
**Machine tools — Test conditions for
external cylindrical and universal grinding
machines with a movable table — Testing
of the accuracy**

*Machine-outils — Conditions d'essai des machines à rectifier les surfaces
de révolution extérieures et à rectifier universelles à table mobile —
Contrôle de la précision*

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Printed in Switzerland

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 2433 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 2433:1984), which has been technically revised.

Annex A of this International Standard is for information only.

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Machine tools — Test conditions for external cylindrical and universal grinding machines with a movable table — Testing of the accuracy

1 Scope

This International Standard describes, with reference to ISO 230-1 and ISO 230-2, geometric tests, machining tests and tests for accuracy and repeatability of positioning axes on general purpose and normal-accuracy external cylindrical and universal grinding machines with a movable table. It also specifies the applicable tolerances corresponding to the above-mentioned tests.

This International Standard applies to machines with a swing diameter of up to 800 mm and a distance between centres of up to 4 000 mm.

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

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This International Standard provides the terminology used for the principal components of the machine and the designation of the axes with reference to ISO 841:ISO 2433:1999

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NOTE In addition to terms used in two of the three official ISO languages (English and French), this International Standard gives in annex A (informative) the equivalent terms in German and Italian; these terms are published under the responsibility of the member bodies for Germany (DIN) and Italy (UNI). However, only the terms given in the official languages can be considered as ISO terms.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC 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.*

ISO 230-2:1997, *Test code for machine tools — Part 2: Determination of accuracy and repeatability of positioning of numerically controlled axes.*

3 Description, terminology, and designation of axes

3.1 Description of machines

3.1.1 Generalities

This International Standard deals with both external cylindrical grinding machines and universal grinding machines with movable tables. Although the constructions of both machines are very similar, the machine functions are different.

The universal grinding machine can grind external and internal, cylindrical and conical surfaces. Whereas the external cylindrical grinding machine can grind only the external cylindrical surfaces and, in some cases, the external conical surfaces.

Both machines have two principal linear movements of the table (Z-axis) and the wheelhead (X-axis) on the bed. These movements are generally at right angles. In some machines, these two movements cross with an oblique angle and are called angular-slide cylindrical grinding machines.

The main components of external cylindrical and universal grinding machines are described below:

3.1.2 Bed

The bed has separate slideways for the table and grinding wheelhead which are generally at 90° to each other.

3.1.3 Table saddle

The table saddle supports the table and moves on the bed slideway (Z-axis).

3.1.4 Table

The workhead, tailstock and, when necessary, steady rests are mounted on the table. The workpiece is supported between the workhead spindle and tailstock spindle. The table can swivel on the table saddle in the case of a universal grinding machine; but in the case of the external cylindrical grinding machine, swivelling is not an essential function. When there is no need for swivelling, the table and table saddle may be constructed as one unit.

3.1.5 Workhead

The workhead rotates the workpiece which is mounted on the workholding chuck or supported between centres. In the case of the universal grinding machine, the workhead may swivel. The workhead may be of a fixed type on the external cylindrical grinding machines.

