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ISO 14137

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Machine tools — Test conditions for wire electrical-discharge machines (wire EDM) — Terminology and testing of the accuracy

Machine-outils — Conditions d'essai des machines d'électroérosion à fil (fil EDM) — Terminologie et contrôle de la précision

Reference number
ISO 14137:2000(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 14137 was prepared by Technical Committee ISO/TC 39, *Machine tools*, Subcommittee SC 2, *Test conditions for metal cutting machine tools*.

Machine tools — Test conditions for wire electrical-discharge machines (wire EDM) — Terminology and testing of the accuracy

1 Scope

ISO 14137 specifies, with reference to ISO 230-1, ISO 230-2 and ISO 230-4, geometric tests, tests of accuracy and repeatability of numerically controlled positioning axes, machining test and circular tests for general purpose, normal-accuracy wire electrical-discharge machines (wire EDM). It also specifies applicable tolerances corresponding to the above-mentioned tests.

ISO 14137 is applicable to single column machines of cross slide table type and double column type machines.

ISO 14137 deals only with the testing of accuracy of the machine. It does not apply to the testing of the machine operation (vibration, abnormal noise, stick-slip motion of components, etc.) nor to machine characteristics (such as speeds, feeds, etc.), which should generally be carried out before testing the accuracy.

ISO 14137 provides the terminology used for the principle components of the machine and the designation of the axes in accordance with ISO 841.

2 Normative references

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

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

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

ISO 230-4:1996, *Test code for machine tools — Part 4 : Circular tests for numerically controlled machine tools.*

3 Terminology and designation of axes

3.1 Cross slide table type

See Figure 1 and Table 1.

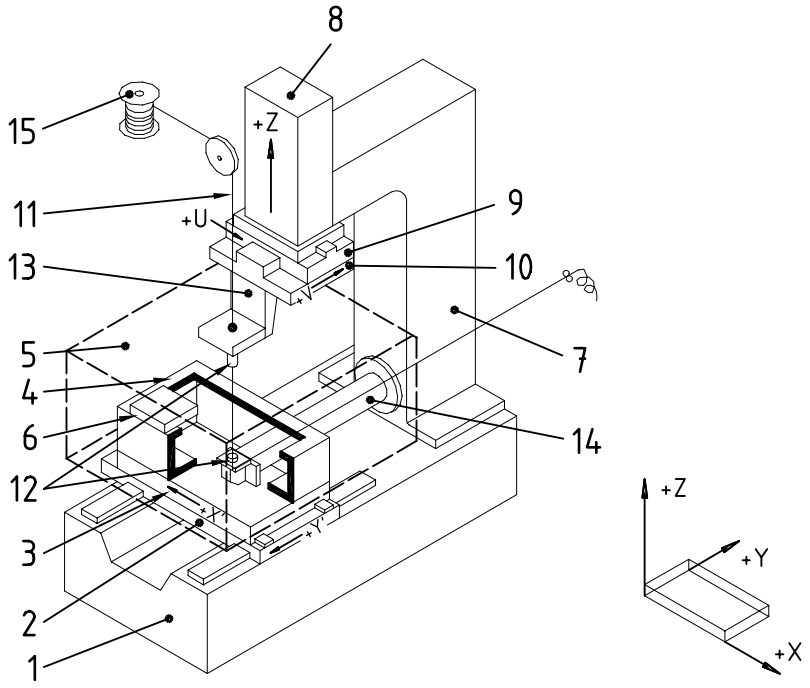


Figure 1

Table 1

Ref.	English	French	German
1	Bed	Banc	Bett
2	Saddle (Y-axis)	Selle (axe Y)	Schlitten (Achse Y)
3	Table (X-axis)	Table (axe X)	Tisch (Achse X)
4	Work-holding frame	Cadre de bridage	Aufspannrahmen
5	Work tank (cover)	Bac de travail	Arbeitsbehälter
6	Workpiece	Pièce à usiner	Werkstück
7	Column	Montant	Ständer
8	Head (Z-axis)	Tête (axe Z)	Schlitten Z
9	U saddle (U-axis)	Selle U (axe U)	Schlitten U
10	V saddle (V-axis)	Selle V (axe V)	Schlitten V
11	Wire electrode	Fil électrode	Drahtelektrode
12	Wire guide	Guide-fil	Drahtführung
13	Upper guide support	Support guide-fil supérieur	Oberer Drahtführungshalter
14	Lower guide support	Support guide-fil inférieur	Unterer Drahtführungshalter
15	Wire spool	Enrouleur de fil	Drahteinroller
NOTE In addition to terms used in two of the three official ISO languages (English and French), this table gives the equivalent terms in German; these are published under the responsibility of the member body of Germany (DIN). However, only the terms given in the official languages can be considered as ISO terms.			

3.2 Double column type

See Figure 2 and Table 2.

