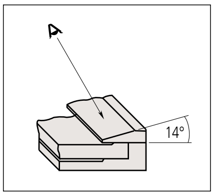
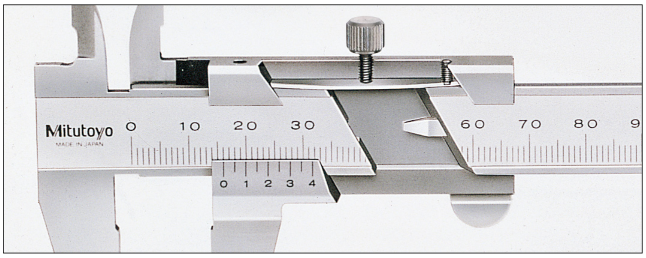
Calipers

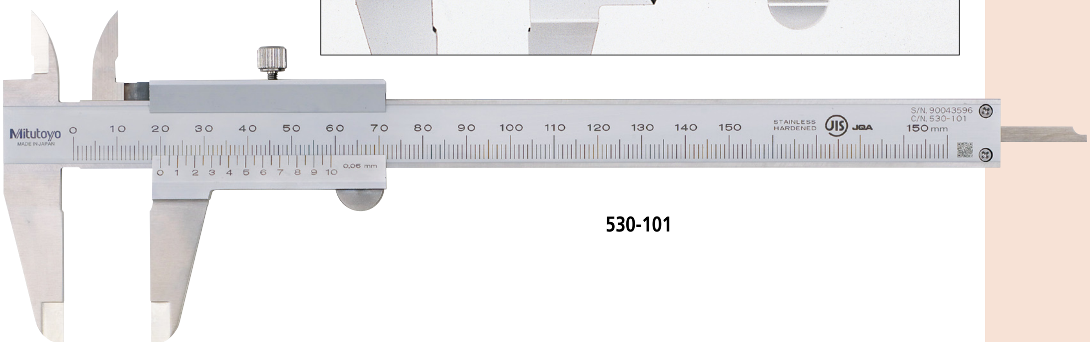
An industry standard in measuring tools

Vernier Caliper
530 Series — Standard model

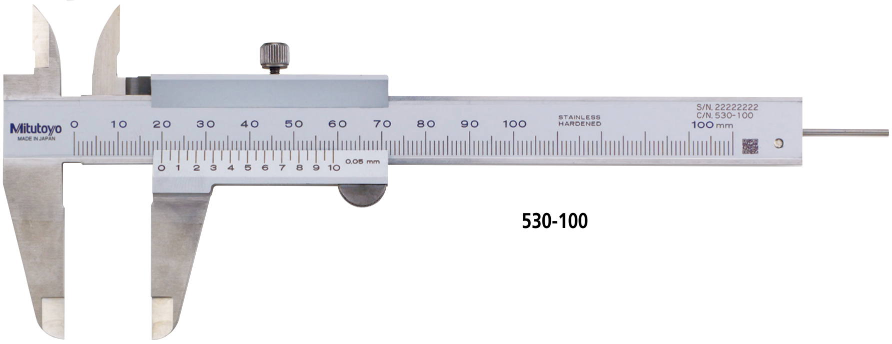
- Plain and basic design.
- Stepped graduation face prevents dust ingress between the main scale and slider.
- The small vernier face angle (14°) provides easy reading.
- Can measure outside and inside dimensions, depth, and steps.
- Carbide-tipped jaw calipers are optimal for rough finished parts, castings, grinding stones, etc.
- Decimal and fractional graduated scales (metric/inch and inch models only).



