



DWL 66FS

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Preface

This manual is meant to help the user to start working with the main applications of the DWL66Fs laser lithography system. It contains a brief system description and step-by-step instructions for the standard tasks of the system operator.

This preface gives information about the terminology used in this manual as well as additional sources of information and support.

In the first chapter, a brief overview of the system components and their interaction is given.

The second chapter contains simple step-by-step instructions for exposure jobs. They guide the operator through preparation and completion of exposure jobs using the DWL66Fs menu, the graphical user interface designed to give the operator an easy-to-use control over the system functions.

In chapter three, the measurement features of the DWL66 are being explained. This set of functions is dedicated to position and linewidth measurements for system calibration or quality checks.

Chapter four gives some simple troubleshooting procedures for common problems.

The last chapter contains information on maintenance procedures.

Related Documentation

Heidelberg Instruments offers several further Manuals related to the machine and its operation. If you did not get one of these or need an update, please contact Heidelberg Instruments, Germany.

<i>Preinstallation Guide</i>	System requirements, sizes and weights of components etc.
<i>Conversion Software Manual</i>	Manual for the HIMT conversion software used for data preparation and fractioning
<i>User Guide, Part II</i>	Reference Manual for functions of the GUI as well as the Matrix Commander program

Conventions used

Throughout this manual there are safety warnings. To classify the degree of danger in each of these situations, the following notation is used:

CAUTION: Advises that you risk damaging your equipment if you do not heed instructions.

WARNING: Advises that you risk danger to personal health if you do not follow instructions carefully.

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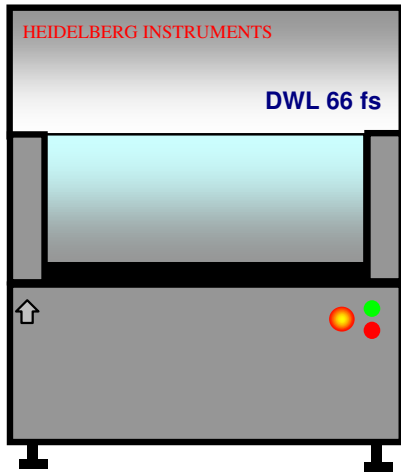
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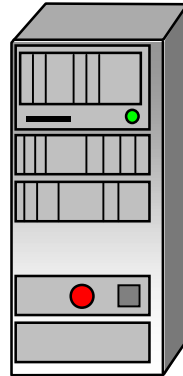
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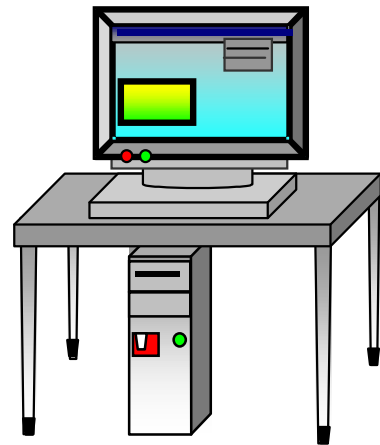
CHAPTER 1 - GETTING STARTED



DWL 66 SYSTEM FRAME



ELECTRONICS



USER PC

INTRODUCTION

The **DWL 66fs** is a high-resolution imaging system where over a million dpi is achieved using a 25-nanometer writeable address grid for exposing metallized plates or wafers. Depending on the individual X/Y stage, a DWL 66 fs will accommodate media up to 6 x 6 inches or even 8 x 8 inches. Design data can be created with any program using DXF, HPGL, Gerber, GDSII, or CIF format and is converted into a LIC format on a "CONVERT" workstation. Design data transfer to the system is then realized via an FTP connection.

Safety Precautions

WARNINGS

- The DWL machines use lasers and high voltage electronics.
- Please read this section carefully before operating the system!
- If instructions are not followed carefully, danger to personal health and damaging the equipment is at risk.

GENERAL PRECAUTIONS

The DWL 66 fs protects operators from exposure to moving parts and laser energy while operating the equipment. All moving parts, lasers and their associated optics are enclosed within the laminar flowbox. During operation, opening the flowbox window will automatically stop an exposure. Please observe the following safety precautions while operating the DWL 66 fs:

- Follow all warnings and instructions given in this manual, the user menu software, or our engineers.
- Ensure that both the voltage and frequency of a power source match the voltage and frequency stated on the equipment's electrical label.
- Except when loading media, never push objects of any kind through openings in the equipment. Dangerous voltage levels may be present. Conductive foreign objects could produce a short circuit resulting in a fire, electric shock, or permanent damage to your equipment.
- To reduce the risk of electrical shock, always plug the DWL 66 fs into an approved outlet with correct safe ground. Power requirements are described in the "DWL 66 fs Preinstallation Guide".
- Not all power cords have the same current ratings. Household extension cords do not have overload protection and are not meant for use with computer systems. Never use household extension cords with the DWL 66 fs or any of its external components.

LASER SAFETY

During normal operation, the DWL 66 fs is a class 2 laser product. Opening the optics covers and leaving them open during exposures changes the laser class to that of the exposure laser (3B or 4, depending on system configuration). In case of the optics cover covering the laser, the safety class of the laser source directly applies upon removal of the cover.

Only trained personnel may be allowed to remove any optics covers.

ELECTRICAL SAFETY

Operating power for the DWL 66 fs is supplied by a CEE type 220-240 V, 16 A connector. Alternatively, a CEE type 220-240 V, 16 A single-phase female cable connector can be used to connect a local-type cable to a local-type wall connector. See the Preinstallation Guide for more details.

The following safety precautions should be observed when doors and covers are opened and the equipment is energized.

- Observe similar electrical precautions as would be for any system consisting of 220-240 VAC dedicated circuit single-phase power, and DC power supplies.
- If access to the interior power of the system or any component is necessary while the system is in operation, exercise extreme caution. ***Only qualified service personnel should have access.***

System Components

The DWL66fs system consists of the following main sub units:

- Granite System
- Flowbox
- Optics System
- Electronic Control Units
- User PC
- Data processing conversion workstation

GRANITE SYSTEM

The DWL main system consists of a heavy granite construction. Granite has been selected for its weight and stability. These properties ensure

- a) effective vibration isolation in connection with the air buffer system, and
- b) a low expansion coefficient.

In order to maintain an even expansion coefficient, all other stage parts are constructed from granite as well. Although this material has certain advantages granite is not completely insensitive to external influences. Temperature and humidity play an important role in the stability of the machine, therefore its external environment must be kept extremely stable. The large volume of the granite results in a long adaptation period before the machine can be expected to produce consistent results. Hence, installation must be done in two stages:

STEP 1: System set up and function tests

These tests can be started when the granite system has been placed in its final location for anywhere between 24 - 48 hours. They serve to demonstrate the functionality of all components

- *Until a system has completely adapted to its location, final calibration procedures will not prove useful*

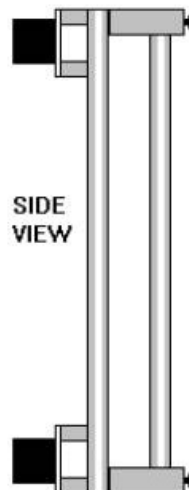
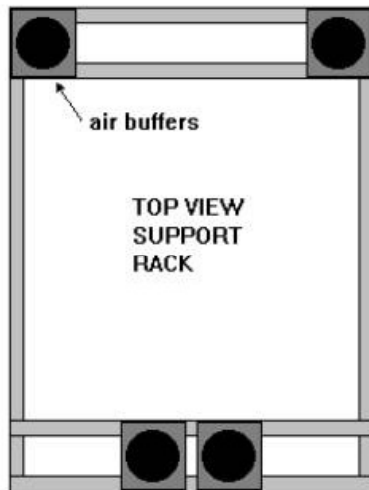
STEP 2: Calibration and end test

Once the system has thermalized and everything is functional, tests and measurements for fine adjustment and end calibration are done. This procedure is often followed by a final acceptance test in cooperation with the customer.

ELEMENTS OF THE GRANITE CONSTRUCTION

SYSTEM SUPPORT:

The granite base is supported by a heavy-duty aluminum construction and four air filled buffers for vibration isolation. These buffers are arranged in a quasi-three point system as to avoid any unnecessary bending forces in the granite.



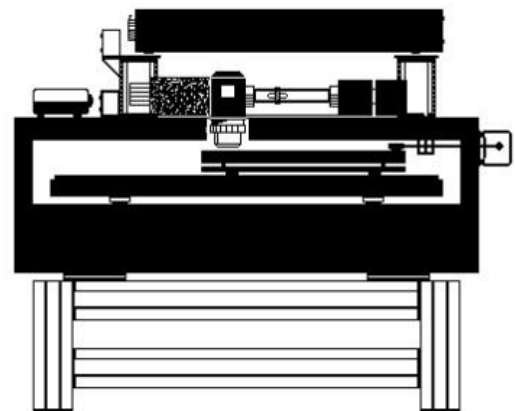
MAIN BLOCK:

The main granite block has gaps to accept the air buffers so that the block's center of gravity lies below the attachment points of the air buffers. This increases the stability of a system during writing. The block also contains screw holes to attach other components to the granite system.

STAGE SYSTEM:

The stage system is a linear motor X/Y-stage. Chosen for its reliability and ease of use, the system's motion is controlled using the X- and Y-interferometer system and the linear motor controller.

The stage is equipped with a vacuum chuck.



OPTICS PLANE:

The optics plane contains all beam control elements, lenses and mirrors. The write lens is also mounted on the optics plane and is directed downwards onto the substrate. To minimize heat generation in this area, HeCd lasers are mounted above the optics plane in an own compartment.

FLOWBOX

The flowbox provides a stable environment for the DWL in terms of temperature, laminar airflow and clean air, guaranteeing controlled and constant exposure conditions and thus minimal variation of exposure parameters.

The front of the flowbox features buttons for powering up or down the system, an emergency STOP button, and a switch for lifting and lowering the window. The covers of the flowbox can be removed for service by authorized service personnel.

WARNING: Opening the flowbox covers gives access to dangerous laser radiation.

ELEMENTS OF THE FLOWBOX

- **Window:**

Used for loading and unloading the DWL; must not be opened during operation (opening window will stop any movement and close laser shutter).

The toggle switch on the front of the flowbox controls the pneumatic system that lifts and lowers the window.

- **Heating and Airflow System:**

Airflow is adjustable to between 0.3 and 0.5m/s and is preset during adjustment for optimum stability. The heating system is situated below the top of the flowbox, and is regulated automatically by a temperature control unit. The temperature setpoint for the flowbox should be chosen 2-3°C above the room temperature to allow stable control. As an option, the air at the inlet can be precooled with an additional precooling chiller to allow a temperature setpoint that is close to the room temperature.

The temperature stability, assuming $\pm 1\text{ }^{\circ}\text{C}$ ($\pm 1.8\text{ }^{\circ}\text{F}$) outside the unit, is $\pm 0.1\text{ }^{\circ}\text{C}$ ($\pm 0.2\text{ }^{\circ}\text{F}$) on the inside.

CAUTION: Although provided with a standard plug, the heater is *not* to be plugged into a standard outlet, rather into the designated outlet at the temperature controller. The heating is installed by service personnel and is not to be modified by the user. Improper installation can cause the system to overheat and to be damaged beyond repair.

- **Light:**

Depending on the type of coating on the plates to be exposed, a red or yellow light may be switched on inside the flowbox.

OPTICS SYSTEM

The exposure optics of the DWL66Fs consists of four major parts: The laser, the beam-shaping modulator, the fast deflector and the write lens. Additional optics include the camera systems for inspection, measurements and alignment, as well as the interferometric system for stage position control.

CAUTION

All systems are factory adjusted and can only be worked on in the field by experienced Service Engineers.

- **LASER UNIT:**

The DWL 66 fs runs either a 442 nm HeCd laser or a 405-410 nm Diode laser. The laser head is mounted directly above (HeCd) or on (diode) the granite base. The power supply is in both cases set outside the system, as it generates heat.

WARNING

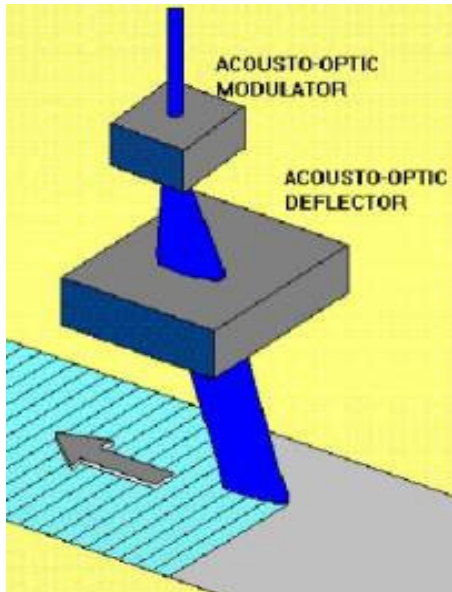
- The laser is a class III b category, and under these conditions, personnel must observe safety precautions (i.e., sufficient eye protection)
- Never look directly into the laser beam
- Never sight down a beam into its source

- **BEAM SHAPING MODULATOR:**

An extremely swift modulator system, generating up to 32 various beam positions, can digitally turn each beam position on and off.

- **FAST SCAN DEFLECTOR:**

The acousto-optic deflector device generates a swift laser scan with an approximate sweep rate of 40 kHz. The scan angle is imaged into the back focal plane of the write lens resulting in a telecentric scan arrangement, so that the laser beam is always perpendicular to the substrate.



- **WRITE LENS SYSTEM:**

Various write lenses can be utilized. The focal length of typical lenses is as follows:

2mm: Used for high-resolution metallized plates and wafers

4mm: Used for high-resolution metallized plates and wafers

10mm: Used for low-resolution metallized plates

20mm: Used for high-resolution emulsion plates and films

40mm: Used for low-resolution emulsion plates and films

The customer, when adapting a system to a unique application, can exchange any lens. An air gauge auto focus system is used to correct for variations in the glass plate thickness by moving the lens accordingly with a piezo.

CAUTION

- Make sure that the nozzle of the air gauge autofocus system never touches the substrate, or the stage!
- When handling a dismantled write head, take care not to scratch or dent the nozzle!

- **CAMERA UNIT:**

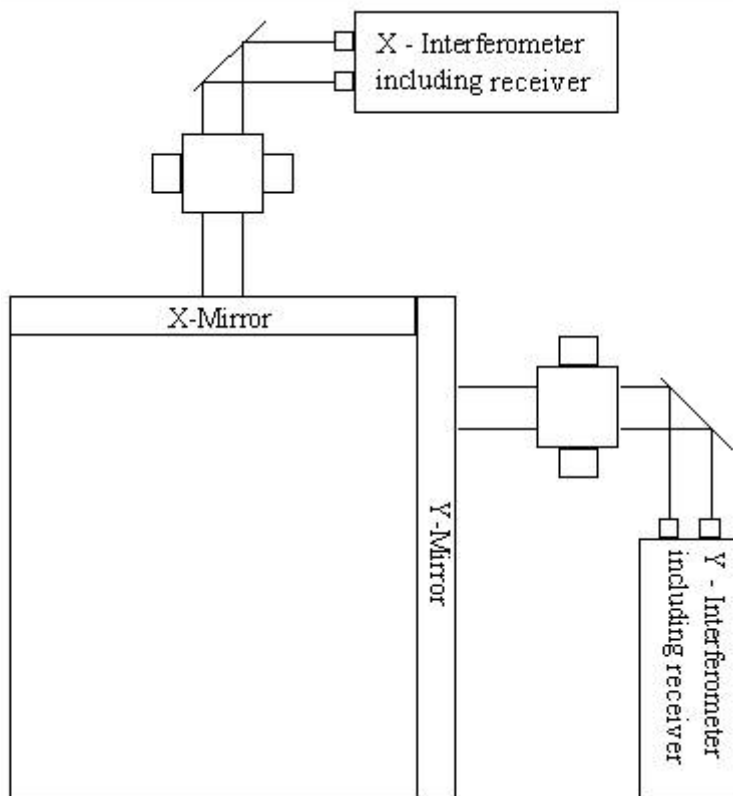
The camera unit optics comprises a micro camera, a macro camera, and a white light illumination. Such a unit can be used to inspect and measure plates and films. For multi-layer applications the cameras are also employed for alignment. The cameras are connected to a video image processing system offering a number of metrology functions (see chapter three).

