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SF-100 User's Manual

Performance, characteristics, specifications, and system configurations are subject to change without prior notice.

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Warranty

Intelligent Micro Patterning, LLC guarantees its products to be free of material and workmanship defects for one year from the date of shipment. This warranty is in lieu of all other guarantees expressed or implied and does not cover incidental or consequential loss.

For Additional Information

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Revision History

Rev	Description of Primary Changes/Additions	Date	Approval
3.1	First Release of Documentation	5/23/02	CF
3.5	Removal of internal variable AC supply	9/16/04	CF
4.0	UV light enhancements, expanded safety information	10/16/04	CF
5.0	Auto Stage Feature Information	3/10/05	CF
6.0	Joystick Control, Level to Level Alignment, Auto Z Focus, Improved Lamp Timer Reset Functions, updates to operational specs, addition of rev history table	6/12/06	CF
7.0	Laser control operation	9/12/07	GH
7.0	Camera operation	9/12/07	GH

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Introduction

This document conveys all pertinent information needed to safely install, operate, and maintain Intelligent Micro Patterning's SF-100 Maskless Photolithography System. Performance, characteristics, specifications, and system configurations are subject to change without prior notice.

The SF-100 is an exposure system used in photolithographic processing. The key technology driving this system is Intelligent Micro Patterning's patented Smart Filter Technology. This technology and the system are described below.

Smart Filter Technology

Smart Filter Technology provides the user with the ability to perform photolithography processing without the need for expensive photomasks. The patented technology combines a number of optical and electronic components that project optical images onto the surface of substrates. Since polychromatic light is selectively filtered to provide this image, the name *Smart Filter* has been given to this technology.

Computer files of your design images are used to provide the necessary information for the Smart Filter. The necessary output data is furnished by using either the optional *Auto Stage*™ "load" function or other graphic image application's full-screen display in a pixel-based (rather than vector-based) graphics format such as bitmap (bmp). The input into the Smart Filter sub-assembly is a therefore a standard video signal from a personal computer (PC).

Output from the Smart Filter assembly is an optical image that is ultimately used to generate the photopolymer exposure pattern onto the substrate surface. The Smart Filter sub-assembly incorporates the optics and electronics needed to ensure that this optical signal is:

- Uniform across the image
- Of high intensity for quick exposures
- Distortion-free to resolve small features on the electronic substrate.

The SF-100 Maskless Photolithography System

In order to provide a complete exposure processing solution to device manufacturers, the SF-100 Maskless Photolithography System was developed. This system incorporates Smart Filter Technology to provide maskless exposures onto electronic substrates and optionally incorporates the *Auto Stage* to make setup quick and easy. A block diagram of the SF-100 is shown in Figure 1.

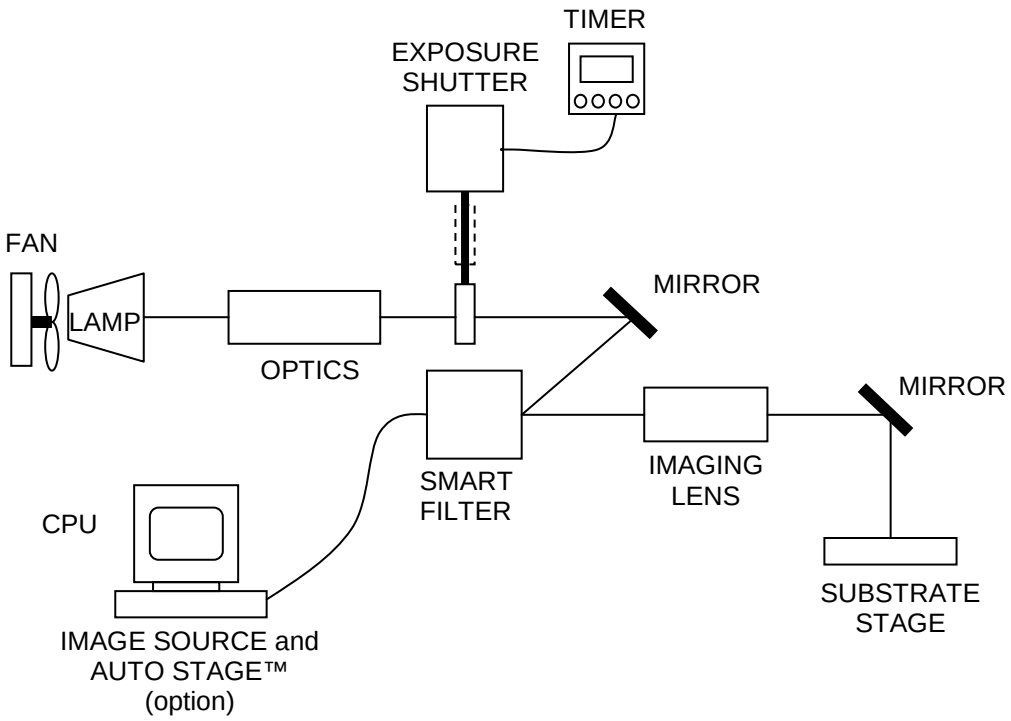


Figure 1: Block Diagram of SF-100 Maskless Photolithography System

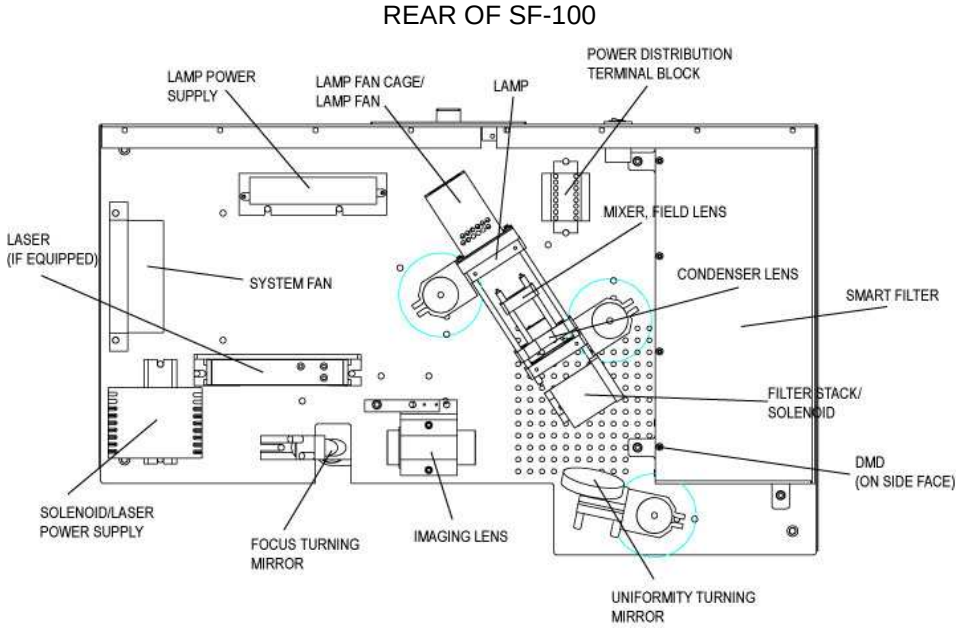


Figure 2: Internal Top View of SF-100 Photolithography System

The SF-100 is an elegantly simple exposure system that provides exceptional imaging quality for micro device researchers and fabricators. Light is introduced into the system using a polychromatic light source. A direct coupled

optical delivery system ensures efficient transfer of this energy to the Smart Filter sub-assembly.

As stated earlier, the Smart Filter incorporates all of the necessary optical and electronic components needed to transfer an image onto the substrate. Using proven optical design techniques, the projected image is free of distortion and uniform throughout the exposure area.

A standard Windows™-based personal computer is interfaced directly to the Smart Filter, providing system control and image storage for the exposure process. The *Auto Stage*, if equipped, then works with the computer to take all the calculations and guesswork out of making multiple aligned exposures.

Light emanating from the Smart Filter is projected directly onto the surface of the substrate located on the surface of the stage. Since the area of this image may be less than the total desired exposure area, a step and repeat motion is used to expose substrate surfaces larger than the field of view. To controllably move the substrate during these activities, highly accurate XYZ and theta stages are incorporated into the base unit.

Optional *Auto Stage* software screens enable full automated setup, calibration and execution of these activities. Manual overrides are also available on the *Auto Stage* screens to facilitate unique applications together with new or experimental processes.

By using the pellicle and the camera, the user may verify and control image-to-substrate alignment. This provides the SF-100 system the capability of fabricating multi-layer devices. A UV filter (internal to the SF-100) automatically removes UV energy from the target image to avoid substrate exposure during image-to-substrate alignment. This filter is necessary in order to prevent the photoresist from exposing while the substrate is being aligned to the image. The filter is lifted out of the light path during exposure using an electronically-operated shutter. Non-automated systems exclusively use a digital timer to provide this function. The optional *Auto Stage* systems use the software screens to configure single and multiple programmed shutter operations.

Safety

This section describes safety information regarding installation, operation, and maintenance of the SF-100. Additional cautions and warnings are provided in the manual where applicable.

Familiarity with the following symbols will help avoid unnecessary risk while using or maintaining the SF-100 unit and its associated equipment. Users and maintenance personnel are encouraged to become totally familiar with the meanings associated with these.

	This symbol alerts the user that important information concerning the operation and maintenance of this unit has been provided in the product documentation. This information should be read carefully to reduce and avoid risk.
	This symbol alerts the user that uninsulated voltage within the unit may be sufficient to cause electrical shock, burn or death. Therefore, it is dangerous to make any contact with inside surfaces without first disconnecting power from the unit.
	This symbol alerts the user that potentially hazardous levels of UV light energy are present in certain areas of the system.
	This symbol alerts the user that surfaces may be hot in the area where this symbol is placed for some time after power is removed. Follow instructions in the manual to avoid injury.
	This symbol alerts the user that protective eyewear is required when operating this equipment. Failure to wear this protective equipment during operation may result in permanent eye damage.
	This symbol indicates that the equipment is very heavy and may cause injury if not lifted properly. Some form of mechanical assistance shall be used to lift the unit to prevent potential injury.
	This symbol indicates that there are nearby areas where hand injury might happen if equipment movement is ignored. Always be aware that equipment may move unexpectedly.

General Safety: The following section details general safety recommendations that need to be considered when working with the SF-100.

WARNING: Failure to follow safety procedures outlined in this document may result in lethal shock, burn or UV energy exposure.

Potential hazards exist in any optical electro-mechanical environment. To prevent injury to personnel or equipment damage, ensure that the power is disconnected when performing any work on the system.

Follow company, local, and government safety regulations.

Keep unauthorized personnel out of the area when working on the equipment.


Voltages supplied to and within certain areas of the system are potentially dangerous and can cause injury to personnel.


Use caution when working inside (and around) the light source. Direct eye exposure with high power optical energy can cause permanent eye damage.

When working on the equipment near the light source or any area that may be exposed to this optical energy, it is recommended that you always wear approved safety goggles that provide protection from ultraviolet light.


Some surfaces of the SF-100 system and its remote equipment may become hot. Caution should be used when near any of these areas.

A partial list of potentially heated areas includes those near the light source and the power supplies.


Installation & Maintenance:

This section highlights safety precautions to be observed with the installation and maintenance of the SF-100 system. In order to maintain the system in sound operating order, and for personal safety, it is essential that the tool be installed and maintained properly and safely.

WARNING: Maintenance on this system is restricted to trained and qualified personnel only!

Safety Precautions To Be Observed:

Bring the system to a safe state by disconnecting power to the system prior to performing any maintenance.

- Use only original spare parts and assemblies provided by Intelligent Micro Patterning for maintenance and service work. This includes all process consumables. Using non-original spare parts can cause malfunctions. It may also result in serious or fatal injuries as well as extensive equipment damage.
- Properly dispose of toxic, flammable or hazardous waste material which may be used during or may result as a consequence of maintenance to system components.
- Stage pinch points should be monitored when this system is functioning since movement may be automatically initiated.

WARNING: Keep foreign and/or flammable objects from falling into the system, particularly in the light path area. Failure prevent these items from entering the system may cause inhibited performance, overheating and fire.

WARNING: Do not tamper with supplementary cover interlock switches to enable system operation without the covers in place. The cover protects the user from hazardous levels of ultraviolet light, which may cause permanent eye damage, and from hazardous voltages which may cause shock, burn or death.

WARNING: Do not place any non-approved optical components into the light path. These may redirect light within the unit and can cause unpredictable outcomes such as eye injuries or even fire.

Handling:

This section lists some recommended handling safety tips for installation and/or maintenance of the SF-100 equipment.

The SF-100 is very heavy and lifting or moving the unit without mechanical assistance may cause personnel injury.


- Use talc-free, oil free and lint-free gloves when working inside (and around) optical components and the process area. Fingerprints can cause contamination during processing or distort the optical image as it is projected through the light path.
- Make sure that any components which are removed and will not be used again immediately are properly contained when being discarded or stored.
- Follow all company, government, and local safety regulations, laws and guidelines for protecting personnel, equipment, the facility and the environment.

Electrical:

This section describes warnings and cautions for working with the SF-100 electrical sub-system in general.

Power shall always be disconnected before opening any enclosures or changing any cables or connections.

If any wires or cables appear damaged, contact Intelligent Micro Patterning immediately to determine the appropriate course of action.


Care should be taken when making input power connections and interconnections between sub-assemblies in the system. Interconnections shall be made with systems powered-off to reduce danger of personnel hazards as well as equipment damage.


For your protection, supplemental cover interlock switches have been designed into the system to further reduce the likelihood of exposure to hazardous voltages when the cover or lamp access panel is removed. Do not tamper with these switches to allow system operation without the cover and/or panel in place. Voltage levels exist within the system that present a lethal shock hazard.


Optical: This section describes warnings and cautions for working with the SF-100 optical sub-system. It also suggests safe practices for working with the optical components.

- Whenever cleaning optical components, use only lens paper to avoid scratching or marring the lens. If dry lens paper is not effective in cleaning the lenses, methanol may be used. Do not clean the pellicle with the lens paper the membrane is very thin.

Note: To effectively clean the lenses internal to the pre-Smart Filter light path, they must be removed from the system. Please contact Intelligent Micro Patterning for assistance in removal, cleaning and replacement of these components if necessary.

CAUTION: The lamp must be changed at the appropriate interval as described in the maintenance section of this manual. If you continue to use the lamp after 1100 hours, the lamp bulb may shatter and pieces of glass may be scattered in the unit. Do not touch these pieces of glass as they may cause injury. If this occurs, contact Intelligent Micro Patterning for lamp replacement.

- Ultraviolet (UV) energy at 365nm is present in the light used during exposure. The irradiance level at 365nm is approximately 25 watt/cm^2 and is sufficient to expose materials sensitive to UV wavelengths.

