SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

# AEROSPACE STANDARD

SAE AS4299

Issued 1991-10-30

Submitted for recognition as an American National Standard

## RINGS, RETAINING - SPIRAL WOUND, UNIFORM SECTION CORROSION AND HEAT RESISTANT, UNS S66286

FSC 5365

### 1. SCOPE:

### 1.1 Type:

This procurement specification covers retaining rings of the spiral wound type with uniform rectangular cross-section, made of a corrosion and heat resistant age hardenable iron base alloy of the type identified under the Unified Numbering System as UNS S66286, work strengthened and heat treated to a tensile strength of 185 to 240 ksi at room temperature.

### 1.2 Classification:

Retaining rings shall be of the types and classes shown in Table 1.

TABLE 1

| Type | Class | Description |
|---|---|---|
| I - External Ring | 1 | Medium Duty |
| | 2 | Heavy Duty |
| II - Internal Ring | 1 | Medium Duty |
| | 2 | Heavy Duty |

### 1.3 Application:

Intended for use on aerospace propulsion systems for retaining parts on shafts and in housing bores where high strength at temperatures up to approximately 900 °F is required.

### 1.4 Dimensions and Tolerances:

Unless otherwise specified herein, dimensions and tolerances are in inches.





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Printed in U.S.A.

2. REFERENCES:

2.1 Applicable Documents:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other documents shall be the issue in effect on the date of the purchase order.

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

| | |
|---|---|
| AMS 2645 | Fluorescent Penetrant Inspection |
| AMS 5525 | Sheet, Strip, and Plate, 15Cr-25.5Ni-1.2Mo-2.1Ti-0.006B-0.30V, 1800 °F (980 °C) Solution Heat Treated |
| AS3219 | Ring, Retaining, Spiral, Minimum Distortion, Dimensional and Acceptance Standard For |
| AS3472 | Ring Retaining - Internal, Spiral Wound, Heavy and Medium Duty, AMS 5525 |

2.1.2 U.S. Government Publications: Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

| | |
|---|---|
| QQ-P-35 | Passivation Treatments for Corrosion Resisting Steel |
| MIL-STD-105 | Sampling Procedures and Tables for Inspection by Attributes |
| MIL-STD-1312 | Fastener, Test Methods |
| MIL-STD-2073-1 | DOD Materiel, Procedures for Development and Application of Packaging Requirements |

2.1.3 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

| | |
|---|---|
| ASTM E 8 | Tension Testing of Metallic Materials |
| ASTM E 18 | Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials |

2.1.4 ANSI Publications: Available from American National Standards Institute, 1430 Broadway, New York, NY 10018.

| | |
|---|---|
| ANSI/ASME B46.1 | Surface Texture (Surface Roughness, Waviness, and Lay) |
| ANSI Y14.5M | Dimensioning and Tolerancing |

2.2 Definitions:

PRODUCTION INSPECTION LOT: Shall be all finished retaining rings of the same part number, made from a single heat of alloy, heat treated at the same time to the same specified condition, produced as one continuous run, and submitted for vendor's inspection at the same time.

2.3 Unit Symbols:

% - percent (1% = 1/100)
ksi - kips (1000 pounds) per square inch
°C - degree Celsius
°F - degree Fahrenheit
$in^2$ - square inch
lbf - pounds-force

3. TECHNICAL REQUIREMENTS:

3.1 Material:

3.1.1 Chemical Composition: Shall conform to AMS 5525 except the percentage by weight for sulfur is 0.03 maximum, and phosphorus is 0.04 maximum.

3.1.2 Condition: Flat wire, cold work strengthened, precipitation heat treated in a vacuum, argon, or nitrogen dry atmosphere, to the tensile properties as in 3.4.2.

