
**Machine tools — Test conditions for
surface grinding machines with vertical
grinding wheel spindle and reciprocating
table — Testing of the accuracy**

*Machines-outils — Conditions d'essai des machines à rectifier les surfaces
planes, à broche porte-meule à axe vertical — Contrôle de la précision*

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Contents

	Page
1 Scope	1
2 Normative reference	1
3 Preliminary remarks	1
3.1 Measuring units	1
3.2 Reference to ISO 230-1	2
3.3 Testing sequence	2
3.4 Tests to be performed	2
3.5 Measuring instruments	2
3.6 Machining tests	2
3.7 Minimum tolerance	2
4 Geometric tests	3
4.1 Linear axes	3
4.2 Table	8
4.3 Spindle	11
5 Machining tests	14
Annex A Bibliography	16

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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.

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.

International Standard ISO 1985 was prepared by Technical Committee ISO/TC 39, *Machine tools*, Subcommittee SC 2, *Test conditions for metal cutting machine tools*.

This third edition cancels and replaces the second edition (ISO 1985:1985), of which it constitutes a technical revision.

Annex A of this International Standard is for information only.

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Machine tools — Test conditions for surface grinding machines with vertical grinding wheel spindle and reciprocating table — Testing of the accuracy

1 Scope

This International Standard specifies, with reference to ISO 230-1, both geometric and machining tests on general purpose, normal accuracy, surface grinding machines with reciprocating table and vertical grinding wheel spindle. It also specifies the applicable tolerances corresponding to the above-mentioned tests.

This International Standard is not applicable to surface grinding machines with fixed or rotating tables or to machines having longitudinal traverse of the wheel head.

This International Standard deals only with the verification of the geometric accuracy of the machine. It does not apply to the testing of the machine operation (vibrations, abnormal noises, stick-slip motion of components, etc.) nor to the checking of its characteristics (such as speeds, feeds, etc.), which should generally be checked before testing the accuracy.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

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

3 Preliminary remarks

3.1 Measuring units

In this International Standard, all linear dimensions, deviations and corresponding tolerances are expressed in millimeters; angular dimensions are expressed in degrees, and angular deviations and the corresponding tolerances are expressed in principle in ratios, but in some cases, microradians or arcseconds may be used for clarification purposes. The equivalence of the following expressions should always be kept in mind:

$$0,010/1\ 000 = 10 \times 10^{-6} = 10 \mu\text{rad} \approx 2''$$

3.2 Reference to ISO 230-1

To apply this International Standard, reference shall be made to ISO 230-1, especially for the installation of the machine before testing, warming up of the spindle and other moving components, description of measuring methods and recommended accuracy of testing equipment.

In the "Observations" block of the tests described in the following sections, the instructions are followed by a reference to the corresponding clause in ISO 230-1 in cases where the test concerned is in compliance with the specifications of ISO 230-1.

3.3 Testing sequence

The sequence in which the tests are presented in this International Standard 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.

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 International Standard. 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.

3.5 Measuring instruments

The measuring instruments indicated in the tests described in the following clauses are examples only. Other instruments measuring the same quantities and having at least the same accuracy may be used. Dial gauges shall have a resolution of 0,001 mm.

3.6 Machining tests

Machining tests shall be made with finishing cuts only, not with roughing cuts which are liable to generate appreciable cutting forces.

3.7 Minimum tolerance

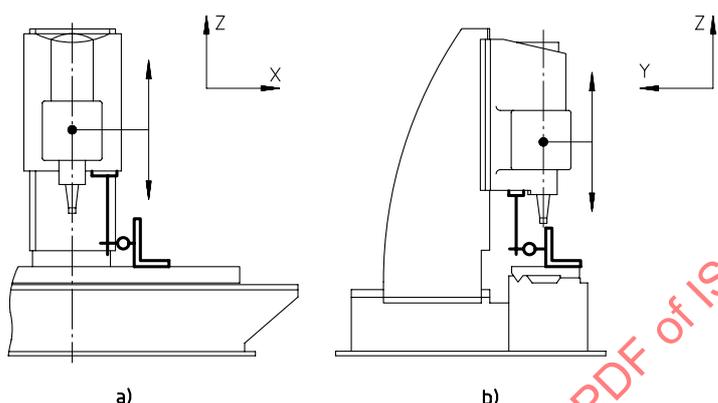
When the tolerance for a geometric test is established for a measuring length different from that given in this International Standard (see 2.311 of ISO 230-1:1996), it shall be taken into consideration that the minimum value of tolerance is 0,005 mm.

