

JIS

JAPANESE INDUSTRIAL STANDARD

**Test Code for Performance and
Accuracy of Machining Centres**

JIS B 6336—1986

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JAPANESE INDUSTRIAL STANDARD

J I S

Test Code for Performance and
Accuracy of Machining Centres

B 6336-1986

1. Scope

This Japanese Industrial Standard specifies the test code for running performance, rigidity, mechanical accuracy and working accuracy of machining centres of horizontal type single spindle having automatic tool changer and swivelling table of which diameter or length of a side is not more than 1000 mm.

Remark: In this standard, the units and numerical values shown in { } are in accordance with the conventional units and appended for informative reference.

Applicable Standards:

JIS B 4105-Single Point Tools with Cemented Carbide Tips

JIS B 4114-Parallel Shank End Mills Brazed with Cemented Carbide Tips

JIS B 4212-End Mills with Taper Shanks

JIS B 6003-Methods of Vibration Testing for Machine Tools

JIS B 6004-Method of Sound Level Measurement for Machine Tools

JIS B 6014-General Code of Safety for Machine Tools

JIS B 6201-Test Code for Performance and Accuracy of Machine Tools

JIS B 6330-Test Code for Performance and Accuracy of Numerically
Controlled Machine Tools

JIS G 5501-Gray Iron Castings

2. Running Test Method2.1 Function Test

2.1.1 Function Test by No Numerical Control The function test by no numerical control shall be carried out according to Table 1 by operating each part manually.

Table 1

No.	Test item	Test method	Informative reference Corresponding No. to 3.2 of JIS B 6201 and 3.2.1 of JIS B 6330
1	Starting, stopping and running operation of main spindle	Carry out continuously 10 times starting, stopping (including inching and braking) concerning positive and reversing revolutions at a suitable spindle speed to test the smoothness and security of working.	1-11
2	Converting operation of spindle speed	Convert the spindle speed to three speeds of the lowest, intermediate and the highest to test the smoothness of working and security of indication of the operation device.	1-12
3	Index of swiveling table	Carry out the index of swiveling table to test the smoothness and security of working.	1-33
4	Clamping operation	Concerning each clamping mechanism of main spindle, spindle head, column, table, and swiveling table, clamp at an arbitrary position of respective motions to test the security.	1-33
5	Attaching and detaching of tool	Test the security and smoothness of attaching and detaching the tool to the main spindle and magazine.	1-41
6	Electrical equipment	Test the insulation condition respectively once before and after the running test. However, it does not apply to the circuit using semiconductor and the like.	1-51
7	Numerical control attachment	Test the smoothness of working and security of function such as each kind of display lamps, tape leader, fan, etc. of numerical control attachment.	1-57

Table 1 (Continued)

No.	Test item	Test method	Informative reference Corresponding No. to 3.2 of JIS B 6201 and 3.2.1 of JIS B 6330
8	Safety device	Test the safety relating to the operator and the security of machine protective function ⁽¹⁾ [see JIS B 6014].	1-52
9	Lubricating device	Test the security of function of oil tightness, adequate distribution of oil amount, etc.	1-53
10	Oil-hydraulic and pneumatic devices	Test the security of function of oil tightness, air tightness, pressure c. adjustment, etc.	1-54
11	Accessories	Test the security of function.	1-55

Note (1) For example, it means the travel limit automatic stopping function of each motion spindle, and the emergency stopping function or the like when the synchronism of control system is lost, or when overheating or overload of electric motor for main spindle is caused.

2.1.2 Function Test According to Numerical Control The function test according to numerical control shall be carried out in accordance with Table 2 by working each part by numerical control tape for test and other numerical control command⁽²⁾.

