



BSI Standards Publication

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

National foreword

This British Standard is the UK implementation of EN ISO 5463:2024. It is identical to ISO 5463:2024.

The UK participation in its preparation was entrusted to Technical Committee TPR/1, Technical Product Realization.

A list of organizations represented on this committee can be obtained on request to its committee manager.

Contractual and legal considerations

This publication has been prepared in good faith, however no representation, warranty, assurance or undertaking (express or implied) is or will be made, and no responsibility or liability is or will be accepted by BSI in relation to the adequacy, accuracy, completeness or reasonableness of this publication. All and any such responsibility and liability is expressly disclaimed to the full extent permitted by the law.

This publication is provided as is, and is to be used at the recipient's own risk.

The recipient is advised to consider seeking professional guidance with respect to its use of this publication.

This publication is not intended to constitute a contract. Users are responsible for its correct application.

© The British Standards Institution 2024
Published by BSI Standards Limited 2024

ISBN 978 0 539 17887 6
ICS 17.040.30; 17.040.40

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 October 2024.

Amendments/corrigenda issued since publication

Date	Text affected

English Version

Geometrical product specifications (GPS) - Rotary axis
form-measuring instruments - Design and metrological
characteristics (ISO 5463:2024)

Spécification géométrique des produits (GPS) -
Instruments de mesure de forme à axe rotatif -
Caractéristiques de conception et caractéristiques
métrologiques (ISO 5463:2024)

Geometrische Produktspezifikationen (GPS) -
Formmessgeräte mit Drehachse - Konstruktion und
messtechnische Eigenschaften (ISO 5463:2024)

This European Standard was approved by CEN on 7 September 2024.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

European foreword

This document (EN ISO 5463:2024) has been prepared by Technical Committee ISO/TC 213 "Dimensional and geometrical product specifications and verification" in collaboration with Technical Committee CEN/TC 290 "Dimensional and geometrical product specification and verification" the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2025, and conflicting national standards shall be withdrawn at the latest by March 2025.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

Any feedback and questions on this document should be directed to the users' national standards body/national committee. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

Endorsement notice

The text of ISO 5463:2024 has been approved by CEN as EN ISO 5463:2024 without any modification.

Contents

Page

Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
3.1 General terms	2
3.2 Terms relating to probe system	3
4 Design characteristics	3
4.1 General	3
4.2 Types of rotary axis form-measuring instruments	4
4.2.1 General	4
4.2.2 Rotating workpiece instrument	4
4.2.3 Stationary workpiece instrument	6
4.3 Design characteristics of probe	8
4.3.1 Contact probe	8
4.3.2 Other types of probe	9
5 Metrological characteristics	9
5.1 General	9
5.2 Rating operating condition	9
5.2.1 Environmental conditions	9
5.2.2 Operating conditions	10
5.3 Correction of form deviations on material measure	10
5.4 Probe characteristics	10
5.4.1 Reference point	10
5.4.2 Probe error	10
6 Determination of conformity to specification	12
6.1 General	12
6.2 Measurement uncertainty	12
6.3 Decision rule	13
Annex A (normative) Design and metrological characteristics for rotating workpiece instruments	14
Annex B (informative) Artefacts for metrological characteristics	38
Annex C (informative) Dynamic response of the probe	42
Annex D (informative) Incidental machine characteristics “Cresting”	45
Annex E (informative) Other types of probes	46
Annex F (informative) Relationship to the GPS matrix model	48
Bibliography	49

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.

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 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).

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 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

