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JIS

JAPANESE
INDUSTRIAL
STANDARD

JIS B 7506 : 2004

(JMA)

Gauge blocks

B 7506 : 2004

Foreword

This translation has been made based on the original Japanese Industrial Standard 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 Association (JMA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently **JIS B 7506**:1997 is replaced with this Standard.

This Standard has been made based on **ISO 3650**:1998 *Geometrical Product Specifications (GPS) — Length standards — Gauge blocks* for the purposes of making it easier to compare this Standard with International Standard; to prepare Japanese Industrial Standard conforming with International Standard; and to propose a draft of an International Standard which is based on Japanese Industrial Standard. Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

Date of Establishment: 1953-05-25

Date of Revision: 2004-03-20

Date of Public Notice in Official Gazette: 2004-03-22

Investigated by: Japanese Industrial Standards Committee
Standards Board
Technical Committee on Testing and Measurement Technology

In the event of any doubts arising as to the contents,
the original JIS is to be the final authority.

FM/HB

Contents

Gauge blocks

Introduction   This Japanese Industrial Standard has been prepared based on the first edition of **ISO 3650** *Geometrical Product Specifications (GPS) — Length standards — Gauge blocks* published in 1998, the corresponding parts of which are adopted without modification in the technical contents.   On the other hand, the items not specified in the International Standard have been added, main contents of which are shown in **a)** to **c)** below.

In this Standard, the portions with sidelines or dotted underlines are the items not contained in the original International Standard or items added.   A list of modifications with the explanation is shown in annex 5 (informative).

a)   Reference condition: standard water vapour pressure and standard carbon dioxide content

b)   Correction items for interferometry: carbon dioxide content

c)   Length inspection certificate or grade inspection certificate for gauge blocks

1   Scope   This Standard specifies the gauge blocks with rectangular cross section, nominal length ranging from 0.5 mm to 1 000 mm and of calibration grade K and of grade 0, 1 and 2.

The accessories of gauge blocks are specified in annex 1.

Remarks :   The International Standard corresponding to this Standard is as follows.

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21**.

ISO 3650:1998   *Geometrical Product Specifications (GPS) — Length standards — Gauge blocks* (MOD)

2   Normative references   The following standards contain provision which, through reference in this Standard, constitute provisions of this Standard.   The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 0021   *Geometrical product specifications (GPS) — Geometrical tolerancing — Tolerancing of form, orientation, location and run-out*

Remarks :   **ISO/DIS 1101**:1996 *Geometrical Product Specifications (GPS) — Geometrical tolerancing — Tolerancing of form, orientation, location and run-out* is identical with the said standard.

JIS B 0641-1   *Geometrical Product Specifications (GPS) — Inspection by measurement of workpieces and measuring equipment — Part 1: Decision rules for proving conformance or nonconformance with specifications*

Remarks :   **ISO 14253-1**:1998 *Geometrical Product Specifications (GPS) — Inspection by measurement of workpieces and measuring equipment — Part 1: Decision rules for proving conformance or non-conformance with specifications* is identical with the said standard.

JIS Z 2244   *Vickers hardness test — Test method*

Remarks :   **ISO 6507-1**:1997   *Metallic materials — Vickers hardness test — Part 1: Test method* is equivalent to the said standard.

JIS Z 8103   *Glossary of terms used in measurement*

ISO 1   *Standard reference temperature for industrial length measurements*

3 Definitions and symbols For the purposes of this Standard, the definitions given in **JIS Z 8103** and the following definitions apply.

a) **gauge block** end standard of rectangular section, made of wear resistant material, with one pair of planar, mutually parallel measuring faces which can be wrung to other gauge blocks or auxiliary plates (plane surfaces)

b) **length of a gauge block(l)** distance between any particular point of the measuring face and the plane surface of an auxiliary plate of the same material and surface texture upon which the other measuring face has been wrung [1] (see figure 1)

Note [1]   The length of a gauge block includes the thickness of wringing layer generated in adhesion to the plane surface of auxiliary plate.
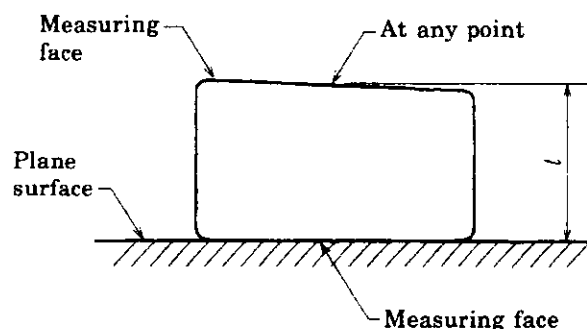
Figure 1   Length of a gauge block

c) **central length of gauge block(l_c)** length of a gauge block taken at the centre of the measuring face (see figure 2)

Information :   When the measuring faces are not parallel, the gauge block has two central lengths l_c and l_{c1} corresponding to the two measuring faces. The difference between l_c and l_{c1}, however, is practically negligible provided that the gauge block has an accuracy specified in this Standard [see figure 2 b)].

Measuring face

Auxiliary plate
(plane surface)

Measuring
face

a) Central length

Measuring
face

Plane
surface

Measuring
face

b) Central length for
two measuring faces
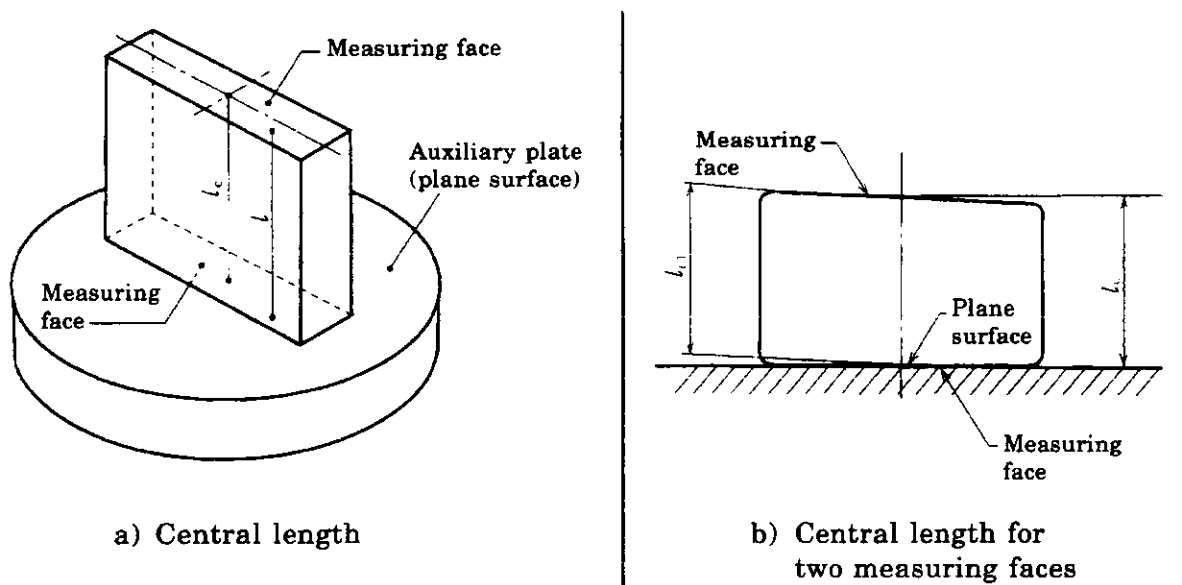
Figure 2   Central length of a gauge block

d) **deviation of the length at any point from nominal length(e)**   algebraic
difference $l - l_n$

Remarks :   Maximum deviation of length (e_d) from nominal length is the larger
value of either $l_{max} - l_n$ or $l_n - l_{min}$ (see figure 3).
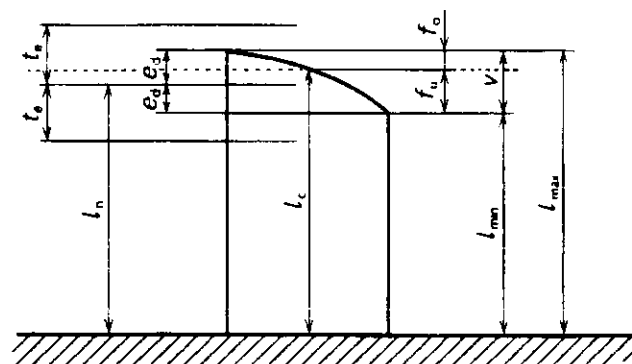
Remarks : t_e :   length tolerance from nominal length.