Table 2

No.	Test item	Test method	Informative reference Corresponding No. to 3.2 of JIS B 6201 and 3.2.1 of JIS B 6330
1	Starting, stopping and reversing of main spindle and conversion of spindle speed	Rotate the main spindle, concerning the starting, stopping, reversing and conversion of spindle speed on the marked three speeds of the lowest, intermediate and the highest, test the security of function and the smoothness of working.	1-13 1-14
2	Starting and stopping of feed and conversion of feed speed	Convert the feed speed to marked three speeds of the lowest, intermediate, and the highest and to quick traverse, carry out starting and stopping concerning the positive and negative of each feed to test the security of function and the smoothness of working. Carry out this test on each control spindle.	1-28
3	Index of swiveling table	Carry out index of swiveling table to test the security of function and the smoothness of working.	1-34
4	Inching	Carry out inching operation on each control spindle to test the security of function and the smoothness of working.	1-21
5	Returning to original point	Carry out returning to original point ⁽³⁾ from an arbitrary point capable of returning on each control spindle to test the security of function and the smoothness of working.	1-35
6	Automatic exchange of tool	Carry out automatic exchange of tool to test the security and the smoothness of working.	1-61
7	Other functions	Concerning other respective functions provided, test the security of function and the smoothness of working.	1-61

Notes ⁽²⁾ Other numerical control commands include those by input according to card, online, manual data input device, manual input by push button on operation board, etc.

⁽³⁾ The travel or rotation shall, as a rule, be quick traverse, and shall not less than the distance or angle including automatic acceleration and deceleration.

Remark: It may be carried out simultaneously with the continuous no-load running test.

2.2 No-Load Running Test For no-load running test, let the main spindle start from the lowest speed, run on each stage, successively run, as a rule for 30 to 60 min continuously at the highest speed and measure each item specified in Record Form 1 of Table 3 [see 3.3 of JIS B 6330].

Make the feed speed at the lowest, intermediate, the highest and quick traverse and respectively measure each item specified in Record Form 2 of Table 4.

Further, observe the vibration and noise. In the case where the vibration and noise are made problem specially, inspect these according to JIS B 6003 and JIS B 6004.

Table 3. Record Form 1

No.	Measuring time h/min	Spindle speed min ⁻¹ {rpm}		Temperature °C			Required power (power source frequency Hz)			Description
		Marked	Actually measured	Spindle bearing		Room temperature	Voltage V	Current A	Input kW	
				Front	Rear					

Table 4. Record Form 2

Measuring item		Feed speed in X-axis direction mm/min		Feed speed in Y-axis direction mm/min		Feed speed in Z-axis direction mm/min		Feed speed in W-axis direction mm/min		Swiveling speed in B-axis direction by numerical command deg./min		Description
		Command	Actually measured	Command	Actually measured ⁽⁴⁾	Command	Actually measured	Command	Actually measured	Command	Actually measured	
Feed speed												
Lowest												
Intermediate	Without override											
	With override ⁽⁵⁾											
Highest												
Quick traverse												

Notes ⁽⁴⁾ Record concerning the speed and its direction (±).

⁽⁵⁾ In the case where the feed speed override function is worked, record the override rate(%) in the command column.

2.3 Continuous No-Load Running Test For the continuous no-load running test, carry out continuous running⁽⁶⁾ of about 2 h according to the test tape containing each function or other numerical control command⁽²⁾ to test the existence of abnormalities (see 3.4 of JIS B 6330). In this case, the test tape or other numerical control command shall include at least, the following contents:

- (1) Positive turning, reverse turning, starting and stopping concerning spindle speeds of not less than 5 kinds containing the marked lowest, intermediate and highest.
- (2) The feed speeds are combined with the marked lowest, intermediate highest and quick traverse for each spindle, the travel distance is about whole marked range and each axis includes the quick traverse of not less than 1/2 of the travel distance.
- (3) Positioning⁽⁷⁾ at an arbitrary position over the whole range of travel distance for each spindle.
- (4) Automatic tool exchange of about 20 times.
- (5) Automatic index of swiveling table.

