

JIS

JAPANESE INDUSTRIAL STANDARD

**Test Code for Performance and
Accuracy of Horizontal
Boring Machines (Table Type)**

JIS B 6210—1986

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Test Code for Performance and Accuracy of
Horizontal Boring Machines (Table Type)

B 6210-1986

1. Scope

This Japanese Industrial Standard specifies the methods of testing and inspecting the running performances, rigidities, mechanical accuracies and working accuracies of the horizontal boring machines (table type) of main spindle diameter 130 mm or under.

Remarks 1. The coordinate axes for machines to be used in this Standard shall be as follows (see JIS B 6310).

Z-axis: Z axis shall be set in parallel direction to the main spindle (left and right direction).

X-axis: X-axis shall be set in vertical direction to Z-axis in a horizontal plane (front and rear directions).

Y-axis: Y-axis shall be set in vertical direction to Z-axis and X-axis (top and bottom directions).

2. The units and formula shown in { } in this Standard are based on the traditional units and are appended for reference.

Applicable Standards:

JIS B 4105-Single Point Tools with Cemented Carbide Tips

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 6310-Axis and Motion Nomenclature for Numerically Controlled Machine Tools

JIS G 3101-Rolled Steel for General Structure

JIS G 4051-Carbon Steels for Machine Structural Use

JIS G 5501-Grey Iron Castings

Corresponding International Standard:

ISO 3070/1-Test conditions for boring and milling machines with horizontal spindle-Testing of the accuracy - Part 1: Table type machines

2. Methods of Running Tests

2.1 Function Tests The function tests shall be carried out in accordance with Table 1.

Table 1

No.	Testing item	Testing method	Reference Corresponding No. in 3.2 of JIS B 6201
1	Starting, stopping and running operations of main spindle and milling spindle ⁽¹⁾	Carry out 10 times starting and stopping (including inching and braking) continuously by normal and reverse rotations, at an appropriate spindle speed, to examine the smoothness and reliability of workings.	1-11
2	Changing operations of main spindle and milling spindle ⁽¹⁾ speeds	Change the main spindle speed by all the marked speeds ⁽²⁾ to examine the smoothness and reliability of workings of operating devices.	1-12
3	Starting, stopping and running operation of feed	Carry out 10 times starting and stopping (including braking.) continuously at an appropriate feed per revolution (or feed speed) ⁽³⁾ , respectively for main spindle, spindle head, table and revolving table.	1-21
4	Changing operation of feed per revolution [or feed speed ⁽³⁾]	Change feed per revolution [or feed speed ⁽³⁾] in respect to 3 feeds of the minimum ⁽⁴⁾ , intermediate and maximum ⁽⁴⁾ of respective markings for main spindle, spindle head, table and revolving table, to examine the smoothness of workings and reliability of indications.	1-22 1-23
5	Hand-feed operation	Shift the main spindle, spindle head, table and revolving table by hand feed, to examine the smoothness and evenness of workings over the overall length of movement as well as to examine the reliability of function of micrometer collar.	1-27

Table 1 (Continued)

No.	Testing item	Testing method	Reference Corresponding No. in 3.2 of JIS B 6201
6	Engaging and disengaging of power feed and rapid traverse and operations of these devices	Relative to main spindle, spindle head, table and revolving table, examine the setting of engaging and disengaging positions of power feed and rapid traverse and the smoothness and reliability of workings.	1-21 1-31
7	Operation of automatic stopping device	Relative to main spindle, spindle head, table and revolving table, examine the setting of commanding position of automatic stopping device and smoothness and reliability of workings.	1-26 1-32
8	Operation of clamping	Relative to clamping mechanisms of main spindle, spindle head, table and revolving table, clamp the devices at an arbitrary position of each motion, to examine its reliability.	1-33
9	Operation of face plate	For a face-plate tool rest, examine the smoothness and evenness of workings by power or hand operation. Further, clamp the device at an arbitrary position of motion to examine its reliability. Examine the reliability of function of micrometer collar.	1-33
10	Operations of boring bar bearing and outer support	In respect to motions of Y axis direction of boring bar bearing and Z axis direction of outer support, examine the smoothness and evenness of workings by power or hand operation. Besides, clamp the devices at an arbitrary position of each motion to examine its reliability. Furthermore, examine the reliability of functions of micrometer collar.	
11	Mounting and dismounting of tools ⁽⁵⁾	Examine the reliability and smoothness of mounting and dismounting of tools.	1-41

