Mitutoyo

Catalogue No. MAP 20

MEASURING INSTRUMENTS CATALOGUE

Mitutoyo Asia Pacific

Calipers

An industry standard measuring tool

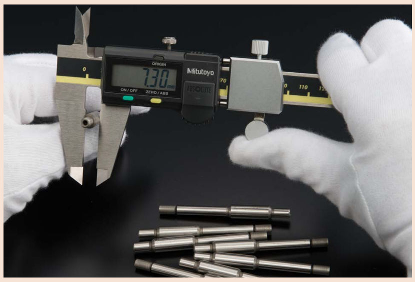
MeasurLink® ENABLED
Data Management Software by Mitutoyo

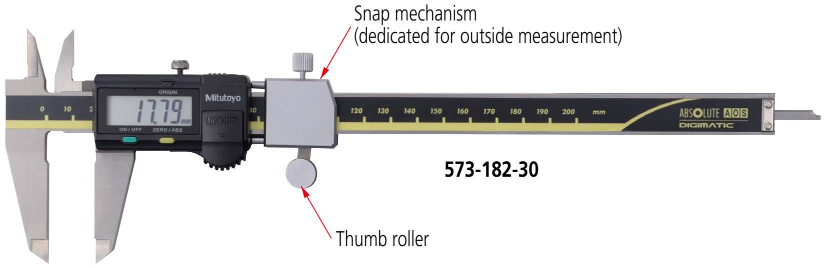
Products equipped with the measurement data output function can be connected to the measurement data network system MeasurLink (refer to page A-5 for details).

ABSOLUTE™

ABSOLUTE Snap Caliper
SERIES 573

- An ABSOLUTE electromagnetic induction linear encoder system is incorporated.
- Snap mechanism allows continuous and easy measurement without moving the slider by using the lever.
- Allows efficient continuous measurement of workpieces during acceptance inspection or mass production.
- Allows step measurement
- Displacement of snap part is 2 mm.
- Measuring force: 7 N to 14 N
- Absolute type. (Refer to page D-6 for details on the Absolute function.)
- Slider action is smooth, firm and comfortable.
- Allows integration into statistical process control and measurement systems for models with measurement data output connector. (Refer to page A-3.)





Technical Data

- Accuracy: Refer to the list of specifications. (excluding quantizing error)
- Resolution: 0.01 mm or 0.0005 in/0.01 mm
- Repeatability: 0.01 mm
- Display: LCD
- Scale type: ABSOLUTE electromagnetic inductive linear encoder
- Jaw retraction: 2 mm
- Max. response speed: Unlimited
- Battery: SR44 (1 pc), **938882**, for initial operational checks (standard accessory)
- Battery life: Approx. 3.5 years under normal use

Optional Accessories

For details, refer to page A-27.

- **959143**: Data hold unit
- Connecting cables for **IT/DP/MUX**
  959149: SPC cable with data button (1 m)
  959150: SPC cable with data button (2 m)
- USB Input Tool Direct
  06AFM380C: SPC cable for **USB-ITN-C** (2 m)
- Connecting cables for **U-WAVE-T**
  02AZD790C: SPC cable with data button (160 mm)
  02AZE140C: SPC cable for foot switch

Wireless Data Output U-WAVE fit

- **U-WAVE-TC**: **264-620** (IP67 type)
  264-621 (Buzzer type)
- **U-WAVE-TCB Transmitter**
  (**Mitutoyo *Bluetooth*® U-WAVE**)
  264-624 (IP type)
  264-625 (Buzzer type)
  Refer to page A-15 for details.
- Connecting unit for **U-WAVE-TC/TCB**:
  02AZF300 (Buzzer type)
  Note: IP67 model is water/dust-proofed suitable for the factory floor.
  Buzzer type is not water/dust-proofed.
  Refer to pages A-16 and A-18 for details.

D

SPECIFICATIONS

Metric

Order No.	Range (mm)	Accuracy (mm)*
573-181-30	0 - 100	±0.02
573-182-30	0 - 150	±0.02

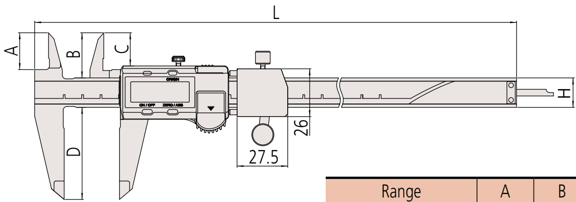
Inch/Metric

Order No.	Range (in)	Accuracy (in)*
573-281-30	0 - 4	±0.001
573-282-30	0 - 6	±0.001

* Excluding quantizing error.
Note: Dedicated for outside measurement (depth bar is not fitted).

