
**Test conditions for numerically
controlled turning machines and
turning centres —**

Part 6:

Accuracy of a finished test piece

iTeh STANDARD PREVIEW

(standards.iteh.ai)

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

Partie 6: Exactitude d'une pièce d'essai usinée

ISO 13041-6:2005

<https://standards.iteh.ai/catalog/standards/sist/2b95dea8-cf81-4c01-81f8-284c3af7d783/iso-13041-6-2005>



PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[ISO 13041-6:2005](https://standards.iteh.ai/catalog/standards/sist/2b95dea8-cf81-4c01-81f8-284c3af7d783/iso-13041-6-2005)

<https://standards.iteh.ai/catalog/standards/sist/2b95dea8-cf81-4c01-81f8-284c3af7d783/iso-13041-6-2005>

© ISO 2005

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword	iv
Introduction	v
1 Scope.....	1
2 Normative references	1
3 Preliminary remarks.....	1
3.1 Measuring units.....	1
3.2 Reference to ISO 230-1	1
3.3 Test sequence	2
3.4 Tests to be performed	2
3.5 Measuring instruments.....	2
3.6 Fixing of test pieces.....	2
3.7 Material of test piece, tooling and cutting parameters	2
3.8 Sizes of test pieces	2
3.9 Information to be recorded	3
3.10 Machine size categories	3
4 Machining tests	4
Bibliography	12

ITeH STANDARD PREVIEW
(standards.iteh.ai)

[ISO 13041-6:2005](https://standards.iteh.ai/catalog/standards/sist/2b95dea8-cf81-4c01-81f8-284c3af7d783/iso-13041-6-2005)

<https://standards.iteh.ai/catalog/standards/sist/2b95dea8-cf81-4c01-81f8-284c3af7d783/iso-13041-6-2005>

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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 13041-6 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 a vertical workholding spindle*

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

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

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

— *Part 8: Evaluation of thermal distortions*

The following parts are under preparation:

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

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

Introduction

A numerically controlled turning machine is a machine tool in which the principal motion is the rotation of the workpiece against the stationary cutting tool(s) and where cutting energy is brought by the workpiece and not by the tool. This machine is controlled by a numerical control (NC) providing automatic function according to of ISO 13041-1:2004, 3.3.4, and can be of single-spindle or multispindle type.

A turning centre is a NC turning machine equipped with power driven tool(s) and the capacity to orientate the work holding spindle around its axis. This machine may include additional features such as automatic tool-changing from a magazine.

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, 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.

iTeh STANDARD PREVIEW (standards.iteh.ai)

[ISO 13041-6:2005](https://standards.iteh.ai/catalog/standards/sist/2b95dea8-cf81-4c01-81f8-284c3af7d783/iso-13041-6-2005)

<https://standards.iteh.ai/catalog/standards/sist/2b95dea8-cf81-4c01-81f8-284c3af7d783/iso-13041-6-2005>

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[ISO 13041-6:2005](https://standards.iteh.ai/catalog/standards/sist/2b95dea8-cf81-4c01-81f8-284c3af7d783/iso-13041-6-2005)

<https://standards.iteh.ai/catalog/standards/sist/2b95dea8-cf81-4c01-81f8-284c3af7d783/iso-13041-6-2005>

Test conditions for numerically controlled turning machines and turning centres —

Part 6: Accuracy of a finished test piece

1 Scope

This part of ISO 13041 specifies, with reference to ISO 230-1, a series of cutting tests, under finishing conditions, of standard test pieces as well as the characteristics and dimensions of the test pieces themselves. This part of ISO 13041 is intended to supply minimum requirements for assessing the cutting accuracy 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 3442-1¹⁾, *Machine tools — Dimensions and geometric tests for self-centring chucks with two-piece jaws — Part 1: Manually operated chucks with tongue and groove type jaws*

