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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

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 14978 was prepared by Technical Committee ISO/TC 213, *Dimensional and geometrical product specifications and verification*.

Introduction

This International Standard is a geometrical product specification (GPS) standard and is to be regarded as a global GPS standard (see ISO/TR 14638). It influences chain links 5 and 6 of all chains of standards in the general GPS matrix.

For more detailed information of the relation of this International Standard to other standards and the GPS matrix model, see Annex C.

This International Standard contains guidance for writing the standards for specific measuring equipment.

This International Standard is intended to give the user a basic understanding of the use of ISO standards for GPS measuring equipment. This International Standard 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 International Standard is also intended as guidance for the manufacturer to evaluate and present specifications for characteristics for GPS measurement equipment.

This International Standard should be close at hand when reading and using ISO standards for a specific GPS measuring equipment.

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

1 Scope

This International Standard specifies the general requirements, terms and definitions of characteristics of simple GPS measuring equipment, e.g. micrometers, dial gauges, callipers, surface plates, height gauges, gauge blocks, but not necessarily excluding more complicated equipment. It forms the basis for standards defining and describing the design characteristics and metrological characteristics for measuring equipment. It also gives guidance for the development and content of standards for GPS measuring equipment.

This International Standard 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 International Standard is also intended as a tool to be used in companies in the process of defining and selecting relevant characteristics for measuring equipment to be used in the quality assurance of measuring processes, i.e. in calibration and in workpiece measurements.

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

2 Normative references

The following referenced documents are indispensable for the application 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 1:2002, *Geometrical Product Specifications (GPS) — Standard reference temperature for geometrical product specification and verification*

ISO 1101:2004, *Geometrical Product Specifications (GPS — Geometrical tolerancing — Tolerances of form, orientation, location and run-out*

ISO 5459:—[1)], *Geometrical Product Specifications (GPS) — Geometrical tolerancing — Datums and datum systems*

ISO 14253-1:1998, *Geometrical Product Specifications (GPS) — Inspection by measurement of workpieces and measuring equipment — Part 1: Decision rules for proving conformance or non-conformance with specifications*

ISO/TS 14253-2:1999, *Geometrical Product Specifications (GPS) — Inspection by measurement of workpieces and measuring equipment — Part 2: Guide to the estimation of uncertainty in GPS measurement, in calibration of measuring equipment and product verification*

ISO/TS 17450-2, *Geometrical product specifications (GPS) — General concepts — Part 2: Basic tenets, specifications, operators and uncertainties*

International vocabulary of basic and general terms in metrology (VIM), BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, 1987

1) To be published. (Revision of ISO 5459:1981.)

International vocabulary of basic and general terms in metrology (VIM), BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, 1993

Guide to the expression of uncertainty in measurement (GUM), BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML, 1993[2)]

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14253-1, ISO/TS 14253-2, ISO/TS 17450-2, VIM and GUM and the following apply.

3.1
measuring equipment
ME
any instrument, measurement standard, reference material and/or auxiliary apparatus or any combination thereof necessary to implement a measurement process for carrying out a specified and defined measurement

NOTE 1 This definition is necessarily wider than that of a measuring instrument [VIM:1993, 4.1] since it includes all the means necessary for producing a measurement result.

NOTE 2 The concept measuring equipment includes, for example, **indicating measuring instruments** (3.2) and **material measures** (3.3).

3.2
indicating measuring instrument
measuring equipment that displays an indication

NOTE 1 The display can be analog (continuous or discontinuous) or digital.

NOTE 2 Values of more than one quantity can be displayed simultaneously.

NOTE 3 A displaying measuring instrument can also provide a record.

[VIM:1993, 4.6]

EXAMPLES

a) Analog mechanical dial gauge,

b) digital calliper,

c) micrometer.

NOTE 4 The examples given in VIM are changed here to examples in length units.

3.3
material measure
device intended to reproduce or supply, in a permanent manner during its use, one or more known values of a given quantity

NOTE 1 The quantity concerned can be called the supplied quantity.

[VIM:1993, 4.2]

2) Corrected and reprinted in 1995.

EXAMPLES

a) Gauge block,

b) ball plate,

c) angle block,

d) limit gauge (e.g. gap gauge),

e) functional gauge,

f) surface texture standard,

g) reference ring,

h) tape measure.

NOTE 2 Material measure is included in the concept measuring equipment.

NOTE 3 The examples given in VIM are changed here to examples in length units.

3.4
mono-characteristic measuring equipment
measuring equipment which can be characterised by a single metrological characteristic

NOTE 1 Mono-characteristic measuring equipment is a simplifying theoretical concept which is described in this standard as a contrast to the case of actual multi-characteristic measuring equipment.

