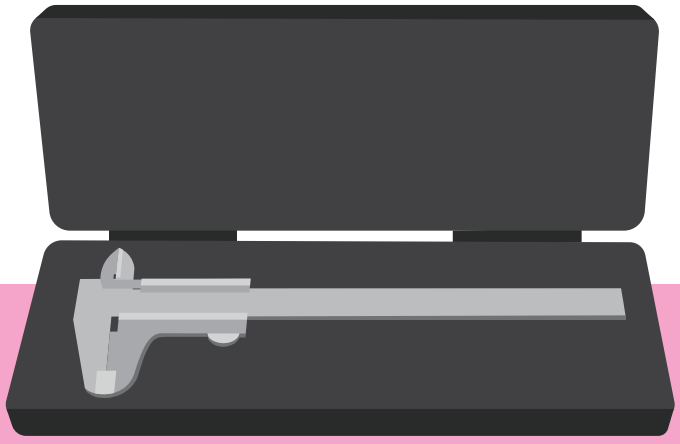
To all those who helped me during
my time as an engineer. Thank you!

A NOTE TO THE LEARNER

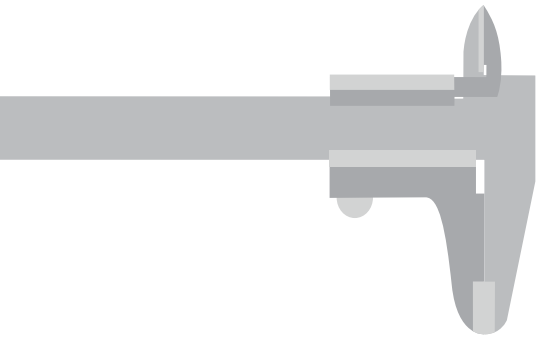
Calipers are powerful tools that help you ensure the highest standards of quality and precision. Mastering their use isn't just a skill—it's a mark of professionalism and pride in your work. This manual will guide you step by step in using and caring for your calipers. Embrace the process, and know that your careful measurements make a real difference in delivering quality products at our organization.



WHAT ARE CALIPERS

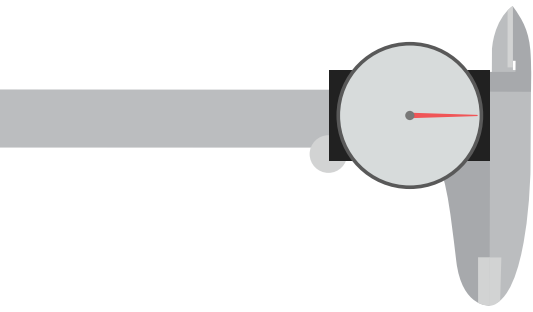
Calipers are precise inspection tools that help measure linear dimensions such as length, diameter, thickness, and depth. They generally consist of two adjustable sets of jaws that can be closed to hold object in place during the measuring process. There are various forms of calipers such as vernier, dial, and digital. While they all have a similar structure, the main difference lies in how they are read. This manual will distinguish the three types of calipers and provide instructions on how to read each one. It will also discuss good maintainence practices and tips and tricks that should be considered when using calipers during the inspection process.

TYPES OF CALIPERS



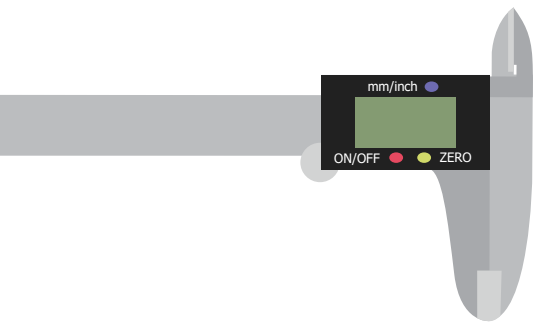
vernier calipers

Vernier calipers have a main scale and a sliding vernier scale. The main scale reading and the vernier scale reading together equals the total reading.



dial calipers

Dial calipers have a main scale and a round dial. The main scale reading and the dial reading together equals the total reading. Generally the least precise.

