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**Test conditions for boring and milling  
machines with horizontal spindle —**

**Part 2:  
Table-type machines**

*Conditions d'essai des machines à aléser et à fraiser, à broche  
horizontale — Contrôle de la précision —*

*Partie 2: Machines à montant fixe*

ISO 3070-2:1997

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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 3070-2 was prepared by Technical Committee ISO/TC 39, *Machine Tools*, Subcommittee SC 2, *Test conditions for metal cutting machine tools*.

This second edition of ISO 3070-2 cancels and replaces the first edition of ISO 3070-1 which has been technically revised.

ISO 3070 consists of the following parts, under the general title *Test conditions for boring and milling machines with horizontal spindle — Testing of the accuracy*:

- *Part 0: General introduction (to become part 1 on its next revision)*
- *Part 2: Table-type machines (formerly part 1)*
- *Part 3: Floor-type machines (formerly part 2)*
- *Part 4: Planer type machines with movable column (formerly part 3)*

Annex A of this part of ISO 3070 is for information only.



# Test conditions for boring and milling machines with horizontal spindle — Testing of the accuracy

## Part 2: Table-type machines

### 1 Scope

This part of ISO 3070 specifies, with reference to ISO 230-1 and ISO 230-2, geometric tests, tests and tests for checking accuracy and repeatability of positioning by numerical control, on general purpose, normal accuracy, table type boring and milling machines with horizontal spindle. These types of machine tools are defined in sub-clause 3.1 of ISO 3070-0:1982. This part of ISO 3070 also specifies the applicable tolerances corresponding to the above mentioned tests.

These machines can be provided with spindle heads of different types corresponding in most cases to figures:

- 4 (spindle head with sliding boring spindle and milling spindle)
- 5 (spindle head with sliding boring spindle and with facing head)
- 6 (spindle head with ram or milling ram)

of ISO 3070-0:1982.

In addition, it should be noted that this part of ISO 3070 concerns machines which have both longitudinal (W-axis) and transverse (X-axis) movement of the table, a vertical movement of the spindle head (Y-axis) and may include a rotary or indexing table.

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

### 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 3070. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 3070 are encouraged to investigate the possibility of applying the most recent editions of the standards 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.*

- ISO 230-2:—<sup>1)</sup>, *Test code for machine tools — Part 2: Determination of accuracy and repeatability of positioning of numerically controlled machine tool axes.*
- ISO 1101:—<sup>2)</sup>, *Geometrical Product Specifications (GPS) — Geometrical tolerancing — Generalities, definitions, symbols, indications on drawings.*
- ISO 3070-0:1982<sup>3)</sup> *Test conditions for boring and milling machines with horizontal spindle — Testing of accuracy — Part 0: General introduction.*

### 3 Terminology and designation of axes

(See ISO 3070-0)

### 4 Preliminary remarks

#### 4.1 Measuring units

In ISO 3070-1, 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 in principle 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:

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

#### 4.2 Reference to ISO 230-1

To apply this part of ISO 3070, 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 that part of ISO 230.

#### 4.3 Testing sequence

The sequence in which the tests are presented in this part of ISO 3070 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.

#### 4.4 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 3070. 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 3070 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.

1) To be published. (Revision of ISO 230-2:1988)

2) To be published. (Revision of ISO 1101:1983)

3) See "Foreword".

#### 4.5 Measuring instruments

The measuring instruments indicated in the tests described in the following sections 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, not with roughing cuts which are liable to generate appreciable cutting forces.

#### 4.7 Minimum tolerance

When the tolerance for a geometric test is established for a measuring length different from that given in this part of ISO 3070 (see 2.311 of ISO 230-1:1996), it shall be taken into consideration that the minimum value of tolerance is 0,005 mm.

