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Parallel screw threads gauges — Measuring method

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Foreword

This Japanese Industrial Standard has been revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Japan Precision Measuring Instruments Manufacturers Association (JMA)/Japanese Standards Association (JSA) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act applied mutatis mutandis pursuant to the provision of Article 16 of the said Act. This edition replaces the previous edition (JIS B 0261:2004), which has been technically revised.

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Parallel screw threads gauges — Measuring method

1 Scope

This Japanese Industrial Standard specifies the method for measuring the screw thread plug gauges and screw thread ring gauges of the limit gauges for metric screw threads and limit gauges for unified screw threads specified in JIS B 0251 and JIS B 0255, respectively, and limit gauges for parallel pipe threads specified in JIS B 0254 (hereafter referred to as thread gauges).

2 Normative references

Part or all of the provisions of the following standards, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 0101 *Screw threads and fasteners — Vocabulary*

JIS B 0251 *Limit gauges for metric screw threads*

JIS B 0254 *Limit Gauges for Parallel Pipe Threads*

JIS B 0255 *Limit gauges for unified screw threads*

JIS B 0271 *Wires for measuring screw threads*

JIS B 7153 *Measuring microscopes*

JIS B 7502 *Micrometers*

JIS B 7506 *Gauge blocks*

JIS B 7725 *Vickers hardness test — Verification and calibration of testing machines*

JIS B 7726 *Rockwell hardness test — Verification and calibration of testing machines and indenters*

JIS Z 2244 *Vickers hardness test — Test method*

JIS Z 2245 *Rockwell hardness test — Test method*

3 Terms and definitions

For the purpose of this Standard, the terms and definitions given in JIS B 0101 apply.

4 Measurement items, positions, procedures and instruments for thread gauge measurement

The thread gauges to be measured are mainly thread plug gauges and thread ring gauges. The measurement items, positions, procedures and instruments for each of

these thread gauges are shown in Table 1.

Upon agreement between the interested parties, other measurement items, positions, procedures and instruments than given in Table 1 may be added as necessary.

Table 1 Measurement items, positions, procedures and instruments

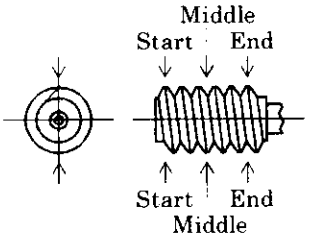
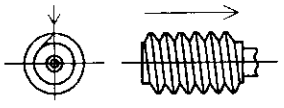
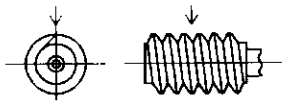
Thread gauge to be measured	Item	Position	Procedure	Instrument [a)]
Thread plug gauge	Major diameter	Three positions: start, middle and end. The measuring direction is added if the influence of geometrical deviation is not negligible. At NOT GO side, it may be just middle and end. 	Measured by means of a micrometer for external measurements. If the pitch of the thread being measured is larger than the length of the measuring face of the micrometer used, a gauge block of Grade 1 specified in **JIS B 7506** shall be used to measure the outside distance.	・Micrometer for external measurements specified in **JIS B 7502** ・Grade 1 gauge block specified in **JIS B 7506**
	Pitch diameter		See Clause **5**.	・Length measuring instrument (scale interval 1 μm max.) ・Grade 1 gauge block specified in **JIS B 7506** ・Wires for measuring screw threads specified in **JIS B 0271**
	Pitch	All the pitches from start to end 	See Clause **6**.	Measuring microscope specified in **JIS B 7153** or pitch measuring instrument
	Half angle	One position 	See Clause **7**.	Measuring microscope specified in **JIS B 7153**
	Minor diameter and shape of root		Checked by means of a measuring microscope.	

