BS ISO 14137:2015

BSI Standards Publication

Test conditions for wire electrical-discharge machines (wire EDM) — Testing of the accuracy

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National foreword

This British Standard is the UK implementation of ISO 14137:2015. It supersedes BS ISO 14137:2000 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee MTE/1/2, Machine tools - Accuracy.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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BS ISO 14137:2015

INTERNATIONAL STANDARD

ISO 14137

Second edition
2015-03-01

Test conditions for wire electrical-discharge machines (wire EDM) — Testing of the accuracy

Conditions d’essai des machines d’électroérosion à fil (fil EDM) — Contrôle de l’exactitude

Reference number
ISO 14137:2015(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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword — Supplementary information.

The committee responsible for this document is ISO/TC 39, *Machine tools*, Subcommittee SC 2, *Test conditions for metal cutting machine tools.*

This second edition cancels and replaces the first edition (ISO 14137:2000), which has been technically revised.

Introduction

The purpose of this International Standard is to standardize methods of testing normal accuracy and general-purpose wire electro-discharge machines (wire EDM).

In this International Standard, the tolerances for G1, G2, G3, G4, P1, P2, P3, P4, and P5 have been changed from those in ISO 14137.

Test conditions for wire electrical-discharge machines (wire EDM) — Testing of the accuracy

1 Scope

This International Standard 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 test for general purpose and normal-accuracy wire electro-discharge machines (wire EDM). It also specifies the applicable tolerances, corresponding to the above-mentioned tests.

This International Standard is applicable to cross-slide table type machines and double-column type machines.

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

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

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 230-1, *Test code for machine tools — Part 1: Geometric accuracy of machines operating under no-load or quasi-static conditions*

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

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

ISO 841, *Industrial automation systems and integration — Numerical control of machines — Coordinate system and motion nomenclature*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
electro-discharge machines
machine tools for the removal of material in dielectric fluid by electro-discharges, which are separated in time and randomly distributed in space, between two electrically conductive electrodes (the tool electrode and the workpiece electrode), and where the energy in the discharge is controlled

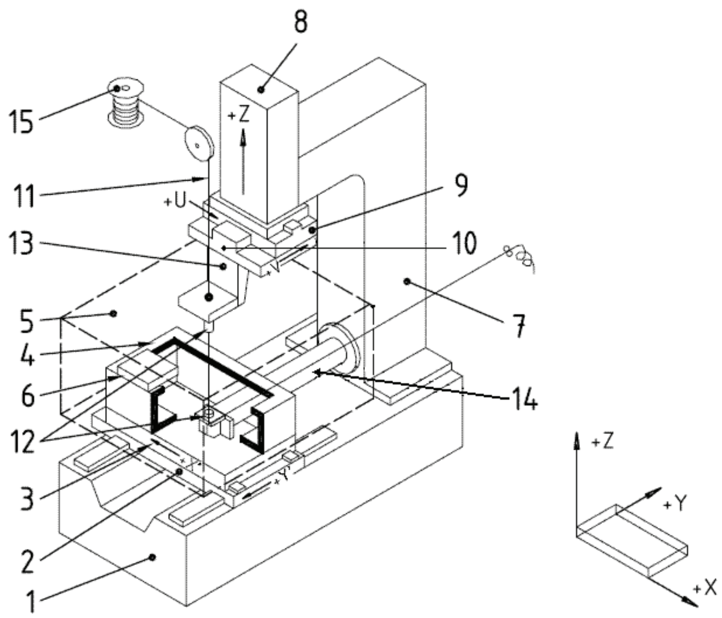
3.2
wire electro-discharge machines
machine tools for the removal of material by electro-discharge machining through the application of a wire electrode to produce prismatic and more complex shapes in a workpiece

3.3
die sinking electro-discharge machines
machine tools for the removal of material by electro-discharge machining through the application of a tool electrode whose geometry matches (defines) the desired shape of the workpiece feature

4 Terminology and designation of axes

4.1 Cross-slide table type

See Figure 1 and Table 1.



NOTE Key: see Table 1

Figure 1 — Cross-slide table type machine

Table 1 — Nomenclature for cross-slide table type machine (see Figure 1)

Key	English	French
1	bed	banc
2	saddle (Y-axis)	trainard (axe Y)
3	table (X-axis)	table (axe X)
4	workholding frame	cadre de bridage
5	work tank (cover)	bac de travail
6	workpiece	pièce à usiner
7	column	montant
8	head (Z-axis)	tête (axe Z)
9	U saddle (U-axis)	trainard U (axe U)
10	V saddle (V-axis)	trainard V (axe V)
11	wire electrode	fil électrode
12	wire guide	guide-fil
13	upper guide support	support guide-fil supérieur

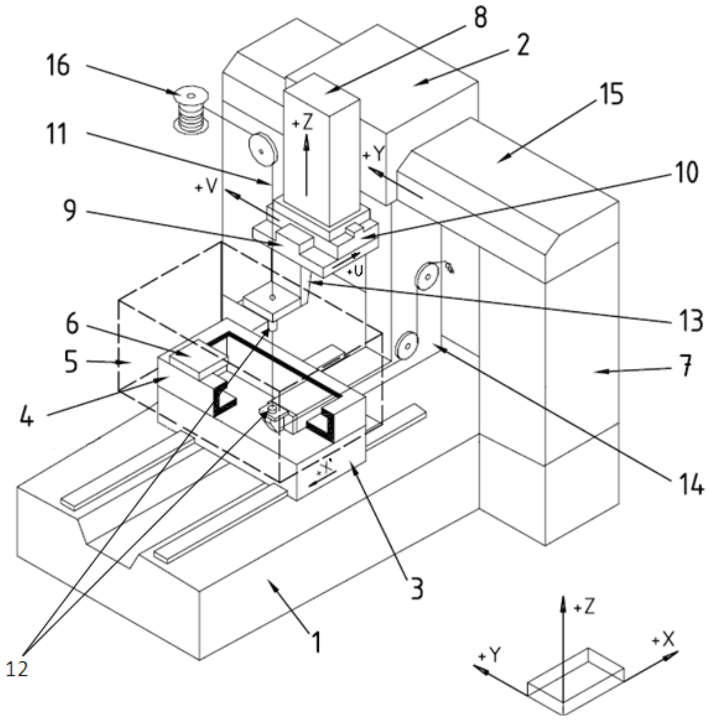
Table 1 *(continued)*

Key	English	French
14	lower guide support	support guide-fil inférieur
15	wire spool	enrouleur de fil

4.2 Double-column type

See Figure 2 and Table 2.

