

# 1. OPERATION OF THE MACHINE

The SUSS MA6 Mask Aligner is designed for high resolution photolithography in a laboratory for development, small volume production or pilot production environment.

It offers unsurpassed flexibility in the handling of irregularly shaped substrates of varying thickness, as well as standard size wafers up to 150 mm in diameter and substrates up to 6"x 6".

Wafers and substrates up to 6 mm thickness may be processed.

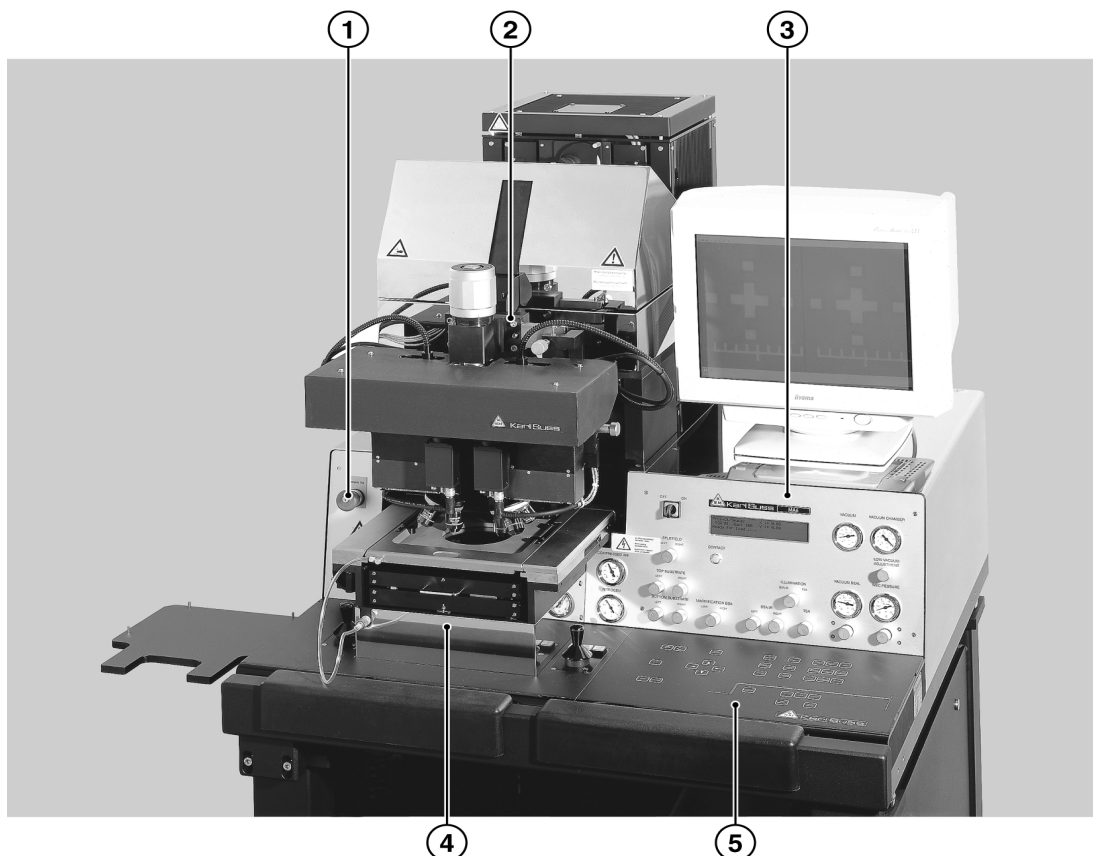
With the modular concept, the MA6 enable easy service. The functional groups are easily accessible and the subassemblies can be quickly exchanged. The SUSS MA6 represents a new generation of state of the art mask aligners, combining time proven features with newly developed technology for

mask aligning wafers, substrates and fractions of it. Based on the proven world wide leader in it's lithography application for more then three decades the SUSS MJB3.

With the SUSS MA6, all contact exposure programs are supplied (vacuum, hard, soft contact and proximity). X- and Y-shift are below 0.1  $\mu\text{m}$  and not detectable by optical means.

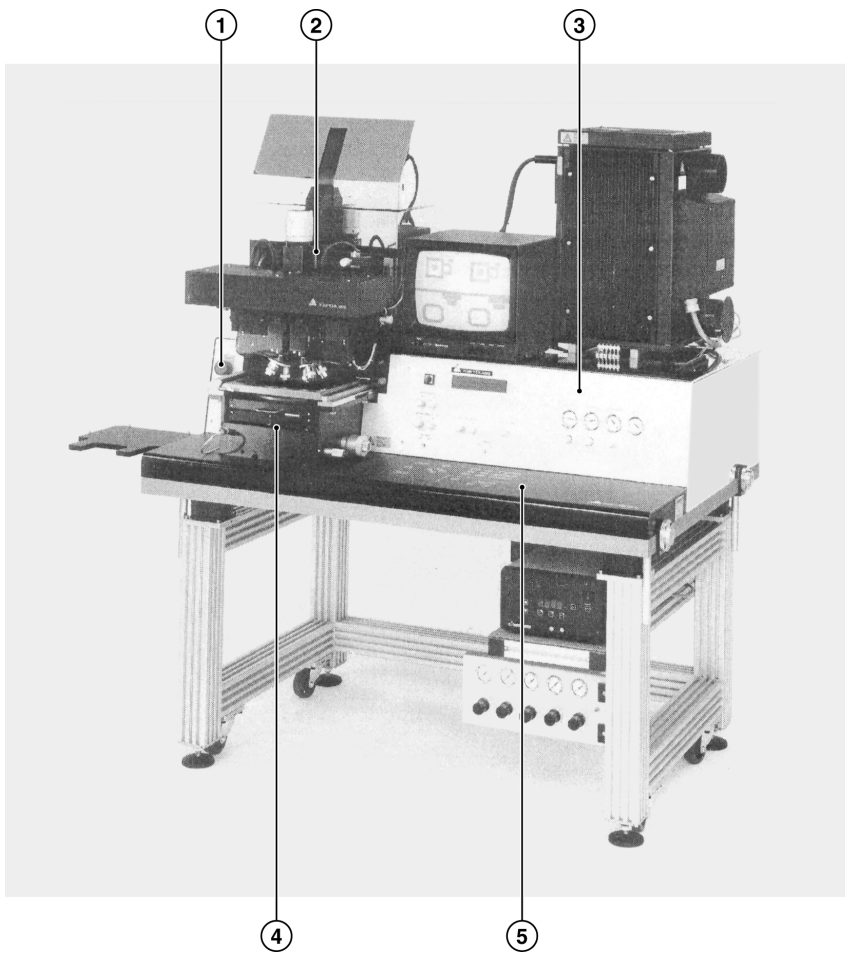
The 400 nm exposure wavelength version is capable of 0.6  $\mu\text{m}$  resolution in vacuum contact. Using 300 nm or 250 nm exposure optics or an excimer laser improves resolution to 0.2  $\mu\text{m}$ .

Various alignment options are available. Top side alignment with a splitfield or a video microscope. Back side alignment with BSA scopes as well as several infrared alignment solutions.



SUSS Mask Aligner MA6

- |                       |                   |
|-----------------------|-------------------|
| 1 EMERGENCY POWER OFF | 4 Alignment stage |
| 2 TSA microscope      | 5 Keyboard        |
| 3 Upper panel control |                   |



SUSS Mask Aligner MA8

- 1 EMERGENCY POWER OFF
- 2 TSA microscope
- 3 Front panel
- 4 Alignment stage
- 5 Keyboard

## 1.1. Definitions

### 1.1.1. How to Use this Manual

Start to reading this manual, some rules are applicable. The name of a control function or control indicator is written in capitals. For example:

#### **EDIT PROGRAM**

Refers to the key named edit program. Words shown in the display are included in quotation marks. For example:

**"move slide into machine and confirm  
with ENTER"**

A warning for the operator of the machine is written cursive. For example:

**Watch out for the microscope movement!**

Every operator control function and display is referred by a number. The first digit of this is equal to the figure number showing it. For example:

#### **204. VACUUM gauge**

This means that the element labeled VACUUM is a gauge explained as item 4 and is displayed in figure 2. This documentation is for using the machine as a mask aligner. The term TOP SUBSTRATE (on which is the upper focus plane) represents the upper substrate during bond alignment and a mask during lithography. The term BOTTOM SUBSTRATE (on which is the lower focus plane) is replaced in the text by the word wafer for bondalignment and lithography.

### 1.1.2. Key LED's

Each key of the keyboard except the ARROW keys is equipped with a light emitting diode, indicating the following:

- LED on:  
key selected or function active
- LED off:  
key not selected or function deactivated
- LED flashing:  
most applicable key to continue

### 1.1.3. Coordinate Systems

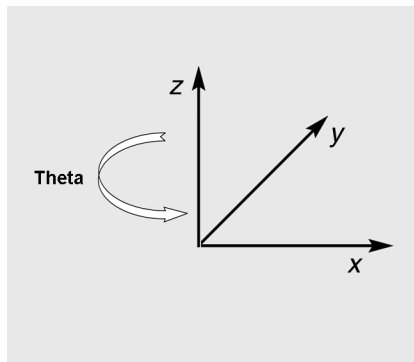
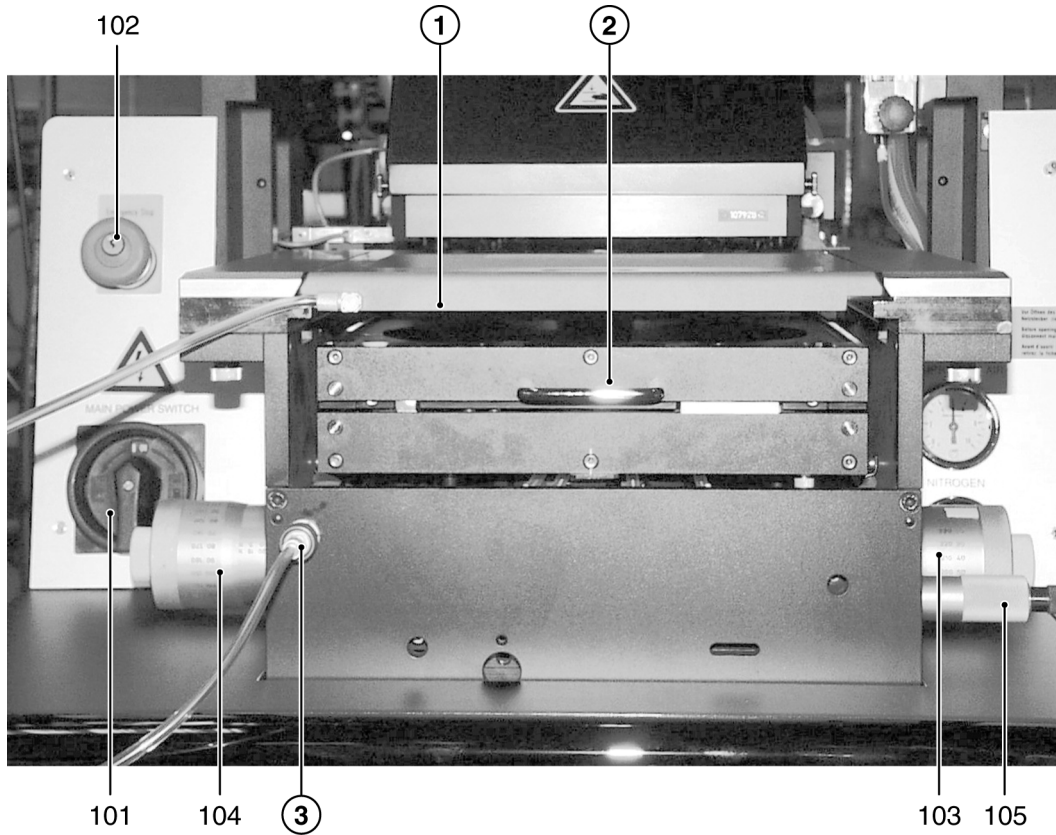
The length units for the x and y-direction are in millimeter. The z-direction length unit is  $\mu\text{m}$ . They refer to

a coordinate system whose origin is in the center of the alignment stage unit. The origin of the z-axis is equal to the mask plane or upper substrate plane (see

