

# Digital Slit Lamp Photography

## A User's Primer

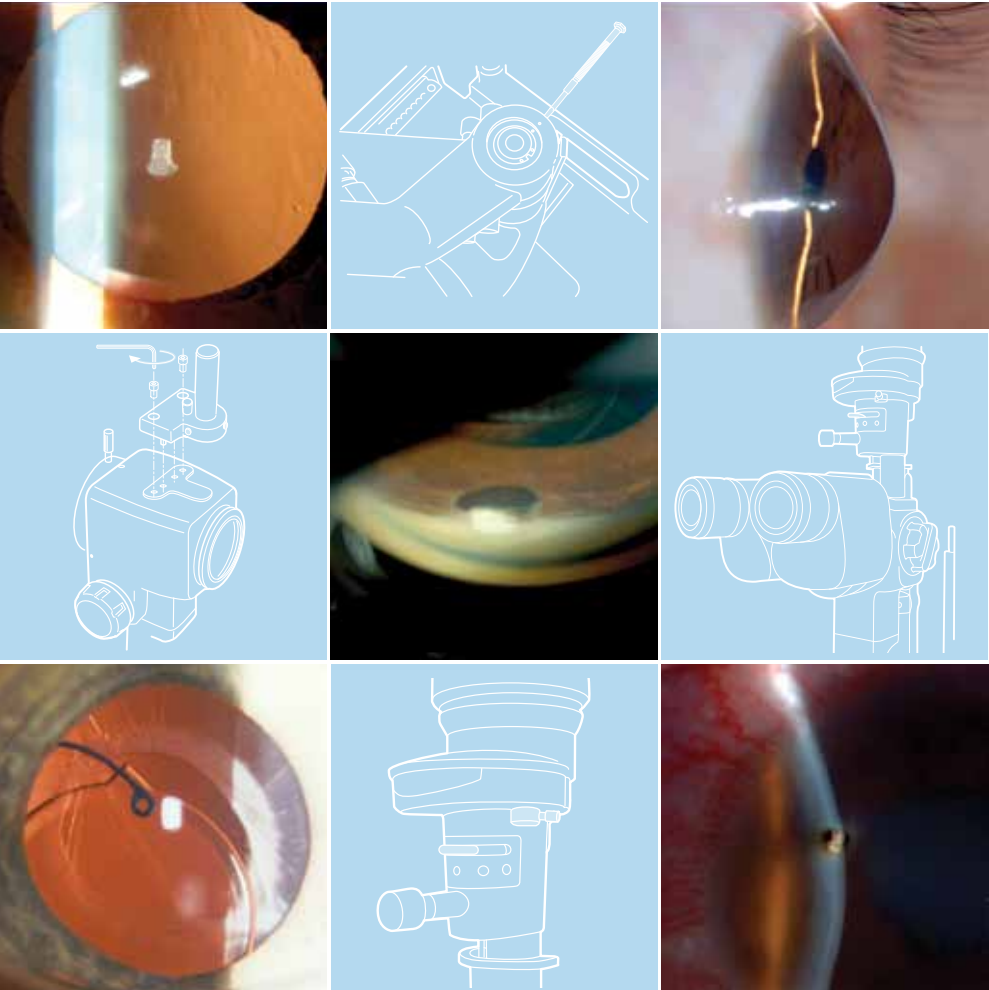


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Introduction – Basic Premises

Slit Lamp Photography is a discipline in constant development. As technology advances, the tools and techniques to obtain images of the anterior segment of the eye become more sophisticated. The results of these advances are more specific and useful images that assist the eye care professional in the diagnosis and treatment of patients.

Slit Lamp Documentation is widely used for documenting pathologies and conditions of the eye as well as for teaching and consulting.

Obtaining useful images of the eye during an eye examination requires not only the basic scientific and anatomical knowledge of the eye but also familiarity with the equipment to be used. A basic understanding of conventional photography is invaluable to achieve the desired results.

During observation through a slit lamp, many eye structures can be visualized. The brain focuses on the details that require our attention and, most importantly, blocks out any distracting artifacts such as reflections, out of focus areas and other disturbances. This is subjective observation in which we look for what we want to see and up to a certain degree, ignore what does not interest us.

However, photography in any of its forms is an objective method of seeing. The camera not only documents what we want to see, but also captures every detail in the recorded scene whether they enhance or worsen the final result.

Frequently we see an image in our mind that is perfect, but when we photograph that image and see the results, many elements that we did not consider show on the picture, in many cases with a detrimental effect.

For that reason, when taking photographs with a slit lamp we need to pay some attention to the surrounding areas of the subject and make sure that they are free of artifacts and distracting elements that can obscure the message we want to convey.

Understanding this premise will prevent us from capturing images that looked good in our eyes, but when displayed on a screen or a print, are loaded with extra elements that distract and reduce the focus of attention. This is particularly noticeable when acquiring images of the retinal structures using a handheld or a contact fundus lens. Often we concentrate on the structure of interest, being the optic nerve, the macula or any area that requires our attention. After we capture the image, frequently we see a number of reflections and artifacts we did not notice when looking at the point of interest. Since the slit lamp was not specifically designed for fundus observation, we need to understand the limitations in quality that those images may have.

For successful slit lamp photography, the user must be thoroughly familiar with

the use and application of each component of the slit lamp and know exactly what each feature does and how can it add or subtract from the final image.

Then he or she must become familiar with the photographic attachment that is being added for the capture.

There are several types of digital photo attachments and configurations in which they can be mounted on a slit lamp. Assuming that one knows how to take slit lamp pictures just because one is familiar with the instrument and knows how to examine the eye will set us up for unsatisfactory results.

Slit lamp photography requires practice, experience and most importantly, patience. Good results will not appear the first time we mount the photo attachment and fire a few shots. Most likely the first images we obtain will be mediocre at best or just plain useless.

Let's not blame the equipment for our lack of experience. Slit lamp photography can be fun and the results can often be elevated to state-of-art if we know our equipment well and we take the time to practice on non-critical imaging first.

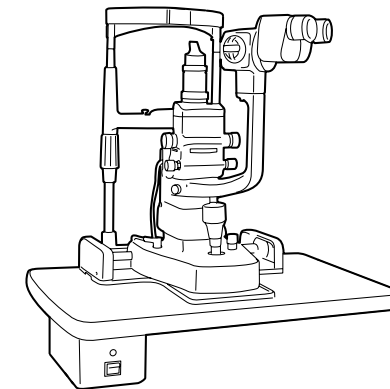
The first thing to do whenever we get a slit lamp photo attachment is learn as much as possible about how to use it, what it is capable of doing and what it is not capable of doing. This will prevent many frustrations and can even change our preference towards a different model or configuration.

Talk to the sales person before you purchase one and specify clearly what you expect from the unit. Some devices allow for photographing with just the normal illumination of the slit lamp. Others require the use of an electronic flash illumination. The configuration of the slit lamp is also important: not all models of slit lamps can accept photographic attachments. Slit lamps that have removable binoculars are the most likely to accept devices for photography. Older models may be configured for attachments using only photographic film while more current ones will accept digital photography attachments. Models that accept the digital photo attachment are called "Digital Ready" since the internal electronics of the instrument are already prepared to connect with the digital device. Some digital attachments can be only mounted on tower type slit lamps while some can be mounted on all models that are digital ready.

