
**Geometrical product specifications
(GPS) — Dimensional measuring
equipment — Design and metrological
characteristics of micrometers for
external measurements**

*Spécification géométrique des produits (GPS) — Équipement
de mesurage dimensionnel — Caractéristiques de conception et
caractéristiques métrologiques des micromètres d'extérieur*

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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 document 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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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 213, *Dimensional and geometrical product specifications and verification*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 290, *Dimensional and geometrical product specification and verification*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 3611:2010), which has been technically revised.

The main changes are as follows:

- general design characteristics have been removed and reference to ISO 14978:2018 has been included;
- metrological characteristics have been clarified and modified;
- requirements for test methods have been included;
- classification system of maximum permissible errors has been added.

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.

Introduction

This document is a geometrical product specification (GPS) standard and is to be regarded as a general GPS standard (see ISO 14638). It influences the chain links for measuring equipment and calibration on size and distance in the general GPS matrix (see [Annex C](#)).

The ISO GPS Matrix Model given in ISO 14638 gives an overview of the ISO GPS system of which this document is a part. The fundamental rules of ISO GPS given in ISO 8015 apply to this document and the default decision rules given in ISO 14253-1 apply to specifications made in accordance with this document, unless otherwise indicated; see ISO/TR 14253-6 for additional information on the selection of alternative decision rules.

For more detailed information on the relation of this document to other standards and the GPS matrix model, see [Annex C](#).

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Geometrical product specifications (GPS) — Dimensional measuring equipment — Design and metrological characteristics of micrometers for external measurements

1 Scope

This document provides the most important design and metrological characteristics of micrometers for external measurements:

- with analogue indication;
- with digital indication: mechanical or electronic digital display.

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 14253-1, *Geometrical product specifications (GPS) — Inspection by measurement of workpieces and measuring equipment — Part 1: Decision rules for verifying conformity or nonconformity with specifications*

ISO 14253-5, *Geometrical product specifications (GPS) — Inspection by measurement of workpieces and measuring equipment — Part 5: Uncertainty in verification testing of indicating measuring instruments*

ISO/TR 14253-6, *Geometrical product specifications (GPS) — Inspection by measurement of workpieces and measuring equipment — Part 6: Generalized decision rules for the acceptance and rejection of instruments and workpieces*

ISO 14978:2018, *Geometrical product specifications (GPS) — General concepts and requirements for GPS measuring equipment*

ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

ISO/IEC Guide 99, *International vocabulary of metrology — Basic and general concepts and associated terms (VIM)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14978, ISO/IEC Guide 99 and the following 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 micrometer for external measurements

measuring instrument which gives the evaluation of a dimensional quantity of an external feature of a workpiece on the basis of movement of a spindle with a measuring face, moving relatively to a material measure and an anvil, with the movement generated by a screw thread

Note 1 to entry: The guiding elements of the spindle and of the anvil are connected by a frame.

Note 2 to entry: Usually, micrometers for external measurements have a thread as a material measure with the anvil, spindle and material measure arranged in a line.

3.2 measuring face contact

contact between the measuring face and an integral feature of a workpiece

3.3 full measuring face contact

contact between the full area of the measuring face and an integral feature of a workpiece

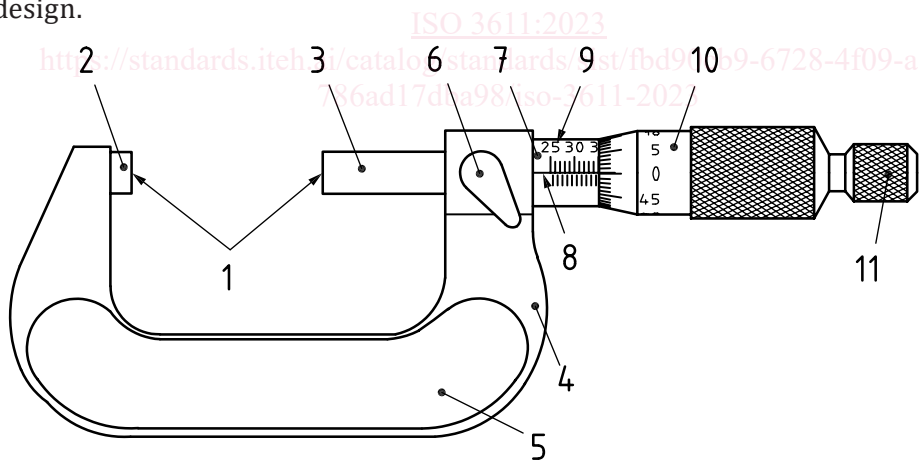
3.4 partial measuring face contact

contact between a partial area of the measuring face and an integral feature of a workpiece

4 Design characteristics

4.1 General design and nomenclature

The design of a micrometer for external measurements shall follow the general guidelines in ISO 14978, including the common design characteristics in ISO 14978:2018, Annex C. See [Figure 1](#) for an example of the general design.