# 1

## OPERATION OF THE MACHINE

Figure 1)



Alignment Stage with Coordinate System

- 101 MAIN POWER switch
- 102 EMERGENCY POWER OFF key
- 103 Knob STG-X-MOVEMENT
- 104 Knob STG-Y-MOVEMENT
- 105 Knob STG- $\theta$ -MOVEMENT

- 1 Mask holder
- 2 Transport slide
- 3 Snap in connector mask vacuum

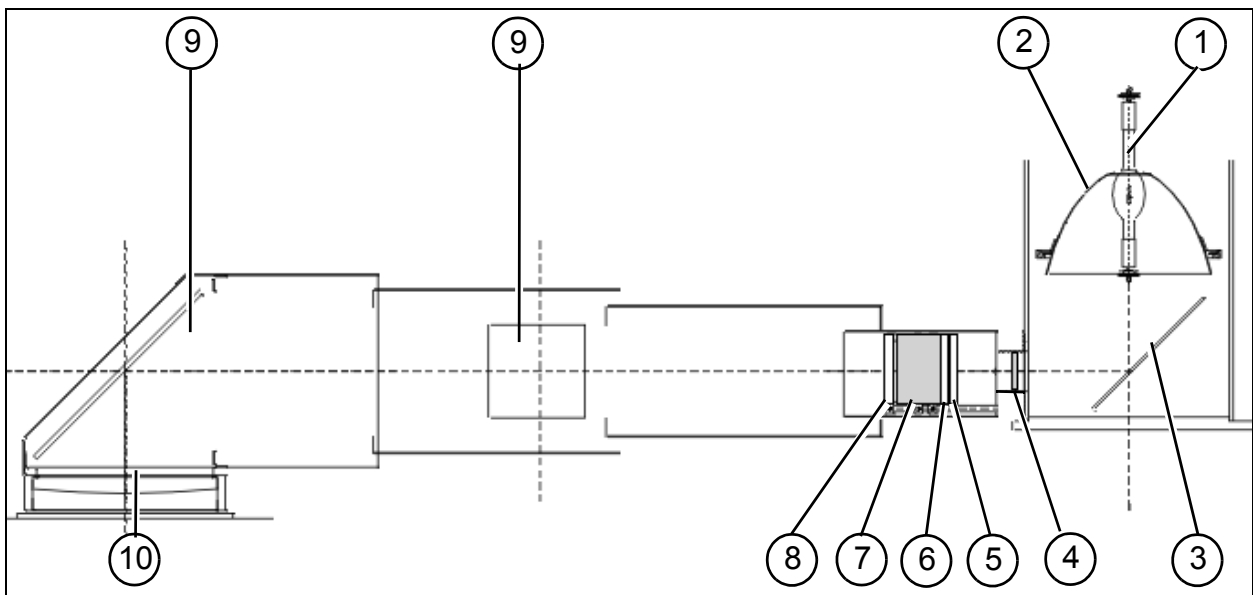
### 1.1.4. Components of the Exposure Optics

The components of the optical system are depending on the used lamp house system.

The UV400, UV300, and UV250, exposure optics are similar in design. The optical system consists of an exposure lamp, ellipsoidal mirror, cold light mirror fly's eye lens, condenser lenses, lens plates, turning mirrors and a front lens as shown in the adjacent figure.

The following lamp houses are available:

- LH350
- LH1500/1000
- LH5000



Exposure Optics MA 8 with LH1000

- 1 Exposure Lamp
- 2 Ellipsoidal Mirror
- 3 Cold Light Mirror
- 4 Fly's Eye Lens or Glass Window
- 5 Condenser Lens

- 7 Integrator Block
- 8 Field Lens
- 9 Turning Mirror
- 10 Front Lens



#### Warning!

UV light can harm eyes and skin.

Work on optical components should be done with the exposure lamp switched off, or at least with closed lamp house shutter. If lighting is essential for adjustment purposes, wear UV protecting goggles and skin protection.



#### Essential Note!

Accurate arrangement of optical components is essential for the quality of exposure.

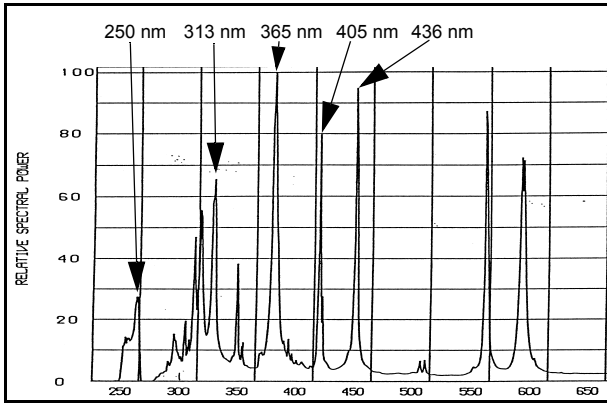
Modify positions or components only if trained for this job, and when the appropriate adjustment procedure is available.

Also orientation of lenses and the cold light mirror must not be changed.

6 Filter, optional

### 1.1.4.1. Exposure Lamp

For the UV400 and UV300 exposure optics, the standard exposure lamp is a 1000 W high pressure mercury short-arc lamp in the LH1000.



### 1.1.4.2. Ellipsoidal Mirror

The exposure lamp is mounted inside an ellipsoidal mirror in a way that the light source is exactly at its first focal point. This mirror collects the radiation emitted by the lamp and focusses it to the second focal point. The ellipsoidal mirror can be the same for all exposure optics. But very high reflection is available for standard UV400.

### 1.1.4.3. Cold Light Mirror

The cold light mirror splits the lamp radiation in the not needed long wavelengths and the exposure light. The long wavelengths pass through the mirror and are absorbed by a heat sink. The exposure light (cold light) is reflected 90° to the integrator optics. A selective coating determines the reflected wavelengths. This application range (e.g. UV400) is marked on the mirror as well as the coated face (by the tip of an arrow at the edge).

Because of the selective coating at least the cold light mirror has to be exchanged when changing the light application range.



#### Warning!

**Mirror exchange must be done only by trained personnel, who understand all the risks associated with lamp replacement!**

### 1.1.4.4. Fly's Eye Lens

This lens disperses the light and directs it to the condenser lens. The fly's eye lens is made of optical grade fused silica for all optical systems. Alternatively for more intensity but with less unifor-

mity in the exposure area, a glass window (same material) is available.

### 1.1.4.5. Condenser Lens

The condenser lens collimates the exposure light. The position of this lens in the mirror house tube affects the intensity and uniformity of the exposure light. A scale is mounted along the optical bench inside the house tube. The position of the condenser lens depends on the type of exposure optics. The condenser lens is made of optical grade fused silica.

### 1.1.4.6. Filters

The filter is located between the condenser lens and the integrator block. Filters are used to select more specific the exposure wavelength than the cold light mirror can do it or reduce the intensity (broad band intensity filter). All filters are made of quartz glass.

### 1.1.4.7. Integrator Block

The integrator block has two lens plates with an exactly defined distance to each other. For a good uniformity, each single light channel is super positioned at the exposure plane. The material of the lenses is optical grade fused silica.

### 1.1.4.8. Field Lens

For best uniformity and a maximum of intensity of the exposure light, the field lens overlays each light channel of the integrator in the exposure plane on each other. The material of the lens is optical grade fused silica.

### 1.1.4.9. Turning Mirror

It deflects the exposure beam to the exposure area. The coated side of the mirror has to face the beam. Mirrors with dielectric coating are marked with the application range and a sign for the coated surface. Metallized mirrors are broad band mirrors, but not optimized to spectral areas.

### 1.1.4.10. Front Lens

This lens provides collimation and uniformity of the exposure beam. The lens is specific for each wavelength range. For the UV 400 exposure optics the front lens is fabricated of optical crown glass. UV300 requires quartz glass.

### 1.1.4.11. Cleaning of Optical Parts

Optical Components can degrade with time by deposition of particles or fumes.

In this case they must be removed from the machine and cleaned very carefully, in order to reconstitute the original quality of the machine.

Optical surfaces are polished and/ or coated. Because of this they are extremely susceptible to mechanical damage. For cleaning they must not be wiped, but only rinsed with liquid solvent.

No other solvent than DI-water (with or without mild detergent) or IPA (Isopropyl alcohol) shall be used. The choice between those depends on the character of contamination. The final cleaning step should always use clear DI. If there is any doubt about the adequate cleaning procedure call SUSS service.

See also instructions in the Maintenance chapter and in the Preventive Maintenance Manual.



#### Caution!

**To avoid damage on optical components, use only recommended solvent and do not wipe.**

**Place the part back to the identical position in the exposure optics system as before**



#### Warning!

**When using IPO protect your skin against contact with the solvent.**

**IPO is flammable, use it only away from any ignition source. Do not spill IPO.**

**Used IPO and tissues soaked with IPO must be deposited as flammable waste following local regulations.**

For details refer to the host interface documentation delivered separately. This document describes the GEM compliant SECS-II interface for the mentioned equipment. It includes the information required by the SECS-II and GEM standards including the GEM State Models, SECS-II Message Documentation, and other interface details.

### 1.1.4.12. Deep UV Exposure

Short-wave UV-light (<315nm) has a high biological radiation effectiveness and recommended maximum dose for skin and eye exposure is very low.

Extended work in front of a laboratory mask aligner at UV250 or UV300 optics can result in exceeding the dose limit. Therefore it is recommended not to look to the stray light, exiting from the mask stage during exposure and to keep unprotected hands away from the stage during exposure.



#### Warning!

**When using UV250 or UV300 then minimize eye-and skin- exposure from UV stray light by increasing your distance to the stage during exposure times.**

**SUSS MicroTec could also provide a special stray light barrier to be placed on top of the mask holder frame.**



Picture shows special cover for deep-UV exposures

## 1.2. Controls and Indicators

### 101 MAIN POWER switch

This connects the machine to the public power station for electricity.

### 102 EMERGENCY POWER OFF key

In any case of danger press this button to disconnect the machine from the public power line.

## 1.2.1. Alignment Stage Controls

### 103 Knob STG-X-MOVEMENT

This is located at the right side of the alignment stage and moves the wafer in x-direction. Maximal travel  $\pm 10\text{mm}$ .

