

F-43-11  
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 SUPERSEDING  
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FEDERAL SPECIFICATION

CALIPER, MICROMETER, (INSIDE, OUTSIDE,  
 TUBE) AND GAGE, DEPTH MICROMETER

This specification is approved by the Commissioner, Federal Supply Service, General Services Administration, for the use of all Federal agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers outside calipers, inside calipers, and depth gages with micrometer readings.

1.1.1 Federal specification coverage. Federal specifications do not include all varieties of the commodity as indicated by the title of the specification or which are commercially available, but are intended to cover only those generally used by the Federal Government.

1.2 Classification.

1.2.1 Types, classes, and styles. The micrometer calipers and gages covered by this specification shall be of the following types, classes, styles, and graduations as specified (see 6.2):

- Type I. Caliper, micrometer, outside.
  - Class 1. Enameled (I-beam or hollow tubular) frame.
    - Style A. Solid anvil.
    - Style B. Interchangeable anvil.
    - Style C. Tubing, ball anvil.
    - Style D. Tubing, upright anvil.
  - Class 2. Finished frame.
    - Style A. Solid anvil.
    - Style B. Paper gage.
    - Style C. Tubing, ball anvil.
    - Style D. Thread.
- Type II. Caliper, micrometer, inside.
  - Class 1. With jaws.
  - Class 2. Rod and sleeve.
  - Class 3. Tubular.
    - Style A. Interchangeable head.
    - Style B. Fixed head.
- Type III. Gage, depth, micrometer.

2. APPLICABLE DOCUMENTS

2.1 Specifications and standards. The following specification and standard of the issues in effect on the date of invitation for bids, or request for proposal, form a part of this specification to the extent specified herein:

Federal Specification:

PPP-P-40 - Packaging and Packing of Hand Tools

Federal Standard:

FED-STD-H28 - Screw-Thread Standards for Federal Services

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supplements as issued, is for sale on a subscription basis by the General Services Administration, Specifications Unit (WFSIS), 7th and D Street SW, Washington, DC 20407.)

(Single copies of this specification and other Federal Specifications required by activities outside the Federal Government for bidding purposes are available without charge from Business Service Centers at the General Services Administration Regional Offices in Boston, New York, Washington, DC, Atlanta, Chicago, Kansas City, Mo., Fort Worth, Denver, San Francisco, Los Angeles, and Seattle, WA.)

(Federal Government activities may obtain copies of Federal Specifications, Standards, and Commercial Item Descriptions and the Index of Federal Specifications and Standards from established distribution points in their agencies.)

Military Standard:

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.

(Copies of Military Specifications and Standards required by contractors in connection with specific procurement functions should be obtained from Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.)

3. REQUIREMENTS

3.1 Illustrations. The illustrations herein are descriptive and not restrictive and are not intended to preclude the purchase of calipers which are otherwise in accordance with this specification.

3.2 Material. The micrometer spindles and anvils and the component parts of types II and III calipers and gages having utile measuring surfaces shall be made of high grade tool steel or alloy tool steel. The steel shall be made by the crucible or electric-furnace process. The ingots from which the bar stock is made shall be sufficiently reduced in cross section in such a manner as to assure proper refinement of structure and uniform carbide distribution. The bar stock shall be sound and free from injurious porosity, excess segregation, soft spots, hard spots, and other defects.

3.3 Graduations. Calipers and gages shall be supplied with English measure, unless tools with metric measure are specified (see 6.2).

3.4 Screw threads. Screw thread construction and tolerances shall conform to FED-STD-H28.

3.5 Heat treatment. All parts of the tools shall be heat-treated as hereinafter specified to obtain the best overall characteristics of the steel used, and shall be stable after final heat treatment.

3.6 Finish. Unless otherwise specified (see 6.2), the frames of type I, class 2 calipers and the thimbles and barrels of all calipers and gages shall have a chrome-plated, dull (nonglare) finish. The surface roughness of all measuring surfaces shall be as specified herein. The other exposed surfaces, except type I, class 1 frames, shall be either ground with a surface roughness not to exceed 32 microinches roughness height rating (r.h.r.), or have a chrome-plated dull (nonglare) finish. The type I, class 1 frames shall have either a smooth or rippled enameled finish, and the manufacturer's data pad, where applicable, shall have a smooth machined surface.

3.7 Instructions. When specified (see 6.2), each caliper or gage shall be accompanied by a clear and concise operational instruction card or leaflet. Card or leaflet shall be enclosed in a waterproof envelope.

3.8 Cases. Cases shall be furnished as hereinafter specified (see 3.10, 3.11, and 3.12).

3.9 Identification markings. In addition to other markings, instruments shall be marked in a permanent and legible manner with the country of origin, the manufacturer's name or with a trademark of such known character that the source of manufacture may be readily determined, and the part number.

3.10. Type I, caliper, micrometer, outside.

3.10.1 Size and range. The size of an outside micrometer caliper shall be defined as being the maximum measurement which can be obtained with the particular micrometer caliper. The range of a micrometer caliper shall be defined as the span of obtainable measurements, between minimum and maximum on the particular micrometer caliper, except for ball-anvil tubing and thread caliper (see 3.10.10.4.1 and 3.10.11.6.5).

3.10.2 Standards. When specified (see 6.2), a micrometer caliper shall be furnished with standards for setting the 0 reading. Standards for the 2-inch and 50 mm micrometers shall be 1-inch disks or rods and 25 mm disks or rods respectively. Standards for the larger sizes shall be rods. The rods shall have flat and parallel or spherical ends. The 1-inch diameter disk and the ends of the standards shall have a hardness on the Rockwell C scale of not less than 58. The disks shall be uniform in diameter to within plus or minus 0.00005 inch or plus or minus 0.0013 mm. The mean diameter shall be within plus or minus 0.00005 inch or plus or minus 0.0013 mm of size. For rod gages with flat ends, the tolerances for flatness and parallelism shall be the same as for the corresponding sizes for micrometer calipers shown in tables I and II. For rod gages 1 inch or 25 mm in length, the error in length shall not exceed 0.00005 inch or 0.0013 mm. For rod gages in sizes 2, 3, and 4 inches, or 50, 75, and 100 mm in length, the error in length shall not exceed 0.0001 inch or 0.0025 mm. For sizes 5, 6, 7, and 8 inches or 125, 150, 175, and 200 mm in length, the error in length shall not exceed 0.00015 inch or 0.004 mm. For sizes 9, 10, and 11 inches or 225, 250, and 275 mm in length, the error in length shall not exceed 0.0002 inch or 0.005 mm. For sizes 12 through 18 inches, error in length shall not exceed 0.00025 inch. For sizes 19 through 24 inches, error in length shall not exceed 0.0003 inch. For sizes 24 to 36 inches, the error in length shall not exceed 0.00035 inch.

TABLE I. English measure.

Size	Range	Permissible flexure (max)	Measuring faces		Error in indicated measurement (max)	Error in spindle & anvil alignment (max)
			Flatness (max error)	Parallelism (max error)		
Inches	Inches	Inch	Inch	Inch	Inch	Inch
1	0 - 1	0.0001	0.00005	0.00005	0.0001	0.002
2	1 - 2	.0001	.00005	.00010	.00015	.003
3	2 - 3	.0001	.00005	.00015	.00015	.0045
4	3 - 4	.00015	.00008	.0002	.0002	.006
5	4 - 5	.00015	.00008	.0002	.0002	.0075
6	5 - 6	.00015	.00008	.0002	.0002	.009
7	6 - 7	.0002	.00008	.00025	.00025	.010
8	7 - 8	.0002	.00008	.00025	.00025	.010
9	8 - 9	.0002	.00008	.00025	.00025	.010
10	9 - 10	.0003	.0001	.0003	.0003	.010
11	10 - 11	.0003	.0001	.0003	.0003	.010
12	11 - 12	.0003	.0001	.0003	.0003	.010
13 to 18	1 inch increments	.0004	.0001	.0004	.0004	.010
19 to 24	1 inch increments	.0005	.0001	.0005	.0005	.010
25 to 30	1 inch increments	.0006	.0001	.0006	.0006	.010
31 to 36	1 inch increments	.0007	.0001	.0007	.0007	.010

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TABLE II. Metric measure.

Size	Range	Permissible flexure (max)	Measuring faces		Error in indicated measurement (max)	Error in spindle & anvil alignment (max)
			Flatness (max error)	Parallelism (max error)		
Mm	Mm	Mm	Mm	Mm	Mm	Mm
13	0 - 13	.0025	0.001	0.0012	0.003	0.03
25	0 - 25	.0025	.0012	.0012	.004	.05
50	25 - 50	.0025	.0012	.0025	.004	.08
75	50 - 75	.0025	.0012	.004	.004	.11
100	75 - 100	.004	.002	.005	.005	.15
125	100 - 125	.004	.002	.005	.005	.19
150	125 - 150	.004	.002	.005	.005	.23
175	150 - 175	.005	.002	.006	.006	.25
200	175 - 200	.005	.002	.006	.006	.25
225	200 - 225	.005	.002	.006	.006	.25
250	225 - 250	.008	.0025	.0075	.0075	.25
275	250 - 275	.008	.0025	.0075	.0075	.25
300	275 - 300	.008	.0025	.0075	.0075	.25

3.10.3 Design. Outside micrometer calipers shall consist essentially of a frame, micrometer screw spindle, anvil, barrel and thimble, adjusting nut, and when specified (see 6.2), a spindle locknut (clamp ring), or lever-type lock, and ratchet or friction stop. The micrometer calipers shall be so shaped as to permit measurement of a cylinder of a diameter equal to the maximum measuring range of the micrometer caliper.

