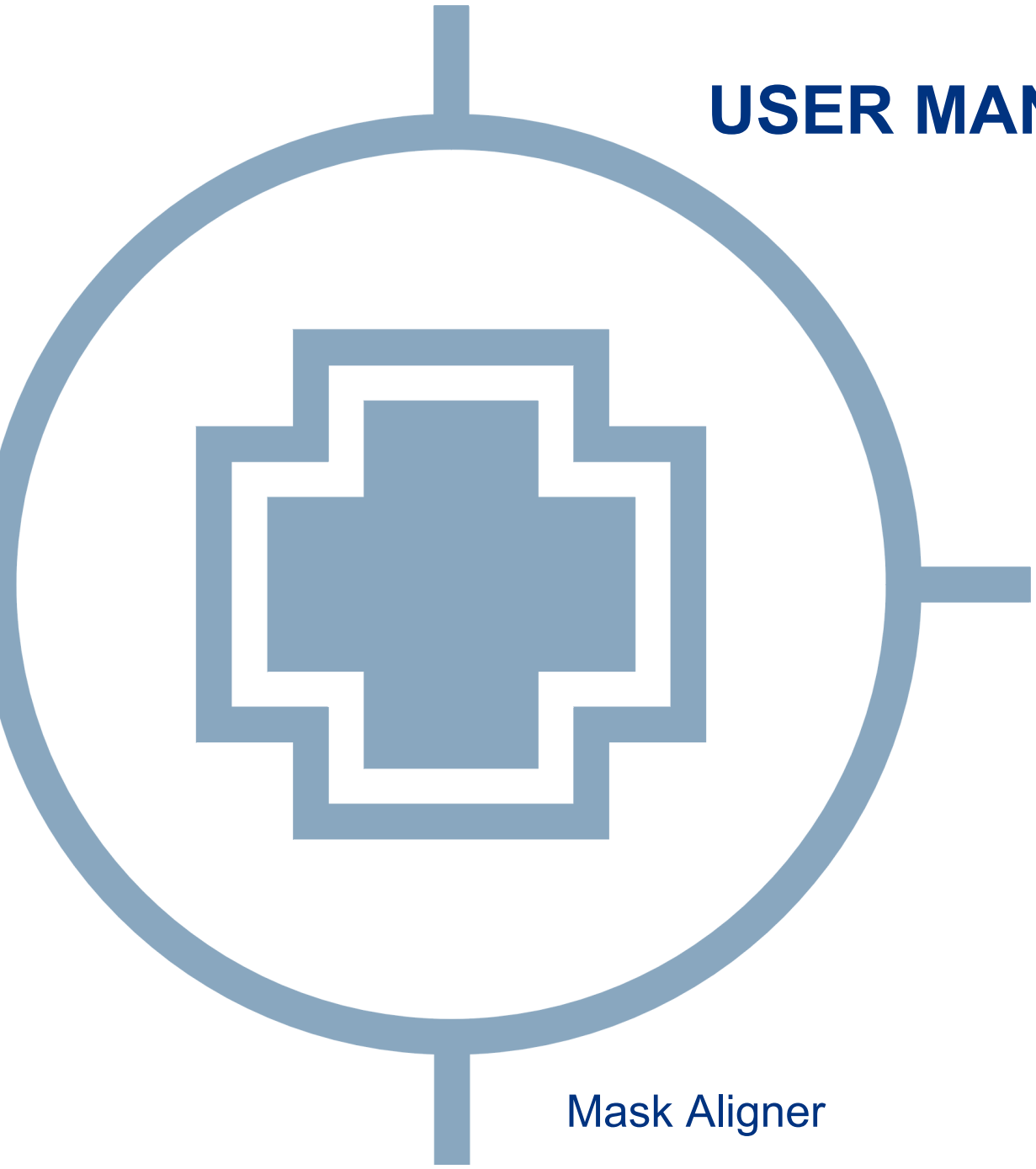
USER MANUAL



Mask Aligner

MJB4

Laboratory Mask Aligner

Rev07/ 05-10

www.suss.com

SÜSS MicroTec

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This manual is available in the following formats: Cleanroom Printed and CD-ROM.
Printed in Europe.

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PREFACE

The MJB4 Mask Aligner is a precision instrument for high-resolution photolithography and is intended for use in research laboratories, small-series production and pilot projects.

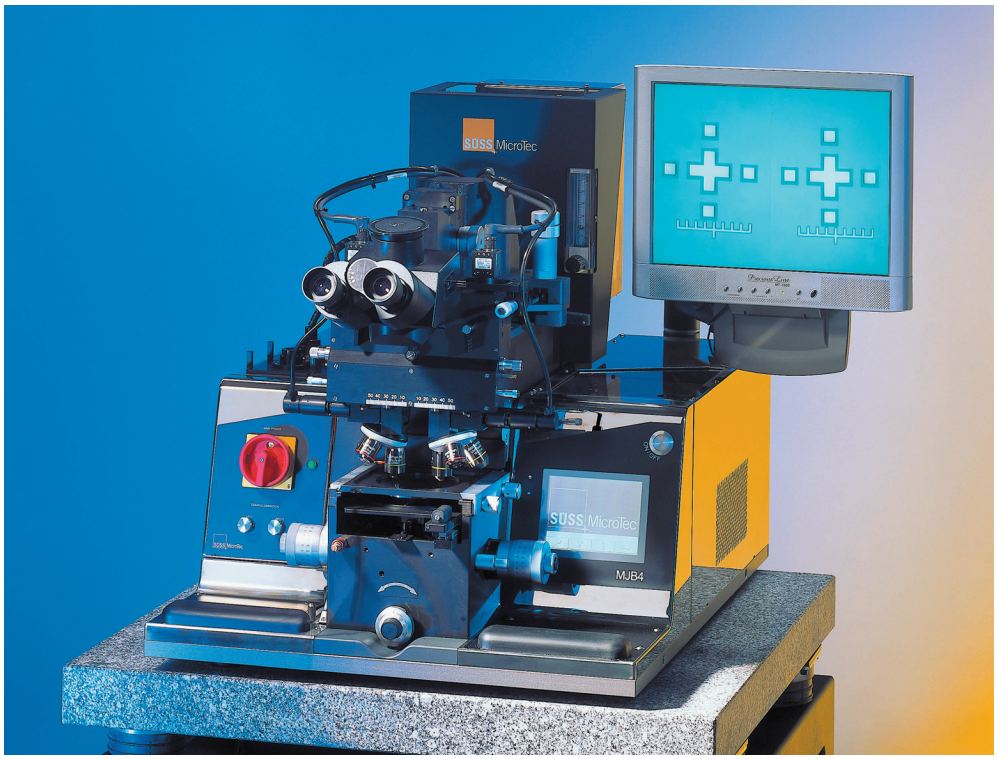
The flexibility of the MJB4 is unsurpassed when exposing standard wafers and substrates and irregularly shaped substrates with a diameter of up to 100 mm or 4"x 4" and various thicknesses.

The MJB4 Mask Aligner is a state-of-the-art instrument. The MJB4 combines proven and newly developed technology for adjusting wafers, fragments of wafers and substrates.

Different versions of the aligner are available.

A single field microscope and a splitfield microscope, which can also be equipped with an optional video system, are available for adjusting the top side. IR adjustment is available for both microscopes.

These microscopes were developed from the successful SUSS MJB3 Mask Aligners, which were the international leaders among these types of instruments for over 3 decades.



1. WARNINGS AND SAFETY PRECAUTIONS

1.1. Guidelines on Safety at Work

This machine has been developed and manufactured in compliance with the current safety regulations and standards.

This operating manual should be read before using the mask aligner. It contains all the information required for the safe and correct use of the machine. Other operating manuals included with this manual must also be read, for power supplies CIC1200, CPC200 and CPC350.

As a further precaution against accidents, the operating and service personnel should be trained and instructed on delivery and at regular intervals, otherwise communication problems and mis-interpretation of the operating manual can lead to injury to the operator.

SUSS MicroTec cannot accept any responsibility for physical injury or damage to the machine which results from incorrect use of this machine and failure to follow these safety instructions.

Attention!

The instructions in this operating manual are only intended for qualified personnel. The machine may only be operated by persons who are authorized and trained to do so!

1.2. Definition of Danger Advice and Warnings

The dangers which can possibly arise during operation of this machine as well as appropriate precautionary measures and recommended procedures are described in this section of the manual - as well as in warnings which are applied to the machine or its assemblies or in some cases to the packaging. Both types of warning must be understood and observed by the MJB4 operator of the machine. Warnings are normally divided into

- a description of the possible hazard
- directions on avoidance of the danger or on the correct procedure to be followed in the event of danger.

A warning or instruction symbol appears next to the warning.
Warnings on the machine also include the key words Danger or Warning:

- "Danger" indicates a potentially serious risk to life,
- "Warning" indicates a risk of injury.

1.3. Intended Use of this Machine

The machine is exclusively intended for use as an alignment and/or exposure device for substrates used in semiconductor and micro system technology.

Any other form of use must be agreed on with SUSS MicroTec Lithography's Engineering Product Support department. In the event of contravention, SUSS MicroTec accepts no liability either for malfunction or for personal injury.

1.4. Main Switch with Emergency Off Function

The machine has a main switched combined with an emergency off function. If the switch is turned to OFF, the machine is immediately cut off from the power supply network, the exposure lamp goes off, and the upper microscope pivots upwards. The switch is signal red and is located on the left front plate.

Attention!I

In case of danger, turn the main switch to OFF!

Warning!

The upper microscope pivots upwards.

To begin operating the machine again, the main switch must be turned to ON and the machine must be restarted.

1.5. Dangers

1.5.1. Physical Dangers

Moving machine parts such as the alignment station, microscopes and their manipulators, the mirror housing and others can cause injury to the operator.

You should take particular care of the movements of the microscope if your machine is equipped with the direct microscope view finder.

Warning!

Moving machine parts can injure the fingers or face.

Do not remove any materials from the machine until all machine movements have stopped!

Warning!

With a machine equipped with a vibration-damped table, the base plate can sink without warning in the event of a drop in pressure in the compressed air supply.

Never place the hands between the base plate and the vibration-damped table of the machine!

Warning!

The movement of a direct viewfinder can cause injury to the eyes or face. Stop looking into the microscope viewfinder before you start the microscope movement!

Caution!

The machine warns by a beep prior to microscope movements in upward or forward direction. When the beep sounds, back off from the microscope immediately!

Danger!

A particular danger results from the fragments thrown out in the event of a lamp explosion!

Situations which can lead to a lamp explosion are described in a separate section.
You should also be aware of the risk of poisoning with Hg following a lamp explosion; this is also described in a separate section.

1.5.2. Thermal Dangers

The upper side of the lamp house gets very hot during operation.
Operating temperatures of several hundred °C occur on the lamp itself.
The lamp cooling must be correctly adjusted according to the lamp type!

Warning!

There is a risk of lamp explosion if the lamp house is opened prematurely while the lamp is hot.

The exposure lamp has to cool down for at least 20 minutes before the lamp house door is opened!

The controlled cooling required for more powerful lamp types must also be left in operation during the cooling phase!

1.5.3. Electrical Dangers

Live parts may be exposed when the machine cover is removed.
High wattages and currents of up to 50 A can occur in the lamp and lamp power supply.
The lamp starting voltage can be up to 30 kV.

Danger!

Do not open the machine until the whole machine has been isolated from the power supply!
Pay attention to this warning symbol on covers!
Where applicable, observe local "log out - tag out" regulations!

The individual electrical assemblies, especially ballasts CIC1200, CPC200 and CPC350, contain no parts which the user could repair or adjust.

1.5.4. Radiation Danger

The high luminous density of the exposure lamp can cause eye damage.

In particular, the **invisible ultraviolet** component of the light can lead to permanent eye damage or skin burns.

Warning!

UV light can permanently damage your eyes.
Covers over the ray path may not be removed while the UV lamp is switched on!

Lamp adjustment work may only be carried out with UV-protective goggles - also with skin protection in the case of intensive radiation!

Light measurements on the exposure chuck also require the use of UV-protective goggles.

UV-protective goggles must carry a marking indicating the protection class. The color of the goggles provides no indication of their protective effect!

Warning!

The lamps of the microscope illumination provide light of high intensity. Especially exposure to the concentrated light from the optical fibers may cause eye injuries or skin irritations.

Do not activate the illumination light while not completely covered and all light paths and optical fibers are in place and secured. Do not peer directly to the light source - in particular not a the end of a fiber.

1.5.5. Danger of Poisoning

1.5.5.1. Mercury Fumes following Lamp Breakage

The biggest danger following a lamp explosion or lamp breakage lies in the inhalation of the toxic mercury fumes. Mercury can cause acute and chronic poisoning.

Note:

The EU safety data sheets can be found in the Appendix and must be read.

Advice on minimizing health risks following a lamp explosion:

- Leave the lamp house exhaust switched on (with powerful lamps)!
- Leave the contaminated room immediately!
- Ventilate the room well for at least 30 minutes!
- Do not open the lamp house for the time being. Allow the interior of the lamp house to cool down for at least 1 hour!
- Carry out lamp house decontamination using an appropriate decontamination agent (see section on changing the exposure lamp)!
- Follow the general and national safety regulations relating to Hg!
- A doctor should be consulted immediately if there is a possibility of mercury fumes having been inhaled!

1.5.5.2. Generation of Ozone during the Operation of the Lamp

Short-wavelength ultraviolet light can ionize the atmospheric oxygen.

An exposure lamp therefore generates ozone during operation.
Long-term and intensive exposure to ozone can lead to damage to the respiratory organs.

Warning!

Where powerful lamps or special lamps for deep-UV are used, additional extraction and controlled cooling by means of nitrogen flushing should be ensured (see setting tables)!

If the stipulated settings are applied correctly, the ozone concentration in the area surrounding the lamp house should remain well below the permissible limit.

1.6. Working with the MJB4 Mask Aligner

Only SUSS MicroTec employees or qualified and trained staff may service the machine.

Danger!

The operating and starting voltages in high-pressure lamps are deadly dangerous!
The machine must be switched off before beginning servicing work on the lamp house or other electrical components!

1.6.1. Fitting, Changing and Cooling the Exposure Lamp

When working with high-pressure lamps, the appropriate safety regulations and service life specifications of the lamp manufacturer must be observed.

Hg-filled UV high-pressure lamps must be changed once the service life specified by the manufacturer has expired. There is an increased risk of lamp explosion after this date!

Premature failure of a lamp can be the result of incorrect lamp cooling (too powerful or too weak), incorrect power setting, soiling of the lamp tube or similar.

Exposure lamps should only be handled with gloves. Clean any grease marks with alcohol!

1.6.1.1. Danger of Lamp Explosion

If the Hg high-pressure lamps are operated according to their specification (type selection on CIC, cooling, min/max power, service life), lamp explosions during operation are extremely rare.

The exposure lamp should always be protected against shock when handling - the lamps should always be stored and transported in their original packaging!

Any other mechanical stress such as bending or twisting during installation should also be carefully avoided!

Warning!

The exposure lamp is under high pressure.

Mechanical face and eye protection should be worn when handling a high-pressure lamp!

If the lamp breaks, do not touch the components with the hand and do not inhale the Hg fumes!

Use a breathing mask with gas absorption during decontamination!

In the event of a lamp explosion, after the immediate measures described in section *Danger of poisoning* an Hg decontamination kit (e.g Mercurisorb) should be used to eliminate the mercury which is still present. Such a kit should always be kept in store. These can be obtained, for example, from:

Carl Roth GmbH & Co
P.O. Box 100121
D-76231 Karlsruhe
http://www.carl-roth.de

1.6.1.2. Changing the Lamp

Only use lamps of a type approved for use by SUSS MicroTec Lithography!

Caution!