### 104 Knob STG-Y-MOVEMENT

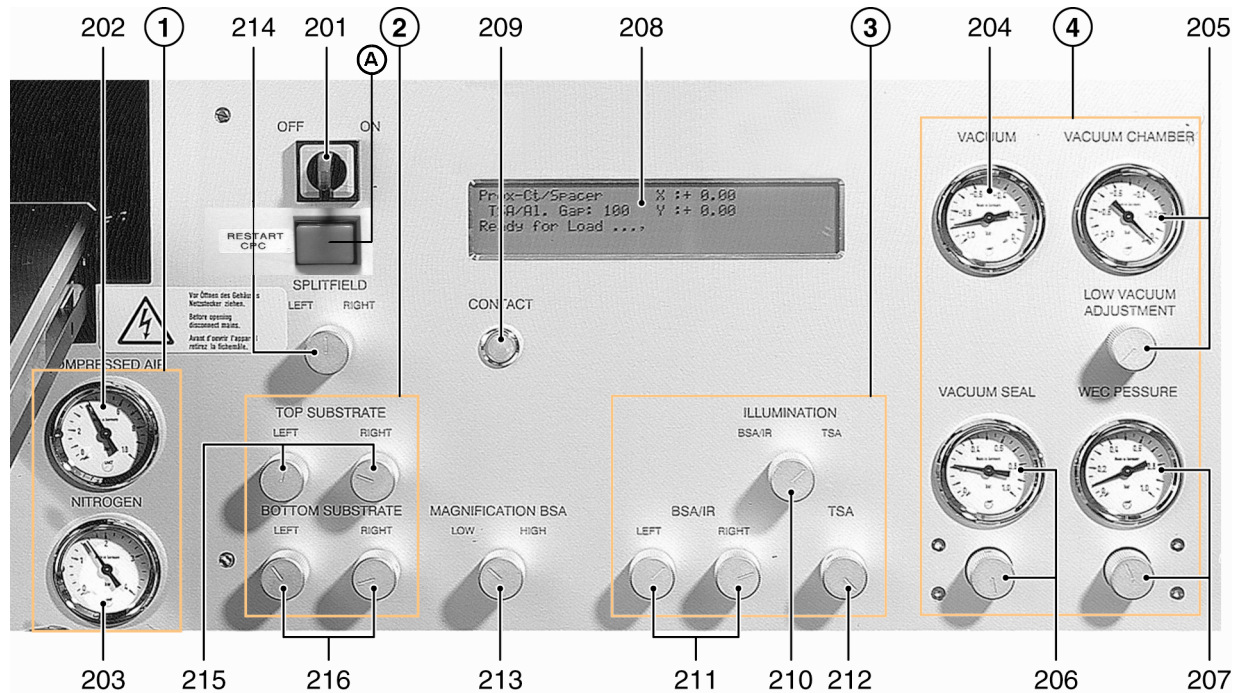
This is located at the left side of the alignment stage and moves the wafer in y-direction. Maximal travel  $\pm 5\text{mm}$ .

### 105 Knob STG- $\Theta$ -MOVEMENT

This is the small knob at the right side of the alignment stage. Maximal travel  $\pm 5^\circ$ .



## 1.2.2. Front Panel Controls



Front panel

### Note

Controls of MA8 Front Panel are identical except their position.

- |     |                                       |     |                                |
|-----|---------------------------------------|-----|--------------------------------|
| 201 | POWER SWITCH ELECTRONIC               | 3   | Illumination                   |
| 1   | Pressure                              | 210 | ILLUMINATION switch            |
| 202 | COMPRESSED AIR gauge                  | 211 | BSA/IR microscope illumination |
| 203 | NITROGEN gauge                        | 212 | TSA microscope illumination    |
|     |                                       | 213 | MAGNIFICATION BSA switch       |
| 4   | Vacuum                                | 214 | SPLITFIELD switch              |
| 204 | VACUUM gauge                          | 2   | Substrate                      |
| 205 | VACUUM CHAMBER gauge (with regulator) | 215 | TOP SUBSTRATE LEFT/RIGHT       |
| 206 | VACUUM SEAL (with regulator)          | 216 | BOTTOM SUBSTRATE LEFT/RIGHT    |
| 207 | WEC - PRESSURE gauge (with regulator) |     |                                |
| 208 | LCD-display                           | 322 | BSA MICROSCOPE key             |
| 209 | CONTACT indicator                     | 323 | LEFT key                       |
|     |                                       | 324 | BOTH key                       |
|     |                                       | 325 | RIGHT key                      |
|     |                                       | 326 | TOP/BOTTOM key                 |
|     |                                       | A   | Button RESTART CPC (optional)  |

**201 POWER SWITCH ELECTRONIC**

Start the MA6 by turning the switch shortly clockwise to ON and release. Stop the MA6 also by turning the switch shortly clockwise to OFF and release.

**202 COMPRESSED AIR gauge**

The machine operates properly when the pressure is set to 5 bar. The air pressure is controlled by a regulator adjusted by a service engineer.

**203 NITROGEN gauge**

N<sub>2</sub> gas is used to cool the exposure lamp, establish a nitrogen "pillow" under the wafer (hard contact exposure), purge the wafer exposure area, and to break residual vacuum after vacuum contact and other secondary functions. At 1 bar N<sub>2</sub> (adjusted by a service engineer) the machine operates properly.

**204 VACUUM gauge**

The vacuum supplied to the machine should be -0.8 bar related to normal air pressure what means 0.2 bar absolute pressure.

**205 VACUUM CHAMBER gauge  
(with regulator)**

The gauge indicates the vacuum level in the vacuum chamber during exposure. The vacuum level is adjusted opening a N<sub>2</sub> leak valve. Open the vacuum restrictor LOW VACUUM ADJUSTMENT below the gauge counter clockwise. Close it by turning the knob clockwise.

**206 VACUUM SEAL (with regulator)**

The required pressure to inflate the rubber lip (necessary to create the vacuum chamber) should be set to a value  $p = 0.1$  to 0.2 bar for standard thickness wafer according SEMI specification. Thicker wafer might need a slightly higher pressure. A improper high pressure could create an overcurrent error.

**207 WEC - PRESSURE gauge (with regulator)**

To perform the wedge error compensation the wafer must be pressed with a defined force against the mask. The WEC-pressure is used to compensate the higher gravitation force of a bigger chuck. The WEC-pressure also must be changed proportional to a change of the wafer area. The air pressure for the WEC-head can be set in accordance with your process requirements (range 0.2 and 1.0 bar). This is

done with the corresponding regulator below the gauge.

**208 LCD-display**

This user interface displays instructions, confirmations and other messages.

**209 CONTACT indicator**

That lamp lights whenever mask and wafer or two wafers for bond alignment are in contact. If you move the wafer manually further up, this indicator starts flashing.

**210 ILLUMINATION switch**

The illumination is supplied either to the TSA or BSA microscope by way of fiber optic light cables from a light source. BSA illumination is selected in the BSA/IR position.

**211 BSA/IR microscope illumination**

The potentiometers labeled LEFT and RIGHT realize the fine illumination adjustment for the two objectives of the BSA microscope (BSA/IR is selected).

**212 TSA microscope illumination**

The fine illumination adjustment is performed with the TSA adjustment knob. For the coarse adjustment use control 501 (see chapter 3.2.5 Lamp house controls).

**213 MAGNIFICATION BSA switch**

Select between low and high magnification.

**214 SPLITFIELD switch**

With the rotary switch in middle position, the left/right objective image is shown on the left/right half side of the video monitor simultaneously. With the switch in right or left position, the right/left objective image is displayed on the whole video monitor. Only for the microscope type M3xx this switch must be in left position and the splitfield must be selected at the microscope itself.

**215 TOP SUBSTRATE LEFT/RIGHT**

In order to improve the image of the mask structures displayed on the video monitor only minor focus adjustments are necessary. The two potentiometers individually control the fine focus of the BSA and TSA microscope objectives at the upper focus plane.

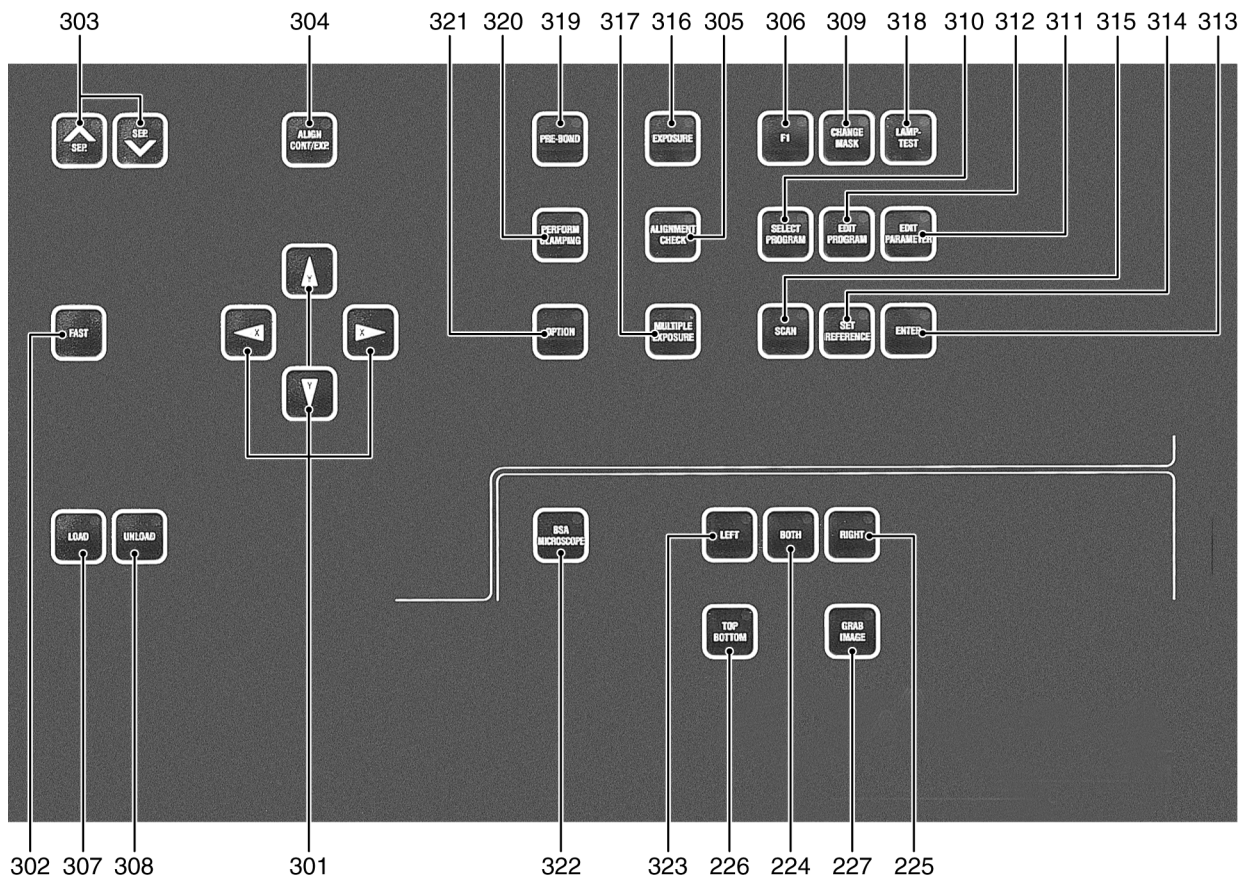
## 216 BOTTOM SUBSTRATE LEFT/RIGHT

In order to improve the image of the wafer structures displayed on the video monitor only minor focus adjustments are necessary. The two potentiometers individually control the fine focus of the BSA and TSA microscope objectives at the lower focus plane.

### A RESTART CPC (optional)

To activate the N<sub>2</sub>- Interlock and to delete the „N<sub>2</sub>-Loss“ message after Switch-off with emergency OFF button or Main switch.

