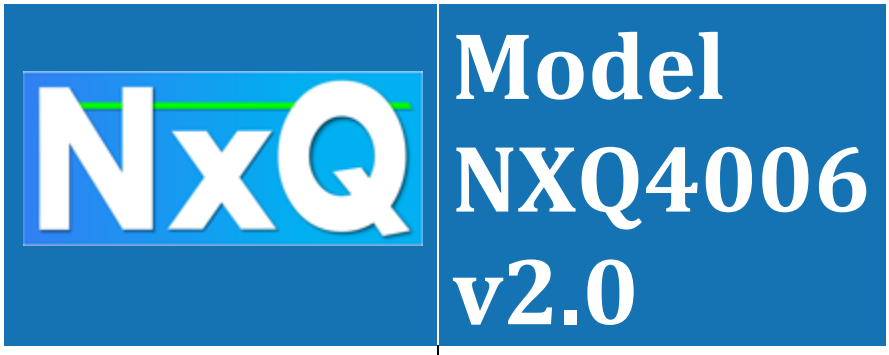

Model NXQ4006 v2.0

Neutronix-Quintel
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2016

OPERATION MANUAL

Neutronix-Quintel Mask Aligner

Model NXQ4006

NXQ 4006 Version 1

NXQ 4006 Version 2

About NxQ

Neutronix-Quintel is located in Morgan Hill, CA. Established in 1978 to provide an alternate source for OEM level product support for the Canon, Kasper and Cobilt brands of contact mask aligners, **NxQ** supplied a reliable source of spare parts, field service, and factory rebuilds for the equipment that the industry relied on for much of its production.

Almost immediately, it became obvious that engineered retrofit assemblies were required to improve reliability, increase flexibility, and reduce down-time for these units if they were to meet the needs of an ever more competitive industry. Utilizing the many years of industry experience of the founding personnel, **NxQ** introduced a series of ground breaking improvements for these older machines. In 1988, **NxQ** offered the first in a series of new designs for improved and expanded capability in contact and proximity class mask aligners.

Today, **NxQ** is a leading producer of reliable, high performance, and low maintenance contact and proximity mask alignment systems. Our systems are used by device manufacturers worldwide, with a large established base throughout the US, Asia, and Europe.

The Engineering staff works closely with the sales and support personnel to continually implement the customer's special requirements. **NxQ's** techniques for modular design lend themselves to creating easily customized instruments that may be configured to meet widely varying material handling and exposure requirements. Through this form of support, **NxQ** is meeting the customer's current needs while designing systems tailored for the products of tomorrow.

Warranty and Service

Every **NxQ** mask alignment system is protected by a one year limited warranty and is backed by our worldwide customer support network.

For warranty service or information contact **Neutronix-Quintel** at:

Tel: 408-776-5190
Fax: 408-776-1039
www.neutronixinc.com

When contacting the factory or its representatives regarding any problem encountered, please be ready to provide the following:

- Model number of the machine
- Serial number of the machine (please refer to the identification label at the rear of the machine for this number)
- Specific part numbers of the items causing trouble, when applicable
- Any relevant configuration information (for example: options installed, type of mask holder, and chuck style being used)
- Detailed information relating to the problem (when it occurs, what happens while it occurs, etc.)

The more details you provide when reporting an issue with your machine, the faster and easier it will be to resolve the problem.

Table of Contents

Safety

The NXQ4006 Mask Aligner is designed to be inherently safe to use. However there are several areas which may be of concern if certain rules are not observed.

Please refer to the **Maintenance** manual for discussions of special tools which should be provided to personnel working with and maintaining this equipment to minimize the potential hazards.

IMPORTANT: Disconnect the main power to the aligner and call for service if the unit has:

- Been exposed to water
- Had liquid spilled on it
- Sustained any physical damage

Physical Hazards

In normal operation, **high temperatures** may be encountered in two areas:

- In close proximity to the lamps used to provide illumination to the microscope
- In the ultraviolet lamp system which provides the exposure light to the wafer after alignment.

Caution must be exercised by maintenance personnel when replacing these lamps, primarily by turning the power off and allowing 10 to 20 minutes for the metal surrounding the light source to cool to levels which will allow safe handling. Even after cooling down contact all parts with extreme caution.

The mercury short arc lamp in the optical head on very rare occasions may explode. This usually occurs on start- up, when thermal and mechanical stresses are at a maximum. For this reason the lamp should never be started without the cover in place, and safety glasses should be worn when adjusting the lamp with the cover off.

Install cover before starting the UV lamp

Electrical Hazards

All exposed electrical contacts within the aligner housing are at a voltage level low enough to permit accidental contact without danger. However, 120/220VAC voltage is present at the DC power supplies, **which must never be removed without insuring that all power sources to the aligner have been disconnected.**

The wire leads to the mercury short arc ultraviolet lamp do not present a hazard during normal operation or during the time that the lamp cover is removed for adjusting the lamp position for ultraviolet illumination tuning. **However, these wires do carry dangerously high voltages during the few seconds that the "START" switch on the ultraviolet lamp power supply is pressed for startup**. For this reason, as well as for physical protection during the initial start-up period for the lamp, the outer lamp house cover must be in place during the startup. Personnel other than the one actually performing the maintenance work should be cautioned to stand back during the start-up.

Environmental Hazards

The only environmental hazard presented by the NXQ4006 is the ozone gas generated in very small quantities by the ionization of the cooling air surrounding the mercury short arc lamp. The cooling air from the lamphouse is removed by the cooling fan attached to the rear of the aligner by a flexible tube; the exhaust of this fan is normally open to the surrounding air and is removed by the normal air exchange in the cleanroom. The amount of ozone generated by the smaller size (350 or 500 watt) ultraviolet lamps is usually very low; if the aligner is equipped with one of the higher wattage (1000 watt) exposure systems, or with a deep ultraviolet light source it might be advisable to connect the cooling fan to a house fume exhaust system.

In the case of a mercury short arc lamp exploding, or being dropped and broken, very small quantities of metallic mercury are liberated. Normal mercury recovery techniques should be utilized to contain this very rare hazard.

Visual Hazards

The standard exposure illumination source in the NXQ4006 Aligner is a mercury short arc ultraviolet lamp which emits radiation that is extremely dangerous to the eyes. The ultraviolet radiation causes the same problems which are experienced by snow sports participants who do not wear eye protection.

It is vital that these rigid safety precautions are observed when working around the lamp:

- **The lamp housing must be in place before the lamp is turned on and started**
- **Never allow direct radiation from the lamp to hit the eyes**
- **Never place a white or metallic reflective surface where it may reflect the light into the eyes**
- **Never place flammable material in the optical path of the mercury arc lamp. When focused, this lamp will ignite paper in seconds.**
- **Be aware of your fellow co-workers and protect them**

Safety glasses must always be worn when working around the ultraviolet mercury short arc light.

If, for any reason, direct observation of the output of the mercury lamp is necessary, do so only with adequate eye and face protection, preferably a welder's hood with SHADE 12 filters.

Whenever working around the mercury short arc ultraviolet lamp to change the bulb or to measure and adjust intensity levels, it recommended that minimal eye protection be worn. The most practical form of protection is light brown safety glasses, with wrap-around protection, which filter out harmful infrared and ultraviolet radiation without reducing visibility.

There are two sources for this type of protection: welder's equipment sellers offer true safety glasses of this type, which arc welders normally wear under their hoods for protection against eye damage before they drop their hoods for actual welding, or quite adequate protection may be obtained from high quality glasses of the type worn for snow sports, which are designated for ultraviolet and infrared blocking. In either case, check the specifications carefully before trusting your eyes to the glasses and never trust this type of protection for direct exposure to the lamps arc.

Introduction

The NXQ4006 Mask Alignment System is an integrated optical-mechanical, pneumatic-electrical machine that aligns and exposes substrates coated with photoresist. The substrates are usually silicon wafers, but they can also be made of glass or other materials. The substrates are accurately aligned to a mask and then exposed with ultraviolet radiation to transfer the pattern of the mask to the substrate. The substrates are then processed further to become a semiconductor or other microelectronic device.

The operator can learn to use the machine in a few hours. The entire mask alignment procedure is designed for fast, convenient operation.

The Mask Aligner consists of several coordinated, interrelated systems. These include the substrate loading and unloading system; the mask supporting system; the align system; the viewing system (microscope and illuminators); and the exposing system. Each of these systems will be briefly described in this introduction, an overview of the NXQ4006.

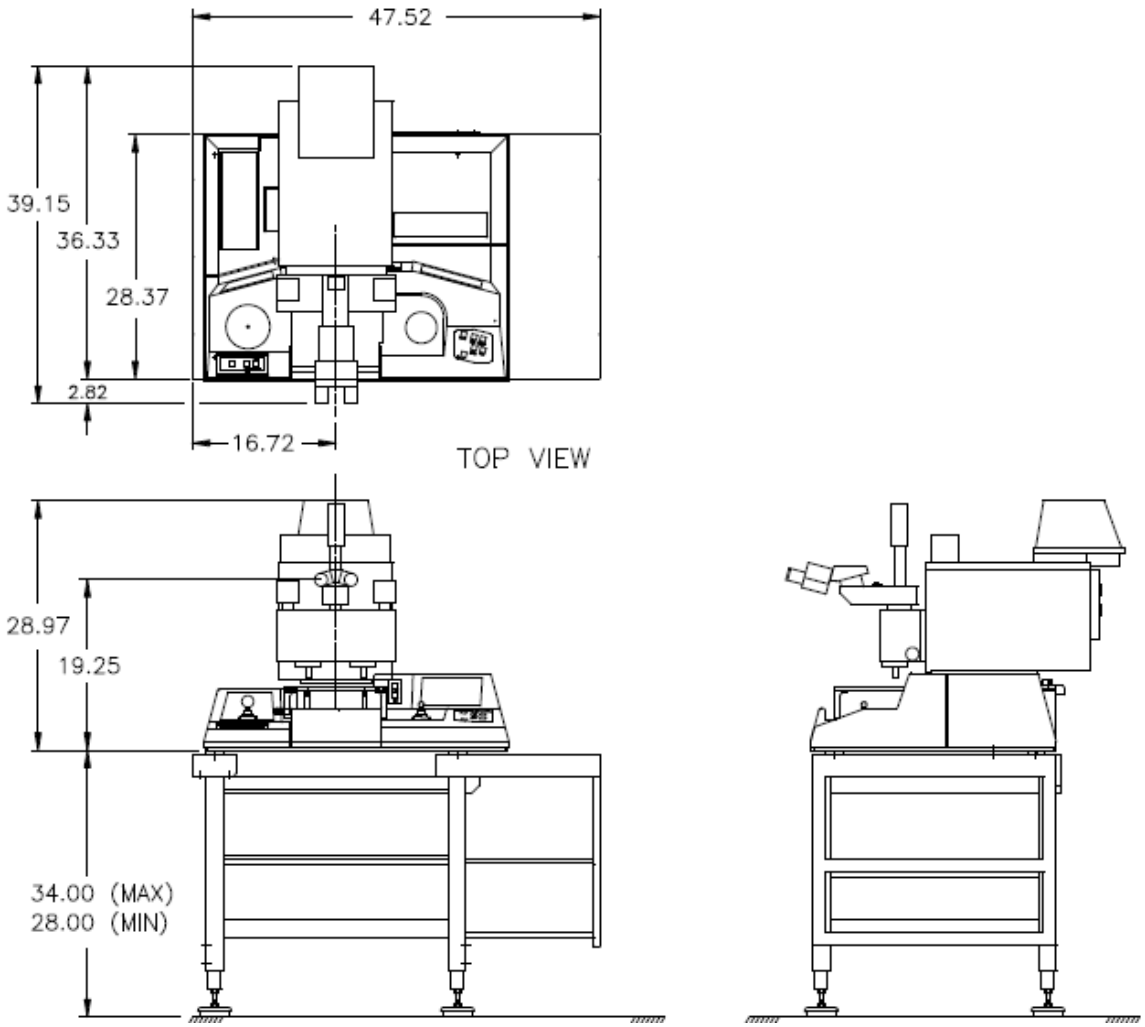
Detailed descriptions of the function, set up, and operation of each system will be found in the appropriate section of this manual. This instruction book is designed to give adequate information to two levels of personnel involvement. These levels are:

- **Operator**
- **Process Engineer/Supervisor**

With this document on hand, the positions above will have all the information necessary to operate the NXQ4006.

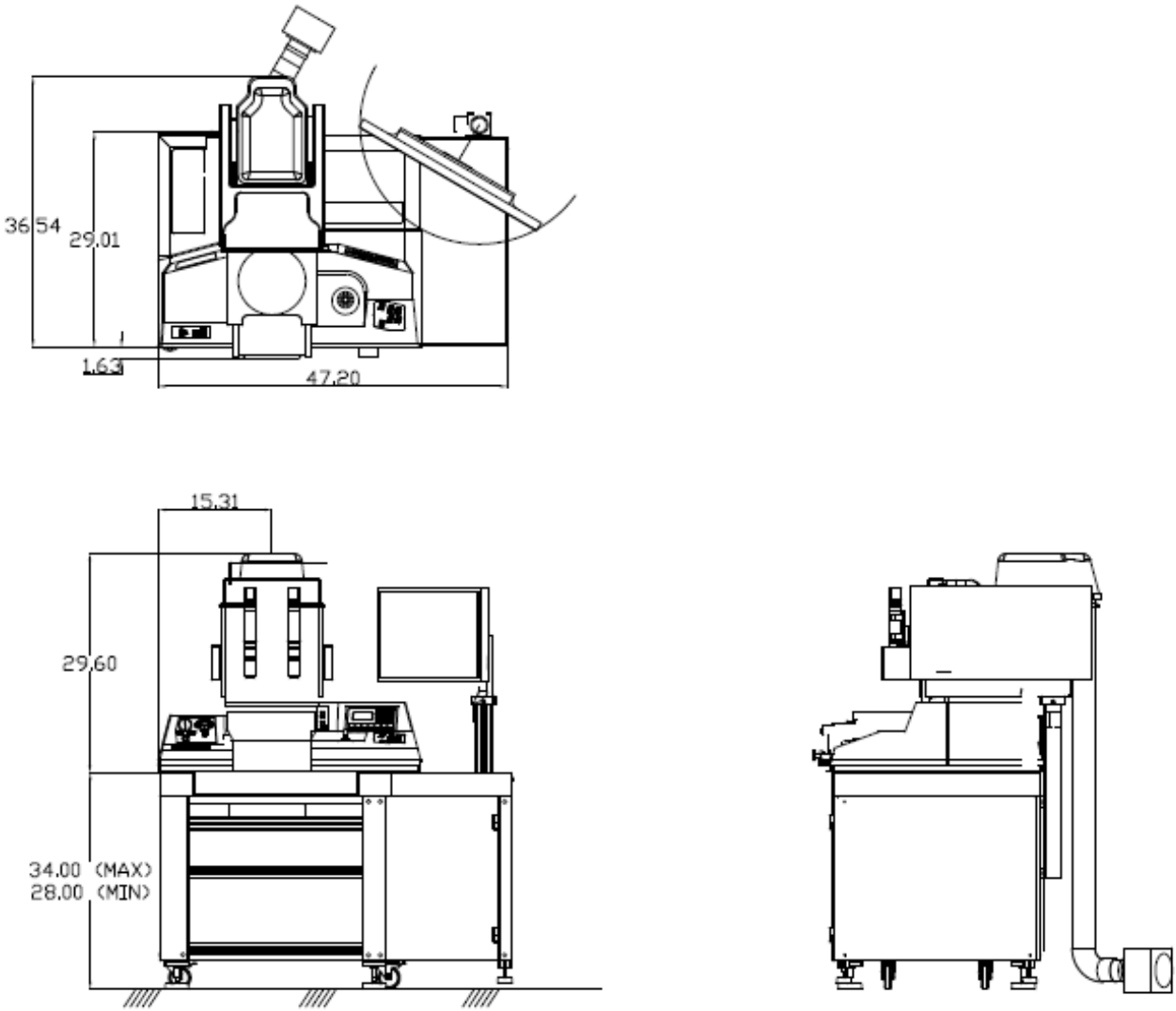
Installation/Utilities

Q4006 Mask Aligner Footprint (Version 1)



NXQ4006 Version 1

Q4006 Mask Aligner Footprint (Version 2)



NXQ4006 Version 2

Machine Environment

The greatest threat to long life for the **NxQ** Aligner systems is particles. For this reason, the instrument should be set up in an area relatively free from atmospheric contamination. Since this requirement is in general agreement with modern semiconductor device manufacturing requirements it normally presents little or no problem.

The machine should be in an acid-free environment. The atmospheric acid content which is tolerable for semiconductor processing can cause serious corrosion problems in the mechanisms and optical surfaces of the aligner.

If evidence of excessive fogging of optical surfaces or symptoms of metallic surface discoloration or corrosion presents itself, the environment in which the aligner is operating should be evaluated carefully.

The NXQ4006 aligner is mounted on a custom designed table which is sufficient to adequately support the instrument. The table provides vibration isolation to eliminate building vibration transmission to the instrument.

Utility Requirements

The utility requirements for the NXQ4006 aligner are detailed in the table outlined on page 15. While the Aligner is designed for operation under normal fabrication area conditions, it is recommended that the quality of the utility supplies be evaluated for uniformity in order to assure optimum performance from your unit.

The aligner should be attached to an electrical source which provides essentially uniform voltage. If the selected circuit also supplies heavy or fluctuating load requirements, it would be advisable to try to use another, more stable circuit.

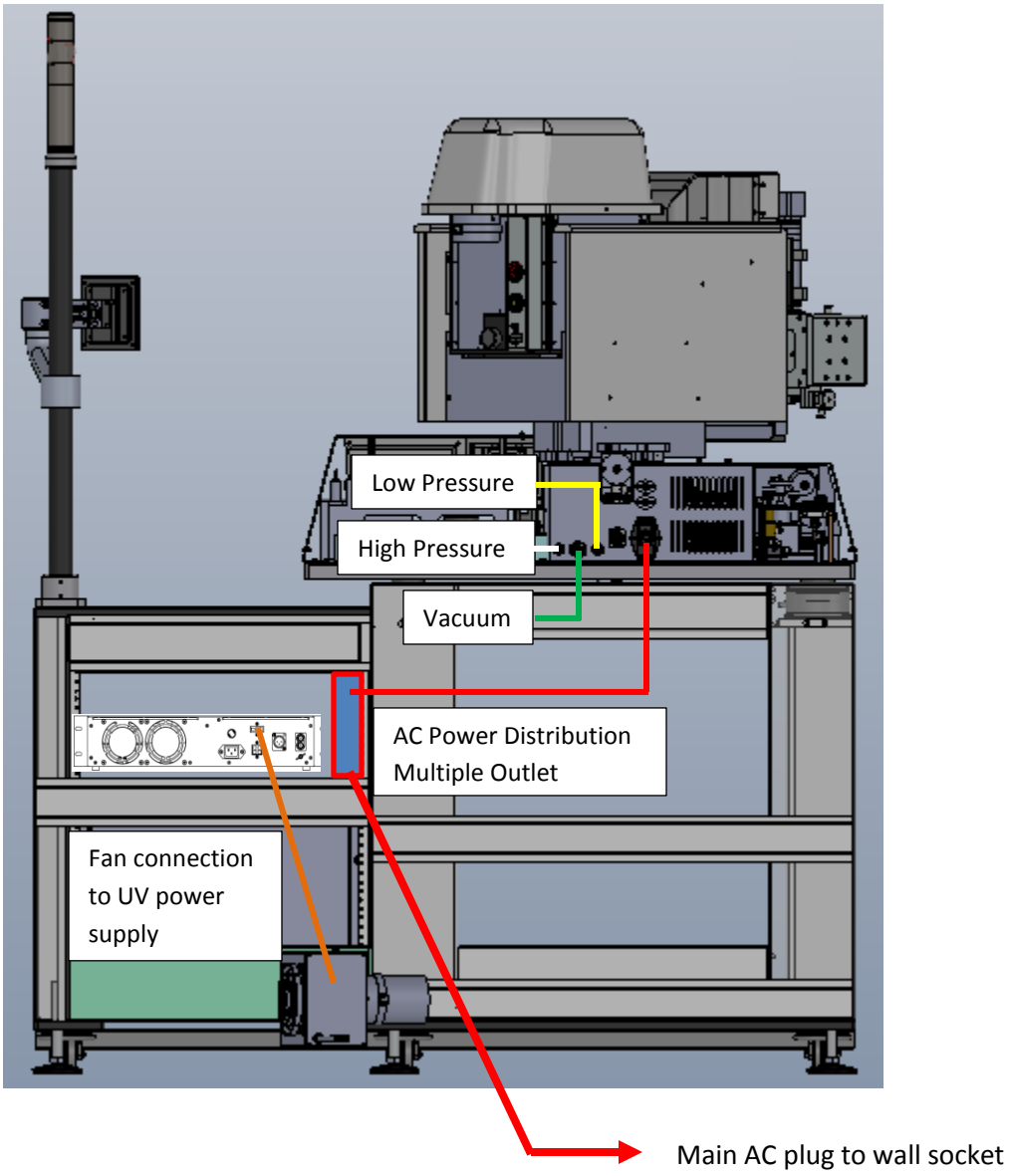
Similarly, if the gas supplies vary in pressure during the day, it is recommended that the connection be made to a source at a higher pressure with a dedicated precision regulator to assure that a constant pressure as recommended below be available at all times. CDA air must be clean and dry.

The NXQ4006 regulates voltages and pressures internally to meet process requirements, but for true process control the facility inputs must meet specification.

NXQ4006 Mask Aligner Utility Requirements Table

Utility	**Required Source**	**Connection**
Electrical:		
Aligner	120 VAC, 15 amp outlet 50/60Hz Single Phase	ASA, 3-wire plug on 3 conductor cable. Selectable, to meet local requirements
	240 VAC, 15 amp outlet 50/60Hz Single Phase	For 220 operation, connector must be replaced to coordinate with local requirements
Mercury Arc Lamp Power Supply		May be connected to the aligner power strip or to a separate wall outlet.
350/500 Watt **1000W**	120 VAC, 15 amp outlet 120 VAC, 20 amp outlet 50/60Hz Single Phase	ASA, 3-wire plug on 3 conductor cable. Selectable, to meet local requirements
350/500 Watt **1000W**	240 VAC, 15 amp outlet 240 VAC, 20 amp outlet 50/60Hz Single Phase	For 220 operation, connector must be replaced to coordinate with local requirements
Vacuum:		
	21” Hg or better @ I CFM	3/8” Imperial Poly Flow
Pressure:		
High Pressure	80-85 PSI (4.8Kg/cm2) minimum, regulated; nitrogen or dry filtered air, @ 0.5 CFM	¼” Imperial Poly Flow
Low Pressure	40-45 PSI(2.0 KG/cm2)minimum, regulated; nitrogen @ 0.1 CFM	¼” Imperial Poly Flow
	(Compressed Dry Air Filter: 1 micron coalescing with .1ppm oil carryover Drier: 38° F dew point)	Quick-disconnect/push-in type

Utility Connections



The main AC cord to the machine is connected to the wall socket. This cord runs to a power strip that distributes AC power to all the individual components of the machine; UV power supply, aligner, fiber optic boxes (OBS), computer (OBS), monitor (OBS), etc.

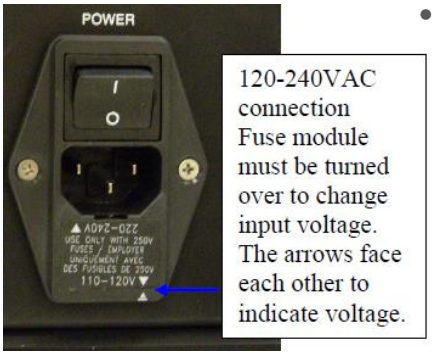
The UV power supply can be plugged into the wall separately from the aligner main AC cord.

The AC power to the UV cooling fan is provided by the UV power supply and is connected at the back of the supply.

Notes on Electrical Connections

The NXQ4006 may be configured to operate on either 120 or 240 volt supplies. The changeover requires two steps:

- Select a cord set (electric cord and plug) with the correct plug on the end to mate with the local style electric outlet.



- Older machines with voltage selector: Remove and invert the selector insert in the AC input module, which revises internal wiring of the aligner and installs the proper size and type fuse in the circuit.

If there is no voltage selector, the aligner will automatically switch. Later machines have this version AC Module.

Configuring the ultraviolet expose lamp power supply will require a technician's services, as it is more complicated. The voltage change requires the reconnection of the incoming line to the power transformer to the correct terminals, and removing the plug on the end of the power cord and replacing it with the correct one to fit the local outlet.

Normally, these operations are completed at the factory before shipment if the order is placed with advice of local electrical requirements for installation. The correct specification of service power is important, since it allows the final factory testing and checkout to be performed utilizing the proper operational voltage.

Notes on Pneumatic Connections

Connections of the gas and vacuum services to the NXQ4006 are made utilizing quick-disconnect type fittings designed to operate with rigid polyethylene plastic tubing, 1/4" outside diameter for the two positive pressure gasses, and 3/8" outside diameter for the vacuum supply.

System Description

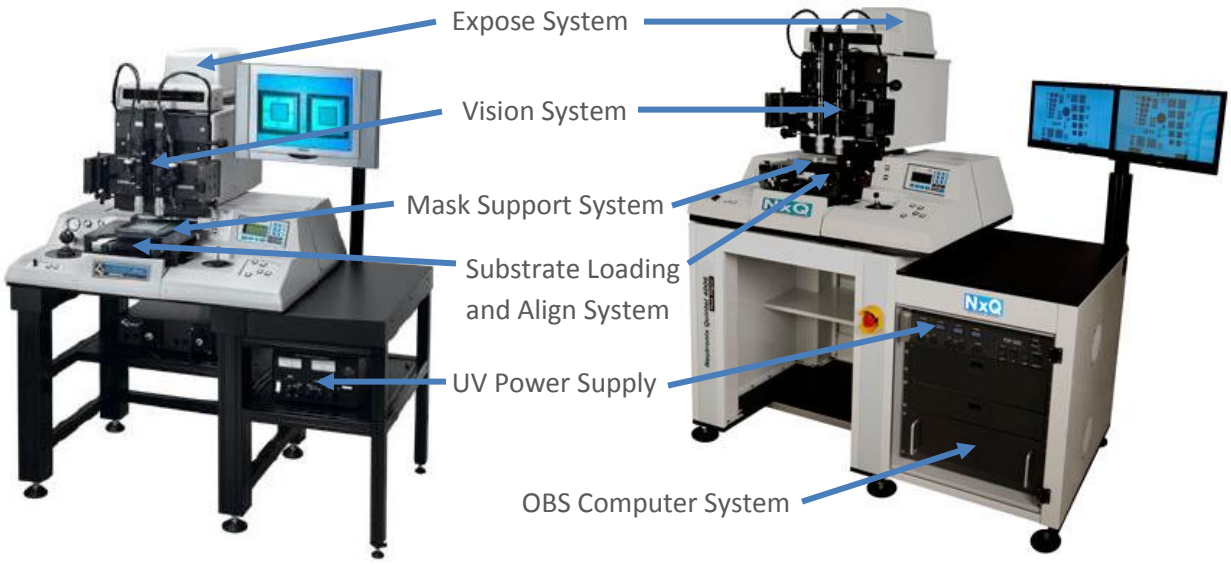
A mask alignment system appears complex, yet when each part of the aligner is described in terms of its content and its relationship to the total system, it's quite easy to become familiar with the machine. The manual will break the machine down so the readers, even those with minimal technical knowledge, will be able to understand how the aligner functions.

The machine requires setup for safe and correct use. For a Quick-Start manual please go to the **Operation Sequence** section.

Overview

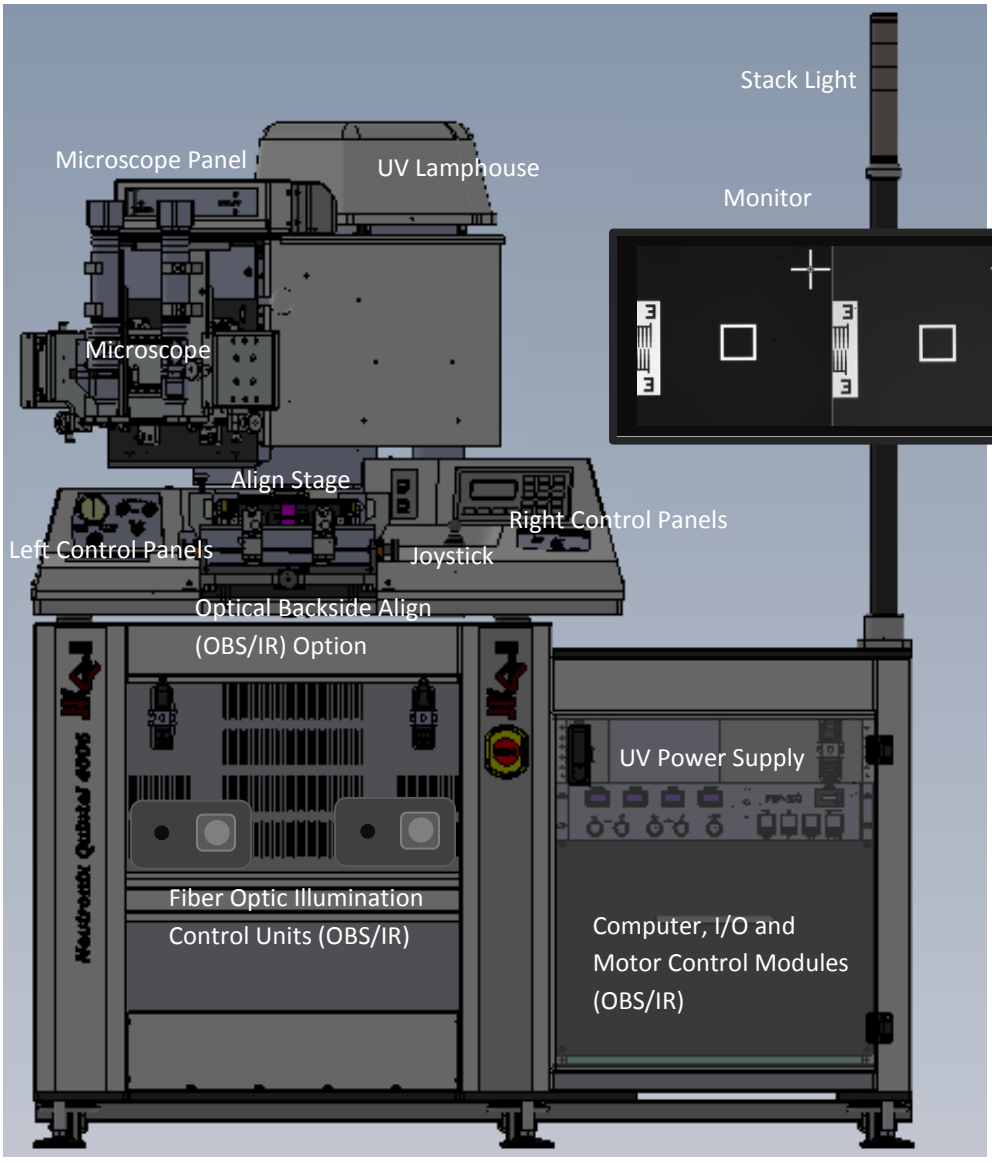
The NXQ4006 Mask Aligner is a **self-contained system**. All power supplies, control units, and utility control systems are mounted within the shell of the base machine or the integrated table.

The aligner is a **modular device**. Each operational section of the machine is built to be installed as a self-contained unit, and in case of problems, replaced as a unit.



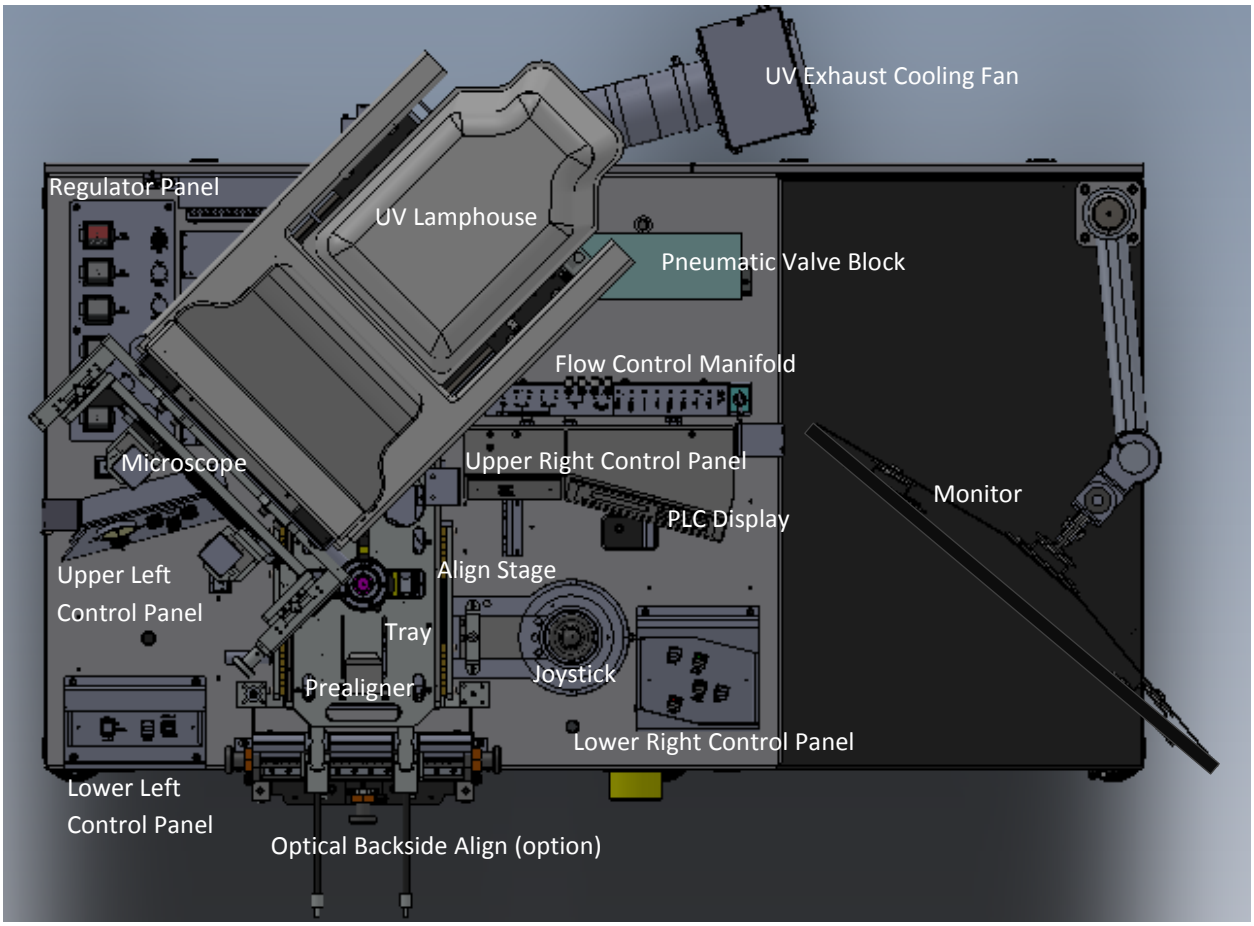
Machine Components

The following diagrams show the major components of the aligner.



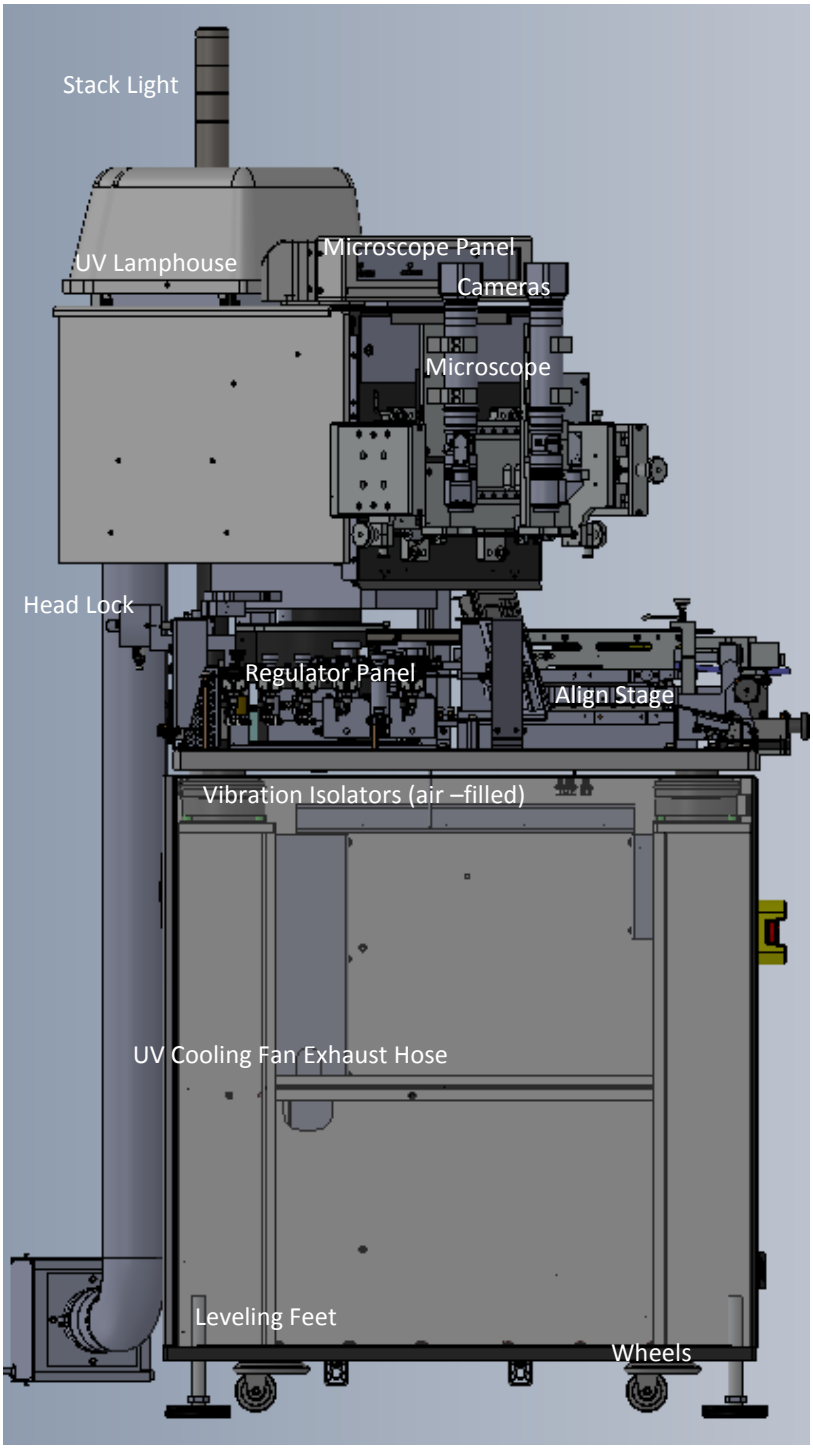
Front View

Machine Components (Top View)



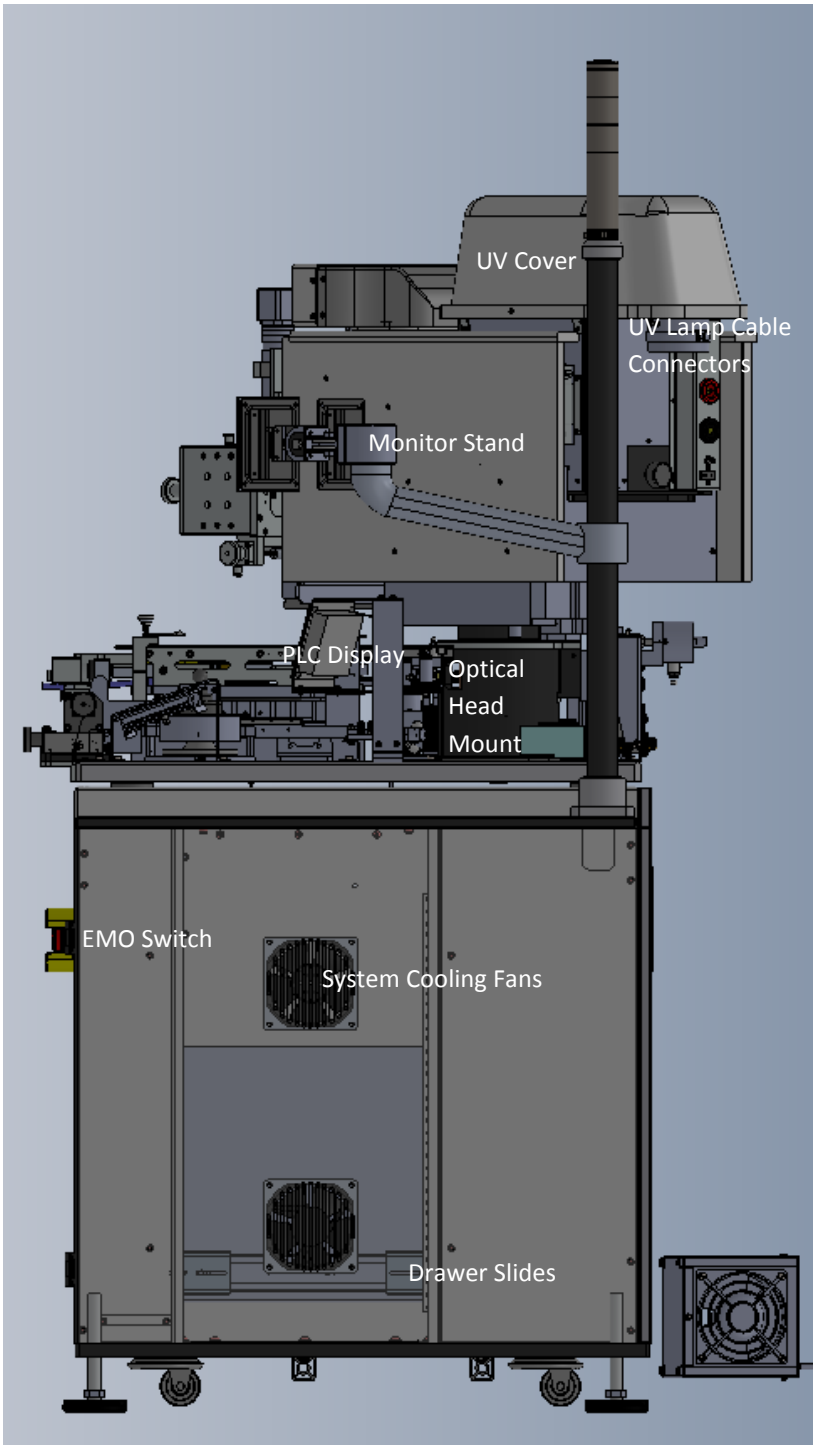
Top View

MACHINE COMPONENTS (Left Side View)



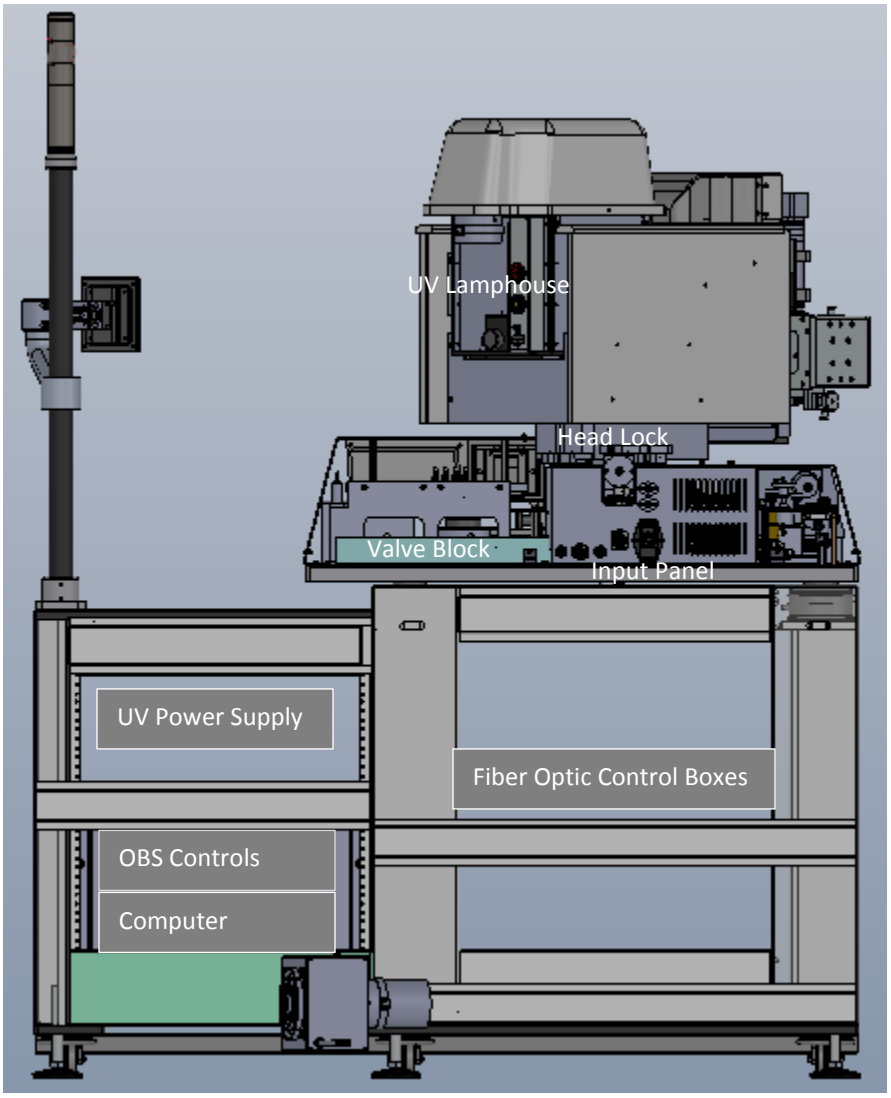
Left Side View

MACHINE COMPONENTS (Right Side View)



Right Side View

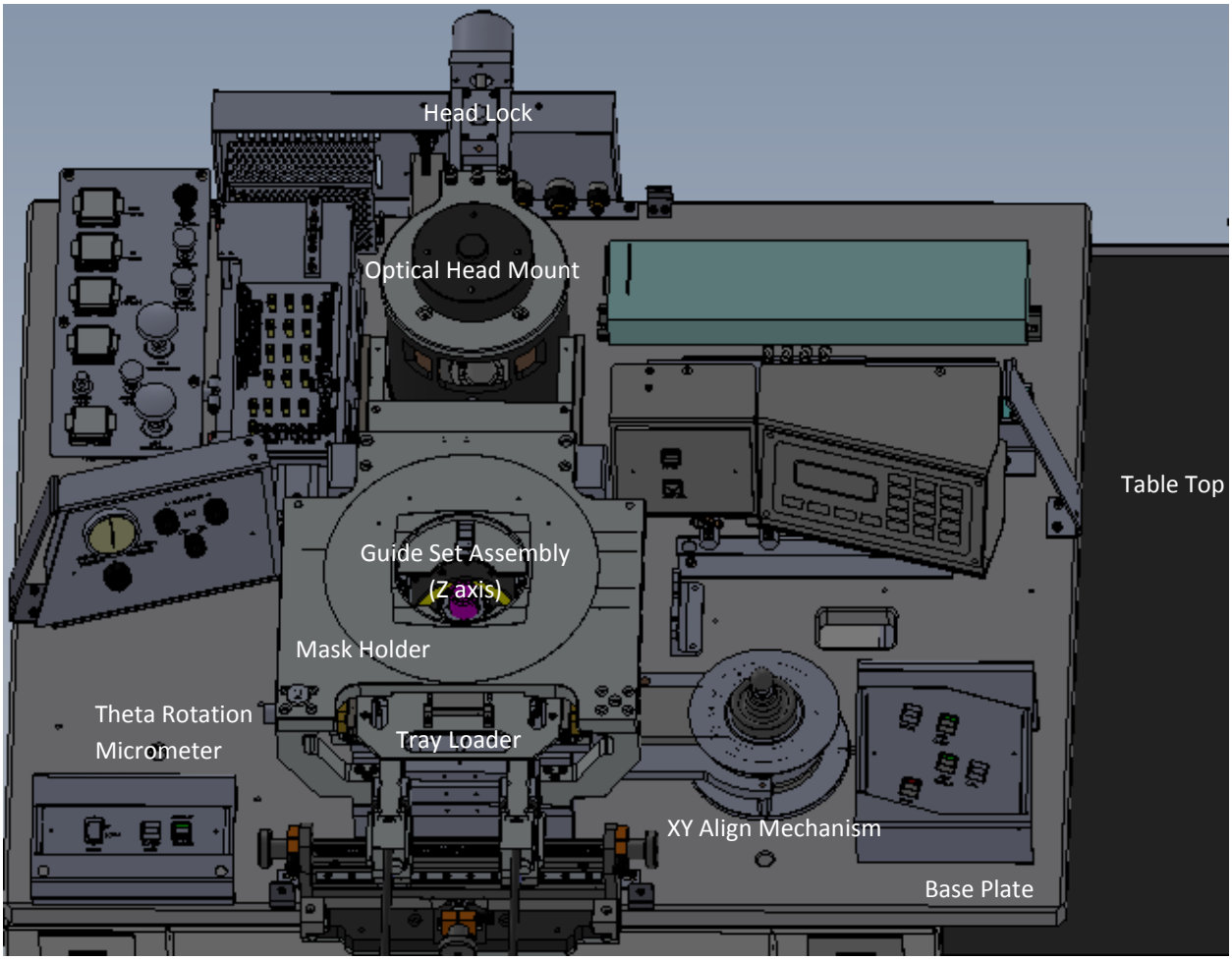
MACHINE COMPONENTS (Back View)



Back View

Machine Systems

Mechanical System

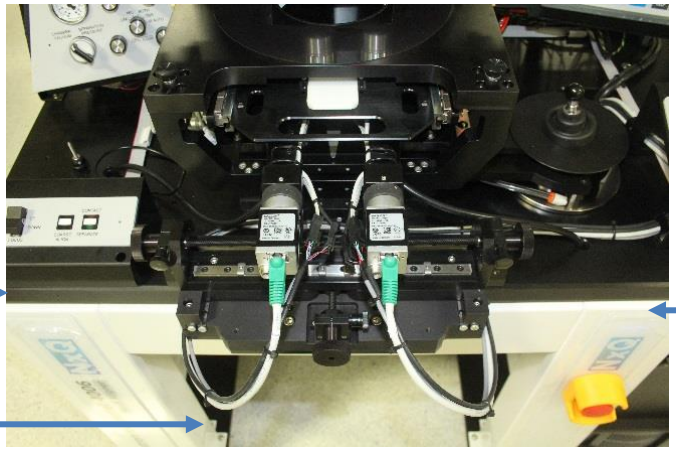


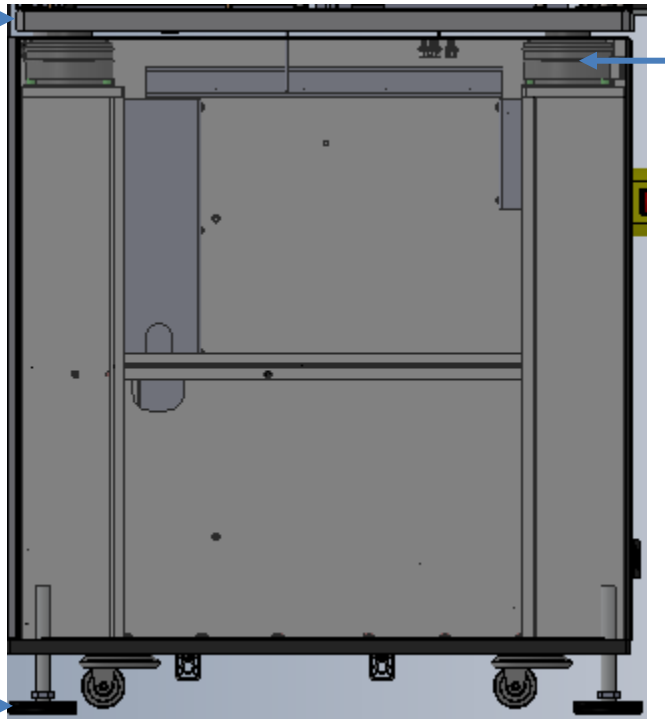
The NXQ4006 mechanical system starts with a thick, very flat aluminum **Base Plate**, which provides a strong foundation for the machine.

