ASME B89.1.13-2001

The American Society of Mechanical Engineers

AN AMERICAN NATIONAL STANDARD

MICROMETERS

ASME B89.1.13-2001

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This Standard will be revised when the Society approves the issuance of a new edition. There will be no addenda issued to this edition.

ASME issues written replies to inquiries concerning interpretations of technical aspects of this Standard. Interpretations are published on the ASME Web site under the Committee Pages at http://www.asme.org/codes/ as they are issued.

This code or standard was developed under procedures accredited as meeting the criteria for American National Standards. The Standards Committee that approved the code or standard was balanced to assure that individuals from competent and concerned interests have had an opportunity to participate. The proposed code or standard was made available for public review and comment that provides an opportunity for additional public input from industry, academia, [redacted]

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FOREWORD

ASME Standards Committee B89 on Dimensional Metrology, under procedures approved by the American National Standards Institute, has the responsibility of preparing standards that encompass the inspection and the means of measuring characteristics of various geometrical parameters, such as diameter, length, flatness, parallelism, concentricity, taper, and squareness. Since micrometers are widely used for the measurement and comparison of some of these features, the B89 Consensus Committee authorized formation of Project Team B89.1.13 to prepare this Standard.

As most of the micrometers used in the United States are built to inch-system specifications, the International Organization for Standardization (ISO) standards do not address all the needs of American industry. The inch-system portion of this Standard is based in part on Federal Specification GGG-C-105C, published by the General Services Administration (GSA), as well as manufacturer's current practices and technologies. The metric-system portion of this Standard is consistent with ISO efforts in support of international commerce.

This Standard was approved by the American National Standards Institute on November 30, 2001.

ASME STANDARDS COMMITTEE B89
Dimensional Metrology

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General. ASME Codes and Standards are developed and maintained with the intent to represent the consensus of concerned interests. As such, users of this Standard may interact with the Committee by requesting interpretations, proposing revisions, and attending Committee meetings. Correspondence should be addressed to:

Secretary, B89 Standards Committee
The American Society of Mechanical Engineers
Three Park Avenue
New York, NY 10016

Proposed Revisions. Revisions are made periodically to the Standard to incorporate changes that appear necessary or desirable, as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published periodically.

The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible: citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

Interpretations. Upon request, the B89 Committee will render an interpretation of any requirement of the Standard. Interpretations can only be rendered in response to a written request sent to the Secretary of the B89 Standards Committee.

The request for interpretation should be clear and unambiguous. It is further recommended that the inquirer submit his/her request in the following format:

Subject:	Cite the applicable paragraph number(s) and provide a concise description.
Edition:	Cite the applicable edition of the standard for which the interpretation is being requested.
Question:	Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation.

Requests that are not in this format may be rewritten in the appropriate format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

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Attending Committee Meetings. The B89 Standards Committee regularly holds meetings that are open to the public. Persons wishing to attend any meeting should contact the Secretary of the B89 Standards Committee.

MICROMETERS

1 SCOPE

This Standard is intended to provide the essential requirements for micrometers as a basis for mutual understanding between manufacturers and consumers. Outside, inside, and depth micrometers are described in the Standard.

2 DEFINITIONS

backlash: a relative movement between interacting mechanical parts, resulting from looseness [ASME B5.54M-1992 (R1998)]. In this Standard, backlash is further defined as the rotation of the spindle, in the opposite direction of the initial reading, before spindle moves in a linear direction. This condition is typically caused by looseness of fit between the lead screw and adjusting nut.

bias: systematic error of the indication of a measuring instrument (VIM).

eccentricity: the distance between the geometric center or axis of the body and its axis of rotation.

end shake: the amount of spindle movement, when an axial force is applied in the direction of the spindle alternating towards the anvil and away from the anvil, without rotating the spindle.

error (of indication) of a measuring instrument: indication of a measuring instrument minus a true value of the corresponding quantity (VIM).

