
Test conditions for machining centres —

Part 2: Geometric tests for machines with vertical spindle (vertical Z-axis)

Conditions d'essai pour centres d'usinage —

*Partie 2: Essais géométriques des machines à broche verticale (axe Z
vertical)*



This document is a preview generated by EUS



COPYRIGHT PROTECTED DOCUMENT

© ISO 2023

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

	Page
Foreword.....	v
Introduction.....	vii
1 Scope.....	1
2 Normative references.....	1
3 Terms and definitions.....	2
4 Preliminary remarks.....	2
4.1 Measurement units.....	2
4.2 Reference to the ISO 230 series.....	2
4.2.1 General.....	2
4.2.2 Consideration of relative measurements.....	2
4.3 Reference to ISO 10791-6.....	2
4.4 Testing sequence.....	3
4.5 Tests to be performed.....	3
4.6 Tolerances.....	3
4.7 Measuring instruments.....	4
4.8 Diagrams.....	4
4.8.1 General.....	4
4.8.2 Alphabetic characters used for the E error expressions.....	4
4.8.3 Error direction.....	4
4.9 Pallets.....	5
4.10 Software compensation.....	5
4.11 Axes not under test.....	5
4.12 Machine configurations.....	5
4.13 Designation.....	6
5 Geometric tests.....	8
5.1 Straightness errors of linear motions.....	8
5.2 Angular errors of linear motions.....	11
5.3 Squareness errors between linear motions.....	16
5.4 Spindle.....	19
6 Horizontal non-rotating tables.....	24
7 Tables rotating around a vertical C'-axis.....	30
8 Tables rotating around a vertical C'-axis and tilting around a horizontal A'-axis.....	41
8.1 General.....	41
8.2 Tests for rotary tables tilting around the A'-axis.....	42
8.3 Tests for the A'-axis tilting from -90° to $+90^{\circ}$	61
8.4 Tests for the A'-axis tilting from -90° to 0°	67
8.5 Tests for the A'-axis tilting from 0° to $+90^{\circ}$	71
9 Tables rotating around a vertical C'-axis and tilting around a horizontal B'-axis.....	75
9.1 General.....	75
9.2 Tests for rotary tables tilting around the B'-axis.....	76
9.3 Tests for the B'-axis tilting from -90° to $+90^{\circ}$	95
9.4 Tests for the B'-axis tilting from -90° to 0°	100
9.5 Tests for the B'-axis tilting from 0° to $+90^{\circ}$	104
Annex A (informative) Tests for error motions of tool holding spindle and work holding rotary table axes related to Clauses 7, 8 and 9.....	108
Annex B (informative) Tests for error motions of axes of rotation of tables rotating around a vertical C'-axis and tilting around a horizontal A'-axis related to Clause 8.....	113
Annex C (informative) Tests for error motions of axes of rotation of tables rotating around a vertical C'-axis and tilting around a horizontal B'-axis related to Clause 9.....	118

Bibliography	123
---------------------------	------------

This document is a preview generated by EVS

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 of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee 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 10791-2:2001), which has been technically revised.

The main changes are as follows:

- Tests applying to all configurations of machines have now been grouped in [Clause 5](#) (tests G5.1 to G5.14).
- Tests for optional horizontal spindles and integral or accessory spindle heads forming the object of [Annexes A](#) through [C](#) in the first edition of this document, have been deleted and will be covered by a more general standard, as they are not only used in machining centres.
- Tests for the movements of four types of work holding tables have been introduced, respectively as [Clauses 6, 7, 8](#) and [9](#), as explained in [4.5](#) and [Table 1](#).
- Three new [Annexes A, B](#) and [C](#) have been introduced, dealing with error motion of rotary axes belonging to spindles and to rotary and tilting tables.
- The test of the table flatness (formerly G15) has been deleted for several reasons, including:
 - the table surface is not normally used as a reference for the location of the workpiece;
 - sometimes, the machine is supplied with some fixtures already mounted on the table;
 - sometimes, the machine is provided with a receiver where several pallets can be mounted;
 - for tests made during the working life of the machine, the table surface can be unsuitable for accurate measurements, mostly on large machines.

A list of all parts in the ISO 10791 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

This document is a preview generated by EVS

Introduction

A machining centre is a numerically controlled machine tool capable of performing multiple machining operations, including milling, boring, drilling and tapping, as well as automatic tool changing from a magazine or similar storage unit in accordance with a machining program.

The object of the ISO 10791 series is to provide information as widely and comprehensively as possible on tests which can be carried out for comparison, acceptance, maintenance or any other purpose deemed necessary by user or manufacturer/supplier.

Test conditions for machining centres —

Part 2:

Geometric tests for machines with vertical spindle (vertical Z-axis)

1 Scope

This document specifies, with reference to the ISO 230 series, the geometric tests for machining centres with vertical spindle (i.e. vertical Z-axis).

This document also establishes the tolerances for the test results corresponding to general purpose and normal accuracy machining centres.

This document is also applicable, totally or partially, to other numerically controlled machines, when their configuration, components and movements are compatible with the tests described herein.

This document applies to machining centres having three numerically controlled linear axes (X-axis up to 5 000 mm length, Y-axis up to 2 000 mm length, and Z-axis up to 2 000 mm length), but refers also to supplementary movements, such as those of rotary, tilting, and swivelling tables. Further tests, contained in [Annexes A, B and C](#), cover axes of rotation of spindles, rotary tables and tilting cradles. Movements other than those mentioned are considered as special features and the relevant tests are not included in this document.

This document takes into consideration in [Clauses 6](#) through [9](#) four possible types of tables, fixed and rotary, as hereunder described:

- [Clause 6](#): horizontal non-rotating tables;
- [Clause 7](#): tables rotating only around a vertical C'-axis;
- [Clause 8](#): tables rotating around a vertical C'-axis and tilting around a horizontal A'-axis;
- [Clause 9](#): tables rotating around a vertical C'-axis and tilting around a horizontal B'-axis.

This document deals only with the verification of geometric accuracy of the machine and does not apply to the testing of the machine operation, which are generally checked separately. Tests not concerning the pure geometric accuracy of the machine are dealt with in other parts of the ISO 10791 series.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 230-1:2012, *Test code for machine tools — Part 1: Geometric accuracy of machines operating under no-load or quasi-static conditions*

ISO 230-7:2015, *Test code for machine tools — Part 7: Geometric accuracy of axes of rotation*

ISO 841:2001, *Industrial automation systems and integration — Numerical control of machines — Coordinate system and motion nomenclature*