# 1 GENERAL DESCRIPTION AND PRINCIPLES OF OPERATION

The SUSS MA 150 is a mask alignment and exposure system which offers unsurpassed, highly economical mass production capabilities for cassette to cassette handling of wafers up to 150 mm in diameter. The machine combines high productivity and superior economy of operation in an extremely flexible system which can be easily adapted to fit your process requirements.

Because of its modular construction, the MA 150 is particularly easy to maintain and service; all functional groups are readily accessible and complete subassemblies are quickly modified or replaced. The microprocessor control and the flat panel touch screen display ensure accurate and rapid data entry, and the program storage capability allows ease of setup. Wafer alignment is simple, quick, and precise due to very functional alignment stage manipulators. In addition, particular emphasis has been placed on the ergonomic aspects of the MA 150. Controls are clearly identified and located for the operator's convenience, and padded and contoured adjustable armrests are positioned for maximum comfort.

## 1.1 A BRIEF ORIENTATION

The SUSS MA 150 is composed of two operational sections, the aligner and the cassette loader. The cassette loader portion includes the input and output cassette elevators as well as the prealigner. The aligner portion consists of the wafer transport system, the alignment stage, the exposure chuck, the wedge error compensation head, the microscope, and the exposure mechanism.

The operation of the MA 150 is very straightforward and easy to learn. First, insert a cassette of unexposed wafers into the input cassette elevator (right side) and an empty cassette into the output cassette elevator (left side). Then load a mask onto the maskholder, the maskholder onto the alignment stage, select the desired process program, and press the START/STOP button.

The input cassette elevator containing the unexposed wafers moves downward until a sensor detects the first wafer. The elevator stops and the transport system removes the wafer from the cassette and places it in the prealigner. The wafer is optically prealigned with the flat facing the operator. The wafer transport system which has removed another wafer from the input cassette for prealignment, transfers the prealigned wafer to the exposure chuck. (If there is an exposed wafer on the exposure chuck at this point, the transport system will remove the wafer and place it in the output cassette.) The exposure chuck ascends and WEC is performed between mask and wafer.

If you have chosen a program that includes mask to wafer alignment, the wedge error compensation head now moves into to the alignment gap selected while maintaining parallelity between mask and wafer. It is simple to align the mask to the wafer by using the microscope and alignment stage manipulators. When the alignment is correct, press the CONT./SEP. button on the X-Y manipulator. The wedge error compensation head now moves the exposure chuck and wafer into contact with the mask (if a contact program was chosen) or to the selected exposure

gap (if the proximity program was chosen). If alignment in the exposure position is satisfactory, press the EXPOSURE button (located on the right side of the armrest assembly) to initiate exposure.

Once the EXPOSURE button is pressed, the microscope is raised and the mirrorhouse slides forward to position the exposure optics over the wafer. The shutter then opens to expose the wafer for the amount of time that has been selected.

When exposure is complete, the mirrorhouse retracts, the microscope is lowered, the exposure chuck returns to its lower position and another cycle begins.

## 1.2 ALIGNMENT/EXPOSURE MODES

The SUSS MA 150 has four exposure modes with "first mask" and "alignment" options for each mode, therefore providing the flexibility of eight possible combinations to match particular processing requirements. The choice depends upon whether a contact or proximity exposure is desired, and whether the machine will be stopped during its cycle to allow for mask to wafer alignment. The option is programmed during the set-up described in Section 2.3 of the Operator's Reference Manual.

### 1.2.1 VACUUM CONTACT EXPOSURE

In the vacuum contact mode, once the wafer is in contact with the mask and the exposure cycle has been initiated, a rubber seal is brought up from the exposure chuck to create a chamber at the exposure chuck, and the air in the chamber between the mask and wafer is evacuated. The vacuum holding the wafer to the exposure chuck is removed. The highest resolution levels can be achieved in this mode. The vacuum in the chamber is adjustable.

