INTERNATIONAL STANDARD

**ISO 1986-1**

First edition
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# Test conditions for surface grinding machines with horizontal grinding wheel spindle and reciprocating table — Testing of the accuracy —

## Part 1: Machines with a table length of up to 1 600 mm

*Conditions d'essai des machines à rectifier les surfaces planes, à broche porte-meules à axe horizontal — Contrôle de la précision —*

*Partie 1: Machines avec une table jusqu'à 1 600 mm de long*

Reference number
ISO 1986-1:2001(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 part of ISO 1986 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 1986-1 was prepared by Technical Committee ISO/TC 39, *Machine tools*, Subcommittee SC 2, *Test conditions for metal cutting machine tools*.

This first edition of ISO 1986-1 cancels and replaces ISO 1986:1985, of which it constitutes a technical revision.

ISO 1986 consists of the following parts, under the general title *Test conditions for surface grinding machines with horizontal grinding wheel spindle and reciprocating table — Testing of the accuracy*:

— *Part 1: Machines with a table length of up to 1 600 mm*

— *Part 2: Machines with a table length longer than 1 600 mm*

# Test conditions for surface grinding machines with horizontal grinding wheel spindle and reciprocating table — Testing of the accuracy —

## Part 1: Machines with a table length of up to 1 600 mm

## 1 Scope

This part of ISO 1986 specifies, with reference to ISO 230-1, both geometric and machining tests on general purpose and normal accuracy surface grinding machines with reciprocating table up to 1 600 mm table length and horizontal grinding wheel spindle. It also specifies the applicable tolerances corresponding to the above-mentioned tests.

NOTE For machines with table length larger than 1 600 mm, ISO 1986-2 is being prepared.

It is not applicable to surface grinding machines with fixed or rotating tables or to machines having longitudinal traverse of the wheelhead.

This part of ISO 1986 deals only with the verification of the 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 machine characteristics (such as speeds, feeds, etc.), which should generally be checked before testing the accuracy.

This part of ISO 1986 provides the terminology used for the principal components of the machine and indicates the designation of the axes in accordance with reference to ISO 841.

## 2 Normative reference

The following normative document contain provisions which, through reference in this text, constitute provisions of this part of ISO 1986. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 1986 are encouraged to investigate the possibility of applying the most recent edition of the normative document 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: Geometric accuracy of machines operating under no-load or finishing conditions*

## 3 Terminology and designation of axes

See Figure 1 and Table 1.