On this base are mounted all of the controls, pneumatic systems, the support for the optical head and the various electrical system components.

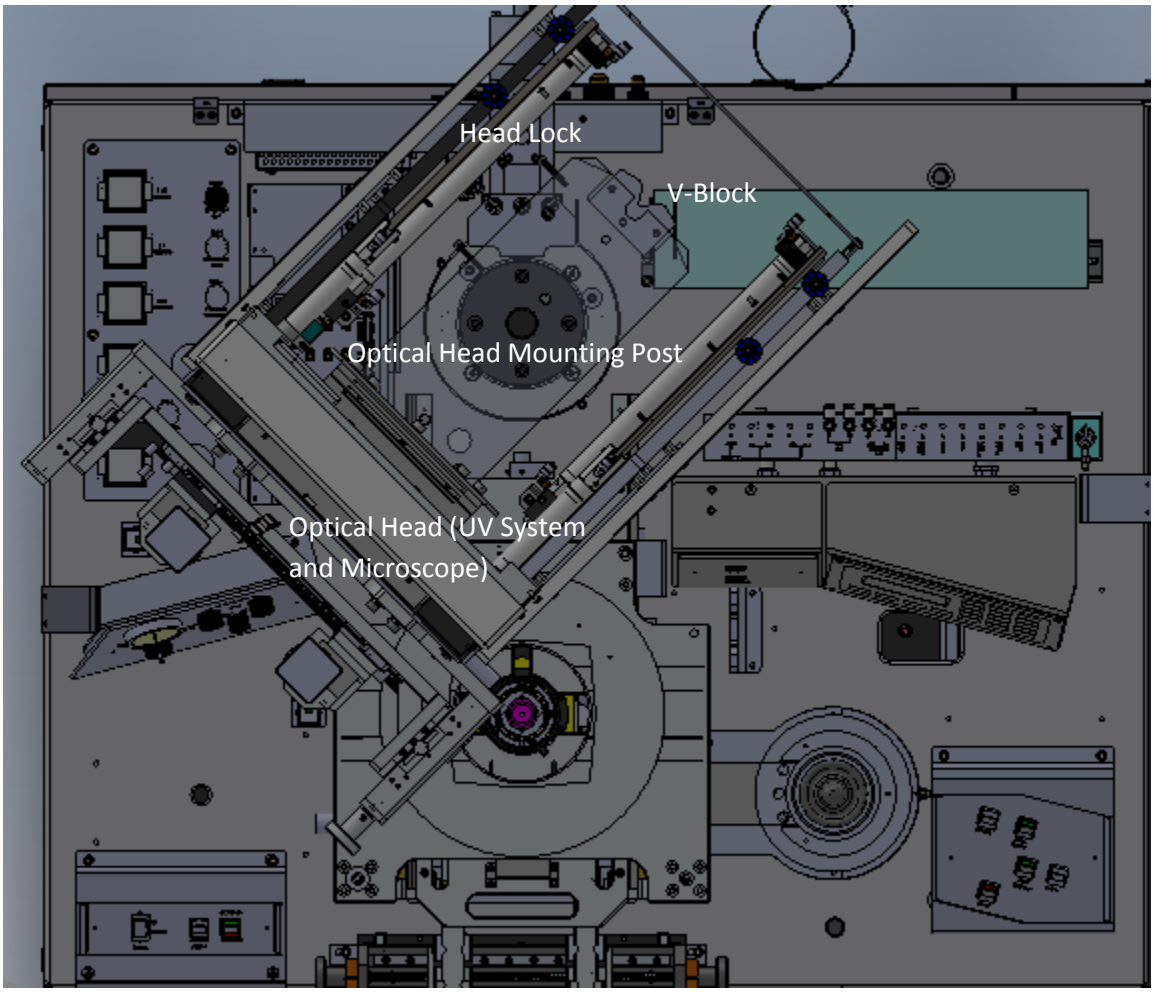
The base plate rests on air-filled vibration isolators mounted to the table. The table legs are adjustable for leveling the machine.

The Base Plate/Optical Head Mount/Head Lock

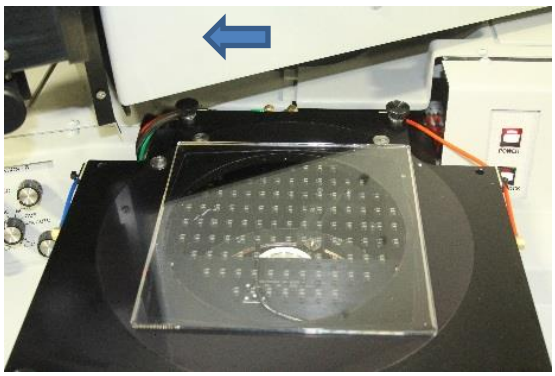




At the back of the base plate is the **mounting post** for the **Optical Head** assembly. This large cylindrical unit contains a precision tapered roller bearing system that provides a rigid mount for the optical head, and at the same time allows rotating the optical head out of the way to facilitate tooling and mask changes.



The Optical Head swivels to the left for mask installation and to the center to view the mask and wafer.



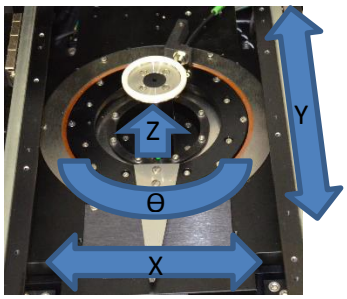
The **Head Lock** mechanism is driven by a high pressure cylinder that locks the optical head in the view or mask load position. The cylinder drives a cam bearing into the view and mask load **V-Blocks**.

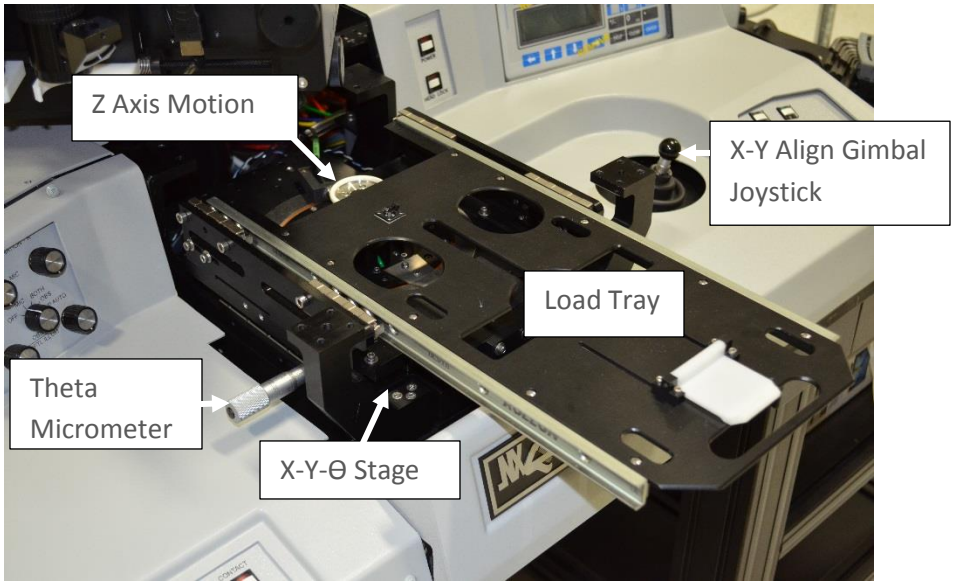
The Align Stage

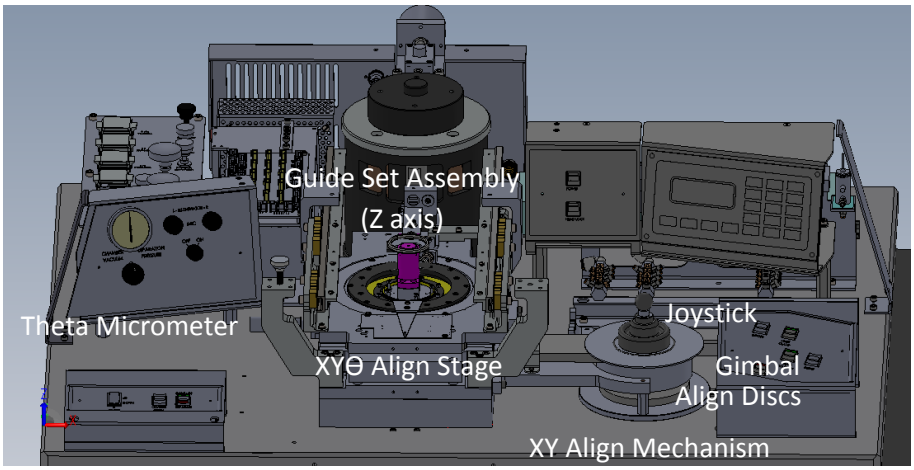
The **X–Y–Z–Θ Align Stage Assembly**, is the heart of the NXQ4006 Aligner System. The stage provides for:

- Z motion to lift the substrate and level it against the mask and move the substrate between **Separation** and **Contact** for alignment and final exposure.
- X –Y–Θ movement of the substrate to align it to the mask. X-Y align is controlled by a right hand finger-tip controlled gimbal, which allows coarse align and fine align movements. Θ align is controlled from the left side of the machine with a micrometer control rotating the guide set.

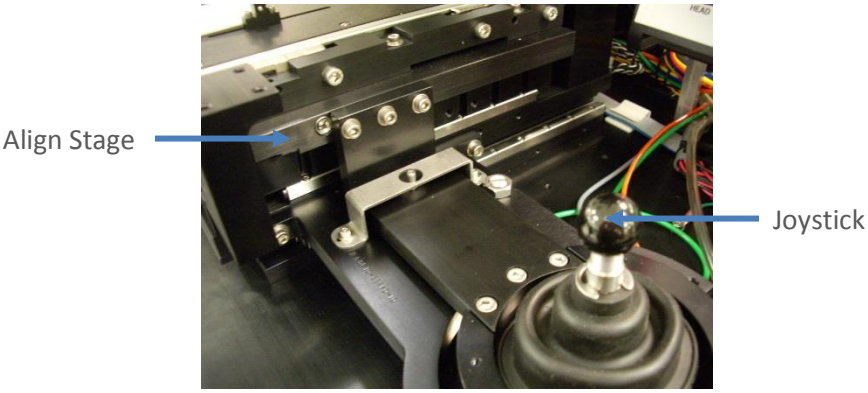
NOTE: For alignment, **X** refers to linear movement left to right, **Y** to linear movement front to back, **Z** is the vertical movement of the substrate up and down, and **Θ** (**theta**) is the rotational movement of the substrate around its center.







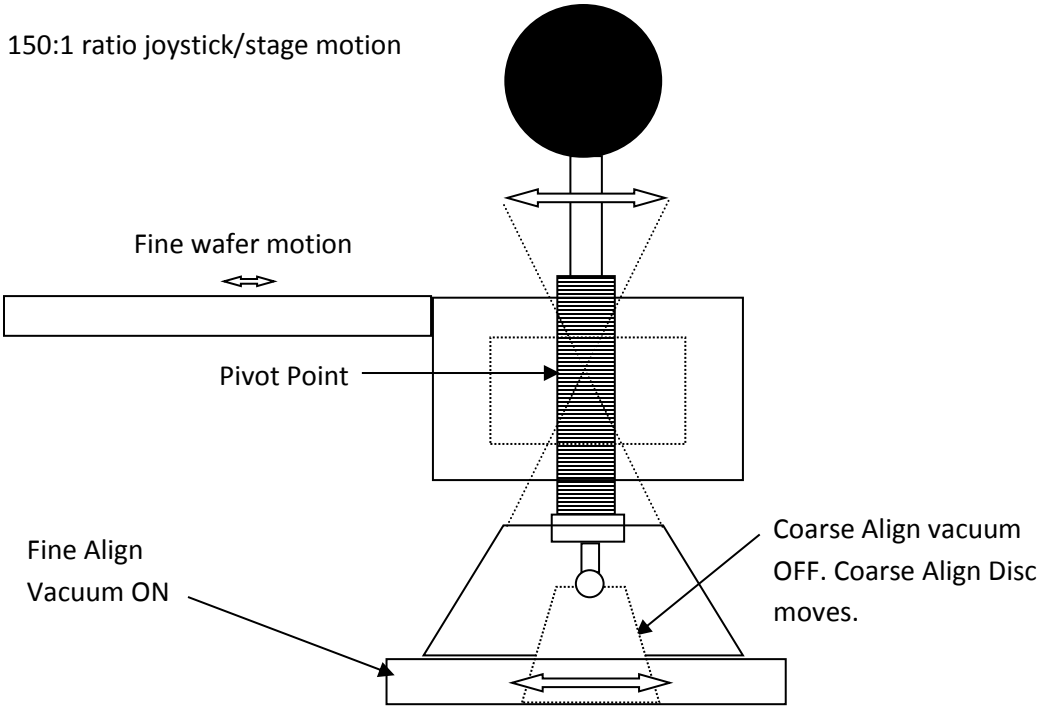
Mounted above the base plate and resting on it is a pair of plates which allow X and Y movement for alignment. This is called the **Align Stage**.



The control of the alignment movement is by a complex joystick, mounted to the right of the stage. On the Front Left Control Panel there is a momentary **Coarse Align** push button switch which controls the flow of vacuum to the align joystick so it either operates at a 3:1 ratio **Coarse Align** mode or at a 150:1 ratio **Fine Align** mode. When the machine goes into **Contact** mode, both align modes are activated effectively locking the align mechanism's movement.

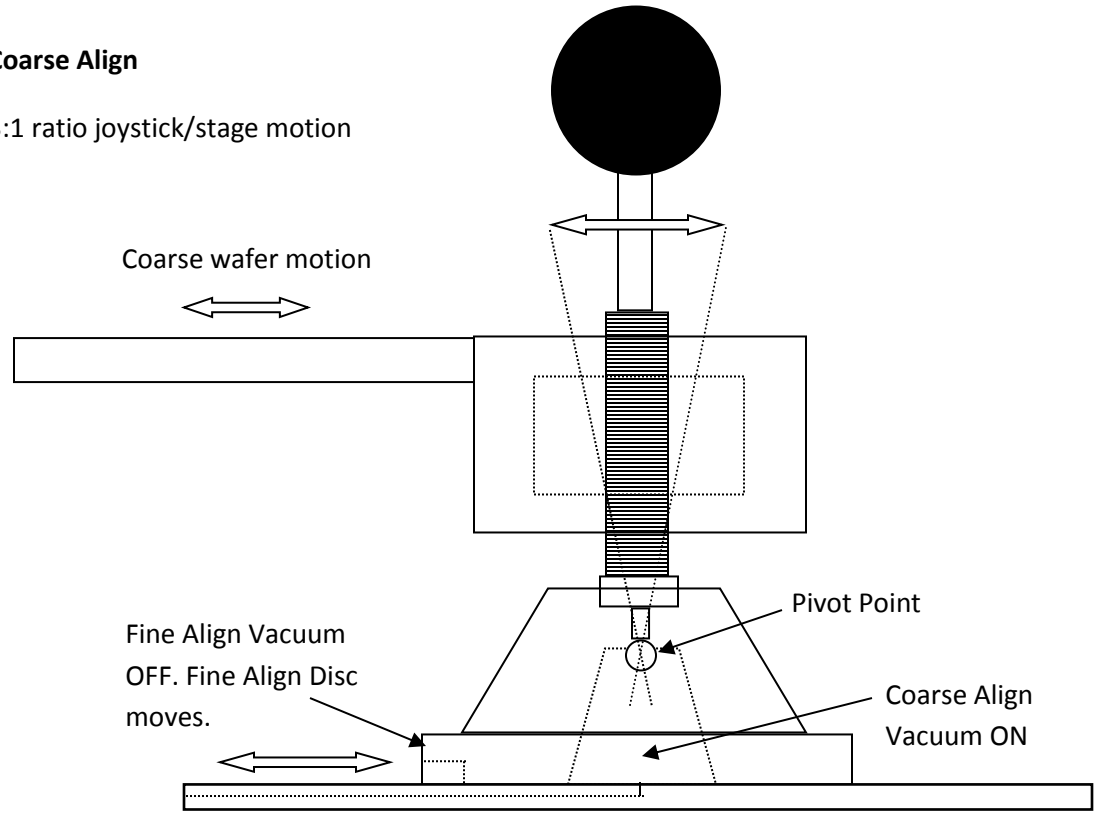
Fine Align

150:1 ratio joystick/stage motion

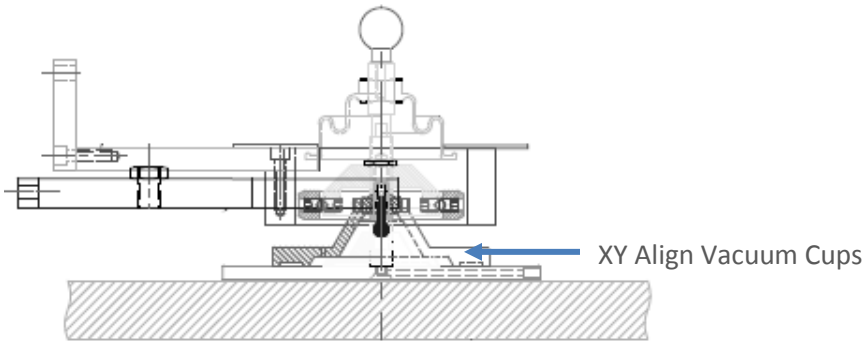


Coarse Align

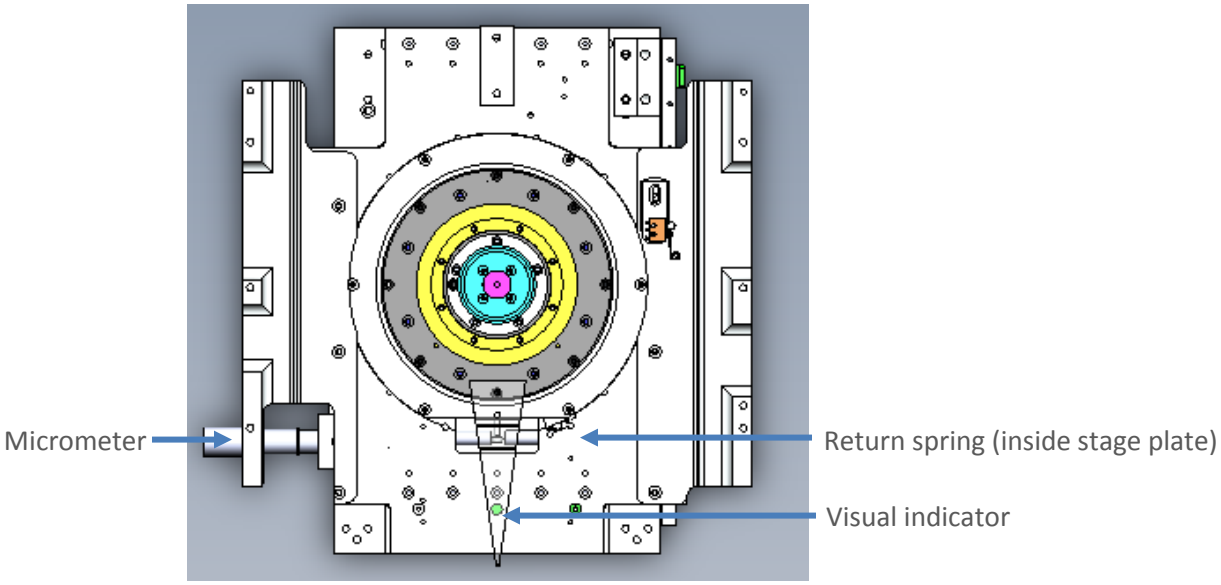
3:1 ratio joystick/stage motion



After alignment is completed, the entire stage assembly is locked to the base plate by the **XY Align Coarse and Fine Discs** (also called Cups or Bells).



Mounted in the top align stage is a large diameter rotary bearing assembly which supports the Air Bearing Guide Set. Its purpose is for **Theta** or **Rotational Movement**. This bearing permits the Guide Set to rotate about its vertical axis, effectively rotating the substrate about its axis. This provides the rotational movement necessary for a complete alignment.

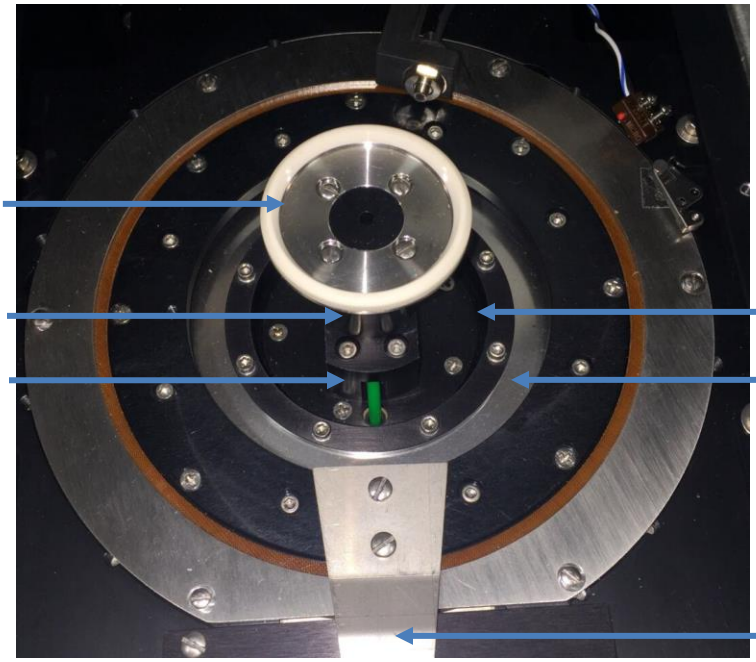


This rotational movement is controlled by a micrometer drive located on the front left side of the stage assembly. This drive is capable of +/- 7 degree rotation, and works against a return spring. There is a visual indicator in the front of the stage to guide the operator in returning the rotation to its center position when starting a new set-up.

Theta Micrometer

The Z Axis Guide Set Assembly

This is the **Guide Set Assembly**, which provides all of the Z motion to the aligner.

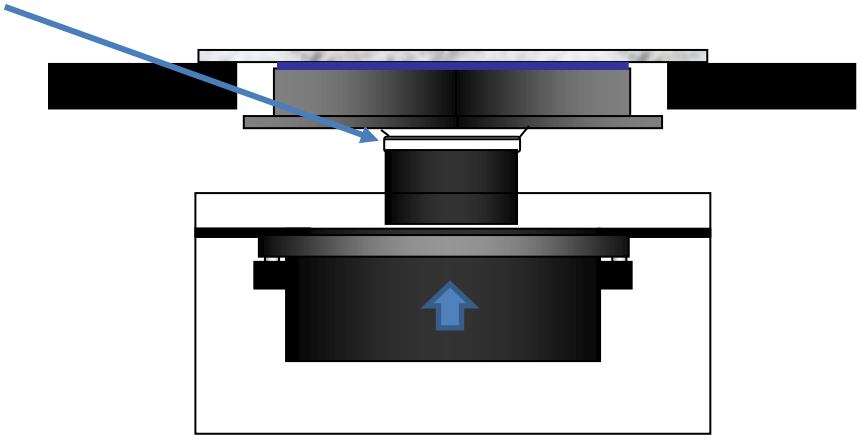


Guide Set

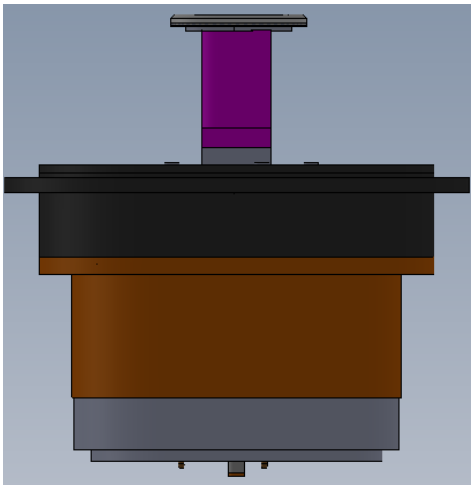
The guide set lifts and supports the substrate chuck. The chuck is provided with a spherical **Ball Segment** on its reverse side which mates with a conical **Ball Seat** on the top of the moveable center **Piston** of the guide set. This combination provides the *swivel* action to permit the substrate to level to the mask on its first contact.

The piston of the guide set lifts the substrate up to the mask (about 1 1/8 inches), then very low pressure air (called Leveling Air) flows between the ball seat and the chuck to provide a frictionless leveling of the substrate to the mask. This is especially important when using very small or fragile substrates.

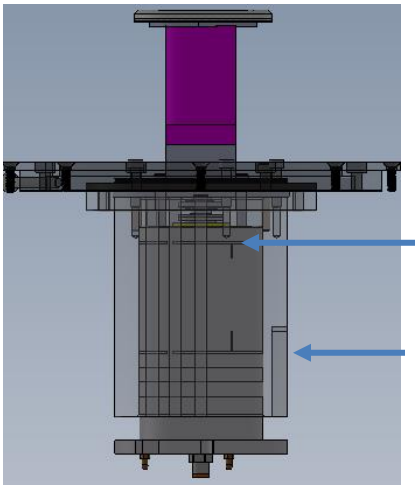
Vacuum is fed to this interface to lock the ball seat and ball segment after leveling.



The key component of the **NxQ** Guide Set Assembly is a full length **Air Bearing**. The air bearing is a SET of parts; the inner post and outer sleeve, or piston. The piston rides up and down on cushion of high pressure air. The air bearing has no side shift and requires no lubrication. As long as the air remains clean and dry it never needs servicing.



The Guide Set Assembly



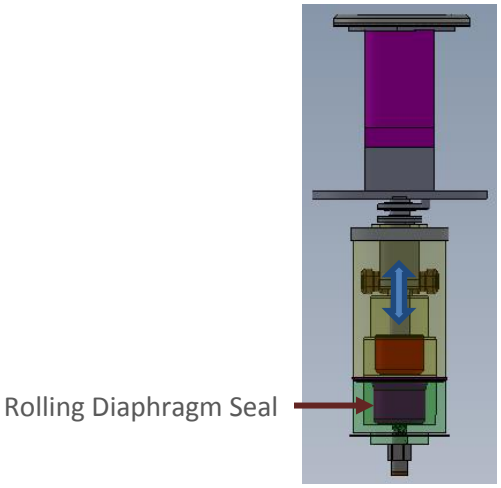
The Guide Set (Air Bearing)

The guide set **Post** has ports and grooves for high pressure air.

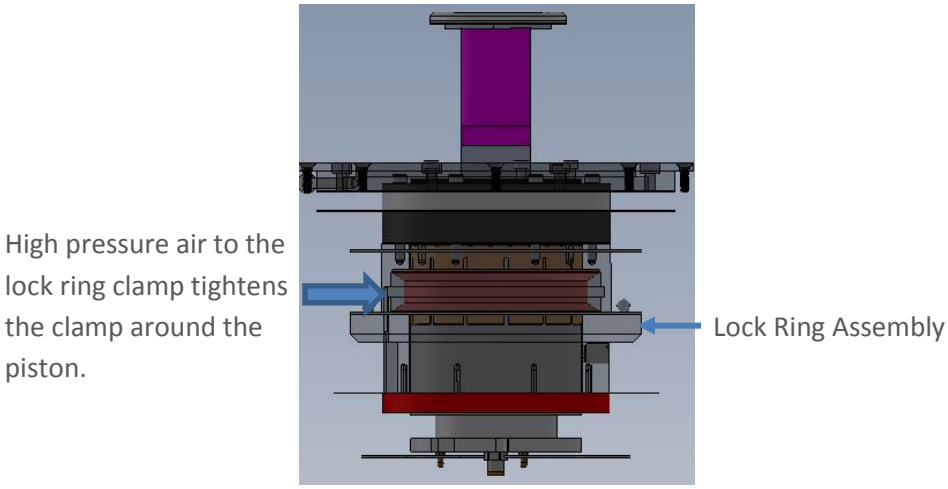
The guide set **Sleeve** (piston) rides up and down on the air bearing provided by the post.

Inside the air bearing post is a **rolling diaphragm seal**, which applies the Contact Force of substrate to mask for printing. The seal also requires no lubrication.

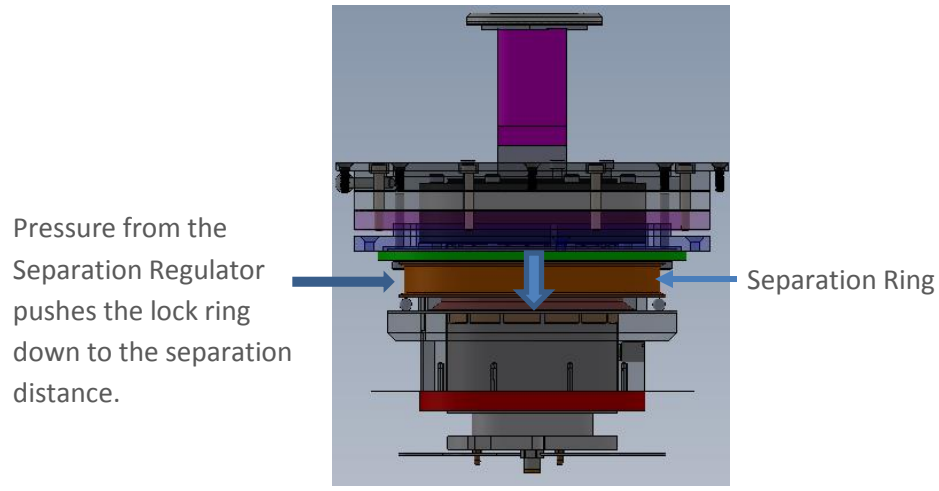
All of the moving parts of this assembly are very light weight; so relatively low, controllable, pressures are used to lift the substrate into its first contact with the mask, thereby limiting mask damage and danger to the substrate.



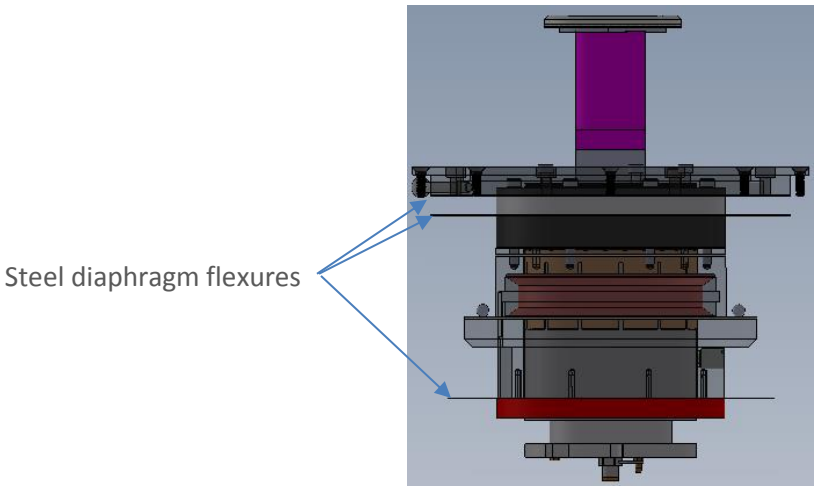
After the first contact, the dynamic air bearing sleeve (piston) is clamped to the **Lock Ring** with high pressure air.



Then the **Separation Ring** moves the substrate to the align gap, or separation distance. This is accomplished by a special linear drive mechanism mounted inside the separation housing, actuated by air pressure. Varying the pressure results in different distances moved. The use of a precision regulator produces very repeatable separation distances (within 1 or two microns). The lock ring, separation housing and guide set sleeve, acting as a unit, are still guided by the air bearing.



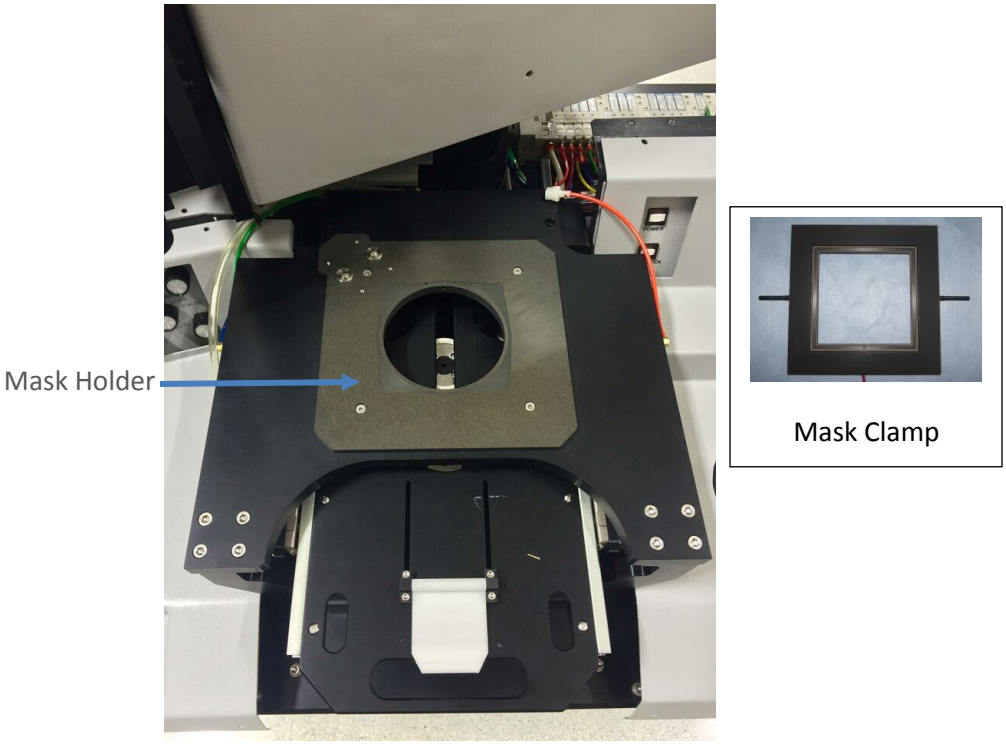
In addition they are stabilized by a stainless steel diaphragm system designed to be very flexible in the Z direction, and extremely stiff in the X and Y directions, resulting in what **NxQ** refers to as their *zero-shift* guide set. You can align in separation, move to contact and verify that your alignment has not shifted as a result of the Z motion.



Please see the **Theory of Operation** section and the **NXQ4006 Maintenance Manual** for details about guide set operation.

Mask Holder/Substrate Support System

All **NxQ** Aligners utilize a highly developed work support system which has evolved through many years of applications work in the semiconductor industry. The system involves two major components; the **Mask Holder** and the substrate support or **Chuck**. Each of these components are optimized to perform their functions while working together to provide complete control of the product while being loaded into the aligner, aligned, exposed and unloaded.



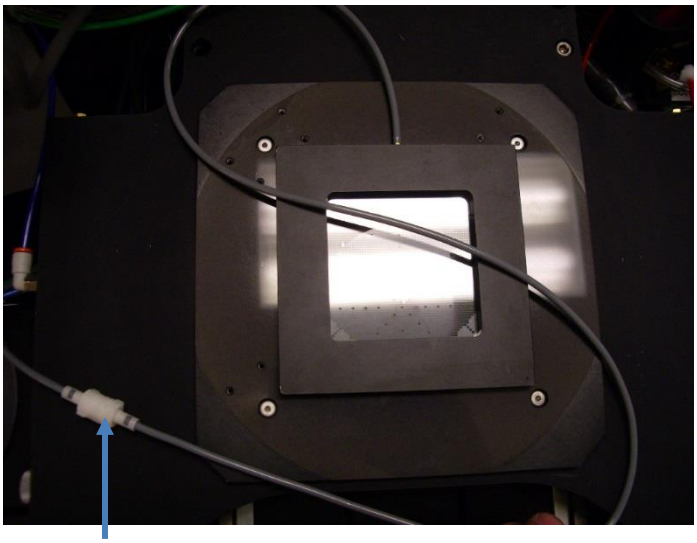
The **Mask Holder** is a very precise work holder designed to support the glass mask on a flat lapped surface, providing vacuum porting to clamp the mask firmly in place. **NxQ** also supplies mask holders to support film masks; consult the factory for more information.

The geometry of the mask holder is governed by several simple rules:

- The opening in the mask holder is always designed to be large enough to accommodate the physical size of the substrate plus the maximum allowable alignment motion. In practice this means that the mask holder opening is, for standard tooling, 0.300 inches larger than the size of the substrate. The wafer can move approximately 4mm in all directions for alignment.

- Since the standard **NxQ** tooling system utilizes a *top mount* mask holder, the minimum mask size that can be used on a given size substrate is controlled by the need to provide adequate hold down force to retain the mask in place when the forces of planarization and expose pressure exert an upward pressure. In **Vacuum Contact** mode of printing, the chamber vacuum is especially powerful and tends to *lift* the edges of the mask. This causes instant loss of mask hold down vacuum. The rule utilized for standard design tooling requires that the mask must be 1 inch larger than the wafer.

  Within reason, any mask size larger than minimum may be used on the mask holder. Mask corner locating stops are provided on all mask holders, with alternate positions available for standard, nominal size masks up to the recommended maximum size. By removing the stops, even larger masks may be accommodated with the mask overhanging the support.



The Mask Clamp is attached to the GRAY hose

There is an optional accessory to the mask holder, the **Mask Clamp**, which is a thin, precise, metal part with a vacuum port to permit vacuum clamping to the top side of the mask.

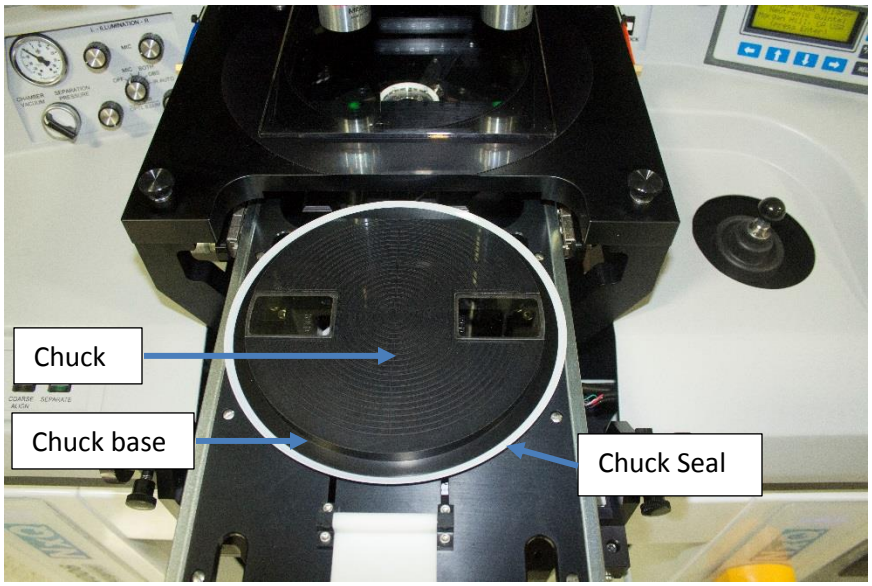
The clamp serves two functions: it provides, by means of protruding handles, a convenient method of placing and aligning the mask under the microscope, and more importantly, a way of "stiffening" the mask and controlling the "mask bow" introduced when the expose chamber and substrate are subjected to pressure, both negative and positive, during the expose cycle.

A Mask Clamp is most often used with small, thin masks to make them easier to handle and less subject to mask bow. They might not work with Offset Objectives and thicker masks due to interferences. With standard thickness masks and wafers that match the mask holder opening, mask clamps are generally not necessary.

Mask Clamps are generally configured to agree with the mask holder they ship with. The outside dimension should *always* match the mask size, and the opening the same size as the mask holder opening. However, when a smaller sized wafer is used the clamp opening should match the actual wafer size. This will achieve optimum mask bow control. There are many size combinations available as standard designs and custom combinations are readily available.

The work support or **Substrate Chuck** provides an optically flat surface to support the wafer during alignment and exposure. It provides vacuum to the wafer/chuck interface to hold the substrate in place during transport in and out of the expose chamber. It can also introduce nitrogen under the wafer at the moment of exposure to produce "pillow pressure" to allow the top of the wafer to conform to the mask.

The substrate chuck normally is made to match the size of the work being supported; in no case should the work "overhang" the support surface. This may cause wafer breakage or chipping. However, it is permissible for the work to be smaller than the support surface. In this case it is desirable to block off the vacuum ports in the surface of the chuck which are not covered by the wafer.

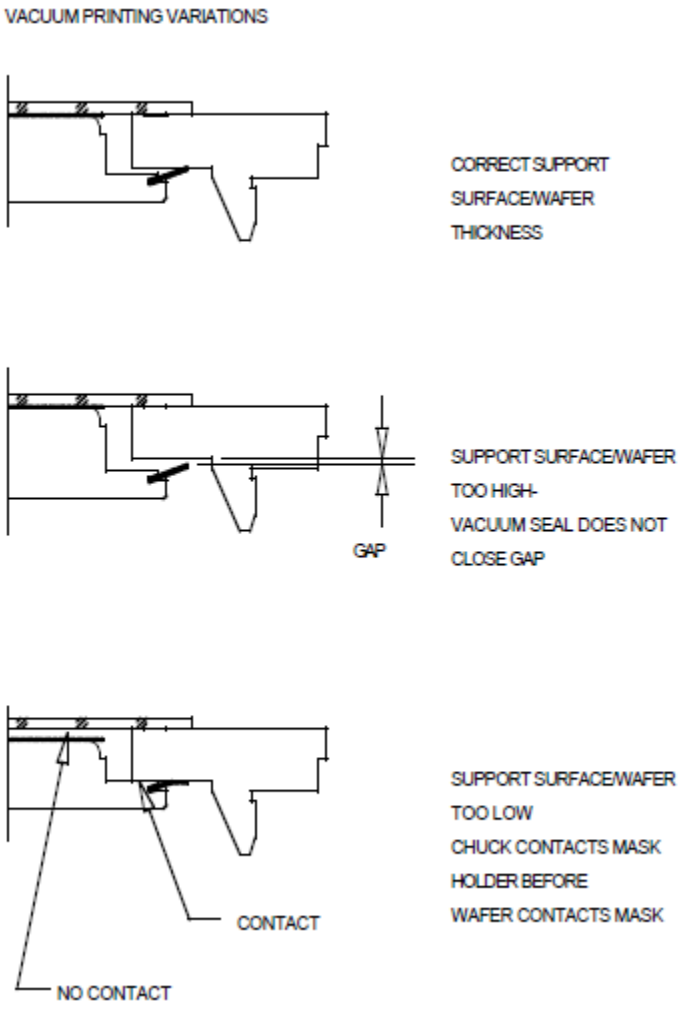


At the perimeter, the chuck base can hold a thin rubber **Chuck Seal** to complete the exposure chamber for **Vacuum** (hard) **Contact** printing mode at the time of exposure. The functioning of this seal makes the thickness of the substrate chuck very important to the correct operation.

In straight **Pressure Contact** printing, the concern is that the chuck and wafer thickness combine so that clearance is maintained between the chuck base and mask holder bottom surface. If the chuck is too thin, the chuck base will hit the bottom of the mask holder before the wafer hits the mask. If the chuck and wafer combination are too thick, it will not go under the mask holder during loading. The maximum thickness of substrate that can be accommodated on a standard configuration machine is 6.3mm or 0.25 inch (with the appropriate chuck).

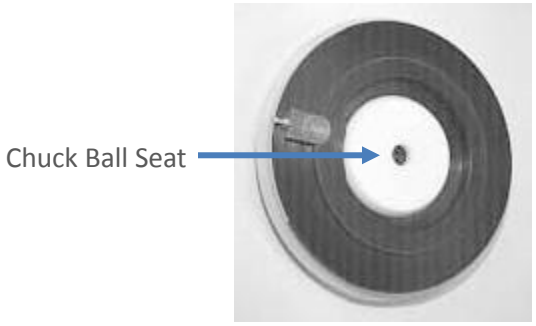
In a non-standard mode of operation, by moving the optical head of the aligner aside, removing the mask, and loading the work onto the chuck through the mask holder opening, substrates as thick as 18mm or 0.71 inch can be loaded and aligned.

For vacuum printing, the rules are much more restrictive. In order to achieve a closed expose chamber, it is necessary to have the chuck seal contact the underside of the mask holder. To achieve this, the chuck surface height is manufactured to a specific dimension to accommodate the wafer thickness. With standard chuck seals and standard wafers the substrate thickness must be within +/0.010 inch. This is sufficient to accommodate normal manufacturing tolerances for wafers and substrates. With special High Curl or Extra Wide seals, substrates as thick as 1mm can be processed.

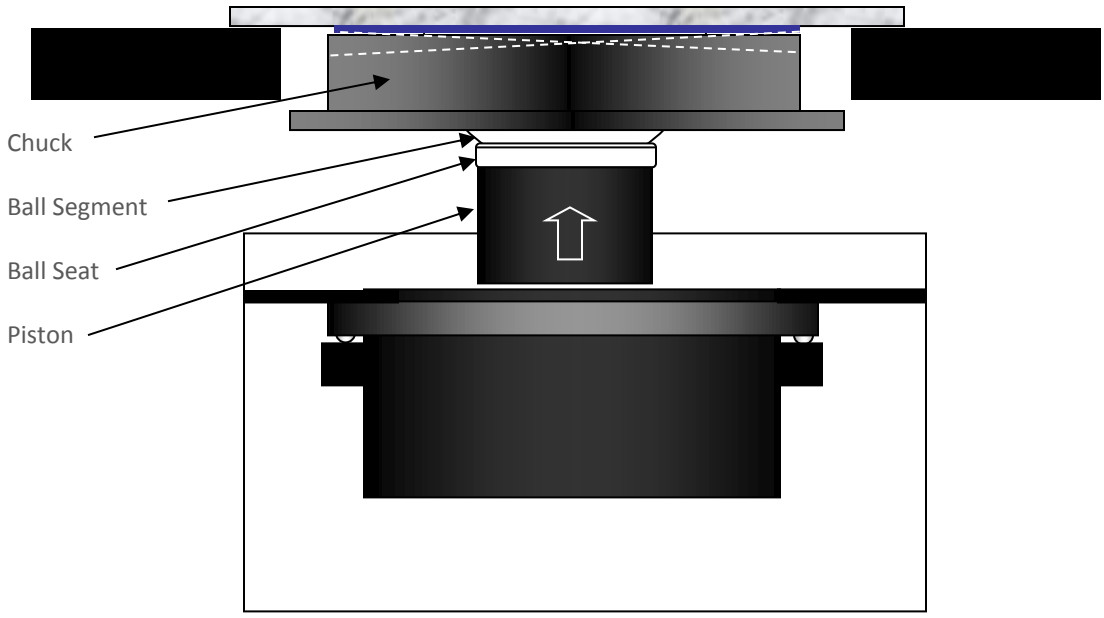


The design of custom tooling systems is an important part of the customization services **NxQ** offers to its customers. There are a great number of critical characteristics which need to be observed in the design of this tooling which makes it difficult for even experienced designers to complete a system design which will operate satisfactorily. You are urged to take advantage of the expertise of **NxQ's** staff in creating tooling for a new product.

On the reverse side of the chuck is mounted a spherical **Ball Segment**, which interfaces with a conical **Ball Seat** on the top of the guide set to provide a means of tilting the chuck, upon initial contact with the mask, to planarize the substrate with the mask. This ball seat is subjected to very slight air pressure during planarization (Leveling Air) and is vacuum clamped at all other times to maintain the mask/substrate leveling initially achieved.



The Chuck tilts on the ball seat and ball segment to level (planarize) the wafer to the mask.



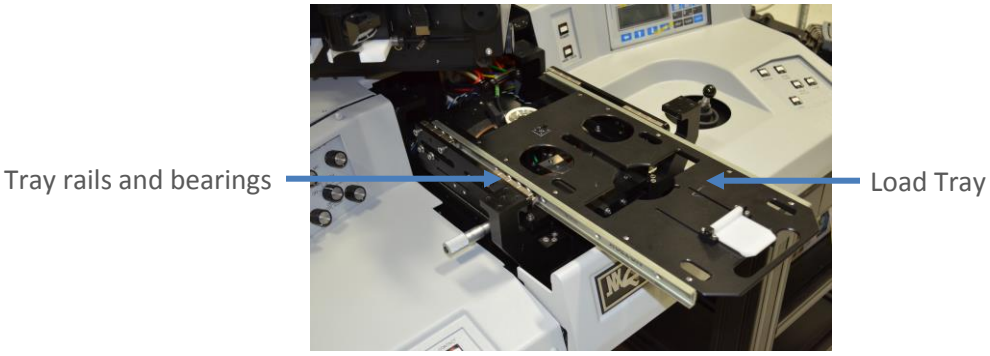
Substrate Leveling

Substrate Load System

The **NxQ** NXQ4006 is a manual load aligner, which requires the operator to remove a substrate from its carrier and place it on the work holder chuck for each product exposed. After completion of the exposure, the operator removes it from its chuck and returns it to the finished product carrier.

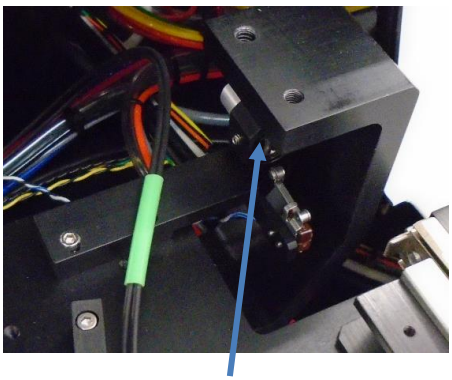
Tray Load

This unload/load sequence is facilitated by the use of a **Load Tray**, which is pulled out towards the operator to a position where the operator may easily pick up or place the product without reaching, and the pre-alignment is performed in an easily viewed location.



The substrate is placed on the chuck surface and prealigned. When the operator is satisfied with the positioning of the substrate, the tray is pushed in slightly, which activates the **chuck top vacuum**, locking the substrate down before the tray is pushed all the way in.

The tray is mounted on four precision bearing units for accurate guidance and easy movement. It is provided with a cushioned “in” stop and with a magnetic restraint to hold it in the full in position to assure that it is properly aligned for the guide set to pick up the chuck.

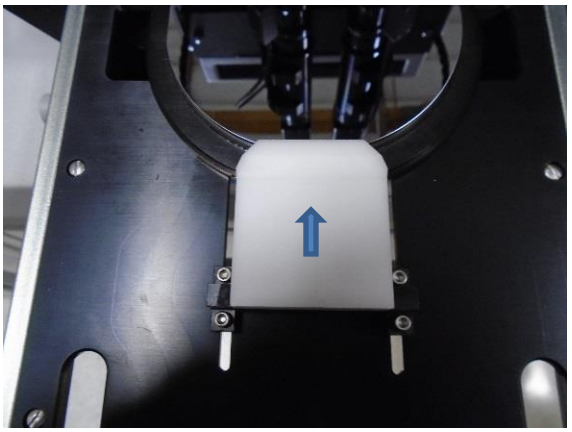


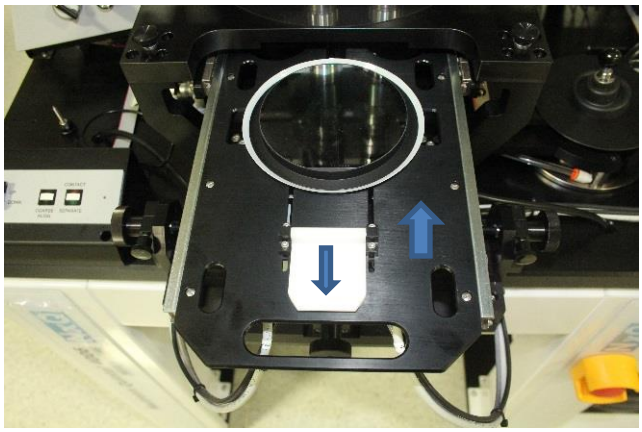
Prealigner

Much of the effective throughput on an aligner is related to the accuracy and speed of the prealignment. If the first photo layer is printed accurately with respect the wafer flat, all subsequent alignments will be faster.

For round wafers or substrates with alignment flats, the **NxQ** NXQ4006 uses a mechanical **Prealigner** to insure fast, accurate prealignments.

