User Manual

XY Phase Series

Spatial Light Modulators

With PCIe 8-bit Electronics

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Table of Contents

Table of Figures

1 Introduction

This User Manual covers the XY Phase Series of liquid crystal on silicon spatial light modulators (SLMs) now available from Meadowlark Optics, Inc. The manual instructs users on how to set up the PCIe electronic hardware, optics, and operate the system software. SLM system setup is fairly complex, incorporating optical components, mounting and positioning hardware, custom drive electronics hardware, and a proprietary software interface.

We strongly recommend that all users first read and familiarize themselves with the entire User Manual before initiating the setup and start up procedures.

1.1 Spatial Light Modulator Principles

An SLM is a device that modulates light according to a fixed spatial (pixel) pattern. The XY Phase Series SLMs convert digitized data into coherent optical information appropriate for a wide variety of applications, including beam steering, optical tweezers, diffractive optics, pulse shaping and more. These applications require modulators that can easily and rapidly change the wavefront of a coherent beam. By combining the electro-optical performance characteristics of liquid crystal materials with silicon-based digital circuitry, Meadowlark now offers high speed SLMs that are also physically compact and optically efficient.

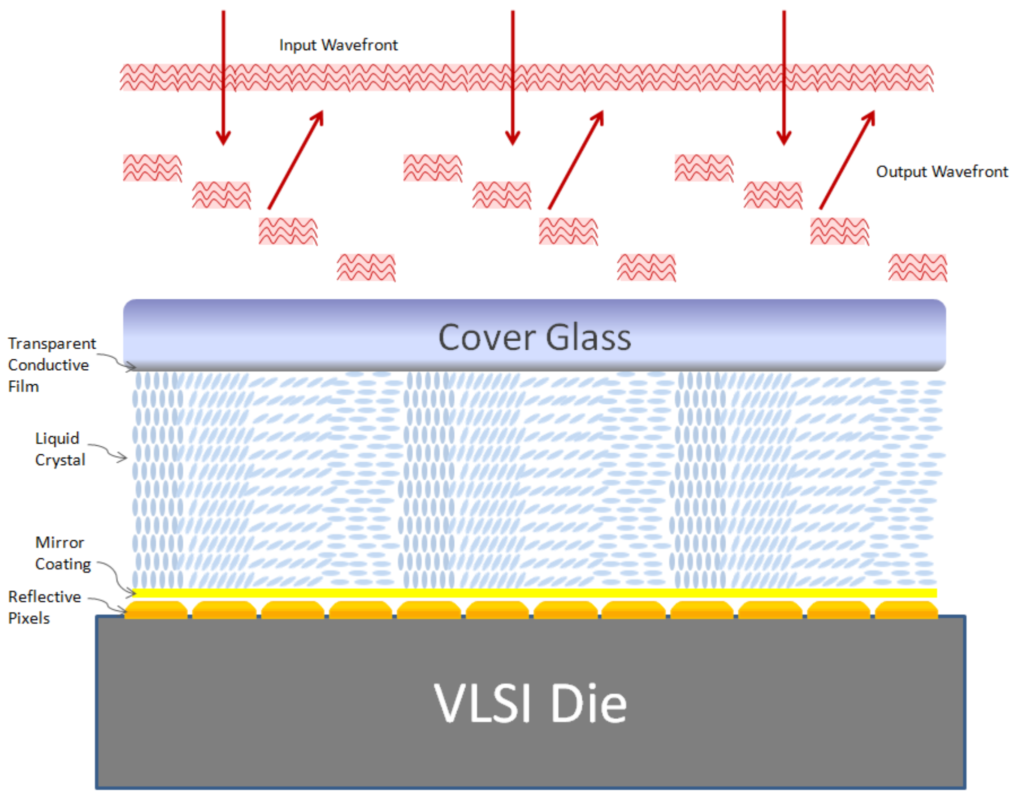


Figure 1 ~ Cross sectional illustration of a liquid crystal spatial light modulator.

Figure 1 shows the cross section of an LC SLM. Polarized light enters the device from the top, passes through the cover glass, transparent conductive film and liquid crystal layer, is reflected off the shiny pixel electrodes and returns on the same path. Drive signals from the driver boards travel through circuitry in the silicon backplane (VLSI die) to each pixel. The analog voltage induced on each electrode (pixel) produces an electric field between that pixel and the cover glass. This field produces a change in the optical properties of the LC layer. Because each pixel is independently controlled, a phase pattern may be generated by loading different voltages onto each pixel.

If requested by the customer, a dielectric mirror coating is applied to the backplane of the SLM. This coating is normally centered at a wavelength specified at the time of ordering. The dielectric mirror coating prevents diffraction from the inter-pixel regions of the backplane, and increases the optical efficiency of the device.

1.2 Phase Modulation

The XY Phase Series of Spatial Light Modulators are fabricated with nematic liquid crystal, aligned in a homogenous configuration. Nematic liquid crystal has a variable electro-optic response to voltage. Figure 2 shows a simplified side view of a spatial light modulator's liquid crystal layer. When no voltage is applied to the LC, the molecules are parallel to the SLM coverglass and VLSI backplane. In this case, incident light will experience the largest difference between the extraordinary (ne) and ordinary (no) index of refraction. As the voltage applied to the liquid crystal is increased, the LC will tilt until the extreme is reached and the LC is nearly normal to the SLM coverglass and VLSI backplane. At this point the difference between the extraordinary and ordinary index of refraction is nearly zero.

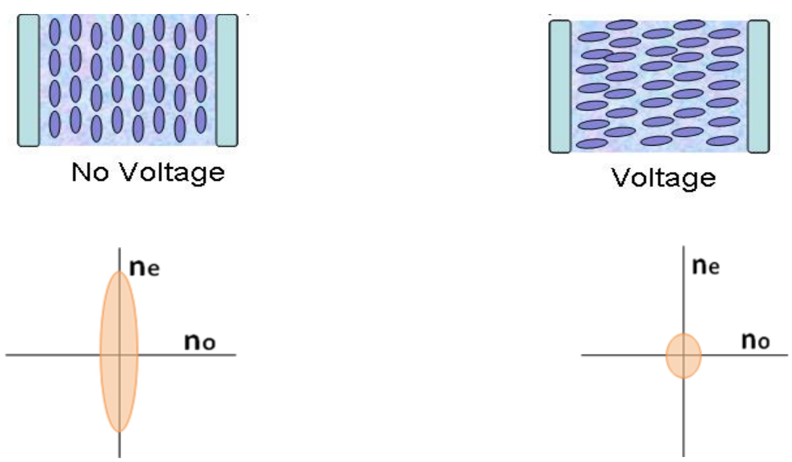


Figure 2 ~ This diagram illustrates the liquid crystal orientation with respect to the coverglass and VLSI backplane as a function of applied voltage.

The molecules are parallel to the coverglass and backplane when no field is applied, and are nearly perpendicular to the coverglass and backplane when full field is applied.