ISO 13041-1:2004, *Test conditions for numerically controlled turning machines and turning centres — Part 1: Geometric tests for machines with a horizontal workholding spindle*

3 Preliminary remarks

3.1 Measuring units

In this part of ISO 13041, all linear dimensions, deviations and corresponding tolerances are expressed in millimetres, angular dimensions are expressed in degrees, and angular deviations and the corresponding tolerances are expressed in ratios; however, in some cases, microradians or arcseconds may be used for clarification purposes. The equivalence of the following expressions should always be kept in mind.

$$0,010/1\ 000 = 10\ \mu\text{rad} \approx 2''$$

3.2 Reference to ISO 230-1

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

1) To be published. (Revision of ISO 3442:1991 and ISO 9401:1991)

3.3 Test sequence

The sequence in which the tests are presented in this part of ISO 13041 in no way defines the practical order of testing.

3.4 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, shall not be considered as binding for any contracting party.

NOTE Test pieces M1 and M2 are defined for machines with a horizontal workholding spindle only. Test pieces for machines with a vertical workholding spindle will be included as soon as ISO 13041-2 and ISO 13041-3 are published. Tests M1 and M2 may be used for machines with a vertical workholding spindle subject to agreement on the sizes between manufacturer and the user.

3.5 Measuring instruments

The measuring instruments indicated in the tests described in Clause 4 are examples only. Other instruments measuring the same qualities and having at least the same accuracy may be used. Dial gauges shall have a resolution of 0,001 mm or better. Reference should be made to ISO/TS 14253-2 and ISO/TR 16015.

3.6 Fixing of test pieces

The test piece shall be conveniently mounted on a proper fixture or chuck, such that maximum stability of tools and fixture is achieved. The mounting surfaces of the fixture and the test piece should be flat and/or cylindrical. It is recommended that suitable means of fixing be used to allow for tool breakthrough (if applicable).

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO 13041-6:2005
<https://standards.iteh.ai/catalog/standards/sist/2b95dea8-cf81-4c01-81f8-284c3af7d783/iso-13041-6-2005>

3.7 Material of test piece, tooling and cutting parameters

The material, tooling and the subsequent cutting parameters for the test piece are subject to agreement between supplier/manufacturer and user, and shall be recorded.

3.8 Sizes of test pieces

If the test pieces are machined several times, with a consequent reduction of external dimensions, it is recommended that the final test piece, when used for acceptance purposes, comply with the dimensions specified in this part of ISO 13041.

If the test pieces come from previous cutting tests and are re-useable, their characteristic dimensions should remain within $\pm 10\%$ of those indicated in this part of ISO 13041. When the test pieces are re-used, a shallow cut shall be made to clean up all surfaces before new finishing test cuts are taken.

It is also recommended that type and serial number of the machine, date of test and names and orientation of the axes are marked on the test pieces and that they are delivered with the machine for reference purposes.

In principle, no more than one piece of each type should be machined for acceptance purposes. In case of special requirements, such as statistical assessment of the machine performance, the machining of more test pieces is to be submitted to agreement between supplier/ manufacturer and user.

Preliminary cuts should be taken in order to make the depth of cut as constant as possible.

3.9 Information to be recorded

For tests made according to the requirements of this part of ISO 13041, the following information shall be compiled as completely as possible and shall be included in the test report:

- a) material and dimensions of the test piece;
- b) material and dimensions of the tool;
- c) cutting speed;
- d) feedrate;
- e) depth of cut;
- f) axes used for machining;
- g) other cutting parameters, e.g. cutting fluid.

3.10 Machine size categories

For the purposes of ISO 13041, machines are classified into size categories depending on their work spindle orientation (see ISO 13041-1 for horizontal workholding spindle machines, ISO 13041-2 for vertical workholding spindle machines and ISO 13041-3 for inverted vertical workholding spindle machines).

The categories and size ranges are referenced in the cutting tests of this part of ISO 13041 and are therefore repeated here for the convenience of the user.