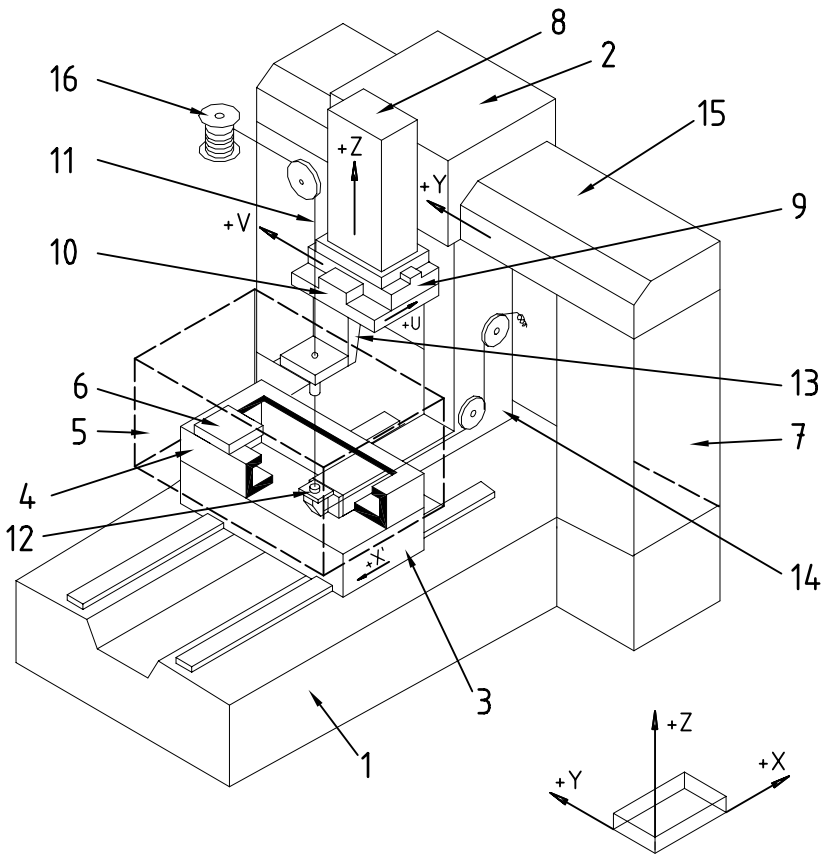


Figure 2

Table 2

Ref.	English	French	German
1	Bed	Banc	Bett
2	Saddle (Y-axis)	Selle (axe Y)	Schlitten (Achse Y)
3	Table (X-axis)	Table (axe X)	Tisch (Achse X)
4	Work-holding frame	Cadre de bridage	Aufspannrahmen
5	Work tank (cover)	Bac de travail	Arbeitsbehälter
6	Workpiece	Pièce à usiner	Werkstück
7	Column	Montant	Ständer
8	Head (Z-axis)	Tête (axe Z)	Schlitten Z
9	U saddle (U-axis)	Selle U (axe U)	Schlitten U
10	V saddle (V-axis)	Selle V (axe V)	Schlitten V
11	Wire electrode	Fil électrode	Drahtelektrode
12	Wire guide	Guide-fil	Drahtführung
13	Upper guide support	Support guide-fil supérieur	Oberer Drahtführungshalter
14	Lower guide support	Support guide-fil inférieur	Unterer Drahtführungshalter
15	Cross beam	Traverse	Querbalken
16	Wire spool	Enrouleur de fil	Drahteinroller
NOTE NOTE In addition to terms used in two of the three official ISO languages (English and French), this table gives the equivalent terms in German; these are published under the responsibility of the member body of Germany (DIN). However, only the terms given in the official languages can be considered as ISO terms.			

4 Preliminary remarks

4.1 Measuring units

In this International Standard, all linear dimensions, deviations and corresponding tolerances are expressed in millimetres; angular dimensions are expressed in degrees, and angular deviations and the corresponding tolerances are expressed primarily 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 μrad ≈ 2"

4.2 Reference to ISO 230-1

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

In the “Observations” block of the tests described in clauses 5 to 8, the instructions are followed by a reference to the corresponding clause in ISO 230-1, in cases where the test concerned is in compliance with the specifications of ISO 230-1.

4.3 Testing sequence

The sequence in which the tests are presented in this International Standard in no way defines the practical order of testing. In order to make the mounting of instruments or gauging easier, tests may be performed in any order.

4.4 Tests to be performed

When testing a machine, it is not always necessary nor possible to carry out all the tests described in this International Standard. When the tests are required for acceptance purposes, it is up to the user to choose, in agreement with the supplier/manufacturer, those tests relating to the components and/or the properties of the machine which are of interest. These tests are to be clearly stated when ordering a machine. Mere reference to this International Standard for the acceptance tests, without specifying the tests to be carried out, and without agreement on the relevant expenses, cannot be considered as binding for any contracting party.

4.5 Measuring instruments

The measuring instruments indicated in the tests described in clauses 5 to 8 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 Minimum tolerance

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

4.7 Positioning tests and reference to ISO 230-2

Tests P1 to P5 are only applied to numerically controlled X, Y, Z, U and V axes.

To apply the tests, reference should be made to ISO 230-2, especially for the environmental conditions, warming up of the machine, measuring methods, evaluation and interpretation of the results.

When other numerically controlled axes exist, checking shall be agreed between the supplier/manufacturer and user.

4.8 Machining test

Concerning the machining test, only simple machining of a cylindrical hole is prepared. Machining of other suitable test parts is also possible under the agreement between the supplier/manufacturer and user. The machining test may be substituted by circular test C1.

4.9 Circular test and reference to ISO 230-4

To apply the tests, reference should be made to ISO 230-4:1996, especially to clauses 4 and 6 for the test conditions and presentation of results.

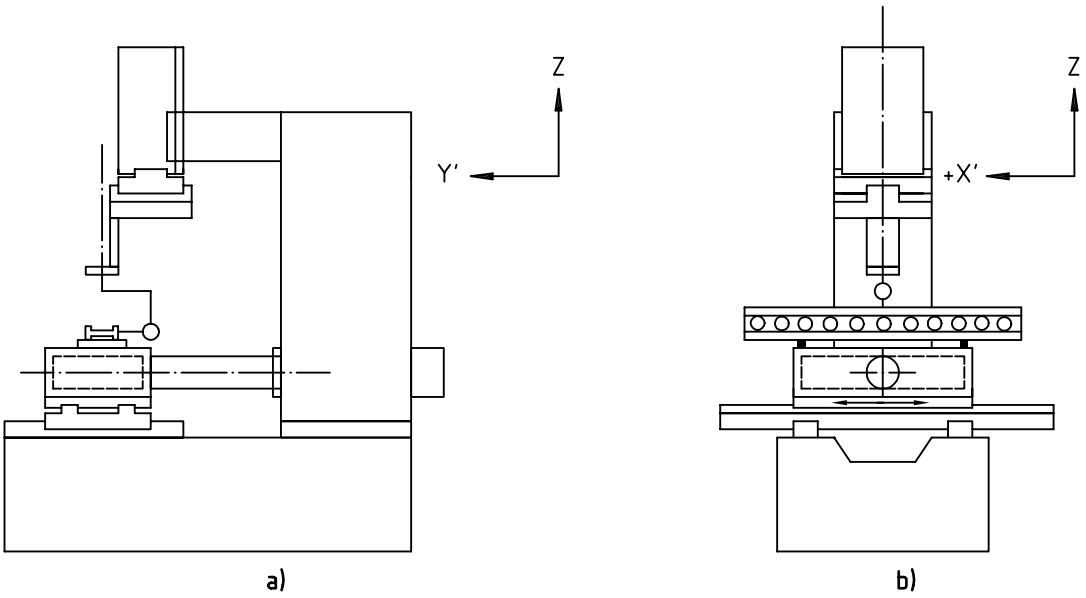
The circular test may be substituted by machining test M1.

