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1 General description and principles of operation

The K&W **MA1006** TSA, **MA1006** TSA/BSA and **MA1006** TSA/IR mask aligners are designed for high resolution photolithography in a laboratory, development, or pilot production environment. They offer unsurpassed flexibility in the handling of irregularly shaped substrates of differing thickness as well as standard size wafers up to 150mm diameter.

All mask aligner of the K&W **MA1006** series are partly motorised with a very easy-to-use user panel. The adjustment is done by micrometerscrews. Both, screw and user panel are designed for best ergonomic position.

For most accurate alignment, each step of alignment can be viewed on a monitor using a splitfield microscope in combination with a CCD camera for bottom side alignment and a high resolution splitfield microscope for top side alignment.

The K&W **MA1006** is a compact mask aligner in a modular assembly design which allows a very easy maintenance procedure. The functional groups are easily accessible and the subassemblies can be quickly exchanged.

1.1 A brief orientation

The main functional block on the K&W **MA1006** mask aligners are: alignment unit (microscope, video-camera-system, X-Y- θ -alignment stage) and exposure unit (lamp housing and mirror housing with lenses).

To start a run, the main switch on the left side of the user panel has to be pressed. Then the mask has to be loaded and the mask holder has to be clamped. After selecting a exposure program, the machine is ready to work.

On the chuck one can find prealignment pins which are used to position the wafer on the chuck. After depositing the wafer on the chuck, the transport slide has to be pushed towards the machine.

Now the wedge error compensation has to be done. The exposure chuck with the prealigned wafer moves up together with the wedge error compensation head on a air cushion until the wafer is in a parallel position to the mask.

This parallel position of mask and wafer is now locked by a clamping system and the chuck is moving into the selected alignment distance. To avoid complete contact of mask and wafer in order to protect mask and the photoresist on the wafer surface, the K&W **MA1006** exposure chucks can be equipped with three high precision distance balls only three point size contact areas are touched during the wedge error compensation step.

The alignment itself is done by micrometerscrews for X-,Y- and θ -direction and can be viewed by a splitfield camera-monitor system for bottom side alignment respectively by a splitfield microscope for top side alignment. After the final alignment the wafer is moving towards the mask to control the wafer-mask position the last time before exposure.

The exposure step starts with the motorised moving of the microscope to the left side and bringing the mirror housing in the exposure position. The shutter between lamp and mirror housing opens for the selected exposure time. Then the exposed wafer is moving together with the wedge error compensation head into the unloading position.

1.2 Alignment and exposure modes

The K&W MA1006 mask aligner are equipped with exposure optics for proximity1, proximity2, hard, soft and vacuum contact. These five exposure modes can be selected for the first exposure as well as for exposure rows so that a huge variety of process possibilities are given.

1.2.1 Proximity1 exposure mode

The proximity exposure mode permits to perform a wedge error compensation without contact of mask and wafer. Three high precision distance balls are inserted between wafer and mask. Therefore only three point size areas on the edge of the wafer are in contact. By using the proximity exposure mode every possibility of wafer and mask damage is eliminated.

The exposure- respectively alignment distance can be selected between 0 and 999 μm in 1 μm steps.

1.2.2 Proximity2 exposure mode

With the proximity2 exposure mode the wedge error compensation between wafer and mask is done in contact. For the exposure the wafer is moving into a selected distance to the mask.

1.2.3 Soft contact exposure mode

In the soft contact exposure mode the vacuum securing the wafer on the exposure chuck remains in "on" mode during the exposure time. The pressure between wafer and mask remains also stable and can be adjusted between 0.03 and 0.07N/cm².

1.2.4 Hard contact exposure mode

In the hard contact exposure mode, the vacuum remaining the wafer on the chuck is removed after the wedge error compensation and simultaneous nitrogen is introduced under the wafer to pressing it against the mask. The contact pressure can be easily adjusted by a throttle starting from 0.07N/cm² up to 0.16N/cm².

1.2.5 Vacuum contact exposure mode

In the vacuum contact exposure mode the chamber between wafer and mask is evacuated after the wedge error compensation: Once the wafer is in contact and totally parallel to the mask, a rubber seal is brought up from the chuck and pressed also on the mask. Then the air in the chamber is evacuated through small holes on the edge of the exposure chuck during a adjustable time step. The vacuum inside the wafer-mask-chamber is fixing the wafer on its position on the chuck.

The highest resolution levels can be achieved in this exposure mode.

1.2.6 Bond mode

With an additional bond kit it is possible to align two wafers to each other. After the alignment a bonding in a bonding oven is possible.

1.2.7 First mask exposure

For the first layer there is no alignment of mask to wafer necessary. During this mode the alignment chuck is always in middle position, so that the following layers can be easily aligned.

1.2.8 Exposure with alignment

For the second or further layer, you have to align the wafer with the first layer structure to the next level mask. With the splitfield microscope for the top side alignment and the splitfield-camera-monitor system for bottom side alignment the fine adjustment can be easily done by using the manipulators. For X- and Y-direction steps in $1\mu\text{m}$ size are possible and the θ -direction can be adjusted in $4.5 \times 10^{-6}^\circ$ steps. For these alignment steps you can change as often as you want between alignment and exposure level.

1.3 Functional groups of the K&W MA1006

The K&W MA1006 is divided in different functional blocks. So a maintain-friendly service procedure was achieved. The separate subassemblies can easily be exchanged and this guarantees only a short machine down time in case of a service.

1.3.1 Wedge error compensation head and exposure chuck

The K&W MA1006 has a calotte-chuck system for the wedge error compensation. The wedge error compensation head contains the exposure chuck.

The wedge error compensation is done in four steps:

I) After finishing the loading of the wafer, the wedge error compensation moves towards the mask.

II) Then the wafer is pressed against the mask and the calotte of the wedge error compensation head slides in a parallel position to the mask. Therefore, any unevenness, taper or bow of wafer and mask is compensated during this step.

If you have chosen a proximity mode exposure, the wafer and the mask are only in contact with the three reference balls.

III) The now parallel position is fixed with a pneumatic clamping system.

IV) After finishing the wedge error compensation, the chuck is moving in the selected alignment or exposure distance.

The alignment chuck has prealignment pins as well as some depressions to allow an easy positioning of the wafer by using tweezers.

1.3.2 Alignment stage

The alignment stage of the K&W MA1006 mask aligner can load masks up to 7"x7" size. The stage itself can move in X, Y and θ (rotation) direction. The smallest alignment step is $1\mu\text{m}$. The stage moves $\pm 5\text{mm}$ in X and Y direction and $\pm 3^\circ$ in θ direction by a smallest movement step of $4.5 \times 10^{-6}^\circ$.

