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Indian Standard

SPECIFICATION FOR EXTERNAL MICROMETER

(First Revision)

1. Scope — Covers the important dimensional, functional and quality characteristics and values for the error of measurement at any point in the measuring range and recommendations for using the instruments and testing for accuracy of external micrometers.

1.1 This standard applies to micrometers fitted with a screw of pitch of 0·5 or 1 mm having a maximum range of 25 mm of least count 0·01 mm covering capacities up to 500 mm, and having non-removable anvils with flat measuring faces.

Note — This standard does not apply to digital reading micrometers but may be used for indicating desirable requirements for such micrometers where appropriate.

2. Nomenclature and Definitions

2.1 For the purpose of this standard, nomenclature indicated in Fig. 1 alongwith the following definitions will apply.

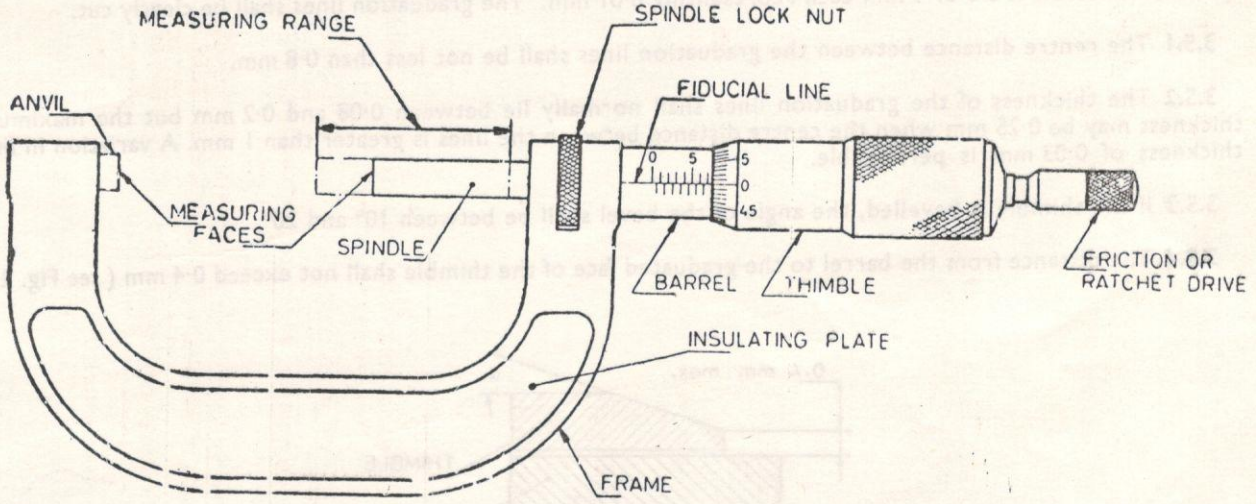

FIG. 1 NOMENCLATURE OF EXTERNAL MICROMETER

2.2 *Error of Measurement* — The algebraical difference between the indicated value and the true value of the quantity measured.

2.3 *Deviation of Traverse of the Micrometer Screw* — The maximum difference between the highest and lowest points for the deviation of the readings obtained along the complete traverse of the screw.

2.4 *The Periodical Error* — It is error of measurement at any optional point of the measuring range by tests.

2.5 *The Total Error* — The total error of the micrometer corresponds to the maximum difference of the highest and lowest points determined over the entire measuring range.

2.6 *Measuring Range* — It is the total travel of the measuring spindle for a given micrometer.

3. Design Features

3.1 *Frame* — The frame shall be so shaped as to permit the measurement of a cylinder equal to the maximum capacity of the micrometer. The stiffness of the frame shall be such that a force equal to the force of the ratchet or friction drive applied between the measuring faces does not alter the distance between them by more than the amount given in Table 1. When no ratchet or friction drive is fitted, the force applied shall be 10 N.

3.1.1 The frame shall be of a suitable material, for example steel or malleable cast iron. It is recommended that heat insulating plates be fitted to the frame, especially on large micrometers.

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3.2 *Spindle and Anvil* — The screw thread on the spindle shall have a pitch of 0·5 or 1 mm and the screw thread shall be smooth fit in the nut.

3.2.1 There shall be full engagement of the nut and spindle screw throughout the range of travel. The front parallel portion of the spindle shall be a free-running fit such as H7-f7 in the bush but without perceptible jerk/lateral movement.