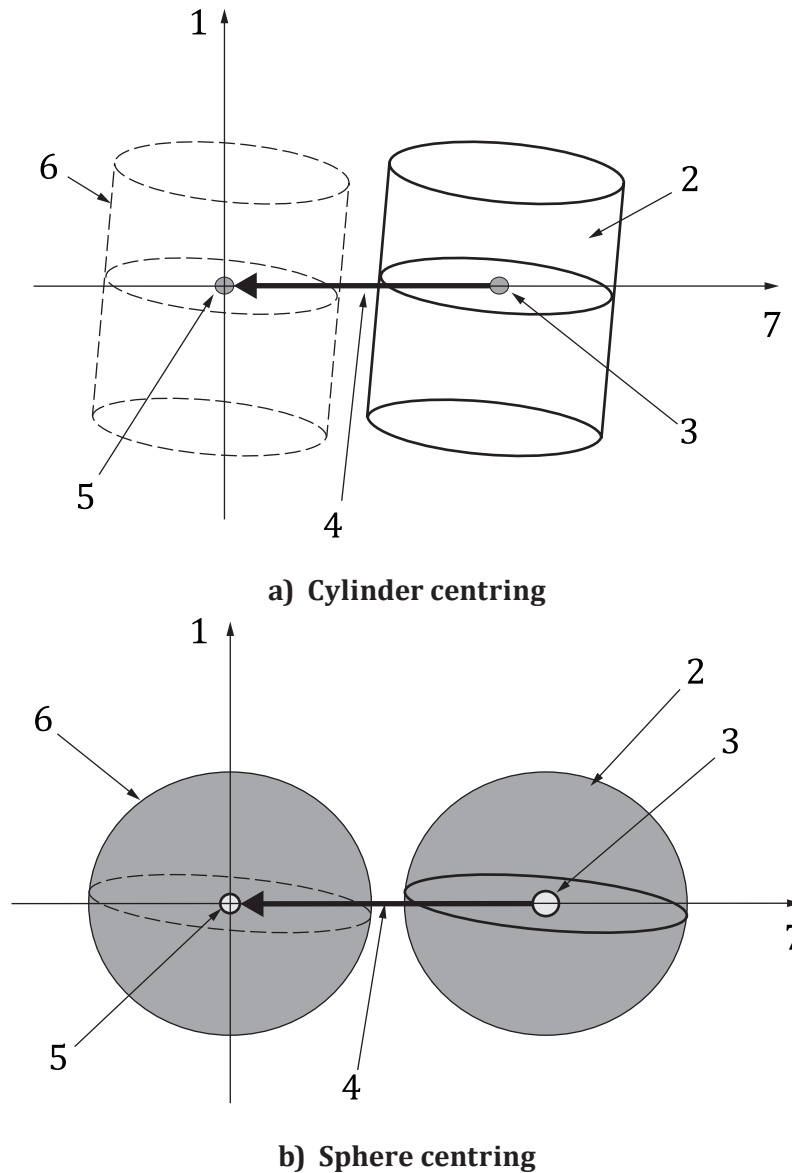
measuring instrument having a rotary axis and quantifying local form deviations from extracted integral surfaces in a cylindrical coordinate system

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](#).



