

**Bearings, Roller, Rod End, Antifriction Self-Aligning**

**FSC 3110**

**1. SCOPE:**

1.1 This specification covers sealed, self-aligning, anti-friction, rod end roller bearings operating in the temperature range of -65 to +300 °F (-54 to +149 °C) and intermittent spikes to 350 °F (177 °C).

**1.2 Classification:**

Bearings shall be of the following types, as specified (see 6.2):

- Type I External thread rod end bearings (AS21221, AS21223, AS21429)
- Type II Internal thread rod end bearings (AS21220)

**2. APPLICABLE DOCUMENTS:**

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

**2.1 SAE Publications:**

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

- AMS-QQ-P-416 Plating, Cadmium (Electro Deposited)
- AMS 2417 Plating, Zinc-Nickel Alloy
- AS8879 Screw Threads, Controlled Radius Root With Increased Minor Diameters; General Specification For

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### 2.2 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-DTL-197	Bearings, Antifriction, Associated Parts and Subassemblies, Packaging of
MIL-STD-129	Marking for Shipment and Storage
MIL-STD-130	Identification Marking of US Military Property
MIL-PRF-23827	Grease, Aircraft and Instrument, Gear and Actuator Screw
MIL-PRF-81322	Grease, Aircraft, General Purpose Wide Temperature Range

### 2.3 ANSI Publications:

Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ANSI/ASME B46.1	Surface Texture (Surface Roughness, Waviness, and Lay)
ANSI/ASQC Z1.4	Sampling Procedures and Tables for Inspection by Attributes

### 2.4 ASTM Publications:

Available from ASTM, 100 Barr Harbor, West Conshohocken, PA 19428-2959.

ASTM A 380	Practice for Cleaning and Descaling Stainless Steel Parts, Equipment, and Systems
ASTM E 1444	Inspection, Magnetic Particle

### 2.5 AIA Publications:

Available from AIA, 1250 Eye Street N.W., Washington DC 20005.

NAS 516	Fitting, Lubrication - 1/8 Inch Drive, Flush Type
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### 3. REQUIREMENTS:

#### 3.1 Aerospace Standards (AS):

The individual item requirements shall be as specified herein and in accordance with the applicable AS sheets. In the event of any conflict between requirements of this specification and the AS sheets, the latter shall govern.

#### 3.2 Qualification:

The bearings furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time prior to the award of a contract (see Sections 4 and 6).

3.2.1 Product Change: Any change in product design, including raceway geometry or dimensions, rolling element dimensions, rolling element quantity, seals, materials or plant location shall be reported to the qualifying activity and will require requalification of the product to an extent determined by the qualifying activity. Any other specific changes which must be brought to the attention of the qualifying activity will be identified in the qualification notification letter.

3.2.2 Product Manufacture: The bearing manufacturer shall be capable of performing the majority of manufacturing operations in-house, but may subcontract these operations at its option. Component inspection shall be performed at the plant listed on the Qualified Products List (QPL). If manufacturing operations are performed in more than one plant, the manufacturer's additional plant(s) shall be reported to the qualifying activity and will be listed accordingly on the QPL. The manufacturer is responsible for meeting all requirements of the specification and for the quality of the end product, whether it is manufactured totally in-house or some of the operations are performed by a subcontractor. Inherent in the responsibility for the end product is the responsibility to verify that the subcontractor's processes meet specification requirements. A change in subcontractor need not be reported to the qualifying activity unless specifically identified in the qualification notification letter.

NOTE: Bearings partly or completely manufactured in foreign countries shall be subject to the laws and procurement regulations pertaining to acquisition of foreign made products.

#### 3.3 Material:

The bearings shall conform to the applicable AS sheets.

#### 3.4 Design and Construction:

Only factory new bearings conforming to requirements specified herein shall be furnished.