NOTE: This concept applies mainly where the instrument is compared to a reference standard.

flatness: the condition of a surface having all elements in one plane (ASME Y14.5M-1994).

maximum permissible error (MPE): extreme values of an error permitted by specifications, etc., for a given measuring instrument (VIM).

parallelism: the condition of a surface or center plane, equidistant at all points from a datum plane or axis, equidistant along its length from one or more datum planes or a datum axis (ASME Y14.5M-1994).

runout: a composite tolerance used to control the functional relationship of one or more features of a part to a datum axis. The types of features controlled by runout tolerances include those surfaces constructed around a datum axis and those constructed at right angles to a datum axis (ASME Y14.5M-1994).

side shake: the amount of spindle side movement, when a force is applied perpendicularly to the measuring end of the spindle, alternating from side to side, without rotating the spindle.

tolerance: the total amount the specified dimension is permitted to vary. The tolerance is the difference between the maximum and minimum limits (ASME Y14.5M-1994).

3 REFERENCES

This Standard has been coordinated insofar as possible with the following standards.

ASME B5.54M-1992 (R1998), Methods for Performance Evaluation of Computer Numerically Controlled Machine Centers

ASME Y14.5M-1994, Dimensioning and Tolerancing

Publisher: The American Society of Mechanical Engineers (ASME International), Three Park Avenue, New York, NY 10016

IEEE/ASTM SI 10-1997, Standard for Use of the International System of Units (SI): The Modern Metric System Revision and Redesignation of ANSI/IEEE Std 268-1992 and ASTM E 380

Publisher: Institute of Electrical and Electronics Engineers (IEEE), 445 Hoes Lane, Piscataway, NJ 08854

ISO 3611, Micrometers Calipers for External Measurements, 1978

Publisher: International Organization for Standardization (ISO), 1 rue de Varembé, Case Postale 56, CH-1121, Genève 20, Switzerland/Suisse

4 MICROMETERS, GENERAL

4.1 Materials

The materials used for the component parts of a micrometer shall meet the minimum requirements for hardness, stability, and strength.

4.2 Resolution

Micrometers using the inch system shall read to the least count of 0.001 in., 0.0001 in., or 0.00005 in. Micrometers using the metric system shall read to 0.01 mm, 0.002 mm, or 0.001 mm.

4.3 Finish

The surface of graduated parts shall have a satin chrome or dull, nonglare finish. All other exposed parts not utilized as measuring components shall be coated to prevent corrosion. Exposed surfaces of measuring components shall have a ground finish with surface roughness not to exceed 32 μin. (0.8 μm) Ra, except where otherwise specified within this document.

4.4 Identification Marking

In addition to other markings, instruments shall be marked in a permanent and legible manner with the manufacturer's name or trademark so that the part number, range of the instrument, and the source of the manufacturer can be readily determined.

4.5 Adjustments

Each instrument shall be adjustable to compensate for wear on the measuring faces and/or wear between the screw portion of the spindle and the nut.

4.6 Micrometers Screw Spindle

The screw spindle material shall be stabilized, precision-ground, and have a hardness not less than 62 on the Rockwell C Scale. The fit between the spindle and its bearings, including the nut, shall be free-turning without perceptible backlash, end shake, or side shake.

4.7 Measuring Faces

All measuring faces shall be hardened to not less than 62 on the Rockwell C Scale.

4.8 Graduations

The graduations shall have the depth reduced below the surface of the component carrying the graduations and shall be of contrasting color. Variations in width of the graduated lines on the thimble and fiducial line on the barrel shall not exceed 0.001 in. (0.025 mm).