NOTE The machine axis designations in Figure 2 comply with ISO 841. However, X- and Y-axis designations may be interchanged to suit axes lengths and/or operator position.



NOTE Key: see Table 2

Figure 2 — Double-column type machine

Table 2 — Nomenclature for double-column type machine (see Figure 2)

Key	English	French
1	bed	banc
2	saddle (Y-axis)	trainard (axe Y)
3	table (X-axis)	table (axe X)
4	workholding frame	cadre de bridage
5	work tank (cover)	bac de travail
6	workpiece	pièce à usiner
7	column	montant
8	head (Z-axis)	tête (axe Z)
9	U saddle (U-axis)	trainard U (axe U)
10	V saddle (V-axis)	trainard V (axe V)

Table 2 *(continued)*

Key	English	French
11	wire electrode	fil électrode
12	wire guide	guide-fil
13	upper guide support	support guide-fil supérieur
14	lower guide support	support guide-fil inférieur
15	cross beam	traverse
16	wire spool	enrouleur de fil

5 Preliminary remarks

5.1 Measurement 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 following expression should be used for conversion of angular deviations or tolerances:

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

5.2 Reference to ISO 230-1

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

In the “Observations” block of the tests described in Clause 6, Clause 7, Clause 8, and Clause 9, the instructions are preceded by a reference to the corresponding clause/subclause in ISO 230-1, in cases where the test concerned is in compliance with the specifications of ISO 230-1. Tolerances are given for each geometric test (see G1 to G8).

5.3 Machine levelling

Prior to conducting tests on a machine, the machine should be levelled according to the recommendations of the manufacturer/supplier (see ISO 230-1:2012, 6.1.2).

5.4 Testing sequence

The sequence in which the geometric tests are given 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.

5.5 Tests to be performed

When testing a machine, it is not always necessary or possible to carry out all the tests given in this standard When the tests are required for acceptance purposes, the choice of tests relating to the components and/or the properties of the machine of interest is at the discretion of the user, in agreement with the manufacturer/supplier. The tests to be used are to be clearly stated when ordering a machine. A 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 parties.

5.6 Measuring instruments

The measuring instruments indicated in the tests described in the following clauses are examples only. Other instruments measuring the same quantities and having the same or smaller measurement uncertainty may be used. Linear displacement sensors shall have a resolution of 0,001 mm or better.

5.7 Diagrams

For reasons of simplification, the figures in Clause 6, Clause 7, Clause 8, and Clause 9 of this International Standard illustrate some types of machines.

5.8 Software compensation

When built-in software facilities are available for compensating geometric, positioning contouring and/or thermal deviations, their use during these tests shall be based on agreement between the manufacturer/supplier and user, with due consideration to the machine tool intended use.

When the software compensation is used, this shall be stated in the test reports.

It shall be noted that when software compensation is used, axes shall not be locked for test purposes.

5.9 Minimum tolerance

When the tolerance for a geometric test is established for a measuring length different from that given in this standard, the tolerance may be determined by means of the law of proportionality (see ISO 230-1:2012, 4.1.2). It shall be taken into consideration that the minimum value of tolerance is 0,005 mm.

5.10 Positioning tests and reference to ISO 230-2

Tests P1 to P5 are applied only to numerically controlled electro-discharge machines.

To apply these tests, reference shall 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, tests shall be agreed between the user and the manufacturer/supplier.

5.11 Machining test

Concerning the machining test, only simple machining of a cylindrical hole is proposed. Machining test of other suitable form is also possible under the agreement between the user and the manufacturer/supplier.

Machining test shall be made under finishing conditions.

The machining test may be substituted by circular test C1.

5.12 Circular test and reference to ISO 230-4

To apply this test, reference shall be made to ISO 230-4:2005, especially to Clauses 4 and 6 for the test conditions and presentation of results.

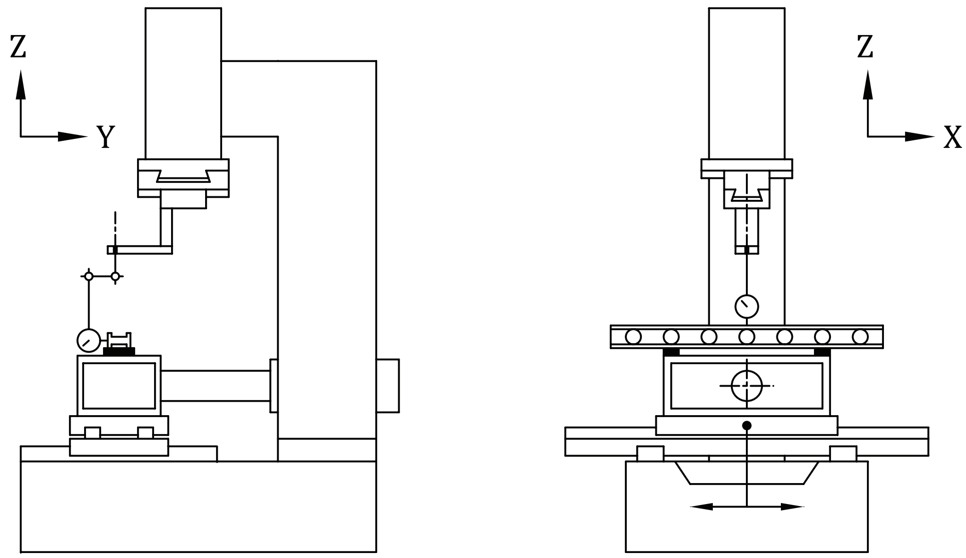
The circular test may be substituted by machining test M1.