3.2.2 The spindle and anvil be of stainless steel having a hardness of not less than 530 *HV* or shall be of hardened high grade tool steel having a hardness of not less than 670 *HV* [see IS : 1501-1968 Method for Vickers hardness test for steel (*first revision*)]. They may be tipped with tungsten carbide or other suitable hard material. Sharp edges shall be chamferred to about 0·1 mm.

3.3 *Spindle Clamp* — If a spindle clamp is fitted, the design shall be such that it effectively locks the spindle without altering the distance between the measuring faces by more than 2 μm.

3.4 *Friction or Ratchet Drive* — The spindle may be fitted with a friction or ratchet drive. When such a drive is fitted, the force exerted by the drive between the measuring faces shall lie between 10 ± 5 N unless otherwise specified by the user.

Note — Whatever the force employed, it should remain substantially the same throughout the traverse of the instrument.

3.5 *Thimble* — The thimble shall be graduated with 50 or 100 divisions according to whether the pitch of the micrometer screw is 0·5 or 1 mm each representing 0·01 mm. The graduation lines shall be clearly cut.

3.5.1 The centre distance between the graduation lines shall be not less than 0·8 mm.

3.5.2 The thickness of the graduation lines shall normally lie between 0·08 and 0·2 mm but the maximum thickness may be 0·25 mm when the centre distance between the lines is greater than 1 mm. A variation in line thickness of 0·03 mm is permissible.

3.5.3 If the thimble is bevelled, the angle of the bevel shall be between 10° and 20°.

3.5.4 The distance from the barrel to the graduated face of the thimble shall not exceed 0·4 mm (see Fig. 2).

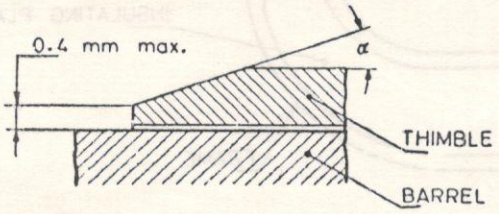

FIG. 2 DISTANCE FROM BARREL TO GRADUATED FACE OF THIMBLE

3.6 *Barrel* — The thickness of the fiducial line on the barrel shall be the same as that of the graduation lines on the thimble and shall be subject to the same permissible variation in thickness of 0·03 mm.

3.7 *Adjustment*

3.7.1 Each micrometer shall be provided with means for adjusting the zero setting.

3.7.2 Each micrometer shall be provided with means for compensating for wear between screw and nut.

Note — The means of adjustment shall be such that, after resetting, the parts are secured and the original accuracy of the instrument is not impaired. Suitable spanner and keys shall be supplied for this purpose.

4. Accuracy

4.1 *General* — The deviations and tolerances specified below and in Table 1 apply to measurements made at the standard reference temperature of 20°C.

4.2 *Deviations and Tolerances* — The deviation of traverse of the micrometer spindle over a range of 25 mm shall not exceed 3 μm. The tolerances f on the zero setting shall be as given in Table 1, they are based on the following formula:

$$f = \pm \left(2 + \frac{A}{50}\right) \mu m$$

where A is the lower limit (that is zero setting) of the measuring range in millimeters.

4.3 *Error of Measurement* — The maximum permissible error of measurement *F Max*, when checked with a measuring force of 10 N is given in Table 1 and is based on the following formula:

$$F\,Max = \left(4 + \frac{A}{50}\right)\ \mu m$$

where

F = error of measurement at any point in the measuring range, and

A = lower limit (that is zero setting) of the measuring range in millimetres. It should be noted that *F Max* may be positive or negative.

Note — Information concerning the maximum error of measurement to be expected from instruments complying with this standard is given in Appendix C.

4.4 *Measuring Faces* — The measuring faces shall be lapped and each face shall be flat to within 1 μm.

When subjected to a measuring force of 10 N, the faces of micrometers not fitted with a friction or ratchet drive shall be parallel to within the amount given in Table 1; when a friction or ratchet drive is fitted, the measuring force that it exerts shall be used (see **3.1**). The tolerances are based on the following formula:

$$f_p = \pm\ \left(2 + \frac{A}{50}\right)\ \mu m$$

where

A = lower limit (that is zero setting) of the measuring range, in millimetres.

5. Designation

5.1 The micrometer shall be designated by the measuring range and the number of this standard.

Example:

A micrometer with a range of measurement of 25 to 50 shall be designated as:

Micrometer 25-50 IS : 2967

6. Marking

6.1 The micrometer shall be legibly marked with unit of graduation (0·01), the measuring range (for example 25-50) and manufacturer's name or trade-mark on the frame.