If light incident upon the SLM is linearly polarized parallel to the extraordinary axis, then a pure, voltage dependent phase shift will be observed. For example, if no voltage is applied to the pixel, the maximum phase retardation (typically a full wave at the design wavelength) will be applied. Likewise, if the pixel is programmed for maximum voltage, a minimum phase delay is applied. The result is a programmable phase on a per pixel basis.

Each of the SLM pixels is independently programmable to 256 discrete voltage states, all providing phase modulation. The response of the liquid crystal within the SLM to the applied pixel value (voltage) is nonlinear. To account for this, each SLM is shipped with a custom look-up-table (LUT) that is preloaded to the PCIe hardware memory. When this LUT is applied to an input image, the result is a linear output phase response ranging from 0 to 2π.

1.3 Optical Test Setup

Depending on the application of the XY Phase Series SLM, many different optical setups can be used for either combined phase-amplitude mode or phase-only mode. Two examples of phase-only optical test setups are shown below.

1.3.1 Interferometer Setup

The first optical setup, illustrated in Figure 3, is a modification of a Twyman-Green interferometer (Handbook of Optics. Vol. 1, pp. 2.28-2.29). Here a monochromatic, collimated light source (i.e. laser beam expanded so it is larger than the diagonal of the SLM) passes through a non-polarizing beamsplitter such that the beam is divided into two beams, with nearly equal intensity. One of these beams illuminates the XY Phase Series SLM, while the other illuminates a reference mirror. Each of these reflected beams is then recombined at the image plane of a lens. If the reference mirror and the SLM are carefully aligned such that they are nearly coplanar, interference fringes will be visible at the image plane. A camera is placed at the image plane in order to magnify the fringes for easier viewing. When the XY Phase Series SLM is driven with different phase patterns, dynamic interference fringes can be viewed. Analyzing the interference fringes will then provide insight into the phase modulation provided by the XY Phase SLM.

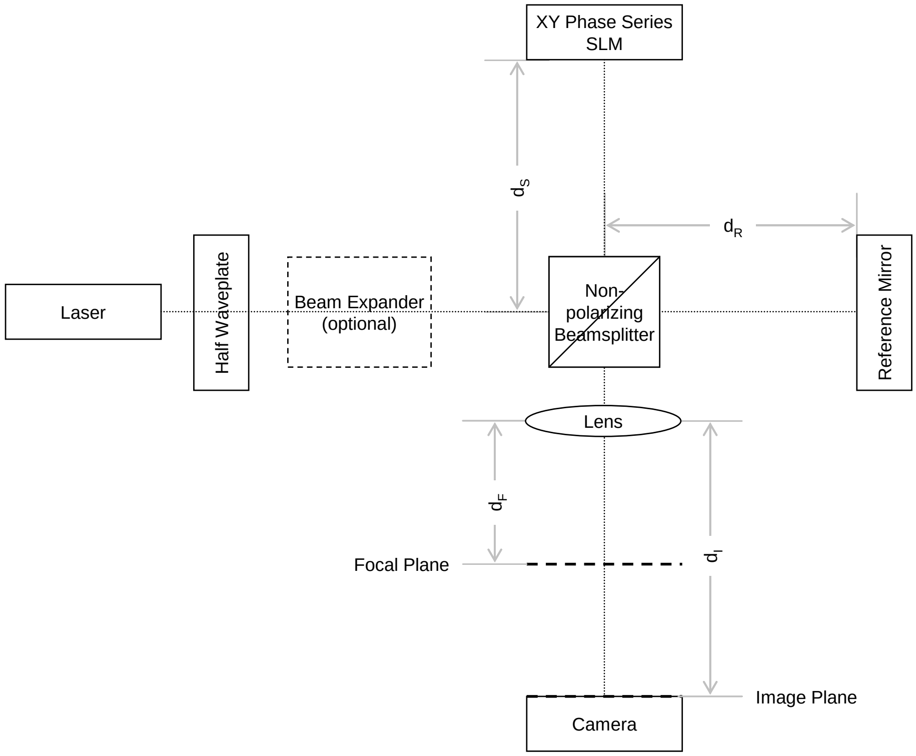


Figure 3 ~ A Twyman-Green interferometer for testing a XY Phase Series SLM.

In order to ease the alignment of the reference mirror and the XY Phase Series SLM in the Twyman-Green interferometer, place the camera or a card into the beam path at the focal plane of the lens. There should be two spots visible, one from the reference mirror and one from the SLM (there may also be very faint high-order diffraction spots from the SLM). If utilizing a beamsplitter cube, there are likely to be additional spots that are ghost images from the beamsplitter. When adjusting the tip/tilt of either the reference mirror or the SLM, the ghost spots will not move, but the true spots from the reference mirror and the SLM will move. Once the correct two spots are located, adjust the tip and tilt of the reference mirror and/or the SLM until these two spots are aligned on top of one another. Place the camera back in the image plane, or remove the card, and interference fringes should be visible in the image plane. By slowly adjusting the tip and/or tilt of just the reference mirror or SLM, the desired interference fringes should be readily obtained.

If working with a laser diode it is important to note that the coherence length of laser diodes are typically much shorter than the coherence length of a gas-discharge laser. With a Twyman-Green interferometer it is critical that both the SLM leg and the reference mirror leg have the same optical path length, ensuring that the short coherence length of a laser diode does not significantly reduce the visibility of the interference fringes. In order to ensure equal path lengths, set the camera such that it is focused onto the SLM – distinct features of the silicon backplane, such as individual pixels or the edge of the active area, should become sharp. Blocking the reference leg beam will likely be necessary in order to prevent crosstalk in the camera. Then move the block from the reference leg to the SLM leg and move the reference mirror closer to, or further from, the beam splitter until it is also in sharp focus on the camera. Since the reference mirror will likely not have any features with which to see the best focal point, look for focus of dust particles, or perhaps very carefully place a card onto the reference mirror such that it covers about half of the beam. The card edge can then be used as a guide to find the best focal position of the reference mirror.

There are a few important issues to remember whenever working with an SLM.

1. **Polarization** – The SLM is basically a variable single-order retardation plate, or wave plate. Like all wave plates, there is a fast axis and a slow axis. However with the XY Phase Series SLMs the index of refraction along the slow axis can be decreased electronically. When the light source is linearly polarized and parallel to the slow axis of the SLM, the result is phase-only modulation of the light source. If instead the light source were incorrectly oriented to be linearly polarized perpendicular to the slow axis, there would be no modulation observed with variable voltage. The use of a passive half-wave plate will greatly facilitate achieving the desired polarization alignment.

2. **Diffraction** – The SLM has discrete, reflective pixel pads in order to isolate the electrical signals and allow phase patterns to be written into the SLM. As a result of these discrete pixel pads, there will be diffraction. This diffraction can easily be seen in the focal plane of the lens. There will be a very bright center spot (0^{th}-order), surrounded by a grid of spots becoming progressively dimmer as they get further from the 0^{th}-order. In order to attain the maximum throughput, it is suggested to use as many of the diffracted spots, or orders, as possible. However, some applications do not allow the use of more than one order (typically the 0^{th}-order).

