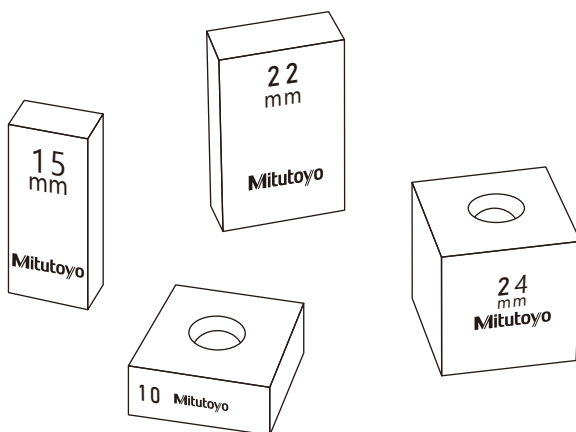




Gauge Blocks/ CERA Blocks



User's Manual

- Instructions for use -

Read this document thoroughly before operating the product. After reading, retain it close at hand for future reference.

This English language version of the document contains the original instructions.

No. 99MAK004B4

Date of publication: January 1, 2023 (1)



■ Product names and model numbers covered in this document

This document is included with the following products.

Product name	Model number
Rectangular Gauge Block set (steel, millimeter units)	BM1-XXX
Rectangular Gauge Block set (ceramic, millimeter units)	BM3-XXX
Square Gauge Block set (steel, millimeter units)	BM4-XXX
Rectangular Gauge Block set (steel, inch units)	BE1-XXX
Rectangular Gauge Block set (ceramic, inch units)	BE3-XXX
Square Gauge Block set (steel, inch units)	BE4-XXX
Square Gauge Block set (ceramic, inch units)	BE6-XXX

■ Notice regarding this document

- Mitutoyo Corporation assumes no responsibilities for any damage to the product, caused by its use not conforming to the procedure described in this document.
- Upon loan or transfer of this product, be sure to attach this document to the product.
- In the event of loss or damage to this document, immediately contact the agent where you purchased the product or a Mitutoyo sales office.
- Read this document thoroughly before operating the product. In particular, be sure to fully understand "Safety Precautions" on page 4 and "Precautions for Use" on page 4.
- The contents of this document are based on information current as of January 2023.
- No part or whole of this document may be transmitted or reproduced by any means without prior written permission of Mitutoyo Corporation.
- Some screen displays in this document may be highlighted, simplified or partially omitted for convenience of explanation. In addition, some of them may differ from actual ones to the extent that no user will misunderstand the functions and operations.
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About This Document

■ Intended readers and purpose of this document

● Intended readers

This document is intended for those who have a basic knowledge of how to use Gauge Blocks, wringing, characteristics, reference gage applications, etc.

● Purpose



The purpose of this document is to help you understand the basic usage, work procedures, and the various functions of Gauge Blocks/CERA Blocks.

Conventions Used in This Document

■ Safety reminder conventions warning against potential hazards

NOTICE	Indicates a situation which, if not avoided, may result in property damage.
---------------	--

■ Conventions indicating referential information or reference location

IMPORTANT	Indicates information that must be known when using the product.
Tips	Indicates further information and details relevant for the operating methods and procedures that are explained in that section.
	Indicates reference location if there is information that should be referred to in this document or an extraneous User's Manual. Example: For details about XX, see  "2 How to Use Gauge Blocks" on page 11.

■ Other conventions

(): Round brackets	Represent a paraphrase of an immediately preceding phrase or a supplementary explanation.
" ": Double quotation marks	Represent a highlighted phrase. They also indicate an index where information to be referenced is described.
1, 2, 3 1, 2, 3, ...	Indicates the order and the contents of tasks. (1 : indicates main tasks, 1 : indicates detailed tasks)
»	Indicates the action resulted from some operation(s).

■ Example of conventions use

2 How to Use Gauge Blocks


4 Wring the 30 mm Gauge Block and other Gauge Blocks together in order of thickness.

Tips
 When wringing a thin Gauge Block, check the state of the measurement surface of the thin Gauge Block. Do not use abrasives on the optical flat.
 For details about wringing, see "2.2 Wringing" (page 16).


5 Perform thermal stabilization.

6 Use as a reference gage.

Example of comparative measurement



Example of zero-setting for a measuring tool



2 How to Use Gauge Blocks

2 Gently place the optical flat on the measurement surface of the Gauge Block.

IMPORTANT
 Place the optical flat on the measurement surface of the Gauge Block so that the arrow printed on the side of the optical flat points downward.

3 Lightly slide the optical flat.
 » If interference fringes appear: Proceed to step 4.

» If interference fringes do not appear: Burrs exist; proceed to step 2.