3.2 Design:

Finished (completely manufactured) parts shall conform to the following requirements:

3.2.1 Design and Dimensions: Unless otherwise specified on the part drawing, retaining rings furnished to this specification shall conform to the design, shape, dimensions, and other requirements specified on the applicable AS standard drawing as in AS3219 and AS3472. Dimensions shall conform to finished unplated rings, unless otherwise specified on the part drawing.

3.2.2 Surface Roughness: Surface texture of finished parts shall conform to the requirements as specified on the part drawing, determined in accordance with ANSI/ASME B46.1.

3.2.3 Crimp: Retaining rings that are required to be crimped (offset at ring ends) shall meet the requirements in AS3219.

3.2.4 Irregularity of Form: The following ring form irregularities shall be not greater than that specified in AS3219.

a. Dish and parallelism
b. Misalignment
c. Radial deformation

3.2.4.1 Distortion: Distortion due to notching shall be no greater than one-half the total tolerance of the ring thickness. See Figure 1.

3.2.4.2 Kinking: Axial kinking shall not exceed the total thickness tolerance, and shall not cause the ring to exceed the maximum thickness. See Figure 1.

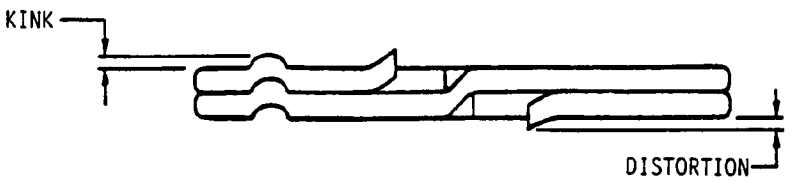


FIGURE 1 - Distortion

3.2.5 Removal Provision: All rings shall be notched to facilitate their removal from the ring groove. Dimensioning of the notch shall be in accordance with the part drawing.

3.2.6 Edges: The edges of the ring material shall be rounded except at the ends and at the removal notches. The edge radius shall be as specified on the part drawing. All edges, including those at the retaining ring ends and at the removal notches, shall be free from burrs, slivers, dents, nicks, cracks, and other irregularities.

3.3 Fabrication:

3.3.1 Rings shall be wound as a spiral of two or more turns from flat wire as in 3.1; finished rings shall meet the requirements of 3.4.2.

3.3.2 Passivation: Finished rings after forming as in 3.3.1 shall be cleaned and passivated in accordance with QQ-P-35.

3.4 Mechanical Properties:

3.4.1 Hardness: Shall be used as a reference to approximate tensile strength, and shall be within the following values for the thickness indicated in Table 2 and determined in accordance with ASTM E 18:

TABLE 2

| Material Thickness, inch | Hardness |
|---|---|
| 0.0067 to 0.0141, incl. | 81.0 - 85.0 HR15N |
| 0.0142 to 0.0212, incl. | 60.5 - 67.5 HR30N |
| 0.0213 to 0.0432, incl. | 71.0 - 75.5 HRA |
| over 0.0432 | 41.0 - 49.0 HRC |

3.4.2 Tensile Strength: Rings rectangular section flat wire shall have a tensile strength within the range 185 to 240 ksi, determined in accordance with ASTM E 8.

3.4.3 Rings shall not be rejected on the basis of hardness if the tensile strength properties in 3.4.2 are met.

3.4.4 Performance: All retaining rings shall be capable of undergoing the test of 4.3.2.1 without showing indications of cracks, excessive permanent set or distortion, or other conditions detrimental to the use of the rings. Distortion or permanent set shall not be to the extent where the minimum diametral interference fit between the ring diameter and the groove diameter, under the stack-up of tolerances is less than 0.003 times the groove diameter as specified in Tables 4 and 5, calculated as follows:

$$F = \phi A - \phi C \geq 0.003 \phi C \qquad \text{(Eq.1)}$$

where:

F = minimum interference fit between ring and groove after performance test
$\phi A$ = maximum ID, external ring as measured after performance test
$\phi A$ = minimum OD, internal ring as measured after performance test
$\phi C$ = minimum groove diameter, external ring
$\phi C$ = maximum groove diameter, internal ring

3.5 Quality:

Parts shall be uniform in quality and condition, clean, sound, smooth, and free from burrs and foreign materials and from imperfections detrimental to usage of the parts.

