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Second edition
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Test conditions for vertical internal type broaching machines — Testing of accuracy

Conditions de réception des machines verticales à brocher les intérieurs — Contrôle de l'exactitude

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Contents

Page

Foreword

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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).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

This second edition cancels and replaces the first edition (ISO 6779:1981), which has been technically revised.

The main changes compared to the previous edition are as follows:

— the title has been changed;

— the document's format has been aligned with new published ISO/TC 39/SC 2 documents;

— "table-up" machines have been added as a new configuration for vertical internal type broaching machines;

— some terms have been changed and equivalent non-formal terms in more languages have been added to Annex A;

— all diagrams in this document have been regenerated;

— old references to ISO/R 230:1961 have been corrected to ISO 230-1:2012 and observations have been updated accordingly;

— levelling test, G01, has been deleted and relevant explanations have been added to Clause 5;

— as the term "coincidence" no longer exists in ISO 230-1:2012, the term "radial offset of coaxiality deviation" has been used for test item G4;

— Clause 7 has been created to provide considerations to machining tests to be agreed between manufacturer/supplier and user;

— imperial units of measurements have been deleted and only metric units are now used.

In addition to terms given in the official ISO languages (English and French), this document gives the equivalent terms in Italian and Persian. These are published under the responsibility of the member bodies for Iran (ISIRI) and Italy (UNI) and are given for information only. Only the terms given in the official languages can be considered as ISO terms.

Introduction

The object of this document is to supply information as wide and comprehensive as possible on tests on vertical internal type broaching machines which can be carried out for comparison, acceptance, maintenance or any other purposes.

This document also establishes the tolerances for the test results corresponding to general purpose and normal accuracy vertical internal type broaching machines.

Test conditions for vertical internal type broaching machines — Testing of accuracy

1 Scope

This document specifies, with reference to ISO 230-1, the geometric tests on vertical internal type broaching machines with vertical Z-axis providing the main cutting motion.

It also specifies the applicable tolerances corresponding to the tests mentioned above for normal-accuracy vertical internal type broaching machines.

This document explains concepts or configurations and common features of vertical internal type broaching machines. It also provides related terminology and designation of axes.

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

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 230-1:2012, *Test code for machine tools — Part 1: Geometric accuracy of machines operating under no-load or quasi-static conditions*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 230-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
internal broaching operation
machining process in which a broach is pushed or pulled through a hole to remove material by linear cutting

3.2
broach
cutting tool that has multiple transverse cutting edges each with progressively increased size

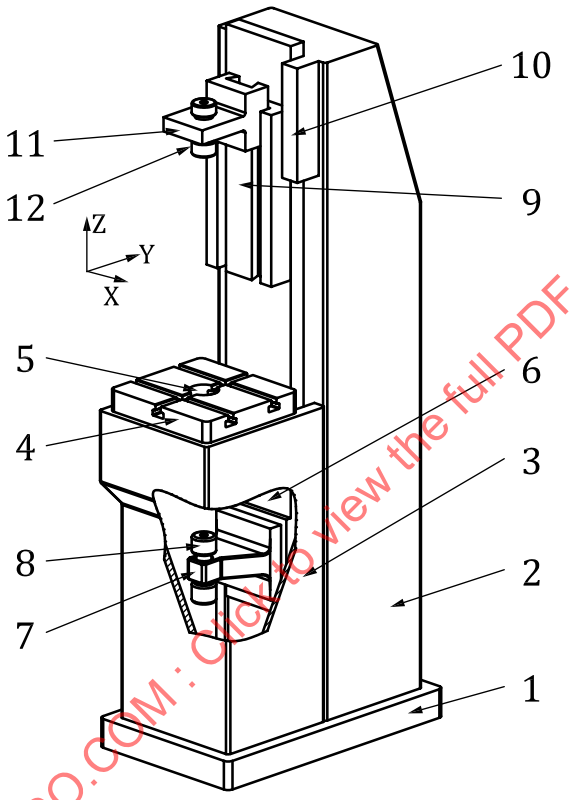
3.3
broaching machine
machine tool in which broaching operation is executed

3.4
vertical internal type broaching machine
vertical broaching machine in which its broach is pushed or pulled through a hole inside of the workpiece to remove material

Note 1 to entry: A vertical broaching machine is understood to be a broaching machine whose main cutting axis (Z-axis) is vertical.

4 Terminology and designation of axes

See Figures 1 and 2.