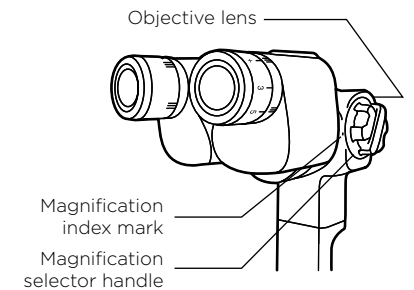
Since the images obtained will be digital, the platform we will use to capture them is as important as the capture device itself. Basic computer knowledge is necessary to comfortably navigate the different features of the software. Practice before you use the software on patients. Become familiar with the entering of the patient's data, the capture procedure, the archiving, retrieval and printing. Once you are comfortable with those functions, you can start taking images knowing that the illumination level will be adequate and that you will save them properly and not lose them when you close the system. Later on, you may try the auxiliary features of the software such as image enhancing, image grouping, measuring devices, annotation, consultation, etc.

## Slit Lamp Components

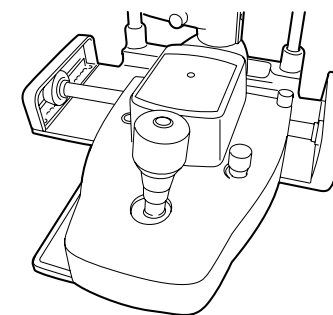
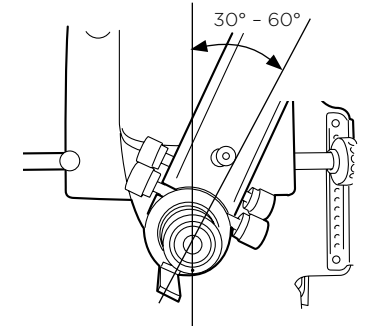
The three basic components of a slit lamp are: A microscope with variable magnification, an illumination source and a sliding base where both are mounted.



**SL-D4 Microscope Unit**



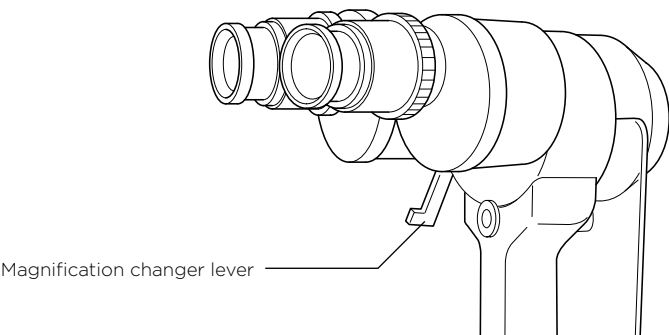
The microscope and the illumination source are jointed at the end of their arms so they can swing from one side to the other independently providing numerous angles of observation and illumination.



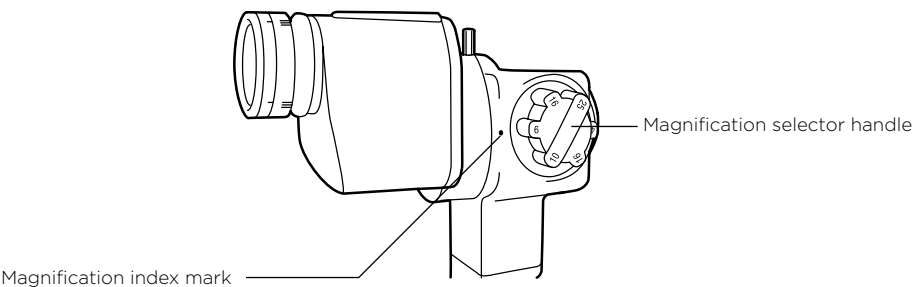
The base slides easily in all directions guided by a lever called a joystick. The joystick can also be used to elevate and lower the instrument and adjust it to the proper eye height.

Microscope

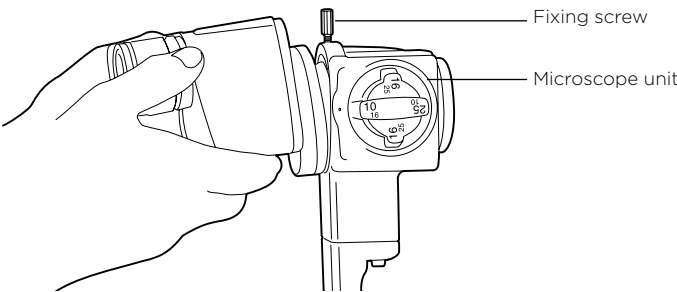
The microscope, depending on the model of slit lamp, can have a set of two magnifications changeable by the movement of a lever that swings a set of higher magnification lenses on top of the lower magnification set. These slit lamps usually have converging optics and due to their design the binoculars cannot be removed making them unsuitable for practical digital photography.



Other models have a combination of converging binoculars and parallel drum magnification that allow the user to have three or five levels of image enlargement by turning a binocular magnification drum located inside the body of the microscope. This converging/parallel combination makes observation more relaxed, reduces fatigue and facilitates image fusion.



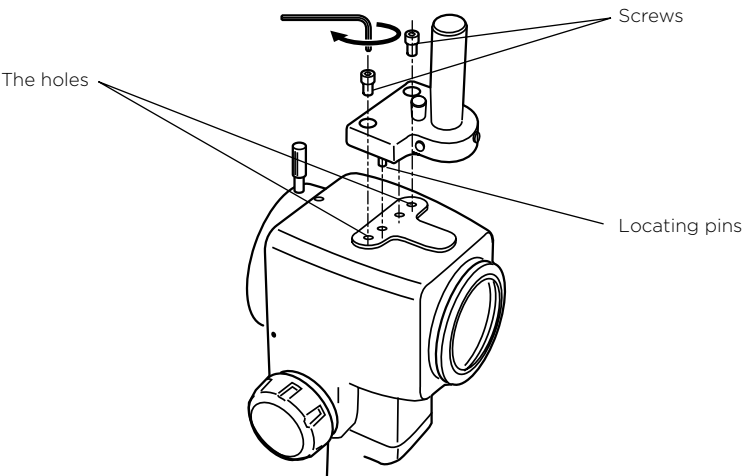
Additionally this configuration permits the binoculars to be removed from the microscope body and the insertion of beam splitters that can derive part of the light reflected by the image to a capturing device such as a digital camera.



Depending on the model of slit lamp, the magnification drum can have 10x, 16x and 25x or 6x, 10x, 16x, 25x and 40x. In both cases, since 16x is the most popular magnification level for anterior segment observation, the value is repeated twice on the magnification drum to facilitate its quick access.

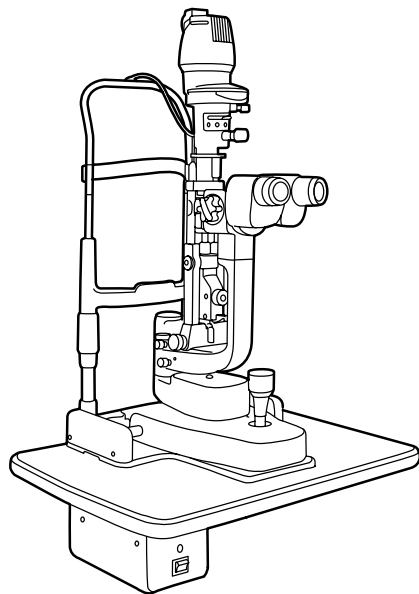
The microscope is mounted on a swinging arm that can be easily moved from one side to the other side of the instrument. A locking knob at the pivoting point allows the user to secure the arm, thereby preventing it from swinging.

On top of the microscope body, there is place to attach a tonometer mount should the user wish to use the slit lamp with an applanation tonometer.

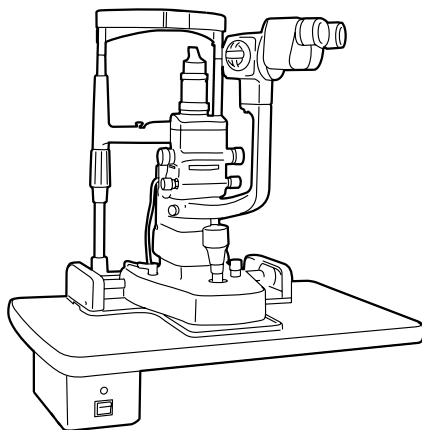


Illumination Source

Two types of illumination sources are common to most slit lamps. The *tower illumination model* has a tower-like construction with the lamp house at the top and the optical system below. The light path travels downwards until it reaches an angled mirror that reflects the light onto the eye in front of the instrument.



