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Geometrical product specifications (GPS) — General concepts and requirements for GPS measuring equipment

Spécification géométrique des produits (GPS) — Concepts et exigences généraux pour les équipements de mesure GPS

Reference number
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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).

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 213, *Dimensional and geometrical product specifications and verification*.

This second edition cancels and replaces the first edition (ISO 14978:2006), which has been technically revised. It also incorporates the Technical Corrigendum ISO 14978:2006/Cor. 1:2008.

The main changes compared to the previous edition are as follows:

— the terms and definitions have been updated relative to ISO/IEC Guide 99:2007;

— a number of design characteristics common in GPS measuring equipment have been added;

— an updated discussion of calibration and verification, including concepts from ISO 14253-5:2015, 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.

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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 chain links F and G for measuring equipment and calibration in the general GPS matrix model (see Annex E).

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 of the relation of this document to other standards and the GPS matrix model, see Annex E.

This document contains guidance for writing the standards for specific GPS measuring equipment.

This document is intended to give the user a basic understanding of the use of ISO standards for GPS measuring equipment. This document presents and defines general concepts to be used in connection with GPS measuring equipment to avoid multiple repetitions in the ISO standards for specific GPS measuring equipment. This document is also intended as guidance for the manufacturer/supplier to evaluate and present specifications for characteristics for GPS measuring equipment.

This document is necessary when reading and using ISO standards for specific GPS measuring equipment.

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Geometrical product specifications (GPS) — General concepts and requirements for GPS measuring equipment

1 Scope

This document specifies the general requirements, calibration, terms and definitions of characteristics of GPS measuring equipment, for example micrometers, callipers, gauge blocks and rotary axis form measuring instruments. This document forms the basis for standards defining and describing the design characteristics and metrological characteristics for measuring equipment and gives guidance for the development and content of standards for GPS measuring equipment.

This document is intended to ease the communication between manufacturer/supplier and customer/user and to make the specification phase of GPS measuring equipment more accurate. This document is also intended as a tool to be used in companies in the process of defining and selecting relevant characteristics for measuring equipment.

This document includes terms which are frequently used in connection with the characterization of specific measuring equipment.

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 14253-5:2015, *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/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

ISO/IEC Guide 98-4:2012, *Uncertainty of measurement — Part 4: Role of measurement uncertainty in conformity assessment*

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/IEC Guide 99:2007, ISO/IEC Guide 98-4:2012, ISO 14253-1, ISO 14253-5:2015, ISO/TR 14253-6 and the following apply.

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

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

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

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3.1 ISO/IEC Guide 99:2007 terms

For the terms shown in Table 1, the definitions from ISO/IEC Guide 99:2007 specifically apply in the use of this document. This non-exhaustive list is included to avoid ambiguity with other possible terms and definitions.

Table 1 — ISO/IEC Guide 99:2007 terms applicable in the use of this document

Term	Terminological entry number
calibration	2.39
indicating measuring instrument	3.3
indication	4.1
material measure	3.6
maximum permissible measurement error maximum permissible error limit of error	4.26
measurand	2.3
measured quantity value measured value	2.10
measurement method	2.5
measurement repeatability repeatability	2.21
measurement result result of measurement	2.9
measurement standard	5.1
measurement uncertainty uncertainty of measurement uncertainty	2.26
measuring instrument	3.1
measuring system	3.2
quantity value value	1.19
rated operating condition	4.9
reference material	5.13
reference measurement standard reference standard	5.6
reference quantity value reference value	5.18
resolution	4.14
uncertainty budget	2.33
verification	2.44

3.2 Synonym terms to ISO/IEC Guide 99:2007 terms

The terms shown in Table 2, as used in this document, are synonyms for the ISO/IEC Guide 99:2007 terms as shown in the table. These synonym terms are used for consistency with previous versions of this document.

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Table 2 — Synonym terms to ISO/IEC Guide 99:2007 terms

Synonym term used in this document	Notes	ISO/IEC Guide 99:2007	
measuring range	See Figure 5	**measuring interval**	4.7
nominal range	See Figure 5	**nominal indication interval**	4.4
nominal span	See Figure 5	**range of a nominal indication interval**	4.5
error of indication indication error		**measurement error** error	2.16

3.3 ISO/IEC Guide 98-4:2012 terms

For the terms shown in Table 3, the definitions from ISO/IEC Guide 98-4:2012 specifically apply in the use of this document. This non-exhaustive list is included to avoid ambiguity with other possible terms and definitions.

