SVENSK STANDARD
SS-ISO 230-2:2016

Fastställd/Approved: 2016-03-01
Publicerad/Published: 2016-03-07
Utgåva/Edition: 3
Språk/Language: engelska/English
ICS: 25.040.20; 25.080.01

Verktygsmaskiner – Mätmetoder för kontroll – Del 2: Bestämning av noggrannhet och repeterbarhet vid positionering av numeriskt styrda maskinaxlar (ISO 230-2:2014, IDT)

Test code for machine tools – Part 2: Determination of accuracy and repeatability of positioning of numerically controlled axes (ISO 230-2:2014, IDT)

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Den internationella standarden ISO 230-2:2014 gäller som svensk standard. Detta dokument innehåller den officiella engelska versionen av ISO 230-2:2014.

Denna standard ersätter SS-ISO 230-2:2006, utgåva 2.

The International Standard ISO 230-2:2014 has the status of a Swedish Standard. This document contains the official English version of ISO 230-2:2014.

This standard supersedes the Swedish Standard SS-ISO 230-2:2006, edition 2.

Upplysningar om sakinnehållet i standarden lämnas av SIS, Swedish Standards Institute, telefon 08-555 520 00. Standarder kan beställas hos SIS Förlag AB som även lämnar allmänna upplysningar om svensk och utländsk standard.

Information about the content of the standard is available from the Swedish Standards Institute (SIS), telephone +46 8 555 520 00. Standards may be ordered from SIS Förlag AB, who can also provide general information about Swedish and foreign standards.

Denna standard är framtagen av kommittén för Uppmätning av verktygsmaskiner, SIS/TK 491.

Har du synpunkter på innehållet i den här standarden, vill du delta i ett kommande revideringsarbete eller vara med och ta fram andra standarder inom området? Gå in på www.sis.se - där hittar du mer information.

Contents

Page

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 39, *Machine tools*, Subcommittee SC 2, *Test conditions for metal cutting machine tools*.

This fourth edition cancels and replaces the third edition (ISO 230-2:2006), which has been technically revised. In particular, the following have been added:

a) for axes lengths larger than 4 000 mm, more than one 2 000 mm segment(s) can be defined for testing (see 5.3.3);

b) nomenclature for parameters of positioning tests, e.g. $E_{XX,A\uparrow}$ (see 8.2.4);

c) evaluation of periodic positioning errors (see Annex C);

d) positioning tests with calibrated ball array or step gauge (see Annex D).

ISO 230 consists of the following parts, under the general title *Test code for machine tools*:

— *Part 1: Geometric accuracy of machines operating under no-load or quasi-static conditions*

— *Part 2: Determination of accuracy and repeatability of positioning of numerically controlled axes*

— *Part 3: Determination of thermal effects*

— *Part 4: Circular tests for numerically controlled machine tools*

— *Part 5: Determination of the noise emission*

— *Part 6: Determination of positioning accuracy on body and face diagonals (Diagonal displacement tests)*

— *Part 7: Geometric accuracy of axes of rotation*

— *Part 8: Vibrations* [Technical Report]

— *Part 9: Estimation of measurement uncertainty for machine tool tests according to series ISO 230, basic equations* [Technical Report]

— *Part 10: Determination of the measuring performance of probing systems of numerically controlled machine tools*

— *Part 11: Measuring instruments suitable for machine tool geometry tests* [Technical Report]

Introduction

The purpose of ISO 230 (all parts) is to standardize methods for testing the accuracy of machine tools, excluding portable power tools.

This part of ISO 230 specifies test procedures used to determine the accuracy and repeatability of positioning of numerically controlled axes. The tests are designed to measure the relative motion between the component of the machine that carries the cutting tool and the component that carries the workpiece.

The manufacturer/supplier is responsible for providing thermal specifications for the environment in which the machine can be expected to perform with the specified accuracy. The machine user is responsible for providing a suitable test environment by meeting the manufacturer/supplier's thermal guidelines or otherwise accepting reduced performance. An example of environmental thermal guidelines is given in ISO 230-3:2007, Annex C.

A relaxation of accuracy expectations is required if the thermal environment causes excessive uncertainty or variation in the machine tool performance and does not meet the manufacturer/supplier's thermal guidelines. If the machine does not meet performance specifications, the analysis of the uncertainty due to the compensation of the machine tool temperature, given in A.2.4 of this part of ISO 230, and the uncertainty due to the environmental variation error, given in A.2.5, can help in identifying sources of problems.

ISO/TC 39/SC 2 decided to add the following to this edition of this part of ISO 230:

a) for axes lengths larger than 4 000 mm, more than one 2 000 mm segment(s) can be defined for testing (see 5.3.3);

b) nomenclature for parameters of positioning tests, e.g. $E_{XX,A\uparrow}$ (see 8.2.4);

c) evaluation of periodic positioning errors (see Annex C);

d) positioning tests with calibrated ball array or step gauge (see Annex D).

Test code for machine tools —

Part 2:
Determination of accuracy and repeatability of positioning of numerically controlled axes

1 Scope

This part of ISO 230 specifies methods for testing and evaluating the accuracy and repeatability of positioning of numerically controlled machine tool axes by direct measurement of individual axes on the machine. These methods apply equally to linear and rotary axes.