The *lower illumination model* has the illumination source located close to the base so the light path travels upwards to a prism located at the top of the device that reflects the light onto the front of the eye.

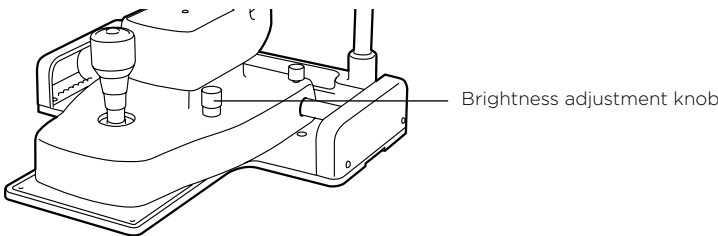


Although different in design and configuration, both illumination systems provide the same observation results and it is strictly a matter of preference on the part of the eye care professional as to which system they will use.

The light of a slit lamp is carefully regulated and adjusted by a number of lenses and condensers that create a homogeneous and bright beam that is projected onto the eye. The beam can be adjusted in width and height creating the effect of a “slit” that characterizes the function of the instrument. The beam can also be rotated and the direction of the beam can be adjusted and placed off center for special observation effects.

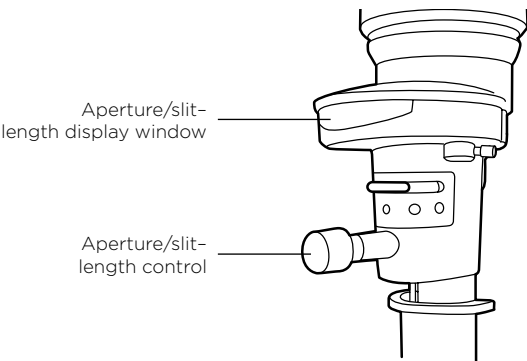
The illumination systems have a number of features permitting a wide variety of illumination techniques and observation. Those features can be divided into:

**Light intensity control:** Controls the intensity of the illumination bulb. In most models, it is adjusted by a rheostat located close to the joystick for easy reach.



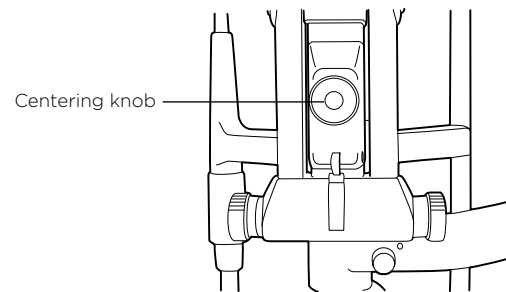
**Slit width:** A continuous rotating knob adjusts the width of the slit from a very thin slice of light to observe fine detail in the corneal stroma to a full circle that covers most of the patient’s cornea.

**Slit height:** In the same fashion, another knob turns to reduce or increase the height of the slit, adjusting it to the best area to observe without generating unnecessary reflections. The slit height can be adjusted in a continuous fashion from 0.1mm to 14mm or in pre-set steps from the same knob.

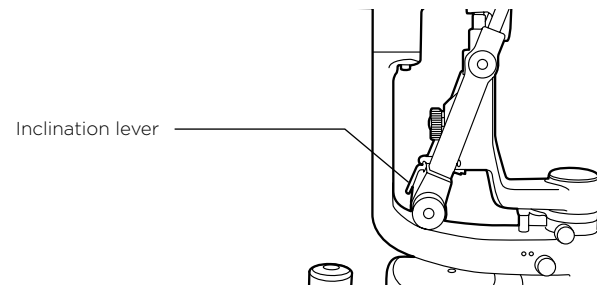


**Slit rotation:** The slit can be rotated from its original 90° vertical position continuously to a horizontal 180° for scanning the entire surface of the cornea.

**Slit decentration:** Originally the direction of the slit is centered at the middle of the observation field of the microscope regardless of the angle of illumination. The decentration feature allows the user to move the center to illuminate adjacent areas for illumination techniques such as scattered light and red reflex enhancement. (Some simpler models of non-photographic slit lamps do not have these functions.)



**Tilt:** This function is only available in tower illumination models. Allows tilting the entire tower up to 20° forward to facilitate gonioscopic observation of the eye using a special gonioscopy lens.



**Swing:** The entire illumination source can swing from one side to the other without interfering with the movement of the microscope arm.

## Filters

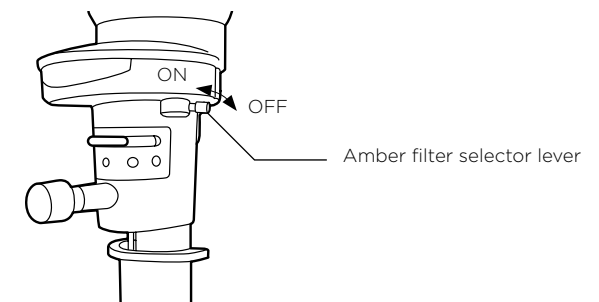
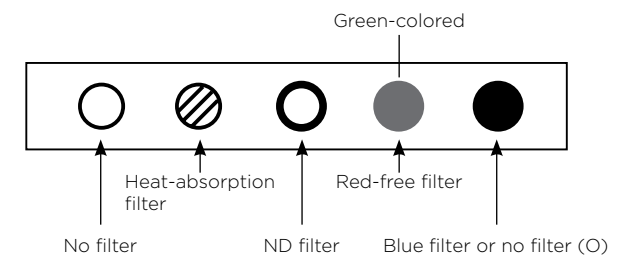
A number of filters can be inserted in the illumination axis to facilitate the viewing of certain structures. The most common filters are:

**Red-free:** A filter green in color that filters out the red component of an image and enhances the contrast between the vessels and the background allowing to differentiate small vessels and other structures.

**Cobalt Blue:** The wavelength in the blue light produces an excitation in sodium fluorescein making it fluoresce in a light green color. Useful in the evaluation of corneal staining and in applanation tonometry.

**Amber:** Confers a warmer tone to the image and adjusts the color balance.

Also some models have a caloric filter designed to prevent excessive heat from the bulb from reaching the eye and a 13% neutral density filter to reduce the brightness of the illumination in certain viewing situations.



Digital Capture Components

The Topcon “D” Series of slit lamps has two types of digital capture attachments:

The *DC-3 Digital Camera Attachment* is a compact device that combines a beam splitter with an 8.1 megapixel digital camera sensor and the necessary cabling to connect to the capture computer.

The entire functioning of this device is software driven so other than the on/off switch on one side, there are no buttons or knobs on the unit’s body, conferring a clean, uncluttered look. In the SL-D2 and SL-D4 models, the DC-3 uses the normal halogen viewing light illumination source to capture images, aided by the BG-2GN background illuminator (see description of background illuminators on pg. 14).

The DC-3 can be used with or without the FD-21 flash attachment for a higher contrast and more controlled color balance. The FD-21 flash attachment can only be used with the SL-D7 and SL-D8Z models.

The *Digital Photo Attachment* is a more sophisticated device kit that requires a commercially available SRL digital camera back such as Nikon D-Series. The digital camera back is not provided with the system and the user is responsible for obtaining one. There is no need for a photographic lens on the camera back to be used with a slit lamp.

