

IS 15250 (Part 1) : 2002

ISO 10791-1 : 1998

भारतीय मानक

(Reaffirmed 2013)

मशीनन केन्द्रों के लिए परीक्षण स्थितियाँ

(Reaffirmed 2018)

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ज्यामितीय परीक्षण (उर्ध्वाधर जेड-अक्ष)

Indian Standard

TEST CONDITIONS FOR MACHINING CENTRES

**PART 1 GEOMETRIC TESTS FOR MACHINES WITH HORIZONTAL
SPINDLE AND WITH ACCESSORY HEADS (HORIZONTAL Z-AXIS)**

ICS 25.040.10

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BUREAU OF INDIAN STANDARDS

MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG

NEW DELHI 110002

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Price Group 14

Machine Tools Sectional Committee, BP 03

NATIONAL FOREWORD

This Indian Standard (Part 1) which is identical with ISO 10791-1 : 1998 'Test conditions for machining centres — Part 1 : Geometric tests for machines with horizontal spindle and with accessory heads (horizontal Z-axis)' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendation of the Machine Tools Sectional Committee and approval of the Basic and Production Engineering Division Council.

The text of the ISO Standard has been approved as suitable for publication as Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

- a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.
- b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to the following International Standard for which Indian Standard also exists. The corresponding Indian Standard which is to be substituted in its place is listed below along with its degree of equivalence for the edition indicated:

<i>International Standard</i>	<i>Corresponding Indian Standard</i>	<i>Degree of Equivalence</i>
ISO 230-1-1996 Test code for machine tools — Part 1 : Geometric accuracy of machines operating under no-load or finishing conditions	IS 2063 (Part 1) : 2002 Test code for machine tools : Part 1 Geometric accuracy of machines operating under no-load or finishing conditions (<i>second revision</i>)	Identical

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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Indian Standard

TEST CONDITIONS FOR MACHINING CENTRES

PART 1 GEOMETRIC TESTS FOR MACHINES WITH HORIZONTAL SPINDLE AND WITH ACCESSORY HEADS (HORIZONTAL Z-AXIS)

1 Scope

This part of 10791 specifies, with reference to ISO 230-1, the geometric tests for machining centres (or numerically controlled milling machines, boring machines, etc., where applicable) with horizontal spindle (i.e. horizontal Z-axis).

This part of ISO 10791 applies to machining centres having basically four numerically controlled axes, of which three are linear (X, Y and Z) up to 2 000 mm in length, and one is rotary (B'), but refers also to supplementary movements, such as those of sliding spindles, rams, or accessory universal heads. Movements other than those mentioned are considered as special features and the relevant tests are not included in this part of ISO 10791.

This part of ISO 10791 takes into consideration, in annexes A, B and C, three possible types of accessory universal heads, described as follows:

- annex A: 45° split indexable heads, with mechanical indexing of the different angular positions of the two bodies (e.g. Hirth couplings): the relevant tests (AG1 to AG9) check only the resulting position of the spindle;
- annex B: swivel heads, with two numerically controlled rotary axes perpendicular to each other (tests BG1 to BG7);
- annex C: 45° split continuous heads, similar to the first type but provided with continuous positioning of the two numerically controlled rotary axes: the relevant tests (CG1 to CG7) check all the geometric features (planes and axes) which contribute to the resulting position of the spindle, excluding the positioning accuracy of the two rotary axes; these tests can also be used for a deeper investigation of the 45° indexable heads, if their movements and locks allow this.

This part of ISO 10791 deals only with the verification of geometric accuracy of the machine and does not apply to the testing of the machine operation, which should generally be checked separately. Certain tests concerning the performance of the machine operating under no-load or finishing conditions are included in other parts of ISO 10791.

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2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this part of ISO 10791. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this part of ISO 10791 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 part of ISO 10791, 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 as the primary method, but in some cases microradians or arc seconds 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 10791, 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 clause 4 and annexes A to C, 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 standard.

3.3 Testing sequence

The sequence in which the tests are presented in this part of ISO 10791 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 nor possible to carry out all the tests described in this part of ISO 10791. 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 10791 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.

3.5 Measuring instruments

The measuring instruments indicated in the tests described in clause 4 and annexes A to C 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.

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 Diagrams

In this part of ISO 10791, for reasons of simplicity, the diagrams associated with geometric tests illustrate only one type of machine.

3.8 Pallets

For machines working with several pallets, the tests concerning the intrinsic geometric features or their behaviour in relation to the axes of the machine (tests G15 to G22) are to be performed on only one representative pallet clamped in position, unless otherwise specified by an agreement between the user and the supplier/manufacturer.

3.9 Software compensation

When software facilities are available for compensating certain geometric deviations, based on an agreement between the user and the supplier/manufacturer, the relevant tests may be carried out with or without these compensations. When the software compensation is used, this shall be stated in the test results.

3.10 Machine configurations

The machines considered in this part of ISO 10791 are divided into 12 basic family configurations based on their architecture and the components moving along the linear axes. These families are identified by means of numbers from 01 to 12 as shown in Figure 1. The classification of these configurations is shown in Table 1.

3.11 Designation

A designation is also supplied, as a short code, in order to define the architecture of a machining centre; this designation is given by the following elements, in the given order:

- a) "machining centre";
- b) the reference of this part of ISO 10791, i.e. ISO 10791-1;
- c) type H for "horizontal spindle type";
- d) the number indicated in the relevant box of Figure 1 and the left-hand column of Table 1.

EXAMPLE

A machining centre, of the horizontal spindle type, with the column moving along the X-axis, the spindle head slide moving along the Y-axis and the table moving along the Z-axis is designated as follows:

Machining centre ISO 10791-1 type H02

3.12 Minimum tolerance

When establishing the tolerance for a measuring length different from that given in this part of ISO 10791 (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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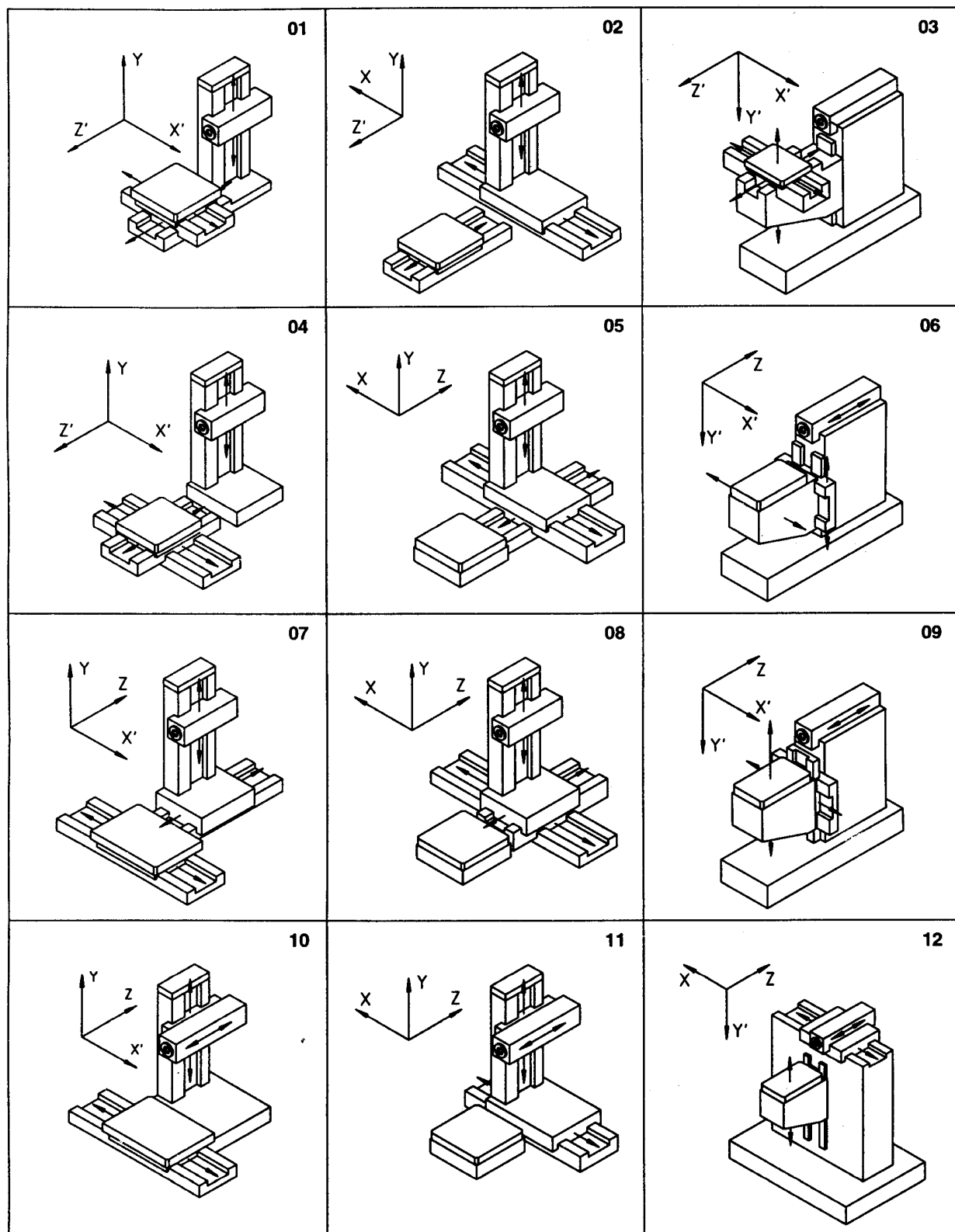


Figure 1

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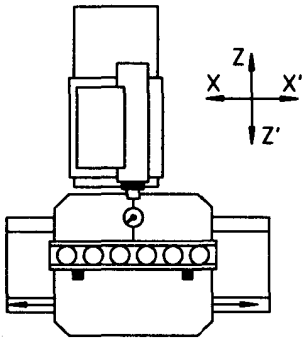
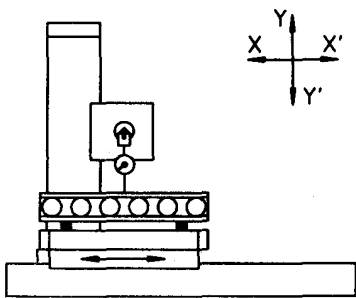
Table 1 — Classification of configurations of horizontal-spindle machining centres