When several axes are simultaneously under test, the methods do not apply.

This part of ISO 230 can be used for type testing, acceptance tests, comparison testing, periodic verification, machine compensation, etc.

The methods involve repeated measurements at each position. The related parameters of the test are defined and calculated. Their uncertainties are estimated as described in ISO/TR 230-9:2005, Annex C.

Annex A presents the estimation of the measurement uncertainty.

Annex B describes the application of an optional test cycle: the step cycle. The results from this cycle are not to be used either in the technical literature with reference to this part of ISO 230, nor for acceptance purposes, except under special written agreements between manufacturer/supplier and user. Correct reference to this part of ISO 230 for machine acceptance always refers to the standard test cycle.

Annex C contains considerations related to periodic positioning error.

Annex D describes tests using ball array and step gauge.

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 230-1:2012, *Test code for machine tools — Part 1: Geometric accuracy of machines operating under no-load or quasi-static conditions*

ISO 230-3:2007, *Test code for machine tools — Part 3: Determination of thermal effects*

ISO/TR 230-9:2005, *Test code for machine tools — Part 9: Estimation of measurement uncertainty for machine tool tests according to series ISO 230, basic equations*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
axis travel
maximum travel, linear or rotary, over which the moving component can move under numerical control

Note 1 to entry: For rotary axes exceeding 360°, there might not be a clearly defined maximum travel.

3.2
measurement travel
part of the axis travel, used for data capture, selected so that the first and the last target positions can be approached bi-directionally

Note 1 to entry: See Figure 1.

3.3
functional point
cutting tool centre point or point associated with a component on the machine tool where cutting tool would contact the part for the purposes of material removal

[SOURCE: ISO 230-1:2012, 3.4.2]

Note 1 to entry: In this part of ISO 230, tests address errors in the relative motion between the component of the machine that carries the cutting tool and the component that carries the workpiece. These errors are defined and measured at the position or trajectory of the functional point.

3.4
target position
P_i (i = 1 to m)
position to which the moving component is programmed to move

Note 1 to entry: The subscript i identifies the particular position among other selected target positions along or around the axis.

3.5
actual position
P_{ij} (i = 1 to m; j = 1 to n)
measured position reached by the functional point on the j^{th} approach to the i^{th} target position

3.6
positioning deviation
deviation of position
x_{ij}
actual position reached by the functional point minus the target position

$$x_{ij} = P_{ij} - P_i$$

[SOURCE: ISO 230-1:2012, 3.4.6, modified]

Note 1 to entry: Positioning deviations are determined as the relative motion between the component of the machine that carries the cutting tool and the component that carries the workpiece in the direction of motion of the axis under test.

Note 2 to entry: Positioning deviations constitute a limited representation of positioning error motion, sampled at discrete intervals.

3.7
unidirectional
refers to a series of measurements in which the approach to a target position is always made in the same direction along or around the axis

Note 1 to entry: The symbol ↑ signifies a parameter derived from a measurement made after an approach in the positive direction, and ↓ one in the negative direction, e.g. x_{ij}↑ or x_{ij}↓.

3.8
bi-directional
refers to a parameter derived from a series of measurements in which the approach to a target position is made in either direction along or around the axis

3.9
standard uncertainty
uncertainty of the result of a measurement expressed as a standard deviation

[SOURCE: ISO/IEC Guide 98-3:2008, 2.3.1]

3.10
combined standard uncertainty
standard uncertainty of the result of a measurement when that result is obtained from the values of a number of other quantities, equal to the positive square root of a sum of terms, the terms being the variances or covariances of these other quantities weighted according to how the measurement result varies with changes in these quantities

[SOURCE: ISO/IEC Guide 98-3:2008, 2.3.4]

3.11
expanded uncertainty
quantity defining an interval about the result of a measurement that can be expected to encompass a large fraction of the distribution of values that could reasonably be attributed to the measurand

[SOURCE: ISO/IEC Guide 98-3:2008, 2.3.5]

3.12
coverage factor
numerical factor used as a multiplier of the combined standard uncertainty in order to obtain an expanded uncertainty

[SOURCE: ISO/IEC Guide 98-3:2008, 2.3.6]

3.13
mean unidirectional positioning deviation at a position
$\bar{x}_i \uparrow$ or $\bar{x}_i \downarrow$
arithmetic mean of the positioning deviations obtained by a series of n unidirectional approaches to a position P_i

$$\bar{x}_i \uparrow = \frac{1}{n}\sum_{j=1}^{n} x_{ij} \uparrow$$

and

$$\bar{x}_i \downarrow = \frac{1}{n}\sum_{j=1}^{n} x_{ij} \downarrow$$

3.14
mean bi-directional positioning deviation at a position
$\bar{x}_i$
arithmetic mean of the mean unidirectional positioning deviations $\bar{x}_i \uparrow$ and $\bar{x}_i \downarrow$ obtained from the two directions of approach at a position P_i

$$\bar{x}_i = \frac{\bar{x}_i \uparrow + \bar{x}_i \downarrow}{2}$$