3.5.1 Fluorescent Penetrant Inspection: Parts shall be fluorescent penetrant inspected in accordance with AMS 2645. There shall be no evidence of cracks, seams, laminations, blanking tears, or laps.

3.5.2 Corrosion Resistance: Rings tested by continuous exposure to salt spray specified in Section 4 shall show no rust when viewed by the unaided eye at normal reading distance.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The vendor of parts shall supply all samples for vendor's test and shall be responsible for performing all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the parts conform to the requirements of this specification.

4.2 Sampling:

4.2.1 For Acceptance Examination - Visual and Dimensional: Sample retaining rings, packages, and shipping containers shall be selected from each production inspection lot in accordance with MIL-STD-105, Inspection Level II for examination in accordance with 4.3.1.

4.2.2 For Acceptance Tests: Sample retaining rings shall be selected from each production inspection lot in accordance with MIL-STD-105, Inspection Level S-3 for testing in accordance with 4.3.2. If the lot consists of less than 26 rings, 10% of the lot shall be selected for testing.

4.3 Inspection:

4.3.1 Acceptance Examination:

4.3.1.1 Visual and Dimensional Examination: Sample retaining rings selected in accordance with 4.2.1 shall be visually and dimensionally examined to verify compliance with the requirements of the part drawing and this specification. The rings shall be accepted or rejected in accordance with the requirements of MIL-STD-105, Acceptance Quality Level (AQL) 4.0% defective, except that the free diameter of retaining rings and the fluorescent penetrant inspection requirements in 3.5.1 and 4.3.2.5 shall be judged in accordance with AQL 1.0% defective.

4.3.2 Acceptance Tests: Sample retaining rings selected in accordance with 4.2.2 shall be tested as specified in 4.3.2.1, 4.3.2.2, and 4.3.2.3 in accordance with the requirements of MIL-STD-105, AQL 1.0% defective. Any retaining ring containing one or more defects shall be rejected. If the quantity of defective rings in the sample exceeds the acceptance quantity for the sample, the lot represented shall be rejected.

4.3.2.1 Performance Tests: Prior to the hardness test of 4.3.2.2, the sample retaining rings selected in accordance with 4.2.2 shall be subjected to the tests of 4.3.2.1.1 and 4.3.2.1.2 as applicable.

4.3.2.1.1 Type I, Classes 1 and 2: External retaining rings shall be expanded over and removed from a groove having a nominal shaft diameter and groove dimensions as specified in Figure 2 and Table 4 for the applicable retaining ring size. After repeating this test five times, the ring shall be visually and dimensionally inspected for conformance to the requirements of 3.4.4.

4.3.2.1.2 Type II, Classes 1 and 2: Internal retaining rings shall be compressed into and removed from a groove having a nominal bore diameter and groove dimensions as specified in Figure 3 and Table 5 for the applicable retaining ring size. After repeating this test five times, the rings shall be visually and dimensionally inspected for conformance to the requirements of 3.4.4.

4.3.2.2 Hardness Test: After the tests of 4.3.2.1, each sample retaining ring selected in accordance with 4.2.2 shall be tested for conformance to the hardness requirements specified in 3.4.1 The surfaces of both sides of each sample shall be prepared for hardness testing by removal of surface conditions which may affect the hardness reading. Hardness readings shall be taken as close as practicable to the center of the surface width of the ring.

