Süss MA6Gen3 – Start me up!

Version of 2019-07-05. Get the latest one at cmi.epfl.ch/photo/files/ma6gen3/ma6gen3.manual.php

1. Introduction

This manual explains you how to start up the Suss mask aligner MA6Gen3 without making a grown man/woman cry[1].

[rare/skip] this title marks steps that you rarely have to do, most of the time you can skip them.

2. Login on accounting system

Login with you "CMi" account and password on the Zone 01 accounting system.
Select the "Suss MA6 Gen3 Mask Aligner"

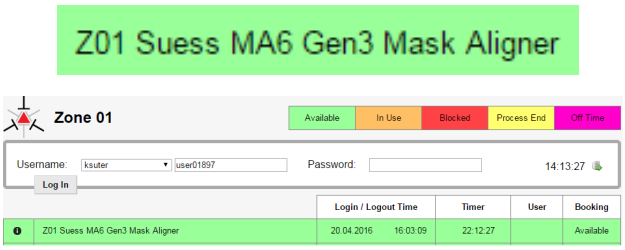


Fig 1: accounting interface

3. [rare/skip] Check main power

If all the gauges are turned off, check basics:

Release EMO (**Em**ergency **O**ff button), shaped like a red mushroom, pull to release.

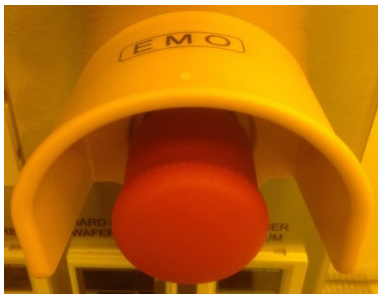


Fig 2: emergency off

Turn **"MAIN SWITCH"** from position "**O OFF**" (9h) to position "**I ON**" (12h).

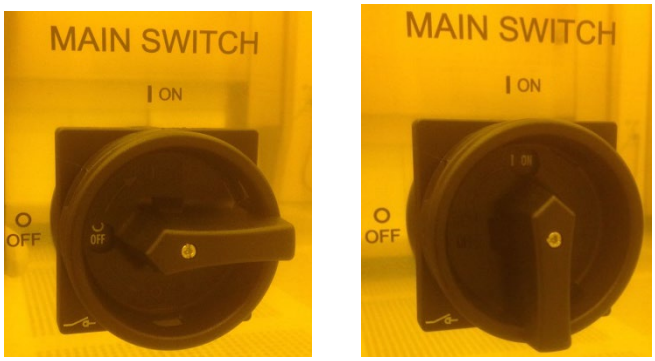


Fig 3: main switch off (left) vs on (right)

If after that nothing happens, call staff.

[1] http://www.metrolyrics.com/start-me-up-lyrics-rolling-stones.html

4. Check utilities

With the power on, some lights appear. The mask aligner needs compressed air, nitrogen and vacuum. The stickers affixed above the respective gauges show the valid pressure ranges. If they are slightly out of spec, don't panic, those are orders of magnitude. They are regulated furthermore inside of the MA6Gen3. If you are uncomfortable with this ambiguity, call staff to do give it a sanity check.

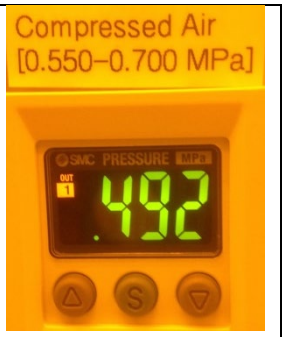
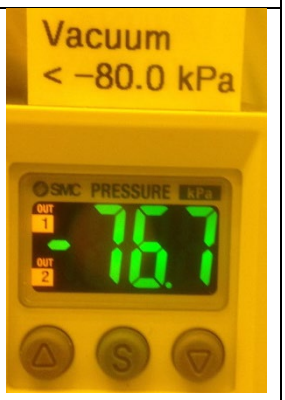
Compressed Air pressure should be between 0.55 and 0.7 MPa [0.492 MPa shown here is out of spec]	
Nitrogen pressure should be between 0.20 and 0.30 MPa [0.183 MPa shown here is out of spec]	
Vacuum (de)pressure should be above -80 kPa [- 76.7 kPa shown here is out of spec]	

Fig 4: utilities' gauges

5. Start lamp controller CIC

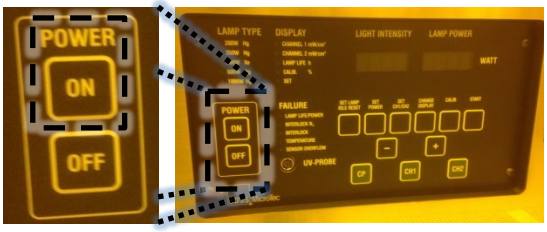
With utilities present, the lamp controller can be started. (CIC=constant intensity controller, smart power supply and regulator for UV lamps). Usually you do:

Display lines [light intensity/ lamp power]	buttons pressed
	see standby
	
	
	
	
	
	You're ready

When the lamps is warm enough to give a stable intensity, the CIC shows a stable number, no more text.

6. [rare/skip] overly detailed how to start lamp controller CIC

If nothing is turned on, push Power “ON” button.

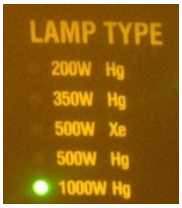


CIC first goes **standby**, “**STAN**” “**D-BY**”

Sometimes, the CIC is already in “standby”. In that case click “ON” and it will go to the next step.

The lamps goes **ready,** “**-REA**” “**DY—**“

Make sure that 1000W lamp is selected, otherwise call staff.