The prealigner flatfinder lies down flat on the chuck surface and the wafer flat is rotated against the flatfinder edge. The side of the chuck is used as a guide for the round wafer edge. The prealigner travels with the tray, so the operator may move the tray in slightly to activate the holding vacuum, then flip the prealigner back to lay flat and out of the way while the tray moves in to its load position. With a little practice an average operator can accomplish almost perfect prealignments very quickly.

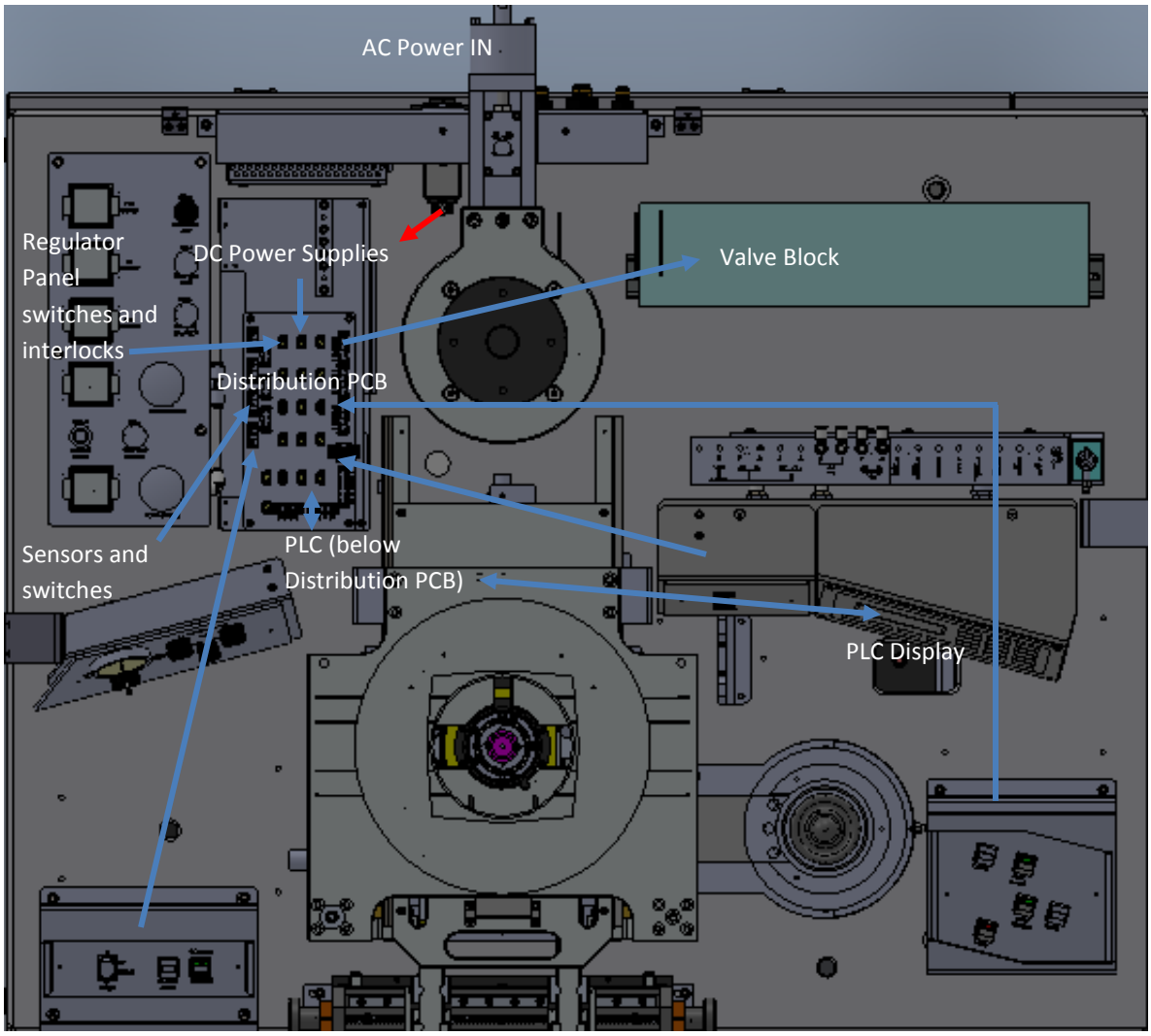




Align the wafer flat with the prealigner. Flip the prealigner back and push the tray in to load the wafer.

For square or rectangular substrates NxQ chucks are equipped with “corner stops,” generally three pins arranged to provide a long side and a stop pin to locate the substrate accurately. No external prealigner is used in this case.

Electrical System



Electrical System

The AC power to the machine runs to the DC power supplies that basically power all the electrical components. There are power relays to switch and hold the DC power.

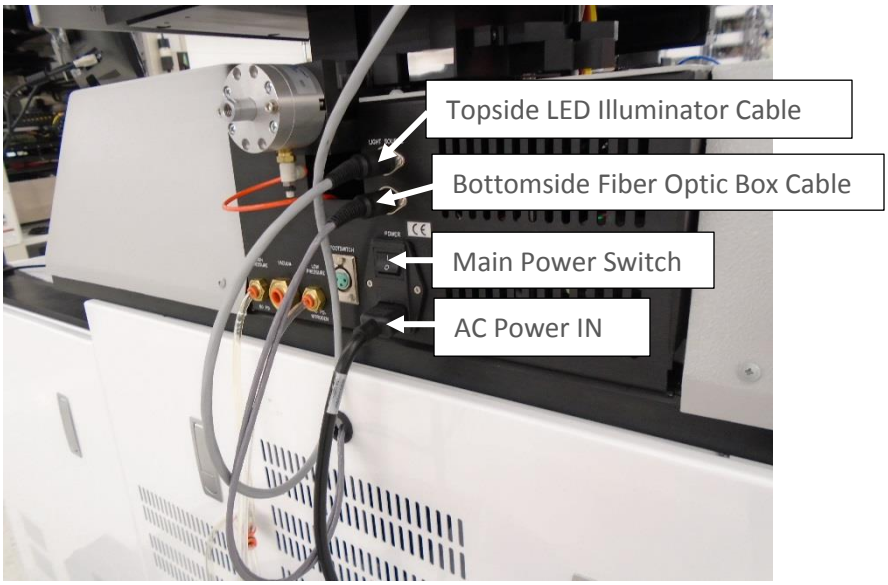
The **Distribution PCB** is the wiring hub of the electrical system. All the sensors and switches feed into the Distribution PCB. From there they are sent to the PLC inputs.

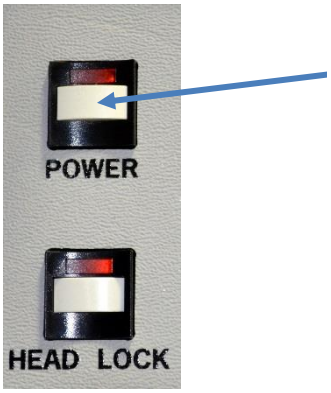
The PLC send the signals to operate the valves to the Distribution PLC and from there they are sent to the Valve Block. The PLC communicates with the PLC Display panel.

The NXQ4006 operates under International Standard electrical sources, and is externally configured by means of a selectable input device to operate with either 120 volts or 240 volts or is automatically switching. The main line is fused at the point of input. There is a **Main Power Switch** at the point of entry which disconnects all voltage to the machine.

The primary AC voltage is then sent to the **24vdc** and **5vdc Power Supplies**.

The 24 volt supply goes to the switches and sensors, PLC, valves, etc. that control most operations of the machine and also provides LED Illuminator power. The 5 volt supply is used for illumination control of the LED's and the OBS/IR Fiber Optic control.

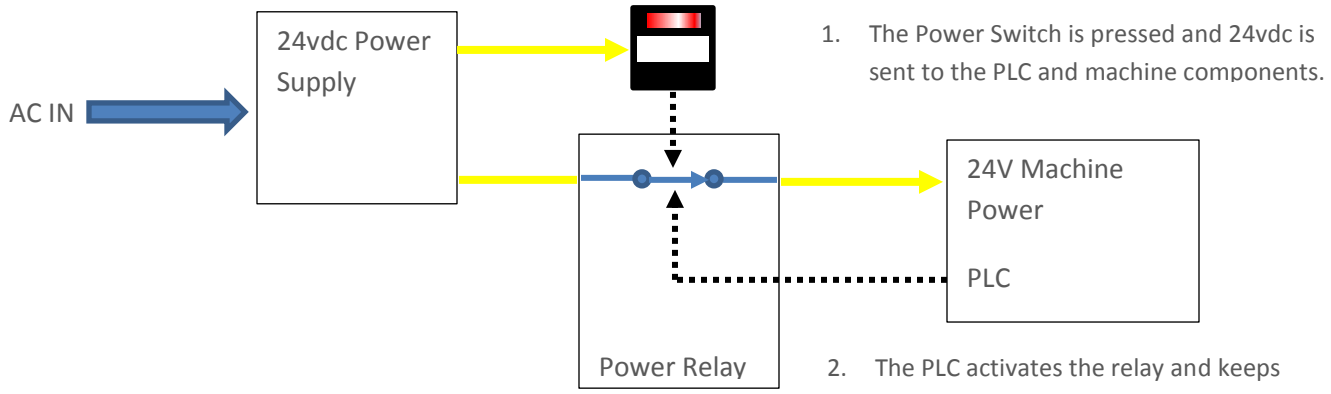




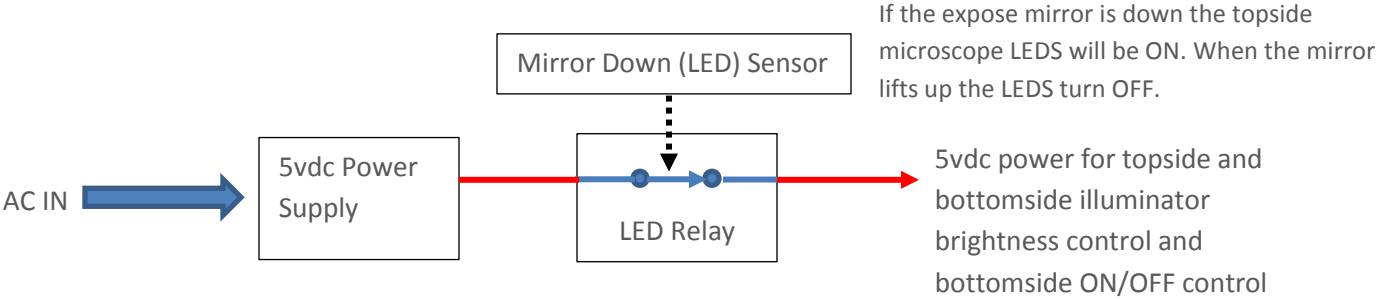
The power supplies are always powered up when the Main Power Switch is turned on. When the **Power Switch** on the upper right panel is pressed, 24vdc is supplied to the machine. This powers the PLC which then continues to activate a relay, maintaining power until the PLC program shuts off the relay.

Power is shut OFF by selecting **POWER OFF in the Main Menu of the PLC**. This is necessary because the PLC needs a brief period of time to store variables like EXPOSE TIME to memory.

NOTE: PRESS AND HOLD THE POWER SWITCH FOR MORE THAN 2 SECONDS SO THE PLC CAN ACTIVATE THE POWER RELAY AND PROVIDE MACHINE POWER.

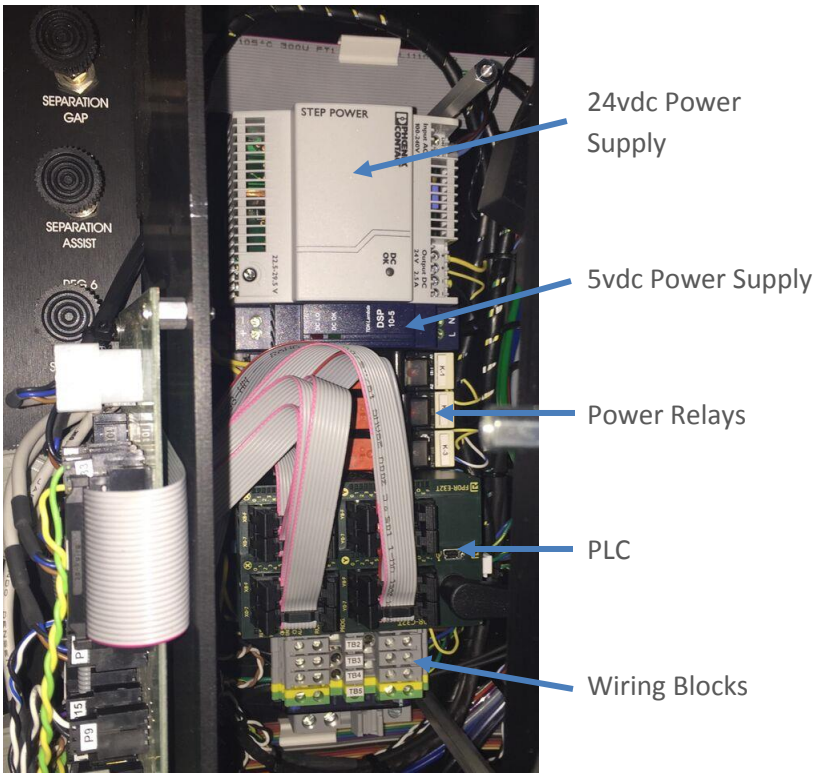


1. The Power Switch is pressed and 24vdc is sent to the PLC and machine components.
2. The PLC activates the relay and keeps power on the machine.



If the expose mirror is down the topside microscope LEDS will be ON. When the mirror lifts up the LEDS turn OFF.

5vdc power for topside and bottomside illuminator brightness control and bottomside ON/OFF control

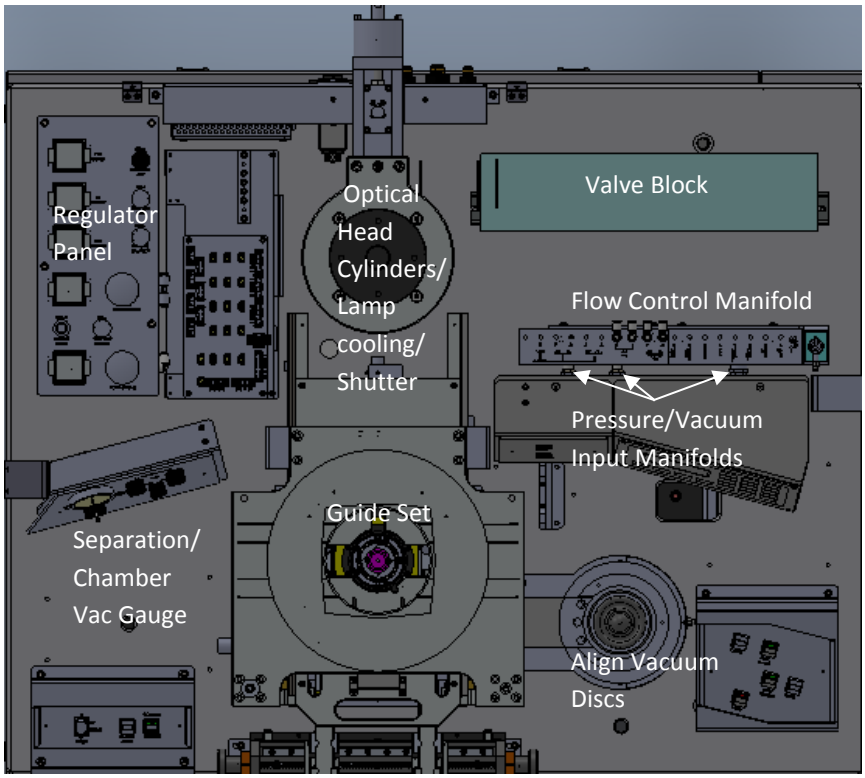


Distribution PCB lifted to show the DC power supplies, relays and PLC

Pneumatic System

Much of the mechanical work done by the mask aligner is performed by pneumatic systems; air pressure moves air cylinders or supports parts on a cushion of air, vacuum applied to a cavity between two parts locks them together to prevent movement, a stream of air cools the UV lamp or a stream of nitrogen cleans and purges the printing chamber.

Two gas utilities are required to supply the machine. At the input panel, provision is made for connection to sources for clean, dry compressed air at 80 psi for the operation of **High Pressure** devices such as air cylinders. **Low Pressure** is supplied by pure nitrogen at 40 psi for use in cleaning and conditioning the expose chamber; generally process related situations. The third connection is for **Vacuum** at ≥ 21 inches of mercury for locking, holding, and providing printing chamber vacuum.



Within the machine at the left rear is the **Regulator Panel**, which holds seven precision pressure regulators to regulate the gas pressures used for various functions. Also mounted on this panel are two pressure switches and a vacuum switch to signal the control system when certain critical pressures are met.

On the right side of the machine directly behind the control panel is mounted a manifold containing **Flow Controls** used to control the rate of gas flow to various components. These controls are used extensively by the Process Technician to fine tune the operation of the machine.

The final component of the pneumatic control system is the array of electrically operated **Solenoid Valves (Valve Block)** which at the direction of the control system, turn the various vacuums and air pressures off during the operation cycle.

The functions of all of these devices are described in detail in the **Machine Controls** and **Theory of Operation** section of the manual

The Viewing System

The NXQ4006 is a **manual** aligner. Alignment is achieved by an operator manually moving the substrate into alignment with the mask. The mask is fixed in its position on the mask holder. The operator aligns with hand controls, while viewing the images of both mask and wafer under high magnification. This section outlines the vision systems used for alignment.

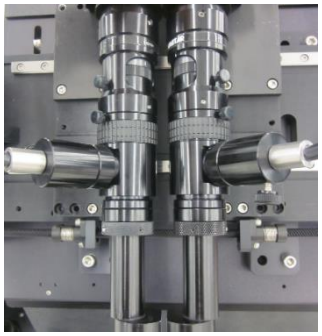
The NXQ4006 may be configured with the **Dual HD Video-View Zoom System** or **QuadCam HD** video system connected to a split screen monitor. The image from one camera fills half of the screen, while the other camera fills the second half.

All of the viewing units may be adjusted for observing at different spread distances (X Tracking) or move forward or back (Y Tracking). There are two locking knobs to lock the Y motion of the microscopes so they do not move when the expose mirror extends.

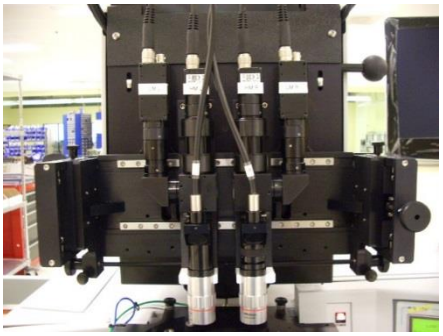
The zoom system changes magnification and field of view. Each objective can be focused individually and the entire microscope can be raised and lowered to focus both objectives at the same time.

NXQ4006 Camera Configurations

HD Cameras/Video-View Zoom Microscopes



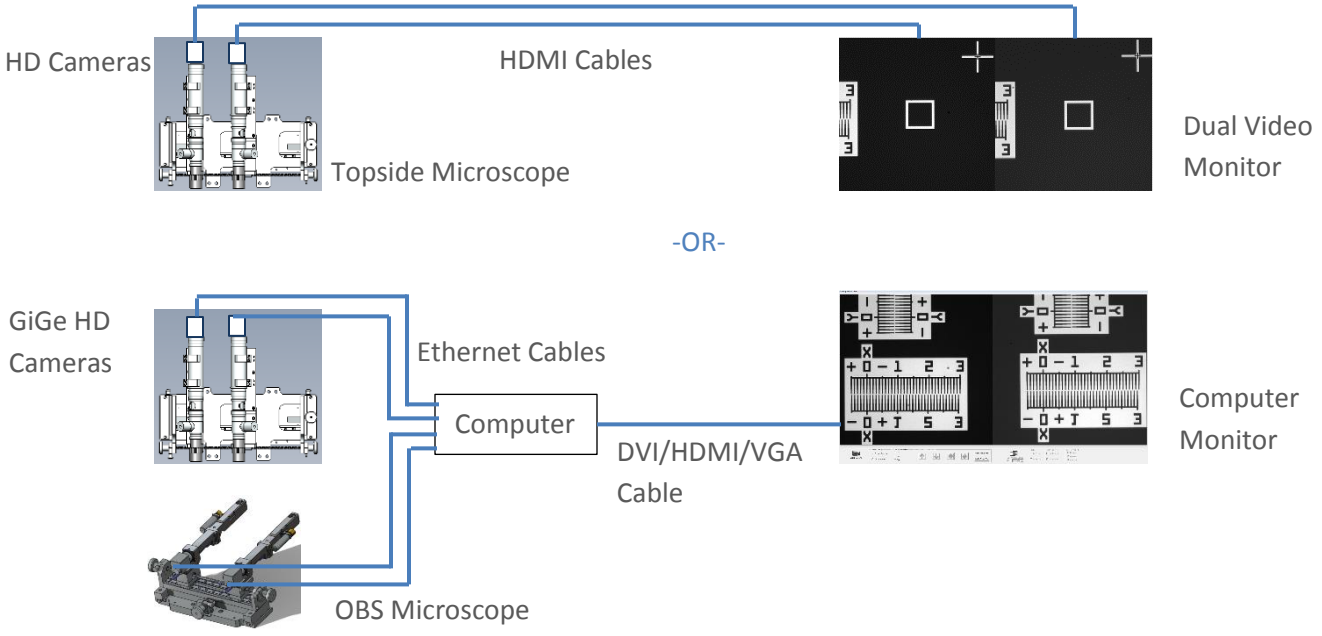
Video-View Zoom Microscopes with Offset Objectives



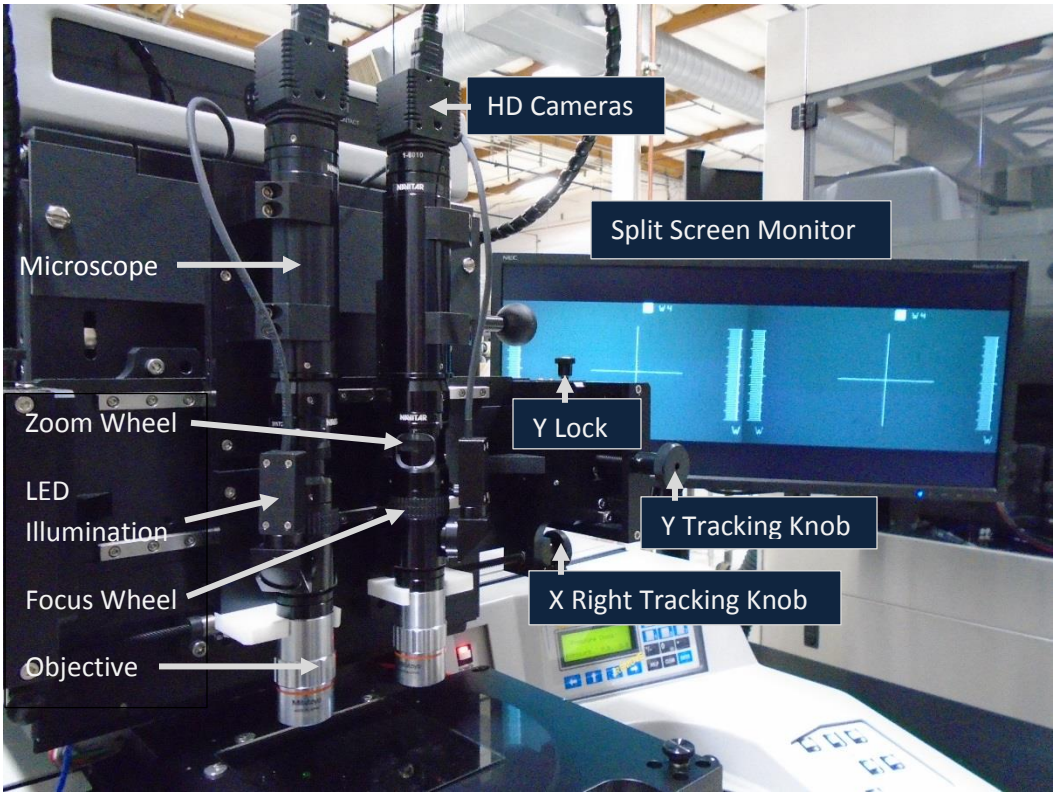
QuadCam Microscope with Standard Objectives

GiGe HD Cameras/Video-View Zoom Microscopes/Standard Objectives

Vision System Connections



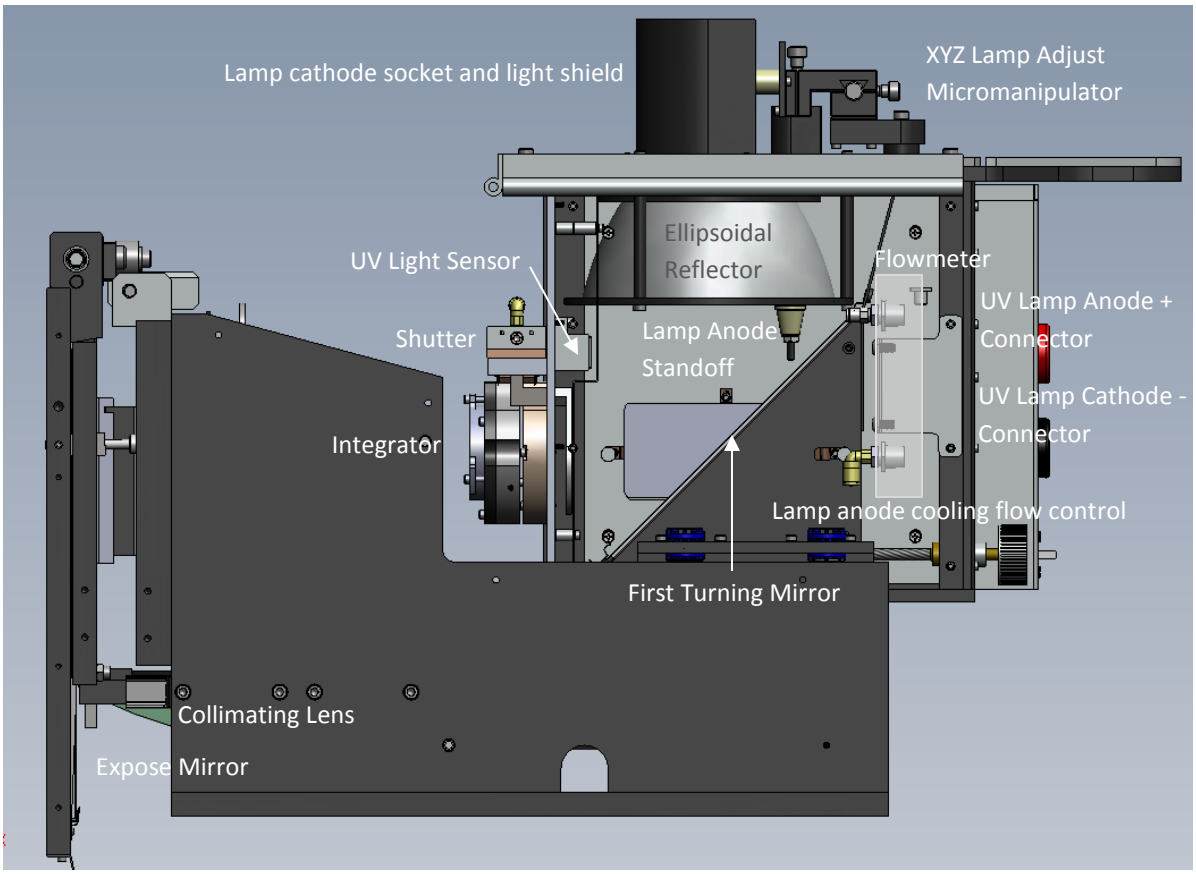
HD Video-View Zoom Components



HD Video-View Zoom System

Please see the **Viewing Optics Setup** in the **Start Up** section of the manual for details.

Exposure System

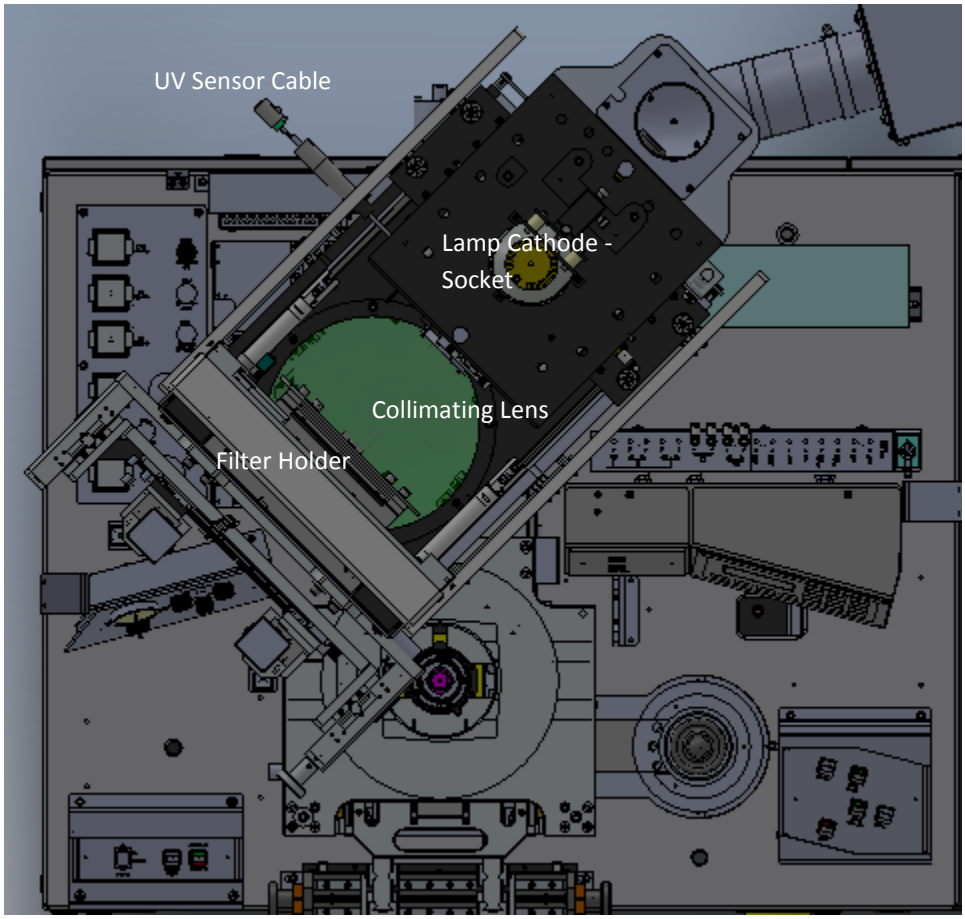


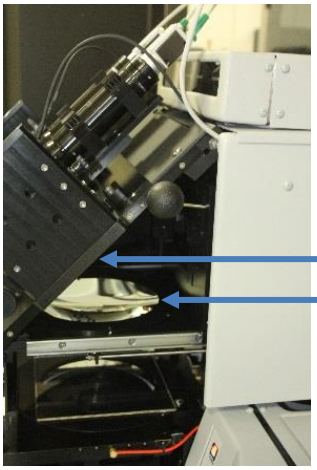
The NXQ4006 is equipped with the state of the art Q170/15 exposure system. This unit can be configured for a range of lamp sizes from 350 watts to 1000 watts. It employs an ellipsoidal mirror as its initial energy gathering element, a precision X–Y–Z manipulator to permit easy and repeatable lamp positioning, a multi-lens light integrator to process the light for optimum uniformity and high efficiency dielectric mirrors for lowest possible energy loss. The mirrors pass through IR to reduce heat at the wafer.

The entire light source unit is contained in an enclosed housing designed to provide maximum environmental protection to the operator and others in the area.

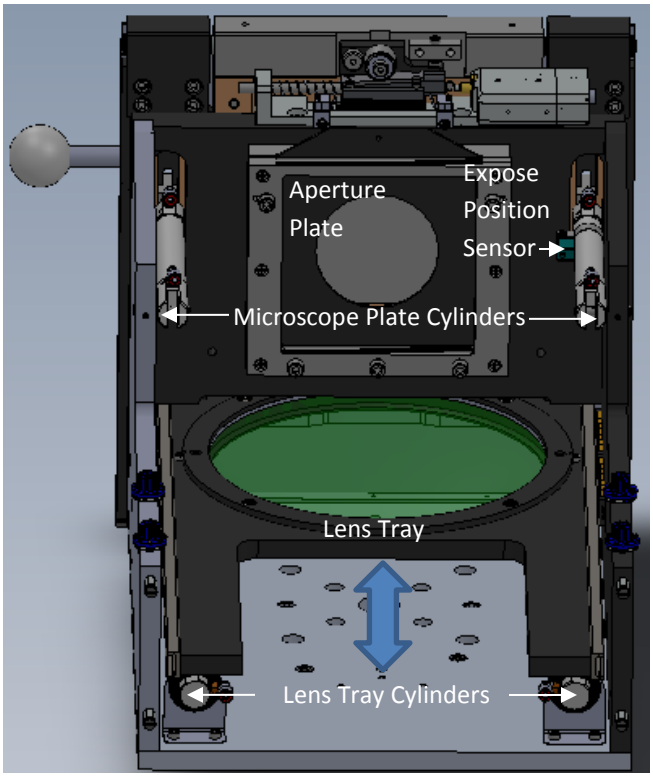
There is a UV light sensor to provide feedback to the UV power supply to maintain lamp intensity throughout the life of the lamp.

A window of UV protective glass allows the technician to observe the inside of the lamphouse safely.





The Collimating Lens and Expose Mirror extend at the time of exposure.



The Lens Tray Cylinders drive the Lens Tray out and this pushes the expose mirror up into the expose position. The Microscope Plate Cylinders pull the microscope plate back into the view position.

UV Lamps and Power Supplies

Because process requirements result in widely varying energy and spectral specifications, there are a number of options available for the light source.

The actual light source for the exposure illumination is a lamp known as a **Mercury Short Arc Lamp**. This lamp employs a quartz envelope which will withstand the high pressure and high temperatures encountered in operation of the lamp.

These lamps are available in the following wattage values:

- 350W
- 500W
- 1000W

The lamps are NOT physically interchangeable and some modifications to the lamp house are necessary to go from one size to another. The 1000W requires a different lamphouse.

The lamp usually used in the NXQ4006 is the 350W lamp. The 500W lamp is used if more intensity is required.

The 350W lamp can be either standard body or integral (flying) lead. The 500W lamp MUST be flying lead.

350W Lamps:

NXQ Part Number	UV Lamp
6000-3501	Lamp, 350W, STD Body
6000-3503	Lamp, 350W, STD Flying Lead

500W Lamp:

NXQ Part Number	UV Lamp
6000-5009	Lamp, 500W, Flying Lead

The Flying Lead Lamp or (Integral Lead Lamp) has the lead wire connected to the anode ribbon of the lamp.

Benefits of the flying lead are:

- The lamp can only go in the correct way (anode down).
- There is no anode terminal to collect heat or block the UV light.
- Does not require a lead wire.

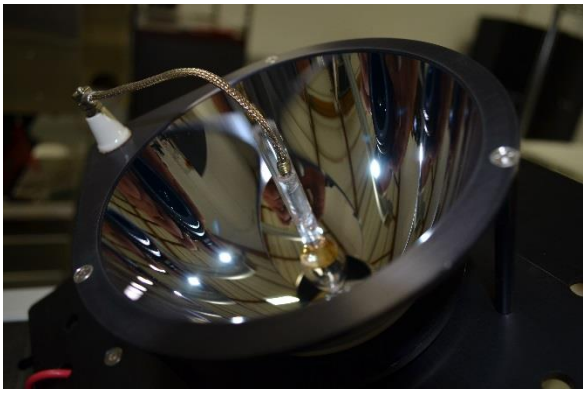
The Standard Body Lamp has an anode lamp terminal. It requires a separate lead wire.

Benefits of the standard body are:

- More common and available from more manufacturers.
- The terminal can be a better ribbon seal connection, although the flying lead is also good.

A **Lead Wire** running from the anode stud to the anode of the lamp is necessary to mount the 350W lamp without integral lead.

NOTE: The UV lamp is always mounted with the ANODE+ DOWN. Only the DUV lamp is anode up.



500W Flying Lead Lamp

The special power supplies required to drive the lamps are manufactured in two sizes, with each size internally switchable to drive two lamp wattages: 350/500 and 500/1000. These power supplies are also internally switchable to accommodate both U.S. and International voltages. Wattage versus output is not linear, but a larger lamp inevitably results in more exposure energy.

350W/500W Controllers

PSP-500 ILLUMINATION CONTROLLER

-OR-

2105C2 ILLUMINATION CONTROLLER

1000W Controller

Another variable with these lamps is the **Spectral Output** of the lamps. The internal configuration of the lamps may be altered at the time of manufacture to enhance various wavelengths. Some of these modifications require modified power supplies such those used with DUV lamps. If the process requirements under consideration dictate a special spectral output, consult the factory for information.

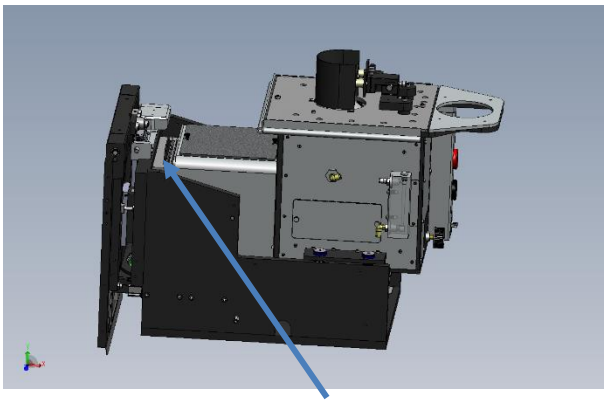
Exposure Light Level Control is an important subject for the process engineer since it has an immediate effect on the quality of product coming from the aligner. There are a number of techniques available for consideration.

All **NxQ** aligners are equipped with a **constant intensity power supply**, which senses the UV light and maintains a set intensity by increasing the lamp power as the lamp ages.

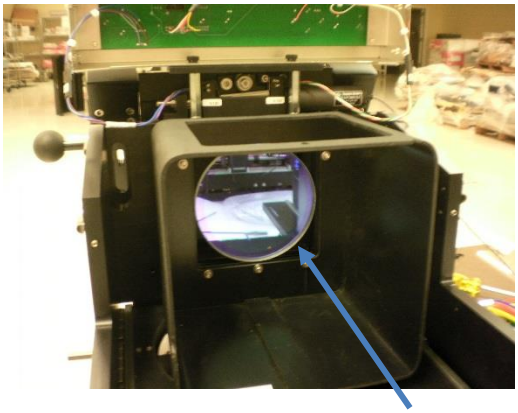
The power supply can also run in a **constant power** mode**.** The lamp power is set by a wattage control knob and increase manually as the lamp degrades. **A lamp run continuously at one power level must always operate within +/-10% of its rated wattage.**

Optical Filters

An excellent, safe, and highly versatile way of modifying light outputs is to make use of **Optical Filters** to either select certain UV wavelengths (bandpass) or reduce the overall intensity (neutral density). NXQ can provide excellent filters to improve performance. SU-8 and I-line filters are most commonly used. The SU-8 filter reduces “T-Topping” and produces straighter walls. The I-line filter can improve resolution when using high resolution resists.



UV Filter Holder



I-Line Narrow Band UV Filter

Defocusing the Lamp

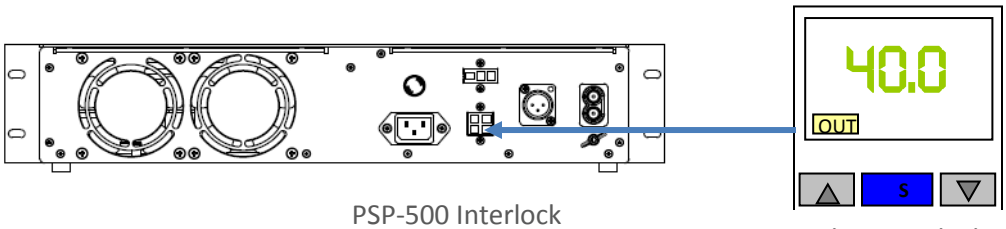
A popular method of reducing output is by "**Defocusing**" the lamp, a technique NOT approved by **NxQ** due to the chance of overheating the anode. However, within very narrow limits this technique can be utilized for "fine tuning" a system, recognizing the hazards of doing so.

From the point of maximum intensity, defocusing should only be done in the direction which **RAISES** the lamp in the reflector. The principal use for this is to "fill" the rear of the lens assembly with light. Never change the intensity more than 2 mw/cm^2 from peak intensity by defocusing.

Cooling

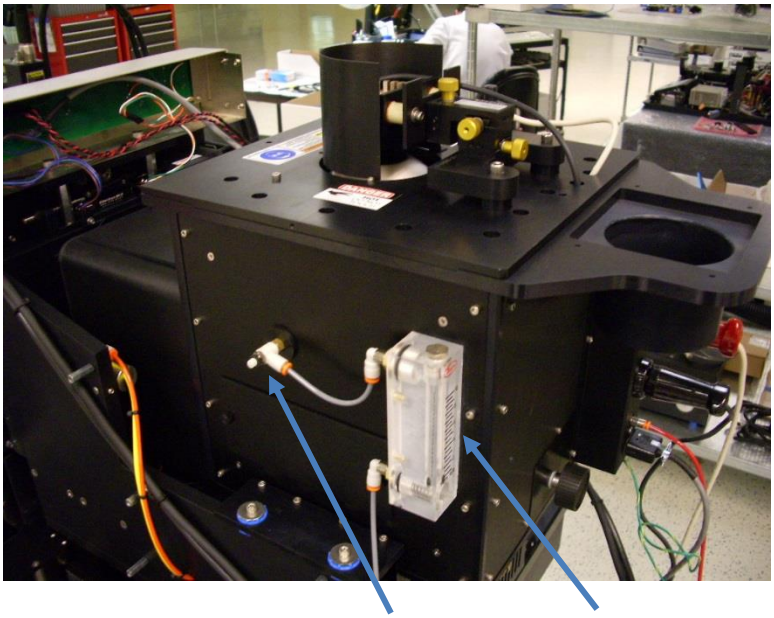
Cooling is critical to the proper operation and life of the lamp. Under-cooling and over-cooling are both detrimental in their own ways. The lamp must always be thermally stable.

The cooling system installed on the NXQ4006 is designed to optimize the cooling and every effort must be made to maintain the system as installed. Do not modify any openings or baffle the inlets or outlets of any of the air circulation system. There is a controlled air flow directed at the lower lamp terminal; the flow control for this air supply is mounted on the lamphouse and should be left at the factory setting for the lamp. There is an interlock that will shut off the UV power supply if the facility low pressure falls below 25 psi.



PSP-500 Interlock

UV Cooling Interlock Set/Display on the Regulator Panel



Nominal flow rates for UV lamp anode cooling:

350W = 2-3 SCFH

500W = 3-4 SCFH

The 1000W system has a dedicated anode cooling fan.

UV Lamp anode cooling flow control and flowmeter

The lamphouse uses an external exhaust fan to remove excess heat from the lamp house. This fan unit normally sits on the floor behind the aligner table, and is connected to the aligner by a flexible hose. Check this fan unit frequently to insure that it is functional and has not had its outlet blocked.

UV Cooling Exhaust Fan

Process System

There are many process options available on the **NxQ** NXQ4006, the majority of which involve the conditions existing in the interface between the mask and the substrate.

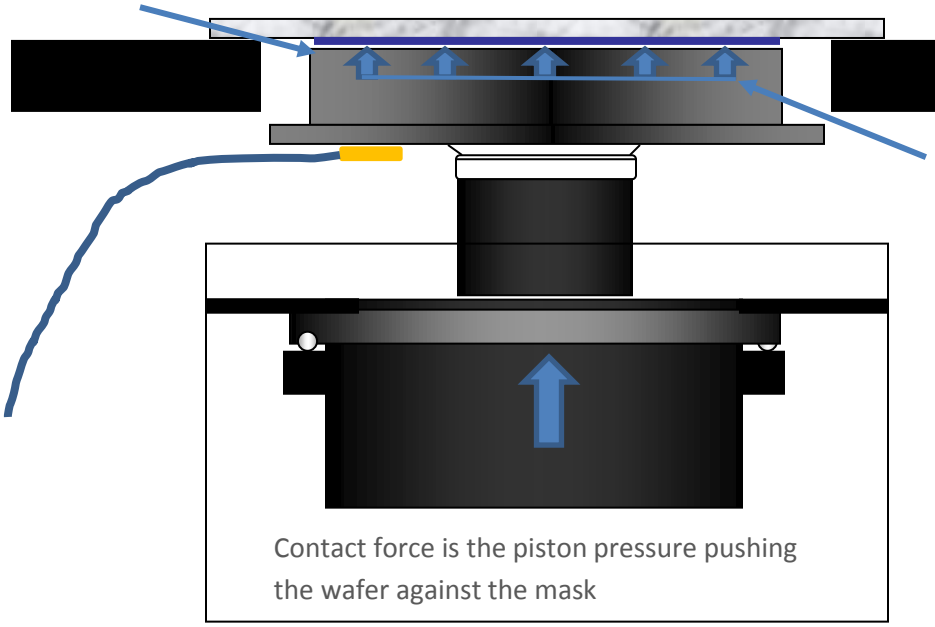
The **Substrate Chuck**, which carries the substrate into the expose chamber provides a very flat and smooth support surface for the substrate. This surface may be considered a reference plane which does not change regardless of what is done around it.

The **Mask**, containing the pattern which we wish to transfer to the substrate, is in itself very precise, but because we require it to be thin and transparent, is not very stable. The process controls provided by the NXQ4006 allow the balancing of various forces to keep the interface as uniform as necessary to achieve the desired product characteristics.

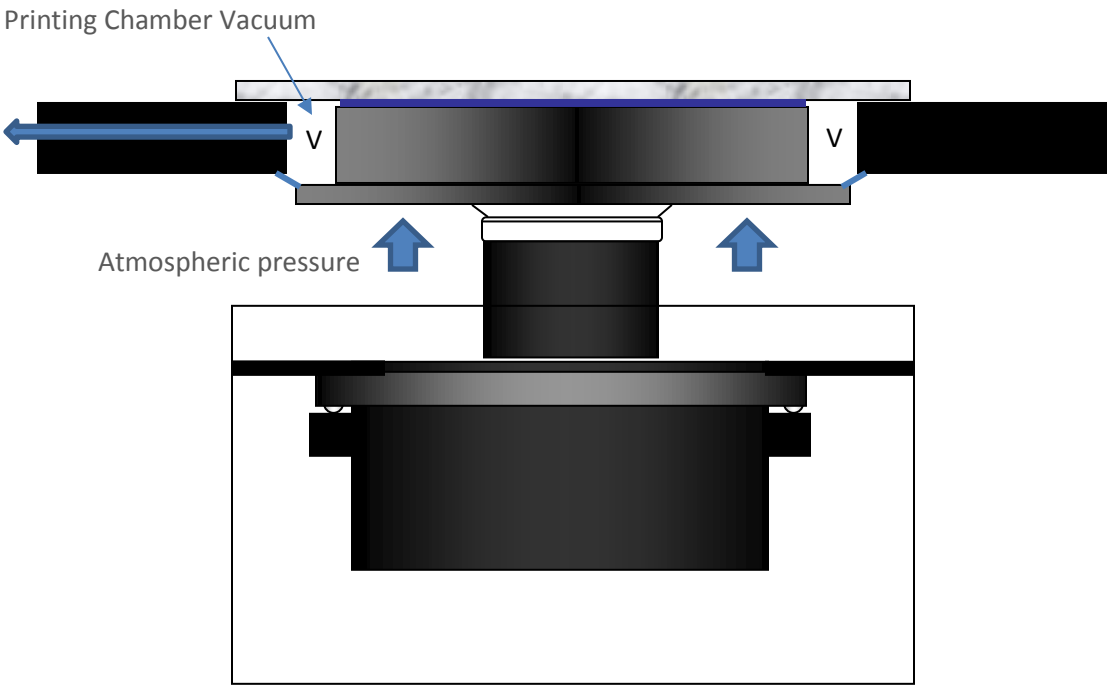
The controls provided are:

- The ability to apply vacuum to the substrate/chuck interface to make the substrate as flat as possible (**chuck vacuum and surface flatness**) or to introduce low pressure to this interface to force the substrate up into intimate contact with the mask (**expose pressure**) or vary the upwards pressure exerted by the guide set on the substrate (**contact force or piston pressure**).

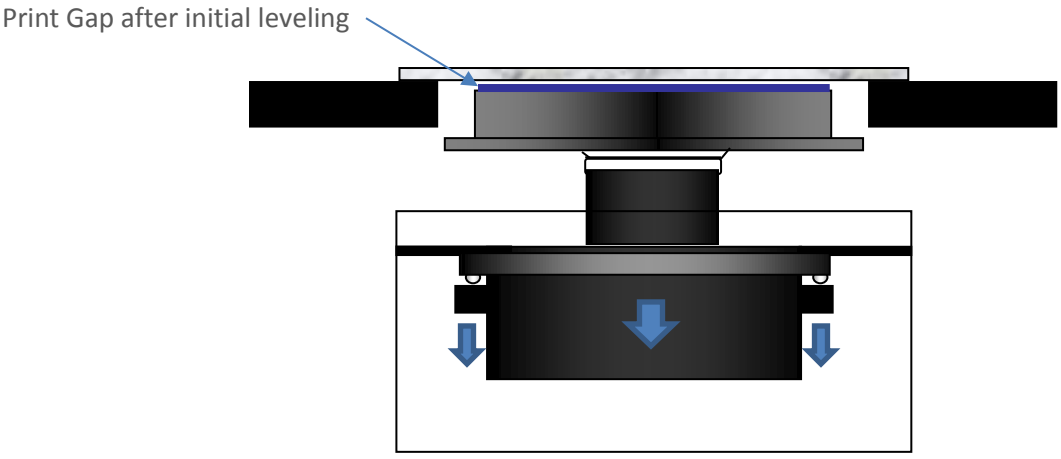
Chuck vacuum/flatness can make the wafer conform to the chuck.



- Introducing a controllable vacuum into the sealed chamber surrounding the mask/substrate, which allows atmospheric pressure to counterbalance these upwards pressures, or to allow the full force of the atmospheric pressure to press the mask and substrate together for a minimum gap during exposure (**vacuum contact**).



- Setting up a procedure which, after the initial leveling contact, never lets the substrate touch the mask again, and allowing the exposure to take place with a controlled gap between the two (**contact calibration**).



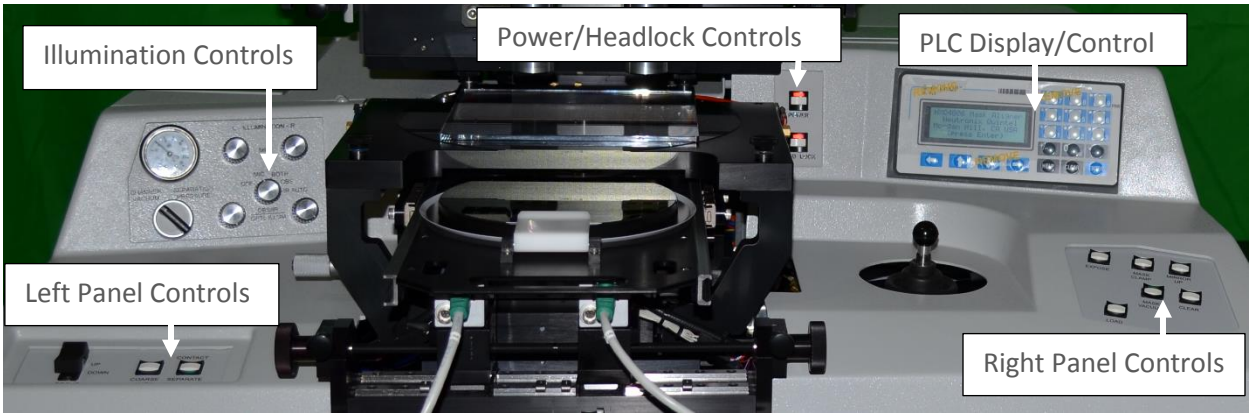
Machine Controls

This section introduces you to the operator-machine interface for the **NxQ** NXQ4006 Aligner. The NXQ4006 has been carefully designed for ease of use by operators of all skill and experience levels, and for a very short learning curve. The user will soon be completely comfortable with the operation of the machine.

