3.0 Optical

Contents

CAUTION! Before performing procedures in this chapter, review the chapter on Safety at the beginning of this manual**.**

WARNING!!! When performing procedures in this chapter that require projector covers to be off, wear high voltage gloves (ANSI/ASTM 10,000 volt rated) when working near the CRTs, Arc Lamp, or power supplies. Wear safety goggles (rated X5) when working anywhere near the light path from the arc lamp or the projection lens.

Dangerous levels of ultraviolet and infrared radiation, dangerous glare, very high temperatures (180°C to 300°C) and high internal gas pressure are present at the Xenon Arc Lamp. The lamp is contained in a protective reflector-housing module and should not be operated outside this housing or outside of the projector.

When replacing the Arc Lamp, replace the Arc Lamp Bulb only, as shown in this manual. **Do not open the Arc Lamp Module or touch the Arc Lamp Engine**, or any connections, when the lamp is ignited or is arcing.

Any servicing of the Arc Lamp must remain restricted to Certified Technicians.

3.1 Arc Lamp Engine

The Arc Lamp Engine is the beginning of the high intensity Light Path. It is located inside the Arc Lamp Module. The Arc Lamp Engine outputs 7-kW of energy, delivering over 10,000 Lumens to the screen.

Arc Lamp Engine - Main Functions:

The Arc Lamp Engine is a single component composed of a Xenon gas bulb at the center of a compound elliptical reflector. It supplies the high intensity white light used by the projector to put a very bright image on the screen. The expected 50% life (half of initial light output) of an Arc Lamp is approximately 500 hours.

Arc Lamp Engine - Inputs

- 32 kV pulse to light the Arc Lamp Power Supply
- 7 kW constant power during normal operation

Arc Lamp Engine - Operation

The Arc Lamp Power Supply and the Igniter Assembly work together to produce a 32 kV pulse that ignites the Arc Lamp. After the Arc Lamp lights, the voltage from the Arc Lamp Power Supply drops to a constant voltage of approximately 42 V at 160-166 amps. It will stay at this level during normal Arc Lamp operation.

Arc Lamp Engine - Service Adjustments

The Arc Lamp alignment must be checked after the bulb has been replaced. Arc Lamp alignment refers to adjusting the X- (Horizontal Centering), Y- (Vertical Centering), and Z- (Lamp Height) axes of the Arc to locate the "hot spot" (brightest place on the screen) to the center of the screen. This provides a relatively uniform brightness across the entire screen. The operator should attempt to obtain a 2:1 (but no more than 3:1) rolloff from screen center to screen edge, and no more than 4:1 from screen center to the 4 screen corners.

NOTE: Rolloff is the gradual decrease in brightness from the center of the screen to the corners of the screen.

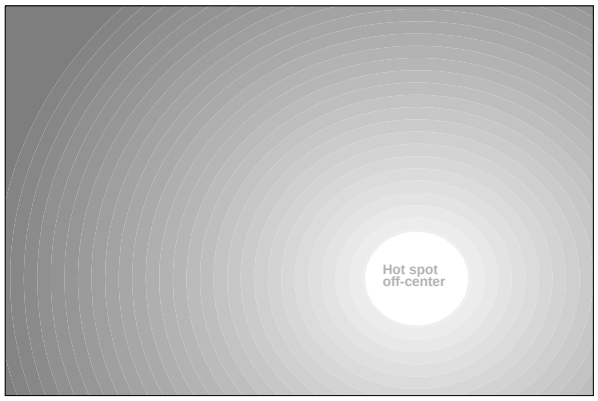


Figure 3-1 Arc Lamp “Hot Spot” (brightest area) is off-center vertically and horizontally. Adjust to center the “hot spot”.

Adjusting the Z-Axis makes the "hot spot" brighter or less bright causing a resulting increase or decrease in rolloff. Adjusting the X or Y axes moves the "hot spot" left/right or up/down with the purpose of centering it to within 5% of center in either direction and leveled brightness in the corners.

The Arc Lamp Bulb is adjusted using the adjustment knobs on the side of the Arc Lamp Module (*see Figure 3-2*).

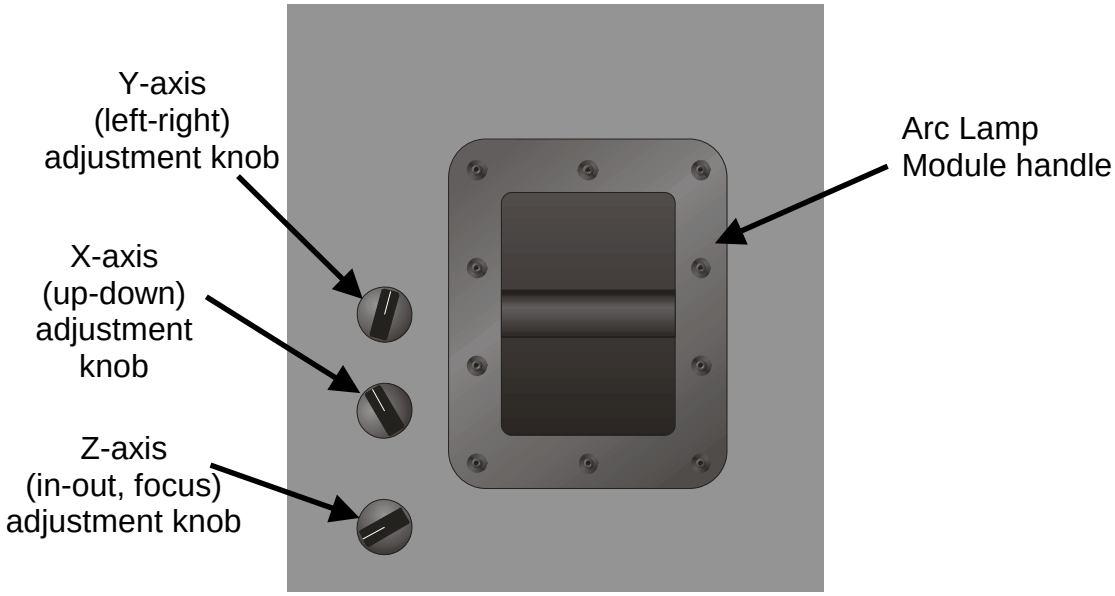


Figure 3-2 X-, Y-, and Z-axis adjustment knobs on the Arc Lamp Module.