5 Geometric tests

5.1 Basic linear motions

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

Diagram



Tolerance	**Measured deviation**
a) and b) 0,015 for any measuring length of 500	a) b)

Measuring instruments

Straightedge, dial gauge and gauge blocks, or optical methods

Observations and references to ISO 230-1:1996 5.232.11

Mount the dial-gauge assembly on the head.

a) Place the straightedge parallel to the X-direction in the XY-plane and set the dial gauge against it. Move the X-axis through the measuring length and record the dial-gauge readings.

b) Repeat the check in the same way in the ZX-plane.

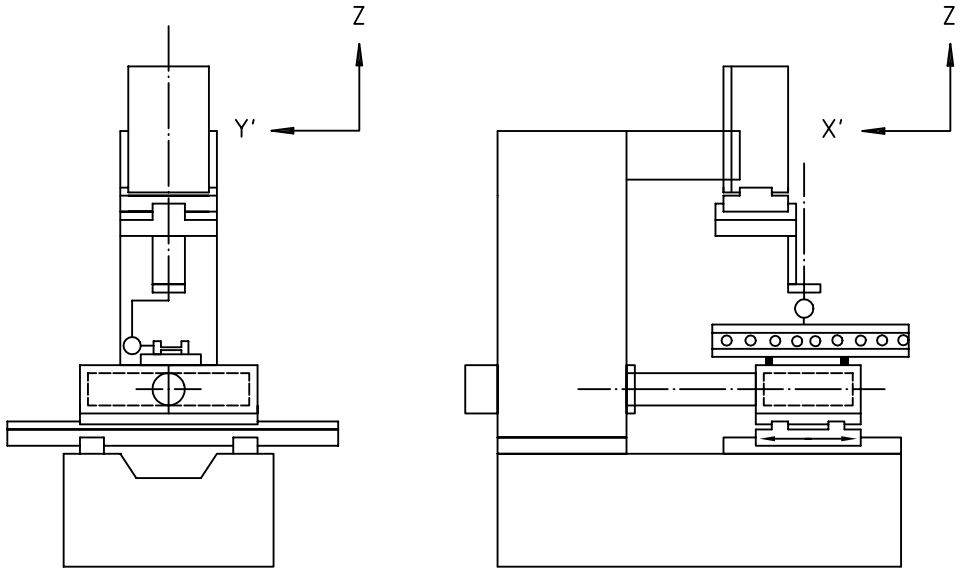
Object **G2**

Checking of straightness of the Y-axis motion:

a) in XY-plane (horizontal plane) EXY;

b) in YZ-plane (vertical plane) EZY.

Diagram



a) b)

Tolerance	**Measured deviation**
a) and b) 0,015 for any measuring length of 500	a) b)

Measuring instruments

Straightedge, dial gauge and gauge blocks, or optical methods

Observations and references to ISO 230-1:1996 5.232.11

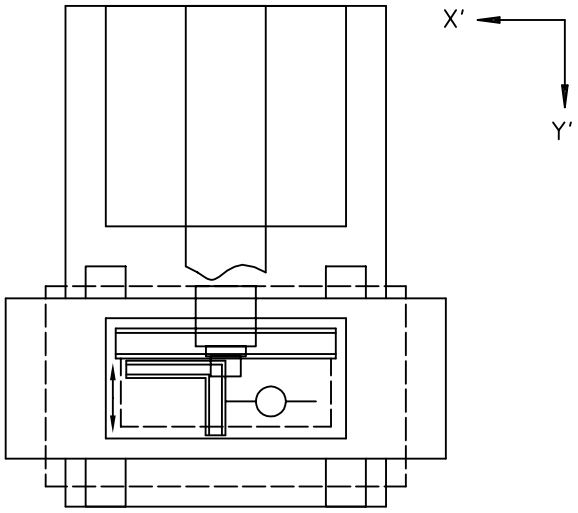
Mount the dial-gauge assembly on the head.

a) Place the straightedge parallel to the Y-direction in the XY-plane and set the dial gauge against it. Move the Y-axis through the measuring length and record the dial-gauge readings.

b) Repeat the check in the same way in the YZ-plane.

Object	**G3**
Checking the squareness between the X-axis motion and the Y-axis motion.	

Diagram



Tolerance	**Measured deviation**
0,015 for any measuring length of 300	

Measuring instruments

Straightedge, square and dial gauge

Observations and references to ISO 230-1:1996 5.522.4

Align the straightedge on the table so as to be parallel to the X-axis motion and press the square against it. Mount the dial-gauge assembly on the head and set it against the square. Move the Y-axis motion through the measuring length and record the dial-gauge reading.

It is also possible to use only the square. In this case,

a) set the square so that the long arm is parallel to the X-axis motion;

b) check parallelism of the short arm with the Y-axis motion.

If necessary, the surface plate can be used for placing the straightedge and the square.