	X	X'	Y	Y'	Z	Z'
01		Table on its saddle	Spindle head			Table saddle
02	Column		Spindle head			Table
03		Table on its saddle		Knee		Table saddle
04		Table saddle	Spindle head			Table on its saddle
05	Column on its saddle		Spindle head		Column saddle	
06		Knee		Knee saddle	Spindle head	
07		Table	Spindle head		Column	
08	Column saddle		Spindle head		Column on its saddle	
09		Knee saddle		Knee	Spindle head	
10		Table	Spindle-head slide		Spindle head on its slide	
11	Column		Spindle-head slide		Spindle head on its slide	
12	Spindle-head slide			Knee	Spindle head on its slide	

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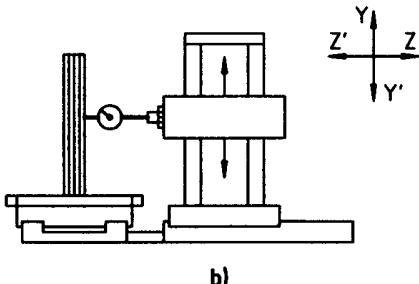
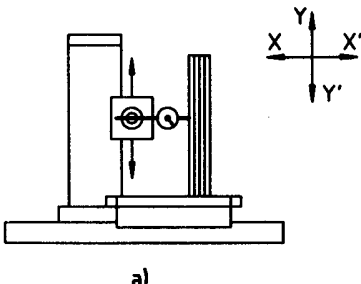
4 Geometric tests

4.1 Straightness of linear motions

Object		G1
Checking of straightness of the X-axis motion: a) in the vertical XY plane (EYX); b) in the horizontal ZX plane (EZX).		
Diagram		
 a)		

Object		G2
Checking of straightness of the Z-axis motion: a) in the vertical YZ plane (EYZ); b) in the horizontal ZX plane (EXZ).		
Diagram		
Tolerance For a) and b)		Measured deviation for Z =
$Z \leq 500$		0,010
$500 < Z \leq 800$		0,015
$800 < Z \leq 1\,250$		0,020
$1\,250 < Z \leq 2\,000$		0,025
Local tolerance: 0,007 for a measuring length of 300		a) b)
Measuring instruments a) Straightedge and dial gauge or optical methods b) Straightedge and dial gauge or microscope and taut wire or optical methods		
Observations and references to ISO 230-1		
5.211, 5.23, 5.231.2, 5.232.1 and 5.233.1		
For all machine configurations, either the straightedge, the taut wire or the straightness reflector shall be placed on the table. If the spindle can be locked, either the dial gauge, the microscope or the interferometer may be mounted on it; if the spindle cannot be locked, the instrument shall be placed on the spindle head of the machine.		
The measuring line should pass as close to the centre of the table as possible.		

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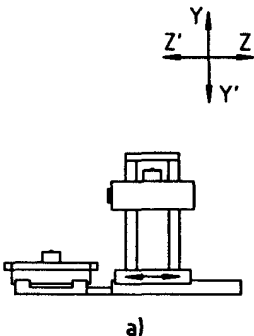
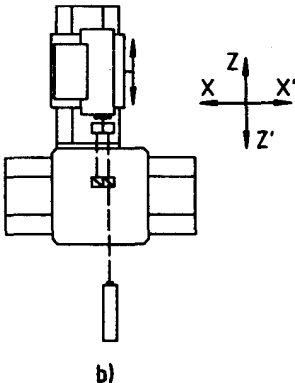
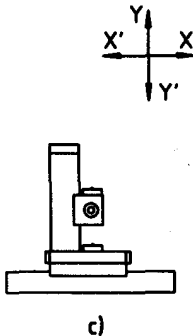
Object		G3							
Checking of straightness of the Y-axis motion: a) in the vertical XY plane (EXY); b) in the vertical YZ plane (EZY).									
Diagram									
									
Tolerance		Measured deviation for Y = a) b)							
For a) and b) <table><tr><td>$Y \leq 500$</td><td>0,010</td></tr><tr><td>$500 < Y \leq 800$</td><td>0,015</td></tr><tr><td>$800 < Y \leq 1\,250$</td><td>0,020</td></tr><tr><td>$1\,250 < Y \leq 2\,000$</td><td>0,025</td></tr></table> Local tolerance: 0,007 for a measuring length of 300			$Y \leq 500$	0,010	$500 < Y \leq 800$	0,015	$800 < Y \leq 1\,250$	0,020	$1\,250 < Y \leq 2\,000$
$Y \leq 500$	0,010								
$500 < Y \leq 800$	0,015								
$800 < Y \leq 1\,250$	0,020								
$1\,250 < Y \leq 2\,000$	0,025								
Measuring instruments									
For a) and b): Square and dial gauge or microscope and taut wire or optical methods									
Observations and references to ISO 230-1		5.211, 5.23, 5.231.2, 5.232.1 and 5.233.1							
For all machine configurations, either the square, the taut wire or the straightness reflector shall be placed as close to the centre of the table as possible. If the spindle can be locked, either the dial gauge, the microscope or the interferometer may be mounted on it; if the spindle cannot be locked, the instrument shall be placed on the spindle head of the machine.									

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4.2 Angular deviations of linear motions

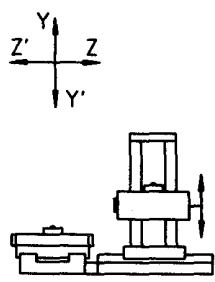
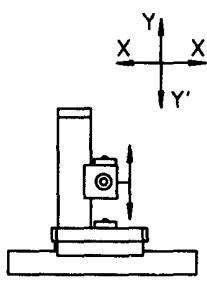
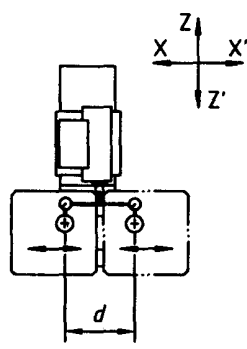
Object		G4
Checking of angular deviations of the X-axis motion: a) in the vertical XY plane perpendicular to the spindle-axis (pitch ECX); b) in the horizontal ZX plane (yaw EBX); c) in the vertical YZ plane parallel to the spindle axis (roll EAX).		
Diagram		
Tolerance		Measured deviation
For a), b) and c) 0,060/1 000 (or 60 μrad or 12")		- a) - b) - c)
Measuring instruments		
a) (pitch ECX) Precision level or optical angular-deviation measuring instruments b) (yaw EBX) Optical angular-deviation measuring instruments c) (roll EAX) Precision level		
Observations and references to ISO 230-1		
5.231.3, 5.232.2 and 5.233.2		
The instrument shall be placed on the movable component: a) (pitch ECX) longitudinally; b) (yaw EBX) horizontally; c) (roll EAX) transversely.		
When X-axis motion causes an angular movement of both spindle head and workholding table, differential measurements of the two angular movements shall be made and this shall be stated. In this case, when using precision levels for measurement, the reference level shall be located on the non-moving component (spindle head or workholding table) of the machine.		
Measurements shall be taken at least at five positions equally spaced along the travel in both directions of movement at every position. The difference between the maximum and the minimum readings shall not exceed the tolerance.		

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Object		G5
Checking of angular deviations of the Z-axis motion: a) in the vertical YZ plane parallel to the spindle axis (pitch EAZ); b) in the horizontal ZX plane (yaw EBZ); c) in the vertical XY plane perpendicular to the spindle axis (roll ECZ).		
Diagram		
  		
Tolerance		Measured deviation
For a), b) and c) 0,060/1 000 (or 60 μrad or 12")		a) b) c)
Measuring instruments		
a) (pitch EAZ) Precision level or optical angular-deviation measuring instruments b) (yaw EBZ) Optical angular-deviation measuring instruments c) (roll ECZ) Precision level		
Observations and references to ISO 230-1		5.231.3, 5.232.2 and 5.233.2
The instrument shall be placed on the movable component: a) (pitch EAZ) longitudinally; b) (yaw EBZ) horizontally; c) (roll ECZ) transversely.		
When Z-axis motion causes an angular movement of both spindle head and workholding table, differential measurements of the two angular movements shall be made and this shall be stated. In this case, when using precision levels for measurement, the reference level shall be located on the non-moving component (spindle head or workholding table) of the machine.		
Measurements shall be taken at least at five positions equally spaced along the travel in both directions of movement at every position. The difference between the maximum and the minimum readings shall not exceed the tolerance.		

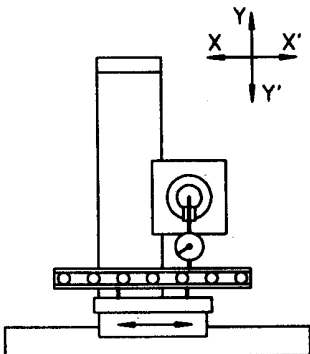
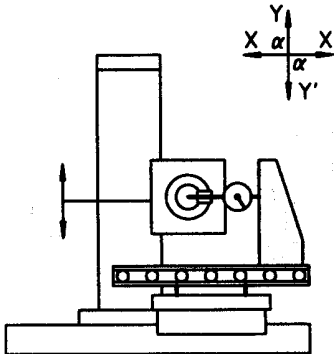
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Object Checking of angular deviations of the Y-axis motion: a) in the vertical YZ plane parallel to the spindle axis (EAY); b) in the vertical XY plane perpendicular to the spindle axis (ECY); c) in the horizontal ZX plane (roll EBY).	G6
Diagram  a)  b)  c)	
Tolerance For a), b) and c) 0,060/1 000 (or 60 μrad or 12")	Measured deviation a) b) c)
Measuring instruments a) and b) Precision level or optical angular-deviation measuring instruments c) (roll EBY) Cylindrical square, precision level and dial gauge, or precision cube and dial gauges	
Observations and references to ISO 230-1 5.231.3, 5.232.2 and 5.233.2 Measurements shall be taken at five positions equally spaced along the direction of travel, in both directions of movement and at every position. The difference between the maximum and the minimum readings shall not exceed the tolerance. The instrument shall be placed on the moving component (spindle head or workholding table): a) (pitch, EAZ) longitudinally; b) (yaw, EBZ) horizontally. When Y-axis motion causes an angular movement of both spindle head and workholding table, differential measurements of the two angular movements shall be made and this shall be stated. In this case, when using precision levels for measurement, the reference level shall be located on the non-moving component (spindle head or workholding table) of the machine. For c) (roll, ECZ), place a cylindrical square on the table, approximately parallel to the Y-axis, and set the stylus of a dial gauge mounted on a special arm against the square. Note the readings and mark the corresponding heights on the square. Move the table along the X-axis and move the dial gauge to the other side of the spindle head so that the stylus can touch the square again along the same line. The possible roll deviation of the X-axis motion shall be measured and taken into account. The dial gauge shall be zeroed again and the new measurements shall be taken at the same heights as the previous ones, then noted. For each measurement height, calculate the difference of the two readings. The maximum and the minimum of these differences shall be selected and the result of $\frac{\text{maximum difference} - \text{minimum difference}}{d}$ shall not exceed the tolerance, "d" being the distance between the two positions of the dial gauge.	

