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Micrometer callipers for external measurement

Micromètres d'extérieur

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FOREWORD

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3611 was developed by Technical Committee ISO/TC 3, *Limits and fits*, and was circulated to the member bodies in December 1974.

It has been approved by the member bodies of the following countries :

Australia	Hungary	Romania
Austria	India	South Africa, Rep. of
Belgium	Italy	Sweden
Bulgaria	Japan	Switzerland
Czechoslovakia	Korea, Dem P. Rep. of	Turkey
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The member bodies of the following countries expressed disapproval of the document on technical grounds :

Canada
U.S.A.
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Micrometer callipers for external measurement

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies the most important dimensional, functional and quality characteristics of micrometer callipers for external measurement. Information concerning values for the error of measurement at any point in the measuring range and recommendations for using the instruments and testing their accuracy are given in annexes.

This International Standard applies to micrometers equipped with a screw having a lead of 0,5 or 1 mm, having a maximum range of 25 mm covering capacities up to 500 mm, and having non-removable anvils with flat measuring faces.

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

2 REFERENCE

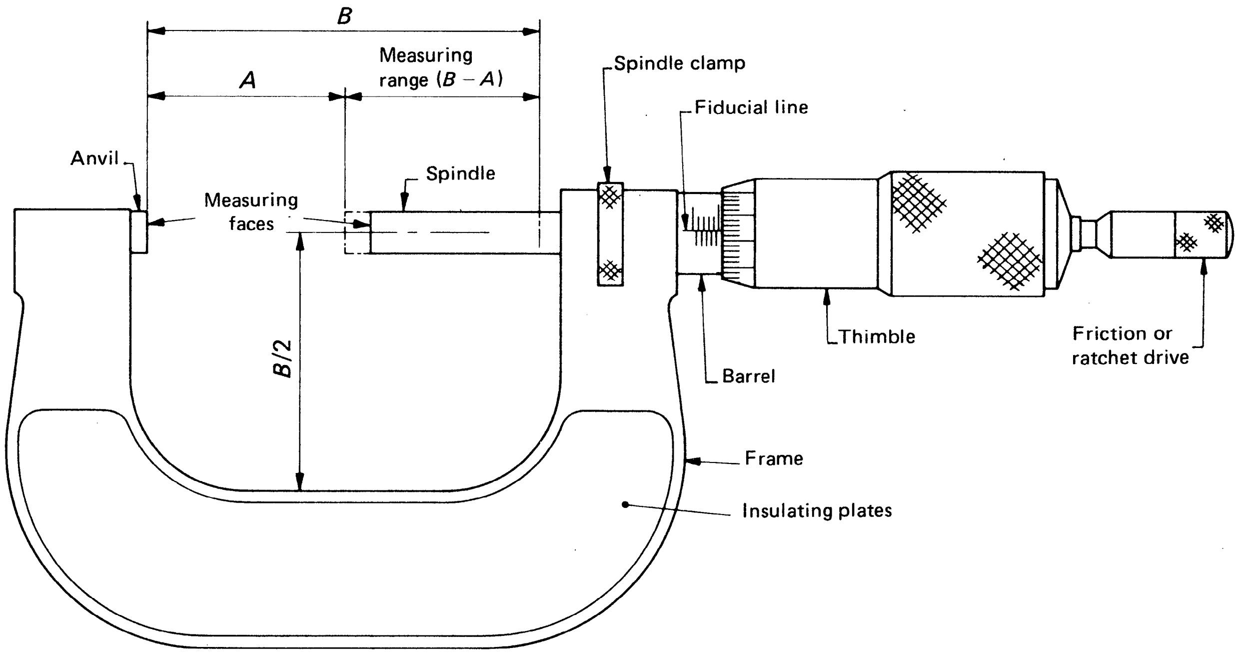
ISO/R 1938, *ISO system of limits and fits — Part II : Inspection of plain workpieces.*

3 NOMENCLATURE AND DEFINITIONS

3.1 For the nomenclature for micrometer callipers, see figure 1.

3.2 error of measurement : The algebraical difference between the indicated value and the true value of the quantity measured.