Table 3 — ISO/IEC Guide 98-4:2012 terms applicable in the use of this document

Term	Terminological entry number
decision rule	3.3.12
specified requirement	3.3.3
tolerance limit specification limit	3.3.4

3.4 ISO 14253-5:2015 terms

For the terms shown in Table 4, the definitions from ISO 14253-5:2015 specifically apply in the use of this document. This non-exhaustive list is included to avoid ambiguity with other possible terms and definitions.

Table 4 — ISO 14253-5:2015 terms applicable in the use of this document

Term	Terminological entry number
test measurand	3.4
test protocol	3.5
test value	3.8
test value uncertainty test uncertainty	3.9

3.5 Terms related to GPS measuring equipment

3.5.1
measuring equipment

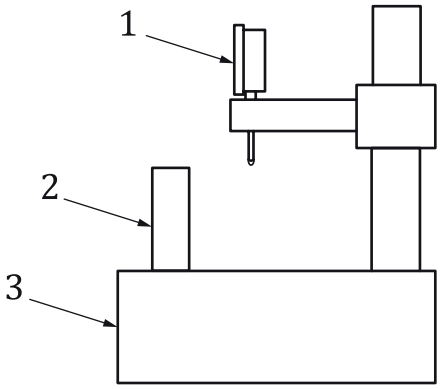
indicating measuring instrument, material measure, software, measurement standard, reference material or auxiliary equipment used in a measurement

Note 1 to entry: This definition is necessarily wider than that of a measuring instrument since it includes all the devices used in a measurement.

Note 2 to entry: Measuring equipment should not be confused with a measuring system, which is a set of measuring equipment used together for a specific measurement.

Note 3 to entry: See Figure 1.

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Key

1 indicating measuring instrument (dial gauge)
2 material measure (gauge block)
3 auxiliary equipment (measuring stand)

Figure 1 — A measuring system composed of various pieces of measuring equipment

3.5.2
metrological characteristic
<measuring equipment> characteristic of measuring equipment, which may influence the results of measurement when using the measuring equipment

Note 1 to entry: The influence on the results of measurement is a contributor to measurement uncertainty (see Clause 6).

Note 2 to entry: The values of a metrological characteristic are expressed in numerical values or as a function and can be evaluated in units other than that of the measurement results.

Note 3 to entry: Measuring equipment usually has several metrological characteristics.

Note 4 to entry: Metrological characteristics can be subject to calibration and verification.

3.5.3
task-related calibration
<measuring equipment> calibration of only those metrological characteristics which influence the measurement uncertainty for the intended use

3.5.4
design characteristic
<measuring equipment> characteristic of measuring equipment which does not influence the measurement directly, but which may be of interest for other reasons when the measuring equipment is used

Note 1 to entry: Design characteristics can influence, for example, interchangeability, scale mark readability for a straight or circular scale, or wear resistance (see Clause 5).

Note 2 to entry: Some design characteristics can influence the equipment's long-term capacity to make measurements (influencing design characteristics), for example its wear resistance or its environmental resistance. Other design characteristics have no influence on measurements (non-influencing design characteristics).

Note 3 to entry: A design characteristic might be expressed as, for example, dimensions, material properties or interface protocols.

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3.5.5
maximum permissible limit
MPL
tolerance limit for a metrological characteristic which is not an error of indication

Note 1 to entry: MPE, not MPL, should be used for metrological characteristics associated with errors of indication.

EXAMPLE 1 MPL for the measuring force for micrometers for external measurements.

EXAMPLE 2 MPL for the size of the gauge element of a plain limit gauge of linear size.

3.5.6
verification test
test
operation that, under specified conditions and with sufficient objective evidence, establishes that measuring equipment conforms or does not conform to stated specifications

Note 1 to entry: A verification test can be used as the calibration when both the first and second step in the definition of calibration are appropriately satisfied (see 6.1.4).

Note 2 to entry: This definition is consistent with the definition of a test in ISO 14253-5:2015, but is broader in scope as the concept of a test in ISO 14253-5:2015 is limited to indicating measuring instruments.

Note 3 to entry: The detailed specification of a verification test is defined in a test protocol.

Note 4 to entry: The specified conditions of a verification test are defined by relevant standards and by the stated rated operating conditions of the measuring equipment.

3.5.7
acceptance test
verification test (3.5.6) agreed upon by the measuring equipment manufacturer/supplier and the customer to verify that the performance of the measuring equipment is as stated by the manufacturer/supplier

Note 1 to entry: Acceptance tests are commonly used by the customer in the purchase of measuring equipment.

