P-17 / P-7

User's Guide

KLA-TENCOR CONFIDENTIAL

Family: Profiler
Software Version 7.31/7.35

Product Line: Profiler P1X / PX
MNL, USER

Model: P-17 / P-7
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TRADEMARKS

REGULATORY COMPLIANCE

At the time of printing, the P-17/P-7 Profiler complies with essential requirements of following directives and standards.

CE Directives:

EMC (Electromagnetic Compatibility	204/108/EC
Machinery, Annex 1	2006/42/EC
Low Voltage, Annex 1	2006/95/EC
Harmonized Electromagnetic standard	EN 50082-2:1995
	EN 50081-2:1993
	EN 55011:2000
Harmonized Safety Standard	EN 60204-1:2006
	EN 61010-1:2001
	EN 61000-6 :2007
	EN 61326-1 :2005
	EN 61326-1

SEMI Standards:

Product Safety Assessment	SEMI S2-0703
Ergonomic Assessment	SEMI S8-0705
Fire Risk Assessment	SEMI S14-0704

RoHS Compliance: All P-17 and P-7 external peripherals and computer components used (main scanner exempt) comply with the European Union's Directive 2002/95/EC, Restrictions of Hazardous Substances ("RoHS" Directive).

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INTRODUCTION & SAFETY

INTRODUCTION

This User Manual represents the Original Instructions for proper operation of the P-7 and P-17 stylus profilers.

INSTRUMENT OVERVIEW

The KLA-Tencor P-17 / P-7 Profiler is a highly sensitive surface profiler that measures step height, roughness, and waviness on sample surfaces. The KLA-Tencor P-17 Profiler systems use stylus-based scanning to achieve high resolution.

The P-17 / P-7 system offers the option between three head configurations, each with a different vertical range: the MicroHead II V SR (standard range), MicroHead V LF(low force), and the MicroHead V XR (extended range).

- The **MicroHead V SR** (standard range) has a vertical range of 327 µm and is capable of scanning at forces between 0.5 and 50 mg.
- The **MicroHead V LF** (low force) has a vertical range of 131 µm. It is capable of scanning with a stylus force between 0.05 and 50 mg. Low force is useful when scanning soft materials such as gold, indium, or photoresist.
- The **MicroHead V XR** (extended range) extends the vertical range to 1000 µm. It is capable of scanning at forces between 0.5 and 50 mg.

Contact KLA-Tencor for detailed specifications.

SAFETY

Introduction

This safety chapter presents an overview of the safety issues involved in the use of the P-17/P-7 Profiler or P-7 Profiler system.

This Chapter describes:

Safety Symbols and Related Keywords

WARNING: Warnings indicate a potentially hazardous situation which, if not avoided, could result in personal injury or death.

	**CAUTION:** Cautions indicate that equipment could be damaged, the operating environment compromised, or data could be lost or corrupted.
	**DANGER:** Dangers indicate an imminently hazardous situation which, if not avoided, will result in death or serious injury. This signal word is limited to extreme situations.
	**PINCH POINT:** Pinch Point indicates a situation where the user, if not careful, could get a hand or finger pinched.
	**LIFTING HAZARD:** Lifting Hazard indicates a procedure where the user, if not using the proper technique or the correct number of people, could be injured.
	**LASER WARNING:** Laser Hazard indicates a procedure or situation in which a laser beam could contact or damage eye tissue..
	**IMPORTANT:** Important highlights critical details about the section for the reader.

Lockout/Tagout Procedure

Introduction

Lockout/tagout is a safety procedure consisting of notifying affected employees, turning off the system, unplugging the power source cord from the electric outlet and placing a locked and tagged shield around the plug to prevent it from being plugged in while the system is being serviced.

During normal operation, the system presents no hazards to its user or to others in the area of its operation. In normal operation, enclosure panels and shielding covers protect operators and other personnel working near the system against electrical and other hazards that could arise from the operation or failure of the system.

Only qualified service personnel are authorized to remove panels or covers. In situations requiring service personnel to work near components that present a potential electrical shock, the *lockout/tagout* procedure should be followed. In addition to electrical hazards, some mechanical dangers such as pinch or crush hazards can also be avoided through the *lockout/tagout* procedure.

Lockout/Tagout Procedure

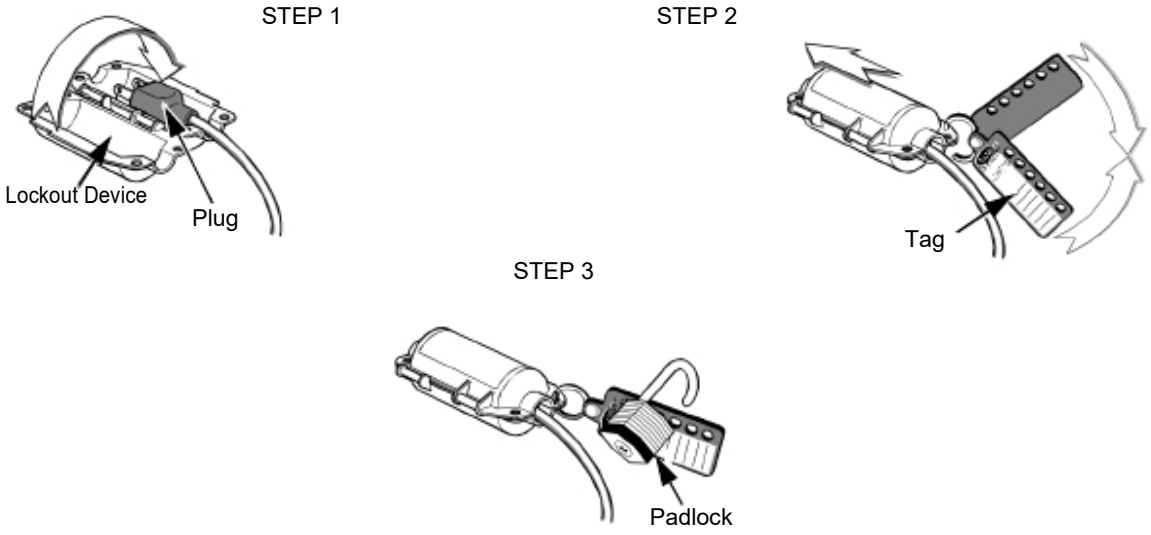
If the system is hardwired to facilities power, the lockout/tagout procedure is to be set by the system owner. Service personnel authorized to perform this type of lockout/tagout must be trained by the system owner in accordance with their set procedures.

HAZARDOUS VOLTAGE - SHOCK HAZARD: For personal safety and system reliability, only qualified service personnel, trained on service procedures for the system being serviced, are authorized to open or remove the panels or any protective electrical shielding.

For systems using the power cord disconnect lockout/tagout procedure for a non-emergency system shutdown, use the following steps:

1. Notify all affected personnel that a lockout is required.
2. Close all running software.
3. After ensuring that the system software has been properly shut down to avoid system start-up problems later, turn off the system by pressing the **OFF** button on the computer and unplug the power supply.
4. Disconnect the Main Power Cord from the outlet and secure it in the Plug Lockout device as illustrated in *Figure 1.1*, step 1.

Figure 1.1 Power Cord Plug Lockout/Tagout



5. Attach the lockout hasp with warning tag to the **lockout device**, as shown in *Figure 1.1*, step 2.

6. Place a padlock through one of the holes on the lockout hasp as shown in *Figure 1.1*, step 3. Make sure the device is secured in the closed position.
7. Before locking the padlock, place the eyelet of an approved lockout tag over the hook of the padlock. Important information must be included on this tag:
   - Your name and/or your ID number.
   - Your contact number.
   - Date and Time.
   - Reason for Lockout.
8. Verify that the power chord *cannot* be plugged in to live AC Power.
9. After the system has been locked out, verify that the system cannot operate. For example, press the **ON** switch on the User Interface and verify that the indicator lamp does not illuminate, that no other indicators on the system show that electrical energy has been applied.

Restoring the system to Service

1. When the system is ready for return to normal operation, notify all affected employees, and check the equipment area to see that no one is exposed.
2. When the equipment area is clear, remove the padlock and tag that you have put in place.
3. Reconnect the power cord into the AC outlet.
4. Announce "*Power On!*" to everyone presently near the system before actually restoring power.
5. Press the Power On button on the User Interface to start the system.
6. Verify the system operates properly.

Stage and Head Movement Hazards

The system is designed so the user is not exposed to any internal moving parts during normal operation. The system is interlocked to prevent stage or head movement when the stage door is open. If stage or head movement is attempted with the door open, the system is automatically disabled.

For any of the stage or head movements to be hazardous to the user, the door interlock must be defeated and the user must have hands, fingers, or loose clothing inside the measurement chamber during a stage or head movement procedure. The normal scanning speed stage movements are very slow, and barely detectable to the eye. The manual load procedure and stage positioning move at a higher speed. If these movements are attempted with the door open, interlock defeated, and a finger, hand, or loose clothing positioned to interfere with the stage movement, an injury could occur.

If none of the components are in motion when the door is opened, or when the interlock is tripped, the system can be activated again by closing the door or by returning the interlock to its normal operating position. If a scan is taking place, if one of the components is in motion, or if an attempt is made to activate the motion system with the interlock tripped, the entire system must be rebooted.

CAUTION: Under no circumstances should the operator defeat any of the safety interlocks. There are no operator procedures that require the door to be open during normal operation. Operation of the system in service mode with interlocks defeated should only be performed by trained and qualified KLA -Tencor service Personnel.

SAFETY AGENCY APPROVAL

This equipment complies with safety regulations set forth by following organizations:

· CE, stands for Conformité Européenne or confirming to European standards which includes safety requirements.The CE mark used on compliant products is shown below:

CE

· SEMI S2-0703, the SEMI (Semicondutor Equipment and Materials International) safety standard.

BASIC SKILLS

OVERVIEW

Before beginning the use of the P-17/P-7 Profiler system, become familiar with basic skills — such as starting and shutting down the system, and operating the system buttons, keyboard, trackball, Microsoft Windows, Profiler application, and other components

ERGONOMIC CONSIDERATIONS

KLA-Tencor equipment has been designed and manufactured with safety and ergonomic principles.

Good Ergonomic Practices

- Avoid repetition of movement to the point of excessive fatigue.
- Maintain good posture that facilitates circulation and sound biomechanics.
- Exercise regularly. Follow suggestions of your health care practitioners.
- Vary your tasks. Do not perform the same tasks with your hands without interruption, or work intensely in the same bodily position for long periods.
- Avoid awkward postures.
- Eliminate poor access, inadequate clearances, and excessive reach.
- Redesign work sites with ergonomics in mind.

When Using The Keyboard

Good ergonomics are important when working at the keyboard. Apply these techniques in your job:

- Avoid eyestrain by adjusting the zoom on the monitor, and by looking away to various distances every few minutes. Sit 18 to 24 inches away from the monitor. It should be set so the top of the screen is even with your eyes.
- Adjust your chair so it positions you well in relation to the monitor, floor,and keyboard. Support your lower back and rest your feet flat on the floor.
- Keep your elbows in a relaxed position next to your side, while keeping your back straight and shoulders back, down, and relaxed.
- Avoid bending, angling, or arching your wrists. Do not twist your wrists in an angled position for more than a brief period. Rest your palm on a soft surface. Place your fingers slightly lower than your wrist.
- Use the minimum amount of force that is needed to push down the keys.
- Keep your fingers and thumbs in a relaxed, natural position.
- Do not rest your wrists on the edge of the keyboard platform while typing. Refrain from using a wrist rest for setting your wrist on while keyboarding.

POWERING UP THE PROFILER

Introduction

By powering up the computer, the system launches Windows.

Power Up Procedure

1. Press the **ON/OFF** button on the monitor to activate the monitor.
2. Press the **ON/OFF** button on the Computer.

   The Computer starts, Windows is launched, and the Windows desktop is displayed.

LOGGING INTO PROFILER SECURITY

After logging into Windows XP as an Administrator, either automatically (default setting) or manually, you will need to log into profiler security.

NOTE: To have Profiler and Windows XP function properly, you must log into Windows XP as an Administrator. Profiler security login is then responsible for granting the user the correct access level.

1. After Windows XP is loaded, you will be presented with the LogOn dialog shown in Figure 2.1.

Figure 2.1 *Logon Dialog*

2. Enter a valid User Name that has been previously created, such as Administrator.

3. Enter a valid Password (case sensitive) that is associated with the User Name.

4. The E10 state is not being tracked by the software, so it can be left at the default value.

5. Click on Logon

STARTING THE PROFILER APPLICATION

Introduction

The Profiler application is the interface with the P-17/P-7 Profiler system from which the scan functions are performed and viewed.

Profiler Start-Up Procedure

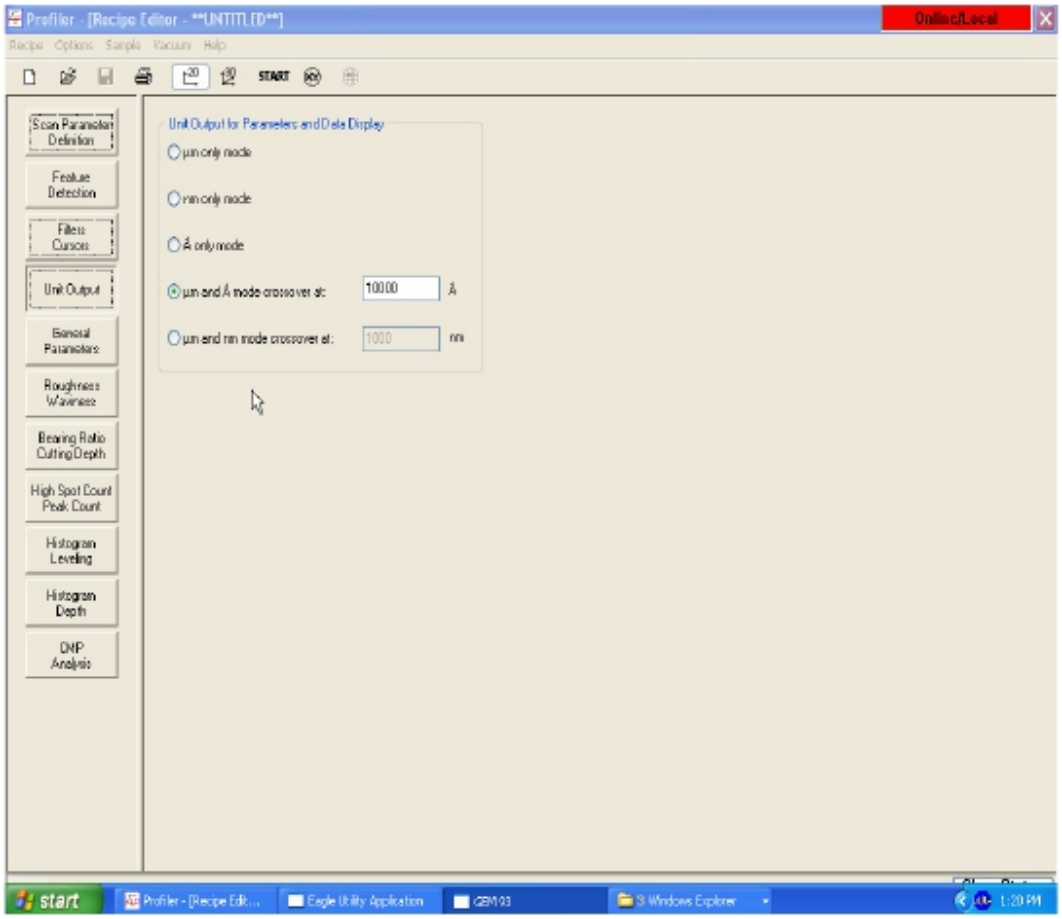
1. Use the trackball to locate the Profiler icon with the screen cursor. Double-click the **Profiler** icon to initiate startup of the P-17/P-7 Profiler system. (See *Figure 2.2*.)

Figure 2.2 *Program Icons*

Step 1 When the boot cycle is complete and the log on is complete, double-click the **Profiler** icon to initiate system start-up.

2. The system goes through its initiation at the end of which the **Profiler Catalog** screen appears. (See *Figure 2.3*.)

Figure 2.3 *Profiler Catalog Screen*



This is the starting point for operating the instrument. In this screen, scan and sequence recipes can be accessed for system operation. Each icon along the right side of the screen opens another application that contains the parameters or controls for a specific type of task. (See Table 2.1)

Table 2.1 *Profiler Program Access Icons*

Icon	Description	Icon	Description
	Configuration Displays the Profiler Configuration screen. This screen provides access to various configuration windows.		**Database File Manager** Displays the screen that provides access to files for export/import and delete.
	Calibration Displays the Profiler Calibration screen. This screen provides access to system calibration windows used for accessing various calibration procedures.		**Stress** Displays the Profiler Stress catalog screen. This screen contains access to the recipe and data file screens.
	Scan Displays the Profiler Catalog screen. This screen provides access to the Scan recipes, Sequence recipes, and data files.		**GEM/SECS** Displays the GEM/SECS screen. This screen is used to configure the system relationship with its host.

NAVIGATING BETWEEN PROGRAM LEVEL SCREENS

Introduction

The program level Profiler screens all have the program icons along the right border of the screen. These icons can be used to navigate between the various other program screens contained in the Profiler software.

Navigation Procedure

Use the following procedure to navigate between screens:

- Click the icon of the required program screen. (See *Figure 2.4*.)

  This ***closes*** the current program screen and accesses the chosen one. This could generate a message box that inquires if changes to settings, or data are to be saved or discarded. Choose the required answer and follow any instruction.

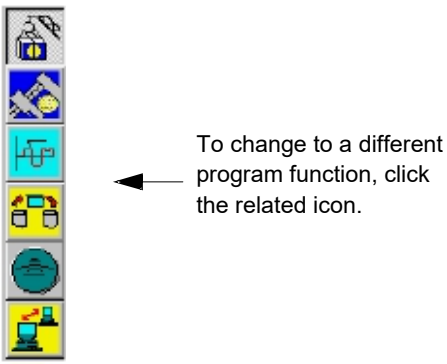
- Functions performed in some screens automatically access other screens.

  EXAMPLE:

  Performing a scan in the XY View screen generates the scan screen then the Analysis screen.

  The above screens do not contain the program icons. To change or exit, click **File** in the Menu Bar and choose **Exit** from the drop-down menu. In some cases it is necessary to click the control button at the top left corner of the screen and choose **Close** from its drop-down menu. This closes the current screen and displays the program screen from which the procedure was entered.

Figure 2.4 *Profiler Configuration Screen*



EXITING THE PROFILER APPLICATION

Introduction

This procedure is used to close the Profiler and Windows applications.

Profiler Exit Procedure

1. Close all screens up to a program screen (program level screens are represented by one of the program icons at the right side of the screen).
2. Click the control button at the top left of the screen to display the menu.
3. Choose **Close** from the drop-down menu.

4. A Profiler Container (message box) appears asking, "Are you sure you want to exit the Profiler?" Click **Yes** to exit.

NOTE: The Profiler system will initialize upon shutdown..

5. Choose **Shut Down** from the menu.

CLEARING A STATUS BAR MESSAGE

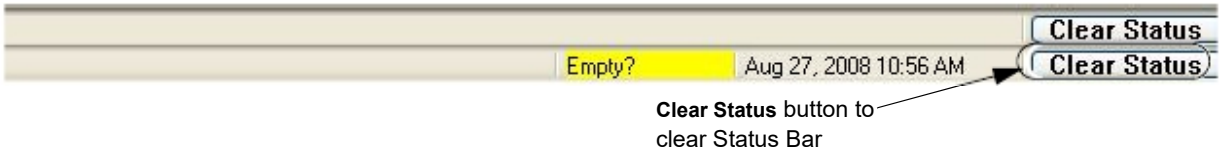
Introduction

Messages appear in the status bar at the bottom of the window when an action or circumstances create the potential for instrument malfunction, such as occurs with a motion error. The system status bar also presents messages that guide the user through many of the system procedures. When a message appears, the status bar at the bottom of the screen becomes red and the status bar must be cleared before it can display any new messages.

Clearing a Status Bar Message Procedure

After reading the message in the status bar at the bottom left of the screen, click the **Clear Status** button on bottom right of the status bar to proceed. See *Figure 2.5*.

Figure 2.5 *Clearing the Status Diagnostic Messages*



PROTECTING THE STYLUS ARM ASSEMBLY

System Provisions for Stylus Protection

The P-17/P-7 Profiler incorporates several design features that protect the stylus from damage. (See Table 2.2)

Table 2.2 *Stylus Arm Assembly Protection*

Protection Name	Stylus Arm Protective Measure	Description of Result
Data Point Saturation	During an ascending scan, the scan is terminated when the stylus reaches its upper limit of travel (when it has pivoted up as high as it can go)	The stylus automatically retracts and the scan is terminated. In the Scan window, the trace ascends and flat lines at the top of its range.
Lowest Elevator Position	As a safety factor, the elevator can be programmed to lower only to a preset limit.	With the **Lowest Elevator Position** properly set, when the measurement head is lowered, it only goes as far as the setting allows, thus protecting the stylus and sample from damage.
Proximity Sensor (P-16 Only)	The Proximity Sensor is designed to detect the sample as the head lowers and slow the descent.	With the Proximity Sensor **ON**, the head slows and stops as it nears the sample surface. If the Proximity Sensor is turned **OFF**, (or not available, as in the P-7 model), then the head descent slows when it reaches 1000 µm above the Lowest Elevator Position. The system then depends on the stylus contact with the sample surface to stop the head descent. If the stylus is coming down in a hole or off the edge of the sample, the system or the sample could be damaged by contact with the sensor assembly.

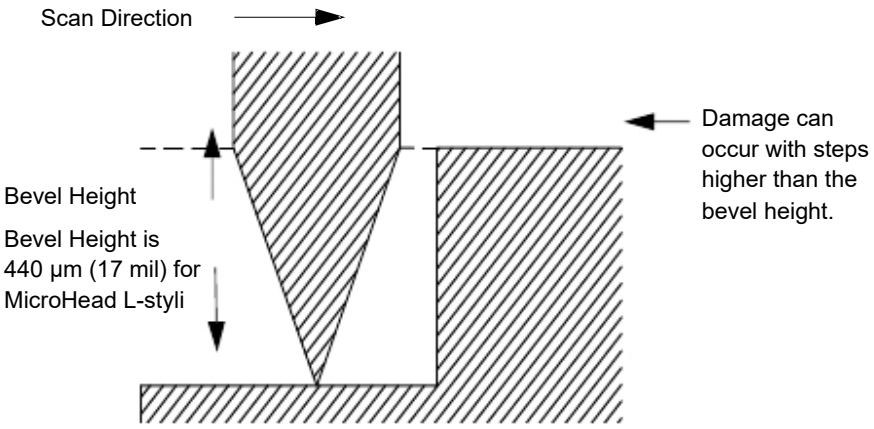
Potential Stylus Damage During Scans

Despite precautionary features, there are still circumstances where damage can occur.

- Damage occurs whenever the stylus is down and a vertical wall that is fixed to the stage moves against the stylus shaft.
- The stylus can be damaged whenever it encounters an obstacle higher than the bevel height of the stylus tip (higher than 440 µm (17 mils) for the MicroHead L-style stylus. (See *Figure 2.6.*)

- The stylus can be damaged by a shorter object if it has sharp corners or burrs that bite into the stylus tip.

Figure 2.6 *Contact Scan Stylus Tip*



- If the stylus is lowered or a scan is started when the sample is not directly under the stylus, damage to the stylus could occur.

  This is most likely to happen when lowering the measurement head such that the stylus drops into the center hole of a hard disk or misses the edge of the sample. Then when the stage is moved, the stylus is damaged.

CAUTION: Do not move the stage unless the stylus is well above the sample surface.

CAUTION: Do not start a scan unless the stylus is directly over the sample or damage to the stylus or head could occur.

- If a sample or precision locator is changed without resetting the **Lowest Elevator Position**, the head can lower onto the locator if the stylus misses the locator surface.

NOTE: The stylus tip is located about 4 mm (165 mils) below the measurement head.

CAUTION: If changing the sample or precision locator to a different height, reset the **Lowest Elevator Position.** Otherwise, damage to the stylus or the measurement head can occur.

When designing custom jigs or fixtures, consider the precautions noted in this section. For instance, when designing a custom hard disk locator, its center section must be flush with the top of the disk surface. Care must be exercised when nulling where there is a hole in a jig, a vacuum hole, or a groove in a surface.

For hard disks only, when measuring the disk, avoid nulling in the Disk Locator hole.

NOTE: The KLA-Tencor Warranty Policy does not cover damage to the stylus arm assembly or the pivot caused by operator error or carelessness.

LOADING A SAMPLE

1. Open the **Scan Recipe** window. (Click the **Scan Recipe** button in the Catalog screen. See *Figure 2.7*.)
2. Once the Scan Recipe window is active, with a recipe highlighted, click the **XY View** button to display the XY View screen. (See *Figure 2.7*.)

Figure 2.7 *Scan Recipe Window in the Catalog Screen*

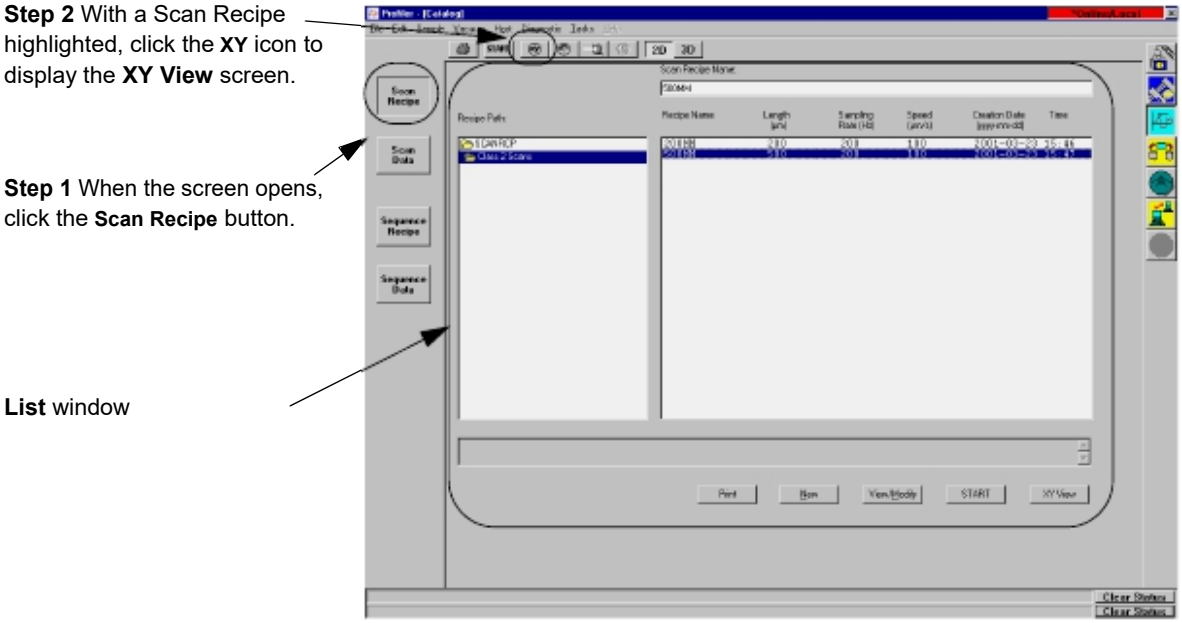
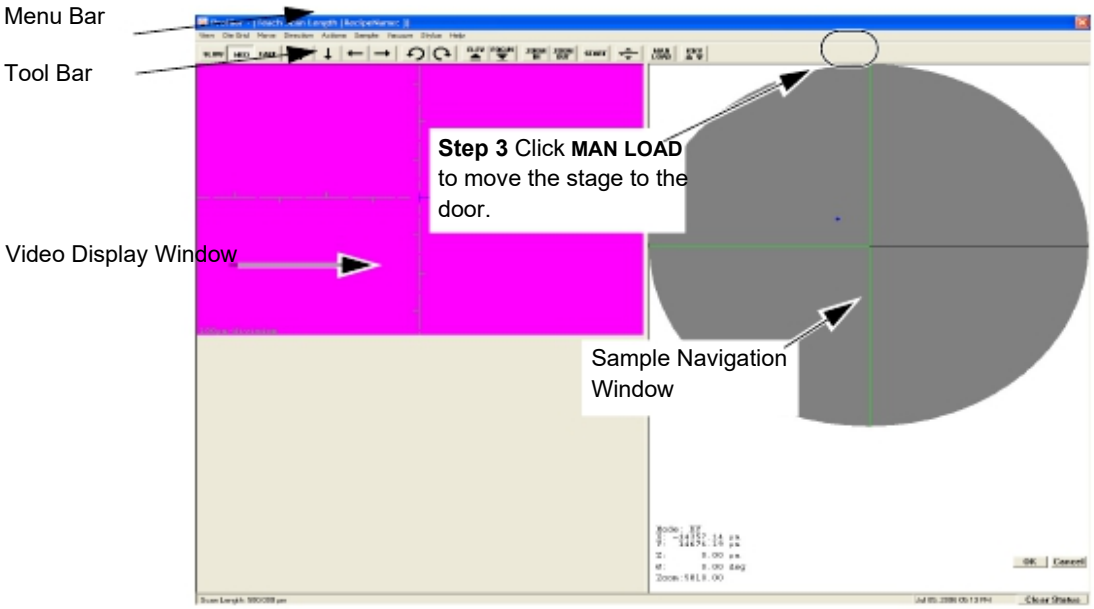


Figure 2.8 *XY View Screen*



3. Click **MAN LOAD** (see *Figure 2.8*) in the Tool Bar to move the stage to the door. (See *Figure 2.8*.)
4. Open the door.

CAUTION: Do not open the door until the stage has completely stopped moving. All motors stop immediately when the door is opened. (Unless the interlock is disabled.)

5. Place the sample on the stage in the proper orientation.
6. Turn on the vacuum switch located on the left inside edge of the door.

   The sample should now be securely in place on the stage.
7. Close the door.
8. Click **MAN LOAD** to move the stage back under the system head.

ADJUSTING THE VIDEO IMAGE

Introduction

The Video Controls allow the view of a particular sample surface to be optimized. The brightness and contrast can be varied for the camera.

NOTE: Changing the focus can invalidate sequences that use pattern recognition because the sample image is less likely to match the stored image in the pattern recognition files.

The purpose of adjusting the video image is to clarify the image resolution and contrast so it can be clearly viewed.

Video Image Adjustment Procedure

1. With a sample loaded on the stage, click the **FOCUS** button to null the stylus on the sample surface and focus at the chosen magnification. (See *Figure 2.8*.)
2. Click **View** in the Menu Bar to display its menu.
3. Select **Video Controls**.

   The **Video Controls** dialog box appears. (See *Figure 2.9*.)

Figure 2.9 *Video Control Dialog Box*

Step 4 Use the slide bar or directly enter the value required.

Step 5 When desired results are achieved, click **Apply**.

Step 6 Click **Exit**.

4. Adjust contrast and brightness controls by moving sliders left or right.
5. When values for **Contrast** and **Lamp Brightness** are set, click **Apply.**
6. When the adjustments are complete, click **Exit.** The settings are stored.

NOTE: If the video image is too bright or too dark, even after making adjustment to the video controls, the problem could be due to auto brightness, adjustment during the focus routine. Adjust the contrast to 0 and the lamp brightness to the mid-point and then return to Step 1, re-focusing the image. If the problem persists, contact KLA-Tencor.

USING FILE NAME CONVENTIONS

Introduction

Scan and sequence recipes and data can be saved, as well as graphs and video images.

In the Windows OS naming convention only the following special characters are allowed:

Table 2.3 *Special Characters Allowed for Naming Purposes*

◆ _ underscore	◆ - hyphen	◆ { left brace
◆ ! exclamation point	◆ & ampersand	◆ } right brace
◆ % percent sign	◆ (left parenthesis	◆ ‘ single quotation mark
◆ # number sign	◆) right parenthesis	◆ ' apostrophe
◆ $ dollar sign	◆	◆

Naming and Saving Files

1. When saving a file, click **File** to display its menu. Click the **Save…** button. A dialog box appears. The content and appearance differ slightly depending on what is being saved and the screen from which **Save…** was chosen.
2. Choose the appropriate folder in which to store the item being saved.
3. Create a distinct file name for the item being saved. It is best to make the name representative of the content of the file if possible. The name can be up to 72 characters in length and should not contain empty spaces. Enter the file name in the file name field.
4. Set any other necessary options required to properly store the information in the file. For example you may see a setting to change the content format of the file to either **Statistics** or **Trace**. These options are only for sequence data.
5. Click **Save** to save the data in the named file.

SAVING VIDEO IMAGES

Introduction

A video image can be captured in the XY View window and saved to a file. Many standard image output file formats are supported.

Naming and Saving Video Images Procedure

1. Go to either the **XY View** or **Theta View** window, and click the **View** menu.
2. Select **Save Image to File** to display the **Save Image As** dialog box.
3. Choose the location in which the image is to be saved.
4. Next to **File name**, enter a name for the image file that is to be created.
5. Select the format that the image is to be saved in.
6. Click **Save** to save the video image.

EXPORTING DATA GRAPHS

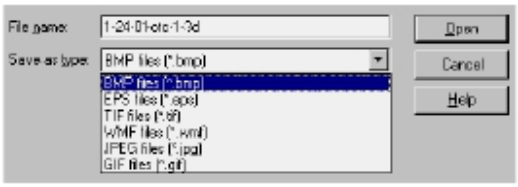
Introduction

Data graphs are contained in the Scan Data catalog, Sequence Data catalog and in the Analysis screen when the scan data is being analyzed. 2D and 3D graphs can be exported directly from the Analysis screen during scan data analysis. 2D and 3D graphs from the Scan Data catalog can be exported in two ways: from the Analysis screen, and from the Database File Manager.

2D and 3D data graphs from the Sequence Data catalog can be exported only from the analysis screen because the file must be opened and the desired graph chosen and displayed before it can be exported.

The data graph is exported as a graphic image as Bitmap format (*.bmp), TIFF (*.tif), JPEG (*.jpg), or Word Metafile Format (*.wmf).

Figure 2.10 *Export File Formats in Drop-Down Menu*

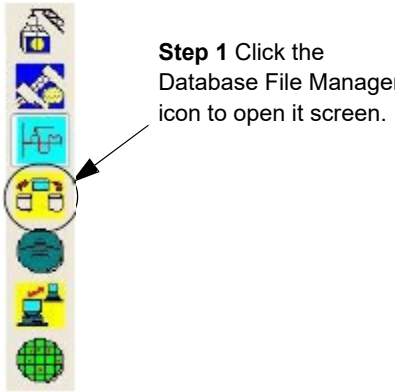


Exporting the Graph from the Scans Catalog (Scan Data Only)

Exporting Graph from the Database File Manager

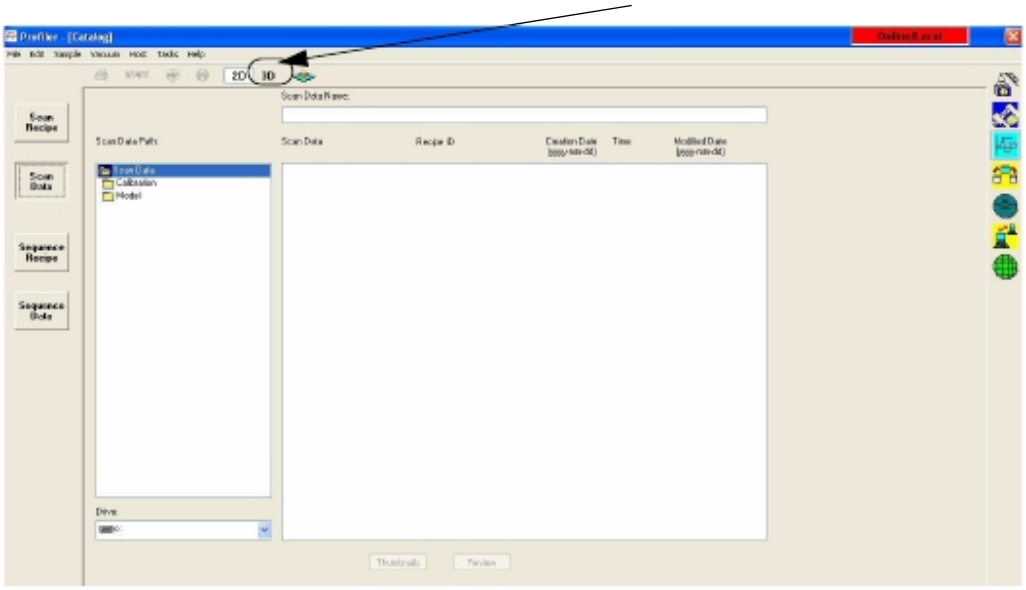
1. Go to any top level screen containing the system icons and click the **Database File Manager** icon. (See *Figure 2.11*.)

Figure 2.11 *Catalog Screen – Database File Manager Icon*



2. In the Database Catalog screen, choose either the **2D** or **3D** button in the tool bar. Depending on the Catalog group chosen, this displays the 2D or 3D data or recipe sets. (See *Figure 2.12*.)

Figure 2.12 *Data Catalog Screen for Export of Data or Recipes*

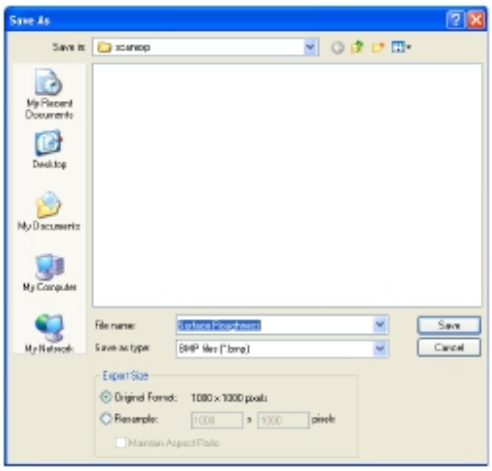


3. Choose **Scan Data** from the Catalog buttons at the left of the screen.
4. Navigate to the folder containing the required graph.

To Open the Export Dialog Box from the Database Screen

5. If the file name is known and there is no need to see the graph, click the file name of the graph, and click **Graph Export…** at the bottom of the screen. This opens the export dialog box titled **Save As**. (See *Figure 2.13*.)

Figure 2.13 *Graphics Export Dialog Box*



6. Set the required variables in the **Save As** dialog box. See *Table 2.4* for an explanation of the variables to be set.

Table 2.4 *Graphics Export Dialog Features*

Variable	Description
Save In	This drop-down menu provides a *browse* feature from which to search for the folder that the graphic is to be exported to or the application that is to analyze it. The location must be and displayed in the **Save In:** field.
File Name	Type the **File Name**, up to 68 -characters in length.
Save as Type	From the drop-down menu, select the **graphic** format: (**BMP**, **TIFF**, **WMF, EPS,** or **JPEG**).
Export Size	Allows the user to keep the original size or resample to a smaller size, or change to a larger format.

7. Complete the information in the dialog box.
8. After all the information has been entered, click **Save** to complete the export.

Exporting the Graph from within Analysis Program (Scan and Sequence Data)

1. When the operator needs to see the scan graph before exporting it, after entering the Scan Data or Sequence Data folder containing the scan file, double-click the file. This opens the Analysis screen with the graph displayed.
2. If the correct graph is displayed, resize or reorient it as required before export.
3. Choose **Export Graph…** from the **File** menu to open the Save As (export) dialog box.
4. Fill in the required information.
5. After all the information has been entered, click **Save** to complete the export.

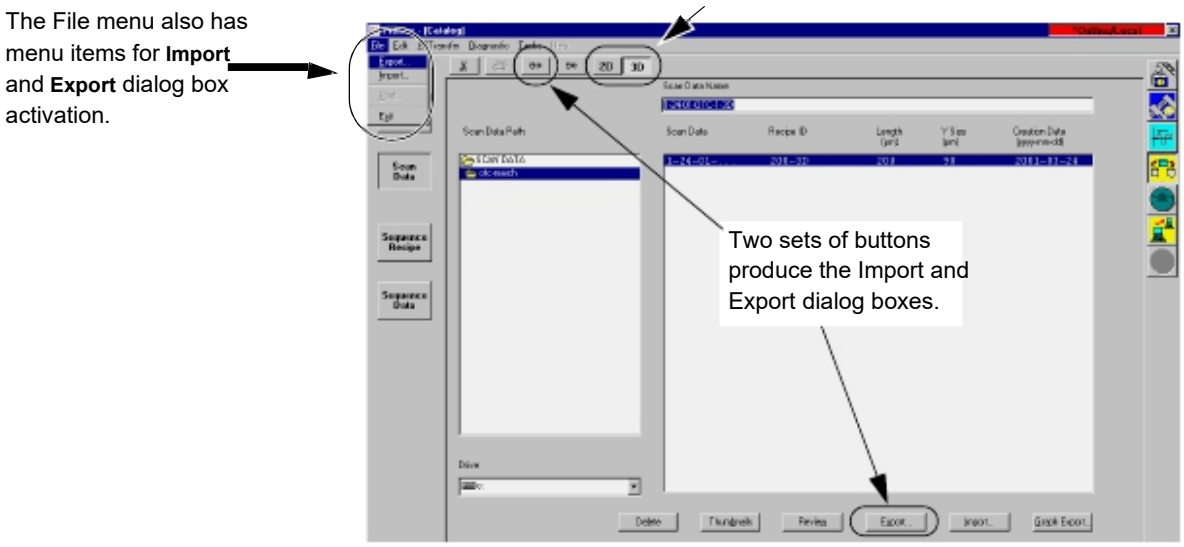
EXPORTING DATA FROM THE DATABASE FILE MANAGER

Export of data files from the Database File Manager is performed the same way for both Scan Data and Sequence Data sets.

1. From the Database File Manager choose either 2D or 3D files.

2. Choose either the Scan Data or Sequence Data catalog button. This displays the related 2D or 3D data files in the chosen catalog.

Figure 2.14 *Data Catalog Screen for Export of Data or Recipes*



3. Navigate to the required data set and click it to highlight it.

   There are three ways to access the **Export Sequence** (or **Scan**) **Data -- Select Export Directory** dialog box.

   - The **Export…** button at the bottom of the screen
   - The **Export Data** icon in the tool bar at the top of the screen
   - The **Export…** menu item in the **File** menu

4. Select **Export…** from one of its access points.

   This displays the **Export Sequence** (or **Scan**) **Data -- Select Export Directory** dialog box.

   From the **Export to:** drop-down menu, choose the directory/folder that the data is to be exported to. The actual path and folder name are displayed at the bottom left of the dialog box.

5. Choose an export format, either ASCII, Binary, or Simple Binary.

   - **ASCII** - Exports data in text format for viewing in programs such as Excel
   - **Binary** - Binary files are used for transporting data between Profiler systems or to offline Profiler software. When sending data to KLA-Tencor for analysis, binary is the preferred format.
   - **Simple Binary** - Binary file format with a header that contains the minimum required to interpret the data and generally does not change between software versions. This allows easier transporting data to third party data analysis programs such as Apex, SPIP, etc.

6. Click **OK** to export the data to the destination folder.

SCAN RECIPES

INTRODUCTION

The P-17/P-7 Profiler system performs scans of sample surfaces using recipes that set the parameters of each scan. Each recipe can be used alone or, in conjunction with other recipes in a sequence to gather necessary data from a given sample. Some system calibrations use recipes to perform vital data gathering and analysis so the system can be calibrated for optimum performance.

The P-17/P-7 Profiler system is capable of high resolution scans in two or three dimensional formats. The three dimensional scan uses a combination of parallel traces. The length of the traces, the distance between parallel traces, and the frequency of data point collection are all defined in the recipe. The two dimensional trace is a collection of data points made at a recipe specified frequency either as one trace, or a recipe specified number of traces over the same scan position, which are then averaged. The data is then presented in either a two or three dimensional graphical format for observation and analysis.

ACCESSING THE SCAN RECIPE CATALOG SCREEN

The Catalog screen is the first screen to appear when the Profiler application is opened. The functional areas in the screen are described in *Figure 3.1* and *Figure 3.2*.

Figure 3.1 *Catalog Sequence Recipe Screen*

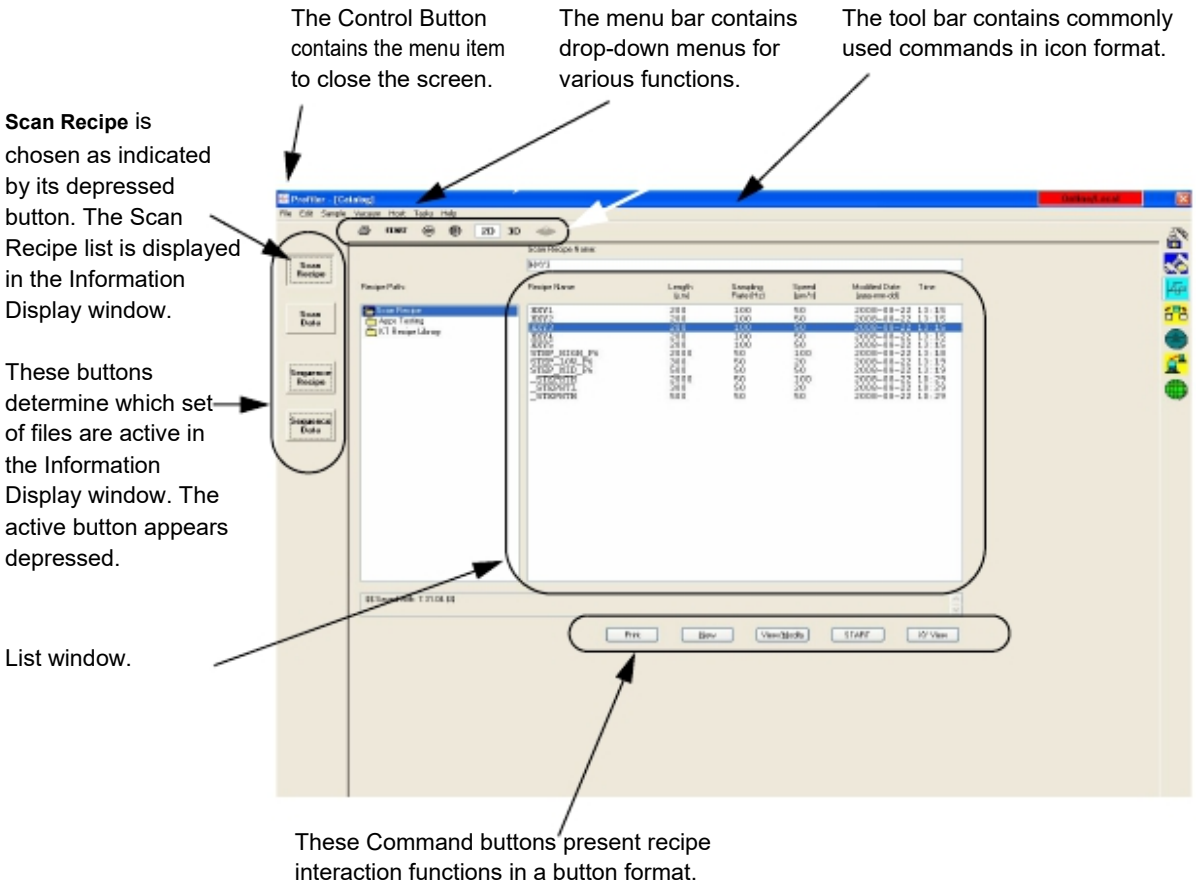
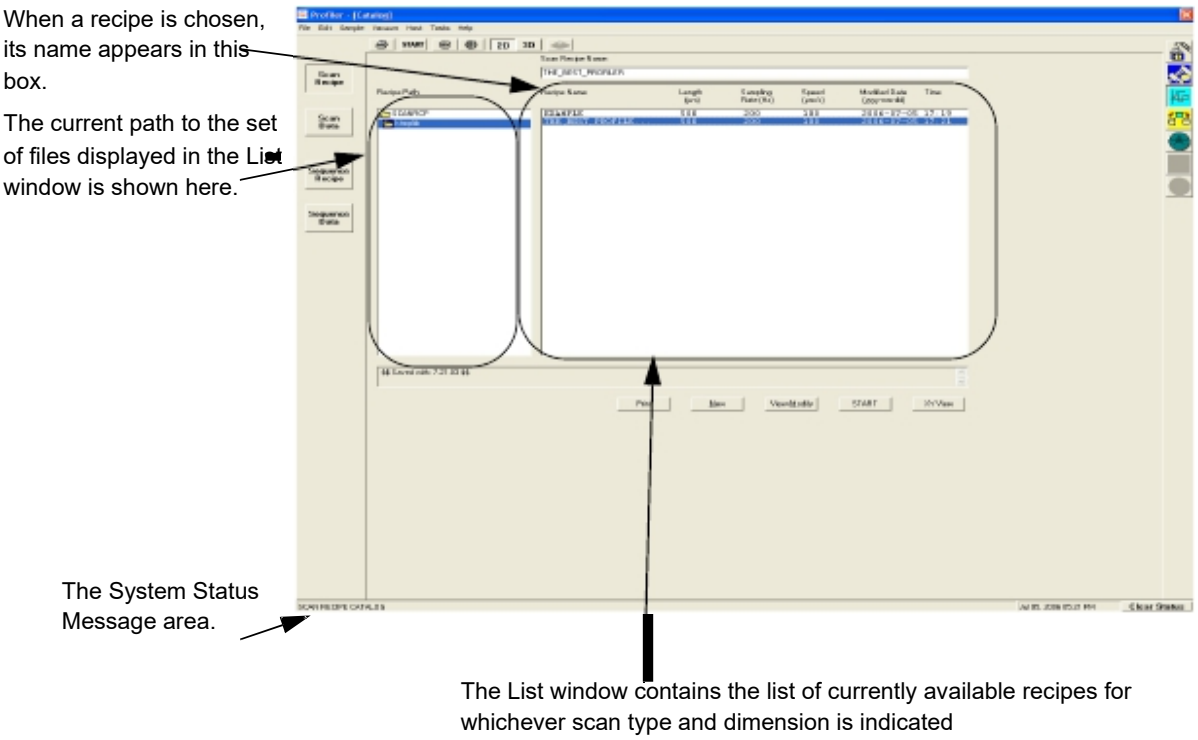


Figure 3.2 *Catalog Sequence Recipe Screen*



If the Scan Recipe button is not chosen, click it. After the **Scan Recipe** button is clicked, the List window changes to the Scan Recipe list. The Scan Recipe screen is divided into functional **components**. Each is discussed in the following section, *Scan Recipe Catalog Screen Components* on page 3-3.

SCAN RECIPE CATALOG SCREEN COMPONENTS

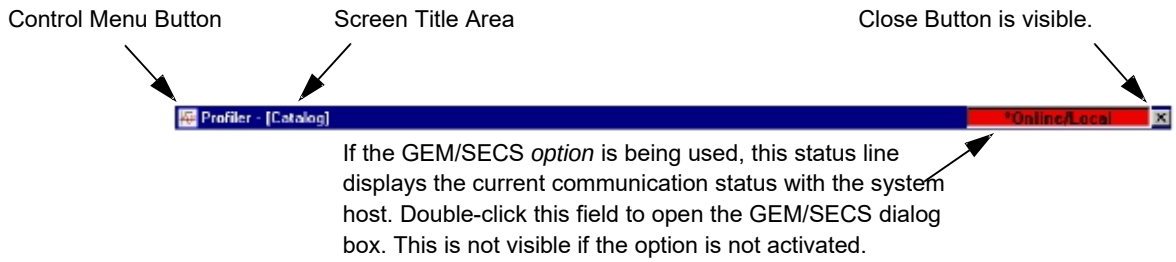
Screen Tools

The Catalog Screen Tools section is divided into three parts: Title Bar, Menu Bar, and the Tool Bar. An additional tool bar is located below the List window and is discussed in *List Window* on page 3-10.

Title Bar

The Title Bar contains the Control menu button, the Screen Title Bar, and the Close/Minimize icons (see *Figure 3.3*) or the GEM Status for systems equipped with the GEM/SECS option.

Figure 3.3 *Title Bar for Catalog Screen*



- **Screen Title Area:** This identifies the current active screen. (See ***Figure 3.3***.) It is not interactive.
- **GEM/SECS Status Display (*Optional Feature*):** This area displays the current GEM status. To view the **GEM Status** dialog box double-click the **GEM Status Display**. (See *Figure 3.3*.) Settings in the dialog box should only be changed by those with a thorough knowledge of GEM/SECS functions in the system.

CAUTION: Only system engineers familiar with the GEM operation should change any settings in the GEM Status dialog box. Changing these settings could disrupt processing.

The following table presents the possible GEM Status messages and the significance of each message.

Table 3.1 *GEM Status Display*

GEM STATUS	Description
Online/Local	**Online** -The P-17/P-7 Profiler system is in the operating mode. **Local** - In this state, the P-17/P-7 Profiler system is controlling its own activity.
Online/Remote	**Online** -This P-17/P-7 Profiler system is in the operating mode. **Remote** - In this state, control of the P-17/P-7 Profiler system comes from the host.
GEM Offline	This means that the GEM communication link is suspended.
GEM Disabled	This means that the communication link is temporarily disabled for a user defined purpose.

Menu Bar

The following tables present the content of each drop-down menu in the **Menu Bar** for the **Scan Recipe Catalog** screen.

NOTE: One or more of the menu options in a given drop-down menu might be grayed out. This can be due to the permission status of the operator currently logged onto the system, it being an option that is not currently available because it requires other system options to be enabled before use, or the option's unavailability at this stage in the procedure.

.

Figure 3.4 ***Menu Bar*** *for* **Scan Recipe** *Screen*

Table 3.2 ***Edit*** *Menu Options Description*

Edit Menu	Description
	New This opens the Recipe Editor screen with an untitled recipe that is using the format of the highlighted recipe in the catalog screen. The recipe title is "UNTITLED" until the new recipe parameters are set and it is saved with a new name.
	View/Modify This opens the Recipe Editor screen displaying the parameters of the recipe that is highlighted on the **Scan Recipe** screen.
	2D This displays the 2D list of Scan Recipes in the Catalog display area. (See *Figure 3.2*.)
	3D This displays the 3D list of Scan Recipes in the Catalog display area. (See *Figure 3.2*.)

Table 3.3 ***File*** *Menu Options Description*

File Menu	Description
	START Starts the currently highlighted scan procedure. The screen changes to the scan screen. In the screen depicted in *Figure 3.2*, it would start the **_STEPHTH** recipe scan.
	Teach Die Grid (Supported on the P-17 with the pattern recognition option) Opens the Teach Die Grid procedure in the XY View Screen.
	XY view Brings up the XY View screen, which is the typical scan screen.
	Print Brings up the Print Manager for printing recipes.
	Exit Exits the Scan screen. This sometimes prompts the display of dialog box asking if the current changes are to be saved.

Table 3.4 *Sample Menu Options Description*

Sample Menu	Description
	Manual Load This moves the sample stage to the Stage Door of the system (the manual load door) so a sample can be manually loaded onto the stage.

Table 3.5 *Vacuum Menu Options Description*

Vacuum Menu	Description
	Off This button is inactive in the P-17/P-7 Profiler because the Vacuum switch is manual.
	On This button is inactive in the P-17/P-7 Profiler because the Vacuum switch is manual.

Table 3.6 *Host Menu Options Description (Only available with GEM/SECS Option)*

Host Menu	Description
	Go Offline This takes the P-17/P-7 Profiler system offline. This is used to prevent the system from responding to a host during a user defined operation.
	Attempt Online This attempts contact with the host to open the system communication link. The system then operates according to its predetermined GEM parameters.
	Local This is an Online state where there is communication with the Host but in which the P-17/P-7 Profiler system controls the system's operation.
	Remote This is an Online state where there is communication with the Host and in which the host controls the P-17/P-7 Profiler system operation.

Table 3.7 *Diagnostics Menu Options Description*

Diagnostics Menu	Description
	ARAMS - This function is not used by P-17 / P-7 systems.

Table 3.8 *Loadport Menu Options Description*

Loadport Menu	Description
	Loadport - This function is not used by P-17 / P-7 systems.

Table 3.9 *Task Menu Options Description*

Tasks Menu	Description
	Configuration - Link to the Configuration page. **Calibration** - Link to the Calibration page. **Scan Catalog** - Link to the Scan Catalog. **Database Catalog** - Link to the Database Catalog. **Stress** - Link to the Stress Function (optional feature). **Gem-Secs -** Link to the GEM-SECS function (optional feature). **Defect Review** - Link to the Defect Review function (optional feature).

ToolBar

The ToolBar has eight icons that work as short cuts to functions.

Figure 3.5 *ToolBar Icons*

The function of each icon is described in *Table 3.10*.

Table 3.10 *ToolBar for the Scan Recipe Catalog Screen*

ToolBar Icon	Description
	Prints the currently highlighted recipe.
	Starts a scan using the highlighted recipe in the List window.
	Switches to XY View screen with the current recipe active, ready for a scan to be run.
	Switches to the XY View screen to teach Die Grid (P-17 Only with Optional Pattern Recognition Feature).
	Displays the following in the List window: ◆ 2D Scan Recipes, when in the **Scan Recipe Catalog** screen; ◆ 2D Sequence Recipes, when in the **Sequence Recipe Catalog** screen
	Displays the following in the List window: ◆ 3D Scan Recipes, when in the **Catalog Scan Recipe** screen; ◆ 3D Sequence Recipes, when in the **Catalog Sequence Recipe** screen.
	Launches Apex application and sends the current file to Apex in a separate window.

Catalog Screen Access Buttons

The Catalog screen presents access to four sets of information. The Scan Recipe and the Sequence Recipe screen, provide access to the currently defined recipes available for execution in the P-17/P-7 Profiler system. Two data screens provide access to saved Sequence and Scan data file information.

Table 3.11 *Catalog Screen Access Buttons*

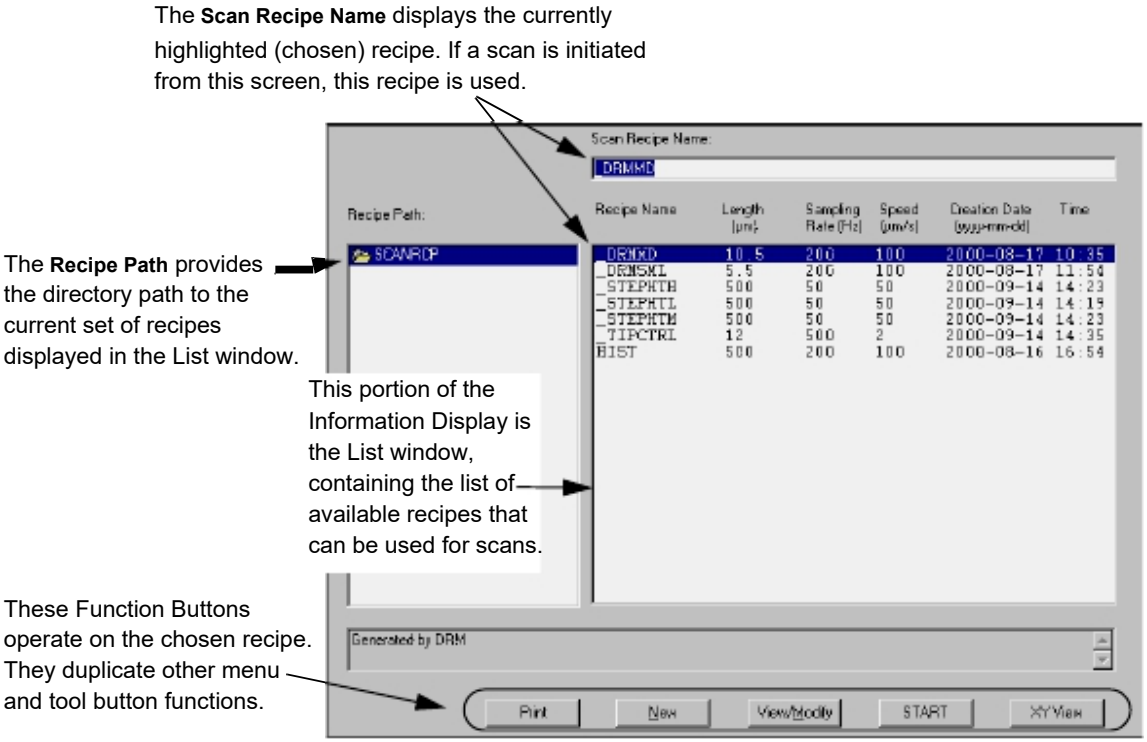
Tool Bar Icon	Description
	This button displays the list of currently available Scan Recipe folders, which when chosen, display their recipes in the Catalog screen's List window. (See *Figure 3.2*.)
	This button displays the list of currently available Scan Data folders, which when chosen, display their data set in the Catalog screen's List window. (See *Figure 3.2*.)
	This button displays the list of currently available Sequence Recipe folders, which when chosen, present their recipes in the Catalog screen's List window. (See *Figure 3.2*.)
	This button displays the list of currently available Sequence Data folders, which when chosen, present their data sets in the Catalog screen's List window. (See *Figure 3.2*.)

List Window

List Window for Scan Recipe

When the **Scan Recipe** button is clicked, the List Window displays the Scan Recipe information and associated function buttons. (See *Figure 3.6*.)

Figure 3.6 *Scan Recipe information in the List Window*



Recipe Path Display

This area is used for navigating to a particular folder of recipes in a directory. The recipes in the List window are contained in the highlighted folder in the Recipe Path display.

Scan Recipe Name Display

This field contains the name of the currently chosen scan recipe. The recipe is chosen by clicking on a recipe in the List window so that the recipe highlights. (See *Figure 3.6*.) The recipe in the **Scan Recipe Name** display is designated to be the *current* recipe. If the **START** button, at the bottom of the Information Display window (see *Figure 3.6*), or the **START** button in the Scan Recipe Catalog tool bar (see *Figure 3.5* and *Table 3.10*), is clicked, a scan is performed using the *current* recipe.

Recipe List Window

This area contains the list of scan recipes that have been created for the various types of scans used by the system. Scan Recipes are categorized into 2D Scan recipes and 3D Scan recipes. The recipes are accessible by clicking on either the 2D button or the 3D button in the tool bar at the top of the screen. (See *Figure 3.7*.) To determine which list is active, look at the 2D and 3D buttons. The active buttons appear to be depressed and highlighted. The inactive buttons appear extruded outward. (See *Figure 3.7*.)

Figure 3.7 *Tool Bar Buttons*

The **2D** button appears depressed and

The **3D** button appears extruded and normal, showing that it is not active.

When a recipe in the current list is clicked on, it highlights and its name appears in the **Scan Recipe Name** display box at the top of the Information Display Window. In addition, the current recipe is featured in the Scan Recipe Editor screen that appears when the **View/Modify** button (a function button under the Information Display window) is activated. (See *Figure 3.6*.)

Function Buttons - Scan Recipe List Window

The function buttons, located at the bottom of the Information Display window, operate on the recipes in the recipe List window. If the button is not accessible, it appears as a 2D object, not 3D, and it is grayed out. Buttons might be inaccessible because:

- The system is operating in a Security level that does not grant the current Log On access permission to perform the corresponding function, or
- A preceding (or set-up) activity is required before the function can be activated.

Table 3.12 *Scan Recipe List Window Function Access Buttons*

Function Icon	Description
	This prints the currently highlighted Recipe. This function is also performed by the printer icon in the tool bar.
	This opens the Recipe Editor for the creation of a New recipe. In the recipe editor, the title is "UNTITLED" until the recipe is named. The recipe content contains the default parameters. The same function is also found in the Edit menu under New.
	This opens the Recipe Editor allowing modification of the currently highlighted recipe. The same function is also found in the Edit menu under View/Modify.

Table 3.12 Scan Recipe List Window Function Access Buttons (Continued)

Function Icon	Description
	This opens the real-time display screen and begins the scan procedure associated with the currently highlighted scan recipe. This function is also performed by the START button in the tool bar at the top of the screen.
	This opens the XY View screen with the currently highlighted recipe in place to teach a scan. This function is also performed by the XY Icon in the tool bar at the top of the screen.

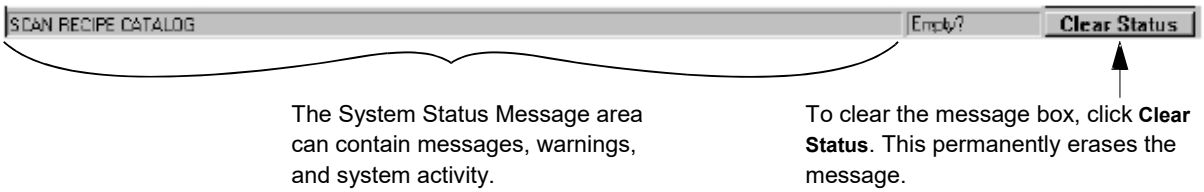
System Status Message

This portion of the screen contains current system status messages. These messages can contain any of the following:

- Instructions to the user.
- Warnings or Cautions
- Current system activity.

It is important to check this field for system information if the system appears to be stalled or inactive. This message field can contain valuable information for system troubleshooting.

Figure 3.8 System Status Message Field



CREATING AND EDITING A SCAN RECIPE

This section presents the procedure for creating a Scan Recipe. Included are:

- Accessing the Scan Recipe Editor where the recipe is created
- A description of the parameters required to create a recipe
- Naming the New Recipe
- Testing the New Recipe

Accessing the Scan Recipe Editor

The actual creation of a scan recipe is performed in the Editor screen. This means that recipe creation and editing is restricted to those whose password permits access to the Recipe Editor. Use the following procedure to access the Recipe Editor screen:

1. Open the Profiler Catalog screen. (See *Table 3.10*.)
2. Choose the **Scan Recipe** button to display the Scan Recipe catalog.
3. Choose 2D or 3D scan recipes by clicking on the appropriate icon.
4. Click **New**, located among the function buttons at the bottom of the Information Display window. In the **Scan Recipe** list, a recipe is highlighted in the list. This has no effect on a **New** recipe. The new recipe is generated using default parameters.
5. Click **New**, located among the function buttons at the bottom of the Information Display window.

Recipe Editor for 2D and 3D Scans

Introduction

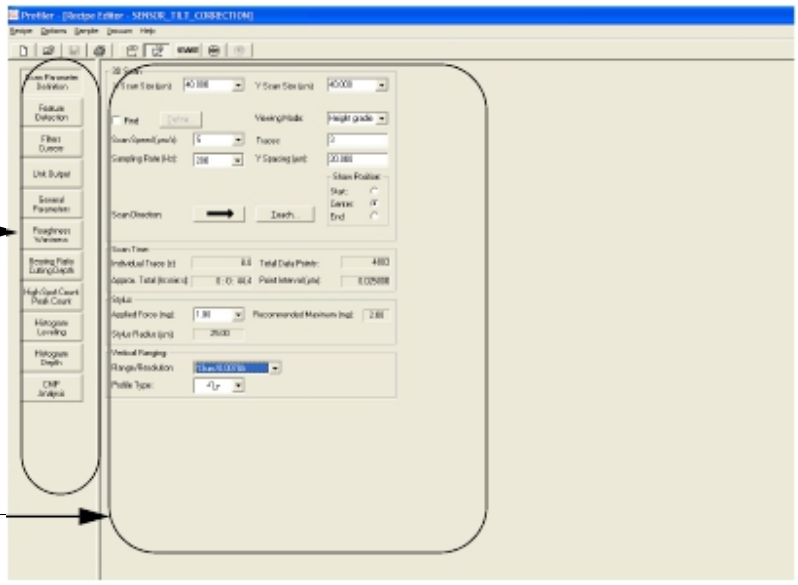
When **New** is clicked, the **Recipe Editor** appears with an UNTITLED recipe. (See *Figure 3.9*.) The UNTITLED recipe contains the default scan parameters. The **Recipe Editor** has eight windows for the 2D recipes and nine for the 3D recipes that, together, contain all the variable scan recipe parameters. Each of these windows is accessed through its own access button on the left side of the **Recipe Editor** Screen. (See *Figure 3.9*.) These windows are discussed one at a time, starting with the top button and working down, until all the parameters required for defining a recipe are explained.

Figure 3.9 *Recipe Editor for a 2D UNTITLED Recipe*

The Title bar shows that the recipe name is currently **UNTITLED** and the screen is **Recipe Editor**.

Each Parameter button displays its parameters in the Information Display window.

The Information Display window contains the parameter set related to the currently activated Parameter button. The current Parameter button appears to be indented, as the **Scan Parameter Definition** does in this illustration.



Scan Parameter Definition Window

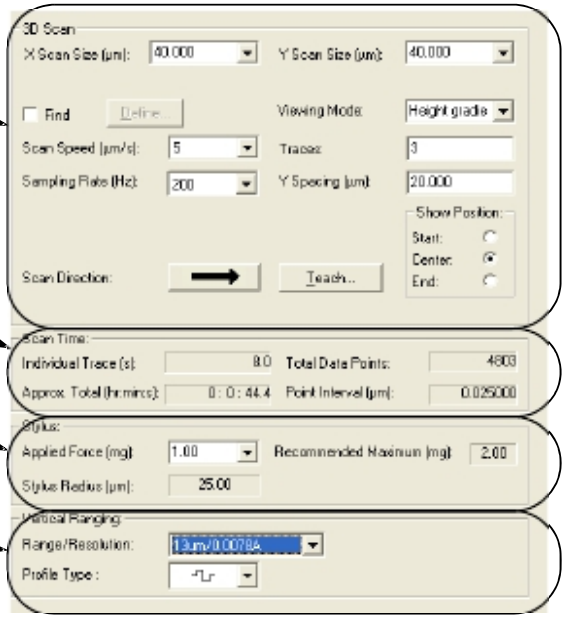
Figure 3.10 *3D Parameters in the Information Display Window*

3D Scan contains scan characteristics. (The 2D version contains fewer variables.)

Scan Time category contains parameters that are results of above actions.

Stylus category contains Stylus force and size parameters.

Vertical Ranging category contains vertical size (height, depth and scan profile of the scan.)

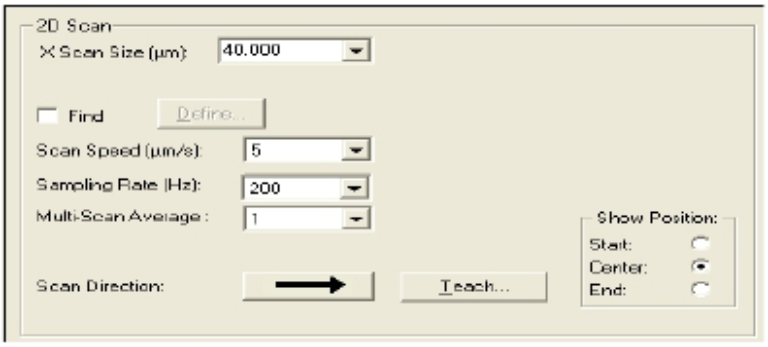


The **Scan Parameter Definition** button displays four categories of 2D or 3D scan parameters: **2D Scan** or **3D Scan**; **Scan Time**; **Stylus**; and **Vertical Ranging**.

2D Scan Category Parameters - Scan Parameters Definition

The parameters defined in this category deal with the actual mechanics of the 2D scan. Each is discussed in *Figure 3.11*.

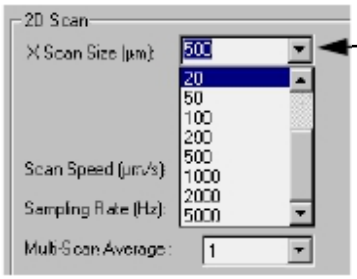
Figure 3.11 *2D Scan Category Parameters*



1. **X Scan Size (µm)**. This variable sets the **length** of the actual scan. It is set in one of two ways: drop down and user definable.

NOTE: The scan length can also be changed when using the Teach function. See Step *3. on page 3-20* for more details. See the Note.

Figure 3.12 *X Scan Size (µm)*



Step 1 Click the menu arrow to display the drop-down menu. To choose the number of microns (µm) in the scan length, click the appropriate number.

2. **Scan Speed (μm/s)** - This parameter sets the speed at which the scan is performed. It has a range between **1 μm/s** and **25000 μm/s**, with numerous options within this range displayed in its drop-down menu and is not user-definable.

NOTE: For short scans, 2mm and smaller, the general rule of thumb is to keep the scan time between 5 and 10 seconds. This is shown in the recipe and can also be determined by dividing the scan length by the scan speed. This rule does not always apply, such as when using the 2 μm HAR stylus with a 50 μm/sec scan speed reccomended limit. This rule also generally does not apply for long scans of the substrate, typically performed for stress measurements.

CAUTION: When scanning soft material (e.g., copper, aluminum, and photoresist) it might be required to reduce the applied force and scan speed.

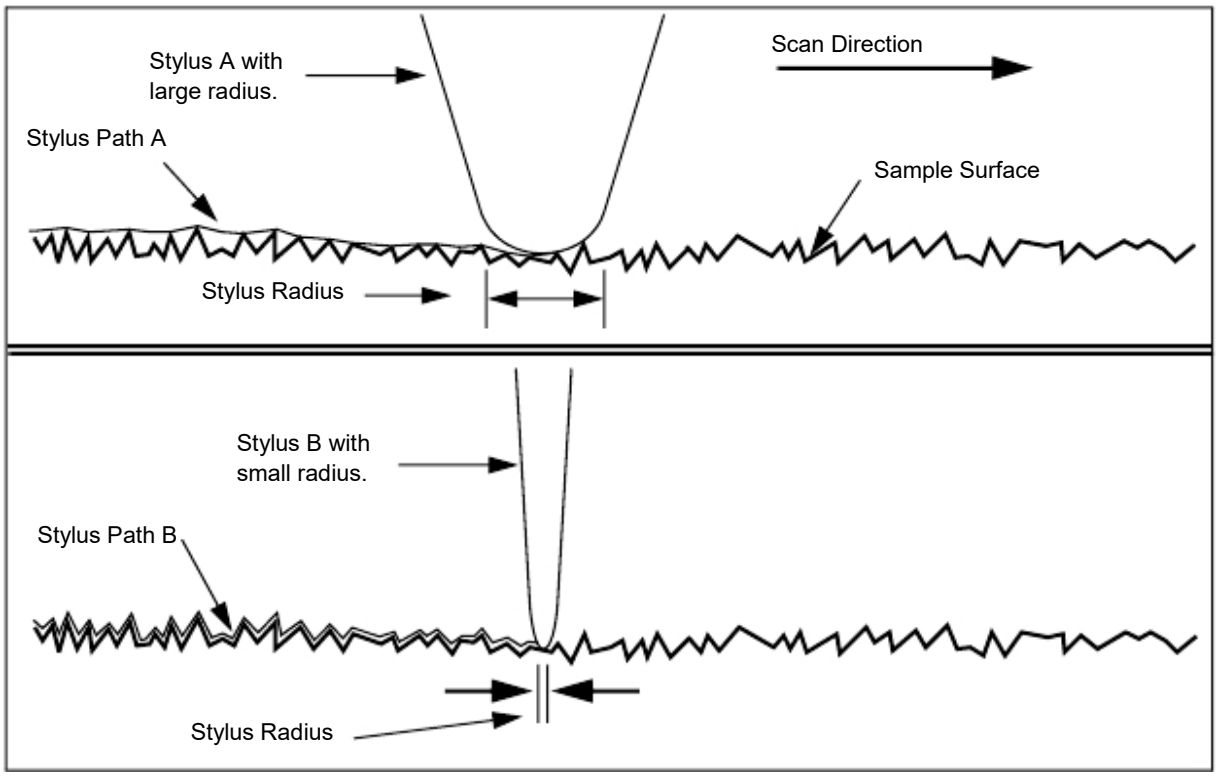
CAUTION: If the scan speed is set too fast when using a small applied force, features might be missed or inaccurately traced.

3. **Sampling Rate (Hz)** - is the frequency at which data points are collected. The Sampling Rate sets the number of data points that are collected per second during a scan. *Figure 3.13* illustrates the impact of stylus radius in generating a scan trace

NOTE: Optimal Sampling Rate is between 50 and 200 Hz.

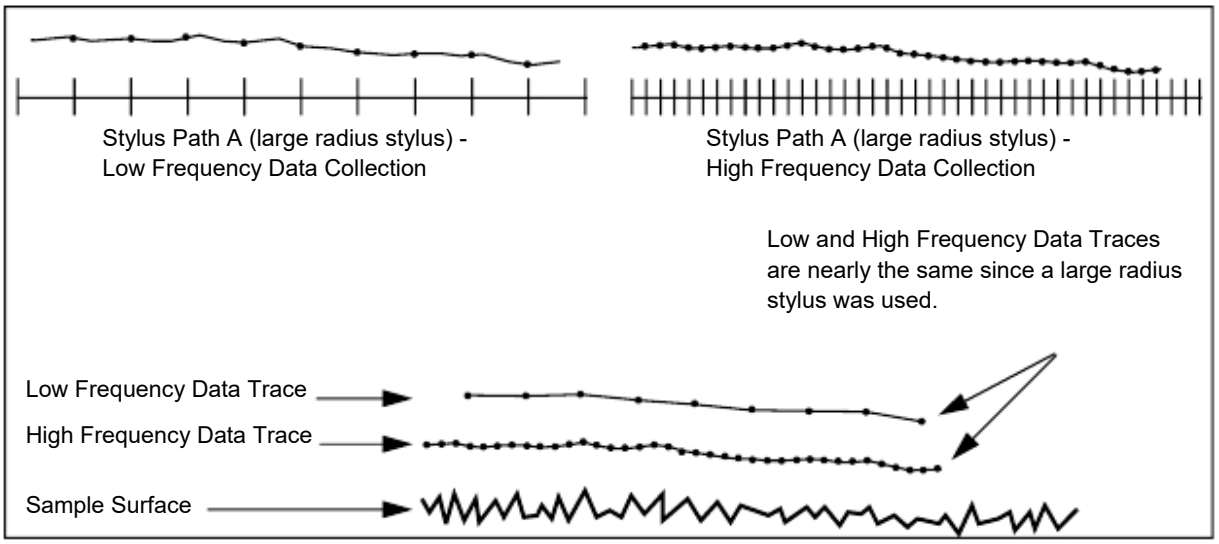
Figure 3.13 illustrates the impact of stylus radius in generating a scan trace..

Figure 3.13 *Scan Trace Comparison - Large vs. Small Stylus Radius*



Comparing the Scan Path of the large radius stylus and the small radius stylus, assessment can be made regarding the validity of higher frequency data collection. In general, the larger radius styli do not detect the smallest features. They give traces that can resemble a statistical average.

Figure 3.14 *Data Collection When Using a* ***Large Radius*** *Stylus*



If the Stylus chosen is small enough to detect the features of interest in the scan, then a sampling rate and scan speed should be optimized to accurately record the level of detail required from the scan.

Figure 3.15 *Data Collection When Using a Small Radius Stylus*

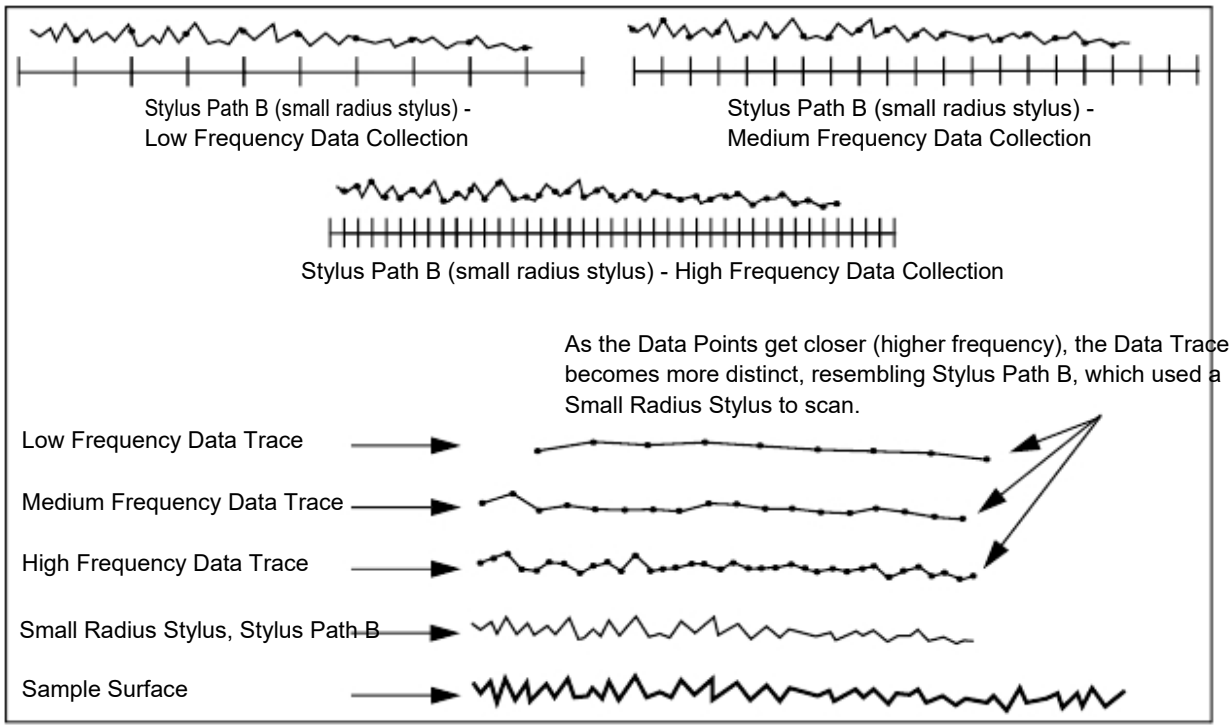
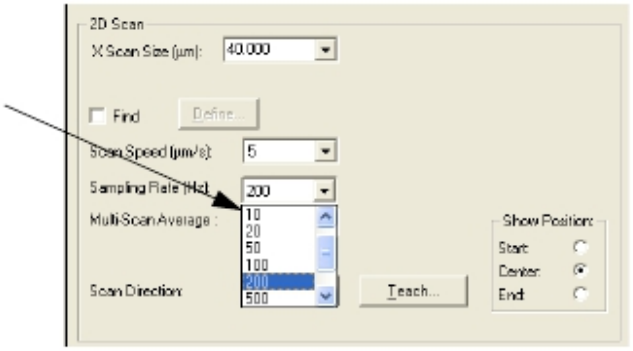
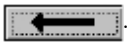


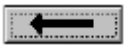
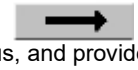
Figure 3.16 *2D Scan Options With Sampling Rate Menu*

Step 3 Click the menu arrow next to the **Sampling Rate** field.



1. **Multi-Scan Average** - This is a 2D option that allows the user to repeat a single scan up to 10 times so that the scan data can be averaged by the number of scans performed. This feature provides an opportunity to minimize the noise factors in a scan.
2. **Scan Direction - Arrow** - This option dictates the direction of the scan, from left to right  or from right to left  .

   ye Changing The Scan Direction: Click the arrow to cause it to point the opposite direction.

NOTE: DO NOT use  unless it is absolutely necessary. The recommended direction is left to right  because it gives better repeatability, protects the stylus, and provides better data.

3. **Scan Direction - Teach** - When the **Teach** button is clicked on, it opens in the XY View. This screen allows the user to set the scan position and scan size.
   a. Click the radio button next to the desired reference position, **Start, Center**, or **End**, that is to be established with respect to the scan feature in the **Teach Scan Length** screen. This can also be changed in the XY View to allow the user to view the start, middle, and end of the scan, which can be very useful when the scan size exceeds the field of view.

NOTE: The Reference Position is for user convenience only. The coordinates stored in the sequence recipe are the always scan center. This allows the user to change the scan size and have it expand or contract about the center of the feature.

*Table 3.13 **Show Position** Options*

Option	Description	Graphic Representation
Start	The **Start** setting is used in the Video portion of the XY view screen to position the start of the scan at the intersection of the Video screen crosshairs. Wherever the user clicks in the video image, that position becomes the starting scan position, and appears at the center of the Video screen, with the scan distance presented as an arrow.	Click here to position Start Outcome Scan Feature
Center	The **Center** setting is used in the Video portion of the XY view screen to position the center of the scan at the intersection of the Video screen crosshairs. Wherever the user clicks in the video image, that position becomes the center of the scan, and appears at the center of the Video screen, with the scan distance presented as an arrow.	Click here to position Center Outcome Scan Feature
End	The **End** setting is used in the Video portion of the XY view screen to position the end of the scan at the intersection of the Video screen crosshairs. Wherever the user clicks in the video image, that position becomes the end of the scan, and appears at the center of the Video screen, with the scan distance presented as an arrow.	Click here to position End Outcome Scan Feature

a.

b. Locate the desired feature in the XY View portion of the screen. Click the reference position (start, center, or end). The screen then positions the scan length arrow over the scan feature according to the chosen position. The reference position is at the center of the video screen crosshairs.

NOTE: When in the **Teach Scan Length** (XY view) screen, it is possible to change the scan length by clicking on a position in the video screen and dragging the new length. After changing the scan length, it is recommended to check the scan speed and sampling rate to ensure optimal performance..

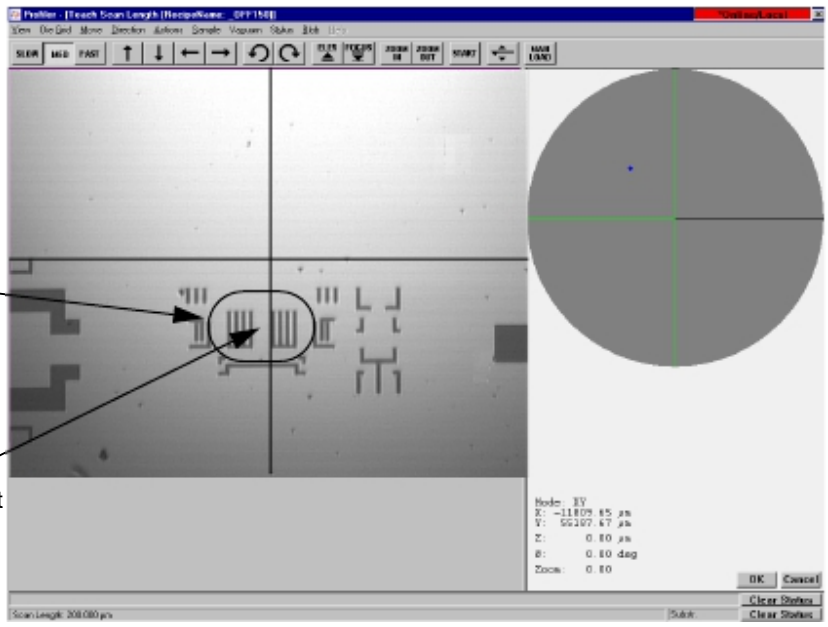
Figure 3.17 *Teach Scan Length, from the 2D Scan Teach Button*

With the feature in the field of view, click in the appropriate reference point (start, center, or end) for the scan. The system positions that point center screen and places the scan arrow over the scan in the appropriate place.

EXAMPLE: If the circled feature is to be scanned…

and the reference is set on **center**…

Click the center of the scan travel distance in the image and that point is positioned center stage with the scan trace through it.



3D Scan Category Parameters - Scan Parameters Definition

The parameters discussed in this section are those that are **additions to** or **differ from** the 2D parameters already presented. For information on parameters that are identical for 2D and 3D scans, see the descriptions in the 2D recipe section. (See *Table 3.14* for identification of which parameter settings are 2D or 3D.)

Table 3.14 *3D Scan Parameters Summary*

Parameter Setting	2D, 3D or Both	Description and Location
X Scan Size	Both	X direction scan length; Step *1. on page 3-15*.
Y Scan Size	3D	The length in the Y-direction through which the X-direction scans are made at each **Y Spacing** interval.
Scan Speed	Both	The speed at which the scan is performed.
Sampling Rate	Both	The rate at which data points on the scan are recorded for analysis.
Traces	3D	This is the number of scans that are made to encompass the Y-distance requirement.

Table 3.14 3D Scan Parameters Summary (Continued)

Parameter Setting	2D, 3D or Both	Description and Location
Multi-Scan Average	2D	The number of single identical scans which are performed and used to create a scan data set that represents the average of the scans.
Spacing	3D	This is the distance between X scans performed across the Y direction of the 3D scan area.
Scan Direction	Both	The direction in which the scan is performed.
Teach…	Both	Displays the **Teach Scan Length** screen that is used to determine the start, center or end of the scan. Can also be used to drag a new scan length.
Show Position	Both	Displays the current position and provides an opportunity to set a new position at which the scan, of scan length set in **X Scan Size**, is started, is centered, or ends.

Y Scan Size (µm)

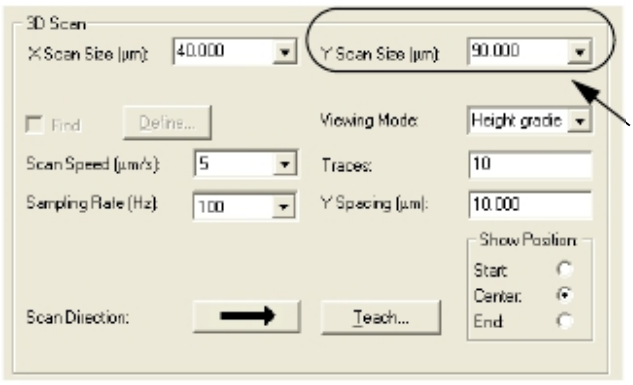
This parameter defines the size, in the Y-direction, of the 3D area to be scanned. It is the area across which the number of scans defined in the parameter **Traces** are divided up. (See *Figure 3.19 on page 3-24*.)

NOTE: If the variable in the **Spacing** parameter is changed, the **Y Scan Size** changes to accommodate the number of **Traces** at the new **Spacing** distance.

Setting or Changing Y Scan Size - Use one of the following procedures:

- Click the menu arrow to the right of the **Y Scan Size** field and click the desired size.
- Highlight the current number and type in the new number. (See also **Automatic Parameter Adjustment**: in Step *on page 3-24*.)

Figure 3.18 3D Scan Parameters

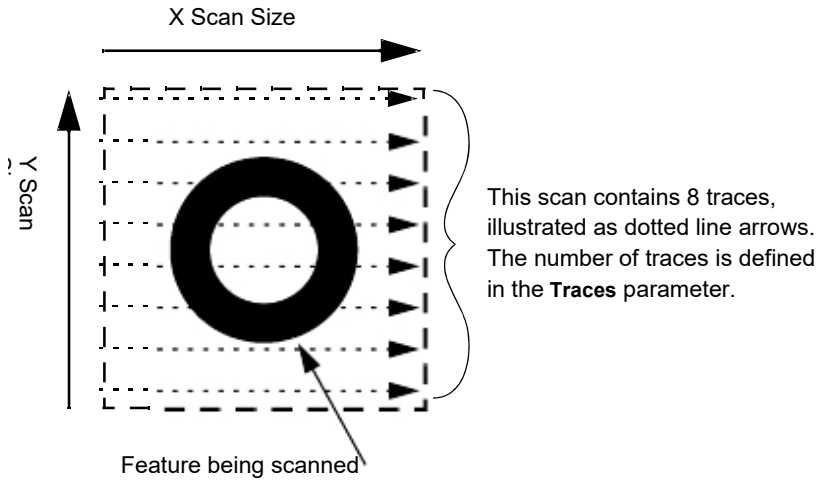


Set the **Y Scan Size** by clicking on the menu arrow and choosing the desired size, or by highlighting the current number and typing in the new number.

Traces

This assigns the number of scans that are made in the X-direction across the **Y Scan Size** direction. In *Figure 3.19*, the number in the **Traces** variable box would be **8**.

Figure 3.19 *Traces - Scan Perimeter with Traces*



If the **Y Scan Size** is set [Y Scan Size = (Traces -1) x Y Spacing], when the **Traces:** parameter is entered, the **Y Spacing** parameter automatically adjusts to reflect the appropriate spacing between scans.

Setting the Number of Traces: To change the number of **Traces** in a 3D scan, highlight the current **Traces** value and type in the new number of traces. (See also **Automatic Parameter Adjustment**: in *Y Spacing (mm)* on page 3-24.)

NOTE: The first trace occurs at y = 0 µm. Setting the number of traces to an odd number ensures that the y-spacing will be an even number. For example, a 100 µm y-size and 11 traces produces 10 µm between each trace.

Y Spacing (µm)

This variable sets the distance in the Y-direction between X-direction scan traces in a 3D scan. The spacing is very important to final 3D data collection set because, together with the stylus radius, it determines the essential resolution of the feature that is scanned.

Consider to following example: If the distance between scans is too great with respect to the stylus radius, important variations in the scanned feature might be missed.

Automatic Parameter Adjustment: - In general, a connection exists in the software such that, when certain parameters are changed, other parameters are readjusted to accommodate the changes. The adjustments occur between the **Y Scan Size**, **Traces**, and **Y Spacing** parameters. After setting a parameter, the user might click on the other parameters and notice a minor adjustment to the parameter that had just been set. This happens to balance the numbers between **Y Scan Size**, **Traces**, and **Y Spacing**.

Show Position - For 3D scans, the three options in this box are used for positioning the scan area parameters box.

***Table 3.15 Show Position** Options*

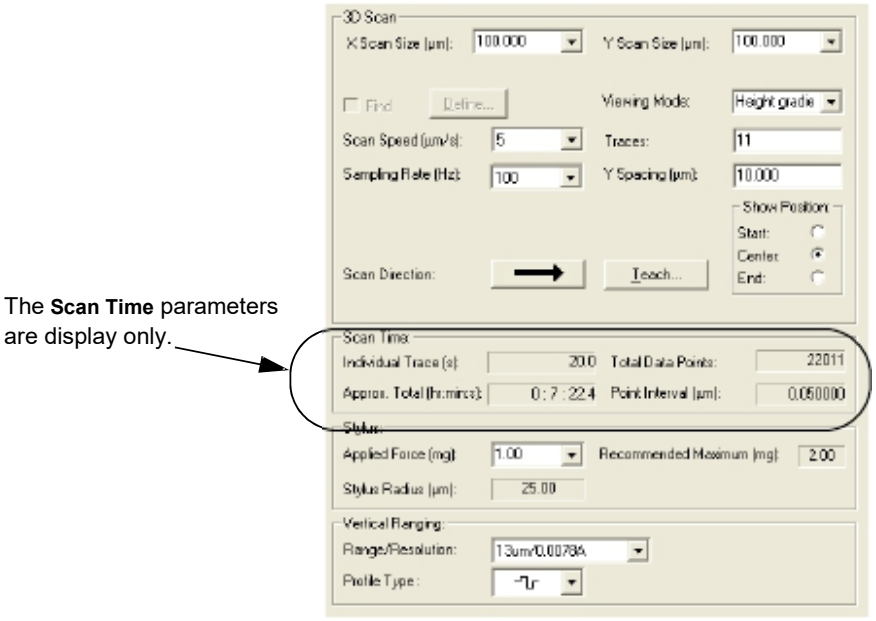
Show Position Option	Description	Graphic Representation
Start	The **Start** setting is used in the Video portion of the XY view screen to position the upper left corner of the scan area box in the Video screen crosshairs. Wherever the user clicks in the video image, that position becomes the upper left corner of the scan area box, and appears at the center of the Video screen. This is not the actual place where the scan starts. **Start** only defines the upper left corner of the scan area box. Literal START is near the lower left corner.	Click here to position Start x Outcome Scan Feature
Center	The **Center** setting is used in the Video portion of the XY view screen to position the center of the scan area box in the center of the Video screen crosshairs. Wherever the user clicks in the video image, that position becomes the center of the scan area box, and appears at the center of the Video screen.	Click here to position Center x Outcome Scan Feature
End	The **End** setting is used in the Video portion of the XY view screen to position the lower right corner of the scan area box in the center of the Video screen crosshairs. Wherever the user clicks in the video image, that position becomes the end of the scan area box, and appears at the center of the Video screen. This is not the actual place where the scan ends. **End** only defines the lower right corner of the scan area box. Literal END is near the upper right corner.	Click here to position End Outcome x Scan Feature

Scan Time Parameters (2D and 3D) - Scan Parameters Definition

The **Scan Time** parameters box displays time and data point values, broken down into general components. (See *Figure 3.20*.) No values can be set or defined in this portion of the screen. These values are read only because they are determined by parameters set in other fields.

NOTE: These values are system generated from parameters set in other fields.

Figure 3.20 *Scan Time - Scan Parameters Definition*



Individual Traces (s)

This defines the number of seconds required to complete one scan. This time parameter divides **X Scan Size (µm)** by **Scan speed (µm/s)** and adds the result to the approximate **move time**.

For 2D and 3D **[X Scan Size / Scan speed] + move time = Individual Traces (s)**

Total (hr:min:s) - This is the total time that it takes to complete the set of scans defined in the scan recipe section, **2D** or **3D Scan**.

Number of Data Points: - This is the total number of scan data points collected during the scan.

For 3D **[(X Scan Size / Scan Speed) x Sampling Rate x Traces] + the number of traces = Number of Data Points**

For 2D **[X Scan Size / Scan Speed] x Sampling Rate x Multi-Scan Average = Number of Data Points**

Point Interval

Point Interval is the distance between data points in the X-direction of each trace.

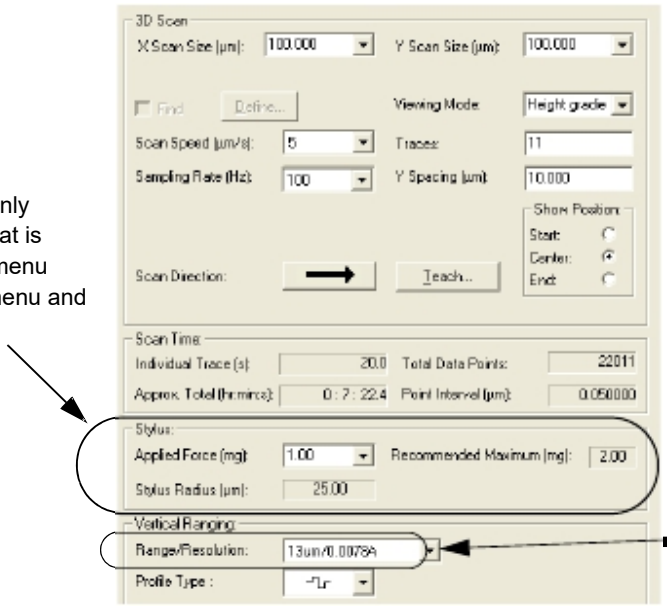
For 2D and 3D **Scan Speed (µm) / Sampling Rate (Hz) = Point Interval:**

Stylus Parameters (2D and 3D) - Scan Parameters Definition

The **Stylus** parameters box contains those variables that deal with the stylus operation. Only the Applied force variable is accessible for change in this screen.

Figure 3.21 *Stylus Parameters (2D and 3D)*

Applied Force is the only parameter in **Stylus** that is adjustable. Click the menu arrow to display the menu and choose the force.



13 µm is SR sensor low gain range

Applied Force (mg)

This is the force exerted by the stylus on the sample surface. With each different stylus radius there are recommended limits that should be taken into consideration when setting the **Applied Force**. The **Applied Force** should not exceed the recommended maximum force.

Changing the **Applied Force** setting:

Table 3.16 *Stylus Force Ranges for the Different Head Configurations*

MicroHead V LF	MicroHead V SR	MicroHead V XR
0.05-50 mg	0.5-50 mg	0.5-50 mg

1. Click the menu arrow next to the variable box to display its menu.
2. Click the desired force setting.

Stylus Radius (μm)

Stylus Radius is the manufacturers stated radius of the stylus. The stylus radius cannot be changed in this screen.

CAUTION: Recommendations and limits are only correct if the "Stylus Change Procedure" was followed when the stylus was installed.

Use the Stylus Change Procedure to change the stylus radius setting. (See Stylus Change Procedure on page 1.)

Recommended Maximum (mg)

Each stylus type is associated with a maximum applied force setting. The maximum setting is deemed to be safe for the stylus and the sample while performing normal scans. This force should not be exceeded.

Vertical Ranging Parameters (2D and 3D) - Scan Parameters Definition

Vertical Ranging contains two parameters: **Range/Resolution** and **Profile Type**. These two parameters are used together to set up the system for:

- Range: The maximum feature measurement limit (theoretical), up or down, that is considered when scanning for a feature,
- Resolution: The theoretical vertical resolution of the electronics.

Three set of ranges are available. The primary differences between the ranges are in their resolution capabilities, and the ability in the 131 μm, 327 μm, and 1000 μm range to set the direction in which the range is applied. The ranges are described below.

Range/Resolution

This parameter sets the maximum size limit of the features that can be scanned in each given range, and the minimum feature size that can be resolved (positively detected). Three ranges are available. (See *Table 3.17*.)

Table 3.17 *Range and Resolution Scan Parameters for the* ***MicroHead V LF*** *Head*

Vertical Range (μm)	Resolution (Å)
± 3.2 (6.5 total)	0.004
± 13 (26 total)	0.016
± 65 (131 total)	0.08

Table 3.18 *Range and Resolution Scan Parameters for the* ***MicroHead V SR*** *Head*

Vertical Range (μm)	Resolution (Å)
± 6.5 (13 total)	0.008
± 32 (64 total)	0.04
± 173 (327 total)	0.2

Table 3.19 *Range and Resolution Scan Parameters for the* ***MicroHead V XR*** *Head*

Vertical Range (μm)	Resolution (Å)
± 6.5 (13 total)	0.008
± 65 (131 total)	0.08
± 500 (1000 total)	0.6

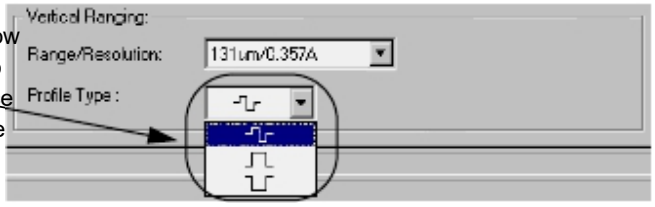
NOTE: The Resolution numbers in *Table 3.17*, *Table 3.18*, and *Table 3.19* are theoretical. Noise levels effect the resolution.

Saturated Data Points

If, in the course of a scan, the upper limit of any one of the ranges is reached, the system aborts the scan and a message is issued reporting that there are too many saturation data points. The scan appears as complete, however, the end of the trace is only a continuation of the last data point, not actual scan data.

Figure 3.22 *Vertical Ranging - Profile Types*

For the 131, 327, and 1000 µm ranges, the three Profile Types allow the user to choose features that go up or down from the sample surface the full range, or split the difference between up and down features.



Profile Type: ***Available choices for each range and the resultant scan traces***

Table 3.20 *Profile Types*

Profile Type	Range	Description
	131 µm 327 µm 1000 µm	131 µm scans features that are approximately **52 µm up** or **down** from the scan's starting point. 327 µm scans features that are approximately **130 µm up** or **down** from the scan's starting point. 1000 µm scans features that are approximately **400 µm up** or **down** from the scan's starting point.
	64 µm	This scans features that are approximately **26 µm up** or **down** from the scan's starting point.
	26 µm	This scans features that are approximately **10 µm up** or **down** from the scan's starting point.
	13 µm	This scans features that are approximately **5 µm up** or **down** from the scan's starting point.
	6.5 µm	This scans features that are approximately **2.5 µm up** or **down** from the scan's starting point.
	131 µm 327 µm 1000 µm	131 µm scans features ≈ **100 µm up** from the scan's starting point. 327 µm scans features ≈ **240 µm up** from the scan's starting point. 1000 µm scans features ≈ **750 µm up** from the scan's starting point.

Table 3.20 *Profile Types (Continued)*

Profile Type	Range	Description
	131 μm 327 μm 1000 μm	131 μm scans features ≈ **100 μm down** from the scan's starting point. 327 μm scans features ≈ **240 μm down** from the scan's starting point. 1000 μm scans features ≈ **750 μm down** from the scan's starting point.

Feature Detection (Only for 2D Scans)

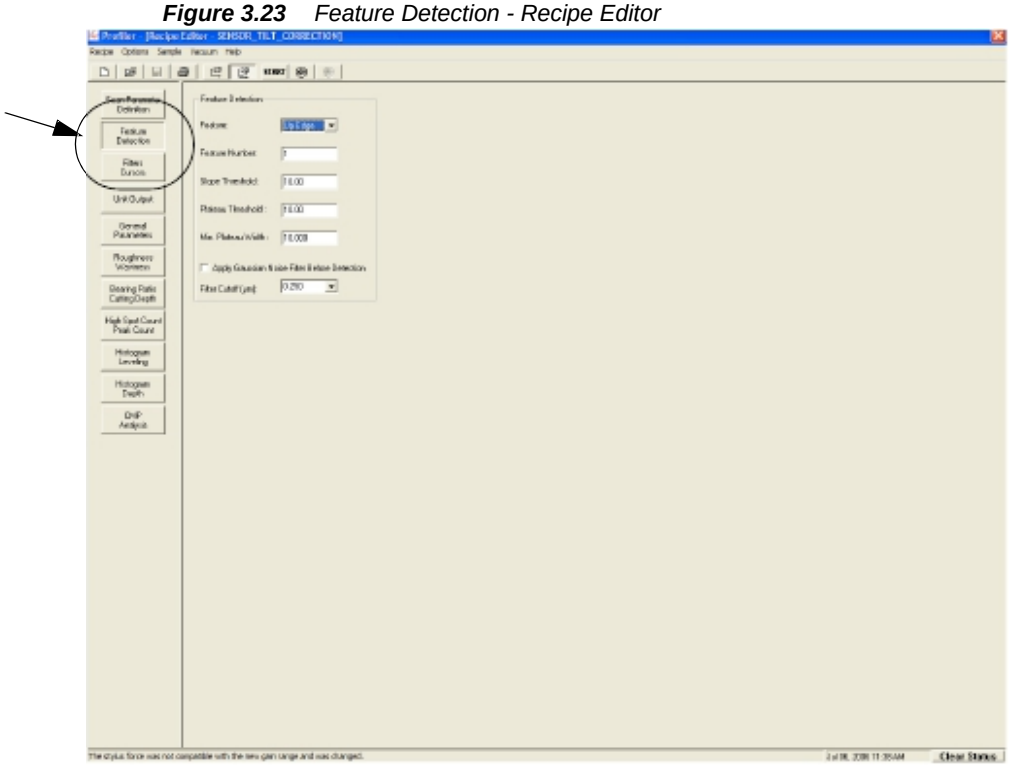
Feature Detection is used to enable automatic detection of some common classes of profile features (see *Figure 3.24* and *Figure 3.25*). Feature detection makes it possible to automatically and reliably set the position of the measurement and leveling cursors relative to the rising and falling edge of a step-like feature or the apex of an arc-like feature.

In conjunction with feature detection, both the location of the edge (or the apex of an arc) and the step width can be calculated and displayed in the Analysis window for up edge, up base, down edge, down base, and Bump. Convex, concave, and Model Feature Detection do not support feature width calculations since they only detect one point in the scan..

Accessing the Feature Detection parameters:

In the **Recipe Editor,** click the **Feature Detection** button. (See *Figure 3.23.*) For information on how to display the **Recipe Editor**, see Accessing the Scan Recipe Editor on page 13.

Figure 3.23 *Feature Detection - Recipe Editor*



Feature

This parameter allows the user to choose between six different features that can be detected and identified during a scan.

Figure 3.24 *Feature Detection Point Locations on a Step*

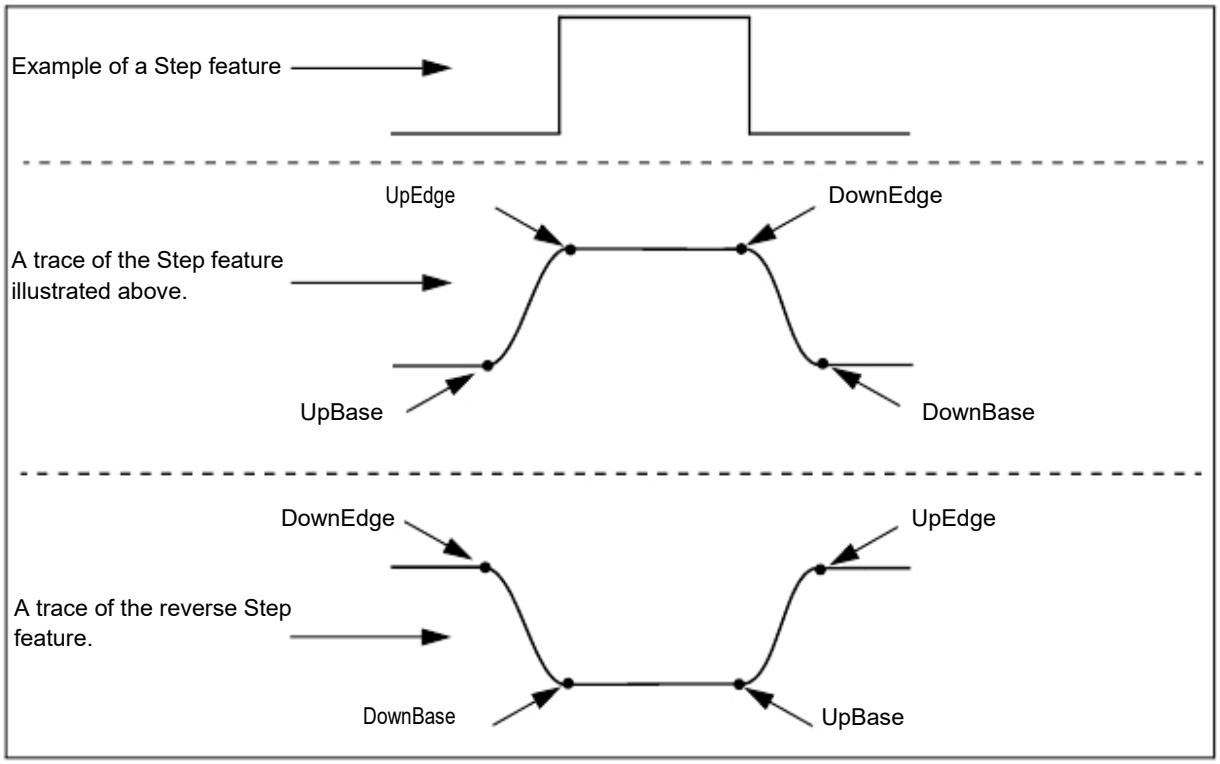


Figure 3.25 *Feature Detection Point Locations for Convex and Concave*

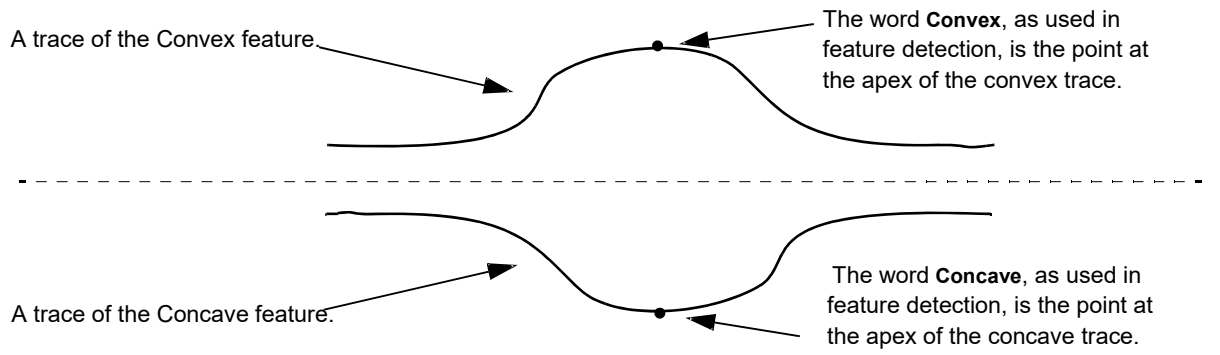


Table 3.21 *Feature Detection Descriptions (See Figure 3.24 and Figure 3.25.)*

Feature	Description
None	No feature detection is being used.
UpEdge	At the trailing edge of a feature rise, it is the point at which the trace begins the plateau. (See *Figure 3.24*.) **NOTE**: This point location can be modified by using **Distance to Edge** parameter in the **General Parameters** Window.
UpBase	At the trailing edge of a plateau, it is the point at which the trace begins to turn upward. (See *Figure 3.24*.)
DownEdge	At the trailing edge of a plateau, it is the point at which the trace begins to turn downward. (See *Figure 3.24*.)
DownBase	At the trailing edge of a feature decline, it is the point at which the trace begins the plateau. (See *Figure 3.24*.)
Convex	This is the point at the apex of a convex feature. (See *Figure 3.25*.)
Concave	This is the point at the apex of a concave feature. (See *Figure 3.25*.)
Bump	This is detection of a bump feature, similar to concave, except it supports width and height calculations common to solar cell lines and C4 bumps.
Model	This is detection of features that cannot be easily found with the other available algorithms (e.g: upedge, convex, bump, etc). Model feature detection is a very powerful analysis tool for oddly shaped feature, features without clearly defined edges, features that can change shape based on process conditions, shallow step heights, etc.

