THE EO AUTO COLLIMATOR

This manual will identify, in a general way, the parts and functions of the EO Auto Collimator (Stock No. #03-658) and familiarize the first-time user with the instrument. It is recommended for the owner to file this manual in a safe place, record the value of the auto collimator at the time of purchase, the purchase date, and serial number of the unit.

The EO Auto Collimator is a precision instrument comprising an achromatic objective, a light source, a reticle, a beamsplitter, and an eyepiece with a reticle calibrated in small increments. The reticle pattern, a crosshair, is projected onto a reflective surface. The returning reflected beam is diverted, via the beamsplitter, to the calibrated eyepiece. The deviation in angle from perpendicularity of the reflective surface is precisely measured at the eyepiece. The instrument has many applications in measuring extremely small angles, and in calibrating and aligning optical instruments and components.

The auto collimator can also be used to measure small deflections and vibrations. The auto collimator has a ¼-20 TPI tap hole for mounting to optical bench posts and positioning equipment. It can also be mounted in a V-block or ring mounts (tube O.D. is 1.72”). The Tubular Lamp Assembly is a self-contained unit comprising a precision reticle and a long-life lens- end lamp. This compact tubular configuration provides versatility so that it may be used as a light source for an optical instrument or as an optical test accessory. As a test accessory, it can be readily mounted in a “V” or ring mount used in conjunction with an optical bench or table.

SPECIFICATIONS

Achromat:	40mm Dia. x 250mm EFL
Angle Measurement Range:	55 arcminutes off-axis (55 arcmin) in 5 arcminute graduations
Eyepiece:	Edmund RKE® 21.5mm
Dimensions:	See dimensions in Figure 1
Power Source:	Plug-in adapter 120 VAC to 2.3 VAC, 1.7 Amp
Light Source:	#222 lens end lamp

SET-UP

1. Mounting your Auto Collimator

The auto collimator should be placed on the same surface plane as your reflecting mirror. If this is not possible, both the auto collimator and the mirror should be set up in a vibration-free environment.

In general, the instrument-to-mirror distance does not affect the accuracy of measurement. Nevertheless, a shorter distance will simplify the setting or alignment of the auto collimator with respect to the mirror. (Note that it is possible to place the mirror too close to the auto collimator. See **Parallax Compensation**).

2. Turning on the Light

Plug the auto collimator into the wall before making any alignment adjustments. This way you do not run the risk of upsetting your alignment should the length of electrical cord add unforeseen mechanical constraints. To plug in your auto collimator, first place the adapter into the back of the auto collimator, then plug the transformer into the wall. If you are unable to view the crosshair image, see **Troubleshooting**.

3. Initial Alignment Procedure

The first step in using your auto collimator is setting the alignment. By rotating the instrument in its mount, position the instrument so that it is both level and in line with the reflecting mirror. Make the axis of the auto collimator as perpendicular to the mirror as possible. In order to do this it may be necessary to observe the instrument’s position by looking at your set-up from both above and the side. Although you may need some mechanical freedom to fine-adjust alignment later, tighten any set screws to generally maintain this position. Beyond this you can continue to better adjust alignment by looking at the mirror from a position of behind and slightly to one side of the auto collimator. Observe the reflection of the auto collimator until optimum alignment has been achieved.

4. Diopter Adjustment

Look into the eyepiece. You should be able to see the micrometer reticle inside the eyepiece. If you do not see this micrometer, or if the micrometer is not completely in focus (it is possible to have the micrometer at a very sharp focus), it will be necessary to slightly change the position of the reticle. To do this, turn the eyepiece either clockwise or counter-clock-wise until the reticle is in focus.

At any time during measurement it may be possible to adjust the focus of the reticle by adjusting its position relative to the eyepiece optics. However, changing the position of the reticle during measurement will limit the accuracy of your alignment. Therefore, before beginning any measurements make sure that the micrometer reticle is of sufficient focus so no later adjustments will be necessary.