NOTE 2 For simplification, especially when evaluating uncertainty contributions, **multi-characteristic measuring equipment** (3.5) can be considered as a "black box" and therefore can be assumed to be a mono-characteristic measuring equipment.

3.5
multi-characteristic measuring equipment
measuring equipment which is characterised by two or more metrological characteristics

NOTE All GPS measuring equipment is multi-characteristic (see 3.4 NOTE 2).

3.6
measurement process
set of interrelated resources, activities and influences which produce a measurement

NOTE 1 This term is commonly used for the calibration of measuring equipment and the measurement of workpieces.

NOTE 2 Resources can be human or material.

3.7
intended use
⟨measuring equipment⟩ measurement process in which specific measuring equipment is to be used

NOTE 1 Knowledge about intended use usually reduces the number of metrological requirements to be calibrated.

NOTE 2 Knowledge about intended use of the maximum permissible errors (MPE, see 3.21) for the metrological requirements that need to be calibrated usually allows adjustment to more economical and less restrictive values.

3.8
calibration
⟨measuring equipment⟩ set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards

NOTE 1 The result of a calibration permits either the assignment of values of measurands to the indications, or the determination of corrections with respect to indications.

NOTE 2 A calibration can also determine other metrological properties, such as the effect of influence quantities.

NOTE 3 The result of a calibration can be recorded in a document, sometimes called a calibration certificate or a calibration report.

[VIM:1993, 6.11]

NOTE 4 The VIM definition of calibration only applies to mono-metrological characteristic measuring equipment and therefore usually does not apply to GPS measuring equipment (see 3.4 and 3.5).

3.9
calibration of a metrological characteristic
set of operations that establish, under specified conditions, the relationship between values of quantities of a metrological characteristic, and the corresponding values realized by standards

NOTE Metrological characteristics can be defined and calibrated as quantities that need mathematical or geometrical transformations to be compatible with the measurement result of the measuring equipment, e.g. flatness and parallelism of the measuring faces of an external micrometer.

3.10
global calibration
⟨measuring equipment⟩ calibration of all metrological characteristics for measuring equipment

NOTE 1 Global calibration can be used if the intended use of the equipment is not known at the time of calibration, or as an acceptance test to verify the agreed specifications in connection with the delivery of new measuring equipment.

NOTE 2 In cases of daily operation of the metrology system in a company, global calibration is usually not needed (see 3.11).

3.11
task-related calibration
⟨measuring equipment⟩ calibration of only those metrological characteristics which influence the measurement uncertainty for the intended use

NOTE 1 Usually a task-related calibration will include the calibration of only those metrological characteristics that have a major influence on the measurement uncertainty for the intended use.

NOTE 2 Task-related calibrations can be performed using other, more economical procedures than those used in global calibration; and a task-related calibration can be designed to deliver information (values and conditions) optimised for use in the specific uncertainty budget.

NOTE 3 This definition of task-related calibration is intentionally formulated differently from that in ISO 12179, but the meaning is the same. The difference in the text indicates a development in the GPS field.

3.12
metrological characteristic
MC
⟨measuring equipment⟩ characteristic of measuring equipment, which may influence the results of measurement

NOTE 1 The influence on the results of measurement is an immediate (short-term) uncertainty contribution (see Clause 6).

NOTE 2 A metrological characteristic is expressed in numerical values and can be evaluated in a unit other than that of the measurement result of the actual measuring equipment.

NOTE 3 Measuring equipment usually has several metrological characteristics.

NOTE 4 Metrological characteristics can be subject to calibration (see 3.10 and 3.11).

3.13
design characteristic
DC
⟨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 Design characteristics can influence interchangeability, readability of line scales and digital read-outs, wear resistance, etc. (see Clause 5).

NOTE 2 Some design characteristics can influence the equipment's long-term capacity to make measurements (influencing design characteristics), e.g. its wear resistance, its environmental resistance, etc. Other design characteristics have no influence the measurements (non-influencing design characteristics).

3.14
metrological requirement
MR
⟨measuring equipment⟩ requirement for a metrological characteristic

NOTE 1 Metrological requirements can be derived from specified requirements for a product/feature to be measured, or can be decided on a general basis.

NOTE 2 A metrological requirement can be presented as a maximum permissible error (MPE, see 3.21) or as permissible limits (MPL, see 3.20).

NOTE 3 Measuring equipment usually has several metrological requirements, one for each metrological characteristic.

3.15
design requirement
DR
⟨measuring equipment⟩ requirement for a design characteristic

NOTE 1 Design requirements can be derived from the intended use of the measuring equipment or decided on a general basis, and can be given in a standard.