Tips
 Interference fringes may not appear if the surfaces were not wiped sufficiently or if paper fibers are present on the surface. In this case, wipe the surfaces again, and then repeat from step 2.

4 Lightly hold down the optical flat.

Indicates an operating procedure to be performed or its outline.

Indicates the referential location.

Indicates specific work procedures.

Indicates supplementary information.

Indicates the action resulted from some operation(s).

Safety Precautions

Read these "Safety Precautions" thoroughly before operating the system to use it properly.

These safety precautions include such information as to prevent an injury to the operator and other persons or damage to property. Be sure to observe the precautions.

NOTICE

Do not exert external forces to this product. Doing so may cause breakage.

Precautions for Use

■ Product applications and handling

● This product is a length reference gage (end standard).

Do not use it for any purposes other than its prescribed usage as a length reference gage.

● This product is precision equipment.

- It must be carefully handled. Be careful not to apply excessive shock or force to any of the parts during storage or use.
- If an excessive impact is applied, the center dimensions or the range of dimension differences, etc., may be affected. Have calibration performed to check the dimensions.
- Before use, use a soft cloth soaked in solvent, etc., to wipe off any dirt or rust-proofing oil. Do not use organic solvents such as thinner or benzene.
- If rusting occurs on the sides of this product, wipe the rust off with a soft cloth. Do not use sandpaper or polishing paper.

■ Operating environment

Only use this product in the following environments.

- Areas free of dirt and dust
- Areas free of vibrations
- Areas in the recommended temperature of 20 °C or so with minimal temperature change

IMPORTANT

When using this product, be sure to perform sufficient thermal stabilization.

- On the surface plate (recommended)

Avoid using the product in the following environments.

- Areas directly subject to drafts of hot air, cool air, or air conditioning

■ Maintenance

After use, wipe dirt off the product with a soft cloth soaked in solvent, etc., and then apply anti-rust oil in a thin layer (for rust prevention). Do not use organic solvents such as thinner or benzene.

Tips

- For Gauge Blocks made of ceramics (CERA Blocks), rustproofing treatment is not necessary.
- Recommended solvent: Normal heptane
- Recommended anti-rust oil: MOLYKOTE SUPERGLISS (Dow Corning Toray Co., Ltd.)

Export Control Compliance

This product falls into the Catch-All-Controlled Goods and/or Catch-All-Controlled Technologies (including Programs) under Category 16 of Appended Table 1 of Export Trade Control Order or under Category 16 of Appended Table of Foreign Exchange Control Order, based on Foreign Exchange and Foreign Trade Act of Japan.

If you intend re-export of the product from a country other than Japan, re-sale of the product in a country other than Japan, or re-providing of the technology (including Programs), you shall observe the regulations of your country.

Also, if an option is added or modified to add a function to this product, this product may fall under the category of List-Control Goods, List-Control Technology (including Programs) under Category 1 - 15 of Appended Table 1 of Export Trade Control Order or under Category 1 - 15 of Appended Table of Foreign Exchange Control Order, based on Foreign Exchange and Foreign Trade Act of Japan. In that case, if you intend re-export of the product from a country other than Japan, re-sale of the product in a country other than Japan, or re-providing of the technology (including Programs), you shall observe the regulations of your country. Please contact Mitutoyo in advance.


Notes on Export to European Countries

When you intend exporting of this product to any of the European countries, it may be required to provide User's Manual(s) in English and Declaration of Conformity in English (in some cases, the official language of the country to be exported). For detailed information, please contact Mitutoyo in advance.

Disposal of Products outside the European Countries

Please follow the official instruction in each community and country.

Warranty

This product has been manufactured under strict quality management, but should it develop problems within one year of the date of purchase in normal use, repair shall be performed free of charge. Please contact the agent where you purchased the product or Mitutoyo sales representative ( "SERVICE NETWORK" on page App-1).

If this product fails or is damaged for any of the following reasons, it will be subject to a repair charge, even if it is still under warranty.

- Failure or damage owing to fair wear and tear
- Failure or damage owing to inappropriate handling, maintenance or repair, or to unauthorized modification
- Failure or damage owing to transport, dropping, or relocation of the product after purchase
- Failure or damage owing to fire, salt, gas, abnormal voltage, lightning surge, or natural disaster
- Failure or damage owing to use in combination with hardware or software other than those designated or permitted by Mitutoyo
- Failure or damage owing to use in ultra-hazardous activities

This warranty is effective only where the product is properly installed and operated in conformance with the instructions in this document within the original country of the installation.

