

Gauge Blocks

Features and Accuracies

Features of Mitutoyo gauge blocks

Mitutoyo offers gauge blocks for use as length standards that are fully domestically manufactured at our plant in Japan and highly trusted worldwide for their accuracy, quality, and durability. They are available in three types: steel rectangular gauge blocks, ceramic rectangular gauge blocks (CERA Blocks), and steel square gauge blocks. In addition, tungsten carbide rectangular gauge blocks and tungsten carbide square gauge blocks are available as protectors. Select the right gauge blocks depending on the conditions, environment, and application of use.

Accuracy

Our calibration technique combined with established traceability to the Japanese national standard ensures that highly reliable products are delivered. We ensure the traceability of all our gauge blocks and guarantee their accuracy based on the national standard, so you can feel confident when using them.

Wringing

Lapping measuring surfaces is one of Mitutoyo's specialties. Our advanced technique, developed over more than half a century, enables us to achieve the optimum flatness and surface finish needed for gauge blocks and thus maximize the wringing force.

Abrasion resistance and dimensional stability

By adopting high-carbon, high-chrome steel that can satisfy various material characteristics necessary for gauge blocks, and thermally processing it carefully and repeatedly with our advanced technology, we produce high levels of hardness for reliable use and minimize aging deterioration as much as possible.

CERA Blocks

Produced by using our ultra-precision processing technology and ceramic materials with excellent surface smoothness, CERA Blocks feature the following advantages not delivered by steel blocks.

(1) Corrosion Resistant

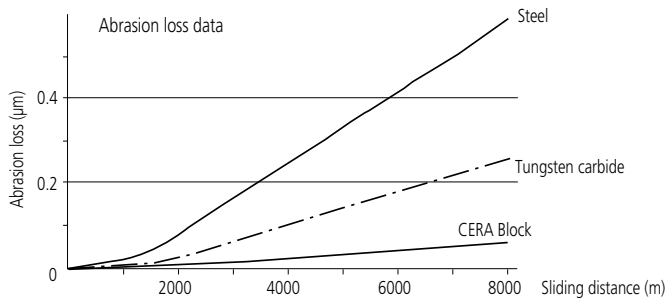
Anti-corrosion treatment is not required when handled normally (i.e. with fingers), resulting in simple maintenance and storage.

(2) No Burrs Caused by Accidental Mishandling

Since the CERA Block is very hard, it will not scratch easily and is highly resistant to burrs. If a burr is formed, it can easily be removed with a ceramic deburring stone (Ceraston).

(3) Excellent abrasion resistance

CERA Blocks are 10 times more resistant to abrasion than steel blocks and therefore have a longer life (based on in-house test results).



(4) Dimensional Stability

CERA Blocks are highly resistant to dimensional changes over time.

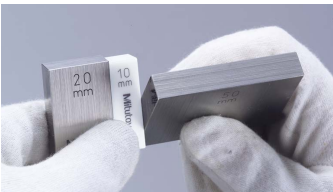
(5) Clearly Marked Sizes

Black characters, indicating the nominal length, are inscribed by laser and are clearly visible against the white surface of the block.

(6) Non-magnetic Nature Prevents Steel Swarf Contamination

(7) High Wringing Force

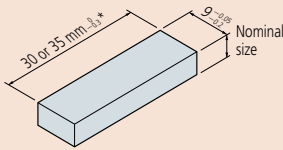
Superior flatness and surface finish provides maximum wringing force.



Classification of Gauge Blocks by Shape

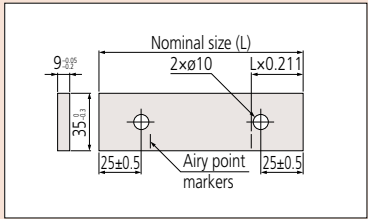
Mitutoyo broadly divides gauge blocks into two categories according to the block shape.

Rectangular gauge blocks



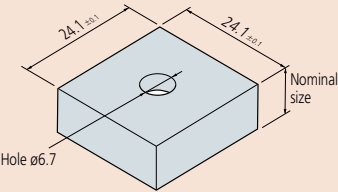
* Depends on the nominal size.
More than 10 mm: 35 mm
10 mm or less: 30 mm

All standard long blocks 125 mm or more have two coupling holes on the body.



