
**Geometrical product specifications
(GPS) — Guidelines for the evaluation
of coordinate measuring machine
(CMM) test uncertainty**

*Spécification géométrique des produits (GPS) — Lignes directrices pour
l'estimation de l'incertitude d'essai des machines à mesurer
tridimensionnelles (MMT)*



PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

This document is a preview generated by EVS

© ISO 2006

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
4 General	2
5 Test probing error	3
6 Test of size	3
6.1 General	3
6.2 Analysis of the uncertainty contributors	4
6.3 Graphical representation of the test results	6
Annex A (normative) Background and more detailed information	8
Annex B (normative) Using an alternative material standard of size	20
Annex C (informative) Examples of uncertainty budgeting	21
Annex D (informative) Relation to the GPS matrix model	30
Bibliography	31

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.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

- an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;
- an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

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/TS 23165 was prepared by Technical Committee ISO/TC 213, *Dimensional and geometrical product specifications and verification*.

Introduction

This Technical Specification belongs to the general Geometrical product specification (GPS) series of documents (see ISO/TR 14638). It influences chain link 5 of the chains of standards on size, distance, radius, angle, form, orientation, location, run-out and datums in the general GPS matrix.

For more detailed information about the relationship of this Technical Specification to other standards and to the GPS matrix model, see Annex D.

ISO 10360-2 deals with the application of the ISO 14253-1 decision rule, which proves conformance or non-conformance of a coordinate measuring machine (CMM) that is accepted or re-verified with its specification. In turn, this decision rule is based on a statement of the measurement uncertainty incurred while testing, and hence requires a full evaluation of the test uncertainty. This uncertainty expresses how accurate the test is, and hence how narrow the safety margins need to be set in order to make a rational decision at a specified confidence level.

Usual practice in CMM measurement familiarizes metrologists and practitioners with measurement uncertainty. Any possible effect which may affect the measurement result is considered and quantified as an uncertainty contributor, and eventually summed up to achieve 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 a performance test of a CMM, the purpose of the measurement is to investigate the CMM's performance rather than the form or size of a material standard, which is calibrated and therefore well-known in advance. The uncertainty being evaluated in this case quantifies how accurate the test is. The test detects the quality of the CMM by comparing the measurement test values with the known calibrated values of the material standards of size (probing error, P , or error of indication, E), and not through the uncertainty statement.

Consequently, only those uncertainty components that pertain to the test itself are included in the test uncertainty budget as contributors. In particular, instrumental errors introduced by the CMM are not included in the budget. In total, they constitute the probing error, P , or the error of indication, E , but do not compromise the test reliability and hence are not contributors to the test uncertainty.

From a different viewpoint, the ISO 14253-1 principle is that it is always the person performing the measurement who is liable for the uncertainty, whether in proving conformance or non-conformance. In other words, the tester is responsible for any imperfection which may occur during the test, and he takes this into account in terms of test uncertainty. A corollary of this is that the tester should only be held accountable for the elements under his responsibility, i.e. only these elements should be included in the test uncertainty budget. As the ISO 10360-2 test is not necessarily performed by the CMM manufacturer, the tester does not have any responsibility for the CMM instrumental errors. For example, a purchaser may want to prove that a CMM with large errors falls outside specification; if the CMM errors were to be considered in the budget, the resulting test uncertainty would be so large that it probably could not prove anything at all. When the test is performed by a CMM manufacturer, the latter, as the tester, takes responsibility for any imperfection in the test implementation with the test uncertainty — which narrows the acceptance zone —, and, as the manufacturer, takes responsibility for any imperfection of the CMM regarding any large values of the probing error, P , and error of indication, E .

This document is a preview generated by EVS

Geometrical product specifications (GPS) — Guidelines for the evaluation of coordinate measuring machine (CMM) test uncertainty

1 Scope

This Technical Specification gives guidance for the application of the test described in ISO 10360-2, by explaining the evaluation of the test uncertainty required for ISO 14253-1.

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 3650:1998, *Geometrical Product Specifications (GPS) — Length standards — Gauge blocks*

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

ISO 10360-2:2001, *Geometrical Product Specifications (GPS) — Acceptance and reverification tests for coordinate measuring machines (CMM) — Part 2: CMMs used for measuring size*

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 in product verification*

ISO 14660-1:1999, *Geometrical Product Specifications (GPS) — Geometrical features — Part 1: General terms and definitions*

ISO/TS 17450-2:2002, *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, OIML, 2nd ed., 1993

Guide to the expression of uncertainty in measurement (GUM), BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML, 1993, corrected and reprinted in 1995