INTERNATIONAL STANDARD

ISO 3070-3

Second edition
1997-12-15

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

Part 3:
Floor type machines with detached, stationary work-holding table

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

Partie 3: Machines à montant mobile, à taque porte-pièce indépendante

Contents

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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 3070-3 was prepared by Technical Committee ISO/TC 39, *Machine tools*, Subcommittee SC 2, *Test conditions for metal cutting machine tools*.

This second edition cancels and replaces the first edition (ISO 3070-2:1978) 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 with detached, stationary work-holding table (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 3:
Floor type machines with detached, stationary work-holding table

1 Scope

This part of ISO 3070 specifies, with reference to ISO 230-1 and ISO 230-2, geometric tests, machining tests and tests for checking accuracy and repeatability of positioning by numerical control, on general purpose, normal accuracy, floor type boring and milling machines with horizontal spindle. These types of machine tool are defined in 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) and
6 (spindle head with ram or milling ram)

of ISO 3070-0:1982.

It should be noted that this part of ISO 3070 concerns machines which have a movement of the column or column saddle on the bed (X-axis), a vertical movement of the spindle head (Y-axis), a movement of boring spindle or ram (Z-axis) and possibly a feed movement of radial facing slide in the facing head (U-axis). Some machines also have an intermediate saddle having slideway between column and bed to achieve additional movement of the column parallel to the spindle axis (W-axis).

This part of ISO 3070 also includes the work-holding fixed table, an independent but necessary part of the machine as defined in ISO 7572.

This part of ISO 3070 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:—[1], *Test code for machine tools — Part 2: Determination of accuracy and repeatability of positioning of numerically controlled machine tool axes.*

ISO 1101:—[2], *Geometrical Product Specifications (GPS) — Geometrical tolerancing — Generalities, definitions, symbols, indication on drawings.*

ISO 3070-0:—[3], *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 this part of ISO 3070, 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 (e.g. 0,00 x /1 000) as the primary method, 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, can not be considered as binding for any contracting party.

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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 millimetres 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.

5 Geometric tests

5.1 Straightness and angular deviations of coordinate axes

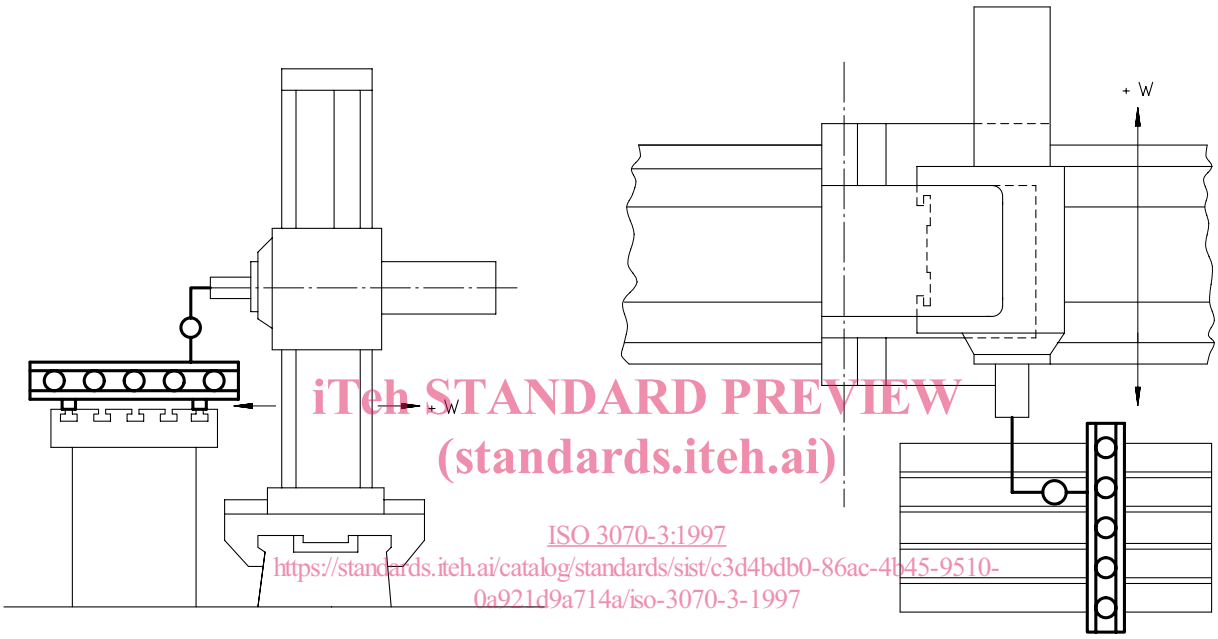
Object **G 1**

Checking of straightness of the column movement (W-axis):

a) in the YZ plane (vertical plane)(EYW);
b) in the ZX plane (horizontal plane)(EXW).