EXCEPT AS SPECIFIED IN THIS WARRANTY, ALL EXPRESS OR IMPLIED CONDITIONS, REPRESENTATIONS, AND WARRANTIES OF ANY NATURE WHATSOEVER INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, NONINFRINGEMENT OR WARRANTY ARISING FROM A COURSE OF DEALING, USAGE, OR TRADE PRACTICE, ARE HEREBY EXCLUDED TO THE MAXIMUM EXTENT ALLOWED BY APPLICABLE LAW.

You assume responsibility for all results due to the selection of this product to achieve your intended results.

Disclaimer

IN NO EVENT WILL MITUTOYO, ITS AFFILIATED AND RELATED COMPANIES AND SUPPLIERS BE LIABLE FOR ANY LOST REVENUE, PROFIT, OR DATA, OR FOR SPECIAL, DIRECT, INDIRECT, CONSEQUENTIAL, INCIDENTAL, OR PUNITIVE DAMAGES HOWEVER CAUSED AND REGARDLESS OF THE THEORY OF LIABILITY ARISING OUT OF THE USE OF OR INABILITY TO USE THIS PRODUCT EVEN IF MITUTOYO OR ITS AFFILIATED AND RELATED COMPANIES AND/OR SUPPLIERS HAVE BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

If, notwithstanding the foregoing, Mitutoyo is found to be liable to you for any damage or loss which arises out of or is in any way connected with use of this product by you, in no event shall Mitutoyo's and/or its affiliated and related companies' and suppliers' liability to you, whether in contract, tort (including negligence), or otherwise, exceed the price paid by you for the product only.

The foregoing limitations shall apply even if the above-stated warranty fails of its essential purpose.

BECAUSE SOME COUNTRIES, STATES OR JURISDICTIONS DO NOT ALLOW THE EXCLUSION OR THE LIMITATION OF LIABILITY FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES, IN SUCH COUNTRIES, STATES OR JURISDICTIONS, MITUTOYO'S LIABILITY SHALL BE LIMITED TO THE EXTENT PERMITTED BY LAW.

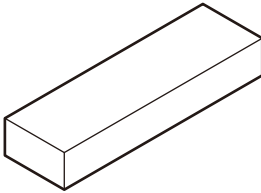
1 Overview

■ Overview of Gauge Blocks

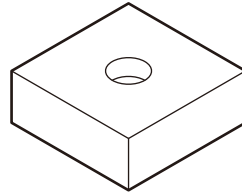
This product is a "length reference gage (end standard)" used as a reference dimension, for the calibration of various measuring tools, etc. This product has two parallel, flat measurement surfaces, and it has been accurately machined so that the distance between the two surfaces should be extremely close to the nominal size. Additionally, by setting together multiple Gauge Blocks firmly (called wringing), you can obtain a very precise custom dimension that is the sum of the dimensions of the wrung Gauge Blocks.

Steel and ceramics, which have high hardness and offer superior wear resistance, are used as the material. The Gauge Blocks are broadly classified as rectangular or square, based on the shape of their cross sections.

Rectangular Gauge Block

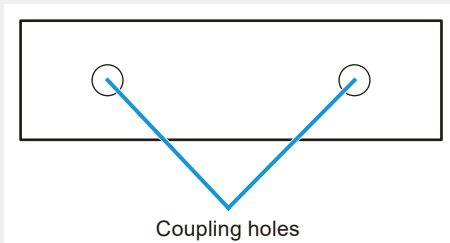


Square Gauge Block




Tips

- Gauge Blocks made of ceramics are referred to as CERA Blocks.
- Rectangular Gauge Blocks of standard size with a nominal size of at least 125 mm have "coupling holes".



■ Grades of Gauge Blocks

Grades that indicate the dimensional accuracy (for example, Grade K, Grade 0, Grade 1, and Grade 2 in the JIS standard) are set for the Gauge Blocks. Select an appropriate grade according to the accuracy required for your application.

For details about the dimensional accuracy, see  "Grade and Application" and "ACCURACY SPECIFICATIONS" in "MEASURING INSTRUMENTS CATALOG / Gauge Blocks" or the relevant standards (ISO/JIS/DIN/BS/ASME) in each country.

Grades and applications (from MEASURING INSTRUMENTS CATALOG)

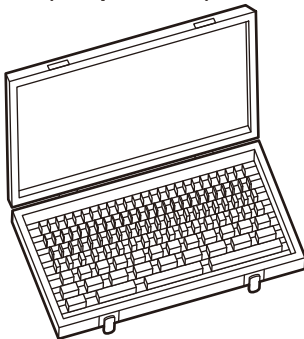
Application		Grade
Reference use	Checking the accuracy of Gauge Blocks for calibration. For academic research	K
Calibration use	Checking the accuracy of Gauge Blocks for workshop/inspection. Checking the accuracy of measuring tools	K or 0
Inspection use	Checking the accuracy of gages. Calibrating measuring tools	0 or 1
	Inspecting mechanical parts, tools, etc.	1 or 2
Workshop use	Manufacturing gages. Calibrating measuring tools	1 or 2
	Mounting tools and cutters	2