Figure 3   Deviation length of a gauge block

e) **limit deviation of the length of a gauge block(t_e)**   permissible deviation of
the length of the gauge block from nominal length at any point of measurement
(see figure 3)

f) **variation in length(v)**   difference between the maximum length l_{max} and the
minimum length l_{min}

Information :   The variation in length is equal to the sum of deviations f_o and f_u
from central length (see figure 3).

g) **tolerance for the variation in length of a gauge block(t_v)**   permissible
value for the variation in length of a gauge block (v)

h) **flatness of measuring face(f_a)** minimum distance between two parallel planes between which all points of the measuring face lie (see figure 4 and **JIS B 0021**)
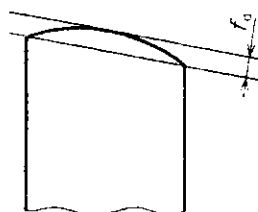
Figure 4 Flatness of a measuring face

i) **wringing** property of the measuring faces of gauge blocks to adhere to other measuring faces or to faces with similar surface finish as a result of molecular forces.

4 Nomenclature The nomenclature of faces of a gauge block is given in figure 5.
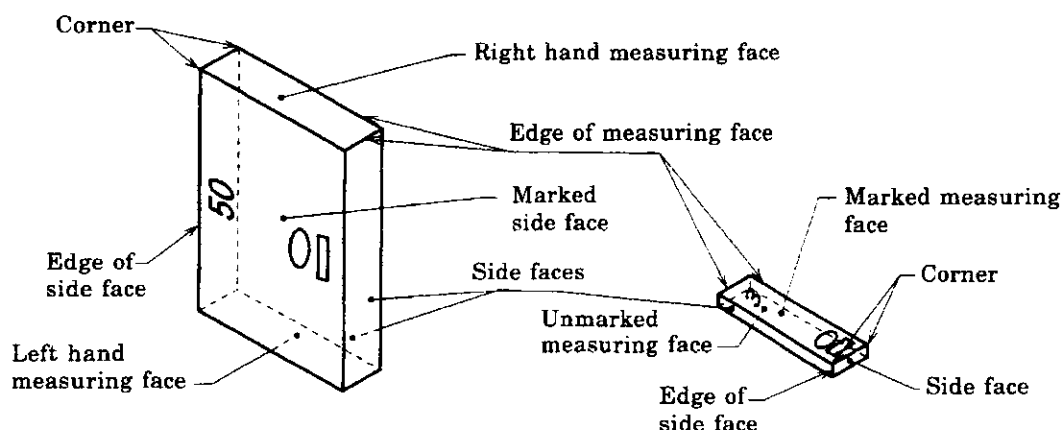
Figure 5 Nomenclature of faces of a gauge block

5 Grades The gauge block shall be classified according to accuracy into four grades of grade K, grade 0, grade 1 and grade 2. The gauge block of grade K shall be calibrated by the method of interferometry to be used for calibration of the other grade block gauges, and shall be always used together with the correction by the values indicated in the inspection certificate. The grade 0, grade 1 and grade 2 gauge blocks shall be calibrated by comparison measurement method.

6 Accuracy requirements

6.1 General Each gauge block shall conform to the requirements of its grade.

The estimated uncertainty of calibration is contained in limit deviation of length and tolerance for variation in length, and considered within their permissible limit values (see **JIS B 0641-1**).

The accuracy requirements apply to the measuring faces of the gauge block omitting a border zone with a maximum width of 0.8 mm as measured from the plane of the side faces. In this border zone the surface shall not lie above the plane of the measuring face.

6.2 Limit deviation of the length

6.2 Limit deviation of the length The limit deviation of the length of gauge blocks(t_e) shall be as specified in table 1.

Table 1 Limit deviations of the length at any point from nominal length and tolerances for variation in length

Unit: μm

Nominal length range (mm)		Grade K		Grade 0		Grade 1		Grade 2	
Over	Up to	Limit deviations of length at any point from nominal length t_e (±)	Tolerance for the variation in length t_v	Limit deviations of length at any point from nominal length t_e (±)	Tolerance for the variation in length t_v	Limit deviations of length at any point from nominal length t_e (±)	Tolerance for the variation in length t_v	Limit deviations of length at any point from nominal length t_e (±)	Tolerance for the variation in length t_v
0.5(2)	10	0.20	0.05	0.12	0.10	0.20	0.16	0.45	0.30
10	25	0.30	0.05	0.14	0.10	0.30	0.16	0.60	0.30
25	50	0.40	0.06	0.20	0.10	0.40	0.18	0.80	0.30
50	75	0.50	0.06	0.25	0.12	0.50	0.18	1.00	0.35
75	100	0.60	0.07	0.30	0.12	0.60	0.20	1.20	0.35
100	150	0.80	0.08	0.40	0.14	0.80	0.20	1.60	0.40
150	200	1.00	0.09	0.50	0.16	1.00	0.25	2.00	0.40
200	250	1.20	0.10	0.60	0.16	1.20	0.25	2.40	0.45
250	300	1.40	0.10	0.70	0.18	1.40	0.25	2.80	0.50
300	400	1.80	0.12	0.90	0.20	1.80	0.30	3.60	0.50
400	500	2.20	0.14	1.10	0.25	2.20	0.35	4.40	0.60
500	600	2.60	0.16	1.30	0.25	2.60	0.40	5.00	0.70
600	700	3.00	0.18	1.50	0.30	3.00	0.45	6.00	0.70
700	800	3.40	0.20	1.70	0.30	3.40	0.50	6.50	0.80
800	900	3.80	0.20	1.90	0.35	3.80	0.50	7.50	0.90
900	1 000	4.20	0.25	2.00	0.40	4.20	0.60	8.00	1.00

Note (2) The nominal length 0.5 mm is included in this length range.

6.3 Variation in length The tolerance for the variation in length (t_v) of gauge blocks shall be as specified in table 1.

6.4 Flatness of measuring face The flatness tolerance (t_{fd}) of the measuring face of gauge blocks shall be as specified in table 2. The gauge blocks 2.5 mm or under in nominal length shall be measured wrung to an auxiliary plate(3) having sufficient rigidity and flatness, and in the case of gauge block unwrung, the measuring face shall be flat to within 4 μm.

Note (3) The thickness of the auxiliary plate shall be 11 mm or over.

Table 2 Flatness tolerance of measuring face

Unit: μm

Nominal length range (mm)		Grade K	Grade 0	Grade 1	Grade 2
Over	Up to				
0.5(4)	150	0.05	0.10	0.15	0.25
150	500	0.10	0.15	0.18	0.25
500	1 000	0.15	0.18	0.20	0.25

Note (4) The nominal length 0.5 mm is included in this length range.

6.5 Wringing property of measuring face The measuring faces of all gauge blocks shall wring readily. Fine scratches without burrs may be accepted when they do not impair the wringing property.

7 Shapes and dimensions

7.1 Dimensions of cross section The dimension of the cross section parallel to the measuring face of gauge block shall be as given in table 3.

Table 3 Dimension of cross section

Unit: mm

Nominal dimension	Dimension of cross section
0.5 or over up to and incl. 10	$30_{-0.3}^{0} \times 9_{-0.2}^{-0.05}$
Over 10 up to and incl. 1000	$35_{-0.3}^{0} \times 9_{-0.2}^{-0.05}$

7.2 Edges The edges of gauge blocks shall have a radius or chamfer of not greater than 0.3 mm. The crossing line of the measuring face and the chamfer shall be under a state free from influencing on wringing property or impairing the opposed measuring face.

7.3 Flatness tolerance and parallelism tolerance of side faces The flatness tolerance and parallelism tolerance of side faces of a gauge block shall be as specified in table 4.

Table 4 Flatness tolerance and parallelism tolerance of side faces

Unit: μm

Nominal dimension (mm)	Flatness tolerance	Parallelism tolerance
0.5 or over up to and incl. 100	40	80
Over 100 up to and incl. 1 000	$40 + 40 \times 10^{-3} \times l_n$	$80 + 80 \times 10^{-3} \times l_n$

Remarks : l_n : nominal length expressed in mm.

7.4 Perpendicularity tolerance of side faces The perpendicularity tolerance of the side faces of a gauge block shall be as specified in table 5 (see figure 6 and **JIS B 0021**). The angle between adjacent side faces shall be 90°±10'.