6 Geometric tests

6.1 Linear axes of motion

Object	**G1**
Checking of straightness of the X-axis motion a) in the horizontal XY plane (E_{YX}), and b) in the vertical ZX plane (E_{ZX}).	

Diagram



a) b)

Tolerance	**Measured Deviations**
for a) and b)	a)
0,010 for any measuring length of 500	b)

Measuring instruments

Straightness reference artefact and linear displacement sensor, or optical measuring instruments

Observations and references to ISO 230-1:2012, 3.4.8, 8.2.2.1, and 8.2.3

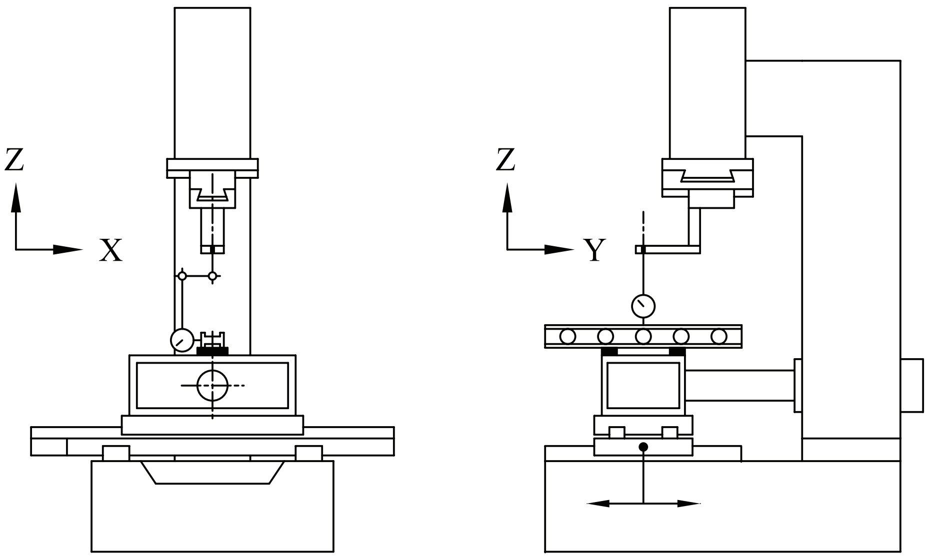
Mount the linear displacement sensor on the head.

a) Set the straightness reference artefact parallel to the X-axis in the XY plane, and set the linear displacement sensor against it. Feed the X-axis through the measuring length, and note the 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 the horizontal XY plane (E_{XY}), and b) in the vertical YZ plane (E_{ZY}).	

Diagram



a) b)

Tolerance	**Measured Deviations**
for a) and b)	a)
0,010 for any measuring length of 500	b)

Measuring instruments

Straightness reference artefact and linear displacement sensor, or optical measuring instruments

Observations and references to ISO 230-1:2012, 3.4.8, 8.2.2.1, and 8.2.3

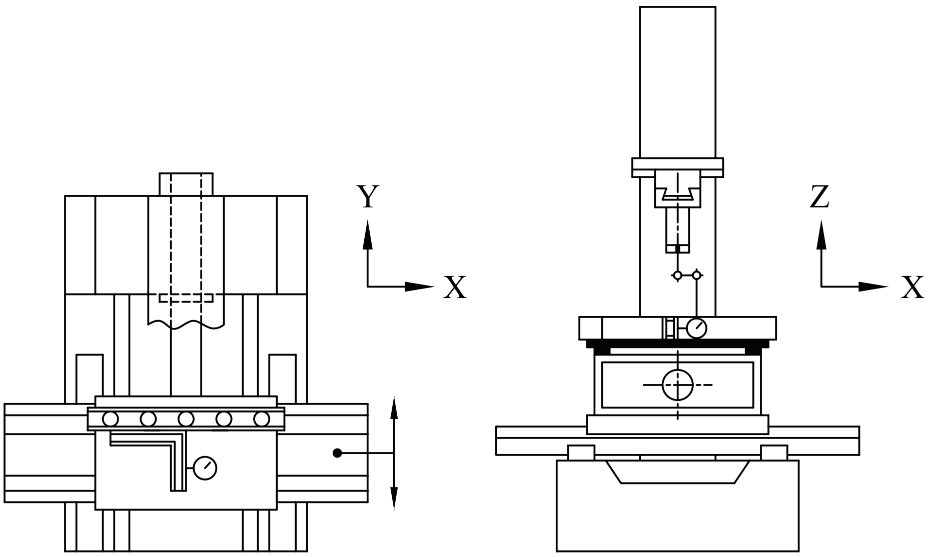
Mount the linear displacement sensor on the head.

a) Set the straightness reference artefact parallel to the Y-axis in the XY plane, and set the linear displacement sensor against it. Feed the Y-axis through the measuring length, and note the readings.

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

Object	**G3**
Checking of squareness of Y-axis to X-axis motion ($E_{C(0X)Y}$).	

Diagram



Tolerance	**Measured Deviations**
0,033/1 000 (0,010/300)	

Measuring instruments

Straightness reference artefact, squareness reference artefact and linear displacement sensor, or optical measuring instruments

Observations and references to ISO 230-1:2012, 3.6.7, 10.3.2.2, and 10.3.2.5

Align the straightness reference artefact on the workholding frame so as to be parallel to the X-axis motion, and press the squareness reference artefact against it.

Mount the linear displacement sensor on the head, and set it against the squareness reference artefact. Feed the Y-axis through the measuring length, and note the readings at several positions. The inclination of the reference straight line of the trajectory of the readings is the squareness error and shall be reported (see ISO 230-1:2012, 3.6.7).