- **BACKSIDE ALIGNMENT CAMERA UNIT:**

One of the options for the DWL66Fs is the capability for alignment to a structure on the backside of a substrate. The backside alignment camera unit comprises the same components as the standard camera unit, plus a focusing objective.

- **INTERFEROMETER:**

Only industry standard interferometer systems with proven qualifications are being utilized. A stage position measurement device provides the necessary information for the online position error correction system. Only through this function will a machine be able to achieve its required level of precision.



CAUTION

- Never interrupt any of the interferometer laser beams, since this causes the loss of position information and, during movement, will cause the stage to stop immediately
- If beams were interrupted, the interferometer must be reinitialized before machine operation may be resumed
- Do not touch the mirror surfaces! ***Touching a mirror surface with bare hands will damage it beyond repair!***

ELECTRONIC CONTROL UNITS

The electronic control of the DWL 66 fs consists of five main parts positioned in separate slots of the electronics control rack:



1. System Control Rack:

The system control rack contains all control units for data processing and positioning. Central units are:

MAIN PROCESSOR (BAB740) – A 68030 Motorola processor running under a multitasking OS9 operating system controls the subprocessors for stage positioning, pixel generation and image alignment via a VME bus. The main CPU board also contains the connection to the ethernet network.

EXPOSURE MEMORY UNIT (EMU) – A card controlling 1 MB of 16-bit-SRAM modules for processing exposure data

EXPOSURE CONTROL UNITS (ECU) – The ECU-A2S unit gets exposure data from the EMU card and controls functions like position-correction, intensity- and frequency-correction, while the ECU-B counts X-/Y-positions and controls the exposure timing.

DETC INTERFACE – A multi-channel ADC, DAC, and digital I/O board, used for sensors, control signals and actuators, e.g. the auto-focus control, interferometer initialization and the shutter.

IMAGE PROCESSOR – The imaging system consists of two cameras of different resolutions, a frame grabber, an image processing board and a FIPS software package. The BAB740 and its subsidiary board are controlling the latter parts.

2. Stepper Motor and AF Control Rack:

In this rack, all units controlling the motion of the system's stepper motors are to be found. In addition, it contains the autofocus control board, which controls the position of the write lens using a pressure sensor signal to correct the position of the lens piezo actuators.

3. AO Rack:

This rack contains the electronics for control of the acousto-optic crystals. The HF signal carrying the information for the laser beam positioning and intensity is generated here as well as the frequency ramp for the scanning of the beam.

4. Power Unit

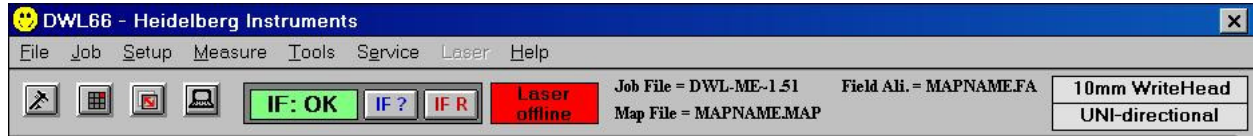
Main power unit including the emergency shutdown, relays and breakers

5. Anorad Controller Rack (behind panel):

This rack controls the stage motion by linear motors.

USER PC

The user PC runs the Windows User Menu, converting user input into DWL commands, and thus controlling functions of the DWL 66 fs. The User PC is a tool for making the DWL 66 fs easier to operate by minimizing handling errors.



The DWL 66 fs User Menu provides instant access to main functions via the control toolbar:



Opens Control Panel for movement, focussing, camera settings etc.



Opens current Exposure Map



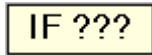
Starts a preprogrammed Manual Global Plate Alignment Sequence



Opens Mini-terminal window, for login and limited communication with the OS9-system



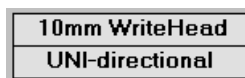
Request Interferometer status

NOTE: The status shown in the label  will only update when this button is pressed!



Resets Interferometer

NOTE: **IF R** also forces a stage reset!



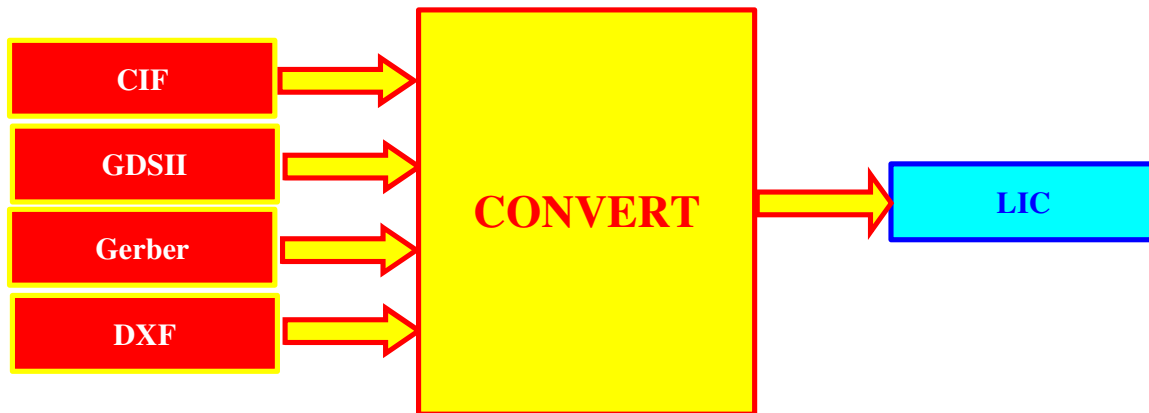
Configuration file in use; double-click to change configuration (see **Chapter 2**, Section **Changing write head and Exposure Mode**)

The main menu offers a number of logical menus:

- **File:**
Contains the functions necessary to inspect which data files are available on the machine's hard disk.
- **Job:**
Exposure conditions and data sets of an Exposure Job are modified using the commands in this menu. A prepared job may be opened for use or modification.
- **Setup:**
The **Setup** commands allow for the setup or modification of a job environment as well as the setup and testing of a number of automatic or semi-automatic sequences for alignment, including the definition of image templates.
- **Measure:**
Measure functions can be used for control of exposure quality.
- **Tools:**
Offers access to a variety of tools for report analysis and other tasks.
- **Service:**
Contains useful tools and functions for calibration and servicing, as well as the function for changing the system configuration
- **Help:**
Gives access to information about the software version, contacts, the software history, and the index of help topics on the use of the menu software.

More information on the user menu will be given in the step-by-step instructions further down in this manual. For a complete reference on all available menu functions, see the **User Guide II: Reference Manual**.

CONVERSION STATION



The conversion workstation contains the conversion software package. The purpose of this software is to convert source files from gerber, dxf, cif, gdsii, hpgl or structure format into the LIC format the machine needs as input. During an exposure, this LIC format data is converted in real time into the final pixel data set. Theoretically the original design data could be converted directly to the final pixel set, but the advantage of the LIC format is that its file size is much smaller due to a highly optimized compression, leading to a much faster data transfer from the workstation to the system.

Applying Power / Powering Down

CAUTION

- *Never use a timer switch with the laser!*
- In case of emergency, press the large red STOP button located on the front of the DWL machine.

APPLYING POWER INSTRUCTION:


1. Press the green **ON**-button located on the front panel of the DWL 66 fs.

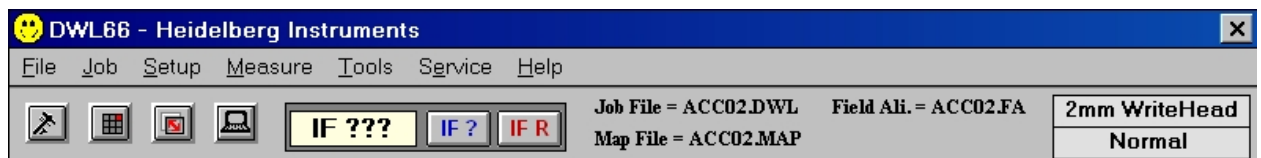
- If system was switched off with Emergency Stop button, that button must be released first
- If the power does not come up, check if the red main breaker at the front of the electronics rack was switched off.




MAIN BREAKER

2. Switch on the User PC.

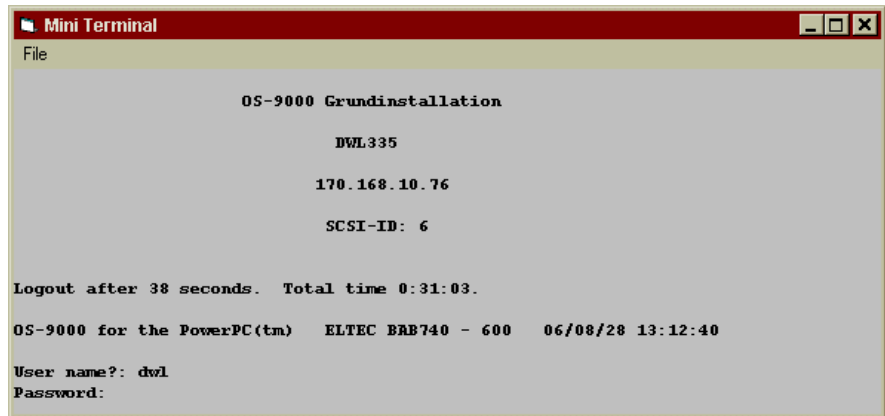
3. Open up the **DWL66** user menu, by clicking on the  icon. The following menu bar will appear:




4. Open up the **Mini Terminal** by clicking on the  icon. The following window will appear:



5. Press **Enter** for the login prompt to appear. Login by entering "**dwl**". The password is set to "**dwl**" by the factory, but it can be changed (consult Heidelberg Instruments).



6. Close the terminal by again clicking on the  icon or the **X** in the upper right corner of the mini terminal window. A window will open showing the system settings of the current configuration. Confirm with **OK**.

Now the communication port is available to process commands, and exposures can be prepared.

7. Switch on the laser with the key switch.
externally controllable laser (e.g. diode): Open menu **Laser** and choose **On**.

NOTES

- The exposure laser and the interferometer laser must warm up before initializing the machine and exposing. *Switch on the laser and the DWL 66 fs electronics at least 30 minutes before exposure.*
- When the DWL is not performing tasks for a longer time, it is advisable to close the Main Menu and shut down the computer.
- Even if the PC was shut down, it stays logged in at the system controller. The login procedure only has to be performed again if the system controller electronics was switched off or rebooted (menu message "DWL does not respond").

POWERING DOWN INSTRUCTION:

1. Switch off the laser using the key switch.
externally controllable laser (e.g. diode): Open menu **Laser** and choose **Off**.
2. Exit **DWL66** Menu by highlighting **Exit** under the **File** submenu.
 - Confirm menu shut down in dialog box
3. Shut down Windows by pressing **Alt-F4** or choosing shutdown from the start menu.
4. Switch off computer and monitor (*if not done automatically*).
5. Press the red **OFF**-button located on the front panel of the DWL 66 fs.
6. For a complete shutdown, switch off the red main breaker at the front of the electronics rack.

CHAPTER 2 - HOW TO PREPARE TASKS

WARNING:

- Be sure to read all safety instructions outlined in the safety precautions section at the beginning of this guide or within this section before operating the DWL 66 fs.
- Always observe all warnings during use of this laser device.

INTRODUCTION

This chapter contains instructions for all procedures that are needed before an exposure or measurement process. These are

- System setup instructions (configuration settings, substrate loading etc.)
- Data preparation (setup of a job environment and the related task sets)
- Matching of coordinate systems (alignment, setting of origin)

Changing Write Head and Exposure Mode

INTRODUCTION

The DWL 66 fs is designed such that the user can easily change the write head in order to change the resolution of an exposure or measurement. The resulting resolution values depend on the detailed system configuration and can be found in the system specification section of the quotation.

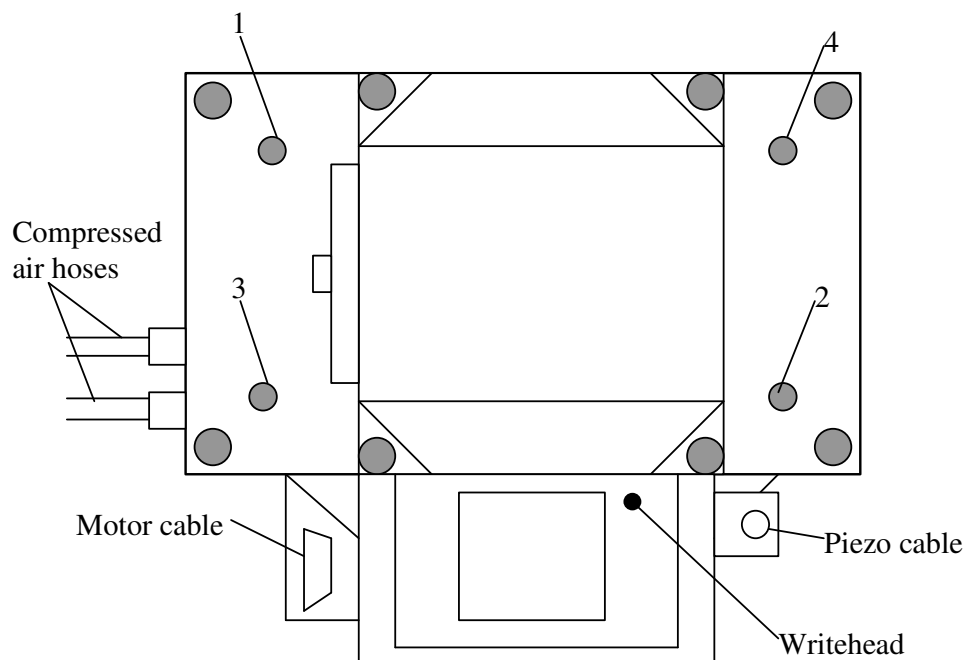
CHANGING WRITEHEAD INSTRUCTION

CAUTION

- Move the writehead completely up before changing as to minimize the risk of damaging the nozzle.
- Take care not to touch the interferometer mirrors during the process of write head changing. *Touching the interferometer mirrors with bare hands will damage them beyond repair.*

1. Unplug the motor cable and piezo cable (as shown in the figure below):
2. Use a #3 Metric Allen wrench to loosen the four screws located on the top of the write head.

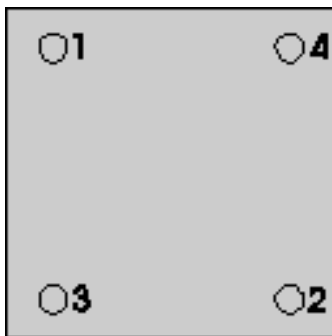
Top view of the write head:



CAUTION

- a. Hold write head with one hand.
- b. Push write head up while loosening the screws.
- c. Be careful that write head does not fall and damage the nozzle and / or the chuck.

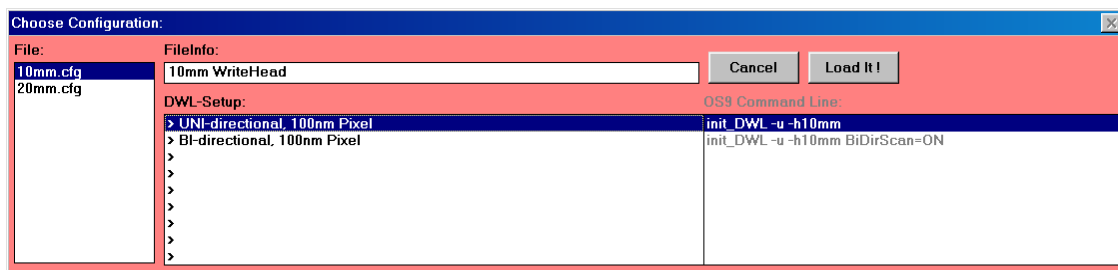
3. Let write head carefully down until it rests on the plastic holders, then pull it out. Hold it fast so it doesn't fall and touch the chuck.
4. Place new write head into the holder with the piezo connector and motor cable facing away from the machine.
 - Don't let the nozzle touch the chuck
5. Push write head in as far as it will go.
6. Tighten screws X-wise, as indicated below, while pushing up on the write head.



- Make sure write head is tightly mounted and in its correct position.