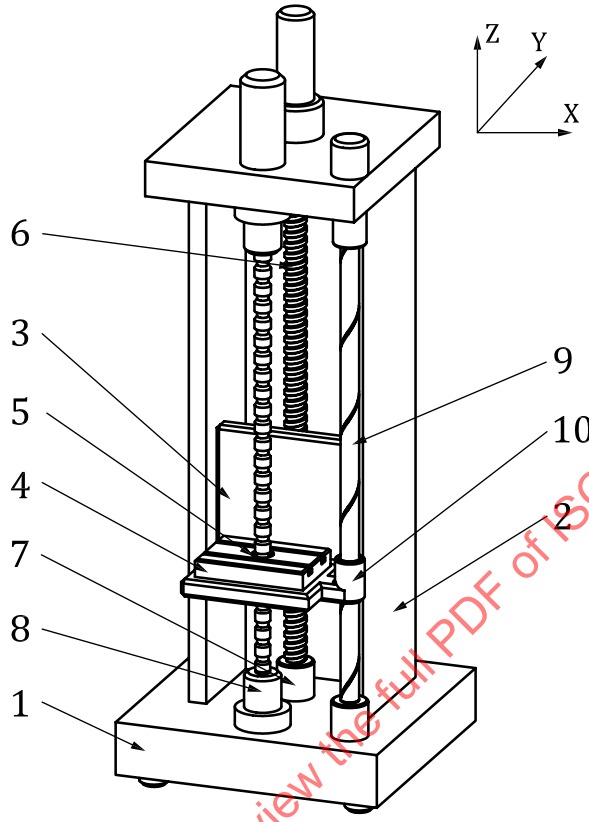
Key

	English	French
1	bed	bâti
2	column	bâti arrière
3	table base	bâti avant
4	work table	table
5	table centre bore	centrage du support de pièce
6	pulling slide (Z-axis)	coulisseau de traction (axe Z)
7	pulling block	chariot de traction
8	pulling chuck	tête d'accrochage avant
9	retrieving slide (W-axis)	coulisseau de relevage (axe W)
10	retrieving slide guide	guidage du coulisseau de relevage
11	retrieving block	chariot d'amenage
12	retrieving chuck	tête d'accrochage arrière

NOTE For languages other than official ISO languages, see Table A.1.

Figure 1 — Typical example of a vertical internal type broaching machine

A common configuration of vertical internal type broaching machines is table-up or push-type which is illustrated in Figure 2.



Key

	English	French
1	bed	bâti
2	column	bâti arrière
3	table base (Z-axis)	bâti avant (axe Z)
4	work table	table
5	table centre bore	centrage du support de pièce
6	table pushing screw	vis de poussée de table
7	push screw rest	support de vis de poussée
8	broach chuck	tête d'accrochage large
9	Z-axis guide	guide de l'axe Z
10	Z-axis bush bearing	palier de support de l'axe Z

NOTE For languages other than official ISO languages, see Table A.2.

Figure 2 — Typical example of a Table-up (Push-type) vertical internal broaching machine

5 Preliminary remarks

5.1 Measurement units

In this document, all linear dimensions, deviations and corresponding tolerances are expressed in millimetres and angular dimensions are expressed in degrees. Angular deviations and the corresponding tolerances are expressed in ratios as the primary method. However, in some cases,

microradians or arcseconds may be used for clarification purposes. Formula (1) should be used for conversion of the units of angular deviations or tolerances:

$$0{,}010 / 1\,000 = 10\,\mu\text{rad} \approx 2'' \quad (1)$$

5.2 Reference to the ISO 230 series

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

In the "Observations" block of the tests described in the following clauses, the instructions are followed by a reference to the corresponding clause in ISO 230-1:2012, in cases where the test concerned is in line with the specifications of ISO 230-1.

5.3 Testing sequence

The sequence in which the tests are presented in this document does not define the practical order of testing. In order to make the mounting of instruments or gauging easier, tests may be performed in any order.

5.4 Tests to be performed

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

When testing a machine tool, it is not always necessary or possible to carry out all the tests described in this document. When the tests are required for acceptance purposes, it is up to the user to choose, in agreement with the manufacturer/supplier, those tests relating to the components and/or the properties of the machine tool which are of interest. These tests are to be clearly stated when ordering a machine tool. A mere reference to this document 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.

5.5 Tolerances and minimum tolerance

In this document, all tolerance values (see ISO 230-1:2012, 4.1) are guidelines. When they are used for acceptance purposes, other values can be agreed between the user and the manufacturer/supplier. The required/agreed tolerance values are to be clearly stated when ordering the machine.

When establishing the tolerance for a measuring length different from that given in this document (see ISO 230-1:2012, 4.1.2), it shall be taken into consideration that the minimum value of tolerance is 0,010 mm.

5.6 Measuring instruments

Measuring instruments indicated in the tests described in the following clauses are examples only. Other instruments capable of measuring the same quantities and having the same or a smaller measurement uncertainty may be used. Reference shall be made to ISO 230-1:2012, Clause 5, which indicates the relationship between measurement uncertainties and the tolerances.

When a "dial gauge" is referred to, it can mean not only dial test indicators (DTI) but any type of linear displacement sensor such as analogue or digital dial gauges, linear variable differential transformer (LVDTs), linear scale displacement gauges, or non-contact sensors, when applicable to the test concerned (see ISO 230-1:2012, Clause 4).

