
**Test conditions for horizontal internal
type broaching machines — Testing of
accuracy**

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





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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 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 third edition cancels and replaces the second edition (ISO 6480:1983), 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;
- some terms have been changed and equivalent non-formal terms in more languages have been added to [Annex A](#);
- terms and definitions related to this machine and its process have been added in [Clause 3](#);
- all diagrams have been regenerated;
- old references to ISO/R 230:1961 have been changed to ISO 230-1:2012;
- levelling test, G01, has been deleted and relevant explanations have been added to [Clause 5](#);
- sections a) and b) of test items G1 have been merged; consequently, only single tolerance is applied;
- as the term “coincidence” is no longer existing in ISO 230-1:2012, the term “radial offset of coaxiality deviation” has been used for test item G5;
- [Clause 7](#) has been created to provide considerations 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 German, Italian and Persian. These are published under the responsibility of the member bodies for Germany (DIN), 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 horizontal 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 horizontal internal type broaching machines.

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

1 Scope

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

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

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

It deals only with the verification of the accuracy of the 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

broach

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

3.2

broaching machine

machine tool in which broaching operation is executed

3.3

internal broaching operation

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

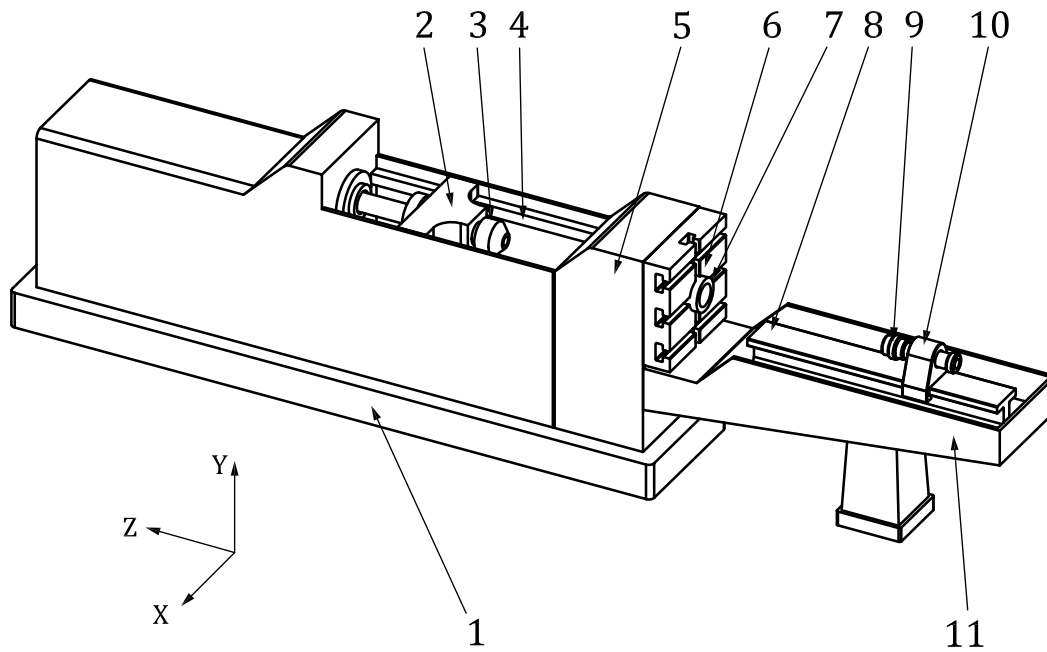
3.4

horizontal internal type broaching machine

horizontal 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 horizontal broaching machine is understood to be a *broaching machine* (3.2) whose main cutting axis (Z-axis) is horizontal.

4 Terminology and designation of axes

See [Figure 1](#).



Key

English	French
1 bed	bâti
2 pull block (Z-axis)	chariot de traction (axe Z)
3 pulling chuck	tête d'accrochage avant
4 pull block ways	guidage du chariot de traction
5 supporting column	colonne de support
6 face plate	plateau de fixation
7 work support bush	support de pièce
8 retrieving support ways	guidage du chariot d'amenage et d'accompagnement
9 retrieving chuck	tête d'accrochage arrière
10 retrieving support block (W-axis)	chariot d'amenage et d'accompagnement (axe W)
11 retrieving support	support du chariot d'amenage

NOTE For languages other than official ISO languages, see [Table A.1](#).