ISO 13041-1 NC turning machines and turning centres with horizontal workholding spindle are classified into three size categories, on the basis of the criteria specified in Table 1.

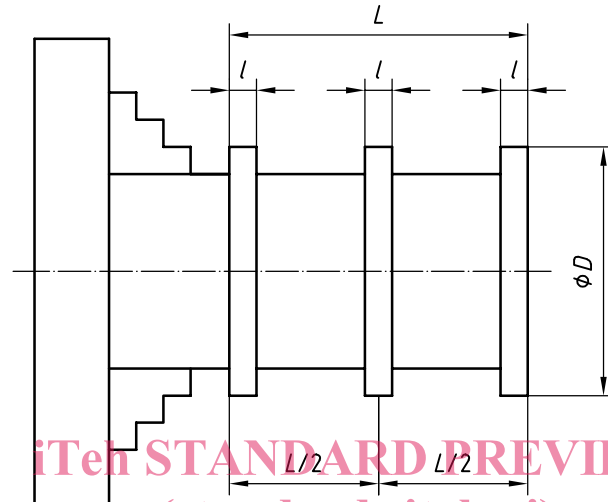
Table 1 — Size range for machines with horizontal workholding spindle

Criterion	Category 1	Category 2	Category 3
Swing diameter over bed	$D \leq 250$	$250 < D \leq 500$	$500 < D \leq 1\ 000$
Nominal bar diameter	$d' \leq 25$	$25 < d' \leq 63$	$63 < d'$
Nominal chuck diameter ^a	$d \leq 125$	$125 < d \leq 250$	$250 < d$
NOTE The choice of the criteria is at the manufacturer's discretion.			
^a Nominal chuck diameter is defined in ISO 3442-1.			

4 Machining tests

Object Turning a cylindrical test piece a) circularity b) consistency of machined diameters	M1
---	-----------

Diagram



For machines with horizontal workholding spindle:

$D_{\min} = 0,3 \times L$ where, for bar machines, $L = 2,5 \times d'$ (nominal bar diameter);
<https://standards.iteh.ai/catalog/standards/sist/2695dca6-c81-4c01-81f8-284c3a7d783/iso-13041-6-2005>

For chucking machines, whichever is the smaller of the following values:

$L = 0,8 \times d$ (nominal chuck diameter), or $0,66 \times$ the maximum turning length.

l should be chosen to suit the measuring instrument.

For machines with a vertical workholding spindle, see the note in Observations.

Tolerance	Measured deviation		
Machines with horizontal workholding spindle			
	Category 1	Category 2	Category 3
a) circularity	0,005	0,005	0,005
b) consistency of machined diameters	0,01	0,015	0,02

Measuring instruments

For a): roundness measuring machine

For b): micrometer

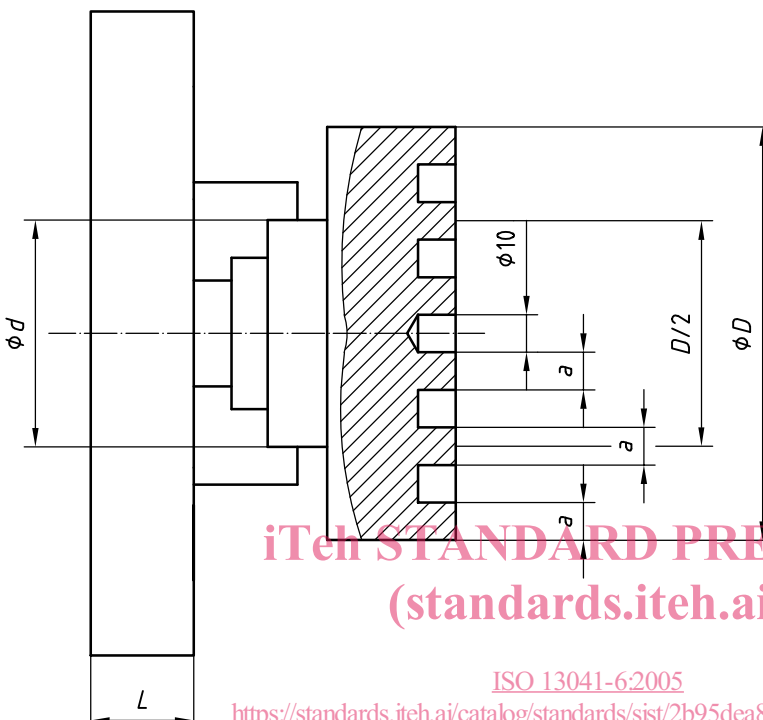
Observations and references to ISO 230-1:1996