Similarly, when a "straightedge" is referred to, it can mean any type of straightness reference artefact, such as a granite, ceramic, steel, or cast iron straightedge, one arm of a square, one generating line on a

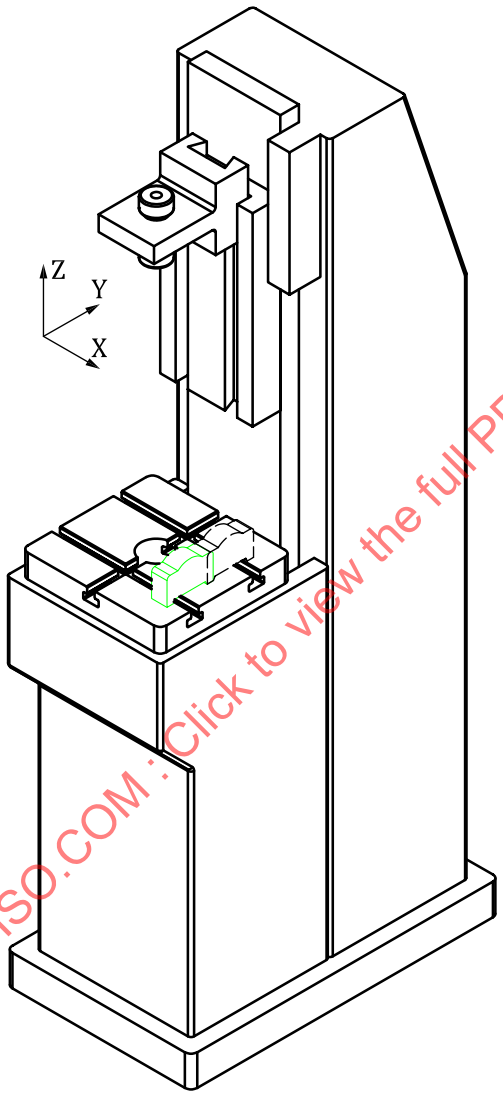
cylindrical square, any straight path on a reference cube, or a special, dedicated artefact manufactured to fit in the T-slots or other references.

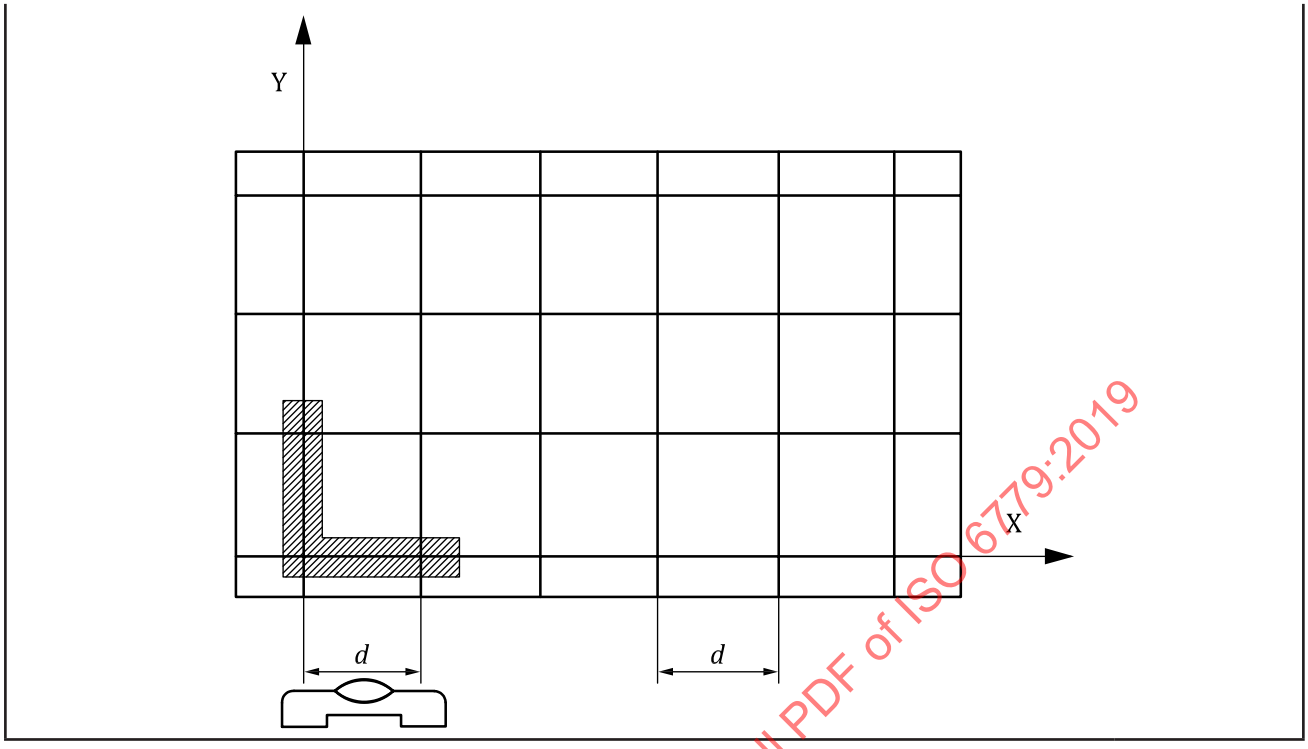
In the same way, when a “square” is mentioned, it can mean any type of squareness reference artefact, such as granite, ceramic, steel or cast-iron square, a cylindrical square, a reference cube, or, again, a special, dedicated artefact.