WARNING: Protective eyewear shall be worn when viewing the substrate area during exposure. Viewing the substrate area during exposure is strongly discouraged to avoid eye discomfort and possible eye damage.


Installation

Installation of an Intelligent Micro Patterning SF-100 Maskless Photolithography System is described below.

Site Requirements:

In order to obtain the maximum benefit and process results from the SF-100, the following requirements shall be made available to the system at the installation location.

- ✓ Granite table or similar anti-vibration table for the optical body of the system and the stage assembly to rest upon. The computer and other free standing subassemblies should not rest upon this table in order to minimize any vibration transmission from these components to the main system body. This table must be a minimum of 24 inches x 36 inches (609.6 cm x 914.4 cm).
- ✓ Since the majority of maintenance activities are made from the rear of the unit, 24 inches (609.6 cm) of free space should be left around the perimeter of the main unit. This will also ensure adequate ventilation for system operation.
- ✓ Electrical requirements: Three (four with Auto Stage) standard (total load < 12A) wall outlets are required for the SF-100. All of the outlets are to be standard line currents and configuration. Two of the outlets will be for the PC (one for the tower and one for the monitor). The last one or two outlets will be for the SF-100 main system and for the optional automated stage motors and controller power supply.
- ✓ The system will need to be located in a UV-free yellow-lighted area to prevent exposure of substrates from the environmental ambient light. Ideally, the yellow light will filter all light wavelengths less than 500nm.

Installation Procedure:

The following procedure should be used to install a new SF-100 Maskless Photolithography System. The procedure shall be performed by an Intelligent Micro Patterning Field Service Engineer or by the customer *with written pre-approval from Intelligent Micro Patterning and proper training.*

1. **Unpacking of Equipment:**
    a. Inspect all enclosed items for visual damage. Any damage to crates, boxes, or materials should be documented using a camera and reported to Intelligent Micro Patterning immediately. Note any shipping damage and begin any appropriate replacement or insurance claim actions to correct. Please take photos of any possible damaged areas and email them to the Intelligent Micro Patterning Customer Service group within 24 hours after determination of the damage
    b. Ensure all correct items are enclosed in each box. Packing slips will accompany each box shipped to a customer site. Each shipment should include the following sub-assemblies:
        i. **SF-100 Head:** This will include the base supporting the optical path, light source, and other components housed in the main body of the SF-100. Additionally, the four legs that elevate this structure will remain attached to it during shipping. The head may be attached to the optical table, item ii, for shipping.
        ii. **Optical Table:** This is the lower base plate of the SF-100 which will support the XYZ and Theta stage assemblies and the SF-100 head. This may arrive attached to the head, item i. Note: if the Auto Stage™ option has been ordered, the XY auto stage adapter plate is typically pre-mounted to this table.
        iii. **Stage Components:** *Manual Stage* parts include labjack, XYZ Flexure Stage, Rotational Platform and any applicable adapter plates. *Automated Stage* parts include XY Stage Assembly, ZT Stage Assembly, Auto Stage Controller Unit, BNC Cable, DAQ Card, Joystick and cabling. Extreme care should be taken when handling the stages. While they are heavy and may appear very

rugged, they are high precision components; subject to damage if mishandled.

iv. **Substrate Holder and Vacuum Pump (when applicable per PO).**

v. **Windows-Based Personal Computer and Monitor:** This will be shipped in its original container. All support devices (e.g. keyboard and mouse) will be included with the computer.

vi. **Spare parts (if ordered)**.

2. **System Positioning and Connection of Sub-components:**

Note: Installation is performed by Intelligent Micro Patterning Field Service Engineers.

Customers: DO NOT attempt to perform self-install without pre-approval and proper training from IMP personnel. The information below is provided for reference purposes only.

a. Using mechanical assist to support unit weight, place the optical table with any attached adapter plates onto an appropriate anti-vibration table.

Note: If the head is attached to the optical table, steps b and c are omitted.

b. Using mechanical assist to support unit weight, place the SF-100 head with support legs on top of the optical table. Align the rear-right corner of the SF-100 body and the optical table. Secure the SF-100 body to the optical table at the right-rear using eight ¼-20 socket head cap screws, two for each leg.

c. Mount and secure stages centered under the exit point for the exposure image, located below the cutout in the front-center of the cover.

For the manual stage, the mounting order bottom to top is Labjack, XYZ Flexure Stage, Adapter Plate, Rotary Stage, Chuck Adapter Plate, Substrate Chuck. (Note: the 1/3 Reduction Adapter takes the place of the Chuck Adapter Plate if the 1/3 reduction option was purchased.)

For the Auto Stage, the mounting order bottom to top is: Adapter Plate (pre-installed), XY Stage, Adapter Plate, ZT Stage, and Substrate Chuck. XY Stage cable orientation should be to the right (X) and rear (Y) of the unit. Z and Theta cable orientation is to the rear.

d. Place the computer tower on the floor or benchtop near the SF-100.

e. Place the monitor on the benchtop near the SF-100.

f. If *Auto Stage* was purchased, place the Auto Stage Controller Unit on the floor near the SF-100.

g. Connect the monitor video cable from the monitor to the video output connector labeled "1" on the computer graphics card.

h. Connect the SF-100 DB9 serial port cable from the port labeled "CONTROL PORT" at the rear of the SF-100 to the mating serial port connector at the rear of the computer.

i. Connect the SF-100 high density DB15 video cable from the port labeled "DATA PORT" at the rear of the SF-100 to the "2" video output on the computer graphics card.

j. If the Auto Stage was purchased, connect the second DB9 serial port cable from the port labeled "LASER PORT" at the right rear of the SF-100 to a mating serial port connector at the rear of the computer.

3. If *Auto Stage* was purchased, insert the DAQ 1200 card into the PCMCIA slot at the rear of the computer and connect the ribbon cable from the computer's DAQ 1200 card to the stage controller unit. The connectors can only fit one way on these ports; rotate as necessary. *Be careful not to bump or dislodge this DAQ card, the connections are very delicate and can be damaged.*

a. If *Auto Stage* was purchased, connect the BNC cable from the Stage Controller unit to the right side of the SF-100 Body.

b. If *Auto Stage* was purchased, connect the circular connectors the X, Y, Z & T axes to their mating connectors. Be certain to leave enough slack in the cables to allow full range of motion for the stages.

c. Connect the power cords from the SF-100, Stage Controller Unit (*Auto Stage* only), monitor and computer into the three (or four) available wall outlets using the supplied power cords.

d. **DO NOT** TURN ON THE SYSTEM OR AUTO STAGE CONTROLLER UNIT AT THIS TIME.

Customers having Manual Stage Systems, proceed to the next section, *Manual Stage Systems-Overview*.

Customers having Auto Stage Systems, proceed to the Auto Stage Systems-Overview section.

Manual Stage Systems-Overview

The SF-100 equipped with a manual stage offers an exceptionally affordable way to expose custom, small area patterns on a variety of substrates. For large feature patterns greater in size than a single exposure area, the precision manual XYZ and Theta stages allow the user to stitch adjacent images together. For small features or large area designs, the purchase of an Auto Stage system is highly recommended.

Manual Stage Systems-Operation

System Power Up:

1. Ensure all cords, cables, and unit covers are in place and all system vents are unobstructed. Turn on the SF-100 using the switch located on the rear of the unit. You should hear the system fan turn on inside the unit and feel a discharge on the left side of the unit. Lack of proper ventilation may shorten lamp life, cause system shutdown or failure.
2. Set the timer for 10 seconds this will be located in the manual or the auto stage program. You should hear the shutter engage, then lower after 10 seconds.

3. Once the system fan and shutter operation has been verified, turn on the computer and monitor.

4. Don the UV-protective eyewear and turn on the lamp. This may be done by accessing the "LAMP CONTROL" program from the PC desktop and click the power switch button. (see the next section "Lamp Control Panel" for program directions)

   When this is done, you should hear the lamp starting and within 1 minute you should see a rectangle of light at the substrate exposure area. Allow the lamp to stabilize for approximately 20 minutes before continuing.

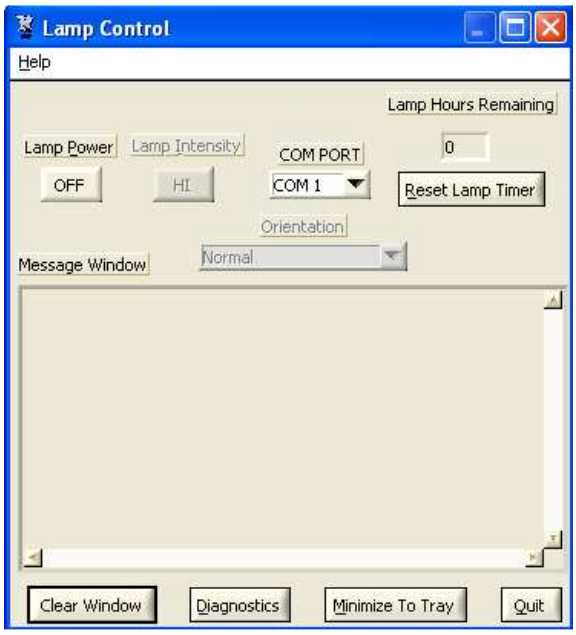
5. Once the lamp has been allowed to stabilize, place a piece of paper or card in the image light path to locate the image in its focal plane. If you do not see an image of your desktop at the focal plane, you may need to change the computer's display settings.

   For units equipped with the *Manual Stage*, the display should be set to dual display/clone mode. Display settings can be accessed in the Control Panel-Appearance & Themes, Display, Settings, Advanced, and Display. The computer is set to clone mode when both displays are active (green).

   DO NOT attempt to use extended desktop when equipped with a manual stage and using ACDSee full screen viewer.

Lamp Control Panel

A customized program is installed on the SF-100 PC so the user may access lamp controls such as switching on/off, changing the intensity, viewing remaining lamp hours and resetting the lamp timer.



Lamp Power

The user may use this button as an alternative to depressing the switch on the front of the SF-100. The two methods are not interchangeable. For example, if the lamp was turned on from the PC screen it may not be turned off using the switch on the SF-100.

Lamp Intensity

Lamp intensity may be adjusted using this button. There are two settings HI (100% intensity) and LOW (90% intensity). Operating the system at the low lamp setting will increase exposure times for highly reactive photoresists.

Lamp Hours Remaining

This indicates the hours of usable life remaining on your lamp. You may wish to monitor this and schedule your replacement lamp orders accordingly. When the lamp hours remaining reach 0, an on-screen message will display declaring it is time to replace the lamp.

Reset Lamp Timer

After the lamp has been replaced, the lamp timer should be reset using this button.

System Diagnostics

Clicking this button will display any system errors. When the system is running normally, the message will read "No Errors Found". Possible error messages are:

- Cover Open
- Lamp Overheated
- Lamp Power Supply Overheated
- Fan Stoppage
- Power Supply Failure
- Lamp Unlit

If you encounter any of these messages, notify Intelligent Micro Patterning Customer Service for assistance.

Image Focus/Z Stage Alignment

Removal of the cover for internal optical component alignment should not be necessary as these items are pre-set and locked-down at the factory. If you suspect your system has moved out of optical alignment, contact IMP Customer Service for assistance.

1. Display an image on the computer screen for use in stage alignment. A simple image such as black text or lines on a white background is best suited for this purpose. Note that this projected image is a left-right "mirrored" image of the computer screen. You may wish to "flip" the image on the screen to compensate for this if necessary.
2. Place desired substrate (glass slide, metal piece, etc) on the stage within the exposure area. If using a glass slide, it is recommended you use one with a label (white area at one end) for focusing.
3. Accessing the camera you can view the projected image from the substrate. Adjust the Z stage (round knob on right of black lab jack at bottom of stage assembly or program key when using an Auto Stage™). As you move the Z axis above and below the focal plane, you should see the image go in and out of focus.

   Note: You may see a slight left-right movement of the substrate during the vertical stage adjustment when using the manual stage version equipped with a lab jack. This is normal and will not affect your exposure results.

Automated Shutter Control Input:

Manual stage users may wish to control the shutter operation remotely using a PC or other control device.

The BNC connector on the rear of the SF-100 and shown in Figure 4 is used for this purpose. The connector accepts a standard TTL input (5VDC/0 VDC) signal for shutter engagement (exposure) and release.

For further information on automated operation of the SF-100, contact Intelligent Micro Patterning using the information located at the end of this document.

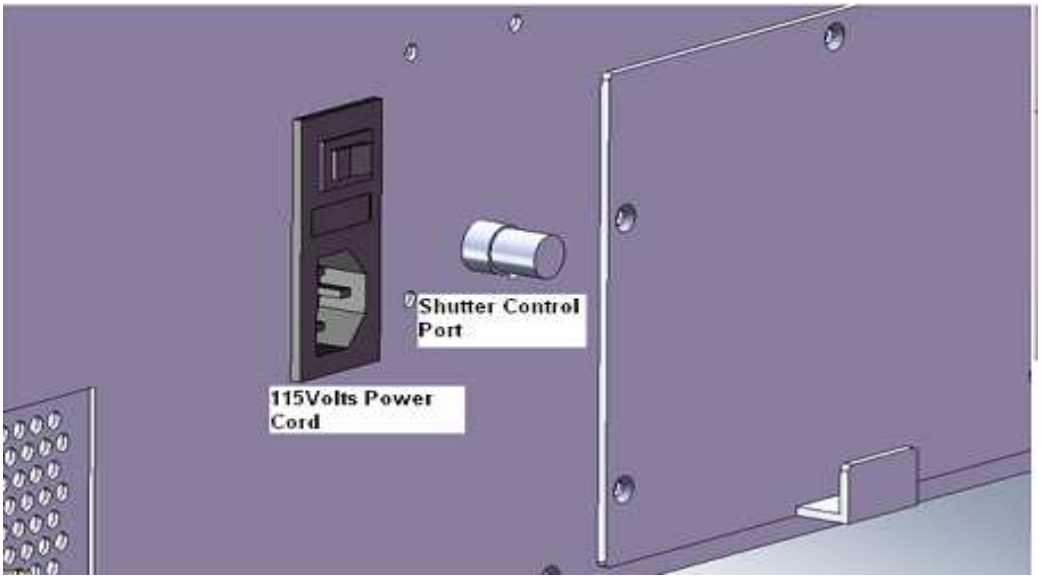


Figure 4: Shutter TTL Input (right-front corner of SF-100 Body shown)

Substrate Exposure:

Once the system has been successfully installed, powered up and aligned, you are ready to expose.

1. Display the desired image to be exposed on the computer screen.

   HELPFUL HINT: Remember that all components of the visible computer screen image will be exposed including any borders, menus or pointers. Clear the screen of all unwanted images before exposure. Also verify that the projected image at the substrate is oriented correctly; you may need to 'flip' the computer screen image to change the left-right mirrored orientation of the projected image. This can be done in the Lamp Control Program.