In almost all exposure lamps, the anode (positive pole) is at the bottom.

Only the 500W DUV Hg/Xe lamp (Ushio) position is reversed.

After changing the lamp type or replacing a CIC1200, CPC200 or CPC350 it is essential to check the correct polarity of the lamp and correct type selection on the CIC1200 before switching on the lamp!

Always follow the lamp manufacturer's directions!

When fitting or removing the lamp, avoid any mechanical load acting on the glass tube! Only tighten the lamp by hand!

Pay attention to the correct handling of different lamp mountings (depending on the lamp house type) - see Servicing section in the manual!

Connect the connection contacts on the lamp in such a way that electrical contact resistances are minimized. Replace all components which show traces of corrosion or overheating!

1.6.1.3. Setting Regulations for Lamp Cooling

The UV-exposure lamps must be cooled in a controlled way in order to maintain safe and optimum operating conditions. The cooling should be set up individually according to the lamp type.

Detailed values for the lamp cooling and the volume flow which needs to be extracted for different lamps can be found in the table "Setting values for lamp cooling and lamp house extraction" in section 2.1. "Prerequisites for Installation".

The basic components of the cooling are:

- Blowing of nitrogen onto the metallic lamp cap (but never the glass tube),
- Blowing of compressed air into a heat sink (for radiation of heat) in the lamp house.

The lamp-specific values both for the adjustment of the blowing of nitrogen onto the upper and lower lamp caps and also for the extraction should be observed.

Significant deviations from the setting values endanger your safety!

Minor deviations affect the operating safety of the lamp and machine.

If a lamp frequently illuminates in an unstable manner, or of the life of the lamp has systematically deteriorated, carefully check the settings for the lamp cooling. Frequently, the cause of such problems lies in incorrect setting of these data or in incorrect fixing of the connections. If you are not sure, call in SUSS MicroTec's service to carry out a check!

Note!

In addition, in order to achieve good exposure results, the evenness of the light should be adjusted after fitting a new lamp.

1.6.1.4. Lamp Housing Extraction

As a rule, no suction is required for 200W and 350W lamps.

Ozone extraction from the lamp housing must be ensured for the 500W DUV Hg/Xe lamp in the 350W lamp housing to avoid health risk. Add-on kit item no. 189553 is required for this purpose.
Detailed values can be found in the table "Setting values for lamp cooling and lamp house extraction" in section 2.1. "Prerequisites for Installation".

1.6.1.5. Disposal

Used lamps should also only be stored and transported in the original protective packaging!

UV high-pressure lamps contain up to 1g of highly-toxic mercury.
These lamps should therefore be treated as special-category waste.

Local regulations on disposal should be observed.

It is possible to return the lamps to the supplier or manufacturer.

1.6.2. Preparing the Machine for Working

Check that the vibration-insulated table (if present) is working.

Caution!

In the event of a loss of pressure, the table can drop and trap your fingers!

1.6.2.1. Preparing to Switch ON

The following instructions assume that the mask aligner has been correctly installed and that the machine has been connected to the power supply network by switching on the main power switch.

The following pressure values should be present on the machine:

- Compressed air
  5,5 - 7 bar (COMPRESSED AIR)
- Nitrogen
  2 - 3 bar (NITROGEN)
- Vacuum
  -0.8 bar (means 0.2 bar absolute (VACUUM))

Caution!

When CDA supply is being pressurized the microsope will rise to its upper resting position immediately.

1.6.2.2. Configuration of MJB4 after Maintenance or Service

Caution!

The moveable front tube of the mirror house shall be adjusted so that there is no gap visible between the front tube and the fixed rear tube in order to avoid pinch points and UV light leaking.

1.6.3. Safety Checks

The important safety functions of the machine should be checked for safe functioning at regular intervals - i.e at least every three months.

This applies as long as the check itself does not represent a hazard.

The following should be tested:

- that the machine stops immediately and the microscope moves up if the main switch is positioned to OFF.
- acoustic warning signal by the power supply unit in the event of a failure in the nitrogen supply - only very brief for test purposes!

2. INSTALLATION AND TRANSPORT

Containers must be opened and the machine must be transported and installed by a SUSS MicroTec service technician or person authorized by SUSS MicroTec.
Users who open containers with system components or install or transport the machine without a SUSS MicroTec technician or a person authorized by SUSS MicroTec **do so at their own risk**.
Power connections and supply connections (compressed air, nitrogen, etc.) at the installation site must be completely installed by the customer before installation so the machine can be connected.

2.1. Prerequisites for Installation

The following installation prerequisites must be met before the machine can be operated optimally:

2.1.1. Ambient Requirements

- The machine must be installed on a vibration-free surface since vibrations can negatively influence the machine's function.

  --> We recommend setting up the machine on a SUSS MicroTec vibration-insulated base frame intended for this purpose.

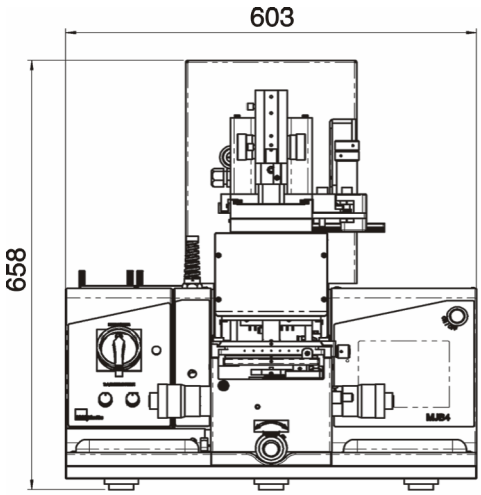
- The machine must be installed in a clean room. Impurities in the air have negative effect on the machine's function.

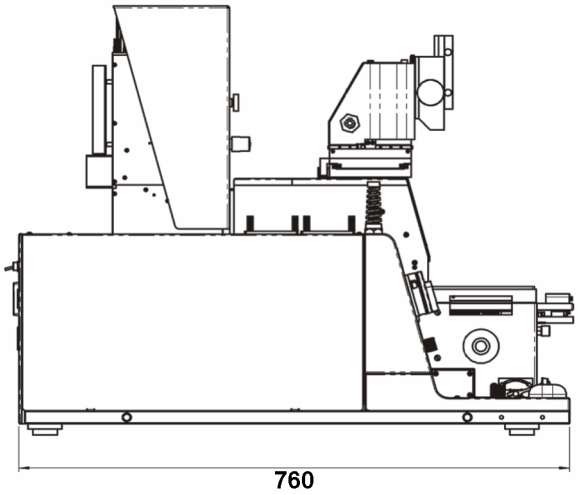
  --> We recommend clean room class 1000 or better.

- The room temperature and relative humidity should be controlled at the setup site.

  --> We recommend a room temperature between 20°C (68°F) and 22°C (72°F) and a relative humidity between 45 and 55% (not condensing).

- When planning the working area for the operator, allow sufficient dorsal space. The microscope moves forward for the exposure, therefore the operator must have adequate space to back off from the machine.





- The back of the machine must be at least 10 cm (4 in) away from the room wall. See the figure "Dimensions of the MJB4 Mask Aligner:" for the exact dimensions of the aligner.

  --> We recommend a distance of 30cm (12in).

Dimensions of the MJB4 Mask Aligner:

Width:	603 mm
Depth:	760 mm
Height:	658 mm 1400 mm (with base)
Weight:	approx. 150 kg MJB4 160 kg base

Power Data:

Standard with CPC200:	300 VA ; 230 V AC ±10% ; 50/60 Hz
Standard with CPC350:	500 VA ; 230 V AC ±10% ; 50/60 Hz
Standard with CIC1200:	1200 VA ; 230 V AC ±10% ; 50/60 Hz
Power overview:	CPC200 = 300 VA CPC350 = 500 VA CIC1200 = 1200 VA Machine = 250 VA Ext. power =250 VA (standard) Max. connected load = 16 A
Power cord:	grounded 3-wire cable; 3.0 m

Specifications for Automatic Circuit Breakers:

V(AC) input [1]	100-240
F1(A) Main Power	7.5
F2(A) Ext. Power	7,5
F3(A) Lamp Power Supply	7,5
F4(A) Electronics	4

1. The CIC1200 only works with 230 V (AC) current

Supply Media:

Nitrogen:	ca. 1.5bar, 30 - 45 psi;
Consumption:	Depends on lamp model; see table 1.
! Warning !	Use dry nitrogen only
	Water, oil and dust particles must be removed from the compressed air supply system.
Vacuum:	-0.8 bar manometer reading (equals 0.2 bar absolute)
Compressed air:	
Without base:	ca. 5.5 bar, 75 psi
With base:	ca. 7.0 bar, 105 psi
Consumption:	ca. 1.0 m^3/h, 35 scf/h

The machine has connections for pneumatic hoses with a 6mm outer diameter or connections for pneumatic hoses with a 1/4 inch outer diameter. Hose couplings for supply media connections are not included.

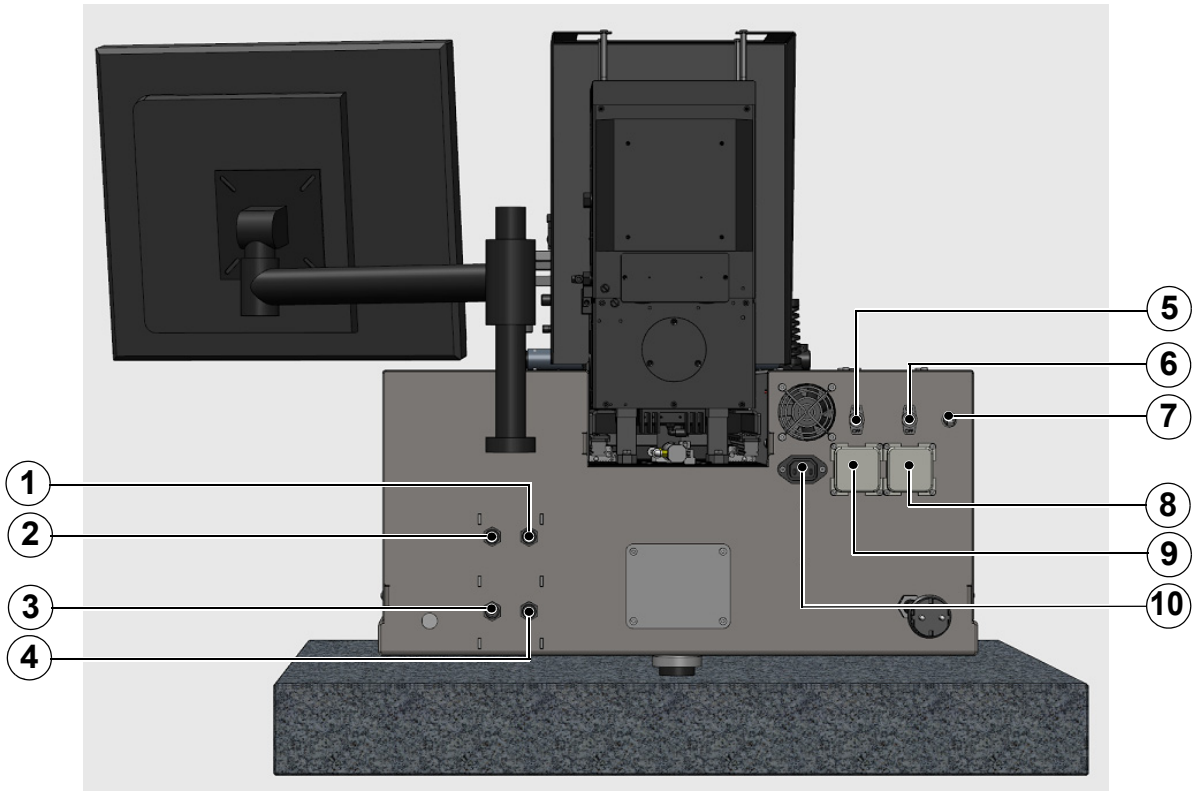
Table 1: **Settings for lamp cooling and lamp housing extraction**

						Notes
Exposure lamp	[W]	200 Osram	350 Osram	350 Ushio	500 Ushio	
Nitrogen Main pressure	[bar]	1.5	1.5	1.5	1.5	
Nitrogen lower lamp base	[l/h]	180	180	180	220	Must be set by service technician
Nitrogen upper lamp base	[l/h]	-	-	-	220	Must be set by service technician
Nitrogen Shutter	[l/h]	260	260	260	260	Must be set by service technician
Diameter of exhaust on bottom	[mm]	closed	closed	closed	100 required	needs adapter tube outlet temp.< 60°C
Notes			reduced DUV+Ozone		**for DUV appl. REVERSED polarity!**	

Lamps that can be used:

- HG 200 W/2 - PN: 146 051
  (additional lamp adapter required, item no.: 189336)
- HBO 350 W-S - PN: 146 049
- USH 350 DS - PN: 182 538

UXM 501 MD - PN: 148 979
(additional lamp adapter required, item no.: 202485)



Connections at MJB4 rear

1 Nitrogen
2 CDA
3 Vacuum
4 Outgoing air
5 F2 - Lamp Power Supply
6 F3 - External Power
7 Main Power
8 External Power
9 Lamp Power Supply
10 External Power

2.2. Transporting the Mask Aligner

Special safety precautions must be taken to protect the Mask Aligner from damage before it can be transported.

The machine must be transported and installed by a SUSS MicroTec service technician or person authorized by SUSS MicroTec.

Users who transport the machine without a SUSS MicroTec service technician or a person authorized by SUSS MicroTec **do so at their own risk**.

2.2.1. Warranty and Restrictions

Devices are delivered with a 12-month warranty. This warranty also applies to material included with the machine and working quality of the machine. This warranty can vary in individual cases due to different national laws in other parts of the world, for example. The warranty for this machine is included in the attached documents.

The warranty is limited to:

- Equipment and material unpacked and installed by a SUSS MicroTec service technician
- Equipment and material used according to the instructions in the operating manual
- Equipment and material that is maintained and handled carefully and as indicated in the instructions

This warranty does not cover:

- Damage caused while transporting the machine (damage must be shown to the shipping company)
- All parts subject to normal wear and tear (e.g. exposure lamps, exposure masks, microscope lights, etc.)

2.2.2. Receiving and Unloading the Machine

- Persons must never stand under suspended loads!
- Check the number of shipping containers
- Observe the transport instructions on the shipping container
- Never tilt or hit shipping containers
- Check shipping packaging for traces of damage due to shipping
- (tilt indicator, impact indicator)
- Inform SUSS MicroTec and the shipper immediately if any damage is detected
- If necessary, the machine must be stored in a dry, heated room

2.2.3. Opening the Shipping Containers

- If shipping damage is suspected, do not open containers until a SUSS MicroTec service technician or a person authorized by SUSS MicroTec is present. If clear damage is detected, call in an average adjuster or an insurance claims adjuster.
- Unpack the machine only in the presence of a SUSS MicroTec service technician or person authorized by SUSS MicroTec.
- Do not lift the machine from the pallet until the sides of the container and machine fixings have been removed.
- Check all accessory parts against the packing slip.
- Store packing material for reshipment or return shipment.
- If you would like to return packaging material, you must make arrangements with the appropriate SUSS MicroTec representative.

2.2.4. Transport without a Pallet

- The relevant safety and shipping conditions in force must be observed for transport
- Persons must never stand under suspended loads!
- Leave the cover above the machine until the machine has reached the intended location
- Do not, under any circumstances, loosen the machine’s transport locks before the machine has reached the intended location
- Lifting the machine by placing a forklift directly beneath the bare base plate causes a serious slip hazard
- Avoid tilting the machine beyond 10° when

transporting the it on wheels over a ramp.

Warning!

The center of gravity is behind the middle of the machine (lamp housing).