### 1.2.3. Keyboard Controls



#### Keyboard

301	X, Y-ARROW keys	315	SCAN key
302	FAST key	316	EXPOSURE key
303	SEP keys	317	Multiple Exposure key
304	ALIGN CONT/EXP key	318	LAMP TEST key
305	ALIGNMENT CHECK key	319	PRE-BOND key
306	F1 key	320	PERFORM CLAMPING key
307	LOAD key	321	OPTION key
308	UNLOAD key	322	BSA MICROSCOPE key
309	CHANGE MASK key	323	LEFT key
310	SELECT PROGRAM key	324	BOTH key
311	EDIT PARAMETER key	325	RIGHT key
312	EDIT PROGRAM key	326	TOP/BOTTOM key
313	ENTER key	327	GRAB IMAGE key
314	SET REFERENCE key		

### 301 X, Y-ARROW keys

The function of these keys depends on the task performed:

- movement of the upper microscope (TSA)
- movement of the lower microscope(BSA)
- movement of the wafer (only motorized stage) (STG)
- selection of next/last parameter in the control software (X-arrows)
- change of parameter values (Y-arrows)

Arrow keys marked with X are labeled with an triangle pointing to the right/left. To move the manipulators along the X-axis press one of this keys. Arrow keys marked with Y are labeled with an triangle pointing upward/downward. To move the manipulators along the Y-axis press one of this keys. In case the manipulator reaches one/both limit positions along the X-and/or Y-axis, the message on the monitor indicates:

**"HW or SW limits active - use ARROW keys"**

to move back into regular range use the key for the opposite direction.

### 302 FAST key

Activating this key (LED is ON) enables the movement of the microscope manipulator and motorized stage if existing into the desired direction with the fast speed (otherwise the movement is performed with the slow speed). The speed level can be adjusted with function F1 - change align speed (see explanations to key F1).

### 303 SEP keys

The keys are labeled with an arrow pointing upward and downward and marked with SEP (separation). With these keys the alignment position of the wafer can be changed in steps of 1  $\mu\text{m}$  along the z-axis. The keys are active after WEC. Moving to mask contact the CONTACT indicator lights on. Further moving the wafer up this indicator flashes.



**If mask and wafer are in contact (CONTACT INDICATOR on), don't align the wafer!**

### 304 ALIGN CONT/EXP key

Acts as a toggle switch. The operator can quickly change the position of the wafer between alignment gap and exposure position relative to the mask.



**If mask and wafer are in contact (CONTACT INDICATOR on), don't align the wafer!**

### 305 ALIGNMENT CHECK key

With this key one can check the alignment prior exposure. Particles between mask and wafer or the edge bead can affect the alignment of the wafer to the mask. To test that the alignment remains stable while moving to exposure position, all parameters of the exposure program are triggered except the exposure itself. This key is active for the exposure programs: Vacuum Contact, Low Vacuum Contact, and Hard Contact. For example: starting the exposure program "Vacuum Contact" triggers the pneumatic procedures:

Pre Vac and Full Vac:

To check the possible influence of these unexpected factors before exposure, press the ALIGNMENT CHECK key. Press this key again to release the wafer back into alignment gap.



**If mask and wafer are in contact (CONTACT INDICATOR on), don't align the wafer!**

### 306 F1 key

If one wishes to leave the variable unchanged, simply press the flashing F1 key.

The different functions of F1 key are:

- Microscope up/down  
During loading, aligning and exposure the microscope does all necessary up and down movements automatically. For a better view to mask and wafer this is manually possible by using the F1 key.
- Change alignment speed  
The user can select between slow and fast alignment speed by the FAST key. The speed selected by the FAST key (fast or slow) will be displayed here. Select the desired alignment speed for the microscopes and motorized stage (if existing). The Y-ARROW keys change the parameter value, the X-ARROW keys toggle between the TSA, BSA and STG parameter. Pressing the FAST key enables the adjustment of the other speed parameter (see

## OPERATION OF THE MACHINE

also 3.5.4 Changing the TSA, BSA and stage alignment speed).

- Single step config  
Define the step width for the alignment stage movement per each depression of a arrow key.
- Centering stage  
For every WEC procedure the alignment stage move to the center position for x, y and  $\Theta$ . Centering stage on (default) means, the wafer goes to alignment gap keeping this center position. Centering stage off means, the alignment stage move to the X-, Y- and  $\Theta$ -position used during the previous alignment at time of EXPOSURE key activation. In case a prior saved program contains this position values, it will be activated.
- Select maskloading  
The two options for the loading process are:
  - load manually (default)
  - load by slide

For Load by slide it's possible to select between:

- without alignment of the mask (no align)
- with BSA alignment of the mask (BSA align)

Both loading procedures are described separately (see chapters 3.3.2 First mask print mode and 3.5.8 Load mask by slide).

- Scope synchron.  
Infrared light is used to look through Wafer which are opaque for visible light. The light is locally supplied using the BSA microscope arms. The TSA microscope is used as a transmitted light microscope. Synchronous movement of TSA and BSA microscope is necessary. To enable this, deactivate the BSA MICROSCOPE key. Switch the ILLUMINATION switch (210) to BSR/IR and (if existing) the IR switch on. Adjust the TSA-objectives by the OBJECTIVE X-SEPARATION knobs (405) to the location of the IR-light supply. The synchronous scope movement is only possible by the arrow keys.
- Single BSA al.  
Use this special function to align substrates which alignment mark distance is smaller then the minimum distance of the BSA objectives. For this case use only one objective in connection with the SET REFERENCE key and SCAN key. For detailed instructions read chapter 3.3.5.
- WEC-delay

A large wafer needs longer time to set itself exactly parallel to the mask. This is necessary to get high quality mask prints of small structures over the whole wafer. The necessary time must be tested and set by the operator.

### 307 LOAD key

After the machine has been powered on, the LED of the LOAD key is flashing. Hit the LOAD key to finalize the boot procedure.

Press the LOAD key to start the wafer loading procedure.

### 308 UNLOAD key

If one wishes to unload the wafer, press this key. This key also terminates some working sequences. Pressing UNLOAD after starting the exposure cycle the exposure sequence will be completed without exposure itself.

### 309 CHANGE MASK key

Starting from the initial screen the operator initiates the procedure for changing (loading/unloading) of the mask.



**Unload the mask before powering off the machine!**

### 310 SELECT PROGRAM key

Select one of the six exposure programs of the machine (see also chapter 3.5.2).

### 311 EDIT PARAMETER key

After the desired exposure program has been selected, press the EDIT PARAMETER key. Edit the parameter of the exposure program. The parameter is changed with the corresponding Y-directional arrow key. The next parameter is selected by the X-directional arrow key. The number of parameters depends on the selected exposure program (see also chapter 3.5.3).

### 312 EDIT PROGRAM key

This key enables the operator to assign all parameter settings and the microscope position to a program number ranging from [0] to [99]. This number helps to keep all settings in the nonvolatile memory (see also chapter 3.5.5):

- save  
after exposure program selection and the parameter adjustment, press the EDIT PROGRAM key and toggle to "save" using the x-ARROW keys. Assign a program number using the y-ARROW-keys. Press ENTER key to save it. A former saved program to this number will be overwritten.
- load  
press the EDIT PROGRAM key and toggle to "load". Select a program number to load a former saved program. Press ENTER key to load it.
- delete  
press the EDIT PROGRAM key and toggle to "delete". Select a program number to delete. Delete the displayed program.

### 313 ENTER key

Press the ENTER key to confirm an action whenever the program prompts you to do so.

### 314 SET REFERENCE key

The SET REFERENCE key enables the operator to store the actual microscope position of the TSA or BSA microscope as reference position. This is necessary for the SCAN key function. This can be used also for the alignment stage.

### 315 SCAN key

This key can be used only after a reference position for the selected microscope with the SET REFERENCE key is stored (i.e. the position for the first alignment mark). Then the microscope can be moved to a new position (i.e. the position for the second alignment mark). Activating the SCAN key toggle the position of the microscope between the current position and the reference position. This can be used also for the alignment stage.

### 316 EXPOSURE key

This key starts the active exposure program after an alignment or in first mask print mode.

### 317 Multiple Exposure key

It is possible to split the exposure in several intervals. The key must be activated for this (LED on). See also chapter 3.4.2.

### 318 LAMP TEST key

Pressing this key moves the mirror house forward and opens the light shutter. Exposure intensity and uniformity adjustment is possible. Deactivating this key finishes this task.

From software version 5.030 the LAMP TEST key offers the additional option „Change Filter“. After pressing the OPTION key the mirror house moves forward to give access to the lenses and filters within the optical tube without opening the shutter.

### 319 PRE-BOND key

Enabled only in the bond-aligner-mode: this moves the wafers together and the vacuum sequence starts.

### 320 PERFORM CLAMPING key

Enabled only in the bond-aligner-mode: this clamps the wafers together with or without spacers.

### 321 OPTION key

The X-ARROW keys controls the  $\Theta$ -movement for the motorized alignment stage when OPTION key is activated.

### 322 BSA MICROSCOPE key

Toggles the motor control and image processing between TSA (LED off) and BSA (LED on) microscopes.

### 323 LEFT key

For BSA alignment only the movement of the left objective is possible.

### 324 BOTH key

The simultaneous movement of both BSA-objectives is possible.

### 325 RIGHT key

For BSA alignment only the movement of the right objective is possible.