CHANGING SYSTEM CONFIGURATION INSTRUCTION

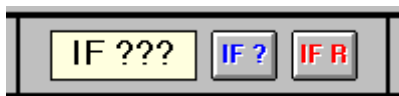
1. Open the DWL 66 fs menu on the User PC and double-click on the configuration information field on the right side of the menu bar.
 - A window with the available DWL 66 fs configuration files will appear:



2. Change configuration according to the installed write head (e.g., 10mm.cfg for 10mm write head).

3. If preparing for an exposure, highlight the desired setup (e.g. b/w or grayscale, if available)
4. Press **Load it!** -button
 - The system will now reload the menu with the new configuration file, and load the corresponding data sets on the system electronics.

Check Interferometer Status



Before the stage can be initialized, the interferometer status has to be checked by clicking on "**IF ?**" in the Main Menu.


- If the label "**IF ???**" changes to "**IF: OK**," proceed to the next section
- If "**IF: FAIL**" appears, then reset the Interferometer by clicking on "**IF R**"

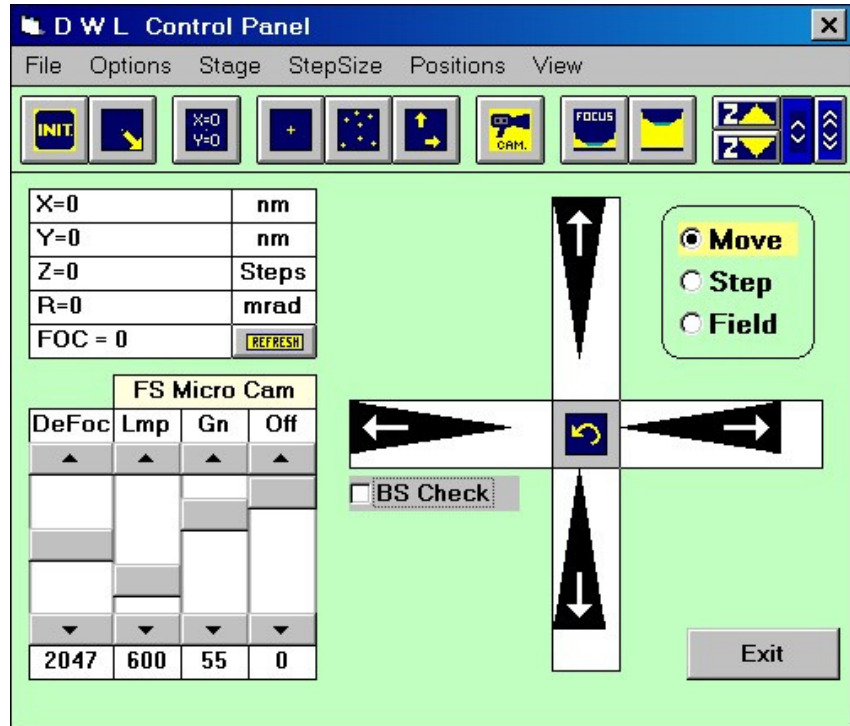
Reasons why the label might still read "**IF: FAIL**" after a reset are:


- The machine was just switched on (the interferometers need about 20 minutes to reach a stable state)
- The interferometer laserbeam is blocked. Check for obstacles in the optical path

NOTE: The **IF** status label is only updated when the "**IF ?**" or "**IF R**" buttons are clicked.

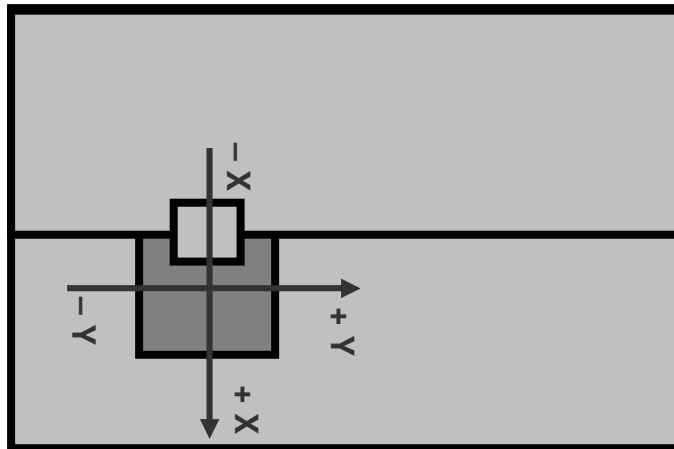
Loading


1. Open the **Control Panel** by clicking on the  toolbar icon, or by clicking on the **DWL Control Panel** under **Service** in the Main Menu.



2. Click on the **INIT** button () to initialize the stage.
 - During the first initialization after system (re-)start, the stage will move slowly in negative X-direction and then in negative Y-direction until it reaches the end switches, from where it will move back to the center position. Any other time the INIT button is pressed, the stage only moves to the center, and the coordinate system is being reset by the software.

- The orientation of the machine's coordinate system is shown in the following picture:



3. Click on the **(UN)LOAD** icon ()
 - The write lens will move up, and the stage will then move to the load position.

NOTE: The **LOAD** button is also available in the **Expose** window, which is opened by highlighting **Run Job** under **Job** in the Main Menu.
4. Before loading the DWL 66 fs (i.e., *loading the plate onto the chuck*), plug the stopper pins into the chuckholes for easy plate alignment.
5. If an unexposed plate will be loaded, switch off the white-light and switch on the safelight in the clean room before opening the plate container. Check the manufacturers data sheet to find out which kind of safelight applies for the plate type used. Usually, for resist coated metallized plates or wafers, yellow safe light is necessary.
 - Leave white light off until the plate is developed

CAUTION

- If computer monitors are positioned close to the DWL they may, after a while, expose the plates.
- Make sure that monitor brightness is set to a minimum.
Make sure that monitors are covered when plates are being handled in front of them for a long period.

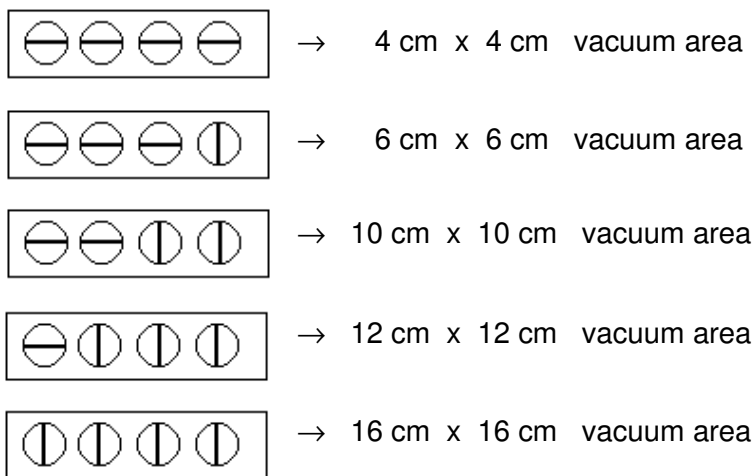
7. Make sure plate and chuck are clean and smooth.
6. Take the plate out of the box.
8. Make sure the resist-covered side of the plate is facing up.

9. Place the plate onto the chuck.

- Keep the plate a little tilted until the stoppers are reached.
- Let the plate down carefully.
- The plate should be roughly centered on the chuck.

10. Switch on the vacuum with the switch at the front of the chuck.

- The four white screws at the front of the chuck are used to adjust the size of the stage vacuum area to the plate size. All vacuum areas are arranged around the center of the chuck.



NOTE: In case the plate is even smaller than the smallest vacuum area, use a thick foil (e.g., copy foil) to cover the open chuckholes.

11. Once the plate is in place and the vacuum is switched on, make sure that the vacuum hold down system is working properly by pushing the plate sideways.


- If the plate can be moved, there is an air leak and suction must be improved by pressing the plate down carefully onto the chuck.

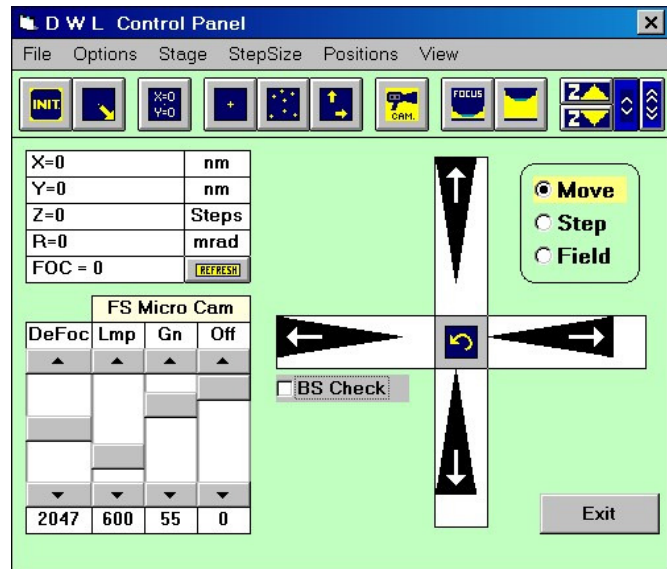
CAUTION: Do not touch the resist on areas to be exposed!



12. If, after pressing down on the plate it is still not held down tightly, check the surfaces again for dirt or scratches.

- If necessary, try a new plate.

Focusing

1. Open the **Control Panel** either by clicking on the  toolbar icon, by typing the "F9" function key, or by choosing on **DWL Control Panel** under **Service** in the Main Menu.



2. Click on the **INIT** button (). The system will center the stage.
 - If the plate was placed in the center of the stage during loading, it is now centered below the write head as well.
 - If not, you should move the center of the plate manually below the write head using the **XY STAGE** control buttons.
3. Click on the **FOCUS** button ().

CAUTION: Before clicking on the **FOCUS** button, always make sure the substrate is under the writehead. *If the system focuses on anything else but the substrate, the nozzle is liable to crash!*

NOTE: The **FOCUS** button is also available in the **Expose** window, which is opened by highlighting **Run Job** under **Job** in the Main Menu.

NOTE: The **DeFoc**-slider sets a focus offset leading to a different final position of the lens with respect to the substrate. Usually it can be left in the default position of 2048. The defocus value for the final exposure must be found in a series of test exposures.



Global Angular Alignment

INTRODUCTION

Even when alignment stops are used, a substrate will usually not be loaded perfectly parallel to the system's coordinate axes. However, in some applications, a correct angular placement of the design is mandatory, and it is especially important for correct measurement results. To align the coordinate system of the DWL to the angular position of the substrate, it is therefore possible to manually do a global angular alignment after loading. As alignment marks, preexposed structures can be used, or the edges of the substrate. For an alignment along the x-axis, horizontal lines are best, while for the y-axis, vertical lines are recommended.

CAUTION: If plate edges are used for alignment, no focussing may be done during the routine, or a nozzle crash will occur!

MANUAL ALIGN PROCEDURE

1. Open the Control Panel by clicking on the  icon in the toolbar.
2. Select the camera that should be used for alignment. Use macro camera for rough adjustment, micro camera for fine adjustment. In case of systems equipped with backside alignment capability, FS stands for the front side camera system, BS for the backside system.
3. Close the Control Panel by clicking on **Exit**.
4. Click on the **Manual Global Alignment** button  in the toolbar.
5. *Systems with backside alignment only:* If the alignment should be performed using structures on the back side, click on the **BS check** checkbox. If the box is unchecked, alignment will be performed using the top side.
6. Choose whether alignment is to be performed along the X- or along the Y-axis.
7. Point camera cursor to the first alignment site on the substrate using the manual alignment window and click **OK**. If the site is not on the screen, click on **Panel** and use the **Control Panel** functions to move the structure into the camera field using the **XY STAGE** directional buttons. For reference on other control panel functions that can be used for stage movement, see **User Guide II**.
8. Point camera cursor to the second alignment site on the substrate along the axis chosen for alignment and click **OK**. If the site is not on the screen, click on **Panel** and use the Control Panel to move the structure into the camera field.

9. The system will calculate the angle of rotation between the two points.
 - The rotation will be compensated by a computational rotation of the stage coordinate system.
 - After calculation of the rotation, a dialogue box will appear showing the calculated rotational angle and ask if the compensation should be executed.
10. Repeat **Steps 2 – 4** until the measured angle is satisfactory.
 - Accept the last compensation, then click "**Cancel**" in the **Point to 1st Site** window to complete the alignment sequence

NOTE

If tighter precision during a sequence is necessary, simply switch to the micro camera using the Panel and use larger distances between the alignment sites. It should be possible to align a substrate in accordance to the coordinate system within a few micro radians, depending on the quality of the alignment sites and the resolution of the write lens.

11. Click on "**Set 0,0 ...**" to set the origin according to next instruction, or click on **Exit** to close the **Manual Global Alignment** window.


Setting the Origin

INTRODUCTION

For a successful exposure it is extremely important to have the origin of the coordinate system set to the correct location as required by the design (i.e., center of the plate, lower left corner of the plate, etc.).

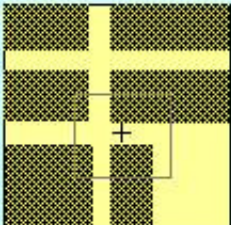
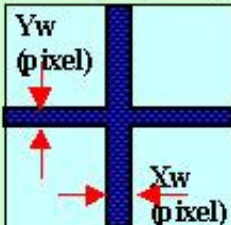

ORIGIN INSTRUCTION

There are two ways to set the origin. The version using the **Control Panel** is comparatively coarse. If a structure exists that can be used to define the center with higher precision, the **Set 0,0 ...** sequence of the **Manual Global Alignment** window should be used.

1. Determine the position on the plate, which the design requires as the coordinate origin.
2. **Manual Global Alignment:** Click on **Set 0,0 ...**. The **Point to Set-to-Zero** window will appear.
3. If the write head is not already above the desired origin position, use the **Control Panel** to move it there. To open it, click on the toolbar  icon or, in case of use of the **Manual Global Alignment**, by clicking on **Panel** in the **Point to Set-to-Zero** window.
4. Move the stage with the **XY STAGE** directional buttons, so that the nozzle gets above the desired coordinate origin.
5. a) **Control Panel version:** When nozzle is in its correct position, click on the **Set 0,0** button in the **Control Panel**.
 - The present position is defined as the origin of the coordinate system.b) **Manual Global Alignment version:** Close the Panel. A crosshair will appear in the monitor. Move the crosshair to the structure that defines the origin and click on **OK**.
 - The system calculates the offset of the structure position from the image center and sets the current coordinates accordingly.

Note: The **Expose** window discussed in the following chapter offers additional features for setting the origin.

Preparing Field Alignment Sequences

METHOD 1	METHOD 2	METHOD 3
<p style="text-align: center;">Template [name, #]</p> <div style="text-align: center;">  </div> <p style="text-align: center;">System searches for a pre-defined template in current image</p>	<ul style="list-style-type: none"> - FindXY(Xw,Yw,Model) - FindX (Xw,Model) - Find Y(Yw,Model) <div style="text-align: center;">  </div> <p style="text-align: center;">System finds center of a line or cross or a set of lines (Model)</p>	<div style="text-align: center;">  </div> <p style="text-align: center;">Find Manual()</p> <p style="text-align: center;">User points to object using the mouse</p>

INTRODUCTION

For overlay exposures as well as for automatic measurements it is important to align the machine coordinate system to alignment structures on the substrate. Aside from the manual angular alignment described before, this also means that the coordinate origin for each field should be adjusted according to the position of an alignment structure, which is part of each of these fields. To do this, a field alignment method for detection of the structure position must be set up, and the coordinates corresponding to the structure position within the design coordinate system must be entered into the **Map** file.

SETUP OF A FIELD ALIGNMENT PROCEDURE

There are two ways of setting up a field alignment procedure for a DWL 66 fs. If the alignment structure is a cross, the procedure may be prepared automatically by using one of the **Simple Cross Alignment** commands under **Setup** in the main menu while the structure is in clear view of the camera. If the structure to be used for alignment is not a cross, the complete procedure must be setup automatically.

SETUP OF A SIMPLE CROSS ALIGNMENT:

1. Load plate and focus.
2. Using the Xy-Stage buttons in the **Control Panel**, move substrate so that the cross is well within the monitor image field (as close to the center as easily possible).
3. Optimize camera settings (lamp, offset, gain) for best contrast.
4. Highlight **Simple Cross Alignment** under **Setup** in the main menu.