3. **Dispersion** – Liquid crystal wave plates are not very achromatic because the index of refraction varies as a function of wavelength. This dispersion means that a device designed to provide a 2π phase stroke at one wavelength, will provide less than 2π phase stroke at a longer wavelength and more than 2π phase stroke at a shorter wavelength.

4. **Optical Quality** – Due to the very small pixel pitch of the SLM, it is important to use high quality optics. A single element lens will generally have too much spherical aberration to provide a good, sharp focus across the entire clear aperture of the SLM. As a result, it is recommended to always use at least a doublet lens. For the same reason, the longer the focal length of the lens, the better the resulting image at the image plane. In addition, the transmitted wavefront distortion of most beamsplitter cubes is typically $\sim\lambda/4$, contributing to unacceptable wavefront distortion at the image plane. The use of a beamsplitter plate in place of a beamsplitter cube could improve the wavefront distortion, but using a beamsplitter plate requires the use of a compensating plate in the reference leg of the Twyman-Green interferometer.

An off-axis setup, shown in Figure 4, is designed to maximize throughput by eliminating the non-polarizing beam splitter. A laser beam is incident on the SLM at a slight angle, reflects off of the reflective pixel pads, and then is imaged with a lens onto a camera. Please note that since this optical setup is not an interferometer, the actual phase modulation will not be visible on the camera. This optical setup is only shown to illustrate the concept of an off-axis system. The setup should be modified to meet the exact application requirements. The off-axis angle should be kept to a minimum in order to reduce crosstalk effects due to the beam traveling through more than one pixel region. Minimizing the off-axis angle also keeps the phase stroke closer to the designed value.

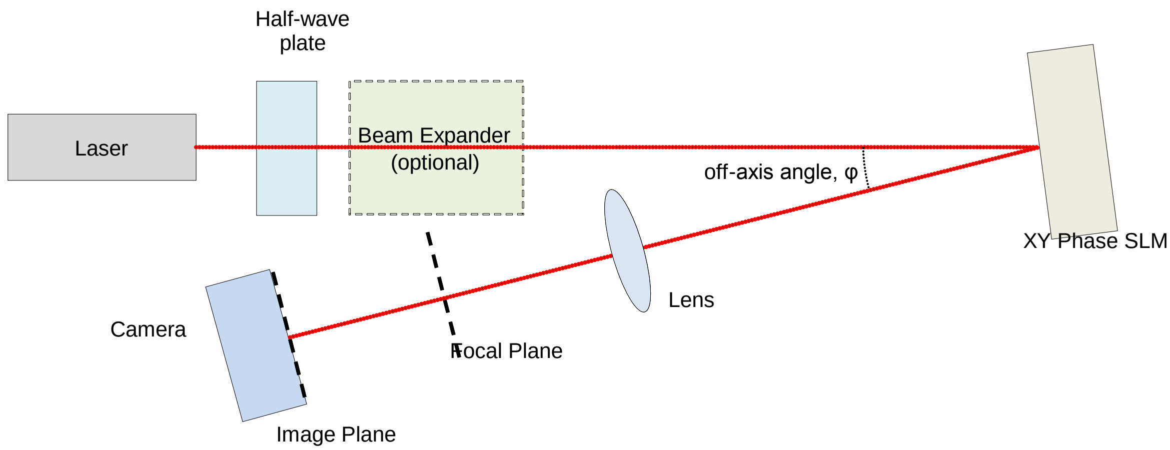


Figure 4 ~ Off-axis optical setup for the XY Phase Series SLMs.

2 SLM System Shipping Contents

Figure 5 displays all the components that are contained within the PCIe system. Included in the system are the SLM optical head, the PCIe Driver box, the PCIe host interface board, a 3 ft ribbon cable, a PCIe x4 cable, an external power supply, a manual, and a software USB flash drive.

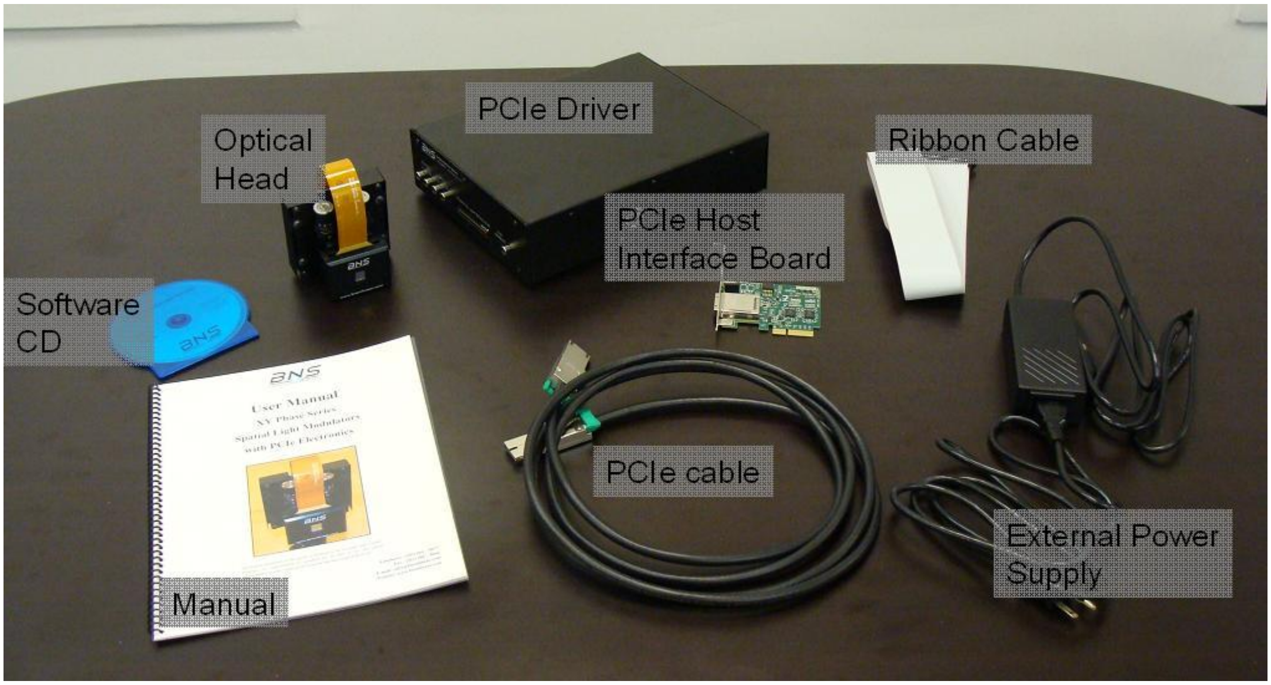


Figure 5 ~ PCIe system shipping contents

3 System Setup

The diagram in Figure 6 shows the hardware for one SLM system. The PCIe host adapter board (C) plugs into a standard PCIe bus slot on an IBM-compatible personal computer (PC). This board provides an extension of the PCIe signals. When the system is running, control commands and digital image data are sent from the PCIe host adapter board through the PCIe cable (D) to the PCIe Driver Module (E) where it is converted to an analog data signal. The analog data signals are then transferred through the ribbon cable (F) to the Op-Amp board (on the SLM head assembly (G)) where they are amplified to appropriate levels.