Notes (6) It shall be continuous running not less than two cycles.

(7) That provided with control function not less than two spindles simultaneously shall be included.

Remark: There shall be no load on the table.

2.4 Load Running Test For the load running test, carry out the following cutting power test to measure the required electric power, and further observe the vibration, noise and condition of finished surface [see 3.4 of JIS B 6201]. In the case where the vibration and noise are made problem specially, apply JIS B 6003 and JIS B 6004.

Furthermore, let the cutting be dry cutting.

For the cutting power test, test that it is able to endure the specified electric power at the high speed cutting, and carry out milling under the following conditions to measure the required electric power and observe the condition of finished surface (see Record Form 3 of Table 5) (see No. 3-11 of JIS B 6201).

Table 5. Record Form 3

Material of workpiece			Diameter. of tool			Number of teeth		Kind, shape, etc. of tool							
No.	Cutting conditions							Required electric power (power source frequency Hz)					Cutting amount par 1 kW of load input cm ³ /min	Condition of finished surface	Descrip- tion .
	Spindle speed (<i>n</i>) min ⁻¹ {rpm}	Cutting speed (<i>V_c</i>) m/min	Depth of cut (<i>a</i>) mm	Feed speed (<i>V_f</i>) mm/min	Feed per tooth (<i>S_z</i>) mm	Cutt- ing width (<i>b</i>) mm	Cutting amount cm ³ /min	Voltage V	Current A	Load input (<i>W</i>) kW	No- load input (<i>W₀</i>) kW	Cutting power (<i>W</i> - <i>W₀</i>) kW			

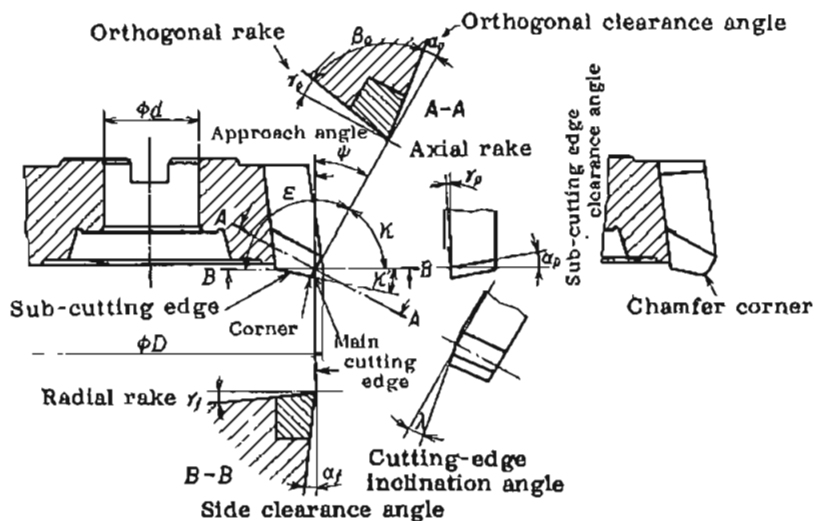
- (a) **Tools** The tool shall, as a rule, be cemented carbide face milling cutter of 75 to 150 mm in diameter and the required items shall be recorded according to Record Form 4 of Table 6.

Table 6. Record Form 4

Cemented carbide face milling cutter								Descrip- tion
Diameter mm	Number of teeth Sheet	Radial rake deg.	Axial rake deg.	Side clearance angle deg.	Sub-cutting edge clearance angle deg.	Approach angle deg.	Chamfer corner width mm	

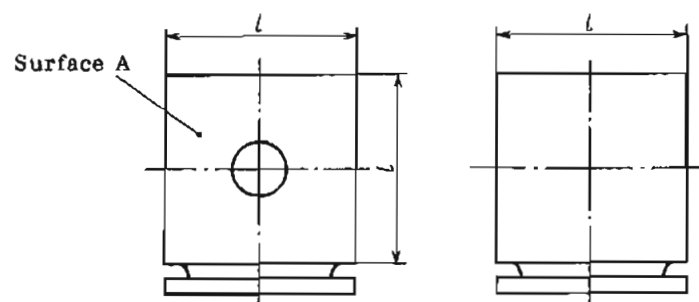
Remark: Names of cutting edge tips of tool shall be in accordance with following Figure.