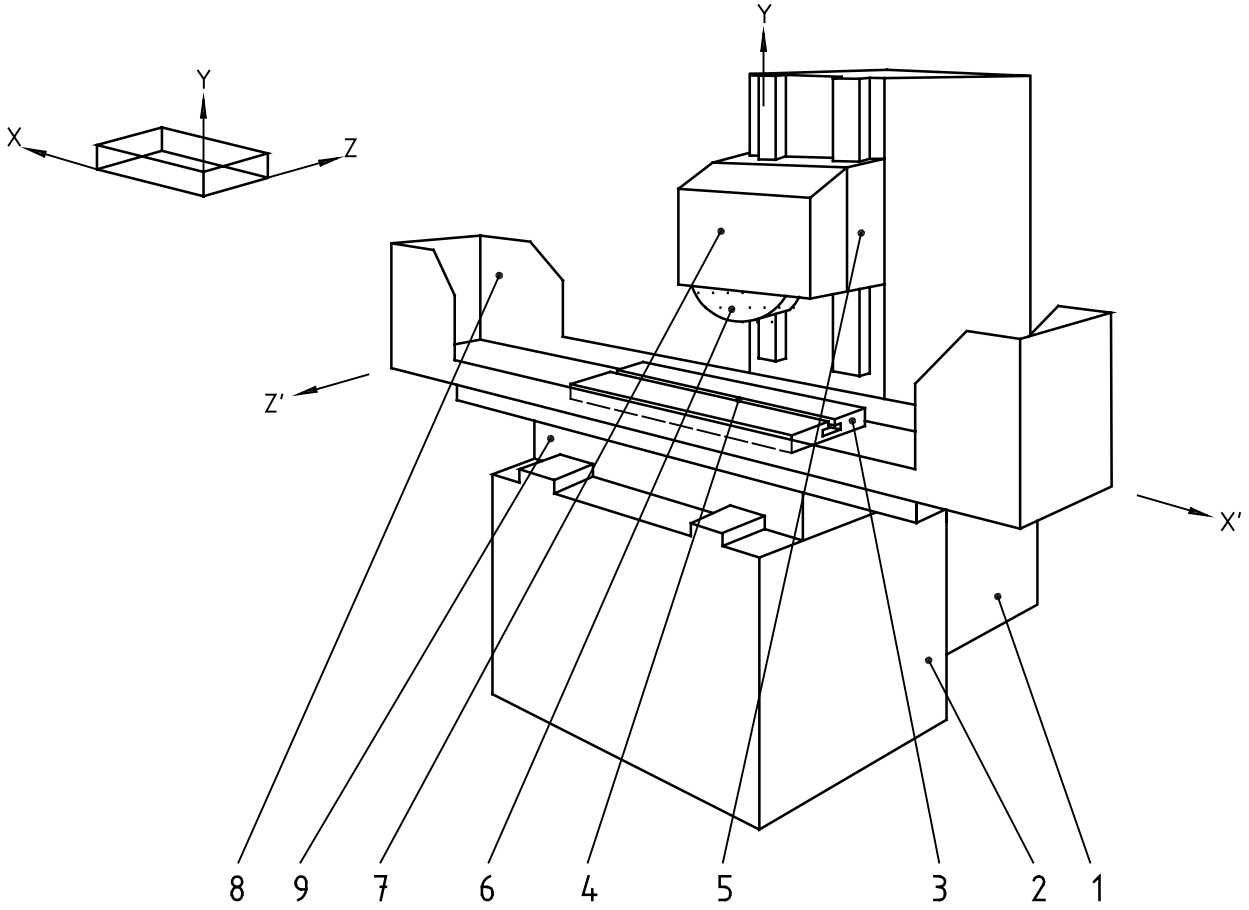



**Figure 1**

**Table 1**

| Repère | English | French | German | Italian |
|---|---|---|---|---|
| **1** | Column | Montant | Ständer | Montante |
| **2** | Bed | Banc | Bett | Banco |
| **3** | Table | Table | Tisch | Tavola |
| **4** | Reference T-slot | Rainure en T de positionnement | Richtnut | Scanalatura di riferimento |
| **5** | Wheelhead | Poupée porte-meule | Schleifspindelstock | Testa porta-mola |
| **6** | Grinding wheel | Outil à rectifier | Schleifwerkzeug | Mola |
| **7** | Wheel guard | Carter de protection | Schutzhaube | Riparo mola |
| **8** | Splash guard | Protection | Fangschutz | Riparo para-spruzzi |
| **9** | Saddle | Chariot transversal | Schlitten | Sella |

NOTE In addition to terms used in the two of the three official ISO languages (English and French), this table gives equivalent terms in German and Italian published under the responsibility of the member bodies for Germany (DIN) and Italy (UNI). However, only the terms given in the official languages can be considered as ISO terms.

# 4 Preliminary remarks

## 4.1 Measuring units

In this part of ISO 1986, 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 also be used for clarification purposes. The equivalence of the following expressions should be kept in mind:

0,010/1 000 = 10 μrad ≈ 2"

## 4.2 Reference to ISO 230-1

To apply this part of ISO 1986, 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 and 6, 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 part of ISO 1986 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 part of ISO 1986. 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.

## 4.5 Measuring instruments

The measuring instruments indicated in the tests described in clauses 5 and 6 are examples only. Other instruments measuring the same quantities and having at least the same accuracy may be used. Dial gauges or other linear displacement probes shall have a resolution of 0,001 mm.

## 4.6 Minimum tolerance

When the tolerance for a geometric test is established for a measuring length different from that given in this part of ISO 1986 (see 2.311 of ISO 230-1:1993), it shall be taken into consideration that the minimum value of tolerance is 0,001 mm.

## 4.7 Machining tests

Machining tests shall be made with finishing cuts only, not with roughing cuts which are liable to generate appreciable cutting forces.

## 4.8 Diagrams

For reasons of simplicity, the diagrams in this part of ISO 1986 illustrate only one type of machine.

# 5 Geometric tests

## 5.1 Linear axes

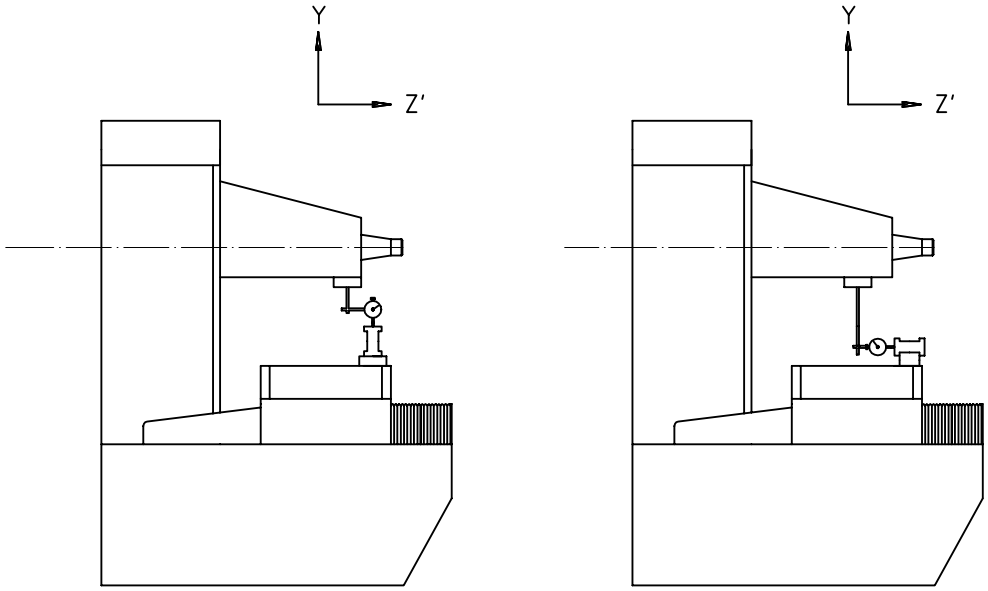
**Object** **G1**

Checking of straightness of the longitudinal (X-axis) movement of the table:

a) in the vertical XY-plane;

b) in the horizontal ZX-plane.