2. Place your photoreactive substrate on the stage under the exposure area.

3. Verify the projected image is in focus on the substrate.

   NOTE: If you are using silicon as your substrate material, a minimum of 7um photoresist is required to view the projected image. Photoresist that is thinner than 7um thick does not have the scattering qualities necessary to view the image. Reducing localized ambient light levels will also help in being able to view the projected image for focusing. The alternative is to focus on another substrate of the same thickness before placing the silicon substrate on the substrate platform/chuck.

4. Set the timer for the desired exposure time.

5. IMPORTANT: Put on UV-protective eyewear.

6. Click on the "EXPOSE" button located in the software.

7. To align multiple images for designs larger than the field of view, manually move your substrate for gross adjustment, and then align the exposed image to the newly projected

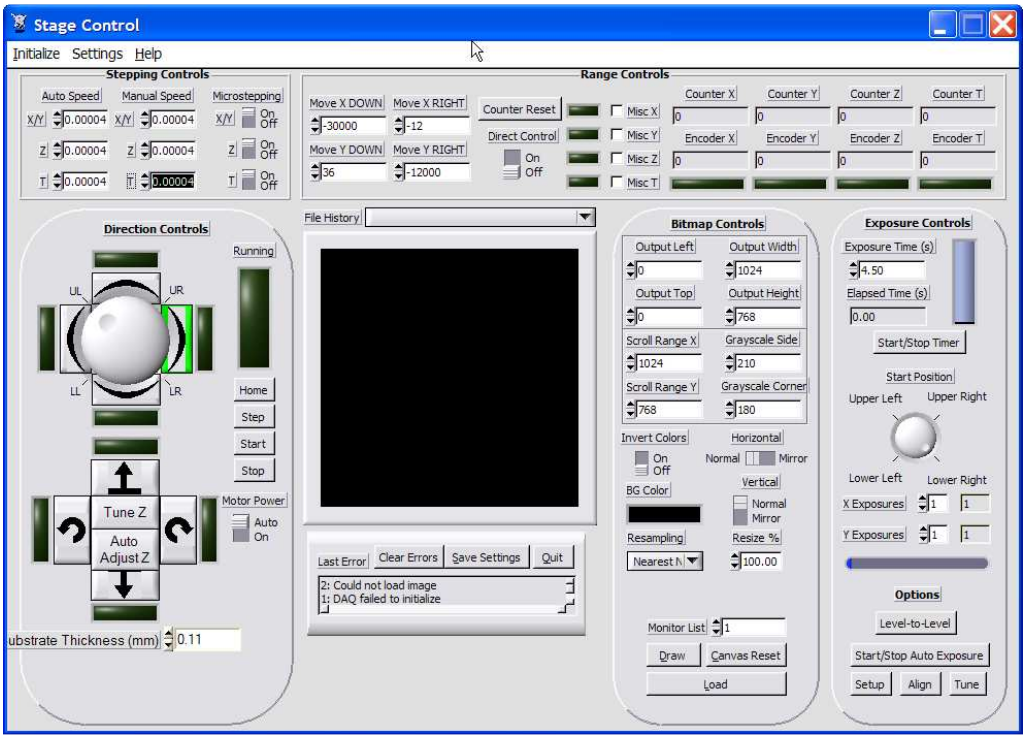
image using the fine xyz and theta stages while looking at the picture on the monitor being displayed by the camera before the next exposure.

HELPFUL HINT: If you wish to manually expose multiple images "stitched" together, it is recommended that you use a resist such as Shipley 220 or a dryfilm photoresist that allows the user to see the previously exposed image prior to development. Alternatively, you will need to use a positive resist such as Shipley 1827 and develop the exposed area before exposing the adjacent area.

HELPFUL HINT: Your developed substrate will vary in appearance depending on exposure and development times. You may need to experiment with both settings to achieve the desired results. Intelligent Micro Patterning has process engineers to assist you in your processing efforts. If you require assistance in this area, contact us for more information.

Auto Stage™ - Overview

SF-100 Maskless Photolithography Systems equipped with the optional *Auto Stage* offer a simple and highly precise means of providing repeatable alignments and exposure accuracy for step-exposing larger images. Smaller images can also be controlled easier as well by merely inserting appropriate exposure setup data while taking advantage of several powerful image control and adjustment features as needed.



- **Stage/Substrate Movement:**
  1. Accuracy, Repeatability and Calibration for stage mechanisms
     a. ALIGN feature for gross corrections (5-pixel resolution)
     b. TUNE feature for fine 0.5 pixel corrections
  2. Stage Movement Speed
     a. Rate of speed adjustable over wide range for gross moves

b. Resolution of movements and steps are set as required

c. Single-Step sizes can also vary for fine moves
   i. Microstep ON = 100nm per step (40nm optional)
   ii. Microstep OFF = 800nm per step (320nm optional)

3. Step Movements

   a. Automated per setup definition and variables

   b. Semi-Automatic for fine tuning with compensated accuracy

   c. Full Manual (DIRECT CONTOL = ON) for override convenience

4. Image-relative movements

- **Image Controls:**

1. Single Pixel (bit) resolution (15µm approx.)
2. Optional optics packages increases resolution 3X (5µm approx.)
3. Size: at >2000 X 2000 pixels, Windows™ 2000 or XP is required
4. Position control via keyboard and Home Screen control buttons
5. Mirror

   a. Vertical (top-bottom) mirror option "toggle switch"

   b. Horizontal (left-right) mirror option "toggle switch"
      i. Note: Exposure on substrate is always mirrored horizontal to the viewed image on the screen

6. Color Invert – allows for black-white reversal via "toggle switch"
7. Display

   a. Viewing window on Home Screen configuration page

   b. Full-Screen for close-up viewing of image and lapping grayscales

   c. Double monitor is accommodated in software, if added.

- **Exposure Controls:**

1. Size: Maximum single exposure = 1024 X 768 Pixels (15.36mm X 11.52mm)
2. Exposure frame (red square) is always relative (1:1) to image on screen and shown in viewing window at all times.
3. Position can be adjusted but movements relate to image – not exposure-frame (red square)
4. Background, for adjacent area exposure control, is fully variable and quick to change. Changes do not affect original image file.
5. Oversized image accommodated with fully automated and optimized step-exposure auto-splice system

   a. Exposure size adjustable manually or automatically to optimize movements and control adjacent area exposures

   b. Exposure step method variables can accommodate anticipated or custom needs of given image or array

   c. Adjacent area compensation has several custom options

   d. Grayscale control:

i. Defined and controlled image overlap splicing
ii. Multiple exposure compensation allows for defining both side and corner exposure reduction needs.

6. Exposure timing – hundredths of seconds capable, if necessary
7. Auto Exposure Start/Stop features:
   a. Single-shot abort capable
   b. Experimental tests of sequences enhanced by this flexibility
   c. Halt-and-resume during step-exposures accommodated
8. Fully Automated Controls:
   a. Configurations can be easily stored for next-day's re-boot of computer for processing of same or similar settings
   b. Fully automatic setup for entire staging of given configuration and image is possible
   c. Manual override capable for unique requirements or experimental sequences

Auto Stage™ - Operation

Basic setup involves ensuring that software is loaded, the Windows™ system and interface card variables are set and then start-up the *Auto Stage* program. The Auto Stage power supply can then be energized. Once the image files are located, substrate processing can essentially begin very quickly

System Power Up:

1. The stage locations are set from the factory and the stage location will already be set to optimize the span of maximum movement for the travel range of the stage axes.
2. Ensure that all the cables that provide the links from the computer's video card to the SF-100 video port and from the computer's stage interface card (DAQ CARD 1200) to the Auto Stage controller box are also installed.
3. With all cables in-place, turn on the system components in the following order:
   a. Computer
   b. Monitor
   c. SF-100

DO NOT turn on the Auto Stage Controller Unit at this time.

Auto Stage Setup:

1. Verify the Windows™ Desktop has the icons for:
   a. National Instruments *Automation and Measurement Explorer*
   b. *NIDAQ*™ Drivers (This may or may not be visible)
   c. *AUTO STAGE*™ by Intelligent Micro Patterning

   If these icons are not located on the desktop, contact Intelligent Micro Patterning Customer Service for assistance.
2. Start *Automation and Measurement Explorer*™ by double clicking the icon on the desktop.

a. At Configuration, select: Devices and Interfaces

b. Highlight: DAQ CARD 1200 (Device 1)

c. Select: Test Panel button

i. If message appears ("Device not responding…"), click OK

ii. At Test Panel, verify that the window shows an output signal; usually a wavy line that scrolls across display screen.

d. Select: Digital I/O tab

i. Check for error number at Last Error box

ii. Box should contain a "0" indicating no errors are present

iii. If box contains a number, select Error Codes button to define;

iv. If problem remains after attempting error correction, contact IMP for assistance

v. Choose CLOSE or close this window then close last window

3. From *WINDOWS*™ Desktop, set the 2nd monitor (the SF-100) to extended desktop mode:

a. Right-click mouse to drop a menu

b. Select: Properties

c. Select: Settings tab

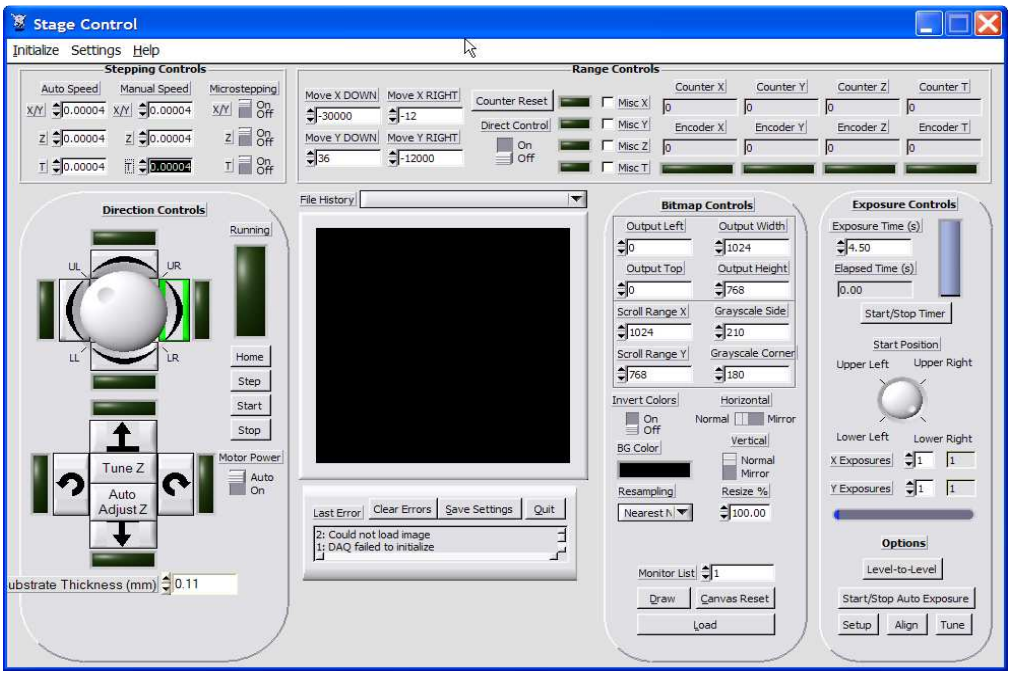
d. Select: Monitor #2 at Display window or by clicking the "2" icon.

i. Check Box: Extend my Windows Desktop onto this monitor

ii. Choose: OK to close the window and return to the desktop

NOTE: Whenever the computer is re-booted, these procedures must be done to both confirm proper DAQ Card function and initiate special non-default video output arrangement prior to starting *Auto Stage*.

4. Start the *AUTO STAGE*™ program by double-clicking the icon on the desktop.



a. The default (last saved) values will load onto Home Screen

b. With the Auto Stage Program running, turn on the Auto Stage Controller Unit using the switch on the enclosure.

c. At Bitmap Controls in the Auto Stage Program Main Screen:

i. Select Load to begin browsing for the desired images and then, once the desired image is highlighted, select Load again in the dialog window to bring the image into the Home Screen display.

ii. This step can be repeated to load several images' paths into the *Auto Stage* for subsequent processing during this session

iii. Above the image display window, the File History button will show the path to all images loaded during this session for quick selection and reloading.

iv. In Monitor List, select and change monitor to "2" and left-click the Draw button. This will illuminate the loaded SF-100 Smart Filter image onto the stage or substrate but will not expose it yet.

v. Select Draw button while Monitor List is set to "1" to have image appear in Full Screen mode where only the exposure frame portion of the full image will be viewable

vi. To return to the Home Page screen, select the ESC key.

Joystick Control:

The SF-100 Auto Stage is equipped with a wireless joystick for convenient control of stage motion. Using the joystick, the user can move the substrate in the following directions as seen from the user located facing the system. In all cases, the direction is selected, then the trigger is activated to start and stop motion.

Up: Rotate Lever Forward to select direction
Down: Rotate Lever Backward to select direction
Right: Move joystick far right to select direction and activate trigger to start motion and again to stop motion
Left: Move joystick far left to select direction
Forward: Move joystick away from user to select direction
Backward: Move joystick toward user to select direction
Rotate Clockwise: Rotate joystick clockwise to select direction
Rotate Counterclockwise: Rotate joystick counterclockwise to select direction

Hat Switch Functionality:

When "Stepping Controls" area is activated on main Auto Stage Screen,
Moving the Hat Switch Away from User will decrease stage speed.

Moving the Hat Switch Toward the User will increase stage speed.

When the "Preview Pane" area on the main Auto Stage Screen is activated, the Hat Switch assumes the roll of the arrow switches in moving the image square:

Away from User = Scroll the image up by "Scroll Range Y" value
Toward User = Scroll the image down by "Scroll Range Y" value
Left of User = Scroll the image left by "Scroll Range X" value
Right of User = Scroll the image right by "Scroll Range X" value

DO NOT TOUCH JOYSTICK DURING AUTO EXPOSE SEQUENCE. STAGE MOTION WILL BE DISRUPTED.

Align and Tune:

The Alignment and Tuning procedures need to be performed under the following circumstances before any processing may be initiated:

- Initial Setup
- If the system has been jarred, moved or bumped
- Following the 6-month interval for the required cleaning and lubricating process.

If none of these are valid and the system is operating correctly, there is no need to perform the Align and Tune procedures.