Start constant power mode by pressing “CP”. Do not use CH1 or CH2, as constant dose mode with intensity regulation is done through timed exposure the software interface.

CP button will go bright.

and message to **=>>Start**, “**=>>S**” “**TART**”

Ignite the lamp by pressing **START** button

The CIC gives message **ignition**, “**IGNI**” “**TION**”

Then switches to **lamp cold**, “**LAMP**” “**COLD**”

Maybe you get **warning lamp** for the “Failure” “Lamp Life/Power”. Ignore, as the message appears as long the lamp is “cold”.

Maybe you get a continuous **warning buzzer** telling you the same thing, until the CIC has warmed the lamp. Ignore, unless it stays on for two or five minutes.

Eventually, the CIC will warm up and display: lamp power, e.g. 894W. This is not the intensity.

Fig 5: lamp power in Watt. Thank you James.

You are now ready for business. This all happens while you get the rest of the machine ready.

Note: To switch off the lamp, press the button OFF on left of the CIC front panel. The lamp will be switched off immediately. The CIC itself will be still in “stand by“ mode with an internal timer controlling the cool down time of the lamp, to prevent re-ignition before the lamp is cool, i.e. ready again.

Time necessary for the 1000W lamp to cool after power has been switched off is **900s** (15min). During this period of time the lamp cannot be started. Message: left alphanumeric display shows that lamp is **cooling**, right one shows **time left in seconds**, before exposure lamp can be restarted, e.g. “**COOL**” “ **816**”.

Fig 6: lamp cooling, remaining cool time in seconds.

Note: During the cool down period, no function of the CIC is accessible. This is a safety feature.

7. Configure light source

Select part of spectrum, spectrum scenario

You have just started the CIC/light source. Now you need to follow the light path to ensure that the part of the spectrum that you want to use for the exposure reaches the substrate.

WARNING: Check the spectrum scenario each time you use the MA6Gen3. Chances are that the precedent user was not using the same scenario as you intend to use. Don't ruin your exposure by not checking.

Choose among following spectrum scenarios:

scenario nickname	target λ[nm]	range λ[nm]
broadband	all	220-500?
i-line	365	350-390
g-line	436	420-480
UV300	320	280-350
DUV250	250	220-270

Table 7: five spectrum scenarios.

The figure below superimposes the ranges of the five filters with the spectrum of the Hg lamp:

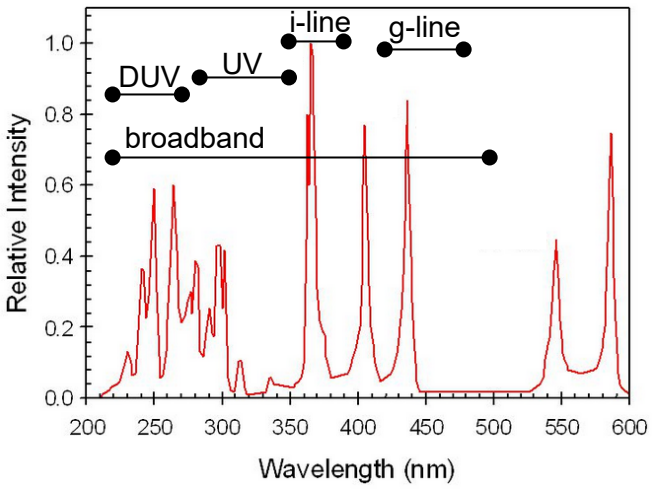


Fig 8: Hg arc lamp spectrum (Chris Mack – fundamental principles of optical lithography)

Configure the machine for one scenario:

- Firstly choose the **wavelength filter**
- Secondly check the **illumination filter** IFP.
- Thirdly set position of the **lamphouse**

Pull the lamphouse towards the right to get access to the filter holders in an optical bench setup.

Wavelength filter

Check the number of the wavelength filter that you require. Do not touch the holders on the right with the condenser lens, or on the left with the IFP. If you must change, then unscrew the finger tightened screw of the wavelength filter holder in the center, until you can unseat it from the optical bench rail, lift it out / exchange it. Cross-check its number with the labels in drawer with the filters.

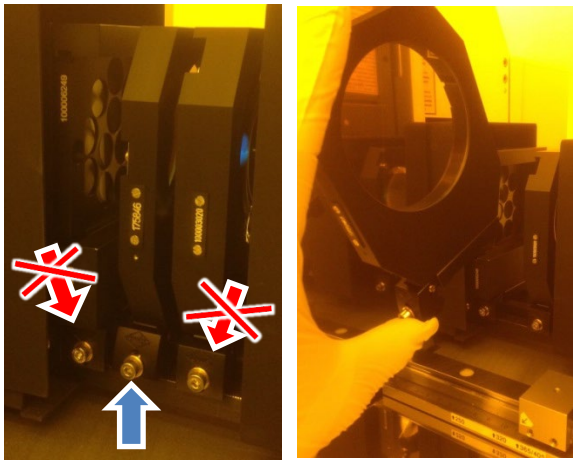


Fig 9 left: wavelength filter plate (center of three inserts) between condenser lens (right slot) and IPF holder (left). Right: lifted wavelength filter plate.

Fig 10 wavelength filter plates stored in top left drawer.

scenario nickname	target λ[nm]	range λ[nm]	filter number
broadband	all	220-500?	- no filter -
i-line	365	350-390	175846
g-line	436	420-480	173860
UV300	320	280-350	100000983
DUV250	250	220-270	100000984

Fig 11 wavelength filter numbers.