Key

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

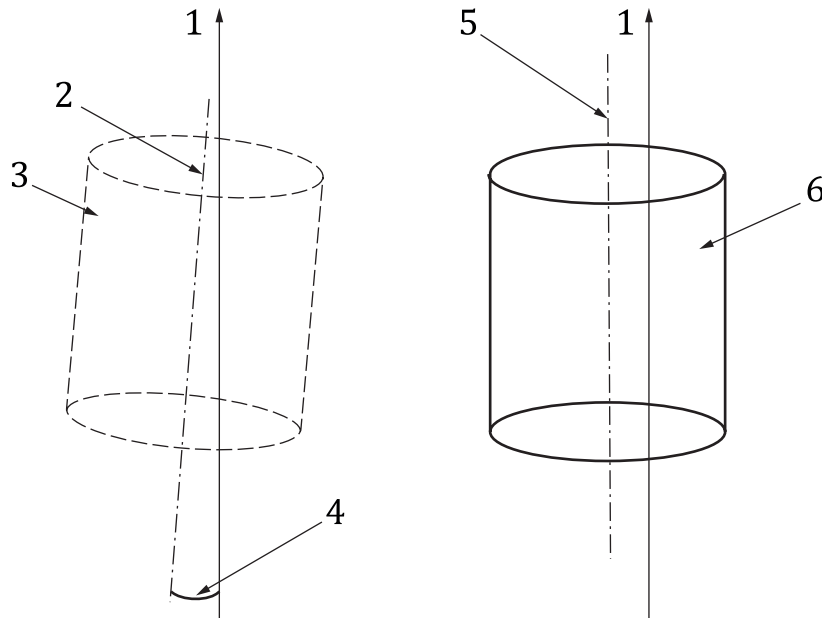
Figure 1 — Centring

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

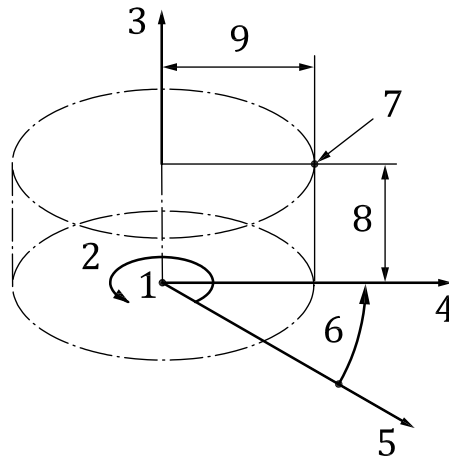
This measuring instrument is primarily constructed to acquire form deviations in cylindrical coordinates through the direct measurement of radial (and axial) deviations. The design characteristics of a rotary axis form-measuring instrument are described generically in [Annex A](#), and depend on its 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 ($\theta=0$) | | |

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.

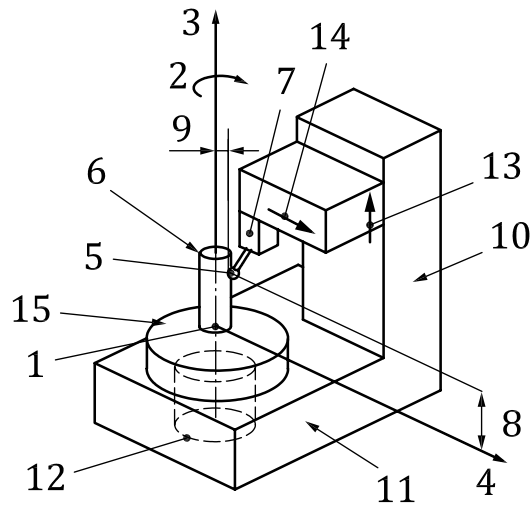
4.2.2 Rotating workpiece instrument

Design characteristics of this type of instrument shall be in accordance with [Annex A](#).

Rotating workpiece instruments include the following variants:

- Vertical axis rotating workpiece instrument on which the workpiece is fixed on a worktable, see [Figure 4](#).
- Horizontal axis rotating workpiece instrument, which is a variant of type a), where the longitudinal axis lies in a horizontal plane, see [Figure 5](#).
- 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.

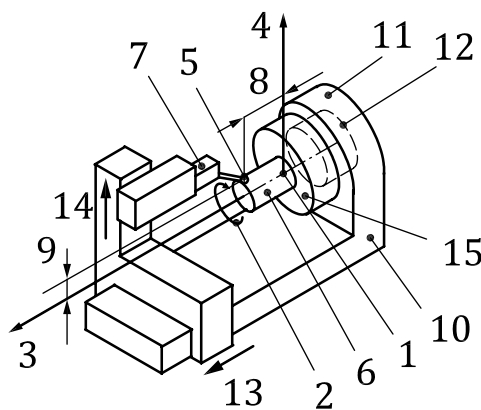
- d) Horizontal axis rotating workpiece between centres, which is a variant of type b), where the workpiece is rotated between centres instead of on a worktable.



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 |

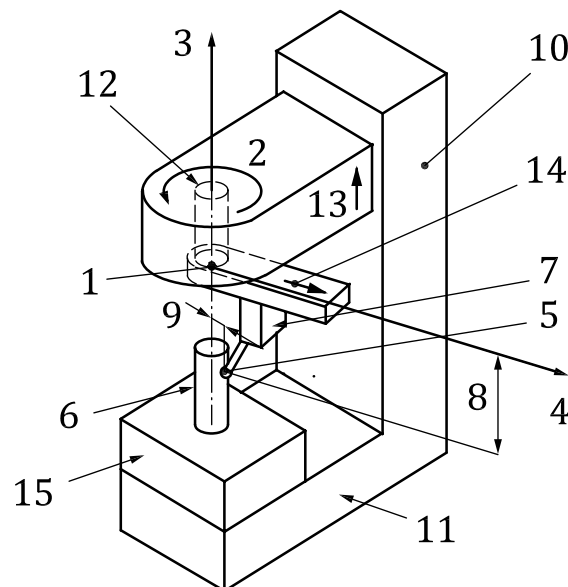
- | | | | |
|---|---|----|------------------------------------|
| 6 | workpiece | 14 | transverse motion |
| 7 | probe | 15 | fixture for workpiece on worktable |
| 8 | probing point height H from worktable top plane | | |