1. **Alignment**:
   a. With Monitor #2 selected in the Bitmap Controls Monitor List, an image should be loaded to demonstrate that the Smart Filter and other image production systems are working properly.
   b. Place the Range Controls Direct Control switch in the ON position
   c. Move the X and Y axes stages to the approximate center of travel in both directions.
   d. Affix a substrate, slide or even a business card with a very fine feature – an edge, a point, a dot that will be easy to align with a small "plus" sign cross-hair image.
   e. Select the Align button and the small "plus" will appear on the left-side of the image – or middle of the side closest to the microscope.
   f. Using the Direction Controls Start/Stop and Step buttons, move the substrate's selected "very fine" feature to align with the center of the "plus" as viewed on the microscope.
   g. When complete, select the Align button a second time and the "plus" will move to the right on the image or directly away from the microscope.
   h. Again, move the stage to align the fine feature at this new location.
   i. Repeat again: select Align, the image will move to the top of the image or to the right-side of the area. Again move the stage to it.
   j. Repeat again: select Align, the image will move to the bottom of the image or to the left-side of the area. Again move the stage to it.
   k. For the fifth time, select Align and the function will be completed. Numbers showing step count alignment correction values will appear in the Range Controls "Move…" boxes.

2. **Tuning**:

   a. Only when an Alignment procedure has been recently completed can the full specified resolution and appropriate response of this next procedure be expected.

   b. Again, with the Direct Control switch still set to ON, move the X and Y axes stages to the approximate center of their travel ranges.

   c. Prepare a minimum 2cm x 2cm substrate with unexposed photo resist.

   d. At the Exposure Time box enter the time needed to expose this particular test substrate.

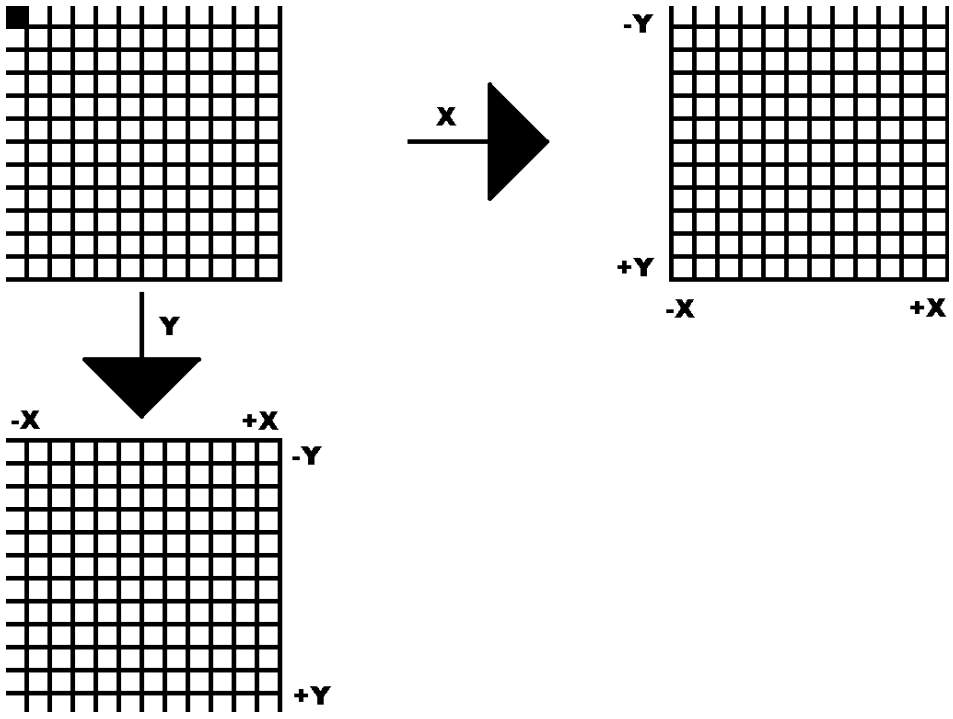
   e. Place this substrate squarely on a loaded full or over-sized image so it aligns in the center of the image and then press the Tune button

   f. The program will then instruct the user to place or confirm placement of the substrate; when complete, select Enter or click Ok

   g. Two new images will be loaded and exposed onto the substrate. The second image will be exposed three times on the substrate.

   h. Following this exposure, the program will ask the user to enter the numbers corresponding to results viewed after the development of the substrate patterns.

   i. Following development, place the substrate where it can be viewed under a microscope. Rotate and align it so that the exterior edge corner that is solid is in the upper-right of the view.



   j. There will be three areas of interest; two are sub-grids in the upper left and right quadrants and the third is in the lower right quadrant. These will each have circles surrounding one of the crossing grids. These circles denote the 0,0 (X,Y) coordinates of each sub-grid area.

   k. The upper left or X-axis sub-grid will have an area where the crossing grids are perfectly aligned. The distance in grid cells from 0,0 to the center of this aligned point will be represented by coordinates. All coordinates are positive-counting as

they move away from the main grid's solid corner and negative-counting as they approach this corner.

l. For example, if the perfectly-aligned point is two columns to the left and one row above the circled point, then the alignment coordinates are: 2,-1. This is what is to be entered into the box on the computer screen. Then click the OK button to get the Y-axis dialog window.

m. The lower right or Y-axis sub-grid will have the same issues and needs.

n. For example, if the perfectly aligned point is directly below the circled point by only one row, then the alignment coordinates would be 0,1. This is what is to be entered into the box on the computer screen as prompted. Then, click the OK button to finish.

o. Before putting away the substrate, look also at the upper-right hand sub-grid. It should show that the circled point is also the best aligned point. If this is not the case however, there is a problem with the mechanisms of the stage and it will need to be serviced and corrected before it can be used.

p. If coordinates other than 0,0 and 0,0 were entered, the values in the "Move…" boxes will likely show slight changes to correct for fine alignment of the equipment.

3. **SAVE:** Left-click the Save Settings button, located near the Error Window on the Home Screen to preserve these new correction values.

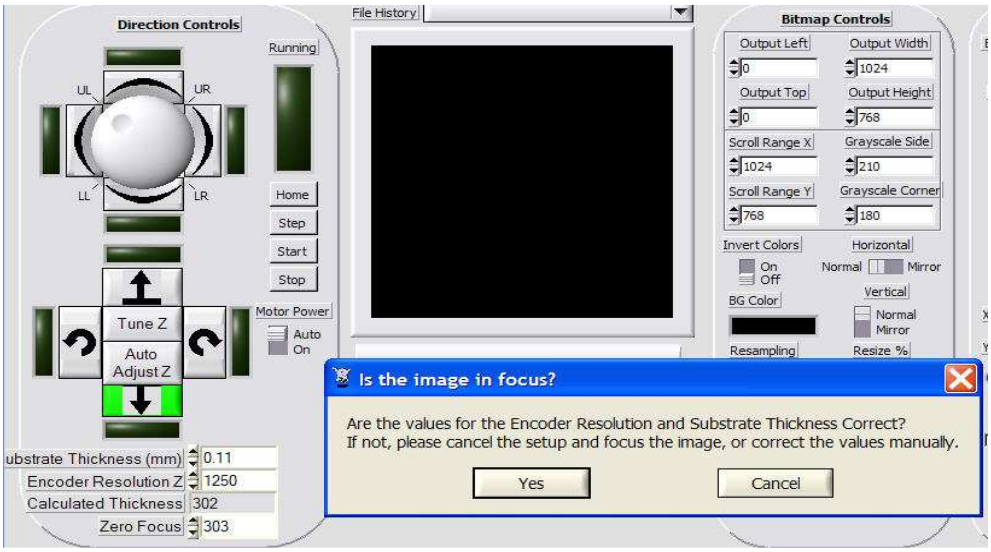
NOTE: If there is suspicion that an alignment problem exists at any time, this procedure can be performed as many times as needed until satisfied. If problems arise, please contact IMP for assistance.

Z Tuning for Auto Stage Systems w/o Laser Auto Focus

This procedure is performed under the following conditions:

- during initial setup
- following a vacuum chuck change
- following adjustment of the internal system optics.

Focus projected image on a substrate of known thickness by checking the image displayed on the monitor via the camera, while moving the Z stage up and down.

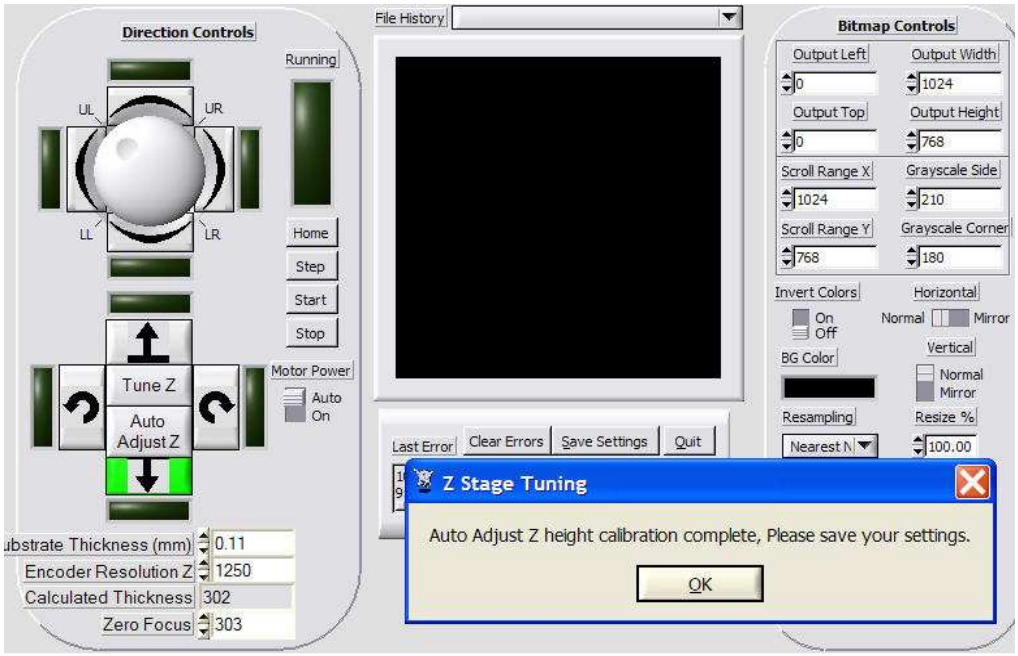


Once the image is in focus, click "yes" in the above window will pop up. The stage will move to the lower limit, then back to focal location.

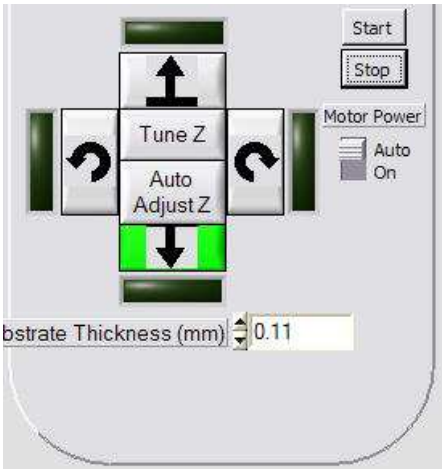
Note: Please verify that;

- The image is in focus
- The encoder resolution and substrate thickness are correct

If the image is not in focus, click "Cancel", correct the values and click "Tune Z" button again.



Once the calibration is complete, click "OK", then click the "Save Settings" button located under the preview image box.



The forms for Encoder Resolution, Calculated Thickness and Zero Focus will disappear once "OK" is clicked. This is normal.

If a new substrate varying in thickness is used, enter new substrate thickness and click "Auto Adjust Z". The stage will move to the lower limit, then return to the correct focus height for the new substrate and you may begin exposing.

NOTE: During calculated step stage motion, **do not** move the mouse or use the keyboard. Doing so will slow down stage motion and may impact your exposure results.

Automatic Exposure Setup and Control:

- **Exposure Controls section and Automatic Exposure Setup**
    1. **Exposure Time** is the manually entered time used at each exposure. It represents the time that the shutter is lifted and the substrate is thus exposed to the maximum UV light levels. At the expiration of the elapsed time, the shutter is dropped back into the UV light path.
        a. Time values may be entered to the hundredths of a second but up/down arrow adjustments will only vary amounts by whole seconds.
        b. Experimentation is recommended to ensure that variables of cure time, quality of material, temperature, humidity, etc. allow a given process combination to fall within boundaries of consistent, predictable results and expectations.
        c. Performing a DOE is recommended for more critical processes, especially when unproven levels of grayscale are also factors.
        d. The Elapsed Time box indicates progress during single or multiple exposure procedures. Monitoring may also prove helpful for observing progressive results during experimental procedures.
    2. **Start/Stop Timer** button
        a. Start begins a single exposure at the current exposure frame location.
        b. Stop halts a single currently-running exposure for any reason.
        c. If performing a multiple-exposure Auto Exposure sequence, the Stop button will stop the current exposure timer but the Auto Exposure sequence will continue to move to the next exposure frame location and continue-on normally.
    3. **Start Position** rotating dial pointer
        a. Dial with a dimple selects the starting corner of the image for an Auto Exposure sequence. If there is only one exposure, the dial has no effect.
        b. The dimple is moved by holding down the left mouse button with the pointer over the dial and moving the pointer in a circular fashion to rotate the dial. The mouse pointer may start at any position on the dial
    4. **X and Y Exposures** boxes:
        a. These boxes contain the number of exposures in each direction performed by a multiple exposure sequence. The numbers can be manually set by entering the numbers directly or clicking on the up/down arrows or are also set by initiating an **Auto Exposure Setup** command which is explained below.
        b. Automatic sequences start in extreme corners, according to the setting of the Start Position dial and move across the image in the X-direction (left or right) first, away from the starting position.

c. At the end of the first row of exposures, the sequence will then move one row in the Y-direction (up or down) for the next exposure and then continue in the opposite X-direction.

d. This sequence continues in a serpentine fashion until all the exposures in a sequence are complete. The serpentine pattern optimizes movement time for the sequences.

5. **Setup** button is dedicated to settings of exposure size and stage initialization. Selecting it brings-up the Auto Exposure Setup screen.

6. The **Image Setup** section of the **Setup** screen has three check boxes.

   a. **Calculate the number of exposures** with the current overlap and screen size performs the calculation and then enters appropriate numbers in the X and Y Exposures boxes, based on the Output and Scroll Range boxes' values.

   b. If Calculate… is checked, then the Pixel Overlap and Image Fit boxes now become available.

   c. **Specify pixel overlap**: Pixel Overlap in X (and Y) are ways to automatically adjust the Scroll Ranges to allow for a specific amount of overlap. These values will automatically be entered based on existing Output and Scroll values but can easily be changed here by entering a value directly or by clicking on the up or down arrows.

   d. **Fit Image**, if checked, makes available three exclusive options:

      i. **Adjust output size** re-sizes the red exposure frame to make it the minimum required to expose the loaded image. This option optimizes stage movements needed and prevents exposure outside the image area itself.

      ii. **Center image** provides an Output Width and Output Height size exposure frame and centers the exposures relative the center of the overall image. It thus exposes the areas uniformly around the image in accordance to the chosen background color (BG Color).

      iii. **Stick to corner** designates that the initial exposure frame should be flush with the adjacent edges of the chosen Start Position corner. If other than an "Adjust output size" frame size is used, there will likely be frame overlap at the two opposite sides onto the surrounding background areas.