**Diagram**




a) b)

| **Tolerance** | **Measured deviation** |
|---|---|
| For a) and b) | |
| 0,010 for a measuring length up to 1 000 | a) |
| 0,016 for a measuring length exceeding 1 000 | b) |

**Measuring instruments**

Straightedge and dial gauge, alignment telescope, laser interferometer or taut wire, and microscope [for b) only]

**Observations and references to ISO 230-1:1996** 5.232.1

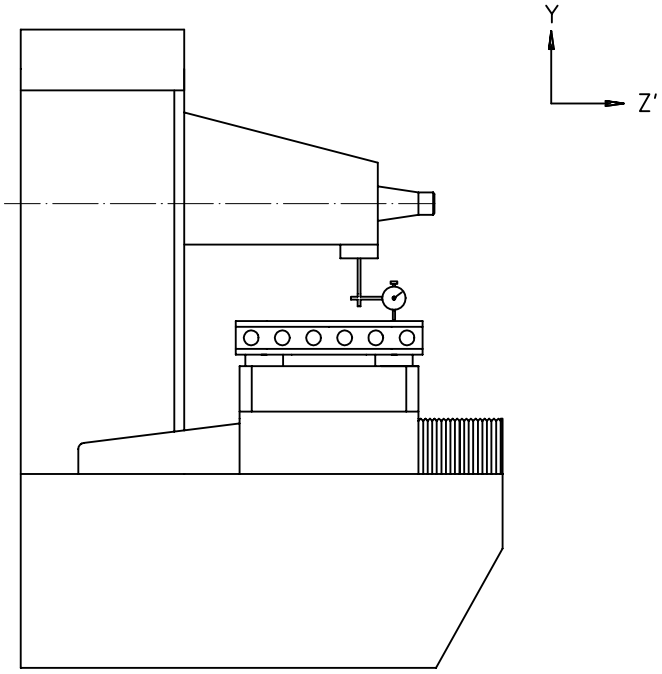
Adjust the straightedge to obtain similar readings at each end of the measuring length.

The dial gauge support shall be placed on a fixed part of the wheelhead, the stylus touching the straightedge.

**Object** **G2**

Checking of the straightness of the transverse movement of the saddle or column or wheelhead (Z-axis) in the vertical YZ-plane.

**Diagram**




| **Tolerance** | **Measured deviation** |
|---|---|
| 0,010 for a measuring length of up to 500<br>0,015 for a measuring length exceeding 500<br>Local tolerance: 0,005 over any measuring length of 300 | |

**Measuring instruments**

Straightedge and dial gauge, alignment telescope or laser interferometer

**Observations and references to ISO 230-1:1996** 5.232.1

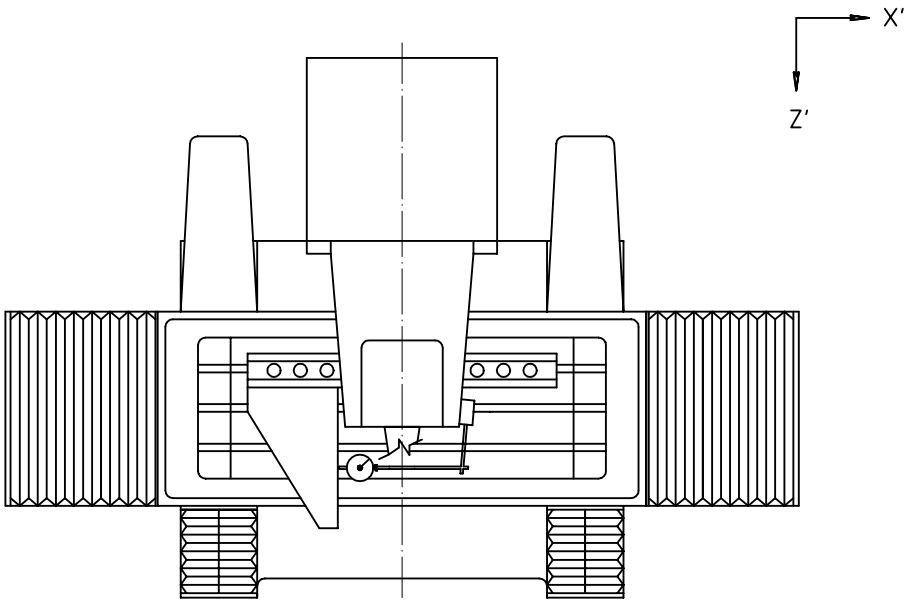
Adjust the straightedge to obtain similar readings at each end of the measuring length.

The dial gauge support shall be placed on a fixed part of the wheelhead, the stylus touching a straightedge.