The first part of the section is devoted to the **Control Panels** which contain the push button switches that operate the manually controlled functions and initiate the machine controlled sequences of the cycle. Also detailed are the various pneumatic controls to set the pressures and flow rates for the aligner.

The final section introduces the **PLC** – the programmable logic controller that stores the process variables and drives machine operation.

Control Panels



These are the electronic controls of the NXQ4006. Three control panels contain push-button switches and one has microscope illumination control knobs.

The brains of the machine is the **Programmable Logic Controller (or PLC)**, a miniature computer-run controller that stores within its memory what needs to be done in which sequence to perform a task.

Upper Right Control Panel

This small panel contains two push button switches; the upper one is the main **Power Switch** which controls the power to all of the functions of the machine.

The second switch is the **Head Lock** switch which locks the optical head in the view position or mask load position.

When the switch is OFF, the head lock deactivates, allowing the optical head to be swung to the left side to facilitate mask changing, tool replacement, cleaning or other maintenance operations.

Return the head to the view position and press the switch to lock it.

NOTE: The Power Switch will <u>NOT</u> turn the aligner off. The off function is under PLC control so process variables can be saved prior to actual turn off.

Shut down by turning off the main input switch, or by power failure, will not damage the machine, but it is recommended that the logic shutdown technique always be used for normal shutdown.

Press 6 on the keypad to turn the aligner OFF

The PLC Display is also in the Upper Right Control Panel. It will be discussed later in this section.

Lower Right Control Panel

This is the main operational panel for the aligner and contains push button switches to control many of the operator initiated functions of the production cycle. Two of these, **Mask Clamp** and **Mask Vacuum**, are used to install the mask on the mask holder. **Mask Clamp** controls the vacuum that holds the mask clamp to the mask. **Mask Vacuum** controls the vacuum that holds the mask to the mask holder.

Refer to the mask loading step in the **Operation Sequence** for more information.

Load initiates the planarization/alignment cycle after the substrate has been placed on the chuck, pre- aligned, and moved into place by the tray. The wafer chuck will always have vacuum when the tray is partly pushed in so the wafer will be held during the move, but the chuck will not lift to the mask holder until the tray is fully in. The normal sequence is to press the Load Switch, prealign the wafer, push the tray in slightly, the flip the prealigner back and then push in the tray to load the wafer.

If **Auto Load** is selected on the Operating Modes, it is not necessary to press the Load Switch. When the tray is pushed in, the piston will automatically lift. While this is faster, care must be taken not to push the tray in with no wafer on the chuck and a mask present. The chuck vacuum will cause the chuck to stick to the mask and it is necessary activate the expose pressure and press Clear to unload the chuck.

Expose initiates the expose cycle, after the operator has completed the alignment of the substrate and has confirmed that the alignment is satisfactory in contact.

Clear is the reset or cancel control for the NXQ4006, and is used to return the substrate/chuck to the start condition when necessary. Pressing Clear will drop the chuck and wafer so the tray can be pulled out to remove the wafer or load the wafer again.

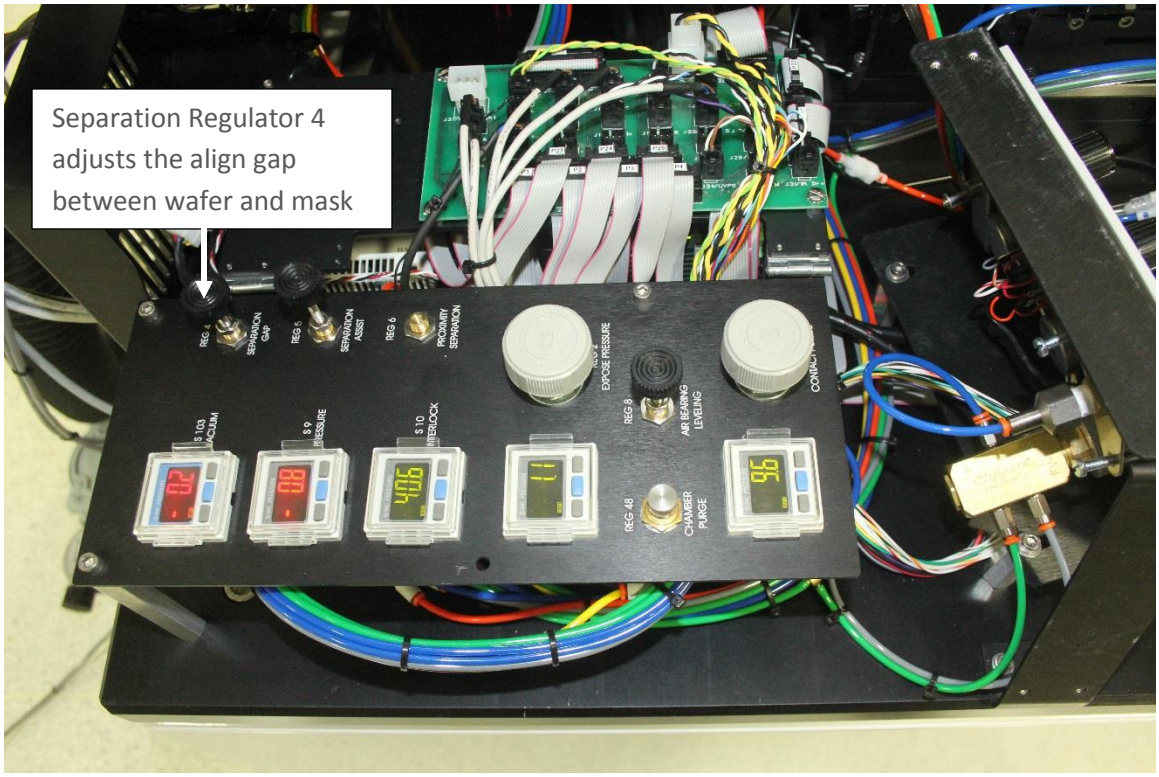
Mirror Up raises the expose mirror and microscope. It is mainly used on an OBS aligner. The mirror should be up before the mask alignment marks are captured in the OBS machine cycle.

Upper Left Control Panel

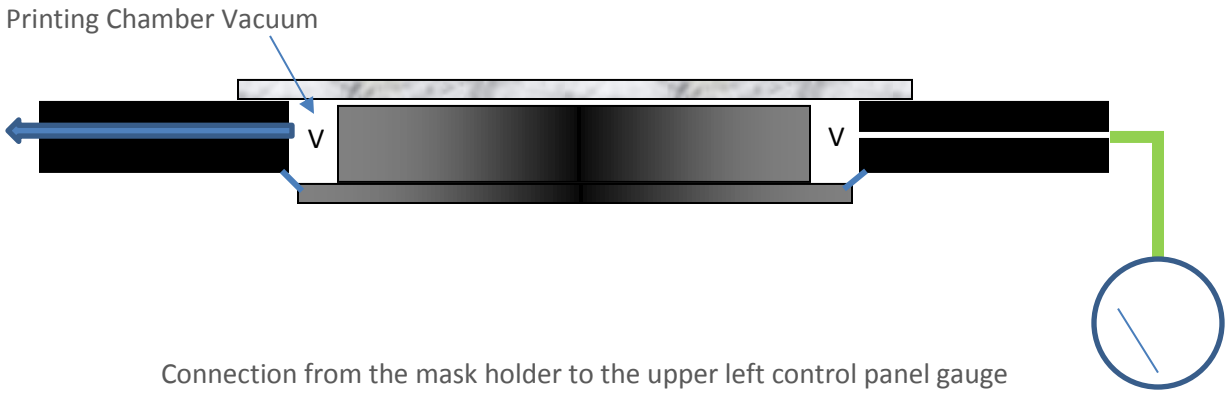
This panel contains a pressure gauge capable of reading both pressure and vacuum and a selector valve to choose whether it reads **Chamber Vacuum** or **Separation Pressure**.

The chamber vacuum mode is used in setting up the machine for vacuum printing and the separation pressure mode is used to establish the separation distance for alignment.

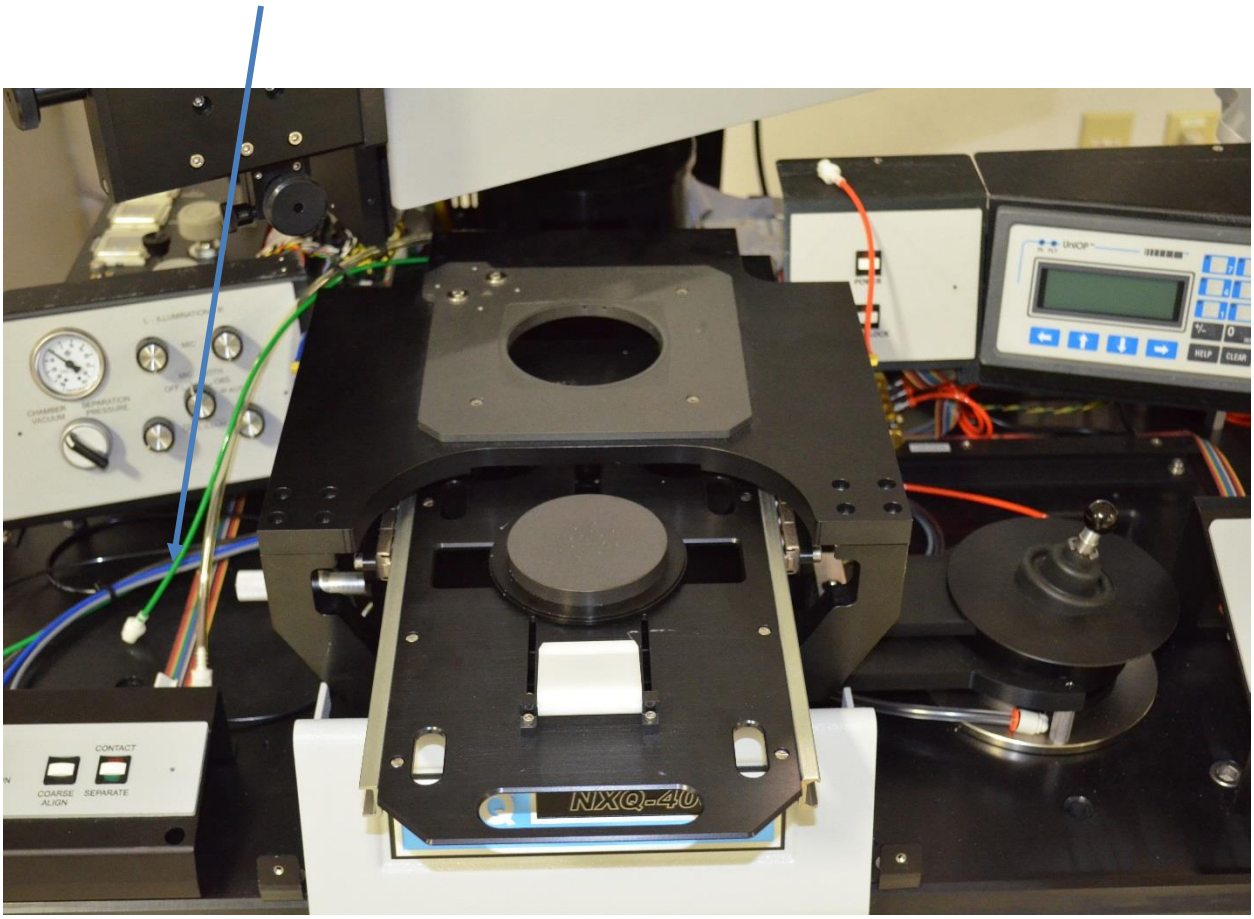
If the gauge selector is set to the right the gauge reads the separation pressure. In general, a separation pressure of 7-10 psi produces an alignment gap (separation distance between mask and wafer) of approximately 20 microns. The separation pressure is set by **Regulator 4** in the Regulator Panel on the left side of the machine. Turning the regulator knob clockwise increases the pressure which can be seen on the gauge. Greater pressures produce more separation distance. A pressure of 25 psi will result in a separation of 100 microns or more. A pressure of 0 psi will produce a gap of approximately 2 microns.



If the gauge selector is switched to the left, it shows a direct reading of the printing chamber vacuum. The green hose to the mask holder is the dedicated hose to read the chamber vacuum.



Connection from the mask holder to the upper left control panel gauge



Also mounted on this panel are the controls for the microscope illuminator brightness. If the aligner has been equipped for infrared viewing or Optical Backside Alignment, a switch is provided to select the mode of illumination; either normal top side bright field, or bottom side through the substrate illumination, or both. In either case there are separate controls for each side of the microscope.

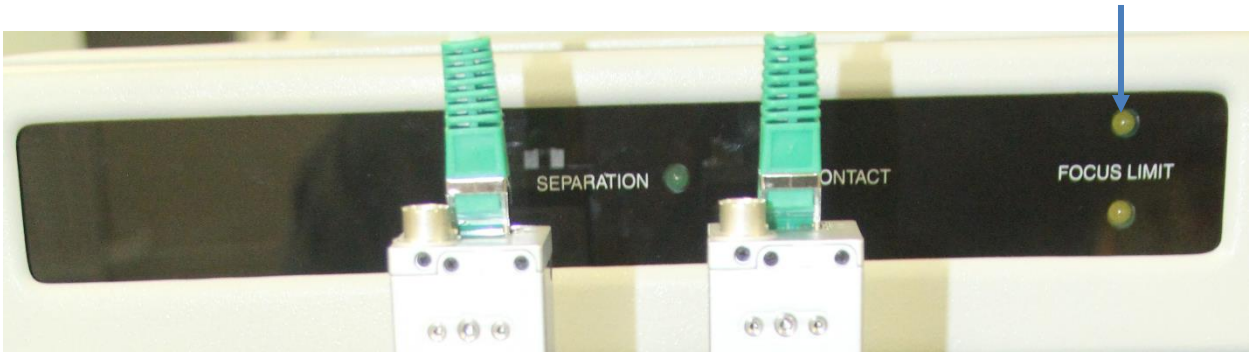
Lower Left Control Panel

The Lower Left Control Panel contains the **Focus Up/Down** Switch, **Coarse Align Switch** and the **Contact/Separate** Switch.

Focus Up/Down moves the entire microscope up and down to focus on the mask. There are individual focus wheels on each microscope tube, but this switch allows the operator to move the microscope into focus after each objective has been set.

It is generally a good idea to focus the left microscope with the Focus Up/Down Switch and the right microscope with the focus wheel. This way the microscope motor stays close to mid position in leadscrew travel.

If the focus motor moves to the end of travel an LED will light up on the Microscope Display Panel.



If the LED lights, push the focus switch in the opposite direction and adjust the microscope focus wheels as needed.

Coarse Align is a momentary switch that is pressed whenever a larger joystick motion is needed during alignment. If you want to move the wafer alignment mark farther in the field of view, press the Coarse Align switch before and during your joystick move. When the switch is released, the joystick will go back to **Fine Align** motion and the wafer will not move as far when you push the joystick.

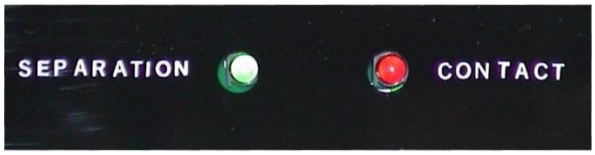
Press the **Contact/Separate Switch** to change the state of the machine between separation and contact. The wafer is aligned on Separation and exposed in Contact.

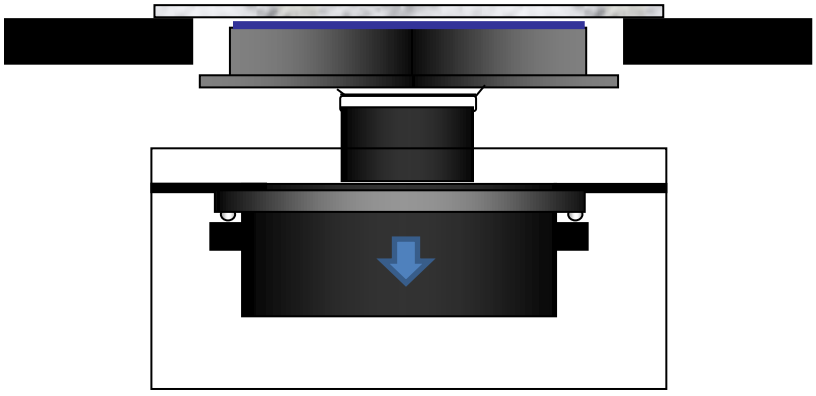
The wafer will load and level against the mask and then automatically wait in Separation so it can be aligned to the mask. When the alignment is satisfactory, press the Contact switch to bring the wafer into contact with the mask.

If the alignment is still good, press the Expose Switch to expose the wafer.

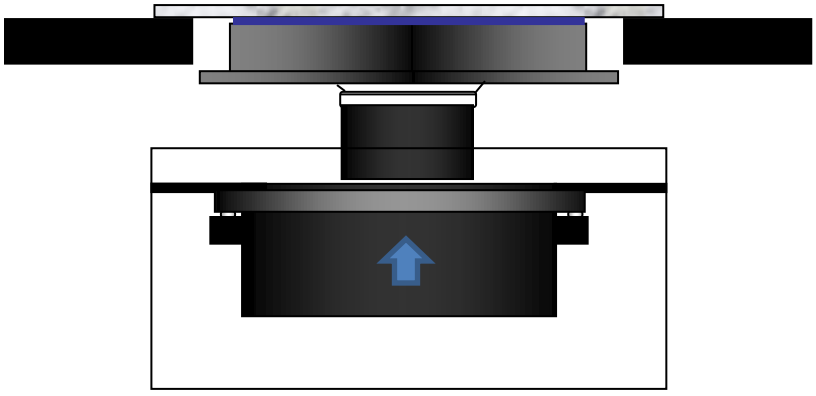
If the alignment is not good, press the Separate switch to bring the wafer back down to the separation distance and realign the wafer.

The Microscope Panel Contact/Separate LEDs will light showing which state the machine is in. The LEDs on the Contact/Separate Switch will also light.



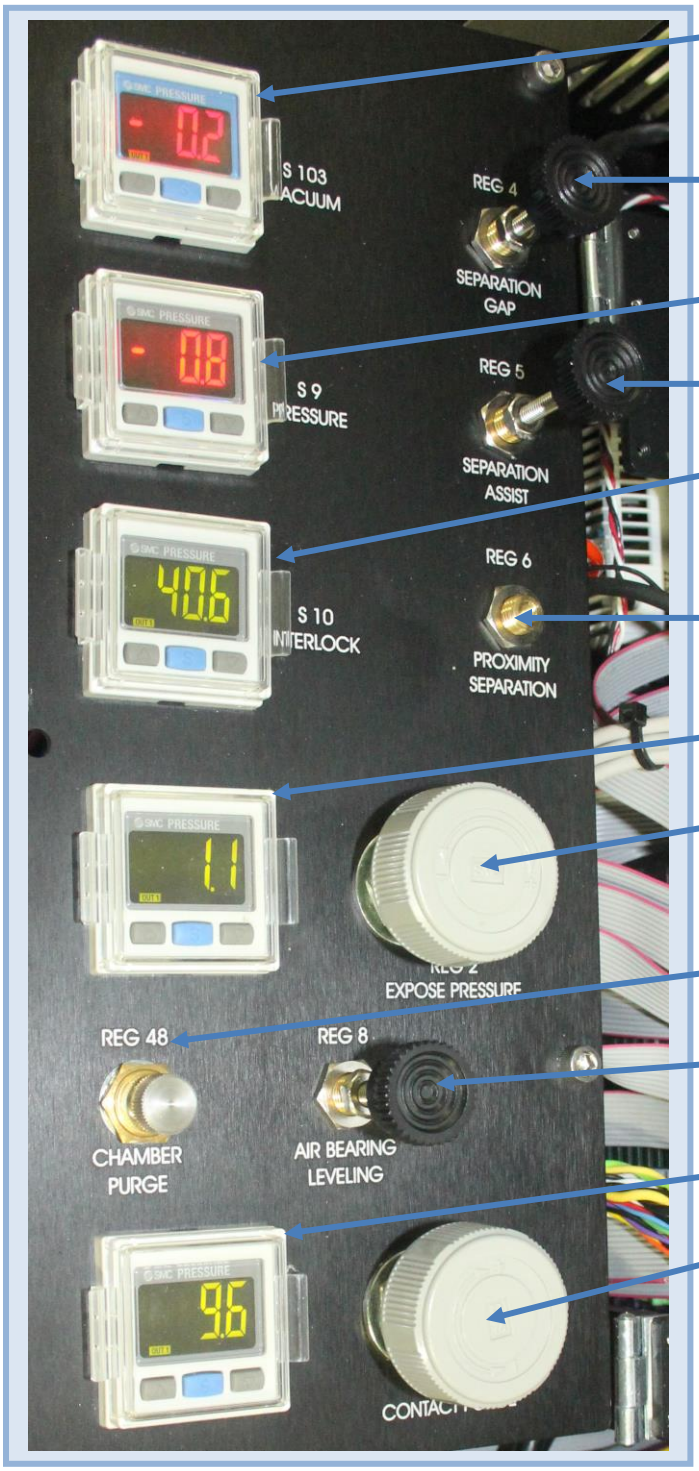


Separate



Contact

Regulator Panel



Switch 103 Vacuum Switch/Display– When in vacuum printing mode, detects when the chamber vacuum has equaled a predetermined setting, to activate the expose sequence.

Regulator 4 Separation Gap– Supplies air to increase or decrease the substrate separation gap during alignment.

Switch 9 Pressure Switch/Display– Detects when the substrate has been lifted into contact with the mask.

Regulator 5 Separation Assist–Provides air pressure to assist the chuck piston in the separation mode.

Switch 10 UV Cooling Pressure Interlock/Display- Usually set for 20-25 psi. If the Low Pressure falls below this value the UV Power Supply will turn OFF. The anode of the UV lamp must have a cooling purge.

Regulator 6 Proximity Separation– Supplies air to control substrate separation for Contact Calibration (Proximity Gap) Printing Mode.

Expose Pressure Display

Regulator 2 Expose Pressure–Expose Pillow Pressure, supplies low pressure between the chuck and the substrate during exposure.

Regulator 48 Chamber Purge–Controls the purge to the printing chamber during separation.

Regulator 8 Air Bearing Leveling–Provides air to the ball seat during initial substrate leveling at the first contact after loading.

Contact Force Display

Regulator 1 Contact Force–Controls the Upward Z axis force which lifts the substrate into contact with the mask.

Flow Control Manifold

Toggle valve 35- Turns expose purge on or off during vacuum contact printing.

FC 39 Chuck Piston Up –Controls the upward speed of the substrate chuck during leveling.

FC 73 Chamber Vacuum–Controls the highest amount of vacuum available to the printing chamber by bleeding air into the system. Controls chamber vacuum when the Purge Toggle valve is in the OFF position.

FC 72 Chamber Vacuum–Controls the volume of vacuum available to the printing chamber.

FC 28 Chamber Purge–Controls the vacuum in the printing chamber by introducing a nitrogen purge into the chamber. Controls the chamber vacuum when the Purge Toggle valve is on the ON position.

FC 49 Scan–Controls the air bearing pressure to the Scan Cup. (Not used on most systems).

FC 24 Shutter–Controls the high pressure air to the ultraviolet light shutter cylinder.

FC 23 Pressure Switch–Controls the air from Regulator 1 to the pressure switch, to adjust Separation timing during substrate leveling.

FC 26 Chuck Piston Down–Controls the downward speed of the substrate chuck after Expose or Clear.

FC 12 and 15 Microscope Plate- control the motion of the microscope mounting plate at expose.

FC 11 and 16 Lens Tray- control the motion of the ultraviolet field lens tray at expose.

The Programmable Logic Controller

The **Programmable Logic Controller** or **PLC** is a miniature computer-based device that contains a software program to interpret the operator's actions and initiate the necessary sequence of machine operation. Through internally stored programs a variety of alternate routines can be used depending on the selected mode of operation.

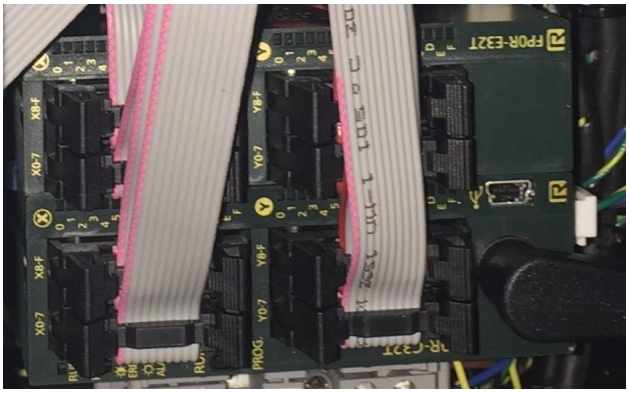
The NXQ4006 **System Controller** actually consists of two hardware items, connected by an electrical logic cable; the first and most important to the operator is the **PLC Display** panel, mounted on the upper right control panel, and the second is the **PLC** unit, located under the electrical Distribution Board at the left rear of the aligner.

The PLC Control Module

The **PLC Control Module** is a small, totally enclosed plastic package, with a power connector, a logic interface connector, four signal input connectors, and four output connectors (only three of which are used by the NXQ4006). The unit requires no maintenance or operator interface for use.

In operation, the unit receives control directions from the control panel and input signals from various sensors and switches. It has an internal clock to control time intervals as needed, some dictated by the program and some, like exposure times, under operator control. The stored program gathers information from all sources, and interprets the information, activating the required actions at the proper time and in the required sequences.

Because the unit requires no access under normal operating conditions, it is located in a protected position inside the aligner.



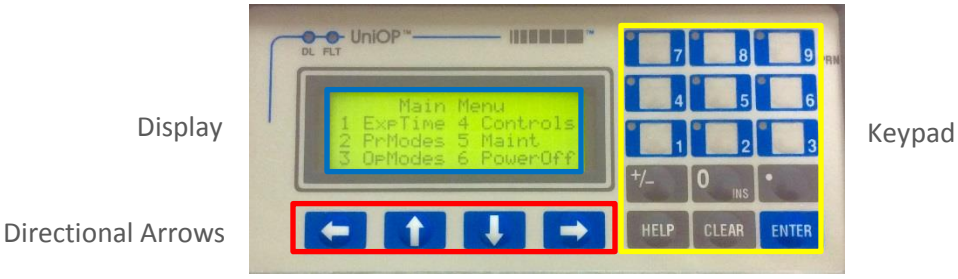
PLC Module

The PLC Display

The **PLC Display** provides easy operator access for operating the aligner and monitoring the progress of the machine cycle. It tells the operator what step the aligner is in or what should be done next.

It is also extensively used by the Process Engineer in setting up the proper process steps in preparing the aligner for production.

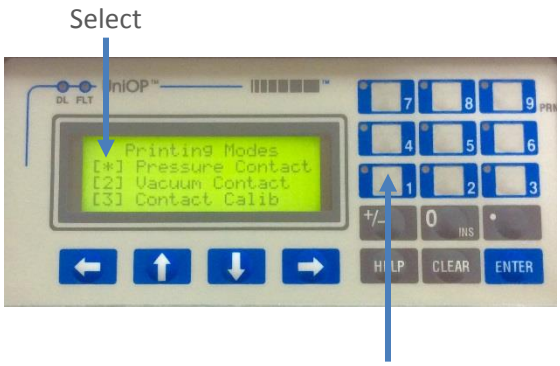
The Control Panel has three general areas: an **LCD** (Liquid Crystal Display) screen, showing a maximum of four twenty-character lines of information, a numeric key pad for inputting numerical data and control functions (Insert, Clear, Enter), and four directional arrows (up, down, left, right).



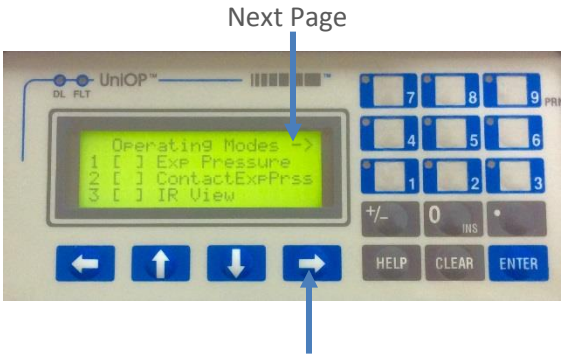
The Control Panel Display serves two purposes in operating the NXQ4006:

- It guides the operator in making the settings which defines how the aligner operates and
- In operation, it maintains a running description of what the aligner is doing at all times and at each step in the program which has been set up.

The software installed in the PLC results in a series of messages displayed on the screen. Movement between screens is controlled by either direction arrows or by selecting a numbered option ("Menu"); a small arrow in the upper right or left corner of the display indicates there is a continuation of that screen in the direction indicated (used if there are more than three choices for that option).



Example: Press "1" to select Pressure Contact



Example: Press the Right Arrow to move to the next page

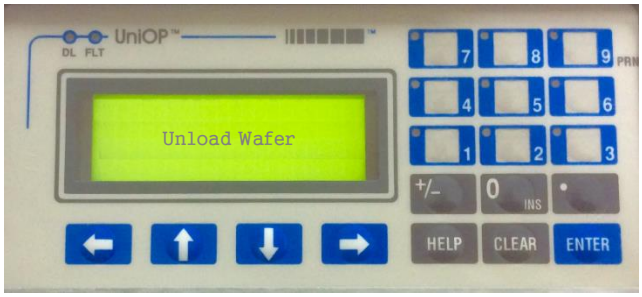
As an introduction to the use of the control panel, we will review the steps to start up the aligner, and to turn the aligner off.

Remember:

There are two switches on the NXQ4006 which control the power to the aligner. The first, the **Main Power Switch**, at the rear of the machine, turns off all power to the aligner. Normally this switch is only turned off when the machine is taken out of service for some reason. The second switch, mounted on the upper right panel, is the **Power Switch**, which is operational only when the Main Power Switch is on. It controls the power to the logic and operational features of the aligner.

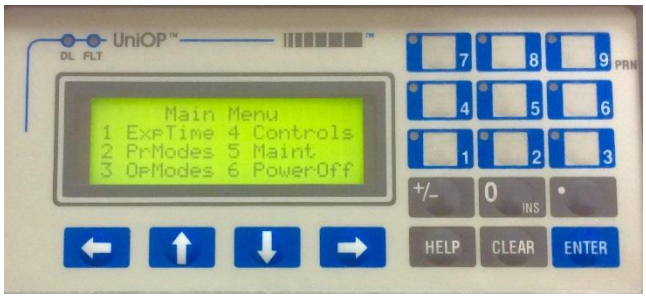
With the Main Power Switch on, the Power Switch off, and the load tray pushed in, press the **Power** button on the upper right control panel. The indicator at the switch should go on, and the display panel screen will show an initialization sequence, ending with the title page. The bottom line of the display will show the machine "state" or condition at the moment, in this case it shows "Press Enter."

When the aligner is first powered up, after the Main Power Switch has been turned off, there will be a noticeable delay in the initialization of the Control Panel, as much as 10 to 15 seconds, while the Control Panel downloads its operating system from the PLC. This delay is much less when the Main Power Switch has not been turned off, maintaining standby power in the system.



Pull out the tray to its out limit; this is “unload”, which sends a signal to the PLC that this operation has been done. At this point, the display changes to the main menu page and the top line of the display shows the machine state of **Load Wafer.**

In normal operation, we would proceed to set up the aligner for new operating conditions, or proceed with loading and aligning a substrate if the machine was already set up. For our initial experience, however, we will select Option 6, **Power Off**, which will result in the PLC turning the power system off, and the indicator light at the power switch will gradually fade out, indicating that the machine power is off.



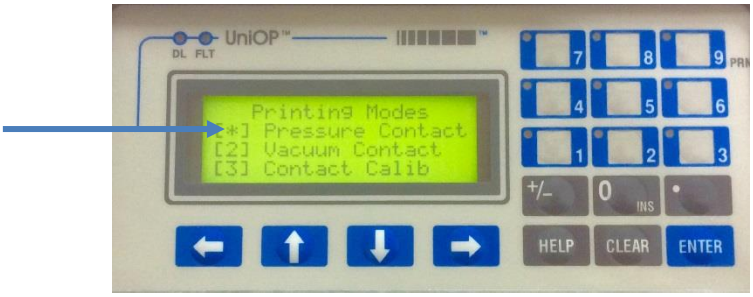
The actual set-up of the PLC will be discussed in the sections **Options for Process Control** and **Start-up**. Much of the set up procedure is the special interest of the process engineer; and thus is described in the sections designated for their use. Normally, the operator will be mostly concerned with the verification of settings and modifying exposure times.

The general instructions for using the PLC Control Panel are as follows:

To select an item in the menu, press the number key on the display panel corresponding to the menu number of the item required.

To return to the previous menu, press **Enter**.

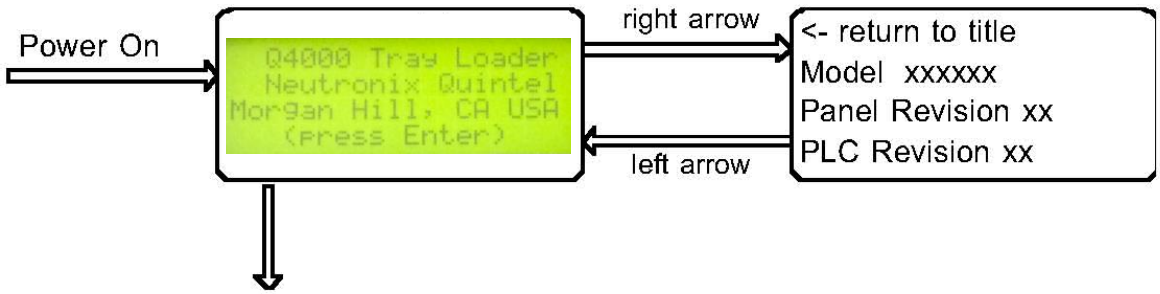
When selecting options, the selected option will be marked with an asterisk (*). To unselect an option, press the number again and the asterisk will be removed.



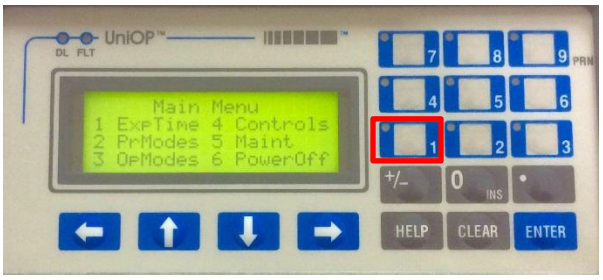
To change a numerical entry, such as a time value, begin by pressing the "0 or INS" (**Insert**) button, then select the field you want to change, using the up or down arrow buttons. Next, enter the desired value and finish by pressing **Enter**.

Enter only whole numbers or one decimal (.x) if required.

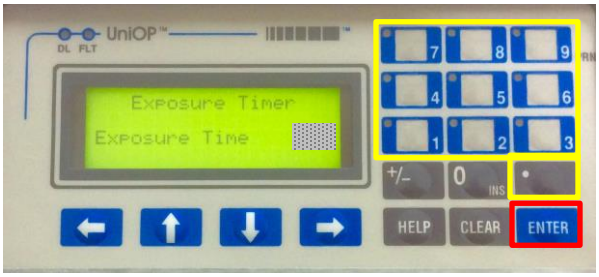
PLC Navigation Charts



SET EXPOSE TIME



Press 1 Exp Time

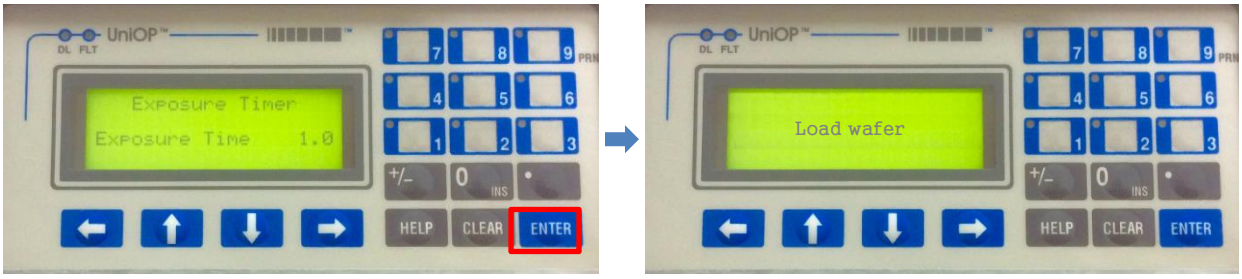


Press INS. The cursor will blink. Set Exposure Time with the keypad. Press ENTER.

Exposure Time is saved

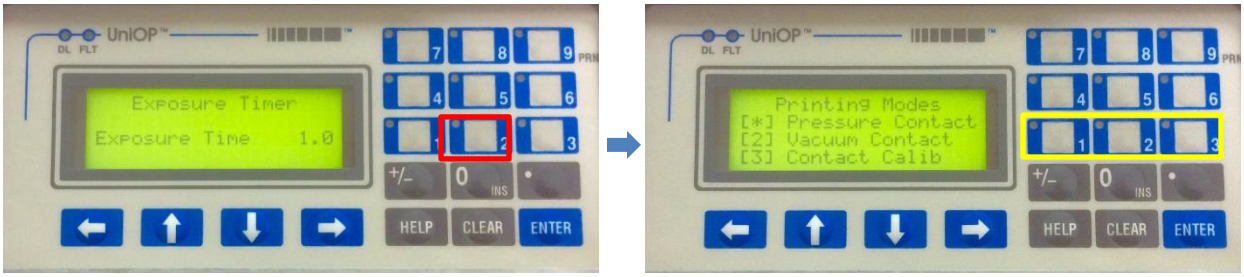
Pressing ENTER from any submenu returns to the Main Menu

Press ENTER from the Main Menu to return to the machine cycle display.



NOTE: The machine will run in any screen and complete the cycle, but only the machine cycle screen will show the steps of the cycle.

SELECT PRINTING MODES



Press 2 PrModes to access the Printing Modes Menu. Select the desired printing mode with the keypad. Press ENTER to return to the Main Menu. Press ENTER again to return to the machine cycle display.

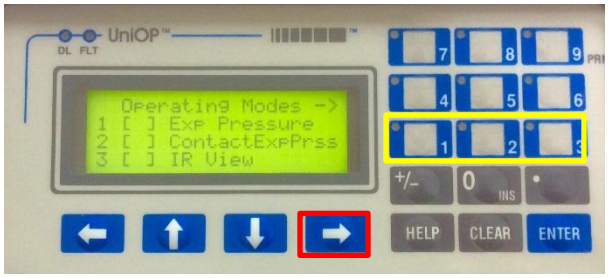
Pressure Contact is the most common printing mode. The wafer is pressed against the mask by the Contact Force of the piston. Use of Expose Pressure or Contact Expose Pressure is recommended in Pressure Contact. The general resolution is approximately 2 microns.

Vacuum Contact is used if higher resolution is required. The wafer is pressed against the mask with piston Contact Force and the force created by the vacuum printing chamber. Resolution is approximately 1 micron.

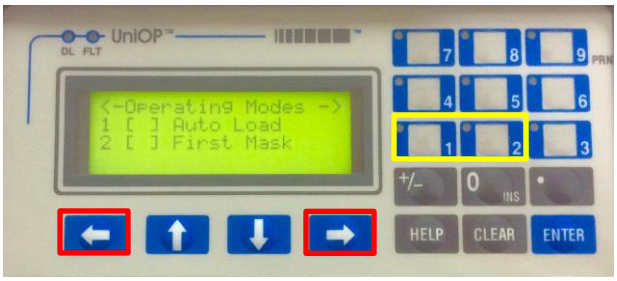
Contact Calibration is very rarely used. It is a pseudo-proximity mode of printing that allows exposure at a proximity gap after the initial leveling of the wafer.

SETTING THE OPERATIONAL MODES

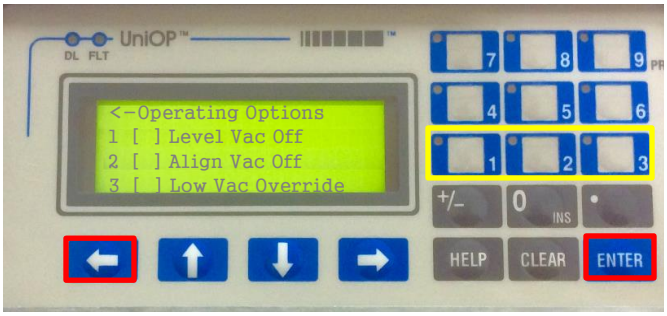
Press 3 OpModes to access the Operating Modes Menu.



Select the desired Operating Modes with the keypad. There are three operating mode screens. Move between the screens with the RIGHT and LEFT ARROW keys.



When the selections are complete, press ENTER to return to the Main Menu and press again to return to the machine cycle display.



Exp Pressure (Expose Pressure) activates the expose pressure (chuck pressure under the wafer) at the time of exposure. When the EXPOSE Switch is pressed, the expose pressure lifts the wafer to conform to the mask. The expose pressure is set with Regulator 2.

ContactExpPrss (Contact Expose Pressure) activates the expose pressure every time the operator presses the CONTACT switch. The expose pressure comes on just after the Contact Expose Pressure Delay. It stays on throughout the exposure of the wafer. The advantage of using Contact Expose Pressure is that the operator can see the effect of the expose pressure on the alignment.

IR View will control the bottomside illumination during a typical IR alignment. When the mask alignment marks are found the bottomside light will be OFF it does not “bloom” the camera image with excess light. After the wafer goes into separation, the bottomside light will turn ON allowing the backside of the wafer to be aligned to the mask.

Auto Load is a method of loading without pressing the LOAD switch. If this option is selected the piston will automatically lift every time the tray is pushed in.

First Mask is generally used for flood exposure or for first mask exposure when there are no wafer alignment marks. The first mask mode automatically continues through the exposure without stopping in separation for alignment. The wafer lifts, levels, goes into contact, exposes and drops to the tray all in one operation. The expose mirror will stay up waiting for the next wafer to expose. Press CLEAR to bring down the expose mirror after the wafers are processed.

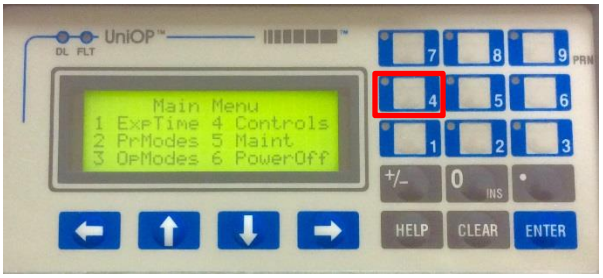
Level Vac Off turns the chamber vacuum OFF in the leveling step of the vacuum printing cycle. It can be very useful if the initial leveling causes the mask to lose vacuum and "pop off". This often happens when a wafer piece or substrate smaller than the chuck is processed. The excess vacuum area in the chamber causes the mask edges to lift and break vacuum. Turning off the chamber vacuum during leveling can help because it allows the wafer to level with no vacuum in the chamber. Then when vacuum is added during contact the piston acts hold the wafer and chuck down preventing it from lifting the mask.

It also reduces mask/wafer damage in general by the softer leveling without chamber vacuum.

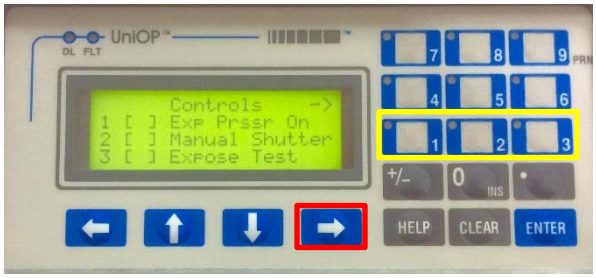
Align Vac Off turns the chamber vacuum OFF during contact. This would be used to alleviate wafer/mask damage or resist sticking during alignment. During exposure the vacuum activates.

Low Vac Override defeats the Low Vacuum Interlock. The Low Vacuum Interlock is set by Vacuum Switch 103, usually to about 2 inHg. If the chamber vacuum does not exceed this value, the machine will not expose the wafer. This prevents wafers from being exposed that require a certain amount of chamber vacuum to achieve good printing. Selecting Low Vac Override will defeat this interlock so the wafer can be exposed under any vacuum condition if necessary.

USING THE CONTROLS



Press 4 Controls to access the Controls Menu.



Select the desired control with the keypad. The controls produce a momentary or one time action. Use the LEFT and RIGHT ARROW keys to navigate to the second controls screen. Press ENTER to return to the Main Menu and press again to return to the machine cycle screen.

Exp Pressr On (Expose Pressure On) will activate the expose pressure for as long as the 1 key is held down on the keypad. Press to visually test the effect of expose pressure on the alignment. It is also useful to clear a chuck that has been lifted to the mask with no wafer on it. Press the Expose Pressure On key to produce a flow of nitrogen to the chuck and then press the CLEAR switch to bring the chuck down.

Manual Shutter activates the shutter whenever it is pressed. Press again to close the shutter. It is mainly used to test the UV light with an external light meter and set up the UV lamp.

Expose Test will lift the expose mirror and extend the lens tray so the UV light can be tested. Press the 3 key and the mirror will lift, then press the 1 key to open the shutter.

Manual Timer will activate the shutter for the length of the set Expose Time. If the Expose Time is 3.0 seconds, pressing the 1 key on the second controls page will open the shutter for 3 seconds. This is useful for testing the total exposure dose in mj/cm^2 if you have this type of exposure meter. It can also be used for a quick flood exposure by pressing Expose Test and then pressing Manual Timer.

Chuck Vac Off will turn the chuck vacuum off for one machine cycle. It is mainly used for test purposes or maintenance.

MAINTENANCE MENU Delays

Press 5 Maint to access the Maintenance Menu.

Press the 1 key access the Delays Menu. Press INS to change the value of the Contact delay. Press ENTER to store the new value. Use UP and DOWN ARROW keys to move up and down in the Delays Menu. Use the LEFT and RIGHT ARROW keys to move between screens.

Press the LEFT ARROW key to move back to the first page. Press ENTER to return to the Main Menu. Press ENTER again to return to the machine cycle screen.

Contact delay is the time between the pressing of the CONTACT switch and the activation of the chamber vacuum. When the wafer is in separation and the CONTACT switch is pressed, the wafer makes contact with the mask and the delay begins. After the delay the chamber vacuum turns ON. This delay reduces shifting between separation and contact because the chamber vacuum has a tendency to pull the wafer up before it is in contact and shifting may occur. Nominal value is 1.0 seconds.

ContactExpPrsr (Contact Expose Pressure) delay is the time between the pressing of the CONTACT switch and the activation of the expose pressure. When the wafer is in separation and the CONTACT switch is pressed, the wafer makes contact with the mask and the delay begins. After the delay the expose pressure turns ON. This delay reduces shifting between separation and contact because the wafer may shift slightly if it is not in contact with the mask before expose pressure is applied. Nominal value is 1.0 seconds.

Level delay is the length of time the air bearing level (leveling air or chuck ball seat pressure) is applied during the wafer leveling process. The delay begins after the Separation Switch activates and the wafer is in initial contact with the mask. The leveling pressure (Regulator 8) turns ON for the length of the delay and then ball seat vacuum and the lock ring activate to hold the wafer planar to the mask for alignment and exposure. The air bearing level is very important because it provides a frictionless level of the wafer to the mask. Nominal value for the delay is 1.0 seconds. Regulator 8 is usually set for 1-2 psi.

Shutter delay is the time between the triggering of the Expose Position Sensor (also called Head Position or Mirror Up Sensor) and the activation of the shutter. It gives time for the mirror and lens tray to completely settle after extending. It is also used to make sure the expose conditions (expose pressure, chamber vacuum, contact, etc.) are optimal before the wafer is exposed. Nominal value is 1.0 seconds.

Separation delay is the time between the pressing of the SEPARATION switch and the activation of the separation ring that pushes the wafer to the separation distance (align gap). It must be long enough for the chamber purge to completely evacuate all the vacuum in the chamber before the wafer moves down off the mask. Regulator 48 controls the Separation Purge (clockwise is more purge) and the chamber vacuum gauge must read zero before the wafer goes into separation. Nominal value is 0.5 seconds.

Piston Down delay is the time between the triggering of the Chuck Motion Sensor and the "Unload wafer" message indicating it is OK to pull out the tray. The delay insures that the piston is fully down before the tray is pulled out. If the piston is still up the tray will hit the balls seat and may damage it. Please wait for the unload message before pulling out the tray. Nominal value is 0.2 seconds.

MAINTENTANCE MENU Status

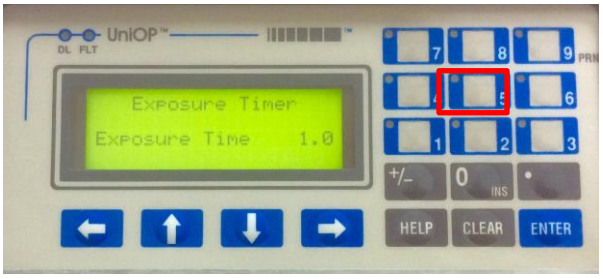
Press 5 Maint to access the Maintenance Menu.

The status of the Chuck Motion Sensor and the Chamber Vacuum Switch 103 are displayed. There are no selections or settings for the status screen. Press ENTER to return to the Main Menu and press again to return to the machine cycle screen.

Piston Down indicates that the Chuck Motion Sensor has activated.

Chamber Vac Low indicates that the chamber vacuum level has fallen below the setting of Vacuum Switch 103. The wafer will not expose unless there is a higher vacuum in the chamber or the Low Vac Override is selected in the Operating Options.

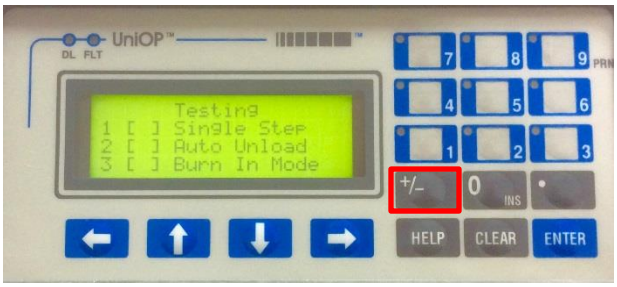
MAINTENANCE MENU Testing



Press 5 Maint to access the Maintenance Menu.

Press 3 Testing to access the Testing Menu. Use the keypad to select the desired mode of testing. Press ENTER to return to the Main Menu. Press ENTER again to return to the machine cycle screen.

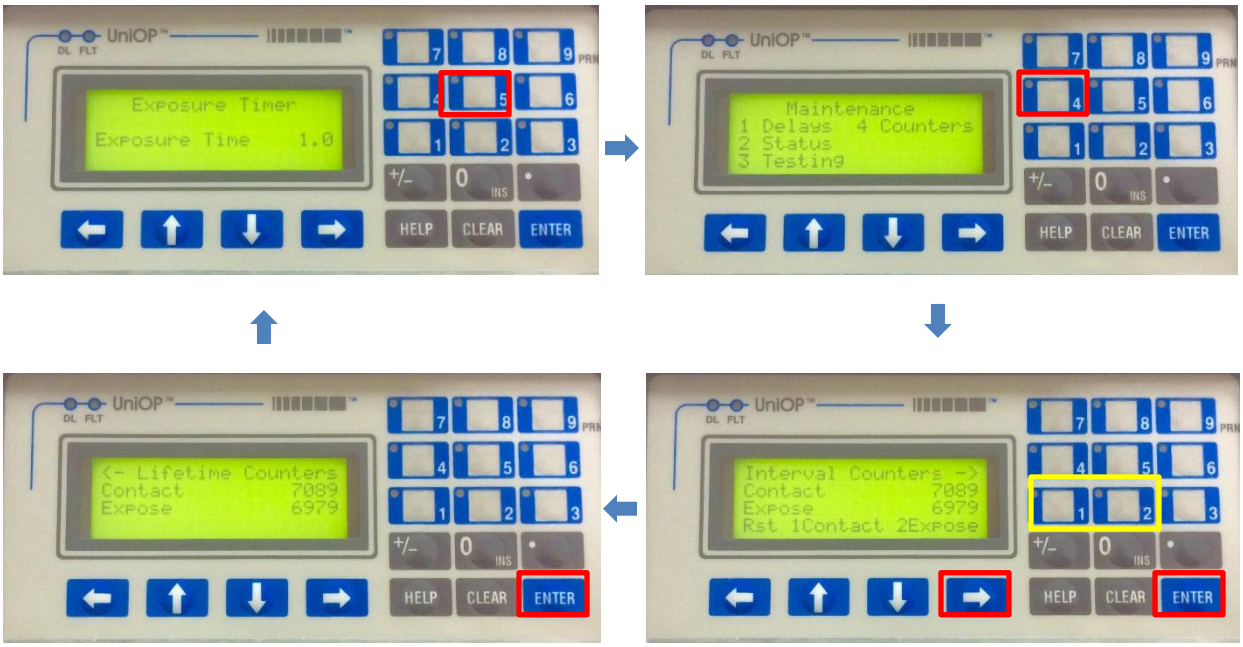
Single Step is very useful for machine setup, maintenance and troubleshooting. When the machine is in Single Step mode it can move through each individual step of the cycle one step at a time. It is best to run in the machine cycle screen. Press the +/- key to move to the next step in machine operation. Deselect to return to normal operation.