Selecting a feature for detection:

1. Click the menu arrow next to the feature box to display its menu.
2. Click the desired feature to select it. If necessary, use the scroll bar to reveal other features.

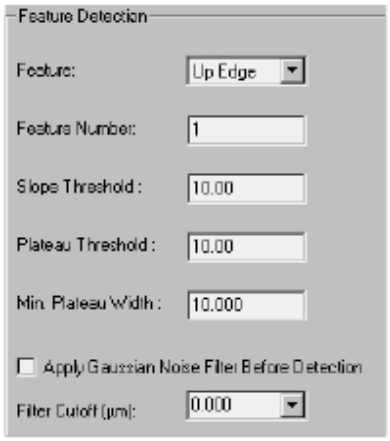
For Up Edge, Up Base, Down edge, Down Base, Convex, and Concave:

Feature Number

If there are multiple edges detected in the scan, **Feature Number** provides a way to select a specific edge for detection. (See *Figure 3.26*.)

Figure 3.26 *Detection Variables - Feature Detection - Recipe Editor*

Detection parameters are changed by clicking in the appropriate variable box to highlight the current number. Then type in the new number.



Slope Threshold

This factor sets the value at which any rise or fall in a trace is considered to be a slope. This means that the **Slope Threshold** defines a point at which the system recognizes a trace line as following or preceding an ***edge***, ***convex*** or ***concave*** point. (See *Figure 3.26*.)

- Use values between 0 and 50
- Default is 10 for a step and 1 for an apex point..

Plateau Threshold

This factor affects finding the end of the feature. For example, when up edge is selected, the slope threshold will be used to find the up edge and the plateau threshold will be used to find the down edge (end of the feature). In the case where the rising and falling edges have similar slopes, use the same value for the slope and plateau thresholds. If they are different, then each needs to be optimized to properly detect the edges.

- Use values between 0 and 50
- Default is 10 for a step and 1 for an apex point.

Min. Plateau Width

Minimum Plateau Width defines the minimum horizontal distance between rising and falling edges (or falling and rising edges). This parameter is useful to differentiate between features of similar shape, but different width. It can also be useful to prevent false detection of a feature.

- Use values between 0.005 and 1000 µm.

Apply Gaussian Noise Filter Before Detection

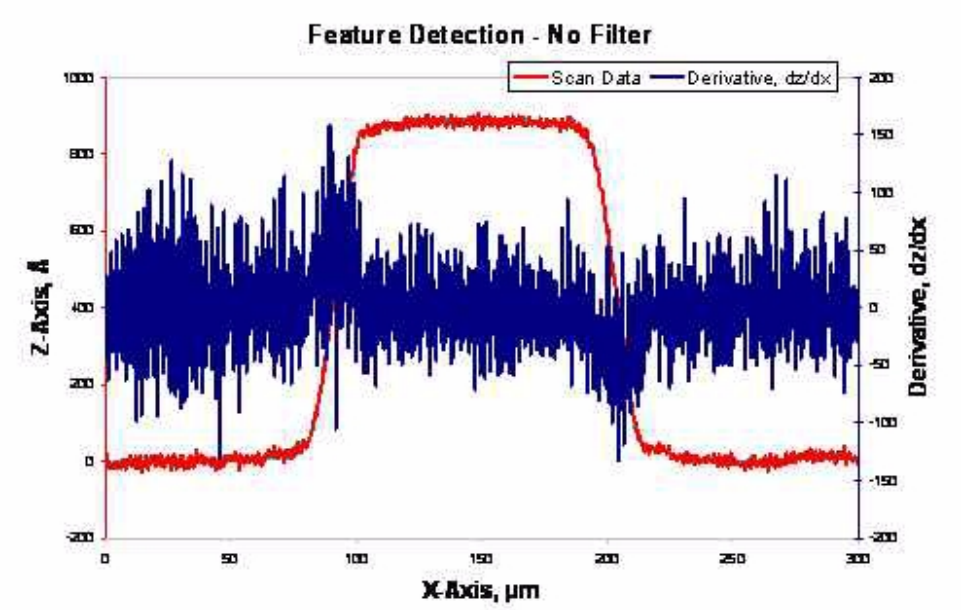
This is used so that feature detection can detect designated features. (See *Figure 3.27*.) Up edge, up base, down edge, down base, convex, and concave Feature Detection operate on the first derivative of the trace. As can be seen in the figure, without any filtering the derivative does not have a clear inflection at the rising and falling edges of the steps. Since each motion of the stylus up and down due to roughness or noise is a change in slope, filtering for Feature Detection is critical to smooth the profile and produce clear derivatives at the rising and falling edges, as can be seen in the figure after applying a filter.

It does not apply the filter to scan used for parameter calculations. It is only used for the purpose of Feature Detection. For use of the **Gaussian Filter** with scan data, see *Filters* on page 3-38.

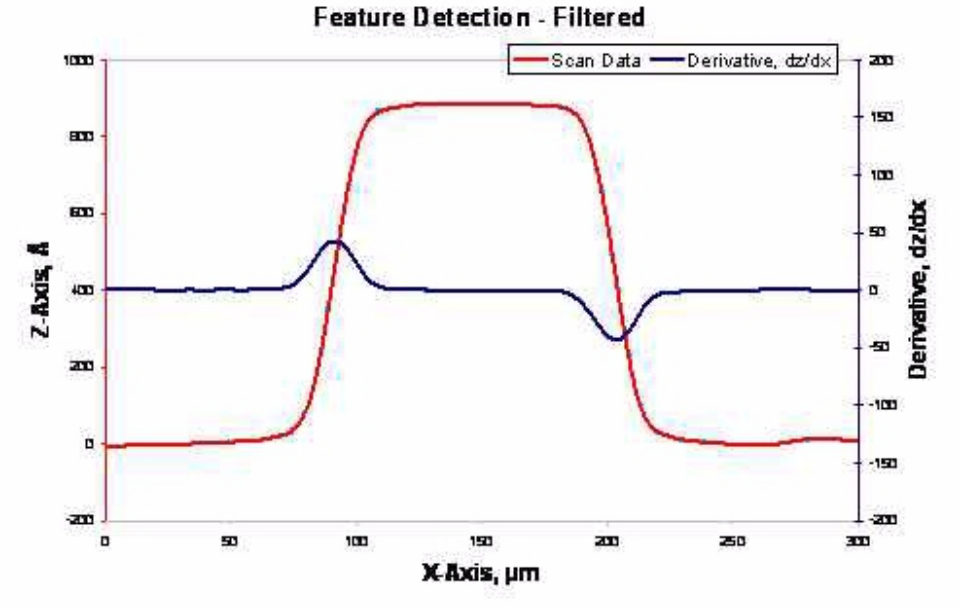
NOTE: It is always recommended to apply a filter to the data. Filtering can be very useful to obtain robust Feature detection performance.

Figure 3.27 *Scan Trace (Red) with First Derivative (Dark Blue) Overlaid on the Same Graph*

Deriviative without filtering does not produce clear inflection points at the rising and falling edges.



Deriviative with filtering shows clear inflection points at the rising and falling edges.



Bump and Model Feature Detection

Filters and Cursors

Filters

Two filters are available for removing noise from scan data, either as the scan is taking place, or after the scan occurs but before the data is saved. The oldest filter is the RC Filter. **RC** stands for Resister Capacitor Filter. The second, the **Gaussian Noise Filter**, is the best of the two and is generally chosen when a filter is required.

Noise Filter

The **Noise Filter** is a *Short Wavelength Cutoff* filter. This is an adjustable software filter used to reject short wavelength components of scan data. When used with the **Waviness Filter** (*Long Wavelength Cutoff*), it also isolates band passes for wavelengths.

Selecting the Short Wavelength Cutoff: (See *Figure 3.28*.)

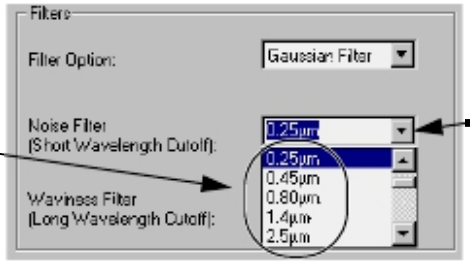
1. Click the **Noise Filter** menu arrow to display its menu.
2. Click the desired Shortwave Cutoff or type in the desired value.

NOTE: The availability of cutoffs is dependent on the scan speed. A short wavelength cutoff cannot be entered if it is longer than the currently selected long wavelength cutoff, or shorter than the value of the analog cutoff.

Short wavelength cutoff ≤ Long wavelength cutoff

Short wavelength cutoff ≥ Analog cutoff

Figure 3.28 *Filters Parameters - Noise Filter Menu*



Step 2 Click the desired Short Wavelength Cutoff.

Step 1 Click the menu arrow to display the cutoff menu.

Waviness Filter

The **Waviness Filter** is the *Long Wavelength Cutoff* filter. It is an adjustable software filter to separate long wavelength components of scan data.

To Select the **Long Wavelength Cutoff**:

1. Click the **Waviness Filter** menu arrow next to display its menu.

2. Click the desired **Long Wavelength Cutoff** value or type in the desired value.

NOTE: The availability of cutoffs is dependent on the scan speed. The systems prevents the accidental entry of a long wavelength cutoff that is shorter than the currently selected short wavelength cutoff or the value of the analog cutoff.

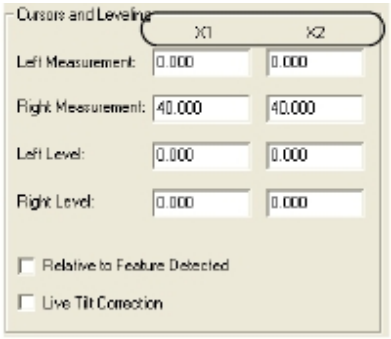
Cursors

Cursors are used for two general purposes:

- **Measurement Cursors** are used to gather data either between the two sets of cursors or within the boundaries of the cursor itself.
- **Leveling Cursors** are used to level the data points in the trace so the trace features fairly represent the actual scanned surface.

Figure 3.29 *Cursor Parameters - Recipe Editor*

Cursor parameters can be changed using the screen variable boxes by clicking in the appropriate variable box to highlight the current number. Then type in the new number. Cursor positions can also be changed by adjusting their position in the data analysis program.

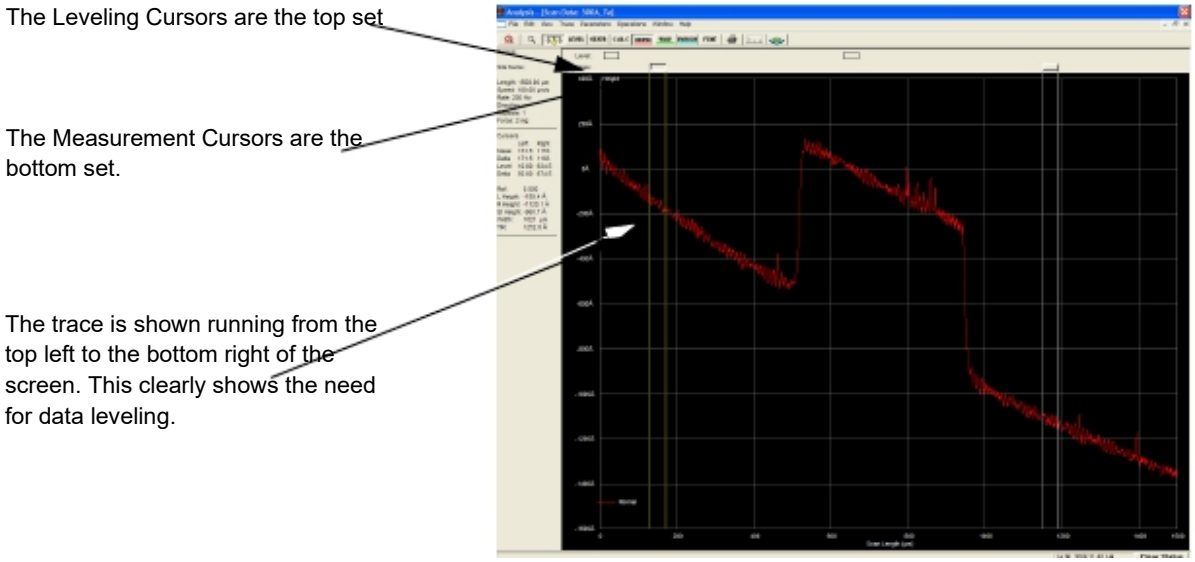


The limits of the cursor boundary are displayed in the X1 and X2 columns for the various cursors.

Each cursor has limits that can be set. The limits of the cursor boundary are displayed in X1 and X2 in the **Cursors** parameters box. The cursor limits are set relative to the starting point of the scan, or relative to the feature detected by the Feature Detection algorithms, if enabled. These values can be set in the window by clicking on the current value in the variable box and typing in the new value.

The easiest way is to set the cursors is in the analysis screen, after the scan, using the click and drag procedure. The procedure is described in the following discussion. (For more information on leveling cursors see *Leveling Cursors* on page 3-40.)

Figure 3.30 *Analysis Screen with Trace in Need of Leveling*



Leveling Cursors

In general, the most effective way to set the **Leveling Cursors** is in the **Analysis** screen by clicking and dragging them into position. When they are in position, use the CALC procedure to enter the new **Cursors** variables. By visually positioning the cursors, the leveling positions are correct for the actual scan.

Setting the Leveling Cursor positions:

1. After the scan is complete, the **Analysis** screen is displayed. Click **LEVEL** to activate the Leveling Cursors.
2. Reposition the leveling cursors using the following procedure. Click the **LEVEL** button in the tool bar. This activates the Leveling cursors. The active cursor header is displayed as a 3D rectangle. The cursor header being moved is indented while the other cursor is in relief. The Measurement cursor heads appear as 2D line boxes.
   a. As the track ball cursor approaches one of the active cursor heads, the cursor head changes appearance to indented and the track ball cursor appears as a double arrow.

      Click and hold on the cursor that is to be moved. Drag it to the desired position, using the track ball to move it. Release the mouse button when the cursor is in position.
3. When the cursor is in position, set each cursor boundary using the following procedure:
   a. Move the track ball cursor down into the black scan trace screen. The boundary that the arrow is pointing at is the one that is moves. (See *Figure 3.31*.)

b. Click and hold the mouse button while using the track ball to drag the boundary into position for leveling the scan. Release the mouse button when the boundary is correctly positioned.

NOTE: Both cursors should be positioned on the same X-plane. The cursor boundaries should be positioned on the same plain, avoiding noise peaks or valleys. This generally gives a flat scan trace.

c. Repeat **Step 1** and **Step 3** for the remaining cursor.

4. Click the **LEVEL** button to level the trace. (See *Figure 3.31*.) This cause the trace to be leveled and displays the trace with the Measurement Cursors active. (See *Figure 3.33* for a leveled trace.)

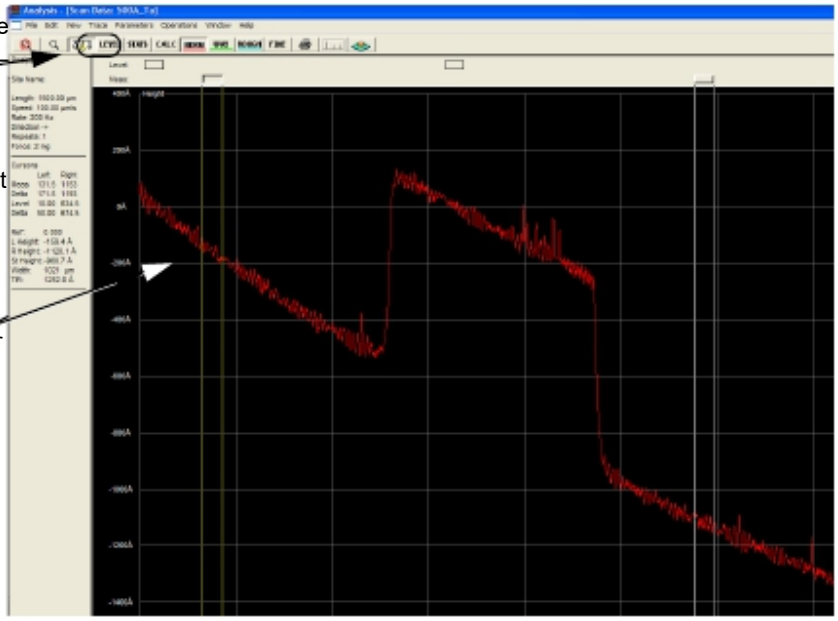
Figure 3.31 *Cursor Boundary Setting on Unleveled Trace*

Step 4 After Leveling cursors have been set, click **LEVEL** to level the trace.

Step 3 When the Leveling Cursor is placed in the general area that it is to be used, move the track ball cursor down into the black trace screen to position the cursor boundaries.

A single arrow points at the cursor boundary that is to be adjusted.

Click and hold the mouse button and use the track ball to move the cursor boundary into place.

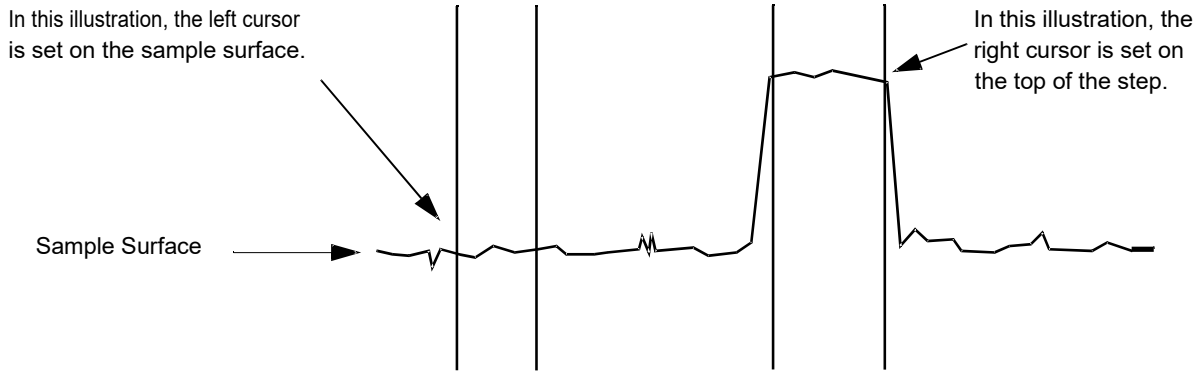


Measurement Cursors

The Measurement cursors are used to measure various attributes of the scan. Some measurements are obtained between the cursors, while others are made within the boundary of a single cursor.

1. It is important to set the measurement cursors to accurately measure the desired feature. In *Figure 3.32* the left cursor is set on the sample surface with the cursor borders positioned to measure a relatively flat trace segment. The right cursor is positioned to detect the height of the step being measured. (See *Figure 3.32*.)

Figure 3.32 *Setting Measurement Cursors*

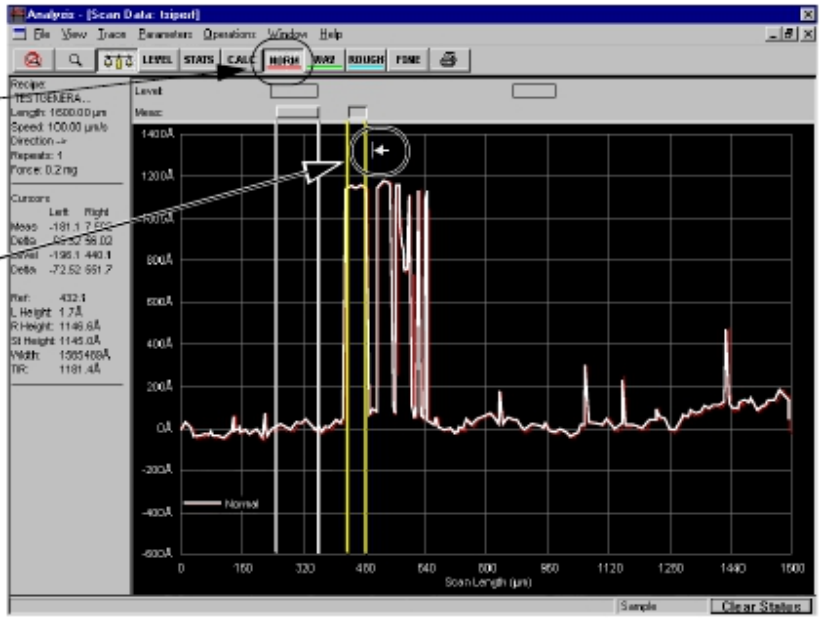


a. The Measurement cursor header appears as a 3D rectangles. The Leveling cursors appear as 2D line boxes. (See *Figure 3.33*.)

Figure 3.33 *Measurement Cursor on Level Trace*

Step 1 The leveled trace appears with the Measurement Cursors active. If the **Measurement Cursors** are not active, click the **NORM** button in the tool bar.

Move the cursor into the graph area and position it next to the cursor boundary that is to be moved. It appears as an arrow.



b. As the track ball cursor approaches one of the active cursors, the cursor header changes to appear indented and the track ball cursor appears as a double arrow as shown in *Figure 3.6*.

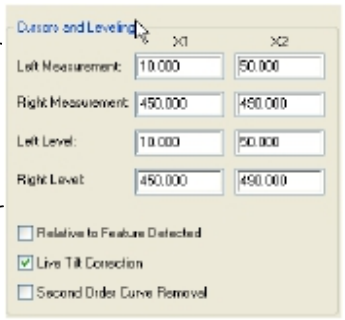
Click and hold on the cursor that is to be moved. Drag it to the desired position using the track ball to move it. Release the mouse button when the cursor is in position.

2. When the cursor is in position, set each cursor boundary using the following procedure:
   a. Move the track ball cursor down into the black scan trace screen. The boundary that the cursor arrow is pointing at is the one that moves. (See *Figure 3.33*.)
   b. Click and hold the mouse button while using the track ball to drag the boundary into position for its intended measurement in the scan. Release the mouse button when the boundary is correctly positioned.
   c. Repeat **Step 1** and **Step 3** for the remaining cursor.
   d. Click the **CALC** button to record the cursor positions in the recipe and calculate the measurement parameters.
3. When the trace has been leveled and the Measurement cursors have been placed, click the **CALC** button to cause the system to recalculate the data with new cursor positions. The new positions are saved as part of the recipe.

The **Recalculation** process places the cursor **limits** in the **Cursors** window of the **Recipe Editor**. (See *Figure 3.34*.)

Figure 3.34 *Cursor Parameters - Recipe Editor*

Cursor parameters (limits) are automatically changed when the **CALC** button is clicked in the **Analysis** screen.

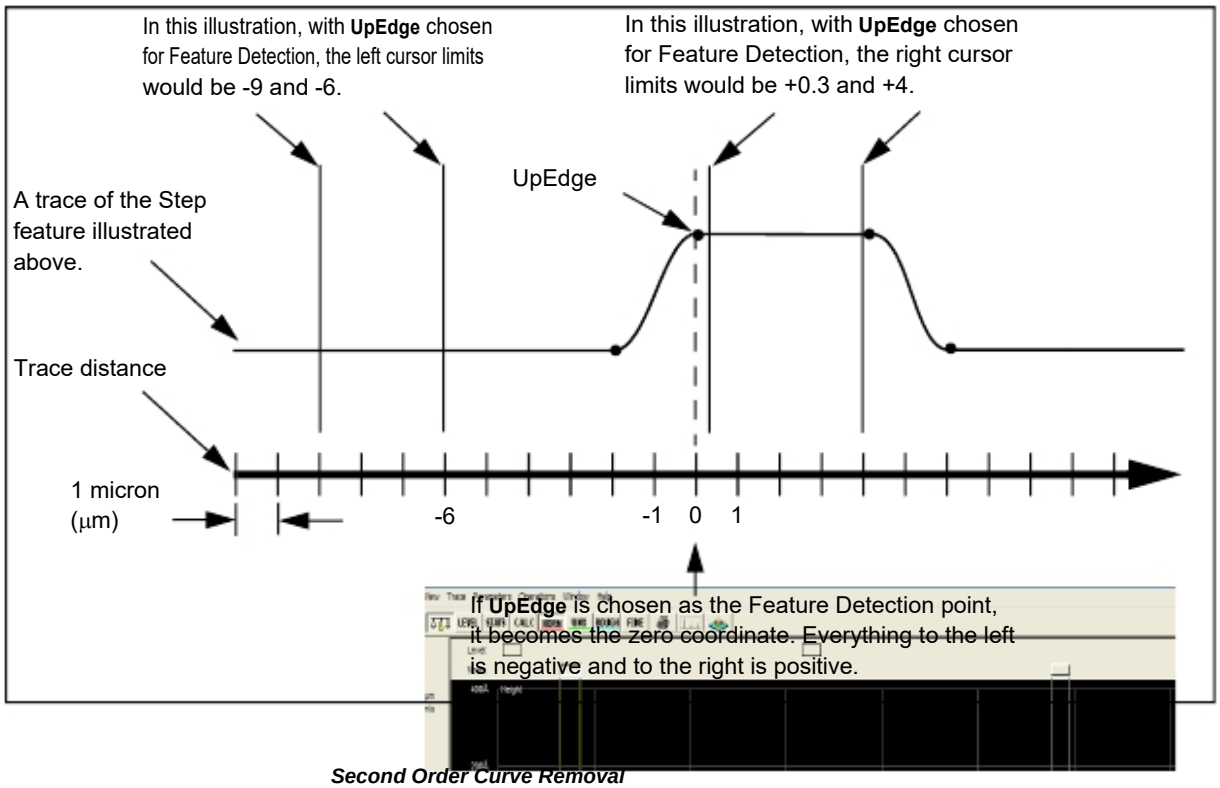


Relative to Feature Detected

When there is a check (✓) in its checkbox, the cursor limits are set relative to the feature that is defined in the **Feature Detection** parameters window in the **Recipe Editor**. (See *Feature Detection (Only for 2D Scans)* on page 3-31.) The feature becomes the **0** point (the origin of the new coordinate system), with the points to the left being negative and those to the right being positive. (See *Figure 3.35*.) The cursors are set using the same method previously described. The system automatically places the measurement and leveling cursors relative to the actual feature instead of relative to the starting point of the scan.

NOTE: If **Relative to Feature Detected** is not checked, there should be no negative numbers in any cursor position because the start of the scan is the "0" point.

Figure 3.35 *Measurement Cursors - Relative to Feature Detection*



Second Order Curve Removal

This option is designed to remove a secondary curvature from the overall trace of a curved surface. Features should then appear relative to a flat surface.

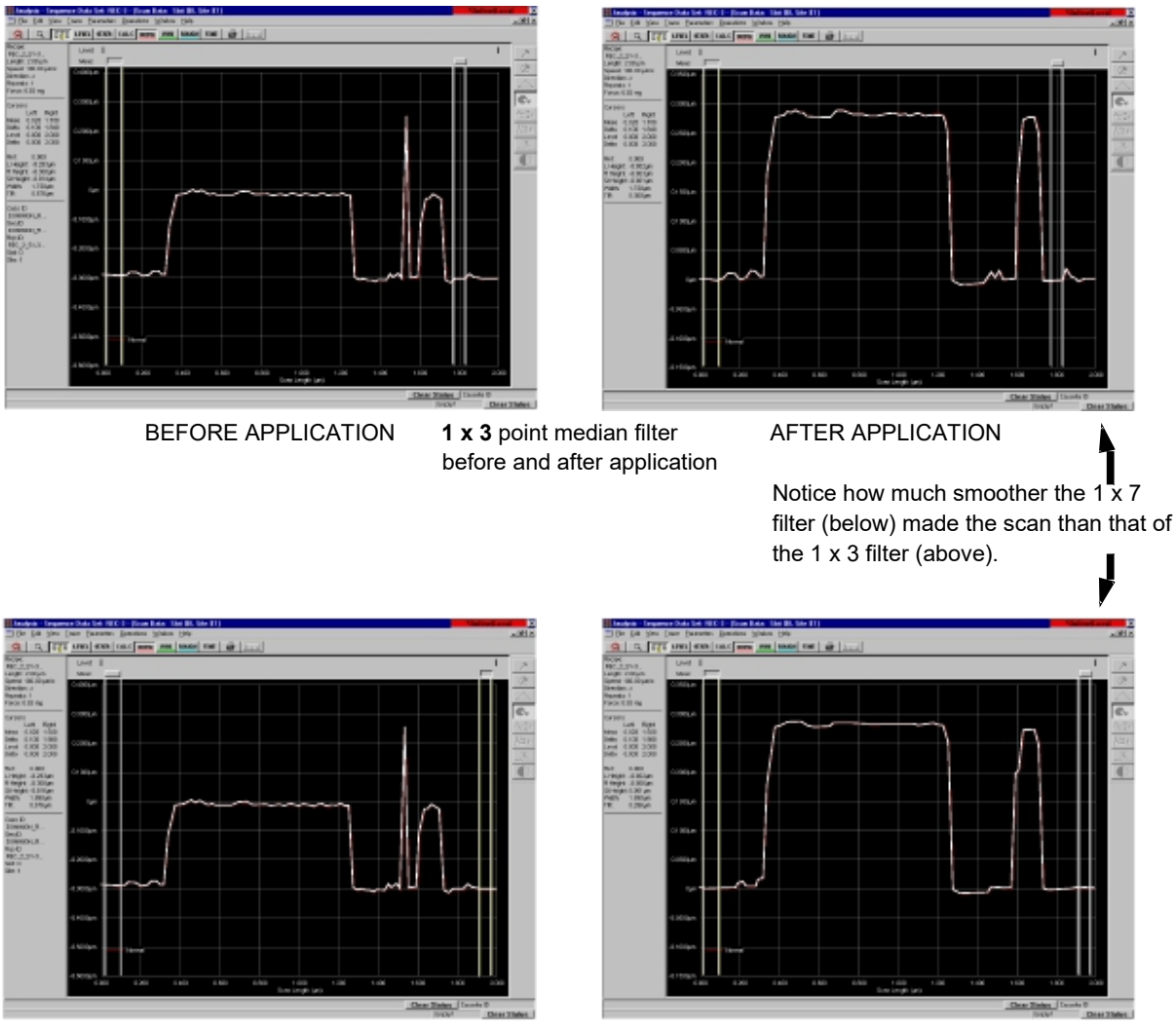
Median Filter for 2D and 3D Data

This filter can be chosen as part of the recipe to help filter out spikes from environmental noise and particulate contamination. A median filter can be turned on before the scan, allowing the system to filter the data before the first viewing. It can also be used on saved data. With the data open in the Analysis screen, the saved data from single scans and sequences can be changed by opening the recipe used to create the scan from the Analysis screen, and changing the filter size in that recipe.

The median filter is used for both 2D and 3D data, with each type having its own menu of kernel sizes for the filters being applied to the data. When the filter is applied before the scan, the data is filtered and permanently changed.

The median filter works as a smoothing tool, taking out glitches and smoothing the trace surface in direct proportion to the size of the kernel. The median if found for the effected points in the kernel and is applied to data. The larger the kernel, the greater the smoothing effect on the data. In general, the smaller the kernel (i.e., the 1 x 3 for 2D and the 3 x 3 for 3D), the less the data is manipulated.

Figure 3.36 *Median Filter Application in Glitch Removal*



The median filter is a major component of the Glitch Removal process used on data in the Analysis screen for both 2D and 3D data.

The available filter sizes (kernels) for 2D data are: 1 x 3, 1 x 5, and 1 x 7 points.

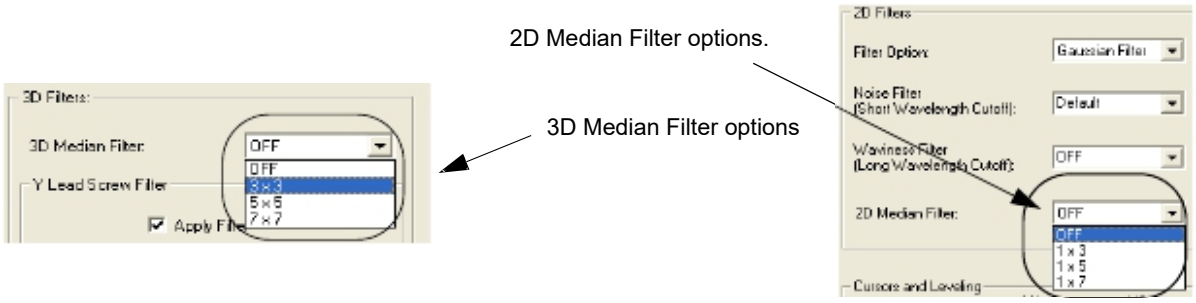
The available filter sizes (kernels) for 3D data are: 3 x 3, 5 x 5, and 7 x 7 points.

To add a filter or change the filter size on existing data, use the following procedure:

1. From the Analysis screen, click **Edit** to display its menu.
2. Select **Recipe**. This opens the recipe used to generate the data.

3. Click **Filters/Cursors** to display the Filters and Cursors parameters.
4. Click the menu-arrow for either the 2D or 3D Median Filter to display the options. (See *Figure 3.37*.)
5. Choose the required filter size for the 2D or 3D data.

Figure 3.37 *2D and 3D Median Filter Options*



6. Click the Analysis screen icon in the tool bar to return to the Analysis screen for the affected data.

For additional use of the median filter, see "Activate 3D Glitch Removal Tool." on page 15.

Y Lead Screw Filter

This filter can be used only with large 3D scans. The Y Lead Screw Filter is designed to remove the Y lead screw noise present in die level 3D scan data.

The Y lead screw noise is a periodic sine wave in the data, due to the coupling of stage motion in the Y direction together with the Y lead screw motion into the measured Z Value.

The Y Lead Screw Filter uses a Fast Fourier Transform (FFT) function to find the amplitude and the phase of the sine wave in the data. The period is already known, defined by the Y lead screw hardware. A plane with the sine wave amplitude, phase, and period is then generated and subtracted from the data.

Y Lead Screw Filter Constraints

For the Y Lead Screw Filter to be effective, the Y-direction scan length and the noise wavelength must meet the following conditions:

Y-direction scan length ≥ Wavelength x 2, **and**

Y spacing ≤ Wavelength ÷ 4

When entering values in the parameter fields the Filter Width should be smaller than 3 wavelengths to avoid distortion. The default (0.9) is recommended.

Apply Filter

The Apply Filter option is enabled by default. This means that the filter is applied to every 3D scan that meets the parameters described in the Y Lead Screw Filter Constraints.

Wavelength

The Wavelength is the spatial frequency or period of the wave (periodical signal). The wavelength is the center of the notch filter, the frequency component which is reduced in the data set. The default value (1000) is set to match the disturbance artificially induced by the Y lead screw. If the value is changed, the value must be a positive floating number with a maximum of two decimal points.

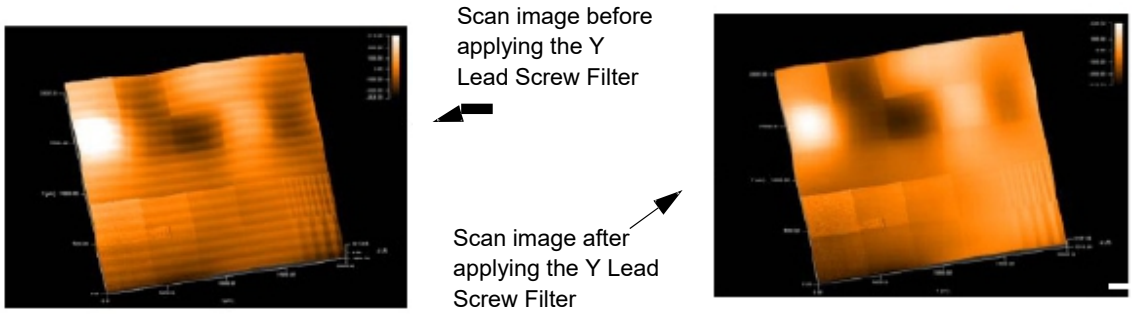
Filter Width

The Filter Width is the a value reflecting the number of wavelengths. The default value for the Filter Width is 0.9 times the wavelength.

Filter Reduction

The default value for the Filter Reduction is 95% of the Wavelength. The Filter Reduction means that the frequency component at the wavelength is reduced by the given percentage (e.g., 95% reduction for the default reduction value). The value must be a positive floating number with a maximum of two decimal points.

Figure 3.38 Y Lead Screw Filter Application



Filters Cursors Menu for a 3D Recipe

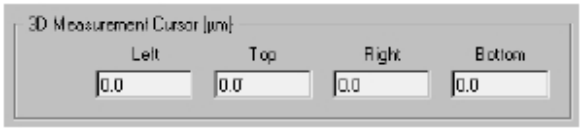
Introduction

The 3D Cursors screen is designed to allow the user to view the cursor coordinates, and manipulate the cursor position and boundaries by coordinate. (See *Figure 3.51*.)

3D Measurement Cursor

The 3D measurement cursor is used to isolate an area of the scan, from which the measurements designated in the recipe for inclusion in the Analysis data (such as some of the parameters in General Parameters on page 51 and Roughness and Waviness Parameters on page 55), can be reported. If no numbers are entered in the 3D Measurement Cursor variable boxes to define the measurement area, the data is compiled for the entire scan area.

Figure 3.39 *3D Measurement Cursor Box*



Setting the Cursors: Click and Drag

Cursor Positioning Using Click-and-Drag

The **3D Measurement Cursor** box is associated with the **Activate Height Tool** button  in the Analysis screen tool bar. In the Analysis screen, if the Activate Height Tool button is clicked on, a box appears that can be resized and moved using the click-and-drag method. As the box is drug around the scan image, the height of all data points in the box is averaged with respect to sample plane and reported under **Height** in the analysis statistics at the left side of the screen.

Set the Box Position in the 3D Measurement Cursor Variable Boxes

After the box is sized and positioned, its position can be entered in the 3D Measurement Cursor variable boxes.

1. Click the **CALC** icon in the toolbar or click **Operations** in the menu bar
2. Choose **Recalc**, to recalculate the parameters and place the cursor locations in the 3D Measurement Cursor variable boxes.

Setting the Cursors: Manually Entering Coordinates

Manually setting the cursors is accomplished by entering the coordinate position of the intended measurement box (Active Height Tool) directly into the **3D Measurement Cursors** variable boxes.

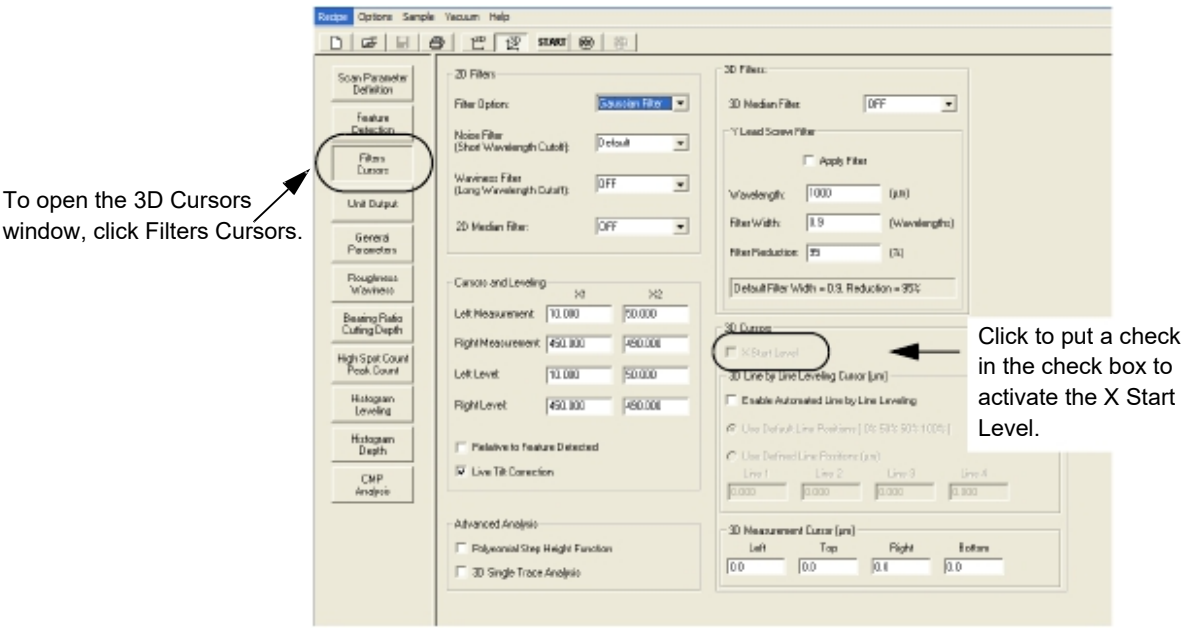
X Start Level

This option is used to level the 3D scan with respect to the X starting position of the scan. It assumes that the entire X=0 length of the scan is on the same plane, having no holes or steps. If this box is checked, the other options are not used in the leveling process. This option only levels in one direction, with respect to the X=0 plane.

To activate the **X Start Level** option, click in the empty checkbox next to X Start Level. (See *Figure 3.40.*)

The 3D scan progresses with each initial trace data point being used for the scan leveling in the Y direction (using the X=0 point of each scan trace).

Figure 3.40 *Recipe Editor - Choosing 3D Cursors*



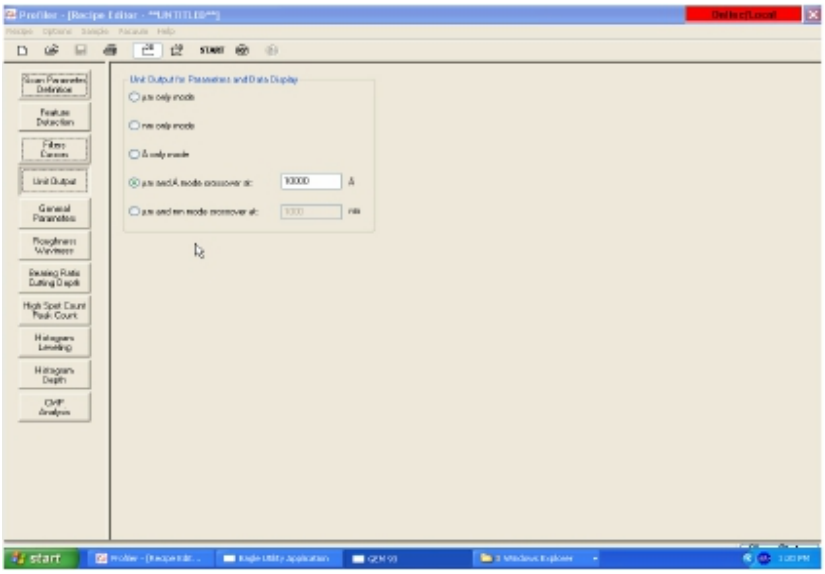
Line by Line Leveling

Clicking the **Enable Automated Line by Line Leveling** option enables the line by line leveling algorithm to level the surface. There are two ways to set up the leveling: Default Line Position (see *Use Default Line Position [0% 50% 50% 100%]* on page 7-34) and Defined Line Position (see *Use Defined Line Positions* on page 7-34).

Unit Output

Unit Output is designed to give the user an opportunity to determine units of output for the parameters calculated and to set automatic crossover values for unit changes. The options here let the user choose the units for the 2D graphical display through the recipe that is used to generate the scan.

Figure 3.41 *Recipe Screen with Unit Output Dialog Box*

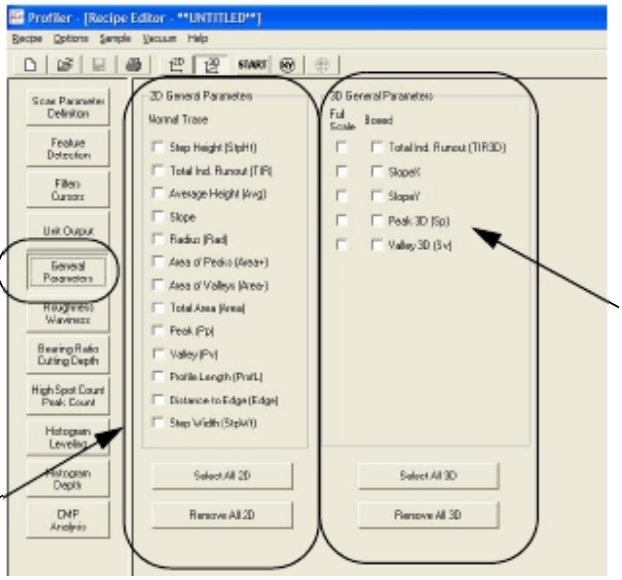


General Parameters

The **General Parameters** window contains a variety of surface analysis calculations which are performed on the scan data when the options are chosen before the scan, or if they are applied to the scan data after the original data has been saved.

For each surface analysis option chosen, a post scan calculation is performed and displayed on the Analysis screen. To access the **General Parameters** window, click the **General Parameters** button in the **Recipe Editor** screen. (See *Figure 3.42*.)

Figure 3.42 *General Parameters - Recipe Editor*



To display the General Parameters options in the Information Display window of the Recipe Editor, click the General Parameters button.

The 3D options are only for 3D scans. 2D cannot be applied to 3D scans.

The 2D options are only for 2D scans and are not available for 3D scans.

2D General Parameters (Normal Trace)

These parameters represent calculations that are performed using the data from a scan. If the options are chosen before the scan is performed, and are part of the *scan recipe*, the calculations are automatically performed by the software and displayed in the Analysis screen upon completion of the scan. Parameters from the 2D General Parameters are for single trace analysis. For 3D scans, the 2D parameters can be calculated for a cross-section of the 3D scan.

Each parameter is discussed below. (See *Figure 3.42*.)

Table 3.22 *2D General Parameters*

Parameter	Description
Step Height (StpHt)	The difference in height between the left and right measurement cursors positions. Each cursor position is an average of the area between the cursor boundaries. The difference is between these averages.
Total Indicator Runout (TIR)	The difference between the highest and lowest points in the scan.
Average Height (Ave)	The average height of all data points between the measurement cursors relative to the leveled baseline. (ANSI)
Slope	The ratio of the difference in vertical positions to the difference in horizontal positions of the measurement cursors. The slope is reported as an angle in degrees. **NOTE:** The position of each cursor is taken to be the horizontal midpoint of each delta cursor band, and the data value at this location is the average of the vertical values within these bands. (ANSI)
Radius	The distance from the center of curvature of the profile arc (assuming a circular profile within the sampling length) to the profile. The measurement cursors define two points of a circular arc. A *least squares* calculation is performed on the points between the cursors. The normal trace should not be leveled unless definite level reference points exist.
Area of Peaks (Area+)	The total area bounded by the leveled baseline and the profile where it rises *above* the baseline. (ANSI)
Area of Valleys (Area-)	The total area bounded by the leveled baseline and the profile where it descends *below* the baseline. (ANSI)
Total Area (Area)	The sum of **Area of Peaks** and **Area of Valleys**. The delta cursors are not used. (ANSI)

Table 3.22 2D General Parameters (Continued)

Parameter	Description
Peak (Pp)	Maximum Z value, measured relative to the leveled reference line, between the left and right measurement cursors.
Valley (Pv)	Minimum Z value, measured relative to the leveled reference line, between the left and right measurement cursors.
Profile Length (ProfL)	The length that would be obtained from drawing out the profile in a straight line. (ANSI)
Distance to Edge (Edge)	Depending on the parameters settings in **Feature Detection**, this distance is either: ◆ The distance between the beginning of the scan and the first rising or falling edge of a profile feature; or ◆ The distance between the beginning of the scan and the first concave or convex arc of a profile feature. ◆ Distance to the model reference point. **NOTE:** This parameter is independent of the cursor positions. It is based on the feature detection parameters.
Step Width (StpWt)	◆ The distance between the first rising edge of an upward step and the falling edge that follows, or the first falling edge of a downward step and the rising edge that follows. This value is not available for a convex or concave arc, bump, and model feature detection. **NOTE:** This parameter is independent of the cursor positions. It is based on the feature detection parameters.

The green trace represents **Waviness**.

The blue trace represents **Roughness**.

3D General Parameters

These parameters represent calculations that are performed using the data from a scan. If the options are chosen before the scan is performed, and are part of the *scan recipe*, the calculations are automatically performed by the software and displayed in the Analysis screen upon completion of the scan. The options can be applied to live or saved data.

Each parameter option can be calculated in two different ways:

- **Full Scale:** With this checkbox selected, the parameter are calculated using data from the entire scan.
- **Boxed:** With this checkbox selected, the parameter are calculated using data from within the box that is defined in the 3D Cursors parameters window of the Recipe Editor. (See *Figure 3.42*.)

Either one or both calculation options can be used. If both are used, two sets of calculations are performed and presented in the Analysis screen.

Table 3.23 *3D General Parameters*

Parameter	Description
Total Ind. Runout (TIR3D)	This is the 3D Total Indicator Runout. **TIR3D** is the difference between the highest and lowest points in the scan.
SlopeX	SlopeX refers to the slopes for lines in the plane: The SlopeX is the slope along the X-direction For the data set in any rectangular area (either a box or the entire area), a plane can be established using the *least squares* method.
SlopeY	SlopeY refers to the slopes for lines in the plane: The SlopeY is the slope along the Y-direction For the data set in any rectangular area (either a box or the entire area), a plane can be established using the *least squares* method.
Peak 3D (Sp)	Maximum Z value, measured relative to the leveled reference plane.
Valley 3D (Sv)	Minimum Z value, measured relative to the leveled reference plane.

Roughness and Waviness Parameters

Introduction

Roughness and Waviness are defined by the Long Wavelength Cutoff setting. In general, when a long wavelength cutoff is set, the wavelengths greater than the cutoff are defined as **Roughness** and those less than the cutoff are defined as **Waviness**. (See *Figure 3.43*.) The long wavelength cutoff setting is generally determined by the specific application for which it is to be used.

A filter is used to remove aspects of the data so other aspects can be more carefully analyzed. As an example, the roughness could be filtered out so the waviness could be better analyzed. (See *Figure 3.44*.)

For applications where the user is unsure of a specific long wavelength cutoff, use the general rule of 1/5 the scan length. This means that for a scan of 50 µm, the cutoff would be 10 µm.

Figure 3.43 *Waviness vs. Roughness*

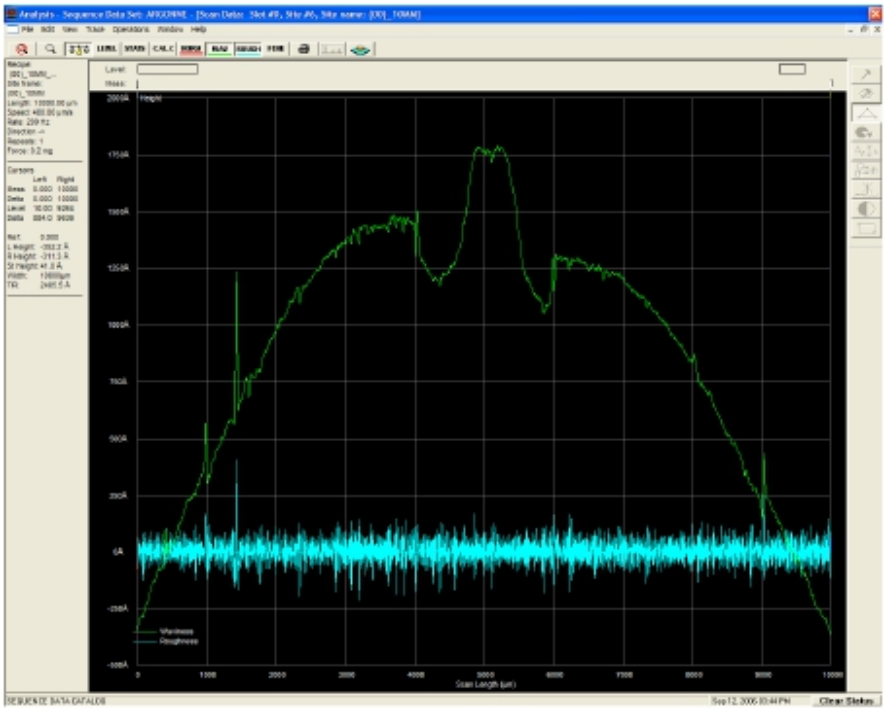


Figure 3.44 *Roughness/Waviness Filter Analysis*

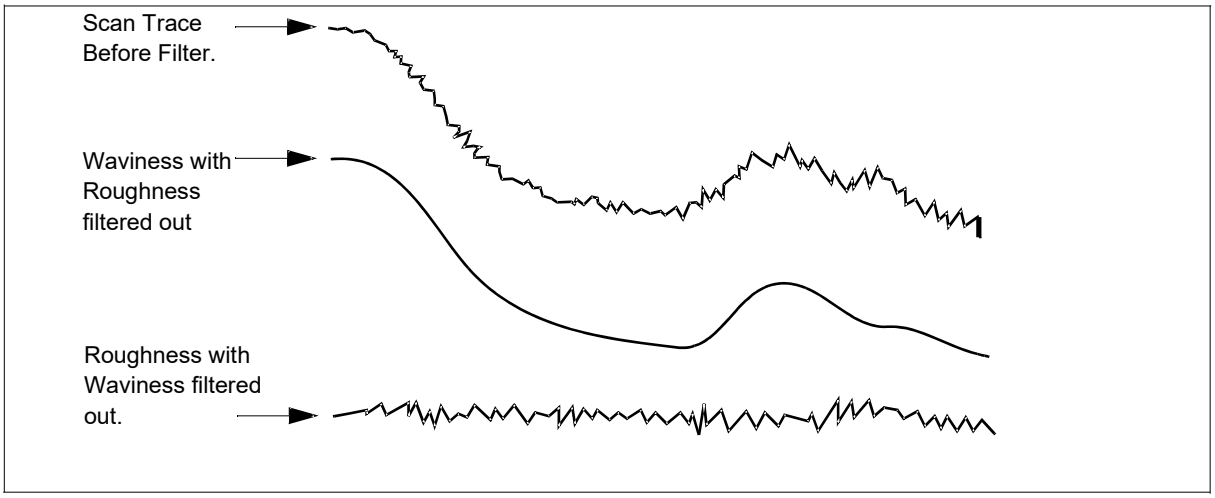
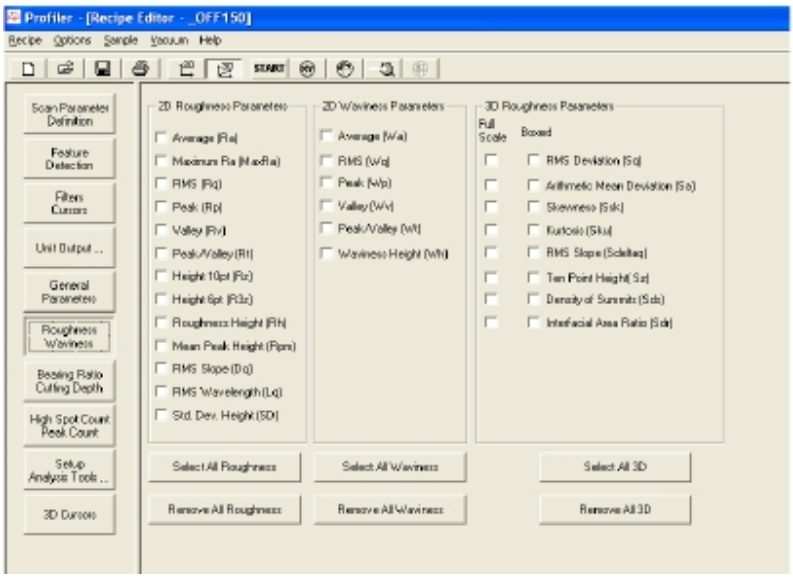


Figure 3.45 shows the Recipe Editor with the Roughness and Waviness parameters in the Information Display window.

Figure 3.45 *Recipe Editor Showing 2D and 3D Roughness/Waviness Parameters*



2D Roughness Parameters

Each of the roughness parameters available in the **2D Roughness Parameters** option box are described in ***Table 3.24 on page 3-58***. (For more information Roughness, see the ***Introduction*** to *Roughness and Waviness Parameters* ***on page 3-55***.)

Table 3.24 *2D Roughness Parameters*

Parameter	Description
Average (R_a)	This is the arithmetic average deviation of the absolute values of the roughness profile from the mean line or centerline. Also known as *centerline average roughness*. The centerline divides profiles such that all areas above it are equal to all areas below it. (ANSI)
Maximum R (Max R_a)	The trace within the cursors is divided into nineteen overlapping sections. Each section is one-tenth of the sampling length. The R_a of each section is calculated, and the maximum is displayed. (ANSI)
RMS (R_q)	The Root-Mean-Square (RMS) or geometric average deviation of the roughness profile from the mean line measured in the sampling length. (ANSI)
Peak (R_p)	The distance between the mean line and the highest peak within the sampling length. (ANSI)
Valley (R_v)	The distance between the mean line and the lowest valley within the sampling length. (ANSI)
Peak/Valley (R_t)	The vertical distance between the highest peak and the lowest valley in the sampling length leveled on the mean line. (Also known as R_{max} R , $_v$ Maximum Peak-to-Valley Roughness.) (ANSI)
Height 10pt (R_z)	The average height difference between the five highest peaks and the five deepest valleys within the cursors measured from a line parallel to the mean line. (ANSI)
Height 6pt (R_{3z})	The average height difference between the three highest peaks and the three deepest valleys in the sampling length measured from a line parallel to the mean line and not crossing the profile. (ANSI)

Table 3.24 *2D Roughness Parameters (Continued)*

Parameter	Description
Roughness Height (R_h)	The difference in height in the roughness profile between the left and right cursor positions. Analogous to the Height data that always appears in the Summary box of the Analysis window. (ANSI)
Mean Peak Height (R_{pm})	The mean value of the local peak heights relative to the mean line of the roughness trace within the sampling length.
RMS Slope (D_q)	The root mean square (RMS) value of the roughness trace slope. The Delta cursors are not used.
RMS Wavelength (L_q)	2π times the ratio of the root mean square (RMS) deviation of the profile (R_q) to the root mean square slope of the profile (D_q). L_q is a measure of the spacing of local peaks and local valleys, taking into account their relative amplitudes and individual spatial frequencies. (ISO International Standards Organization)
Std. Dev. Height (SD)	The standard deviation of the local peak heights about the mean peak height relative to the mean line within the sampling length.

2D Waviness Parameters

Table 3.25 *2D Waviness Parameters*

Parameter	Description
Average (W_a)	This is the arithmetic average deviation of the absolute values of the waviness profile from the mean line or centerline also known as centerline average waviness). The centerline divides profiles such that all areas above it are equal to all areas below it. (ANSI)
RMS (W_q)	The Root-Mean-Square (RMS) or geometric average deviation of the waviness profile from the mean line measured in the sampling length. (ANSI)
Peak (W_p)	The distance between the mean line and the highest peak within the sampling length. (ANSI)
Valley (W_v)	The distance between the mean line and the lowest valley within the sampling length. (ANSI)
Peak/Valley (W_t)	The vertical distance between the highest peak and the lowest valley in the sampling length leveled on the mean line. Also known as W_{max} W_v, Maximum Peak-To-Valley Waviness. (ANSI)
Waviness Height (W_h)	The difference in height in the waviness profile between the left and right cursor positions. Analogous to the Height data that always appears in the Summary box of the Analysis window. (ANSI)

3D Roughness Parameters

Each of the roughness parameters available in the 3D Roughness Parameters option box is described in *Table 3.26 on page 3-61*. (For more information Roughness, see the *Introduction* to *Roughness and Waviness Parameters* on page 3-55.)

Figure 3.46 *3D Roughness Parameters*

Either or both of the options for each parameter can be chosen.

Each parameter option can be calculated in two different ways:

- **Full Scale:** With this checkbox selected, the parameter are calculated using data from the entire scan.
- **Boxed:** With this checkbox selected, the parameter are calculated using data from within the box that is defined in the 3D Cursors parameters window in the Recipe Editor. (See *Figure 3.42*.)

Table 3.26 *3D Roughness Parameters*

Parameter	Description
RMS Deviation (S_q)	Root-Mean-Square Deviation of the Surface. The root-mean-square value of the surface departures within the sampling area.
Arithmetic Mean Deviation (S_a)	Arithmetic Mean Deviation of the Surface. The arithmetic mean of the absolute values of the surface departures above and below the mean plane within the sampling area.
Skewness (S_{sk})	The measure of asymmetry of surface deviations about the mean plane. It effectively describes the shape of the surface height distribution.

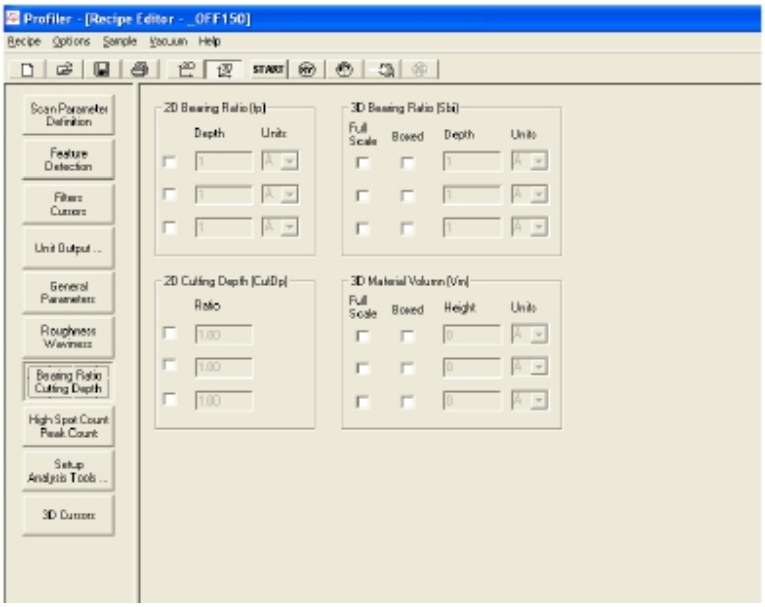
Table 3.26 *3D Roughness Parameters (Continued)*

Parameter	Description
Kurtosis (S_{ku})	A measure of the peakedness or sharpness of the surface height distribution. It characterizes the spread of the height distribution.
RMS Slope ($S_{delta\ q}$)	The root-mean-square value of the surface slope within the sampling area. RMS slope is sensitive to sampling rate.
Ten Point Height (S_z)	The average value of the absolute heights of the five highest peaks and the depths of the five deepest pits or valleys within the sampling area.
Density of Summit (S_{ds})	The number of summits of a unit sampling area.
Interfacial Area Ratio (S_{dr})	The ratio of the increment of the interfacial area of a surface over the sampling area. The Interfacial Area Ratio reflects the hybrid property of surface.

Bearing Ratio and Cutting Depth

Access the Bearing Ratio and Cutting Depth Information Display window by clicking the Bearing Ration/Cutting Depth button in the Recipe Editor. (See *Figure 3.47*.)

Figure 3.47 *Bearing Ration and Cutting Depth Parameters*



Bearing Ratio (t_p)

Bearing Ratio is also know as **Bearing Length Ratio** (t_p). ANSI defines it as:

> **Bearing Length Ratio (t_p) and Others**. A reference line is drawn parallel to the mean line and at a preselected or predetermined distance from it to intersect the profile in one or more subtended lengths. The bearing length ratio is the ratio of the sum of these subtended lengths to the length of the mean line.

The **Bearing Ratio** is determined according to the following formula:

$$t_p = \frac{S1 + S2}{L}$$

The **bearing length** is the sum of the subtended lengths (S1 and S2 in *Figure 3.50*). The **bearing ratio** is the ratio of the bearing length to the sampling length (L in *Figure 3.50*) as shown in the above formula.

Setting the 2D Bearing Ratio

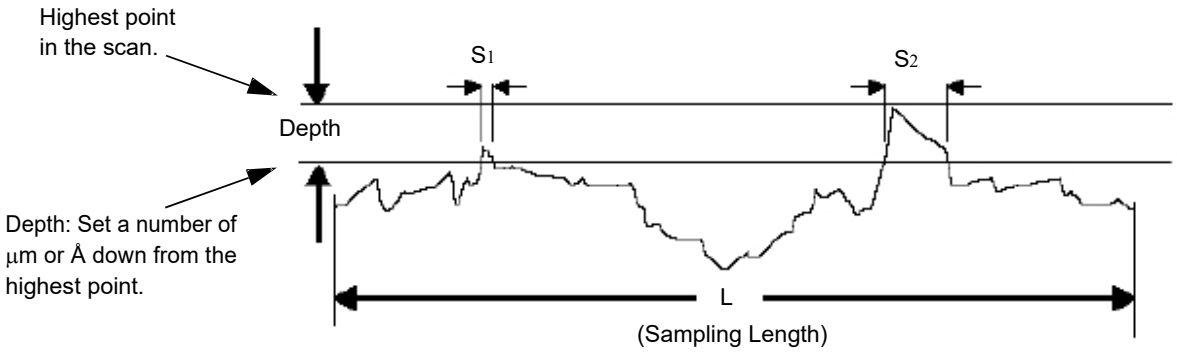
Use the following procedure to set the 2D Bearing Ratio variables.

1. The option exists to create three 2D bearing ratio parameters. Click in up to three empty checkboxes to put a check (✓) in them and activate their variable boxes. (See *Figure 3.48*.)

Figure 3.48 *2D Bearing Ratio*

2. The depth is set down from the highest peak in the scan. It can be set in either microns (µm) or angstroms (Å). Determine which units are going to be used and, if a change is necessary, click the menu arrow under units to display its menu.
3. Click the desired unit signifier, **µm** or **Å**.
4. **Depth** is the distance down from the top of the highest point in the scan. To set or change the **Depth**, double-click the current **Depth** variable and type in the new depth. (See *Figure 3.49*.)

Figure 3.49 *Depth for 2D Bearing Ratio*



2D Cutting Depth (CutDp)

Cutting Depth is related to Bearing Ratio in that Bearing Ratio uses an operator set depth from the top peak in the scan, adding up the points between the top peak and the set depth, while **Cutting Depth** uses an operator set *ratio of data points* in the scan that are below the highest peak in the scan, causing the system to determine the depth. (See the definition of **Bearing Length Ratio** in *Bearing Ratio (tp)* on page 3-63.)

Use the following procedure to set the 2D Cutting Depth variables.

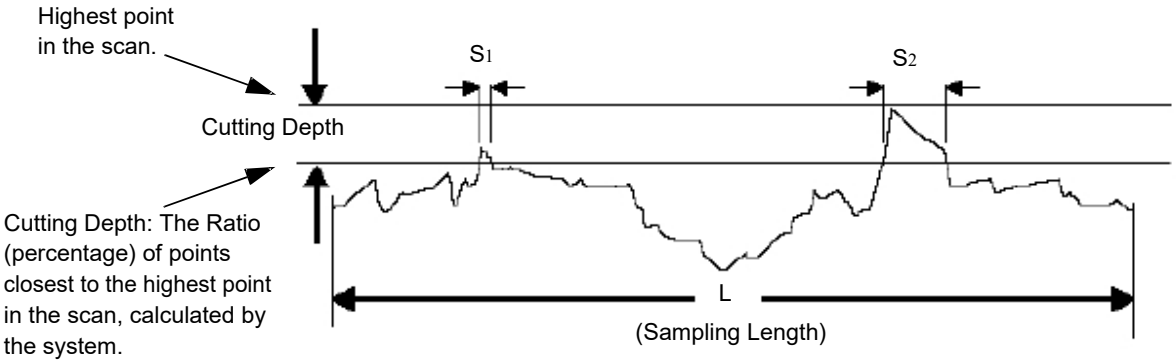
1. The option exists to create three 2D cutting depth parameters. Click in up to three empty checkboxes to put a check (✓) in them and activate their variable boxes.
2. The Cutting Depth is a ratio of points below the highest peak in the scan. The operator chooses the ratio and the software automatically takes the that ratio of data points in the scan that are the closest to the highest peak and calculates the Cutting Depth (CutDp) variable, displaying the results in the Analysis screen.

   EXAMPLE:

   If the user want to calculate a set of parameters comparing 20%, 30%, and 40% cutting depth, all three check boxes are checked and the respective variable boxes have: **0.20**, **0.30**, and **0.40** in them.

   To set or change one or more of the Cutting Depth variables, double-click the number in the variable field so that it highlights, and type in the new ratio.

Figure 3.50 *Cutting Depth*



3D Bearing Ratio (Sbi)

The 3D Bearing Ratio is a 3D version of the 2D Bearing Ratio in that it uses a distance down from the highest point in the scan to compute a bearing ratio with respect to a plane instead of area with respect to a single line trace.

In addition, two options are available for each of three parameter settings for calculating the 3D Bearing Ratio. The scope of the calculation is set by clicking in ***one or both*** of the range boxes: **Full Scale** and **Boxed**. The depth can then be set.

Use the following procedure to set the 3D Bearing Ratio variables.

1. To chose the scope of the 3D Bearing Ratio calculation, click in the empty checkbox to activate the variable field and place it in the recipe. **Either or both** options can be chosen.

   Choose up to three sets of calculations with different depths. If all boxes are checked, two calculations are performed for each of the three variable depths.
2. The depth is set down from the highest peak in the scan. It can be set in either microns (µm) or angstroms (Å). Determine which units are going to be used and, if a change is necessary, click the menu arrow under units to display its menu.
3. Click the desired unit signifier, **µm** or **Å**.

4. The **Depth** is the distance down from the top of the highest point in the scan. To set or change the **Depth**, double-click the current **Depth** variable and type in the new depth.

3D Material Volume (Vm)

The 3D Material Volume is a 3D version of the 2D Cutting Depth Ratio. It is set by using a ratio (percentage) of the overall data points below the highest peak in the scan to compute a material volume (Vm) with respect to a plane instead of area with respect to a single line trace.

In addition, two options are available for each of three parameter settings for calculating the 3D Material Volume. The scope of the calculation is set by clicking in ***one or both*** of the range boxes: **Full Scale** and **Boxed**. The depth can then be set.

Use the following procedure to set the 3D Material Volume variables.

1. To choose the scope of the 3D Material Volume calculation, click in the empty checkbox to activate the variable field and place it in the recipe. **Either or both** options can be chosen.

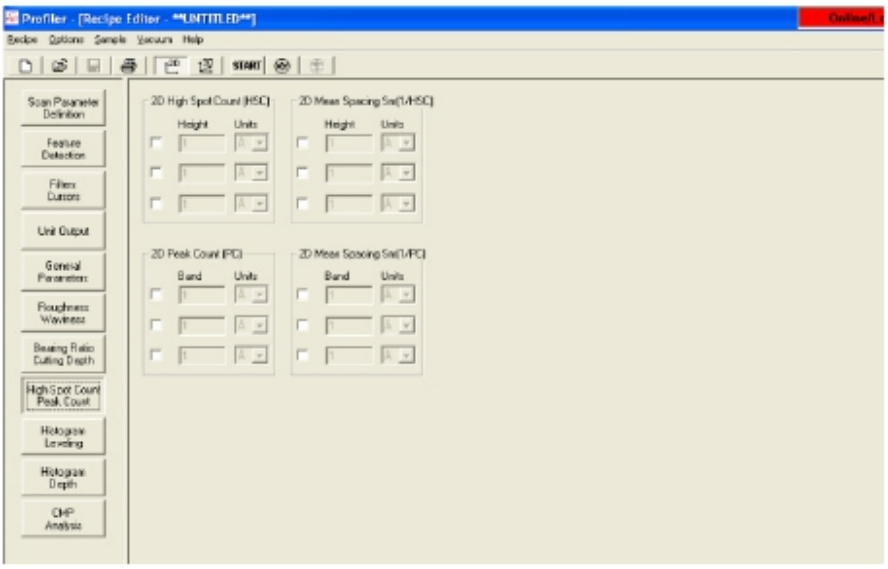
   Choose up to three sets of calculations with different depths. If all boxes are checked, two calculations are performed for each of the three variable depths.

2. The depth is set down from the highest peak in the scan. It can be set in either microns (µm) or angstroms (Å). Determine which units are going to be used and, if a change is necessary, click the menu arrow under units to display its menu.
3. Click the desired unit signifier, **µm** or **Å**.
4. The **Depth** is the distance down from the top of the highest point in the scan. To set or change the **Depth**, double-click the current **Depth** variable and type in the new depth.

High Spot Count and Peak Count

Access the High Spot Count and Peak Count Display Window by clicking the **High Spot Count/Peak Count** button in the Recipe Editor. (See *Figure 3.51*.)

Figure 3.51 *Bearing Ratio and Cutting Depth Parameters*



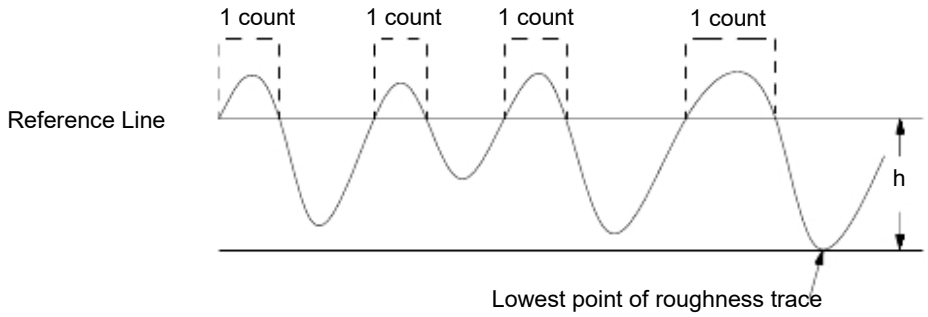
High Spot Count (HSC)

High Spot Count is the number of profile peaks per unit of length projecting through a reference line parallel to and at a given height above, a line drawn parallel to the mean line through the lowest point of the roughness trace. (See *Figure 3.52*).

The mean line is the line at the mean height of all data. Another line is drawn through the lowest point in the trace, parallel to the mean line. The reference line is at a user specified height above the lowest point line.

Projecting through means that the profile curve first climbs above the reference line and then falls below it. Thus, if the profile rises above the reference line, descends without falling below it, then rises again, multiple peaks are not identified.

Figure 3.52 *High Spot Count*



Use the following procedure to set the 2D High Spot Count variables.

1. The option exists to create three 2D High Spot Count parameters. Click in up to three empty checkboxes to put a check (✓) in them and activate their variable boxes.
2. The height can be set in either microns (µm) or angstroms (Å). Determine which units are going to be used and, if a change is necessary, click the menu arrow under units to display its menu.
3. Click the desired unit signifier, **µm** or **Å**.
4. The **Height** is the distance **up** from the lowest point of the roughness trace.

   To set or change the Height, double-click the current **Height** variable and type in the new height.

2D Mean Spacing Sm (1/HSC)

Mean Peak spacing is the mean value of the local peak spacing of the profile within the sampling length. The peaks for High Spot Count are defined by the Height parameter from the High Spot Count window. ***Spacing*** is the inverse of the count.

It is important to note that the **2D High Spot Count (HSC)** and the **2D Mean Spacing Sm (1/HSC)** are related. If running a scan in which these values are to be compared, the ***height*** **of both must be identical** for the data to have direct correlation.

Use the following procedure to set the 2D Mean Spacing Sm variables.

1. The option exists to create three 2D Mean Spacing Sm parameters. Click in up to three empty checkboxes to put a check (✓) in them and activate their variable boxes.
2. The height can be set in either microns (µm) or angstroms (Å). Determine which units are going to be used and, if a change is necessary, click the menu arrow under units to display its menu.
3. Click the desired unit signifier, **µm** or **Å**.

4. The **Height** is the distance **up** from the lowest point of the roughness trace. In most scans, this value is compared to High Spot Count (HSC) so this height must be identical to the **Height** in **High Spot Count (HSC)**.

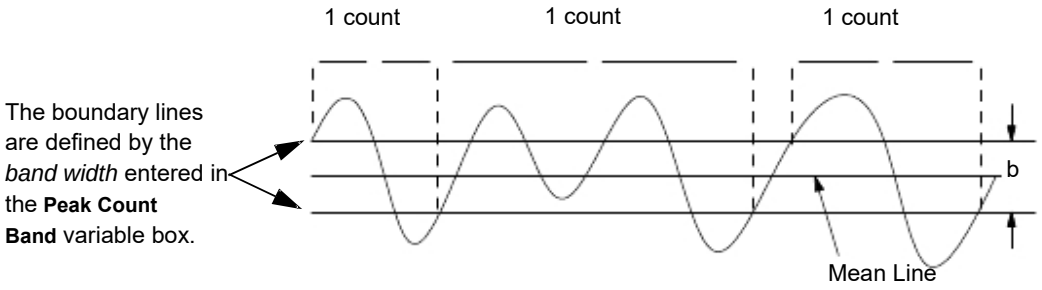
   To set or change the Height, double-click the current **Height** variable and type in the new height.

2D Peak Count (PC)

Peak Count is the number of peak and valley pairs per unit length projecting through a band of width **b** centered about the mean line. (See *Figure 3.53*.)

The Mean line is the line at the mean height of all data. The band is the area bounded by two lines running parallel to the mean line, at an equal distance from the mean line.

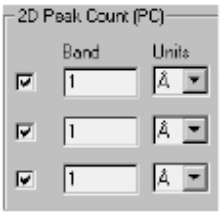
Figure 3.53 *Peak Count*



Use the following procedure to set the 2D Peak Count variables.

1. The option exists to create three 2D Peak Count bandwidth settings. Click in up to three empty checkboxes to put a check (✓) in them and activate their variable boxes. (See *Figure 3.54*.)

   Figure 3.54 *2D Peak Count (PC)*



2. The bandwidth can be set in either microns (µm) or angstroms (Å). Determine which units are going to be used and, if a change is necessary, click the menu arrow under units to display its menu.
3. Click the desired unit signifier, **µm** or **Å**.
4. The **Band** is the bandwidth surrounding the mean line. (See *Figure 3.53*.)

   To set or change the Band, double-click the current **Band** variable and type in the new bandwidth. (See *Figure 3.54*.)

2D Mean Spacing Sm (1/PC)

Mean Peak spacing is the mean value of the local peak spacing of the profile within the sampling length. The peaks for Peak Count are defined by the **Band** (bandwidth) parameter from the Peak Count (PC) window. ***Spacing*** is the inverse of the count. (See *Figure 3.53.*)

It is important to note that the **2D Peak Count (PC)** and the **2D Mean Spacing Sm (1/PC)** are related. If running a scan in which these values are to be compared, the ***bandwidth* of both must be identical** for the data to have direct correlation.

Use the following procedure to set the 2D Mean Spacing Sm

1. The option exists to create three 2D High Spot Count parameters. Click in up to three empty checkboxes to put a check (✓) in them and activate their variable boxes.
2. The bandwidth can be set in either microns (µm) or angstroms (Å). Determine which units are going to be used and, if a change is necessary, click the menu arrow under units to display its menu.
3. Click the desired unit signifier, **µm** or **Å**.
4. The **Band** is the bandwidth bordered equidistant above and below the mean line of the scan. In most scans, this value is compared to **Peak Count (PC)** so this **Band** (bandwidth) must be identical to the **Band** in **Peak Count (PC)**.

   To set or change the Band, double-click the current **Band** variable and type in the new bandwidth.

Histogram Leveling and Depth Analysis

This tool has two purposes that are used in the analysis of the gathered data.

- First, the leveling of the data is accomplished based on a choice of data to be used as a leveling basis.
- Second, the data is compiled as a histogram for comparison of feature depth in the scan.

The parameters available in this window work on already accumulated data. Therefore, the parameters can be adjusted and recalculated over and over again on the same data to help analyze the scan results.

Both the leveling and the depth analysis histogram are discussed in this section.

Histogram Leveling

From the Recipe Editor, click the Histogram Leveling button to open the Histogram Leveling parameters.

Leveling Reference

The system offers the following data planes to choose from for leveling the scan data:

- Most Populous Plane
- Highest Plane
- Lowest Plane
- All Data Planes

The leveling takes place based upon the data points identified in one of the three data distribution planes identified above. The planes are associated with modes that are defined as a bin or group of bins that hold a significant number of data points. The total Z-axis distance of the scanned object is divided up into equal Z-axis portions called bins.

The data bins form a histogram generated by the scan data. The contents of the bins are set using the parameters displayed directly below the Leveling Reference variable box in the **Setup Analysis Tools** dialog box. The parameters are:

- Number of Bins
- Bin Z Range Data Inclusion
- % for Qualifying Neighboring Bins
- Minimum Mode Population

Number of Bins

Bins are actually ranges in the Z scan height. The total Z scan height is divided by the number of **Bins** chosen. Each bin presents the number of data points collected in its range, as compiled from data collected across the entire scan length.

Bin Z Range Data Inclusion

The histogram can be influenced by data points that are actually spikes in the scan. The user may remove this effect by setting bounds on the data to be included in the calculations. The bounds are the lower percentile and upper percentile of the Z range to be included.

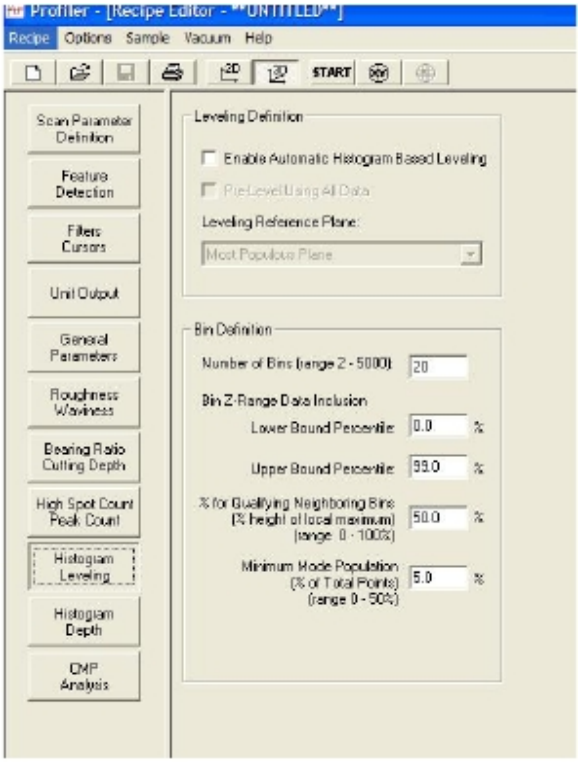
Percentage (%) for Qualifying Neighboring Bins

While it is possible to set up the bin distribution so that the points are clearly distributed in single bins, not spread over several bins, it is more likely that neighboring bins contain data points that, when taken together, constitute a mode. (See *Figure 3.60*.)

Minimum Mode Population

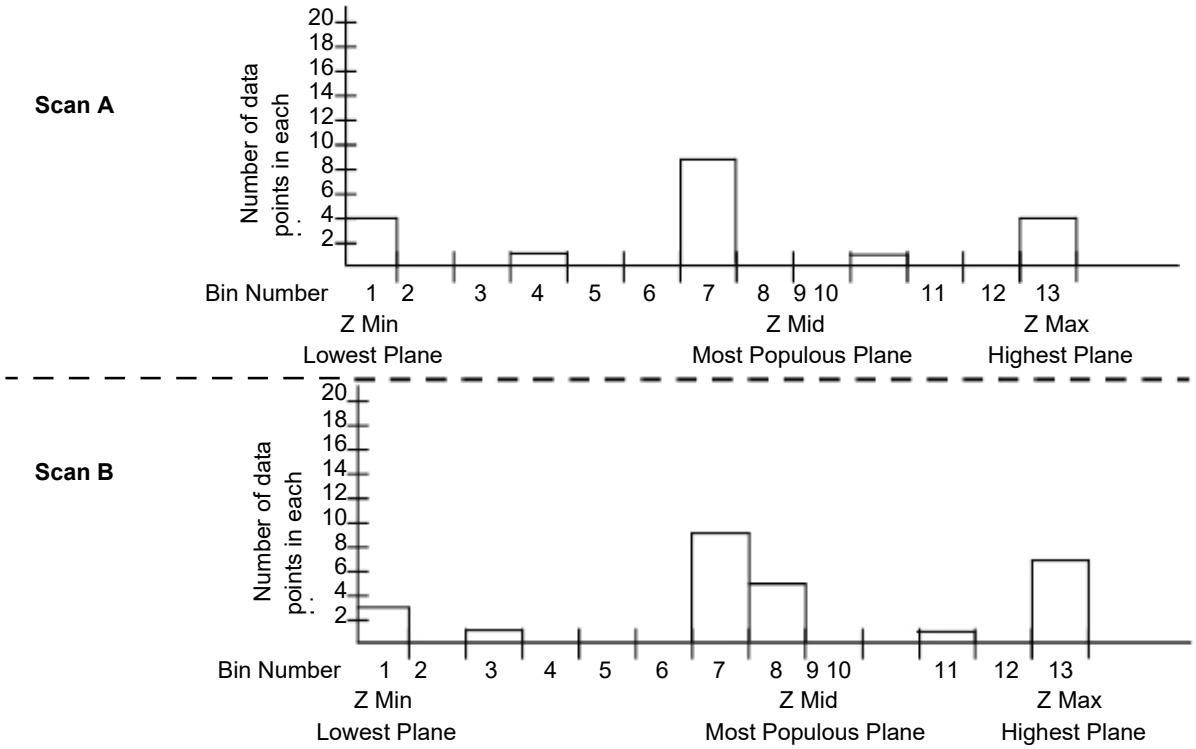
A mode may be identified that represents a cluster of data points but is not a true plane. The user may exclude this local mode by setting a minimum mode population that is a percentage of the total data points in the scan.

Figure 3.55 *Histogram Leveling Parameters*



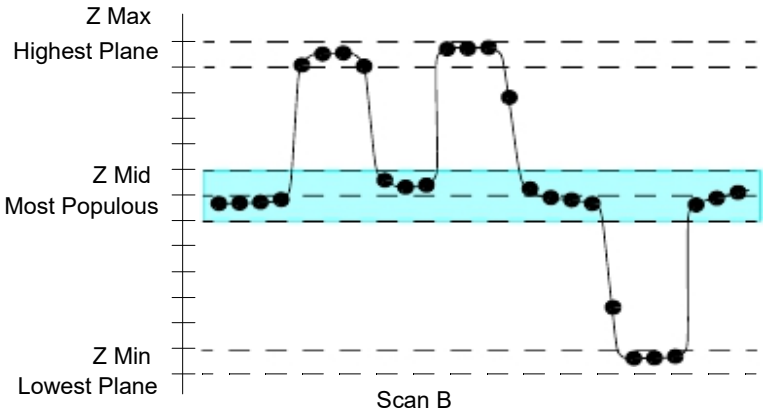
In *Figure 3.60*, Scan A shows that the major distribution of points lie clearly in Z Min, Z Mid, and Z Max. The histogram of this distribution would be clearly presented in three ranges. However, in Scan B, the distribution for the Z Mid is between two bins. One bin near the center has 9 data points while its neighbor has 5 points. The user might want this distribution of points to be considered together as a mode. This is where the **Percentage for Qualifying Neighboring Bins** is used.

Figure 3.56 *Histograms of Scans A and B*



The user can set a percentage factor such that, if the bin containing the most data points (reference bin) has a neighboring bin that contains the user set percentage of the number of data points in the reference bin, it is also considered as part of the same mode and used in the leveling procedure.

Figure 3.57 *Multiple Bins (Mode) Used to Define a Plane*



Leveling Reference

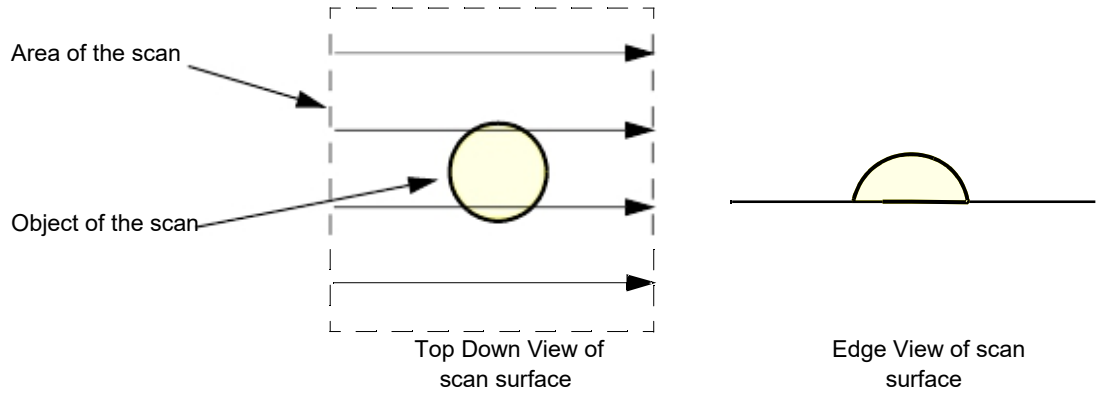
Three reference planes exist, from which one must be chosen to level the scan. Two of the planes are easy to understand and use; the Highest Plane and Lowest Plane.

- Highest Plane – Referring to *Figure 3.57*, the Highest Plane corresponds to the data set in the Z Max range (or mode if looking at the histogram).
- Lowest Plane – In the same illustration, the Lowest Plane corresponds to the data set in the Z Min range.

The following illustrations describe the most common scan situations and the possible difficulties associated with using the Most Populous Plane for leveling and data analysis.

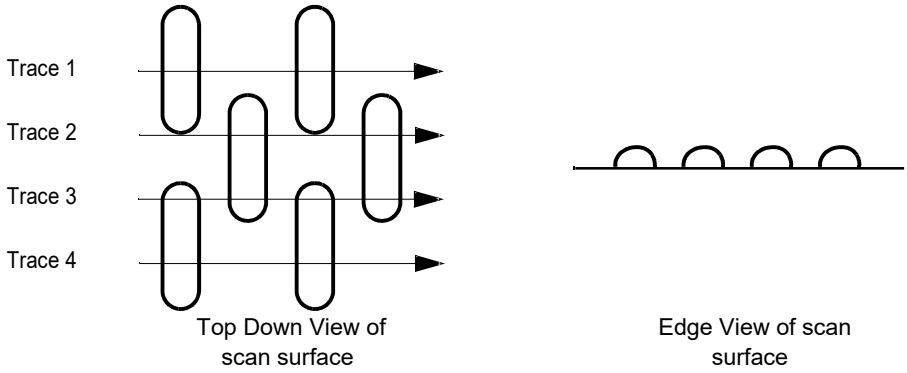
The Scan illustrated in *Figure 3.58* would be an acceptable candidate for Most Populous Plane. This scan is of a single attribute with a relatively large surface area surrounding it. No matter which scan trace is used, the sample surface level, in this case the Lowest Plane, would also be the Most Populous Plane. Either the Lowest Plane or the Most Populous plane could be used for leveling.

Figure 3.58 *Flat Surface Scan of a Single Object*



The scan illustrated in *Figure 3.59* would not be an acceptable candidate for Most Populous Plane. This scan has four traces that would give different data sets depending on which trace was used to level the scan. If Most Populous Plane was chosen as the leveling reference, traces 1, 2, and 4 would level the trace on the Lowest Plane of the scan. Trace 3 would level the trace on the Highest Plane of the scan. This would change the way the data is analyzed. The depths calculated from either of its two neighboring scans would be very different. Setup Analysis Tools – Leveling

Figure 3.59 *Most Populous Plane Trace Variation*



To activate Histogram Leveling, use the following procedure.

1. From the Recipe Editor, click **Histogram Leveling**.
2. Click in the empty **Automatic Histogram Based Leveling** checkbox.

Change **Leveling Reference**

3. The **Leveling Reference** – The leveling attribute must be tied to the available data set. The leveling algorithms are set up to operate on one of four data sets (planes), **Most Populous Plane**, **Highest Plane**, **Lowest Plane or All Data**.

Change **Number of Bins**

4. The **Number of Bins** – highlight the current number in the Number of Bins variable box and enter the new number of bins to be used.

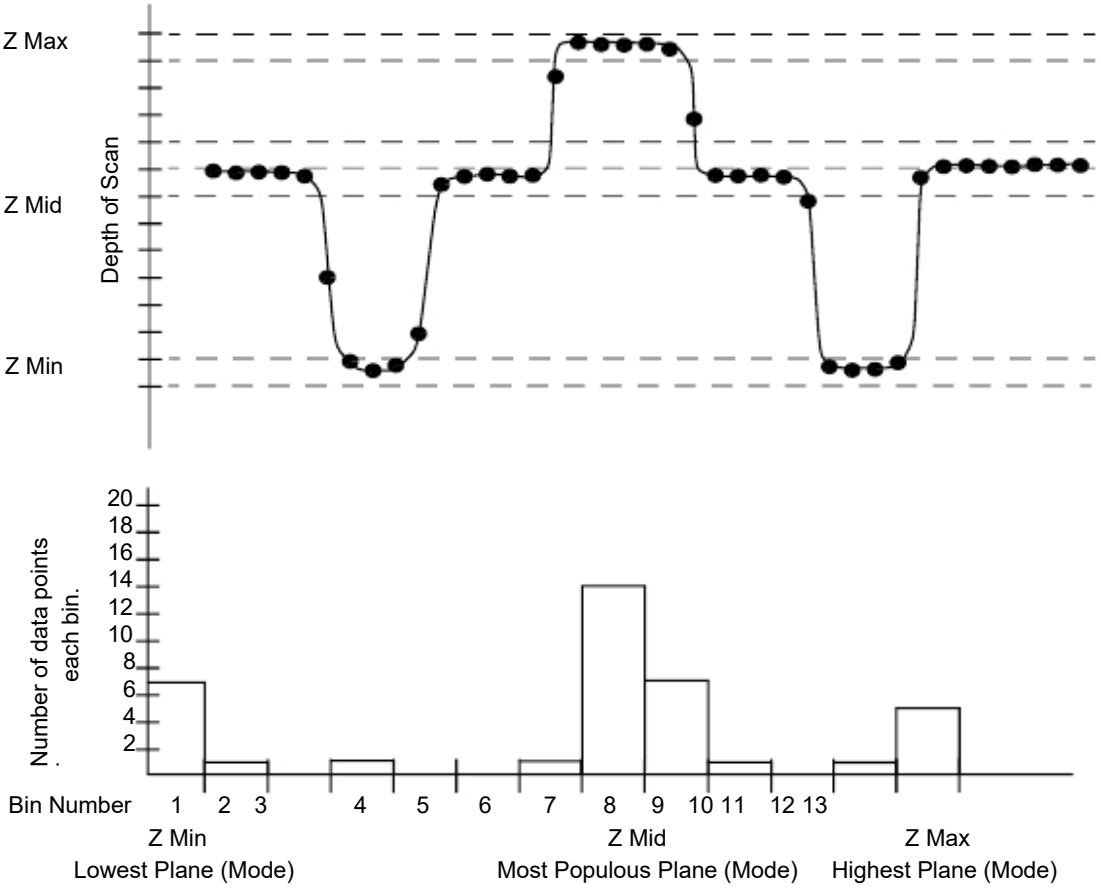
   Remember, the more bins, the fewer number of data points each bin might contain. Be sure to carefully evaluate the distribution of data points in the bins so that the percent **for Qualifying Neighboring Bins** can ensure that the proper number of points are included in the calculated modes for the leveling procedure.

Change the percent for qualifying neighboring bins

5. **Percent for qualifying neighboring bins** – Highlight the current percentage, in the **percent for qualifying neighboring bins** variable box, and enter the new percentage.

   Remember, the number of bins is divided up in equal spacing increments across the entire depth of the scan. The more bins, the more significant the **percent for qualifying neighboring bins** becomes. This number, as well as the other attributes in this window can be adjusted after the scan data is collected; so assessing the data might help adjust the percentage to include all necessary data points.

Figure 3.60 *Histogram of a Scan*



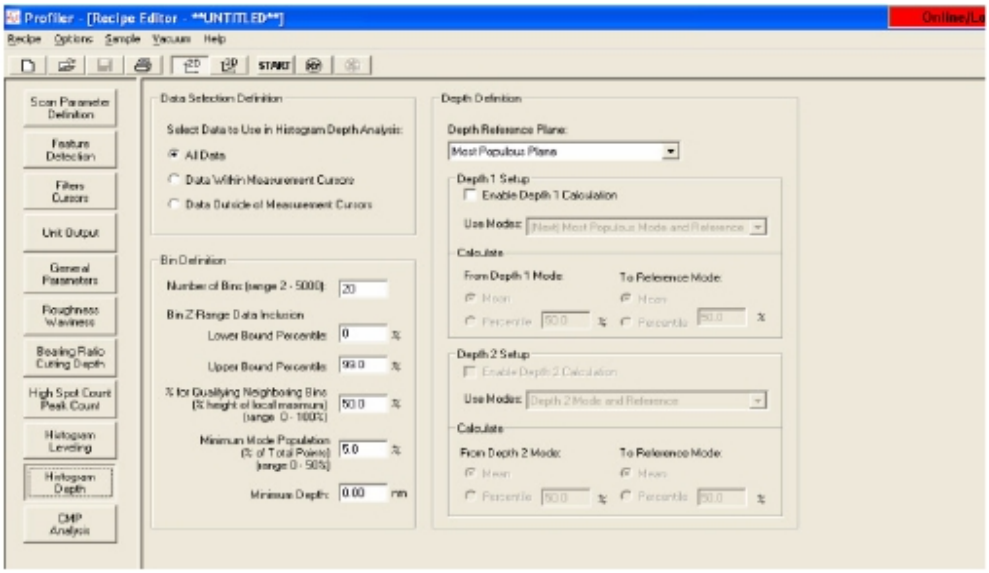
In the Histograms, the different planes (modes) are color coded for easy reference and identification. The Histogram is displayed in green. The major modes, when displayed, appear in red.

6. After all adjustments are complete, click **OK** to save the changes, or **Cancel** to discard the changes.

HISTOGRAM DEPTH

The Histogram Depth tool is used in the analysis of the gathered data to calculate step height for two reference planes. The data is compiled as a histogram for calculating the feature depth in a way similar to the Histogram Leveling tool. Users can check the **Enable Depth 1 Calculation** checkbox to set up the first depth calculation, and select the **Enable Depth 2 Calculation** checkbox to set up the second depth calculation. See *Figure 3.61*.

Figure 3.61 *Histogram Depth*



CMP ANALYSIS

Introduction

CMP (Chemical Mechanical Polishing) processes are used on a variety of different surface compositions. In general, the analysis of CMP surface scans centers around three structures: arrays, lines, and pads. The analysis can be performed in 2D or 3D scans. Each basic structure is discussed in its own section.

Figure 3.62 *CMP Analysis - Lines or Array*

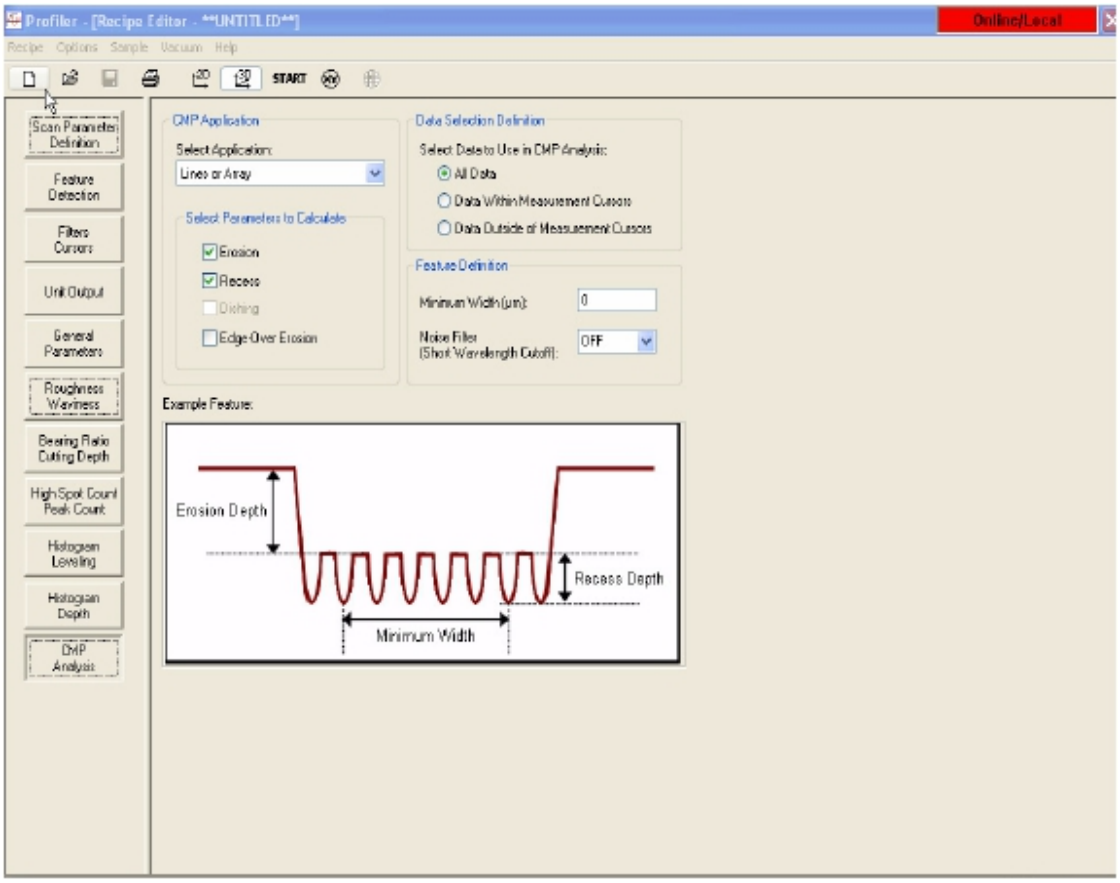
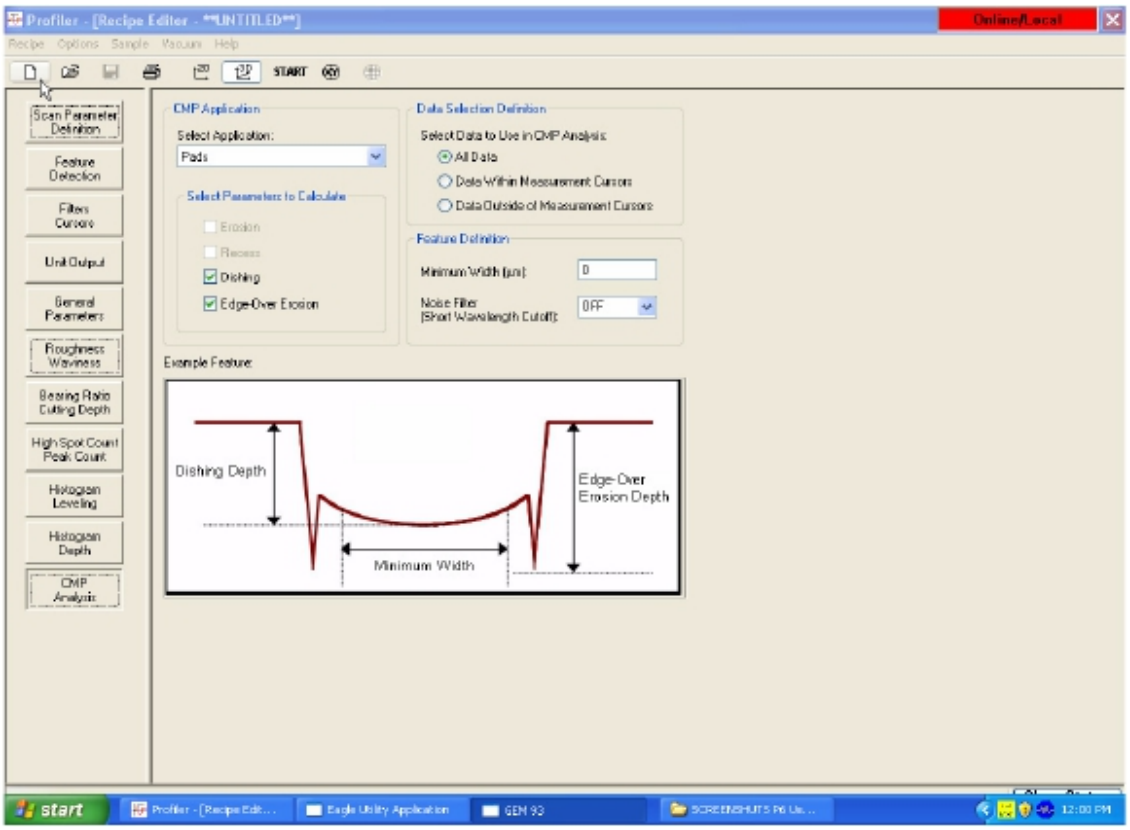


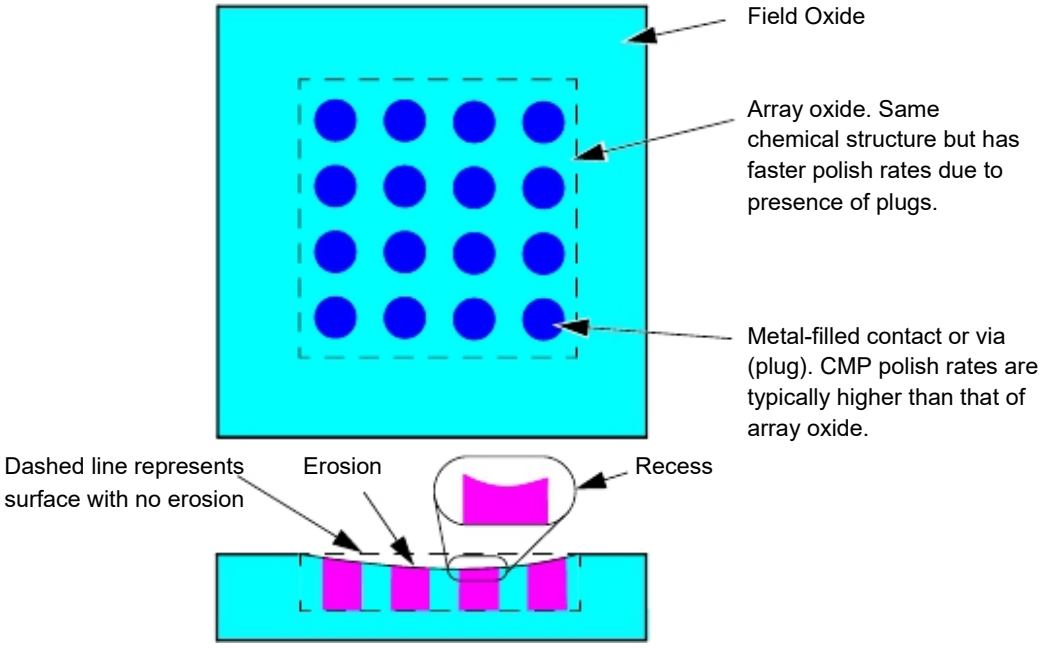
Figure 3.63 *CMP Analysis - PADS*



Arrays

For the purposes of this analysis, "array" is defined as an array of contacts or vias (plugs). The contacts or vias are usually a metal like tungsten or copper which typically have polish rates higher than that of the surrounding array oxide. The basic composition of a sample array is illustrated in *Figure 3.64*.

Figure 3.64 Sample Array



Using the ARRAY Analysis Routine

This routine is designed to perform analysis on both 2D and 3D Profiler data. The same set of input parameters are used for 2D and 3D data belonging to a single recipe, e.g., 2D slices from a 3D data set. **The routine is intended for use with array profiles that have negligible recess and considerable erosion**. It can calculate both erosion and recession.

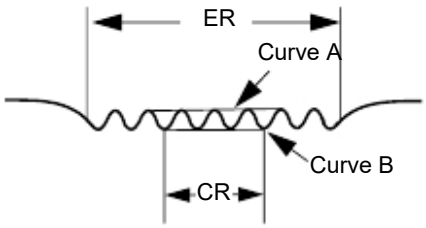
CAUTION: The Array Analysis algorithm assumes that there will be a flat profile at the beginning of the scan and at the end of the scan. Therefore, the scan must start in the field oxide and end in the field oxide so that the required flat regions border the scan target.

Analysis Process

The analysis is performed on Normal data as described in the following sequence:

1. The "erosion region" (ER) is found by determining the minimum and maximum slopes in the profile.
2. The "calculations region" (CR) is defined as some fraction of the ER.

Figure 3.65 ER and CR

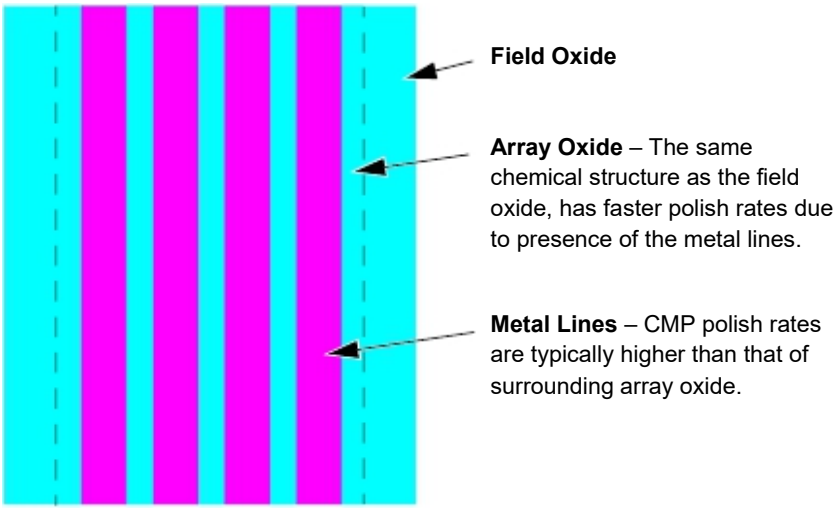


3. Determine the local maxima within the CR.
4. Determine the local minima within the CR.
5. Using the local maxima, interpolate to obtain a curve that fits those points (curve A).
6. Using the local minima, interpolate to obtain a curve that fits those points (curve B).
7. Calculate the average of curve A. This is the erosion value.
8. Calculate the average of curve B. Subtract the erosion value from this average to obtain the recess value.

Lines

For the purposes of this analysis, "lines" is defined as an intermittent distribution of metal and oxide lines. The metal line are usually a soft metal like aluminum or copper which typically have polish rates higher than that of the surrounding array oxide. The basic composition of a sample set of lines is illustrated in *Figure 3.66*.