(In the case of a column saddle being provided for movement of the column.)

Diagram



Tolerance	**(Measured deviation)**
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	a) b)

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

Set a straightedge on the table, parallel[1)] to the column movement (W-axis) for a) horizontally and b) vertically.

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.

Traverse the column in the W-direction and note readings.

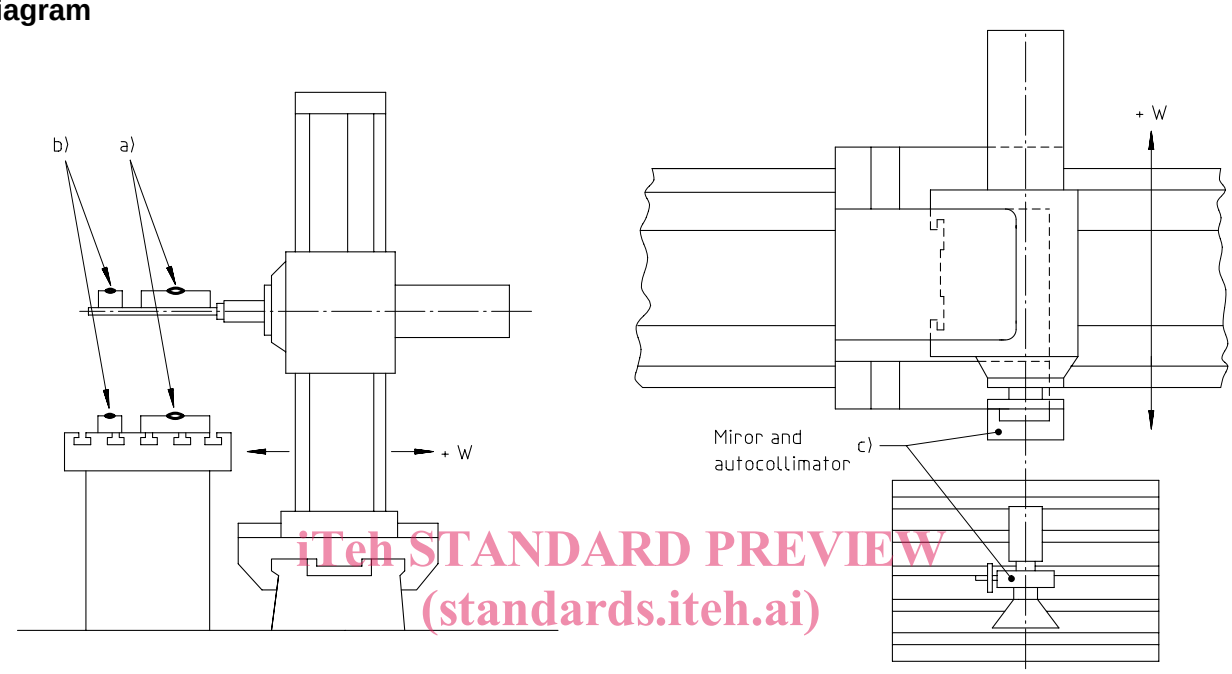
1) Parallel means that the readings of the dial gauge touching the straightedge at both ends of the movement are the same value, in which case the maximum difference of the readings gives the straightness deviation.

Object **G 2**

Checking of angular deviation of the column 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	**(Measured deviation)**
a), b) and c) 0,04/1 000 Local tolerance: 0,02/1 000 for any measuring length of 300	a) b) c)

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 spindle head:

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 work holding table, 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 directions of the movement.

