International Standard

ISO 5463

First edition
2024-09

Geometrical product specifications (GPS) — Rotary axis form-measuring instruments — Design and metrological characteristics

Spécification géométrique des produits (GPS) — Instruments de mesure de forme à axe rotatif — Caractéristiques de conception et caractéristiques métrologiques

Reference number
ISO 5463:2024(en)

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Published in Switzerland

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Foreword

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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).

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Introduction

This document is a geometrical product specification standard and is to be regarded as a general GPS standard (see ISO 14638). It influences chain link F of the chains of standards on form, orientation, location and run-out.

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. For more detailed information of the relation of this document to other standards and the GPS matrix model, see Annex F.

See ISO/TR 14253-6 for additional information on the selection of alternative decision rules.

There are different types and variants of rotary axis form-measuring instrument. The metrological characteristics described in this document apply to all types and variants.

Geometrical product specifications (GPS) — Rotary axis form-measuring instruments — Design and metrological characteristics

1 Scope

This document specifies the most important design and metrological characteristics of rotary axis form-measuring instruments.

It is not applicable to coordinate measurement systems as defined by the ISO 10360 series, whether the systems are fitted with a rotary axis or not, except by special agreement.

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 1101, *Geometrical product specifications (GPS) — Geometrical tolerancing — Tolerances of form, orientation, location and run-out*

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 99:2007, *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 1101, ISO 14978 and 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

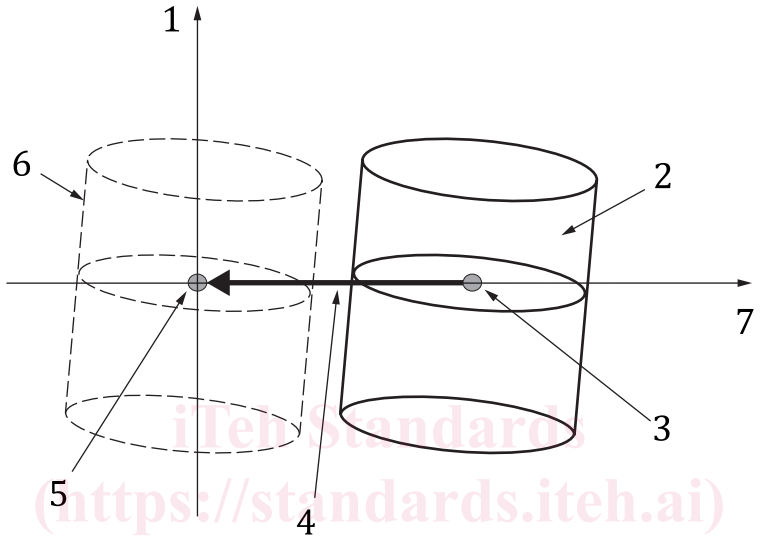
— IEC Electropedia: available at https://www.electropedia.org/

3.1 General terms

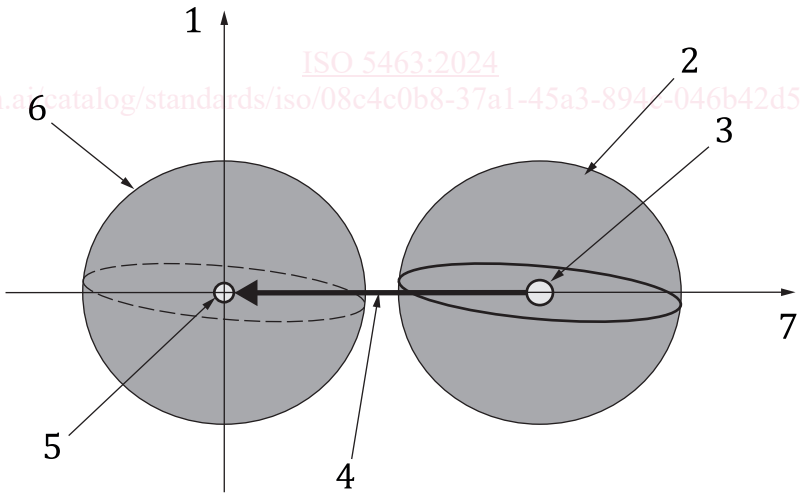
3.1.1
rotary axis form-measuring instrument
measuring instrument having a rotary axis and quantifying local form deviations from extracted integral surfaces in a cylindrical coordinate system

3.1.2
centring
adjusting, in a plane perpendicular to the axis of rotation, the position of the centre point of the workpiece to be coincident to the axis of rotation of the instrument

Note 1 to entry: See Figure 1.