Figure 3.66 Sample Array of Lines



Using the LINES Analysis Routine

The LINES routine assumes that the lines are running parallel to each other. The scan path must be perpendicular to the lines. This routine is designed to perform analysis on both 2D and 3D Profiler data. The same set of input parameters are used for 2D and 3D data belonging to a single recipe, e.g., 2D slices from a 3D data set. The analysis is intended for profiles exhibiting both recess and erosion. It calculates both erosion and recession.

CAUTION: The algorithm assumes that there will be a flat profile at the beginning of the scan and at the end of the scan. Therefore, the scan must start in the field oxide and end in the field oxide so that the required flat regions border the scan target.

Analysis Process

The analysis is performed on Normal data as described in the following sequence:

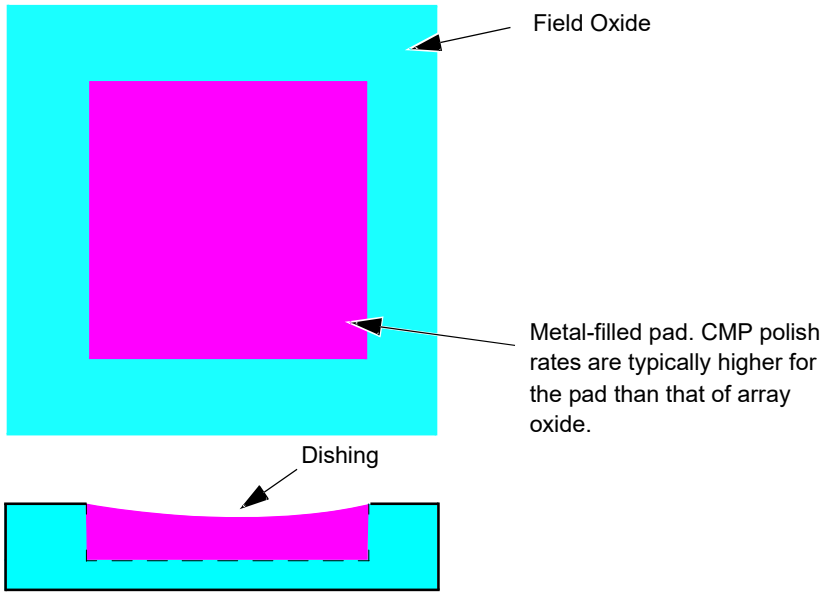
1. The "erosion region" (ER) is found by determining the minimum and maximum slopes in the profile.
2. The "calculations region" (CR) is defined as some fraction of the ER.

3. Determine the vertical range of data within the CR.
4. Determine the local maxima within the CR using a window of variable size. The size of the window is roughly equivalent to the pitch of the lines. The Tolerance is used to calculate the size of this window for each individual data point.
5. Determine the local minima within the CR using a window of variable size. The size of the window is roughly equivalent to the pitch of the lines. The Tolerance is used to calculate the size of this window for each individual data point.
6. Using the local maxima, interpolate to obtain a curve that fits those points (curve A).
7. Using the local minima, interpolate to obtain a curve that fits those points (curve B).
8. Calculate the average of curve A. This is the erosion value.
9. Calculate the average of curve B. Subtract the erosion value from this average to obtain the recess value.

Pads

For the purposes of this analysis, "pads" is defined as a larger region of metal surrounded by an oxide. The pads are usually a soft metal like Aluminum (Al) or Copper (Cu), which typically have a polish rate higher than that of the surrounding oxide. The basic composition of a sample pad is illustrated in *Figure 3.67*.

Figure 3.67 Sample Pad



Using the PADS Analysis Routine

This routine is designed to perform analysis on both 2D and 3D Profiler data. The same set of input parameters are used for 2D and 3D data belonging to a single recipe, e.g., 2D slices from a 3D data set. The routine is intended for use with pad profiles to calculate dishing.

Analysis Process

CAUTION: The algorithm assumes that there will be a flat profile at the beginning of the scan and at the end of the scan. Therefore, the scan must start in the field oxide and end in the field oxide so that the required flat regions border the scan target.

The analysis is performed on Normal data as described in the following sequence:

1. Find the "erosion region" ER by finding the minimum and maximum slopes in the profile.
2. The "calculations region" (CR) is defined as some fraction of the ER.
3. Calculate the average of all data points within the calculation region. This will be the dishing value.

FEATURE FIND

Feature Find is a function used to locate a feature using scan data for improved positioning accuracy. For example, it can be used to find the center of a 10 µm box, allowing the measurement scan to be performed through the center of the box. Not only does it improve positioning accuracy, but it can improve measurement repeatability since the analysis can be better tailored to the feature, i.e., cursor placement, and it can reduce sample variation error, such as variation in the y-direction.

Feature Find can be used in Contact Mode, with the sample and sensor stage. The options will change depending on the scan mode and stage used for the scan, but the basic concept is the same for all Feature Find scans. The function works by analyzing data as it is collected and once a feature is scanned that meets the specified criteria, the Feature Find scan is stopped and the measurement scan is performed with the coordinates found as the center of the feature becoming the center of the measurement scan. For example, if you are trying to find a 10 µm line, the system performs scans in the x-direction until one of the scan lines contains the 10 µm line. Once the 10 µm line is found the Feature Find scans are stopped and the measurement scan is performed with 10 µm line at the center of the scan. The real-time analysis of the scan data enables Feature Find to find a feature faster since it does not have to perform all lines specified in the Feature Find scan.

Figure 3.68 shows the Feature Find parameter definition tab in the recipe. It can be accessed by placing a check-mark in the box called Find in the scan

recipe and then clicking the Define button. If the option Model Feature is selected the recipe editor selections will change slightly to display different options. *Table 3.27* contains a short description of the recipe parameters. Each parameter is discussed in detail as well.

Figure 3.68 *Feature Find Parameter Definition*

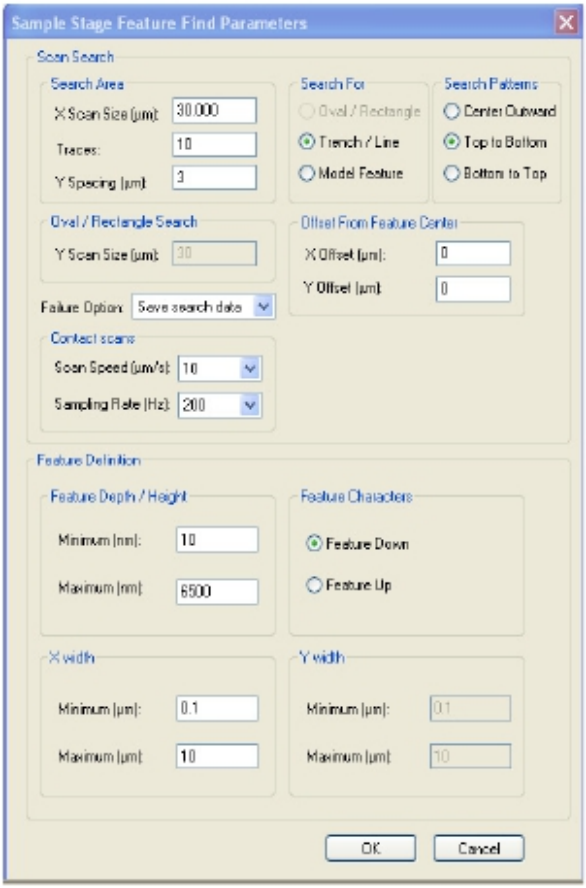


Table 3.27 *Feature Find Recipe Parameters*

Parameter Setting	Sensor or Sample	Oval, Trench or Model	Description
Trench/Line	Both	Trench	Feature Find scan looks for a feature that has dimension in the x direction only, such as a trench.
Model Feature	Both	Model	Feature Find scan looks for the model, which is a saved scan, performing a pattern recognition match.
Search Patterns	Both	All	Defines the pattern for data collection during the feature find scan, such as center outward.

Table 3.27 Feature Find Recipe Parameters (Continued)

Parameter Setting	Sensor or Sample	Oval, Trench or Model	Description
X Scan Size (μm)	Both	All	X direction scan size of the feature find scan
Traces	Both	All	This is the maximum number of x direction scans performed during the x portion of the search.
Y-Spacing (μm)	Both	All	This is the distance between x direction scans performed during the x portion of the search.
Scan Speed (μm/s)	Both	All	The speed at which the x direction scans are performed.
Sampling Rate (Hz)	Both	All	The rate at which data points on the scan are recorded for analysis.
Failure Option	Both	All	Action taken if the Feature Find scan fails to find a feature.
Scan-Offset from Center (μm)	Both	All	After a feature is found, these offsets are added to the found offsets, shifting the measurement scan location.
Feature Characters	Both	Oval and Trench	Defines the feature as above (line) or below (trench) the sample surface.
Feature Depth/Height (nm)	Both	Oval and Trench	Defines the minimum and maximum feature heights that will be accepted as the defined feature.
X width (μm)	Both	Oval and Trench	Defines the minimum and maximum feature x length that will be accepted as the defined feature.
Model	Both	Model	The model is a saved 3D scan that is used to locate the same feature during the Feature Find scan.
Matching Methods	Both	Model	Defines what pattern recognition algorithm will be used to match scan data with the model.
Matching Scores	Both	Model	Defines the minimum and maximum pattern recognition score that will be accepted as the defined feature.
Reference Point (μm)	Both	Model	Defines a point within the model that will be the center of the measurement scan.

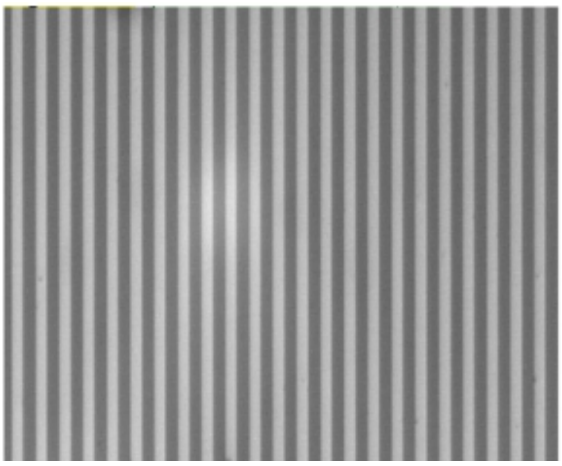
Search For: Trench / Line

Trench / Line feature definition is for features that have dimensions in the x direction only, such as the features shown in*Figure 3.69, Trench / Line Features*. When performing the Feature Find scan, it first performs an x direction scan trace. At the end of the trace, it analyzes the data to see if any features in the scan meet the defined requirements, which are discussed in detail later in the chapter. If a feature is not found, the stage is stepped in the y direction by the specified amount and another x scan is performed. This

process continues until a feature is found or until all x scan lines have been attempted. If no x scan lines find a feature, then the Feature Find scan failed. If during any of the x scan lines a feature is found that meets the requirements, the remaining x scans are canceled and the found coordinate becomes the Feature Find offset, which is the center point of the measurement scan. *See "Example: Trench / Line Search Method for a 5 µm Line" on page 3-87* for clarification on the search method.

The Trench / Line search option can be selected for sensor or sample stage scans. This option can be used for Contact and Dipping modes.

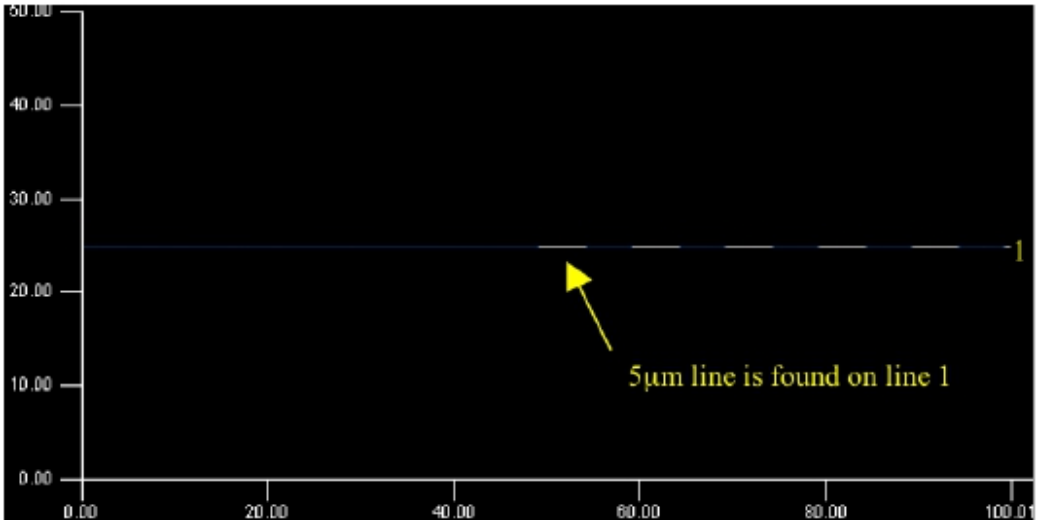
Figure 3.69 *Trench / Line Features*



Example: Trench / Line Search Method for a 5 µm Line

- One x direction scan is performed in a Center Outward search pattern, with the 5 µm line found on the first line.
- Since multiple lines are contained in the scan, the first line that meets the Feature Find criteria is the found feature.
- The x offset, plus the offset in the y direction for the current line from scan center becomes the Feature Find offset for the measurement scan.
- In the scan in *Figure 3.70*, the center is (50 µm, 25 µm), and the feature is found at (52 µm, 25 µm), so the offset from scan center is (2 µm, 0 µm).

Figure 3.70 *Trench / Line Scan*

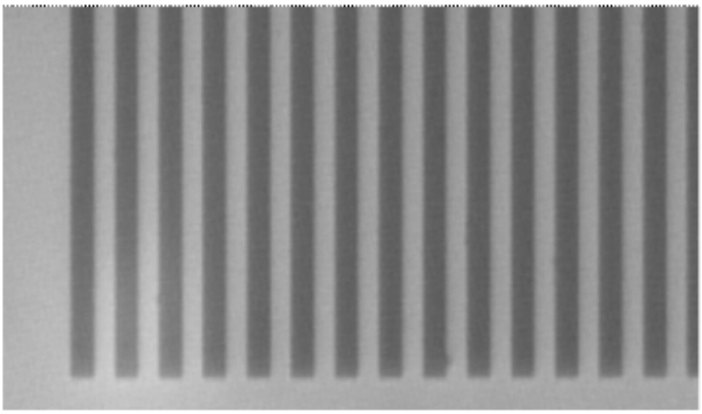


Search For Model Feature

Model Feature definition is for features that are not easily defined as a rectangle or line. These features can be of irregular shape, an edge, or attempting to find a feature at the edge of an array for repeatability testing, as shown in *Figure 3.71*. Instead of looking for features based on the dimensions of the features in x, y, and z, it performs a pattern recognition operation comparing the current scan data to a saved scan data model. The model is discussed in more detail later in the chapter. When performing the Feature Find scan, it first performs an equal number of x direction scan traces as the size of the model used. Once this is complete, it then compares the scan data to the saved model. If the model is not found, the stage is stepped in the y direction by the specified amount and another x scan is performed. This process continues until the model is found or until all x scan lines have been attempted. If the model is not found, then the Feature Find scan failed. If during any of the x scan lines the model is found, the remaining x scans are canceled and the found coordinate becomes the Feature Find offset, which is the center point of the measurement scan. See "Example: Model Feature Search for the Edge of an Array of 5µm Lines" on page 90 for clarification on the search method.

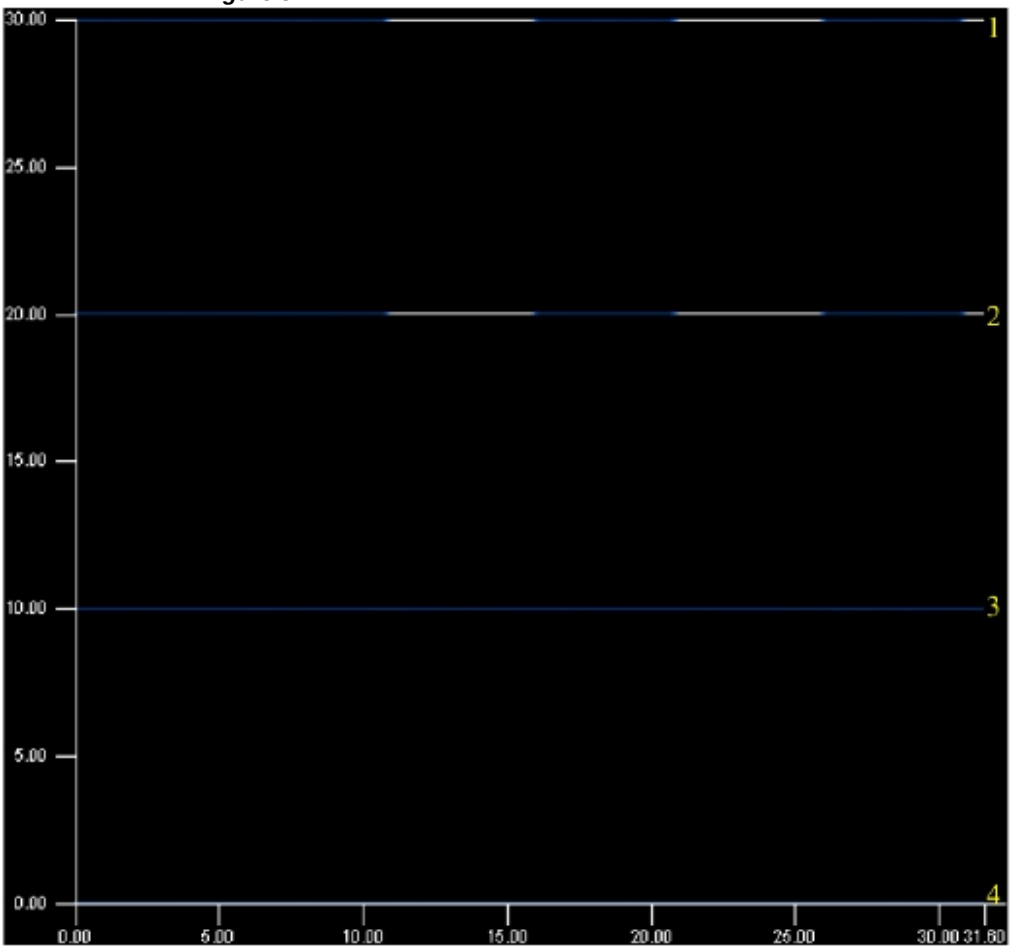
The Model Feature search option can be selected for sensor or sample stage scans. This option can be used for Contact and Dipping modes.

Figure 3.71 *Edge of an Array of 5 µm Lines*



Scan data is saved as model, such as the model shown below. This model is for the edge of the array, with the top two lines including the 5 µm lines and the bottom two lines including the flat surface below the array.

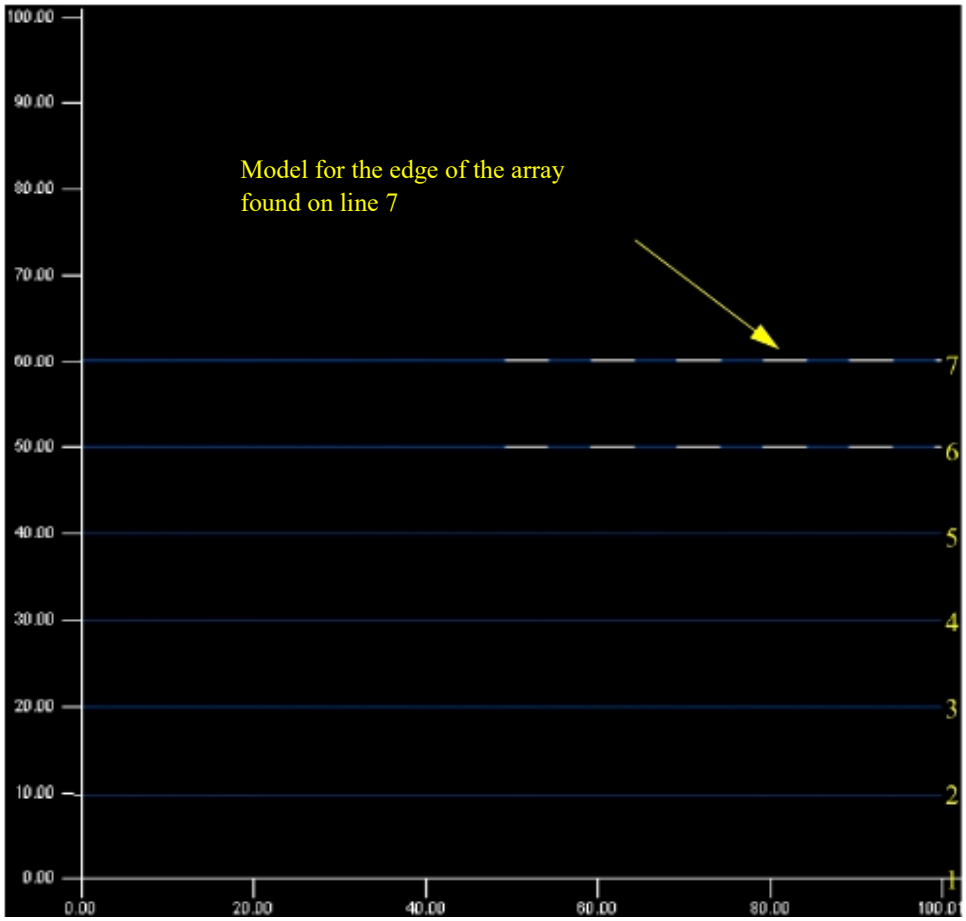
Figure 3.72 *Model Feature Search for the Edge of an Array of 5 µm Lines*



Example: Model Feature Search for the Edge of an Array of 5µm Lines

- Four x scans are performed, lines one through four, from Bottom to Top, to build a scan size equal to the number of lines as the model size.
- Since the model is not contained in the first four lines, additional lines are collected until the seventh line is completed. At this point the Feature Find scan is stopped since the model is contained in lines four through seven.
- The x offset, plus the offset in the y direction for the model location from scan center becomes the Feature Find offset for the measurement scan.
- In the scan in *Figure 3.73*, the center is (50 µm, 50 µm), and the feature is found at (50 µm, 50 µm), so the offset from scan center is (0 µm, 0 µm).

Figure 3.73 *Model Feature Scan*



Search Patterns: Center Outward, Top to Bottom, or Bottom to Top

There are three different search patterns that can be used in combination with any of the search types. All of the search patterns can be used with sensor or sample stage measurements. The search pattern used should be set based upon feature properties and the surroundings.

A Center Outward search should be used when looking for an isolated feature, such as an isolated contact or the 5µm box shown in *Figure 3.68*.

The Center Outward search is done by performing an x scan in the center of the search area, then alternating above and below the center of the search area by the y step size. For Model Feature the search pattern is basically the same, but it will perform multiple scan lines equal to the model size each time it shifts above or below the center of the search area. A Center Outward search pattern is displayed in the Trench / Line illustration, see *Figure 3.70*.

A Top to Bottom or a Bottom to Top search should be used when the approach direction of the Feature Find scan can affect the result of Feature Find or find the pattern faster. The Model Feature illustration, *Figure 3.72*, used a Bottom to Top search which would be the best method for this scan since the edge of the lines array is at the bottom of the scan.

X Scan Size (µm)

This defines the size of the scan in the x direction, which should be at a minimum three times larger than the feature size. In general, it should be even larger to account for positioning error. The X Scan Size will need to be set for all search types, with some specific restrictions for Model Feature that are discussed in detail later in the chapter. When setting up a sample stage recipe, there are limits on the scan size, but for most applications the limit will not be reached, so it is not discussed in detail in the User's Guide. When setting up a sensor stage recipe, the allowable size of the x scan is limited by the recipe x scan size and any offsets in the Feature Find definition, with total summing to less than the 90 µm scan size limitation for the sensor stage.

Traces

Traces are the number of parallel x direction scans that are performed in the Feature Find scan separated by the Y Spacing. The number of traces should be set so that the area searched is at least three times larger than the feature size. In general, it should be even larger to account for positioning error. Since the Feature Find algorithms operate in real-time after each scan line is performed, it does not hurt throughput to set the number of Traces higher than required, creating a robust recipe that will still find the feature for those cases where positioning error is higher than normal. The number of Traces will need to be set for all search types, with some specific restrictions for Model Feature that will be discussed in detail later in the chapter. When setting up a sample stage

recipe, the number of Traces is limited to 2000. When setting up a sensor stage recipe, the allowable number of Traces is limited to 200 and is also limited by the recipe y size, and Feature Find Y Spacing and any offsets, with the total summing to less than the 90 µm scan size limitation for the sensor stage. In addition, if Oval / Rectangle search type is used, the Y Size for this scan also limits the number of traces.

Y Spacing (µm)

Y Spacing is the distance between traces. When searching for an isolated feature, the Y Spacing should be set at about two thirds of the feature size. As shown in a previous example, when searching for a 5 µm box, the Y Spacing should be set to about 3.5 µm. If it is set larger, then the Feature Find scan can step over the box entirely and not find it during the scan. If the Y Spacing is set smaller than 3.5 µm, then throughput is decreased since a larger number of lines are required to find the feature. When searching for a feature in an array of identical features, the Y Spacing should be set at about two thirds of the pitch between features in the y direction. Again, this allows for a quicker search than setting at a smaller value. It should never be set at the pitch in the y direction since this can result in no features being found since each x scan line will be run on similar features.

Scan Speed (µm/s)

The Scan Speed should be set with the same guidelines as discussed in the Contact Mode section of the scan recipe chapter.

Sampling (Hz)

The Sampling Rate should be set with the same guidelines as discussed in the Contact Mode section of the scan recipe chapter.

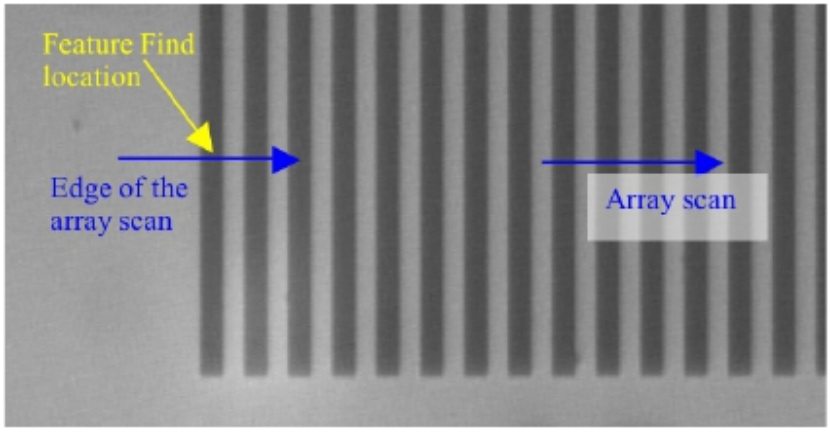
Failure Option: Save Search Data, Skip Current Scan, or Scan at Center

The choice of Failure Option depends on the preference of the user and the purpose of the Feature Find scan. When running a recipe with a Feature Find scan in a sequence recipe, if the option to Save Search Data is selected, after the Feature Find fails, it will save the x scan search data in the sequence data set and proceed to the next measurement site. Although the y search scan is not saved sequence data set, a diagnostic option can be enabled to save the x and y search scan for an Oval / Rectangle search pattern to a simple binary file for failure analysis. Similarly if Skip Current Scan is selected, after the Feature Find fails, it will skip the current site and proceed to the next site, without saving the data to the sequence data set. This option is not recommended since the Failure Option to Save Search Data also skips the current site and the data is saved for failure analysis. The Scan at Center failure option is generally used if the Feature Find scan is being used as a delay mechanism. For example, after the stylus is nulled on the sample surface, the elevator does not stop all motion. On a nanometer scale, there is still some small motion of the elevator and isolation table. Feature Find can be used as a delay before the measurement scan begins to allow the elevator and isolation table to reach equilibrium. For a 3D scan that will take a long amount of time, the extra time for the Feature Find scan can help to make a better looking image.

Scan Offset from Center (µm)

The Scan Offset from Center will add the specified offset to the feature that was found. This can be useful if the feature that you want to scan cannot be easily found with one of the search types, but there is a nearby feature that can be easily found, as shown in *Figure 3.74*. For example, if the user wants to look at micro-loading effects where a different etch depth will be seen at the open area near the edge of the array compared to within the array. Two recipes would be setup with each finding the edge of the array. In one recipe a scan would be done at the found coordinates and in the second recipe an offset would be applied so that the scan is performed within the array. In this case it is difficult or impossible to find a specific line within the array, but easy and fast to find the first line at the edge of the array.

Figure 3.74 *5µm Lines Measurement Pattern*



Feature Characteristics: Feature Down or Feature Up

When using the Oval / Rectangle and Trench / Line search types the user must define the physical characteristics of the feature. Feature Down or Feature Up defines if the feature is below or above the sample surface. For example, a line is a Feature Up and a contact would be a Feature Down.

Feature Depth / Height (nm)

When using the Oval / Rectangle and Trench / Line search types the user must define the physical characteristics of the feature. In the Feature Depth / Height the user must define the minimum and maximum feature depth that will be accepted as the correct feature. For robust Feature Find performance, the user should set the parameters relatively loose. For example, if the feature is a 500nm trench, the minimum and maximum should be set at about 350 to 650nm, respectively. The one exception to setting the parameters relatively loose is if there are similar features that would be contained in the Feature Find scan at a different depth. For example, if there is a 400nm trench near the 500nm trench, the minimum depth should be increased to about 450nm so that the 400nm trench is not found during the Feature Find scan.

X Width (µm)

When using the Oval / Rectangle and Trench / Line search types the user must define the physical characteristics of the feature. In the X Width the user must define the minimum and maximum feature width that will be accepted as the correct feature. The X Width that is used is the width at the sample surface. For example, when measuring a contact, the width is at the top of the contact. For robust Feature Find performance, the user should set the parameters relatively loose. For example, if the feature is a 1 µm trench, the minimum and maximum should be set at about 0.5 to 1.5 µm, respectively. There is one note of caution. The width tolerance, maximum minus the minimum, defines the

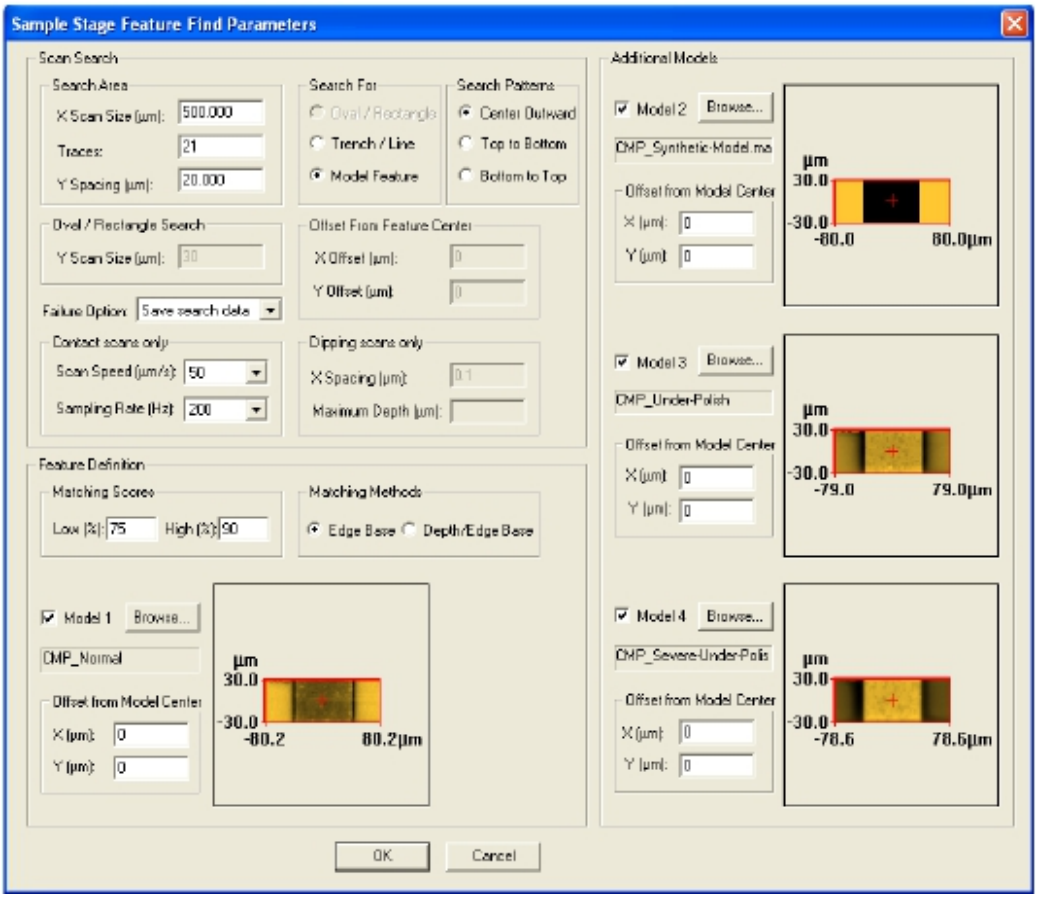
filter size for the Feature Find scan. So if the tolerance is set too large, then a large filter can be applied which will affect the scan and Feature Find search performance. In addition, if there are similar features that would be contained in the Feature Find scan at a different width, setting it too loose can result in finding the wrong feature, similar to the Feature Depth / Height restrictions.

Model

Figure 3.75 shows the Feature Find definition for Model Feature, which was discussed earlier in the chapter. Model Feature does not have the user define the dimensions of the feature in x, y, and z, but instead uses scan data as a model and compares this model to the Feature Find scan data as it is collected in a pattern recognition type operation. For Model Feature the user loads a model, which is a 3D scan data file. The model is created by running a 3D scan or by cropping a portion of a 3D scan to form the model. Cropping is discussed in more detail in a separate chapter of the User's Guide.

The model used must contain a minimum of three lines. When setting the X Scan Size in Feature Find definition, the scan length must be larger than the model size, with three times the model size the minimum scan length recommended. An even larger Feature Find scan is recommended to account for positioning error. In addition, the Y Spacing should be set at the same value as the Y Spacing from the model. Although Feature Find will interpolate the model Y Spacing if it does not match Feature Find Y Spacing, this results in unpredictable pattern recognition performance, so it is not recommended. The number of Traces must be set at a minimum equal to the number of lines from the model, but a larger number is recommended to account for positioning error.

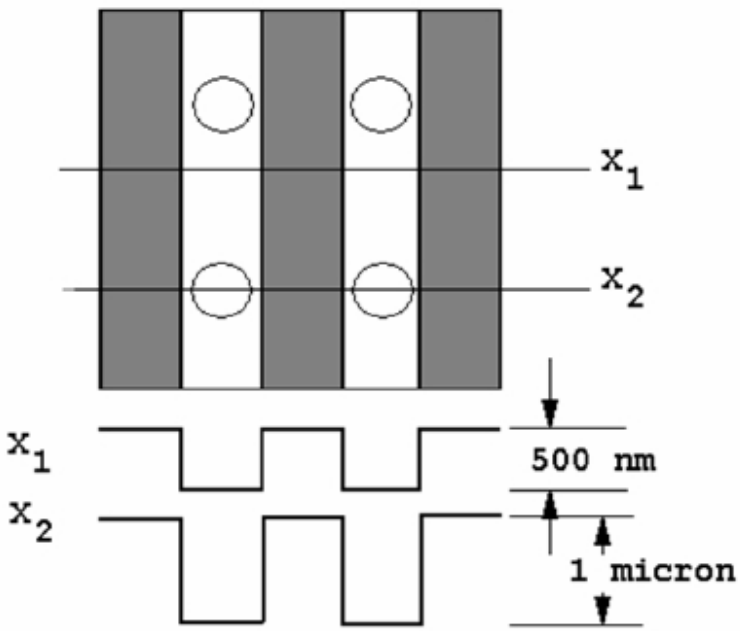
Figure 3.75 *Feature Find Definition for Model Feature*



Matching Methods: Edge Base or Depth Base

Edge Based matching method is the setting for most applications. It used the x and y edges of features in the model and compares it to the Feature Find scan data. When Depth Base matching method is selected, both Edge and Depth matching are used, with the pattern recognition score an average of the score from the Edge and Depth Based matching algorithms. This adds a comparison of the model depth, z direction match, to the matching method. Depth Base can be very useful if there are similar features that have the same x and y edges, but different depths. *Figure 3.76* shows a dual damascene structure where the edges will be in the same location, but depending on the location of the x direction scan, the depth will be different.

Figure 3.76 *Dual Damascene Example for Model Feature using Depth Based Matching*



Matching Scores

The Matching Scores function in the way as the scores for sequence recipe pattern recognition. As each Feature Find scan line completes, a pattern recognition score is given that shows how well the model matches the scan data. If the score is above the High score, the model is found in the scan data, the Feature Find scans stop, and the found location become the Feature Find offsets for the measurement scan. If the entire Feature Find scan is completed without a score larger than the High score, then algorithm looks for the largest score that is above the Low score. This score and the corresponding location become the Feature Find offsets for the measurement scan. If the Feature Find scan completes with all scores below the Low score, then the Feature Find scan fails. So the High and Low scores function in the same manner as the Minimum Score to Stop Groping and the Lowest Match Score from sequence pattern recognition operations, respectively

NOTE: The Model Feature pattern recognition scores will be shown on the status bar during the Feature Find scan. When optimizing the recipe, these scores should be noted to ensure that the High and Low matching scores are set properly. The pattern recognition algorithm will set all scores below the Low matching score to zero percent, even if they are non-zero. So during recipe optimization, set the Low matching score to one percent so that all scores are displayed on the status bar, allowing the user to find the best settings for the Matching Scores.

Reference Point (µm)

The Reference Point is the x and y coordinates relative to the center of the model that is used to define a different coordinate within the model as the found location of the Feature Find scan. Recall that the offsets found during the Feature Find scan become the center of the measurement scan. If the model used does not have the desired reference point at the center of model, the user can select a new location within the model as the reference point. This is done by selecting a location with the mouse. In *Figure 3.75*, the reference point shown is the center of the model, but in reality, the user might want the edge of the first line as the reference point, shifting it left by about 5 µm.

Diagnostic Options

This dialog box presents options that can be used to run diagnostic scans such as **No Motion** and **No Nulling** scans.

NOTE: Scans using these options should only be used by KLA–Tencor service personnel or applications engineers for diagnostic purposes only.

1. To display the **Diagnostic Options** dialog box:
   a. Click **Recipe** in the menu bar to display its menu,
   b. Click **Diagnostic...** from the drop-down menu.
2. This displays the **Diagnostic Options** dialog box.

   To chose an option for a diagnostic scan, click in the empty checkbox next to the desired option. A check (✓) in the checkbox indicates that the option is chosen.

   Each **Option** is discussed below.

CAUTION: Each of the options is active for the recipe in which it is saved. If the recipe is used as a template to create other recipes, the option will remain intact unless turned off. This could create numerous scan data deviations from the expected scan results.

3. Click **OK** when all required options have been chosen.

Diagnostic Options

Listed below are options located in the Diagnostic options window.

Table 3.28 *Diagnostic Options*

Option	Description
No Motion Scan	During the scan, data is collected but the stage does not move. **NOTE:** This scan is only available in 2D.
Do Not Null Before Scan	No movement of the elevator (for nulling) occurs before the scan is performed and the data collected.

Scan Options

This is a set of miscellaneous scan related options.

Table 3.29 *Standard - Diagnostic Options*

Option	Description
No Back Scan Before Scan	Back Scan is a technique where, immediately prior to the scan, the stage moves the scan start position back and begins the scan nulling and movement. The mechanical portion of the system has an opportunity to settle before actually reaching the beginning of the data collection. This option prevents the Back Scan positioning from taking place.
No Noise Filter	This prevents postprocessing of the scan data with cutoff filters.
No Leveling	This prevents postprocessing data leveling of scan data.
No Linearity Correction	Only used during the Linearity Calibration.

Linearity Calibration Only – Diagnostic Options

Table 3.30 *Linearity Calibration Only – Diagnostic Options*

Option	Description
Use Raw Data	Raw data from the scan is presented with no postprocessing; without scaling to the measurement range. **NOTE:** This option has no useful application apart from the Linearity Calibration.
No Stylus Arc Correction	Data from the scan is presented with no postprocessing arcal correction. **NOTE:** This option has no useful application apart from the Linearity Calibration.

Entering Comments

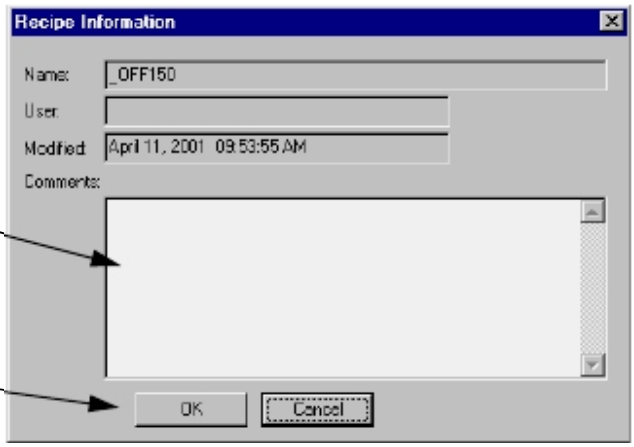
Introduction

This feature is designed for recording important comments about the recipe. The only field that is active for user input is the Comments: field. The other fields are automatically set by the system to reflect the specific recipe.

Procedure

1. Click **Recipe** in the menu bar of the **Recipe Editor**.
2. The Recipe menu is displayed. Click **Info** to display the **Recipe Information** dialog box. (ALTERNATIVE: Press **Ctrl** + **I**.)
3. Click in the **Comments** text field and enter the information that is to accompany the recipe.

Figure 3.77 *Recipe Information Dialog Box*



Step 3 The cursor should be blinking in this field. Enter any required comments in the field.

Step 4 After comments have been added, click **OK** to save them and close the dialog box.

4. When the information is entered, click **OK** to save it and close the dialog box.

XY VIEW SCREEN

INTRODUCTION

The name XY View comes from the function of the screen itself, which is for viewing the sample surface, and positioning a scan. The XY View screen also provides other tools required to set up and perform a scan.

The P-17/P-7 Profiler has a zoom capability that allows the operator to zoom in and out to view the sample surface at different magnification levels.

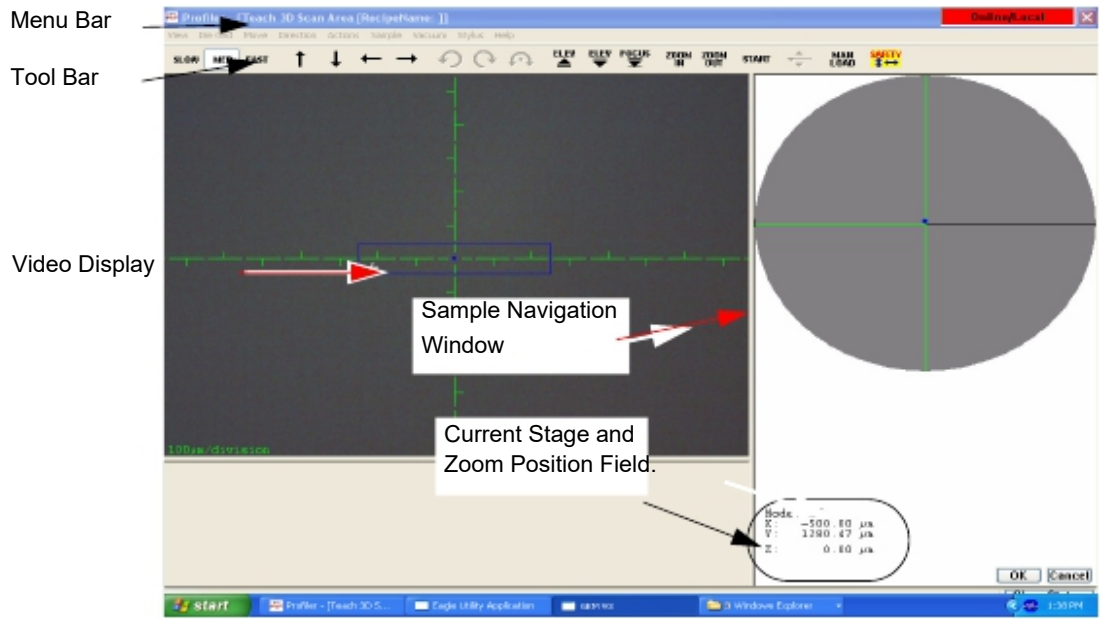
STARTING THE XY VIEW APPLICATION

Procedure

1. When the **Catalog** screen is first displayed, the **Sequence Recipe** list is in the Information Display window. To change to the **Scan Recipe** list, click the **Scan Recipe** button.
2. Once the Scan Recipe window is active, ensure that the desired scan recipe is highlighted by clicking on it. With the recipe highlighted, click the **XY** button to display the XY View screen. (See *Figure 4.1*.)

XY View Window Features

Figure 4.1 *XY View Screen*



XY View Menu Bar

The Menu Bar contains the majority of the available screen function commands. Each function is explained in detail in this section.

View Menu

Table 4.1 *View Menu Description*

View Menu	Description
	Focus Using the current magnification setting, this button causes the system to focus on the sample that is on the stage at the same time that the stylus is nulled on the sample surface.
	Video Controls… Displays the Video Display Dialog Box.
	Save Image to File… Displays the dialog box which set up the location of the file where the image is to be saved.
	Print Image… Displays the dialog box for printing the image in the video portion of the screen.
	Align Sample… (P-17 Only) Displays the dialog box used for setting up the angular rotation of the sample on the sample stage and initiates the automated procedure for aligning the sample to the video display.
	Zoom In Causes the optics to zoom in to a higher magnification.
	Zoom Out Causes the optics to zoom out to a lower magnification.
	Reset Zoom Resets the zoom position to "0" when the Zoom is active (position not saved).
	Save Zoom Position Displays a dialog box where the zoom position is set and locked so that it cannot be changed by the Zoom In and Zoom Out buttons.
	Show Start of Feature Displays, at the crosshair of the video display, the starting point of the scan.
	Show Center of Feature Displays, at the crosshair of the video display, the center of the scan on the sample surface.
	Show End of Feature Displays, at the crosshair of the video display, the end of the scan on the sample surface.

Die Grid Menu (Optional Feature with Pattern Recognition Option, P-17 Only)

Table 4.2 *Die Grid Menu*

Die Grid Menu	Description
	Load… Displays the dialog box used to load a die grid pattern.
	Save As… Saves the die grid pattern.
	Clear Die Grid Removes any die grid pattern on the video display window. [See *Clearing a Die Grid (Turn OFF Die Grid Navigation)* on page 4-28.]
	Clear Dropout Dies Blocks the dies from being scanned when a mouse cursor is placed over the die on the Sample Positioning Window and the **SHIFT+LEFT MOUSE BUTTON** is pressed.
	Clear Associated Dies Removes dies which were previously **associated** in a sequence recipe.
	Pattern Rec. Options… This displays the Load Die Grid dialog box. [See *Loading a Die Grid (Turning ON Die Grid Navigation) for a Single Scan* on page 4-25.]
	Display Numbers Displays the numbers on the Sample Positioning Window.
	Move To Partial Dies Scans the partial die at the edge of the wafer perimeter, only when this feature is enabled.

Move Menu

Table 4.3 *Move Menu*

Move Menu	Description
	Slow – Sets the XY stage to move in the slowest, or smallest increment, speed as defined in the **Move Extents**.
	Medium – Sets the XY stage to move in medium, or intermediate increment, speed as defined in the **Move Extents**.
	Fast – Set the XY stage to move in fast, or largest increment, speed as defined in the **Move Extents**.
	Move Extents – Sets the increment (Slow, Medium, Fast) for the stage movement. Enter the μm per click distance in each field for X/Y movement and the degrees in the Theta fields. ***Figure 4.2*** *Move Extents Dialog Box.*
	Precision Move – Takes out any backlash in the lead screws.
	To Position – This displays the **Move To Position** dialog box. Enter the coordinates the stage is to move to. If a rotational move is used to reorient a feature already in view so it can be scanned in a different direction, also choose **Rotate About Camera Position**. Click **OK** to make the move. ***Figure 4.3*** *Move To Position Dialog Box*

Direction Menu

Table 4.4 *Direction Menu*

Direction Menu	Description
	Up – Moves the stage in the +Y direction away from the front door by one increment (as defined in **Move Speeds** for the set speed) per button click. Click and hold the button for continuous movement.
	Down – Moves the stage in the -Y direction toward the front door by one increment (as defined in **Move Speeds** for the set speed) per button click. Click and hold the button for continuous movement.
	Left – Moves the stage in the -X direction toward the left by one increment (as defined in **Move Speeds** for the set speed) per button click. Click and hold the button for continuous movement.
	Right – Moves the stage in the +X direction toward the right by one increment (as defined in **Move Speeds** for the set speed) per button click. Click and hold the button for continuous movement.
	Fast Z Up – Raises the measurement head away from the stage by one increment per button click. Click and hold the button for continuous movement. This is the same as clicking the **Elev** button.
	Fast Z Down (Focus) – Lowers the measurement head and sensor to the null position, and focuses the video image. The measurement head automatically lowers to the correct distance from the sample for real-time video. This is the same as clicking the **Focus** button.
	Arrow Key (Zup/down) - Enables the keyboard arrow keys to move the elevator up (Elevate) or Down (Focus).
	Rotate Counterclockwise (P-17 Only) – Rotates the stage in the theta counterclockwise direction by one increment (as defined in **Move Speeds** for the set speed) per button click. Click and hold the button for continuous movement.
	Rotate Clockwise (P-17 Only) – Rotates the stage in the theta clockwise direction by one increment per button click. Click and hold the button for continuous movement.

Actions Menu

Table 4.5 *Actions Menu*

Actions Menu	Description
	Start Scan Starts the scan process.
	View Scan Changes to the View Scan window.

Sample Menu

Table 4.6 *Sample Menu*

Sample Menu	Description
	Manual Load Moves the stage towards the front door. This is used for loading wafers.
	Load/Unload Not applicable for the P-17/P-7 Profiler system.
	Initialize Handler Not applicable for the P-17/P-7 Profiler system.
	Pod Operations… Not applicable for the P-17/P-7 Profiler system.
	Change Configuration This brings up the **Safe Area** configuration box.

Vacuum Menu

Table 4.7 *Vacuum Menu*

Vacuum Menu	Description
	Off Not applicable for P-17/P-7 Profiler systems. The vacuum status is set using a manual switch next to the door.
	On Not applicable for P-17/P-7 Profiler systems. The vacuum status is set using a manual switch next to the door.

Stylus Menu

Table 4.8 *Stylus Menu*

Stylus Menu	Description
	Drop/Lift (Applicable to P/17 only) Causes the stylus to pivot up. A check mark is visible while it is in the UP position. Click it to release it back to its normal scanning position
	Distance… Displays the **Distance From Sample** dialog box. This is the distance from the stylus to the sample surface during scan positioning. Set the number in μm and click **OK**. The distance remains in effect until changed by the user. ***Figure 4.4*** *Distance Dialog Box*

Tool Bar Buttons

Table 4.9 *XY View window Tool Bar Buttons*

Button	Description
	Sets the XY stage to move in small increments as set in **Move Extents**.
	Sets the XY stage to move in moderate increments as set in **Move Extents**.
	Sets the XY stage to move in large increments as set in **Move Extents**.
	Moves the stage in the +Y direction (away from the front door) by one increment (as set in **Move Extents**) per button click. Click and hold the button for continuous movement.
	Moves the stage in the -Y direction (toward the front door) by one increment (as set in **Move Extents**) per button click. Click and hold the button for continuous movement.
	Moves the stage in the -X direction (toward the left) by one increment (as set in **Move Extents**) per button click. Click and hold the button for continuous movement.
	Moves the stage in the +X direction (toward the right) by one increment (as set in **Move Extents**) per button click. Click and hold the button for continuous movement.

Table 4.9 *XY View window Tool Bar Buttons (Continued)*

Button	Description
	(P-17 Only) Rotates the stage in the theta counterclockwise direction by one increment (as set in **Move Extents**) per button click. Click and hold the button for continuous movement.
	(P-17 Only) Rotates the stage in the theta clockwise direction by one increment (as set in **Move Extents**) per button click. Click and hold the button for continuous movement.
	Raises the measurement head away from the stage by one increment per button click. Click and hold the button for continuous movement.
	Lowers the measurement head containing the sensor assembly to the null position, with the stylus just above the surface, and focuses the video image.
	Changes to a higher magnification with each click.
	Changes to a lower magnification with each click.
	Starts the scan process.
	(P-17 Only) A toggle that lifts and drops the stylus.
	Toggle button that moves the stage to and away from the Manual Load position. Before each movement, the measurement head moves to the set Z-height to protect the sensor assembly from accidental contact.
	Allows user to control the focus or elevation of the head by selecting the button and then using the up or down arrow on the keyboard. This feature is particularly useful for tricky sample geometries.
	Defines the distance the stage can be safely moved before the elevator will lift the head to protect the stylus and sensor assembly from damage due to tall features on the sample of sample locator.

SETTING THE MAGNIFICATION

Introduction

The system has an optical zoom function that allows the operator to view the sample surface at different magnifications for feature identification and scan placement.

If the system has Pattern Recognition operating (P-17only), zooming in and out could prevent the system from performing accurately because the recognition function also takes into consideration the size of the image as well as its shape.

Changing the Magnification

Click the **ZOOM IN** or **ZOOM OUT** to change the magnification. Each click changes the magnification level in or out by a small amount.

(Alternative:
In the Menu bar click **View** to display its menu. From the **View** menu, select either **Zoom In** or **Zoom Out** to change the magnification. Each click changes the magnification level in or out by an amount a little more than twice the size of the button icons.)

Resetting the Zoom to "0.00"

If the zoom function has been used, it might be necessary to use the **Reset Zoom** to return the zoom magnification to exactly "**0.00**" in the Zoom field at the bottom right of the screen.

Click **Reset Zoom** and the system automatically zooms out to the furthest position and sets the Zoom field to **0.00**.

Figure 4.5 *View Menu and the Stage and Zoom Coordinate Field*

Click **Reset Zoom** from the View menu to reset the **Zoom** to exactly **0.00**.

In the **Zoom** field, the current zoom position is displayed. This is not the magnification.

Saving the Current Zoom Position

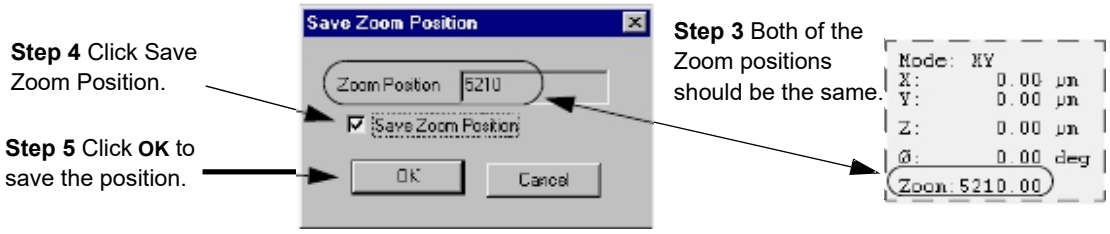
For systems operating with the Pattern Recognition option, verify that the Zoom position is ***locked.*** This way, the system can perform the pattern recognition function with greater accuracy. Secure the zoom position by using the **Save Zoom Position** dialog box to set and lock the desired position.

For more accurate pattern recognition, set and lock the zoom to 0.00.

1. Verify that the current Zoom position is set to the desired magnification. If so, proceed to the next step. If not, adjust the zoom (magnification) to the required level using the zoom icons or menu items.
2. To save the current zoom position, click **Save Zoom Position** in the **View** menu. This opens the Save Zoom Position dialog box.

3. Ensure that the zoom position in the dialog box **Zoom** field agrees with the **Zoom Position** in the screen display. (See *Figure 4.6*.)
4. Click the **Save Zoom Position** check box. (See *Figure 4.6*.)

Figure 4.6 *Save Zoom Position Dialog Box*



5. Click **OK** to save the position and lock the zoom function. (See *Figure 4.6*.)

FOCUSING THE VIEW

Introduction

After the null and focus procedure, if the sample surface is not in focus, the focus knobs can be used to bring the surface into focus. (This should only be required after stylus change.)

The purpose of focusing the view is to sharpen the image in the video window. If the focus is clear the first time, and the sample is flat, focus should be maintained each time the stage moves to another location on the same sample surface.

Focus the Optics – Top- or Side-View

NOTE: Side-View optics are P-17 only.

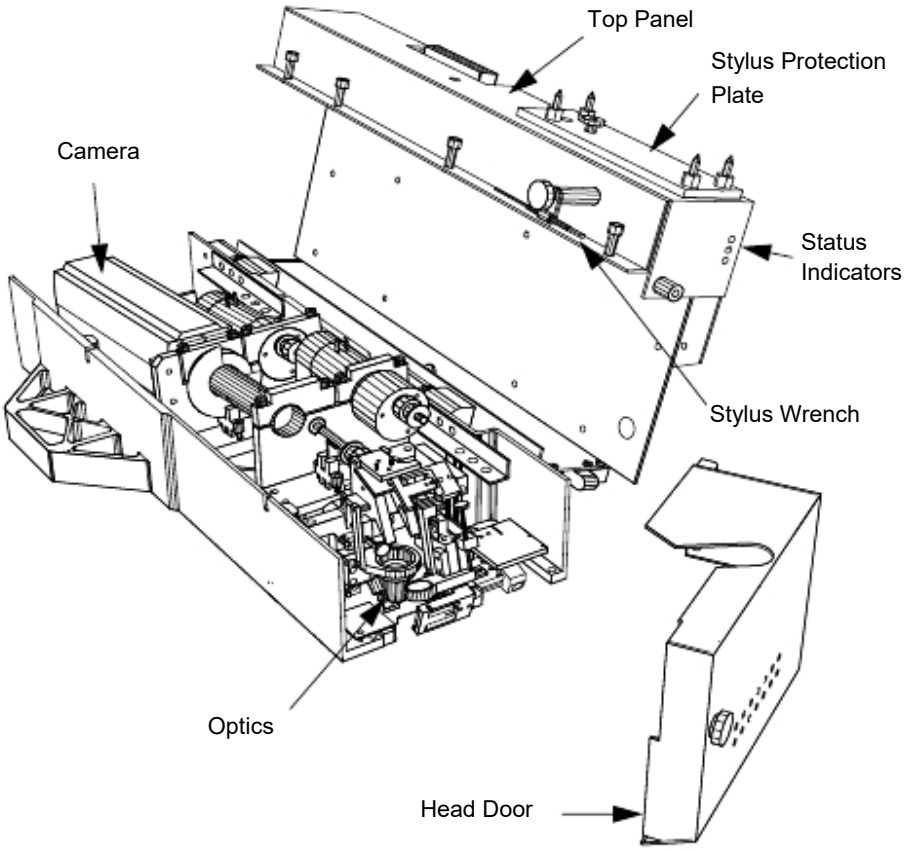
1. Raise the measurement head.

CAUTION: Before lowering the head, be sure that the sample is under the center of the optics, that the stage is not significantly out of level, and that there are no physical obstacles.

2. Use the **Focus** button to null the stylus on the sample (use a patterned sample with easily defined features).

3. Open the measurement chamber door and then the head door. (See *Figure 4.7*.)

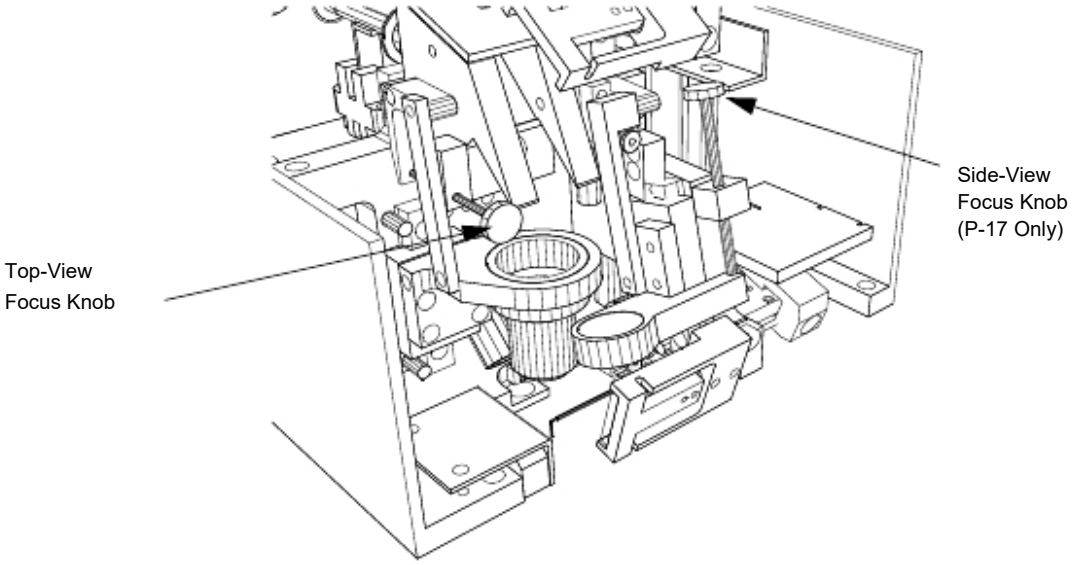
Figure 4.7 *P-17 MicroHead Measurement Head.*



4. If the initial view requires focusing, turn the **Top-View Focus** knob to focus the top view. (See *Figure 4.8*)
5. (P-17 Only) Click the **Stylus Drop-Lift** icon to lower the stylus onto the sample surface.

6. If the side view requires focusing, use the **Side-View Focus** knob to focus the side view. (See *Figure 4.8*)

Figure 4.8 *P-17 Focusing the Optics (Dual-View Optics).*



7. Test the Video Calibration after any mechanical refocusing event by clicking on a clearly definable feature and see if it lines up exactly with the screen crosshair. If not, perform the Video Calibration.

POSITIONING THE SCAN SITE

Introduction

The stage can be moved in the X, Y, and theta direction to orient an object image for scan positioning. The stage can be moved to reach any point on the sample surface within the Safe Area limits. (See *Safe Area Configuration* on page 13-12)

The stage moves incrementally in the following directions:

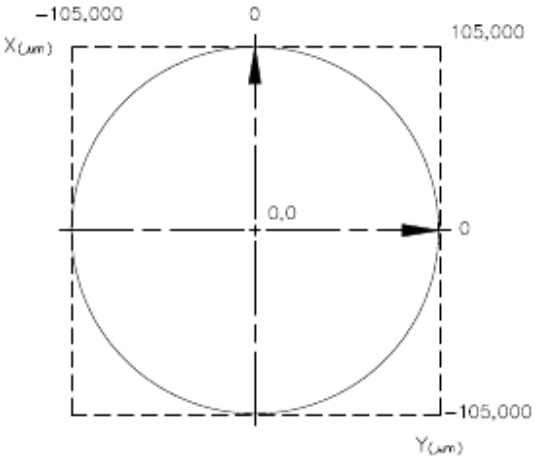
- The X direction moves the stage left and right
- The Y direction moves the stage forward and backward
- The theta direction rotates the stage clockwise and counterclockwise.

A common way to move the stage is to click the arrow button that points in the direction that the stage is to move. Notice that the arrow points in the direction the stage moves and not in the direction that the image moves in the field of view.

NOTE: When using the toolbar arrow buttons, the image appears to wiggle as it stops. This is a normal part of the procedure designed to eliminate the slight mechanical backlash in the stage movement that could make precise positioning difficult.

Figure 4.9 shows the stage coordinate system (SEMI Standard M20-92) used by the Profiler. The X and Y coordinates relative to the center of the measurement area are displayed in the current stage coordinate area of the XY View window. The travel area of the stage is limited to a circle 210 mm (8.2 in.) in diameter. (See *Figure 4.9*.)

Figure 4.9 *Coordinate System of the KLA-Tencor Profiler Stage*



The coordinates are P-17 max coordinates.

P-7 is 75mm in each axis.

Scan Site Positioning Procedure

1. After the sample is loaded on the stage and the stage returned to the scan position under the stylus, click **FOCUS**.
2. Use one or more of the following methods to locate a scan site. (See *Table 4.10*.)

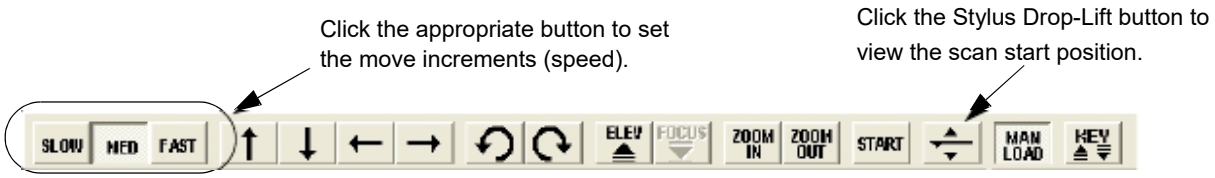
Table 4.10 *Locating a Scan Site*

Movement Required	Movement Method
To make a large move across the sample surface, use the **Sample Navigation Window** (See *Figure 4.11*.)	**Sample Navigation Window** – The navigation circle represents the stage area. Click the location on the Sample Navigation Window to move to the corresponding location on the sample. (See *Figure 4.11*.)
Move to a different site in the current **Video Display Window** (See *Figure 4.11*.)	**Video Display Window** – Click the desired site in video display window. (See *Figure 4.11*.) The site moves so that the video crosshair are centered on the chosen location.

Table 4.10 *Locating a Scan Site*

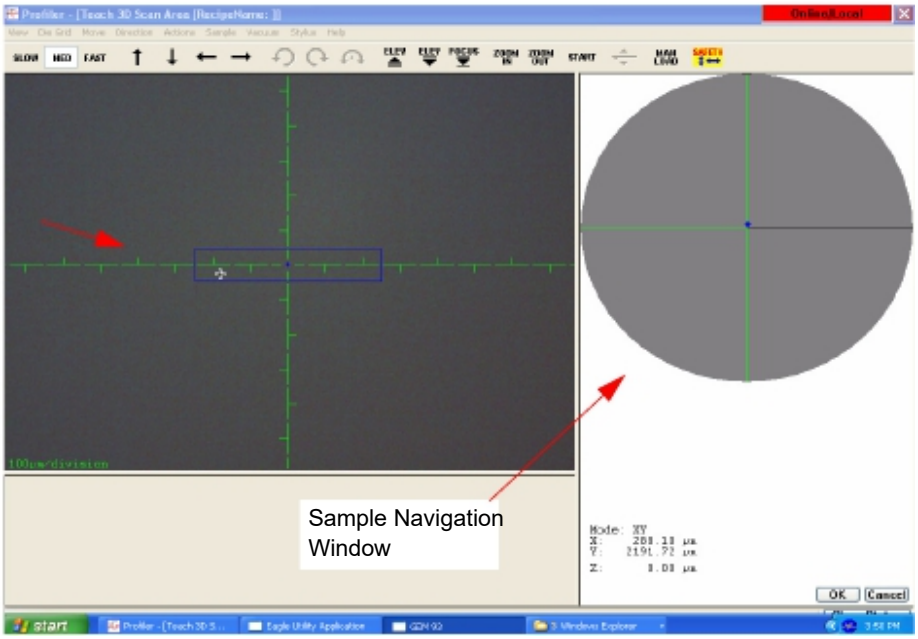
Movement Required	Movement Method
Move in increments across the sample using the **Video Display Window** to locate a feature or scan site.	**Arrow Buttons Positioning** – Click the **Fast**, **Medium**, or **Slow** buttons (move extents) to change the stage movement increments. (See *Figure 4.10*.) With the cursor over the arrow button, click for one move of the distance defined by the move extents setting. Click and hold to start and continue the stage movement in increments defined by the move extents. Release to stop the stage movement. **NOTE:** The incremental distance represented by the **Fast**, **Medium**, and **Slow** buttons can be changed by choosing **Move Extents** from the **Move** menu. The **Move Extent** dialog box appears in which the new speeds for each button can be entered.
Precision positioning using the Stylus Drop-Lift	**Stylus Drop-Lift Positioning** – After the null is complete, click the **Stylus Drop-Lift** button. This changes the optics to side-view with the stylus in the down position. Click the scan site beginning point. Repeat if necessary until the stylus is at the desired starting point of the scan.

Figure 4.10 *XY View Screen Tool Bar*



3. Click the **Stylus Drop-Lift** button to null the stylus on the sample and confirm the scan position.

Figure 4.11 *XY View Screen*



USING DIE GRID NAVIGATION (OPTIONAL FEATURE, P-17 ONLY)

Introduction

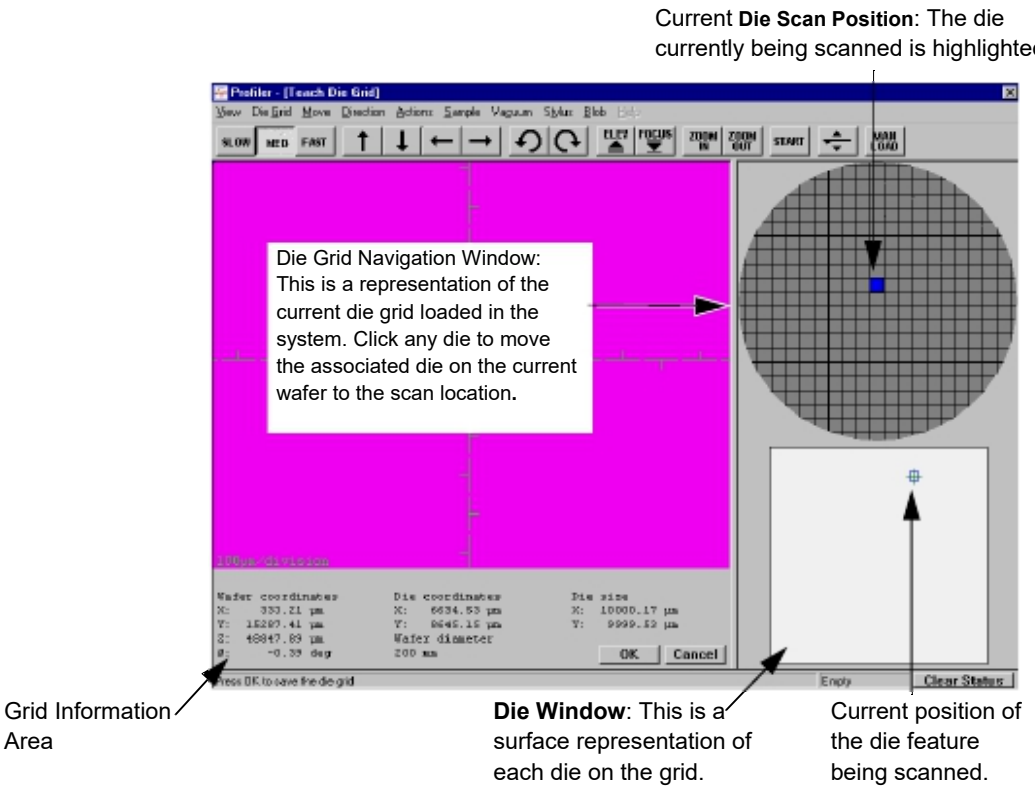
When scanning a wafer, the ***die grid navigation features*** can be used to teach scan and sequence sites by die location rather than by stage coordinates. The Die Grid feature is enabled with the pattern recognition option.

Die grid navigation is composed of two components: Die Grid Navigation Window; and Die Window.

The Die Grid Navigation Window presents a representation of the die positions on the wafer surface. (See the Die Grid Navigation Window in *Figure 4.12*.) The small highlighted rectangle, in the upper right quadrant of the die matrix, represents the die currently being scanned. Each time a new die is chosen, the scan is performed on the same position in that die. (See Die Window in *Figure 4.12*.)

The Die Window is designed to pinpoint the location of the feature to be scanned on each die. (See the Die Window in *Figure 4.12*.) The cursor in the rectangle represents the location on the die where the feature to be scanned resides. To move to another scan position in the die, click the new position in the Die Window box.

Figure 4.12 *Teach Die Grid Screen with Loaded Die Grid*



Once a die grid pattern is loaded, the Die Grid Navigation Window appears in the Teach Scan screen (except in calibration procedures), Teach Sequence Site screen, and Teach Blob Analysis screen.

Die Grid windows (see *Figure 4.12*) differ from standard Teach windows in three aspects:

- **Die Grid Navigation Window**—replaces the Sample Navigation Window. (See *Figure 4.1*.) Click in the desired die grid to quickly move the corresponding die into the field of view in the Video Display Window.
- **Die Window**—for positioning a feature in the field of vision within the die itself. Click in the desired region to quickly move that area of the die into the field of view.
- **Grid information area**—contains wafer and current die coordinates, wafer diameter, and die size.

In making it more convenient to position scans on a wafer, Die Grid Navigation provides the following options:

- Mask out the dies that are not to be measured. Masked dies appear blacked out on the Die Grid Navigation Window, providing visual reference points.
- Display the die coordinates on the Die Grid Navigation window and even change the font and size of the numbers.
- Show the partial dies on the edge of the wafer.

Creating a Die Grid

Introduction

To use a die grid, one must be created using a sample with clearly defined identical dies, equally spaced. Once created, it can be used whenever measurements are being made on samples which are identical to the one used to make the die grid. Numerous die grids can be created, stored, and loaded as they are needed.

Wafer alignment on the sample stage is critical to the systems ability to consistently locate dies on the wafer. It must be precisely placed with it X- Y- orientation identical to that of the die grid. This can be accomplished by using a precision locator on the sample stage. The loaded die grid pattern is accurate only as long as the wafer is not moved after the initial die grid alignment procedure. This means that the vacuum must be turned on when the wafer is loaded and not turned off until the wafer is unloaded. If the wafer is moved, the die grid must be reloaded, a procedure which realigns the wafer dies with the die grid.

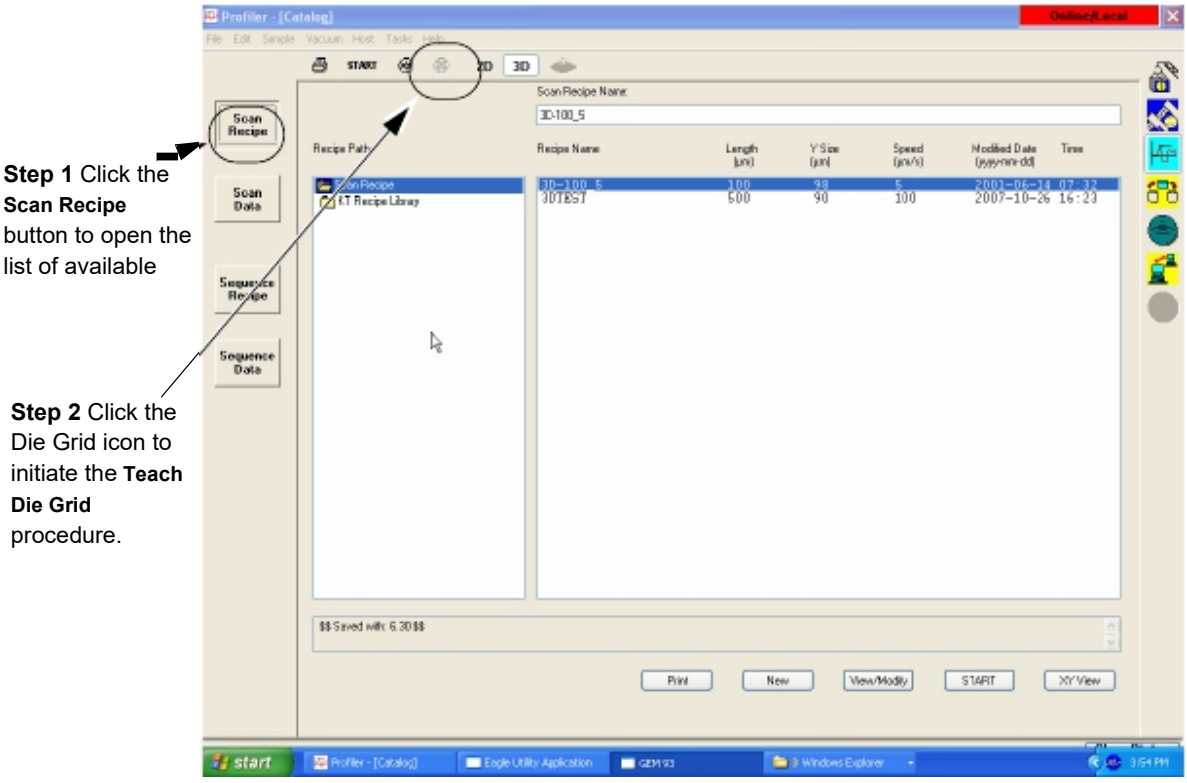
The die grid is created by establishing its size and position on a wafer, and identifying a unique and distinguishable feature which the system can use to locate the same position on any die.

Teach a Die Grid

Creating a die grid is a user friendly procedure. Once the Teach Die Grid procedure is initiated, each step is prompted by a message at the bottom of the screen or next to the graphic.

1. Click the **Scan Recipe** or the **Sequence Recipe** button at the top of the option list located at the left of the Catalog screen. (See *Figure 4.13*.)

Figure 4.13 *Scan Catalog Screen*

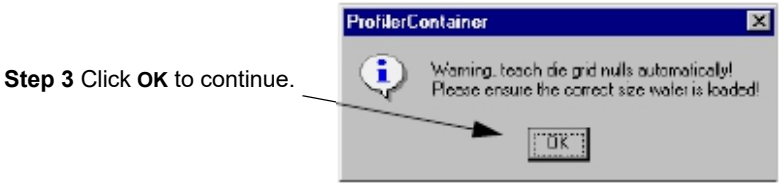


2. Click the **Die Grid** button in the tool bar, or select **Teach Die Grid** from the **File** menu. (See *Figure 4.13*.)

   The **Teach Die Grid** window appears with a warning about the automatic null feature of the Teach Die Grid procedure. (See *Figure 4.14*.)

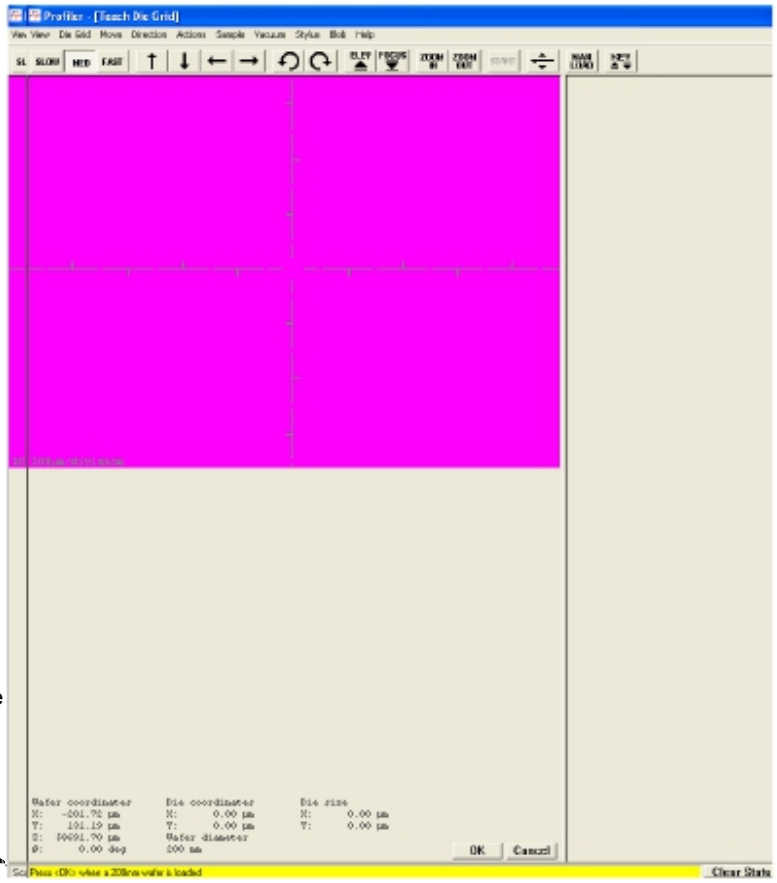
NOTE: The die grid button maybe grayed out unless the following is true: A recipe exists in the current scan recipe path; The pattern recognition option is enabled; Safe Area is properly set.

Figure 4.14 *Warning – Automatic Null*



3. Click **OK** to continue with the procedure. (See *Figure 4.14*.)
4. In the **Teach Die Grid** screen, the procedure is prompted from the message display area at the bottom left of the screen. (See *Figure 4.15*.)

Figure 4.15 *Teach Die Grid Screen*



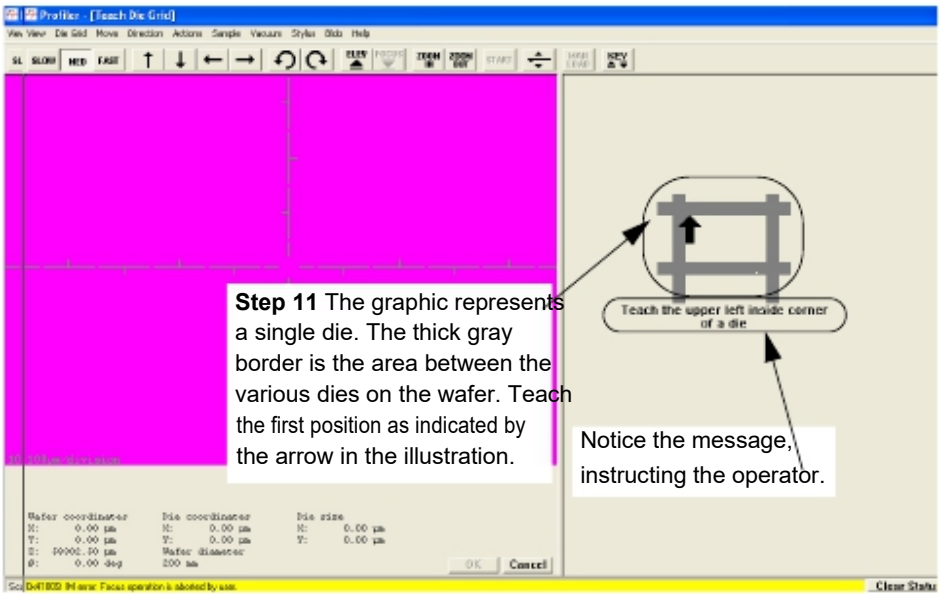
Step 4 The message prompt, here under the graphic, informs the operator of procedures as they occur and operator requirements.

Notice in *Figure 4.15* that the message prompt tells the operator to place a specific sized wafer on the stage and then click **OK**. The system is configured to run a specific sized wafer. It is important that only that size wafer be used.

5. Obtain the wafer to be used in the teach die grid procedure
6. Click **MAN LOAD** to move the stage to the door.
7. Open the door and load the wafer onto the precision locator. (If there is no precision locator, have one installed before continuing with this procedure.)
8. Turn **ON** the vacuum using the switch located at the left inside edge of the door.
9. Close the door and click **MAN LOAD** to send the stage back under the measurement head.

10. Click **OK** when all variables are correct.

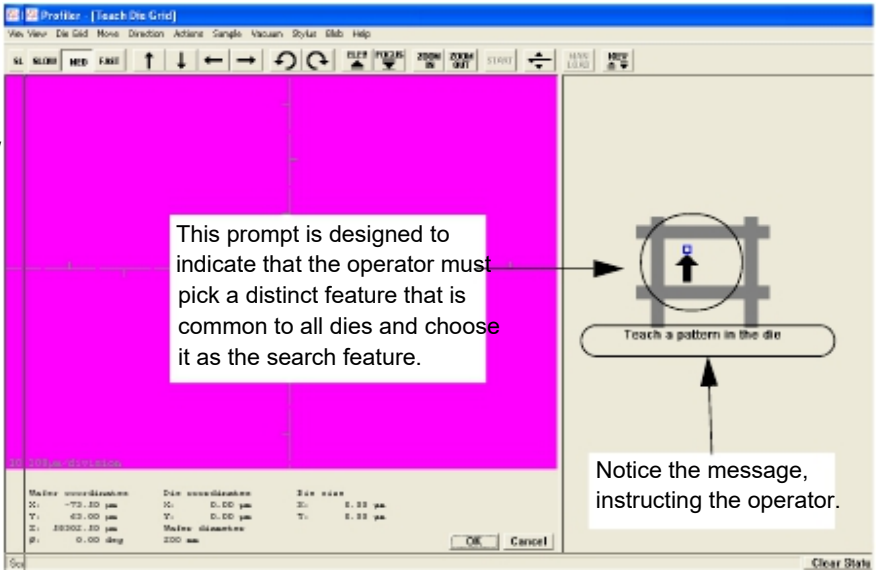
Figure 4.16 *Teach Die Grid - Teach First Position*



11. Teach the upper left inside corner of the die: (follow the instructions on the screen)
    - It is recommended to enter the die height and width from stepper mask layout information for optimal die grid accuracy.
    - Position the die image using the arrow buttons so that the upper left corner of the die is in the field of view.
    - Position the mouse cursor at the left inside corner of the die, as indicated in the *Figure 4.16* illustration, and click.

Figure 4.17 *Teach Die Grid - Teach Feature*

Step 12 Use the arrow buttons to locate a distinct feature. Use the click and drag procedure to draw a box around the feature. The system displays a message if the box is too small or too large.



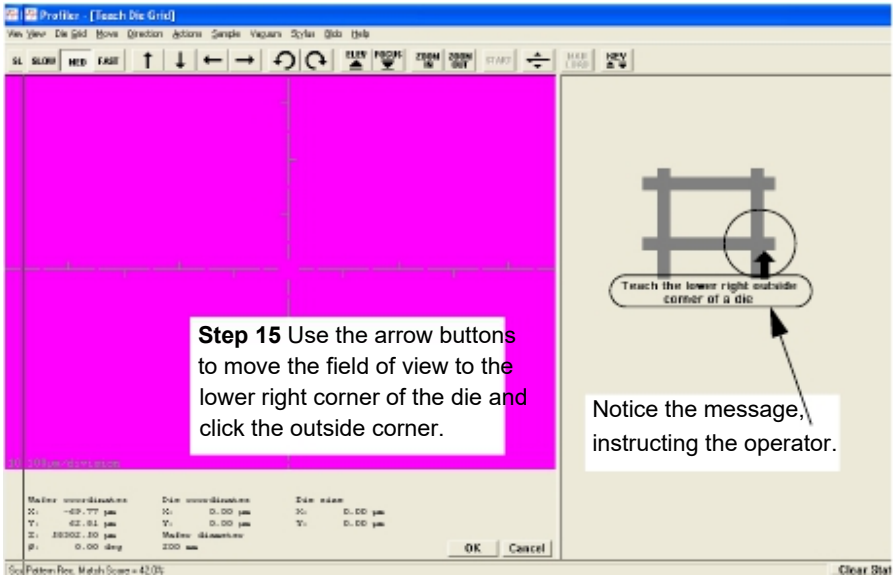
12. Teach a pattern in the die:
    - Using the arrow buttons, locate a feature that is present in every die. The pattern should be distinct from other nearby features.
    - Click and drag to draw a box around the feature. Start at the upper left corner and drag across the feature so that it is centered in the box when the mouse button is released.

    The instrument centers the pattern in the image crosshairs twice. The Wafer Data dialog box appears.
13. Verify and correct the wafer data and type in die width and height if known.
    - It is recommended to enter the die height and width from stepper mask layout information for optimal die grid accuracy.
    - To have theProfiler software determine the die size, leave **Die width** and **Die height** at **0**.

14. After making any required adjustments, click **OK**.

    If the die width and height were not entered, the instrument continues to the third position in the Teach Die Grid sequence:

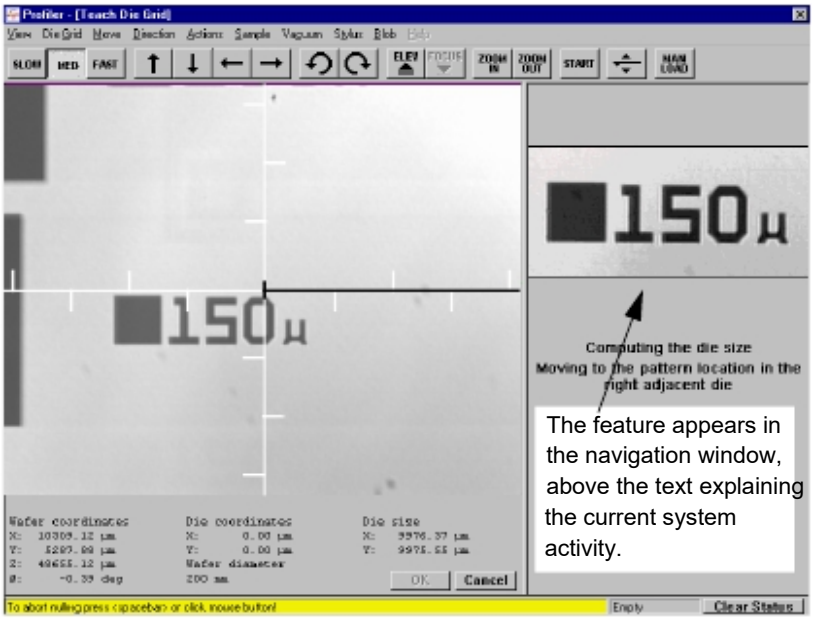
Figure 4.18 *Teach Die Grid - Lower Right Corner*



15. Use the arrow buttons to move the die image so the lower right outside corner of the die is visible. Move the mouse cursor to the lower right outside corner of the die and click it to teach the position.

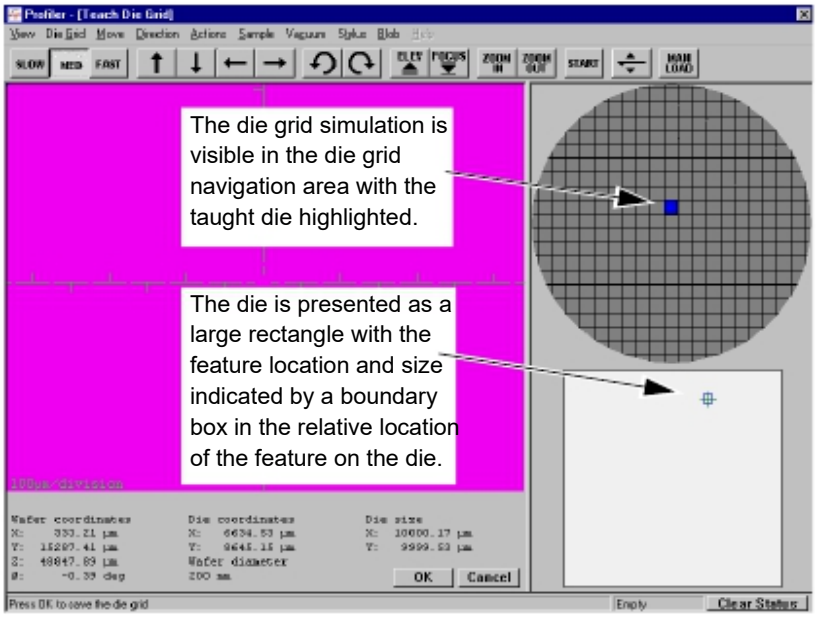
    - The stage moves to various dies on the wafer, locating the pattern taught in **Step 12** The taught image appears in the navigation window with a comment underneath it that advises the operator which die is being checked. (See *Figure 4.19*.)

Figure 4.19 *Teach Die Grid - With Feature in Navigation Window*



16. When the system completes its check, the die grid is applied. The Teach Die Grid screen changes its die grid navigation window to reflect the current die grid configuration on the wafer. (See *Figure 4.20*.) The taught die appears in dark blue. The operator is prompted to click **OK** to save the die grid.

Figure 4.20 *Teach Die Grid - Die Grid Simulation in Navigation Window*



At the bottom of the die grid navigation window is a representation of the die grid, which appears as a bounded white rectangle. The taught feature is pictured a small bounded box appearing in its relative position in the die. This makes it easier for the operator to locate the feature if a visual search is necessary.

17. Click **OK** (bottom center of the screen) to save the die grid.

    A save dialog box appears.

18. Choose the drive and directory for storage of the die grid file.
19. Ensure that the proper file format is chosen for saving the die grid file. Click the **Save As Type:** menu arrow to display its menu and choose the required format from the menu.
20. Type a name for the die grid in the **File name:** variable box.
21. Click **Save**.

    The extension ***.die** is supplied automatically. Die Grid Navigation is enabled with the new die grid applied. *Using Die Grid Navigation (Optional Feature, P-17 only) on page 4-16* describes how to use Die Grid Navigation with sequences.

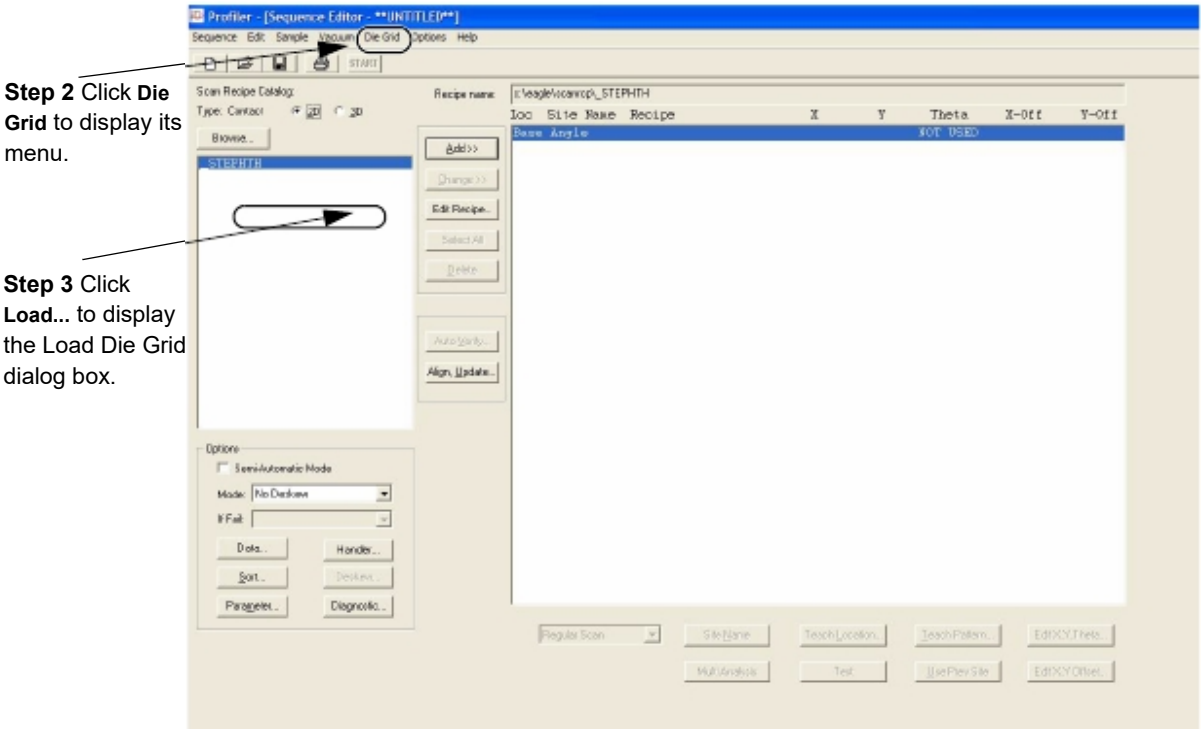
Loading a Die Grid (Turning ON Die Grid Navigation) for a Single Scan

1. Ensure that the wafer is in place on the stage. It must have the same pattern as that of the die grid being loaded.

CAUTION: It is very important that the wafer is placed in the same orientation that the die grid was taught. If not, the system cannot find the dies. Use a precision locator to place the wafer in the proper orientation.

2. In the **XY View**, **Scan Editor**, or **Sequence Editor** windows, click **Die Grid** from the menu bar. (See *Figure 4.21*.)

Figure 4.21 *Sequence Editor with Die Grid Menu*



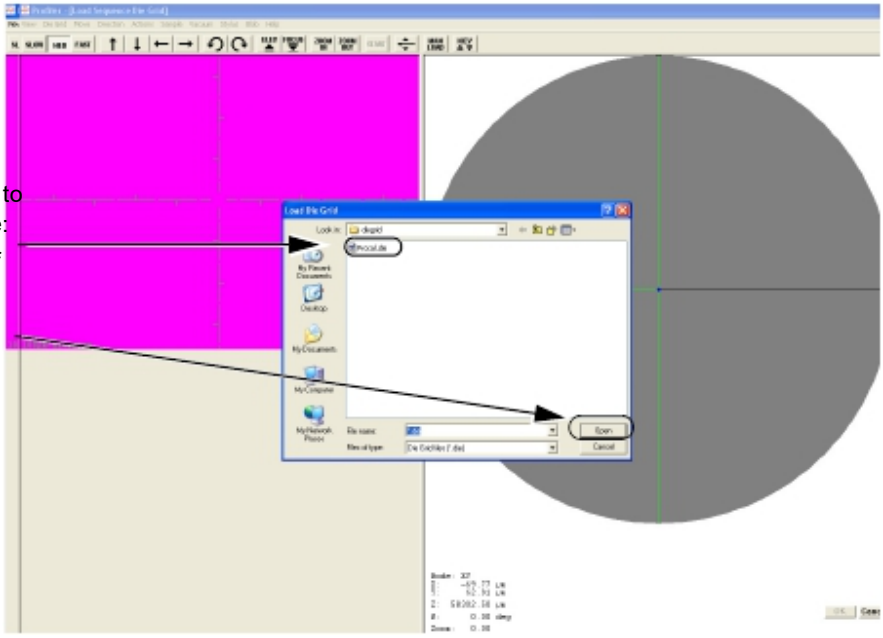
3. Click **Load** to display the **Load Die Grid** dialog box. (See *Figure 4.22*.)

4. In the **Load Die Grid** dialog box, double-click the name of the die grid to be used. This displays die grid name in the File Name display box.

Figure 4.22 *Load Sequence Die Grid*

Step 4 To choose a die grid to associate with the sequence:

1. Double-click the name of the die grid.
2. Click **Open** to load it.



5. Click **Open** to load the die grid.

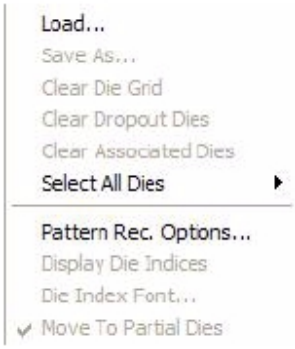
   The system nulls the stylus and begins to search for the pattern that is displayed on the right side of the screen. After it successfully locates the test pattern, the die grid is loaded.

   Die Grid navigation is now active and the die grid selected is applied.

Clearing a Die Grid (Turn OFF Die Grid Navigation)

1. Go to the **Teach Scan** window.
2. Click the **Die Grid** menu, and select **Clear Die Grid**. (See *Figure 4.23*.)
   Standard navigation is active again.

Figure 4.23 *Die Grid Menu From the Menu Bar*



Navigating Across the Wafer Using the Die Grid

1. Load a die grid using the procedure in *Loading a Die Grid (Turning ON Die Grid Navigation) for a Single Scan* on page 4-25)
2. Die Grid Navigation (see Figure 4.12 on page -17) uses the representation of the sample that appears in the Sample Navigation Grid at the right of the XY View screen. To move the to a specific die, click its location. The system moves the stage to that die and focuses on the feature. The feature's position is indicated in the die representation below the Sample Navigation Grid.

Enabling the Dropout Die Option

Go to the **Teach Scan** window, and press the **SHIFT** key while clicking the dies in the Die Grid Navigation Window that are to be dropped out. These dies are not scanned.

The die is blacked out. To restore a dropped out die, click it again.

Clearing Dropout Dies From the Grid

From the **Die Grid** menu, click **Clear Drop Out Dies**. The dies are restored to availability for scan purposes.

Moving to Partial Dies

1. From the **Die Grid** menu select **Enable Partial Die** to enable the Partial Die option.
2. Go to the **Teach** window, click **Die Grid**, then click **Move To Partial Dies**. (See *Figure 4.23*.)
3. In the Die Grid Navigation Window, click the partial die to navigate to it.

Displaying Grid Numbers in the Die Grid Navigation Window

From a **Teach Scan**/**Site** window, click **Die Grid**, then click **Display Numbers**. (See *Figure 4.23*.)click

If the numbers are too small to see, increase the size of the Die Grid Navigation Window by clicking and dragging the window's vertical separator bar to the left.

To Change the Font and Color of the Grid Numbers

1. Go to a **Teach Scan**/**Site** window, click **Die Grid**, click **Font**.

   A standard font dialog box appears.

2. Select the font attributes desired and click **OK**.

ALIGNING THE SAMPLE

Introduction

This procedure aligns the sample image with the X-axis of the view screen using a straight feature on the sample. Two methods for accomplishing this, each of which rotate the stage (theta movement) to accomplish the alignment, are detailed in the following sections. With the sample features aligned with the X-axis, more accurate scans can be taken and die grid navigation is more accurate.

Procedure

Aligning the Sample with the Instrument

This procedure assumes that the sample is already on the sample stage and ready for alignment. The sample must have a straight, easily discernible feature that can be used to aligned the sample features with the X-axis of the XY view screen.

1. Click the **FOCUS** button in the tool bar. The stylus nulls on the sample surface and the sample image comes into focus.
2. Using the linear movement arrow buttons, locate the center of the feature to be used for alignment.

CAUTION: It is very important that the chosen feature be such that it lies in a straight line across the X-axis of the sample. A thin line is best for use in the alignment procedure.

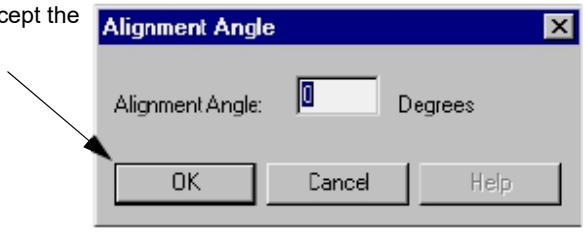
3. Use the arrow buttons to approximately center the screen crosshair in the center of the feature. (Or, move the cursor to the center of the feature and click. This should move the crosshair to that location.)

NOTE: Steps 4-11 apply to P-17 only. For P-7, use manual theta adjustment for stage.

4. Click **View** in the tool bar to display its menu. In the menu, click **Align Sample**. This sets up the **Alignment Sample** procedure which aligns the XY axis of the screen with the chosen feature.
5. A dialog box appears requesting input of the intended alignment angle. The default is **0** which aligns the feature with the X-axis after the procedure is complete. Click **OK** in the dialog box to accept the **0** value. (See *Figure 4.24*.)

Figure 4.24 *Setting Alignment Angle*

Step 5 Click **OK** to accept the "**0**" angle alignment.



6. Using the **right** arrow button (→), scroll across the feature to the left portion of the feature. Stay close to the feature, and stop when a reasonable distance has been covered (or at the end of the feature if it is small).
7. Place the crosshair cursor on a portion of the feature that is easily duplicated at its other end and click with the left mouse button. The system performs adjustments which align the screen crosshair to the feature at the point of contact.
8. The message prompt displays at the bottom left of the screen, "**Press OK to accept the first alignment position**." Click **OK,** at the bottom right of the screen, to accept the first alignment position.
9. Using the **left** arrow button (←), scroll across the center of the feature (starting point). Stay close to the feature, and stop when the sample has move a significant enough distance to give the software a long interval over which to align the sample with the X-axis. Place the crosshair cursor **over the same portion of the feature that was used to set the first position** and click with the left mouse button. The system performs final adjustments, aligning the feature with the XY axis.
10. The message prompt displays "**Press OK to accept the second alignment position.**" Click **OK,** at the bottom right of the screen, to accept the second alignment position.
11. After the adjustments have been completed by the system, the message prompt at the bottom of the screen indicates that the **OK** button must be clicked to accept the new alignment adjustment. Click **OK** (bottom right of screen) to accept or click **Cancel** to run a new alignment angle calculation.

    This completes the Align Sample procedure.

Manual Alignment of the Sample (P-17 only)

The sample can be aligned manually using the XY view screen in conjunction with the theta (rotational) movement arrow buttons on the tool bar.

1. Follow **Step 1** through **Step 3** in *Aligning the Sample with the Instrument*.

2. Use the theta movement arrows in the tool bar (in conjunction with the other arrow buttons as necessary) to rotate the chosen feature until it aligns with the X-axis on the XY view screen.

   a. Click the button for counterclockwise rotation.

   b. Click the button for clockwise rotation.

   The Theta movement buttons may rotate the image past the point required to align the sample features with the X-axis. If this happens, the following adjustments to the theta movement can be made:

   i. Check the Speed Setting in the **Move** menu. In the tool bar at the top of the XY view screen, click **MOVE** to display the menu. (See *Figure 4.25*.) Three speeds (which are actually movement increments) are available: **Slow**, **Medium** and **Fast**. If the image always rotates past the X-axis, refine the movement by moving to the next slower movement. If the **Slow** setting still does not allow alignment, move to step *ii*.

Figure 4.25 *Move Menu*

Click the desired speed in the **Move** menu. The chosen speed has a check in front of it.

Click **Move Speeds** to display the **Move Extent** dialog box.

   ii. The amount of rotation in the theta arrow buttons is set in degrees in the **Move Extents** dialog box (see Figure 4.2 on page -5) with each setting (**Slow, Medium,** or **Fast**) having its own rotation in degrees. Check the **Slow Move Extent** box and set it as low as **0.01**. Click **OK** to set the new speed.

   iii. In the **XY** view screen, click **Move** and choose **Slow**. (See *Figure 4.25*.) The theta movement should now be small enough for proper alignment.

VIEW SCAN WINDOW

2D SCREEN FUNCTION

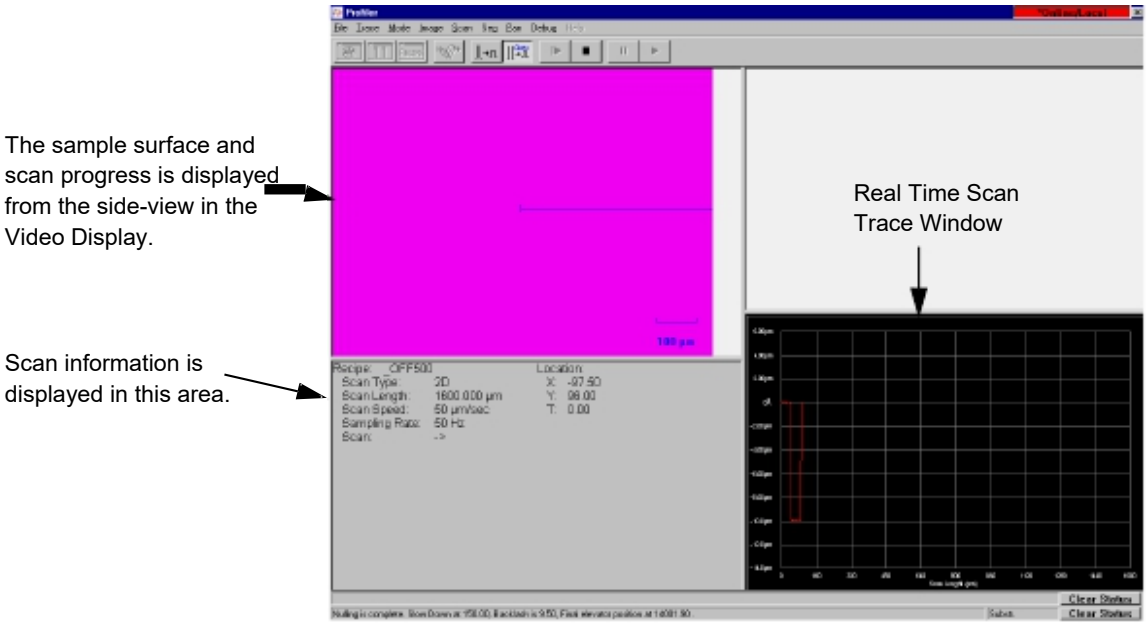
The **View Scan Window** appears while a scan is being run. It allows the user to observe the progress of the scan and to adjust scan parameters in the various screens for optimum scan results. The scan can be started once the recipe has been chosen and the sample loaded onto the sample stage. The scan can be started from several places. The most common two starting points are:

- With the required recipe chosen, click **START** in the Scan Recipe screen.
- From the Scan Recipe screen, click the **XY** icon. From the XY screen click **START**.

Click **START** to begin the scan. The View Scan screen appears. (See *Figure 5.1*.)

The head lowers bringing the stylus into contact with the sample at the start-of-scan position. The scan begins, first briefly traveling *opposite* the scan direction, then reversing. This allows the mechanical instruments to settle down and the stage to reach the programmed scan speed before data collection begins. The View Scan window appears and the scan begins. The video image freezes during the scan and the Real Time Scan view in the lower right corner displays the data in real time as it is collected. (See *Figure 5.1*). When the scan is finished, the data is automatically displayed in the **Analysis** window.

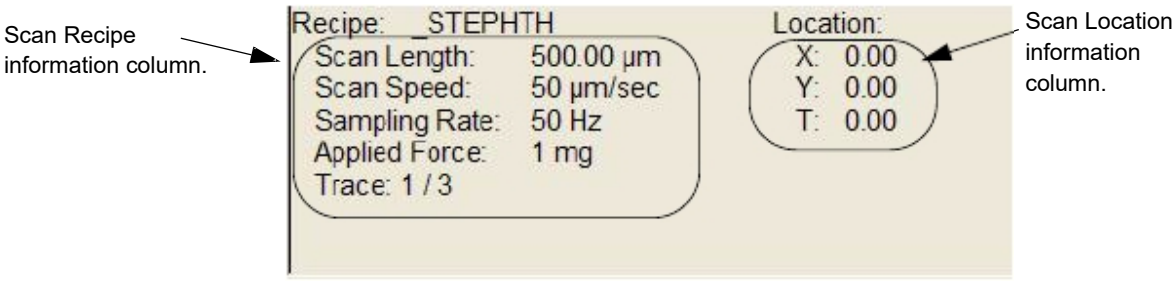
Figure 5.1 *2D Single Scan View Scan Window*



Two columns of information are presented in the lower left quadrant of the 2D scan screen (*Figure 5.1*) and three columns in the 2D sequence screen.

2D Scan Information Field

Figure 5.2 *2D Scan Window - Scan Information Field*



2D Recipe Column

The first column in the 2D Scan Information Field is the Recipe column. *Table 5.1* presents a brief description of each parameter.

Table 5.1 *Scan Screen - Recipe Information Column*

Parameter	Description
Recipe	Gives the name of the recipe being used to create the scan. If the name is followed by "…" then it is truncated.
Scan Type	The type of scan being produced, 2D or 3D.
Scan Length	The length of the scan on the X-axis direction.
Scan Speed	How fast the stage moves during the data gathering portion of the scan.
Sampling Rate	The number of data points being collected per second during the scan.
Scan	The direction in which the scan is being performed. -> is in the positive direction, and <- is in the negative direction.