■ Contents of a Gauge Block set

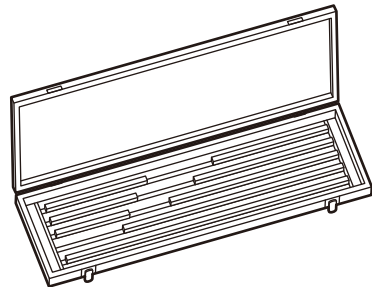
A set is composed of Gauge Blocks with various nominal sizes. Wring Gauge Blocks together to obtain the desired dimension.

Examples of standard sets:

BM1-112 (112-piece set)



BM1-8R (8-piece set)



2 How to Use Gauge Blocks

This section describes an example of typical usage (assembling of a reference gage with a desired length) and explains the wringing process.

2.1 Example of Typical Usage (Assembling a Reference Gage with a Desired Length)

Assemble a reference gage with a desired length by wringing Gauge Blocks together.

The assembled reference gage can be used for the zero setting for measuring tools and for comparative measurement.

As an example, this procedure explains the assembly of a 37.785 mm length reference gage.

■ Precautions about the assembly

- Use as few Gauge Blocks as possible for the assembly.
- Select thick Gauge Blocks as much as possible.
- Begin by selecting a Gauge Block where the last digit of the target dimensions matches the last digit of the nominal size.

NOTICE

If you select the same Gauge Blocks each time you assemble them, those Gauge Blocks will wear down faster than the other Gauge Blocks.

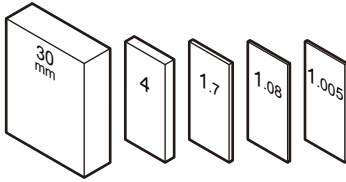
Make a different combination each time so that Gauge Blocks will wear down at the same rate.

The following shows an example assembly.

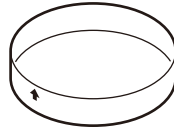
Gauge Block to use	Selection order
1.005	1
1.08	2
1.7	3
4	4
30	5
<hr/>	
37.785 mm	

■ Preparation

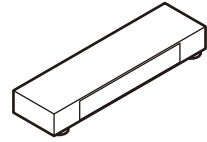
Necessary Gauge Blocks and tools



Gauge Blocks
30 mm/4 mm/1.7 mm/1.08 mm/1.005 mm



Optical flat
(Option accessory)



Ceraston
(Option accessory)

■ Assembly

NOTICE

To prevent changes in the surface condition caused by temperature and rusting due to exposure to sweat, it is recommended that you wear gloves for precision work.

Before assembling, all the Gauge Blocks to be wrung must be checked for burrs, and any burrs must be removed. In the case of new Gauge Blocks, it is not necessary to check for or remove burrs.

1 Checking for burrs on the measurement surfaces with an optical flat

Tips

An optical flat is a product for performing a simple flatness check.

- 1 Wipe the measurement surfaces of the Gauge Block and both surfaces of the optical flat with lens cleaning paper soaked in solvent (such as normal heptane), and then wipe the surfaces dry with a dry portion of the paper.

Tips

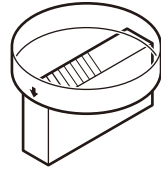
For wiping, use lens cleaning paper or other material which does not leave paper fibers.

2 How to Use Gauge Blocks

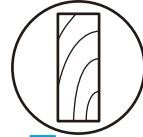
- 2 Gently place the optical flat on the measurement surface of the Gauge Block.

IMPORTANT

Place the optical flat on the measurement surface of the Gauge Block so that the arrow printed on the side of the optical flat points downward.



- 3 Lightly slide the optical flat.
 - » If interference fringes appear: Proceed to step 4.

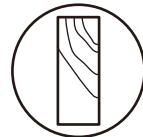
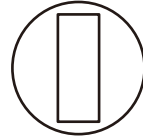


- » If interference fringes do not appear: Burrs exist; proceed to step 2.

Tips

Interference fringes may not appear if the surfaces were not wiped sufficiently or if paper fibers are present on the surface. In this case, wipe the surfaces again, and then repeat from step 2.

- 4 Lightly hold down the optical flat.
 - » If interference fringes do not appear: No burrs exist; proceed to step 3.
 - » If interference fringes partially appear: Burrs exist; proceed to step 2.



Tips

If interference fringes partially appear, slide the optical flat slightly. If the interference fringes move with the optical flat, it means that there are burrs on the optical flat, and not on the Gauge Block. Use a new optical flat.