Using the squareness reference artefact only is also possible. In this case

1) set the squareness reference artefact so that the long arm is parallel to the X-axis motion, and

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

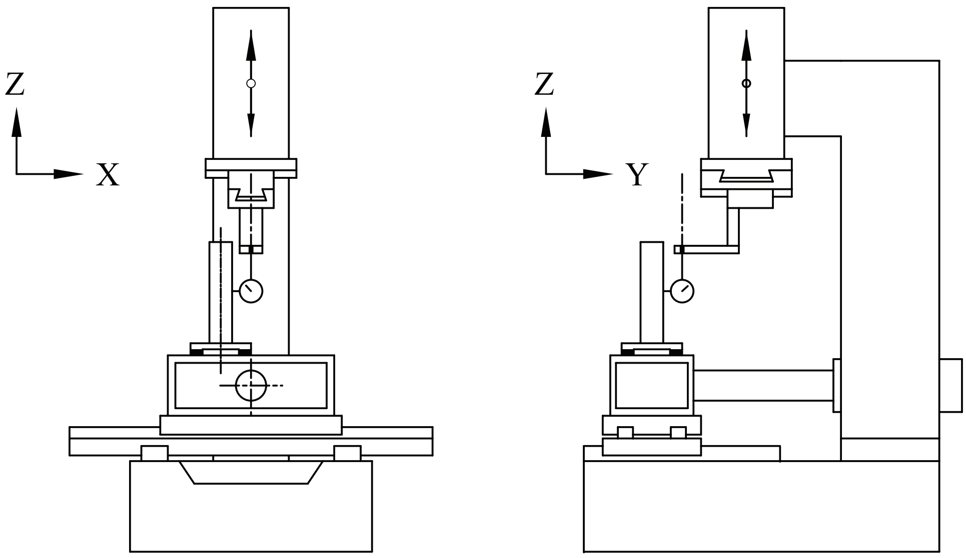
Object | **G4**

Checking of squareness of the vertical movement of head (Z-axis) to

a) the X-axis motion ($E_{B(0X)Z}$), and

b) the Y-axis motion ($E_{A(0Y)Z}$).

Diagram



a) b)

Tolerance	**Measured Deviations**
for a) and b)	a)
0,033/1 000 (0,010/300)	b)

Measuring instruments

Squareness reference artefact, surface plate, adjustable blocks and linear displacement sensor, or optical measuring instruments

Observations and references to ISO 230-1:2012, 3.6.7, 10.3.2.2, and 10.3.2.5

Mount the surface plate on the workholding frame and adjust it so that the surface is parallel to both the X and Y axes. Place the squareness reference artefact on the surface plate. Mount the linear displacement sensor on the head.

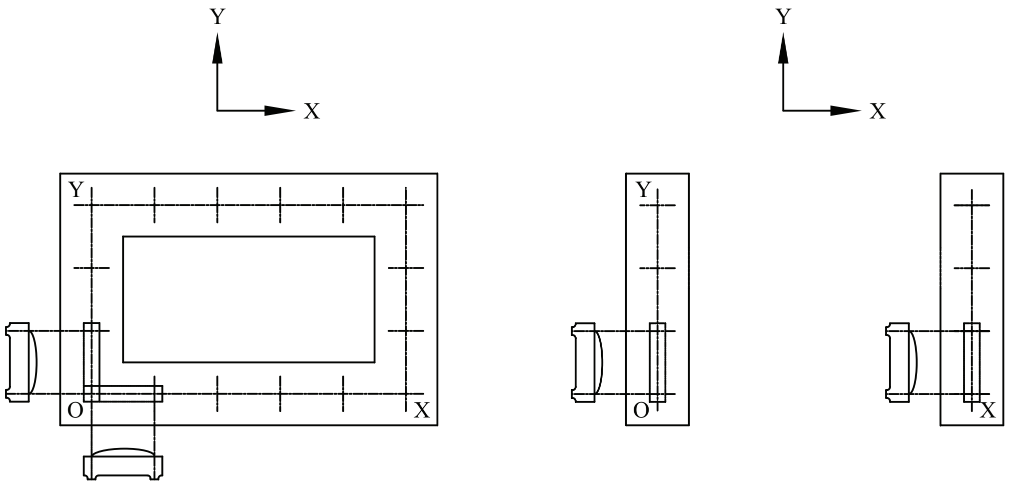
a) Set the linear displacement sensor against the squareness reference artefact in the X-direction and move the head in the Z-direction through the measuring length, and note the readings at several positions. The inclination of the reference straight line of the trajectory of the readings is the squareness error and shall be reported (see ISO 230-1:2012, 3.6.7).

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

6.2 Workholding frame

Object	**G5**
Checking of flatness of the workholding frame surface.	

Diagram



Method A) Method B)

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

Measuring instruments

Method A) Precision level, or optical measuring instruments

Method B) Precision level, or optical measuring instruments

Observations and references to ISO 230-1:2012, 12.2.4.2, and 12.2.5

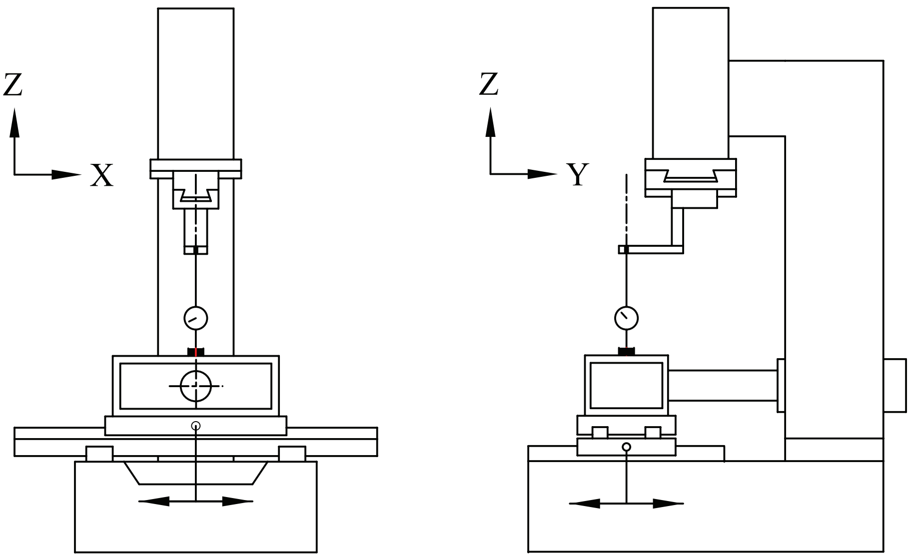
For Method A), place the precision level on the workholding frame and move it in the X- and Y-directions in the steps corresponding to its length and record the readings.