5.7 Axes not under test

During the execution of some geometric tests on one axis of motion, the position of the other axes not under test can affect the results. Therefore, the positions of these axes, as well as the offsets on the tool side and on the workpiece side, are to be recorded in the test report.

6 Geometric tests

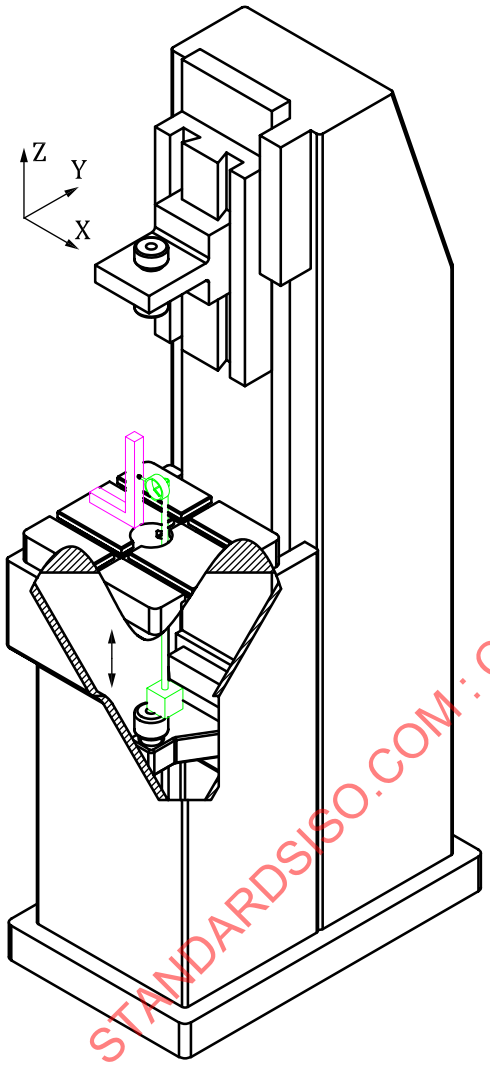
Object	**G1**
Checking of flatness of the work table	
Diagram  	
Tolerance 0,04 for a measuring length of up to 1 000	
Measured deviation	
Measuring instruments Precision level	
Observations and references to ISO 230-1:2012, 12.2.4 Measurements shall be carried out at a number of positions equally spaced with measuring distance, *d*. For more details and interpretation of obtained results, refer to ISO 230-1;2012, 12.2.4.	



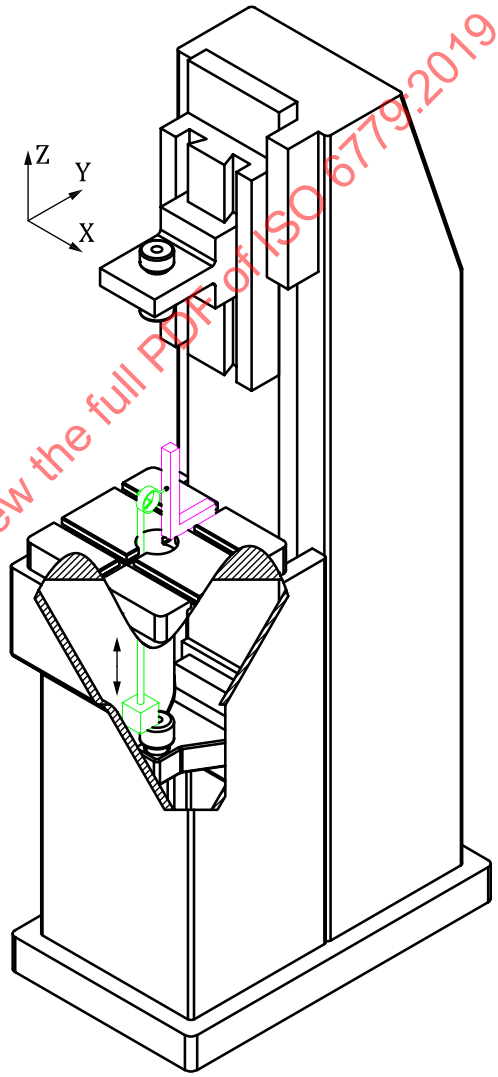
Object	**G2**
Checking of squareness of the pulling chuck movement (Z-axis) to the work table: a) In ZX plane; b) In YZ plane.	

Diagram

a) In ZX plane



b) In YZ plane



Tolerance

For a) and b)

0,05 / 300 (0,165/1 000) or 33”

Measured deviation

a) b)

Measuring instruments

Square and dial gauge.

