

## KARL SUSS MA8 Mask Aligner Users Manual



**Coral name:** Suss MA8  
**Model:** KARL SUSS MASK ALIGNER MA6/BA6  
**Location:** Nanofab, Building 215, Room A102  
**Contact:** [nanofab\\_litho@nist.gov](mailto:nanofab_litho@nist.gov)  
**Version:** 1.0

## OVERVIEW:

- UV broadband (250nm-450nm), I-line (365nm) and G-line (436nm) wavelength available. Contact super-user for installing I-line or G-line filters.
- Exposure methods: flood, proximity, soft and hard contacts, low vacuum and vacuum contacts.
- Mask size: 2.5"x 2.5", 4"x 4", 5"x 5" and 8"x 8"
- Wafer size for Top-Side Alignment: up to 6" in diameter (small samples, 2",3",4" and 6").
- Wafer size for Bottom-Side Alignment: 3" and 4"chucksore
- Maximum wafer thickness: 3mm
- The machine is exclusively intended for use as an alignment and/or exposure device for substrates used in Semiconductor and Microsystems Technology.

## RESTRICTIONS:

- Must be qualified to use the tool by the super-user. In order to be certified on the tool the user should be trained by the super-user.
- Do not lean on the machine during alignment or exposure.

## SAFETY PRECAUTIONS:

- **WATCH OUT FOR THE MICROSCOPE MOVEMENT AT ALL THE TIMES.**
- There is a red colored emergency off switch located on the left of the front panel next to the main power switch. If it is pressed machine gets isolated from the power supply. Press this button only in an event of danger.
- In case of lamp explosion immediately leave the contaminated room otherwise the mercury fumes released during the explosion may cause poisoning.
- Nitrogen failure for longer than 5 minutes will turn off the exposure lamp automatically. Do not attempt to turn the lamp on again.

## Contamination Control Procedures

- Keep substrates and photomask as clean as possible
- Minimize photoresist contamination on substrate chuck – try to clean off any resist that is transferred to chuck
- Please remember to clean resist spin coater

## OPERATING PROCEDURE:

### Power on Procedure

#### 1. Before powering on the machine check the following

- Compressed Air: 5 bar
- Nitrogen: 1 bar
- Vacuum. The gauge should read ~0.8 bar

Turn the **MAIN POWER** switch (on the left side of the alignment stage) to the **ON** position.

## 2. Exposure lamp Ignition:

- **POWER SWITCH ELECTRONIC** of the machine (mask aligner) should be **OFF**.
- Check the status of Constant Intensity Controller Switch on power of the Constant Intensity Controller (CIC).
- If it is “**STAND-BY**” mode, press **ON** key and wait until **READY** appears on the Display.
- Press CP (Constant Power) key. Display shows “wait”, followed by “Start”.
- Press Start key. This will ignite the exposure lamp. The display shows **IGNITION** and then **LAMP COLD** and the **LAMP LIFE/POWER** LED will flash until the lamp is warmed up.

**Attention: Nitrogen failure for longer than 5 min will turn off the exposure lamp! Do not attempt to turn the lamp on again! Call super-user or facility manager.**

- If it is not in **CH2** Press **CH2** key and go to Part 3 (Mask Aligner Start-Up)

## 3. Starting the machine or mask aligner

- Turn the **POWER SWITCH ELECTRONIC** on the front panel clockwise into **ON** position and release.

The display message says:

**“Ready for Start – press LOAD Button**

- Press the flashing **LOAD** key on the keyboard  
After pressing the load key the display says “**Watch out machine is starting!**”
- Now you are asked for:  
**Select Machine Configuration:MA6**  
**MA6-BA6-[M] V 4.000 04.05.01 SW:P”**
- Select between mask align- (MA6) and bond alignment (BA6) operation mode with the Y-ARROW keys. After making MA6 selection press **ENTER** key. The display reads “**Ready for Load**”.
- Proceed to load the Mask and wafer.

**FIRST LEVEL LITHOGRAPHY:** This process doesn’t require any kind of alignment since it is a first level lithography. Starting from the initial following steps are to be performed:

### 1. Adjust Parameters

- Check the status of the constant intensity controller and refer to the Power on Procedure.
- If **CHANGE MASK** and **ENTER** keys **LED** are flashing, press **CHANGE MASK** key and then **ENTER** key to confirm ( **LOAD** key will start flashing )

- For Selecting Exposure Mode: Press **SELECT PROGRAM** key. Toggle through the menu and confirm your exposure program by pressing **SELECT PROGRAM** key again.
- Press **EDIT PARAMETER** key to edit the parameters. Change necessary parameters and their values and confirm by pressing **EDIT PARAMETER** key again.
- There is an optional possibility to save this parameter set for the future. Toggle with the **X-ARROW** keys to “**SAVE PROGRAM.**” Select with the **Y-ARROW** keys a program number. Prior saved programs to the same number will be overwritten. Save the settings by pressing “**EDIT PROGRAM**” key.