For Method B), in the case of both-sides frame, when a precision level is used, check the flatness by integrating angular measurements in the Y-axis direction, taken on each side, maintaining the same precision level zero setting.

The flatness of the workholding frame surface shall be calculated according to angular deviation method (ISO 230-1:2012, 12.1.3).

Object	**G6**
Checking of parallelism of the workholding frame surface (Frame) to: a) the X-axis motion ($E_{B(0X)Frame}$); b) the Y-axis motion ($E_{A(0Y)Frame}$).	

Diagram



a) b)

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

Measuring instruments

Linear displacement sensor and straightness reference artefact

Observations and references to ISO 230-1:2012, 3.6.5, and 12.3.2.5

When the workholding frame surface is measured directly:

a) Mount the linear displacement sensor on the head, and touch the workholding frame surface with its stylus. Feed the X-axis through the measuring length, and note the readings;

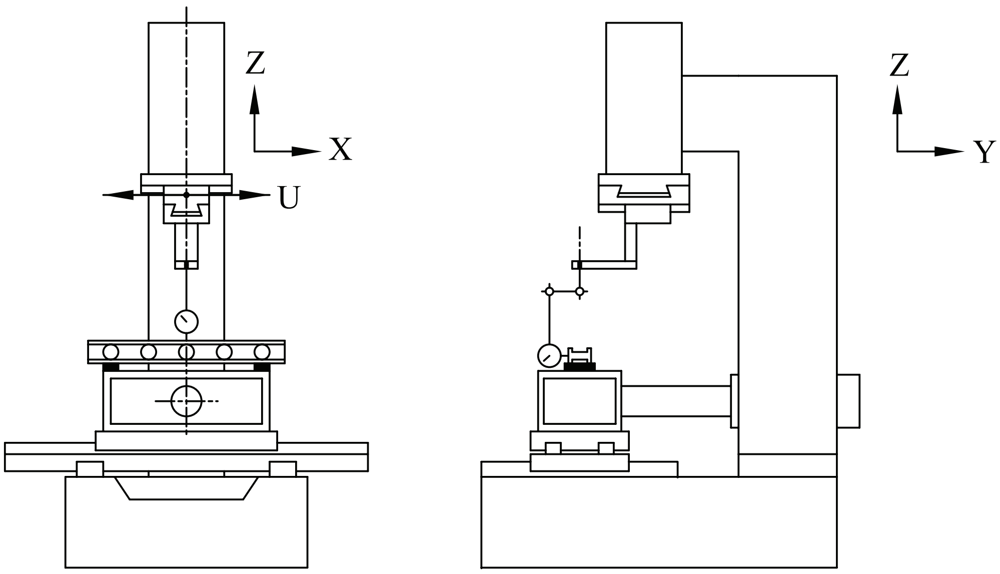
b) Repeat the check in the same way in the Y-direction.

A straightness reference artefact set on the workholding frame may also be used (see ISO 230-1:2012, 12.3.2.5.2). Then the measurement shall be done approximately along the centrelines of the workholding frame in X- and Y-directions.

6.3 Motion of U- and V-axes

Object	**G7**
Checking of parallelism of the U-axis motion to the X-axis motion: a) in the vertical ZX plane ($E_{B(0X)U}$); b) in the horizontal XY plane ($E_{C(0X)U}$).	

Diagram



a) b)

Tolerance	**Measured Deviations**
a) 0,30/1 000 (0,030/100)	a)
b) 0,15/1 000 (0,015/100)	b)

Measuring instruments

Straightness reference artefact, linear displacement sensor

Observations and references to ISO 230-1:2012, 3.6.2, and 10.1.2.2

Mount the linear displacement sensor on the head.

a) Set the straightness reference artefact parallel to the X-axis motion in the ZX plane and set the linear displacement sensor against it.

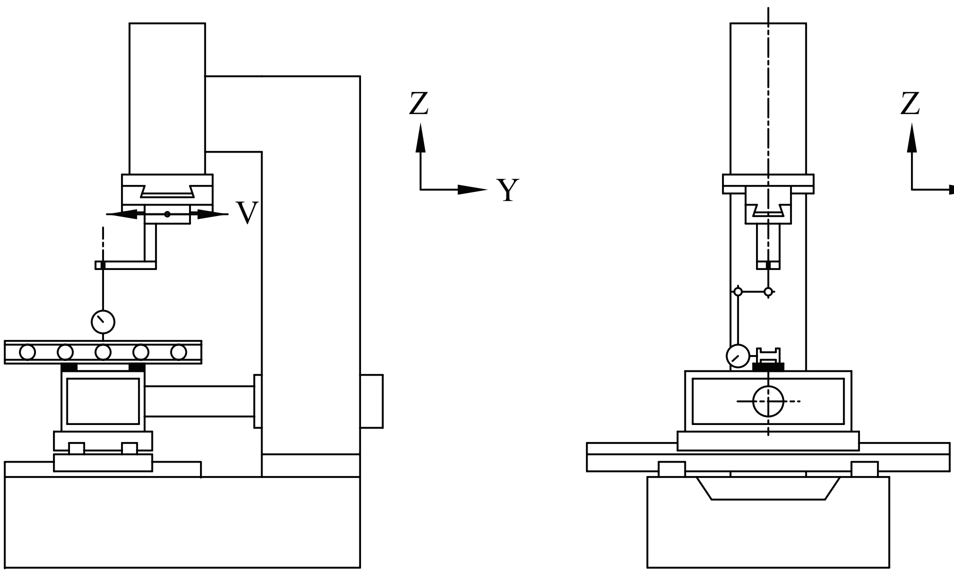
Feed the U-axis through the measuring length, and note the readings.