Table 5 Perpendicularity tolerance of side faces

Unit: μm

Nominal length (mm)		Perpendicularity tolerance
Over	Up to	
10 (⁵)	25	50
25	60	70
60	150	100
150	400	140
400	1 000	180

Note (⁵) The nominal length 10 mm is included in this range of length.
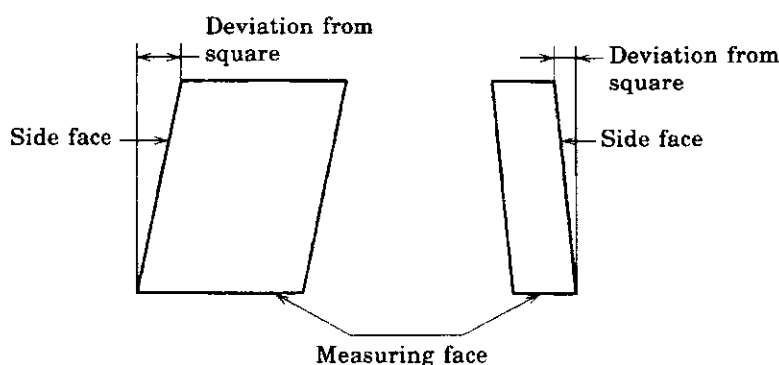
Figure 6 Perpendicularity of side faces

7.5 Coupling hole Where gauge blocks with nominal length over 100 mm are coupled or a hole is provided to the gauge block in order to hold the object which is wrung to it, figure 7 shall be applied(⁶).

Note (⁶) Gauge blocks of grade K shall not be combined using coupling holes.

Unit: mm
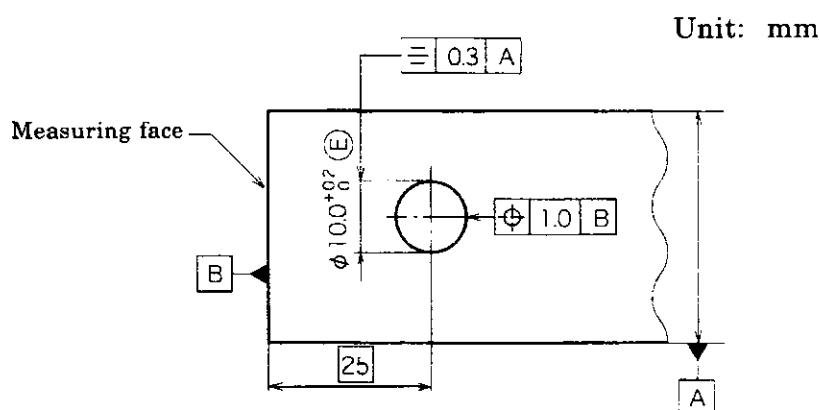
Figure 7 Coupling holes

8 Material properties

8.1 Material Gauge blocks shall be made of high grade steel or of other similarly wear resistant material capable of being finished with surfaces that will wring readily, and which will have consistent length.

8.2 Coefficient of thermal expansion The coefficient of thermal expansion of steel gauge blocks in the temperature range of 10°C to 30°C shall be $(11.5 \pm 1.0) \times 10^{-6}$ K^{-1}. The coefficient of expansion, with its estimated uncertainty of determination, of steel grade K gauge blocks, gauge blocks of all grades made of material not in the range of the thermal expansion coefficient, and those made of materials other than steel shall be clearly indicated.

8.3 Hardness The measuring faces of steel gauge block shall have a Vickers hardness of not less than 800HV0.5 (see **JIS Z 2244**).

8.4 Dimensional stability For the dimensional stability of gauge blocks, the change in length by aging shall not exceed the maximum permissible change in length as given in table 6. The dimensional stability shall be confirmed by the test with a sample, and the sample shall be stored under a state wherein the length stability is free from special influences, i.e., exceptional temperature, vibration, shock, magnetic field or mechanical force during that period. The test period shall be long enough for discerning the change in the length, taking the accuracy of length measurement into account.

Table 6 Dimensional stability

Unit: μm/year

| Grade	Maximum permissible change in length per year
K, 0	$\pm(0.02 + 0.25 \times 10^{-3} \times l_n)$
1, 2	$\pm(0.05 + 0.5 \times 10^{-3} \times l_n)$

Remarks : l_n : nominal length expressed in mm.

9 Basis of measurement, traceability and reference condition

9.1 Unit of length : metre (information) The metre is defined as the length of the path travelled by light in vacuum in 1/299 792 458 of one second (17th General Conference of Weights and Measures, in 1983). This definition is realized by working wavelength standards recommended by Comité International des Poids et Mesures (International Committee of Weights and Measures).

9.2 Traceability of the length of a gauge block (information) When the measured result is related to the gauge blocks calibrated with an interferometer for which a suitable wavelength standard is used through an unbroken chain of comparison measurements marked with uncertainty, the length of the block gauges maintains traceability with the national or international standard.

9.3 Reference condition The length of block gauges shall be obtained at 20°C reference temperature (see **ISO 1**), 101 325 Pa (= 1.013 25 bar) standard atmospheric pressure, 1 333 Pa standard water vapour pressure, and 0.03 % standard carbon dioxide content([7]).

Note ([7]) The deformation of gauge blocks caused by deviation from standard atmospheric pressure, standard water vapour pressure, and standard carbon dioxide content may be ignored under an ordinary atmospheric condition.

9.4 Reference orientation of gauge blocks The length of a gauge block up to and including 100 mm nominal length refers to the vertical orientation with the measuring faces horizontal. The length of a gauge block over 100 mm nominal length refers to the horizontal orientation, the block being supported on one of the narrow side faces without additional stress by suitable supports each at a distance of 0.211 times the nominal length from the ends. When such a gauge block is measured by interferometry in horizontal orientation, the weight of the auxiliary plate wrung to one of the measuring faces shall be compensated for.

10 Calibration of gauge blocks

10.1 Measurement by interferometry

10.1.1 Measured length The length of gauge block of grade K as shown in figure 2 shall be measured at the centre of the measuring face using the method of interferometry. It shall be stated, whether the calibration result is based on a single measurement with one specified measuring face wrung to the auxiliary plate or whether it is the mean of two measurements made with the block wrung in turn to the auxiliary plate by each of the two measuring faces.

10.1.2 Auxiliary plate (plane surface) The auxiliary plate should preferably be in the same surface state as that of the gauge block. If auxiliary plate of some other material, such as crystalline quartz, is used, the necessary correction shall be taken into account (see **10.1.3**). The auxiliary plate shall be not less than 11 mm thick and shall have a wringing face with a flatness deviation less than 0.025 μm for a diameter of over 40 mm.

10.1.3 Corrections to measurements by interferometry The following correction shall be carried out in measurements by interferometry:

a) Temperature, atmospheric pressure, atmospheric humidity, and concentration of carbon dioxide on the wavelength of light

b) Deviation of temperature of the gauge block from 20°C

c) The wringing action on the length of the gauge block when the gauge block and the auxiliary plate are of different materials

d) Optical phase changes on the reflection of the light wave

e) The aperture of the interferometer (diagram size and focal length) on the position of the interference fringes

f) Compression owing to gravity of the gauge block over 100 mm when measured in vertical position

10.1.4 Length inspection certificate The following measuring items shall be contained in the length inspection certificate:

a) Central length or the deviation of central length from nominal $l_c - l_n$

b) Estimated uncertainty

c) Used reference wavelength and its traceability

d) Coefficient of thermal expansion

e) Wrung measuring face in measurement

10.2 Measurement by comparison

10.2.1 Central length The difference of the central length of the gauge block to be measured from the central length of the reference gauge block is obtained. The measured difference is added to the length of the reference gauge block. The measuring faces of each gauge block are touched from opposite dirsections in the manner of figure 8 to be measured. The reference gauge block may either directly be measured by interferometry or related through one or several stages of measurements by comparison to a reference gauge block measured by interferometry.

Information : The effect of wringing of the reference gauge block is contained in the value of the measurement by comparison.
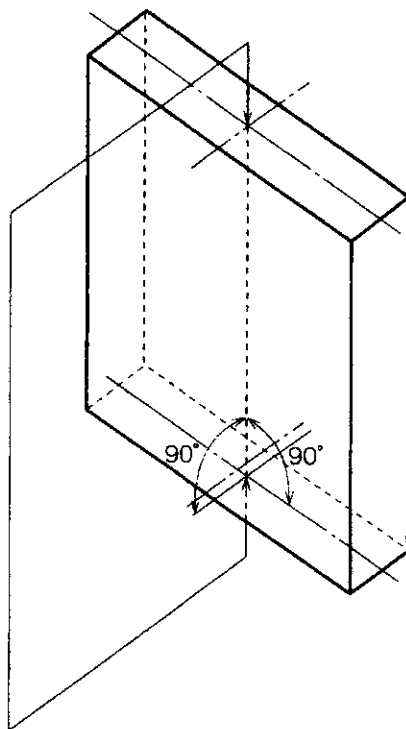
Figure 8   Measurement by comparison of central length

10.2.2 Method for measurement by comparison Based on the central length of a reference gauge block with small deviation, the difference of central length of an unknown gauge block shall be measured by a high resolution length indicator.

10.2.3 Variation in length A variation in length is obtained by the method for measurement by comparison. The variation in length is determined by the difference among the maximum and the minimum lengths at five points including the central position of the measuring face and four corners about 1.5 mm apart from the side face. The variation in length measured at places other than the abovementioned measuring points shall be clearly indicated in the inspection certificate.