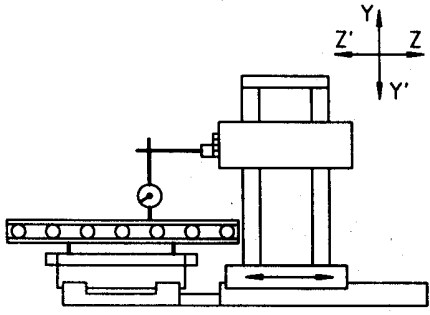
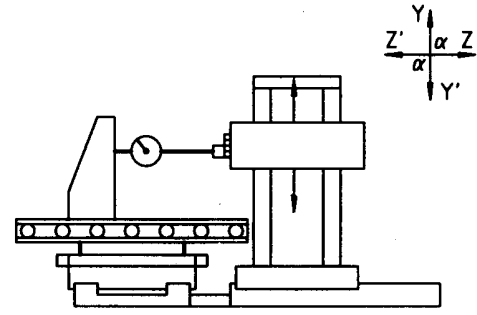
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4.3 Squareness between linear motions

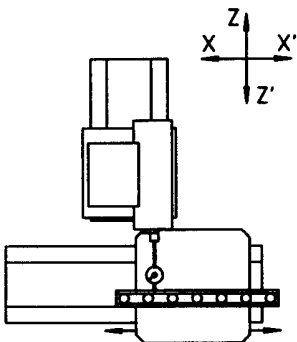
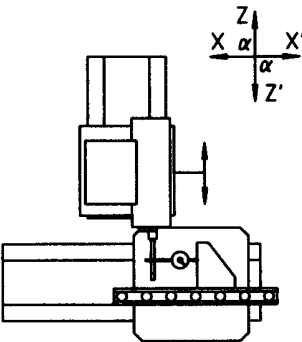
Object		G7
Checking of squareness between the Y-axis motion and the X-axis motion.		
Diagram  Step 1)  Step 2)		
Tolerance		Measured deviation
0,02 for a measuring length of 500		
Measuring instruments Straightedge or surface plate, square and dial gauge		
Observations and references to ISO 230-1 5.522.4 In Step 1), the straightedge or the surface plate shall be set parallel to the X-axis. In Step 2), the Y-axis shall then be checked by means of a square standing on the straightedge or on the surface plate. If the spindle can be locked, the dial gauge may be mounted on it; if the spindle cannot be locked, the dial gauge shall be placed on the spindle head of the machine. The value of angle α, being less than, equal to or greater than 90°, should be noted for information and possible corrections.		

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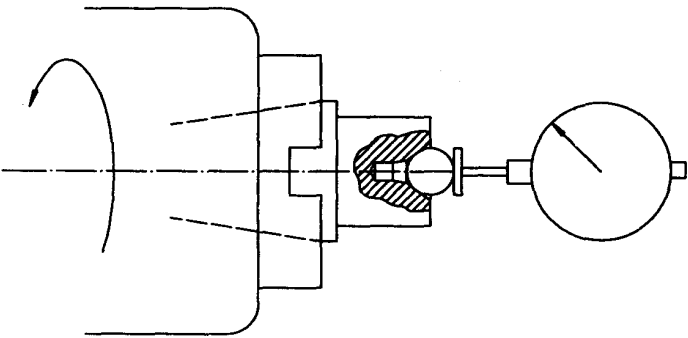
Object		G8
Checking of squareness between the Y-axis motion and the Z-axis motion.		
Diagram  Step 1)  Step 2)		
Tolerance 0,02 for a measuring length of 500		Measured deviation
Measuring instruments Straightedge or surface plate, square and dial gauge		
Observations and references to ISO 230-1 5.522.4 In Step 1), the straightedge or the surface plate shall be set parallel to the Z -axis. In Step 2), the Y-axis shall then be checked by means of a square standing on the straightedge or on the surface plate. If the spindle can be locked, the dial gauge may be mounted on it; if the spindle cannot be locked, the dial gauge shall be placed on the spindle head of the machine. The value of angle α , being less than, equal to or greater than 90° , should be noted for information and possible corrections.		

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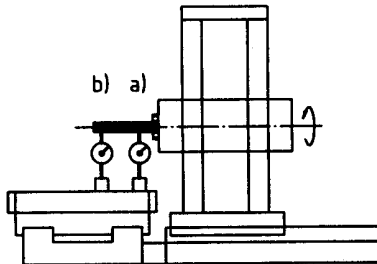
Object		G9
Checking of squareness between the Z-axis motion and the X-axis motion.		
Diagram  Step 1)  Step 2)		
Tolerance 0,02 for a measuring length of 500		Measured deviation
Measuring instruments Straightedge, square and dial gauge		
Observations and references to ISO 230-1 5.522.4 In Step 1), the straightedge shall be set parallel to the X (or Z)-axis. In Step 2), the Z (or X)-axis shall then be checked by means of a square placed on the table with one side against the straightedge. This test can also be performed without the straightedge, aligning one arm of the square along one axis and checking the second axis on the other arm of the square. If the spindle can be locked, the dial gauge may be mounted on it; if the spindle cannot be locked, the dial gauge shall be placed on the spindle head of the machine. The value of angle α , being less than, equal to or greater than 90° , should be noted for information and possible corrections.		

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4.4 Spindle

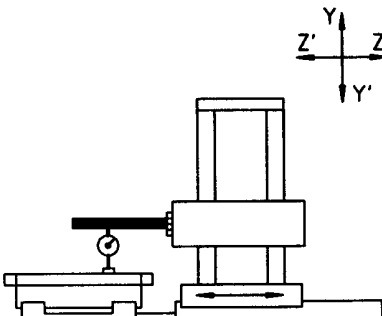
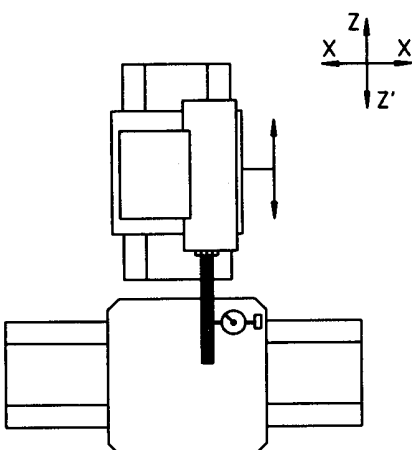
Object		G10
Checking of periodic axial slip of the spindle.		
Diagram 		
Tolerance		Measured deviation
0,005		
Measuring instruments		
Dial gauge		
Observations and references to ISO 230-1 5.621.1 and 5.622.2 This test shall be performed on all working spindles of the machine.		

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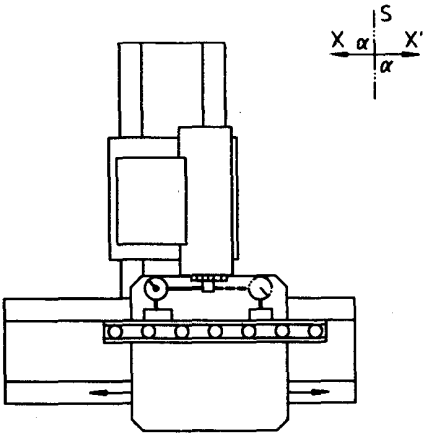
Object		G11
Checking of run-out of internal taper of the spindle:		
a) at the spindle nose; b) at a distance of 300 mm from the spindle nose.		
Diagram		
		
Tolerance		Measured deviation
For the integral spindle:		a)
a) 0,007		b)
b) 0,015		
For spindles of accessory heads:		
a) 0,01		
b) 0,02		
Measuring instruments		
Test mandrel and dial gauge		
Observations and references to ISO 230-1		5.611.4 and 5.612.3
This test shall be performed on all working spindles of the machine.		
This test shall be carried out through at least two revolutions, in accordance with the note in 5.611.4 of ISO 230-1:1996.		

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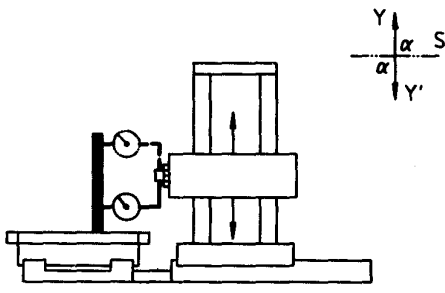
Object		G12
Checking of parallelism between the spindle axis and the Z-axis motion:		
a) in the vertical YZ plane; b) in the horizontal ZX plane.		
Diagram		
 		
Tolerance		Measured deviation
For a) and b) 0,015 for a measuring length of 300		a) b)
Measuring instruments		
Test mandrel and dial gauge		
Observations and references to ISO 230-1		5.412.1 and 5.422.3
Z-axis in centre of the travel.		
For a), Y-axis to be locked, if possible.		
For b), X-axis to be locked, if possible.		

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Object		G13
Checking of squareness between the spindle axis and the X-axis motion.		
Diagram 		
Tolerance 0,015/300 Where 300 is the distance between the two measuring points touched.		Measured deviation
Measuring instruments Straightedge, special arm and dial gauge		
Observations and references to ISO 230-1 5.512.1, 5.512.32 and 5.512.4 Y and Z-axes to be locked, if possible. The straightedge shall be set parallel to the X-axis. This squareness deviation can also be derived from tests G9 and G12 b). The value of angle α , being less than, equal to or greater than 90° , should be noted for information and possible corrections.		

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Object		G14
Checking of squareness between the spindle axis and the Y-axis motion.		
Diagram 		
Tolerance	0,015/300	Measured deviation
Where 300 is the distance between the two measuring points touched.		
Measuring instruments Square, special arm and dial gauge		
Observations and references to ISO 230-1		
		5.512.1, 5.512.32 and 5.512.42
X and Z-axes to be locked, if possible.		
The measurement side of the square should be set parallel to the Y-axis, or the lack of parallelism shall be considered in the measurement.		
This squareness deviation can also be derived from tests G8 and G12 a).		
The value of angle α , being less than, equal to or greater than 90° , should be noted for information and possible corrections.		

