

Karl Suss MA4 Mask Aligner

SOP

Prerequisites for operating the Mask Aligner:

- a) Read and understand the Karl Suss Mask Aligner MA4 Users Manual Section III. * *A hard copy is located at the machine*
- b) Receive “one on one” training and certification from ECTI Staff.
- c) Obtain an ECTI ID (if you do not already have one) by completing the [ECTI 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 look 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 ECTI Staff.
- **High Power:** The MA4 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.
- **Manual Intervention:** never help the machine when the machine is in motion to the designated position even when the motion likely gets stuck (**Attn:** the machine is getting old).
- **N2 Supply:** Always make sure enough N2 supply is available for high pressure (HP-N2 at 80psi) and low pressure (LP-N2 at 40psi) before using the tool.

1.0 Tool Reservation

- 1.1 Reserve tool time via reservation system on the [ECTI 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 1000)

- 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 CIC unit located under the main system. The CIC performs a self calibration test and displays “ready” (“rdy”). Press the “DS” key on the CIC for more than 3 but less than 5 seconds in order to display the total lamp hours. Record this value on the user datasheet. This gives the total time the bulb in the lamp house has been ignited.
- 2.3 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 (It takes about 30 minutes.).
- 2.4 Allow at least 30min for the lamp to warm up and stabilize before doing any exposure. To toggle the display on the CIC between power used by the bulb [W] and the intensity of the light during exposure [mW/cm²], press the “DS” button. The lamp will idle (once it has warmed up) at 474 W Press “CI1” button for 3~5sec to check the intensity set for the exposure. After the intensity has been verified to be 9.0mW/cm², press the “CI1” button again to return to the normal display. Before doing an exposure, the set intensity must be recorded in the user data sheet.

ATTENTION: Nitrogen failure for longer than 5 minutes will turn off the exposure lamp!

3.0 Power up the machine

- 3.1 Press the red POWER button on the MA4 front panel control (indicator light up) and release. Machine initializes.
- 3.2 Press the red LOAD key, the stage should move under the lamp housing. The moving of the stage activates the controls.
- 3.3 Press the ALIGN key to get the alignment stage back out. Now, it's ready for loading the mask.

4.0 Load Mask

- 4.1 Warning: Watch out for the microscope movement!

- 4.2 Start mask loading sequence: Take out the mask holder, flip it (180°) and gently put it on the panel (make sure the holder does not squeeze any buttons on the panel). **If a mask is loaded, 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.**
- 4.3 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 plate. Toggle the Mask Vacuum on.
- 4.4 Flip the mask holder back and slide it into the machine. Lock the mask holder slide by screw-tie two nuts on the left side of the alignment stage.

5.0 Pre Exposure Operation

- 5.1 Verify that the CH1 button is illuminated in the Lamp Power (CIC) unit. If not depress CH1. This enables automatic exposure dose compensation.
- 5.2 Note: this procedure assumes you will NOT be using a program that you have already created.
- 5.3 There are 4 contact modes to select. Press WHITE button to toggle through selections. For example to have soft contact the red light on the white buttons “st” and “soft contact” should be on. To get the desired function press the appropriate button. These buttons are on/off toggle buttons. To obtain hard contact, press the white “hard contact” button (“St” should still be lit). For soft H.P. contact the “H.P.” button should be lit. For the H.P. mode, the chamber is under vacuum and in order to get “Vac Chamb” is used.
- 5.4 Set the exposure time using the timer located on the vertical front panel above the stage.
- 5.5 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

6.0 Load wafer

- 6.1 The stage should be in the align position.
- 6.2 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.

- 6.3 Pull out the transport slide completely. Insert the proper chuck and place the wafer against the pre-alignment pins. Confirm by toggle on the “Wafer Vacuum” button. Now the wafer is held by vacuum. Gently slide in the wafer stage.
- 6.4 To bring the wafer in contact with the mask pull the large lever on the left side of the stage to the vertical position. The “Wafermask Parallel” light will come on when contact has been made.
- 6.5 To separate the wafer and mask by as much as 90um, pull the horizontal separation-contact lever towards the operator. **Aligning is done in the separation mode.** There are lights to indicate when the stage is in contact or in separation.

Note: WEC starts automatically after the last action is completed. The wafer is adjusted parallel to the mask.

7.0 Alignment

- 7.1 Use the micrometer screws of the alignment stage for *STG-X-Y-Θ-MOVEMENT*.

8.0 Exposure

- 8.1. After the alignment is done and the stage is in the contact position(the blue contact light is on)
- 8.2. Confirm the exposure time
- 8.3. Press the red “LOAD” button to move the stage under the exposing camber. The vibration isolation table will take ~30sec to adjust to the weight shift.
- 8.4. Put UV goggles on
- 8.5. Press the red “Expose” button to start the exposure.
- 8.6. When the timer has finished counting down, the stage will automatically drop to come out of the “Wafermask Parallel” mode. If H.P. modes are used, air must be blown into the chamber by putting the stage in the separation mode.
- 8.7. Press “Align” to bring the stage out for changing wafers. Pull the wafer holder out and remove the exposed wafer.
- 8.8. When finishing with the MA4, turn off the bulb by turning off the CIC1000. Take the mask off the mask holder. The vacuum pump and the power for the mask aligner should be turned off. The high and low

pressure N2 should be left on for 30min after turning off the bulb in order to cool the lamp housing.

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.

Proximity exposure

Space between mask and wafer could be set at 10~50um

Soft contact exposure

Mask and wafer are brought in contact. The 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.

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