5. The Crosshair Image

Turn the illumination to its highest setting so that the crosshair image is as bright as possible. Again (as done in step 3) look down the length of the tube into the mirror from directly behind and to one side of the back of the auto collimator. You should be able to see at least a portion of the crosshair image being reflected in your mirror. If not, further adjust the position of either your auto collimator or your mirror. At this point, if your mirror is mounted in equipment that allows you to do so, it should be simpler to fine-adjust the position of the mirror. When the crosshair image is visible to you in the mirror, look into the eyepiece. If the illuminated crosshair is not visible through the auto collimator, further adjust the mirror or the auto collimator. If necessary, place your eye behind and to one side of the auto collimator again and repeat the above steps.

OPERATION

1. Parallax Compensation

As you begin to use your auto collimator, it may happen that, even though the eyepiece reticle is perfectly focused, the image of the illuminated crosshair will not be sharp. This is due to parallax. Parallax means that there exists no exact coincidence of the focal plane (where the micrometer reticle is) and the image plane (where you see the illuminated crosshair). This is often caused by deficient flatness of the reflecting mirror. Parallax is often responsible for inaccurate measuring results.

One simple solution to parallax is to increase the distance between the auto collimator and your reflecting surface. Another method is to lower the illumination of the crosshair reticle, since the brighter the crosshair, the larger the crosshair will appear when you view it through the eyepiece. However, if your mirror is not of sufficient quality to completely remove parallax, you may have to tolerate that you will not be to achieve perfect focus.

2. Taking a Measurement

When viewing the reflection of the crosshair with the mirror, read the angular differences in the horizontal and vertical dimensions by noting the location of the center of the crosshair image. In Figure 2b, for example, the crosshair image is displaced from the center of the micrometer reticle by 0°28' [28 arcminutes] horizontally and 0°07' [7 arcminutes] vertically.

When setting up a reference mirror, it is best to align the centers of the micrometer and the crosshair image (so that the displacement between them is 0 arcminutes horizontally and vertically – see Figure 2c). Now when a test surface is used, the difference between the reference and the test surfaces is much easier to determine. For example, if Figure 2c represents the reference surface and Figure 2b represents the test surface, it is easy to see that the test surface differs from the reference by 0°28' horizontally and 0°07' vertically. These angular differences can then be used to calculate distances between surface points or edges by using trigonometry.

The micrometer reticle in the instrument only has markings every 5 arcminutes, and yet it may be desirable to determine angular displacement to a more exact resolution. Doing this would require sufficient angular scale on your reflecting mirror mount. For example, if you want to be absolutely sure that the crosshair image in Figure 2b is really displaced by 0°07' vertically.

At this point, record the angular location of the test mirror by reading the vertical scale on your mirror mount. Let us suppose that the mount is tilting the test mirror exactly 2° vertically from the surface plane. Adjust the mirror mount (thus slightly tilting the mirror vertically) until the crosshair is perfectly superimposed upon the reticle scale in the eyepiece.

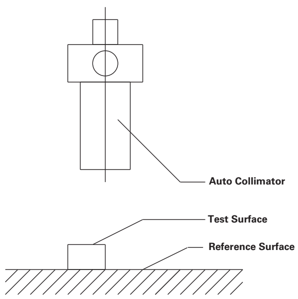
Now look at the vertical measurement. Let us suppose at this point the mount tells you the mirror is tilted 2°06'55" (or 1°53'05", depending upon whether the tilt is "up" or "down") from the surface of the table. Thus you know that the mirror was originally displaced 6 arcminutes and 55 arcseconds from the reference mirror.

Use only just enough illumination to make the reticle visible when taking a measurement. A brightly illuminated crosshair will have bright back reflections from the optics inside the auto collimator, and these reflections can interfere with the effectiveness of measurement. If the crosshair was brightly illuminated during general alignment procedure, use the rheostat to lower the intensity of the crosshair brightness during exact measurement taking.

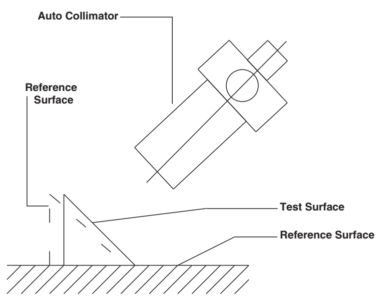
SUGGESTED USES

The EO Auto Collimator can be used in a number of different applications. Below are five examples, though there are many more uses than those listed here. These five examples are included to further boost understanding of how the instrument works, as well as to inspire the user toward developing efficient measurement techniques for specific situations.