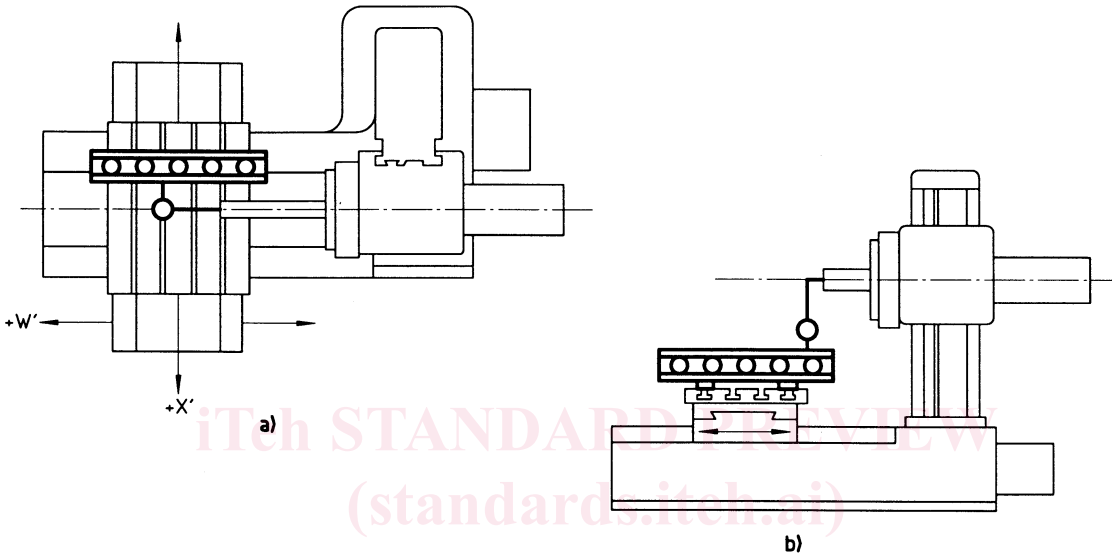
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## 5 Geometric tests

### 5.1 Straightness and angular deviations of coordinate axes

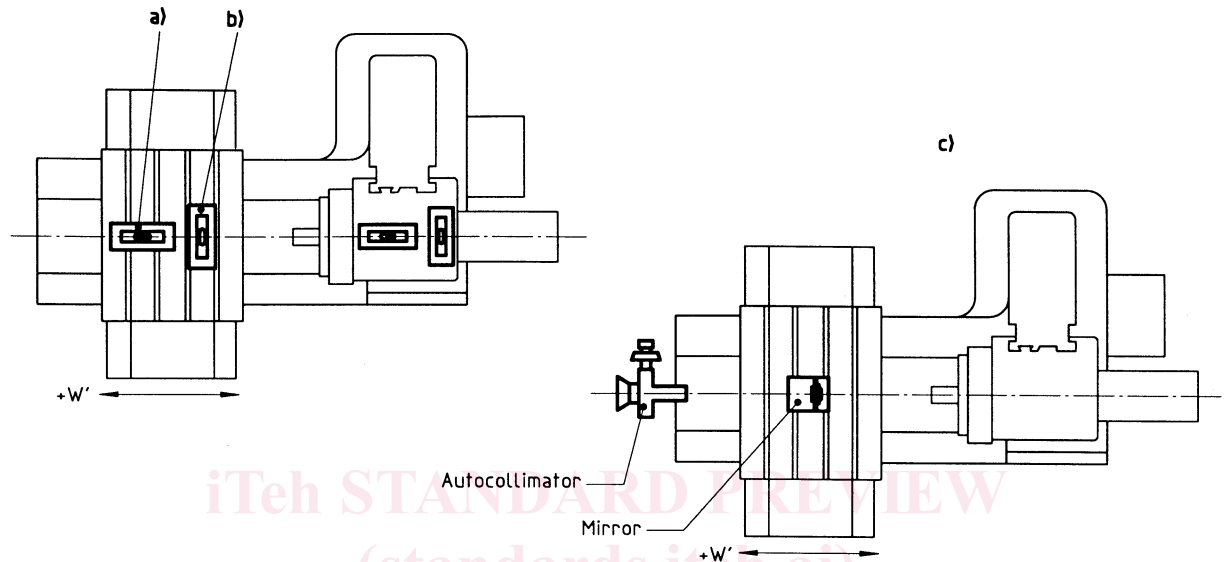
<b>Object</b>	<b>G 1</b>
Checking of straightness of the table saddle movement (W-axis): a) in the ZX-plane (horizontal plane)(EXW); b) in the YZ-plane (vertical plane)(EYW).	
<b>Diagram</b>	
	