DIMENSIONS

Unit: mm



Thickness of outer jaw: 3.5 mm

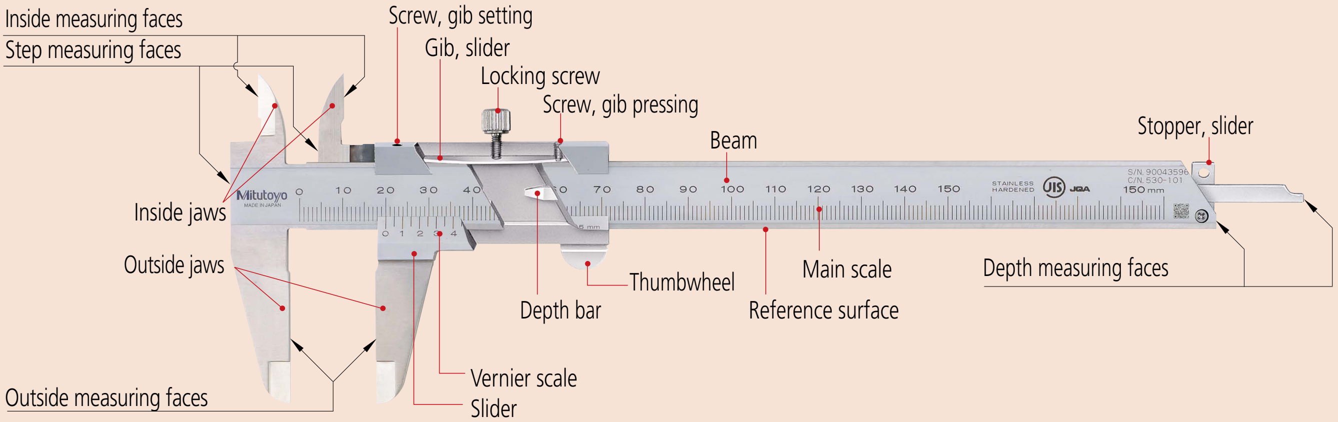
Range	A	B	C	D	H	L
0 - 100 mm/0 - 4 in	16.5	21	14.5	40	16	233
0 - 150 mm/0 - 6 in	20	24.5	18	50	16	290