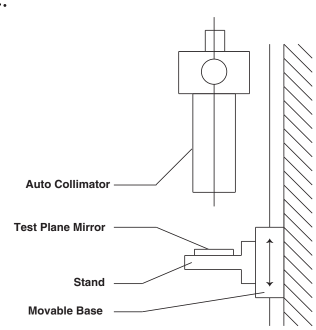
1. Parallelism between two end surfaces (Figure 3).
By placing the auto collimator perpendicular to a reference mirror, it is possible to notice the angular displacement of a test surface from the reference plane.



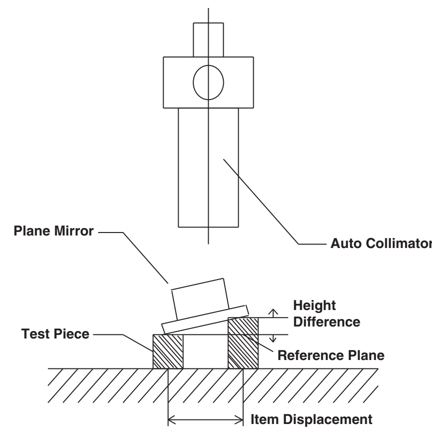
2. Angular error (Figure 4).
Align the auto collimator using a standard reference item. Mark the location of the item, then replace it with the test item. Any angular differences between the reference and the test items will appear as displacement in the auto collimator.



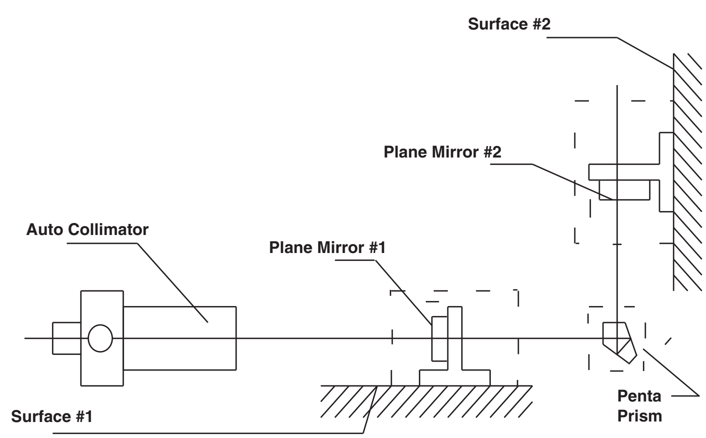
3. Straightness of movement (Figure 5).
Place the collimator at a stationary location and attach a mirror to your movable stage. Align the mirror with the auto collimator. Then slowly move the stage (thus changing the distance between the auto collimator and the mirror), either taking careful readings of angular displacement throughout the throw of the stage or taking measurements at either end of the stage's movement range.



4. Differences in length (Figure 6).
Place two items of identical standard lengths upon a standard surface. Lower a plane mirror across the edges of these two items and align the auto collimator with this mirror. Then exchange one of the standard length items with the test item. Measure the angular displacement of the mirror caused by differing item heights.



5. Squareness of two surfaces (Figure 7).
Using two plane mirrors set up perpendicularly to two surfaces, it is possible to determine how perpendicular the surfaces are to each other. Use the mirror on the first surface to align the auto collimator. Then remove this mirror so that the auto collimator can view a second mirror as reflected by a penta prism. (A penta prism, as pictured in Figure 7, will reflect light perpendicularly [90°] regardless of the incident angle. Simply place the penta prism in front of the auto collimator since it is not necessary to align it with the auto collimator). In fact, the penta prism can be used in many situations where a 90° angle is being tested.



TROUBLESHOOTING

1. Collimating your auto collimator

When you receive your auto collimator, it will have already been collimated - no adjustments will be necessary. Nevertheless, without caution during use it is possible to ruin the collimation. This would only occur if the micrometer reticle were touched when the eyepiece was removed or if the illuminated crosshair were touched while the lighting fixture was removed. If it becomes necessary to recollimate your instrument, follow the steps below for recollimation.

