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## Acceptance conditions for boring and milling machines with horizontal spindle — Testing of the accuracy —

### Part 1: Table-type machines

*Conditions de réception des machines à aléser et à fraiser, à broche horizontale — Contrôle de la précision —*

*Partie 1: Machines à montant fixe*

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# Acceptance conditions for boring and milling machines with horizontal spindle — Testing of the accuracy —

## Part 1: Table-type machines

### 1 Scope and field of application

This part of ISO 3070 describes, with reference to ISO 230-1, geometrical and practical tests on general purpose and normal accuracy boring and milling machines, horizontal spindle, table type, defined in ISO 3070-0, and the corresponding deviations which apply.

In addition it should be noted that this part of ISO 3070 concerns machines which have both longitudinal and traverse movement of the table, and may include a rotary or indexing table. It will also have a vertical movement of the spindle head, and possibly a facing head.

It deals only with the verification of the accuracy of the machine. It does not apply to the testing of the running of the machine (vibrations, abnormal noises, stick-slip motion of components, etc.) or to machine characteristics (such as speeds, feeds, etc.) which should generally be checked before testing the accuracy.

### 2 Preliminary remarks

**2.1** In this part of ISO 3070, deviations and ranges are expressed in millimetres and inches.

**2.2** To apply this part of ISO 3070, reference should be made to ISO 230-1, especially for installation of the machine before testing, warming up of spindles and other moving parts, description of measuring methods and recommended accuracy of testing equipment.

**2.3** The sequence in which the geometrical tests are given is related to the sub-assemblies of the machine and this in no way

defines the practical order of testing. In order to make the mounting of instruments or gauging easier, tests may be applied in any order.

**2.4** When inspecting a machine, it is not always necessary to carry out all the tests given in this part of ISO 3070. It is up to the user to choose, in agreement with the manufacturer, those tests relating to the properties which are of interest to him, but these tests are to be clearly stated when ordering a machine.

**2.5** Practical tests shall be made with finishing cuts.

**2.6** When establishing the tolerance for a measuring range different from that given in this part of ISO 3070 (see subclause 2.311 in ISO 230-1) it should be taken into consideration that the minimum tolerance value is 0,002 5 mm (0.000 1 in).

NOTE — Rotary table machines are covered by an addendum.

### 3 References

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

ISO 1101, *Technical drawings — Geometrical tolerancing — Tolerancing of form, orientation, location and run-out — Generalities, definitions, symbols, indications on drawings*.

ISO 3070-0, *Acceptance conditions for boring and milling machines with horizontal spindle — Testing of the accuracy — Part 0: General introduction*.

Permissible deviation		Measuring instruments	Observations and references to the ISO 230-1 acceptance code
mm	in		
a) 0,02 up to 1 000	a) 0,000 8 up to 40 (flat to convex) Local tolerance: 0,006 over any measuring length of 300	Precision level, optical or other methods	<p>a) Subclauses 3.11, 3.21, 5.212.21 and 5.212.22</p> <p>Measurements shall be made at a number of positions equally spaced along the length of the bed:</p> <ol style="list-style-type: none"> <li>1) the table shall be placed in the middle of its longitudinal travel and transverse travel;</li> <li>2) the table shall then be placed at the extremities of the longitudinal travel and in the middle of the transverse travel.</li> </ol> <p>The levels may be placed on the table [this is valid for a) and b)].</p>
b) Variation of level 0,02/1 000	0,000 8/40	Precision level and support	b) Subclause 5.412.7
a) 0,02 up to 1 000	a) 0,000 8 up to 40	Precision level, optical or other methods	<p>a) Subclauses 3.11, 3.21, 5.212.21 and 5.212.22</p> <p>Measurements shall be made at a number of positions equally spaced along the length of the slideways.</p> <p>Levels may be placed on the table [this is valid for a) and b)].</p>
b) Variation of level: 0,03/1 000	0,001 2/40	Precision level and support	b) Subclause 5.412.7