Tools Needed

Minolta Illumination Meter T-1 (light meter) or equivalent

To adjust the X and Y axes:

1. Connect the AC Power Cord to AC Power source.
2. Toggle the Main AC Circuit Breaker on the front panel to ON.

3. Make sure the three Subassemblies AC Circuit Breaker
4. Connect the Tethered Remote to the Terminal-In jack at the rear of the projector (*see the "Terminal or Tethered Remote" section in Chapter 6 of the Installation section*).
5. Press both Power keys simultaneously on the Tethered Remote or press Ctrl + P on the keyboard of a computer terminal.
6. Wait at least 15 minutes for the projector to warm up prior to making Arc Lamp adjustments.
7. Using the light meter, measure the area around the center of the screen to determine the brightest area (hot spot).

   NOTE: The Arc Lamp alignment process is much easier if performed with two people. One person can stand at the screen and take light readings with the light meter while the other person is at the projector adjusting the Arc Lamp.

   HINT: For a course adjustment of the X- and Y-axes, remove the green projection lens. A dark spot (from the Arc Lamp will appear on the screen. Adjust the X- and Y-axes knobs until the dark spot is centered on the screen. Reinstall the green projection lens for the Z-axis adjustment.
8. If this hot spot is not in the center of the screen, the X- or Y-axis knob (or both) must be adjusted to center the hot spot.
9. Turn the X-axis knob clockwise to move the hot spot to the right or counterclockwise to move it to the left.
10. Turn the Y-axis knob clockwise to move the hot spot up and counterclockwise to move it down.

These adjustments are illustrated graphically in Figure 3-3. The operator should take readings with the light meter after each adjustment of the X- or Y-axis knob to ensure that the proper corrections are being made to center the hot spot.

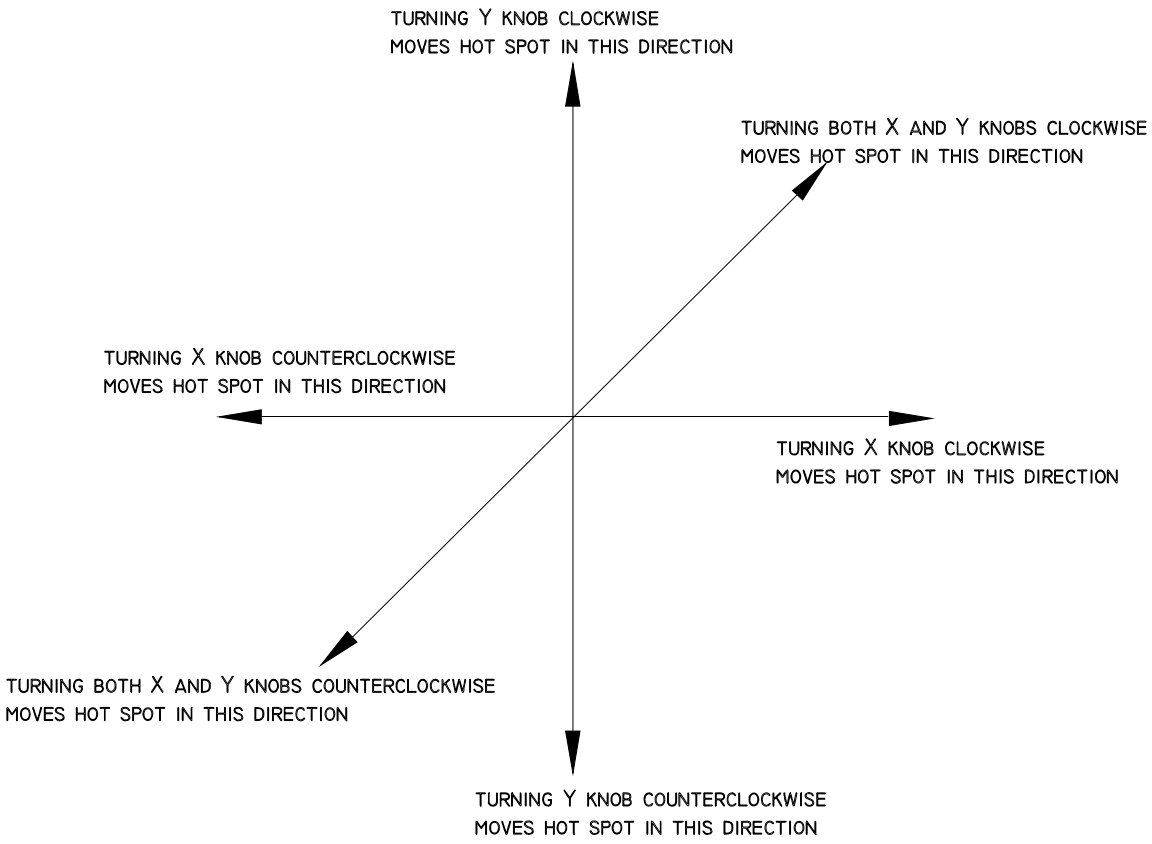


Figure 3-3 Graphical Representation of "Hot Spot" movement on screen.

After the X-axis and Y-axis knobs have been adjusted so that the hot spot is centered on the screen, the Z-axis knob must be adjusted for proper rolloff from the screen center to the screen edges and corners.

To adjust the Z-Axis:

1. Use the light meter and measure the brightness at the screen center.
2. Measure the brightness at the four corners of the screen. They should measure approximately the same brightness. If this is not the case, the X- and/or Y-axis adjustment above should be repeated until all corners measure about the same brightness.
3. If all of the corners measure about the same, calculate the rolloff by dividing the brightness measured at the screen center by the brightness measured at any of the four corners. This should be no more than 4:1 (preferably 3:1). If the rolloff ratio is too high turn the Z-axis knob in a counterclockwise direction to reduce rolloff. If the rolloff ratio is low, turn the Z-axis knob in the clockwise direction.
4. Continue to take readings with the light meter and make adjustments until proper rolloff is obtained.