<b>Tolerance</b> For a) and b) 0,02 for measuring lengths up to 1 000 0,03 for measuring lengths above 1 000 Local tolerance: 0,006 for any measuring length of 300	<b>(Measured deviation)</b>
<b>Measuring instruments</b>	
Straightedge, dial gauge/support and gauge blocks or optical methods.	
<b>Observations and references to ISO 230-1</b> 5.232.11 and 5.232.13	
<p>Table shall be set at its mid-travel.          Set a straightedge on the table, parallel<sup>1)</sup> to the table saddle movement (W-axis) for a) horizontally and b) vertically.</p> <p>If the spindle can be locked, mount a dial gauge on it. If the spindle cannot be locked, the dial gauge shall be mounted on the head. The stylus shall be normal to the reference face of the straightedge.</p> <p>Traverse the table saddle in the W-direction and note readings.</p> <p><sup>1)</sup> Parallel means that readings of the dial gauge touching the straightedge at both ends of the movement are the same value and in this case, the maximum difference of the readings gives the straightness deviation.</p>	



**G 2****Object**

Checking of angular deviation of the table saddle movement (W-axis):

- a) in the YZ-plane (EAW: pitch);
- b) in the XY-plane (ECW: roll);
- c) in the ZX-plane (EBW: yaw).

**Diagram****Tolerance**

For

a), b) and c) 0,04/1 000

Local tolerance: 0,02/1 000 for any measuring length of 300

**(Measured deviation)****Measuring instruments**

- a) Precision level or optical angular deviation measuring instruments
- b) Precision level
- c) Optical angular deviation measuring instruments

**Observations and references to ISO 230-1** 5.231.3 and 5.232.2

The level or instrument shall be placed on the moveable component:

- a) (EAW: pitch) in the Z-axis direction (set vertically)
- b) (ECW: roll) in the X-axis direction (set vertically)
- c) (EBW: yaw) in the Z-axis direction (set horizontally)

The reference level shall be located on the spindle head, and the spindle head shall be in the middle of the travel range.

When W 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.

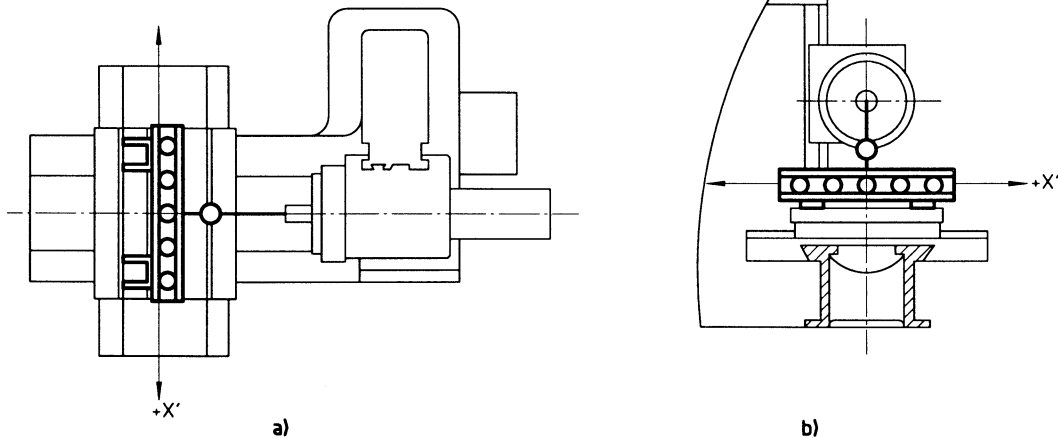
Measurements shall be carried out at a minimum of five positions equally spaced along the travel in both direction of the movement.