We recommend the following procedure for lifting the machine:

- Loosen the 4 angle brackets used to secure the machine to the pallet.
- Next screw in the 4 eyebolts (see figure “Eyebolts”) into the holes where the mounting brackets were attached.
- Next thread 4 transport straps of a sufficient and equal length through the eyebolts.

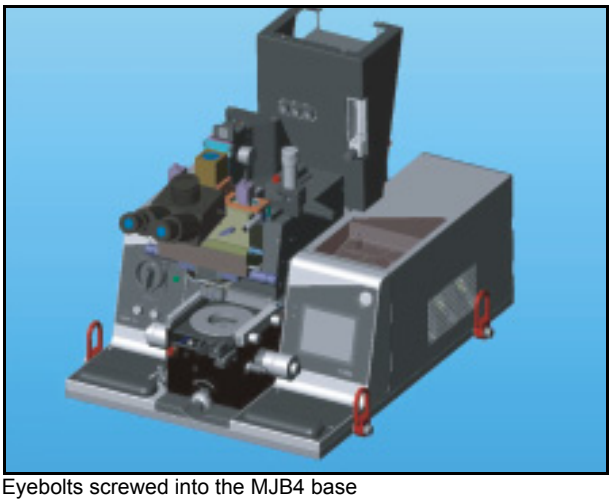
Warning!

Make sure the transport straps have sufficient lifting capacity. Refer to the shipping papers for the weight of the machine, which varies according to the equipment.

Warning!

Also make sure the transport straps are made of an appropriate material to avoid damaging the machine.

Eyebolts

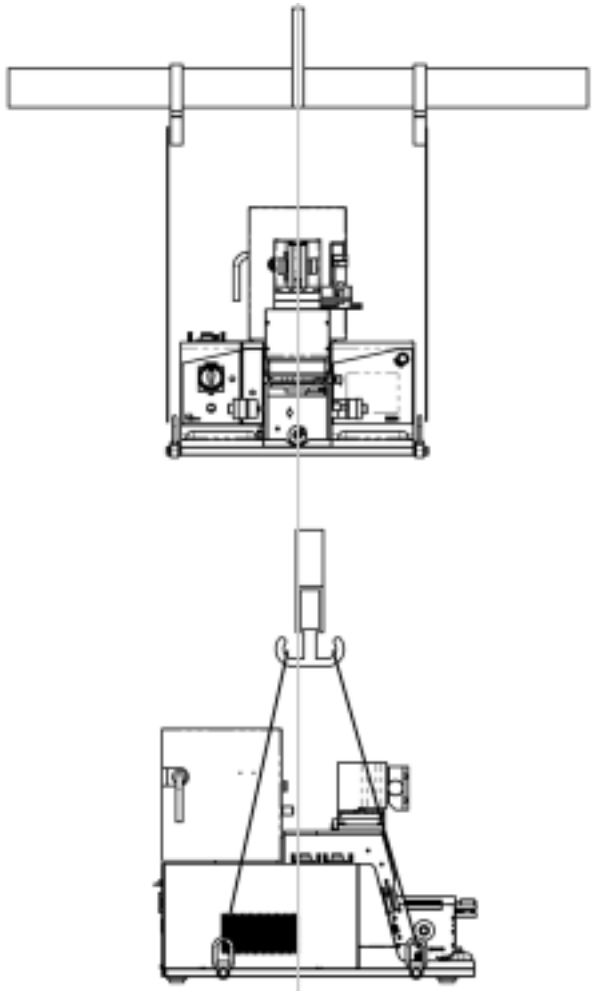


Eyebolts screwed into the MJB4 base

- We recommend using cross beam part no.: **187724** for transporting the machine (see figure: “Transporting the MJB4 using a cross beam”).

  The cross beam ensures that the transport straps do not lie against the machine and therefore cannot exert any forces on the machine (coverings, lamp housing, etc.), which could happen if transport straps are lead to a centered lifting hook.

If no transport cross beam is available, make sure the transport straps do not damage the machine. We recommend dismantling the lamp housing.



Transporting the MJB4 using a cross beam

2.2.5. Transportation Locks

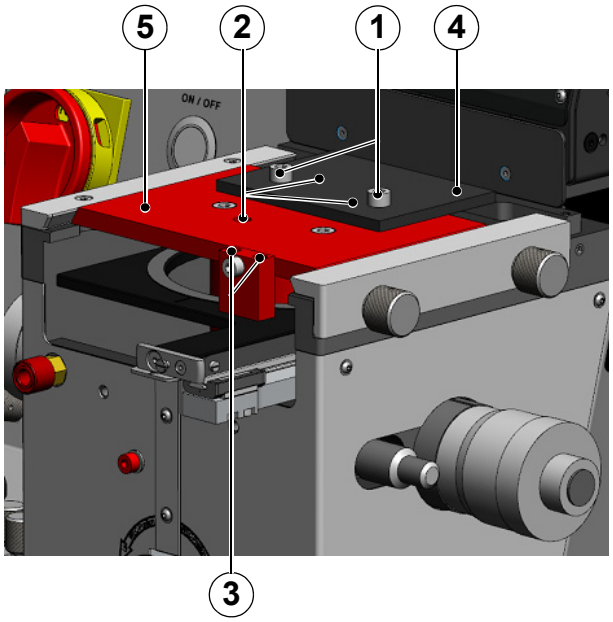
The following transportation locks must be removed before commissioning the machine.

Alignment Stage

- Unscrew and remove screws 1 (2x) and remove plastic plate.
- Unscrew and remove screws 2 (two of them were hidden from the plastic plate) (3x)
- Unscrew and remove screws 3 (2x)
- Open the mask holder clamping and remove the transport lock.

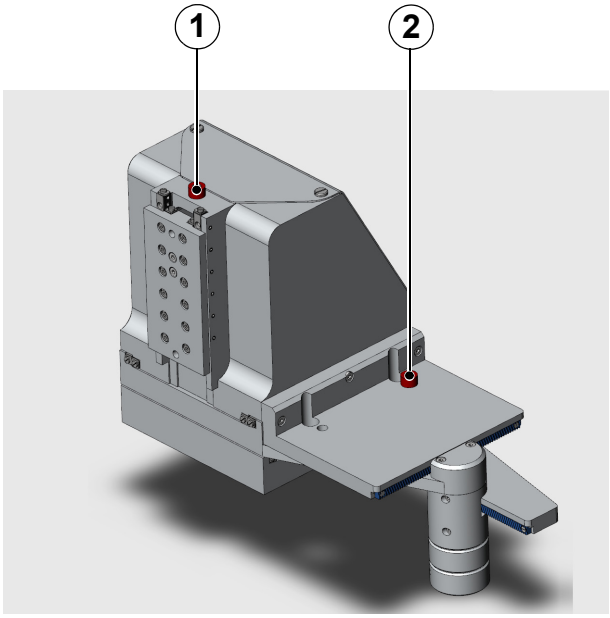
TSA Microscope Manipulator

- Remove screws 1 and 2.
- Screw 1 secures the microscope stroke, and screw 2 secures the X-Y adjustment on the manipulator.



Alignment Stage

1 Screw 1 (2x)
2 Screw 2 (3x)
3 Screw 3 (2x)
4 Plastic plate
5 Transport lock (marked red)



TSA Microscope Manipulator

1 Screw 1
2 Screw 2

2.2.6. Taking the Machine out of Service

Before shutting down the machine for a longer period of time, you must be advised by a SUSS MicroTec service technician.

We strongly recommend the following before long-term decommissioning:

- Perform maintenance on all mechanically moved parts
- Cover the machine with a dust-tight cover
- Add sufficient drying agent inside the cover.

Special safety precautions must be taken to protect the Mask Aligner from damage before it can be transported.

The machine must be transported and installed by a SUSS MicroTec service technician or person authorized by SUSS MicroTec.

Users who transport the machine without a SUSS MicroTec service technician or a person authorized by SUSS MicroTec do so at their own risk.

The following minimum requirements must be fulfilled to prepare the machine for transportation:

- Exposure lamp and exposure optics
- All transport safeguards provided are attached and/or activated
  (adjusting table, TSA microscope manipulator, lamp housing)
- Machine is covered with a dust-tight cover

The previous sections must be observed for actual transportation.

If you anticipate strong vibrations or high temperature fluctuations, additional special safety precautions are required!

2 INSTALLATION AND TRANSPORT

3. OPERATION OF THE MJB4

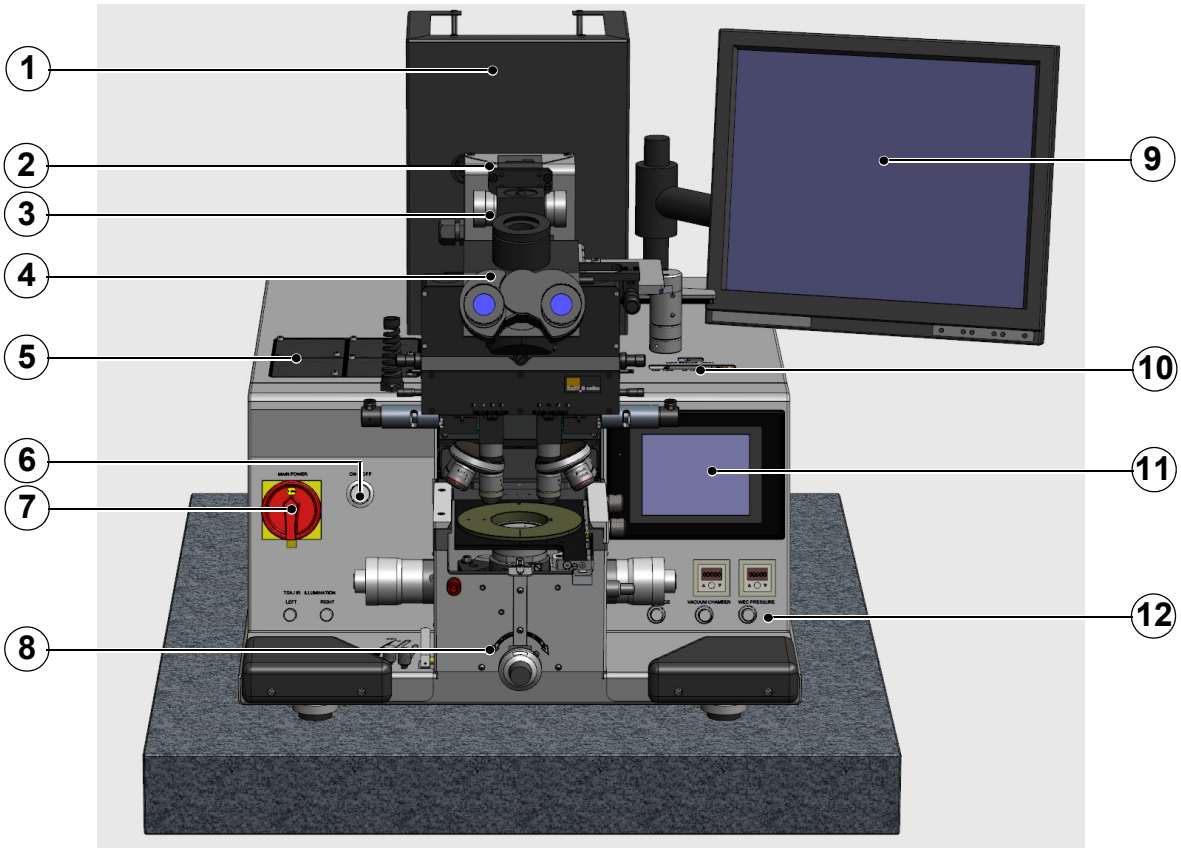
The MJB4 Mask Aligner allows contact exposures of different types (vacuum, hard, soft contact) as well as exposures at short distances and can be used to transfer structure dimensions down to the submicron range.

The achievable alignment accuracy X, Y and Theta is below 1 µm.

Masks and wafer/substrates to a total thickness of 9.00 mm can be processed.

The MJB4 is equipped with 400 nm exposure optics and lamps that allow a resolution of< 1µm in vacuum contact. Using 300 nm or 250 nm exposure optics or an Excimer laser results in a significantly higher resolution.

Unitary construction ensures that the components are easy to service. Function groups are easy to reach and the individual Unites, such as for the pneumatic system and the PLC controller, can be quickly replaced.



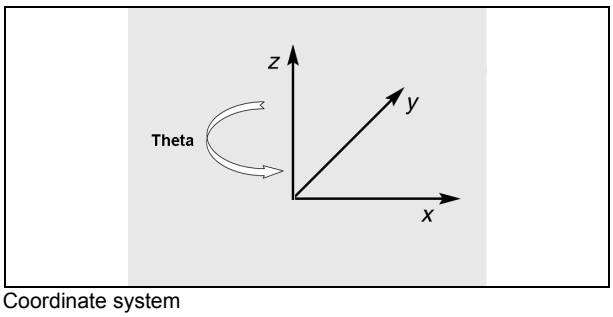
SUSS MJB4 Mask Aligner

1 Lamp house
2 TSA microscope manipulator
3 Microscope focus setting
4 TSA microscope
5 TSA/IR illumination
6 Electronics ON/OFF key
7 Main switch with emergency off function
8 Alignment stage
9 Monitor for microscope video image (option)
10 Pneumatic settings
11 Display/touch screen
12 Pneumatic gauges

3.1. Definitions

3.1.1. Coordinate System

The unit for position specifications in the X and Y directions is millimeters. The unit for position specification in the Z-direction is micrometers. The specifications refer to a coordinate system whose X and Y origin is the center of the alignment station. The zero point of the Z-axis is in the active mask level or the upper substrate level.



Coordinate system

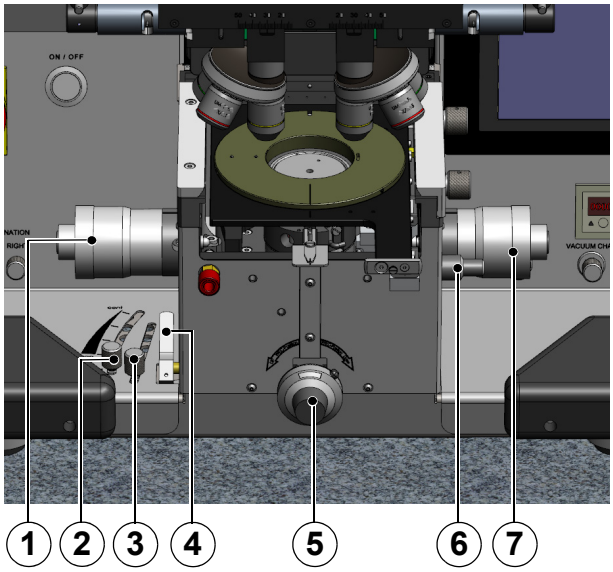
3.2. Controls and Displays

Main switch with emergency off function

This switch connects or disconnects the mask aligner and its lamp power supply to or from the power supply network.

In the event of danger, turn the switch to the OFF position.

3.2.1. Alignment Stage



Alignment stage with coordinate system

1 Stage – Y motion
2 Separation lever
3 Alignment gap setting
4 Contact lever
5 Variable thickness setting
6 Stage – Theta motion
7 Stage – X motion

Stage - X Motion

This micrometer screw is located on the right side of the alignment stage and moves the substrate in X-direction. The travel path is ±5 mm.

Stage - Y Motion

This micrometer screw is located on the left side of the alignment stage and moves the substrate in Y-direction. The travel path is ±5 mm.

Stage – Theta Motion
This is the small micrometer screw on the right side of the alignment stage. The maximum turning range is ±5°.

Separation Lever
The separation lever is on the left side of the alignment stage. For wedge error compensation, it must always be set to the contact position (CONT). This lever moves the substrate from the contact position to the alignment distance. The separation lever only works if the contact lever is in the rear position.

The alignment distance is set using the knurled knob next to the separation lever on the right. After setting the distance, tighten the knob until it is snug.