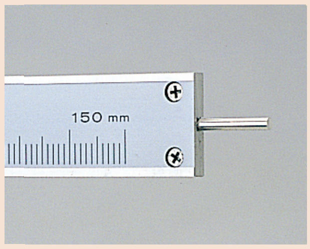




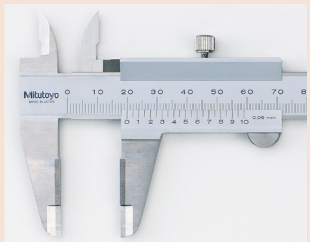
530-101



530-100



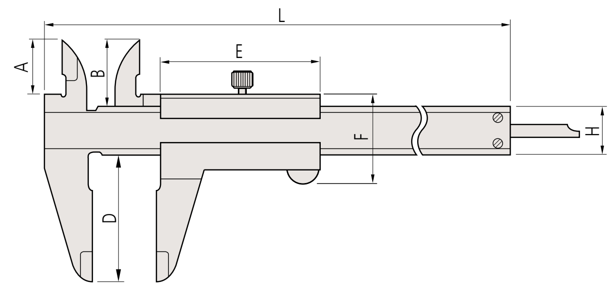
530-102 (Round depth bar type)



530-320 (Carbide-tipped jaw type)

DIMENSIONS

Unit: mm



Range	Outside jaw thickness
0 - 100mm	3
0 - 150mm	
0 - 200mm	
0 - 300mm	3.8
0 - 600mm	6
0 - 1000mm	8

Range	A	B	D	E	F	H	L
0 - 100mm	17	21.5	40	53.5	30	16	182
0 - 150mm	17	21.5	40	53.5	30	16	229
0 - 200mm	20.5	25	50	53.5	30	16	288
0 - 300mm	22	27.5	64	66.5	36	20	404
0 - 600mm	38	47	90	89	50	25	780
0 - 1000mm	50	60	130	111	61	32	1240

* Code No.530-100 and No.530-102 incorporate a round depth bar (ø1.9mm).
The depth bar shown in the illustration above is a different type.

Technical Data

Accuracy: ±0.05mm (≤200mm), ±0.08mm (≤300mm)
±0.10mm (≤600mm), ±0.15mm (≤1000mm)
High accuracy type:
±0.03mm (≤200mm), ±0.04mm (≤300mm)

Graduation: 0.05mm, 0.05mm (1/128”) or .001” (1/128”)
High accuracy type:
0.02mm or 0.02mm (.001”)

SPECIFICATIONS

Metric

Order No.	Range	Depth bar	Remarks
530-100	0 - 100mm	ø1.9mm rod	—
530-102	0 - 150mm		—
530-101		Blade	—
530-320			Carbide-tipped jaws for outside measurement
530-335			Carbide-tipped jaws for outside and inside measurement
530-122*			High accuracy model: ±0.03mm
530-108	0 - 200mm		—
530-321			Carbide-tipped jaws for outside measurement
530-123*			High accuracy model: ±0.03mm
530-109	0 - 300mm		—
530-322			Carbide-tipped jaws for outside measurement
530-124*			High accuracy model: ±0.04mm
530-501	0 - 600mm	—	—
530-502	0 - 1000mm		

* Graduation: 0.02mm

Metric/Inch with metric/inch double scale

Order No.	Range	Depth bar	Inch graduation	Remarks
530-104	0 - 150mm	Blade	1/128"	—
530-316			1/128"	Clamping screw below the slider
530-312*			.001"	High accuracy model: ±0.03mm
530-114	0 - 200mm		1/128"	—
530-118*			.001"	High accuracy model: ±0.03mm
530-115	0 - 300mm		1/128"	—
530-119*			.001"	High accuracy model: ±0.04mm