Quick Guide to Precision Measuring Instruments

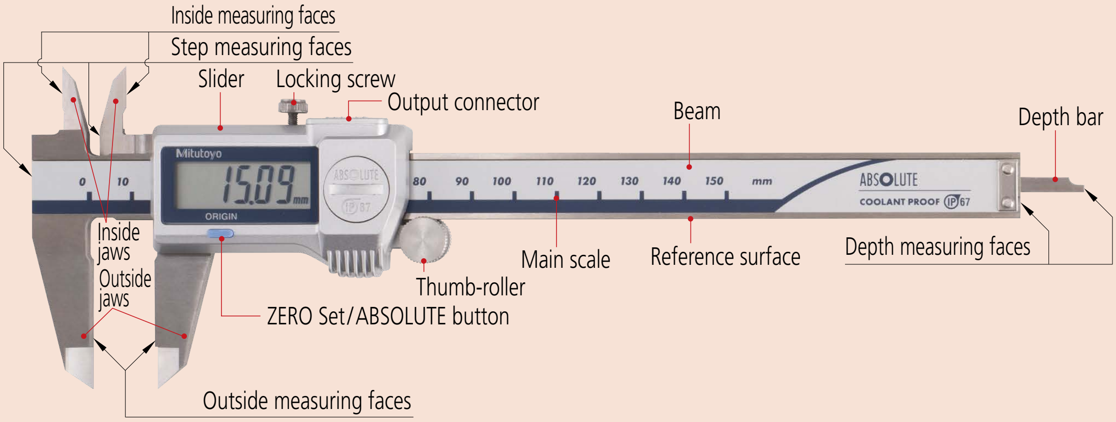
Calipers

Nomenclature

Vernier Caliper

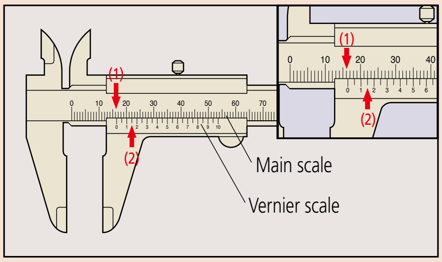


Absolute Digimatic Caliper



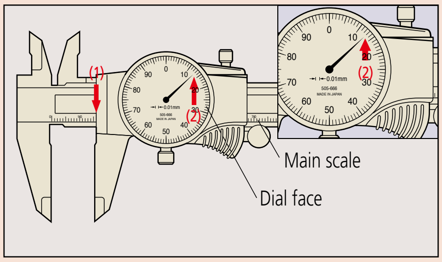
How to Read the Scale

- **Vernier Calipers**



Graduation	**0.05 mm**
(1) Main scale	16 mm
(2) Vernier	0.15 mm
Reading	16.15 mm

- **Dial Calipers**

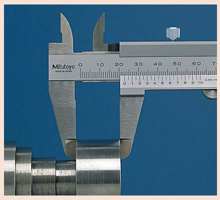


Graduation	**0.01 mm**
(1) Main scale	16 mm
(2) Dial face	0.13 mm
Reading	16.13 mm

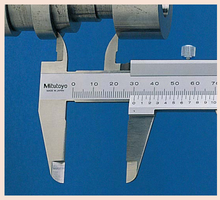
Note: Above left, 0.15 mm (2) is read at the position where a main scale graduation line corresponds with a vernier graduation line.