Table 1 (Continued)

No.	Testing item	Testing method	Reference Corresponding No. in 3.2 of JIS B 6201
12	Electric apparatus	Examine insulating conditions before and after the running test each once. However, this is not applicable to the circuit which has been used for semiconductors and the like.	1-51
13	Safety devices	Examine the reliability of safety facilities for workers and machine protecting functions (see JIS B 6014).	1-52
14	Lubricating apparatus	Examine the reliability of functions such as oiltightness and correct distribution of oil.	1-53
15	Oil hydraulic apparatus	Examine the reliability of functions such as oiltightness and pressure control.	1-54
16	Accessories	Examine the reliability of functions.	1-55

Notes (1) Test shall be carried out on the spindle head which is separately driven from the main spindle.

(2) In the case of a variable speed driving, test shall be carried out on 3 speeds of the minimum, intermediate and maximum.

(3) Test shall be carried out on that having independent driving apparatus.

(4) In the case of the feed speed, these shall be read as the lowest and the highest.

(5) The mounting and dismounting of the shank to the tapered hole of main spindle shall be included.

2.2 No-Load Running Test Start the no load running test from the lowest speeds of the main spindle and spindle head⁽¹⁾ operating through respective stages, and running on at the highest speed for 30 to 60 min as a rule, to measure respective items specified in Table 2 Recording Form 1-1 (See 3.3 of JIS B 6201).

Furthermore, after the main spindle has operated at the highest speed, make it run at an appropriate speed, setting the feed per revolution [or feed speed⁽³⁾] at the minimum⁽⁴⁾, intermediate and maximum⁽⁴⁾, to measure for respective items specified in Table 3 Recording Form 1-2.

In addition, observe vibrations and noises. In the case, where the vibrations and noises are particularly at issue, refer to JIS B 6003 and JIS B 6004.

Table 2. Recording form 1-1

No.	Time of measurement (o'clock·minute)	Speed of main spindle or milling spindle min ⁻¹ (rpm)		Temperature (°C)			Required electric power (source frequency Hz)			Description
		Marked	Actually measured	Main bearing		Room temperature	Voltage (V)	Current (A)	Input (kW)	
				front	rear					

Table 3. Recording form 1-2

Measuring item		Speed of main spindle min ⁻¹ {rpm}	Feed of main spindle			Feed of spindle head in Y-axis direction			Feed of table in Z-axis direction			Feed of table in X-axis direction			Revolution of table			Description		
			Feed per revolution mm	Required electric power (source frequency Hz)	Feed per revolution mm	Required electric power ⁽⁶⁾ (source frequency Hz)	Feed per revolution mm	Required electric power (source frequency Hz)	Feed per revolution mm	Required electric power (source frequency Hz)	Number of revolution min ⁻¹ (rpm)	Required electric power (source frequency Hz)								
Measuring position	Marked	Actually measured	Voltage (V)	Current (A)	Input (kW)	Marked	Actually measured ⁽⁶⁾	Voltage (V)	Current (A)	Input (kW)	Marked	Actually measured	Voltage (V)	Current (A)	Input (kW)	Marked	Actually measured	Voltage (V)	Current (A)	Input (kW)
Main spindle and spindle head or table		Maximum feed (°)																		
		Intermediate feed																		
Rapid feed																				

Note (°) Respective values in the plus and the minus directions of Y-axis shall be noted and recorded in the description column to that effect.

2.3 Load Running Tests In the load running tests, measure electric powers required in the chattering test (boring with main spindle and milling with main spindle), cutting power test (milling with milling spindle) and facing with face plate.