3.5.8
reverification test
verification test (3.5.6) to verify that the performance of the measuring equipment is as stated by the user

Note 1 to entry: The specifications chosen might or might not be the same as those used in the original acceptance test for the measuring equipment.

Note 2 to entry: Reverification tests are not used in the purchase of measuring equipment.

3.5.9
test point
specific point within the measuring range used in a verification test

Note 1 to entry: Test points are usually defined relative to a reference point.

3.5.10
reference point
setting point
point within the measuring range of measuring equipment where the error of indication is stated or adjusted to be zero whenever permitted by the design of the measuring equipment

Note 1 to entry: Depending on the measuring equipment, the reference point might or might not be considered fixed (established in a permanent manner) for the intended use of the equipment.

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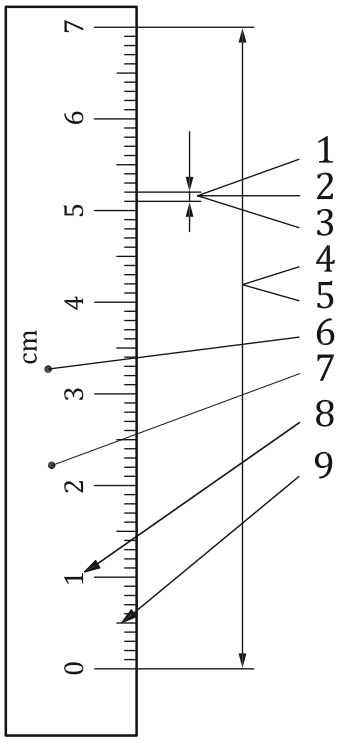
3.5.11
hysteresis
property of measuring equipment, or a metrological characteristic, whereby the indication of the equipment or value of the metrological characteristic depends on the orientation of the preceding stimulus

3.5.12
digital step
smallest possible change in the least significant digit in a digital indicating device

Note 1 to entry: For a digital indicating device, the resolution is equal to the digital step.

3.5.13
scale division
space on a scale between any two successive scale marks

Note 1 to entry: See Figures 2 and 3.



Key
1 scale division
2 scale interval: in this example, 0,1 cm
3 scale spacing: in this example, 0,1 cm
4 scale length: in this example, 7 cm
5 scale range: in this example, 0 to 7 cm; scale span: in this example, 7 cm
6 units marked on the scale (in this example, cm)
7 scale face
8 scale numbering: in this example 0, 1,...,7
9 scale mark

Figure 2 — Terms related to an analogue straight scale

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3.5.14
scale interval
absolute value of the difference between the values corresponding to two successive scale marks, in the units marked on the scale

Note 1 to entry: Scale interval should not be confused with resolution, which is not necessarily equal to the scale interval.

Note 2 to entry: See Figures 2 and 3.

3.5.15
scale spacing
<analogue straight scale> distance between two successive scale marks

Note 1 to entry: See Figure 2.

3.5.16
scale spacing
<analogue circular scale> arc length between two successive scale marks of the circle passing through the centres of all the shortest scale marks

Note 1 to entry: See Figure 3.

3.5.17
scale length
<analogue straight scale> length between the first and the last scale marks

Note 1 to entry: See Figure 2.

3.5.18
scale length
<analogue circular scale> arc length of the circle passing through the centres of all the shortest scale marks

Note 1 to entry: See Figure 3.

3.5.19
scale range
set of values bounded by the extreme indications

Note 1 to entry: The lower limit of the scale range is not necessarily zero, for example in the case of an internal micrometer whose scale range starts at 5 mm.

Note 2 to entry: See Figures 2 and 3.

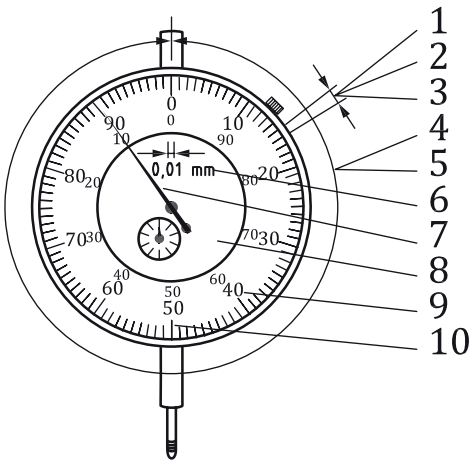
3.5.20
scale span
absolute value of the difference between the two limits of a scale range

Note 1 to entry: See Figures 2 and 3.

3.5.21
index
fixed or movable part of an analogue indicating device whose position with reference to the scale marks enables an indicated value to be determined

Note 1 to entry: For some measuring equipment, the index is called the “pointer”.