3.10.3.1 Frames. Frames of all outside micrometers in sizes 1/2 to 4 inches shall be of steel and shall be steel or malleable iron for larger sizes.

3.10.3.2 Micrometer screw spindle. Unless otherwise specified (see 6.2), the entire micrometer screw spindle shall be hardened, stabilized, precision ground, and smoothly lapped, including the thread form. The threads shall be unified form for English measurements and shall have a pitch of 1/40 inch or a pitch of 0.5 mm for metric measurements. The hardness of the screw spindle shall be not less than 62 on the Rockwell C scale. When micrometers with carbide measuring tips or faces are required (see 6.2), the hardness of the screw spindle shall be not less than 55 on the Rockwell C scale. The cylindrical front portion of the micrometer screw spindle shall be a good free-turning fit in its frame bearing without bind or shake in excess of 0.0003 inch measured as close as practicable to the outer face of the bearing, and shall run freely and smoothly throughout the length of its travel. There shall be no perceptible backlash between the screw spindle and the nut, and when at the maximum reading there shall be not less than 0.240-inch engagement of the nut on the screw portion of the spindle. The lead of the spindle shall be of such accuracy throughout its entire length as to permit compliance with the tolerances for errors in indicated measurements as specified in tables I and II at the standard reference temperature of 68 degrees Fahrenheit (F). The diameter of the spindle shall be not less than 3/16 inch for 1/2-inch micrometer caliper and not less than 15/64 inch for 1-inch micrometer caliper and larger. In any one instrument the diameter of the spindle and anvil shall be equal in diameter to within 0.0015 inch.

3.10.3.3 Barrel and thimble. The diameter of the graduated surface of the barrel shall be not less than 13/32 inch. The angle of the bevel at the graduated end of the thimble shall be not more than 20 degrees as measured from the barrel, the beveled edge at the reading end of the thimble shall be sharp, but dulled to prevent cutting of the fingers, and the thimble shall be sufficiently diamond knurled to facilitate ease of rotation. The radial clearance from the barrel to the reading end of the graduations on the thimble shall not exceed 0.020 inch and shall remain substantially constant for appropriately spaced measurements within the range of thimble movement. When set at 0.025, 0.050 inch, etc., at least 2/3 of graduation line shall be visible. The barrel shall be so constructed as to prevent dust or other foreign matter from coming in contact with the threaded portion of the barrel and thimble.

3.10.3.4 Adjustments. Each micrometer caliper shall be provided with a friction or adjusting nut to compensate for wear between the screw portion of the spindle and the nut, and shall be provided with means of adjustment to compensate for wear on the measuring faces. Both adjustments shall be such that they remain secure after resetting and do not impair the original accuracy of the instrument. Calipers with friction-adjusting sleeve on barrel shall have not less than 3-1/2 inch-pounds nor more than 15 inch-pounds torque on the friction sleeve. Suitable spanners, keys, or other means for making these adjustments shall be supplied with each micrometer caliper.

3.10.3.5 Spindle lock. Calipers shall be furnished with or without a spindle lock, as specified (see 6.2). If spindle lock is furnished, it shall effectively lock the spindle without altering the distance between the measuring faces by more than 0.0001 inch or 0.003 mm, and shall be diamond knurled, unless the spindle lock is the lever-operated type.

3.10.3.6 Ratchet or friction stop. Calipers shall be furnished with or without a ratchet or friction stop (see 6.2). If ratchet or friction stop is furnished, it shall be sufficiently knurled to enable satisfactory operation and shall exert a total compressive force between the measuring faces of 1 to 2-1/2 pounds up to the 6-inch size and 1 to 3 pounds for larger sizes.

3.10.4 Measuring faces. All measuring faces shall be hardened, ground, and lapped. The hardness shall be not less than 62 on the Rockwell C scale. The surface roughness of the measuring faces shall not exceed 4 microinches arithmetical average (AA).

3.10.4.1 Measuring face of micrometer screw spindle. The face of the spindle for all positions of rotation of the micrometer screw spindle shall be at right angles to the axis of the spindle and shall be flat and parallel with the face of the anvil within the tolerances specified in table I or II.

3.10.4.2 Carbide measuring tips. When specified (see 6.2), outside micrometer calipers shall be furnished with carbide measuring tips. Carbide tips shall be not less than 0.030 inch in thickness and shall be an integral part of the spindle and anvil.

3.10.5 Graduations. Reference, graduation, and vernier lines on the barrel and thimble shall be clearly cut to width of not more than 0.010 inch, and all vernier and graduation lines shall be within 0.001 inch for size and uniformity. The lines and numbers shall have clean edges and shall be so distinct as to be clearly legible under ordinary service conditions. The barrel and thimble shall be graduated as follows:

3.10.5.1 English reading micrometer calipers. The thimble shall be graduated with 25 divisions, each representing 0.001 inch, and numbered at 0, 5, 10, 15, and 20, or 0, 1, 2, .....23, and 24. The barrel shall be graduated with a longitudinal reference line parallel to the axis of the spindle with 40 equal divisions to the inch, each representing 0.025 inch. The first, and every fourth graduation shall be number 0, 1, 2, .....9, and 0. The 0.100-inch increment lines shall meet and extend above the longitudinal reference line. The 0.050-inch increment lines shall meet and may extend above the longitudinal reference line. The intervening 0.025-inch increment lines shall meet the longitudinal reference line. For 10,000ths-inch micrometer calipers, vernier lines shall be engraved on the upper part of the barrel, the 10 vernier spaces being equal to 9 divisions on the thimble. The graduations shall be numbered 0, 1, 2, .....9, and 0. These graduation lines shall extend a sufficient length of the barrel to provide for the reading of 0.0001 inch in any position within the range of the micrometer caliper.

3.10.5.2 English reading micrometer calipers shall be supplied with 1000ths-inch graduations unless 10,000ths-inch graduations are specified (see 6.2).

3.10.5.3 Metric reading micrometer calipers. The thimble shall be graduated with 50 divisions, each representing 0.01 mm and numbered 0, 5, 10, 15, ..... and 45. The barrel shall be graduated at 0.5-mm intervals, with a longitudinal reference line parallel to axis of the spindle. The first and every tenth graduation shall be numbered 0, 5, 10, 15, 20, and 25. The graduation lines indicating the full millimeters shall be distinguished from the graduation lines

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indicating the half millimeters either by length or position, that is, the full millimeter lines may be longer, or may meet and extend above the longitudinal reference line; or the 0.5-mm lines may extend from the opposite side of the reference line, or be set apart in a separate row. The 5-mm increment lines shall be distinguished from both of these by their greater length or by meeting and extending above the longitudinal reference line.

3.10.6 Accuracy. When tested at the standard temperature of 68 degrees F, the permissible flexure, the flatness and parallelism of measuring faces, the error in indicated measurement, and the error in spindle and anvil alignment for each micrometer caliper shall not exceed the values shown in the tables contained under the requirements for each type of micrometer caliper, when tested throughout its range as specified in 4.3.

3.10.7 Flexure. Under a 2-pound load applied in the direction of and at the spindle axis, the permissible flexure of the frame shall not exceed the tolerances specified in tables I or II.

3.10.8 Sizes. Type 1, class 1, style A, and type 1, class 2, style A micrometer calipers shall be furnished in 1-inch increments in the sizes shown in tables I and II, as specified (see 6.2), and shall be accurate within the tolerances as shown.

3.10.9 Attachment, ball. When specified (see 6.2), a ball attachment similar to figure 1 shall be supplied for use with outside micrometer calipers. The ball shall be either 0.200-inch or 0.250-inch diameter as specified.



FIGURE 1. Ball attachment.

3.10.9.1 Design. Attachment shall be designed to permit standard micrometer calipers to be used for measuring tubing and other rounded surfaces. It shall consist of a hardened ball and ball retainer. The retainer shall readily snap on and off the spindle or anvil of the micrometer caliper without the use of tools. It shall allow the ball to rotate freely and also maintain constant contact with the measuring face to which attached. The ball shall not become detached from the retainer under ordinary handling. The ball shall be ground to an even decimal diameter size to simplify subtraction from the full micrometer reading.

3.10.9.2 Hardness. Ball hardness shall be not less than 62 on the Rockwell C scale. The surface roughness of the ball shall not exceed 4 microinches AA.

3.10.9.3 Accuracy. The ball diameter shall be accurate within plus or minus 0.0001 of the given size.

3.10.10 Class 1, enameled frames. The frames shall have a cutaway, long taper back, or C-type frame of I-beam or hollow tubular frame construction as shown on figure 2, and shall have either a smooth or rippled enameled finish (see 6.2).

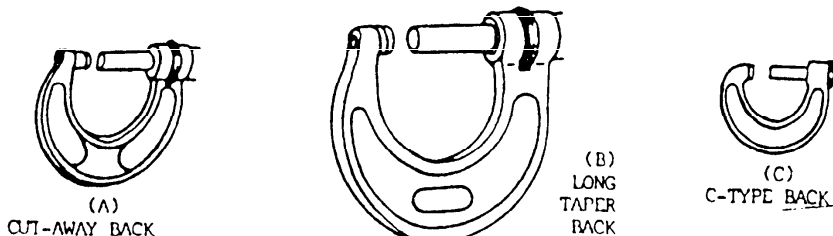


FIGURE 2. Type 1, class 1, enameled frames.



