11

CONFIGURATION

INTRODUCTION

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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 a solid floor.

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 or an air-conditioning vent or heating outlet.

Facility Specifications

***Table 11.1** Facility Specifications*

FACILITY	SPECIFICATION
Vacuum	**Required to hold down the samples**: 6 mm (0.25 in.) nominal line providing a minimum of 500 mm (20 in.) mercury of vacuum at a flow of 27 liters/min. (1 cfm).
Dimensions	**Instrument** (without monitor): 57 cm (23 in.) wide, 78 cm (31 in.) deep, 46 cm (17.5 in.) high. **Monitor** (15-in.) SVGA:
Electrical	90-110 V, 50/60 Hz 110-130 V, 50/60 Hz 208-260 V, 50/60 Hz UL, CSA, European-qualified. **NOTE:** If the power source is susceptible to radio-frequency interference, an isolation transformer is required for providing additional filtering. Sensitive computer components require a power source that is free from spikes, dips, and surges. **NOTE:** If power failure is a common occurrence, use an Uninterruptable Power Supply (UPS) device. A UPS device supplies post interruption power for 30 minutes so an orderly system shutdown can be accomplished during a power failure. See *Loss of Power* on page 11-44 for details.
Ambient Temperature	Specified operating range: 16°–26°C. Maximum rate of temperature change: ≤ 1°C/hr.
Vibration	Floor vibration must be less than 250 µin./sec. (6.4 µm/s) RMS, 1-100 Hz
Audio Noise	≤ 80 dB (C weighting scale)
Air Pressure	90-125 psi, flow (6.4 kg/cm^2 - 8.9 kg/cm^2)
Laminar Air Flow	≤ 100 ft/min (30 m/min), down-blowing

Introduction to System Configuration

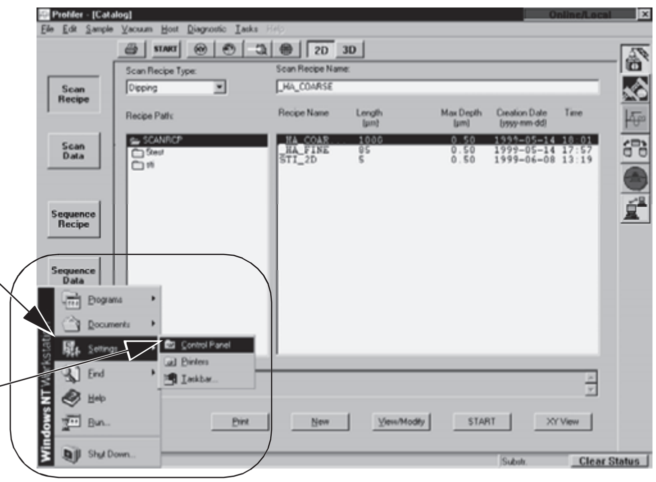
The KLA-Tencor system application software must have the correct information in its internal configuration files to properly run the instrument. The following sections cover checking and editing these configurations.

SETTING THE DATE AND TIME

To Set the Date and Time

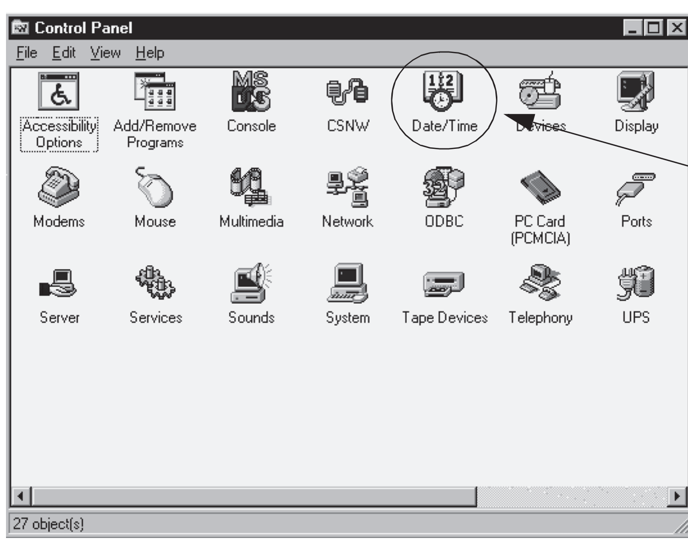
1. Before starting the Profiler system, click **Start** to display its menu.
2. Move the scroll cursor to **Settings** to display its menu.
3. Click on **Control Panel** to display the Control Panel window. (See *Figure 11.1*.)

Figure 11.1 *Start Menu with Setting Menu Displayed*



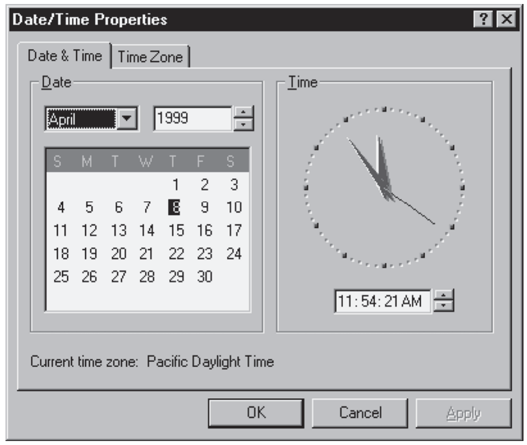
4. In the Control Panel window, click on **Date/Time** (it is either in a list or displayed under its icon). (See *Figure 11.2*.)

Figure 11.2 *Control Panel*



5. Choose the new value from the drop-down menu or highlight the part of the date or time (e.g., month, hour) that requires updating.
6. Enter the new value. (See *Figure 11.3*.)

Figure 11.3 *Date/Time Properties Window*



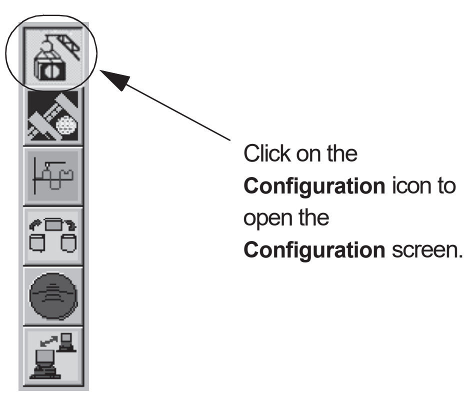
7. Repeat for each new value that requires updating.
8. Click **OK** to reset the system with the new date or time and to exit from the dialog box.
9. Close the Control Panel

CONFIGURATION WINDOW

The Configuration screen is password protected. If the icon or the function buttons in the Configuration screen are not active, the user should logon with the appropriate log-on ID and password for access.

To access the **Configuration** screen, click on the **Configuration** icon in any system level screen. (See *Figure 11.4*.)

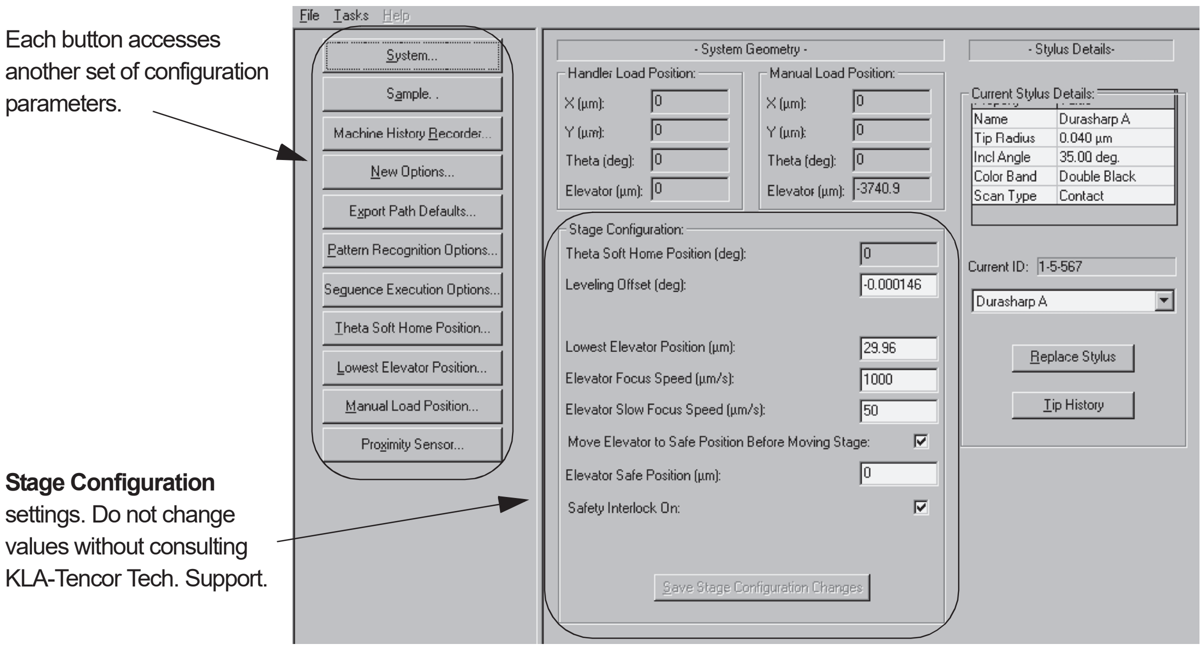
Figure 11.4 *Choose Calibration*



The **Configuration** window is displayed. (See *Figure 11.5*)

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.**

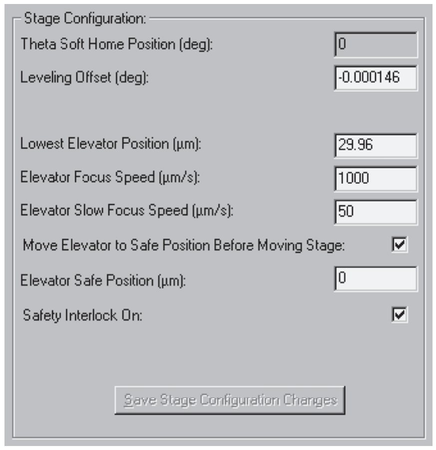
Figure 11.5 *Configuration Screen*



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. (See *Teaching the Soft Home Position* on page 11-6.)

Figure 11.6 *Stage Configuration Parameters*



Theta Soft Home Position

The Soft Home position is related to the X- Y-stage Theta Home Switch and the puck cutout. It is set at manufacturing and should not require further adjustment unless the entire Y-drive is replaced. Prior to performing this adjustment, the Y-orthogonality should be adjusted. The Soft Home position might be changed by teaching a new position.

This procedure should only be attempted by a KLA-Tencor trained technician. An error in this position could create further alignment difficulties.

Teaching the Soft Home Position

Figure 11.7 *Configuration - Theta Soft Home Position…*

Step 1 Choose **Theta Soft Home Position** to display its screen.

1. Choose **Theta Soft Home Position…** from the buttons on the left side of the **Configuration** screen. (See *Figure 11.7*.) The **Teach Soft Home Position** screen appears. (See *Figure 11.8*.)

   The stage rotates to the current Soft Home, *theta*, position.
2. Click **MAN LOAD** to move the stage to the stage door. (See *Figure 11.8*.)
3. 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 switch has been disabled).

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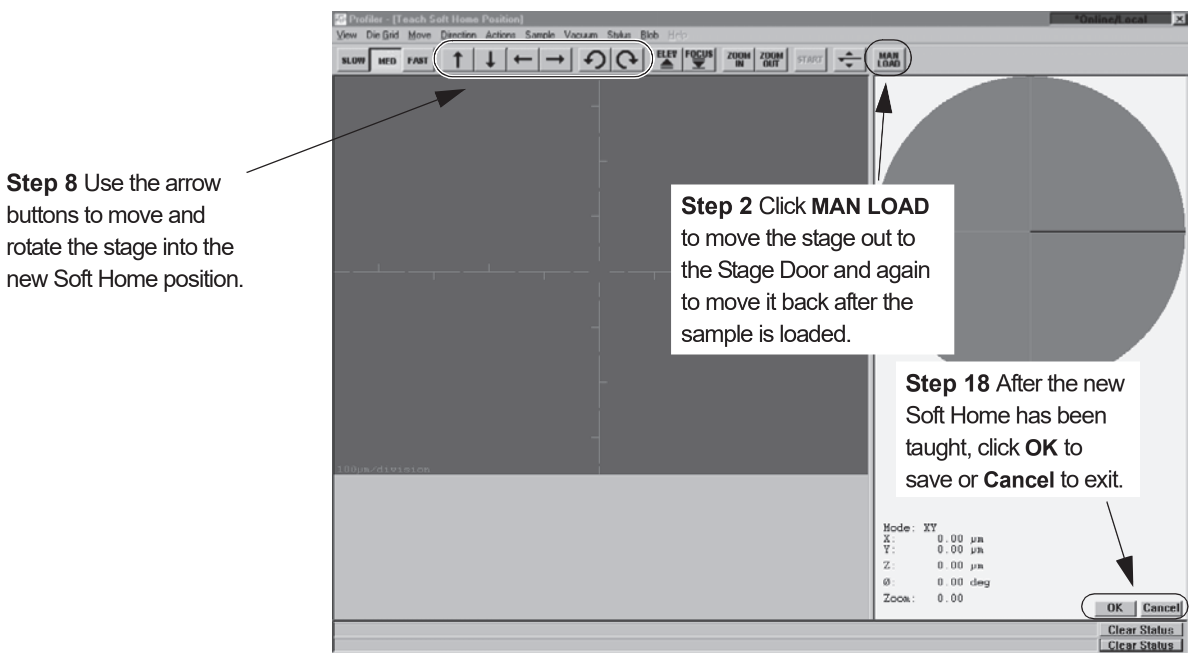
4. Load the **orthogonality fixture** onto the stage. (If the fixture is not available, use a patterned wafer, seated in a precision locator.)
5. Close the door.
6. Click **MAN LOAD** to move the stage back under the stylus.

Figure 11.8 *Teach Soft Home Position Screen*



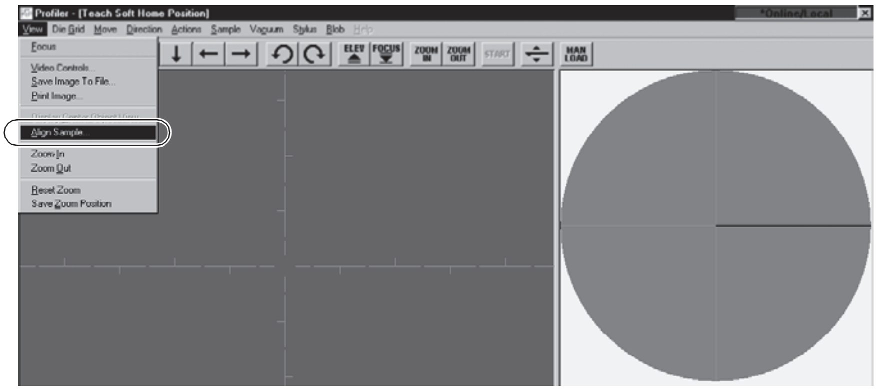
7. Click on **FOCUS** to focus on the sample surface.
8. Find a line or row of attributes using the arrow buttons in the tool bar, move the sample to the desired new position. If necessary, use the rotation buttons to rotate the stage to a new theta position. (See *Figure 11.8*) For a more precise setting, use the Align Sample procedure detailed in Step *9.* through Step *9.*

Begin: ALIGN SAMPLE

9. Click on **View** in the tool bar to display its menu. In the menu, click on **Align Sample**. (See *Figure 11.9*.) This sets up the Align Sample procedure used to align the XY axis of the screen with the tool's pattern.

Figure 11.9 *Align Sample Procedure - Scan Offset Calibration*

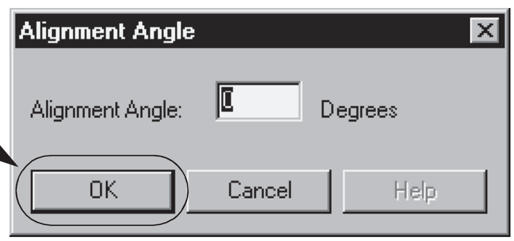
Step 9 To align the Stylus Alignment Tool with the XY axis of the screen, click on **Align Sample**.



10. The alignment Angle dialog box appears requesting input of the intended alignment angle. The default is "**0**" and should appear in the variable box. Click on **OK** in the dialog box to accept the "**0**" value. (See *Figure 11.10*.)

Figure 11.10 *Setting Alignment Angle*

Step 10 Click on **OK** to accept the "**0**" angle alignment.



11. The message prompt at the bottom of the screen appears as follows:

Figure 11.11 *Message Prompt After Alignment Angle is Set*

Using the **right** arrow button (→), scroll across the a horizontal pattern.

12. Place the crosshairs cursor on the horizontal line or die border and click. The system performs adjustments that align the screen grid dashes to the crosshairs.
13. The message prompt displays the following:

Figure 11.12 *Message Prompt to Accept of First Alignment Location*

Click **OK,** at the bottom right of the screen, to accept the first alignment location.

14. The following message appears in the message prompt:

    Figure 11.13 *Message Prompt for Selecting Second Alignment Location*

    Using the **left** arrow button (←), scroll across the wafer or sample. Stay close to the chosen horizontal feature. Travel at least one centimeter. Place the crosshairs cursor on the horizontal feature (in the same relative position as the first position) and click with the left mouse button. The system performs final adjustments, aligning the screen grid to the horizontal feature (the sample pattern is now aligned with the XY axis.)

15. The message prompt appears as follows:

    Figure 11.14 *Message Prompt to Accept Second Alignment Location*

    Click **OK,** at the bottom right of the screen, to accept the second alignment location.

16. The message prompt appears as follows:

    Figure 11.15 *Message Prompt to Accept the Alignment*

    After the adjustments have been completed by the system, the message prompt at the bottom of the screen requests the user to click **OK** to accept the new alignment adjustment. (See *Figure 11.15*.) Click **OK** (bottom right of screen) to accept, or click **Cancel** to run a new alignment calculation.

End: ALIGN SAMPLE

This completes the Align Sample procedure.

17. Click at the X- Y-junction on the video image to record the new position's coordinates.
18. Click **OK** to save the new position, or click **Cancel** to keep the original value and return to the Configuration screen. (See *Figure 11.8*)

Leveling Offset

The Leveling Offset is set at manufacturing. It should not be necessary to adjust it unless other mechanical procedures have been performed on the stage or drive systems. The leveling calibration procedure is automated and, when completed, provides a value for this field. (See *Level Calibration* on page 12-41)

KLA-Tencor recommends that this number not be changed except 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.

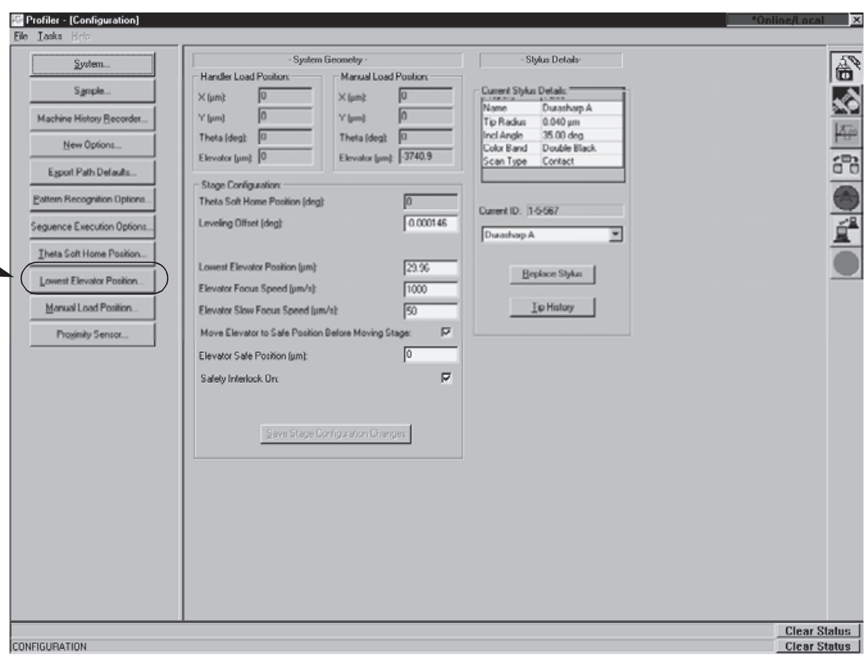
Procedure to Teach Lowest Elevator Position

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. From the **Configuration** screen, choose **Lowest Elevator Position…** from the menu buttons at the left side of the screen. (See *Figure 11.16*.)

Figure 11.16 *Configuration Screen - Lowest Elevator Position*

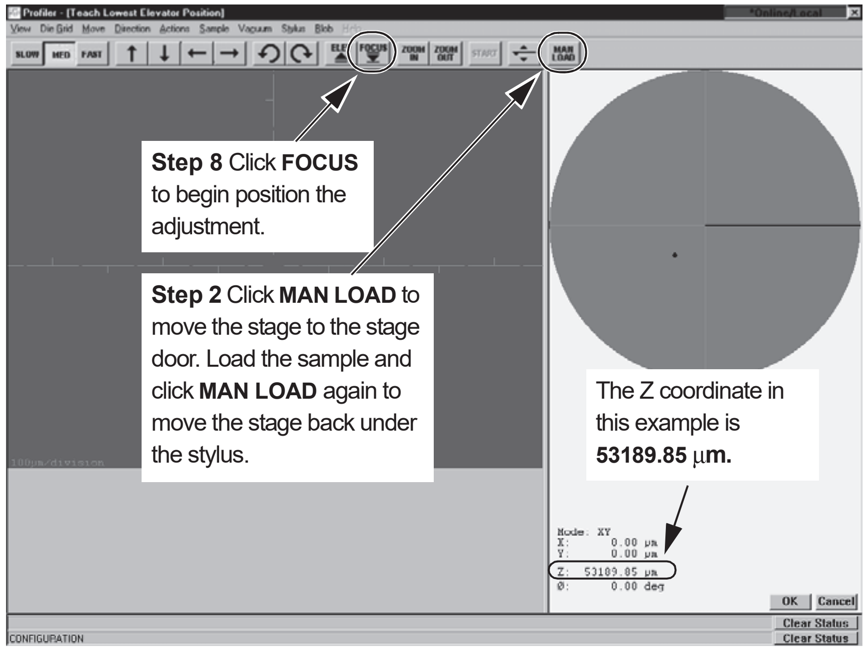
Step 1 To open the screen for teaching lowest elevator position, click **Lowest Elevator Position…**



2. The window shown in *Figure 11.17* appears. Assuming that the samples of consistent thickness are being used, load one of the samples onto the stage.

   To manually load a wafer or other sample, click **MAN LOAD** to move the stage to the stage door. (See *Figure 11.17*.)

Figure 11.17 *Teach Lowest Elevator Position Screen*



3. 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 switch has been disabled).

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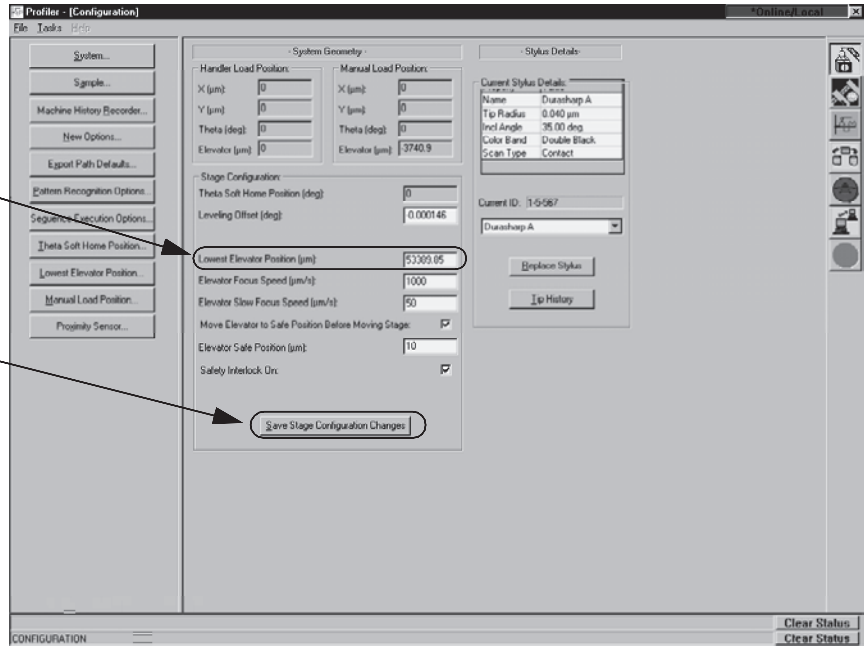
4. Load the sample from the stage.
5. Switch on the vacuum using the switch on the upper left inside door frame.
6. Close the door.
7. Click **MAN LOAD** to move the stage under the stylus. (See *Figure 11.17*.)
8. Click **FOCUS** in the tool bar to move the head down to focus on the sample. (See *Figure 11.17*.) The system is set to protect the stylus so this final null could take a relatively long time.
9. 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 11.18*.)

Figure 11.18 Configuration Screen - Lowest Elevator Position

The new value for Lowest Elevator Position. In this case it is: **53389.85**.



Step 10 When an acceptable change to the Lowest Elevator Position has been entered, click on **Save Stage Configuration Changes**.

10. 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 11.6 on page 11-6* also *Figure 11.18*.)

Settings Determining Trip Position

- 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 11.6 on page 11-6* also *Figure 11.18*.)

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 11.6 on page 11-6* also *Figure 11.18*.)

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 11.6 on page 11-6* also *Figure 11.18*.)

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.

Safety Interlock On

The door to the P-15 has an interlock that should be used to protect the user from injury and the instrument from damage. When the safety interlock is ON, the interlock system is active. This protective status prevents the system motors from engaging if the measurement chamber (stage) door is open. If any of the system stage or elevator motors are active when the stage door is opened, they are immediately turned off. They remain inoperative until the door is closed.

A check in the check box shows that the interlock system is ON. Like many of the Configuration features, this feature requires a security log on to enter and change. It is View Only to those without the clearance.

CAUTION: the Safety Interlock should not be defeated except for service requiring the service engineer to operate the motors with the door open. There are no operator defined functions requiring the door to be opened during system operation. **Only KLA-Tencor trained service personnel should ever defeat the Safety Interlock System**.

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

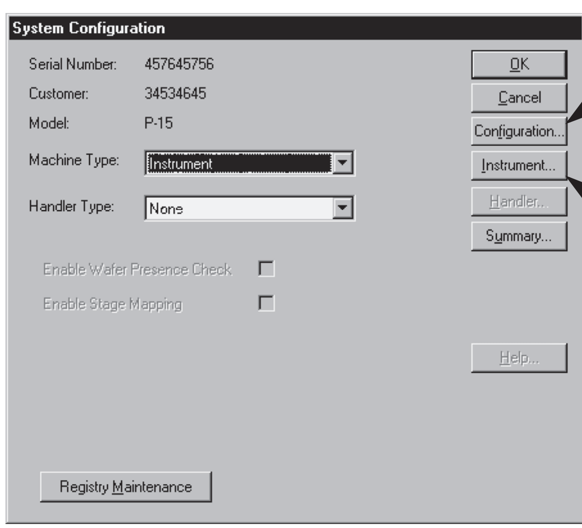
1. Click on the **System…** button at the left side of the Configuration screen. (See *Figure 11.19*).

Figure 11.19 *Configuration Screen*

Step 1 To open the System Configuration dialog box, choose **System…**

The **System Configuration** dialog box appears. (See *Figure 11.20*)

Figure 11.20 *System Configuration Dialog Box*



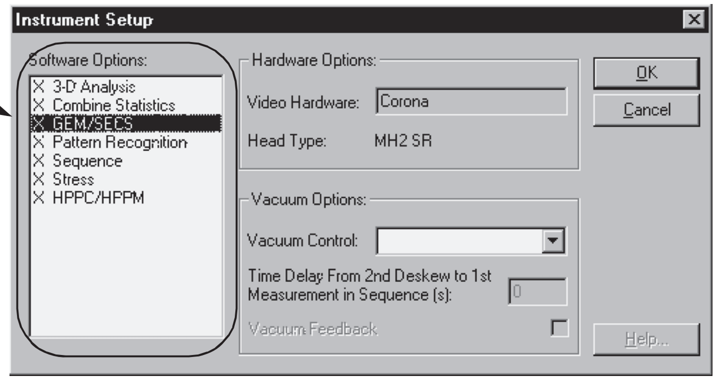
Configuration… Dialog Box

Instrument… Dialog Box

Instrument Setup Configuration Dialog Box

Figure 11.21 *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 11.21*.)

