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1.0 SYSTEM DESCRIPTION

1.1 General System Description

The ABM, high performance Mask Alignment and Exposure System is designed to provide precise, repeatable mask alignment and exposure of photoresist-coated substrates. These systems can be manufactured in a variety of configurations each designed to provide the user with the level of performance desired. Modular in design, the system incorporates all the functions necessary to produce high-quality patterning on materials that can have a wide range of physical size, and photolithographic properties.

Major subsystems (modules) are integrated in a typical system which include:

- a. Mask alignment tooling module
- b. Operator's control module
- c. Alignment optics
- d. Proximity-type, collimated UV or DUV lightsource system
- e. Lamp power supply/controller

All of these (sub) systems are integrated within a laboratory grade console that produces a fully operational, table top, high performance mask aligner system with outstanding capabilities and exceptional reliability.

Before attempting to operate this system, spend time reviewing this and the other associated appendices which describe in greater detail the functions of the system's major components. Also included in this (operator's) manual, there are sections covering the UV/DUV lightsource system, and lamp power supply controller.

Contact ABM, Inc., or it's local representative, if there are any questions regarding this or any other ABM equipment you may have. Failure to operate this equipment properly can cause damage in addition to negating the warranty.

1.2 Basic Subsystem Description

The aligner has been designed to provide the versatility needed for R & D, Pilot Production and Production.

1.3 Mask-to-Wafer Alignment Modules

ABM features the choice of two types of Vacuum Chucks. Technical descriptions are listed below, the basic difference being the leveling operation of the chuck.

1.3.1 Fixed Level Wafer-to-Mask Vacuum Chucks / Alignment Module

A high precision mask alignment tooling module (proximity and contact adjustable) incorporates functions necessary to produce precise, repeatable sub-micron features. X, Y and O motions are precise, backlash-free micrometer movements capable of resolving 0.1 micron increments (optional differential micrometers). Rotation of the Z axis knob allows the user to set the chuck assembly for mask-to-wafer separation to a precision of better than 2.5 microns for substrate thickness compensation, proximity gap adjustments and alignment separation.

The tooling module includes one (1) set of interchangeable mask holders and substrate chucks (with pre-alignment). The wafer chuck is precision lapped to ensure wafer flatness and to ensure a good wafer-to-mask seal, both important especially when using previously processed wafers. The chuck seal is designed in close proximity to the edge of the wafer chuck so that the contact sealing is made directly on the mask creating minimal leverage and resulting in negligible mask bow. The chuck also incorporates a nitrogen (N₂) purge to minimize outgassing which effects the printing quality when some negative resists are used. The mask assembly is pneumatically actuated up and down for operator convenience and to safeguard against the operator accidentally dropping the mask assembly and damaging the mask or other components. The alignment module is capable of accommodating proximity, soft contact and hard contact (vacuum) printing requirements.

Fixed Level Vacuum Chucks are primarily used with flat wafers & substrates.

1.3.2 Planarizing Wafer-to-Mask Vacuum Chucks / Alignment Module

The semiconductor-grade mask alignment tooling module (proximity and contact adjustable) incorporates functions necessary to produce precise, repeatable sub-micron features. X,Y and O motions are precise, backlash-free micrometer movements capable of resolving .1 micron increments (optional differential micrometers). The chuck mechanism utilizes an air bearing which is needed to planarize previously processed wafers. The chuck seal is designed in close proximity to the edge of the wafer chuck so that the contact sealing is made directly on the mask, creating minimal leverage and resulting in negligible mask bow. The mask assembly is pneumatically actuated up and down for operator convenience and to safeguard against the operator accidentally dropping the mask assembly and damaging the mask or other components. The alignment module is capable of accommodating proximity, soft contact and hard contact (vacuum) printing requirements.

Planarizing Vacuum Chucks are primarily designed for high resolution, precise registration and proximity printing requirements.