Figure 1 — Typical example of a horizontal internal type 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 horizontal internal type broaching machine, the machine 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).

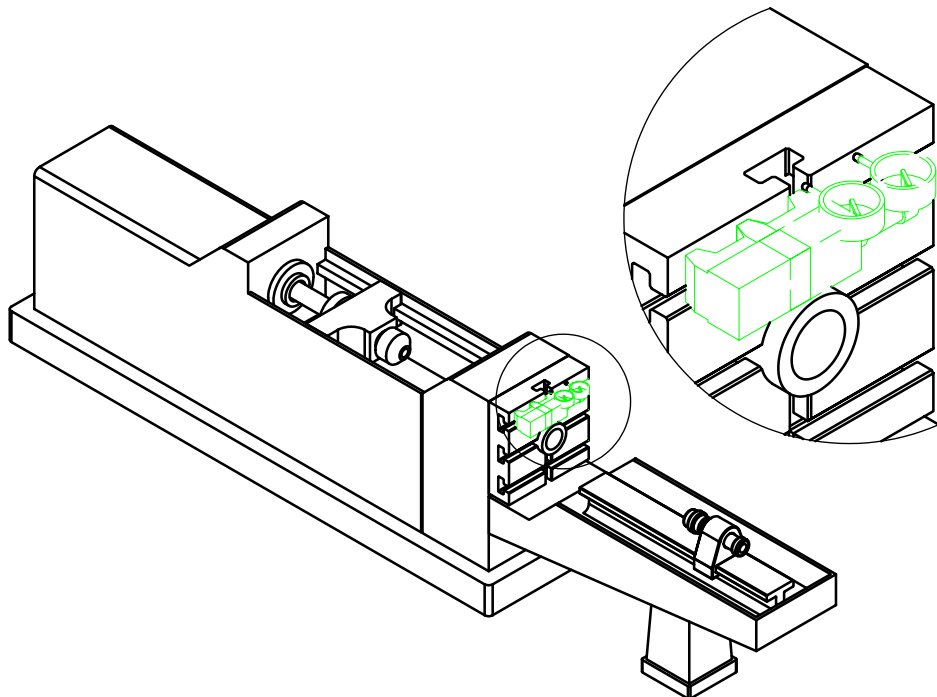
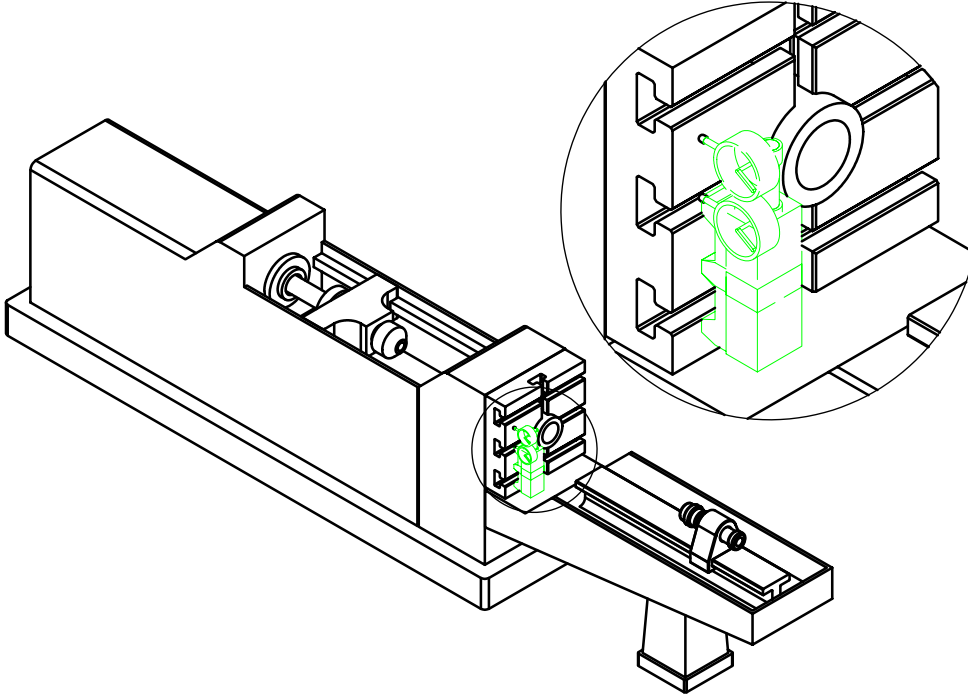
Similarly, when a “straightedge” is referred to, it can mean any type of straightness reference artefact, such as a granite, ceramic, steel or cast iron straightedge, one arm of a square, one generating line on a cylindrical square, any straight path on a reference cube, or a special, dedicated artefact 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 a granite or ceramic or steel or cast-iron square, a cylindrical square, a reference cube, or, again, a special, dedicated artefact.

