INTERNATIONAL STANDARD

ISO 11093-4

Third edition
2022-03

Paper and board — Testing of cores —

Part 4:
Measurement of dimensions

Papier et carton — Essais des mandrins —

Partie 4: Mesurage des dimensions

Contents

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 6, *Paper, board and pulps*.

This third edition cancels and replaces the second edition (ISO 11093-4:2016), which has been technically revised.

The main changes are as follows:

— due to roundness deviation of paper cores with an internal diameter >180 mm and a wall thickness of <3 mm in 6.2.2, a maximum value for the internal diameter of ≤180 mm and a minimum value for the wall thickness of ≥3 mm has been added for Method A;

— the number of methods for determining the internal diameter has been increased from two to four and the remaining methods have been renamed;

— Figure 2 has been changed (5 levels of calibrated mandrel instead of 11 levels);

— information under Figure 2 has been added;

— a new Figure B.2 has been added.

A list of all parts in the ISO 11093 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Paper and board — Testing of cores —

Part 4:
Measurement of dimensions

1 Scope

This document specifies test methods for the determination of the internal diameter, the external diameter, the wall thickness and the length of paper and board cores.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 11093-1, *Paper and board — Testing of cores — Part 1: Sampling*

ISO 11093-2, *Paper and board — Testing of cores — Part 2: Conditioning of test samples*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
internal diameter
d
dimension of the internal width of the cylindrical core

Note 1 to entry: See Figure 1.

3.2
external diameter
D
dimension of the external width of the cylindrical core

Note 1 to entry: See Figure 1.

3.3
wall thickness
s
distance between the inner and outer surfaces of the core

Note 1 to entry: See Figure 1.

3.4
length
l
distance between the two ends of the core

Note 1 to entry: See Figure 1.

3.5
deformation
visual surface changes that can affect test results

EXAMPLE   Seams, lab joints and cutting burrs.
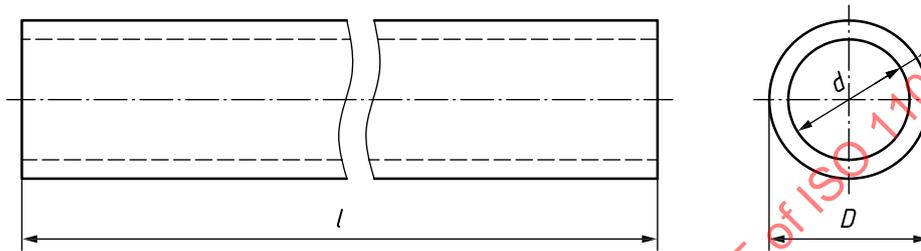
Figure 1 — Diagram of a core showing dimension lines

4   Sampling

Samples shall be taken in accordance with ISO 11093-1.

NOTE   For the purpose of measuring the length, the specimen constitutes the test piece.

5   Conditioning

Test pieces shall be conditioned in accordance with ISO 11093-2.

6   Measurement of internal diameters

6.1   General

Four methods for determining the internal diameter are available. They are of differing accuracy and speed. The method used shall be compatible with the type of core being measured and shall be specified and reported.

— Method A: Internal tri-point micrometer (see Figure A.1);

— Method B: Internal vernier calliper (see Figure B.1 to Figure B.3);

— Method C: Calibrated step mandrel;

— Method D: By calculation from the external diameter and wall thickness.

6.2 Method A

6.2.1 Apparatus

An internal tri-point micrometer equipped with a ratchet and accurate to at least 0,025 mm. The instrument shall also be fitted with a slip arrangement such that the measuring force cannot exceed the following:

— internal diameter up to 100 mm: (4,5 ± 0,2) N;

— internal diameter over 100 mm: (9,0 ± 0,3) N.

6.2.2 Procedure

Before using, the device should be calibrated using a calibration ring. To get accurate results, use, if possible, a measurement plate or a centring ring. Avoiding any obvious deformation, insert the tri-point micrometer at least 10 mm from one end of the test piece, such that the device is accurately parallel to the core direction. Take two measurements, to the nearest 0,025 mm, approximately 60° apart. Repeat the procedure at the other end of the test piece. Average the four readings and report to the nearest 0,025 mm.

Due to the roundness deviation of paper cores with an internal diameter >180 mm and a wall thickness <3 mm, an internal tri-point-micrometer shall only be used for paper cores with an internal diameter ≤180 mm and a wall thickness ≥3 mm.

6.3 Method B

6.3.1 Apparatus

A vernier calliper accurate to at least 0,1 mm (see ISO 13385-1).

6.3.2 Procedure

Avoiding any obvious deformations, insert the calliper into the test piece such that the measuring faces are aligned axially and radially. Take two measurements, to the nearest 0,1 mm, 90° apart. Repeat the procedure at the other end of the test piece. Average the four readings and report to the nearest 0,1 mm.

