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Geometrisk produktspecifikation (GPS) – Koordinatmätmaskiner (CMM): Teknik för bestämning av mätosäkerhet – Del 3: Användning av kalibrerade arbetsstycken och referenser (ISO 15530-3:2011)

Geometrical product specifications (GPS) – Coordinate measuring machines (CMM): Technique for determining the uncertainty of measurement – Part 3: Use of calibrated workpieces or measurement standards (ISO 15530-3:2011)

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Denna standard ersätter SIS-ISO/TS 15530-3:2007, utgåva 1.

The European Standard EN ISO 15530-3:2011 has the status of a Swedish Standard. This document contains the official version of EN ISO 15530-3:2011.

This standard supersedes the Swedish Standard SIS-ISO/TS 15530-3:2007, edition 1.

**Förhållandet till övriga delar under samma huvudtitel - Utdrag ur Förord i ISO 15530-3:2011/
Relations to other parts under the same general title - Extract from the Foreword of
ISO 15530-3:2011**

ISO 15530 consists of the following parts, under the general title *Geometrical product specifications (GPS) — Coordinate measuring machines (CMM): Technique for determining the uncertainty of measurement*:

- *Part 1: Overview and metrological characteristics* [Technical Specification]
- *Part 3: Use of calibrated workpieces or measurement standards*
- *Part 4: Evaluating task-specific measurement uncertainty using simulation* [Technical Specification]

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Denna standard är framtagen av kommittén för Mätteknik GPS och Ytstruktur, SIS/TK 507/AG 6.

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EUROPEAN STANDARD

EN ISO 15530-3

NORME EUROPÉENNE

EUROPÄISCHE NORM

October 2011

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Supersedes CEN ISO/TS 15530-3:2007

English Version

Geometrical product specifications (GPS) - Coordinate measuring machines (CMM): Technique for determining the uncertainty of measurement - Part 3: Use of calibrated workpieces or measurement standards (ISO 15530-3:2011)

Spécification géométrique des produits (GPS) - Machines à mesurer tridimensionnelles (MMT): Technique pour la détermination de l'incertitude de mesure - Partie 3: Utilisation de pièces étalonnées ou d'étalons de mesure (ISO 15530-3:2011)

Geometrische Produktspezifikation und -prüfung (GPS) - Verfahren zur Ermittlung der Messunsicherheit von Koordinatenmessgeräten (KMG) - Teil 3: Anwendung von kalibrierten Werkstücken oder Normalen (ISO 15530-3:2011)

This European Standard was approved by CEN on 14 October 2011.

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Foreword

This document (EN ISO 15530-3:2011) has been prepared by Technical Committee ISO/TC 213 "Dimensional and geometrical product specifications and verification" in collaboration with Technical Committee CEN/TC 290 "Dimensional and geometrical product specification and verification" the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2012, and conflicting national standards shall be withdrawn at the latest by April 2012.

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The text of ISO 15530-3:2011 has been approved by CEN as a EN ISO 15530-3:2011 without any modification.

Introduction

This part of ISO 15530 is a Geometrical Product Specification (GPS) and is to be regarded as a general GPS document (see ISO/TR 14638). It influences chain link 6 of the chain of standards on size, distance, radius, angle, form, orientation, location, run-out and datums.

The ISO/GPS Masterplan given in ISO/TR 14638 gives an overview of the ISO/GPS system of which this standard 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.

For more detailed information on the relation of this standard to the GPS matrix model, see Annex B.

Coordinate measuring machines (CMMs) have become essential for the verification of geometry in industry. According to the ISO 9000 series of standards, in a quality management system, the relevant measuring equipment is required to be calibrated against certified equipment having a known and valid relationship to internationally or nationally recognized standards in order to establish traceability. According to the *International vocabulary of basic and general terms in metrology* (VIM), a calibration comprises — besides the establishment of the relationship between the measured and the correct values of a quantity — the uncertainty evaluation in the final results (measurands) of the measurement task. However, uncertainty evaluation methods covering the errors arising in the innumerable measurement tasks a CMM can actually perform are often very complex. In these cases, the risk of an unrealistic estimation of task-related uncertainty is likely to arise.

The aim of this part of ISO 15530 is to provide an experimental technique for simplifying the uncertainty evaluation of CMM measurements. In this experimental approach, measurements are carried out in the same way as actual measurements, but with calibrated workpieces or measurement standards of similar dimension and geometry instead of the unknown objects to be measured. The description of this experimental technique to evaluate measurement uncertainty is the key element of this part of ISO 15530. The standardization of such procedures for the uncertainty evaluation serves the worldwide mutual recognition of calibrations and other measurement results.

This part of ISO 15530 is applicable for non-substitution measurement of workpieces or measurement standards, where the measurement result is given by the indication of the CMM. Furthermore, this part of ISO 15530 is applicable for substitution measurement, where, in opposition to the non-substitution measurement, a check standard is used to correct for the systematic errors of the CMM. The latter will generally decrease the measurement uncertainty and is often used, especially in the field of gauge calibration.

This part of ISO 15530 describes one of several methods of uncertainty evaluation, which will be outlined in later ISO documents. Because of the experimental approach, it is simple to perform, and it provides realistic statements of measurement uncertainties.