      Note: To change fit image settings the canvas reset button must be selected first.

7. The **Stage Setup** section of the Setup screen has two check boxes:

   a. **Home to corner** moves the stages to the designated Start Position corner as part of the setup step prior to starting the exposure sequence. When not checked, the stages begin the sequence from where they currently are.

   b. **Leave free space** is authorized to be checked when the Home to corner box is checked. This box addresses the space that is unusable due to alignment compensation values that were assigned to the "Move…" boxes following an Align and Tune procedure. These spaces come into concern whenever the stages are used near the limits of their travel.

      i. Checking this box brings-up two options: Automatic and Manual for setting the space to be "left" and not used by the stages and Auto Exposure sequences.

ii. Automatic lets all the compensation be handled by the intelligence of the *Auto Stage* software. This is the recommended position of this selection, when Home is also chosen.

iii. Manual allows the user to override and identify this unusable space to be "left", if desired.

8. **Run** is selected when all choices of Auto Exposure are set as desired.

   a. The stages will move as directed, all data boxes will be populated with appropriate values and the image and exposure frame will be adjusted, as necessary to begin the configured Auto Exposure sequence.

   b. Run will need to be selected prior to each Start of an Auto Exposure to reset the starting point.

9. **Cancel** allows return to the Home Screen without performing a pre-sequence Setup.

10. After selecting **Run**, clicking OK to the notice that Setup [is] completed, substrate placement should be verified for the last time.

    a. **Start/Stop Auto Exposure** can now be selected to run the image exposure sequence.

    b. **For an additional exposure sequence of another substrate** using the same image, the Setup and Run buttons will need to be selected again to reset the system to the Start Position.

    c. **Immediately aborting an Auto Exposure** sequence requires clicking the Start/Stop Auto Exposure and then immediately clicking the Start/Stop Timer. All functions will then stop.

    d. **Halting an Auto Exposure sequence** after the last exposure requires only clicking the Start/Stop Auto Exposure. The current exposure will finish, the stages will move to the next exposure location and then all action will stop.

    e. **To re-start a halted exposure sequence**, the X and Y exposure values will have to be adjusted to address only the remaining exposures–possibly more than once.

       i. First, finish the current row (X-axis) by putting the number of remaining exposures in this row in the X Exposures box. If at the "head" of the row, skip to step "vii." below.

       ii. Then change the number of Y Exposures to "1".

       iii. Change the Start Position dial to reflect this new *starting* position, if necessary. Remember that the sequence is *away* from the Start Position.

       iv. Then select the Start/Stop Auto Exposure button. When done, Auto Exposure will stop at the end of the row.

       v. Using the Direction Controls, select the up or down button to move the stage in the Y-direction. If the red frame needs to go down, use the up button (image goes up) and vice versa.

       vi. Highlight the viewing window and use the up arrow to move the red frame relatively down (image goes up) or vice versa as needed. Now the image and the stages are aligned again in the next row.

       vii. Once at the "head" of the next row, reset the X and Y Exposures windows to represent the full number of remaining exposures for this entire image.

viii. Change the Start Position dial, if necessary, to represent this new *starting* position, as explained above.

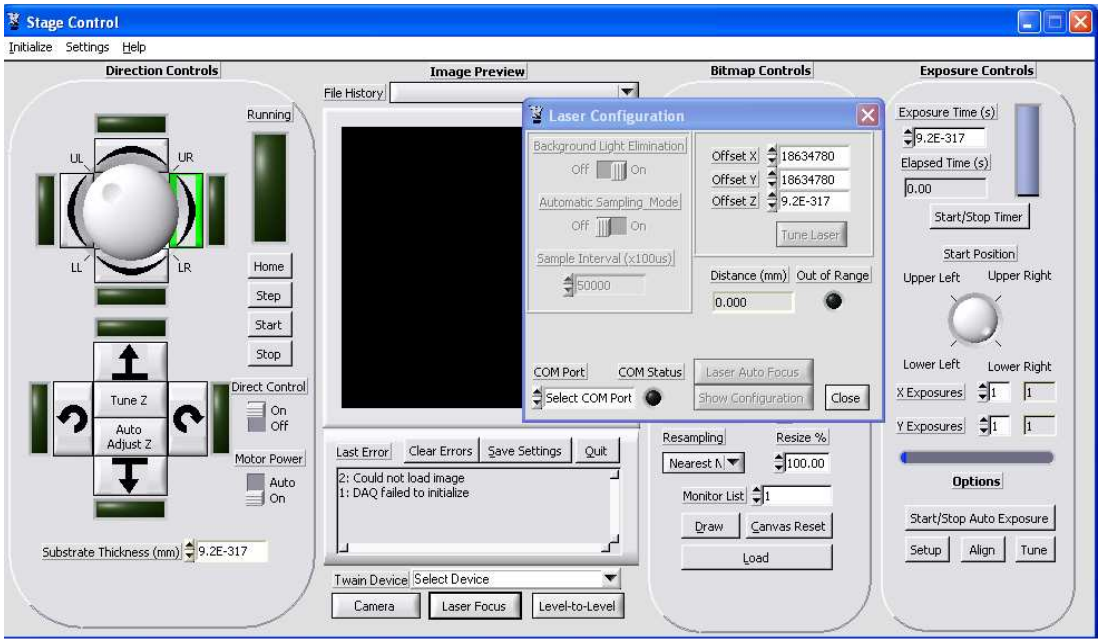
ix. Select the Start/Stop Auto Exposure and it will finish the remaining exposures and shut off.

Z Tuning for Auto Stage System with Laser Auto Focus

This procedure is performed under the following conditions:

- during initial setup
- following the SF-100 location has changed or the system has been bumped
- following adjustment of the internal system optics.

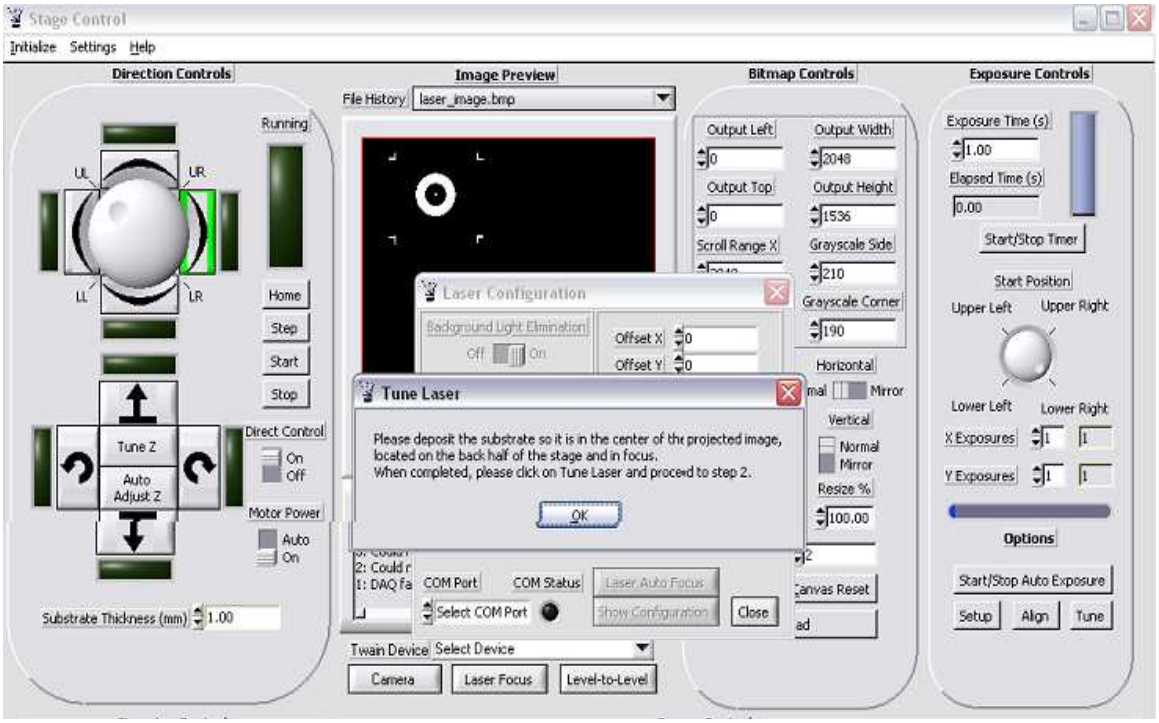
To setup the Laser Focus, click the "Laser Focus" button in the window below.



Verify "Laser Configuration" box is being displayed.

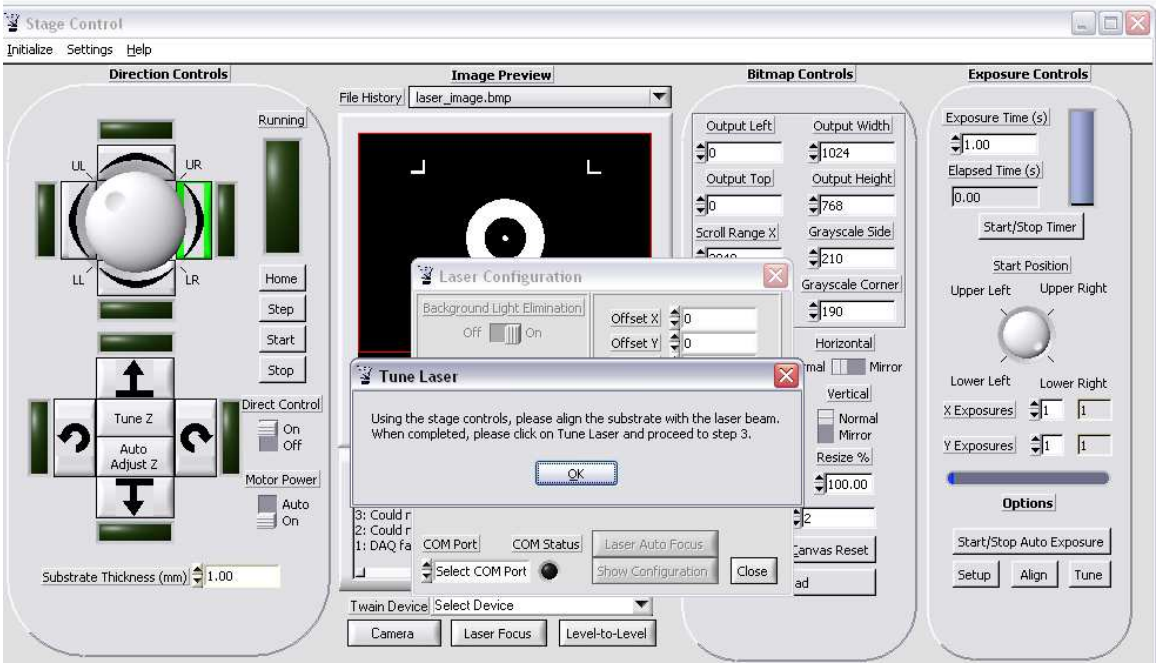
Click the "Tune Laser" button in the Laser Configuration box.

Once the "Tune Laser" button has been pushed the screen below will be displayed.



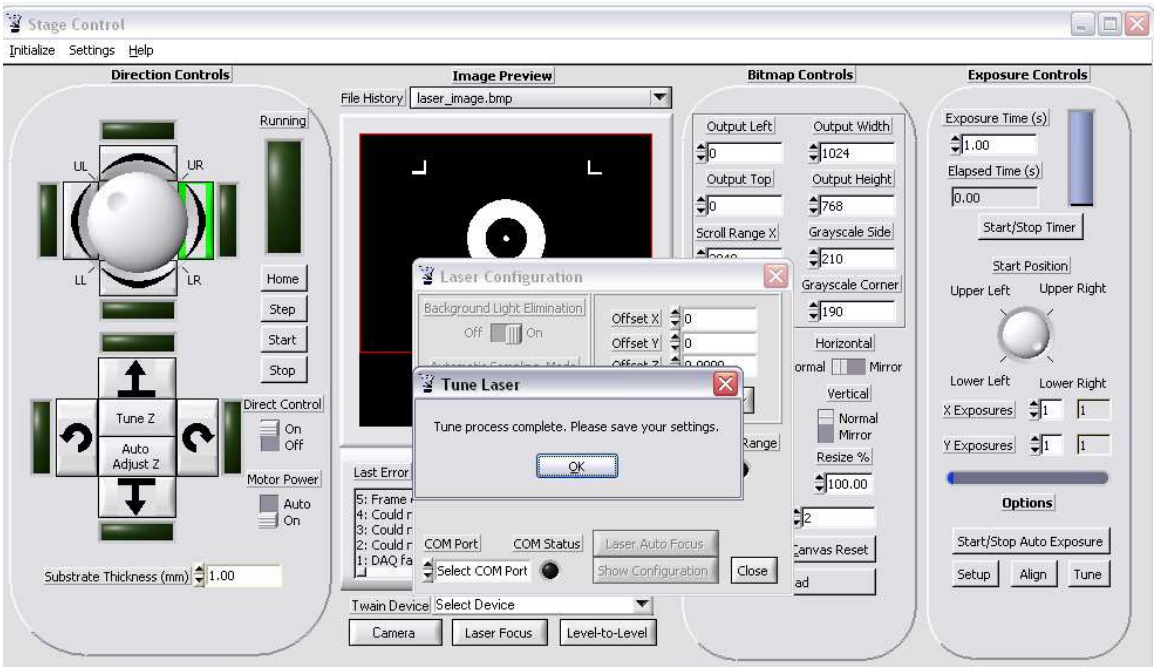
This is step one of the laser tune process. Click the "OK" button and Auto or manually focus the image on a glass specimen slide, placing the image on the back half of the wafer holder. This needs to be done to acquire the laser beam. Place a dot in the center of the bulls' eye for a reference to the laser beam only.

Once this step is complete, click the "Tune Laser" button and proceed to step 2.



The above screen is step 2 of the tuning process. Using the stage controls manually run the stage back and line the laser up with the dot on the specimen slide.

Once this step has been completed click the "Tune Laser" button and proceed with step 3.



The above screen is step 3of the tuning process. The tune process is complete using the save setting button listed below the preview pane

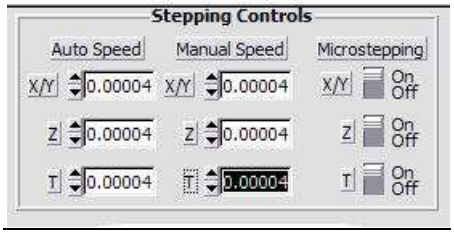
Once the laser has been tuned the "Laser Auto Focus" button can be used to focus the image.

Auto Stage™ Systems – Additional Features and Capabilities

Scanning down the list of topics in this section will allow for a quick introduction to features contained within each box/section of the Home Screen although many will be somewhat obvious by their labeling.