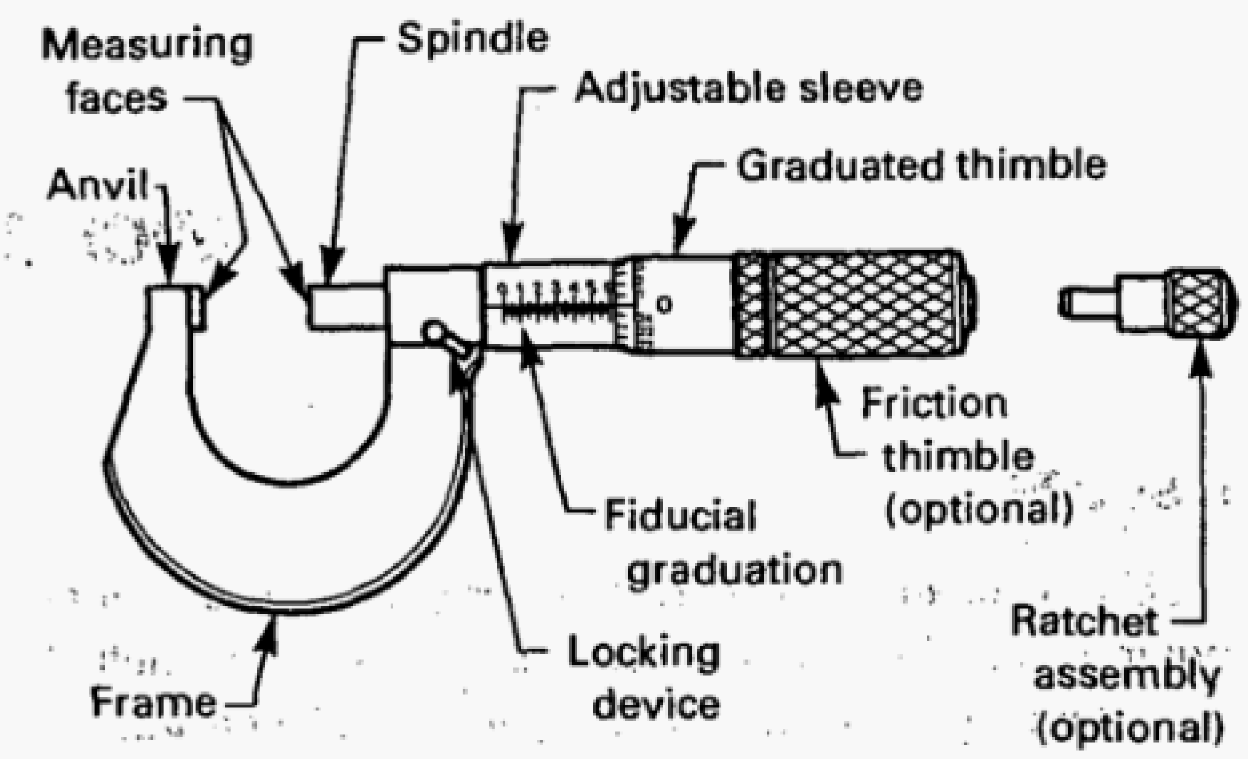

FIG. 1 TYPICAL OUTSIDE MICROMETER

5 OUTSIDE MICROMETERS (SEE FIG. 1)

5.1 Frame

The frame shall be shaped to permit the measurement of a cylinder having a diameter equal to the maximum capacity of the micrometer caliper. The cross section design and the frame material shall be such that when a force of 2 lb for inch-reading micrometers, or 10 N for metric-reading micrometers, is applied to the anvil end of the frame parallel to the spindle axis, the flexure of the frame shall not exceed the tolerances specified in Table 1 or 2.

5.2 Measuring Faces

For outside micrometers with flat measuring faces, the maximum flatness error allowable shall not exceed 40 μin. (1 μm) for each face. The maximum flatness error allowable for both faces shall not exceed the maximum parallelism error allowable for a given range as stated in Table 1 or 2. Surface finish shall not exceed 4 μin. (0.1 μm) Ra.

