INTERNATIONAL STANDARD

ISO 13041-7

First edition
2004-01-15

Test conditions for numerically controlled turning machines and turning centres —

Part 7: Evaluation of contouring performance in the coordinate planes

Conditions d'essai des tours à commande numérique et des centres de tournage —

Partie 7: Évaluation des performances en contournage dans les plans de coordonnées

Reference number
ISO 13041-7:2004(E)

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Published in Switzerland

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.

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 13041-7 was prepared by Technical Committee ISO/TC 39, *Machine tools*, Subcommittee SC 2, *Test conditions for metal cutting machine tools*.

ISO 13041 consists of the following parts, under the general title *Test conditions for numerically controlled turning machines and turning centres*:

— *Part 1: Geometric tests for machines with a horizontal workholding spindle*

— *Part 2: Geometric tests for machines with vertical workholding spindle*

— *Part 3: Geometric tests for machines with inverted vertical workholding spindle*

— *Part 4: Accuracy and repeatability of positioning of linear and rotary axes*

— *Part 5: Accuracy of feeds, speeds and interpolations*

— *Part 6: Accuracy of a finished test piece*

— *Part 7: Evaluation of contouring performance in the coordinate planes*

— *Part 8: Evaluation of thermal distortions*

Introduction

The object of ISO 13041 is to supply information as wide and comprehensive as possible on geometric, positional, contouring, thermal and machining tests which can be carried out for comparison, acceptance, maintenance or any other purpose.

ISO 13041 specifies, with reference to the relevant parts of ISO 230, *Test code for machine tools,* tests for turning centres and numerically controlled turning machines with/without tailstocks standing alone or integrated in flexible manufacturing systems. ISO 13041 also establishes the tolerances or maximum acceptable values for the test results corresponding to general purpose and normal-accuracy turning centres and numerically controlled turning machines.

Test conditions for numerically controlled turning machines and turning centres —

Part 7:
Evaluation of contouring performance in the coordinate planes

1 Scope

This part of the ISO 13041 describes a method of checking the contouring performance of turning centres (or numerically controlled turning) by conducting circular tests and by evaluating the radial deviation F and circular deviation G, in accordance with ISO 230-4.

NOTE Measurements of circular movements can be carried out by different methods as described in Clause 6.6 of ISO 230-1:1996. These methods consist of using a rotating one-dimensional probe and a test mandrel, a circular masterpiece and a two-dimensional probe, or a telescoping ball bar. Other test methods may be applied if the accuracy of the equipment is the same as (or better than) the accuracy of the methods described. Influences of typical machine deviations on circular paths are shown in Annex B of ISO 230-4:1996.

The concept of checks by circular tests described in this part of ISO 13041 is to verify the circular movement

— only in one position per coordinate plane of the machine,

— at only one feed rate, and

— to repeat the test once in the opposite contouring direction.

The purpose of this part of ISO 13041 is not to provide a means of analysing the causes for the measured circular deviations, but to offer the user a method for periodic checking of the machine tool. It is recommended to carry out the tests of this part of ISO 13041 after the machine tool has passed the acceptance tests and to use these results as a basis for comparison during periodic checks. Therefore acceptable deviations from the initial results have to be decided by the user.

If the tests are used for machine acceptance purposes, the supplier/manufacturer and the user have to agree on specific diameters, feed rates and tolerances for the tests.

NOTE ISO 13041-5, which deals with the accuracy of feeds, speeds and interpolations, also includes as test K4 a circular test. There the aim is to check the mutual behaviour of two linear axes (generally X and Y) at two defined feed rates for one defined diameter. This is more or less a diagnostic test with respect to the circular interpolation, whereas the circular tests of this part of ISO 13041 give information on the overall contouring performance of the machine.