Auto Unload is generally used for testing the piston and setting the flow controls for piston up and down speed. It can be used any time to eliminate the step of pulling out the tray to unload the wafer. When Auto Unload is selected, the “Unload wafer” message will not appear. Pressing LOAD will lift the piston immediately because the tray is already in. Deselect to return to normal operation.

Burn In Mode is an iron man mode used to make sure the machine will run continuously without error. It is mainly used in final test at the factory, but can be used to test the machine after a repair or part replacement, etc. Select the Burn In Mode and then press LOAD and push the tray in. The machine will go through a complete cycle and then repeat the cycle until the CLEAR switch is pressed and the tray is pulled out. Deselect to return to normal operation.

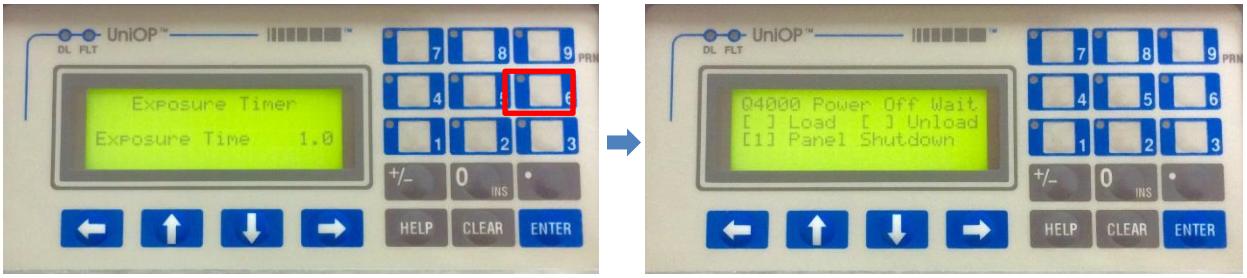
COUNTERS



Lifetime (“odometer”) counters

Press 1 to reset the Contact counter. Press 2 to reset the Expose Counter.

POWER OFF



Press 6 Power Off to access the Power Off Menu.

There will be a short delay while the process variables such as expose time, etc. are stored to battery-backed RAM and then the power to the machine will turn OFF.

Machine Setup

The NXQ4006 must be set up before use. These are the basic setup procedures for machine operation; process options, vision system and exposure system.

Process Setup

The process setup involves adjusting the machine settings for a particular printing mode and operational mode. It includes expose time settings

Printing Modes

There are three Printing Modes provided in the NXQ4006:

- Pressure Contact
- Vacuum Contact
- Contact Calibration

These modes are selected in the **Print Mode** menu of the PLC Display.

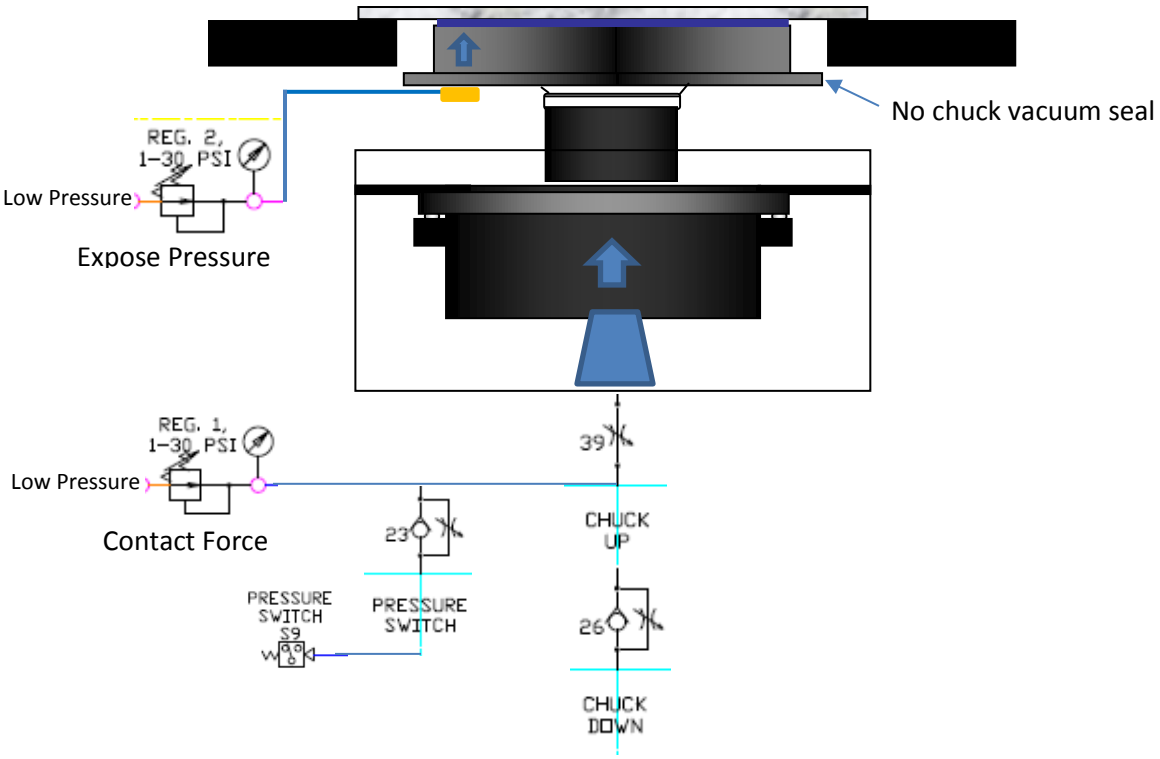
Pressure Contact Setup

This is the most frequently encountered form of Contact Printing and is used where a balance between mask life and resolution is desired. **Pressure Contact** refers to the pressure (Contact Force) exerted by the piston on the substrate in pressing it against the mask.

The contact force is set by Regulator 1 and can be adjusted according to the chuck size, substrate weight, fragility of the substrate, size of substrate, etc.

Expose pressure is usually used to improve printing, but may not be necessary.

Pressure Contact Pneumatics



The NXQ4006 is setup for Pressure Contact using the following procedure:

- Remove the vacuum seal from the groove in the base of the substrate chuck (this is only used for vacuum printing).
- Press **2** at the Main Menu page to select Print Mode Options.
- Press **1** to select Pressure Contact. An asterisk (*) will appear.
- Press **Enter** to return to the Menu.
- Raise the pressure on **Regulator 1** to an appropriate pressure for the process.

  These are the nominal settings for Reg. 1 Contact Force:

  2-3 inch wafers 8-10 psi

  4-6 inch wafers 10-15 psi

  8 inch wafers 15-20 psi

  If better contact is required, the pressure can be raised and if the wafers are very fragile it can be lowered. If the pressure changes, you may have to adjust the separation switch and timing. See below.

- After setting the Contact Force, adjust Flow Control 39 for a smooth, medium speed piston up motion. The chuck should lift to the mask holder in about 1-2 seconds. It is easier to do if you select Auto Unload in the Maintenance > Testing Menu. Then you don't have to pull the tray in and out. Just press LOAD to lift the chuck and CLEAR to drop the chuck. (Don't forget to turn the Auto Unload OFF after setting up the piston speed).

  Adjust Flow Control 26 for a smooth piston down motion.

FC 26 FC 39

- Adjust the Separation Switch.

  Set the Pressure Switch S9 for about 2 psi less than the Regulator 1 pressure.

When there is no pressure to the switch the display will read a low number in red.

When the piston lifts the pressure from Reg. 1 will go to the switch and the display will turn green if the pressure has met or exceeded the switch set point. The OUT indicator will light.

To set a new establish a new set point, push the SET button and adjust the set point with the arrow buttons. The set point should be about 2 psi less than the Contact Force. Press SET again.

- Load the chuck up against the mask holder. Adjust the flow to the pressure switch so the wafer rests against the mask holder for about 1 second before the PLC display message changes from “PRESSURE CHECK” to “LEVEL AIR DELAY”. Close Flow Control 23 to increase the time and open Flow Control 23 to reduce the time. The piston should lift the chuck up so it makes contact with the mask holder, then after 1 second the machine should go to LEVEL AIR DELAY.

FC 23

If Expose Pressure is desired:

- Select option [1] **Exp Pressure** (Expose Pressure) on the **Operating Modes** page or-
- Select option [2] **ContactExpPrss** (Contact Expose Pressure). This will allow the operator to see the effect of the expose pressure whenever the aligner moves the wafer into contact.

SOFT CONTACT is an optional setting of the pressure contact printing mode to be used where extremely brittle materials are being processed, resist sticking problems are being experienced or where long mask life is more important than high resolution.

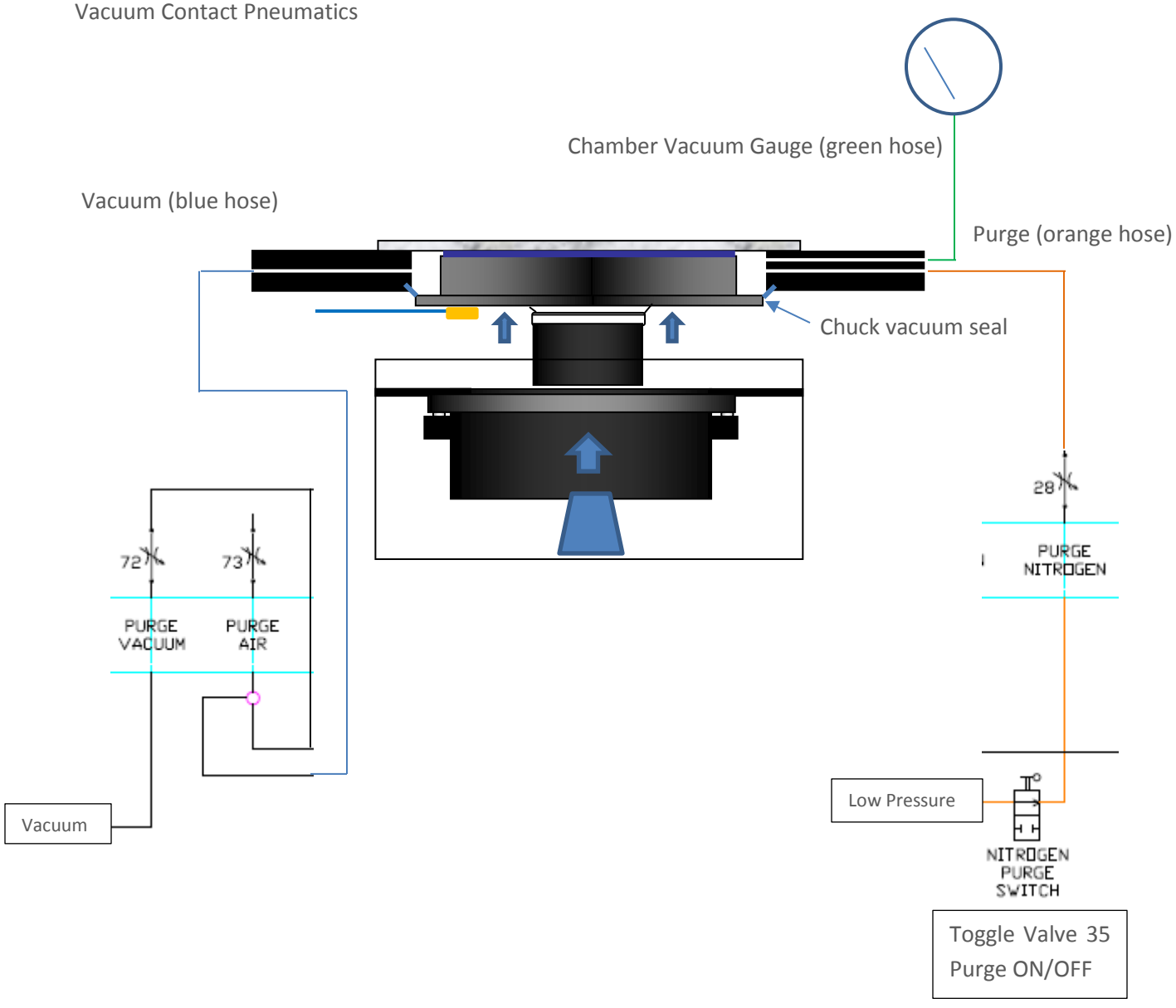
The NXQ4006 may be setup for **Soft Contact** using the following procedure, which involves setting the contact piston pressure to a minimum value.

- Open Flow Control 39 full.
- Reduce the pressure on Regulator 1 to the lowest possible pressure that will operate the piston in your application (typically 6-10 PSI).
- Install a Mask.
- Load a test substrate into soft-contact with the mask to check piston movement. Adjust piston speed with FC39 until piston moves smoothly and gently up to the mask. Clear and reload several times if necessary.
- Clear and reload, adjusting pressure switch S9 so the aligner goes in to separation immediately after the substrate fully contacts the mask.
- Adjust FC23 for a one second delay between initial contact and separation.

Vacuum Contact Setup

This is the highest resolution form of contact printing and is reserved for applications where mask life is secondary to high quality replication of mask images. The printing resolution in this mode is more limited by the process conditions of the particular application than by the mechanical limitations of the aligner. The chamber vacuum can be controlled either by introducing ambient air (Purge OFF) or nitrogen purge (Purge ON).

Vacuum Contact Pneumatics



NOTE: The piston pressure and separation timing must be previously set up as seen in the Pressure Contact setup above.

The NXQ4006 is setup for **Vacuum Contact Printing** using the following procedure:

- Place the vacuum seal in the groove at the base of the substrate chuck; the seal should be evenly mounted in the grove so there is a smooth, even, upward angle of the outer lip around its perimeter.
- Select **Vacuum Contact** (option 2) in the **Print Modes** Menu.
- On the upper left panel, turn the selector to **Chamber Vacuum**.

Set the Chamber Vacuum using the following procedure:

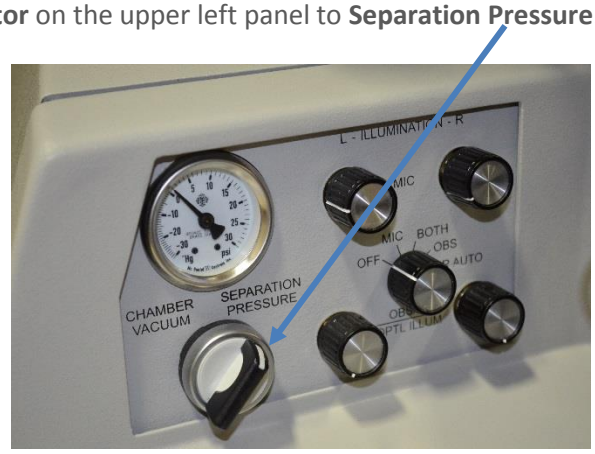
- Load a test substrate and advance the aligner into **Contact**.
- Turn **Toggle Valve 35** to **Purge OFF**.
- Close **Flow Control 73** full CW.
- Open **Flow Control 72** full CCW.
- Read the **Chamber Vacuum**: this will be your maximum possible chamber vacuum.
- Close **Flow Control 72** just until the chamber vacuum begins to decrease. This will conserve machine vacuum by slightly restricting the vacuum flow.
- Open **Flow Control 73** until you achieve the desired maximum chamber vacuum. This is usually 15-20 inHg.
- Turn **Purge Valve 35** ON and adjust **Flow Control 28** to achieve about 5-10 inches vacuum in the chamber. This is the nominal chamber vacuum value for NXQ4006 Vacuum Contact Printing. Adjust these controls to achieve the printing resolution required. Close **Flow Control 28** for MORE vacuum, open it for LESS vacuum.

Contact Calibration Setup

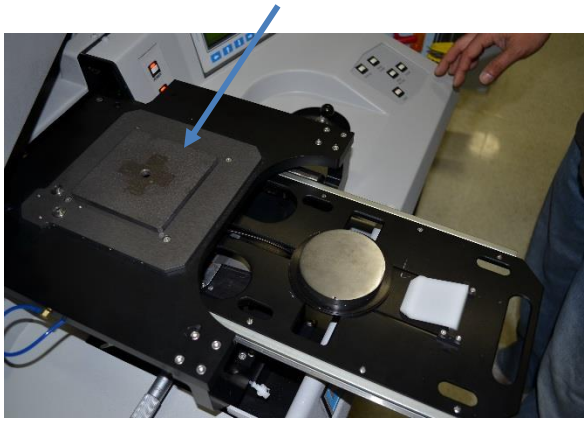
This exposure mode is used where long mask life is paramount and geometries are 5 microns and larger. In this mode, the substrate makes an initial contact with the mask to planarize the substrate to the chuck and then drops into separation. On all subsequent “contacts”, including the final contact during expose, the substrate stops short of the mask by the proximity gap selected.

The following setup procedures are required:

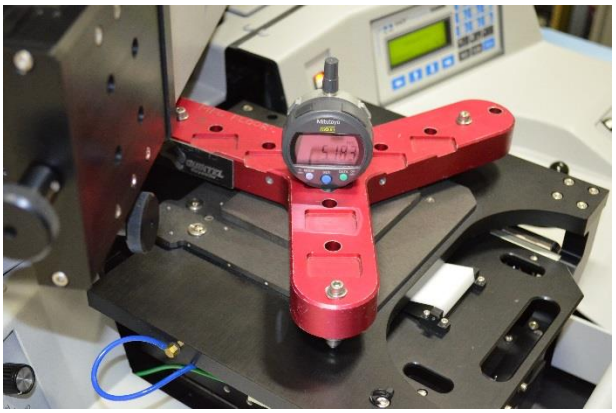
- Remove the vacuum seal from the groove in the base of the substrate chuck.
- Select option 3, **Contact Calib**, in the **Printing Modes** Menu.
- Turn the **Selector** on the upper left panel to **Separation Pressure**.

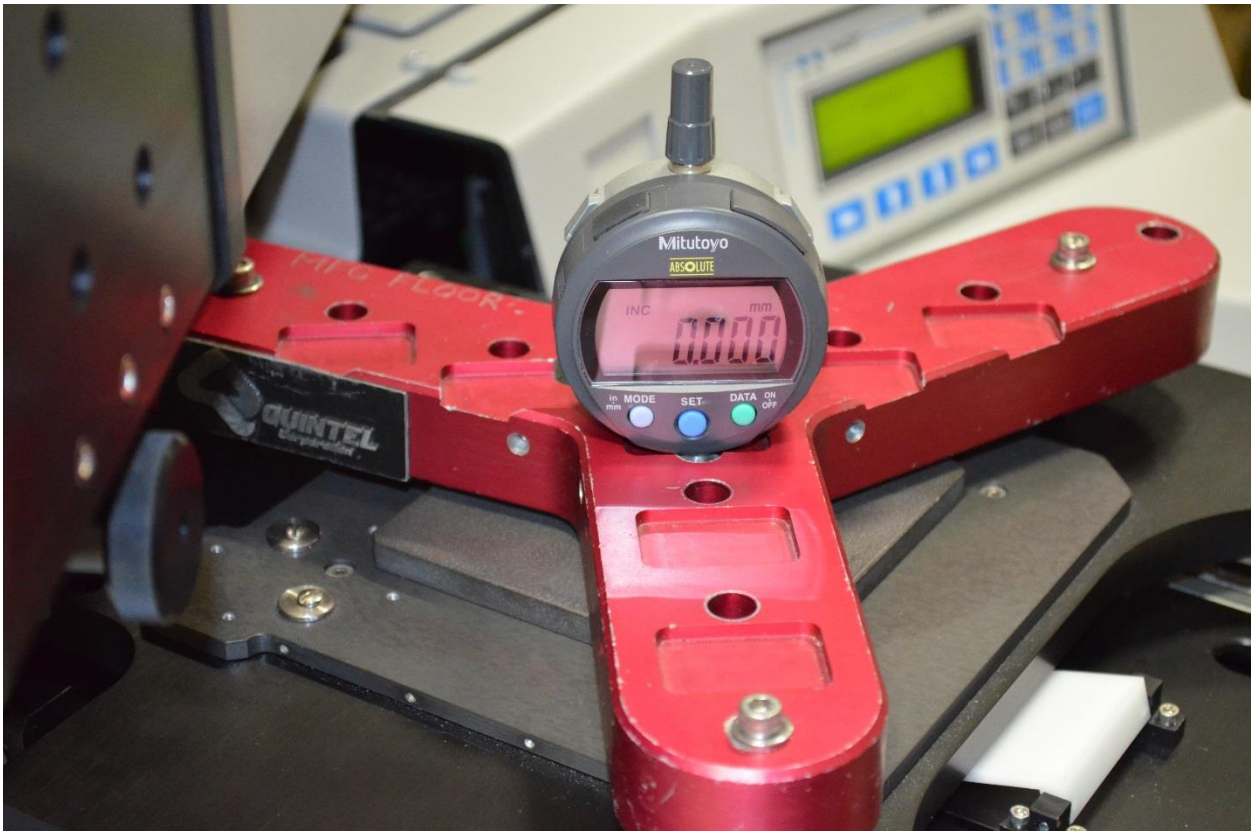


- Deselect option 11, **Exp Pressure** (Expose Pressure), on the **Operating Modes** Menu to verify that this option is **OFF**.
- Deselect option 2, **ContactExpPressure** (Contact Expose Pressure), on the **Operating Modes** Menu to verify that this option is **OFF**.
- Install a dummy substrate and **Reference Mask**.



- Load the wafer into separation and then press the CONTACT switch to put the wafer into contact with the reference plate.
- Install the **Mask Deflection Gauge Assembly** taking care to place the gauge tip in the center hole without the touching the sides of the hole.





- Adjust **Regulator 6** to the desired contact calibration gap; usually -5 to -20 microns.

- Press the CONTACT/SEPARATE switch to put the wafer in separation. Adjust the separation distance with **Regulator 4** to achieve the desired separation.

- Cycle back and forth between separation and contact and readjust the regulators until both separation and contact calibration values are correct.
- Clear and reload the wafer several time to make the sure the values remain constant to within a few microns.

Operating Mode Setup

Expose Pressure

Selecting this option puts an air cushion under the substrate during exposure. The expose pressure will be applied when the Expose Switch is pressed.

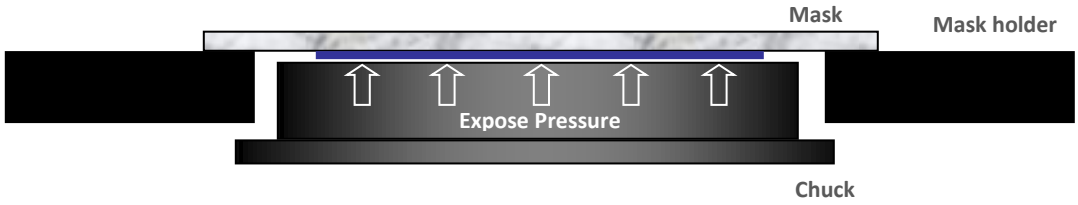
To test the expose pressure, put the wafer into contact and then select Controls > Expose Pressure On. Hold down this key on the PLC Display and look at the wafer to mask contact. Newton rings should be visible when the wafer comes into better contact with the mask. Check under the microscope to see the wafer moving up to basically the same focus as the mask.

It is easier to adjust the expose pressure when you select the Contact Expose Pressure option because the expose pressure will activate each time you press contact and stay on.

Start with Regulator 2 at zero psi and then gradually increase it. The Newton rings usually stop moving at about 1-2 psi. It will not help to increase the pressure after this point. Check with the microscope tp make sure there is not excessive shifting or wafer bowing. The idea is to use the minimum pressure that will produce good printing.

Contact Expose Pressure

This option is similar to Expose Pressure, except it activates during every contact, so the effect of the Expose Pressure with respect to the final alignment may be evaluated prior to exposure. It will stay on throughout the exposure. This is the recommended mode for applying expose pressure.



IR View

IR View controls the bottomside illumination during a typical IR alignment. When the mask alignment marks are found the bottomside light will be OFF it does not “bloom” the camera image with excess light. After the wafer goes into separation, the bottomside light will turn ON allowing the backside of the wafer to be aligned to the mask.

Auto Load

Auto Load is a method of loading without pressing the LOAD switch. If this option is selected the piston will automatically lift every time the tray is pushed in. While this is faster, be aware that the chuck will come up against the mask holder every time the tray is pushed in. If there is a mask present and no wafer on the chuck, the chuck will be fixed to the mask by chuck vacuum.

To release the chuck from the mask, press Controls > Expose Pressure On and then press the Clear Switch to drop the chuck.

First Mask

First Mask is generally used for flood exposure or for first mask exposure when there are no wafer alignment marks. The first mask mode automatically continues through the exposure without stopping in separation for alignment. The wafer lifts, levels, goes into contact, exposes and drops to the tray all in one operation. The expose mirror will stay up waiting for the next wafer to expose. Press CLEAR to bring down the expose mirror after the wafers are processed.

Level Vac Off

Level Vac Off turns the chamber vacuum OFF in the leveling step of the vacuum printing cycle. It can be very useful if the initial leveling causes the mask to lose vacuum and “pop off”. This often happens when a wafer piece or substrate smaller than the chuck is processed. The excess vacuum area in the chamber causes the mask edges to lift and break vacuum. Turning off the chamber vacuum during leveling can help because it allows the wafer to level with no vacuum in the chamber. Then when vacuum is added during contact the piston acts hold the wafer and chuck down preventing it from lifting the mask.

It also reduces mask/wafer damage in general by the softer leveling without chamber vacuum.

Align Vac Off

Align Vac Off turns the chamber vacuum OFF during contact. This would be used to alleviate wafer/mask damage or resist sticking during alignment. During exposure the vacuum activates.

Low Vac Override

Low Vac Override defeats the Low Vacuum Interlock. The Low Vacuum Interlock is set by Vacuum Switch 103, usually to about 2 inHg. If the chamber vacuum does not exceed this value, the machine will not expose the wafer. This prevents wafers from being exposed that require a certain amount of chamber

vacuum to achieve good printing. Selecting Low Vac Override will defeat this interlock so the wafer can be exposed under any vacuum condition if necessary.

Expose Time Setup

The amount of energy reaching the sensitive surface is controlled by two factors; the length of time that the light is on and the electrical energy driving the lamp. The **NxQ** NXQ4006 offers means to control both of these factors to help attain optimum results. Please refer to **Exposure System Setup** for lamp setup and control.

Single Expose Time Control

The elementary time control for exposure duration is a simple timer controlled **on** and **off**. This mode of operation is set up by accessing **Option 1** in the Menu page, which brings up the **Timer–Single Expose** Menu. For the single exposure mode, press the **INS** (insert) key. The field which can be modified will flash. Press the expose time desired and then press the Enter key.

Sequential Pulse Exposure Time Control

The **NxQ** NXQ4006 offers, as an option, a sophisticated expose control system. By pressing the right arrow button, when in the **Timer–Single Expose** Menu, on aligners equipped with the **Advanced Timer** option, you can access two additional timer modes. These are **Multiple Exposure** and **Recipe Exposure**. Use this for exposing thick photoresist layers or anytime it is necessary to allow the wafer to reestablish contact with the mask after resist outgassing.

In **Multiple Exposure** mode, the timer is programmed for an ON time, an OFF time and a TOTAL time. The timer will alternately hold the shutter open for the ON period and hold the shutter closed for the OFF period up until the TOTAL exposure time has been reached. The OFF periods do not contribute to the accumulation of TOTAL time.

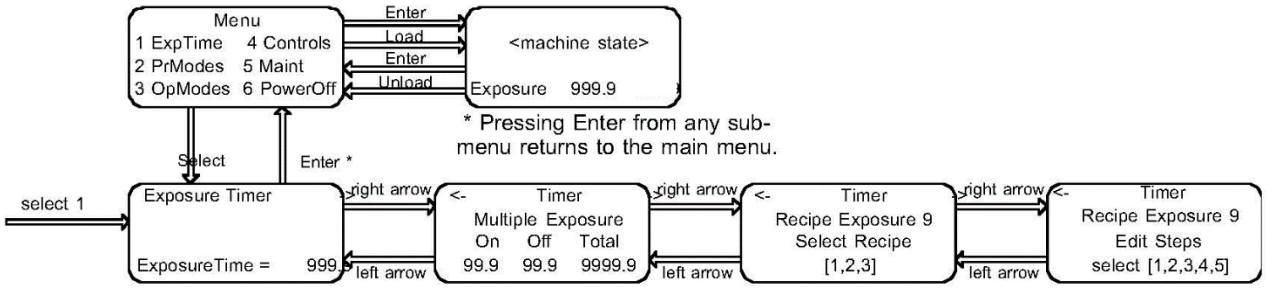
In **Recipe Exposure** mode, the timer is programmed for up to 5 different sequences of ON time and OFF time. Each sequence is referred to as a “step” in the recipe. Each step can be programmed with an ON time, an OFF time and a COUNT. The resultant TOTAL time is calculated and displayed by the timer as the operator makes the entries.

The **TIMER FUNCTIONS** are viewed on the **display** in **four different screens**. To access the separate screens, use the right and left arrow keys. The "left-most" screen is the **Single Exposure Screen**. Press the left arrow key until this screen is displayed. The next screen visible with a press of the right arrow key is the **Multiple Exposure Screen**. One more press of the right arrow key will display the **Recipe Exposure Screen**. The last screen available with a press of the right arrow key is the **Recipe Exposure Programming Screen**, where the individual steps of the recipe can be defined.

TO SET UP THE TIMER FOR MULTIPLE EXPOSURE, first use the right and left arrow keys to view the appropriate setup screen. For the single and multiple exposure functions, all the setup parameters are visible on one screen. The recipe exposure requires multiple screens to view all of the recipe parameters.

For the single and multiple exposure modes, press the **INS** (insert) key (this is also the "**0**" key during data entry). The field which can be modified will flash. You may select a different field with the arrow keys. Press the numeric keys to change the value of the selected field. After all entries are made, press the **Enter** key.

For the recipe exposure, there are two setup screens. The first (screen 3) selects one of three possible recipes. The next (screen 4) allows programming the exposure steps in the recipe. You must first select the step that you want to modify. Press the keys "1" through "5" to select the corresponding step "1" through "5". Once the step is displayed, you may press **INS** and enter values as described above for the multiple exposure mode.



Delays

Delays are computer controlled interruptions introduced automatically at various times during the program sequence to allow time-critical functions to complete themselves before the next operation starts. An example of this might be the build-up of pressure in a chamber, which does not take place instantly, but rather over a fraction of a second; a delay is much simpler and more reliable than trying to detect the completion of the build-up with a sensor.

Delays are generally set at the time of machine setup and seldom need adjusting unless there is a major machine reconfiguration.

Contact Delay

Contact delay is the time between the pressing of the CONTACT switch and the activation of the chamber vacuum. When the wafer is in separation and the CONTACT switch is pressed, the wafer makes contact with the mask and the delay begins. After the delay the chamber vacuum turns ON. This delay reduces shifting between separation and contact because the chamber vacuum has a tendency to pull the wafer up before it is in contact and shifting may occur. Nominal value is 1.0 seconds.

Contact Expose Pressure Delay

ContactExpPrsr (Contact Expose Pressure) delay is the time between the pressing of the CONTACT switch and the activation of the expose pressure. When the wafer is in separation and the CONTACT switch is pressed, the wafer makes contact with the mask and the delay begins. After the delay the expose pressure turns ON. This delay reduces shifting between separation and contact because the wafer may shift slightly if it is not in contact with the mask before expose pressure is applied. Nominal value is 1.0 seconds.

Level Air Delay

Level delay is the length of time the air bearing level (leveling air or chuck ball seat pressure) is applied during the wafer leveling process. The delay begins after the Separation Switch activates and the wafer is in initial contact with the mask. The leveling pressure (Regulator 8) turns ON for the length of the delay and then ball seat vacuum and the lock ring activate to hold the wafer planar to the mask for alignment and exposure. The air bearing level is very important because it provides a frictionless level of the wafer to the mask. Nominal value for the delay is 1.0 seconds. Regulator 8 is usually set for 1-2 psi.

Shutter Delay

Shutter delay is the time between the triggering of the Expose Position Sensor (also called Head Position or Mirror Up Sensor) and the activation of the shutter. It gives time for the mirror and lens tray to completely settle after extending. It is also used to make sure the expose conditions (expose pressure, chamber vacuum, contact, etc.) are optimal before the wafer is exposed. Nominal value is 1.0 seconds.

Separation Delay

Separation delay is the time between the pressing of the SEPARATION switch and the activation of the separation ring that pushes the wafer to the separation distance (align gap). It must be long enough for the chamber purge to completely evacuate all the vacuum in the chamber before the wafer moves down off the mask. Regulator 48 controls the Separation Purge (clockwise is more purge) and the chamber vacuum gauge must read zero before the wafer goes into separation. Nominal value is 0.5 seconds.

Piston Down Delay

Piston Down delay is the time between the triggering of the Chuck Motion Sensor and the "Unload wafer" message indicating it is OK to pull out the tray. The delay insures that the piston is fully down before the tray is pulled out. If the piston is still up the tray will hit the balls seat and may damage it. Please wait for the unload message before pulling out the tray. Nominal value is 0.2 seconds.

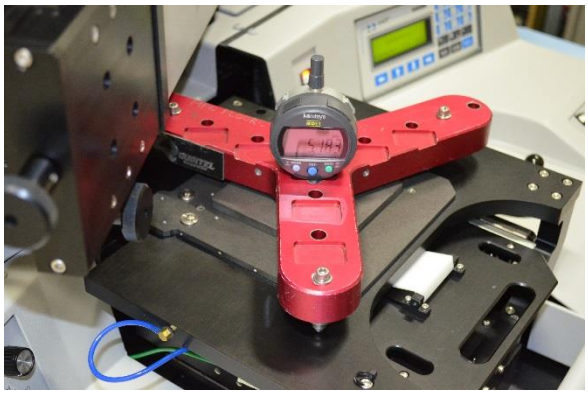
Mask Deflection Setup

One of the most valuable features of the **NxQ** Alignment System is the absolute control over the small vertical movements of the substrate mounted on its support chuck.

For routine work on relatively coarse geometries, factory settings or visually established settings for these controls are adequate. To attain the high levels of process control possible with the Aligner system, **NxQ** supplies a precise measuring tool system. This tool allows direct measurement of the movement of the substrate chuck, in order to evaluate and establish alignment separation and proximity gap distances. This tool is referred to as the **Mask Deflection Gauge**.

Mask Deflection Gauge

The **Mask Deflection Gauge** is supplied with a very flat, rigid metal **Reference Mask**, which is used when an absolute reference is required. Because it has an access hole through the center, direct measurements of the substrate surface may be made, for example when it is desired to measure or set separation distances.



Mask Deflection Gauge Tripod Assembly

Reference Mask

Mask Bow

The Mask Deflection Gauge may also be used to measure the bending of the glass of the mask itself under contact pressure. This condition, known as **Mask Bow**, may be measured and adjusted using the control capabilities of the NXQ4006 Aligner. Mask Bow is an important factor in the accuracy of reproduction of the mask image to the substrate. Typically, positive or “up in the center” bow results in a greater separation at the center than at the edge, causing images to spread and be progressively larger

towards the center. Conversely negative bow results in edge images being larger. The control provided by the NXQ4006 allows the balancing of these factors, permitting attainment of near ideal conditions for the best exposures.

The measuring unit itself consists of a three legged support mounting a precision electronic measuring instrument capable of measuring down to microns. The design of the support provides three hardened spherical support legs which contact the mask support plate to provide a stable foundation for the precise measurements required.

Mask Deflection

Masks, being physically a semi-solid glass are subject to some bending or bowing no matter how carefully they are made. Anytime the wafer is pressed against the mask there is potential for bow. Even applying the mask vacuum to hold the mask imparts a bow. The more force that is applied to mask, the more it will bow, but the strongest deflection happens during a vacuum contact mode.

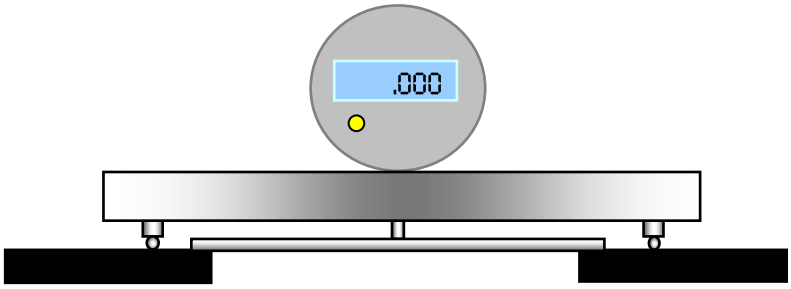
The NXQ8000 Tooling is very carefully designed and made to hold the mask as flat and as securely as possible. The surface is heat treated hard anodized and lapped extremely flat.

The other items that affect the deflection or bow of the mask are:

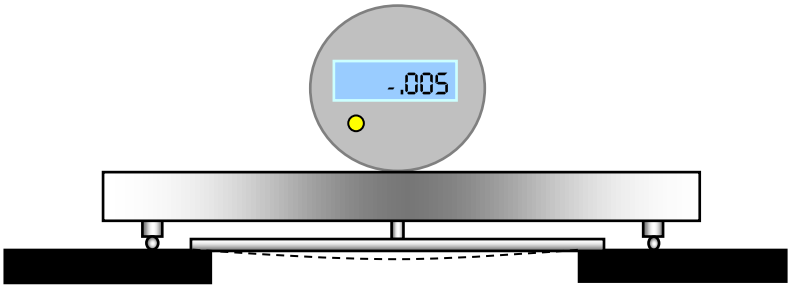
- The thickness of the mask
- The amount of chrome material on the mask
- The flatness of the mask
- The strength of the mask vacuum and mask holder design
- The pressure of the wafer against the mask
- The amount of vacuum in the chamber
- The amount of nitrogen purge in the chamber
- The wafer topography and flatness
- The leveling and final parallelism of the mask

The bow of the mask can be measured by the Digital Gauge Assembly. This will be used in the following section that describes how the mask deflects during a wafer cycle:

1. The mask is placed on the mask holder. The gauge is zeroed. This is as flat as the mask will ever be.

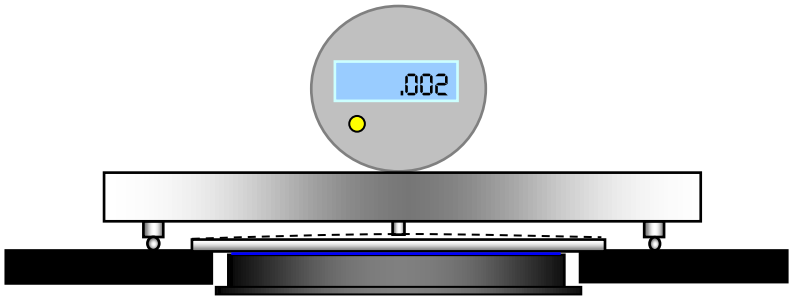


2. Mask vacuum is applied. The mask will bow 0-10 microns in a negative direction. Part of the movement is the actual motion of the mask being pulled down, but there is deflection involved, as well.



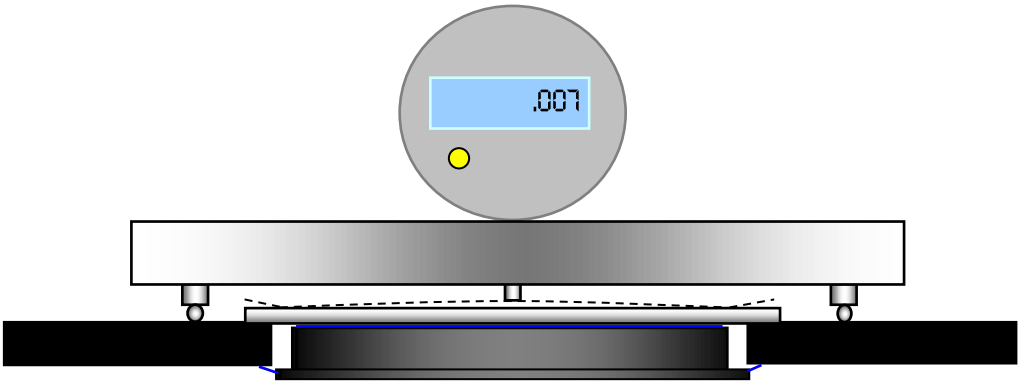
This is called the Initial Mask Bow. Ideally, the best bow is about -5 microns. It is good to have some mask bow in the center so the center of the wafer makes contact with the mask first. If the outer edge of the wafer touches first, the contact may good in the center and printing may be affected in that area. On the other hand, too much bow may cause the center of the wafer to make contact with the mask during separation, requiring a larger separation gap. Since the depth of focus in a microscope is fixed by the objectives and 5x-10x objectives are normally used for aligning, any separation gap beyond -20 microns will appear unclear, especially with the 10x. So it is best not have to separate too much.

3. When the wafer comes into contact with the mask, there will generally be a positive bow. In the case of a pressure contact mode, the bow should be very slight unless the mask is thin or the piston pressure is high.



(The dotted mask deflection lines in these pictures are greatly exaggerated)

If the printing mode is vacuum contact, the mask bow can be greater because the edge of the wafer and chuck act as a kind of fulcrum and the mask is pulled down in the chamber vacuum area between the chuck seal and the mask.



NOTE: If the mask is thin (60 mil) and the chamber vacuum is high (>15 inHg), the bow may be excessively high and the edges of the mask may lift causing the mask to loose vacuum. This is especially true if the wafer is smaller than the chuck. The greater vacuum area in high chamber vacuum may cause extremely high bow, and if the mask does not release from the mask holder it could actually break. In cases where the wafer is smaller, i.e. a 2 inch wafer on the 3 inch chuck, it is a good idea to use a mask clamp on top of the mask to stiffen it and keep the chamber vacuum below 5 inHg.

Another thing that will help with mask bow and mask popping (loosing vacuum), is to level the wafer using little or no vacuum in the chamber (select Level Vac Off in the Operational Modes. The Contact and Expose Vacuum can be increased because the piston is locked and helping to hold the wafer down in these steps.

Start Up

This section deals with the preparation of the aligner for operation– the installation of the proper tooling for the task at hand, setting the machine options for the process to be run, adjusting the optics for optimum viewing, and checking the exposure system to be sure it will do its job correctly.

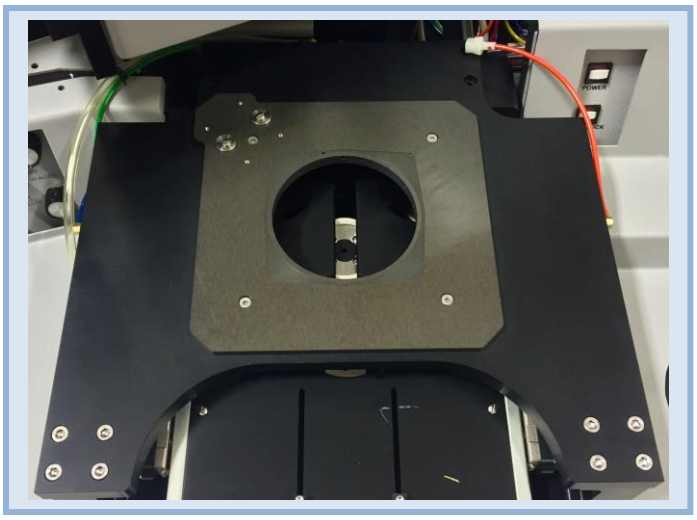
Note:

In order to simplify the description of the installation process, we will define the parts of the mask holder assembly as follows: The **Mask Holder** is the part which actually contacts the exposure mask; it has an opening in the center which corresponds to the size of the product to be exposed, and a mask clamping surface which fits the size mask to be used. This part is mounted in the **Mask Support**, which is the large plate which mounts to the aligner on four posts at the corners of the alignment stage. On the larger size wafers and substrates, those 125 mm or 150 mm in diameter, or 4 inches square for example, these two parts may be combined into an **Integral Mask Holder**.

Installation of Tooling

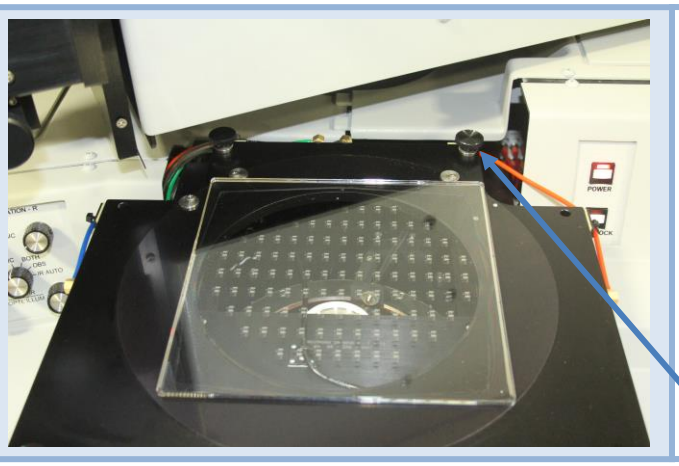
There are three major tooling components to be checked or installed when preparing the aligner for production– the mask holder and clamp, the substrate holder or “chuck,” and the pre-aligner.

The first of these, the **Mask Holder**, is supplied in three different formats or styles, all of which accomplish the same task in slightly different ways. The differences affect the way in which the tooling is changed for a different size.



Mask Holder Replacement

Verify that the proper mask holder is installed in the machine for the process requirements. If not, use the following procedure to change the mask holder:

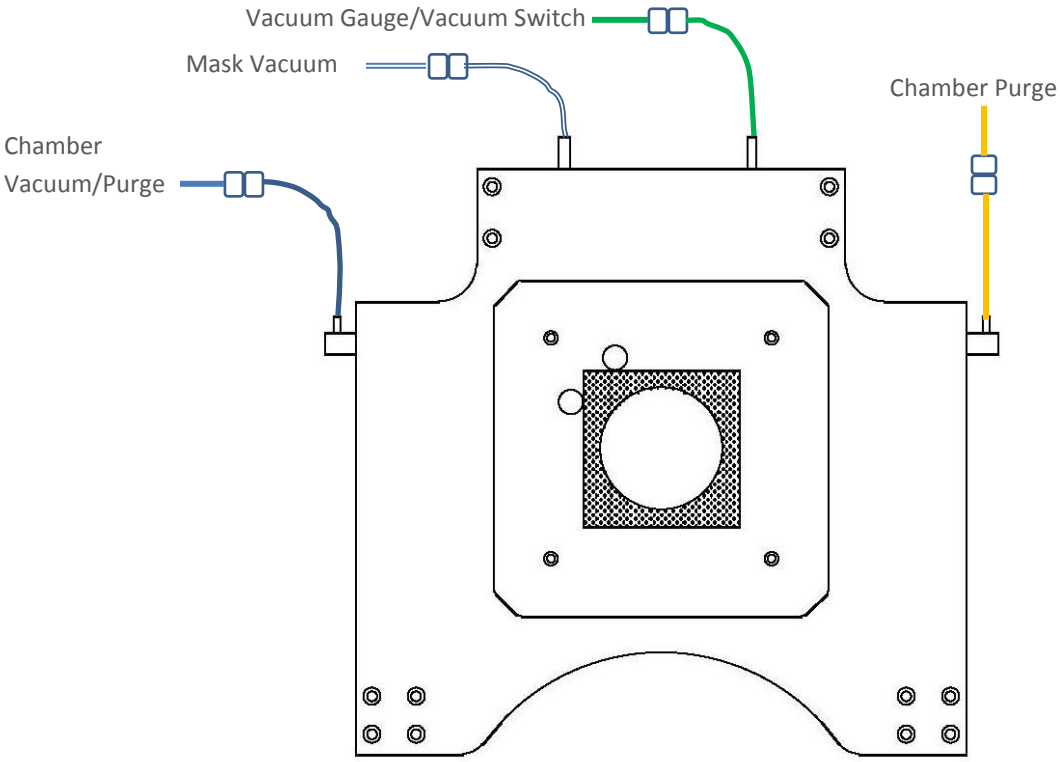


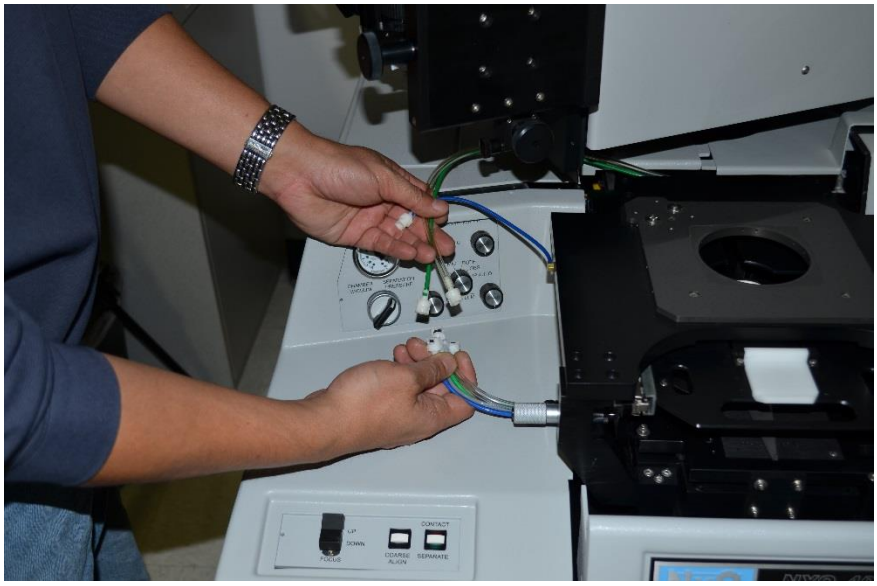
Note:

The installation of the mask support (with the mask holder mounted in it) on the mask support legs uses four 10-32 x 5/8" Socket Head Cap Screws at each front corner and two 10- 32 x 5/8" S.H.C.S. at each rear corner of the mask support.

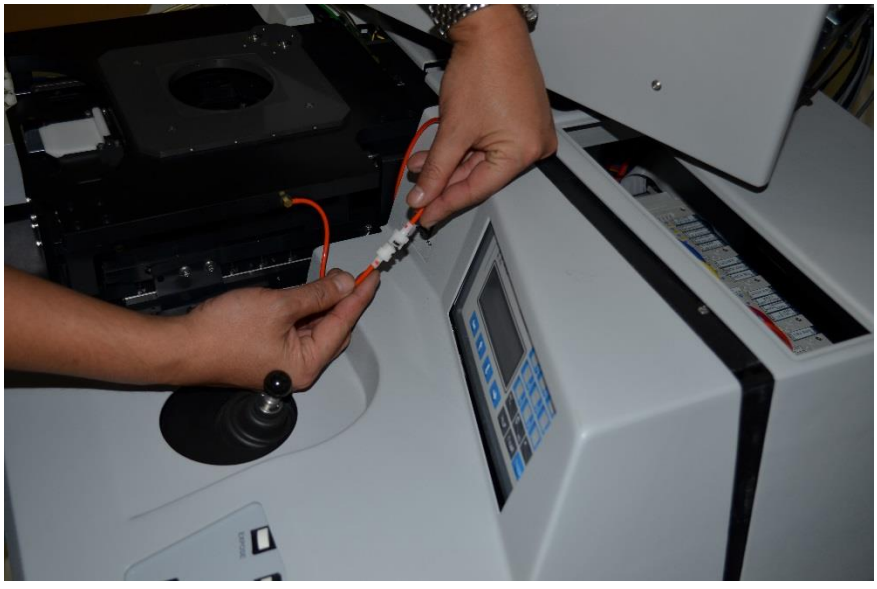
Or it is mounted with four 10-32 thumbscrews.