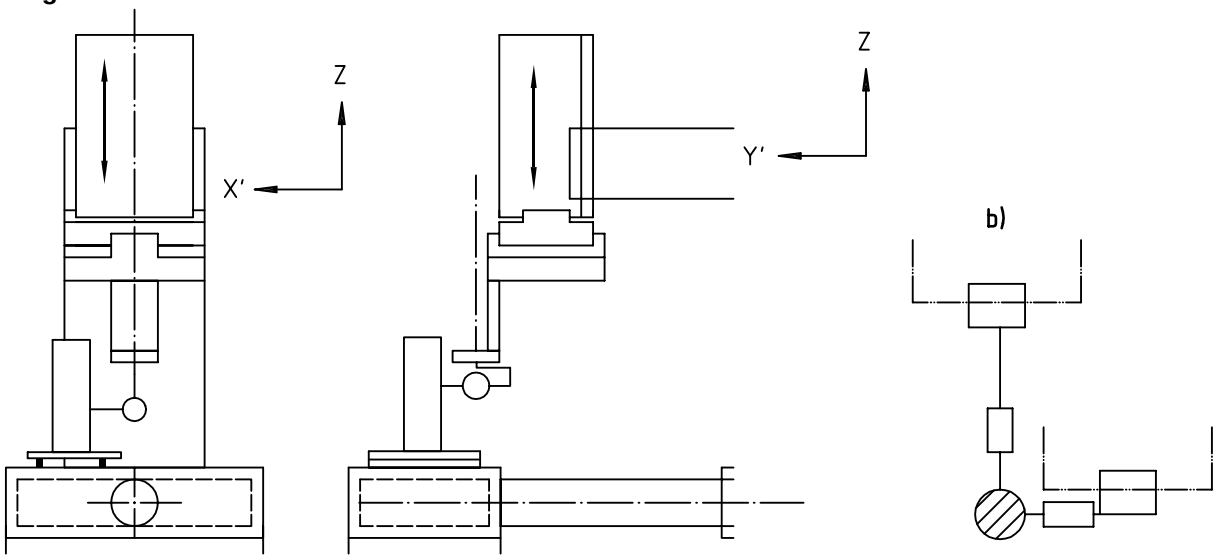
Object	**G4**

Checking of squareness between the Z-axis motion and

a) the X-axis motion;

b) the Y-axis motion.

Diagram



Tolerance	**Measured deviation**
a) and b) 0,02 for any measuring length of 300	a) b)

Measuring instruments

Cylindrical square, surface plate, adjustable blocks and dial gauge

Observations and references to ISO 230-1:1996 5.522.4

Place the surface plate on the work-holding frame and adjust it so that the surface is parallel to the motion of both the X- and Y-axes. Place the cylindrical square on the surface plate. Mount the dial-gauge assembly on the head.

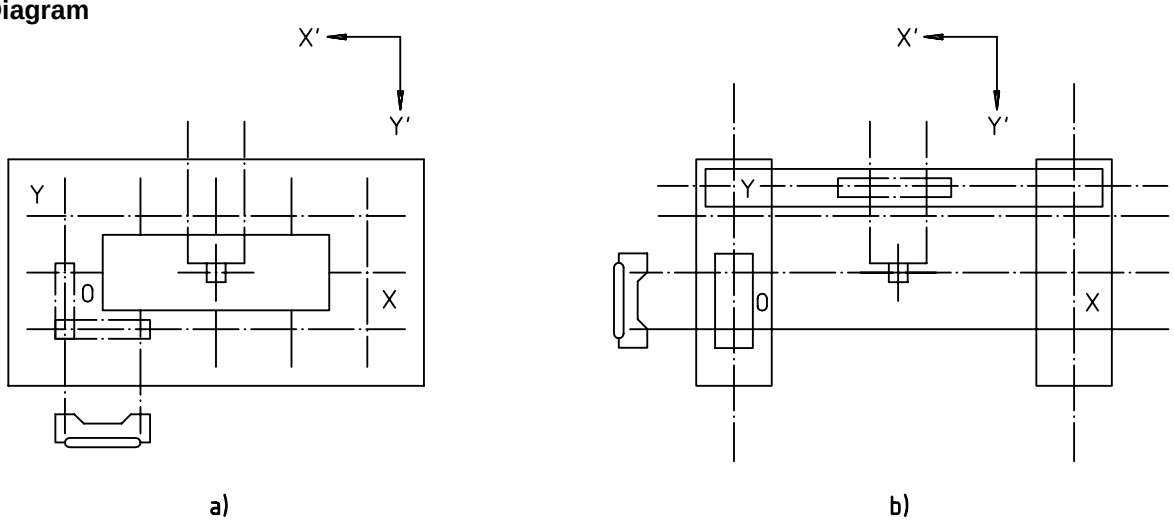
a) Set the dial gauge against the cylindrical square in the X-direction and move the head in the Z-direction through the measuring length and record the dial-gauge reading.

b) Repeat the check in the same way in the Y-direction.

5.2 Work-holding frame

Object	**G5**
Checking of flatness of the work-holding frame surface.	

Diagram



Tolerance	**Measured deviation**
0,03 up to a measuring length of 1 000	a)
Add 0,01 for any further 1 000 increase in length	b)
NOTE Measuring length means the longer length of O-X and O-Y	

Measuring instruments

Precision level or straightedge, gauge blocks, dial gauge, or optical or other equipment

Observations and references to ISO 230-1:1996 5.322, 5.323 and 5.324

For a), place the precision level on the surface of the work-holding frame and move it in the directions O-X and O-Y in the steps corresponding to its length and record the readings.

For b), in the case of a both-sides frame, check the flatness of both sides in the Y-direction and then check parallelism by using the bridge in the X-direction.

Record and evaluate the values obtained for each step.

NOTE Since the frame size is longer than the X- and Y-travels, direct measurement using a dial gauge fixed on the head is normally not possible.

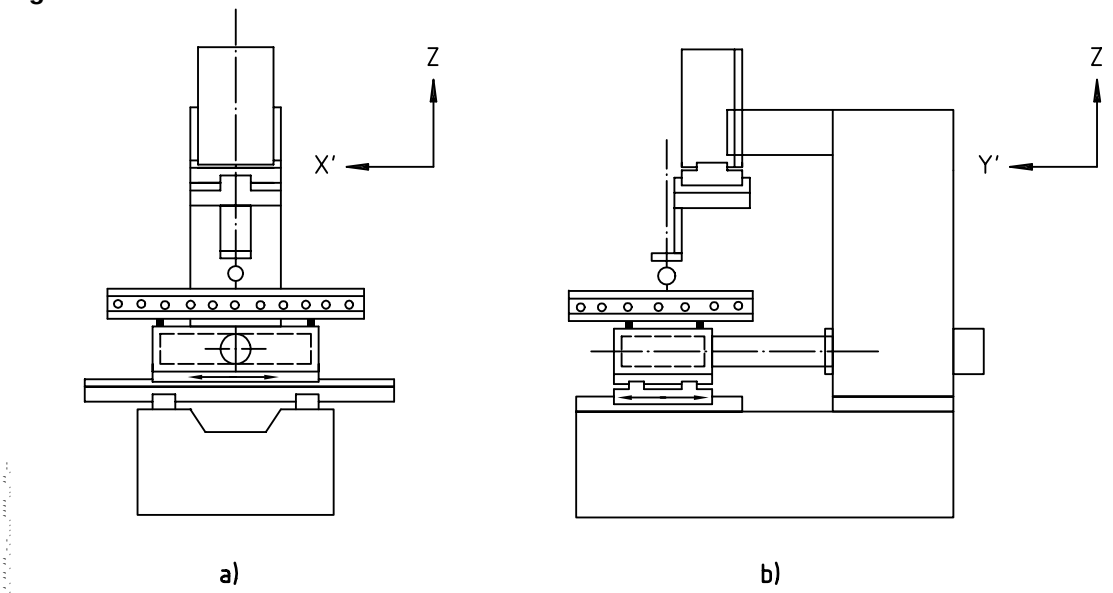
Object	**G6**

Checking of the parallelism of the work-holding frame surface to:

a) the X-axis motion;

b) the Y-axis motion.