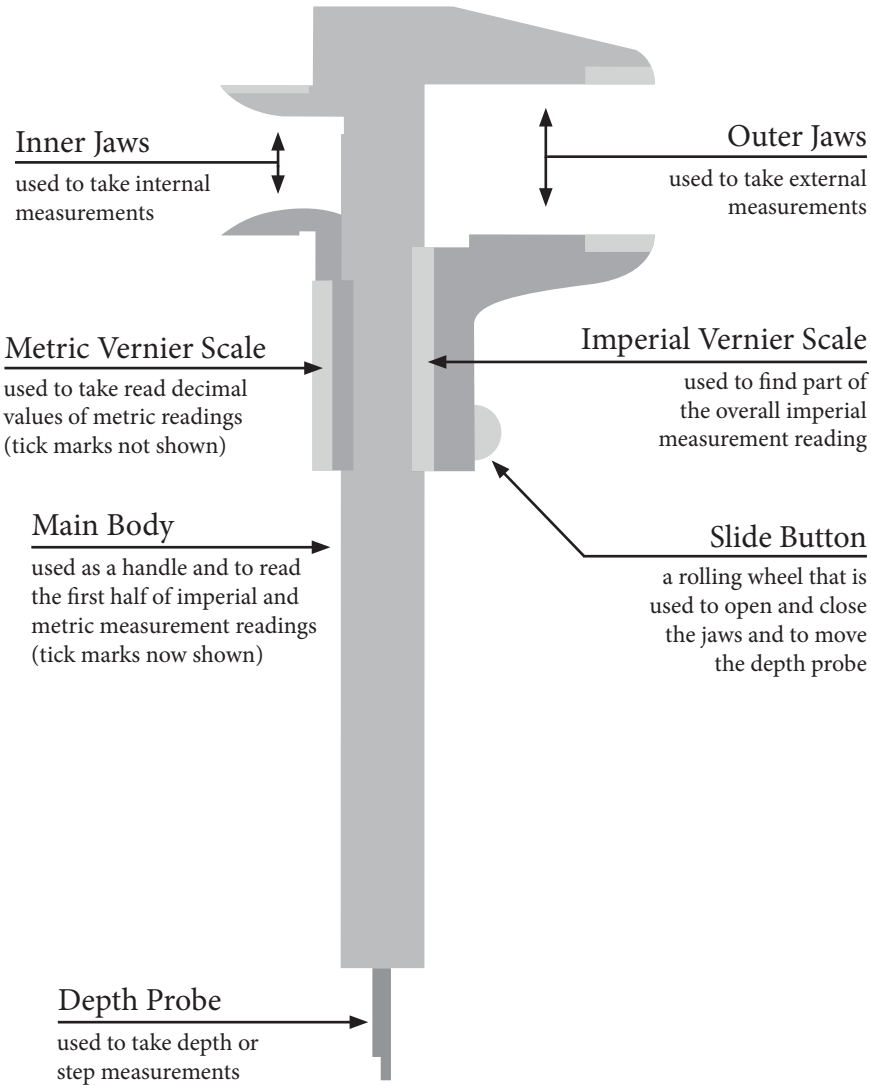


digital calipers

Digital calipers display the measurement directly making them the easiest to read amongst the three.