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3.10.10.1 Finish. The frames shall be finished with either a smooth or rippled enamel, except the manufacturer's data pad where applicable shall have a smooth machined surface. The utile measuring face of the anvils and spindles shall have a surface roughness not to exceed 4 microinches AA, and the surface roughness of the outside diameter of the spindles and anvils shall not exceed 32 microinches AA. The thimbles and barrels shall have a chrome-plated, dull (nonglare) finish.

3.10.10.2 Style A, solid anvil. Style A calipers shall be similar to figure 3, and shall conform to the requirements of table I or II.

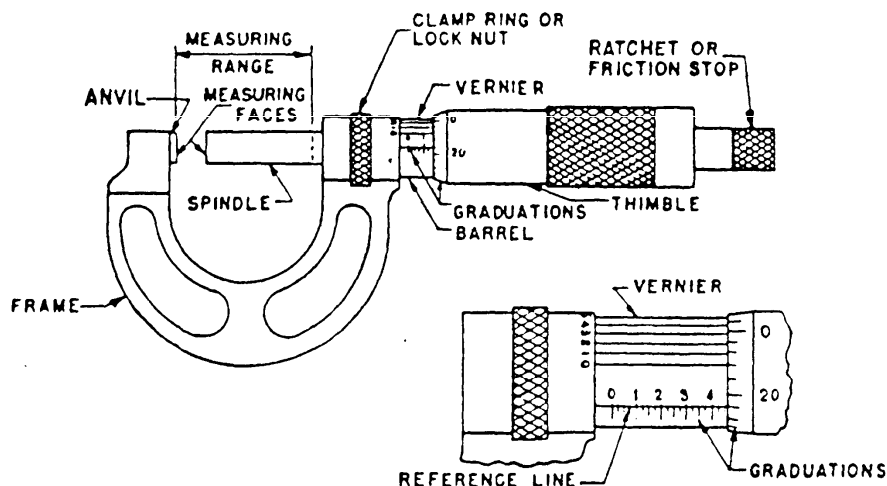


FIGURE 3. Type 1, class 1, style A, caliper, micrometer, outside, enameled (I-beam or hollow tubular) frame, solid anvil.

3.10.10.2.1 Cases. Each instruments shall be furnished in a wood, molded, or metal case. The case shall be properly fitted to hold all parts of the instrument in such a manner as to preclude damage to any parts thereof during ordinary usage and handling and shall be well made. Wooden cases shall have a hinged cover and clasp or a sliding cover and shall be coated both inside and out with a protective coating of lacquer or varnish which will not absorb, affect, or be affected by the compound specified for preservation of the items. Metal cases shall have a spring loaded piano type hinge. The case shall be vinyl covered with expended polyethylene form heat impressed inserts in base and cover. The impressions shall conform to the configuration of the instrument, thus making a secure case for shipment and storage with ample cushioning.

3.10.10.2.2 Plush-lined cases. When specified (see 6.2), the instruments shall be furnished with a velvet or plush-lined case. The outside of the case shall be covered with leatherette or similar material, and shall be a smooth, finished, natural wood with a good protective coating of lacquer or varnish which will not absorb or be affected by the compound specified for preservation of the items.

3.10.10.3 Style B, interchangeable anvil. Style B calipers shall be similar to figure 4 and shall conform to the requirements of table I or II for accuracy. The interchangeable anvils shall be so designed as to provide positive seating, without any permissible side motion, when assembled. Anvils shall be provided with means to compensate for wear of measuring faces. Calipers shall be supplied in size ranges in accordance with table III, as specified (see 6.2).

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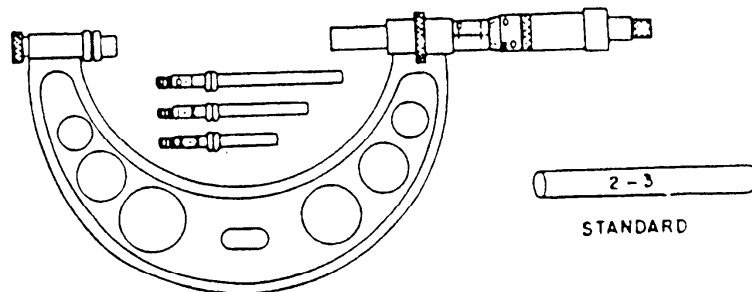


FIGURE 4. Type I, class 1, style B, caliper, micrometer, outside, enameled (I-beam or hollow tubular) frame, interchangeable anvil.

TABLE III. Type I, class 1, style B, interchangeable anvil.

Size range	
Inches	Mm
0 - 4	0 - 100
2 - 6	50 - 150
6 - 9	150 - 225
6 - 12	150 - 300
9 - 12	225 - 300
12 - 16	300 - 400
12 - 18	300 - 450
16 - 20	400 - 500
18 - 24	450 - 600
20 - 24	500 - 600
24 to 96 in 6 inch increments	600 to 2400 in 150 mm increments

3.10.10.3.1 A standard shall be supplied for positive checking of each length anvil. Standards and anvils shall be plainly and permanently marked with length or range applicable.

3.10.10.3.2 Cases. The instrument, interchangeable anvils, and setting standards shall be furnished in a case conforming to 3.10.10.2.1.

3.10.10.4 Style C, tubing, ball anvil. The calipers shall be similar to figure 5.

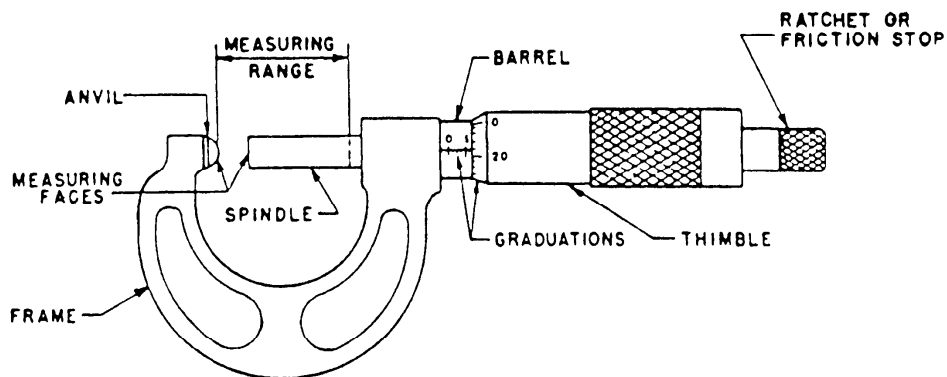


FIGURE 5. Type I, class 1, style C, caliper, micrometer, outside, enameled (I-beam or hollow tubular) frame, tubing, ball anvil.



3.10.10.4.1 Size and range. The style C calipers shall be furnished in 1/2-inch, 1-inch, 13-mm or 25-mm sizes, as specified (see 6.2). The range and accuracy of the calipers shall be as shown in table I or II, except that the 1/2-inch size shall have a range of 0 to 1/2 inch and shall conform to the accuracy requirements for the 1-inch size shown in table I. The size of style C calipers shall be defined as being the maximum wall thickness of tubing which can be obtained with the particular caliper. The range of a caliper shall be defined as the span of obtainable wall thicknesses of tubing, between minimum and maximum, on the particular caliper.

3.10.10.4.2 Anvil. The measuring face of the anvil shall be a portion of a sphere with the center of its radius located on the projected axis of the spindle and shall be of such a radius as to permit accurate measurements of the wall thickness of tubing having inside diameters 5/16-inch and larger for the 0- to 1/2-inch range calipers and inside diameters of 3/8 inch or larger for the 0- to 1-inch range for English calibrated calipers. For metric calibrated calipers, the anvil shall be of such a radius as to permit accurate measurement of the wall thickness of tubing having inside diameters 8-mm, or larger for the 0- to 13-mm range calipers and inside diameters 10-mm or larger for the 0- to 25-mm range calipers. The diameter of the bottom of the anvil shall be not less than 15/64 inch for 1-inch or 25 mm calipers and not less than 3/16 inch for 1/2-inch or 13-mm calipers. Anvils shall be approximately the thickness of the frame.

3.10.10.4.3 Cases. Instruments shall be furnished in cases conforming to 3.10.10.2.1. When specified (see 6.2), instruments shall be furnished with cases conforming to 3.10.10.2.2.

3.10.10.5 Style D, tubing, upright anvil. Calipers shall have a half C-type frame of I-beam construction with the axis of the anvil at right angles to the spindle. The axis of the spindle and anvil shall be in the same plane.

3.10.10.5.1 Measuring face of micrometer screw spindle. The face of the spindle for all positions of rotation of the micrometer screw spindle shall be at right angles to the axis of the spindle and shall be flat and parallel within the tolerances specified in table I. The face of the spindle shall be not less than 15/64 inch in diameter.

3.10.10.5.2 Anvil. The anvil shall be a solid cylindrical stem positioned upright in relation to the axis of the micrometer screw spindle and having the outermost portion of its cylindrical surface opposite the measuring face of the micrometer screw spindle. The diameter and length of the anvil shall permit the anvil to freely enter a 3/8-inch diameter hole to a depth of 3/4 inch and shall permit accurate measurements of the wall thickness of tubing having inside diameters 3/8 inch and larger.

3.10.10.5.3 Calipers shall be supplied in 1-inch or 25-mm sizes as specified (see 6.2), and shall be similar to figure 6. Calipers shall conform to the requirements of table I or II for range and accuracy.