The hardware should be installed before the software.

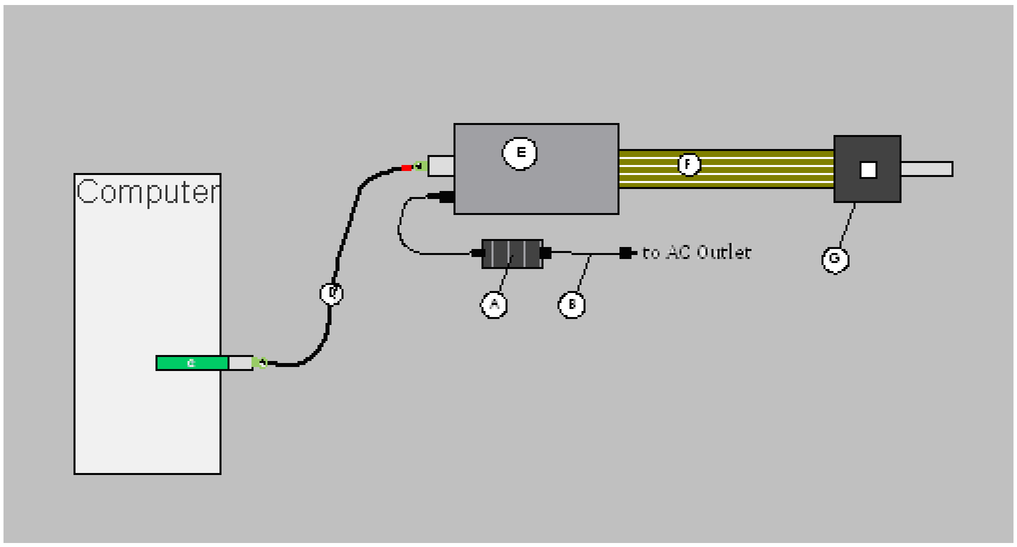


Figure 6 ~ Top level diagram illustrating major components of the Meadowlark SLM system.

3.1 Hardware Installation

CAUTION

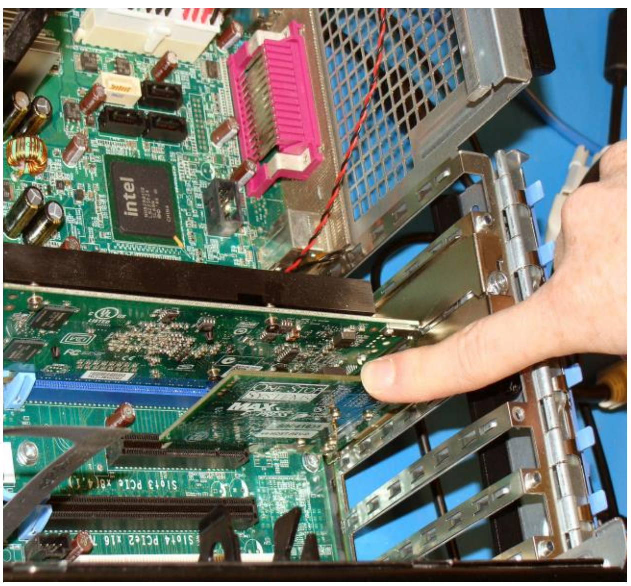
Ensure that your computer is completely powered off prior to installing any hardware.

Do not power the computer on until ALL cables included with your SLM system have been properly connected and the SLM board is powered up.

Unpack and locate the items shown in the Section 2. The optical head is not shipped with a post holder.

Follow static safe procedures. Attach a wrist strap and ground it to the computer case or a grounded static dissipative mat.

The following steps outline the hardware installation procedure.

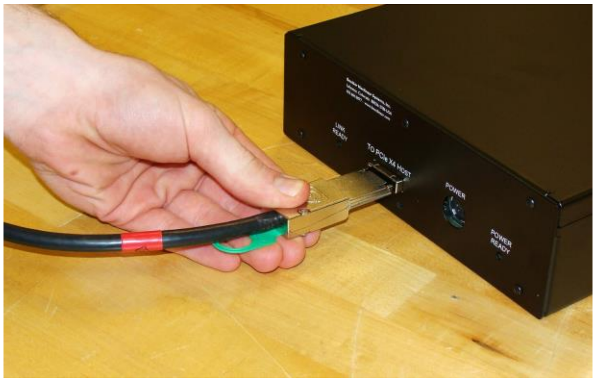


Power down and remove the outside cover of your computer. Insert the PCIe Host Adapter Board into any unused slot that is at least x4. Secure the card by screwing the mounting bracket of the PCIe board to the back panel of the computer.

Figure 7 ~ PCI Board installation.

Locate the PCIe cable. Attach one end of the PCIe cable to the PCIe Host Adapter Board. The cable does not have orientation, so either end may be plugged into the Host Adapter Board. Ensure the cable is securely locked into place.

Figure 8 ~ PCIe cable to PCIe host adaptor attachment.



Attach the other end of the PCIe cable to the SLM Driver Module. The included cable may not have red tape on either end. Ensure the cable is locked into place.

Figure 9 ~ PCIe cable to SLM Driver module attachment.

Attach the Op-Amp ribbon cable to the SLM Driver module. Press firmly to ensure a proper connection. Note that the white arrows need to line up for proper connection.

Figure 10 ~Connecting ribbon cable to optical head op-amp

Attach the other end of the ribbon cable to the PCIe driver box. As with connecting the cable to the optical head, make sure the white arrows line up for proper connection.

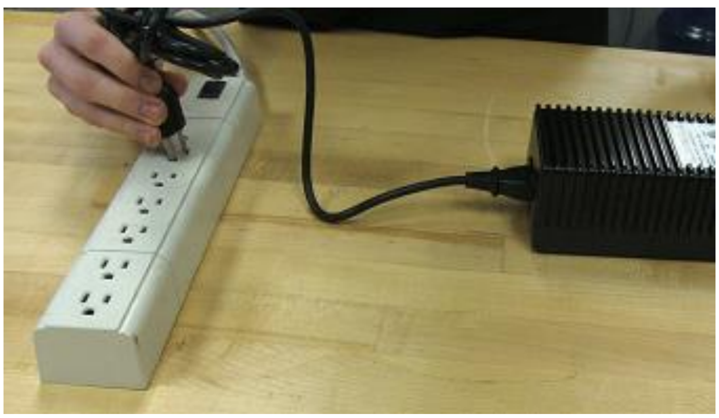
Figure 11 ~ Connecting ribbon cable to PCIe Driver box

Attach the power supply cable to the power supply. Press the cable firmly into power supply module.