Table 1 (concluded)

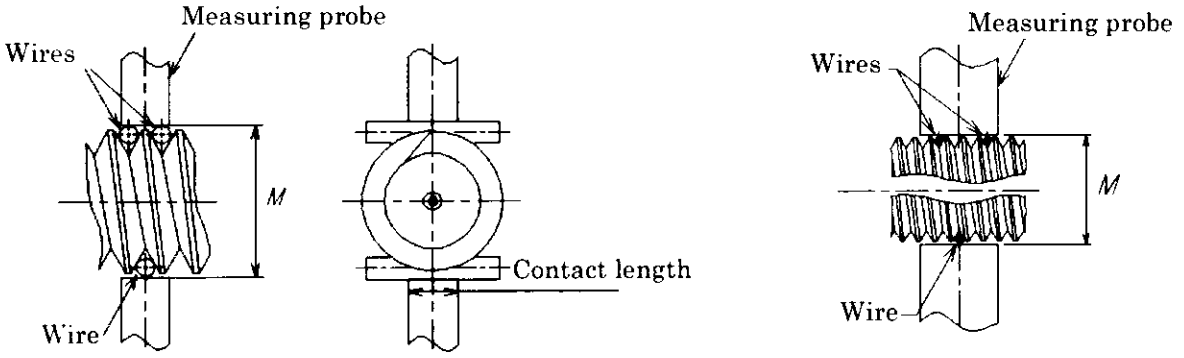
Thread gauge to be measured	Item	Position	Procedure	Instrument [a)]
Thread ring gauge	Pitch diameter, pitch, half angle and major diameter	—	Checked by means of a check gauge.	Check gauge specified in **JIS B 0251**, **JIS B 0254** or **JIS B 0255**
	Minor diameter	—	Directly measured by means of a minor diameter measuring instrument or checked by means of a minor diameter check gauge.	Minor diameter measuring instrument or minor diameter check gauge specified in Clause 8
	Form of relief	—	Visually checked. In case of doubt, transcribed with gypsum, resin etc. and then observed with a measuring microscope.	Measuring microscope specified in **JIS B 7153**
Thread plug gauge and thread ring gauge	Surface roughness	Flank	Compared with surface roughness reference piece.	Surface roughness reference piece
	Hardness	At least one position as close to the gauging part as possible	Tested by the Vickers hardness test method specified in **JIS Z 2244** or Rockwell hardness test method specified in **JIS Z 2245**.	Vickers hardness testing machine conforming to **JIS B 7725** or Rockwell hardness testing machine conforming to **JIS B 7726**
Note [a)] Other instruments than given in the table may be used provided they are capable of providing results with at least an equivalent accuracy.				

5 Measurement of pitch diameter of thread plug gauge

The pitch diameter of thread plug gauge shall be measured by the three-wire method described as follows.

Select the wires to use from those specified in **JIS B 0271** according to the pitch or threads per inch (25.4 mm) of the thread to be measured. Where measurement with the wires of **JIS B 0271** is found to be difficult, other wires shall be selected upon agreement between the interested parties.

Position the three wires in the thread as shown in Figure 1 a) or Figure 1 b) by placing two wires in contact with two adjacent grooves or two grooves apart from each other by a few grooves, and one wire in an opposing position from and in between the two wires. Measure the outside distance between the opposing wires, M, by a length measuring instrument.



a) **Placing two wires in two adjacent grooves**

b) **Placing two wires apart by a few grooves**

Figure 1 Positioning of wires

If the contact length of the two wires with the measuring face is not sufficient, perform the measurement using a Grade 1 gauge block specified in **JIS B 7506** as shown in Figure 2.

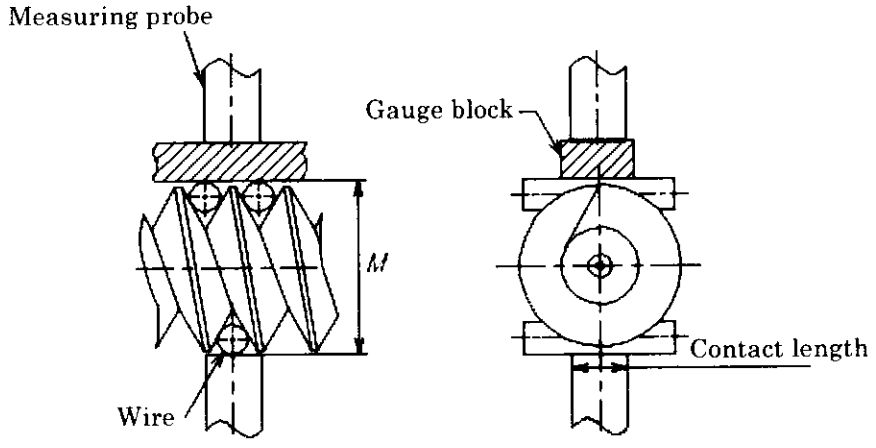


Figure 2 Measurement using a gauge block

Calculate the pitch diameter, d_2', from the outside distance between the opposing wires, M, according to Formula (1) :