There are two methods offered:

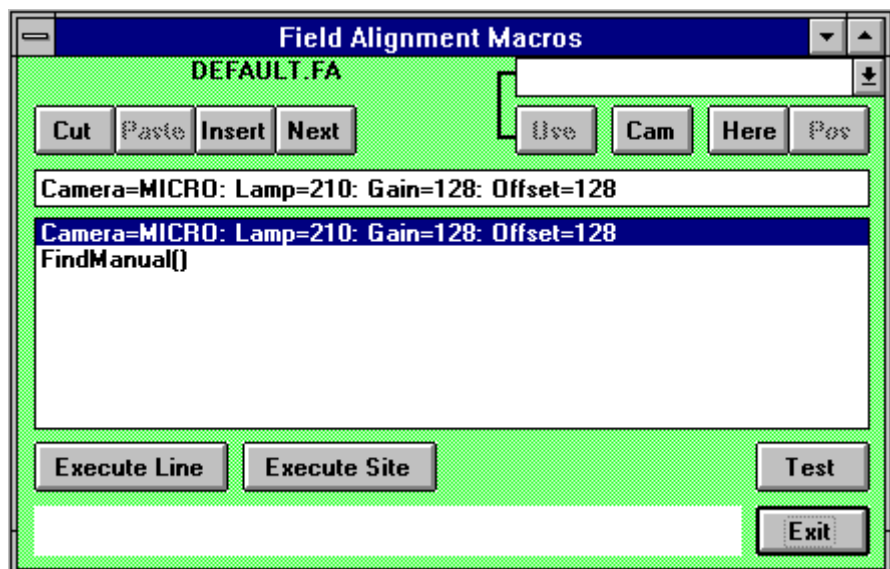
- **Using Find XY** for a cross with a clear outline
 - **Using Pos XY** for a cross where the outline is blurred, e.g., by an additional resist layer
5. Indicate the borders of the cross following the instructions given.
 - The system will try to detect the cross and determine the width of the lines
 - All values (camera settings, alignment method settings) are entered into field alignment procedure macro, which is automatically setup after the method has been chosen and the cross has been detected
 6. To check, test and edit the field alignment macro that has been created, highlight **Field Alignment Method**. Check if the values obtained from the bracket behind the alignment method are non-zero; otherwise, manually enter estimation for the values necessary. *All values are in tics.*
 - **Pos XY:** Values to be entered are (in the following order)
 - Small side of measurement box: should be larger than the cross linewidth
 - Large side of of measurement box: 4 – 5 times the cross linewidth

- Distance of measurement boxes from monitor image center: should be around 200 pixels, depending on the size of the cross (more than one linewidth)

7. Test method by clicking on **Test** button.

SETUP OF OTHER ALIGNMENT PROCEDURES

1. Load plate and focus.
2. Using the **Xy-Stage** buttons in the **Control Panel**, move substrate so that the structure is well within the monitor image field
3. Optimize camera settings (lamp, offset, gain) for best contrast.
4. Highlight **Field Alignment Method** under **Setup** in the main menu.
 - The following window will open:



5. Empty the list of all entries by pressing **Cut** repeatedly.
6. Transfer the current camera settings to the edit line by pressing **Cam**; press **Enter** on the keyboard to transfer this line to the command macro list.
7. Press **Next** to continue with the next command line.
8. From the selection box (upper-right corner of the **Field Alignment Macros** window), choose the command **delay()** and press **Use**.
 - Enter the number of seconds the system should wait after a movement before the alignment sequence starts

- Press **Enter** on the keyboard to transfer the command to the list
9. Proceed to the next line and choose an alignment function from the list.
- **Find XY, Pos XY:** Detect a cross (see Simple Cross Alignment)
 - **Find Manual:** Structure must be marked manually by the operator
 - **Find Template:** Structure is detected by comparison with a predefined template
 - **Find X, Find Y:** Detect horizontal / vertical lines; if both are used successively (with a possible movement in between), the position of the point where the lines would cross is the result of the alignment procedure
10. Repeat the alignment function if a higher precision is necessary (3-repetitions recommended)
11. Test sequence by pressing the **Test** button.

For more in-depth explanations of the alignment functions or template definition, see **User Guide PART II: Reference Manual**.

NOTE

A field alignment sequence should be tested thoroughly in different portions of the plate before it is used for overlay exposures or measurements. Besides testing the alignment sequence from the **Field Alignment Macros** window, it is also possible to start a full alignment test run for all fields where alignment has been set to "1"* in the Job file by pressing the **Test Align** button in the **Exposure** window (see previous section). Highlighting **Analyse Report for Alignment Results** under **Tools** in the main menu will allow for the viewing of test results.

*(or the number of alignment sites given in the map)

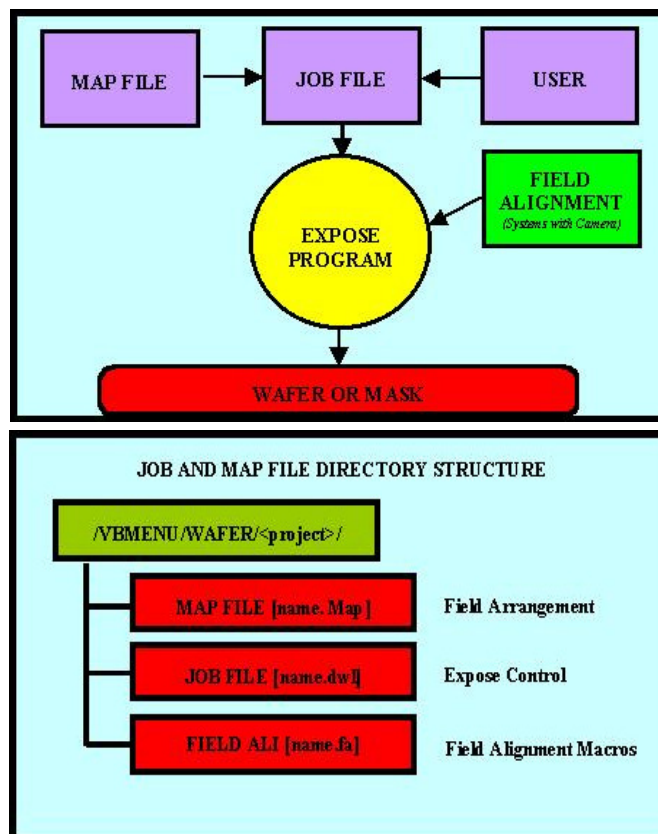
CHAPTER 3 - HOW TO DO EXPOSURES

INTRODUCTION

For exposures and automatic measurement sequences, the DWL requires several job dependent data files:

- **Map File** (.map) - containing information on positioning
- **Job File** (.dwl) - containing data in which map fields which tasks should be performed, and under what conditions.
- **Field Alignment File** (.fa) - containing a sequence for coordinate alignment to existing structures

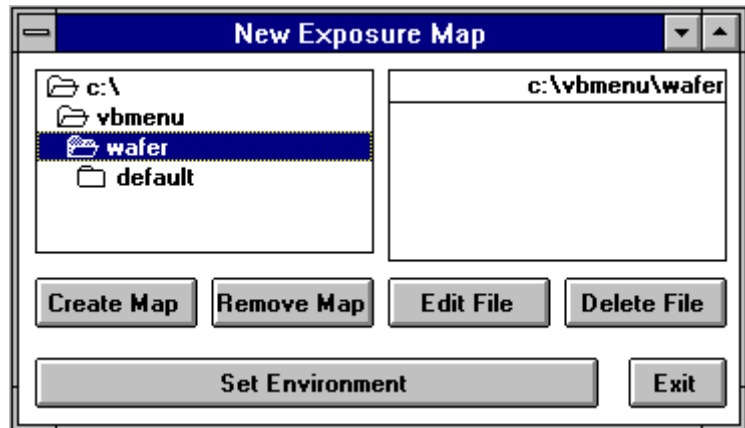
All files for one project, including report files, have to be located in the same directory. This set of files defines a **Job Environment**.



Once such an environment has been completed, an exposure (or automatic measurement) process can be easily and repeatedly done using the **Run Job** utility.

Creating a Job Environment

1. Highlight **N**ew under **S**etup in the Main Menu.
 - The **New Exposure Map** window will appear:

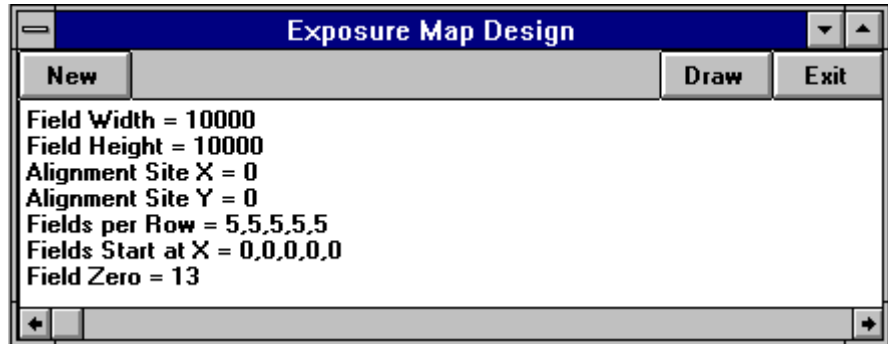


2. In the directory select box on the left, **\VBMENU\WAFER** should already be selected. If not, open these folders before proceeding.
3. a) To create a new job environment directory, click on the **Create Map** button and input a name consisting of not more than eight characters.
 - The eight-character name entered is used as project name for all components of the environment
 - A project directory is created and the program copies three default root files from **\VBMENU\WINDWL** into the new directory, giving them new names consisting of the project name and the respective extension.b) To load an existing map, click on the environment folder in the directory select box, then double-click on the map file (<project name>.map) listed to the right.
4. Confirm in dialog box to change to the new project environment.
5. Press **Set Environment**.
6. Exit **New Exposure Map** window.

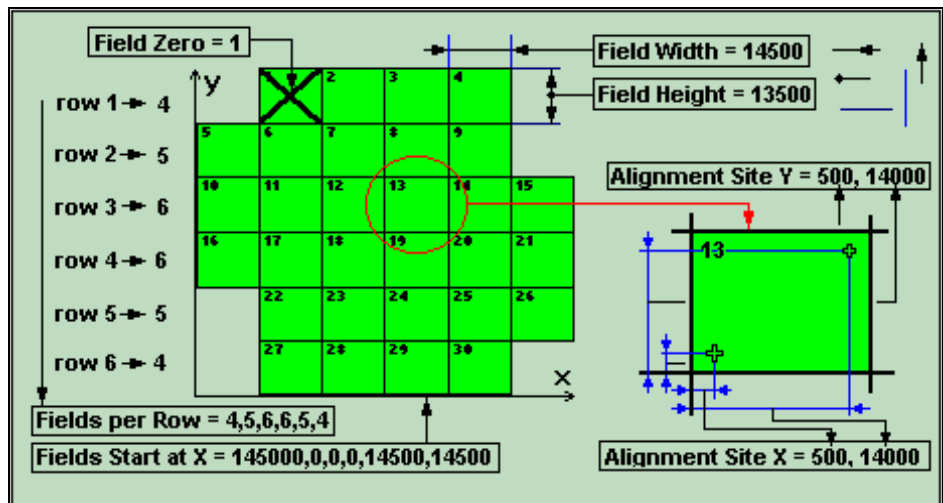
ADJUSTING THE EXPOSURE MAP

If an existing environment was loaded, the data from this environment is now ready for use. If a new environment was created, the default map is loaded and can be adjusted.

1. Highlight **E**xposure Map located under **S**etup in the Main Menu. The **Exposure Map Design** window will appear, showing the settings of the current **Map**:



2. Click on the **New** button to create a map file without any values.
3. During exposure, each design will be exposed such that its origin falls onto the center of the map field, or die, it is exposed in. Enter numbers according to sizes and desired positions of the design or designs that are to be exposed:



LINE 1: Field Width =:

- Enter desired width in micrometers
- Value must be large enough for the design
- If width is too small, there will be overlapping

LINE 2: Field Height =:

- Enter desired height in micrometers
- Value must be large enough for the design
- If the height is too small, there will be overlapping

LINE 3 / 4: Alignment Site X / Y =:

- Distance of the alignment sites to the origin of the die
- Up to four alignment sites can be entered, separated by commas

LINE 5: Fields per Row =:

- For each row of dies, enter the number of dies it should contain, separated by a comma. As many rows will be created as there are numbers in this entry.
- The number of rows and fields per row must fit on the substrate

LINE 6: Fields Start at X =:

- Enter position in micrometers where each row is to begin in the X direction with respect to the field furthest to the left.

LINE 7: Field Zero =:

- Enter the number of the field corresponding to the substrate origin

NOTE: The center of this field is the zero point for the exposure! This has to match the coordinate origin set before with the **Control Panel** or by using the **Set 0,0 ...** function of the **Manual Global Alignment**.

NOTE

If just one design is to be exposed on a mask without any alignment features, the Map might look like the following:

Field Width = 100000 (value is of no importance, but may **not** be 0 or void)

Field Height = 100000 (value is of no importance, but may **not** be 0 or void)

Alignment Site X =

Alignment Site Y =

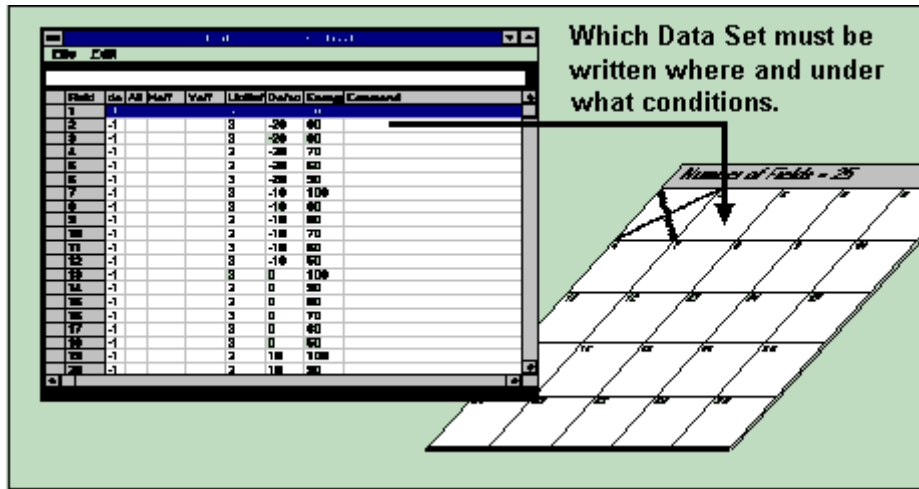
Fields per Row = 1

Fields Start at X =

Field Zero = 1

4. Click on the **Draw** button. The Map corresponding to the latest entries will be displayed in the **Map** window.
5. Close **Exposure Map Design** window with the **Exit** button.

Job Setup

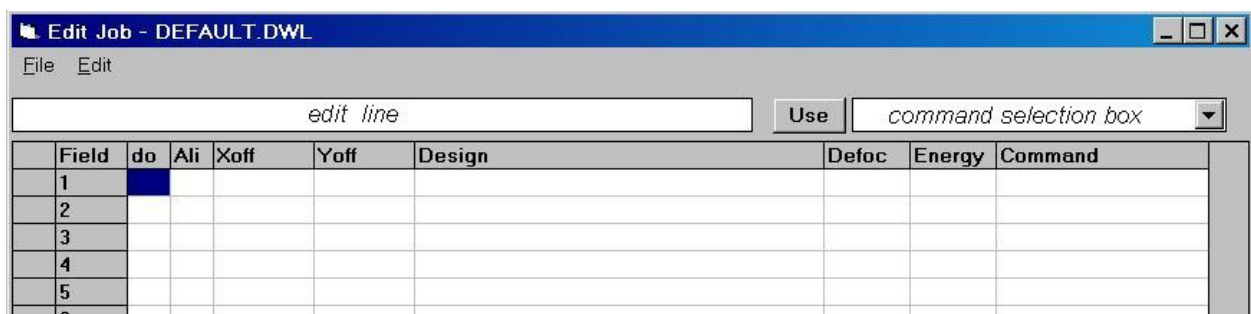


INTRODUCTION

When choosing **Make Job** in the **Job** menu, the **Edit Job** spreadsheet opens. This sheet allows the user to choose exposure or measurement parameters, such as the exposed **Design** (allowing also the selection of a predefined measurement routine instead), **Defocus**, and **Energy**.