Arc Lamp Bulb - Remove and Replace

The Arc Lamp Bulb must be replaced after 500 hours of Arc Lamp operation.

Tools Needed

10-mm Balldriver Hex-head wrench

8-mm Balldriver Hex-head wrench

Equipment Needed

Minolta Illumination Meter T-1 or equivalent

To replace the Arc Lamp bulb

Power off the projector by Tethered Remote or computer terminal, and allow the cooling fans to run until they shut off.

Turn the Main AC Circuit Breaker to the OFF position but leave the AC Power Cord plugged in to maintain chassis ground.

Figure 3-4 Arc Lamp Bulb in shipping container.

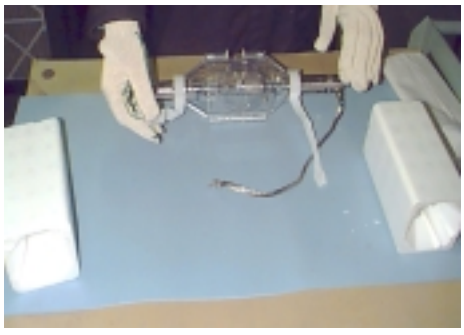


Figure 3-5 Remove bulb from container and place on padded table.

CAUTION! Keep the anode cable away from the bulb glass to avoid breaking the bulb!!

1. Remove the Arc Lamp Bulb from its container. Observe that the bulb itself is contained inside a plastic bulbcase for protection (*see Figure 3-4*).
2. Remove the bulb from the bulbcase by squeezing the locking pins together to open the bulbcase.
3. Lift up the Arc Lamp Spider. The Spider holds the Anode (cable) end of the Arc Lamp in place
4. Insert the Arc Lamp bulb through the hole at the bottom of the parabolic shaped reflector and into the socket in the bottom of the Arc Lamp Engine. The bulb should insert fully into the socket (about ¾-inch).
5. Ensure that the bulb is secure enough in the socket by verifying that it cannot be pulled out from the top.
6. Lower the Spider Assembly down onto the top of the Arc Lamp Bulb.
7. Connect the Arc Lamp Bulb anode cable (attached to bulb) to the Ignitor terminal. Ensure the cable is routed through the cable guide and is a minimum of 1-inch from nearby surfaces to avoid arcing during lamp ignition.

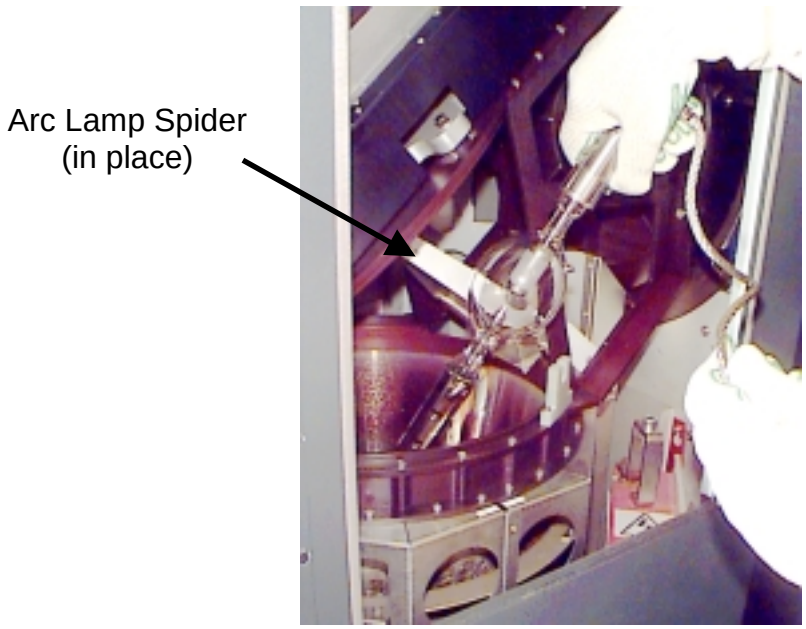


Figure 3-6 Insert the bulb into the bulb socket. Note that anode cable is at the top.

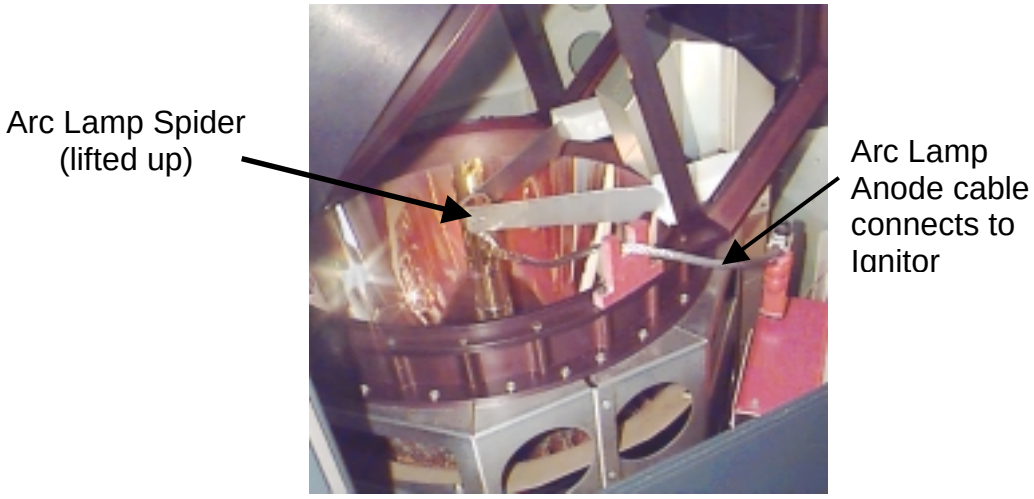


Figure 3-7 Arc Lamp Bulb installed with cable connected. Lift the spider from the top of the Arc Lamp Bulb.

WARNING!!! Dangerously bright light and high current exist in this area of the projector. Before proceeding with the removal of any subassemblies below, verify that the circuit breaker at the rear of the projector is turned off and the power plug is removed from the AC outlet.