Figure 12 ~ Power supply cable to the Power supply.

Attach the power supply output cable to the SLM Driver module. Press the cable firmly into SLM Driver module.

Figure 13 ~ Power supply to SLM Driver Module.



Locate a surge protected power strip. Make sure the strip is in the OFF position.

Plug the power supply cable(s) into the power strip.

Figure 14 ~ Power supply to AC outlet.

Turn on the Power Strip.

The SLM Driver Module should have power applied *before* the computer is powered up.

Figure 15 ~ Powering the system

CAUTION

IF THE COMPUTER IS POWERED BEFORE THE POWER STRIP IS POWERED, THEN UPON BOOTING THERE WILL BE A BIOS ERROR FOR EACH PCIe BOARD IN THE COMPUTER:

"Alert! Error initializing PCI Express slot X

Strike the F1 Key to continue, F2 to run the setup utility"

If this error occurs, and the user proceeds with booting the computer, then when running PCIeBlink the user will get a second error saying:

"Failed Scanning PCI Bus"

because the boards were not powered, and therefore not recognized. If this occurs, the user should shut down the computer, and properly power the external supplies to the PCIe boards.

After the hardware has been fully installed, turn the computer on and follow the instructions in the software installation section.

3.2 Software Installation

An installation USB flash drive is provided with the system. The details of the software setup using the USB flash drive are outlined below.

3.2.1 Minimum System Requirements

In order to effectively utilize your SLM system some basic computing hardware is required. The following components are essential to properly achieve the full performance of your SLM system.

IBM-compatible personal computer (PC), Pentium® -based (100 MHz minimum) system.

USB port

Available x4 or greater PCIE slot for each system.

Windows®-based computer operating system (Windows 7 or Windows 8).

Mouse or other pointing device.

Display monitor with 800 x 600 pixel format (minimum) and 256 colors (or more).

32 megabytes (MB) of available hard disk space is required for the PCIe-Blink basic software installation.

32 MB of available random access memory (RAM) to store and manage user-selected frames.

3.2.2 Software Installation Instructions

The PCIeBlink software on the USB flash drive contains the executable code necessary to operate the SLM, as well as sample pattern files, sequence files, and various other support files. Please follow these steps to install the software.

Insert the USB flash drive that came with your SLM system into the USB port.

When the PCIeBlink install shield appears, follow the onscreen instructions to complete the installation. At the end of the installation the installer will attempt to install the device drivers from a series of two command prompt screens. This will be followed by an installation of the Visual C++ redistributable files.

When the installation is complete, eject the USB from the drive and store it away carefully. After the software is fully installed, reboot the computer to finalize the device driver installation. After rebooting the computer, follow the instructions in the device driver installation section to verify the drivers were installed correctly.

3.2.3 Device Driver Installation

After rebooting the computer open the Device Manager. Note a major item listed as Jungo. After the drivers are properly installed there will be two or more sub-items depending on the number of PCIe systems installed in the computer. There should be one sub-item listed as WinDriver and a sub-item instance of PCIeDriver for each PCIe board found in the system. The PCIeDriver will wManager is opened before rebooting the computer to finalize the driver setup, then the screen in Figure 16 will be visible. Note that at this point, the PCIe hardware is recognized as a PCI Standard RAM controller. After rebooting, the screen in Figure 17 should be visible with the extra PCIeDriver being visible.