3.1.6 Tailstock

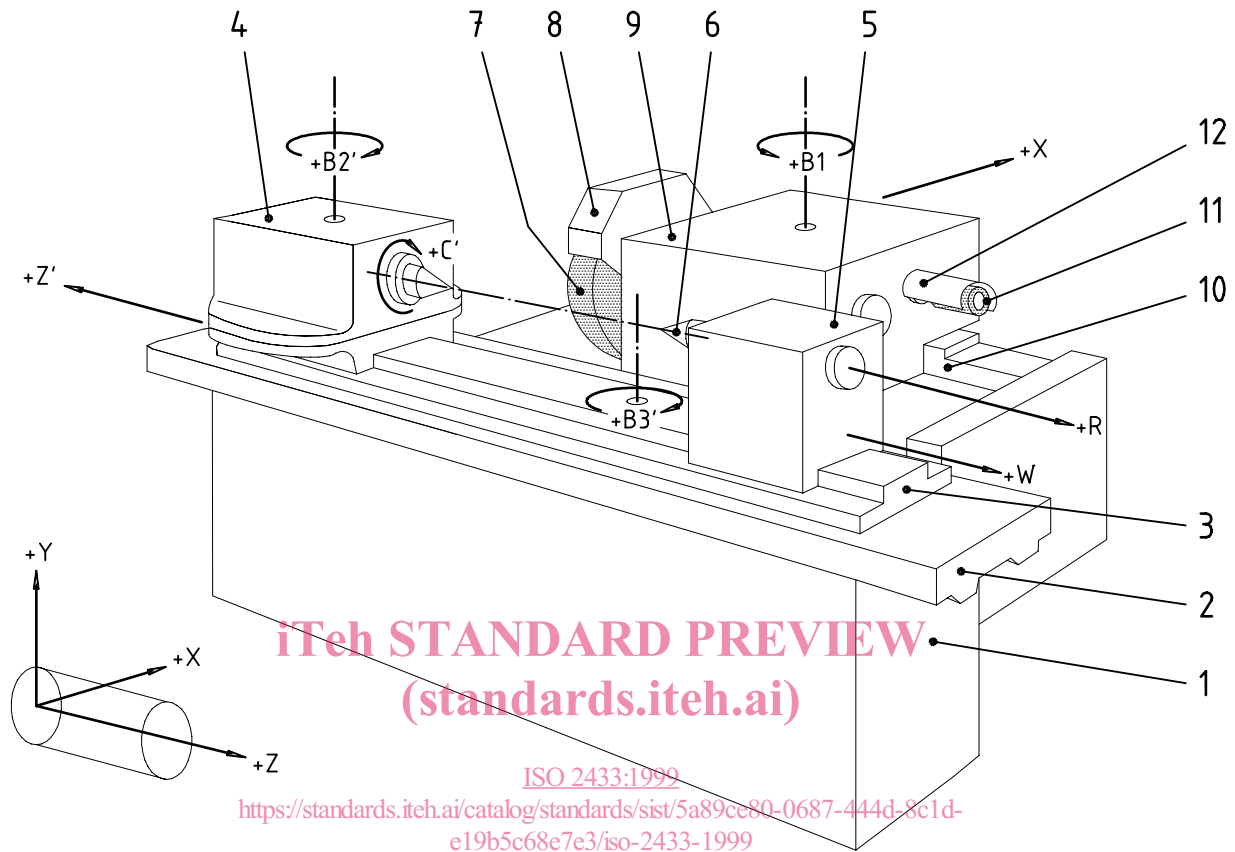
The tailstock can move on the tabletop for adjusting the distance between centres. The tailstock quill movement is used for fine adjusting (work loading).

3.1.7 Wheelhead

The wheelhead is mounted on the wheelhead saddle and may swivel. The grinding wheel is mounted on the wheelhead spindle. In the case of the universal grinding machine, the internal grinding spindle is integral, or attachable, to the wheelhead. The axis of the wheel spindle is in the zero position of swivelling, parallel to the table movement.

3.2 Terminology and designation of axes

For simplicity, only one example of a universal grinding machine is shown in Figure 1.



NOTE Axis B1 is used for convenience

Figure 1 — Universal grinding machine

Table 1 — Terminology

Reference	English	French
1	Bed	Banc
2	Table saddle	Selle
3	Table, swivelling	Table pivotante
4	Workhead	Poupée porte-pièce
5	Tailstock	Contre-poupée
6	Tailstock quill	Fourreau contre-poupée
7	Grinding wheel	Meule
8	Wheel guard	Carter de protection
9	Wheelhead	Poupée porte-meule
10	Wheelhead saddle	Selle de poupée porte-meule
11	Internal grinding wheel	Meule intérieure
12	Wheel guard for internal grinding wheel	Dispositif de protection pour meule intérieure

4 Preliminary remarks

4.1 Measuring units

In this International Standard, 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 primarily expressed 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:

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

4.2 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" box of the tests described in clauses 5, 6 and 7, 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 that part of ISO 230.

4.3 Testing sequence

The sequence in which the tests are presented in this International Standard does not define the practical order of testing. In order to make the mounting of instruments or gauging easier, tests may be performed in any order.

4.4 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. Mere reference to this International Standard 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.

4.5 Measuring instruments

The measuring instruments indicated in the tests described in clauses 5, 6 and 7 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 or better.

4.6 Machining tests

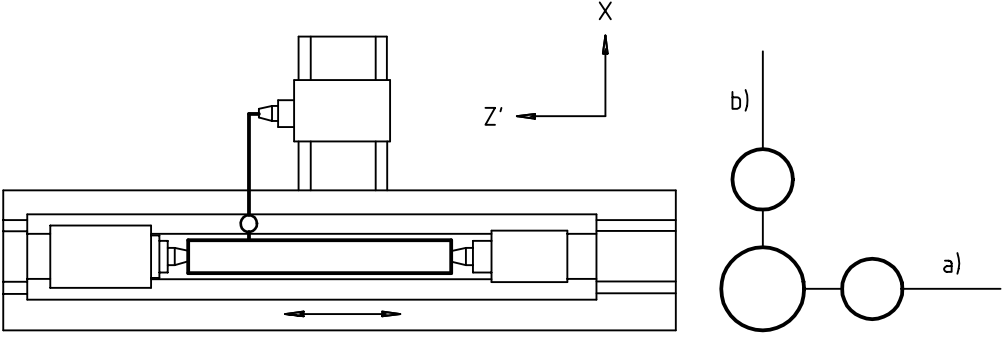
Machining tests shall be made with finishing cuts only. Roughing cuts shall be avoided since they are liable to generate appreciable cutting forces.