6.4 Method C

6.4.1 Apparatus

A solid round mandrel with external diameters that can accurately determine the diameter to be measured. The mandrel is stepped over its length and graduated in increasing diameters of 0,1 mm with a diameter tolerance of ±0,01 mm and each step having a minimum length of 50 mm.

An example of a solid mandrel is given in Figure 2.

6.4.2 Procedure

Insert the mandrel into the test piece until a push fit is obtained and note the graduation at this point. Repeat this procedure at the other end of the test piece. Average the two results and report to the nearest 0,1 mm.

Dimensions in millimetres
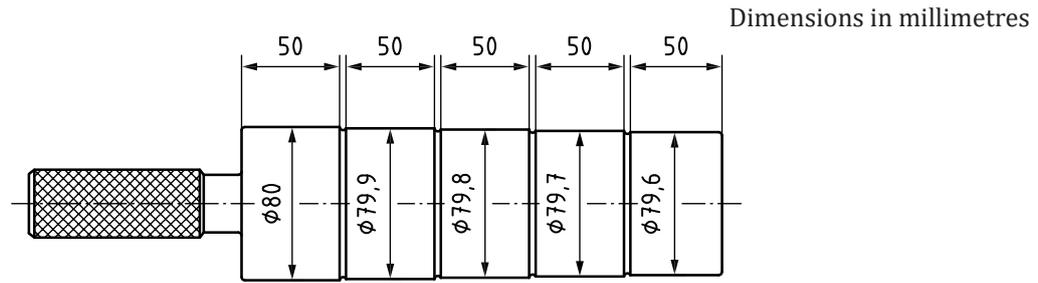
Figure 2 — Example of a calibrated step mandrel

Due to the weight and resulting canting, a test mandrel with a maximum of 5 levels is recommended for diameters >70 mm.

6.5 Method D

Measure the external diameter, D, and the wall thickness s of the test piece as detailed in Clause 7 and Clause 8. Calculate the internal diameter, d, using Formula (1):

$$d = D - 2s \tag{1}$$

7 Measurement of external diameters

7.1 General

Three methods of measuring the external diameter are available. They are of differing accuracy and speed. The method used shall be reported and shall be compatible with the type of core being measured.

— Method E: External micrometer (see Figure C.1);

— Method F: External vernier calliper (see Figure B.1 to Figure B.3);

— Method G: Flexible tape.

7.2 Method E

7.2.1 Apparatus

A micrometer accurate to at least 0,025 mm (see ISO 3611). In addition, the micrometer anvil and spindle faces shall be flat and parallel and have a diameter between 6,00 mm and 8,00 mm. The ratchet drive shall allow a measuring force between the following values:

— external diameter up to 150 mm: 4 N to 12 N;

— external diameter over 150 mm: 4 N to 14 N.

7.2.2 Procedure

In order to avoid any obvious deformations, position the micrometer round the test piece at least 10 mm from the end. Ensure that the faces of the measuring anvil and the measuring spindle are radially aligned to the test piece. The measurement shall be made by means of the external micrometer and recorded to the nearest 0,025 mm. Determine and record the maximum and minimum values of external diameter by rotating the test piece around the circumference. Repeat the procedure at the other end of the test piece. Average the four readings and report the result to the nearest 0,025 mm.

7.3 Method F

7.3.1 Apparatus

A vernier caliper accurate to at least 0,1 mm (see ISO 13385-1).

7.3.2 Procedure

In order to avoid any obvious deformations, position the vernier caliper at one end of the test piece as shown in Figure 3, ensuring that no deformation of the test piece surface is caused. Measure and record results to the nearest 0,1 mm.

Figure 3 — Position of vernier caliper

Rotate the test piece through 180°. Determine and record the maximum and minimum values of external diameter by rotating the test piece around the circumference. Repeat the procedure at the other end of the test piece. Average the four readings and report the result to the nearest 0,1 mm.

7.4 Method G

7.4.1 Apparatus

A flat, fully flexible, metal tape graduated in millimetres.

NOTE   A more accurate result can be obtained using a circumferential tape with a vernier scale with 0,1 mm graduations.

7.4.2 Procedure

Wrap the tape around the test piece at least 10 mm from the end, ensuring that the tape is flat on the surface and avoiding any obvious deformations. The tape shall be perpendicular to the axis of the cylindrical core. Record the measurement to the nearest millimetre.

If the tape used does not allow a direct reading of the diameter, Formula (2) shall be used:

$$D = \frac{C}{\pi} \tag{2}$$

where

C is the circumference, in millimetres;

D is the external diameter, in millimetres.

8 Measurement of wall thickness

8.1 General

Three methods of measuring the wall thickness are available. They are of differing accuracy and speed. The method used shall be compatible with the type of core being measured and shall be reported.