The attachment includes all cabling, a beam splitter with a mount for the digital camera back, the FD-21 flash attachment with power supply, flash tube and lamp house and fiber optic background illuminator. The fiber optic background illuminator takes a small amount of light from the flash tube and transfers it to the 45° mirror in the illumination tower so as to evenly illuminate the eye. In this way, the slit image will not be overpowered by the background since both increase and decrease proportionally.

This attachment provides a higher quality slit lamp image and it is especially indicated when maximum resolution and color accuracy are needed, such as in publishing, research, teaching, etc.

Setup and Connections

Mounting the DC-3 to a “D” Series Slit Lamp:

- 1. Using a Phillips screwdriver, remove the cover of the arm of the slit lamp.
- 2. Turn the joystick counterclockwise all the way to elevate the slit lamp. Move the arm aside so you can access the holes to thread the cables.
- 3. Pass the power interface cable (connector side for the body) and USB cable through the openings on the chinrest and base of the slit lamp. Care should be taken not to pull the cables to avoid stripping and damage. All kinks should be removed to insure a smooth passage.

- 4. Connect the power interface and USB cables into the DC-3 body as shown.
- 5. Attach the mount of the DC-3 to the back mount of the microscope and secure with the thumbscrew located on top. While doing this, hold the cables inside the groove of the microscope arm to prevent slacking.
- 6. After the DC-3 is mounted, install the special cover under the microscope arm taking care that no cable is caught. Secure the cover with the screws.
- 7. Remove any kink from the cables and secure them under the table with the supplied ties. Verify the free movement of both arms to the right and left insuring that there is enough slack in the cables.
- 8. Mount the binoculars onto the DC-3 back mount and secure them with the thumbscrew.
- 9. Connect one end of the power interface cable to the base of the slit lamp as shown.
- 10. Connect the other end of the power interface cable to the power supply using the designed connector in the back.
- 11. Connect the USB cable to a PC computer that has installed capture software such as IMAGEnet® Lite or IMAGEnet® EZ Lite

It is recommended that you use the Topcon background illuminator BG-2GN to obtain evenly illuminated images (see description of background illuminators on pg. 14).



## Digital Photo Attachment

### Setup and Connections

The Digital Photo Attachment is comprised of the following items:

FD-21 electronic flash device, including power supply, flash relay lens, flash tube, camera attachment with beam splitter (SR-52), fiber optic background illuminator, camera mount, arm cover and cabling.

A commercially available Nikon D-Series camera body.

To install the Digital Photo Attachment on the SL-D7 / SL-D8Z, it is necessary to disassemble some of the components of the illumination tower. It is recommended that a qualified technician perform this procedure.

### Fitting the Flash Relay Lens Unit

Remove the illumination cable from the lamp house and turn the cover counterclockwise to uncover.

The lamp house is attached to the illumination tower by four screws. Remove all four screws and dismount the lamp house.

Mount the flash relay lens unit to the illumination tower in the same spot and position where the lamp house was. Secure it to the tower with the provided screws.

Mount the lamp house on top of the relay lens and secure it with the previously removed screws.

### Mounting the Fiber Optic Background Illuminator

The fiber optic background illuminator has in one end a plug that fits inside the hole on the side of the flash relay lens unit. A small thumbscrew is located near the hole to secure the background illuminator plug and prevent movement.

The other end of the background illuminator has a device that allows for the adjustment of the intensity of the background light into high, low and off.

The device has two prongs similar to an electric plug that attach to the holes located above the illumination tower mirror. Just plug them all the way in. No securing knobs are necessary.

### Installing the Xenon Flash Bulb

To install the flash tube, first it is necessary to attach the tube to the socket at one of the ends of the connection cable. Unscrew the silver ring, insert the three prongs of the flash tube into the socket and secure it by reattaching the silver ring.

A cable support tube is included with the FD-21 flash device. This tube attaches to the side of the chinrest of the slit lamp to guide the cable to the flash relay lens and to prevent entangling. Be sure to attach the tube to the side of the chinrest before installing the flash tube into the relay lens.

The flash tube has a central opening that shows the glass cylinder of the tube and on one side it has a smaller opening for light to go to the fiber optic background illuminator. Make sure that the small hole on the side of the flash tube is facing the side on which the background illuminator is plugged in. Insert the flash tube into the opening and secure it with the thumbscrew.

### Mounting the Camera Attachment

Remove the arm cover by unscrewing the small set screw at the bottom of the slit lamp optical system arm.

Pass the three cables to be connected to the camera attachment and Nikon camera through the openings at the front of the slit lamp and thread them into the space inside the arm.

Remove the binoculars by loosening the thumbscrew on top.

Attach the USB and other connection cables to the camera attachment SR-52. Mount the camera attachment to the optical system where the binoculars were previously mounted. Secure it with the thumbscrew.

Install the camera mount onto the Nikon camera body by aligning the red mark on the camera mount with the mounting marker on the camera and turn until it clicks.

Mount the camera onto the camera attachment and secure the mount with the thumbscrew located on the side.

Cover the back of the arm with the supplied cover, which is shorter and has a forked end.

Replace the binoculars attaching them to the back of the camera mount using the thumb screw.

Follow the instructions in the Instruction Manual for the rest of the connections of the FD-21 Flash Device. Refer to “Examples of system configuration” on Page 24 of the Instruction Manual.

## Photographic Technique

Essentially, whatever the user sees in the clinical exam, he/she should be able to reproduce in images. However it is important to be aware that images are usually too static to capture the entire examination in one photo. There is always a compromise between capturing the entire area of pathology and capturing the fine detail of it. Therefore, one image is never enough to tell the whole story. To achieve these results it is advisable to start with a wider image and work down to specific fine detail, both in magnification and illumination. Start with an overall general diffuse illumination of the eye and then work into higher magnifications while using various illumination techniques to highlight and draw focus to the pathology or area of interest.

Focusing is also another area of attention. Unlike a retinal camera, where a focus knob is used to obtain a clear, sharp image, focus in a slit lamp comes from “rock focus,” or adjusting the working distance by movement of the joystick. It should be noted that as long as the slit is centered, both the illumination and biomicroscope image come into focus together at the same point.

Therefore, once your slit beam is sharp, so will be your image.

Illuminating the area correctly is of utmost importance. In cases where there is raised pathology, such as elevations and texture on the surface of the iris, lens capsule, or lids, the best method is side lighting, as it enhances the texture far better than lighting from the front. Another important point is the actual placement of the light. Users need to be sure that they are methodically placing their specular reflections in areas that do not obstruct the view of any pathology.

Carefully placed specular reflections may also be used to showcase surface quality and texture of the eye, which may be important aspects in documentation.

### Background Illuminators

Background illumination is used to evenly illuminate the area being photographed without overpowering the slit beam that delineates the subject. Because the sensors in the digital cameras have a different sensitivity and response to light than the human eye, if a slit image is taken without background illumination, the slit beam will appear to be surrounded by a very dark field in which hardly any detail can be seen. This produces an extremely high contrast image that may not reflect the geographical location of the slit beam in the eye. To avoid this effect, the background illumination creates an evenly illuminated field that provides detail on the rest of the image but permits the slit beam to still be the most prominent illumination.

Background illuminators can be adjusted at various intensities to match the illumination needs of numerous photographic situations. They are used with

and without flash and depending on the model can be individually adjusted or can adjust automatically together with the slit illumination level.

There are two models of background illuminators designed to be used with the “D” series of Topcon slit lamps: the BG-2GN and the BG-4N.

The BG-2GN encompasses the power supply that attaches to the side rod of the chinrest by two set screws, the flexible gooseneck arm and the reflector. The reflector has a light source providing a flood type illumination of the external part of the eye. The intensity of the illumination can be adjusted with the rheostat located at the top of the power supply. By pressing the rheostat down, the BG-2GN turns on and off.