4.7 Minimum tolerance for geometric tests

When establishing the tolerance 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.

5 Geometric tests

5.1 Linear axes of motion

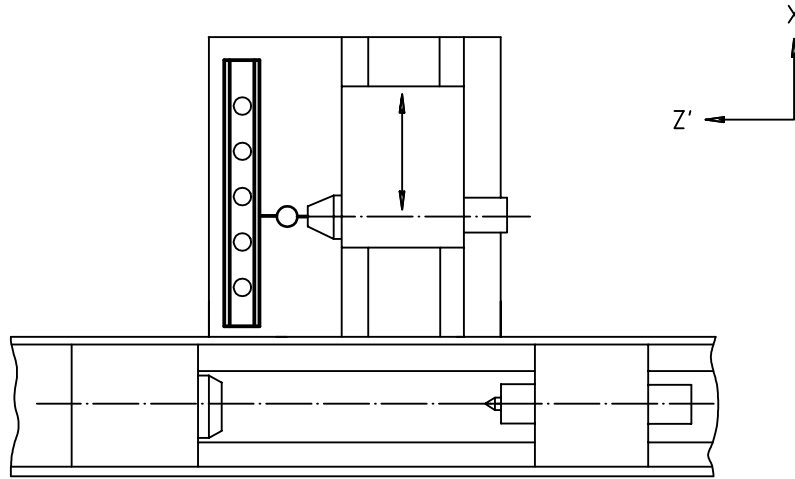
Object	G1
<p>a) Checking of straightness of the table-saddle movement (Z-axis) in the horizontal ZX-plane.</p> <p>b) Checking of parallelism of the axis between the centres of the workhead spindle and the tailstock quill and the table-saddle movement (Z-axis) in the vertical YZ-plane.</p>	
Diagram 	
Tolerance <p>a) 0,01 for a measuring length of up to 1 000 Add 0,005 for each additional 1 000 or part thereof</p> <p>b) 0,02 for a measuring length of up to 1 000 Add 0,005 for each additional 1 000 or part thereof</p>	Measured deviation <p>a)</p> <p>b)</p>
Measuring instruments <p>a) Dial gauge and test mandrel between centres or straightedge, or optical method, or taut wire and microscope or laser method.</p> <p>b) Dial gauge and test mandrel between centres.</p>	
Observations and references to ISO 230-1 <p>5.212 (Figure 11), 5.232.11, 5.232.12, 5.232.13, 5.232.14 and 5.422.3</p> <p>Test mandrel of sufficient length shall be used as the reference.</p> <p>Workhead and table, when of the swivelling type, shall be set at zero position of swivelling. Tailstock quill retracted.</p> <p>Move the table and take measurements at a number of equally spaced positions.</p> <p>Determination of straightness deviation shall be in accordance with ISO 230-1:1996, 5.212.1 but the maximum difference of the readings may be substituted as the straightness deviation.</p>	

G2

Object

Checking of straightness of the wheelhead-saddle movement (X-axis) in the horizontal ZX-plane.

Diagram



Tolerance

0,02 for full travel

Measured deviation

Measuring instruments

Straightedge and dial gauge or optical methods

Observations and references to ISO 230-1

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5.232.11, 5.232.13 and 5.232.14

Place a straightedge on the fixed part of the machine using gauge blocks near the wheel-spindle nose so that its reference face is parallel^a to the X-axis movement in the horizontal ZX-plane.

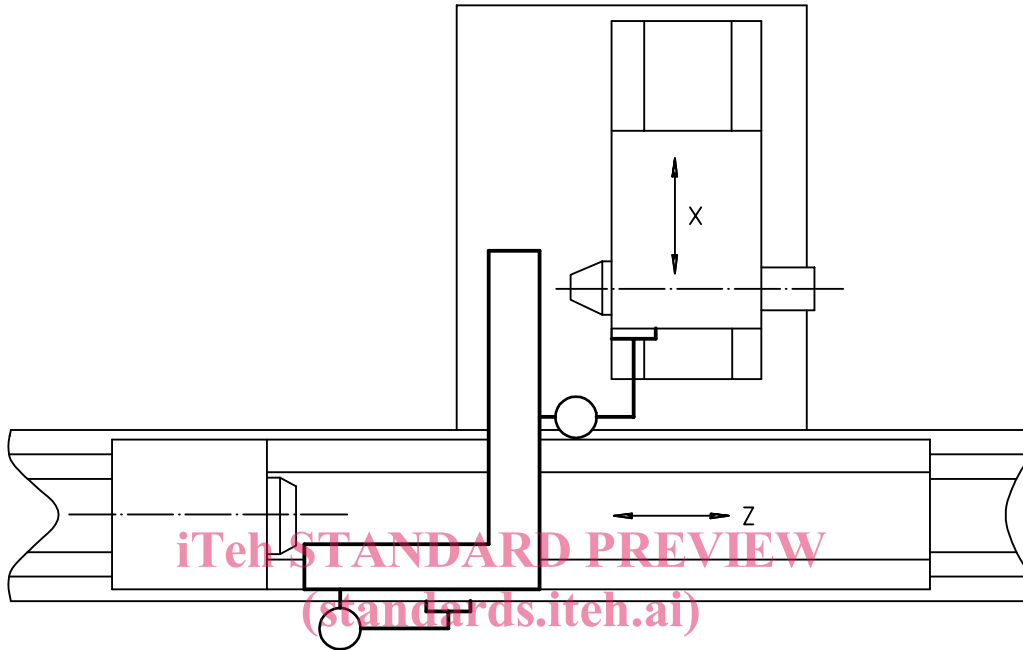
Set a dial gauge on the wheelhead near its spindle. The stylus shall touch the reference face of the straightedge.