1.3.3 Specification for Alignment Module adjustments

Z Motion (Fixed Level Chuck)	.250" Motion, in 2.5 micron increments with Z knob adjustment
Z Motion (Planarizing Chuck)	.250" Motion, in 2.5 micron increments with Z knob adjustment air bearing planarizing (wedge compensation)
Theta	Chuck rotates approximately $\pm 5^\circ$
Mask rotation (O)	Mask holder rotates approx. $\pm 45^\circ$ may be rotated 360° if necessary
Fine Theta (O)	Chuck mask $\pm 5^\circ$ - micrometer driven
X Motion	Micrometer driven ± 0.5
Y Motion	Micrometer driven ± 0.5
Optional:	Micrometer, coarse/fine. Fine, < 1 micron

NOTE: Differential micrometers may also be fitted to theta (O).

1.3.4 Mask Holding Options (all types)

Vacuum clamp, Top Load (one & two piece)	Mask is loaded from the top, allowing for almost full utilization of mask surface for contact printing
Vacuum Clamp, Bottom Load	Mask is loaded from the bottom, allowing full utilization of mask surface for contact
Special	Different types * Mechanical Clamp * Multiple mask holder * Custom
Mask Assembly	Pneumatically Actuated for Load/Unload of Wafers & Substrates

1.3.5 Mask Holding Options

There are two different methods available for holding the mask in (or against) the mask holder assembly:

- a. Top Load
- b. Bottom Load

The Top Load (drop-in) type provides greater mask position control and mask safety while the vacuum clamped for quick-change capability. Top load mask holders are used when substrates are at least 1.0" smaller (length/width) than masks.

Bottom Load Vacuum clamping is generally used for applications where substrates are almost the same size as masks. Rotation of mask-to-substrate is greater because more mask area is exposed to the vacuum chuck contact seal.

Both mask holders are rotational. These mask holders are designed to allow the operator to align the mask to the row and column layout and to handle patterns which are not parallel to the sides. Mask sizes up to 9" X 9" can be accommodated with this rotatable mask feature.

1.3.6 Vacuum Chuck Assemblies

Fixed level vacuum chucks are designed as one piece (multiple pieces in planarizing vacuum chucks) assemblies consisting of an insert and a chuck mount. This arrangement produces a readily changeable chuck system that can handle a variety of sizes, shapes, and thickness'.. Chuck assemblies are available that can handle substrates from 1.0" X 1.0" to 6.0" X 6.0". Chucks can be furnished with pre-alignment aids capable of repeatable material orientation to typically better than 7 microns.

1.4 Alignment Optics/ Exposure Source Platforms

To maximize printing performance and operator convenience, the ABM alignment system employs a laterally-moving platform for each of the alignment optics and lightsource system. The platform positions the lightsource and alignment optics above the mask alignment tooling module when aligning or exposing and move to their home positions for loading/unloading of wafers & substrates. This method of moving the lightsource and optics ensures that the mask alignment tooling remains undisturbed -virtually eliminating the possibility of any movement between the aligned mask and substrate.

1.5 Operator's Control Panels

There are two operator control panels located on the top console of the aligner.

1.5.1 Operator's Control Modules (electrical & pneumatic)

Left front is the Electrical Control Panel with power on/off, auto expose, manual expose, timer stop/reset & auto expose on/off. Right front is the Pneumatic Control Panel that has substrate, mask & contact vacuum, contact vacuum adjust, N2, N2 adjust, mask frame raise/lower, align/home, expose/home & mask, substrate, and contact vacuum gauges. On top of the control panel is a vacuum gauge and pressure gauge that display house input levels.

1.5.2 Operating Function Description

These items operate all key functions of the aligner except for the lamp housing power supply. Operation of any particular function is provided by either a push-button or a toggle valve.