3.2 Optical Path

Optical Path - Main Function

- Transports the Arc Lamp high intensity light from the Arc Lamp to the ILA® device and from the ILA® device to the Projection Lens
- Removes the Infrared light that contains most of the heat
- Removes the unwanted Ultraviolet light
- Condenses the white light using the Light Pipe for a uniform output
- Separates the white light into its RGB component colors using Dichroic Beamsplitters.
- Polarizes each of the component RGB light beams
- Combines the component RGB image beams into one beam and delivers that to the Projection Lens.

Optical Path - Inputs

Arc Lamp high intensity white light

Component RGB Image light from each of the ILA® device

Optical Path - Outputs

Component RGB polarized light to the ILA® device

Output image light to the Projection Lens

Optical Path - Operation

The high intensity light originates at the Arc Lamp Engine. It reflects off the 45° #1 Cold Mirror and passes through the first and second Condensing Lens. The Cold Mirrors filter out Infrared (IR) heat radiation. The Optical Path has four Condensing Lenses that work together to take the source light from the Arc Lamp and image it onto the output face of the ILA® device. The UV Filter filters out unwanted ultravioltet light. UV Filters filter out unwanted Ultra Violet light rays.

CAUTION! The term "cold mirror" is used because the mirror passes infrared light and its reflection contains only "cold' light that does not transmit appreciable heat. As a result of the absorption of infrared heat radiation, "**cold" mirrors get very hot**.

The #1 and #2 Condensing Lenses are actually part of the Arc Lamp Module (*see Figure 3-8*), however, when the Arc Lamp Module is mated to the Projection Module, these Condensing Lenses are inserted into the Projection Module (*see Figure 3-9*).

From the #1 and #2 Condensing Lenses, the light travels through a Halo Mask that blocks stray light from the Prism Assemblies. The Halo Mask is a rotated rectangular shaped aperture. From the Halo Mask, the light passes through the #3 Condensing lens and UV Hot Filter and is reflected off the #2 Cold Mirror.

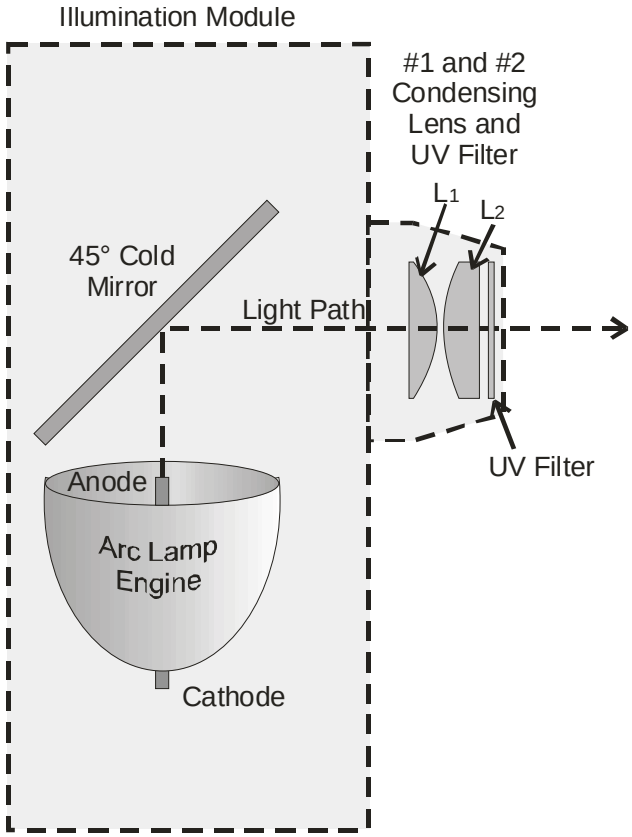


Figure 3-8 Light Path inside Arc Lamp Module (side view).

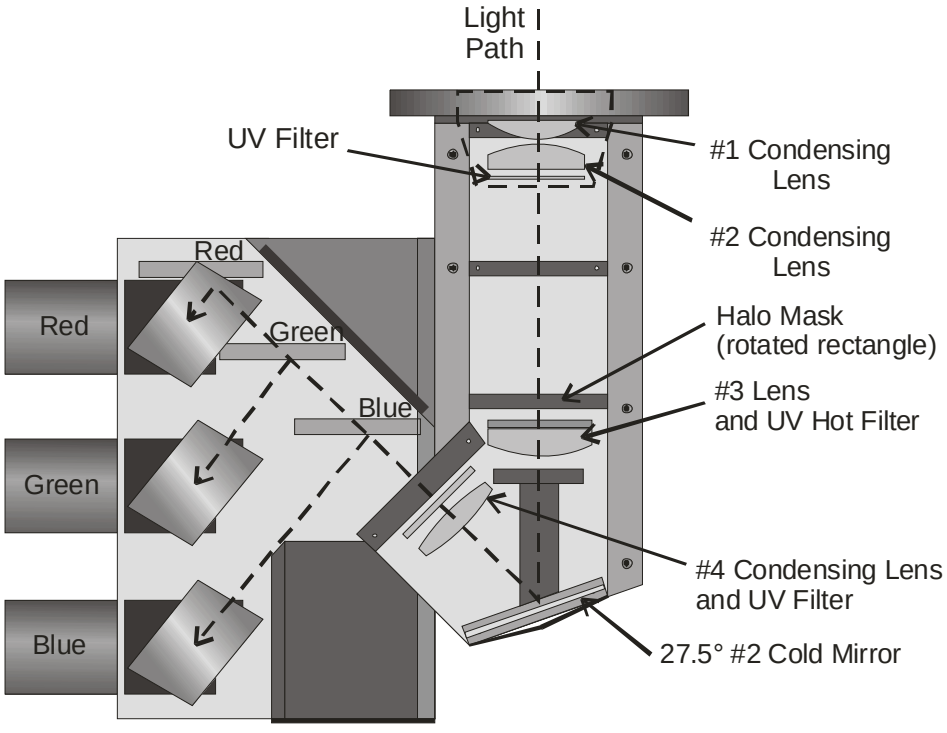


Figure 3-9 Optical Path inside Projection Module (top view).