The drawer has the following labels:

Fig 12 wavelength labels

IFP illumination filter plate

The illumination filter plate (IFP) allows for flexible illumination, and reduces diffraction effects. It is the “illumination angle defining element” of the optical path. Do not touch the IFP holder (number 100006248). The standard IFP plate is the “HR” (High Resolution) one, with the traditional 12 circles, it carries number 100006249.

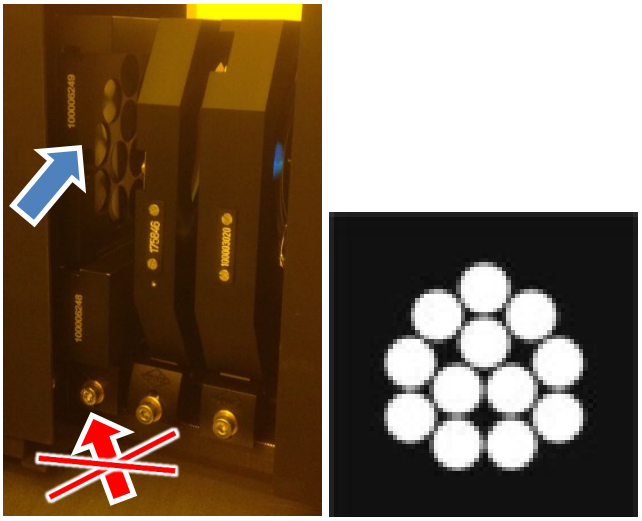


Fig 13 left: illumination filter plate (IFP) inserted in the IFP holder (leftmost). Right: HR-IFP filter plate (100006249).

Check that you have the right one.

Lamphouse

The light source in the lamp house couples optimally into the optical system at different positions for different wavelengths. The manufacturer supplied different stopping positions for optimal efficiency. There are no hard stops, but a stopper block is moved along a rail to align with indicated locations, then screwed tight.

scenario nickname	target λ[nm]	position [cm]	label
broadband	all	11.3	⬆365/405
i-line	365	11.3	⬆365/405
g-line	436	11.3	⬆365/405
UV300	320	9.7	⬆320
DUV250	250	6.5	⬆250

Table 14: stops for five spectrum scenarios.

Fix the the arresting block using an Allen wrench (hex key, inbus). Align arrows.

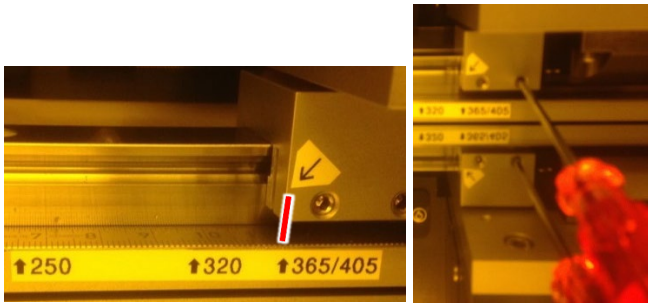


Fig 15: lamp house stopper block locations

Slide the lamp house gently towards the left, until it touches (not hits) the stopper block.

8. [rare/skip] Start user interface PC

Turn on the monitor (if it was turned off).

If the MA6Gen3 user interface does not appear on the screen, then the user interface computer might be turned off.

Pull out the keyboard tray.

NB: The computer lives on an uninterruptible power supply. Turning off the MA6Gen3 main switch does not turn off the computer, and shutting down the user interface computer does not shut down the MA6Gen3 PLC (programmable logical controller). When you shut down the computer (via software), then it will not start up when you turn on the main switch of the machine. To start the user interface computer, type on the keyboard:

"**<ctrl>-<F1><F1><F1><F1><F1>**"

i.e. type and hold <ctrl> then type five times <F1>. That will start the computer. However this is only valid in the first 15min after the machine main switch was shut down. If the machine main switch is turned on 15min or more after shut down, then the computer will also be started. This is to avoid that hardware off/on cycle also powercycle the computer.

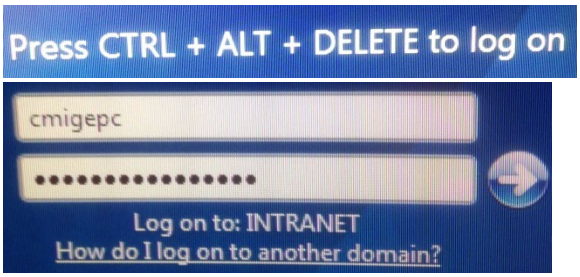


Fig 16: newest generation login screens

Login with the UID and PWD (standard cmi general login, affixed to left side of monitor).

Note: If the computer was not shut down, but the machine was, then you may start up the machine and immediately find yourself logged on the PC and with the application running.

9. [rare/skip] Start the software

Start the software by double clicking on the icon:

Fig 17: newest generation pixelated icons

The software comes up with a great desire to communicate. But it starts up a bit tersely. See for yourself:

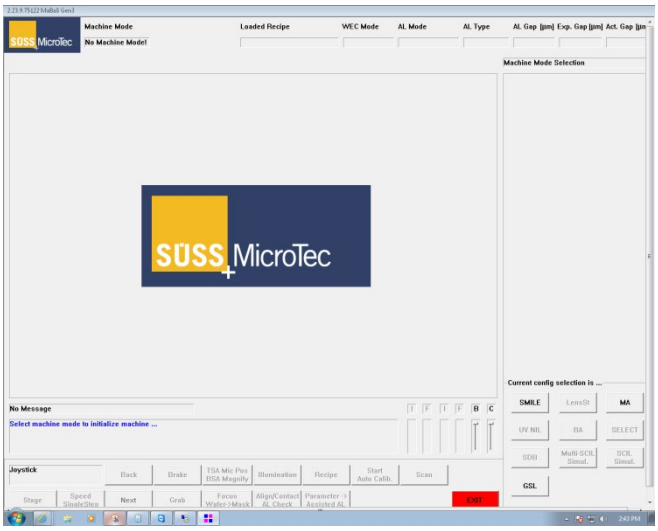


Fig 18: software screen real estate

You will find in "top left" that:

Info: "No Machine Mode!" has been chosen

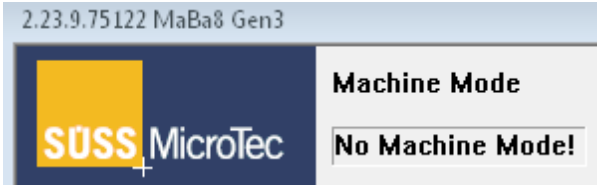


Fig 19: machine mode

10. [rare/skip] Setup machine mode

Here it comes: Select machine mode

Which is L33T speak for initialize the hardware.
Follow Status/Instructions field (lower left):

Fig 20: status / instructions field

The 3 current machine modes & acronyms are:

MA: mask aligner
GSL: gray scale lithography
SMILE: suss microtec imprint lithography equip

In “Current config selection is…” (lower right)

choose “**MA**” machine mode: 

.

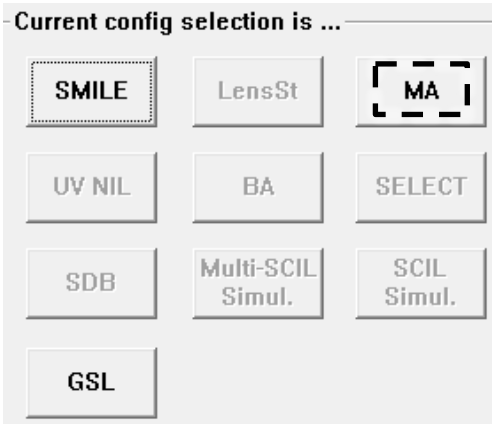


Fig 21: Configuration: “Current config selection is…

Machine will meditate. Be patient. Say “om” ॐ.

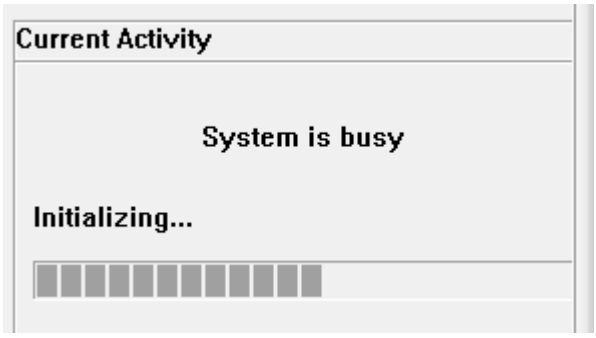


Fig 22: Om.

Once the machine has reached spiritual coherence, follow the orders in the “Status/Instructions” field:

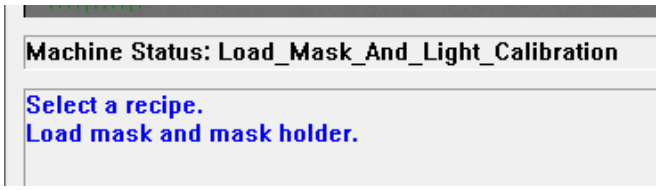


Fig 23: Let’s get cracking.

From here on there the machines is configured, and depending on your application a different flow has to be followed. Here is given a simple example.

11. Recipe editor

All work on the mask aligner is done through a recipe, and the recipes are editor before the machine starts executing them.

Start with setting up or selecting a recipe.

The easiest is to copy an existing recipe to a new name. That way you carry over a lot of settings.

Suss; recipe naming convention:

JDo.TSA.assisted.alignment

<3initials>.<purpose>.<yourstuff>

JDo 3 Initials (1 of FirstName, 2 of LastName, e.g. Jane Doe -> JDo)

“.” recommended delimiter: “.” (period, dot)

TSA purpose, according your own convention typical: TSA, top side align, BSA backside align, AssistAlign, Manual Align, …

Yourstuff information that will make you remember what was so special about this recipe. Currently, there is no limitation on the number of recipes, so please keep your number low, so that we never will have to start enforcing some standard.

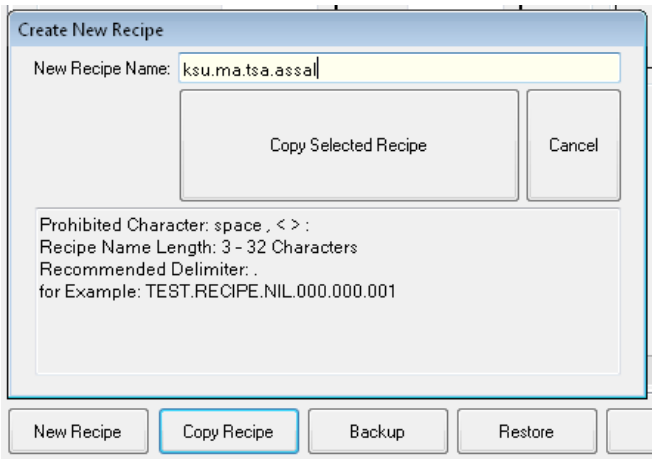


Fig 24: recipe naming.

When you have finished typing “new recipe name” click “Copy Selected Recipe”

Recipe editor opens

Alignment tab

Chose TSA/BSA/Flood/Assisted/Test…..