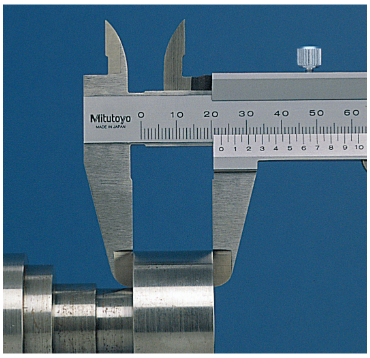
* Graduation: 0.02mm

Inch with inch/inch double scale

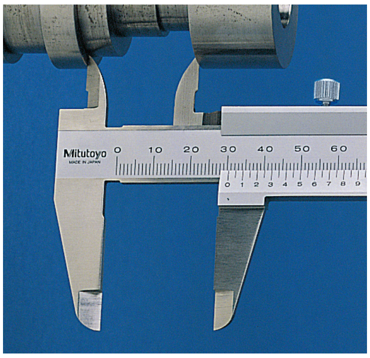
Order No.	Range	Depth bar	Inch graduation	Remarks
530-105	0 - 6"	Blade	1/128"	—
530-116	0 - 8"			

Measurement Applications

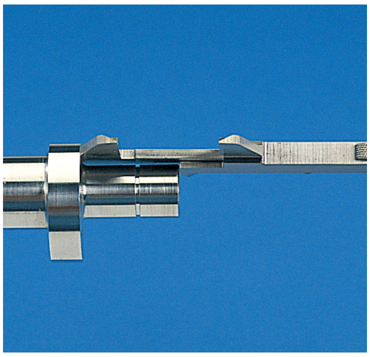
1. Outside measurement



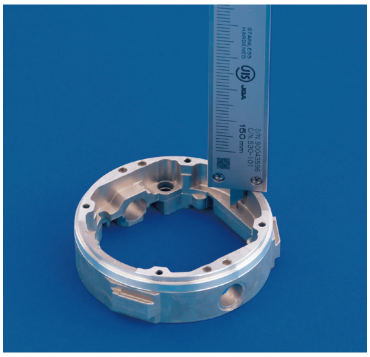
2. Inside measurement



3. Step measurement



4. Depth measurement

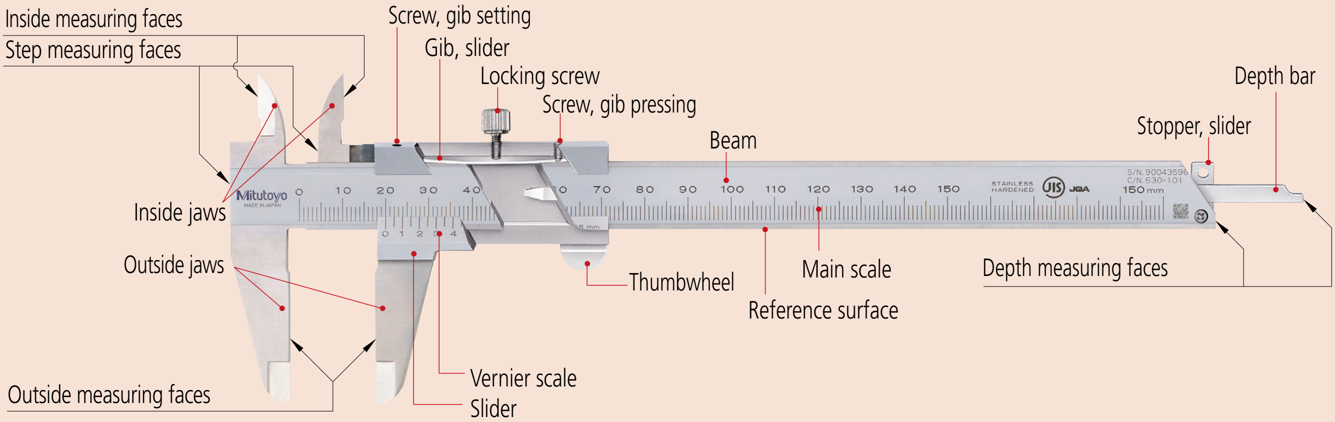


Quick Guide to Precision Measuring Instruments

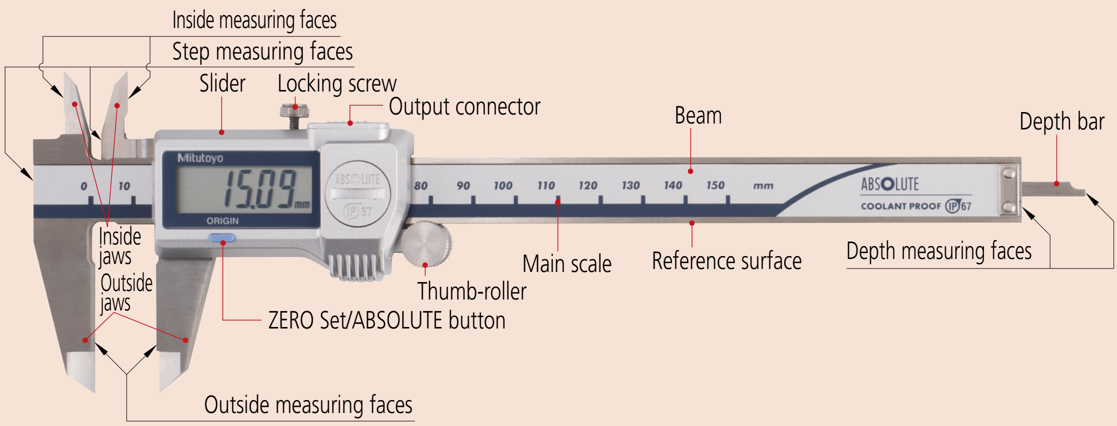