## 2. LOAD MASK

- Press **CHANGE MASK** key. If the Mask holder is inside the mask aligner machine, bring it out, flip it 180 degrees and put it on the tray outside. If a mask is loaded on the mask holder press **ENTER** to toggle the mask fails and remove the mask.
- Place your mask onto the mask holder against the stop pins. Turn the vacuum on by pressing the **ENTER** key. Activate the mechanical mask clamp by pressing vacuum off, retract the mechanical mask clamp which holds the mask incase the vacuum the leaf spring
- Flip the mask holder which has your mask placed on it and move it into your machine. Lock the mask holder slide by pressing **CHANGE MASK** key.

## 3. LOAD WAFER

- Press **LOAD** key. The display reads “**PULL SLIDE AND LOAD SUBSTRATE ONTO CHUCK**”.
- Pull out the transport slide completely. Insert the proper chuck and place the wafer against the prealignment pins. The flat touches the two pins which are close to each other. Confirm with “**ENTER**” key. Now the wafer is held by vacuum.
- The machine then instructs “**Move slide into machine and confirm with Enter**”
- Move slide into the machine and confirm with **ENTER**
- WEC starts automatically after the last action is completed. The wafer is adjusted parallel to the mask in WEC adjustment.

## 4. EXPOSURE

- Press **EXPOSURE** key to expose the resist coated wafer. The wafer moves into the exposure position and wafer is exposed. Depending on the exposure program selected all program steps will be performed automatically. After finishing the exposure process wafer chuck moves down to unload the exposed wafer.

## 5. UNLOAD WAFER

- Wait till the message on the LCD screen appears “**UNLOAD SUBSTRATE FROM THE SLIDE**”
- Pull out transport slide completely; otherwise the vacuum will be on.
- Unload wafer and move the transport slide into the machine
- If you would like to expose additional wafers, perform step 3-5

## 6. UNLOAD MASK

- Hit the **CHANGE MASK** key and the mask holder will be released.
- Pull the mask holder out, flip it by 180 degrees and store it on the ray to your left.
- Hit **ENTER** to switch the mask vacuum off.
- Retract the mechanical clamping and remove the mask.

## TOP SIDE ALIGNMENT

In this mode the wafer is aligned to the mask using the top side alignment microscope (TSA). Before performing this type of lithographic exposure one should be familiar with **SPLITFIELD** switch, **ILLUMINATION** switch, **TOP/BOTTOM** key, **TOP/BOTTOM SUBSTRATE** fine focus knob, **OBJECTIVE X-SEPARATION** knobs, **Θ-MOVEMENT** knob, **X/Y-ARROW** keys, **FAST** key, **SCAN** key, **ALIGNMENT CHECK** key, **ALIGN CONT/EXP** key, and **SEP** keys. Perform Power on Procedure. After starting the machine do the following

### 1. Adjust Parameters

- Check the status of the constant intensity controller and refer to the Power on Procedure.
- If **CHANGE MASK** and **ENTER** keys **LED** are flashing, press **CHANGE MASK** key and then **ENTER** key to confirm ( **LOAD** key will start flashing).
- Deactivate **BSA MICROSCOPE** key (LED OFF).
- For Selecting Exposure Mode: Press **SELECT PROGRAM** key. Toggle through the menu and confirm your exposure program by pressing **SELECT PROGRAM** key again.
- Press **EDIT PARAMETER** key to edit the parameters. Change necessary parameters and their values and confirm by pressing **EDIT PARAMETER** key again.
- There is an optional possibility to save this parameter set for the future. Toggle with the **X-ARROW** keys to “**SAVE PROGRAM.**” Select with the **Y-ARROW** keys a program number. Prior saved programs to the same number will be overwritten. Save the settings by pressing “**EDIT PROGRAM**” key.