Figure 5 — Horizontal axis rotating workpiece instrument

4.2.3 Stationary workpiece instrument

The stationary workpiece type instruments include the following variants:

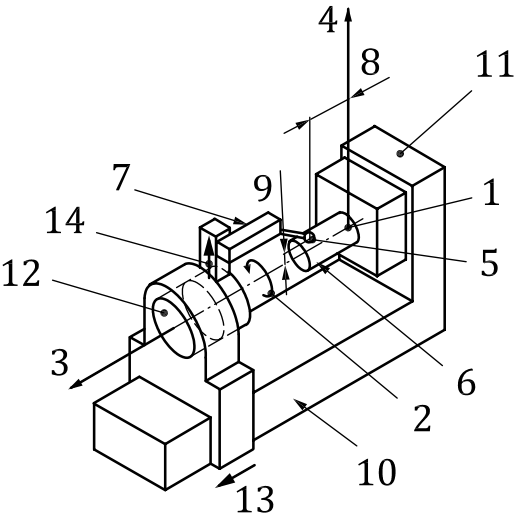
- Vertical axis stationary workpiece instrument on which the stylus turns around the workpiece, which is fixed on a worktable, see [Figure 6](#).
- Horizontal axis stationary workpiece instrument, which is a variant of type a) in which the longitudinal axis lies in a horizontal plane, see [Figure 7](#).
- 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.
- 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 | 9 | probing point distance 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 origin at the transverse axis | | |

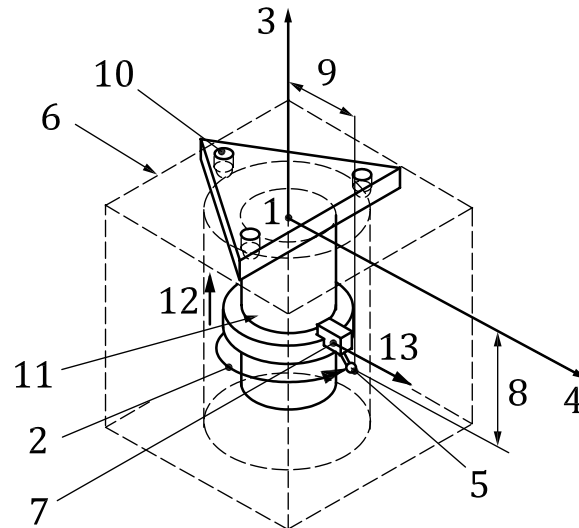
Figure 6 — Vertical axis stationary workpiece instrument



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	11	rotary spindle
5	probing point	12	longitudinal motion
6	workpiece	13	axis of the lever type probe
7	probe		

Figure 8 — Hole insertion with stationary workpiece instrument

4.3 Design characteristics of probe

4.3.1 Contact probe

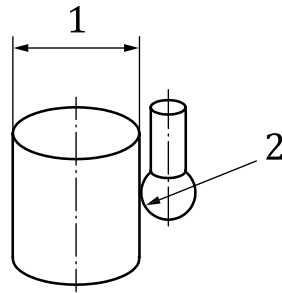
A contact probe consists of a fixed part (“main body including transducer”) (see ISO/IEC Guide 99:2007, 3.7) and a movable part (“stylus”) which is also called the “measuring element”.

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](#)).