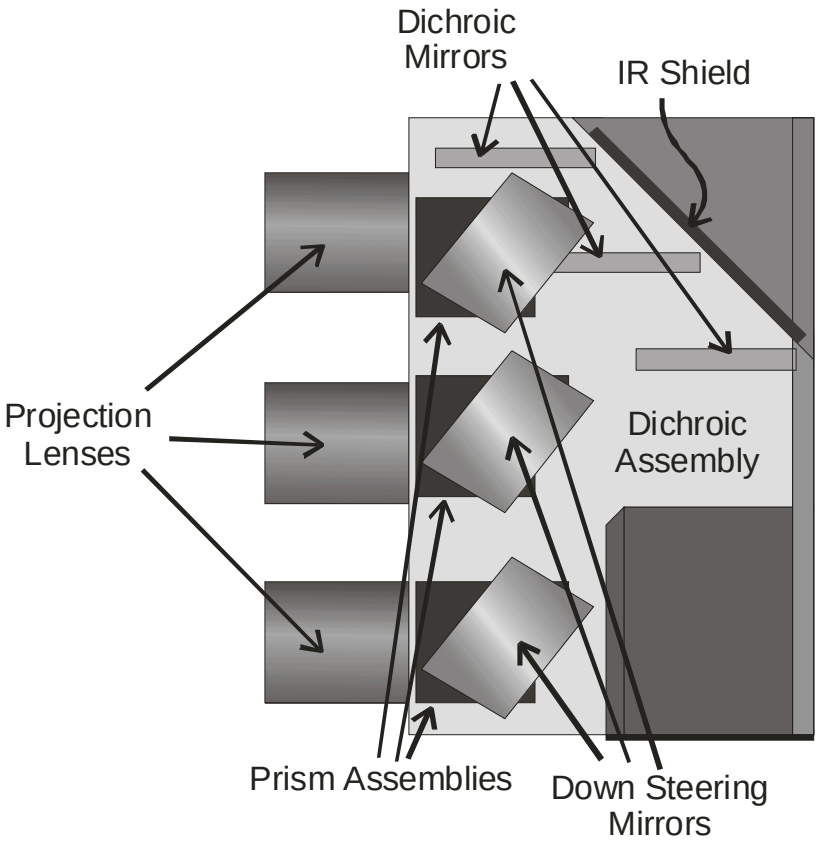


Figure 3-10 Optical path components (top view).

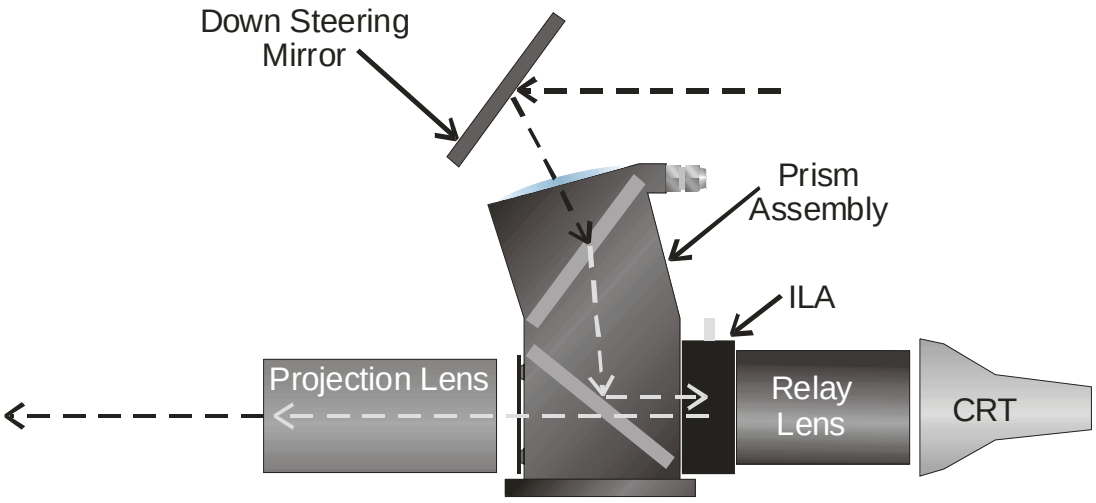


Figure 3-11 Optical path to Projection Lens (side view).

From the #2 Cold Mirror the light passes through the #4 Condensing Lens and UV Filter. From there the light passes through the Dichroic Mirrors where the light is separated in Red, Green and Blue components (see Figure 3-9). As the light passes through the blue Dichroic Mirror, blue light is reflected toward a

Down-Steering Mirror where it is reflected down into a Prism Assembly. The light that is not reflected, passes through the blue Dichroic Mirror and travels on to the green Dichroic Mirror where the green wavelength light is reflected toward its Down-Steering Mirror and down into its Prism Assembly. The remaining light passes through the green Dichroic Mirror and continues on to the red Dichroic Mirror where the remaining light is reflected to its Down-Steering Mirror and down into its Prism Assembly (*see Figure 3-11*).

Each Prism Assembly contains a pre-Polarizer and a Polarizer that polarizes its respective light (red, green or blue). Polarized light is described as follows:

Light can be viewed as having two electromagnetic components: a Horizontal-electric field and a Vertical-electric field. These fields are perpendicular to each other. When unpolarized light travels through a polarizing beamsplitter, one of these fields is reflected and one is transmitted (passes through the beamsplitter). Upon striking the Prepolarizer, the Vertical field is reflected and is wasted, the Horizontal electric field is passed through the Prepolarizing Beamsplitter and continues on to the Main Polarizer. The Main Polarizing Beamsplitter (PBS) is rotated 90° from the Pre-Polarizing Beamsplitter so the Horizontal field that was transmitted through the Prepolarizer is reflected by the Main Polarizer. The reflected polarized light, either red, green or blue, leaves the PBS and goes directly into the ILA® device.