Scan Information Field - 2D Location Column

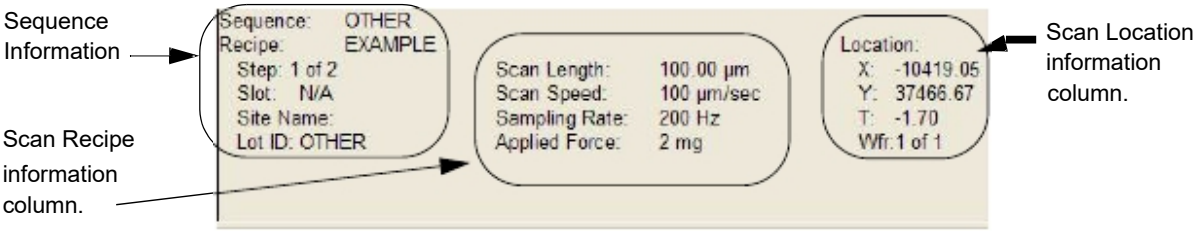
The second column in the Scan Information field is the Location column. *Table 5.2* presents a brief description of each parameter.

Table 5.2 *View Scan Screen - 2D Location Information Column*

Parameter	Description
X	The X coordinate of the scan origination point
Y	The Y coordinate of the scan origination point
T	The rotational value of the sample at the scan origination point.

Scan Information Field - 2D Sequence Recipe Column

Figure 5.3 *2D Scan Window - Scan Information Field*



2D Sequence Column

The first column in the Scan Information field is the **Sequence** column. *Table 5.3* presents a brief description of each parameter.

Table 5.3 *View Scan Screen - 2D Location Information Column*

Parameter	Description
Sequence	The Sequence Recipe Name
Step	Shows which step of the total number of step the system is currently performing.
Slot	N/A – No handler for P-17/P-7 Profiler.
Lot ID	The name of the sample lot. This is assigned by the operator or the system defaults to Recipe Name. (See *Table 6.7 on page 6-26*.)

2D Recipe Column

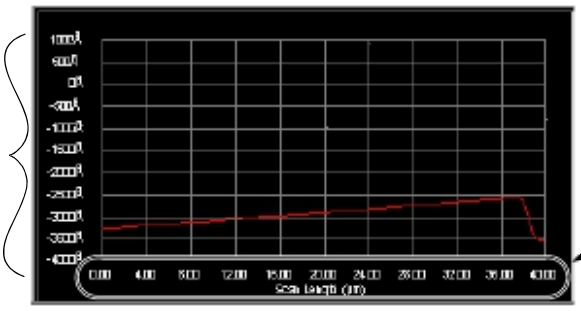
The second column in the Scan Information Field is the **Recipe** column. *Table 5.1* presents a brief description of each parameter.

Real Time Scan Trace Window

This window presents a real time trace of the scan. (See *Figure 5.4*.) A 2D scan can be set up for multi-scan averaging which causes the system to scan the same location as many times as the set parameter requires. Each subsequent scan's trace appears in a different color in the window using a four color rotation. At the end of the scan, the traces are averaged by the system and the result presented in the Analysis screen.

Figure 5.4 *Scan screen - real time Trace Window*

This is the Y axis of the scan graph. It is set by system to capture the height and depth of sample surface features.



This is the X axis of the scan graph. It is determined by the **Scan Length** setting in the recipe.

In the Real Time trace window the height/depth of the features relative to the surface is presented as a trace across the graph. The graph's **Y** coordinates are set by the system and displayed in a scale that is appropriate for displaying scan features. The X-axis scale is determined by the scan length set in the scan recipe. (See *Figure 5.4*.)

2D View Scan Screen Tool Bar

The tool bar buttons are provided for convenience. Many of their functions are duplicated from other screen menu items in the menu bar. *Table 5.4* presents a brief description of the function of each button.

Use the buttons to customize the appearance of the Real Time view. Note that while the scan is still **Live** (not saved), the XY view, Analysis Window, Recipe Editor and Scan View screen can all be toggled between so parameters can be readjusted to improve the scan. The first buttons in the following table open the various screens. All the buttons are located in the tool bar at the top of the View Screen. (See *Figure 5.7* and *Table 5.1*.)

NOTE: During the scan, the buttons are grayed out and cannot be accessed until the scan is complete. Only the **STOP** icon is active.

Table 5.4 *2D View Scan Window Tool Bar Buttons*

Button	Description
	XY View Screen Icon – Changes to view the XY View screen.
	Analysis Screen Icon – Changes screens to view the Analysis screen.
	Recipe Editor Screen Icon – Changes screens to view the Recipe Editor Screen
	Manual Scaling – Resizes the trace to fit in the graph. Requires operator initiation.
	Auto Scaling – Automatically resizes the trace after each scan.
	START SCAN – Starts a stopped scan. The scan that was stopped begins again from the start, the prior partial scan is not retained.
	STOP SCAN – Stops a scan that is in process. A stopped scan cannot be started again from the place in the scan where it stopped. The scan begins again from the beginning.
	PAUSE SEQUENCE – N/A for single scans.
	START/RESUME SEQUENCE – N/A for single scans.

2D View Scan Screen Menu Bar

The menu bar contains those functions that are related to the activities required in the View Scan Screen. Some of the functions are duplicated in the tool bar. (See *Figure 5.5*.) Each menu is discussed in its own table.

Figure 5.5 *2D View Scan Screen Menu Bar*

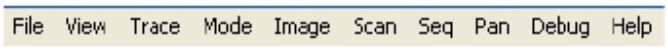


Table 5.5 *2D View Scan Screen - File Menu*

File Menu	Description of Menu Items
	Oscilloscope – Not available with P-series systems.
	XY View – Returns to the XY View screen. If the scan was stopped in the View Scan screen, and the **File/XY View** menu item was used to toggle to the XY view screen, the scan start position can be adjusted. The user then toggles back to the View Scan screen from the **Actions/View Scan** menu item in the XY View screen, and the scan can be run again in the new location.
	Analysis – Returns to the Analysis screen with the current data displayed. ◆ If the scan is stopped by the user, the user can toggle to the Analysis screen by using the File/Analysis menu item. ◆ If the user returns to the View Scan screen from the Analysis screen to start a stopped scan, when the scan is complete, the screen does not automatically return to the Analysis screen. To return to the Analysis screen, use the File/Analysis menu item.
	Edit Recipe – Opens the Recipe screen for the current scan. ◆ If the user stops a scan and wants to edit the scan recipe, the Recipe Editor can be opened using the **File/Edit Recipe** menu item.
	Exit Scan – Closes the current screen.

Table 5.6 *2D View Scan Screen - View Menu*

View Menu	Description of Menu Items
	Toggle Video or Wafer Mode – Provides choice of view between live video as the system scans in the video overlay or to view a representation of the wafer and the the scanning position on the video overlay. This option shows multiple scan areas if a sequence is running. Additionally, an **Auto Scroll Statistics** dropdown option displays the statistics in a statistics pane of a live scan scan page.

Table 5.7 *2D View Scan Screen - Image Menu*

Image Menu	Description of Menu Items
	The image menu is only available for HRP systems equipt with a high resolution sensor stage. The image controls then allow the user to adjust the 3D scan location and parameters within the range of the sensor stage without lifting the stylus.

Table 5.8 *2D View Scan Screen - Trace Menu*

Trace Menu	Description of Menu Items
	Rescale – Resizes the trace to fit in the graph. Requires operator initiation.
	Auto Scale – Scales the trace as it is being created.
	AC/DC – Grayed out - Not available.

Table 5.9 *2D View Scan Screen - Scan Menu*

Scan Menu	Description of Menu Items
	Start – Starts the scan after it has been stopped mid process. This is the same as the START button in the tool bar. The grayed out option is the currently active one.
	Stop – Stops the scan during a scan without canceling the procedure.

Table 5.10 *2D View Scan Screen - Sequence Menu*

Sequence Menu	Description of Menu Items
	Pause – Used in Scan Sequences only.
	Resume – Used in Scan Sequences only.

Table 5.11 *2D View Scan Screen - Pan Menu*

Pan Menu	Description of Menu Items
	The pan menu is only available for HRP systems equipt with a high resolution sensor stage. The pan controls then allow the user to adjust the 2D scan location within the range of the sensor stage without lifting the stylus.

3D Screen Function

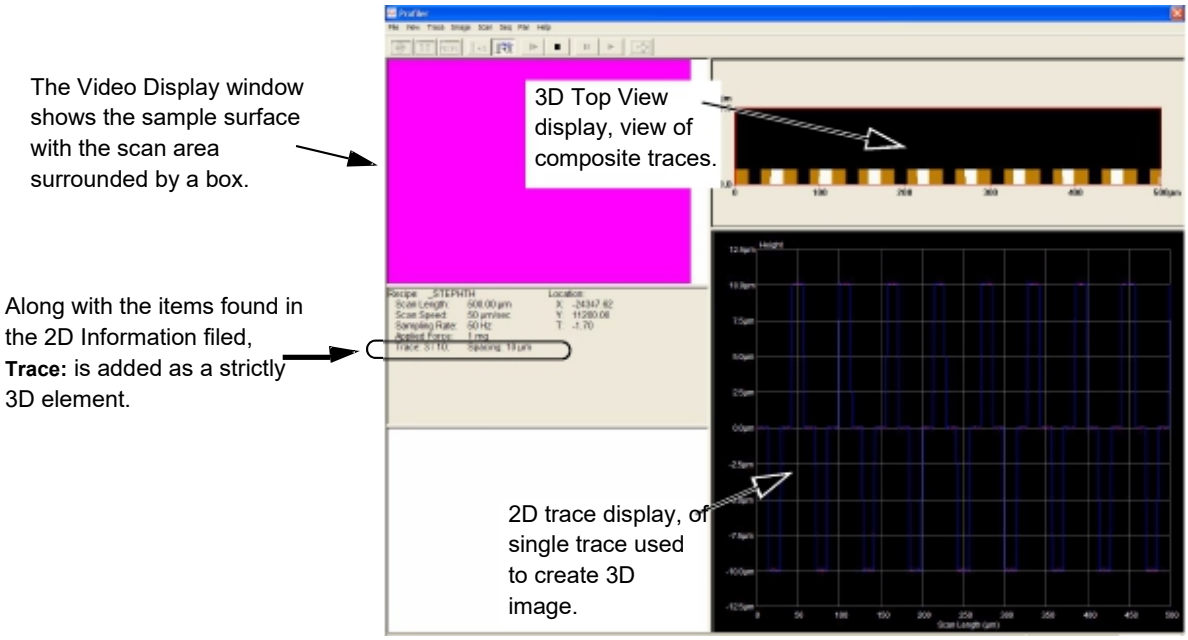
The function of the 3D View Scan screen is similar to that of the 2D screen. Some additions to the screen are made to facilitate 3D analysis and operator monitoring of the scan process. Some menu items from the Menu bar are not accessible when operating 3D sequences.

The **View Scan Window** for 3D scans appears while a scan is being run. It allows the user to observe the progress of the scan and to adjust scan parameters in the various screens for optimum scan results. The scan can be started once the recipe has been chosen and the sample loaded onto the sample stage. The scan can be started from several places, similar to the 2D scan.

Click **START** to begin the scan. (See *Figure 5.6*.)

The View Scan window appears, switches to side view optics (P-17) or Top View (P-7), and the scan begins. The side view video image shows the stylus in contact with the sample surface during the scan from the side-view perspective. The top view is offset from the actual scan site by the scan position offset, with is approximately 2 mm above the scan site. The Real Time Scan graph in the lower right quadrant displays the data in a real time trace as it is collected. (See *Figure 5.6*). After each trace, the data is presented in the 3D Top View window, with each successive trace being added to the others until all traces are viewed in the window. When the scan is finished, the system performs calculations on the data and automatically displays it in the **Analysis** window.

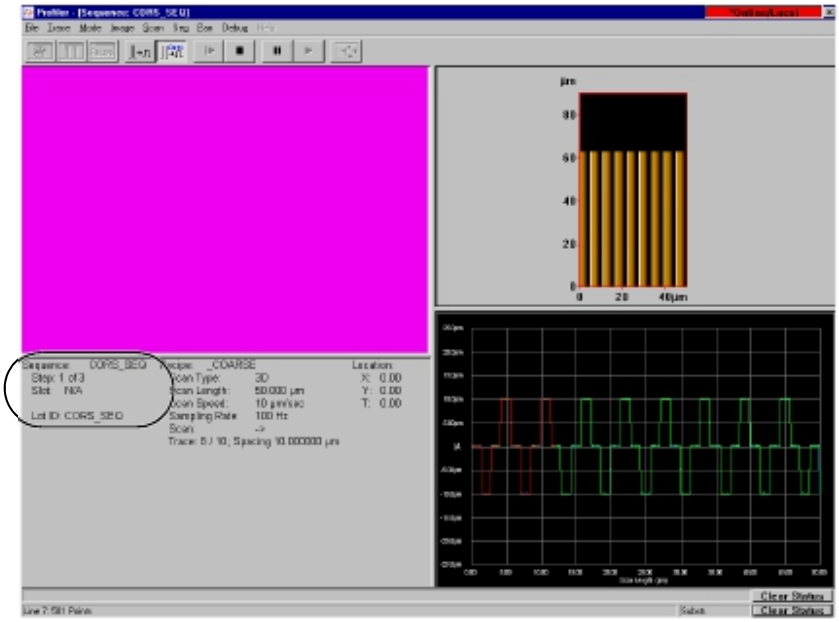
Figure 5.6 *3D View Scan Screen During a Single Scan*



Two columns of information are presented in the lower left quadrant of the 3D *scan* screen (*Figure 5.6*) and three columns in the 3D *sequence* screen (*Figure 5.7*).

Figure 5.7 *3D View Scan Screen During a Scan Sequence*

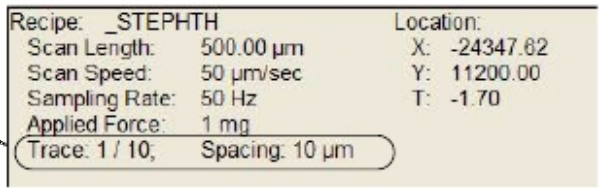
When performing a sequence, the Sequence information is added to the information set.



3D Scan Information Field

Figure 5.8 *3D Scan Window - Scan Information Field*

The only parameter in this field that is different from the 2D field is **Trace:**



3D Scan Recipe Column

The first column in the Scan Information Field is the scan Recipe column. It contains the scan recipe name and some of the critical determining recipe parameters.
The 3D column adds **Trace** to information presented in a 2D parameter set.

3D Location Column

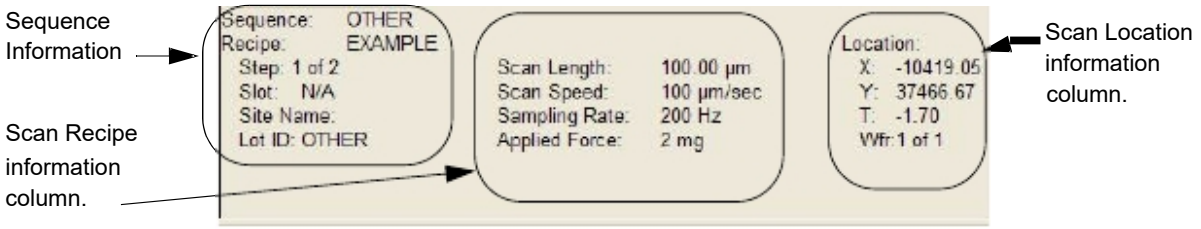
The second column in the Scan Information field is the Location column. It contains the coordinates and orientation of the scan starting point. *Table 5.12* presents a brief description of each parameter. This information is identical with that for 2D scans.

Table 5.12 *View Scan Screen - 3D Location Information Column*

Parameter	Description
X	The X coordinate of the scan origination point
Y	The Y coordinate of the scan origination point
T	The rotational value of the sample at the scan origination point.

Scan Information Field - 3D Sequence Recipe Column

Figure 5.9 *3D Scan Window - Scan Information Field*



3D Sequence Column

The first column in the Scan Information field is the **Sequence** column. It contains the information regarding the sequence being used in the scan. The 3D sequence view scan screen is the same as the 2D sequence as shown in *Table 5.1*.

3D View Scan Screen Tool Bar

The tool bar buttons are provided for convenience. Many of their functions are duplicated from other screen menu items in the menu bar.

In 3D sequences most of the buttons are not active. Note that while the scan is still under way and when a sequence scan is paused, the XY view, Analysis Window, Recipe Editor and Scan View screen icons are all disabled. All the buttons are located in the tool bar at the top of the View Screen. (See *Figure 5.7*)

NOTE: During the scan, the buttons are grayed out and cannot be accessed.

3D View Scan Screen Menu Bar

The menu bar contains those functions that are related to the activities required in the View Scan Screen. Some of the functions are duplicated in the tool bar. (See *Figure 5.10*.) Some menus such as the 3D View Scan Screen - Trace, Mode, Image and Debug menus, are similar to the 2D View Scan Screens. Refer to o. The remaining menus are discussed in their own tables.

Figure 5.10 *View Scan Screen Menu Bar*

Table 5.13 *3D View Scan Screen - File Menu*

File Menu	Description of Menu Items
	Oscilloscope – Not available with P-series systems.
	XY View – Disabled for 3D scans
	Analysis – Disabled for 3D scans
	Edit Recipe – Disabled for 3D scans
	Exit Scan – Disabled for 3D scans

Table 5.14 *3D View Scan Screen - Trace Menu*

Trace Menu	Description of Menu Items
	Rescale – Resizes the trace to fit in the graph. Requires operator initiation.
	Auto Scale – Scales the trace as it is being created.
	AC/DC – Disabled.

Table 5.15 *3D View Scan Screen - Image Menu*

Image Menu	Description of Menu Items
	The image menu is only available for HRP systems equipped with a high resolution sensor stage. The image controls then allow the user to adjust the 3D scan location and parameters within the range of the sensor stage without lifting the stylus.

Table 5.16 *3D View Scan Screen - Scan Menu*

Scan Menu	Description of Menu Items
	Start – **Sequences**: The sequence is terminated when the STOP button is clicked. There is no opportunity to use this menu item. **Single Scans**: Starts a 3D scan from the View Scan window. Operates the same as the Start Scan icon.
	Stop – Sequences: Stops the sequence during a scan, canceling the sequence and returning to the Sequence Catalog screen. Single Scans: Stops the scan and returns to the Scan Catalog screen.

Table 5.17 *3D View Scan Screen - Sequence Menu*

Sequence Menu	Description of Menu Items
	Pause – Pauses the scan sequence. The current scan is abandoned and will be started over when the Resume icon or menu item is clicked.
	Resume – Resumes the sequence again, initiating it at the beginning of the scan that was interrupted.

Table 5.18 *3D View Scan Screen - Pan Menu*

Pan Menu	Description of Menu Items
	The pan menu is only available for HRP systems equipped with a high resolution sensor stage. The pan controls then allow the user to adjust the 2D scan location within the range of the sensor stage without lifting the stylus.

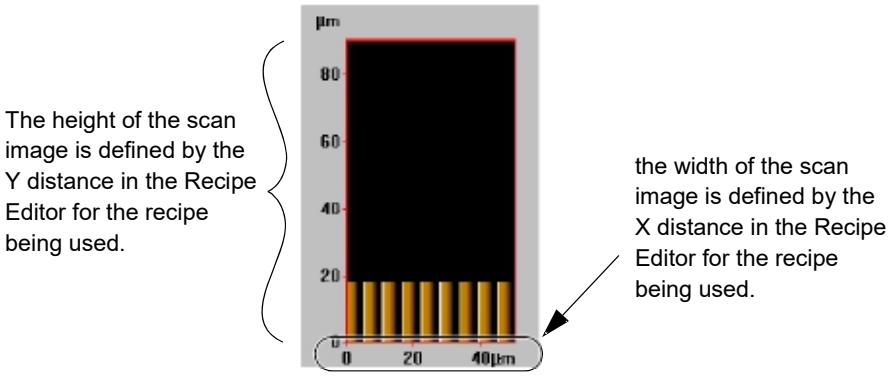
Video Image

The upper left section of the screen displays scan image on the sample surface. (See *Figure 5.7*.) Prior to the scan, a scan boundary box surrounds the scan area in the image.

Real Time Scan Window

In a 3D scan each subsequent scan's trace is presented in the 3D Top View display. (See *Figure 5.11*.) At the end of the scan the system presents the results in the 3D Analysis screen.

Figure 5.11 *Top View Image of the 3D Scan In Progress*



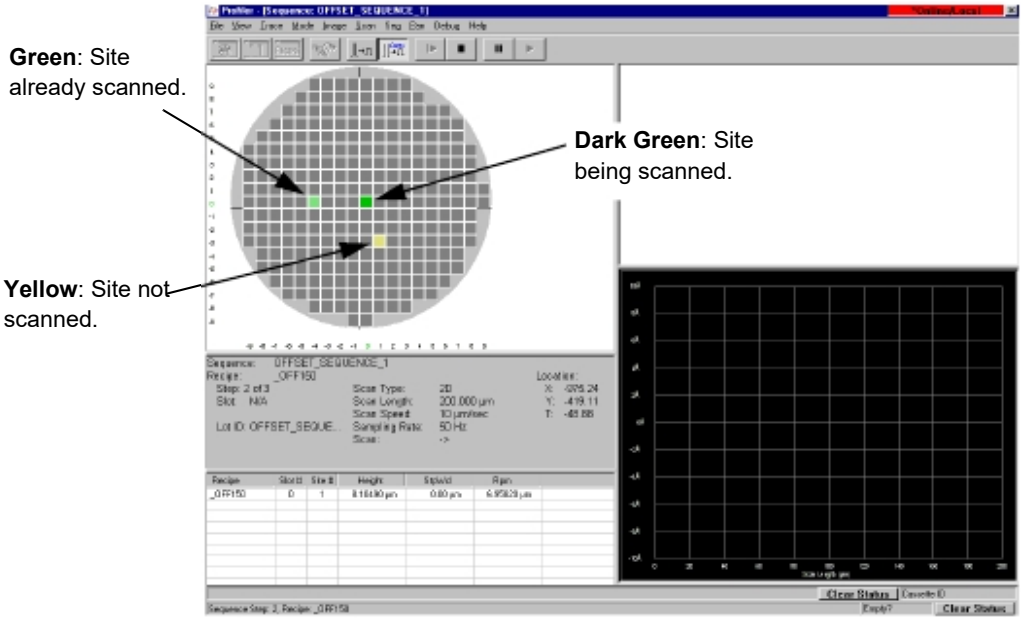
Wafer Image Display

If the Wafer Map is chosen, all of the sites that are to be scanned are visible on the wafer image. If the wafer has a die grid and the die is loaded, the wafer map looks like the die map and the entire die containing the scan site(s) is highlighted in a color. The die is color coded to represent its scan status. The colors are as follows:

- **Yellow**: Site waiting to be scanned
- **Dark Green**: Site being scanned
- **Green**: Site already scanned.

If the wafer is not characterized by a die grid, or the die map is not loaded, the scan sites appear as colored dots at the scan location. The color code is the same as that of the wafer having a die grid map.

Figure 5.12 *Sequence Scan Screen with Die Measurement Site Map*



Scan Site Image Display

As the sequence progresses through each scan site, the image of the current scan site is displayed in the video screen. This is the view that alternates with the **Die Measurement Site Map** (see *Figure 5.12*) as the **View** menu options are toggled between (see *Figure 5.12*). This image is not live, but is a snap shot of the scan site start position as it appears before the scan.

ABORTING A SCAN

Click the **Stop** button at any time to abort the scan. The scan can be started over again, but not from where it stopped. All data from the aborted scan is lost. If a sequence is halted using the **Pause** button, and the sequence is resumed, the Analysis screen might not be displayed at the end. Click **File/Analysis** to open Analysis.

SEQUENCE RECIPE AND DATA

INTRODUCTION

Limited Sequence Recipe and Data applications are now standard on the P-17/P-7. However, the capability of the Sequence application can be greatly extended using the 1000- site sequence option. The Sequence application uses sequences that contain multiple scan recipes combined into one file for automatic sequence scanning. This saves time when repeatedly scanning the same location(s) on multiple samples. The Sequence Recipe and Data application consists of two parts:

- Sequence Recipe Editor to load, create, edit, and save Sequence Recipes for scanning.
- Sequence Database to load, collect, manipulate, and save data obtained from scanning.

Sequences can be created using any combination of 2D and 3D recipes. The Sequence Recipe contains information that directs the system to precisely position the sample beneath the measurement head for each measurement in the sequence of scans. Each measurement location in a sequence is called a site. The information for how to scan each site is contained in the Scan Recipe that is connected with the site in the Sequence Recipe. See *Chapter 3* for more information on creating and editing Scan Recipes.

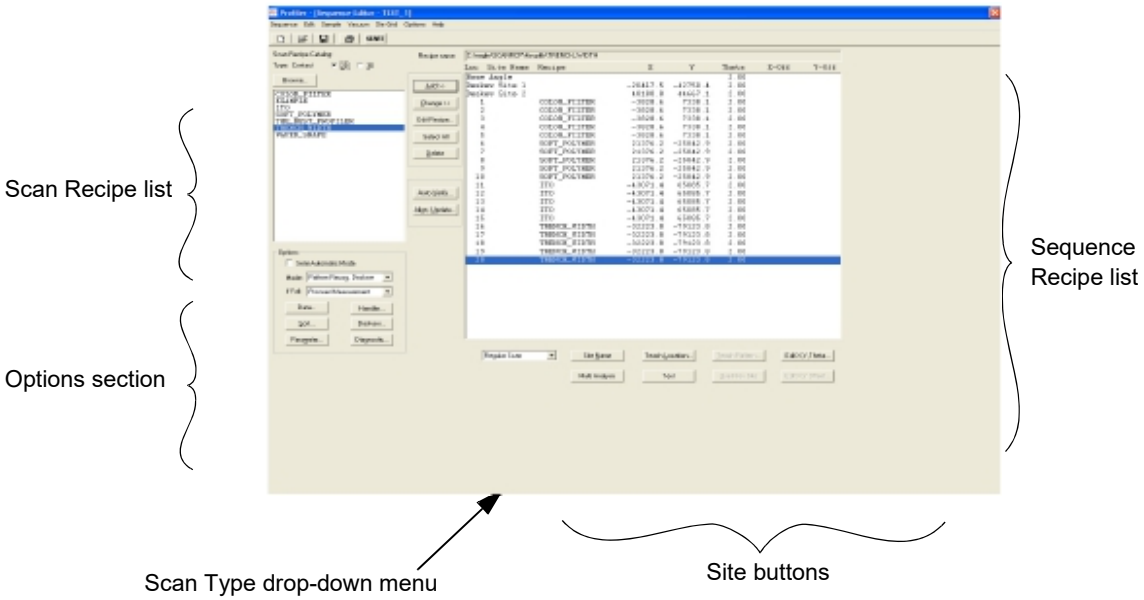
The Sequencing feature provides the following capabilities:

- Combines up to 20 sites and recipes standard, or optionally up to 1000 sites and recipes
- Set reference points for correcting translational and rotational variations between substrates (deskew)
- Re-scan portions of a long scan, using the long scan as a data reference for the subscans so their measurements correlate with each other
- Set Deskew manually or automatically using Pattern Recognition (Optional feature, P-17 only)
- Set Pattern Recognition options to search locally for a match when a match is not found in the camera's field of view at deskew sites, and carry out user-selected instructions if the search fails
- Set pattern recognition to reference sites using site-by-site Pattern Recognition
- In Multi Analysis mode, apply different Scan recipes to a single scan
- Automatically display, print, export, and save statistics and trace data for all sites
- Teach scan sites and alignment reference points interactively, with or without theta
- Export the data from each wafer immediately following the wafer processing
- Choose the number of times the Sequence Recipe is run and allow the data to be saved for each run

STARTING THE SEQUENCE EDITOR APPLICATION

1. In the Catalog screen, if it is not already active, click the **Sequence Recipe** button.
2. Select a Sequence recipe to be edited.
3. Click the **View/Modify** button. (It is also possible to double-click the recipe to open the Sequence Editor.
   The Sequence Editor screen appears. (See *Figure 6.1*).

Figure 6.1 *Sequence Editor Screen*



CREATING A SEQUENCE RECIPE

A sequence allows the user to assemble a series of scans that can be performed on a single scan position or on multiple scan sites on a sample. In a production environment, the sequence can be set up to run multiple sites on multiple identical samples. The sequence recipe can be created for many different scenarios. The following procedure progresses through the creation of a sequence recipe that includes die grid navigation, a necessary ingredient for scanning multiple dies on a sample.

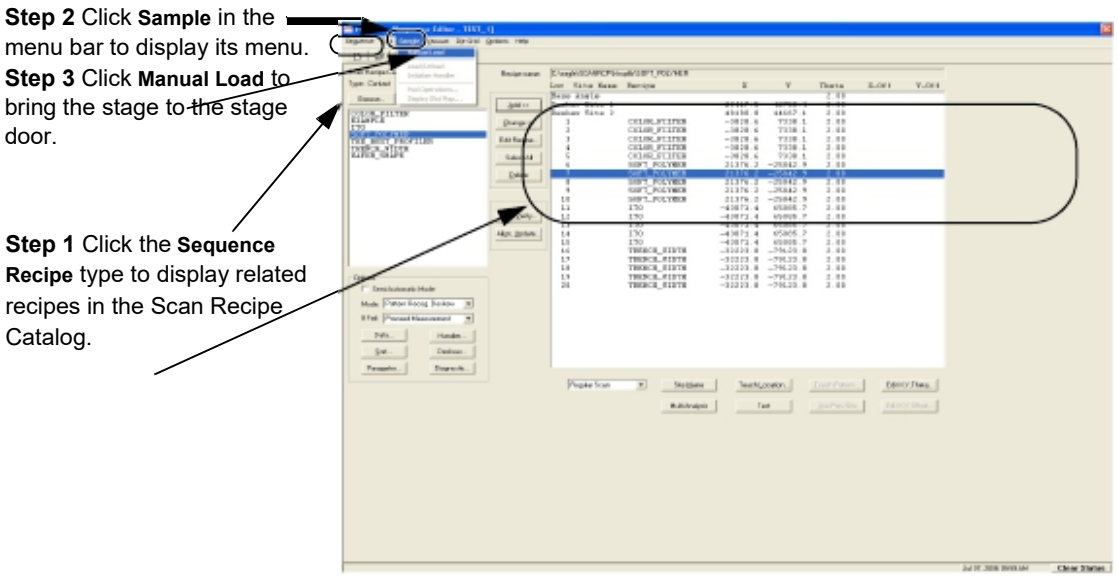
This procedure assumes that no wafer is currently present on the measurement chamber table/chuck.

Begin: Load Sample Procedure

1. From the Catalog screen, click the **Sequence Recipe** type to display related scan recipes in the Information Display Window.

2. To load a sample, click **Sample** in the menu bar at the top of the screen to display its menu. (See *Figure 6.2*.)

Figure 6.2 *Sequence Recipe Catalog Screen*



3. Choose **Manual Load** from the Sample menu. The sample stage moves to the stage door.
4. *After the stage stops*, open the stage door.

CAUTION: Wait until the stage has completely stopped moving before attempting to open the measurement chamber door. If it is open when the system is in movement, the profiler software does not operate because the interlock switch stops all the stage and elevator motors.

5. Place the patterned wafer on the stage paying close attention to the orientation of the wafer. The die grid should be as square with the stage X-Y-axis as possible. It is best to use a precision locator to place the wafer securely and squarely on the stage. Otherwise, if the system has to deskew the wafer very much, measurements and pattern recognition could fail later.
6. Turn the vacuum on using the switch on the upper left door frame.
7. Close the measurement chamber door.

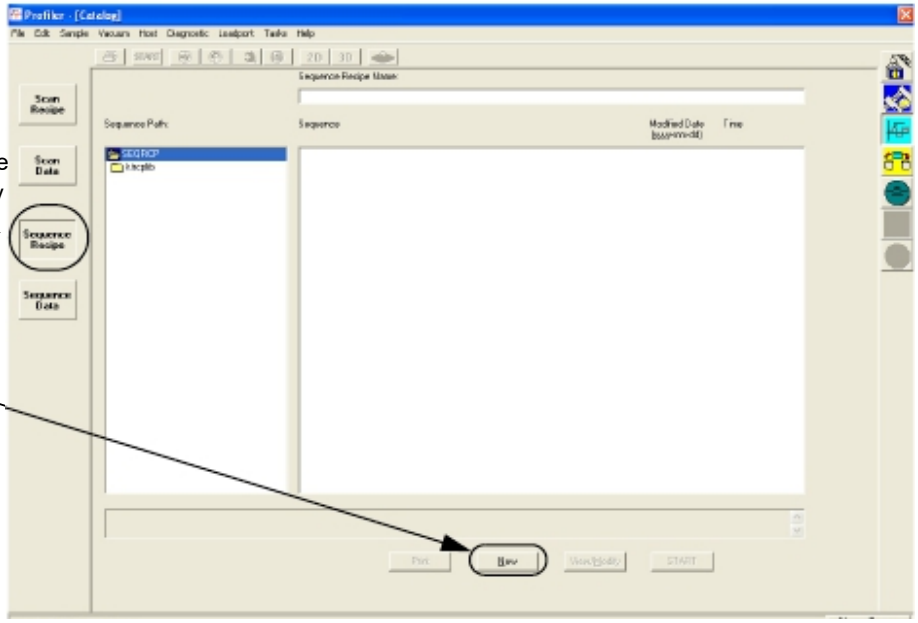
End: OPTIONAL Manual Wafer Load Procedure

8. After the door is closed, click **Sample** in the menu bar, then on **Manual Load**. The stage moves back under the measurement head.

Figure 6.3 *Scan Sequence Catalog*

Step 9 Click the Sequence Recipe button to display the Sequence list in the display window.

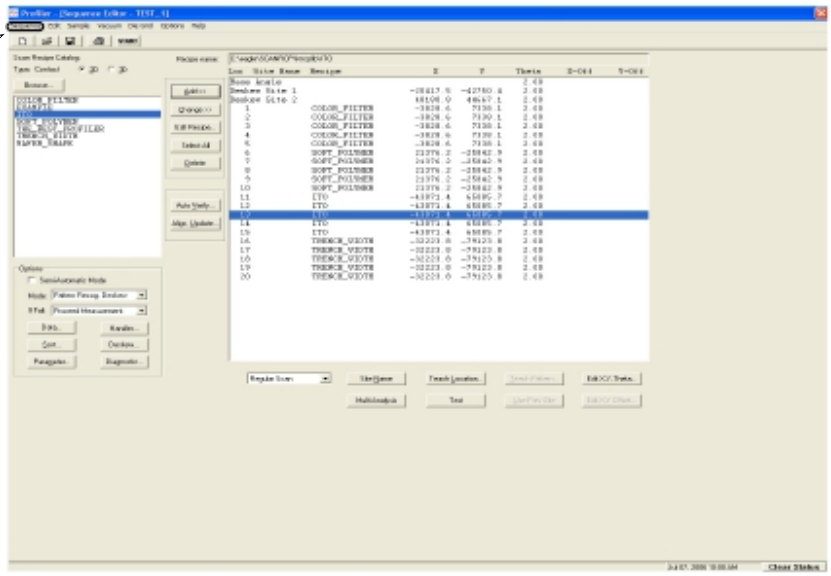
Step 10 To open the Sequence Editor for a new recipe, click the **NEW** button at the bottom of the screen.



9. Click the **Sequence Recipe** button to change to the Sequence catalog list. (See *Figure 6.3*.)
10. From the **Sequence** catalog, open a new sequence by clicking on the **NEW** button at the bottom of the screen. (See *Figure 6.3*.)

    The Sequence Editor opens, formatted to create a new sequence recipe. (See *Figure 6.4*.)

Figure 6.4 *Sequence Editor for NEW Recipe with Pattern Recognition*



11. Click **Sequence** in the menu bar to display its menu. (See *Figure 6.4.*)
12. Click **Save** or **Save As** to name and save the sequence.
13. The **Save Recipe** dialog box appears. Type in the name of the new sequence and click **OK** to save it.

Linking a Die Grid with a Sequence (Optional Feature, P-17 only)

When linking a die grid with a sequence, it is better to link it while creating a new sequence recipe rather than to associate a die grid with an existing recipe that uses the same recipe sequence. Use the following procedure for linking a recipe as part of the creation of a new recipe.

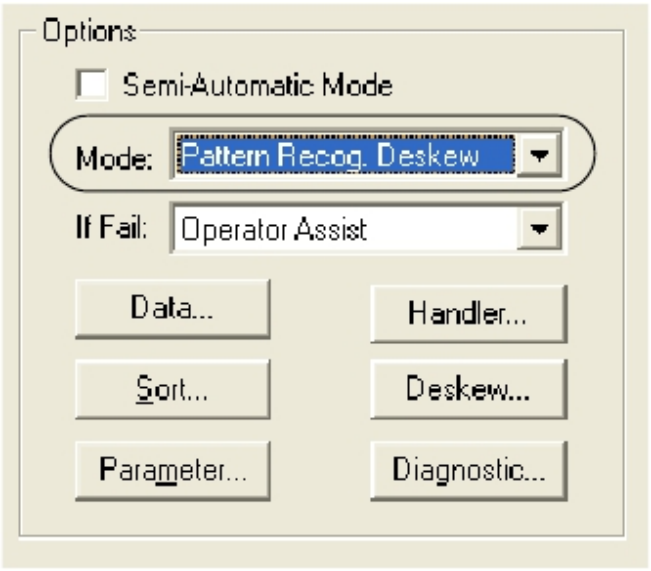
1. To use a die grid, Pattern Recognition Deskew must be in place. To tie the deskew process to pattern recognition, use the following procedure. In the **Options** box located in the lower left corner of the Sequence Editor, click the menu arrow next to the **Mode** field.

2. Click **Pattern Recog. Deskew…** (See *Figure 6.5*.)

Figure 6.5 *Options Section in the Sequence Editor (Optional feature, P-17 only)*

Step 1 Click the menu arrow for its menu.

Step 2 Choose **Pattern Recog. Deskew**.



Begin: Load Die Grid

3. This sequence is being set up to work on a particular wafer with a set die grid that is to be measured. The sequences must be connected to the Die Grid for scanning and navigational purposes.

Die Grid Navigation with single scans requires loading the die grid at the beginning of each scanning session. With sequences, a die grid can be associated with a sequence, so that it loads and aligns the wafer automatically when teaching sites for the sequence. The die grid can also be disassociated if the sequence no longer requires Die Grid Navigation.

For additional information about the use of Die Grid Navigation, see *Using Die Grid Navigation (Optional Feature, P-17 only) on page 4-16.*

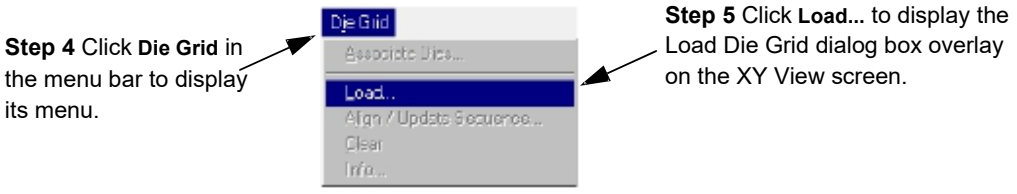
NOTE: Whenever possible, load a die grid before teaching any sites; because it invalidates all currently taught positions.

Ensure that the wafer on the stage has the same pattern as that of the die grid being loaded.

CAUTION: It is very important that each wafer is placed in the same orientation that the die grid was taught in. If not, the system cannot locate the dies. When placing the wafer in the system, it is best to use a precision locator to place the wafer in the proper orientation.

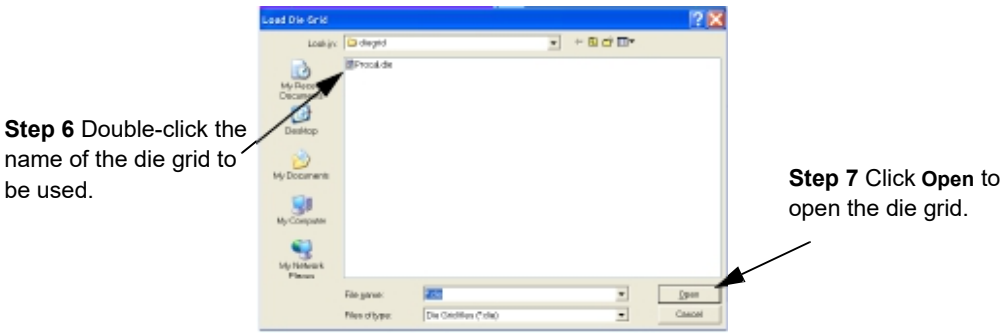
4. In the menu bar, click **Die Grid** to display its menu. (See *Figure 6.6*.) If **Die Grid** is grayed out in the menu bar, the Safe Area might be incorrect. Set the **Safe Area** in the Configuration screen to the size of the wafer being used. See *Safe Area Configuration* on page 13-12.

Figure 6.6 *Die Grid Menu*



5. Click **Load...** (See *Figure 6.6*.)

Figure 6.7 *Load Die Grid Dialog Box*



This displays the XY view screen with the **Load Die Grid** dialog box overlay. (See *Figure 6.7* for dialog box.))

6. In the **Load Die Grid** dialog box, double-click the name of the die grid to be used.
   This displays the die grid name in the **File Name** display box. (See *Figure 6.7*.)
7. Click **Open** to load the die grid. (See *Figure 6.7*.)
   The system nulls the stylus and begin to search for the pattern that is displayed in the sample navigation window. After it successfully locates the test pattern, the die grid is loaded.

CAUTION: The die grid must match the die grid pattern on the wafer that has been loaded. If not, the die grid feature cannot be found and the die grid does not load.

8. A warning message box appears warning that adding the die grid to the recipe changes the base angle and can invalidate deskew and measurements sites. Since this is a new recipe and the site have yet to be determined, click **OK**. (See *Figure 6.8*.)

Figure 6.8 *Sequence Editor*

Step 8 Read the warning and click **OK** to close it.

End: Load Die Grid

9. In the Sequence Editor, save the Sequence Recipe by clicking on **Sequence** to display its menu, then on **Save**.

Begin: Teach Global Pattern Recognition Sites

10. This procedure is designed to set up the pattern recognition that allows the system to recognize the current wafer as related to the die grid and to perform a deskew procedure on to align the wafer with the X- Y-axis.

    In the Sequence Recipe Catalog screen, click **Deskew Site 1.** (See *Figure 6.9*.)

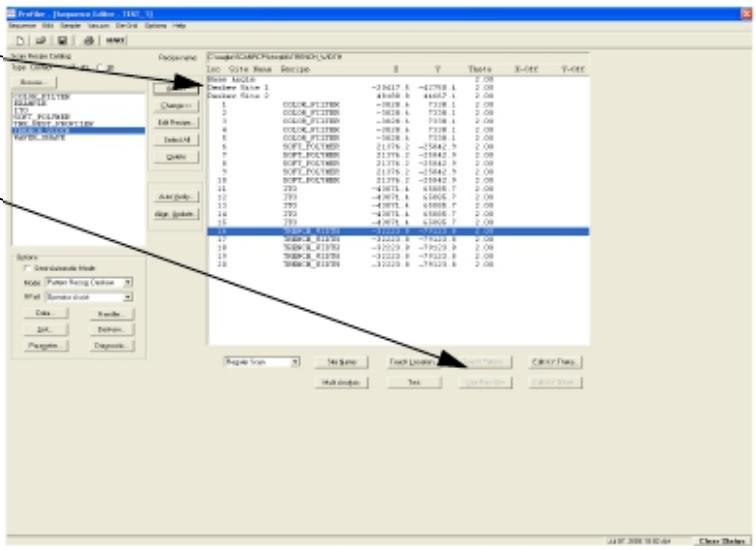
11. The **Teach Pattern** button at the bottom of the screen becomes active. (See *Figure 6.9*.) Click the button to begin the Teach Pattern procedure for Site #1.

Figure 6.9 *Sequence Editor*

Step 10 Click **Deskew Site 1**.

Step 11 Click **Teach Pattern**.

After the pattern is taught, repeat the procedure for Site 2.

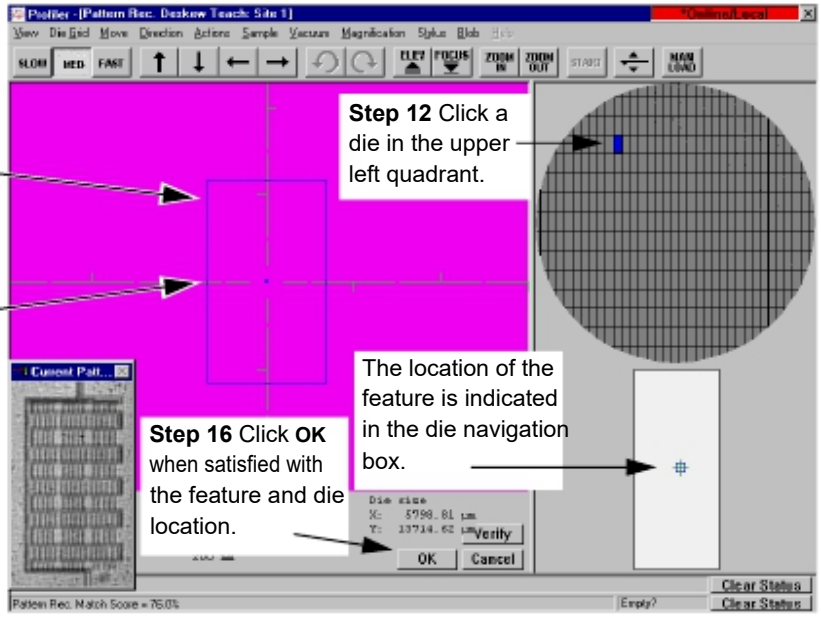


12. The **Pattern Rec. Deskew Teach: Site 1** screen is displayed. Click a die in the upper left quadrant of the sample navigation grid. the dark (blue on the screen) rectangle has been chosen in *Figure 6.10*.

Figure 6.10 *Pattern Rec. Deskew Teach: Site 1 Screen*

Step 15 Use the click-and-drag process to draw a box around the feature to be used for pattern recognition deskew.

(The video image is not visible in this illustration but would be present on the actual screen.) The box is drawn around the feature that is displayed in the **Current Patt...** box.



13. After the die in the upper left quadrant is clicked, the system moves that die into view in the video window. Click **FOCUS** in the tool bar to bring the die into clear focus.
14. Use the arrow buttons in the tool bar to move the field of vision to a feature in that die that is used for centering the die and aligning the wafer. It is best to use the same feature that is used in the die grid. (See *Figure 6.10*.)
15. After locating the feature, use the click and drag procedure, starting from the upper left corner of the feature, to draw a rectangle around the feature. When the box is complete, the system centers it in the X-Y-grid and a replica of it is produced in a box on the screen. The die navigation box, under the die grid navigation grid, now contains a small blue box indicating the position of the feature with respect to the die boundaries. (See *Figure 6.10*.)
16. When satisfied with the die position and the feature, click **OK**.

End: Teach Global Pattern Recognition Sites

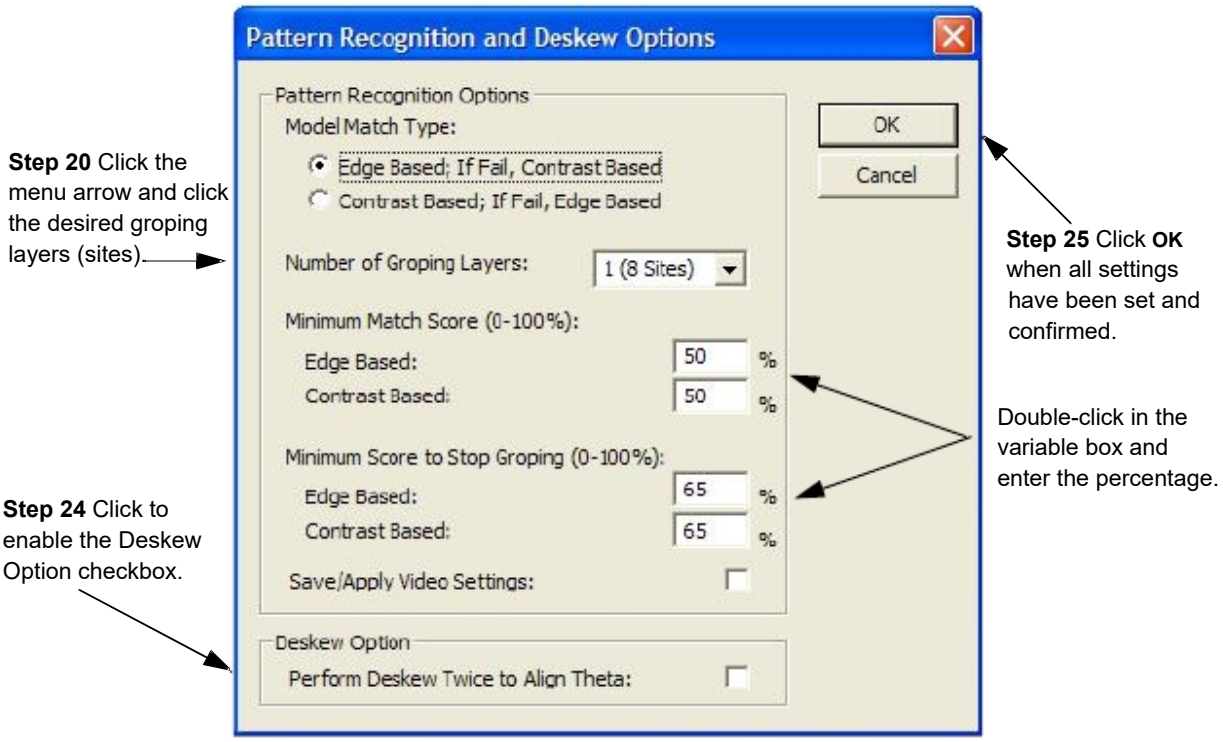
17. Repeat **Step 10** through **Step 16** for **Site 2**. For a location, choose the lower right quadrant, at approximately the opposite die position, at an approximate 45° angle through the center of the die grid from the first die.

Begin: Setting Deskew Options

18. Deskew Options set the number of groping Layers, set the maximum and minimum percentage match for identification of a feature, and offer the ability to turn on or off Deskew Twice and Image Processing options. (See *Groping with Pattern Recognition (P-17 Only)* on page 6-44.)

    Click **Deskew** in the menu bar and then on **Options...** to display the dialog box. (See *Figure 6.11*.)

Figure 6.11 *Deskew Options Dialog Box*



19. To enable **Edge Based Pattern Rec**., click to put a check in the check box. (See "Edge Based Pattern Rec." in *Table 6.12 on page 6-45*.)
20. Set the **Number of Groping Layers** by clicking on the down-arrow and then clicking on the desired number of layers and sites. (See *Groping with Pattern Recognition (P-17 Only)* on page 6-44 for more information on groping layers.)
21. Set the **Minimum Match Score** by double-clicking in the variable box and typing in the new percentage. (See *Figure 6.11*.)
22. Set the **Minimum Score to Stop Groping** by double-clicking in the variable box and typing in the new percentage. (See *Figure 6.11*.)
23. To enable **Save/Apply Video Settings**, click to put a check in the check box. (See "Save/Apply Video Settings" in *Table 6.12 on page 6-45*.)

24. If desired, click to put a check in the check box for **Perform Deskew Twice to Align Theta** to enable it. (See "Perform Deskew Twice to Align Theta" in *Table 6.12 on page 6-45*.)

End: Set Deskew Options

25. Click **OK** when all the parameters have been set.

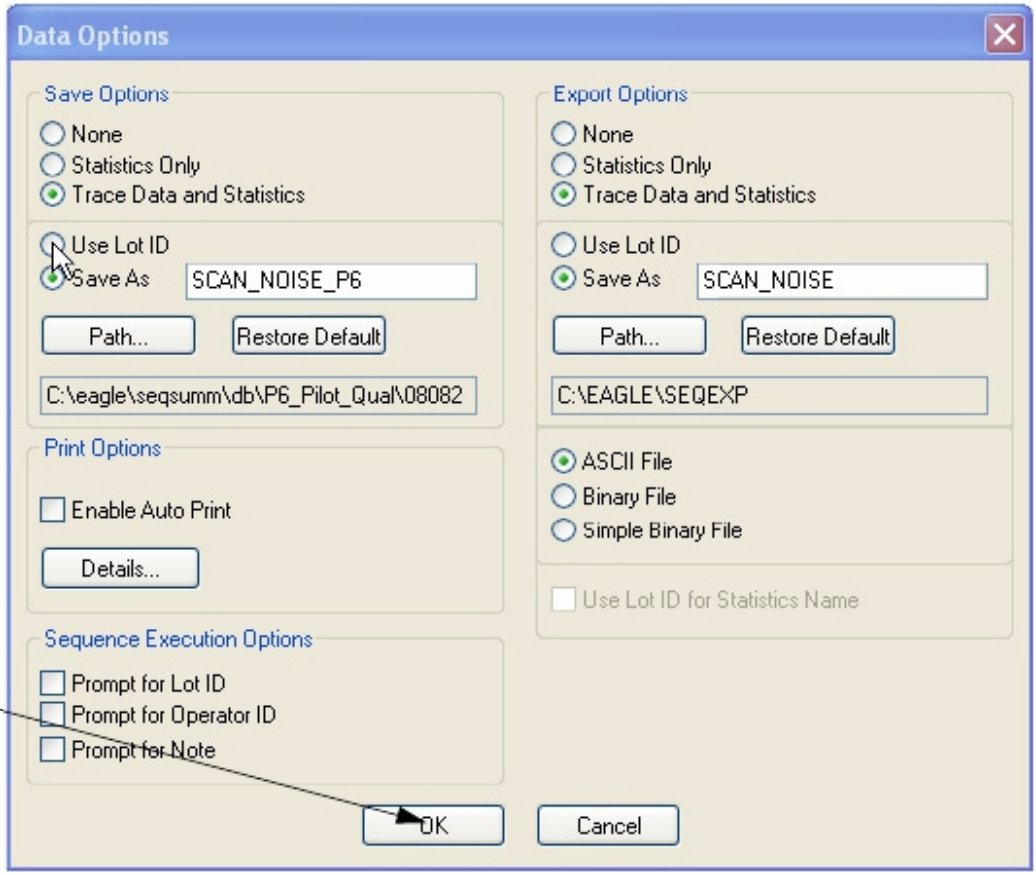
Begin: Set Data Options

26. Data Options are explained in detail beginning in Step *2. on page 6-25*, in *Editing the Options Field in the Sequence Editor*.

    Click **Data...** in the Options section in the lower left corner of the Sequence Editor. This displays the **Data Options** dialog box.

    The **Data Options** dialog box appears. (See *Figure 6.12*.) Once set, the Profiler automatically either exports, saves, or prints the file data.

Figure 6.12 *Data Options*



Step 28 - When the Options have been chosen, Click **OK**

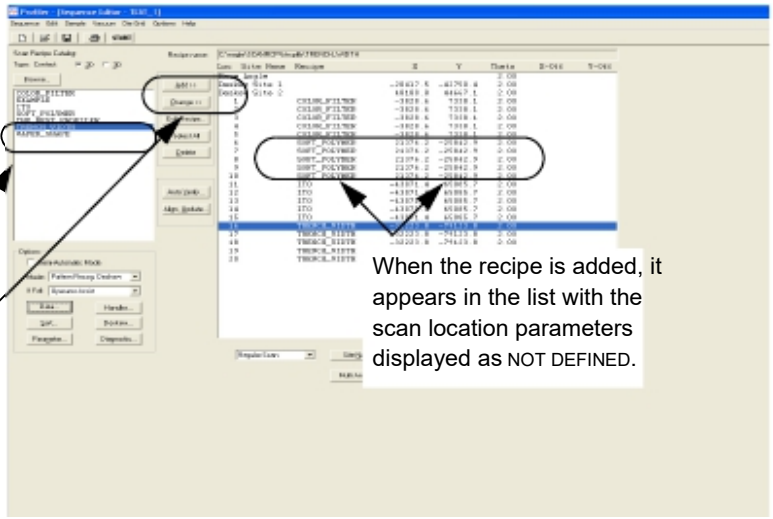
1. Set the options according to the scan sequence requirements. (See Step 2 on page -25 through Step 2 on page -26, in *Editing the Options Field in the Sequence Editor*.)

End: Set Data Options

2. Click **OK** when options have be set.

3. Save the Sequence by clicking on **Sequence** to display its menu, then on **Save**.

Figure 6.13 *Sequence Editor Set Up for New Recipe*



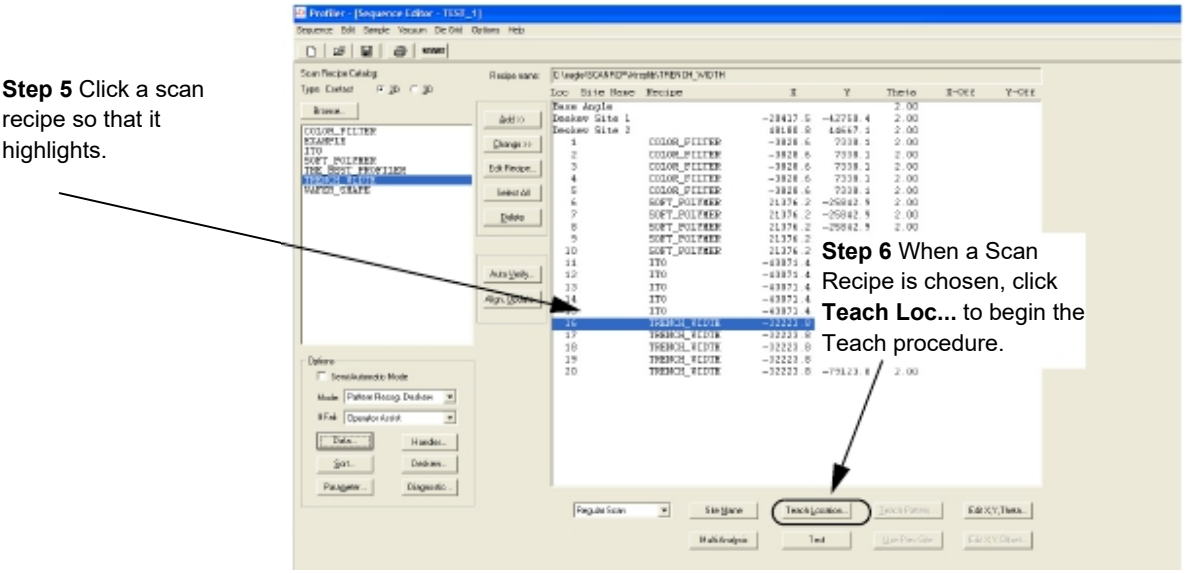
Adding Scan Recipes

4. The Sequence Editor appears with no scan recipes in the Sequence list. Add the required recipes to the sequence using the following procedure: (See *Figure 6.13*.)
   a. In the scan recipe list, click the first recipe to be included in the sequence. It highlights when selected.
   b. Click the **Add** button to add the recipe to the sequence.
   c. Repeat this procedure for every scan recipe that is to be added to the sequence.

Begin: Teach Scan Location

5. In the **Sequence Editor**, click a scan recipe in the sequence. It highlights when chosen. (See *Figure 6.14*.)

Figure 6.14 *Sequence Editor - Teach Scan Location*



6. Click the **Teach Loc** button at the bottom of the screen.

   The XY view screen appears and the system proceeds to null on the sample surface. It then searches for the feature in the die. When it is found, the scan path indicator is displayed over the feature. (See *Figure 6.15*.)

7. The die grid is visible in the sample navigation window with the die navigation box below it. During a scan sequence, the system uses the Pattern Recognition Deskew to situate the wafer.

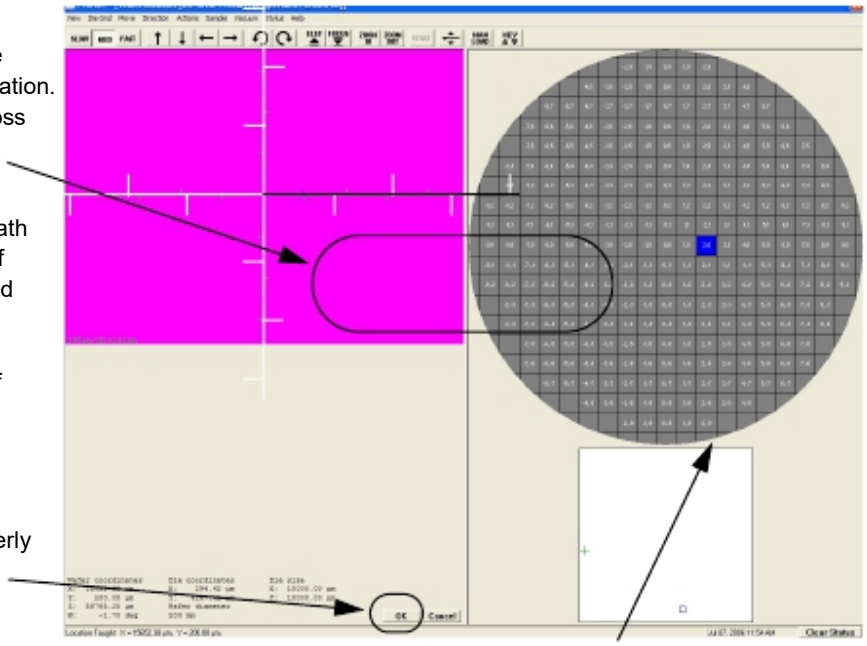
8. Find the feature in the die that is to be scanned using the first recipe. Click in the relative position in the die navigation box to move the feature close to the field of view. Use the arrow buttons to move the feature into view. Click in the relative position in the die navigation box

Figure 6.15 *Teach Location for First Recipe Scan*

Step 8 The **Teach Location** screen displays the sample surface under low magnification. Position the scan path across the chosen feature.

Step 9 Position the scan path indicator over the portion of the die that is to be scanned by the recipe in the sequence. Use the arrow buttons to move the field of vision and locate the scan location.

Step 10 Click **OK** when the scan path indicator is properly placed.

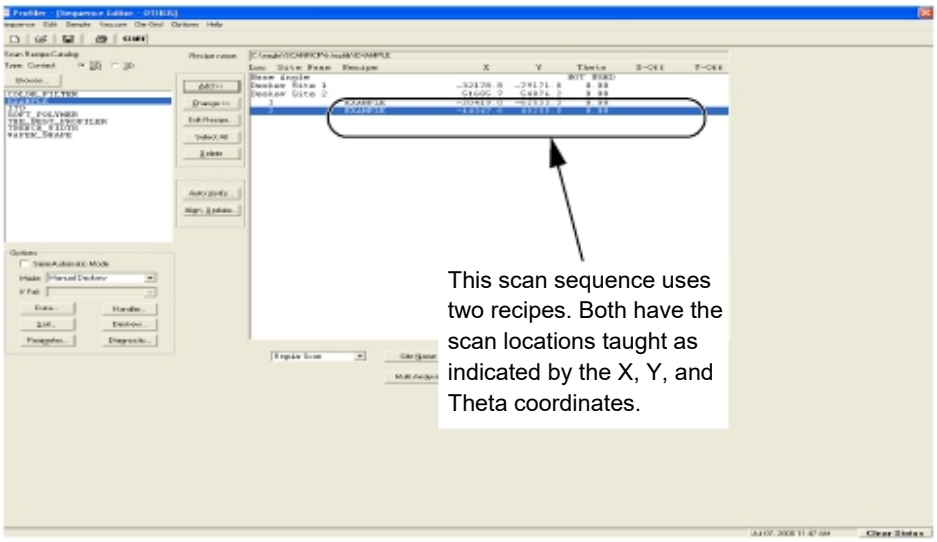


The die navigation box can be used to position the scan for the recipe. Click the place in the die where the scan feature resides. The video image displays that position.

9. After the feature is centered in the video window, position the scan path indicator over the feature in the die that is to be scanned using the first recipe in the sequence. (See *Figure 6.15*.)
10. When the scan path indicator is correctly positioned, click **OK**. (See *Figure 6.15*.) The screen changes back to the Sequence Recipe screen.

    In the Sequence Recipe screen, there are now coordinates next to the scan recipe which describe the location of the scan path in the die for that recipe. (See *Figure 6.16*.)

Figure 6.16 *Sequence Editor*



11. Repeat **Step 5** through **Step 10** (Teach Scan Location) for each recipe in the sequence. Be sure to use the same die as that used to teach the first location.

Associating Dies with a Sequence Using Die Grids

After a die grid has been associated with the scans in a sequence, it is possible to associate other dies on the same sample with the scans using the die grid. This creates a longer sequence in which additional scan locations on the sample are scanned automatically, using validated scan locations.

Use the following procedure to associate dies with the sequence scans using die grids.

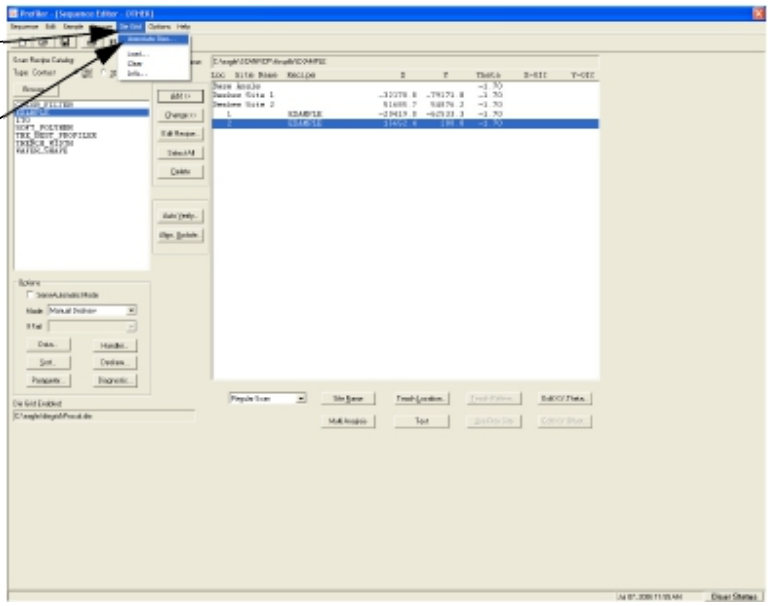
1. Ensure that the procedure in *Linking a Die Grid with a Sequence (Optional Feature, P-17 only)* on page 6-5 has been completed for the sequence being used.
2. From the Sequence Editor highlight the recipe that is to have additional dies associated with.
3. Click **Die Grid** in the menu bar. (See *Figure 6.17*.)

4. Click **Associate Dies...** (See *Figure 6.17*.)

Figure 6.17 *Sequence Editor with Die Grid Menu*

Step 3 Click **Die Grid** in the menu bar to display its menu.

Step 4 Click **Associate Dies...** to begin the process of choosing new scan sites.

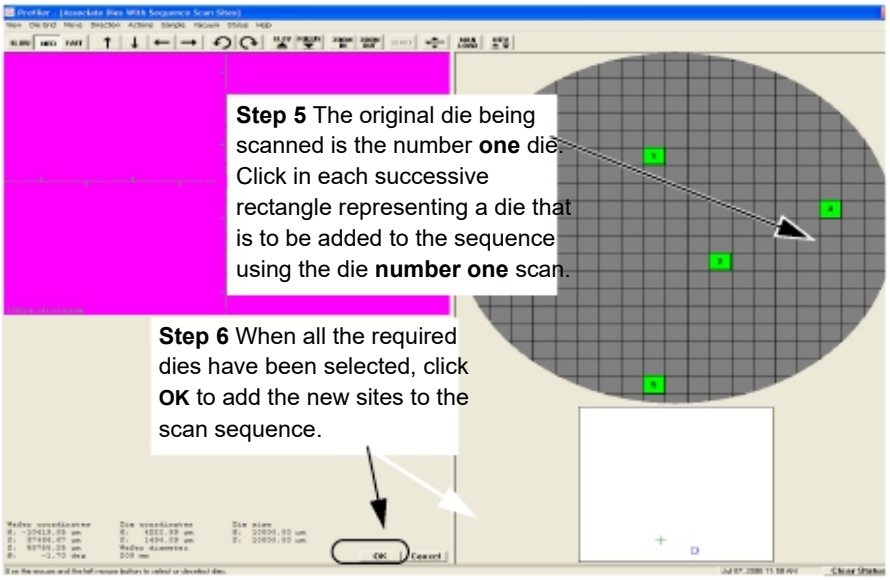


This displays XY screen titled "**Associate Dies With Sequence Scan Sites**," with a graphic display of the die grid configuration, visible to the right of the video display area. (See *Figure 6.18*.).

5. Each rectangle on the die grid configuration represents a single die. The green one with the number one (1) in it represents the original scan site designated for the chosen scan recipe. To add dies, simply click the desired die where the additional scan is to be made. Each successive site turns green and contains a number.

NOTE: The scans are performed according to the die site numbers. To reduce sequence timing, choose the scan sites in a circular fashion for minimum time of travel between scan sites. (See *Figure 6.18*.)

Figure 6.18 *XY View with Sequence Scan Sites*



NOTE: Dies can be selected or deselected by clicking or them.

6. After all the required dies have been selected, click **OK** to add them to the sequence. (See *Figure 6.18.*)
7. The **Sequence Editor** message box appears with a message saying that the chosen sites will be added to the sequence, asking whether to proceed with the additions.

   Click **OK** to continue or **Cancel** to abort the addition of the sites to the sequence.

Figure 6.19 *Sequence Editor Message Box*

Step 7 Click **OK** to add the additional selected sites to the scan sequence.

When **OK** is clicked, the Sequence Editor is displayed with the additional sites in the Sequence Recipe.

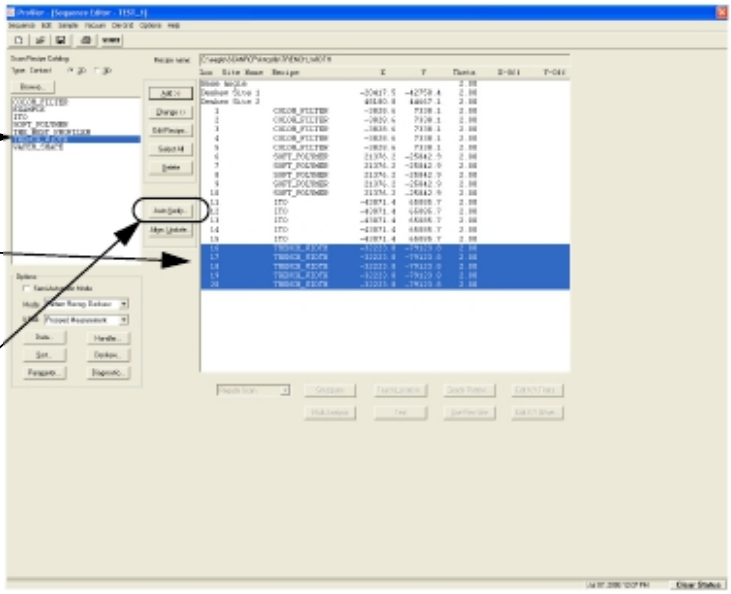
Notice that each new site has the coordinates of the scan location for that die. In the illustration *Figure 6.20*, two sets of new sites have been added, one for additional dies using the scan named FIRST, and one for dies using the scan named SECOND.

CAUTION: The coordinates presented for the scans in the new sites might not be exactly where they are needed. It is important to verify each of their locations.

Figure 6.20 *Sequence Editor with New Scan Sites*

Step 8 The new scan sites are presented below the original ones in the recipe list. Each has its own scan position coordinates listed. Highlight the entire group of new scan locations by clicking the first recipe, then hold down the shift key and click the last one.

Step 9 After all the new recipes are highlighted, click **Auto Verify** .



Begin: Auto Verify

8. Highlight the entire group of new scan sites by clicking on the first one, holding the shift key down and clicking on the last one.
9. Click the **Auto Verify** button to begin the process of verifying each scan location.
10. The XY view screen is now displayed. The system moves the field of vision to each scan site and displays the site with the scan path positioned as it is during the actual scan. Adjust each site individually using the following procedures:
    a. The feature being scanned should be visible in each site. If not, locate it.
    b. Ensure that the scan path indicator is positioned correctly. If it is not, move the cursor to the exact location where the scan is to **begin** and click. The system should adjust the scan position on the screen.
    c. When complete, click **OK** to verify that location. The next site appears on the screen automatically.

End: Auto Verify

d. When the last site is verified, the screen reverts back to the Sequence Editor. Save the Sequence by clicking on File and **Save** or **Save As**.

e. A dialog box appears. Enter the name of the new sequence and click **OK** to save it.

Disassociating a Die Grid with a Sequence

1. Make sure the sequence is displayed in the Sequence Editor
2. Click **Edit** to display its menu.
3. Select **Clear Die Grid**.

SEQUENCE EDITOR WINDOW FEATURES

The Sequence Editor window consists of the following elements:

- Scan recipe catalog for selecting from available Scan recipes
- Options section for setting sequence options
- Control buttons for sequence programming
- Sequence list, linking sites with Scan recipes

Sequence Editor Menus

The Sequence Editor menu bar provides access to commands through its menus. Click the titles in the menu bar to view their menus.

Sequence Editor Toolbar

The Sequence Editor toolbar contains buttons that provide an alternative way to access commonly used functions. (See *Table 6.1*.)

Table 6.1 *Sequence Editor window buttons*

Button	Description
	Creates a new default Sequence recipe.
	Opens Sequence recipe editor for the currently chosen recipe in the sequence.
	Saves the current Sequence recipe; if the current Sequence recipe has never been saved, displays the **Save Sequence As** dialog box first.
	Prints the selected Sequence recipe.
	Starts a scan using the current Sequence recipe.

Table 6.2 *Sequence List Buttons*

Button	Description
	Adds the selected Scan recipe into the sequence.
	After highlighting an existing site in the Sequence list, clicking this button changes the Scan recipe for the site to whatever is highlighted in the catalog.
	Displays the Scan Recipe Editor, open to the recipe selected in the Scan recipe Catalog (the field to the left of the **Edit Recipe…** button.)
	This selects all the recipes in the current Sequence Recipe.
	This goes to the XY View screen and locates the current scan location in the video screen for verification.
	Deletes the selected site from the sequence.
	This feature corrects for wafer placement error due to wafer loading. Alignment is accomplished through Center of Wafer, Die Grid, and Double Deskew analysis. This feature should be used before modifying or adding sites to an existing Sequence recipe that uses deskew.

Table 6.3 *Options Buttons*

Button	Description
	Displays the Data Saving Options dialog box where sequence data can be automatically saved, exported, or printed.
	Displays the **Handler** dialog box. The P-17/P-7 Profiler has no handler so the only option available is **Manual Load**.
	Allows the user to select specific recipe parameter values to be displayed and updated during data acquisition
	From this dialog box, the user can select criteria for Pattern Recognition and Deskew.
	This dialog box offers the user the option to automatically save the Deskew Site and Scan Site images directly from the camera.

Table 6.4 *Site Buttons*

Button	Description
	Goes to the XY view so a measurement site can be chosen based on a location observed on the screen.
	Goes to the XY view so a pattern can be taught for pattern recognition.
	Defines a measurement site by allowing the manual entry of the X, Y, and Theta coordinates.
	Defines the measurement site as a multi analysis site where analysis is performed on data from the last site with defined coordinates. Basically, uses the same raw data but with a different scan recipe.
	This button allows the user to name each scan site in a sequence.
	Runs only the highlighted site without running the whole sequence.
	A measurement site can be set up to use the previous site's pattern for site-by-site pattern recognition.
	X and Y offset values can be manually entered from a pattern rec site to a measurement site.

Displaying the Sequence Information Dialog Box

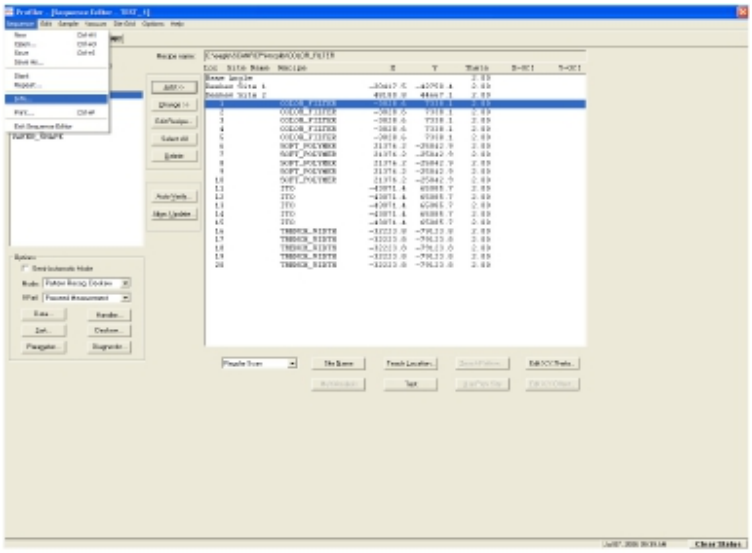
The Sequence Information dialog box displays the title, author, date and time of creation (or modification) of the sequence. It also provides a text box for annotations.

1. In the Sequence Editor, click the **Sequence** menu to display its menu. (See *Figure 6.21*).

Figure 6.21 *Sequence Editor – Sequence Menu*

Step 1 Click **Sequence** to display its menu.

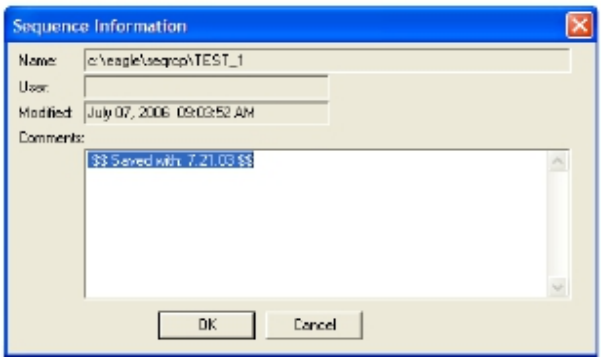
Step 2 Click **Info…** to display its dialog box.



2. From the Sequence Menu, select **Info…** (See *Figure 6.21*)

Figure 6.22 *Sequence Information Dialog Box*

Step 4 This field, the **Comments:** text box, can be used to record messages or information on the sequence listed in the dialog box heading.



The Sequence Information dialog box is displayed. The Name, User, and Modified fields cannot be edited.

3. Click in the **Comments** field, or press **TAB**← or **TAB**→ until the **Comments** text box is highlighted.
4. Enter the text of the information which needs to be passed from one operator to the other.

EDITING THE OPTIONS FIELD IN THE SEQUENCE EDITOR

In the **Options** variable fields, sequence mode (deskew options) and data transfer options can be defined for the sequence displayed in the editor.

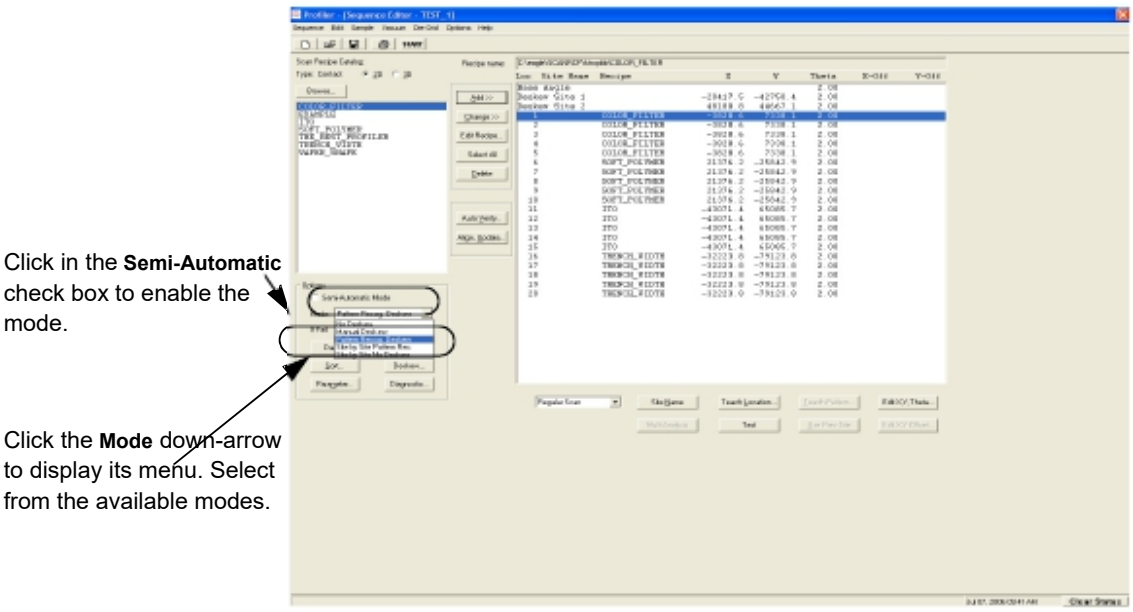
Semi-Automatic

In the Sequence Editor, put a check in the **Semi-Automatic** check box to enable the mode. (See *Figure 6.23*)

For **2D scans**, the Semi-Automatic mode causes a sequence to display the trace data after each scan and pause before proceeding to the next step. Each step can be verified and, if needed, the scan sites can be adjusted and the scan performed again before proceeding to the next step.

For **3D scans**, the Semi-Automatic mode does not halt the sequence between steps.

Figure 6.23 *Sequence Editor – Mode Menu*



Set Deskew Mode

Click the **Mode** drop-down menu (see *Figure 6.23*), and select the from the following **Sequence** modes. (See *Table 6.5*)

NOTE: Pattern Rec. Deskew is an option for P-17 only. P-7 only supports no deskew and manual deskew.

Table 6.5 *Mode Drop-down Menu Options*

Mode	Description
No Deskew	The sequence contains no deskew points for alignment.
Manual Deskew	Deskew points are set and must be confirmed manually by the operator.
Pattern Rec. Deskew (P-17 Only)	Deskew points are set using the Pattern Recognition option.
Site-by-Site Pattern Recognition (P-17 Only)	Scan sites are set relative to a Pattern Recognition site and deskew is performed by pattern recognition.
Site-by-Site No Deskew (P-17 Only)	Each site is scanned without deskew.

CAUTION: It is important that when scanning with Pattern Recognition, use the same zoom setting for the scan that was used to capture the pattern. If zoom is used during the procedure, always zoom completely out before starting the scan. If a particular zoom setting is required, use the Zoom-lock feature to ensure that the zoom setting remains unchanged throughout the procedure.

Set Scan Status Option if Pattern Recognition Fails

1. Click the **If Fail** drop-down menu, and select the action to take if the pattern recognition fails to find a site. (See *Table 6.6*.)

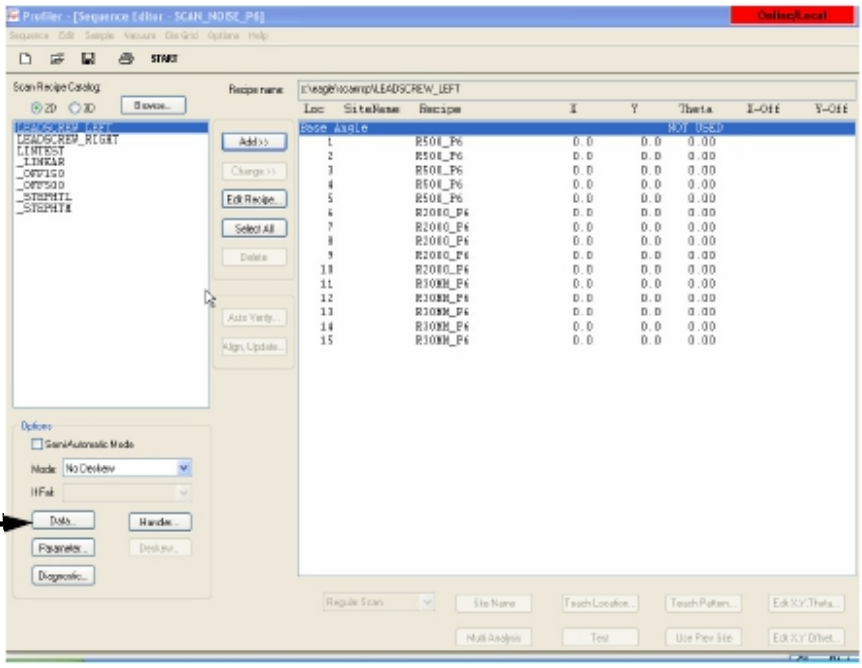
Table 6.6 *If Fail Drop-down Menu*

Feature	Description
Operator Assist	Hold the sequence until Operator Assistance is achieved.
Skip, No Measurement	Measurement of that wafer is suspended.
Cancel Sequence	Sequence is suspended. User must restart the sequence.
Proceed Measurement	Continue with the next site as if the scan had worked.

Begin: Set Data Options

2. Click the **Data** button to choose options for data collection that automatically execute upon sequence completion.

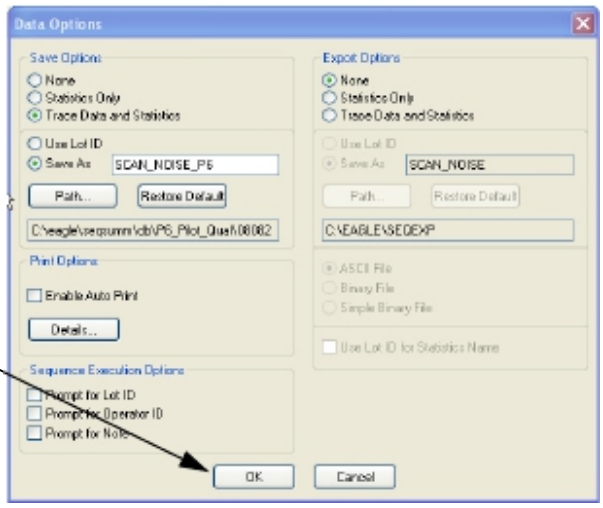
Figure 6.24 *Sequence Editor*



Step 2 Click the Data button to open the **Data Options** dialog box.

The **Data Options** dialog box appears. (See *Figure 6.25*.) Once set, the Profiler automatically either exports, saves, or prints the file data.

Figure 6.25 *Data Options*



Step 1 When the options have been chosen, click **OK**.

1. Choose an option from the Save, Export, and Print options. (See *Table 6.7*.)

Table 6.7 *Save and Export Options*

Feature	Description
None	Saves or exports no data.
Statistics	Saves or exports only the statistics for the specified parameters, the recipe ID, part ID, and sequence ID. The results for each parameter at each measurement site are not printed, saved, or exported. Statistics are calculated for scans taken with the same recipe and are saved only if two or more scans are taken with that recipe.
Trace Data and Statistics	Saves or exports everything, including the recipes used, the raw data points for each scan, parameter results, and the statistics.
Use Lot ID	Prompts the operator to enter the Lot ID before running the sequence, then saves or exports the data under the Lot ID name.
Use Name	Saves or exports the data under the sequence name or a user-specified name. The Path button opens a dialog box for designating the path of the desired file.
Use Operator ID	Prompts the operator to enter their ID before running the sequence. The data file contains the operator ID but is still saved under the Lot ID or the **Use Name**.

The Export Options also contain a choice of export file type. (See *Table 6.8*.)

Table 6.8 *Export Options*

Feature	Description
ASCII File	Data is exported in ASCII code.
Binary File	Data is exported in binary code.
Simple Binary File	Data is exported in simple binary format.

The Print Option contain the following feature. (See *Table 6.9*.)

Table 6.9 *Print Option*

Feature	Description
Enable Auto Print	Automatically prints data at the end of the sequence. Click the **Details...** button to open a standard print dialog box and set print options.

End: Set Data Options

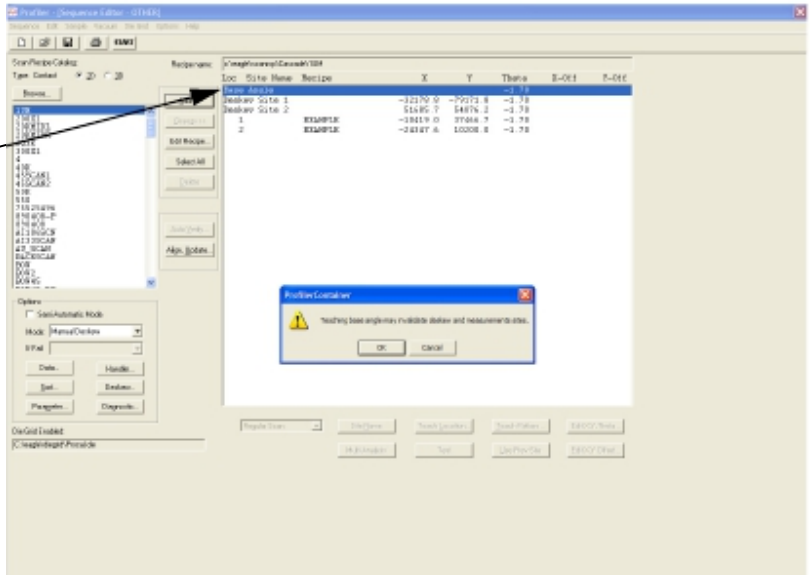
2. Click **OK** to set the options.

Teaching the Base Angle (P-17 Only)

The Base Angle is an offset angle relative to the orientation of the sample's pattern. It is used to align scans with the wafer geometry. It is to be used primarily for scan sequences using manual load in conjunction with the **No Automatic Load/Unload** handler option in the system. (The Base Angle is fixed for all scans in the sequence. Use the following procedure to program the Base Angle.

1. Double-click **Base Angle** in the sequence list. (See *Figure 6.26*.)
2. A warning is displayed before the Teach Location screen appears. The warning says that deskew and measurement sites could be invalidated. Click **OK** to proceed or **Cancel** to abort the procedure.
3. Before the Teach Location screen appears, a warning message is generated, stating that updating the Base Angle may invalidate the Deskew sites.

Figure 6.26 *Sequence Editor*



4. The Teach Location window appears. Locate a line or other pattern to use for a reference.
5. Click the clockwise or counterclockwise **Rotation** buttons in the toolbar until the crosshair is aligned with the reference feature.

NOTE: As the range rotates, if necessary, move the stage to keep the reference feature in the field of view.

6. **ALTERNATIVE** to steps *4.* and *5.*: To align the current sample surface with the screen crosshair, use the principles described in *BEGIN Align Sample Procedure* on page 14-15. Use a horizontal feature on the sample surface in place of the dotted line on the ProCal Wafer described in the procedure.
7. Click **OK** to return to the **Sequence Editor** window.

   Notice that the **Base Angle** now has a value instead of the phrase **Not Used**.

   When running a sequence with a non-zero Base Angle, the stage rotates to that position immediately before deskew (if applicable).

RUNNING A SEQUENCE

1. Click the **Start** button, or click the **Sequence** menu, and select **Start**.
2. Perform manual deskew, if applicable. Also, refer to manual deskew section for explanation of how to do this.
3. Click the **Stop** button to stop the sequence before normal termination.

QUEUE

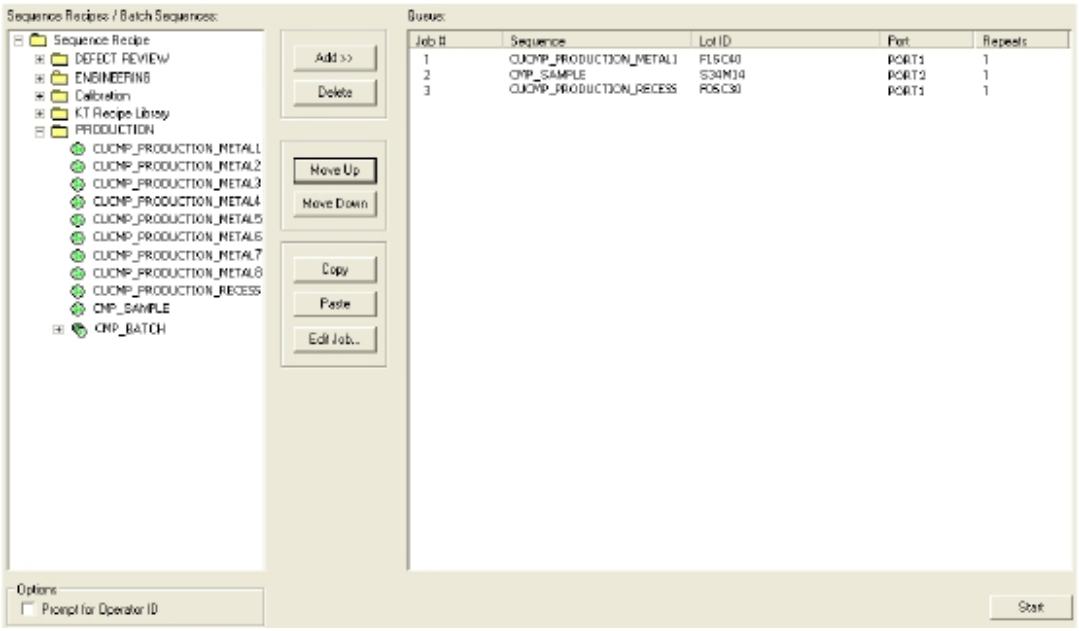
The queue allows the user to setup the system to run multiple sequences without user intervention. This can be done before starting a sequence or while the system is currently executing a sequence. The user can also save the queue as a batch for sequences that are frequently run together, such as a daily qualification set of sequences.

Setting up a Queue

1. From the **Sequence Recipe Catalog** click on the **Queue** button or from the **Edit** menu, select **Sequence Queue**.

2. This will open the **Queue Editor** that allows the user to add sequences to the queue as shown in Fig. 6.27.

Figure 6.27 *Queue Editor*



3. The user can add sequences to the queue by navigating to the correct sequence in the sequence recipe database on the left and then clicking on **Add**. **Sequences** will be added to the bottom of the list.
   a. If a batch is added, it will add all of the sequence recipes for the batch.
4. The user can remove sequences from the queue by selecting the sequence from the list on the right and then clicking on **Delete**.
5. The user can modify the order of the sequences by selecting a sequence on the left and then clicking on **Move Up** or **Move Down.**
6. The user can add the same sequence to the queue multiple times by selecting the sequence from the list on the right and then click on **Copy** and then **Paste**. The standard Windows XP shortcut keys for copy and paste work as well. The sequences will be added to the bottom of the list.
7. The user can change some of the properties of the sequence, such as the data save options, handler options, and the number of times the sequence is repeated by selecting **Edit Job**. Refer to the sequence editor section of the manual for details on these options.
   a. These modified parameters are stored with the queue and do not affect the original sequence recipe.
8. After the queue is created, the user can save the queue as a batch that will be stored in the sequence recipe catalog, available for execution at any time.

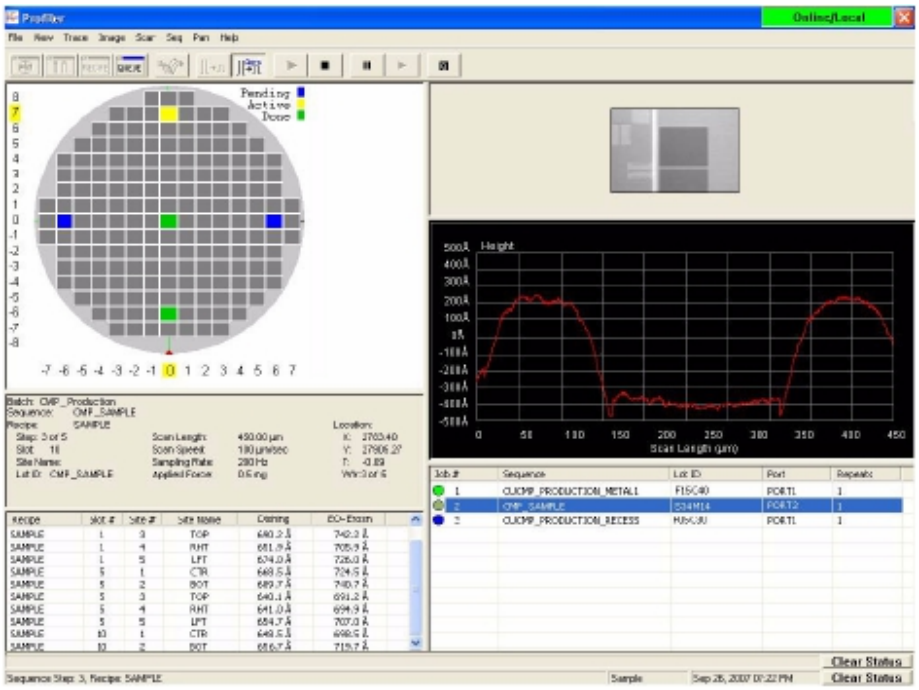
9. Alternatively, the user can start the queue without saving the changes for instances when this collection of sequence recipes will not be repeated in the future.

Adding Sequence Recipes to the Queue at Runtime

After a sequence recipe, queue, or batch has been started, the user can modify the queue while the sequences are being executed.

1. Click on the **Queue** button on the toolbar in the runtime view as shown in Fig. 6.28. This will open the **Queue Editor**.
   a. The sequence recipe will continue to execute during the editing process.

Figure 6.28 *Runtime View with the Sequence Queue*



2. The user can add new sequences to the queue, modify the properties of any sequence already in the queue that has not been started, or change the order of sequences already in the queue that have not been started.
3. Once complete, exit the **Queue Editor** and save the changes to have them take effect.
4. The changes will be reflected in the sequence queue, shown in the lower right corner sequence queue status list, as shown in Fig. 6.28.

CORRELATION SCANS

Scans are correlated when a long scan is performed first, then small scans are performed in the same general location. Correlation scanning combines local area scans with macroscopic scans so that discrete features can be related to global surface planarity.

From the scan data of a long scan, distinct features can be located which require a repeat scan at high resolution, then create a sequence that performs high resolution sub-scans along the length of the long scan. Data for each sub-scan is based on the long scan, providing a data reference for correlating the measurements of the sub-scans.

1. Open an existing Sequence recipe or create a new one in the **Sequence Editor**.
2. Select the recipe to use for the long scan (one that traverses the targeted feature).
3. Click the **Scan Type** arrow below the sequence to open the list.
4. Click the **Correlation Long Scan** button.

   A message dialog box appears, warning that the recipe immediately following is designated a Correlation Sub-scan and if it is set up for multiple analysis, it resets to single scan. The Sub-scan is the short scan that is tied to the long scan. It provides the local, small-scale analysis. It is set up in step 7, next page.

NOTE: Multiple correlation scan sets can be established; each set is marked by the initial long scan in red lettering and its associated sub-scans immediately following in blue.

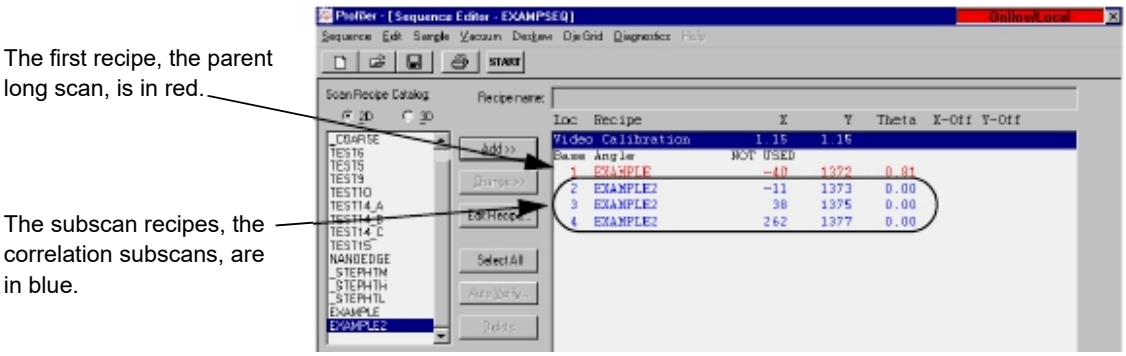
5. Click **OK**.

   The long scan recipe becomes red; the recipe immediately following becomes blue, indicating that it is a sub-scan to that long scan. Sub-scans always follow long scans in sequence.

6. Designate the other sub-scans (usually 100 µm or less) as done for the long scan, using the **Scan Type** list to select **Correlation Sub-scan**.

   Figure 6.29 shows the Sequence Editor for a correlation scan where the parent long scan recipe is EXAMPLE, Loc is location 1. The sub-scans are EXAMPLE2, Loc are location 2, location 3, and location 4.

Figure 6.29 *Correlation Scan Sequence*



7. Teach the long scan position.
   a. Press the **Teach LOC** button.
   b. Go to the location and click it. To accept the location, click **OK** in the dialog box that appears.
8. Teach the sub-scan position.
   a. Press the **Teach LOC** button.
   b. Go to the location and click it. To accept the location, click **OK** in the dialog box that appears.

   The Teach Sub-Scan window appears.
9. If the current position of the sub-scan is not close enough to the position of the long scan for both to appear in the video image, a red arrow and the coordinates of the long scan appears on the video image.

   Move the stage in the direction of the arrow to bring the long scan into view.

   The long scan is represented in the window by a red scan line; the sub-scan by blue.
10. Position the sub-scan on the desired portion of the long scan line.
11. Click **OK**.

    The Sequence Editor returns to view.
12. Repeat for all sub-scans.

Viewing the Correlation Scan Data

1. Run the correlation sequence. Save the recipe and click **Start**.

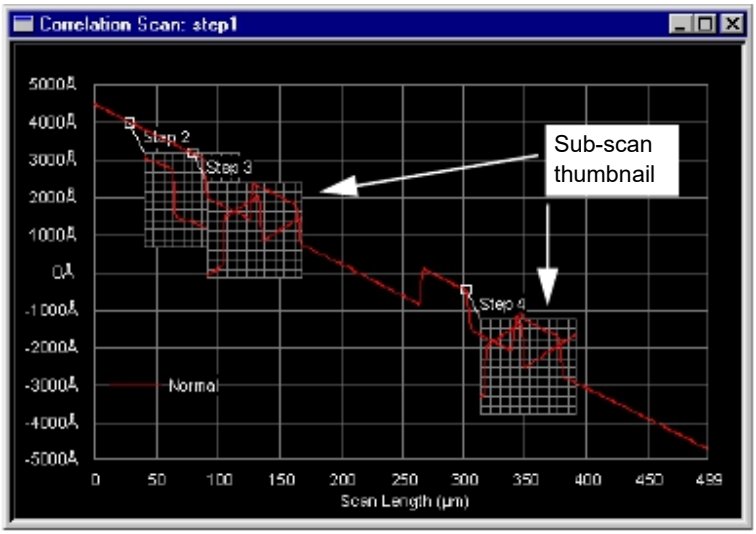
   The Analysis window appears, showing the results of the first recipe in the sequence.
2. Click the **File** menu, and select **Correlation Scan**.

   The Correlation Scan dialog box appears.
3. Click the long scan

4. Click **OK** to display the **Correlation Scan** window.

   The Correlation Scan window appears, showing the long scan trace and thumbnail callouts of each of its sub-scans positioned on the long scan (see *Figure 6.30*).

Figure 6.30 *Correlation Sub-scan Window*



5. Double-click the thumbnail on the graph to view the sub-scan trace.

   The trace appears in its own analysis window. A Statistics window also appears for the long scan.

6. Click the **File** menu, and select **XXX** to view the correlation scan statistics.

   Multiple Analysis cannot be used with correlation scans.

VIEWING SAVED SEQUENCE DATA

Viewing Old Sequence Data

1. Go to the **Catalog** window, and click the **Sequence Data** button.

   The Sequence Data Catalog window appears.

2. Select the data set from the list in the catalog, and click the **Review** button, or double-click the desired data set.

Recovering Sequence Data

In the case of a system crash during a sequence execution, using this recovery tool, it is possible to go back to the screen that displayed the last data, including unsaved data.

1. Go to the **Sequence Data** catalog window.
2. Select a sequence.

3. Click the **Recover** button.

Calculating Combined Sequence Statistics

Values from different sequence sets can be combined into one, and used to calculate the standard deviation, mean, and so forth. The computer accesses stored data from selected data sets in the Sequence Data catalog and recalculates them.

1. Click the **Sequence Data** command button in the Catalog screen.

   The Sequence Data catalog window appears.

2. Highlight the data files to be combined.
3. Press **CTRL** while clicking to highlight multiple data files.
4. Click the **Combine** button.
5. Enter a name for the new combined data set.
6. Click **OK**.

   A statistics summary with the new data appears after a short calculation interval.

USING MULTI ANALYSIS IN SEQUENCE

Multiple data analyses can be obtained from a single scan by applying the data analysis settings of additional recipes to its raw data. The process is a modification of a sequence recipe in which the instrument uses the first scan recipe to scan and analyze in the usual manner, then takes settings from the subsequent recipes to reanalyze the first recipe's scan data.

It is important to note that the raw data for the scan be saved and therefore can be subjected to numerous different parameter adjustments. Each set of data that is obtained from applying the new parameters can be save under its own name. This means that after the scan is run and the results saved, the additional information can be retrieved at a later date, even calculated on a desktop version of the software if it has been purchased.

Time can be saved and throughput improved by using multiple analysis for:

- Measurements that require more than one cursor setting — such as two different step heights on a single scan
- Measurements with different filter settings
- Measurements with different surface parameters enabled in the Scan recipe.

1. Go to the **Sequence Recipe** catalog window, and select a Sequence recipe.
2. Click the **View/Modify** button to open the Sequence Editor window.
3. Click the **New** button at the bottom of the screen or click the **Sequence** menu, and select **New**.

   A blank sequence list appears.

4. Set up the scanning recipe to scan with its existing settings:
   a. Click the name of the required recipe to be used for the scan.
   b. Click **Add** to add the Scan recipe to the list.
5. To make changes to an existing Scan recipe.

a. Click its name in the list
b. Click **Edit** recipe to change any parameters and filter settings. Cursor positions can only be changed by entering them numerically.
c. Save the recipe.
d. To teach cursor positions later from the scan trace:
e. Click **Save As** to create a new recipe even if no changes were made to the recipe at this point.
f. Exit the Recipe Editor window to return to the Sequence Editor window.
g. Select the new recipe that was just created.
h. Click **Add** to add the Scan recipe to the list.

6. Set up the analyzing Scan recipes:
   a. Go to the **Scan Recipe** catalog list, and click a Scan recipe containing the required analysis settings.

      This recipe should have the same scan length, scan speed, sampling rate, stylus force, contact speed, and range as the scanning recipe.

   b. Make changes to the Scan recipe as in **Step 5***b*.

      This step can also be performed before compiling the sequence list, using the Scan recipe to scan the sample and teach the cursor positions.

   c. Add the Scan recipe to the sequence list.
   d. While the Scan recipe is still highlighted, click the **Multi Analysis** button.

      This instructs the instrument not to scan the sample again but to reanalyze the data according to the recipe's data analysis parameters. Note that the Multi Analysis button is not active (dimmed) for the first recipe in a sequence.

   e. Repeat the process as many times as needed.
7. Click the **Sequence** menu, and select **Save As** to save the sequence.

Viewing Multi Analysis Results

1. Tile the windows to display the Sequence Parameter Summary window and the Scan Trace simultaneously.
2. Go to the Sequence Parameter Summary window:
   - Site 1 shows data analyzed with the first Scan recipe in the sequence list.
   - Site 2 data corresponds to the second Scan recipe, and so on with each additional site.
3. To view each Scan recipe's data set in both Trace and Summary windows:
   a. Click the arrow in the **Recipe** drop-down menu on the tool bar.
   b. Select the Scan recipe.

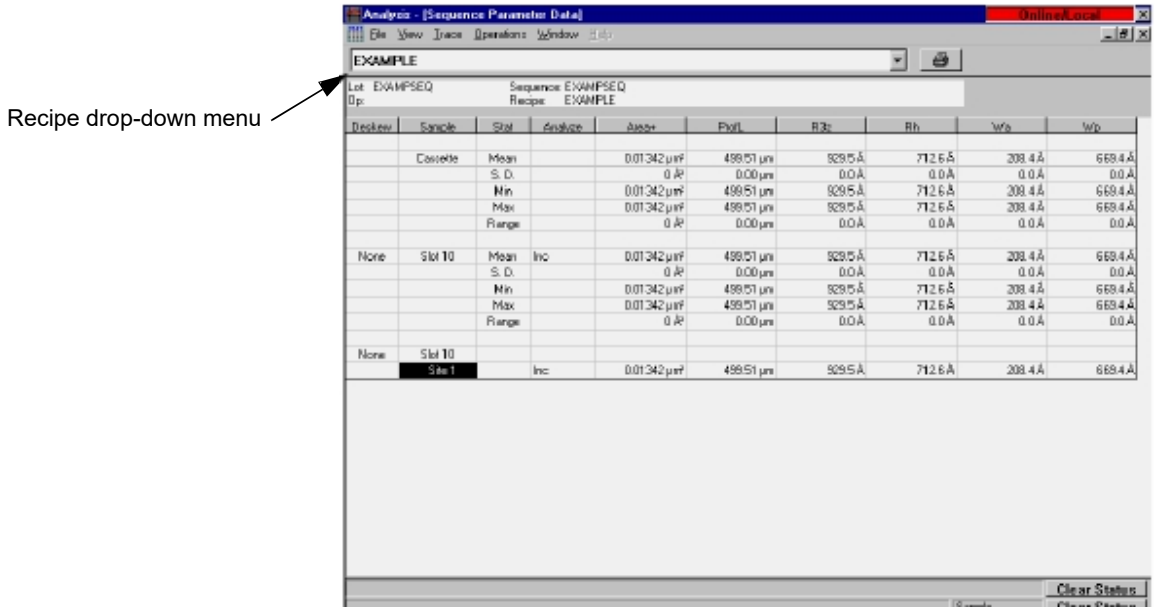
VIEWING SEQUENCE DATA

Viewing Wafer Summary Data

The Sequence Parameter Data window displays the detailed results of each site scanned in the sequence.

1. Go to the **File** menu in the **Analysis** window, and select **Surface Summary**.

Figure 6.31 *Sequence Parameter Data window*



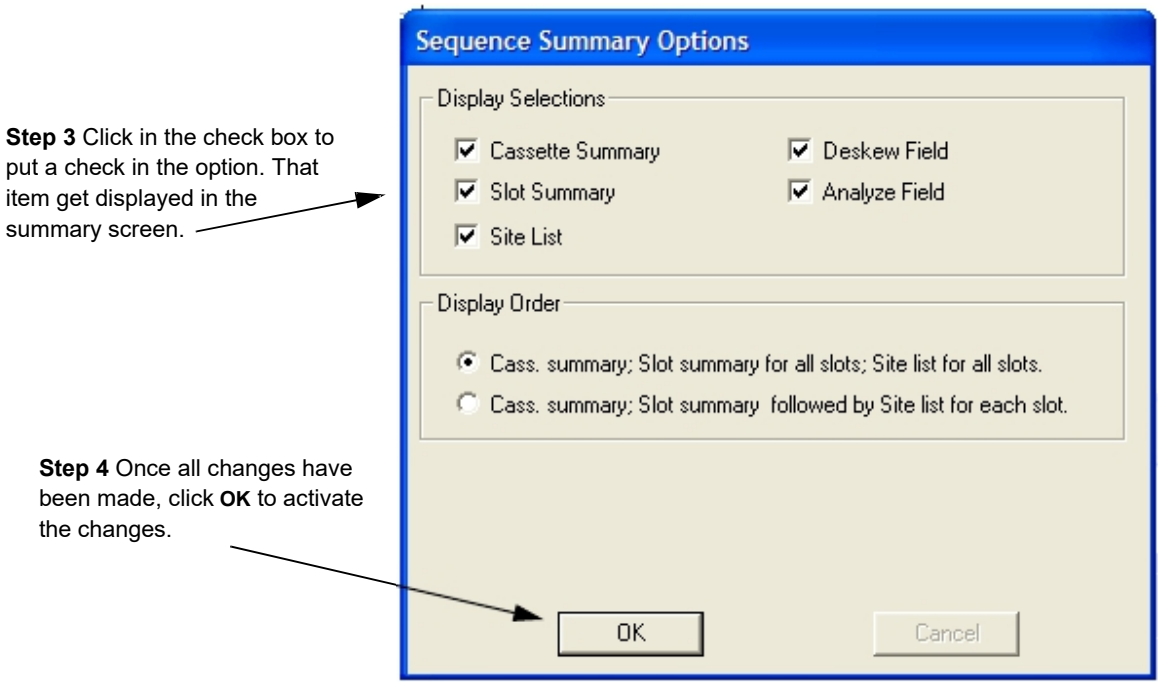
2. Maximize the **Sequence Parameter Data** window to view the entire **Sequence Parameter Data** screen from the **Analysis** window.
3. Go to the **Sequence Parameter Data** window, and click the **Recipe** drop-down menu on the left of the toolbar. (See the **Recipe** location at the top left of *Figure 6.31*.) This drop-down menu displays all Scan recipes that are included in the sequence.
4. Choose the desired recipe by clicking on it.