The maximum alignment distance between the mask and substrate is 50 µm.

Contact Lever
The contact lever is also located on the left side of the alignment stage.

Pulling this lever back activates wedge error compensation and automatically connects the vacuum for chuck and substrate.

Variable Thickness Setting
The variable thickness setting is located on the front side of the alignment stage.

It sets the contact position between the mask and substrate. It must be reset for different mask and substrate thicknesses. The thickness setting can also be used for higher contact pressure.

Turning the setting knob clockwise moves the Z-axis downward and turning it counterclockwise moves the Z-axis upward.

- 1 revolution corresponds to 150 µm
- More instructions on this setting can be read in section 3.4.7. "Setting the Mask Substrate Thickness".

3.2.2. Display/Touch Screen

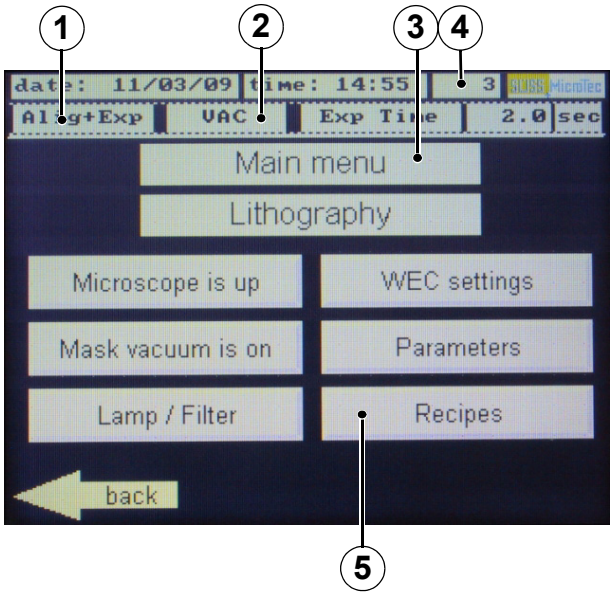
Instructions, confirmations and other information appear on this screen depending on the situation.

When pressing the displayed buttons directly at the touch screen, programming and operation can be performed.

The messages in the display always show the ACTUAL status of settings, e.g:

If the microscope is in the operating position, "**Microscope is down**" appears in the main menu. Pressing this button moves the microscope upwards and the display button changes to "**Microscope is up**."

The arrows in the lower right and left of the display toggle through the program menu. The marking of the arrows shows the access to the next program step



Main Menu

1 Selected program mode
2 Set parameters
3 Screen name
4 Screen number
5 Menu selection

Note:

After 30 minutes without action the monitor is switched off (screen saver). Touching the panel switches it on again.

3.2.3. Topside (TSA) Microscope Manipulator

The microscope manipulator is moved in the X- and Y-directions using the split knurled knob on the right side of the manipulator.

The upper knob moves the microscope in the X-direction. The travel path is ±40 mm.

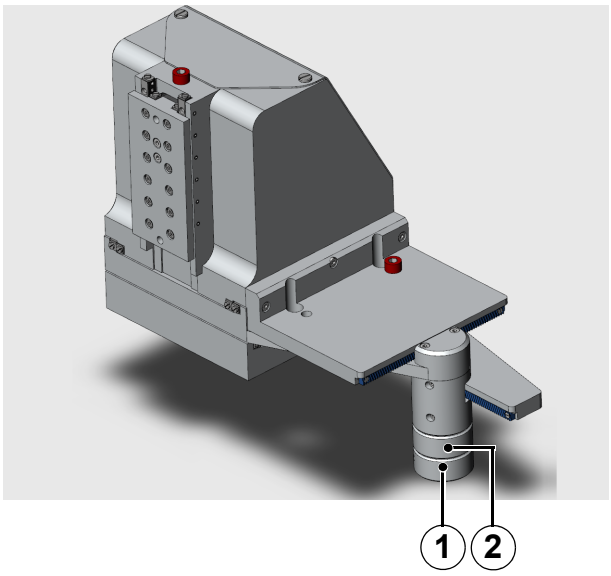
The lower knob moves the microscope in the Y direction. Here the travel path is +30 mm/-50 mm.

Attention!

Before exposure and during mask loading and unloading, the microscope moves up by 20mm and the exposure unit moves approx. 150 mm toward the operator.

Caution!

The machine warns by a beep prior to microscope movements in upward or forward direction. When the beep sounds, back off from the microscope immediately.



TSA Microscope Manipulator

1 Movement in the Y direction
2 Movement in the X direction

3.2.4. TSA Microscope

3.2.4.1. M500 Microscope

The Brightness is regulated with the left controller under the main power switch.

TSA Beam Splitter
This slide to the right of the microscope selects the lens image for the eyepiece, the monitor or both.

TSA Z Motion
These large knobs are located above the microscope on both sides.

Fine focusing takes place with very little torque up to one revolution. Further rotation with increased torque activates coarse focusing.

TSA Illumination Aperture
The aperture diaphragm is used to set lens illumination separately.

4x Lens Revolver
Lenses can be changed by turning the thumb wheel by 90°.

3.2.4.2. M604 Microscope

Before using the microscope, the microscope illumination must be switched on using the corresponding button on the touch panel.

Brightness is regulated by the controllers under the main power switch.

TSA Beam Splitter
This slide to the right of the microscope selects the lens image for the eyepiece, the monitor or both.

TSA Z-Motion
These large knobs are located behind the microscope body on both sides. Fine focusing takes place with very little torque up to one revolution. Further rotation with increased torque activates coarse focusing.

TSA Theta Motion
The small knob on the front upper right side rotates the microscope around the Z-axis.

Fine Setting of Lens Focus
Separate fine focusing of the M604 microscope is only possible using the controllers to the left and right of the microscope body.

Lens X Separation Button
The left/right lens can be moved separately in the X-direction using the left/right controller.

TSA Illumination Aperture Diaphragm
The left and right aperture diaphragms are used for the separate setting of the left and right lens illumination.

TSA Splitfield Switch
This switch on the front of the microscope selects the left and/or right lens images as the source for the eyepiece and the monitor.

3.2.4.3. TSA Splitfield Switch for IR Use

The splitfield switch for IR use of an M604 microscope is set within the display in the **Parameter** menu. The settings can be done as follows:

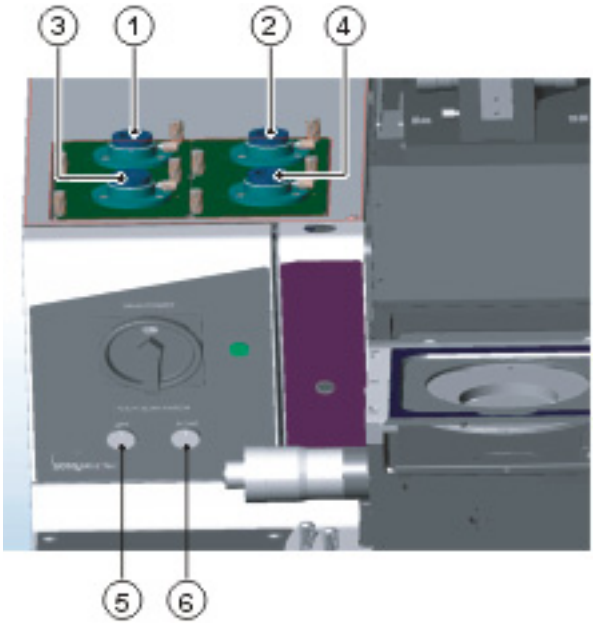
– right frame
– left frame
– splitfield

3.2.5. Microscope Illumination

TSA/IR Illumination Switch
The illumination for the TSA microscope or IR use can be switched using the "**Incident light**" or "**Infrared transmitted light**" button on the touch panel within the **Parameter** menu. The light is supplied via a fiber optic cable.

TSA/IR Microscope Illumination

Depending on which illumination type is selected, the TSA or IR illumination can be set using the left/ right ILLUMINATION potentiometers on the left front plate.



Microscope Illumination

1 Illumination fixture 1
2 Illumination fixture 2
3 Illumination fixture 3
4 Illumination fixture 4
5 Left illumination controller
6 Right illumination controller

Illumination Assignment

– Illumination 1:
M500 single-field microscope
– Illumination 1 + 2:
M604 split-field microscope
– Illumination 3 + 4:
are for using IR incident light and IR transmitted light

3.2.6. Lamp House

If the uniformity of the exposure lamp varies by more than ±5%, it should be readjusted within the lamp house and optics.

When an exposure lamp is replaced (see section 1.6.1.2. "Changing the Lamp"), the uniformity should be checked first and then readjusted if necessary. To do so, use the three setting knobs at the front of the lamp house.

- Left setting knob for Y-direction
- Middle setting knob for Z-direction
- Right setting knob for X-direction

Setting Instructions:

The lamp must be on for about 20 minutes before it reaches operating temperature. **The Lamp test** function can be selected in the main menu. Using the SUSS UV1000 intensity meter with the appropriate probe, you check and set the intensity and uniformity of the light.

Setting procedure: Place the probe in the center of the light. The middle setting knob for the Z-direction should be set so that the measuring device displays the highest value. Do the same for the X- and Y-directions.

Next, the light uniformity over the entire exposed surface must be tested and, if necessary, slightly corrected using the X, Y and Z setting knobs.

Attention!

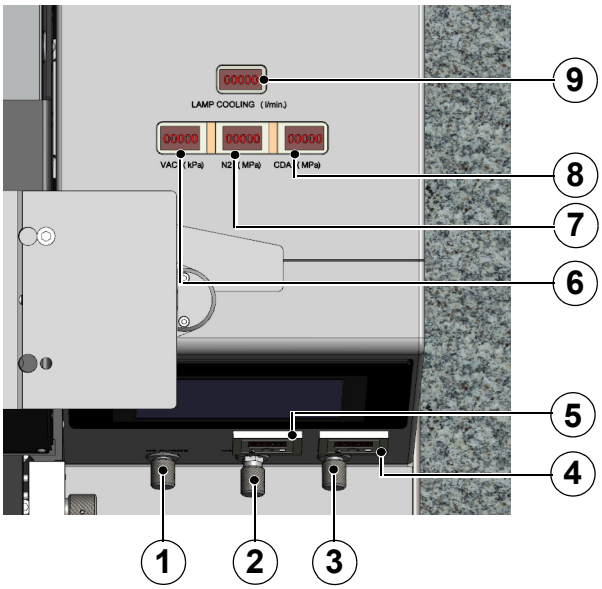
UV light can seriously damage your eyes.

Never remove the covers on the beam path when the UV lamp is on!

Always wear UV protection goggles and skin protection as well during lamp adjustment.

UV protection goggles must be worn even when measuring light on the exposure chuck.

3.2.7. Basic Pneumatic Settings



Basic pneumatic settings

1 Nitrogen purge mask holder controller
2 Reduced vacuum chamber controller
3 WEC pressure controller
4 WEC pressure gauge
5 Vacuum chamber gauge
6 Vacuum gauge
7 Nitrogen gauge
8 CDA gauge
9 Lamp cooling gauge

Compressed Air

The device works reliably at an operating pressure of >5.5 bar. The pressure must be set correctly on the pressure reducing valve by a service engineer and then read from the manometer.

Nitrogen

A nitrogen pressure rated at 1.5 bar must be set on the pressure reducing valve by a service engineer and then read from the manometer.

Nitrogen is used to cool the exposure lamp, to build up additional pressure under the substrate (hard contact exposure), as a cover gas for the substrate, and to ventilate the vacuum chamber after vacuum exposure.

Vacuum
The vacuum supplied to the machine should be -0.8 bar. The vacuum level can be read on the corresponding manometer.

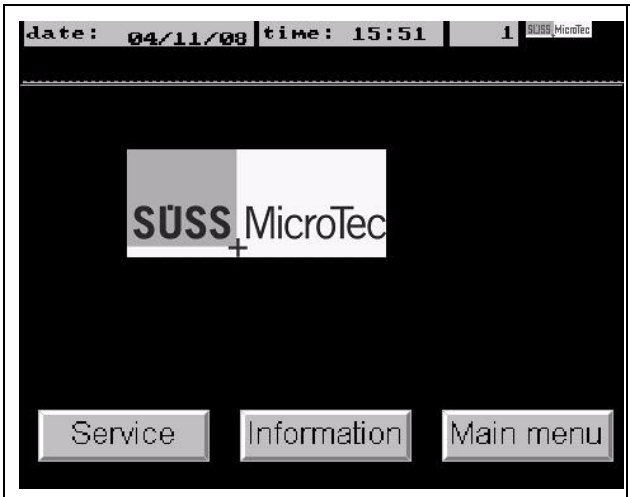
All main pressures are monitored by detectors which display an error message on the touch screen if there is a deviation of approx. -20%.

Low Vacuum (with controller)
This controller sets the low pressure within the vacuum chamber between the substrate and mask. The vacuum is regulated by injecting additional nitrogen into the vacuum line.

WEC Pressure (with controller)
For wedge error compensation, the substrate must be pushed against the mask with a defined amount of force. The WEC pressure is used to compensate for the greater weight of a large chuck. The WEC pressure must also be proportionally adjusted to the substrate surface. The pressure for wedge error compensation can be set to meet specific processor requirements (value between 0.2 and max. 2.0 [bar]). This can be done using the WEC PRESSURE setting knob.

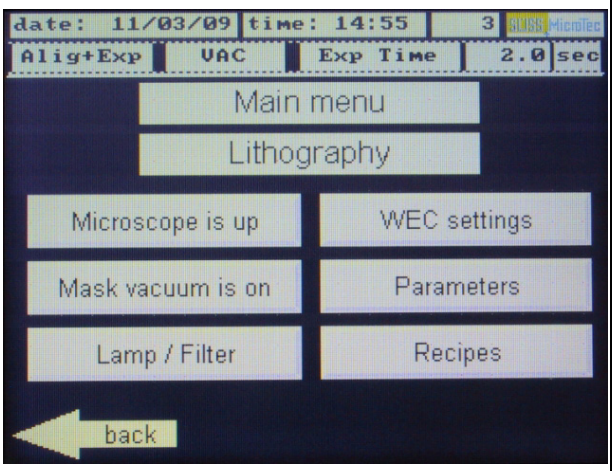
N_2 Purge Mask Holder (with controller)
The alignment station is equipped with nitrogen purge to reduce the oxygen content between mask and substrate when negative resist is used. The nitrogen is injected from the back of the mask holder frame between the mask and substrate. The volume of nitrogen can be set using the PURGE MASK HOLDER throttle.

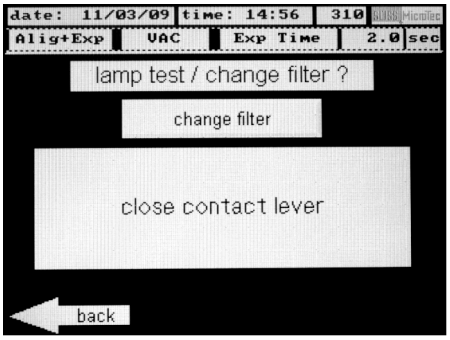
3.3. Main Screens and Menu Navigation



Screen Page: Start

- The start screen appears after switch-on and initialisation of the machine
- The button **Service** provides access to the service programs (only for well trained service personnel and after input of a 5-digit number)
- Pushing the button **Information** gives access to 4 different information pages. Following informations are available:
  - Serial numbers
  - Software versions
  - Machine configurations
  - Time settings
- The button **Main menu** leads to the main screen page of the user interface.