JOB SETUP INSTRUCTIONS

1. Highlight **Make Job** located under **J** in the Main Menu. The **Edit Job** spreadsheet will appear:



The contents of this spreadsheet determine which data set will be written where and under what conditions.

2. Together with the **Edit Job** spreadsheet, a graphical representation of the **Map** currently loaded for an exposure / measurement is being displayed. See **User Guide II** for more information on the functions of the **Map** window.

3. The following options are located under **File** in the **Edit Job** window:

- Highlight **New** to open an empty spreadsheet. The number of rows in the sheet corresponds to the current **Map** file.
- Load a **Job** file from the **\VBMENU\WAFER** directory (if available). If the corresponding **Map** file is not loaded, then only the number of fields that cover the current **Map** file will be displayed.

NOTE

The corresponding alignment file will not necessarily be loaded. If an alignment is necessary, check the current alignment procedure before executing the new exposure Job.

- Load a **New Map** from the **\VBMENU\WAFER** directory. A **New Map** with default settings appears, and a new **Job** file with the name: "**NONAME.DWL**" is created. The name of the new **Map** is used to create a new environment folder that will contain all environment and job files connected with the new map.

Each option will also automatically lead to an update of the **Map** window.

The following steps describe the setup of a new sheet column by column. For a thorough description of available options and the **Edit Job** menu commands see the **User Guide, PART II**.

4. In the **Edit Job** window, the first column (**Field Column**) shows the row number which is at the same time the number of the corresponding field. It can not be edited. Whenever a row in the spreadsheet is highlighted, the field with the corresponding field number in the **Map** window will turn blue.

FIELD COLUMN

Contains a field number, which refers directly to the field in the wafer **Map**, shown concurrently with the **Edit Job** window. The field number usually coincides with the number of the row it is in, but this is not essential. Fields will be exposed according to their position on the sheet and not according to the field number. However, fields cannot be moved using the menu (Use *i.e.*, *MS Excel* for moving fields).

5. Click on the first row of the **do** column. Now you can enter a value for this field in the edit line at the top of the spreadsheet. The value entered here determines whether the Map field corresponding to this row is to be written.

DO COLUMN

- Enter **-1** if the flag is true and the field is to be written.
- Enter **0** or leave the field empty, if you want the field to be skipped.

6. Click on the first row of the **Ali** column. The value entered here determines the number of sites at which the prepared field alignment method is used:

ALI COLUMN

Enter the value:

- ALI=:** No Alignment
- ALI=0:** No Alignment
- ALI=1:** One Site Alignment
- ALI=2:** Two-Site Alignment
- ALI=3:** Three-Site Alignment
- ALI=4:** Four-Site Alignment

Multi-site alignment can be used to increase alignment accuracy and control more coordinate system parameters:

- 1 site: control of field origin
- 2 or 3 sites: correction of linear distortions in one axis / two axes
- 4 sites: rotational correction (on top of global alignment)

7. Click on the first row of the **Xoff** column. This value, determines the X offset in microns of the starting point of the exposure from the point that is determined from the Map geometry

- *The value may be negative and can have a decimal point*

8. Click on the first row of the **Yoff** column. This value, determines the Y offset in microns of the starting point of the exposure from the point that is determined from Map geometry

- *The value may be negative and can have a decimal point*

9. Click on the first row of the **Design** column.

- To do an exposure (see the **Exposures box** below), enter the name of the directory where LIC data is stored.
- To make a measurement, enter the name of a measurement procedure (see **Measurements box** below) preceded by an “**M:**”

DESIGN COLUMN

Enter the path and name of the LIC directory where graphics data is stored.

1. Exposures:

It is possible to expose more than one design, or even the same design several times, by entering more design names separated by a semicolon.

2. Measurements:

The name of the measurement file must be entered preceded by “**M:**” (e.g., **M:test.msr**). If several measurements are to be executed in the same field, a semicolon must separate the file names.

10. Click on the first row of the **Defoc** column.

- Enter a value between 0 and 4095 as a focus offset
- A value of 2048 means no defocus
- If the cell in the **Defoc** column is left empty, the defocus value of the previous exposure is used
- The 4095 steps equal an (uncalibrated) range of approximately $\pm 10\mu\text{m}$, so one unit equals approximately 5 nm
- Before making a final exposure, a series of fields with the same pattern at various defocus levels is exposed to find the best focus offset for the exposure (Necessary for substrates with relatively thick resists)
- *When choosing the defoc values for such a series, keep in mind that the focus depth of e.g. the 4mm write lens is $1.8\mu\text{m}$ and the autofocus is stable within a range of 100nm*
- *Since the 40mm write lens has a focus depth of $250\mu\text{m}$, it is not necessary to adjust the autofocus offset when working with this lens*

11. Click on the first row of the **Energy** column.

- Enter the number for an intensity correction file: *the file 100 sets the **energy** to 100%; 90 sets the **energy** to 90%, etc*
- Not all values are available. Generally, the values from 10 to 100 in steps of 10 are prepared. To check which files are available; open the mini-terminal and type, "**chd sys**" followed by, "**dir.**" The files corresponding to the numbers will appear with a preceding "**FI_**". Before leaving the **Mini-Terminal**, retype "**chd.**"
- Similarly to finding the best focus by varying the **defocus**, the **Energy** column is used for finding the best energy by varying the energy across an array of fields
- *If less than 30% of the maximum energy is necessary, use the grey filters for a basic adjustment*

12. Click on the first row of the **Command** column.

- Enter a number of commands to be executed before or after the exposure or measurement. The available commands are listed in the selection box on the right above the **Job** table
- To select a command, highlight it in the list and click on the **Use** button (The command will be automatically added to the current command sequence)
- Enter the numeric or string value, if required.
- All commands to be executed before an exposure or measurement must be preceded by the keyword **BEFORE:**
- Commands to be executed after the exposure / measurement are to be preceded by the keyword **AFTER:**
- **BEFORE: / AFTER:** These two words must only appear once, but each can be followed by a number of commands (*The commands must be separated by a semicolon*)
- For a list of available commands, refer to **User Guide, Part II**

CAUTION

Use the **BEFORE: / AFTER:** option with care and test it thoroughly.

NOTE

- For special service jobs, the **Command** column is used for placing **OS9** commands
- Enter a command preceded by **OS9**:
- If an **OS9** command is not preceded by any of the two keywords **BEFORE:** or **AFTER:** the command will always be executed before an exposure / measurement.

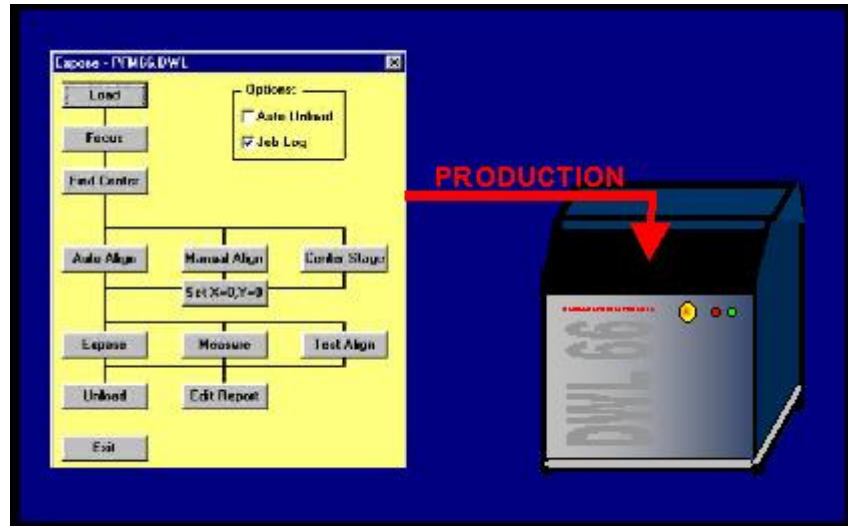
13. Repeat steps 4: through 11: proceeding to the next spreadsheet row for every cycle.

- Repeat for the number of rows (i.e. fields) necessary.

14. To save a current job file under a new name, scroll down and highlight **Save As...** under **F**ile in the **Edit Job** Main Menu, or save it under the original name (if applicable) by highlighting **S**ave under **F**ile in the **Edit Job** Main Menu.

15. Once the setup of an exposure is complete, close both the **Map** and the **Edit Job** window, by scrolling down and highlighting **E**xit located under **F**ile in the **Edit Job** window.

Exposing



INTRODUCTION

The expose window is kept as simple as possible and can be used to routinely run pre-defined jobs. It also contains additional access points for most of the controls used during exposure preparation (loading, focussing, aligning ...).

Before exposing, make sure the correct environment and the correct job are loaded. Now, follow the logical sequence given in the **Expose** window.

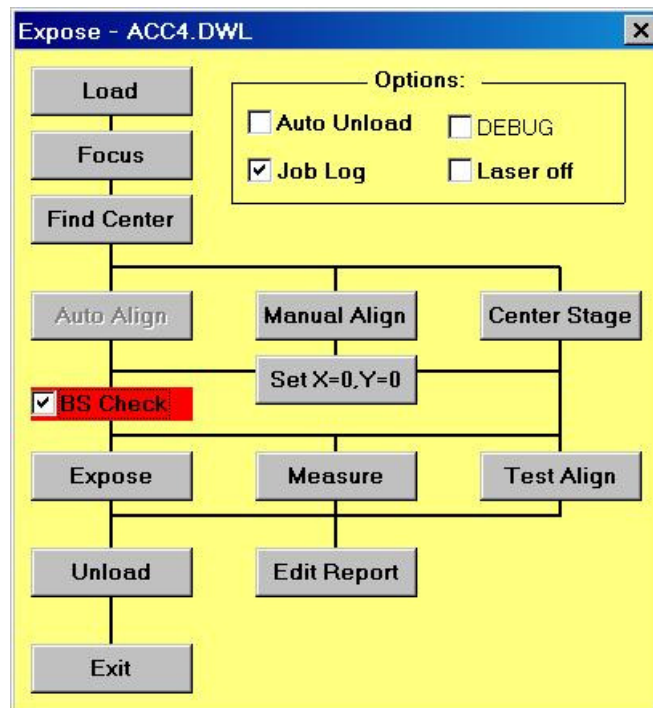
EXPOSE INSTRUCTION

1. *externally controlled laser*: If laser was set to **Disable** before, open **Laser** menu and choose **Enable**. If laser is off, choose **On**.

NOTE: Exposure lasers need a warmup-time to stabilize before exposures should be started (e.g. ~3 min for TOPTICA diodes). Refer to laser manufacturers guide for detailed information.

2. Open the **Expose** window by highlighting **Run Job** under **J** in the Main Menu.

- The following window will appear:



If the substrate was not yet loaded and focused:

3. Load substrate and focus:
 - a. Click on the **Load** button. The stage will initialize if necessary, and move to the load position. A dialog box appears.
 - b. Manually load the substrate.
 - c. Click **OK** in the dialog box to let the stage move back below the write head.
 - d. Click on **Focus**.
 - Make sure substrate is completely under the nozzle before clicking on the **Focus** button
4. If the origin was not previously set, the **Expose** window offers several possibilities for choosing and setting the origin.

- If the origin should be set in the center of the substrate, the **Find Center** function can be used to detect the substrate edges using the autofocus and deducing the substrate center position from them
CAUTION: Be sure to focus near the plate center before starting the **Find Center** procedure
 - If the center position should be set in the stage center, press **Center Stage** and then **Set X=0,Y=0**
 - If coordinate angle and origin should be set according to alignment marks, press **Manual Align**. The manual global alignment procedure previously described will be started.
5. To check if the field alignment works correctly in all fields, the **Test Align** button can be used. Alignment results will be written to a report file.
6. To start an exposure, press **Expose**. Alternatively, an automatic measurement sequence can be started by clicking on **Measure**. All alignment results, measurement results, exposure commands and error are written to a report file in the job environment directory.

- The **Map** window is continuously updated during an exposure
- While a field is exposed the User PC waits and displays how many stripes remain to be written for each field
- In case of an emergency, pressing the BREAK button in the **During Exposure** window will interrupt the current exposure
- After **Break** is pressed, the current stripe will finish and all processes necessary for completing an exposure will be stopped.

NOTE: Do not press the Expose button until everything is setup correctly, i.e., the **Make Job** file is correct, the write head is in correct position, etc.

NOTE: Make sure system is focused!

7. Once exposure is finished, click **Unload** button
- Write head will move up while the stage moves to the unload position
8. The **Edit Report** button allows for the (test) exposure report to be viewed and saved under a different name.

Note: The menu always stores reports for the same job under the identical name. To preserve a report for later use, it is important to rename it!

OPTIONS

□ **AUTO UNLOAD:**

If checked, the Unload function will be executed automatically after the exposure is finished.

□ **JOB LOG:**

If checked, the name of the exposure / measurement job environment is entered into a list, followed by the first design name or measurement file name encountered. Next, both start time and date and stop time and date are listed, and this information is entered into the file, "JOBLOG.TXT" -which can be found under C:\VBMENU\WINDWL.

□ **LASER OFF:** *(only available in systems with externally controllable laser)*

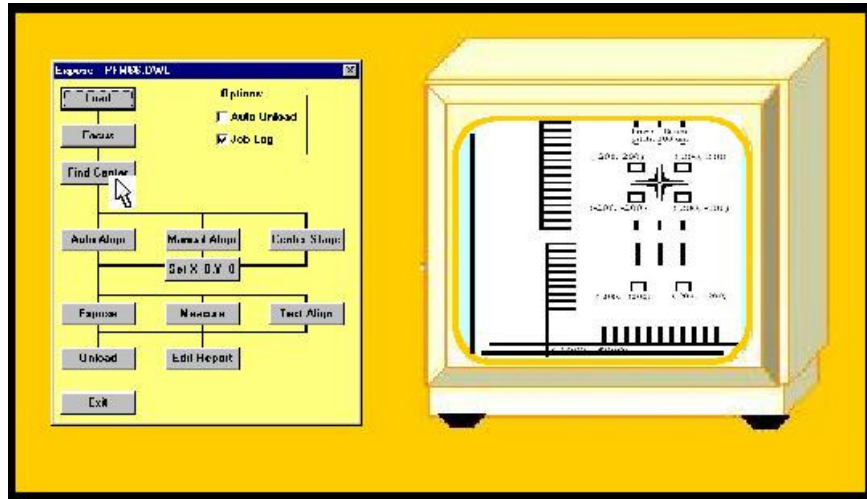
This will lead to an automatical shutdown of the laser after an exposure is finished.

□ **DEBUG:**

If continuous problem occur with a specific job, the debug mode can be used to obtain more detailed information about the system processes for analysis by HIMT service engineers.

This option needs a lot of disk space and should only be used if absolutely necessary!

Overlay Exposures



INTRODUCTION

Several preparations are necessary to do overlay exposures:

Before starting an exposure of the second (third...) layer, the machine coordinate system must be aligned to the previous layer(s) on the substrate, and the position of the write beam must be measured with respect to the center of the monitor image.