The mask holder hoses are connected with quick-disconnect fittings. Match the color of the hoses, push and twist to connect.





Left side mask holder hoses



Right side mask holder hoses

Substrate Chuck Installation

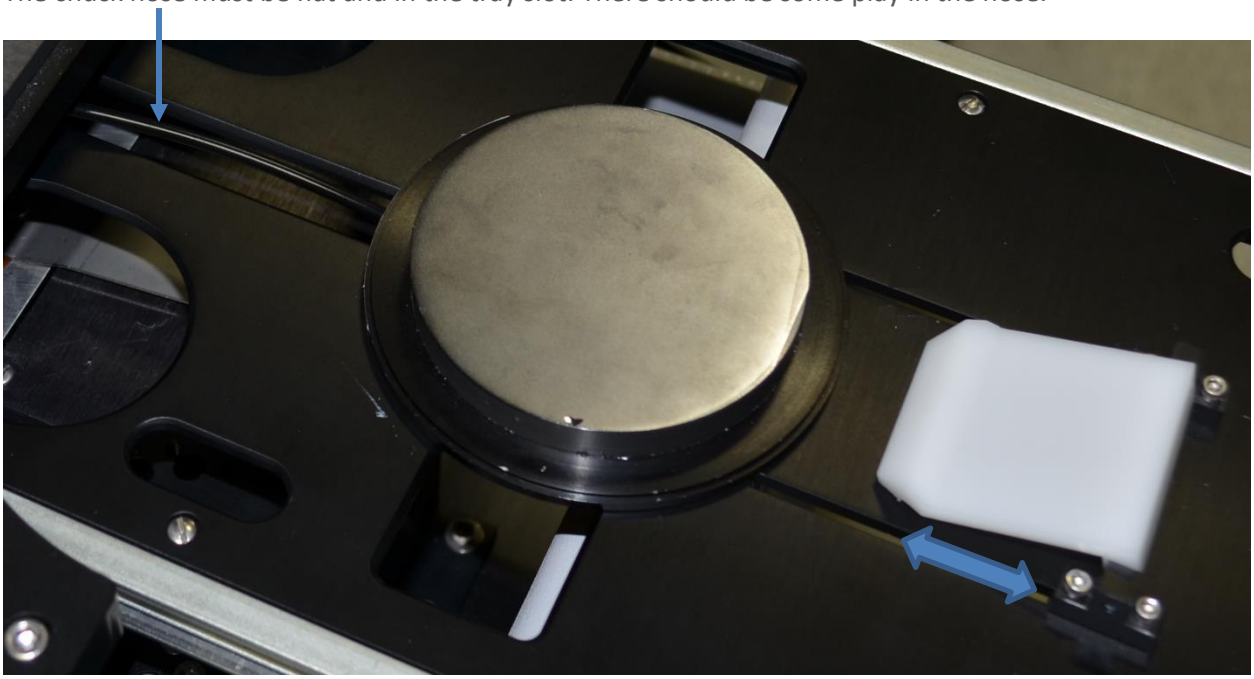
Pull the tray to its outer limit.

Install the chuck by attaching the small black hose to the back of the chuck and replacing the chuck onto the tray, carefully aligning the hose fitting with the slot in the tray. Pull the hose back from the chuck until there is only enough slack between the chuck and the clamp to allow the chuck to lift to the mask holder. Too much hose loop will prevent the chuck from seating in the tray properly.

Cycle the aligner through several load-eject cycles to be sure that the hose is free and that the chuck is seating properly in the tray.

If the new chuck represents a different wafer/substrate size, make certain that the pre-align fixture on the tray is also changed (to a different position).

The chuck hose must be flat and in the tray slot. There should be some play in the hose.

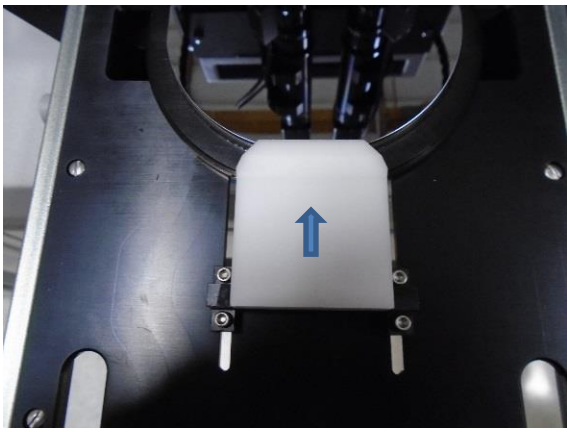


Move the prealigner up and down as needed. Loosen the 8 screws, move and retighten.

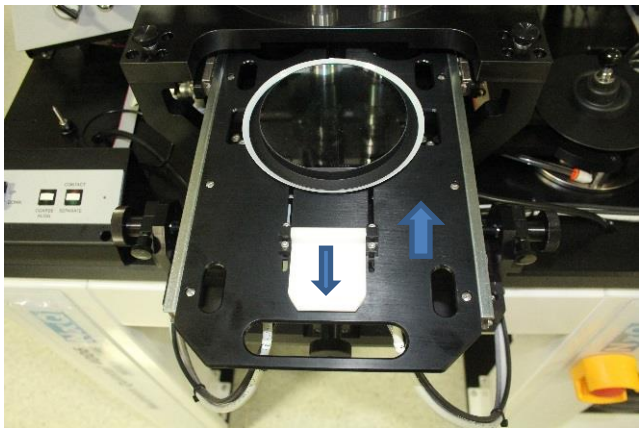
Pre-Aligner Adjustment

This procedure applies to the set-up for round wafers with alignment flats; if setting up for square or rectangular substrates, the chuck provides the pre-alignment capability.

- Carefully center the alignment stage.
- Place the aligner control in "Ready" state.
- To adjust the pre-aligner, pull the tray load out to its outer stop and place a sample wafer on the chuck with the wafer flat toward the operator.
- Flip the pre-aligner block over, center the wafer flat against the block and check centering of the wafer on the chuck top.
- If necessary, loosen the screws securing the pivot brackets on the underside of the load tray and move the pre-align block in or out to accurately center the wafer on the chuck. Retighten the pivot bracket screws.
- Flip the pre-align block toward the operator and push the load tray into the rear stop position.
- Press the **Load** Switch and check the centering of the wafer to the mask.
- Press the **Clear** Switch to lower the chuck and permit the withdrawal of the load tray to the unload position.



Align the wafer flat with the prealigner.



Flip the prealigner back and push the tray in to load the wafer.

Separation Adjustment

This adjustment controls the distance between the mask and substrate when the instrument is in separation mode. Before the substrate can be aligned, there must be enough separation between the substrate and mask for the substrate to move freely. Adjustment is effected as follows:

The aligner should be in separation mode, with the SEP light illuminated. If not return the aligner to the separation mode by pressing the SEP switch. The separation is controlled by Regulator 4; turning the knob clockwise increases the pressure and the separation, counterclockwise reduces them.

There are two methods for setting the separation; the first is strictly visual and relies on the operator's judgment.

Looking through the split field microscope will show the separation taking place. Check that there is enough separation between the substrate and mask by tapping the mask holder support. Viewed through the microscope, the substrate image should "wobble" under the mask image when the mask holder is tapped. If the substrate does not move, put the instrument back into contact mode and increase the mask/substrate separation by turning the adjustment knob a few more degrees clockwise.

Do not increase the separation any more than is necessary or it will be impossible to focus the microscope sharply. Since the ability to see both the mask and substrate simultaneously depends on the depth of focus of the microscope, which is very limited at higher magnifications, minimum separations are essential.

A much more precise and repeatable method for setting separations is by the use of the Mask Deflection Gauge described previously. By using the Reference Mask and measuring the surface of a dummy substrate, the actual movement of the substrate may be measured and set to a preferred value.

Recommended separations for the various objective lens powers are as follows:

Objective Power	Recommended	Maximum
2x	30µm, .0016"	100µm, .004"
5x	20µm, .0008"	50µm, .002"
10x	10µm, .0004"	22µm, .0009"
20x	5µm, .0002"	14µm, .0006"

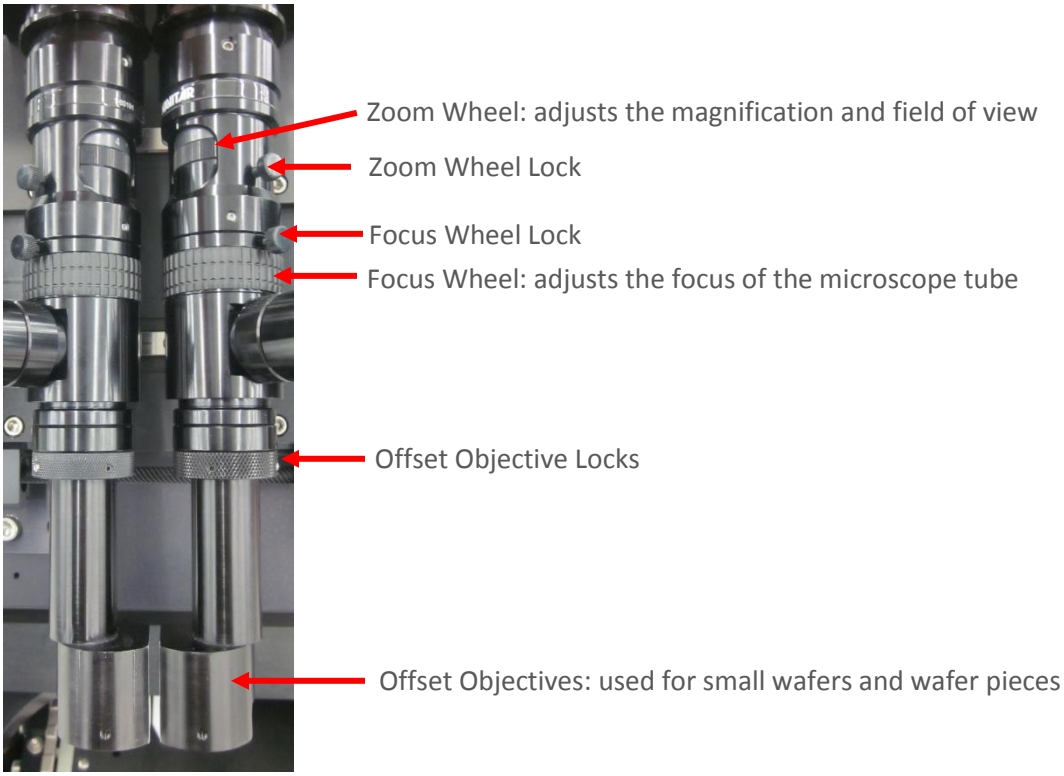
Viewing Optics Setup

The viewing system setup is most important in that a properly configured system assures operator comfort and productivity, resulting in more and better product. The **NxQ** NXQ4006 can be configured with a variety of optical systems, operating differently in detail, but the major considerations are all very similar.

Microscope Focusing

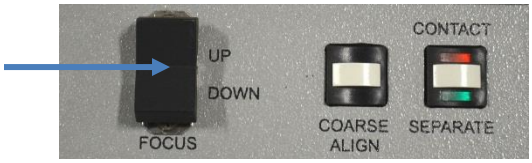
The focusing of the microscope optics is critical to efficient operation of the aligner. Each model microscope used on the NXQ4006 has a slightly different method of focusing, and is discussed individually in the following section.

The **Video-View microscope** consists of two individual optical tubes. Each of these tubes contains three operating controls. The upper control is the magnification zoom control. Before attempting to adjust the focus of the microscope it is important to adjust the two zoom controls to the same value.



Video-View optics shown with Offset Objectives

The Video-View optical head provides over all focusing by means of a remote power focus system. The control for this is a lever action switch mounted on the front left control panel. Moving this lever down drives the microscope up or down as indicated. The center position is “off” so by moving the lever back and forth a very critical focus may be achieved.

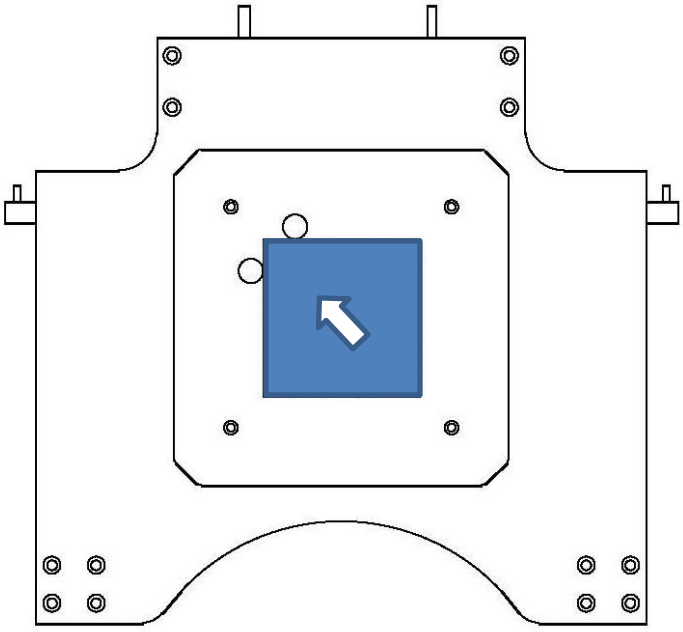


When adjusting the individual microscope tubes, check that the motorized focusing is approximately in the center of its travel first.

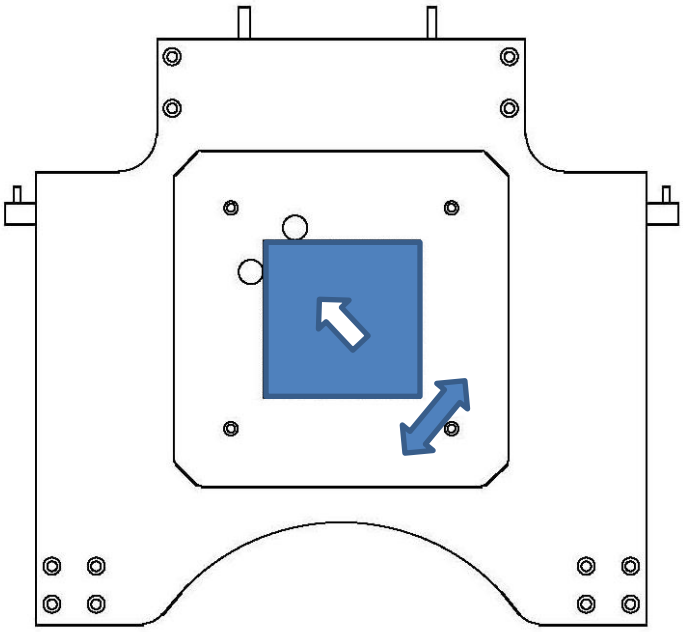
The next control down the tube is the focus control: adjust each of these to a uniform degree of sharpness.

Mask Setup

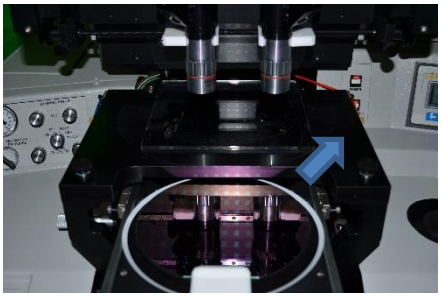
- Place the mask on the mask holder and push the left corner up against the mask stops.

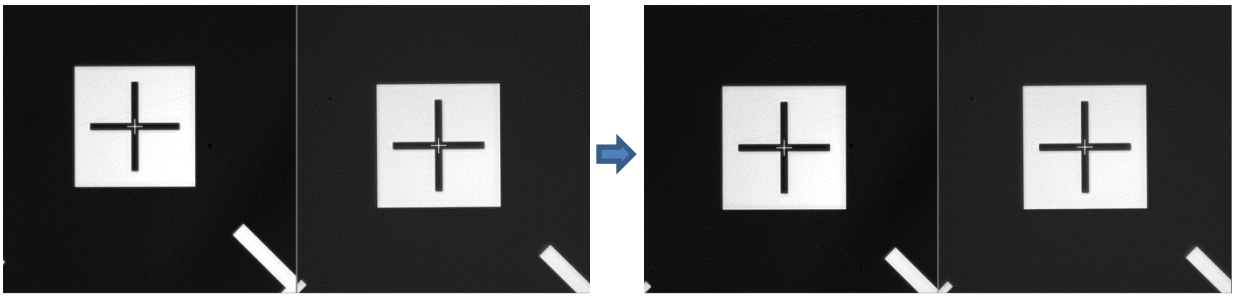


- Zoom to a low magnification/larger field of view so you can see more of the wafer and mask to initially locate the alignment marks. One the marks have been found zoom back up to the desired magnification for alignment. If the mask is always pushed up against the left upper corner (reference corner), the marks will be in the same place every time.



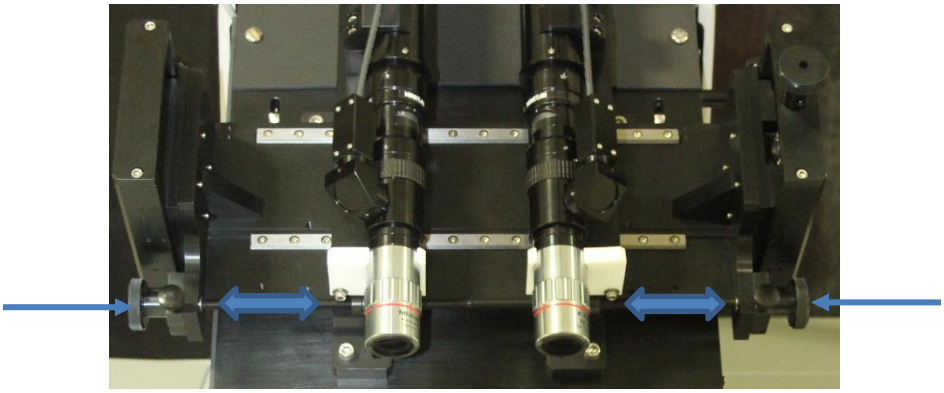
Lightly grasp the right lower corner of the mask and move slightly to adjust the theta position of the mask. The mask alignment marks should be approximately parallel to the edge of the monitor to facilitate alignment.



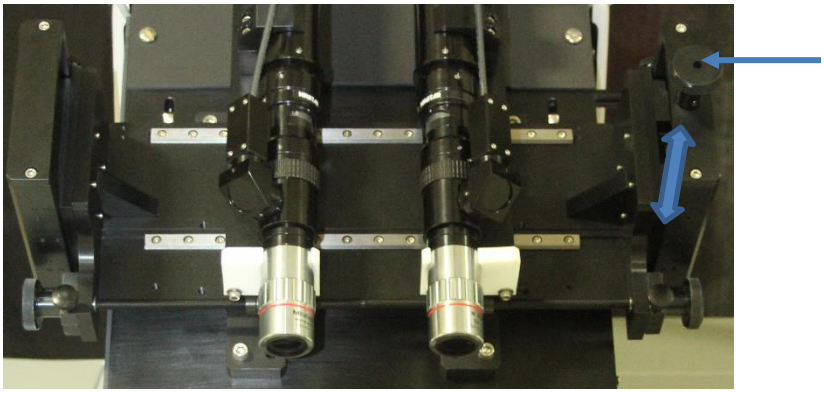


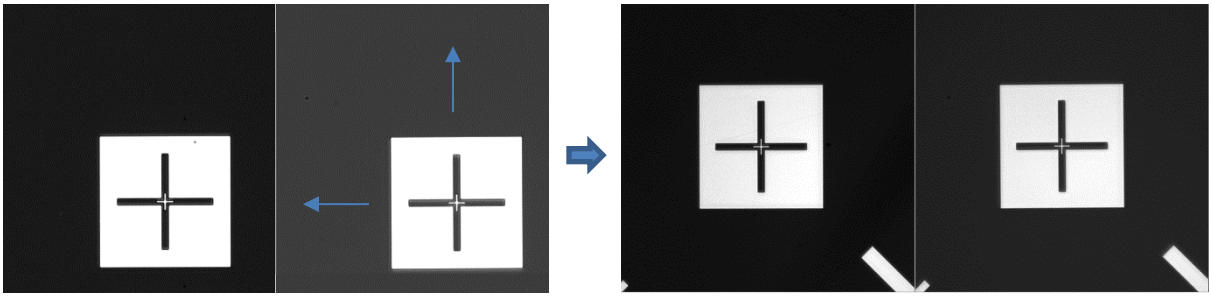
Theta adjustment

- Use the **Right and Left X Tracking Knobs** to move the objectives to the right and left.



- Use the **Y Tracking Knob** to move the objectives back and forth.





X and Y Tracking adjustment

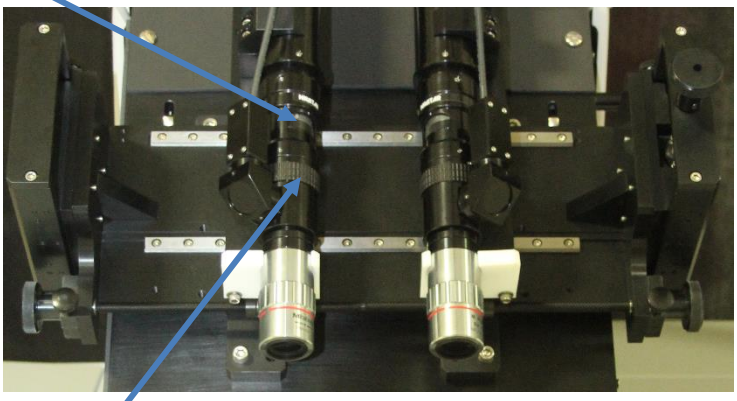
- Adjust the microscope illumination at any time as needed.

Topside Microscope LED Illumination Controls

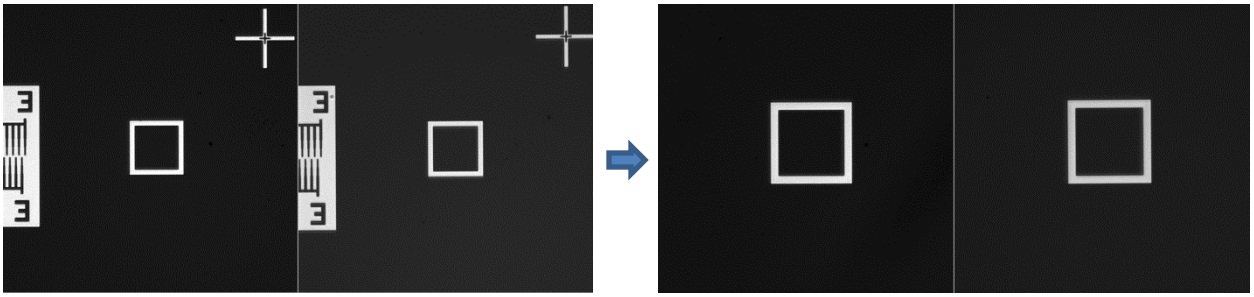
Illumination Select Switch

Bottomside Halogen Lamp Illuminator Controls

- Adjust the zoom magnification for the best field of view for aligning the wafer to the mask.



Refocus if necessary.



Zoom adjustment

Exposure System Setup

As a preliminary to production with the NxQ NXQ4006, and as a routine system check, the exposure system must be checked for uniformity of exposure, exposure energy levels, and exposure time settings. This procedure assumes that the lamp has been installed correctly by a qualified maintenance technician.

The NXQ4006 has incorporated a precision micro positioner lamp base which facilitates accurate X, Y & Z alignment of the mercury arc lamp to the optical path for optimum light intensity and uniformity. To adjust the arc lamp, there are three knobs located on the lamp base which control the X, Y & Z positioning of the arc lamp.

Caution:

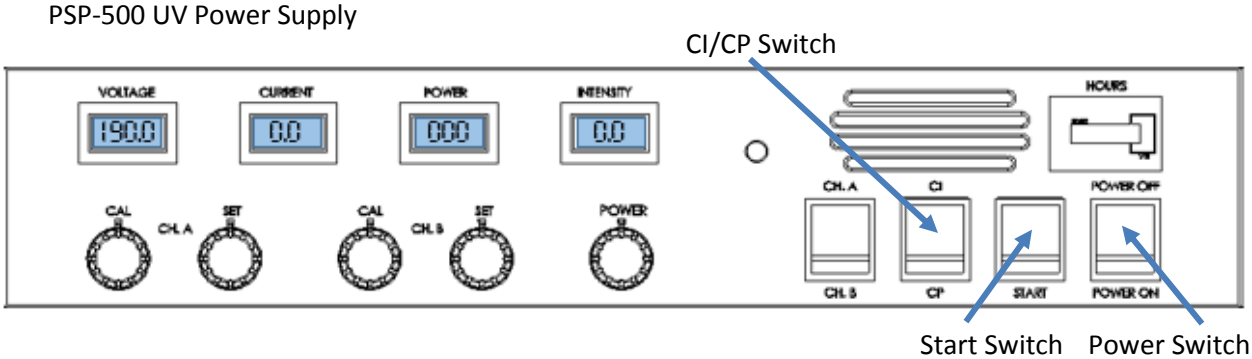
Please review all the Safety Procedures discussed at the start of this manual. Improper handling of this lamp can and will have serious consequences.

Adjusting Light Uniformity

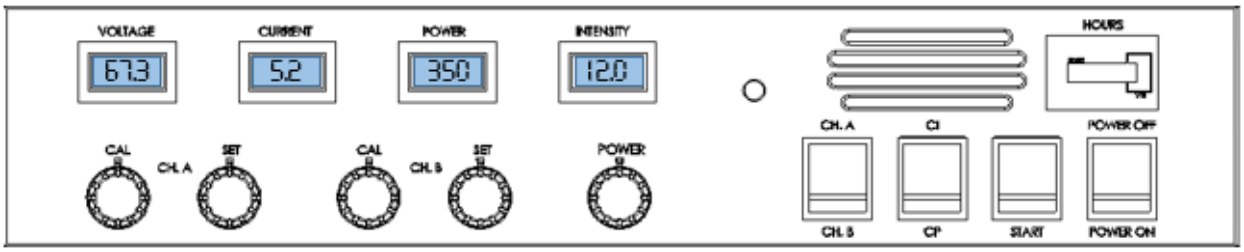
To adjust the arc lamp, use the following procedure:

- Turn the UV Power Supply ON.
- Set the CI/CP Switch for Constant Power (CP).
- Depress the arc lamp **Start** switch, located on the ultraviolet Power Supply, momentarily. NOTE: Do not press the Start switch for more than 2 seconds. Holding it in longer may damage the solid state starting circuit. If the lamp does not start. Depress again. Allow at least 10 minutes for the arc lamp to reach equilibrium.

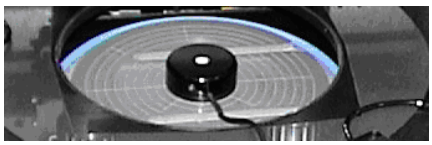
PSP-500 UV Power Supply

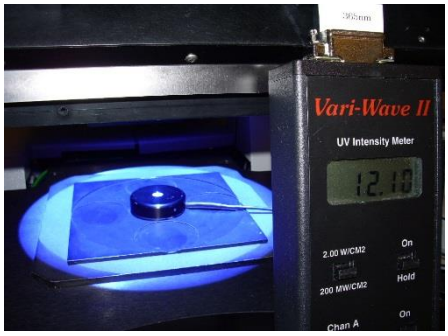


The power supply should look like this when using a 350W mercury arc lamp after warm-up.



- Place a mask, reference plate or probe plate on the mask holder and press the MASK VAC switch to hold it in place. Prepare the external light meter to read the UV intensity. The meter probe can also be placed on the chuck.
- Select Controls > Expose Test on the PLC display. The mirror will lift and the collimating lens will extend.
- Select Controls > Manual Expose to open the shutter.

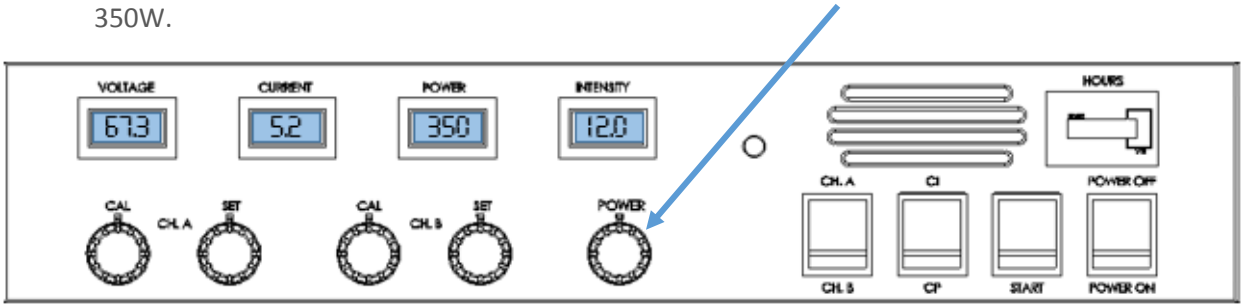

Center of the Chuck



Center of the Probe Plate

NOTE: If Expose Test does not lift the expose mirror, press CLEAR and pull out the tray so the display reads "Load wafer". Then push in the tray.

If the power stops and stays stable lower than 350W, use the Power Knob to raise the power to 350W.



NOTE: The general rule for running lamps in Constant Power is that the power should be within +/- 10% of the rated power for the lamp. The lamp will be running continuously at this power so setting it below this level can cause overcooling and setting above this level can cause overheating. Both conditions cause degradation of lamp performance and loss of lamp life.

Lamp Power

350W Lamp	**315W-385W**
500W Lamp	**450W-550W**
1000W Lamp	**900W-1100W**

The PSP-500, 2105C2 and 2110C2 all have power limits in Constant Power mode that act according to this rule. If you try to raise the power too high (>385W), the lamp power will stop at this point or near this point. There is also a low limit. If the power is too low and the cooling remains the same, the lamp may drop in power rapidly to point where the lamp actually goes out.

NOTE: When a lamp is first installed it must be ADJUSTED for correct position in the reflector. This MUST be done in CONSTANT POWER mode.

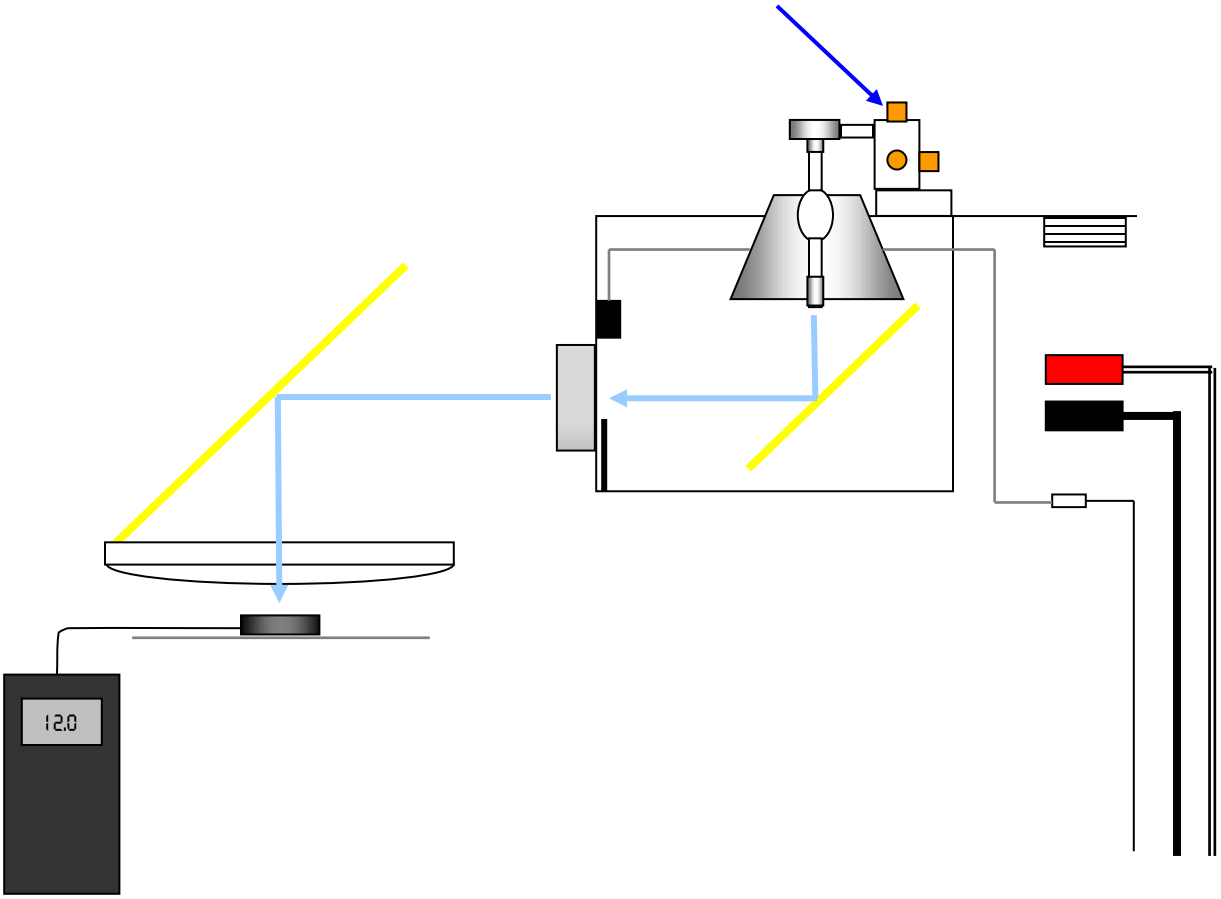
- PEAK the lamp.

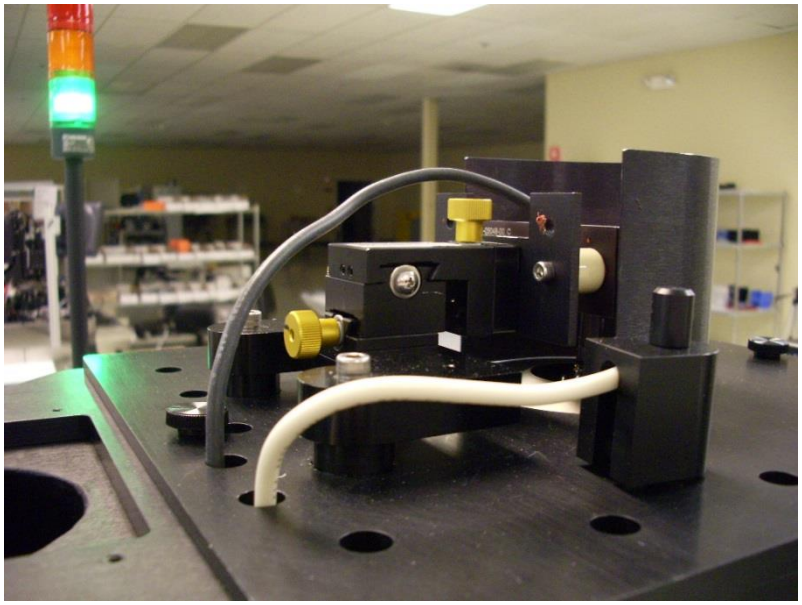
Adjusting the UV lamp is done by a procedure called "**peaking**". The lamp must be put in the best position inside the reflector for best uniformity and intensity at the wafer. This position is usually where the highest intensity is achieved in the center of the wafer or light circle on the mask.

Position the intensity meter probe in the center of the chuck, reference mask or probe plate and adjust the XYZ Micromanipulator to get the highest reading.

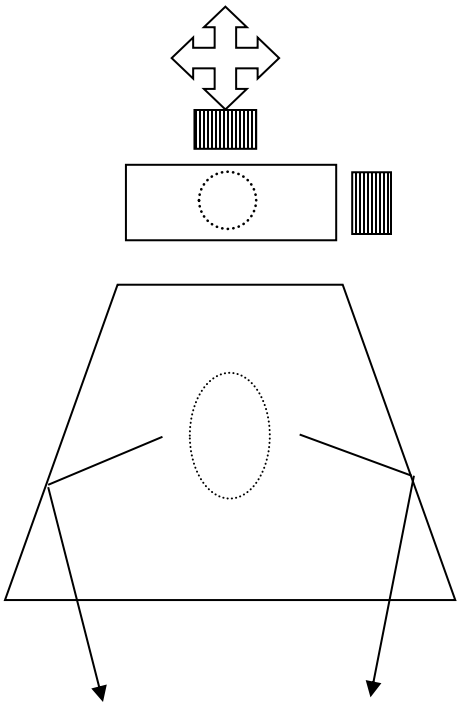
NOTE: You must adjust each axis AT LEAST 3 TIMES to peak the lamp; XYZ…XYZ…XYZ, etc.

The **XYZ Micromanipulator** is used to set the lamp in its peak position.





XYZ Micromanipulator



Lamp Uniformity

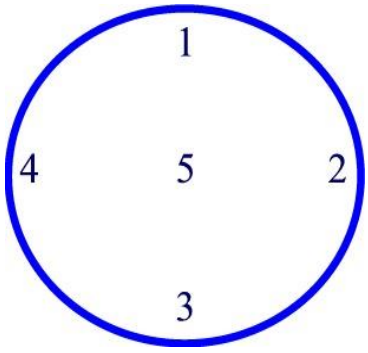
Lamp uniformity refers to the uniformity of the intensity over the entire circle of light hitting the wafer. Of course, perfect uniformity is desired but rarely possible. The general specification is:

1-4 inch wafers: +/- 3 %

5-6 inch wafers: +/- 4 %

8 inch wafers: +/- 5 %

Often a better uniformity can be achieved. Generally, the uniformity is read at 5 points on the wafer, as seen below.



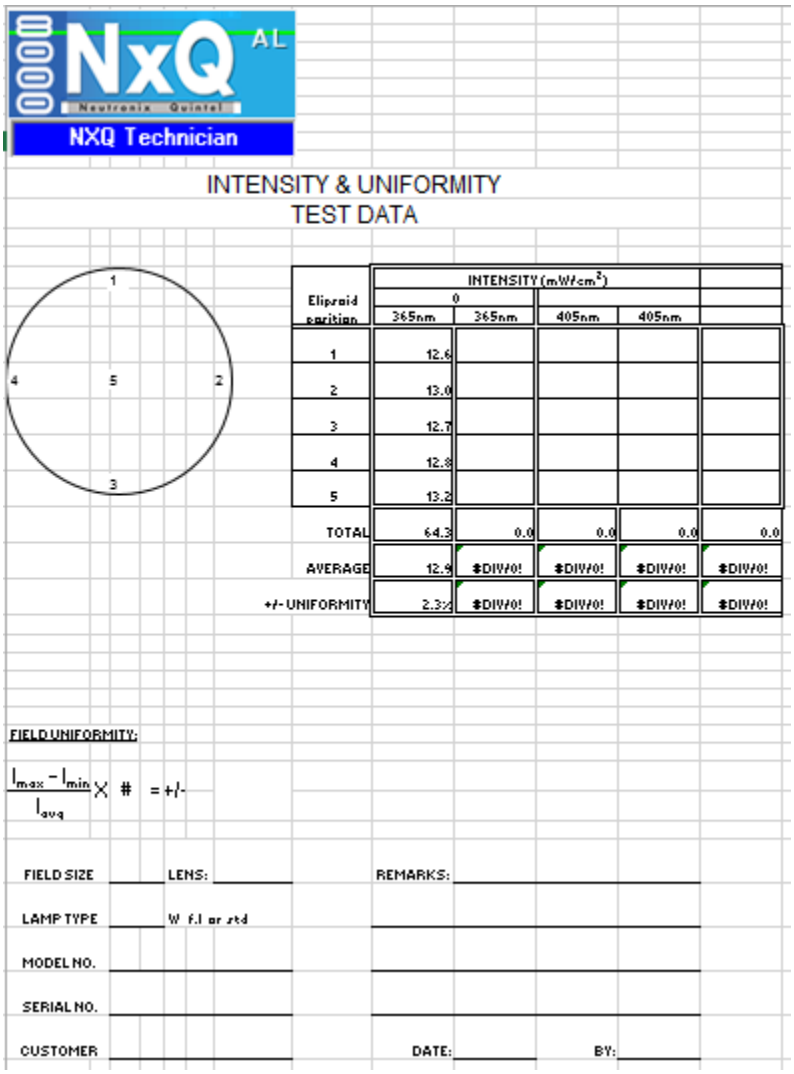
There are several ways to calculate uniformity. At Neutronix we use the following method:

$$\frac{I(max) - I(min)}{I(avg)} \times 50 = +/- \text{ uniformity}$$

Or:

$$\frac{\text{maximum intensity - minimum intensity}}{\text{average intensity}} \times 50 = +/- \text{ uniformity}$$

Below is a picture of an Excel file that we use at NXQ to automatically calculate uniformity. It is helpful to have this on the Desktop. Enter the measured intensities and the uniformity and average will be calculated by the formula. Please let us know if you would like the file.



NxQ AL
Neutronix Quintel
NXQ Technician

INTENSITY & UNIFORMITY
TEST DATA

Eliprad position	INTENSITY (mW/cm²) 0 365nm	365nm	405nm	405nm	
1	12.6				
2	13.0				
3	12.7				
4	12.8				
5	13.2				
TOTAL	64.3	0.0	0.0	0.0	0.0
AVERAGE	12.9	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
+/- UNIFORMITY	2.3%	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

FIELD UNIFORMITY:

$\frac{I_{max} - I_{min}}{I_{avg}} \times \#$ = +/-

FIELD SIZE _____ LENS: _____ REMARKS: _____

LAMP TYPE _____ W f.l or std

MODEL NO. _____

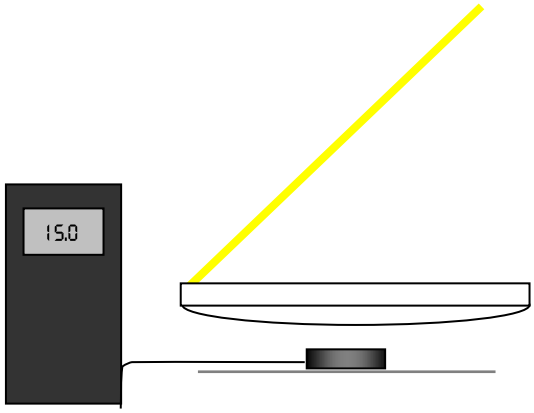
SERIAL NO. _____

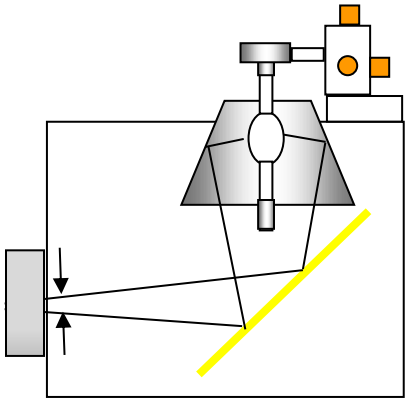
CUSTOMER _____ DATE: _____ BY: _____

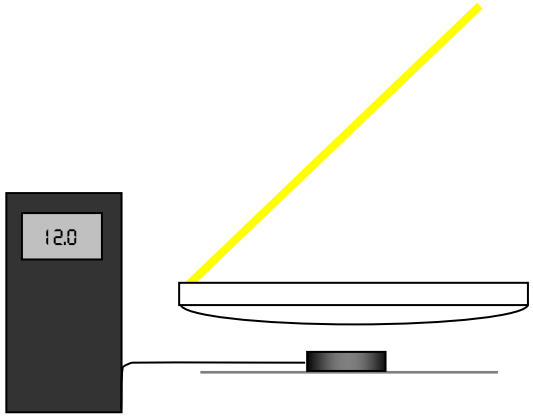
Improving uniformity

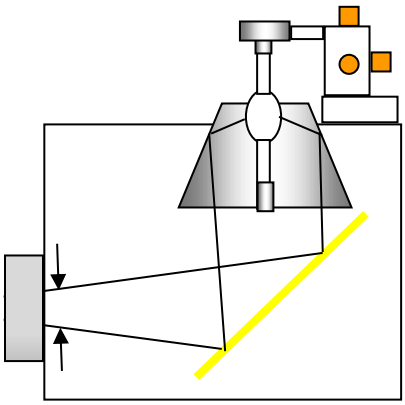
Although it is usually not necessary, uniformity may be improved by raising the lamp slightly in the reflector with the Z axis micromanipulator. This will widen the circle of light that hits the integrator. The overall intensity will drop as the lamp is raised up. This is called **defocusing** the lamp.

CAUTION: Do not adjust the Z axis of the lamp so the intensity drops more than 2 mw/cm^2. This could put the anode of the lamp in wrong position and result in overheating. Generally, a drop of 1-2 mw/cm^2 is acceptable.









The intensity drops slightly as the lamp is raised.

The beam of light that hits the integrator increases in diameter allowing all the lenses to be filled with light. This can improve uniformity.

Exposure Process Control in Constant Power

In Constant Power mode the only way to raise the intensity is by increasing the power with the Power Knob. Since the lamp power in this mode is continuous, the best idea is to set the initial power level slightly low so there is some room to increase the power and intensity as the lamp degrades.

For example, suppose the intensity at 350W is 13 mw/cm^2 at the wafer. It is better to set the process expose intensity at 12 mw/cm^2 at 320W (or similar) so as the lamp degrades you can gradually increase the power and maintain the desired process intensity longer.

After the lamp requires 385W to achieve 12 mw/cm^2 the only choice is to increase expose time or change the lamp.

When a lamp reaches 30% of the original intensity, the life of the lamp is considered over. It often happens that this coincides with the time that the lamp requires full power to reach the original intensity. The life of a lamp varies, but the average life is 1000-1500 hours. Lamp manufacturers rarely guarantee more than 400-500 hours, however. Exceeding 2000 hours is not recommended due to possibility of catastrophic failure and explosion.

The other process choice is to simply set the lamp at the rated wattage, read the intensity every day and set a new expose time. Exposure energy is:

I (Intensity in milliwatts/square centimeter) x **T** (Time in seconds) = **E** (Exposure Energy in millijoules/square centimeter)

Example: 12 mw/cm^2 x 5 seconds = 60 mj/cm^2

To recap:

Method 1: Set the lamp power slightly lower and raise the lamp power gradually to maintain the initial intensity and exposure dose. Expose time remains the same. When the lamp needs full power to reach the process intensity, change the lamp.

Method 2: Set the lamp power to the rated wattage and leave it there. As the lamp degrades and loses intensity, recalculate the expose time to maintain the desired exposure dose. When the lamp intensity drops 30%, change the lamp.

In production, it is often best to use the next mode of lamp control, Constant Intensity.

Exposure Process Control in Constant Intensity

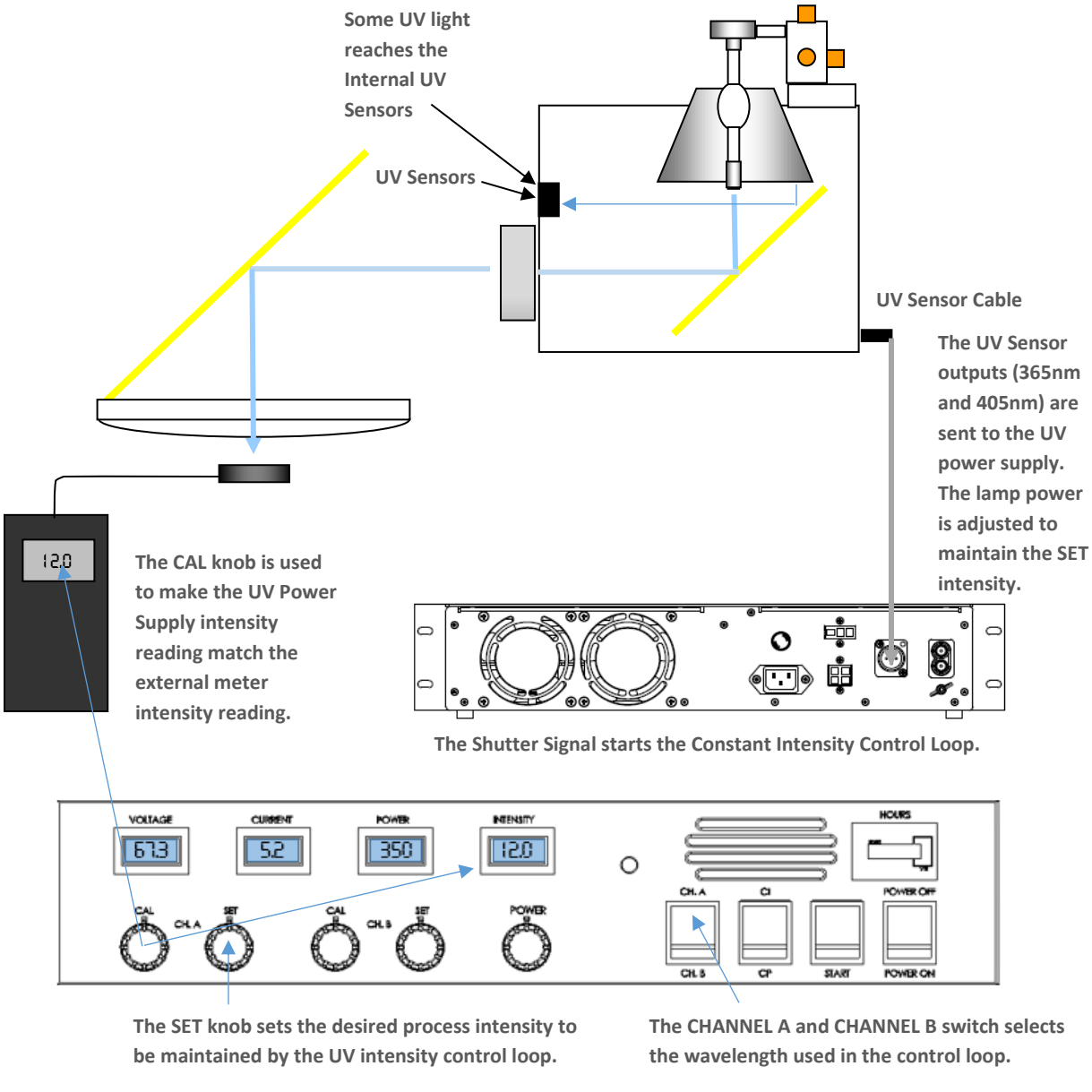
In **Constant Intensity** mode the lamp intensity is constantly monitored by sensors inside the lamphouse. When the shutter opens, a feedback loop is activated that drives the lamp power to maintain the desired expose intensity at the wafer. When the shutter closes, the lamp power falls back to a nominal or **IDLE** wattage.

As the lamp degrades and loses intensity, the power is automatically adjusted to keep maintain the initial SET process expose intensity. The expose time remains constant. When the lamp requires too much power to reach the expose intensity, a limit in the power supply will set off an alarm whenever the shutter is open. Then it is time to change the lamp.

Basically, the Constant Intensity mode accomplishes the Constant Power mode Method 1 automatically.