Sequence Summary Options

The Sequence Summary Options dialog box specifies the information to be displayed in the Sequence Parameter Data window. The individual scans in any sequence can be viewed in the Analysis window by clicking the appropriate site number in the Sequence Parameter Data window.

1. Open the **Analysis** window.
2. Click the **Operations** menu, and select **Summary Display Options** to display the Sequence Summary Options dialog box. (See *Figure 6.32*.)

Figure 6.32 *Sequence Summary Options Dialog Box*



3. Choose the items to be displayed in the summary screen. A check in the box indicates those that are displayed. (See *Figure 6.32*.)
4. Click **OK** to activate changes to the summary display items. (See *Figure 6.32*.)

Viewing Sequence Data with the Corresponding Trace, Site-by-Site

The screen can be set up to display a site's parameter data along with the trace itself.

1. Open both the **Analysis** and the **Sequence Parameter Data** windows.
2. Go to the **Windows** menu, and select **Tile Vertically**.
3. Size the windows by clicking and dragging their frames.
4. Display the desired trace:
   a. Go to the **Sequence Parameter Data** window, and click the numbered **Site** box of the trace desired.

      The Analysis window displays the trace for that site.

   b. Repeat for other sites, displaying each trace in turn.
5. Save the workspace:
   a. Click the **File** menu, and select **Save Workspace** to save this window orientation.

      The dialog box appears.

b. Enter a name for the workspace.

c. Click **OK** to save.

6. To review both parameter data and the trace:

a. Click the **File** menu, and select **Load Workspace** to retrieve the workspace.

b. Highlight the workspace name in the drop-down menu.

c. Click **OK**. The screen reconfigures to the desired trace/data window orientation.

SEQUENCING WITH MANUAL DESKEW (APPLIES TO BOTH P-17 AND P-7)

The reason for programming a sequence is to automate a repetitive series of measurements on multiple samples. The example contains all of the essential features of a sequence.

Even with a locator or some sort of fixture, the second and subsequent samples cannot reliably be placed on the stage in the exact same position, and with the same alignment, as the first. The new sequence can still be used, but each of the scan sites must be manually located and retaught before running the sequence.

Deskew enables and defines two points on a sample to be used as reference points prior to the start of a sequence. These points are then used to mathematically correct for translational (X, Y) and rotational (theta) error in sample positioning.

1. Create a new sequence.
2. When ready to set up manual deskew, proceed with the following steps.
3. Set the deskew mode to **Manual Deskew**.

   Note that two deskew steps now appear in the sequence list on the right side of the window.
4. Select the first deskew site by double-clicking anywhere on the **Deskew Site 1** line in the sequence list.
5. Click the **Teach Loc** button, or double-click the deskew site. The Manual Deskew Teach window appears.

   The two deskew points should be in opposite quadrants, with each being at least half way to the edge of the substrate.
6. Select the first deskew point. Select an obvious point, such as the corner of an easily and uniquely identifiable rectangle.

   Click the chosen position.

   The stage moves so that the crosshair are centered on the selected site.
7. Click **OK**.

   The Sequence Editor window reappears, with the X and Y coordinates of the selected site entered in the deskew Site 1 step.
8. Select the second deskew point.
9. Repeat steps **Step 5** through **Step 7** for the second deskew site.
10. Once the deskew sites have been successfully established, proceed to program the rest of the sequence steps.

11. Run the sequence.

    After each deskew operation, the instrument pauses and requests acceptance of the deskew site.

12. If it is out of the field of view, use the arrow buttons to move the stage and search for the site. Click the deskew site, moving it to the center of the crossmarks.
13. Click **OK** to accept the deskew site.
14. Repeat **Step 11** through **Step 13** for deskew site #2.

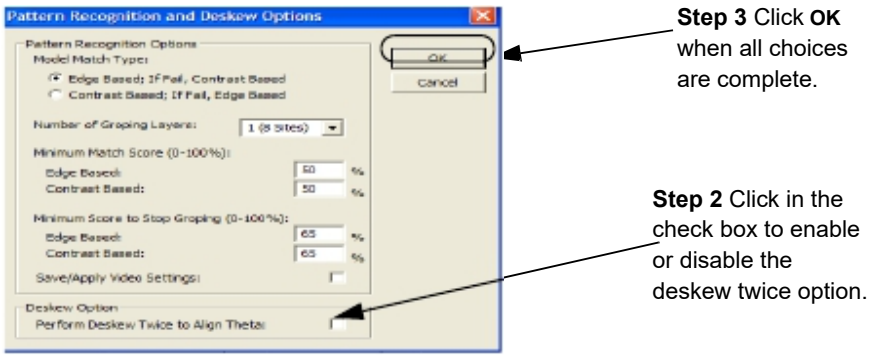
    The tool then proceeds with the measurement sites.

DESKEWING TWICE TO ALIGN THETA (P-17 ONLY)

With a single deskew operation, there is no stage rotation to compensate for the small rotational error in sample placement. A second deskew can be performed to compensate for this error by enabling this option in the Pattern Recognition and Deskew Options dialog box. This allows accurate sample rotations within a sequence.

1. From the **Configuration** screen, choose **Calib Pattern Recognition Options...** button. The Deskew Options dialog box appears (see *Figure 6.33*).

Figure 6.33 *Deskew Options Dialog Box*



2. Click the **Perform Deskew Twice to Align Theta?** check box to enable or disable the second deskew.
3. Click **OK** to set the options and close the dialog box.

SEQUENCING WITH PATTERN RECOGNITION DESKEW (OPTIONAL PATTERN RECOGNITION FEATURE, P-17 ONLY)

The **Pattern Recognition** option minimizes operator intervention in sequence operation by automating the precise setting of deskew points at the beginning of a sequence.

Pattern Recognition deskew replaces and automates the manual deskew process. The same considerations of global deskew point placement that apply to manual deskew apply equally to pattern recognition deskew.

NOTE: To minimize positioning error, space the deskew points at least one-half the diameter of the sample. It is recommended to not set the deskew points parallel to the X-axis or Y-axis, but instead use two points on a diagonal line. If the deskew points are identical, the sequence aborts.

NOTE: Although a coordinate transformation is made, there is no stage rotation to compensate for the small rotational error in sample placement unless the deskew option is set to perform a second deskew. See *Deskewing Twice To Align Theta (P-17 only)* on page 6-39 for more information.

NOTE: Note also that any rotational error is magnified when traversing a long distance across a large wafer. This might cause the deskew site to be outside the field of view when a wafer is loaded.

A pattern recognition deskew site is a unique pattern of wafer features visible within the instrument's field of view. The size and shape of the pattern must be uniquely different from other wafer features visible in the field of view to ensure that the instrument can locate the sites without ambiguity. (See *Table 6.10*).

Table 6.10 *Pattern Examples*

Pattern Example	Description
Good Patterns	◆ Alphanumeric characters ◆ Rectangular pads that appear singly ◆ Crosses ◆ Alignment marks ◆ Other polygon shapes
Bad Patterns	◆ Sections of a repetitive grid ◆ Circular pads or rectangular pads that repeat in or near the field of view

When choosing patterns, keep the following points in mind. (See *Table 6.11*).

Table 6.11 *Pattern Search Criteria*

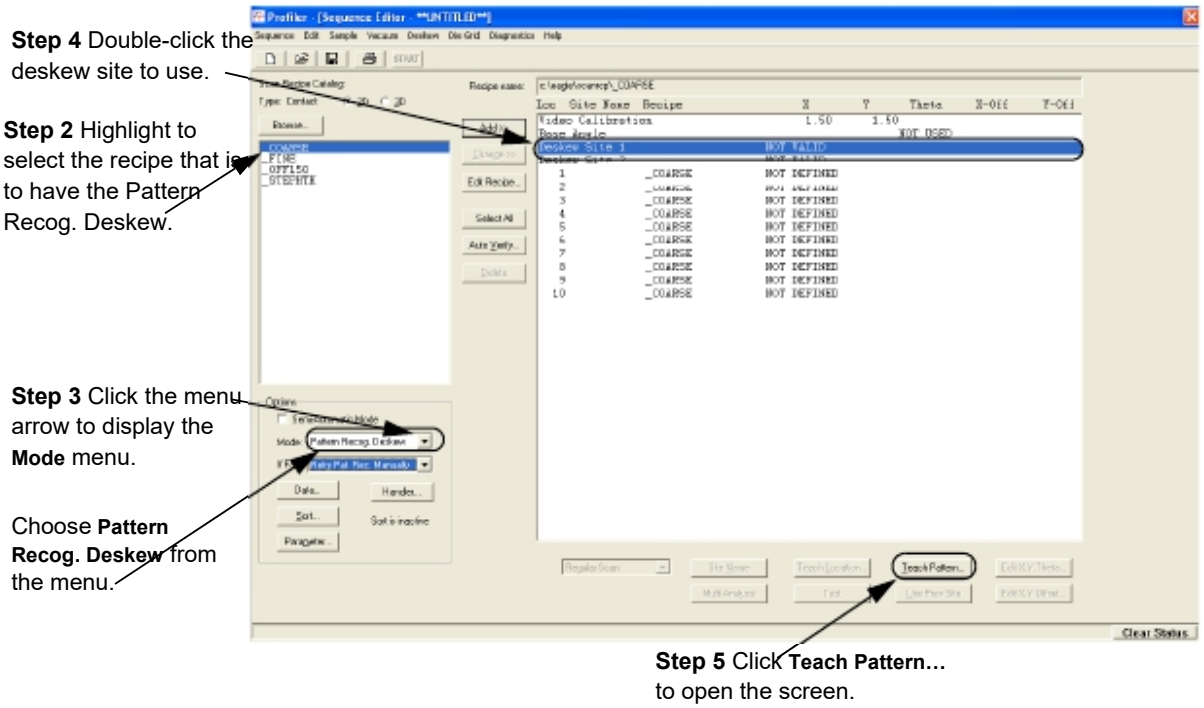
Search Criteria	Description
Search time depends on pattern size.	The larger the pattern, the faster the system can recognize the pattern. However, larger patterns require more accurate initial positioning within the camera's field of view because the search area is reduced. Also, Pattern Recognition options can be set so that the system performs a pattern search if the pattern is not found within the field of view. See *Groping Parameters* on page 6-45 for information.
When using rectangular pads, use the entire rectangle.	If only two corners are used, other rectangles in the field of view could confuse the pattern recognition system.
The pattern should be unique and as simple as possible.	However, uniqueness cannot be sacrificed for simplicity.
Select symmetric patterns.	They are less sensitive to image rotation. Circular patterns are rotationally symmetric and therefore are good patterns. Similarly, the best polygon patterns have the most sides.
High contrast features make pattern recognition matches easier.	When available, select high contrast features. Noise does not have as much effect on the pattern recognition match. The pattern colors are important because the pattern recognition system reads the black and white image, not the color image.
Avoid patterns with rough surfaces.	By using edge enhancement, the instrument computer emphasizes the fine features present on a rough surface. Because roughness is random, these features add noise to the system and make the pattern recognition system less reliable.

NOTE: It is generally a good idea to avoid fixed dust particles in the field of view as well. Avoid selecting wafer-specific defects or features as patterns, or the instrument computer could become confused. This includes dust particles, partially etched areas near the edge of the wafer, and so on.

To set up Pattern Recognition deskew:

1. Go to the **Sequence Editor** window.
2. Select the sequence recipe that is to have Pattern Recog. Deskew.
3. Select **Pattern Recog. Deskew** from the **Mode** drop-down menu. (See *Figure 6.34*.)

Figure 6.34 *Profiler Sequence Editor Window*



4. Double-click the **Deskew Site 1** entry near the top of the sequence list or highlight the **Deskew Site 1** entry. (See *Figure 6.34*.)
5. Click the **Teach Pat** button. (See *Figure 6.34*.)

   The Pattern Rec. Deskew Teach window appears and the stylus automatically nulls on the sample surface.
6. Select a pattern to use for pattern recognition.

   As a rule of thumb, select something that is simple and easily recognizable, like an alphanumeric character or an alignment mark. (See *Table 6.10 on page 6-40* and *Table 6.11 on page 6-41*.) Something that looks much like another feature that is also within the field of view does not work reliably because the wrong site might be identified.
7. Define a rectangular area that encloses the chosen pattern as follows:
   a. Press and hold the left trackball button at the top left corner of the desired rectangle.
   b. Move the trackball toward the bottom right corner of the desired rectangle.

      A blue box appears that follows the trackball cursor as it moves.
   c. When satisfied with the desired rectangular area, release the trackball button.

      The system processes the image information defined by the rectangle.

d. If the rectangle was too small or too large, a message dialog box appears indicating that the rectangle was too small or too large:

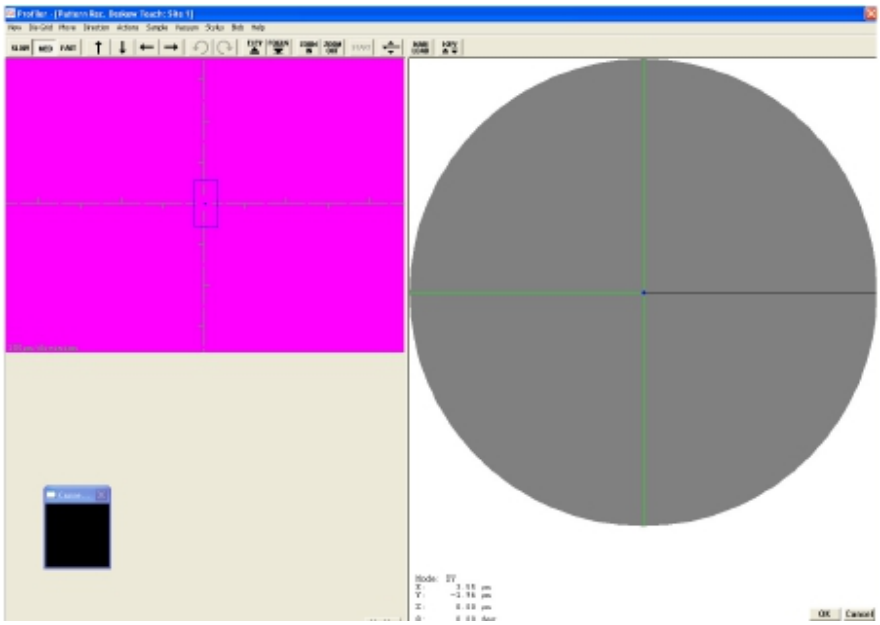
   i. Click **OK**.

   ii. Teach the pattern again.

8. The blue box remains on the window with a darker blue dot in the center.

   The stage moves until the selected feature is centered in the crosshair (*Figure 6.35 on page 6-43*).

Figure 6.35 *Pattern Rec. Deskew Teach Window After Teach*



9. Move the stage a small distance.
10. Click **Verify** to test whether the system can accurately find the taught feature.

    A box is drawn around the feature when it is found.

11. If recognition fails, select another pattern and retry.
12. Click **OK** to accept the new pattern.
13. Repeat **Step 2** to **Step 9** for **Deskew Site 2** to establish the second deskew point.
14. Once the deskew sites have been successfully established, proceed to programming the rest of the sequence steps.

    Due to the number of variables that affect pattern recognition, the computer might not always be successful in locating a deskew site. The instrument can be preset to do one of four things in the event of a failure:

    - Continue scanning
    - Stop scanning the wafer and proceed to the next scan site
    - Repeat the pattern recognition
    - Stop the entire sequence

15. Choose a Pattern Recognition Failure Response from the **If Fail** drop-down menu.
16. Run the sequence.

GROPING WITH PATTERN RECOGNITION (P-17 ONLY)

Introduction

Deskew Options can be set so that the system performs a pattern search if the pattern is not found within the field of view when the sample is positioned at the deskew site. This search is called groping. Note that these same parameters (in a slightly different format and with slightly different wording for the Lowest Match Score parameter) are available in the Pattern Recognition and Deskew Options dialog box in the Configuration screen. The parameters set in the Deskew Options dialog box take precedence over those from the Pattern Recognition and Deskew Options dialog box.

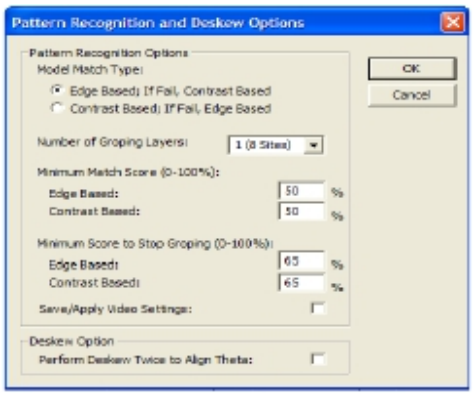
Access to the Pattern Recognition and Deskew Options dialog box is through the Configuration screen's **Pattern Recognition Options…** button. Access to the Deskew Options dialog box is through the **Deskew** menu in the Sequence Recipe screen. Notice that, the parameter, "Minimum Match Score" in the Pattern Recognition dialog box, has not yet been changed to "Lowest Match Score" as it has in the Deskew Options dialog box. *The values set in the Deskew Options dialog box for each sequence recipe override those set in the Pattern Recognition Options dialog box*.

The three groping parameters are described in *Table 6.12*.

Setup Procedure

1. From the Sequence Editor, click **Deskew** in the menu bar to display its menu.
2. Click **Options…** to open the Deskew Options dialog box. (See *Figure 6.36*).

Figure 6.36 *Pattern Recognition and Deskew Options Dialog Box*



3. Click the **Number of Groping Layers** menu-arrow to display its menu. (See *Figure 6.36*.)

4. Choose the number of layers from the menu. (See *Figure 6.36*. For information on the groping layers see *Table 6.12*.)
5. Set the Lowest Match Score (%) by highlighting the current percentage and entering the new one. (See *Figure 6.36*. For information on match scores see *Table 6.12*.)
6. Set the Minimum Score to Stop Groping (%) by highlighting the current percentage and entering the new one. (See *Figure 6.36*. For information on match scores see *Table 6.12*.)
7. Edit the fields by using the parameters described in *Table 6.12*.

Table 6.12 *Groping Parameters*

Parameter	Description
Number of Groping Retry Layers	This parameter controls how much of the area around the deskew site is searched for the pattern. Each layer consists of a square area constructed by evenly surrounding the deskew site with squares the size of the camera field of view. (See *Figure 6.37*). ***Figure 6.37*** *Groping Retry Layers* Groping disabled searches only camera field of view 1st Retry Layer searches for 8 more square areas 2nd Retry Layer searches for 24 more square areas 3rd Retry Layer searches for 48 more squares; 4th Retry Layer searches for 80 more squares. It stops after the 4th try. Available choices are: ◆ None (the default) ◆ 1 (8 Sites) ◆ 2 (24 Sites)) **NOTE:** It takes 10 s to move the stage, null the stylus, and search one such area; 8 search sites (1 layer of retry) takes as long as 90 s; and 24 sites (2 layers) takes as long as 250 s, and so on. First, the deskew site field of view is searched. If the pattern is not found, the stage moves to one corner of the next layer and searches the field of view there. This continues until the pattern is found or until all search sites have been examined. If the pattern is still not found, the stage moves to one corner of the next layer and continues.

Table 6.12 *Groping Parameters (Continued)*

Parameter	Description
Lowest Match Score (Was changed from Minimum Match Score, which is still the term used in the Configuration screen version of this parameter.)	Lowest Match Score is used to compare all the groping positions in the given groping levels. Once the groping stops (assuming that the Minimum Score to Stop Groping is not found) the highest score achieved, among those scores that qualified for Lowest Match Score acceptance, is chosen as the search pattern (model). This number must be smaller than the Minimum Score to Stop Groping. Allowed values range between 20 to 100%; the default is 65%. This parameter allows adjustment of the threshold at which the pattern recognition system concludes that it has found a candidate for the desired deskew site.
Minimum Score To Stop Groping	Minimum Score to Stop Groping defines a value at which the system accepts the image as the model for which it is searching. Groping stops if this score is reached and the image corresponding to the score is considered to be the search pattern (model). EXPLANATION: If the pattern recognition system is groping to find the desired pattern, frequently the matching pattern is found with little ambiguity. If a score equal to or better than the Minimum Score to Stop Groping occurs, the searching process stops and the deskew site is placed. Allowed values range between 20 to 100%; the default is 70%. If no matches are found that are as good as this setting, the search continues until all retry layer areas are searched. The highest score above the Lowest Match Score setting determines the placement of the deskew site.
Edge Based Pattern Recognition	The **Edge Based Pattern Recognition** option is used for low contrast image recognition on a sample surface or where there is a large surface light variation. If this option is chosen (with a check in the check box), the normal image contrast grayscale processing takes place first, then a series of filters are applied that further contrast and sharpen edges for a better pattern recognition. The image data is stored before these filters are applied so the data is not effected by this option. It is strictly a tool used for pattern recognition where contrast is low or where light varies significantly. If the option is not chosen, only the image contrast grayscale processing is performed..
Save/Apply Video Settings	The lamp brightness setting is important in pattern recognition. If the lamp brightness is different from when the original sequence was established, the pattern recognition images could be difficult for the system to detect. A check in the **Save/Apply Video Settings** checkbox ensures that the lamp brightness is saved with each deskew site pattern so future scans have the same image view with the same light for pattern recognition.

Table 6.12 Groping Parameters (Continued)

Parameter	Description
Perform Deskew Twice to Align Theta	With a single deskew operation, there is no stage rotation to compensate for the small rotational error in sample placement. By enabling this option in the **Pattern Recognition and Deskew Options** dialog box, a second deskew is performed to compensate for this error. This allows accurate sample rotations within a sequence.

8. Click **OK** to set the options and close the dialog box.

SEQUENCING WITH SITE-BY-SITE PATTERN RECOGNITION (P-17 ONLY)

Sometimes it is more effective to position a scan relative to a taught feature.

Site-by-Site Pattern Recognition stores an offset from a taught pattern for any scan in the sequence. The pattern must first be taught the "home" feature, then teach the scan. With Site-by-site Pattern Recognition enabled, the instrument stores the scan position as an offset from the taught feature.

1. In the **Options** section of the **Sequence Editor**, click the drop-down button of the **Mode** option. (See *Table 6.5 on page 6-24*.)
2. Click the **Site-by-site Pattern Rec.** option. (See *Table 6.5 on page 6-24*.)
3. Teach Pattern Recognition for the two initial deskew sites. (See Step 10 on page -8 through Step 16 on page -9.)
4. Insert Scan recipes for the measurement sites. (See STEP 4 ON PAGE -12.)
5. Click the site in the **Sequence** list to be taught.
6. Click the **Teach Pat** button, or click the **Use Previous Site** button to use the pattern from previous site.

   The **Pattern Rec. Deskew Teach Window** appears.
7. Teach a **Pattern Rec**. feature near the intended scan location, following the guidelines in *Table 6.10* and *Table 6.11*.
8. Click **OK**.
9. With the site still highlighted, click the **Teach Loc** button.
10. Teach the location for the actual measurement. This position is recorded as an offset from the **Pattern Rec.** site.
11. Click **OK**.
12. Repeat for all sequence sites.

SAVING SEQUENCES

Sequences can be saved on the hard drive or network drive

NOTE: For SEMI compliance, both scan recipes and sequences share the same directory. This means that a sequence cannot have the same name as an existing recipe.

1. Click the **Sequence** menu, and select:
   - **Save** to save the current recipe, or
   - **Save As** to save the current recipe under a different name.
2. Type a sequence name in the **Name** field.

   The name can be upper or lower case. If using special characters, only the following are allowed:

~ tilde	**(** left parenthesis
! exclamation point	**)** right parenthesis
@ at sign	_ underscore
# number sign	**-** hyphen
$ dollar sign	{ left brace
% percent sign	} right brace
^ caret	‘ single quotation mark
& ampersand	' apostrophe

3. Click **OK**.

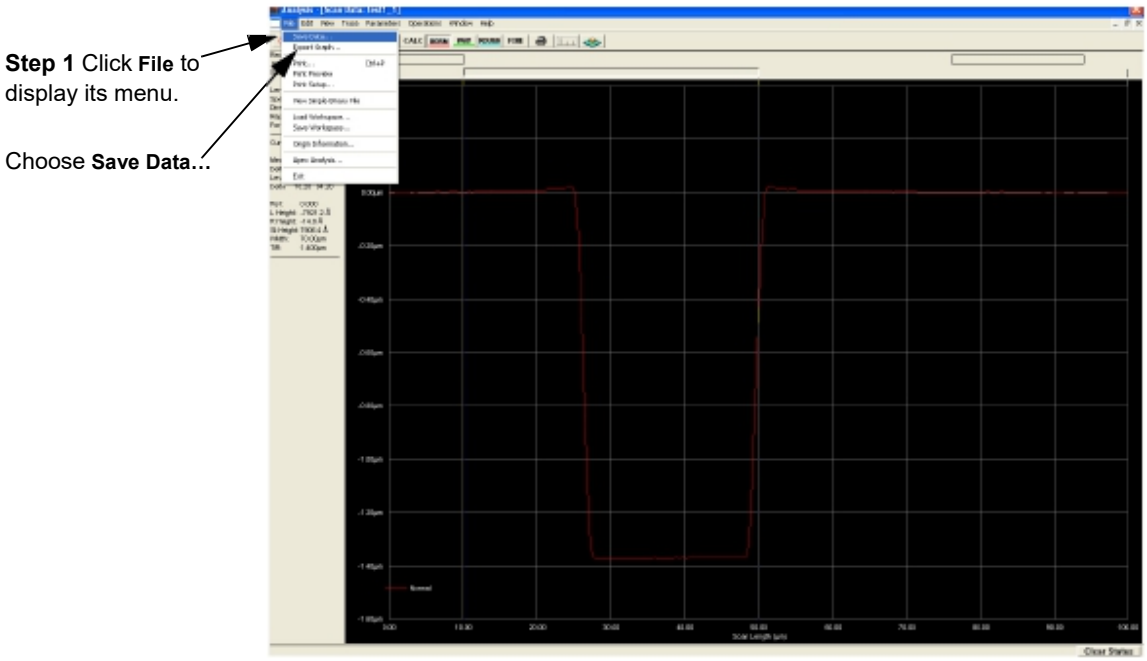
SAVING THE SEQUENCE DATA

The Scan and Sequence Data sets can be saved and retrieved for future review and additional reanalysis using different scan recipe parameters.

If a scan is completed without being interrupted, the Analysis screen automatically appears after the scan is complete.

1. Click **File**, and select **Save Data**. The dialog box appears. (See *Figure 6.39*.)

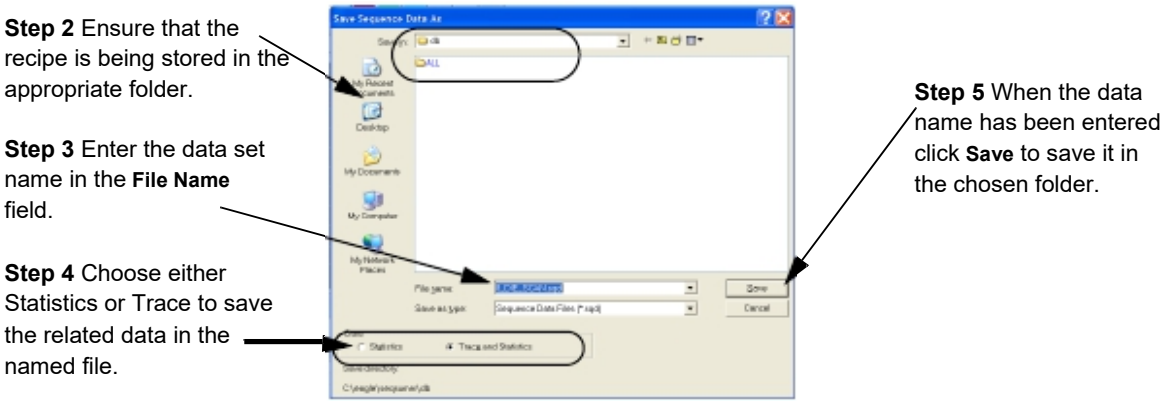
Figure 6.38 *Analysis Screen with File Menu*



2. Ensure that the data is being saved into the correct folder. (See *Figure 6.39*.)
3. Type a name (up to 72-alphanumeric characters) in the **File Name** field.

   The name can be upper or lower case. If using special characters, refer to *Using File Name Conventions* on page 2-13. (See *Figure 6.39*.)

Figure 6.39 *Save Data Set Dialog Box*



4. Choose either Statistics or Trace. If both require saving, perform the save function two times, one for each option, giving names to each different data set.

   Trace creates a scan data set containing the actual trace data. This can then be used to display the trace in the Analysis screen for further analysis or recalculation with new parameters. The system also uses this data to create the Thumbnail trace for comparison.

   Statistics creates a file of the scan data parameters that were set in the scan recipe used to create the different scans. This data can also be displayed in the Sequence summary screen and analyzed or recalculated with different scan parameters.

5. Click **Save**. Once a data set has been saved, it is added to the Sequence Data catalog. The Sequence Data catalog window allows for the selection of individual data sets for reviewing. Unwanted data sets can also be deleted.

ANALYZING 3D SCAN DATA

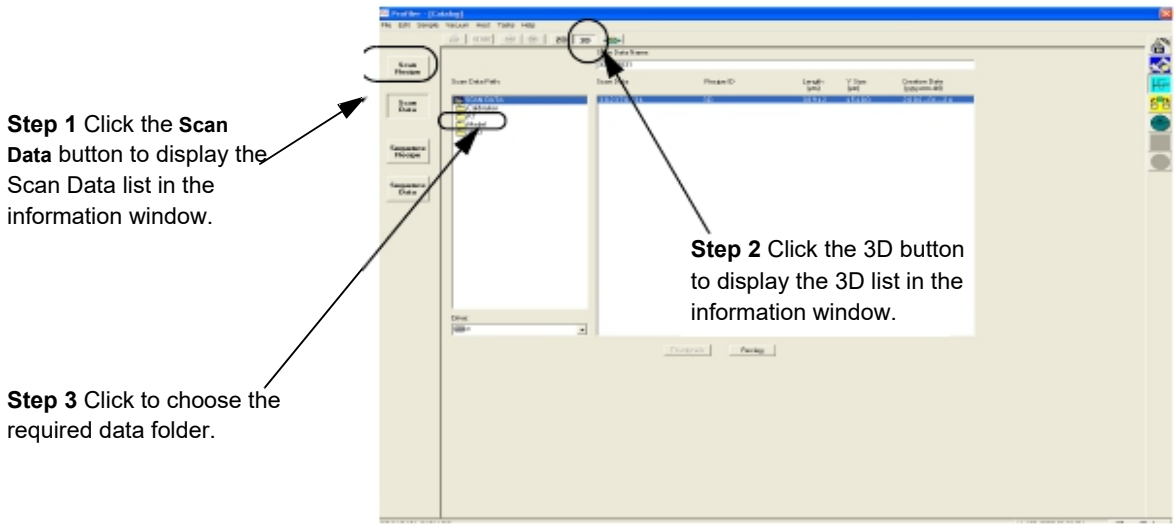
INTRODUCTION

The 3D scan data analysis displays the 3D scan image and trace information after a scan is completed. A 3D scan is an image built by taking a series of 2D scans, arranged in a raster pattern, to form a picture of the sample surface at the scan location. With 3D analysis, complete surface analysis can be performed.

STARTING THE 3D ANALYSIS APPLICATION

1. Click the **Scan Data** or **Sequence Data** command button to display the data information in the Catalog window. (See *Figure 7.1*.)

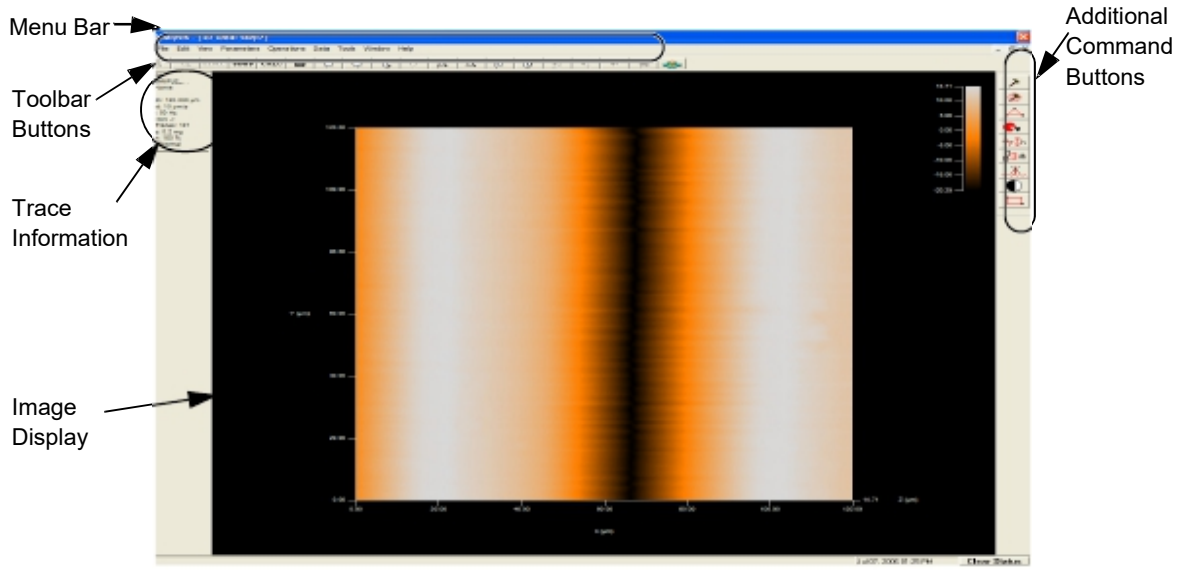
Figure 7.1 *Scan Catalog Screen with Scan Data Active.*



2. Click the **3D** button. (See *Figure 7.1*.)
3. In the **Scan Data Path** column, click the folder name. (See *Figure 7.1*.)
4. In the **Scan Data** list, click a data set to be analyzed.

5. With the data set highlighted, click the **Review** button. The Analysis window appears. (See *Figure 7.2*.)

Figure 7.2 *3D Analysis Screen with 3D Object Displayed*



3D ANALYSIS SCREEN FEATURES

Analysis Screen – Image Orientation

The image in the Analysis Image Display area can be rotated to orient it for analysis and viewing. Four options exist for rotation of the object. All four are presented, with the Recommended procedure coming first.

Recommended Image Rotation Procedure

Option 1 – Automatic Image Rotation. Use the Image Rotation buttons in the tool bar. (See *Figure 7.3*) These are Automatic Image Rotation buttons, described in *Table 7.1*.

Figure 7.3 *Analysis Tool Bar Image Rotation Buttons*

Table 7.1 *Automatic Image Rotation Buttons*

Button	Description of Action
	Rotates the image to the left on its horizontal plane. Each click moves the image a small distance. (Identical to the **left** arrow key.)
	Rotates the image to the right on its horizontal plane. Each click moves the image a small distance. (Identical to the **right** arrow key.)
	Rotates the image in a backward roll. Each click moves the image a small distance. (Identical to the **up** arrow key.)
	Rotates the image in a forward roll. Each click moves the image a small distance. (Identical to the **down** arrow key.)

Option 2 – Manual Handle Drag. There are also Manual Image Rotation buttons, described in *Table 7.2*.

Table 7.2 *Manual Image Rotation Buttons*

Button	Description of Action
	Rotates the image on its horizontal plane using four handles that are manipulated by click-and-drag method. (See *Figure 7.4*.)
	Rotates the image on its horizontal plane using a single handle that is manipulated by the click-and-drag method. (See *Figure 7.4*.)

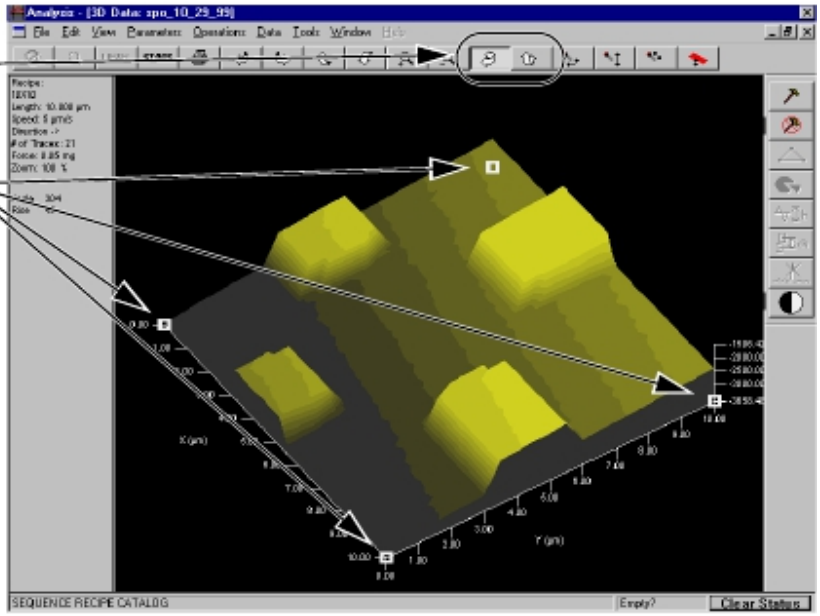
1. Click the button representing the plane in which the required rotation is to take place. The image appears to have handles attached to it. (See *Figure 7.4*)

2. Click one of the handles (see *Figure 7.4*) and, while holding down the mouse button, drag the image to rotate it to a different orientation in the chosen plane. Release the mouse button to set the image in its new orientation.

Figure 7.4 *Manual Image Rotation Handles*

Click the button representing the required plane of rotation.

With the particular angular rotation button clicked, click one of the four handles and hold the mouse button down while dragging the image in the chosen rotation plane. Release the button to terminate the rotation.



Option 3 – Arrow Keys. Use the arrow keys on the keyboard. The movement provided by each key is described in *Table 7.3*.

Table 7.3 *Image Rotation Using the Arrow Keys*

Button	Description of Action
	Rotates the image to the left on its horizontal plane. Each click moves the image a small distance. (Identical to the **left** rotation button.)
	Rotates the image to the right on its horizontal plane. Each click moves the image a small distance. (Identical to the **right** rotation button.)
	Rotates the image in a backward roll. Each click moves the image a small distance. (Identical to the **up** rotation button.)
	Rotates the image in a forward roll. Each click moves the image a small distance. (Identical to the **down** rotation button.)

Option 4 – Rotate Image Menu. Use the **Rotate Image** menu rotation options. The rotation provided by each menu item is identical to that provided by the representative arrow key (cited next to each option) as described in *Table 7.3*, and the related Image Rotation button described in *Table 7.1*.

Figure 7.5 *Image Rotation Using the Rotate Image Menu*

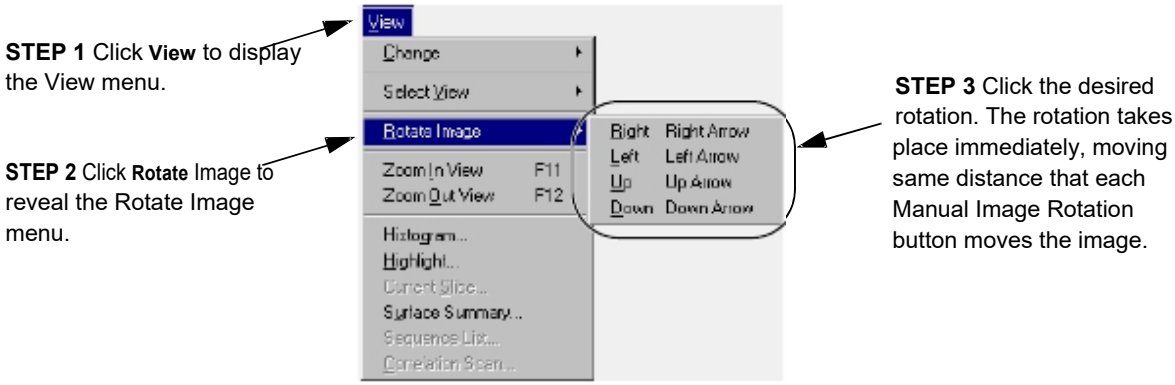


Table 7.4 ***Rotate Image*** *Menu Options (From View Menu)*

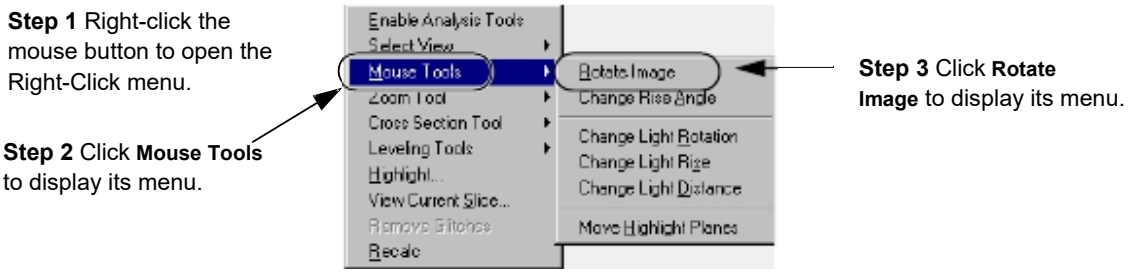
Menu Item	Description of Action
	Rotates the image to the left on its horizontal plane. This action only move the image one increment each time. The menu must be opened again for each move.
	Rotates the image to the right on its horizontal plane. This action only move the image one increment each time. The menu must be opened again for each move.
	Rotates the image in a backward roll. This action only move the image one increment each time. The menu must be opened again for each move.
	Rotates the image in a forward roll. This action only move the image one increment each time. The menu must be opened again for each move.

Use the **Mouse Tool** in the Right-Click menu.

1. Right-click to display the **Right-Click** menu. (See *Figure 7.6*.)
2. Click **Mouse Tools** to display its menu. (See *Figure 7.6*.)
3. Choose **Rotate Image** from the Mouse Tools menu. (See *Figure 7.6*.)
4. Choose the required rotation from the menu. This menu is the same as the Rotate Image menu from in the View drop-down menu in the Menu Bar. (See *Figure 7.5* and *Table 7.4*.)

   Each click moves one increment only. The entire menu process must be completed for each single movement.

Figure 7.6 *Right-Click Menu – Mouse Tools*



Graphics Buttons and Their Function)

Figure 7.7 *Analysis Tool Bar Graphics Buttons*

Automatic and Manual Image Rotation Buttons

The Automatic and Manual Image Rotation buttons are displayed in *Figure 7.3*. They are discussed beginning in *Analysis Screen – Image Orientation* on page 7-2 and explained in *Table 7.1* through *Table 7.4*.

In general, the automatic rotation buttons move the image in the depicted direction by one increment of movement each time they are clicked on. The manual rotation buttons place handles on the image to allow it to be moved in the indicated direction.

Zoom Features

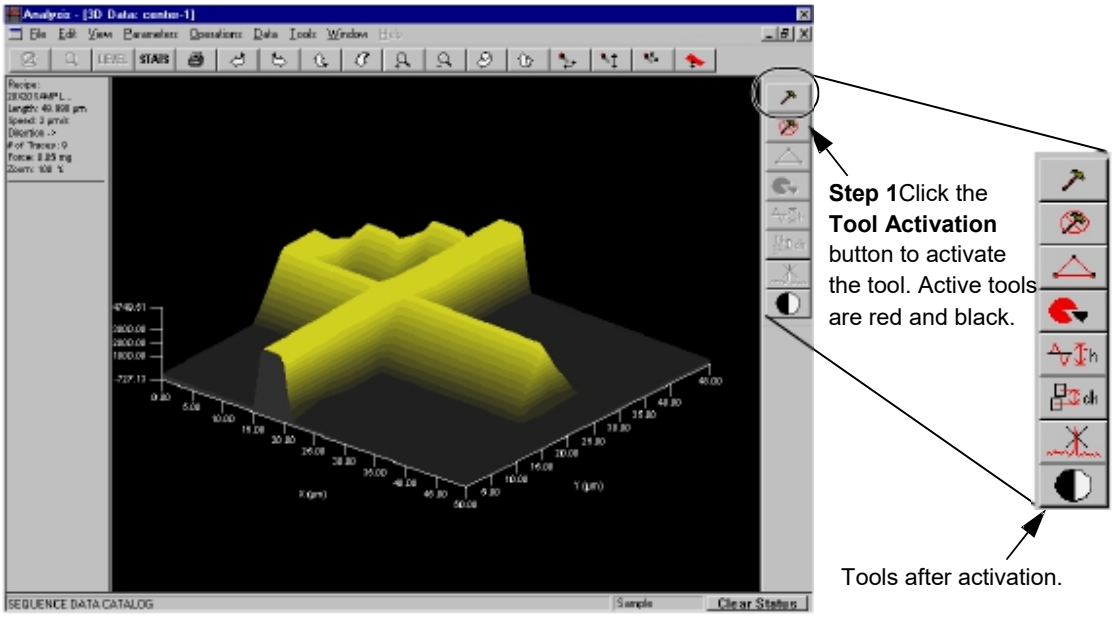
The Zoom features are designed to facilitate zooming in on a portion of the 3D graphic for closer inspection. The zoom can be accomplished through the use of several zoom tools.

- The View menu contains zoom features.
- The tool bar contains zoom features shaped like magnifying glasses.
- The Right-Click menu contains zoom tools.

The following explanation demonstrates the use of the zoom tools in the most efficient manner. Other combinations of zoom tool usage exist, but this combination should be the simplest.

1. In the Analysis screen, click the **Tool Activation** icon at the top of the tool bar on the right side of the screen. This activates (enables) the side tool bar tools. (See *Figure 7.8.*) When the side tool bar is activated, the graphic image is changed to **top view**.

Figure 7.8 *Analysis Screen - Tool Activation*



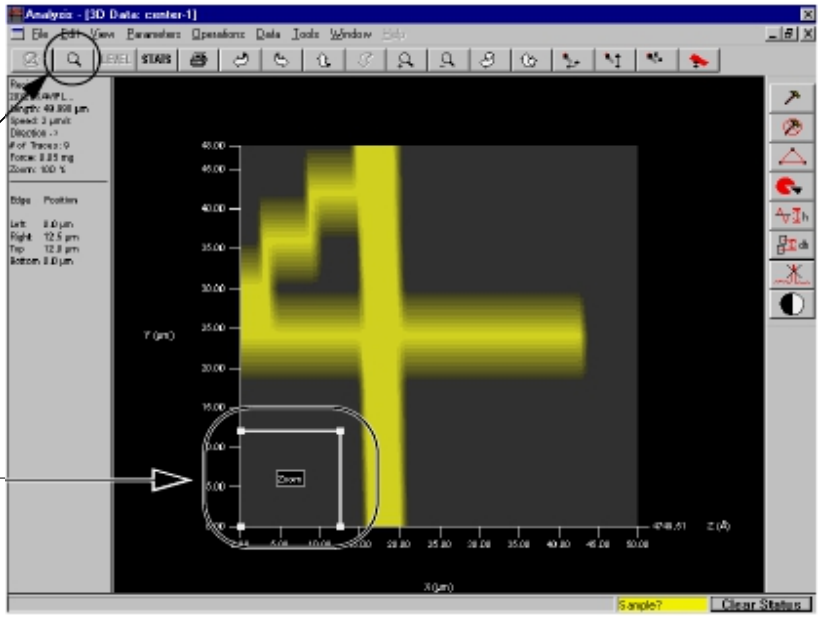
2. Place the cursor over the graphic display and right-click to display the tool menu.
3. In the tool menu, move the cursor over **Zoom Tool** to display its menu.

4. Click **Enable Zoom Tool** to activate the zoom process. (See *Figure 7.9*.)

Figure 7.9 *Analysis Screen - Zoom Active*

Step 5 When zoom is active, the **Zoom In** magnifying glass icon is enabled. It zooms in on whatever is outlined by the **Zoom** box.

When zoom is active, a **Zoom** box is displayed at the bottom left corner of the 3D graphic display.



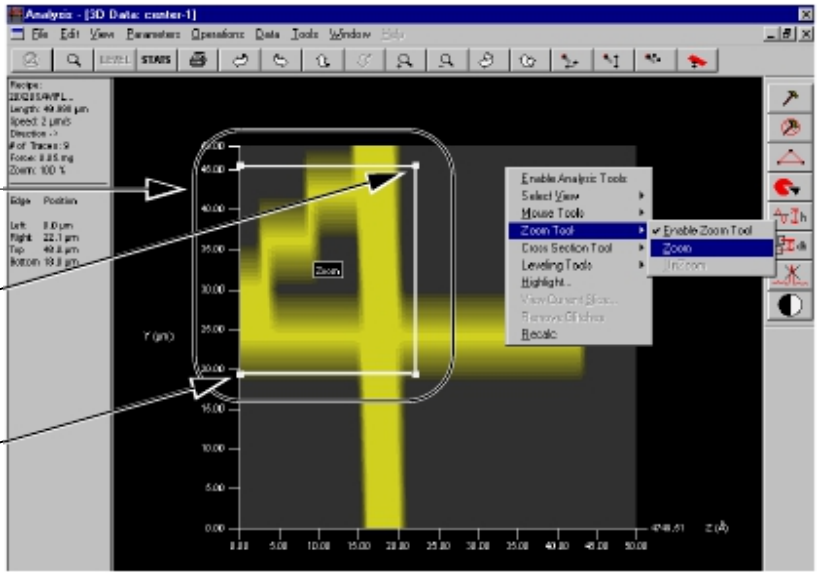
5. When the zoom process is activated, the **Zoom In** magnification glass is activated and the **Zoom** box is deployed at the bottom left of the 3D graphic display. (See *Figure 7.9*.)

Figure 7.10 *Analysis Screen with Zoom Box*

Zoom box relocated to the intended Zoom area.

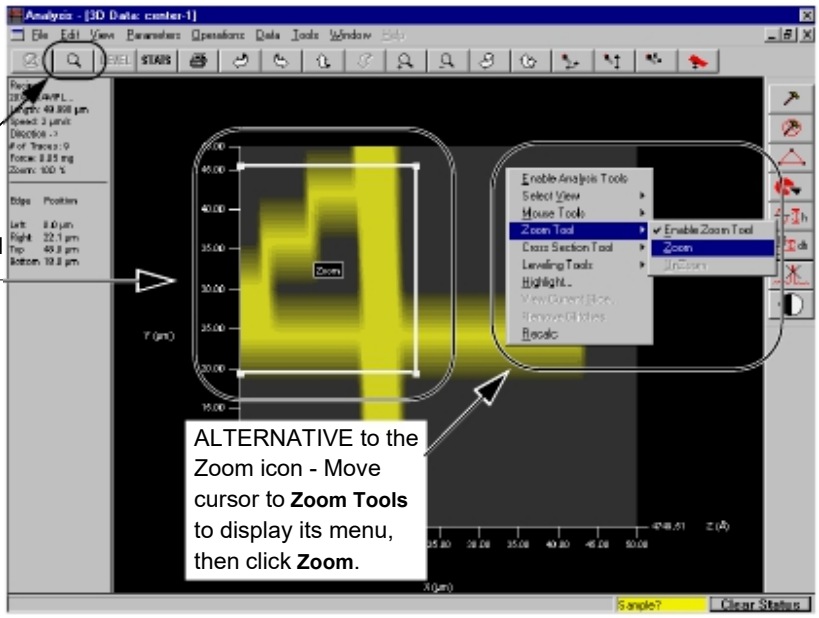
Step 6 Click hold and drag the upper right corner to the top right corner of the **intended zoom area**.

Step 6 Click hold and drag the lower left corner of the **Zoom** box to the lower left corner of the **intended zoom area**.



6. A good way to position the **Zoom** box is, click and hold on the top right handle (boxed corner) of the **Zoom** box and position it where the top right corner of the intended zoom area. Repeat the process with the bottom left corner, placing it at the bottom left corner of the intended zoom area. (See the intended zoom area in *Figure 7.10*.)

Figure 7.11 *Analysis Screen – Using the Zoom In Icon*



Step 7 Click the Zoom In icon to zoom into the boxed area.

Zoom box relocated to the intended Zoom area.

7. When the **Zoom** box is positioned as the boundary of the intended zoom area, click the **Zoom In** icon  in the tool bar. (See *Figure 7.11*.)

The 3D graphic image changes, displaying only the bounded area within the **Zoom** box. (See *Figure 7.12*.)

ALTERNATIVE procedure for activating the zoom to display the area within the **Zoom** box:

a. Right-click to display the Right-Click menu. (See *Figure 7.11*.)

b. Click Zoom Tools. (See *Figure 7.11*.)

c. Choose Zoom. (See *Figure 7.11*.)

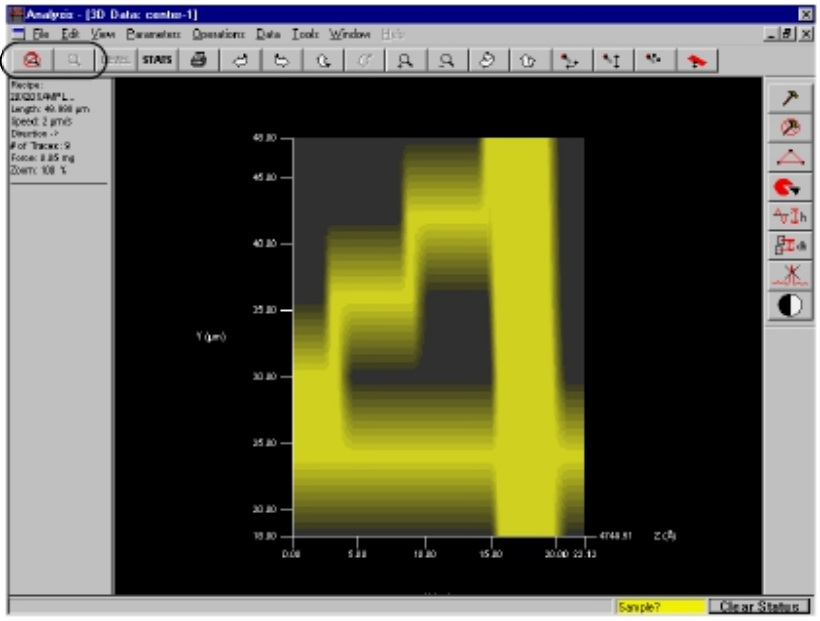
Working with a Zoomed Image

While in the view containing the zoomed image, all the procedures contained in the right side tool bar can be executed on the image. The Level, Slice, Height, Step Height, and Glitch Removal, all function the same way with a zoomed image that they do with a standard top view image.

While in the view containing the zoomed image, it is not possible to zoom in further. To zoom in closer, return to the original image and repeat the zoom procedure using a smaller area within the Zoom Box for the zoom image.

When the Zoom In procedure is complete, the Zoom Out icon is activated to allow the User to return to the pre-zoom image. (See *Figure 7.12*.)

Figure 7.12 *Analysis Screen – Zoomed In Area*



Step 8 When the Zoom In procedure is complete, the **Zoom Out** icon is activated to allow the user to return to the pre-zoom image. The Zoom In icon is deactivated.

8. To return to the pre-zoom image, click the **Zoom Out** icon. The image returns to the prior display. (See *Figure 7.12*.)

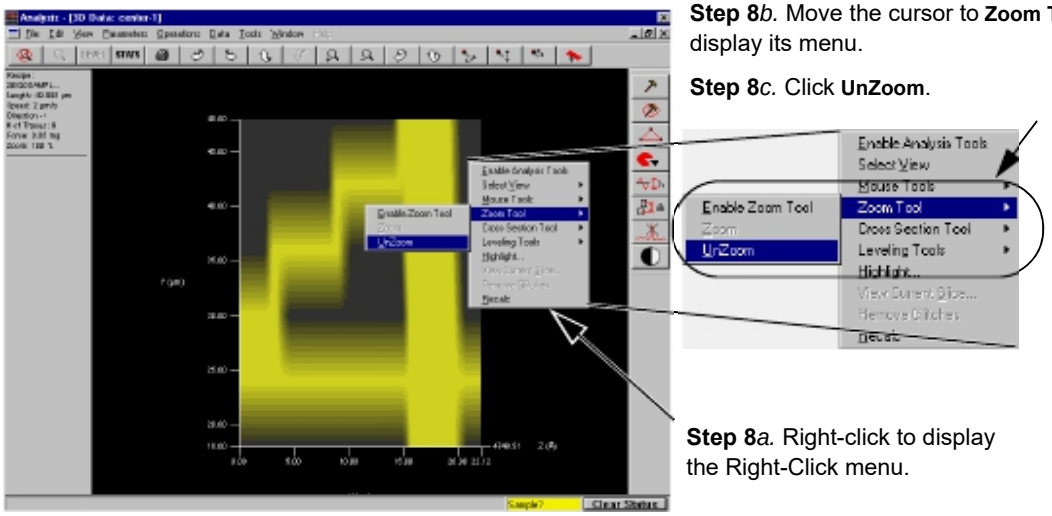
   ALTERNATIVE: (See *Figure 7.13*.)

   a. Right-click the graphic display area to display its menu.

   b. Move the cursor to **Zoom Tools**, to display its menu.

   c. Choose **Unzoom** and click. The image returns to the prior display.

Figure 7.13 *Analysis Screen – Unzoom Using Right-Click Menu*



Step 8*b.* Move the cursor to **Zoom Tools** to display its menu.

Step 8*c.* Click **UnZoom**.

Step 8*a.* Right-click to display the Right-Click menu.

Analysis Screen Toolbar Button Functions

Table 7.5 *Analysis Toolbar Buttons*

Button	Description of Action
	Zoom In on the area bounded using a zoom box to form the boundary. This is for use with the Zoom Box. This icon is used as a trigger to execute zoom of the data according to the parameters set using the Zoom Box. **Procedure**: (See procedure as described beginning with *STEP 1. on page 7-6*.) The following is an abbreviated version of the procedure. 1. Click the **Hammer** in the Analysis Tool box to enable the Analysis Tools. 2. Right-click to display its menu. 3. Move the cursor to the **Zoom Tools**. 4. Click **Zoom** in the Zoom Tools menu. 5. Adjust the size and position of the zoom box so it forms the boundary of the area to be zoomed. 6. Click the **Zoom In** icon to zoom to the area bounded by the zoom box (or click **Zoom** in the **Tools** menu - as illustrated below). **1.** Click **Tools** to display its menu. **2.** Click **Zoom Tools** **3.** Click **Enable Zoom Tool** to enable the **Zoom In** icon. **4.** Click **Zoom**
	Zoom Out tool. This returns the image to its pre zoom magnification. This tool works with the Zoom In tool described above. It is for use after zooming in on a bounded area. (See *STEP 8. on page 7-10*.)
	LEVEL icon. This is for use with the three point leveling tool. It is used as a trigger to execute leveling of the data according to the three vertex positions set using the Leveling Tool. **Procedure**: 1. Click the **Hammer** in the Analysis Tool box (on the right side of the image), The Analysis Tools are enabled. 2. Click the **Leveling Tool** . The **LEVEL** icon is enabled. 3. Use the click-and-drag procedure (click the center of each vertex) to position them. (For more information on the procedure, see *Activate Leveling Tool on page 7-13*.) 4. Click the **LEVEL** icon to complete the leveling procedure.

Table 7.5 *Analysis Toolbar Buttons (Continued)*

Button	Description of Action
	Statistics information box. This displays the statistics information box on the screen, usually beneath the analysis image. The positioning can be manipulated.
	Print. This causes the system to print the analysis information.
	Positive Magnification. This causes the entire image to be magnified by one increment each time it is clicked on. The image continues to grow in size, having its outside edges cropped as its size increases past the image area of the screen.
	Negative Magnification. This causes the entire image to be reduced in magnification by one increment each time it is clicked on.
	Move highlight planes... This moves each highlighted plane for visibility. Up to 10 planes can be identified for viewing.

Analysis Screen Side Toolbar Buttons

These buttons, located at the right of the image, are active in the **Top View** only (looking directly down on the image surface). (See *Table 7.6*).

Analysis Screen Side Toolbar Button Functions

Table 7.6 *Analysis Side Toolbar Buttons*

Button	Description of Action
	Enable Analysis Tools (Top View). This button enables the remaining tools in this tool bar. It moves the image to the **Top View** because all the tools require this view.
	Disable analysis Tools. This button disables active tools. This includes the tools in this tool bar as well as those in the top tool bar.

Table 7.6 Analysis Side Toolbar Buttons (Continued)

Button	Description of Action
	Activate Leveling Tool. This button activates the leveling tool that places three interactive boxes on the image surface for leveling the image. Each box represents a corner of the leveling triangle. Procedure: 1. Click-and-drag the center of the boxes (labeled vertexes in the data column at the left) to locations on the image surface that are to be used as leveling points. The information in the square is averaged to form a height for leveling that point in the triangle. 2. If desired, use the handles at the corners of the squares to resize the squares so the surface bounded by each vertex creates the average desired height for that point. **NOTE:** It is very important that the area covered by each box is on the same plane. In addition, the contents of all three boxes must also be on the same plane, or the image is not properly leveled and the image itself could become distorted. Boxes **1** and **2** in the illustration below are too large to properly level the image. 3. Click the **LEVEL** button on the top tool bar to level the image. Each leveling box must be placed in an area containing data that is on one plane. All three boxes must be on the same plane for the leveling to be accurate. Boxes **1** and **2** contain data on more than one plane and will produce inaccurate leveling. Each box has its location statistics displayed in the data column, to the left of the image.
	Activate Height Tool. This button activates the tool that places a box on the image surface. The box borders an area containing data that is averaged to give a single average height of the contents of the box. Using the center of the box, it can be moved using the click-and-drag procedure. The handles at the corners of the box can be used to change the area of the box. The data is automatically calculated as the box is moved, or as its area is changed by moving its borders.

Table 7.6 *Analysis Side Toolbar Buttons (Continued)*

Button	Description of Action
	Activate Slicing Tool. This button activates the tool that allows the user to slice the image down from the top surface to the foundation of the image and display a 2D image of the cross section at the slice. This tool provides three options (see also *Table 7.14*) for the slice: horizontal, vertical, and diagonal. (Diagonal can be adjusted to any angle.) All three options can be adjusted to any length. (See *Table 7.9*, in the **Current Slice** section.) **Procedure**: a. When this tool is clicked, a slice line is displayed on the 3D image in the chosen orientation. b. Click and hold while dragging the slice line to the desired location on the image. c. Adjust the length of the slice by using the click-and-drag procedure with one of the handles at the end of the slice line. d. Right-click to display the Right-click menu. (See below.) In the View menu, click **View Current Slice** to display the 2D image at the slice indicated in the 3D image. e. Click **View Current Slice** (shown above) to view the current slice trace. To display both the 2D image along with the 3D image (as illustrated below), click **Window**, then choose **Cascade**. (See *Creating and Saving 2D Slice Data from a 3D Scan* on page 7-41 for information on creating a slice and saving current slice data.)
	Activate Step Height Tool. This button activates the tool that places two boxes on the image surface. Using using the click-and-drag procedure with the center of each box, it can be moved to a new location on the image surface. It can then be resized using the corner handles. The software determines the difference between the average height in one box and the average height in the other box. This difference is automatically calculated as the boxes are moved or resized.

Table 7.6 *Analysis Side Toolbar Buttons (Continued)*

Button	Description of Action
	Activate 3D Glitch Removal Tool. This button activates the 3D glitch removal option. The tool is used in the following manner: 1. Activate the glitch removal button by clicking on it. A box is displayed at the bottom right of the top view of the 3D image. 2. Drag the box over an area that presents the identical but correct formation of the area that contains the glitch. Resize the box to capture only those attributes and only the size that is to be corrected in removing the glitch. (See left side illustration below. Note that it is important to gather enough data points for the system to make the analysis and remove the glitch.) 3. Right-click to display the right-click menu. Place and resize glitch removal box in a position modeling desired data. In right-click menu choose filter option. 4. Move cursor to **Remove Glitches Within Cursors** and choose the median filter to be used; 3 x 3, 5 x 5, or 7 x 7. (See right side illustration above.) (For more information on median filters, see also *Median Filter for 2D and 3D Data* on page 3-45.) 5. Move the box over the glitch area, placing it in the same relative position that the initial box was placed. (See left side illustration below.) Move the glitch removal box over the glitch area. In right-click menu, choose **Remove Glitches**. 6. Right-click to display the right-click menu. (See right side illustration above.) 7. Move the cursor to **Remove Glitches** and click.(See right side illustration above.) The glitch is removed using the chosen filter and the data gathered in the first box.

Analysis Menu Bar

Most of the functions available in the two Analysis Tool Bars and the Right-click menu, are also available using the Menu Bar at the top of the screen. In addition, there are numerous other menu items that facilitate functions necessary for the processing of 3D scan data.

Figure 7.14 *Analysis Screen Menu Bar*

File Menu

Table 7.7 ***File*** *Menu Operations*

Menu Item	Description of Action
	Saves the current data to a file. This option displays the Save Dialog box with its associated options.
	Exports the current data. This option displays the Export dialog box with its associated options.
	Prints the current data. This option displays the Print dialog box with its associated options.
	This option displays a thumbnail presentation of the material that is to be printed so it can be reviewed.
	This option displays the Print Setup dialog box with its printer/print setup options.

*Table 7.7 **File** Menu Operations (Continued)*

Menu Item	Description of Action
	This option allows the user to choose a specifically designed work space from a drop-down menu in the Select Work Space dialog box.
	This option presents a dialog box that allows the user to establish a named work space.
	This option Exits from the Analysis screen.

Edit Menu

*Table 7.8 **Edit** Menu Option*

Menu Item	Description of Action
	This option places the image and data information on the clipboard.

View Menu

Table 7.9 ***View*** *Menu Options*

Menu Item	Description of Action
	This option displays another menu presenting options effecting the image perspective, view position, lighting and color.

Table 7.9 ***View*** *Menu Options (Continued)*

Menu Item	Description of Action
	This option displays another menu offering options to view the image from different perspectives. See *Table 7.11* for more detail on each view. Top View Oblique View Front View Back View Left View Right View

Table 7.9 ***View*** *Menu Options (Continued)*

Menu Item	Description of Action
	This option displays another menu presenting options, each of which rotate the image by one increment each time they are chosen. (See *Table 7.4* for a complete explanation of the movement of each option.) **NOTE:** This is the most inefficient way of image rotation since each time an option is used, the menu disappears and must be accessed again for another single movement rotation. The rotation buttons in the tool bar or the arrow keys on the keyboard are much more efficient.
	This option causes the magnification of the entire image by one increment of magnification each time it is clicked on.
	This option causes the reduction in size of the entire image by one increment of magnification each time it is clicked on.
	This option opens the Analysis screen where it presents a graphical representation of the histogram of the data in the chosen data file allowing the user to select the histogram for leveling or depth analysis..

Table 7.9 ***View*** *Menu Options (Continued)*

Menu Item	Description of Action
	This option displays the Highlight dialog box with its highlight options for chosen planes in the analysis image.
	This options presents the trace of the **Current Slice** as an Analysis Screen graph. 2D image of the slice. 3D image with a horizontal slice displayed.
	This option displays the Surface Summary box in the Analysis Screen.
	Not applicable to 3D data analysis

***Table 7.9 View** Menu Options (Continued)*

Menu Item	Description of Action
	Not applicable to 3D data analysis

Change Menu From the View Menu

***Table 7.10 Change** Menu Option From the View Menu*

Menu Item	Description of Action
	This option displays the **Set Viewing Parameters** dialog box with its options and settings.
	This option displays the **Light Properties** dialog box with its options and settings.

*Table 7.10 **Change** Menu Option From the View Menu (Continued)*

Menu Item	Description of Action
	This option displays the **Light Properties** dialog box with its options and settings. The color is applied to the primary image on the Analysis screen.

Select View Menu From the View Menu

*Table 7.11 **Change** Menu Option From the View Menu*

Menu Item	Description of Action
	Restore Original View returns the image view to the first view that it is presented in when the **Analysis** screen opens.
	Top turns the image surface flat, giving the user a top down view of the image. This is the same view that is presented when the side tool bar is activated.

*Table 7.11 **Change** Menu Option From the View Menu (Continued)*

Menu Item	Description of Action
	Oblique turns the image so that it is rotated to the left and down from the Original View, giving more view of the top surface.
	Front is rotated a short distance in the counter-clockwise direction from the Original View.
	Back rotates the image so that the surface is in the same basic orientation as the Original View, only with the front to the rear and rear of image to the front.

*Table 7.11 **Change** Menu Option From the View Menu (Continued)*

Menu Item	Description of Action
	Left Side rotates the image so that the surface is in the same basic orientation as the Original View, only with the front to the right, the rear of image to the left and the left side to the front of the display.
	Right Side rotates the image so that the surface is in the same basic orientation as the Original View, only with the front to the left, the rear of image to the right and the right side to the front of the display.

Parameters Menu

The Parameters Menu is designed to display the checked parameters in the analysis data. This information is included and saved in the Surface Summary record. To include the menu parameter in the Surface Summary, click next to it so that a check appears. (See *Figure 7.15*.)

*Figure 7.15 **Parameters** Menu from the Analysis Screen Menu Bar*

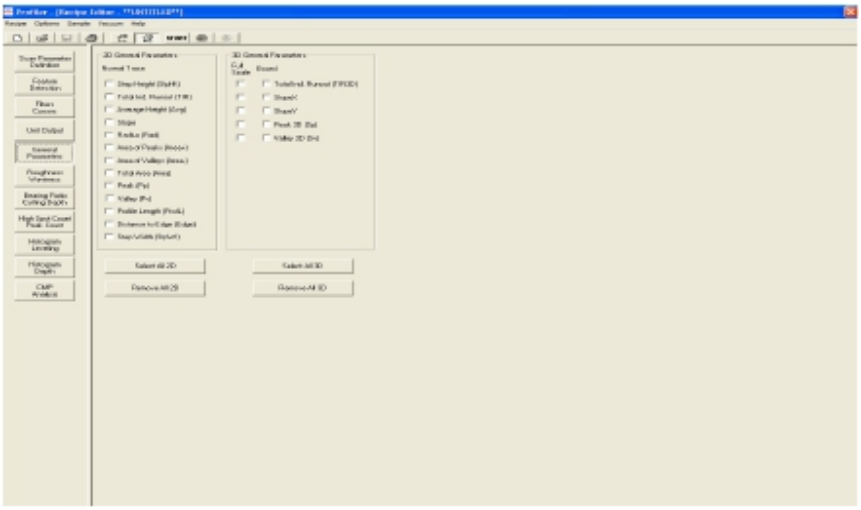
The General, Roughness, Waviness and Hybrid parameters are sets of parameters found in the Recipe Editor for the recipe being used to create the 3D scan that is being analyzed. For details on each parameter set, see *Chapter 3*. To cause these parameters to be displayed in the **Surface Summary** information, use the following procedure:

1. From the **Edit** menu, select **Recipe** to modify the recipe parameters saved with the data set, such as leveling, filtering, and parameter calculations.

General Parameters

2. Click the **General Parameters** button (see *Figure 7.15.*) to display the **General Parameters** information in the Information Display Window.

Figure 7.16 *3D Recipe Editor*

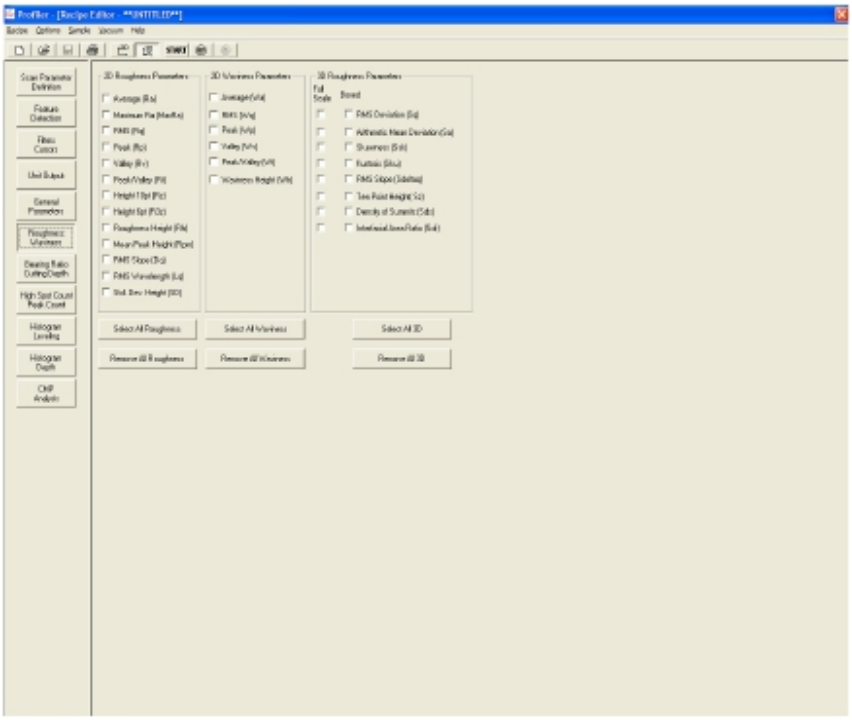


3. Ensure that the required parameters for the scan are chosen. (*Figure 7.16.*)

Roughness/Waviness Parameters

4. Click **Roughness/Waviness** button to display the **Roughness/Waviness** options in the information display window. (See *Figure 7.17.*)

Figure 7.17 *3D Recipe Editor with Roughness/Waviness Options*

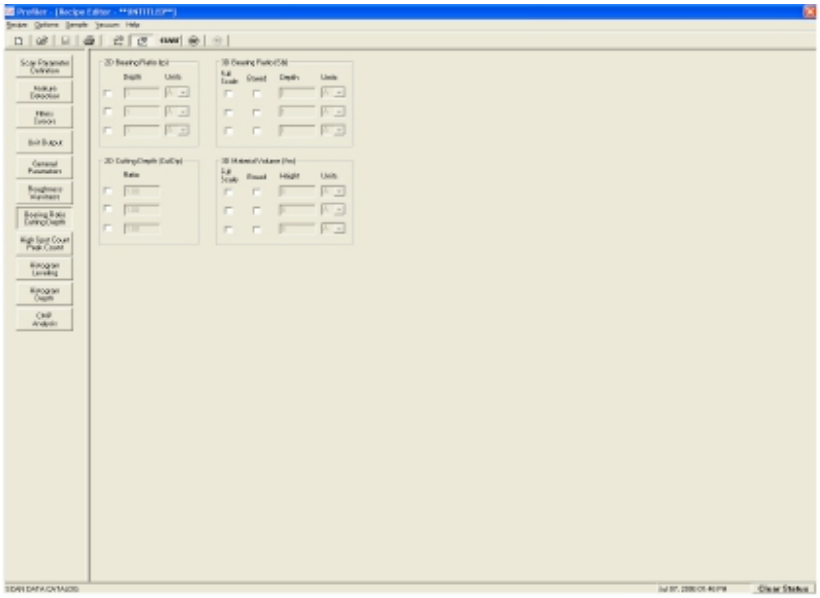


5. Click in each empty check box next to the parameters that are to be displayed in the **Surface Summary** box after the scan. This activates the procedure so that the information is available for data analysis. (See *Figure 7.17*.)

Hybrid Parameters

6. This is the set of parameters contained in **Bearing Ratio**, **Cutting Depth**, **High Spot Count**, and **Peak Count**. Click the **Bearing Ratio/Cutting Depth** button. (See *Figure 7.18*.)

Figure 7.18 *Bearing Ratio/Cutting Depth in Recipe Editor*



7. Make the required adjustments to the 3D parameter settings. (See *Figure 7.18*.)

NOTE: The **High Spot Count/Peak Count** parameters are only for 2D analysis and do not show up in 3D analysis.

8. When all changes are complete, click on the Analysis icont on the tool bar to process the data with the new recipe settings.

Operations Menu in the Analysis Screen Menu Bar

Table 7.12 ***Operations*** *Menu Options (From Menu Bar)*

Menu Item	Description of Action
	This option activates the Leveling procedure by activating the tool bar to the right of the image, orientating the image to the **Top View**, and placing the leveling cursors on the image surface. (See *Table 7.5*, **Level tool**.)
	This button is activated when the Leveling procedure is activated. If the Leveling procedure is begun and the user wishes to cancel it prior to completion, this button can be clicked to abort the procedure.

***Table 7.12 Operations** Menu Options (From Menu Bar) (Continued)*

Menu Item	Description of Action
	This option displays the Line Leveling dialog box for use in leveling the image. There are two sets of lines that work just like setting cursors. There is a left and right side of the "line" that will be used for leveling. It is very important that the bounded area in both "lines" is all in the same plane. For this reason, the example shown below would not be a good candidate for this type of leveling since no vertical line could be drawn on a single plane.
	This displays the Image Arithmetic dialog box which allows the user to compare the current image with other images using various mathematical operators.
	This option allow the user to **recalculate** the current data using **new** parameters.

Data Menu from the Analysis Screen Menu Bar

***Table 7.13 Data** Menu Options (From Menu Bar)*

Menu Item	Description of Action
	This option inverts the data and changes the screen image to reflect the inverted data.
	This option allows the user to choose how many of the collected data points will be used. It opens a dialog box that with the necessary settings. This feature sets the gain of the image. The computer records more data points than are possible to plot on-screen, so it uses a subset of the points taken to build the image. In general, the smaller the subset, the coarser the image and the faster it can be displayed and rotated. To control the image granularity from coarse to fine, set the parameters for the data subset, using the Data Granularity dialog box.
	This option is the default view mode. If checked (like Low Resolution in the following field), the image will be presented in a higher resolution.
	This option is for display purposes only. If checked, as in the illustration, the image will be presented in a lower resolution. This enhances generation time when the image is rotated or magnified.

Tools Menu from the Analysis Screen Menu Bar

***Table 7.14 Tools** Menu Options (From Menu Bar)*

Menu Item	Description of Action
	This options enables the Side Tool Bar Buttons. (See *Table 7.6*.)
	This options disables the Side Tool Bar Buttons.
	This option displays the Analysis Tools menu.
	This option changes the image to Top View, places the zoom box at the bottom left corner of the image, and activates the Zoom In (magnification) icon in the top tool bar. (See *Table 7.5*, Zoom In.)
	Once the Zoom In boundary box is set on the area to be zoomed in on, this option completes the zoom procedure to magnify the surface bounded by the box.
	This button restores the pre zoom image.
	This option displays the **Mouse Tools** menu. These tools are all duplications of tools on the top tool bar. For **Rotate Image** and **Change Rise Angle**, see *Table 7.2*. For three **Change Light...** options, see *Table 7.5*, look for the same titles. For the **Move Highlight Planes**, see *Table 7.5*, look for the same title.
	This option is used with the Slicing Tool. (See *Table 7.6*, in the Activate Slicing Tool section.) When this option is chosen, the slicing tool will automatically go to the horizontal position and only operate in that position for the slicing procedure.

***Table 7.14 Tools** Menu Options (From Menu Bar) (Continued)*

Menu Item	Description of Action
	This option is used with the Slicing Tool. (See *Table 7.6*, in the Activate Slicing Tool section.) When this option is chosen, the slicing tool will automatically go to the vertical position and only operate in that position for the slicing procedure.
	This option is used with the Slicing Tool. (See *Table 7.6*, in the Activate Slicing Tool section.) When this option is chosen, the slicing tool automatically set the slicing line at a diagonal across the image. This line can be changed to any angle or length.

LINE-BY-LINE LEVELING

Introduction

Line-by-Line Leveling is designed to provide a tool for leveling 3D images where planes at the same "Z" level can be detected running from top to bottom (along the Y-axis) of the 3D image. This process is used to remove errors caused by scan drift. This is accomplished by the system which averages the points between the cursor borders to come up with a single value. The 3D image is leveled using the trace line along the x-axis and the averaged value for the leveling cursor.

Each cursor is color coded with a right and left side and progressively higher headers that help the user to set them in their proper order. All four lines can be used for leveling. The left line (shorter cursor border) of each color set is the left cursor border. This keeps the lines identifiable so they are not placed out of order. It is important that the lines be kept in order.

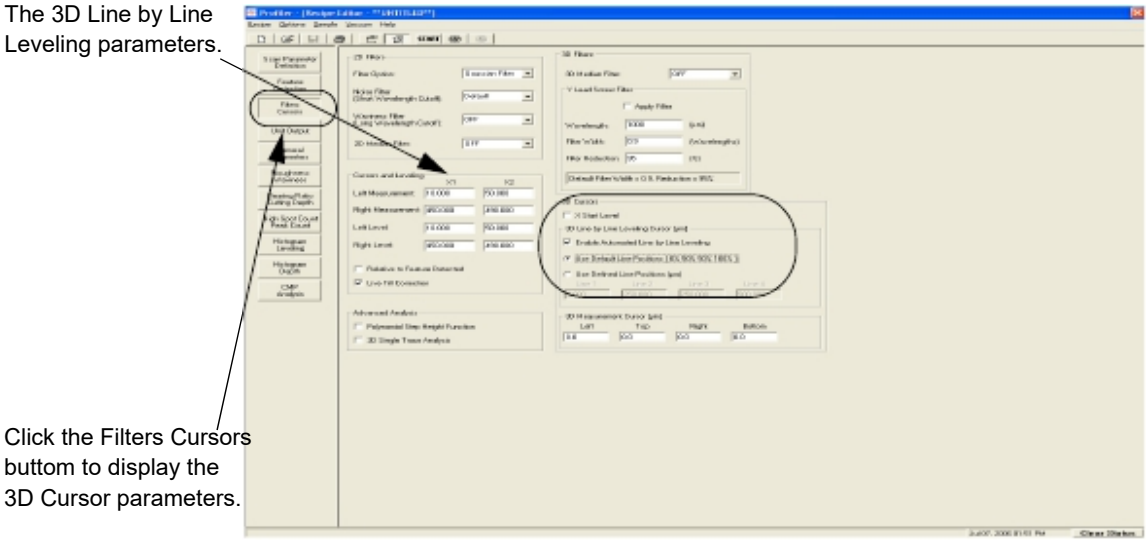
Activating Line Leveling

Opening the 3D Cursor Parameters Window

Line-by-Line Leveling is activated in the Recipe Editor. It is used only in 3D images and is only accessible through a 3D recipe.

After opening the 3D scan data in the data analysis window, select **Edit Recipe** to open the data analysis parameters for that data, as shown in *Figure 7.19*.

Figure 7.19 *Recipe Editor - 3D Cursors Window*

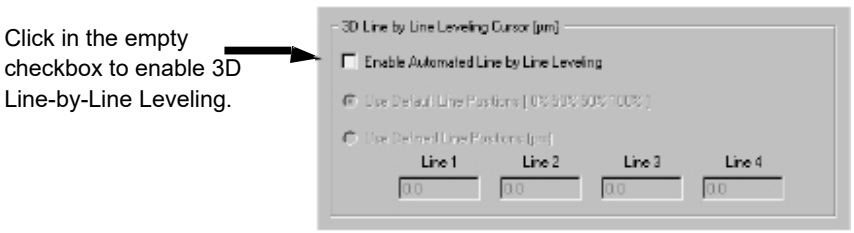


Enabling 3D Line-by-Line Parameters

The 3D Line-by-Line Leveling option is enabled by putting a check in the **Enable Automated Line by Line Leveling** checkbox. After the option is enabled, the user can choose between two leveling options, or manually set the cursors in the Analysis screen after the scan.

Enable the 3D Line-by-Line Leveling by clicking in the empty **Enable Automated Line by Line Leveling** checkbox to put a check in it. (See *Figure 7.20.*)

Figure 7.20 *3D Line by Line Leveling Cursor Parameters*



After the Line-by-Line Leveling is enabled, the two leveling options are also active so one or the other can be enabled. Clicking in the empty radio button toggles between the options.

Use Default Line Position [0% 50% 50% 100%]

This option can be used best when scanning a sample with uniform texture typical of film roughness scans. This function operates best when there are known flat regions throughout the Y axis direction. This preset option automatically levels the scan by placing the left cursor's left border at the origin of the scan, the left cursor's right border at the mid point of the scan, the right cursor's left border also at the midpoint of the scan, and the right cursor's right border at the end point of the scan.

Use Defined Line Positions

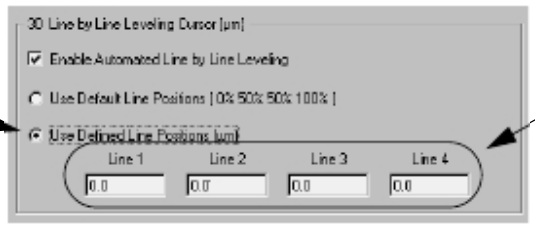
The Defined Line Positions can be set in two ways:

- The operator chooses **Use Defined Line Positions** as the leveling tool. The operator manually enters (sets) the positions of the cursors in microns. These settings are between 0 µm and the number of microns in the scan length, as defined in the recipe.
- The operator can enable line-by-line leveling and choose **Use Defined Line Positions** as the leveling tool. The operator then either runs the scan to obtain the data, or opens saved data that used the same recipe. The Line-by-Line procedure is used to level the data and the data is saved. Once saved, the positions of the newly placed cursor lines is displayed in the recipe.

Manual Entry of Line Position in Line Field

1. Follow the instruction in *Opening the 3D Cursor Parameters Window* on page 7-32.
2. In the 3D Cursor Parameters window, ensure that **Enable Automated Line by Line Leveling** is enabled. (See *Figure 7.21*.)
3. Click the empty radio button next to **Use Defined Line Positions** to enable it. (See *Figure 7.21*.)

Figure 7.21 *3D Line by Line Leveling Cursor Field*



Step 3 Choose **Use Defined Line Positions**

Either:
Manually enter positions in each field.
OR
Manually position the line cursors on the image in Analysis screen.

Once **Use Defined Line Positions** is enabled, the four Line fields become active.

4. If the positions for the line spacing is known, enter the respective positions in each of the fields. Remember the following when entering the position:
   - The units are microns (µm).
   - The range is [0 µm to (Length of scan) µm] (length as defined in the scan recipe being used).
   - **0** ≤ **Line 1** position < **Line 2** position < **Line 3** position < **Line 4** position ≤ **Scan Length**
   - If the cursor line entries fall outside the scan limits, the system automatically adjusts the cursors according to the sequential priority in the above bullet.

Manually Position Line Cursors on Image to Enter Line Position

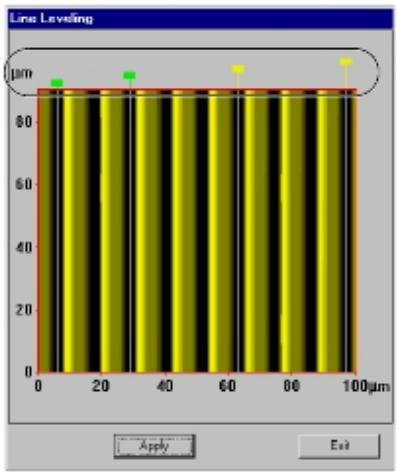
1. Run the scan using the recipe that is modified as illustrated in *Figure 7.21*.
2. From the Analysis screen choose Operations in the Menu Bar.
3. Select Line Leveling from the Operations menu.

   The graphic display of the data appear midscreen in the top view with the four line cursors in place at opposite borders of the image.
4. Click and drag each line to its required position. All four line cursors must be on the same plane for the data to be properly leveled. (See *Figure 7.22*.)

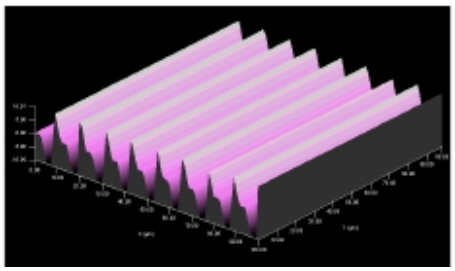
Figure 7.22 *Line Leveling Top View Analysis Screen*

Step 4 Click and drag lines to the required positions.

Notice that all the cursor lines are set to level on the same plane.



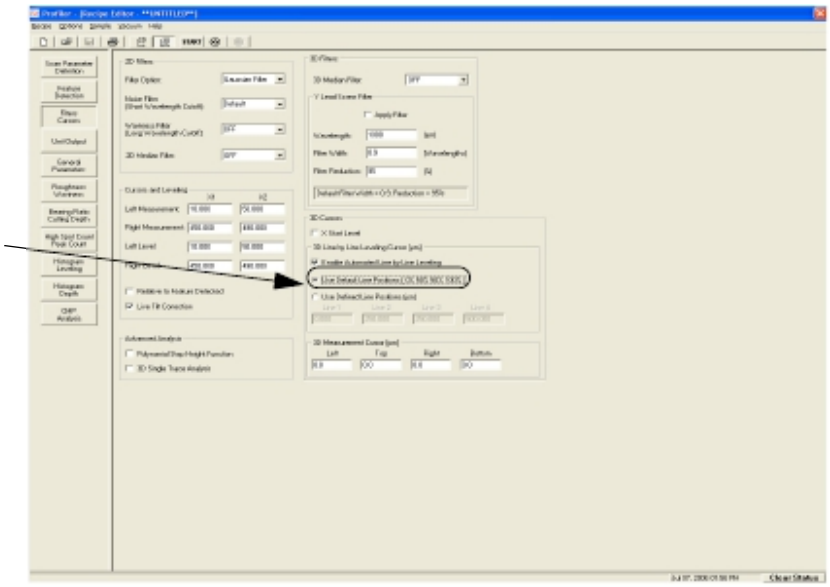
If necessary, view the same image from a different perspective so positioning cursors is easier.



5. It is not necessary to save the data for the new cursor position to be recorded in the recipe.
6. To observe the recipe, click **Edit** in the Menu Bar to display its menu.
7. Select **Recipe** from the Edit menu to return to the Recipe Editor.

8. In the Recipe Editor, click the **Filters Cursors** button at the bottom of the parameter window icon column. (See *Figure 7.23*.)

Figure 7.23 *Recipe Editor with 3D Cursors Window Displayed*



CUSTOMIZING THE SCAN IMAGE

Setting the Image Proportions

1. Go to the **View** menu, and select **Change**.

   The **View Properties** dialog box appears.

2. Type a number that gives an appropriate value for the image height in Data Height Mag. (See *Table 7.10 on page 7-22*, View Properties.)

   Since the number depends on the relative heights of the features in the image, select a higher value to obtain a taller image, a smaller value to reduce it. Click **OK**.

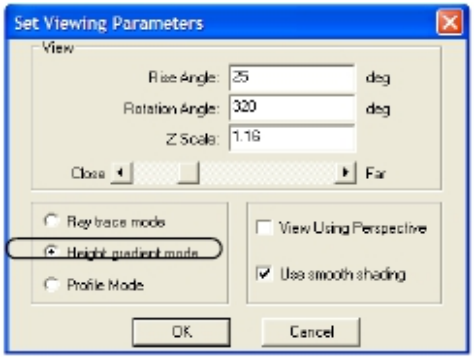
Setting the Shading Mode

1. In the View menu, click **Change...**
2. In the **Change...** menu, click **View Properties**.

   The **Set Viewing Parameters** dialog box appears.

Figure 7.24 *Set Viewing Parameters Dialog Box*

Shading mode options. Chose the one that best fits the requirements by clicking in its empty radio button.



CUSTOMIZING THE VIEW

Changing the Image Colors

1. Go to the **View** menu, and select **Change...**
2. Click **Display Color**.
3. Select a color from the palette or create a custom color.

   Saving the scan file also saves custom colors. (See *Table 7.10 on page 7-22*.)
4. Click **OK** to close the dialog box and apply the choice.

Changing the Scan Height Colors

Images can be color-coded and displayed in the Height Gradient Mode format to better delineate height features. The Highlight feature allows the user to define a highlight plane to bring out certain features of the image.

1. Go to the **View** menu, and select **Highlight**.

   A dialog box appears with the minimum and maximum heights obtained in the scan.
2. Go to the **Plane Height** entry field, and type the desired height.
3. Click **Set Headlight Plane Color**.
4. Select a color from the palette or create a custom color.
5. Click **OK**.
6. If desired, repeat to define additional planes.

Removing Banding with Line Leveling

Line leveling can be used to remove banding caused by environmental signal drift with each successive trace in a 3D scan baseline. Line leveling calculates corrections by comparing line segments line-by-line rather than by averaging areas. Line leveling should generally be used when calculating 3D roughness, area, volume, and other parameters.

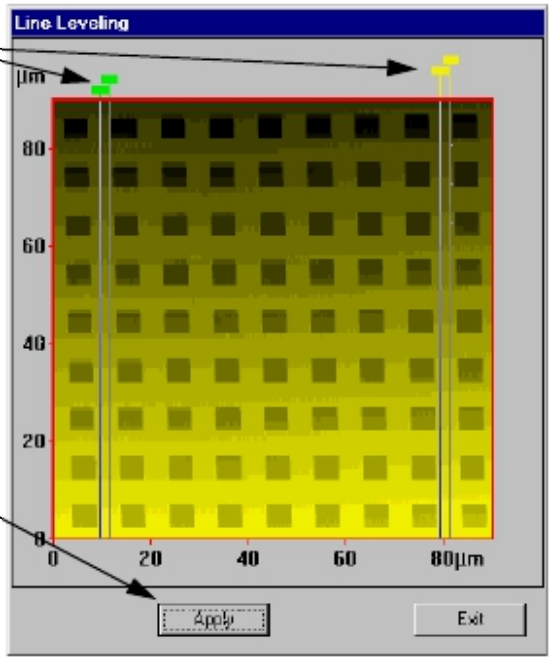
1. Click **Operations** in the Analysis screen menu bar.
2. Click **Line Level...**
3. Go to the **Operations** menu, and select **Line Level**.

   The dialog box appears (see *Figure 7.25*).

Figure 7.25 *Line Leveling Dialog Box After Cursors Positioned*

Step 4 The cursors in this illustration must be placed close together to ensure that they are covering the same plane.

Step 5 After the cursors are set, click **Apply** to preview the results.



4. Click and drag the lines of each pair of boundary cursors to define segments of the scan lines on the same plane.

   Do not include features, only flat areas (see *Figure 7.25* for placement of cursors). Notice that in the image, the lines must be vary close together in order to keep from including unwanted features.

   The instrument compares the bounded segments and calculates an average baseline for the scan.
5. Click the **Apply** button to preview the results. The **Undo** button become active.
6. Click the **Exit** button to return to the scan data window and view the results on the scan image.
7. If the new leveling is to be retained, it must be saved. If the screen is closed without saving, the changes are lost.

USING IMAGE ARITHMETIC TO COMPARE DATA

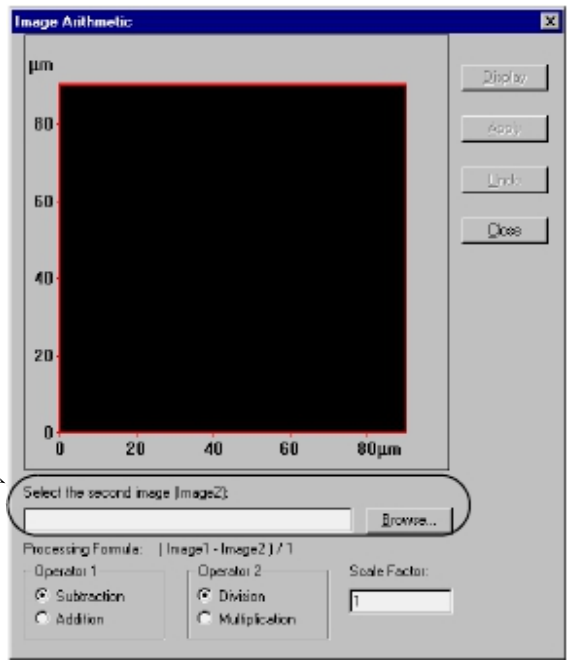
Two 3D scans can be compared with similar surfaces or the same site to evaluate noise and roughness. Both scans must use the same recipe:

- Recipe
- X-size and Y-size

1. Open the data file that is to be use in the calculations. This is **Image 1.**
2. Go to the **Operations** menu, and select **Image Arithmetic**.

   The dialog box appears (see *Figure 7.26*)

Figure 7.26 *Image Arithmetic Dialog Box*



Step 3 Enter the name of the second image or click the **Browse...** button to search for the image.

3. Type in the name of the second image or Browse for the second image.

   The second image must have used the same recipe as the first image, and it must be the same size.
4. Press **ENTER**, or click the **Display** button.

   The second image appears in the display area in the dialog box.

5. Go to the **Operator** panels, and click e of the buttons for:
   - Subtraction or addition
   - Division or multiplication

   The Processing Formula above the panels displays the selection.
   - Scale Factor sets the value for Operator 2.
   - If division or subtraction are not being performed on the data, go to the **Scale Factor** field, and enter **1**.
6. Click the **Apply** button to perform the operations.
7. To revise the operations and recalculate, click the **Undo** button.
8. When the results are satisfactory, click the **Close** button.

   A Save message dialog box appears.
9. Click **OK** to save the resulting image.

SAVING SCAN DATA

Scan data can be saved for reviewing at a later time. This is especially important because the data that is saved, using software version 6.1 or newer, can be reanalyzed at a later date using different scan parameters.

In addition to saving the 3D data, current slice data can be save. This procedure is covered at the end of this section.

Saving 3D Scan Data

1. Click **File** in the Menu Bar to display the File menu.
2. Select **Save Data…**

   The Save Scan Data dialog box appears.
3. Click the menu arrow next to **Save In** to reveal the available drives and directories.
4. Select the drive and directory from the drop-down menu.
5. Double-click the folder that the data is to be stored in. A list of all current data files appear.
6. Enter a name for the data set in the File name variable box.
7. Click **Save** to save the data in the new file.

   Once a data set has been saved, it is added to the Scan Data catalog. The Scan Data catalog window allows selection of individual data sets for reviewing. Unwanted data sets can be deleted.

Creating and Saving 2D Slice Data from a 3D Scan

1. From the **Analysis Screen**, click the hammer tool to activate the tool bar.

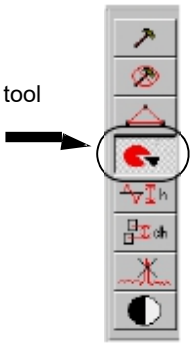
Figure 7.27 *Analysis Screen - Analysis Tool Bar*

Step 1 Click the hammer icon to activate the tool bar function.

2. In the activated tool bar, click the slice tool to activate the slice tool.

Figure 7.28 *3D Analysis Tool Bar with Slice Tool Activated*

Step 2 Click the slice tool to activate it.



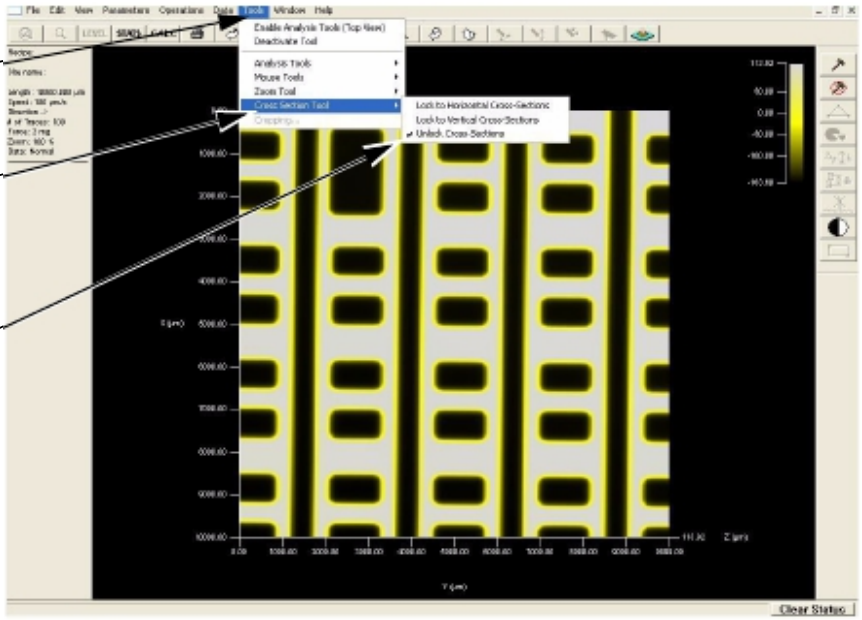
3. Choose the desired slice direction. Click Tools to display its menu. (See *Figure 7.29*.)

Figure 7.29 *Analysis Screen with View*

Step 3 Click **Tools** to display its menu.

Step 4 Click **Cross Section Tool** to display its menu.

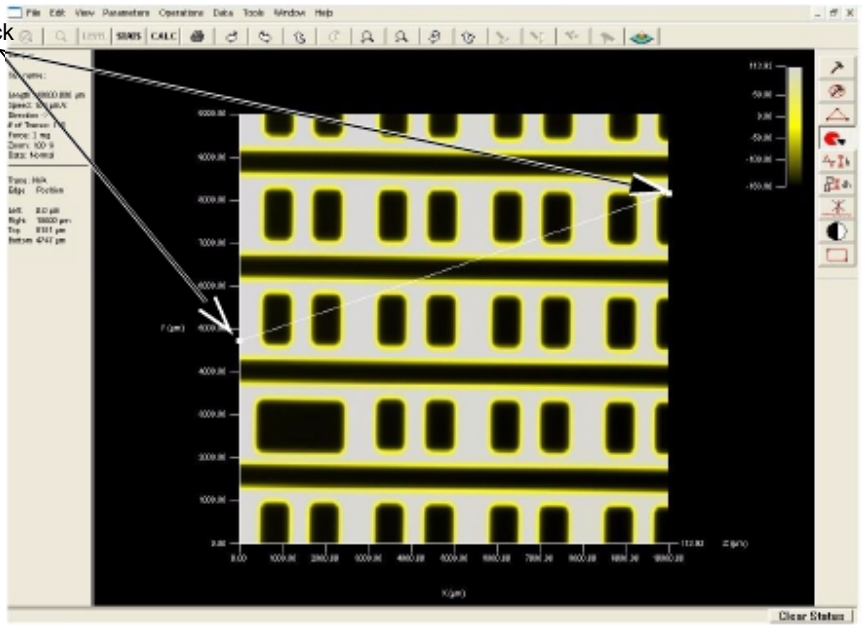
Step 5 Choose the desired slice direction. **Unlock Cross-Section** is chosen, making any direction slice possible.



4. Select Cross Section Tool from the Tools menu to display its menu. (See *Figure 7.29*.)
5. Choose the desired cross section tool for the slice direction. (See *Figure 7.29*.)
6. For the **Horizontal** and **Vertical** tools, click and drag the slice line to the desired location on the 3D image to display the 2D trace of the scan at that location. For the **Unlock Cross-Section** tool, click and drag the slice line end points to the desired location on the border of the image as seen in *Figure 7.30*.

Figure 7.30 *Analysis Screen with Slice Tool Active*

Step 6 To create the slice, click and drag the endpoints of the unlocked slice tool or the line segment of the vertical or horizontal slice tools.

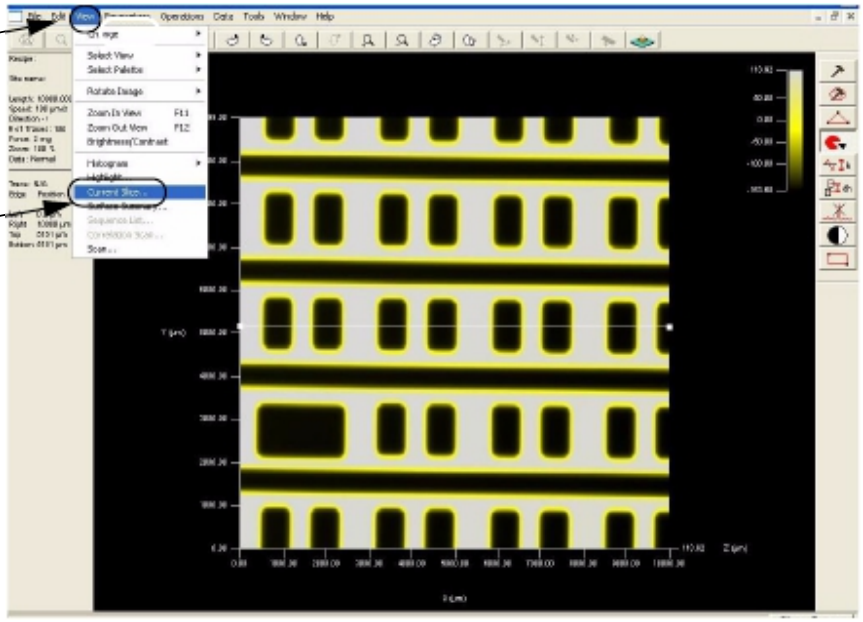


7. When the slice line has been placed, click **View** in the menu bar to display its menu. (See *Figure 7.31*.)
8. Choose **Current Slice…** to display the 2D slice trace. (See *Figure 7.31*.)

Figure 7.31 *Analysis Screen with Both 2D and 3D Images*

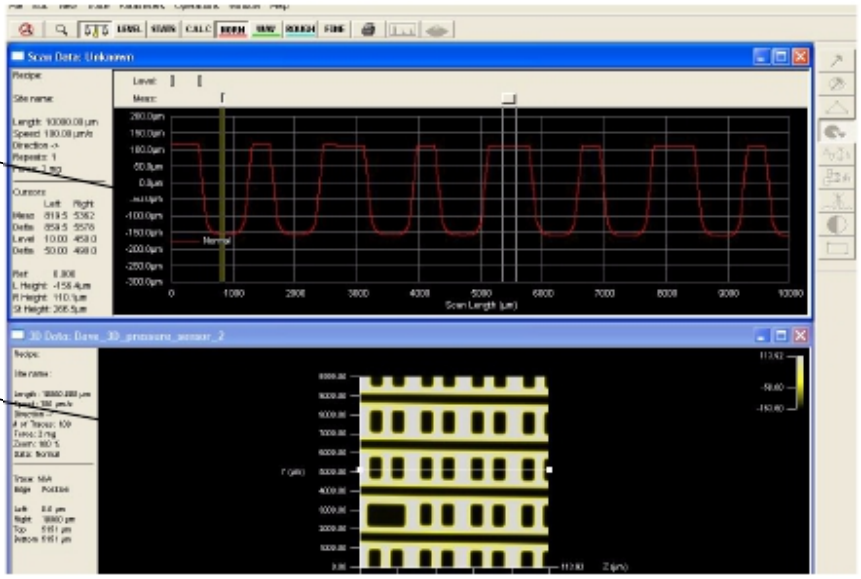
Step 7 With the slice tool placed, click **View** in the menu bar to display its menu.

Step 8 Choose **Current Slice…** from the menu.



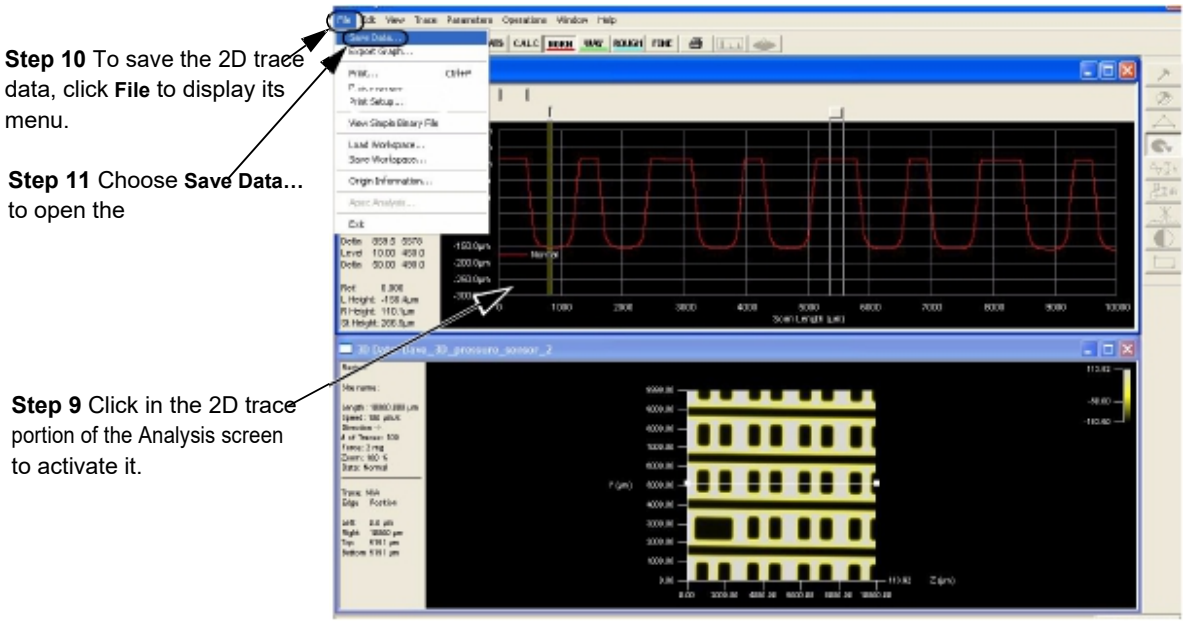
If the Window option is set to Tile Horizontal then the image is displayed as illustrated in *Figure 7.32*. The 2D slice trace is displayed above the 3D image. The 3D image is shown with the slice tool placed across the image at the place where the 2D image is generated.

Figure 7.32 *Analysis Screen with Both 2D and 3D Images*



9. To save the 2D trace data from the 3D scan, click in the 2D trace portion of the Analysis screen to activate it.

Figure 7.33 *Analysis Window with File Menu*



10. To save the 2D slice data click **File** to display is menu. (See *Figure 7.33*.)
11. Choose **Save Data...** to display is dialog box. (See *Figure 7.33*.) This displays the Save Scan Data dialog box. It should be set up to save 2D data as shown by the data type "Scan Data Files (*.dat)" in the **Save as type:** field.
12. Click the down-arrow next to **Save In** to reveal the available drives and directories.
13. Select the drive and directory from the drop-down menu.
14. Double-click the folder that the data is to be stored in. A list of all current data files appear.
15. Enter a name for the data set in the File name variable box.
16. Click **Save** to save the data in the new file.

    Once a data set has been saved, it is added to the Scan Data catalog. The Scan Data catalog window allows selection of individual data sets for reviewing. 2D slice data saved from a 3D scan can be reevaluated in the Analysis screen by changing the recipe parameters and performing a recalculation of the information. Unwanted data sets can be deleted.

APEX 2D/3D - GETTING STARTED

INTRODUCTION

This appendix provides information about configuring Apex 2D/3D to work with the Profiler system.

LICENCE AGREEMENT

- The copyright laws and international treaties, as well as other intellectual property laws and treaties protect the software product
- The software product is licensed as a single product. Its component parts may not be separated for use on more than one computer.
- You may not reverse engineer, decompile, or disassemble the software product.
- The source code was designed and developed by Digital Surf and is the property of Digital Surf, France.
- Apex 2D and Apex 3D are Trademarks of KLA-Tencor Corp.