Stage Movement:

- **Stepping Controls section: STEP SIZE of Stage Movement**
  1. Microstep toggle switch changes by left-clicking either the switch or the desired words with the mouse pointer on them
     a. ON = 40nm per step with stage motors (when exposing)
     b. OFF = 320nm per step with stage motors (for gross stage movements only)



- **Stepping Controls section: SPEED of Stage Settings**

  1. Changing the Speed value, which is the seconds between steps, adjusts the estimated Move Rate, as indicated.
  2. By changing this value, movement *resolution* is also directly affected
     a. Faster speeds will make movements more coarse, best for large-feature-size images that do not require high resolution movements
     b. Slower speeds will make movements finer and more repeatable.
  3. Speed changes are made by highlighting the Speed box and entering a new value or by left-clicking the up/down arrows to adjust in 0.0010 steps up or down.
  4. A 0.00000 Speed value will set the speed control to an uncontrolled computer communication and processor speed limit, which depends on several variables. This is the fastest speed the axes can move and should only be used for general stage motion, but **not** during an exposure sequence. Recommended speed during exposure is .00004 with microstepping turned ON for all axes.

- **Stepping Controls section: Stage MOTOR POWER Setting**

  1. **AUTO** position removes power to the stage motors upon completion of a commanded movement. This position will likely suffice in most all stage movement conditions with the exception of manual STEP movements; the ON position is required for these. An error message will remind the user of this requirement.
  2. **ON** position leaves 25% power applied to all the motors upon completion of any movement as a holding torque. The holding force may be necessary if stage inertia is large enough to cause shifting after stopping a given motor. This condition is rarely needed except when single stepping and when optional 5µm optics are used.

- **Direction Controls section for Stage Movement**

  1. **Movement feedback**: Counters and Encoders
     a. **Counter Values**
        i. Values shown are relative to any starting position (0,0,0,0).
        ii. Values can be reset at any time to a new (current) starting position by clicking on the Range Controls Counter Reset button. All values will be simultaneously placed at zero.
        iii. Movements DOWN (Y-axis), RIGHT (X-axis), VERTICALLY-UP (Z-axis) or CLOCK-WISE (Theta-axis) will increase the counters and vice versa.
        iv. Counter errors (limit exceeded, etc.) will add a red frame to the window of the affected counter.

v. Error details will be shown in the error window.

b. **Encoder Feedback**

i. Encoder windows, which are located below the respective axes counter windows, reflect values relative to the cumulative angular rotation of the stage motors themselves.

ii. These values will not necessarily match the counter values but are monitored by *Auto Stage* for errors.

iii. When there are errors in correlated tracking between the counter and encoder, lack of power to a stage controller, shorts in wiring or motor stalls occur, these events will turn-on the red lights below the affected encoder indicators.

iv. Specific error details will be shown in the error window.

c. **Hardware "Home" auxiliary functions and feedback**

i. Inside the Range Controls and located to the left of the Counters and Encoders are rectangular lights and check-boxes.

ii. **The X and Y-axis check boxes** can be checked by left-clicking them. *NOTE*: This feature is ONLY available on these two axes if the stage motors being used are the PLG 10 (standard coarse) type.

1. Checking the box will enable the light next to it to turn green when the axis is moved, in the *proper* direction, all the way to an adjustable auxiliary "home" switch location.

2. *NOTE*: Moving *away* from these auxiliary hardware "home" switches will run the stage to the main Direction Controls limit and stop the motion.

3. Movement will stop at these "home" locations if the box is checked. If not checked, the light will become green but movement will not be halted.

4. This special switch might be user-adjusted to help quickly find the any given X or Y-axis position, as desired.

iii. **The Z-axis check box** can be checked by left-clicking it.

1. The functions are identical to the X and Y-axis, above.

2. This switch might be user-adjusted to help quickly find the optical focus point without having to hunt for it, as described below in (2.a.v.) **Z-axis**, if desired.

iv. **The Theta-axis check box** can be checked by clicking it.

1. The functions are identical to the X and Y-axis, above, except it is not an adjustable switch–it is embedded in the stage platform itself.

2. This fixed switch might be used to find a common "reset" point for providing the angular reference point of the Theta-axis stage location, if desired.

2. **Modes of Movement Control**

   a. ***Manual Mode***: indicated by placing the Range Controls section Direct Control toggle switch to ON by left-clicking with mouse on either the switch or the words ON/OFF

      i. Stage movement is initiated when a desired Direction Controls located direction mode button is selected and then the Home, Step or Start/Stop buttons are left-clicked. How each button affects movements is described in other sections below.

      ii. Direction of the stages is NOT relative to the image but is only relative to the SF-100 unit, in *this* mode.

      iii. The top rectangular Direction Controls button is for "UP" (**Y-axis**) and will set the movement mode of the stage from the Front toward the Back–away from the microscope–and decrease the counter, when initiated. The bottom Y-axis button is for "DOWN", sets movement mode opposite of UP and will increase the counter.

      iv. LEFT (**X-axis**) button will set the movement mode of the stage along the front plane of the SF-100 to the left and will decrease the counter. The RIGHT (X-axis) button is opposite along the same plane and will increase the counter.

      v. **Z-axis** or vertical movement buttons located in the lower set of Direction Controls will set the movement mode of the stage UP (increasing the counter) with selecting the top button or DOWN (decreasing the counter) with the bottom button.

         1) It is used solely to focus the exposure images onto the substrates and should be verified and re-adjusted when substrate thickness changes.

         2) Focus: Is verified using a fine one or two pixel line or dot in an image, a fine feature or scratch on the substrate (or equal-thickness plate or painted slide) for focal comparison using the microscope.

         3) Movement of this axis is disabled by Direct Control switch when in the OFF position.

      vi. **Theta-axis (θ)** or rotational movements about the top stage central vertical axis, are shown as right or left turning arrows on the lower set of Direction Controls, and are also disabled by Direct Control switch when in the OFF position.

         1) Clockwise rotation, as viewed from the top, increases the counter

         2) Counter-clockwise rotation decreases the counter

         3) This axis has no limit switches so counter values should only be used for relative references. Counter maximum is approximately 2×10^9

   b. ***Automatic Mode***: Is created by placing the Range Controls section Direct Control toggle switch to OFF by clicking with mouse on either the switch or the words ON/OFF and by using the Exposure

Controls Setup button to establish a fully automatic exposure operation.

i. Directions of movement, sizes of steps or exposures, starting point and sequence of "next" exposure location are selected in the Exposure Controls section in concert with the Setup button and are explained in detail below in **Automatic Exposure Setup**.

ii. Movement of the stage is *relative to the image* in this mode with the accepted knowledge that the computer image is left-right mirrored onto the stage/substrate horizontal plane.

c. ***Semi-Automatic Mode***: is similar to the Automatic mode (Direct Control = OFF and *image*-relative), but is a state wherein the stage movements are *manually*-initiated by using the Direction Controls button combinations.

i. Image-relative movement is requested by selecting the rectangular button which corresponds to the direction of X-axis (left-right) or Y-axis (up-down) movement desired.

ii. **START** and **STOP** are then selected, once the direction button is chosen to start and halt continuous movements.

iii. The stage will stop after it has proceeded the number of counts in the Scroll Range box corresponding to the direction chosen. This is also one (red) exposure frame amount.

iv. The speed with which the movement proceeds is controlled as described above under Stepping Controls: **SPEED**.

v. The START and STOP physically perform the following:

1) **UP** movement START commands move the stage to the "**right**" along the front plane of the SF-100, which is toward the top of the image.

2) **DOWN** is opposite–to the "**left**".

3) **RIGHT** movement commands move the stage "**away**" from the microscope, toward the back of the SF-100, which is toward the right side of the image.

4) **LEFT** commands move the stage "**toward**" the micro-scope.

5) **STOP** halts the active movement before it reaches the Scroll Range value, unless it is already stopped.

6) See Keyboard Shortcuts directly below under Sub-Modes, Step movements (2.a.iv) to view alternate means of movement initiation.

7) Depending on the values in the Range Controls "Move" boxes, the counters will not likely register a move on any single counter; rather, multiple counters will likely register the move.

3. **Sub-Modes** of stage movement control

a. ***Step*** movements are a single counter step-at-a-time in the chosen relative direction; the Motor Power switch needs to be ON for this.

i. Step movements are always relative to the SF-100 only. They are not affected by the position of the Direct Control switch

ii. Select a direction on a given axis (any of the 8 buttons).

iii. Select the STEP button once–or many times–to move in the desired direction on the chosen axis.

iv. Keyboard Shortcut for Direction: Shift-key with any of the arrow keys will highlight the corresponding X or Y axis Direction Controls movement mode button.

v. Keyboard Shortcut for Movement:

1) Then, Shift+Home will initiate START;

2) Shift+End will STOP and

3) Shift+Insert will perform a single STEP move.

vi. Microstep being ON or OFF (see **Stepping Controls**, above) and which optional stage motors are supplied will affect the actual physical size of each counter-registered step.

b. ***Home*** movement button has user-selectable quadrant corners and affects X and Y axes only

i. In the center of the X/Y axes upper controls, there is a round dial with a "dimple" in it. The SF-100-relative position of this dimple establishes which end-of-travel "home" is currently chosen as a destination.

ii. The dimple is moved by holding down the left mouse button with the pointer over the dial and moving the pointer in a circular fashion to rotate the dial. The pointer may start at any position on the dial.

iii. Once the dimple is located as desired and indicated by the UL (Upper Left), UR (Upper Right), LR (Lower Right) and LL (Lower Left) labels, the HOME button is selected to initiate the movement relative to the SF-100–not the image.

iv. First the X-axis will actuate to move the stage to the farthest point it can move toward the selected corner then the Y-axis will follow suit. Corresponding counters will verify this.

v. Both limit switches (yellow = "at limit") will light when their respective limits are reached. It is possible and common for the first one to shut off when the next axis begins movement.

Image Movement and Exposure Control:

- **Bitmap Controls: Exposure Sizes**

1. **Output** = Exposure (Red) Frame (Maximum 1024 X 768)

a. **Output Left** is the relative left-side X-axis starting point of the image that will be presented onto the substrate by the *Smart Filter* output. It is usually "0" but may be any positive number <1024. Values larger than zero will reduce the maximum width (1024 pixels) of the exposure area.

b. **Output Width** is the right-side location of the exposure frame relative to the Output Left plane. It may be any positive number but must be larger than "0" to have an effective exposure image.

c. The sum of the Left and Width numbers must be less than 1024. Any excessive area beyond that amount will not be part of the Smart Filter exposure output.

d. **Output Top** is the relative upper-side Y-axis starting point of the image that will be presented onto the substrate by the *Smart Filter* output. It is usually "0" but may be any positive number <768. Values larger than zero will reduce the maximum height (768 pixels) of the exposure area.

e. **Output Height** is the lower-side location of the exposure frame relative to the Output Top plane. It may be any positive number but must be larger than "0" to have an effective exposure image.

f. The sum of the Top and Height numbers must be less than 768. Any excessive area beyond that amount will not be part of the Smart Filter exposure output.

2. **Scroll Range X and Y**

a. **Scroll Range X** is the size of the "macro" step or exposure frame movement to either the left or right, relative to the image and last frame location, that either the auto-exposure uses for subsequent exposures or that the arrow-keys will move the image.

b. **Scroll Range Y** is the up or down equivalent of the "X" scroll range described above.

c. **Overlap** of adjacent exposure frames is controlled by the arithmetic differences of the Output Width or Height to the Scroll Ranges of X or Y, respectively.

i. If overlap is desired, then the Scroll values should be less by the amount of overlap desired.

ii. If overlap is NOT desired, then the Scroll values should match (not recommended) or be larger than the corresponding Output values if exposures are adjacent to one another.

iii. For multiple exposures of the same small image, Scroll values can be set more than Output values as is needed.

3. **Canvas Reset function**

a. Canvas Reset button, located at the bottom of the Bitmap Controls section will make Output Left and Top boxes read zero (0).

b. It will also make Output Width and Height boxes read the maximum that the available Full Screen (Monitor 1, Draw) has available. This is normally 1024 and 768, respectively but may be reduced if special "Always-on-top" program bars (task bars) occupy portions of the screen.

c. Scroll Range X and Y boxes will also be reset to match the Output Width and Height boxes, respectively at maximum screen values.

- **Bitmap Controls: Keypad Shortcut Exposure/Image Movements**

1. **Image and exposure frame viewing**:

a. Left-click mouse pointer anywhere in the viewing window to highlight (wide green frame) for image movement authorization.

b. Click a button or data box outside of the window to de-highlight and resume normal key-command functions

2. **Full-screen close-up viewing** of exposure image limits and grayscale
    a. Keyboard shortcuts are always active in full screen view. This view is available by clicking the DRAW button in Bitmap Controls after selecting Monitor "1" from the Monitor List.
    b. ESC key returns to Home Screen display and window viewing of image and exposure frame (red square)

3. Keyboard Shortcuts: Arrow keys

a. Moves image relative to view and exposure frame
    i. Opposite-feel of familiar page-scroll response
    ii. With an image smaller than the exposure frame, image appears to move in the direction of the arrow relative to the red exposure frame.
    iii. With an image larger than the red exposure frame, the exposure frame itself appears to move *opposite* of the selected arrow key.
    iv. Moving the image off the viewing window will shrink the viewing *scale* to keep all elements in-view and in-perspective.

4. **Insert key** toggle (ON/OFF)
    a. The default condition makes macro-step movements per configured (Scroll Range vs. Output sizes) exposure frame with arrow key strokes.
    b. Toggle of Insert key makes *micro*-step movements in selected direction. Size of Microstep is one pixel. Toggling it again puts it back into the "macro" step mode.

5. Home Key

a. Moves image to the lower-right so that red exposure frame is positioned flush with the upper-left corner of overall image.

- **Grayscale exposure image splicing – viewing and application**

1. When exposing more than one segment of a larger image, Grayscale options ensure that exposures of adjacent areas are handled without lines or gaps in adjacent exposures.
2. Grayscale exposure levels
    a. **Grayscale Side**: Double-exposures of sides and top/bottoms sets exposure for ½ of value needed for single-shot exposure
        i. Value varies with several variables but a 200 value is common starting point.
    b. **Grayscale Corner**: Quad-exposure (maximum) for corners of adjacent exposures sets exposure for ¼ (max.) of value needed for single-shot exposures.
        ii. Value varies with several variables but a 180 value is common starting point.
    c. Grayscale values represent graphic scale levels of grayscale, not exposure percentages nor relative time.
        iii. 0 = Fully black or no exposure

iv. 255 = Fully white or full exposure

v. Successful exposure with any given set of variables with a specific process requires experimentation to determine optimum values and margins of error.