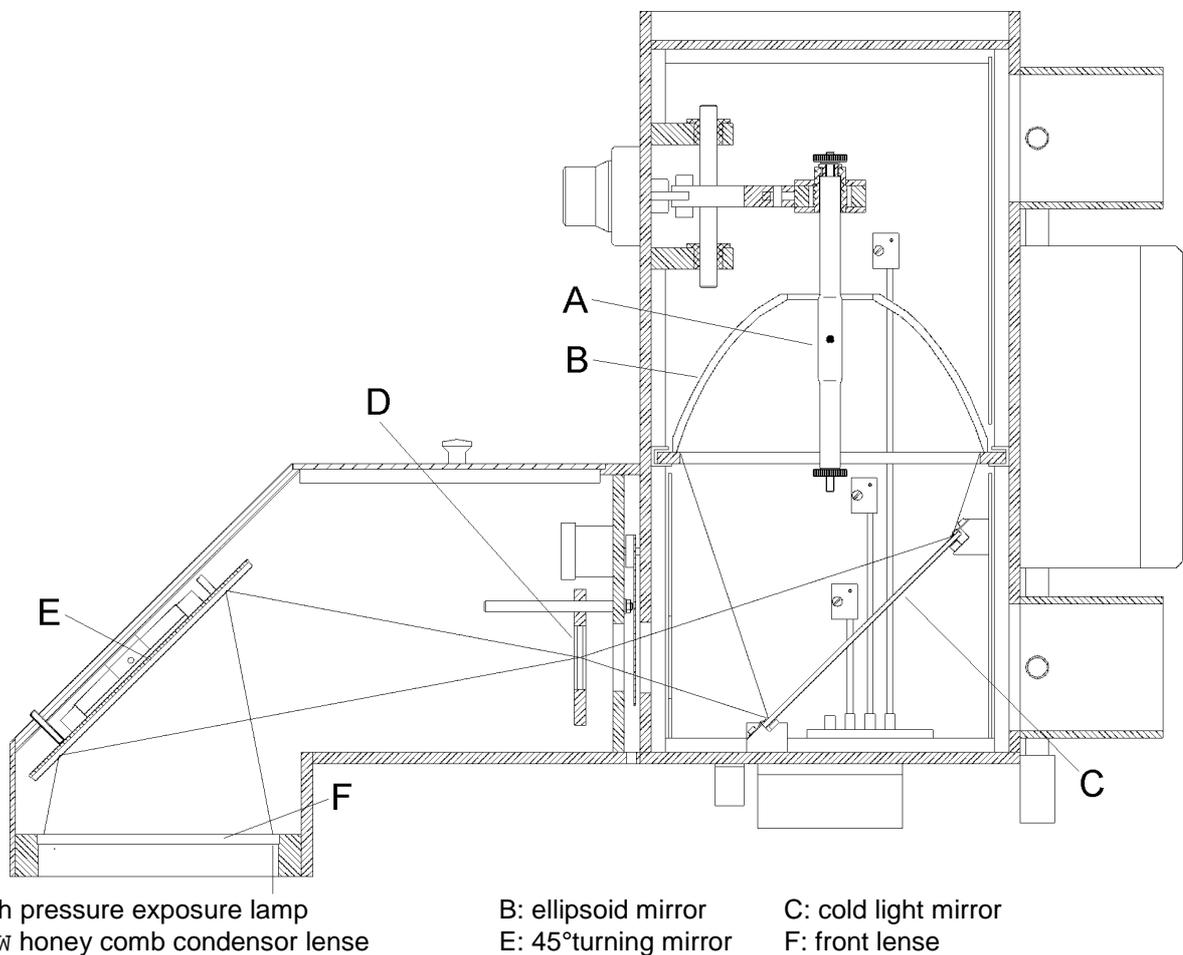
Additionally the Z axis raises and lowers the wedge error compensation head to the exposure chuck to the selected alignment and exposure gaps. The smallest Z-axis move is also $1\mu\text{m}$.

1.3.3 Lamphouse

The K&W MA1006 lamphouse can be used for exposure lamps up to 1000W. The lamphouse also contains the exposure optics. So the best results in exposure uniformity are achieved in terms of steep resist edges and small diffraction effects. Normally the exposure uniformity for a 6" wafer is $\pm 5\%$.

The light is conducted from the exposure lamp via an ellipsoid mirror and then the requested light wavelength is selected by a cold light mirror with a special coated surface. This surface is deflecting the requested "cold" ultraviolet light which is required for the exposure. In addition the light is now directed in a horizontal direction towards the shutter. Behind the shutter there is the so-called exposure optic system which is optimised for lowest diffraction effects.

picture 1: K&W MA1006 Lamphouse



1.3.4 Mirrorhouse

In the mirrorhouse the horizontal light is directed via the 45° front mirror in a strictly vertical direction. The front lens now separates the light into parallel light beams which are brought onto the wafer surface.

1.3.5 Splitfield camera system

The K&W **MA1006** can be equipped with a splitfield-camera-monitor system, which allows together with a image storage system and two CCD camera tubes the alignment of the wafer to the mask. This opto-electrical alignment system is used by bottom side alignment (BSA) procedures. The system recognises the alignment marks on the mask, saves them and aligns the wafer to these marks.

1.3.6 Splitfield microscope

For top side alignment (TSA) the K&W **MA1006** is equipped with a splitfield microscope. The tubes and objectives can be selected according customers specifications and needs.

With this splitfield microscope the field can be observed either through the right or the left objective or through both at the same time.

1.3.7 Armrest assembly

On the armrests on the left hand and right hand side of the K&W **MA1006**, the logically arranged control buttons for the program steps are located.

Here, the operator can change and control the program steps. In addition a display shows actual program values and in case of a malfunction of the program, the failure with its description.

1.3.8 Underframe unit

The K&W **MA1006** mask aligner is mounted on a vibrationfree aluminium underframe. The whole underframe is build in a modular assembly design and can be easily moved by its castors. In its finally position, the machine is stabilised with position levers.

Between the underframe and the machine functional block, five adjustable vibration dampers are located. This prevents vibration flow from the surrounding of the machine onto the exposure chuck and guarantees best vibration isolation.

The whole machine is designed in a compact style, so smallest clean room area is required.

2 General warnings and safety hazards

In this chapter general warnings are summarised to establish a safe usage for the operator.

2.1 Exposure lamp

The light sources required for photolithographic exposures are high pressure lamps filled with mercury or toxic gases. The lamps are radiating ultra violet light and are needing a very high initial voltage to start.

Special precautions must be taken when working with these lamps.