**Key**

1 diameter of cylindrical workpiece

2 tip radius of sphere stylus in any direction

Figure 9 — Sphere stylus tip geometry**4.3.2 Other types of probe**

There are many different types of probe, which may have limitations on the types of materials that can be measured. For rotary axis form-measuring instruments equipped with other probes, the manufacturer can state each of the specifications (see [Annex E](#)).

5 Metrological characteristics**5.1 General**

The metrological characteristics, other concepts and principles that are common across types and variants are described below. Because the verification of the metrological characteristics may vary dependent on instrument type and variant, testing and verification are described in [Annex A](#) relating to the instrument type and variant. The testing and verification shall be carried out as specified in [Annex A](#). The material measures for these tests are described in [Annex B](#).

A rotary axis form-measuring instrument can be used to measure many types of geometrical features. The instrument may, therefore, have many different metrological characteristics. The supplier of a rotary axis form-measuring instrument shall specify the maximum permissible error (MPE) of each metrological characteristic. These MPEs apply when the instrument is used in accordance with the rated operating conditions stated by manufacturer or supplier and the manufacturer's recommendations.

NOTE The manufacturer or supplier does not need to specify MPE values for metrological characteristics that are not included in the instrument functions or in the required measurements on the target workpiece.

The probe error is presented in [5.4](#), separately from [Annex A](#), due to its potential contributor to all other metrological characteristics of a rotary axis form-measuring instrument.

The length unit of metrological characteristics is micrometres, by default.

5.2 Rating operating condition**5.2.1 Environmental conditions**

Limits for permissible environmental conditions that influence the measurements (e.g. temperature conditions, humidity, vibration and ambient lighting at the site of installation) shall be specified by:

- the manufacturer, in the case of acceptance tests;
- the user, in the case of reverification tests.

In both cases, the user is free to choose the environmental conditions within the specified limits given in the instrument data sheet under which testing to this document will be performed.

The user is responsible for providing the environmental conditions as stated by the manufacturer in the data sheet. If the environment is not within the rated operating conditions, then conformity or nonconformity decision cannot be made unless the rated operating condition are met.

5.2.2 Operating conditions

The instrument shall be operated using the procedures given in the manufacturer's operating manual when conducting the tests given in [Annex A](#).

5.3 Correction of form deviations on material measure

As discussed in [Annex B](#), many of the measurement standards needed for verifying conformity to specification should have small form deviations. The form deviations contribute to the measurement uncertainty of the test values. To reduce the contribution of the form deviations on the material measure to the test uncertainty, this document allows correction of the form deviations.

NOTE The following methods are typically used for correction of the form deviation of the measurement standards:

- a) compensation of the calibrated profile method;
- b) reversal error separation method (see ISO 230-7 and references [21],[22],[25] and [27]);
- c) multi-step error separation method; (see references [23],[24],[25],[27],[28] and [32]).

5.4 Probe characteristics

5.4.1 Reference point

Where applicable, the probe used for form measurements shall be provided with user-accessible means for setting the probe to zero or to the reference point. The metrological characteristics described in this document apply when the probe is properly set in accordance with the manufacturer's recommendations, and the reference point is considered fixed when verifying the metrological characteristics.

5.4.2 Probe error

5.4.2.1 General

The probe error (E_p) is the error of indication when the probe is in contact with a material measure, for any angular motion of the material measure or of the stylus depending on the type of the rotary axis form-measuring instrument. The probe error is calculated as the signed deviation of the probe indication from the calibrated reference value of a material measure.

The MPE of probe error shall be specified in at least one measuring range stated by the manufacturer or supplier.

NOTE 1 The probe error can include the sensitivity error, the linearity error, the instrumental drift, the resolution or digital step, the repeatability, the measurement noise, the hysteresis error and the dynamic response (see [Annex C](#)).

NOTE 2 The probe error is a contributor to all metrological characteristics of the instrument.

The sensitivity shall be adjusted following the manufacturer's recommendations prior to the probe error test.

5.4.2.2 Test method

5.4.2.2.1 Test points and range

The verification test of probe errors shall be carried out with five or more test points. The test points shall be well distributed, as evenly as practicable, throughout the measuring range of the probe (see [Figure 10](#)). The test points shall cover at least the central 75 % of the measuring range of the probe.