6.2 *Certification Marking* — Details available with the Bureau of Indian Standards.

7. Packing

7.1 Each micrometer shall be coated with a suitable protective preparation.

7.2 Each micrometer shall be supplied with a suitable protective case or box.

8. Care and Use of External Micrometer

8.1 *Recommended Practice for Use of External Micrometer*

8.1.1 Recommended practice for use of external micrometer is given in Appendix A.

8.2 *Recommended Methods of Testing of External Micrometer*

8.2.1 Recommended method of testing of external micrometer is given in Appendix B.

8.3 *Error of Measurement in External Micrometer*

8.3.1 Error of measurement at any point in the measuring range is explained in Appendix C.

TABLE 1 PERMISSIBLE FLEXURE OF FRAME SUBJECT TO A FORCE OF 10 N AND TOLERANCES ON THE ZERO SETTING ON PARALLELISM OF MEASURING FACES AND ERROR OF MEASUREMENT

Clauses 3.1, 4.2, 4.3 *and* 4.4)

Measuring Range of Micrometer	Permissible Flexure of Frame	Tolerance on Zero Setting f	Tolerance on Parallelism of Measuring Faces f_p	Error of Measurement F Max
mm	μm	μm	μm	μm
0 to 25	2	± 2	2	4
25 to 50	2	± 2	2	4
50 to 75	3	± 3	3	5
75 to 100	3	± 3	3	5
100 to 125	4	± 4	4	6
125 to 150	5	± 4	4	6
150 to 175	6	± 5	5	7
175 to 200	6	± 5	5	7
200 to 225	7	± 6	6	8
225 to 250	8	± 6	6	8
250 to 275	8	± 7	7	9
275 to 300	9	± 7	7	9
300 to 325	10	± 8	8	10
325 to 350	10	± 8	8	10
350 to 375	11	± 9	9	11
375 to 400	12	± 9	9	11
400 to 425	12	±10	10	12
425 to 450	13	±10	10	12
450 to 475	14	±11	11	13
475 to 500	15	±11	11	13

APPENDIX A

(*Clause* 8.1)

RECOMMENDED PRACTICE FOR USE OF EXTERNAL MICROMETER

A-1. The measuring faces should be kept clean by wiping with clean tissue.

A-2. The micrometer screw should run smoothly throughout its traverse. Jerkiness usually indicates the presence of dirt in the screw. A very little lubrication with a light, high quality oil is recommended to increase smoothness of traverse.

A-2.1 The micrometer screw should move without either tightening or slackening, alternate tightening and slackening indicates a bent spindle.

A-3. It is usually easier to measure with a micrometer if the weight of the frame is supported independent of the action of the spindle.

A-4. The micrometer spindle should be gently propelled by the action of the ratchet or friction drive or the thimble.

A-5. The reading of the micrometer should be checked with a setting gauge of known size and the reading adjusted as necessary. This gauge should preferably have the same geometrical form of measuring faces or the part to be measured by the micrometer.

Note — The setting gauges supplied with micrometer are usually made to the minimum capacity of the instrument within manufacturing tolerances for size as per IS : 3455-1971 ' Gauging practice for plain workpieces (*first revision*) '.

APPENDIX B
(*Clause* 8.2)

RECOMMENDED METHODS OF TESTING OF EXTERNAL MICROMETER

B-1. Measuring Faces

B-1.1 *Flatness* — The flatness of the measuring faces is tested by means of an optical flat. When the faces have been cleaned thoroughly, the optical flat is brought into contact with each one in turn.

B-1.1.1 Unless the faces are perfectly flat, a number of coloured interference bands will be seen on their surfaces and the optical flat should be applied in such a way that the minimum number of bands is obtained. The shape and number of the bands indicate the degree of flatness of the face, for the faces to comply with the specified flatness tolerance of 1 μm, not more than four bands of the same colour should be visible on either of the faces.

B-1.1.1.1 The bands are rendered much more distinct if the test is carried out using a monochromatic light source.

B-1.2 *Parallelism* — The parallelism of the measuring faces of a 0 to 25 mm micrometer may be tested by means of a set of four optical flats with parallel faces and thicknesses that differ by approximately a quarter of a pitch so that the test is carried out at four positions of a complete rotation of the micrometer spindle face.