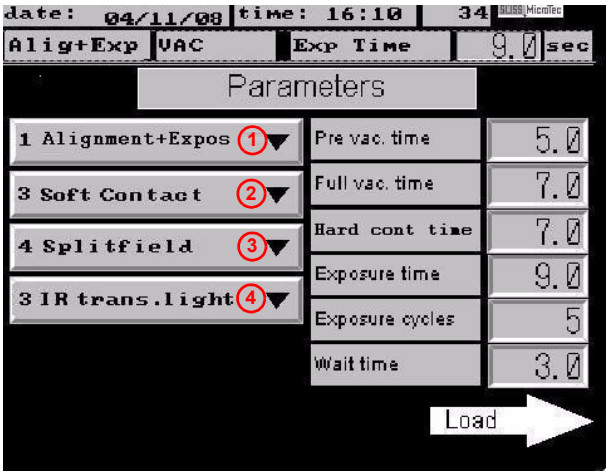




Screen Page: Main menu - Lithography

- The buttons **Microscope is up/ down** and **Mask vacuum is on/off** each show the actual state of the machine. Pushing the button each activates the opposite state.
- Pressing the button **Lamp/ Filter** opens a subwindow. The toggle switch **lamp test/ change filter?** gives access to
  - **Lamp Test:** the mirror house moves forward and the shutter is opened. Now the intensity and uniformity within the exposure area can be checked.
  - **Filter Change:** the mirror house moves forward, shutter keeps closed. Free access to change the filter within the optics tube.

  Contact lever must be closed to use the options.
- Using the button **WEC settings** provides access to the screen **WEC setting**. After pushing the contact lever the retraction depth of the wedge error compensation head can be adjusted.
- The button **Parameters** opens the parameter screen. Depending on the selected exposure program different parameters can be programmed.
- The button **Recipes** gives access to the recipe editor. Here new recipes can be stored or existing recipes can be selected and deleted.



Screen Page: Parameters

- **Button 1** gives access to the selection of:
  - Alignment+Expos.
  - Flood Exposure
  - Imprint (option).
  - Test Exposure

After pushing the desired program it is displayed on button 1.

- **Button 2** gives access to following exposure modes:
  - Soft contact
  - Hard contact
  - Low vacuum contact
  - Vacuum contact
  - Gap exposure

  They are displayed on button 2.
- With **Button 3** different microscope image displays can be selected:
  - Splitfield
  - Right frame
  - Left frame
- With **Button 4** alternatively **Incident light** or **IR-transmitted light** (if configured for this application) can be selected. The selected microscope option is displayed on button 4
- Depending on the selected exposure program different parameters e.g. Pre vac time, Full vac time, Exposure time can be programmed. As soon as the corresponding button has been pushed a numerical key board is displayed. The desired values can be typed in and are confirmed with ENTER.
- Pushing the arrow key **Load** activates the selected program.

Screen Page: Recipe Editor

- To save a program permanently it has to be stored with its own name within the recipe editor.
- First, select the desired parameters for the new program
- After pressing the button **New** a key board appears and the desired name for the recipe can be typed in.
- With ENTER you can save the recipe which is then displayed with its name in the recipe list.
- The selection of a recipe is performed by moving the cursor with the black arrow keys to the desired position and pressing the arrow **Load**. The program switches back to the main menu and the actual selected program name is displayed at the upper info line.

Screen Page: Exposure menu

As soon as wedge error compensation and alignment have been performed and the substrate is in contact with the mask the exposure menu appears on the screen:

- After pressing the button **Alignment Check** the exposure program is started (sequence depends on the selected program) and is stopped before exposure. The alignment accuracy can be checked at this point (e.g. for shifting)
- The button **Exposure** starts the program sequence and performs exposure without a stop.
- When pressing the button **Parameters** the program jumps back to the parameter screen and the actual data can be changed.

3.4. Operating Sequences

3.4.1. Switching the Machine On/ Off

3.4.1.1. Preparation for Switching the Machine ON

The following procedure assumes that the mask aligner is properly installed and the equipment is connected to the power supply as soon as the main switch is turned on.

The machine should have the following pressure values:

- **Compressed air: 5.5 bar**
- **Nitrogen: 1.5 bar**
- **Vacuum: -0.8 bar (0.2 bar absolute)**

3.4.1.2. Switching On the Machine

Turn the main switch with emergency off function (front plate, left) to ON and wait until „Start machine with ON/OFF button“ is displayed then press the Electronics ON/OFF button (front plate).

Then the start page appears and after pushing the button **Main menu** the main menu is displayed.

The exposure lamp is switched on automatically if a CPC200/CPC350 power supply is used.

The CICI200 power supply is in stand-by mode after the machine is switched on. The lamp must be switched on separately at the CIC1200.

If the CIC1200 must be recalibrated after replacing the lamp, proceed as described in section 3.4.2. "Switching On and Calibrating the Exposure Lamp".

3.4.1.3. Switching Off the Machine

The machine is switched off using the Electronics ON/OFF button.

Press ON/OFF button longer than 2 sec to switch off the lamp and the electronics.

The lamp power supply is switched off immediately and the MJB4 electronics switches off automatically after the cool down phase is complete (10 minutes).

IMPORTANT NOTE:

- **To switch on the mask aligner, select the start page and press the Electronics ON/OFF button on the left side of the front plate.**
  Using the CPC200/CPC350 power supply the exposure lamp is also switched on.
  Using the CIC 1200 the lamp must be switched on separately using the CIC 1200 key pad.

Attention!

Unload the mask before switching off the machine!

Caution!

The microscope pivots upwards!

Only coarse focus the TSA microscope when it is pivoted down or else the lenses may be set too low and collide with the mask or the mask holder.

In case of danger, turn the main switch to OFF!

3.4.2. Switching On and Calibrating the Exposure Lamp

(also refer to the operating manual of the respective power supply)

Lamp power supply CPC200/CPC350

If the mask aligner is equipped with a CPC200/ CPC350 power supply, the lamp can be switched on or off directly with the ON/ OFF switch of the mask aligner. For this purpose the toggle switch of the CPC200/ CPC350 has to set to „1“.

The lamp can also be switched on and off with the toggle switch of the CPC if the machine is already switched ON. (see also user manual CPC200/ CPC350).

Lamp Power Supply CIC1200

If the mask aligner is equipped with a CIC1200 power supply, the lamp can only be switched on directly at the CIC1200 and only if the mask aligner is already switched on.

To switch off the lamp either the ON/ OFF switch of the aligner or the power supply can be used.

The calibration of the CIC1200 is performed according to the user manual directly at the power supply (see manual CIC1200).

For both applications a 10 minutes long waiting period must be kept. Within this period the lamp must not (and cannot) be ignited.

Warning!

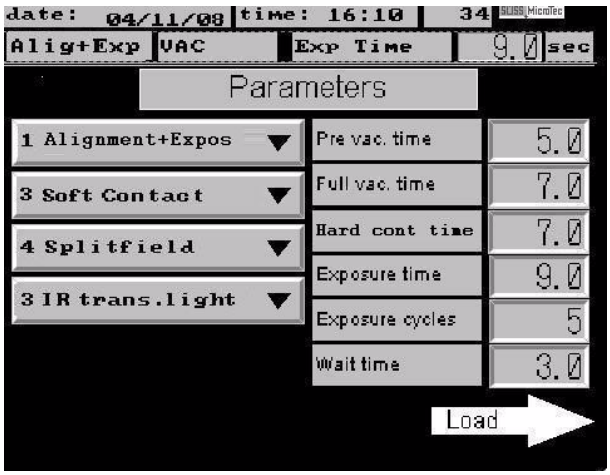
The exposure lamp is switched off automatically if there is nitrogen loss for longer than 3 minutes or 5 minutes resp. depending on the lamp type!

If problems occur with the power supply unit during ignition of the exposure lamp, shut down the machine immediately via the EMO at the mask aligner and inform the service department of SUSS MicroTec.

SUSS MicroTec assumes no liability for damages resulting from the improper use of the mask aligner.

3.4.3. Setting the Parameters

This selection is activated by pressing the **Parameters** button in the main menu. Depending on the selected exposure program (button 1 and 2) a choice of different parameters are displayed.



Parameters

Pre-Vacuum Time

Sets the pre-vacuum time for LOW vacuum and vacuum contact.

Full Vacuum Time

Sets the main vacuum time before exposure for LOW vacuum and vacuum contact.

Hard Contact Time

This function is used to set the time for nitrogen pressure under the substrate before exposure.

Exposure Time

Pressing this button opens a key board which allows you to enter the desired exposure time. Confirm your entry with the ENTER button. The display automatically switches back to the **Parameters** menu and adds the value that you just set.

Exposure Cycles

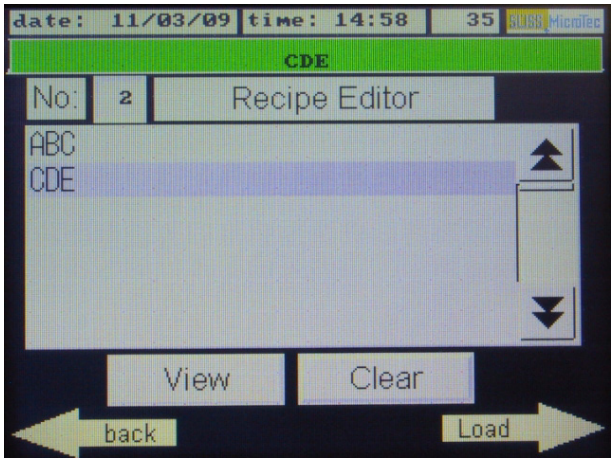
If more than one exposure cycle is entered, the pause time between the individual cycles can be changed. Press **Wait time** on the display to do so.

Pressing the arrow key **Load** adds the set parameters.

3.4.4. Saving and Loading Programs

This function allows for saving of selected settings to a specific program space or selecting a previously saved program.

Pushing the button **Recipes** in the main menu the **Recipe Editor** appears. Here all already stored programs are listed and new programs can be stored. With the black arrow keys you can scroll through the list.

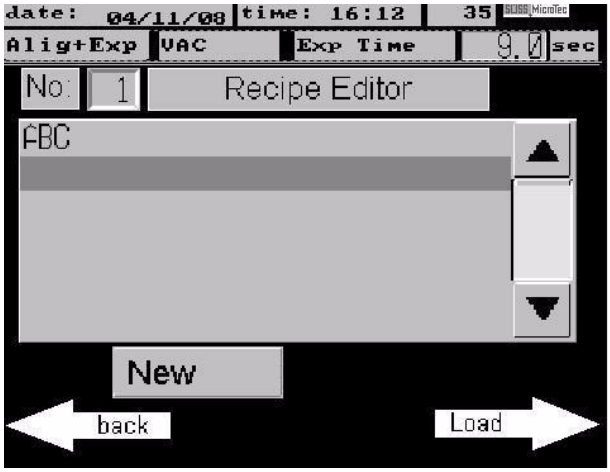


Screen: Recipe Editor

- An already stored recipe in the menu is selected with the **Show** button. All included parameters are displayed. Pushing the button **Load** will activate the selected parameters and the display switches back to the **Main menu**. The recipe name is shown on top of the display.

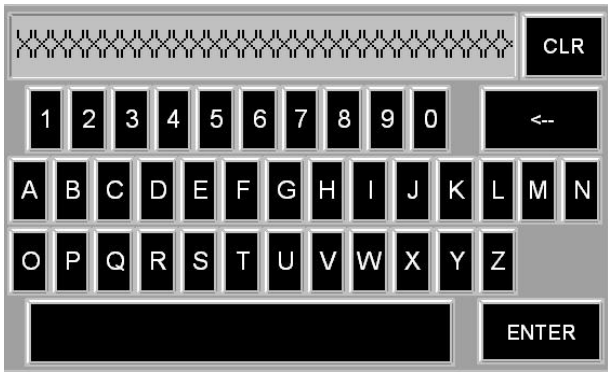
Attention!

If you press the CLEAR button, all selected parameters are deleted and the program space is available again.



Recipe Editor: New Recipe

- If a new recipe is created with new parameters or if an existing recipe has been changed you can store the recipe as a new one within the recipe editor.
  You have to select the next free program space with the cursor (with the black arrow keys).
  Pushing the button **New** opens an alphanumerical key board. The program name for the new program can be typed in and stored via the **Enter** button.
  The display returns to the main menu and the process can be started.



Alphanumerical keyboard

3.4.5. Loading the Mask

Caution!

If the microscope is in the lower position when loading or unloading the mask, the microscope must be moved to the upper position by pressing the "Microscope is down" button. The button changes to "Microscope is up" and displays the actual position of the microscope.

Mask Loading Routine
Remove the mask holder by loosening both knurled screws on the mask holder frame and then place on a tray upside down. Unload any mask if necessary and insert the desired mask.

For safety reasons the „**Mask vacuum is on"** button must be pressed for 2 seconds to switch off the mask vacuum.
The mask can be removed as soon as the button changes to **„Mask vacuum is off"**.

Load the Mask
Place the mask on the mask holder against the stop pins.

The button" **Mask vacuum is off**" is used to switch on the mask vacuum.

Loading and Clamping the Mask Holder
With the top side facing up, push the mask holder into the alignment station and then fasten it in the mask holder frame using the knurled screws.

Attention!

Proper wedge error compensation is not possible if the mask holder is not clamped correctly in the alignment station. The exposure result will be insufficient!

3.4.6. Loading the Substrate

Pulling out the transport slide and loading the substrate

Pull out the transport slide as far as it is possible. Insert a suitable substrate chuck with the substrate resting on the stop pins.

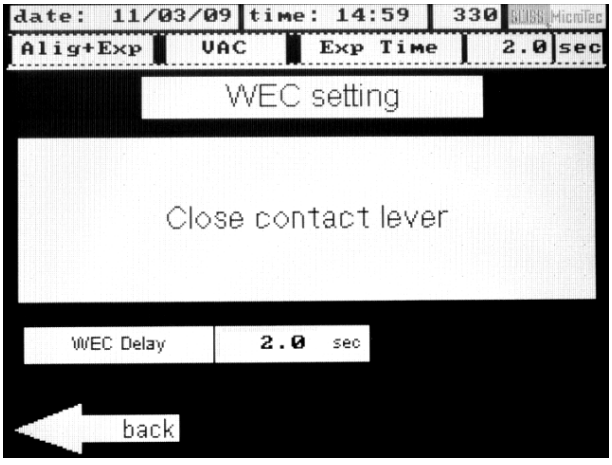
There is a hand valve on the front right side of the transport slide that switches on the transport vacuum for the contact and vacuum chuck.

Carefully insert the transport slide until it reaches the end stop.

3.4.7. Setting the Mask Substrate Thickness

For newly loaded equipment, the thickness setting at the alignment station must be checked and reset if necessary.

To do so, turn the thickness setting on the adjusting table clockwise until it is at its lowest position. Now load the new equipment with mask and substrate. In the main menu select **WEC settings**.



- At the touch screen appears:
  „**Close contact leve**r"
  Move the substrate towards the mask by pushing the contact lever forwards. Afterwards turn the thickness setting upwards (counterclockwise) until the information „**WEC setting OK**" appears on the display.

Clamp down the black lever on the setting knob to prevent it from rotating any further.

The contact lever must be pulled back in order to return to the **Main menu**.

3.4.8. Wedge Error Compensation Pressure

For wedge error compensation (WEC), the substrate must be pushed against the mask with a defined amount of force. The WEC pressure is used to compensate for the greater weight of a large chuck. The WEC pressure must also be proportionally adjusted to the substrate surface. The pressure for wedge error compensation can be set to meet specific process requirements (value between 0.0 and max. 2.0 [bar]). This can be done using the WEC PRESSURE setting knob.

The set value is indicated at the gauge above the setting knob.

3.4.9. Wedge Error Compensation (WEC)

The WEC is performed manually.

To perform WEC using the contact lever, the separation lever must be in contact position. The substrate is moved against the mask with the previously set pressure (section 3.4.8) and WEC is performed. The mask and substrate are now completely parallel to each other.

