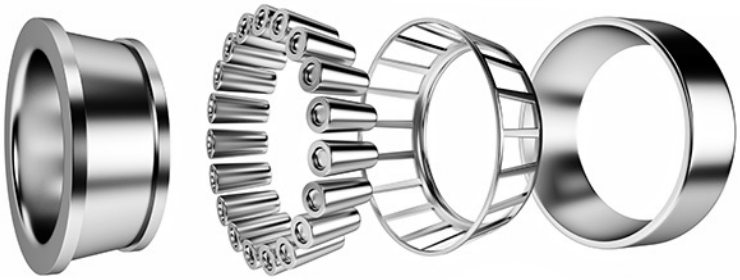
- Ball bearings and solid roller bearings controlled under ECCN 2A001.a have both of the following:
  - All tolerances are specified by the manufacturer in accordance with ISO 492 Tolerance Class 2 or Class 4 (or national equivalents) or better.
  - Both rings and rolling elements are made from Monel or beryllium.
- Most ball bearings and solid roller bearings are not controlled under ECCN 2A001.a.

- Chrome steel (SAE 52100) is the most common material used in precision bearings.
- Stainless steel (Grade 440 or Grade 316) is another common material for applications requiring higher corrosion resistance (e.g., seawater, weaker acids/alkalis).
- Monel and beryllium are much less common bearing materials and are typically used in harsh or extreme environments.

- ECCN 2A001.a does not control tapered roller bearings.

Beryllium copper roller bearing

- Excellent heat dissipation
- Applications: cryogenics, ultrahigh vacuum,magnetically sensitive environments, highly corrosive environments



Tapered roller bearing (not controlled by ECCN 2A001.a).

***From left to right,* assembly, inner raceway, rolling elements (tapered), cage, outer raceway.**

Radial Ball Bearings

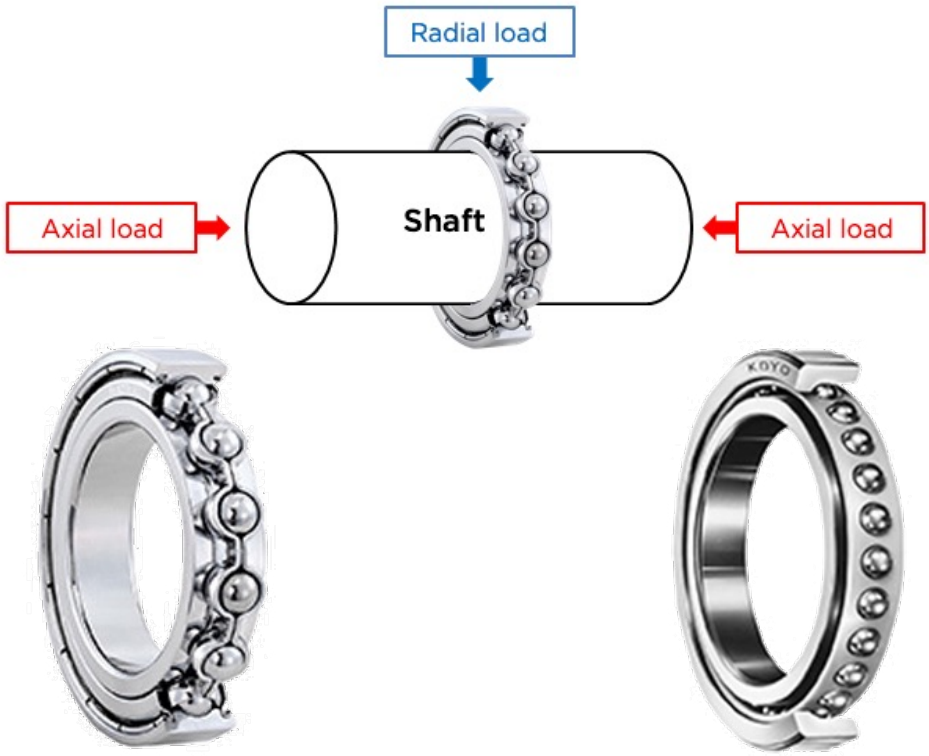
ECCN 2A101

KEY POINTS

- Radial ball bearings controlled under ECCN 2A101 have all tolerances specified in accordance with ISO 492 Tolerance Class 2 (or Class ABEC-9 or other national equivalents) or better and have all the following:

- An ID between 12 and 50 mm
- An OD between 25 and 100 mm
- A width between 10 and 20 mm

- Useful conversion: 1 in. = 25.4 mm
- Radial ball bearings are ball bearings that can support a force that is applied perpendicularly to the shaft.



A deep groove radial ball bearing is the most widely used and can support both a radial load and a certain amount of axial load.

An angular contact radial ball bearing can support a radial load and a one-directional axial load at the same time.

DOE/NNSA High Risk Property

https://hrp.doe.gov

https://ecap.doe.gov

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