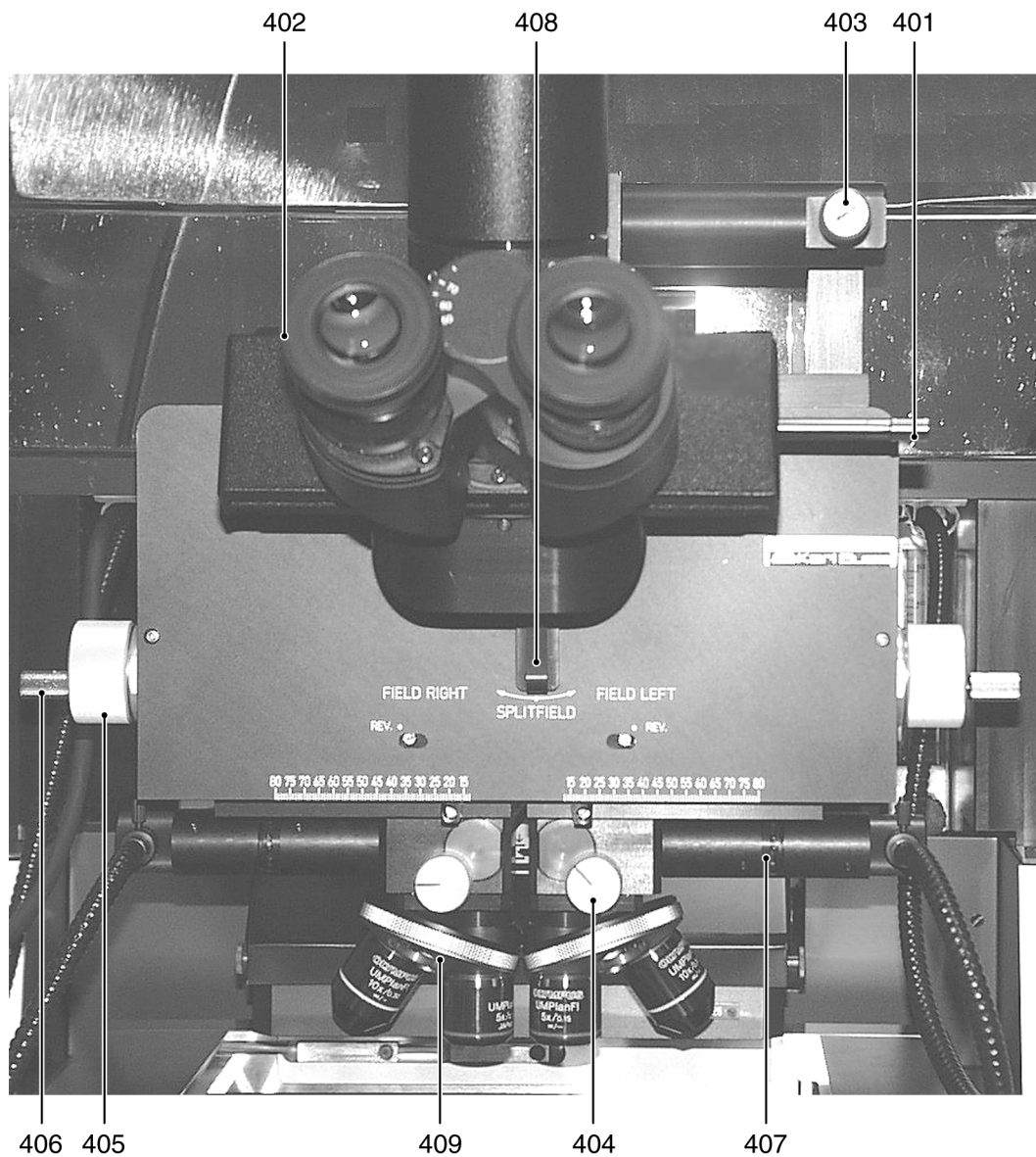
### 326 TOP/BOTTOM key

Toggle the focus plane between mask plane (LED on) and wafer plane.

### 327 GRAB IMAGE key

By activating this key the current monitor image is stored as background image to be superimposed with the wafer image later on.

## 1.2.4. TSA-Microscope Controls



TSA-Microscope M 336

- 401 BEAM SPLITTER TSA
- 402 TSA Z-MOVEMENT knob
- 403 TSA  $\Theta$ -MOVEMENT knob
- 404 OBJECTIVE FOCUS FINE MANUAL knob
- 405 OBJECTIVE X-SEPARATION knobs
- 406 CLAMPING SCREW
- 407 APERTURE TSA-Illumination
- 408 TSA SPLITFIELD switch
- 409 Turret



### 1.2.4.1. M 3xx Microscope

Before using the microscope make secure the TSA illumination (control 210) is on and the BSA MICROSCOPE key is off. Turn the SPLITFIELD switch (control 214) on the front panel to left to get the TSA image on the monitor.

Located on the microscope front this switch selects the left, right or both TSA-objective as source for the eyepieces and monitor image.

#### 409 Turret

Turn the knurled ring to move another objective in the beam.

#### 401 BEAM SPLITTER TSA

This slide on right side of the microscope tube guide the beam to the eyepieces, the monitor or both.

#### 402 TSA Z-MOVEMENT knob

The fine movement works at any position in a range less than on turn and with a low torque. Continuing rotation increases the torque and enables the coarse adjustment.

#### 403 TSA $\Theta$ -MOVEMENT knob

Rotates the microscopes around the z-axis by turning the knob located in the upper right TSA microscope front.

#### 404 OBJECTIVE FOCUS FINE MANUAL knob

For the M 3xx without motorized focus, fine focus of the left/right objective is possible by the left/right knobs only.

#### 405 OBJECTIVE X-SEPARATION knobs

The right/left objective can move independently in x-direction by the big knobs located in the right/left side of the TSA microscope body. Never turn this screw when the CLAMPING SCREW is fixed.

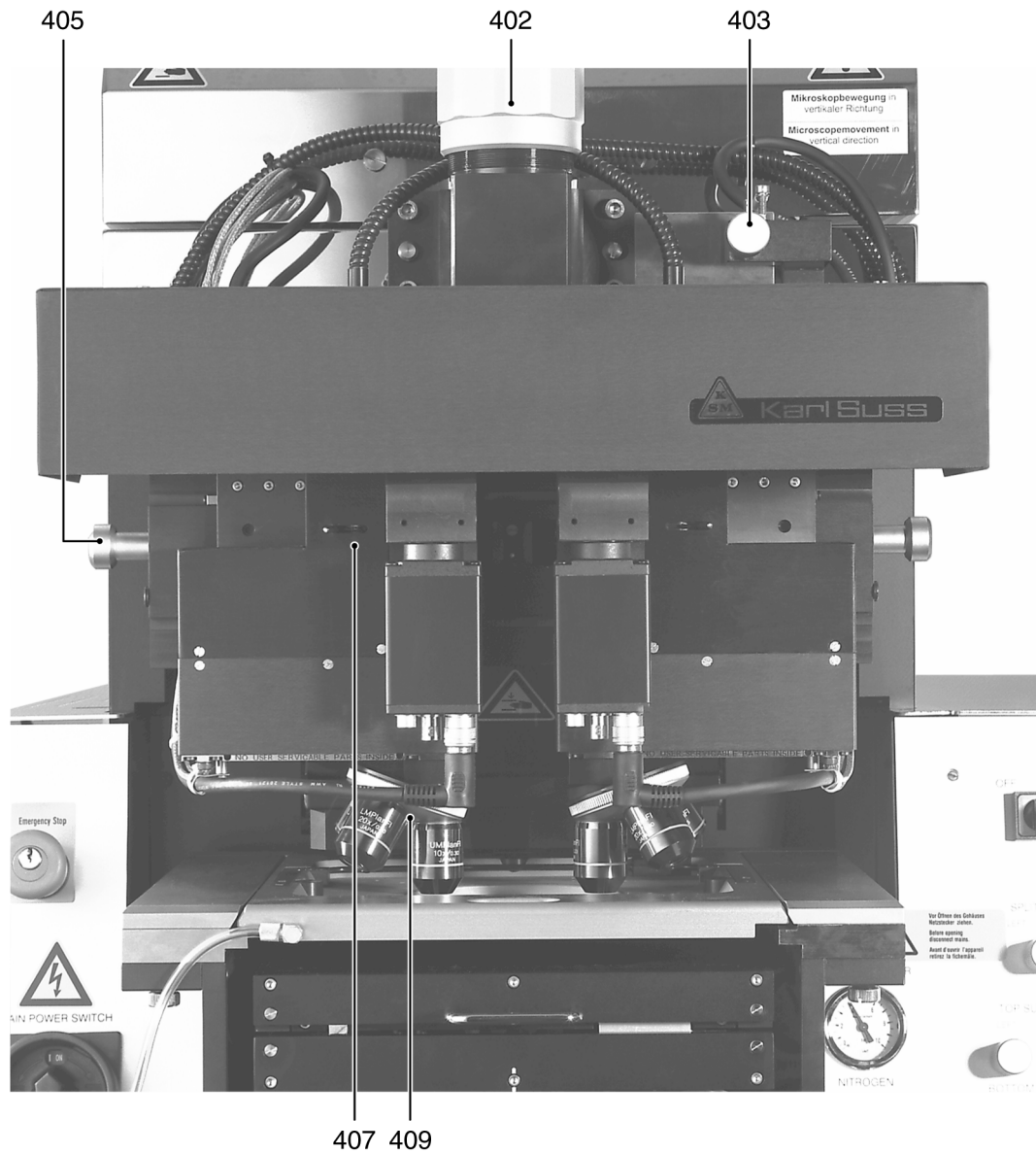
#### 406 CLAMPING SCREW

This has two functions. First it acts as a crank. Second it is used to clamp a certain objective position. Press that knob gentle toward the microscope body and turn clockwise. To release turn in the opposite direction until it snaps out.

#### 407 APERTURE TSA-Illumination

This right/left aperture at TSA-microscope front adjusts the illumination for the right/left TSA-objective separately.

#### 408 TSA SPLITFIELD switch



Dual Video Microscope DVM 6

- 402 TSA Z-MOVEMENT Knob
- 403 TSA  $\Theta$ -MOVEMENT knob
- 405 OBJECTIVE X-SEPARATION knobs
- 407 APERTURE TSA-Illumination
- 409 Turret

### 1.2.4.2. Dual Video Microscope DVM 6/8

Before using the microscope make sure the ILLUMINATION TSA (210) is on and the BSA MICROSCOPE key is off.

#### 401 BEAM SPLITTER TSA

On this microscope not necessary.

#### 402 TSA Z-MOVEMENT Knob

Turn this big knob to focus the microscope coarse.

#### 403 TSA $\Theta$ -MOVEMENT knob

Rotates the microscopes around the z-axis by turning the knob located in the upper right TSA microscope front.

#### 404 OBJECTIVE FOCUS FINE MANUAL knob

This is a motorized focus here.

#### 405 OBJECTIVE X-SEPARATION knobs

The right/left objective can move independently in x-direction by the big knobs located in the right/left side of the TSA microscope body.

#### 406 CLAMPING SCREW

Does not exist at this microscope.

#### 407 APERTURE TSA-Illumination

This right/left aperture at TSA-microscope front adjusts the illumination for the right/left TSA-objective separately.

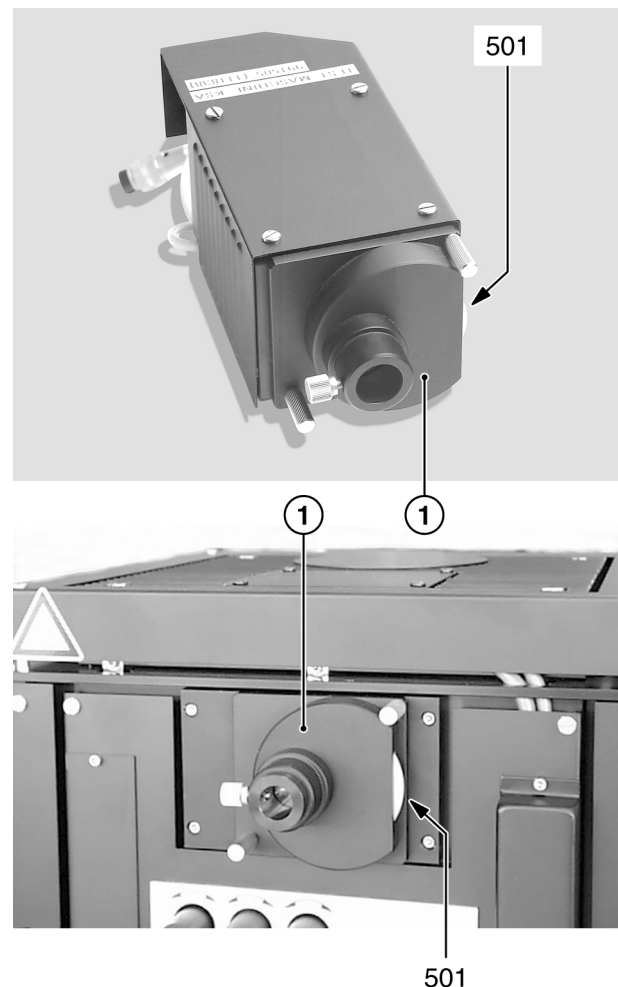
#### 408 TSA SPLITFIELD switch

This function is electronically realized. See the manual for the corresponding image processing system.