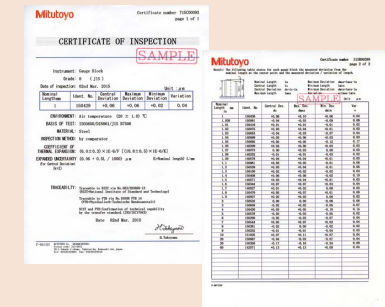
Long rectangular gauge blocks

Square gauge blocks



Mitutoyo Gauge Blocks and Inspection Certificates

A Certificate of Inspection is furnished with all Mitutoyo gauge blocks with a serial number on the box (in the case of sets) and an identification number on each block. The deviation of each block from nominal length, at the time of inspection, is stated. For this inspection, each gauge block is measured relative to the upper level master using a gauge block comparator. Grade K gauge blocks are measured by a primary measurement method using an interferometer.



Selecting Gauge Blocks

- Select gauge blocks in accordance with the combination range required.
If a large length is required, use one or more blocks from a long-block set.
- Select gauge blocks in accordance with the minimum length step required. Add a wear block at each end of the stack if the workpiece material is abrasive, or if the stack will be used frequently.
- If a set containing a large number of gauge blocks is selected, the number of gauge blocks required for any particular length is reduced and the number of combinations is increased. Accuracy of the blocks in the set will be retained longer because normal wear will be spread over a larger number of blocks.
- Gauge block sets dedicated to micrometer and caliper inspection are available (refer to page 01-13 for details).
- If using only one length repeatedly, it is a good idea to purchase discrete gauge blocks (refer to pages 01-15, 01-16, 01-17, 01-18, 01-25, and 01-26 for details).
- Products can be provided in combinations other than those in our standard sets. When placing such orders, please specify whether a storage box is required. Feel free to consult us if you need gauge blocks compliant with British (BS), American, or other standards. The U.S. Federal Specification for gauge blocks was replaced by ASME B89.1.9 in 2002. Please contact your local Mitutoyo sales office for further information.
- 2 mm-based gauge blocks, which take the base of the minimum length step as 2 mm, are available and many people find them easier to handle than 1 mm-based gauge blocks.
- All Mitutoyo gauge blocks, whether sold in sets or individually, come with a measurement inspection certificate.

Constructing a Gauge Block Stack

The following points should be noted when constructing a gauge block stack:

- (1) Use as few gauge blocks as possible to obtain the required length by selecting thick blocks wherever possible.
- (2) Select the block for the least significant digit first, then work back through the more significant digits until the required length is attained.
- (3) There are multiple combinations for the integer part of a length. To prevent wear as much as possible, do not always use the same gauge blocks.

Example: Required length=45.6785 mm

• For a 1 mm-based gauge block set

$$\begin{array}{r}
 1.0005 \\
 1.008 \\
 1.17 \\
 17.5 \\
 +) \quad 25 \\
 \hline
 45.6785 \text{ mm}
 \end{array}$$

• For a 2 mm-based gauge block set

$$\begin{array}{r}
 2.0005 \\
 2.008 \\
 2.17 \\
 14.5 \\
 +) \quad 25 \\
 \hline
 45.6785 \text{ mm}
 \end{array}$$

Note: Regarding the method for wringing, refer to "Quick Guide to Precision Measuring Instruments" on page 13-28.



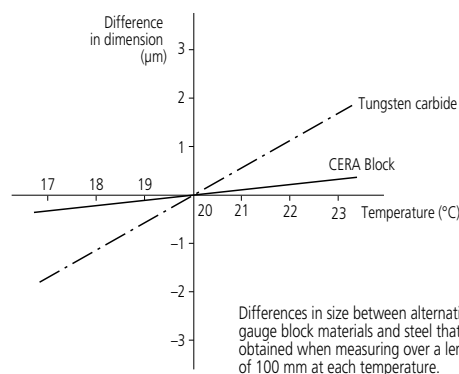
(8) Superior Material Characteristics of CERA Block