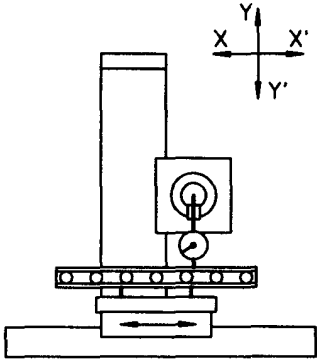
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4.5 Table or pallet

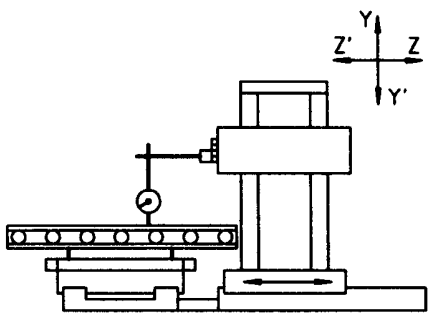
Object		G15
Checking of flatness of the table surface ¹⁾ .		
1) Built-in rotary table or one representative pallet clamped in position.		
Diagram		
Tolerance		Measured deviation
$L \leq 500$ 0,020		for $L = \dots$
$500 < L \leq 800$ 0,025		
$800 < L \leq 1\,250$ 0,030		
$1\,250 < L \leq 2\,000$ 0,040		
where L is the length of the shorter side of the table or pallet.		
The surface shall not be convex.		
Local tolerance: 0,012 for a measuring length of 300		
Measuring instruments		
Precision level or straightedge and slip gauges and dial gauge or optical methods		
Observations and references to ISO 230-1		5.322, 5.323 and 5.324
X and Z-axes are to be in centre of travel.		
The flatness of the table shall be checked twice, the first time with the rotary table clamped, then not clamped (if applicable). Both measured deviations shall not exceed the tolerance.		

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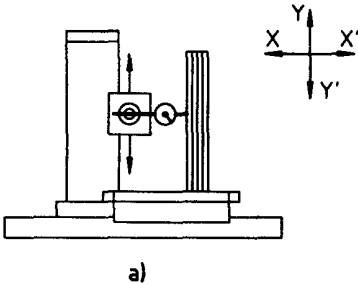
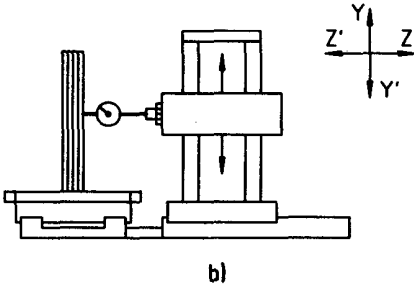
Object	G16								
Checking of parallelism between the table¹⁾ surface, in the four rotary positions at 90° from each other, and the X-axis motion.									
1) Built-in rotary table or one representative pallet clamped in position.									
Diagram 									
Tolerance <table style="width: 100%; margin-top: 10px;"> <tr> <td style="text-align: right;">$X \leq 500$</td> <td style="text-align: left;">0,020</td> </tr> <tr> <td style="text-align: right;">$500 < X \leq 800$</td> <td style="text-align: left;">0,025</td> </tr> <tr> <td style="text-align: right;">$800 < X \leq 1\,250$</td> <td style="text-align: left;">0,030</td> </tr> <tr> <td style="text-align: right;">$1\,250 < X \leq 2\,000$</td> <td style="text-align: left;">0,040</td> </tr> </table>	$X \leq 500$	0,020	$500 < X \leq 800$	0,025	$800 < X \leq 1\,250$	0,030	$1\,250 < X \leq 2\,000$	0,040	Measured deviation for X =
$X \leq 500$	0,020								
$500 < X \leq 800$	0,025								
$800 < X \leq 1\,250$	0,030								
$1\,250 < X \leq 2\,000$	0,040								
Measuring instruments Straightedge, gauge blocks and dial gauge									
Observations and references to ISO 230-1 5.422.1 and 5.422.2 Y-axis to be locked, if possible. The stylus of the dial gauge is to be placed approximately at the working position of the tool. The measurement may be made on a straightedge laid parallel to the table surface. If the spindle can be locked, the dial gauge may be mounted on it. If the spindle cannot be locked, the dial gauge shall be placed on the spindle head of the machine.									

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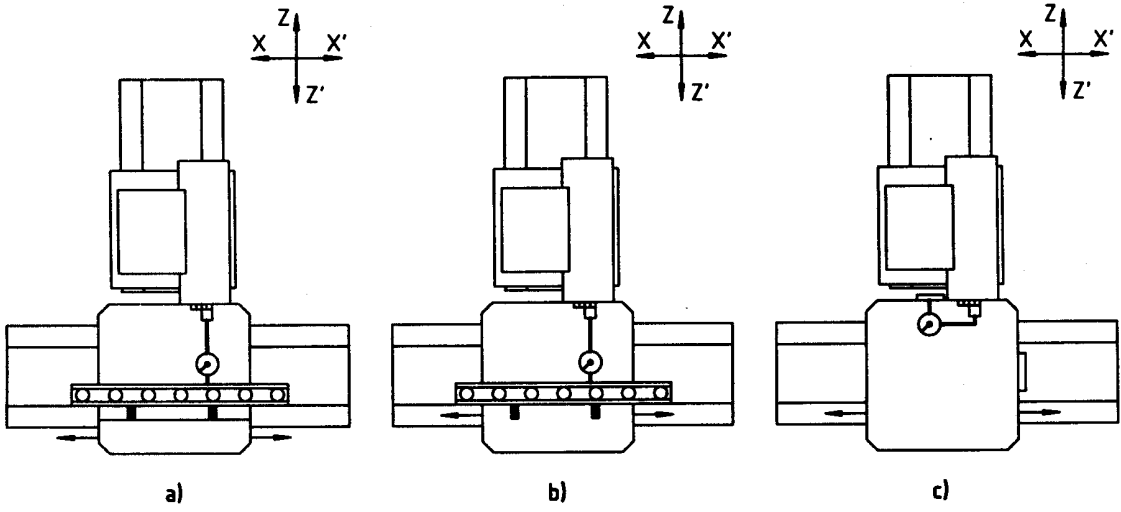
Object		G17								
Checking of parallelism between the table ¹⁾ surface, in the four rotary positions at 90° from each other, and the Z-axis motion.										
1) Built-in rotary table or one representative pallet clamped in position.										
Diagram										
										
Tolerance		Measured deviation								
<table><tr><td>Z ≤ 500</td><td>0,020</td></tr><tr><td>500 < Z ≤ 800</td><td>0,025</td></tr><tr><td>800 < Z ≤ 1 250</td><td>0,030</td></tr><tr><td>1 250 < Z ≤ 2 000</td><td>0,040</td></tr></table>		Z ≤ 500	0,020	500 < Z ≤ 800	0,025	800 < Z ≤ 1 250	0,030	1 250 < Z ≤ 2 000	0,040	for Z =
Z ≤ 500	0,020									
500 < Z ≤ 800	0,025									
800 < Z ≤ 1 250	0,030									
1 250 < Z ≤ 2 000	0,040									
Measuring instruments										
Straightedge, gauge blocks and dial gauge										
Observations and references to ISO 230-1 5.422.1 and 5.422.2										
Y-axis to be locked, if possible.										
The stylus of the dial gauge is to be placed approximately at the working position of the tool. The measurement may be made on a straightedge laid parallel to the table surface.										
If the spindle can be locked, the dial gauge may be mounted on it. If the spindle cannot be locked, the dial gauge shall be placed on the spindle head of the machine.										

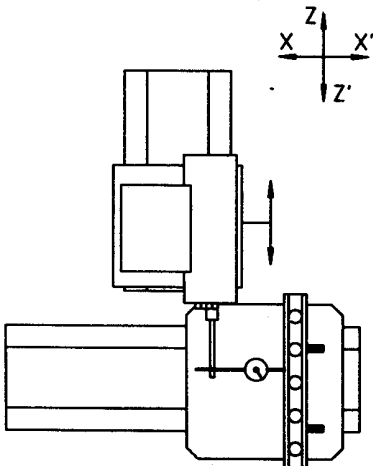
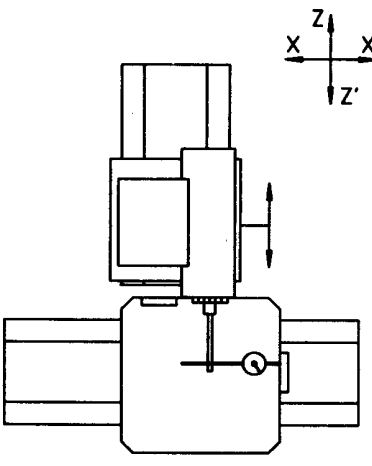
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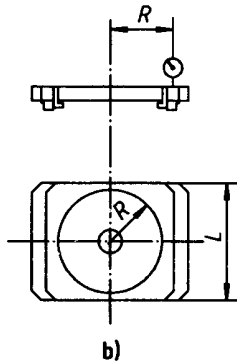
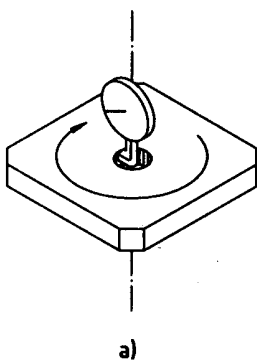
Object	G18
Checking of squareness between the table¹⁾ surface and the Y-axis motion, in the four rotary positions at 90° from each other: a) in the vertical XY plane perpendicular to the spindle axis; b) in the vertical YZ plane parallel to the spindle axis 1) Built-in rotary table or one representative pallet clamped in position.	
Diagram  a)  b)	
Tolerance For a) and b) 0,015 for a measuring length of 300	Measured deviation a) b)
Measuring instruments Surface plate, square or cylindrical square and dial gauge	
Observations and references to ISO 230-1 5.522.2 a) X-axis to be locked, if possible. b) Z-axis to be locked, if possible. The square or cylindrical square should be in the centre of 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 shall be placed on the spindle head of the machine. This squareness deviation can also be derived: - for a), from tests G7 and G16; - for b), from tests G8 and G17.	

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Object		G19
Checking of parallelism between - the longitudinal median or reference T-slot, or - the centre line of the alignment holes (if longitudinal), or - the longitudinal edge locator of the table¹⁾ in the 0° position and the X-axis motion. 1) Built-in rotary table or one representative pallet clamped in position.		
Diagram 		
Tolerance For a), b) and c) 0,015 for a measuring length of 300		Measured deviation
Measuring instruments Dial gauge and, if necessary, straightedge and master pins		
Observations and references to ISO 230-1 5.422.1 and 5.422.2 Z-axis to be locked, if possible. If the spindle can be locked, the dial gauge may be mounted on it. If the spindle cannot be locked, the dial gauge shall be placed on the spindle head of the machine. When the alignment holes exist, two master pins which fit in the holes and have protruding parts of the same diameter shall be used, and a straightedge shall be placed against them.		