4.3.2.3 Tensile Strength Test: Tensile strength test shall be conducted in accordance with ASTM E 8 on three specimens of wire material of the same lot of alloy used to produce the production inspection lot of the finished parts. Such specimens shall withstand the tensile strength stress specified in 3.4.2. The rectangular cross-section area of the wire specimen shall be determined from measurements of thickness and width taken prior to the test. The tensile test load shall be determined as follows:

$$A = T \times W - .12T^2 \qquad \text{(Eq.2)}$$

$$F = S_t \times A \qquad \text{(Eq.3)}$$

where:

A = area of wire specimen cross-section, $in^2$
T = thickness of wire specimen, inch
W = width of wire specimen, inch
F = tensile test load, lbf
$S_t$ = tensile stress specified in 3.4.2, psi

4.3.2.4 Packaging, Packing, and Marking: Samples of packaging and packing containers selected in accordance with 4.2.1 shall be examined for compliance with this specification in accordance with the requirements of MIL-STD-105, AQL 4.0% defective.

4.3.2.5 Nondestructive Inspection: Parts shall be fluorescent penetrant inspected in accordance with AMS 2645 and shall meet the requirements in 3.5.1.

4.3.3 Corrosion Resistance Test: Rings shall be tested by continuous exposure to salt spray in accordance with MIL-STD-1312-1 for a duration of 300 h ± 0.5. After testing, rings shall be examined for compliance with the requirements specified in 3.5.2. Testing shall be performed at a frequency selected by the vendor or unless frequency of testing is specified by purchaser; sampling shall be as in 4.2.2.

4.4 Reports:

The vendor of parts shall furnish with each shipment a report stating that the chemical composition conforms to 3.1.1, showing the results of tests to determine conformance to the acceptance examination and acceptance tests requirements and, when performed, the corrosion resistance test requirements, and stating that the parts conform to the other technical requirements of this specification. This report shall include the purchase order number, lot number, AS4299, contractor or other direct supplier of material, part number, nominal size, and quantity.

4.5 Resampling and Retesting:

If any part or specimen used in the tests fails to meet the specified requirement, disposition of the parts may be based on the results of testing three additional parts or specimens for each original nonconforming part or specimen. Failure of any retest part or specimen to meet the specified requirement shall be cause for rejection of the parts represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Packaging and Identification:

5.1.1 Parts having different part numbers shall be packed in separate containers.

5.1.2 Each container of parts shall be marked to show not less than the following information:

a. RETAINING RINGS, STEEL, CORROSION AND HEAT RESISTANT
b. AS4299
c. PART NUMBER
d. PURCHASE ORDER NUMBER
e. QUANTITY
f. MANUFACTURER'S IDENTIFICATION
g. LOT NUMBER

5.1.3 Containers of parts shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the product to ensure carrier acceptance and safe delivery.

5.1.4 For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-2073-1, Industrial packaging, unless Level A is specified in the request for procurement.

6. ACKNOWLEDGMENT:

A vendor shall mention this specification number in all quotations and when acknowledging purchase orders.

7. REJECTIONS:

Parts not conforming to this specification, or to modifications authorized by purchaser, will be subject to rejection.

8. NOTES:

8.1 Direct U.S. Military Procurement:

Purchase documents should specify the following:

Title, number, and date of this specification
Part number of parts desired
Quantity of parts desired
Level A packaging, if required (See 5.1.4)