The BG-2GN comes standard with three filters: One clear lens that covers the light source and protects it against fingerprints and dust. A frosted filter that further diffuses the light to obtain softer illumination effects. An amber filter that adjusts the color of the light making it warmer and removing some of the excess blue. These filters can be used separately or in combination to obtain balanced color and illumination results. Some practice will let the user select what combination works best for the type of images desired.

The BG-2GN is designed primarily for the SL-D2 and SL-D4 models, but can also be used on the SL-D7 and D8Z models. It has a power supply that attaches to the side rod of the chinrest with two set screws, a flexible gooseneck arm and the reflector. Its light source provides a flood type illumination of the external part of the eye. The intensity of the illumination can be adjusted with the rheostat located at the top of the power supply. By pressing the rheostat down, the BG-2GN turns on and off.

### The BG-2GN Comes Standard with Three Filters:

- One clear lens that covers the light source and protects it against fingerprints and dust.
- A frosted filter that further diffuses the light to obtain softer illumination effects.
- An amber filter that adjusts the color of the light making it warmer and removing some of the excess blue.

These filters can be used separately or in combination to obtain balanced color and illumination results. Some practice will let the user select what combination works best for the type of images desired.

The BG-4N is designed specifically to be used on the SL-D7 and SL-D8Z models and cannot be combined with other models with a lower illumination tower. The BG-4N is a combination of lamp house and fiber optic background illuminator that replaces the standard lamp house in the SL-D7 and D8Z models only. It contains a fiber optic tube that draws a small amount of light from the main halogen bulb and shines it on the eye to be photographed. The level of illumination can be adjusted to low, high and off.

The BG-4N replaces the cap that covers the lamp house at the top of the illumination tower and the reflector that covers the halogen bulb. At the top of the mirrored reflector, there is a fiber optic guide attached in such a way that some of the light produced by the halogen bulb is directed into the fiber optic. The other end of the fiber optic has a device that allows the adjustment of the intensity of the background light into high, low and off. The device has two prongs similar to an electric plug that attach to the holes located above the illumination tower mirror. In this way, every time the light of the slit lamp is adjusted, both the slit beam and the background illuminator are adjusted insuring that the background light will never overpower the intensity of the slit beam.

### DC-3 Attachment

There are two ways to obtain digital images with the DC-3 Digital Attachment:

- With the use of the Electronic Flash Device FD-21
- Without the use of flash

Even though the final results are similar, there are some differences in the capturing techniques when using flash and when not using flash.

### Capturing Images Without Flash

When capturing images without the flash attachment, the use of the BG-2GN background illumination device is strongly recommended. This device is especially recommended when using the models SL-D2 and SL-D4 slit lamps. The models SL-D7 and SL-D8Z can use either the BG-2GN or the BG-4N. In either case the use of background illumination is fundamental for the acquisition of good quality images.

### SL-D2 / SL-D4

When capturing images with these models of slit lamps, the capture will be done using the viewing light of the instrument.

There are four basic types of illumination that are commonly used to document the anterior segment:

- Diffuse illumination
- Slit illumination
- Combined slit and diffuse
- Cobalt blue filter illumination

### Diffuse Illumination

This illumination is used mostly to photograph superficial conditions that require an even illumination, such as conjunctival hemorrhages, lid abnormalities, superficial tumors, pterygiums, chalazae, GPC, corneal grafts, etc. Depending on the illumination angle, the diffuse illumination can provide a flat effect if projected coaxial to the observation path or more textured if projected laterally. This type of illumination requires that the slit beam is completely closed and no slit is projected onto the eye. Practice and viewing will indicate what approach will be appropriate.

### Slit Illumination

This illumination is used to observe the structures of the transparent media of the eye. By varying the width and the height of the slit beam, a large number of structures can be examined, such as corneal layers, crystalline lens, vitreous, corneal blebs, IOL's, cataracts, corneal and lens opacities, penetrating keratoplasty, corneal dystrophies, keratoconus, tractions, etc. In some cases, a wide slit beam can be used as diffuse illumination to observe large areas of pathology. However, even though this method of observation is good for clinical diagnosis, it is not recommended for documentation due to the excess of light being reflected. The results are almost always over exposed. With this type of illumination, the background illuminator may be on or off depending on the desired effect.

### Combined Illumination

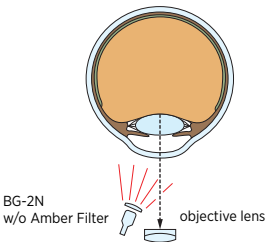
This illumination allows the documentation of images taken with a thin slit beam to be photographed with a fill-in illumination that provides an overall view of the area, but without overpowering the slit illumination. This type of illumination is used when the slit will show the detail of interest but its overall location is important to see as well. In these cases, the background illuminator is used at a lower level of intensity just to keep the background visible and thus, provide a geographic location of the slit beam that otherwise would show against a background too dark to show detail.

Illumination Techniques Using the DC-3 Capture Device and the BG-2N LED

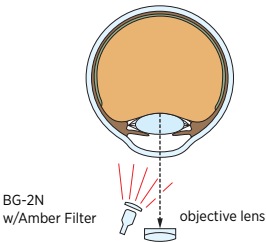
Models SL-D2, SL-D4, SL-D7 and SL-D8Z

Diffuse Illumination

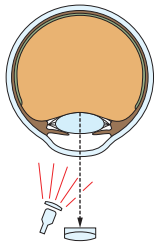
To photograph superficial conditions that require an even illumination, such as conjunctival hemorrhages, lid abnormalities, superficial tumors, pterigyums, chalazae, GPC, corneal grafts, etc., diffuse illumination is recommended. To evenly illuminate the front of the eye, it is best to use the background illuminator BG-2N with the diffuser filter. Keep the slit completely closed so no slit beam is projected onto the eye. By aiming the BG-2N to illuminate the area of interest, an even diffuse illumination can be achieved. If texture view is necessary, move the BG-2N so the light illuminates the eye laterally.



Diffuse illumination at 10x using the BG-2N without amber filter at approximately 30° to the left of the objective lens



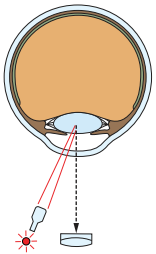
Diffuse illumination at 10x using the BG-2N with amber filter at approximately 30° to the left of the objective lens



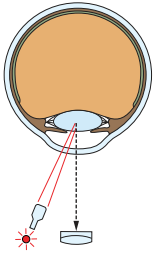
Diffuse illumination at 16x using the BG-2N with amber filter at approximately 30° to the left of the objective lens

Slit Illumination

When photographing a detail of the cornea, the lens or any other transparent media in high magnification, isolating it with a narrow slit beam can make the detail stand out against a darker background. In this case, the background illumination may not be used.



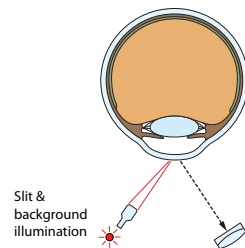
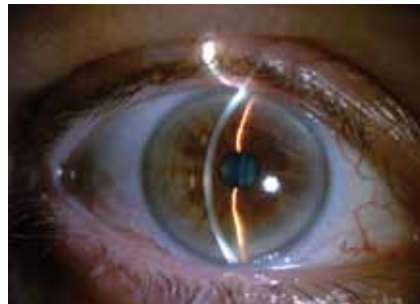
Thin slit illumination without using the BG-2N at 10x with illumination tower at approximately 45° to the left of the objective lens



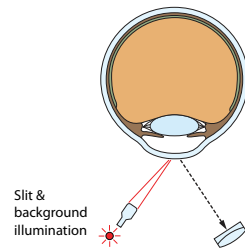
Thin slit illumination without using the BG-2N at 16x with illumination tower at approximately 45° to the left of the objective lens

### Combined Slit and Diffuse Illumination

To combine slit and diffuse illumination, the intensity of the slit and the intensity of the BG-2N must be adjusted in such a way that the BG-2N provides enough light to visualize the structures adjacent to the area of interest without overpowering the slit beam. A rule of thumb would be to watch the image on the live monitor displayed on the screen. If the image on the live monitor shows what you want to see, the image captured will be equivalent. Small adjustments may be needed to fine tune the final image.