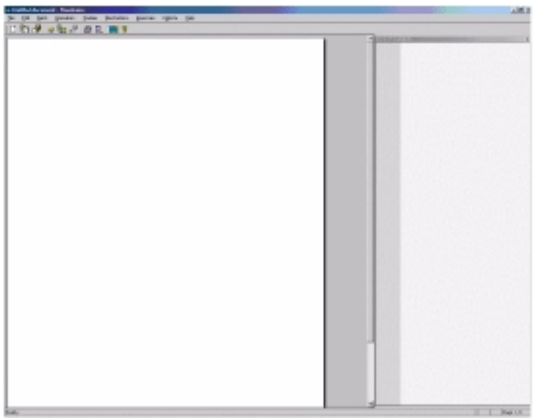
OVERVIEW OF APEX 2D/3D

Starting the Software

To start the software, click the shortcut on the desktop, or click **Program Files >Digital Surf >Apex** in the **Start** Menu.

The program displays an empty document (below).

Figure 8.1 *Empty Document*



Loading a Studiable

Studiable is a word that refers to all data (2D profile, 3D surface...) that can be studied and that can be stored in a file. Apex can load files from a large number of measurement instruments.

See *www.digitalsurf.fr/en/mntformats.htm* for more information.

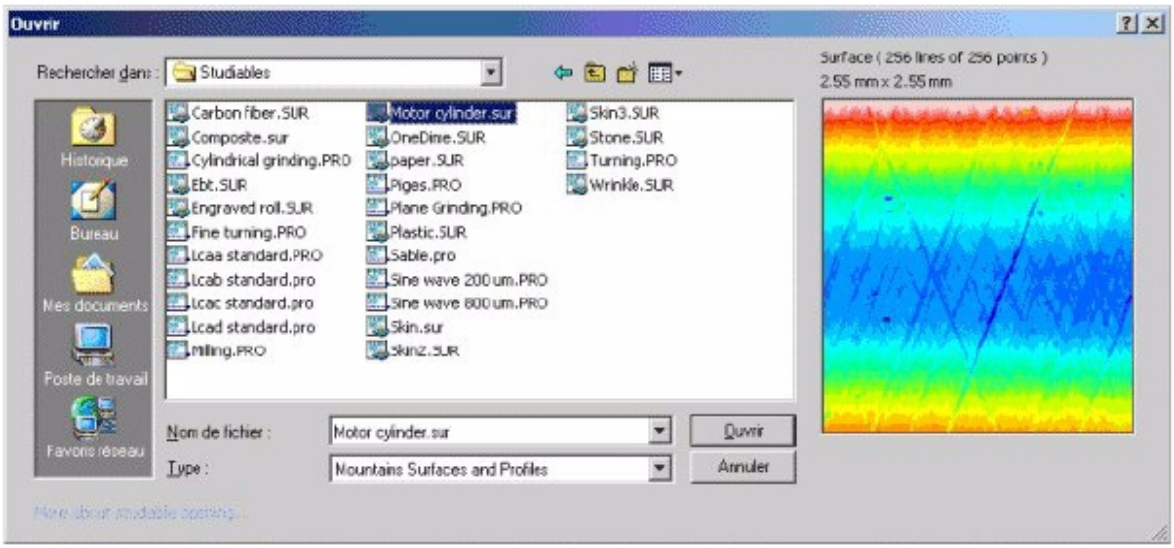
Click **File >Open,** or click the **Open Studiable** button in the general toolbar.

The general toolbar at the top of the screen is available when you click the background of the document. (See below.)

Figure 8.2 *General Toolbar*

Navigate to the **Samples** folder in the installation directory of the software, and click **Studiables**. Select one of the **.sur** or **.pro** files, for example **Motor cylinder.sur**, and open it.

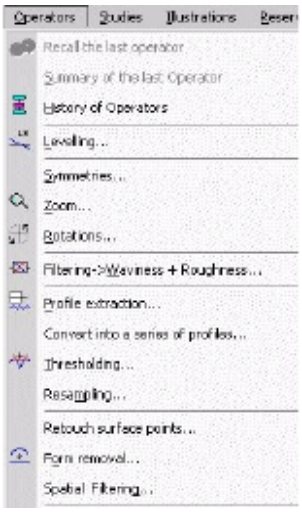
Figure 8.3 *Studiables Directory*



The **.sur** file extensions are 3-dimensional surface files, whereas **.pro** file extension are 2-dimensional profile files.

The studiable is displayed in a reserve at the top left side of the document.

Applying an Operator or Carrying out a Study

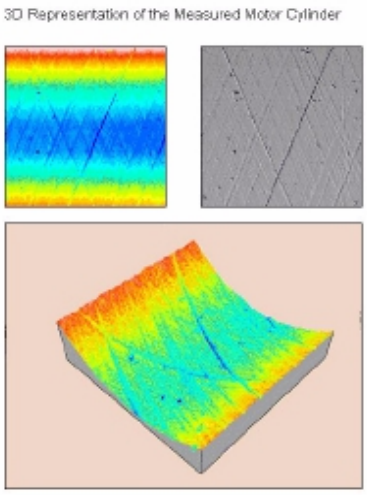


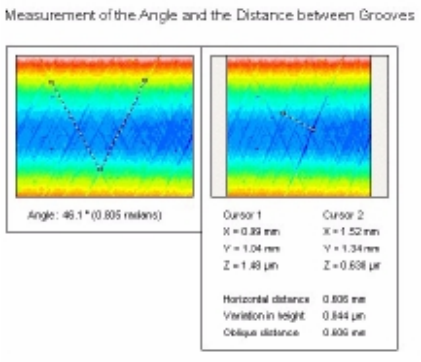
An **operator** is a mathematical **operation** that is applied to a studiable and generates one or more new studiables.
To apply an operator, select any studiable (by clicking on it so that its border is displayed as a dotted blue line), then select an operator from the Operators menu (for example Zoom, Levelling, Roughness/waviness filtering, Form removal operator...).

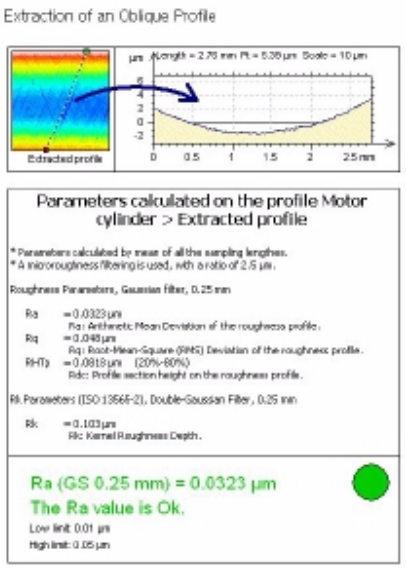
A **study** is a **graphical representation** of a studiable (for example, 3D representation of a surface...) or an **analysis** done on a studiable (calculation of the Ra parameter...)
To apply a study, select any studiable, then select a study from the Studies menu.
For complete info on how to use Apex, go to the **Help Menu** and click **Help Topics**.

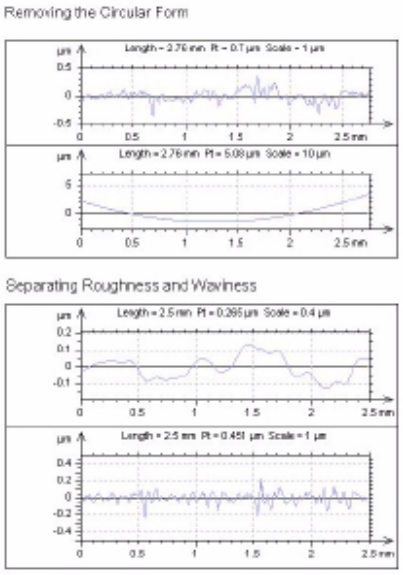
Building an Analysis Document

Apex contains all the tools needed to build and lay out a complete **Analysis Document** in a straightforward way.









STRESS (OPTIONAL FEATURE)

Introduction

Stress can be generated in the film and wafer as a result of film deposition. Dissimilar thermal expansion coefficients of films can create bending and compressing, or expansion of the substrate surface. Careful monitoring of film stress data is useful for reducing process variation.

The KLA-Tencor Wafer Stress application option provides a tool for measuring the wafer curvature at the wafer surface so calculations can be made regarding the stress generated by a deposited film. This is accomplished by creating a reference scan before deposition, and comparing it with the post deposition scan of the same wafer, in the same position, using the same scan recipe.

2D stress is generated for P-16 and P-17, and 3D stress is generated for P-17 only due to motorized theta available on P-17.

THEORY

Stoney Equation

The Stoney equation for stress in a thin-film layer deposited on a substrate is as follows:

$$\sigma = \frac{1}{6K(1-\nu)t_f}\frac{E}{}\frac{t_s^2}{}$$

where

$$\frac{E}{(1-\nu)} = \text{Biaxial Elastic Modulus of the substrate}$$

σ = stress

t_s = wafer thickness

t_f = film thickness

E = Young's Modulus for the wafer (substrate)

ν = Poisson's Ratio

K= change in the radius of curvature

$$\frac{1}{K} = \frac{1}{(R_f(X))} - \frac{1}{(R_s(X))}$$

R = radius of curvature

As a profile is taken, the height of the wafer is being measured as a function of position:

$$Z = f(x)$$

where

$$R(x) = \frac{[1 + ((dZ)/dx)^2]^{3/2}}{(d^2Z)/dx^2}$$

.

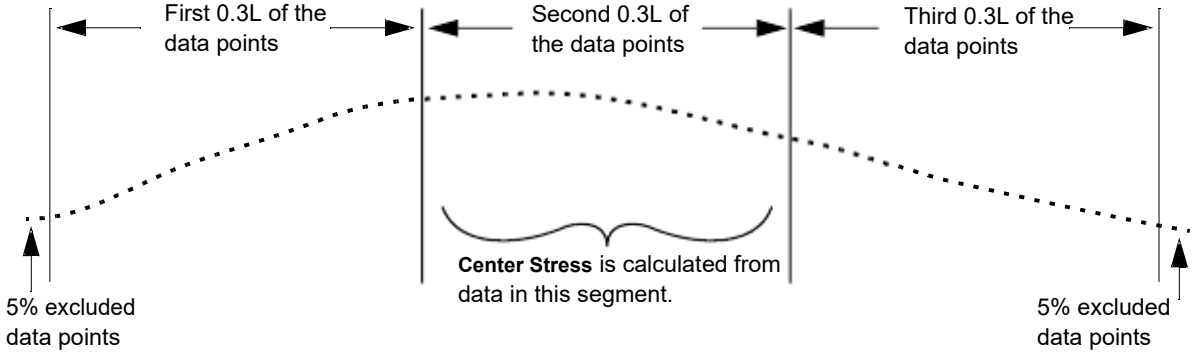
Two methods are available to obtain $Z = f(x)$ from the profile: The least square fit (13 Point Least Square Fit), and the polynomial fit. The recommended algorithm is the Polynomial Fit. This algorithm produces the best repeatability of the two available methods, since it best "maps" to the data collected. The calculation provides three polynomial order options, 5th, 6th, and 7th order. For the best repeatable results, use the 5th order polynomial fit.

NOTE: For comparison to a Flexus Stress Measurement tool, use 13-point least square fit, and the average stress result.

The KLA-Tencor Profiler software calculates the following stress values:

- Average Stress — The average stress of the profile data, excluding 5% of the fit data on either end.
- Maximum Stress — The maximum absolute stress of the profile.
- Center Stress — Stress at the midpoint of the profile data.

Figure 9.1 *Stress Calculation Regions*



Polynomial Fit

The Polynomial Fit uses the entire data set. It is important to note that higher order polynomials (6th and 7th) might result in fitting data to local irregularities. The polynomial fitting procedure is as follows:

A function **y = f(x)** can be expressed in terms of a polynomial order **n** as

y = c0 + c1x + c2x2 +…+ cnxn

As illustrated above, n + 1 coefficients exist for polynomial n. After the value of the coefficients are computed, the new y values for different values of x can be computed.

EXAMPLE:

In the actual polynomial fit algorithm, a 5th, 6th, or 7th order polynomial is used for the calculation. In this example, a 3rd order polynomial is going to be used for the purpose of illustrating the process of fitting a polynomial.

The general equation for a 3rd order polynomial is:

y = c0 + c1x + c2x2 + c3x3

To compute the coefficients 4 equations are required to compute the 4 unknowns. The 4 equations are generated by multiplying the above equation by the coefficients of **c3, c2, c1, and c0.**

x3y = c0x3 + c1x4 + c2x5 + c3x6

x2y = c0x2 + c1x3 + c2x4 + c3x5

xy = c0x + c1x2 + c2x3 + c3x4

y = c0 + c1x + c2x2 + c3x3

The next step is to solve this set of simultaneous equations to find the values of **c3, c2, c1, and c0.** Crout's method is used here to solve this.

When the coefficients have been calculated, the new values for y are computed for different values of x. The radius of curvature is calculated for any value of x using the following formula:

$$R(x) = \left[\frac{1 + ((dY)/dx)^2}{(d^2Y)/dx^2}\right]^{3/2}$$

where,

$dY/dx = 3c_3x^2 + 2c_2x + c_1$ and $d^2Y/dx^2 = 6c_3x = 2c_2$

The calculated radius is then used to calculate stress using the stress formula presented at the beginning of this section.

Least Square Fit

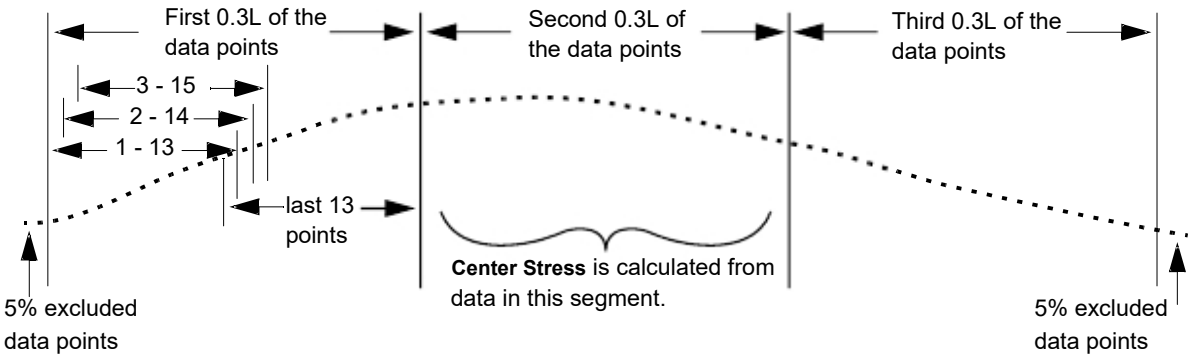
The Least Square Fit method is more complicated than the Polynomial Fit method. It consists of fitting local sections of data to circular arcs and computing the mean radius from the local radius of curvature. This is more susceptible to noise variations and fine surface geometries, making it less robust.

NOTE: The Least Square Fit method is provided so that users can correlate stress results with old generation profilers where it was the default algorithm used for stress. In addition, KLA-Tencor Flexus systems use this method to calculate the radius.

Explanation: The **13 Point Least Square Fit** algorithm immediately disregards the beginning and ending 5% of the data points. It then divides the remaining scan length into three identical lengths of 0.3L (L equals the scan length). (See *Figure 9.2*.)

Within each 0.3L section, the local radius of curvature is calculated for each set of 13 data points in the section. Starting with the first data point, it calculates the local radius for the first 13 points (1-13). Then the calculation is made for the second set of 13 points (2-14). (See *Figure 9.2*.) This continues until data point N-12 of the section where it calculates the last point (N = total data points in the section).

Figure 9.2 *13 Point Least Square Fit Calculation Illustration*



The average radius of each 0.3L segment is the mean of the local radii. The stress is calculated for each 0.3L segment based on the mean radius of that section. The Average Stress and the Max Stress reflect the mean and maximum stress of all the segment stress calculations. The Center Stress is the stress calculated from the mean radius of the center 0.3L segment. (See *Figure 9.2*.)

THE 2D STRESS APPLICATION WINDOW (P-17 AND P-7)

The Stress Screen Tool Bar

The Stress Screen tool bar shows all icons available in stress analysis. Icons are enabled or disabled (grayed) when they do not apply. For example, the start button is only available when the scan can be started in the stress recipe catalog.

Table 9.1 *Tool Bar Icons*

Button	Action
	Invokes the Stress Recipe Editor to add a new stress recipe.
	This icon is only active if there is a change in a recipe or for saving a new recipe. It saves changes to the current file.
	Displays the Print dialog box for printing data on the current screen.
	UnZoom removes the affect of the previous Zoom.
	Zoom Mode (toggle) allows for higher resolution of the Y axis.
	AutoScale On/Off (toggle) changes Y axis scale automatically to keep the full scan in view.
	Level (toggle) Levels the scan to adjust for chuck planarity.
	Starts a scan using the current stress recipe.
	Toggles to the XY View screen.
	Enables 2D stress measurements.
	Enables 3D stress measurements.

Stress Recipe Catalog

This section describes the various parts of the Stress Recipe Catalog screen and the function of the stress recipe related buttons.

- **Print** Prints the list of recipes.
- **View/Modify** Opens the Stress Recipe Editor for the currently highlighted recipe.
- **Start** Initiates a stress scan using the currently highlighted recipe.
- **Delete** Deletes the currently highlighted recipe from the recipe list.

Stress Scan Data File Catalog

This section describes the various parts of the Stress Data Catalog screen and the function of the data file related buttons.

- **Review** Opens the Stress Analysis screen to view the data in the highlighted data file.
- **Delete** Deletes the currently highlighted stress data set.
- Calculation functions:
  - **Set Pre** Makes the currently highlighted data file the pre-stress scan.
  - **Set Post** Makes the currently highlighted data file the post-stress scan.
  - After both pre- and post-stress data files are chosen, click the **Calculate** button to perform the stress calculation.

NOTE: The recipe used to collect the data must exist in the stress recipe catalog. If it has been deleted, then the stress cannot be calculated.

CREATING A STRESS RECIPE

Number of Stress Points

Ignore this number. This number was used with the **Least Square Fit** calculation procedure. The calculations related to this procedure are described in the introduction to this chapter. This number belongs to legacy software and has no effect on any calculation.

Scan Start Position

This is the start position on the wafer X-, Y-coordinates. If the proper procedure was used for wafer placement on the stress locator, this setting ensures that the pre- and post-processing scans are performed at the same location on the wafer.

NOTE: If the wafer needs to be rotated, enter the XY View screen, rotate the wafer, exit the XY View screen, then enter new coordinates. If the system has a handler, it is best to use the pre-aligner to load the wafer at the correct angle.

Scan Parameters

The Scan Parameters allow the user to set the scan length, speed, sampling rate and applied force. Each of these parameters affects the outcome of the stress calculation.

Scan Length: For general purposes, the longer the scan, the more accurate are the results. KLA-Tencor recommends scanning 80% of the wafer diameter to determine the stress.

EXAMPLE:

When measuring stress for an eight inch wafer (200000 µm), the scan should be 160000 µm long. The scan start position would be:
X = -80000, Y = 0. It should end at X = 80000, Y = 0.

Scan Speed: Scan speed often works in concert with Applied Force. If the speed is too high with a very light Applied Force, the stylus will remain above the wafer, leading to inaccurate results.(See Stylus Force below.) For long stress scans, it is recommended that the scan speed be 10000 µm/s or less, with 2000 µm/s - 5000 µm/s being optimum.

Sampling Rate: This is the number of data points collected as a function of time. For a set sampling rate, as the scan speed increases, the data points are spaced further apart.

Stylus Force (Applied Force): Applied Force is the force exerted on the sample surface by the stylus tip. As the force increases, the greater the potential for damage to the sample surface and to the tip itself.

Also, for a constant force, as the tip radius decreases, the pressure applied increases. Since stress is measuring the waviness of the wafer and not small features on the wafer, a larger tip radius is recommended.

For these reasons, a 2 µm tip or larger should be used. The larger tip allows for a greater Applied Force and a faster scan speed without danger to the tip or sample surface. The recommended force setting for a long fast scan using a 2 µm stylus is 1 to 2 mg.

Substrate Specification

The Substrate settings refer to the wafer composition and thickness. Each type of substrate has a biaxial modulus that is required for the stress calculation. The software is pre-programmed with the **Modulus** for common substrates. The user must enter the substrate **Thickness** by entering the new thickness in microns (µm). If the user is measuring a substrate that is not listed, the user can choose **None** from the list of substrates and enter the modulus and thickness.

The following is a list of common substrates and their corresponding modulus. The Orientation is the crystalline orientation of the substrate being tested.

Table 9.2 *Elastic Constant of Substrates*

Substrate Material	Orientation	Elastic Constants (10^{11}Pa)
Aluminum	n/a	1.030
Aluminum Oxide (Al_2O_3)	amorphous	3.835
Aluminum Oxide (Al_2O_3)	amorphous	4.895
Aluminum Nitride (AlN)	amorphous	4.367
Beryllium Oxide (BeO)	amorphous	4.367
Borophosphosilicate (BPSG) Glass	amorphous	1.500
Gallium Arsenide (GaAs)	111	1.741
Gallium Arsenide (GaAs)	100	1.239
Germanium (Ge)	111	1.837
Germanium (Ge)	100	1.420
Phosphosilicate (PSG) Glass	amorphous	0.988
Quartz	amorphous	0.850
Sapphire	amorphous	4.080
Silicon	111	2.290
Silicon	100	1.805
Sodalime glass (Corning microsheet 0211)	amorphous	0.973

CREATING STRESS DATA

Load a Wafer on the Stress Locator

It is essential that the wafer be placed in the same place, in the same orientation on the stage, for both the pre- and post-stress scans. It is also very important that the wafer be supported on three points. If the wafer rests flat on the stage, its weight could create deformation that could distort the stress data. For these reasons it is essential that the stage be equipped with a stress precision locator.

Loading Wafers

The system might come with one of the two stress locators. Check the stress locator received with the system against the image displayed in *Figure 9.3*.

The stress measurement procedure depends on a pre-processing scan of the same wafer that is subsequently measured after processing. The two scans are then compared and a stress calculation is performed by the system. For the results to be meaningful, the scan must be taken of the identical location on the same wafer, before and after processing. Therefore it is critical to load the wafer in the same orientation for the pre and post stress scans.

This procedure assumes that the precision locator is in place on the sample stage.

Load Wafer - Manual Procedure

Begin: (Manual) Load Wafer Procedure

1. From the **Catalog** screen, click the **Stress** icon. This opens the Stress catalog screen displaying the Stress Recipe list.
2. From the **Sample** menu choose **Manual Load**. This moves the sample stage to the stage door. Do not open the stage door until the stage stops.

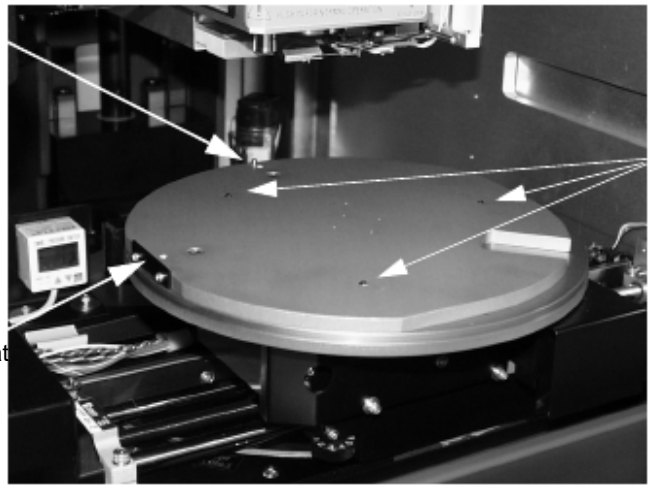
CAUTION: Do not operate the stage or elevator with the stage door open. If the stage or elevator is activated with the stage door open, the system door interlock causes the system to cut power to all motors.

3. Open the stage door.

   The figure shown below is for P-17 only. In order to see the locator section for P-17 and P-7, use stress locators of various sample sizes.

Figure 9.3 *Precision Locator on the Stage (P-17)*

Step 4 Place the wafer on the stage with the stage pin in the **notch**.



Three points on which the wafer rests.

Step 4 Position the wafer so that it rests against the **positioning plate**.

4. Place the wafer on the stress precision locator, with the locator pin firmly in the wafer notch, and the left side of the wafer against the positioning plate. This ensures that the wafer is loaded in the correct orientation and location for the pre and post measurements. The wafer rests on the three pins, which are positioned so that the chuck does not change the shape or stress of the wafer. (See *Figure 9.3*.)
5. Close the stage door.

End: (Manual) Load Wafer Procedure

6. From the Sample menu, choose **Manual Load**. This moves the sample stage back under the stylus.
7. Leave the Stress screen open for the next procedure.

Taking a Pre-Stress Scan

In order to create stress data that is accurate and usable, the following must be observed:

- The same wafer must be used for the pre- and post-stress scans.
- The wafer must be positioned in exactly the same place on the stage for both pre- and post-stress scans. This is accomplished through the use of a stress precision locator.
- The pre- and post-stress scans must be performed using the same recipe.

Taking a Post-Stress Scan

Use the same procedure detailed in Taking a Single Pre-Stress Scan. Be sure to name the scan in such a way that it can be distinguished clearly from other scans in regards to pre- or post-stress, substrate, and any other pertinent information.

The scan should:

- Have the same recipe as the pre-stress scan.
- Be made with the wafer placed on the stress locator.
- Be made with wafer in the same orientation on the locator as in the pre-stress scan.

Analyzing Stress Scan Results

Stress analysis is accomplished through the comparison of a pre-stress scan and a post-stress scan. The analysis is not saved, but is instead generated each time the calculations are performed from the original pre and post stress scan data.

Viewing Stress Scan Results

The data can be reviewed by opening a data set. The screen displayed is similar to the scan data analysis screen described earlier in this manual. All data manipulations performed are temporary. It cannot be saved. Leveling is done automatically as part of the stress algorithm, and no additional leveling can be applied.

Stress Scan Analysis Procedure

Analysis can be made by comparing a pre-stress single trace with a post-stress single trace of the same wafer at the same location using the same stress recipe.

1. Select the pre-stress scan from the stress scan data catalog and click **set pre.**
1. Repeat step 1, except choose the post-stress scan and click **set post**

2. When both pre- and post-stress data files are chosen, the **Calculate** button is enabled. Check the recipe shown in the Analysis box and ensure that it matches the recipe used for the pre and post stress scans. The stress cannot be calculated if the recipe name used for the pre and post scans do not match.

NOTE: If an incorrect match is made of recipes between the pre- and post-stress data files, then the stress cannot be calculated. The software only checks to see if the recipe names match. If the user modifies a recipe parameter, such as the scan length, the calculation will proceed, but the results are not necessarily valid.

3. Click **OK** to start the calculation. Enter the **Film Thickness** in microns (µm) then click **OK**.

Analyzing the Results

The results in each category are displayed in MPa and dynes/cm2. In addition, the **R:** in each set of data represents the change in the Radius of Curvature.

NOTE: The method used to calculate the radius of curvature, polynomial or 13-point least squares fit, can be changed in the recipe, then re-calculate the stress with the new method. To do this, exit stress results, and change the radius of curvature calculation method.

Table 9.3 *Stress Calculation Results Box Contents*

Result	Explanation
Stress Designation	**Compressive** Negative value average stress (Ave.) Negative change in radius. Tensile Positive value average stress (Ave.) Positive change in radius.
Ave.	Average stress over the entire scan, derived from the polynomial fit of the entire profile minus 5% on either end.
Max.	Maximum absolute stress over the entire profile
Center	Stress at the center of the profile

Table 9.3 *Stress Calculation Results Box Contents (Continued)*

Result	Explanation
Method	Polynomial Fit or 13 Point Least Square Fit
Polynomial Order	Chosen as part of the Recipe.
Max. Dev.	Maximum Deviation of the fit polynomial from the original profile
Variance	Variance = $(\text{Standard Deviation})^2$
Std. Dev.	Standard Deviation from the Mean

3D STRESS (OPTIONAL FEATURE, P-17 ONLY)

Introduction

In addition to performing 2D stress measurements, the P-17 has the capability to perform full wafer stress measurements, with the aid of Apex software. 3D stress allows the examination of wafer stress over the entire wafer, instead of a single line as with 2D stress analysis. The theory of operation is identical to 2D stress, in which a bare wafer reference scan is taken and then comparing this to a post deposition scan. The stress values are calculated by subtracting the curvature of the "pre-measurement" reference scan from the curvature of the "post-measurement" scan.

Definitions

Some common terms that will be referenced in this chapter are defined in Table 10.1.

Table 10.1 *Common Terms Defined*

Item	Definition
Stress Recipe	Refers to a recipe which once run, the collected data is used for stress related measurements
Stress Recipe Catalog	Current interface database where stress recipes are saved.
Stress Scan Data	Refers to a collected data set that shall be later used for calculating stress related measurements. There is no significant difference between regular profiler scan data and a "stress data" scan in terms of the raw data. Different terminology is used only to indicate such a data scan shall be used for stress related measurements and applications. A stress scan is later identified as a Pre-measurement scan or as a Post-Measurement scan by a user prior to calculating stress results.
Stress Data Catalog	Interface database where stress scan data is saved.
Stress Difference Catalog	Database where stress results shall be saved. Stress results are the processing of a Post-Measurement and a Pre-Measurement.
"Pre-Measurement" Scan	Name given to identify a scan trace derived from a scan taken before film deposition. Also refers to a scan that will be used as reference in comparing a Post deposition scan.
"Post-Measurement" Scan	Name given to identify a scan trace derived from a scan taken after film deposition. Also refers to the scan for which data compared against a Pre-deposition scan.
"Difference" Map	Name given to the map that shows the topographical difference by subtracting the Post-measurement scan from the Pre-measurement scan.
Average Radius of Curvature	The averaged radius of curvature over the entire length of the scan.
Radius of Curvature	The radial value belonging to a radius fit at a user specified location of a profile. This is the Radius of Curvature for the length defined by the measurement cursors.

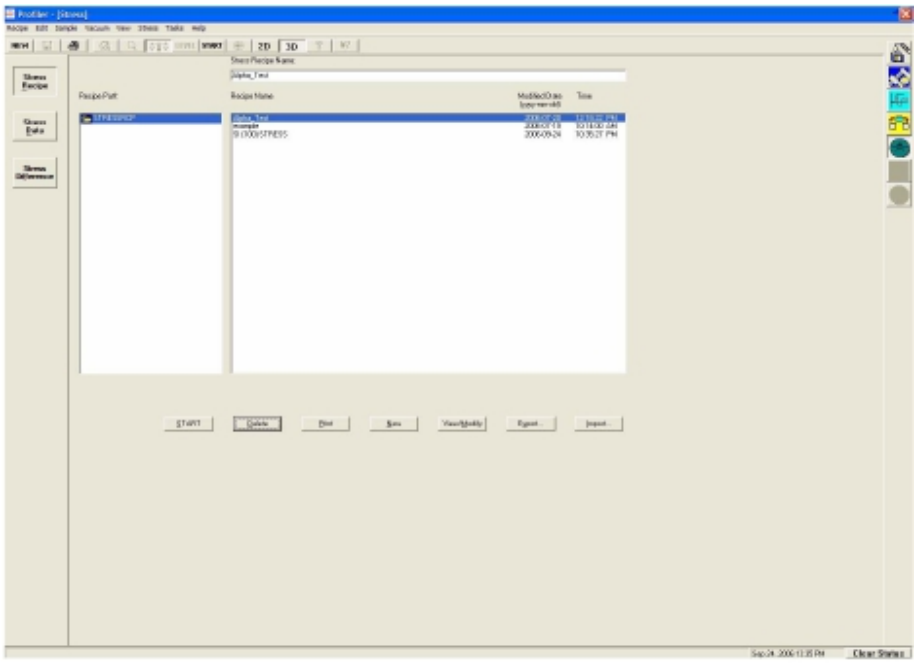
Table 10.1 *Common Terms Defined*

Maximum Deflection	The maximum vertical displacement of a data point from a predefined reference. This reference shall be a flat line between the leveling cursor areas.
Deflection	This is the TIR value between measurement cursors for any stress related scans.
Center, Maximum, and Average Stress	The center, maximum, and average stresses where stress is defined per Stoney's equation of Film Stress based on an algorithm fit through the entire data set. - Center stress: the middle 1/3 of the resulting stress trace - Maximum Stress: the maximum stress measured over the entire resulting stress trace - Average Stress: the average stress measured over the entire resulting stress scan
Local Stress	The average of the stresses measured in between the measurement cursors or the stress value at a given data point based on Stoney's equation by finding the difference in radius between the Post Measurement and the Pre-Measurement.
Radial Scans	Refers to a series of consecutive 2D scans taken automatically by rotating the substrate about its center at user specified theta intervals. The radial scans are then used to create a 3D map of stress, deflection, or radius of curvature.
3D Mesh	The creation of a three-dimensional surface by use of algorithms based on a few Radial Scans taken across user specified intervals on the substrate.
3D-Deflection	Name given to the parameter that identifies the average deflection value determined by a square, circular, or zigzag measurement tool used on a 3D Stress Map.
3D-Radius of Curvature	Name given to the parameter that identifies the average radius of curvature determined by a square, circular, or zigzag measurement tool used on a 3D Stress Map.
3D-Stress	Name given to the parameter that identifies the average stress value within a user specified square, circular, or zigzag measurement tool used on a 3D stress results map.
3D-Stress Delta	Name given to the parameter that identifies the difference in averages of stress, deflection, or radius of curvature values within two user specified square measurement tools used on a 3D stress results map.
Profile Extraction	Refers to 2D cross-section taken from a 3D image.
Zigzag Measurement Tool	Refers to a cursor, whose shape is determined by the user.

The 3D Stress Application Window

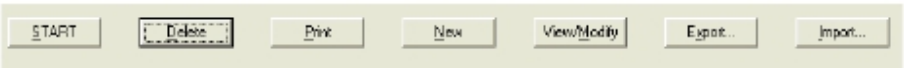
Once 3D Stress has been selected from the stress toolbar, the 3D Stress Catalog will appear, as seen in Figure 10.1. From the 3D Stress Catalog, there are three navigation buttons on the left hand side of the editor. These buttons navigate between the Stress Recipe Catalog, Stress Data, and Stress Difference data.

Figure 10.1 *The 3D Stress Catalog Window*



From the Stress Recipe Catalog window, recipes can be created, modified, deleted, exported, and imported using the buttons on the bottom of the menu.

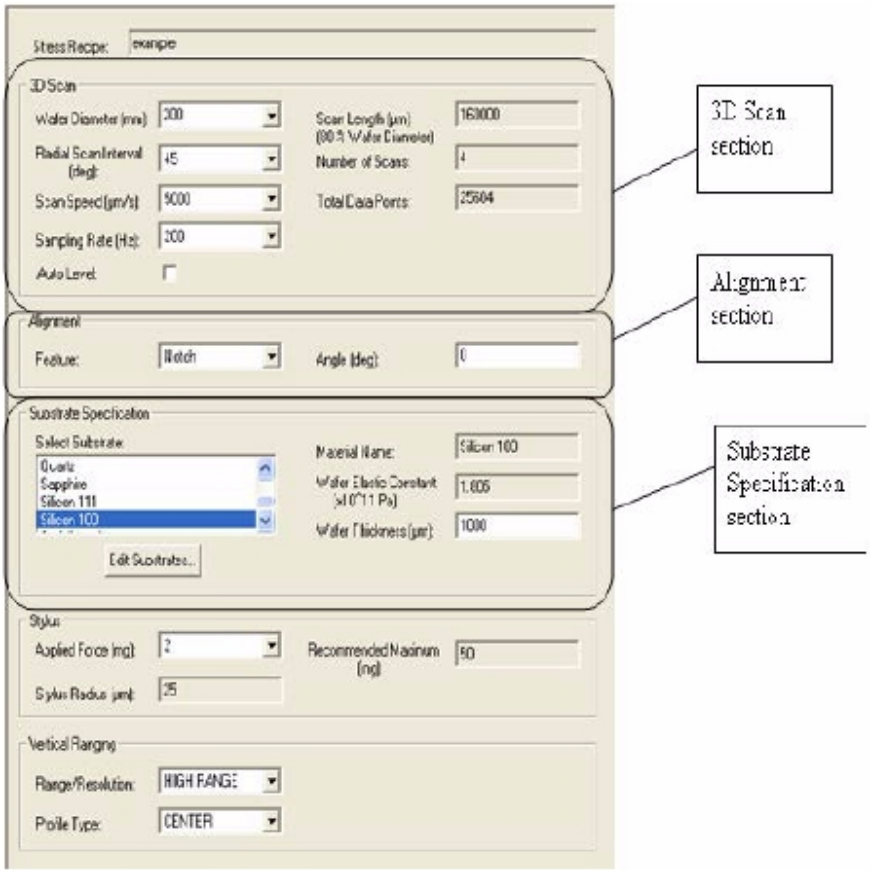
Figure 10.2 *3D Stress Buttons Found in the 3D Stress Catalog Window*



Creating a 3D Stress Recipe

New 3D Stress recipes can be created from the Stress Catalog window. By clicking on the New button, the 3D Stress Recipe Editor window is launched, where new recipes can be created. Figure 10.3 shows the 3D Stress Recipe Editor window.

Figure 10.3 *3D Stress Recipe Editor Window*



The 3D Stress Recipe Editor window is similar in content to the 2D Stress Recipe Editor window, though the layout is different. Definitions of the fields in the 3D Stress Recipe Editor window are listed below in Table 10.2.

Table 10.2 *Field Descriptions in the 3D Stress Recipe Editor Window*

Item	Description
Wafer Diameter	The diameter of the substrate to be scanned. This is a dropdown menu with entries for the most common wafer sizes. These sizes include 25, 50, 75, 100, 125, 150, and 200mm diameters.
Radial Scan Interval	The angular spacing between each successive scan required to build the 3D image. The dropdown menu values range between 5 and 90 degrees.
Scan Speed	Speed at which the stage moves during the scan, The dropdown menu values range between 1 and 25000 um/s.
Sampling Rate	The frequency at which data is captured during the scan.
Auto Level	Selecting this box causes the system to perform a stage level before each 3D profile is performed. By default (unchecked), a stage level is performed only once after the wafer is loaded.
Scan Length	(Read Only) The scan length of the profile is automatically calculated based on the Wafer Diameter entry. The scan length is 80% of the inputted Wafer Diameter.
Number of Scans	(Read Only) The total number of scans required to build the 3D profile. This is calculated by dividing 180 by the Radial Scan Interval value.
Total Data Points	(Read Only) The total amount of data points collected during the 3D scans.

Under the Alignment section, wafer attributes can be selected. See Table 10.3. These include the wafer notch or flat and location of the notch or flat. This is used as a reference when the wafer is loaded and unloaded.

Table 10.3 *Field Descriptions in the Alignment Section of the Recipe Editor*

Item	Description
Feature	Select feature found on the wafer. Either Notch, Flat, or Square.
Angle	Angle at which the feature is found on the wafer as referenced to orientation of wafer on the stage.

In the Substrate Specification section, the user can choose the type of substrate that is to be scanned as well as input the wafer thickness. The user may choose from a list of predefined substrates or create new substrates based on their application. See Table 10.4.

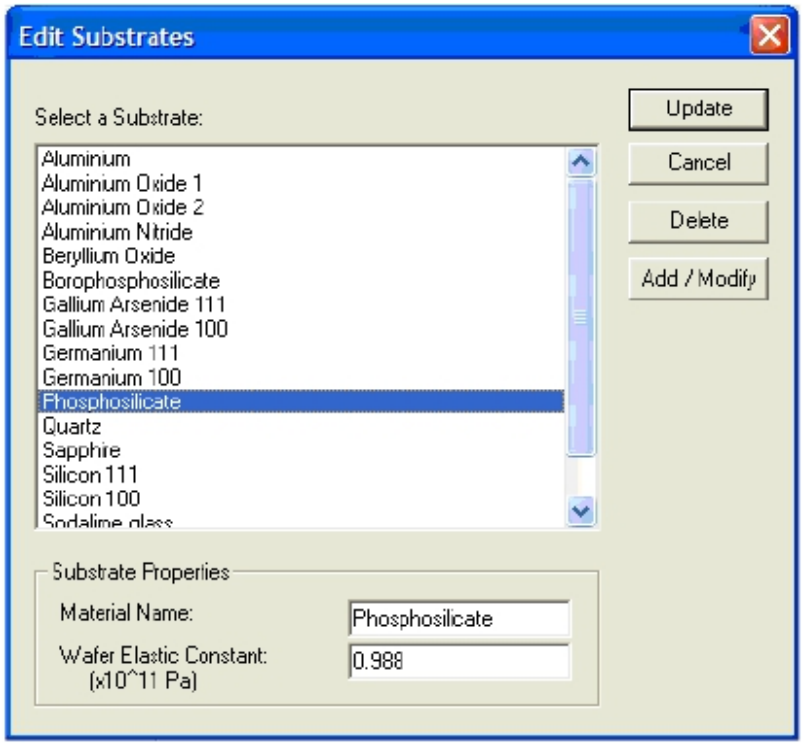
Table 10.4 *Field Descriptions in the Substrate Specification Section of the Recipe Editor*

Item	Description
Select Substrate	List of predefined and user defined substrates including name and Wafer Elastic Constant.
Edit Substrates	Allows user to define new materials for stress measurements.
Material Name	Substrate name taken from the list of substrates.
Wafer Elastic Constant	Constant associated with the type of substrate selected.
Wafer Thickness	Thickness of wafer.

Adding New Substrates to the Substrate Database

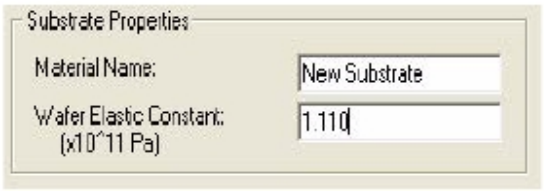
The Profiler 3D Stress software allows for the flexibility of adding and editing new substrates. To add a new substrate, click on the Edit Substrate button found in the Substrate Specification section of a 3D Stress recipe. See the Edit Substrates window, where the user can add new substrates, in Figure 10.4.

Figure 10.4 *Edit Substrates Window*



This will open the Edit Substrates window. To create a new substrate, type in the name of the new substrate into the Material Name field under the Material Properties section and then add the Wafer Elastic Constant into its respective field. The units for the Wafer Elastic Constant are 10^11 Pa. Be sure to properly convert units. See the Substrate Properties window, where the user can add new substrate names and values, in Figure 10.5.

Figure 10.5 *Substrate Properties Window*



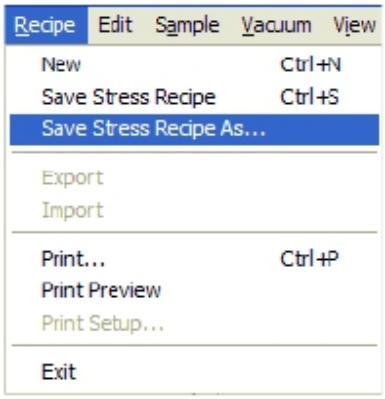
Once these values are entered click on the Add/Modify button in the Edit Substrates window. The Select a Substrate window will now reflect the new entry. To save the new material to the Substrate Database click the Update button in the Edit Substrates window. Existing Substrates can be removed by selecting the substrate and then clicking on the Delete button. Additionally existing substrate names or Wafer Elastic Constants can be modified by selecting the substrate of interest and then changing substrate values under the Substrate Properties section. Click the Add/Modify button when the modifications to the substrate are complete. See the Edit Substrate buttons used for adding and deleting substrate entries in Figure 10.6.

Figure 10.6 *Edit Substrate Buttons*

Saving a Stress Recipe

To save a newly created Stress Recipe click on the Recipe dropdown menu and then select Save Stress Recipe As. A Windows XP Save As window will appear, where the recipe can be saved. The default folder for stress recipes is C:\eagle\stressrcp.The default recipe file extension is .3sr. See Figure 10.7.

Figure 10.7 *Recipe Dropdown Menu*



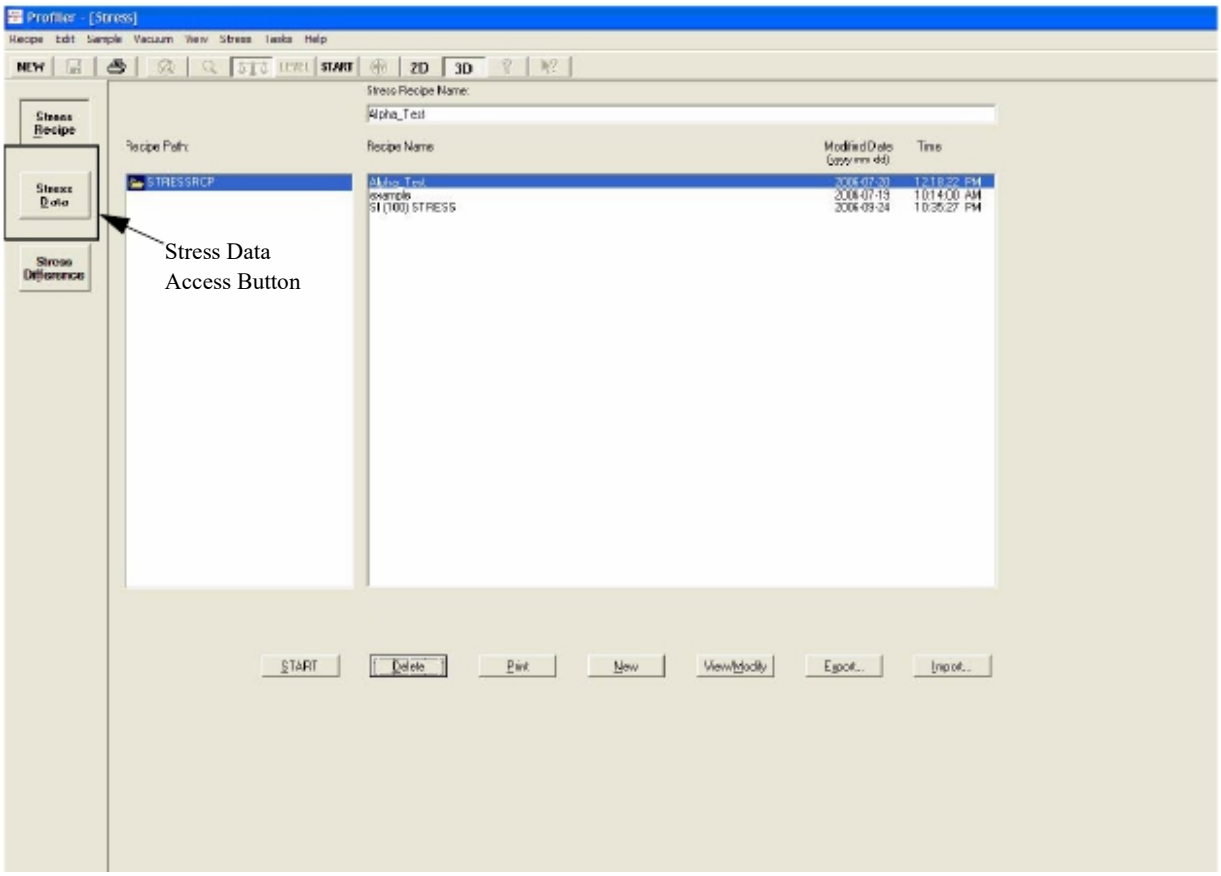
Taking 3D Stress Data

To begin stress data capture include the required recipe parameters and click the Start button. The software will automatically offset the stage to accommodate the Substrate Diameter. If a Stress stage is used, you may need to re-teach the Wafer Center. Once the data capture is complete, the data will be opened in Apex 3D by way of a XML and Simple Binary file. Save the data to the default folder location. The data will now be in the 3D Stress Database, and is located in the Stress Data window.

Creating and Analyzing 3D Stress Data

Once the pre and post scan data has been saved, use the Stress Data window to designate which scans are to be compared for stress analysis. The Stress Data window can be accessed via the button in the 3D Stress Catalog window. See the 3D Stress Catalog window with the Stress Data button selected in Figure 10.8.

Figure 10.8 *3D Stress Catalog Window and Stress Data Button*



To designate the pre- and post-measurement data use the buttons at the bottom of the Stress Data window. Select the pre-measurement data by clicking on the entry and then clicking the Set Pre button. Then select the post-measurement data by selecting the data and then clicking on the Set Post button. Then click on the Calculate button. The pre and post measurement data designation is displayed in Figure 10.9.

Figure 10.9 *Pre and Post Measurement Data Designation*

Once the data is selected and the Calculate button is clicked, the user will be prompted to enter the film thickness in microns. See Figure 10.10. The film thickness can be changed later in the Apex software.

Figure 10.10 *Film Thickness Window*

By default, the 3D Stress document in Apex will resemble the image displayed in Figure 10.11. First the pre and post scan data will be shown, followed by a 3D rendition of the difference of the two surfaces. On the second page is the actual Stress Map calculated from the pre and post measurements, followed by a 2D Profile Extraction (cross-section) from the Stress Map. See Figure 10.12.

The location of the profile extraction can be changed by clicking on the following icon in the Bank of Studiables on the right hand side of the Apex window:

Figure 10.11 *Default Format of the 3D Stress Analysis Window in Apex*

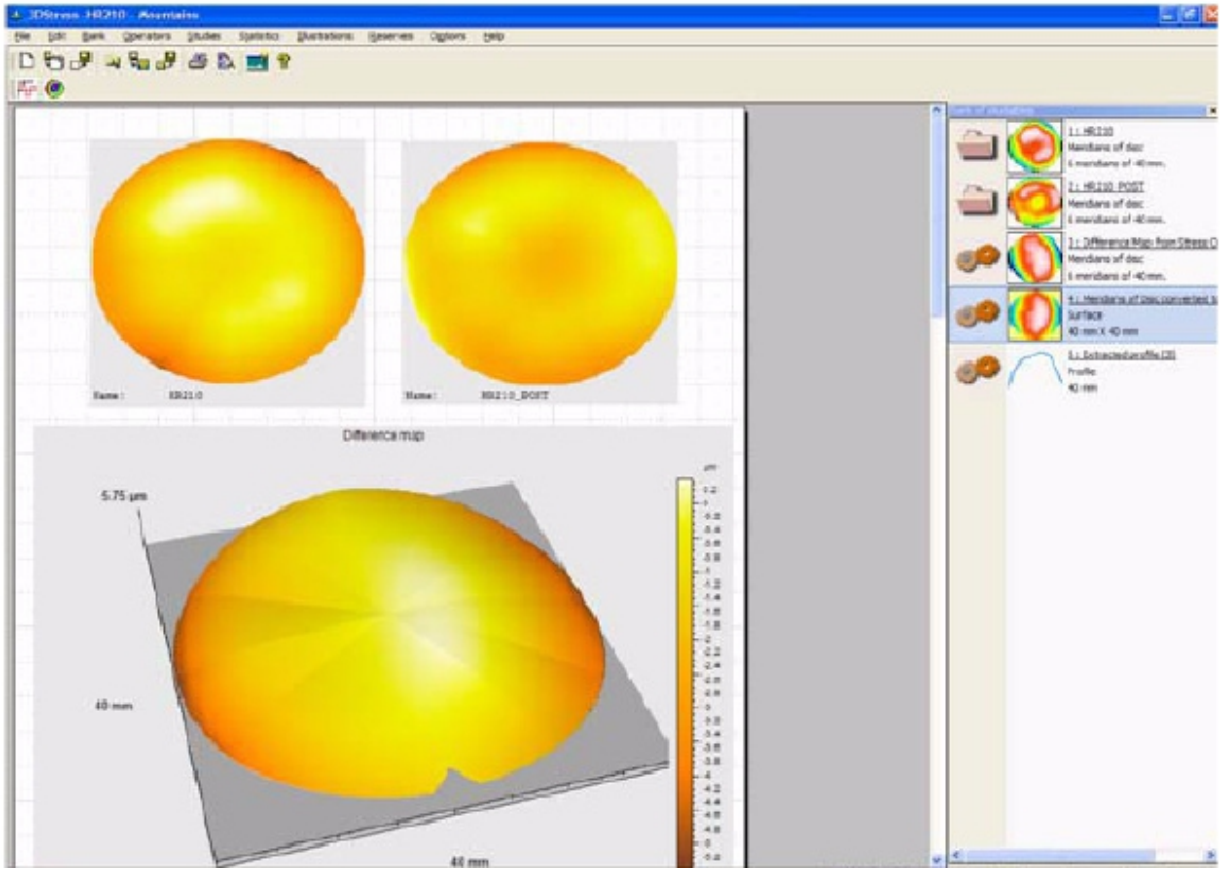
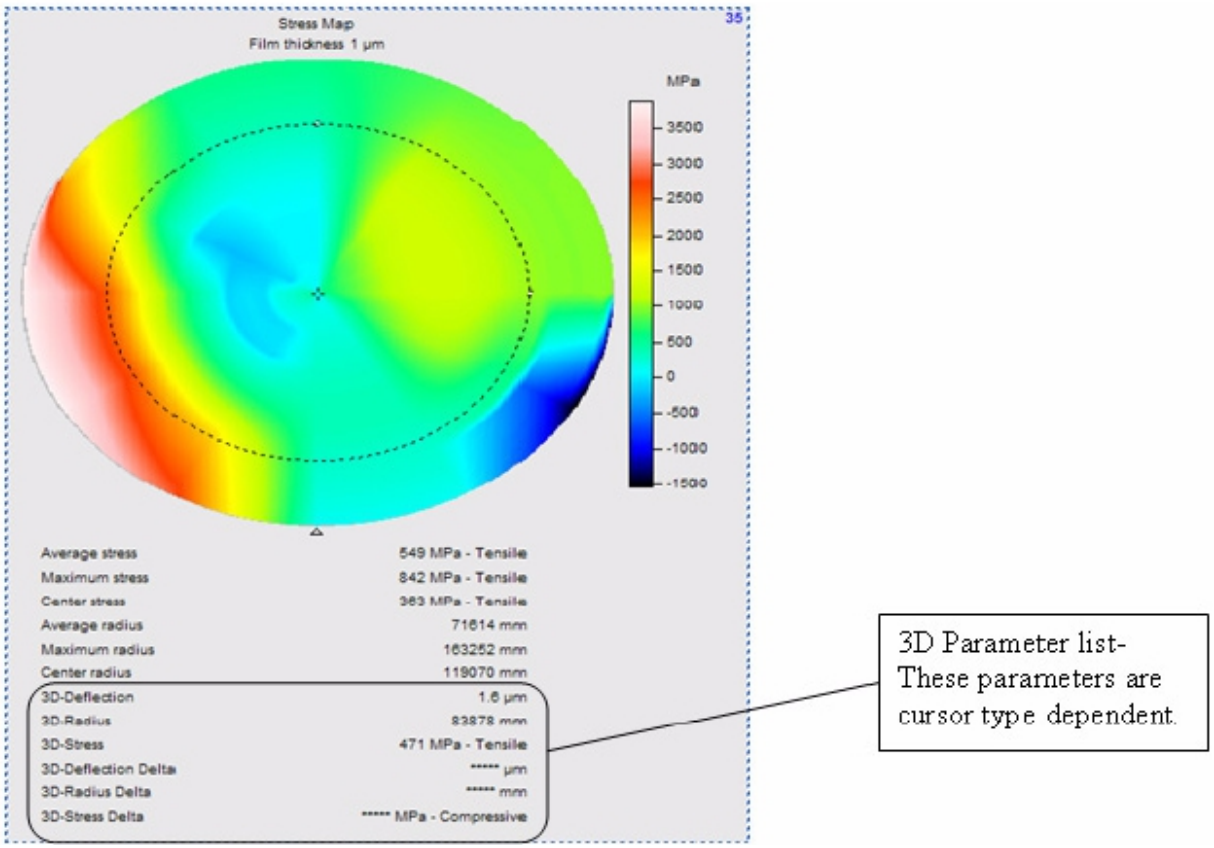


Figure 10.12 *Stress Map Calculated by Apex Software*



The stress values are automatically calculated in the 3D Stress Map. The Average Maximum and Center parameters are based on the entire surface and do not change with cursor location. However, the availability of the 3D parameters are cursor dependent, and the type of cursor used can be changed via the Apex toolbar. Figure 10.13 displays the 3D Stress toolbar in the Apex software, with the commonly used buttons highlighted.

Figure 10.13 *3D Stress Toolbar in Apex Software*

Table 10.5 defines and describes the toolbar icons used to change the shape and number of cursors to calculate the 3D parameters in the Stress Map image.

Table 10.5 *Tool Bar Icons for the Stress Map Image Cursors*

Graphic	Icon Name	Description
	Square Zone	Cursor is a user definable square.
	Circular Zone	Cursor is a circle with a user definable diameter.
	Portion Zone	Cursor is a arc section with user definable area.
	Zig Zag Zone	Cursor shape is completely definable.
	Two Rectangular Zone	Cursors are two user definable rectangles allowing for comparisons on different areas of the Stress Map.
	Two Portion Zone	Cursors are two portions for comparisons on different areas of the Stress Map.

Additionally the type of rendering can be toggled in Apex between Difference Map, Deflection Map, Curvature Map, and Stress Map by use of the toolbar. See Table 10.6 for descriptions of the toolbar icons used to change the image rendering.

Table 10.6 *Tool Bar Icons for Adjusting Image Rendered*

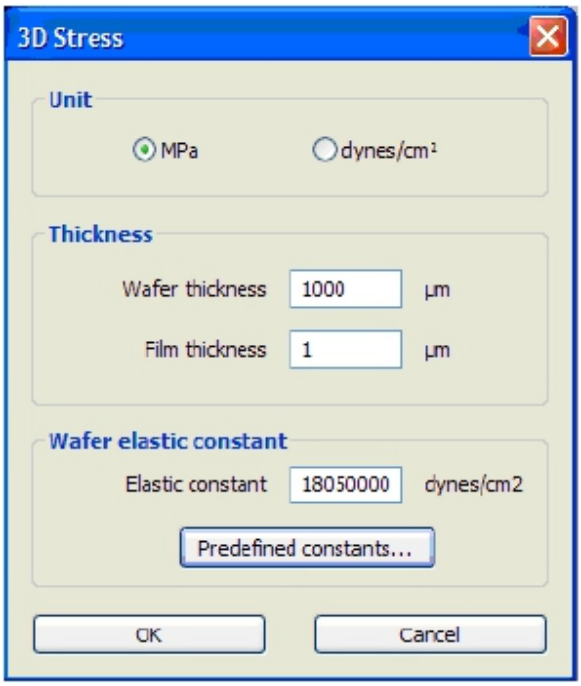
Graphic	Icon Name	Description
	Difference Map	Renders the topography difference between the pre and post scan data.
	Deflection Map	Renders the change in bow between the pre and post scan data.
	Curvature Map	Renders the difference in curvature between the pre and post scan data.
	Stress Map	Renders the stress between the pre and the post scan based on Stoney's equation.

There are several other useful icons in the toolbar. These allow the user to show and position the wafer notch or flat and also to change the values used for the calculation of 3D Stress.

The  icon produces a dialogue box in which the location of the wafer attribute can be changed.

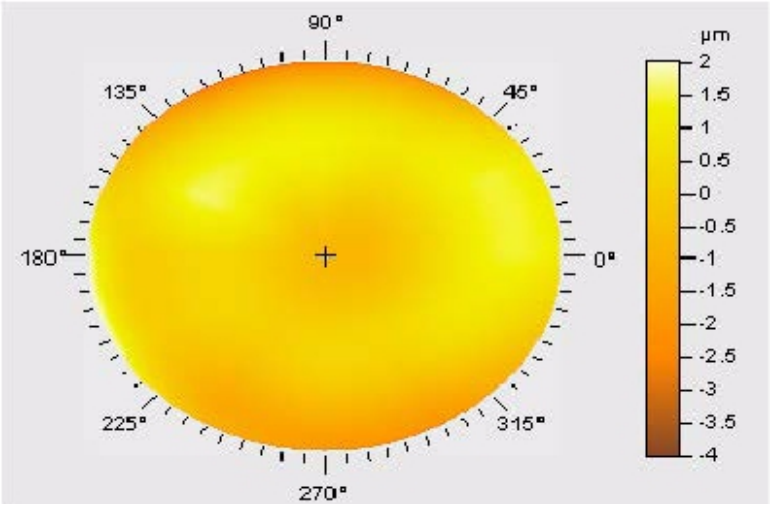
The  icon produces the 3D Stress dialogue box where the user can modify the stress units, wafer and film thicknesses as well as the Substrate Specifications. See Figure 10.14.

Figure 10.14 *3D Stress Dialogue Box*



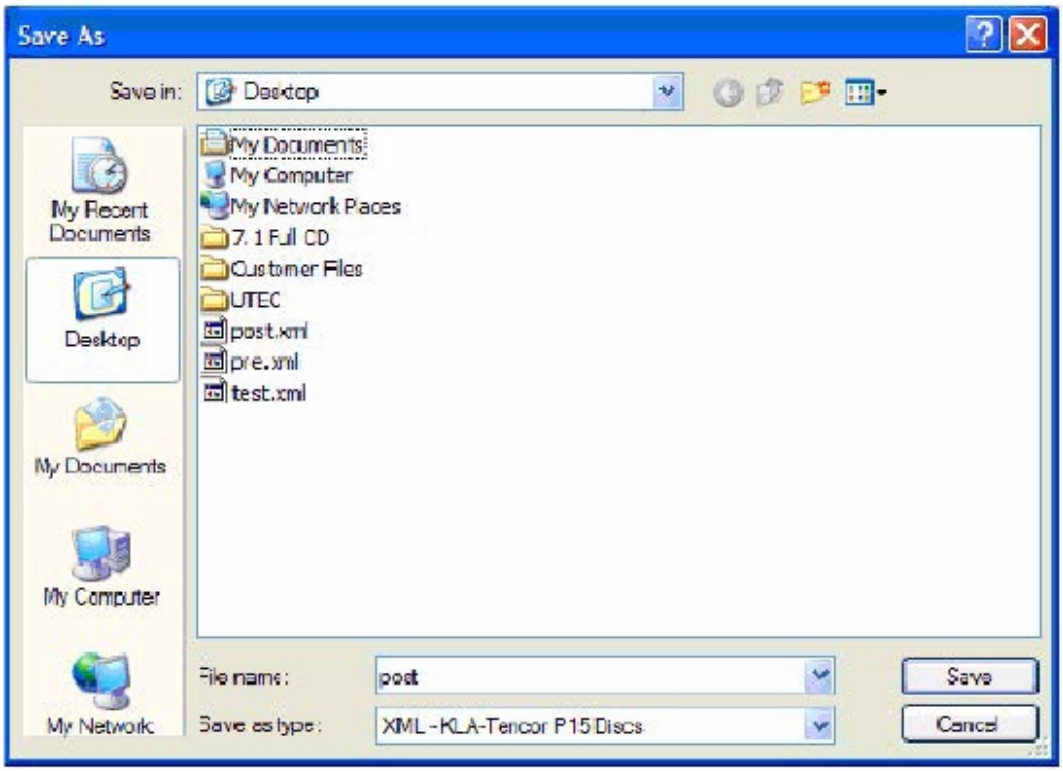
3D stress difference data can also be generated from the Apex software, without the use of the Profiler software. To create a stress measurement using this method, the pre and post stress data must be saved as an .XML file. To do this, launch the pre-measurement data from the Profiler software to the Apex software by double clicking on the file of interest from the Stress Data Catalog in the Profiler. Once the data is in Apex, select the angular data image in the document (see Figure 10.15) and select File > Save the Disc Measurement. Repeat this procedure for the post-measurement data.

Figure 10.15 *Angular Data Image in Apex Software*



From the Save As window shown in Figure 10.16, select the file type XML - KLA-Tencor P-17 Discs. Once the Save button is selected, the system will save two files having the same name and different file extensions, .XML and .MAP.

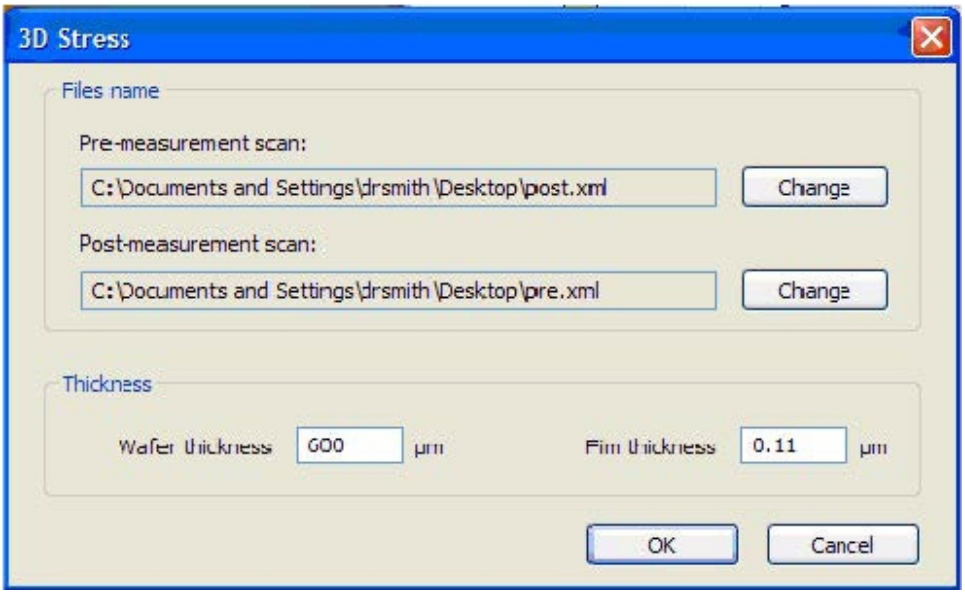
Figure 10.16 *Save As Window for Saving Only the Xml Data Files*



Once the pre and post data has been saved launch the Apex software if it is not already running.

Click on the  icon in the toolbar. This will launch the 3D Stress window where the files of interest are selected. See Figure 10.17. To select the pre and post .XML files select change and an explorer window is launched. Find only the .XML files of interest, not the .MAP files. You will need to change the extensions list in the explorer window to **All Formats. From this window wafer and film thicknesses can also be inputted.

Figure 10.17 *3D Stress File Selection Dialogue Box*



Saving the Stress Difference Data

As with other Apex analysis, the entire stress analysis routine can be saved as a document or only the data itself. To save the entire routine, go to File > Save the Document As. This will save the routine in the native Apex format with the extension .MNT. By default the document will be saved to the directory that corresponds with Stress Difference button in the Profiler software, though data can be saved anywhere on the system. To save only the Stress difference data, go to File' Save the Disc Measurement. Saving only the Stress difference data allows multiple stress files to be added into the same Apex document.

SYSTEM SECURITY

INTRODUCTION

The Profiler system security is designed to provide users with membership in various groups for access to the Profiler functions for which they are responsible. This is performed in two ways. The first is to create Windows XP users and assign various levels of access to Profiler software. To change users (and thus change access levels) use the Logout function available from the following pages: **Configuration**, **Calibration**, **Scans Catalog**, **Import and Export Catalog**, **Stress Application**, **Defect Review Application**, and from the **Runtime View**. This can also be done iwith Profiler software closed, using the logout shortcut on the desktop.

KLA-Tencor Operating System Security

Profiler software is integrated with a security module developed by the KLA-Tencor common software group. This module accesses the users and security controls in Windows XP to control access to Windows and Profiler features.

In order for the security to function correctly, the software needs to log into Windows XP as an Administrator. To facilitate this login the system is setup to use the AutoLogonUser account, automatically logging into Windows XP as an Administrator. After logging into Windows XP, the Profiler security login dialog box, Figure 11.1 , is presented to the user, allowing any defined users, Administrators or Operators, to logon. Profiler security then grants the user defined level of access to Windows XP and Profiler software.

Figure 11.1 *Log On Dialog*

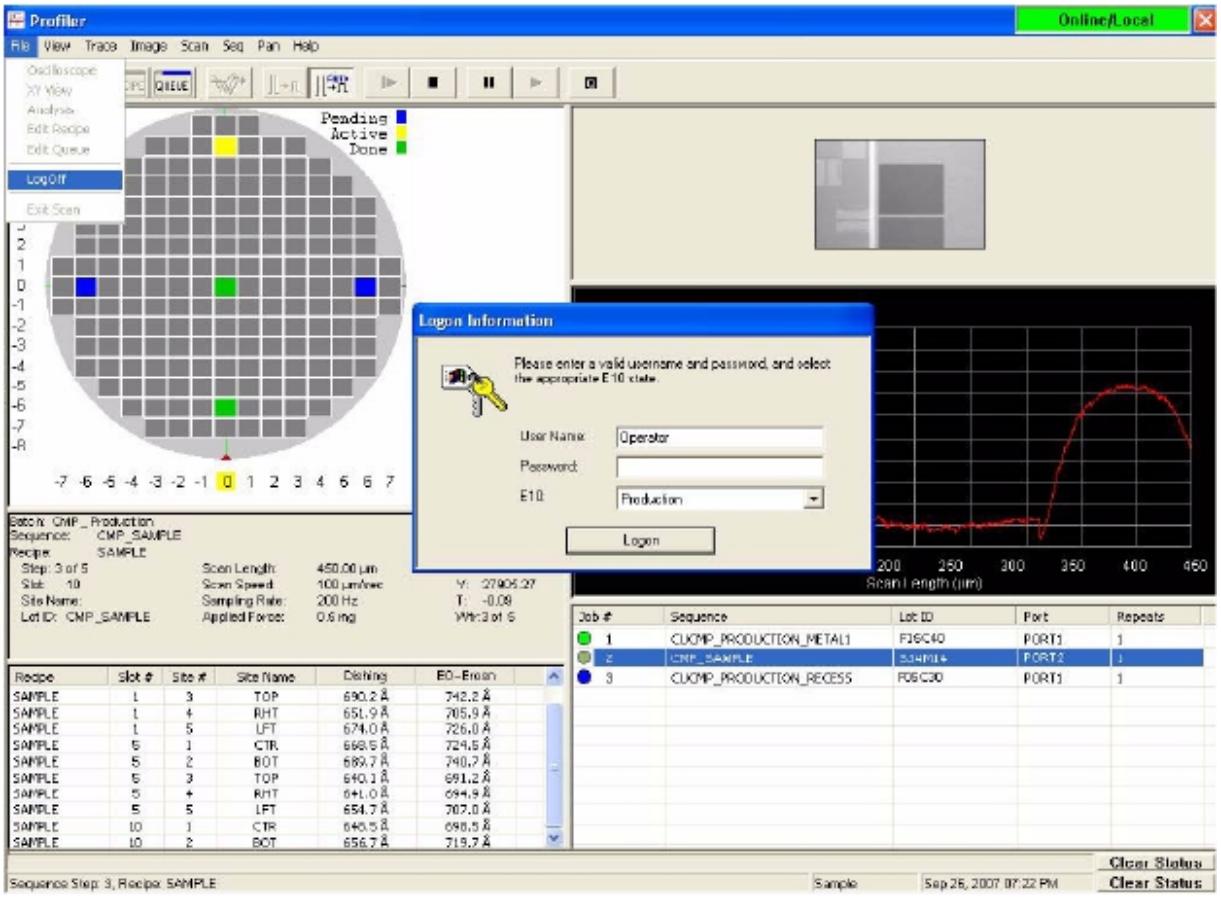
LOGIN AND LOGOUT PROCEDURE

You can change access levels using previously created user from the following locations:

- Configuration Page - File menu, select LogOff
- Calibration Page - File menu, select LogOff
- Scans Catalog - File menu, select LogOff
- Import and Export Catalog - File menu, select LogOff
- Stress Application - Recipe menu, select LogOff
- Defect Review Application - File menu, select LogOff
- Sequence Runtime View - File menu, select LogOff
- Windows Desktop - Double click on the LogOff shortcut
- Programs Menu - Click on the LogOff shortcut

1. LogOff the profiler software from one of the locations listed earlier.
2. Log back into profiler software by entering a valid from the Logon dialog shown in.Figure 11.2

Figure 11.2 *Log On Dialog at Runtime*

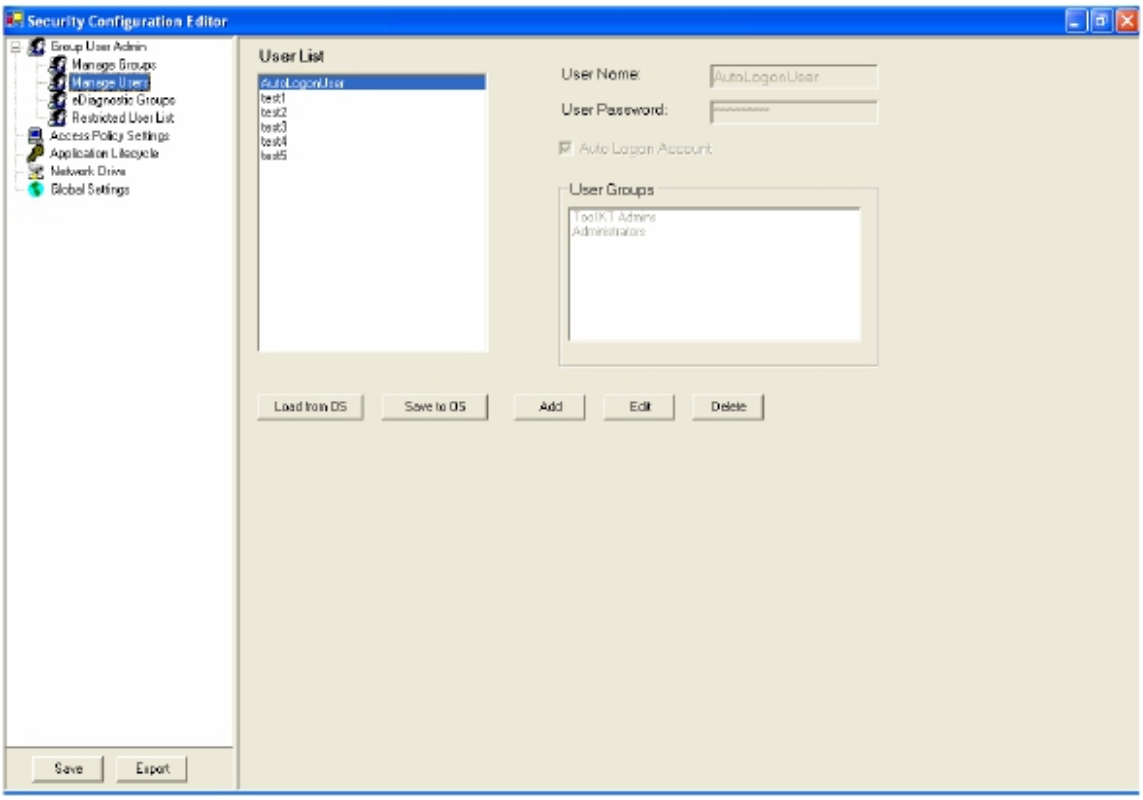


3. Enter a valid User Name that has been previously created, such as **Administrator**.
4. Enter a valid Password (case sensitive) that is associated with the User Name.
5. The E10 state is not being tracked by the software, so it can be left at the default value.
6. Click on **Logon**.

CONFIGURING KLA-TENCOR SECURITY

Security settings are defined in the **Security Configuration Editor** as shown in Figure 11.3. This program controls the access level of the Administrator and non-administrator to Windows XP functions. It also enables auto logon into Windows XP. In addition, it provides supplemental user management, however most user management activity is performed through Windows XP as described as in the **Security Groups** section of the manual. Finally, it allows for the automatic launch of programs when logging into Windows XP.

Figure 11.3 *Security Configuration Editor*



The **Security Configuration Editor** is divided into five sections, as described in Table 11.1. The security software module used by profiler software is used by multiple software groups in KLA-Tencor. As a result, not all of the sections and settings available in the editor apply to profiler software. What settings apply to profiler software is described in more detail in this chapter.

Table 11.1 *Security Configuration Editor Sections*

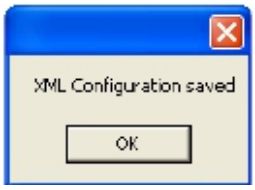
Section	Use In Profiler	Description
Group User Admin - Manage Groups	Not Applicable	Not Applicable
Group User Admin - Manage Users	AutoLogonUser setting	User administration, creating and modifying user accounts and access levels, is mainly performed in Windows XP. The one exception is that after changing the password for the AutoLogonUser account in Windows XP, the same password must be entered into the Security Configuration Editor
Group User Admin - eDiagnostics Groups	Not Applicable	Not Applicable
Group User Admin - Restricted User List	Not Applicable	Not Applicable
Access Policy Settings	Windows XP access settings	Access policy settings defines the user rights within Windows XP. This is broken down into two groups, Administrators and non-Administrators. These settings are set at the factory and generally do not require modification.
Application Lifecycle	Not used, but can be used by profiler software, if required	Application lifecycle allows the user to define programs that will be launched when logging into Windows XP, such as automatically launching the profiler software application.
Network Drive	Not Applicable	Not Applicable
Global Settings	Enable - Disable AutoLogonUser	Global settings are used to enable or disable automatic logon into Windows XP through the AutoLogonUser account. By default, this is enabled.

PROCEDURE TO MODIFY SECURITY SETTINGS

1. Navigate to C:\Program Files\KLA-Tencor\Component Suite\KTSecurity\
2. Double-click on **SecurityConfigurationEditor.exe**
3. Select the section to modify from the list on the left. Details on each setting that can be modified for profiler software are provided in subsequent sections of this chapter.
4. When all changes are complete, select Save at the lower, left corner of the **Security Configuration Editor** as shown in Figure 11.3.

5. The software will display a dialog box informing the user of a successful save of the configuration changes, as shown in Figure 11.4.

Figure 11.4 *XML Configuration Saved*

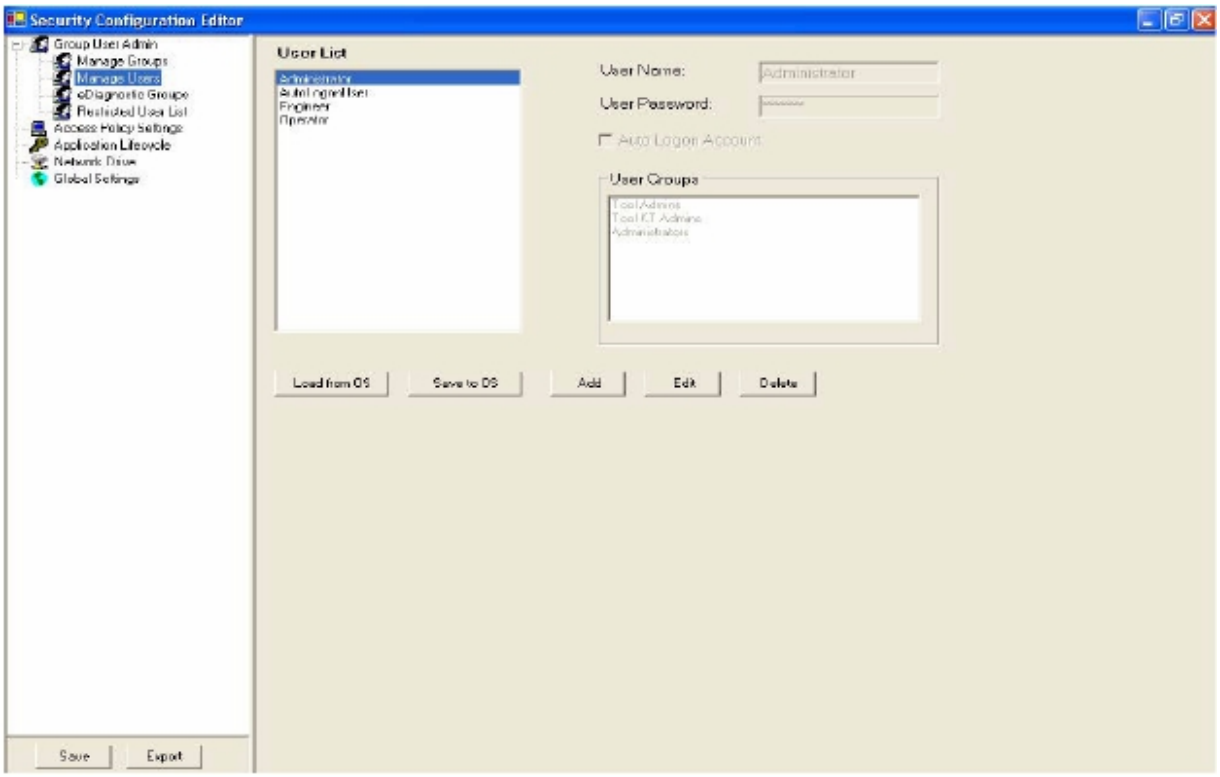


6. Close the **Security Configuration Editor.**
7. **Restart** the computer to have the new changes take affect.

GROUP USER ADMIN - MANAGE USERS

Figure 11.5 shows the **Group User Admin - Manage Users** dialog. User administration is performed through Windows XP, as previously described. The only application of the **Manage Users** setting is if the user needs to change the **AutoLogonUser** password. It is recommended to not change this password and leave it at its default setting. If the password of any other user needs to be changed, this should be performed through Windows XP.

Figure 11.5 *Group User Admin - Manage Users*



PROCEDURE TO CHANGE THE AUTOLOGONUSER PASSWORD

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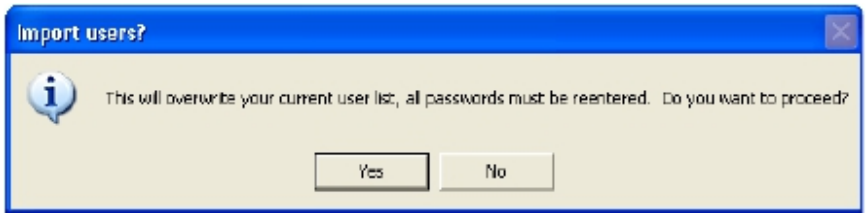
CAUTION: Changing the AutoLogonUser password is not recommended. Prior to starting the procedure, the Administrator changing the AutoLogonUser password must know the passwords of all other users defined in Windows XP as they will be required to enter these passwords during the procedure.

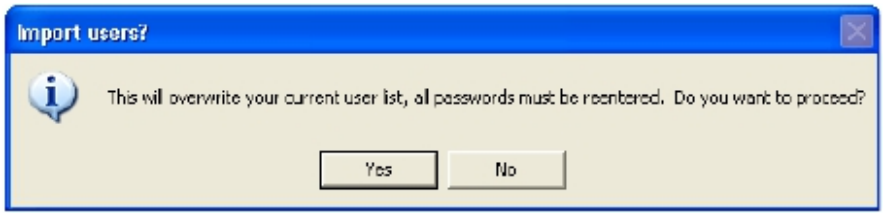
1. Open the **Security Configuration Editor** and select **Group User Admin - Manage Users**.
2. Click on the button Load from OS as shown in Figure 11.5.
3. The user will be shown a dialog box asking if they want to overwrite the current user list and reenter all passwords as shown in Figure 11.6. Ensure that all passwords for the current users are known and select **Yes**.

Figure 11.6 *Load from OS Import Users*



4. The user should now choose to load users from the **Local System** as shown in Figure Figure 11.7 since the AutoLogonUser is defined on the local computer.

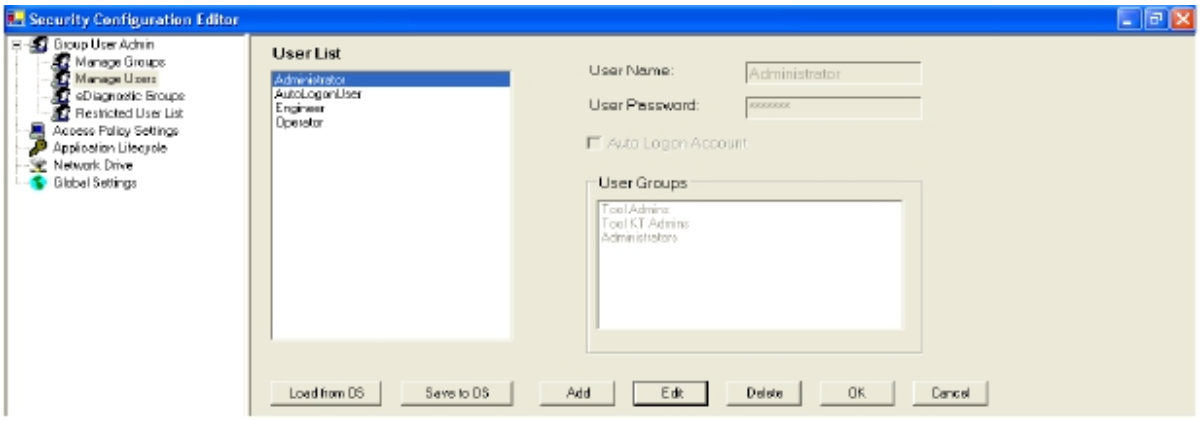
Figure 11.7 *Choose Users From Local System*



5. After all users are imported from the **Local System,** the user is required to edit each user by selecting the **Edit** button as shown in Figure 11.8 and enter the password for each user, including the new password for the AutoLogonUser account.

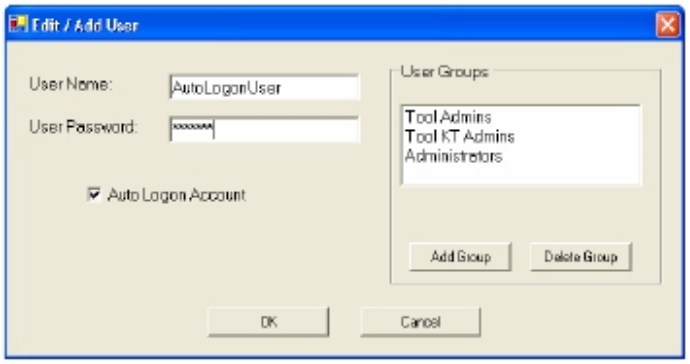
a. For user accounts not used by the Profiler software, select the user in the list and then select Delete.

Figure 11.8 *Edit Users*



6. Enter the user password as shown inFigure 11.9 and when complete, select **OK**.
   a. For the AutoLogonUser ensure that the checkbox is enabled for **Auto Logon Account**.

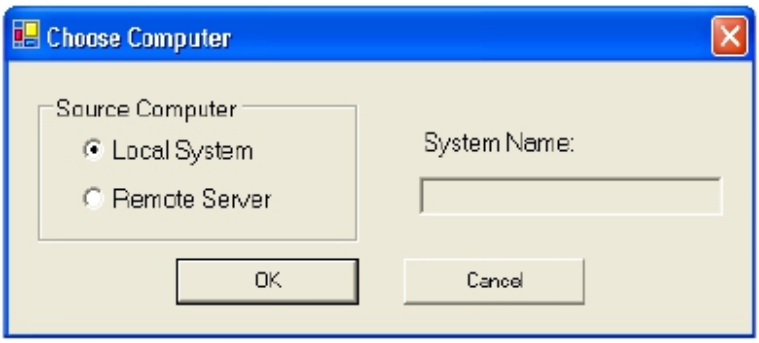
Figure 11.9 *Change User Password*



7. In the **Security Configuration Editor** after entering the user password, select **OK** as shown in Figure 11.8.
8. Repeat Steps 5 through 7 for all users.
9. When all passwords have been entered, select Save to OS as shown in Figure 11.8.

10. When presented with the dialog shown in Figure 11.10 select Local System and then select **OK**.

Figure 11.10 *Save Users to Local System*



11. Select Save from the lower, left corner as shown in Figure 11.5.
12. Close the Security Configuration Editor and restart Windows XP for the changes to take affect.

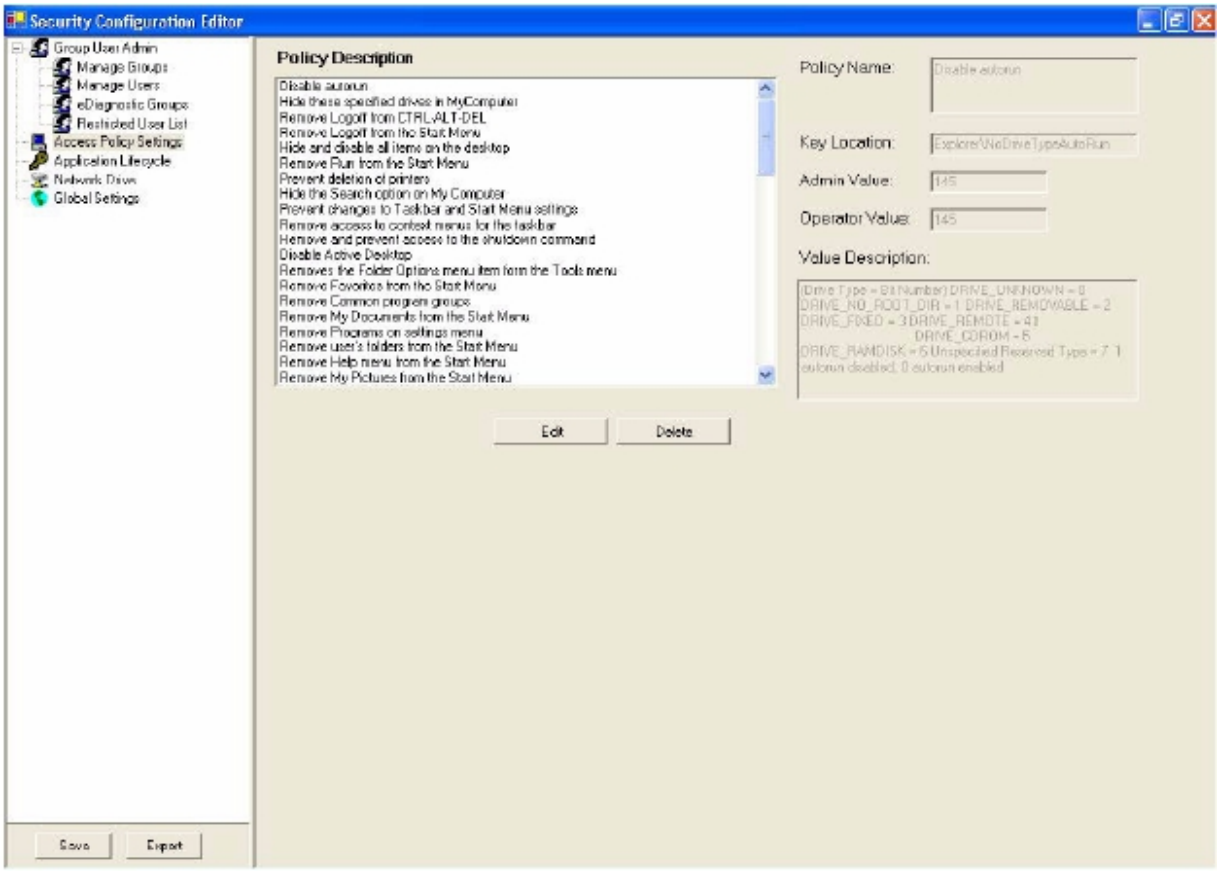
ACCESS POLICY SETTINGS

Figure 11.11 shows the **Access Policy Settings** dialog from the **Security Configuration Editor.** This controls the access level of the user to Windows XP functions. These settings are defined in the factory and generally do not need to be changed by the user.

The policy settings provide two levels of access: one for Administrators and one for all other users that are not a member of the Administrator security group. The policy settings define most aspects of control to Windows XP functions, such as the ability to view icons on the desktop (by default enabled for all users).

The Windows XP desktop and start menu shortcuts are also broken into a set of shortcuts for all users, including the Administrator and a set of shortcuts for the Administrator only. The shortcuts common to all users are found in the AutoLogonUser account. The shortcuts specific to the Administrative account are found in the All Users account only. Do not include the same shortcut in the Administrative account (All Users) as the shortcuts common to all users (AutoLogonUser account), otherwise the Administrator will see two sets of shortcuts. The Administrative account should only contain the additional shortcuts that are not allowed for the all other users, such as access to DRUN or the Security Configuration Editor.

Figure 11.11 *Access Policy Settings*

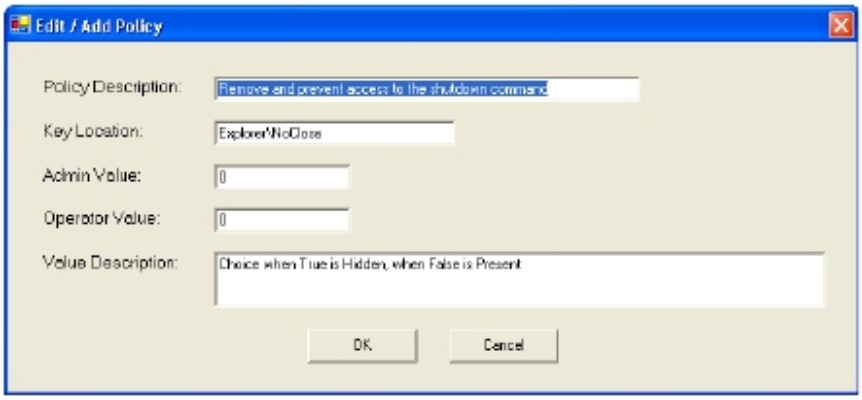


PROCEDURE TO CHANGE ACCESS POLICY SETTINGS

1. Open the **Security Configuration Editor** and select **Access Policy Settings**.
2. Select the policy setting from the list that you want to modify.
    a. As shown in Figure 11.11, the right side of the screen shows the name of the policy, settings for administrator and operator, and a description of the policy.
    b. Most settings use a 1 or 0 to define **True** or **False** for user access to this policy, but in all cases, refer to the value description to determine the potential settings for each policy.

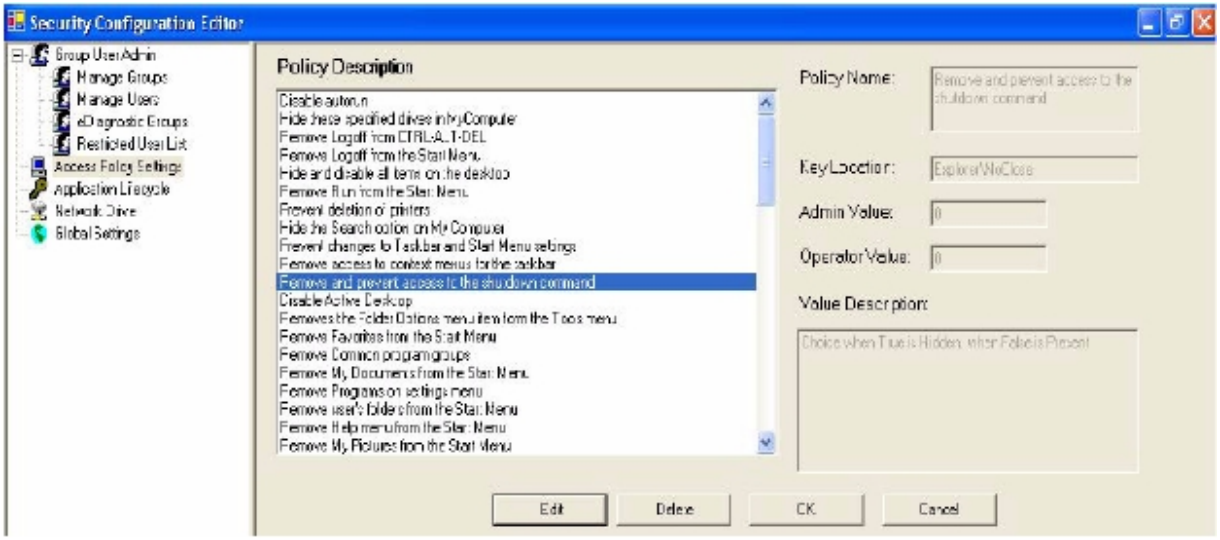
3. Click on the **Edit** button. Figure 11.12 shows an example of editing the policy setting that allows the **Administrator and Operator** access to the Windows XP shutdown command.

Figure 11.12 *Edit Access Policy Setting for Windows Shutdown Command*



4. Review the **Value Description** and then change the **Admin Value** and / or the **Operator Value** to the new settings and select **OK** in the policy editing dialog, Figure 11.12, when complete.
   a. Table 11.2 shows the default settings recommended for use on the profiler.
5. Select **OK**, as shown in Figure 11.13, to save the change to the policy setting.

Figure 11.13 *Saving the Access Policy Setting*



6. Repeat Steps 2 through 5 until all policy setting changes are complete.
7. Select **Save** from the lower, left corner as shown in Figure 11.11.

8. Close the **Security Configuration Editor** and restart Windows XP for the changes to take affect..

Table 11.2 *Access Policy Settings*

Policy Description	Admin Value	Admin	Operator Value	Operator	Notes
Disable autorun	145		145		Do not change the default values
Hide these specified drives in MyComputer	0	No Drives	15	Local Drives	Local drives are hidden from the operator
Remove Logoff from CTL-ALT-DEL	0	False	1	True	Operator does not need Win XP logoff
Hide and disable all items from the desktop	0	False	0	False	Allosw users to see desktop shortcuts
Remove Run from the Start Menu	0	False	1	True	Operator has minimal access to Win XP settings
Prevent deltion of printers	0	False	1	True	Operator has minimal access to Win XP
Hide the Search option on My Compter	0	False	1	True	Operator has minimal access to Win XP settings
Prevent changes to Taskbar and Start Menu settings	0	False	1	True	Operator has minimal access to Win XP settings
Remove access to context menus for the taskbar	0	False	1	True	Operator has minimal access to Win XP settings
Remove and prevent access to the shutdown command	0	False	0	False	All users ned to be able to shutdown the computer
Disable Active Desktop	1	True	1	True	No users need Active Desktop
Remove the Folder Options menu item from the Tools menu	0	False	1	True	Operator has minimal access to Win XP settings
Remove Favorites from the start Menu	0	False	1	True	Operator has minimal access to Win XP settings
Remove Favorites from the Start Menu	0	False	1	True	Operator has minimal access to Win XP settings
Remove common program groups	0	False	1	True	Operator has minimal access to Win XP settings
Remove My Documents from the Start Menu	0	False	1	True	Operator has minimal access to Win XP settings
Remove Programs from the Settings Menu	0	False	0	False	All users have access to start menu shortcuts

Table 11.2 *Access Policy Settings*

Policy Description	Admin Value	Admin	Operator Value	Operator	Notes
Remove user folders from teh Start Menu	0	False	1	True	Operator has minimal access to Win XP settings
Remove Help Menu from the Start Menu	0	False	1	True	Operator has minimal access to Win XP settings
Remove My Pictures from the Start Menu	0	False	1	True	Operator has minimal access to Win XP settings
Remove My Music from the Start Menu	0	False	1	True	Operator has minimal access to Win XP settings
Remove My Network Places from the Start Menu	0	False	1	True	Operator has minimal access to Win XP settings
Remove drag and drop context menus from the Start Menu	0	False	1	True	Operator has minimal access to Win XP settings
Turn off personalized Menu	0	False	1	True	Operator has minimal access to Win XP settings
Force classic Start Menu	0	False	0	False	Do not need to force users to classic start menu
Remove All Program list from the Start Menu	0	False	0	False	All users have access to start menu shortcuts
Remove frequently accessed program list from the Start Menu	0	False	1	True	Operator has minimal access to Win XP settings
Remove Properties from My Computer context message	0	False	1	True	Operator has minimal access to Win XP settings
Prohibit access to control panel	0	False	1	True	Operator has minimal access to Win XP settings
Remove the Documents menu from the Start menu	0	False	1	True	Operator has minimal access to Win XP settings
Remove Windows Security item from the Start Menu	0	False	1	True	Operator has minimal access to Win XP settings
Remove Set Program Access and Defaults page from the Start Menu	0	False	1	True	Operator has minimal access to Win XP settings
Hide user name from the Start Menu	1	True	1	True	Operator has minimal access to Win XP settings
Remove Pinned Programs List from the Start Menu	0	False	1	True	Operator has minimal access to Win XP settings

Table 11.2 *Access Policy Settings*

Policy Description	Admin Value	Admin	Operator Value	Operator	Notes
Don't save settings at exit	0	False	1	True	Operator has minimal access to Win XP settings
No Network Setup	0	False	1	True	Operator has minimal access to Win XP settings
Hide Network Identification Page	0	False	1	True	Operator has minimal access to Win XP settings
Hide Network Access Control Page	0	False	1	True	Operator has minimal access to Win XP settings
Remove lock computer	0	False	1	True	Operator has minimal access to Win XP settings
Remove Change Password	0	False	1	True	Operator has minimal access to Win XP settings
Remove Task Manager	0	False	1	True	Operator has minimal access to Win XP settings
Remove Display in Control Panel	0	False	1	True	Operator has minimal access to Win XP settings
Hide desktop tab	0	False	1	True	Operator has minimal access to Win XP settings
Hide Screen Saver tab	0	False	1	True	Operator has minimal access to Win XP settings
Hide appearances and themes tab	0	False	1	True	Operator has minimal access to Win XP settings
Hide settings tab	0	False	1	True	Operator has minimal access to Win XP settings
Disable the Remove Administration tab in the Password Properties dialog box	0	False	1	True	Operator has minimal access to Win XP settings
Hide user profiles page	0	False	1	True	Operator has minimal access to Win XP settings
Hide device manager page	0	False	1	True	Operator has minimal access to Win XP settings
Hide hardware profiles page	0	False	1	True	Operator has minimal access to Win XP settings
Hide vitrual memory button	0	False	1	True	Operator has minimal access to Win XP settings
Disable Add/Remove Programs	0	False	1	True	Operator has minimal access to Win XP settings
Disable Change and Remove Programs	0	False	1	True	Operator has minimal access to Win XP settings

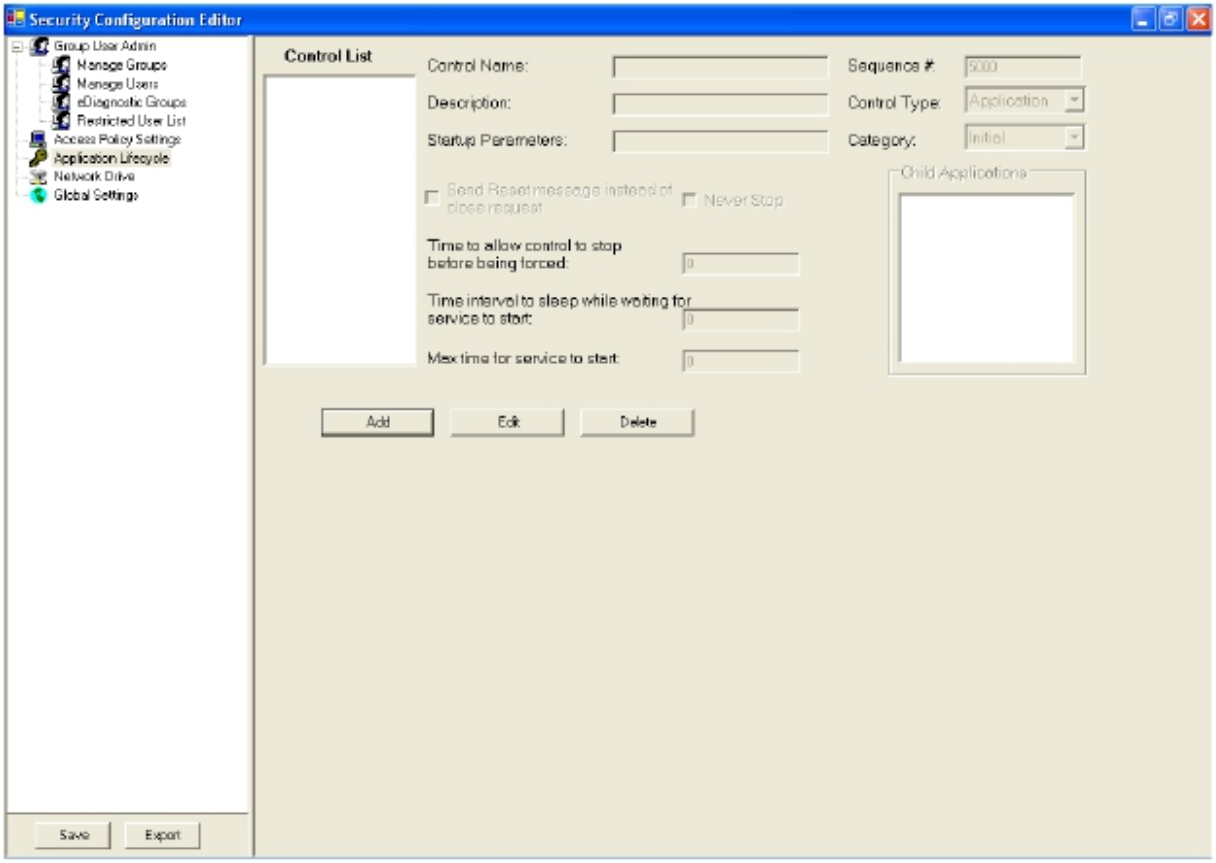
Table 11.2 *Access Policy Settings*

Policy Description	Admin Value	Admin	Operator Value	Operator	Notes
Disable Windows Components Wizard	0	False	1	True	Operator has minimal access to Win XP settings
Hide 'Add a Program from CD-ROM or Disk' Option	0	False	1	True	Operator has minimal access to Win XP settings
Hide 'Add programs from Microsoft' option	0	False	1	True	Operator has minimal access to Win XP settings
Hide 'Add programs from your network' option	-	False	1	True	Operator has minimal access to Win XP settings
Go directly to Windows Components Wizard	0	False	1	True	Operator has minimal access to Win XP settings
Diable Support mstns: Information	0	False	1	True	Operator has minimal access to Win XP settings
Forbid users to launch MS-DOS applications	0	False	1	True	Operator has minimal access to Win XP settings
Disable Command Prompt	0	False	2	False	All users can run automatic command prompt scripts
Remove 'My Computer' from the Desktop and Starrt menu	0	False	1	True	Operator has minimal access to Win XP settings
Hide 'Printers and Faxes' from the Start menu	1	False	0	True	Operator has minimal access to Win XP settings
Hide 'My Computer' from the Start menu	1	False	0	True	Operator has minimal access to Win XP settings
Hide 'Administrative Tools' from the Start menu	1	False	0	True	Operator has minimal access to Win XP settings
Prevent users from changing the password-protection settings	0	False	0	False	Operator has minimal access to Win XP settings
Hide the taskbar in the desktop	0	False	0	False	All users see the taskbar

APPLICATION LIFECYCLE

Figure 11.14 shows the Application Lifecycle dialog box. This allows the user to define programs that will automatically start with Windows XP logon. Some users might desire to have programs that are always launched on startup, such as Profiler software. This can be enabled by adding the program to the control list. In general, most users prefer to start profiler manually since there are instances where Windows XP is being launched and it is not desired to immediately start profiler software. As a result, the default setting is that no programs are launched automatically upon login to Windows XP.

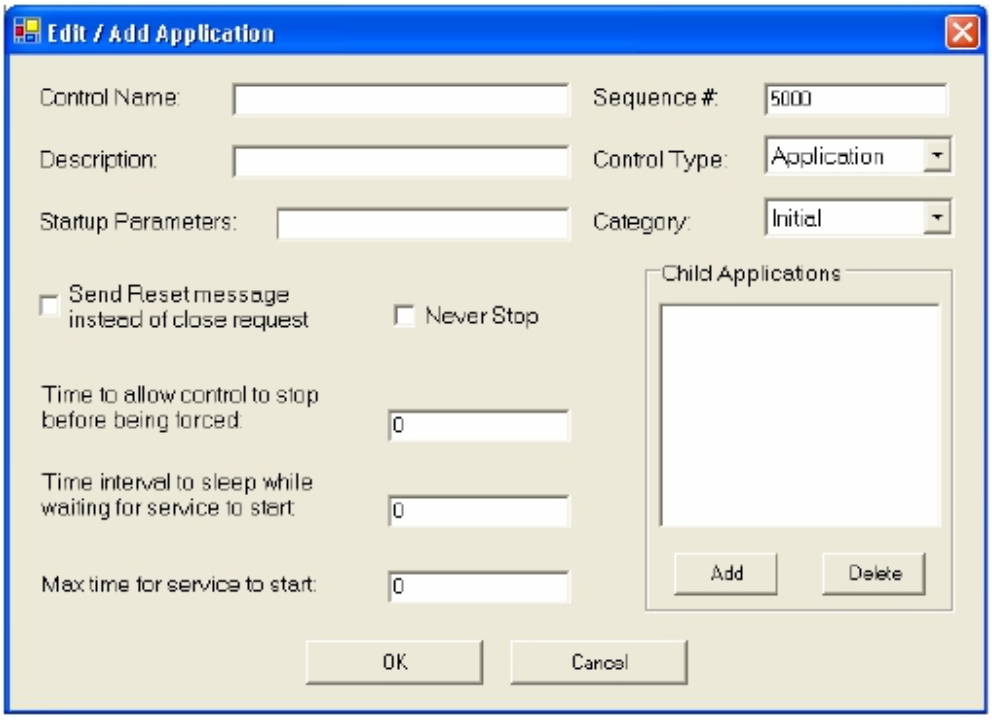
Figure 11.14 *Application Lifecycle*



PROCEDURE TO CHANGE APPLICATION LIFECYCLE SETTINGS

1. Start the Security Configuration Editor and select Application Lifecycle.
2. To remove programs from the control list:
   a. Select the program from the list
   b. Select Delete
   c. Repeat Step 2 to delete additional programs
   d. Proceed to Step 4, skipping Step 3 when done deleting programs
3. To add programs to the control list:
   a. Click on Add
   b. In the Control Name field shown in Figure 11.15, type in the name of the executable program. For example, type in notepad.exe to have Windows notepad launch upon starting Windows XP.