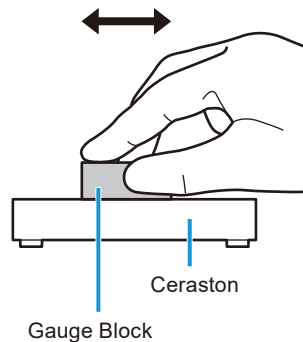
2 Removing burrs from the measurement surface with a Ceraston (part No. 601644 or No. 601645)

- 1 Wipe the measurement surface of the Gauge Block and the surface of the Ceraston with lens cleaning paper soaked in solvent (such as normal heptane), and then wipe the surfaces dry with a dry portion of the paper.

Tips

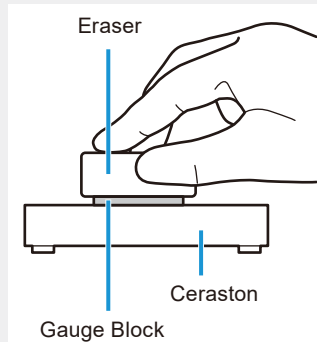
For wiping, use lens cleaning paper or other material which does not leave paper fibers.

- 2 Place the measurement surface of the Gauge Block with burrs facing towards the Ceraston.
- 3 While holding the Gauge Block by its sides with your thumb and middle finger, lightly push the upper surface of the Gauge Block with your index finger to give a back and forth motion to the Gauge Block 10 times on the Ceraston.



Tips

- If the Gauge Block is too thin to hold (a nominal size of 3 mm or less, for example), using an eraser or other rubbery object to hold down the Gauge Block may help apply the force uniformly, as shown in the figure on the right.
- The Gauge Block will smoothly slide on the Ceraston as long as there are burrs. The Gauge Block will start to stick to the Ceraston as burrs are removed.



- 3 Repeat steps 1 and 2 to check and remove burrs on all the Gauge Blocks to be wrung.


Tips

If burrs cannot be removed even by repeating steps 1 and 2, the Gauge Block cannot be used as a reference gage. Purchase a new Gauge Block with the same nominal size as a replacement.

4 Wring the 30 mm Gauge Block and other Gauge Blocks together in order of thickness.

Tips

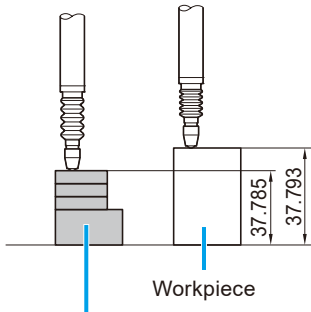
When wringing a thin Gauge Block, check the state of the measurement surface of the thin Gauge Block by placing on the optical flat.

For details about wringing, see  "2.2 Wringing" (page 16).

5 Perform thermal stabilization.

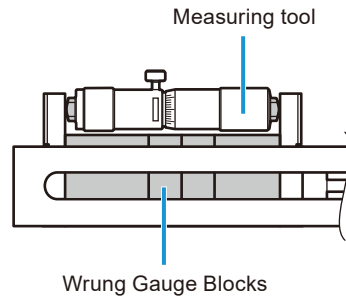
6 Use as a reference gage.

Example of comparative measurement



Reference gage (wring Gauge Blocks)

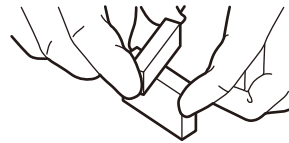
Example of zero-setting for a measuring tool



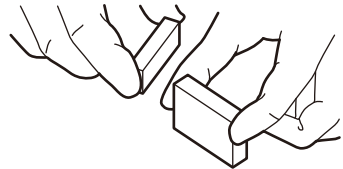
Disassembly

1 Disengaging the wringing

- 1 Rotate the wrung Gauge Blocks until they form a cross shape.




- 2 Slide the Gauge Blocks to detach them.



2 Wipe any dirt off the Gauge Blocks.

Tips

For details about cleaning, see  "■ Cleaning" (page 19).

2.2 Wringing

The process of firmly assembling Gauge Blocks together is called "wringing". A steel Gauge Block and a CERA Block can also be wrung together.

NOTICE

When handling Gauge Blocks and accessories, wear gloves for precision work. If handled with bare hands, the resulting heat conduction can alter the block's dimensions. For steel Gauge Blocks, oils and sweat can cause rusting to occur.

- 1 Wipe surfaces for wringing with lens cleaning paper soaked in solvent (such as normal heptane), and then wipe the surfaces dry with a dry portion of the paper.**

NOTICE

If small pieces of dirt or grease are left on surfaces for wringing, it is added to the dimension of wrung Gauge Blocks, or the Gauge Blocks may be scratched.

Tips

For wiping, use lens cleaning paper or other material which does not leave paper fibers.