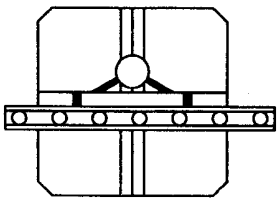
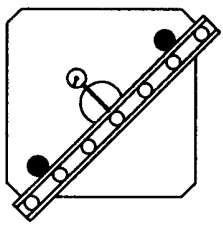
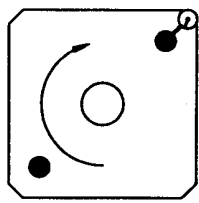
Object		G20
Checking of parallelism between a) the centre line of the alignment holes (if transverse), or b) the transverse edge locator of the table ¹⁾ in the 0° position and the Z-axis motion.		
1) Built-in rotary table or one representative pallet clamped in position.		
Diagram		
 a)  b)		
Tolerance		Measured deviation
For a) and b) 0,015 for a measuring length of 300		
Measuring instruments		a) b)
Dial gauge and, if necessary, straightedge and master pins		
Observations and references to ISO 230-1		5.422.1 and 5.422.2
Z-axis to be locked, if possible.		
If the spindle can be locked, the dial gauge may be mounted on it. If the spindle cannot be locked, the dial gauge shall be placed on the spindle head of the machine.		
When the alignment holes exist, two master pins which fit in the holes and have protruding parts of the same diameter shall be used, and a straightedge shall be placed against them.		

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Object		G21
Checking of		
a) run-out of the centre hole of the table ¹⁾ (when the centre hole is used for locating purposes); b) camming of the table ¹⁾ surface ²⁾ .		
1) Build-in rotary table or one representative pallet clamped in position. 2) For indexing tables, check at least four positions at 90° from each other.		
Diagram		
		
Tolérance		Measured deviation
a) 0,025	b) $L \leq 500$	0,030
	$500 < L \leq 800$	0,040
	$800 < L \leq 1\,250$	0,050
	$1\,250 < L \leq 2\,000$	0,060
where L is the length of the shorter side of the table or pallet.		a) b) for $L = \dots$
Measuring instruments		
a) Dial gauge b) Gauge blocks and dial gauge		
Observations and references to ISO 230-1		
a) 5.612.3 X and Z-axes to be locked, if possible. If the spindle can be locked, the dial gauge may be mounted on it. If the spindle cannot be locked, the dial gauge shall be placed on a fixed part of the machine.		
b) 5.632 Y-axis to be locked, if possible. The radius R shall be as large as possible.		
These tests shall be performed on all workholding tables, rotating around vertical or horizontal axes, changing the nomenclature of the axes accordingly.		

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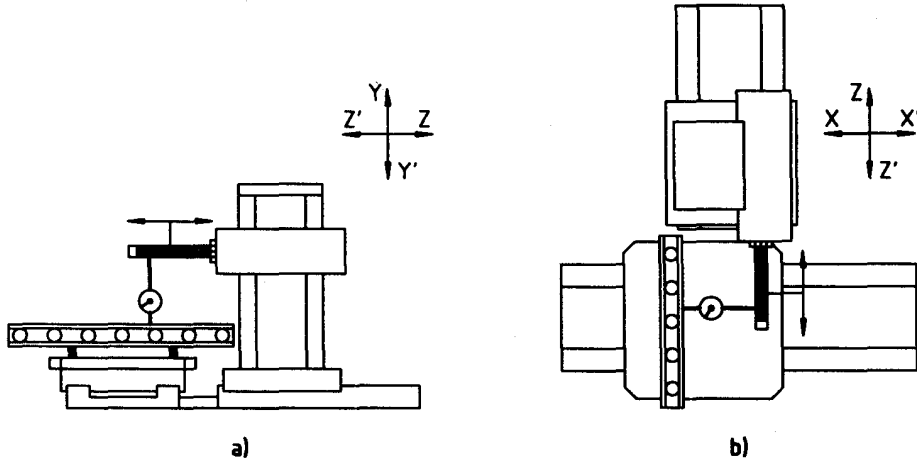
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Object		G22
Checking of - intersection of the centre line of the longitudinal median T-slot, or between the alignment holes, or of the cross-tenon slot (when existing) with the axis of rotation of the table; - equidistance of the alignment holes with the axis of rotation of the table¹⁾. 1) Built-in rotary table or one representative pallet clamped in position.		
Diagram    a) b)		
Tolerance For a) and b) 0,030		Measured deviation
Measuring instruments - Straightedge, gauge blocks or master pins and dial gauge - Master pins and dial gauge		
Observations and references to ISO 230-1 The dial gauge, placed on a fixed part of the machine, is zeroed against the straightedge which is then removed and the table is rotated 180°. The straightedge is then re-placed against the other side of the gauge blocks, or master pins, and the new dial gauge reading shall not exceed the tolerance. When the alignment holes exist, two master pins which fit in the holes and have protruding parts of the same diameter shall be used instead of the gauge blocks. These tests shall be performed on all workholding tables, rotating around vertical or horizontal axes, changing the nomenclature of the axes accordingly.		

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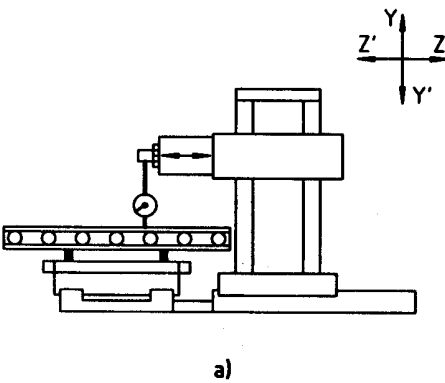
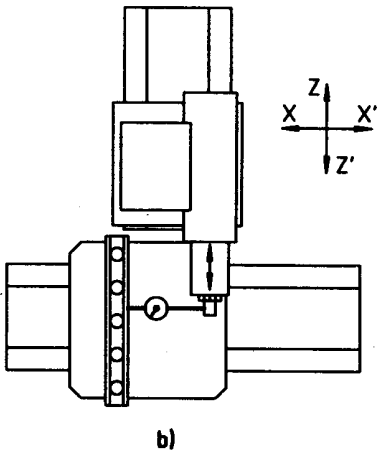
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4.6 Supplementary axes parallel to the Z-axis

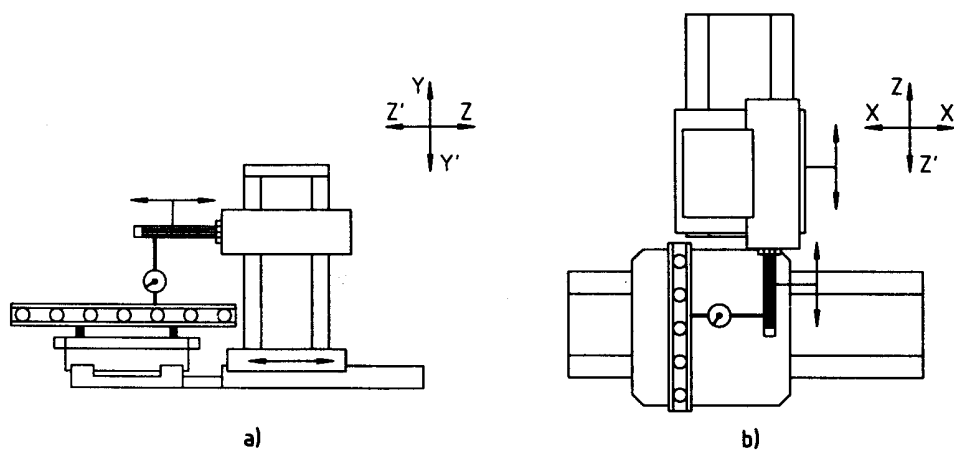
Object		G23
Checking of straightness of the axial movement of the spindle: a) in the vertical YZ plane; b) in the horizontal ZX plane.		
Diagram		
 The diagram consists of two parts, (a) and (b), illustrating the setup for checking the straightness of the axial movement of the spindle. Part (a) shows a vertical YZ plane with a coordinate system (Y, Z, Y', Z') and a dial gauge measuring the spindle's axial movement. Part (b) shows a horizontal ZX plane with a coordinate system (X, Z, X', Z') and a dial gauge measuring the spindle's axial movement.		
Tolerance		Measured deviation
For a) and b) 0,015 for a measuring length of 300		a) b)
Measuring instruments		
Straightedge and dial gauge		
Observations and references to ISO 230-1		
5.211, 5.23, 5.231.2, 5.232.1 and 5.233.1		
a) Y-axis to be locked, if possible. b) X-axis to be locked, if possible.		
It should be noted that, for a), the deviation includes the normal deflection of the spindle.		

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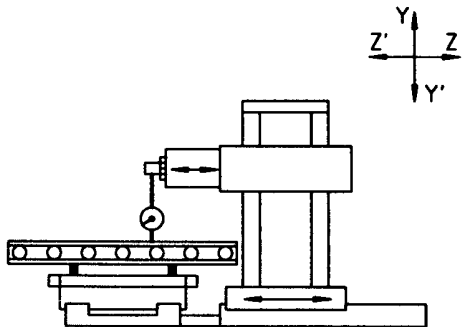
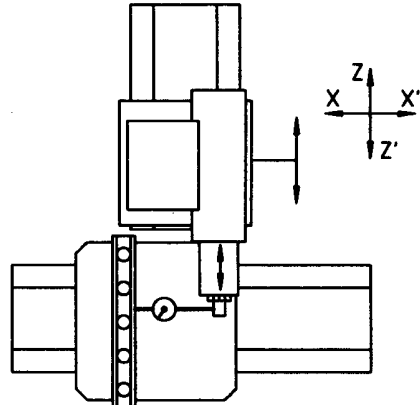
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Object		G24
Checking of the straightness of the ram movement: a) in the vertical YZ plane; b) in the horizontal ZX plane.		
Diagram  		
Tolerance For a) and b) 0,015 for a measuring length of 300		Measured deviation a) b)
Measuring instruments Straightedge and dial gauge		
Observations and references to ISO 230-1		
a) Y-axis to be locked, if possible. b) X-axis to be locked, if possible.		5.211, 5.23, 5.231.2, 5.232.1 and 5.233.1

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Object		G25
Checking of parallelism between the axial movement of the spindle and the Z-axis motion:		
a) in the vertical YZ plane; b) in the horizontal ZX plane.		
Diagram		
		
Tolerance		Measured deviation a) b)
For a) and b) 0,025 for a measuring length of 300		
Measuring instruments		
Straightedge and dial gauge or gauge block and dial gauge		
Observations and references to ISO 230-1		5.422.2 and 5.422.5
a) Y-axis to be locked, if possible. b) X-axis to be locked, if possible.		
It should be noted that, for a), the deviation includes the normal deflection of the spindle.		
If the two movements can be operated together, move the two parts by the same amount so that the stylus always touches the straightedge or the gauge block in the same point.		
If this is not possible, the straightedge should be set parallel to the Z-axis, or the lack of parallelism shall be considered in the measurement.		