**Object** | **G3**

Checking of squareness between the longitudinal (X-axis) movement of the table and the transverse movement (Z-axis) of the saddle or column or wheelhead.

**Diagram**




| **Tolerance** | **Measured deviation** |
|---|---|
| 0,03 for any measuring length of 300 | |

**Measuring instruments**

Straightedge, square and dial gauge

**Observations and references to ISO 230-1:1996** 5.522.4

The dial gauge shall be placed on a fixed part of the wheelhead.

Place a straightedge parallel to the longitudinal movement of the table and then place the table in its central position.

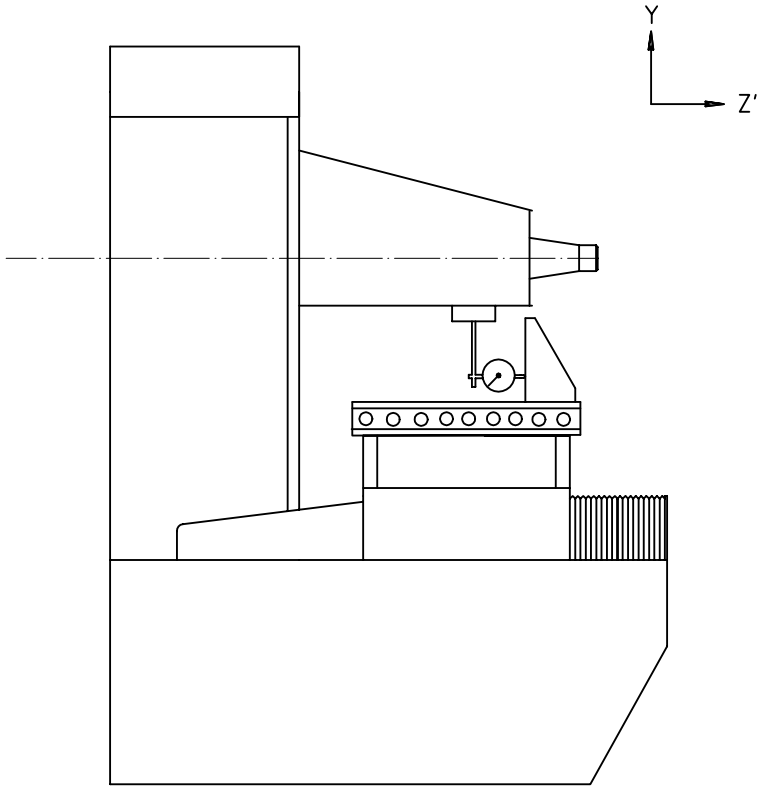
Place a square in contact with the straightedge.

Check the transverse movement of the saddle or column or wheelhead.

**Object** **G4**

Checking of the squareness between the vertical movement of the wheelhead (Y-axis) and the transverse movement of saddle or column or wheelhead (Z-axis).

**Diagram**




| **Tolerance** | **Measured deviation** |
|---|---|
| 0,04 for a measuring length of 300 | |

**Measuring instruments**

Dial gauge and square, straightedge and gauge blocks

**Observations and references to ISO 230-1:1996** 5.522.4

The dial gauge shall be placed on a fixed part of the wheelhead.

Place a straightedge parallel to the transverse movement of the table and then place the table in its central position.

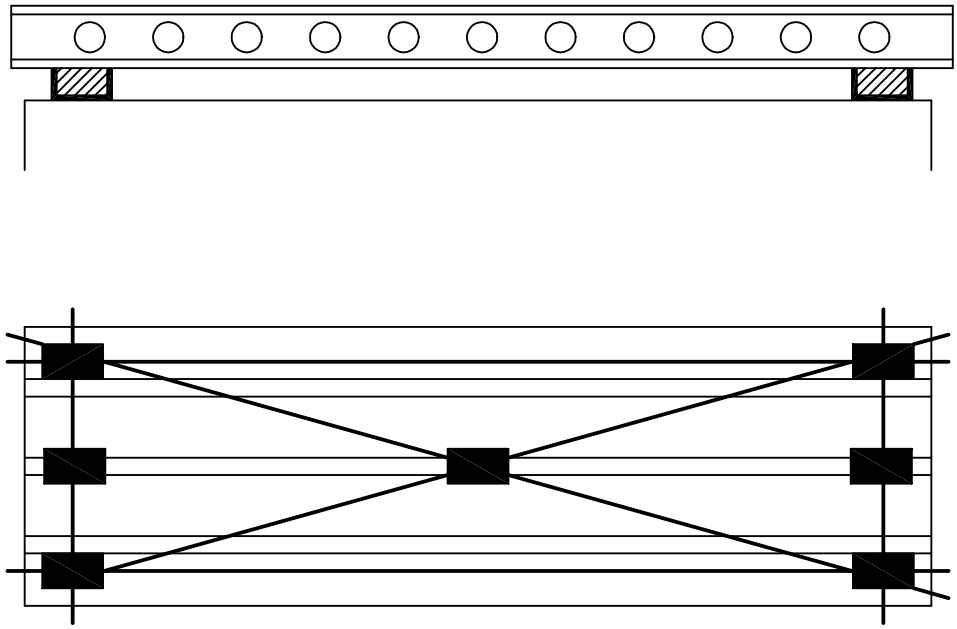
Place a square in contact with the straightedge.