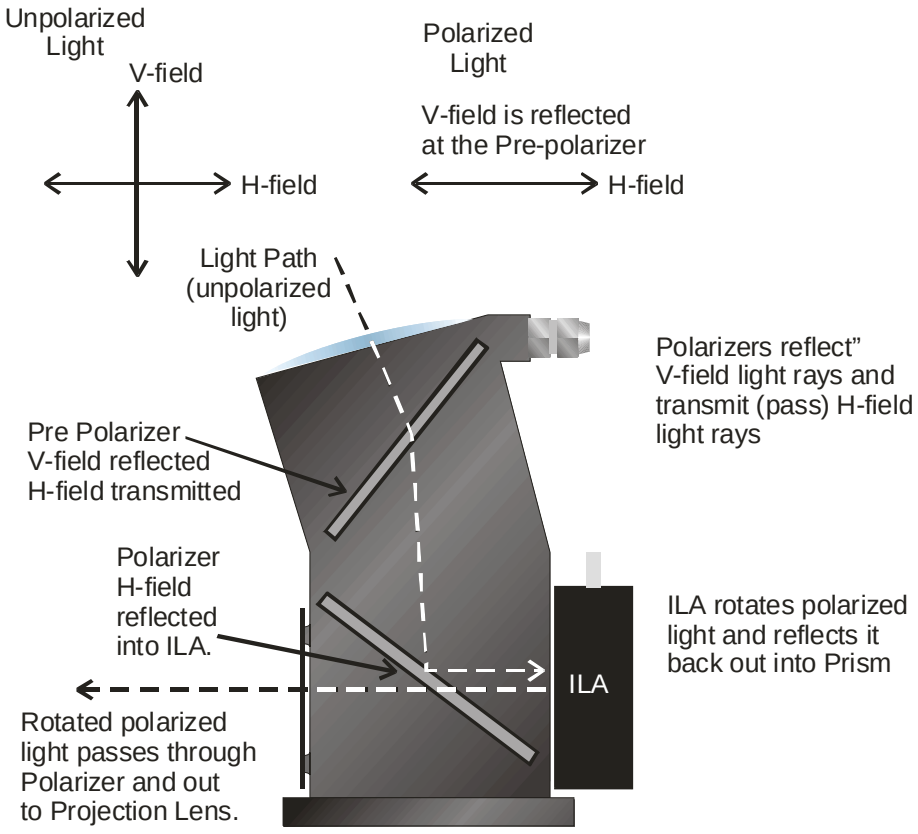
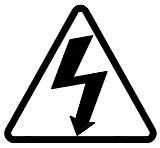


Figure 3-12 Polarizing the light in the Prism Assembly.

Each color exits a Prism Assembly and enters an ILA® device where the Liquid Crystal in the ILA® device rotates the polarized light according to image light from the ILA® device and ILA® device bias. The CRT generates image light from electronic video signals. The image from each CRT passes through a Relay Lens and is focused onto the input side of each ILA® device. The image light striking the input side of the ILA® device modulates the polarized light. The modulated image light leaves the output side of the ILA® device and re-enters the Prism Assembly. The image light exits the Prism Assembly, passes through the Projection Lens, and is projected out to the screen.



WARNING!!! Wear safety goggles (rated X5) when working anywhere near the light path from the arc lamp or the projection lens.
DO NOT open any of the Optical Support Assembly covers while the projector is ON. The bright light may cause severe eye damage.

Optical Path - Service Adjustments

The Optical Path has no serviceable parts.

3.3 ILA® Device

ILA® device Main functions

- Modulates image light from the CRT onto the high intensity polarized light from the Arc Lamp
- Reflects high intensity light received from the Prism Assembly back into the Prism Assembly after modulating with image light
- Adjustable bias voltage and frequency (ILA® Sensitivity)
- Adjustable offstate with Super Contrast ILA®s
- Image light from CRT is blocked from output. Image is electrostatically coupled to output

ILA® device Inputs

Arc Lamp light - High intensity polarized Red, Green or Blue light from the Prism Assembly.

Image light - Red, Green, or Blue image light from the CRTs.

ILA® device Bias Voltage and Frequency - 10-13 Vac at 2 kHz

ILA® device Outputs

Image light - High intensity polarized image light output to the Prism Assembly and then to the Projection Lens and screen.