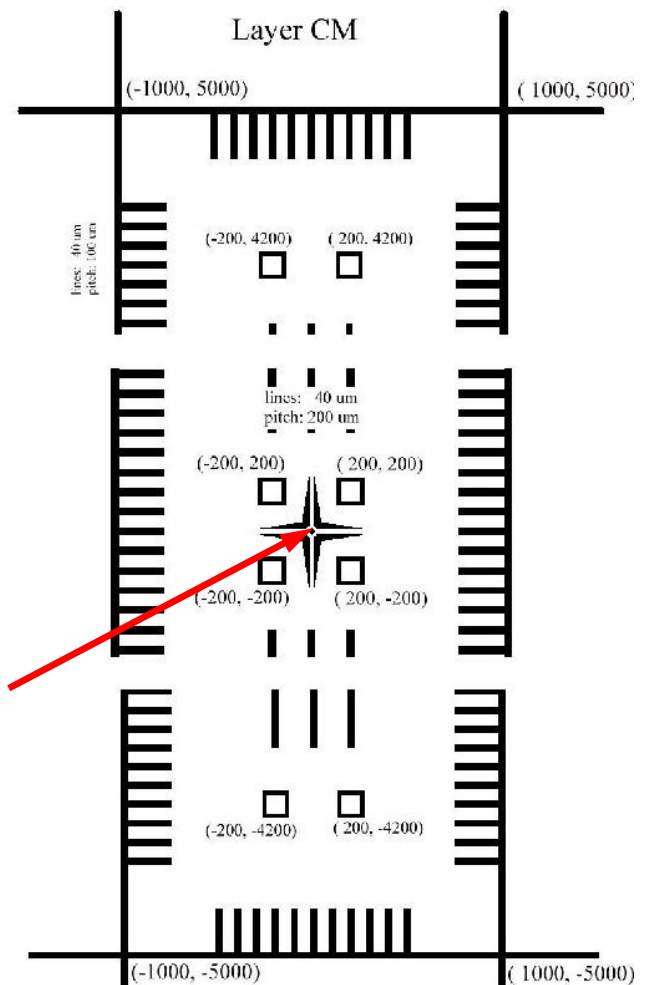
Note: It is important that for overlay exposures, all layers are converted with the same stripe width that the calibration was done with. Otherwise, an offset in x corresponding to half the difference of the stripe width from the calibration stripe width has to be taken into account.

TESTING AND ADJUSTING OVERLAY ACCURACY

The testing and adjustment of overlay accuracy must be executed whenever a write head has been changed or removed for any reason since the last overlay exposure. Such a procedure serves to measure the write spot position with respect to the center of the monitor image, which is the reference point for alignment.

1. Load a fresh substrate and set the zero point in the center (use **Find Center** function).
2. Load the environment for overlay test exposures which was setup for the current write head: **C:\VBMENU\wafer\align_<focal length of write head>**
 - In systems with only one write head, the environment is sometimes called “align”
3. Expose the first layer of the test design.

- In the Job file, enter “0” in the **Ali** cell, and “OL <focal length of write head> **mmCM**” in the **Lic Buffer** cell
 - Choose standard energy and defocus
 - Run the exposure
4. After developing, load substrate and move one of the corner crosses of the design close to the center of the monitor image. Edit the current field alignment method by highlighting **Field Alignment Method** under **Setup** in the main menu and test the method by pressing **Test**.
- If problems occur, try to adjust the method until it works reliably
5. Execute a manual alignment procedure along the y-axis (choose **No**) using the two crosses at either end of the overlay design.
- Press the **Auto** button to use the Field Alignment Method for structure position detection when the crosses are well within the monitor image field
 - *Do not Set 0,0 position*
6. Open **Expose** window and press the **Find Center** button to determine the coordinate origin (should be roughly in the center of the sloping cross structure).
7. Expose the second layer:
- Change **Ali** to 4 so alignment is executed using all 4 corner crosses
 - Change design name to “OL <focal length of write head> **mmCU**”
 - Expose



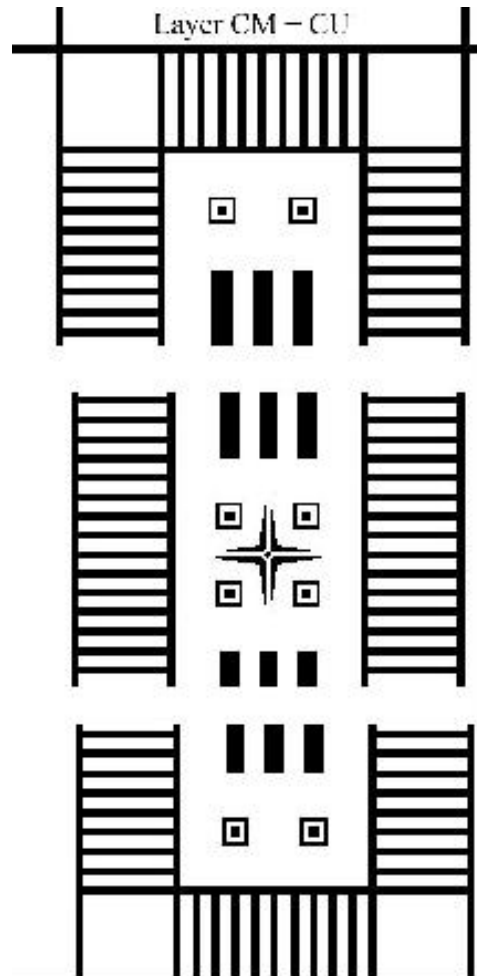
8. After developing, determine the registration between the layers either by using an overlay measurement on the box-in-box structures, or by checking the overlap of the line structures.

- Enter the numbers gained from the measurement into the menu configuration file by adding it to the values given for XBEAM and YBEAM

9. Perform another test exposure repeating steps 1 through 8.

- Repeat until registration is satisfactory

Note: The overlay test design is prepared with a different magnification for each write head. The numbers given in the picture of **Layer CM – CU** are valid for magnification 1, which is used for 20mm write head. For the other write heads, the numbers are scaling with the focal length.



OVERLAY EXPOSURE INSTRUCTION

1. If since the last overlay exposure the write head has been moved for any reason, perform the overlay accuracy test first.
2. Expose and develop first layer.
3. Setup a field alignment method for a typical structure, which should be used for alignment of the coordinate origin for each field.
4. Perform a manual alignment for rotational correction.
5. Set the origin in the position demanded by the design.
6. In the Map file, enter the positions of the field alignment sites relative to the respective field origin (Parameters **Alignment Site X=** and **Alignment Site Y=**; up to four sites with identical structures may be defined, coordinates are then set apart by commas).
7. Open **Exposure** window and perform a **Test Align** procedure to verify that all sites are found for all fields.
8. Start second layer exposure.

Using Backside Alignment

INTRODUCTION

If the system is equipped with the backside alignment option, exposures and measurements can be done in a defined position with respect to reference marks on the backside of the substrate, using the backside alignment cameras. All processes are identical apart from that the backside check has to be activated, and the backside camera system has to be calibrated.

TESTING AND ADJUSTING BSA ACCURACY

The testing and adjustment of overlay accuracy must be executed whenever a write head has been changed or removed for any reason since the last BSA adjustment. Such a procedure serves to measure the write spot position with respect to the center of the backside monitor image, which is the reference point for backside alignment. An overlay pattern of a frame centered around a square should be used for the test. As the thickness of the substrate is of importance in this calibration, the procedure needs to be performed independently for different types of substrates.

1. Expose reference marks on top of a photoresist coated substrate and etch this pattern.
2. Coat the backside of the substrate with photoresist.
3. Flip substrate so that the reference marks are on the bottom side and the resist coated side is on the top.
4. Align along y-axis with a BSA camera using the **Manual Alignment** function.
5. Set one of the alignment marks as reference point and expose the square.
6. Rotate substrate by 180 degree and align the y-axis again with the same backside camera. Set the same alignment mark as reference point as before and expose the frame.
7. Develop pattern.
8. Measure the misalignment of the overlay pattern. The calibration offset is half the misalignment of each axis.
9. Enter the offsets gained from the measurement into the menu configuration file by adding it to the values given for XBEAMBS and YBEAMBS, and repeat procedure until a good match is reached.

CHAPTER 3 - HOW TO DO METROLOGY

INTRODUCTION

A number of measurement procedures to quantify exposures are listed under **Measure** in the main menu. Some of these commands are specifically developed to aid with the measurement of parameters important for system specific adjustments and calibrations. Most metrology commands require top illumination, which will lower quality measurement of emulsion plates if using the high magnification objectives with 4mm and 10mm focal lengths.

- **Overlay:**

Measures the relative positioning accuracy of two overlaid exposures on a single plate by utilizing a number of models, such as box-in-box structures, etc.

- **Distance:**

Offers both an automatic and a manual metrology method for measuring the distances between two features on a substrate.

- **Positions:**

Measures die-to-die alignment of a feature in order to ensure that the machine coordinate system is linear and orthogonal.

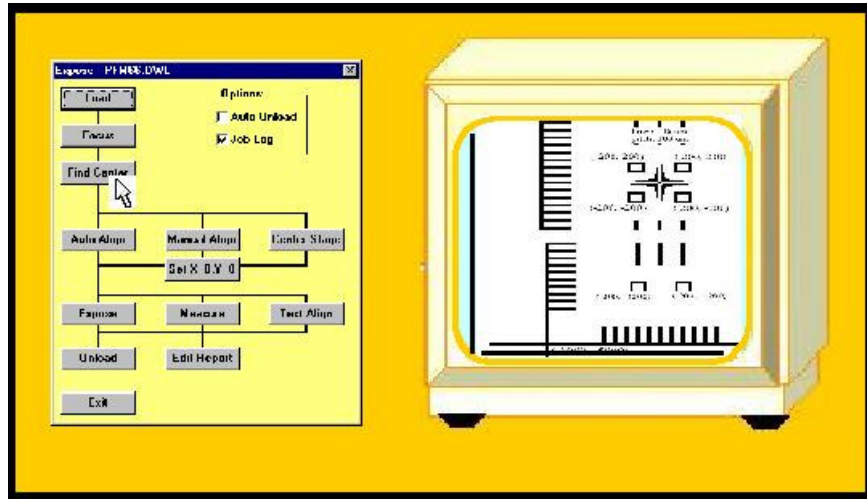
- **Linewidth:**

Measures and analyzes the line width of a feature based on its video profile.

- **Pitch, Stitching, Edge**

Measures the distance between two identical features by associating video profiles of the images and then searching for the maximum in the correlation function. These measurements are then repeated in different locations and the results are analyzed according to the method chosen.

Overlay Measurements



INTRODUCTION

The purpose of overlay measurements is to determine the registration between two exposed layers that are printed on top of each other. In order to achieve the best results, the micro-camera is used for most overlay measurements. The Heidelberg Instruments PERFORM Test Pattern can be used to check the overlay quality of the system. For each write head there are several special performance files available. Measurement methods for two types of test patterns are available: The Large Box in Box method, and the Small Box in Box method.

LARGE BOX IN BOX METHOD

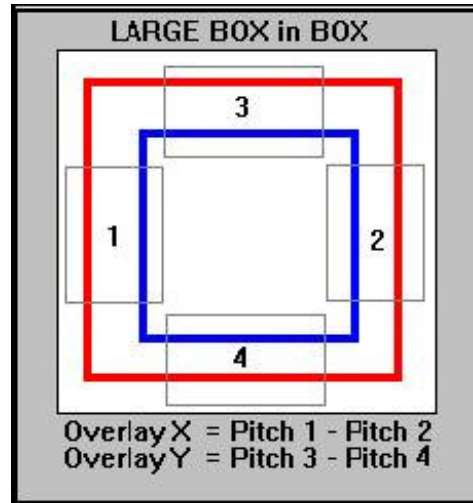
REQUIRED PATTERN:

Part of the HIMT test pattern may be used:
A frame is written to a first layer
(e.g., "PFMXX_AX").

A second frame with equal line thickness but
of a different size is written onto the second
layer ("PFMXX_BX") over the first layer.

Ideally, the centers of the two squares
coincide.

How well the two layers actually do coincide, is
determined by the *Overlay Measurements*
program.



MEASUREMENT PROCEDURE:

Four fields must be defined as shown in the **Large Box in Box** figure above. Within each of the four fields the pitch between the two lines is measured.

- For the overlay measurement in the X direction the pitch measurements of the fields 1 and 2 are compared
 - For the Y direction the pitch measurement of the fields 3 and 4 are compared
- The overlay error in x and y is then calculated from the difference between the X and Y pitches, respectively.
- The **Large Box in Box** structure is usually larger than the micro-camera field. The system therefore must measure the fields sequentially and centers each one on the screen before doing a pitch measurement

SMALL BOX IN BOX METHOD

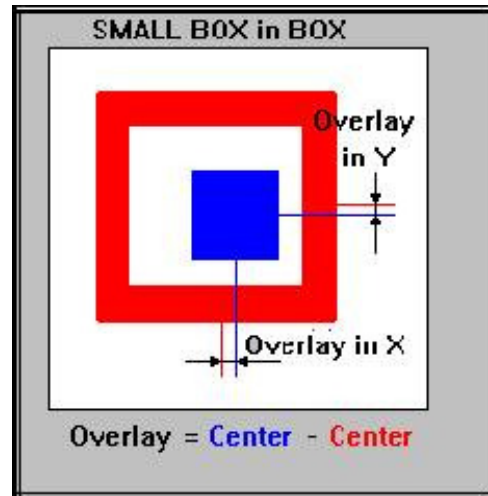
REQUIRED PATTERN:

The **Small Box in Box** structure consists of two patterns, as shown in the figure on the right.

A frame is written to the first layer, and a square is written to the second layer over the first layer.

Ideally, the centers of the two structures coincide.

How well the two layers actually do coincide, is to be determined by the *Overlay Measurements* program.

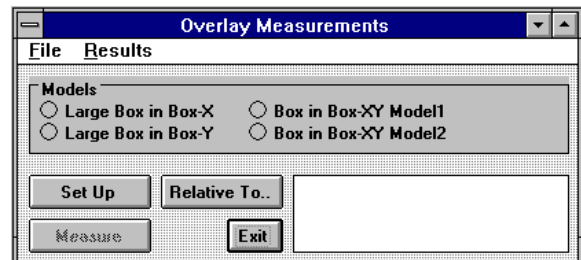


MEASUREMENT PROCEDURE:

The overlay is determined by measuring the distance between the symmetry axes, as shown in the **Small Box in Box** figure above.

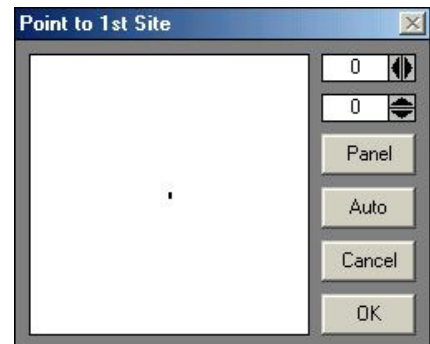
OVERLAY MEASUREMENTS INSTRUCTION

1. Load DWL with the substrate to be measured as described in the **Loading** and **Focusing** sections.
2. Move stage to chosen overlay structure.
3. Highlight **Overlay** located under **M**measure in the Main Menu.
 - The following window will appear:



4. To proceed with a measurement file previously created in the **\MEASURE** directory, open up the **Overlay Measurements File** menu, highlight **L**oad and load desired file.
 - The **Model** option is read from the file and switches on automatically

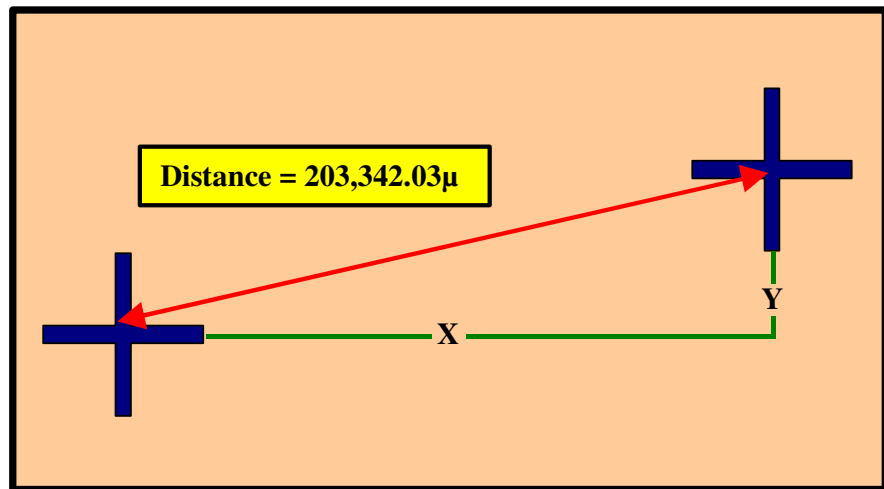
- A Window will request to: "**Point to the Reference Site**," relative to which all positions will be measured



- Once file is loaded, proceed directly to **Step 11**
5. To set up a new measurement file, choose one of the four models:
 - **Large Box in Box-X:**
Performs measurement previously described above in the X direction.
 - **Large Box in Box-Y:**
Performs measurement previously described above in the Y direction.
 - **Box in Box-XY Model1:**
(Actually: **Small Box in Box Model**) Performs measurement previously described above, measuring x and y overlay quality at the same time.
 - **Box in Box-XY Model2:**
(Actually: **Small Box in Box Model**) Performs measurement previously described above, and is especially designed for low contrast designs and structures covered by a resist layer.
 6. Click on the **Set Up** button, to setup measurement program.
 7. Depending on which model was selected, the **Define Box** window appears, requesting that measurement frames be placed over the structure.
 8. After the measurement procedure is set up, click on **Cancel** to close the **Define Measurement #...** window.
 9. To save the measurement program, select a reference point.