The inclination of the reference straight line of the trajectory of the readings is the parallelism error and shall be reported (see ISO 230-1:2012, 3.6.2).

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

Object	**G8**
Checking of parallelism of the V-axis motion to the Y-axis motion:	
a) in the vertical YZ plane ($E_{A(0Y)V}$);	
b) in the horizontal XY plane ($E_{C(0Y)V}$).	

Diagram



a) b)

Tolerance	**Measured Deviations**
a) 0,30/1 000 (0,030/100)	a)
b) 0,15/1 000 (0,015/100)	b)

Measuring instruments

Straightness reference artefact, linear displacement sensor

Observations and references to ISO 230-1:2012, 3.6.2, and 10.1.2.2

Mount the linear displacement sensor on the head.

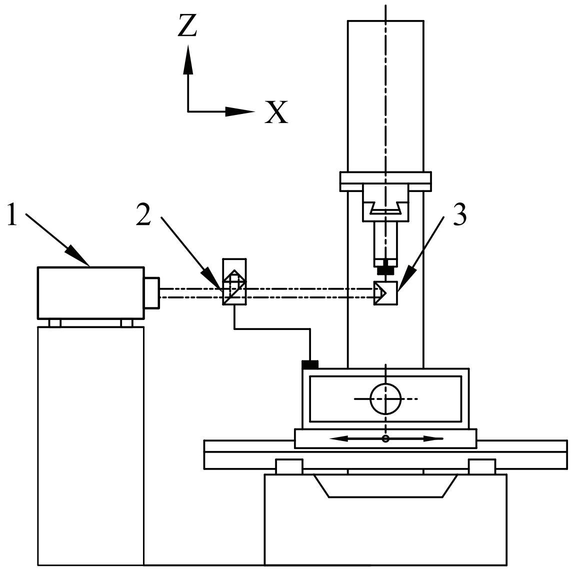
a) Set the straightness reference artefact parallel to the Y-axis in the YZ plane and set the linear displacement sensor against it.

Feed the V-axis through the measuring length, and note the readings.

The inclination of the reference straight line of the trajectory of the readings is the parallelism error and shall be reported (see ISO 230-1:2012, 3.6.2).

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

7 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 (E_{XX}).				
Diagram **Key** 1 laser head 2 interferometer 3 reflector 				
Tolerance	**Measuring length**			**Measured deviation**
	≤500	≤1 000	≤2 000	
Bi-directional accuracy of positioning $E_{XX,A}$	0,012	0,016	0,020	
Unidirectional repeatability of positioning $E_{XX,R\uparrow}$ and $E_{XX,R\downarrow}$	0,005	0,008	0,010	
Bi-directional repeatability $E_{XX,R}$	0,010	0,012	0,016	
Reversal value of axis $E_{XX,B}$	0,008	0,010	0,013	
Mean reversal value $E_{XX,\overline{B}}$	0,004	0,005	0,006	
Bi-directional systematic deviation of positioning $E_{XX,E}$	0,010	0,012	0,016	
Mean bi-directional positional deviation of the axis $E_{XX,M}$	0,006	0,008	0,010	
Measuring instruments Laser measurement equipment or linear scale				
Observations and references to ISO 230-1:2012, 8.3 and ISO 230-2:2014 Linear scale of length or beam axis of laser measurement equipment shall be set parallel to the axis under test. Rapid feed is used for positioning in principle, but arbitrary feed speed may be used by agreement between the user and manufacturer/supplier.				

Object						**P2**
Checking of accuracy and repeatability of positioning of numerically controlled Y-axis motion (E_{YY}).						

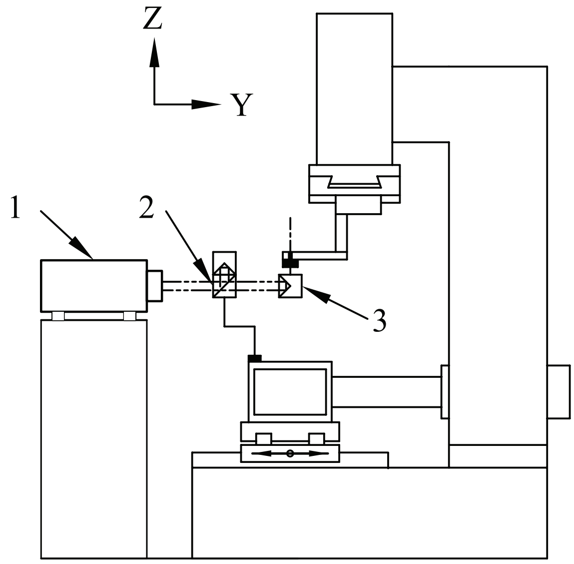
Diagram

Key

1 laser head

2 interferometer

3 reflector



Tolerance		**Measuring length**			**Measured deviation**
		≤500	≤1 000	≤2 000	
Bi-directional accuracy of positioning	$E_{YY,A}$	0,012	0,016	0,020	
Unidirectional repeatability of positioning	$E_{YY,R\uparrow}$ and $E_{YY,R\downarrow}$	0,005	0,008	0,010	
Bi-directional repeatability	$E_{YY,R}$	0,010	0,012	0,016	
Reversal value of axis	$E_{YY,B}$	0,008	0,010	0,013	
Mean reversal value	$E_{YY,\overline{B}}$	0,004	0,005	0,006	
Bi-directional systematic deviation of positioning	$E_{YY,E}$	0,010	0,012	0,016	
Mean bi-directional positional deviation of the axis	$E_{YY,M}$	0,006	0,008	0,010	