Property	Material	CERA Block (ZrO ₂)	Steel (Fe)	Tungsten Carbide (WC-Co)	ZERO CERA Blocks (Low thermal expansion)
Hardness (HV)		1350	800	1650	826
Coefficient of thermal expansion (10 ⁻⁶ /K)		9.3±0.5	10.8±0.5	5.5±1.0	0±0.02
Flexural strength by 3-point bending (MPa)		1270	1960	1960	210
Fracture toughness K _{1c} (MPa·m ^{1/2})		7	120	12	1.2
Young's modulus ×10 ⁴ (MPa)		20.6	20.6	61.8	130
Poisson's ratio		0.3	0.3	0.2	0.3
Specific gravity		6.0	7.8	14.8	2.5
Thermal conductivity (W/m·K)		2.9	54.4	79.5	3.7

Note: Ceramics have the advantage of a slow response to temperature changes due to the low thermal conductivity. However, caution is required when using CERA blocks under conditions of rapid temperature change.

(9) Difference in expansion coefficient between steel and CERA blocks is just 1.5×10⁻⁶/K

The thermal expansion coefficient of a CERA Block is quite similar to that of a steel gauge block.



(10) Highly Resistant to Dropping and Impact Damage

The CERA Block material is one of the toughest ceramics. It is extremely difficult to crack a CERA Block in normal use.

Features of Square Gauge Blocks



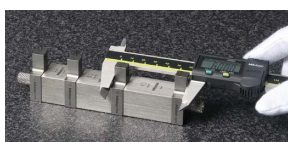
(1) Gauge blocks in a stack can be clamped together

After wringing square gauge blocks, a tie rod can be inserted through the center hole to clamp the blocks together for extra security.



(2) A height reference standard can easily be made

A precision height reference standard can be made easily and inexpensively using accessories such as the plain jaw and block base.



(3) A dedicated inspection jig can easily be made

A dedicated inspection jig for periodic inspection of instruments can be made easily and inexpensively.



(4) A wide measuring surface with cross-sectional dimensions of 24.1×24.1 mm is available.

A square gauge block retains stable orientation both longitudinally and laterally. A wide range of applications is covered, including cutting tool positioning, angle measurement with a sine bar, taper measurement with a roller, and inspection of depth micrometers.

Long and Ultra-Thin Gauge Blocks

Mitutoyo offers extra-thin gauge blocks from 0.10 mm to 0.99 mm (increments of 0.01 mm) as well as long gauge blocks up to 1,000 mm as standard products.

Gauge Blocks

Features and Accuracies

Grade and Application

The following table can be used to select the gauge block grade according to usage (specified by ISO3650, BS4311, and JIS B 7506).

	Applications	Grade
Workshop use	• Mounting tools and cutters	2
	• Manufacturing gages	1 or 2
	• Calibrating instruments	
Inspection use	• Inspecting mechanical parts, tools, etc.	1 or 2
	• Checking the accuracy of gages	0 or 1
	• Calibrating instruments	
Calibration use	• Checking the accuracy of gauge blocks for workshop • Checking the accuracy of gauge blocks for inspection • Checking the accuracy of instruments	K or 0
Reference use	• Checking the accuracy of gauge blocks for calibration • For academic research	K

ACCURACY SPECIFICATIONS: JIS B 7506-2004 (JAPAN) ISO 3650:1998 (at 20 °C)