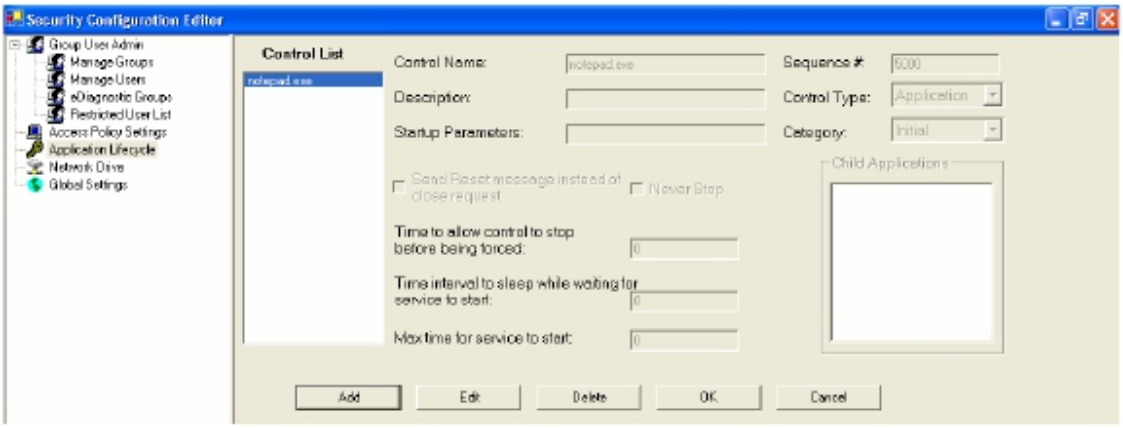
Figure 11.15 *Add Programs to the Control List*



   c. When complete, select OK in Figure 11.18.

d. To save the changes to the Control List, select OK in Figure 11.16

Figure 11.16 *Save Changes to the Control List*



e. Repeat Step 3 to add additional programs

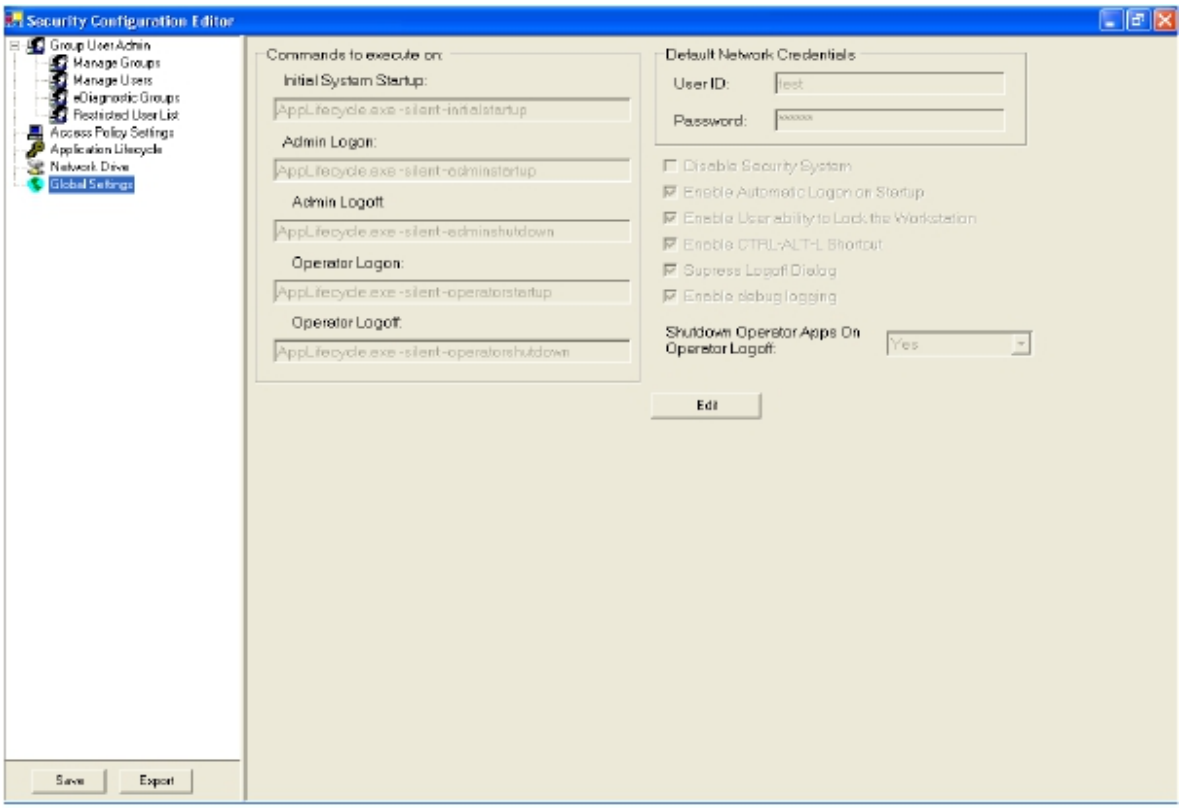
f. Proceed to Step 4, when done adding programs

4. Select Save from the lower, left corner as shown in Figure 11.14.
5. Close the Security Configuration Editor and restart Windows XP for the changes to take affect.

GLOBAL SETTINGS

Figure 11.17 shows the Global Settings dialog box. This is used to enable or disable automatic logon into Windows XP. Profiler security requires that the user logs into Windows XP as an Administrator. If you do not login as an Administrator, the software will not function correctly. To prevent non-administrators from being required to know an Administrative password to log into Windows XP, automatic logon will log into Windows XP using an Administrator account, without user intervention. After Windows XP is launched, the profiler login dialog is presented to the user and at this point profiler software controls Windows XP security and provides appropriate access level based on the user that logs into the profiler login dialog

Figure 11.17 *Global Settings*

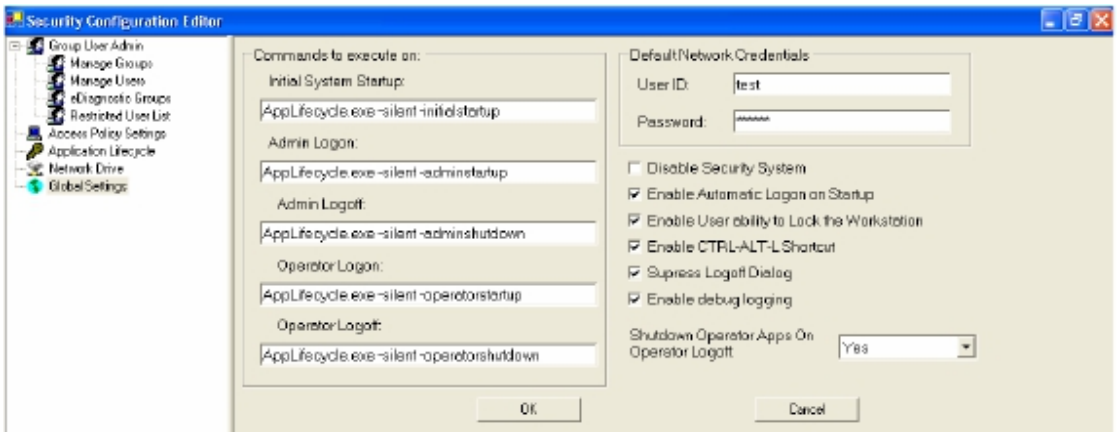


PROCEDURE TO CHANGE THE GLOBAL SETTINGS

NOTE: It is recommended to use automatic logon through the AutoLogonUser account. This is configured by default on new profiler systems shipping from KLA-Tencor.

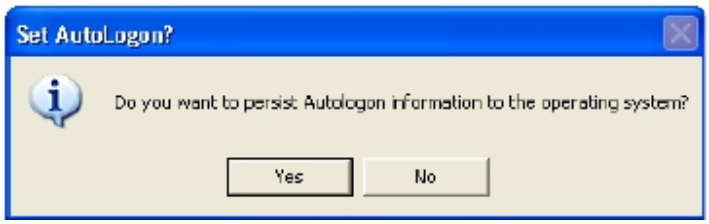
1. Start the Security Configuration Editor and select Global Settings.
2. Select the Edit button,which enables modification of settings as shown in Figure 11.18.

Figure 11.18 *Modify Global Settings*



3. To enable automatic logon (default, recommended value), check Enable Automatic Logon on Startup.
4. To disable automatic logon, uncheck Enable Automatic Logon on Startup.
5. Select Save from the lower, left corner as shown in Figure 11.17.
6. Select Yes to make the appropriate changes to Windows XP to enable Autologon, as shown in Figure 12.19

Figure 11.19 *Persist Autologon to Operating System*



7. Close the Security Configuration Editor and restart Windows XP for the changes to take affect.

SECURITY GROUPS

The computer is configured with a set of default Windows XP and Profiler software security groups. The administrator can create new user accounts that provide users access to these groups. The security groups and procedure to create new users is described in more detail below.

Windows XP defined groups functions as follows:

- **Administrator and Power Users:** A user who is a member of either of these predefined groups has all of the Profiler privileges. That is, he is allowed to use any and all Profiler software features and can create, delete, or modify any Profiler system or data files.
- **User:** A user who is a member of predefined Users group has the basic set of Profiler privileges:
  - View a scan or sequence recipe
  - Run a scan or sequence recipe
  - Save the data in a new data file
  - View data
  - Perform the Applied Force calibration

The Profiler defined groups have privileges as follows:

- **P_Configuration:** Gives the user the rights to view and modify all configuration settings, except advanced configuration settings: Theta Soft Home Position, Manual Load Position, and the elevator approach speeds.
- **P_AdvConfiguration:** Gives the user the rights to view and modify all configuration settings.
- **P_Calibration:** Gives the user the rights to view and modify all calibration settings, except advanced calibration settings: Linearity, Stagemapping, and Center of Rotation.
- **P_AdvCalibration:** Gives the user the rights to view and modify all calibration settings.
- **P_AppliedForce:** Gives the user the rights to perform the applied foce calibration.
- **P_RecipesData:** Give the user the rights to create and modify recipes and data, for scans and seqeunces. It also provides full access to the import and export functionality of recipes and data.
- **P_XYView:** Gives the user rights to access the XY View application.
- **P_GEMSECS:** Gives the user rights to modify all GEM/SECS settings.
- **P_Stress:** Gives the user rights to create and modify stress recipes and data.
- **P_DefectReview:** Gives the user rights to use the Defect Review application.

COMPUTER MANAGEMENT/USER ACCOUNTS

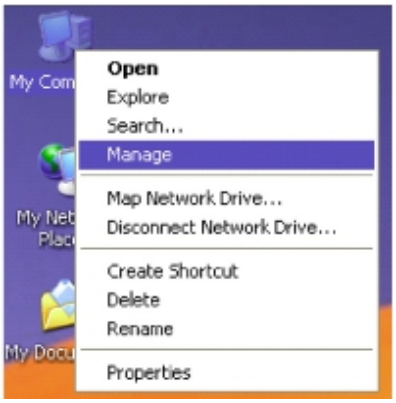
Computer Management or User Accounts is the security system interface for Windows XP. See Microsoft help for advanced user management not discussed in the Profiler user guide. The Profiler uses the Windows XP security system as one method to control access to Profiler software. All assignment of users to user groups and creation of user passwords are set in this screen. Only those with Administrator access can perform any of the functions in the computer management / user accounts screen.

PROCEDURE TO CREATE A NEW USER ACCOUNT

This procedure describes how to create an operator account. The tool owner should create at a minimum an Administrator, Engineer, and Operator account to limit tool access to authorized users. The default administrator password should not be changed since it could create problems for KLA-Tencor to access the tool for applications and maintenance activities. See Microsoft help for additional guidance on creating user accounts.

1. Log on to the Profiler as an Administrator. Make sure Profiler software is closed.
2. From the desktop, right click on My Computer as shown in Figure 11.20 and select Manage.

Figure 11.20 *My Computer/Manage*



3. From System Tools select Local Users and Groups as shown in Figure 11.21 This shows all of the user accounts on the tool.

4. Right click on the Users folder and select New User. This opens the dialog to create a new user account as shown in Figure 11.22

Figure 11.21 *User Account Management*

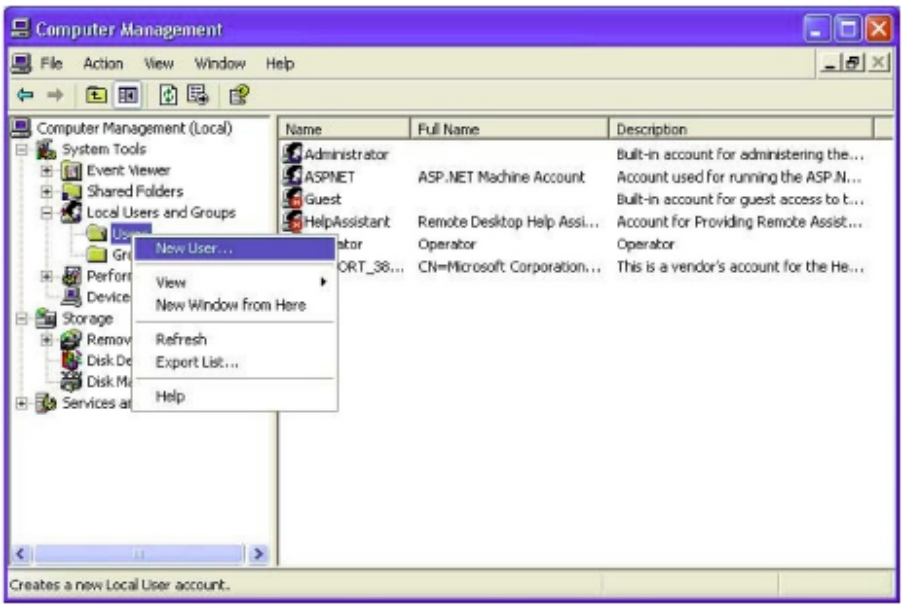
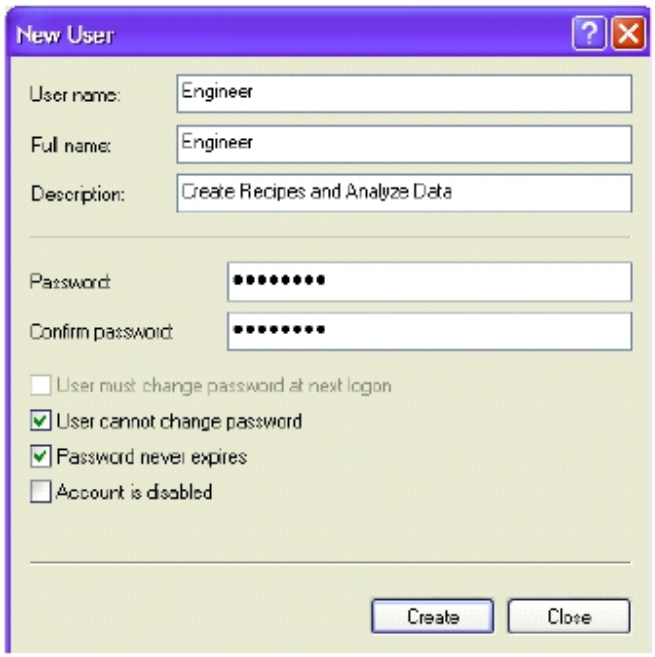


Figure 11.22 *New User Interface*



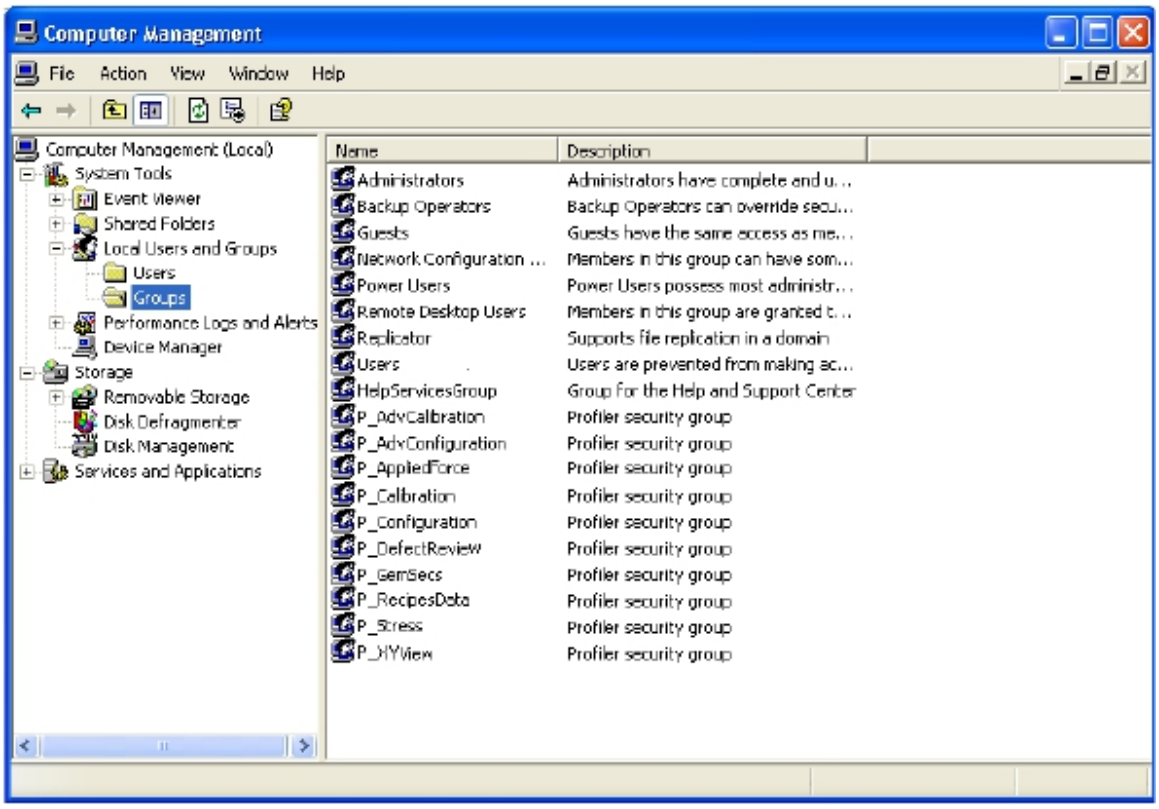
5. Enter the information for the new user and when complete, click on **Create**. When all of the new users have been added, click Close.
6. Now add the new user(s) to the correct Windows XP and Profiler security groups. For limited access only provide Windows XP User group access and then give access to the required Profiler security groups. This can be done by adding users to security groups or by adding security groups to the user accounts.

NOTE: It is generally easier to add users to the security groups since it is easy to remember the user name and more difficult to remember all of the combinations of groups.

PROCEDURE TO ADD USERS TO SECURITY GROUPS

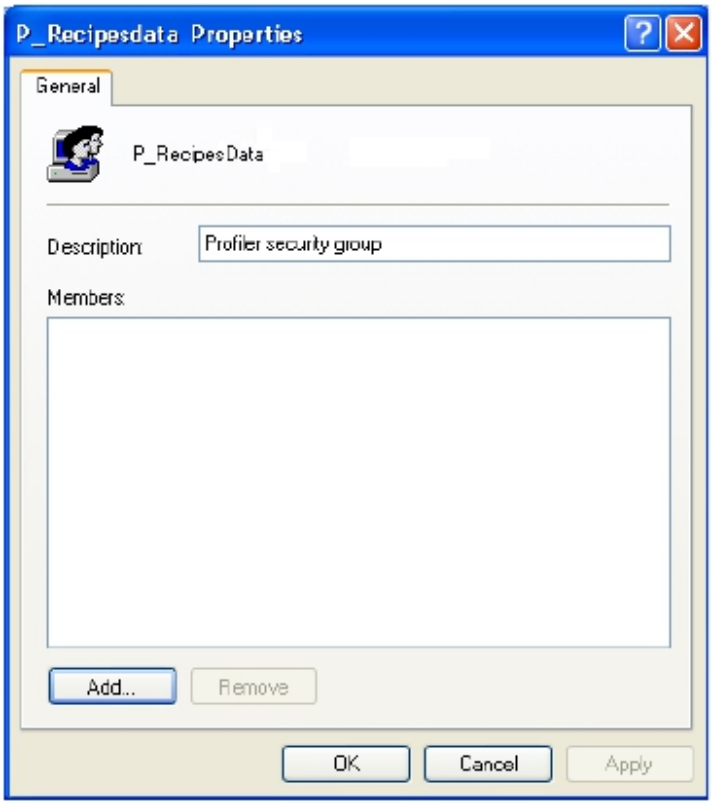
1. Select the Groups folder, as shown in Figure 11.23.

Figure 11.23 *Security Group Management*



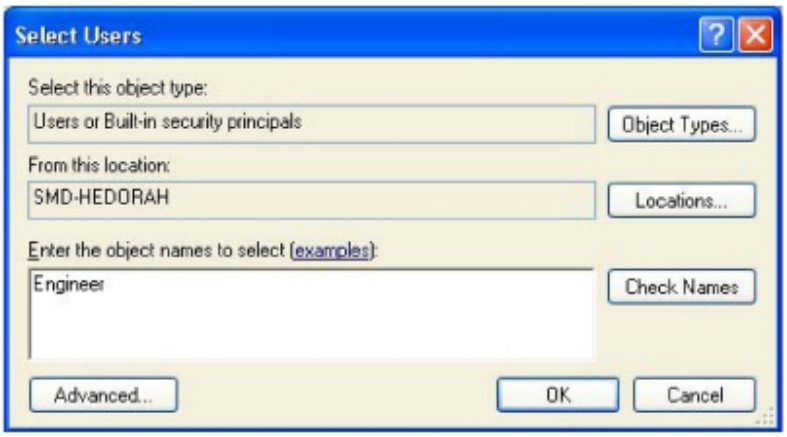
2. Double click on the Windows XP or Profiler security group to change the users who have access to this group. Figure 11.24 shows the P_RecipesData security group which grants access to edit, create recipes, and data.

Figure 11.24 *Profiler Security Group Members*



3. Click on Add to grant new users access to the security group as shown in Figure 11.25.

Figure 11.25 *Add a User to a Security Group*

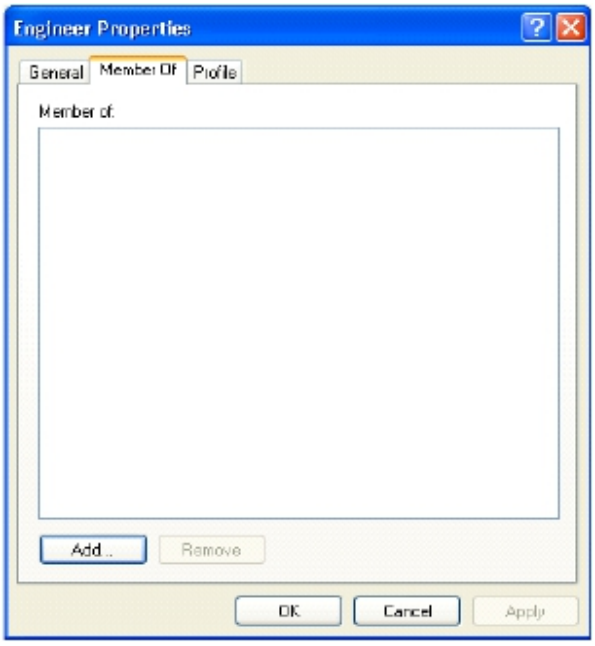


4. Type in the user name(s) in the object names field and click on **OK** when complete.
5. Click on OK from the security group window to complete adding the user(s) to the security group.
6. Repeat these steps for each security grup that the user(s) requires access.

PROCEDURE TO ADD SECURITY GROUPS TO USER ACCOUNTS

1. Select the Users folder, as shown in Figure 11.21.
2. Double-click on the ser, such as Engineer, to change the access right to the Windows XP or Profiler security grups and select the tab Member of as shown in Figure 11.26

Figure 11.26 *Windows XP User:Engineer*



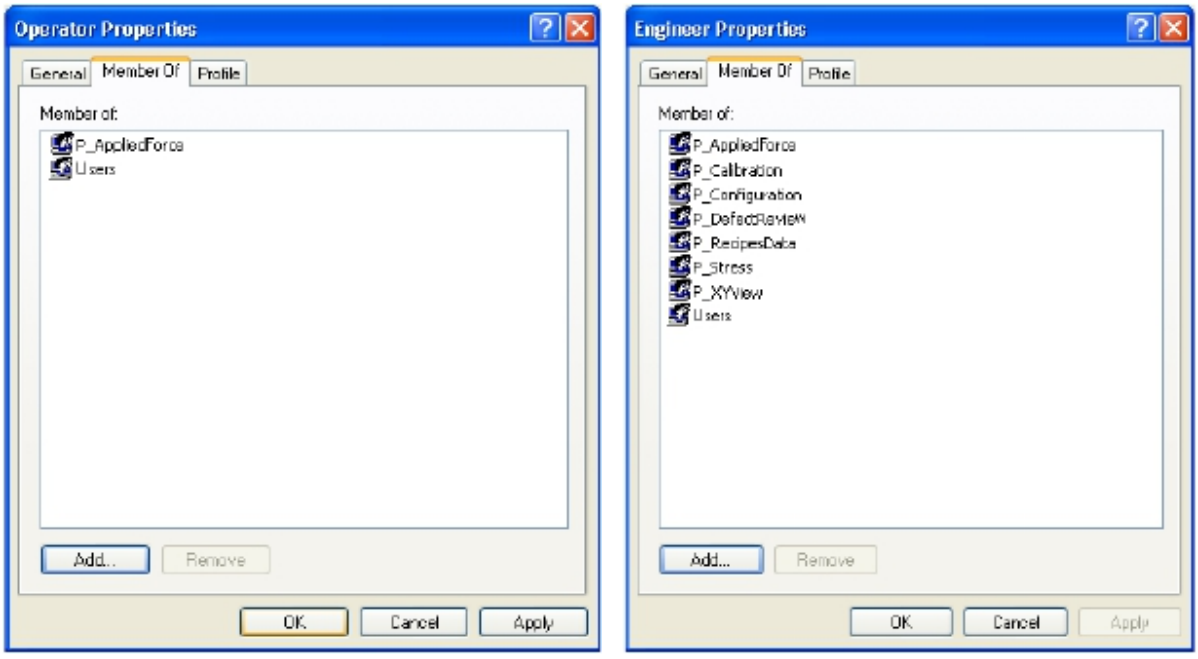
3. Click on Add to grant the user account access to security groups as shown in Figure 11.27.

Figure 11.27 *Add a Security Group to a User*

4. Type in the security group name(s) in the object names field and click on OK when complete.
5. Click on OK from the user group window to complete adding the security group(s) to the user account.
6. Repeat these steps for each user account that requires access to security group(s).

Figure 11.28 shows a typical operator and engineer user account. The operator belongs to the Profiler P_AppliedForce and Windows XP Uer security groups and is thus limited to only running recipes, viewing data, and running the applied force calibration. The engineer has access to most functionality, but is limited from the advanced access to calibrations and configuration settings. A lower level of engineer might be limited to only creating recipes and modifying data. Each tool administrator should create similar accounts to ensure that users can only access functions that they are trained on and require access to perform their daily job functions.

Figure 11.28 *Examples of Operator and Engineer Security Group Access*



CALIBRATIONS

STANDARD CALIBRATION MATRIX

The system is facilitated by a series of interconnected calibrations. The interdependency of the calibrations makes it important that those who calibrate the systems understand the which calibrations affect other calibrations. When performing any of the calibrations for the system, ensure that all prerequisite calibrations are performed prior to performing the target calibration. When the target calibration is completed, ensure that any necessary subsequent calibrations are performed or the possibility exists for inaccurate scans.

Table 12.1 *Standard Calibration Matrix*

Calibration to be Performed	Calibration Prerequisites	Post Calibration Requirements	System Performance Results
Applied Force	none	none	Protects stylus and sample during nulling procedure.
Video Calibration	Applied Force	none	Objects chosen (clicked on) in the screen are accurately positioned in the center of the screen. Improves accuracy of pattern recognition deskew and site-by-site pattern recognition.
Scan Position Offset Calibration	Applied Force, Video	none	When performing a scan with the sample stage, the general location taught for the scan is accurate. The scan occurs very near the taught position.
Step Height	Applied Force, Scan Position Offset	none	Feature steps on the sample surface are more accurately measured.
Radius of Curvature	Applied Force, Step Height	none	Radii of curved surfaces are more accurately measured.
Level	Applied Force	none	Ensures that the stylus does not exceed its vertical range due to the excessive tilt or level orientation of the stage.
Lamp Balance	Applied Force, Drop Timer	none	
Drop Timer	Applied force	none	

APPLIED FORCE CALIBRATION

Check the Calibration Matrix on *page 12-1* for possible interaction with other calibrations.

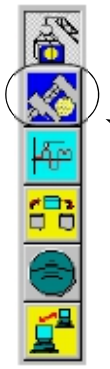
Introduction

Applied force is the force between the stylus tip and the sample when the stylus is in contact with the sample. Mechanical changes in the stylus arm can affect calibration settings.

Applied Force Calibration Procedure

1. Double-click the **Calibration** icon. (See *Figure 12.1*.)

Figure 12.1 *Catalog Screen - Choose Calibration*

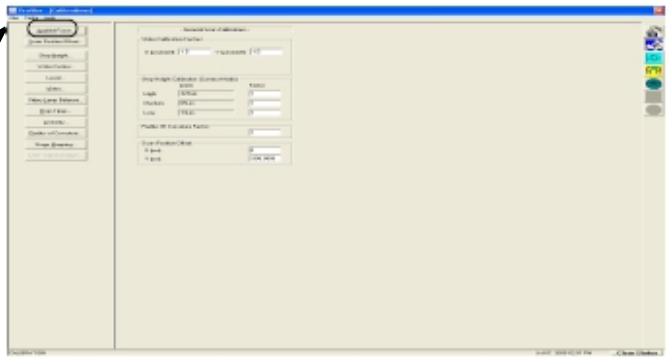


Step 1 Double-click the **Calibrations** icon to open the **Calibrations** screen.

2. Click the **Applied Force** button in the **Calibration** screen. (See *Figure 12.2*.) The Applied Force Calibration dialog box is displayed. (See *Figure 12.3*.)

Figure 12.2 *Calibrations Screen*

Step 2 Click **Applied Force** to display the Applied Force Calibration window.

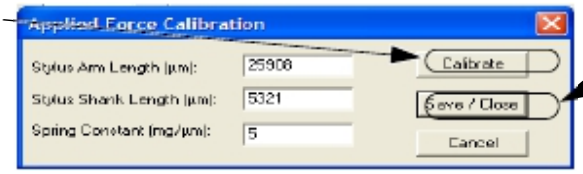


3. Click **Calibrate** to begin the calibration procedure.

   The system performs the calibration and displays the results in the three fields of the Applied Force Calibration dialog box. (See *Figure 12.3*.)

Figure 12.3 *Applied Force Calibration Window*

Step 3 Click **Calibrate** to begin the Applied Force Calibration.



Step 4 When the calibration is complete, click **Save/Close** to save the calibration results of the Applied Force Calibration.

4. Click **Save/Close** button to save the calibration results. (See *Figure 12.3*.)
   OR, click **Cancel** to retain the old calibration results.

CAUTION: Do Not Manually Change any of the numbers in the fields.

VIDEO CALIBRATION

Check the Calibration Matrix on *page 12-1* for possible interaction with other calibrations.

Introduction

Video calibration ensures that the stage position is correlated to the video image on the screen. The calibration calculates the video pixels/micron. This means that when a position on the video screen is clicked, that position moves to the screen crosshair. This calibration works two different ways depending on whether or not the Profiler system has the Pattern Recognition option (P-17 only). Both calibration procedures are presented.

1. In this procedure, using the ProCal Wafer is recommended. The directions in this procedure include loading a sample, like the ProCal Wafer.

NOTE: It is recommended to use Video Calibration procedure with pattern recognition, if available. The procedure using pattern recognition is covered first, starting on Page 12-3.

Video Calibration Procedure

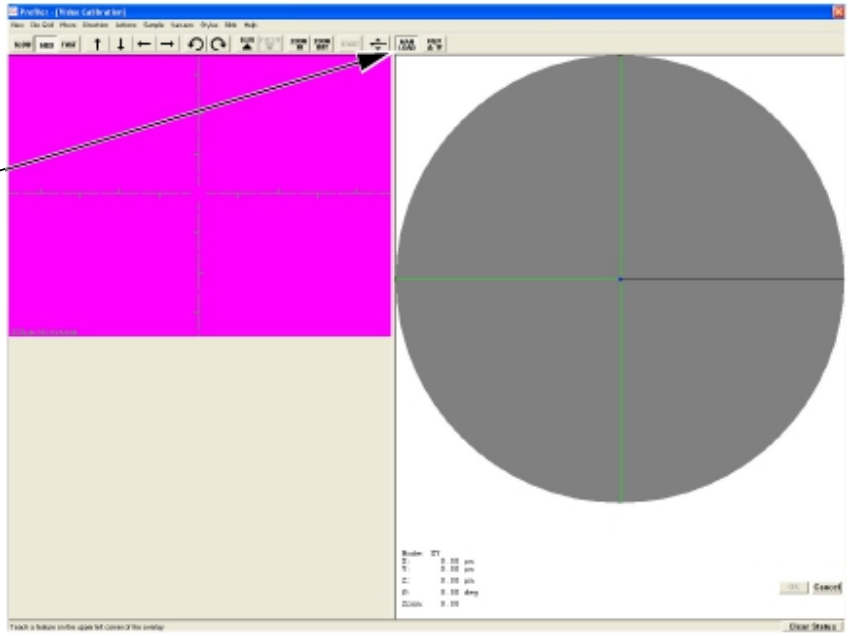
1. Click the **Calibration** icon. The **Calibrations** screen is displayed.
2. Choose **Video**. The XY View **Video Calibration** screen appears. (See *Figure 12.4*.)

Loading the ProCal Wafer

3. From the **Video Calibration** screen choose **MAN LOAD** to move the stage out to the stage door. (See *Figure 12.4*.)

   Use the ProCal Wafer to perform this calibration.

Figure 12.4 *Manual Load from the Video Calibration Screen*



Step Click **MAN LOAD** to bring the stage to the door so the sample can be loaded.

Step 7 After the sample is loaded on the stage, click **MAN LOAD** to return stage under stylus.

CAUTION: A system safety shutdown occurs if an attempt is made to activate any stage or elevator motion when the stage door is open, unless the interlock defeat switch has been disabled.

4. Place the ProCal Wafer (or other sample) on the stage. Position it in the center of the stage as squarely as possible with respect to the XY axis.
5. Turn of the vacuum using the switch just inside the left side of the door.

NOTE: The vacuum menu in the screen's menu bar is disabled. It does not effect the stage vacuum.

6. Close the door.
7. Click **MAN LOAD** to move the stage back into position under the stylus and the optics. (See *Figure 12.4*.)
8. Click **FOCUS** in the tool bar. (See *Figure 12.5*.) The system nulls on the sample (nulls = brings the head down and focuses the optics according to the currently set magnification with the stylus very near contact with the sample surface).
9. Ensure that the current zoom setting is correct for the measurements that this calibration is preparing for. The zoom setting is read at the bottom right of the screen. A setting of 0.00 is zoomed all the way out. (See *Figure 12.5*.)

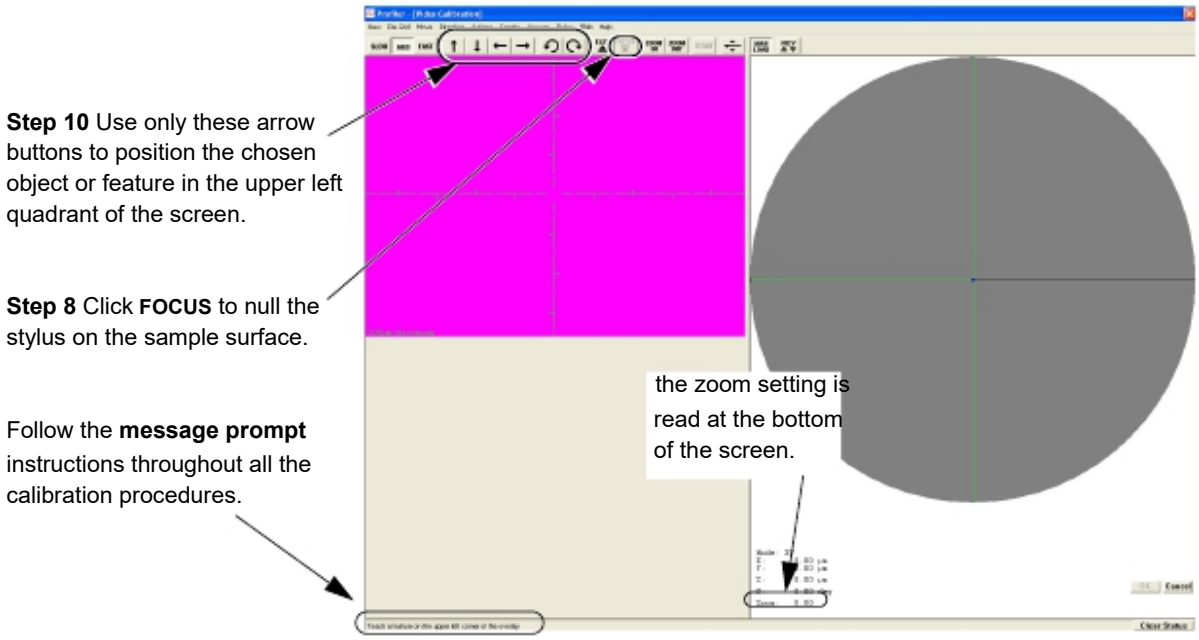
10. The prompt in the lower left corner of the screen reads, **"Teach a feature on the upper left corner of the overlay."** Use the linear arrow keys to position a feature in the upper left quadrant of the screen for use in teaching the calibration. *Avoid features that are identical or similar to other features nearby*. (See *Figure 12.5*.)

Teaching for Systems with Pattern Recognition

11. To TEACH the feature, drag a pattern recognition box around the chosen feature. (Pattern recognition box: Move the cursor above and to the left of the feature. Click and hold the mouse button, drag the box down below and to the right of the feature, and release the button.)

    The system moves the feature and pattern recognition locates it again. If the system locates the feature go to Step on page -6. Otherwise continue on to the next step.

Figure 12.5 *Message Prompt and Focus Button*



12. If the pattern recognition program does not find the pattern, perform the calibration again. If the system locates the feature, go to the results that are explained in **Step 14**. If the system still does not locate the feature, use the procedure for systems without pattern recognition as described in **Step 13** and **Step 14**.

Teaching for Systems without Pattern Recognition

13. Choose a feature in the upper left quadrant of the screen. To choose the feature, move the cursor crosshair over the feature and click it at a precise point that can be exactly identified again. The system moves the feature to another location nearby.

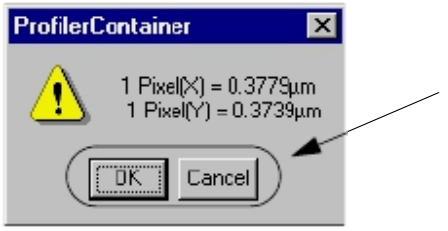
14. Click the same feature again in exactly the same place on the feature as the first click.

    The Profiler Container message box is displayed (this is true also if the pattern recognition finds the chosen pattern after Step 11 on page -5).

    The calibration results are presented as calculated ratios of:

    vertical and horizontal screen units called pixels *to* **X and Y stage coordinates** in microns (a ratio of Pixels to microns, see *Figure 12.6*.)

Figure 12.6 *XY Video Display Message Box*



Step 15 Click **OK** to save the calibration or **Cancel** to reject it and retain the old calibration.

15. Click **OK** to save the calibration or **Cancel** to reject it and retain the old calibration. The **Calibration** screen is then displayed. (See *Figure 12.6*.)

SCAN POSITION OFFSET CALIBRATION

Introduction

The Scan Position Offset Calibration procedure scans for data that it then uses to calculate the X-, Y-axis offsets from the optics and stylus, for positioning the sample stage.

During the Stylus Change procedure, the system automatically sets up the Scan Position Offset Calibration to be performed as part of the procedure.

See the "Scan Position Offset Calibration" , starting on Page 14-9, for the scan position offset calibration procedure.

STEP HEIGHT CALIBRATION

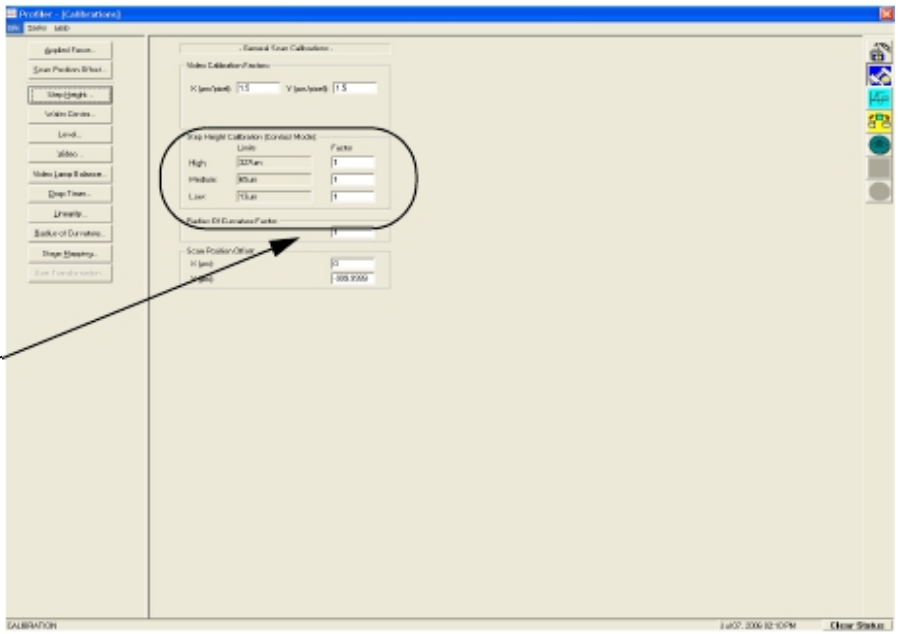
Check the Calibration Matrix on *page 12-1* for possible interaction with other calibrations.

The vertical sensing transducers in the system are not absolute devices and, therefore, require calibration.

CAUTION: All vertical ranges must be calibrated. Each calibration must be performed independently.

The best calibration results come from precision techniques carefully repeated. To promote uniformity in results, the procedure for Step Height Calibration is automated for each range. The recipes are written for use with VLSI Standards Inc. step height calibration standards. The ***step height calibration should be performed periodically***, ***for each of the three ranges***.

Figure 12.7 *Step Height Calibration Factors*



Step Height Calibration Factors are presented in the Calibrations screen.

Calibration Procedure:

Check the Calibration Matrix on *page 12-1* for possible interaction with other calibrations.

All three ranges must be calibrated.

1. From any top level screen choose the Scan Catalog icon to open the Catalog screen.
2. From the Scan Catalog screen, click the **XY** icon in the tool bar to open the XY View screen.
3. Click **MAN LOAD** in the tool bar, to move the sample stage to the door.
4. Open the stage door.

CAUTION: A system safety shutdown occurs if an attempt is made to activate any stage or elevator motion when the stage door is open (unless the interlock defeat switch has been disabled).

5. Place the **Step Height Standard** so it is centered on the stage, positioned squarely with respect to the X-Y axis.

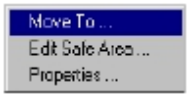
   (P-17 Only) If the step height standard does not cover the vacuum holes so they can be effective, it might be necessary to rotate the standard 45° so it does cover the vacuum holes.

   If the standard was rotated 45°, it is necessary to rotate the stage 45° in the same direction so the step and other scan features are properly oriented for a scan. To accomplish this

   a. Right-click in the navigation window to display the menu dialog box.

   b. Click **Move To...** to open its dialog box. (See *Figure 12.8*.)

Figure 12.8 *Navigation Window Right-Click Menu*



Step 5*b.* Choose **Move To...** to open its dialog box.

   c. In the Move To Position dialog box, enter 90 or -90 in the T (deg) field, depending on which way the step standard was rotated on the stage. (See *Figure 12.9*.) This step applies to P-17 only.

Figure 12.9 *Move To Position Dialog Box*

Step 5*c.* Enter 90 in the T (deg) field.

Step 5*d.* Click **OK** when the entry is complete.

   d. Click **OK** to rotate the stage and close the dialog box. (See *Figure 12.9*.)

6. Turn **ON** the Vacuum using the switch on the upper left inside jam of the door.
7. Close the door.
8. Click **MAN LOAD** in the tool bar, to move the sample stage back under the stylus.
9. Close the XY View screen. This returns to the Scan Catalog screen.
10. Click the Calibration icon to open the Calibration screen.

11. From the **Calibrations** screen, choose **Step Height…** (See *Figure 12.10*.) The **Step Height Calibration Options** dialog box appears in the center of the window. (See *Figure 12.11*.)

Figure 12.10 *Calibration Menu in the Calibration Screen*

Step 11 From the Calibration screen, choose **Step Height…** to open the Step Height calibration screen.

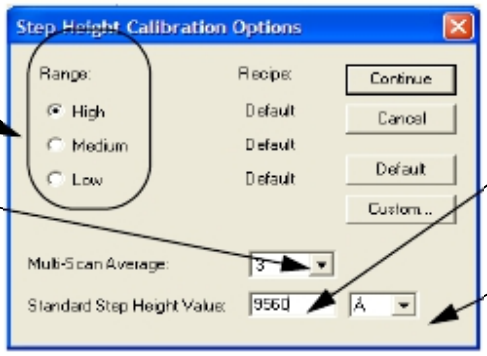
12. ***Range***: Choose the range to be calibrated. Select the appropriate step height standard for use in calibrating the selected range. (See the circled area in Figure 12.11.)
13. ***Multi-Scan Average***: This determines the number of times the profiler scans the same feature during each scan procedure. Data from all scans are automatically averaged and their average is presented as the scan result. Click the down-arrow next to the **Multi-Scan Average** value box to display the menu.

    Select the number of scans per calibration from the drop-down menu. (See *Figure 12.11* below.) The value should be at least 3, with 5 being optimum.

14. ***Standard Step Height Value:*** Enter the nominal step height value, for the standard being used, into the Standard Step Height Value field. Select the correct units from those available in the drop-down list to the right. See *Figure 12.11*.

NOTE: Units in **Å** correspond to recipes for VLSI Thin Film standards; units in **µm** correspond to the longer scan VLSI Thick Film standards.

Figure 12.11 *Step Height Calibration Options Dialog Box*



Step 12 Choose the range that is to be calibrated.

Step 13 Click the down arrow to display the menu. Choose the number of scans per calibration.

Step 14 The step height standard being used should have an absolute height value on it. Double-click the numerical box next to Standard Step Height Value: and type in the height displayed on the standard.

Ensure that the units displayed are identical to the step height units. To change the units, click the menu-arrow and click the correct units.

15. ***Recipe:***

CAUTION: KLA-Tencor recommends using the Default recipe for all calibrations. Default recipes should always be used unless there is a very good reason for creating a custom recipe. Creating a custom recipe for a calibration procedure could result in inaccurate calibration results. The system is designed to operate using Default recipes only.

The system provides both default and customizable calibration recipes for each of the three ranges. When a range is chosen, either the Default or a Custom recipe can be used to perform the calibration. The currently applied calibration recipe is displayed to the right of the chosen range. If nothing is changed, the currently displayed recipe is used for the calibration procedure.

Choose **Default** for the calibration unless there is a very good reason to change the recipe

16. To proceed with the calibration using the recipe indicated to the right of the range (Default or Custom), click **Continue**.

Default Recipe Option

17. To apply the Default recipe when "Custom" is indicated, click **Default**. The message, "Copy Default to Custom recipe?" appears. Clicking on **Yes** replaces the parameters in the Custom recipe with Default values. Clicking **No** retains the current Custom value.

18. Click **FOCUS** to null the stylus near the VLSI Step Height Standard surface and bring the standard into focus.

19. Use the arrow buttons to locate the calibration step on the standard.

    If the Video Calibration has been performed in the current zoom position, the hash marks on the crosshair are 100 µm apart.

20. Position the crosshair about 200 µm from the left side of the step and click **OK** (at the bottom right of the screen), or click **Start** in the tool bar. The instrument performs the same scan through the exact same location as many times as prescribed in the recipe (the **Multi-Scan Average on** *page 12-9*, set in the **Step Height Calibration Options** dialog box, *Figure 12.11*).

21. During the Step Height Calibration Scan procedure, the progression of each scan can be observed in the lower right corner of the screen, on the scan graph. Each scan is displayed in a different color.

22. The individual scans (Multi-Scan Average) are averaged to arrive at a single step height. The system then compares the average of the scans with the known VLSI standard step height that was entered into the Step Height Calibration Option dialog box. (See Step 14 on page -10.)

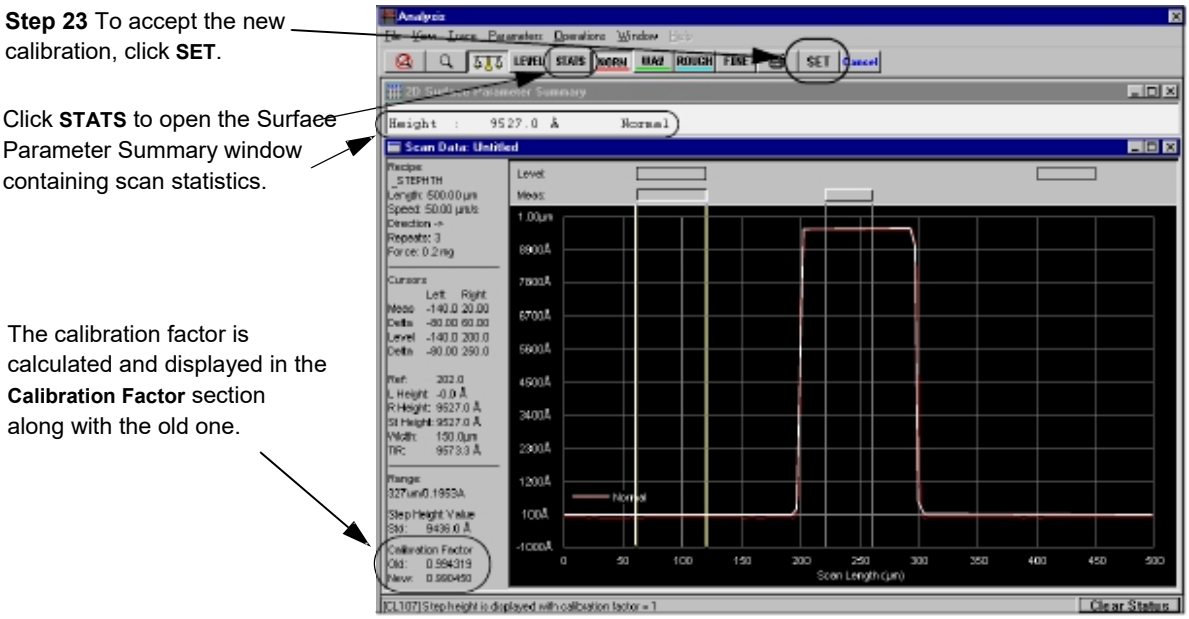
    When complete, the calibration factor is automatically calculated and displayed at the end of the information area of the Analysis window. (See the circled area at the bottom left in *Figure 12.12*.)

    The calibration factor is displayed with the last calibration factor. Both should be close. See the circled area at the bottom left of *Figure 12.12*.

    To compare the step height standard value with the averaged measured height, click STATS in the tool bar to open the Surface Parameter Summary statistics window. The step height result is displayed in the Statistics window. See the white area just above the Analysis trace window in *Figure 12.12*.

23. Click the **SET** button in the tool bar to save the calibration factor, or the **Cancel** button to keep the original value and return to the Calibrations screen. (See the circled area at the top right in *Figure 12.12*.)

Figure 12.12 *Saving the New Calibration*



24. Use the above procedure to repeat the step height calibration for the remaining ranges. Each range is significant and important for the integrity of future scans.

P-16 Series Level Calibrations

Accurate scans depend on the X- and Y-axis planes of the Sample Stage being parallel to the stage motion in the respective planes. Two independent calibrations, Tilt and Level, are required to ensure that these planes are parallel to the stage motion in their respective directions.

The Tilt Calibration (adjustment) sets the Y-axis plane of the Sample Stage surface parallel to the stage motion, which is defined by the surface of the reference flat. The Tilt calibration requires the manual adjustment of a screw under the stage. This calibration should be performed by a KLA-Tencor trained technician. The Tilt calibration is described in the Service Manual.

The Level Calibration sets the X-axis plane of the Sample Stage surface parallel to the stage motion, which is defined by the surface of the reference flat. The Level calibration is totally automated for the P-17/P-7 Profiler.

NOTE: Check the Calibration Matrix on *page 12-1*for possible interaction with other calibrations

The Level Calibration should be performed whenever one of the following conditions are present.

- System does not complete the initialization procedure
- Changing sample locators (e.g.: Adding a precision stress locator)
- Scans have excessiveraw non-level

Level Calibration Procedure

1. From from any top level screen, click on the **Calibrations** icon  .
2. Click **Level…** to open the Level Calibration screen.

Figure 12.13 *Calibration Screen*

Step 2 Click **Level...** to open the calibration screen.

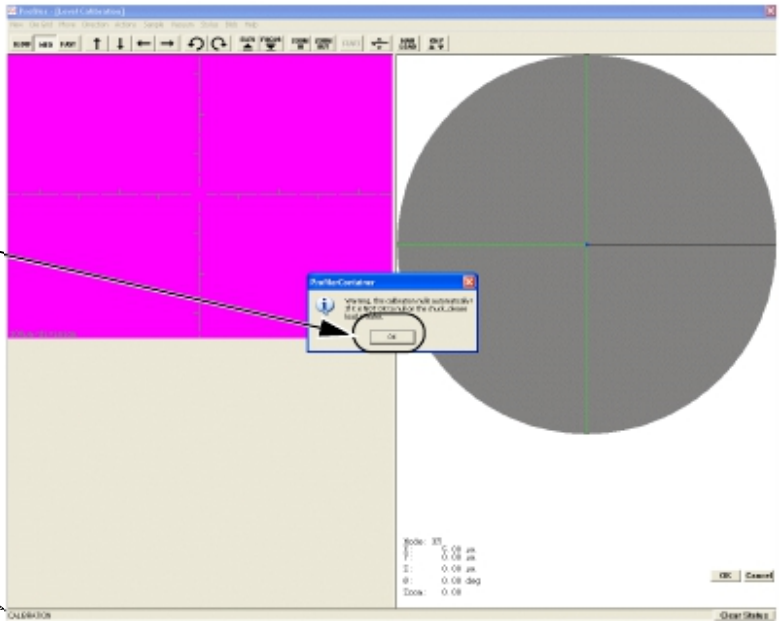
3. A warning appears in the **Profiler Container** message box. It states that the system automatically nulls in this calibration and advises that a sample be placed on the stage to prevent stylus damage. (See *Figure 12.14*.)

   Read the message and click **OK** to close the message box. (See *Figure 12.14*.)

Figure 12.14 *Level Calibration Warning*

Step 3 Click on **OK** to acknowledge the message warning of the automatic nulling of the stylus in this calibration.

System Status Bar.



4. After the warning message is acknowledged, a message is displayed (see *Figure 12.15*) in the system status bar at the bottom left of the screen as pointed out in *Figure 12.14*. The message requests the user to load a wafer onto the stage that matches the sample safe area then click the **OK** button. See the following wafer loading procedures.

Figure 12.15 *Tilt Calibration System Status Load Wafer Message*

Press <OK> when a 200mm wafer is loaded

Begin: Load Wafer

5. Click on **MAN LOAD** to move the stage to the Stage Door.
6. (See CAUTION below.) Open the stage door.

CAUTION: Do not activate the stage motion system with the door open, unless the interlock switch is disabled.

7. Load a **featureless** wafer onto the sample stage. Place it in the center of the stage.
8. Turn the vacuum ON using the switch on the upper left door jam.
9. Close the stage door.

End: Load Wafer Manually

10. Click **MAN LOAD** to move the stage back under the optics.

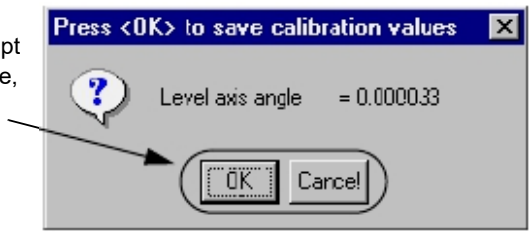
11. Click **OK** to begin the calibration.

    The stylus nulls twice, once each near the left and right extremes of the wafer. With each nulling, the Z value is registered. The system then calculates and corrects the stage level status such that, when the calibration is performed again, the entire surface of the stage has nearly the same Z value (assuming the wafer has a minimal bow and that the Tilt calibration is correct).

12. When the Level calibration is complete, the system presents a dialog box with the results and an option to accept or reject the calculation. Click **OK** to accept the calculated value or **Cancel** to reject it. (See *Figure 12.16*.)

Figure 12.16 *Tilt Axis Angle Calibration Value Dialog Box*

Step 12 Click **OK** to accept the Level calibration value, or **Cancel** to reject it.



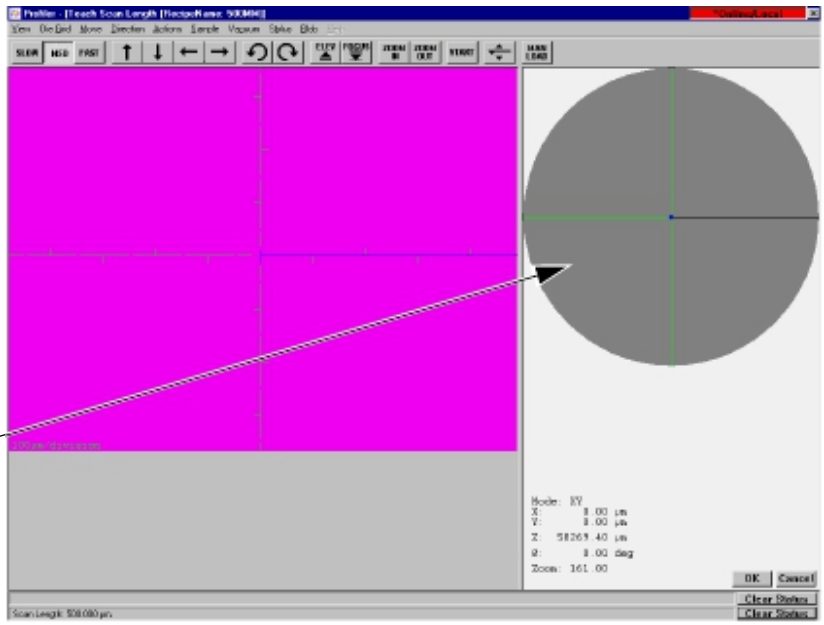
Level Calibration Confirmation

After the Level calibration is complete, a confirmation test must be made of the calibration results. The test consists of nulling near the left edge of the wafer and recording its Z height at null, and then nulling near the right edge of the wafer and recording its Z height at null. This can be done using the Lowest Elevator Position procedure accessed through the Configuration screen. The difference between the left and right Z value should be 20 µm or less for the calibration to be acceptable. If the Z value is greater than 20 µm, perform the Level calibration again.

1. Open the XY View screen. (See *Figure 12.17*.)

Figure 12.17 *Activating Focus in the XY VIEW Screen*

Step 2 Right-click in the Navigation window to open the **Move To...** menu.



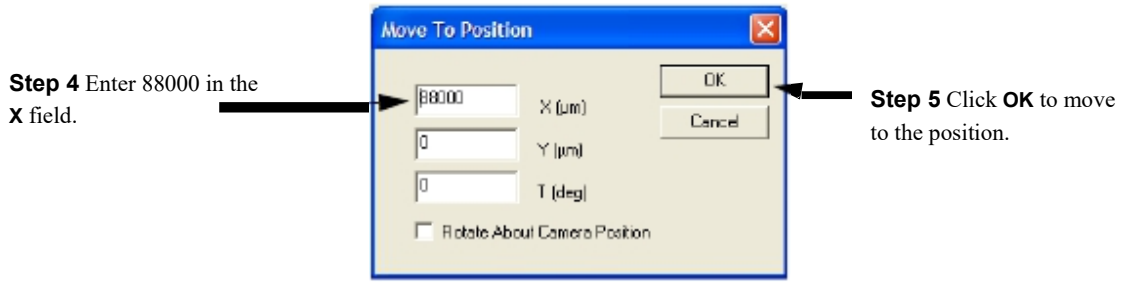
2. Right-click in the navigation window to display the Move Menu. (See *Figure 12.18*.)
3. From the Move Menu choose **Move To...** (See *Figure 12.18*.)

Figure 12.18 *Move To Menu*

Step 3 Choose **Move To...** to open the Move To Position dialog box.

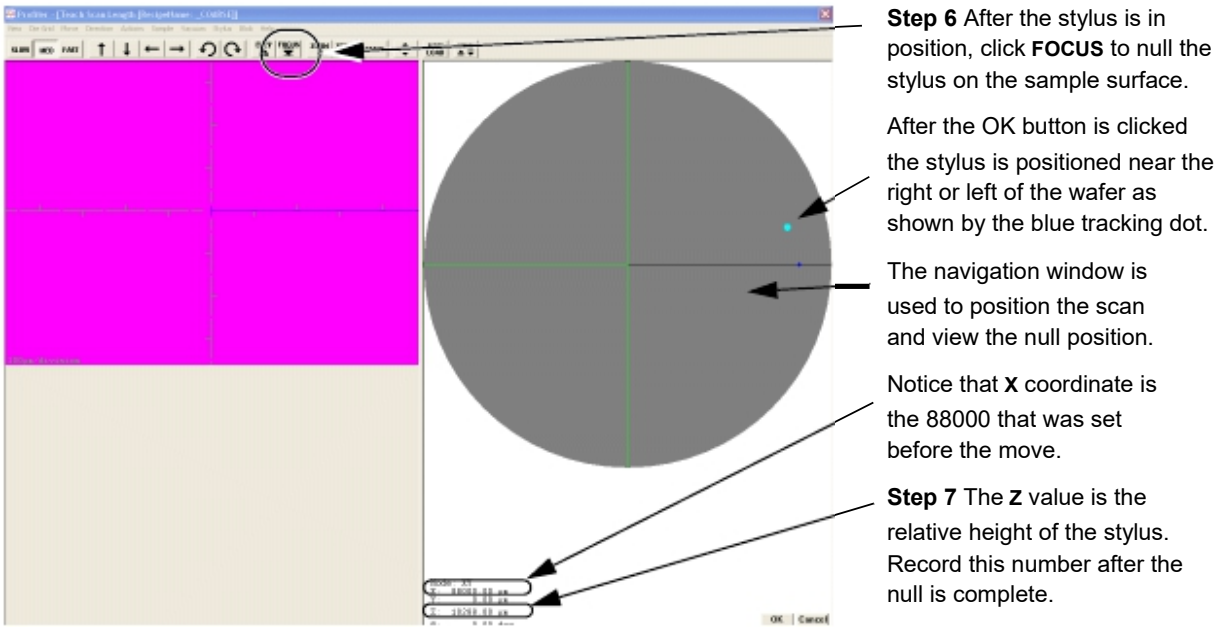
4. The Move To Position dialog box opens. Leave the Y and T fields empty and move to a coordinate approximately 10% from the left edge of the sample. For example, when using a 200 mm wafer, enter **88000** in the **X** field. (See *Figure 12.19*.) This positions the stylus at the right side of the stage as shown in *Figure 12.20*.

Figure 12.19 *Move To Position Dialog Box*



5. After the entry is complete, click **OK** to close the dialog box and position the stylus at the new coordinates. (See *Figure 12.19*.)

Figure 12.20 *Teach Lowest Elevator Position Screen*



6. After the stylus is in position, click on **FOCUS** to null the stylus near the back of wafer. (See *Figure 12.20*.)
7. When the focus procedure is complete, record the **Z** value as indicated in the lower right corner of the screen. (See *Figure 12.20*.)
8. Right-click in the navigation window to display the Move Menu.

9. From the Move Menu choose **Move To...** (See *Figure 12.21*.)

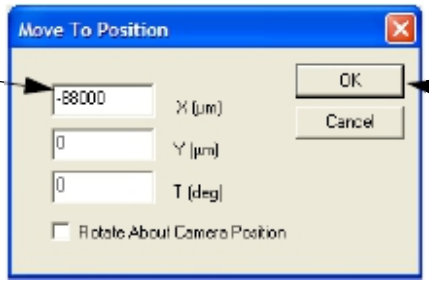
Figure 12.21 *Move To Menu*

Step 9 Choose **Move To...** to open the Move To Position dialog box.

10. The Move To Position dialog box opens. Leave the Y and T fields empty and move to a coordinate approximately 10% from the right edge of the sample. For example, when using a 200 mm wafer, enter **-88000** in the **X** field. (See *Figure 12.22*.)

Figure 12.22 *Move To Position Dialog Box*

Step 10 Enter -88000 in the **X** field.



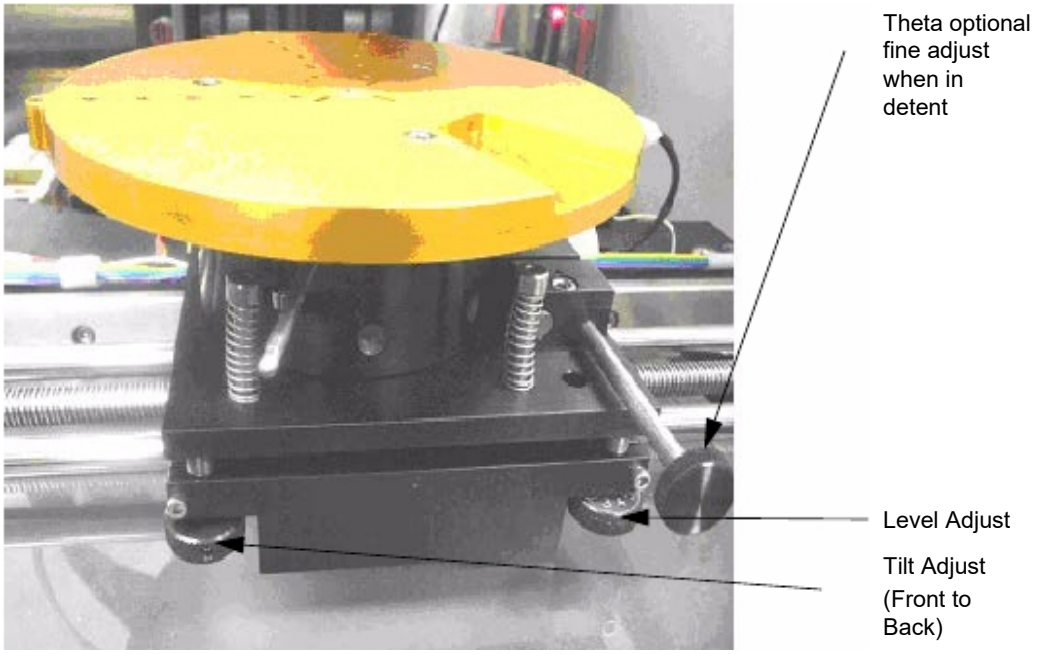
Step 11 Click **OK** to move to the position.

11. After the entry is complete, click **OK** to close the dialog box and position the stylus at the new coordinates. (See *Figure 12.22*.) The blue tracking dot appears at the left edge of the wafer.
12. After the stylus is in position, click on **FOCUS** to null the stylus near the front of wafer.
13. When the focus procedure is complete, record the **Z** value as indicated in the lower right corner of the screen. (See *Figure 12.20*.)
14. The numerical difference between the Z value near the right edge of the wafer and the Z value near the left edge of the wafer represents the level calibration results. If this number is less than 20 µm, the calibration is within specifications. If it is not within the specifications, perform the Level calibration again and check the results.

P-7 LEVELING

P7 Leveling is performed manually using the lower right knob as shown below:

Figure 12.23 *P7 Precision Standard Locator Chuck*



Procedure:

1. Press level button under calibrations.
2. Press OK to close dialogue box in middle of screen.
3. Press OK in lower right corner after wafer has been loaded onto the chuck.
4. After level calibration is complete, dialogue box will prompt user to turn lower right knob beneath stage, a fraction of a revolution either CW or CCW.

WAFER CENTER CALIBRATION

The sequence transportability depends on the system using the center of the wafer as a reference point instead of the center of the stage, as has been done in the past. This requires that the **Calibrate Wafer Center** calibration be run. The **Calibrate Wafer Center** calibrates the center of the wafer as the (0,0) reference point. After this calibration has been run, all sequence recipes and the system **Safe Area** settings use the wafer coordinates. (See "Calibrate Wafer Center" Calibration.)

The P-17/P-7 Profiler systems do not use a handler, so this is only effective if the system has a precision locator for wafer alignment.

Calibration Procedure

Before performing the Calibrate Wafer Center calibration, all system calibrations must be current, including the Center of Rotation if applicable. If not, perform these calibrations first along with any prerequisites. After these are acceptably completed, proceed with the following calibration.

1. From the Calibration screen, click the Calibrate Wafer Center button.
2. Load a wafer.
3. Click **OK** after the wafer is loaded.

   The system moves the wafer to until its edge is under the optics, normally moving to the edge at 30. When the stage stops, the system focuses on a point near the wafer edge.
4. For the P-17 with Pattern Recognition Option, the system will use pattern recognition to locate the edge of the wafer. Otherwise, the user must move the stage to align the edge of the wafer with the screen crosshairs..
5. Click **OK**.
6. Repeat Steps 4 and 5 for two more edges, normally at 120 and 300°.
7. After the calibration is complete, the system will display a dialog box showing the new and old wafer center values, asking the user to accept or cancel the calibration. If the results are good, select OK.
8. The status bar will show a message that calculates the difference between the new and old wafer center calibration results to determine the change made to the calibration was large or small.

CONFIGURATION

OPERATING ENVIRONMENT

The KLA-Tencor systems use an internal, passive vibration isolator system to allow operation in a normal production-line environment. For highly sensitive measurements (i.e., for artifacts below 500 Å or when the system is located in excessively noisy areas), KLA-Tencor recommends an isolation table.

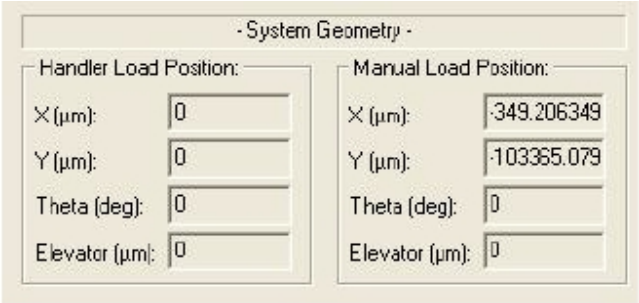
For service access, approximately 50 cm (20 in.) of air space on both sides and to the rear of the instrument is required.

CAUTION: The installation site must be free from sudden temperature changes or extreme drafts. Do not place the instrument directly in the airstream of an air-conditioning vent or heating outlet.

SYSTEM GEOMETRY

The System Geometry shown in *Figure 13.1* displays the handler and manual load positions for reference only. They are set during system installation and should not be changed except by qualified service personnel. Handler Load Position does not apply to P-17/P-7 Profiler.

Figure 13.1 *System Geometry*



The elevator manual load position is important to system throughput and reliability. Typically, the manual load position is set to X=0, Y=10000. Leave the load position at the front edge to insure that the sample is not under the stylus when exchanged. Set the Z height to 1000 µm above the sample if they are all of similar thicknesses and the sample is easily removed without any possibility of hitting the stylus. If a large sample is under the stylus at the manual load position, then decrease the elevator value to provide 20,000 clearance.

Level and Tilt

The P-17 has motorized level (left to right). The P-7 has manual level by adjusting a thumb screw. Both the P-17 and P-7 have manual tilt (front to back) by adjusting a thumb screw. The "Level Calibration Procedure" is discussed in the "Calibrations" chapter, starting on page 12-13 (P-17) and page page 12-20 (P-7).

Software Tilt Correction

The software tilt correction factors are offsets that improve upon the mechanical tilt and level controls. These correction factors do not affect the mechanical leveling of the stage, but instead are applied through software algorithms to the raw scan data as it is collected and shown to the user during runtime. In addition to a tilt correction, this feature also normalizes the scan data so that the first point is shown at zero. This scan recipe option is enabled by default. As always, the raw data is saved in a separate data buffer so that the user can reprocess the data at anytime, with or without software tilt correction factors applied.

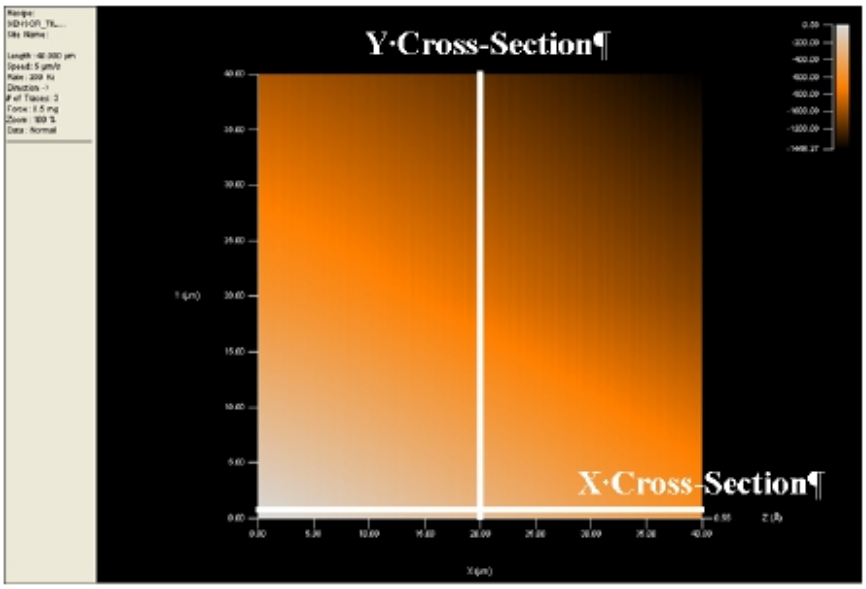
The software tilt correction factors are determined by running 3D scans at the center of the wafer, finding the angle of x and y cross-sections, and entering the results in the calibration page. The same calibration procedure is used for all systems, except the recipes used will be based on the configuration of the tool. The procedure below shows an example of calibrating the tilt offset on a P-17/P-7.

NOTE: It is recommended to perform a level calibration before determining the software tilt correction factors.

Calibration Procedure for Software Title Correction Factors

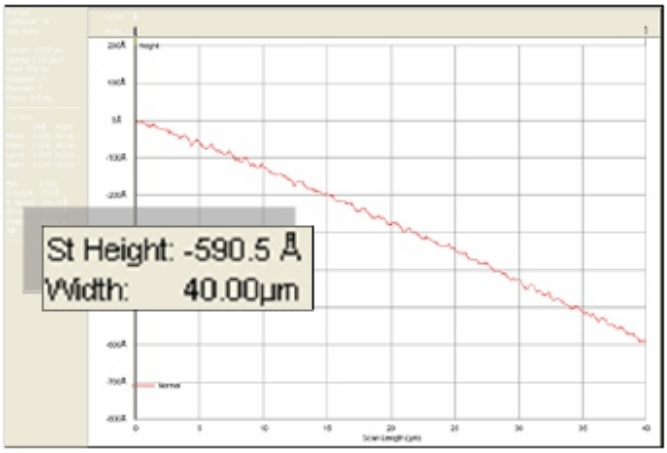
1. From the scan recipe catalog, open the sensor tilt correction recipe, SAMPLE_TILT_CORRECTION, located in the KT Recipe Library folder.
2. Load the ProCal wafer or a bare Si wafer.
3. Position the scan in an unpattered section of the wafer, near the center of the stage. Start the scan recipe once it is correctly positioned.
4. Once the scan completes, it should look similar to Figure 13.2, showing a tilt in the X and Y directions.

Figure 13.2 *Example Sample Stage Tilt Calibration Scan*



5. Enable the cross-section toolbar function.  Take a cross-section in the x-direction, as indicated in Figure 13.1, on the first line of the 3D scan. It should look similar to Figure 13.2.
6. The leveling cursors should be at the start of the scan to disable leveling. The step height cursors should be at each end of the scan to calculate the tilt of the scan.

Figure 13.3 *Example Sample Stage X-Direction Cross-Section Calculation*



$$\theta = Tan^{-1}\left(\frac{StepHeight}{StepWidth}\right)$$

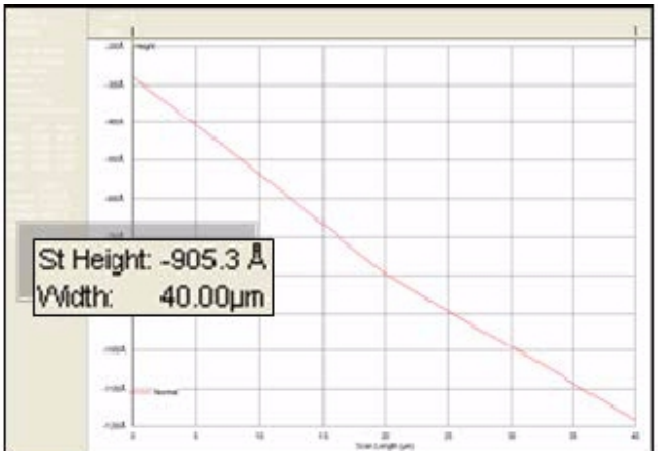
$$\theta = Tan^{-1}\left(\frac{590.5}{40.0*10000}\right)$$

$$\theta = 0.085°$$

NOTE: Change the calculation to 700 instead of 40.
If the height is given in angstroms, divide by **10000**.
If the height is given in micrometers, divide by **700 µm**.

7. Calculate the sample stage x-axis tilt correction factor using the formula shown in Figure 13.3. This is done by taking the absolute value of the scan width and the step height, located in the information pane to the left of the scan, and calculate the tilt correction factor using the formula shown in Figure 13.2.
8. Calculate the y-axis tilt correction factor by repeating steps 5 through 7, except using a y-direction cross-section. A y-direction cross-section can be created by right-clicking on the 3D scan, selecting Lock to Vertical Cross-Sections from the Cross Section Tool menu. Position the cross-section through the center of the scan, as indicated in Figure 13.1 and calculate the tilt correction factor as shown in Figure 13.4.

Figure 13.4 *Example Y-Direction Cross-Section Calculation*



$$\theta = Tan^{-1}\left(\frac{StepHeight}{StepWidth}\right)$$

$$\theta = Tan^{-1}\left(\frac{905.3}{40.0*10000}\right)$$

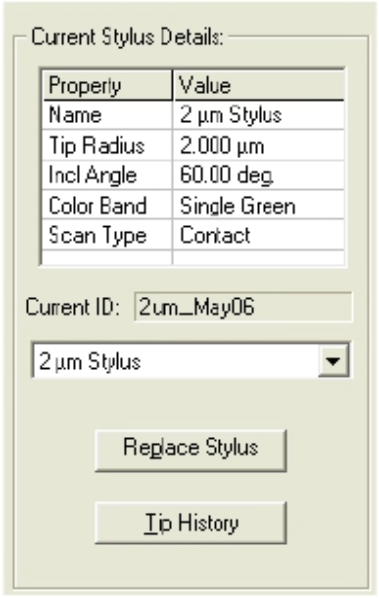
$$\theta = 0.130°$$

9. For a downward slope (negative step height), multiply the tilt correction factor by negative one (-1). For an upward slope (positive step height), no adjustment is required.
10. Enter the sample correction factors on the Configuration page of the software and click on the button Save Stage Configuration Changes when done.

Stylus Details

The Stylus Details configuration shown in Figure 13.5 displays information about the stylus currently installed in the system. The current stylus details section provides basic information about the stylus, such as the tip radius and cone angle. Below this section is the stylus ID entered by the user at the time of the stylus exchange. It is important to give each stylus a unique ID since the system keeps a history file for each stylus installed in the system based on the user entered ID. The Tip History button opens the stylus history file in a text viewer.

Figure 13.5 *Stylus Details*

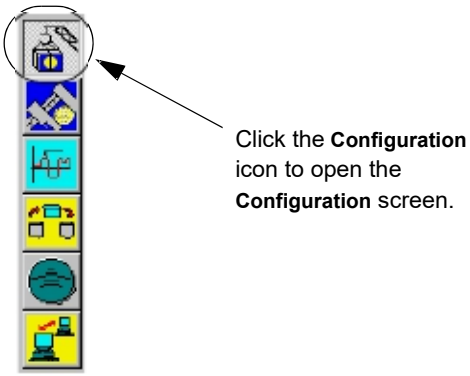


INTRODUCTION TO SYSTEM CONFIGURATION

The KLA-Tencor system application software must have the correct information in its internal configuration files to properly run the instrument. The following sections cover checking and editing these configurations.

To access the **Configuration** screen, click the **Configuration** icon in any system level screen. (See *Figure 13.6*.)

Figure 13.6 *Choose Calibration*



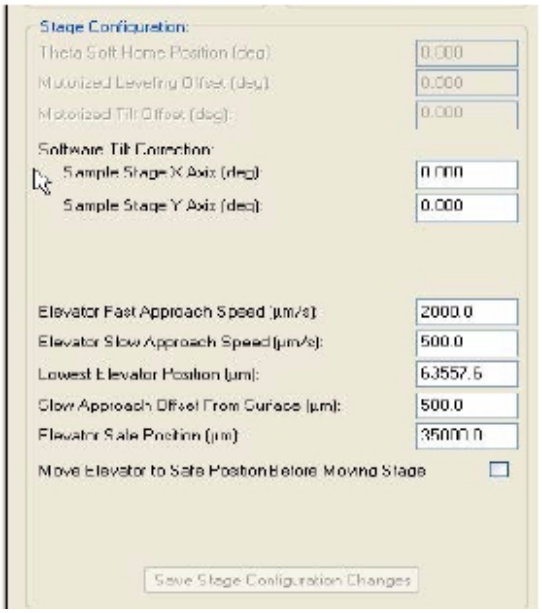
The **Configuration** window is displayed.

The left side of the screen contains a series of access buttons that open configuration parameter dialog boxes in which configuration values can be set. The right side of the window shows some of the current configuration values. Most of these values are set by manufacturing technicians prior to shipment of the system. **Although these values are editable, they should not be changed without advice from KLA-Tencor Technical Support personnel.**

STAGE CONFIGURATION

The items in the Stage Configuration area are all editable using Configuration screen options. All of the variable fields except the Theta Soft Home Position, the ones with the active variable fields (white background), can be edited directly in the field itself. The Theta Soft Home Position must be changed using the configuration procedure presented by clicking its configuration button.

Figure 13.7 *Stage Configuration Parameters*



Theta Soft Home Position

The Soft Home position is set at manufacturing and should not require adjustment.

This procedure should only be attempted by a KLA-Tencor trained technician.

Teach Lowest Elevator Position

Introduction

The Lowest Elevator Position sets the vertical motion range of the stage. Using this feature, a limit (**Z coordinate**) can be set for the elevator so that the measurement head cannot descend past the level of the sample surface.

Correctly teaching the Lowest Elevator Position protects the measurement head when the Proximity Sensor (which is used to switch from **Elevator Focus Speed** to **Elevator Slow Focus Speed**) is not being used.

CAUTION: It is very important to reset the correct **Lowest Elevator Position** after a precision locator is installed. The stylus can be damaged if the stage remains configured to the original setting.

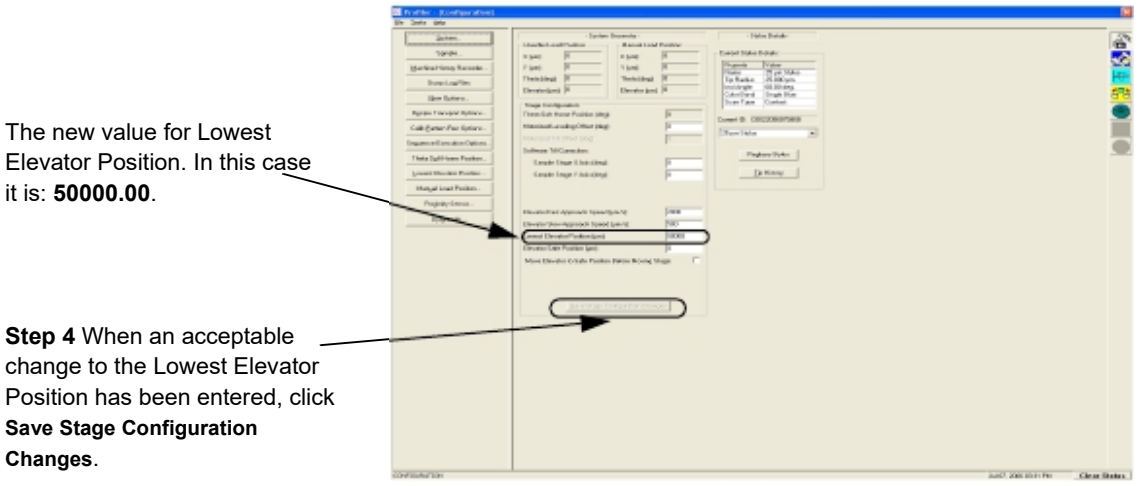
Procedure to Teach Lowest Elevator Position

This positioning procedure requires that the stylus make contact with the stage surface, precision locator surface, or a ample (if samples of consistent thickness are used) in order to assign a lowest elevator position that allows the system to locate and use the sample support surface or embedded standards. It is best to use a sample if the samples tested are of a consistent thickness. **Make sure that the stylus stops on the top surface and not in a hole or grove.** Once the stylus is aligned with the proper surface position, the remainder of the procedure is automatic.

1. Load a sample.
2. Click **FOCUS** in the tool bar to move the head down to focus on the sample. The system is set to protect the stylus so this final null could take a relatively long time.
3. When the null is complete, click **OK** to accept the Lowest Elevator Position (Z coordinate) position or **Cancel** to reject the new position (Z coordinate) and retain the previous one. The screen should close and return to the Configuration screen.

   The system takes the null position Z coordinate and adds 500 µm to it. The new accepted position is automatically entered into the Lowest Elevator variable field in the Configuration screen. (See *Figure 13.8*.)

Figure 13.8 *Configuration Screen - Lowest Elevator Position*



4. In the Configuration screen, if the Lowest Elevator Position (**Z coordinate**) is acceptable, click **Save Stage Configuration Changes** to accept the new value; or, to retain the previous position, close the screen without saving the changes.

Elevator Focus Speed

This is the speed at which the elevator lowers the head toward the sample surface until it reaches the Proximity Sensor Trip Position. When it reaches the trip position, it proceeds with the Elevator Slow Focus Speed until Soft Null or Null is reached, depending on whether the proximity sensor is being used. (See *Figure 13.7 on page 13-7*, also *Figure 13.8*.)

Settings Determining Trip Position

NOTE: Proximity sensor is in P-17 only.

- If the proximity sensor is *not on*, the Elevator Focus Speed is active until the elevator reaches 1mm above the Lowest Elevator Position, at which point the Elevator Slow Focus Speed is activated.
- If the proximity sensor is *on*, the Elevator Focus Speed is active until the proximity sensor trip position is reached, at which time the Elevator Slow Focus Speed is activated.

Elevator Speed

The elevator speed in this setting cannot exceed 1000 µm/second if the proximity sensor is off. Otherwise, if it is on, the speed is 2000 µm/second

Elevator Slow Focus Speed

The Elevator Slow focus Speed is the speed at which the elevator lowers the head from the Elevator Focus Speed trip position until null is accomplished. (See *Figure 13.7 on page 13-7* also *Figure 13.8*.)

Move Elevator to Safe Position Before Moving Stage

This checkbox works in conjunction with the Elevator Safe Position variable. If this box is checked, the elevator moves the head up to the recorded height in the Elevator Safe Position variable field. This prevents the stylus from contacting the surface of an ununiform or tilted sample as the sample moves from one location to another. (See the checkbox in *Figure 13.7 on page 13-7* also *Figure 13.8*.)

Elevator Safe Position

This feature works in conjunction with the Move Elevator to Safe Position Before Moving Stage checkbox. If there is a check in the box, this variable is used. If there is no check in this box, the head is not lift up this distance. This is the absolute elevator height that the system moves the head to every time the stage is moved under the prescribed circumstance. (See *Figure 13.7 on page 13-7*, also *Figure 13.8*.)

NOTE: The smaller the number, the longer it takes for the head to rise before the move and lower after the move. Set this number carefully if processing time is a concern, especially in sequence scans.

SYSTEM CONFIGURATION

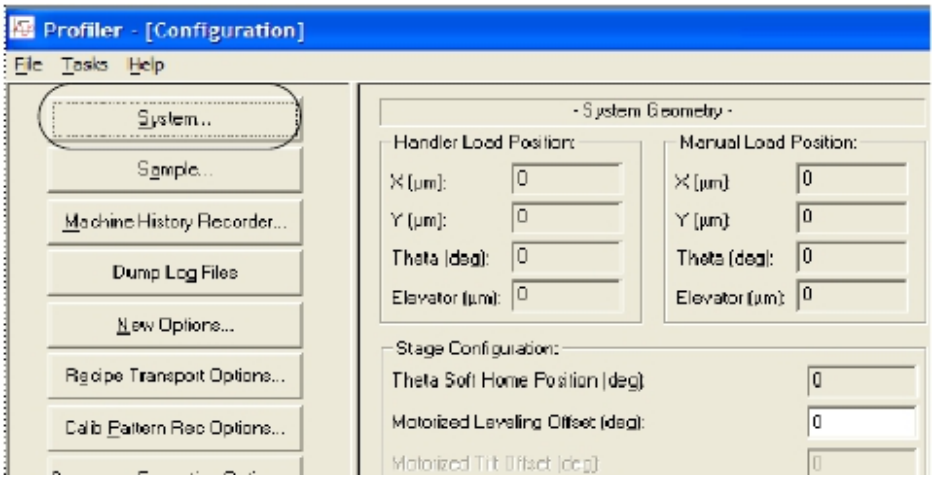
The System Configuration options can only be observed in the System Configuration dialog box, not edited. The System Configuration screen contains tabbed windows that allow the user to observe the process and hardware settings for the instrument. Changes must be performed by KLA-Tencor trained technicians.

Editing the System Configuration

1. Click the **System…** button at the left side of the Configuration screen. (See *Figure 13.9*).

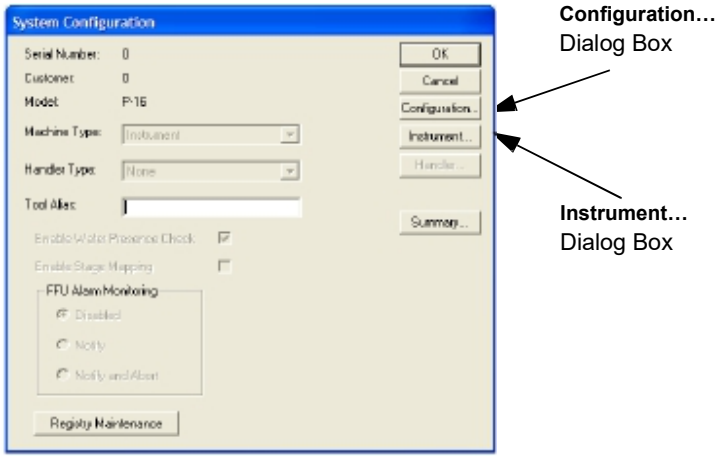
Figure 13.9 *Configuration Screen*

Step 1 To open the System Configuration dialog box, choose **System…**



The **System Configuration** dialog box appears. (See *Figure 13.10*)

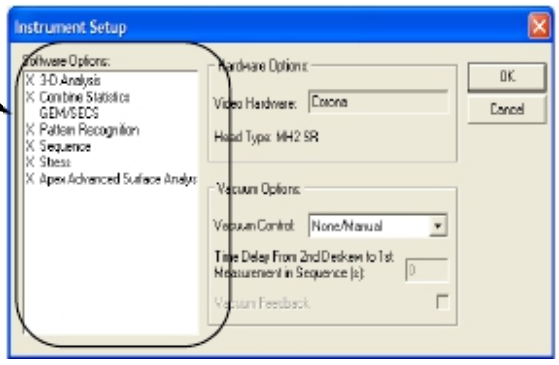
Figure 13.10 *System Configuration Dialog Box*



Instrument Setup Configuration Dialog Box

Figure 13.11 *Instrument Setup Dialog Box*

Step 1 Change the Software Options by clicking on them. The chosen options will have an **X** next to them. Deactivated options have no **X**.



The **Instrument Setup** dialog box provides access to the **Software Options** activation box and the **Vacuum Options** box. The **Hardware Options** box is a display box that reports the current Video Hardware and MicroHead type. The following steps detail the operation and function of each activity box and check box. (See *Figure 13.11*.)

Software Options

1. All of the purchased software options should appear in this box. (See the circled area in *Figure 13.11*.) An **X** before the option name indicates that it has been enabled. Click the option to toggle between enabled and disabled. Choose the options that are to be enabled in the upcoming scanning session. When the configuration changes are complete, a system warning tells the user that the system must be restarted to initiate the new options and other changes.
2. The vacuum system is manually operated so no changes are required in the **Vacuum Options** field. Click **OK** to confirm the **Software Options** selection.
3. The **System Configuration** window appears again. If no further changes are required, click **OK** to confirm the current changes. A window appears advising the operator that the system must be restarted to activate the newly enabled software configuration (selected options). The system MUST BE RESTARTED TO ACTIVATE THE NEW SOFTWARE OPTION CONFIGURATION.

SAFE AREA CONFIGURATION

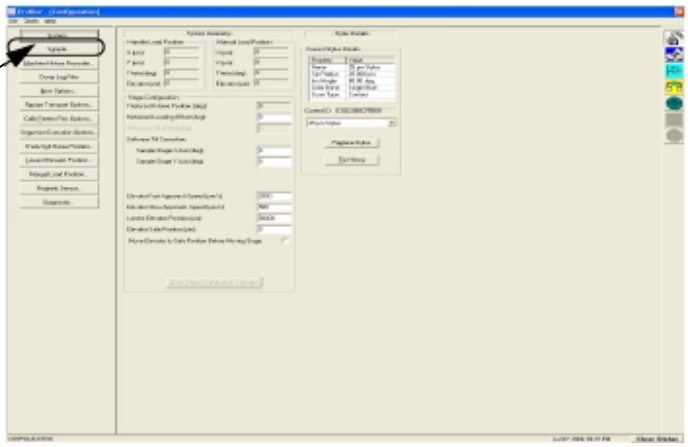
The Stage Limit setting is designed to limit the movement of the stage to the current setting parameters. The setting defines the mechanical movement limit called the **SAFE AREA**. There is also a hardware limit switch that automatically stops the stage movement if the setting in the Radius box is too large.

NOTE: If the Safe Area is set too large, as would be the situation after original installation, the die grid application cannot be loaded and the Die Grid button in the Sequence Recipe Editor is grayed out. To correct this, set the Safe Area to coincide with the sample being used.

1. Click **Sample…** to open the **Safe Area Configuration** dialog box. (See *Figure 13.12*.)

Figure 13.12 *Configuration Screen*

Step 1 To open the **Safe Area Configuration** dialog box, choose **Sample…**



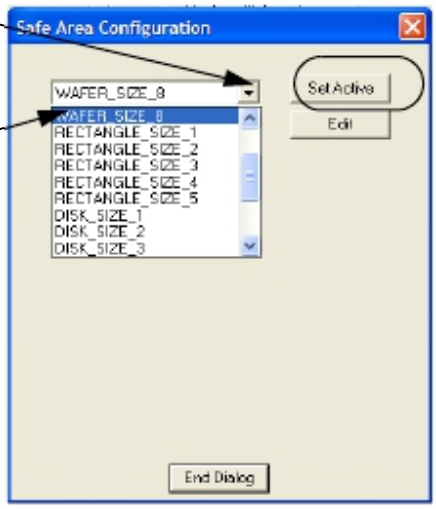
The Safe Area Configuration dialog box opens with only the wafer configuration drop-down menu active.

2. Click the menu arrow to access the Sample Configuration menu. (See *Figure 13.13*.)

Figure 13.13 *Safe Area Configuration - Sample Configuration Menu*

Step 2 Click the menu arrow to display the **Sample Configuration** menu.

Step 3 Click the sample configuration to be used in the scans.



Step 4 After the Sample Configuration is chosen, click **Set Active** to activate it.

3. Choose the required sample configuration. (See *Figure 13.13*.) This changes the information in the Safe Area configuration display.
4. Click **Set Active** to activate the new Safe Area configuration. (See *Figure 13.13*.)
5. To edit the safe area configuration parameters, click **Edit**
6. The Safe Area Configuration dialog box safe area can now be edited. (See *Figure 13.14*.)

Begin: Changing Safe Area Values

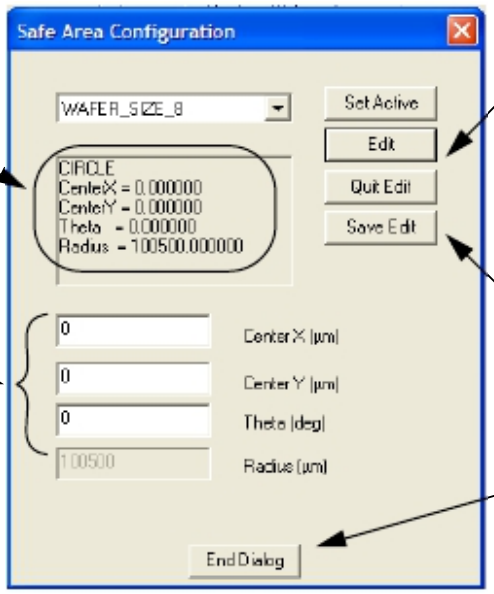
7. Change the safe area parameters by highlighting the appropriate box and entering the new parameter. (See *Figure 13.14*.)

CAUTION: DO NOT CHANGE these parameters without consulting a KLA-Tencor system specialist. Incorrectly set parameters could seriously damage the system.

Figure 13.14 *Safe Area Configuration - Edit Safe Area Values*

When the Sample Configuration is chosen and set to active, the information in the Safe Area Configuration display is changed to match the chosen configuration.

Step 7 To change the parameters, highlight the parameter to be changed and enter the new value.



Step 9 Click **Quit Edit** when the new values have been entered and saved, or to abandon the edit without changing the values.

Step 8 When the new values have been entered in the variable boxes, click **Save Edit** to apply the values.

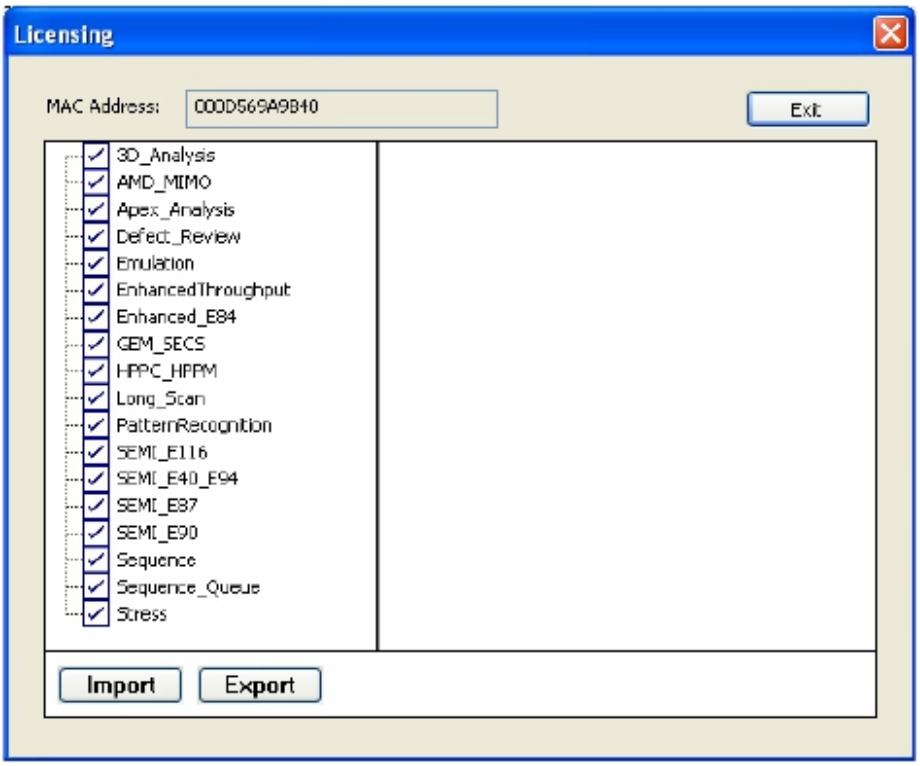
Step 10 To exit the Safe Area Configuration dialog box, click **End Dialog**.

8. After the parameters have been entered, click **Save Edit** to accept the new safe area. (See *Figure 13.14*.)
9. If the edit is to be abandoned without accepting the new parameters, click **Quit Edit**. (See *Figure 13.14*.)
10. To exit the Safe Area Configuration dialog box, click **End Dialog**. (See *Figure 13.14*.)

LICENSE OPTIONS

The License Options dialog shown in Figure 13.15 is the interface for importing and exporting license files. The license file system is based on the MAC address of the tool since this HEX value is unique to each computer (each network connection on the computer). A blue checkmark indicates that the option and license are valid. A red x next to an option indicates that the option and license are invalid. This is generally due to an expiration of a temporary license file. Features can be temporarily enabled to allow users to get a trial run of the feature.

Figure 13.15 *License Options*



Procedure to Enable/Purchase New Options

1. If the desired software feature has not been purchased, contact sales and provide the information on the feature that you want to purchase as well as the MAC Address from the computer.
2. After KLA-Tencor has provided the new license file to enable a new software feature or to fix a problem on the system, such as an expired license or a new license required due to a computer change, from the Configuration Page open the License Options dialog shown in Figure 13.15 and click on Import.
3. Navigate to the license file provided by KLA-Tencor and open the file.
4. Verify that the option(s) have a blue checkmark next to them and then Exit the licensing dialog.

5. From the **Configuration** page open the **System Configuration** editor, and select the **Instrument** dialog.
6. Verify that the options that need to be enabled have an X next to the option.
7. If any changes are made, close the Instrument and System dialog, then close and restart profiler software.
8. After profiler software has finished initializing, verify that the new option functions correctly.

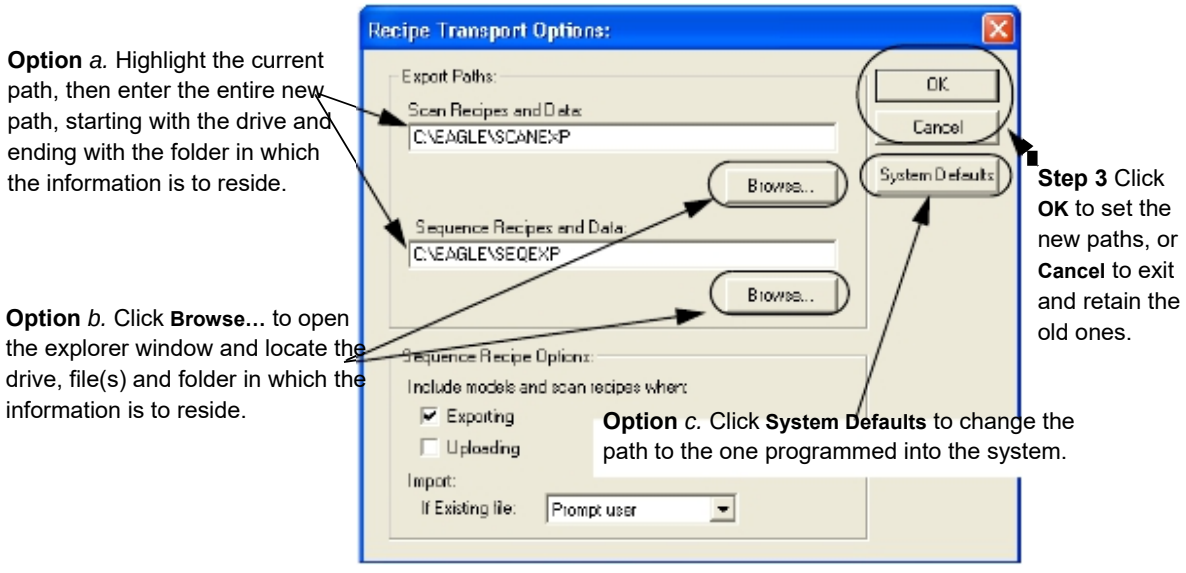
RECIPE TRANSPORT OPTIONS

Recipe Transport Options set the default path for exporting scan and sequence recipes and data.

Data Export Paths Configuration

1. Choose **Export Paths** in the **Configuration** screen. (See *Figure 13.12*.) The **Recipe Transport Options** dialog box opens. (See *Figure 13.16*.)
2. To set the default path for either the Scan or Sequence recipe and data, use one of the following:
   a. Enter the desired path, starting with the drive and continuing through the entire sequence, ending with the folder in which the information is to reside. (See *Figure 13.16*.)
   b. Click **Browse...** to find the drive and folder in which the information is to reside. (See *Figure 13.16*.)
   c. Click **System Defaults**. This sets the path to the one programmed into the system as displayed in *Figure 13.16*.

Figure 13.16 *Recipe Transport Options*



3. Click **OK** to save the new values and return to the **Configuration** window, or click **Cancel** to return to the **Configuration** screen without changing the previous values. (See *Figure 13.16*.)

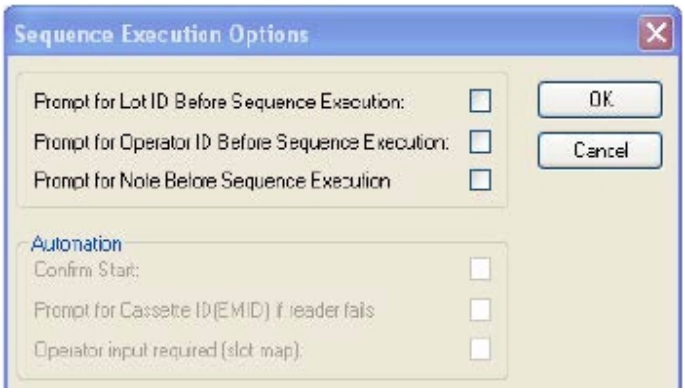
SEQUENCE EXECUTION OPTIONS

This automatically saves sequence data under a lot ID and/or operator ID. To enable and define this option, the **Sequence Execution Option** must be set to display an ID information prompt before each sequence.

Open Sequence Execution Options Dialog Box

Choose **Sequence Execution Option from the option buttons** in the **Configuration** screen. (See *Figure 13.12*.)

Figure 13.17 *Sequence Execution Options Dialog Box*



PROXIMITY SENSOR CONFIGURATION (P-17 ONLY)

The proximity sensor is responsible for signalling when the stylus is in near proximity to the sample surface. The proximity sensor activity has configurable parameters that can be accessed in the **Proximity Sensor Configuration** dialog box.

Configuration Procedure

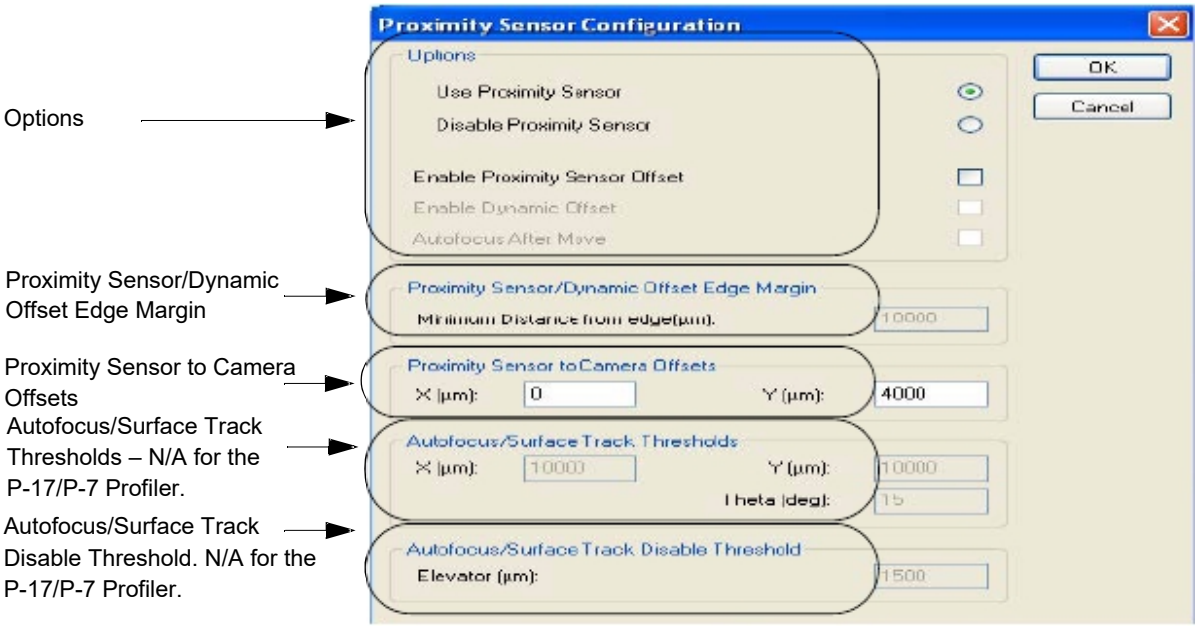
1. To open the **Proximity Sensor Configuration** dialog box, click **Proximity Sensor…** at the bottom of the Configuration screen menu buttons. (See *Figure 13.12*.)

   The Proximity Sensor dialog box (see *Figure 13.18*) is divided into four sections:

   - Options
   - Proximity Sensor to Camera Offsets

   The options and the variables within each one are discussed in the following sections.

Figure 13.18 Proximity Sensor Configuration



Options

A check in the checkbox next to each option indicates that it is enabled.

- ***Disable Proximity Sensor:*** The MicroHead optics are perpendicular to, and focus directly on, the sample surface. When the instrument is to *scan a very small sample*, the sample stage moves the sample from under the optics focal point to a position under the stylus. When this options is enabled, the proximity sensor is not used in the focusing operation. The stylus is lowered and nulls directly on the small sample.
- ***Use Proximity Sensor:*** This option is active and can be changed to meet processing requirements. With this option enabled, the Proximity Sensor signal causes the system to slow the head descent at a preset distance from the sample surface, then stops the head before the stylus touches the surface.
- ***Enable Proximity Sensor Offset:*** When this option is enabled, the following sequence of events occurs during the nulling procedure:
  a. The sample stage moves the sample under the proximity sensor.
  b. The head is lowered until the proximity sensor detects the sample surface, causing the head to stop.
  c. The sample stage moves the sample under the stylus.
  d. The head is lowered until the stylus nulls on the sample surface.

1. In the **Options** section of the Proximity Sensor Configuration dialog box, put a check (✓) in the check box of every option that is to be used. (See *Figure 13.18*.)

2. If no other changes are to be made in the Proximity Sensor Configuration dialog box, click **OK** to accept the configuration. (See *Figure 13.18*.)

PRECISION LOCATORS (P-17 ONLY)

Various precision locators are available to provide for exact positioning of a sample relative to a fixed reference point. See *Precision Locators (P-17 Only)* on page 13-19 and *Precision Locators (P-17 Only)* on page 13-19 for graphic representations of the available precision locators.

The stage table is removable so the *precision locators* can be bolted directly to the stage. *Disc locators* bolt directly to the stage table.

Wafer Precision Locators

CAUTION: Nominally, the top surface of a standard precision locator should be at the same level relative to the measurement head as the top surface of the stage tabletop. Still, it is a good idea to confirm the accuracy of the setting for Lowest Elevator Position when a precision locator is installed. The stylus can be damaged if the existing settings are incorrect. Refer to the procedures in *Teach Lowest Elevator Position* on page 13-7 for details.

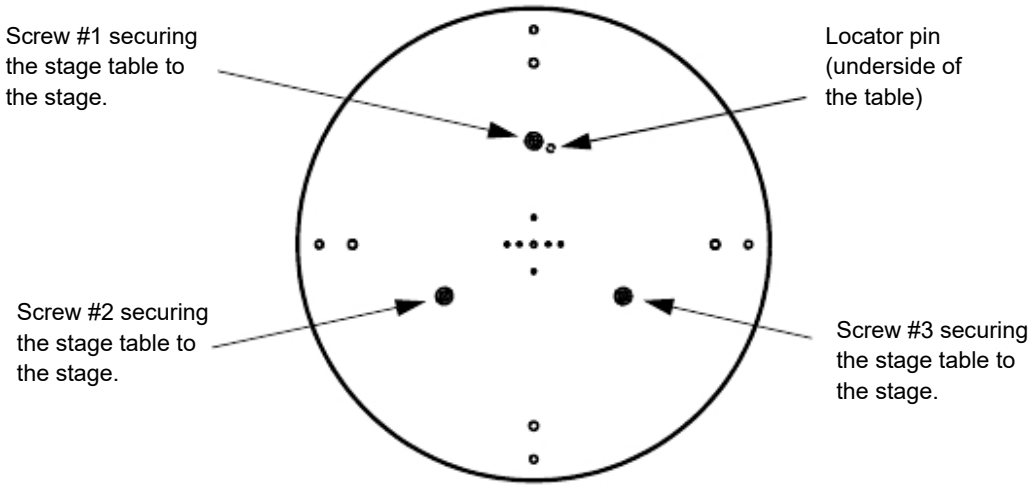
Installing the Precision Locator:

1. In the **Catalog** screen, choose **Scan Recipe** to display the scan recipes in the site list area.
2. With a recipe highlighted, click the **XY** icon in the tool bar to open the XY View screen. The XY View screen opens.
3. Click **MAN LOAD** to move the head up and bring the stage out to the stage door.
4. If the head does not move up during the **MAN LOAD** procedure, click the **ELEV** button as many times as necessary to move the head to a high enough position so that contact with the stylus can be avoided when removing the stage table.
5. Open the door.