Diagram



Tolerance	**Measured deviation**
a) and b) 0,015 for any measuring length of 300 Maximum tolerance: 0,04	a) b)

Measuring instruments

Dial gauge, straightedge, and gauge blocks

Observations and references to ISO 230-1:1996 5.422.21 and 5.422.22

Mount the dial-gauge assembly on the head.

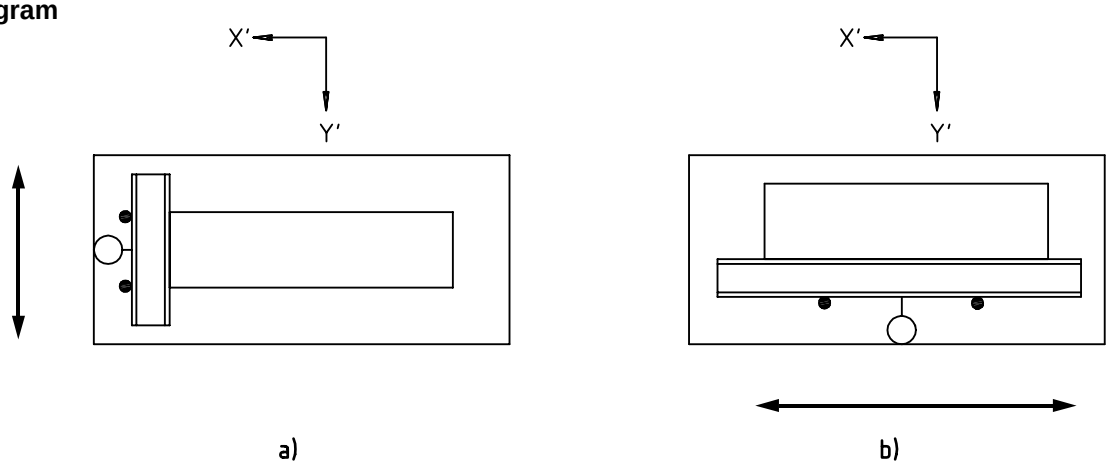
a) Place the straightedge on the gauge blocks in the X-direction, move the X-axis through the measuring length and record the dial-gauge reading.

b) Repeat the check in the same way in the Y-direction.

Direct measurement of the work holding frame surface without using the straightedge is also possible.

Object	**G7**
Checking of the parallelism between the locating pins or the reference surface of the work holding frame to: a) the X-axis motion; b) the Y-axis motion.	

Diagram



Tolerance	**Measured deviation**
a) and b) 0,015 for a measuring length of 300 Maximum tolerance: 0,04	a) b)

Measuring instruments

Dial gauge, straightedge

Observations and references to ISO 230-1:1996 5.422.21 and 5.422.22

Mount the dial-gauge assembly on the head.

Place a straightedge horizontally so that the reference face of the straightedge touches the locating pins.

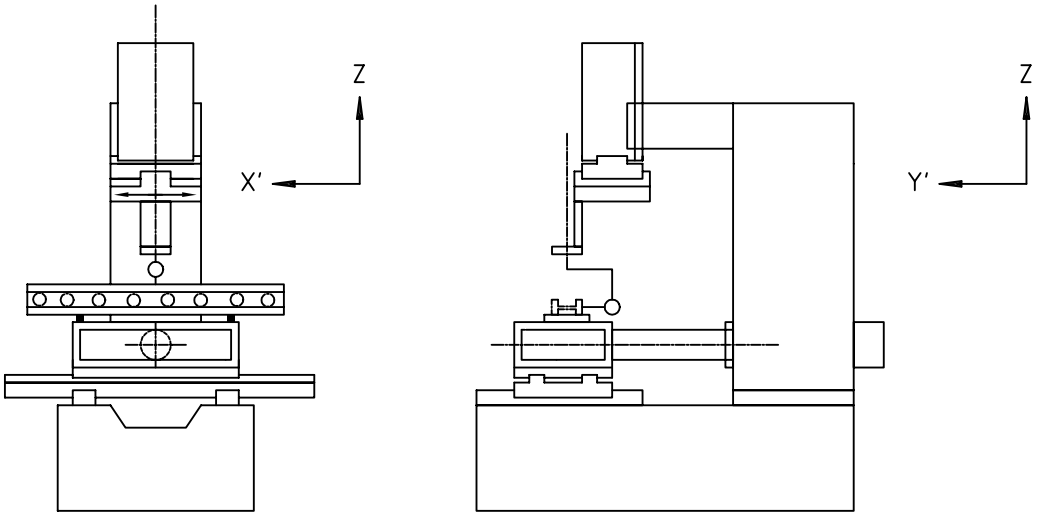
Set the dial gauge against the reference surface of the straightedge. Move the X-axis or Y-axis through the measuring length and record the dial-gauge reading.

Setting the dial gauge directly against the locating pins and recording the difference of the readings is also possible. In this case, the tolerance value shall be changed proportionally according to the distance between the locating pins.

5.3 Motion of U- and V-axes

Object	**G8**
Checking of the parallelism of the U-axis motion to the X-axis motion: a) in the ZX-plane; b) in the XY-plane.	

Diagram



a) b)

Tolerance	**Measured deviation**
a) 0,030 for any measuring length of 100	a)
b) 0,015 for any measuring length of 100	b)

Measuring instruments

Straightedge, dial gauge and gauge blocks

Observations and references to ISO 230-1:1996 5.232.11

Mount the dial-gauge assembly on the head.

a) Place the straightedge parallel to the X-axis motion in the ZX-plane and set this dial gauge against it. Move the U-axis through the measuring length and record the dial-gauge reading.

b) Repeat the check in the same way in the XY-plane.

