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Geometrical product specifications (GPS) — Inspection by measurement of workpieces and measuring equipment —

Part 5: Uncertainty in verification testing of indicating measuring instruments

Spécification géométrique des produits (GPS) — Vérification par la mesure des pièces et des équipements de mesure —

Partie 5: Incertitude liée aux essais de vérification des appareils de mesure indicateurs

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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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 213, *Dimensional and geometrical product specifications and verifications*.

ISO 14253 consists of the following parts, under the general title *Geometrical product specifications (GPS) — Inspection by measurement of workpieces and measuring equipment*:

— *Part 1: Decision rules for proving conformity or nonconformity with specifications*

— *Part 2: Guide to the estimation of uncertainty in GPS measurement, in calibration of measuring equipment and in product verification*

— *Part 3: Guidelines for achieving agreements on measurement uncertainty statements*

— *Part 4: Background on functional limits and specification limits in decision rules*

— *Part 5: Uncertainty in verification testing of indicating measuring instruments*

— *Part 6: Generalized decision rules for the acceptance and rejection of instruments and workpieces* [Technical Report]

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Introduction

This part of ISO 14253 belongs to the general geometrical product specification (GPS) series of documents (see ISO 14638). It influences chain link F of all chains of standards in the general GPS matrix.

The ISO/GPS matrix model given in ISO 14638 gives an overview of the ISO/GPS system of which this international standard is a part. The fundamental rules of ISO/GPS given in ISO 8015 apply to this part of ISO 14253 and the default decision rules given in ISO 14253-1 apply to specifications made in accordance with this part of ISO 14253, unless otherwise indicated.

For more detailed information about the relationship of this part of ISO 14253 to other standards and to the GPS matrix model, see Annex B.

Decision rules for deciding conformity or non-conformity to specifications are based on the measurement uncertainty incurred while testing.

Usual practice in measurement familiarizes metrologists and practitioners with measurement uncertainty. Any possible effect that may affect the measurement result is considered and quantified as an uncertainty component and is eventually included in the combined uncertainty. The purpose of the measurement is to gather quantitative information on a given measurand, and the uncertainty statement expresses how reliable that information is.

In the case of tests of indicating measuring instruments, the purpose of the measurement is to investigate one or more metrological characteristics of the indicating measuring instrument rather than to measure characteristics of features of a workpiece. The uncertainty being evaluated in this case, the test value uncertainty, quantifies the accuracy of the test value. The test detects the quality of the indicating measuring instrument, reported through the test values and not through the test value uncertainty.

The test value uncertainty for indicating measuring instruments is not conceptually trivial to evaluate, and careful consideration is necessary to determine which uncertainty components should and which should not be accounted for.

Some tests of indicating measuring instruments may be relative to quantities other than instrument indications, or a single test may investigate both the instrument indication(s) and other metrological characteristics. An example is a test of a micrometer investigating the indication error (subject to an MPE) as well as the measuring force (subject to an MPL). For tests, or portions of them, relative to metrological characteristics other than instrument indications, this part of ISO 14253 is not applicable: they are about quantities for which the application of the ISO/IEC Guide 98-3 (GUM) and of the ISO 14253-2 is conceptually straightforward, with no need of further guidance in this part of ISO 14253.

A rigorous definition of the test value uncertainty when testing indicating measuring instruments is given. Application of conventional uncertainty evaluation based on this definition and according to the ISO/IEC Guide 98-3 (GUM) and the ISO 14253-2 determines which uncertainty components to account for.

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Geometrical product specifications (GPS) — Inspection by measurement of workpieces and measuring equipment —

Part 5:
Uncertainty in verification testing of indicating measuring instruments

1 Scope

This part of ISO 14253 specifies concepts and terms for evaluating the uncertainties of the test values derived according to a test protocol agreed upon by the parties and relative to instrument indication(s), obtained in verification testing of GPS indicating measuring instruments.

NOTE The uncertainty of the test values, referred to as test value uncertainty, is not to be confused with the measurement uncertainty associated with using that indicating measuring instrument to measure workpieces. The former only is covered in this part of ISO 14253; for guidance on the latter see the ISO/IEC Guide 98-3 (GUM) and ISO 14253-2.