Measurement examples

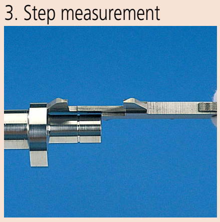
1. Outside measurement



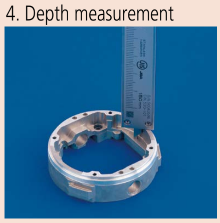
2. Inside measurement



3. Step measurement

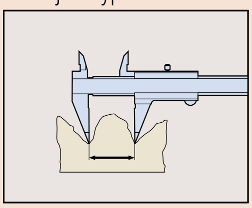


4. Depth measurement



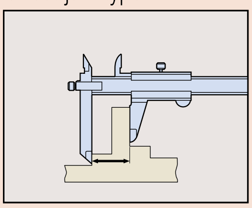
Special Purpose Caliper Applications

Point jaw type



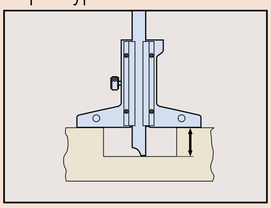
For uneven surface measurement

Offset jaw type



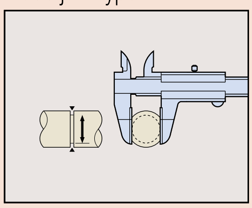
For stepped feature measurement

Depth type



For depth measurement

Blade jaw type

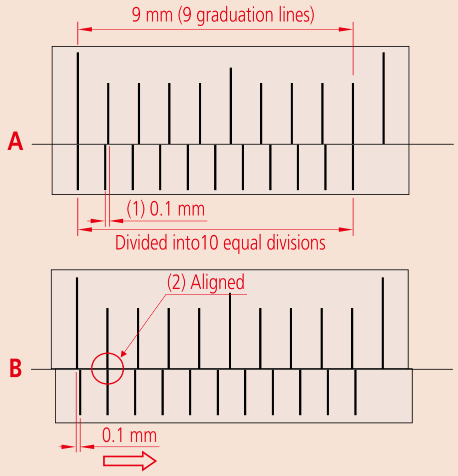


For diameter of narrow groove measurement

Mitutoyo

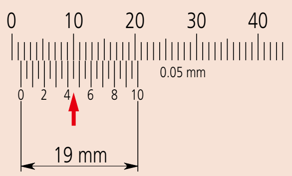
Vernier scale

This is a short auxiliary scale that enables accurate interpolation between the divisions of a longer scale without using mechanical magnification. The principle of operation is that each vernier scale division is slightly smaller than a main scale division, so that successive vernier graduations successively coincide with main scale graduations as one is moved relative to the other. Specifically, n divisions on a vernier scale are the same length as n-1 divisions on the main scale it works with, and n defines the division (or interpolation) ratio. Although n may be any number, in practice it is typically 10, 20, 25, etc., so that the division is a useful decimal fraction. The example below is for n = 10. The main scale is graduated in mm, and so the vernier scale is 9 mm (10 divisions) long, the same as 9 mm (9 divisions) on the main scale. This produces a difference in length of 0.1 mm (1) as shown in figure A (the 1st vernier graduation is aligned with the first main scale graduation). If the vernier scale is slid 0.1 mm to the right as shown in figure B, the 2nd graduation line on the vernier scale moves into alignment with the 2nd line on the main scale (2), and so enables easy reading of the 0.1 mm displacement.



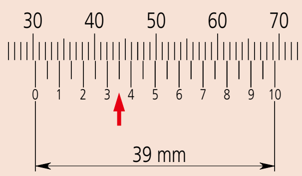
Some early calipers divided 19 divisions on the main scale by 20 vernier divisions to provide 0.05 mm resolution. However, the closely spaced lines proved difficult to read and so, since the 1970s, a long vernier scale that uses 39 main scale divisions to spread the lines is generally used instead, as shown below.

- 19 mm Vernier scale



Scale reading 1.45 mm

- 39 mm vernier scale (long vernier scale)

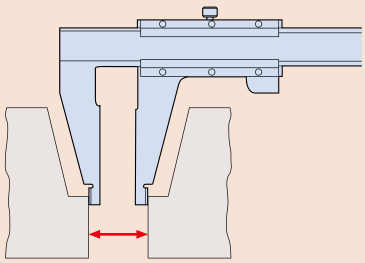


Scale reading 30.35 mm

Calipers were made that gave an even finer resolution of 0.02 mm. These required a 49-division vernier scale dividing 50 main scale divisions. However, they were difficult to read and are now hard to find since Digital calipers with an easily read display and resolution of 0.01 mm appeared.

About Long Calipers

Steel rules are commonly used to roughly measure large workpieces but if a little more accuracy is needed then a long caliper is suitable for the job. A long caliper is very convenient for its user friendliness but does require some care in use. In the first place it is important to realize there is no relationship between resolution and accuracy. For details, refer to the values in our catalog. Resolution is constant whereas the accuracy obtainable varies dramatically according to how the caliper is used.
The measuring method with this instrument is a concern since distortion of the main beam causes a large amount of the measurement error, so accuracy will vary greatly depending on the method used for supporting the caliper at the time. Also, be careful not to use too much measuring force when using the outside measuring faces as they are furthest away from the main beam so errors will be at a maximum here. This precaution is also necessary when using the tips of the outside measuring faces of a long-jaw caliper.



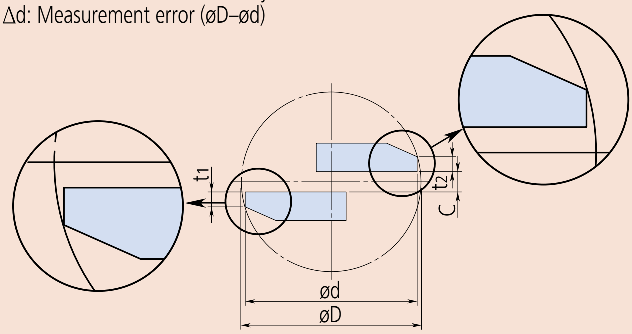
Small hole measurement with an M-type caliper

A structural error d occurs when you measure the internal diameter of a small hole.

øD: True internal diameter
ød : Measured diameter
t_1, t_2: Thickness of the inside jaw
C: Distance between the inside jaws
Δd: Measurement error (øD–ød)

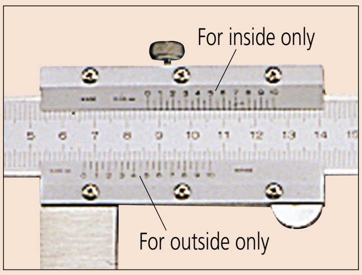
True internal diameter (øD: 5 mm) Unit: mm