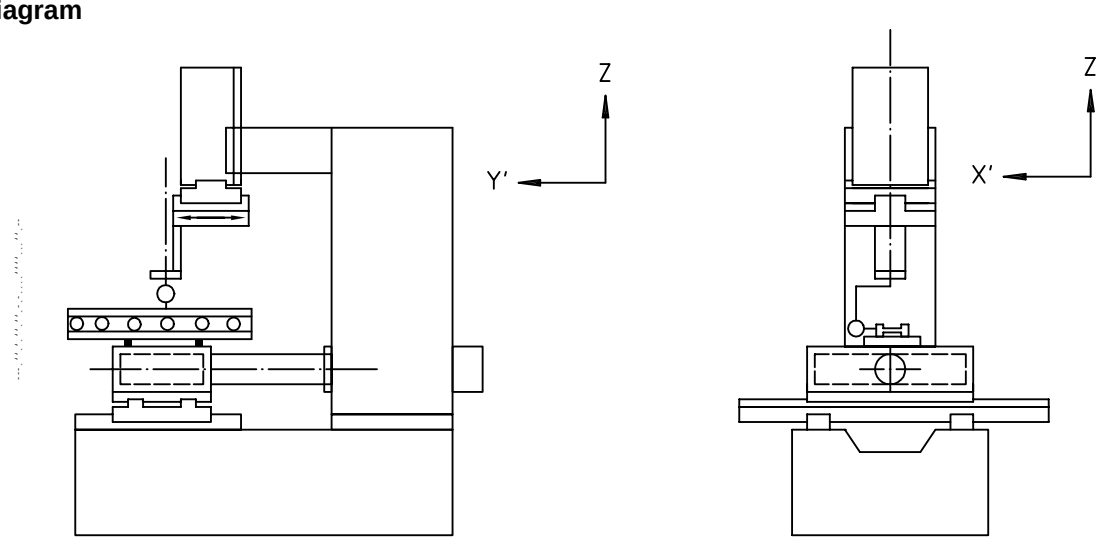
Object	**G9**

Checking of parallelism between the V-axis motion and the Y-axis motion:

a) in the YZ-plane;

b) in the XY-plane.

Diagram



a) b)

Tolerance	**Measured deviation**
a) 0,030 for any measuring length of 100	a)
b) 0,015 for any measuring length of 100	b)

Measuring instruments

Straightedge, dial gauge and gauge blocks

Observations and references to ISO 230-1:1996 5.232.11

Mount the dial-gauge assembly on the head.

a) Place the straightedge paralell to the Y-direction in the YZ-plane and set the dial gauge against it. Move the V-axis through the measuring length and record the dial-gauge readings.

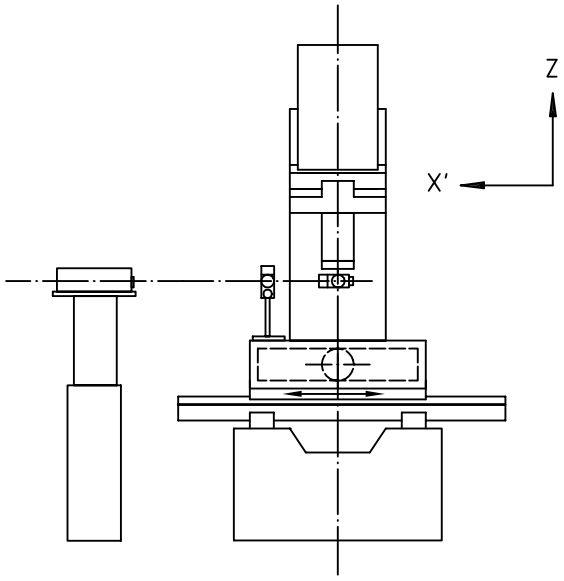
b) Repeat the check in the same way in the XY-plane.

6 Checking of accuracy and repeatability of numerically controlled positioning axes

Object **P1**

Checking of accuracy and repeatability of positioning of numerically controlled X-axis motion (table) EXX.

Diagram



Tolerance		Measuring length ⩽ 500	⩽ 1 000	⩽ 2 000	**Measured deviation**
* Bidirectional accuracy	A	0,016	0,020	0,025	
* Unidirectional accuracy	R ↑ or R ↓	0,008	0,010	0,013	
* Bidirectional systematic deviation	E	0,013	0,016	0,020	
* Reversal value	B	0,008	0,010	0,013	
* Range of mean bidirectional positioning deviation	M	0,004	0,005	0,006	

NOTE * May provide a basis for machine acceptance.

Measuring instruments

Standard scale of length and microscope or laser measurement equipment.

Observations and references to ISO 230-1:1996, 2.322.1**, and to ISO 230-2**

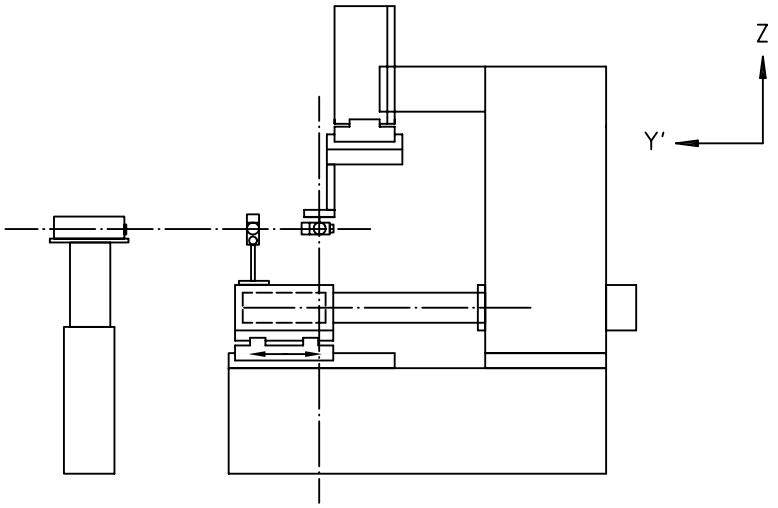
Standard scale of length or laser beam shall be set parallel to the travelling axis.