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- 3.4.1 Hardness: The inner ring and rollers shall be through-hardened and shall have a hardness of HRc 60 to 65. The outer raceway be through-hardened or case-hardened and shall have a minimum hardness of HRc 60. Total case depth shall not exceed 50% of cross sectional area. Rod end shanks shall have a uniform cross sectional hardness with minimum hardness of HRc 27.
- 3.4.2 Surface Roughness: The sides of the inner ring shall have a smooth, machined finish that will not exceed 125 microinches Ra. Otherwise, the surface roughness shall be as specified on the AS sheets.
- 3.4.3 Seals: Seals of contact type shall be provided to prevent entrance of dust and to retain the lubricant throughout the temperature range specified. The material shall be reinforced PTFE fiberglass or polyether-ester.
- 3.4.4 Relubrication Provisions: Provisions for lubrication shall be made by use of an external lubrication fitting as specified on the AS sheets.
- 3.4.5 Retainers: Roller retainers shall be made of steel, beryllium-copper, or copper alloy in accordance with applicable AS sheets.
- 3.4.6 Rings: The outer rings shall be of single piece construction with the rod end shank. The inner ring shall be of single piece construction.
- 3.4.7 Threads: Threads shall conform to UNJF-3A and UNJF-3B in accordance with AS8879 for external and internal threads, respectively.
- 3.4.8 Lubrication: The bearings shall be thoroughly cleaned and dried before being lubricated. The bearings shall be filled with grease conforming to MIL-PRF-81322 or MIL-PRF-23827 so that at least eighty percent of the bearing void shall be filled. Bearings shall not have been lubricated more than 36 months prior to date of delivery. The bearing shall be preserved with the operating lubricant or compatible oil per MIL-DTL-197.
- 3.4.9 Dimensions and Tolerances: Dimensions and tolerances shall be in accordance with the applicable AS sheets.
- 3.4.10 Shank Alignment: The point representing the center of self-alignment motion shall be coincident with the axis of the rod end within .010 inch.
- 3.5 Performance:
- 3.5.1 Radial Strength:
- 3.5.1.1 Radial Limit Load Rating: When tested in accordance with 4.5.6, the bearing shall have a radial limit load rating of not less than the value specified on the AS sheet. If starting torque increases by 100% or more, bearing shall be considered to have failed.

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- 3.5.1.2 Radial Ultimate Load: When tested in accordance with 4.5.7, the minimum static fracture capacity shall be not less than 1.5 times the radial limit load rating specified on the applicable AS sheet. Following the test, bearings that cannot be turned by hand, or that have fractured parts, shall be considered to have failed.
- 3.5.1.3 Radial Dynamic Load Rating: When tested in accordance with 4.5.8, the bearings shall have a radial dynamic load rating of not less than the values specified on the applicable AS sheet. A bearing shall be considered to have failed if any of the following defects are detected: wear of the outer raceway greater than .002 inches or .002 inches in radial displacement during dynamic testing; spalling, cracking detected by MPI, or fracture of any component. The bearings shall have a B<sub>50</sub> life of 10,000 cycles or the entire lot shall be considered to have failed the test.
- 3.5.2 Axial Strength:
- 3.5.2.1 Axial Limit Load Rating: When tested in accordance with 4.5.9, the bearing shall have an axial limit load rating of not less than the value specified on the applicable AS sheet. If starting torque increases by 100% or more, the bearings shall be considered to have failed.
- 3.5.2.2 Axial Ultimate Load: When tested in accordance with 4.5.10, bearings that cannot be turned by hand or that have parts fractured, shall be considered to have failed.
- 3.5.3 Radial Internal Clearance: When tested in accordance with 4.5.11, radial internal clearance measured before the radial limit load rating test (4.5.6) shall be as specified on the applicable AS sheet.
- 3.5.4 Axial Internal Clearance: When tested in accordance with 4.5.12, axial internal clearance measured before the axial limit load rating test (4.5.9) shall be as specified on the applicable AS sheet.
- 3.5.5 Seal Performance:
- 3.5.5.1 Seal Test (Lubricant Retention): Bearings shall withstand the seal test specified in 4.5.13, without failure. Not less than 25% of the lubricant's weight shall be retained in the bearing at the end of the test.
- 3.5.5.2 Dust: Bearings subjected to the dust test procedure specified in 4.5.14 shall meet the following requirements:
- Starting torque increase no more than 100% or 2 inch-ounces over initial measured value, whichever is greater.
  - Radial internal clearance increase no more than 50% or .0002 inches over initial measured value, whichever is greater.

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### 3.6 Weight:

The approximate weight of the bearings shall be as specified on the applicable AS sheet.