2.1.1 Electrical hazards

The voltage and current required to run a high pressure lamp constitute a lethal combination. Starting ignition voltage are 30 kV and during usage the required voltage are around +100V_{DC}.

NOTA:

During performing any maintenance on the exposure lamp, the lamphouse and the lamp power supply, it is indispensable to disconnect the power line of the machine and of the lamp power supply.

2.1.2 Lamp explosion

The used high pressure lamps are operating at a extremely high pressure (50-70atm). Explosion is therefore a possibility when these lamps are handled or operated wrongly. In order to avoid lamp explosions, please follow the instructions below:

- **respect the requested lamp cooling**
- **with each lamp changing, control the correct fixing of connection cables from and to the lamp**
- **by handling the lamps, even when they are cold, wear always protective face shields**
- **never touch a lamp without wearing gloves**
- **never run a lamp longer then the guaranteed lifetime (see manufacturer notes)**

The K&W MA1006 lamphouse is designed to minimise damage of the interior of the mask aligner and prevent possible injury of the operator in case a lamp explosion occurs. For this reason, all assemblies and protective covers must be in place during operation of the machine.

In case of a lamp explosion, please switch of the power and let the machine cool down for at minimum 1 hour.

When opening the lamp house, wear protective face shields and gloves. Never touch the fragments of the lamp an/or breathing the vapour. The lamp fragments must be disposed as high toxic garbage.

2.1.3 Eye and skin safety by working with UV-light

The ultraviolet light of the high pressure exposure lamps can cause erythema of the skin, which is similar to sunburn and conjunctivitis. The high infrared light output of those lamps can also cause retinal burns resulting in blindness.

The K&W MA1006 mask aligner is designed for opacity on the lightpath during normal operation.

In case of a maintenance procedure it can be necessary to remove covers and shields. For this reason **it is recommended to wear an eye protection during maintenance procedures and during light intensity measurements.**

2.1.4 Exhaust requirements

All high pressure UV lamps are producing ozone during their usage. The ozone is produced due to chemical interactions of the air oxygen and the radiation emitted below a wavelength of 250nm. Ozone is hazard gas because it attacks the mucous membranes of the human respiratory system, producing symptoms similar to pneumonia. These effects are cumulative.

High pressure mercury lamps up to 500W should be operated in well ventilated areas only.

If the machine is running with high pressure mercury lamps above 500W or with Cd-Xe- or Hg-Xe-lamps, a exhausting system must be installed to avoid hazard ozone concentrations in the operating room.

2.2 Electrical equipment

The K&W MA1006 mask aligner is CE certificated. By using the machine according the required safety rules, no danger can occur from the electrical equipment.

Maintaining and repairing off the K&W MA1006 should be done only by trained persons.

2.3 Broken wafers

Since fragments of broken wafers can be very sharp as well as toxic (in case of GaAs wafers), removing of such fragments should be only done by using proper tools, i.e. tweezers, to minimise the injury risk for the operator.

2.4 Moving parts

The operator should be careful to keep loose clothing or long hair from getting caught in the machine.

2.5 Covers

Never place any parts on top of the machine.

All covers are designed for best safety and follow the general rules.

Never remove any cover during operating the machine!

3 General demands for proper operation

The K&W MA1006 mask aligner is a high precision photolithographic machine. To obtain best results possible, some general requirements for the used material and the surrounding have to be reached. The K&W MA1006 mask aligner cannot be expected to function properly unless it is not correctly adjusted, placed and maintained.

3.1 Environment and working conditions

The alignment and resolution which are achievable with the K&W MA1006 mask aligner are in the submicron range. At this level of precision almost everything in a normal environment, like dust or pollen can be declared as "dirt". To achieve best exposure results on semiconductor devices, it is necessary to operate the K&W MA1006 mask aligner only in a clean room environment.

In addition it is necessary to avoid any chemical process next to the machine, which can produce an effect on the exposure results. Also the handling of corrosive chemicals next to the machine should be neglected in order to avoid any damage the high precision mechanical parts of the K&W MA1006.

It goes without saying that only good wafer and mask material can lead to good exposure results.

3.1.1 Requirements for the mask

A mask aligner like the K&W MA1006 produces a 1:1 image of the mask structures onto the wafer. Therefore it is very important that the mask is not damaged and totally clean. Each grain of dust or even a fingerprint produces a defective exposure result on the wafer. Especially by using the vacuum exposure mode, where the wafer is always pressed on the mask, the mask should be cleaned before each exposure and should be changed by showing even only small defects.

In addition, the flatness of the mask material is very important for the exposure results and also the thickness of the mask material should be selected according the SEMI specifications.

The maximum size for the mask is 7"x7" and should be always at minimum 1" larger in diameter then the wafer to be exposed. Again, the SEMI specifications prescribing the exact tolerances for diameter, flatness and thickness of wafer and mask.

For easy alignment, the alignment marks on the mask should be in a symmetrical direction to the middle of the mask. So it is ensured that the wafer can be aligned by using only the fine alignment distances.

3.1.2 Requirements for the coated wafer

Like all mask dimensions, also the wafer sizes (like flatness, thickness and diameter) should be within the SEMI specifications.

The coating of the wafer should be done by using a special spinner/coater to ensure best resist coating.

3.2 Machine checks

The K&W MA1006 mask aligner should be checked on a regular basis to ensure that the machine is still adjusted to optimum performance conditions.

3.2.1 Exposure chuck and mask holder

Mask holder and exposure chuck are manufactured with very fine mechanical tolerances. Before each exposure, check mask holder, the chuck and the induction areas for cleanliness and mechanical integrity. Any evidence of residues, i.e. like photoresist will also result in poor equipment performance.

You should clean the chuck and the mask holder before each exposure by using a cleanroom towel and pure alcohol.

3.2.2 Light intensity

On a regular basis, the lamp conditions and the light intensity has to be recorded to ensure constant quality of the exposure results.

By checking the high pressure lamp the electrical contacts are to be controlled. The glass of the lamp bulb should be clear and without any darkening. If such a effect is visible, the lamp has to be exchanged to avoid lamp explosions. The on-time of the lamp has to be controlled and the lamp has to be exchanged if the manufactures noted lifetime is exceeded.

All optical parts of the lamp- and mirror house should be checked for cleanliness and coatings, because this can cause a leak of light intensity.

