First edition
2006-07-15

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)

Reference number
ISO/TS 23165:2006(E)

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Published in Switzerland

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Foreword

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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:

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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order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn.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again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.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.