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Key

1 scale division
2 scale interval: in this example, 0,01 mm
3 scale spacing: in this example, approximately 1 mm
4 scale length: in this example, approximately 100 mm (for a diameter of 32 mm)
5 scale range: in this example, 0,00 to 1,00 mm; scale span: in this example, 1 mm
6 units marked on the scale (in this example, mm)
7 pointer
8 scale face
9 scale numbering: in this example there are two sets of scale numbering
10 scale mark

Figure 3 — Terms related to an analogue circular scale

3.5.22
scale face
surface of measuring equipment that carries the scale

Note 1 to entry: See Figures 2 and 3.

3.5.23
scale numbering
ordered set of numbers associated with the scale marks

Note 1 to entry: See Figures 2 and 3.

3.5.24
scale mark
lines on the scale face

Note 1 to entry: See Figures 2 and 3.

3.5.25
probe
device that generates a signal which is used in the determination of a measured value

Note 1 to entry: For some measuring equipment, the probe is called the “sensor” or “detector”.

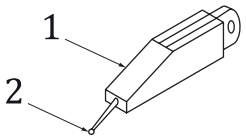
Note 2 to entry: See Figure 4.

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3.5.26
measuring element
element of measuring equipment that interacts with a measured item during a measurement

Note 1 to entry: For some measuring equipment, the measuring element is called the "measuring face", the "stylus tip" or the "contact element".

Note 2 to entry: See Figure 4.



Key

1 probe

2 measuring element (stylus tip)

Figure 4 — Terms related to a probe

3.5.27
measuring span
absolute value of the difference between the extreme quantity values of a measuring range

Note 1 to entry: See Figure 5.

3.5.28
pre-range
range of indications obtainable with a particular setting of measuring equipment from the lowest possible indication to the lower limit of the measuring range

Note 1 to entry: See Figure 5.

3.5.29
pre-span
absolute value of the difference between the two limits of a pre-range

Note 1 to entry: See Figure 5.

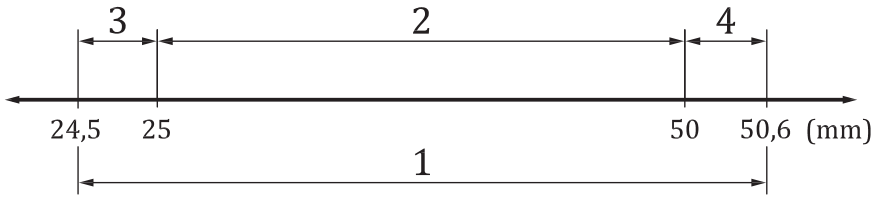
3.5.30
post-range
range of indications obtainable with a particular setting of measuring equipment from the upper limit of the measuring range to the highest possible indication

Note 1 to entry: See Figure 5.

3.5.31
post-span
absolute value of the difference between the two limits of a post-range

Note 1 to entry: See Figure 5.

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Key

1	nominal range:	24,5 mm to 50,6 mm
	nominal span:	26,1 mm (50,6 mm – 24,5 mm = 26,1 mm)
2	measuring range:	25 mm to 50 mm
	measuring span:	25 mm (50 mm – 25 mm = 25 mm)
3	pre-range:	24,5 mm to 25 mm
	pre-span:	0,5 mm (25 mm – 24,5 mm = 0,5 mm)
4	post-range:	50 mm to 50,6 mm
	post-span:	0,6 mm (50,6 mm – 50 mm = 0,6 mm)

NOTE An external micrometer with a measuring range of 25 mm – 50 mm has been used as an example.

Figure 5 — Range and span terms

4 Abbreviations

For the purposes of this document, the abbreviations in Table 5 apply.

Table 5 — Abbreviations

Abbreviation	Term	Reference
MPE	**maximum permissible measurement error** maximum permissible error limit of error	ISO/IEC Guide 99:2007, 4.26
MPL	**maximum permissible limit**	3.5.5

5 Design characteristics

5.1 General

5.1.1 Importance of design characteristics

Design characteristics for measuring equipment can be of interest even if they do not have an influence on the uncertainty of measurement, for example for the sake of interchangeability. Important design characteristics may be subject to specification by the manufacturer/supplier and/or the user/customer of the measuring equipment. The kinds of important design characteristics are dependent on the type, design and intended use of the measuring equipment.

Some design characteristics may have an influence on the equipment's long-term ability to measure, for example wear may influence some of the metrological characteristics.

Design characteristics common to a variety of measuring equipment are as specified in Annex C.

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