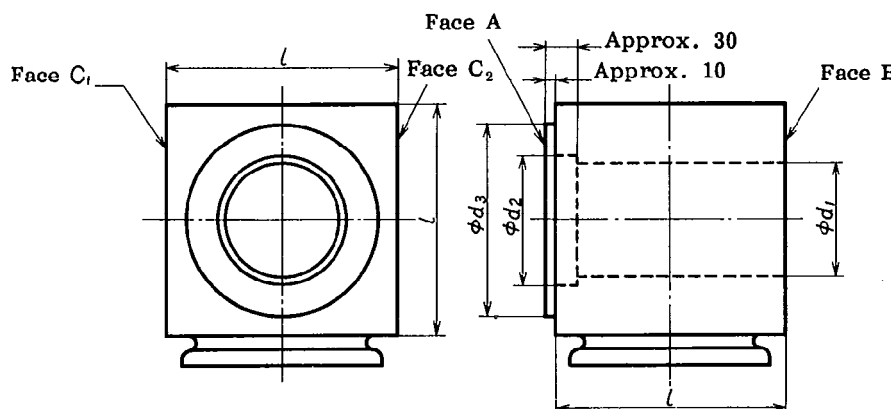
In addition, observe the vibrations, noises and finished surface conditions (see 3.4 of JIS B 6201).

In the case where vibrations and noises are particularly at issue, refer to JIS B 6003 and JIS B 6004.

Workpieces shall conform to Fig. 1, and cuttings shall all be dry cutting.

Fig. 1

Unit: mm



Diameter of main spindle (D)	l (approx.)	d_1 (approx.)	d_2 (approx.)	d_3 (approx.)	Material
90 or under	$4 D$	$1.3 D$	$1.5 D$	$3.5 D$	Generally FC 20 specified in JIS G 5501 shall be used.
Over 90 up to 130			$2 D$		

2.3.1 Chattering Test In the chattering test, which tests the stability of cutting, observe chattering conditions, carrying out boring with the main spindle and milling with the main spindle under the following conditions (see No. 3 - 14 of JIS B 6201).

In this test, carry out the test gradually increasing the speed until chattering occurs. However, when the main spindle motor has reached the prescribed electric power before occurrence of chattering, stop feeding at this point.

- (1) **Boring with Main Spindle** Carry out boring, which is a stub boring with the main spindle, by main spindle feed under the following conditions (see Table 4 Recording Form 2).

Table 4. Recording form 2

Material of workpiece															
No.	Cutting conditions					Type of tool, shape, etc.	Extended length of main spindle (7)		Required electric power (source frequency Hz)					Chattering condition	Description
	Spindle speed (n) min ⁻¹ (rpm)	Cutting speed (V_c) m/min	Cutting depth (a) mm	Feed per revolution (S) mm	Cutting area ($a \cdot S$) mm ²		At start of cutting mm	At end of cutting mm	Voltage V	Current A	Load input (W) kW	No-load input (W_0) kW	Cutting power ($W - W_0$) kW		

Note (7) The extended length of the main spindle means the distance from the end face of the milling spindle to the tool edge.

- (a) **Tools** The tools shall generally be of type 31 or type 32 specified in JIS B 4105.

(b) **Cutting Conditions**

Cutting speed: $V_c = 50$ to 80 (m/min)

Cutting depth: $a \approx \frac{D}{25}$ (mm)

Diameter of boring: $d = 1.4 D$ to $2 D$ (mm)

Feed per revolution: $S \approx \frac{D}{400}$ to $\frac{D}{160}$ (mm/rev)

where D : diameter of main spindle (mm)

- (c) Cutting Method Carry out the boring of hole d_1 in a workpiece, extending the main spindle. The distance from the opposite face of the workpiece to the end face of the milling spindle shall be $2D$, and to the final position of cutting shall be about $4D$.
- (2) Milling with Main Spindle Carry out milling with the main spindle under the following conditions (see Table 5 Recording Form 3).

Table 5. Recording form 3

Material of workpiece												Required electric power (source frequency Hz)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
No.	Cutting conditions							Type of tool, shape, etc.	Extended length of main spindle(′) (mm)	Required electric power (source frequency Hz)										Chattering condition	Description																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
	Spindle speed (n) min ⁻¹ (rpm)	Cutting speed (V_c) m/min	Cutting depth (a) mm	Feed per revolution (S) mm	Feed per blade (S_z) mm	Cutting width (b) mm	Cutting volume (cm ³ /min)			Power for main spindle					Power for feed(′)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
										Voltage V	Current A	Load input (W) kW	No-load input (W_0) kW	Cutting power ($W - W_0$) kW	Voltage V	Current A	Load input kW	No load input kW	Feed power kW																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	

Note (6) For the machine of which main spindle motor and feed motor are not separated, the values shall be entered in the column of powers for main spindle, and be recorded in the description column to that effect.