3.2.3 Light uniformity

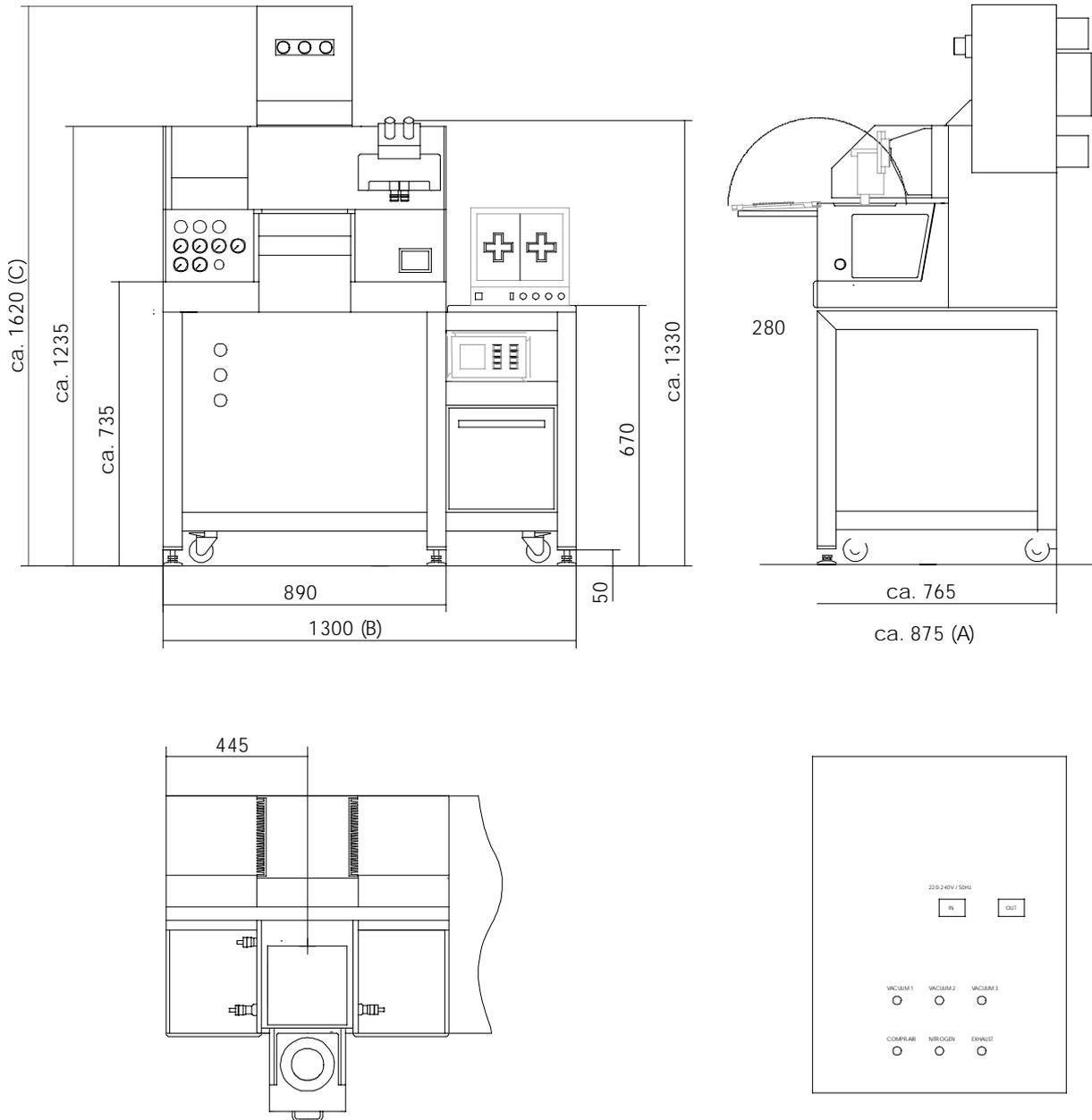
To measure the light uniformity you should do the following test i.e. on a daily basis: With the K&W UV2000 lightmeter measure the light intensity on at minimum five positions (12,3,6,9 o'clock and in the centre). With these five measured data's you can calculate and monitor the light uniformity i.e. as the average uniformity ($= ((\text{max value} - \text{min value}) * 100) / (2 * \text{average value})$).

It is also possible to re-adjust the lamp for a better light uniformity result.

4 Installation

To prepare you for your new K&W MA1006 mask aligner and to make the decision where to install the machine easier for you, here some dimensions and technical requirements of the K&W MA1006:

picture 2: Dimensions of the K&W MA1006



MAX. DIMENSIONS:
 DEPTH (A): 875mm
 WIDTH (B): 1300mm
 HEIGHT (C): 1620mm

K&W MA 1006 MASKALIGNER
 DIMENSIONS IN MM
 SUBJECT TO CHANGE WITHOUT PRIOR NOTICE
 REVISION 01.98

CONNECTIONS
 BACKSIDE

4.1 Delivery

Some weeks before shipment, K&W will decide unison with you the exact delivery date.

Upon arrival of the shipment, the container should be inspected for evidence of damage. If any damage is apparent, notify the shipping carrier and K&W at once.

4.2 Installing and start up

The K&W MA1006 mask aligner must be installed by a K&W service engineer. The start up procedure has also to be done by K&W service engineer to ensure best operating performance. The machine and the subassemblies may be transferred to the installation location, but no container should be opened until the K&W service engineer arrives. This procedure is necessary in order to avoid any question regarding equipment warranty.

4.3 Machine dimensions

length:	1300mm
depth:	875mm
height:	1620mm
weight:	approx. 300kg

4.4 Power requirements

The unit requires 230V / 50Hz AC. It is also possible to run the machine with 220V / 50Hz or 240V / 50Hz or 110V / 60Hz without any change. K&W will provide the correct power cord for the country of delivery.

The power consumption by using the machine with a 350W Hg high pressure lamp 1200VA, and for the operation with a 1000W high pressure lamp 2000VA.

4.5 Environmental requirements

The K&W MA1006 should be installed in a vibration-free area which is also free from any possible dust and acid fumes. The room temperature should be controlled and around 19°C (66°F) to 24°C. Also the relative humidity in the operating room has to be stable between 45% to 55%.

The distance from the machine to the wall must be at least 10cm (4in) to allow a proper cooling and ventilation.

To avoid any electrical problems due to static electricity the floor where the machine is installed should not generate any static charge.

4.6 Other requirements

For nitrogen, vacuum and compressed air the requirements are as follows:

- Vacuum:** < -0.8bar gauge (or more than 24" of Hg or less than 200mbar absolute); the flow rate is insignificant
All machine vacuum connections should be separated to the house vacuum system to avoid any vacuum interference's
- Compressed air:** 4 to 6bar (or 60 to 90psi); the consumption can be neglected;
any dust, particles, oil or humidity should be avoid in the compressed air lines
- Nitrogen:** 2 to 3bar (or 30 to 45psi); the consumption is less than 0.1m³/h
only dry nitrogen should be used

With the shipment, K&W delivers also hoses and connectors to connect nitrogen, vacuum, and compressed air. The hoses have normally a length of about 2m, but can also being ordered in any other length. The connectors provided from K&W are 1/8" male pipe gas threads. Thus the customer should supply a sufficient number of connections with 1/8" female gas threads.