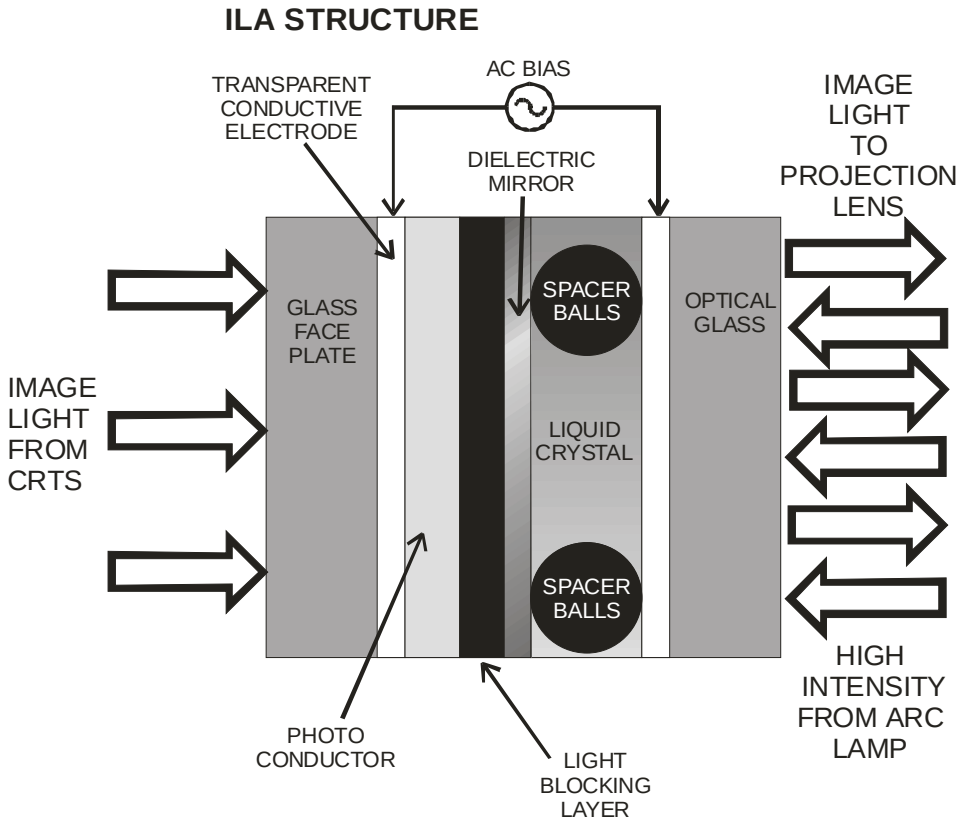


Figure 3-13 ILA® device structure

ILA® device Operation

The ILA® device plays a critical part in bringing the image to the screen. The ILA® receives the image light when the CRT projects the image through the Relay Lens and focuses it onto the photoconductive layer on the input side of the ILA® device. The image does not pass directly through the ILA® device but is transferred by a change of impedance of the photoconductive layer to the Liquid Crystal Layer on the output side of the ILA® device. The light coming from the Arc Lamp enters the output side of the ILA® and passes through the Liquid Crystal layer. Here the polarized light is rotated according to the orientation of the liquid crystal molecules. It then reflects off the mirror and passes back through the liquid crystal layer. The polarized light it is rotated again and then exits the ILA®. The amount the liquid crystal rotates the polarized light depends on the ILA® Bias, ILA® device Sensitivity (frequency), and CRT brightness (Sensitivity and Threshold).

ILA® device Service Adjustments

ILA® device Bias and Sensitivity Adjustment

The ILA® device has adjustable bias and frequency (sensitivity). The ILA® device bias and sensitivity are adjusted by software through the menu (*see ILA-12K User's Guide, section 1.6 ILA® device bias*). The ILA® device bias is individually

adjustable for each ILA® device; the ILA® device sensitivity (frequency) adjusts all the ILA® devices together.

Super Contrast ILA® device Compensator Adjustment

The offstate level can be adjusted on Super Contrast ILA®s. The Compensator adjustment moves a lever on the top of each Super Contrast ILA® to a null position. The null position is where the offstate level is as dark as possible. The Compensator is set at the factory and should not need adjustment. Perform this procedure only when replacing a Super Contrast ILA® device assembly or if the Compensator adjustment lever has been inadvertently moved.

Tools Needed

10-mm Balldriver Hex-head wrench

To set the Super Contrast ILA® Compensator:

1. Switch the Main AC Circuit Breaker to ON. Switch the three Subassembly AC Circuit Breakers to ON and allow the projector to stabilize for at least 30 minutes.
2. Remove the upper left-side access cover on the Projection Module. The upper right-side front access cover may provide better access to the red ILA® device.
3. On the Tethered Remote Control, use the CUTOFF key to hide red and blue (keyboard equivalent is F and R,G, or B). Block the Projector Lenses for colors (red and blue) not being adjusted
4. Disconnect the connector from the top of the green ILA® device assembly.
5. Move the Compensator lever (this lever is just in front of the ILA® device connector) to the right and left until the darkest level appears on the screen.
6. Reconnect the ILA® device connector to the green ILA® device.
7. Repeat the above steps for the red ILA® device and blue ILA® device. Block the light from the other two ILA® devices each time, using the HIDE key.
8. Replace the access cover.

   NOTE: Reset the ILA® device bias after setting the Compensator and check G_2 Sensitivity Offset, and Threshold Offset level (*see ILA-12K User's Guide, section 1.7 Black Level G_2 and Sensitivity Offset*).

ILA® device Remove and Replace

The ILA-12K has three ILA® devices, each sitting in a cradle on the front of the Relay Lens.

NOTE: It is not necessary to power OFF the projector while replacing an ILA® device. It is very important, however, not to leave the ILA® device cradle empty for more than a few seconds. The bright light from the Arc Lamp that would normally strike the face of the ILA® device will continue through the Relay Lens to the CRT face. This bright light may damage the phosphor on the face of the CRT. Remove the old ILA® device and immediately install the new ILA® device.

Tools Needed

10-mm Hex wrench

Parts Needed

Super Contrast ILA® devices

Blue	102630-14
Green	102630-15
Red	102630-16

NOTE: Do not interchange Super Contrast ILA®s. The Compensators on the ILA®s are color specific and can not be interchanged i.e. the green ILA® can not be put in the red channel or blue channel.

To Remove the ILA®:

1. Remove the upper left-side access cover on the Projection Module. The upper right-side front access cover may provide better access to the red ILA® device.
2. Disconnect the connector from the ILA®.
3. Loosen the two thumbscrews on either side on the backside of the ILA® device and remove the ILA® assembly (it will slide out with some resistance).
4. Reinstall the new ILA® device in the cradle immediately.

It will be necessary to reset ILA® device bias, Projection Lens alignment, ILA® Compensator, G_2 setting, and shading for the ILA® being replaced should be checked.

3.4 Relay Lenses

The Relay Lens focuses the image light received from the CRT on the photoconductive layer of the ILA® (*see Figure 3-13 and Figure 3-11*). There are no service adjustments for the Relay Lens. The Relay Lens rarely needs service and is not considered a serviceable part.

3.5 Projection Lenses

Projection Lens - Input

Red, green or blue image light from each Prism Assembly after it is modulated by the ILA® device.

Projection Lens - Output

Output red, green, or blue image light to the screen

Projection Lens - Operation

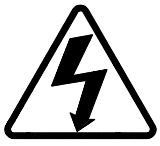
The projection lens receives image light from the Prism Assembly. The light is high intensity light from the ILA® that has been modulated by the image light from the CRT. After leaving the ILA®s the modulated light travels back through the Prism Assembly where the red, green, and blue image light are combined. The Projection Lens focuses this output image light onto the screen.

Projection Lens - Service Adjustments

Projection Lens Focus and Alignment

The Projection Lens Alignment allows the operator to converge the red and blue projection lenses to the fixed green lens. Verify that green is centered on the screen properly before adjusting red and blue to match green.

For long projection distances, use an assistant to make focusing adjustments. One person can focus while another stands in front of the screen to guide.