Key

- | | |
|------------------------------|-----------------------|
| 1 measuring faces | 7 sleeve |
| 2 anvil | 8 fiducial line |
| 3 measuring spindle | 9 analogue indication |
| 4 frame | 10 thimble |
| 5 thermally insulating plate | 11 fast drive |
| 6 spindle clamp | |

Figure 1 — Nomenclature and general design of a micrometer for external measurements

4.2 Dimensions

The manufacturer shall state important dimensions, such as those shown in [Figure 2](#) and [Table 1](#). The values shown in [Table 1](#) are typical dimensions and are not requirements of this document.

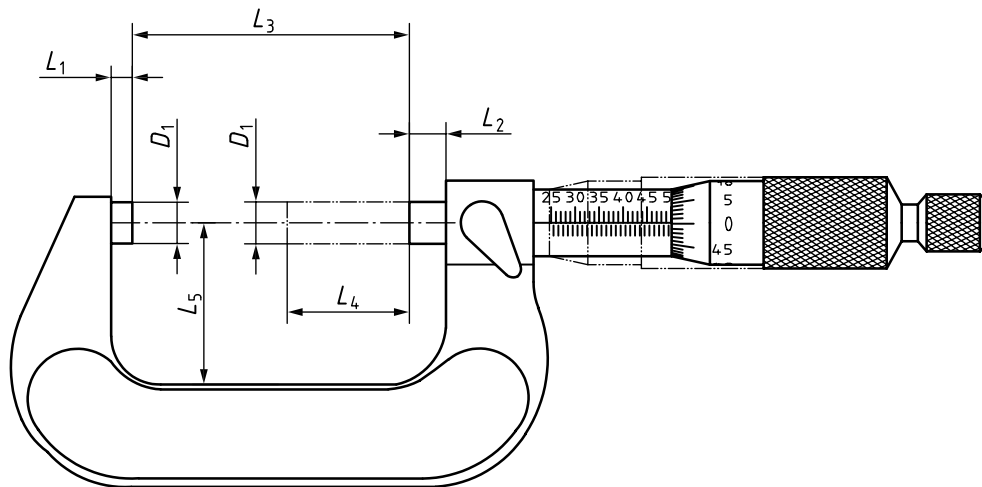


Figure 2 — Dimensions of a micrometer for external measurements

Table 1 — Dimensions of a micrometer for external measurements

Dimension	Nominal value
Anvil length, L_1	
Spindle length at maximum position, L_2	
Maximum dimension measurable, L_3	
Measuring span, L_4	25 mm ^a
Frame depth, L_5 ^b	
Spindle and anvil diameter, D_1	
NOTE The dimensions D_1 , L_1 and L_2 are important for the interchangeability of accessories mounted on the measuring faces.	
^a Usually, the measuring span L_4 is 25 mm. Other measuring spans are possible.	
^b Usually, the frame is shaped to permit the measurement of a cylinder whose diameter is equal to the last value of the measuring range.	

4.3 Types of indicating device

4.3.1 General

Several types of indicating device are possible:

- analogue indicating devices;
- digital indicating devices with mechanical digital display;
- digital indicating devices with electronic digital display.

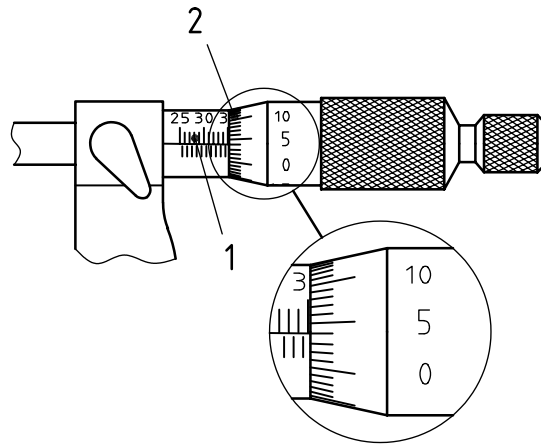
NOTE Combinations of analogue and digital indicating devices are possible.