Information :   The length of a gauge block shall be measured at five positions as given in informative figure 1.

The • mark indicates
a measuring position.
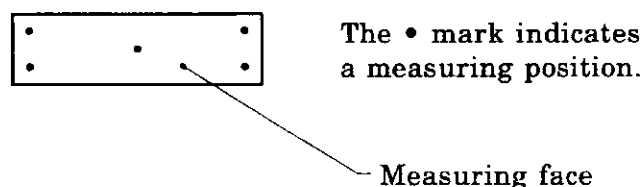
Measuring face

Informative figure 1   Positions for measuring length of gauge block

10.2.4   Correction in measurement by comparison   The following corrections shall be carried out in the measurement by comparison:

a)   Bias of the measuring device

b)   Influence of temperature differing from 20°C and different coefficients of thermal expansions of the gauge blocks under comparison

c)   Influence of surface deformation of the measuring faces owing to the shape of measuring spindle, in case the standard and the measured gauge blocks are made of different materials

10.2.5   Length inspection certificate   The length inspection certificate shall contain the following items:

a)   Central length or deviation of central length from nominal $l_c - l_n$ (see **12.4**)

b)   Estimated uncertainty

c)   Statement of traceability

d)   Coefficient of thermal expansion

10.3   Wringing test   The wringing property of measuring faces of the gauge block is tested using an optical flat which shall satisfy a flatness tolerance of 0.1 μm. The wrung measuring face shall be observed through the optical flat and shall be judged with interference bands, colour and bright spots. For gauge blocks of grade 1 and 2 bright spots or shades in a minor extent are permitted.

11   Designation of products   Gauge blocks shall be designated with number or title of this Standard, nominal length and grade.

   Example :   **JIS B 7506**   100 mm   Grade 0

12   Marking

12.1   Marking items   The following items shall be marked on gauge blocks. All markings shall be distinct, and the manufacturer's name or its abbreviation and the nominal length shall be marked in characters of size not less than 1.5 mm.

a)   Manufacturer's name or its abbreviation

b)   Nominal length

c)   Manufacturing number[8]

   Note (8)   The first two digits of the manufacturing number express the last 2 digits of A.D. year number. However, the year number and other figures may be separately marked.

The face to be marked shall be the side face for gauge blocks of 6 mm or over nominal length. Gauge blocks smaller than 6 mm nominal length may be marked on a measuring face, but an area of 9 mm × 12 mm at the centre of the measuring face and an area of 2.5 mm × 2.5 mm in each of the four corners shall be left clear of any marking (see figure 9). The marking should preferably be as given in figure 9.

For nominal length of 6 mm or over

For nominal length of under 6 mm
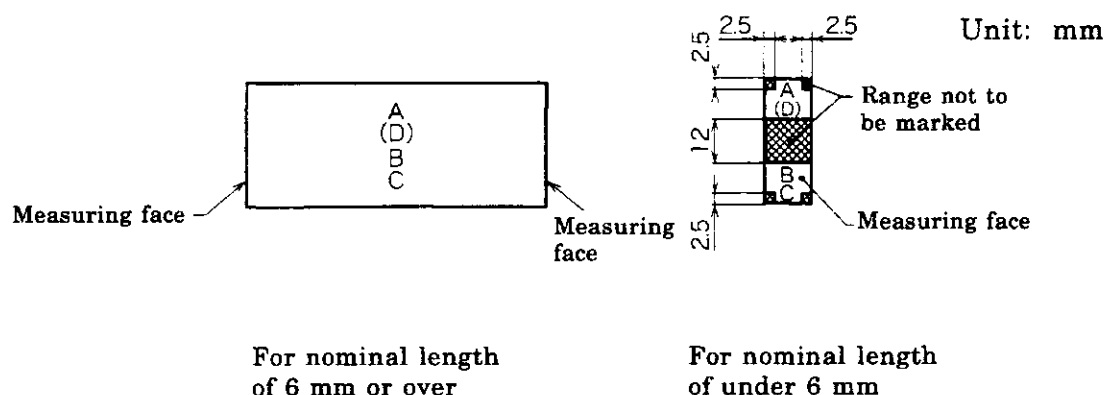
Remarks : A : nominal length (mm may be omitted)

B : manufacturer's abbreviation

C : manufacturing number

(D : material symbol)

Figure 9 Marking

12.2 Marking for support position The gauge block exceeding 100 mm in nominal length should preferably bear the marks for indicating the support positions at a place which is apart from the measuring faces by the nominal length × 0.211.

12.3 Marking for grade When a grade is marked on gauge blocks, the following stamps are used.

Grade K: K

Grade 0 : 0

Grade 1 : −

Grade 2 : =

12.4 Inspection certificate of length and grade The gauge blocks of grade K and grade 0 shall be provided with the length inspection certificate, and the block gauges of grade 1 and grade 2 shall be provided with the grade inspection certificate guaranteeing their grades. The values to be marked on the length inspection certificate shall be the central length or the deviation of central length from nominal $(l_c - l_n)$, and only the grades shall be marked on the grade inspection certificate.

Annex A (informative)   Example of a device for the comparison of gauge blocks

Introduction   This annex is to describe an example of a device for the comparison of gauge blocks and not to constitute the provision of this Standard.

A.1   Device for the comparison of gauge blocks   There are two types of devices for the comparison of gauge blocks : a vertical position comparator and a horizontal position comparator.   They are used for comparison measurement of the length and the variation in length of the gauge block.

A.2   Vertical position comparator   An example of the vertical position comparator is given in annex A figure 1. a) shows an example of the comparator by two points measuring method. The length of gauge block is measured by putting the gauge block between the upper measuring spindle and the lower measuring spindle. The connection line between two measuring spindles shall be normal to the measuring face of the gauge block. b) shows an example of the comparator by one point measuring method. Put a gauge block on the measuring table, bring down a measuring spindle to contact with the measuring face of the gauge block to measure the length. The upper part of the measuring table is so constructed as to be able to support stably the gauge block with a small contact area by having three or more crests. The measuring spindle shall be positioned on a line vertical to the upper face of the central crest of the measuring table.

High resolution
length indicator

Gauge block to
be calibrated

Reference
gauge block

Table

$\square\square\square$

0.01μm

Lifting
device

a) Example of a comparator by two point measuring method

High resolution
length indicator

Lifting device

$\square\square\square$

0.01μm

Reference
gauge block

Gauge block to
be calibrated

Measuring table
with three crests
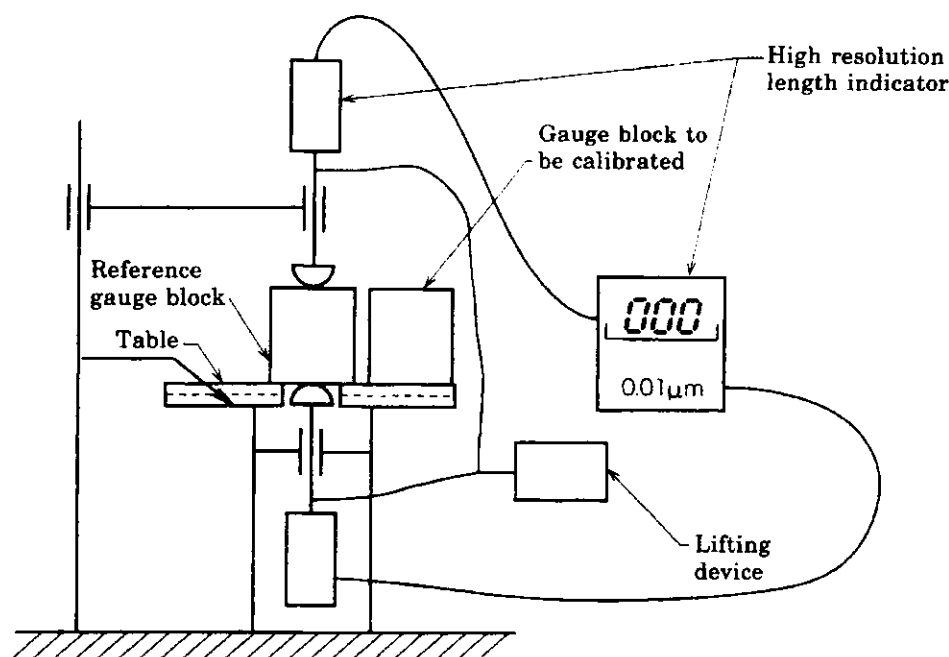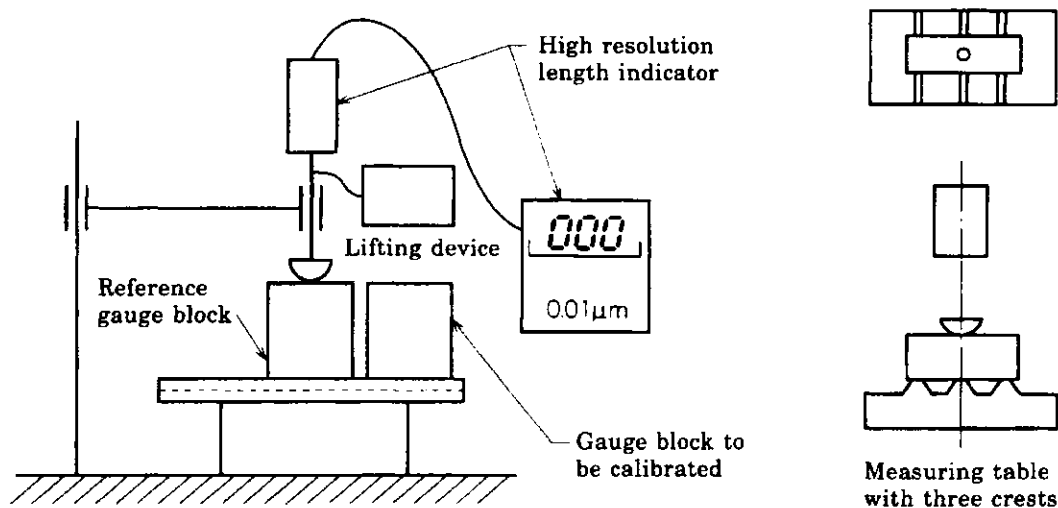
b) Example of a comparator by one point measuring method