Using a screwdriver, release the housing set screws (see Figure 1) so that the illuminated crosshair and the bulb slide back and forth inside the auto collimator. Fasten the auto collimator to a stationary surface, aim the auto collimator at a very distant object (such as a building at least a block away), and adjust the eyepiece until that object comes into focus. During this process, disregard any defocus of the micrometer reticle. When the distant object is at its sharpest focus, carefully move the crosshair and bulb toward or away from the cube beamsplitter (located in the tube directly underneath the eyepiece).

This will adjust the distance between the crosshair and the optics which is designed to image it. When this distance is perfectly set, the illuminated crosshair will also be in perfect focus. When both the distant object and the illuminated crosshair are in perfect focus, the auto collimator is in perfect collimation, and the set screws should be put back into place to firmly hold the crosshair in place. Now you can adjust your eyepiece so that the micrometer comes into a sharp focus for measurement (see **Diopter Adjustment)**.

Figure 1.

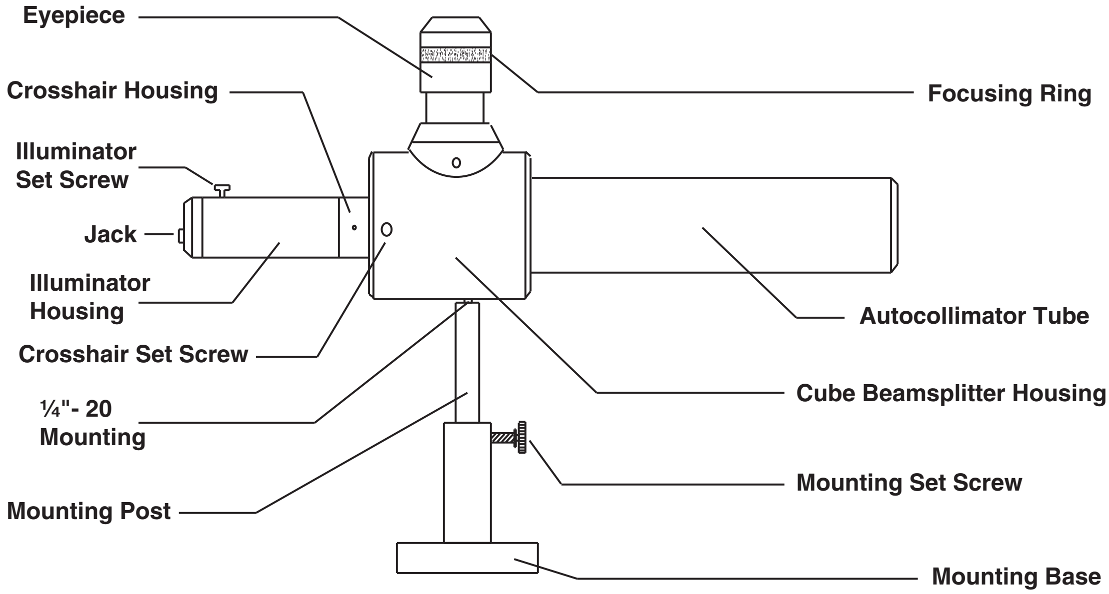
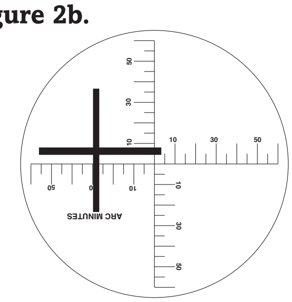


Figure 2a.

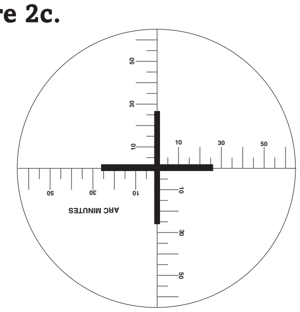
Micrometer only

Figure 2b.



Crosshair displaced by 0° 28' H, 0° 07' V

Figure 2c.



Crosshair perfectly aligned with reticle