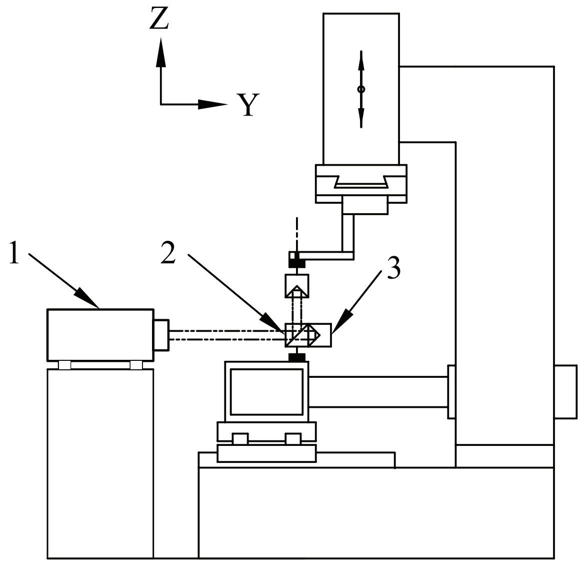
Measuring instruments

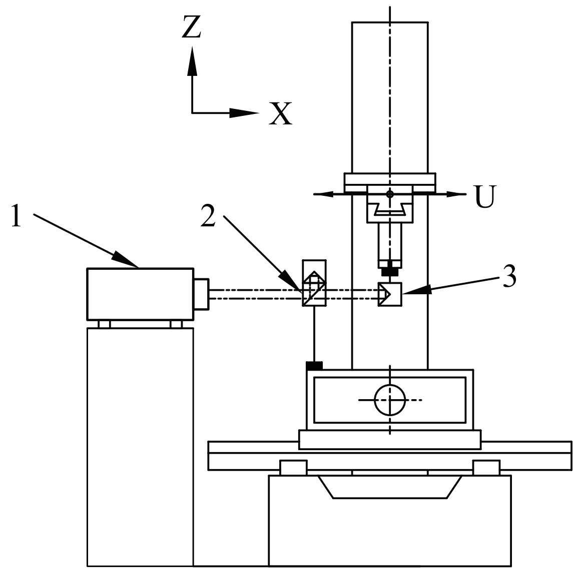
Laser measurement equipment or linear scale

Observations and references to ISO 230-1:2012, 8.3 and ISO 230-2:2014

Linear scale of length or beam axis of laser measurement equipment shall be set parallel to the axis under test.

Rapid feed is used for positioning in principle, but arbitrary feed speed may be used by agreement between the user and manufacturer/supplier.

Object					**P3**
Checking of accuracy and repeatability of positioning of numerically controlled Z-axis motion (E_{ZZ}).					
Diagram **Key** 1 laser head 2 interferometer 3 reflector					
Tolerance		**Measuring length**			**Measured deviation**
		≤ 250	≤ 500	≤ 1 000	
Bi-directional accuracy of positioning	$E_{ZZ,A}$	0,012	0,016	0,020	
Unidirectional repeatability of positioning	$E_{ZZ,R\uparrow}$ and $E_{ZZ,R\downarrow}$	0,005	0,008	0,010	
Bi-directional repeatability	$E_{ZZ,R}$	0,010	0,012	0,016	
Reversal value of axis	$E_{ZZ,B}$	0,008	0,010	0,013	
Mean reversal value	$E_{ZZ,\overline{B}}$	0,004	0,005	0,006	
Bi-directional systematic deviation of positioning	$E_{ZZ,E}$	0,010	0,012	0,016	
Mean bi-directional positional deviation of the axis	$E_{ZZ,M}$	0,006	0,008	0,010	
Measuring instruments					
Laser measurement equipment or linear scale					
Observations and references to ISO 230-1:2012, 8.3 and ISO 230-2:2014					
Linear scale of length or beam axis of laser measurement equipment shall be set parallel to the axis under test. Rapid feed is used for positioning in principle, but arbitrary feed speed may be used by agreement between the user and manufacturer/supplier					

Object				**P4**
Checking of accuracy and repeatability of positioning of numerically controlled U-axis motion (E_{XU}).				
Diagram				
Key 1 laser head 2 interferometer 3 reflector				
Tolerance		**Measuring length**		**Measured deviation**
		≤ 100	≤ 200	
Bi-directional accuracy of positioning	$E_{XU,A}$	0,016	0,020	
Unidirectional repeatability of positioning	$E_{XU,R\uparrow}$ and $E_{XU,R\downarrow}$	0,008	0,010	
Bi-directional repeatability	$E_{XU,R}$	0,012	0,016	
Reversal value of axis	$E_{XU,B}$	0,010	0,013	
Mean reversal value	$E_{XU,\overline{B}}$	0,005	0,006	
Bi-directional systematic deviation of positioning	$E_{XU,E}$	0,012	0,016	
Mean bi-directional positional deviation of the axis	$E_{XU,M}$	0,008	0,010	

Measuring instruments

Laser measurement equipment or linear scale

Observations and references to ISO 230-1:2012, 8.3 and ISO 230-2:2014

Linear scale of length or beam axis of laser measurement equipment shall be set parallel to the axis under test.

Rapid feed is used for positioning in principle, but arbitrary feed speed may be used by agreement between the user and manufacturer/supplier.

Object				**P5**
Checking of accuracy and repeatability of positioning of numerically controlled V-axis motion (E_{YV}).				