The difference between the maximum and the minimum readings shall not exceed the tolerance.

**Object****G 3**

Checking of straightness of the table movement (X-axis):

- a) in the ZX-plane (horizontal plane)(EZ<sub>X</sub>);
- b) in the XY-plane (vertical plane)(EY<sub>X</sub>).

**Diagram****Tolerance**

For a) and b)

0,02 for measuring lengths up to 1 000

Add 0,01 to the preceding tolerance for each 1 000 increase in length beyond 1 000

Maximum tolerance: 0,05

Local tolerance: 0,006 for any measuring length of 300

**(Measured deviation)****Measuring instruments**

Straightedge, dial gauge/support and gauge blocks or optical methods.

**Observations and references to ISO 230-1** 5.232.11 and 5.232.13

Table shall be set at its mid-travel.

Set a straightedge at the middle position of the table, parallel<sup>1)</sup> to the table saddle movement (X-axis) for a) horizontally and b) vertically.

If the spindle can be locked, mount a dial gauge on it. If the spindle can not be locked, the dial gauge shall be mounted on the head. The stylus shall be normal to the reference face of the straightedge.

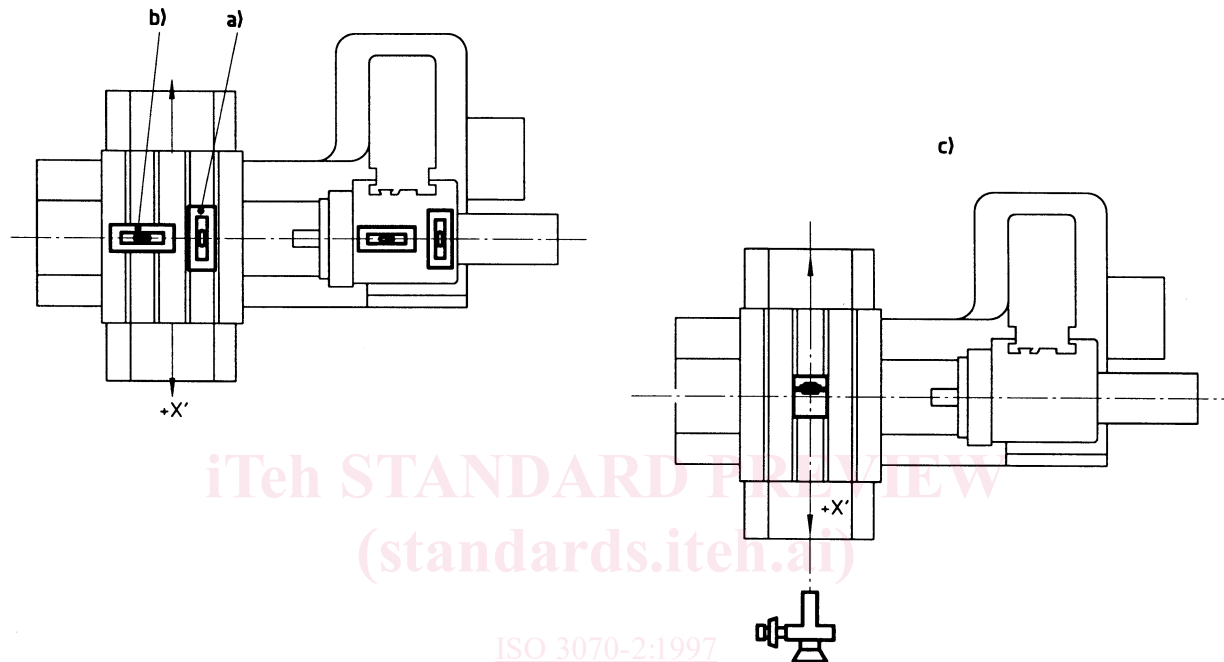
Traverse the table in the X-direction and note the readings.