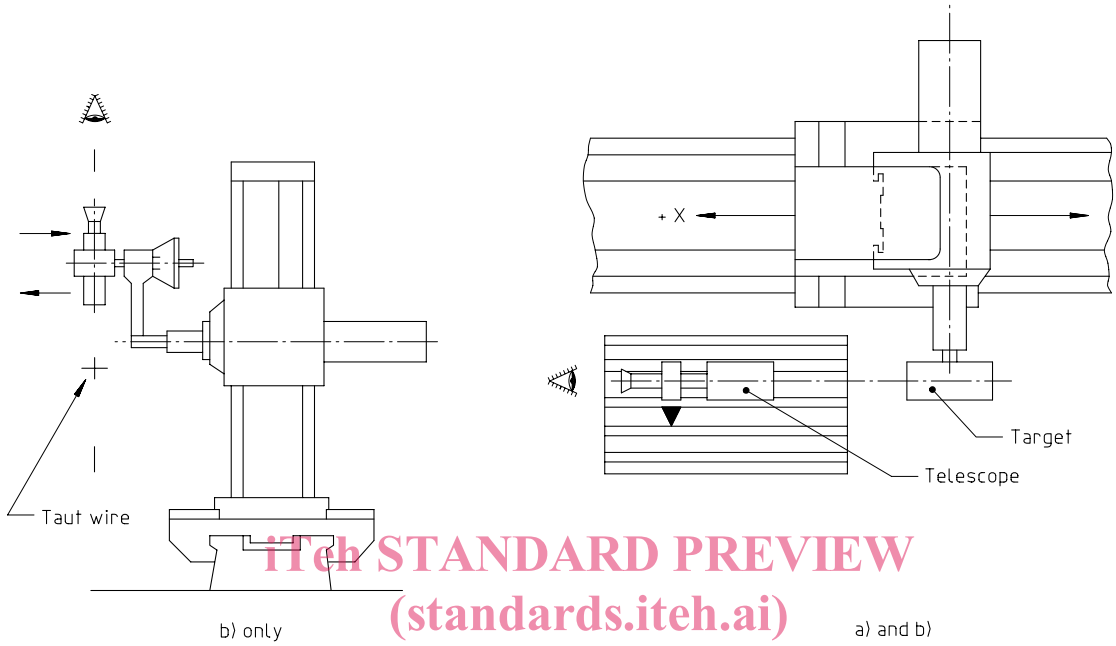
The difference between the maximum and the minimum readings shall not exceed the tolerance.

Object **G 3**

Checking of straightness of the column saddle movement (X-axis):

a) in the XY plane (vertical plane)(EYX);
b) in the ZX plane (horizontal plane)(EZX).

Diagram



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: 0,12 Local tolerance: 0,006 for any measuring length of 300	**(Measured deviation)** a) b)

Measuring instruments

Optical methods or microscope and taut wire

Observations and references to ISO 230-1 5.232.12 and 5.232.13

a) Taut wire is not recommended because of the sag of the wire. The alignment telescope may be fixed vertically on the work-holding table so that the optical beam is parallel[1)] to the X-axis movement of the column saddle movement.

If the spindle can be locked, mount the target mirror on it. If the spindle cannot be locked, the target mirror shall be mounted on the spindle head.

Traverse the column saddle in the X-direction and note the readings.

b) When taut wire is used, the microscope shall be fixed on the spindle or spindle head. When the optical method is used, the telescope shall be set horizontally.

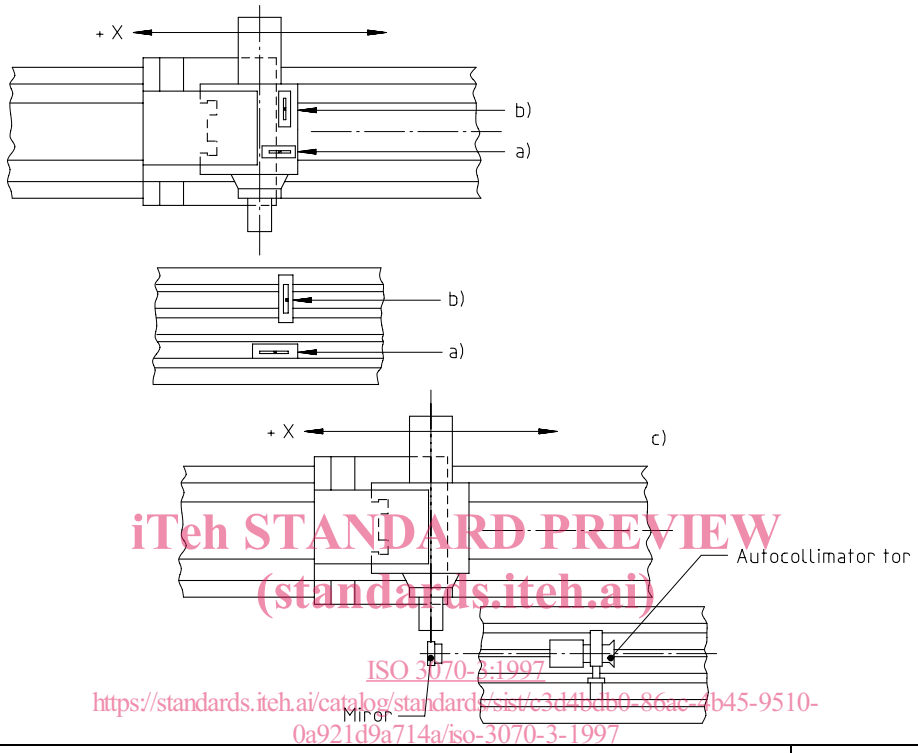
1) Parallel means that the readings of the dial gauge touching the straightedge at both ends of the movement are the same value in which case, the maximum difference of the readings gives the straightness deviation.