8.2 Key Words:

Rings, retaining; procurement specification

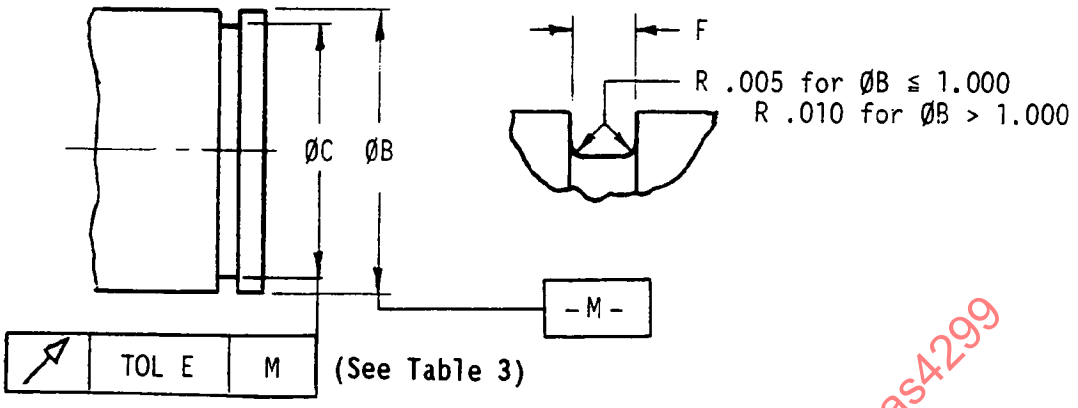


FIGURE 2 - Groove Dimensions, Type I, Classes 1 and 2 Retaining Rings (See Table 4)

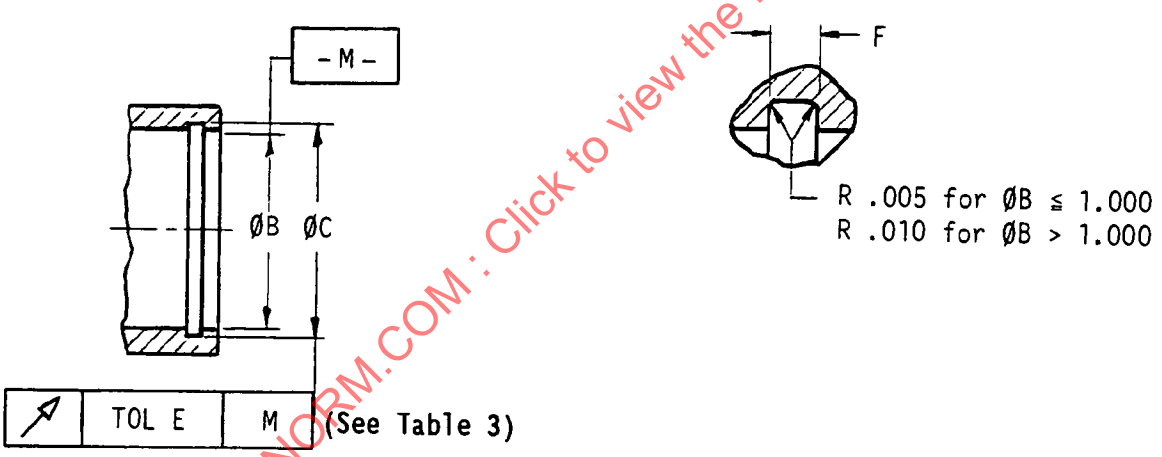


FIGURE 3 - Groove Dimensions, Type II, Classes 1 and 2 Retaining Rings (See Table 5)



TABLE 3 - Groove Runout Tolerance (inches)

| E | ϕB |
|---|---|
| 0.004 | 0.469 thru 1.094 |
| 0.006 | Over 1.094 thru 2.165 |
| 0.008 | Over 2.165 thru 3.149 |
| 0.010 | Over 3.149 thru 5.907 |
| 0.012 | Over 5.907 thru 15.000 |

NOTE: Dimensioning and tolerancing in accordance with ANSI Y14.5M.

TABLE 4 - Groove Dimensions, External Rings (inches)