Functions include:

Power	Turns timer power on
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Auto Expose	Opens exposure shutter and starts timer
Manual Expose	Opens exposure shutter to measure light intensity and uniformity
Stop/Reset	Closes exposure shutter & resets timer
Auto Exposure on/off	On, exposure shutter opens/timer starts automatically when exposure source is over mask alignment module. Off, auto expose function must be activated to open shutter & start timer
Timer	Allows user to set exposure time from .1 seconds to 999.9 seconds, in increments of .1 second.
Contact Vacuum	Applies vacuum to contact substrate to mask
Contact	Regulates the level of contact vacuum
N2 Flow Meter	Allows flow of nitrogen between mask and substrate
Mask Frame	Raises/lowers mask frame
Mask Vacuum	Applies vacuum to clamp to mask
Substrate	Applies vacuum to hold substrate
Align/Home	Moves alignment optics to and from align position
Home/Expose	Moves exposure source to and from expose position
System Vacuum Gauge	Displays incoming vacuum
System Pressure Gauge	Displays incoming CDA pressure
Mask Vacuum Gauge	Displays vacuum securing mask
Substrate Vacuum Gauge	Displays vacuum securing substrate

Contact Vacuum Gauge

Displays contact vacuum between mask & substrate

1.6 Alignment Optics

There are numerous options available in the selection of alignment optics. Binocular microscopes, stereo zoom microscopes, single field & split field microscopes (with optional trinocular head & CCTV) and Dual CCD split field alignments systems. Additionally, the user can select illuminators from the simplest Nicholas style (single beam, side lighting), ring or coaxial illuminators. Darkfield/light field is also available.

1.7 Alignment Optics Mounting Hardware

Mounting includes precision X,Y slide stage with +/- 4" motion. Stage motion is excellent for low/high magnification applications, and includes pneumatic (air) X,Y position locks.

1.8 Exposure Lamp Power Supply/Controller

Standard aligner includes a 350 watt constant intensity controller. Available wattage/adjust range: 200W (130W low, 195W idle, 260W high), 350W (200W low, 300W idle, 425W high), 500W (375W low, 450W idle, 625W high), 1,000W (750 low, 950 idle, 1250 high), 2,000 (1700 low, 1900 idle, 2200 high).

1.9 UV/DUV Lightsource System

ABM offers high performance collimated (and non-collimated) Model 60 lightsource systems for Near UV, Mid UV and Deep UV output. Beam areas from 6.0" to 8.0" square are. A wide range of intensities can be produced depending on lamp wattage and beam size. Adjustable intensity range is typically 3:1. Quick release mirror mounting for UV or DUV output is standard.

2.0 SYSTEM OPERATION

2.0 Start-Up Procedures

In the event the system is in a full "shutdown" condition (i.e., system and lightsource power off), you must first bring the lightsource into operation. To start up the lightsource, complete the following procedures:

- a. Turn the POWER switch on the front of the intensity controller to the ON position.
- b. Press START to produce ignition of the mercury arc lamp.
- c. Check to make sure that the cooling fans are operating.

NOTE: If the lightsource cooling fan is not operating, shutdown the system and make sure the 3-prong fan plug is secured in the receptacle in back of the intensity controlling power supply. The source should be stabilized in approximately ten minutes.

- d. Set correct intensity for both channel 1 (negative resist) and channel 2 (positive resist).
- e. Select proper channel for photoresist being exposed.

This is all that is required to bring lightsource into operation unless calibration or some other changes are desired.

2.2 General System Operation

*** N2 On At All Times When Using The Aligner, Adjust Between 2-5 PSI (operator control panel)**

*** IR ALIGNMENT, SEE INSERT IN BACK SECTION OF MANUAL**

- a. Turn all pneumatic switches to "OFF" position
- b. Turn on "POWER" switch to activate shutter timer module
- c. Set timer to desired exposure time
- d. Move alignment optics and lightsource to "HOME" positions
- e. Place mask in holder, then press "MASK ON" to vacuum clamp mask
- f. Position substrate on chuck, switch "SUBSTRATE" to "ON"
- g. Lower mask assembly, (if in up position)
- h. Switch "ALIGN" button to bring alignment optics over tooling module
- i. Turn Z control knob counter clockwise until the clutch begins to slip (Fixed Level Chuck)
- j. Turn Z control knob counter clockwise while pressing the button located in the front of the module (chuck leveling) until the clutch begins to slip (Planarizing Chuck)
- k. Release the button to lock the chuck planar to mask
- l. Set separation gap by turning the Z control knob clockwise to the desired gap setting

Note: With automatic planarization function, after setting separation gap wafers thereafter can be planarized by pushing, then releasing Chuck Level. Wafer will planarize to mask then drop to pre set gap setting.