- (a) Tools The tools shall generally be cemented carbide face milling cutters, of which diameters shall be in accordance with Table 6, and necessary matters shall be recorded in accordance with Table 7 Recording Form 4.

Table 6

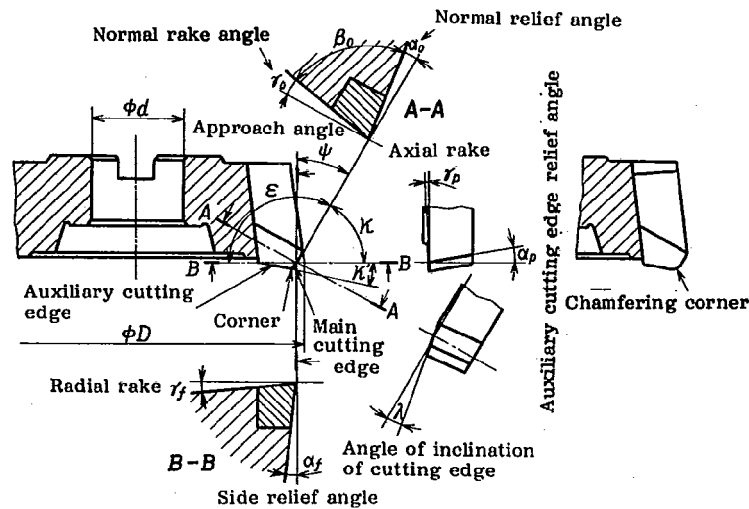
Diameter of main spindle mm	Diameter of milling cutter (approx.) mm
90 or under	100 to 200
Over 90 up to 130	150 to 250

Table 7. Recording form 4

Cemented carbide face milling cutter								Description
Diameter mm	No. of knives piece	Radial rake deg	Axial rake deg	Side relief angle deg	Auxiliary cutting edge relief angle deg	Approach angle deg	Width of chamfering corner mm	

Remark: The names of cutting edges of tool shall be in accordance with Fig. 2.

Fig. 2

(b) Cutting ConditionsCutting speed: $V_c = 50$ to 80 (m/min)Cutting depth: $a \approx \frac{D}{25}$ (mm)Feed per blade: $S_z \approx 0.1, 0.2, 0.3, 0.4, 0.5$ (mm)Cutting width: $b \approx$ diameter of milling cutter $\times 2/3$ (mm)

- (c) Cutting Method Carry out milling on face C_1 (or face C_2) of the workpiece by feeds of table and spindle head. The distance between the end face of milling spindle and the cutting edge of milling cutter shall be about 1.5 to $2 D$.

2.3.2 Cutting Power Test In the cutting power test, which examines whether the machine is capable of enduring the prescribed electric power, carry out milling with the milling spindle to measure required electric powers (see Table 8 Recording Form 5) (see No. 3-11 of JIS B 6201).

Table 8. Recording form 5

Material of Workpiece																				
No.	Cutting conditions							Type of tool, shape, etc.	Required electric power (source frequency Hz)								Metal removal ⁽³⁾ per 1 kW cm ³ /min	Description		
	Spindle speed (n) min ⁻¹ (rpm)	Cutting speed (V_c) m/min	Cutting depth (a) mm	Feed per revo- lution (S) mm	Feed per blade (S_z) mm.	Cutting width (b) mm	Metal removal cm ³ /min		Power for main spindle				Power for feed ⁽⁸⁾							
									Voltage V	Current A	Load input (W) kW	No load input (W_0) kW	Cutting power (W — W_0) kW	Voltage V	Current A	Load input kW			No load input kW	Feed power kW

Note (3) The electric power required for obtaining the metal removal per kW shall be a sum of the load input for main spindle and the load input for feed.

- (1) Tools The tools shall generally be cemented carbide face milling cutters, of which diameters shall be in accordance with Table 9 to be recorded in accordance with Table 7 Recording Form 4.