### 1.2.2 HARD CONTACT EXPOSURE

In the hard contact exposure mode, once the wafer is in contact with the mask and the exposure cycle has been initiated, the vacuum securing the wafer to the exposure chuck is removed. Nitrogen is introduced under the wafer, pressing the wafer against the mask. This pressure can be easily adjusted to suit the particular process requirements.

### 1.2.3 SOFT CONTACT EXPOSURE

In the soft contact exposure mode, the vacuum securing the wafer to the exposure chuck remains "on" during exposure. The only force pressing the wafer to the mask is that exerted by the wedge error compensation head when parallelity is performed.

### 1.2.4 PROXIMITY EXPOSURE

The proximity exposure mode permits the MA 150 to perform wedge error compensation and exposure without contact between the mask and the wafer, which eliminates the possibility of mask damage due to contact with the wafer. This may result in greatly increased mask life and lower mask costs. During wedge error compensation, three precision reference balls are inserted between the mask and the wafer. After parallelity adjustment, the balls are removed and the wafer is brought to the alignment or the exposure position, depending on the mode chosen. Both the alignment and exposure gaps are easily selected and can be entered in 1 micron increments.

## 1.2.5 FIRST MASK EXPOSURE

Use the first mask mode whenever there is no requirement for manually aligning the mask to the wafer. (The automatic prealigner and wafer transport system will still prealign the wafer on the chuck to an accuracy of ± 25 microns.) After the operating parameters are set and the cassettes are loaded into the machine, the MA 150 removes the first wafer from the input cassette, prealigns and exposes it, and then inserts it into the output cassette. The machine continues through the program non-stop until the input cassette is empty or the output cassette is full.

## 1.2.6 EXPOSURE WITH ALIGNMENT

This mode is substantially the same as the First Mask mode except that you have the opportunity to align the mask to the wafer. After the wafer has been prealigned and placed on the exposure chuck, but prior to exposure, you may align the mask to the wafer by using the microscope and alignment stage manipulators. (The alignment stage is an extremely precise mechanism that allows the mask to be moved in 0.1 micron increments.) You may alternate between the alignment gap and the exposure gap (or contact, if using a contact program) as many times as you wish. When the alignment is satisfactory, press the EXPOSURE button. The MA 150 exposes and then removes the wafer as previously described.

## 1.3 THE SUBASSEMBLIES OF THE MA 150

The MA 150 is made up of various subassemblies:

a. Input Cassette Elevator - The input cassette elevator (which accommodates all commercially available types of cassettes) holds the cassette of unexposed wafers and lowers the wafers to the transport plate. The elevator is stepper motor driven for accuracy. The compartment spacing can be changed to accommodate special wafer sizes. It is located on the right side of the the machine.

b. Prealigner - The prealigner accepts the unexposed wafer from the transport plate, centers the wafer by lowering it into the funnel, and finds the flat on the rotating wafer by means of photosensors. The wafer stops with the flat facing forward. The prealignment is repeated to provide a more precise prealignment. The aligner then transfers the wafer to the wafer transport system at the proper time in the process cycle. Individual wafers can also be prealigned .

c. Wafer Transport System - The wafer transport of the MA 150 is a pick-and-place system. The wafers are handled exclusively from the backside; there are no belts or other contamination producing elements utilized. The transport system consists of three transport plates attached to a high precision locating mechanism. The right plate moves wafers from the input cassette to the prealigner, the center plate moves wafers from the prealigner to the exposure chuck, and the left transport plate moves wafers from the exposure chuck to the output cassette. If there is a vacuum failure, the three plates are designed so the wafers will remain on the transport system instead of dropping and causing possible damage.

d. Wedge Error Compensation (WEC) Head - The exposure chuck is contained in the WEC head. Once the wafer is deposited on the exposure chuck, the WEC head raises the chuck and wafer to the mask. The chuck and the WEC head float which compensate for any wafer taper (wedge). When the mask and wafer are parallel, the chuck locks in position and, if an alignment program has been chosen, moves the wafer to the selected alignment separation distance.