- m. Align substrate to mask and when satisfied, switch "CONTACT" to "ON" position
- n. Switch "EXPOSE" System will bring exposure source over tooling module for exposure.
- o. Switch "HOME/EXPOSE" to "HOME" to bring system to "LOAD/UNLOAD" position
- p. Switch "CONTACT" to the "OFF" position
- q. Switch "MASK RAISE" to lift mask assembly
- r. Switch "SUBSRATE" to "OFF" position
- s. Unload substrate
- t. Repeat steps a through s for each substrate

2.3 High Resolution Printing

Utilize the system as described above, except in step m, after switching on “CONTACT”, switch off “SUBSTRATE”, then proceed as described.

The substrate will be forced upward against the mask, improving the intimate contact between them.

3.0 PERIODIC MAINTENANCE

3.1 Maintenance

The aligner has been designed to minimize maintenance. However, there are some items which may need maintenance to eliminate problems:

Alignment Tooling:	Z up/down motion. If vacuum chuck motion is not smooth or is sticking (typically noted when chuck is lowered from mask. Turn Z knob clockwise until it stops (do not force). Raise chuck by hand and lubricate stainless steel shaft below chuck with TRI-FLOW (with Teflon) or light machine oil. Then manually (by hand) move chuck up/down to lubricate SS shaft/bearing assembly.
Alignment System:	Alignment system X,Y, Z linear rails should be lubricated once every six months with normal usage, and monthly in heavy production with TRI-FLOW (with Teflon) or light machine oil.
Lightsource & Alignment System Motion Rails:	Remove center panel (below lightsource/alignment optics). Lubricate both rails with TRI-FLOW (with Teflon) or light machine oil every six months.
Lightsource:	When replacing the lamp, always clean connections and oxide build-up inside/outside heat sink. Always clean lamps with methanol or alcohol before installing.
Mirrors:	Should be cleaned every six months using glass cleaner, then with methanol or alcohol with lens cloth. Dry with filtered air.
Metal Reflector:	Should be carefully cleaned using lens cloth or

cotton balls with methanol or alcohol. Clean several times with new cloth to remove film and streaks.

Intensity Controllers:

No regular maintenance required.

Power Supply/Intensity Meter
Calibration

Should be checked daily or weekly and adjusted if as required.

Alignment Optics:

Clean microscope objectives, eyepieces, ccd assy and zoom lenses as required.

4.0 UNPACKING AND INSTALLATION PROCEDURE

The following set of instructions deal with the unpacking and installation of your ABM Mask Aligner.

4.1 Remove your aligner from the crate

- a. Have the crate moved into or near the area that the aligner will be used.

NOTE: These machines have many precision parts, and any harsh movement out-side of the shipping crate should be minimized as it may cause damage and/or detune some factory-set mechanisms.

- b. If it is not possible or practical to do, move the crate as close to the install position as possible before unpacking.
- c. Remove all the other separate boxes included in the crate.
- d. Unpack these boxes carefully and lay their contents about the table for identification.

NOTE: Handle all these boxes with care as most contain delicate instruments and subsystems which will be fitted onto your aligner..

- e. Remove the aligner from the crate.

4.2 Plumbing Pneumatic Lines

Hook up your house vacuum and nitrogen lines to the system via the pneumatic manifold located at the rear of the machine on the lower left side.

- a. Connect the CDA line to the left port (regulated).
- b. Connect the vacuum line to the right port (unregulated).
- c. Connect the nitrogen line to the center port (regulated).