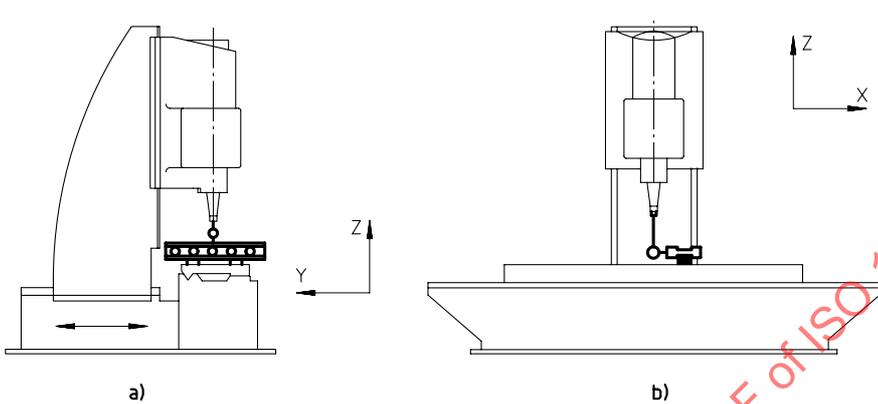
4 Geometric tests

4.1 Linear axes

<p>Object</p> <p>Checking of straightness of the table movement (X-axis): a) in the vertical ZX-plane; b) in the horizontal XY-plane.</p>		<p>G1</p>
<p>Diagram</p> <p>The diagram consists of two parts, (a) and (b). Part (a) shows a vertical cross-section of a grinding machine table. A dial gauge is mounted on a vertical spindle, with its stylus touching a straightedge that is laid parallel to the table's longitudinal movement. A coordinate system is shown with the Z-axis pointing upwards and the X-axis pointing to the right. Part (b) shows a side view of a grinding machine table. A dial gauge is mounted on a horizontal spindle, with its stylus touching a straightedge. A coordinate system is shown with the Z-axis pointing upwards and the Y-axis pointing to the left.</p>		
<p>Tolerance</p> <p>For a) and b) 0,01 for measuring lengths up to 1 000 For each 1 000 increase in length, add 0,01 to the preceding tolerance Maximum tolerance: 0,025</p>		<p>(Measured deviation)</p> <p>a) b)</p>
<p>Measuring instruments</p> <p>Straightedge and dial gauge, or taut wire and microscope [for b) only] or optical methods</p>		
<p>Observations and references to ISO 230-1</p> <p>The dial gauge support should be placed on the grinding spindle nose or on the head near the spindle, the stylus touching a straightedge laid parallel to the general direction of the longitudinal movement of the table.</p>		<p>5.232.1</p>