CONSTANT INTENSITY

How it works

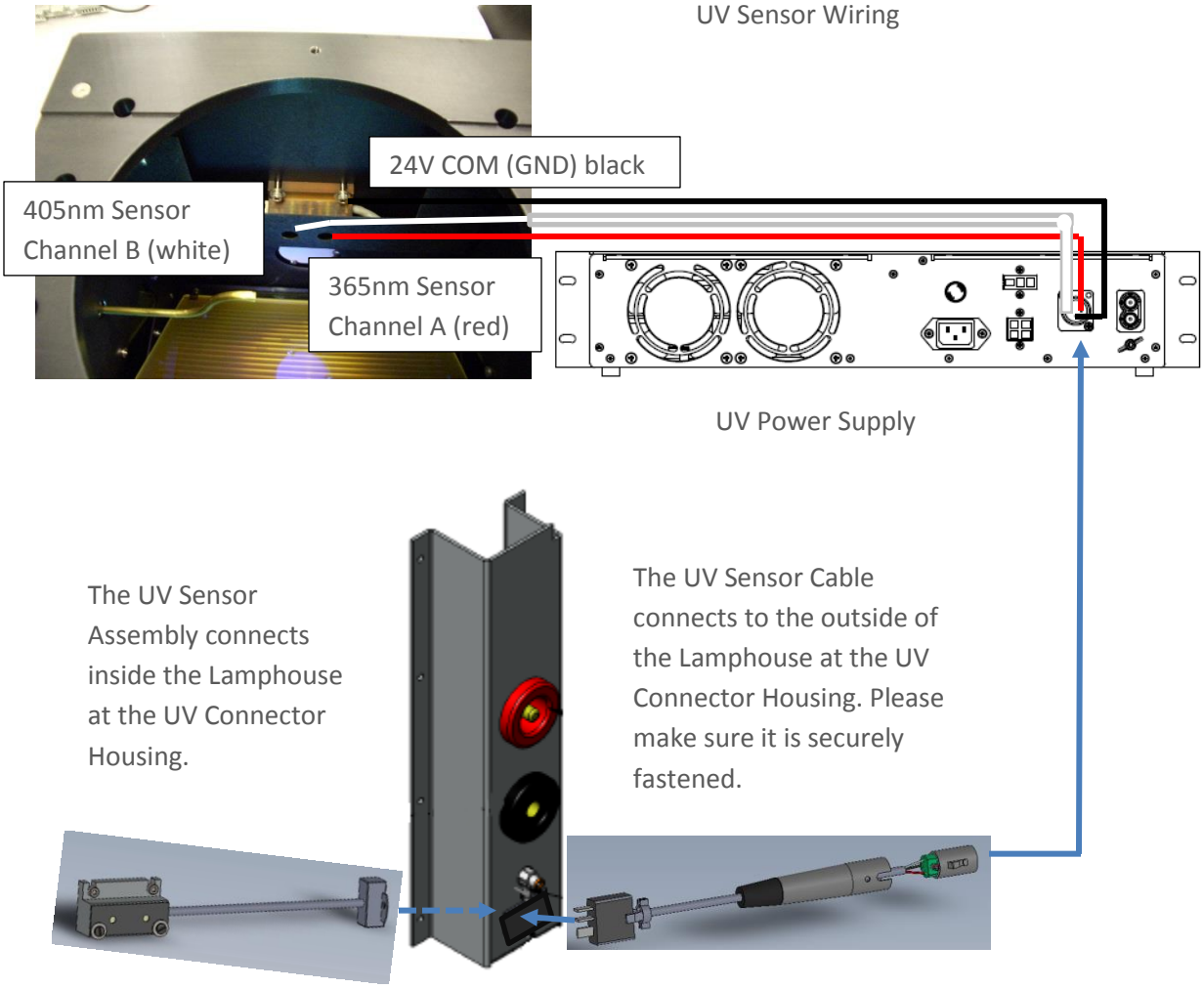


CONSTANT INTENSITY CALIBRATION AND SET PROCEDURE

- Place the external meter probe in the center of the Chuck or Probe Plate. Choose the UV wavelength desired. Most resists are I-line at this time, so the 365nm sensor and probe will be used as the example.

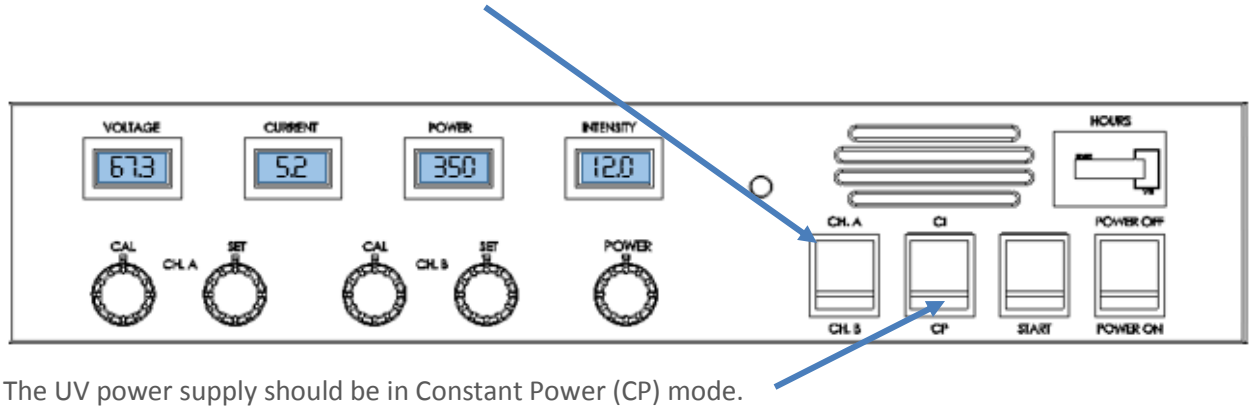
  Channel A is normally the 365nm channel of the UV power supply. The 365nm internal sensor is connected to Channel A.

  Channel B is normally the 405nm channel of the UV power supply. The 405nm internal sensor is connected to Channel B.



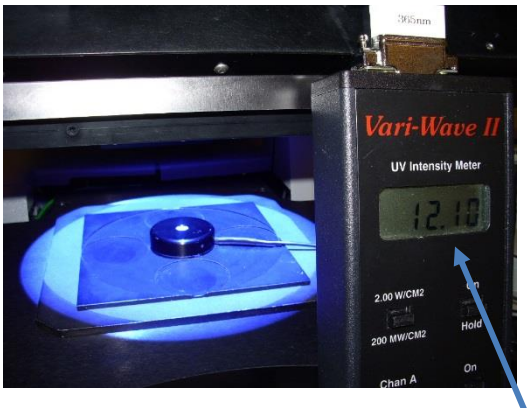
The connection of the internal UV Sensors to the UV Power Supply.

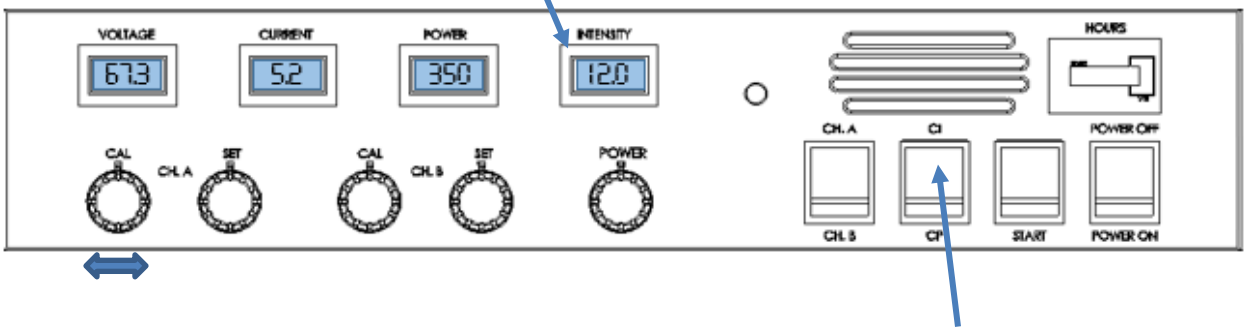
Select Channel A for the 365nm sensor.



The UV power supply should be in Constant Power (CP) mode.

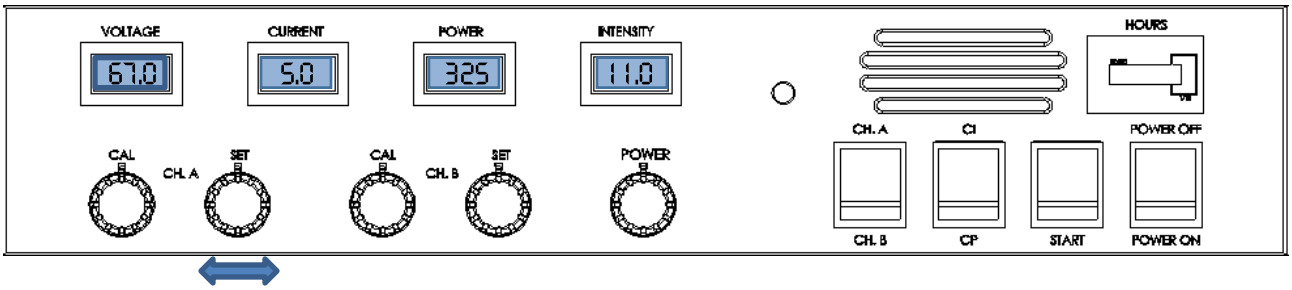
- Do **Coarse Calibration** of the internal sensor to the external meter. Turn the CAL knob until the power supply matches the external meter.



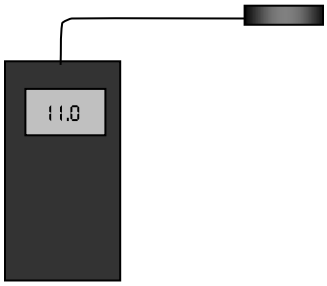


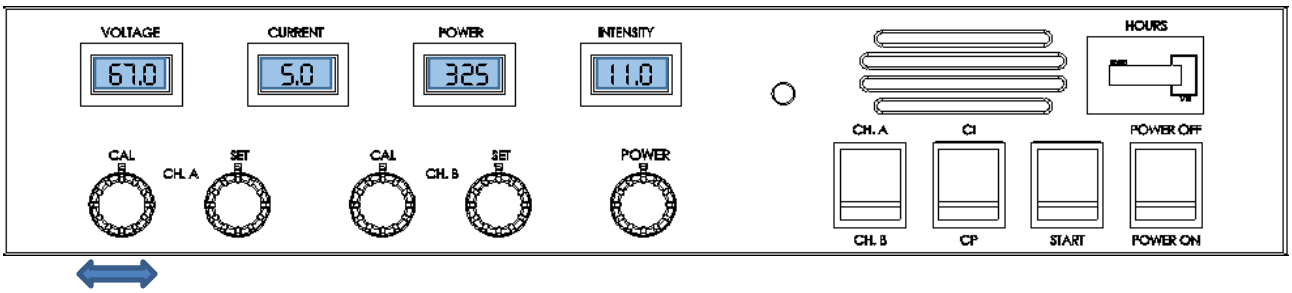
- Switch the power supply to Constant Intensity mode with the CI/CP switch.

- Turn the **Set Knob** to set the desired process intensity. This intensity should not be far from the peak intensity at 350W. Ideally it will be slightly less, more closely matching the intensity at idle wattage; 325W for example. While it is fine to start running the lamp at a process intensity requiring 350W, the lamp will get longer life if it starts out running a bit lower.



- Now do a Fine Calibration of the system. Adjust the CAL knob so the intensity at the wafer (external light meter) matches the set process intensity.





- Close the shutter by deselecting Manual Expose in the Controls menu.
- Set the Idle Power of the lamp with the Power Knob slightly more than 10% lower than the rated wattage of the lamp, i.e., for a 350W lamp set the idle power to 320W-325W.

Operation Sequence

This section describes the normal sequence of operation for the **NxQ** NXQ4006 aligner. The initial section is a summary of the sequence, while the following sections explore techniques and procedures.

If you have not done so already, please familiarize yourself with the previous two sections: **Start Up** and **Machine Setup**. **Operation Sequence** has been written with the assumption that the aligner has been configured and set up accordingly, and is ready for operation. The procedures described in this section cover the operation actions at the start of the shift or at the time of changing to another task using the same basic configuration.

If you have not already done so, start up your aligner. Use the following procedure:

1. POWER UP THE ALIGNER SYSTEMS

- Turn on the **Power Strip** behind the table (if necessary). It is usually already on when the main AC cord is plugged in to the wall.

(OBS System shown)

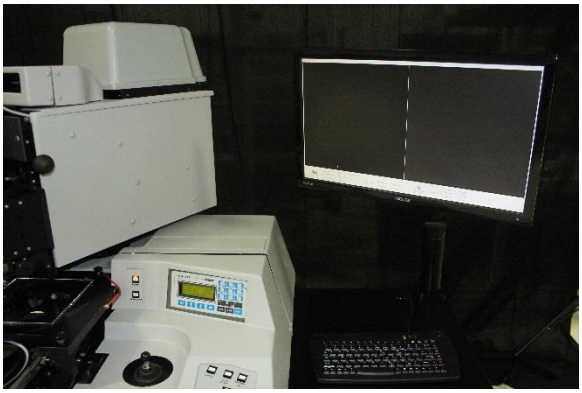
- Turn on the **Aligner Main Power**.

- Turn on the aligner by pressing the **Power** switch on the upper right panel for 2 seconds.

- Turn on the **UV Power Supply**. Start the UV lamp.

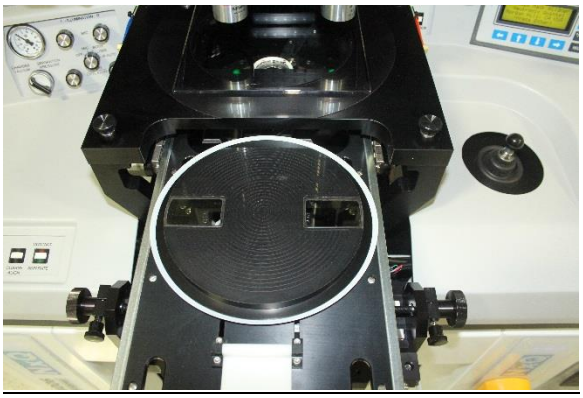
- Turn on the two **Light Box** switches beneath the table (if the aligner has OBS/IR).

- Turn on the **Monitor**.



2. VERIFY OR SELECT THE PRINTING OPTIONS

- Pull tray out.

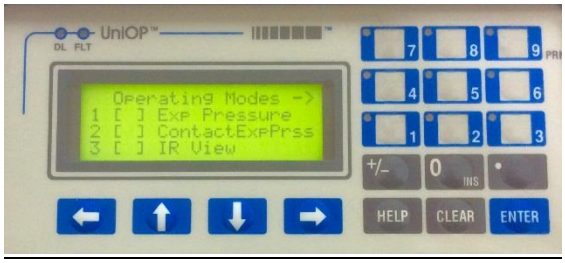


- Press **Enter** to display the main menu.

- Select or verify **Printing Mode** parameter.

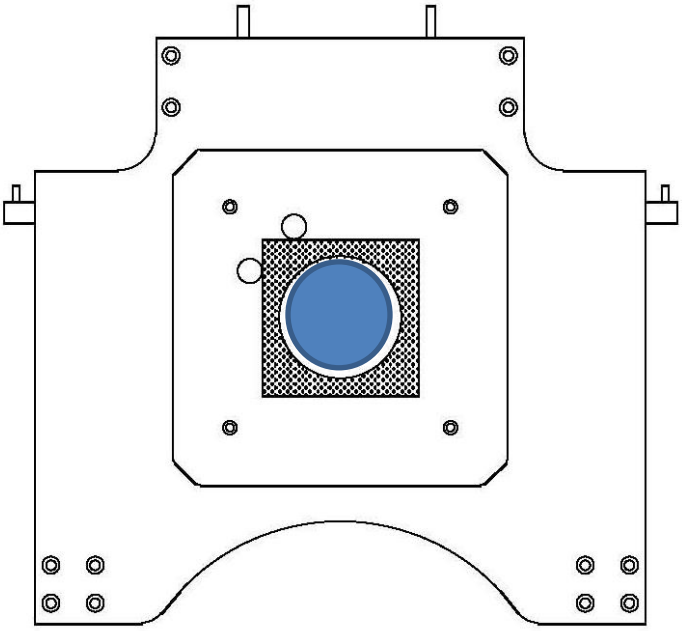
- Set or verify the **Exposure Timer** parameter.

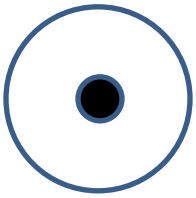
- Select or verify the **Operating Modes** parameter.



3. CENTER THE STAGES

- Complete one **Load Cycle** *without* a wafer or mask. Advance the aligner to **Separation**.
- Using the coarse and fine align, **center the chuck in the mask holder opening**.

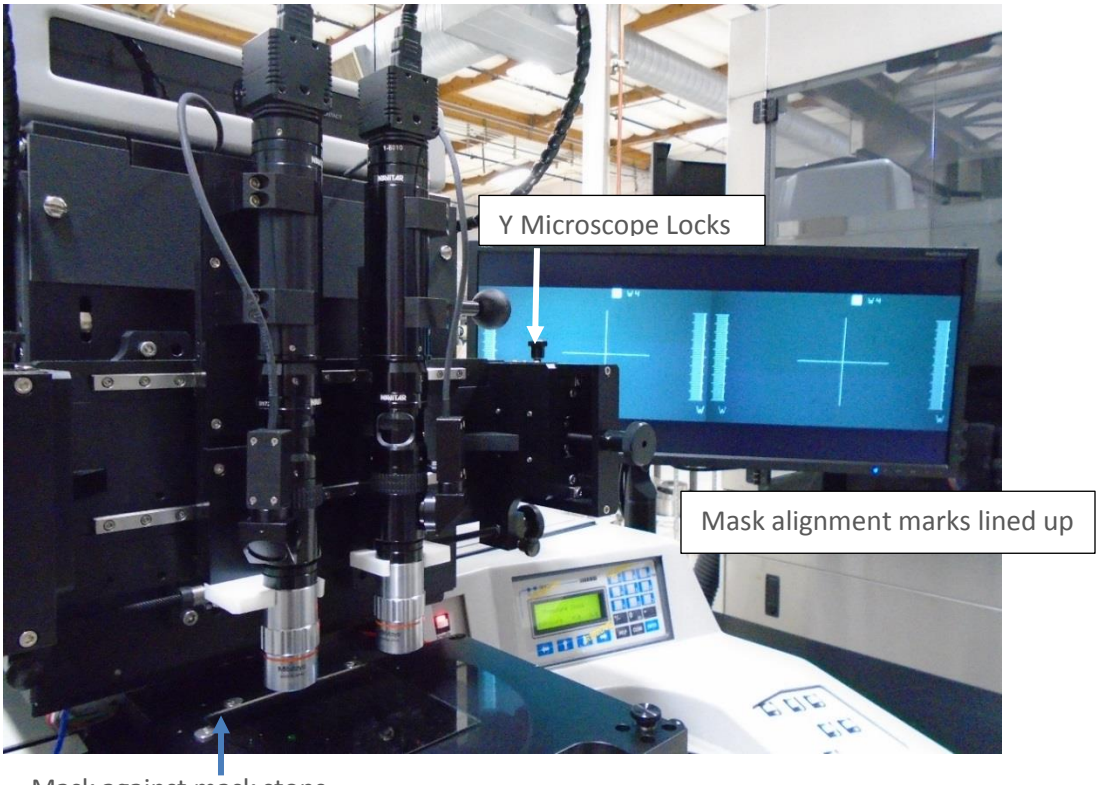


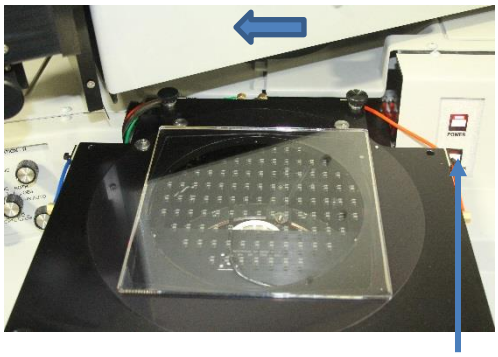


The chuck should be centered in the mask holder opening and the joystick should be straight up and centered. Use Fine and Coarse Align to accomplish this.

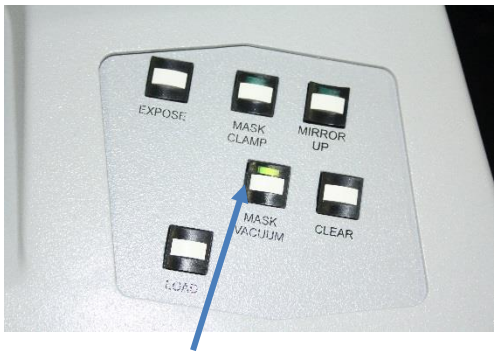
4. LOAD THE MASK

- Press the **Head Lock** switch and turn the optical head.
- Place the mask on the mask holder and push the upper left corner into the mask stops.
- Swivel the optical head back over the mask. Press Head Lock again to lock it. Adjust the optics and illumination as needed. Line up the mask alignment marks.
- Press the **Mask Vacuum** switch to secure the mask to the mask holder.
- Lock the Y microscope with the **Left and Right Y Microscope Locks**. This prevents the microscope from losing position when the expose mirror lifts.





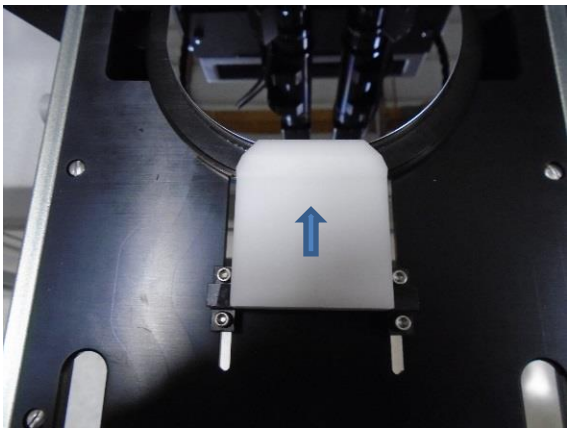
Press Head Lock and swivel the optical head.

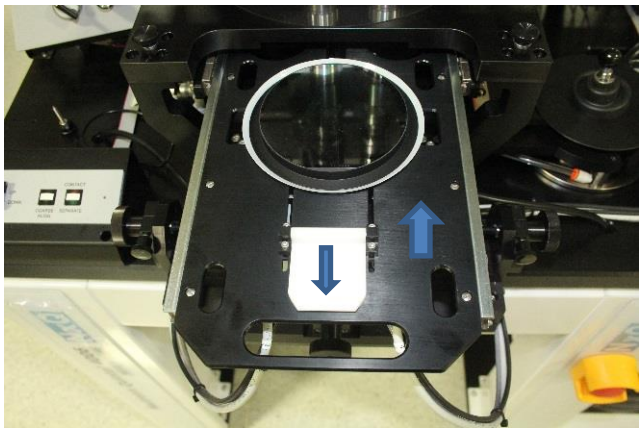


Press Mask Vacuum after mask is adjusted.

5. LOAD THE SUBSTRATE

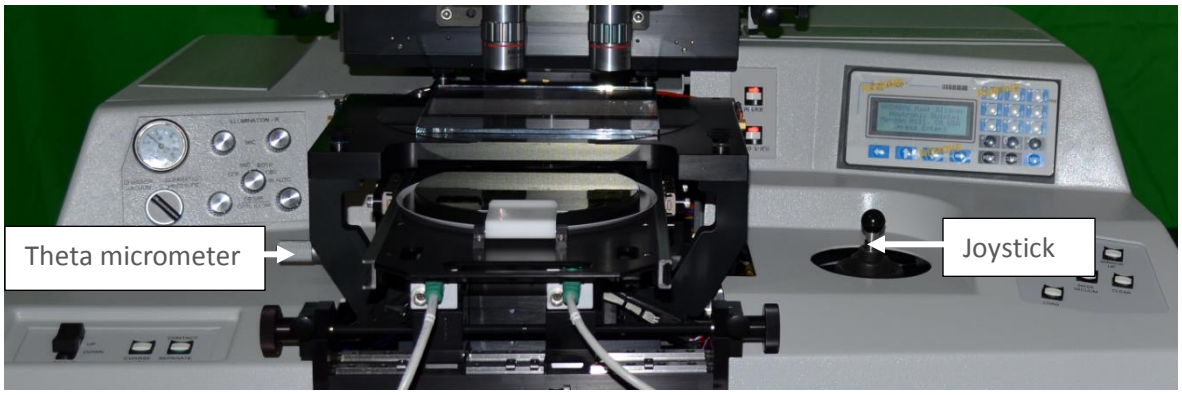
- Position the substrate on the chuck.
- Pre-align the substrate. Push the tray in slightly for wafer vacuum. Flip back the prealigner.
- Press the **Load** button on the lower right panel.
- Push the tray in gently until it firmly hits the tray stop: the piston lifts the chuck to contact, levels the substrate, and then automatically drops into Separate position.

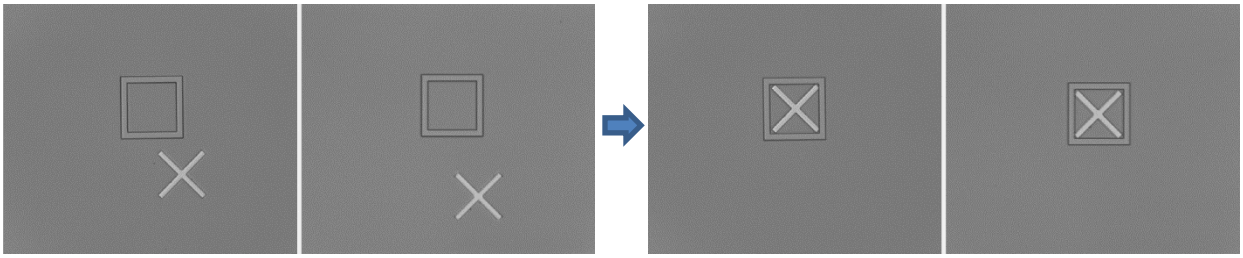




Align the wafer flat with the prealigner. Flip the prealigner back and push the tray in to load the wafer.

6. ALIGN THE WAFER: USE THE JOYSTICK TO ALIGN IN X AND Y. USE THE THETA MICROMETER TO ALIGN THETA

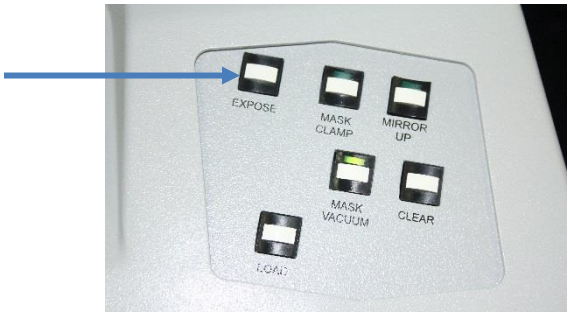


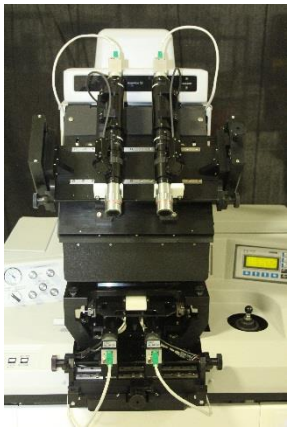


7. PRESS THE CONTACT BUTTON ON THE LOWER LEFT PANEL
   - Verify that the alignment accuracy is acceptable.

8. ADJUST ALIGNMENT IF NECESSARY
   - Press **Separate** on the left panel; realign as required.

9. EXPOSE THE WAFER
   - Press the Expose button on the front right panel to initiate the expose cycle.
   - The piston will lower when the exposure is complete.





10. UNLOAD
    - Pull the tray out to unload the wafer.

The cycle is complete.

Summary Chart

Display Reads	Control Panel Switch	Action Required	Result
Load Wafer			Ready for Operation
		Load Substrate	
		Pre-align Substrate	
	Press **Load**		Initiates Sequence
Push Tray in			Instructs Action
	Push **Tray In**		
Piston Up			Guide Set has lifted the substrate up to the mask for leveling
Pressure Check			Allows time for the lift piston pressure to reach proper level before proceeding
Level Air Delay			Allows the chuck to level before the locking vacuum is applied to the ball.
Separation			Drops the chuck into the designated separation gap
Separation Vac Delay (if in VACUUM CONTACT)			Allows the purge to eliminate any chamber vacuum before the separation ring activates
		Align the Substrate	
	Press **Contact**		The air bearing piston moves the substrate into contact with the mask.
Contact			Allows the operator to verify alignment
	Press **Separate**		Optional repeat of steps 10-12 for optimum alignment
	Press **Expose**		Initiates exposure sequence
Expose			Delays sequence until the optical head is manually rotated to the expose position
Shutter Delay			Delay to allow system to settle before starting exposure.
Exposure			Shutter opens (2nd line displays set expose time and elapsed time)
			At the end of the expose period, shutter closes
Piston Down			Delay to allow air bearing piston to retract
Unload Wafer	Pull **Tray Out**		
Load Wafer		Remove Substrate	Completes Cycle

Standard Operation Charts

Power On Sequence		
		Power Off
Press Power		Power On
		Screen shows initialization sequence, ending with title page
	Press **Enter**	
	Pull Tray Out	
		The aligner is ready to program or operate

Shut Down Procedure		
	Press **Enter**	From any menu
	Press **Power Off**	PLC resets itself and actuates the power down circuit
Power indicator light fades to off		Power is off

Exposure Time Set Procedure		
	Press **Enter**	From any menu
	Press **EXP Time**	
		Ready to enter time value
	Press **Insert,** then highlighted numbers as required	Enters time value
	Press **Enter**	Returns to main menu

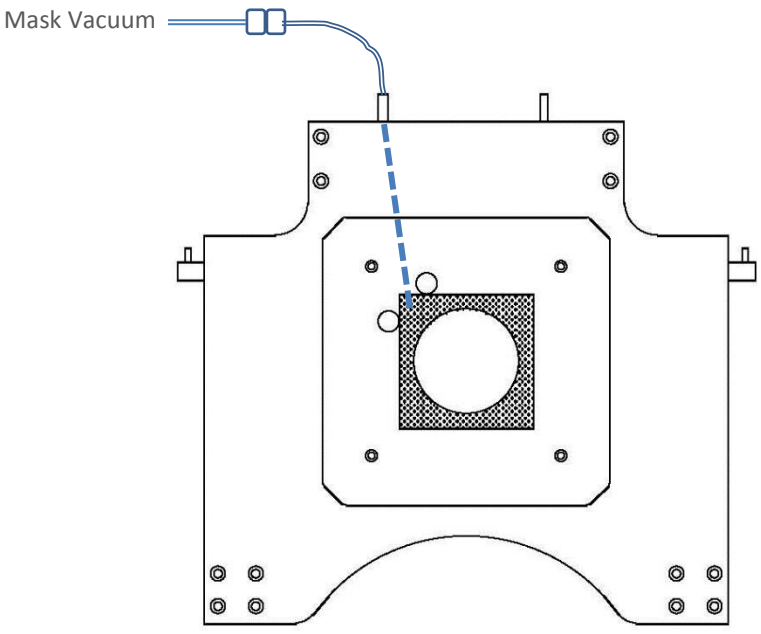
Theory of Operation

This section of the manual consists of a summarization of the mechanisms, sensors and controls that make the aligner perform its tasks. First, we will look at the sensors and controls for the normal machine cycle.

MASK LOAD

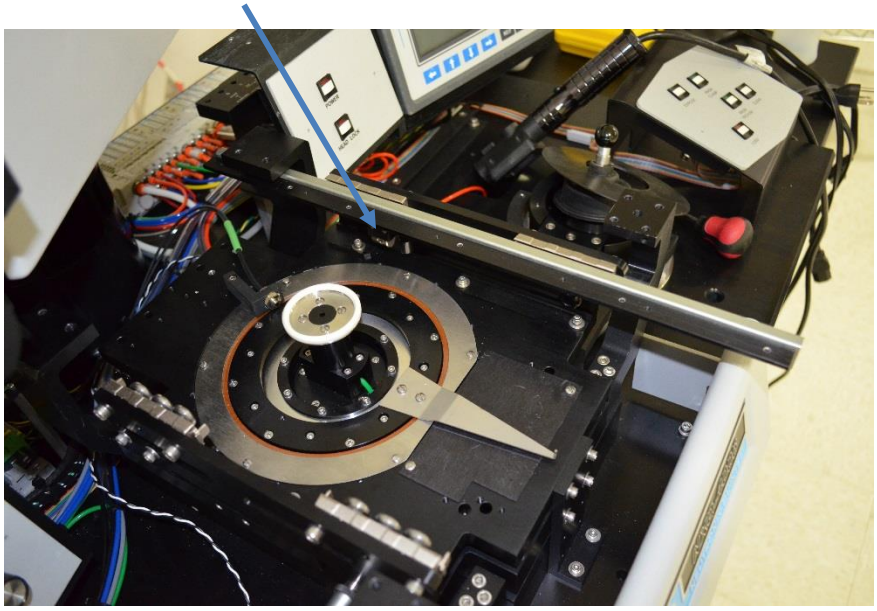
When the HEAD LOCK switch is turned OFF, the **Head Lock Cylinder** retracts allowing the optical head to be turned. Turn it on to lock the head.

The MASK VACUUM switch will activate the **Mask Vacuum Valve** and the mask will be held to the mask holder.



LOAD WAFER/PUSH TRAY IN

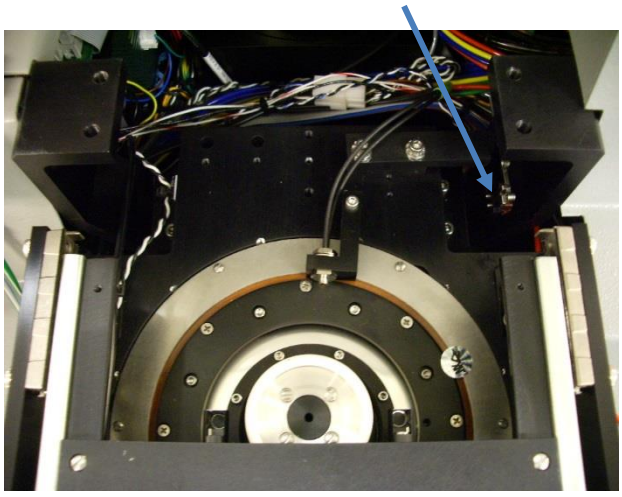
After the wafer is prealigned, pushing the chuck slightly forward will turn ON the **Chuck Vacuum** valve. This happens when the **Tray Out Microswitch** is triggered by the tray.



Even if the LOAD switch is not pressed the chuck vacuum will turn ON when the tray is slightly pushed in and the microswitch actuates. This is convenient for holding the wafer position on the chuck after prealignment. Push the tray forward until the chuck holds the wafer and then flip back the prealigner. The LOAD switch can be pressed at any time. When the LOAD switch is pressed the message on the PLC display will change to “Push Tray In”.

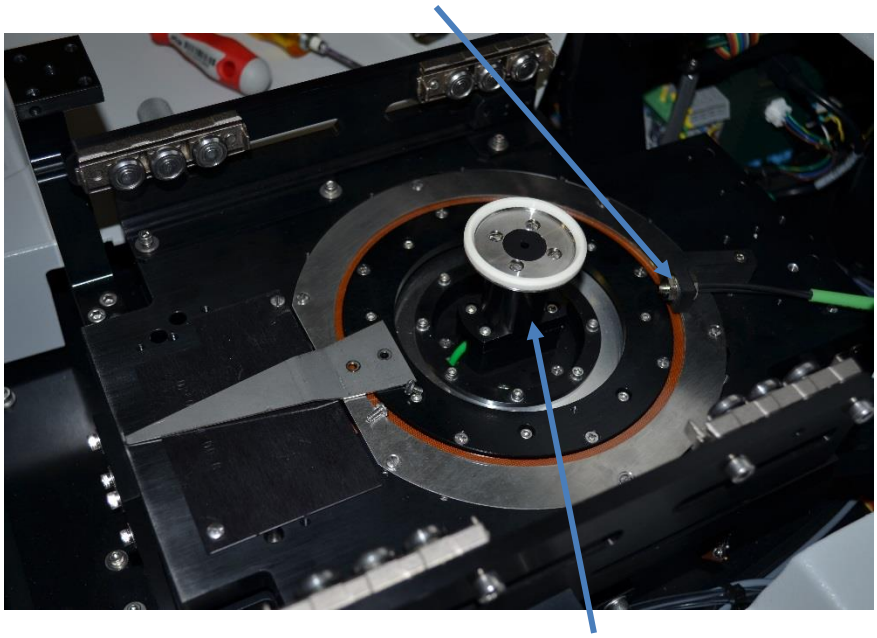
PISTON UP

When the tray is fully in it will activate the **Tray In Microswitch**.

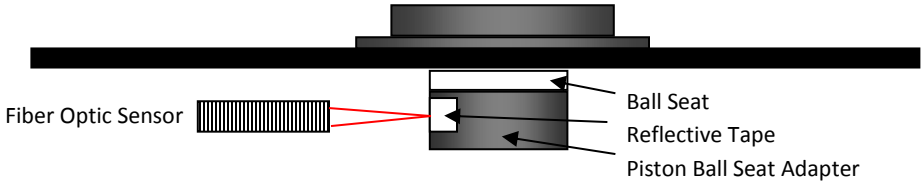


The PLC display will read “Piston Up”. The **Air Bearing** and **Piston Lift** valves will turn ON and the piston will begin to lift.

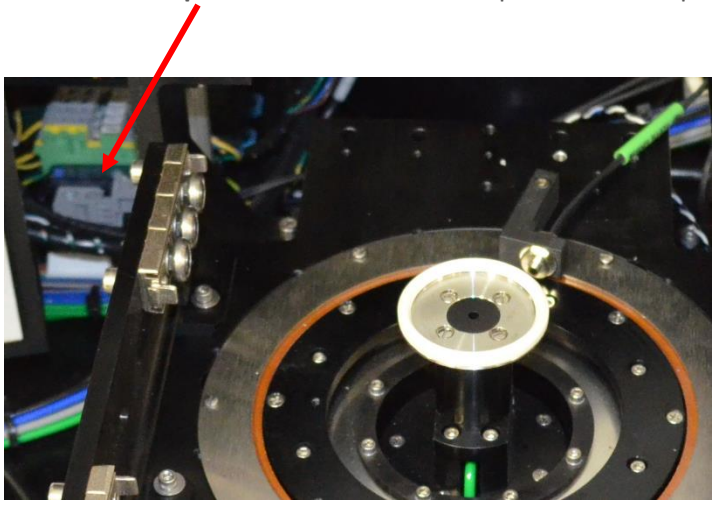
The program is now looking for the **Chuck Motion Sensor** to change state.



This fiber optic sensor looks at reflective tape on the side of the **Ball Seat Support**. It detects a change in reflectivity as the piston rises.



The sensor connects to an **amplifier** that is calibrated to produce an output when the sensor sees the reflective tape.

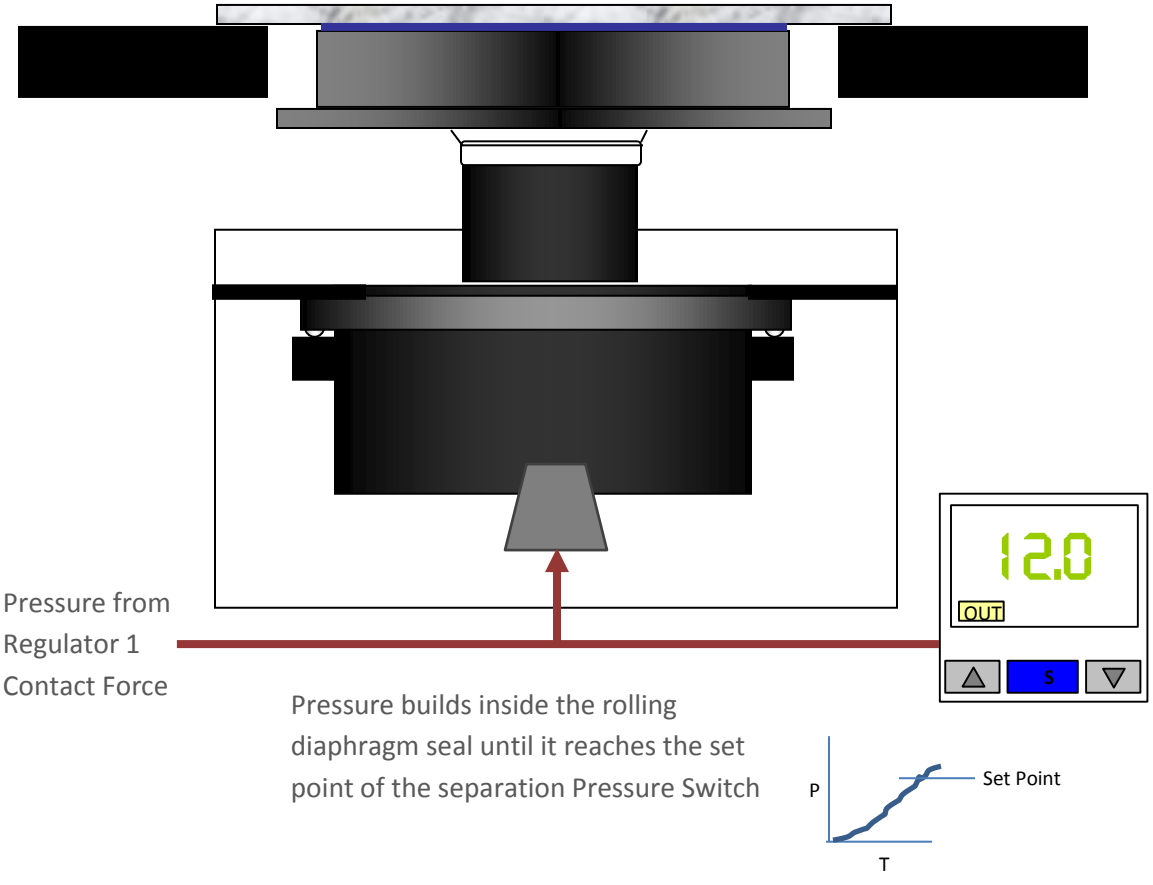


PRESSURE CHECK

After the Chuck Motion Sensor has activated, the program begins to look for the **Pressure Switch S9**. The display will read “Pressure Check”.

When the pressure from Regulator 1 builds up inside the piston rolling diaphragm to the level set by the pressure switch, the machine will move into **Level Air Delay**.

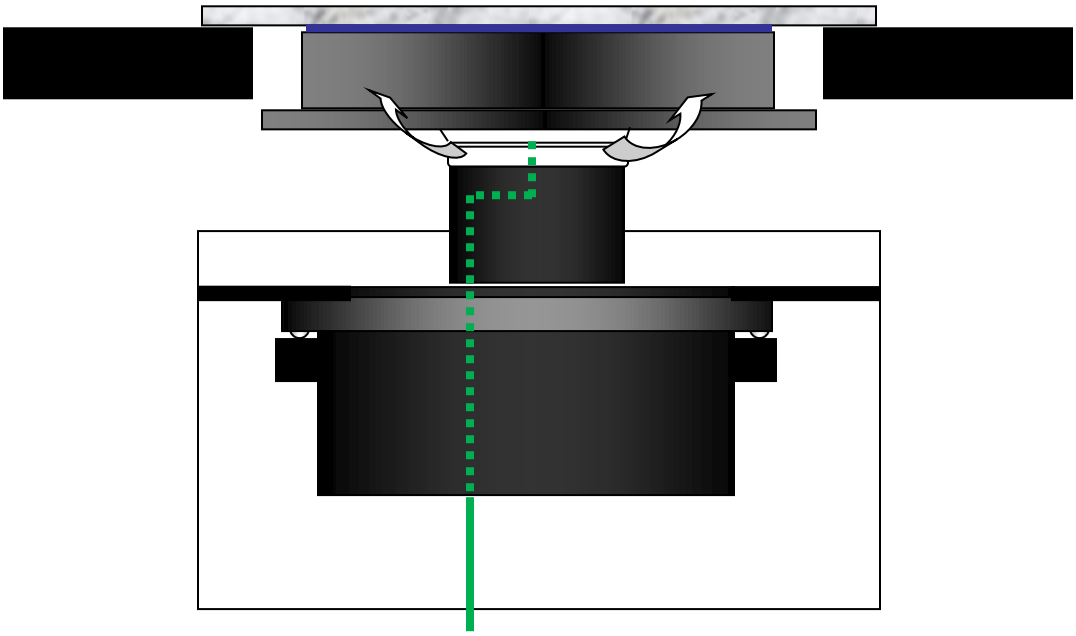
The Pressure Switch is actually a pressure display module that produces an OUT signal when the pressure reaches the set point.



LEVEL AIR DELAY

The display will now read “Level Air Delay”. This is the beginning of the **Level Delay** set in the Maintenance Delay Screen.

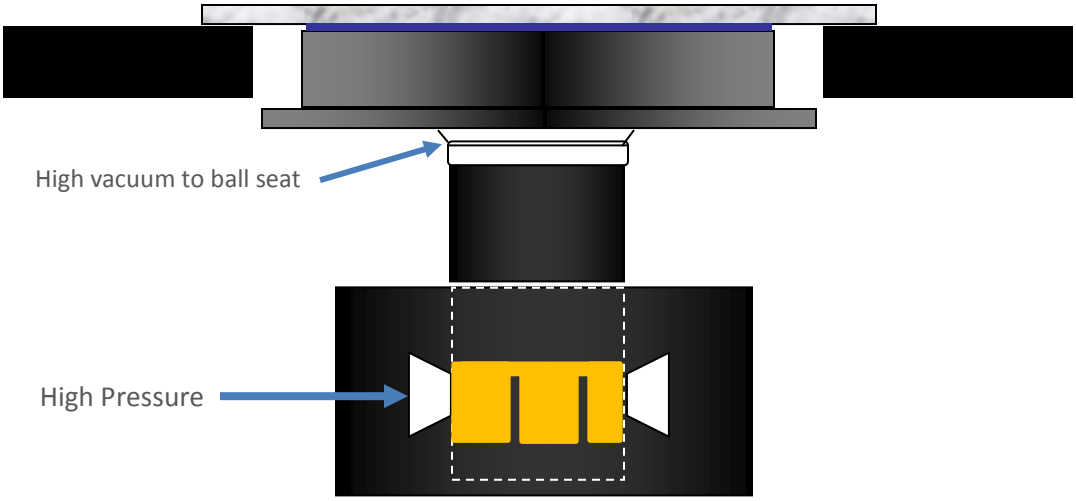
During the Level Air Delay the **Leveling Air Valve** turns ON for the time of the delay. This provides nitrogen or air from Regulator 8 to the chuck ball seat creating a frictionless swiveling action to planarize the wafer against the mask.



Regulator 8 Air Bearing Level

At the end of the delay high vacuum will be applied to the ball seat from the **Ball Seat** valve to hold the chuck and wafer planar to the mask for alignment. The display will then read “Lock Ring Delay”.

The **Lock Ring** valve will activate providing high pressure air to the **Lock Ring**. This ring with copper fingers clamps securely onto the piston and holds it in the up position. The piston will remain locked throughout exposure until the lock ring is released to let the chuck drop to the tray.



Lock ring activated

SEPARATION

The first thing that will happen when the display reads “Separation” is the purges will be applied to the printing chamber. (The purge through Flow Control 28 to the right side of the mask holder is always ON if the Purge Toggle Valve is set to Purge ON).

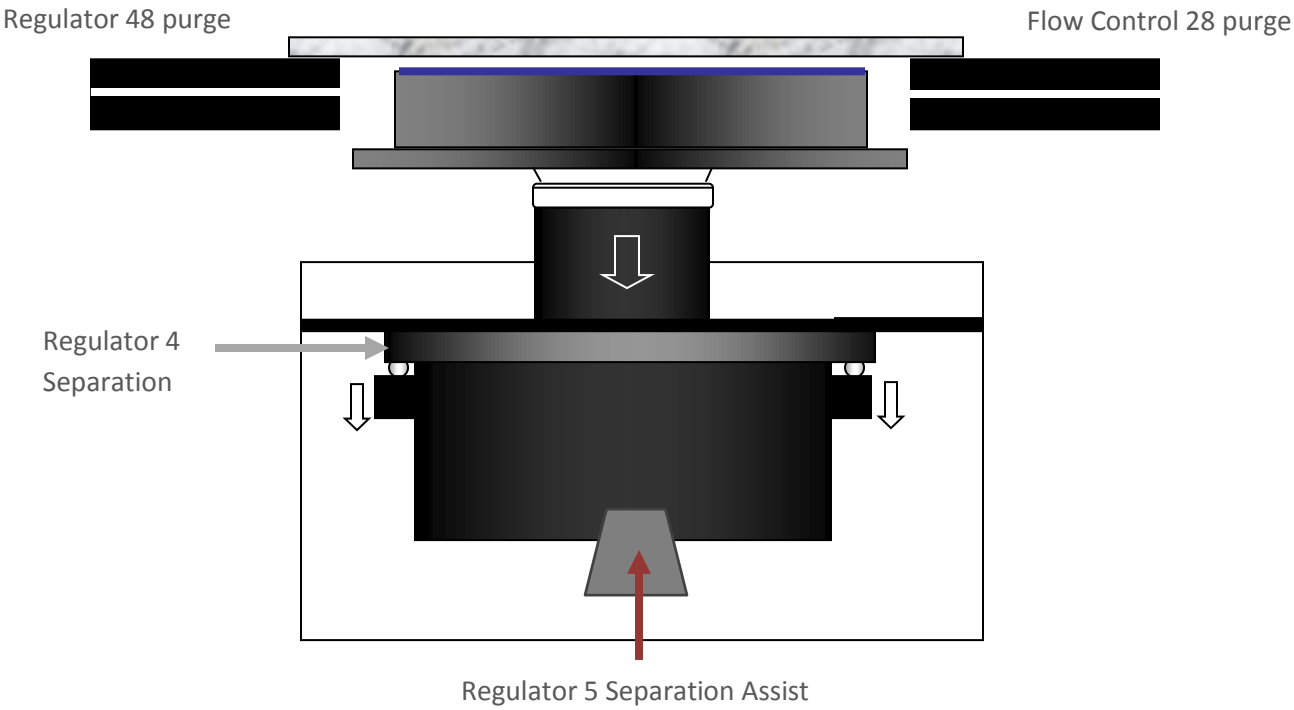
If the printing mode is **Vacuum Contact** and **Level Vac Off** is NOT selected in the Operation Modes, the hose on the left side changes to Chamber Vacuum during leveling (**Chamber Vacuum** valve is ON). There must be NO vacuum in the printing chamber when the wafer moves to separation, therefore this valve must turn OFF and change to purge. This purge is set by Regulator 48.

There is a short delay (Separation Delay) set in the Maintenance > Delays Screen that allows the purges to fill the chamber with nitrogen before the wafer moves to separation.

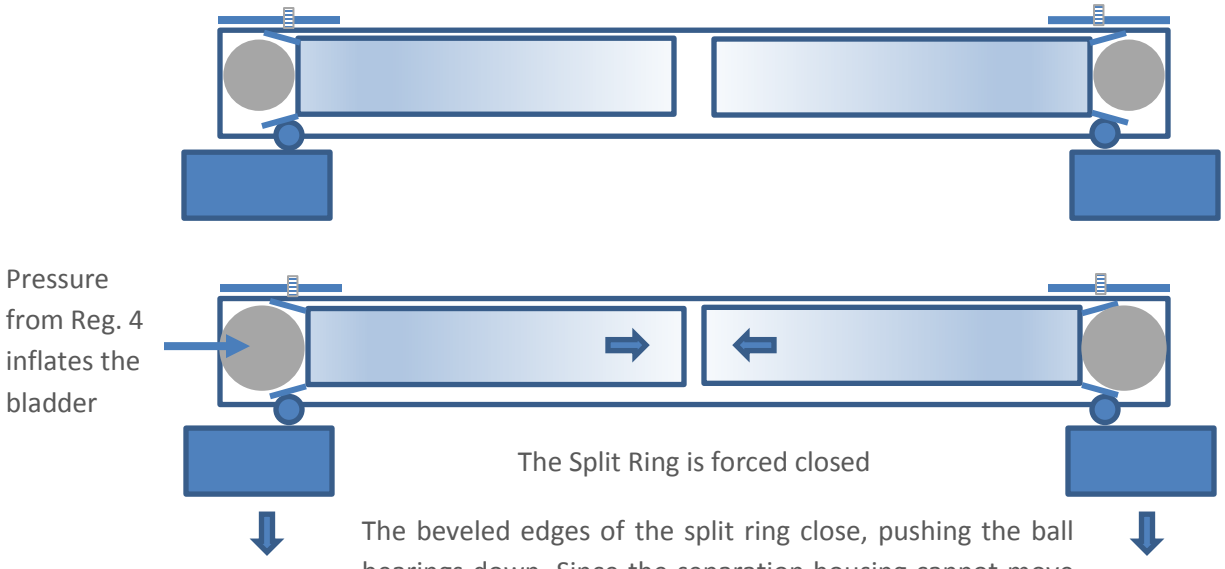
In separation, the **Separation Ring** and **Separation Assist** valves turn ON. The separation valve provides air from Regulator 4 to the Separation Ring.

Separation assist is an opposing air pressure from Regulator 5 that can push up on the piston (like Contact Force) during separation to lift heavy chucks. Heavy chucks tend to drop, so the separation distance (align gap) may be too great even with zero pressure from Regulator 4. Adding the Separation Assist will bring the wafer up closer to the mask when the wafer is at minimum separation.

