Length Standard
Gauge block with calibrated coefficient of thermal expansion

Catalog No. E4334

Grade-K gauge block has highly accurate CTE calibration

Mitutoyo

Gauge block with calibrated Coefficient of Thermal Expansion (CTE)

Mitutoyo, by integrating advanced technologies for temperature compensation, can now offer a gauge block with a precisely calibrated CTE as demanded in this new age of high accuracy

Specifications

Nominal values	100, 125, 150, 175, 200, 250, 300, 400, 500mm
Materials	Steel, ceramic
Standards	Grade K JIS/DIN/ISO
Uncertainty of CTE	0.035×10^{-6} / K (k=2)
Uncertainty of central length calibration value	30nm (k=2) (in 100 mm gauge blocks)

* Calibration certificate is included

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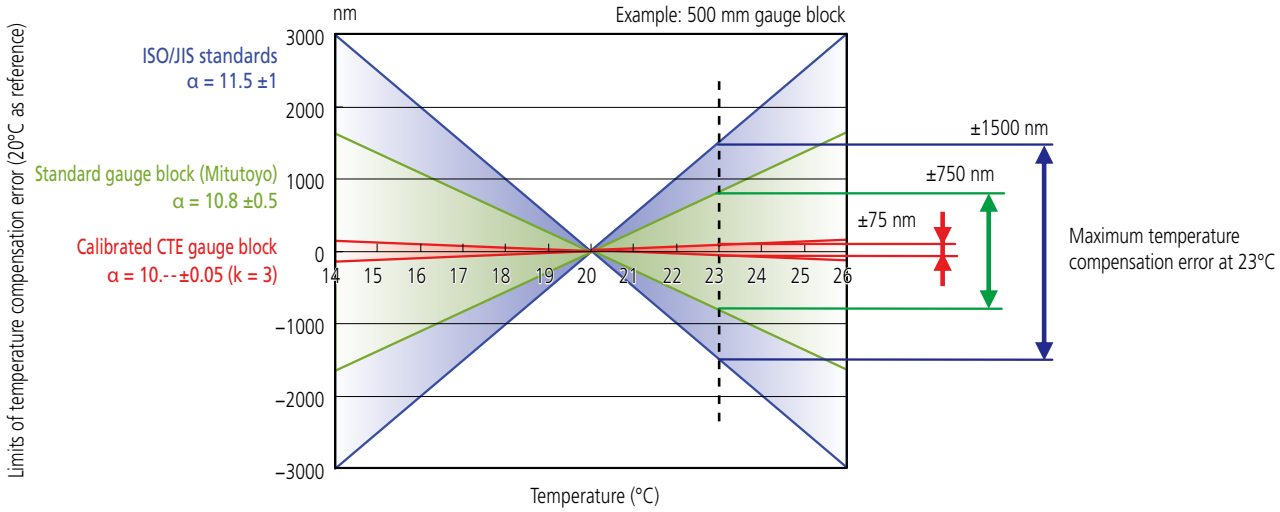
How much influence does uncertainty in the CTE value have on length measurement?

Compensating for the effect of a non-20˚C temperature

A gauge block is calibrated at 20˚C and therefore, due to its non-zero CTE, compensation needs to be applied to its calibrated length when it is used in a non-20˚C environment.

However, the CTE as supplied by the manufacturer is subject to an uncertainty in its value, which gives rise to the potential for error in the amount of compensation applied. The degree of this uncertainty can depend both on the manufacturer and the national standard to which the block was manufactured, as shown by the chart below. This chart indicates the potential compensation error in the case of various 500 mm gauge blocks used within a fairly small temperature range centered on 20˚C, and clearly shows the large reduction in error for blocks that have had their CTE accurately calibrated.

To illustrate the case, take the example of using these gauge blocks at a temperature of 23˚C. The maximum compensation error is 75 nm at this temperature for the Calibrated CTE gauge block. This contrasts with 750 nm maximum error for the standard Mitutoyo product, 10 times as much, and 1500 nm for the ISO/JIS product – 20 times greater! This is why uncertainty in the CTE is an important consideration in high accuracy work with gauge blocks. Of course, in work of this class, temperature measurement and stability must also be of a high order.



An accurate CTE promotes high accuracy and quality

The CTE of gauge blocks

CTE values of gauge blocks differ according to the material and heat treatment applied during manufacture.
Also, strictly speaking, each gauge block has a unique CTE value due to unavoidable differences between different batches of material, and even within batches.

Extremely low uncertainty for Calibrated CTE gauge block

To meet demands for higher accuracy, Mitutoyo now offers a gauge block with a calibrated CTE, the value of which is individually and precisely measured. The uncertainty of the CTE is 0.05×10^{-6}/K (K=3): this is one twentieth of the ISO/JIS value. Mitutoyo has achieved such an extremely low uncertainty in CTE measurement by the continuous development, over many years, of advanced, proprietary technology for the accurate measurement of the central length of gauge blocks, and also of temperature.

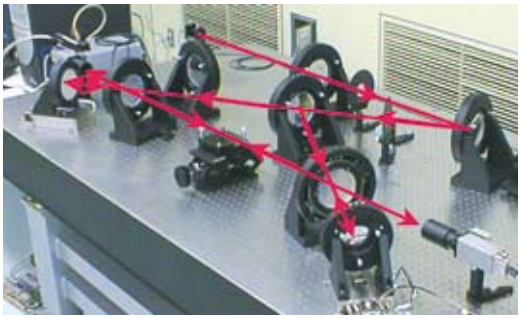
Improved uncertainty in CTE for standard Mitutoyo gauge blocks

Historically, Mitutoyo has used 1×10^{-6}/K as the CTE uncertainty for standard blocks, which is equivalent to ISO/JIS standards. Now, in response to industry demanding higher accuracy, Mitutoyo has improved this figure to 0.5×10^{-6}/K based on the results of CTE measurement of its gauge blocks over 30 years.

New interferometric technique enables highly accurate CTE measurement

(patent pending)

Mitutoyo has developed a dual-side interferometric measurement technique that simultaneously projects a laser beam onto both sides of a gauge block to measure gauge block length, and difference between lengths of two gauge blocks, with high accuracy. By combining this technique, which enables the detection of smaller length deviations, with the latest temperature measurement technology, Mitutoyo has been able to measure CTE more accurately than was previously possible.



Default CTE uncertainty in ISO/JIS standards

Gauge blocks without a calibrated CTE and associated stated uncertainty must be compliant with ISO/JIS standards. Therefore, such gauge blocks are presumed to have a CTE uncertainty of 1×10^{-6}/K.

Gauge blocks with a small CTE uncertainty will soon be required for CMM calibration

Revision of ISO10360-2 / JIS B 7440-2 standards

For calibrating highly accurate CMMs, gauge blocks with a very small CTE and uncertainty are currently used in order to minimize thermal influence, and hence any compensation needed, on the length standard. Gauge blocks made from low-expansion glass or ceramic are typically used.
ISO10360-2:2008 newly revised specifies that at least one gauge block from among those used for inspecting a CMM must have a CTE of between 8×10^{-6}/K and 13×10^{-6}/K. This means adding at least one gauge block with a large coefficient of thermal expansion, such as one made from steel. Therefore, the CTE of such a gauge block must have a low enough uncertainty to match the accuracy of the CMM to be inspected.

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