$$d_2' = M - d_m \times \left\{ 1 + \frac{1}{\sin\left(\frac{\alpha}{2}\right)} \right\} + \frac{P}{2 \times \tan\left(\frac{\alpha}{2}\right)} \quad \cdots\cdots (1)$$

where, d_m : mean indicated wire diameter (mm)

$\alpha/2$: specified half angle (°)

P : specified pitch (mm)

Table 2 gives the recommended measuring forces and contact lengths.

Table 2 Recommended measuring forces and contact lengths

Pitch of gauge for metric screw threads (mm)	Threads per inch (25.4 mm) of gauge for unified screw threads and gauge for parallel pipe threads	Measuring force (N)	Contact length (mm)
0.2 to 0.5	80 to 48	1.7 to 2.3	4 to 6
0.6 to 1.0	44 to 24	4.4 to 5.4	
1.25 to 4.0	20 to 6	8.8 to 10.8	6 to 8
4.5 to 8.0	5 to 4		8 to 10

In the case of using other measuring force and/or contact length values than above, it shall be verified that the measurement using the selected values is equally accurate and free from any defects, and the pitch diameter shall be calculated using the formula given in Annex A.

6 Measurement of pitch of thread plug gauge

For pitch measurement of a thread plug gauge, the single pitch and cumulative pitch of the thread plug gauge shall be measured over the entire length of the gauge starting from the groove of the complete thread at the end of the gauge. The largest values of single pitch and cumulative pitch errors shall be taken as the deviation from the specified pitch.

An example of the procedure using a measuring microscope specified in **JIS B 7153** is shown in the following.

a) Align the X axis of the measuring microscope with the axis of the thread plug gauge in the field of view of the eyepiece.

b) Incline the column of the measuring microscope by the specified lead angle, ψ, of the thread.

Calculate ψ according to Formula (2) :

$$\psi = \tan^{-1}\left(\frac{P}{\pi \times d_2}\right) \quad \cdots\cdots (2)$$

where, d_2 : basic pitch diameter of external thread (mm)

P : specified pitch (mm)

π : circular constant

c) Make adjustment until both flanks come into clear focus in the field of view of the eyepiece.

d) Bring the fine V line into equal alignment with the two flanks of the groove profile of the first complete thread at the edge of the gauge in the field of view of the eyepiece, read the position of the V line in the X axis direction at this time and note it as the starting point.

e) Repeat this procedure for all the complete threads in the gauge, determine the cumulative pitch, and then determine the single pitch from the results obtained.

7 Measurement of half angle of thread plug gauge

The half angle of a thread plug gauge shall be measured as follows.

a) Align the X axis of the measuring microscope with the axis of the thread plug gauge in the field of view of the eyepiece.

b) Incline the column of the measuring microscope by the specified lead angle, ψ, of the thread.

c) Make adjustment until both flanks come into clear focus in the field of view of the eyepiece.