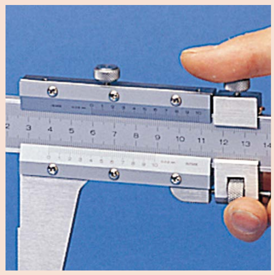
t_1+t_2+C	0.3	0.5	0.7
Δd	0.009	0.026	0.047



Inside Measurement with a CM-type Caliper

Because the inside measuring faces of a CM-type caliper are at the tips of the jaws the measuring face parallelism is heavily affected by measuring force, and this becomes a large factor in the measurement accuracy attainable.
In contrast to an M-type caliper, a CM-type caliper cannot measure a very small hole diameter because it is limited to the size of the stepped jaws, although normally this is no inconvenience as it would be unusual to have to measure a very small hole with this type of caliper. Of course, the radius of curvature on the inside measuring faces is always small enough to allow correct hole diameter measurements right down to the lowest limit (jaw closure).
Mitutoyo CM-type calipers are provided with an extra scale on the slider for inside measurements so they can be read directly without the need for calculation, just as for an outside measurement. This useful feature eliminates the possibility of error that occurs when having to add the inside-jaw-thickness correction on a single-scale caliper.



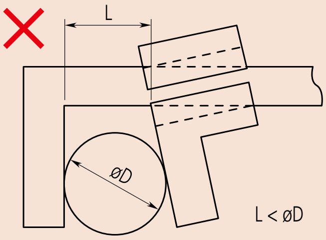


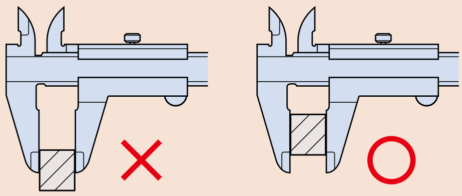
D

General notes on use of the caliper

1. Potential causes of error

A variety of factors can cause errors when measuring with a caliper. Major factors include parallax effects, excessive measuring force due to the fact that a caliper does not conform to Abbe's Principle, differential thermal expansion due to a temperature difference between the caliper and workpiece, and the effect of the thickness of the knife-edge jaws and the clearance between these jaws during measurement of the diameter of a small hole. Although there are also other error factors such as graduation accuracy, reference edge straightness, main scale flatness on the main blade, and squareness of the jaws, these factors are included within the E_{MPE} error tolerances. Therefore, these factors do not cause problems as long as the caliper satisfies the E_{MPE} error tolerances. Handling notes have been added to the JIS so that consumers can appreciate the error factors caused by the structure of the caliper before use. These notes relate to the measuring force and stipulate that "as the caliper does not have a constant-force device, you must measure a workpiece with an appropriate even measuring force. Take extra care when you measure it with the root or tip of the jaw because a large error could occur in such cases."





2. Inside measurement

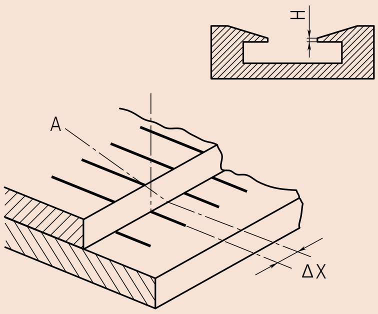
Insert the inside jaw as deeply as possible before measurement.
Read the maximum indicated value during inside measurement.
Read the minimum indicated value during groove width measurement.

3. Depth measurement

Read the minimum indicated value during depth measurement.

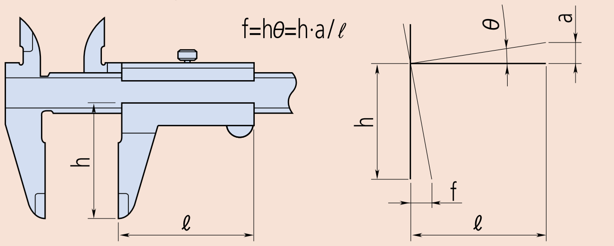
4. Parallax error when reading the scales

Look straight at the vernier graduation line when checking the alignment of vernier graduation lines to the main scale graduation lines.
If you look at a vernier graduation line from an oblique direction (A), the apparent alignment position is distorted by ΔX as shown in the figure below due to a parallax effect caused by the step height (H) between the planes of the vernier graduations and the main scale graduations, resulting in a reading error of the measured value. To avoid this error, the JIS stipulates that the step height should be no more than 0.3 mm.