5.3 Maximum Permissible Error

With the micrometer set to read zero at minimum travel, the error of indication, parallelism of the spindle face to the anvil face, and misalignment between anvil and spindle shall not exceed the maximum values indicated in Table 1 or 2 at any point within the measuring range of the instrument.

TABLE 1 MAXIMUM PERMISSIBLE ERRORS FOR OUTSIDE MICROMETERS (INCH SYSTEM)

Range, in.	Frame Flex Maximum (2 lb force), in.	Error of Indication (1), ± in.	Maximum Parallelism Fixed Anvil, in.	Maximum Parallelism Interchangeable Anvil, in.	Spindle-Anvil Alignment, in.
0–1	0.00010	0.00010	0.00005	0.00040	0.00200
1–2	0.00010	0.00020	0.00010	0.00040	0.00300
2–3	0.00010	0.00020	0.00020	0.00040	0.00450
3–4	0.00015	0.00020	0.00020	0.00040	0.00600
4–5	0.00015	0.00020	0.00020	0.00040	0.00800
5–6	0.00015	0.00020	0.00020	0.00040	0.01000
6–7	0.00020	0.00020	0.00020	0.00040	0.01000
7–9	0.00020	0.00020	0.00025	0.00060	0.01000
9–12	0.00030	0.00030	0.00030	0.00060	0.01000
12–18	0.00040	0.00040	0.00040	0.00080	0.01500
18–24	0.00050	0.00050	0.00050	0.00080	0.01500
24–30	0.00060	0.00060	0.00060	0.00100	0.01500
30–36	0.00070	0.00070	0.00070	0.00100	0.01500

NOTE:
(1) Independent of flatness and parallelism.

5.4 Setting Standards

The measuring surfaces of setting standards for outside micrometers shall have a hardness of not less than 60 on the Rockwell C Scale. The deviation in length from the nominal size shall not exceed the values listed in Table 3 or 4.

6 INSIDE MICROMETERS (SEE FIG. 2)

Inside micrometers may be either of fixed length or have interchangeable rods that carry the measuring faces. The measuring faces shall have a radius of curvature less than one-half of the smallest measuring range. Surface finish shall not exceed 8 μin. (0.2 μm) Ra.

6.1 Maximum Permissible Error

The maximum allowable error in the movement shall be 0.0001 in. within each inch of travel, or 0.0025 mm within each 25 mm of travel. With the screw set at the zero position, the maximum permissible error in overall length of the micrometer head shall be 0.0003 in. (0.0075 mm). When applicable, extensions, collars, or sleeves can be used to extend the range of measurement. An additional permissible error of 0.0002 in. (0.005 mm) will be allowed for each extension, collar, or sleeve, in overall length.

7 DEPTH MICROMETERS (SEE FIG. 3)

Depth micrometers shall consist of a micrometer head fixed into a base with a flat reference surface, and interchangeable rods to measure distance in relation to the flat reference surface.

7.1 Base

The reference surface of the base shall have a hardness of not less than 62 on the Rockwell C Scale, shall be flat within 0.0001 in. per inch of length (0.0025 mm per 25 mm of length), and shall have a finish not to exceed 8 μin. (0.2 μm) Ra.

7.2 Measuring Rods

The rods shall be interchangeable to measure in increments within the travel of the micrometer screw. Rods shall be provided with a means to compensate for wear. The rods shall be straight and the runout (double the eccentricity) when fully extended shall not exceed 0.003 in. per inch of extension or 0.075 mm per 25 mm of extension. Measuring faces of rods shall be flat within 0.0001 in. (0.0025 mm), and the surface finish shall not exceed 4 μin. (0.1 μm) Ra.