### 3.7 Plating:

Plating, when specified, shall be zinc-nickel alloy plated in accordance with AMS 2417, Type 2, or cadmium plating in accordance with AMS-QQ-P-416, Type I, Class 2, to a thickness of .0003 to .0006 inch. Plating shall be on all external steel surfaces, except bore, seals and seal retainers.

### 3.8 Identification of Product:

Bearings shall be permanently and legibly marked with the manufacturer's name, part number, and CAGE code. The individual bearing package and container shall be marked with the complete MS part number, and the manufacturer's name and part number, and date of lubrication in accordance with MIL-STD-129.

### 3.9 Workmanship:

All details of workmanship shall be high grade to ensure satisfactory service life. Parts shall not contain sharp edges, burrs, loose chips, dirt, or other foreign matter. The mating surfaces of the rod end the inner ring with rollers shall be free of tool marks, galling, and scratches after assembly.

### 3.10 Magnetic Particle Inspection:

Certification of such inspection, in accordance with 4.5.1.2, shall be furnished with Qualification and Quality conformance inspection samples.

## 4. QUALITY ASSURANCE PROVISIONS:

### 4.1 Responsibility for Inspection:

Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any other commercial laboratory acceptable to the purchaser. The purchaser reserves the right to perform any of the inspection set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to the prescribed requirements.

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4.1.1 Responsibility for Compliance: All items shall meet all requirements of Sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or suppliers submitted for acceptance comply with all requirements of the contract. Sampling inspection, as a part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements. However, this does not authorize submission of known defective material either indicated or actual, nor does it commit the Government to accept defective material.

### 4.2 Classification of Inspections:

The examination and testing of the bearings shall be classified as:

- a. Qualification inspection (4.3).
- b. Quality Conformance inspection (4.4).

### 4.3 Qualification Inspection:

Qualification inspection shall consist of all tests specified under 4.5 and in accordance with Table 1.

4.3.1 Qualification Test Samples: Unless otherwise specified by the qualifying activity, test samples shall consist of 25 bearings for each AS sheet -6 part number, representative of the production bearing. The samples shall be identified with the manufacturer's part number and such other information as required by the procuring activity (see 6.2). Successful testing of the bearing samples utilizing MIL-PRF-81322 shall grant approval to MIL-PRF-23827 based on similarity.

4.3.2 Test Reports: The manufacturer's test report shall be prepared in accordance with the qualifying activity authorization letter. The report shall include a dated drawing which shall describe in detail the manufacturer's product by specifying all dimensions and tolerances, materials, construction, lubricant, plating, and heat treatment. Any information the manufacturer deems proprietary must be so indicated.

4.3.3 Qualification Failure: For initial qualification, any failures during examinations or tests shall be reported to the qualifying activity before continuing testing. Based on corrective action, authorization to complete the qualification test may be granted by the qualifying activity. The applicant's products shall pass all requirements of the specification. Failure of any requirement of this specification shall be cause for refusal to grant qualification.

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4.3.4 Retention of Qualification: In order to retain qualification, the results of the retention of qualification tests, listed in Table 2, shall be furnished to the qualifying activity at 60 month intervals. One part number from each AS sheet for which the manufacturer is qualified shall be tested. The qualifying activity shall select the dash number to be tested. To retain qualification, the manufacturer's products shall pass all of the retention of qualification tests. Failure to furnish the test information shall result in loss of qualification for that product

4.3.4.1 Failure of Retention of Qualification: Any failures during retention of qualification testing shall be reported immediately to the qualifying activity. Authorization to continue retention of qualification testing will be based on acceptance of the corrective action.

4.4 Quality Conformance Inspection:

Quality conformance inspection shall consist of individual tests and sampling tests.

4.4.1 Individual Tests: The individual tests shall consist of the examination of product of 4.5.1 as defined in Table 3.

4.4.2 Sampling Tests: The sampling tests shall consist of the tests of 4.5.2, 4.5.3, 4.5.4, 4.5.5, 4.5.11, and 4.5.12 as defined in Table 3.

4.4.2.1 Lot: A lot shall consist of all bearings of the same type and part number manufactured under the same conditions and offered for acceptance at the time.

4.4.2.1.1 Samples for Quality Conformance Inspection: The sample bearings shall be selected at random from each lot in accordance with Table 4. If no defects are found in the samples, the lot shall be accepted. If any defects are found in the sample, the entire lot shall be 100% inspected for each characteristic found, and the defective parts shall be removed from the lot. If any hardness defects are found in the Normal Inspection Plan of Table 4A, the lot shall be re-inspected under the Tightened Inspection Plan of Table 4A. If a defect is found in the Tightened Inspection sample, the entire lot shall be rejected and shall not be offered for sale or acceptance under this specification.

