

Karl Suss MA6 Mask Aligner

SOP

Prerequisites for operating the Mask Aligner:

- a) Read and understand the Karl Suss Mask Aligner MA6 Users Manual Section III. * A hard copy is located at the machine and a PDF version is available from UFNF Staff.
- b) Receive “one on one” training and certification from UFNF Staff.
- c) Obtain a UFNF ID (if you do not already have one) by completing the [UFNF Lab Use Request Form](#).

Safety

- **UV Exposure:** The high energy light produced by the high pressure Mercury Xenon lamp can cause eye damage and skin burns. Be sure that the light guards around the exposure area are not removed, and that the high pressure lamp and exposure path are enclosed. Do not looking directly at the mask during exposure.
- **Ozone:** The high-pressure lamp produces ozone, which can result in pneumonia-like symptoms. The effects are cumulative. The lamp may only be “on” when the HEPA air flow is “on”.
- **Lamp Explosion:** If you suspect that the UV Lamp has exploded, evacuate the room immediately and notify UFNF Staff.
- **High Power:** The MA6 mask aligner uses ignition voltages of 30kV and operating voltages of 180V, with currents of 5 to 30amps. Ensure that the power line is disconnected before any system maintenance.
- **Moving Components** – The User should be aware **at all times** of the moving components associated with this tool. For instance, the topside microscope assembly moves up and down, and does present a potential hazard. The User must exert caution **at all times** such that a limb, finger, or article of clothing does not become trapped or entangled (or worse, violently detached) when components of the machine are in motion.

1.0 Tool Reservation

- 1.1 Reserve tool time via reservation system on the UFNF web site. Put on new gloves. WARNING No solvents are allowed near the machine!!

1.2 Sign in the Logbook.

2.0 Power on the Constant Intensity Controller (CIC)

- 2.1 Check if the CP, CH1 or CH2 buttons on the CIC are illuminated "green". If any one button is on then the lamp is on and you may proceed to step 3.0. If the lamp is not on, proceed with step 2.2.
- 2.2 Switch ON power of the Constant Intensity Controller (CIC) located under the main system. The software version is shown on the display. The CIC performs a self calibration test and displays "ready". Press CP (constant power) key. Display shows "wait", followed by "Start". Press the START key. This will ignite the exposure lamp. LED LAMP LIFE/POWER is flashing until lamp warming up is finished. **ATTENTION-** Nitrogen failure for longer than 5 minutes will turn off the exposure lamp!

3.0 Power up the machine

- 3.1 Toggle clockwise the *POWER SWITCH ELECTRONIC* on the front panel control clockwise to ON position and release. Machine initializes. An example for the display message is:
- 3.2 Press the flashing LOAD key on the keyboard to initialize the system.

4.0 Calculate Your Dose

- 4.1 Prior to loading your mask, press CH1 on the CIC controller (use CH2 if exposing 405nm photoresist).
- 4.2 Depress the lamp check button on aligner and record the power value displayed on the CIC display. This is the power output of the lamp at 365nm in Watts/cm².
- 4.3 To calculate dose, divide the desired dose by the power displayed on the RED LED readout. This is your exposure time in seconds. Example:
 $140\text{mj} / 10\text{Watts} = 14 \text{ seconds.}$

5.0 Load Mask

- 5.1 Warning: Watch out for the microscope movement!
- 5.2 Start mask loading sequence - CHANGE MASK key. *NOTE: If the change lamp key is already blinking, press enter and change mask alternately to get the system out of the last mask change sequence. This may be needed when the last user does not complete the mask sequence.* Take out the mask holder, flip it 180° and put it on the tray to the left. If a mask is loaded, press ENTER to toggle the mask vacuum off, retract the mechanical mask clamp by pushing down on the leaf spring until it stops in the detent and remove the mask.

- 5.3 Place the mask (chrome side up, glass side touching mask holder surface) onto the mask holder against the stop pins to the left and top of the mask platen. Toggle the mask vacuum on by pressing the ENTER key. Activate the mechanical mask clamp by pressing on the leaf spring until it contacts the edge of the mask.
- 5.4 Flip the mask holder 180° back and slide it into the machine. Lock the mask holder slide by pressing CHANGE MASK key again.