Object **G 4**

Checking of angular deviations of the column saddle 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



), b) and c) X ⩽ 4 000: 0,04/1 000 X > 4 000: 0,06/1 000 Local tolerance: 0,02/1 000 for any measuring length of 300	**(Measured deviation)** a) b) c)

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 spindle head:

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 work holding table, 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.

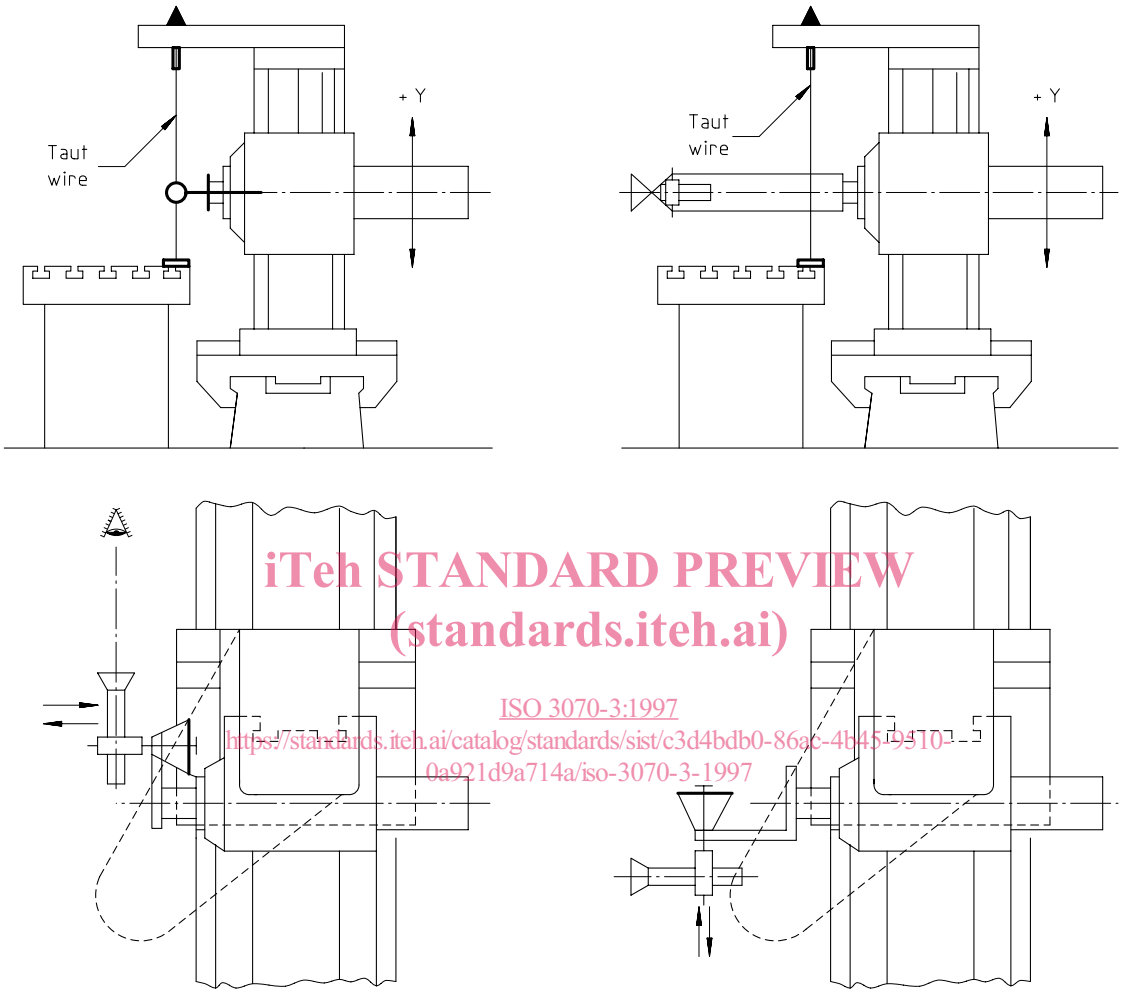
The difference between the maximum and the minimum readings shall not exceed the tolerance.