After the WEC head stops, the separation lever must be moved to the “alignment distance” position in order to perform an alignment.

Caution!

No alignment must be done if the mask and substrate are in contact.

Doing so may damage the mask and substrate!

3.5. Substrate Alignment with the Top Side Microscope

With this mode the substrate is adjusted using the TSA microscope. The following example explains the necessary steps for adjustment and exposure with manual mask loading, soft contact exposure and wedge error compensation in contact mode. With the machine in its initial state, the following procedure steps must be carried out:

3.5.1. Setting the Exposure Values

See section 3.4.3. "Setting the Parameters".

3.5.2. Loading the Mask

See section 3.4.5. "Loading the Mask".

Attention!

In order for all the processes to start, the Main menu must be selected and the contact lever must be moved!

3.5.3. Loading the Substrate

See section 3.4.6. "Loading the Substrate".

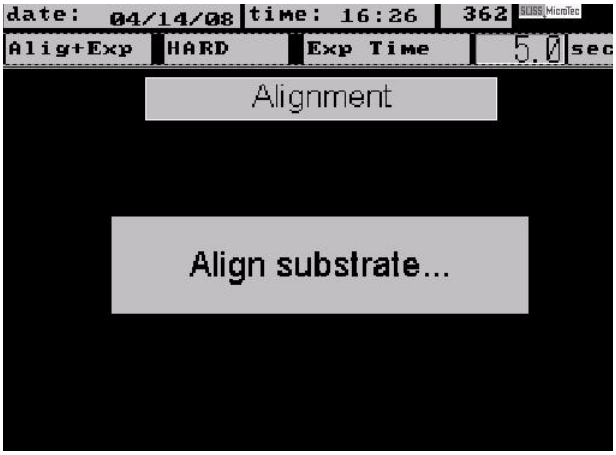
Caution!

The microscope pivots downwards!

Setting the Separation Lever to the Alignment Position

Never align the substrate if the mask and substrate are in contact! Doing so will damage the mask and substrate.

The display shows the page: „Align substrate...“



Screen page: Alignment

3.5.4. Adjusting the Microscope

Setting the TSA Microscope
The splitfield switch must be set to the middle position for the M604 microscope. If a video camera or monitor is not available, then you have to look through the microscope eyepieces.

Microscope Illumination
The illumination has to be **Incident light** which has to be set in the **Parameters**. Set the brightness using the left/right potentiometers on the left front plate.

The left and right aperture diaphragms on the microscope allow you to set the illumination on the left and right separately.

Mask Level Focusing
Coarse focusing is possible using the TSA Z-motion located behind the TSA microscope.

Fine focusing is set separately on the microscope. To do this, use the OBJECTIVE FOCUS FINE MANUAL knob on the microscope.

Set the TSA Microscope to the Mask Alignment Crosses.
The right/left microscope is set to the right/left mask alignment crosses with OBJECTIVE X-SEPARATION.

3.5.5. Aligning the Substrate

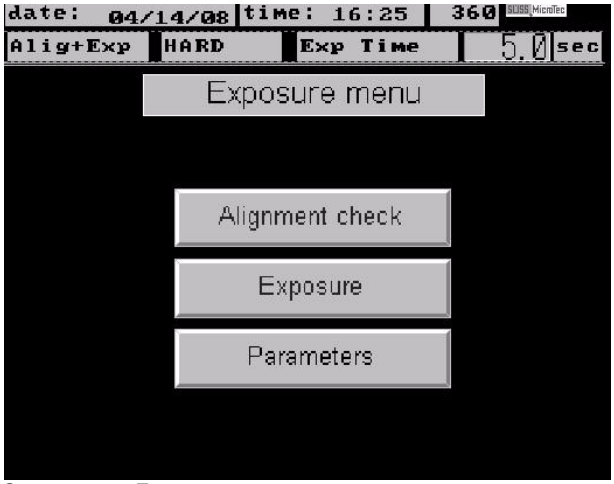
Substrate Level Focusing
For fine lens adjustment, use the OBJECTIVE FOCUS FINE MANUAL knob on the microscope.

Alignment (menu in the display: Align substrate...)
Use the X, Y and Theta micrometer screws on the alignment table for this. Align the substrate alignment crosses so that they are central-symmetrical to the mask alignment crosses.

Caution!

Never align the substrate if the mask and substrate are in contact! Doing so will damage the mask and substrate.

As soon as the alignment is finished, the separation lever must be moved into contact position.
The menu page: **Exposure menu** appears on the touch screen.



Screen page: Exposure menu

3.5.6. Exposure

Once the substrate is aligned and brought to the exposure position using the SEPARATION LEVER, press the **Expose** button to perform the exposure. You must press additionally **Yes** on the display to confirm the exposure.

Screen page: Exposure

If you press NO or use the CONTACT or SEPARATION LEVER, the shutter keeps closed. The substrate can now be unloaded or readjusted.

After pressing Yes the shutter will be opened for the programmed exposure time.

Caution!

Microscope in motion!

3.5.7. Unloading the Mask

To release the mask holder, remove both screws on the right side of the mask holder frame. Take out the mask holder and place it on a tray upside down. Switch off the mask vacuum by pressing the **Mask vacuum is on** button.

The mask can now be removed.

3.6. Substrate Alignment with IR Illumination

For IR substrate alignment, special IR cameras p/n 186259 and special IR lenses are required for the opaque area.

The following example explains the necessary steps for IR alignment and exposure with manual mask loading, soft contact exposure and wedge error compensation in contact mode. With the machine in its initial state, the following procedure steps must be carried out:

3.6.1. Incident Light

The M500 microscope must only be used for IR transmission light, and the M604 microscope requires a special IR filter slide. The option **IR transm. light** is selected within the **Parameters** menu.

3.6.1.1. Setting the Exposure Values

See section 3.4.3. "Setting the Parameters".

3.6.1.2. Loading the Mask

See section 3.4.5. "Loading the Mask".

Attention!

In order for all the processes to start, the Main menu must be selected and the contact lever must be moved!

3.6.1.3. Loading the Substrate

See section 3.4.6. "Loading the Substrate".

Caution!

The microscope pivots downward!

Setting the Separation Lever to the Alignment Position

Attention!

Never align the substrate if the mask and substrate are in contact! Doing so will damage the mask and substrate.

3.6.1.4. Adjusting the Microscope

Setting the TSA Microscope

The splitfield switch must be set to the middle position for the M604 microscope and the lever for the IR camera opening must be in the IR position.

The left/right camera frame or the splitfield can be set in the **Parameters** menu.

Microscope Illumination

Connect the microscope fiber optics to the IR light source (illumination 3+4) and switch the illumination to **Infrared transm. light** in the **Parameters** page.

Set the brightness using the left/right potentiometers on the left front plate.

Make separate illumination settings for right/left using the right/left aperture diaphragms on the microscope.

Focusing the Mask Level

Coarse focusing is possible using the TSA Z-motion located behind the TSA microscope.

Fine focusing is separately set on the M604 microscope. To do so, use the OBJECTIVE FOCUS FINE MANUAL knob on the microscope.

Setting the TSA Microscope to the Mask Alignment Crosses.

The right/left microscope is set to the right/left mask adjusting crosses with OBJECTIVE X-SEPARATION.

3.6.1.5. Aligning the Substrate

Focusing the Substrate Level

For fine lens adjustment, use the OBJECTIVE FOCUS FINE MANUAL knob on the microscope.

Adjustment (menu in the SUBSTRATE ADJUSTMENT display)

Use the X, Y and Theta micrometer screws on the alignment table for this. Align the substrate alignment crosses so that they are central-symmetrical to the mask alignment crosses.

Attention!

Never adjust the substrate if the mask and substrate are in contact! Doing so will damage mask and substrate!

Checking the Alignment

See section 3.5.5. "Aligning the Substrate".

3.6.1.6. Exposure

Once the substrate is aligned and brought to the exposure position using the SEPARATION LEVER, press the **Exposure** button to perform the exposure. You must press **Yes** again on the display to confirm the exposure.

If you press **No** or use the CONTACT or SEPARATION LEVER, the shutter keeps closed. The substrate can now be unloaded or readjusted.

After pressing Yes the shutter will be opened for the programmed exposure time.

Caution!

Microscope in motion!

3.6.1.7. Unloading the Mask

To release the mask holder, remove both screws on the right side of the mask holder frame. Take out the mask holder and place it on a tray upside down. Switch off the mask vacuum by pressing the **Mask vacuum is on** button.

The mask can now be removed.

3.6.2. Transmitted Light

3.6.2.1. Setting the Exposure Values

See section 3.4.3. "Setting the Parameters".

3.6.2.2. Loading the Mask

See section 3.4.5. "Loading the Mask".

Attention!

In order for all the processes to start, the MAIN MENU must be selected and the contact lever must be pressed!

3.6.2.3. Adjusting the Microscope with IR Illumination

Setting the TSA Microscope

The splitfield switch must be set to the middle position for the M604 microscope and the lever for the IR camera opening must be in the IR position.

Focusing the Mask Level

Coarse focusing is possible using the TSA Z-motion located behind the TSA microscope.

Set the fine focusing on the M604 microscope separately. To do so, use the OBJECTIVE FOCUS FINE MANUAL knob on the microscope.

Setting the TSA Microscope to the Mask Adjusting Crosses

The right/left microscope is set to the right/left mask adjusting crosses using OBJECTIVE X-SEPARATION.

Unloading the Mask

To release the mask holder, remove both screws on the right side of the mask holder frame. Take out the mask holder and place it on a tray upside down. Switch off the mask vacuum by pressing the button **"Mask vacuum is on"**.

The mask can now be removed.

IR Illumination Setting

The **Parameters menu** must be selected on the touch screen and the illumination must be set to **Infrared transm.light**. The IR illumination arms can now set precisely under the lenses.

Set the brightness using the left/right potentiometers on the left front plate.

The left and right aperture diaphragms on the microscope allow you to set the illumination on the left and right separately.

Loading and Clamping the Mask Holder

With the top side facing up, the mask holder is pushed into the adjusting station and then fasten in the mask holder frame using the knurled screws.

3.6.2.4. Loading the Substrate

See section 3.4.6. "Loading the Substrate".

Caution!
The microscope pivots downward!

Setting the Separation lever to the Alignment Position

Attention!

Never adjust the substrate if the mask and substrate are in contact! Doing so will damage the mask and substrate.

3.6.2.5. Aligning the Substrate

Focusing the Substrate Level

For fine lens alignment, use the OBJECTIVE FOCUS FINE MANUAL knob on the microscope.

Alignment (screen page: Alignment)

The X, Y and Theta micrometer screws on the alignment table are used for alignment. Align the substrate alignment crosses so that they are central-symmetrical to the mask alignment crosses.

Attention!

Never align the substrate if the mask and substrate are in contact! Doing so will damage the mask and substrate.

Checking the Alignment

See section 3.5.5. "Aligning the Substrate".

3.6.2.6. Exposure

Once the substrate is aligned and brought to the exposure position using the SEPARATION LEVER, press the **Exposure** button to perform the exposure. You must press **Yes** again on the display to confirm the exposure.

If you press No or use the CONTACT or SEPARATION LEVER, the shutter keeps closed. The substrate can now be unloaded or readjusted.

After pressing **Yes** the shutter will be opened for the programmed exposure time.

Caution!

Microscope in motion!

3.6.2.7. Unloading the Mask

To release the mask holder, remove both screws on the right side of the mask holder frame. Take out the mask holder and place it on a tray upside down. Switch off the mask vacuum by pressing the button **„Mask vacuum is on“** .

The mask can now be removed.

3.7. Exposure Programs

An important parameter for exposure is the type of contact between the mask and substrate. The type of exposure program and all required parameters are selected and edited in the **Parameters** menu.

3.7.1. Distance Exposure

Wedge error compensation takes place in contact. After the substrate is adjusted to the mask, exposure is carried out at a specific distance up to 50 µm.

The substrate intake vacuum is maintained during exposure.

3.7.2. Soft Contact Exposure

The mask and substrate are brought into contact. The structure resolution is better than in distance exposure. The substrate intake vacuum is maintained during exposure. The pressing force of the substrate against the mask is equal to the force applied for wedge error compensation.

3.7.3. Hard Contact Exposure

This exposure type is similar to the soft contact exposure. After the substrate is in contact, the substrate intake vacuum is switched off and replaced with nitrogen overpressure. This guarantees better contact, even for exposing larger substrates. To test the set values and adjustment, use the **Alignment check** button in the **Exposure men**u.

3.7.4. Vacuum Contact Exposure

This exposure type ensures the highest structure resolution. It requires a vacuum-capable chuck with a sealing lip. The substrate is in a mini vacuum chamber from which the air is gradually extracted. The pre-vacuum ensures that the mask-substrate contact is established slowly. It also prevents gas bubbles from forming under the substrate. In the next stage the final vacuum is applied. The intake vacuum is then replaced with nitrogen overpressure. This results in the best possible contact between the

mask and substrate. Following exposure, the mini chamber is flushed with nitrogen. Larger substrates increase the time required for extraction and ventilation. For the best results, it is recommended to start a test series with long times and then gradually reduce these times.

All parameters can be set in the **Parameters** menu. To test the set values and the alignment, use the **Alignment check** button before exposure.

3.7.5. Low Vacuum Contact Exposure

This exposure type is identical to the vacuum contact exposure with one exception: The vacuum inside the vacuum chamber can be adjusted with the controller LOW VACUUM. The setting can be read at the display.

This allows high structure resolution of the vacuum contact exposure to be combined with the least possible mechanical stress from the substrate and mask. To test the set values and the adjustment, use the **Alignment Check** button.

3.7.6. Flood Exposure

This type allows the entire substrate to be exposed without the mask. Once this exposure type is set in the Parameters menu, the sequence can be started by switching the contact lever. The substrate is exposed according to the set exposure time regardless of whether or not the mask holder was loaded.

3.7.7. Test Exposure

This program allows to expose substrate sections with different exposure times. The wedge error compensation head keeps clamped and the substrate remains in exposure gap for the number of single exposure cycles.

- Up to 99 cycles are programmable.
- After each cycle a new exposure time must be entered to perform the next test exposure step.

3.7.8. Multiple Exposure

For special applications or to determine exposure times, the entire exposure time can be divided into equal intervals. A wait time must in which no exposure occurs must be set between these intervals.

One exposure interval and one wait time are referred to as an exposure cycle.

The following parameters must also be specified for multiple exposure:

3.7.8.1. Exposure Cycles

Pressing this button allows you to enter the number of desired exposure cycles (min. 2) and then confirm your entry with the ENTER button. Now the following buttons appear in the **Parameters** menu:

3.7.8.2. Wait Time

Sets the wait time between individual cycles.

3.7.8.3. Exposure Time

Pressing this button opens a keyboard, which allows you to enter the desired single exposure time. Press ENTER to confirm your entry. The display automatically switches back to the **Parameters** menu and adds the value that you just set.

Press the right/left arrow buttons to add the set parameters.

Load, align and expose the substrate as described above.

3.8. Step-by-Step Machine Operation

3.8.1. Selecting exposure program, e.g., soft contact

Menu in the Display		Button Strokes in the Display
MAIN MENU	→	PARAMETERS
PARAMETERS	→	BUTTON 1
Selection BUTTON 1		**Align & Exposure** Flood Exposure Imprint (Option)
Selection BUTTON 2 Exp. Program		**SOFT CONTACT** HARD CONTACT Enter the HC time in the submenu and press ENTER to confirm LOW VACUUM CONTACT Enter the pre-vacuum and full vacuum time in the submenu and press ENTER to confirm VACUUM CONTACT Enter the pre-vacuum and full vacuum time in the submenu and press ENTER to confirm DISTANCE EXPOSURE Wedge error compensation in contact exposure with distance, adjustable to 50 µm
EXPOSURE TIME selection	→	EXPOSURE TIME Enter the exposure time in the submenu and press ENTER to confirm
	Confirm the set parameters with	Load
MAIN MENU		

3.8.2. Programs

Saving a New Program

All active parameters are stored under a selected program name.

