How to choose what is the correct optical comparator:

Question # 1 – Is a Horizontal or Vertical optical comparator best for your application?

Horizontal light path Optical Comparators have a beam of light traveling horizontally across a work stage. This is the most common and versatile style of comparator and comprises more then 95% of comparator inspection applications. The horizontal beam is well suited for large and small parts and the work stage can accommodate a wide variety of work-holding tooling. Typical applications include milled or turned components, screw machine parts, plastic injection molded parts, threads, grooves, extrusions, large heavy parts and shafts to be held on V blocks or between centers. Optical comparators can be configured to operate manually or under full CNC control. They can also be fitted with a video camera system to operate in tandem with the projection optics when configured as a Video Measurement System

ertical light path Optical Comparators have a beam of light traveling vertically. Parts being inspected are placed on a plate of glass that the light beam travels through. Vertical comparators are ideal for flat parts like gaskets, O rings, stamped parts and electronics. Many of these components can also be inspected using Vision Systems (video camera based).

Question# 2 – What screen size and stage size satisfies your application?

Standard optical projector screen sizes are 10", 14", 20", 30" and 50" but we can also offer special models with a screen size range between 6" to 120". Before choosing a screen size, determine how much of the part must be viewed at one time. When using a digital readout system it is not necessary to view the entire part to measure it. Calculations can be made by dividing the screen diameter by the lens magnification. For example using 10X lens on a 14" optical comparator would enable viewing 1.4" of the part on the screen 14"/10=1.4". Verify that the work stage size, travel and weight capacity will accommodate all of the parts that are intended to be inspected.

Question# 3 How large of a viewing screen should you get?

The answer is based on the type of measurements you plan to make.

Measurement by comparison (with overlay charts or screen templates) can use the entire viewing screen. A larger screen means you can see more of the part at any one time, perhaps measuring many features at once with the same chart. Measurement by motion (with visual alignment or edge detection) uses the movement of the worktable assembly and screen rotation to measure the part. How large of a part you can measure is based solely on the overall travel of the worktable.

If you need to use overlay charts, for thread or form measurement for example, then a larger screen may be needed depending on the size of the parts. The table below shows the field-of-view (how much can be seen at one time) for some common screen sizes and magnification levels. For other combinations, simply divide the screen size by the lens magnification.

Field Of View

	14"	20"	30"
5X	--	--	--
10X	1.40"	2.00"	3.00"
20X	0.70"	1.00"	1.50"
50X	0.28"	0.40"	0.60"
100X	0.14"	0.20"	0.30"

Question # 4 – Which lens/lenses you will require?

Follow the chart below to decide what lens will match the tolerances required. A basic rule of thumb is that a typical attentive operator can repeatedly discriminate .004" on the comparator screen. Dividing the "discernible resolution" by the lens magnification determines the minimum resolution attainable for each lens.**Back to Top**

Question # 5 – What type of digital readout should I get?

Select a basic XY digital readout if only positions and distances are required. If measurement of circles, angles, and parametric distance is required, then select a readout with geometric capability. Q axis (rotation) is also available on many readouts. Repetitive part measurement may encourage the selection of a CNC capable readout. Automatic edge sensing is available instead of just cross hair measurement. The automatic edge detector eliminates the operator having to perfectly align the cross hair on the edge of a feature. The automatic edge sensor picks up the threshold from going dark to light or light to dark. Automatic edge detection should be considered to eliminate operator subjectivity and increase repeatability and accuracy.

Question # 6 – What options or fixtures should I purchase for my Optical Comparator?

Repeatability and accuracy will suffer if the work piece is not properly and securely held. Work-holding is just as important when inspecting a component as when machining the component. Careful consideration should be given to tooling and to the surface on which you place your comparator. Most common is buying a rotary vise.

Question # 7 Benchtop or Floor Model optical projector?

Optical comparators come in an wide variety of shapes and sizes. Benchtop, floor model, in-line, side-screen, front screen, side-table.

Whether you choose a benchtop or floor model comparator may ultimately depend on the size and weight of the parts to be measured. Other factors to consider include space (floor models typically take up more space than benchtop systems), required screen size (benchtop systems rarely have screens larger than 14" or 16"), and cost (floor models are generally more expensive).

What kind of parts are being measured?

Benchtop models are smaller, lighter, and have lower load carrying capacity and measuring range than most floor model systems. Consequently, one usually finds benchtop comparators employed for measurement of small, lightweight parts such as plastic moldings, stampings, lathe work, etc.