Observations and references to ISO 230-1:2012, 12.4.5

For a)

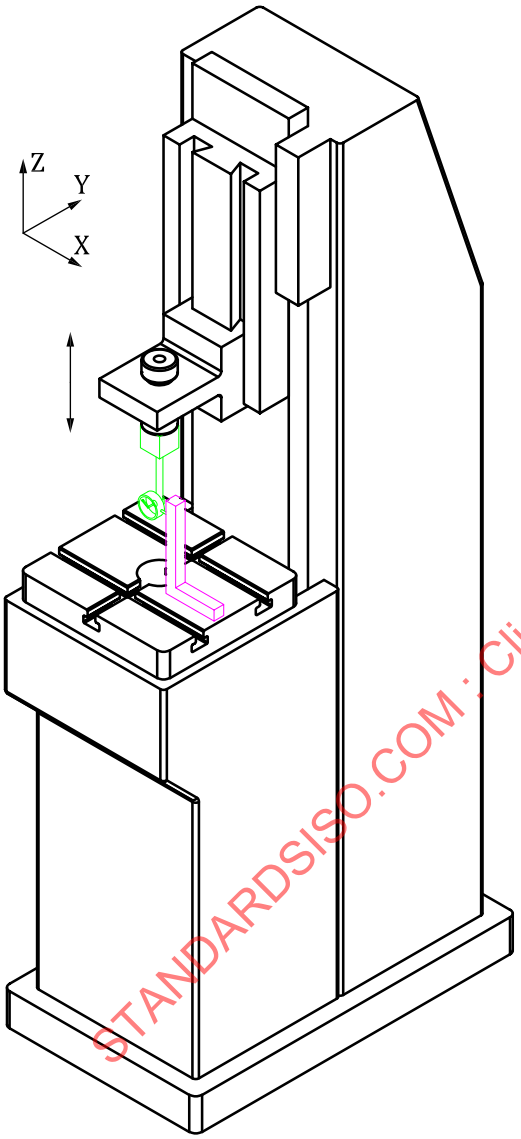
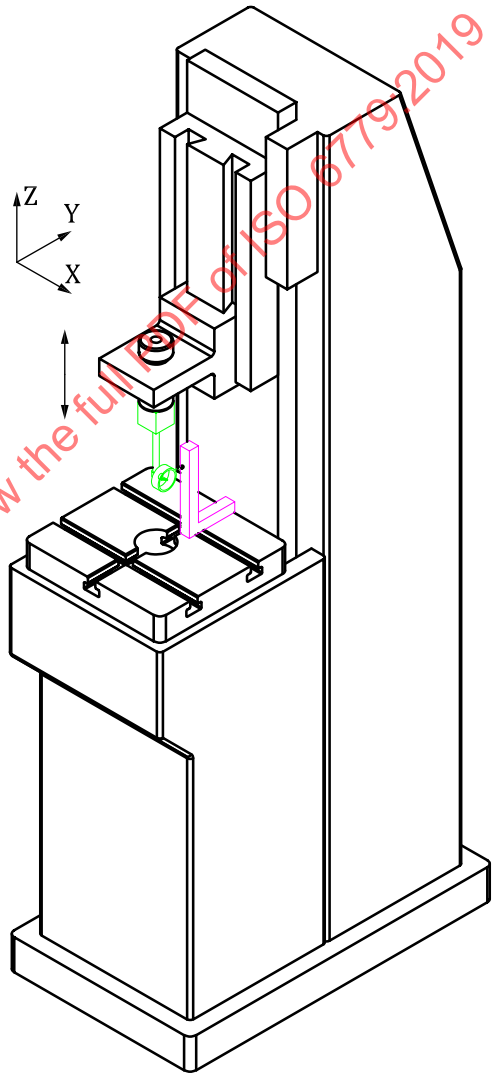
Fix a square on the work table while the measuring side of the square is aligned in X direction. Set the base of the dial gauge on the pulling chuck. Contact the stylus of the dial gauge to the measuring face of the square in ZX plane. Move the dial gauge attached to the pulling block (Z-axis) in front of the square and record the variations of the dial gauge and also the first and the last positions of Z-axis.

The squareness error is the difference between the readings at two ends of the square divided by the predetermined stroke of Z-axis at those positions.

For b)

Fix a square on the work table while the measuring side of the square is aligned in Y direction. Set the base of the dial gauge on the pulling chuck. Contact the stylus of the dial gauge to the measuring face of the square in YZ plane. Move the dial gauge attached to the pulling block (Z-axis) in front of the square and record the variations of the dial gauge and also the first and the last positions of Z-axis.

The squareness error is the difference between the readings at two ends of the square divided by the predetermined stroke of Z-axis at those positions.

Object	**G3**
Checking of squareness of the retrieving chuck movement (W-axis) to the work table: a) In ZX plane; b) In YZ plane.	
Diagram a) In ZX plane  b) In YZ plane  	
Tolerance For a) and b) 0,03 / 300 (0,100/1 000) or 20”	
Measured deviation a) b)	
Measuring instruments Square and dial gauge.	

Observations and references to ISO 230-1:2012, 12.4.5

For a)

Fix a square on the work table while one measuring side of the square is oriented along X direction. Set the base of the dial gauge on the retrieving chuck. Contact the stylus of the dial gauge to the measuring face of the square in ZX plane. Move the dial gauge attached to retrieving chuck (W-axis) in front of the square and record the variations of the dial gauge and also the first and the last positions of W-axis.

The squareness error is the difference between the readings at two ends of the square divided by the predetermined stroke of W-axis at those positions.