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 230-1:1996, *Test code for machine tools — Part 1: Geometric accuracy of machines operating under no-load or finishing conditions*

ISO 230-4:1996, *Test code for machine tools — Part 4: Circular tests for numerically controlled machine tools*

ISO 13041-1:2003, *Test conditions for numerically controlled turning machines and turning centres — Part 1: Geometric tests for machines with a horizontal spindle*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13041-1 apply.

4 Preliminary remarks

4.1 Reference to ISO 230-1 and ISO 230-4

To apply this part of ISO 13041, reference shall be made to ISO 230-1 and ISO 230-4, especially for the installation of the machine before testing, warming up of the machine, description of measuring methods, evaluation, as well as for the recommended accuracy of the testing equipment and presentation of the results.

4.2 Testing sequence

The circular tests shall be carried out in the XZ plane and, if applicable, in the other coordinate planes (e.g. XY plane, YZ plane, X2Z2 plane and Y2Z2 plane). The sequence in which the tests are presented in this part of ISO 13041 in no way defines the practical order of testing. In order to make the mounting of instruments or gauging easier, tests may be performed in any order.

4.3 Tests to be performed

When testing a machine, it is not always necessary or possible to carry out all the tests described in this part of ISO 13041. When the tests are required for acceptance purposes, it is up to the user to choose, in agreement with the supplier/manufacturer; those tests relating to the components and/or the properties of the machine which are of interest. These tests are to be clearly stated when ordering a machine. Mere reference to this part of ISO 13041 for the acceptance tests, without specifying the tests to be carried out, and without agreement on the relevant expenses, cannot be considered as binding for any contracting party.

4.4 Position of linear axes not under test

During the check of contouring performance, those of the three basic linear axes not involved in the test shall be kept as far as possible in the middle of their working displacement, or otherwise in a position such as to minimize deflections of elements affecting measurements. Sliding spindles, etc., when they are supplementary axes, shall be kept retracted.

4.5 Measuring Instruments

In accordance with 6.63 of ISO 230-1:1996, i.e. rotating one-dimensional probe, or circular masterpiece and two-dimensional probe or telescoping ball bar.

For the checking of radial deviation, the reference dimension of the test instrument shall be known.

4.6 Presentation of results

Table 1 provides an example of the format for the presentation of the results, and a graphical presentation of the results should be provided as specified in ISO 230-4.

Table 1 — Presentation of results

Measuring conditions		Recorded deviation
Test parameters	Diameter of nominal path: Contouring feed: Contouring direction: Machine axes under test:	
Location of measuring instruments	Centre of circle: Offset to tool reference: Offset to workpiece reference:	
Data-acquisition method	Starting point: Stop point: Number of measuring points (digital only): Data-smoothing process:	
Compensation used:		
Positions of axes not under test:		
Radial deviation, F	F_{max}: F_{min}:	
Circular deviation, G:		

5 Information to be recorded

5.1 General

To comply with this part of ISO 13041, the test report shall include the information defined in 5.2 to 5.4.

5.2 Data identifying the machine

a) name of the manufacturer;

b) year of construction, if available;

c) type and serial number.

5.3 Data identifying the test

a) date and place of test;

b) company and name of inspector;

c) list of testing equipment used, including manufacturer's name, type and serial number of the components.

5.4 Points to be agreed between supplier/manufacturer and user

a) warm-up procedure prior to testing the machine;

b) test parameters;

c) which test result data for the circular deviation G and/or radial deviation F are required and shall be presented;

d) test angle for radial deviation F only, if different from the default angle of 360°.

Bibliography

[1] ISO 1708:1989, *Acceptance conditions for general purpose parallel lathes — Testing of the accuracy*

[2] ISO 2806:1994, *Industrial automation systems — Numerical control of machines — Vocabulary*

[3] ISO 6155:1998, *Machine tools — Test conditions for horizontal spindle turret and single spindle automatic lathes — Testing of the accuracy*

[4] ISO 13041-5, *Test conditions for numerically controlled turning machines and turning centres — Part 5: Accuracy of feeds, speeds and interpolations*

ICS 25.040.20

Price based on 4 pages