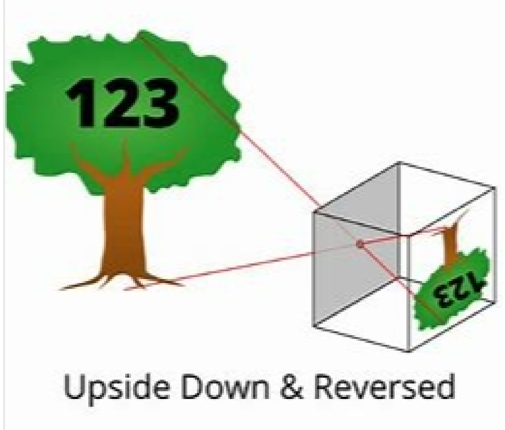
Floor models, on the other hand, offer substantial load capacity and large travel, and are often used to measure large machined castings, dies, and heavy tooling.

Objective Lenses / Optics

The optics are the heart of any comparator. When you think about it, the lenses in a comparator are really gages. Why? Because it is the image they form that is measured, not the part itself. And to make sure the image is accurate, optical quality (in design and manufacture) is critical. You will find several different types of optics offered on optical comparators. Regardless of the type, however, the optics must be free of distortion (magnification change across the image), produce a flat field (image over the entire screen is in sharp focus) and have excellent resolution (sharpness of the image). Let us take a look at each type and discuss the relative merits of each

Simple Reversed Optical System –

Simple reversed optic images that are upside down and reversed.



The smallest, simplest, brightest and least expensive optical system is referred to as a simple reversed optical system. In these instruments, an objective projection lens magnifies the object and the image is directed to the angled screen by a single mirror. The image is inverted (upside down) and reversed (left to right). The objective projection lenses are mounted on the outside of the instrument and changing magnification involves removing a lens from the front of the machine and replacing it with another. Some systems make this more convenient by providing a multiple lens slide or turret. When using simple reversed optics, the front working clearance of the lenses (the distance between the face of the lens and the part being inspected) decreases as the magnification is increased. Surface reflection options used on simple reversed systems will be oblique off-axis fiber optics or will incorporate a half reflecting mirror adapter mounted in front of or on the magnification lens. It must be noted that J&L has developed a series of magnification lenses that can be used in a 14" simple reversed optical system and that produce a fully corrected image. This series of lenses is the only exception to the reversed image description above. systems.

Simple Reversed Optical System –

Images on machines with Erect optics are corrected top to bottom but reversed side to side.

An adaptation of simple reversed optical systems is the Erect optical system. This type of instrument is basically a simple reversed system with the addition of another mirror in the vertical optical plane. The second mirror flips the image top to bottom so that it becomes corrected in the vertical plane. This instrument has all of the advantages and disadvantages of the simple reversed system except that the instrument itself is not as deep as the reversed machine and the screen is vertical for a better viewing angle.

Fully Corrected Optics –

Images on machines with Erect optics are corrected top to bottom but reversed side to side.

Fully Corrected optical comparators use an additional optical system, called a relay lens, to form an intermediate image which is in turn magnified by the projection lens. The final image is fully corrected, or in other words, erect and unreversed. An important benefit afforded by fully corrected optics is a constant front working clearance, regardless of magnification. This allows the inspection of large heavy parts and those with large diameters. Front working distances are as follows 14" = 6.7", 20" = 7.4", 30" = 13", 50" = 24" . Another important benefit of the fully corrected optical system is that the surface reflection system travels coaxially down the projection path.

This allows for superb, bright illumination with less power consumed. It can also illuminate directly down inside of deep blind holes and slots. Due to the extra optics in relay lens systems, the magnification lenses are usually arranged in an internal turret, often motorized for convenience.

Telecentric lenses

The closer an object is to you, the larger it appears. This is one of the fundamental principles of optics. The same is true for any optical system, whether your eye, a camera, or an optical comparator. But this can cause an error when measuring a three dimensional part, or if the image is simply a little bit out of focus. Why? Because adjusting the focus on a non-telecentric, simple optics system changes the distance between the part and the optics, and that changes the magnification. The effect is not that large (typically several thousandths of an inch measured at the part), but in today's world of ever shrinking tolerances, you need to be as precise as you can.

Telecentric relay lens optics were developed by J&L and Eastman Kodak in 1945 to alleviate this problem. Here is a good example that shows the difference between non-telecentric and telecentric optics:

A simple part, with a step and two through holes machined into it, will appear "in perspective" to a non-telecentric system, as shown below (the effect is exaggerated for clarity). The machined step on the top (which is farther away from the optics) looks smaller. A telecentric system will create an image free from this effect, with no measurable difference in magnification

Benefits

- Magnification accuracy is not affected by part geometry or configuration.
- Magnification stays the same regardless of different operators focusing the Optical Comparators in slightly different places.
- When coupled with relay lenses, coaxial or through-the-lens surface illumination is possible.
- Coaxial surface illumination provides brighter and more even illumination.

Depth of field (the distance you can move the part along the focus axis before the image appears to go out of focus) is increased.