7.3 Maximum Permissible Error

The maximum permissible error of indication in the movement of the screw shall be 0.0001 in. within each

TABLE 2 MAXIMUM PERMISSIBLE ERRORS FOR OUTSIDE MICROMETERS (METRIC SYSTEM)

Range, mm	Frame Flex Maximum (10 N), mm	Error of Indication (1), ± mm	Maximum Parallelism Fixed Anvil, mm	Maximum Parallelism Interchangeable Anvil, mm	Spindle-Anvil Alignment, mm
0–25	0.002	0.004	0.002	0.010	0.050
25–50	0.002	0.004	0.002	0.010	0.100
50–75	0.003	0.005	0.003	0.010	0.100
75–100	0.003	0.005	0.003	0.010	0.150
100–125	0.004	0.006	0.004	0.010	0.200
125–150	0.005	0.006	0.004	0.010	0.250
150–175	0.006	0.007	0.005	0.015	0.250
175–200	0.006	0.007	0.005	0.015	0.250
200–225	0.007	0.008	0.006	0.015	0.250
225–250	0.008	0.008	0.006	0.015	0.250
250–275	0.008	0.009	0.007	0.015	0.250
275–300	0.009	0.009	0.007	0.015	0.250
300–350	0.010	0.010	0.008	0.020	0.250
350–375	0.011	0.011	0.009	0.020	0.250
375–400	0.012	0.011	0.009	0.020	0.250
400–425	0.012	0.012	0.010	0.020	0.250
425–450	0.013	0.012	0.010	0.020	0.250
450–475	0.014	0.013	0.011	0.025	0.380
475–500	0.015	0.013	0.011	0.025	0.380
500–600	0.017	0.015	0.013	0.030	0.380
600–700	0.020	0.017	0.015	0.030	0.380
700–800	0.022	0.019	0.017	0.035	0.380
800–900	0.025	0.021	0.019	0.035	0.380

NOTE:
(1) Independent of flatness and parallelism.

inch of travel (0.0025 mm within each 25 mm of travel). With the head set to zero, the maximum permissible error of the rod and head together shall not exceed 0.0002 in. (0.005 mm).

8 SPECIALTY MICROMETERS

A large variety of specialty micrometers are commercially available for measuring tubing, threads, specialized measuring-face configurations for use in restricted areas, large diameter measuring faces, spherical shaped measuring faces, and conical measuring faces. These micrometers shall meet all the general requirements covered in paras. 4.1 through 4.8. They shall meet the maximum permissible error (MPE) requirements of Table 1 or 2 for interchangeable anvil micrometers when applicable.

TABLE 3 INCH-MEASURE SETTING STANDARDS

Size, in.	Maximum Permissible Error, ± in.
0–1	0.00005
2–4	0.00010
5–8	0.00015
9–11	0.00020
12–18	0.00025
19–24	0.00030
25–36	0.00035

9 MICROMETERS WITH DIGITAL READOUT

In addition to meeting all of the requirements applicable under this specification, the following shall apply to micrometers with digital readout.

TABLE 4 METRIC-MEASURE SETTING STANDARDS

Size, mm	Maximum Permissible Error, ± mm
0–25	0.002
50–125	0.002
150–200	0.003
225–275	0.004
300–425	0.005
450–575	0.006
600–750	0.007
775–900	0.008