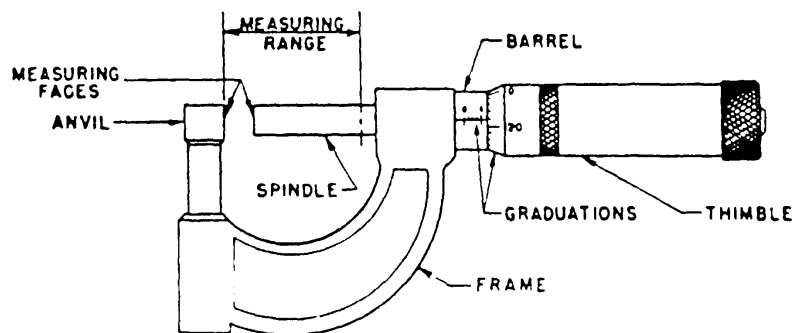


FIGURE 6. Type 1, class 1, style D, caliper, micrometer, outside, enameled (I-beam or hollow tubular) frame, tubing, upright anvil.

3.10.10.5.4 Cases. Cases shall conform to 3.10.10.4.3.

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3.10.11 Class 2, finished frame. Finished frames shall have a cutaway, long taper back, or C-type frame of solid rectangular construction. Sides shall be stamped, engraved or otherwise permanently marked in a practicable location with decimal equivalents of the following fractions: 8ths, 16ths, 32nds, and 64ths. Decimal equivalents of additional fractions will be acceptable. Stamping and engraving shall be substantially deep to make the characters readily legible under ordinary service conditions.

3.10.11.1 Finish. The frames and all other exposed surfaces, except the anvil and spindle, shall have a chrome-plated, dull (nonglare) finish. The anvils and spindles shall conform to 3.10.10.1.

3.10.11.2 Cases. Cases for class 2 micrometers shall conform to 3.10.10.2.1. When specified (see 6.2), cases shall conform to 3.10.10.2.2.

3.10.11.3 Style A, solid anvil. Style A calipers shall be furnished in three sizes 0-1, 1-2, and 2-3 inches, and shall conform to table I or II for the size specified (see 6.2) and be similar to figure 7.

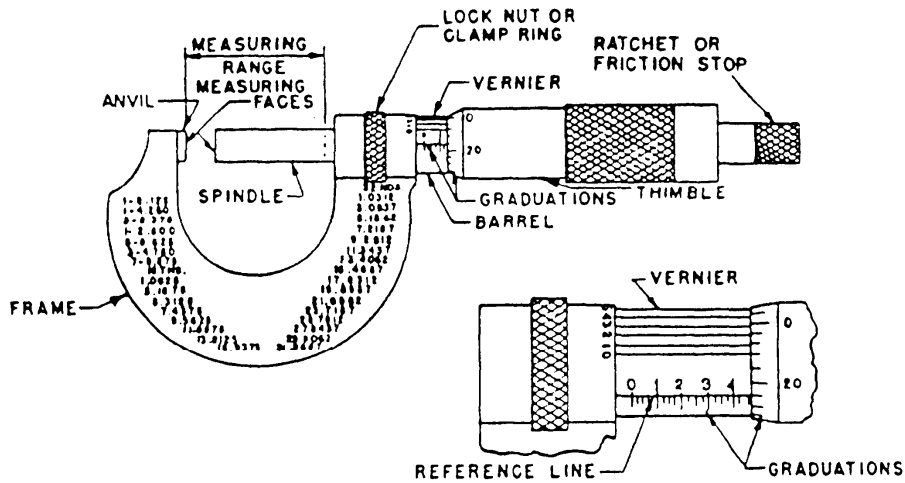


FIGURE 7. Type I, class 2, style A, caliper, micrometer, outside, finished frame, solid anvil.

3.10.11.4 Style B, paper gage. Calipers shall be similar to figure 8. Calipers shall be designed with a disk attached to the spindle and anvil. The disk shall be approximately 7/16 inch in diameter. Calipers shall be supplied in ranges of 0 to 11/32 inch plus 1/32 or 0 to 8.7 mm, plus 3/10 mm as specified (see 6.2), and shall conform to the 1-inch and 13-mm accuracy requirements shown in tables I and II as applicable.

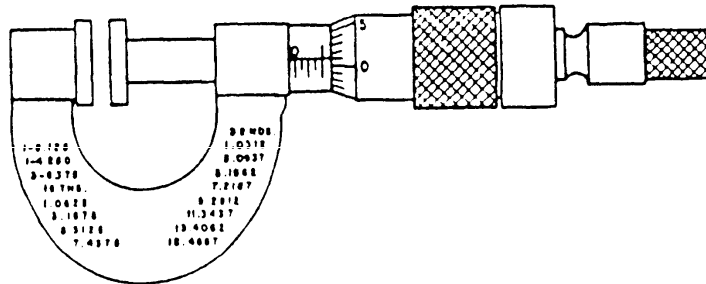


FIGURE 8. Type I, class 2, style B, caliper, micrometer, outside, finished frame, paper gage.

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3.10.11.5 Style C, tubing, ball anvil. Caliper shall be similar to figure 9 and shall conform to the requirements of table 1 or 11 for size specified. Calipers shall conform to 3.10.10.4.1 and 3.10.10.4.2.

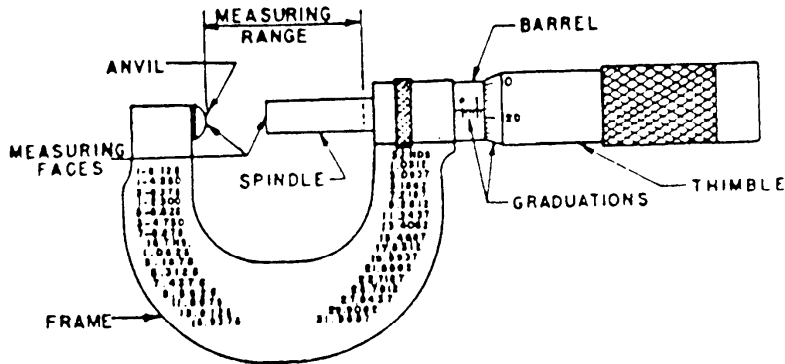


FIGURE 9. Type 1, class 2, style C, caliper, micrometer, outside, finished frame, tubing, ball anvil.

3.10.11.6 Style D, thread. Calipers shall be similar to figure 10 and shall conform to the requirements shown in table IV for the size specified.

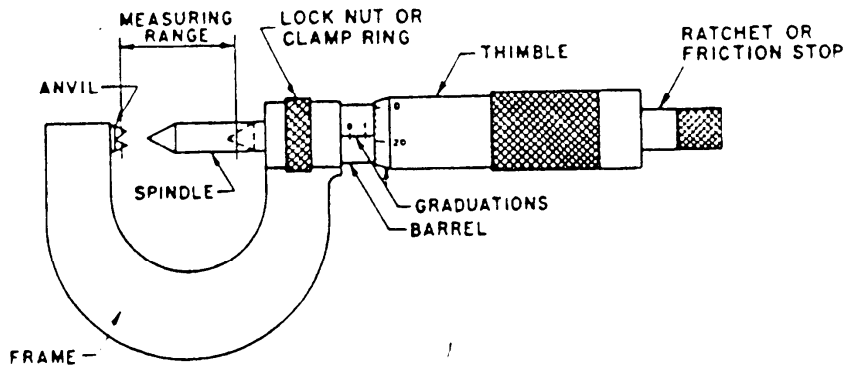


FIGURE 10. Type 1, class 2, style D, caliper, micrometer, outside, finished frame, thread.

TABLE IV. Type 1, class 2, style D, caliper, micrometer, outside, finished solid frame, thread.

Size	Range	Number of threads	Permissible flexure (max)	Measuring faces		Error in indicated measurement (max)	Error in spindle & anvil alignment (max)
				Tolerance (+) on half angle of face			
Inches	Inches	Per inch	Inch	Degree	Minutes	Inch	Inch
1/2	0 - 1/2	48 to 64	0.0001	0	18	0.00010	0.00010
1	0 - 1	8 to 13	.0001	0	5	.00020	.00020
1	0 - 1	14 to 20	.0001	0	6	.00015	.00015
1	0 - 1	22 to 30	.0001	0	8	.00015	.00015
1	0 - 1	32 to 40	.0001	0	12	.00015	.00015
2	1 - 2	4-1/2 to 7	.0001	0	4	.00025	.00030
2	1 - 2	8 to 13	.0001	0	5	.00025	.00030
2	1 - 2	14 to 20	.0001	0	6	.00020	.00015
2	1 - 2	22 to 30	.0001	0	8	.00020	.00015

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3.10.11.6.1 The thread micrometer caliper shall be so shaped as to permit measurements of screw-thread pitch diameters of unified form threads within the size and range of the thread micrometer caliper. The measuring end of the micrometer screw spindle shall terminate in a cone of the same angle as the thread to be measured having its apex on the axis of the micrometer screw spindle and complying with all applicable requirements of table IV.

3.10.11.6.2 Anvil. The anvil shall be located in the frame with its axis central with the axis of the micrometer screw spindle and shall be without perceptible shake or longitudinal movement. The anvil shall be a good free turning fit in the frame. The end of the anvil facing the cone of the micrometer screw spindle shall have a V-groove of the same form as the thread to be measured.