3.3 deviation of traverse of the micrometer screw : The maximum difference between the ordinates of the curve for the deviation of the readings obtained along the complete traverse of the screw.



NOTE — The illustration is diagrammatic only and is not intended to show details of design.

FIGURE 1 — **Nomenclature for a micrometer calliper for external measurement**

4 SPECIFICATION

4.1 Design features

4.1.1 *Frame*

The frame shall be so shaped as to permit the measurement of a cylinder of diameter equal to the maximum capacity of the micrometer calliper. 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.

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

4.1.2 *Spindle and anvil*

The screw shall have a lead of 0,5 or 1 mm and the screw thread shall be a good fit in the nut.

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 good free-turning fit in its bush but without perceptible shake.

The spindle and anvil shall be of stainless steel having a hardness number of not less than 530 HV or shall be of hardened high grade tool steel having a hardness number of not less than 670 HV. They may be tipped with tungsten carbide or other suitable hard material. Sharp edges shall be slightly chamfered (approximately 0,1 mm).

4.1.3 *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.

4.1.4 *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 5 and 15 N unless otherwise required by the user.

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

4.1.5 *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 cleanly cut.

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

The thickness of the graduation lines shall normally lie between 0,08 and 0,2 mm but the maximum thickness may be up to 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.

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

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

4.1.6 *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.

4.1.7 *Adjustments*

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

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

4.1.8 *Marking*

Each micrometer calliper shall have legibly and permanently marked upon it the division value, the measuring capacity and the manufacturer's name or trade mark.

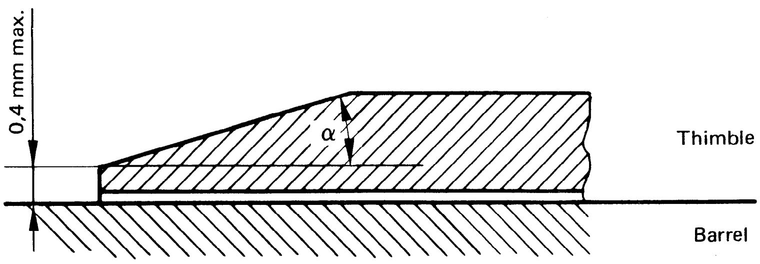


FIGURE 2 — **Distance from barrel to graduated face of thimble**

5 ACCURACY

5.1 General

The deviations and tolerances specified below and in tables 1 and 2 apply to measurements made at the standard reference temperature of 20 °C.

5.2 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 :

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

where A is the lower limit (i.e. zero setting) of the measuring range, in millimetres.

5.3 Error of measurement

Information concerning the maximum error of measurement to be expected from instruments complying with this International Standard is given in annex A.

5.4 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 amounts given in table 1; when a friction or ratchet drive is fitted, the measuring force that it exerts shall be used (see 4.1.1).

The tolerances are based on the following formula :

$$2 + \frac{A}{50}$$

where A is the lower limit (i.e. zero setting) of the measuring range, in millimetres.

TABLE 1 — **Permissible flexure of frame subject to a force of 10 N, and tolerances on the zero setting and on parallelism of measuring faces**

Measuring range of micrometer	Permissible flexure of frame	Tolerance on zero setting, f	Tolerance on parallelism of measuring faces
mm	µm	µm	µm
0 to 25	2	± 2	2
25 to 50	2	± 2	2
50 to 75	3	± 3	3
75 to 100	3	± 3	3
100 to 125	4	± 4	4
125 to 150	5	± 4	4
150 to 175	6	± 5	5
175 to 200	6	± 5	5
200 to 225	7	± 6	6
225 to 250	8	± 6	6
250 to 275	8	± 7	7
275 to 300	9	± 7	7
300 to 325	10	± 8	8
325 to 350	10	± 8	8
350 to 375	11	± 9	9
375 to 400	12	± 9	9
400 to 425	12	± 10	10
425 to 450	13	± 10	10
450 to 475	14	± 11	11
475 to 500	15	± 11	11