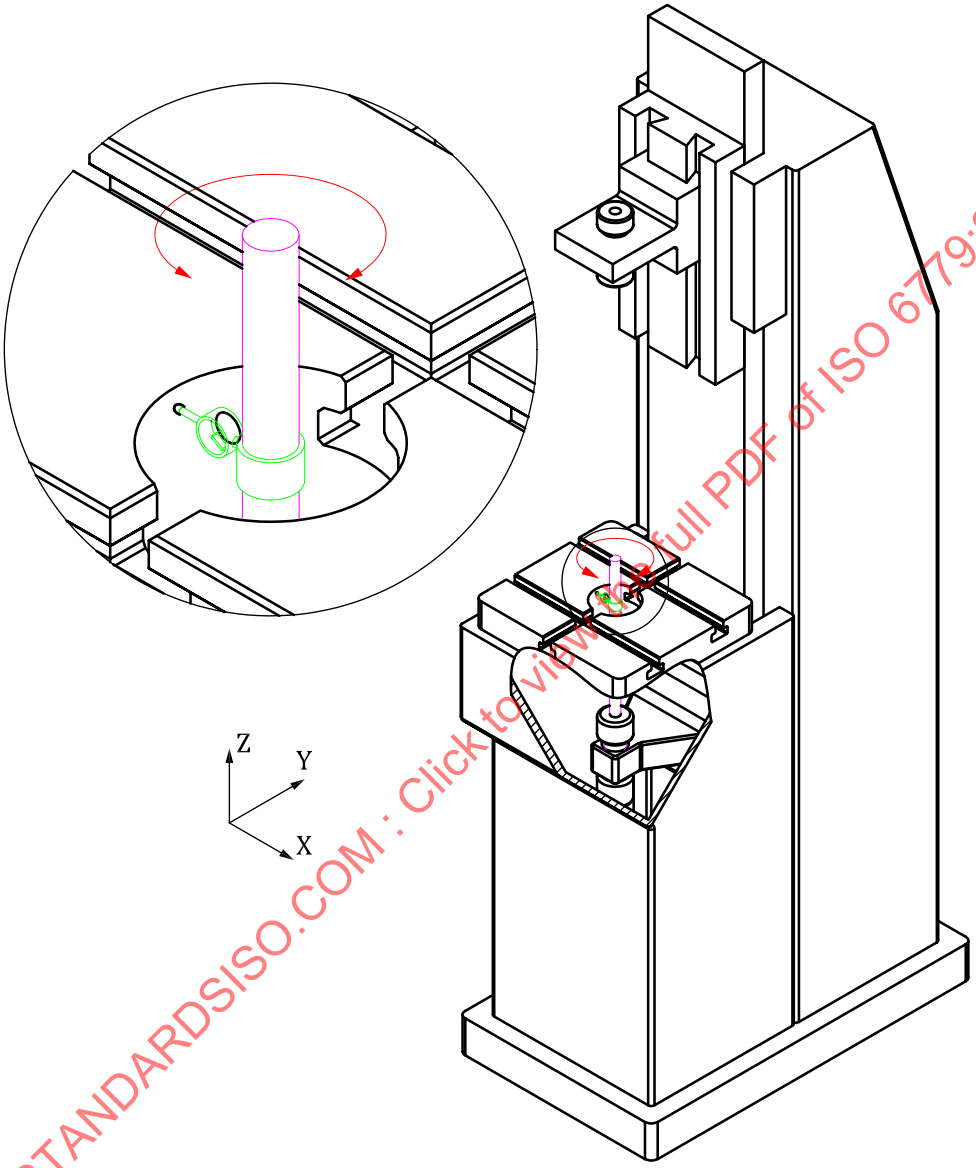
For b)

Fix a square on the work table while one measuring side of the square is oriented along Y direction. Set the base of the dial gauge on the retrieving chuck. Contact the stylus of the dial gauge to the measuring face of the square in YZ plane. Move the dial gauge attached to retrieving chuck (W-axis) in front of the square and record the variations of the dial gauge and also the first and the last positions of W-axis.

The squareness error is the difference between the readings at two ends of the square divided by the predetermined stroke of W-axis at those positions.

Object	G4
Checking of radial offset of coaxiality deviation of the pulling chuck hole axis to the centre hole of work table	

Diagram



Tolerance

0,050

Measured deviation

Measuring instruments

Test mandrel and dial gauge mounted on a bush[1)].

