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**Paper and board — Testing of cores —  
Part 4:  
Measurement of dimensions**

*Papier et carton — Essais des mandrins —  
Partie 4: Mesurage des dimensions*

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## 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](http://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](http://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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#).

The committee responsible for this document is ISO/TC 6, *Paper, board and pulps*.

This second edition cancels and replaces the first edition (ISO 11093-4:1997), which has been technically revised.

ISO 11093 consists of the following parts, under the general title *Paper and board — Testing of cores*:

- *Part 1: Sampling*
- *Part 2: Conditioning of test samples*
- *Part 3: Determination of moisture content using the oven drying method*
- *Part 4: Measurement of dimensions*
- *Part 5: Determination of characteristics of concentric rotation*
- *Part 6: Determination of bending strength by the three-point method*
- *Part 7: Determination of flexural modulus by the three-point method*
- *Part 8: Determination of natural frequency and flexural modulus by experimental modal analysis*
- *Part 9: Determination of flat crush resistance*

# Paper and board — Testing of cores —

## Part 4: Measurement of dimensions

### 1 Scope

This part of ISO 11093 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, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 13385-1, *Geometrical product specifications (GPS) — Dimensional measuring equipment — Part 1: Callipers; Design and metrological characteristics*

ISO 3611, *Geometrical product specifications (GPS) — Dimensional measuring equipment: Micrometers for external measurements — Design and metrological characteristics*

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.

#### 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 which can affect test results

EXAMPLE Seams, lab joints and cutting burrs.

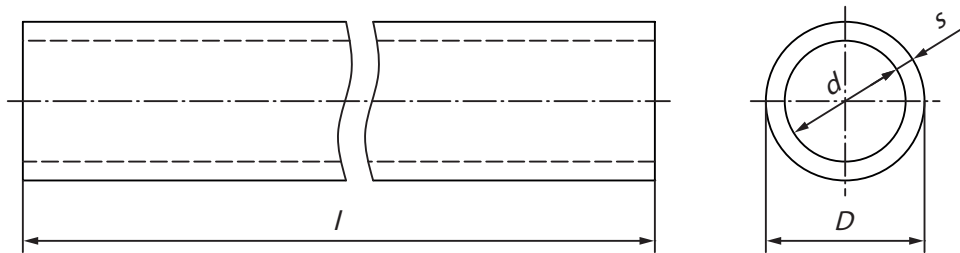


Figure 1 — Diagram of a core showing dimension lines

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**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 of measuring and calculation 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.

- Method A: Internal tri-point micrometer (see [Figure A.1](#)).
- Method B: Internal vernier calliper (see [Figure B.1](#) and [Figure B.2](#)).
- Method C: Calibrated step mandrel.
- Calculation.

## 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:  $(4,5 \pm 0,2)$  N;
- internal diameter over 100 mm:  $(9,0 \pm 0,3)$  N.

### 6.2.2 Procedure

Before using, the device should be calibrated with the help of 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 in a way that device is accurately in 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.

## 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 spanning the accuracy range for 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  $\pm 0,01$  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.

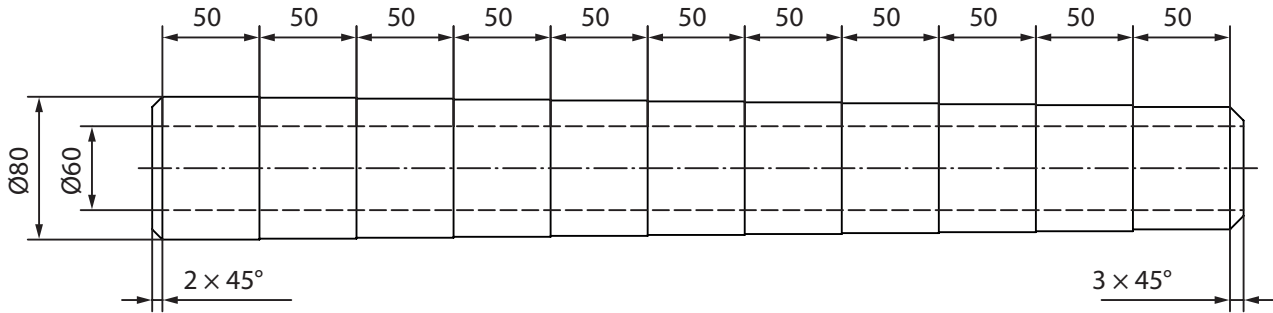


Figure 2 — Example of a calibrated step mandrel

### 6.5 Calculation

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

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

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- Method D: External micrometer (see [Figure C.1](#)).
- Method E: External vernier calliper (see [Figure B.1](#) and [Figure B.2](#)).
- Method F: Flexible tape.

### 7.2 Method D

#### 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 should 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. The micrometer shall be rotated along the circumference in order to determine the minimum and maximum values. Repeat the procedure at the other end of the core. Average the four readings and report the result to the nearest 0,025 mm.



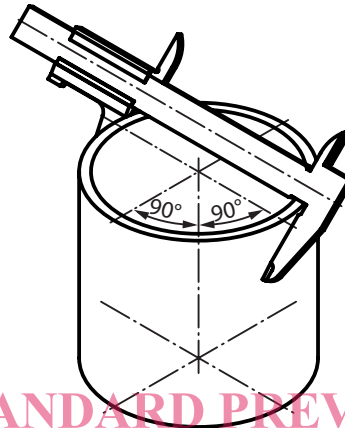
### 7.3 Method E

#### 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.



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Figure 3 — Position of vernier caliper

Rotate the test piece through 180°. The vernier caliper shall be rotated along the circumference in order to determine the minimum and maximum values. Repeat the procedure at the other end of the winding core. Average the four readings and report the result to the nearest 0,1 mm.

### 7.4 Method F

#### 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:

$$D = \frac{C}{\pi} \quad (2)$$

where

$C$  is the circumference, in millimetres;

$D$  is the external diameter, in millimetres.