Combined diffuse and slit illumination at 10x using the BG-2N with amber filter placed at 30° to the right of the objective lens. Slit at 30° to the left.

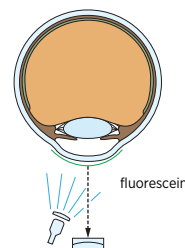
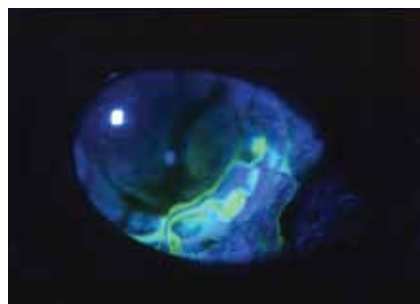


Combined diffuse and slit illumination at 10x using the BG-2N with amber filter placed at 30° to the right of the objective lens. Slit at 30° to the left.

### Cobalt Blue Filter Illumination

This illumination is used to document corneal staining when using sodium fluorescein as a staining agent. The wavelength of the cobalt blue filter excites the fluorescein and it shows on the image in bright green color.

For this illumination, the BG-2N must be off and the slit width all the way open so the beam projected is circular in shape. Adjust the intensity of the light according to the results needed. Again, the image on the live image monitor is a good indicator of the final result.



Corneal staining image using the cobalt blue filter with the slit at its maximum aperture. Background illumination is off.

### Illumination Techniques Using the DC-3 Capture Device and the BG-4N Halogen

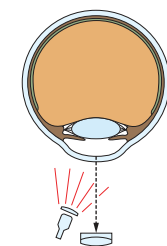
#### Models SL-D7 and SL-D8Z Only

Because the BG-4N uses light from the same halogen bulb that is used as the main illumination bulb for the slit lamp, the adjustment between the intensity of the background light and the slit beam is done automatically. The BG illumination will not overpower the slit beam regardless of the intensity. Also the BG-4N has two intensity levels and can be turned off by occluding the fiber optic beam with the lever located at the front of the device.

#### Diffuse Illumination

To photograph superficial conditions that require an even illumination, such as conjunctival hemorrhages, lid abnormalities, superficial tumors, pterigyums, chalazae, GPC, corneal grafts, etc, diffuse illumination is recommended. To evenly illuminate the front of the eye, it is best to use the background illuminator BG-4N in the High position. Keep the slit completely closed so no slit beam is projected onto the eye. The BG-4N is fixed on top of the illumination tower mirror so it cannot be aimed. Moving the angle of the illumination tower can modify the illumination and provide more or less texture.

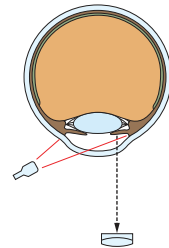
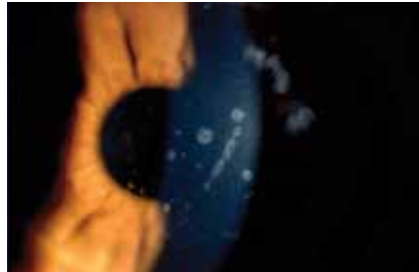
For a different technique with the same results, the SL-D7 and D8Z models have a flip-on diffuser lens that hinges at the bottom of the mirror. By flipping the diffuser up, the slit beam is intercepted by the diffuser regardless of the width. The illumination projected onto the eye will be diffuse. This feature provides a higher degree of control over the diffuse illumination in these models.



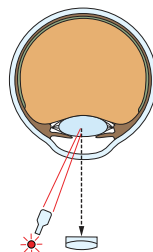
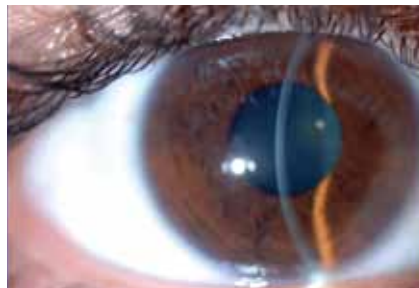


**Slit Illumination**

When photographing a detail of the cornea, the lens or any other transparent media in high magnification, isolating it with a narrow slit beam can make the detail stand out against a darker background. In this case, the BG-4N should be turned off by moving the lever to the off position.

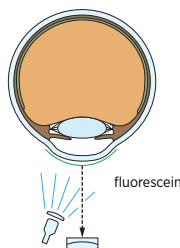
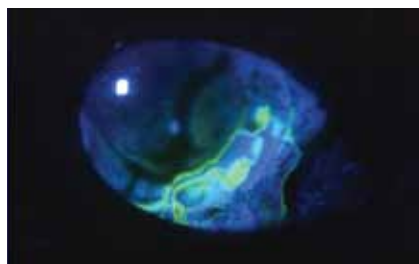
**Combined Slit and Diffuse Illumination**

Combining slit and diffuse illumination with the BG-4N is easy since the slit will be always brighter than the background. Simply adjust the width of the slit to visualize the area of interest and the BG-4N will illuminate the adjacent surfaces either in high or in low for a more subdued effect. A rule of thumb would be to watch the image on the live monitor displayed on the screen. If the image on the live monitor shows what you want to see, the image captured will be equivalent. Small adjustments may be needed to fine tune the final image.

**Cobalt Blue Filter Illumination**

This illumination is used to document corneal staining when using sodium fluorescein as a staining agent. The wavelength of the cobalt blue filter excites the fluorescein and it shows on the image in bright green color.

For this illumination, the BG-4N must be off and the slit width all the way open so the beam projected is circular in shape. Adjust the intensity of the light according to the results needed. Again, the image on the live image monitor is a good indicator of the final result.

**Illumination Techniques Using the DC-3 Capture Device and the FD-21 Flash Attachment****Models SL-D7 and SL-D8Z Only**

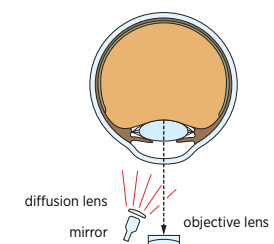
Capturing images using a flash attachment greatly enhances the quality of the final result. Because the main illumination for the capture is provided by a xenon flash, the color temperature of the illumination is similar to daylight. Therefore, colors are more balanced and the contrast is enhanced. Also, since the duration of the flash exposure is very short (about 1/10,000 of a second) eye movement and blinking are virtually nonexistent.

The background illumination uses light from the same xenon bulb that is used as the main flash illumination for the slit lamp, therefore, the adjustment between the intensity of the background light and the slit beam is done automatically. The BG illumination will not overpower the slit beam regardless of the intensity. Also the background illumination has two intensity levels and can be turned off by occluding the fiber optic beam with the lever located at the front of the device.

**Diffuse Illumination**

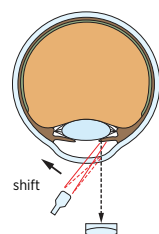
To photograph superficial conditions that require an even illumination, such as conjunctival hemorrhages, lid abnormalities, superficial tumors, pterygiums, chalazae, GPC, corneal grafts, etc., diffuse illumination is recommended. To evenly illuminate the front of the eye, it is best to use the background illumination in the High position. Keep the slit completely closed so no slit beam is projected onto the eye. The background illumination is fixed on top of the illumination tower mirror so it cannot be aimed. Moving the angle of the illumination tower can modify the illumination and provide more or less texture.