Annex A Figure 1   Example of vertical position comparators

A.3   Horizontal position comparator   An example of the horizontal position comparator is given in annex A figure 2.   The horizontal position comparator is generally used for measuring a length of the gauge block of long size.   When a length of the gauge block is measured under a horizontal position, the support can be adjusted horizontally and vertically, one measuring spindle comes in contact with one measuring face of the gauge block, and the other measuring spindle can be moved on the measuring face until the minimum value of the length is obtained contacting the other measuring face of the block gauge.
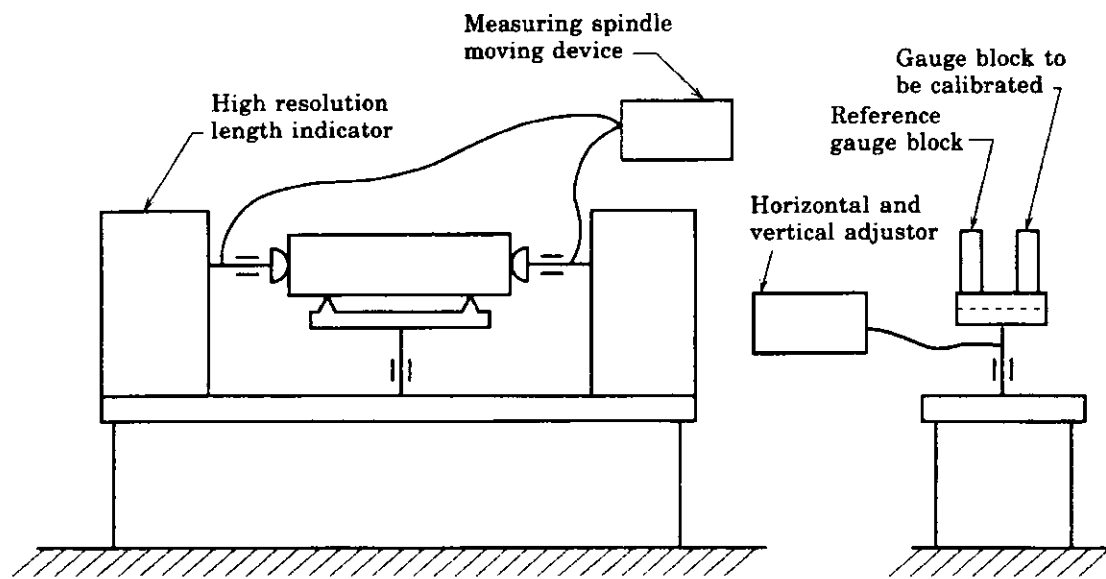
Annex A Figure 2   Example of a horizontal position comparator

Annex B (informative)   Relation to the GPS matrix model

Introduction   This annex is for informative purposes only and not to constitute the provisions of this Standard.

For full details about the GPS matrix model, see **ISO/TR 14638**:1995 *Geometrical Product Specifications (GPS) — Master plan*.

B.1   Information about this Standard and its use   This Standard specifies the characteristics of gauge blocks.   Gauge blocks are the commonly used standard of length in industry for materialized standards.   It also defines four classes of gauge blocks and explains the two methods used for calibration of gauge blocks (interferometry and comparison).

B.2   Position in the GPS matrix model   This Standard is a General GPS standard, which influences chain link 6 (Calibration requirements — Calibration standards) of the chains of standards on size and distance in the *General GPS matrix*, as graphically illustrated in annex B figure 1.

Fundamental GPS standards	Global GPS standards						
	General GPS matrix						
	Chain link number	1	2	3	4	5	6
	Size						▓
	Distance						▓
	Radius						
	Angle						
	Form of line independent of datum						
	Form of line dependent on datum						
	Form of surface independent of datum						
	Form of surface dependent on datum						
	Orientation						
	Location						
	Circular run-out						
	Total run-out						
	Datums						
	Roughness profile						
	Waviness profile						
	Primary profile						
	Surface imperfections						
	Edges						

Annex B Figure 1

B.3   Related standards   The related standards are those of the chains of standards indicated in annex B figure 1.

Annex C (informative) Bibliography

[1] ISO/TR 14638:1995 *Geometrical product specifications (GPS) — Masterplan*

[2] *Guide to the expression of uncertainty in measurement (GUM)*, BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML, 1st edition, revised in 1995, ISO.

Annex 1 (normative)　Gauge block accessories

1　Scope　This annex specifies the gauge block accessories (hereafter referred to as "accessories").

2　Kinds　The kinds of the accessories shall be as listed below:

a)　Round jaw (used for both internal and external measurement)

b)　Flat jaw type A (used for both internal and external measurement) and type B (used for external measurement)

c)　Scriber point

d)　Centre point

e)　Holder

f)　Base block

3　Wringing surfaces　The wringing surfaces of the accessories shall be easily able to wring the gauge blocks closely.

4　Materials　The materials for the accessories shall be of high quality and homogeneous, and shall comply with the requirements specified in this annex; the surface hardness of the measuring faces(*) and wringing faces shall be of 800HV0.5 or better.

Note　(*)　The measuring faces herein include the extreme end points of the scriber point and the centre point.

5　Round jaw　The dimensions and accuracy of the round jaw shall be as specified in annex 1 table 1 and shall satisfy the requirements given below.

Annex 1 Table 1　Dimensions and accuracy of round jaw
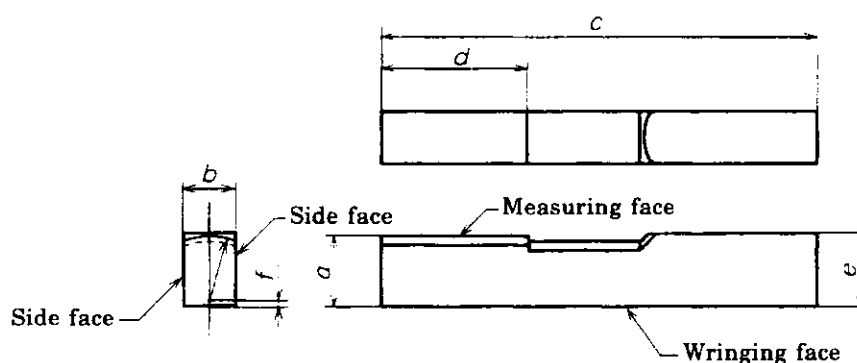
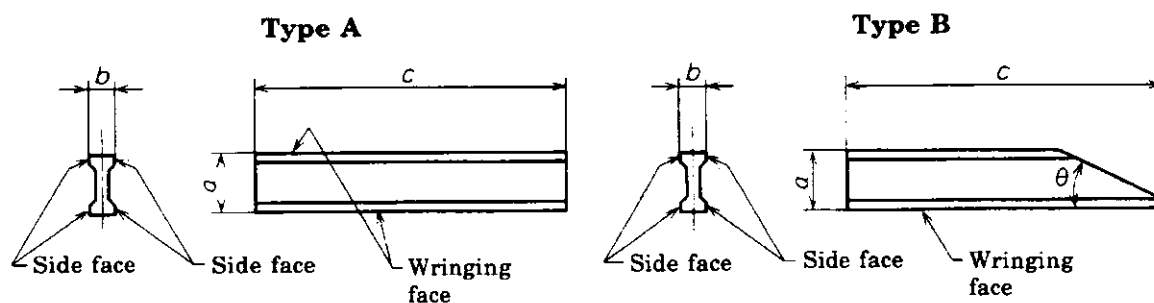Remarks :　The figures do not show the details.