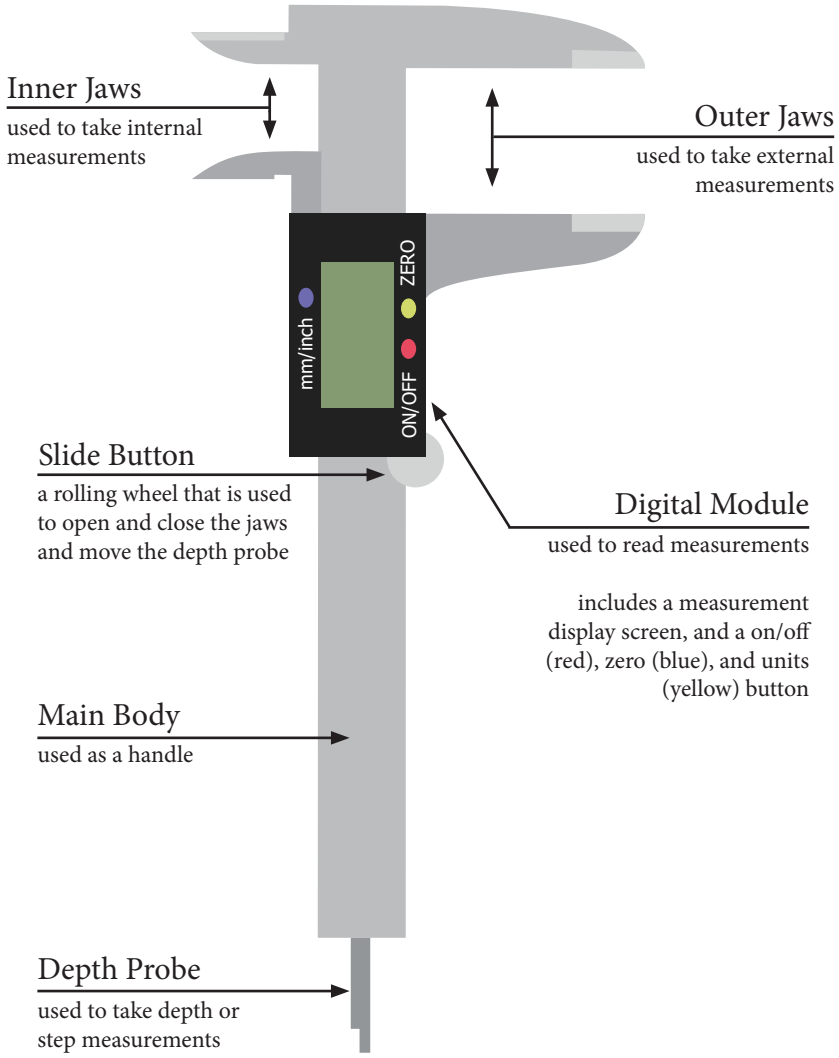
VERNIER CALIPERS

The following diagram is a breakdown of all the parts of vernier calipers:



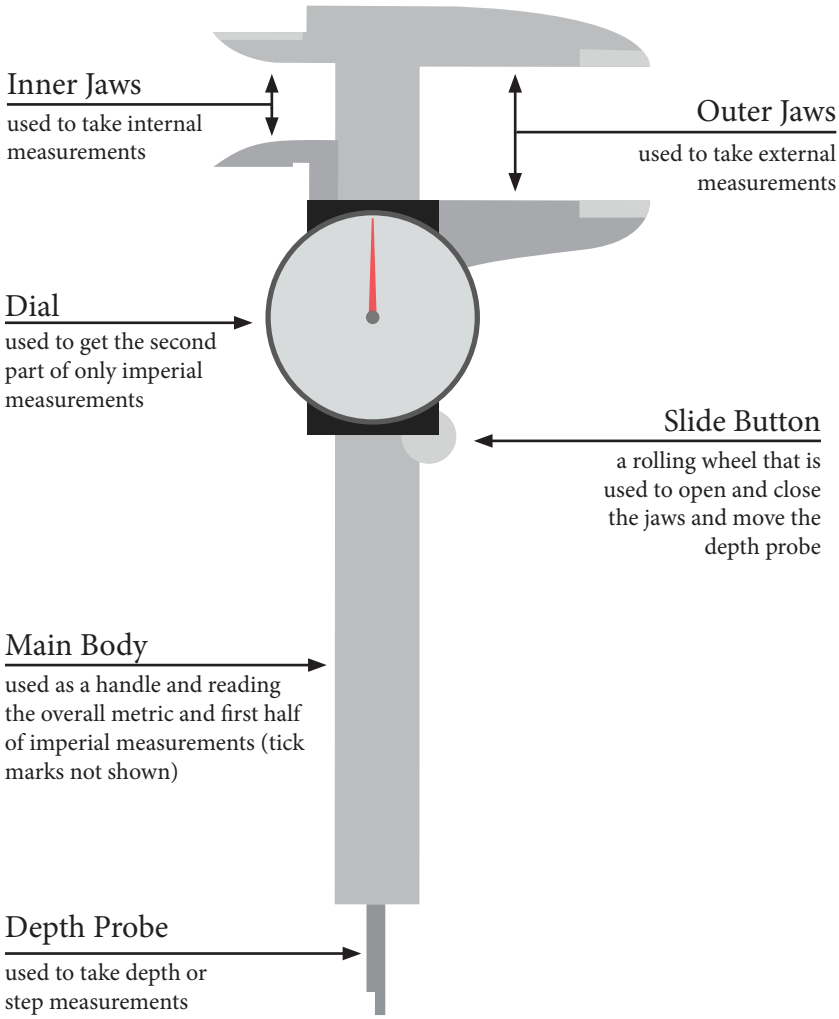
DIGITAL CALIPERS

The following diagram is a breakdown of all the parts of digital calipers:



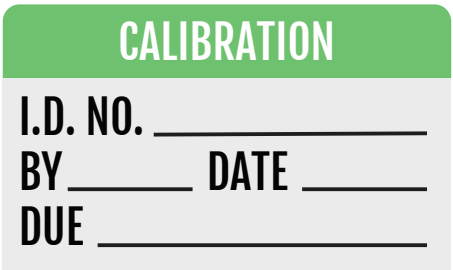
DIAL CALIPERS

The following diagram is a breakdown of all the parts of dial calipers:



CALIBRATION PROCEDURES

To ensure proper calibration of the tool, each pair of calipers will come with a calibration sticker (seen below) which will contain the following information:



I.D. NO. - This will be the identification number assigned to the tool. This number will be used for tracking purposes in the tool system.

BY - This is where the person who calibrates the tool will sign or stamp indicating the tool has been calibrated to the correct standards.

DATE - This is the date that the tool was last calibrated.

DUE - This is the date that the tool will be due for its next calibration.

Tools will be calibrated in the Metrology lab, therefore it is important for each person assigned a tool to ensure that it gets turned on time for calibration and every tool they use is not out of calibration.

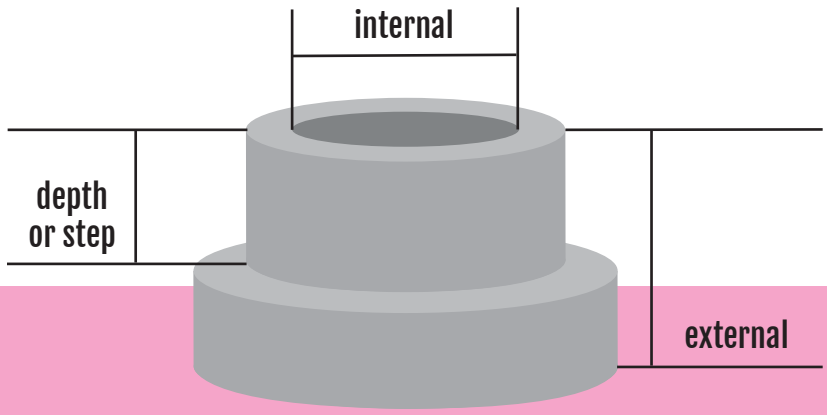
TYPES OF MEASUREMENTS

The example part below has multiple dimensions that can be measured using all the features of a pair of calipers. This part will be used for the next few pages to demonstrate how to collect each measurement.

External measurements include length, width, height, outside diameter.

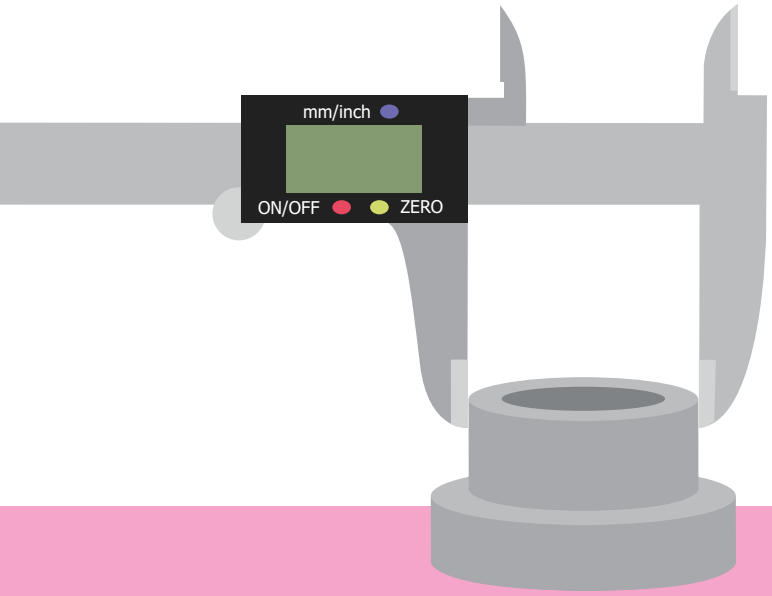
Internal measurements include hole diameter, or length of any features that cave in.