NOTE 2 A design requirement can be given in the form of dimensions, material requirements, interface protocols, etc. (see Clause 5).

3.16
error (of indication)
⟨measuring equipment⟩ indication of measuring equipment minus a true value of the corresponding input quantity

NOTE 1 Since a true value cannot be determined, in practice a conventional true value is used (see VIM:1993, 1.19 and 1.20).

NOTE 2 This concept applies mainly where the instrument is compared to a reference standard.

NOTE 3 For a material measure, the indication is the value assigned to it.

[VIM:1993, 5.20]

NOTE 4 The VIM term and definition generally do not apply to set-up specifications for GPS measuring equipment and certainly not to the concept of a metrological characteristic in multi-characteristic measuring equipment. Term 3.18 is used instead.

3.17
value of the actual metrological characteristic
value found by calibration and characterising the metrological characteristic

3.18
error (deviation value) of a metrological characteristic
error value characterising the actual metrological characteristic (actual value minus ideal value of the characteristic)

NOTE 1 An error of a metrological characteristic can be evaluated in a unit other than that of the measurement result of the actual measuring equipment.

NOTE 2 This term is used for multi-characteristic measuring equipment (see 3.16, NOTE 4).

3.19
maximum permissible errors
⟨measuring equipment⟩ extreme values of an error permitted by specifications, regulations, etc. for a given piece of measuring equipment

See 7.5 and Figures 9 to 12.

NOTE 1 This definition is a parallel to VIM:1993, 5.21 for measuring instruments.

NOTE 2 This term is only applicable to mono-metrological characteristic measuring equipment.

NOTE 3 This term and definition generally do not apply to specifications for GPS measuring equipment and certainly not to the concept of a metrological characteristic in multi-characteristic measuring equipment. Term 3.20 or 3.21 is used instead.

3.20
permissible limits of a metrological characteristic
MPL
extreme values of a metrological characteristic permitted by specifications, regulations, etc. for a given piece of measuring equipment

See 7.5.5 and Figure 12.

NOTE MPL can be a value or set of values or a function (MPL-function).

3.21
maximum permissible errors for a metrological characteristic
MPE
extreme values of an error of a metrological characteristic permitted by specifications, regulations, etc. for a given piece of measuring equipment

See 7.5 and Figures 9 to 12.

NOTE 1 This definition is a parallel to VIM:1993, 5.21 for measuring instruments (see 3.19).

NOTE 2 MPE can be a value or set of values or a function (MPE-function).

3.22
repeatability
⟨measuring instrument⟩ ability of a measuring instrument to provide very similar indications for repeated applications of the same measurand under the same conditions of measurement

NOTE 1 These conditions include:

— reduction to a minimum of the variations due to the observer,

— the same measurement procedure,

— the same observer,

— the same measuring equipment, used under the same conditions,

— the same location,

— repetition over a short period of time.

NOTE 2 Repeatability can be expressed quantitatively in terms of the dispersion characteristics of the indications.

[VIM:1993, 5.27]

NOTE 3 This term and definition generally do not apply to specifications for GPS measuring equipment and certainly not to the concept of a metrological characteristic in a multi-characteristic measuring equipment. Term 3.23 is used instead.

3.23
repeatability of a metrological characteristic
ability of measuring equipment to provide very similar values for repeated measurements of a particular metrological characteristic under the same conditions

NOTE 1 This definition is parallel to 3.22 for the total measurement equipment.

NOTE 2 Repeatability can be expressed quantitatively in terms of the dispersion characteristics of the indications.

3.24
hysteresis
property of measuring equipment, or a characteristic whereby the indication of the equipment or value of the characteristic depends on the orientation of the preceding stimuli

NOTE Hysteresis can also depend, for example, on the distance travelled after the orientation of stimuli has changed.

3.25
discrimination (threshold)
largest change in a stimulus that produces no detectable change in the response of a measuring instrument, the change in the stimulus taking place slowly and monotonically

NOTE The discrimination threshold can depend, for example, on noise (internal or external) or friction. It can also depend on the value of the stimulus.

[VIM:1993, 5.11]

3.26
resolution (of a displaying device)
smallest difference between indications of a displaying device that can be distinguished meaningfully

NOTE 1 This concept also applies to a recording device.

[VIM:1993, 5.12]

NOTE 2 See 6.3.2.3.

NOTE 3 For a digital displaying device, the resolution is equal to the digital step.

3.27
digital step
in a digital displaying device, the smallest possible change in the least significant digit

3.28
analogue scale
See Figures 1 and 2.

NOTE For detailed definitions of 3.28.1 to 3.28.10, see VIM:1993, 4.16, 4.18, 4.19, 4.20, 4.21, 4.22, 4.28 and VIM:1987, 4.17.