- If a reference point is not selected, the program will simply save the current stage position as the reference point
 - To define a reference point click on the **Relative To..** button
 - For a local series of measurements, the location of the first structure is usually chosen as the reference point
 - When preparing a method for a fully automatic measurement procedure, the field alignment site can be used
10. Save measurement program by highlighting **S**ave **M**easurement located under the **F**ile menu in the **Overlay Measurements** window.
- In case a reference site has never been marked, a window will appear notifying the fact and asking if the method should be saved anyway
11. Start measurement by clicking on the **M**easure button and continue the measurement until enough data is collected.
- A result window shows the updated values
 - After the measurement, the average value is displayed
12. To view measurement results click on the **R**esults menu in the **Overlay Measurements** window and highlight **V**iew and **S**ave.
- An editor displays the results, which may be saved by highlighting **S**ave **A**s.. under File in the **Overlay Measurements** window
13. Scroll down and highlight **T**o **E**xcel located under the **R**esult menu in the **Overlay Measurements** window to view results on a **M**icrosoft **E**xcel spreadsheet.
- Highlighting **T**o **E**xcel will copy the results into the Clipboard
 - Start **M**icrosoft **E**xcel and load data into a spreadsheet by pressing **CTRL-V** or by using the **P**aste function
 - All data processing options that **M**icrosoft **E**xcel offers are available
 - When spreadsheet results are complete return to the **Overlay Measurements** window
14. Click **E**xit to return to the main menu window.

Distance Measurements

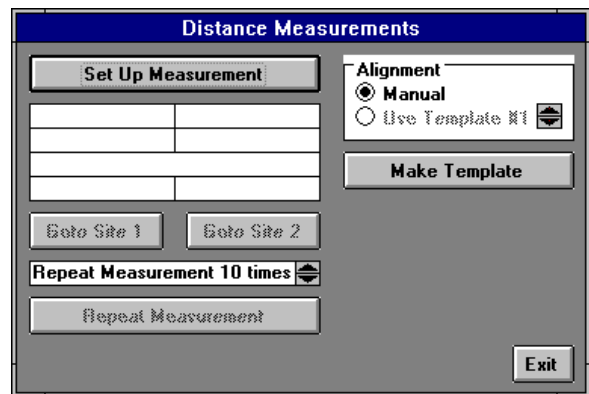


INTRODUCTION

The **Distance Measurements** program is designed for the measurement of distances between structures on a substrate. A distance can be small as to fall within the camera image, or large as to encompass the entire stage travel range. Repeating measurements several times can enhance the precision, and will result in additional statistical information. The best values are obtained when automatic template recognition is used for the real measurement.

MEASUREMENTS USING MANUAL ALIGNMENT INSTRUCTION

1. Load the DWL with the substrate to be measured as described in the **Loading** and **Focusing** sections.
2. Use the **XY STAGE** directional buttons on the **Control Panel** for moving the stage to the structures to be measured.
3. Open the **Distance Measurements** window by highlighting **D**istance located under **M**easure in the Main Menu.



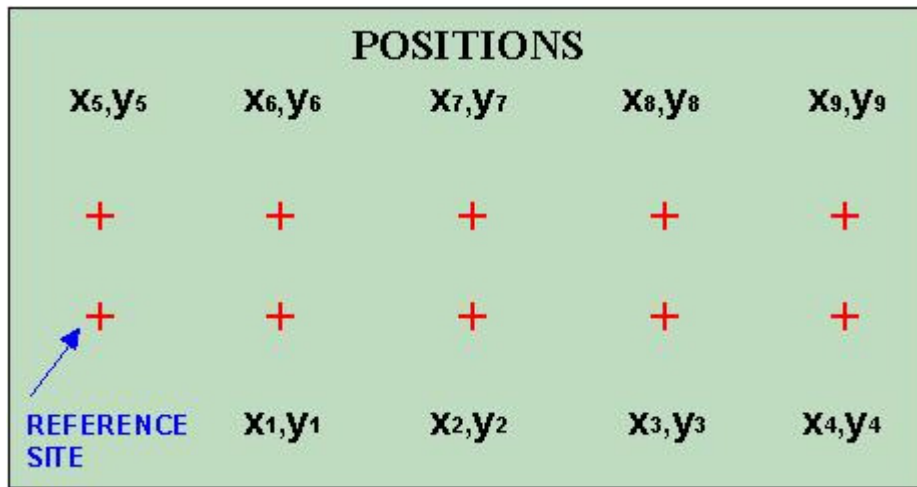
4. Check **Manual** inside the **Alignment** box.
 - For instructions on how to proceed using a template, read the next section
5. Click on the **Set Up Measurement** button and the **Point to 1st Site** window will appear.
6. Using the cursor, select first and second measuring sites.
 - If the two sites do not fall within the camera field, use the **Control Panel** to move the stage
 - The **Control Panel** may be used to switch between cameras, adjust the contrast, etc
7. To view the two chosen reference sites, click on the **Goto Site 1** and the **Goto Site 2** buttons.
8. Set the **Repeat Measurement # times** box to at least 5 for a good measurement.
9. Start the measurement by clicking on the **Repeat Measurement** button.
 - When measurement is complete, the distance between the two points will be shown in microns

10. When distance measurements are complete, click **Exit** and return to the main menu window.

MEASUREMENTS USING A TEMPLATE INSTRUCTION

1. Load the DWL with the substrate to be measured as described in the **Loading** and **Focusing** sections.
2. Use the **XY STAGE** directional buttons on the **Control Panel** for moving the stage to the structures to be measured.
3. Open the **Distance Measurements** window by highlighting **D**istance located under **M**easure in the Main Menu.
4. Choose one of the templates offered in the **Alignment** field
 - If there are no templates, click on the **Make Template** button
 - For an explanation on how to define a template, refer to **User Guide II**
5. Once a template is defined, set the **Repeat Measurement # times** box to at least 5.
 - The higher the value, the more precise the measurement, and the lower the value, the less time measurement takes
6. Start measurement by clicking on the **Repeat Measurement** button in the **Distance Measurements** window.
 - When measurement is complete, the distance between the two points will be shown in microns
7. When distance measurements are complete, click **Exit** and return to the main menu window.

Position Measurements

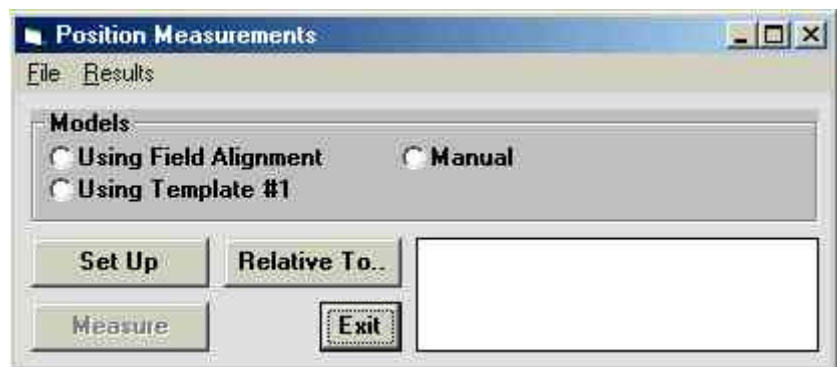


INTRODUCTION

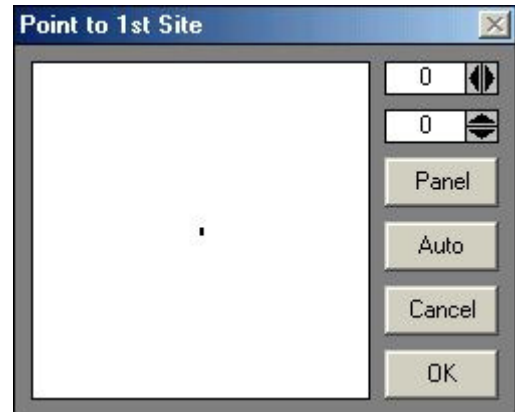
Position measurements provide information, not only about distances, but angular distortions or non-linearity over a substrate as well. Position measurements are therefore an important tool for initial system calibration and exposure quality control.

POSITION MEASUREMENTS INSTRUCTION

1. Load the DWL with the substrate to be measured as described in the **Loading** and **Focusing** sections.
2. Using the **XY STAGE** directional buttons on the **Control Panel**, move the stage to the structure to be measured.
3. Open the **Position Measurements** window by scrolling down and highlighting **Positions** located under **Measure** in the Main Menu.



4. To proceed with a measurement file previously created in the **\MEASURE** directory, open up the **Position Measurements File** menu, highlight **Load** and load desired file.
 - The **Model** option is read from the file and switches on automatically
 - A Window will request to: "**Point to the Reference Site,**" relative to which all positions will be measured



- Once file is loaded, proceed directly to **Step 10**
 - To set up a new measurement file, choose one of the **Methods** described above for a measurement in the X or in the Y direction
5. Click on the **Set Up** button, to setup measurement program.
 6. Depending on which model was selected, the **Define Box** window appears, requesting that measurement frames be placed over the structure.
 7. After the program is set up, click on **Cancel** to close the **Define Box** window.
 8. Start measurement by clicking on the **Measure** button and continue the measurement until enough data is collected.
 - A result window shows the updated values
 - After the measurement, the average value is displayed
 9. To save the measurement program, select a reference point.
 - If a reference point is not selected, the program will simply save the current position as the reference point
 - To define a reference point click on the **Relative To..** button

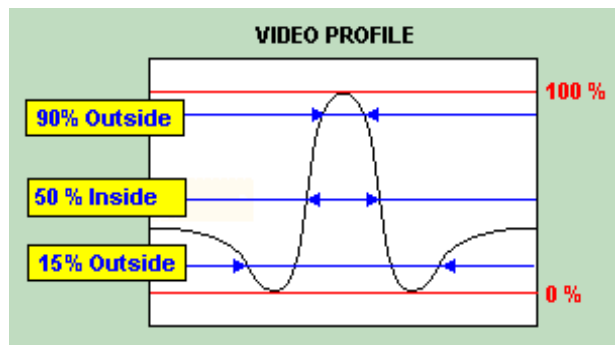
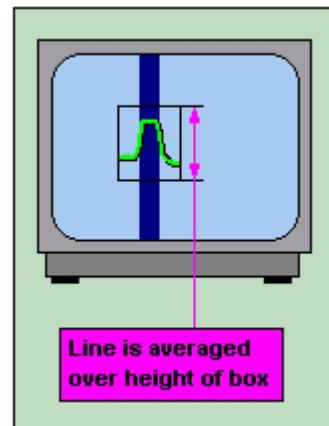
- For a local series of measurements, the location of the first structure is usually chosen as the reference point
 - When preparing a method including a fully automatic program, the field alignment site can be used
10. Save measurement program by highlighting **S**ave **M**easurement located under the **F**ile menu in the **P**osition **M**easurements window.
- In case a reference site has never been marked, a window will appear notifying the fact and asking if the method should be saved anyway
11. To view measurement results click on the **R**esults menu in the **P**osition **M**easurements window and highlight **V**iew and **S**ave.
- An editor displays and will save the results
12. Scroll down and highlight **T**o **E**xcel located under the **R**esult menu in the **P**osition **M**easurements window to view results on a **M**icrosoft **E**xcel spreadsheet.
- Highlighting **T**o **E**xcel will copy the results into the Clipboard
 - Start **M**icrosoft **E**xcel and load data into a spreadsheet by pressing **C**TRL-**V** or by using the **P**aste function
 - All data processing options that **M**icrosoft **E**xcel offers are available
 - When spreadsheet results are complete return to the **P**osition **M**easurements window
13. Click **E**xit to return to the main menu window.

Linewidth Measurements

INTRODUCTION

The line width measurement program allows line widths in the X and Y direction as well as circle diameters to be measured. In order to achieve the most precise results, modify Lamp, Gain and Offset parameters of the camera in the **Control Panel** to optimize the contrast of the image.

As shown in the figure on the right, a box is to be defined across the line. The pixels belonging to the line structure are summed up vertically, which results in a curve with a variation in X. A fit is performed on the curve and the fitted curve is normalized.



In the **Figure** shown on the left, the line width is determined by finding the expansion in X of a fit to the measured intensity values at a given threshold value.

The **Figure** shows that there are different methods for finding the expansion in X (Inside, Outside, etc.), and various procedures and thresholds can be defined.

MODEL

- **LineWidth-X:**

Measures the width of vertical lines.

- **LineWidth-Y:**

Measures the width of horizontal lines.

- **Thick LineWidth-X:**

Selects the measurement method for thick vertical lines (larger than $\frac{1}{2}$ monitor image).

- **Thick LineWidth-Y:**

Selects the measurement method for thick horizontal lines (larger than $\frac{1}{2}$ monitor image).

PROPERTIES

- **Threshold=#:**

Defined in percent, with the amplitude of the normalized video profile equal to 100%. For most purposes the threshold value should range between 25% and 50%.

- **Repeats=#:**

In order to improve the results, the pixel count for the whole box can be done several times and the result will be averaged.

- **Inside:**

The line width is defined as the horizontal expansion of the profile at the threshold value. The profile is traced until the threshold height is reached, starting at the *center*.

- **Outside:**

The line width is defined as the horizontal expansion of the profile at the threshold value. The profile is traced until the threshold height is reached, starting at the *endpoints*.

- **Minimum:**

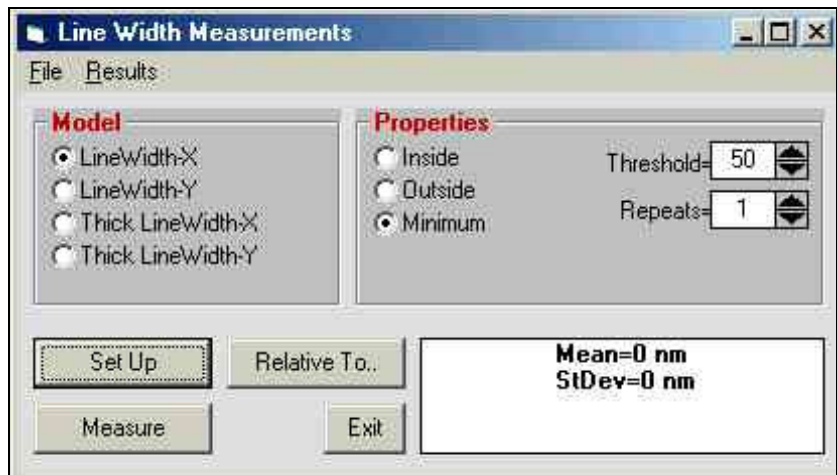
The line width is defined as the distance between the two minima. The location of the extrema is found by locally fitting a parabola.

NOTE

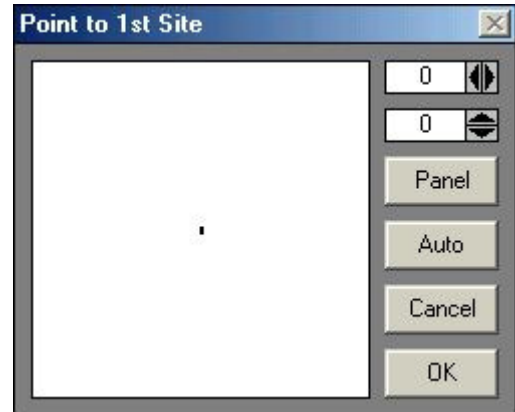
- There are several ways to define the line width, meaning that obtained values are only useful for *comparing* line widths.
- The values are not correct on an absolute scale.
- If the absolute values are necessary, an offset must be defined using a calibration standard.