Calipers

Nomenclature

Vernier Caliper

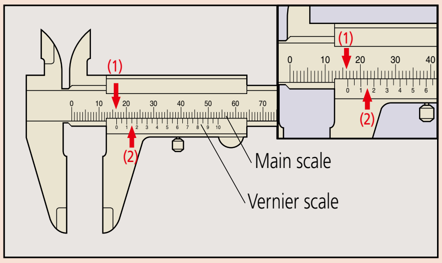


Absolute Digimatic Caliper



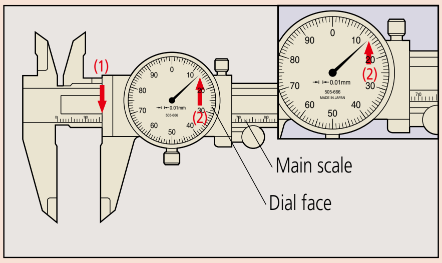
How to Read the Scale

●Vernier Calipers



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

●Dial Calipers

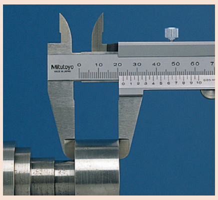


Graduation	0.01mm	
(1) Main scale	16	mm
(2) Dial face	0.13	mm
Reading	16.13	mm

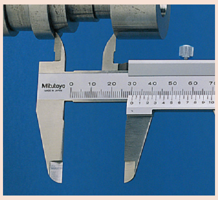
Note) Above left, 0.15 mm (2) is read at the position where a main scale graduation line corresponds with a vernier graduation line.