The limitations of this method can be summarized as: the availability of artefacts with sufficiently defined geometrical characteristics, stability, reasonable costs, and the possibility of being calibrated with sufficiently small uncertainty.

Geometrical product specifications (GPS) — Coordinate measuring machines (CMM): Technique for determining the uncertainty of measurement —

Part 3: Use of calibrated workpieces or measurement standards

1 Scope

This part of ISO 15530 specifies the evaluation of measurement uncertainty for results of measurements obtained by a CMM (coordinate measuring machine) and by using calibrated workpieces or measurement standards. It provides an experimental technique for simplifying the uncertainty evaluation of CMM measurements, whose approach (substitution measurements) leads to measurements being carried out in the same way as actual measurements, but with calibrated workpieces of similar dimension and geometry instead of the unknown workpieces to be measured.

Non-substitution measurements on CMMs are also covered, as are the requirements of the uncertainty evaluation procedure, the measurement equipment needed, and the reverification and interim check of the measurement uncertainty.

NOTE The evaluation of measurement uncertainty is always related to a specific measuring task.

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

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)*

ISO 14978:2006, *Geometrical product specification (GPS) — General concepts and requirements for GPS measuring equipment*

3 Terms and definitions

For the purpose of this part of ISO 15530, the terms and definitions given in ISO 10360-1, ISO/IEC Guide 98-3, ISO/IEC Guide 99 and the following apply.

3.1 non-substitution measurement

measurement where the uncorrected indication of the CMM is used as a result

3.2 substitution measurement

measurement where both a workpiece and a check standard are measured in order to provide additional corrections for systematic errors of the CMM

4 Symbols

For the purpose of this part of ISO 15530, the symbols given in Table 1 apply.

Table 1 — Symbols

Symbol	Interpretation
b	Systematic error observed during the evaluation of the measurement uncertainty
Δ_i	Difference between the measured and calibrated values of the check standard when applying the substitution method
k	Coverage factor
l	Measured dimension
n	Number of repeated measurements
T	Average temperature of the workpiece or measurement standard
u_{cal}	Standard uncertainty of the parameter of the calibrated workpiece or measurement standard
u_p	Standard uncertainty of the measurement procedure
u_b	Standard uncertainty of the systematic error
u_w	Standard uncertainty associated with the variations in the uncalibrated workpieces
u_{wp}	Standard uncertainty associated with the variations in the mechanical properties of the uncalibrated workpieces
u_{wt}	Standard uncertainty associated with the variations in the CTEs (thermal expansion coefficients) of the uncalibrated workpieces
u_α	Standard uncertainty of the thermal expansion coefficient
U	Expanded measurement uncertainty
U_{cal}	Expanded uncertainty of the calibrated workpiece parameter or measurement standard
x_{cal}	Value of the parameter of the calibrated workpiece or measurement standard
y	Measurement result
y_i	Measurement results during evaluation of measurement uncertainty
y_i^*	Uncorrected indications of the CMM during evaluation of measurement uncertainty when applying the substitution method
\bar{y}	Mean value of the measurement result

5 Requirements

5.1 Operating conditions

Before starting the measurements, initialize the CMM and perform procedures such as probe configuration and probe qualification according to the conditions specified in the manufacturer's operating manual. In particular, an adequate thermal equilibrium of the (calibrated) workpiece or measurement standard and the CMM should exist.

For the measurements given in 7.2, the environmental and operational conditions quoted by the CMM manufacturer and conditions quoted in the user's quality manual shall apply. In particular, existing error compensating functions (such as corrections applied via the software of the CMM's computer) shall be active if this is prescribed in the quality manual.

The CMM shall fulfil the specifications of the manufacturer, or — if different — the specifications laid down in the procedural instructions for the measurement task (task-related calibration, see ISO 14978); therefore, it is not necessary to calibrate all the metrological characteristics of a CMM (global calibration, see ISO 14978).

5.2 Similarity conditions

The method requires similarity of the following.

- a) The dimension and geometry of the workpiece or measurement standard used in the actual measurements (see 7.2.2) and the calibrated workpiece or measurement standard used in the evaluation of measurement uncertainty (see 7.2.3).

NOTE Conditions to be repeated are, for example, positions and orientations.

- b) The measurement procedure of the evaluation of measurement uncertainty and the actual measurement.

NOTE Conditions to be repeated are, for example, handling, exchange and clamping, time elapsed between probing points, loading and unloading procedures, measuring force and speed.

- c) The environmental conditions (including all variations) during evaluation of measurement uncertainty and actual measurement.

NOTE Conditions to be repeated are, for example, temperature, temperature stabilization time and temperature corrections (if used).

In Table 2, the similarity requirements are given.

Table 2 — Similarity requirements for workpieces or standard to be measured and the calibrated workpieces or standard used during evaluation of measurement uncertainty

Subject	Requirements	
Dimensional characteristics	Dimensions	Identical within: — 10 % beyond 250 mm — 25 mm below 250 mm
	Angles	Identical within $\pm 5^\circ$
Form error and surface texture	Similar due to functional properties	
Material (e.g. thermal expansion, elasticity, hardness)	Similar due to functional properties	
Measuring strategy	Identical	
Probe configuration	Identical	