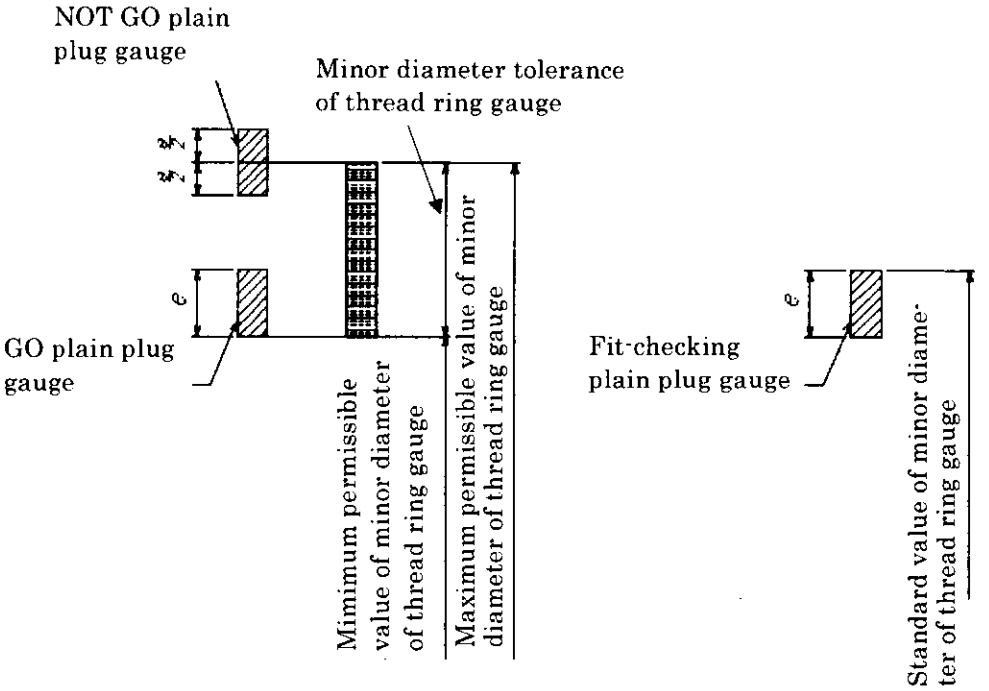
d) Bring the two lines forming the fine V line into respective alignment with the leading and following flanks, read the angle $\alpha_m/2$ at this time with the scale on a goniometer eyepiece, and convert this value to the half angle value, $\alpha_c/2$, using Formula (3) :

$$\frac{\alpha_c}{2} = \tan^{-1}\left\{\frac{\tan\left(\frac{\alpha_m}{2}\right)}{\cos\psi}\right\} \quad \cdots\cdots(3)$$

8 Measurement of minor diameter of thread ring gauge

The minor diameter of a thread ring gauge shall be checked by GO and NOT GO limit plain plug gauges or fit-checking plain plug gauge.

For thread ring gauges for which a minor diameter tolerance is specified, GO and NOT GO limit plain plug gauges as shown in Figure 3 a) shall be used, and for thread ring gauges for which a minor diameter standard value is specified, the fit-checking plain plug gauge as shown in Figure 3 b) shall be used.



a) GO and NOT GO limit plain plug gauges b) Fit-checking plain plug gauge

Maximum permissible value or standard value of minor diameter of thread ring gauge (mm)	Tolerance for minor diameter check gauge e (μm)
18 or under	3
Over 18 up to and incl. 50	4

Figure 3 Minor diameter check gauge

9 Report

When a report is issued, it shall contain the following information. The interested parties may deliberate on specifics of each of the following items.

a) Marking of thread gauge

b) Number of this Standard (JIS B 0261)

c) Date of measurement

d) Measurement environment

e) Measurement results

f) Name of a person who conducted the measurement or a person responsible for the measurement

g) Name of the measuring organization

h) Other matters of significance

Annex A (normative)
Calculation of pitch diameter for three-wire method not using Table 2

Where other measuring force and/or contact length values than recommended in Table 2 have been used for the three-wire method, the pitch diameter, d_2', shall be calculated using the following Formula (A.1) after it has been verified that the measurement using the selected values is equally accurate and free from any defects:

$$d_2' = M - d_m \times \left\{ 1 + \frac{1}{\sin\left(\frac{\alpha}{2}\right)} \right\} + \frac{P}{2 \times \tan\left(\frac{\alpha}{2}\right)} + C_2 \quad \cdots\cdots (A.1)$$

where, d_2' : pitch diameter (mm)

M : outside distance between the opposing wires (mm)

d_m : mean indicated wire diameter (mm)

$\alpha/2$: specified half angle (°)

P : specified pitch (mm)