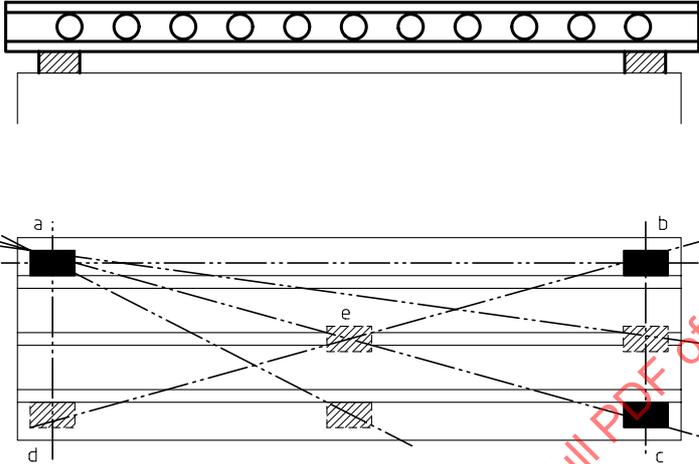
Object		G2	
<p>Checking of angular deviations of the table movement (X-axis):</p> <p>a) in the longitudinal ZX-plane (pitch EBX);</p> <p>b) in the transverse YZ-plane (roll EAX).</p>			
Diagram			
Tolerance		(Measured deviation)	
a) 0,04/1 000	b) 0,02/1 000	a)	b)
Measuring instruments			
Precision level or optical angular deviation measuring instruments			
Observations and references to ISO 230-1		5.232.2	
<p>The level or the instrument shall be placed longitudinally for a) and transversely for b)</p> <p>1) on the first 300 mm of the table surface;</p> <p>2) on the centre of the table;</p> <p>3) on the last 300 mm of the table surface.</p> <p>When X-axis motion causes an angular movement of both spindle head and work-holding table, differential measurements of the two angular movements shall be made and this shall be stated.</p> <p>The reference level (when used) shall be located on the spindle head, and the spindle head shall be in the middle of the travel range.</p> <p>Measurements shall be taken at a number of positions equally spaced along the travel.</p> <p>The difference between the maximum reading and the minimum reading of the two directions shall not exceed the tolerance, both for the centre of the table and for the ends of the table.</p>			

<p>Object</p> <p>Checking of straightness of the vertical movement of the wheelhead (Z-axis) and of squareness between the above movement and the table surface:</p> <p>a) in the longitudinal ZX vertical plane;</p> <p>b) in the transverse YZ vertical plane.</p>	<p>G3</p>		
<p>Diagram</p> 			
<p>Tolerance</p> <p>For a) and b) 0,02 for a measuring length of 300.</p>	<p>(Measured deviation)</p> <table border="1" style="width: 100%; text-align: center;"> <tr> <td style="width: 50%;">a)</td> <td style="width: 50%;">b)</td> </tr> </table>	a)	b)
a)	b)		
<p>Measuring instruments</p> <p>Dial gauge and square</p>			
<p>Observations and references to ISO 230-1 5.522.2</p> <p>Clamp the wheelhead, if possible, when taking measurements.</p> <p>If the spindle can be locked, the dial gauge may be mounted on it. If the spindle cannot be locked, the dial gauge should be placed on a fixed part of the wheelhead.</p>			

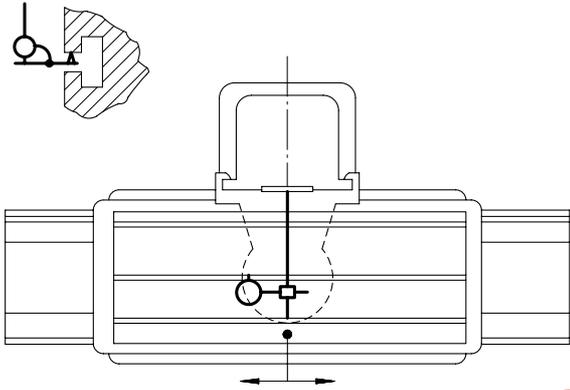
<p>Object</p> <p>Checking of straightness of the column movement (Y-axis):</p> <p>a) in the vertical ZY-plane;</p> <p>b) in the horizontal XY-plane.</p>	<p>G4</p>
<p>Diagram</p> 	
<p>Tolerance</p> <p>For a) and b) 0,01 for measuring lengths up to 1 000</p> <p>For each 1 000 increase in length, add 0,01 to the preceding tolerance</p> <p>Maximum tolerance: 0,025</p>	<p>(Measured deviation)</p> <p>a)</p> <p>b)</p>
<p>Measuring instruments</p> <p>Straightedge and dial gauge, or taut wire and microscope [for b) only] or optical methods</p>	
<p>Observations and references to ISO 230-1 5.232.1</p> <p>The dial gauge support should be placed on the grinding spindle nose or on the head near the spindle, the stylus touching a straightedge laid parallel to the general direction of the movement of the column.</p>	