5. Moving Jaw Tilt Error

If the moving jaw becomes tilted out of parallel with the fixed jaw, either through excessive force being used on the slider or lack of straightness in the reference edge of the beam, a measurement error will occur as shown in the figure. This error may be substantial due to the fact that a caliper does not conform to Abbe's Principle.



Example: Assume that the error slope of the jaws due to tilt of the slider is 0.01 mm in 50 mm and the outside measuring jaws are 40 mm deep, then the error (at the jaw tip) is calculated as (40/50) ×0.01 mm=0.008 mm.
If the guide face is worn then an error may be present even using the correct measuring force.

6. Relationship between measurement and temperature

The main scale of a caliper is engraved (or mounted on) stainless steel, and although the linear thermal expansion coefficient is equal to that of the most common workpiece material, steel, i.e. (10.2±1) $\times 10^{-6}$/K, note that other workpiece materials, the room temperature and the workpiece temperature may affect measurement accuracy.

7. Handling

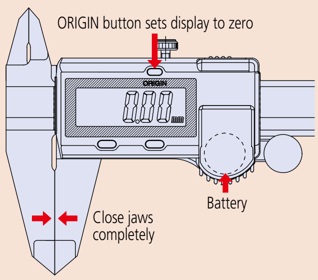
Caliper jaws are sharp, and therefore the instrument must be handled with care to avoid personal injury.
Avoid damaging the scale of a digital caliper and do not engrave an identification number or other information on it with an electric marker pen.
Avoid damaging a caliper by subjecting it to impact with hard objects or by dropping it on a bench or the floor.

8. Maintenance of beam sliding surfaces and measuring faces

Wipe away dust and dirt from the sliding surfaces and measuring faces with a dry soft cloth before using the caliper.

9. Checking and setting the origin before use

Clean the measuring surfaces by gripping a sheet of clean paper between the outside jaws and then slowly pulling it out. Close the jaws and ensure that the vernier scale (or display) reads zero before using the caliper. When using a Digimatic caliper, reset the origin (ORIGIN button) after replacing the battery.



10. Handling after use

After using the caliper, completely wipe off any water and oil. Then, lightly apply anti-corrosion oil and let it dry before storage.
Wipe off water from a waterproof caliper as well because it may also rust.

11. Notes on storage

Avoid direct sunlight, high temperatures, low temperatures, and high humidity during storage.
If a digital caliper will not be used for more than three months, remove the battery before storage.
Do not leave the jaws of a caliper completely closed during storage.

Performance evaluation method for the caliper

JIS B 7507 was revised and issued in 2016 as the Japanese Industrial Standards of the caliper, and the “Instrumental error” indicating the indication error of the caliper has been changed to “Maximum Permissible Error (MPE) of indication”.
The “Instrumental error” of the old JIS adopts acceptance criteria that the specification range (precision specification) equals acceptance range, and the OK/NG judgment does not include measurement uncertainty. (**Fig. 1**)
The “Maximum Permissible Error (MPE) of indication” of the new JIS adopts the basic concept of the OK/NG judgment taking into account the uncertainty adopted in the ISO standard (ISO 14253-1).
The verification of conformity and nonconformity to the specifications is clearly stipulated to use the internationally recognized acceptance criteria (simple acceptance) when the specification range equals the acceptance range, and it is accepted that the specification range equals the acceptance range if a given condition considering uncertainty is met.
In this case, the internationally recognized acceptance criterion is ISO/TR 14253-6: 2012. (**Fig. 2**)
The following describes the standard inspection method including the revised content of JIS 2016.

Fig. 1 **Old JIS** Instrumental error
JIS B 7507-1993

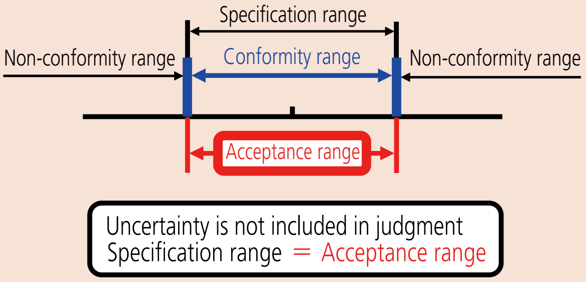
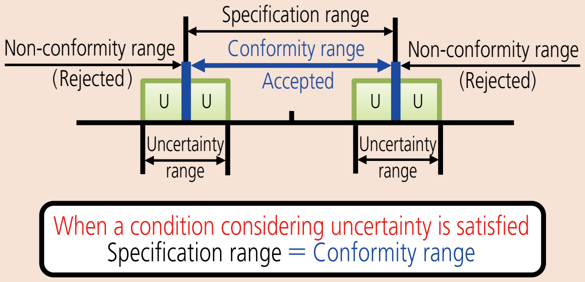