a) Cylinder centring



b) Sphere centring

Key

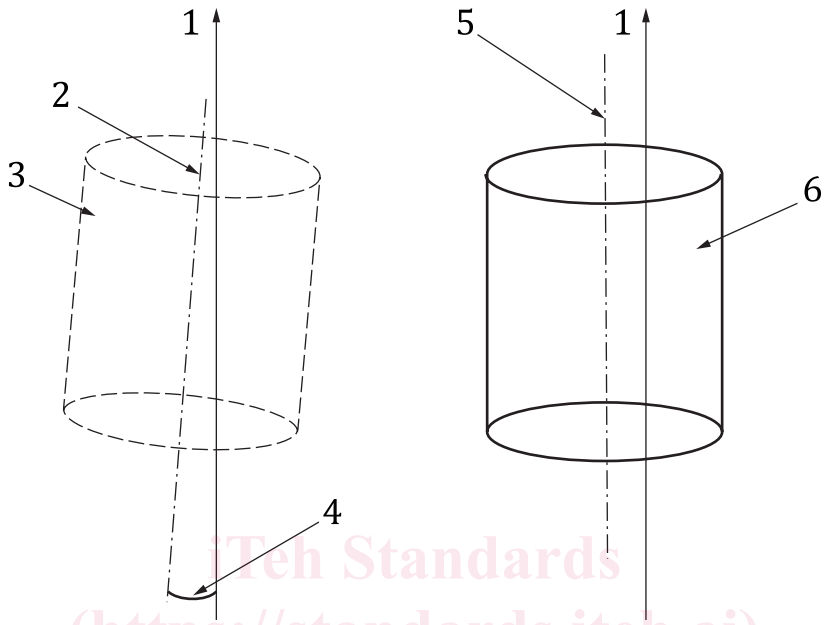
1 axis of rotation
2 revolute workpiece before centring
3 centre point before centring
4 centring displacement
5 centre point after centring
6 revolute workpiece after centring
7 orthogonal axis to the axis of rotation

Figure 1 — Centring

3.1.3
levelling
adjusting the centre line of the workpiece to be parallel to the axis of rotation or adjusting the normal vector to a plane feature of the workpiece to be parallel to the axis of rotation

Note 1 to entry: See Figure 2.

Note 2 to entry: Levelling is often combined with, or followed by, centring in order to bring the axis of the workpiece to be coaxial with the rotary axis of the instrument.



Key

1	axis of rotation	4	angular displacement
2	centre line of revolute workpiece before levelling	5	centre line of revolute workpiece after levelling
3	revolute workpiece before levelling	6	revolute workpiece after levelling

Figure 2 — Levelling

3.2 Terms relating to probe system

3.2.1
stylus
mechanical device consisting of a tip and an arm

4 Design characteristics

4.1 General

This measuring instrument is primarily constructed to acquire form deviations in cylindrical coordinates through the direct measurement of radial (and axial) deviations. The design characteristics of a rotary axis form-measuring instrument are described generically in Annex A, and depend on its type.

The cylindrical coordinate system is configured with the longitudinal axis nominally coincident with the rotary axis and with a nominally perpendicular transverse axis.

NOTE 1 See Figure 3.

NOTE 2 Displacements measured along the longitudinal axis are designated as *H* and are measured from a point specified by the manufacturer.

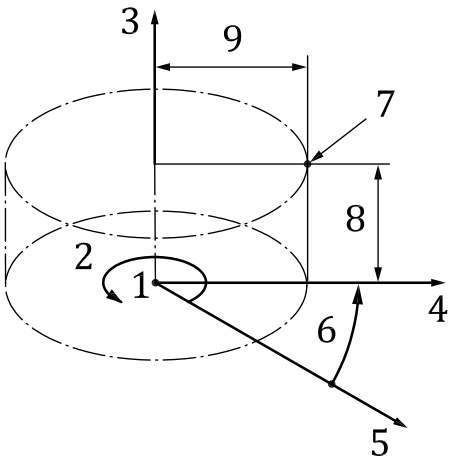
NOTE 3 Radius, designated as *R*, is measured from the rotary axis and its basic direction is the transverse axis.

NOTE 4 Rotation angle, designated as θ, is measured from a line with orientation specified by the manufacturer in the transverse plane.

NOTE 5 Direction along the rotary axis is called “axial direction” for rotary characteristics.

NOTE 6 Outward direction around the rotary axis is called “radial direction” for rotary characteristics.

NOTE 7 Rotating direction around the rotary axis is called “angular direction” for rotary characteristics.