Measurement examples

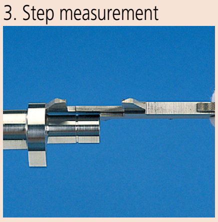
1. Outside measurement



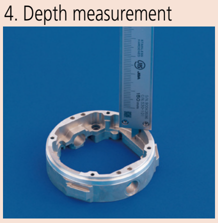
2. Inside measurement



3. Step measurement

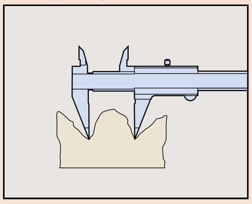


4. Depth measurement



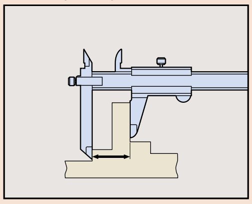
Special Purpose Caliper Applications

Point jaw type



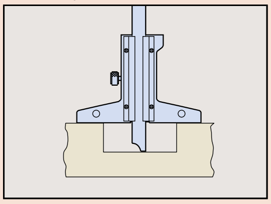
For uneven surface measurement

Offset jaw type



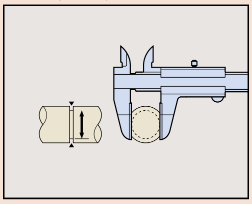
For stepped feature measurement

Depth type



For depth measurement

Blade jaw type

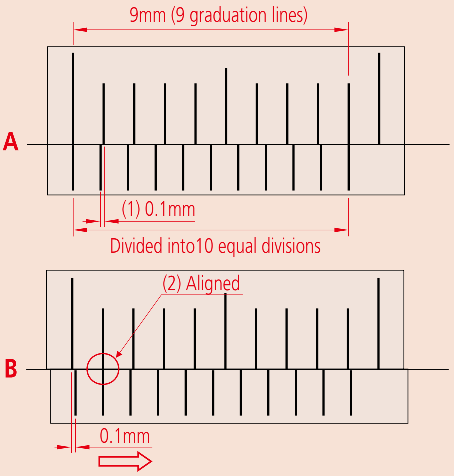


For diameter of narrow groove measurement

D

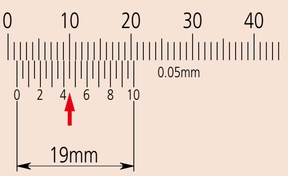
Vernier scale

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 9mm (10 divisions) long, the same as 9mm (9 divisions) on the main scale. This produces a difference in length of 0.1mm (1) as shown in figure A (the 1st vernier graduation is aligned with the first main scale graduation). If the vernier scale is slid 0.1mm 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 0.1mm displacement.



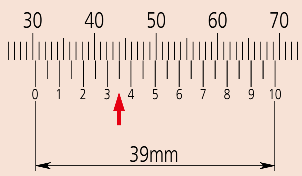
Some early calipers divided 19 divisions on the main scale by 20 vernier divisions to provide 0.05mm resolution. However, the closely spaced lines proved difficult to read and so, since the 1970s, a long vernier scale that uses 39 main scale divisions to spread the lines is generally used instead, as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

- 19mm Vernier scale



Scale reading 1.45mm

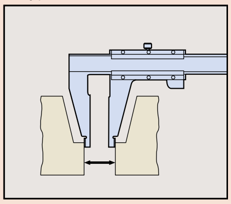
- 39mm vernier scale (long vernier scale)



Scale reading 30.35mm

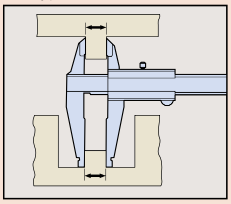
Calipers were made that gave an even finer resolution of 0.02mm. These required a 49-division vernier scale dividing 50 main scale divisions. However, they were difficult to read and are now hard to find since Digital calipers with an easily read display and resolution of 0.01mm appeared.

C-type



Standard outside measurement
Inside measurement of a stepped hole
Measurement of a stepped part

CN-type

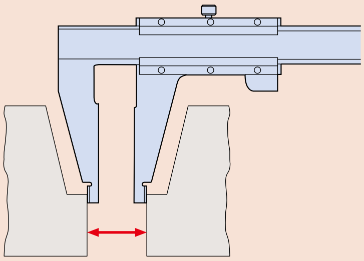


Standard outside measurement
Measurement of a stepped hole
Measurement of a stepped part

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.