3.10.11.6.3 Measuring surfaces. The conical surface of the micrometer screw spindle shall rotate concentrically with the axis of the micrometer screw spindle and shall conform to all applicable requirements of table IV. The intersection of the angular surfaces of the V-groove of the anvil shall form a straight line which shall be normal to and in the same plane as the axis of the anvil. The angular surfaces of the V-groove shall conform to all applicable requirements of table IV. The conical surface of the micrometer screw spindle and the angular surfaces of the V-groove of the anvil shall be hardened, ground and lapped. The hardness shall be not less than 62 on the Rockwell C scale. The surface roughness of these surfaces shall not exceed 4 microinches AA.

3.10.11.6.4 Standards. Each thread micrometer caliper of 2-inch size shall be furnished with a standard for setting the 0 reading. The mean pitch diameter of the disk shall be within plus or minus 0.00005 inch of the nominal size.

3.10.11.6.5 Range. The range of a thread micrometer caliper shall be defined as the variation in screw-thread pitch diameter measurements, between minimum and maximum, which can be obtained on the particular thread micrometer caliper.

3.10.11.6.6 Sizes. Thread micrometer calipers shall be furnished for unified form threads in sizes shown in table IV, as specified (see 6.2).

### 3.11 Type II, caliper, micrometer, inside.

3.11.1 Class 1, with jaws. Calipers shall be similar to figure 11 and shall conform to the requirements shown in table V for size specified (see 6.2).

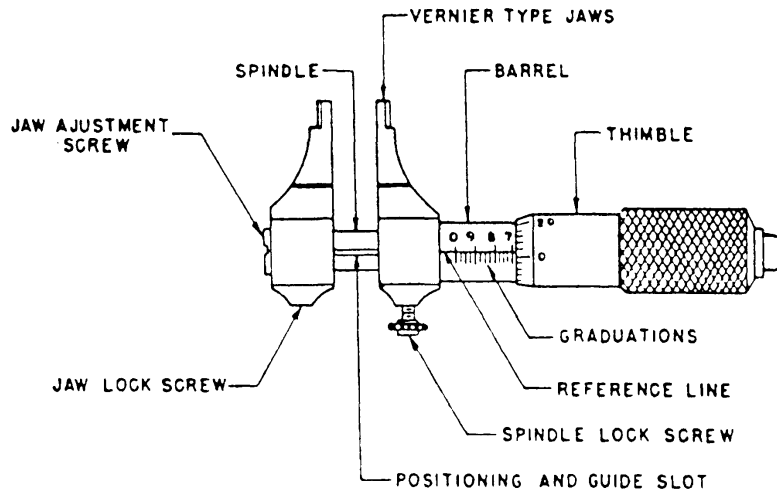


FIGURE 11. Type II, class 1, caliper, micrometer, inside, with jaws.

TABLE V. Type 11, class 1, caliper, micrometer, inside, with jaws.

Size	Range	Error in indicated measurements (max)	Error in radial alignment of jaws
Inches	Inches	Inch	Inch
1	0.200 to 1	0.0002	0.003
1-1/2	.500 to 1-1/2	.0002	.003
2	1 to 2	.0002	.003

3.11.1.1 Design. Calipers shall consist essentially of vernier-caliper style jaws, micrometer screw, spindle, barrel and thimble, knurled lock screw, lock nut or clamp ring, and adjusting screw.

3.11.1.2 Jaws. The inside micrometer calipers shall have vernier-caliper style jaws, and be so designed that the two jaws remain parallel under normal service conditions within the full measuring range.

3.11.1.3 Micrometer screw. Calipers shall have a micrometer screw, the lead of which shall be of such accuracy throughout its entire length as to permit compliance with the tolerances in indicated measurements as specified in table V at the standard reference temperature of 68 degrees F and shall otherwise conform to the thread requirements of the micrometer screw spindle in 3.10.3.2.

3.11.1.4 Spindle. Calipers shall have a spindle of which the micrometer screw is not an integral part, but shall be so designed as to have longitudinal movement only in the barrel, by having the micrometer screw secured to the thimble and free to rotate on the spindle. The spindle shall have a good free fit in barrel bearing without bind or shake in excess of 0.0005 measured as close as practicable to the outer face of the bearing, and shall move freely and smoothly throughout the length of its travel.

3.11.1.5 Barrel and thimble. The barrel and thimble shall conform to the applicable requirements of 3.10.3.3 and shall be graduated in accordance with the applicable requirements of 3.10.5 and 3.10.5.1 with the exception of vernier lines. The numerals for graduations on the barrel shall read in the opposite direction from those on the barrel of the conventional outside micrometer calipers. The first and every fourth graduation shall be numbered 0, 9, 8, . . . . 3, and 2 for the 0.200 to 1-inch range inside micrometer calipers; and 15, 14, 13, . . . . 6, and 5 for the 0.500 to 1-1/2-inch range inside micrometer calipers. However, if 0.025-inch divisions are placed on the spindle in lieu of on the barrel and read in the opposite direction from those on the conventional outside micrometer calipers, the graduations for the 0.200 to 1-inch range inside micrometer calipers, shall start at the 0.200-inch graduation and the first and every fourth graduation read, 2, 3, 4, . . . . 9, and 0; and start for the 0.500 to 1-1/2-inch range inside micrometer calipers at the 0.500-inch graduation and the first and each fourth graduation read 5, 6, 7, . . . . 14, and 15 with a straight longitudinal reference line located on the barrel only. The numerals for graduations on the thimble shall read in the opposite direction from those on the thimble of the conventional outside micrometer calipers for inside micrometer calipers with graduations on the barrel or on the spindle.

3.11.1.6 Spindle locknut (clamp ring). The spindle locknut (clamp ring) shall conform to 3.10.3.5, except that a knurled lock screw may at the option of the contractor be furnished in lieu of locknut (clamp ring).

3.11.1.7 Adjustments. Adjustments shall conform to all requirements of 3.10.3.4.

3.11.1.8 Measuring faces. Measuring faces on the two jaws shall be at right angles to the axis of the spindle and shall have a radius of curvature less than one-half of the smaller value of the measuring range of the inside micrometer caliper, and shall otherwise conform to the requirements of 3.10.4.

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3.11.1.9 Accuracy. When tested at the standard temperature at 68 degrees F as specified in 4.3, the errors as indicated in table V shall not be exceeded.

3.11.1.10 Finish. The jaws and all other exposed surfaces, except the measuring face of the jaws and the spindle, shall have a chrome-plated, dull (nonglare) finish. The measuring face of the jaws and spindle shall conform to 3.10.10.1.

3.11.1.11 Cases. Cases shall conform to 3.10.10.2.1. When specified (see 6.2), cases shall conform to 3.10.10.2.2.

3.11.2 Class 2, rod and sleeve.

3.11.2.1 Ranges. Class 2 calipers shall be similar to figure 12 shall be furnished in the ranges shown in tables VI and VII as specified (see 6.2).

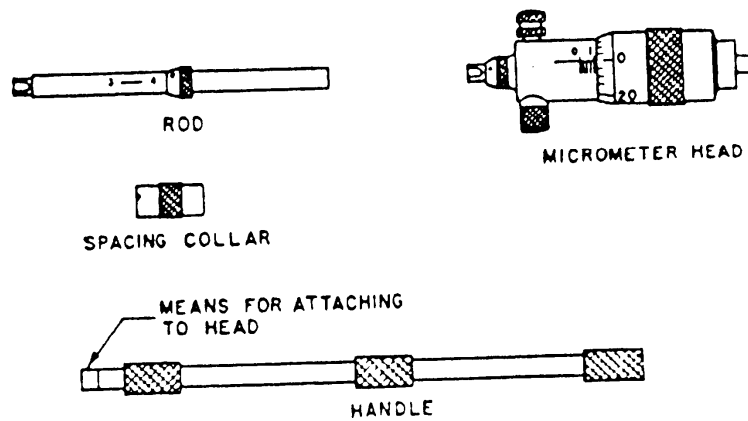


FIGURE 12. Type 11, class 2, caliper, micrometer, inside, rod and sleeve.

TABLE VI. Type 11, class 2, caliper, micrometer, inside, rod and sleeve, English measure.

Range (size)	Error in indicated measurement in the micrometer Head (max)	Permissible error in length (plus or minus)
Inches	Inch	Inch
1 to 2	0.0002	0.0003
2 to 8	.0002	.0004
2 to 12	.0002	.0005
8 to 32	.0002	.001
8 to 36	.0002	.001

TABLE VII. Type 11, class 2, caliper, micrometer, inside, rod and sleeve, metric measure.

Range (size)	Error in indicated measurement in the micrometer Head (max)	Permissible error in length (plus or minus)
Mm	Mm	Mm
25 to 50	0.005	0.0075
50 to 200	.005	.010
50 to 300	.005	.0125
200 to 800 or 900	.005	.025

3.11.2.2 Design. Calipers shall consist essentially of a micrometer head, measuring rods, knurled locking screw (excluding notched or annular rods, except in 8- to 32- or 36-inch range) and spacing collars, and handles when so specified, and shall be capable of measuring any internal dimension within the specified range. Annular rods in all ranges shall be solid, except 8- to 32- and 36-inch range may be tubular or solid. These micrometer calipers shall be similar to figure 12.