1) Parallel means that readings of the dial gauge touching the straightedge at both ends of the movement are the same value and in this case, the maximum difference of the readings gives the straightness deviation.

**G 4****Object**

Checking of angular deviation of the table movement (X-axis):

- a) in the XY-plane (ECX: pitch);
- b) in the YZ-plane (EAX: roll);
- c) in the ZX-plane (EBX: yaw).

**Diagram****Tolerance**

For

a), b) and c) 0,04/1 000

Local tolerance: 0,02/1 000 for any measuring length of 300

(Measured deviation)

**Measuring instruments**

- a) Precision level or optical angular deviation measuring instruments
- b) Precision level
- c) Optical angular deviation measuring instruments

**Observations and references to ISO 230-1** 5.231.3 and 5.232.2

The level or instrument shall be placed on the movable component:

- a) (ECX: pitch) in the X-axis direction (set vertically)
- b) (EAX: roll) in the Z-axis direction (set vertically)
- c) (EBX: yaw) in the X-axis direction (set horizontally)

The reference level shall be located on the spindle head, and the spindle head shall be in the middle of the travel range.

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.

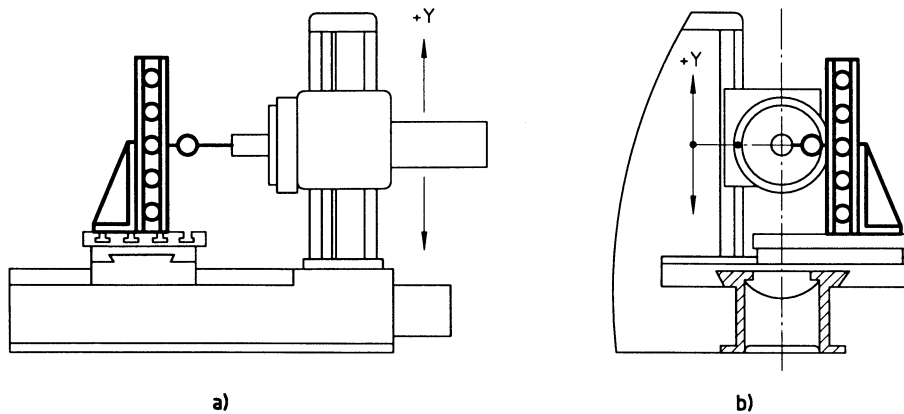
Measurements shall be carried out at a minimum of five positions equally spaced along the travel in both directions of the movement.

The difference between the maximum and the minimum readings shall not exceed the tolerance.

**Object****G 5**

Checking of straightness of the spindle head movement (Y-axis):

- a) in the YZ-plane (vertical plane coaxial with spindle axis)(EZY);
- b) in the XY-plane (vertical plane square to the spindle axis)(EXY).

**Diagram****Tolerance**

For a) and b) 0,02 for any measuring length of 1 000

**(Measured deviation)****Measuring instruments**

Square and straightedge, or cylindrical square, surface plate, adjustable blocks and dial gauge/support