Rapid feed is used for positioning in principle, but an arbitrary feed rate can be used in agreement between the user and supplier/manufacturer.

Object **P2**

Checking of accuracy and repeatabillity of positioning of numerically controlled Y-axis motion (table saddle or spindle head) EYY.

Diagram



Tolerance		Measuring length			**Measured deviation**
		⩽ 500	⩽ 1 000	⩽ 2 000	
* Bidirectional accuracy	A	0,016	0,020	0,025	
* Unidirectional accuracy	R ↑ or R ↓	0,008	0,010	0,013	
* Bidirectional systematic deviation	E	0,013	0,016	0,020	
* Reversal value	B	0,008	0,010	0,013	
* Range of mean bidirectional positioning deviation	M	0,004	0,005	0,006	

NOTE * May provide a basis for machine acceptance.

Measuring instruments

Standard scale of length and microscope or laser measurement equipment.

Observations and references to ISO 230-1:1996, 2.322.1**, and to ISO 230-2**

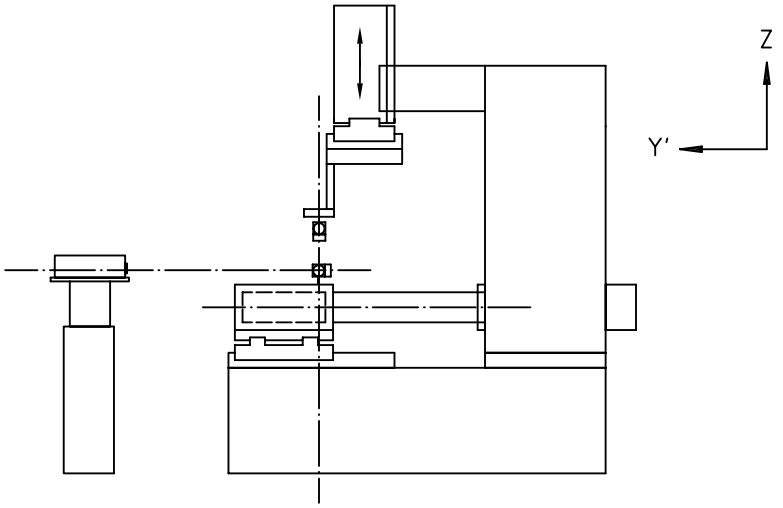
Standard scale of length or laser beam shall be set parallel to the travelling axis.

Rapid feed is used for positioning in principle, but an arbitrary feed rate can be used in agreement between the user and supplier/manufacturer.

Object	**P3**

Checking of accuracy and repeatability of positioning of numerically controlled Z-axis motion (spindle head) EZZ.

Diagram



Tolerance		Measuring length ⩽ 250	⩽ 500	⩽ 1 000	**Measured deviation**
* Bidirectional accuracy	A	0,016	0,020	0,025	
* Unidirectional accuracy	R ↑ or R ↓	0,008	0,010	0,013	
* Bidirectional systematic deviation	E	0,013	0,016	0,020	
* Reversal value	B	0,008	0,010	0,013	
* Range of mean bidirectional positioning deviation	M	0,004	0,005	0,006	

NOTE * May provide a basis for machine acceptance.

Measuring instruments

Standard scale of length and microscope or laser measurement equipment.

Observations and references to ISO 230-1:1996, 2.322.1**, and to ISO 230-2**

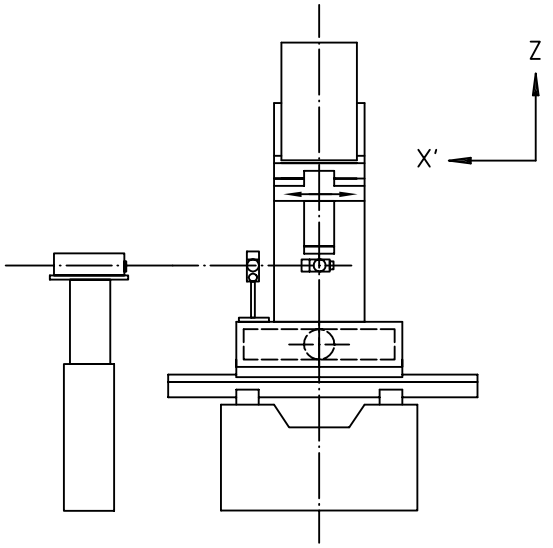
Standard scale of length or laser beam shall be set parallel to the travelling axis.

Rapid feed is used for positioning in principle, but an arbitrary feed rate can be used in agreement between the user and supplier/manufacturer.

Object	**P4**

Checking of accuracy and repeatability of positioning of numerically controlled U-axis motion (U-saddle on the spindle head) EXU.

Diagram



Tolerance		Measuring length ⩽ 100	Measuring length ⩽ 200	**Measured deviation**
* Bidirectional accuracy	A	0,020	0,025	
* Unidirectional repeatability	R ↑ or R ↓	0,010	0,013	
* Bidirectional systematic deviation	E	0,016	0,020	
* Reversal value	B	0,010	0,013	
* Range of mean bidirectional positioning deviation	M	0,005	0,006	

NOTE * May provide a basis for machine acceptance.

Measuring instruments

Standard scale of length and scale reader, or laser measurement equipment.

Observations and references to ISO 230-1:1996, 2.322.1**, and to ISO 230-2**

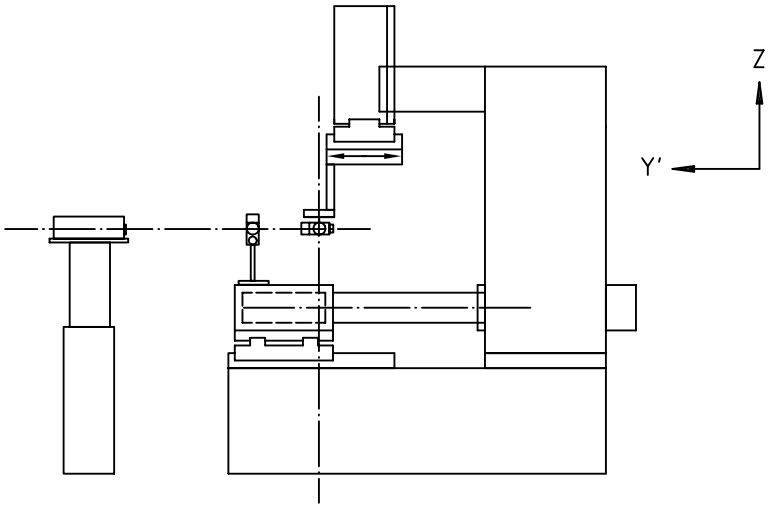
Standard scale of length and microscope or laser measurement equipment.