4.1, 6.6, 6.8

For b), readings are taken at each band in one plane only, the variation of the readings between adjacent bands shall not exceed 75 % of the tolerance.

The machine axes used shall be recorded.

NOTE This test piece is defined for machines with horizontal workholding spindle only. Machines with vertical workholding spindle will be included as soon as ISO 13041-2 and ISO 13041-3 are published. Test M1 may be used for machines with vertical workholding spindle subject to agreement on the sizes between manufacturer and user.

<p>Object</p> <p>Checking of the flatness of surfaces perpendicular to the spindle axis</p>	<p>M2</p>								
<p>Diagram</p>  <p>For machines with horizontal workholding spindles:</p> <p>a = should be chosen to suit the measuring instrument</p> <p>$d = 0,5 \times D$ or nominal bar diameter</p> <p>$d_{\min} = 75$ mm for chucking machines</p> <p>$D = 0,8 \times$ nominal chuck diameter or $1 \times$ nominal bar diameter</p> <p>$D_{\max} = 300$</p> <p>For $D \leq 160$, the middle ring may be omitted</p> <p>For $D \leq 60$, all grooves may be omitted.</p> <p>$L = 0,25 \times$ nominal chuck diameter</p> <p>$L_{\max} = 60$</p> <p>For machines with a vertical workholding spindle, see the note in Observations</p> <p style="text-align: center;">iTeH STANDARD PREVIEW (standards.iteh.ai)</p> <p style="text-align: center;">ISO 13041-6:2005 https://standards.iteh.ai/catalog/standards/sist/2b95dea8-cf81-4c01-81f8-284c3af7d783/iso-13041-6-2005</p>									
<p>Tolerance</p> <p>Machines with horizontal workholding spindle</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th></th> <th style="text-align: center;">Category 1</th> <th style="text-align: center;">Category 2</th> <th style="text-align: center;">Category 3</th> </tr> </thead> <tbody> <tr> <td>Flatness</td> <td style="text-align: center;">0,010</td> <td style="text-align: center;">0,015</td> <td style="text-align: center;">0,020</td> </tr> </tbody> </table>		Category 1	Category 2	Category 3	Flatness	0,010	0,015	0,020	<p>Measured deviation</p>
	Category 1	Category 2	Category 3						
Flatness	0,010	0,015	0,020						
<p>Measuring instruments</p> <p>Dial gauge, surface plate or coordinate measuring machine (CMM)</p>									
<p>Observations and references to ISO 230-1:1996 4.1; 5.321.1</p> <p>Measurements shall be recorded from at least two diameters.</p> <p>No deviation shall result in a convex surface except by special agreement.</p> <p>The machine axes used shall be recorded.</p> <p>NOTE This test piece is defined for machines with a horizontal workholding spindle only. Machines with vertical workholding spindle will be included as soon as ISO 13041-2 and ISO 13041-3 are published. Test M2 may be used for machines with a vertical workholding spindle subject to agreement on the sizes between manufacturer and user. The diameter d is used for workpiece holding only in order to prevent distortion of the test piece blank due to clamping forces.</p>									