C_2 : elastic deformation correction value when not using Table 2, calculated according to Formula (A.2) :

$$C_2 = \frac{0.7629}{\sin\left(\frac{\alpha}{2}\right)} \times \frac{2K'}{\pi\mu} \times \left\{ \frac{1}{d_w} + \frac{\sin\left(\frac{\alpha}{2}\right)}{d_2} \right\}^{\frac{1}{3}} \times \left[\frac{1}{\left\{ \sin\left(\frac{\alpha}{2}\right) + 0.05 \times \cos\left(\frac{\alpha}{2}\right) \right\}^2} \right]^{\frac{1}{3}}$$
$$\times \left\{ \left(\frac{1-\nu_1^2}{E_1} + \frac{1-\nu_2^2}{E_2} \right)^{\frac{2}{3}} \times F^{\frac{2}{3}} - 4.453 \times 10^{-4} \times F_0^{\frac{2}{3}} \right\} + \left(\frac{1}{d_w} \right)^{\frac{1}{3}} \quad \cdots\cdots (A.2)$$
$$\times \left(\frac{k_{s1} \times F}{L} + \frac{k_{s2} \times F}{2 \times L_B} - 7.058 \times 10^{-5} \times \frac{F_0}{L_0} \right)$$

where, d_w : nominal wire diameter (mm)

d_2 : basic pitch diameter of external thread (mm)

ν_1 : Poisson's ratio of the wire (see Table A.1)

ν_2 : Poisson's ratio of the thread (see Table A.1)

E_1 : modulus of longitudinal elasticity of wire (N/mm²) (see Table A.1)

E_2 : modulus of longitudinal elasticity of thread (N/mm²) (see Table A.1)

Table A.1 Poisson's ratio and modulus of longitudinal elasticity of materials

Material	Poisson's ratio ν_1, ν_2	Modulus of longitudinal elasticity E_1, E_2 (N/mm²)
Alloy tool steel	0.28	196 133
Cemented carbide	0.2	550 000

$\frac{2K'}{\pi\mu}$: coefficient dependent on the shape of the object and/or contact position, determined according to Table A.3 based on calculation by the following formula :

$$\cos\tau = \frac{\dfrac{d_2}{\sin\left(\dfrac{\alpha}{2}\right)} - d_w}{\dfrac{d_2}{\sin\left(\dfrac{\alpha}{2}\right)} + d_w}$$

F : actual measuring force (N)

F_0 : median value of measuring force recommended in Table 2 (N)

L : contact length between the measuring probe and the wire (mm)

L_0 : median value of contact length recommended in Table 2 (mm)

L_B : contact length between the gauge block and the wire (9 mm in **JIS B 7506**) ; $L_B = L$ if a gauge block is not used.

k_{s1} : coefficient for when the measuring probe and the wire come into contact (see Table A.2)

k_{s2} : coefficient for when the gauge block and the wire come into contact (see Table A.2) ; $k_{s1} = k_{s2}$ if a gauge block is not used.

Table A2 Coefficient for when the measuring probe and the wire come into contact and that for when the gauge block and the wire come into contact

Material of wire	Material of measuring probe k_{s1}		Material of gauge block k_{s2}
	Alloy tool steel	Cemented carbide	Alloy tool steel
Alloy tool steel	4.705×10^{-5}	4.1×10^{-5}	4.705×10^{-5}

The following is Formula (A.1) with values assigned to ν_1, ν_2, E_1, E_2, k_{s1} and k_{s2} of C_2 in the last term of the formula, in the case of using no gauge block, and the material of measuring probe, wires, and thread gauge being alloy tool steel :

$$d_2' = M - d_m \times \left\{1 + \frac{1}{\sin\left(\frac{\alpha}{2}\right)}\right\} + \frac{P}{2 \times \tan\left(\frac{\alpha}{2}\right)} + \frac{3.397 \times 10^{-4}}{\sin\left(\frac{\alpha}{2}\right)} \times \frac{2K'}{\pi\mu}$$

$$\times \left[\frac{1}{\left\{\sin\left(\frac{\alpha}{2}\right) + 0.05 \times \cos\left(\frac{\alpha}{2}\right)\right\}^2}\right]^{\frac{1}{3}} \times \left\{\frac{1}{d_w} + \frac{\sin\left(\frac{\alpha}{2}\right)}{d_2}\right\}^{\frac{1}{3}} \times \left(F^{\frac{2}{3}} - F_0^{\frac{2}{3}}\right) \quad \cdots\cdots\cdots (A.3)$$

$$+ 7.058 \times 10^{-5} \times \left(\frac{1}{d_w}\right)^{\frac{1}{3}} \times \left(\frac{F}{L} - \frac{F_0}{L_0}\right)$$

