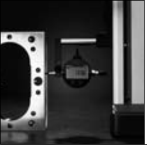
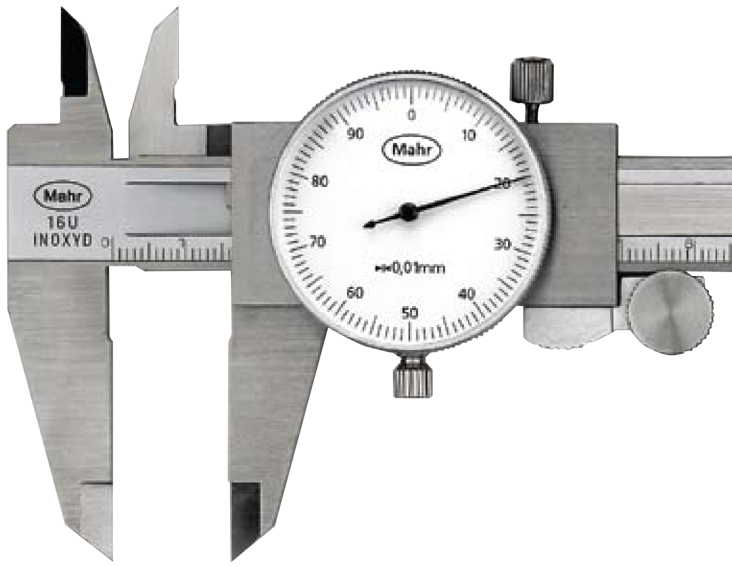


WHAT YOU MUST KNOW ABOUT CALIPERS

THIS PRIMER CONCLUDES OUR SERIES ON VARIOUS MEASUREMENT PROCESSES BY MATCHING DIFFERENT CALIPER DESIGNS WITH SELECTED APPLICATIONS TO PREVENT MEASUREMENT ERRORS FROM CREEPING IN.

By George Schuetz, Mahr Federal Inc.



For the curious, the word *caliper* is short for *caliper compass*, which was a device with curved legs used to measure the caliber, or bore, of cannon and small arms. In today's machine shop, calipers are very versatile instruments used to make a wide variety of measurements, including ODs and IDs (such as the bore of a cannon).

Frequently confused with micrometers (which are actually a hybrid, more accurate form of caliper with more limited range), calipers consist of a precision beam with an integral scale and two sets of jaws, one fixed, the other sliding. Calipers can span from two inches to four feet, depending on the length of the scale. External measurements are made by closing the jaws over the piece to be measured, and internal measurements by opening up the inside diameter contacts. Depth and other measurements can typically be made with a depth rod built into the instrument's beam.

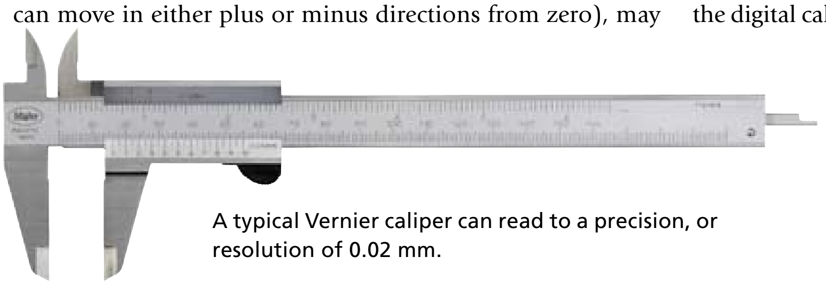
Modern calipers are of three basic types:

Vernier. This caliper was the original design and is still the most rugged. The Vernier scale was invented by Pierre Vernier in 1631. It allows measurements to be read more precisely from an evenly divided scale by the alignment of an etched scale on the Vernier plate with an equally spaced scale running the length of the tool's handle. Skillful alignment of the tool and interpretation of the reading is necessary to achieve the measurement tool's stated accuracy. A typical Vernier caliper can read to a precision, or resolution of 0.02 mm.

Dial. Similar in construction to the Vernier caliper but offering better resolution and easier reading, this caliper replaces the Vernier scale with a dial indicator. The indicator is fixed to the moveable jaw, and engaged with a toothed rack on the body of the unit. The dial, which is typically balanced (i.e., can move in either plus or minus directions from zero), may be graduated in either inch or metric units.

The dial caliper is a dual-purpose instrument and can make either direct or comparative measurements. To make a comparison, first measure the reference dimension and set the dial indicator to zero. Then measure the dimension to be compared. The indicator will show how much the compared dimension varies from the original (plus or minus).

Digital. The most recent innovation is the digital caliper. The latest designs incorporate numerous electronic features which make the device easier to use, while adding little in the way of cost. These include: easy switching between inch and metric units on the readout; tolerance indications; digital output to electronic data collection systems; zero setting anywhere along the caliper's range; and retention of the zero setting even when the caliper is turned off. With no moving parts in the readout, the digital caliper is exceptionally durable, standing up to some of the toughest manufacturing environments. Newer units are even waterproof.