- 2 Slightly spread Vaseline or grease onto the surfaces for wringing before wiping.**

Tips

Wipe until the oil layer is almost completely gone.



- 3 Wring the Gauge Blocks together.**

The following three situations are possible:

- For a thick Gauge Block and a thick Gauge Block
- For a thick Gauge Block and a thin Gauge Block
- For a thin Gauge Block and a thin Gauge Block

Tips

A Gauge Block with a nominal size of less than 3 mm is considered a thin Gauge Block.

2 How to Use Gauge Blocks

For a thick Gauge Block and a thick Gauge Block

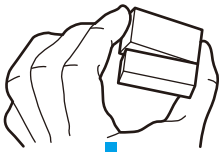
- 1 Cross the Gauge Blocks at the center of each measurement surface at 90° (45° for Square Gauge Blocks).



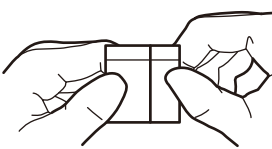
- 2 While slightly applying force, rotate one Gauge Block 90° (45° for Square Gauge Blocks) until both measurement surfaces are aligned with each other.

Tips

It will feel like the blocks are sticking together while you are sliding the blocks.



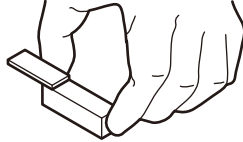
- 3 Align the measurement surfaces with each other.



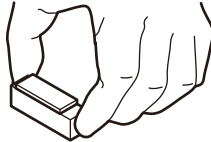
Proceed to step **5**.

For a thick Gauge Block and a thin Gauge Block

- 1 Place one end of the thin Gauge Block on top of one end of the thick Gauge Block (to prevent thin Gauge Blocks from bending).



- 2 Slide the thin Gauge Block while pressing the entire overlapped area until both measurement surfaces are aligned with each other.

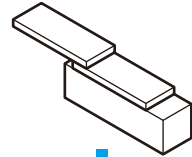



Proceed to step **4**.

For a thin Gauge Block and a thin Gauge Block



- 3 Wrap another thin Gauge Block on top of the thin Gauge Block wrung in steps 1 through 2.



- 4 Detach the thick Gauge Block wrung in steps 1 through 2. For details, see  "Disassembly" (page 15).



2 How to Use Gauge Blocks

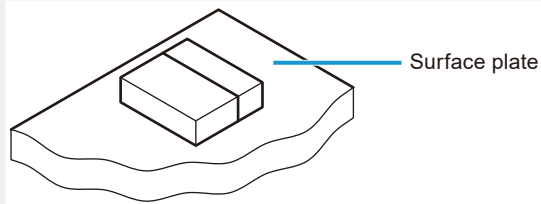
4 If a thin Gauge Block is wrung, the surface of the Gauge Block must be checked with the optical flat (flatness check).

- » If interference fringes do not appear: The wrung Gauge Block is not bent. → Step **5**
- » If interference fringes appear: The wrung Gauge Block is bent. → Redo wringing from the beginning.

5 Wipe the measurement surfaces, and then place the wrung Gauge Blocks on the surface plate (for thermal stabilization).

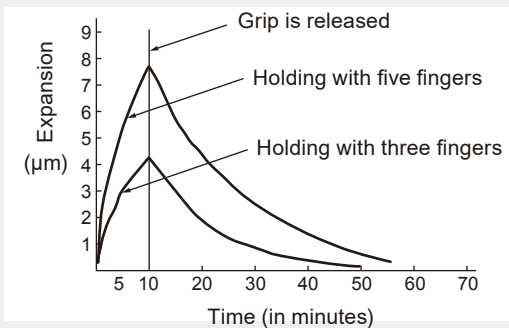
NOTICE

Generally, CERA Blocks have the advantage of a slow response to temperature changes because of their low thermal conductivity. However, if they are used in an environment with drastic temperature changes, caution must be taken because of their slow recovery speed from an expanded or contracted state.



Tips

The following figure shows an example of changes in dimension when a 100 mm steel Gauge Block is handled with bare hands.



3 Maintenance

This section explains the regular inspection and cleaning of this product.

In order to use this product with sufficient performance safely and for a long period, follow the items below to perform inspection and cleaning.

■ Regular inspection

Check the appearance of the Gauge Block for dirt/dust, scratches, and wear.

To check for wear on the surfaces for wringing, use a tool such as an optical flat to check for interference fringes.

If there are any burrs or nicks, use a Ceraston* to remove them.

To maintain the quality of your Gauge Blocks, we recommend periodic calibration/inspection services provided by Mitutoyo.

* Ceraston: Part No. 601644 or No. 601645

■ Cleaning

After use, wipe dirt off the Gauge Block with a soft cloth soaked in solvent, etc., and then apply anti-rust oil in a thin layer before housing and storing it in a safe place (for rust prevention).