— Method H: Wall-thickness micrometer (see Figure C.2);

— Method I: External vernier calliper (see Figure B.3);

— Method J: Calculation from the external diameter and the internal diameter.

8.2 Method H

8.2.1 Apparatus

A wall-thickness micrometer accurate to at least 0,025 mm (see ISO 3611). In addition, the anvil shall be replaced by a cylindrical anvil where the length of the anvil shall be parallel to the spindle face. The dimensions of the anvil and spindle shall be in the following ranges:

— anvil diameter: 8,0 mm to 9,5 mm;

— anvil length: 7,0 mm to 9,0 mm;

— spindle face diameter: 6,0 mm to 8,0 mm.

The ratchet drive shall allow a measuring force in the range 4 N to 14 N.

8.2.2 Procedure

Avoiding any obvious deformations, position the micrometer anvil inside one end of the test piece at least 10 mm from the end and ensure that the spindle face is parallel to the axis of the cylindrical test piece. Close the micrometer and record the measurement to the nearest 0,025 mm. Rotate the test piece through 90° and repeat the measurement. Repeat the procedure at the other end of the test piece. Average the four measurements and record to the nearest 0,025 mm.

8.3 Method I

8.3.1 Apparatus

A vernier caliper accurate to at least 0,1 mm (see ISO 13385-1).

8.3.2 Procedure

Avoiding any obvious deformations, position the vernier calliper with one face inside the test piece. Ensure that the faces of the vernier calliper are parallel to the lengthwise axis of the test piece. Close the faces, ensuring no deformation of the test piece surface, and record the measurement to the nearest 0,1 mm. Rotate the test piece through approximately 120° and repeat the measurement. Rotate through a further 120° and repeat the measurement. Repeat the procedure at the other end of the test piece. Average the six readings and record to the nearest 0,1 mm.

8.4 Method J

Measure the external diameter, *D*, and the internal diameter, *d*, of the test piece as detailed in Clause 6 and Clause 7. Calculate the wall thickness *s* using Formula (3):

$$s = \frac{D-d}{2} \tag{3}$$

9 Measurement of length

9.1 Apparatus

A flexible metal tape graduated in millimetres and fitted with a hook at one end. The hook shall be at a right angle to the tape face and not less than 10 mm high. For lengths of less than 500 mm, an external vernier calliper in accordance with ISO 13385-1 may be used.

9.2 Procedure

Avoiding any obvious deformations, insert the tape into the test piece. With the hook held firmly against the end face of the test piece and ensuring that the tape is parallel to the longitudinal axis, record the measurement to the nearest millimetre. Rotate the test piece through 120° and repeat the measurement. Rotate through a further 120° and repeat the measurement. Repeat the above procedure at the other end of the test piece. Average the six measurements and record to the nearest millimetre.

Where it is not practical to measure the inside length, the outside length may be measured, the procedure being the same.

10 Test report

The test report shall include the following information:

a) reference to this document, i.e. ISO 11093-4:2022;

b) type and designation of the sample tested;

c) date of testing;

d) measurement method used for each dimension;

e) individual values, in millimetres, separately for internal diameter, external diameter, wall thickness and length; values being recorded in ascending order with any mean or standard deviation, if calculated;

f) name of the person performing the test;

g) any deviations from the procedure or any other circumstances that might have affected the results.