3.11.2.3 Micrometer head. The micrometer head shall consist of a micrometer screw barrel and thimble graduated in accordance with 3.10.5 with the exception of vernier lines and that graduations on the barrel shall be as specified herein. For calipers with English calibrations, the 1- to 2-inch range inside micrometer caliper shall be graduated a distance of 0 inch to 0.250 inch on the barrel. The 2- to 8-inch and the 2- to 12-inch range inside micrometer calipers shall be graduated a distance of 0 inch to 0.500 inch on the barrel. The 8- to 32- or 36-inch range inside micrometer calipers shall be graduated a distance of 0 inch to 1 inch on the barrel. For calipers with metric calibrations the 25- to 50-mm range inside micrometer calipers shall be graduated a distance of 0 mm to 7 mm on the barrel. The 50- to 200-mm and the 50- to 300-mm range inside micrometer calipers shall be graduated a distance of 0 mm to 13 mm on the barrel. The 200-mm to 800- or 900-mm range inside micrometer calipers shall be graduated a distance of 0 mm to 25 mm on the barrel. Head shall conform to the requirements of 3.10.3.2 and 3.10.3.3, as applicable.

3.11.2.3.1 Micrometer screw. The lead of the micrometer screw shall be accurate throughout the entire length within the tolerances specified in tables VI and VII at the standard reference temperature of 68 degrees F and shall otherwise conform to 3.10.3.2.

3.11.2.4 Barrel and thimble. The barrel shall be so constructed as to prevent dust or other foreign matter from coming in contact with the threaded portion of the barrel and thimble. Barrel and thimble shall conform to the requirements specified in 3.10.3.3.

3.11.2.5 Measuring rods and spacing collars. A sufficient number of measuring rods and spacing collars shall be provided to cover any measurement within the range of each inside micrometer caliper and shall be so designed as to provide positive seating with no permissible side motion when assembled to the micrometer head. Rods shall be provided with adjustable contact points to compensate for wear in the measuring faces. Each rod shall be plainly and permanently marked with the applicable range of measurement.

3.11.2.6 Measuring faces. Measuring faces shall have a radius of curvature less than one-half of the smallest measuring range of the inside micrometer caliper, and shall otherwise conform to 3.10.4.

3.11.2.7 Handles. When specified (see 6.2), handles shall be furnished with the 1- to 2-inch, 2- to 8-inch and the 2- to 12-inch and the 25- to 50-, 50- to 200-, and 50- to 300-mm range inside micrometer calipers. The handles shall be so designed as to fasten securely to the micrometer head and shall have a knurled finger grip.



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3.11.2.8 Adjustments. Provision shall be made for adjustment to compensate for wear of micrometer screw-thread contact surfaces and for maintaining individual length of rods.

3.11.2.9 Rigidity. There shall be no readable difference in the indicated measurements when taken with the inside micrometer caliper horizontally supported at the two ends as compared with the same measurements taken vertically.

3.11.2.10 Finish. The barrel and thimble shall have a chrome-plated, dull (nonglare) finish. The utile measuring faces shall have a surface roughness not to exceed 4 microinches AA. The locating faces on the rods, spacers, and ends of the micrometer head shall have a surface roughness not to exceed 8 microinches AA. The diameter of the rods shall have a surface roughness not to exceed 32 microinches AA.

3.11.2.11 Cases. Cases for class 2 inside micrometers shall conform to 3.10.10.2.1.

3.11.3 Class 3, tubular.

3.11.3.1 Style A, interchangeable head. Calipers shall conform to 3.11.2 except for the measuring rods and handles shall be similar to figure 13, and shall conform to the requirements of tables VIII and IX for accuracy.

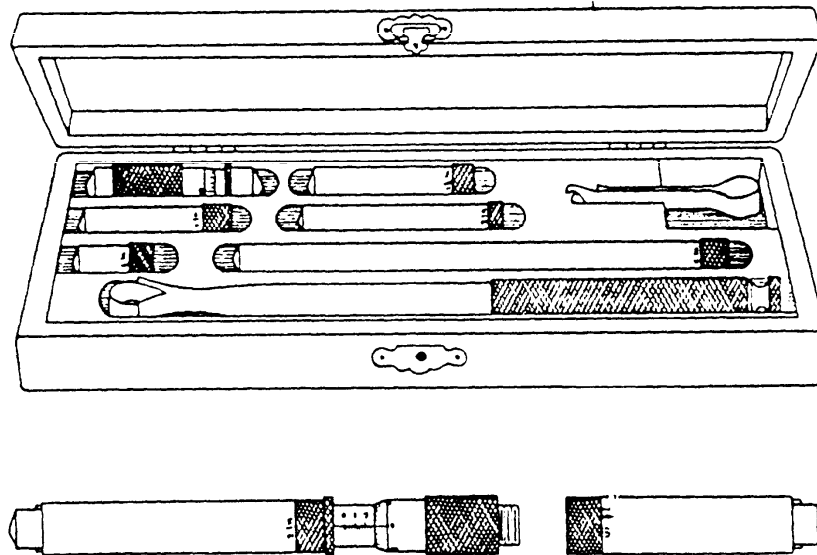


FIGURE 13. Type II, class 3, style A, caliper, micrometer, inside, tubular, interchangeable head.

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TABLE VIII. Type II, class 3, style A, caliper, inside, tubular, interchangeable head, English measure.

Range (size)	Movement of head	Error in indicated measurement in the micrometer Head (max)	Permissible error in length (plus or minus)
		Inch	Inch
Inches	Inch	Inch	Inch
1-1/2 to 8	1/2	0.0002	0.0005
1-1/2 to 12	1/2	.0002	.0005
4 to 24	1	.0002	.0007
4 to 32	1	.0002	.0009
4 to 40	1	.0002	.001
1-1/2 to 32 (two heads)	1/2 and 1	.0002	.0015

TABLE IX. Type II, class 3, style A, caliper, inside, tubular, interchangeable head, metric measure.

Range (size)	Movement of head	Error in indicated measurement of head (max)	Permissible error in length (plus or minus)
		Mm	Mm
Mm	Mm	Mm	Mm
40 to 200	13	0.005	0.012
40 to 300	13	.005	.012
100 to 600	25	.005	.018
100 to 800	25	.005	.022
100 to 1000	25	.005	.022
40 to 800 (two heads)	13 and 25	.005	.035

3.11.3.1.1 If calipers in sizes other than those listed in table VIII or IX are required, they shall otherwise conform to the requirements of this specification.

3.11.3.1.2 Measuring rods. A sufficient number of measuring rods of hollow steel tubing shall be provided to cover any measurement within the range of each inside micrometer caliper and shall be so designed that they can be added to either or both ends of the micrometer head. Each rod shall be individually adjustable by means of a hardened and ground plug at one end which can be turned either into or out of the rod.

3.11.3.1.3 Handles. Handles shall be furnished with the 1-1/2- to 8-, 1-1/2- to 12- and 1-1/2- to 32-inch range inside micrometer calipers. The handle shall be so designed that it may be attached anywhere along the head or extension rods so as to maintain perfect balance.

3.11.3.1.4 Finish. The finish shall conform to 3.11.2.10.

3.11.3.1.5 Cases. Cases for class 3, style A inside micrometers shall conform to 3.10.10.2.1.

3.11.3.2 Style B, inside, tubular, fixed head. Calipers shall be of hollow steel tube construction. Each rod shall have a micrometer head permanently attached thereto. Each tool shall be equipped with one or more fiber grips to guard against inaccuracies due to heat of hand. Calipers shall be similar to figure 14 and shall conform to the requirements of table X or XI.

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FIGURE 14. Type 11, class 3, style B, caliper, micrometer, inside, tubular, fixed head.

TABLE X. Type 11, class 3, style B, caliper, micrometer, inside, tubular, fixed head, English measure.

Range (size)	Movement of head	Error in indicated measurement in head (max)	Permissible error in length (max)
Inches	Inch	Inch	Inch
2 to 2-1/2	1/2	0.0002	0.0003
2-1/2 to 3	1/2	.0002	.0003
3 to 3-1/2	1/2	.0002	.0003
3-1/2 to 4	1/2	.0002	.0003
4 to 4-1/2	1/2	.0002	.0003
4-1/2 to 5	1/2	.0002	.0003
5 to 12 (in inch increments)	1	.0002	.0004

TABLE XI. Type 11, class 3, style B, caliper, micrometer, inside tubular, fixed head, metric measure.

Range (size)	Movement of head	Error in indicated measurement in head (max)	Permissible error in length (max)
Mm	Mm	Mm	Mm
50 to 63	13	0.005	0.007
63 to 75	13	.005	.007
75 to 88	13	.005	.007
88 to 100	13	.005	.007
100 to 113	13	.005	.007
113 to 125	13	.005	.007
125 to 300 in 25 mm increments)	25	.005	.010

3.11.3.2.1 Micrometer head. The micrometer head shall consist of a micrometer screw spindle, barrel, and thimble. The screw spindle shall conform to 3.10.3.2, and the barrel and thimble shall conform to 3.10.3.3.

3.11.3.2.2 Adjustments. Adjustments to compensate for wear shall conform to 3.10.3.4.

3.11.3.2.3 Measuring faces. The measuring faces shall be ground on a spherical radius not to exceed one-half the radius of the smallest measuring range and shall otherwise conform to 3.10.4.

3.11.3.2.4 Spindle lock. The inside micrometer, except the 2- to 2-1/2-inch range, shall be furnished with a spindle lock conforming to 3.10.3.5.

3.11.3.2.5 Graduations. Graduations shall conform to 3.10.5, except that the vernier lines are not required and micrometers of 4-1/2- to 5-inch range and smaller shall have a 1/2 inch travel.

3.11.3.2.6 Handles. When specified (see 6.2), handles shall be furnished for micrometers 4-1/2- to 5-inch range and smaller. The handles shall be so designed to lock securely to the micrometer and shall have a knurled finger grip.