Annex 1 Table 1 (concluded)

Unit: mm

Nominal length	a		b	c (infor-mative)	d (infor-mative)	e (infor-mative)	f (infor-mative)
	Basic dimension	Tolerance (μm)					
2	2	±0.5	$9^{-0.05}_{-0.2}$	40	5.5	7.5	0.05
5	5			45	14		
8	8			50	18.5	8.5	
12.5	12.5			75	25	13	

a) The flatness tolerance of the wringing face shall be 0.5 μm.

b) The parallelism tolerance of generating line of the cylindrical measuring face to the wringing face shall be 0.5 μm.

c) The perpendicularity tolerance of the side face to the wringing face shall be 50 μm.

6 Flat jaws The flat jaws shall be classified into two types: type A and type B. Their dimensions and accuracies shall be as specified in annex 1 table 2 and shall satisfy the requirements given below.

Annex 1 Table 2 Dimensions and accuracies of flat jaws

Type A   **Type B**

Remarks : The figures do not show the details.

Unit: mm

Nominal length	a		b (Type B infor-mative)	b	c (infor-mative)	θ (infor-mative)
	Type A					
	Basic dimension	Tolerance (μm)				
100	20	±1	20	$9^{-0.05}_{-0.2}$	100	20°
150					150	

a) The flatness tolerance of the wringing face shall be 1 μm.

b) The parallelism tolerance of the wringing faces of type A shall be 1 μm.

c) The perpendicularity tolerance of the side faces to the wringing face shall be 50 μm.

7 Scriber point The dimensions and accuracy of the scriber point shall be as specified in annex 1 figure 1 and shall satisfy the requirements given below.

Unit: mm
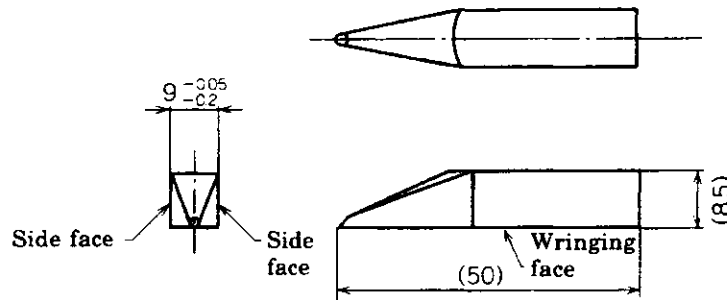
Remarks :   The figures do not show the details.

Annex 1 Figure 1   Dimensions of scriber point

a)   The flatness tolerance of the wringing face shall be 0.5 µm.

b)   The perpendicularity tolerance of the side face to the wringing face shall be 50 µm.

8 Centre point The dimensions and accuracy of the centre point shall be as specified in annex 1 figure 2 and shall satisfy the requirements given below.

Unit: mm

Remarks :   The figures do not show the details.

Annex 1 Figure 2   Dimensions of centre point
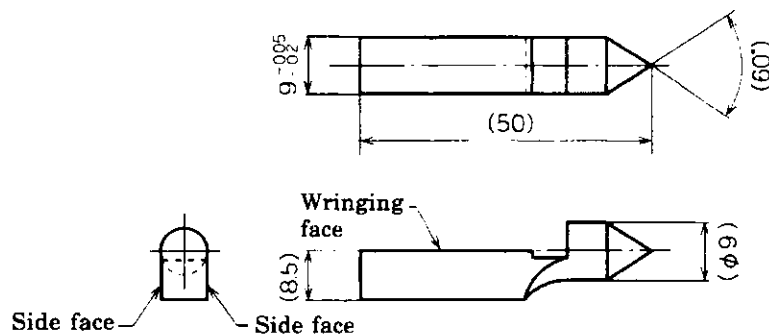
a)   The flatness tolerance of the wringing face shall be 0.5 µm.

b)   Difference between the centre of a point and the wringing face shall be 10 µm or under.

c)   The perpendicularity tolerance of the side face to the wringing face shall be 50 µm.

9 Holder The dimensions and accuracy of the holder shall be as specified in annex 1 figure 3 and shall satisfy the requirements given below.

Unit: mm
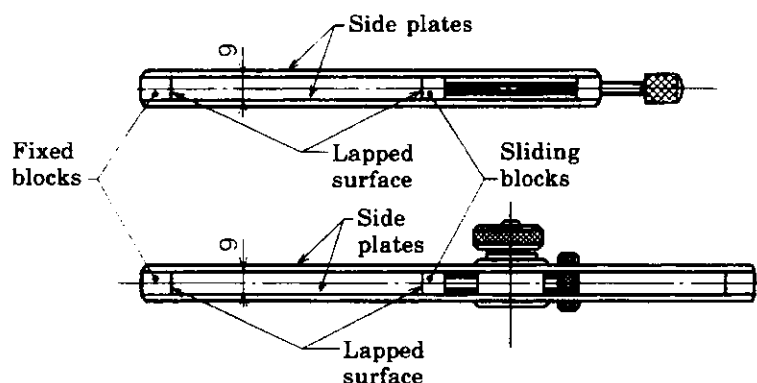
Remarks :   The figures do not show the details.

Annex 1 Figure 3   Dimensions of holder

a)   The nominal length of the holder shall be expressed by the maximum interval between the fixed block and the sliding block.

b)   The permissible deviation from squareness of the side plate relative to the lapped surface of the fixed block shall be 0.3 mm for the maximum interval 300 mm or under.

c)   The distance between the side plates of the holder given in annex 1 figure 3 applies to that of the maximum interval 300 mm or under.

10   Base block   The dimensions and accuracy of the base block shall be as specified in annex 1 figure 4 and shall satisfy the requirements given below.
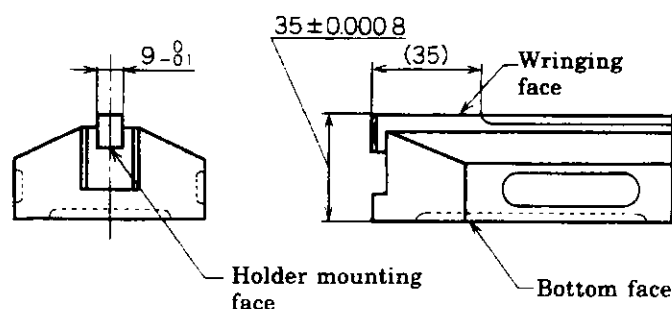
Unit: mm

Remarks :   The figures do not show the details.

Annex 1 Figure 4   Dimensions of base block

a)   The perpendicularity tolerance of the side face of holder mounting portion to the wringing face shall be 50 μm.

b)   The parallelism tolerance of the holder mounting face to the wringing face shall be 2 μm.

c)   The flatness tolerance of the wringing face shall be 0.5 μm.

d)   The flatness tolerance of the bottom face shall be 1 μm.

e)   The parallelism tolerance of the bottom face to the wringing face shall be 0.8 μm.

11 Designation The accessories shall be designated by the number of this Standard, kind and nominal length.

Example : **JIS B 7506** Flat jaw Type A 150 mm

12 Marking The accessories shall be marked with the following details.

a) Manufacturer's name or its abbreviation

b) Nominal length (if any)

Annex 2 (informative) Nominal length and set (combination) of gauge blocks

Introduction This annex is to supplement the matters related to the text and the annex (normative) and not to constitute the provision of this Standard.

1 Nominal length The nominal length of gauge blocks shall generally be as specified in annex 2 table 1. In order to protect the gauge block, protective gauge blocks used by wringing both ends of the gauge block are contained.

Annex 2 Table 1 Nominal length of gauge blocks

Unit: mm

Nominal length									Step of length
1.000 5									—
0.991	0.992	0.993	0.994	0.995	0.996	0.997	0.998	0.999	0.001
1.001	1.002	1.003	1.004	1.005	1.006	1.007	1.008	1.009	
1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	0.01
1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	
1.19	1.20	1.21	1.22	1.23	1.24	1.25	1.26	1.27	
1.28	1.29	1.30	1.31	1.32	1.33	1.34	1.35	1.36	
1.37	1.38	1.39	1.40	1.41	1.42	1.43	1.44	1.45	
1.46	1.47	1.48	1.49						
1.6	1.7	1.8	1.9						0.1
0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	0.5
5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	
9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	
14.0	14.5	15.0	15.5	16.0	16.5	17.0	17.5	18.0	
18.5	19.0	19.5	20.0	20.5	21.0	21.5	22.0	22.5	
23.0	23.5	24.0	24.5	25.0					
30	40	50	60	70	80	90			10
75	100	125	150	175	200				25
250									—
300	400	500	600	700	800	900	1 000		100
750									—

Remarks :   The nominal length of a protective gauge block is 1 mm and 2 mm.