6.0 Pre Exposure Operation

- 6.1 Verify that the CH1 button is illuminated in the Lamp Power (CIC) unit. If not depress CH1. This enables automatic exposure dose compensation.
- 6.2 Move all the stage micrometers to the center position. X and Y micrometers shall be set to 20 and the Theta micrometer shall be adjusted so that the white line on the theta position indicator is parallel with the front of the stage.
- 6.3 Note: this procedure assumes you will NOT be using a program that you have already created.
- 6.4 Press SELECT PROGRAM key. Toggle through the menu using the Y keys to select the exposure mode (Flood E, Vac, Low Vac, Hard, Soft) and confirm your exposure program by pressing SELECT PROGRAM key again
- 6.5 Edit parameters - Press EDIT PARAMETER and use the Y keys to scroll through and change all necessary values and confirm by pressing EDIT PARAMETER key again. The following list shows each parameter. Most parameters need not be adjusted by the user and recommended settings are provided.
 - 6.5.1. Exp Time- Determined by user
 - 6.5.2. AI Gap- 100um
(this may be adjusted, but a setting lower than 60um will cause the sample to touch the mask during alignment)
 - 6.5.3. WEC Offset- 0
 - 6.5.4. WEC Type- contact
 - 6.5.5. Exp type- Determined by user, see supplemental section at the end of this document and the Karl Suss Users Manual. The Proximity mode is not available on this system. Additional parameters for each

mode show below.

- If vacuum mode is used:
 - Pre Vac-recommend 4 seconds
 - Full Vac-recommend 4 seconds
 - Vac Purge-recommend 4 seconds
- If Hard Contact mode is used:
 - H.C. wait time = 4

6.6 You may save your settings for future use by storing it to a program number. Press the EDIT PROGRAM key – Press the Y keys to select a new recipe number in which to store your recipe. Make sure your selecting a new un-used prog number. When a recipe is empty the top left corner of the display will read “Empty program”. Now, toggle with the X-ARROW keys til the display reads “SAVE Pgrm to”. Save the settings by the EDIT PROGRAM key. Prior saved programs to the same number will be overwritten without warning. The Edit Prog key may also be used to select existing programs by selecting “Load Pgrm”.

7.0 Load wafer

- 7.1 Center the sample stage by moving the X (located to the right of the exposure stage) and Y (located to the left of the exposure stage) micrometers to approximately 10mm as read on the horizontal black scale. Press the LOAD key. The machine instructs: “pull slide and load substrate onto chuck”. Pull out the transport slide completely. Insert the proper chuck and place the wafer against the pre-alignment pins. Confirm with ENTER key. Now the wafer is held by vacuum
- 7.2 The machine instructs: move slide into machine and confirm with ENTER. **Watch out for the microscope movement!** WEC starts automatically after the last action is completed. The wafer is adjusted parallel to the mask. If the microscope is not lowered automatically press F1 key, confirm with ENTER.

8.0 Alignment

- 8.1 For a first level print, no alignment is needed and you can continue to section 8.0.
- 8.2 The TSA-microscope image on the monitor is enabled by turning the SPLITFIELD switch to LEFT. Make sure the BSA MICROSCOPE key LED is off. It should stay off as this system has no BSA.
- 8.3 Turn *ILLUMINATION* switch to TSA and select the light intensity with the

potentiometer underneath this switch. Separate intensity selection for the left/right objective is possible with the aperture located at the left/right microscope front.

- 8.4 Coarse focus is possible by using the large TSA Z-MOVEMENT knob behind the TSA-microscope. Make sure the TOP/BOTTOM key LED is on and adjust the fine focus separately using the TOP SUBSTRATE LEFT/RIGHT regulators.
- 8.5 Move the left and right microscopes (separately) to the mask alignment marks using the *OBJECTIVE X-SEPARATION knobs* (metal knobs to the sides of the microscopes).
- 8.6 Use the GRAB IMAGE key (option) to superimpose the mask alignment mark image on the monitor with the substrate live image. Here's how. First keystroke grabs the present image and then moves the objectives to the substrate focal plane. The TOP/BOTTOM key LED goes off. The motor control of the microscope manipulator is disabled at this time to prevent you from changing the microscope image reference. Second keystroke deletes the stored image and enables the manipulator again.
- 8.7 Adjust the left/right microscope image fine focus with the *BOTTOM SUBSTRATE LEFT/RIGHT regulator*.
- 8.8 **Caution: If mask and wafer are in contact (*CONTACT INDICATOR LIGHT ON*), don't align the wafer!**
- 8.9 Use the micrometer screws of the alignment stage for *STG-X-Y- Θ -MOVEMENT*.
- 8.10 Alignment check- Depending on your overlay requirements, an alignment check could be helpful using the SEP keys, ALIGN CONT/EXP key or the ALIGNMENT CHECK key. See Karl Suss Manual for more detail.