Software Options

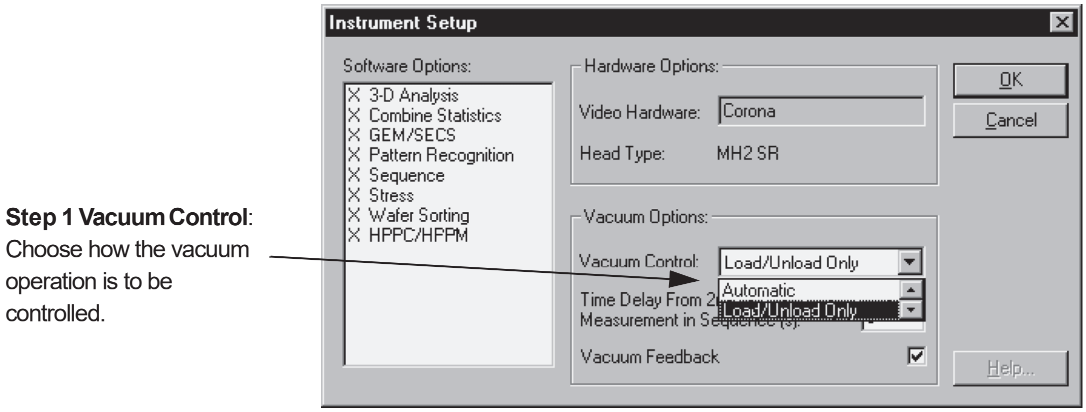
1. All of the purchased software options should appear in this box. (See the circled area in *Figure 11.21*.) An **X** before the option name indicates that it has been enabled. Click on the option to toggle between enabled and disabled. Choose the options that are to be enabled in the upcoming scanning 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.

Vacuum Options

Vacuum Control Option

1. **Vacuum Control** contains three options that are presented in the Vacuum Control drop-down menu: **None/Manual**; **Automatic**; and **Load/Unload Only**. (See *Figure 11.22*. It might be necessary to scroll down to see all options.) The P-15 system operates using a manual set of vacuum controls. The only valid option in the Vacuum Control menu is **None/Manual**. The vacuum control for the P-15 is a manual switch on the upper left inner portion of the system door frame.

Figure 11.22 Vacuum Options

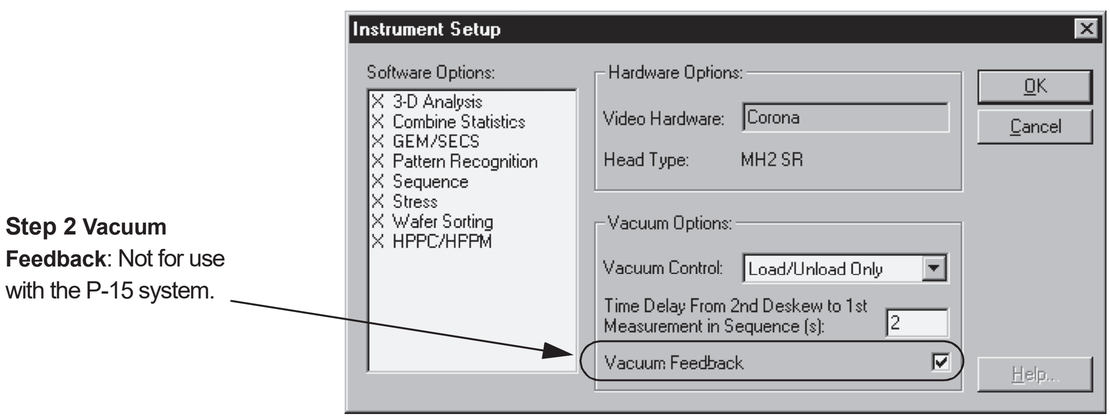


Click on the **Vacuum Control** menu arrow to display the **Vacuum Control** options. Select the desired option. (See *Figure 11.22*.)

Vacuum Feedback Option

2. **Vacuum Feedback**: Vacuum Feedback is not available in the P-15 system.

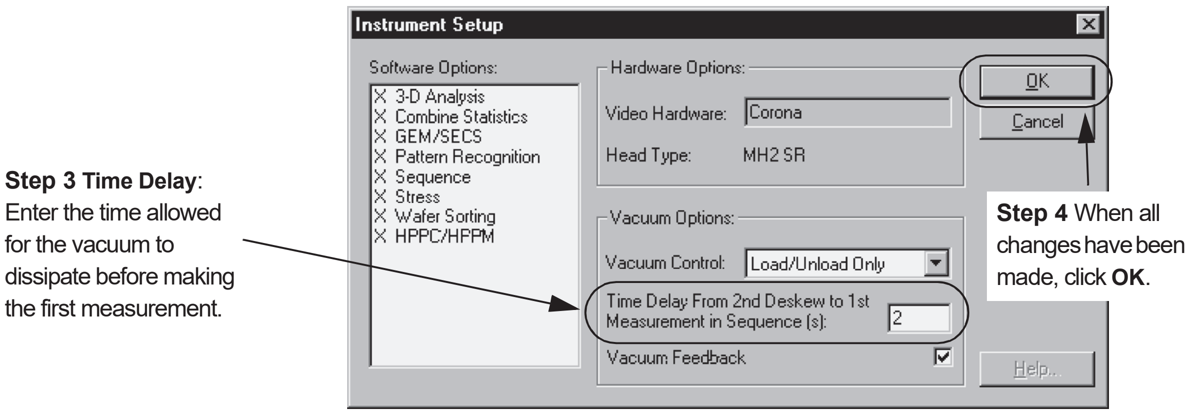
Figure 11.23 Vacuum Feedback



Time Delay Option

3. **Time Delay Between 2nd Deskew and 1st Measurement in Sequence (in sec):** is designed to provide enough time, after the last stage movement and before the beginning of a scan sequence, to dissipate the vacuum holding a sample. This option is only available for entering a value when the **Load/Unload Only** option in the **Vacuum Control** menu is enabled. (See **Load/Unload Only** in Step 1 on page -15 of the *Vacuum Options* section.)

Figure 11.24 *Vacuum Options*



To enable the **Delay**, highlight the number in the box next to **Time Delay From 2nd Deskew to 1st Measurement in Sequence (s):**. (See Vacuum Options on page 15.) Enter the number of seconds that the system must pause for the dissipation of the vacuum holding the sample. (See *Figure 11.24*.)

If there is a number in this box, and the field behind it is white, the Delay is already enabled. If the number is **0**, it has no delay effect on the scan. If the **0,** or other number in the box, has a gray background, enable the **Load/Unload Only** option in the **Vacuum Control** menu to activate the field so it can receive a value (enabled and accessible for change).

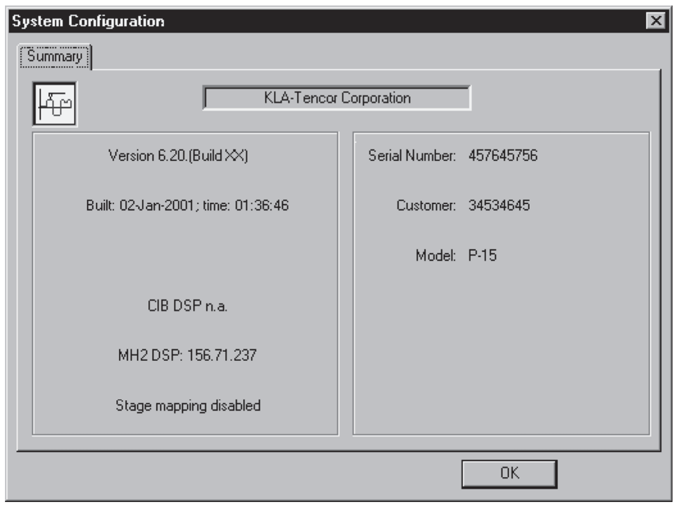
4. If no other changes are to be made in the Instrument Setup window, click **OK** to confirm the changes.
5. The **System Configuration** window appears again. If no further changes are to be made, click **OK** to confirm the current changes. A window appears advising the operator that the system must be restarted to enable the new software configuration (selected options). If there were changes to the Software Options, the system MUST BE RESTARTED TO ENABLE THE NEW SOFTWARE OPTION CONFIGURATION.

Summary Configuration

The Summary Configuration is a display of information regarding the current system configuration. None of the items are configurable in this screen; it is read only. The items covered in this screen inform the user of the following system configuration parameters:

- The Software version and the build number for that version is indicated in the first field at the to top left of the window, Version 6.20.(Build XX) . In this example, the software version is 6.30.00, and Build number is XX. (See *Figure 11.25*.)

Figure 11.25 *System Configuration Summary Window*



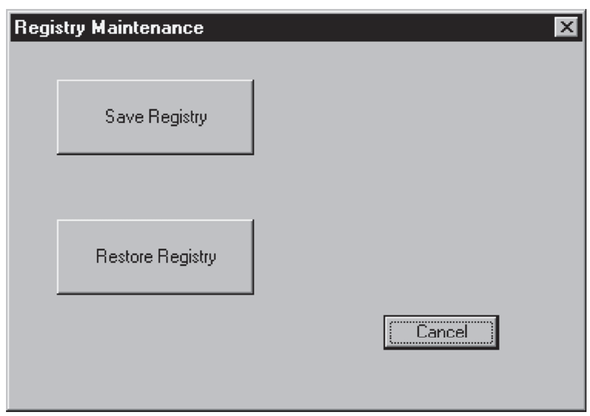
- The Build date for the specific build of the current Software version is presented in the second field down in the left panel, Built: 02-Jan-2001; time: 01:36:46. The date and time of the software compilation are recorded for identification of the exact software build being used on the system.
- The version of software operating the CIB is presented in the third field down in the left panel, CIB DSP n.a. . In this example, *no CIB is present* so no software version is operating the CIB.
- The system scanning head being used, and the software version operating the head are presented in the fourth field down in the left panel, MH2 DSP: 156.71.237 . In this example, the MH2 head is being used and the 115.71.237 version software is driving it.

- Stage mapping can be enabled or disabled. The current status is displayed in the fifth field down in the left panel, Stage mapping disabled. In this case, Stage Mapping is disabled. (See also *Figure 11.27*.) This feature is only available with the pattern recognition option.
- The Mechanical assembly serial number of the system is recorded in the first field of the right panel, Serial Number: 457645756 .
- The customer number, assigned for use in conjunction with the serial number to enable easy access for the user to Customer Services, Customer: 34534645 .
- The system Model type is displayed in the third field down in the right panel, Model: P-15. In this case, it is a P-15 profiler.

Registry Maintenance

The Registry Maintenance dialog box is provided so that the registry can be either updated with the new information or reset to the previous registry information. The registry should only be accessed by KLA-Tencor Field Service Engineers. Certain calibration information is stored here and must be used by a trained technician who understands the registry requirements.

Figure 11.26 *Registry Maintenance Dialog Box*



Completing the Configuration

1. Check the configurable information in the System Configuration box itself.
    - **Machine Type**: This presents a choice between **Desktop** and **Instrument**. **Desktop** means that the software is actually being run as a simulation on a desktop computer (this is primarily for data assessment), not on the instrument itself. **Instrument** indicates that the software is being used to run the instrument. (See *Figure 11.27*.)

CAUTION: Do not Change the Machine Type information. This information has been set at installation and changing it renders the tool useless. It is not possible to restore the system exactly to it previous state because vital information is lost at conversion.

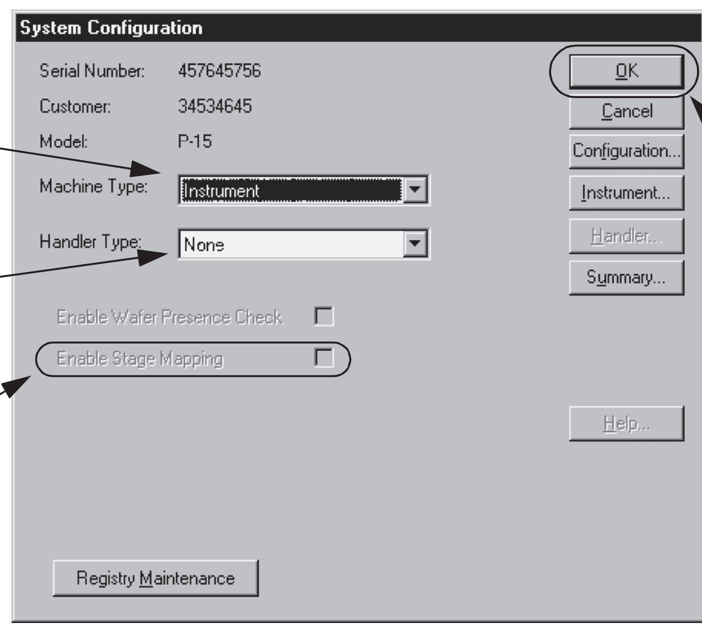
- **Handler Type**: The P-15 does not have a handler. The only option available is **None**. (See *Figure 11.27*.)

Figure 11.27 *System Configuration Dialog Box*

Step 1 DO NOT CHANGE THIS SETTING.

Step 1 There is no handler so the only option is **None**.

Enable Stage Mapping check box.
Notice that this option is currently grayed out. This happens when Stage Mapping has not yet been performed on the system.



Step 2 Click **OK** when all changes have been made.

2. After all necessary changes are made, from the **System Configuration** dialog box, and click **OK** to accept the changes, or **Cancel** to close this dialog box and return to the **Configuration** window with the original settings unchanged. A message box appears warning the operator to reboot the system if any changes have been made.
3. To reboot the system, follow the instructions in *Turning Off or Resetting the Instrument* on page 11-44.

SAFE AREA CONFIGURATION

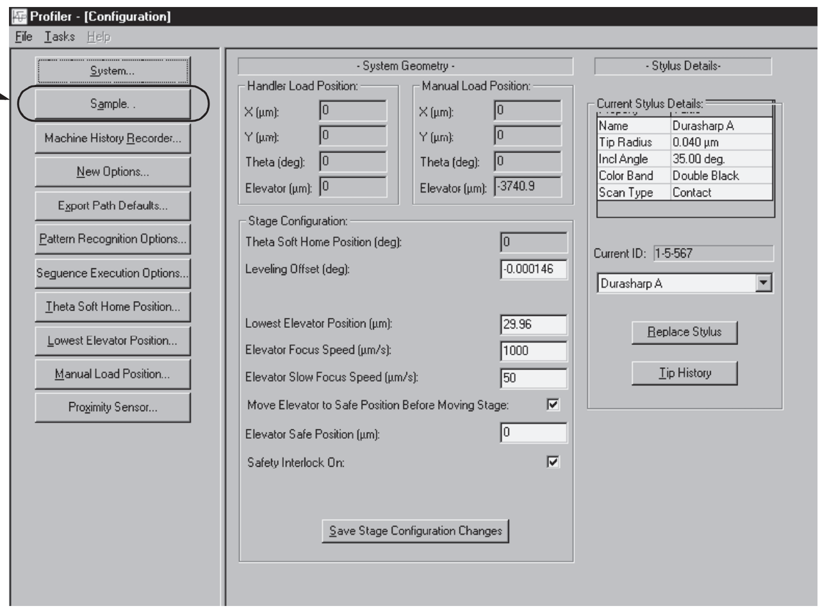
The Stage Limit setting is designed to limit the movement of the stage to the current setting parameters. The setting defines the mechanical movement limit called the **SAFE AREA**. There is also a hardware limit switch that automatically stops the stage movement if the setting in the Radius box is too 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 on **Sample…** to open the **Safe Area Configuration** dialog box. (See *Figure 11.28*.)

Figure 11.28 *Configuration Screen*

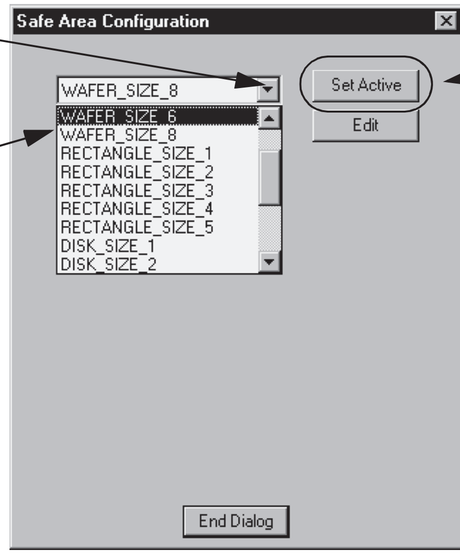
Step 1 To open the **Safe Area Configuration** dialog box, choose **Sample…**



The Safe Area Configuration dialog box opens with only the wafer configuration drop-down menu active.

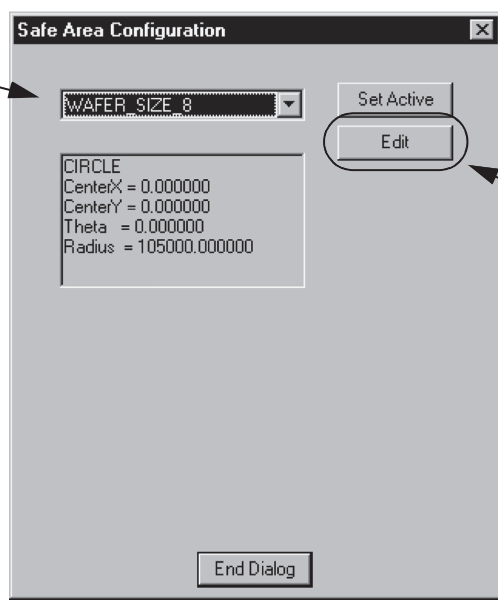
2. Click on the menu arrow to access the Sample Configuration menu. (See *Figure 11.29*.)

Figure 11.29 *Safe Area Configuration - Sample Configuration Menu*



3. Choose the required sample configuration. (See *Figure 11.29*.) This changes the information in the Safe Area configuration display (circled in *Figure 11.31*).
4. Click on **Set Active** to activate the new Safe Area configuration. (See *Figure 11.29*.)
5. To edit the safe area configuration parameters, click **Edit**. (See *Figure 11.30*.)

Figure 11.30 *Safe Area Configuration Dialog Box*



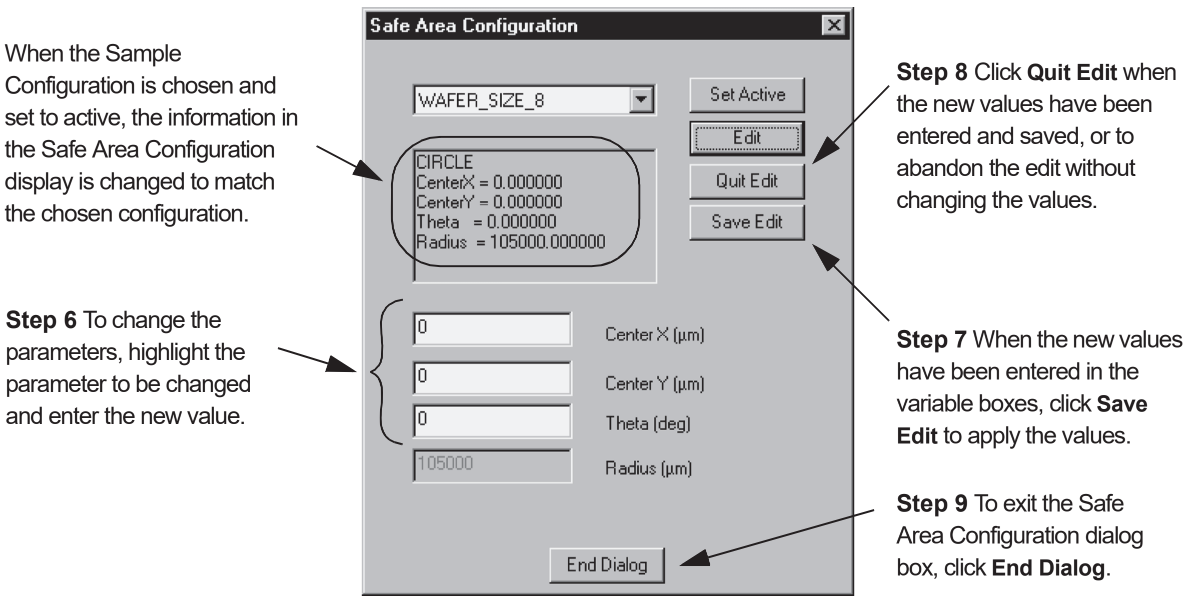
The Safe Area Configuration dialog box safe area can now be edited. (See *Figure 11.31*.)

Begin: Changing Safe Area Values

6. Change the safe area parameters by highlighting the appropriate box and entering the new parameter. (See *Figure 11.31*.)

CAUTION: DO NOT CHANGE these parameters without consulting a KLA-Tencor system specialist. Incorrectly set parameters could seriously damage the system.

Figure 11.31 *Safe Area Configuration - Edit Safe Area Values*



7. After the parameters have been entered, click **Save Edit** to accept the new safe area. (See *Figure 11.31*.)
8. If the edit is to be abandoned without accepting the new parameters, click **Quit Edit**. (See *Figure 11.31*.)
9. To exit the Safe Area Configuration dialog box, click **End Dialog**. (See *Figure 11.31*.)

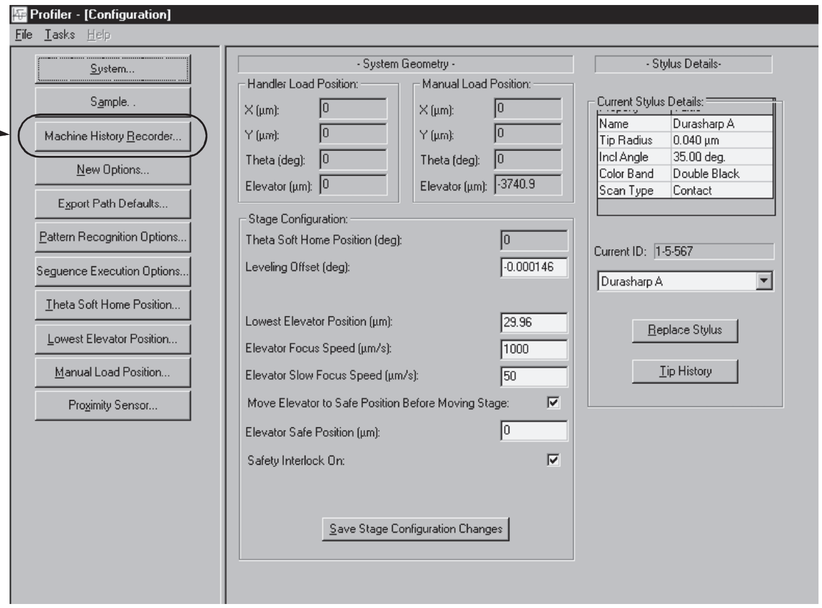
MACHINE HISTORY RECORDER CONFIGURATION

The Machine History Recorder is designed to provide a log of certain system activities as a process record and for review. The log information is limited to messages generated by the system. Each of the five message types can be entered in the log. The log itself can be maintained as a continuous log or can be set to generate a separate log for each processing session.

1. From the **Configuration** screen, choose **Machine History Recorder…** (See *Figure 11.32*.)

Figure 11.32 *Configuration Screen*

Step 1 To open the Machine History Recorder Configuration dialog box, click on **Machine History Recorder…**



Create: Recorder File Name

2. The **Recorder File Name** variable box allows the user to set another file name for the log that is to be generated. The default is MHRLog.log.

   To change the current log name, highlight the current name and enter the new one. (See *Figure 11.33*.)

Enable: Recorder Actively Recording

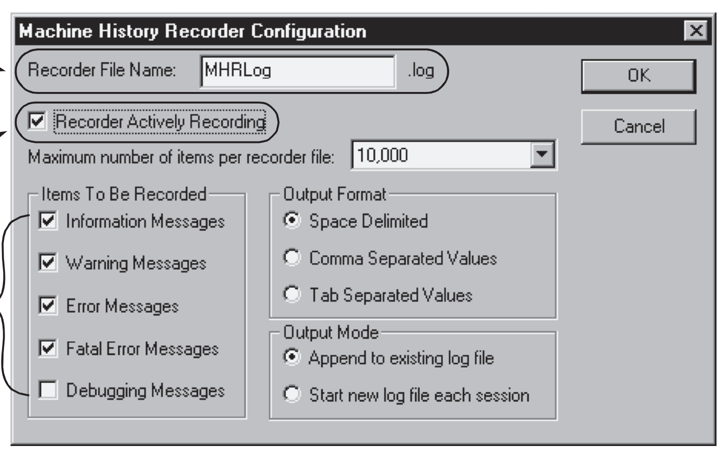
3. The **Recorder Actively Recording** check box allows the user to enable or disable the active log entry process. If this feature is enabled, the recorder makes real time entry of system messages into the designated log. (See *Figure 11.33*.)

Figure 11.33 *Machine History Recorder Configuration Dialog Box*

Step 2 To change the file name for the log, highlight the current name and enter the new one.

Step 3 A check in the check box activates the recorder to make message entries in the designated log file.

Step 4 A check in the check box includes that message type in the designated log file when the recorder is active.



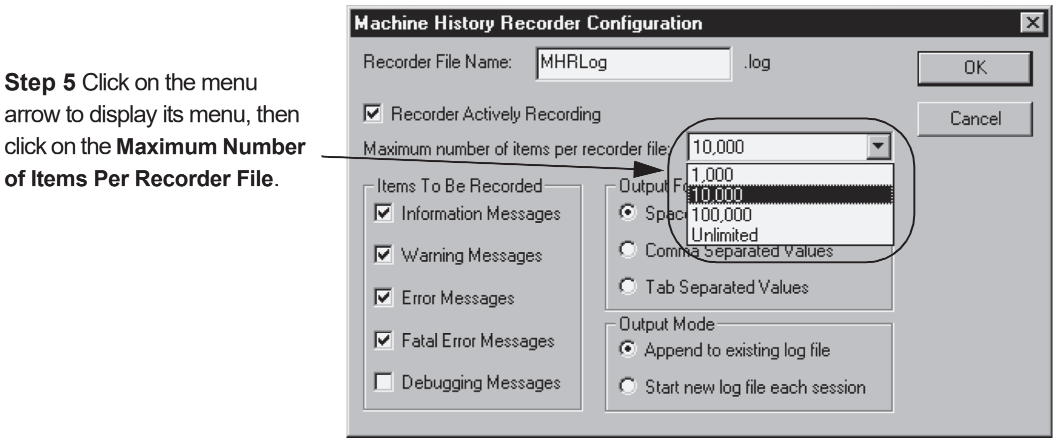
Select: Items To Be Recorded

4. In the **Items To Be Recorded** menu box, ensure that there is a check (✓) in each check box of the messages that are to be recorded in the log. (See *Figure 11.33*.)

Set: Maximum number of items per recorder file

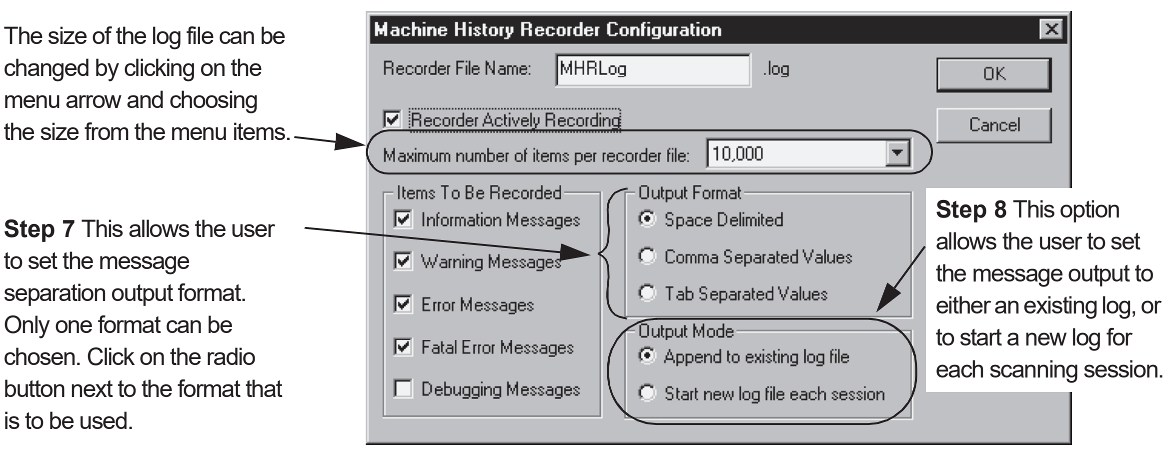
5. To set the log file size, click on the menu arrow next to the **Maximum number of items per recorder file** variable field. This displays its menu. (See *Figure 11.35*.)

Figure 11.34 *Machine History Recorder Configuration with Drop-Down Menu*



6. Choose the number of items from the drop-down menu by clicking on the number, either **1,000**, **10,000**, **100,000** or **Unlimited**. The new number is displayed in its field. (See *Figure 11.35*.)

Figure 11.35 *Machine History Recorder Configuration Dialog Box*



Choose: Output Format

7. The **Output Format** allows the user to determine what type of spacing is used in the log to separate the messages. The separator is either a space, a comma or a tab.

   A selected option has a dot in its radio button. To choose an unselected option, click in the empty radio button next to it.

Choose: Output Mode

8. The **Output Mode** allows the user to choose to add new messages to the existing log file, or put the messages in a new log file for each session.