Optional a K&W vacuum pump is available and it goes without saying that the pump is supplied with appropriate connectors.

4.7 Basic alignments

4.7.1 Frame unit

The machine has to be installed in a clean room with a vibration-free floor in an absolutely horizontal direction.

First the four adjustable feet which are mounted on the underframe unit should be positioned for best horizontal direction. Then the machine's ground plate has to be adjusted as well for best horizontal direction by the vibration damper. The best adjustment is reached when there is a ca. 10mm gap between the groundplate and the under frame unit. The pressure of the vibration damper should be around 1.5bar. The control knobs for the five vibration dampers are located on the left hand side of the underframe unit.

The pressure of the vibration dampers should not exceed 2.5 bar to avoid any damage.

4.7.2 Central nitrogen, vacuum and compressed air supply

The central compressed air supply should be adjusted at 2 bar, the nitrogen pressure at 2 bar. The vacuum line should have at minimum 0.8 bar.

All control instruments and the control knobs are located on the back side of the machine. There, also the connector for the waste air is located.

4.7.3 Adjustment procedure for the process pressures

In addition to the central pressure supply, there are some process pressures which have to be adjusted before the first use:

Pressure supply for the wedge error compensation head:

An adjustment of 0.25 bar leads to a mask-/wafer contact pressure of 9 N.

Pressure supply for hard and soft contact exposure sequences:

These pressure have to be adjusted according the needed pressures for your system.

All control instruments, knobs and valves are located in one area underneath the left cover. This makes it easy for you to control and adjust all process pressures.

5 Warranty and limitations

In almost every case the K&W MA1006 mask aligner carries a six month warranty. This warranty is covering labor, material and workmanship. Nevertheless the outlined warranty terms in your quotation are your specific warranty agreement with K&W.

5.1 Scope

The K&W warranty is limited to the following points:

- I) The machine is unpacked and installed by a K&W service engineer or a K&W trained service person.
- II) The equipment has to be used and operated in accordance with this reference manual.
- III) The machine has to be properly maintained on a regular basis.

The K&W warranty excludes any damage during shipment or any items that are subject to wear during normal operation of the K&W MA1006 mask aligner. Those items are: exposure lamps, mask holders, chucks and rubber lips.

5.2 Exposure lamp explosions

Any damage of the optics or the lamphouse due to a exposure lamp explosion is not covered by the warranty.

In case an exposure lamp explosion occurs, please return the lamp socket and some glass fragments to K&W. K&W will contact the lamp manufacturer and try to determine the cause of the explosion. If the failure of the lamp is due to faulty workmanship, K&W will replace the lamp at no cost.

Because nearly every lamp explosion is caused by improper handling, operating and installing of the lamp, K&W strongly suggested to follow all lamp starting, adjustment and cooling procedures.

5.3 Warranty terms in case of resell

K&W offers only a warranty to the original purchaser of the equipment.

6 Operating procedures of the K&W MA1006

6.1 Machine controls and their functions

Language selection:

Press both **ENTER** and **EDIT**. Now you are in the language select menu. Choose your language with **←** and **→**. Confirm your choice with **ENTER**.

6.1.1 Right armrest assembly

RESET	performs a complete machine reset
F1, F2, F3	no function
FIRST EXP	button to select first mask exposure
INTERV EXP	button to select interval exposure
ALIGN CHECK	offers the opportunity to control the wafer-to-mask alignment before exposure
EDIT	button to edit a program
←; →	program enter buttons
ENTER	button to confirm an input
TSA	button to select top side alignment
BSA	button to select bottom side alignment
LIVE	selects the actual view from the BSA camera tubes
STORE	stores the actual view from the BSA camera tubes to the image storage system
IMAGE	shows the stored image of the BSA camera tubes
LOAD MASK	mask holder loading or reloading
VAC	switches on the holding vacuum for the wafer on the chuck
START	starts the program
CONT / SEP	switches between alignment- and exposure gap
EXP	starts the exposure

6.1.2 Left armrest assembly

TSA	switches from camera to microscope
BSA-L	switches to the left BSA camera tube
BSA-R	switches to the right BSA camera tube
BSA-Z	switches to the Z movement for the BSA camera tubes; the camera tube to be moved has to be selected by simultaneous pressing the BSA-L or/and BSA-R button
←; ↑; →; ↓	controls the movement in X-, Y-direction for the microscope (for camera tubes also in Z-direction)
FAST	fast movement; the movement direction has to be selected by simultaneous pressing an arrow button.

On the left armrest assembly also the main switch and the emergency-power-off switch are located.

6.2 Alignment of camera / microscope to the mask

To align the camera or the microscope to the mask, the button **LIVE** on the right hand side has to be pressed.

To move the microscope, the button **TSA** on the left armrest assembly has to be pressed. Then a movement direction has to be selected by the arrow buttons: **↑** and **↓** for the Y-direction and for the X-direction **←** and **→**. By pressing the button **BSA-L** the left camera tube can be moved. For a right camera tube movement you should press **BSA-R**. By pressing both buttons – **BSA-R** and **BSA-L** – both tubes can be moved synchronously.

By pressing the **BSA-Z** button together with one or both of the tube selection buttons, the selected tube or both tubes are moving in Z direction. Use the arrow buttons : **↑** and **↓** for up and down movements. If also the **FAST** button is pressed, the movement speed is enlarged.

6.3 Loading and unloading of a mask

To load or unload a mask, first the button **LOAD MASK** has to be pressed. Then you should pull the transport slide and fold the mask holder to your direction. Then the cleaned mask has to be positioned on the mask holder frame. A vacuum is pressing the mask on the mask holder. Fold the mask holder back to its normal position and press the button **LOAD MASK** once again. The machine is now clamping the mask holder.

6.4 Loading of a stored program sequence

The K&W MA1006 mask aligner allows you to store 99 program sequences on its hard drive. To recall a already stored program, you have to press the **EDIT** button. With the arrow keys the program number has to be selected. When you found the right program number, press **ENTER** again to confirm your choice. After loading the wafer, the selected program sequence starts.