Check the vertical movement of the wheelhead.

## 5.2 Table

| **Object** | **G5** |
|---|---|
| Checking of flatness of the table surface. | |

**Diagram**



| **Tolerance** | **Measured deviation** |
|---|---|
| 0,01 for a measuring length up to 1 000<br>0,02 for a measuring length exceeding 1 000<br>Local tolerance: 0,005 over any measuring length of 300 | Table length = ..... |

**Measuring instruments**

Straightedge and gauge blocks or precision level.

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

Horizontal movements (X and Z) shall be in mid-position.

If the machine is equipped with a magnetic chuck, the test may be carried out on its top surface.

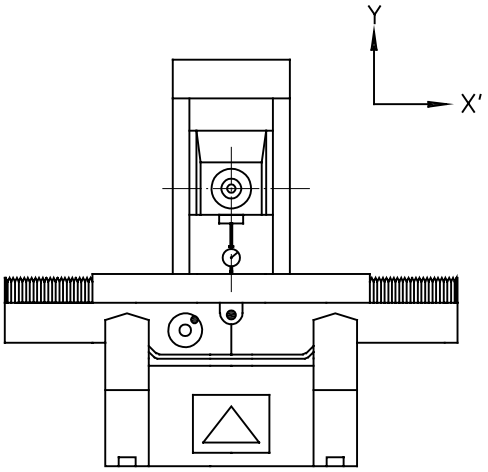
**Object** **G6**

Checking of parallelism between the table surface and

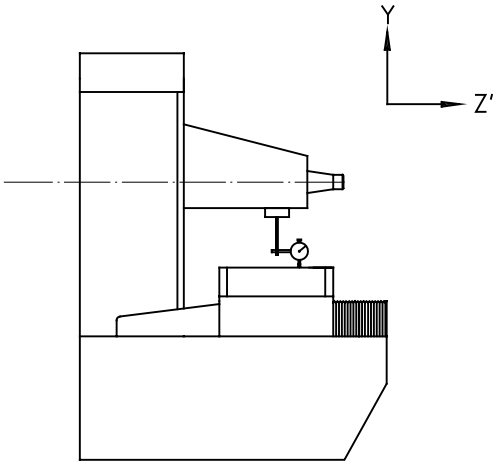
a) its longitudinal movement (X-axis);

b) the transverse movement of the saddle or column or wheelhead (Z-axis).

**Diagram**




**a)**




**b)**

| **Tolerance** | **Measured deviation** |
|---|---|
| a) 0,012 × $L$/1000 | |
| Local tolerance: 0,003 over any measuring length of 300 | a) |
| b) 0,012 × $L$/1000 | |
| where $L$ is the measuring length. | b) |

**Measuring instruments**

Dial gauge

**Observations and references to ISO 230-1:1996** 5.321.1, 5.422.21 and 5.422.1

The dial gauge shall be placed on a fixed part of the wheelhead.

The stylus should be placed approximately in the vertical plane centring the wheel spindle axis.

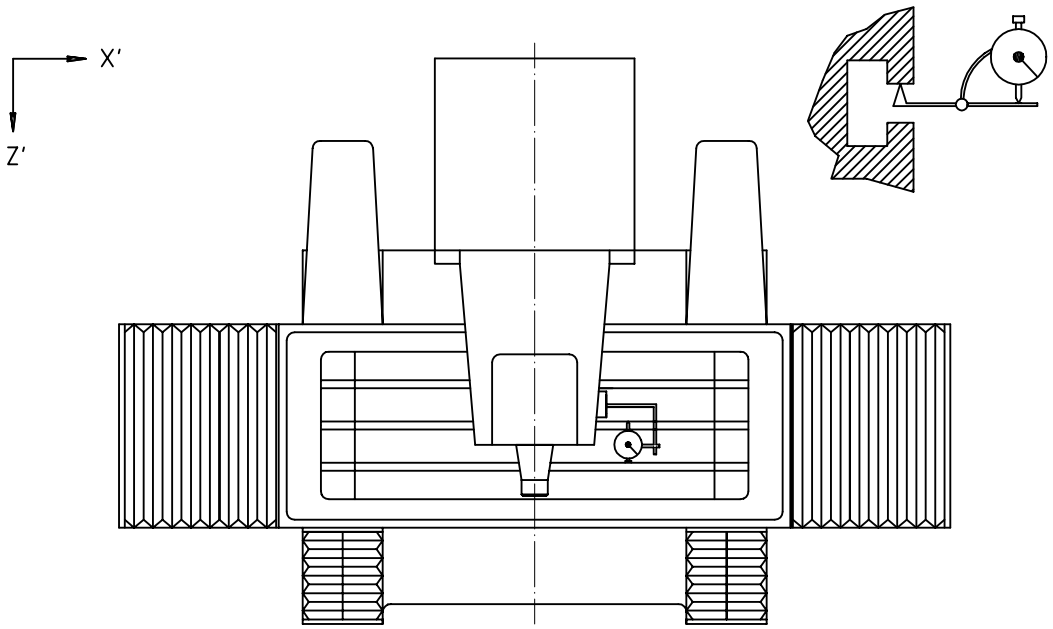
If the machine is equipped with a magnetic chuck, the test may be carried out on its top surface.