It is not always necessary to use Separation Assist and it is set at the factory during the setting of separation distance.



Separation is accomplished by the Split Ring. Pressure from Reg. 4 is applied to a Separation Bladder which acts on the ring to close it, pushing the ball bearings of the ring down to move the lock ring down to separation.



The beveled edges of the split ring close, pushing the ball bearings down. Since the separation housing cannot move up (it is locked by a plate), the ball bearings push the lock ring down into separation. The piston, chuck and wafer are all locked together by vacuum or lock ring, so the wafer also moves down into separation.

In fine wafer alignment motion, the Coarse Align valve is OFF and the Fine Align valve is ON. The Fine Align Disc is secured to the Align Plate, the Coarse Align Disc is free to float and the gimbal motion is a ratio of 150:1. The stage will move very little for a large movement of the joystick.

If the COARSE ALIGN switch is pressed, the Coarse Align valve is ON and the Fine Align valve is OFF. The Coarse Align Disc is secured to the Align Plate, the Fine Align Disc is free to float and the gimbal ratio is 3:1. The stage will move much farther for a large movement of the joystick.

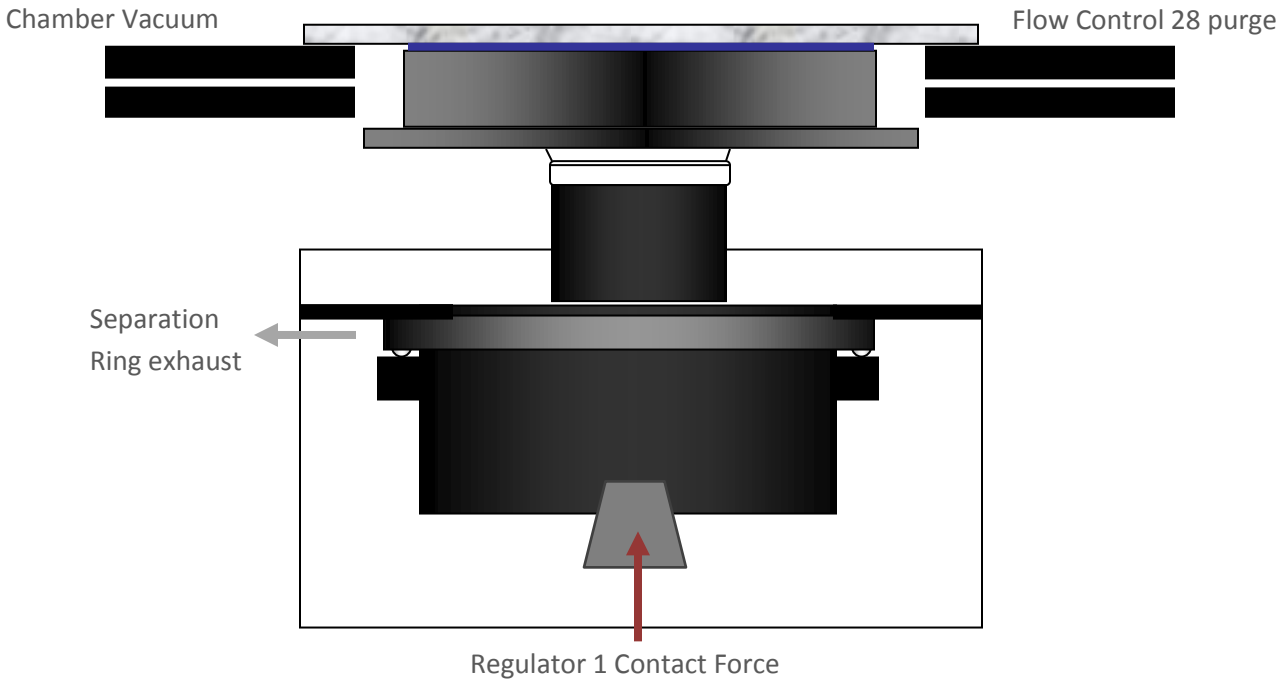
CONTACT

When the CONTACT switch is pressed, the Separation Bladder exhausts, allowing the Lock Ring to move the wafer up into Contact. The piston pressure changes from Separation Assist to Contact Force, pushing the wafer against the mask. The display reads “Contact”.

If Vacuum Contact is used, the Chamber Vacuum valve turns on and sends vacuum to the blue hose on the left side of the mask holder. This happens after the Contact Vacuum Delay set in the Maintenance > Delays screen.

Both the Coarse Align and Fine Align discs are locked to hold the stage in a locked position with the joystick gimbal.

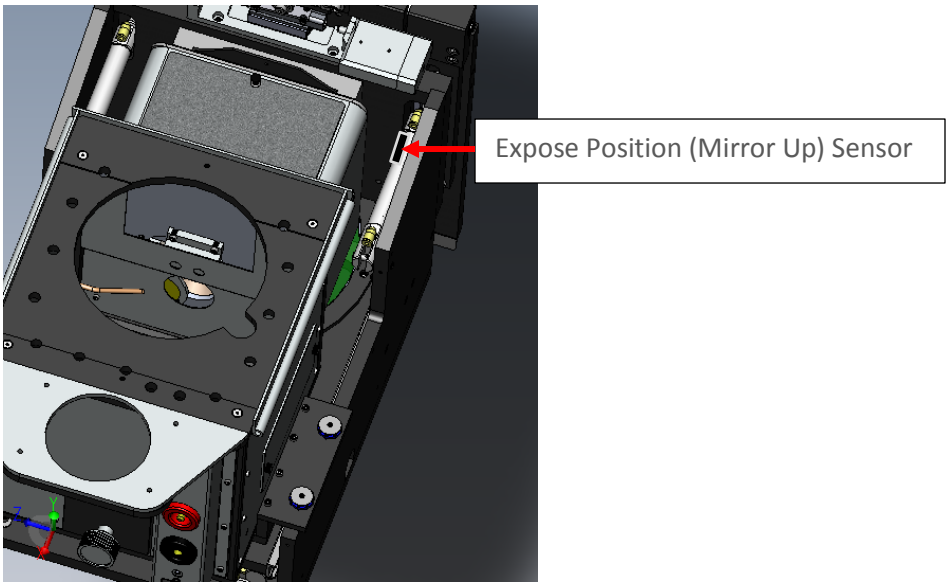
If Contact Expose Pressure is selected in the Operational Modes, the Expose Pressure valve activates after the Contact Expose Pressure Delay set in the Maintenance > Delays screen.



EXPOSE

When the operator presses the EXPOSE switch, the **Microscope Plate** and **Lens Tray** valves operate to lift the expose mirror and extend the collimating lens. The message reads “Expose”.

Inside the optical head on the right side is the **Expose Position** or **Head Position** Sensor. It is a magnetic sensor mounted to the left **Microscope Plate Cylinder**. When the expose mirror goes up and the cylinder extends, the sensor is triggered. This signals the program to begin the **Shutter Delay**.



Expose Position Sensor

If the machine is in Vacuum Contact mode, the program checks the **Vacuum Switch 103** to see if it detects enough vacuum in the printing chamber. If there is not enough, the shutter will not open. The message may stop at “Vacuum Check”.

If the vacuum is OK or if the machine is not in Vacuum Contact, the program will advance to the Shutter Delay.

SHUTTER DELAY

The **Shutter Delay** is set in the Maintenance > Delays screen. It gives the machine time to settle after the mirror extends. At the end of this delay the shutter will open. The display will read “Shutter Delay”.

EXPOSURE

The **Shutter** valve turns on and the wafer will be exposed for the time set in the Expose Time screen. The display will read “Exposure”.

PISTON DOWN

When the shutter closes, the program will basically wait for the Chuck Motion Sensor to activate as the piston descends. The display will read “Piston Down”.

There are many things that happen during this step. If the machine is in Vacuum Contact mode, the chamber vacuum hose will change to purge, allowing the wafer do drop from the mask.

If Expose Pressure or Contact Expose Pressure was applied, the expose pressure will turn OFF and wafer vacuum will be turned ON, holding the wafer to the chuck.

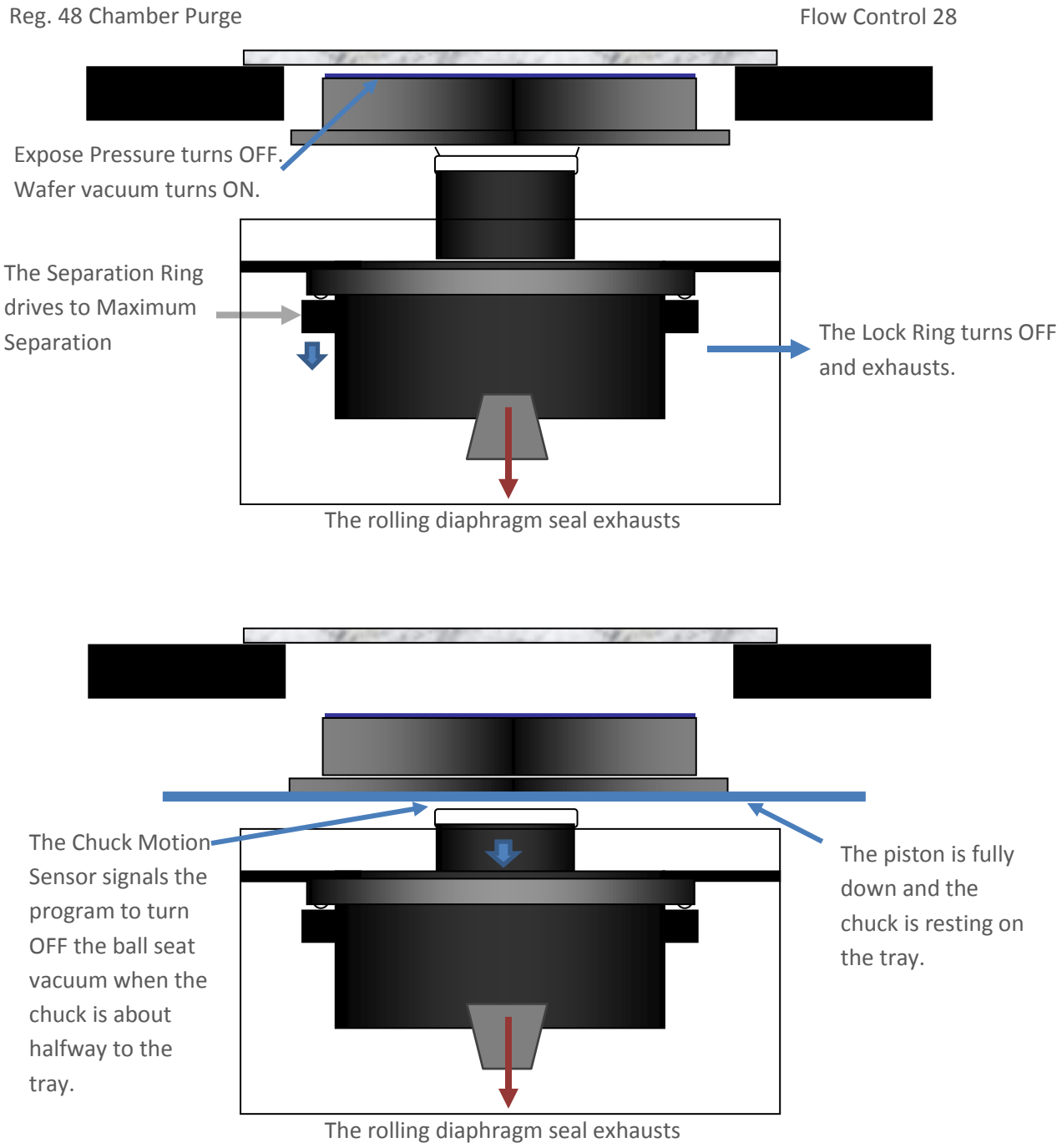
After this, low pressure will be sent to the separation ring, closing the split ring and driving the lock ring into Maximum Separation. The machine may display “Maximum Separation” at this point. This operation provides an active force to pull the wafer from the mask in case the photoresist is causing the wafer to stick to the mask.

The piston pressure is turned off and the rolling diaphragm inside the guide set exhaust so the piston can drop.

The lock ring now deactivates and allows the piston to descend with chuck and wafer.

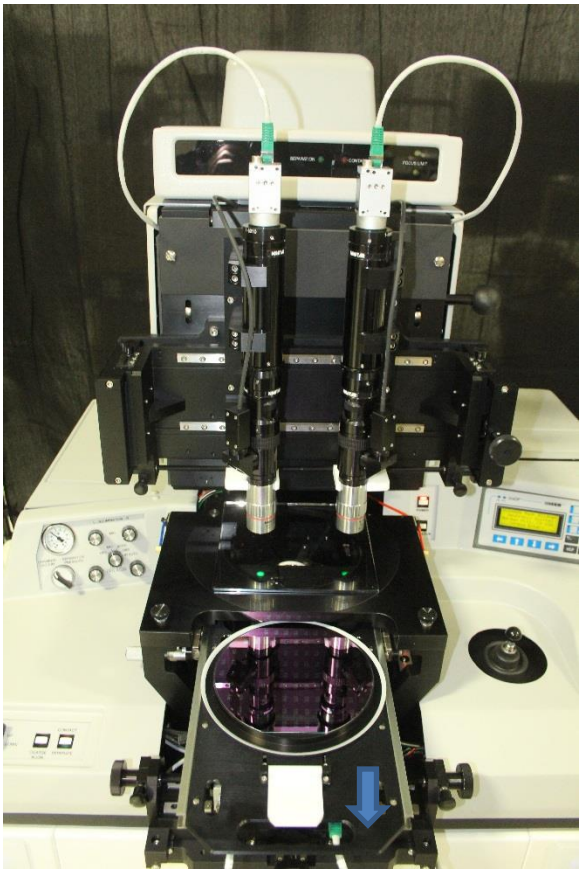
As the piston descends, the Chuck Motion Sensor triggers and the ball seat vacuum is turned off and exhausted to allow the chuck to settle into the tray.

After the **Piston Down Delay** set in the Maintenance > Delays screen, the tray is ready to be pulled out.



UNLOAD WAFER

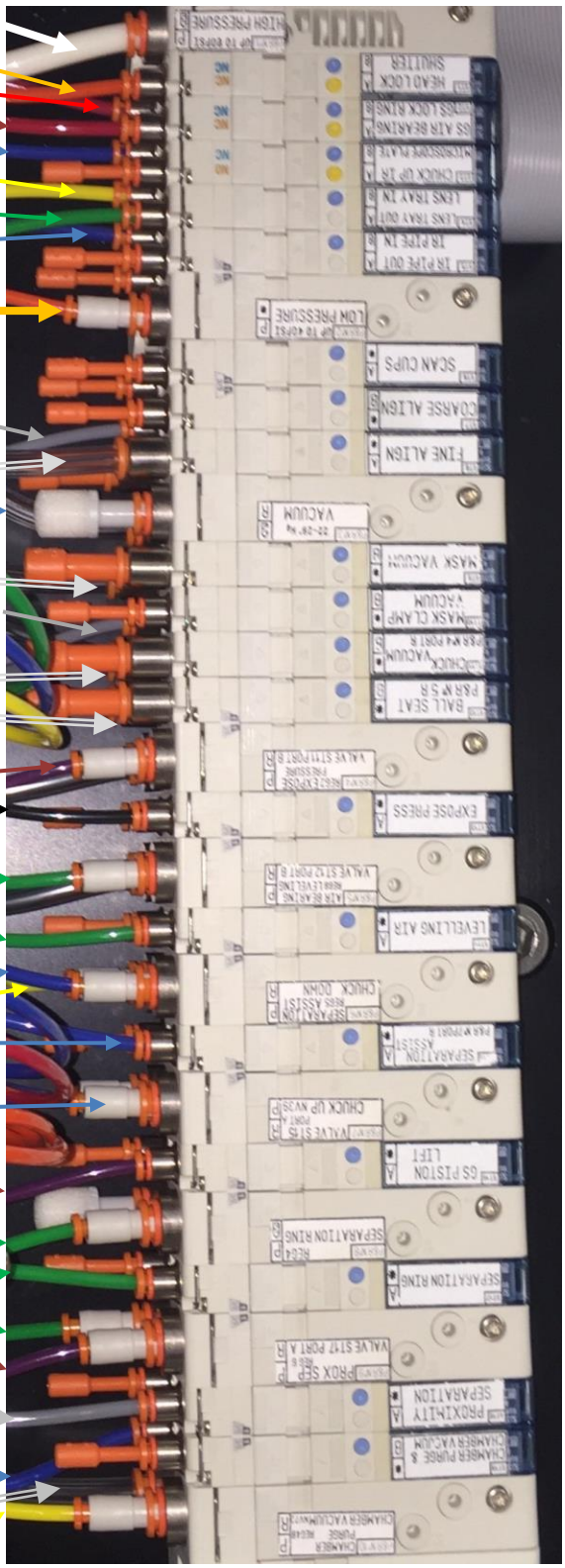
After the piston down delay the message will read “Unload Wafer”. Now the tray can be pulled out to unload the wafer. When the Tray Out detector is triggered, the chuck vacuum will turn OFF and the wafer can be removed.



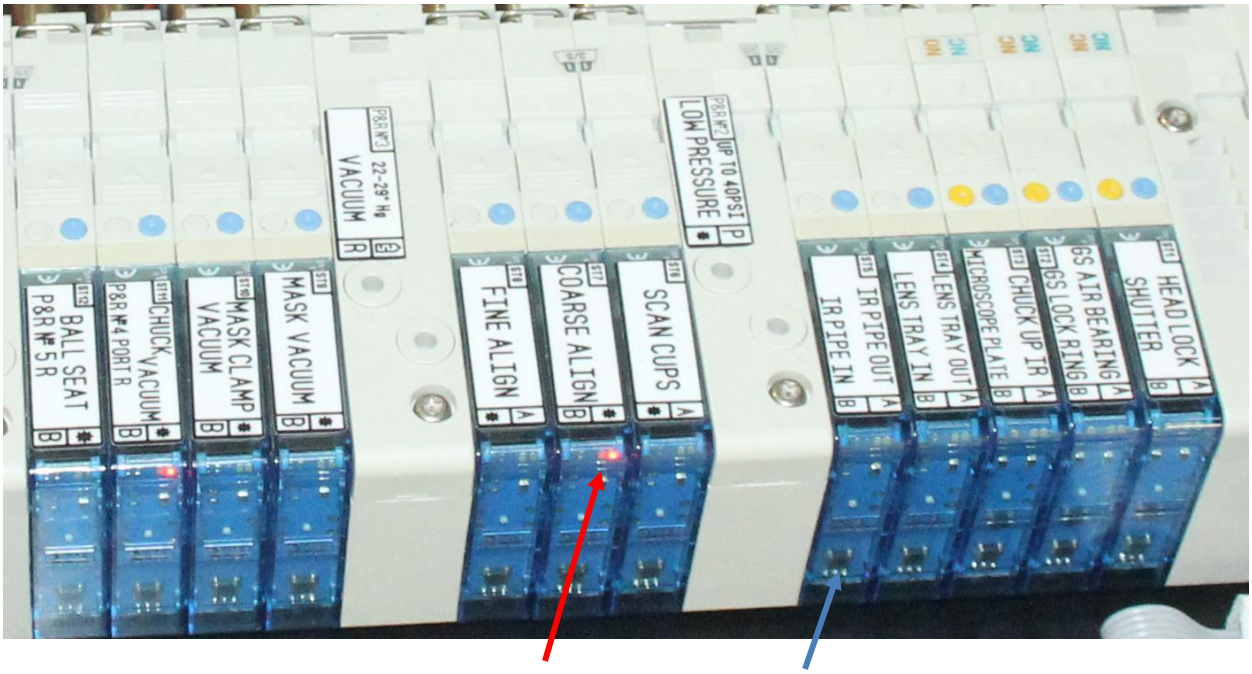
LOAD WAFER

The message will now read “Load Wafer”. The cycle is now complete and the next wafer can be prealigned and loaded into the system.

The Pneumatic Valve Block



The valves light up when ON and can be manually activated by pressing a button on the valve.



LED indicators and manual buttons

Schematics

NXQ4006 Power

NXQ4006 Wiring

NXQ4006 Distribution Board to PLC

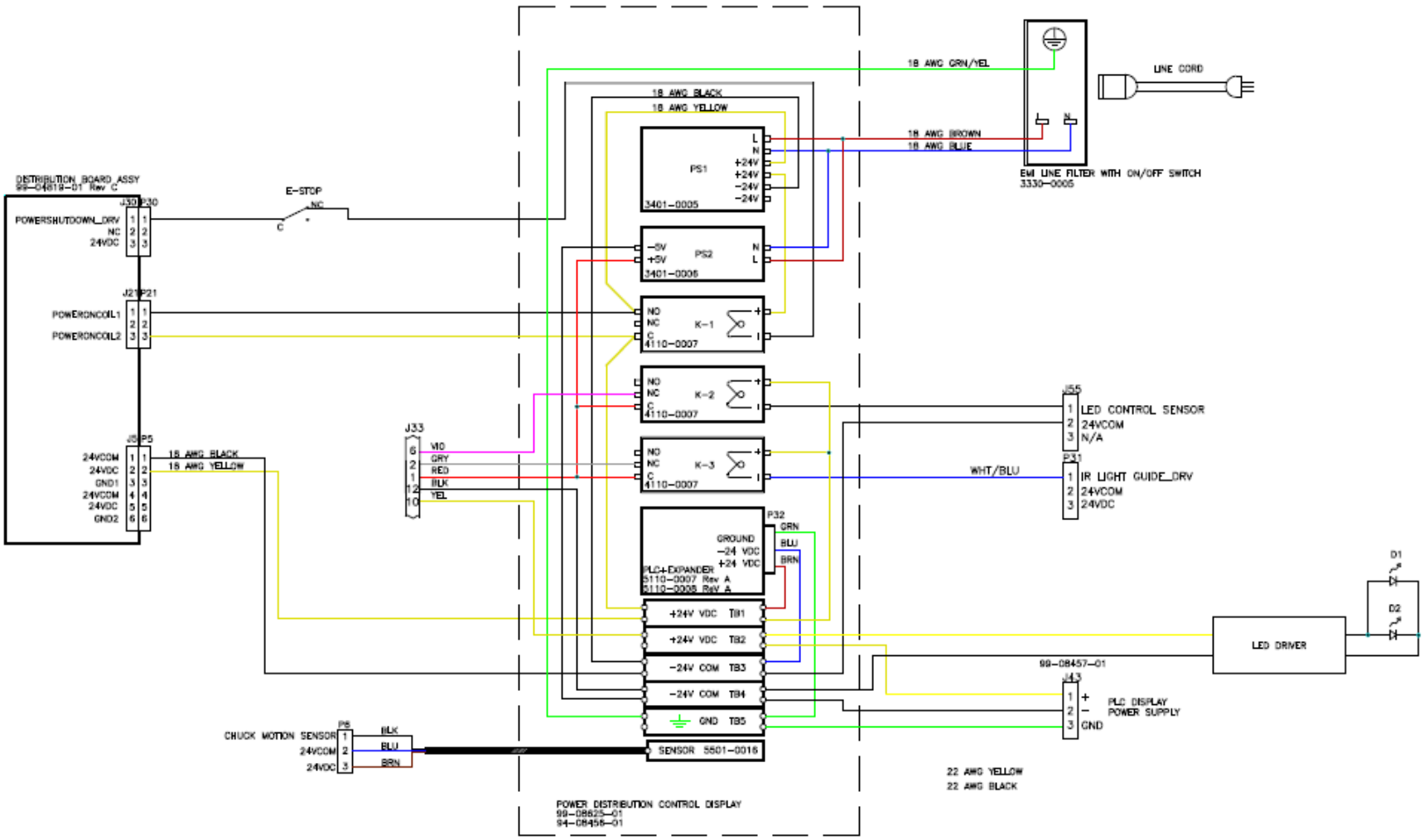
NXQ4006 PLC to Valve Block

NXQ4006 Illumination/Tray/Left Panel

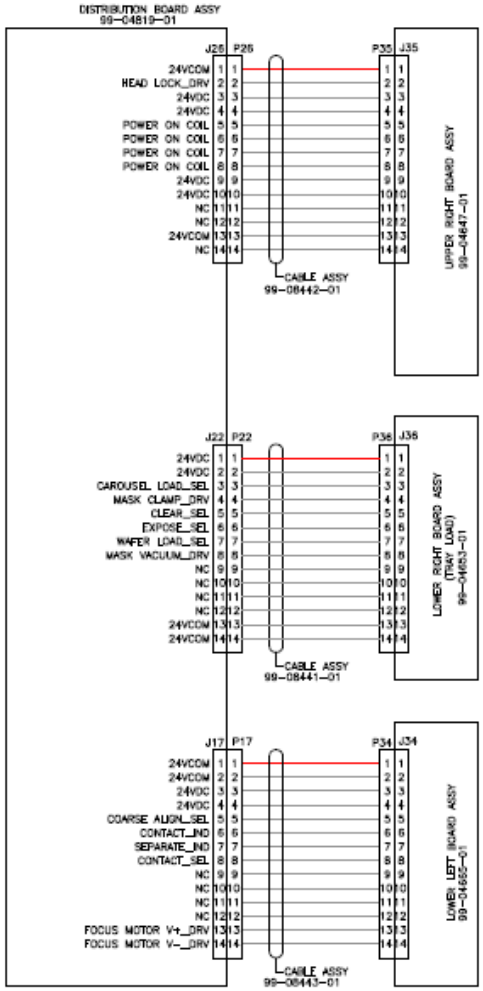
NXQ4006 Illuminator Switches

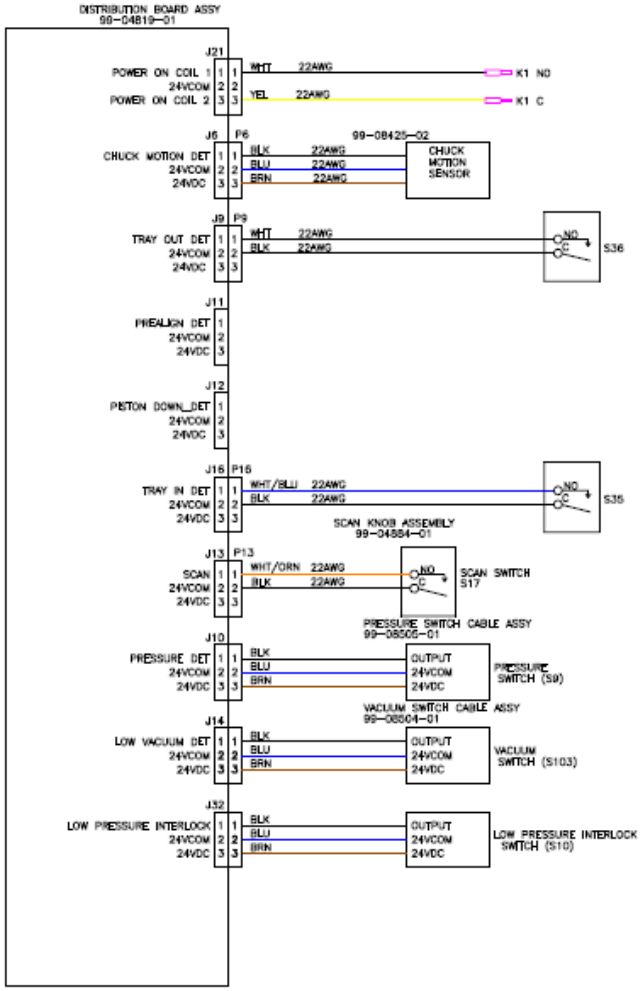
NXQ4006 Microscope Panel

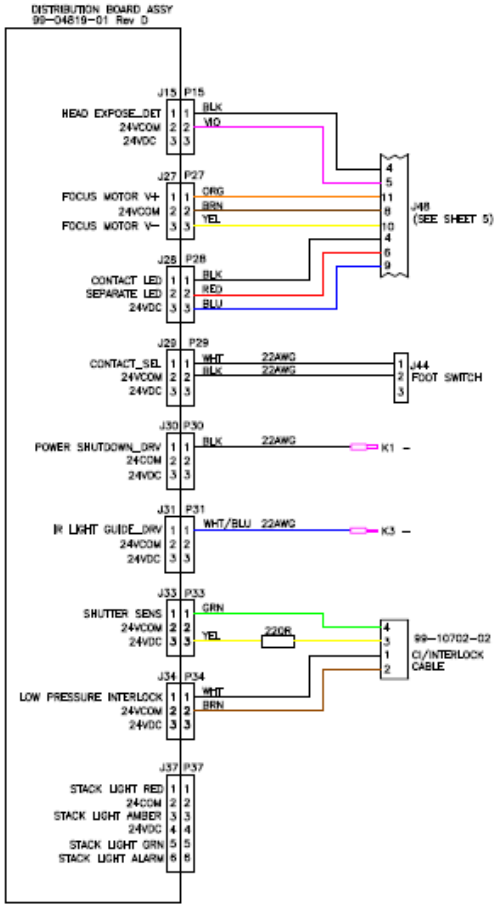
NXQ4006 Pneumatics


DISTRIBUTION_BOARD_ASSY
99-04819-01 Rev C
J30 P30
POWERSHUTDOWN_DRV
NC
24VDC
E-STOP
NC
C
J21 P21
POWERONCOIL1
POWERONCOIL2
J5 P5
24VCOM
24VDC
GND1
24VCOM
24VDC
GND2
18 AWG BLACK
18 AWG YELLOW
J33
VIO
GRY
RED
BLK
YEL
18 AWG GRN/YEL
18 AWG BLACK
18 AWG YELLOW
18 AWG BROWN
18 AWG BLUE
PS1
3401-0005
PS2
3401-0006
K-1
K-2
K-3
4110-0007
PLC+EXPANDER
5110-0007 Rev A
5110-0008 Rev A
P32
GRN
BLU
BRN
GROUND
-24 VDC
+24 VDC
+24V VDC TB1
+24V VDC TB2
-24V COM TB3
-24V COM TB4
GND TB5
SENSOR 5501-0016
P6
CHUCK MOTION SENSOR
BLK
BLU
BRN
24VCOM
24VDC
LINE CORD
L
N
EMI LINE FILTER WITH ON/OFF SWITCH
3330-0005
J55
LED CONTROL SENSOR
24VCOM
N/A
P31
IR LIGHT GUIDE_DRV
24VCOM
24VDC
WHT/BLU
LED DRIVER
D1
D2
99-08457-01
J43
PLC DISPLAY
POWER SUPPLY
GND
22 AWG YELLOW
22 AWG BLACK
POWER DISTRIBUTION CONTROL DISPLAY
99-08625-01
94-08456-01

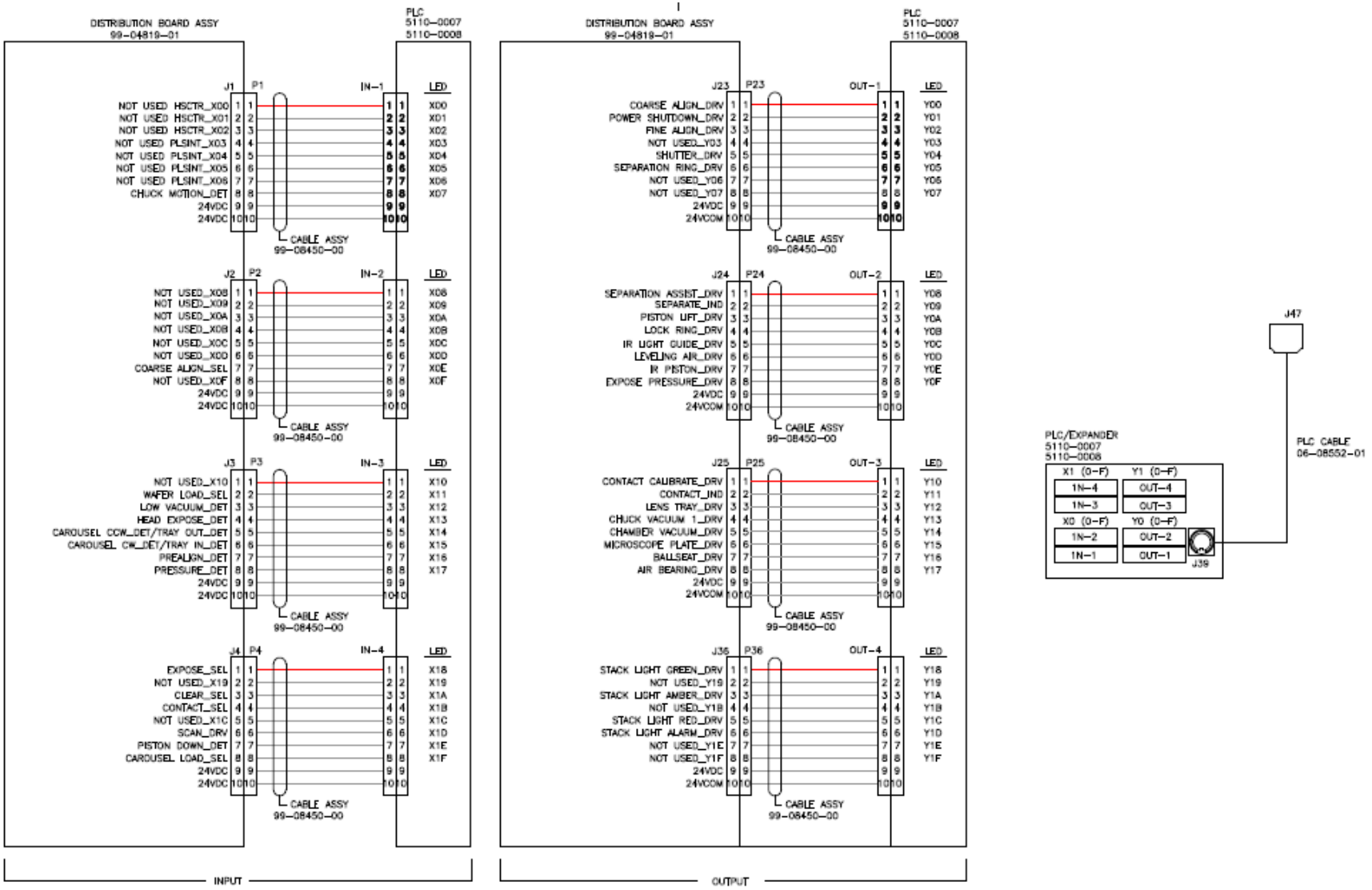
Q4006 Power



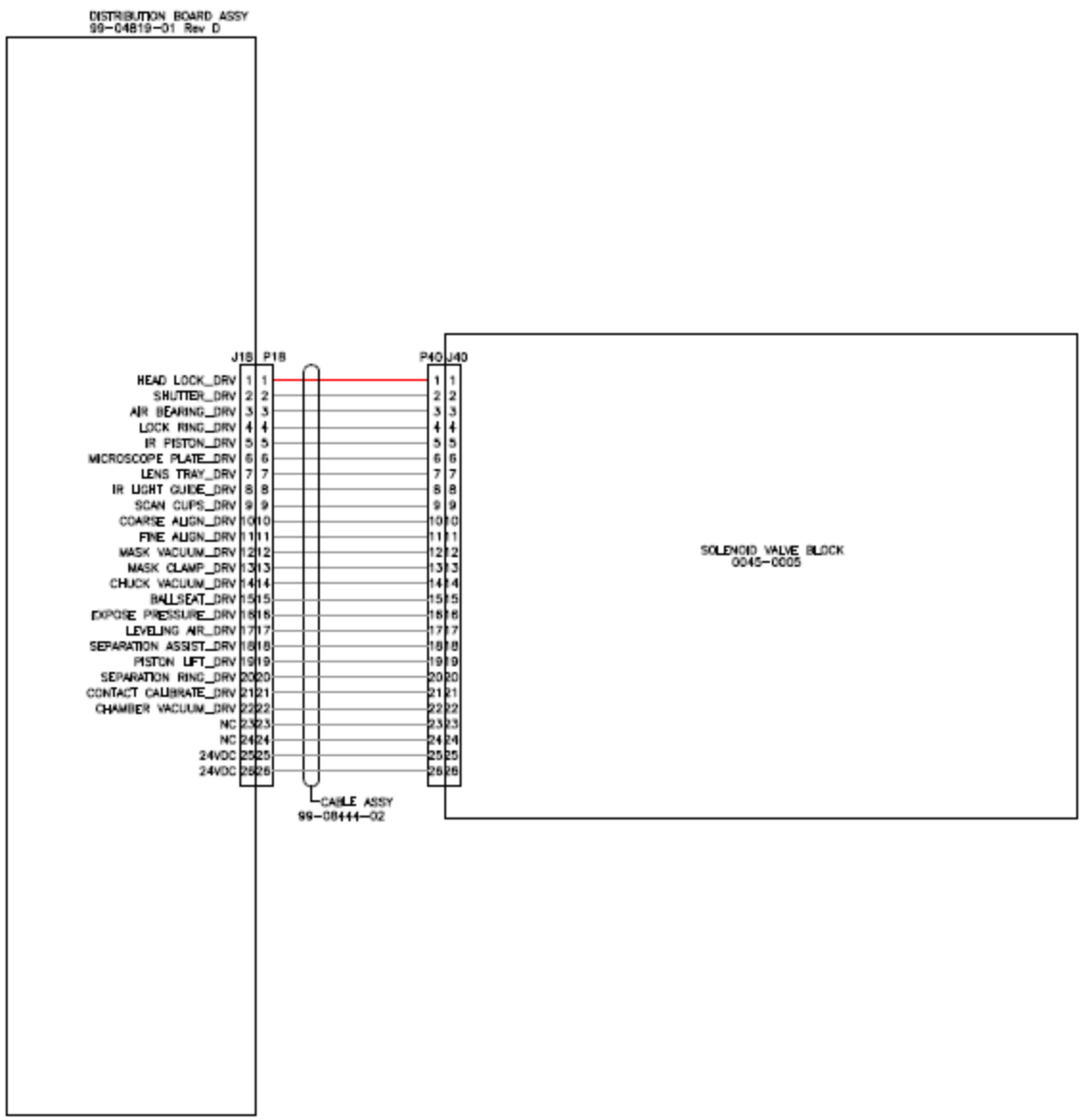




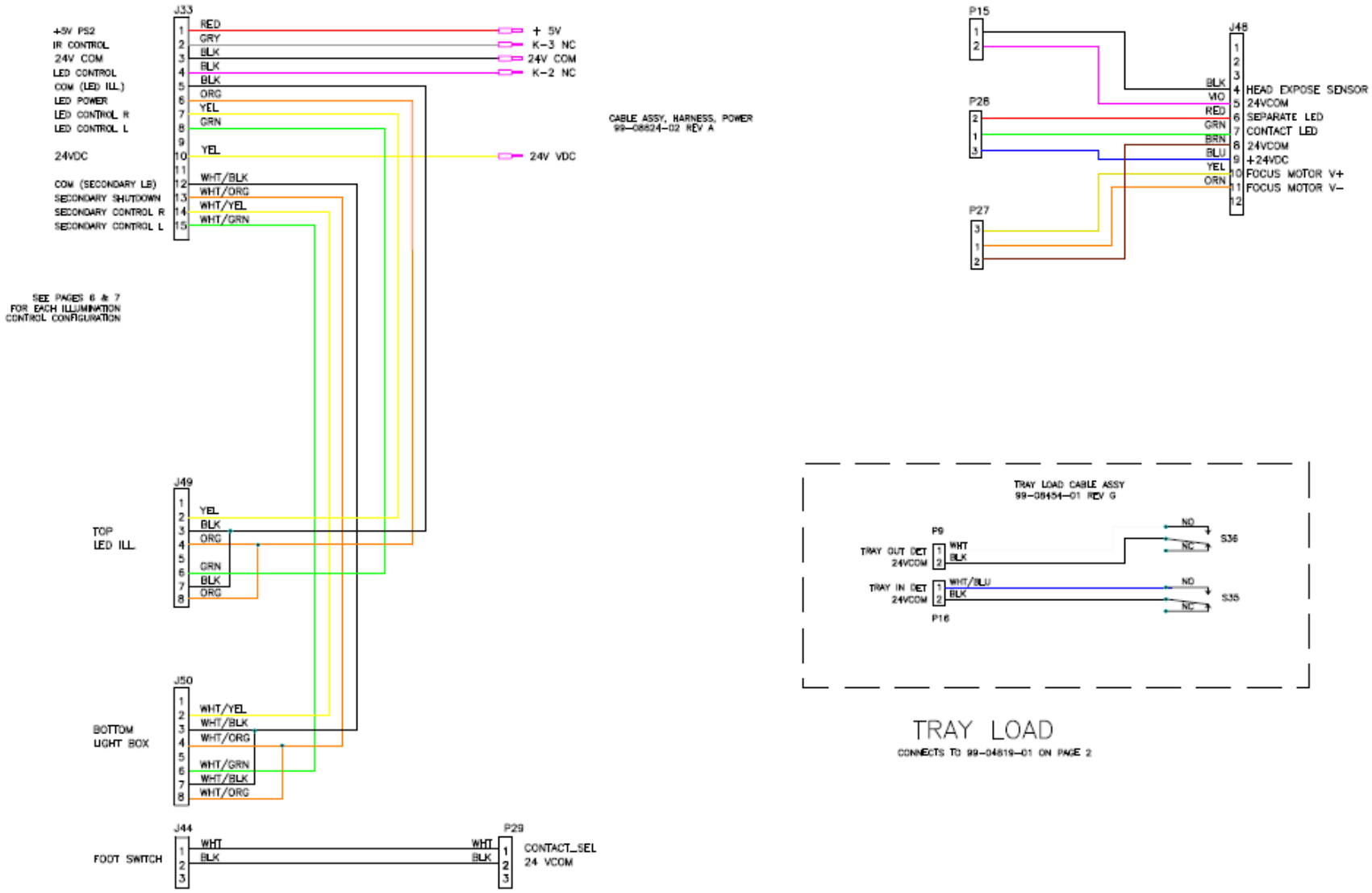
Q4006 Wiring



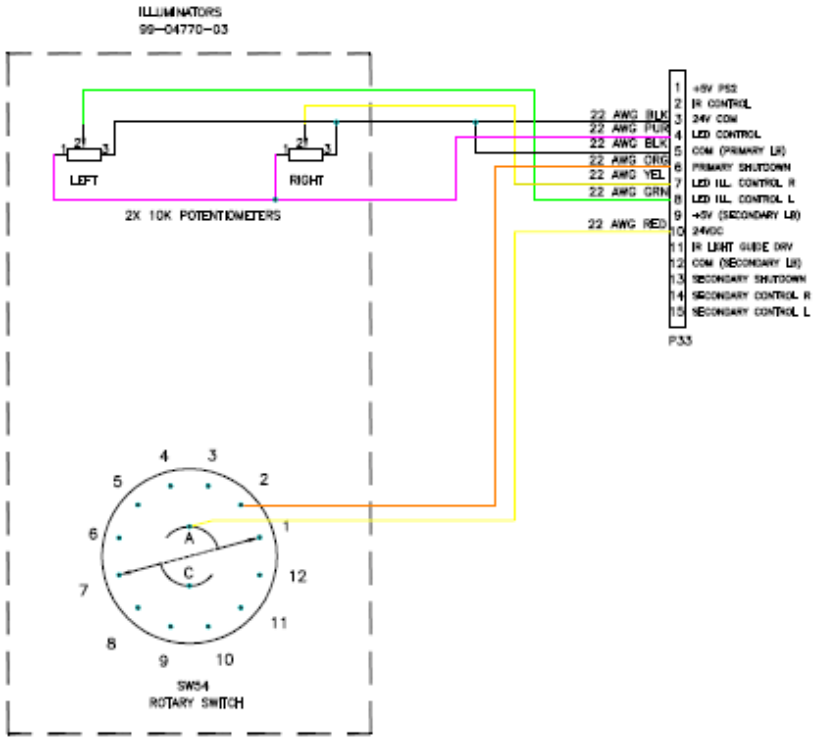
Q4006 Distribution Board to PLC

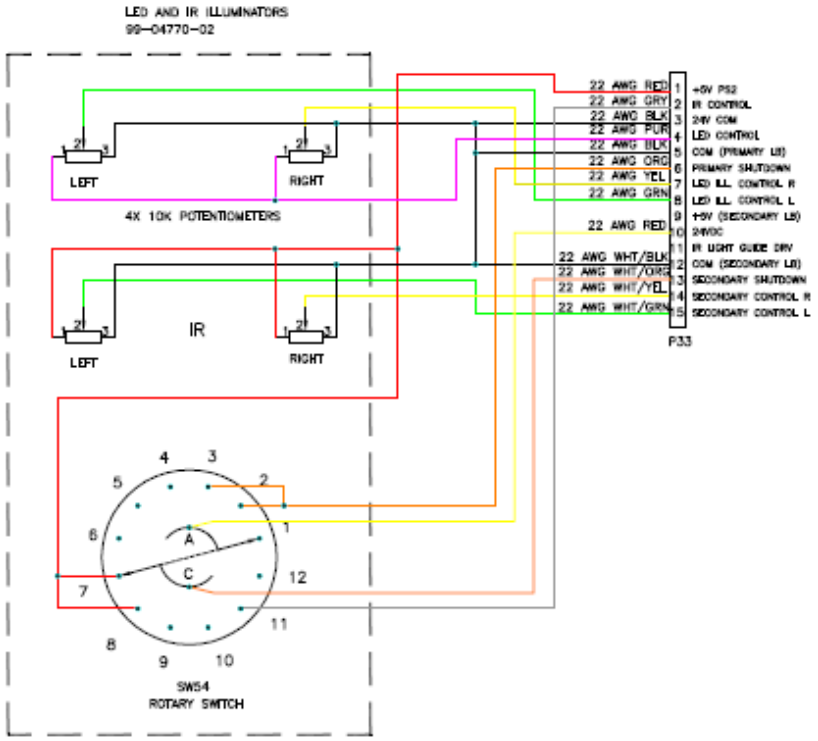


Q4006 PLC to Valve Block

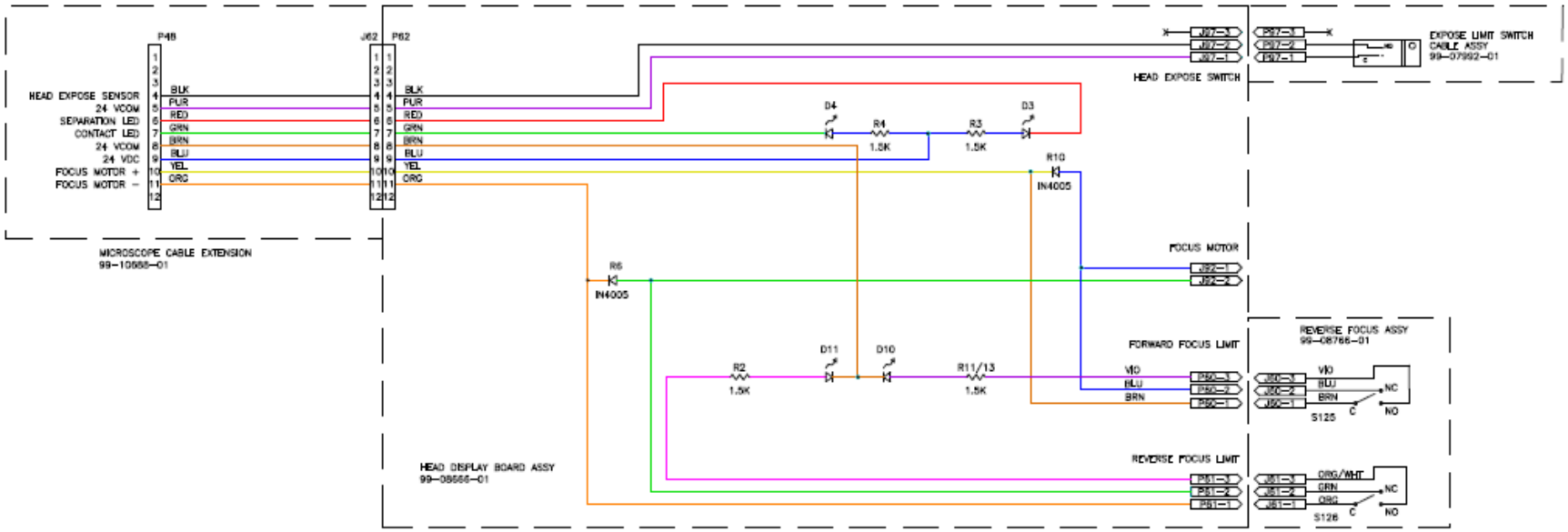


Q4006 Illumination/Tray/Left Panel

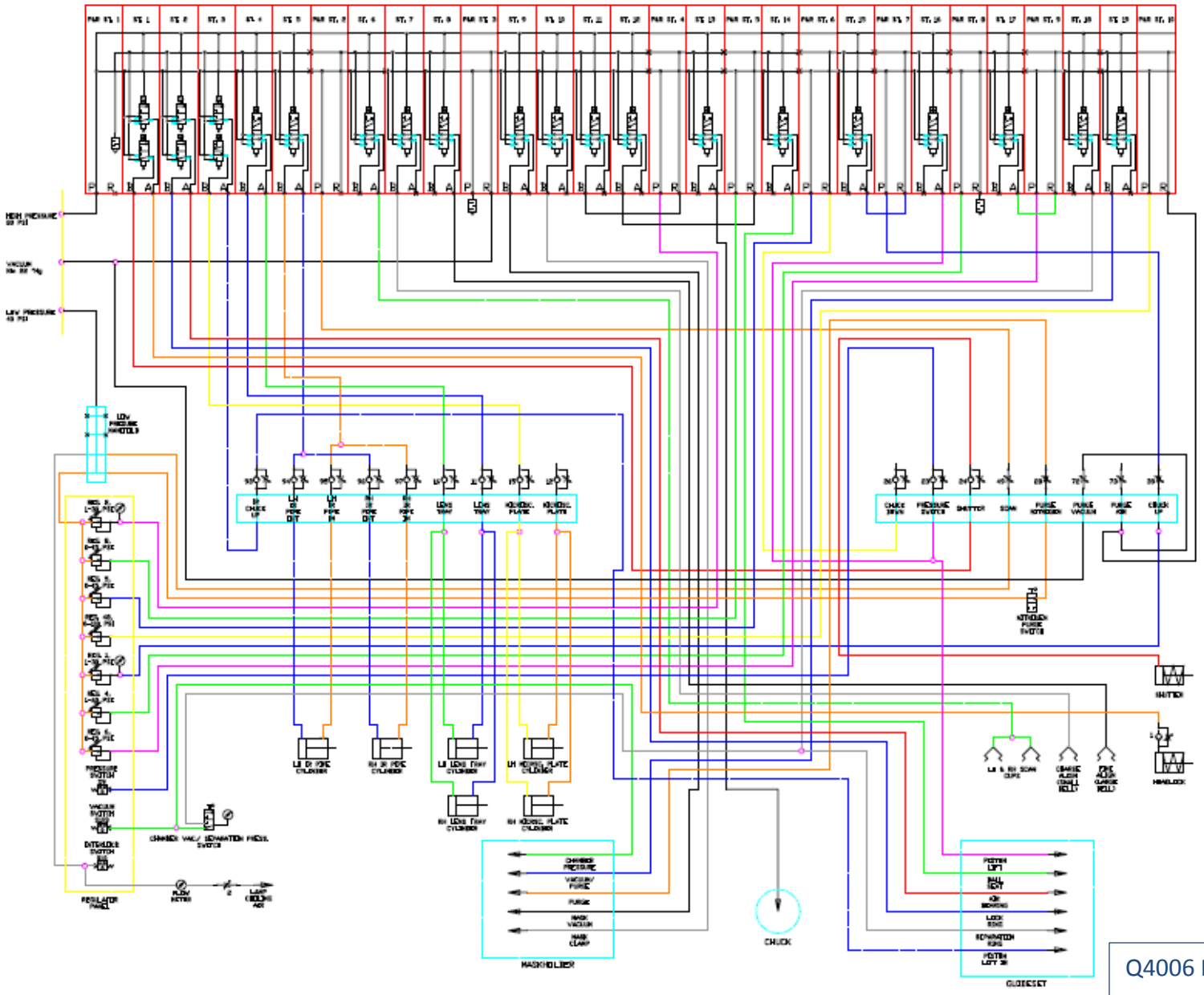




Q4006 Illuminator Switches



Q4006 Microscope Panel



Q4006 Pneumatics