6.5 Writing and editing a program sequence

To write a new program sequence or to edit an existing program, you have to press **EDIT**. The machine's display is now showing you all values and parameters of the selected program sequence. Each value can be selected with the arrow buttons and can be edited after pressing the **EDIT** button. The editing is done by changing the values with the up and down arrow keys. When you have selected the right parameter value, press **ENTER** to confirm it. After editing all parameters, press **SAVE** to save this changing. Now you can choose whether you want to save the changing to a new program number or whether you want to keep the existing program number.

6.5.1 EXPOSURE TIME

By pressing the **EXPOSURE TIME** button you can edit the requested exposure time with the arrow keys. Steps starting from 1 to 9999 are possible. **Each step represent a 1/10sec time step.** Again press **ENTER** after you have chosen your exposure time.

6.5.2 ALIGNMENT GAP

You can varying the alignment gap between mask and wafer. Distances from 1µm up to 999µm are possible. Select the **ALIGNMENT GAP** line by using the arrow buttons **←** and **→**.. Then press **ENTER** and select the distance with the arrow keys **↑** and **↓**. Confirm your choice with **ENTER**.

6.5.3 EXPOSURE GAP

Like for the alignment, you can also choose your gap between wafer and mask for the exposure step. The exposure gap has to be at minimum in the same size like the alignment gap. If you don't follow this rule, the display will show you an operating failure.

To edit the exposure gap, press **EXPOSURE GAP**, select the distance with the arrow keys and confirm your choice with **ENTER**.

6.5.4 PROG. TYPE

After pressing the **PROG. TYPE** button, the display shows the whole range of possible program modes Make your choice by selecting the program with the arrow keys and confirm with **ENTER**.

Possible program modes are: bond, proximity1, proximity2, soft contact, hard contact and vacuum contact. Please be aware that for each mode you need to use a different exposure chuck respective a bond tool.

6.5.5 INTERVAL

By pressing this button you can switch between normal and interval exposure. Interval exposure may be necessary i.e. if your resist is very thick. For a exposure sequence the selected exposure time is divided into several interval steps (see 6.5.6). Between each step there is a pause (see 6.5.7).

After pressing **INTERVAL** you can choose the number of intervals and the pause time (see 6.5.7 and 6.5.8).

6.5.6 #INTERVALS

This button allows you to select the number of exposure steps for an interval exposure. Numbers from 1 to 99 are available. Choose the interval count with the arrow keys an confirm with **ENTER**.

6.5.7 PAUSE

For an interval exposure you also have to select the pause time between each exposure step. This can be done by pressing the **PAUSE** button and selecting the pause time between 1 1/10sec and 9999 1/10sec. Confirm your choice with **ENTER**.

6.5.8 CHECK ALIGNMENT

When you are using the vacuum contact exposure mode, there is the following program sequence: First you align your wafer to the mask. Then you press **EXPOSURE**. Now the chuck rubber lips are pressed against the mask and the now existing chamber between mask and wafer is evacuated. You can control your alignment now by pressing **CHECK ALIGNMENT**. If everything is ok, you have to press **EXPOSURE** once again to start the exposure step.

6.6 Start of a program sequence

With the K&W MA1006 it is very simple for the operator to run the machine in the correct way, because each selection to do is shown in the display. As soon as READY, PRESS START appears in the display, the program sequence can be started by simply pressing the **START** button.

6.7 Reset of the machine

By pressing the **RESET** button, the machine will be put into normal condition.

7 Program sequences

7.1 Exposure programs

After switching on the machine the last active program is reloaded. The display shows the program number. Now, by pressing ENTER, the machine is activating this last active program again. By pressing EDIT, the user can go for any other program by choosing the corresponding program number.

Because the high pressure lamp will need some time to reach the operating temperature, it is useful to start directly the lamp power supply. Simply switch on the K&W LPS1000 power supply, which is mounted in the electronic assembly on the right hand side of the K&W MA1006 underframe unit. The K&W LPS1000 power supply starts with its self test and the START button needs to be pressed for the lamp ignition. For a more detailed description of the K&W LPS1000 power supply, please refer to the operating manual, which is also a part of the machine's manuals.

The next operating step shown in the display is PULL TRANSPORT. Follow this instruction until the transport has reached the end position. The display gives you the information LOAD WAFER. Position the wafer on the chuck by using the prealignment pins. After the right prealignment procedure, press the **VAC** button. If this button is not pressed, the machine starts the fixing vacuum for the wafer on the chuck when the transport is pushed back to the exposure position. When the transport is now in it's final position, the display gives you the following information: READY; PRESS START. By activating the **START** button, the K&W MA1006 now starts with the selected exposure program sequence:

After the prealignment of the wafer on the chuck, the wedge error compensation starts. The wedge error compensation head is moving towards the mask until the wafer is fully in contact with the mask, respectively until the three precision distance balls (by proximity exposure) are in contact with the mask. Now wedge error compensation is finished and the chuck / wedge error compensation unit is moving down into the fine alignment distance. Now the camera tubes / microscope is sliding in the alignment position. The display shows now the information ALIGNMENT POSSIBLE.

Now adjust the camera tubes / microscope for a sharp view of the alignment marks. Use the **BSA-R** and **BSA-L** buttons to control the movements of the camera tubes to left or right direction. For up and down moves, use the **BSA-Z** button. An alignment of the camera tubes / microscope is only possible when the **LIVE** status is active!