3. **Viewing grayscale bars** on the exposure image for verification or fine-tuning their locations:

   a. Standard numerical keypad selects location of gray areas to display on full-screen display (Draw)–top, left, right or bottom–or all

      i. 8 adds gray indication to top of screen, if present

      ii. 4 adds gray indication to left-hand side of screen, if present

      iii. 6 adds gray indication to right-hand side of screen, if present. In this full-screen view; next step to right may show this area on its left-hand side instead.

      iv. 2 adds gray indication to bottom of screen, if present in this view. Stepping down may show this area on its top side.

      v. 5 adds gray indications to all viewable and applicable sides

      vi. Function key "F5" clears all gray from the image being shown

   b. If using a laptop or no separate keypad is available, number keys along top of keyboard provide the same function per above.

- **Bitmap Controls: Image and Background changes**

  1. **Invert Colors** switch performs a "reverse video" on the image as a whole–white becomes black, etc.. It does not alter the original file, just the loaded image. The switch is changed by clicking on it or the desired ON or OFF condition.

  2. **Horizontal–Normal or Mirror** switch allows a reversal to compensate for the optical left-right mirror presented to the substrate relative to the loaded image. The image will now appear mirrored but the exposure image will match the original file. Again, the switch is changed by left-clicking on it or the desired condition word.

  3. **Vertical–Normal or Mirror** switch works the same as the Horizontal mirror switch except it alters the up-down perspective, as desired.

  4. **BG Color** is a window where the background color surrounding the loaded image is controlled by clicking inside the box, selecting a new color and clicking that. Remember that black is "no exposure" and white is "full exposure"

Level-to-Level Alignment:

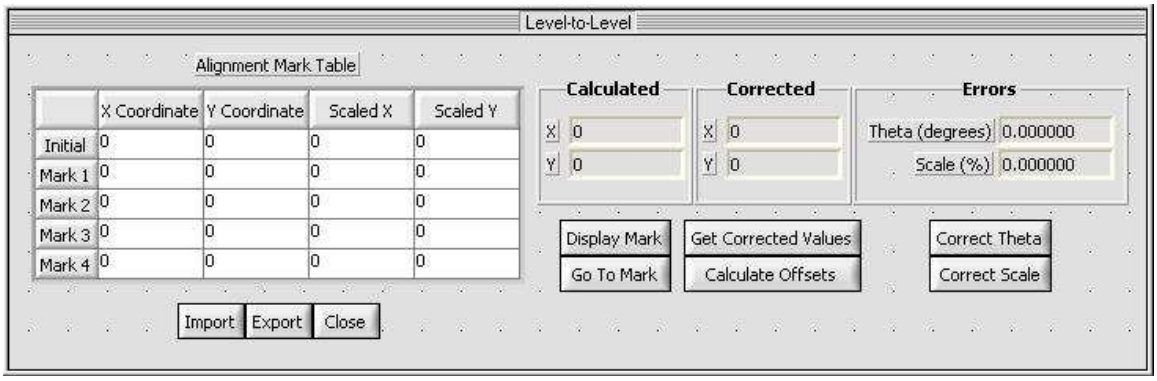
In the event a customer requires the ability to realign a previously exposed substrate for additional patterning, the process below can be used to accomplish this task. A minimum of three alignment marks are required on the substrate and bitmap file (for projected image) to accomplish this re-alignment.

1. Center and orient the substrate as close as possible to the original location on the substrate chuck.

2. Activate vacuum hold on the substrate chuck.

3. If not already completed, run the "Auto Stage Setup" presented earlier in this document.

4. From the main Auto Stage screen, open the "Level-to-Level" Alignment control window.



NOTE: The coordinates for the Initial alignment mark in the table above will be populated. These values should not be modified.

5. Beginning at the upper left of the computer screen, enter, in pixels, the coordinates of the four alignment marks located on your bitmap file. Alternatively, you may import a text file containing these values.

6. Select "Mark 1" then "Display Mark" then "Go To Mark"

7. Verify "Direct Control" is on before proceeding. Using the joystick control, move the stage and align the projected image Mark 1 with the equivalent mark on your substrate.

8. Select "Mark 2", "Display Mark", then "Go To Mark"

9. Using the joystick control, move the stage and align the projected image Mark 2 with the equivalent mark on your substrate.

10. Select "Get Corrected Values" then "Calculate Offsets".

11. If projected and substrate marks are not aligned, select "Correct Theta" then "Correct Scale".

12. After Correcting for Theta, verify marks are still aligned. If not, move the stage using joystick control to re-align the marks.

13. Select "Mark 3" then "Display Mark" then "Go To Mark".

14. <u>If projected and substrate marks are aligned</u>, alignment is complete and no further action is required.

15. <u>If projected and substrate marks are not aligned</u>, select "Correct Theta" then "Correct Scale".

16. After Correcting for Theta, verify marks are still aligned. If not, move the stage using joystick control to re-align the marks.

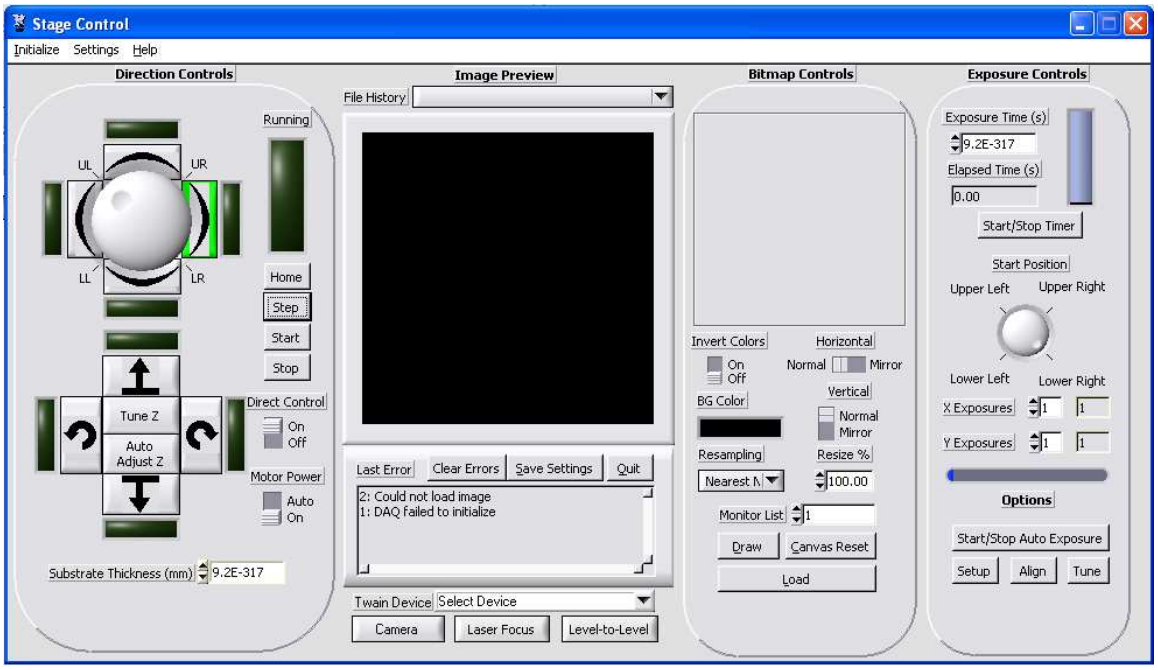
17. To verify projected and substrate marks are aligned, select "Mark 4", "Display Mark", then "Go To Mark". The projected and substrate marks should be aligned and you may exit the Level-to-Level Alignment Control screen and proceed to the exposure steps.

18. Click on "Initial", "Display Mark", then "Go to Mark" to return to Auto Start Position.

19. If you wish to save the alignment marks for future use, click "EXPORT" and save the file before closing the Level to Level window.

20. Close the Level to Level window and proceed with auto exposure.

Camera Controlling:



To view the image through the camera using the Auto Stage program click the "Camera". The Motic MC Camera 1.1 program will open.
To get a image that is crisp and sharp your will need the manipulate one of the listed setting or all of them.

- Gain
- Exposure
- Sharpness
- Color Correction
- Gamma

The Auto Stage Axis can be run and the camera can be viewed simultaneously by minimizing the Motic Camera and selecting the appropriate needed axis. Doing this will bring the image into focus.

Maintenance

In order to ensure outstanding operation of the system, the following routine maintenance procedures must be utilized at the time intervals indicated.

Cable, Connector and Enclosure Maintenance:

- Ensure that all connectors and cables are free of kinks, tears or cuts on a periodic basis.
- Always use care when removing or replacing the unit cover in order to avoid disconnecting, pinching or breaking the wires connecting the cover to the main body.
- Wipe off the SF-100 enclosure (cover) as needed using a dry, soft cloth. Do not use solvents or cleaners for this, as these chemicals may destroy the finish on the system.

Lamp Maintenance:

- To maximize light source life, the source should be turned off when the system is not in use.
  - Turn the light source on or off by depressing the LAMP button located on the front of the SF-100 system or by activating the lamp in the Lamp Control program.
  - When the light source is turned on, it will require 20 minutes to stabilize before using the system.
- The light source needs to be replaced at a maximum of 1100 hours of use. This is the longest time that a lamp should be run. Critical processes may require that the light source be changed more frequently. See "Replacing the Lamp" in the next section for lamp replacement instructions.
- Check the exposure energy at the substrate surface using a handheld exposure meter on a regular basis. If you do not have an exposure meter, Intelligent Micro Patterning can make a recommendation or supply you with one for a nominal charge. Contact us for more information and a quote.

Replacing the Lamp:

1. Turn off the lamp by depressing the "LAMP" switch at the front of the SF-100 or by accessing the Lamp Control Program.
2. Turn off the SF-100 using the switch on the inlet power module (see figure 5) and disconnect the power cable from the electrical outlet.
3. Wait a minimum of 60 minutes for the lamp to cool prior to continuing.
4. Remove the (5) five UNC # 6-32 flathead screws holding the lamp access panel in place on the back of the unit. See figure 5 below.

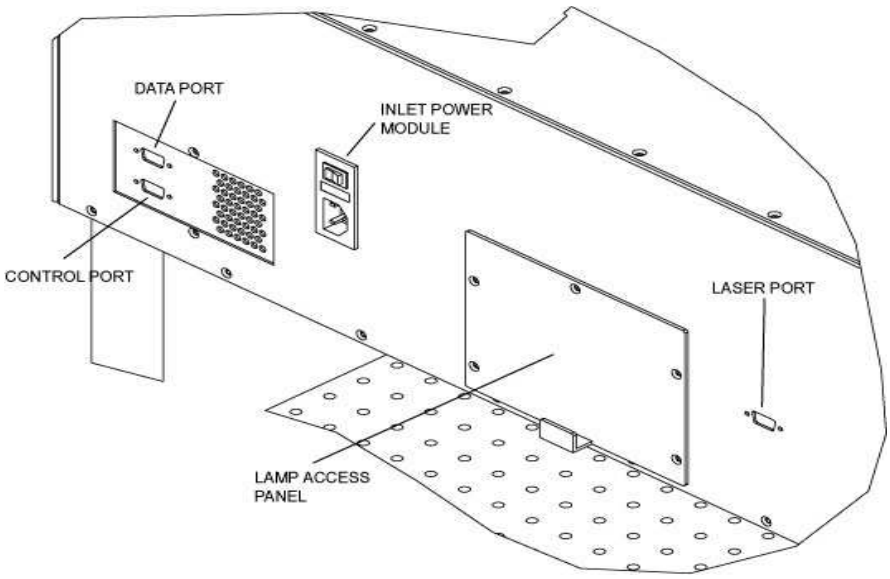


Figure 5: Rear View of SF-100 Maskless Photolithography System

5. Remove the lamp access panel from the SF-100.

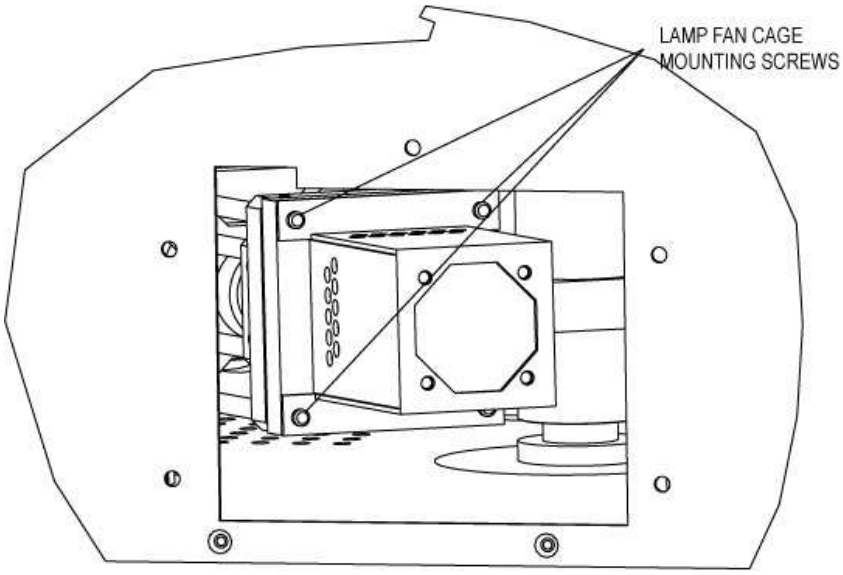
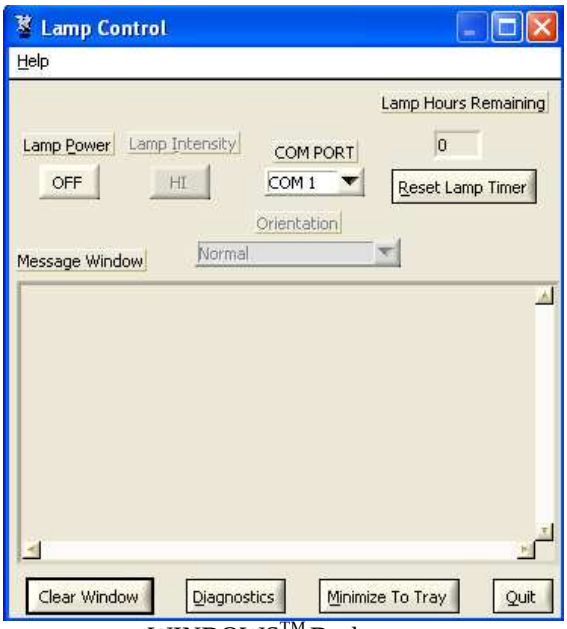


Figure 6: Internal Rear View of Lamp Assembly

6. Disconnect the lamp fan by gently separating the mating connectors.
7. Using a Phillips screwdriver, carefully remove the (4) four UNC #4-40 Phillips pan head retaining screws holding the lamp fan cage in place at the beginning of the optical path.
8. Carefully remove the lamp fan cage assembly from the rear of the system.
9. Disconnect the old lamp by gently separating the lamp power connectors.