## 2. LOAD MASK

- Press **CHANGE MASK** key. If the Mask holder is inside the mask aligner machine, bring it out, flip it 180 degrees and put it on the tray outside. If a mask is loaded on the mask holder press **ENTER** to toggle the mask vacuum off, retract the mechanical mask clamp which holds the mask incase the vacuum fails and remove the mask.
- Place your mask onto the mask holder against the stop pins. Turn the vacuum on by pressing the **ENTER** key. Activate the mechanical mask clamp by pressing the leaf spring
- Flip the mask holder which has your mask placed on it and move it into your machine. Lock the mask holder slide by pressing **CHANGE MASK** key.

## 3. LOAD WAFER

- Press **LOAD** key. The display reads “**PULL SLIDE AND LOAD SUBSTRATE ONTO CHUCK**”.
  - Pull out the transport slide completely. Insert the proper chuck and place the wafer against the prealignment pins. The flat touches the two pins which are close to each other. Confirm with “**ENTER**” key. Now the wafer is held by vacuum.
  - The machine then instructs “**Move slide into machine and confirm with Enter**”
  - Move slide into the machine and confirm with **ENTER**
- WEC starts automatically after the last action is completed. The wafer is adjusted parallel to the mask in WEC adjustment.

## 4. MICROSCOPE ALIGNMENT

- Turn the monitor on. For the M3XX microscope only, an actual **TSA**-microscope image on the monitor is enabled by turning the splitfield switch to left.
- Turn the **SPLITFIELD** switch to the left. Toggle **BSA MICROSCOPE** key off
- Turn **ILLUMINATION** switch to **TSA** and select the light intensity by the potentiometer under this switch.
- Coarse focus can be done by using the TSA Z-movement knob placed behind the TSA-microscope. Make sure that that the top/bottom key LED is on and adjust the fine focus separately using the **TOP SUBSTRATE LEFT/RIGHT** regulators.
- Adjust microscope to the mask alignment marks. Move the left/right objective to the left/right mask alignment mark by the **OBJECTIVE X-SEPARATION** knobs

- Adjust microscope to the mask alignment marks. Move the left/right objective to the left/right mask alignment mark by the **OBJECTIVE X-SEPARATION** knobs.
- Click **GRAB IMAGE** key to get the image of the alignment marks.

#### 5. WAFER ALIGNMENT

- Focus on the wafer plane by adjusting the left/right microscope image with the **BOTTOM SUBSTRATE LEFT/RIGHT** regulator. Now you get the alignment marks on the wafer on to the monitor.
- Use the micrometer screws of the alignment stage for **STG-X-Y-T-MOVEMENT**. Align the wafer alignment marks central symmetrical to the mask alignment marks.

#### 6. EXPOSURE

- Press **EXPOSURE** key to expose the resist coated wafer. The wafer moves into the exposure position and wafer is exposed. Depending on the exposure program selected all program steps will be performed automatically. After finishing the exposure process wafer chuck moves down to unload the exposed wafer.

#### 7. UNLOAD WAFER

- Wait till the message on the LCD screen appears "**UNLOAD SUBSTRATE FROM THE SLIDE**"
- Pull out transport slide completely; otherwise the vacuum will be on.
- Unload wafer and move the transport slide into the machine
- If you would like to expose additional wafers, perform step 3-5

#### 8. UNLOAD MASK

- Hit the **CHANGE MASK** key and the mask holder will be released.
- Pull the mask holder out, flip it by 180 degrees and store it on the ray to your left.
- Hit **ENTER** to switch the mask vacuum off.
- Retract the mechanical clamping and remove the mask.

#### 9. STAND BY MODE

- Turn off the monitor
- Turn **ILLUMINATION** knob to **BSA/IR** position.
- Turn the **RIGHT** and **LEFT** knobs for **BSA/IR** position light intensity adjustment all the way to the left
- Set micrometer screws to  $X=10$ ,  $Y=10$  and  $\Theta = 0$

## BOTTOM SIDE ALIGNMENT

The wafer is aligned to the mask using the bottom side alignment microscope (BSA). Before performing this type of lithographic expose one should be familiar with **SPLITFIELD** switch, **ILLUMINATION** switch, **TOP/BOTTOM** key, **TOP/BOTTOM SUBSTRATE** fine focus knob, **OBJECTIVE X-SEPARATION** knobs, **Θ-MOVEMENT** knob, **X/Y-ARROW** keys, **FAST** key, **SCAN** key, **ALIGNMENT CHECK** key, **ALIGN CONT/EXP** key, and **SEP** keys. Perform Power on Procedure. After starting the machine do the following