| Type/Class | Nom Shaft ϕB | Groove Diameter ϕC | Groove Width F |
|---|---|---|---|
| Type I, Class 2 | 0.469 | 0.441 - 0.445 | 0.029 - 0.032 |
| | 0.500 | 0.466 - 0.470 | 0.039 - 0.042 |
| | 0.551 | 0.517 - 0.521 | 0.039 - 0.042 |
| | 0.562 | 0.528 - 0.532 | 0.039 - 0.042 |
| | 0.594 | 0.556 - 0.562 | 0.039 - 0.042 |
| | 0.625 | 0.585 - 0.591 | 0.039 - 0.042 |
| | 0.669 | 0.626 - 0.632 | 0.039 - 0.042 |
| | 0.688 | 0.643 - 0.649 | 0.046 - 0.049 |
| | 0.750 | 0.701 - 0.707 | 0.046 - 0.049 |
| | 0.781 | 0.730 - 0.736 | 0.046 - 0.049 |
| | 0.812 | 0.759 - 0.765 | 0.046 - 0.049 |
| | 0.875 | 0.818 - 0.824 | 0.046 - 0.049 |
| | 0.938 | 0.879 - 0.885 | 0.046 - 0.049 |
| | 0.984 | 0.923 - 0.929 | 0.046 - 0.049 |
| | 1.000 | 0.937 - 0.943 | 0.046 - 0.049 |
| | 1.023 | 0.958 - 0.964 | 0.046 - 0.049 |
| | 1.062 | 0.994 - 1.002 | 0.056 - 0.060 |
| | 1.125 | 1.055 - 1.063 | 0.056 - 0.060 |
| | 1.188 | 1.114 - 1.122 | 0.056 - 0.060 |
| | 1.250 | 1.172 - 1.180 | 0.056 - 0.060 |
| | 1.312 | 1.228 - 1.236 | 0.056 - 0.060 |
| | 1.375 | 1.287 - 1.295 | 0.056 - 0.060 |
| | 1.438 | 1.346 - 1.354 | 0.056 - 0.060 |
| | 1.500 | 1.402 - 1.410 | 0.056 - 0.060 |
| | 1.562 | 1.463 - 1.473 | 0.068 - 0.072 |
| | 1.625 | 1.524 - 1.534 | 0.068 - 0.072 |
| | 1.687 | 1.584 - 1.594 | 0.068 - 0.072 |
| | 1.750 | 1.645 - 1.655 | 0.068 - 0.072 |
| | 1.771 | 1.664 - 1.674 | 0.068 - 0.072 |
| | 1.812 | 1.703 - 1.713 | 0.068 - 0.072 |
| | 1.875 | 1.764 - 1.774 | 0.068 - 0.072 |
| | 1.969 | 1.852 - 1.862 | 0.068 - 0.072 |
| | 2.000 | 1.881 - 1.891 | 0.068 - 0.072 |
| Type 1, Class 1 | 2.062 | 1.986 - 1.998 | 0.056 - 0.060 |
| | 2.125 | 2.045 - 2.057 | 0.056 - 0.060 |
| | 2.156 | 2.076 - 2.088 | 0.056 - 0.060 |
| | 2.165 | 2.085 - 2.097 | 0.056 - 0.060 |
| | 2.188 | 2.107 - 2.119 | 0.056 - 0.060 |
| | 2.250 | 2.170 - 2.182 | 0.056 - 0.060 |
| | 2.312 | 2.228 - 2.240 | 0.056 - 0.060 |
| | 2.362 | 2.278 - 2.290 | 0.056 - 0.060 |
| | 2.375 | 2.291 - 2.303 | 0.056 - 0.060 |
| | 2.437 | 2.349 - 2.361 | 0.056 - 0.060 |
| | 2.500 | 2.412 - 2.424 | 0.056 - 0.060 |
| | 2.559 | 2.467 - 2.479 | 0.056 - 0.060 |
| | 2.562 | 2.470 - 2.482 | 0.056 - 0.060 |
| | 2.625 | 2.533 - 2.545 | 0.056 - 0.060 |
| | 2.688 | 2.591 - 2.603 | 0.056 - 0.060 |