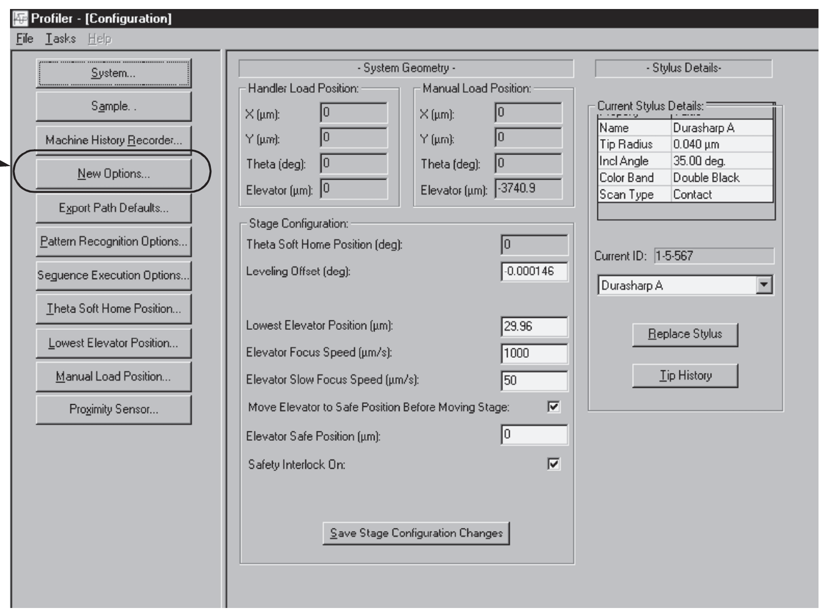
   A selected option has a dot in its radio button. To choose an unselected option, click in the radio button next to it.

ENABLE NEW OPTIONS (PROPRIETARY)

In most cases, options can be added to an installed instrument without additional software or hardware installation. The system software contains all the options. The options that are enabled and available for use are activated by entering the configuration code programmed into the Configuration Key during manufacturing. Using this dialog box and a code provided by the KLA-Tencor Sales representative, desired options can be enabled for the instrument.

Figure 11.36 Configuration Screen

Step 1 To add new options, choose **New Option…** to open its dialog box.



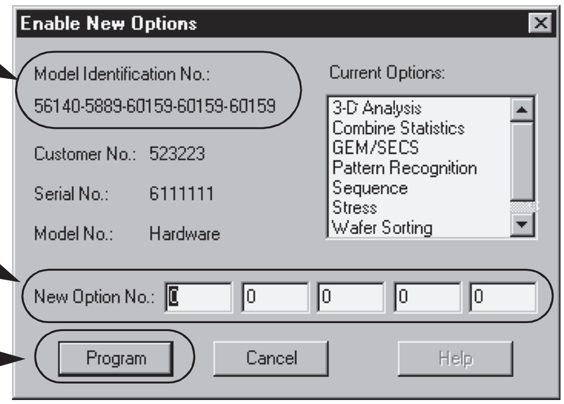
1. To add an option that is purchased after the system is installed, choose **New Options…** to open the New Options dialog box. (See *Figure 11.36*.)

Figure 11.37 *Enable New Options Dialog Box*

Step 4 Current **Model Identification No.** (MIN). Record the new number on the form after the new option is enabled.

Step 2 Enter the number provided on the Configuration Key Update Form in these boxes.

Step 3 After the number is entered, click **Program** to enable the option.



2. The option to be added is identified in the software by a series of numbers similar to that displayed under the **Model Identification No:** in *Figure 11.37*. When the option is purchased from KLA-Tencor, the series of numbers is provided on the **Configuration Key Update Form**.

   Enter each set of numbers into the provided series of boxes using the dash between number segments as the indicator to move to the next box. (See *Figure 11.37*.)

3. When the number has been entered, click **Program** to initiate enabling of the option program. (See *Figure 11.37*.)
4. Once enabled, the Model Identification No. (MIN) changes. Record the new MIN on the **Configuration Key Update Form** for future reference. This is the number that KLA-Tencor uses for identification of the customer and current options when ordering software upgrades or new options for the system. (See *Figure 11.37*.)
5. After the program is enabled, a system message box might request that the system be restarted to initialize the new option. Follow the instructions; they differ depending on the option purchased.

EXPORT PATH DEFAULTS

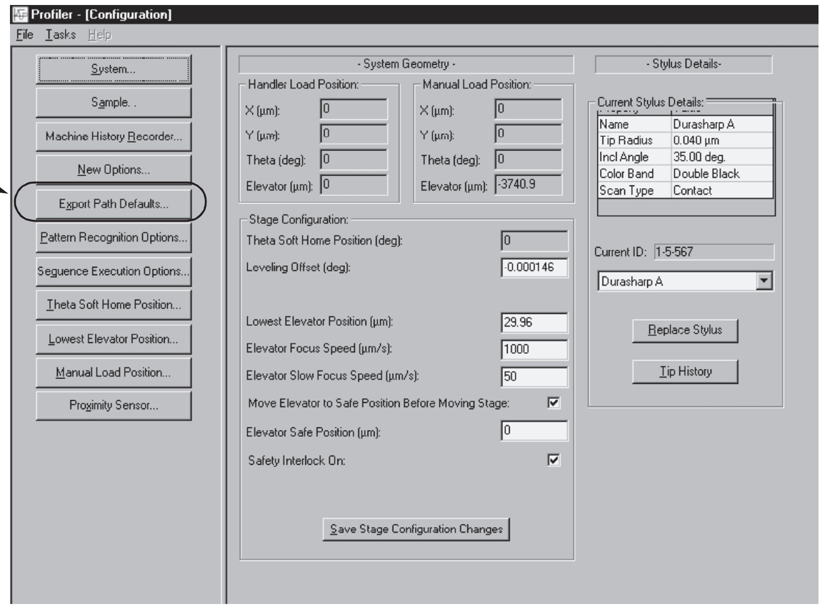
Export Path Defaults set the default path for exporting scan and sequence recipes and data.

Data Export Paths Configuration

1. Choose **Export Paths** in the **Configuration** screen. (See *Figure 11.38*). The **Export Path Defaults** dialog box opens. (See *Figure 11.39*)

Figure 11.38 Configuration Screen

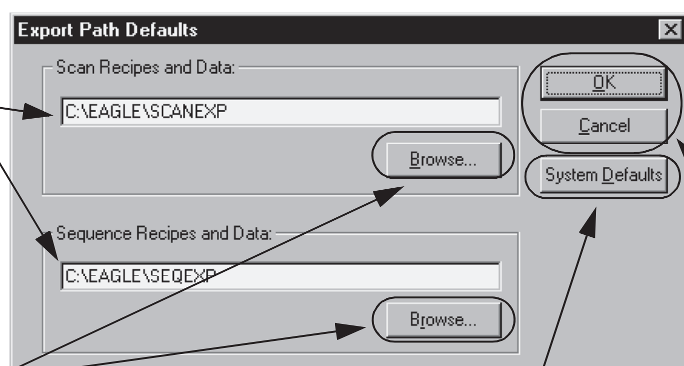
Step 1 Click **Export Path Defaults…** to open its dialog box.



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 11.39*.)
   b. Click **Browse…** to find the drive and folder in which the information is to reside. (See *Figure 11.39*.)
   c. Click **System Defaults**. This sets the path to the one programmed into the system as displayed in *Figure 11.39*.

Figure 11.39 Export Path Defaults

Option *a*. Highlight the current path, then enter the entire new path, starting with the drive and ending with the folder in which the information is to reside.



Step 3 Click **OK** to set the new paths, or **Cancel** to exit and retain the old ones.

Option *b*. Click **Browse…** to open the explorer window and locate the drive, file(s) and folder in which the information is to reside.

Option *c*. Click **System Defaults** to change the path to the one programmed into the system.

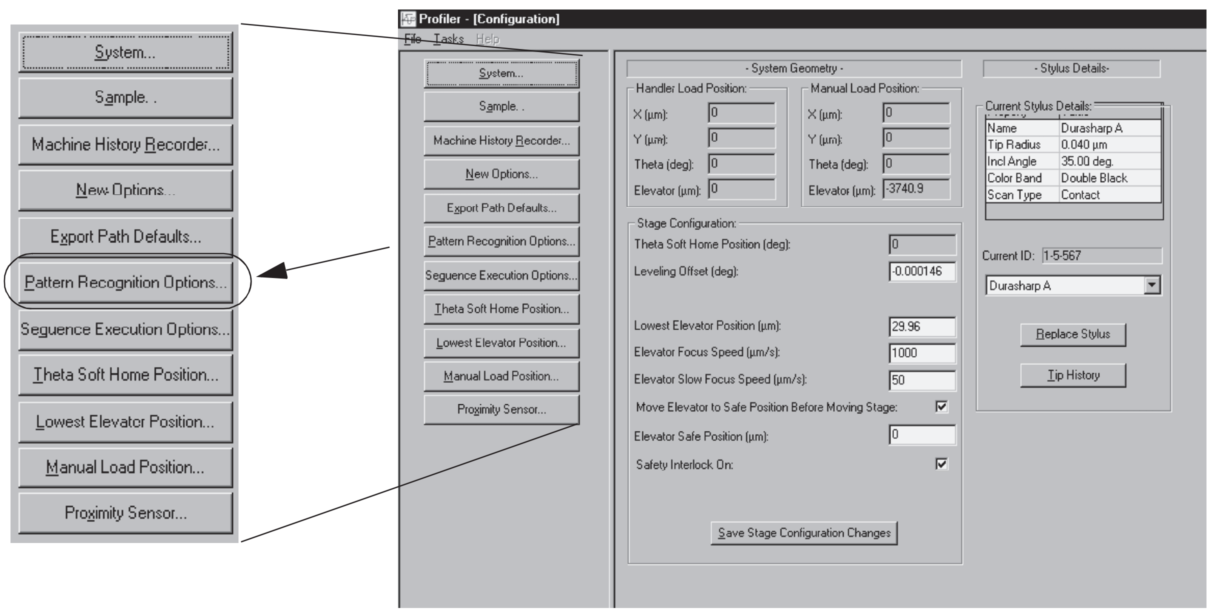
3. Click **OK** to save the new values and return to the **Configuration** window, or click **Cancel** to return to the **Configuration** screen without changing the previous values. (See *Figure 11.39*.)

PATTERN RECOGNITION OPTIONS AND DESKEW

Introduction

Configuration of the Pattern Recognition and Deskew options is performed in the **Pattern Recognition and Deskew Options** dialog box, and the Deskew Options dialog box. Access to the Pattern Recognition and Deskew Options dialog box is through the Configuration screen’s **Pattern Recognition Options…** button. (See *Figure 11.40*.) Access to the Deskew Options dialog box is through the **Deskew** menu in the Sequence Recipe screen. (See *Using Groping with Pattern Recognition* on page 7-44.) 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*.

Figure 11.40 *Configuration Screen*

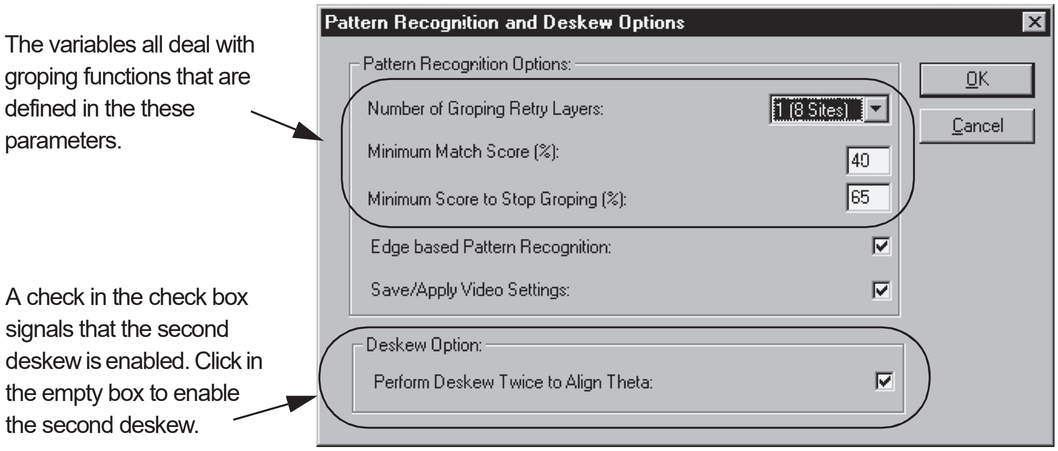


Deskew Twice To Align Theta

With a single deskew operation, there is no stage rotation to compensate for the small rotational error in sample placement. 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.

A second deskew operation is, therefore, sometimes necessary to improve the accuracy of pattern recognition deskew, in the Pattern Recognition Option. (See *Figure 11.41*.)

Figure 11.41 *Pattern Recognition and Deskew Options Dialog Box*



Using Groping with Pattern Recognition

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 when the sample is positioned at the deskew site. This search is called groping.

The three groping parameters are described. (See *Figure 11.41*).

1. From the **Configuration** screen, choose **Pattern Recognition Options**.

   The **Pattern Recognition and Deskew Options** dialog box appears. (See *Figure 11.41*)

2. Edit the fields by using the parameters described in *Table 11.2*.

Table 11.2 *Groping Parameters*

Parameter	Description
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.
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.

Table 11.2 *Groping Parameters (Continued)*

Parameter	Description
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. **NOTE:** When this option is enabled, the pattern recognition process takes longer than if it is not chosen. The filtering and sharpening procedures require significant extra time.

Table 11.2 *Groping Parameters (Continued)*

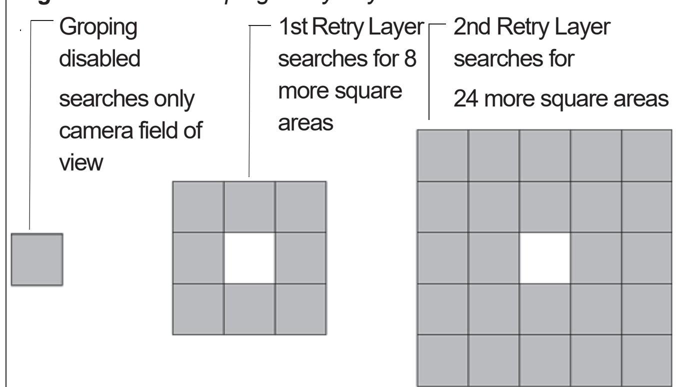
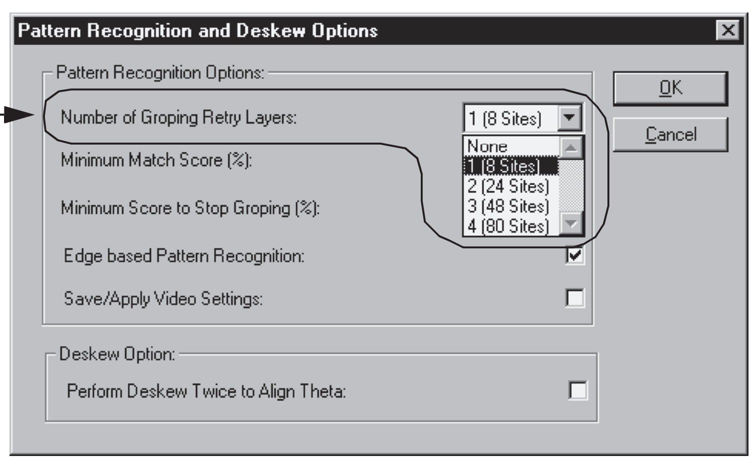
Parameter	**Description**
Number of Groping Retry Layers	This parameter controls how much of the area around the deskew site is searched looking for the pattern. Each layer consists of a square area constructed by evenly surrounding the deskew site with squares the size of the camera field of view. (See *Figure 11.42*.) ***Figure 11.42*** *Groping Retry Layers*  3rd Retry Layer searches for 48 more squares; 4th Retry Layer searches for 80 more squares. It stops after the 4th try. Options in the drop-down menu are: (See *Figure 11.43*.) ◆ None (the default) ◆ 1 (8 Sites) ◆ 2 (24 Sites) ◆ 3 (48 Sites) ◆ 4 (80 Sites) **NOTE:** It takes 10 seconds to move the stage, null the stylus, and search one such area; 8 search sites (1 layer of retry) takes as long as 90 seconds; and 24 sites (2 layers) takes as long as 250 seconds, 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 11.2 *Groping Parameters (Continued)*

Parameter	Description
Minimum Match Score (Renamed in Deskew Options dialog box to: **Lowest Match Score**)	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. 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 score must be smaller than the Minimum Score to Stop Groping. Allowed values range between 20 to 100%; the default is 65%. If the pattern does not show up in the original field of view, the search begins, and if any images score greater than the Lowest Match Score, the pattern recognition system concludes that the best of these is the correct deskew site (unless it finds a match equal to or greater than the Maximum Score and stops groping). Allowed values range from 20 to 100%; the default is 65%. **For Desktop versions, use the minimum value, 20.**
Minimum Score To Stop Groping	If the pattern recognition system is groping to find the desired pattern, sometimes 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 from 20 to 100%; the default is 70%. **For Desktop versions, use the minimum value, 20.** If no matches are found that are as good as this setting, the search continues until the retry layer areas are all searched. If this occurs, the best score above the **Minimum Match Score** setting determines the placement of the deskew site.

Figure 11.43 *Pattern Recognition and Deskew Options Dialog box*

Step 3 The drop-down menu for **Number of Groping Retry Layers** displays the number of tries and the number of sites associated with the groping level.



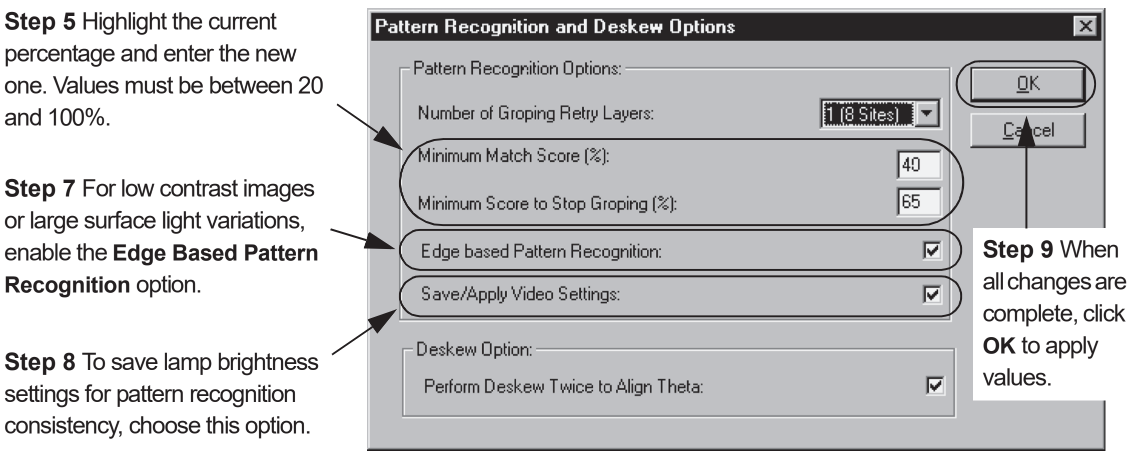
Setting: Number of Groping Retry Layers

3. Click on the menu arrow to display the **Number of Groping Retry Layers** drop-down menu. (See *Figure 11.43* and *Table 11.2*.)
4. From the drop-down menu, choose the number of groping layers (sites) to be searched in pattern recognition attempts. (See *Figure 11.43* and *Table 11.2*.)

Setting: Minimum Match Score (%)

5. Highlight the current value in the variable box associated with **Minimum Match Score (%)** and enter the new percentage value. Values can be from 20-100%. Default is 65%. (See *Figure 11.44*.)

Figure 11.44 *Pattern Recognition and Deskew Options Dialog Box*



Setting: Minimum Score to Stop Groping (%)

6. Highlight the current value in the variable box associated with **Minimum Score to Stop Groping (%)** and enter the new percentage value. Values can be from 20-100%. Default is 70%. (See *Figure 11.44* and *Table 11.2*.)

Selecting: Edge Based Pattern Recognition

7. 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 the option is not chosen, only the image contrast grayscale processing is performed.

   To select this option, ensure that there is a check in the check box. Click in the empty check box to place a check (✓) in it. (See *Figure 11.44*.)

NOTE: When this option is enabled, the pattern recognition process takes longer than if it is not chosen. The filtering and sharpening procedures require significant extra time.

Selecting: Save/Apply Video Settings

8. The **Save/Apply Video Settings** option saves the lamp brightness settings so image processing for pattern recognition is the same when the same recipe is used for the scan or sequence.

   To select this option, ensure that there is a check in the check box. Click in the empty check box to place a check (✓) in it.

9. Click **OK** to set the options and close the dialog box. (See *Figure 11.44*.)

Sequence Execution Options

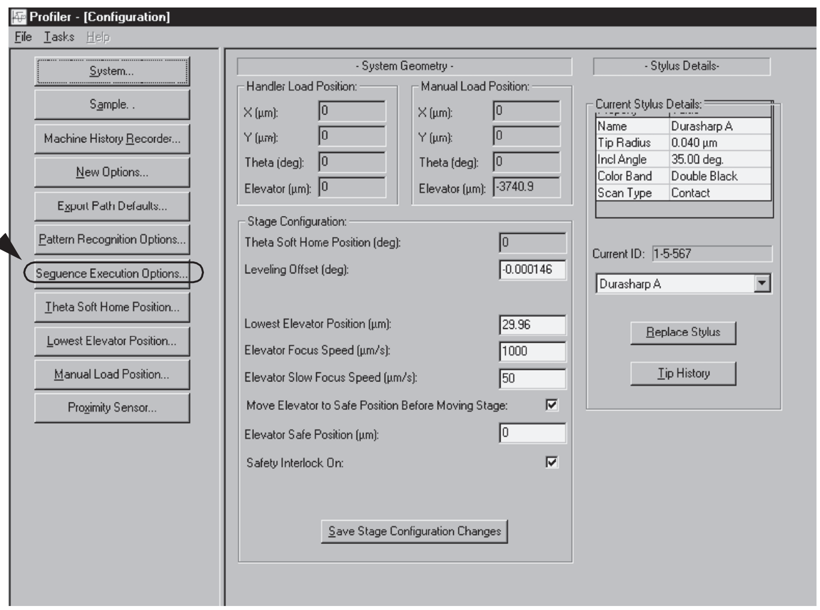
This option is only for those systems that have the Sequence Option as part of the system package. It automatically saves sequence data under a lot ID and/or operator ID. To enable and define this option, the **Sequence Execution Option** must be set to display an ID information prompt before each sequence.

Open Sequence Execution Options Dialog Box

Choose **Sequence Execution Option from the option buttons** in the **Configuration** screen. (See *Figure 11.45*).

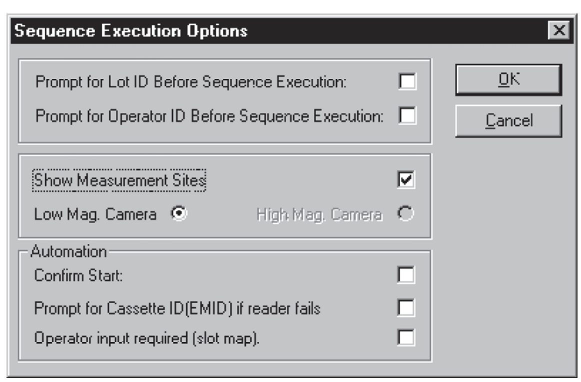
Figure 11.45 *Configuration Screen*

Step Click **Sequence Execution Option…** to open its option box.



The **Sequence Execution Options** dialog box appears. (See *Figure 11.49*.)

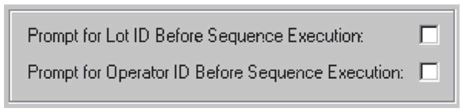
Figure 11.46 *Sequence Execution Options Dialog Box*



Enable Sequence ID Prompts

The first combo box in the Sequence Execution Options dialog box contains options for operator identification. (See *Figure 11.47*.)

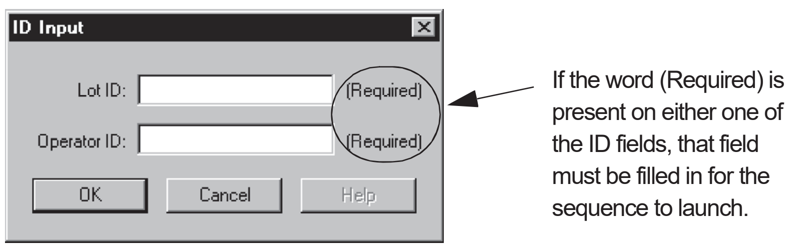
Figure 11.47 *Sequence Prompts Combo Box*



The first item, **Prompt for Lot ID Before Sequence Execution,** requires the operator to enter a **Lot ID** code in the Lot ID field before the sequence can proceed. If there is a check in the checkbox, the word **(Required)** appears next to the ID field. (See *Figure 11.48*.) If **(Required)** is *not* present, then the sequence can be started without entering the ID.

The second item, **Prompt for Operator ID before Sequence Execution**, requires the operator to enter an operator ID code before the sequence can proceed. If there is a check in the checkbox, the word **(Required)** appears next to the ID field. (See *Figure 11.48*.) If **(Required)** is *not* present, then the sequence can be started without entering the ID.

Figure 11.48 *ID Input Dialog Box*

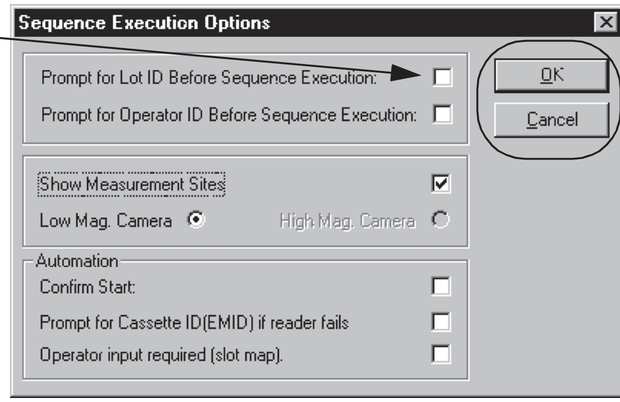


1. To choose one or both of the listed options, put a check (✓) in its check box. (See *Figure 11.49*.)

   Before the sequence begins, each option is displayed in a dialog box. If the option was chosen in the options dialog box, that option must be responded to by the operator before sequence processing starts. (See *Figure 11.48*.)

Figure 11.49 Sequence Execution Options

Step 1 Click on the empty check box to put a check in the box and enable the option.



Step 2 Click **OK** to accept the changes or **Cancel** to retain previous settings.

2. Click **OK** to save the new settings and return to the **Configuration** screen, or click **Cancel** to return to the **Configuration** screen retaining the previous settings.

View Scan Display Settings

The View Scan Display Settings are designed to give the operator the opportunity to choose which view is presented in the View Scan screen during a sequence scan. If the Show Measurement Sites option is chosen, then the operator has the option to view either the scan site on the sample surface or the site map showing the individual scan sites for the current sequence. (See *Figure 11.50*.) See *Show Measurement Site During Sequence Run* on page 6-21 for explanation and examples of the settings.

Figure 11.50 View Scan Display Settings

1. Click in the empty **Show Measurement Sites** checkbox to ensure that the operator can view both the measurement site map and the scan site by toggling between them in the View Scan screen during a sequence. (See *Figure 11.50*.)

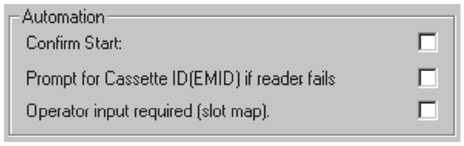
   The **Low Mag. Camera** is automatically chosen for the scan site view.

2. Click **OK** to accept the changes and close the dialog box. (See *Figure 11.49*.)

Automation Settings

Automation settings found in this dialog box are not functional in the P-15 system. These settings are used with systems having a handler and cassettes that have slot map criteria available for the system. The checkboxes might appear to be enabled but there is no affect on the system. (See *Figure 11.51*.)

Figure 11.51 *Automation Combo Box in Sequence Execution Options*



Teach Manual Load Position

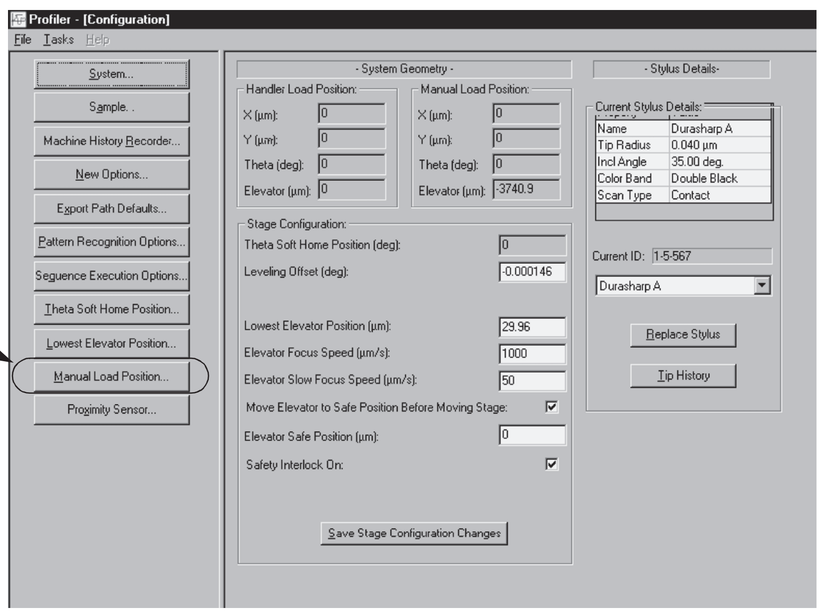
This procedure sets the manual load position of the stage and elevator. The Manual Load position can be changed by teaching the new position.