Nominal length (mm)		Grade K		Grade 0		Grade 1		Grade 2	
		Limit deviation of length at any point (μm)	Tolerance for the variation in length (μm)	Limit deviation of length at any point (μm)	Tolerance for the variation in length (μm)	Limit deviation of length at any point (μm)	Tolerance for the variation in length (μm)	Limit deviation of length at any point (μm)	Tolerance for the variation in length (μm)
from 0.5	up to 10	±0.20	0.05	±0.12	0.10	±0.20	0.16	±0.45	0.30
over 10	up to 25	±0.30	0.05	±0.14	0.10	±0.30	0.16	±0.60	0.30
over 25	up to 50	±0.40	0.06	±0.20	0.10	±0.40	0.18	±0.80	0.30
over 50	up to 75	±0.50	0.06	±0.25	0.12	±0.50	0.18	±1.00	0.35
over 75	up to 100	±0.60	0.07	±0.30	0.12	±0.60	0.20	±1.20	0.35
over 100	up to 150	±0.80	0.08	±0.40	0.14	±0.80	0.20	±1.60	0.40
over 150	up to 200	±1.00	0.09	±0.50	0.16	±1.00	0.25	±2.00	0.40
over 200	up to 250	±1.20	0.10	±0.60	0.16	±1.20	0.25	±2.40	0.45
over 250	up to 300	±1.40	0.10	±0.70	0.18	±1.40	0.25	±2.80	0.50
over 300	up to 400	±1.80	0.12	±0.90	0.20	±1.80	0.30	±3.60	0.50
over 400	up to 500	±2.20	0.14	±1.10	0.25	±2.20	0.35	±4.40	0.60
over 500	up to 600	±2.60	0.16	±1.30	0.25	±2.60	0.40	±5.00	0.70
over 600	up to 700	±3.00	0.18	±1.50	0.30	±3.00	0.45	±6.00	0.70
over 700	up to 800	±3.40	0.20	±1.70	0.30	±3.40	0.50	±6.50	0.80
over 800	up to 900	±3.80	0.20	±1.90	0.35	±3.80	0.50	±7.50	0.90
over 900	up to 1000	±4.20	0.25	±2.00	0.40	±4.20	0.60	±8.00	1.00

ACCURACY SPECIFICATIONS: BS 4311:2007 (UK) (at 20 °C)

Nominal length (in)		Grade K		Grade 0		Grade 1		Grade 2	
		Limit deviation of length at any point (μin)	Tolerance for the variation in length (μin)	Limit deviation of length at any point (μin)	Tolerance for the variation in length (μin)	Limit deviation of length at any point (μin)	Tolerance for the variation in length (μin)	Limit deviation of length at any point (μin)	Tolerance for the variation in length (μin)
over 0	up to 0.4	±8	2	±5	4	±8	6	±18	12
over 0.4	up to 1	±12	2	±6	4	±12	6	±24	12
over 1	up to 2	±16	3	±8	4	±16	7	±32	12
over 2	up to 3	±20	3	±10	5	±20	7	±40	14
over 3	up to 4	±24	3	±12	5	±24	8	±48	14

Note 1: The accuracy of nominal lengths from 0.1 mm up to less than 0.5 mm follows that of nominal lengths from 0.5 mm up to 10 mm.

Note 2: Grade K gauge blocks are only available as made-to-order rectangular gauge blocks.

Note 3: Grade K gauge blocks are supplied with a JCSS calibration certificate. When ordering, kindly provide your formal name and contact information.

ACCURACY SPECIFICATIONS: ASME B89.1.9-2002 (USA)

(at 20 °C)

Nominal length (in)		Grade K		Grade 00		Grade 0		Grade 1		Grade 2	
		Limit deviation of length at any point (μin)	Tolerance for the variation in length (μin)	Limit deviation of length at any point (μin)	Tolerance for the variation in length (μin)	Limit deviation of length at any point (μin)	Tolerance for the variation in length (μin)	Limit deviation of length at any point (μin)	Tolerance for the variation in length (μin)	Limit deviation of length at any point (μin)	Tolerance for the variation in length (μin)
	up to 0.05	±12	2	±4	2	±6	4	±12	6	±24	12
over 0.05	up to 0.4	±10	2	±3	2	±5	4	±8	6	±18	12
over 0.45	up to 1	±12	2	±3	2	±6	4	±12	6	±24	12
over 1	up to 2	±16	2	±4	2	±8	4	±16	6	±32	12
over 2	up to 3	±20	2	±5	3	±10	4	±20	6	±40	14
over 3	up to 4	±24	3	±6	3	±12	5	±24	8	±48	14
over 4	up to 5	±32	3	±8	3	±16	5	±32	8	±64	16
over 5	up to 6	±32	3	±8	3	±16	5	±32	8	±64	16
over 6	up to 7	±40	4	±10	4	±20	6	±40	10	±80	16
over 7	up to 8	±40	4	±10	4	±20	6	±40	10	±80	16
over 8	up to 10	±48	4	±12	4	±24	6	±48	10	±104	18
over 10	up to 12	±56	4	±14	4	±28	7	±56	10	±112	20
over 12	up to 16	±72	5	±18	5	±36	8	±72	12	±144	20
over 16	up to 20	±88	6	±20	6	±44	10	±88	14	±176	24
over 20	up to 24	±104	6	±25	6	±52	10	±104	16	±200	28
over 24	up to 28	±120	7	±30	7	±60	12	±120	18	±240	28
over 28	up to 32	±136	8	±34	8	±68	12	±136	20	±260	32
over 32	up to 36	±152	8	±38	8	±76	14	±152	20	±300	36
over 36	up to 40	±160	10	±40	10	±80	16	±168	24	±320	40