Do not use organic solvents such as thinner or benzene.

Tips

- Recommended solvent: Normal heptane
- Recommended anti-rust oil: MOLYKOTE SUPERGLISS (Dow Corning Toray Co., Ltd.)
- Placing evaporative anti-rust paper into the storage case provides more effective storage.
- For CERA Blocks, rustproofing treatment is not necessary.

MEMO

4 Periodic Calibration/Inspection

To maintain the quality of your Gauge Blocks, we recommend periodic calibration/inspection services provided by Mitutoyo.

Reference: Frequency of calibration/inspection

Application	Cycle	Grade (for reference)
Reference use	1–2 years	K
Calibration use	2 years	K or 0
Inspection use	2 years	0 or 1
Workshop use	6 months–2 years	1 or 2

NOTICE

Send your Gauge Blocks, appropriately packed with shock-absorbing material, to Mitutoyo for calibration/inspection. If the Gauge Blocks are not appropriately packed, the accuracy or appearance of the Gauge Blocks may be impaired during transport.

MEMO

5 Specifications

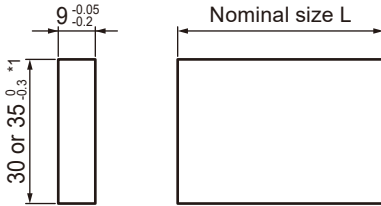
5.1 Specifications

■ Cross-sectional diagram and dimensions

● Rectangular Gauge Block

Steel: Nominal size L 0.1 mm–100 mm, 0.004 in–4 in

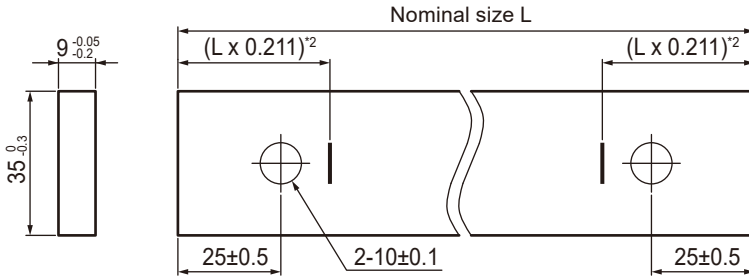
Ceramics: Nominal size L 0.5 mm–100 mm, 0.03125 in–4 in



*1 Nominal size L is 10 mm or less: 30 mm
Nominal size L is more than 10 mm: 35 mm

Steel: Nominal size L 125 mm–1000 mm, 5 in–20 in

Ceramics: Nominal size L 125 mm–500 mm, 5 in–20 in

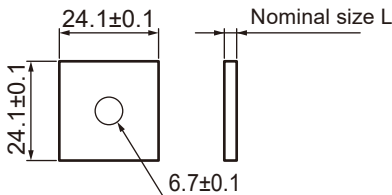


*2 The dimension from the end face to the airy point

● Square Gauge Block

Steel: Nominal size L 0.5 mm–4.5 mm, 0.01 in–0.19 in

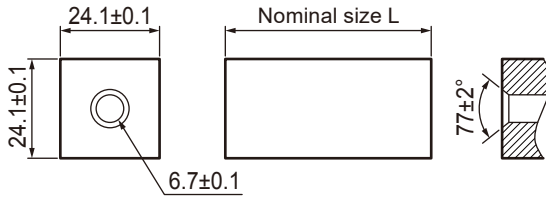
Ceramics: Nominal size L 0.05 in–0.19 in



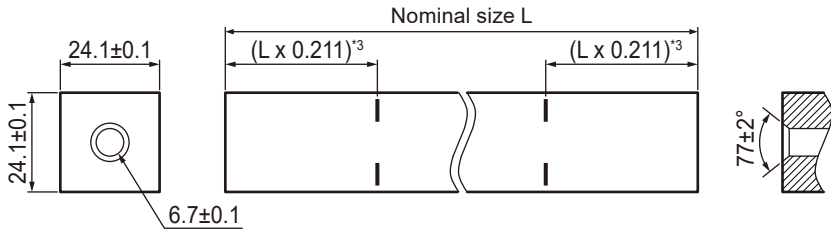
5 Specifications

Steel: Nominal size L 5 mm–100 mm, 0.2 in–4 in

Ceramics: Nominal size L 0.2 in–4 in



Steel: Nominal size L 125 mm–500 mm, 5 in–20 in



*3 The dimension from the end face to the airy point

Material and properties

Application		Material	CERA Block (Zirconia)	Steel	Tungsten carbide	Zero CERA Block (Low thermal-ex- pansion ceramics)
Hardness	HV		1350	800	1650	826
Thermal expansion coefficient	$10^{-6}/K$		9.3 ± 0.5	10.8 ± 0.5	5.5 ± 1.0	0 ± 0.02
Flexural strength (three points)	MPa		1270	1960	1960	210
Fracture toughness (KIC)	$MPa \cdot m^{1/2}$		7	120	12	1.2
Young's modulus ($\times 10^4$)	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

5.2 Related Products

■ Gauge Blocks with thermal expansion coefficients (steel, ceramic)

Gauge Blocks with highly accurate thermal expansion coefficients.
Provided in nominal sizes (100 mm–500 mm) of Rectangular Gauge Blocks.