10. Using lint-free gloves to prevent getting fingerprints on the lamp, remove the old lamp assembly and replace it with a new lamp assembly. Do not forget to reconnect the lamp power connectors.



11. Replace the lamp fan cage assembly, ensuring the lamp power cable is positioned in the slot at the bottom. Secure the fan assembly to the rear of the lamp assembly using the (4) four UNC # 4-40 Phillips pan head screws removed earlier.

12. Reconnect the lamp fan mating connectors.

13. Replace the lamp access panel onto the SF-100 using the original (5) five screws that hold the panel in place.

14. Turn on the SF-100 using the switch located on the inlet power module at the rear of the unit.

15. Reset the lamp timer by accessing the Lamp Control Program located on the WINDOWS™ Desktop.

16. Turn on the lamp by depressing the "LAMP" switch on the front of the unit or through the Lamp Control Program.

Replacing the UV Filter Assembly:

1. Turn off the lamp by depressing the "LAMP" switch located on the front of the SF-100 or through the Lamp Control Program
2. Turn off the SF-100 using the switch on the inlet power module at the rear of the unit.
3. Disconnect the SF-100 main power cable located on the inlet power module at the rear of the unit, from the electrical outlet.
4. Using a Phillips screwdriver, remove the screws holding the system cover in place.
5. Carefully remove the system cover, making certain you do not damage the cables connecting the cover to the SF-100 body. Set the cover on its side at next to the SF-100. You are not required to disconnect the cover cables.
6. Using lint free gloves or being careful not to touch the filters, remove the two screws and washers (see figure 7) securing the UV Filter Assembly to the shutter control valve arm. You may wish to lift the assembly slightly for better access to the screws.

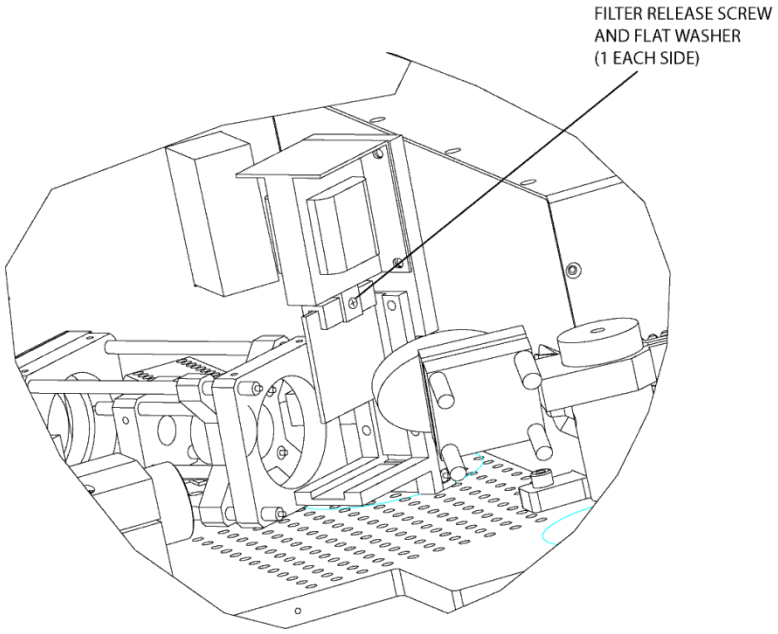


Figure 7: UV Filter Assembly Replacement

7. Lift UV Filter Assembly and remove from shutter control valve arm. Be careful when doing this as the arm will drop once not supported.
8. Re-insert shutter valve arm into slot and place new UV Filter Assembly on shutter valve arm. Secure using two screws and two flat washers. Note: If flat washers are not used, screws may bottom out on filters and cause damage.
9. Replace the system cover and all screws.
10. Reconnect power to SF-100.

Optical Component Maintenance:

- If the SF-100 is not used in a clean room environment, the lenses and mirrors may become dirty and require cleaning. If necessary, lens paper with methanol or lens cleaning solution may be used to clean the lenses. To effectively clean the lenses internal to the pre-Smart Filter light path, they must be removed from the system. Please contact Intelligent Micro Patterning for assistance in removal, cleaning and replacement of these components if necessary.

WARNING: Use of flammable materials near heat or electricity can cause fire or explosion. Ensure power is disconnected and all surfaces are cool before cleaning.

Lubrication of Auto Stage:

- This procedure shall be performed on a strict 6-months basis to ensure that accuracy, repeatability and resolution are maintained within IMP and stage manufacturer's specification tolerance.
- If conditions of service warrant (high usage, spills, suspended particulates, dirt or vapors are common, etc.), this frequency may need to be increased.
- Included in the documentation package will be stage manuals from the stage manufacturers.
- Please find the corresponding manual pages relating to lubrication and follow the cleaning and lubricating process for each of the four axes.
- Each manufacturer has different requirements, lubricants and procedures. It is essential that they be followed explicitly.

Calibration (Align and Tune) of Stages:

Calibration of the stages is required under the following circumstances:

- Initial Setup
- If the system has been jarred, moved or bumped
- Following the 6-month interval for the required cleaning and lubricating process.

To recalibrate the stages, follow the Align and Tune procedure located in the Auto Stage Setup section of this user guide.

Replacing the Smart Filter:

1. Turn off the lamp by depressing the "LAMP" switch located on the front of the SF-100 or by accessing the Lamp Control Program from the WINDOWS™ desktop.
2. Turn off the SF-100 using the switch on the inlet power module at the rear of the unit.
3. Disconnect the SF-100 main power cable located on the inlet power module at the rear of the unit, from the electrical outlet.
4. Using a Phillips screwdriver, remove the screws holding the system cover in place.
5. Carefully remove the system cover, making certain you do not damage the cables connecting the cover to the SF-100 body. Set the cover on its side at next to the SF-100. You are not required to disconnect the cover cables.

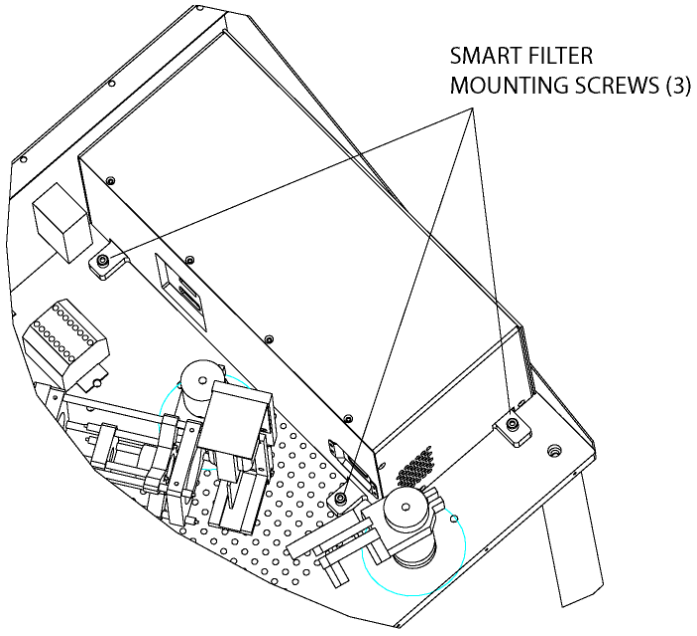


Figure 8: Internal View of Smart Filter Sub-assembly

6. Remove the (2) two UNC #6-32 Phillips flat head screws on the back panel near the data port.
7. Detach the (4) four input connectors located on the left side of the smart filter near the terminal block. These connectors are keyed and unique to prevent incorrect re-insertion.
8. Using a 3/16" Allen wrench, remove the (3) three ¼ -20 socket head cap screws that attach the Smart Filter sub-assembly to the unit base.

9. Replace the Smart Filter unit. Do not attempt to repair the Smart Filter sub-assembly. Only factory authorized personnel are fully trained on the Smart Filter operation and maintenance. NOTE: OPENING THE SMART FILTER WILL VOID YOUR WARRANTY.
10. Replace the three ¼-20 socket head cap mounting screws that attach the Smart Filter sub-assembly to the unit base.
11. Re-connect the (4) four input connectors located on the left side of the Smart Filter near the terminal block. These connectors are keyed and unique to prevent incorrect re-insertion.
12. Replace all system covers, being certain to use all supplied screws. Eliminating screws can cause EMI (electromagnetic interference) compatibility issues.
13. Plug the main power cable for the SF-100 into the electrical outlet.

Replacing the System Cooling Fan:

1. Turn off the SF-100 using the switch at the rear of the unit. Disconnect the main power cable that powers the SF-100 unit from the electrical outlet.
2. Remove the system cover.
3. Disconnect the power cable from the cooling fan.
4. Remove the (2) two ¼-20 socket head cap mounting screws that attach the cooling fan mount to the base.
5. Remove the fan and finger guard from the mount by removing the 4 sets of UNC #6-32 x 2" screws and washers.

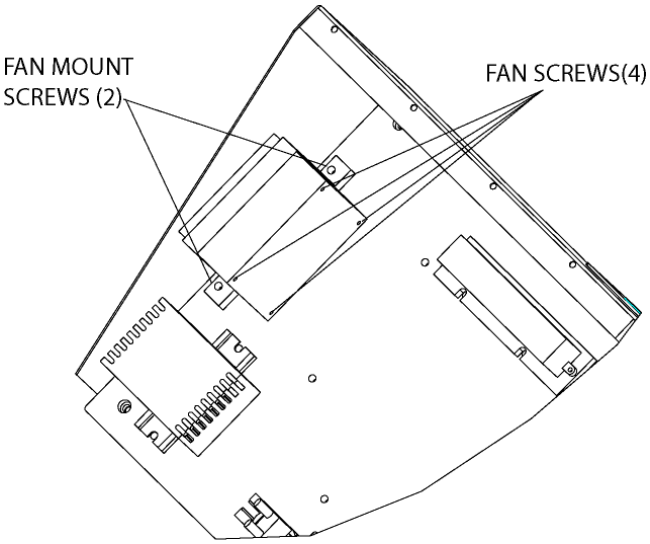


Figure 9: Top View of System Cooling Fan-Baffle Assembly

6. Secure the new fan and finger guard on to the mount with the air flow indication arrow directed outward from the unit utilizing the appropriate mounting screws.
7. Making certain the fan wires are not pinched under the fan or mount, secure the assembly to the base using the (2) two UNC ¼-20 socket head cap screws previously removed. When positioned correctly, there should be a gap (~1/2") between the fan mount and unit side panel. Incorrect mounting of the fan may result in lamp shutdown during system use.

8. Reconnect cooling fan power cable.
9. Replace the system cover and fasten all screws.
10. Connect the main power cable for the SF-100 into the electrical outlet turn on the unit, and check air flow from the fan. Air should be blowing OUT of the system. If airflow is directed INTO the system, remove the cover and reorient the fan properly.

Common Problems & Solutions

The following table describes problems that may be observed on the SF-100 and some common solutions for these.

Problem	*Check These Items*
Unit Doesn't Turn On	• Power may be disconnected. Verify power cord is plugged into wall outlet. • Fuse may be blown or missing. Check fuse status. If needed, replace only with fuse supplied by Intelligent Micro Patterning.
Lamp Doesn't Turn On	• The supplemental cover interlock switches may be open. Verify that the system and lamp access covers are in place. • The lamp usage may have exceeded the 1100 hour limit. This would have been indicated by a warning message in the Lamp Control program. See above lamp replacement procedure. • Ensure that the fans are turning when the unit is powered on and airflow is directed OUTWARD. • Make sure that all ventilation areas around the unit are open and allow for proper air flow. • If using the Lamp Control Program to turn on lamp, make sure the cable connection is secure.
MS Paint will not work	• Verify all cables are in place and the computer is turned on BEFORE the SF-100. If powered up in this sequence, MS Paint will work.

Problem	*Check These Items*
No Image Appears at Substrate **No Image Appears at Substrate (cont')**	• Check the Data Port Cable connection to see if it is loose. • Check to see the computer has monitors set to the correct display mode.
Projected Image is Mirrored from Image on Computer Screen	• To correctly orient the projected image for exposure, flip the image in the Lamp Control or Auto Stage Programs.
Cannot View Projected Image on Silicon Substrate	• Verify at least 7um of photoresist is on substrate. This minimum thickness is required for optical scattering. • Reduce localized ambient light levels.
Image is Not Exposing	• Image may not be projecting onto the substrate. Verify that data cable is attached from the computer to the SF-100 unit. • Exposure time may be too short. Increase exposure time. • Ensure that the exposure filter is moving out of the optical path during exposure using the UV meter supplied with the spare parts kit. Correct operation is indicated by high levels of UV detected by the meter during the substrate exposure. • The photoresist or developer may be beyond its expiration date or been exposed to light or heat prior to use on substrate. Verify the photoresist and developer is within its usable lifetime and has been stored properly. • Other processes to check include the coating, baking, and developing part of the photoimaging process.
Image Appears to be Overexposed	• Exposure time may be too long. Reduce exposure time. • Verify that all covers are in place on the SF-100. Failure to have all covers in place may result in stray light from the optical path being projected onto the substrate.

Specifications

The following section provides technical information about the SF-100.

- **Input Power**: 100-120/200-240 VAC 50/60 Hz
- **Input Current**: 3.3A (100-120 VAC)/1.6A (200-240 VAC)
- **Dimensions**: 36.0" W x 24.0" D x 19.5" H
  91.44cm W x 60.96cm W x 49.53cm H
  (Note: dimensions vary with customization)
- **Weight**: 175lbs (79.5kg)
- **Operational Temperatures**: 41 to 82 deg F (5 to 28 deg C)
- **Operational Humidity**: 30-50%, non condensing
  (for effective resist processing)
- **Regulatory**: Conforms to applicable CE directives and Norms

The following section provides technical information about the optional Auto Stage.

- **Input Power**: 100-120/200-240 VAC 50/60 Hz
- **Input Current**: 0.7A (100-120 VAC)/0.4A (200-240 VAC)
- **Dimensions**: 16" W x 6.75" D x 16" H
  41cm W x 17cm W x 41cm H
- **Weight**: 45lbs (20.5kg)
- **Operational Temperatures**: 41 to 82 deg F (5 to 28 deg C)
- **Operational Humidity**: 30-50%, non condensing
  (for effective resist processing)
- **Regulatory**: Conforms to applicable CE directives and norms

Corporate Contact Information

The following contact information should be used if there are any questions on the materials contained in this manual:

Intelligent Micro Patterning, LLC
1922 Illinois Avenue Northeast
St. Petersburg, FL 33703
(T) 727-522-0334
(F) 727-522-3896
info@intelligentmp.com
www.intelligentmp.com

Appendices

Appendix A

Commonly Required Spare Parts:

A new SF-100 system requires very little maintenance and as a result there are few spare parts needed. Commonly used spare parts are listed below:

- SP-1: Replacement lamp assembly