If direct contact of the table with the dial gauge affects the measurement due to T-slots or chip pockets, gauge blocks can be used between the dial gauge and table surface in the measuring points.

**Object** **G7**

Checking of parallelism between the median or reference T-slot and the longitudinal movement of the table (X-axis).

**Diagram**




| **Tolerance** | **Measured deviation** |
|---|---|
| 0,015 for a measuring length up to 1 000<br>0,020 for a measuring length exceeding 1 000<br>Local tolerance: 0,008 over any measuring length of 300 | |

**Measuring instruments**

Dial gauge

**Observations and references to ISO 230-1:1996** 5.422.1 and 5.422.21

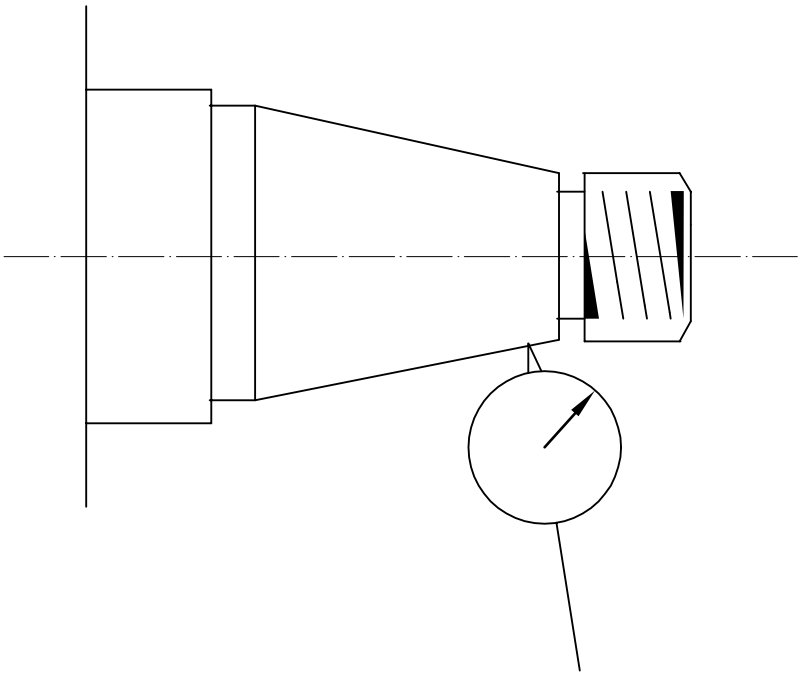
The dial gauge shall be placed on a fixed part of the wheelhead.

If the machine is equipped with a magnetic chuck, the test may be carried out on its reference edge.

## 5.3 Wheel spindle

| **Object** | **G8** |
|---|---|
| Measurement of runout of the wheel-spindle nose. | |

**Diagram**



| **Tolerance** | **Measured deviation** |
|---|---|
| 0,005 | |

**Measuring instruments**

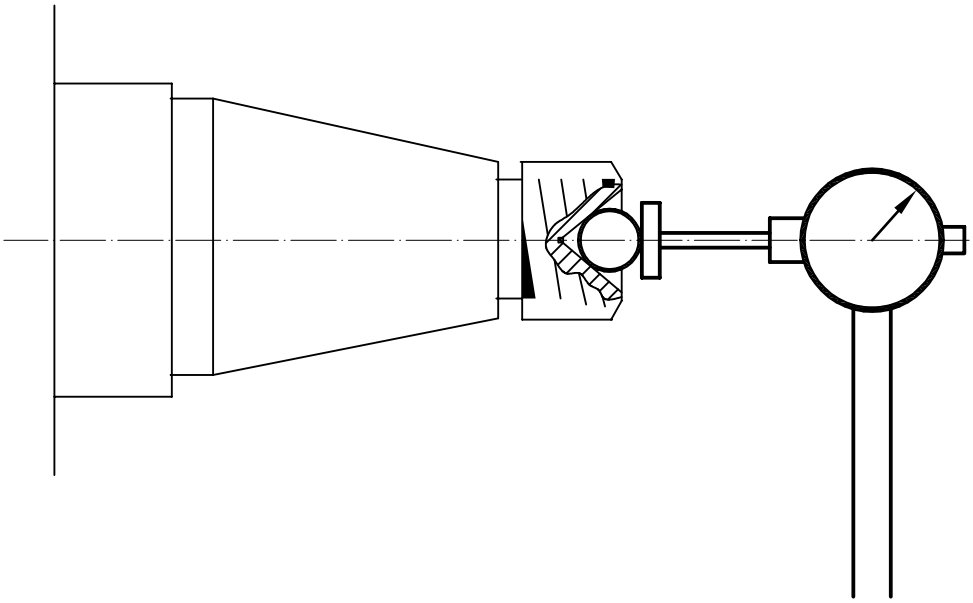
Dial gauge

**Observations and references to ISO 230-1:1996** 5.612.1 and 5.612.2

The stylus of the dial gauge shall be set normal to the surface which is to be checked at the smaller end of the taper.