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Permissible deviation		Measuring instruments	Observations and references to the ISO 230-1 acceptance code
mm	in		
0,02 up to 1 000	0,000 8 up to 40	Dial gauge, straightedge and supports or optical methods	<p>Subclause 5.232.1</p> <p>The dial gauge shall be fixed on the middle position of the saddle touching a straightedge laid parallel to the Z axis.</p>
0,006 over any measuring length of 300	0,000 24 12		<p>The straightedge shall be placed on a fixed part, independent or integral with the machine, and as near as possible to the slideways.</p>
For each 1 000 mm (40 in) increase in length beyond 1 000 mm (40 in), add to the corresponding preceding tolerance:			
0,01	0,000 4		
Maximum permissible deviation:			
0,05	0,002		
0,02 up to 1 000	0,000 8 up to 40	Dial gauge, straightedge, supports or optical methods	<p>Subclause 5.232.1</p> <p>The dial gauge shall be fixed on the middle position of the table with the stylus touching a straightedge laid parallel to the Z axis.</p>
0,006 over any measuring length of 300	0,000 24 12		<p>The straightedge shall be placed on a fixed part, independent or integral with the machine, and as near as possible to the slideways.</p>
For each 1 000 mm (40 in) increase in length beyond 1 000 mm (40 in), add to the corresponding preceding tolerance:			
0,01	0,000 4		
Maximum permissible deviation:			
0,05	0,002		
0,04/1 000	0,001 6/40	Dial gauge, straightedge and square	<p>Subclause 5.522.4</p> <p>a) The straightedge shall be set parallel to the table saddle longitudinal movement; then the square shall be placed against the straightedge. The table saddle shall then be locked in the central position.</p> <p>b) The transverse movement of the table shall then be checked.</p> <p>If the spindle can be locked, then the dial gauge may be mounted on it. If the spindle cannot be locked the dial gauge shall be placed on a fixed part of the machine.</p>

Permissible deviation		Measuring instruments	Observations and references to the ISO 230-1 acceptance code
mm	in		
0,03 up to 1 000  Local tolerance: 0,02 over any measuring length of 300	0,001 2 up to 40  0,000 8 12	Precision level or straightedge and gauge blocks	<p>Subclauses 5.322 and 5.323</p> <p>Table in its mid-position.</p> <p>Table saddle and table base may be locked in the middle of their travel.</p>
For each 1 000 mm (40 in) increase in length beyond 1 000 mm (40 in), add to the corresponding preceding tolerance:			
0,01	0,000 4		
Maximum permissible deviation:			
0,05	0,002		
a) 0,04 up to 1 000  Local tolerance: 0,015 over any measuring length of 300			
a)	0,001 6 up to 40  0,000 6 12	Straightedge and dial gauge	<p>Subclause 5.232.1 or 5.422.21</p> <p>The stylus of the dial gauge shall be placed approximately in a vertical plane coaxial with the spindle axis.</p>
For each 1 000 mm (40 in) increase in length beyond 1 000 mm (40 in), add to the corresponding preceding tolerance:			
0,01	0,000 4		
Maximum permissible deviation:			
0,06	0,002 4		
b) 0,04 over any measuring length of 1 000			
b)	0,001 6 40	Straightedge and dial gauge	<p>Measurement may be made on a straightedge laid parallel to the table surface. If the table length is greater than 1 600 mm (64 in), carry out the inspection by successive movements of the straightedge.</p> <p>If the spindle can be locked, the dial gauge may be mounted on it. If the spindle cannot be locked, the dial gauge shall be placed on a fixed part of the machine.</p>
a) Carry out the test with the transverse movement locked for the table.			
b) Carry out the test with the longitudinal movement locked for the table saddle.			
0,02 for any measuring length of 1 000  Maximum permissible deviation: 0,03	0,000 8 40  0,001 2	Straightedge and dial gauge, or gauge blocks, or microscope and taut wire	<p>Subclauses 5.212, 5.212.1, 5.212.3 or 5.232</p> <p>The straightedge may be set directly on the table.</p>

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Permissible deviation		Measuring instruments	Observations and references to the ISO 230-1 acceptance code
mm	in		
0,03 for a measuring length of 1 000	0,001 2 40	Straightedge, gauge blocks and dial gauge	Subclauses 5.232.1 and 5.422.21 If the spindle can be locked, the dial gauge may be mounted on it; otherwise, it shall be mounted on a fixed part of the machine.
0,04	0,001 6		
a) 0,02 for a measuring length of 500	a) 0,000 8	Dial gauge and straightedge or square	Subclause 5.232.1 Carry out the test with the table saddle locked; the table and table base may be locked in mid-position. As an exception to the acceptance code, a square may be used instead of a straight-edge.
b) 0,02 for a measuring length of 500	b) 0,000 8 20		If the spindle can be locked, the dial gauge can be mounted on it. If the spindle cannot be locked, the dial gauge shall be placed on the spindle head of the machine.
a) 0,02/500	a) 0,000 8/20	Dial gauge and square	Subclause 5.522.2 Carry out the test with the table saddle locked; the table base may be locked in mid-position. Lock the spindle head when taking measurements. If the spindle can be locked, the dial gauge can be mounted on it. If the spindle cannot be locked, the dial gauge shall be placed on the spindle head of the machine.
b) 0,02/500	b) 0,000 8/20		The square is placed at the centre of the table.