Depth measurements can include depth of a hole or caving feature, but also the step measurement from two outer surfaces facing the same direction.



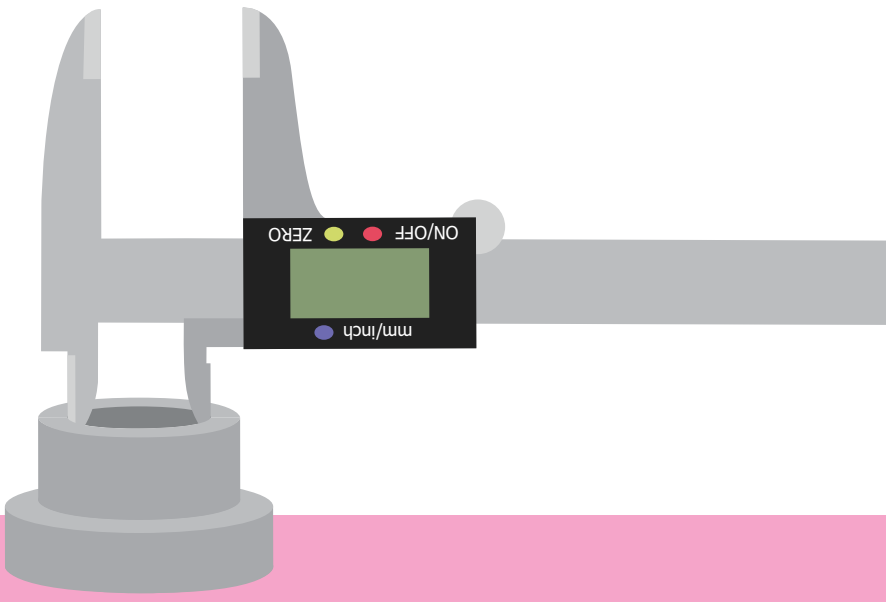
EXTERNAL MEASUREMENTS

To collect an external measurement like a external diameter of a cylindrical part, roll the slide button wheel to open the outer jaws so they firmly align around the two walls of the shape as seen below. You will notice that when the slide button is used, both pair of jaws and the depth probe will move together.



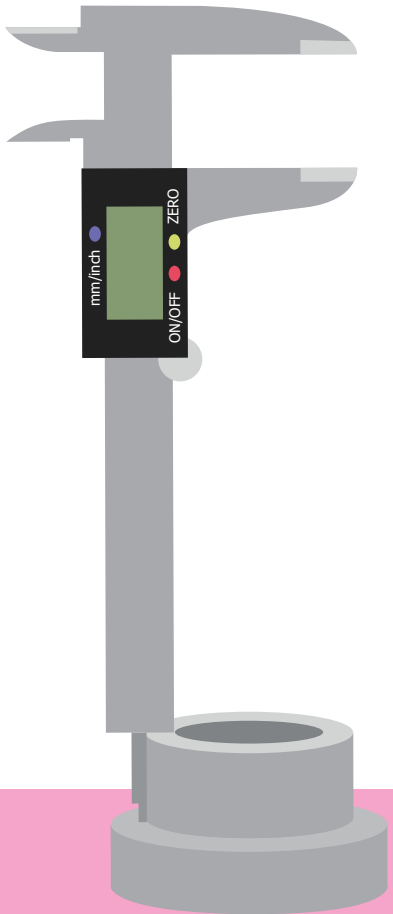
INTERNAL MEASUREMENTS

To collect an internal measurement like a inner diameter of a hole, roll the slide button wheel so the inner jaws firmly align against the two walls of the hole as seen above.