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Object		G26
Checking of parallelism between the ram movement and the Z-axis motion: a) in the vertical YZ plane; b) in the horizontal ZX plane.		
Diagram		
 a)  b)		
Tolerance		Measured deviation a) b)
For a) and b) 0,025 for a measuring length of 300		
Measuring instruments		
Straightedge and dial gauge or gauge block and dial gauge		
Observations and references to ISO 230-1		5.422.2 and 5.422.5
a) Y-axis to be locked, if possible. b) X-axis to be locked, if possible.		
If the two movements can be operated together, move the two parts by the same amount so that the stylus always touches the straightedge or the gauge block in the same point.		
If this is not possible, the straightedge should be set parallel to the Z-axis, or the lack of parallelism shall be considered in the measurement.		

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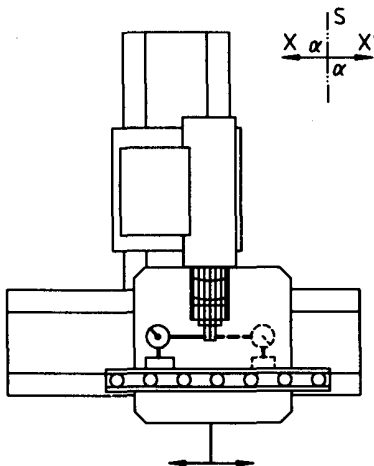
Annex A (normative)

Accessory 45° split indexable heads

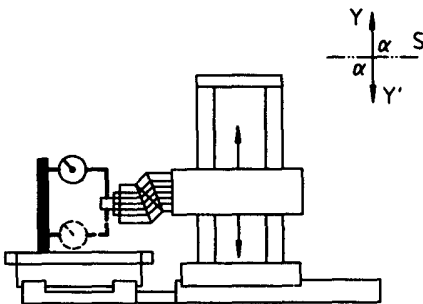
Object		AG1
Checking of parallelism between the spindle axis and the Z-axis motion:		
a) in the vertical YZ plane; b) in the horizontal ZX plane.		
Diagram		
Tolerance		Measured deviation
For a) and b) 0,025 for a measuring length of 300		a) b)
Measuring instruments		
Test mandrel and dial gauge		
Observations and references to ISO 230-1		5.412.1 and 5.422.3
X-axis should be in the centre of the direction of travel.		
For a), Y-axis to be locked, if possible.		
For b), X-axis to be locked, if possible.		

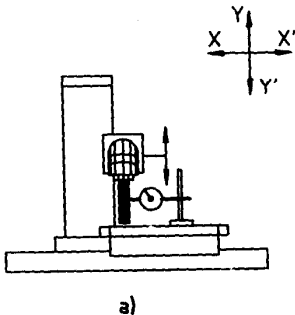
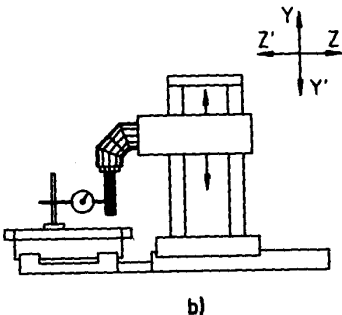
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Object		AG2
Checking of squareness between the spindle axis and the X-axis motion.		
Diagram		
		
Tolerance		Measured deviation
0,025/300		
Measuring instruments		
Straightedge, special arm and dial gauge		
Observations and references to ISO 230-1		5.512.1, 5.512.32 and 5.512.42
Z-axis to be locked, if possible.		
The straightedge shall be set parallel to the X-axis.		
This squareness deviation can also be derived from tests G9 and AG1 b).		
The value of angle α , being less than, equal to or greater than 90° , should be noted for information and possible corrections.		

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Object		AG3
Checking of squareness between the spindle axis in the horizontal position along the Z-direction and the Y-axis motion.		
Diagram 		
Tolerance 0,025/300		Measured deviation
Measuring instruments Square, special arm and dial gauge		
Observations and references to ISO 230-1		
		5.512.1, 5.512.32 and 5.512.42
Z-axis to be locked, if possible. The measurement side of the square should be set parallel to the Y-axis, or the lack of parallelism shall be taken into account in the measurement. This squareness deviation can also be derived from tests G8 and AG1 a). The value of angle α , being less than, equal to or greater than 90° , should be noted for information and possible corrections.		

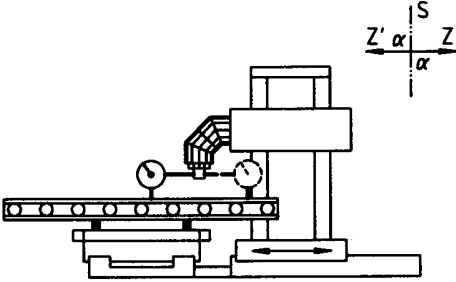
Object		AG4
Checking of parallelism between the spindle axis in the vertical position and the Y-axis motion: a) in the vertical XY plane; b) in the vertical YZ plane.		
Diagram  a)  b)		
Tolerance For a) and b) 0,025 for a measuring length of 300		Measured deviation a) b)
Measuring instruments Test mandrel and dial gauge		
Observations and references to ISO 230-1 5.412.1 and 5.422.3 X-axis should be in the centre of the direction of travel. For a), X-axis to be locked, if possible. For b), Z-axis to be locked, if possible.		

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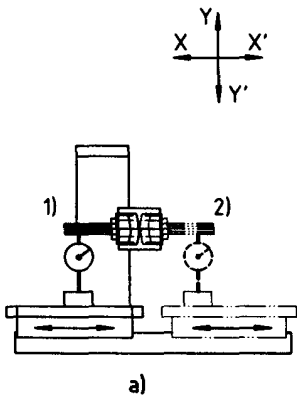
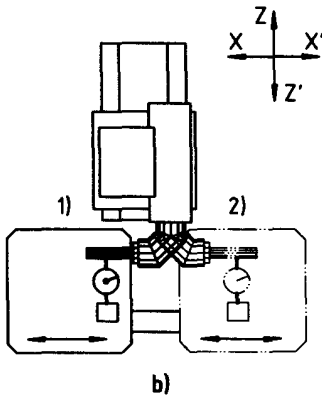
Object		AG5
Checking of squareness between the spindle axis in the vertical position and the X-axis motion.		
Diagram		
Tolerance		Measured deviation
0,025/300		
Measuring instruments		
Straightedge, special arm and dial gauge		
Observations and references to ISO 230-1 5.512.1 and 5.512.42 Y-axis to be locked, if possible. The straightedge shall be set parallel to the X-axis. This squareness deviation can also be derived from tests G7 and AG4 a). The value of angle α, being less than, equal to or greater than 90°, should be noted for information and possible corrections.		

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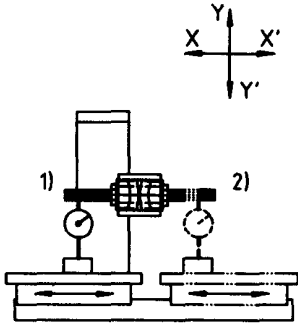
Object	AG6
Checking of squareness between the spindle axis in the vertical position and the Z-axis motion.	
Diagram 	
Tolerance 0,025/300	Measured deviation
Measuring instruments Straightedge, special arm and dial gauge	
Observations and references to ISO 230-1 5.512.1 and 5.512.42 Y-axis to be locked, if possible. The straightedge shall be set parallel to the Z-axis. This squareness deviation can also be derived from tests G8 and AG4 b). The value of angle α, being less than, equal to or greater than 90°, should be noted for information and possible corrections.	

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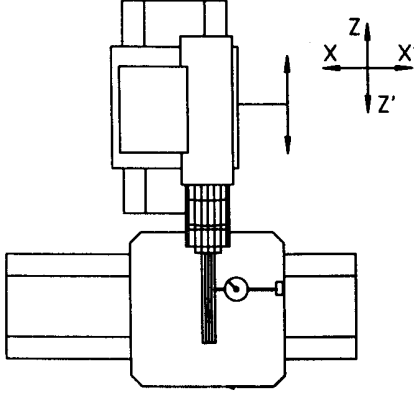
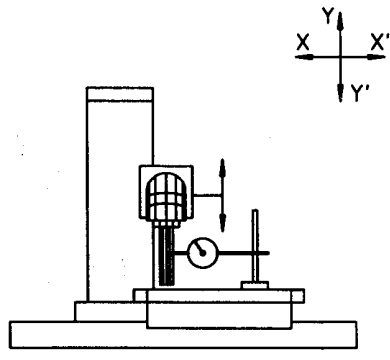
Object Checking of parallelism between the spindle axis in either of the two horizontal positions along the X-direction and the X-axis motion: 1) With the spindle in the left position: a) in the vertical XY plane; b) in the horizontal ZX plane. 2) With the spindle in the right position: a) in the vertical XY plane; b) in the horizontal ZX plane.	AG7
Diagram  	
Tolerance For a) and b) 0,025 for a measuring length of 300	Measured deviation a) b)
Measuring instruments Test mandrel and dial gauge	
Observations and references to ISO 230-1 For a), Y-axis to be locked, if possible. For b), Z-axis to be locked, if possible. 5.412.1 and 5.422.3	

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Object		AG8
Checking of difference between the spindle heights in the two horizontal positions in the X-direction.		
Diagram 		
Tolerance	0,03	Measured deviation
Measuring instruments Test mandrel and dial gauge		
Observations and references to ISO 230-1 This deviation can be derived from measurements 1) a) and 2) a) of test AG7, taking the readings at the spindle nose only, in order to ignore the parallelism deviations.		