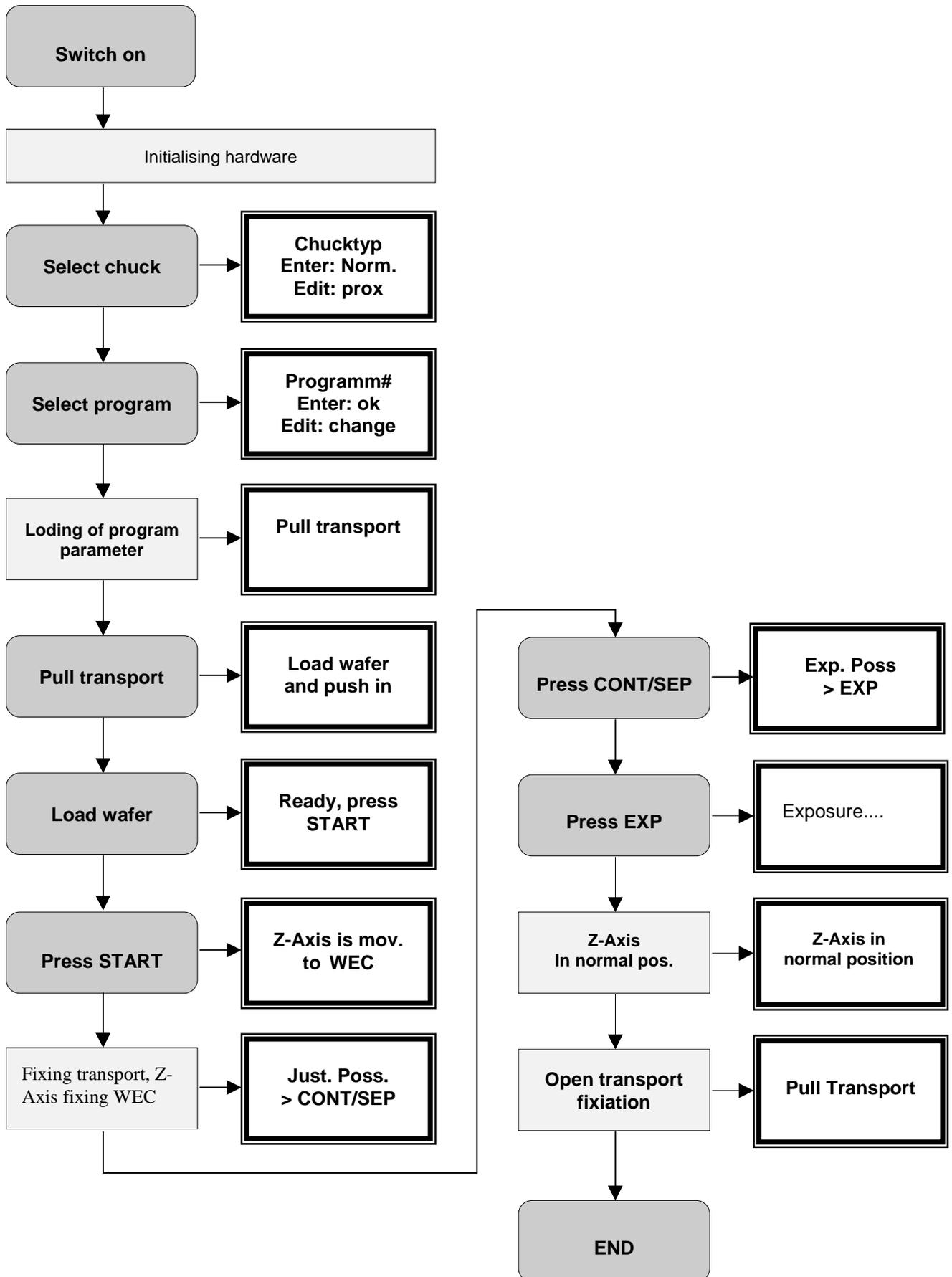
The fine alignment of the wafer is done by the three high precision micrometer screws on the left hand and right hand side of the alignment table unit.

The alignment position can be controlled by the alignment marks on the wafer and on the mask. Either the position can be viewed in the microscope or on the monitor mounted on the right hand side of the machine. (On the screen it seems, that the wafer is moving relatively to the mask, but it is the mask which is moving synchronously with the camera tubes relatively to the wafer. The wafer and the chuck are not moving.)

After the fine alignment is done, the wafer can be moved to the exposure gap position by pressing the button **CONT/SEP**. With this button it is possible to switch between the alignment gap position and the exposure gap position as often as the operator wants to control the wafer/mask alignment. When the wafer is in the exposure gap position the display shows EXP POSSIBLE. When the **EXP** button is now pressed, the machine starts the exposure sequence of the program: First, the camera tubes are moving back and the microscope is sliding to the right. The moving part of the lamp house is moving into the exposure position and the shutter is opening for the selected exposure time. When an interval exposure is activated, the shutter is switching between open and close for the requested times. The display the information EXPOSURE and a bar is showing the remaining exposure time.

After the exposure, the shutter is closing and the display asks you to pull the transport (PULL TRANSPORT). Now you can remove the exposed wafer and start a new exposure sequence for a new wafer.

7.2 Flowchart of a program sequence



7.3 Bond program

If a bond program is selected instead of a exposure program, the sequence is changing substantial.

At the begin of the program the display ask you to PUT BOND TOOL IN. After the bond tool is in its right position and also fixed, the display gives you the information to PRESS START. After pressing the **START** button once, the display gives you the information to SEPERATORS AUSSCHWENKEN; PRESS START. Now the separators of the bond tool has to be removed manually and the **START** button has to be activated a second time.

The display asks you now to PULL TRANSPORT. If this is done, the bond glass has to be loaded (LOAD BOND GLAS) and the start button has to be pressed again (PRESS START). Now the bond glass is fixed by a vacuum.

In the next step, the wafer has to be loaded (1. LOAD WAFER AND ALIGN, PRESS START). After loading and aligning the wafer and pressing **START**, a fixing vacuum for the wafer is also activated and the display ask you to PUSH TRANSPORT. Now the display gives you the information READY, PRESS START and with pressing **START** again, the wedge error compensation is activated. When the bond glass and the wafer are in parallel position, the wafer remains in contact with the bond glass and the information VACUUM MASK ON appears. Now the mask vacuum has to be activated by the rotary switch on the left side of the machine. The first wafer is now fixed and the display asks you to PULL TRANSPORT again.

The second wafer has to be loaded and aligned (2. WAFER LOAD AND ALIGN, PRESS START). The transport has to be pushed back (PUSH TRANSPORT). Now you have to follow the display instructions: INSERT SEPERATOR; PRESS START. Pull in the separators manually and press **START** again. Now the Z-axis is moving into contact. Now the display asks you to INSERT CLAMPS and to PRESS START. The machine is fixing the two wafers to each other and the Z-axis is moving down. After this bonding alignment is done, the display asks you to REMOVE BONDTOOL, PRESS START: Remove the bond tool with the two wafers and start a new bond alignment sequence by pressing **START**.

This is only a short bond sequence description. By equipping your K&W MA1006 with the bond alignment option a detailed bond alignment manual will be handed out to you.

7.4 Power down of the K&W MA 1006

To power down the machine, first switch off the lamp power supply K&W LPS1000 with it's main switch. Now the machine can be also switched off by the main switch.

8 Machine alarms and their repairs

The K&W **MA1006** mask aligner is programmed to stop immediately the program sequences in case a machine alarm occurs.

The reasons for a machine alarm can be different:

8.1 Vacuum leak

The vacuum for the transport and chuck is controlled by vacuum guards. If there is a vacuum leak, the machine stops and shows you an error note in the display.

The most common reason for vacuum leaks are dirty wafers or dirty / corroded chucks. Clean them with pure alcohol and a clean room towel and start the program again.

8.2 Nitrogen supply failure

The nitrogen line is also controlled by a pressure guard. If there is a leak in the nitrogen supply, the cooling for the lamp house is also effected. For this reason, the exposure lamp is powered down in case of a nitrogen supply cut to avoid defects or lamp explosions due to overheating. Of course, in the display an error note is visible. Control the line and check for leaks.