DEPTH OR STEP MEASUREMENTS

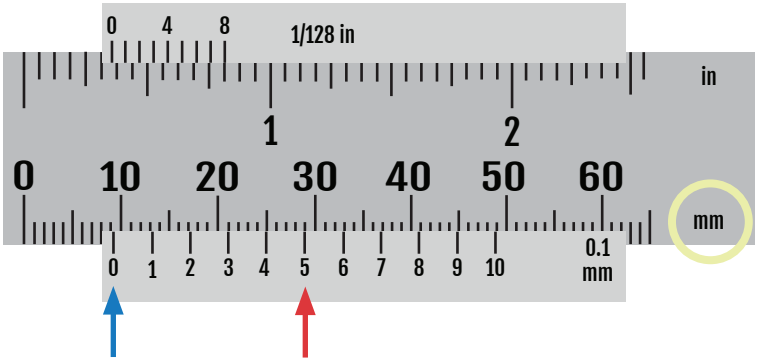
To collect an depth or step measurements, roll the slide button wheel to open the jaws and align the bottom of the depth probe on the bottom surface of the part you are measuring and the bottom of the main caliper body on the top surface. Ensure the calipers are exactly vertical and perpendicular to the bottom surface.



READING THE MEASUREMENTS

Each type of caliper requires its own process for reading measurements. The easiest is the digital caliper as it simply requires reading the display screen. Vernier caliper measurements can be calculated using the following formula:

total measurement = main scale reading + vernier scale reading



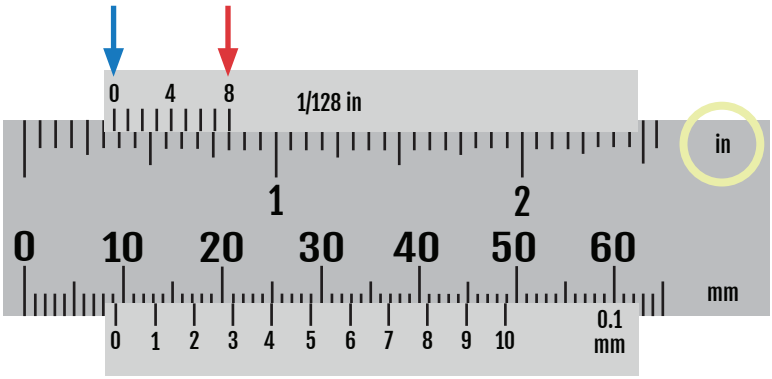
To measure in milimeters, first locate the milimiters side of the caliper scale based on the “mm” marking (circled in yellow).

On the main scale, each tick mark on the milimeter side represents 1 mm. Read to where the 0 on the vernier scale is located (blue arrow), that serves as the whole number marker. In the example above, the main scale reading is 9 mm because the 0 on the vernier scale is just past the 9 mm tick mark.

To find the vernier scale reading look for the tick mark that is most closely aligned with a tick mark on the main scale. Then take that number and multiply it by the scaling, which is written on the vernier scale itself. In the example above, the tick mark that is most aligned is 5 (red arrow) so multiplying that by the scaling factor (0.1 mm) gives a vernier reading of 0.5 mm. To get the final measurement, add the main scale and vernier scale numbers together, which is the following:

9.0 mm + 0.5 mm = 9.5 mm

Reading the imperial scale on a caliper follows the same exact process as the metric reading. The only difference is the vernier scale is on the other side.



To measure in inches, locate the inches side of the caliper scale based on the "in" marking (circled in yellow).

On the main scale, each tick mark on the inches side represents 1/16 inch and whole numbers are labeled. To find the main scale measurement, read to where the 0 on the vernier scale is located. In the example below, the main scale reading is 5/16 inch because the 0 on the vernier scale is past that mark.

To find the vernier scale reading look for the tick mark that is most closely aligned with a tick mark on the main scale. Then take that number and multiply it by the scaling, which is written on the vernier scale itself. In the example above, the tick mark that is most aligned is 8 so multiplying that by the scaling factor (1/128 in) gives a vernier reading of 8/128 in.

To get the final measurement, add the main scale and vernier scale numbers together, which is the following:

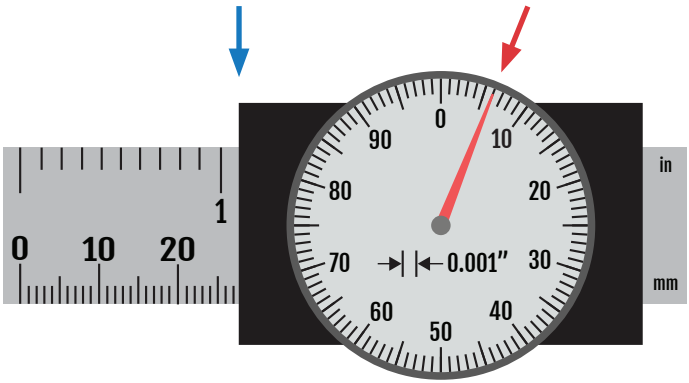
5/16 (0.3125) in + 8/128 (0.0625) in = 6/16 (0.375) in