Teach Procedure

1. To open the Teach Manual Load Position screen, click on the **Manual Load Position…** button on the left side of the Configuration screen. (See *Figure 11.52*.)

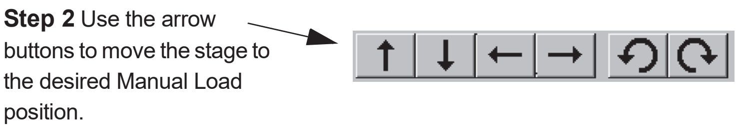
Figure 11.52 *Configuration Screen - Manual Load Position*

Step 1 To open the Teach Manual Load Position screen, click **Manual Load Position…**



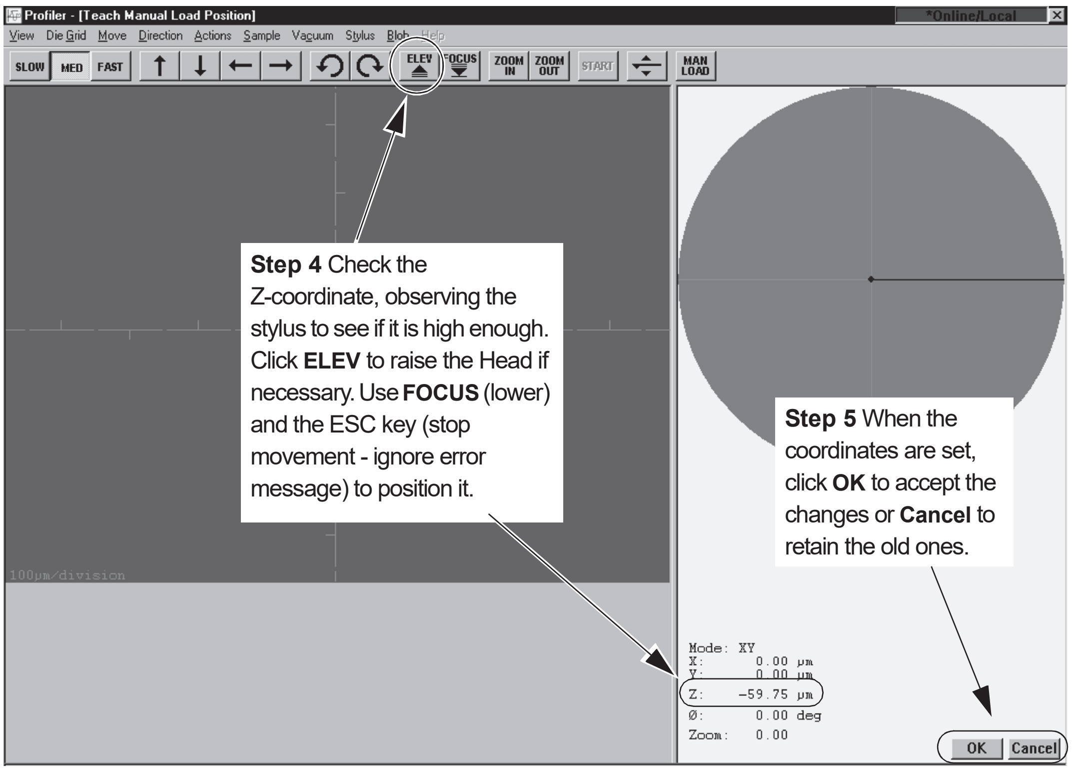
2. The **Teach Manual Load Position** screen appears. (See *Figure 11.53*.) The stage moves to the current Manual Load position. Using the arrow and rotation buttons on the tool bar, move the sample to the desired position. It is also possible to click the destination point in the wafer map on the XY View screen.

Figure 11.53 *Teach Manual Load Position*



3. If desired, adjust the Z coordinate by raising the head with the **ELEV** button. Or, lower it using the **FOCUS** to start the head lowering and the **ESC** key on the key board to stop it at the desired height. (See *Figure 11.54*.)

Figure 11.54 *Teach Manual Load Position Screen*



4. If desired, adjust the Z coordinate by raising the head with the **ELEV** button. Or, lower it using the **FOCUS** to start the head lowering and the **ESC** key on the key board to stop it at the desired height. (See *Figure 11.54*.)
5. Click **OK** to save the new position, or click **Cancel** to keep the original values and return to the Configuration screen. (See *Figure 11.54*.)

PROXIMITY SENSOR CONFIGURATION

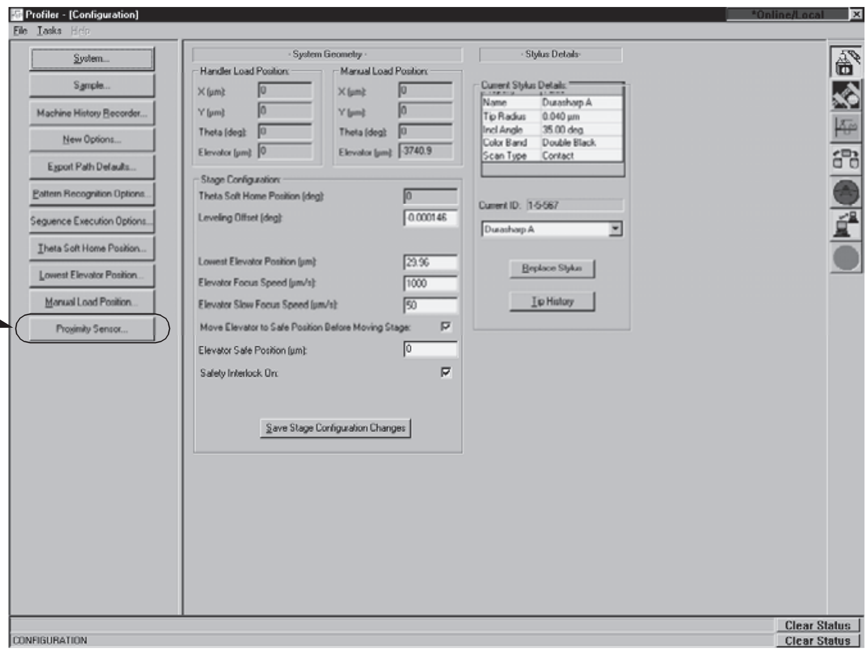
The proximity sensor is responsible for signalling when the stylus is in near proximity to the sample surface. The proximity sensor activity has configurable parameters that can be accessed in the **Proximity Sensor Configuration** dialog box.

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 11.55*.)

Figure 11.55 *Configuration Screen - Proximity Sensor*

Step 1 Click **Proximity Sensor…** to open the **Proximity Sensor Configuration** dialog box.

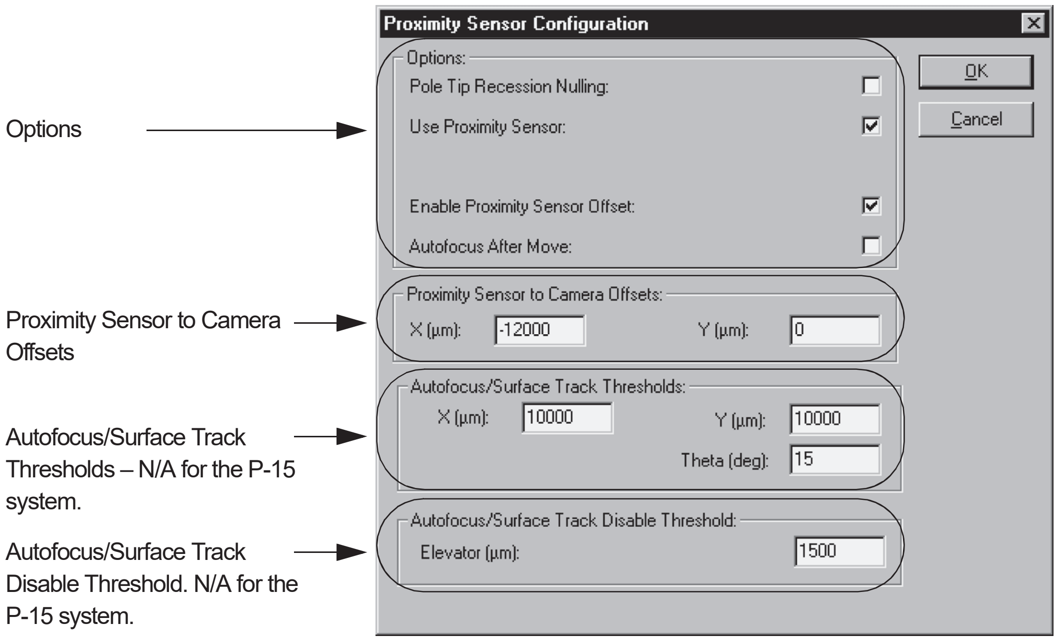


The Proximity Sensor dialog box (see *Figure 11.56*) is divided into four sections:

- Options
- Proximity Sensor to Camera Offsets

The options and the variables within each one are discussed in the following sections.

Figure 11.56 *Proximity Sensor Configuration*



Options

A check in the checkbox next to each option indicates that it is enabled.

- ***Pole Tip Recession Nulling:*** The MicroHead II 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. Before enabling this option, the **Pole Tip Recession Nulling** must be disabled. With this option enabled (a check in the check box), 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:*** This option is used to prevent the stylus from hitting the sample too hard in situations where the proximity sensor is out of position to detect the sample surface; e.g., beyond the edge of the sample. This option should be used for Scan Position Offset and Step Height Calibrations. 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 11.56*.)
2. If no other changes are to be made in the Proximity Sensor Configuration dialog box, click **OK** to accept the configuration. (See *Figure 11.56*.)

Proximity Sensor to Hi Mag Camera Offsets

CAUTION: Do not change this number unless told to by an authorized KLA-Tencor representative.

This is a hardware parameter. At manufacturing, it is precisely set according to the distance from the Proximity Sensor to the Hi Mag Camera. This number is used by the software to perform certain centering functions. Currently this number is set at **0** in the **Y-**axis and **-12000** in the **X-**axis. (See *Figure 11.56*.)

Password – Mid-Session Calibration or Configuration Access

Introduction

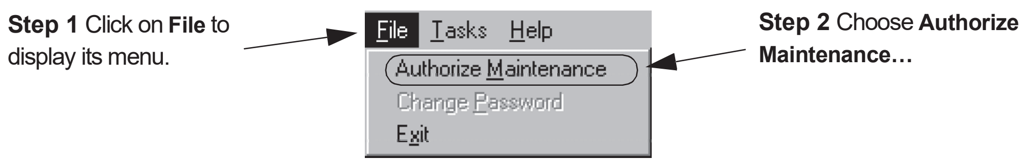
If a system is currently being used by an operator who *is not* logged in as a member of the Administrators, P_Configuration, P_Calibration, or P_AdvCalibration security group, most of the Calibration and Configuration screen functions are not available to the operator. This feature provides an operator, who has a valid password, the ability to enter the Calibration or Configuration screen procedures in the current session without the necessity of exiting and restarting the Profiler software under the required security level.

Accessing the Maintenance Functions

To access the Calibration or Configuration functions, the user must enter the Authorize Maintenance dialog box from either the Configuration or Calibration screen, depending on which screen's functions are to be accessed. If a calibration is to be performed, enter through the Calibration screen. If configuration changes are to be made, enter through the Configuration screen. Access is granted only as long as the user stays in the Configuration or Calibration screen. Access is terminated when the user clicks on one of the other Program icons.

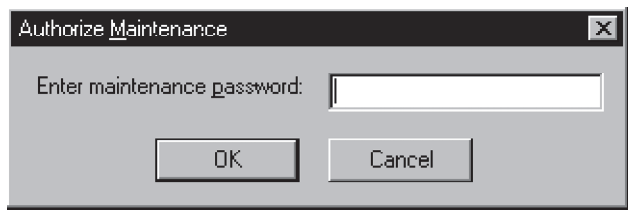
1. In the Calibration or Configuration screen, click on **File** to display its menu. (See *Figure 11.57*.)

Figure 11.57 *File Menu for Choosing Authorize Maintenance*



2. From the File menu choose **Authorize Maintenance…** This opens a Authorize Maintenance dialog box. (See *Figure 11.57*.)

Figure 11.58 *Authorize Maintenance Dialog Box*



3. Enter the password required for access to the Calibration or Configuration screen. (See *Figure 11.58*.)
4. Click **OK** when the password has been entered. (See *Figure 11.58*.)

If the valid password was correctly entered, access is granted to the Calibration or Configuration functions until the user exits the accessed screen.

Changing the Maintenance Password

Introduction

A member of the **Administrators** security group can change the Maintenance Password. Once changed, the same password is used for entrance to either the Configuration or Calibration screen functions.

Choosing a Password

Choose a password with the following parameters in mind:

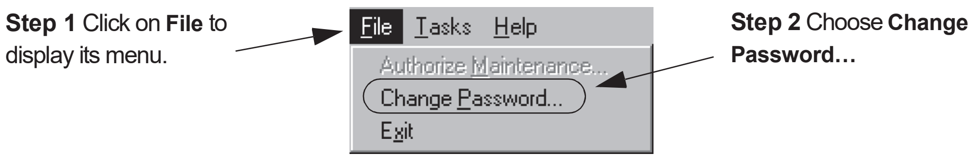
- It can only have alphabetic and/or numeric characters.
- It is case sensitive.
- It must have between 6 and 14 characters.

Password Change Procedure

Use the following procedure to change the password.

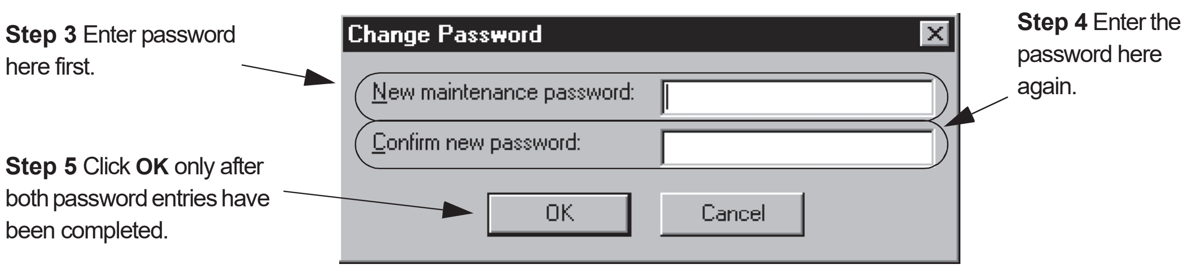
1. From either the Configuration or Calibration screen click on **File** to display its menu. (See *Figure 11.59*.)

Figure 11.59 *File Menu for Change Password… Dialog Box Access*



2. From the File menu choose **Change Password…** This opens the Change Password dialog box. (See *Figure 11.59*.)

Figure 11.60 *Change Password Dialog Box*



3. Enter the new password first in the **New maintenance password** field. ***Do not*** click **OK.**
4. Enter the identical password into the **Confirm new password** field. (See *Figure 11.60*.)
5. Click **OK**. If both passwords were the same, the system receives it and it becomes the new password for both screens.

Loss of Power

The KLA-Tencor profiler should be protected from power loss.

- The head of the hard disk drive auto-parks at power loss so that the hard disk drive does not suffer damage. However, if power returns and cycles quickly on and off two or three times within 100 to 200 ms, there is a remote possibility of a head crash and permanent damage.
- If power failure is a common occurrence, use an Uninterruptable Power Supply (UPS) device that supplies power for 30 minutes to provide time for an orderly shutdown.

Turning Off or Resetting the Instrument

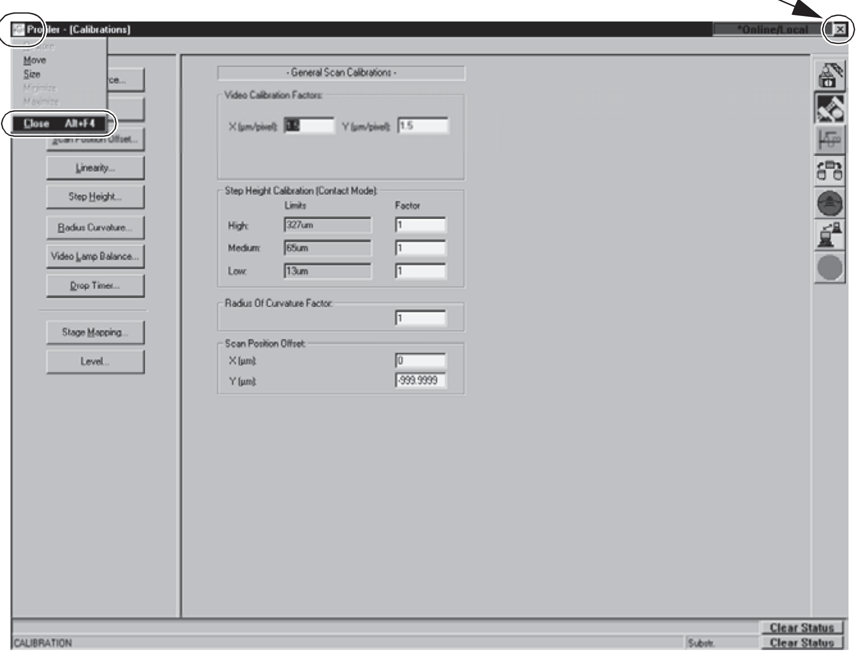
When powering down the instrument, use the following procedure to ensure against loss of data and recipes.

Exit to Windows

1. Close all screens up to a program screen, one with the icons at the right side. (See *Figure 11.61*.)
2. Click on the control button at the top left of the screen to display it menu. (See *Figure 11.61*.)

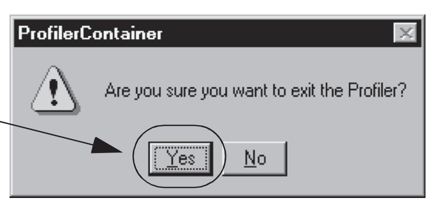
   ALTERNATIVE: Click on the Exit button at the top right corner of the screen. Then proceed to **Step 4.** (See *Figure 11.61*.)
3. Choose **Close** from the drop-down menu. (See *Figure 11.61*.)

Figure 11.61 *Closing the Profiler Application Using the Control Button*



4. A Message box is displayed asking, "Are you sure you want to exit the Profiler?" Click on **Yes** to exit. (See *Figure 11.62*.)

Figure 11.62 *Profiler Container for Profiler Shutdown*



To log off to shut down the system

5. If exiting from the program so that another user can log on, click on the **Start** button at the bottom left of the screen to display its menu. (See *Figure 11.63*.)

Figure 11.63 *Start Menu*

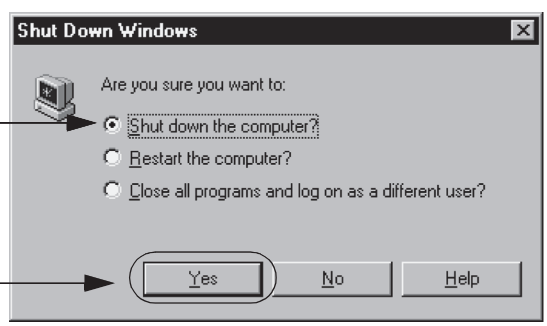
Step 6 Click on **Shut Down…** to display its dialog box.

Step 5 Click on **Start** to display its menu.

6. Choose **Shut Down…** from the menu. (See *Figure 11.63*.)

   This displays a dialog box that presents three options. (See *Figure 11.64*.)

Figure 11.64 *Shut Down Windows Dialog Box*



Step 7 To shut down the computer, click in the radio button next to **Shut down the computer?**

Step 8 Click **Yes** to initiate the shut down procedure for the computer.

To Shut Down the System:

7. Choose, "**Shut down the computer?**" *Figure 11.61*
8. Click on **Yes** to initiate the shut down procedure. (See *Figure 11.64*.)
9. After the computer has closed all applications and written information to the system drive, it displays a message box which says, "**It is now safe to shut down your computer.**"
10. Turn off the computer. The system is shut down.

To Restart the Computer

11. If rebooting the system (without powering down the system), from the Shut Down Windows dialog box (see *Figure 11.64*), click on **Restart the computer?**

12. Click **Yes** at the bottom of the dialog box to initiate the reboot.

INSTALLING A PRECISION LOCATOR

Various precision locators are available to provide for exact positioning of a sample relative to a fixed reference point. See *Standard Precision Locators* on page 11-54 and *Optional Precision Locators* on page 11-54 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.

Standard Precision Locators

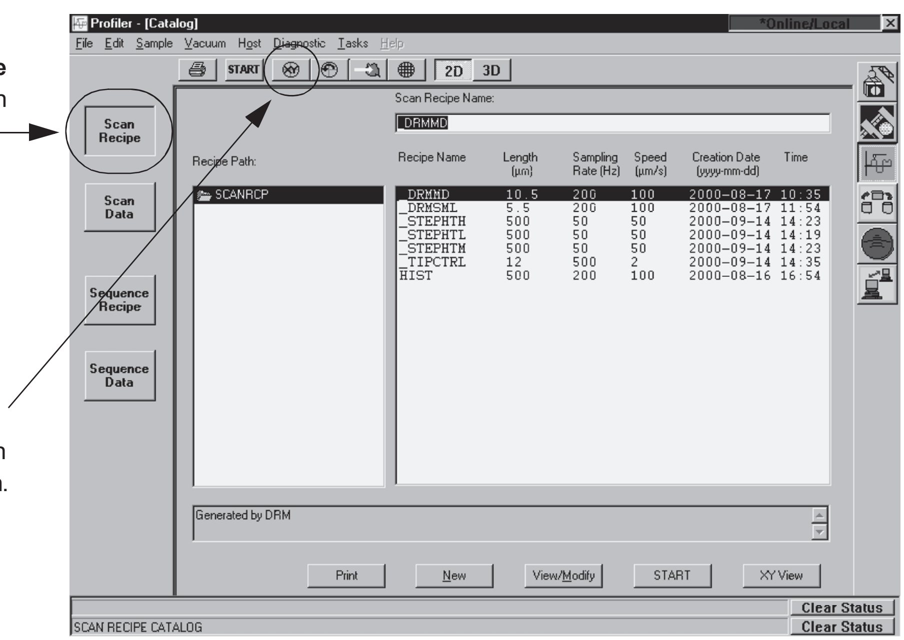
CAUTION: Nominally, the top surface of a standard precision locator should be at the same level relative to the measurement head as the top surface of the stage tabletop. Still, it is a good idea to confirm the accuracy of the setting for Lowest Elevator Position when a precision locator is installed. The stylus can be damaged if the existing settings are incorrect. Refer to the procedures in *Teach Lowest Elevator Position* on page 11-10 for details.

Installing the Precision Locator:

1. In the **Catalog** screen, choose **Scan Recipe** to display the scan recipes in the site list area. (See *Figure 11.65*.)

Figure 11.65 *Catalog - Scan Recipe Screen*

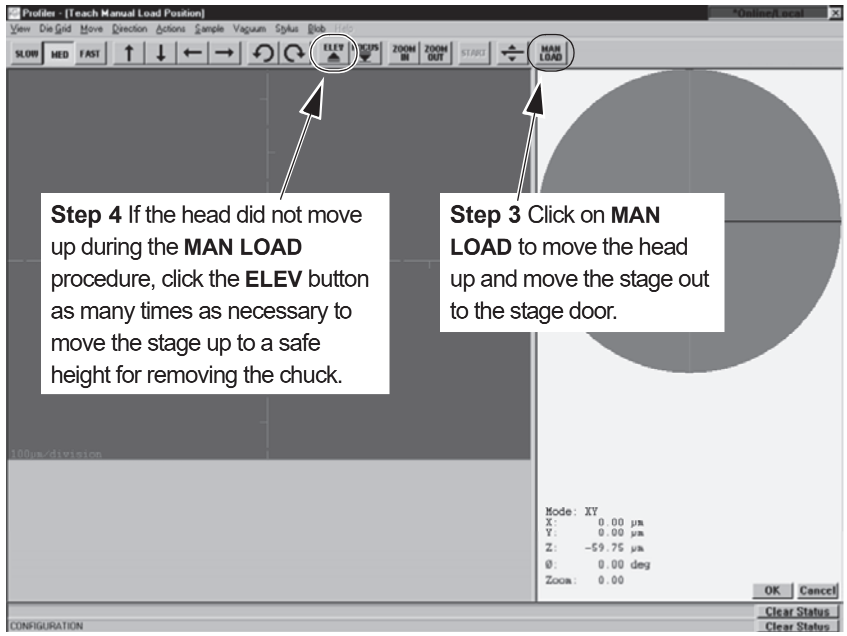
Step 1 When the screen opens, click on **Scan Recipe** to display the scan recipes in the site list area.



Step 2 With a recipe highlighted, click the **XY** icon to open the XY View screen.

2. With a recipe highlighted, click on the **XY** icon in the tool bar to open the XY View screen. (See *Figure 11.65*.) The XY View screen opens. (See *Figure 11.66*.)

Figure 11.66 *XY View Screen*

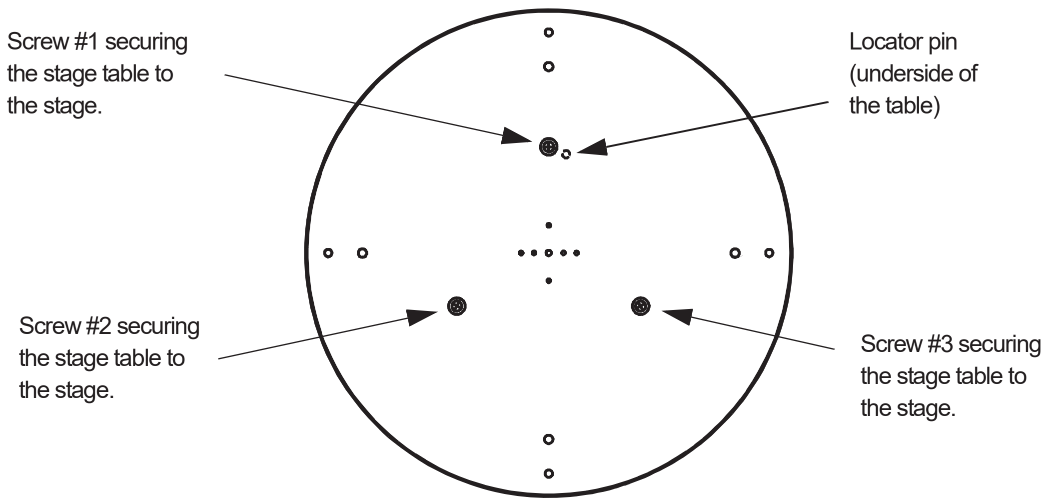


3. Click on **MAN LOAD** to move the head up and bring the stage out to the stage door. (See *Figure 11.66*.)
4. If the head does not move up during the **MAN LOAD** procedure, click the **ELEV** button (see the Tool Bar in *Figure 11.66*) as many times as necessary to move the head to a high enough position so that contact with the stylus can be avoided when removing the stage table.
5. Open the door.

CAUTION: If Interlock is ON, 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.

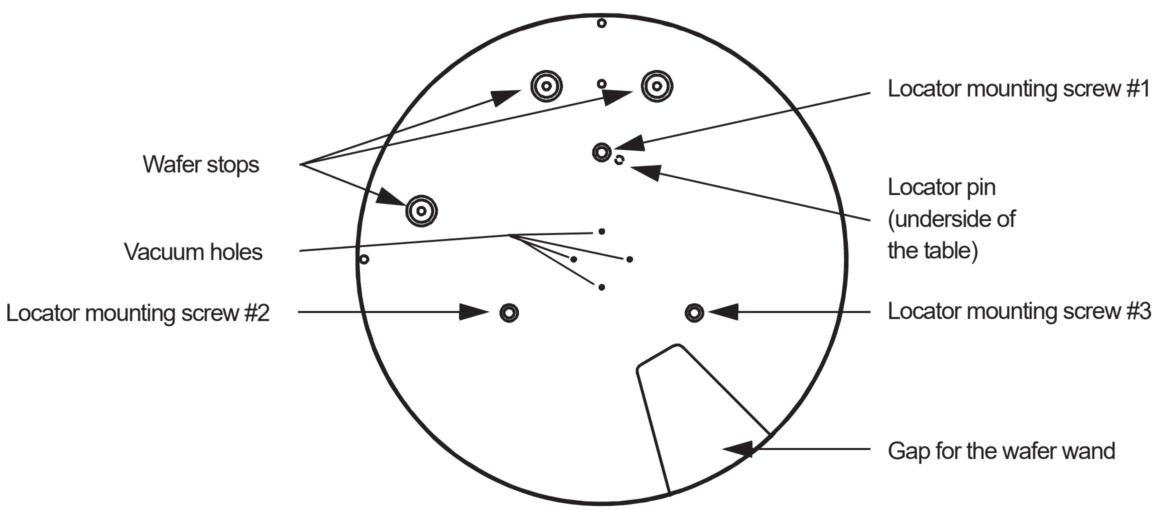
6. Remove the three screws (see *Figure 11.67*) that hold the stage table to the stage. Remove the table. It might be necessary to rotate the stage using the rotational arrow buttons (in the tool bar) for easier access to the screws.