Alignment positions

You just inherit here the information of your last time using the recipe. This can be a real gain of time, when you already arrive with correct illumination and focus and x/y coordinates on the mask.

Exposure tab

The recipes do recognizes the holder and chuck, therefore they must be correctly specified from within the recipe editor:

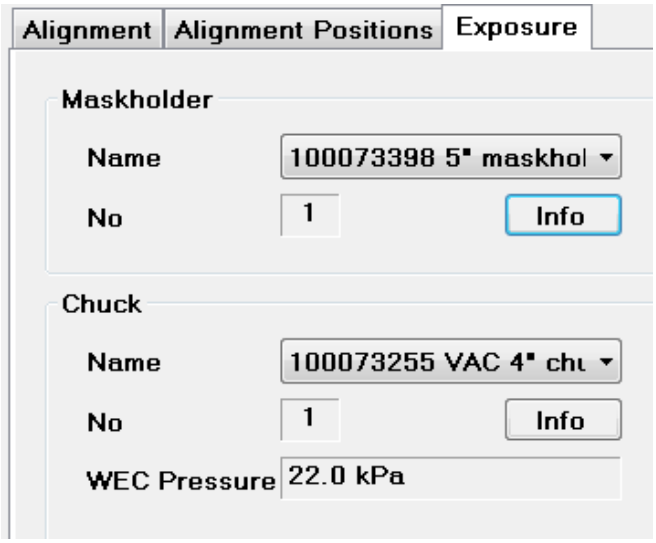


Fig 25: recipe editor, exposure tab.

The WEC pressure specified in the software for the case of the 4” chuck is 22.0 kPa. Verify on the machine’s pressure gauge that value is correctly set, otherwise the mask will be popped out of the holder. In below example it is too high (wrong).

Fig 26: WEC pressure gauge (left and right) WEC pressure knob (bottom center).

Adjust with the rotatory knob, the lower one, until you reach target value.

Save and Quit recipe editor.

12. Insert tooling.

There a many configurations possible, and many forbidden, (e.g. 6” chuck for 5” mask holder). There exists a compatility matrix given elsewhere in the CMi online documentation with regards to this.

For this example here, we select tooling for standard lithography 100mm, i.e. 4” wafer and 5” mask, as configured in the recipe editor. Before inserting the work area looks as follows.

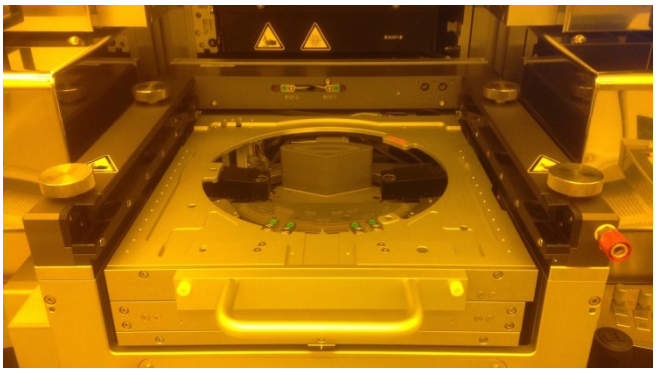


Fig 27: MA6Gen3 with no mask holder loaded, no chuck loaded

First insert mask holder. Match the number on the mask holder and the number in the recipe. Strictly follow the instructions if you do it the first time.

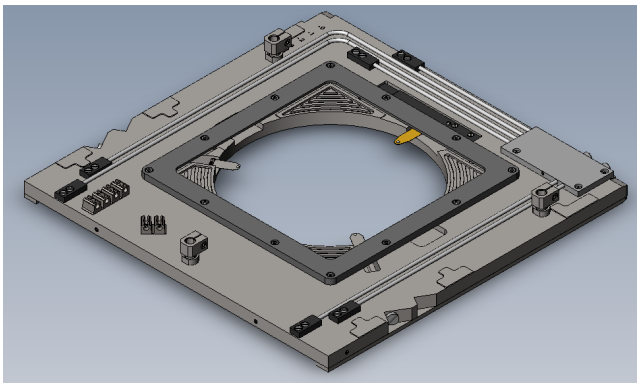


Fig 28: 100073398 MASK HOLDER MA8BA8GEN3/ TL/PROX/CONT/M-5/W-100

Label located on top left corner. Insert chuck.

Then pull out the tray and insert the chuck.

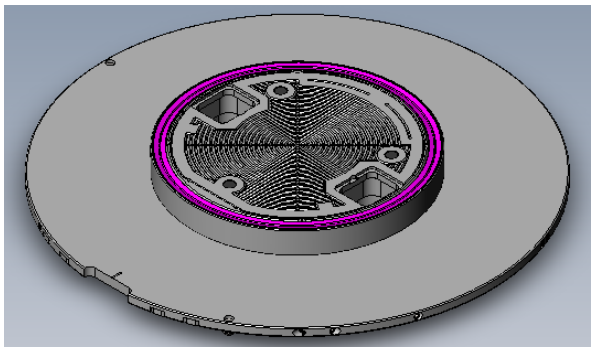


Fig 29: 100073255 CHUCK MA8GEN3/ TL/VAC/BSA/W-100/ARC/SPEC

The serial number of the chuck is on its backside:

Fig 30: Serial number of chuck (backside)

You already have adjusted the WEC pressure when writing the recipe. After inserting holder and chuck machine looks like this:

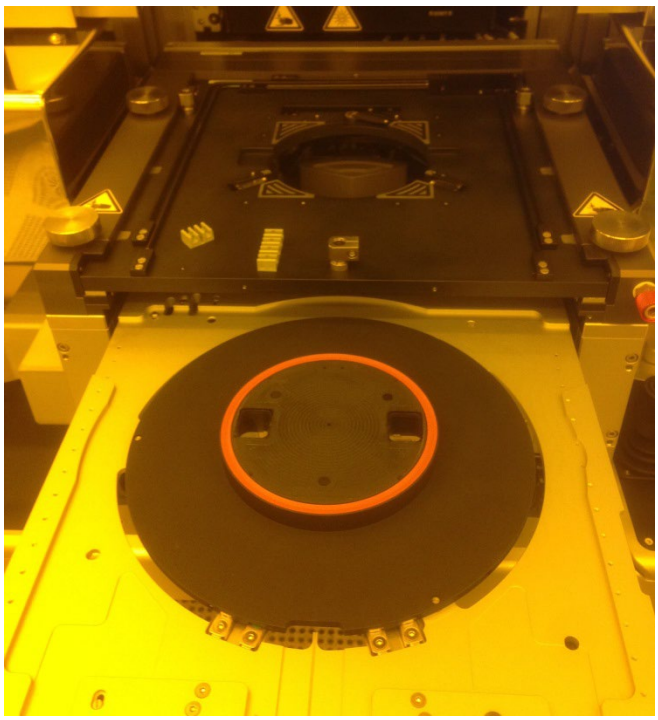
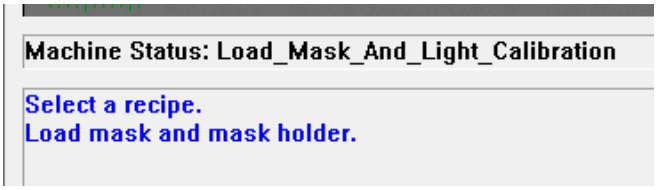
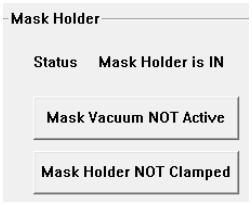


Fig 31: Machine with mask holder and chuck

Mask holder and substrate chuck are now inserted, continue to follow Status/Instructions field

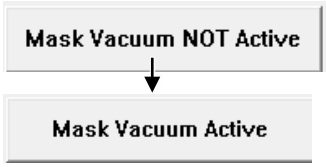


Load mask: You have to put the mask on top of the mask holder, and have it butting with the two screws on the top edge, and with the one screw on the left edge. Once this is done, look at this part of the menu:

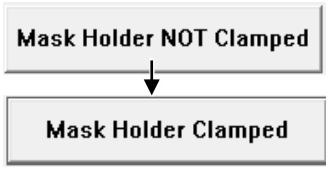


Historically, with bottom loading mask holder, you first turn on vacuum before handling the mask holder.

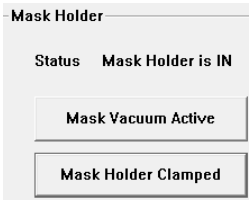
Turn on mask vacuum



Then you clamp the mask holder to the machine:

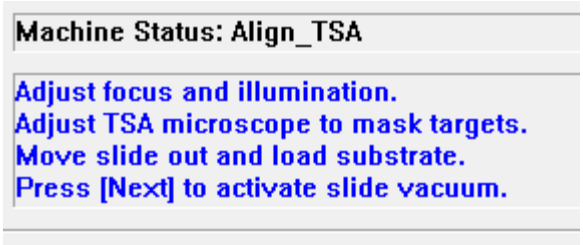


Status should now be:



Continue to follow Status/Instructions field

13. Exposure



Now it is just following instructions.

Adjust left and right objective **focus**. There is the **objective separation** micrometrics screws behind the microscope oculars. Below of them are the **coarse focus** micrometrics screws

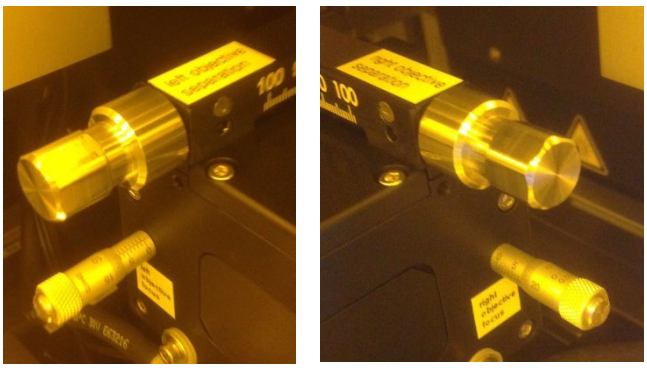


Fig 32: right and left objective separation/focus knobs

The field of hard buttons and knob has a correspondence in the software. The buttons I (illumination) and F (focus) are for left and right microscope. When pushed down, they are faster.

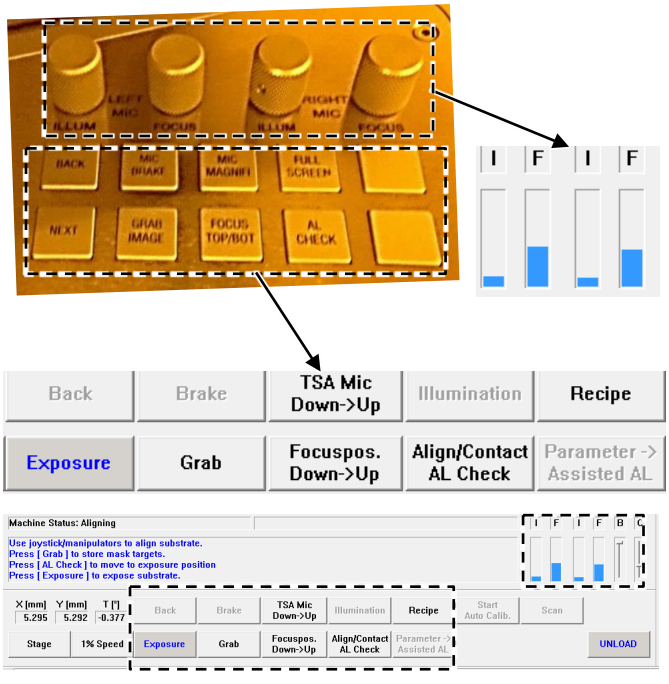


Fig 33: correspondence soft&hard buttons

To do adjust for the mask targets:

Adjust TSA microscope to mask targets.