e. Alignment Stage - The alignment stage is the heart of the MA 150. This stage holds the maskholder and mask, and is movable in the X, Y, and Theta (rotational) directions for alignment. It also contains the Z axis movement which raises and lowers the wedge error compensation head to position the exposure chuck at the proper alignment and exposure gaps. The stage provides minimum alignment movement of 0.1 microns in the X and Y directions and minimum vertical movement of 1.0 micron.

f. Lamphouse - The lamphouse is easily accessible and contains the exposure lamp and custom optical components which direct light to the wafer. Light from the exposure lamp is reflected by an ellipsoidal mirror to the cold light mirror. The cold light mirror filters the infrared radiation (heat) produced by the bulb and reflects the "cold" ultraviolet light required for exposure through the wafer exposure system.

The SUSS exposure system with diffraction reducing optics provides extraordinarily high uniformity and collimation over the entire exposure area, resulting in steep resist edges and small diffraction effects. The optical system is specifically matched to the customer's process requirements, therefore the particular configuration varies from machine to machine. Several types of filters are available and provided where required. The lamphouse also contains two shutters. One shutter opens to initiate the wafer exposure, while the other shutter closes to complete the exposure. Both shutters then return to their starting positions. This system ensures that the entire wafer receives the same amount of exposure energy.

g. Output Cassette Elevator - The output cassette elevator holds the cassette for exposed wafers and properly positions the cassette for wafer input. The elevator is stepper motor driven for accuracy, and the compartment spacing can be easily changed to accommodate special wafer sizes. It is located on the left side of the the machine.

h. Microscope - The MA 150 is equipped with a SUSS Splitfield Microscope. The field can be observed through either the left or the right objective, or through both objectives at the same time. There are controls for both coarse and fine objective spacing, and each objective has a fine focus adjustment. Illumination is provided by means of fiber optics and the intensity can be varied. Each objective has its own contrast control for greater flexibility.

i. Microscope - The microscope and its mounting assembly contain the drive motors which allow microscope movement in the X, Y, and Theta (rotational) directions, as well as the coarse focus control for the microscope.

j. Arm Rest Assembly - The armrest assembly contains the alignment stage manipulators, the emergency power switch, the vacuum, nitrogen, and compressed air gauges, and the control buttons.

k. Alignment Stage Manipulators - The two manipulators mounted on the armrest assembly control the motion of the alignment stage and/or the microscope in relation to the wafer. The speed is proportional to the manipulators' range of movement. The manipulators also include recessed buttons that allow selection of different features.

l. Electronics Module - The electronics module is situated at the right side of the MA 150, and rests on casters which provide isolation from the aligner and permit the unit to be moved easily should service be required. Cable connections and cooling exhaust are located at the rear of module.

m. Flat Panel Touch Screen - The flat panel touch screen is attached to a support arm and mounted on the right side of the arm rest assembly. The screen contains a flat panel

which displays operational data. It also contains a touch input system which allows the operator to enter all of the required operational data by simply pointing to menu selections on the screen. The screen can be oriented for operator comfort and convenience.

n. Computer - The MA 150 is controlled by a personal computer located in the footwell of the machine base. The computer is equipped with a keyboard and a floppy disk drive for machine servicing and software updating. The keyboard and floppy drive are not needed during normal machine operation.

## 1.4 Special Features

Special features of the MA 150 can be accessed directly or indirectly through the flat panel touch screen. These features allow program changes to be made easily and contribute to the versatility of the machine. They include:

a. Short Program - Selecting this feature disables the elevators and wafer transport system. You are able to manually place a wafer on the exposure chuck and operate just the aligner section, or expose a wafer which is already on the exposure chuck.

b. Negative Resist - An optional nitrogen purge feature is provided to flush the exposure area during exposure. It should be used when processing negative resists, and can be adjusted easily to suit particular requirements. This feature requires an optional mask holder.

For a more detailed description of the machine operation and capabilities, please refer to Section 2.3 in the Operator's Reference Manual.

## 1.5 Service Programs

Numerous service programs are available for ease of maintenance of the MA 150. The service program menu is accessed by pressing the SYSTEM key when the main screen is displayed.

**CAUTION: Service programs are for use by factory trained personnel only.**