LINEWIDTH MEASUREMENT INSTRUCTION

1. Load the DWL with the substrate to be measured as described in the **Loading** and **Focusing** sections.
2. Using the **XY STAGE** directional buttons on the **Control Panel**, move the stage to the line or circle structure to be measured.
3. Open the **Line Width Measurements** window by scrolling down and highlighting **Linewidth** located under **Measure** in the Main Menu.



4. To proceed with a measurement file previously created in the **\MEASURE** directory, open up the **Line Width Measurements File** menu, highlight **Load** and load desired file.
 - The **Model** option is read from the file and switches on automatically
 - A Window will request to: **Point to the Reference Site,** relative to which all positions will be measured:



- Once file is loaded, proceed directly to **Step 12**
5. To set up a new measurement file, choose one of the **Methods** described above.
 6. Choose the **Properties** as described above.
 7. Click on the **Set Up** button, to setup measurement program.
 8. Depending on which model was selected, the **Define Box** window appears, requesting that measurement frames be placed over the structure.
 9. After the program is set up, click on **Cancel** to close the **Define Box** window.
 10. To save the measurement program, select a reference point.
 - If a reference point is not selected, the program will simply save the current position as the reference point
 - To define a reference point click on the **Relative To..** button
 - For a local series of measurements, the location of the first structure is usually chosen as the reference point
 - When preparing a method for a fully automatic measurement procedure, the field alignment site can be used
 11. Save measurement program by highlighting **Save Measurement** located under the **File** menu in the **Line Width Measurements** window.
 - In case a reference site has never been marked, a window will appear notifying the fact and asking if the method should be saved anyway
 12. Start measurement by clicking on the **Measure** button and continue the measurement until enough data is collected.
 - A result window shows the updated values

- After the measurement, the average value is displayed
13. To view measurement results click on the **Results** menu in the **Line Width Measurements** window and highlight **View and Save**.
- An editor displays the results, which may be saved
14. Scroll down and highlight **To Excel** located under the **Result** menu in the **Line Width Measurements** window to view results on a **Microsoft Excel** spreadsheet.
- Highlighting **To Excel** will copy the results into the Clipboard
 - Start **Microsoft Excel** and load data into a spreadsheet by pressing **CTRL-V** or by using the **Paste** function
 - All data processing options that **Microsoft Excel** offers are available
 - When spreadsheet results are complete return to the **Line Width Measurements** window
15. Click **Exit** to return to the main menu window.

Pitch and Stitching

INTRODUCTION

In many cases it is important to measure the distance between two structures, located relatively near to each other. If such structures are identical in appearance, the distance being measured- or *pitch* is uniquely defined by a numerical comparison of the two video profiles of each structure. A cross correlation will yield the *pitch* with an extremely high repeatability.

MODELS

STITCHING MEASUREMENTS:

Determines the vertical distance of two horizontal lines or the horizontal distance of two vertical lines and is designed to run DWL stitching performance measurements in both X and in Y, using the system test pattern.

- **Stitching-X:**

Measures the distance between two vertical lines, on both left and right sides of a stripe border, and will repeat the measurement in other locations on the substrate, if required. The RMS deviation of the results from the resulting average will determine stitching quality in X.

- **Stitching-Y:**

Measures the vertical distance between the sections of two horizontal lines, on both left and right sides of a stripe border, and will repeat the measurement in other locations on the substrate, if required. The RMS deviation of the results from the resulting average will determine stitching quality in Y. This value depends on the stage velocity and therefore must be minimized by optical adjustment for each configuration individually.

PITCH MEASUREMENTS:

The pitch measuring method is applied for finding the horizontal distance of two vertical lines or for finding the vertical distances of horizontal lines. This method may be extended to measure whole sets of equidistant lines.

- **Pitch-X:**

Compares the distance between two vertical lines or a row of equidistant lines over a programmed area.

- **Pitch-Y:**

Compares the distance between two horizontal lines or a row of equidistant lines over a programmed area.

EDGE MEASUREMENTS:

The measurement of edge roughness in an exposure; the position of a horizontal or vertical edge is measured at a number of positions along the edge. The RMS deviation of a fit through these position measurement results will determine edge roughness.

- **Edge-X:**

Determines the roughness of a vertical edge due to position fluctuations. No other structures may be close to the edge.

- **Edge-Y:**

Determines the roughness of a horizontal edge due to position fluctuations. No other structures may be close to the edge.

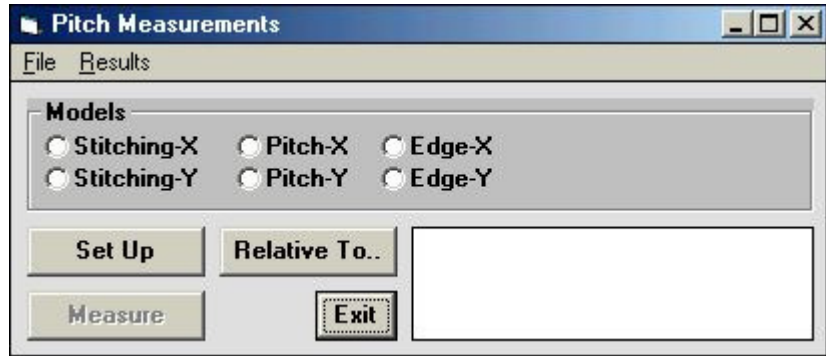
OTHER APPLICATIONS:

- **Scan Linearity:**

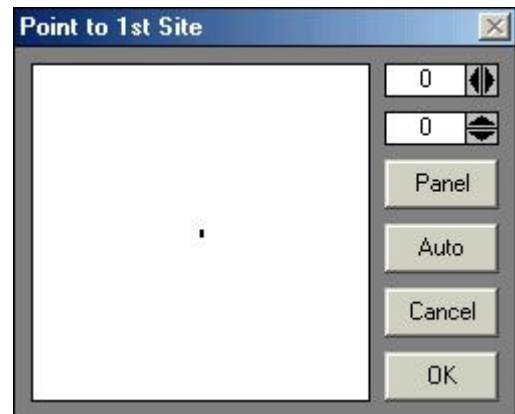
If Scan Linearity is measured, a series of pitch measurements are applied to successive positions in the linearity measurement area of the **DWL PERFORMANCE PATTERN**. The RMS deviation of the average becomes the *scan linearity quality*.

PITCH MEASUREMENTS INSTRUCTION

1. Load the DWL with the substrate to be measured as described in the **Loading** and **Focusing** sections.
2. Using the **XY STAGE** directional buttons on the **Control Panel**, move the stage to the first line to be measured.
3. Open the **Pitch Measurements** window by scrolling down and highlighting **Pitch, Stitching, Edge, Positions** located under **Measure** in the Main Menu.



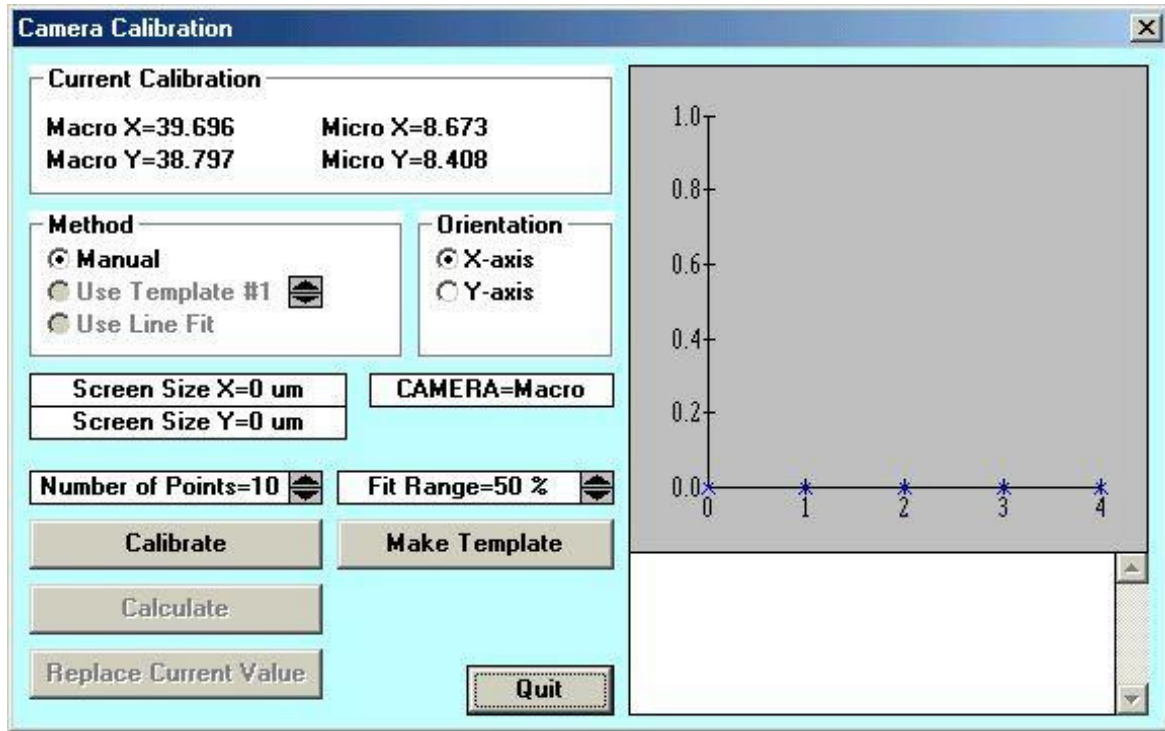
4. To proceed with a measurement file previously created in the **\MEASURE** directory, open up the **Pitch Measurements File** menu, highlight **Load** and load desired file.
 - The **Model** option is read from the file and switches on automatically
 - A Window will request to: "**Point to the Reference Site**," relative to which all positions will be measured:



- Once file is loaded, proceed directly to **Step 11**
5. To set up a new measurement file, choose one of the **Methods** described above for a measurement in the X or in the Y direction
 6. Click on the **Set Up** button, to setup measurement program.
 7. Depending on which model was selected, the **Define Box** window appears, requesting that measurement frames be placed over the structure(s)
 8. After the program is set up, click on **Cancel** to close the **Define Box** window.
 9. To save the measurement program, select a reference point.
 - If a reference point is not selected, the program will simply save the current position as the reference point

- To define a reference point click on the **Relative To..** button
 - For a local series of measurements, the location of the first structure is usually chosen as the reference point
 - When preparing a method including a fully automatic program, the field alignment site can be used
10. Save measurement program by highlighting **S**ave **M**easurement located under the **F**ile menu in the **Pitch Measurements** window.
- In case a reference site has never been marked, a window will appear notifying the fact and asking if the method should be saved anyway
11. Start measurement by clicking on the **M**easure button and continue the measurement until enough data is collected.
- For Pitch Measurements, the first distance measured will be used as default, and only the first box will have to be placed for every succeeding measurement
 - A result window shows the updated values
 - After the measurement, the average value is displayed
12. To view measurement results click on the **R**esults menu in the **Pitch Measurements** window and highlight **V**iew and **S**ave.
- An editor displays the results, which may be saved
13. Scroll down and highlight **T**o **E**xcel located under the **R**esult menu in the **Pitch Measurements** window to view results on a **M**icrosoft **E**xcel spreadsheet.
- Highlighting **T**o **E**xcel will copy the results into the Clipboard
 - Start **M**icrosoft **E**xcel and load data into a spreadsheet by pressing **CTRL-V** or by using the **P**aste function
 - All data processing options that **M**icrosoft **E**xcel offers are available
 - When spreadsheet results are complete return to the **Pitch Measurements** window
14. Click **E**xit to return to the main menu window.

Camera Calibration



CAMERA CALIBRATION INSTRUCTION

1. Load substrate as described in **Loading** and **Focusing**.
2. Select camera to be calibrated and switch on the camera monitor
 - Use the **DWL Control Panel** to select camera
3. Move a clearly defined structure on the substrate (i.e., a cross) to the approximate center of the screen.
4. Train system a template for finding the defined structure at various stage positions.

NOTE: Camera calibration may also be done manually, but the result may be less precise.

- a) Use Gain and Offset slides to optimize contrast of the image.
- b) Exit **Control Panel**.
- c) Highlight **Video Calibration** under **Service** in the Main Menu and the **Camera Calibration** window will appear.

- d) Click on **Make Template** and the **Define Template** window will appear.
 - e) Define a template from the image on the monitor by placing a box of an appropriate size above a structure or part of a structure, which can be easily recognizable even if it is in a different part of the monitor image. First, place the box and then choose the size.
 - f) Store the template in the temporary memory on the frame grabber-card by clicking on **Save Template in IPC**.
 - g) Test template. If the result is poor, try to improve the contrast, or find a structure better suited, and repeat instruction beginning at **Step 4c**).
5. Select number of data points and the range of the camera field over which the calibration should take place.
 - Calibration range is limited to 90%, so the structure may drift out of view
 6. Click on **Calibrate** button.
 - The stage will now be moved around the camera field and the position of the plate is measured using the defined template
 - If manual mode is chosen, the operator must manually point to the structure's edge, or center at each measurement position
 7. Click on **Calculate** and the system will calculate the best fit.
 8. Replace old calibration value with the new one by clicking on **Replace Current Value**.
 9. Repeat full instruction for both axes and both cameras.

CHAPTER 4 - ERRORS AND TROUBLESHOOTING

Most problems that can occur result in an error message by the menu suggesting corrective action. This section lists some additional common difficulties and offers possible explanations and solutions.

THE DWL WILL NOT IMAGE

1. Verify that the AC power cord is plugged into the wall outlet and that the outlet is receiving power.
2. Verify that the flowbox window is completely closed.
3. Try rebooting the OS9 system and the user PC.

LINES NOT TO SIZE

Line thickness problems may have the following causes:

- Developing technique (time, developer dilution etc.) not matched with material requirements
- Wrong resist thickness
- Focus height incorrect
- Incorrect exposure energy
- Out of date material (fotosensitive coating, developer)
- File creation error

FILM FOGGING

Fogging of emulsion coated films may have the following causes:

- Too much ambient light
- Safe light with wrong filter (Use a red filter or one recommended by the film manufacturer)
- Safe light on for too long
- Out of date emulsion or media
- Safe light power too high

- Wrong developer

THE DWL STOPS ANYTIME DURING THE EXPOSURE

- The accessed file is too big or the lic buffer is too small
 - Try split lic
- The DWL reached an endswitch, because the imaging area was set incorrectly during conversion or in the menu map
- The accessed file has the wrong format
- The data file is too complex, which causes the MBCIII to be selected without being READY.
 - Try a slower writing speed or a smaller stripe width
- The interferometer head is broken

PLATE COMES OUT COMPLETELY UNEXPOSED

- Wrong substrate for this laser type
- Something is blocking the beam path

ONLY HALF THE SCAN IS EXPOSED

- Stripe distance was not entered correctly in the conversion (wrong writehead chosen)
- Wrong writehead installed
- Wrong configuration was chosen

CHAPTER 5 - OPERATOR MAINTENANCE

INTRODUCTION

The DWL 66 fs requires some minimal operator maintenance; however, only trained service engineers should perform regular maintenance on the system. See **Chapter 1 - Safety Precautions**.

SYSTEM CHECKS

Before operation the following routine maintenance should be performed:

1. Make sure all access covers are firmly in place.
2. Clean the chuck surface with a dry towel
3. Verify that the room temperature and humidity are within the following limits:
TEMPERATURE: 65° - 75°F (18° - 24°C)

<p style="text-align: center;">NOTE</p> <p>In addition to being within the recommended range, the temperature must be stable (within 2°C) in order to assure high quality film and plate registration.</p>

RELATIVE HUMIDITY: 40% to 60% (non-condensing)

CLEAN ROOM: Class 1000

ENVIRONMENTAL ADJUSTMENTS

1. Allow room humidity to come within the specified range before using the MaskWrite.
2. If temperature is out of range, determine how long this condition has prevailed.
3. Adjust room temperature to within the specified temperature range and allow the DWL to stabilize.
4. For stabilization of the system allow an amount of time equal to the time the temperature was out of range.

<p style="text-align: center;">NOTE</p>
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- During imaging, the most accurate results are obtained when the environment remains at a constant temperature and humidity.
- If the system is equipped with a laminar flowbox, to achieve the optimum accuracy during imaging, place substrate on chuck 2-3 hours before exposure, close DWL window, and do not open window until exposure is finished.