Rapid feed is used for positioning in principle, but an arbitrary feed rate can be used in agreement between the user and supplier/manufacturer.

Object **P5**

Checking of accuracy and repeatability of positoning of numerically controlled V-axis motion (V-saddle on the spindle head) EYV.

Diagram



Tolerance		Measuring length ⩽ 100	Measuring length ⩽ 200	**Measured deviation**
* Bidirectional accuracy	A	0,020	0,025	
* Unidirectional accuracy	R ↑ or R ↓	0,010	0,013	
* Bidirectional systematic deviation	E	0,016	0,020	
* Reversal value	B	0,010	0,013	
* Range of mean bidirectional positioning deviation	M	0,005	0,006	

NOTE * May provide a basis for machine acceptance.

Measuring instruments

Standard scale of length and microscope or laser measurement equipment.

Observations and references to ISO 230-1:1996, 2.322.1**, and to ISO 230-2**

Standard scale of length or laser beam shall be set parallel to the travelling axis.

Rapid feed is used for positioning in principle, but an arbitrary feed rate can be used in agreement between the user and supplier/manufacturer.

7 Machining tests

Object | **M1**

Checking of roundness and axial squareness of machined hole under finishing conditions:

a) roundness;

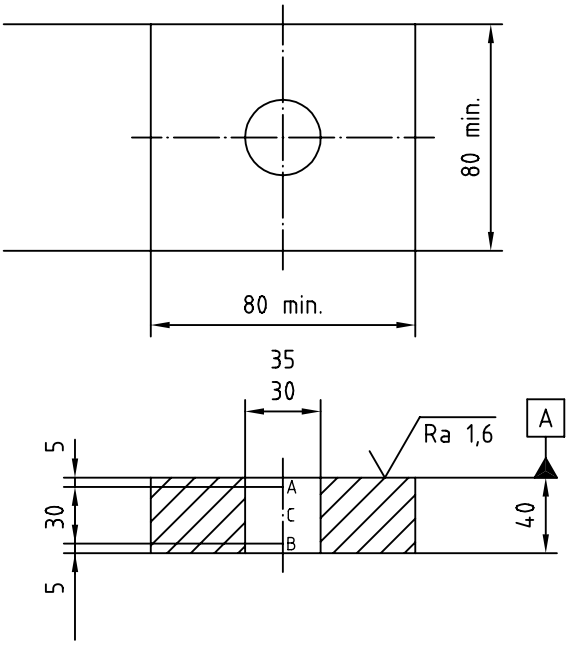
b) squareness between hole axis and reference surface of workpiece;

c) cylindricity.

Another form of machining is also possible when agreed between the supplier/manufacturer and user.

The machining test and circular test may be alternative.

Diagram



Roughness of surface in micrometres

Machining shape

Hole diameter:	∅ 30 to ∅ 35
Depth of hole:	40

Workpiece

Steel:	80 × 80 (min.)
Thickness:	40

Wire electrode

Brass

Diameter of wire:	∅ 0,2 to ∅ 0,3

Finished surface condition

Finishing condition such that the roughness of finished surface is 2 Ra or less.

Machining condition

Circular feed rate shall be determined by the supplier/manufacturer considering the finished surface condition

Tolerance	**Measured deviation**
a) 0,02	a)
b) 0,01/30	b)
c) 0,03	c)

Measuring instruments

Coordinate-measuring machine or roundness-measuring machine

Observations and references to ISO 230-1:1996 6.622

Set the reference surface of the workpiece parallel to the XY-plane.

a) Measure the roundness at respective points A, B and C. Take the maximum value as the measured value.

b) Measure the centre of the least-squares circle at respective points A and B. Take the distance between the two centres (A,B) as the measured value.

8 Circular tests

Object | **C1**

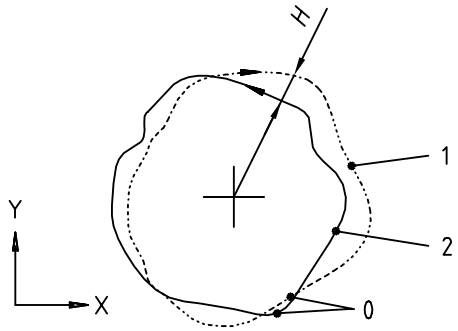
Checking of circular hysteresis and circular deviation of circular movement:

a) circular hysteresis;

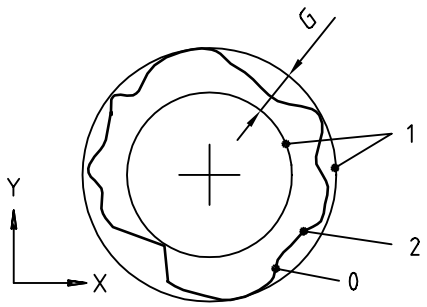
b) circular deviation.

(The circular test and machining test may be used alternatively.)

Diagram



Key
0 Starting point
1 Actual path clockwise
2 Actual path counter-clockwise



Key
0 Starting point
1 Minimum zone circles
2 Actual path

Test conditions	Diameter mm	Feed mm/min
Feed rate and diameter: choose one of the following diameters, depending on the size of the machines	40	50
	80	70
	160	100
	320	140

Tolerance	**Measured deviation**
a) Circular hysteresis, H 0,02 b) Circular deviation, G 0,015	

Measuring instruments

One-dimensional probe; circular masterpiece and two-dimensional probe; or telescoping ballbar

Observations and references to ISO 230-1 and ISO 230-4

ISO 230-1:1996, 6.631, 6.632, 6.633

ISO 230-4:1996, 3.3, 3.4, 4.4, 6

For b), the circular deviation G, take the maximum of G (XY) and G (YX), the circular deviations from the clockwise and the counter-clockwise contouring.

Bibliography

[1] ISO 841:—[1)], *Industrial automation systems — Physical device control — Coordinate system and motion nomenclature.*

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

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