B-1.2.1 The flat should be placed between the measuring faces, contacting both of them under the pressure of the ratchet or friction drive. By carefully moving the optical flat between the faces, the number of interference bands visible on one face should be reduced to a minimum and those on the opposite face should then be counted. This procedure should be repeated with each optical flat in the set and in no case should the total number of bands exceed eight.

B-1.2.1.1 If desired, the same method may be used for testing the parallelism of the faces of larger micrometers up to about 100 mm capacity. In this case, two of the optical flats are then wrung on the measuring faces of a suitable combination of slip gauges and the whole combination thus formed is used as a parallel ended test piece between the measuring faces.

B-1.2.2 The test can be carried out in four positions, as before by changing the length of the gauge block combination between the optical flats.

B-1.2.2.1 It should be noted that it is most desirable to keep number of slip gauges in these combinations to the minimum in order to avoid the introduction of cumulative errors.

B-2. Micrometer Screw — The deviation of traverse of micrometer screw is usually checked by taking readings on a series of slip gauges.

B-2.1 The sizes of the slip gauge should be chosen so as to test the micrometer-screw at complete turns of the spindle and also at intermediate positions. As for example, for a micrometer with a pitch of 0·5 mm a convenient series of slip gauges is:

2·5, 5·1, 7·7, 10·3, 12·9, 15·00, 17·6, 20·2, 22·8 and 25 mm.

This series may be used to give readings for two complete but not adjacent, revolutions of the spindle, thus providing a check on any periodic variation that may be present.

B-2.2 In the case of micrometer with capacities above 25 mm, the errors in the traverse of the micrometer screw may be checked with slip gauges as indicated above by carefully clamping the micrometer to a fixture or surface plate and fixing the temporary anvil of appropriate length and with a rounded face close to the face of the micrometer spindle.

B-3. Ratchet or Friction Drive — The efficiency of the ratchet or friction drive may be tested with the aid of a dynamometer.

B-4. Deflection of Frame — Hold the micrometer with measuring anvil pointing downwards and spindle axis in vertical. Measure the quantity of deflection when the force of 50 N is applied to the anvil, and obtain the quantity of deflection per 10 N.

APPENDIX C
(*Clause* 8.3)

ERROR OF MEASUREMENT AT ANY POINT IN THE MEASURING RANGE

C-1. Any measuring instrument has its inherent error, independent of the part to be measured. To select the type of instrument most suitable for this purpose and set its inspection limits to ensure that the design limits are respected as far as possible without encroaching too far on the manufacturing tolerances, it is recommended that manufacturers of measuring instruments should indicate the likely measuring uncertainty of their measuring instruments.

C-1.1 It is sufficient to say that the numerical values given for this uncertainty are statistical values in that they are based on the application of a formula to test on a complete batch of instruments and apply only to the instruments as supplied.

C-1.2 The maximum values of measuring uncertainty that can be regarded as acceptable for instruments intended to check workpieces manufactured to tolerances from IT 13 to IT 16 are given below:

Workpieces Dia	Measuring Uncertainty, μm			
mm	IT 13	IT 14	IT 15	IT 16
0 to 3	9·5	15	24	38
3 to 6	12	19	30	48
6 to 10	14	22	36	56
10 to 18	18	28	45	70
18 to 30	21	33	53	85
30 to 50	25	40	63	100
50 to 80	30	48	75	120
80 to 120	36	56	90	140
120 to 180	40	63	100	160
180 to 250	45	70	110	180
250 to 315	50	80	125	200
315 to 400	56	90	140	220
400 to 500	63	100	160	250

The values of error of measurement given in Table 1 can therefore be compared with those of measuring uncertainty given above so that the user can decide whether the micrometers covered by this standard are suitable for checking products made to the above grades of tolerances.

EXPLANATORY NOTE

This standard was first published in 1964 and was based on DIN 863 : 1956 ' External micrometers, conceptions, specifications permissible deviations and testing ', and BS : 870-1950 ' External micrometers '.

In 1978, the International Organization for Standardization (ISO) published ISO : 3611-1978 ' Micrometer callipers for external measurement '. Subsequently, DIN 863 was also revised in 1977 based on original ISO draft.

This revised standard is based on ISO 3611-1978 incorporating the following changes:

1) Scope has been revised in accordance with ISO : 3611 to include the values for the error of measurement and recommendations for use and testing for accuracy. Definitions of least count and backlash appearing in the original standard have been deleted.

2) Two grades which were covered in original standard, have been deleted considering current practice followed in industries.

3) Recommendations for use and testing methods have been given separately in appendices.

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