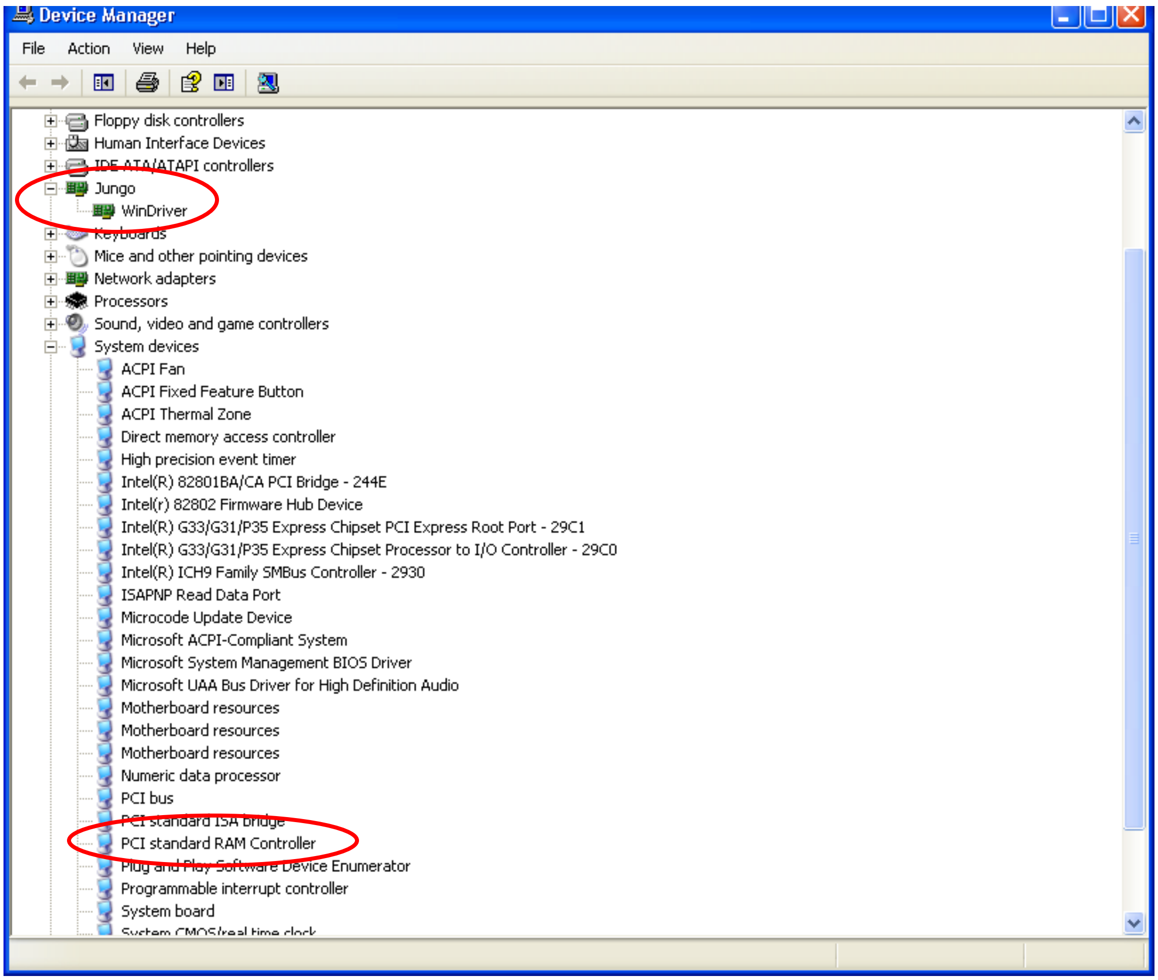


Figure 16 ~ Device Manager prior to rebooting

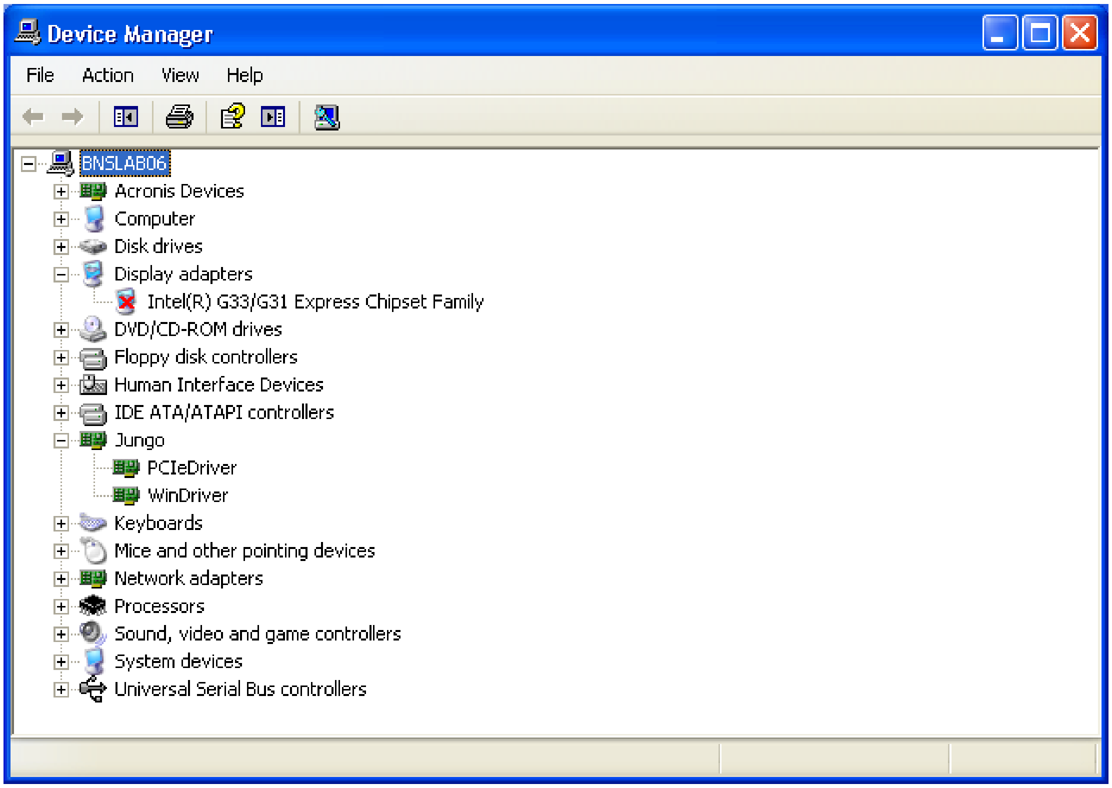


Figure 17 ~ Installation of Device Driver after software installation

When looking at the details of PCIeDriver and WinDriver, the screens in Figure 18 and Figure 19 should be visible.

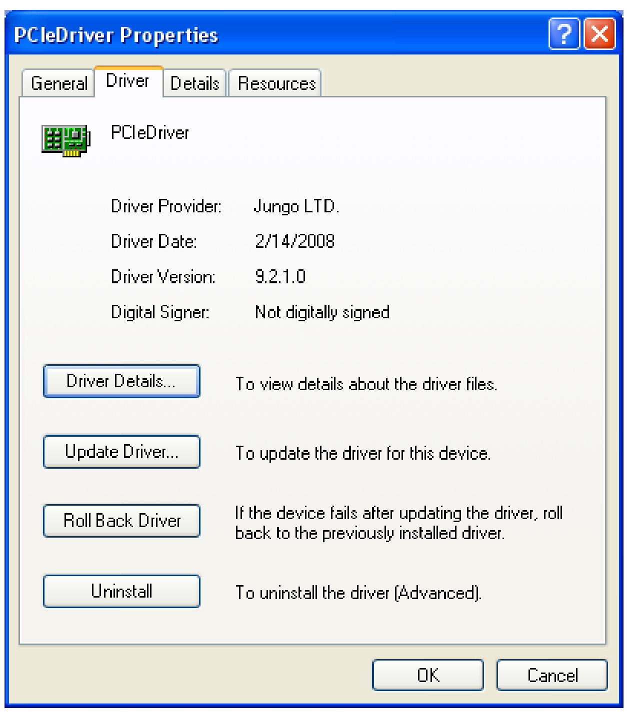


Figure 18 ~ Installation of PCIe Device Driver.

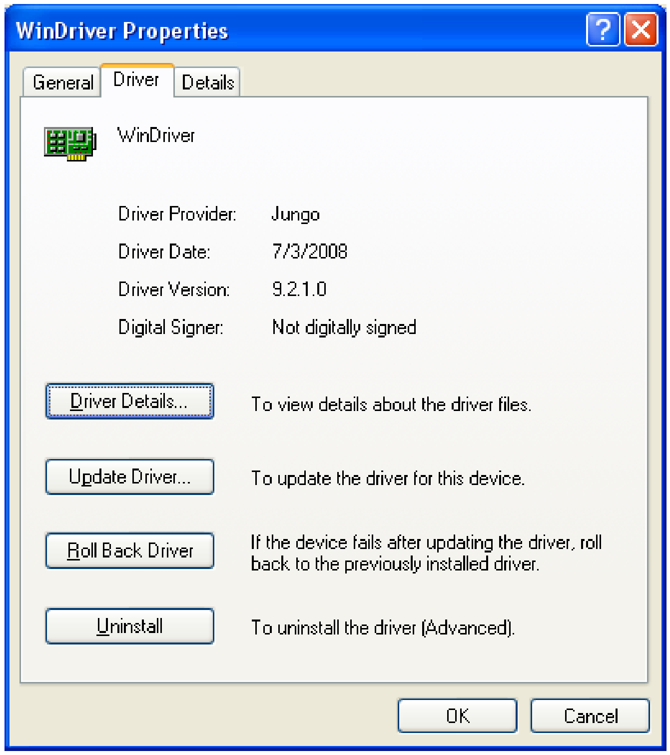


Figure 19 ~ Installation of WinDriver Device Driver.

If rebooting does not update the 'PCI Standard RAM Controller' driver, then right click on this item and select to update the driver. In the Hardware Update Wizard at the prompt that says 'Can Windows connect to Windows Update to search for software', select 'No, not this time'. At the next window, select to 'Install from a list or specific location'. At the next window, select 'Don't search. I will choose the driver to install'. At the next window within the Model list box the PCIeDriver option should be found. Clink on it, and proceed with the driver update. If it is not found, click on the background of the list box to un-select all items, and then click on the 'Have Disk' button. This will allow you to browse to C:\BLINK_PCIe\PCIeDriver.inf. If this also fails, then contact Meadowlark support for further information.