| **Object** | **G9** |
|---|---|
| Measurement of periodic axial slip of the wheel spindle. | |

**Diagram**



| **Tolerance** | **Measured deviation** |
|---|---|
| 0,005 | |

**Measuring instruments**

Dial gauge

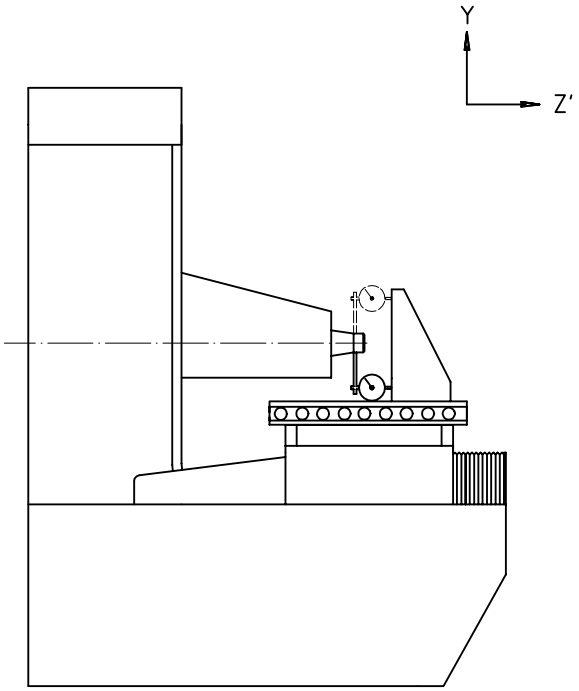
**Observations and references to ISO 230-1:1996** 5.622.1 and 5.622.2

The line of action of the stylus of the dial gauge shall be co-axial with the spindle.

| Object | G10 |
|---|---|

Checking of parallelism between the wheel spindle axis and the transverse movement of the saddle or column or wheel head (Z-axis).

**Diagram**




| Tolerance | Measured deviation |
|---|---|
| 0,025/ 300[a] | |

[a] Distance between the two measuring points touched

**Measuring instructions**

Dial gauge and square, straightedge and gauge blocks

**Observations and references to ISO 230-1:1996** 5.512.1 and 5.512.42

Place a straightedge parallel to the transverse movement of the table and then place the table in its central position.

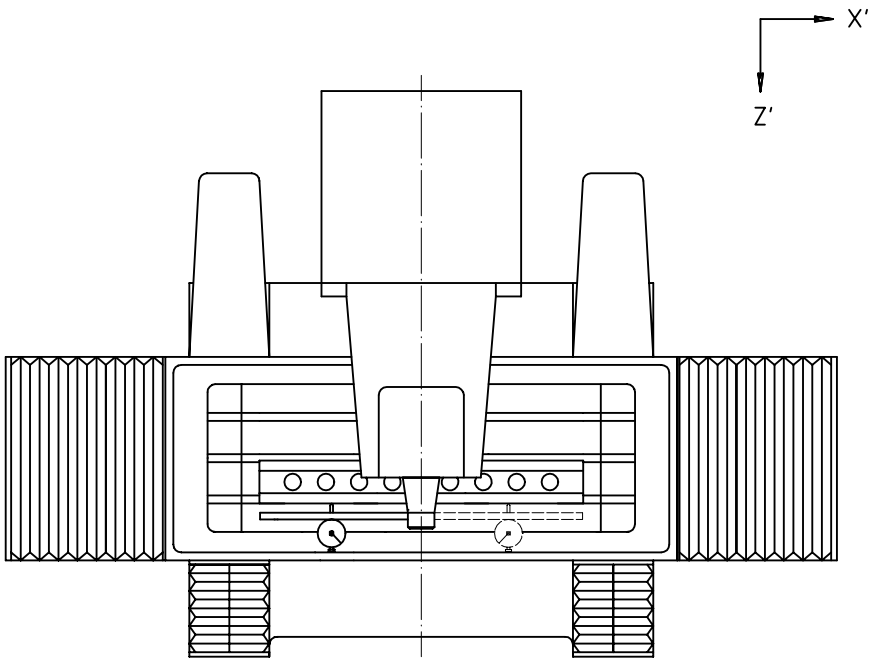
Place a square in contact with the straightedge.

Check the wheel-spindle axis by rotating the dial gauge against the square.

| **Object** | **G11** |
|---|---|

Checking of squareness between the wheel-spindle axis and the longitudinal movement of the table (X-axis).