Figure 11.67 *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 11.68*.)

Figure 11.68 *Precision Locator*



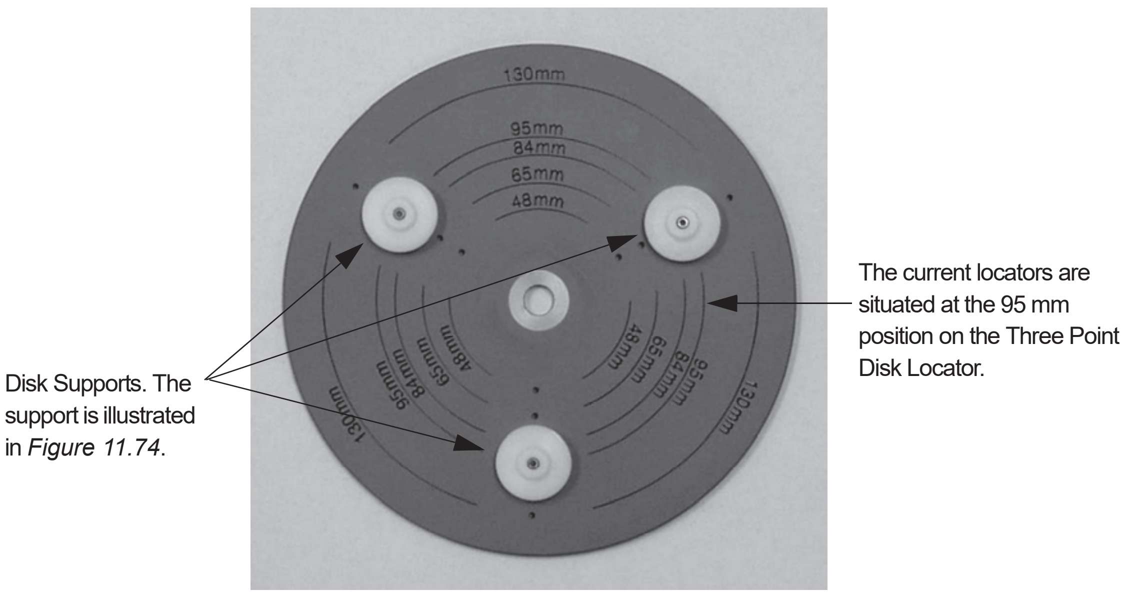
Press down on the precision locator to slide the pin into the groove. When positioned as shown in *Figure 11.68*, the precision locator is in the "0" theta position (that is, theta equals 0 degrees).

8. Screw in the mounting screws to secure the locator to the stage. (See *Figure 11.68*.)

Three Point Disk Locator

The KLA-Tencor three point disk locator for profilers (Part No. 304247) is shown in *Figure 11.69*.

Figure 11.69 *Three Point Disk Locator*

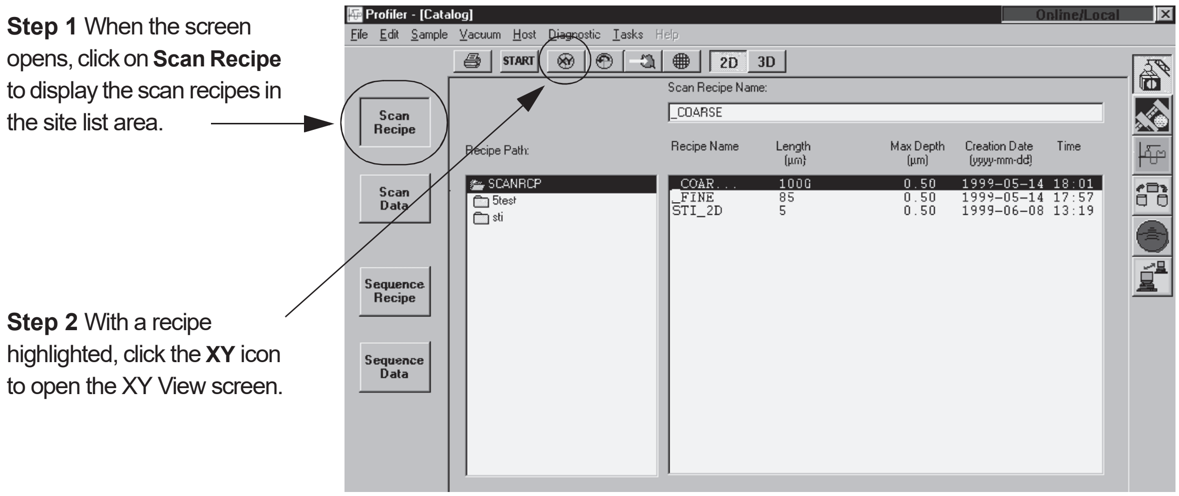


The three point Disk Locator has three disk supports that can be situated to support five sizes of disk: 48 mm, 65 mm, 84 mm, 95 mm, and 130 mm disks.

Installing the 3-point Disk Locator on the Stage:

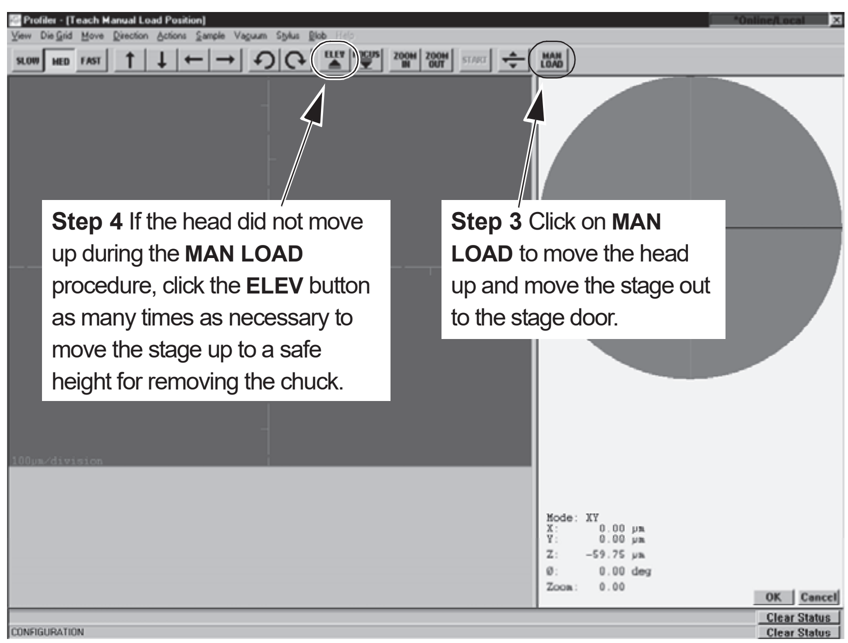
1. In the **Catalog** screen, choose **Scan Recipe** to display the scan recipes in the site list area. (See *Figure 11.70*.)

Figure 11.70 *Catalog - Scan Recipe Screen*



2. With a recipe highlighted, click on the **XY** icon in the tool bar to open the XY View screen. (See *Figure 11.71*.) The XY View screen opens. (See *Figure 11.71*.)

Figure 11.71 *XY View Screen*

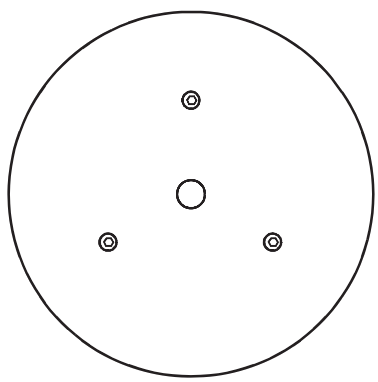


3. Click on **MAN LOAD** to move the head up and bring the stage out to the stage door. (See *Figure 11.71*.)
4. If the head does not move up during the **MAN LOAD** procedure, click the **ELEV** button (see the Tool Bar in *Figure 11.71*) as many times as necessary to move the head to a high enough position so that contact with the stylus can be avoided when removing the stage table.
5. Open the door.

CAUTION: If Interlock is ON, 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.

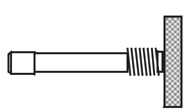
6. Remove the three screws (8-32×3/8 in.) that hold the stage table to the stage. Remove the table.
7. The Three Point Disk Locator has a base plate (see *Figure 11.72*) that has three holes for mounting it in place of the stage table. Place the disk locator base plate on the stage so that the three mounting holes line up.
8. Insert the three mounting screws and tighten. (See *Figure 11.72*.)

Figure 11.72 *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 11.73*.) Be sure that the washer is between the screw and the Three Point Disk Locator.

Figure 11.73 *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: If Interlock is ON, 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.

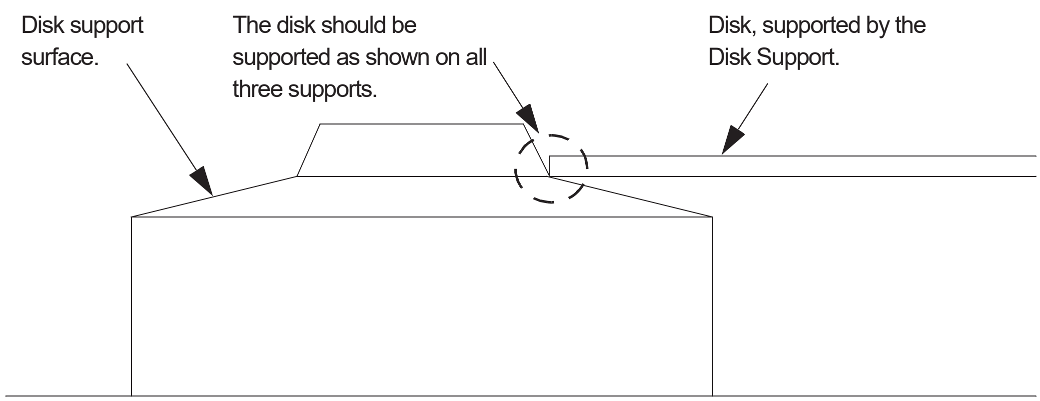
11. Click **MAN LOAD** to move the stage back under the measurement head

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 11-10 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 11.69*.)
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 11.74*.

Figure 11.74 *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:

Standard Precision Locators

These locators provide positioning for square samples, wafers with flats, and notched wafers. Instruments are shipped with a choice of the standard stage table or one of the locators in this list. (See *Figure 11.75* through *Figure 11.80*.)

Standard precision locators include:

- 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

Optional Precision Locators

These locators allow positioning of less common sizes of square substrates and wafers. They bolt on top of the standard stage table.

NOTE: These locators must be purchased separately.

Optional precision locators include (See *Figure 11.81* through *Figure 11.88*)

- 2-in. for Wafer with Flat/Square Substrate
- 3-in. for Wafer with Flat/Square Substrate
- 82-mm for Wafer with Notch
- 4-in. for Wafer with Flat/Square Substrate
- 5-in. for Wafer with Flat/Square Substrate
- 5-in. for Wafer with Notch

Optional 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 11-47,

Optional disk precision locators include (See *Figure 11.89*)

- 48-mm for Disk
- 65-mm for Disk
- 95-mm for Disk
- Adjustable Three Point Disk Locator (48 mm, 65 mm, and 95 mm)

Optional 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.

Optional, Stress Locator - Manual Load for 200 mm Wafers (see *Figure 11.90*).

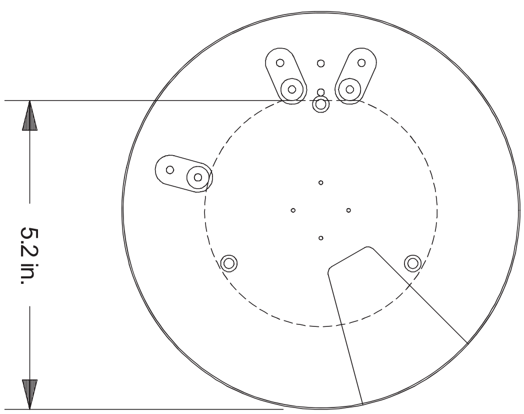


Figure 11.75 *For 4 in. Wafer w/Flat or Square Substrate*

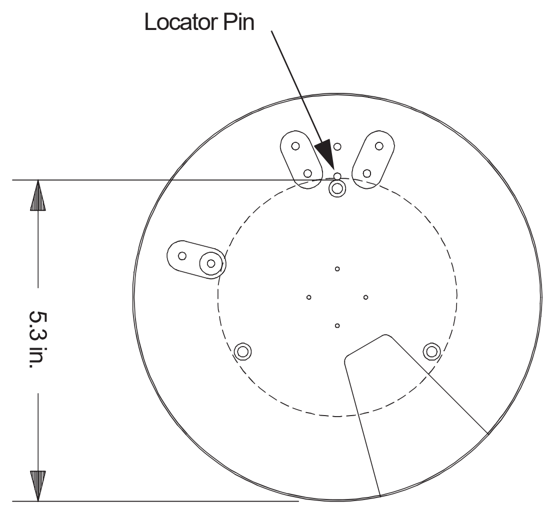


Figure 11.76 *For 4 in. Wafer with Notch*

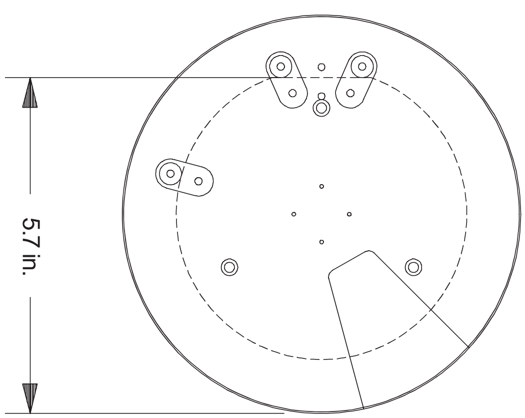


Figure 11.77 *For 5 in. Wafer w/flat or Square Substrate*

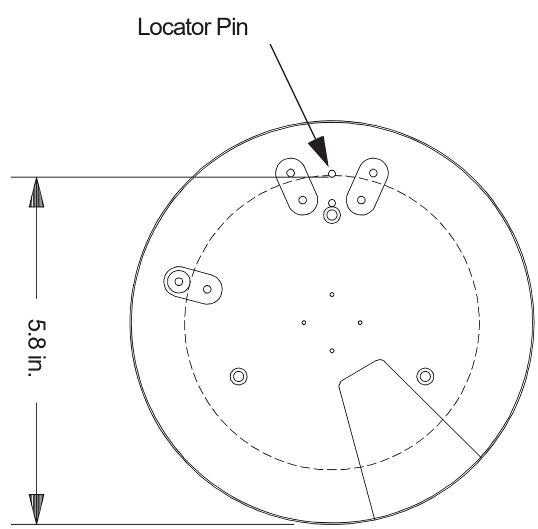


Figure 11.78 *For 5 in. Wafer with Notch*

Figure 11.79 *For 6 in. Wafer w/flat or Square Substrate*

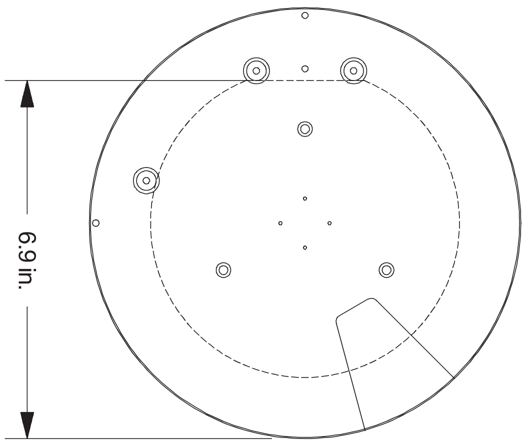
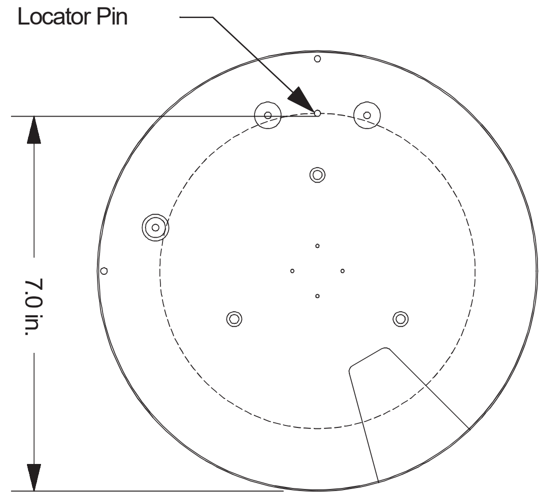


Figure 11.80 *For 6in. Wafer with Notch*



OPTIONAL PRECISION LOCATORS

Figure 11.81 *For 2 in. Wafer w/Flat or Square Substrate*

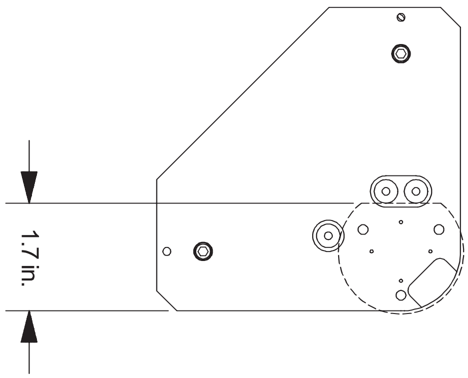


Figure 11.82 *For 3 in. Wafer w/Flat or Square Substrate*

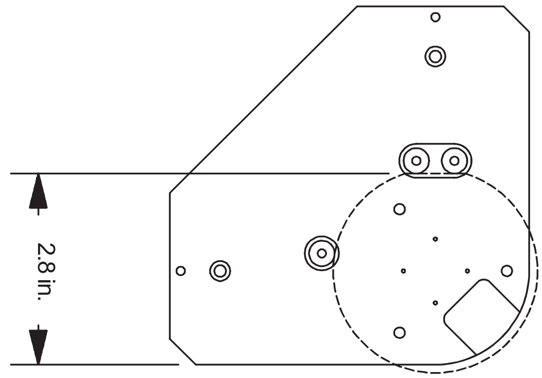


Figure 11.83 *For 4 in. Wafer w/Flat or Square Substrate*

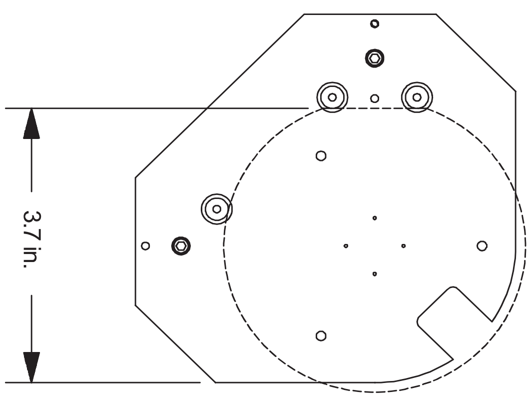


Figure 11.84 *For 4 in. Wafer with Notch*

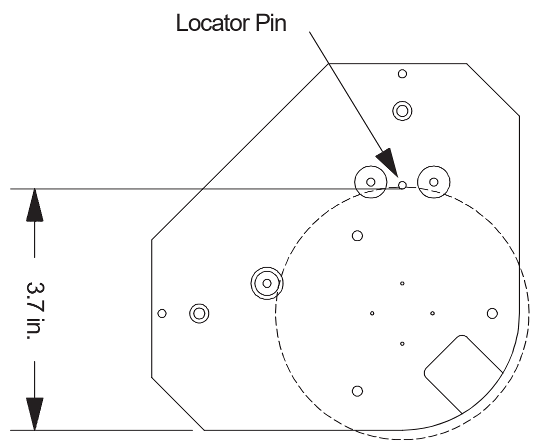


Figure 11.85 *For 5 in. Wafer w/Flat or Square Substrate*

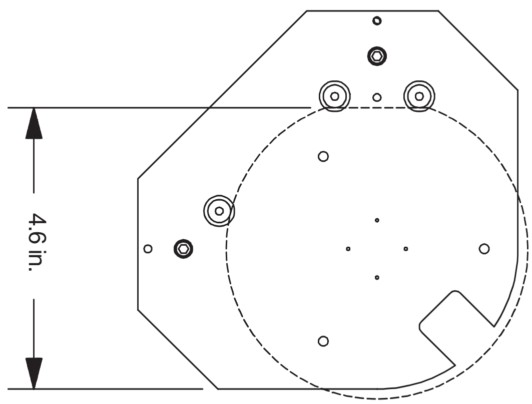


Figure 11.86 *For 5 in. Wafer with Notch*

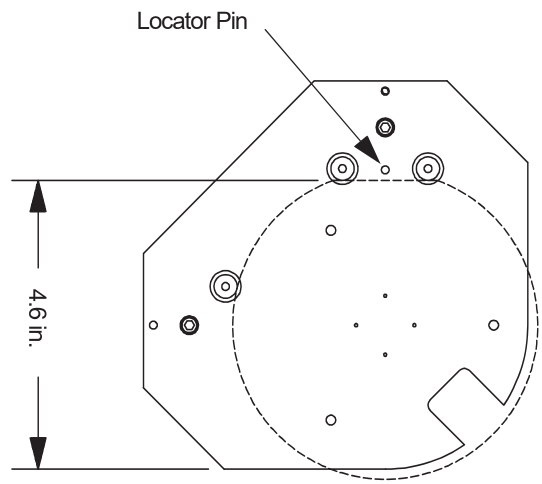


Figure 11.87 *For 6-in. Wafer w/Flat or Square Substrate*

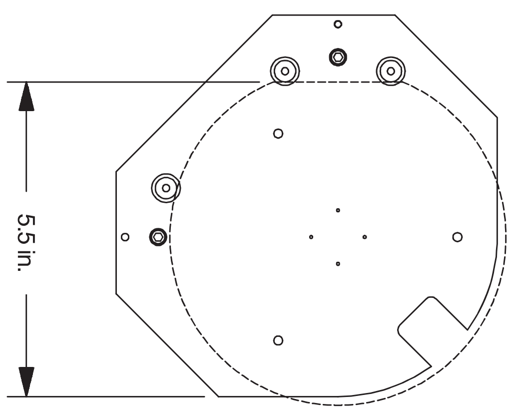


Figure 11.88 *For 82-mm Wafer with Notch*

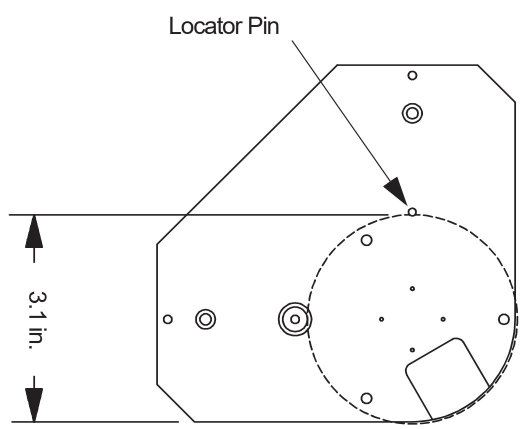


Figure 11.89 *Adjustable, for 48, 65, and 95-mm Disks*

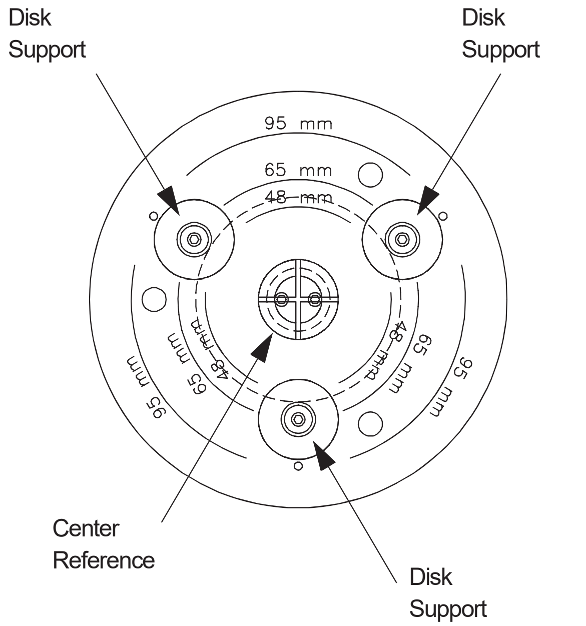
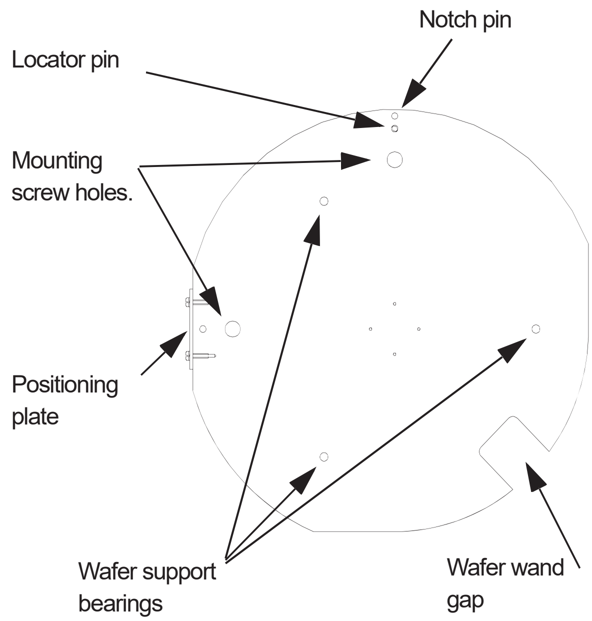


Figure 11.90 *Stress Locator - Manual Load*



12

CALIBRATIONS

INTRODUCTION

This chapter describes:

- *Password – Mid-Session Calibration or Configuration Access* on page 12-1
- *Applied Force Calibration* on page 12-3
- *Video Calibration* on page 12-5
- *Scan Position Offset Calibration* on page 12-10
- *Scan Position Offset Calibration* on page 12-10
- *Step Height Calibration* on page 12-28
- *Level Calibration* on page 12-41
- *Level Calibration* on page 12-41
- *Standard Calibration Matrix* on page 12-51

PASSWORD – MID-SESSION CALIBRATION OR CONFIGURATION ACCESS

Introduction

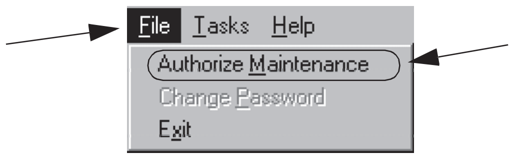
If a system is currently being used by an operator who *is not* logged in as a member of the Administrators, P_Configuration, P_Calibration, or P_AdvCalibration security group, most of the Calibration and Configuration screen functions are not available to the operator. This feature provides an operator, who has a valid password, the ability to enter the Calibration or Configuration screen procedures in the current session without the necessity of exiting and restarting the Profiler software under the required security level.

Accessing the Maintenance Functions

To access the Calibration or Configuration functions, the user must enter the Authorize Maintenance dialog box from either the Configuration or Calibration screen, depending on which screen's functions are to be accessed. If a calibration is to be performed, enter through the Calibration screen. If configuration changes are to be made, enter through the Configuration screen. Access is granted only as long as the user stays in the Configuration or Calibration screen. Access is terminated when the user clicks on one of the other Program icons.

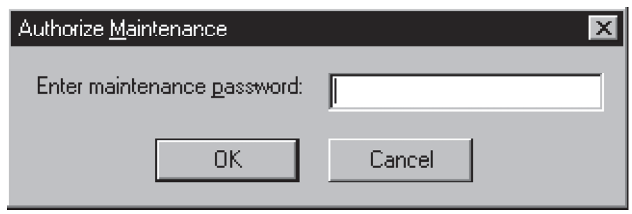
1. In the Calibration or Configuration screen, click on **File** to display its menu. (See *Figure 12.1*.)

Figure 12.1 *File Menu for Choosing Authorize Maintenance*



2. From the File menu choose **Authorize Maintenance…** This opens a Authorize Maintenance dialog box. (See *Figure 12.1*.)

Figure 12.2 *Authorize Maintenance Dialog Box*



3. Enter the password required for access to the Calibration or Configuration screen. (See *Figure 12.2*.)
4. Click **OK** when the password has been entered. (See *Figure 12.2*.)

If the valid password was correctly entered, access is granted to the Calibration or Configuration functions until the user exits the accessed screen.

Changing the Maintenance Password

Introduction

A member of the **Administrators** security group can change the Maintenance Password. Once changed, the same password is used for entrance to either the Configuration or Calibration screen functions.

Choosing a Password

Choose a password with the following parameters in mind:

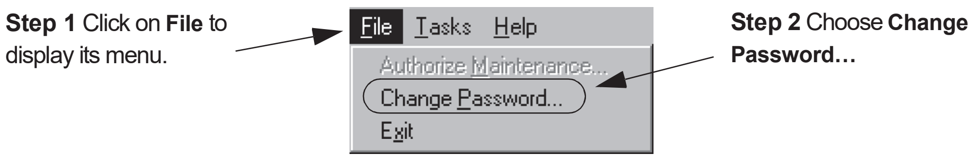
- It can only have alphabetic and/or numeric characters.
- It is case sensitive.
- It must have between 6 and 14 characters.

Password Change Procedure

Use the following procedure to change the password.