2 Set (combination)

2.1 Set The set of gauge blocks shall be stored in one storing box, and all those gauge blocks shall be of the same grade.

2.2 Storing box The storing box of a set shall have a sufficiently rigid structure wherein gauge blocks can be individually surely stored, and easily put in and taken out, with effective dust prevention and rust prevention. Principal kinds of the sets are given in annex 2 table 2.

Annex 2 Table 2 Kinds of principal sets

Step of length (mm) →	0.001	0.001	0.01	0.01	0.1	0.5	0.5	1	1	—	—	—	—	—	—	—	—	—	—	—	25	—	100	
Range of length → / **Symbol of set ↓**	0.991 to 0.999	1.001 to 1.009	1.01 to 1.09	1.01 to 1.49	1.1 to 1.9	0.5 to 9.5	0.5 to 24.5	1 to 9	1 to 24	1.000 5	1.005	10	20	25	30	40	50	60	75	100	125 to 200	250	300 to 500	Total number of pieces
Number of pieces →																								
S112[1]		9		49			49			1				1			1		1	1				112
S103				49			49				1			1			1		1	1				103
S76				49		19				1	1	1			1	1	1		1	1				76
S47			9		9				24		1			1			1		1	1				47
S32			9		9			9			1	1	1		1			1[2]						32
S18	9	9																						18
S9(+)		9																						9
S9(−)	9																							9
S8																					4	1	3	8

Notes [1] 1.000 5 of S112 may be excluded to constitute S111 (set of 111 pieces).

[2] Instead of 60 mm, 50 mm may be taken.

Remarks : For the symbol wherein protective gauges (two pieces) are added to the abovementioned set, P is suffixed to the end of the set symbol.

Annex 3 (informative) Materials of gauge blocks

Introduction This annex is to supplement the matters related to the text and the annex (normative) and not to constitute the provision of this Standard.

1 Types and symbols of materials The types and symbols of principal materials of gauge blocks shall be as given in annex 3 table 1.

Annex 3 Table 1 Types and symbols of materials

Types of material		Symbol
High carbon high chromium steel		
Chromium carbide		CC
Tungsten carbide		TC
Ceramics	Zirconia	ZO
	Silicon nitride	SN

Annex 4 (informative)   Radiation as wavelength standard for interferometry radiation

Introduction   This annex is to describe the list of radiation recommended as wavelength standard for interferometry by the International Committee of Weights and Measures, and not to constitute the provision of this Standard.

1   Radiation as wavelength standard for interferometry   Radiation as wavelength standard for interferometry of gauge blocks shall be as given in annex 4 table 1, annex 4 table 2 and annex 4 table 3([1]).

Note ([1])   These tables are cited from "Practical realization of the definition of the metre, including recommended radiations of other optical frequency standards (2001)" by T. J. Quinn, Metrologia 40 (2003), pp103-133.

Annex 4 Table 1   Radiation of laser stabilized by saturated absorption

No.	Name of laser	Absorbed atom, molecules	Transition, component	Frequency f (kHz)	Vacuum wavelength λ (fm)	Degree of uncertainty $(k=1)$
1.1	Fourfold multiplying frequency 946 nm Nd: YAG laser	^{115}In$^+$	$5_s^2\,^1S_0 - 5_s5_p\,^3P_0$	1 267 402 452 899.92	236 540 853.549 75	3.6×10^{-13}
1.2	Twofold multiplying frequency 486 nm colouring matter laser	^{1}H	1S-2S	1 233 030 706 593.55	243 134 624.626 04	2.0×10^{-13}
1.3	Twofold multiplying frequency 563 nm colouring matter laser	^{199}Hg$^+$	$5d^{10}6s\ ^2S_{1/2}(F=0)$ $-5d^96s^2\ ^2D_{5/2}(F=2)$ $\Delta m_F=0$	1 064 721 609 899.143	281 568 867.591 969	1.9×10^{-14}
1.4	Twofold multiplying frequency 871 nm semiconductor laser	^{171}Yb$^+$	$6s\ ^2S_{1/2}(F=0.m_F=0)$ $-5d\ ^2D_{3/2}(F=2.m_F=0)$	688 358 979 309.312	435 517 610.739 69	2.9×10^{-14}
1.5	Twofold multiplying frequency 934 nm titan-sapphire laser	^{171}Yb$^+$	$^2S_{1/2}(F=0.m_F=0)$ $-^2F_{7/2}(F=3.m_F=0)$	642 121 496 772.6	466 878 090.061	4.0×10^{-12}
1.6	Iodine-stabilized Nd: YAG laser	^{127}I$_2$	R(56) 32-0 a_{10} component	563 260 223 513	532 245 036.104	8.9×10^{-12}
1.7	Iodine-stabilized helium neon laser	^{127}I$_2$	R(127) 11-5 a_{16} (f) component	473 612 353 604	632 991 212.58	2.1×10^{-11}
1.8	Calcium-stabilized laser	^{40}Ca	$^1S_0-^3P_1$; $\Delta m_J=0$	455 986 240 494.150	657 459 439.291 67	1.1×10^{-13}
1.9	Strontium-stabilized semiconductor laser	^{88}Sr$^+$	$5\ ^2S_{1/2}-4^2D_{5/2}$	444 779 044 095.5	674 025 590.863 1	7.9×10^{-13}
1.10	Rubidium-stabilized semi-conductor laser	^{85}Rb	$5S_{1/2}(Fg=3)$ $-5D_{5/2}(Fe=5)$	385 285 142 375	778 105 421.23	1.3×10^{-11}
1.11	Acetylene-stabilized semiconductor laser or solid laser	^{13}C$_2$H$_2$	$P(16)(\nu_1 + \nu_3)$	194 369 569.4 (MHz)	1 542 383 712	5.2×10^{-10}

Annex 4 Table 1 (concluded)

No.	Name of laser	Absorbed atom, molecules	Transition, component	Frequency f (kHz)	Vacuum wavelength λ (fm)	Degree of uncertainty ($k=1$)
1.12.1	Methane-stabilized helium neon laser	CH_4	P(7) ν_3 $F_2^{(2)}$ component Irresolvable spectrum	88 376 181 600.18	3 392 231 397.327	3.0×10^{-12}
1.12.2	Methane-stabilized helium neon laser	CH_4	P(7) ν_3 $F_2^{(2)}$ component Broken down ultrastructure	88 376 181 600.5	3 392 231 397.31	2.3×10^{-11}
1.13	Osmium-stabilized CO_2 laser	OsO_4 $^{12}C^{16}O_2$	R(10)(00^{0}1)-(10^{0}0)	29 054 057 446.579	10 318 436 884.460	$1.4 \cdot 10^{-13}$

Annex 4 Table 2 Radiation of spectral lamp

No.	Name of lamp	Isotope	Transition	Frequency	Vacuum wavelength λ (pm)	Degree of uncertainty ($k=3$)
2.1	Krypton lamp	^{86}Kr	$5d_5$-$2p_{10}$	–	605 780.210 3	3.9×10^{-9}
2.2	Krypton lamp	^{86}Kr	$2p_9$-$5d'_4$ $2p_8$-$5d_4$ $1s_3$-$3p_{10}$ $1s_4$-$3p_8$	–	645 807.20 642 280.06 565 112.86 450 361.62	2.0×10^{-8}
	Mercury lamp	^{198}Hg	6^1P_1-6^1D_2 6^1P_1-6^3D_2 6^3P_2-7^3S_1 6^3P_1-7^3S_1	–	579 226.83 577 119.83 546 227.05 435 956.24	5.0×10^{-8}
	Cadmium lamp	^{114}Cd	5^1P_1-5^1D_2 5^3P_2-6^3S_1 5^3P_1-6^3S_1 5^3P_0-6^3S_1	–	644 024.80 508 723.79 480 125.21 467 945.81	7.0×10^{-8}