#### 409 Turret

Turn the knurled ring to move another objective into the beam.

### 1.2.5. Lamp House Controls



Lamp house LH 350 and LH 1000

501 Illumination adjustment coarse

1 Thumb wheel housing

#### 501 ILLUMINATION ADJUSTMENT COARSE

For a coarse adjustment of the light intensity turn the thumb wheel at the microscope light source. Turn clockwise / counterclockwise to open/close the aperture. The big thumb wheel ILLUMINATION ADJUSTMENT COARSE (501) has a diameter of nearly 5 cm, 0.5 cm thick.

For the lamphouse LH 350 find the adjustment wheel behind the lamp house. It might be necessary to remove the left stainless steel cover of the lamphouse to have access to the microscope illumination.

For the lamphouse LH 1000 find the adjustment wheel on the upper front side of the lamphouse. Lamp exchanging is possible opening the two knurled screws.

### 1.2.6. Joystick and Buttons

(motorized stage only)



Joystick keys

- 601 STG/TSA/BSA button
- 602 CONT/ALIGN/EXP button
- 603 SINGLE STEP button
- 604 X-Y-JOYSTICK

#### 601 STG/TSA/BSA button

- Illuminated:  
Joystick and arrow keys controls the alignment stage motors.
- Dark:  
Joystick and arrow keys control the TSA or BSA motors depending on the status of the BSA MICROSCOPE key (see 322).

#### 602 CONT/ALIGN/EXP button

The wafer is in alignment position if this button is activated, otherwise the wafer is in exposure position.

#### 603 SINGLE STEP button

Every joystick flexure or arrow key depression will only result in a single step movement in accordance with the value programmed via the F1 key.

#### 604 X-Y-JOYSTICK

Flexure the joystick located on the right side of the alignment stage in this direction in which the microscope/alignment stage should move. Release if final position is reached. The movement speed increase by a stronger joystick flexure. Activating FAST key allows fast movement.

#### 605 $\ominus$ -JOYSTICK (alignment stage only)

This joystick is located at the left side of the alignment stage. Flexure in x-direction rotates the wafer in fast speed clockwise or back. Flexure in y-direction rotates the wafer in slow speed clockwise or back.

## 1.3. Operating Procedures

A condensed step by step operation instruction is described in chapter 3.5 Step by step machine interactions.

### 1.3.1. Power on Procedure

**Before powering on the machine check or adjust**

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

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

#### Ignition of the exposure lamp (CIC 1200)

POWER SWITCH ELECTRONIC of the machine should be OFF. Switch on power of the Constant Intensity Controller (CIC). The software version is shown in the display. The CIC performs a self calibration test and displays "ready". Press CP (constant power) key. Display shows "wait", followed by "Start". Press START key. This will ignite the exposure lamp. LED LAMP LIFE/POWER is flashing until lamp warming up is finished. For more detailed information use the CIC-manual.



**Attention! Nitrogen failure for longer than 5 minutes will turn off the exposure lamp!**

#### Starting the machine

Shortly turn the POWER SWITCH ELECTRONIC (201) on the frontpanel clockwise into ON position and release. Machine initialize. An example for the display message is:

**"Ready for Start - press LOAD Button  
MA6-BA6-[M] V 4.000 04.05.01 SW:P"**

The meaning of the second displayed line is:

**configuration software version date included options (here: purge)**

Press the flashing LOAD key on the keyboard.

**"Watch out machine is starting!"**

Now you are asked for:

**"Select machine configuration: MA6"**

Select between mask align- (MA6) and bond align- (BA6) operation mode (with the Y-ARROW keys). After this selection the software is loaded and the machine is in a initial state, ready for operate and displays:

**"Ready for load"**

All motorized manipulators (TSA, BSA and alignment stage) are set to the position used before the machine was powered off. For your information: if you need a software reset, press the key combination FAST - UNLOAD (nearly 200ms time distance). Keep the EDIT PARAMETER key (311) pressed down while power on the POWER SWITCH ELECTRONIC (201) overwrites all parameter settings with the default values from the EPROM. Power off the machine by turning the POWER SWITCH ELECTRONIC (201) on the front panel counterclockwise into OFF position and release.

### 1.3.2. First Mask Print Mode

The first mask print of a wafer is done without alignment. This software sequence is started by the EXPOSURE key. Starting from the initial state of the machine this steps has to be performed:

#### 1. Adjust Parameters

- select mask loading type: F1 key  
Make secure that no mask is loaded before select mask loading type.
- select exposure mode: SELECT PROGRAM key  
Press SELECT PROGRAM key (310). Toggle through the menu and confirm your exposure program by pressing SELECT PROGRAM key again.
- edit parameters: EDIT PARAMETER key  
Press EDIT PARAMETER key (311) to edit the parameter. Change all necessary value and confirm by pressing EDIT PARAMETER key again.
- save all settings: EDIT PROGRAM key  
This function is an optional possibility to save this parameter set for the future. Toggle with the X-ARROW keys to "SAVE Pgm.". Select with the Y-ARROW keys a program number. Prior saved programs to the same number will be overwritten without warning. Save the settings by the EDIT PROGRAM key (312). Existing programs can be loaded from here.

## 2. Load Mask



**Watch out for the microscope movement!**

- start mask loading sequence: CHANGE MASK key  
You have to take out the mask holder, flip it 180° and put it on the tray left. If a mask is loaded, press ENTER to toggle the mask vacuum off, retract the mechanical mask clamp and remove the mask.
- load mask and fix it: ENTER key  
Place the mask onto the mask holder against the stop pins. Toggle the mask vacuum on by pressing the ENTER key. Activate the mechanical mask clamp by pressing on the leaf spring.
- slide the mask holder back into the machine and clamp it: CHANGE MASK key  
Flip the mask holder 180° back and move it into the machine. Lock the mask holder slide by pressing CHANGE MASK key again.

## 3. Load Wafer

- first pull out transport slide and load wafer: EXPOSURE 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 prealignment pins. Confirm with ENTER key. Now the wafer is hold by vacuum.
- move slide in: ENTER key  
The machine instructs: "move slide into machine and confirm with ENTER"
- wedge error compensation  
WEC starts automatically after the last action is completed. The wafer is adjusted parallel to the mask.

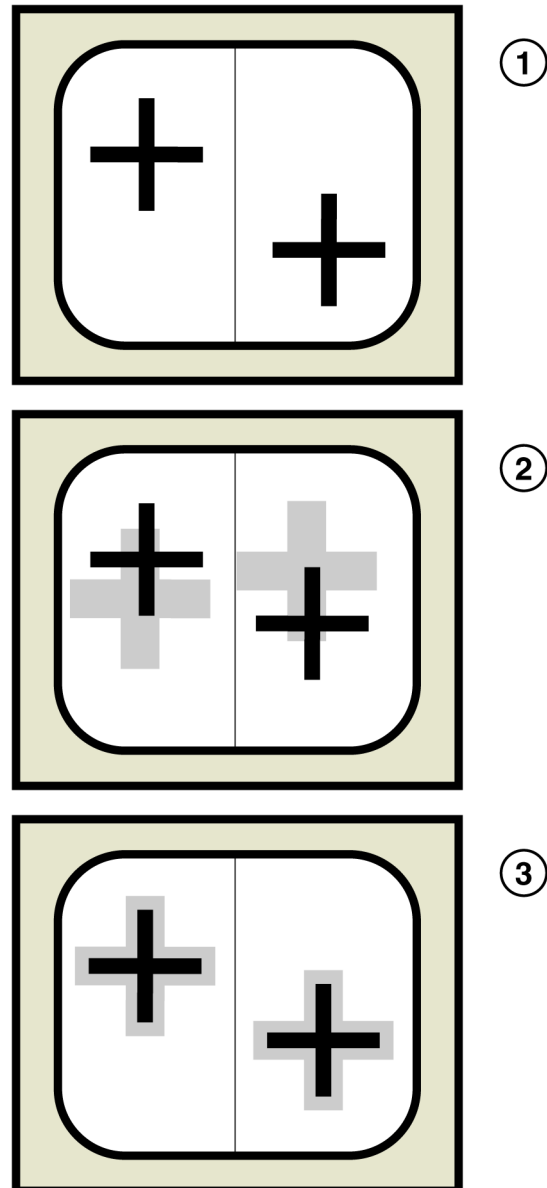
## 4. Exposure

After WEC the wafer moves automatically in exposure position. Depending on the exposure program selected all program steps will be performed automatically. Exposure takes place. After finishing the wafer chuck moves down to unload the exposed wafer.

## 5. Unload Mask: CHANGE MASK key

Hit the CHANGE MASK key 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. Hit ENTER to switch the mask vacuum off. Retract the mechanical clamping and remove the mask.

## 1.3.3. Top Side Alignment



Alignment Procedure

- 1 Grabbed mask alignment marks
- 2 Superimposed wafer alignment marks
- 3 Alignment marks central symmetrical aligned

In this mode the wafer is aligned to the mask using the topside alignment microscope (TSA). The following example explains the steps to align and expose with manual mask loading, soft contact print and WEC-type contact. Starting from the initial state of the machine these tasks must be performed:

## 1. Adjust Parameters

- select mask loading type: F1 key  
Make secure that no mask is loaded before select mask loading manual (default).
- select alignment microscope  
Deactivate BSA MICROSCOPE key (LED off).
- select exposure mode: SELECT PROGRAM key  
Press SELECT PROGRAM key (310). Toggle through the menu and confirm the selection soft contact by pressing SELECT PROGRAM key again.
- edit parameter: EDIT PARAMETER key  
Press EDIT PARAMETER key (311) to edit the parameter exposure time, alignment gap and WEC-type. Change all necessary value and confirm by pressing EDIT PARAMETER key again.
- save all settings: EDIT PROGRAM key  
This function is an optional possibility to save this parameter set for the future. Toggle with the X-ARROW keys to "SAVE Pgm.". Select with the Y-ARROW keys a program number. Prior saved programs to the same number will be overwritten without warning. Save the settings by the EDIT PROGRAM key (312). Existing programs can be loaded from here.

## 2. Load Mask



### Watch out for the microscope movement!

- start mask loading sequence: CHANGE MASK key  
You have to take out the mask holder, flip it 180° and put it on the tray left. If a mask is loaded, press ENTER to toggle the mask vacuum off, retract the mechanical mask clamp and remove the mask.
- load mask and fix it: ENTER key  
Place the mask onto the mask holder against the stop pins. Toggle the mask vacuum on by pressing the ENTER key. Activate the mechanical mask clamp by pressing on the leaf spring.
- Slide the mask holder back into the machine and clamp it: CHANGE MASK key  
Flip the mask holder 180° back and move it into the machine. Lock the mask holder by pressing CHANGE MASK key again.

## 3. Load Wafer

- pull out transport slide and load wafer: 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 prealignment pins. Confirm with ENTER key. Now the wafer is hold by vacuum.
- move slide in: ENTER key  
The machine instructs: "move slide into machine and confirm with ENTER"



### Watch out for the microscope movement!

- wedge error compensation  
WEC starts automatically after the last action is completed. The wafer is adjusted parallel to the mask and moves to the alignment gap. The microscope moves down to start the alignment.