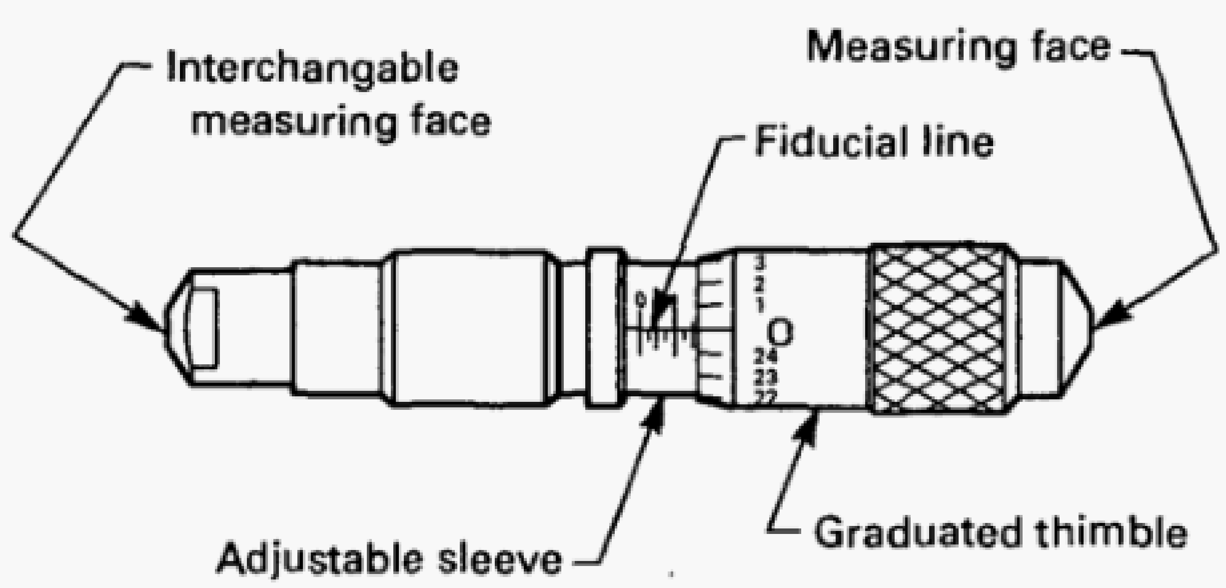

FIG. 2 TYPICAL INSIDE MICROMETER

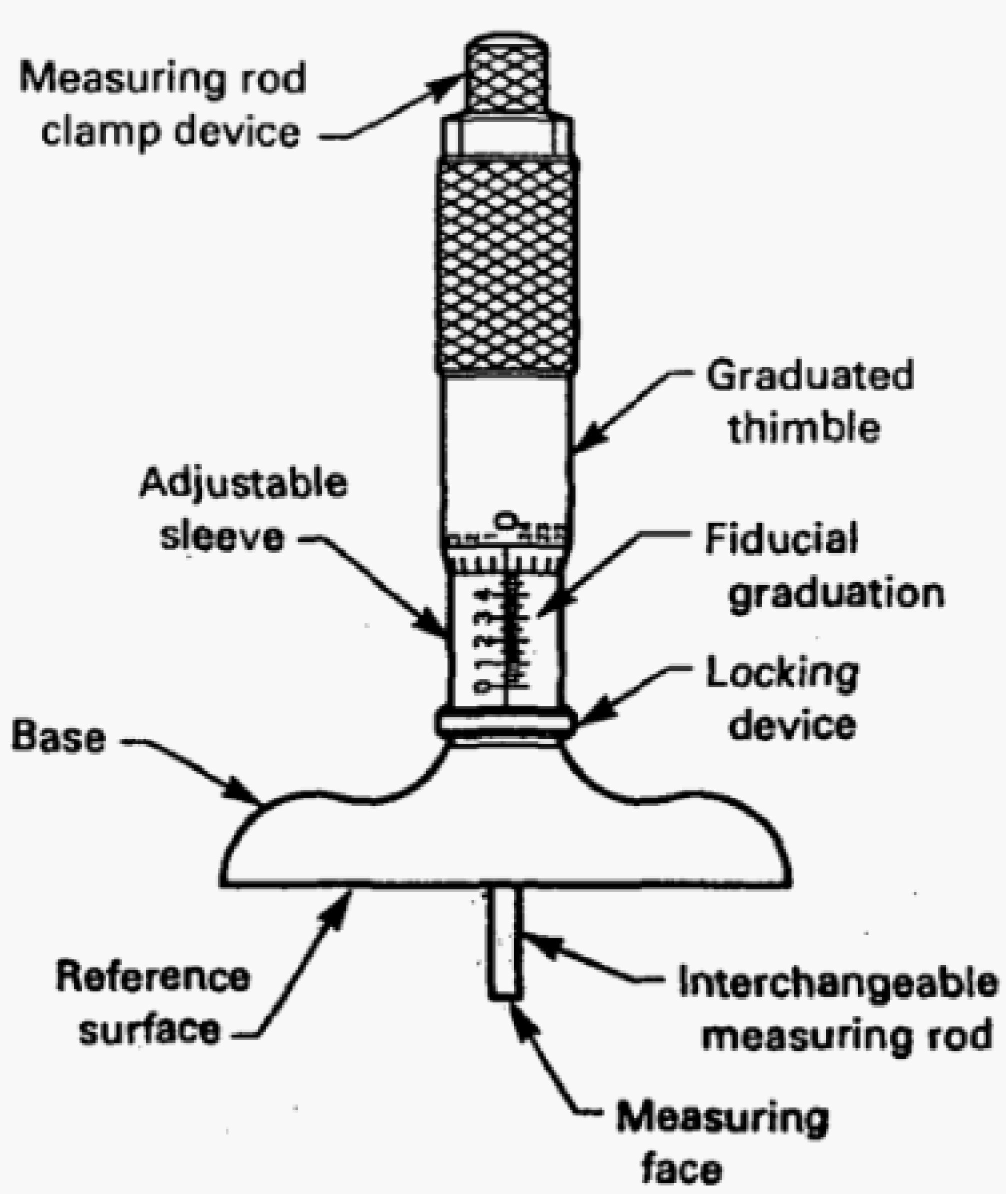

FIG. 3 TYPICAL DEPTH MICROMETER

9.1 Mechanical Digital (See Fig. 4)

The figures of the display shall have good contrast with the background, and the least-count digit shall agree with the analog reading within one digit of least count.