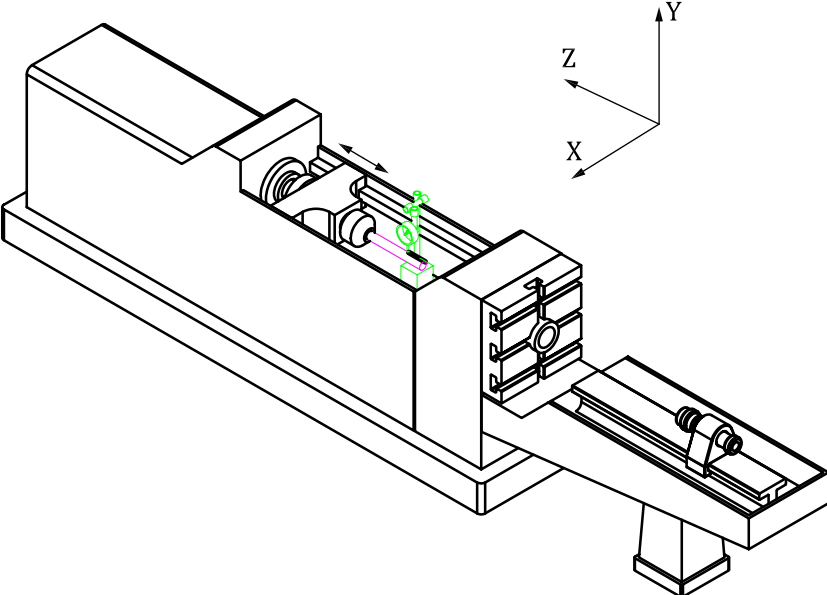
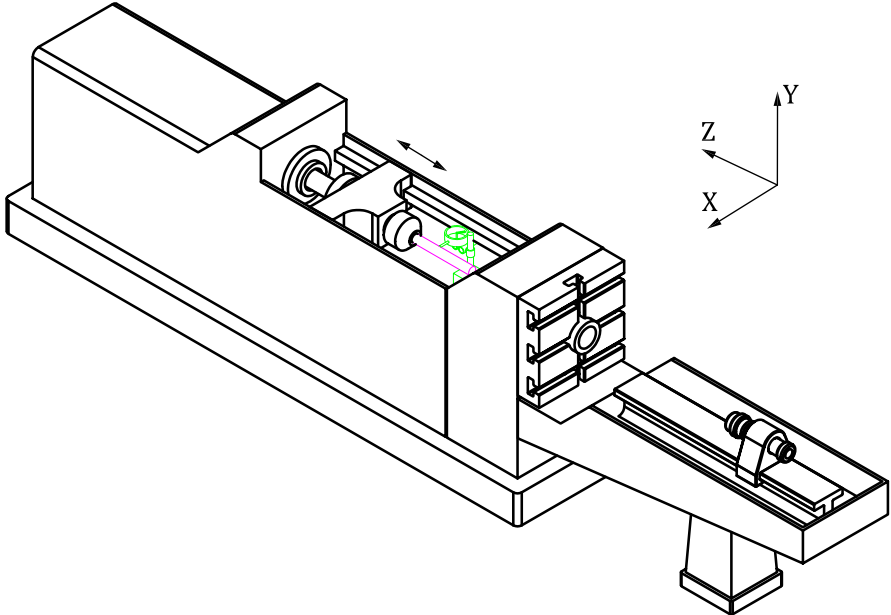
5.7 Axes not under test