### 1. Adjust Parameters

- Check the status of the constant intensity controller and refer to the Power on Procedure.
- If **CHANGE MASK** and **ENTER** keys **LED** are flashing, press **CHANGE MASK** key and then **ENTER** key to confirm ( **LOAD** key will start flashing).
- Activate **BSA MICROSCOPE** key (LED ON).
- For Selecting Exposure Mode: Press **SELECT PROGRAM** key. Toggle through the menu and confirm your exposure program by pressing **SELECT PROGRAM** key again.
- Press **EDIT PARAMETER** key to edit the parameters. Change necessary parameters and their values and confirm by pressing **EDIT PARAMETER** key again.
- There is an optional possibility to save this parameter set for the future. Toggle with the **X-ARROW** keys to “**SAVE PROGRAM.**” Select with the **Y-ARROW** keys a program number. Prior saved programs to the same number will be overwritten. Save the settings by pressing “**EDIT PROGRAM**” key.

### 2. LOAD MASK

- Press **CHANGE MASK** key. If the Mask holder is inside the mask aligner machine, bring it out, flip it 180 degrees and put it on the tray outside. If a mask is loaded on the mask holder press **ENTER** to toggle the mask vacuum off, retract the mechanical mask clamp which holds the mask incase the vacuum fails and remove the mask.
- Place your mask onto the mask holder against the stop pins. Turn the vacuum on by pressing the **ENTER** key. Activate the mechanical mask clamp by pressing the leaf spring
- Flip the mask holder which has your mask placed on it and move it into your machine. Lock the mask holder slide by pressing **CHANGE MASK** key.

### 3. LOAD WAFER CHUCK FOR BSA



- Insert a proper chuck without wafer into the transport slide
- Move the BSA-chuck placed onto the transport slide into the machine.

#### 4. MICROSCOPE ALIGNMENT

- Turn the monitor on
- Turn the spitfield switch to middle position and toggle **BSA MICROSCOPE** key on (**LED ON**).
- Turn the illumination switch to **BSA/IR** and adjust the light intensity by the potentiometers labeled **BSA/IR** microscope illumination left/right.
- Make sure that the **TOP/BOTTOM** key **LED** is on and adjust the fine focus separately with the **TOP SUBSTRATE LEFT/RIGHT** regulators
- Select **LEFT, RIGHT, BOTH** keys to move the left/right or both objectives with the **X** and **Y ARROW** keys. If necessary use fast speed (**FAST** key **LED** on ).
- Press **GRAB IMAGE** key to grab the image of the alignment marks on the mask. If you press the above key again the image gets deleted.

#### 5. LOAD WAFER

- After Grabbing the image of the mask the machine reads “ **Ready for load. BSA image stored**”.
- Press **LOAD** key
- Pull out transport slide.
- Load wafer onto chuck and push slide into the machine as prompted on the display
- Press **ENTER** key

#### 6. WAFER ALIGNMENT

- Start out with **LOW MAGNIFICATION** to locate the alignment marks on the substrate.
- Adjust the left/right objective image with the **BOTTOM SUBSTRATE LEFT/RIGHT** regulators. Correct illumination if necessary
- Use the micrometer screws of the alignment stage for **STG-X-Y- $\theta$  MOVEMENT**. Align the wafer alignment marks central symmetrical to the mask alignment marks.
- Alignment check can be done by pressing **ALIGN CONT/EXP** key.

#### 7. EXPOSURE

- Press **EXPOSURE** key to expose the resist coated wafer. The wafer moves into the exposure position and wafer is exposed. Depending on the exposure program selected all program steps will be performed automatically. After finishing the exposure process wafer chuck moves down to unload the exposed wafer.

### 8. UNLOAD WAFER

- Wait till the message on the LCD screen appears “**UNLOAD SUBSTRATE FROM THE SLIDE**”
- Pull out transport slide completely; otherwise the vacuum will be on.
- Unload wafer and move the transport slide into the machine
- If you would like to expose additional wafers, perform step 3-5

### 9. UNLOAD MASK

- Hit the **CHANGE MASK** key and the mask holder will be released.
- Pull the mask holder out, flip it by 180 degrees and store it on the ray to your left.
- Hit **ENTER** to switch the mask vacuum off.
- Retract the mechanical clamping and remove the mask.