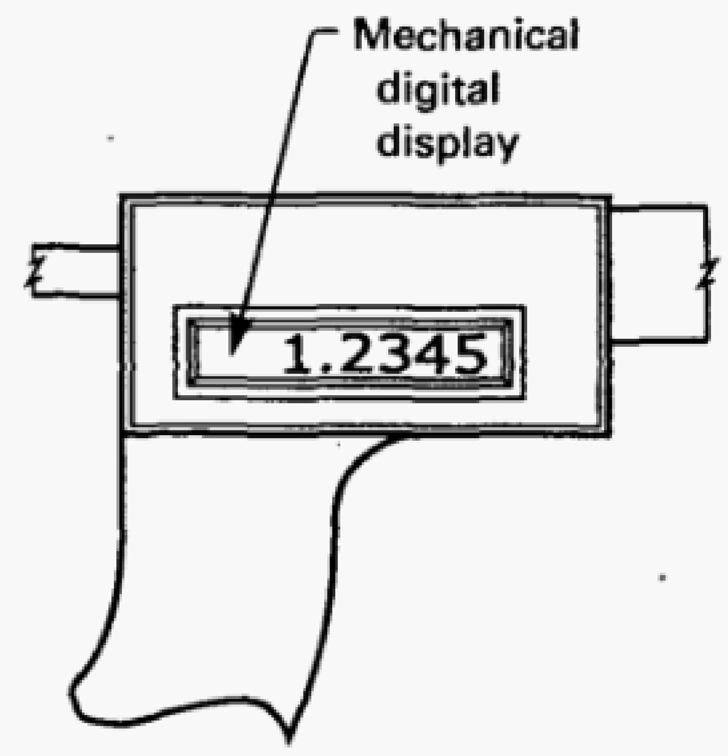

FIG. 4 MECHANICAL DIGITAL MICROMETER

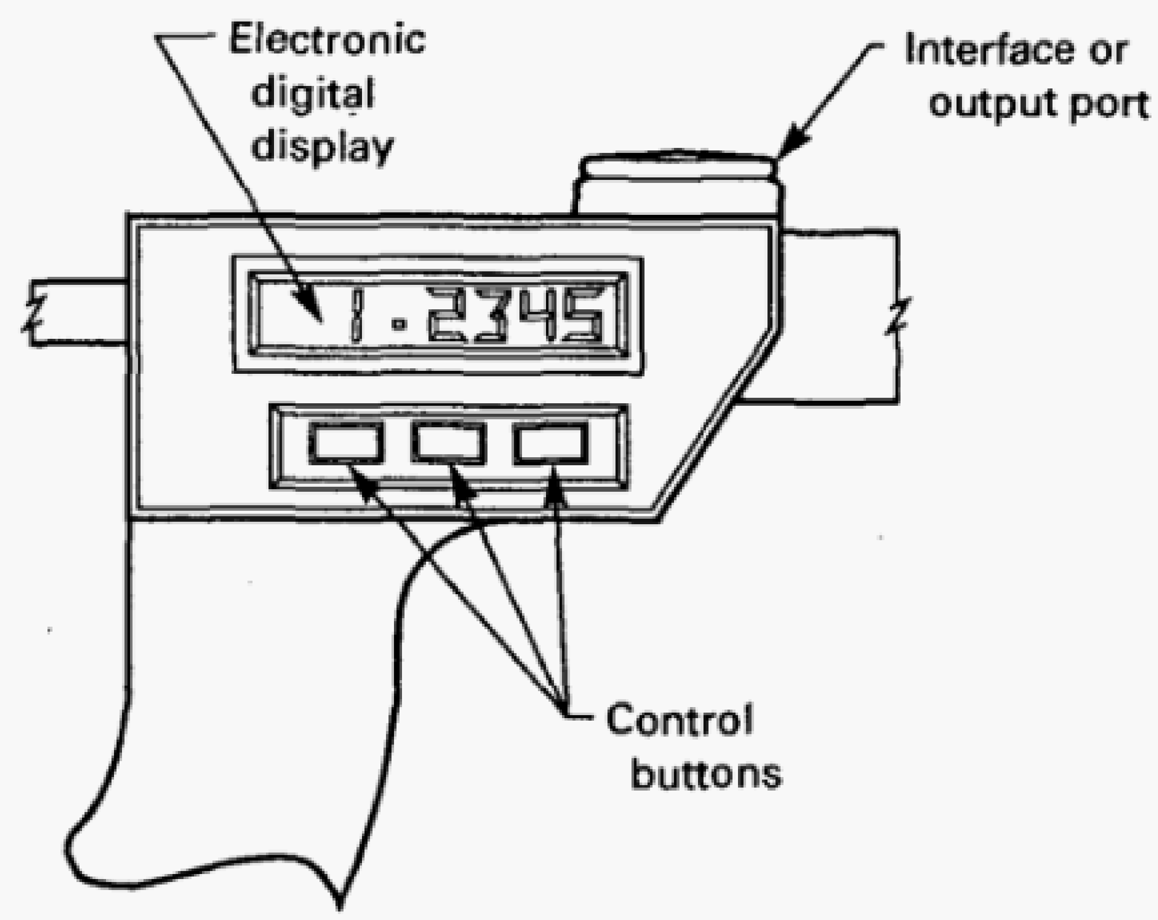

FIG. 5 ELECTRONIC DIGITAL MICROMETER

9.2 Electronic Digital (See Fig. 5)

The figures of the display shall have good contrast with the background, and the least-count digit shall agree with the analog reading within one digit, where applicable. The least count shall be correctly rounded, not simply a truncated digit. The electronics shall have the ability to retain the zero setting when in the off mode, and micrometers with greater capacity than 1 in. (25 mm) shall have preset capabilities so that a complete measurement (e.g., 5.1254) can be displayed and transmitted. If for any reason the microprocessor loses count (e.g., due to quick movement or a low battery condition), an error message shall appear on the display. Micrometers having the ability to transfer data shall have the output protocol designated by the manufacturer and described in sufficient detail to allow for interfacing with existing equipment.