You have to use the joystick. Cycling with the top left buttom switches between Stage and microscope, the right button does different speeds, e.g. 100%, 10%, 5%, 1%, 10um, 1um, 50nm.

Make sure that at the beginning, you are close to the origin, that wil maximise your dynamic range where you want to find the alignment markers.

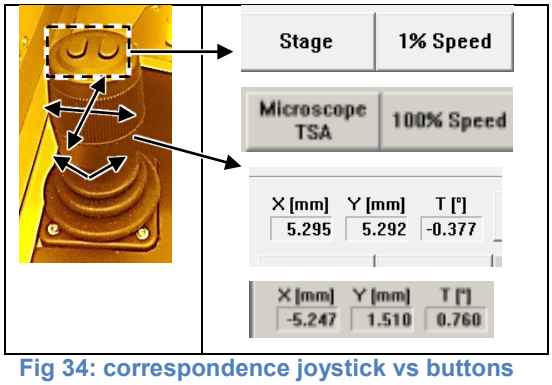


Fig 34: correspondence joystick vs buttons

Now load the substrate, carfully, always aligning with the alignment pins on the chuck.

Move slide out and load substrate.
Press [Next] to activate slide vacuum.

Often after moving the slide with substrate inside, you get the “inner substrate vacuum not in range” error. Ignore, it seems to have no consequences so far. It could be turned off in the recipe editor, but it seems to be buggy.

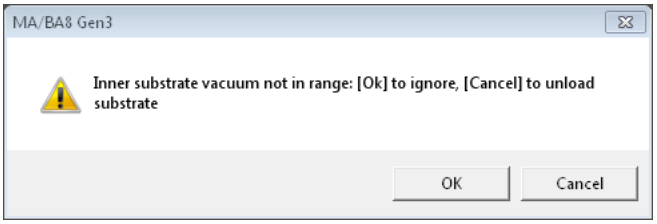


Fig 35: ignore error: inner substrate vacuum

An explanation about buttons and correspondence buttons and software knows follows.

Then, depending on exposure mode, you will eventually press “exposure” and get your substrate illuminated.

14. [rare/skip]: Accounting system

The accounting system is billing usage time as long you are a) using recipe editor, or b) mask holder is clamped (loaded).

Therefore, if you want to log out of the accounting system, you must make sure: that

- Mask Holder NOT Clamped
- Mask Vacuum NOT Active
- Recipe editor exited

Only then logout from zone01 pc.

Otherwise you cannot logout and will get this:

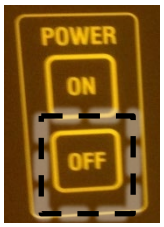
- Admin pc status : Red: Blocked
- Admin pc status : Yellow: Process End

15. [rare/skip]:System shutdown

You do not need to shut the system down.

There is a timer which turns off the CIC (lamp controller) at 19h00 (plus some minutes safety margin). This simple measure distributes the practical lamp life of 1000h over not just 42 days [worst case: always on ((7d/7d)x24h)] but over 117 days [worst case: on from Monday through Friday 7-19h, ((5d/7d)x12h)].

If you are the last user of the day, then turn off the CIC by pushing the “POWER OFF” button. The following user will have to wait 15min (cooldown), then 10min for restart, so use only if certain.



16. [rare/skip]:Machine name

The mask aligner is a third generation Suss MA8 machine body with tooling for 6 inch wafers. There are versions of the machines which are tooled for bond alignment (BA), but not this one. Therefore you will see through documentation and software referring to various present or absent features of the product line.

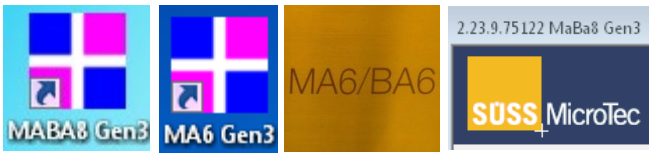


Fig 36: naming inconsistency

The software icon says MABA8 Gen3, the imprint on the machine body MA6/BA6 (both changed to MA6 Gen3), the machine type MA6BA6Gen3, the Suss Product MA8BA8Gen3, the purchase order confirmation MA6Gen3 mask aligner.

Keep a flexible mind. We have a third generation mask aligner, tooled for 6 inch wafers, without BA, call it MA6Gen3.

CMi has a second MA6 type machine, the **MABA6** in zone 06, which is a second generation machine, equipped for bonding alignment, don't interchange the names.

This guide is excessively detailed, so that you can get on your feet without any assistance. It is a prerequisite guide for other MA6Gen3 related documentation.