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 face plate	
Diagram	
First step of measurement in horizontal direction	
	
Second step of measurement in vertical direction	
	
Tolerance	
0,025 for a measuring length of up to 300	
Total tolerance: 0,050	

Measured deviation
Measuring instruments
Dial gauge with metrological carriage.
Observations and references to ISO 230-1:2012, 12.1.3.5 and 12.2
In order to determine flatness of the rectangular surface which is a vertical plane, a dial gauge with a special base is used. In the first step, measurements shall be carried out at a number of positions equally spaced in horizontal directions. In the second step, measurements are performed in vertical directions by the same dial gauge with its special base with equally spaced measuring distances. For more details and interpretation of obtained results, refer to ISO 230-1:2012, 12.2.4.

Object	G2
<p>Checking of parallelism error of the pulling chuck hole axis to its movement (Z-axis):</p> <p>a) in vertical YZ plane ($E_{A0ZChuckHole}$);</p> <p>b) in horizontal ZX plane ($E_{B0ZChuckHole}$).</p>	
<p>Diagram</p> <p>a) in vertical YZ plane</p>  <p>b) in horizontal ZX plane</p> 	
<p>Tolerance</p> <p>For a) and b)</p> <p>0,050 / 300 (0,165 / 1 000) or 33''</p>	

Measured deviation	
a)	b)
Measuring instruments	
Test mandrel and dial gauge.	
Observations and references to ISO 230-1:2012, 12.3.2.5.1	
for a)	
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.	
for b)	
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 horizontal variations.	

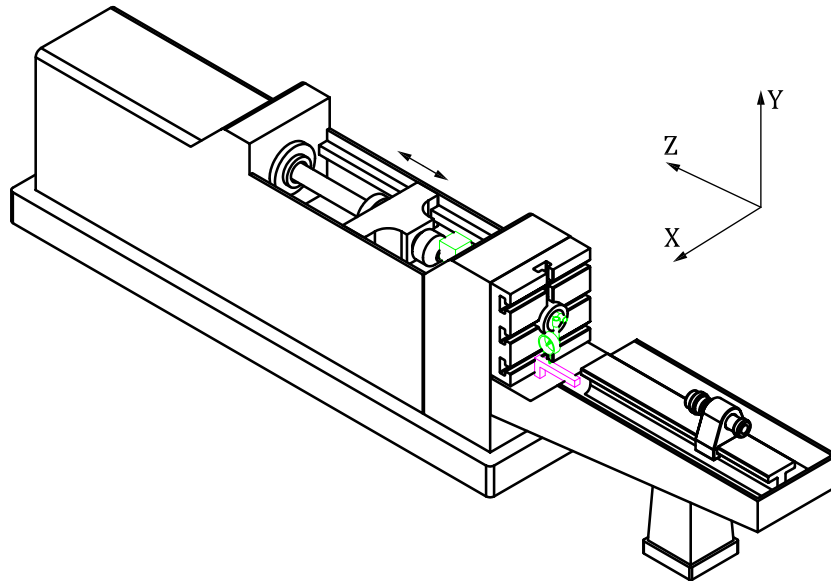
Object**G3**

Checking of squareness of the pulling chuck movement (Z-axis) to the face plate:

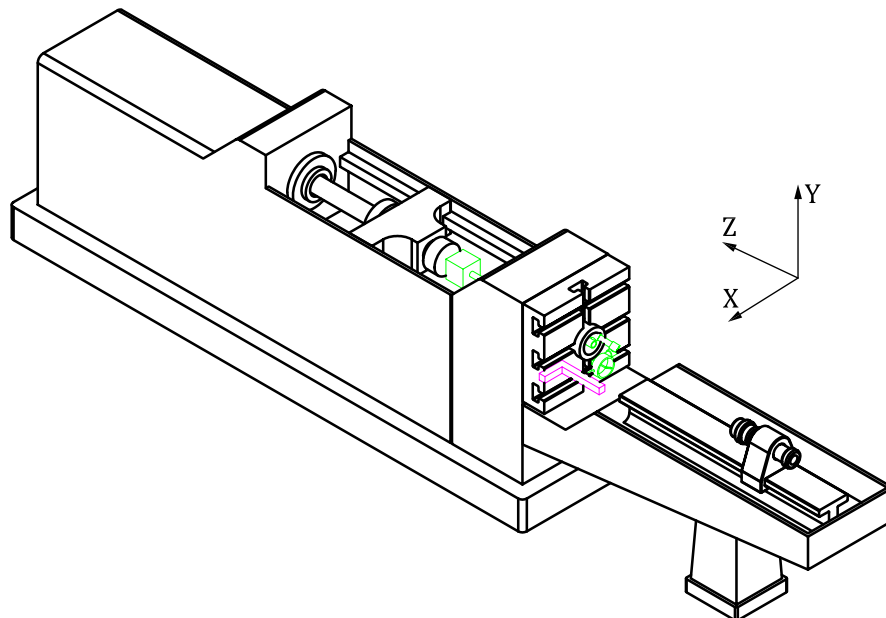
- a) in vertical YZ plane;
- b) in horizontal ZX plane.

Diagram

- a) in vertical YZ plane



- b) in horizontal ZX plane

**Tolerance**

For a) and b)

0,035 / 300 (0,115 / 1 000) or 23''

Measured deviation	
a)	b)
Measuring instruments	
Square and dial gauge.	
Observations and references to ISO 230-1:2012, 12.4.5	
For a)	
<p>Fix a square on the face plate while one measuring side of the square is oriented along 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 along Y direction. Move the dial gauge attached to 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.</p> <p>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.</p>	
For b)	
<p>Fix a square on the face plate while one measuring side of the square is oriented along 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 along X direction. Move the dial gauge attached to 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.</p> <p>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.</p>	

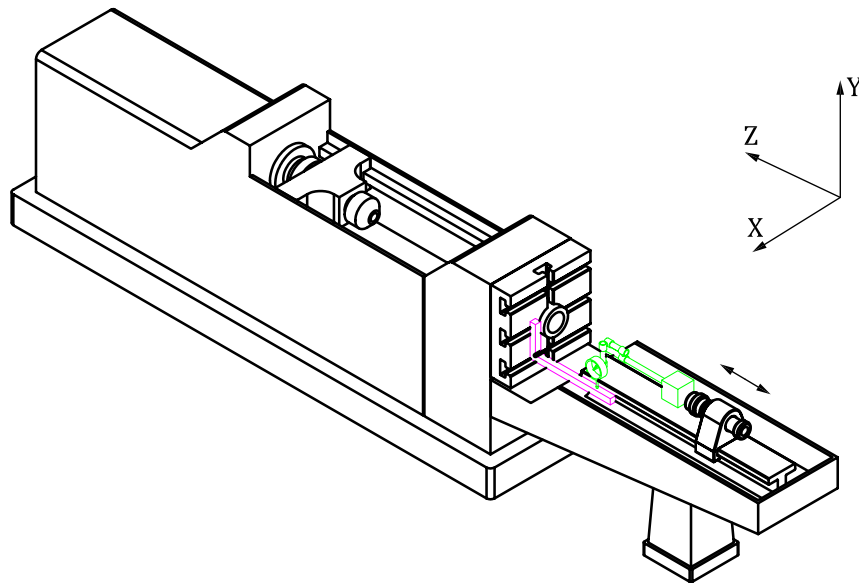
Object**G4**

Checking of squareness of the retrieving chuck movement (W-axis) to the face plate:

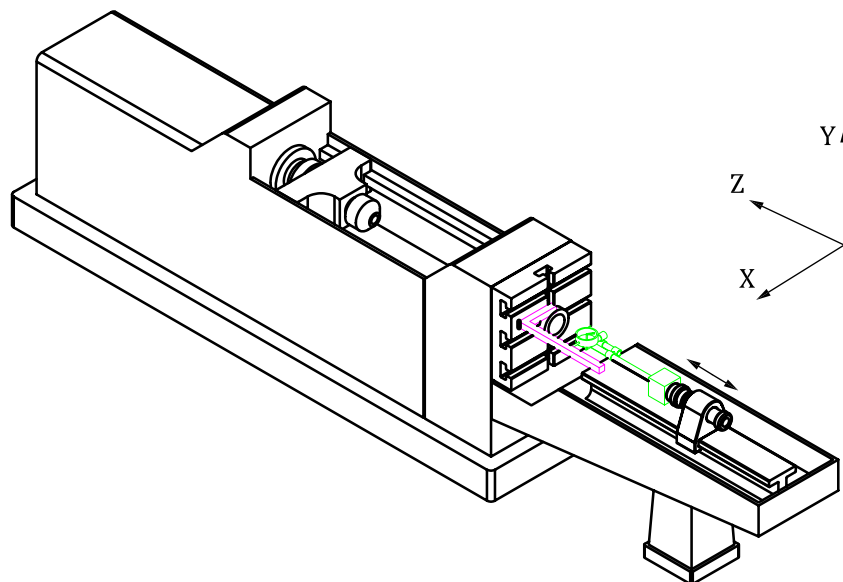
- a) in vertical YZ plane;
- b) in horizontal ZX plane.