NOTE: The mask aligner system requires a minimum of 25 inches of vacuum to operate, and the regulator for the nitrogen (or air) line on the system should be set to 9 PSI.

4.3 Lightsource and Power Supply Installation

- a. Locate the lightsource cables that are hanging inside the system underneath the table top.
- b. Remove the packing material from them and place to the back of the machine
- c. Take the lightsource power supply (which was unpacked from the crate), and place it on the shelf of the table that your table top aligner will be placed on.
- d. Plug in the cables from the lightsource into the power supply, making sure that the anode (+) and cathode (-) plugs are in the proper outlet and that the fan plug is firmly plugged in.
- e. Push the system up next to the wall as all installation procedures that concern the rear of the system have been completed.
- f. Once in place, remove all the remaining packing material from the system, making sure to remove the wrap from the bottom of the lightsource lens.

4.4 Lamp Installation

NOTE: Read Appendix 11, Lightsource System, of this manual before proceeding further. Once you have completed reading the Lightsource System section, you are ready to begin lamp installation.

- a. Remove all thumbscrews from the lightsource panel that has the warning sticker displayed.
- b. Remove the tape from the lead.
- c. Remove the lightsource lamp (another item previously unpacked) from its box.

NOTE: Be very careful not to touch the glass part of the lamp as the oils and acids on your skin can damage the lamp and affect its performance.

- d. (UV lamp) Holding the lamp at the anode (+) end (gold side toward the hand), place cathode (-) end of lamp up into the parabolic mirror and out the hole at the other end where it threads into a brass lamp mount.
- e. Thread the lamp into the mount until it stops (do not force tight).
- f. Remove the small nut on the exposed end of the lamp, and install the lamp heat sink (the aluminum extrude piece) over the end of the lamp.
- g. Take the nickel lead wire and place the ring terminal around the stud of the lamp and secure with the lamp nut.
- h. Mount and secure the lightsource side panel.

4.5 Hi-Magnification Motion System

- a. Take the microscope and its mount and line up the two holes on the mount to the two on the motion bar of the microscope transit.
- b. Mount the microscope “Y” in place with the two ¼-20 socket cap screws included, and tighten firmly.
- c. Plug the lamp transformer into a wall outlet.
- d. Plug the illuminator(s) into the transformer and attach the illuminator(s) to the microscope in the appropriate mounts.

The preliminary installation of your system has been completed.

RECOMMEDED SPARE PARTS FOR ABM MASK ALIGNER

ITEM	QTY	DESCRIPTION	
1	1	Flow Control Valve (contact vacuum & N2)	
2	1	3-Port Toggle Valve (contact/substrate vacuum & N2)	
3	1	5-Port (ADI) Toggle Valve (align/expose)	
4	1	5-Port (Pneumadyne) Toggle Valve (align/expose)	
5	1	5- Port Push Valve (mask vacuum)	
6	1	3-Port Push Valve (chuck lock on/off)	
7	1	3-Port Valve (mask frame, to interlock align/expose)	
8	1	2-Port Valve (console, to interlock align/expose & mask up)	
9	1	24 Volt Switch Lamp (console electrical switches)	
10	1	UV or DUV Lamp (specify type & wattage)	
11	1	Lamp Heat Sink (specify lamp size)	
12	1	51/4" Reflector W/Mount	
13	1	8" Reflector W/Mount	
14	1	4.5" x 6.0" x .125" UV Mirror	
15	1	4.5" x 6.0" x .125" DUV Mirror (specify wavelength)	
16	1	4800 Cooling Fan (200, 350 & 500 Watt)	17
	1	4600 Cooling Fan (1,000 Watt)	
18	1	Mask Frame (Stainless Steel Post Seal)	
19	1	Vacuum Chuck Contact Seal	
20	1	EKE 21v, 150 Watt Lamp (coaxial & ring illumination)	
21	1	EKE 21v, 150 Watt Lamp (GOLD, for infrared alignment)	
22	1	Zeiss, 6v / 15 Watt Lamp (coaxial illumination)	