Nominal length (mm)		Grade K		Grade 00		Grade 0		Grade 1		Grade 2	
		Limit deviation of length at any point (μm)	Tolerance for the variation in length (μm)	Limit deviation of length at any point (μm)	Tolerance for the variation in length (μm)	Limit deviation of length at any point (μm)	Tolerance for the variation in length (μm)	Limit deviation of length at any point (μm)	Tolerance for the variation in length (μm)	Limit deviation of length at any point (μm)	Tolerance for the variation in length (μm)
	up to 0.5	±0.30	0.05	±0.10	0.05	±0.14	0.10	±0.30	0.16	±0.60	0.30
over 0.5	up to 10	±0.20	0.05	±0.07	0.05	±0.12	0.10	±0.20	0.16	±0.45	0.30
over 10	up to 25	±0.30	0.05	±0.07	0.05	±0.14	0.10	±0.30	0.16	±0.60	0.30
over 25	up to 50	±0.40	0.06	±0.10	0.06	±0.20	0.10	±0.40	0.18	±0.80	0.30
over 50	up to 75	±0.50	0.06	±0.12	0.06	±0.25	0.12	±0.50	0.18	±1.00	0.35
over 75	up to 100	±0.60	0.07	±0.15	0.07	±0.30	0.12	±0.60	0.20	±1.20	0.35
over 100	up to 150	±0.80	0.08	±0.20	0.08	±0.40	0.14	±0.80	0.20	±1.60	0.40
over 150	up to 200	±1.00	0.09	±0.25	0.09	±0.50	0.16	±1.00	0.25	±2.00	0.40
over 200	up to 250	±1.20	0.10	±0.30	0.10	±0.60	0.16	±1.20	0.25	±2.40	0.45
over 250	up to 300	±1.40	0.10	±0.35	0.10	±0.70	0.18	±1.40	0.25	±2.80	0.50
over 300	up to 400	±1.80	0.12	±0.45	0.12	±0.90	0.20	±1.80	0.30	±3.60	0.50
over 400	up to 500	±2.20	0.14	±0.50	0.14	±1.10	0.25	±2.20	0.35	±4.40	0.60
over 500	up to 600	±2.60	0.16	±0.65	0.16	±1.30	0.25	±2.60	0.40	±5.00	0.70
over 600	up to 700	±3.00	0.18	±0.75	0.18	±1.50	0.30	±3.00	0.45	±6.00	0.70
over 700	up to 800	±3.40	0.20	±0.85	0.20	±1.70	0.30	±3.40	0.50	±6.50	0.80
over 800	up to 900	±3.80	0.20	±0.95	0.20	±1.90	0.35	±3.80	0.50	±7.50	0.90
over 900	up to 1000	±4.20	0.25	±1.00	0.25	±2.00	0.40	±4.20	0.60	±8.00	1.00

Note 1: The accuracy of nominal lengths from 0.1 mm up to less than 0.5 mm follows that of nominal lengths from 0.5 mm up to 10 mm.

Note 2: Grade K gauge blocks are only available as made-to-order rectangular gauge blocks.

Note 3: Grade K gauge blocks are supplied with a JCSS calibration certificate. When ordering, kindly provide your formal name and contact information.

Limit deviation of length at any point

This is the permitted deviation from nominal length.

The deviation of length, expressed as "actual length - nominal length", is measured at a total of five points: the "middle point" of the gauge block measuring face and the "four corners, at 1.5 mm on the inside from the side faces".

Tolerance for the variation in length

This is the permitted variation in length.

The variation in length is expressed as "deviation of length for the maximum (greatest length) - deviation of length for the minimum (smallest length)" among those measured at the five points mentioned above.