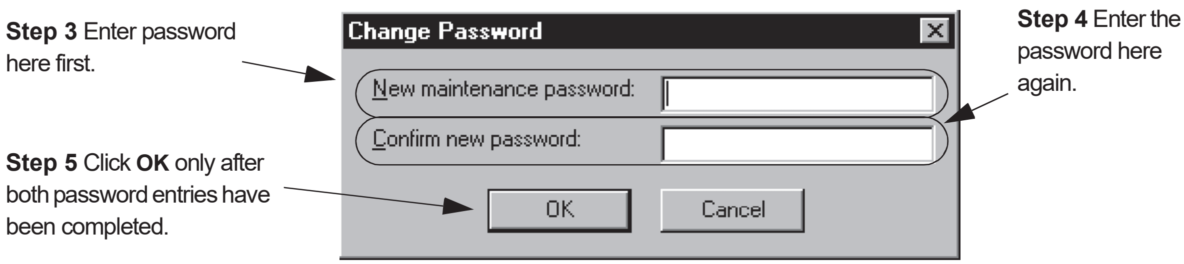
1. From either the Configuration or Calibration screen click on **File** to display its menu. (See *Figure 12.3*.)

Figure 12.3 *File Menu for Change Password… Dialog Box Access*



2. From the File menu choose **Change Password…** This opens the Change Password dialog box. (See *Figure 12.3*.)

Figure 12.4 *Change Password Dialog Box*



3. Enter the new password first in the **New maintenance password** field. ***Do not*** click **OK.**
4. Enter the identical password into the **Confirm new password** field. (See *Figure 12.4*.)
5. Click **OK**. If both passwords were the same, the system receives it and it becomes the new password for both screens.

APPLIED FORCE CALIBRATION

Windows - Applied Force Calibration Procedure

Introduction

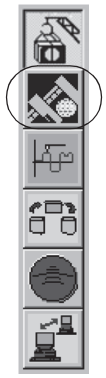
Check the Calibration Matrix on *page 12-51* for possible interaction with other calibrations.

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 on the **Calibration** icon. (See *Figure 12.5*.)

Figure 12.5 *Catalog Screen - Choose Calibration*

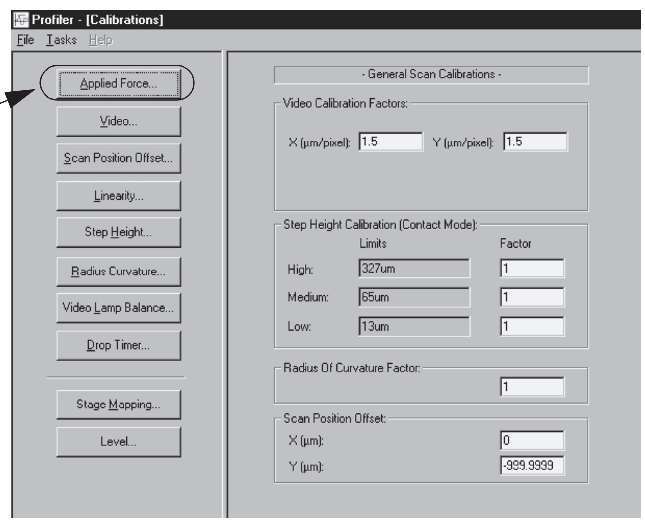


Step 1 Double-click on the **Calibrations** icon to open the **Calibrations** screen.

2. Click on the **Applied Force** button in the **Calibration** screen. (See *Figure 12.6*.) The Applied Force Calibration dialog box is displayed. (See *Figure 12.7*.)

Figure 12.6 *Calibrations Screen*

Step 2 Click on **Applied Force** to display the Applied Force Calibration window.

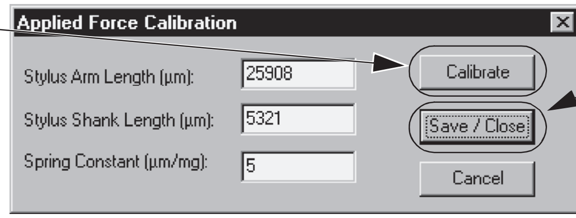


3. Click on **Calibrate** to begin the calibration procedure.

   The system performs the calibration and displays the results in the three fields of the Applied Force Calibration dialog box. (See *Figure 12.7*.)

Figure 12.7 *Applied Force Calibration Window*

Step 3 Click on **Calibrate** to begin the Applied Force Calibration.



Step 4 When the calibration is complete, click on **Save/Close** to save the calibration results of the Applied Force Calibration.

4. Click on **Save/Close** button to save the calibration results. (See *Figure 12.7*.) OR, click on **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 12-51* for possible interaction with other calibrations.

Introduction

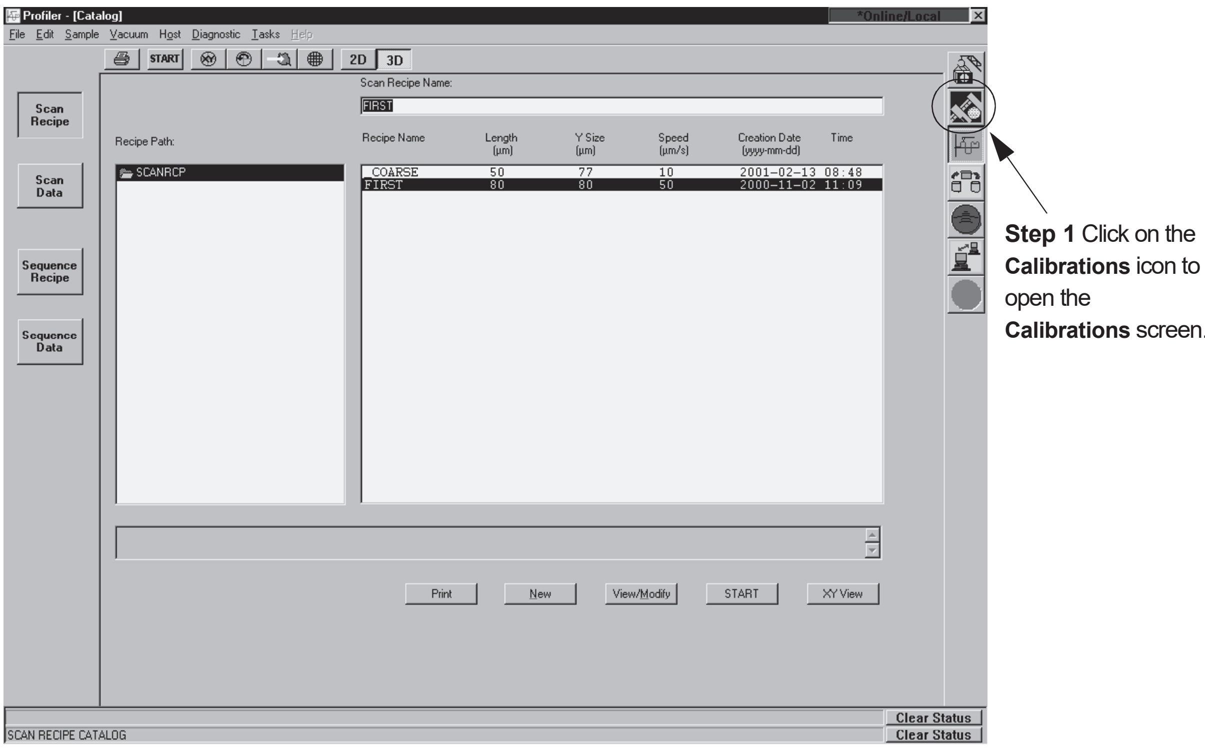
Video calibration ensures that the stage position is correlated to the video image on the screen. The calibration calculates the $^{\text{video pixels}}/_{\text{micron}}$. This means that when a position on the video screen is clicked, that position moves to the screen crosshair. This calibration works two different ways depending on whether or not the P-15 system has the Pattern Recognition option. Both calibration procedures are presented.

In this procedure, the Stylus Alignment Tool, Stage Mapping Wafer, or another sample with distinctive features can be used. The Stylus alignment Tool is recommended. The directions in this procedure include loading a sample, like the Stylus Alignment Tool (KLA-Tencor part number 219517).

Video Calibration Procedure

1. Click on the **Calibration** icon. (See *Figure 12.8*.) The **Calibrations** screen is displayed. (See *Figure 12.9*.)

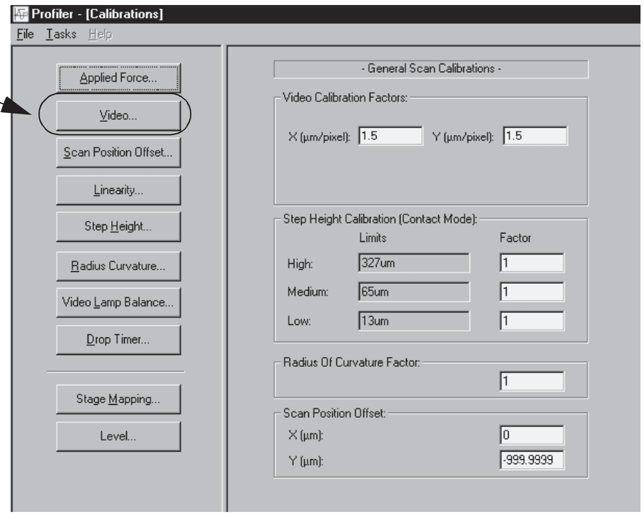
Figure 12.8 *Catalog Screen - Choose Calibration*



2. Choose **Video**. (See *Figure 12.9*.) The XY View **Video Calibration** screen appears. (See *Figure 12.10*.)

Figure 12.9 *Calibrations Screen- Accessing the Video Calibration*

Step 2 Click on the **Video…** button to display the **Video Calibration** window.



Loading the Stylus Alignment Tool

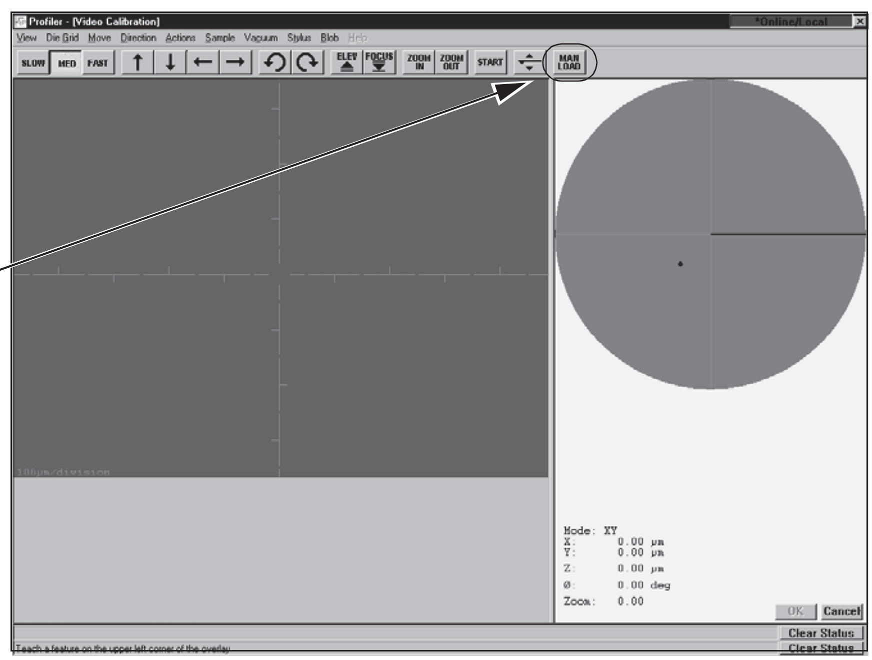
3. From the **Video Calibration** screen choose **MAN LOAD** to move the stage out to the stage door. (See *Figure 12.10*.)

   The Stylus Alignment Tool should be used to perform this calibration. A patterned sample that provides very distinct features could also be used if the Stylus Alignment Tool is not available.

Figure 12.10 *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 8 After the sample is loaded on the stage, click **MAN LOAD** to return stage under stylus.



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 Stylus Alignment Tool (or other sample) on the stage. Position it in the center of the stage as squarely as possible with respect to the XY axis.
6. 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.

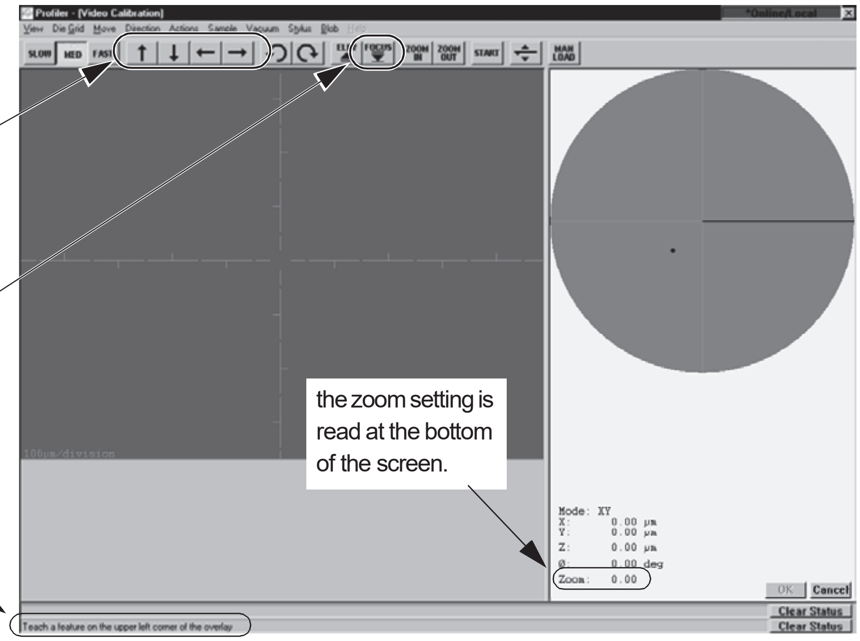
7. Close the door.
8. Click **MAN LOAD** to move the stage back into position under the stylus and the optics. (See *Figure 12.10*.)
9. Click **FOCUS** in the tool bar. (See *Figure 12.11*.) The system nulls on the sample (nulls = brings the head down and focuses the optics according to the currently set magnification with the stylus very near contact with the sample surface).
10. 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 12.11*.)
11. 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 12.11*.)

Teaching for Systems with Pattern Recognition

12. 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 -10. Otherwise continue on to the next step.

Figure 12.11 *Message Prompt and Focus Button*



13. 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 15**. If the system still does not locate the feature, use the procedure for systems without pattern recognition as described in **Step 14** and **Step 15**.

Teaching for Systems without Pattern Recognition

14. Choose a feature in the upper left quadrant of the screen. To choose the feature, move the cursor crosshair over the feature and click on it at a precise point that can be exactly identified again. The system moves the feature to another location nearby.

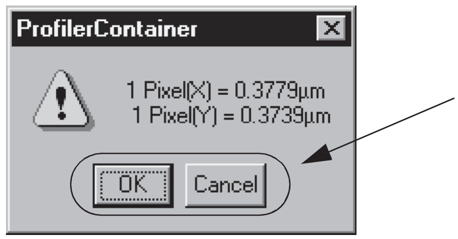
15. Click on the same feature again in exactly the same place on the feature as the first click.

    The Profiler Container message box is displayed (this is true also if the pattern recognition finds the chosen pattern after Step 12 on page -8).

    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 12.12*.)

Figure 12.12 *XY Video Display Message Box*



16. Click **OK** to save the calibration or **Cancel** to reject it and retain the old calibration. The **Calibration** screen is then displayed. (See *Figure 12.12*.)

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.

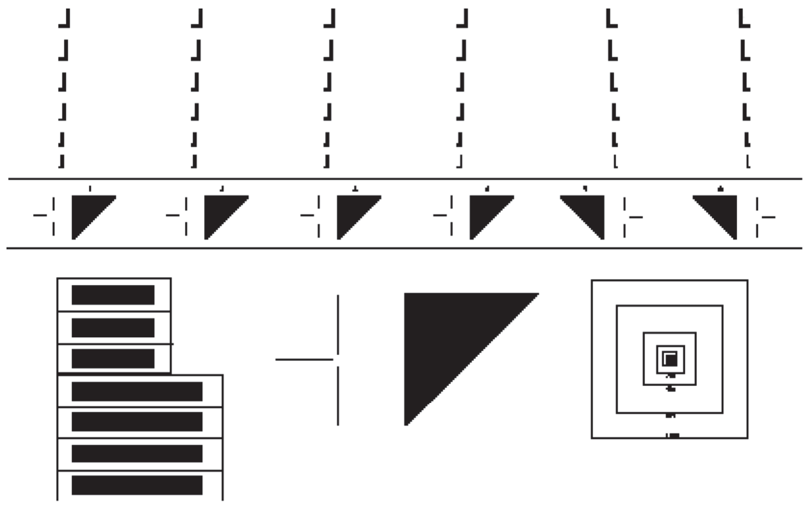
During the Stylus Change procedure, the system automatically sets up the Scan Position Offset Calibration to be performed as part of the procedure.

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.

Use the Stylus Alignment Tool (KLA-Tencor Part Number 219517 – see *Figure 12.13*) 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 12.13 *KLA-Tencor Stylus Alignment Tool*



150 µm (Standard) Scan Position Offset Calibration

1. From the **Scan Offset Calibration** screen click **MAN LOAD** to move the stage out to the stage door. (See *Figure 12.14*.)
2. ***After the system has completely stopped moving***, open the stage door.

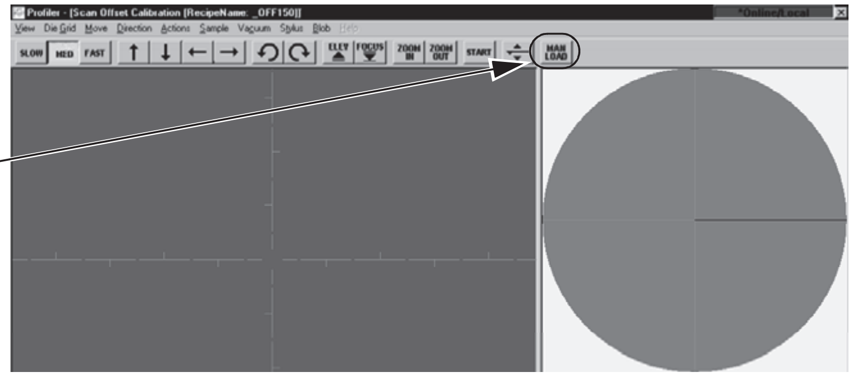
CAUTION: Wait until the stage motion has completely stopped before opening the door. If the stage is still in motion when the door is opened, the system stops. (Unless the interlock is disabled)

CAUTION: Do not activate the stage motion system with the door open or the system stops. (Unless the interlock is disabled)

Figure 12.14 Manual Load from the Scan Offset Calibration Window

Step 1 To move the stage to the open door, click on the **MAN LOAD** icon. It highlights and the stage moves forward.

Step 6 After loading the Stylus Alignment Tool, click on **MAN LOAD** again to send the stage back under the stylus.

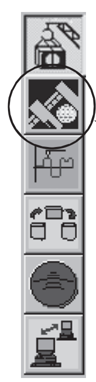


3. Place the **Stylus Alignment Tool** precisely in the center of the stage, squarely positioned with respect to the XY axis.
4. Turn the vacuum on using the switch on the left inside edge of the door.

NOTE: The Vacuum menu in the screen's menu bar is disabled. It does not effect the stage vacuum.

5. Close the stage door.
6. From the **Scan Offset Calibration** screen, click **MAN LOAD** in the tool bar to move the stage back beneath the stylus. (See *Figure 12.14*.)
7. From the **Catalog** screen click on the **Calibration** icon to display the **Calibration** screen. (See *Figure 12.15*.)

Figure 12.15 Catalog Screen - Click on the Calibration Icon



Step 7 Click on the **Calibration** icon to display the **Calibration** screen.

8. Ensure that the Video Calibration is correct at the zoom setting being used for the Scan Position Offset calibration. (If, when clicking on an object to center it in the XY View screen, the object does not move to the crosshair junction, perform the Video Calibration. This should correct the symptom. See *Video Calibration* on page 12-5.) *Zoomed out all the way out is recommended.*

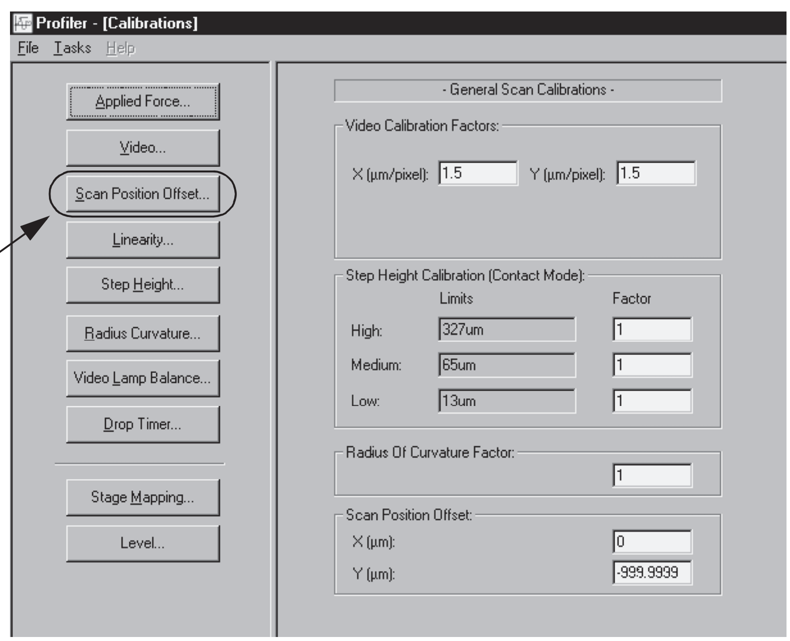
CAUTION: Use the zoom-lock or zoom all the way out when performing the Scan Position Offset calibration.

Each zoom setting has a slightly different Scan Position Offset. It is important that the system be calibrated at the zoom setting which is being used for the scans. It is very important that the zoom setting be consistent when using pattern recognition and that the pattern recognition image be captured at the zoom setting being used to locate the pattern. Scans zoomed all the way out are consistent as is any zoom position that has been locked.

NOTE: Ensuring that the Video Calibration is correct helps to avoid introducing error into the Scan Position Offset calibration.

9. Ensure that the proximity sensor is ON (see *Proximity Sensor Configuration* on page 11-40) or reteach the Lowest Elevator Position using the alignment tool as the sample surface. (See *Teach Lowest Elevator Position* on page 11-10.)
10. In the XY View screen, click and hold the **ZOOM-IN** button until the optics are fully zoomed out.
11. From the Calibration screen, click on the **Scan Position Offset…** button. (See *Figure 12.16*.)

Figure 12.16 *Scan Calibrations Screen*



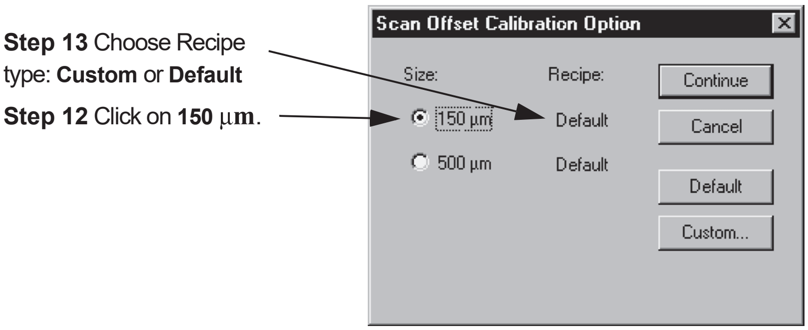
Step 11 Click on the **Scan Position Offset…** calibration button to display the **SCAN OFFSET CALIBRATION OPTION** dialog box.

The **Scan Offset Calibration Option** dialog box is displayed (see *Figure 12.17*) 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 width of the triangle that is to be scanned and therefore, which triangle the scan is to be performed on. If the width is 150 µm then the 300 µm triangle is being used. If the width is 500 µm then the 1000 µm (1 mm) triangle is being used.

12. Choose **150 µm** (standard) to continue with the calibration. (See *Figure 12.17*)

Figure 12.17 *Scan Position Offset Calibration Options dialog box*



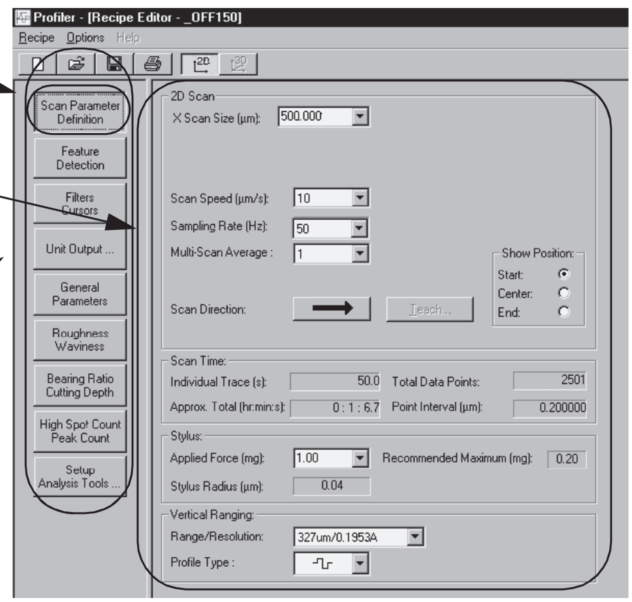
13. Choose a recipe type, Default or Custom.

    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 any contact stylus. The default settings are the KLA-Tencor recommended recipe settings for all the calibrations.
    - **Custom**: (CUSTOM RECIPE CREATION IS AN OPTION BUT IS NOT NOT RECOMMENDED BY KLA-TENCOR.) 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 12.18*.) 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 12.21*). When chosen, the **Scan Parameter Definition** button (in the top left corner of the screen, circled in *Figure 12.18*) appears to be indented.

Figure 12.18 *Window Buttons - COARSE - 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: SOME OF THESE BUTTONS ARE PASSWORD PROTECTED WITH RESTRICTED ACCESS.

CAUTION: The DuraSharp stylus should only be used with the low force head. If using the DuraSharp stylus, DO NOT set the Scan Speed higher than the default, **10 µm/second**, and do not set the Applied Force higher than the default, **0.2 mg**. In general, these settings should be established through the Stylus Change procedure only, and not changed manually in their fields.

14. The recipes are set as follows:

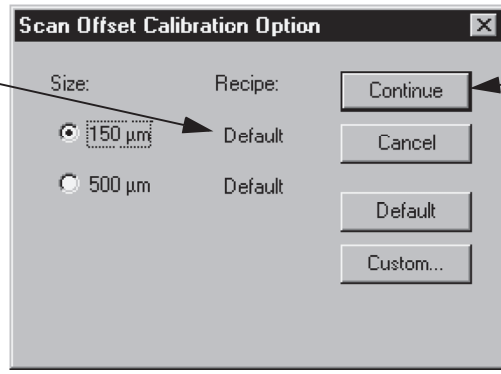
CAUTION: KLA-Tencor recommends using the Default recipes unless there is a very good reason for creating a custom recipe.

To use the currently selected recipe:

a. To use the calibration recipe indicated to the right of the **Size** selection (see *Figure 12.19*), click **Continue** to proceed.

Figure 12.19 *Scan Position Offset Calibration Options dialog box*

The current recipe type is displayed here.



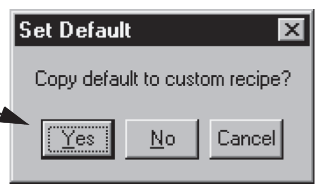
Step 14*a*. Click on **Continue**

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 12.20*.)

Figure 12.20 *Set Default Dialog Box*

Step 14*b*. To change from Custom to Default, click on **Yes** to set default values in the custom recipe.

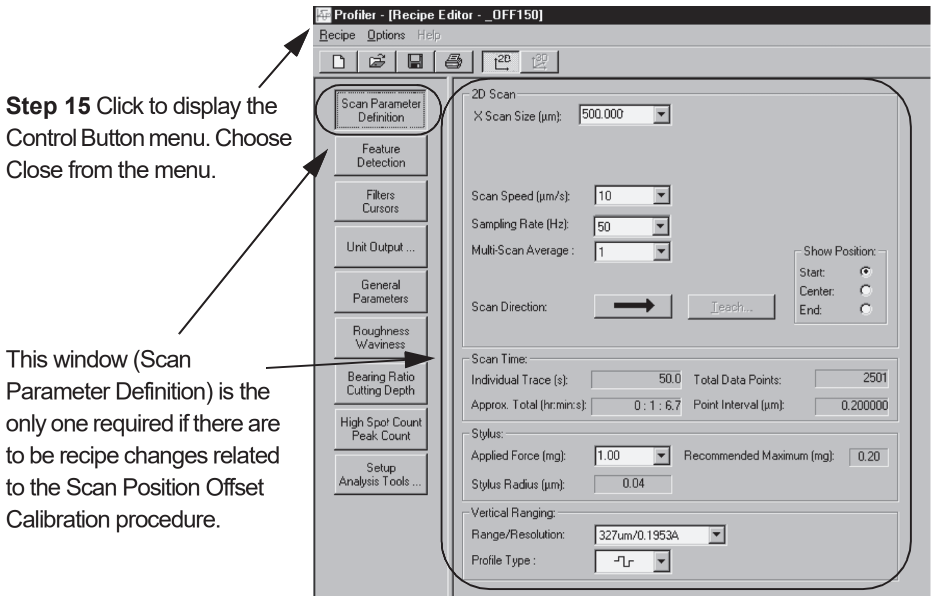


To change the recipe from Default to Custom

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 12.21*.)