Figure



- (b) Workpieces The material shall, as a rule, be FC 20 specified in JIS G 5501. The shape and dimensions shall be in accordance with Fig. 1.

Fig. 1



$l \approx \text{about } 2/3 D \text{ or about } 2/3 L$

D : diameter of swiveling table

L : length of a side of swiveling table

(c) Cutting Conditions

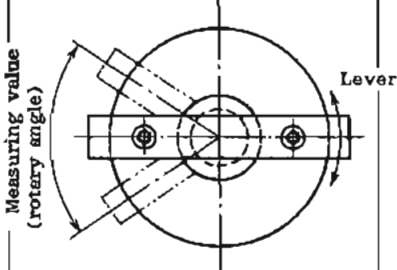
Cutting speed	$V_c \approx 60 \text{ to } 100 \text{ (m/min)}$
Depth of cut	$a \approx 3 \text{ (mm)}$
Feed per tooth	$S_z \approx 0.1, 0.2, 0.3, 0.4, 0.5 \text{ (mm)}$
Cutting width	$b \approx \text{milling cutter diameter} \times \frac{2}{3} \text{ (mm)}$

However, when the specified electric power (see JIS B 6201) has been reached, stop at that feed, and when it is not reached, increase the depth of cut by each 1 mm.

- (d) Cutting Method Carry out milling of workpiece by feeds in X-axis direction and Y-axis direction.

2.5 Backlash Test Carry out the backlash test according to Table 7.

Table 7

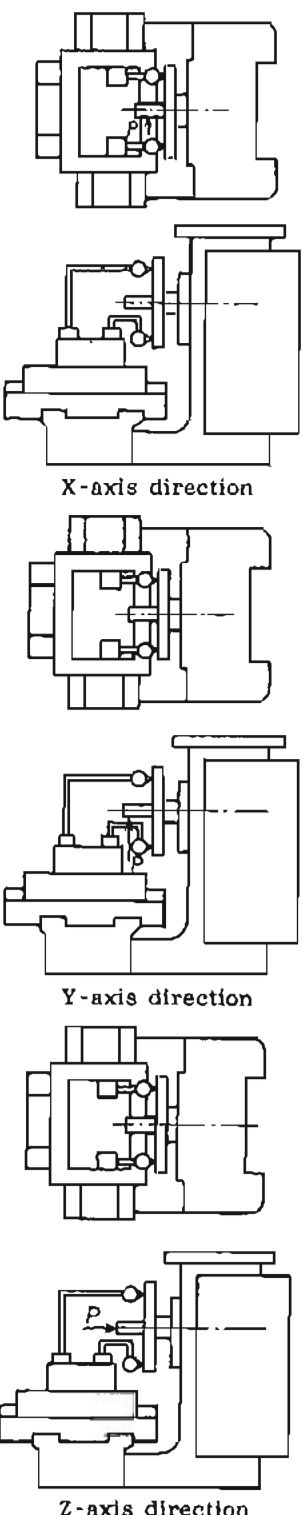
No.	Test item	Measuring method	Measuring method diagram	Informative reference Corresponding No. of 3.5 of JIS B 6201
1	Synthetic backlash of spindle driving system	(1) Set the spindle speed converter at the highest and the lowest speeds, move the main spindle respectively in positive and reverse directions, and measure the rotary angle of main spindle until the basic spindle begins to rotate. (2) Move the basic spindle in positive and reverse directions, and then the rotary angle of basic spindle until the main spindle begins to rotate may be measured. (3) Express the backlash by the rotary angle of main spindle.		4-11

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3. Rigidity Test Method

Carry out the rigidity test according to Table 8.