Key

1	origin (centre position of rotary bearing)	6	rotation angle (angular distance of transverse axis from reference axis)
2	angular motion	7	probing point
3	axis line of rotation (longitudinal axis)	8	longitudinal distance (distance of the probing point from the transverse plane)
4	transverse axis or radial direction	9	radial distance (of the probing point from the rotary axis)
5	angular reference axis in the transverse plane (θ=0)		

Figure 3 — Measuring coordinate system

4.2 Types of rotary axis form-measuring instruments

4.2.1 General

There are a number of different types of rotary axis form-measuring instruments, with variants of each of these types.

4.2.2 Rotating workpiece instrument

Design characteristics of this type of instrument shall be in accordance with Annex A.

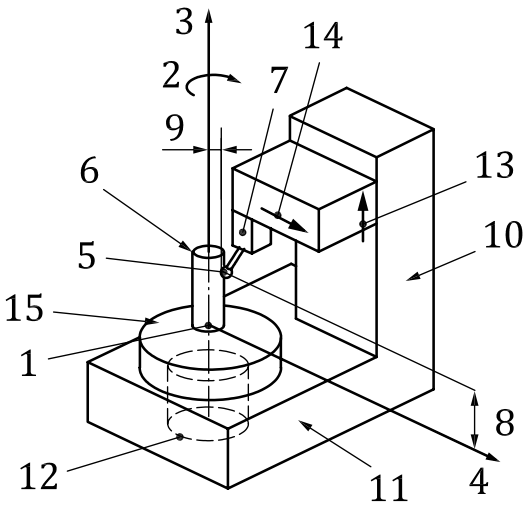
Rotating workpiece instruments include the following variants:

a) Vertical axis rotating workpiece instrument on which the workpiece is fixed on a worktable, see Figure 4.

b) Horizontal axis rotating workpiece instrument, which is a variant of type a), where the longitudinal axis lies in a horizontal plane, see Figure 5.

c) Vertical axis rotating workpiece between centres, which is a variant of type a), where the workpiece is rotated between centres instead of on a worktable.

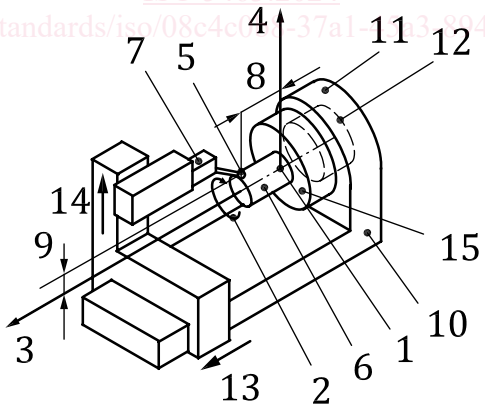
d) Horizontal axis rotating workpiece between centres, which is a variant of type b), where the workpiece is rotated between centres instead of on a worktable.



Key

1	origin of measuring coordinate system	9	probing point radius *R* from rotary axis
2	angular motion	10	column
3	axis line of rotation	11	base
4	transverse axis	12	rotary spindle
5	probing point	13	longitudinal axis motion
6	workpiece	14	transverse axis motion
7	probe	15	worktable
8	probing point height *H* from the top plane of the worktable		

Figure 4 — Vertical axis rotating workpiece instrument



Key

1	origin of measuring coordinate system	9	probing point radius *R* from rotary axis
2	angular motion	10	column
3	axis line of rotation or longitudinal axis	11	base
4	transverse axis direction	12	rotary spindle
5	probing point	13	longitudinal motion

6 workpiece
7 probe
8 probing point height *H* from worktable top plane
14 transverse motion
15 fixture for workpiece on worktable

Figure 5 — Horizontal axis rotating workpiece instrument

4.2.3 Stationary workpiece instrument

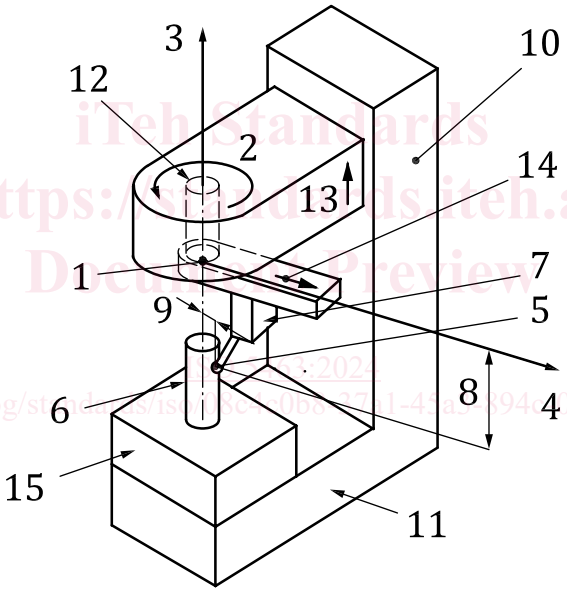
The stationary workpiece type instruments include the following variants:

a) Vertical axis stationary workpiece instrument on which the stylus turns around the workpiece, which is fixed on a worktable, see Figure 6.

b) Horizontal axis stationary workpiece instrument, which is a variant of type a) in which the longitudinal axis lies in a horizontal plane, see Figure 7.

c) Horizontal axis stationary workpiece between both centres instrument, which is a variant of b), where the workpiece is held between centres instead of in a workpiece fixture.