**Diagram**




| **Tolerance** | **Measured deviation** |
|---|---|
| 0,015/300 | |

**Measuring instruments**

Dial gauge and special arm and straightedge

**Observations and references to ISO 230-1:1996** 5.512.1 and 5.512.42

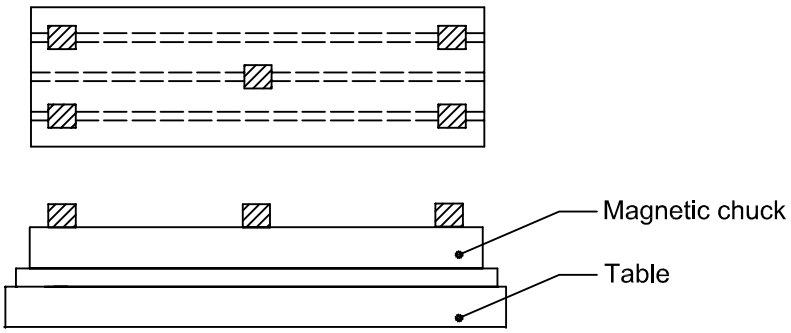
Place a straightedge horizontally at the centre of the table, parallel to the X-axis movement of the table. Set transverse and longitudial movements (X and Z) in mid-position.

## 6 Machining tests

**Object** **M1**

Surface grinding five test pieces to equal height.

**Diagram**




| **Tolerance** | **Measured deviation** |
|---|---|
| 0,005 for a distance between test pieces of 300<br>(Distance between the test pieces < 300: a tolerance proportional to the distance should be taken which does not fall below 0,001)<br>Maximum tolerance: 0,025 | |

**Measuring instruments**

Precision dial gauge

**Observations and references to ISO 230-1:1996** 3.1, 3.22, 4.1 and 4.2

The surface of the test pieces in contact with the table or magnetic chuck shall be ground before carrying out the test.

The test pieces shall be suitably fixed to the table and positioned as follows:

— one at the central point of the table;

— one at each of the four corners of the table.

Material from which the test pieces should be manufactured may be either:

a) cast iron;

b) steel.

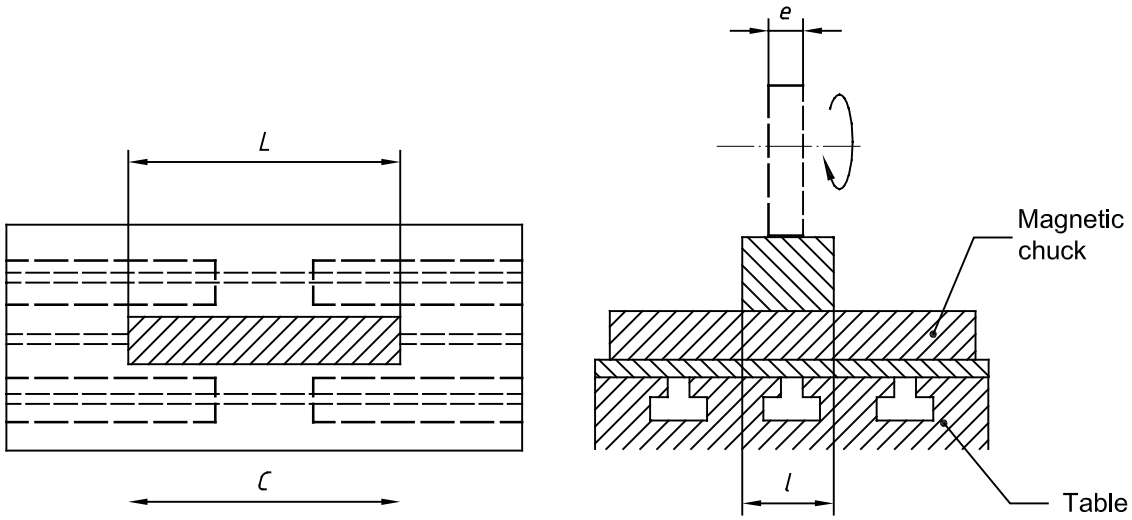
The test pieces should be of equal hardness.

The dimensions of the functional surfaces of the test pieces should be as small as practicable, for instance: 50 mm × 50 mm square or 50 mm diameter.

**Object** | **M2**

Grinding of a single rectangular test piece with a combination of longitudinal and transverse movements.

**Diagram and sizes of test pieces**




$L \geqslant C/2$ $l \leqslant 3e$

$e$ = width of the grinding wheel
$l$ = width of test piece
$L$ = length of test piece
$C$ = length of table travel

Material from which the test pieces should be manufactured may be either

a) cast iron;

b) steel.

**Checks to be applied**

For any given position of the test piece on the table, the thickness of the test piece should be constant.

| **Tolerance** | **Measured deviation** |
|---|---|
| 0,005 for a measuring length of 300<br>Maximum tolerance: 0,020 | |

**Measuring instruments**

Precision dial gauge, comparator

**Observations and references to ISO 230-1:1996** 3.1, 3.22, 4.1 and 4.2

The rigidity of the test piece shall be such as to prevent the clamping causing deformation of the test piece.

For the first test, the test piece shall be fixed at the central position on the table.

For any additional test, the test pieces may be fixed at any other position on the table.

The reference surface in contact with the table should be ground before carrying out the test.

# Bibliography

[1] ISO 841:2001, *Industrial automation systems and integration — Numerical control of machines — Coordinate system and motion nomenclature*

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