9.0 Exposure

- 8.1. Pressing the exposure key will move the wafer into exposure position. Exposure takes place. After finishing the wafer chuck moves down to unload the exposed wafer.
- 8.2. Press the CHANGE MASK key when done and the mask holder will be released. Pull the mask holder out, flip it by 180° and store it on the tray to your left. Press ENTER to switch the mask vacuum off. Retract the mechanical clamping and remove the mask.

Supplemental Information

Exposure Programs

The selection of the correct exposure method for your particular application is critical. See the following for details of each mode. The type of exposure program is selectable with the SELECT PROGRAM key. After this selection it is possible to edit all corresponding parameters by pressing the EDIT PARAMETER key.

Proximity exposure

Our system does not have the proximity option

Soft contact exposure

Mask and wafer are brought in contact. The structural resolution is better than in proximity exposure. The vacuum securing the wafer onto the chuck is maintained during exposure. The only force to press the wafer against the mask is the force applied during WEC.

Hard contact exposure

This is similar to soft contact mode. After the wafer has moved into contact, the vacuum underneath the wafer is switched off and nitrogen is purged under the wafer to allow close contact between wafer and mask.

Vacuum contact exposure

This mode performs the highest resolution levels. After the WEC and alignment the wafer is brought into contact with the mask. The rubber seal of a vacuum chuck is creating a mini chamber between mask and wafer. The rubber seal pressure is adjustable by the VACUUM SEAL regulator. This chamber is evacuated in steps. Pre vacuum gently pulls vacuum into that mini chamber to enable a smooth contact between mask and wafer i.e. it prevents gas bubbles to be trapped. Full vacuum will be applied with the next step. The wafer will be brought to the closest contact position. The vacuum securing the wafer on the chuck is replaced by nitrogen. In this mode the best contact between mask and wafer is achieved. After exposure, nitrogen will be purged into the mini chamber to break the vacuum. The larger the wafer the longer the vacuum and purge times. For best results start a test with long times and reduce them gradually. All the parameters can be set using the EDIT PARAMETER key.

Low vacuum contact exposure

This mode is similar to vacuum contact with one difference: the vacuum level in the wafer chamber can be adjusted by the LOW VACUUM ADJUSTMENT regulator. So the high resolution level of the vacuum contact exposure can be combined with a minimum mechanical stress for

wafer and mask. Set an appropriate vacuum with the vacuum chamber regulator and test the result using the ALIGNMENT CHECK key.

Flood exposure

It is possible to expose the whole wafer without a mask. After this mode is selected, the exposure can be started from the *initial state* by pressing the EXPOSURE key. The exposure takes place as long as the exposure time was set independent if a mask (and mask holder) is loaded or not.

Multiple exposure

For special applications the numerical value for the overall exposure time can be segmented into equal exposure intervals alternating with wait time intervals in which the wafer is not exposed. One exposure time and one wait time is named as one exposure cycle. To perform Multiple Exposure, proceed as follows:

1. Select the corresponding exposure program by the SELECT PROGRAM key.
2. Press the MULTIPLE EXPOSURE key Press the EDIT PARAMETER key Edit the parameter for the exposure program. Edit the numerical value of the corresponding parameters wait time and cycles.
3. Press the flashing EDIT PARAMETER key to finish editing and start alignment followed by the multiple exposure process.

Wedge error compensation

During this procedure the top side of the wafer will be set parallel to the bottom side of the mask i.e. sets the entire wafer surface on the (as close as possible with this method) same focal plane. Set the WEC type using the EDIT PARAMETER key. Two methods are standard:

Contact mode:

For the exact parallel setting the wafer will be moved against the mask.

Spacer mode:

To treat mask and wafer with maximum care the machine moves spacers in between both. A proximity mask holder is necessary. Contact area is reduced to three points near the wafer edge.