Reading a dial caliper is similar to a vernier caliper with a slight tweak to the formula (see right).

main scale reading
+ dial scale reading

total measurement

The main difference is that the vernier scale is replaced with a circular dial. Follow the presented steps to get the reading:



Choose a unit system to measure in whether it be metric (mm) or imperial (in). If you using the metric system, only the main scale of the caliper is used. If using imperial, the main scale and dial will be used.

Find where the frontend of the dial portion (blue arrow) of ends up and read the main scale like a ruler to get the first number. Each tick mark on the inch side is 0.1 inches. In the above case, the inches reading is 1.1 in. Each marking on the mm side is 1 mm. If using metric, that will be the total measurement. In the above case, the metric reading is 28 mm.

When getting a imperial measurement in inches, get the dial part of the measurement by reading the circular dial. Multiply the number by the scaling factor shown in the middle (.001 in). In this case, the red dial hand is at 6 (red arrow), therefore the dial reading is 6 x .001, which is .006 in. According to the formula, the total imperial reading is the following:

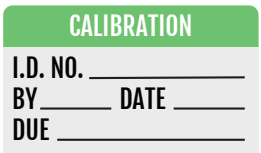
1.1 in + .006 in = 1.106 in

CARE AND MAINTAINENCE

For the effective operation of a pair of calipers, it is important to follow a few general guidelines to maintain them:

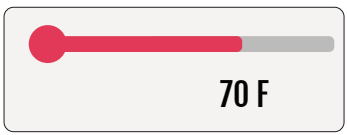
calibrate

Ensure calipers are calibrated before using them. Calibration status can be determined by the calibration sticker.



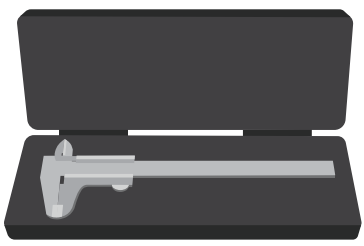
temperature

Calipers should ideally be maintained at around 70 degrees fahrenheit, however room temperature is a good realistic goal.



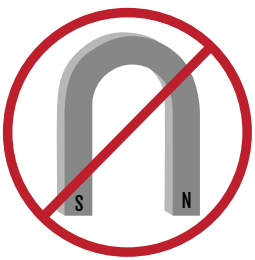
proper storage

Always store calipers with their jaws closed in the provided case. This prevents them from collecting dust.



avoid magnets

Precision measurement tools should not be placed near anything magnetic as it can affect accuracy.



check for damage

Routinely inspect calipers for wear and tear particularly scratches or burrs on the jaws. This can affect the accuracy of the calipers because it is dependent on the flatness of the jaws. A good trick to use is to close the jaws and hold them up to the light to see if there are any gaps. If there is any damage found on your calipers, do not try to fix it on your own. Send them to Metrology and get a calibrated replacement set of calipers.

TIPS AND TRICKS

Here are some tips and tricks to remember when using your calipers:

the zero feature

For digital calipers, it is useful to use the zero button, which resets the display to zero no matter what position the calipers are open in. This allows the transferring of measurements if needed. It is good practice to zero out vernier and dial calipers too by ensuring the '0' markings line up.

find consistency

When using calipers, it is important to use a consistent level of pressure for each measurement. It is also beneficial to generally use the same part of the jaws to further increase consistency.

use a different method

Most measurements can be acquired using different parts of calipers, therefore it can be good practice to try and inspect a singular measurement in multiple ways. For example, the height of a part can be measured using the external jaws, but it could also be measured using the depth probe on a completely flat surface.

hole center to center measurement

A common tricky measurement to inspect is the distance between two holes. It can be considered tricky because the caliper jaws cannot sit in the middle of a hole since there is no surface.

The trick here is to measure the diameter of each hole using the inner jaws and then measure the distance of the outer edges of the two holes using the outer jaws. To get the distance between the centers of the holes, take the outer edge distance and add half of the diameter of each hole.