Menu in the Display		Button Strokes in the Display
MAIN MENU	→	PARAMETERS
PARAMETERS	→	Edit parameters
PARAMETERS	→	Load
MAIN MENU	→	Recipes
RECIPE EDITOR	→	Select available program space
RECIPE EDITOR	→	New
ALPHANUM. KEYBOARD	→	Enter program name
RECIPE EDITOR	→	Load All parameters stored under the program name are displayed and saved
MAIN MENU		

Selecting an Existing Program

All parameters stored under the respective program number are activated.

Menu in the Display		Button Strokes in the Display
MAIN MENU	→	RECIPES
RECIPE EDITOR	→	SELECT Select existing program space
RECIPE EDITOR	→	LOAD The display switches back to the main menu The machine is ready for use
MAIN MENU		

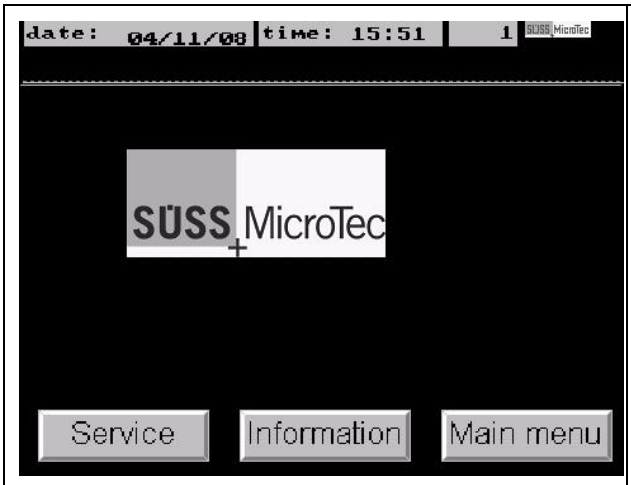
3.8.3. Loading, Aligning and Exposing the Substrate

Menu in the Display		Button Strokes in the Display
MAIN MENU	→	LOAD SUBSTRATE
LOAD SUBSTRATE	→	Load the mask holder with the mask
		Pull out the slide and load the chuck
		Place the substrate on the chuck
		Insert the slide completely
		Raise the substrate with the contact lever (WEC)
	⚠	WARNING! Microscope pivots downwards
EXPOSE		Separation lever set to alignment position
SUBSTRATE ALIGNMENT		Align substrate Separation lever set to alignment position for exposure
EXPOSE		ALIGNMENT CHECL For checking the adjustment in the selected exposure program
		EXPOSURE For exposing the substrate
	⚠	WARNING! Microscope pivots upwards Mirror housing and microscope move towards the operator.
UNLOAD SUBSTRATE		Pull the contact lever back, pull out the transport slide and load the substrate
MAIN MENU		

4. SPECIALS

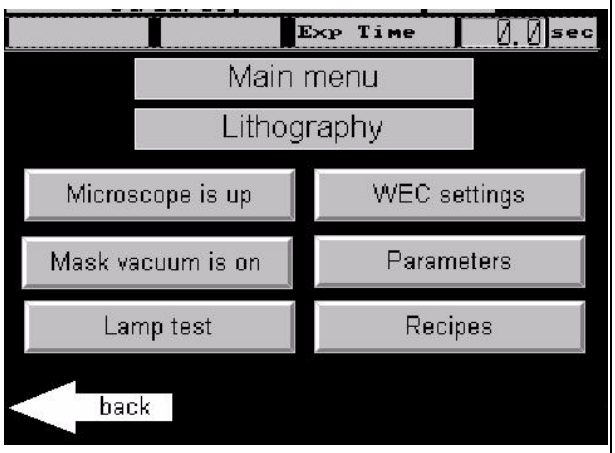
4.1. Nano Imprint Lithography - NIL

The imprint process is a special application for the MJB4 and therefore needs a modified operation sequence which is described below:



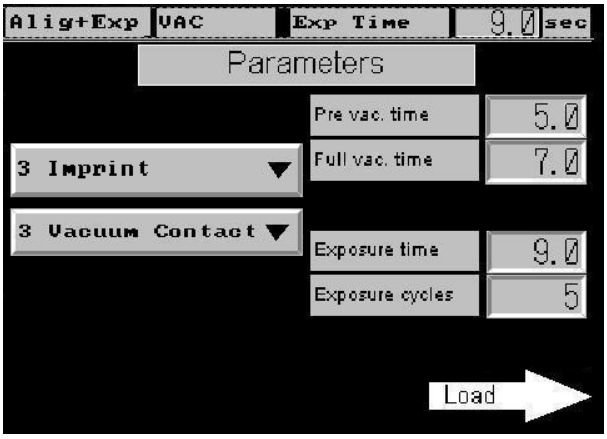
Screen Page: Start

- The start screen appears after switch-ON and initialisation of the machine
- The button **Main menu** leads to the main screen page of the user interface.



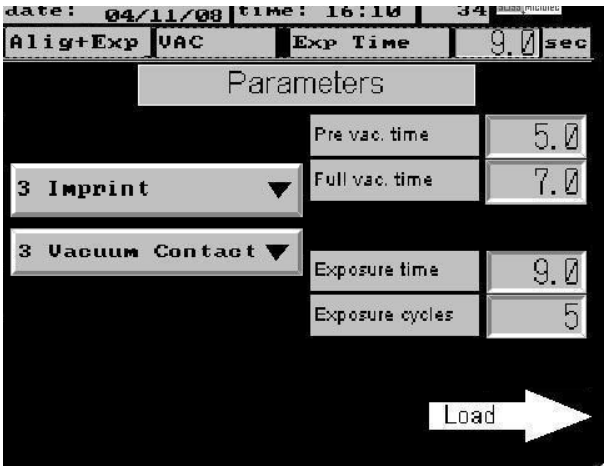
Screen Page: Main menu

- The button **Parameters** opens the parameter screen.

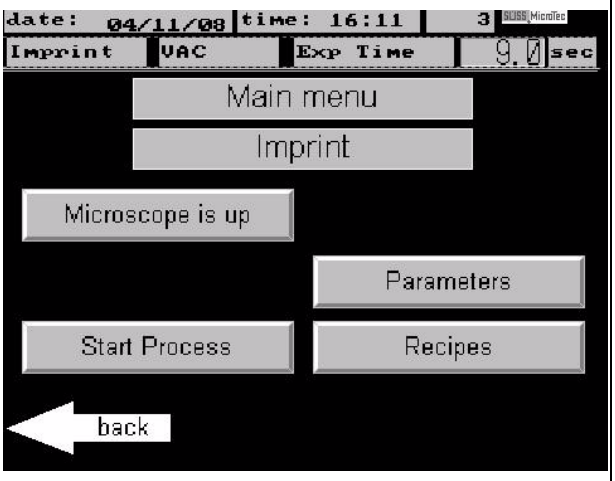


Screen Page: Parameters

- Within the **Parameters** Screen the **Imprint** process can be selected within the program button. It gives access to the selection of either **Alignment+Expos**., **Flood exposure or Imprint**.
- After pushing the **Imprint** program it is displayed on the button.

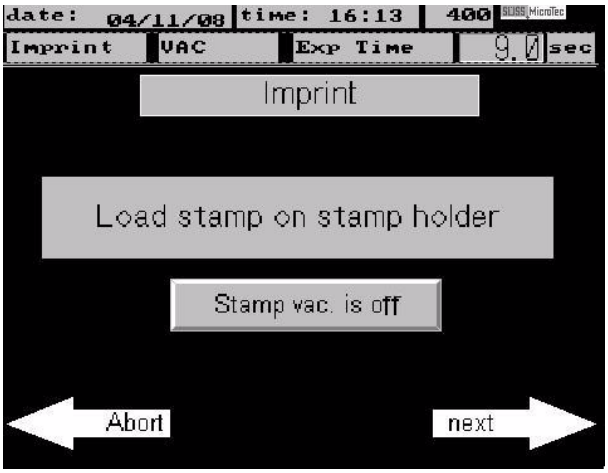


- Choose the exposure program **Vacuum Contact** and program your parameters. Confirm each parameter with ENTER.
- To store the parameters permanently use the Recipe Editor (see chapter 3.4.4)
- Confirm with **Load**

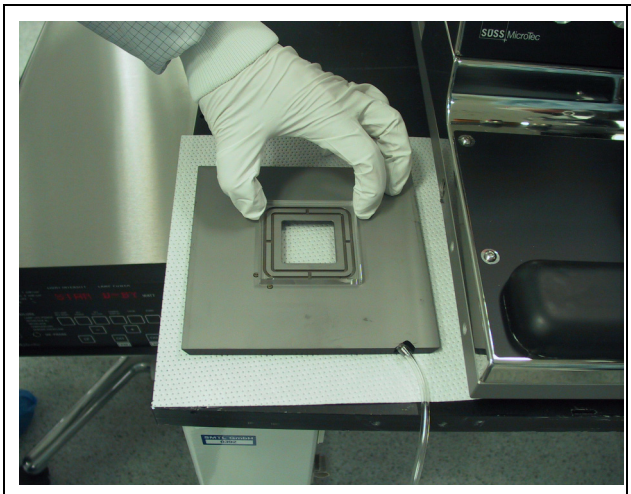


Screen Page: Main menu Imprint

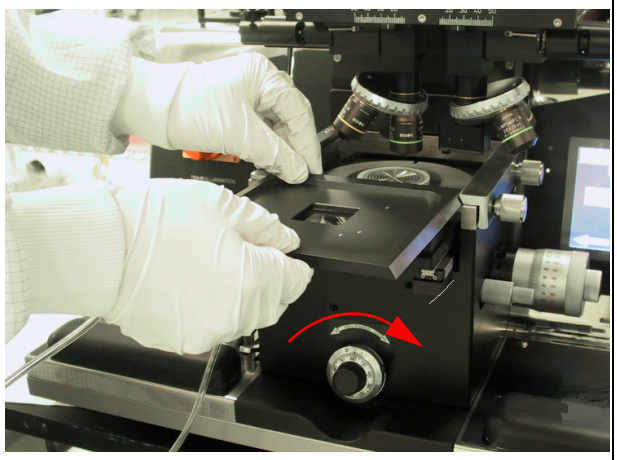
- The program displays the **Main menu Imprint** Screen.
- Press **Start Process**



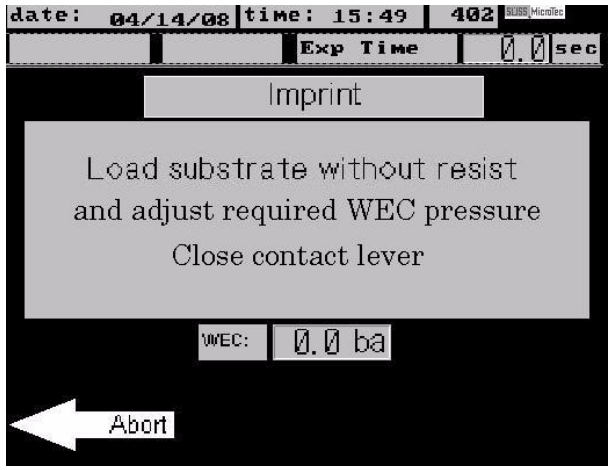
- The program prompts the operator to load the stamp on the stamp holder.



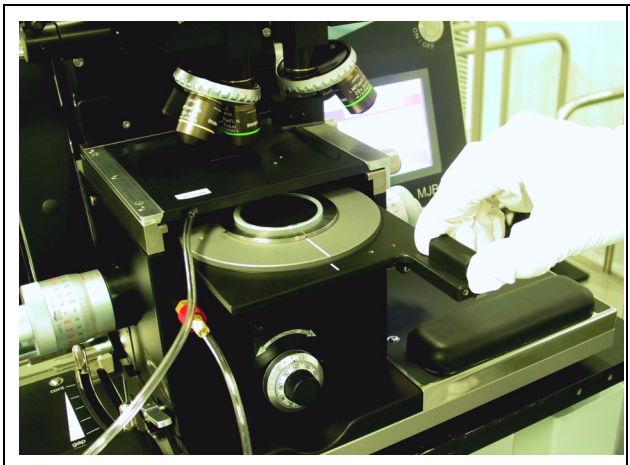
- Load the stamp on the stamp holder and adjust it against the fixed pins
- Fix the stamp with vacuum by pressing the key **Stamp vac. is off**



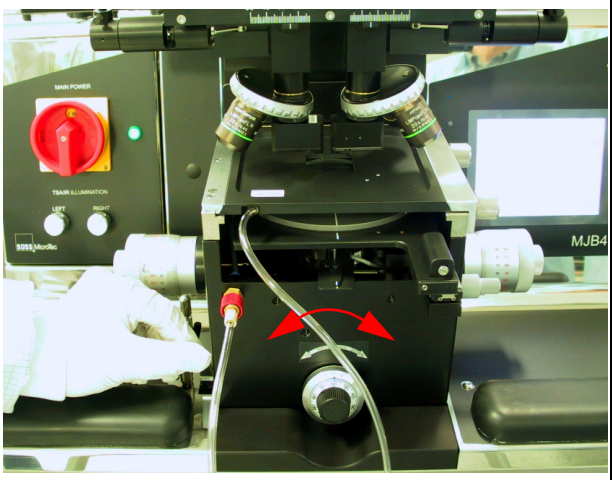
- Load the stamp holder into the mask holder frame and fix it with the knurled knobs.
- Press **next** to confirm.
- If you start your process for the first time turn the knob for the variable thickness setting down (clockwise) to be within a save distance for WEC.



- The program prompts the operator to load the substrate without resist.
- The subsequent steps are
  - WEC
  - WEC pressure adjustment



- Pull out the transport slide and load the substrate onto the chuck.
- Activate the transport vacuum and insert the transport slide until it reaches the end stop.



- Turn the contact lever back to perform WEC. Be sure that the contact lever can be pushed all the way down.
- One of the following messages will appear on the screen:
  - '**Mask + Wafer too thick'**
    Adjust WEC to the right (down)

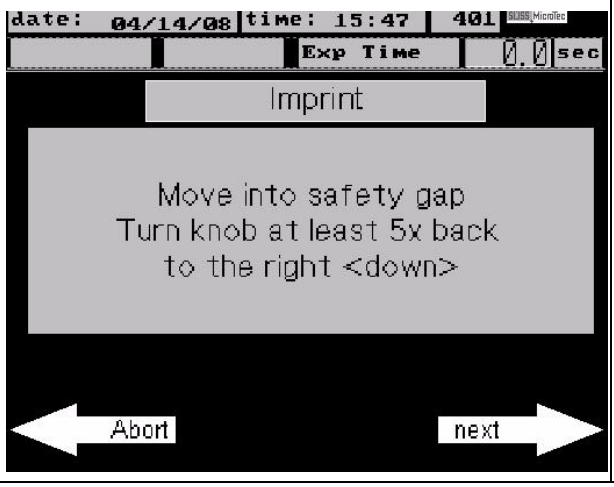
or

  - „**Adjust WEC to the left (up)**"
- Turn the thickness setting knob depending on the message until you hear a signal and the information „**WEC setting OK open the contact lever**" appears on the display.