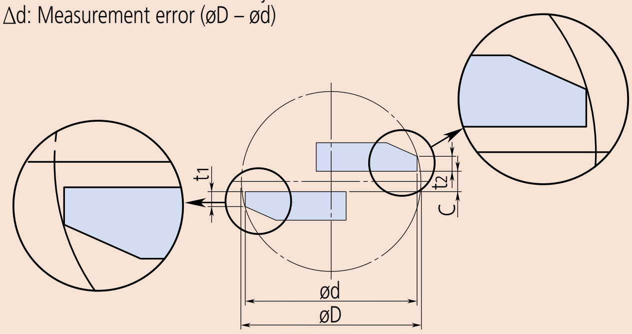
Small hole measurement with an M-type caliper

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)

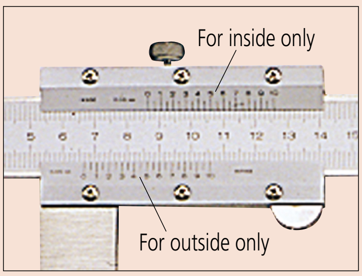
True internal diameter (øD: 5mm) Unit: mm

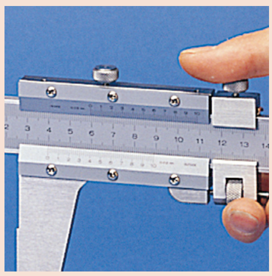
t_1+t_2+C	0.3	0.5	0.7
Δd	0.009	0.026	0.047



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.

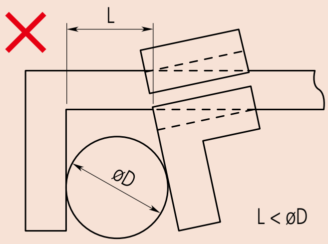


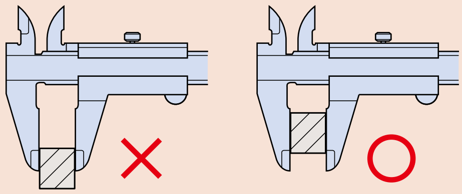


General notes on use of caliper

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 instrumental error tolerances. Therefore, these factors do not cause problems as long as the caliper satisfies the instrumental 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

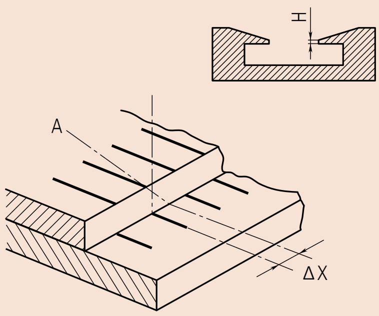
Insert the inside jaw as deeply as possible before measurement.
Read the maximum indicated value during inside measurement.
Read the minimum indicated value during groove width measurement.

3. Depth measurement

Read the minimum indicated value during depth measurement.

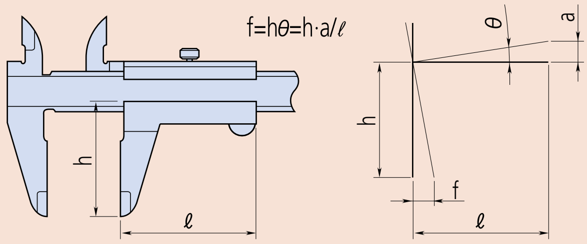
4. Parallax error when reading the scales

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 0.01mm in 50mm and the outside measuring jaws are 40mm deep, then the error (at the jaw tip) is calculated as (40/50)x0.01mm = 0.008mm.
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

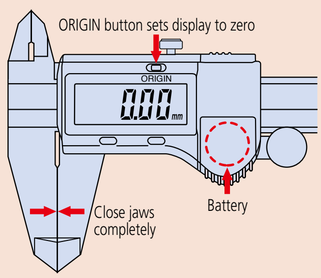
Caliper jaws are sharp, and therefore the instrument must be handled with care to avoid personal injury.
Avoid damaging the scale of a digital caliper and do not engrave an identification number or other information on it with an electric marker pen.
Avoid damaging a caliper by subjecting it to impact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