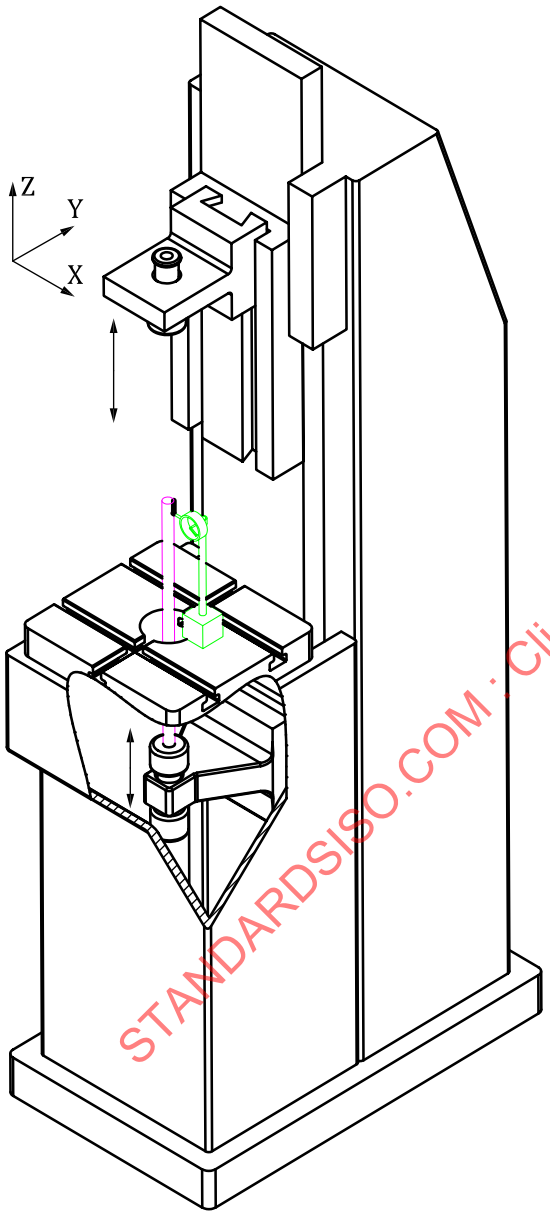
[1)] For more information about the bush (ring), refer to ISO 230-1:2012, 12.3.4.

Observations and references to ISO 230-1:2012, 10.2 and 12.3.4
Mount the dial gauge ring-type base on the test mandrel which is inserted to the pulling chuck. Contact the stylus of the dial gauge radially to the central hole of work support bush. By swivelling the dial gauge on the test mandrel and touching the hole surface, record maximum and minimum deviations of the dial gauge. Radial offset of coaxiality deviation is the half value of the deviation between maximum and minimum readings of the dial gauge.

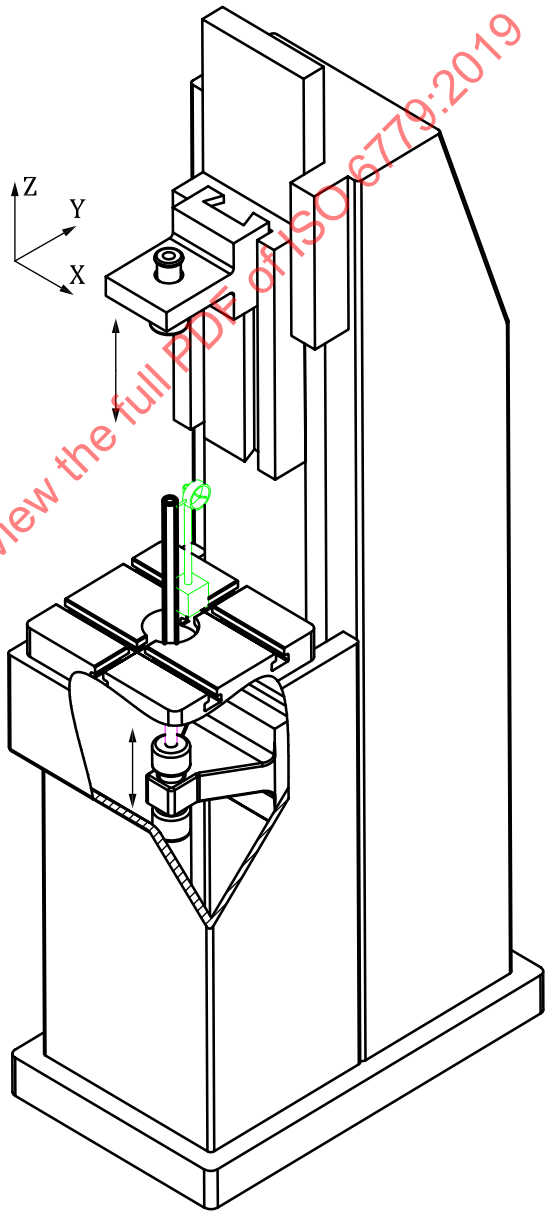
Object	**G5**
Checking of parallelism error of the pulling chuck hole axis to its movement (Z-axis): a) In ZX plane; b) In YZ plane.	