3.11.3.2.7 Finish. All exposed surfaces, except the hand grips and measuring ends, shall have either a chrome-plated, dull (nonglare) finish or a ground surface roughness not to exceed 32 microinches AA.

3.11.3.2.8 Cases. Cases for individual micrometers and cases for sets of micrometers shall conform to 3.10.10.2.1.

3.12 Type III gage, depth, micrometer. The depth gage shall be similar to figure 15, and shall consist of a micrometer head, base, and measuring rods and when specified (see 6.2), a ratchet or friction stop and clamp ring, spindle lock nut or lever-type spindle lock.

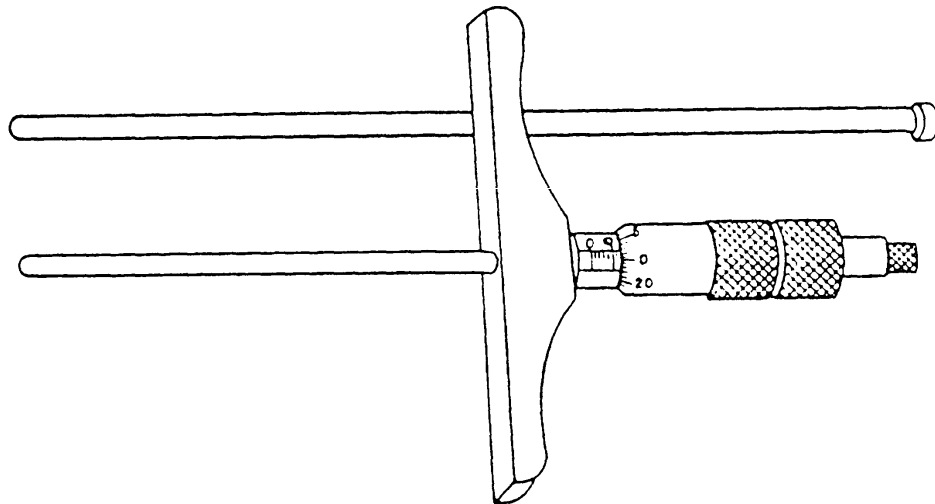


FIGURE 15. Type III, gage, depth, micrometer.

3.12.1 Micrometer head. The micrometer head shall have a measuring range of 1 inch or 25 mm as specified (see 6.2). Head shall conform to the requirements specified in 3.10.3.2, 3.10.3.3, and 3.10.3.5 as applicable. The graduations on the barrel shall read from the thimble end toward the base (see 3.10.5 as applicable)

3.12.2 Base. The measuring surface of the base shall be not less than 3/8 inch nor more than 7/8 inch in width. The length of the measuring surface shall be either 2, 2-1/2, 3, 4, 5, or 6 inches as specified (see 6.2). Surface of the rod seat on the barrel end of the base shall be parallel with the face of the base. The measuring rods shall have good free fit through the base without bind, and shall run freely and smoothly throughout the length of travel. The measuring surface of base shall have a hardness of not less than 62 on the Rockwell C scale, shall be flat to 0.0001 inch per inch of length, and shall have a finish such that the surface roughness does not exceed 4 microinches AA.

3.12.3 Measuring rods. Three measuring rods of not less than 3/32 inch in diameter shall be furnished to provide for measuring ranges of 0 to 1, 1 to 2, and 2 to 3 inches or 0 to 25, 25 to 50, and 50 to 75 mm. They shall be arranged for insertion one at a time through a hole in the micrometer screw spindle, securely held to a positive seat, and shall be provided with means to compensate for wear. The rods shall be straight and the "run out" (2 times the eccentricity) when fully

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extended shall not exceed 0.003 inch per inch of extension of rod. Measuring faces of the rods shall have a hardness of not less than 62 on the Rockwell C scale, shall be flat within 0.0001 inch and shall have a finish such that the surface roughness does not exceed 4 microinches AA.

3.12.3.1 Additional rods. When specified (see 6.2), rods of additional lengths shall be supplied. Rods shall otherwise conform to the requirements of this specification.

3.12.3.2 Accuracy. When tested at the standard temperature of 68 degrees F as specified in 4.3, the errors shall not exceed those indicated in table XII.

TABLE XII. Type III, gage micrometer, English measure.

Range (size)	Movement of head	Permissible error in indicated measurement in head <sup>1/</sup> (max)	Permissible error in accuracy of measurement with head and rod <sup>2/</sup> (max)
Inches	Inch	Inch	Inch
0 to 3	1	0.0001	0.0003
0 to 6	1	.00015	.0004
0 to 9	1	.0002	.00045

<sup>1/</sup> Difference between any two readings specified in 4.3.8.3.

<sup>2/</sup> Length of rods determined in the assembled position, at the zero setting. Determinations to be made from the base working surface to the working surface of each rod.

3.12.4 Spindle lock, lever-type lock or clamp ring. When specified (see 6.2), depth gages shall be furnished with a spindle lock, lever-type lock or clamp ring in conformance with 3.10.3.5.

3.12.5 Ratchet or friction stop. When specified (see 6.2), depth gages shall be furnished with a ratchet or friction stop, in conformance with 3.10.3.6.

3.12.6 Finish. The thimbles and barrels shall have a chrome-plated, dull (nonglare) finish. The nonutile surfaces of the base shall have either a dull chrome or ground finish. The utile surface of the base and rods shall have a surface roughness not to exceed 4 microinches AA. The diameter of the rods shall have a surface roughness not to exceed 32 microinches AA.

3.12.7 Cases. Cases shall conform to 3.10.10.2.1.

3.13 Workmanship. The requirements within this specification are intended to describe the best commercial quality calipers and gages available. The calipers and gages shall conform to the quality of the end product specified by the requirements of this specification. In addition, the calipers and gages shall be free from rust, burrs, fins, nodules, or other defects which may impair their serviceability, durability or appearance.

3.14 Setting of calipers and gages. Prior to delivery, calipers and gages shall be set to within specification limits. No adjustments shall be necessary prior to use.

#### 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

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4.2 Sampling for quality conformance inspection. Sampling for quality conformance inspection shall be performed in accordance with the provisions set forth in MIL-STD-105, except where otherwise indicated herein.

4.2.1 Intermediate, visual, and dimensional examination. The intermediate product or assemblies which cannot be checked or measured after final assembly shall be examined at various stages of manufacture for compliance with this specification. The examination shall be made at an appropriate intermediate station for defects in construction, design, dimensions, workmanship, and materials. Any deviation from specified requirements shall be classified a defect. The inspection level shall be level II with an Acceptable Quality Level (AQL) of 2.5 defects expressed in defects per hundred units.

4.2.2 Inspection of the end item. Inspection of the calipers and gages shall be performed as specified in the following paragraphs. The lot sizes shall be expressed in units of calipers or gages for the purpose of determining the sample size in accordance with MIL-STD-105. The sample unit shall be one completely fabricated caliper or gage of one type, class, style, graduation, and size, or the sample unit shall be one completely fabricated case with instrument.

4.2.2.1 Sampling for test. Samples for testing shall be selected in accordance with inspection level I with an AQL of 1.0 defects expressed in defects per hundred units.

4.2.2.2 Visual examination. Each sample unit shall be visually and dimensionally examined in accordance with applicable characteristics of defects listed in table XV. The inspection level shall be level II with an AQL of 1.5 defects for major defects and 4.0 for total defects expressed in defects per hundred units.

TABLE XV. Classification of defects.

Categories	Defects
<u>Critical:</u> 1	None defined.
<u>Major:</u> 101	Type, class, and style not as specified.
102	Materials defective or not as specified; evidence of cracks, rust, nonmetallic inclusions, injurious porosity, excess segregation, soft spots, hard spots, or other injurious defects.
103	Screw spindle defective, less than specified diameter, threads stripped, cracked, crossed, not smoothly lapped, or not of pitch specified; evidence of sticking, binding, looseness or perceptible backlash when spindle is moved throughout the length of its travel; less than minimum specified engagement of the nut on the screw portion of spindle; lead of spindle not accurate enough to comply with tolerances for errors listed.
104	Diameter of the graduated surface of the barrel less than specified minimum; angle of the bevel at the graduated end of the thimble not as required; radial clearance between barrel and reading end of thimble exceeds the specified maximum and is not constant within range of thimble movement (types I and II only).
105	Adjusting device does not perform function specified; is not secure after resetting, impairs accuracy of instruments; suitable adjusting tools not supplied (types I and II only).