- Losen the contact lever to move the substrate with the chuck down into normal position

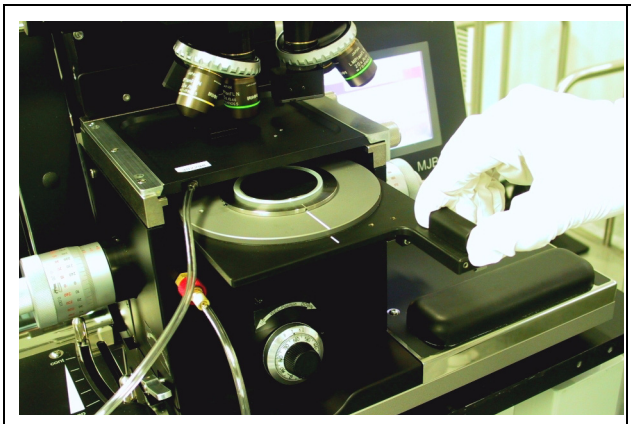
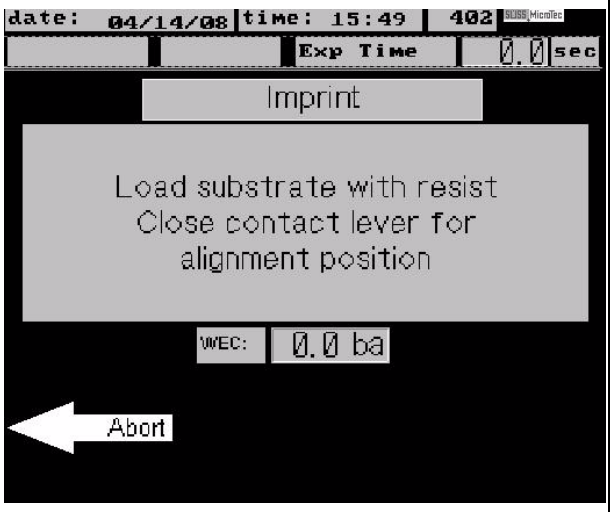
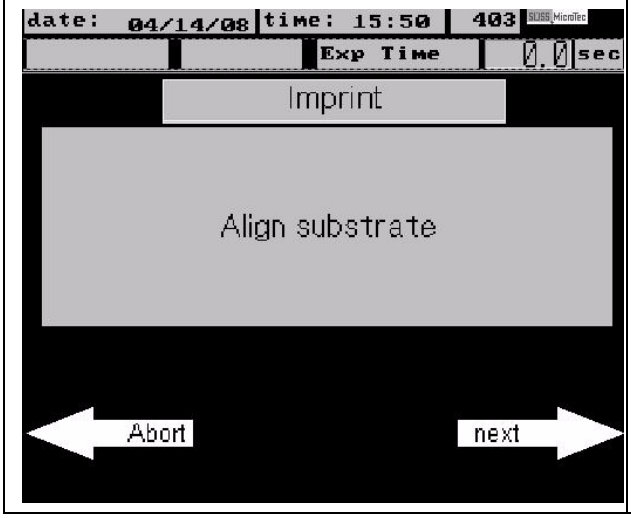
Note:

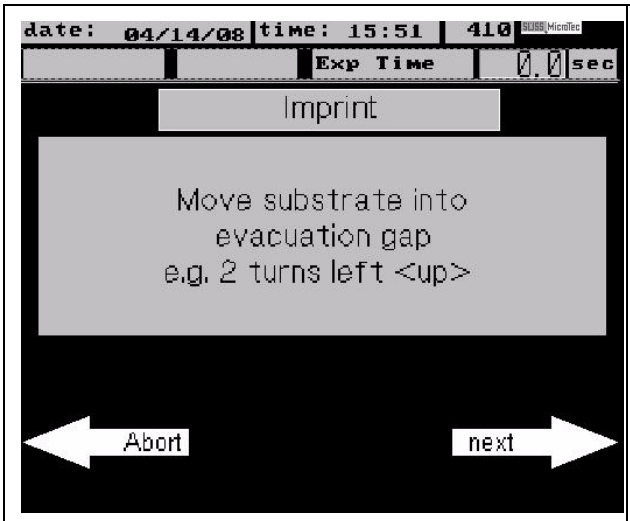
The WEC-head remains clamped to keep the wedge error compensation.



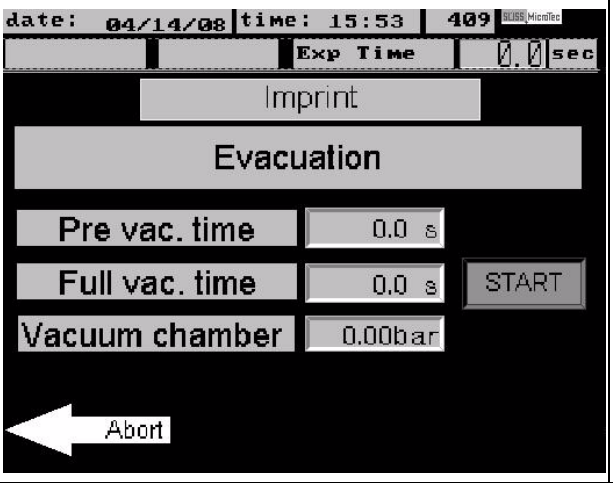
- The program prompts you to turn the thickness setting knob clockwise (down) to move the substrate into a save distance.

  This is necessary to avoid contact of the coated substrate with the stamp before starting the imprint process.
- Press **next** to continue.

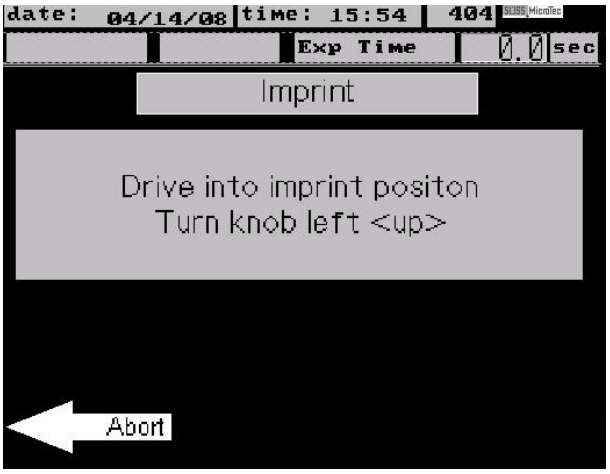
	• The blank substrate can be unloaded.
	• Now follow the instructions on the screen and load the coated substrate. • Use the transport vacuum to prevent the substrate from moving during transport. • Close the contact lever. The substrate is moved into alignment position.
	• Now the substrate can be aligned to the stamp. • As soon as you are finished press **next** to continue.



- Turn the thickness setting knob up (counter-clockwise)
- Press **next** to continue



- The next screen shows the information about the programmed parameters and prepares for evacuation.
- Press **START** to start the evacuation.
- As soon as the evacuation is finished press **next** to continue.



- Turn the WEC setting knob counterclockwise (up) until the message

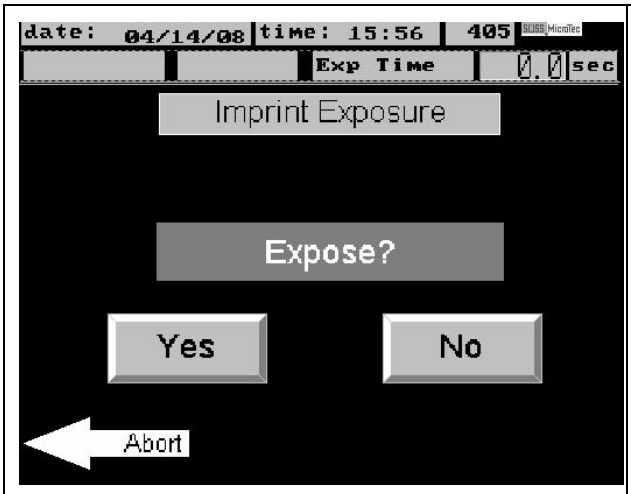
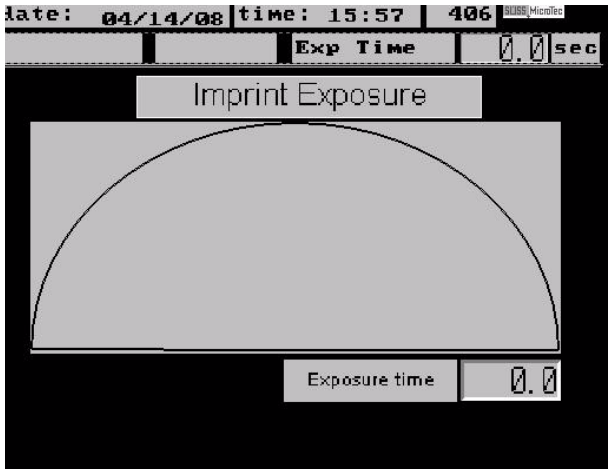
  „**POSITION REACHED !**“ starts flashing.

  The screen displays the options

  - **N2 under wafer on/off**

  and

  - **Wafer Vacuum on/off**
- Depending on your selection the options toggle between ON and OFF.
- Press **next** to continue.

	• The next program step will start the exposure • Press **Yes** to start exposure.
	• The display shows the progress of the exposure time. • As soon as the exposure is finished the vacuum at the stamp holder will be switched off.
	• The screen shows the message **Open the contact lever** **Unload substrate + template** • Turn the contact lever to move the substrate package down • Pull out the transport slide with the chuck and the substrate package and unload.

4 SPECIALS

5. MAINTENANCE

5.1. Parameter Ranges and Default Settings

This table lists the value ranges of parameters used in the main processes.

Parameter	Description	Default value	Range of values
Expose Type	Type of exposure	Soft	[Soft, Hard, Low Vac, Vac, Flood-E, Lamp test]
Exp. Time	Exposure time	5.0 sec.	[0.1…999.9]
Wait Time	Pause between exposure intervals (multiple exposure)	5 sec.	[2.0…999.9]
Exp. Cycles	Number of cycles (multiple exposure)	1	[1…99]
HC-Wait Time	Time for N2 purge below wafer before exposure	5 sec.	[0.1…999.9]
Pre Vac	Length of pre-vacuum	5 sec.	[0.1…999.9]
Full Vac	Length of main vacuum	5 sec.	[0.1…999.9]
Vac Purge	N_2 purge time of mini chamber following vacuum exposure	5 sec.	[01…999.9]

5.1.1. Overview

5.1.1.1. Valves (V)

Identifier	Medium	Function
5/V1	V	Chuck clamping on WEC - head
5/V2	P	WEC – brake close
5/V3	V	WEC – brake opener
6/V1	V	Mask vacuum (valve open for constant vacuum)
8/V1	V	Vacuum under substrate
8/V2	N2	Vacuum reduction under substrate
8/V3	N2	Nitrogen flow under substrate (hard contact)
8/V4	N2	Nitrogen flow under substrate (release after exposure)
8/V5	R	Ventilation under substrate, pressure controller
8/V6	R	Ventilation, hard contact and after exposure
8/V7	V	Main vacuum, vacuum chamber
8/V8	V	Pre-vacuum, vacuum chamber
8/V9	N2	Reduced vacuum chamber
8/V10	N2	Vacuum chamber reduction / nitrogen pressure
8/V11	R	Ventilation, vacuum chamber
11/V1	P	Shutter, closer
11/V2	P	Shutter, opener
11/V3	P	Lamp house, focus cooling
11/V4	N2	Lamp cooling (shutter and upper and lower lamp socket)
12/V1	P	Microscope lift up/down
12/V2	P	TSA manipulator brake, X- and Y-direction
15/V1	P	Mirror house forward/ back

5.1.1.2. Throttles (T; T0)

Identifier	Function
5/T04	Exhaust throttle WEC pressure
6/T02	Purge mask holder for negative resist
8/T02	Vacuum reduction under substrate
8/T03	Nitrogen under substrate (hard contact)
8/T04	Nitrogen under substrate (release of substrate) / volume controlled
8/T05	ventilation under substrate/ pressure controlled
8/T08	Pre-vacuum, vacuum chamber
8/T09	Reduced vacuum chamber
8/T010	Chamber nitrogen purge / volume controlled
11/T01.1	Speed shutter opener - open
11/T01.2	Speed shutter opener - close
11/T02.1	Speed shutter closer - open
11/T02.2	Speed shutter closer - close
11/T3	Cooling lamp house - heat sink
11/T4.1	Cooling shutter
11/T4.2	Cooling lower lamp socket
11/T4.4	Cooling upper lamp socket (only with 500W HgXe lamp)
12/T01.1	Controls speed of microscope motion up
12/T01.2	Microscope motion, down
15/T01.1	Speed of mirror house motion backward
15/T01.2	Speed of mirror house motion forward

5.1.1.3. Pneumatic Controllers (PG)

Identifier	Medium	Function
0PG1 - B5	P	Machine main air pressure
0PG2 - B6	N_2	Machine main nitrogen pressure
0PG3 - B7	N_2	Vacuum
1/FM1 - B10	V	Flowmeter
5/PG1 - B8	P	WEC pressure
8/PG7 - B9	V	Vacuum chamber

5.1.1.4. Pressure Regulators (PR)

Identifier	Function
0PR1	Machine main air pressure
0PR2	Machine main nitrogen pressure
5PR1	WEC pressure

5.1.1.5. Sensors (B, S)

Identifier	Function
S1	Z axis Contact position
S3	Z axis align position
S2	Z axis Z-grab position
B4	Microscope up / down
B2	Mirror house front
B3	Mirror house back
B1	WEC head brake
S4	Main switch - ON
B10	Lamp cooling
B5	Air pressure limit
B6	Nitrogen limit
B7	Vacuum limit

5.2. Lock-Out / Tag-Out Checklist

Lock-out/tag-out is an essential safety procedure that protects workers from injury while working on or near electrical circuits and equipment. Lock-out involves applying a physical lock to the power source(s) of circuits and equipment after they have been shut off and de-energized. The source is then tagged out with an easy-to-read tag that alerts other workers in the area that a lock has been applied.

In addition to protecting workers from electrical hazards, lock-out/tag-out prevents contact with operating equipment parts: blades, gears, shafts, presses, etc.

A worker was replacing a V-belt on a dust collector blower. Before beginning work, he shut down the unit at the local switch. However, an operator in the control room restarted the unit using a remote switch. The worker's hand was caught between the pulley and belts of the blower, resulting in cuts and a fractured finger.

When performing lock-out/tag-out on machinery, you must always lock out and tag out ALL energy sources leading to the machinery.

Also, lock-out/tag-out prevents the unexpected release of hazardous gasses, fluids, or solid matter in areas where workers are present.

An employee was cutting into a metal pipe using a blowtorch. Diesel fuel was mistakenly discharged into the line and was ignited by his torch. The worker burned to death at the scene.

All valves along the line should have been locked out, blanked out, and tagged out to prevent the release of fuel. Blanking is the process of inserting a metal disk into the space between two pipe flanges. The disk, or blank, is then bolted in place to prevent passage of liquids or gasses through the pipe.

When performing lock-out/tag-out on circuits and equipment, you can use the checklist below.

- ✔ Identify all sources of electrical energy for the equipment or circuits in question.
- ✔ Disable backup energy sources such as generators and batteries.
- ✔ Identify all shut-offs for each energy source.
- ✔ Notify all personnel that equipment and circuitry must be shut off, locked out, and tagged out. (Simply turning a switch off is NOT enough.)
- ✔ Shut off energy sources and lock switchgear in the **OFF** position. Each worker should apply his or her individual lock. Do not give your key to anyone.
- ✔ Test equipment and circuitry to make sure they are de-energized. This must be done by a qualified person.*
- ✔ Deplete stored energy by bleeding, blocking, grounding, etc.
- ✔ Apply a tag to alert other workers that an energy source or piece of equipment has been locked out.
- ✔ Make sure everyone is safe and accounted for before equipment and circuits are unlocked and turned back on. Note that only a qualified person may determine when it is safe to re-energize circuits.

*OSHA defines a "qualified person" as someone who has received mandated training on the hazards and on the construction and operation of equipment involved in a task.

5 MAINTENANCE

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