## 4. Microscope Alignment

- set the TSA to meet your requirements (see 3.2.4): SPLITFIELD switch  
For the M3xx microscope only, an actual TSA-microscope image on the monitor is enabled by turning the SPLITFIELD switch (214) to LEFT. Toggle BSA MICROSCOPE key (322) off. This key switch also the controlled manipulator motors from BSA to TSA. If no camera and monitor exists, use the microscope eyepieces.
- microscope illumination: ILLUMINATION to TSA  
Turn ILLUMINATION switch (210) to TSA and select the light intensity by the potentiometer under this switch. Separate intensity selection for the left/right objective is possible with the aperture located at the left/right microscope front.
- focus on the mask plane: TOP/BOTTOM key  
Coarse focus is possible by using the TSA Z-MOVEMENT knob (402) placed behind the TSA-microscope. Make secure the TOP/BOTTOM key LED (326) is on and adjust the fine focus separately using the TOP SUBSTRATE LEFT/RIGHT (215) regulators. If no motorized focus exist, use the OBJECTIVE FOCUS FINE MANUAL (404 ) on the microscope.
- 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 (405).

- grab image: GRAB IMAGE key (option)  
First keystroke grabs the image. The objectives move the focal plane to the wafer and the TOP/ BOTTOM key LED (326) goes off. The motor control of the microscope manipulator is disabled at this time. Second keystroke delete the stored image and enables the manipulator again.

## 5. Wafer Alignment

- focus on the wafer plane  
Adjust the left/right microscope image with the BOTTOM SUBSTRATE LEFT/RIGHT (216) regulator. If no motorized focus exist, use the OBJECTIVE FOCUS FINE MANUAL (404) on the microscope.
- alignment  
Use the micrometer screws of the alignment stage for STG-X-Y-T-MOVEMENT (103, 104, 105). If these doesn't exist use instead this the ARROW-keys or joysticks. Align the wafer alignment marks central symmetrical to the mask alignment marks(see Figure 7 alignment procedure).



**If mask and wafer are in contact (CONTACT INDICATOR on), don't align the wafer!**

- alignment check  
Depending on your requirements, an alignment check could be helpful using the SEP keys (303), ALIGN CONT/EXP key (304) or the ALIGNMENT CHECK key (305).

## 6. Exposure

- EXPOSURE key  
By pressing this key the wafer will move into exposure position. Exposure takes place. Despite the exposure was initiated hitting the UNLOAD key before the light shutter has opened will continue it's exposure without wafer exposure. After finishing the wafer chuck moves down for unload the exposed wafer.



**Watch out for the microscope movement!**

## 7. Unload Mask: CHANGE MASK key

Hit the CHANGE MASK key 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. Hit ENTER to switch the mask vacuum off. Retract the mechanical clamping and remove the mask.

## 1.3.4. Bottom Side Alignment

The wafer is aligned to the mask using the bottom side alignment microscope (BSA). The following example explains the steps to align and expose with manual mask loading, vacuum contact and WEC-type proximity. Starting from the initial state of the machine these steps have to be performed:

### 1. Adjust Parameters

- select maskloading type: F1 key  
Make secure that no mask is loaded before select mask loading type.
- select alignment microscope  
Activate BSA MICROSCOPE key (LED on).
- select exposure mode: SELECT PROGRAM key  
Press SELECT PROGRAM key (310). Toggle through the menu up to exposure type "Vac" and confirm by pressing SELECT PROGRAM key again.
- edit parameter: EDIT PARAMETER key  
Press EDIT PARAMETER key (311) to edit the parameter for exposure time, alignment gap, preVac time, fullVac time, purge time and WEC type: spacer. Confirm the settings by pressing EDIT PARAMETER key again.
- save all settings: EDIT PROGRAM key  
This function is an optional possibility to save this parameter set for the future. Toggle with the X-ARROW keys to "SAVE Pgm.". Select with the Y-ARROW keys a program number. Prior saved programs to the same number will be overwritten without warning. Save the settings by EDIT PROGRAM key (312). Existing programs can be loaded from here.

### 2. Load Mask



**Watch out for the microscope movement!**

- start mask loading sequence: CHANGE MASK key  
You have to take out the mask holder, flip it 180° and put it on the tray left. If a mask is loaded, press ENTER key to toggle the mask vacuum off, retract the mechanical mask clamp and remove the mask.
- load mask and fix it: ENTER key  
Place the mask onto the mask holder against the



stop pins. Toggle the mask vacuum on by pressing the ENTER key. Activate the mechanical mask clamp by pressing on the leaf spring.

- slide the mask holder back into the machine and clamp it: CHANGE MASK key  
Flip the mask holder 180° back and move it into the machine. Lock the mask holder slide by pressing CHANGE MASK key again.

### 3. Load Wafer Chuck for BSA

- Insert a proper chuck without wafer onto the transport slide  
Move the BSA-chuck placed onto the transport slide into the machine. Don't press a key.

### 4. Microscope Alignment

- set the monitor image: SPLITFIELD switch  
Turn the SPLITFIELD switch (214) to middle position and toggle BSA MICROSCOPE key on (LED on). This key enables the microscope manipulators accordingly.
- microscope illumination: ILLUMINATION to BSA/IR  
Turn the ILLUMINATION switch (210) to BSA/IR and adjust the light intensity by the potentiometers labeled BSA/IR microscope illumination left/right (211).
- focus on the top focus plane: TOP/BOTTOM key  
Make secure the TOP/BOTTOM key LED (326) is on and adjust the fine focus separately with the TOP SUBSTRATE LEFT/RIGHT regulators.
- move objectives to the chuck opening: LEFT, BOTH, RIGHT keys  
Select one of these keys to move the left/right objective with the ARROW keys. If necessary use fast speed (FAST key LED on).
- grab image: GRAB IMAGE key (option)  
First keystroke grabs the mask image. The objectives move to the wafer focus plane (TOP/BOTTOM key LED off). The motor control of the microscope manipulator is disabled. Second keystroke GRAB IMAGE key deletes stored image and enables the manipulator again.

### 5. Load Wafer

- pull out transport slide and load wafer: LOAD key  
After grab image the machine informs you: "ready for load... BSA image stored". Press LOAD key to

start this procedure. Load wafer onto chuck and push slide into the machine as prompted on the display. Press ENTER key.



**Attention! Microscope moves downwards!**

- wedge error compensation  
WEC starts automatically. After WEC the wafer will move to the alignment gap.

### 6. Wafer Alignment

- focus on the wafer plane  
Adjust the left/right objective image with the BOTTOM SUBSTRATE LEFT/RIGHT (216) regulators. Correct illumination if necessary.
- alignment  
Use the micrometer screws of the alignment stage for STG-X-Y-Θ-MOVEMENT (103, 104, 105). If these doesn't exist use instead this the ARROW-keys or joysticks. Align the wafer alignment marks central symmetrical to the mask alignment marks (see Figure 7 alignment procedure).



**If mask and wafer are in contact (CONTACT INDICATOR on), don't align the wafer!**

- alignment check  
Depending on your requirements, an alignment check could be helpful using the SEP keys (303), ALIGN CONT/EXP key (304) or the ALIGNMENT CHECK key (305).

### 7. Exposure

- EXPOSURE key  
By pressing this key the wafer will move into exposure position. Exposure takes place. Despite the exposure was initiated hitting the UNLOAD key before the light shutter has opened will continue it's exposure without wafer exposure. After finishing the wafer chuck moves down for unload the exposed wafer.

### 8. Unload mask: CHANGE MASK key

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

### 1.3.5. Single Bottom Side Alignment

This procedure describes the adjustment of small substrates to a mask using only one BSA microscope. Therefore we recommend a transparent wafer chuck. Starting from the initial state of the machine these steps have to be performed:

#### 1. Adjust Parameters

- select maskloading type: F1 key  
Make secure that no mask is loaded before select mask loading type. Select mask loading by slide with BSA alignment.
- select single BSA align: F1 key  
Toggle to single BSA align and enable this option.
- select alignment microscope  
Activate BSA MICROSCOPE key (LED on).
- select exposure mode: SELECT PROGRAM key  
Press SELECT PROGRAM key (310). Toggle through the menu up to the desired exposure type and confirm by pressing SELECT PROGRAM key again.
- edit parameter: EDIT PARAMETER key  
Press EDIT PARAMETER key (311) to edit the parameter for the exposure. Confirm the settings by pressing EDIT PARAMETER key again.
- save all settings: EDIT PROGRAM key  
This function is an optional possibility to save this parameter set for the future. Toggle with the X-ARROW keys to "SAVE Pgm.". Select with the Y-ARROW keys a program number. Prior saved programs to the same number will be overwritten without warning. Save the settings by EDIT PROGRAM key (312). Existing programs can be loaded from here.

#### 2. Load Mask



**Attention! Microscope moves up!**

- start mask loading sequence: CHANGE MASK key  
Follow the displayed instructions.
- load mask holder  
For this sequence make sure the prealignment pins and the mechanical mask clamping is removed from the mask holder.

- load mask transfer chuck and mask: ENTER key  
Insert mask transfer chuck into transport slide. Load mask face down onto mask transfer chuck. Toggle the mask vacuum on by pressing the ENTER key.
- slide the transport slide in: ENTER key  
For non motorized stages only if the chuck is not centered, move it with the micrometer screws to the middle position. Confirm with ENTER key. After WEC relative to the mask holder the mask is in 100 µm alignment gap.
- alignment preparation  
Enable the used single BSA microscope using the SPLITFIELD switch (214). Adjust the microscope illumination using the BSA/IR microscope illumination left/right (211). Focus on the mask plane by activating the TOP/BOTTOM key (326) and the corresponding TOP SUBSTRATE LEFT/RIGHT focus regulator (215). Search for a reference mask alignment mark with the BSA microscope. Store this stage position by activating the SET REFERENCE key (314). Search for a second mask alignment mark only by the x-movement of the BSA-microscope. Toggle back to the reference alignment mark using the SCAN key (315). Press GRAB IMAGE key (327) to store the reference alignment mark image. Toggle to the second alignment mark using the SCAN key (315).
- mask alignment  
For an motorized stage only switch the manipulator control to the stage activating the STG/TSA/BSA button (601). Adjust the real mask alignment mark to the stored one only with the (⊖)-JOYSTICK (605) or the (⊖)-micrometer screw of the alignment stage about 1/2 of the misalignment. Switch the manipulator control to BSA deactivating the STG/TSA/BSA button (601). Toggle to the reference alignment mark using the SCAN key (315). Press GRAB IMAGE key (327) twice to release the stored and grab the new image. Press SCAN key (315) to toggle to the second alignment mark position. Repeat this mask alignment until there is no misalignment left.

- load mask: ENTER key  
Pressing ENTER the mask moves to the mask holder and is taken by the mask holder vacuum. Transport chuck moves down for unloading.

#### 3. Load Substrate

- load wafer chuck and substrate onto the transport slide: LOAD key

We recommend to use a transparent wafer chuck. Move the loaded transport slide in and confirm with ENTER key.

- wedge error compensation  
WEC starts automatically. The substrate moves to the alignment gap.