17. Known Issues: Rubber lip pressure alarm

Running, in mask aligner mode, with the contact mode "Vacuum contact", after doing WEC, the error message says:

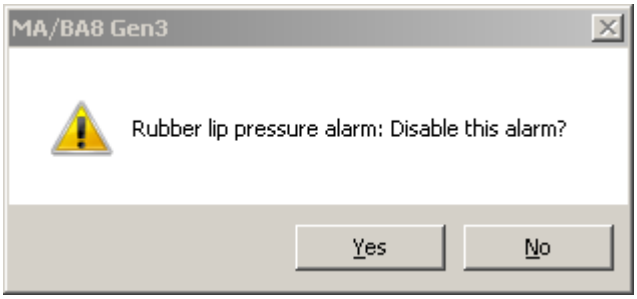
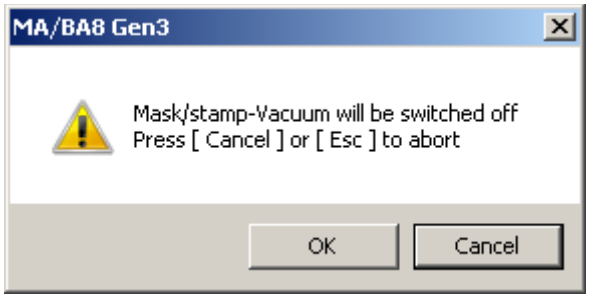


Figure 37: Rubber lip pressure alarm.

The first interpretation is that "rubber lip pressure alarm" means there is a leak at the rubber lip. Unfortunately, it is not straightforward. What it means is that the "seal pressure", i.e. the pressure difference across the vacuum ring rubber lip of the chuck, is not in the range of the set points, which for the "seal pressure" gauge are set to P1L=5kPa , P1H=15kPa.
So I increase the "**seal pressure**" knob until you read **10kPa** on the gauge, and the vacuum contact exposure will produce no more this error.

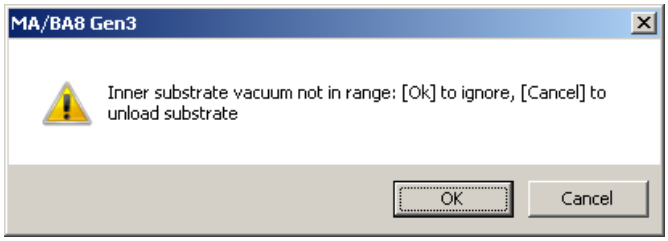
18. Known Issues: Warning: Mask Vacuum will be switched off

When unloading mask, in case you have the mask holder still inside. Remeniscent from the time of bottom loading mask, where this would cause the mask falling down on the chuck..

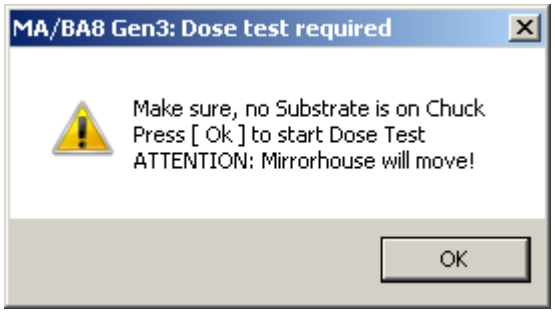


19. Known Issues: Warning: Inner substrate vacuum not in range

Not regular, only for Vacuum contact mode.



20. Known Issues: No substrate on chuck during dose test.



The machine needs to calibrate its dose-power. Warmning, this does about 200s of time maximum, so if the expected dose is higher than what the dose test could cumulate as energy during the dose test, the machine will aimlessly hang there with the shutter.

21. Known Issue: ZAxis movement stopped when WEC sensor was triggered

This issue has been fixed with by software, and now a question will be asked before going into cardiac arrest. If that does not work, then follow these instructions:

Remove the chuck from chuck holder.

The chuck holder must be empty as fig below.

Do not select a machine mode if a chuck is inserted in the chuck holder.

NB: the mask holder frame and the mask holder can be left inserted.

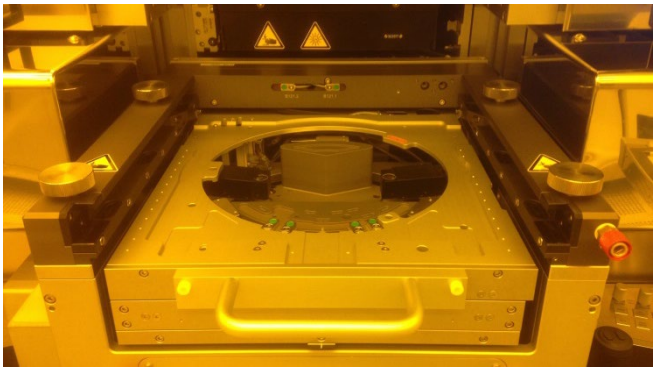


Fig 38: MA6Gen3 with no mask holder loaded, no chuck loaded

Nota bene: If you have a chuck inserted, and select a machine mode, then the machine initializes that machine mode, but it will set the last used recipe for the mode. At no point you are able to change anything in the recipe. If you read on the gauge that WEC pressure is set to e.g. 22kPa, and the recipe expects a higher value e.g. 66kPa, then the machine will initialize its Z-axis and create an error as follows:

Fig 39: Error message: “ZAxis movement stopped when WEC sensor was triggered”

If you get this error, then increase the “WEC pressure” up to 100kPa then “Retry”. Then higher, and retry. Sometimes, there is no escape of this error in the machine state, except by turning off the software, removing the chuck, and restarting everything. This may lead, and has already twice led, to the corruption of the recipe database. Bad perspectives. Avoid, call staff.

22. Known Issues

This is the end of the document.

Be safe, work safely.

Fig 40: Always wear your safety goggles.