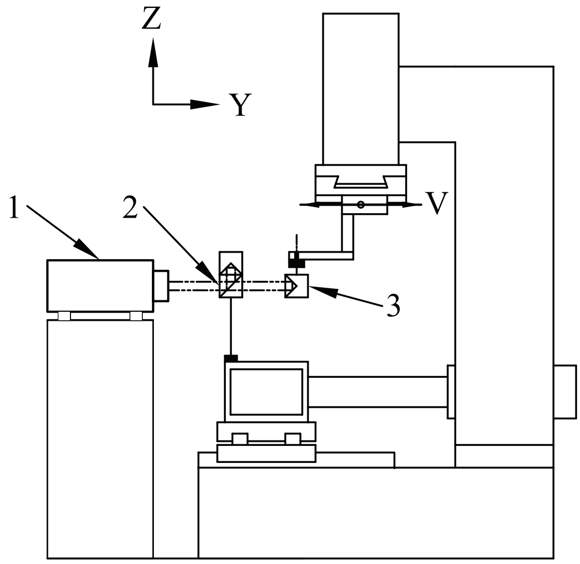
Diagram

Key

1 laser head

2 interferometer

3 reflector



Tolerance		**Measuring length**		**Measured deviation**
		≤ 100	≤ 200	
Bi-directional accuracy of positioning	$E_{YV,A}$	0,016	0,020	
Unidirectional repeatability of positioning	$E_{YV,R\uparrow}$ and $E_{YV,R\downarrow}$	0,008	0,010	
Bi-directional repeatability	$E_{YV,R}$	0,012	0,016	
Reversal value of axis	$E_{YV,B}$	0,010	0,013	
Mean reversal value	$E_{YV,\overline{B}}$	0,005	0,006	
Bi-directional systematic deviation of positioning	$E_{YV,E}$	0,012	0,016	
Mean bi-directional positional deviation of the axis	$E_{YV,M}$	0,008	0,010	

Measuring instruments

Laser measurement equipment or linear scale

Observations and references to ISO 230-1:2012, 8.3 and ISO 230-2:2014

Linear scale of length or beam axis of laser measurement equipment shall be set parallel to the axis under test.

Rapid feed is used for positioning in principle, but arbitrary feed speed may be used by agreement between the user and manufacturer/supplier.

8 Machining test

Object — **M1**

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

a) roundness;

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

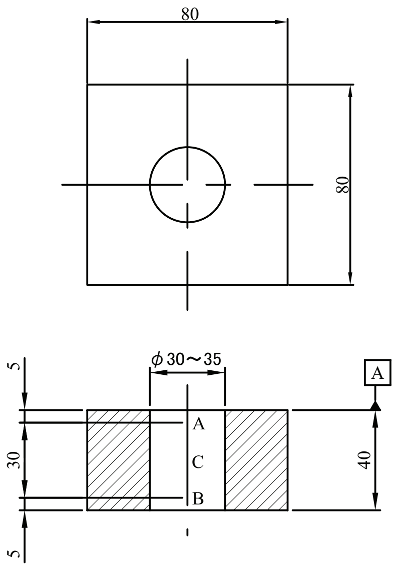
c) consistency of diameters.

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

This machining test and circular test (C1) may be alternative.

Diagram

Dimensions are in millimetres



Workpiece
Steel
Size: 80 × 80
Thickness: 40

Wire electrode
Brass
Diameter of wire: Φ 0,2 ~ Φ 0,3

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

Machining condition
Feed speed shall be determined by the manufacturer/supplier considering the finished surface condition.

Tolerance	**Measured Deviations**
a) 0,02	a)
b) 0,01	b)
c) 0,03	c)

Measuring instruments

Coordinate measuring machine or roundness measuring machine

Observations and references to ISO 230-1:2012

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) in the horizontal XY plane as the measured value.

c) Measure the diameter at the respective points A, B and C. Take the maximum difference of the 3 results as the measured value (see ISO 230-1:2012, B.2.3).

The distance of the upper wire guide to the top surface of workpiece shall be reported.

NOTE When the wire orientation is adjusted in reference to the table surface, the parallelism of the top surface to the bottom surface of workpiece may influence the perpendicularity of the machined hole.

9 Circular test

Object | **C1**

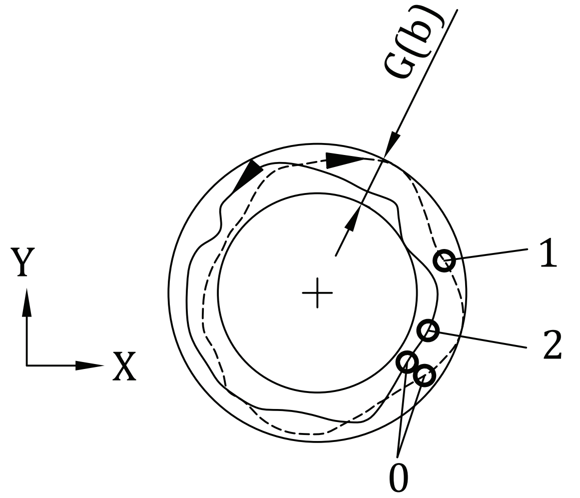
Checking of bi-directional circular deviation and circular deviation of circular movement:

a) bi-directional circular deviation;

b) circular deviation.

This circular test and machining test (M1) may be alternative.

Diagram



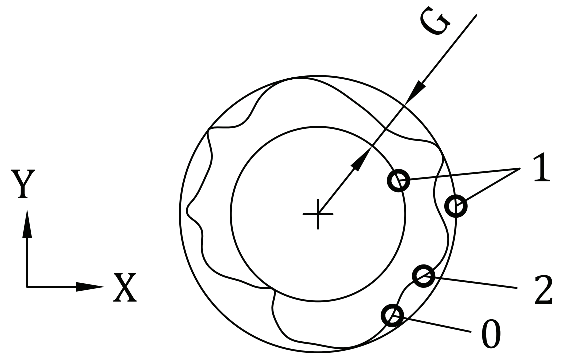
Key

0 starting point

1 actual path, clockwise

2 actual path, counter-clockwise

a)



Key

0 starting point

1 minimum zone circles

2 actual path

b)

Test conditions

Feed speed and diameter: choose one of the following diameters, depending on the size of the machines.

Diameter mm	**Feed** mm/min
50	12
100	16
150	20

Tolerance	**Measured Deviations**
a) bi-directional circular deviation, G(b) 0,02	a)
b) the circular deviations of the clockwise (G_{XY}) and the counter-clockwise (G_{YX}) path 0,015	b)

Measuring instruments

Ball bar, two-dimensional digital scale

Observations and references to ISO 230-1:2012 and ISO 230-4:2005

ISO 230-1:2012, 11.3.4.2, 11.3.4.3, and 11.3.4.4

ISO 230-4:2005, 3.3, 3.4, 4.4, and 6

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