Diagram

a) In ZX plane



b) In YZ plane



Tolerance

For a) and b)

0,05 / 300 (0,165/1 000) or 33”

Measured deviation

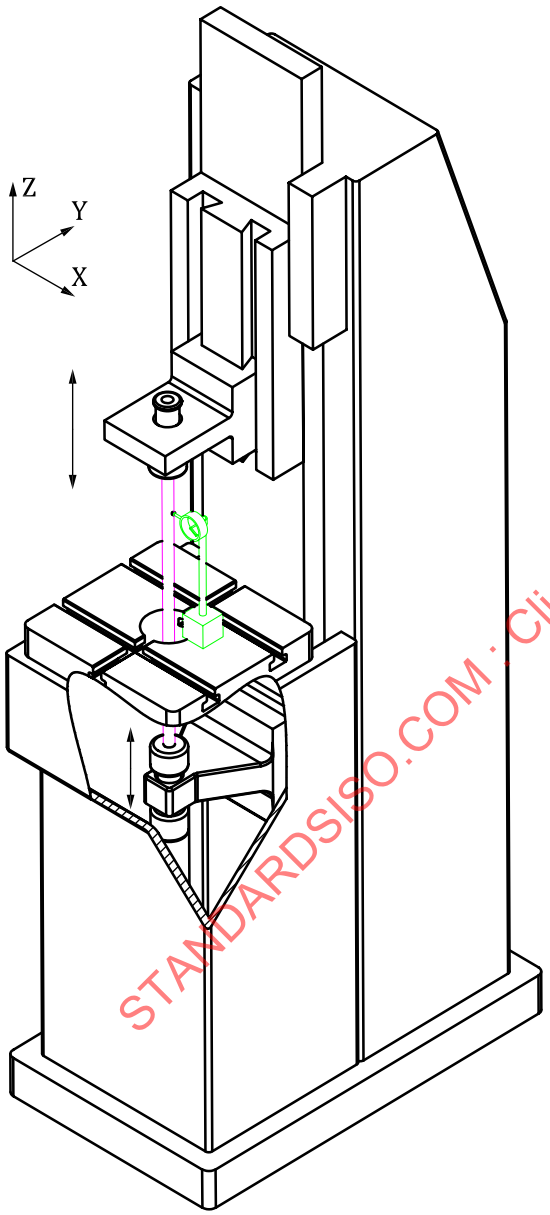
a) b)

Measuring instruments
Test mandrel and dial gauge.
Observations and references to ISO 230-1:2012, 10.1.4
For a)
Fix the dial gauge base on a fixed part of the machine. Contact the stylus of the dial gauge along X direction to the test mandrel which is inserted to the pulling chuck. While the dial gauge is fixed, move the test mandrel attached to the pulling block along the Z-axis and record vertical variations. Take the difference in the reading of the last and first position and divide it by the distance in Z.
For b)
Fix the dial gauge base on a fixed part of the machine. Contact the stylus of the dial gauge along Y direction to the test mandrel which is inserted to the pulling chuck. While the dial gauge is fixed, move the test mandrel attached to the pulling block along the Z-axis and record vertical variations. Take the difference in the reading of the last and first position and divide it by the distance in Z.

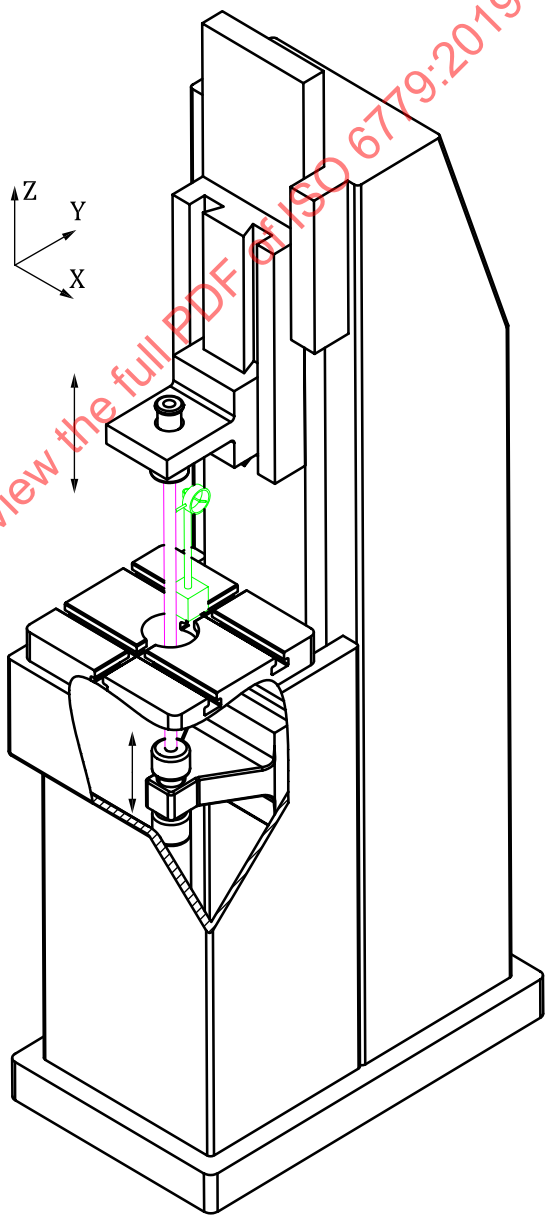
Object	G6
Checking of radial offset of coaxiality deviation of the retrieving chuck hole axis to the pulling chuck hole axis a) In ZX plane; b) In YZ plane.	

Diagram

a) In ZX plane



b) In YZ plane



Tolerance

For a) and b)

0,060 over a measuring length of 500

Measured deviation

a) b)