Object		G5	
Checking of angular deviations of the column movement (Y-axis): a) in the ZX-plane (roll EBY); b) in the YZ-plane (pitch EAY).			
Diagram			
Tolerance		(Measured deviation)	
a) 0,02/1 000	b) 0,04/1 000	a)	b)
Measuring instruments			
Precision level or optical angular deviation measuring instruments			
Observations and references to ISO 230-1		5.232.2	
The level or the instrument shall be placed transversely for a) and longitudinally for b). When Y-axis motion causes an angular movement of both spindle head and work-holding table, differential measurements of the two angular movements shall be made and this shall be stated. The reference level (when used) shall be located on the work-holding table, and the spindle head shall be in the middle of the travel range. Measurements shall be taken at a number of positions equally spaced along the travel. The difference between the maximum reading and the minimum reading of the two directions shall not exceed the tolerance, both for the centre of the table and for the ends of the table.			

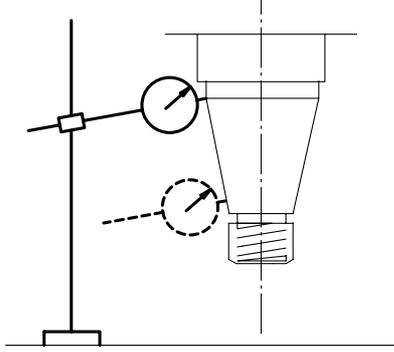
4.2 Table

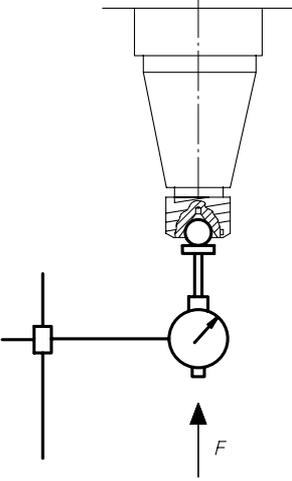
<p>Object</p> <p>Checking of flatness of the table surface.</p>	<p>G6</p>
<p>Diagram</p> 	
<p>Tolerance</p> <p>0,01 for measuring lengths up to 1 000 For each 1 000 increase in length, add 0,01 to the preceding tolerance Maximum tolerance: 0,04 Local tolerance: 0,005 over any measuring length of 300</p>	<p>(Measured deviation)</p>
<p>Measuring instruments</p> <p>Straightedge and gauge blocks or precision level</p>	
<p>Observations and references to ISO 230-1</p> <p>Table not locked and positioned at the centre of travel.</p> <p style="text-align: right;">5.322 and 5.323</p>	