Object **G 5**

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

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

Diagram



	(Measured deviation)
) and b) 0,02 for any measuring length up to 1 000 Add 0,01 to the preceding tolerance for each 1 000 increase in length up to 4 000 Add 0,02 for each 1 000 increase in length over 4 000	a) b)

Measuring instruments

Microscope and taut wire or optical methods

Observations and references to ISO 230-1 5.232.1, 5.232.12 or 5.232.13

The column saddle shall be locked and the column shall be locked at mid-travel.

The taut wire shall be tightened between the work-holding table and another fixed part on the machine as near as possible to the vertical slide ways of the column.

If the spindle can be locked, the microscope to the alignment telescope can be mounted on it. If the spindle cannot be locked, the microscope shall be placed on the spindle head of the machine.

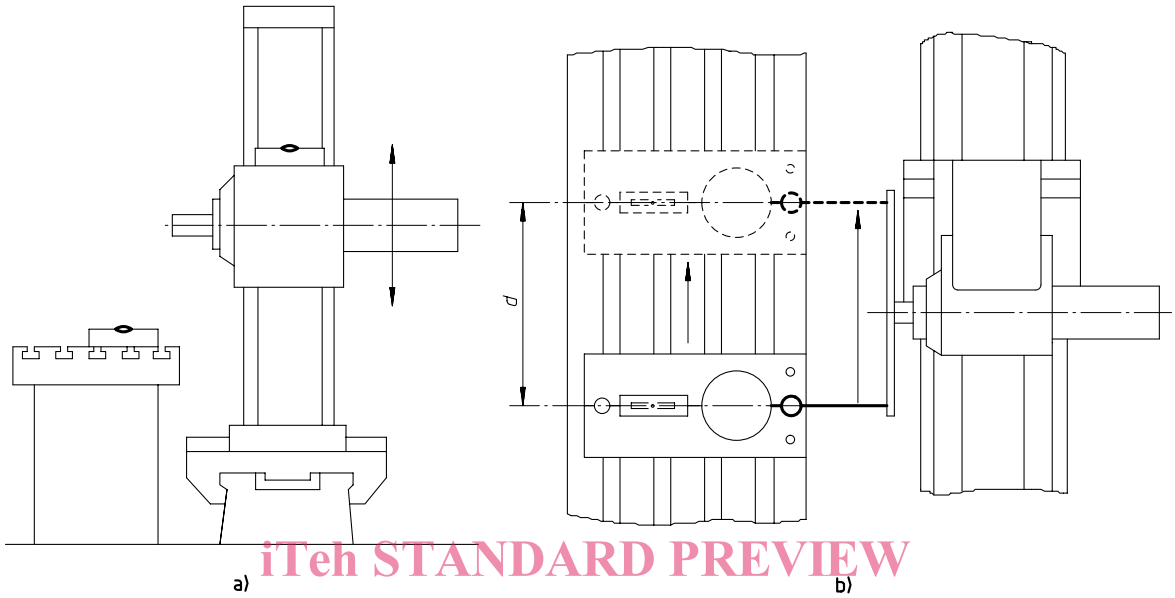
The spindle head shall be locked when taking measurements.

Object **G 6**

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

a) in the YZ plane (EAY);
b) in the ZX plane (EBY).

Diagram



Tolerance	**(Measured deviation)**
a and b) $Y \leqslant 4\,000$: 0,04/1 000 $Y > 4\,000$: 0,06/1 000	a) b)

Measuring instruments

a) Precision level or optical angular deviation measuring instruments
b) Surface plate, cylindrical square, level and dial gauges/support arm

Observations and references to ISO 230-1 5.231.3 and 5.232.2

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

a) Place a level on the spindle head in the Z-axis direction. The reference level shall be located on the work-holding table in the same direction.

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

b) Mount a surface plate on the work holding table and adjust it so that its face is level.

Place a cylindrical square on the surface plate so that it is touched by the stylus of the dial gauge mounted on a special arm fixed to the spindle head. Place a level on the surface plate in the Z-axis direction.

Note the readings at the measuring positions of the spindle head travel (Y-axis).

Move the surface plate with cylindrical square by a distance *d*, and adjust the level of the surface plate to its original position. Reset the dial gauge so that the stylus still touches the cylindrical square and take readings at the same measuring positions of the spindle head travel.

For each measuring position calculate the differences of two readings; the difference of maximum and minimum divided by distance *d* then gives the angular deviation.