Table A.3 Values of $\frac{2K'}{\pi\mu}$ for cos τ

cos τ	$\frac{2K'}{\pi\mu}$	cos τ	$\frac{2K'}{\pi\mu}$
0	1.000	0.905	0.672
0.10	0.998	0.910	0.664
0.20	0.991	0.915	0.655
0.30	0.979	0.920	0.646
0.40	0.962	0.925	0.636
0.50	0.938	0.930	0.626
0.60	0.904	0.935	0.615
0.62	0.896	0.940	0.603
0.64	0.888	0.945	0.591
0.66	0.879	0.950	0.577
0.68	0.869	0.955	0.563
0.70	0.859	0.960	0.547
0.72	0.847	0.965	0.529
0.74	0.835	0.970	0.509
0.76	0.822	0.975	0.486
0.78	0.808	0.980	0.459
0.80	0.792	0.985	0.427
0.81	0.783	0.990	0.384
0.82	0.774	0.992	0.362
0.83	0.765	0.994	0.335
0.84	0.755	0.996	0.301
0.85	0.745	0.998	0.249
0.86	0.733	0.999 0	0.206
0.87	0.721	0.999 5	0.170
0.88	0.709	0.999 9	0.107
0.89	0.695	1.000 0	0
0.90	0.680		

Annex B (informative)

Calculation of pitch diameter for three-wire method in the case of a thread pitch larger than that of coarse thread

B.1 General

This Annex provides for information the formulae for pitch diameter calculation of three-wire method that is applicable where the pitch of the thread is larger than that of a coarse thread. These formulae were included in Annex 1 of JIS B 0261 : 2004.

B.2 Calculation of pitch diameter for three-wire method in the case of a thread pitch larger than that of coarse thread

If the pitch of the thread being measured is larger than that of a coarse thread, the pitch diameter, d_2', can be calculated according to Formula (B.1). This is applicable only when C_1 meets the specified accuracy.

$$d_2' = M - d_m \times \left\{ 1 + \frac{1}{\sin\left(\frac{\alpha}{2}\right)} \right\} + \frac{P}{2 \times \tan\left(\frac{\alpha}{2}\right)} - C_1 \quad \cdots\cdots (B.1)$$

where,
- d_2' : pitch diameter (mm)
- M : outside distance between the opposing wires (mm)
- d_m : mean indicated wire diameter (mm)
- $\alpha/2$: specified half angle (°)
- P : specified pitch (mm)
- C_1 : correction value for leaning of the wire, calculated according to Formula (B.2) :

$$C_1 = \left(\frac{d_w}{2}\right) \times \frac{1}{\tan\left(\frac{\alpha}{2}\right)} \times \cos\left(\frac{\alpha}{2}\right) \times \left\{ 1 + \frac{d_w}{d_2 + d_w \times \sin\left(\frac{\alpha}{2}\right)} \times \sin\left(\frac{\alpha}{2}\right) \right\} \times \left[\frac{P}{\pi \times \left\{ d_2 + d_w \times \sin\left(\frac{\alpha}{2}\right) \right\}} \right]^2 - \frac{d_w}{8} \times \frac{1}{\tan\left(\frac{\alpha}{2}\right)} \times \left[\frac{P}{\pi \times \left\{ d_2 + d_w \times \sin\left(\frac{\alpha}{2}\right) \right\}} \right]^4 \quad \cdots\cdots (B.2)$$

where, d_w : nominal wire diameter (mm)

d_2: basic pitch diameter of external thread (mm)

π : circular constant

Bibliography JIS B 0261 : 2004 *Parallel screw thread gauges — Measuring method of gauges*

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