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Object		AG9
Checking that the spindle axis S and rotary axis at 45° D lie in the same plane.		
Diagram  Step 1)  Step 2)		
Tolerance	0,020	Measured deviation
Measuring instruments		
Test mandrel and dial gauge		
Observations and references to ISO 230-1 X-axis to be locked, if possible. Step 1) Set the spindle in the horizontal position along the Z-direction. Zero the dial gauge touching the test mandrel close to the spindle nose. Lock the dial gauge on the table. Step 2) In order to avoid interferences with the dial gauge, drive away the head by means of movements along the Y and Z-axes only. Rotate the D-axis in order to set the spindle axis in the vertical position, and again bring the test mandrel into contact with the dial gauge by means of Y- and Z-axis movements. When the movements in step 2) have been completed, half of the reading on the dial gauge shall not exceed the tolerance. The deviation of this test can be measured by performing test AG4 a) after AG1 b), without moving the X-axis and without resetting the dial gauge.		

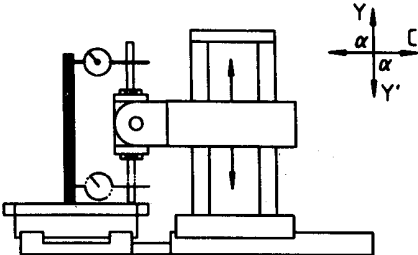
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Annex B (normative)

Accessory swivel heads

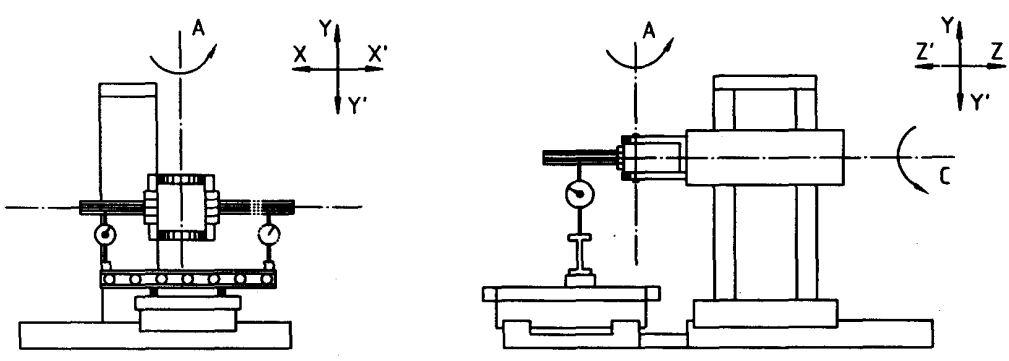
Object		BG1
Checking of squareness between the C-axis of the yoke rotation and the X-axis motion.		
Diagram		
Tolerance 0,025/500		Measured deviation
Measuring instruments Straightedge and dial gauge		
Observations and references to ISO 230-1		
Z-axis to be locked, if possible.		5.512.1, 5.512.32 and 5.512.42
The straightedge shall be set parallel to the X-axis.		
The dial gauge may be mounted either on the yoke body or on the spindle head, in this case setting the spindle perpendicular to the Z-axis.		
The value of angle α , being less than, equal to or greater than 90° , should be noted for information and possible corrections.		

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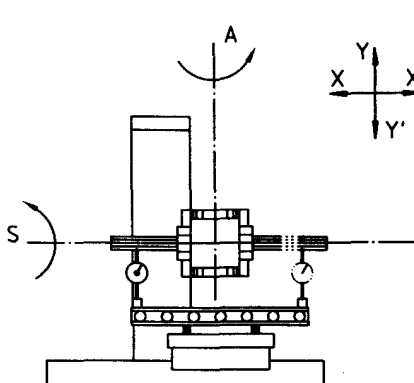
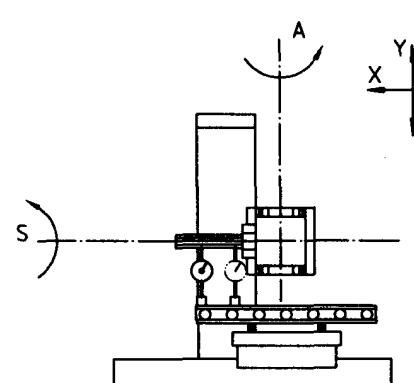
Object		BG2
Checking of squareness between the C-axis of the yoke rotation and the Y-axis motion.		
Diagram 		
Tolerance 0,025/500		Measured deviation
Measuring instruments Square and dial gauge		
Observations and references to ISO 230-1 5.512.1, 5.512.32 and 5.512.42 Z-axis to be locked, if possible. The square shall be set parallel to the Y-axis. The dial gauge may be mounted either on the yoke or on the spindle head, in this case setting the spindle perpendicular to the Z-axis. The value of angle α, being less than, equal to or greater than 90°, should be noted for information and possible corrections.		

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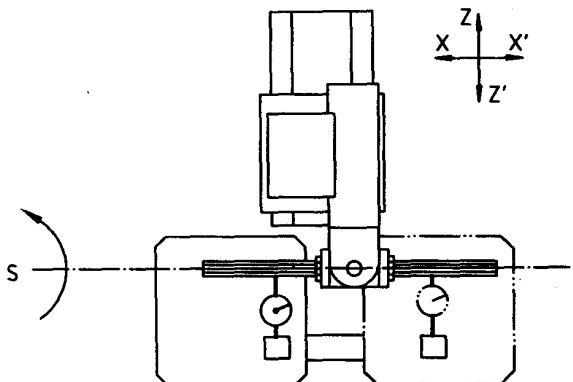
Object	BG3
Checking of squareness between the A-axis of the head rotation and the C-axis of the yoke rotation.	
Diagram  Step 1) Step 2)	
Tolerance 0,035/500	Measured deviation
Measuring instruments Straightedge or surface plate, test mandrel and dial gauge	
Observations and references to ISO 230-1 Y-axis to be locked, if possible. The straightedge shall be set parallel to the X-axis. Step 1) Adjust the angular position of the yoke (C-axis) until the two dial gauge readings, with the spindle in the right and in the left position, are equal to each other (A-axis is perpendicular to X-axis). Then zero the dial gauge and mark the contact point on the test mandrel. Step 2) Rotate the head (A-axis) 90° in order to set the spindle horizontal along the Z direction (in the YZ plane) and move the Z-axis (and the dial gauge on the straightedge) until the stylus touches the test mandrel again in the marked point. Note the reading. Step 3) Rotate the yoke (C-axis) 180°, repeat adjustment step 1) and measurement step 2). Half of the difference between the two measurements step 2); divided by the distance between the dial gauge and the A-axis of the head rotation, shall not exceed the tolerance. NOTE — Half of the sum of the two measurements in step 2), i.e. their mean value, divided by the distance between the dial gauge and the A-axis of the head rotation, gives the parallelism deviation between the C-axis and the Z-axis in the vertical YZ plane, corresponding to the combination of tests G8 and BG2. The squareness deviation between the spindle axis S and the A-axis, to be measured by test BG4, is bypassed by zeroing the dial gauge during the adjustment step 1).	

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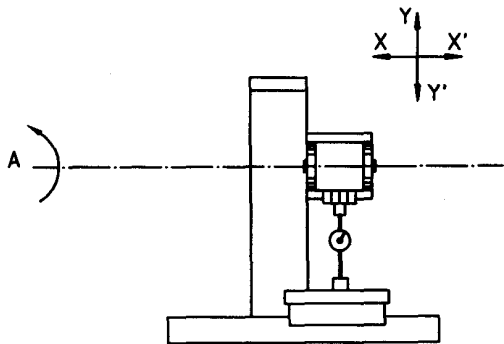
Object		BG4
Checking of squareness between the spindle axis S and the A-axis of the head rotation.		
Diagram  Step 1)  Step 2)		
Tolerance		Measured deviation
0,040 for a measuring length of 500		
Measuring instruments		
Straightedge or surface plate, test mandrel and dial gauge		
Observations and references to ISO 230-1		
Y-axis to be locked, if possible.		
The straightedge shall be set parallel to the X-axis.		
Step 1) Use the adjustment carried out in Step 1) of the previous test (BG3).		
Step 2) Measure the parallelism deviation between the spindle axis S in the vertical XY plane in any of the two horizontal positions of the spindle. This deviation is equal to the squareness deviation between the spindle axis S and the A-axis.		

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Object	BG5
Checking that the spindle axis S and the A-axis of the head rotation lie in the same plane.	
Diagram 	
Tolerance 0,020	Measured deviation
Measuring instruments Test mandrel and dial gauge	
Observations and references to ISO 230-1 Z-axis to be locked, if possible. Turn the head crosswise on one side, and adjust the A-axis until the test mandrel is parallel to the X-axis in the horizontal ZX plane. Zero the dial gauge and lock it on the table. In order to avoid interferences with the dial gauge, drive away the head by means of movements along the X and Y-axes only. Rotate the A-axis 180°, and again bring the test mandrel into contact with the dial gauge by means of X- and Y-axis movements. Adjust the A-axis until the test mandrel is again parallel to the X-axis on the other side, without resetting the dial gauge. Half of the new reading shall not exceed the tolerance.	

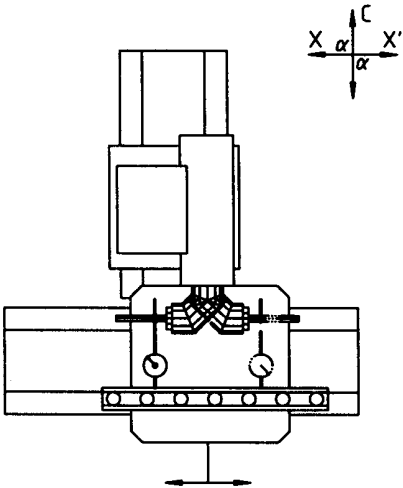
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Object		BG7
Checking that the A-axis of the head rotation and the C-axis of the yoke rotation lie in the same plane.		
Diagram 		
Tolerance 0,020		Measured deviation
Measuring instruments Dial gauge and surface plate		
Observations and references to ISO 230-1 Y-axis to be locked, if possible. The surface plate shall be set parallel to the ZX plane. If the spindle can be locked, the dial gauge may be mounted on it. Adjust the A and C-axes so as to have the spindle perpendicular to the surface plate. Zero the dial gauge. Turn both A and C-axes 180° and take the new reading. Half of the new reading shall not exceed the tolerance.		