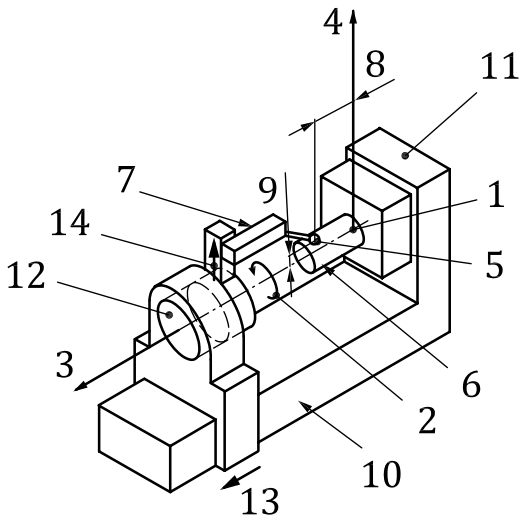
d) Hole insertion with stationary workpiece instrument, a variant of a type where the instrument works inside a fixed cylindrical hole on a workpiece, see Figure 8.



Key

1 origin of measuring coordinate system
2 angular motion
3 axis line of rotation
4 transverse axis
5 probing point
6 workpiece
7 probe
8 probing point height *H* from the origin at the transverse axis
9 probing point distance *R* from rotary axis
10 column
11 base
12 rotary spindle
13 longitudinal axis motion
14 transverse axis motion
15 worktable

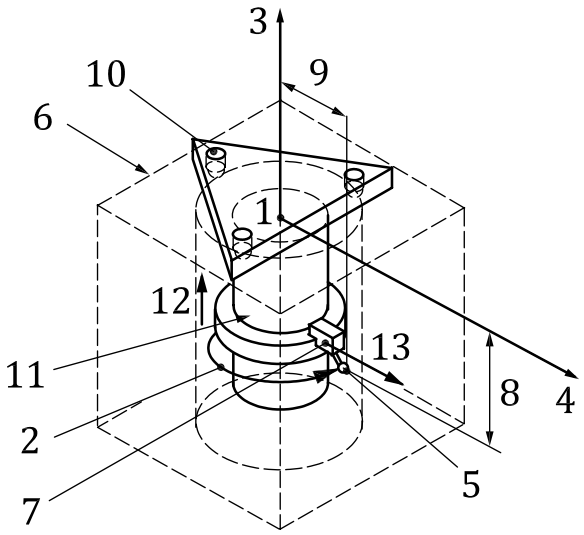
Figure 6 — Vertical axis stationary workpiece instrument



Key

1	origin of measuring coordinate system	8	probing point height *H* from the origin at the transverse axis
2	angular motion	9	probing point distance from rotary axis
3	axis line of rotation or transverse axis	10	base
4	longitudinal axis	11	column
5	probing point	12	rotary spindle
6	workpiece	13	transverse axis motion
7	probe	14	adjusting radius

Figure 7 — Horizontal axis stationary workpiece instrument



Key

1	origin of measurement coordinate	8	probing point height *H* from the origin at the transverse axis
2	angular motion	9	radius *R* of workpiece at the position of the probe contacting point
3	axis line of rotation axis	10	base
4	transverse axis		
5	probing point	11	rotary spindle
6	workpiece	12	longitudinal motion
7	probe	13	axis of the lever type probe

Figure 8 — Hole insertion with stationary workpiece instrument

4.3 Design characteristics of probe

4.3.1 Contact probe

A contact probe consists of a fixed part (“main body including transducer”) (see ISO/IEC Guide 99:2007, 3.7) and a movable part (“stylus”) which is also called the “measuring element”.

A contact probe needs a measuring force to maintain contact with the surface throughout the measurement. Excessive force could cause bending in the measurement loop and also damage the contacting point or the surface being measured. The measuring force should therefore be kept as small as possible.

The stylus tip should be manufactured from hard, wear-resistant material. It shall be well finished and free of flats or other irregularities which could affect the accuracy of the instrument.

The geometrical properties of the contact element shall be sufficient for the use of the measuring instrument.

The default geometry of a stylus tip is a sphere (see Figure 9).