#### 4. Substrate Alignment

- alignment preparation  
Adjust the microscope illumination using the BSA/IR microscope illumination left/right (211). Select the Substrate focus plane by deactivating the TOP/BOTTOM key (326). Focus by the BOTTOM SUBSTRATE LEFT/RIGHT focus regulator (216). Search for a reference wafer alignment mark with the BSA microscope. Store this stage position by activating the SET REFERENCE key (314). Search for a second wafer alignment mark only by the x-movement of the BSA-microscope. Toggle back to the reference alignment mark using the SCAN key (315). Press GRAB IMAGE key (327) to store the reference alignment mark image. Toggle to the second alignment mark using the SCAN key (315).
- substrate alignment  
For an motorized stage only switch the manipulator control to the stage activating the STG/TSA/BSA button (601). Adjust the real substrate alignment mark to the stored one only with the  $\ominus$ -movement of the alignment stage about 1/2 of the misalignment. Switch the manipulator control to BSA deactivating the STG/TSA/BSA button (601). Press SCAN key (315) to toggle to the reference position. Press GRAB IMAGE key (327) to release the stored image. Deactivate the TOP/BOTTOM key (326) and grab the new image using GRAB IMAGE key (327). Repeat this substrate alignment until there is no misalignment left.
- substrate to mask alignment  
Move the substrate away using the x-y-movement of the alignment stage to see a real mask alignment mark. Focus on the mask plane by activating the TOP/BOTTOM key (326) and using the corresponding TOP SUBSTRATE LEFT/RIGHT focus regulator (215). Press GRAB IMAGE key (327) to store the mask alignment mark. Move the substrate back using the x-y-movement of the alignment stage. Focus on the substrate plane by deactivating the TOP/BOTTOM key (326) and using the corresponding TOP SUBSTRATE LEFT/RIGHT focus regulator (215). Align the substrate alignment mark central symmetrical to the mask alignment mark. Check the alignment using the

ALIGN CONT/EXP key (304).

#### 5. Exposure

- EXPOSURE key  
By pressing this key the substrate will move into exposure position. Exposure takes place. Despite the exposure was initiated hitting the UNLOAD key before the light shutter has opened will continue it's exposure without substrate exposure. After finishing the wafer chuck moves down for unload the exposed substrate.

#### 6. Unload Mask

- CHANGE MASK key  
Hit the CHANGE MASK key to start the unload procedure. Follow the displayed instructions to unload the mask.

## 1.4. Advanced Technology

### 1.4.1. Exposure Programs

An important parameter for the exposure is the contact method between mask and wafer. 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

This is the most careful exposure for the mask. Mask damage is reduced to a minimum. But the structural resolution is not as high as with any contact exposure. Between mask and wafer is a distance left, the exposure gap. The gap value is adjustable by the EDIT PARAMETER key. The wedge error compensation is performed by using three precision reference spacers between mask and wafer.

#### 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 instead. So a closer contact between wafer and mask is guaranteed, even with large wafers.

#### 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 necessary vacuum chuck is creating a mini chamber between mask and wafer. The rubber seal pressure is adjustable by the VACUUM SEAL regulator (206). This chamber is evacuated in steps. Pre vacuum gently pulls vacuum into that mini chamber to enable a smooth contact between mask and wafer. Furthermore it prevents gas bubbles to be trapped between both. Full vacuum will be applied with the next step. The wafer will be loaded in 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 the exposure nitrogen will purge 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 parameter could be set using the EDIT PARAMETER key (311).

#### 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 (205). 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 (205) and test the result using the ALIGNMENT CHECK key (305).

#### 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 (316). The exposure takes place as long as the exposure time was set independent if a mask (and mask holder) is loaded or not.

### 1.4.2. 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:

- Select the corresponding exposure program by the SELECT PROGRAM key (310).
- Press the Multiple Exposure key (317).
- Press the EDIT PARAMETER key (311).
- Edit the parameter for the exposure program. Edit the numerical value of the corresponding parameters wait time and cycles.
- Press the flashing EDIT PARAMETER key to finish editing and start alignment followed by the multiple exposure process.

### 1.4.3. Wedge Error Compensation

During this procedure the top side of the wafer will be set exactly parallel to the bottom side of the mask. This guarantees a perfect gap setting and so a homogeneous quality of the exposed structures over the whole wafer. Set the WEC type using the EDIT PARAMETER key (311).

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.

Additionally two other methods are also possible. Global WEC between mask and chuck. This could be used for pieces or other special applications. It is mandatory to set the thickness of a substrate or wafer accordingly before WEC procedure is initiated.

- global WEC contact mode:  
The WEC will be performed between wafer chuck and mask without the wafer (GlobCont). Before alignment set the wafer thickness. Another parameter of the EDIT PARAMETER menu is listed. It is the substrate thickness.
- global WEC spacer mode:  
The WEC will be performed between wafer chuck and mask using spacers in between (GlobSpac). Depending of the spacer and substrate dimensions it's enabled to perform this with a loaded substrate. Before alignment set the wafer thickness using the EDIT PARAMETER menu.

### 1.4.4. Load Mask by Slide

Additional to the manual mask loading (described in the operating procedures, Chapter 3.3.3, Load mask) this method is available. Mask and mask holder must not be flipped 180°. The active side of the mask is never face up. A standard mask holder and mask loading chuck are necessary. Working with this loading sequence prealignment pins and mechanical mask clamping has to be removed from the mask holder. Load the mask holder in the stage and clamp

it. insert the mask transfer chuck in the transport slide and place the mask face down on it. Fix it by toggle the vacuum on. Move transport slide in the machine and confirm. Now there are two possibilities depending of the prior selection (by F1 key):




























- without alignment  
The machine moves the mask against mask holder. After the vacuum sensor detect that the mask holder vacuum take in the mask, the transport slide vacuum switches off. Transport slide moves down.
- with alignment  
The machine moves the mask against mask holder and backwards in a alignment gap. Align mask now and confirm finally with ENTER key. Mask moves up. Same procedure as described in without alignment follows.

## 1.5. Step by Step Machine Interactions

### 1.5.1. Select Mask Loading Type









For example: select manual mask loading (default)

**Unload the mask before this selection is initiated!**

Display message	Following operator action (keystroke)
"ready for Load"	  F1 
"microscope up/down"	  x → 
"change align speed"	  x → 
"single step config"	  x → 
"centering stage"	  x → 
"select maskloading"	  ENTER 
"manual"	  x → 
"slide"	  x → 
"manual"	  ENTER 
"ready for load"	

### 1.5.2. SELECT PROGRAM for Exposure

















For example: select soft contact

Display message	Following operator action (keystroke)		
"ready for Load"	→	 SELECT PROGRAM	←
"Exposure Type: Soft"	→	 y ↓	←
"Exposure Type: Flood E"	→	 y ↓	←
"Exposure Type: Prox"	→	 y ↓	←
"Exposure Type: Vac"	→	 y ↓	←
"Exposure Type: Low Vac"	→	 y ↓	←
"Exposure Type: Hard"	→	 y ↓	←
"Exposure Type: Soft"	→	 SELECT PROGRAM	←
"ready for Load"			

### 1.5.3. EDIT PARAMETER Menu

For example: select exposure time, alignment gap, WEC type and exposure type






















The number of parameters listed depends of prior selections.

Display message	Following operator action (keystroke)
"ready for Load"	  EDIT PARAMETER 
"Exp. Time [s]: 5.0"	  x → (Edit value by Y↑ and Y↓) 
"Al. Gap [μm]: 100"	  x → (Edit value by Y↑ and Y↓) 
"WEC Type: Contact"	  x → (Edit value by Y↑ and Y↓) 
"Exposure Type: Soft"	  x → (Edit value by Y↑ and Y↓) Press EDIT PARAMETER key to confirm the edited value 
"ready for Load"	



### 1.5.4. Changing the TSA, BSA and Stage Alignment Speed

(If necessary)

















Display message	Following operator action (keystroke)
"ready for Load"	  F1 
"microscope up/down"	  X → 
"Change align speed"	  ENTER 
"BSA Parameter Slow Speed [%]: 39"	  X → (Edit value by Y↑ and Y↓) 
"STG Parameter Slow Speed [%]: 39"	  X → (Edit value by Y↑ and Y↓) 
"TSA Parameter Slow Speed [%]: 39"	  X → (Edit value by Y↑ and Y↓) 
"BSA Parameter Slow Speed [%]: 39"	  ENTER 
"ready for Load"	

(to edit the fast speed activate the FAST key, LED on)

### 1.5.5. EDIT PROGRAM Menu










For example: save a program

All active parameters and the stage position are stored. A stored file number is indicated with [0] on the display.



Display message	Following operator action (keystroke)
"ready for Load"	  EDIT PROGRAM 
"Load Pgm. From: 0"	  x → (Edit value by Y↑ and Y↓) 
"EXIT Pgm. Editor"	  x → 
"DELETE Pgm. no: 0"	  x → (Edit value by Y↑ and Y↓) 
"SAVE Pgm to: 0"	  (Edit value by Y↑ and Y↓) EDIT PROGRAM 
"ready for Load"	

### 1.5.6. Change Mask

For example: manual

Display message	Following operator action (keystroke)
"ready for Load"	  CHANGE MASK 
"Change Mask - press ENTER to toggle mask vacuum: OFF"	  <ul style="list-style-type: none"> <li>• pull out mask holder and flip it 180°</li> <li>• deposit it on the tray left</li> <li>• place the mask against the stop pins</li> <li>• press ENTER</li> </ul> 
"Change Mask - press ENTER to toggle mask vacuum: ON"	  <ul style="list-style-type: none"> <li>• activate the mechanical mask clamping by pressing the leaf spring</li> <li>• flip mask holder 180° and slide it back into the machine (up to the end and preferably to the right position)</li> <li>• press CHANGE MASK</li> </ul> 
"ready for Load"	








## 1.5.7. Load Wafer

Display message	Following operator action (keystroke)
"ready for Load"	 LOAD 
"pull slide and load substrate onto chuck"	 <ul style="list-style-type: none"> <li>• place wafer against the prealignment pins on the chuck</li> <li>• confirm with ENTER</li> <li>• vacuum on transport slide goes on</li> </ul> 
"move slide into machine and confirm with ENTER"	 ENTER 
"performing WEC - please wait..." "microscope moving - please wait..." (if BSA MICROSCOPE key is off)	
"Align substrate"	 <ul style="list-style-type: none"> <li>• setup microscope (see chap. 3.3.3, par. 4)</li> <li>• align wafer</li> <li>• optional check the alignment using ALIGN CONT/EXP key (304) or ALIGNMENT CHECK key (305)</li> <li>• press EXPOSURE</li> </ul> 
"z-axis moving - please wait..."	(wafer moves to exposure position)
"Microscope moving - please wait..."	(exposure takes place)
"please wait..."	(wafer moves down) 
"Microscope moving - please wait..."	
"pull slide and unload exposed substrate"	do it 
"ready for Load"	

### 1.5.8. Load Mask by Slide


For Example: load mask by transport slide with BSA align

**Unload the mask before this selection is initiated!**

Display message	Following operator action (keystroke)
"ready for Load"	  F1
"microscope up/down"	  x →
"Change align speed"	  x →
"single step config"	  x →
"centering stage"	  x →
"select maskloading"	  ENTER
"manual"	  x →
"slide"	  ENTER
"no align"	  y ↑
"TSA align"	  y ↑
"BSA align"	  ENTER
"ready for Load"	  CHANGE MASK
"Load maskholder"	  ENTER
"Load mask transfer plate and mask"	  ENTER
"Perform mask loading - please wait"	

# 1

## OPERATION OF THE MACHINE

Display message	Following operator action (keystroke)	
"continue: ENTER - align mask abort: UNLOAD"	→	 <ul style="list-style-type: none"> <li>align mask using the alignment stage controls and continue with ENTER</li> </ul>
"Performing mask loading - please wait"	→	(mask vacuum takes mask in)
"center chuck automatically"	→	(mask transfer chuck goes down)
"ready for Load"		