15. 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 12.21*.)
16. 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 12.21 *Scan Parameter Definition -* ***_OFF150*** *- Recipe Editor*



17. (**BEFORE CONTINUING** see **CAUTION** below.) Click **FOCUS** in the tool bar. The Stylus Alignment Tool's surface image comes into focus.

CAUTION: As the stylus lowers toward the Stylus Alignment tool, 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 stylus makes its measurement. If the stylus and the sensor are not descending directly onto the stylus alignment tool's measurement area, press the ESC key, on the computer keyboard, to stop the stylus descent. Manually relocate the tool under the stylus. Click on **FOCUS** again to resume the procedure.

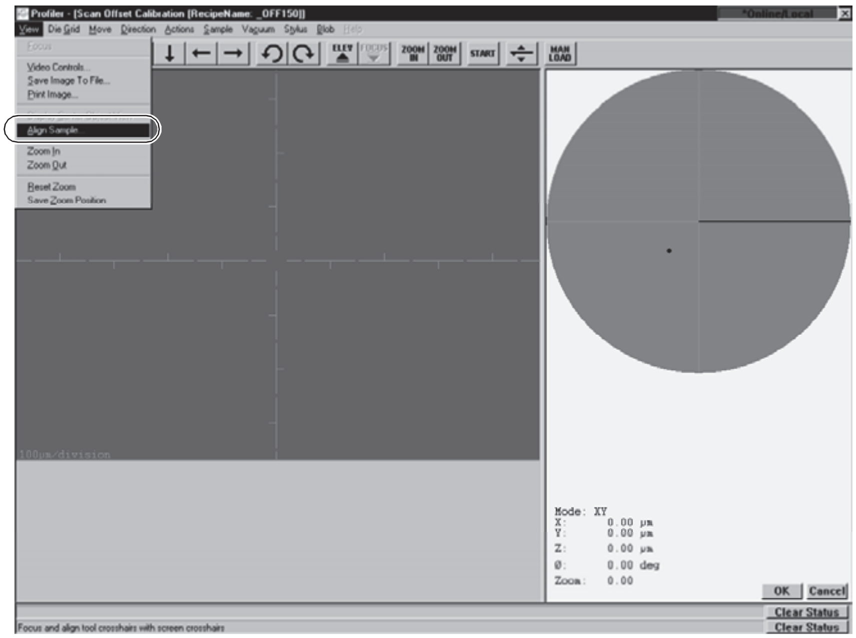
BEGIN Align Sample Procedure

18. The Stylus Alignment Tool 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. (See *Figure 12.22*.)

    This displays the Alignment Angle Dialog Box.

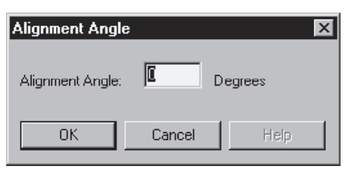
Figure 12.22 *View Menu with Align Sample Chosen*

Step 18 Click on **Align Sample…** to begin the sample alignment procedure.



19. In the Alignment Angle dialog box, leave the setting at the default, "0" and click **OK** to accept the alignment angel of 0°.

Figure 12.23 *Alignment Angle Dialog Box*



The prompt at the bottom of the screen now says,.

Click the left mouse button to teach the first point

20. Use the arrow buttons to locate the border line between the 300 µm triangles and the 1000 µm triangle. Still using the arrow buttons, follow the line to the left side of the tool. (See *Figure 12.24*.)
21. Move the cursor to the line and click precisely on the line.

    The prompt at the bottom of the screen now says,

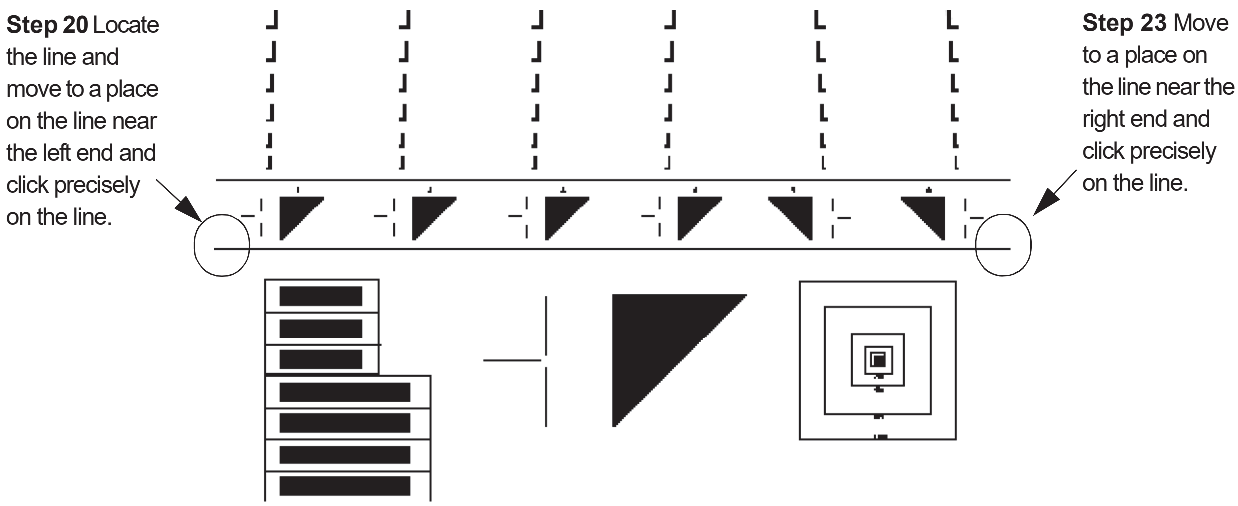
Press OK to accept the first alignment location

22. Click **OK** at the bottom right corner of the screen.

    The prompt at the bottom of the screen now says,

    Click the left mouse button to teach the second point

Figure 12.24 KLA-Tencor Stylus Alignment Tool



23. Use the left arrow button follow the dividing line to the right until it reaches the end of the line. (See *Figure 12.24*.)
24. Move the cursor directly over the line and click precisely on the line.

    The system adjusts the theta alignment so the Stylus alignment tool is lined up with the X- and Y-axis. The prompt at the bottom of the screen now says,

    Press OK to accept the second alignment location

END Align Sample Procedure

25. Click **OK** at the bottom right of the screen to accept the stage alignment of the Stylus Alignment Tool.

    The prompt at the bottom of the screen now says,

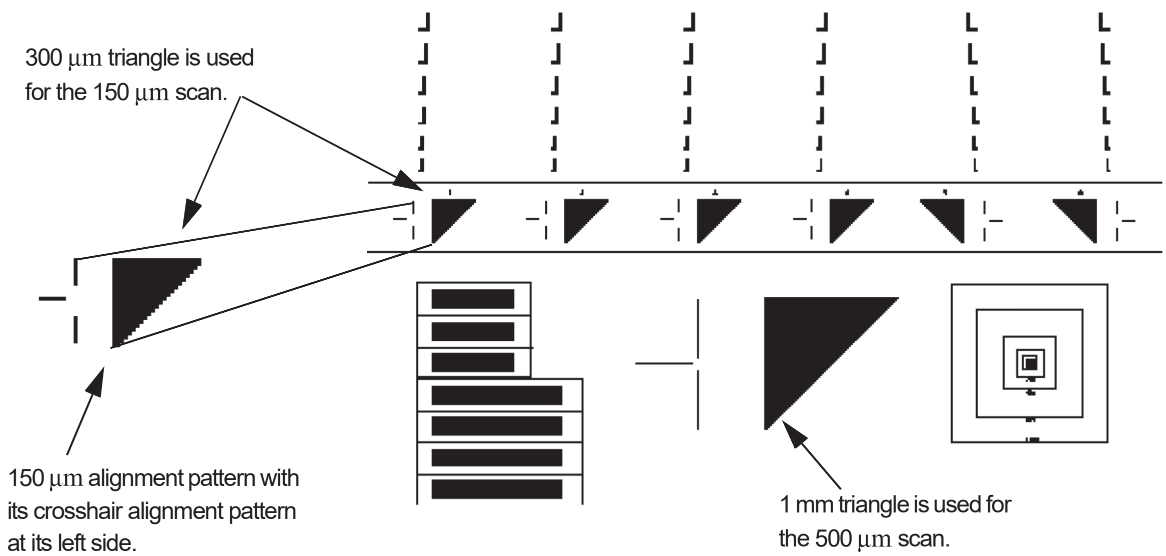
    Focus and align tool crosshairs with screen crosshairs

    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.

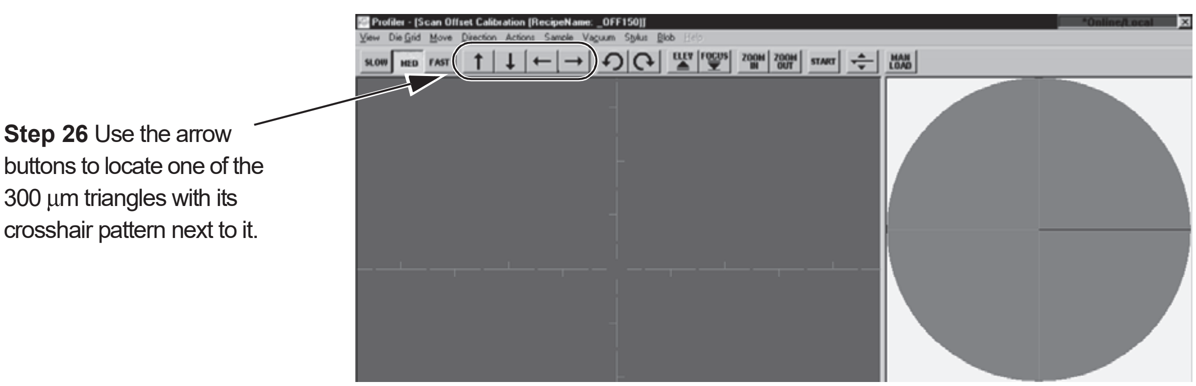
If the 500 µm scan missed the 1000 µm triangle, the stylus needs to be physically realigned by an authorized KLA-Tencor service representative.

***Figure 12.25** KLA-Tencor Stylus Alignment Tool*



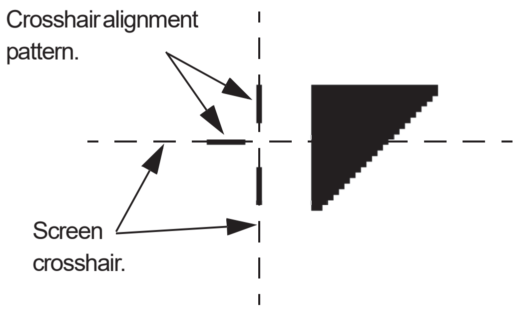
26. Use the linear movement arrow buttons (see *Figure 12.26*.) to locate one of the 150 µm alignment patterns with its crosshair alignment pattern at its left side, or, if they are in view on the video screen, click on one to move it to the screen crosshair. (See *Figure 12.25*.)

***Figure 12.26** Aligning the Tool with Screen Crosshair*



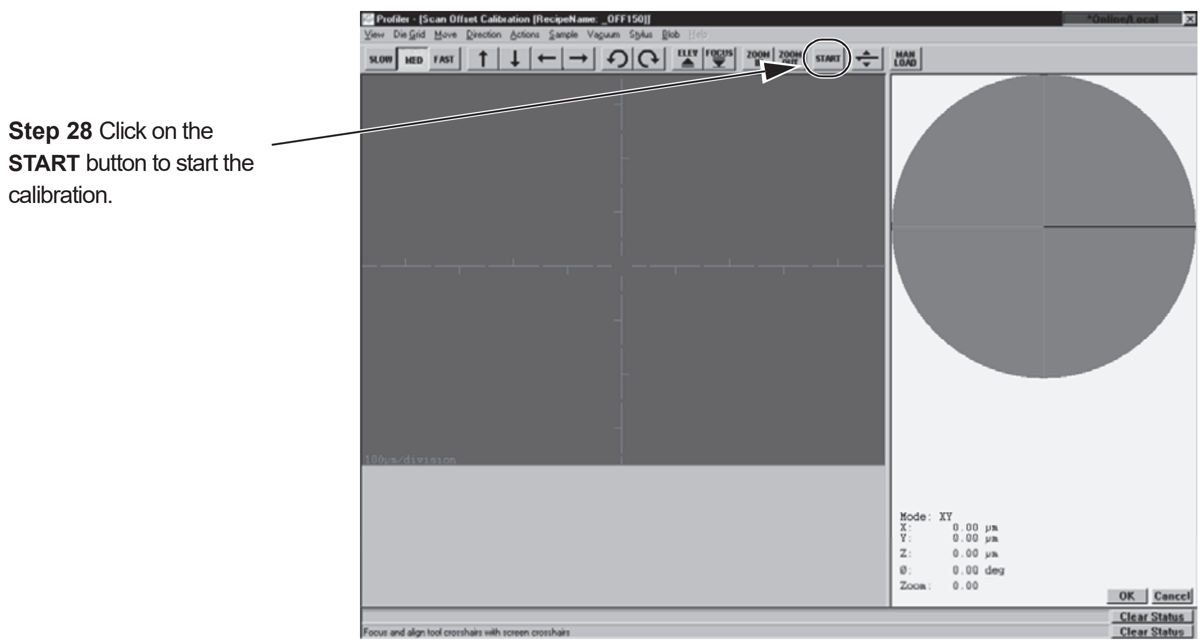
27. Click at the center of the Crosshair Pattern to align it with the screen crosshair. (See *Figure 12.27*.) The crosshair pattern should align precisely with the screen crosshair.

Figure 12.27 Align Screen Crosshair with 150 µm Crosshair Pattern



28. Click the **START** button located in the screen tool bar. (See *Figure 12.28*.)

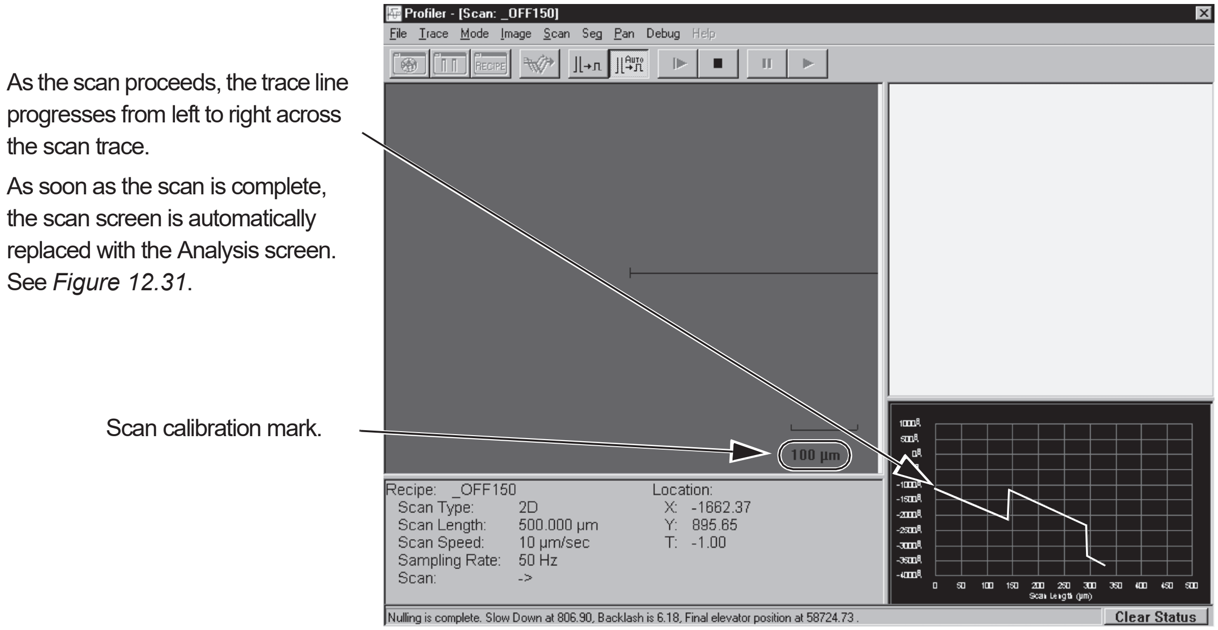
Figure 12.28 Manual Load from the Scan Offset Calibration Window



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 12.29 *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 12.30 *Trace Path Through the Triangle*

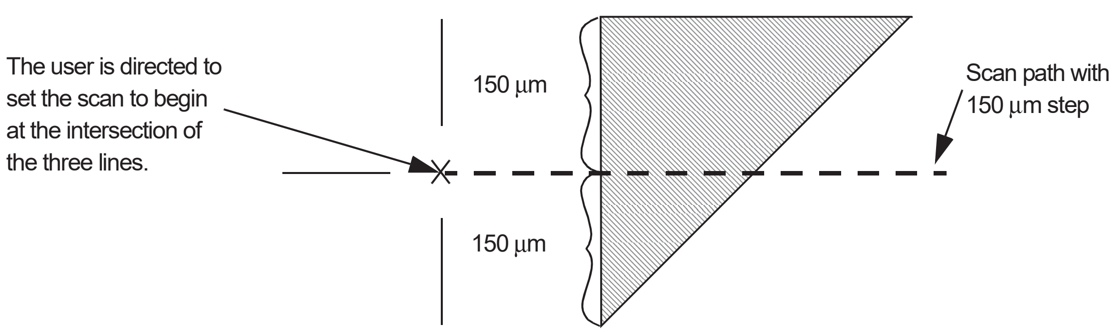
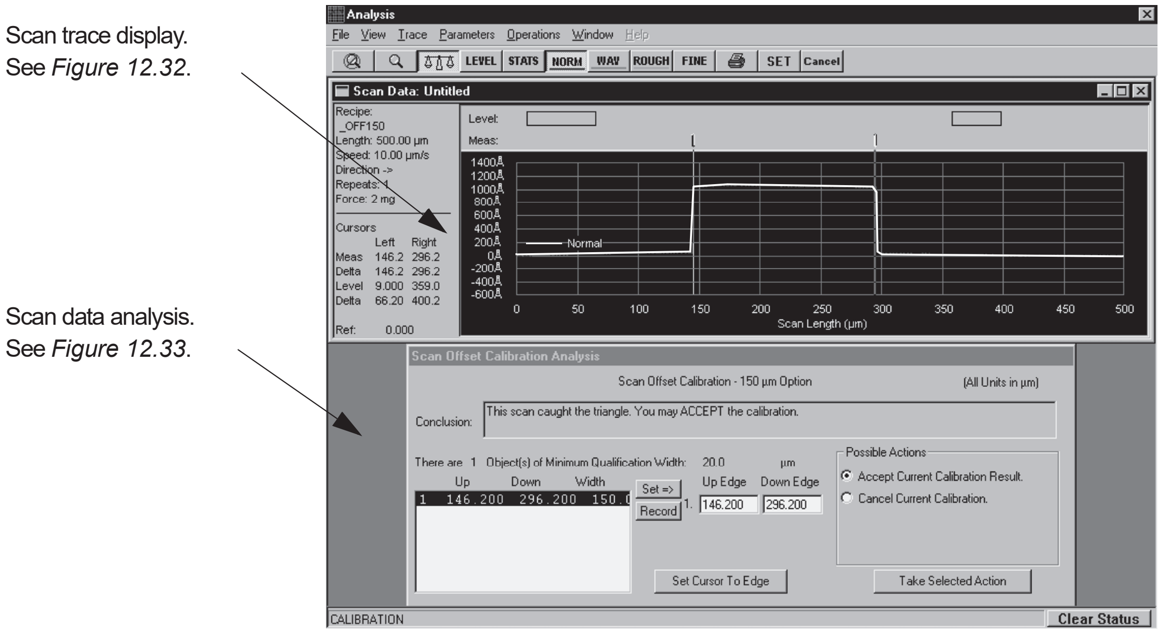
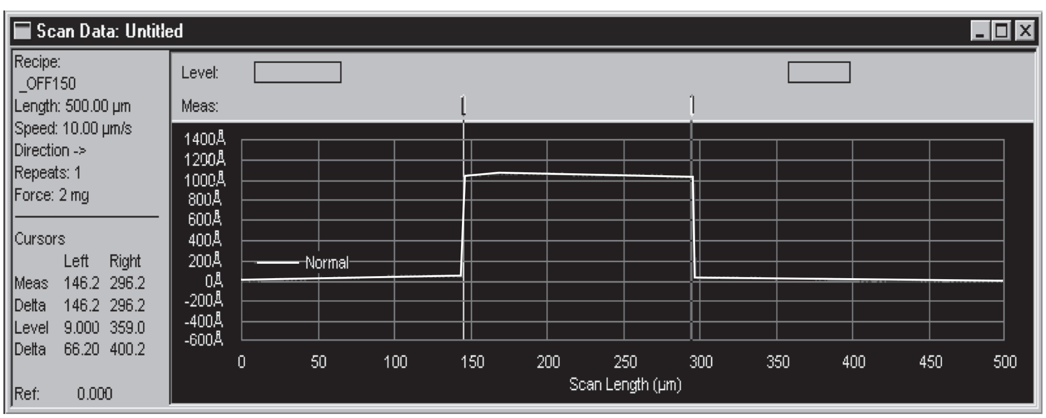


Figure 12.31 *Data Analysis Window.*



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 12.32*. 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.

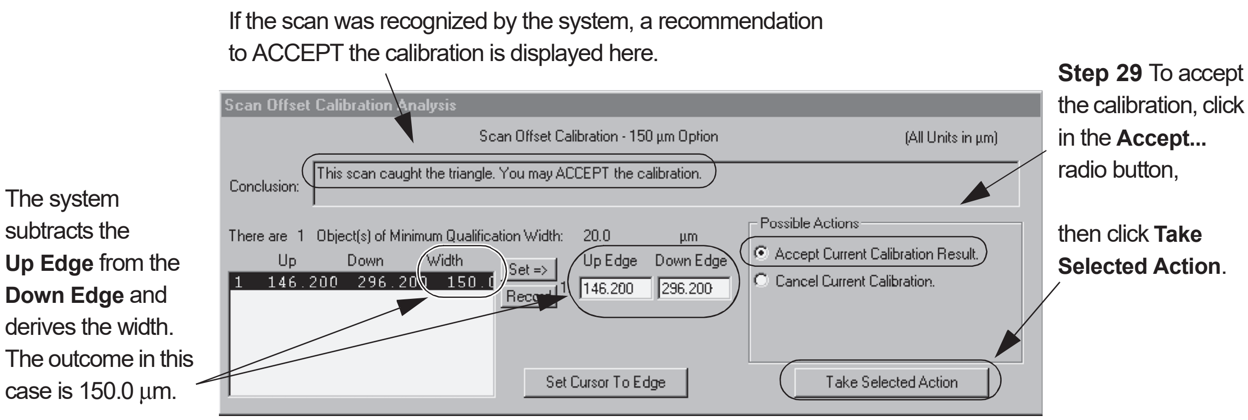
Figure 12.32 *Scan Data Portion of the Analysis Window*



In the bottom half of the window, the **Scan Offset Calibration Analysis** appears. In *Figure 12.33* 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 **Stylus Alignment Tool** triangle pattern.

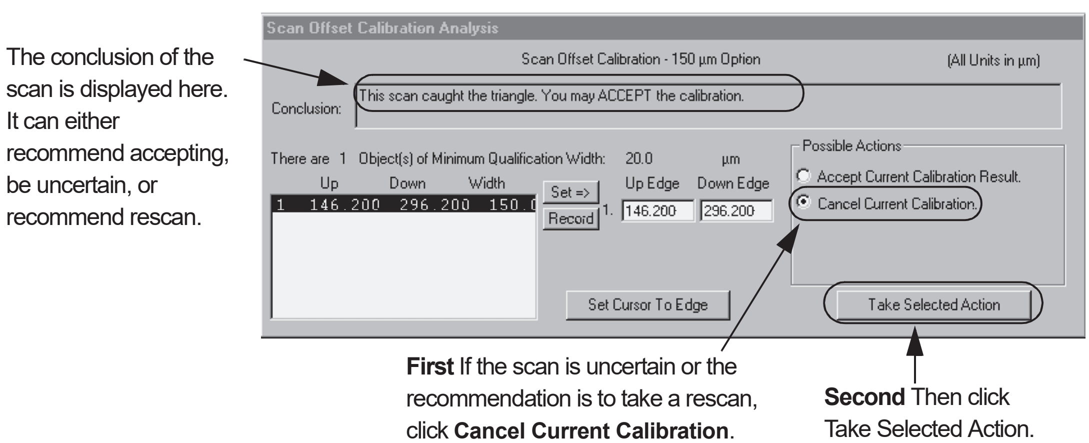
29. To accept the recommendation, ensure that **Accept Current Calibration Result** is chosen, then click on **Take Selected Action**. (See *Figure 12.33*.)

Figure 12.33 *150 µm Scan Data Analysis Window*



If the trace misses the triangle or is unable to identify it, one of several messages can be displayed. The message could say that scan might have caught the triangle and ask the user to choose either to accept it, change the location, or reject it. The message might read, "Unknown situation..." in which case the user should perform the 500 µm scan. If the message is uncertain, perform the entire scan procedure again, this time using the 1000 µm (1 mm) triangle and the 500 µm scan recipe, _OFF500.

Figure 12.34 *"Unknown Situation" Corrective Action*



After the scan calibration has been accepted, the **Calibrations** screen returns with the **Scan Offset Calibration Option** dialog box open on top.

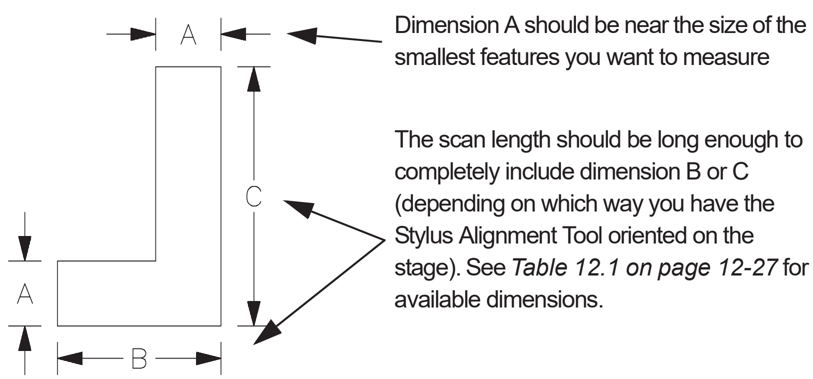
Scan Position Offset Calibration Validation

Introduction

This procedure is used to verity the accuracy of the Y dimension in the offset. If the calibration result was 150 µm, the offset error should be **0**. The offset error is determined by subtracting the scan result from the intended width, 150 µm.

To verify the calibration for a specific sample size the Scan Position Offset Verification procedure is used. The Stylus Alignment Tool provides a set of various sized right angle test features that can be used to ensure that the calibration is effective for the sample size being scanned. Use the right angle test feature that has features closest in size to features that are to be measured.

Figure 12.35 *Angle Features on the Stylus Alignment Tool*

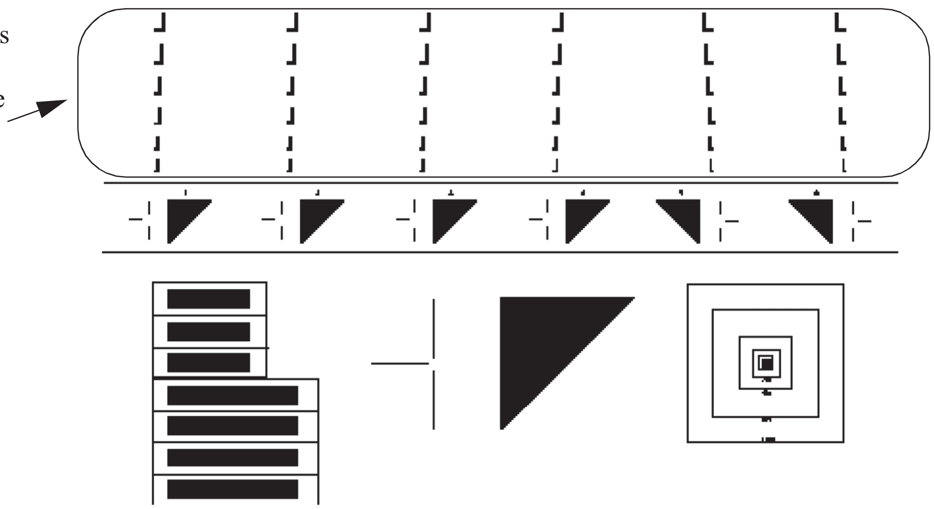


The right angle features are at the top of the Stylus Alignment Tool (KLA-Tencor Part Number 219517 – see *Figure 12.36*). They are used to validate the effectiveness of the Scan Position Calibration. Each of the six columns contain the same sized angle features, duplicated above each triangle that is available for use in the calibration procedure.

Figure 12.36 *KLA-Tencor Stylus Alignment Tool*

The Angle Features are presented in various sizes at the top of the tool.