When a test of an indicating measuring instrument comprises several test values, some relative to the instrument indication and some to other metrological characteristics, this part of ISO 14253 is concerned with the uncertainty of the former only.

This part of ISO 14253 does not provide guidelines to ensure the adequacy of a test protocol; rather, once a test protocol is given, it describes how to evaluate the consequent test value uncertainty.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 10360-1:2000, *Geometrical Product Specifications (GPS) — Acceptance and reverification tests for coordinate measuring machines (CMM) — Part 1: Vocabulary*

ISO 14253-1:2013, *Geometrical product specifications (GPS) — Inspection by measurement of workpieces and measuring equipment — Part 1: Decision rules for proving conformity or nonconformity with specifications*

ISO/TR 14253-6:2012, *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 14978:2006, *Geometrical product specifications (GPS) — General concepts and requirements for GPS measuring equipment*

ISO 17450-2:2012, *Geometrical product specifications (GPS) — General concepts — Part 2: Basic tenets, specifications, operators, uncertainties and ambiguities*

ISO/IEC Guide 98-3:2008, *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)*

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3 Terms and definitions

For the purpose of this document, the terms and definitions given in ISO 10360-1, ISO 14253-1, ISO/TR 14253-6, ISO 14978, ISO 17450-2, ISO/IEC Guide 98-3 (GUM), ISO/IEC Guide 99 (VIM), and the following apply.

3.1
test
<of a GPS indicating measuring instrument> sequence of preparatory, measurement, mathematical and decisional actions according to a test protocol

Note 1 to entry: Not all steps in the sequence are necessarily present in a test protocol.

Note 2 to entry: Tests are often used to verify the specifications of a GPS indicating measuring instrument.

Note 3 to entry: The specification of an indicating measuring instrument may be expressed by one or more MPEs (Maximum Permissible Errors).

Note 4 to entry: Prominent cases of tests are the acceptance test and the reverification test.

Note 5 to entry: This term is sometimes used in a wider sense, encompassing cases when a test produces a binary or categorical result. An example of a binary assessment is determining whether or not a software algorithm converged. For the purpose of this part of ISO 14253, tests are restricted to those based on test values.

Note 6 to entry: See Figure 1.

3.2
test instance
combination of test equipment, set up, measurement sequence, environmental and instrumental conditions of a test, which yields a test value(s)

3.3
permissible test instance
test instance in compliance with the test protocol, and with the alternatives and stipulations therein

Note 1 to entry: An alternative occurs when the test protocol allows options, either discrete among enumerated cases, or continuous in a range of permissible values. An example of the former is the choice of the test equipment, e.g. a gauge block or a step gauge for testing a CMM; an example of the latter is the ambient temperature within the required test conditions.

Note 2 to entry: A stipulation occurs when the test protocol specifies the amount of measurement in a test, e.g. a specific number of repeated measurements.

Note 3 to entry: A test may be subject to alternatives and stipulations at the same time. For instance, test equipment is applied to an indicating measuring instrument in a limited number of configurations (stipulation) chosen at the tester counterpart's discretion (alternative).

Note 4 to entry: Alternatives serve two purposes. (1) To accommodate to actual conditions. For instance, alternative test equipment to accommodate actual availability, or any environmental condition within the required test conditions to accommodate the actual testing environment. (2) To leave details of the test unspecified up to the time of testing, to encourage the indicating measuring instrument manufacturer – in order to avoid non-acceptance of the instrument – to deliver overall compliant indicating measuring instruments. For instance, some procedural details may be left to the *tester counterpart* (3.14) to decide at the time of testing, to force the manufacturer to deliver a compliant indicating measuring instrument for any possible procedural option.

3.4
test measurand
metrological characteristic of an indicating measuring instrument intended to be verified in a test, based on a single permissible test instance, defined by a test protocol

Note 1 to entry: A test protocol may allow for multiple permissible test instances, to adapt to actual circumstances and to limit the experimental effort. The test measurand is defined for each single test instance, and different permissible test instances may give raise to different test measurands.

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