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Permissible deviation		Measuring instruments	Observations and references to the ISO 230-1 acceptance code
mm	in		
$D^{1)} < 125:$ a) 0,01 b) 0,02	$D^{1)} < 5:$ a) 0,000 4 b) 0,000 8	Dial gauge and test mandrel	Subclause 5.612.3 Carry out measurements with the spindle retracted (sliding spindle).
$D^{1)} > 125:$ a) 0,015 b) 0,03	$D^{1)} > 5:$ a) 0,000 6 b) 0,001 2		1) $D$ = diameter of boring spindle.
$D^{1)} < 125:$ a) 0,01 b) 0,02	$D^{1)} < 5:$ a) 0,000 4 b) 0,000 8	Dial gauge	Subclause 5.612.2
$D^{1)} > 125:$ a) 0,015 b) 0,03	$D^{1)} > 5:$ a) 0,000 6 b) 0,001 2		1) $D$ = diameter of boring spindle.
0,01	0,000 4	Dial gauge	Subclauses 5.622.1 and 5.622.2 Carry out this test with the spindle retracted (sliding spindle). The existence, value and direction of application of the force $F$ shall be stated by the manufacturer.
0,03/1 000 <sup>1)</sup> with $\alpha < 90^\circ$	0,001 2/40 <sup>1)</sup>	Dial gauge or optical means	Subclauses 5.512.1, 5.512.42 and 5.442 Spindle head locked in mid-travel, spindle retracted (sliding spindle). For large machines for which sizes have a great importance, the measuring reference shall be related to a plane parallel to the vertical movement of the spindle head (Y axis). 1) Distance between the two points touched.

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Permissible deviation		Measuring instruments	Observations and references to the ISO 230-1 acceptance code
mm	in		
0,02 over a measuring length of 300	0.000 8 12	Dial gauge and test mandrel	<p>Subclause 5.412.4</p> <p>Spindle head locked in mid-travel, table and table saddle locked.</p> <p>Spindle out (sliding spindle).</p>
a) 0,02 for a measuring length of 300	a) 0.000 8 12	Straightedge and dial gauge	<p>Subclause 5.232.1</p> <p>Spindle head locked.</p> <p>The straightedge shall be set parallel to the sliding spindle movement; then, with the stylus of a dial gauge fixed on the spindle nose, touch the functional surface of the straightedge. Repeat the same operations in the two planes (horizontal and vertical) after rotating the spindle by 90°.</p>
b) 0,02 for a measuring length of 300	b) 0.000 8 12		<p>It should be noted that for b) the permissible deviation includes the normal deflection of the spindle.</p> <p>For a machine having a ram, it shall be maintained locked, retracted.</p>
For an extension of the spindle equal to twice the spindle diameter + 0,015 (upwards)	+ 0.000 6	Straightedge, gauge blocks and dial gauge	<p>Subclause 5.232.1</p> <p>Place a straightedge on the machine table and align it in the vertical plane containing the spindle axis, and adjust the straightedge to bring it parallel to the table plane.</p>
For an extension of the spindle equal to four times the spindle diameter ± 0,02	± 0.000 8		
For an extension of the spindle equal to six times the spindle diameter - 0,06 (downwards)	- 0.002 4		
NOTE — The extension of the spindle is limited to six times the spindle diameter, and shall not exceed		Extend the spindle to the required length and note the dial gauge readings for each of the successive positions.	
900	36		