Fig. 2 **New JIS** Maximum Permissible Error (MPE)
JIS B 7507: 2016 (ISO/TR 14253-6: 2012)



Maximum Permissible Error of partial measuring surface contact error *E*MPE [JIS B 7507: 2016]

The partial measuring surface contact error of a caliper is an indication error applied to outside measurement.
Table 1 shows the Maximum Permissible Error *E*MPE for various measuring ranges and graduation/resolution of a caliper.
The value can be obtained by inserting a gauge block (or an equivalent standard) between the outside measuring surfaces (**Fig. 3**), measuring it at arbitrary positions between the jaws and then subtracting the dimension of the gauge from the maximum or minimum indicated value.

Scale Shift Error *S*MPE [JIS B 7507: 2016]

The scale shift error in a caliper is an indication error of the inside measurement, depth measurement, etc., if measuring surfaces other than the outside measuring surfaces are used.
The Maximum Permissible Error *S*MPE of the indication value for inside measurement is given in **Table 1**. The Maximum Permissible Error *S*MPE of depth measurement is obtained by adding 0.02 mm to a value in **Table 1**.
The indication error for inside measurement can be obtained by using gauge blocks (or equivalent standards) and standard jaws from an accessory set to form accurate inside dimensions for calibration (**Fig. 4**), with the error being given by the indicated value minus the gauge block size.

Unit: mm

Measurement range	Scale interval, graduation or resolution	
	0.05	0.02
50 or less	±0.05	±0.02
Over 50, 100 or less	±0.06	±0.03
Over 100, 200 or less	±0.07	
Over 200, 300 or less	±0.08	±0.04

Note: *E*MPE includes the measurement error arising from the straightness, flatness and parallelism of the measuring surfaces.

Table 1: Maximum Permissible Error *E*MPE of partial measuring surface contact error in a conventional caliper

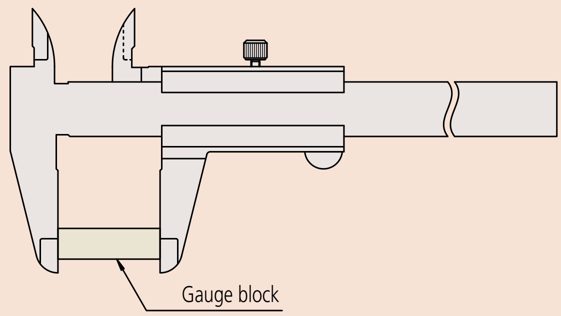


Fig. 3: Determining partial measuring surface contact error

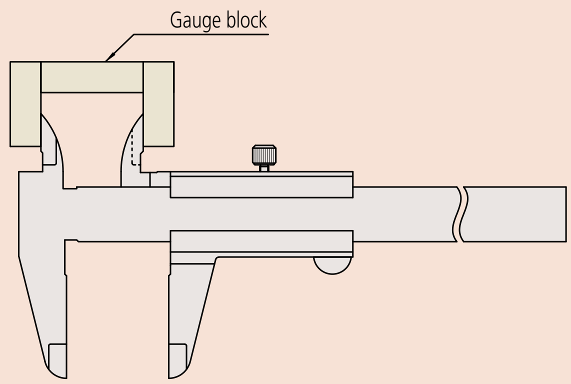


Fig. 4: Determining inside measurement indication error

The “Instrumental error” indicating the indication error of JIS has been changed to “Maximum Permissible Error (MPE) of indication” for the following three models:

- **Vernier Caliper 530 SERIES — Standard model** described on page D-9 (**530-101 530-108 530-109**)
- **Vernier Caliper 532 SERIES — with fine adjustment** described on page D-11 (All models)
- **Vernier Caliper 531 SERIES — with thumb grip** described on page D-11 (All models)