### 10. STAND BY MODE

- Turn off the monitor
- Turn **ILLUMINATION** knob to **BSA/IR** position.
- Turn the **RIGHT** and **LEFT** knobs for **BSA/IR** position light intensity adjustment all the way to the left
- Set micrometer screws to  $X=10$ ,  $Y=10$  and  $\Theta = 0$ .

## SHUT DOWN PROCEDURE

1. **NOTE:** Mask Aligner computer should be turned off before the exposure lamp at the end of the day
  - Make sure that the mask is unloaded and mask holder on the tray, otherwise it might damage your mask and aligner
  - Turn the **POWER SWITCH ELECTRONIC** on the front panel control clockwise into **OFF** position and release it. Use the off switch located on the control panel to the right of the microscope stage not the Main Power switch.
2. **EXPOSURE LAMP SHUT-DOWN**
  - NOTE:** Exposure lamp should be turned off on the last day of the week, or in the event that the system is not to be used for an extended period of time or for maintenance. Otherwise, the CIC controller should be ON.
  - Make sure that the mask aligner is off
  - Press **OFF** key on the Constant Intensity Controller, the message will display “**STAND-BY**”.

Constant Intensity Controller Operating Manual:

## WARNINGS AND SAFETY HAZARDS:

**Intended Use of the CIC 1200:** The CIC is designed to operate as a power supply for high pressure lamps installed in a SUSS lamp house.

**Electrical Precautions:** Never open the housing while the power line is connected.

**Lamp Explosion:** Careful handling of the lamp and proper operation of the equipment will reduce the possibility of Lamp Explosion.

- a. In case of lamp explosion turn power to the supply and the machine off immediately.
- b. Do not turn off exhaust system.
- c. Evacuate the immediate area of the machine to prevent inhalation of the mercury vapor. Wait atleast 20 minutes before returning.
- d. Immediately inform the facility manager or the technician about it.

**Eye and skin safety:** The ultraviolet light produced by these lamps can cause erythema of skins (similar to sunburn) and conjunctivitis. In addition the large infrared output can cause retinal burns resulting in blindness. The mask aligner should never be operated without the protective covers in place.

### SELECTING THE EXPOSURE LAMP:

- Select the appropriate exposure lamp before starting the CIC with the key **ON** of the front panel. The display of the front panel reads **STAND-BY**.
- Actuate the key **SET LAMP** (press button for 2 sec) to activate the menu **LAMP TYPE** of the CIC unit. The display shows the currently loaded exposure lamp, e. g. **LAMP 1000**.
- The corresponding LED of the annunciator **LAMP TYPE** is on.
- Choose the required exposure lamp power by **+** or **-** keys located on the front panel.
- Now the LED adjacent to that lamp power is on
- Validate with key **SET LAMP** (press button for 2 sec). An audible beep is heard.
- The display on the front panel shows the message **STORED** then **L: RESET?**

### RESET LAMP HOURS:

- To reset the Lamplife press **+** or **-** key
- The **?** disappears from the display. Confirm with **SET LAMP**
- The display shows **STORED** and then automatically **STAND BY**
- To leave the stored hours in the memory as they were before press **SET LAMP** after the instruction **L:RESET?**
- The display shows **NO STORE** and then automatically **STAND BY**.

**IGNITION OF THE EXPOSURE LAMP:**

- Commence ignition and activate **POWER** by pressing the key **ON**.
- The display shows the message **READY**
- The **LED** of the group **LAMP TYPE** is **ON**
- Actuate the key **CP**
- The alphanumeric display shows **IGNITION** then **LAMP COLD**
- In the annunciator group Failure the **LED** of the **LAMP LIFE/POWER** is flashing until the lamp reaches operating conditions- depending on conditions set.
- Upon the completion of the warm-up sequence the alphanumeric display will indicate the real value of **LIGHT INTENSITY** (if the shutter is open) and **POWER** of the exposure lamp.
- To run the lamp in “idle” mode actuate key **IDLE**
- The display shows **IDLE XXX**. In **IDLE** –mode the lamp power is 275.
- Quit the idle mode by actuating the key **IDLE**

**CHANGE DISPLAY:**

- Actuating the key **CHANGE DISPLAY** one gets access to **CHANNEL 1**, **CHANNEL 2** and **LAMP LIFE** modes of the annunciator group **DISPLAY**.
- On activating the **CHANGE DISPLAY** key each time the next LED will be activated in the sequence **CHANNEL 1**, **CHANNEL 2** and **LAMP LIFE**.
- The Display reads light intensity for Channel 1, Channel 2 and number of hours for lamp life when the corresponding modes are actuated.