Annex A
(informative)
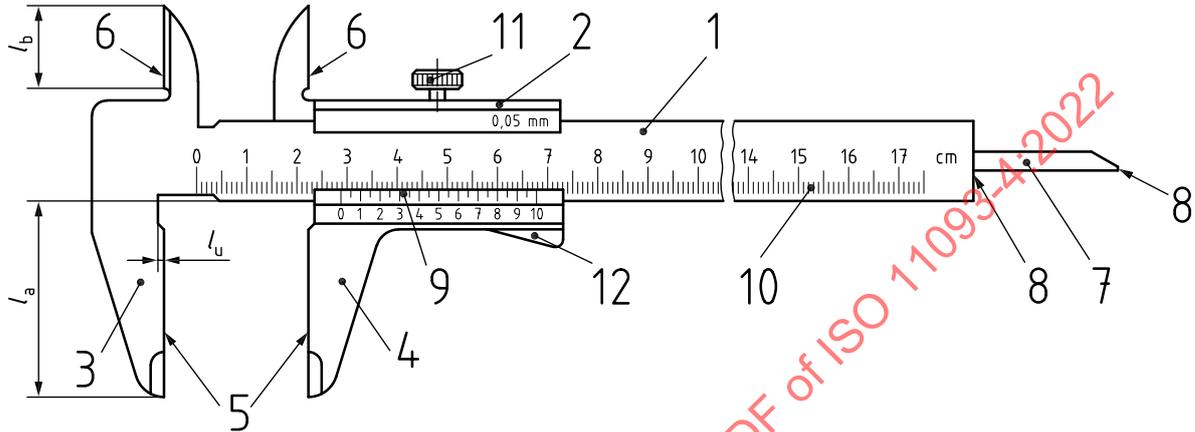
Example of an internal-tri-point micrometer
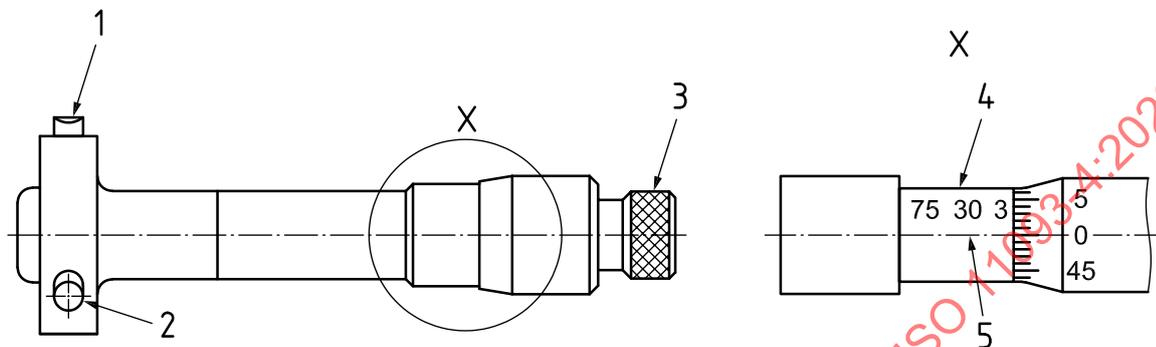
Key

1   measuring bolt
2   face for internal measurements
3   coupling (ratchet)
4   barrel
5   fiducial line

Figure A.1 — Example of an internal tri-point micrometer

Annex B
(informative)
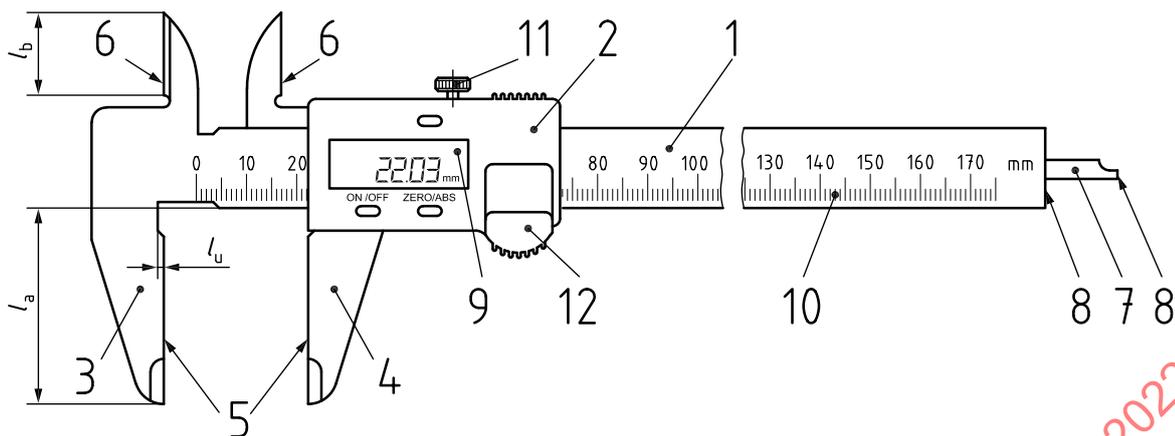
Examples of vernier callipers

Key

1   beam
2   slider
3   fixed (measuring) jaw
4   sliding (measuring) jaw
5   measuring faces for external measurements
6   measuring faces for internal measurements (crossed knife-edge faces)
7   depth measuring rod
8   measuring faces for depth measurement
9   vernier scale
10 mainscale
11 locking screw
12 clamping device
l_a length of jaw
l_b length of jaw for internal measurements
l_u undercut depth

Figure B.1 — Example for a design of an analogue calliper for external internal and depth measurement (slider with locking screw or with clamping device)

Key

1   beam
2   digital device
3   fixed (measuring) jaw
4   sliding (measuring) jaw
5   measuring faces for external measurements
6   measuring faces for internal measurements (crossed knife-edge faces)
7   depth measuring rod
8   measuring faces for depth measurement
9   display
10   mainscale
11   locking screw
12   slider
l_a length of jaw
l_b length of jaw for internal measurements
l_u undercut depth

Figure B.2 — Example for a design of a digital calliper for external internal and depth measurement (slider with locking screw or with clamping device)