4.5 Test Methods:

4.5.1 Examination of Product: The bearings shall be carefully examined for conformance to this specification and the applicable AS sheet with respect to dimensions, identification, workmanship, marking, shank alignment, lubrication provisions and threads.

4.5.1.1 Preservation, Packaging, and Packing: Preservation, packaging, and packing shall be examined for conformance with Section 5.

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- 4.5.1.2 Magnetic Particle Inspection: This inspection shall be in accordance with ASTM E1444. The bearing outer race and shank shall be 100% magnetically inspected by both longitudinal and circular methods prior to assembly (See 3.10).
- 4.5.2 Hardness: The bearings shall be disassembled and tested for hardness, using a standard Rockwell hardness tester. The test shall be made on the rolling contact area of the inner and outer raceways and on three rollers. Readings for rollers shall be taken on a flat surface. Readings for rod ends shall be taken on or near the end of the shank (See 3.4.1).
- 4.5.3 Surface Roughness: Surface roughness shall be measured in accordance with ANSI/ASME B46.1. The test shall be made on the bearing disassembled for 4.5.2 (See 3.4.2).
- 4.5.4 Plating: Plating shall be tested for conformance with 3.7 and the applicable AS sheet.
- 4.5.5 Lubrication: The lubricant shall be inspected for quality and cleanliness and shall be in conformance with the type of grease specified in 3.4.8.
- 4.5.6 Radial Limit Load: The bearings shall be mounted in a rigid support as shown on Figure 1, and the bearing rotated manually to determine operational smoothness before testing. The starting friction torque shall be recorded. The appropriate load specified on the applicable AS sheet shall be applied for one minute. The load shall be removed and the bearing inspected for evidence of failure (See 3.5.1.1).
- 4.5.7 Radial Ultimate Load: The radial fracture load of 1.5 times the radial limit load specified on the AS sheet shall be applied to the bearing for one minute. After removal of the load, the bearing shall be examined for failure (See 3.5.1.2).
- 4.5.8 Radial Dynamic Load: Ten bearings of each AS sheet part number submitted shall be tested for radial dynamic load. The bearings shall be mounted on a test fixture having suitable support bearings and drive linkages to provide oscillation of the inner ring. The radial dynamic load specified on the AS sheet shall be applied unidirectionally with respect to the rod end body and maintained within  $\pm 1\%$  for the duration of the test. The bearing shall be oscillated through an arc  $90^\circ$  and back to the starting position for 10,000 cycles at room temperature. Termination of each test shall be an indication of spalled race surfaces as measured by roughness of operation or increase in radial internal clearance. The bearings shall be disassembled and the raceways inspected (See 3.5.1.3).
- 4.5.9 Axial Limit Load: The bearing shall be mounted in rigid support as shown on Figure 1 and the bearing rotated manually to determine operational smoothness before testing. The starting friction torque shall be measured. The appropriate load specified on the applicable AS sheet shall be applied for one minute. The load shall be removed and the bearing inspected for evidence of failure (See 3.5.2.1).