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Permissible deviation			Measuring instruments	Observations and references to the ISO 230-1 acceptance code
mm	in			
a) 0,03 for a measuring length of 500	a)	0,001 2	Dial gauge and test mandrel	Subclauses 5.412.1 and 5.422.3 Spindle head locked in mid-travel. Table and table base may be locked in central position.
	b)	0,001 2		The measurement shall be carried out with the aid of a test mandrel mounted in the spindle nose.
b) 0,03 for a measuring length of 500		20		Evaluate the mean value of measurements taken at two positions of the spindle at 180°.
0,03/1 000 <sup>1)</sup>	0,001 2/40 <sup>1)</sup>		Dial gauge	Subclauses 5.512.1 and 5.512.52 Spindle head locked in mid-travel. Table saddle and possibly table base locked in central position.
0,02/500 <sup>1)</sup>	0,000 8/20 <sup>1)</sup>		Gauge blocks, dial gauge and dial gauge support	Subclause 5.522.3 Place the stylus of the dial gauge against the gauge block on the table. Turn the boring spindle 180° and move the table to touch the gauge block at the same point. Determine the difference between the two readings.
$D^{1)} < 125:$				1) Distance between the two points touched.
a) 0,01 b) 0,01 c) 0,02	$D^{1)} < 5:$		Dial gauge	a) Subclause 5.612.2
	a)	0,000 4		b) Subclauses 5.622.1 and 5.622.2 The existence, value and direction of application of the force $F$ shall be specified by the manufacturer.
	b)	0,000 4		c) Subclause 5.632
$D^{1)} > 125:$				The distance $A$ of dial gauge c) from the spindle axis shall be as large as possible.
a) 0,015 b) 0,015 c) 0,03	$D^{1)} > 5:$		Dial gauge	1) $D$ = diameter of milling spindle.
	a)	0,000 6		
	b)	0,000 6		
	c)	0,001 2		

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Permissible deviation		Measuring instruments	Observations and references to the ISO 230-1 acceptance code
mm	in		
a) 0,02 for a measuring length of 500	a) 0,000 8 20	Straightedge and dial gauge	<p>Subclause 5.232.1</p> <p>Spindle head locked.</p> <p>Boring spindle retracted.</p> <p>The straightedge shall be set parallel to the ram movement. Then touch the functional surface of the straightedge with a dial gauge fixed at the end of the ram.</p>
b) 0,02 for a measuring length of 500	b) 0,000 8 20		<p>Repeat the same operations in the two planes : horizontal and vertical.</p>
0,03/500	0,001 2/20	Square-type square, dial gauge or optical methods	<p>Subclause 5.522.4</p> <p>Place a square-type square on the table, with one arm oriented parallel to the vertical spindle head motion, and touch the other arm of the square by moving the ram.</p>
0,03 for a measuring length of 500	0,001 2 20	Straightedge and dial gauge or optical methods	<p>Subclause 5.232.1</p> <p>Place a straightedge on the machine table, align it in the vertical plane containing the spindle axis and adjust the straightedge to be parallel to the table surface. Touch the functional surface of the straightedge with a dial gauge fixed on the ram. Extend the ram to the required length and note the dial gauge readings for each position.</p>
a) 0,02	a) 0,000 8	Dial gauge	a) Subclause 5.442
b) 0,02/500	b) 0,000 8/20		b) Subclause 5.512.42
<p>NOTE — This operation is valid only if there is a circular locating surface on the ram.</p>			
0,025/300	0,001/12	Dial gauge and square	<p>Subclause 5.522.2</p> <p>Repeat the same operation after turning the plate by 180°.</p>

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Permissible deviation		Measuring instruments	Observations and references to the ISO 230-1 acceptance code
mm	in		
0,025 for a measuring length of 300	0,001 12	Straightedge and dial gauge	<p>A straightedge laid parallel to the transverse movement of the table shall be placed on the bed.</p> <p>The stylus of a dial gauge fixed on the radial facing slide of the surfacing head shall touch the straightedge.</p> <p>Repeat the test after turning the facing head by 180°.</p>
$D^{1)}$ < 125: a) 0,02 b) 0,03 $D^{1)}$ > 125: a) 0,03 b) 0,04	$D^{1)}$ < 5: a) 0,000 8 b) 0,001 2 $D^{1)}$ > 5: a) 0,001 2 b) 0,001 6	Dial gauge	<p>Subclause 5.442</p> <p>A dial gauge fixed on the facing head shall touch the spindle at the mouth and at 300 mm (12 in).</p> <p>For each operation, determine half the difference of the extreme readings to obtain the coaxiality deviation.</p> <p>This check is valid only if the facing head is mounted on bearings independent of those of the boring spindle.</p>
		1) $D$ = diameter of boring spindle.	
0,03/1 0001)	0,001 2/40 <sup>1)</sup>	Dial gauge on rigid support	<p>Subclause 5.522.3</p> <p>Place the stylus of the dial gauge against the gauge block on the table.</p> <p>Turn the dial gauge support 180° and move the table to touch the gauge block at the same point.</p> <p>Determine the difference between the two readings.</p>
		1) Distance between the two points touched.	

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