8.3 Compressed air supply failure

If the pressure of the compressed air line falls below 4 bar, the machine stops immediately and an error note appears in the display.

Control the line and check for leaks.

8.4 Basic machine failure

The K&W **MA1006** is equipped with control sensors and micro switches. If one of them shows a failure, read the detailed error description the display is showing you and control the effected positions / parts.

9 Maintenance

9.1 Cleaning of the machine

Maskholder, chuck, transport must be free of dust, dirt, corrosion and mechanical defects to ensure best exposure results.

The best and easiest way of cleaning such parts is done by technical alcohol and a clean room towel on regular basis.

If a wafer has been broken or there are pieces of dirt on the machine, please use a vacuum cleaner to remove the dirt and dust. By using a compressed air flow, dirt and dust can be blown inside the machine and can cause mechanical defects, so use only a vacuum cleaner!

9.2 Cleaning of optical parts.

Optical parts shouldn't be touched and should only be cleaned by a nitrogen air flow. If a lens or mirror is broken, please call K&W for spare part delivery.

9.3 Lamp replacement and adjustment procedure

9.3.1 Lamp replacement procedure

For any maintenance on the lamp and the lamp house, the machine and the lamp power supply have to be switched off.

In case the machine was running, you have to wait and let cool down the lamp and the lamp house for at least 45 minutes. Inside the lamp house temperatures above 150°C can be reached during operation.

Before opening the lamp house, please first pull out the power cord. To open the lamp house, please loosen the screws on the right side. Then you can open the cover like a door to the right side. Now you can check the cold light mirror, which should be clean and without any damage. The position of the cold light mirror should be exact and not too strongly fixed in the holders. If the fixing is too strong, the tension due to heat during operation can cause a mechanical damage of the cold light mirror.

For lamp replacement, the nut on the lower pole of the exposure lamp must be loosened and the connection cable has to be removed. Then the lamp has to be screwed out.

Never touch the bulb with bare finger! Touch the lamp only on the metallic poles!

Some exposure lamps are mounted by the use of an adapter. In this case, remove the adapter and fix it on the new exposure lamp. In case any corrosion is visible on the adapter, replace it in order to avoid a lamp explosion due to bad (because corroded) contacts.

Now open the package of the new exposure lamp. Screw the minus pole of the lamp in the upper connector: Then connect the lower end by using the nut and a nickel plate with the connection cable.

If you use a 1000W lamp, please do not attach a nickel plate between lamp and nut. The lamp is now replaced and after closing the lamp house, the machine and the lamp power supply can be started again.

If any corrosion is visible on the connectors, screws, nuts or cables, please replace the whole lamp connection kit in order to avoid a lamp explosion!

9.3.2 Lamp adjustment procedure

After the replacement of the exposure lamp an adjustment is necessary to ensure an uniform exposure result. Also the light intensity has to be checked and the exposure times have to be controlled.

On the front of the lamp house three alignment knobs are visible which are used to adjust the lamp position within the ellipsoid mirror.

For all exposure lamp adjustments, wear UV protection for eyes and skin!

After the lamp replacement let the lamp burning-in for at least 20 minutes. Then the optimal operating temperature is reached and the lamp can be adjusted.

Place the maskholder without a mask in the correct position, press **EDIT** and select **service**. Now you can open the shutter by selecting **light measurement**.

Place the sensor with the correct light wavelength sensitivity in the middle of the exposure chuck and adjust the lamp position with the Z,X and Y knob for highest intensity.

Now the uniformity of the light has to be adjusted. For that, place the sensor of your light measurement instrument to the 12 o'clock and 6 o'clock position and adjust for equivalent intensity values with the Y knob.

Do the same procedure with the sensor on the 3 o'clock and 9 o'clock position by using the X knob.

Now the lamp power supply has to be calibrated. For this procedure, please refer to the K&W LPS1000 manual.

When lamp and lamp power supply are adjusted and calibrated, close the shutter of the lamp house by selecting **light measurement** again.

9.3.3 Exposure lamp cooling

The cooling of the lamp and the lamp house is realised in different ways:

The lower part of the lamp housed is cooled by compressed air. The shutter and the exposure lamp socket needs a nitrogen flow to be cooled. The valve positions for the lamp house cooling will be adjusted during the machine start-up by a K&W service engineer.

Be aware

If the cooling of the lamp house is too low, an overheating can cause a lamp explosion.

If the cooling of the lamp house is too high, the lamp can not reach their operating temperature and so the light intensity will be too low.

9.4 Appearing of unknown noise

If unknown noise is audible, check the functional groups of your K&W MA1006 maskaligner by running some testwafers. If the sound is not locatable, please call K&W. Do not run the machine in order to avoid a colossal blunder.

9.5 List of consumables for K&W MA1006

9.5.1 Optical parts

Lamps:

High pressure mercury lamp USH200DP	99-7007211
High pressure mercury lamp USH350DP	99-7007212
High pressure mercury lamp USH1005DP	99-7007213
High pressure Xenon lamp UXM501MD	99-7007214

Lamp connector cables

Cable USH200 Positive	99-5005411
Cable USH200 Negative	99-5005412
Cable USH350 Positive	99-5005413
Cable USH350 Negative	99-5005414
Cable USH1005 Positive	99-5005415
Cable USH1005 Negative	99-5005416

mirrors

ellipsoid mirror	99-7007215
cold light mirror UV400	99-7007216
cold light mirror UV300	99-7007217
cold light mirror UV250	99-7007218
condensor lens UV300/UV400	99-7007219
condensor lens UV 250	99-7007220
turning mirror 45°	99-7007221

9.5.2 electronic parts

PC-Boards

Input/Output-TTL	99-5005417
Input-24	99-5005418
Output-24	99-5005419
Stepping-Motor Logic	99-5005420
Stepping-Motor Driver	99-5005421
Power-Supply 5V/3A 24V/5A	99-5005422

Sensors

inductive quadruple	99-5005423
Inductive round	99-5005424
end position switch micro	99-5005425
end position switch	99-5005426
PEN-M5	99-5005427

9.5.3 Pneumatic parts

valve unit compressed air	99-6006211
valve unit nitrogen	99-6006212
valve unit vacuum	99-6006213
throttle valve (backwards)	99-6006214
manometer 0-10bar	99-6006215
manometer 0-4bar	99-6006216
manometer -1-0bar	99-6006217
fine adjustment pressure regulator 0-4bar	99-6006218
pressure regulator 0-7bar	99-6006219
pneumatic switch on/off	99-6006220