**Observations and references to ISO 230-1**

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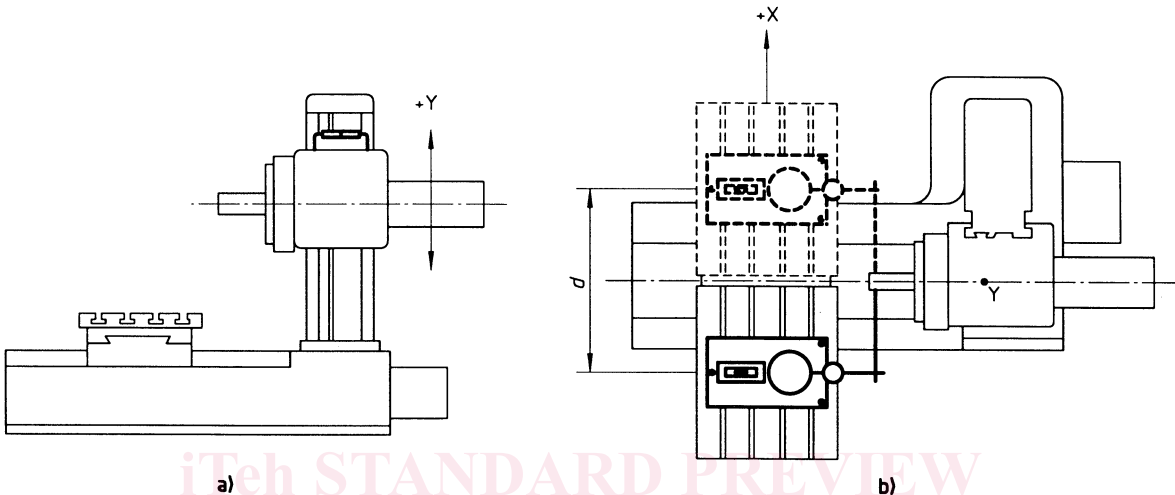
Set a square and a straightedge on the table so that the straightness is parallel<sup>1)</sup> to the movement of the spindle head (Y-axis)

Lock the table and the table saddle at mid-travels.

If the spindle can be locked, the dial gauge can be mounted on it. If the spindle cannot be locked, the dial gauge shall be placed on the spindle head of the machine.

- a) Apply the stylus of the dial gauge to the straightedge in Z-direction and move the head in the Y-direction through measuring length.
- b) Apply the stylus of the dial gauge to the straightedge in X-direction and carry out the same procedure mentioned above.

1) Parallel means that readings of the dial gauge touching the straightedge at both ends of the movement are the same value and in this case, the maximum difference of the reading gives the straightness deviation.

<b>Object</b> Checking of angular deviations of the Y-axis movement of the spindle head: <ol style="list-style-type: none"> <li>in the YZ-plane (EAY);</li> <li>in the ZX-plane (EBY).</li> </ol>	<b>G 6</b>
<b>Diagram</b> 	
<b>Tolerance</b> For a) and b) 0,04/1 000	<b>(Measured deviation)</b>
<b>Measuring instruments</b> <ol style="list-style-type: none"> <li>Precision level or optical angular deviation measuring instruments</li> <li>Surface plate, cylindrical square, level and dial gauges/support arm</li> </ol>	
<b>Observations and references to ISO 230-1</b> 5.231.3 and 5.232.2 <p>Measurements shall be carried out at a minimum of five positions equally spaced along the travel in both directions of up and down movement.</p> <ol style="list-style-type: none"> <li>Place a level on the spindle head in the Z-axis direction. The difference between the maximum and the minimum readings shall not exceed the tolerance.</li> <li>Mount a surface plate on the table and adjust it so that its face is horizontal. Place a cylindrical square on the surface plate and touch it by the stylus of the dial gauge mounted on special arm fixed to the spindle head. Place a level also on the surface plate in Z-axis direction. Note the readings at the measuring positions of the spindle head travel (Y-axis). Move the table distance <math>d</math> and reset the dial gauge so that the stylus touches the cylindrical square. When the level shows a change because of roll in table movement, adjust the level of surface plate to with that of the first position and then note readings at the same measuring positions. For each measuring position calculate the differences of two readings. The difference of maximum and minimum divided by distance <math>d</math> gives the angular deviation.</li> </ol>	