Also, the SL-D7 and D8Z models have a flip on diffuser lens that hinges at the bottom of the mirror. By flipping the diffuser up, the slit beam is intercepted by the diffuser regardless of the width. The illumination projected onto the eye will be diffuse. This feature provides a higher degree of control over the diffuse illumination in these models. Depending on the results desired, it is recommended that you start the exposure for color pictures at 75Ws (third notch in the intensity switch or the three green illuminated boxes in the control panel). According to the results on the screen, increase or decrease the flash intensity. In cases in which even the lowest intensity of the flash device produces over exposure, the 13%ND filter can be used to reduce the flash illumination. The 13% ND filter is inserted from the filter lever located at the top of the illumination tower.

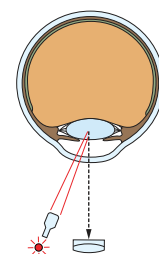


**Slit Illumination**

When photographing a detail of the cornea, the lens or any other transparent media in high magnification, isolating it with a narrow slit beam can make the detail stand out against a darker background. In this case, the background illumination should be turned off by moving the lever to the off position. Depending on the results desired, it is recommended that you start the exposure for color pictures at 75Ws (third notch in the intensity switch or the three green illuminated boxes in the control panel). According to the results on the screen, increase or decrease the flash intensity. In cases in which even the lowest intensity of the flash device produces over exposure, the 13%ND filter can be used to reduce the flash illumination. The 13% ND filter is inserted from the filter lever located at the top of the illumination tower.

**Combined Slit and Diffuse Illumination**

Combining slit and diffuse illumination with the background illumination is easy since the slit will always be brighter than the background. Simply adjust the width of the slit to visualize the area of interest and the background illuminator will illuminate the adjacent surfaces either in high or in low for a more subdued effect. Small adjustments may be needed to fine tune the final image. Depending on the results desired, it is recommended that you start the exposure for color pictures at 75Ws (third notch in the intensity switch or the three green illuminated boxes in the control panel). According to the results on the screen, increase or decrease the flash intensity. In cases in which even the lowest intensity of the flash device produces over exposure, the 13%ND filter can be used to reduce the flash illumination. The 13% ND filter is inserted from the filter lever located at the top of the illumination tower.

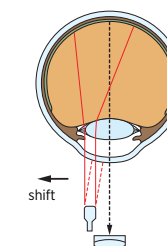
**Cobalt Blue Filter Illumination**

This illumination is used to document corneal staining when using sodium fluorescein as a staining agent. The wavelength of the cobalt blue filter excites the fluorescein and it shows on the image in bright green color.

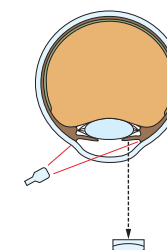
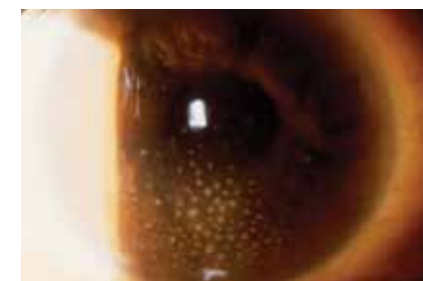
For this illumination, the background illumination must be off and the slit width all the way open so the beam projected is circular in shape. Adjust the intensity of the flash according to the results needed. Depending on the results desired, it is recommended that you start the exposure for color pictures at 50Ws (second notch in the intensity switch or the two illuminated green boxes in the control panel). According to the results on the screen, increase or decrease the flash intensity.

**Transillumination**

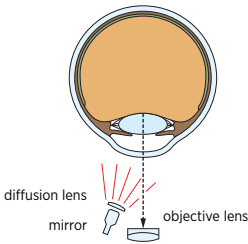
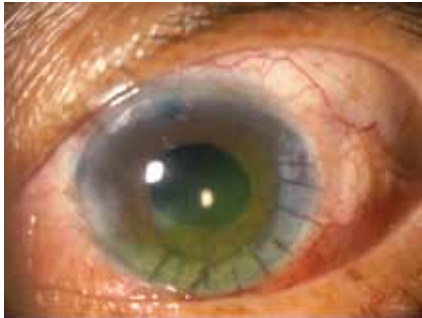
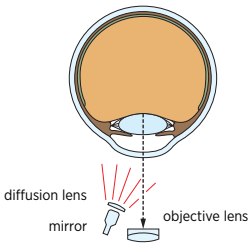
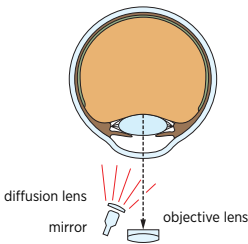
Transillumination is a technique to illuminate opacities, iris fenestrations and other irregularities of the eye structures by reflecting the slit beam on the retina and using the returning light to outline the opaque tissue or abnormalities. For this type of illumination, the slit beam should be almost coaxial with the visual axis of the operator so the light beam will bounce at the same angle and be visualized. When using the retroillumination off the fundus (or transillumination) technique it is best not to use the rectangular specular illumination, instead use a half moon shape that flows with the edge of the iris to obscure as little as possible. This is one of the cleanest and least obstructing ways to capture an image using that technique.

**Scattered Light**

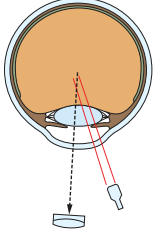
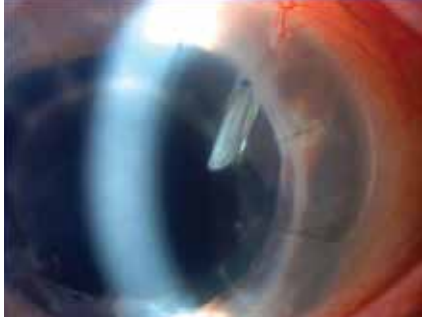
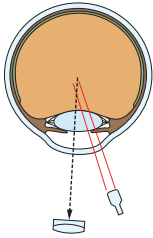
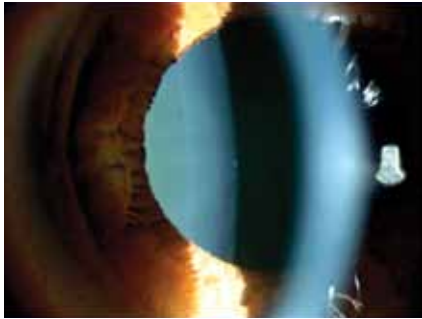
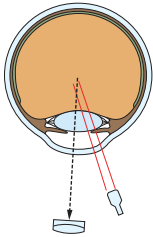
To illuminate small opacities suspended inside the cornea, the slit beam is directed to the border of the cornea in the limbal area. The reflected light bouncing between the front and back layers of the cornea illuminates the opacities while leaving the background dark for better contrast. With this particular illumination technique, the limbal area is usually over exposed.