4.3.2 Analogue indicating devices

The measuring spindle should have a pitch of 0,5 mm or 1 mm. In the case of micrometers with spindles having a pitch of 0,5 mm, the 0,5 mm graduation lines on the main scale shall be clearly distinguishable

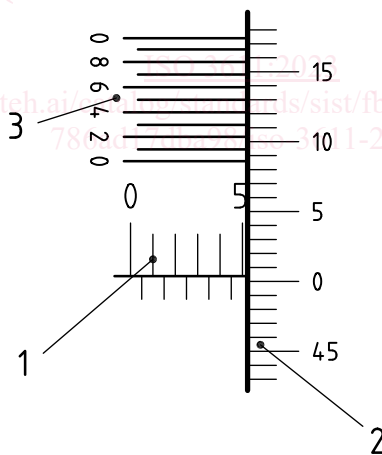
from the 1 mm graduation lines by means of their arrangement above and below the fiducial line. See [Figures 3](#) and [4](#).

The secondary scale on the thimble should have a scale graduated with 50 (pitch 0,5 mm) or 100 (pitch 1 mm) graduation lines, each scale interval representing 0,01 mm. For graduations of 0,001 mm, a vernier scale can be added on the sleeve. See [Figure 4](#).



- Key**
- 1 main scale
 - 2 secondary scale

Figure 3 — Analogue indicating device with spindle pitch of 0,5 mm



- Key**
- 1 main scale
 - 2 secondary scale
 - 3 vernier scale

Figure 4 — Analogue indicating device with spindle pitch of 0,5 mm and vernier scale interval of 0,001 mm

4.3.3 Digital indicating devices

The mechanical or electronic digital display should have a digital step of 0,01 mm or 0,001 mm.

4.4 Frame

The rigidity of the frame shall be consistent with the measuring force. For hand-held micrometers, the frame can be insulated to prevent body heat from being transmitted.

4.5 Measuring force limiting device

Each micrometer for external measurements shall be provided with a measuring force limiting device integrated in the thimble or in the fast drive.

NOTE Typical measuring force limiting devices include ratchet and friction devices.

The measuring force generated by the measuring force limiting device should exceed the frictional force of the spindle. See [5.7](#).

5 Metrological characteristics

5.1 General

The metrological characteristics and associated maximum permissible error (MPE) values apply to any indications permitted for use of the micrometer for external measurements as defined by the manufacturer and when used in accordance with the manufacturer's recommendations. The MPE values cannot be smaller than the digital step but may be smaller than the scale interval. See [Clause B.6](#) for more information on reading indications between scale marks.

5.2 Rated operating conditions

The manufacturer shall state any rated operating conditions that apply to the MPE values. All MPE values apply at a rated operating condition for temperature of 20 °C exactly, unless otherwise stated. Test values shall therefore be corrected to 20 °C to obtain the error of indication that the micrometer for external measurements would have produced had the test been performed at 20 °C. If temperature correction to 20 °C is not performed, this document allows the consequences to be included in the evaluation of the measurement uncertainty of the test values (see [6.2](#)).

A micrometer for external measurements is a manually operated measuring instrument, and the user of the micrometer for external measurements is therefore necessarily included in the measuring system that is specified in accordance with this document. The user shall be reasonably skilled in the operation of the micrometer for external measurements.

5.3 Reference point

Each micrometer for external measurements shall be provided with user-accessible means for setting the micrometer to zero or to the reference point. For further information, see [Annex B](#). The metrological characteristics described in this document apply when the micrometer for external measurements is properly set in accordance with the manufacturer's recommendations, and the reference point is considered fixed at the beginning of the measuring range when evaluating the metrological characteristics.

5.4 Test methods

The errors of indication shall be tested with suitable measurement standards, e.g. with gauge blocks in accordance with ISO 3650. When testing conformity to specification, sufficient testing shall be used to establish confidence in the results.

For acceptance testing, the customer is free to choose the test points; however, unless otherwise specified, the acceptance testing shall conform to the requirements in this document.