Table 8

No.	Test item	Measuring method	Measuring method diagram	Informative reference Corresponding No. of 3.5 of JIS B 6201																																			
1	Rigidity of main spindle, spindle head, column, bed and table	(1) Apply load (P) between the arbor attached to the main spindle and the table in X-axis, Y-axis and Z-axis directions and measure the change of relative inclination between the main spindle and the table upper surface at that time in Y-Z plane and Z-X plane. For change of relative inclination, apply the test indicator placed stationarily on the table to the circular plate or cross slide arm attached to the main spindle from the axial direction, and express the change of relative inclination by the difference of readings of test indicator at both ends of 300 mm diameter. (2) The load (P) and the position to be applied with the load shall be in accordance with the following Table. Table <table> <tr> <th rowspan="2">Rating of electric motor for main spindle kW</th><th colspan="2">Load (P)</th><th colspan="2">Position to be applied with load</th></tr> <tr> <th>N</th><th>(kgf)</th><th>Distance from the main spindle end (L) mm</th><th>Height from the table upper surface (H) mm</th></tr> <tr> <td>3.7</td><td>1 570</td><td>{ 160 }</td><td rowspan="8">100</td><td rowspan="8">1/2 of motion in Y-axis direction</td></tr> <tr> <td>5.5</td><td>2 350</td><td>{ 240 }</td></tr> <tr> <td>7.5</td><td>3 140</td><td>{ 320 }</td></tr> <tr> <td>11</td><td>4 610</td><td>{ 470 }</td></tr> <tr> <td>15</td><td>6 280</td><td>{ 640 }</td></tr> <tr> <td>19</td><td>7 940</td><td>{ 810 }</td></tr> <tr> <td>22</td><td>9 220</td><td>{ 940 }</td></tr> <tr> <td>28</td><td>11 000</td><td>{ 1 200 }</td></tr> </table> (3) Make each moving part the clamped condition.	Rating of electric motor for main spindle kW	Load (P)		Position to be applied with load		N	(kgf)	Distance from the main spindle end (L) mm	Height from the table upper surface (H) mm	3.7	1 570	{ 160 }	100	1/2 of motion in Y-axis direction	5.5	2 350	{ 240 }	7.5	3 140	{ 320 }	11	4 610	{ 470 }	15	6 280	{ 640 }	19	7 940	{ 810 }	22	9 220	{ 940 }	28	11 000	{ 1 200 }	 X-axis direction Y-axis direction Z-axis direction	5-22
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28	11 000	{ 1 200 }																																					

Remark: For the rigidity test of machine of the same design, represent by the test results carried out on a representative one unit, and the tests for others may be omitted. .

4. Test and Inspection Methods for Mechanical Accuracy

4.1 Static Accuracy Inspection Carry out the static accuracy inspection according to Table 9.

Table 9

Unit: mm

No.	Inspection test	Measuring method	Measuring method diagram	Permissible value	Informative reference Corresponding No. of 4. of JIS B 6201
1	Straightness of table motion in Z-axis direction ^(a)	a X-axis direction in X-Y plane		0.04/m	6-26
		b Z-axis direction in Y-Z plane		0.04/m	
		c Z-axis direction in Z-X plane		0.01 per 500	6-21
2	Straightness of table motion in X-axis direction ^(1b)	a X-axis direction in X-Y plane		0.04/m	6-26
		b Y-axis direction in Y-Z plane		0.04/m	
		c X-axis direction in Z-X plane		0.01 per 500	6-21

Notes ^(a) To machining centre of which column conducts the motion in Z-axis direction, this standard applies, as appropriate.

^(b) Place the straightedge so that the readings of the test indicator at its both ends coincide with each other.

^(1b) To machining centre of which column conducts the motion in X-axis direction, this standard applies, as appropriate.