SVENSK STANDARD
SS-ISO 230-7:2020

Verktygsmaskiner – Mätmetoder för kontroll –
Del 7: Geometrisk noggrannhet av rotationsaxlar (ISO 230-7:2013, IDT)

Machine tools – Test code for machine tools –
Part 7: Geometric accuracy of axes of rotation (ISO 230-7:2013, IDT)

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

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Europastandarden ISO 230-7:2013 gäller som svensk standard. Detta dokument innehåller den officiella engelska versionen av ISO 230-7:2013.

Denna standard ersätter SS-ISO 230-7:2006, utgåva 1.

The European Standard ISO 230-7:2013 has the status of a Swedish Standard. This document contains the official version of ISO 230-7:2013.

This standard supersedes the SS-ISO 230-7:2006, edition 1.

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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).

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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 second edition cancels and replaces the first edition (ISO 230–7:2006), which has been technically revised.

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]

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Introduction

This International Standard has been revised based on the comments received from industry and academia related to the applications of axis of rotation error motions to rotary tables, and other milling and drilling operations where more than one sensitive direction can be of critical importance. In this revision, the terms and definitions were updated and the special cases, where 1st order harmonic of radial error motion differs in different directions, were addressed. They are also reordered based on a modified structure for better clarifying the general concepts and their applications. The cases where there are multiple sensitive directions as well as the consequence of axis of rotation error motion in radial location of parts (2D sensitive direction) are described.

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Test code for machine tools —

Part 7:
Geometric accuracy of axes of rotation

1 Scope

This part of ISO 230 is aimed at standardizing methods of specification and test of the geometric accuracy of axes of rotation used in machine tools. Spindle units, rotary heads, and rotary and swivelling tables of machine tools constitute axes of rotation, all having unintended motions in space as a result of multiple sources of errors.

This part of ISO 230 covers the following properties of rotary axes:

— axis of rotation error motion;

— speed-induced axis shifts.

The other important properties of rotary axes, such as thermally induced axis shifts and environmental temperature variation-induced axis shifts, are dealt with in ISO 230-3.

This part of ISO 230 does not cover the following properties of spindles:

— angular positioning accuracy (see ISO 230-1 and ISO 230-2);

— run-out of surfaces and components (see ISO 230-1);

— tool holder interface specifications;

— inertial vibration measurements (see ISO/TR 230-8);

— noise measurements (see ISO 230-5);

— rotational speed range and accuracy (see ISO 10791-6 and ISO 13041-6);

— balancing measurements or methods (see ISO 1940-1 and ISO 6103);

— idle run loss (power loss);

— thermal effects (see ISO 230-3).

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*

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3 Terms and definitions

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

NOTE They are presented in this sequence to help the user develop an understanding of the terminology of axes of rotation. The alphabetical cross-references for these definitions are given in Annex G.

3.1 General concepts

3.1.1
spindle unit
tool or workpiece carrying device providing a capability to rotate the tool or the workpiece around an axis of rotation

Note 1 to entry: A machine tool may have one or more spindle units.

3.1.2
rotary table
swivelling table
component of a machine tool carrying a workpiece and providing a capability for changing angular orientation of the workpiece around an axis of rotation

Note 1 to entry: If a rotary table of a machining centre can be used for turning operations, the rotary table can be seen as a spindle unit for these operations.

3.1.3
rotary head
swivelling head
component of a machine carrying a tool holding spindle unit and providing a capability for changing the angular orientation of the spindle unit around an axis of rotation

Note 1 to entry: Sometimes multiple axes of rotations may be combined in a machine component.

3.1.4
spindle
rotor
rotating element of a spindle unit (or rotary table/head)

3.1.5
spindle housing
stator
stationary element of a spindle unit (or rotary table/head)

3.1.6
bearing
element of a spindle unit (or rotary table/head) that supports the rotor and enables rotation between the rotor and the stator

3.1.7
axis of rotation
line segment about which rotation occurs

[SOURCE: ISO 230-1:2012, 3.5.2]

Note 1 to entry: See Figure 1 a).

Note 2 to entry: In general, during rotation, this line segment translates (in radial and axial directions) and tilts within the reference coordinate frame due to inaccuracies in the bearings and bearing seats structural motion or axis shifts, as shown in Figure 1 a) and b).

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3.1.8
positive direction
in accordance with ISO 841, the direction of a movement that causes an increasing positive dimension of the workpiece

3.1.9
perfect spindle (or rotary table/head)
spindle or rotary table/head having no error motion of its axis of rotation relative to its axis average line

3.1.10
perfect workpiece
rigid body having a perfect surface of revolution about a centreline

3.1.11
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]

3.1.12
axis average line
straight line segment located with respect to the reference coordinate axes representing the mean location of the axis of rotation

Note 1 to entry: See Figure 1 a).

Note 2 to entry: The axis average line is a useful term to describe changes in location of an axis of rotation in response to load, temperature, or speed changes.

Note 3 to entry: Unless otherwise specified, the position and orientation of the axis average line should be determined by connecting the calculated least-squares centres of two data sets of radial error motion taken at axially separated locations (see 3.4).

Note 4 to entry: ISO 841 defines the Z-axis of a machine as being "parallel to the principal spindle of the machine". This implies that the machine Z-axis is parallel to the axis average line of the principal spindle. However, since axis average line definition applies to other spindles and rotary axes as well, in general, not all axes of rotation are parallel to the machine Z-axis. An axis average line should be parallel to the machine Z-axis only if it is associated with the principal spindle of the machine.

3.1.13
axis shift
<axis of rotation> quasi-static relative angular and linear displacement, between the tool side and the workpiece side, of the axis average line due to a change in conditions

Note 1 to entry: See Figure 1 c).

Note 2 to entry: Causes of axis shift include thermal influences, load changes, as well as speed and direction changes. Axis of rotation error motion measurements are carried out over a period of time (number of revolutions) and conditions that avoid axis shift.

3.1.14
structural loop
assembly of components which maintains the relative position and orientation between two specified objects (i.e. between the workpiece and the cutting tool)

Note 1 to entry: A typical pair of specified objects is a cutting tool and a workpiece on a machine tool (e.g. lathe). In this case, the structural loop would include the workpiece holding fixture (e.g. chuck), spindle, bearings and spindle housing, the machine head stock, machine bed, the machine slideways, carriages, and the tool holding fixture.