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TABLE XV. Classification of defects. (Continued)

Categories	Defects
<u>Major:</u>	
106	Torque less than specified maximum for calipers with fraction adjustment sleeve on barrel (type I only).
107	Evidence of change in position (or adjustment) of the measuring faces when the locking device is tightened (types I and II only).
108	Pressure in excess of specified maximum exerted between measuring faces when ratchet or friction stop is operated (types I and III only).
109	Measuring faces not smoothly finished as required; evidence of fins, burrs, pits, nodules, or deep tool marks (type I only).
110	Carbide tips, if specified, less than minimum thickness, not as integral part of spindle (type I only).
111	Graduations and vernier lines missing, incomplete, illegible, edges not well defined, or not as specified (type I only).
112	Ball attachment, if specified, difficult to install or remove, evidence of sticking, binding or excessive looseness (type I only).
113	Interchangeable anvil length not in accordance with sizes specified; excessive side motion, when installed; no means to compensate for wear of measuring faces (type I only).
114	Checking standards not supplied as specified (type I only).
115	Spindle sticks or binds in barrel, bearing evidence of excessive looseness, does not move freely and smoothly throughout its length of travel (type II only).
116	Graduations and numerals missing, incomplete, illegible, edges not well defined, or not as specified (types II and III only).
117	Number of measuring rods and spacing collars not sufficient to cover range of caliper; rods not provided with adjustable contact points (type II only).
118	Measuring rod sticks or binds in base, evidence of excessive looseness, does not move freely or smoothly throughout its length of travel (type III only).
119	Diameter of measuring rods less than specified minimum, not provided with means to compensate for wear, rods not securely held to a positive seat in screw spindle (type III only).
120	Length of base not as specified (type III only).
<u>Minor:</u>	
201	Thimble, spindle locking device, or ratchet stop not knurled (if required).
202	Marking, country of origin and manufacturer's name or trademark missing, illegible, incorrect, or not permanent.
203	Case defective, not coated (inside and outside), or case fails to hold parts in such a manner as to preclude damage during handling.
204	Operational instruction leaflet missing or, when specified, not enclosed in a waterproof envelope.
205	Measuring surface of the base not within the maximum and minimum dimensions specified (type III only).



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4.2.2.3 Examination of sets. Examination of sets (when applicable) shall be made for defects listed below. A lot shall consist of completely assembled sets. The sample unit shall be one complete set. The inspection level shall be S-4 with an AQL of 1.0 defects per hundred units.

Examine	Defects
Set	Component missing. Not type, class, or style required. Component damaged, affecting serviceability

#### 4.3 Test procedures.

4.3.1 All dimensional accuracy checks shall be determined at standard room temperature, 68 degrees F (20 degrees Celsius). Micrometers shall be adjusted to the zero setting before beginning the tests.

4.3.2 Graduation. Graduations shall be checked for straightness of edges, width, spacing, parallelism, and perpendicularity of edge of graduated surface by means of a toolmaker's microscope or a method of comparable accuracy. Depth of graduations shall be checked by measuring the height of the ridges formed in a wax impression or by a method of comparable accuracy.

4.3.3 Threads. Threads shall be checked by means of thread plug and ring gages. Threads may be checked indirectly through the test for error in indicated measurement.

4.3.4 Surface roughness. Surface roughness shall be determined at representative spots by commercially recognized instruments for surface roughness measurement.

4.3.5 Planeness. Planeness shall be checked with an optical flat where the surface finish so permits or by means of a precision indicator and precision reference surface, the test piece being supported as required by toolmaker's angles or other means of adequate accuracy.

4.3.6 Angular trueness of reference surfaces. Angular trueness of reference surfaces shall be checked by means of a precision square and feeler gage, precision angle blocks, precision dividing head, autocollimator or method of equivalent accuracy.

4.3.7 Hardness. Where practicable, hardness shall be determined from a minimum of three readings, taken at points representative of the hardened area or areas concerned. Any individual reading outside the range of hardness specified shall be cause for rejection.

#### 4.3.8 Accuracy.

4.3.8.1 Type 1, calipers. The accuracy of outside micrometer calipers shall be checked by means of measuring standards having an accuracy of not less than 0.00001 inch. The sizes of these standards should be chosen so as to test the micrometer caliper not only at complete turns of its thimble but also at intermediate positions. This is required as a check on the accuracy of the graduations around the thimble. The following series of standards shall serve for testing calipers both for progressive errors throughout their range and for periodic errors:

(a) For testing an inch micrometer, the series of standards is: 0.105, 0.210, 0.315, 0.420, 0.500, 0.605, 0.710, 0.815, 0.920, and 1.000 inch.

(b) For a metric micrometer caliper a convenient series of standards is: 2.5, 5.1, 7.7, 10.3, 12.9, 15.0, 17.6, 20.2, 22.8, and 25.0 mm.

(c) As a check on the vernier graduations of an inch micrometer caliper, readings are taken on the following series of standards: 0.1000, 0.1002, 0.1004, 0.1006, 0.1008, and 0.1010 inch.

(d) For testing larger micrometer calipers, appropriate standards should be used to obtain progressive errors throughout its range and for periodic errors.

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4.3.8.1.1 Classes 1 and 2, style C. The accuracy of tubing micrometers shall be checked against combinations of four decimal place measuring standards (gage blocks, and plug gages), as specified in 4.3.8.1.

4.3.8.1.2 Class 2, style D, calipers. The thread calipers shall be tested on a lapped thread plug of the correct range of threads for the pitch diameter.

4.3.8.1.3 Calipers with friction adjusting sleeve on barrel shall be tested for conformance with 3.10.3.4.

4.3.8.2 Type II calipers. The accuracy of inside micrometer calipers shall be checked against internal dimensions, or in a combination with properly arranged measuring standards as specified in 4.3.8.1.

4.3.8.3 Type III gage. On micrometer type gages, error in indicated measurement shall be determined by securing the gage in correct relation to a precision surface and checking a series of readings against precision end measures such as gage blocks. The following denominations of length standards shall be included for inch and millimeter reading gages: 0.105, 0.210, 0.315, 0.420, 0.500, 0.605, 0.710, 0.815, 0.920, 1.000 inch, and 2.5, 5.1, 7.7, 10.3, 12.9, 15.0, 17.6, 20.2, 22.8, 25 millimeter.

4.3.9 Rigidity (type I). In checking rigidity of micrometer caliper frames, the frame shall be gripped vertically at that portion of the frame that serves as a bearing for the micrometer screw spindle in the jaws of a vise, suitably protected to preclude damage to the frame. A 2-pound load shall be applied on the frame as near as possible to the inside edge of the anvil and in the direction of the spindle axis by string suspension or other suitable means. The flexure of the frame, as determined by taking the difference between the measuring faces before and after load is applied, shall not exceed the values as shown in table I, II or IV, as applicable. (For testing the larger sizes of micrometer calipers, gage blocks in combination with gage rods may be used.)

4.3.10 Measuring faces. If deemed advisable, the inspector may check flatness and parallelism of measuring faces by means of optical flats.

4.3.11 Spindle and anvil alignment (types I and II). In checking spindle and anvil alignment of 0- to 1-inch and 0- to 25-mm range micrometer calipers, the measuring face of the micrometer screw spindle shall be brought in contact with the measuring face of the anvil. The error in spindle and anvil alignment of these micrometer calipers shall be determined by measuring the combined overall diameter of both spindle and anvil. The difference between this measurement and the diameter of either the anvil or spindle, whichever is the smaller, shall not exceed the values specified in table I, II or IV, as applicable. In checking spindle and anvil alignment of larger size micrometer calipers, the micrometer caliper, with the spindle fully extended, shall be horizontally secured to an appropriate size of toolmakers box parallel or other suitable means and the micrometer screw spindle accurately lined up in a horizontal plane by some means such as an appropriate surface gage, indicated arrangement utilizing an indicator fastened to the spindle rod of a surface gage. Indicator readings shall then be taken on the spindle and the anvil in both a vertical and horizontal plane, and the difference between these readings shall not exceed the values shown in table I, II or IV, as applicable.

4.3.12 Type I and type II, class 1 micrometers shall be checked for shake in accordance with 3.10.3.2 and 3.11.1.4, as applicable.

4.4 Inspection of preparation for delivery. An inspection shall be made to determine that the preservation, packaging, packing, and marking requirements comply with section 5.

## 5. PREPARATION FOR DELIVERY

5.1 Preservation, packaging, packing, and marking. Preservation, packaging, packing, and marking shall be in accordance with PPP-P-40.

## 6. NOTES

6.1 Intended use. The nomenclature of the various types, classes, and styles of micrometer calipers and gages are self-explanatory as to their intended use for measuring outside and inside dimensions.

6.2 Ordering data. Purchasers should select the preferred options permitted herein and include the following information in procurement documents:

- (a) Title, number, and date of this specification.
- (b) Type, class, and style of caliper or gage required (see 1.2).
- (c) Size required (see applicable table and 3.10.10.4.1, 3.10.10.5.3, 3.10.11.3, 3.10.11.4, and 3.12.1).
- (d) Whether metric measure is required (see 3.3).
- (e) If chrome-plated, dull (nonglare) finish is not required (see 3.6).
- (f) Whether operational instruction card or leaflet is required (see 3.7).
- (g) Whether standards are required (see 3.10.2).
- (h) Whether unhardened micrometer screw spindles are required (see 3.10.3.2).
- (i) Whether spindle lock is required (see 3.10.3, 3.10.3.5, 3.11.1.6, and 3.12.4).
- (j) Whether ratchet or friction stop is required (see 3.10.3, 3.10.3.6, 3.12, and 3.12.5).
- (k) Whether carbide tips or faces are required (see 3.10.3.2 and 3.10.4.2).
- (l) Whether 10,000th inch readings are required (see 3.10.5.2).
- (m) Size of ball attachment, if required (see 3.10.9).
- (n) Whether a smooth or rippled enamel finish is required (see 3.10.10).
- (o) Type of case or box required, if other than specified (see 3.10.10.2.1, 3.10.10.2.2, 3.10.10.4.3, 3.10.11.2, and 3.11.1.11).
- (p) Whether handles are required (see 3.11.2.7 and 3.11.3.2.6).
- (q) Length of base required (see 3.12.2).
- (r) Whether additional rods are required (see 3.12.3.1).

## MILITARY INTERESTS:

Custodian:

Air Force - 99

Review activity:

Air Force - 84

Army - GL

Navy - YD

## PREPARING ACTIVITY:

GSA/FSS