Table 9

Diameter of main spindle mm	Diameter of milling cutter (approx.) mm
90 or under	125 to 200
Over 90 up to 130	175 to 250

- (2) Cutting Conditions

Cutting speed: $V_c = 50$ to 80 (m/min)

Cutting depth: $a \approx \frac{D}{25}$ (mm)

Feed per blade: $S_z \approx 0.1, 0.2, 0.3, 0.4, 0.5$ (mm)

However, when the motor for main spindle has reached the prescribed power, stop feeding at that rate.

Cutting width: $b \approx$ diameter of milling cutter $\times 2/3$ (mm)

- (3) Cutting Method Carry out milling cutting on the face C_1 (or face C_2) of workpiece by feeds of table and spindle head.

2.3.3 Facing Test with Face Plate In the facing test with the face plate, which examines the stability of cutting with the face palte, carry out cutting under the following conditions (see Table 10 Recording Form 6) (see No. 3-14 of JIS B 6201).

Table 10. Recording form 6

No.	Cutting conditions					Type of tool, shape, etc.	Required electric power (source frequency Hz)					Description
	Spindle speed (n) min^{-1} (rpm)	Cutting speed (V_c) m/min	Cutting depth (a) mm	Feed per revolution (S) mm	Cutting area ($a \cdot S$) mm^2		Voltage V	Current A	Load input (W) kW	No-load input (W_0) kW	Cutting power ($W - W_0$) kW	

- (1) Tools The tools shall generally be type 41 or type 42 specified in JIS B 4105.

(2) Cutting ConditionsCutting speed: $V_c=50$ to 70 (m/min)Cutting depth: $a \approx \frac{D}{30}$ (mm)Feed per revolution (S): This shall be appropriately determined according to the functions of the machine.

- (3)
- Cutting Method
- Cut the face A of the workpiece in the direction of the centre moving from the outer periphery.

Reference 1

The cutting torque tests given in the following are given for informative reference and do not constitute a part of the Standard.

Cutting Torque Test In the cutting torque tests, a machine is subjected to the test to see whether it is endurable to the prescribed torque in an intensive cutting, and an intensive boring is carried out under the following conditions by the milling main spindle (see Reference Recording Form) (see No. 3-12 of JIS B 6201).

Reference Table 1. Reference Recording Form

Material of workpiece															
No.	Cutting conditions					Type of tool, shape, etc.	Required electric power (source frequency Hz)					Torque ⁽²⁾ (T) N.m {kgf.m}	Description		
	Spindle speed (n) min ⁻¹ {rpm}	Cutting speed (V_c) m/min	Cutting depth (a) mm	Feed per revo- lution (S) mm	Cutting area ($a \cdot S$) mm ²		Power for main spindle			Power for feed ⁽¹⁾					
							Voltage V	Current A	Load-input (W) kW	No load input (W_o) kW	Cutting power ($W - W_o$) kW			Voltage V	Current A
		</													

Notes ⁽¹⁾ For a machine of which motor for main spindle and motor for feed are not separated, the data are noted in the column of electric power for main spindle to be recorded in the column of description to that effect.

⁽²⁾ The torque is obtained from the following formula:

$$T = \frac{9550 (W - W_o)}{n} (\text{N} \cdot \text{m}) \quad \left\{ T = \frac{974 (W - W_o)}{n} (\text{kgf} \cdot \text{m}) \right\}$$

where W : load in put (kW)

W_o : no-load input (kW)

n : main spindle speed min⁻¹ {rpm}

(1) **Tools** The tools are generally type 31 or type 32 of JIS B 4105.

(2) **Workpieces** The material of workpieces is generally S 45 C specified in JIS G 4051 or SS 41 specified in JIS G 3101.

(3) Cutting Conditions

Cutting speed: $V_c = 30$ to 90 (m/min)

Cutting depth: $a \approx \frac{D}{25}$ to $\frac{D}{10}$ (mm)

Feed per blade: $S_z \approx 0.1, 0.2, 0.3, 0.4, 0.5$ (mm)

However, when the prescribed torque has been attained, stop feeding at this point.

Cutting radius: $r \approx 2.5 D$ (mm)

- Remarks 1. The prescribed torque means the effective cutting torque laid down as reference in designing the machine.
2. The cutting torque tests may be carried out, other than by this method, by milling with milling spindle or else the prescribed torque may be tested by other methods.