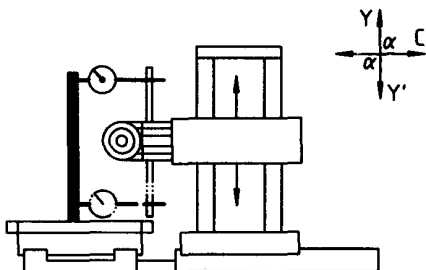
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Annex C (normative)

Accessory 45° split continuous heads

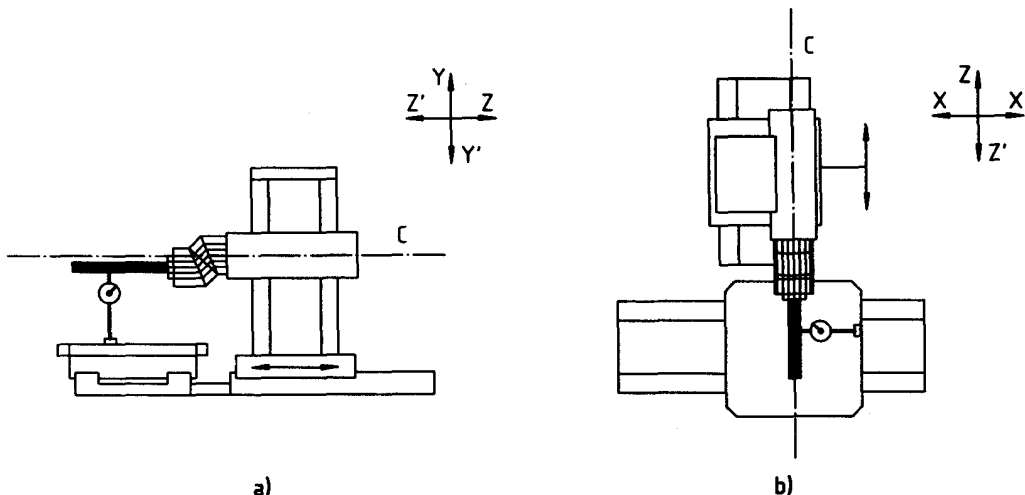
Object	CG1
Checking of squareness between the C-axis of the head base rotation and the X-axis motion.	
Diagram 	
Tolerance 0,035/500	Measured deviation
Measuring instruments Straightedge and dial gauge	
Observations and references to ISO 230-1 5.512.1, 5.512.32 and 5.512.42 Z-axis to be locked, if possible. The straightedge shall be set parallel to the X-axis. The dial gauge may be mounted on the head base, in this case setting the spindle perpendicular to the Z-axis. The value of angle α, being less than, equal to or greater than 90°, should be noted for information and possible corrections.	

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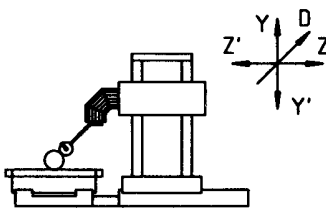
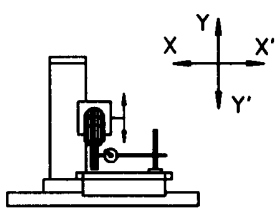
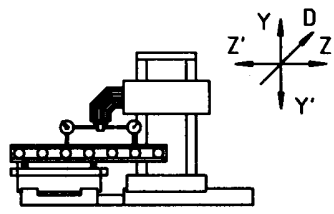
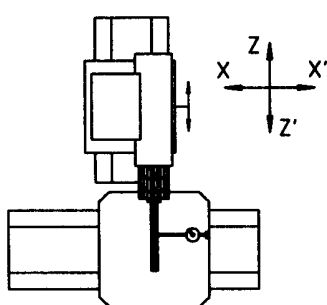
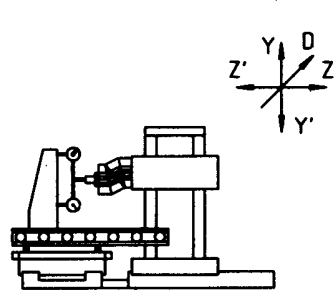
Object		CG2
Checking of squareness between the C-axis of the head base rotation and the Y-axis motion.		
Diagram 		
Tolerance 0,035/500		Measured deviation
Measuring instruments Square and dial gauge		
Observations and references to ISO 230-1		
		5.512.1, 5.512.32 and 5.512.42
Z-axis to be locked, if possible. The square shall be set parallel to the Y-axis. The dial gauge may be mounted on the head base, in this case setting the spindle perpendicular to the Z-axis. The value of angle α , being less than, equal to or greater than 90° , should be noted for information and possible corrections.		

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Object		CG3
Checking of parallelism between the C-axis of the head base rotation and the Z-axis motion: a) in the vertical YZ plane; b) in the horizontal ZX plane.		
Diagram		
		
Tolerance		Measured deviation a) b)
For a) and b) 0,020 for a measuring length of 300		
Measuring instruments Test mandrel and dial gauge		
Observations and references to ISO 230-1 5.412.1 and 5.422.3		
This test can be performed only if the C-axis can rotate at least 180°.		
X-axis in centre of the travel.		
For a), Y-axis to be locked, if possible.		
For b), X-axis to be locked, if possible.		
Orientate the spindle in the horizontal position along the Z direction and check its parallelism with the Z-axis, both in the vertical YZ plane and in the horizontal ZX plane.		
Rotate the head base (C-axis) 180° and again measure the parallelism in the two planes.		
In both planes, the mean value of the two deviations read before and after the 180° rotation shall not exceed the tolerance.		

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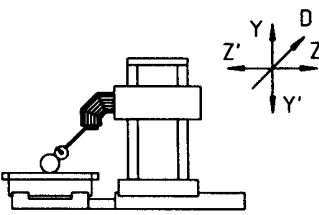
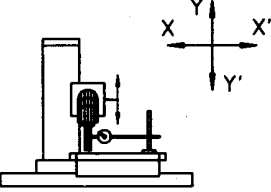
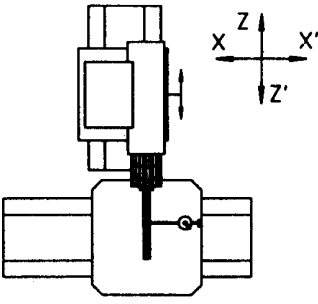
Object	CG4
Checking of accuracy of the 45° angle between the spindle axis S and the D-axis of the head rotation.	
Diagram  Step 1)  Step 2)  Step 3)  Step 4)  Step 5)	
Tolerance 0,020/300	Measured deviation
Measuring instruments Test mandrel, straightedge, square, cylindrical square and dial gauge	
Observations and references to ISO 230-1 Step 1) Adjust the head base (C-axis) in the vertical position by means of a cylinder set parallel to the X-axis, and rotating by 180° the head (D-axis) on which the dial gauge arm is fixed. Lock the head base. Step 2) Adjust the head (D-axis) in the vertical position so that the spindle axis is parallel to the Y-axis in the XY plane. Step 3) Measure the squareness between the spindle axis and a straightedge set parallel to the Z-axis. Note the reading and its direction (e.g., positive = open and negative = closed). Step 4) Then adjust the head (D-axis) in the horizontal position so that the spindle axis is parallel to the Z-axis in the horizontal ZX plane. Step 5) Measure the squareness between the spindle axis and a square placed on the straightedge. Note the reading and its direction. Half of the algebraic difference between the deviations measured in step 3) and step 5) shall not exceed the tolerance. (This shall not be confused with half of the algebraic sum, which has a totally different meaning).	

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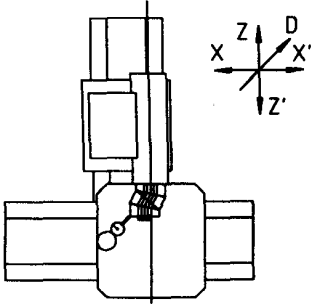
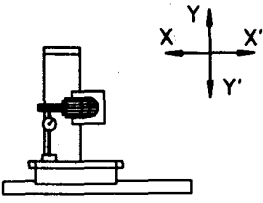
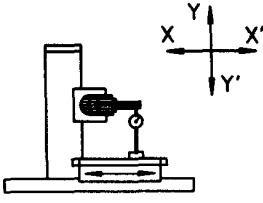
Object		CG5
Checking the accuracy of the 45° angle between the D-axis of the head rotation and the C-axis of the head base rotation.		
Diagram Step 1) Step 2) Step 3) Step 4)		
Tolerance	0,020/300	Measured deviation
Measuring instruments Straightedge, square, cylindrical square and dial gauge		
Observations and references to ISO 230-1 Step 1) Adjust the head base (C-axis) in the lateral position by means of a cylinder set parallel to the Y-axis, and rotating by 180° the head (D-axis) on which the dial gauge arm is fixed. Lock the head base. Step 2) Place a straightedge on the table and set it perpendicular to the D rotary axis. Step 3) Using the same procedure as in step 1), adjust the head base on the other side. Step 4) Measure the squareness between the D rotary axis and a square placed on the straightedge. Half of the measured deviation shall not exceed the tolerance.		

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Object		CG6
Checking that the spindle axis S and the D-axis of the head rotation lie in the same plane.		
Diagram  Step 1)  Step 2)  Step 3)		
Tolerance		Measured deviation
0,020		
Measuring instruments		
Test mandrel and dial gauge		
Observations and references to ISO 230-1 X-axis to be locked, if possible. Step 1) Adjust the head base (C-axis) as in step 1) in test CG4. Step 2) Adjust the head (D-axis) as in step 2) in test CG4. Zero the dial gauge. Step 3) Adjust the head (D-axis) as in step 4) in test CG4, without resetting the dial gauge and only moving the Y and Z-axes. When the adjustment in step 3) has been completed, half of the reading on the dial gauge shall not exceed the tolerance.		

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Object		CG7
Checking that the D-axis of the head rotation and the C-axis of the head base rotation lie in the same plane.		
Diagram  Step 1)  Step 2)  Step 3)		
Tolerance 0,020		Measured deviation
Measuring instruments Test mandrel and dial gauge		
Observations and references to ISO 230-1 Y-axis to be locked, if possible. Step 1) Adjust the head base (C-axis) as in step 1) in test CG5. Step 2) Adjust the head (D-axis) so that the spindle axis is parallel to the X-axis in the vertical XY plane. Zero the dial gauge. Step 3) Rotate the head base (C-axis) 180° and adjust it so that the spindle is again parallel to the X-axis on the other side, without resetting the dial gauge and moving X and Z-axes only. Half of the reading on the dial gauge equals the algebraic sum of the deviation of this test and the deviation of test CG6.		

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Annex D **(informative)**

Bibliography

- [1] ISO 841:—¹⁾, *Industrial automation systems — Physical device control — Coordinate system and motion nomenclature.*
- [2] ISO 8526-1:1990, *Modular units for machine tools — Workholding pallets — Part 1: Workholding pallets up to 800 mm nominal size.*
- [3] ISO 8526-2:1990, *Modular units for machine tools — Workholding pallets — Part 2: Workholding pallets of nominal size greater than 800 mm.*

1) To be published. (Revision of ISO 841:1974)

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