ANNEX A

ERROR OF MEASUREMENT AT ANY POINT IN THE MEASURING RANGE

As stated in ISO/R 1938, any measuring instrument has its inherent error, independent of the part to be measured and of external conditions of measurement. To enable the user to select the type of instrument most suitable for his purpose and set his 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 the manufacturers of measuring instruments should indicate the likely measuring uncertainty of those instruments and this is expressed in terms of the "standard deviation S_M", full details of which are given in ISO/R 1938.

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

ISO/R 1938 includes a table giving the maximum values of S_M that can be regarded as acceptable for instruments intended to check workpieces manufactured to tolerances from IT3 to IT16. The values in table 2 can therefore be compared with those in ISO/R 1938 so that the user can decide whether the micrometer callipers covered by this International Standard are suitable for checking products made to the ISO grade of tolerance concerned. They are "statistical" values in the sense described above and represent the error of measurement F at any point in the measuring range of micrometers conforming to this International Standard, when checked with a measuring force of 10 N, and are based on the following formula :

$$F_{max} = 4 + \frac{A}{50}$$

where

F is the error of measurement at any point in the measuring range;

A is the lower limit (i.e. zero setting) of the measuring range in millimetres.

It should be noted that F_{max} may be positive or negative.

TABLE 2 — Values of F_{max}

Measuring range of micrometer	F_{max}
mm	µm
0 to 25	4
25 to 50	4
50 to 75	5
75 to 100	5
100 to 125	6
125 to 150	6
150 to 175	7
175 to 200	7
200 to 225	8
225 to 250	8
250 to 275	9
275 to 300	9
300 to 325	10
325 to 350	10
350 to 375	11
375 to 400	11
400 to 425	12
425 to 450	12
450 to 475	13
475 to 500	13

ANNEX B

RECOMMENDED PRACTICE FOR USING A MICROMETER CALLIPER

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

B.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.

The micrometer screw should move without either tightening or slackening; alternate tightening and slackening indicates a bent spindle.

B.3 It is usually easier to measure with a micrometer calliper if the weight of the frame is supported independently of the action of the spindle.

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

B.5 The reading of the micrometer calliper 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 as the part to be measured by the micrometer calliper.

NOTE — The setting gauges supplied with micrometer callipers are usually made to the minimum capacity of the instrument within certain manufacturing tolerances for size.

ANNEX C

RECOMMENDED METHODS OF TESTING EXTERNAL MICROMETER CALLIPERS

C.1 MEASURING FACES

C.1.1 Flatness

The flatness of the measuring faces is best 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.

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.

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

C.1.2 Parallelism

The parallelism of the measuring faces of a 0 to 25 mm micrometer calliper 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.

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.

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 onto the measuring faces of a suitable combination of gauge blocks and the whole combination thus formed is used as a parallel-ended test piece between the measuring faces.

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

It should be noted that it is most desirable to keep the number of gauge blocks in these combinations to the minimum in order to avoid the introduction of cumulative errors due to the blocks themselves.

C.2 MICROMETER SCREW

The deviation of traverse of a micrometer screw is usually checked by taking readings on a series of gauge blocks.

The sizes of the gauge blocks should be chosen so as to test the micrometer screw at complete turns of the spindle and also at intermediate positions.

As an example, for a micrometer calliper with a pitch of 0,5 mm, a convenient series of gauge blocks is 2,5 – 5,1 – 7,7 – 10,3 – 12,9 – 15,0 – 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.

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

C.3 RATCHET OR FRICTION DRIVE

The efficiency of the ratchet or friction drive may be tested with the aid of a dynamometer.