WARNING BRIGHT LIGHT!!! Use caution around the light path. **DO NOT** look directly into the light near the lamp housing or the projection lens**!**

Tools Needed:

Large Flatblade screwdriver

10-mm Balldriver Hex-head wrench

1/8-inch Balldriver Hex-head wrench

To focus the projection lenses:

1. Select the Pluge test pattern (Test Pattern #5).

2. Cover the red and blue lenses with lens caps (a square of cardboard can be used).
3. Rotate the green lens locking rod (*see Figure 3-14*) 1/4 turn counterclockwise using the large Flatblade screwdriver. The lens locking rods are located on top of each projection lens.

   NOTE: Turning the rod all the way will allow the lens to slide out for replacement. A 1/4 turn will loosen the lens but not allow it to fall out.
4. Move the green lens slightly in and out by hand (twisting as you slide makes the lens easier to move),adjusting for the best focus on the screen while an assistant observes the "spacer balls" for the sharpest focus.

   NOTE: "Spacer balls" can be seen from directly in front of the screen in the bright areas of the image. They are tiny, random, irregularly-shaped spots that are visible throughout the image. When these spots are distinctly defined, the projection lens is focused (*see Figure 3-13*).
5. When optimal focus is reached, turn the green lens locking rod clockwise back to the lock position.
6. Verify that the green lens is still in focus after locking it.
7. Cover the green lens and uncover the red lens.
8. Repeat Steps 3, 4, 5, and 6 for the red lens.
9. Cover the red lens and uncover the blue lens.
10. Repeat Steps 3, 4, 5 and 6 for the blue lens.
11. Uncover all lenses and press ESC to exit this adjustment.

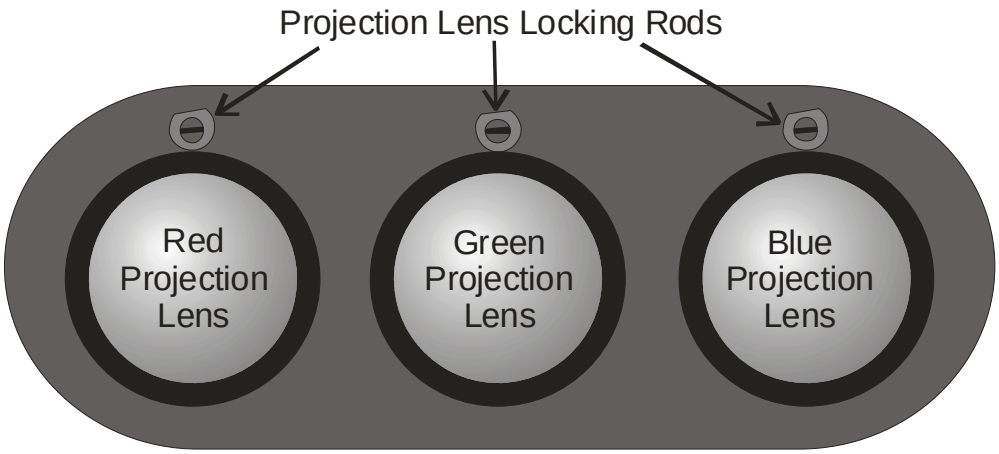


Figure 3-14 Locking rods on Projection Lenses.

To align the projection lenses:

1. Display the MAIN MENU.
2. Select the ILA MENU.

3. Select MAX-ON, NO VIDEO.
4. Verify all lenses are uncovered.
5. Verify the green ILA® device image is physically centered on the screen. If the image is not centered, repeat Projector Positioning section to center the image.
6. Block the blue lens and use a 1/8" Balldriver Hex-head wrench to laterally adjust the R lens to horizontally match the Green lens (there is no vertical adjustment). The lateral adjustment screws are accessed through two holes located about four inches from the front of the projector on the base.
7. Repeat Step 6 for the blue projection lens.
8. Press ESC to exit this adjustment.

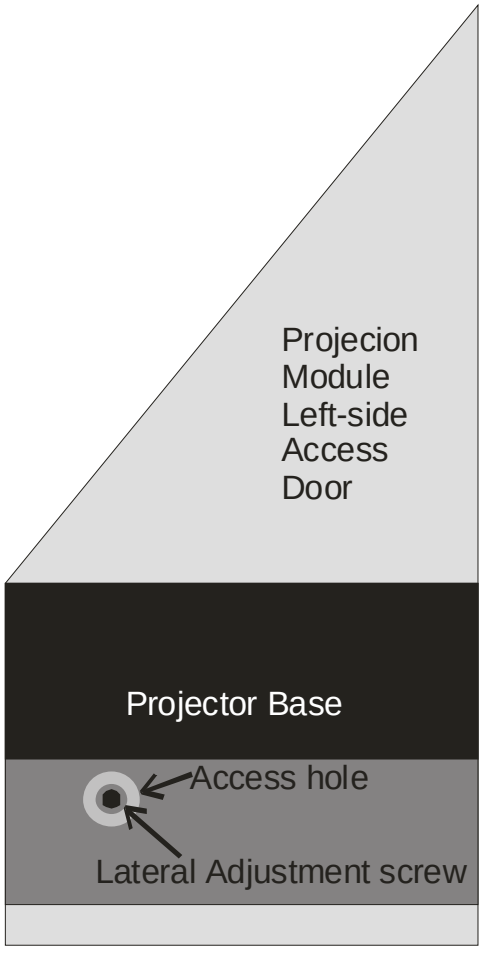


Figure 3-15 Lateral Adjustment screw as seen through the left-side Access door on the Projection Module.

Projection Lens - Remove and Replace

Tools Needed

Large Flatblade screwdriver

To remove the Projection Lens:

1. Rotate the green lens locking rod (*see Figure 3-14*) 1/4 turn counterclockwise using the large Flatblade screwdriver. The lens locking rods are located on top of each projection lens.
2. Carefully pull the Projection Lens forward with a twisting motion.

   NOTE: Projection Lenses are heavy. Suppport the Projection Lens from the bottom of the Lens as it is being pulled out of the Projection Lens support fixture to prevent it from dropping and becoming damaged.