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- 4.5.10 Axial Ultimate Load: The axial fracture load of 1.5 times the axial limit load specified on the AS sheet shall be applied to the bearing for one minute. After removal of the load, the bearings shall be examined for failure (See 3.5.2.2).
- 4.5.11 Radial Internal Clearance: The bearings of each AS sheet size shall be tested for radial internal clearance. The inner ring shall be held rigidly and a radial load of 22 pounds applied alternately in opposite directions to the outer ring. A dial indicator shall be used to measure total movement of the outer ring (See 3.5.3).
- 4.5.12 Axial Internal Clearance: Bearings of each AS sheet size shall be tested for axial internal clearance. The outer ring shall be held rigidly and an axial load of 22 pounds applied alternately in opposite direction to the inner ring. A dial indicator shall be used to measure total movement of the inner ring (See 3.5.4).
- 4.5.13 Seal Test (Lubricant Retention): Three bearings of each size shall be maintained at 250°F-260°F (121°C-127°C) for 100 hours while being operated in the test chamber at 3 rpm with no applied bearing load. The bearings shall be mounted on a horizontal shaft with the outer rings held stationary (See 3.5.5.1). The bearings shall be weighed with no lubricant to establish a baseline weight and then filled with lubricant and weighed again.
- 4.5.14 Dust Test: Three bearings of each AS sheet size shall be subjected to the dust test. Bearings shall be tested for 48 hours 77°F ± 5°F (25°C ± 3°C) in the closed test chamber specified in 4.5.14.1. The bearings shall be mounted on a horizontal shaft and shall be operated at 3 rpm with no applied bearing load and with the bodies held stationary. Pre-test values of starting torque and radial internal clearance shall be recorded. Post-test measurements of starting torque shall be made in the "as tested" condition. Before post-test measurement of radial internal clearance, seal retainers shall be removed and the bearings cleaned thoroughly and relubricated with the same type of grease as originally measured. Both set of measurements shall be recorded.
- 4.5.14.1 Test Chamber Requirements: The test chamber shall be cubic, 2 feet per side, and shall provide view ports for test observation. A minimum layer of 1 inch of dust test media shall be maintained on the chamber floor. Test chamber actuation shall provide continuous movement of dust test media, creating a uniform cloud which shall render test specimens not readily visible through the view ports. Test specimens shall have a minimum spacing of 3 inches from each other and from chamber walls, and the mounting shaft center line shall be 8 to 16 inches above the chamber bottom.
- 4.5.14.2 Dust Test Media: Dust test media shall be Arizona Road Dust in accordance with ISO 12103-1 supplied to SAE Coarse Grade (see 6.4).

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**5. PACKAGING:**

**5.1 Preservation:**

Preservation shall be in accordance with MIL-DTL-197, Level A, C, or commercial as specified (see 6.2.1).

**5.2 Packing:**

Packing shall be in accordance with MIL- DTL -197, Level A, B, C or commercial as specified (see 6.2.1).

**5.3 Marking:**

Marking shall be in accordance with MIL- DTL -197, and MIL-STD-129.

**6. NOTES:**

This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.

**6.1 Intended Use:**

These sealed and shielded antifriction bearings are intended for use in aircraft control systems. These bearings are not intended for applications involving high rotative speeds.

**6.2 Acquisition Requirements:**

Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Type and MS Part No. (see 1.2 and 3.3).
- c. Quantity.
- d. Levels of preservation, packaging, and packing (see 5.1 and 5.2).

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### 6.3 Qualification:

With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved for inclusion in the applicable Qualified Products List, whether or not such products have actually been so listed by that date. The attention of the suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they proposed to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this standard. For direct government procurement or end government usage, the qualifying activity and the activity responsible for the Qualified Products List is the Naval Air Systems Command, Code 4.3.5.4, Building 2187, 48110 Shaw Road, Patuxent River, MD 20670-1906. Information pertaining to qualification of products may be obtained from that activity.

6.3.1 Qualification of a Bearing Distributor: Department of Defense (DoD) standardization regulations have specific requirements covering qualifications approval of a distributor. Details of these requirements may be obtained from the qualifying activity (see 6.3).

6.3.2 Procurement of Bearings from a Distributor not Listed on the Government Maintained QPL: Government contractors and subcontractors who plan to procure a qualified bearing from a distributor not listed on the Government QPL should be aware that distributors frequently stock bearings which were manufactured several years earlier. Since specification requirements are occasionally changed without a corresponding change in part marking, the parts offered for sale by the distributor may not meet current specification requirements. To assure that parts meet current specification requirements, the contractor should require the following information from the distributor:

- (1) Certification that the bearings have been inspected for compliance to the current specification requirements.
- (2) Certification of the original manufacturer's name, part number and date of of lubrication on the outside of each unit package.

NOTE: DoD regulations state that only distributors who been approved by the qualifying activity for listing on a QPL may re-brand a QPL listed item.

### 6.4 Dust Test Media:

Dust test media may be purchased from Powder Technologies Inc., P.O. Box 1464, Burnsville, MN 55337, or from other sources.

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6.5 Subject term (keyword) listing:

Antifriction  
Self-Aligning  
Roller  
Rod End  
Bearing  
Lubricated  
Teflon Seal  
Zinc Nickel Plating

6.6 The change bar ( | ) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document.

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