3.3 Software Operation

To start the software, double click the “PCIeBlink” shortcut located on your desktop, or click on the Windows “Start” button, select, “Run…”, type “C:\Blink_PCIe\PCIeBlink.exe”, then click “OK”. The screen shown in Figure 20 should now be visible.

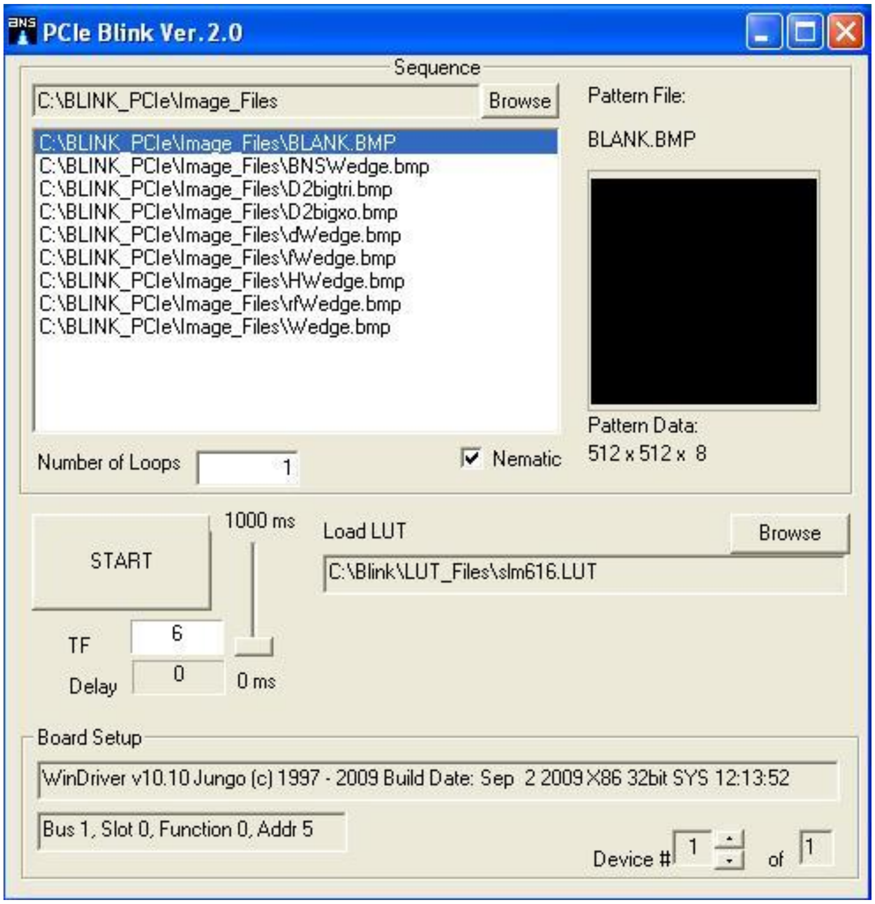


Figure 20 ~ Main window for the PCIe-Blink software.

When the software first starts the SLM is powered on. The green indicator light on the SLM Driver Module should be on. The highlighted Pattern File should also be visible on the SLM.

The checkbox with the Nematic label next to it controls whether the SLM is used in Phase mode (Nematic is selected) or Amplitude mode (Nematic is not selected). TF (True Frames) controls the toggling rate of the liquid crystal. The toggle rate is the rate at which the hardware changes the pattern file between the true pattern data and the inverse of the pattern data. Toggling between true and inverse patterns is required to prevent permanent damage to the LC. The true frames number is set by Meadowlark for optimum performance and should not be modified.

Note: The Pattern File display on the main screen is a gray-scale representation of the data in the Pattern File. Pixel values of 0 (0 λ phase stroke with slm*XXXX*.lut) are displayed as dark, while pixel values of 255 (1 λ phase stroke with slm*XXXX*.lut) are displayed as light (the exact intensity displayed is dependent upon the values in the look-up table). Values in between are represented by a linear gray-scale ramp. Depending on your optical setup, this may not look the same as the pattern visible on the SLM; see Section 1.3 for details on the optical setup.

To change the Pattern File currently loaded into the SLM, simply point the mouse at a different Pattern File in the Sequence List and click. This new Pattern File should now be highlighted, and be immediately loaded into the SLM. The cursor key (↑ and ↓) can also be used to select different Pattern Files in the Sequence list.

3.4 Sequences

The Sequence List is a predefined list of Pattern Files that will be loaded into the SLM (top to bottom). The name of the directory containing these images is shown at the top of the screen. New sequences can be created by creating a new directory and filling the directory with desired images.

Sequencing through the list can be initiated by clicking on the "START" button (see). Once the "START" button has been pressed the software will loop through the sequence the number of times specified by the user in "Loops", and the "START" button will be grayed or disabled. Once the sequence looping is complete, the "START button will be re-enabled. While the software is looping between patterns, the small window showing the current image will not update as it causes a slow down in the software.

The user can slow the rate at which the software loops through the images using the slider bar. This will insert a delay of the prescribed time before the image is changed. For example, setting the delay to 1000 (ms) would have the images sequence at approximately 1 Hz.

Note: The maximum Image Rate supported by the PCIe Blink software is considerably faster than the response time of the liquid crystal in the XY Phase SLM. Please contact Meadowlark to determine the response time of your SLM.

To open a new sequence file move the cursor over the "Browse Seq" button and click. This opens the standard Windows wizard for opening a directory. The user is asked to locate the directory containing the sequence on the hard disk. Once located, the new sequence is automatically loaded into the system.

There are two image directories shipped with the SLM system:

PCIeBLINK/Image_Files -	The default Image directory containing a series of common phase patterns.
PCIeBLINK/Other_Images -	Additional image files that the user may find useful such as Zernike polynomials.

3.5 Look-Up Tables

A LUT is a hardware look up table used to map the original input data to a set of new output values when the Pattern Files are loaded into the hardware. The LUT provides greater control by allowing the user to quickly change the response of a large set of Pattern Files without having to modify the Pattern Files themselves. Typically this is used to provide an approximately linear phase response to a linear set of pixel values. The LUT file is a text file that can be edited with a simple text editor (e.g. Notepad) with two columns of numbers. The first column is the input pixel value of your Pattern File. The second column contains the corresponding output pixel values that are loaded into the SLM hardware when a particular input pixel value is encountered in the Pattern File.

Each SLM system is shipped with a custom LUT designed to enable a linear phase stroke versus pixel value. This LUT will be named "slm*XXXX*.lut", where *XXXX* corresponds to the serial number of your SLM. When using this LUT, a pixel value of 0 will correspond to the minimum, or 0 λ phase stroke, a pixel value of 63 corresponds to ¼ λ of phase stroke, 127 corresponds to ½ λ of phase stroke, 191 corresponds to ¾ λ phase stroke, and 255 corresponds to 1 λ, or one wave, of phase stroke.