Examples of Diffuse Illumination Only

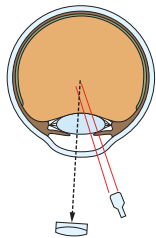
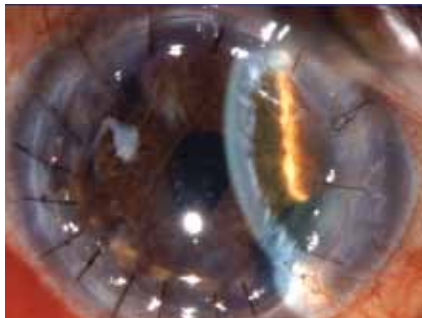
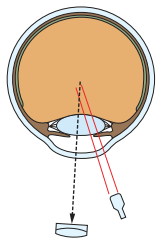
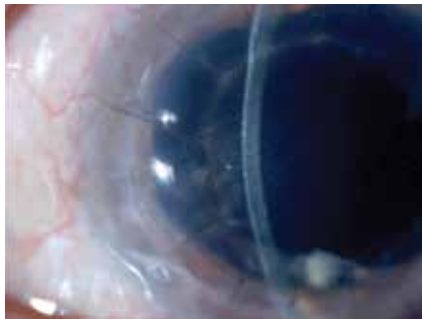
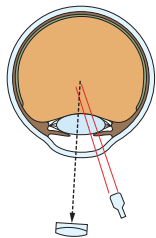


Examples of Slit Illumination Only

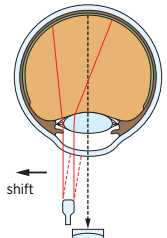
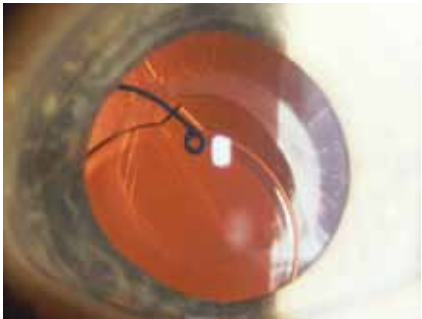
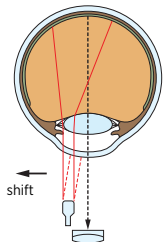
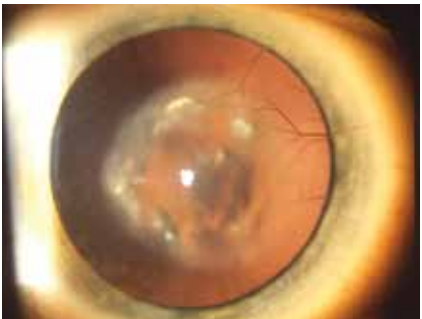




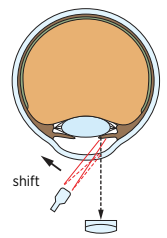
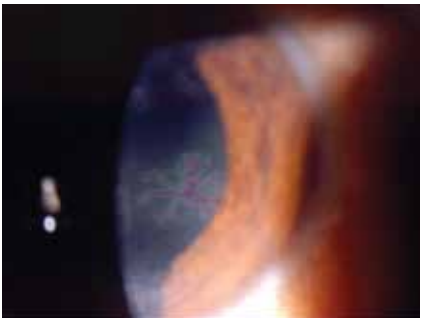
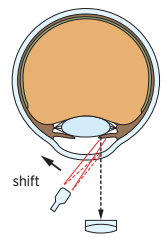
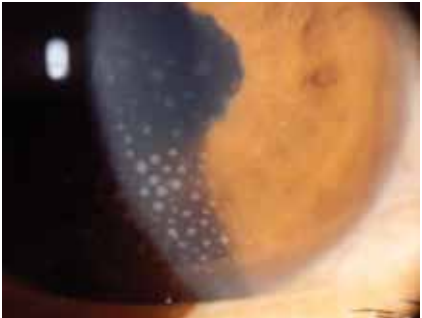
Examples of Combined Illumination



Examples of Transillumination

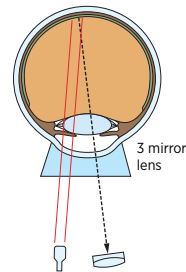
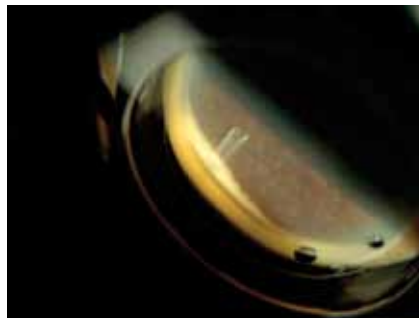
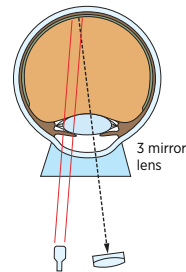
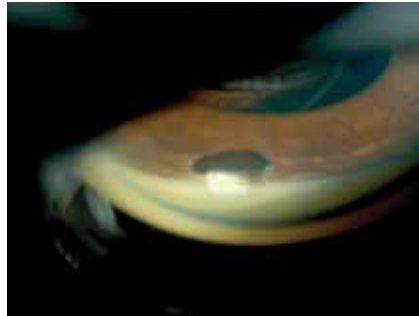


Examples of Scattered Light Illumination



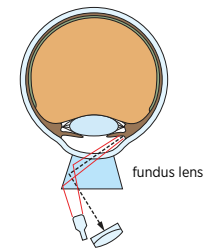
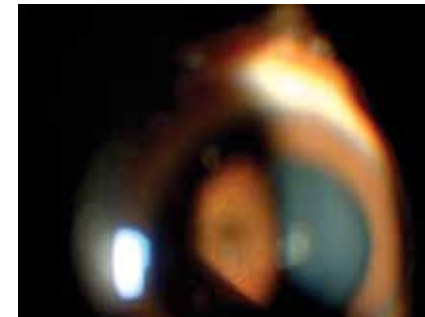
## Gonioscopy

Gonioscopy images are obtained using a special contact lens that is positioned against the anesthetized cornea by using an interface of methyl cellulose gel such as Goniosol®. No background illumination should be used and the slit width should be adjusted accordingly with the surface of the area that is observed. The capture of the image is similar to the capture of views using slit illumination only.



## Fundus Imaging

Certain areas of the retina can be photographed with a slit lamp using a fundus lens in front of the slit lamp objective lens. Fundus lenses can be hand held, or the contact type that require anesthetizing the cornea and using a methyl cellulose interface similar to the gonioscopy lens. Fundus lenses come in different dioptric powers depending the area of the retina that needs to be visualized. Some common powers are 98D, 78D, 60D, and 35D. This technique requires practice and a cooperative patient, as well as a clear, scratch-free lens. Since the capturing device is coaxial with the right eye piece, anything the operator can see through the right eye will be captured. It is important to adjust the angle of the fundus lens to minimize reflections when photographing the retinal structures. Regardless of practice and experience, it is virtually impossible to eliminate all reflections and often images do not match the operator's expectations. Practice and experience are paramount on this technique.



Topcon Family of Digital Photo Slit Lamps and Accessories



**SL-D2**  
**Three Magnification Digital Slit Lamp**  
The SL-D2 incorporates a parallel drum magnification changer that allows for quick and easy selection among three convenient magnifications of 10X, 16X and 25X. The SL-D2 offers the most cost-effective digital imaging solution with optimal clarity, color resolution and depth-field.

**SL-D4**  
**Five Magnification Digital Slit Lamp**  
The SL-D4 incorporates a parallel drum magnification changer that allows for quick selection among five convenient magnifications of 6X, 10X, 16X, 25X and 40X. The 40X magnification is especially useful for Corneal Endothelium observation. Encompassing a variety of ophthalmic applications, the demanding eye care specialist can produce excellent images of both anterior and posterior structures of the eye.



**SL-D7**  
**Five Magnification Digital Slit Lamp**  
The SL-D7 incorporates a parallel drum magnification changer that allows for quick selection among five convenient magnifications of 6X, 10X, 16X, 25X and 40X. When the optional FD-21 Flash Device is incorporated, the SL-D7 converts to a true digital photographic slit lamp providing exceptional images of the cornea, endothelium and fundus to enhance accurate documentation.

**SL-D8Z**  
**Zoom Magnification Digital Slit Lamp**  
The SL-D8Z offers a zoom magnification changer, which provides continuous observation through the magnification range of 6.35X to 31.75X. The highly efficient zoom optics allow for extraordinary visualization of minute anterior segment conditions. When the optional FD-21 Flash Device is incorporated, the SL-D8Z becomes the premier zoom photographic slit lamp for unparalleled digital documentation.



## Background Illumination BG-2GN



[Return to TOC](#)

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