Move the wheelhead and take measurements at a number of positions equally spaced. The maximum difference of the readings is the straightness deviation.

^a Parallel means that the dial gauge readings at both ends are the same. In this case, the maximum difference of the readings gives the straightness deviation.

G3**Object**

Checking of squareness of the wheelhead-saddle movement (X-axis) to the table-saddle movement (Z-axis), where applicable.

Diagram**Tolerance**

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<https://standards.iteh.ai/catalog/standards/sist/5a89ce80-0687-444d-8c1d-c195c68c7c9/iso-2433-1999>
 0,02 for a measuring length of 300

Measured deviation**Measuring instruments**

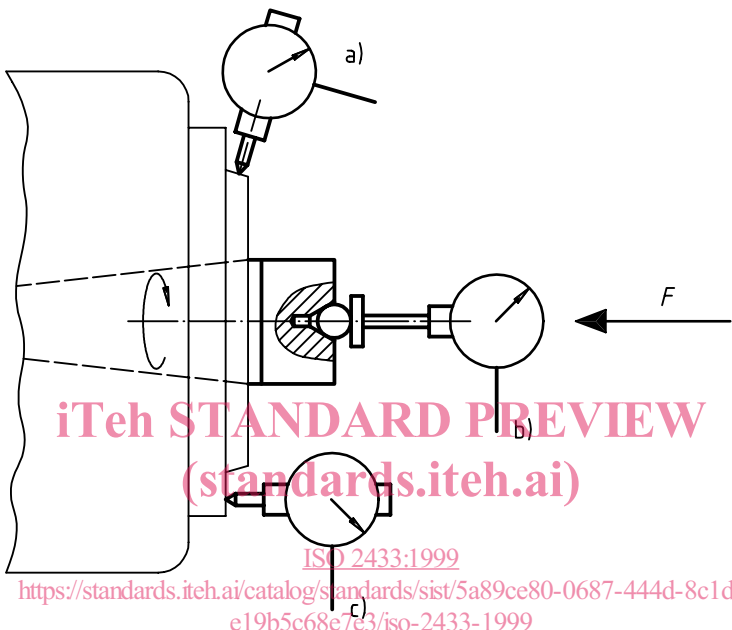
Square and dial gauge

Observations and references to ISO 230-1

5.522.4

Adjust one arm of the square to be parallel to the table movement (Z-axis). Set a dial gauge on the wheelhead and touch the other arm of the square during the transverse movement (X-axis).

5.2 Workhead

<p>Object</p>		<p>G4</p>
<p>Checking of the workhead live spindle:</p> <ul style="list-style-type: none"> a) run-out of the external register diameter; b) periodic axial slip; c) camming of the register face (including periodic axial slip). 		
<p>Diagram</p>  <p style="text-align: center;"> https://standards.iteh.ai/catalog/standards/sist/5a89ce80-0687-444d-8c1d-e19b5c68e7e3/iso-2433-1999 </p>		
<p>Tolerance</p> <p style="text-align: center;">a) 0,005 b) 0,005 c) 0,01</p>	<p>Measured deviation</p> <p style="text-align: center;">a) b) c)</p>	
<p>Measuring instruments</p> <p>Dial gauge</p>		
<p>Observations and references to ISO 230-1</p> <p>a) 5.612.2</p> <p>In the case of a tapered spindle nose, the stylus of the dial gauge shall be set normal to the surface to be checked.</p> <p>b) and c) 5.621.2, 5.622.1, 5.622.2 and 5.632</p> <p>The value and the direction of the axial force F to be applied shall be specified by the supplier/manufacturer.</p> <p>When preloaded bearings are used, there is no need to apply the force F.</p>		