Another LUT, named "linear.lut", is also shipped with each SLM. This LUT is not to be confused with the custom LUT shipped with each SLM. This LUT provides an unmodified mapping of input pixel value to output pixel value, eg. 128 in the data file will be loaded into the SLM as 128.

3.6 PCIe Board Setup Information

At the bottom of the PCIeBlink screen is listed information regarding the PCIe interface to the board. When an instance of the PCIeBlink software is opened, the Bus, Address, Slot and Function number of the board located will be displayed in the bottom left corner. The total number of PCIe devices found as well as the device number of the currently selected hardware will be displayed in the bottom right corner. If the device number is changed by clicking on the spin box, then the user will change which PCIe Board and SLM the user is currently interacting with. The sequence list, the number of loops in the sequence list, the LUT, and the wavefront calibration are all parameters of a specific board. The sequencing delay allows the software to automatically sequence through the images in the sequence list at a user specified rate. This is a global parameter. If multiple boards are in the system, and the user clicks on the START button to start automatic sequencing, then the boards will be updated with their respective images, and then there is a delay that holds the images on the SLM for the user specified period of time. This delay can range from 0 – 1000 ms.

3.7 Exiting

When the Exit button is clicked, the application will shut down the system. The current user settings should be automatically saved. However, with Windows Vista, the program cannot save the users current settings unless the user privileges are properly set up. The user should have administrator privileges, and in the control panel it is imperative that the user select to "Disable User Account Protection".

4 Mechanical Housing

The SLM Housing has vertical and horizontal micrometers for adjusting the tip and tilt up to ± 3°. The housing also allows the user to rotate the SLM about the optical axis by ~15°. A set screw (located beneath the flex, between the knobs) locks the rotation about the optical axis.

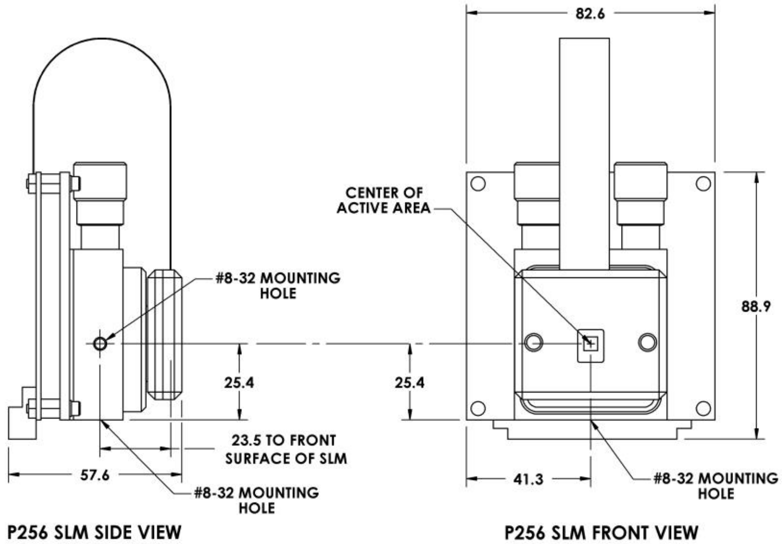


Figure 21 ~ Outline drawing showing front and side views of 256 SLM Optical Head. Dimensions in millimeters.

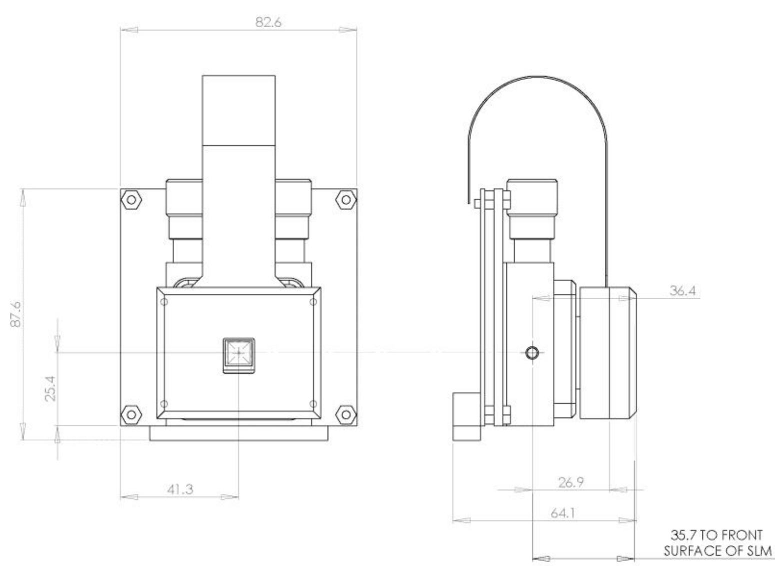


Figure 22 ~ Outline drawing showing front and side views of 512 SLM Optical Head. Dimensions in millimeters.

5 SLM care and cleaning

CAUTION

Failure to follow the recommendations included in this document may violate your warranty. Always ensure all personnel involved in the handling of your SLMs have appropriate tools (including static guards), equipment, and training prior to cleaning any SLM.

Never use acetone to clean your SLM. Acetone will cause irreparable damage to your SLM.

Never use pressurized air or nitrogen to clean your SLM. Pressurized air or nitrogen will destroy the bond wires that provide the electrical interface to the SLM.

The SLM is shipped with a piece of black paperboard covering the SLM aperture. This aperture, or a similar aperture, should be kept in place while the SLM is not in use to reduce the buildup of dust and debris on the SLM coverglass. When removing the aperture cover, or while the SLM coverglass is exposed, care should be taken to avoid any contact with the coverglass.

If dust or debris does contaminate the coverglass, gently remove it with a methanol soaked lens tissue. Take a small lens tissue or cleanroom wipe and soak a corner of it with methanol. Let the methanol evaporate until the lens tissue is just damp then gently wipe off the particles with the corner of the wipe. For more stubborn debris a methanol drag method can be used. Fold a lens tissue several times until it is just small enough to fit inside of the SLM aperture. Soak the folded edge with methanol and let it evaporate until just damp. Line up the folded edge of the lens tissue with the edge of the glass, and drag the tissue straight across the glass. Never wipe the glass more than once with the same lens tissue as it will merely transfer dirt back onto the coverglass. Repeat as necessary.

If there is any dirt or contamination that cannot be removed, please contact Meadowlark for additional cleaning instructions.

Thank you for purchasing a Meadowlark Optics Spatial Light Modulator.

For additional product and company information, please contact:

Meadowlark Optics, Inc.
5964 Iris Parkway
P.O. Box 1000
Frederick, CO 80530

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Website: www.meadowlark.com

Please feel free to contact us with any questions you may have as well as to leave feedback about your device.

For questions regarding customer support for Meadowlark SLM products, please contact us by telephone or by e-mailing slmsupport@meadowlark.com

For questions regarding purchasing and pricing of additional Meadowlark SLM products, please contact us by telephone or by e-mailing sales@meadowlark.com