Diagram

- a) in vertical YZ plane



- b) in horizontal ZX plane

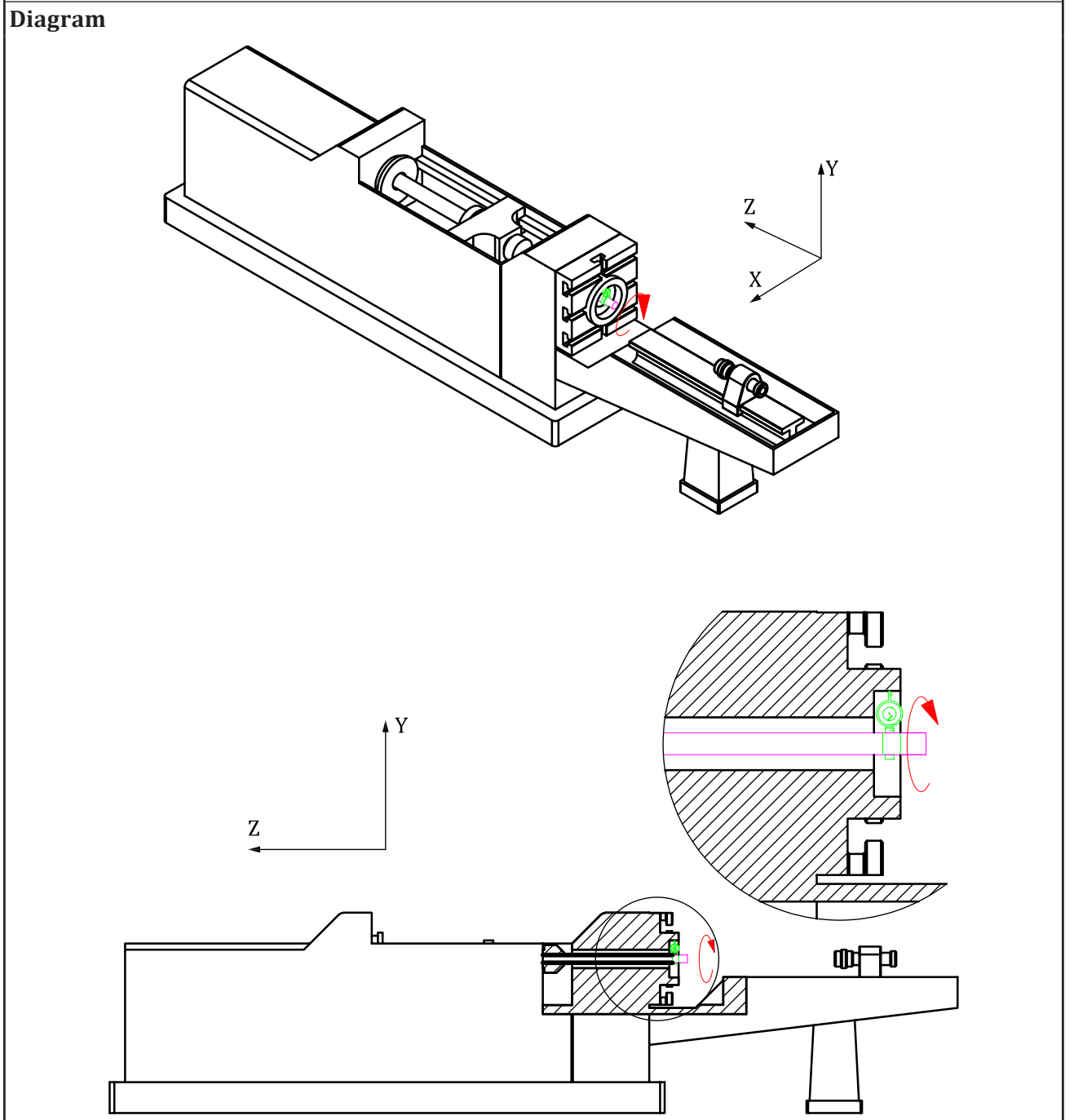
**Tolerance**

For a) and b)

0,075 / 300 (0,250 / 1 000) or 50''

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 face plate 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 along Y direction. 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 face plate 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 along X direction. 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	G5
Checking of radial offset of coaxiality deviation of the pulling chuck hole axis to the centre hole of the face plate	



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

Fix 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.

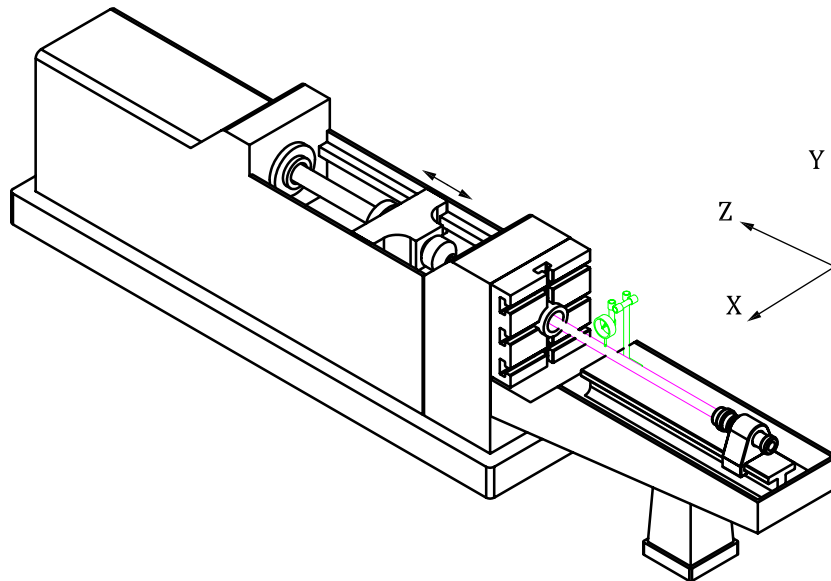
Object**G6**

Checking of radial offset of coaxiality deviation of the retrieving chuck hole axis to the pulling chuck hole axis:

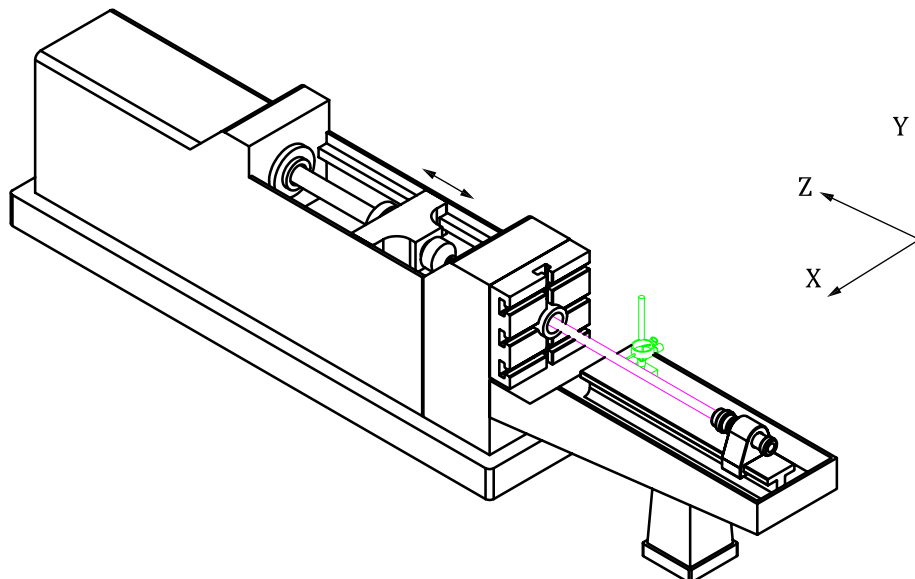
- in vertical YZ plane (vertical offset);
- in horizontal ZX plane (horizontal offset).

Diagram

- in vertical YZ plane



- in horizontal ZX plane

**Tolerance**

For a) and b)

0,060 over a measuring length of 500

Measured deviation	
a)	b)
Measuring instruments	
Test mandrel and dial gauge.	
Observations and references to ISO 230-1:2012, 10.2 and 12.3.4	
For a)	
Fix a test mandrel between the retrieving chuck hole and the pulling chuck hole. Set 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. While the dial gauge is fixed, move the test mandrel fixed between the two chucks by simultaneous motion of Z-axis and W-axis and record vertical variations of the dial gauge.	
For b)	
Fix a test mandrel between the retrieving chuck hole and the pulling chuck hole. Set 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. While the dial gauge is fixed, move the test mandrel fixed between the two chucks by simultaneous motion of Z-axis and W-axis and record horizontal variations of the dial gauge.	

7 Machining tests

Because of the diversity of shape of components produced by horizontal internal type broaching machines, practical tests with determined shapes have not been introduced in this document. If the user requests to carry out a machining test, details of this test shall be stated in agreement with the manufacturer. The following information should be stated in the agreement and final test result:

- test piece (i.e. material, dimensions);
- broach (i.e. material, geometry, tooling and sharpening process);
- conditions of internal broaching operation (i.e. cutting speed, coolant, fixturing);
- geometry of broached features (i.e. technical drawing, dimensions, tolerance);
- measuring instrument for checking the accuracy of finished test piece (i.e. resolution, uncertainty).

Annex A (informative)

Terms in other languages

See [Table A.1](#).

Table A.1 — Terms in other than official ISO languages for [Figure 1](#)

Item Number	German	Italian	Persian
1	Bett	Bancale	بستر
2	Schafthalteraufnahme	Testa di trazione	بلوك كِشنده (محور Z)
3	Schafthalter	Pinza di trazione	خانگیر (ابزارگیر) كِشنده
4	Werkzeugschlittenführung	Guide della testa di trazione	ریل راهنمای بلوك كِشنده
5	Ständer für Aufspannplatte	Banco della tavola	ستون نگهدارنده
6	Aufspannplatte	Tavola porta-pezzi	صفحه کارگیر
7	Werkstückvorlage	Supporto pezzo	بوش نگهدارنده قطعه کار
8	Endstückhalterführung	Guide della testa posteriore	ریل راهنمای برگرداننده
9	Endstückhalter	Pinza posteriore	خانگیر (ابزارگیر) برگرداننده
10	Endstückhalteraufnahme (W-axis)	Testa posteriore	بلوك برگرداننده (محور W)
11	Tisch	Bancale posteriore	نگهدارنده بیرونی

Bibliography

- [1] ISO/TR 230-11, *Test code for machine tools — Part 11: Measuring instruments suitable for machine tool geometry tests*
- [2] ISO 1101, *Geometrical product specifications (GPS) — Geometrical tolerancing — Tolerances of form, orientation, location and run-out*