A typical Vernier caliper can read to a precision, or resolution of 0.02 mm.

USING CALIPERS

The biggest problem with calipers is the level of operator skill required to make accurate, repeatable measurements. Since the caliper is a contact instrument, the jaws must be correctly aligned

Water resistant digital calipers are designed for use in extreme production environments in accordance with the IP67 standard. Built for durability, some digital calipers have specially resistant materials in the casing and keyboard, and a fluid protection system to safeguard sensitive electronic components.

on the part, and sufficient torque must be applied to the anvils to make good positive contact between the part and the instrument. The only torque calibration in the human hand is the operator's 'feel.' What feels like solid contact to one operator may not feel correct to another, so the readings may be different.

Subjective or psychological factors also influence caliper measurements. Tell an inspector that the best machinist in the plant made a part – or that the boss made it – and those measurements may tend to be better (or worse!) than the part deserves. In addition, studies show that if an operator knows what size a selection of parts ought to be before he measures them, readings will tend to be closer to that ideal than if the target dimension is unknown.

APPLICATIONS

The popularity of calipers is based both on their versatility and ease of use. Figures 1a and 1b illustrate basic OD and ID measurements. Figures 1c and 1d illustrate more complex depth and step measurements. Other common caliper measurements include measuring the center distance between two holes, comparing a shaft diameter to a hole ID, and gaging remaining thickness when drilling a hole in a workpiece.

There are also any number of different anvils and contacts available which extend caliper use to many special measurement applications.

Ball contacts are used to measure wall thickness of tubes and other cylindrical components. Calipers are available with one or two ball/radiused contacts, and in some cases the ball contacts can be supplied as attachments for use with standard flat tipped anvils. The attachments may be quickly and easily applied, but when using this type of attachment, the ball diameters must be taken into account by subtracting them from the caliper reading.

Similarly, other specialized anvil attachments and accessories are available to measure threads, bores and serrations, recesses, recessed IDs and ODs, grooves, and distances between grooves. A depth measuring bridge can extend the effective diameter of the beam, allowing depth measurement of wider holes. Some models even offer an attachable device for measuring force.

However, because these accessories and attachments extend the measuring range, parallelism errors can creep into the measurement. Thus, checking the parallelism of the contacts using a precision ball is important. A discrepancy of more then a grad on the Vernier scale is a sign that the parallelism of the anvil needs to be corrected.

Even the best and most basic hand measuring tool can be made better by adapting it to special application requirements. By choosing the most appropriate accessories for the application, you will achieve faster and more accurate measurement results.

With no moving parts in the readout, the digital caliper is exceptionally durable.

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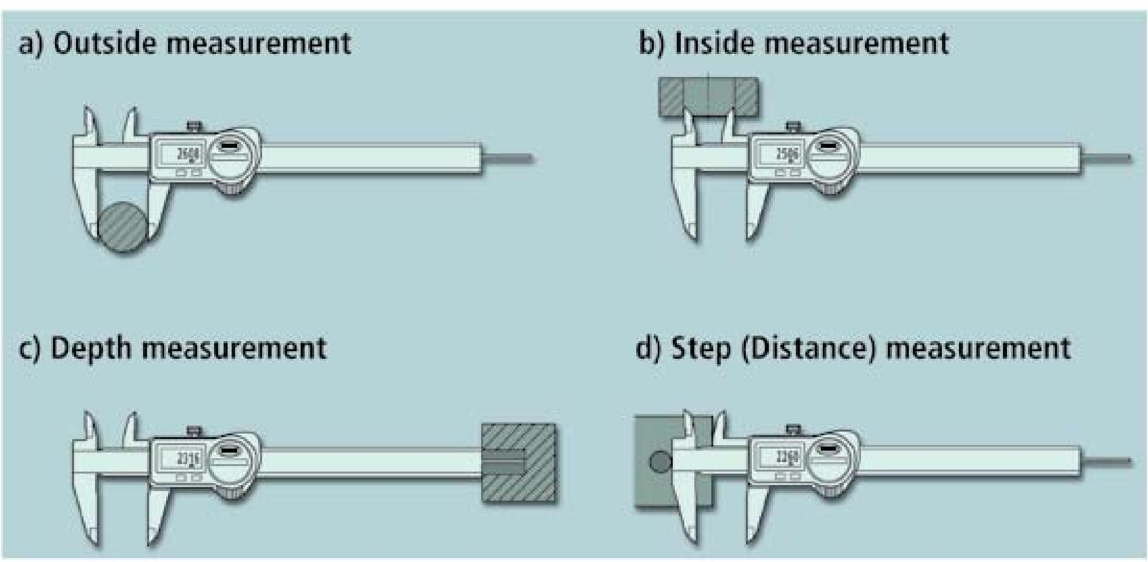

Figure 1. Figures 1a and 1b illustrate basic OD and ID measurements. Figures 1c and 1d illustrate more complex depth and step measurements.