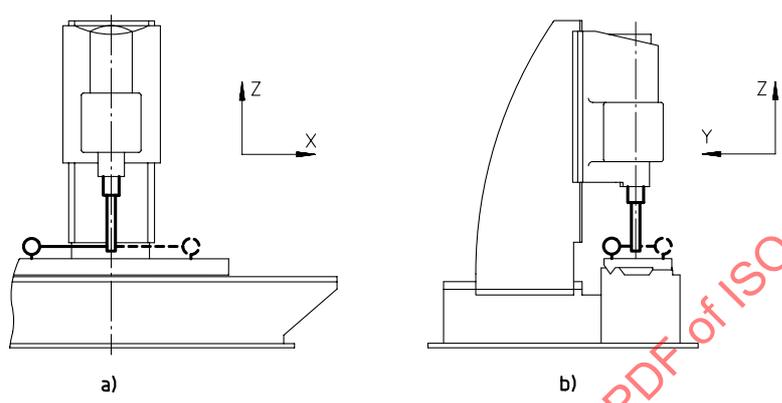
Object		G7
<p>Checking of parallelism between the table surface and</p> <p>a) its longitudinal movement (X-axis);</p> <p>b) the transverse movement of the wheel head column or the table (Y-axis). (Only for machines having this movement.)</p>		
Diagram		
Tolerance	Alternative	(Measured deviation)
<p>a) $0,010 \times L/1\ 000$ Maximum tolerance: 0,030 Local tolerance: 0,003 for any measuring length of 300</p> <p>b) $0,007 \times L/1\ 000$</p> <p>where L is the measuring length</p>	<p>a) $0,007 \times L/1\ 000$ Maximum tolerance: 0,020</p> <p>b) $0,007 \times L/1\ 000$</p>	<p>a)</p> <p>b)</p>
Measuring instruments	Alternative	
Dial gauge	Dial gauge and precision straightedge	
Observations and references to ISO 230-1	5.422.21	
Alternative		
<p>1) Checking by direct contact with the table. If the spindle can be locked, the dial gauge may be mounted on it. If the spindle cannot be locked, the dial gauge should be placed on a fixed part of the machine. The stylus is to be placed approximately in the wheel spindle axis.</p>	<p>2) Checking with a straightedge. It is unnecessary to follow the test code ISO 230-1. The checking should be made on a straightedge laid parallel to the table surface and placed in the direction of the movement concerned.</p>	

<p>Object</p>	<p>G8</p>
<p>Checking of parallelism between the median or reference T-slot and the longitudinal movement of the table (X-axis).</p> <p>(Only for machines having transverse movement of the wheel head or the table.)</p>	
<p>Diagram</p> 	
<p>Tolerance</p> <p>0,015 for measuring lengths up to 1 000 For each 1 000 increase in length, add 0,01 to the preceding tolerance Maximum tolerance: 0,05 Local tolerance: 0,008 over any measuring length of 300</p>	<p>(Measured deviation)</p>
<p>Measuring instruments</p> <p>Dial gauge</p>	
<p>Observations and references to ISO 230-1 5.422 and 5.422.21</p> <p>If the spindle can be locked, the dial gauge may be mounted on it. If the spindle cannot be locked, the dial gauge should be placed on a fixed part of the machine.</p>	

4.3 Spindle

Object	G9
Checking of the run-out of the wheel spindle nose.	
Diagram 	
Tolerance 0,005	(Measured deviation)
Measuring instruments Dial gauge	
Observations and references to ISO 230-1 5.612.1 and 5.612.2 <p>The stylus of the dial gauge should be set normal to the surface which is to be checked. Checking should be carried out at each extremity of the taper. This is not stated in the test code ISO 230-1.</p>	

Object	G10
Checking of periodic axial slip of the wheel spindle.	
Diagram 	
Tolerance 0,005	(Measured deviation)
Measuring instruments Dial gauge	
Observations and references to ISO 230-1 5.622.1 and 5.622.2 <p>A force F, specified by the supplier/manufacturer of the machine, should be exerted coaxially with the spindle.</p> <p>The line of action of the stylus of the dial gauge should be coaxial with the spindle.</p> <p>When preloaded bearings are used, there is no need to apply force F.</p>	

<p>Object</p> <p>Checking of squareness between the wheel spindle axis and the table surface: a) in the longitudinal ZX-plane; b) in the transverse YZ-plane. (For machines which have no wheel spindle regulation in that plane.)</p>		<p>G11</p>
<p>Diagram</p> 		
<p>Tolerance</p> <p>For a) and b) 0,01/300¹</p> <p>Where 300 is the distance between the two measuring points touched.</p>	<p>(Measured deviation)</p> <p>a)</p> <p>b)</p>	
<p>Measuring instruments</p> <p>Dial gauge</p>		
<p>Observations and references to ISO 230-1 5.512.1 and 5.512.42</p> <p>Table in central position.</p> <p>Wheelhead clamped if possible.</p>		