Annex 4 Table 3 Other light sources

No.	Name of laser	Absorbed atom, molecules	Transition	Frequency f (MHz)	Vacuum wavelength λ (fm)	Degree of uncertainty ($k=1$)
2.3	Iodine-stabilized Argon ion laser	$^{127}I_2$	P(13) 43-0 a_3 component	582 490 603.38	514 673 466.4	2.5×10^{-10}
2.4	Iodine-stabilized helium neon laser	$^{127}I_2$	R(12) 26-0 a_9 component	551 579 482.97	543 516 333.1	2.5×10^{-10}
2.5	Iodine-stabilized colouring matter laser (twofold multiplying helium neon laser)	$^{127}I_2$	P(62) 17-1 a_1 component	520 206 808.4	576 294 760.4	4.0×10^{-10}
2.6	Iodine-stabilized helium neon laser	$^{127}I_2$	R(47) 9-2 a_7 component	489 880 354.9	611 970 770.0	3.0×10^{-10}
2.7	Iodine-stabilized helium neon laser	$^{127}I_2$	P(10) 8-5 a_9 component	468 218 332.4	640 283 468.7	4.5×10^{-10}

Annex 5 (informative) Comparison table between JIS and corresponding International Standard

(I) Requirements in JIS — JIS B 7506 : 2004 Gauge blocks		(II) International Standard number	(III) Requirements in International Standard — ISO 3650 : 1998 Geometrical Product Specifications (GPS) — Length standards — Gauge blocks		(IV) Classification and details of technical deviation between JIS and the International Standard by clause — Location of deviation: text, annexes; Indication method: dotted underlines or continuous sidelines		(V) Justification for the technical deviation and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
1 Scope	Provisions for length, grade and accessories in annex 1, of gauge blocks	ISO 3650	1	Length and grade of gauge blocks	MOD/addition	Provisions for accessories are added.	In JIS, the provisions for accessories are considered necessary for effective on-site use.
2 Normative references	JIS B 0021 JIS B 0641-1 JIS Z 2244 JIS Z 8103 ISO 1		2	ISO/DIS 1101 ISO 14253-1 ISO 6507-1 VIM ISO 1	IDT		
3 Definitions and symbols	Definitions and symbols gauge block length of a gauge block central length deviation of the length from nominal length limit deviation of the length tolerance for the variation in length flatness wringing Figure 1 Length Figure 2 Central length Figure 3 Deviation of length Figure 4 Flatness		3	Definitions and symbols gauge block length of a gauge block central length deviation of the length variation in length flatness wringing Figure 1 Length, central length, measuring face, auxiliary plate Figure 3 Deviation of length and variation in length Figure 2 Deviation from flatness	MOD/addition	JIS has more detailed explanation.	

(I) Requirements in JIS		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between JIS and the International Standard by clause. Location of deviation: text, annexes. Indication method: dotted underlines or continuous sidelines		(V) Justification for the technical deviation and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
4 Nomen-clature	Nomenclature Figure 5 Nomenclature of faces of a gauge block		4	Nomenclature Figure 4 Nomenclature of faces	MOD/addition	JIS has more detailed explanation.	
5 Grades	Grades			International Standard has not this clause.	MOD/addition	International Standard mentions them slightly in the scope and the clause for Calibration.	
6 Accuracy	Accuracy		7	Metrological requirements			JIS has a description easier to understand and is more convenient for the users. We will work ISO to modify its style like that of JIS.
	Requirements for grades and treatment of uncertainties of calibration are given in "General". Limit deviation of the length, tolerance for the variation in length, table 1 Flatness tolerance on measuring face, table 2 Wringing property		7.1	Requirements for grades and treatment of uncertainties of calibration are given in "General". Flatness tolerance on measuring face, table 3 Limit deviation of the length and tolerance for the variation in length, table 5 Measuring faces (wringing, edges)	IDT	International Standard gives the limit deviation of the length and the tolerance for the variation in length in table 5.	
			7.2		IDT		

(I) Requirements in JIS		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between JIS and the International Standard by clause Location of deviation: text, annexes Indication method: dotted underlines or continuous sidelines		(V) Justification for the technical deviation and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
7 Shapes and dimensions	Dimension of cross section, table 3 Edges Flatness tolerances and and parallelism tolerance of side faces, table 4 Perpendicularity tolerance of side faces, table 5 and figure 6 Coupling holes, figure 7		6 6.1 7.3 7.4	General dimensions, material properties, marking General dimensions, table 1, coupling holes, figure 5 Measuring faces, edges Side faces Flatness tolerances, table 3 Parallelism tolerances Perpendicularity tolerances, table 4, figure 6	IDT IDT IDT	International Standard specifies general dimensions and their limit deviations as one of the performances. JIS specifies them separately.	
8 Material	Material Coefficient of thermal expansion Hardness Dimensional stability, table 6		6.2	Material Coefficient of thermal expansion Hardness Dimensional stability, table 2	IDT		
9 Basis of measurement, traceability and reference condition	Unit of length: metre Traceability of the length of a gauge block Reference conditions Reference orientation		5	Unit of length: metre Traceability of the length of a gauge block Reference temperature and standard pressure Reference orientation	MOD/addition	JIS adds standard water vapour pressure and standard carbon dioxide content to the standard condition.	JIS takes into consideration the Japanese environmental conditions.

(I) Requirements in JIS		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between JIS and the International Standard by clause — Location of deviation: text, annexes; Indication method: dotted underlines or continuous sidelines		(V) Justification for the technical deviation and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
10 Calibration of gauge blocks			8	Calibration of gauge blocks	IDT		JIS takes into consideration the Japanese environmental and using conditions.
			8.1	General			
	Measurement by interferometry / Measured length / Auxiliary plate / Corrections / Length inspection certificate		8.3	Measurement by interferometry / Measured length / Auxiliary plate / Corrections / Calibration certificate	MOD/addition	JIS describes this in each measuring item. JIS adds the concentration of carbon dioxide to the correction item in measurement by interferometry, and shows the measuring positions of variation in length in measurement by comparison in informative figure 1.	
	Measurement by comparison / Central length, figure 8 Measurement of central length / Method for measurement / Variation in length, informative figure 1 / Corrections / Length inspection certificate / Wringing test		8.4	Measurement by comparison / Principle of measurement, figure 7 / Measurement of central length / Central length / Method for determining length by comparison, annex A / Variation in length / Corrections / Calibration certificate / Wringing test	MOD/addition		
			8.2		IDT		
11 Designation of product	Designation of product is specified.				MOD/addition	International Standard has no specification.	

32
B 7506 : 2004

(I) Requirements in JIS		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between JIS and the International Standard by clause Location of deviation: text, annexes Indication method: dotted underlines or continuous sidelines		(V) Justification for the technical deviation and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
12 Marking	Marking items (marking face and position), figure 9 Marking Marking for support position Marking for grade Inspection certificate of length and grade		6.3	Marking (marking items, marking face and position)	MOD/addition	JIS has the additional specification that, the gauge blocks of grades K and 0 shall be provided with the length inspection certificate and those of grades 1 and 2 shall be provided with the grade inspection certificate.	
Annex A (informative) Example of a device for the comparison of gauge blocks	Three examples of comparators are shown: by two point measuring method, by one point measuring method and the horizontal position type used for gauge blocks of long size.			An example of a comparator by two point measuring method is shown.	MOD/addition	JIS adds the examples of comparators used in Japan.	
Annex B (informative) Relation to the GPS matrix model					IDT		
Annex C (informative) Bibliography					IDT		

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(I) Requirements in JIS		(II) International Standard number	(III) Requirements in International Standard			(IV) Classification and details of technical deviation between JIS and the International Standard by clause — Location of deviation: text, annexes — Indication method: dotted underlines or continuous sidelines		(V) Justification for the technical deviation and future measures
Clause	Content		Clause		Content	Classification by clause	Detail of technical deviation	
Annex 1 (normative) Gauge block accessories	Accessories required for using gauge blocks are specified.					MOD/addition	International Standard has no specification.	Gauge blocks cannot be used effectively without accessories. **JIS** makes much of user's convenience while the International Standard primarily intends to give the criteria. So the difference will remain (same for the following).
Annex 2 (informative) Nominal length and set (combination) of gauge blocks	Series of nominal length and their typical sets (combination) of gauge blocks are shown as information.					MOD/addition	International Standard has no specification.	**JIS** makes much of users' convenience for the user.
Annex 3 (informative) Materials of gauge blocks	Materials of gauge blocks and their symbols are shown as information.					MOD/addition	International Standard has no specification.	**JIS** makes much of convenience for both manufacturers and users.
Annex 4 (informative) Radiation as wavelength standard for interferometry radiation	The recommendation of wavelength standard for interferometry by the International Committee of Weights and Measures is shown as information.					MOD/addition	International Standard has no specification.	**JIS** makes much of convenience for personnel using interferometry.

Designated degree of correspondence between **JIS** and International Standard: MOD

Remarks 1 Symbols in sub-columns of classification by clause in the above table indicate as follows:

– IDT: Identical in technical contents.

– MOD/addition: Adds the specification item(s) and content(s) which are not included in International Standard.

2 Symbol in column of designated degree of correspondence between **JIS** and International Standard in the above table indicates as follows:

– MOD: Modifies International Standard.

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