■ Low thermal-expansion ceramic Gauge Blocks (Zero CERA Blocks)

Gauge Blocks that have extremely small thermal expansion coefficients.
Provided in nominal sizes (30 mm–1000 mm) of Rectangular Gauge Blocks.

■ Gauge Block Maintenance set (Code No. 516-650E)

A tool set necessary for burr removal and wringing.
Accessories may also be purchased individually.

Set contents	Part No.
Ceraston with both sides finished by lapping (100 mm × 25 mm × 12 mm)	601645
Optical flat OF-45B (ø45, thickness: 12 mm, flatness: 0.2 μm)	158-117
Tweezers	600004
Brush (blower brush for photographs)	600005
Cleaning paper (lens cleaning paper, 82 mm × 304 mm, 500 pieces)	600006
Mat (B4 size, artificial deerskin)	600007
Cleaning solution container (plastic, 100 ml)	600008
Gloves for inspection	600009

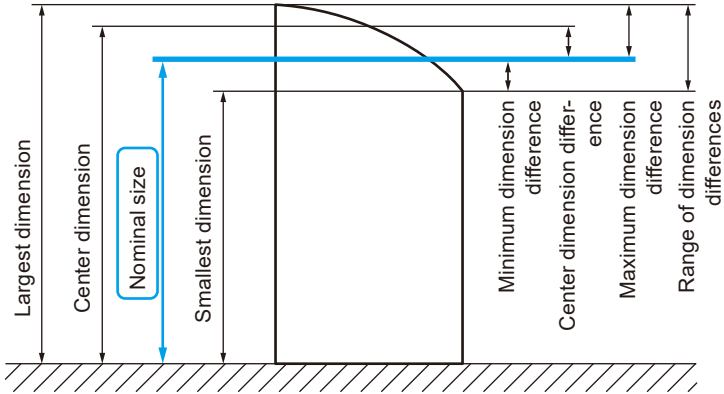
Tips

For details, see  "MEASURING INSTRUMENTS CATALOG".

MEMO

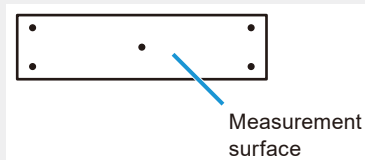
6 Appendix

■ About the terms used in inspection reports



Tips

In inspection, dimensions are measured at five points: the center and the four inner corners (1.5 mm inward from the sides) of the measurement surface of the Gauge Block.



6 Appendix

Term	Explanation
Center dimension difference	Difference between the actual dimension and the nominal size at the center.
Maximum dimension difference	Difference between the largest dimension among the five measurement points and the nominal size. The calibration-result report and inspection report do not indicate which of the five measurement points was the largest.
Minimum dimension difference	Difference between the smallest dimension among the five measurement points and the nominal size. The calibration-result report and inspection report do not indicate which of the five measurement points was the smallest.
Range of dimension differences	Difference between the largest dimension and the smallest dimension.
Measurement uncertainty (standard uncertainty)	Expressed by the standard deviation (deviation between individual measured values and the average of the group) of the variations of the measurement results.
Expanded measurement uncertainty	The standard deviation is expressed by " σ " (sigma). The standard uncertainty is expressed by 1σ , but the expanded measurement uncertainty is expressed by the value obtained by multiplying σ by a coefficient. Mitutoyo has adopted 2σ (a confidence level of 95 %). This is indicated in inspection reports as "coverage factor $k=2$ ". For example, if an inspection report contains "Expanded measurement uncertainty: $0.06 \mu\text{m}$ Coverage factor ($k=2$)", this can be read as "with a probability of 95 %, the measured values in the inspection report fall within the range of $\pm 0.06 \mu\text{m}$. (The remaining 5 % may be outside the range.)".
Light-wave interferometry	A method that directly obtains the length of a Gauge Block by using light wavelengths based on the definition of length. The "center dimension difference" of K-grade products can be obtained with the light-wave interferometry.
Comparative measurement	A method that obtains the dimensions through comparison with a Gauge Block for calibration (reference Gauge Block) whose length is known.

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