CAUTION: Do not open the door before moving the stage into position or the system might shut down due to the safety interlock activation on the stage door.

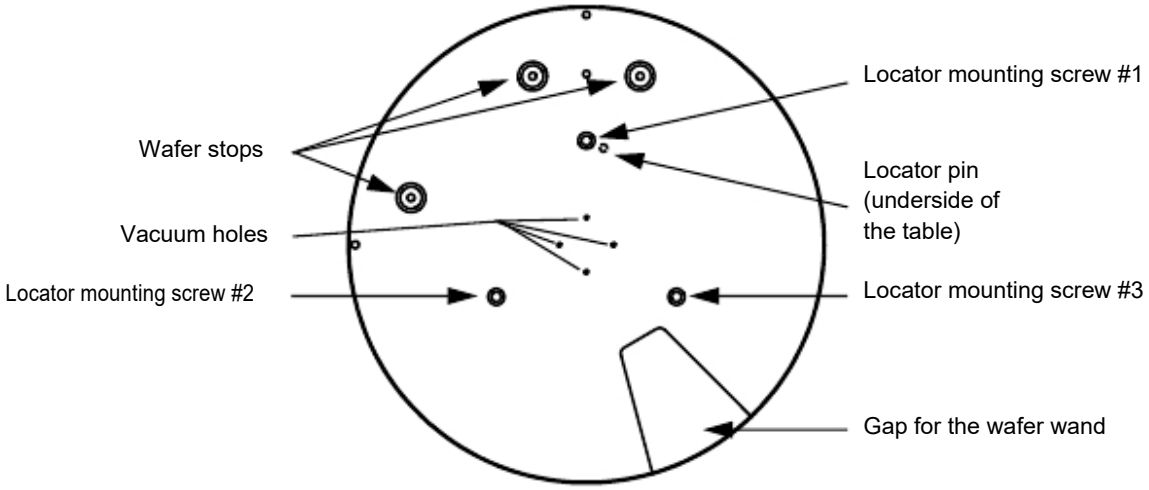
6. Remove the three screws (see *Figure 13.19*) that hold the stage table to the stage. Remove the table. It might be necessary to rotate the stage using the rotational arrow buttons (in the tool bar) for easier access to the screws.

Figure 13.19 *Lightweight Stage Table Top*



7. Place the precision locator on the stage so that the three holes line up with the mounting holes. A pin on the bottom of the locator fits into the groove on the stage just to the right of the 12 o'clock position as seen from above. (See *Figure 13.20*.)

Figure 13.20 *Precision Locator*



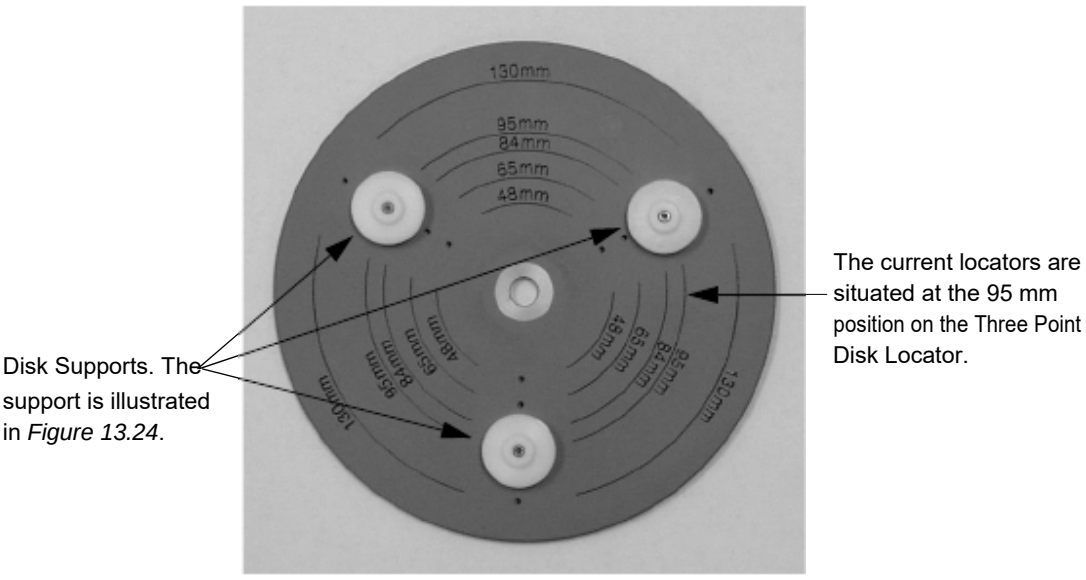
Press down on the precision locator to slide the pin into the groove. When positioned as shown in *Figure 13.20*, the precision locator is in the "0" theta position (that is, theta equals 0 degrees).

8. Screw in the mounting screws to secure the locator to the stage. (See *Figure 13.20*.)

Three Point Disk Locator

The KLA-Tencor three point disk locator for Profilers is shown in *Figure 13.21*.

Figure 13.21 *Three Point Disk Locator*



The three point Disk Locator has three disk supports that can be situated to support five sizes of disk: 48 mm, 65 mm, 84 mm, 95 mm, and 130 mm disks.

Installing the 3-point Disk Locator on the Stage:

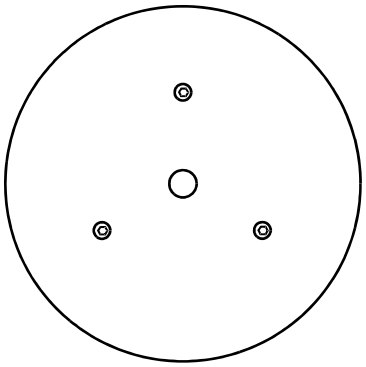
1. In the **Catalog** screen, choose **Scan Recipe** to display the scan recipes in the site list area.
2. With a recipe highlighted, click the **XY** icon in the tool bar to open the XY View screen. The XY View screen opens.
3. Click **MAN LOAD** to move the head up and bring the stage out to the stage door.
4. If the head does not move up during the **MAN LOAD** procedure, click the **ELEV** button as many times as necessary to move the head to a high enough position so that contact with the stylus can be avoided when removing the stage table.
5. Open the door.

CAUTION: Do not open the door before moving the stage into position or the system might shut down due to the safety interlock activation on the stage door.

6. Remove the three screws (8-32×3/8 in.) that hold the stage table to the stage. Remove the table.

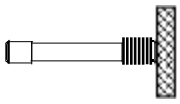
7. The Three Point Disk Locator has a base plate (see *Figure 13.22*) that has three holes for mounting it in place of the stage table. Place the disk locator base plate on the stage so that the three mounting holes line up.
8. Insert the three mounting screws and tighten. (See *Figure 13.22*.)

Figure 13.22 *Three Point Disk Locator Base Plate*



9. Place the Three Point Disk Locator on its base plate and screw in the center hub screw. (See *Figure 13.23*.) Be sure that the washer is between the screw and the Three Point Disk Locator.

Figure 13.23 *Center Hub Screw*



10. Close the door

PINCH POINT: Keep fingers, hands, and other body parts clear of the closing door to prevent a pinch injury.

CAUTION: Do not open the door before moving the stage into position or the system might shut down due to the safety interlock activation on the stage door.

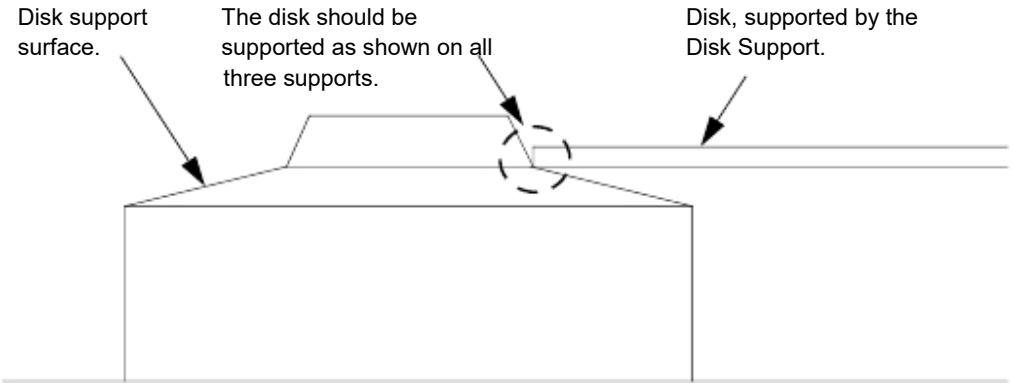
11. Click **MAN LOAD** to move the stage back under the measurement head

The Lowest Elevator Position is set at the factory to allow the stylus to be nulled on the stage surface for both the standard stage and a precision locator. When a wafer locator is installed, a new lowest elevator position must be redefined, and that position entered into the stage configuration file. See ***Teach Lowest Elevator Position*** on page 13-7 for details.

Adjusting the Disk Size:

1. Remove the screws (2-56×1/2 in.) securing each of the three disk supports.
2. Position each disk support to the required disk size. The five disk sizes are identified by concentric circles on the locator surface, with the representative disk size printed over each circle. The are three disk support mounting holes associated with each disk size. (See *Figure 13.21*.)
3. Insert the screws and loosely tighten, leaving some play in the position of each disk support. Place a representative disk on the supports and adjust them so that the disk is supported snugly between the three supports. The final positioning of the disk should resemble that illustrated in *Figure 13.24*.

Figure 13.24 *Disk Support for the Three Point Disk Locator*



4. When the three disk supports are adjusted, tighten the three disk support screws and recheck the disk position. Leave enough clearance to take into account manufacturing tolerances so that all disks of this size fit. Try to get the disk centered around the central hub of the locator.

Precision Locators - Description

Precision locators are fixtures that provide for exactly positioning of a sample relative to a fixed reference point. KLA-Tencor provides the following types of precision locators:

Wafer Precision Locators

- 2-in. for Wafer with Flat/Square Substrate
- 3-in. for Wafer with Flat/Square Substrate
- 4-in. for Wafer with Flat/Square Substrate
- 4-in. for Wafer with Notch
- 5-in. for Wafer with Flat/Square Substrate
- 5-in. for Wafer with Notch
- 6-in. for Wafer with Flat/Square Substrate
- 6-in. for Wafer with Notch

Disk Precision Locators

These locators are used for holding hard disk samples to the stage. They bolt on top of the standard stage table. Note: These locators have to be purchased separately.

Instructions for installing precision locators can be found in *Installing the Precision Locator:* on page 13-19,

Disk precision locators include

- 48-mm for Disk
- 65-mm for Disk
- 95-mm for Disk
- Adjustable Three Point Disk Locator (48 mm, 65 mm, and 95 mm)

Stress Precision Locators

These locators are used for holding wafers in place, suspended at three points, for measurement of stress related to a deposition on the wafer surface. The Manual Load Stress Locator is attached to the stage table. The Adjustable Stress Locator is mounted to its own base place that is secured to the stage.

Stress Locators

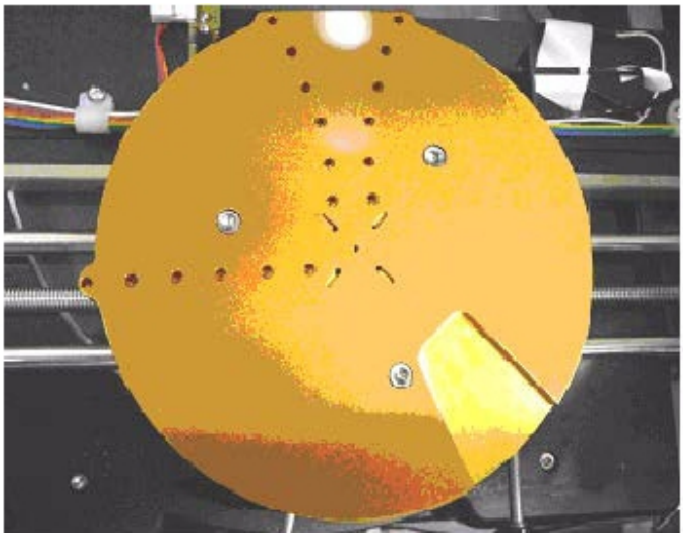
- For 4 in. wafer with a flat or square substrate
- For 4 in. wafer with notch
- For 5 in. wafer with a flat or square substrate
- For 5 in. wafer with notch
- For 6 in. wafer w/flat or square substrate
- For 6 in. wafer with a notch

P-7 PRECISION LOCATORS

The P-7 has both a wafer and a wafer stress locator chuck to accommodate either 2, 3, 4, 5 or 6 inch samples.

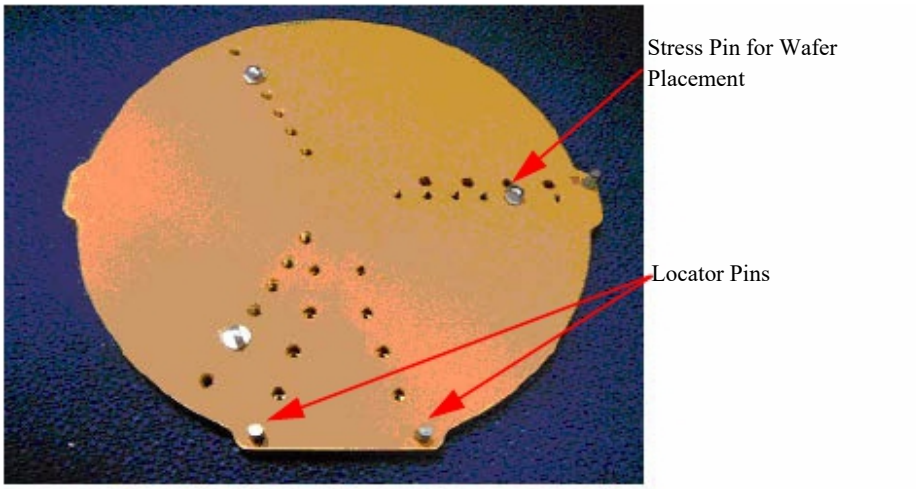
The chuck has a series of holes that accept pins to provide precision alignment of the sample. The pair of holes are used for aligning the wafer flat or for non-flatted wafer, the edge of the sample. The single hole is for aligning the other edge of the sample. To switch between wafer sizes, move the pins between wafer holes..

Figure 13.25 *P-7 Precision Standard Locator Chuck*



The stress chuck is placed on top of the standard chuck, using three pins at the edge of the chuck to align the two samples. The stress chuck has the same pin holes as the standard chuck for alignment of the sample. In addition, it has three stress pins that need to be placed in the correct position to properly support the sample during the stress measurements.

Figure 13.26 *P-7 Stress Chuck*



STYLUS CHANGE PROCEDURE

INTRODUCTION

Styli are available in various sizes for a variety of different scanning requirements. Each stylus is a delicate tool and requires careful handling.

Styli are color-coded to indicate radius. Check the color band on the stylus arm against the following table for the stylus radius.

Table 14.1 *Available L-Stylus Radius*

Color Code Band	Stylus Radius (µm)	Cone Angle (Deg.)
Red	12.5	60
Yellow	5.0	60
Green	2.0	60
Double Green	2.0	20
Orange	2.0	45
Black[a]	0.3–0.8	85
Black[a]	0.1–0.2	85
Dual Blue	0.040	40

a. For radius values, refer to the SEM documents provided with the stylus.

NOTE: The Dual Blue band, 0.040 µm radius and 40° cone angle stylus is only supported on the P-17 profiler.

STYLUS REMOVAL AND REPLACEMENT

The following discussion contains procedures for changing the stylus in the sensor assembly of the P-17/P-7 Profiler system.

Stylus replacement in the P-17/P-7 Profiler system is relatively simple.

Important:

Use only an approved stylus from KLA-Tencor.

Do not modify the measurement head in any way. If, while using the prescribed procedure, there is difficulty in mounting the stylus, call KLA-Tencor Customer Service.

Know the stylus type and radius for input later in the procedure.

Follow the instructions as presented in this section to avoid omitting steps.

CAUTION: The stylus tip is very fragile! When removing the stylus from its shipping container, use stainless tweezers (422320) to hold the arm while gently peeling back the foam. Grasp the arm in the center section and lift the stylus out tip first. To place the stylus back in its shipping container, place the rounded end into the round end of the holder and slowly rotate the tip end down. Release the tip only when it is properly positioned in the groove.

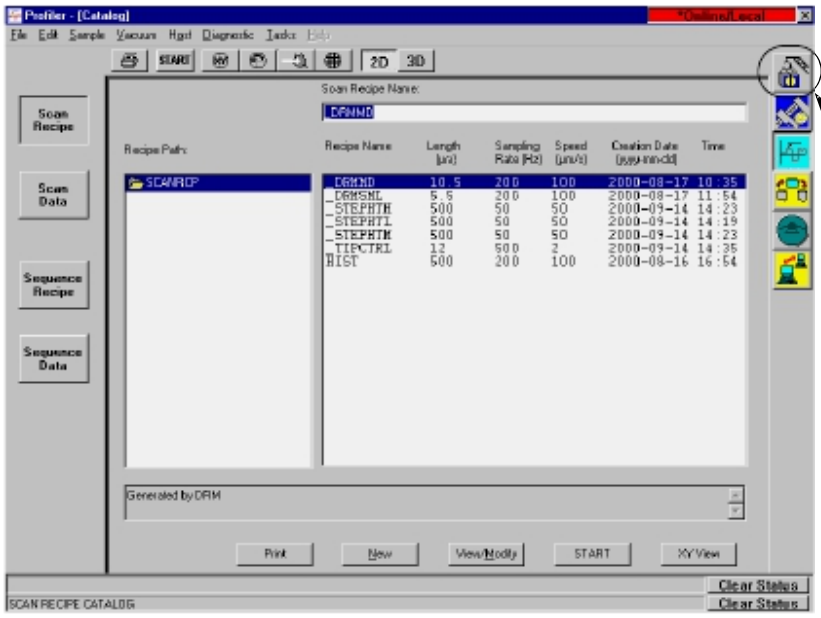
The procedure consists of six parts:

- Stylus removal procedure
- Stylus replacement procedure
- Scan Position Offset Calibration

Stylus Removal

1. From the **Profiler [Catalog]** screen click on the **Configuration** icon to display the **Configuration** screen. (See *Figure 14.1*.)

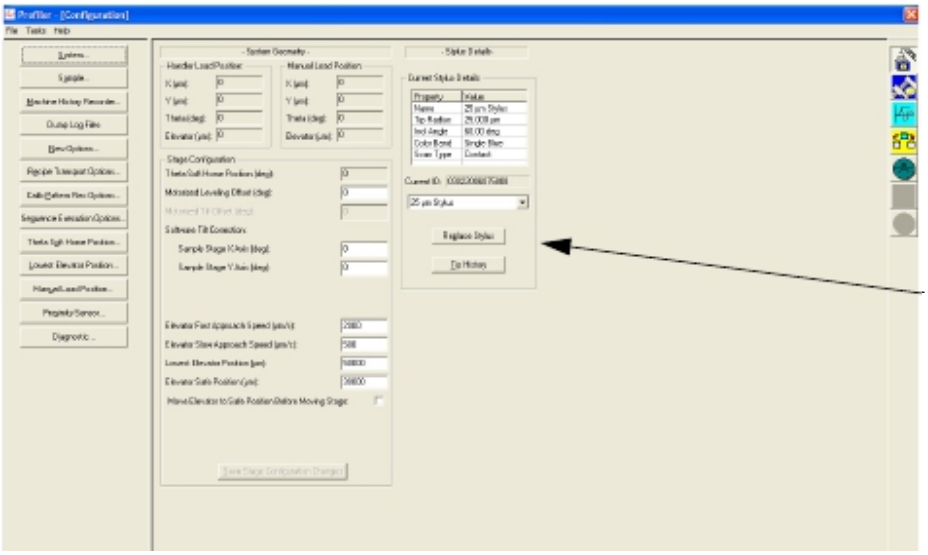
Figure 14.1 *Profiler [Catalog] - Click on the Calibration Icon*



Step 1 Click on the **Configuration** icon to display the **Configuration** screen.

2. From the **Configuration** screen click on the menu arrow to the right of the stylus type variable box to display its menu. (See *Figure 14.2*.)

Figure 14.2 *Stylus Force Calibration Button*

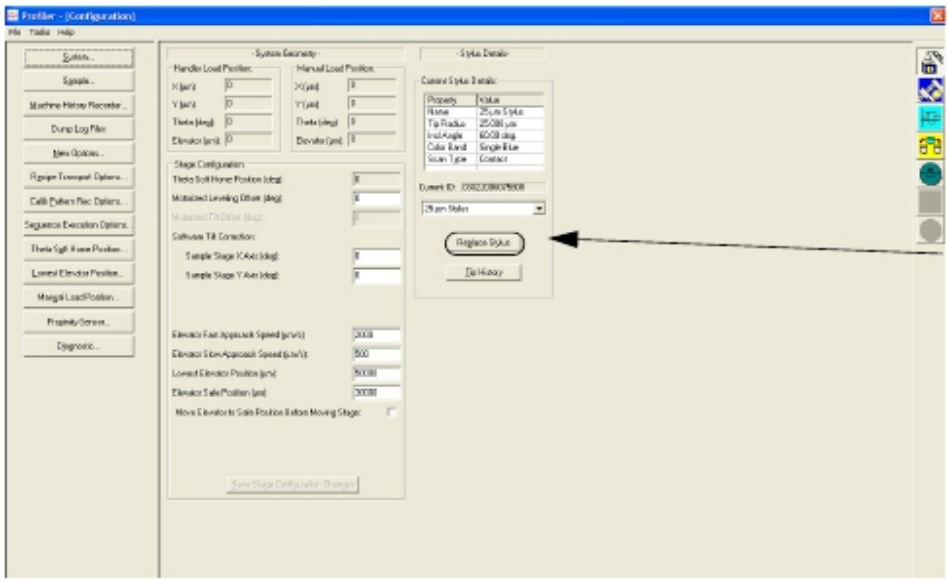


Step 2 Click the menu arrow to display the list of stylus types.

Step 3 Click on the stylus type of the stylus that is to be mounted.

3. Click on the stylus type that will replace the current stylus. (See *Figure 14.2*.)
4. Click on **Replace Stylus** to display its dialog box. (See *Figure 14.3*.)

Figure 14.3 *Configuration Screen*



Step 4 To begin the stylus replacement procedure, click **Replace Stylus** to display its dialog box.

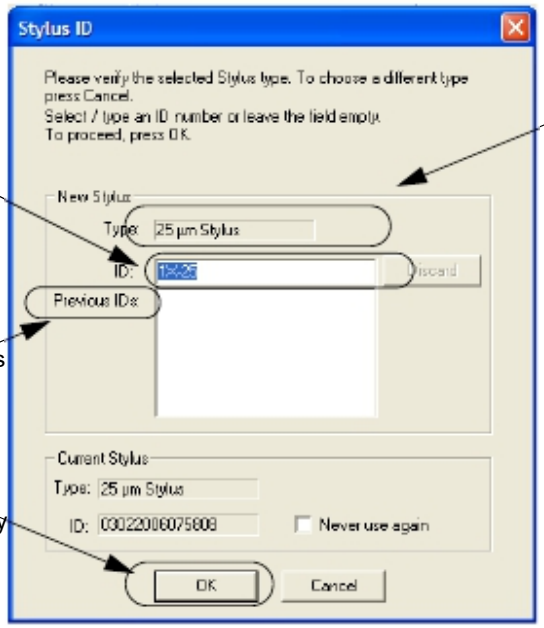
5. To make it easier to track stylus performance, the system provides an opportunity to name the stylus. The type of stylus has already been set before moving to this screen (see Step *3.*), and is identified in the **Type** variable box. This variable cannot be changed in this dialog box, only in the Configuration screen. The name identifies the specific stylus of the Type referred to in the **Type** variable box.

   The **Stylus ID** dialog box is displayed. (See *Figure 14.4*.) It contains the name of the stylus and a list of previously identified styli of the Type referenced in the **Type** variable box.

   To identify a new stylus: When using a new stylus, double-click in the ID variable box and enter the new name.

   To enter the name of previous stylus: When mounting a previously used stylus, click on the name of the stylus from the **Previous ID's** list. The name should appear in the **ID** box.

Figure 14.4 *Stylus ID Dialog Box*



Step 5 To enter a new stylus name, double-click to highlight the old name in the ID box and enter the new name.

If a previously used stylus is being mounted, click on the name given to that stylus.

Step 6 When the stylus name has been successfully entered, click **OK** to save it and close the dialog box.

The Type of stylus being mounted in the system should be reflected in the Type box.

6. When the new name is entered, click **OK** to save it and exit the dialog box. (See *Figure 14.4*.)
7. The profiler message box is displayed inquiring if the name displayed is the correct stylus name. Click **Yes** to affirm the name or **No** if the name is incorrect and needs to be changed.

   When **Yes** is clicked, the system head is automatically raised to the manual load height for easy access to the stylus.

   (If **No** is clicked, it is necessary to name the stylus again.)

Figure 14.5 *Message Box for Stylus Name Affirmation*

Step 7 Click **Yes** if the name reflected next to ID is the name of the stylus just entered in the Stylus ID dialog box.

8. After **Yes** is chosen, another message box is displayed. (See *Figure 14.6*.) This box states that the stylus can be changed.

   Notice that the message box contains a caution telling the user to "ensure the sensor is unlocked." Disregard this part of the message, it is not for the MicroHead II sensor assembly.

   DO NOT CLICK OK UNTIL THE STYLUS HAS BEEN CHANGED.

Figure 14.6 *Message Box for Stylus Change Permission*

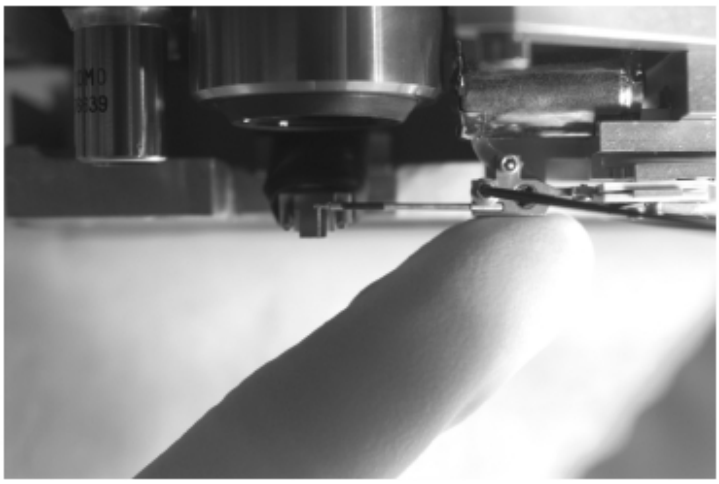
CAUTION: **C**lick OK **ONLY WHEN** the new stylus is installed.

9. Open the Stage door.

CAUTION: Do not operate the stage or any motor driven component **with the door open** or the system will have to be rebooted.

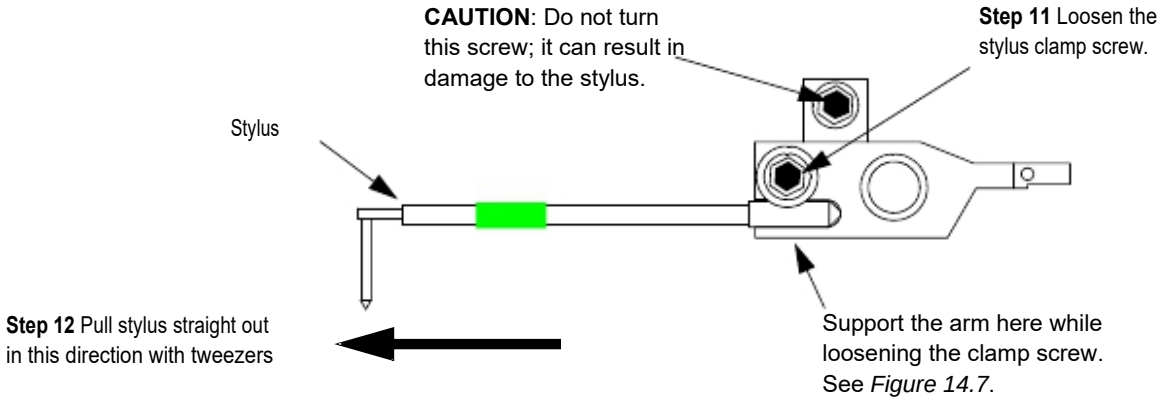
10. Loosen the thumbscrew holding the stylus wrench to the side of the head and slide the wrench out of its holder.
11. The head of the stylus clamp screw is visible from the front of the instrument. Place a finger under the Stylus Mount to support it while the screw is being loosened. Loosen the screw by inserting the stylus wrench and turning the wrench counterclockwise 1/2 turn. Be careful to apply turning torque only. Do not push against the screw head any harder than is necessary to seat the wrench. (See *Figure 14.7* and *Figure 14.8*.) Do not remove the screw.

Figure 14.7 *Supporting Stylus Mount During Stylus Change*



12. With the stylus clamp screw loose, take hold of the stylus with tweezers and pull gently straight to the left until the stylus comes free. (See *Figure 14.8*.)

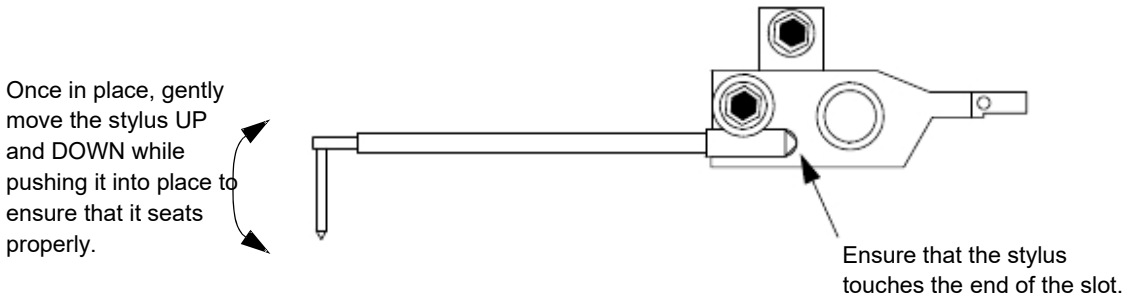
Figure 14.8 *Sensor Assembly - Loosening Stylus Clamp Screw*



Stylus Replacement

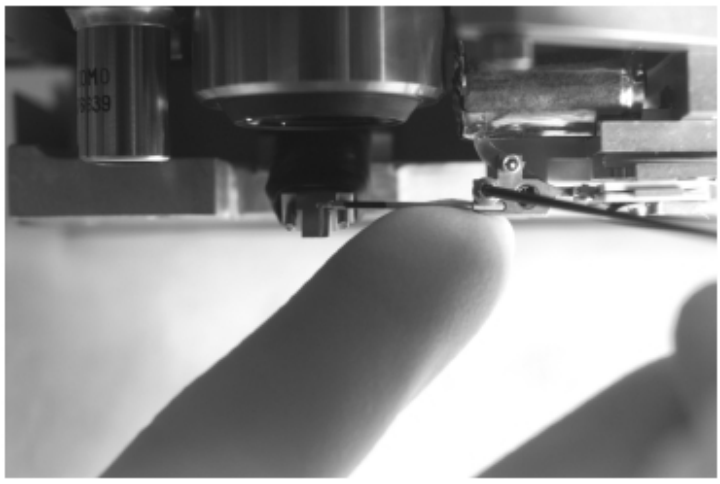
1. Using tweezers, take hold of the new stylus with the tip pointing downward toward the stage. Insert the long arm of the stylus into the support groove in the stylus arm. Gently maneuver it into the slot. Once in the slot, move it up and down gently to ensure that it reaches the end of the slot and seats properly. (See *Figure 14.9*.)

Figure 14.9 *Sensor Assembly - Seating the New Stylus*



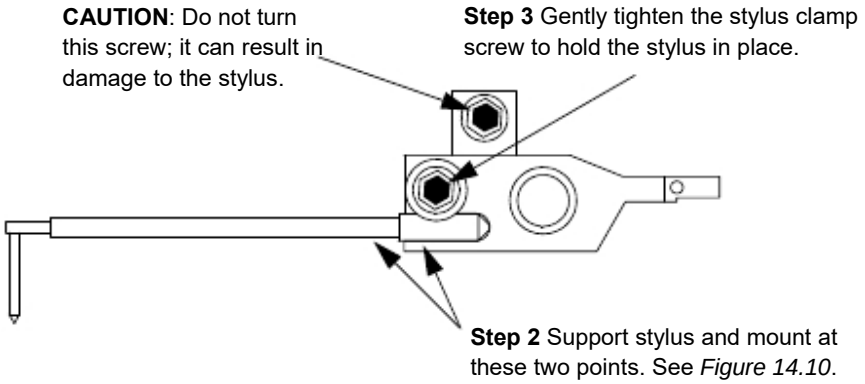
2. Support the **stylus mount (arm) and stylus** with a finger to protect it from damage while tightening the mounting screw. (See *Figure 14.10*.)

Figure 14.10 *Supporting Stylus and Mount During Tightening Procedure*



3. While supporting the stylus and the stylus arm, gently tighten the clamp screw to hold the stylus in place. Do not over tighten or damage can occur to the stylus arm pivot. (See *Figure 14.10* and *Figure 14.11*.)

Figure 14.11 *Sensor Assembly - Seating the New Stylus*



4. Remove the wrench from the clamp screw and replace it in its mount. Tighten the thumbscrew to hold the wrench in place.

5. When the stylus installation is complete, click **OK**. (See *Figure 14.12*.)

Figure 14.12 *Message Box for Stylus Change Permission*

Step 5 When the stylus installation is complete, click **OK**.

6. The system performs an Applied Force calibration.

Scan Position Offset Calibration

Introduction

As soon as the Applied Force calibration is complete, the Scan Position Offset procedure is initiated. The Scan Position Offset Calibration procedure scans for data that it then uses to calculate the X-, Y-axis offsets from the optics and stylus, for positioning the sample stage.

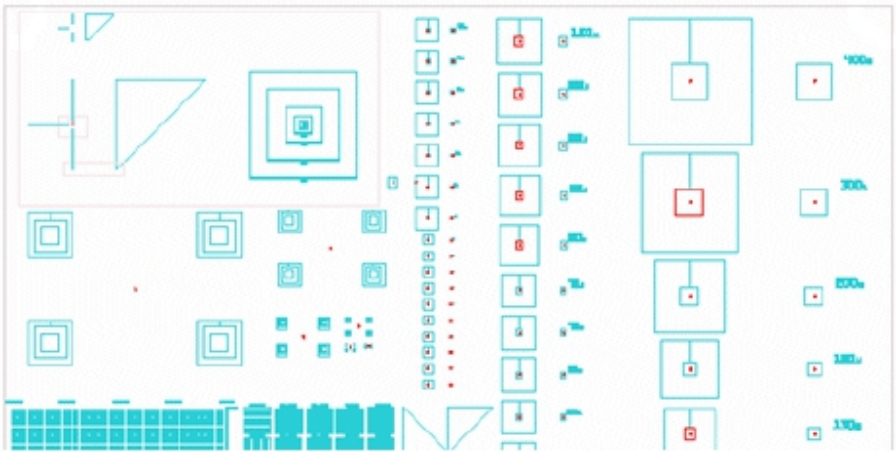
For the standard styli this procedure is performed in the following order:

1. 150 µm (standard) calibration
2. If the 150 µm scan fails to locate the triangle, then the 500 µm (backup) calibration is performed.
3. If the 500 µm was performed successfully, the 150 µm calibration must be performed again.

Calibration Procedure

Use the ProCal Wafer (see *Figure 14.13*) to perform the Scan Position Offset Calibration and determine the distance that the stylus tip is offset from the crosshair overlay in the XY View window.

Figure 14.13 *KLA-Tencor ProCal Wafer*



1. A message box is displayed requesting the user to place the Scan Position Offset tool on the stage. (See *Figure 14.14*.)

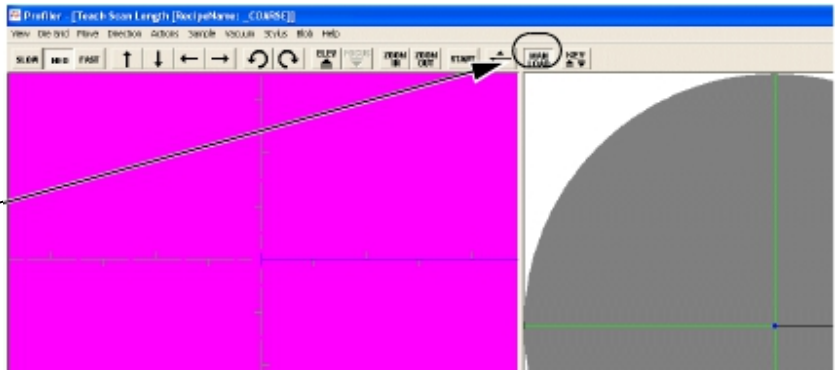
   Figure 14.14 *Message Box Requesting SPO Standard Placement*

2. Open the stage door.

Figure 14.15 *Manual Load from the Scan Offset Calibration Window*

Step 10 After loading the ProCal Wafer, click **MAN LOAD** again to send the stage back under the stylus.



3. Place the **ProCal Wafer** precisely in the center of the stage, squarely positioned with respect to the XY axis.
4. Turn the vacuum ON using the switch on the upper left inside door frame.

NOTE: The Vacuum menu in the screen's menu bar is not functional. It does not effect the stage vacuum.

5. Close the stage door.
6. Click OK in the message box. (See *Figure 14.14*.)

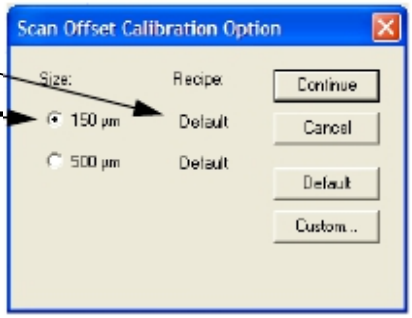
   The **Scan Offset Calibration Option** dialog box is displayed (see *Figure 14.16*) on top of the Calibration screen.

   Two columns present the two options used to set up the Scan Offset Calibration. The first column is the **Size** column. It is used to determine the length of the step that is to be scanned and, therefore, which triangle the scan is to be performed on. If the step is 150 µm, the system uses the 300 µm triangle. If the step is 500 µm, the system uses the 1000 µm (1 mm) triangle.
7. Choose **150 µm** (standard) to continue with the calibration. (See *Figure 14.16*)

Figure 14.16 *Scan Position Offset Calibration Options dialog box*

Step 8 Choose Recipe type: **Custom** or **Default**

Step 7 Click on **150 µm**.



8. **Use the Default recipe unless there is a very good reason not to**.

RECIPE TYPES. Two calibration options exist in the **Scan Offset Calibration Option** dialog box. Each option provides the user with the opportunity to choose between using a default recipe or to create/use a custom recipe. Default and Custom recipes are explained below:

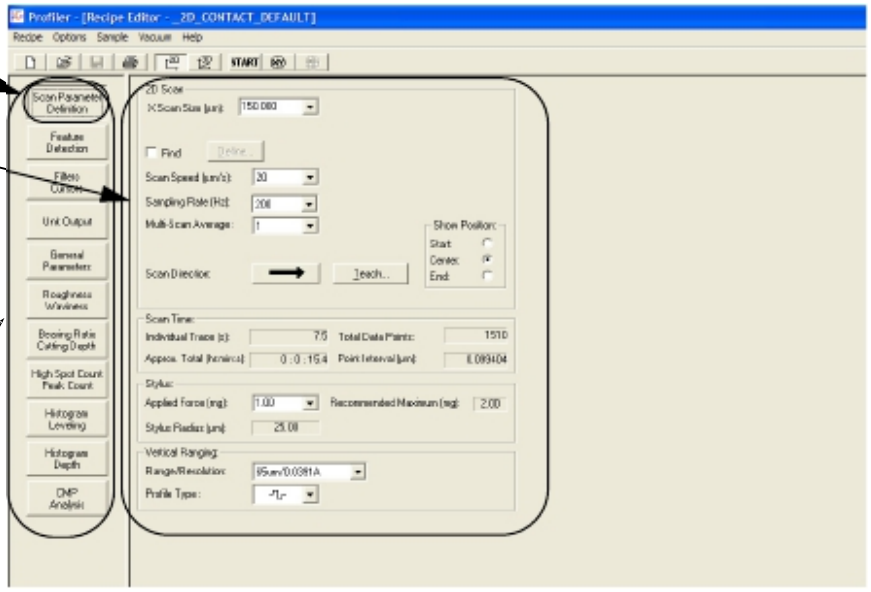
- **Default**: This recipe is designed to operate with a scan speed and stylus force setting that is safe for the stylus. The default settings are the KLA-Tencor recommended recipe settings for all the calibrations.
- **Custom**: This recipe type offers the user the option to customize recipe parameters to meet specific scan requirements. In the Recipe Editor there are seven windows, each with configurable parameters. (See *Figure 14.17*.) For the **Scan Position Offset Calibration**, the only **Recipe Editor** window necessary is the **Scan Parameter Definition** that appears when the editor is first opened (see *Figure 14.20*). When chosen, the **Scan Parameter Definition** button (in the top left corner of the screen, circled in *Figure 14.17*) appears to be indented.

Figure 14.17 *Window Buttons - _OFF150- Recipe Editor*

Scan Parameter Definition: displays the **2D Scan** window shown in the illustration.

Each button in this column displays a user configurable window in which recipe parameters can be defined for use in various types of scans.

NOTE: THESE BUTTONS ARE PASSWORD PROTECTED WITH RESTRICTED ACCESS.



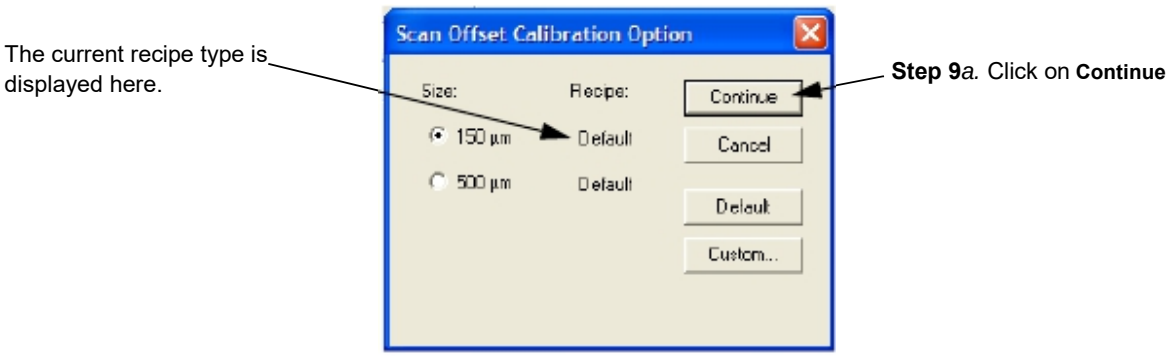
9. The recipes are set as follows:

CAUTION: KLA-Tencor recommends using the Default recipes unless there is a very good reason for creating a custom recipe.

To use the currently selected recipe:

a. To use the calibration recipe indicated to the right of the **Size** selection (see *Figure 14.18*), click **Continue** to proceed.

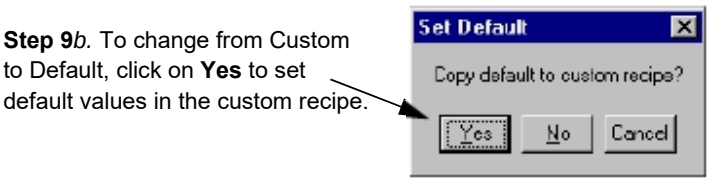
Figure 14.18 *Scan Position Offset Calibration Options dialog box*



To change the recipe from Custom to Default

b. To apply the **Default** recipe when **Custom** is indicated, click on **Default**. The message box, "**Copy default to custom recipe?**" appears. Click **Yes** in the message box to replace the parameters in the custom recipe with default values. (See *Figure 14.19*.)

Figure 14.19 *Set Default Dialog Box*



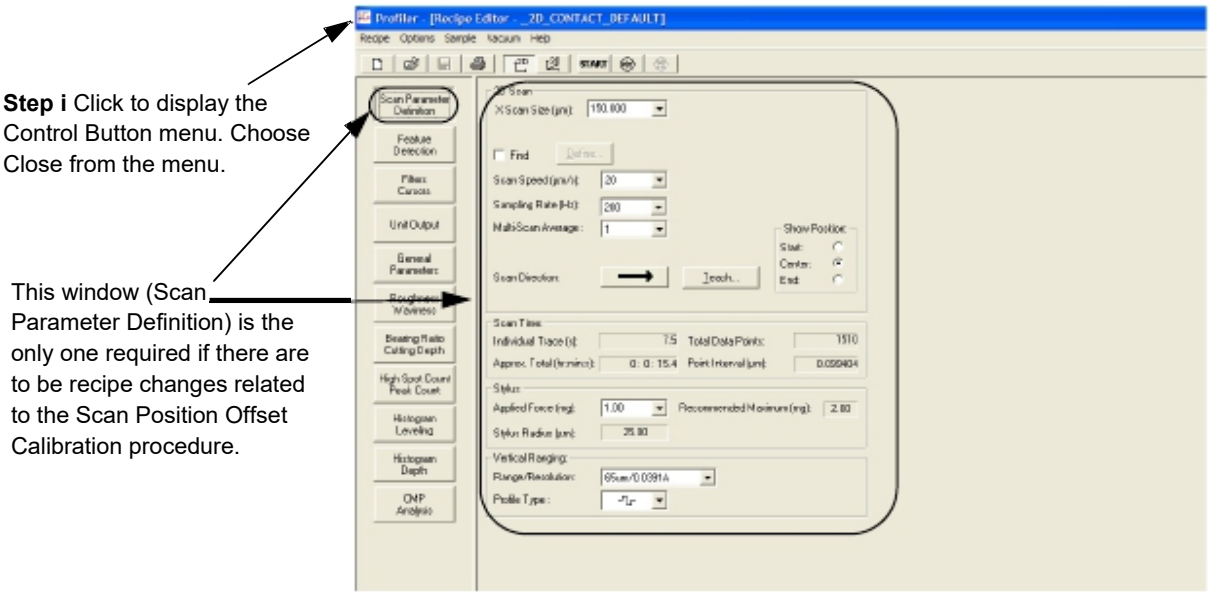
To change the recipe from Default to Custom

c. To apply a **Custom** recipe when **Default** is indicated, or to modify the custom recipe that is indicated, click **Custom**. The **Recipe Editor** opens, displaying the custom recipe. Change the parameters as required. (See *Figure 14.20*.)

i. Close the **Recipe Editor** by clicking on the control button in the upper left corner and choosing **Close** from the drop-down menu. (See *Figure 14.20*.)

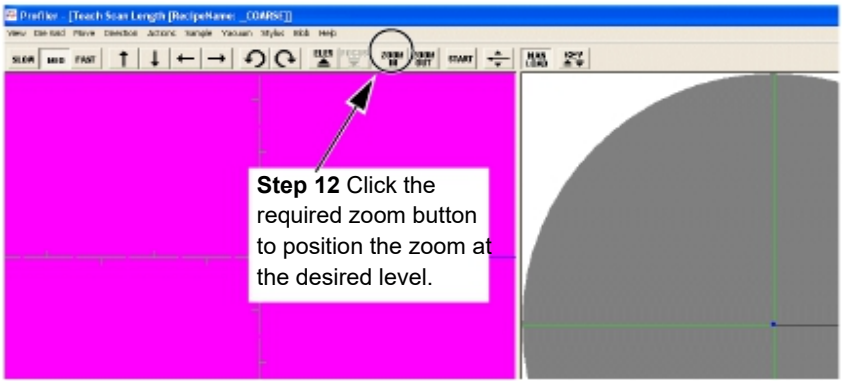
ii. If the new parameter values were not already saved, a dialog box requires the user to choose between the save options before exiting the Recipe Editor. Choose Save Changes to set the changes to the Custom recipe so they are used in the scan.

Figure 14.20 *Scan Parameter Definition - _**OFF150** - Recipe Editor*



10. From the **Scan Offset Calibration** screen, click **MAN LOAD** in the tool bar to move the stage back beneath the stylus. (See *Figure 14.15*.)

Figure 14.21 *ZOOM IN - Scan Offset Calibration*



NOTE: KLA-Tencor recommends that the optics be zoomed all the way out (set at 0), or that the desired zoom setting be locked.

11. (**BEFORE CONTINUING** see **CAUTION** below.) Click **FOCUS** in the tool bar. The ProCal Wafer's surface image comes into focus. (See *Figure 14.21*.)

CAUTION: As the stylus lowers toward the ProCal Wafer, watch carefully to ensure that both the proximity sensor and the stylus come down on the tools measurement surface. With the Proximity Sensor Offset option chosen in the Proximity Sensor Configuration box, the proximity sensor is coming down directly on the position where the measurement is to be made. If the stylus and the sensor are not descending directly onto the ProCal Wafer's measurement area, press the Space Bar on the computer keyboard or a mouse click, to stop the stylus descent. Manually relocate the tool under the stylus. Click on **FOCUS** again to resume the procedure.

12. The zoom setting should be the same as that at which the scans are performed. To zoom in or zoom out, click and hold the correct button until the optics are at the required zoom setting. (See *Figure 14.21*.)

NOTE: KLA-Tencor recommends that the optics be zoomed all the way out (set at 0), or that the desired zoom setting be locked.

BEGIN Align Sample Procedure

13. The ProCal Wafer must be aligned with respect to the X-, Y-axis in order for the calibration to be as accurate as possible. Click on **View** in the menu bar to display its menu.
14. Choose **Align Sample…** from the menu. See Chapter 5 for the Theta Alignment procedure.

    The prompt at the bottom of the screen now says,

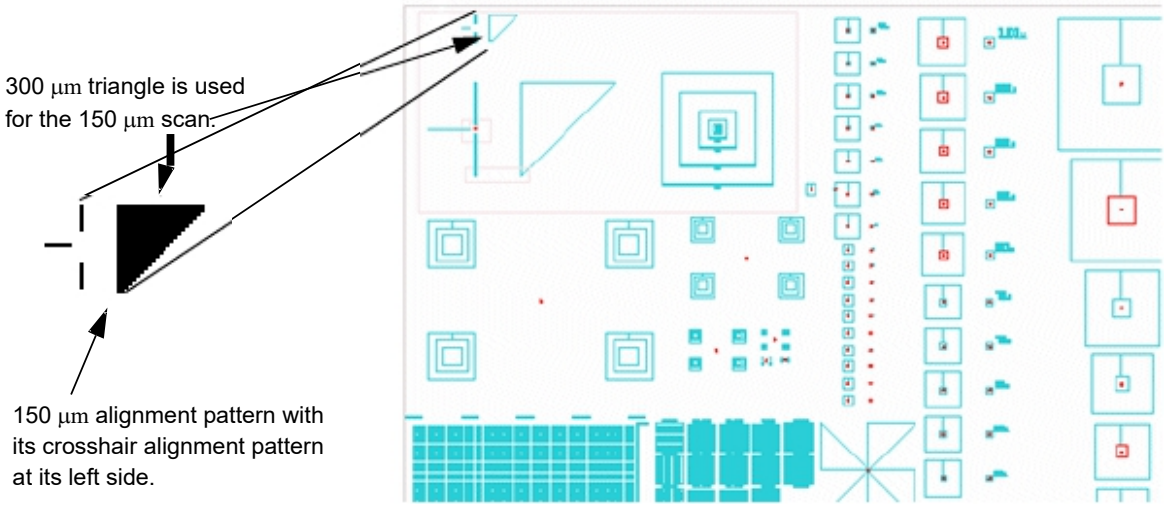
    Focus and align tool crosshairs with screen crosshairs

    There are two different alignment patterns that can be used in the Scan Position Offset Calibration. Each scan is conducted at the midpoint of the triangle where the step distance is one half the length of both right angle triangle sides. The first and primary alignment pattern is the 300 µm triangle which is called the 150 µm alignment pattern. It has this name because the scan traverses the triangle at it midpoint where the distance is 150 µm. The second is the 1000 µm (1 mm) triangle which is called the 500 µm alignment pattern because its midpoint scan distance is 500 µm. It is used when the 150 µm scan fails to locate the 300 µm triangle.

When making this calibration, first use the 300 µm triangle to complete the 150 µm scan. If the stylus offset is too great, the scan misses the triangle. If this happens, try the 1000 µm (1 mm) triangle to complete the 500 µm scan. If that is successful, retry the 300 µm triangle.

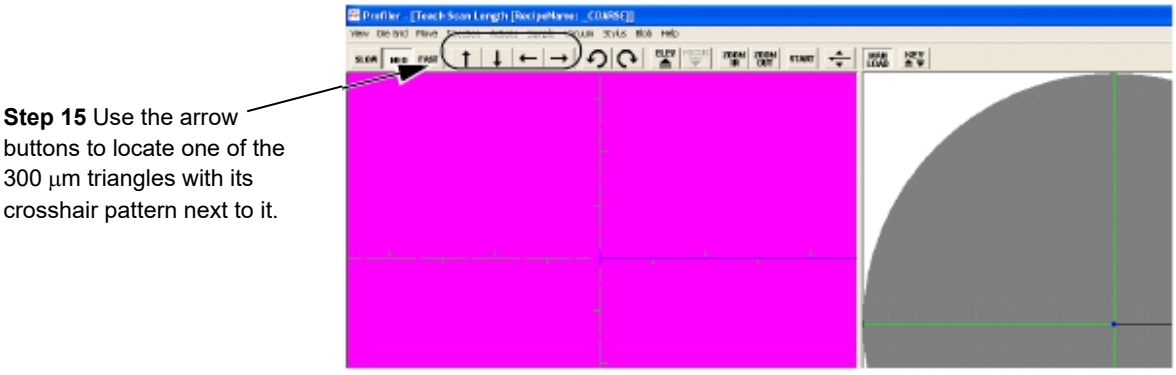
If the 500 µm scan missed the 1000 µm triangle, the stylus needs to be physically realigned by an authorized KLA-Tencor service representative.

Figure 14.22 *KLA-Tencor ProCal Wafer*



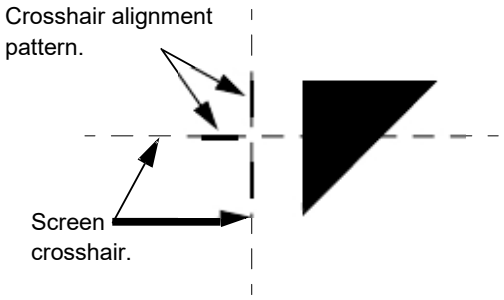
15. Use the linear movement arrow buttons (see *Figure 14.23*.) to locate one of the 150 µm alignment patterns with its crosshair alignment pattern at its left side. (See *Figure 14.22*.)

Figure 14.23 *Aligning the Tool with Screen Crosshair*



16. Click at the center of the Crosshair Pattern to align it with the screen crosshair. (See *Figure 14.24*.) The crosshair pattern should align precisely with the screen crosshair.

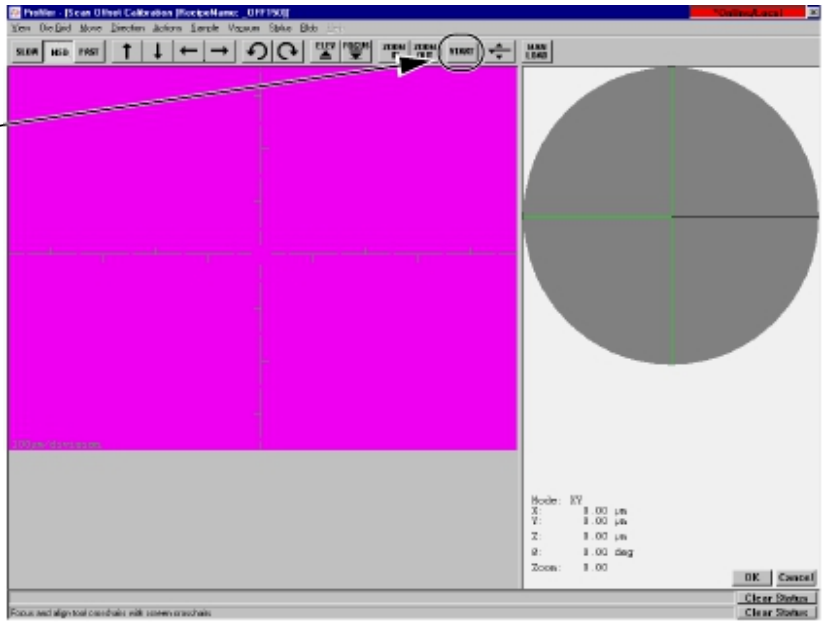
Figure 14.24 *Align Screen Crosshair with 150 µm Crosshair Pattern*



17. Click the **START** button located in the screen tool bar. (See *Figure 14.25*.)

Figure 14.25 *Manual Load from the Scan Offset Calibration Window*

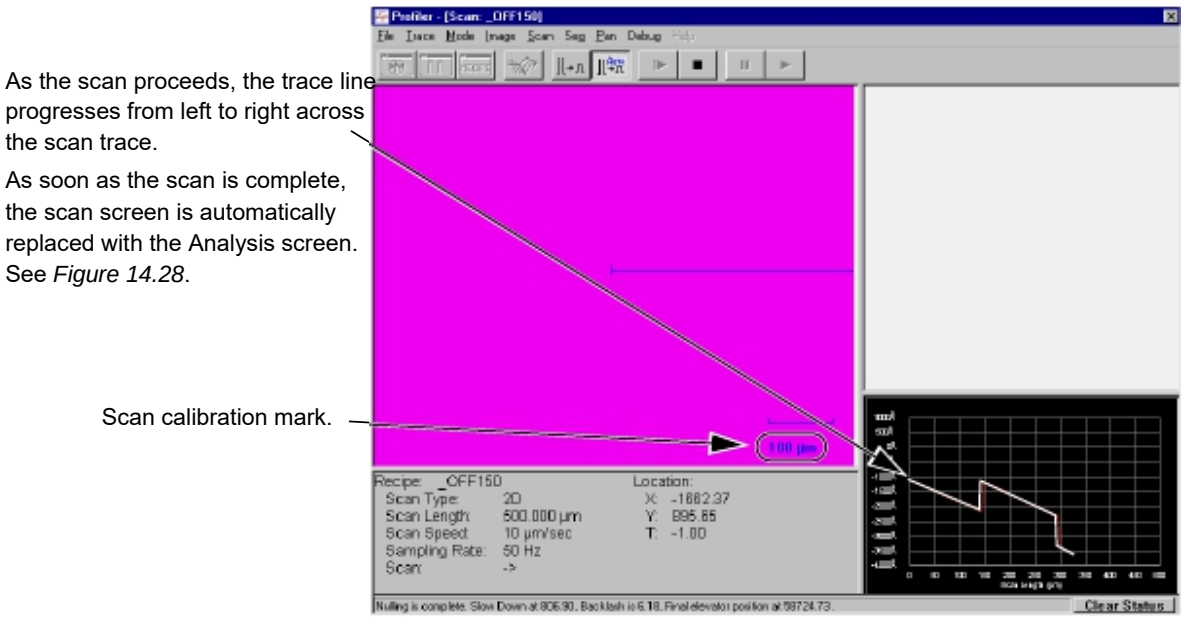
Step 17 Click on the **START** button to start the calibration.



The video image changes to side view as the stage moves to position the start of the scan on the beginning of the start pattern near the calibration triangle.

When the stylus has reached the beginning of the 150 µm scan trace, the screen changes to the **Scan: _OFF150** window. The scan automatically begins.

Figure 14.26 *Scan: _OFF150 Window*



The scan can be viewed at the bottom right of the **Scan: _OFF150** screen as it progresses from left to right across the scan trace window, forming a linear image of the scanned surface. The Start pattern next to triangle is set up to direct the scan through the middle of the triangle using the **_OFF150** recipe. In a perfectly calibrated system, the scan trace goes directly through the center of the 300 µm triangle creating a 150 µm trace step. However, this is not a common occurrence for a system that has not yet been calibrated after a stylus change.

The system uses the step and the distance across the triangle to determine where the trace was performed and then automatically calculates the offsets.

Figure 14.27 *Trace Path Through Upper Triangle*

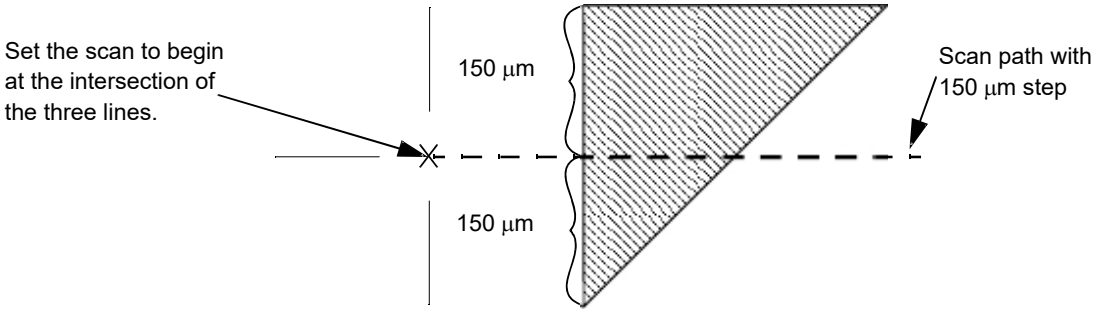
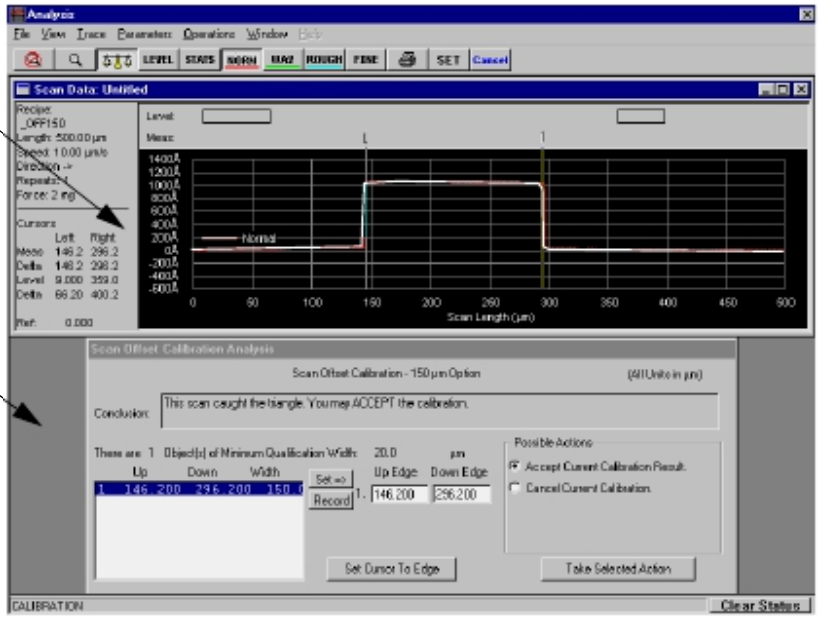


Figure 14.28 *Data Analysis Window.*

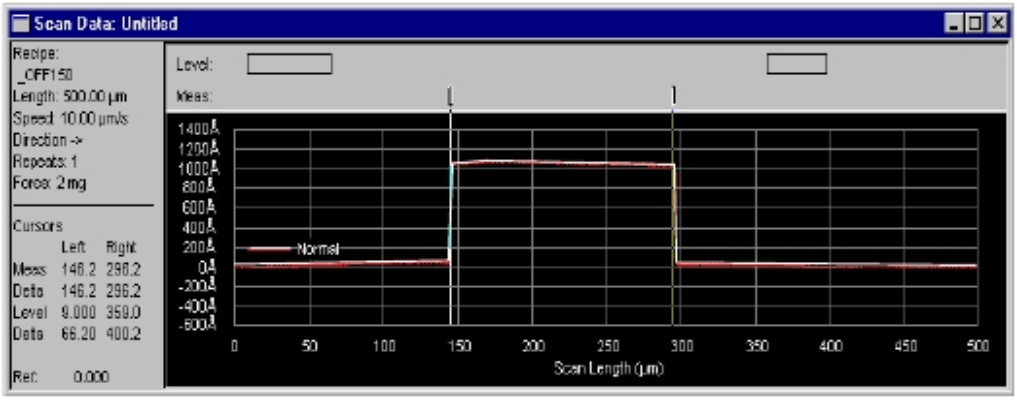
Scan trace display.
See *Figure 14.29*.

Scan data analysis.
See *Figure 14.30*.



When the scan is complete, the **Data Analysis** window automatically replaces the **Scan: _OFF150** screen. The window contains a scan data trace as shown in *Figure 14.29*. If the scan was successful, the system detected the triangle and set cursors at the edges of the triangle for visual inspection. It is possible to observe the scan and determine, visually, where the trace is running through the triangle.

Figure 14.29 *Scan Data Portion of the Analysis Window*

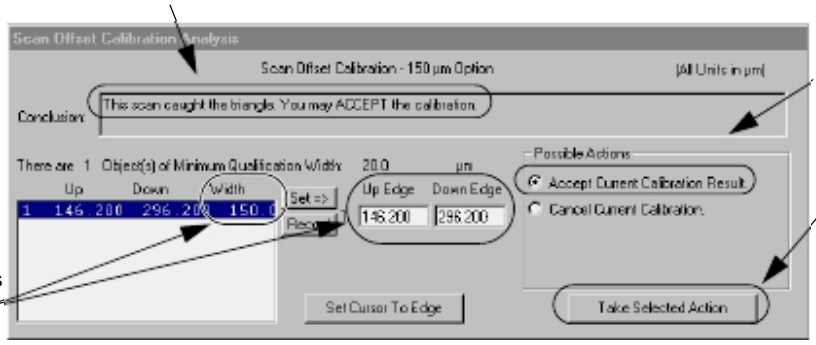


In the bottom half of the window, the **Scan Offset Calibration Analysis** appears. In *Figure 14.30* the system has subtracted the Up Edge from the Down Edge and calculated the result to be 150.0 µm. Using this analysis of the scan, the system makes a recommendation based upon its recognition of the **ProCal Wafer** triangle pattern.

18. To accept the recommendation, ensure that **Accept Current Calibration Result** is chosen, then click on **Take Selected Action**. (See *Figure 14.30*.)

Figure 14.30 *Coarse Scan Data Analysis Window*

If the scan was recognized by the system, a recommendation to ACCEPT the calibration is displayed here.



The system subtracts the **Up Edge** from the **Down Edge** and derives the width. The outcome in this case is 150.0 µm.

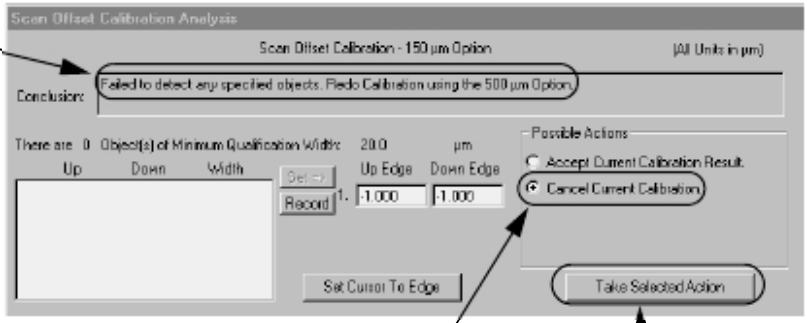
Step 18 To accept the calibration, click in the **Accept...** radio button,

then click **Take Selected Action**.

If the trace misses the triangle or is unable to identify it, one of several messages can be displayed. If the message reads, "Unknown situation…" or is otherwise uncertain, perform the entire scan procedure again, this time using the 1000 µm (1 mm) triangle and replacing the 150 µm scan recipe with the 500 µm scan recipe, _OFF500. If the 500 µm scan is acceptable, perform the 150 µm scan again. The results should be acceptable.

Figure 14.31 *"Unknown Situation" Corrective Action*

The conclusion of the scan is displayed here. It can either recommend accepting, be uncertain, or recommend rescan.



First If the scan is uncertain or the recommendation is to take a rescan, click **Cancel Current Calibration**.

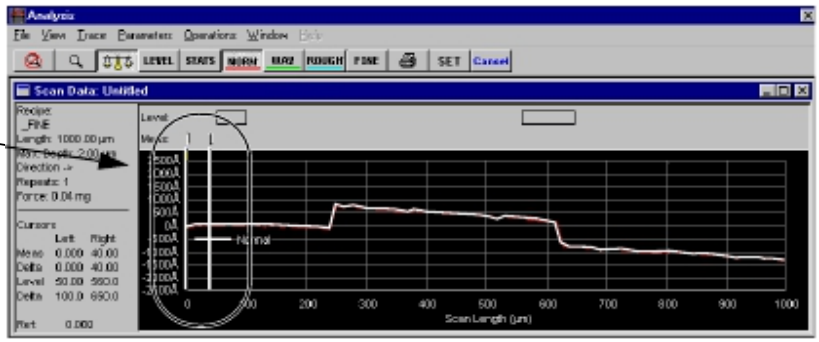
Second Then click Take Selected Action.

When the Triangle is Present, But System Does Not Find It.

The message could also say that the scan might have caught the triangle and ask the user to choose either to accept it, change the location, or reject it. If the **Conclusion** box informs the user that the system either didn't find the triangle for sure or asks the user to check the trace for the presence of the triangle, it might be necessary to reset the measurement cursors. (See *Figure 14.32*.)

Figure 14.32 *Pre Acceptance Analysis Screen*

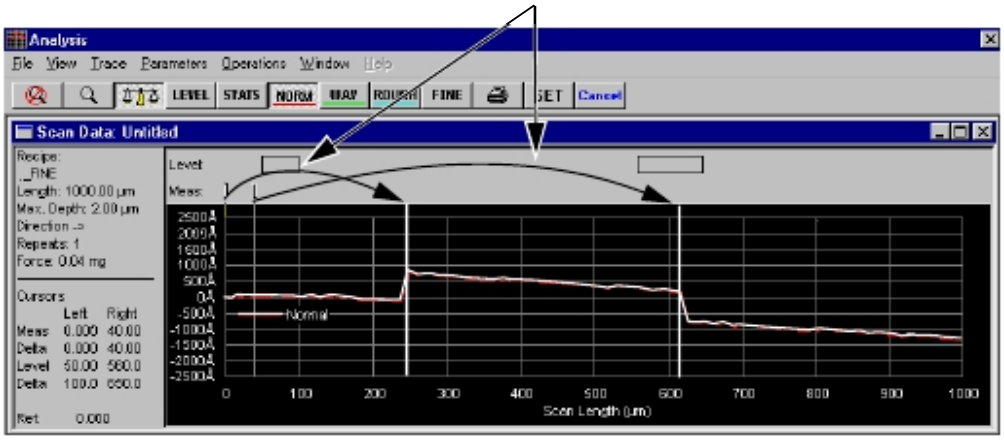
In this case, the system placed the identification cursors at the left edge of the trace, missing the triangle that is obviously displayed mid trace. (See *Figure 14.33* for resolution.)



1. If the triangle is obvious, reset the measurement cursors to the top edges of the triangle. To reset the measurement cursors, look in the top area over the graph, click and hold on the right cursor, then drag it to the top right corner of the step in the trace. Repeat for the left cursor, dropping it on the top left corner. (See *Figure 14.33*.)

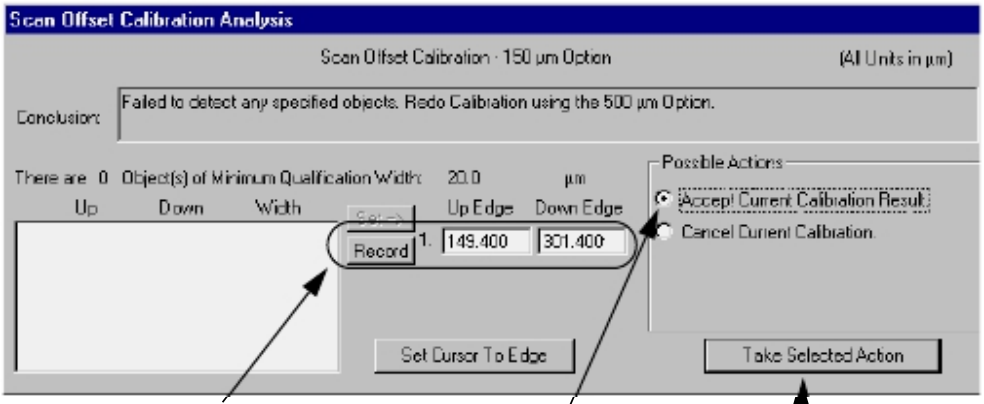
Figure 14.33 *Analysis Screen with Cursors Manually Placed*

Click, hold and drag each cursor to the top edges of the step.



2. Once the measurement cursors are in position, click **Record** in the Scan Offset Calibration Analysis section of the screen. (See *Figure 14.34*.)

Figure 14.34 *Scan Offset Calibration, Analysis Information Window*



Step 2 Once the cursors have been placed at the top edges of the triangle, click **Record** to set the coordinates of the triangle edges in the Up Edge and Down Edge fields.

Step 2 Choose **Accept Current Calibration Results** by clicking in its empty radio button.

Step 3 Click **Take Selected Action** to save the calibration results.

3. When the edges of the triangle have been recorded, choose **Accept Current Calibration Result** in the **Possible Actions box**. (See *Figure 14.34*.)
4. Click **Take Selected Action**. (See *Figure 14.34*.)

When More Than One Possibility is Displayed

On rare occasions the system fails to recognize the triangle even though it is in the data set. The system might also make a determination that one of a number of detected features is the correct one. To determine if the triangle is in a given data set, review the scan data set of detected features at the bottom left of the Scan Offset Calibration Analysis portion of the screen. If the triangle is present then the scan calibration can be reset.

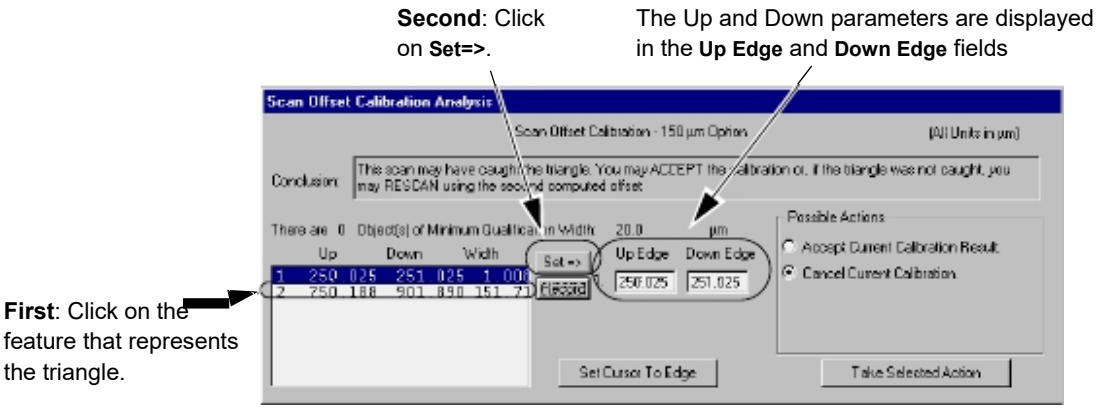
1. Click on the scan feature data set that represents the triangle so that it highlights.

   In *Figure 14.35* the system choose feature number 1 and set its parameters in the Up Edge and Down Edge fields. (See *Figure 14.35*.) However, feature number 2 is 151.71 µm which is very near the expected scan distance of 150 µm. In this example the user would click on that feature to highlight it.

2. With the feature highlighted, click on **Set** to choose that feature as the triangle.

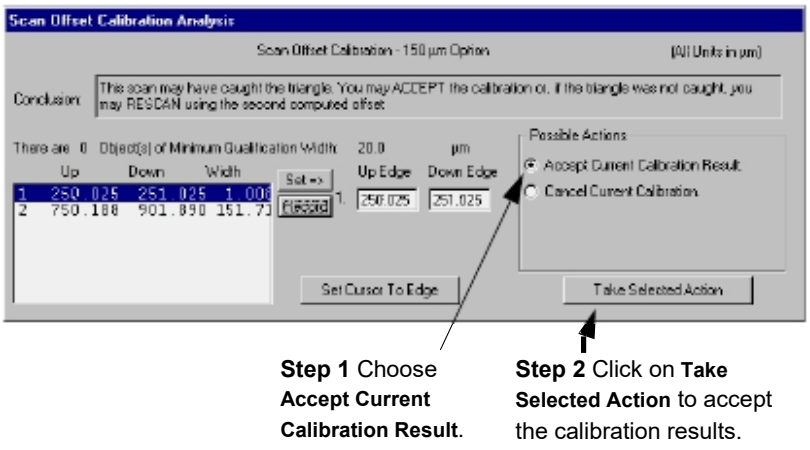
   The Up and Down parameters of the data set are recorded in the Up Edge and Down Edge fields. (See *Figure 14.35*.)

Figure 14.35 *Hand Selecting the Triangle Data in Analysis Screen*



1. Once the feature is chosen, choose **Accept Current Calibration Result**. (See *Figure 14.36*.)
2. Click **Take Selected Action**. (See *Figure 14.36*.)

Figure 14.36 *Accepting Adjusted Scan Results*



3. After the scan calibration has been accepted, the **Calibrations** screen returns. Close the Calibration screen.

PREVENTIVE MAINTENANCE

INTRODUCTION

This chapter describes:

- *Periodic Preventive Maintenance*

PERIODIC PREVENTIVE MAINTENANCE

The reliable operation of the P-17/P-7 Profiler system is dependent on its proper maintenance. The most important part of the system's maintenance program is periodic Preventive Maintenance (PM). The following maintenance procedures are divided into periodic categories. Each task in the periodic lists is actually a procedure. Where possible, the approximate time required for performing the designated task is specified so maintenance technicians can plan system down-time and allot the proper amount of time for the associated tasks. Perform the tasks in the order they appear in the tables.

Each periodic PM procedures list is independent of the others. This means that several sets of procedures are often required in the same time interval. For example, the weekly PM procedures and monthly PM procedures would both be performed in the same week that the monthly PM procedures are due.

Weekly PM Procedures

Table 15.1 *Weekly PM Procedures*

TASK #	DESCRIPTION	REASON	RESOURCES	TIME
1.	Run the Applied Force Calibration.	To verify that the correct stylus force is being used		
2.	Ensure that the hard disk capacity is less than 70% full.	To prevent system file corruption	Windows Explorer	
3.	Perform PBackup	To prevent loss of date in case of an unexpected failure	See the PBackup section in this manual	

Monthly PM Procedures

Table 15.2 *Monthly PM Procedures*

TASK	DESCRIPTION	REASON	RESOURCES	TIME
1.	Perform the Scan Position Offset - Coarse Calibration.	To ensure accurate low-power optics video positioning with respect to the stylus.		
2.	Check, and if necessary, perform the Step Height Calibration for 131-µm range (Contact mode).	To ensure accurate high range step height measurements.		
3.	Check, and if necessary, perform the Step Height Calibration for 26-µm range (Contact mode).	To ensure accurate Medium Range step height measurements.		
4.	Check, and if necessary, perform the Step Height Calibration for 6.5-µm range (Contact mode).	To ensure accurate Low Range step height measurements.		
5.	Perform the contact version of the Scan Position Offset - Fine Calibration	To ensure accurate low power optics video positioning with respect to the stylus.		
6.	Defragment the hard drive with Microsoft Defrag Utility.	To ensure efficiency of computer file system.	Windows	
7.	Perform PBackup	To prevent loss of date in case of an unexpected failure	See PBackup section in this manual.	

Semi-Annual PM Procedures

Table 15.3 *Semi-Annual PM Procedures*

TASK #	DESCRIPTION	REASON	RESOURCES	TIME
1.	Check all cables, connections and conduit, for binding, pinching or breakage.	To ensure connectivity of cables and prevent wear or damage.		
2.	Perform PBackup	To prevent loss of date in case of an unexpected failure	See PBackup section in this manual.	

NOTE: Only KLA-Tencor certified service/maintenance personnel are authorized to perform these lubrication procedures.

BACKUP AND RESTORE

Introduction

The Backup and Restore procedures are used to prevent loss of information and system settings. The Backup procedure should be a regular part of the preventive maintenance (PM) of the system. If there is a failure of the system, the saved information and system settings can then restore the system to its status at the time of the last backup. This includes calibration, configuration and data.

Backup and Restore are broken down into subcategories so the user can choose what to backup and what to restore. For backup, each time the procedure is performed, calibration, configuration, and recipes (scan and sequence) information is automatically included. The user has the option to include the data in the backup.

For restore, the user has the option of restoring the calibration, configuration, recipes, data or everything.

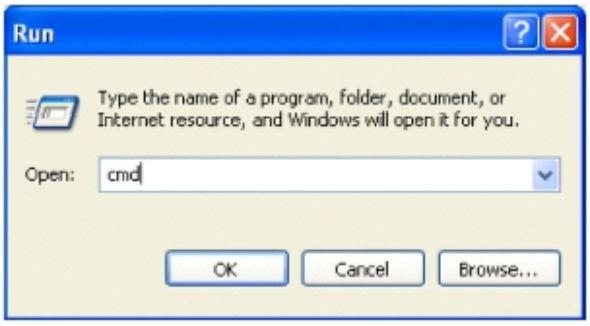
NOTE: When including data in the backup, the procedure can be lengthy, depending on the amount of data on the system. A potential PM maintenance schedule could have a system backup on a more frequent basis to ensure that configurations, calibrations and recipes are not lost and data backup is done on a less frequent basis.

Profiler Backup Procedure

The Profiler Backup Procedure can be performed by any user logged into Windows XP. Follow these steps to backup Profiler:

1. Close Profiler software.
2. From the Windows Start Menu select Run.
3. Type in cmd to open a command prompt window. See Figure 16.1.

Figure 16.1 *Windows Run Function*



4. To start the backup, type in pbackup, the destination drive, and data (optional). See Figure D.16 for an example.

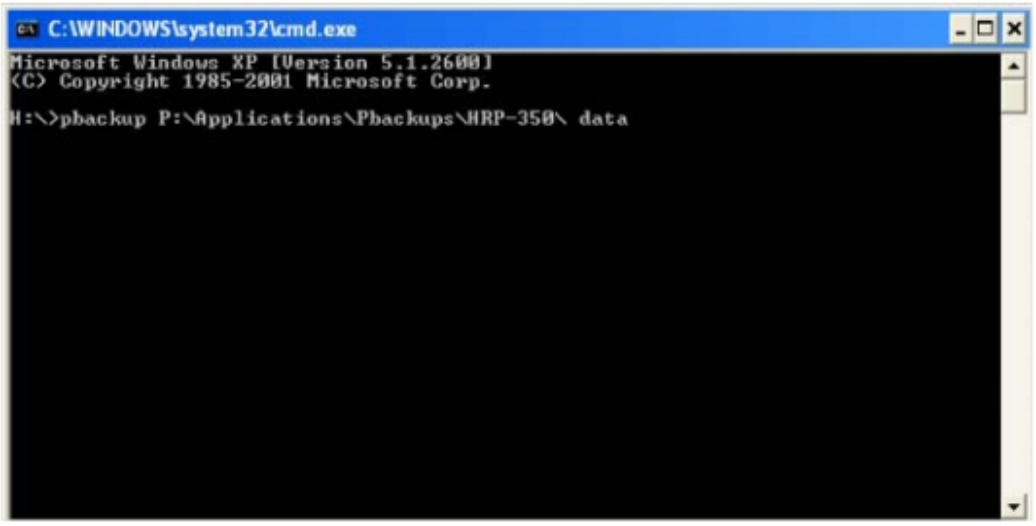
b. Destination drive can be any of the following: local hard drive, CD RW drive, DVD RW drive, USB drive or any mapped network drive.

c. The following will be automatically backed up: configuration, calibrations, system registry, EPROM, scan recipes, and sequence recipes.

d. Adding data (optional) to the command will include scan and sequence data in the backup..

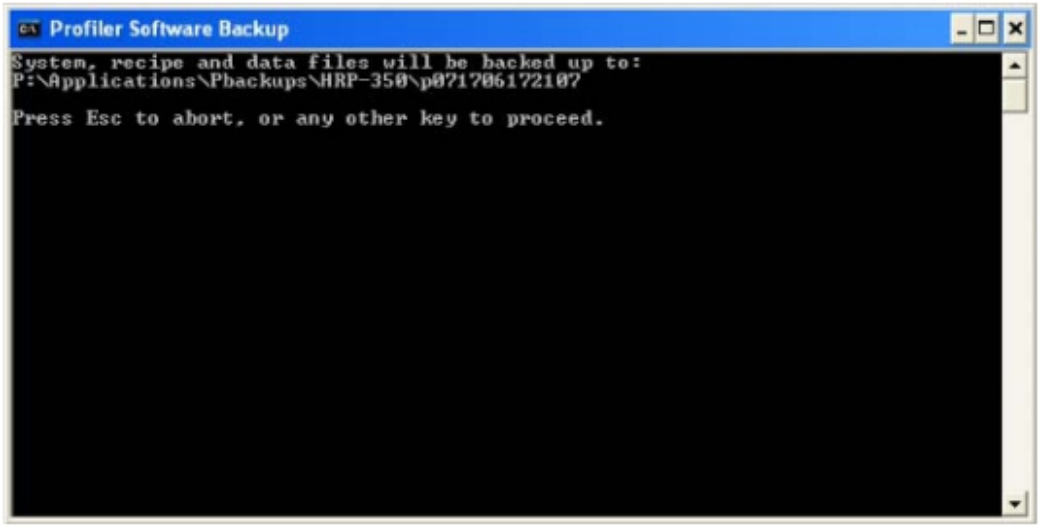
NOTE: To receive instructions for the backup or restore procedures, type pbackup or prestore in the command prompt window. This will display instructions for the backup or restore procedure.

Figure 16.2 *Profiler Backup Command*



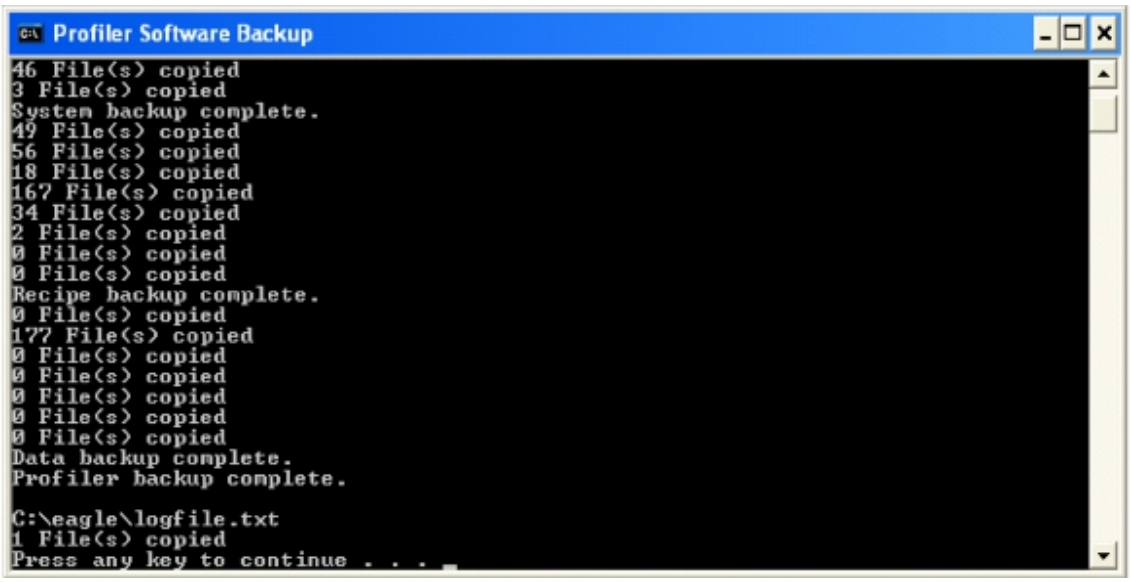
5. A second command prompt window will be automatically opened as shown in Figure 16.3. Select any key to proceed with the backup or ESC to abort the backup.

Figure 16.3 *Profiler Backup Command Confirmation*



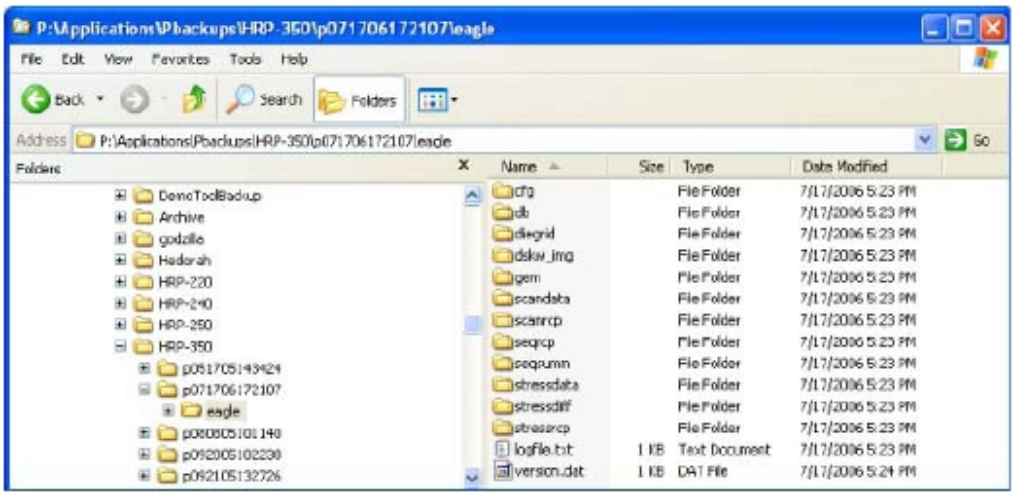
6. The second command prompt window will display the status of the backup, as shown inFigure 16.4 . The time for the backup will vary depending on the data transfer rate and the files chosen for backup. Excluding data, backup will typically take less than 10 minutes..

Figure 16.4 *Profiler Backup Complete*



7. Press any key to continue, which will close the second command prompt window. Close the first command prompt window by typing Exit.
8. Check to ensure that the files were correctly backed up, which should look similar to Figure 16.5.
   a. Backup will create a date-time stamped folder such as p071706172107, which indicates that the backup was started on July 17, 2006 at 17:21:07.
   b. All profiler backed up files will be contained within the eagle folder.
   c. Open the text file logfile.txt in the eagle folder to show a log confirming a successful backup.

Figure 16.5 *Profiler BackupFiles*



Profiler Restore Procedure

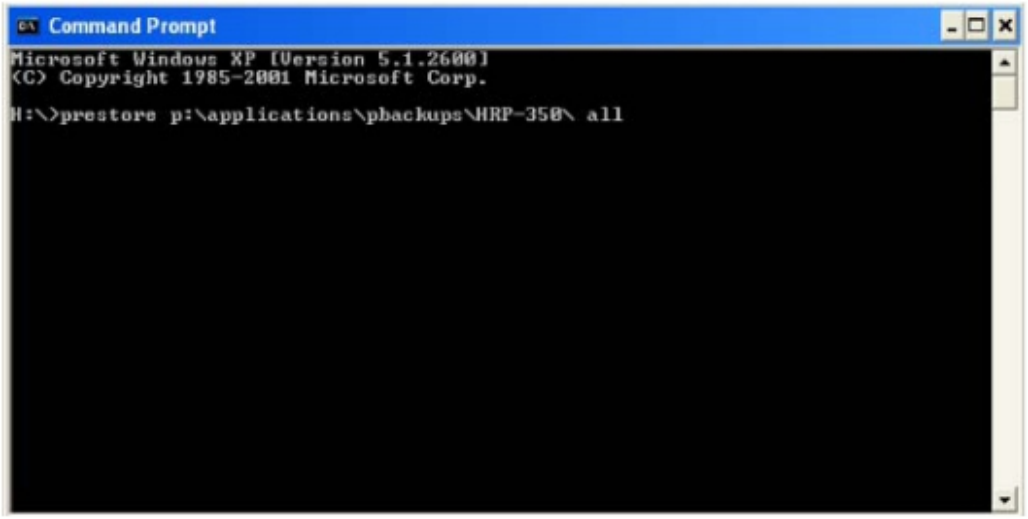
The Profiler Restore Procedure can only be performed by an administrator. This procedure allows the user to choose to restore the configuration, calibrations, recipes, and data. This should only be performed after Windows XP and the correct version of Profiler software are loaded on the system.

1. Close the Profiler software and log into Windows XP as an administrator.
2. From the Windows Start Menu select Run.
3. Type in cmd to open a command prompt window.
4. To start the restore, type in prestore, the location of the backup files, and he information that needs to be restored. See Figure 16.6 for an example.
   a. Location of the files can be any of the following: local hard drive, CD RW drive, DVD RW drive, USB drive or any mapped network drive.
   b. The location used should be to the path before the date-time stamped folder as shown in Figure 16.6.

c. The user can choose to restore the following: system (configuration, calibrations, system registry, and EPROM), recipes (scan and sequence recipes), data (scan and sequence data) or all (system, recipes, data).

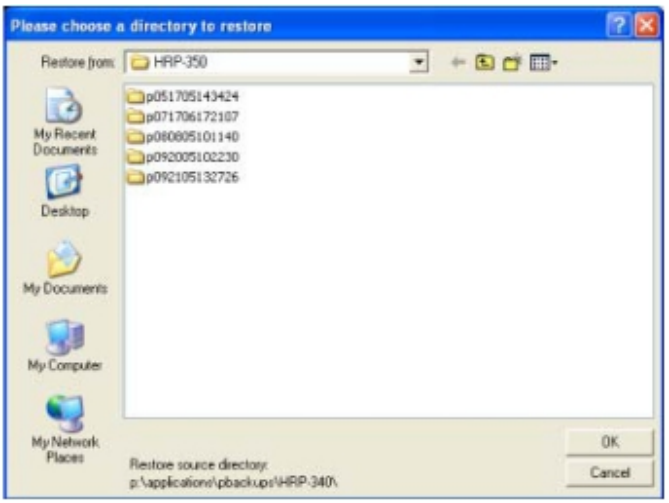
NOTE: To receive instructions for the backup or restore procedures, type pbackup or prestore in the command prompt window. This will display instructions for the backup or restore procedure.

Figure 16.6 *Profiler Restore Command*



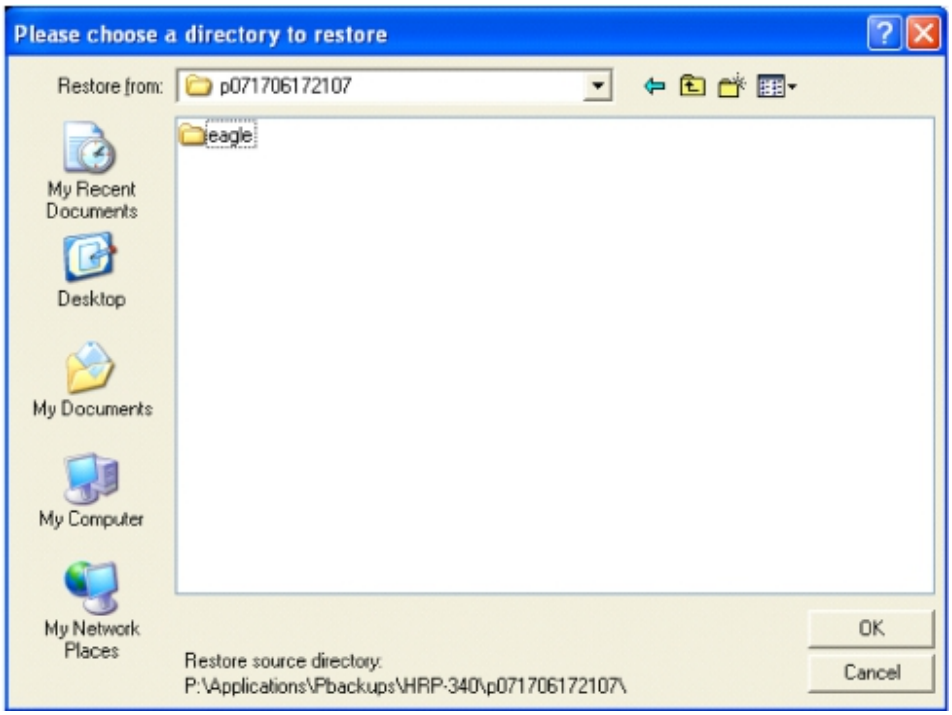
5. A second command prompt window will open and then a dialog box prompting the user to select a directory to restore as shown in Figure 16.7.

Figure 16.7 *Profiler Restore Directory Selection*



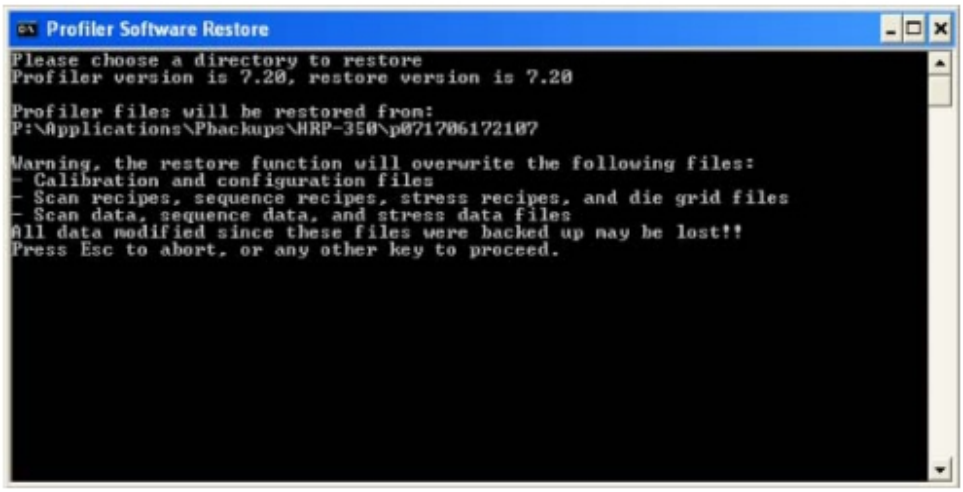
6. Double-click on the correct date-time stamped folder and select OK to restore the selected files as shown in Figure 16.8.

Figure 16.8 *Profiler Restore Directory Selection*



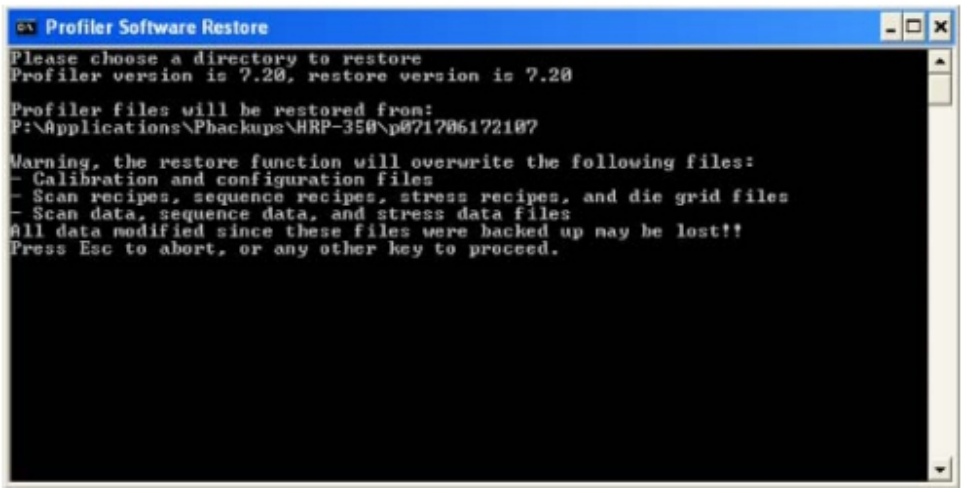
7. After selecting OK the dialog box will close and return to the second command prompt window with a warning that the restore function will over-write existing files as shown in Figure 16.9. Select any key to continue or ESC to abort.

Figure 16.9 *Profiler Restore Command Confirmation*



8. The second command prompt window will display the status of the restore, as shown in Figure 16.10. The time for the backup will vary depending on the data transfer rate and the files chosen for backup. Excluding data, backup will typically take less than 10 minutes.

Figure 16.10 *Profiler Restore Complete*



9. Press any key to continue, which will close the second command prompt window. Close the first command prompt window by typing Exit.
10. Start Profiler software and verify correct functionality of the Profiler by running standard qualification recipes.

HAZARDOUS MATERIALS

INTRODUCTION

The purpose of this document is to identify materials within the product that are considered environmentally hazardous according to the Waste Electronics and Electrical Equipment (WEEE) and Restriction of Hazardous Substance (RoHS) directives. At the end of life of this equipment, the product shall be dismantled and hazardous materials shall be dismantled.

The WEE & RoHS Hazardous Material appendix contains the following sections:

HAZARDOUS MATERIAL CONTENT

Lead is typically found in solder connections including PCBA terminations. **Mercury** can be found in electronic components such as switches and relays. **Lead, mercury** and **cadmium** may be found in insulation of electrical cables. **Hexavalent Chromium** may be used as a coating on frames, steel, screws and fasteners.

Computer monitors are used in this equipment and contain **lead** in the CRT

Batteries are used in this equipment which contain **cadmium/ lithium**. Also, **lead-acid batteries** are provided in the UPS. Batteries shall be separated and disposed of to meet local regulations.

Mercury can be found in the lamp in this equipment used as a light source. The mercury lamp shall be disposed of properly and adequate precautions shall be taken when handling the mercury lamp.

Capacitors can be found in electronic equipment and may contain various materials such as **polychlorinated biphenyls/ terphenyls** (PCB/ PCT). All such capacitors and electrolytic capacitors shall be separated and disposed of properly.

Brominated flame retardants may be found in plastic casings and enclosures in this product.

All parts with hazardous material shall be separated and disposed of to comply with applicable local laws and regulations including the European WEEE Directive.

The crossed out wheeled bin symbol represents that hazardous content is included in the equipment. (See Fig. A.1.) The equipment and parts with hazardous content shall not be disposed of with unsorted municipal waste. It is required that Electric and electronic equipment be disposed of under separate collection.

For equipment at the end of life in the European Union, KLA-Tencor works with local recyclers to ensure that equipment is properly disposed. Contact KLA-Tencor regarding the disposal of equipment in the EU when you see the following symbol:

Figure A.1 *Hazardous Content Symbol*

HAZARDOUS MATERIALS LIST

The following provides a more detailed list of where hazardous materials may be found. These components, if used in the equipment, shall be separated and disposed of properly.

Table A.1 *Hazardous Materials List*

Material	Used In
Lead (Pb)	PCBA
	Electronic Component
	Solder
	Component lead finish
	Die attach
	Ceramic packages
	internal filp chip balls
	BGA balls
	Cable/Wire insulation, jacketing
	Rubber hardner, pigment, paint, lubricated
	Metal allo
	Connectors
	Fuses
	Circuit Breakers
	Motors & Encoders
	Fans
	Flex circuits

Table A.1 *Hazardous Materials List (Continued)*

Material	Used In
	Power supplies
	Cathode Ray Tubes
	Glass
Cadmium *Cd)	Plastics as a pigment or stabilizer (i.e. PVC)
	Relays and switches (i.e. electrical contacts)
	Batteries
	Semiconductors
	LEDs, Light sensors (Optical materials)
	Chip resistors
	Infrared detectors
	Cables
	Zinc plating & Metallic finish
	Threaded fasteners
	Recycled plastics
Mercury (Hg)	Batteries
	Electrical Contacts
	Switches and relays
	Pigments and paint
	Polyurethane finish
	High gloss windows
	PVC & Rubber additives
	Mercury Discharge Lamps
Hexavalent Chromium (CrVI)	Passivation coatings
	Corrosion resistant paints and coatings
	Hard Chrome plating
	Plastic etchant for metallized plastics
	Photocopier Toners
	Rust inhibitor
Polybrominated Diphenyl Ethers (PBDE) and Polybrominated Biphenyls	Flame retardants

Table A.1 *Hazardous Materials List (Continued)*

Material	Used In
	Plastic connectors
	Plastic housing
	Cables
	Connectors
	PCBA
	High power components
	ABS & Injection molded plastics
	Paints & Epoxy
	Nylon Plastics
	Fans

P SERIES PROFILER - PREPARING FOR SHIPMENT

INTRODUCTION

The purpose of this section is to provide the guidelines and steps required for the proper, safe shipment of the P series Profiler tools. This appendix includes instructions for both Hardware and Software.

Required tools

NOTE: The P-7 and P-17 systems should only be installed or uninstalled by a qualified engineer: KLA-Tencor service engineer, KLA-Tencor applications engineer, or a qualified distributor. Before installing a system, please refer to the P-7 or P-17 pre-install guides to ensure that the facilities meet system and safety specifications.

Table B.1 *Minimum Parts Required*

Item	Description	Ext Qty
176931	HOOK,"S",3/16 DIA,STEEL	2
176940	TURNBUCKLE,HOOK&EYE,114DIAX6"	1
280380	PROTECTIVE PLATE ASSY,M2	1
118699	CLAMP ASSY,SHIPPING,P1	1
248142	CRATE,SHIPPING,P10	1

PROCEDURE

1. Remove the left side cover from the system.
   a. For the P-17, open the front door to the profiler and locate the two large black knobs on the upper front and rear of the left side panel. Remove each of these knobs, and lift the panel away from the system.
   b. For the P-7, the panels have screws on the side covers. When removing the screws, if any screw is retained or used with a keyhole attachment, it should not be fully removed from the cover. Once the screws are loose, lift the left side panel away from the system.
2. Using the Profiler software, move the XY stage so it is centered directly beneath the measurement head.

3. Install the protection plate on the under side of the measurement head by aligning the four holes on the bottom of the head with the 4 pins on the plate, placing the hole in the plate directly below the stylus tip.
4. Push upward to lock the protection plate into place.
5. Install the stage shipping clamp (yoke) onto the XY chuck so it is centered beneath the protection plate on the head (with the padded edges resting directly on the left and right sides of the X drive assembly). Have ¼" clearance between the clamp and the Guide bar so that when we pull down, we don't push against the leadscrew bearings.

   NOTE: Pull out interlock override on sides and close the front door. The elevator post should spin down below the elevator casting as visible in the center of the elevator. Should have about ¼" clearance before and 1/8" after tightening turnbuckle.)

6. Lower the head down until the protection plate comes into contact with the shipping clamp. This can be achieved by clicking FOCUS from within the XY screen of the Profiler software OR by doing the following:

   NOTE:
   1) For UPI based tools (P16 and below), (-) negative provides downward Z motion. For MIB based tools (P17 and P7), (+) provides downward motion.
   2) Z axis # varies as well depending on whether it's an MIB or UPI based tool.

   a. Exit the Profiler software
   b. Click on START and select RUN
   c. Type in DRUN and press ENTER
   d. Press m for Motion Commands (All letters should be lower case)
   e. Press m for Move Commands
   f. Press a for Set Active Axis
   g. Press 2 to select the Z axis
   h. Press m for Move Relative
   i. Type in -26000 and press ENTER
   j. The measurement head should start coming down
   k. Press s to stop the motion of the elevator once it has come into contact with the stage clamp. It should press down on the clamp hard enough to hold the XY stage and the clamp in place but not so hard that it crushes the stage clamp or causes the left and right sides to lift upward.
   l. If the motion is stopped too soon, continue the downward travel in smaller increments (m, -10000, ENTER).
   m. When the contact between the protection plate and the shipping clamp is good, press q several times to exit the DRUN software.
7. Exit the Operating System and power down the system.
8. Install the turn buckle between the measurement head and the system chassis.
   a. Loosen the turn buckle to increase the length to maximum

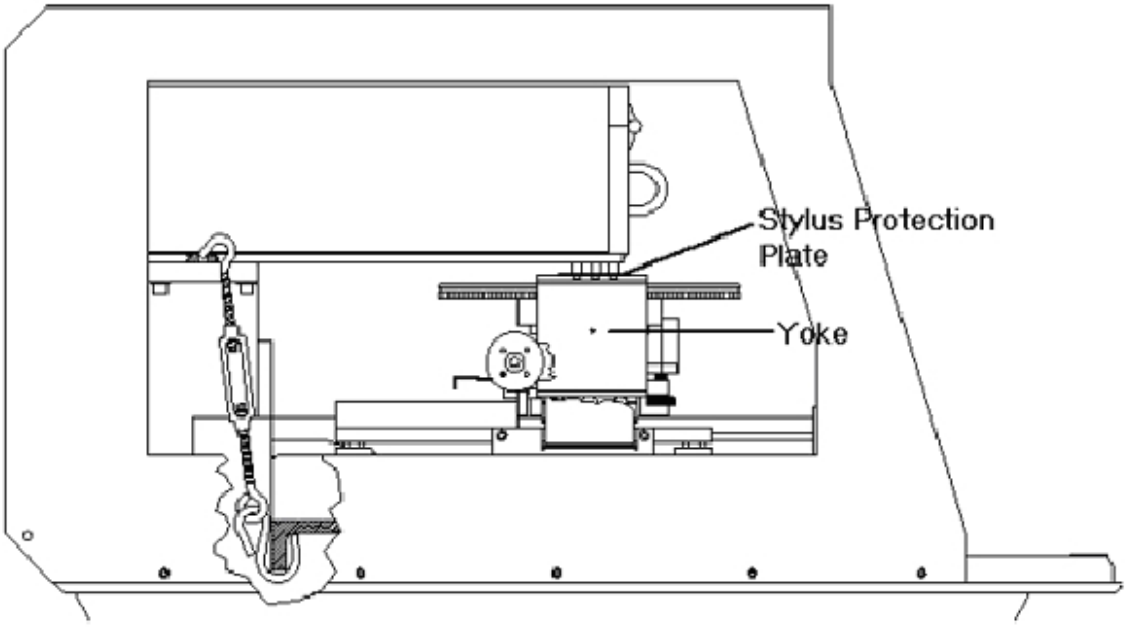
b. Place the two S hooks on the circular side of the turn buckle assembly and lock the last S hook underneath the edge of the system chassis (best achieved near the rear of the tool, between the Y motor assembly and the elevator assembly)

c. Place the hook portion of the turn buckle onto the base of the measurement head (see figure below) and rotate the assembly until it is tight, locking the measurement head down onto the XY stage.

9. Re-install the side panel to the system using the two large black knobs.

NOTE: Note: P7 differs from P17 in that there's a permanently mounted hook, therefore one only needs to insert the turnbuckle round side in the hook, and tighten.

Figure B.1 *P-7 and P-17 Shipping Restraints*



Revision History

Rev.	Rev. Date	Changes Made	Author	Owner
AA	08/2007	Draft 1 to include updates for P6 model	John Warren	Norman Manoukian
AB	1/2009	Updates for P^ Model	John Warren	Mohamd Najm
AC	08/2011	Added CE Declaration of Conformity data	Sasi Raj	Jeff Reichert

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