TABLE 4 (Continued)

| Type/Class | Nom Shaft ϕB | Groove Diameter ϕC | Groove Width F |
|---|---|---|---|
| Type 1, Class 1 (Continued) | 2.750 | 2.654 - 2.666 | 0.056 - 0.060 |
| | 2.813 | 2.716 - 2.728 | 0.056 - 0.060 |
| | 2.875 | 2.775 - 2.787 | 0.056 - 0.060 |
| | 2.937 | 2.837 - 2.849 | 0.056 - 0.060 |
| | 2.952 | 2.852 - 2.864 | 0.056 - 0.060 |
| | 3.000 | 2.898 - 2.910 | 0.068 - 0.073 |
| | 3.062 | 2.960 - 2.972 | 0.068 - 0.073 |
| | 3.125 | 3.021 - 3.033 | 0.068 - 0.073 |
| | 3.149 | 3.045 - 3.057 | 0.068 - 0.073 |
| | 3.187 | 3.083 - 3.095 | 0.068 - 0.073 |
| | 3.250 | 3.144 - 3.156 | 0.068 - 0.073 |
| | 3.312 | 3.202 - 3.214 | 0.068 - 0.073 |
| | 3.343 | 3.233 - 3.245 | 0.068 - 0.073 |
| | 3.375 | 3.265 - 3.277 | 0.068 - 0.073 |
| | 3.437 | 3.325 - 3.337 | 0.068 - 0.073 |
| | 3.500 | 3.338 - 3.400 | 0.068 - 0.073 |
| | 3.543 | 3.427 - 3.439 | 0.068 - 0.073 |
| | 3.562 | 3.446 - 3.458 | 0.068 - 0.073 |
| | 3.625 | 3.509 - 3.521 | 0.068 - 0.073 |
| | 3.687 | 3.569 - 3.581 | 0.068 - 0.073 |
| | 3.740 | 3.622 - 3.634 | 0.068 - 0.073 |
| | 3.750 | 3.632 - 3.644 | 0.068 - 0.073 |
| | 3.812 | 3.694 - 3.706 | 0.068 - 0.073 |
| | 3.875 | 3.751 - 3.763 | 0.068 - 0.073 |
| | 3.938 | 3.814 - 3.826 | 0.068 - 0.073 |
| | 4.000 | 3.870 - 3.882 | 0.068 - 0.073 |
| | 4.063 | 3.933 - 3.945 | 0.068 - 0.073 |
| | 4.125 | 3.994 - 4.006 | 0.068 - 0.073 |
| | 4.134 | 4.004 - 4.016 | 0.068 - 0.073 |
| | 4.188 | 4.052 - 4.064 | 0.068 - 0.073 |
| | 4.250 | 4.114 - 4.126 | 0.068 - 0.073 |
| | 4.312 | 4.176 - 4.188 | 0.068 - 0.073 |
| | 4.331 | 4.194 - 4.206 | 0.068 - 0.073 |
| | 4.375 | 4.239 - 4.251 | 0.068 - 0.073 |
| | 4.437 | 4.301 - 4.313 | 0.068 - 0.073 |
| | 4.500 | 4.358 - 4.370 | 0.068 - 0.073 |
| | 4.562 | 4.416 - 4.428 | 0.079 - 0.084 |
| | 4.625 | 4.479 - 4.491 | 0.079 - 0.084 |
| | 4.687 | 4.541 - 4.553 | 0.079 - 0.084 |
| | 4.724 | 4.578 - 4.590 | 0.079 - 0.084 |
| | 4.750 | 4.604 - 4.616 | 0.079 - 0.084 |
| | 4.812 | 4.666 - 4.678 | 0.070 - 0.084 |
| | 4.875 | 4.729 - 4.741 | 0.079 - 0.084 |
| | 4.937 | 4.791 - 4.803 | 0.079 - 0.084 |
| | 5.000 | 4.850 - 4.862 | 0.079 - 0.084 |
| | 5.118 | 4.968 - 4.980 | 0.079 - 0.084 |
| | 5.125 | 4.975 - 4.987 | 0.079 - 0.084 |
| | 5.250 | 5.100 - 5.114 | 0.079 - 0.084 |
| | 5.375 | 5.221 - 5.235 | 0.079 - 0.084 |
| | 5.500 | 5.346 - 5.360 | 0.079 - 0.084 |