Each column is identical.



Each angle feature has its own "Dimension A" displayed just above it on the tool. The top angle feature in *Figure 12.37* is 14 µm in the "A" direction as demonstrated in *Figure 12.35*. The bottom feature is 10 µm. The displayed size is also a key in determining the length of the angle feature arms, features "B" and "C" in *Figure 12.35*. Each size ("A" dimension) is recorded in the first column of *Table 12.1*, Angle Feature Dimensions. Find the size and the corresponding lengths are displayed in that row.

Figure 12.37 *Angle Features*

Table 12.1 *Angle Feature Dimensions*

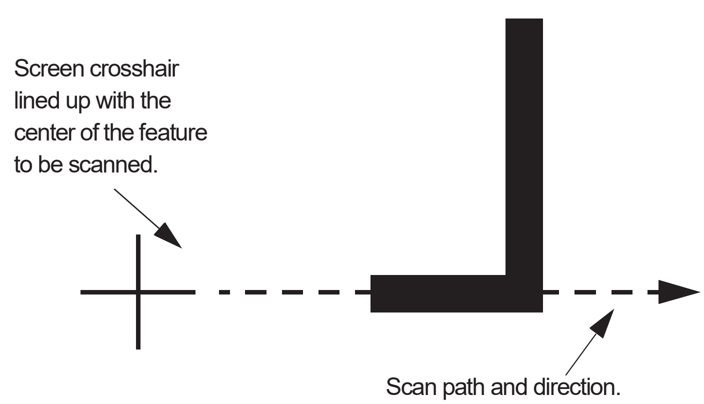
Dimension A (μm)	Dimension B (μm)	Dimension C (μm)
4	16	50
6	24	60
8	32	80
10	40	100
14	56	100
18	72	100

Verification Procedure

The verification procedure can be performed using the recipe that the scan is being used to verify.

1. With the Scan Recipe screen open, select the recipe to be used.
2. Click on the **XY** icon to open the XY View screen.
3. Ensure that the zoom setting is exactly the same as was used in the calibration procedure. It is best to perform the calibration zoomed all the way out.
4. Click on **FOCUS**. The system focuses on the Stylus Alignment Tool.
5. Find an angle feature that has the dimension size needed to verify that the system can find and scan a feature of that size.

   If the need arises to use a feature that is vertically positioned on the screen, use the rotation buttons to reorient the stage so the feature is horizontally positioned. Or, right-click on the navigation window to display the **Move To** dialog box and enter 90° in the Theta field.
6. Use the arrow buttons to approximately position the feature for the scan.
7. Position the cursor crosshair and click such that the screen crosshairs are exactly lined up horizontally with the left side of the feature, far enough from the feature to allow the stylus room to scan the approach to the feature before actually scanning the feature itself.



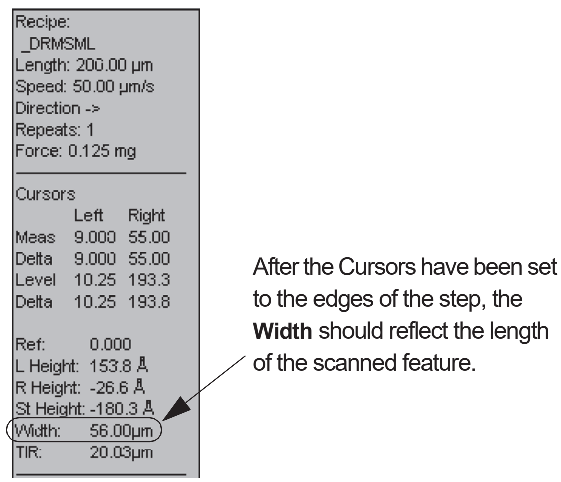
8. Click **START** to begin the scan. The scan progresses like other scans, with the real-time trace displayed at the bottom right of the screen.

   Observe the stylus image on the screen to ensure that it contacts the feature at the intended location.

   When the scan is complete, the Analysis screen is displayed. On the left side of the Analysis screen are some of the statistics of the scan itself.

9. In the Analysis screen, set the measurement cursors to the edges of the step.

   Figure 12.38 *Scan Information Display in Analysis Screen*



10. In the Analysis screen, look in the Analysis display (see *Figure 12.38*) and locate the **Width**.

    The Width should show that the correct feature was scanned. In *Figure 12.38* the scan Width of 56 µm would show that the "B" dimension of the right angel feature labeled "14" (see *Figure 12.37 on page 12-26* and *Table 12.1 on page 12-27*) was scanned.

    If the stylus passed over the intended object and the Width verifies that the object scanned was the correct one, the verification is complete and the system is ready to be used for scans.

    If the scan missed its intended object, repeat the Scan Position Offset Calibration. After the calibration is complete, repeat the verification procedure.

STEP HEIGHT CALIBRATION

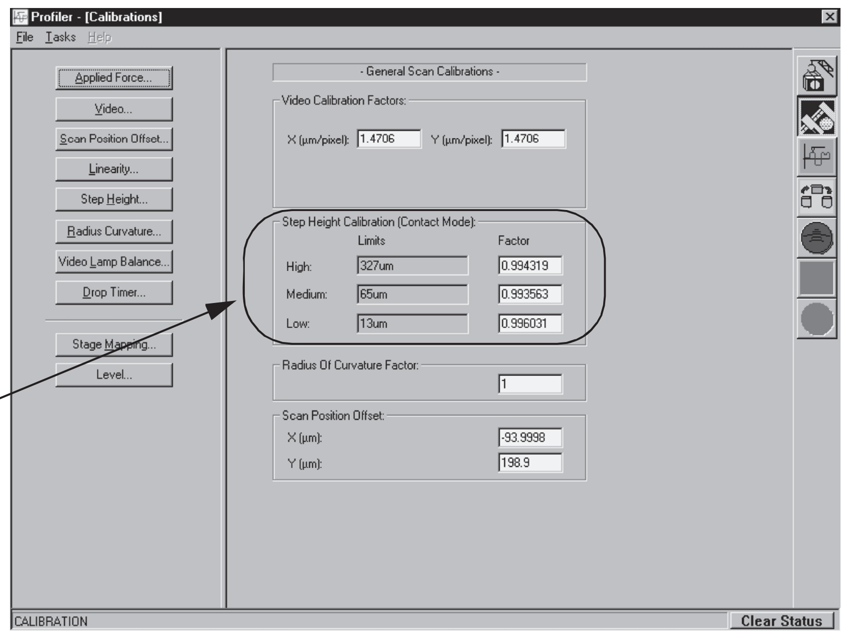
Check the Calibration Matrix on *page 12-51* for possible interaction with other calibrations.

The vertical sensing transducers in the system are not absolute devices and, therefore, require calibration. The calibration factors for the available vertical ranges are set to approximately 1.00 at the factory. (See *Figure 12.39*.)

CAUTION: All vertical ranges must be calibrated. Each calibration must be performed independently. Use the 2 μm stylus fo this calibration

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***, depending on the amount of system use, ***for each of the three ranges***.

Figure 12.39 *Step Height Calibration Factors*



Step Height Calibration Factors are presented in the Calibrations screen.

Calibration Procedure:

Check the Calibration Matrix on *page 12-51* 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 on 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.

   If the step height standard does not cover the vacuum holes so they can be effective, it might be necessary to rotate the standard 90° so it does cover the vacuum holes.

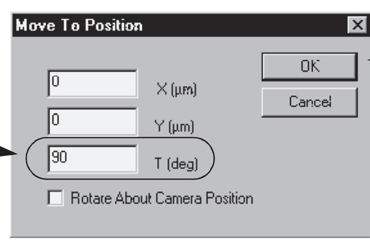
   If the standard was rotated 90°, it is necessary to rotate the stage 90° in the same direction so the step and other scan features are properly oriented for a scan. To accomplish this

   a. Right-click in the navigation window to display the menu dialog box.
   b. Click on **Move To…** to open its dialog box. (See *Figure 12.40*.)

   Figure 12.40 *Navigation Window Right-Click Menu*

   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 12.41*.)

   Figure 12.41 *Move To Position Dialog Box*



   d. Click **OK** to rotate the stage and close the dialog box. (See *Figure 12.41*.)

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 on the Calibration icon to open the Calibration screen.

11. From the **Calibrations** screen, choose **Step Height…** (See *Figure 12.42*.) The **Step Height Calibration Options** dialog box appears in the center of the window. (See *Figure 12.43*.)

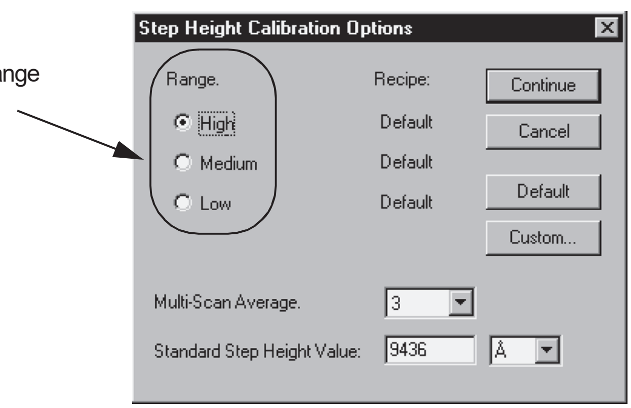
Figure 12.42 *Calibration Menu in the Calibration Screen*

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 12.43.) If using the **Low** range, the step limit should be 3.5 µm or less, if using the **Medium** range, the step limit should be 13 µm or less, and if using the **High** range, the step limit should be 65 µm or less.

Figure 12.43 *Step Height Calibration Options Dialog Box*

Step 12 Choose the range that is to be calibrated.

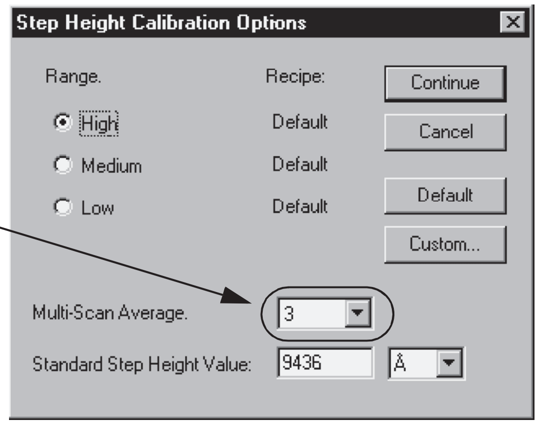


13. ***Multi-Scan Average***: This determines the number of times the profiler scans the same feature during each scan procedure. Data from all scans are automatically averaged and their average is presented as the scan result. Click on the down-arrow next to the **Multi-Scan Average** value box to display the menu.

    Select the number of scans per calibration from the drop-down menu. (See *Figure 12.44* below.) The value should be at least 3, with 5 being optimum.

***Figure 12.44** Multi-Scan Average Option*

Step 13 Click on the down arrow to display the menu. Choose the number of scans per calibration.

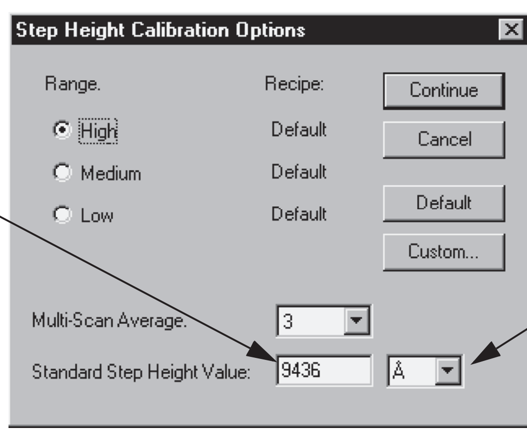


14. ***Standard Step Height Value**:* Enter the nominal step height value, for the standard being used, into the Standard Step Height Value field. Select the correct units from those available in the drop-down list to the right. See the circled area in *Figure 12.45*.

NOTE: Units in **Å** correspond to recipes for VLSI Thin Film standards; units in µ**m** correspond to the longer scan VLSI Thick Film standards.

***Figure 12.45** Setting Standard Step Height Value*

Step 14 The step height standard being used should have an absolute height value on it. Double-click on 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 on the menu-arrow and click on 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.

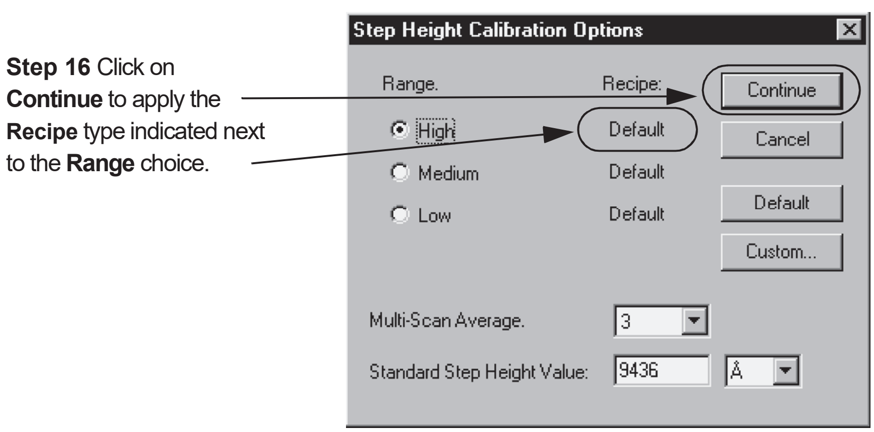
The system provides both default and customizable calibration recipes for each of the three ranges. When a range is chosen, either the Default or a Custom recipe can be used to perform the calibration. The currently applied calibration recipe is displayed to the right of the chosen range. If nothing 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.

> **CAUTION:** In Low Force Head systems, the Default recipe for the short scan (6.5 µm) should be used for systems operating with the DuraSharp stylus. This stylus requires a slow scan speed to protect its tip. If using a DuraSharp tip, do not modify a custom recipe scan speed to operate at faster than the recommended 10 µm/second (5 µm/sec is best), to protect this delicate stylus.

16. To proceed with the calibration using the recipe indicated to the right of the range (Default or Custom), click **Continue**. (See *Figure 12.46*.)

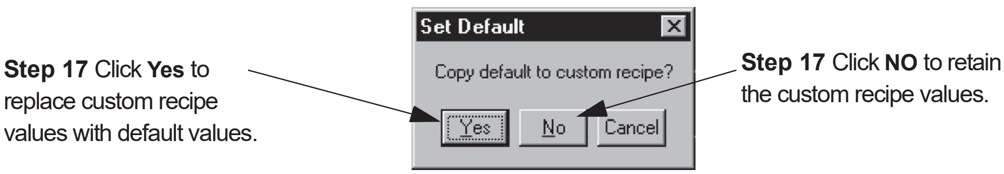
Figure 12.46 *Confirming the Displayed Calibration Recipe*



Default Recipe Option

17. To apply the Default recipe when "Custom" is indicated, click on **Default**. (See the circled areas in *Figure 12.48*.) The message, "Copy Default to Custom recipe?" appears. (See *Figure 12.47*.) Clicking on **Yes** replaces the parameters in the Custom recipe with Default values. Clicking **No** retains the current Custom value.

Figure 12.47 *"Copy default to custom recipe?" Message*



Custom Recipe Option

18. To apply a Custom recipe when "Default" is indicated or to modify the Custom recipe that is indicated, click on **Custom...** (See the circled areas in *Figure 12.49*.) The **Recipe Editor** opens, displaying the parameters for the custom recipe. A custom recipe for each Range is already in the Scan Recipe Catalog File with a name representing the recipe; _STEPHTL for **L**ow step; _STEPHTM for **M**edium step; and _STEPHTH for **H**igh step. (The procedure continues *on page 12-36*.)

Figure 12.48 *Changing the Calibration Recipe Option to Default*

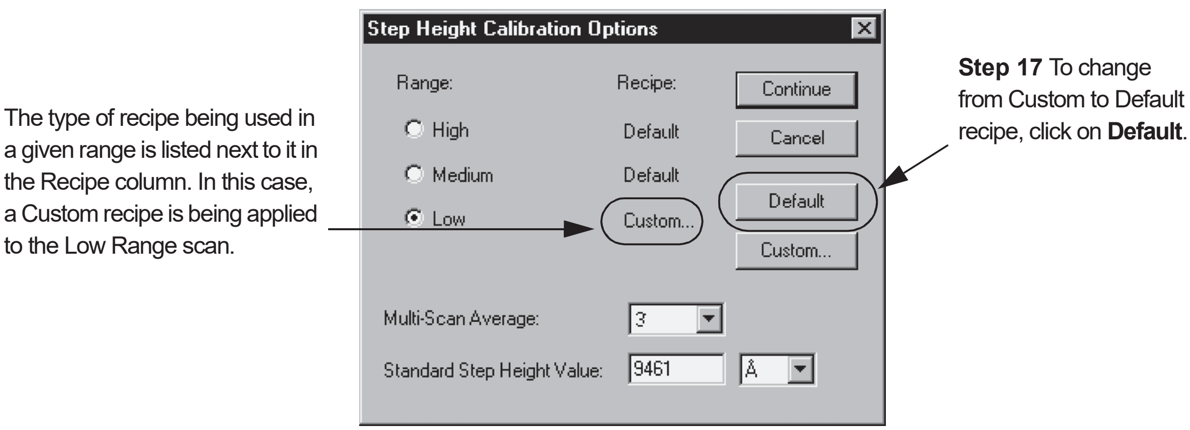
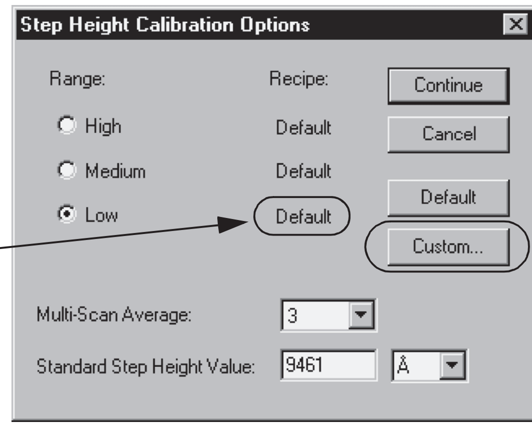


Figure 12.49 *Changing the Calibration Recipe Option to Custom*



The type of recipe being used in a given range is listed next to it in the Recipe column. In this case, a Default recipe is being applied to the Low Range scan.

Step 18 To change from **Default** to a **Custom** recipe, or to modify the current recipe, click **Custom…**

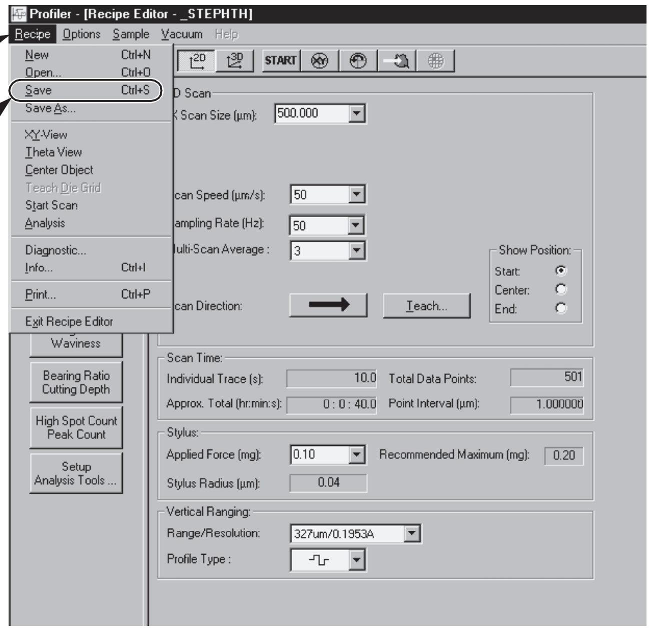
19. The parameters that can be modified are included in the Recipe Editor screen. (See *Figure 12.50*.) Each recipe, including the Default, has a specific name that is included in the Scan Recipes screen under the 2D recipe catalog. Custom recipes can be modified to meet special scan requirements including custom calibration scans. If the Default recipe is not going to be used, great care should be taken to modify only those parameters absolutely necessary to provide the best step height calibration

CAUTION: Step Height Calibration is a critical procedure, vital to future process scan integrity. Do not modify the calibration recipe parameters without understanding the consequences of such modification. Only parameters included in the **Step Height Calibration Options** dialog box are used for the calibration.

***Figure 12.50** Recipe Editor for _STEPHTL*

Step 20 From the **Recipe** drop-down menu, click on **Save**.

Step 21 Choose **Save**.

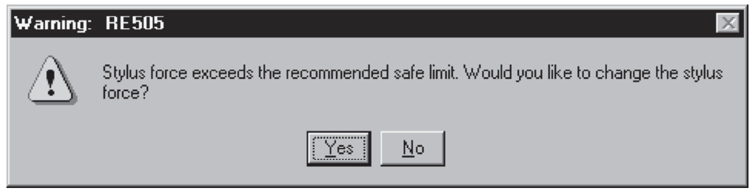


The parameters that can be modified for the scan calibration are: Scan Length; Scan Speed; Sampling Rate; Multi-Scan Average; Stylus Force; Contact Speed; Range/Resolution; and Profile Type.

- **Range/Resolution** and **Multi-Scan Averaging** should have already been set in the **Step Height Calibration Options**. There should be no need to change these in this screen. Range/Resolution is not available for change at this point in the procedure.
- **Profile Type** only contains options for the High (131 µm/0.357Å) Range. Both of the other ranges have only one profile type available.
- **Scan Speed** can be changed. If the speed is increased, the accuracy could suffer. The Step Height Calibration is critical to scan data accuracy. If the speed is set at a higher rate than the Default value, the number in the **Multi-Scan Average** should also be set to at least 5.
- When using the DuraSharp tip (not recommended for P-15), the Scan Speed defaults to 5 µm/s and the associated drop-down menu contains only 2, 5, and 10 µm/s options.
- **Scan Length** should reflect about 200 µm on each side of the step.
- **Stylus Force** should never be set higher than the recommended value (indicated next to the box containing the current value.) If it is set too high, a message box might appear that prompts the user to consider changing back to within the safe force limits. (See *Figure 12.51*.)

  This should not be a problem if the recommended 2 µm stylus is used.

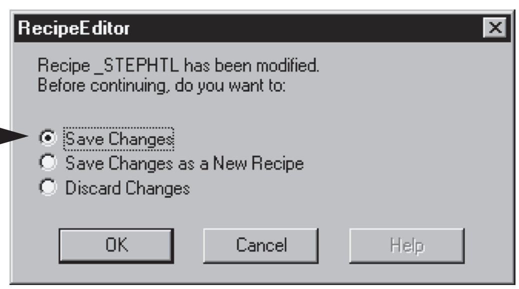
Figure 12.51 *Stylus Force Change Message*



20. When the required modifications to the recipe have been completed, click **Recipe** in the menu bar to display the menu.
21. Choose **Save** from the drop-down menu. (See *Figure 12.50*.)
22. To close the Recipe Editor, first click on the control button at the top left corner of the screen to display its menu.
23. If the recipe was not saved, and **Exit** is chosen from the control button drop-down menu, a dialog box opens requesting a decision on the changes made to the recipe. Choose **Save Changes** to save the changes so they can be used in the Step Height Calibration. (See *Figure 12.52*.)

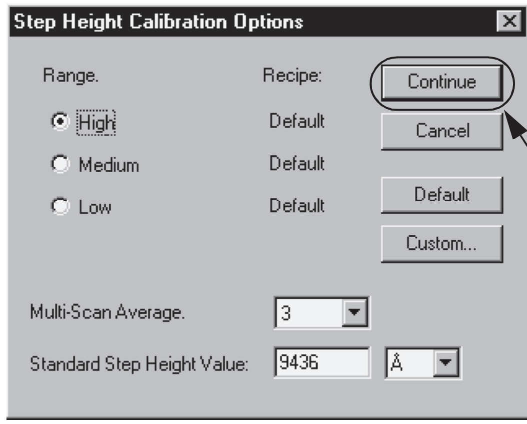
Figure 12.52 *Recipe Editor - Saving Recipe Changes*

Step 23 Click on the radio button next to **Save Changes** then on **OK** so the new parameters are in effect for the Step Height Calibration.



24. After the modifications to the recipe are saved, the **Step Height Calibration Options** dialog box appears again. Click on **Continue**. (See *Figure 12.53*.) This displays the **Step Height Calibration** screen.

***Figure 12.53** Completing the Options Selection*



Step 24 After all modifications have been saved, click **Continue** to proceed to the **Calibration** screen for the Step Height Calibration scan.

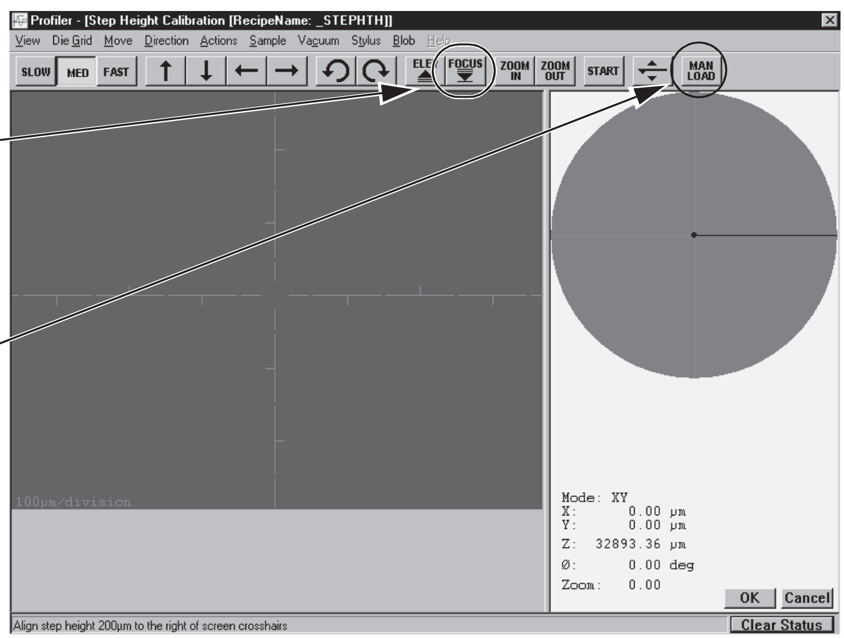
25. Click on **FOCUS** to null the stylus near the VLSI Step Height Standard surface and bring the standard into focus. (See *Figure 12.54*.)

***Figure 12.54** Loading the Step Height Calibration Standard*

Step 25 After the Step Height Calibration Standard has been placed on the stage and the stage centered under the stylus, Click **FOCUS** to null the stylus.

Step 3 Click on **MAN LOAD** to move the stage to the open door.

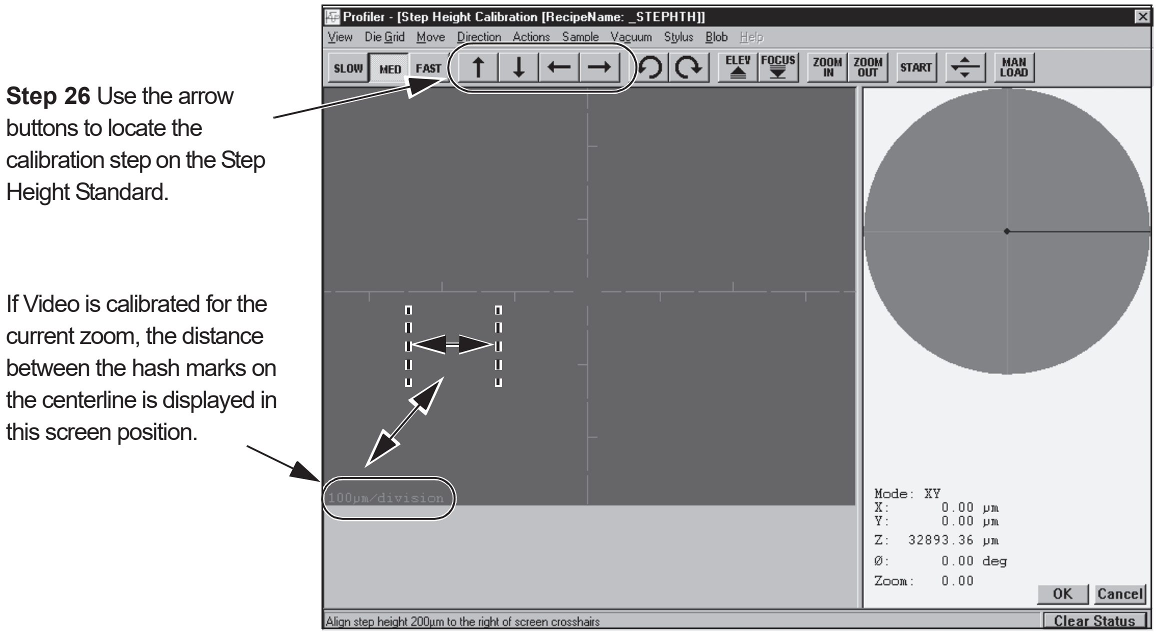
Step 8 After the Step Height Calibration Standard is centered on the stage, click **MAN LOAD** to send the stage back under the stylus.



26. 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. (See *Figure 12.55*.)

Figure 12.55 *Step Height Calibration Window*

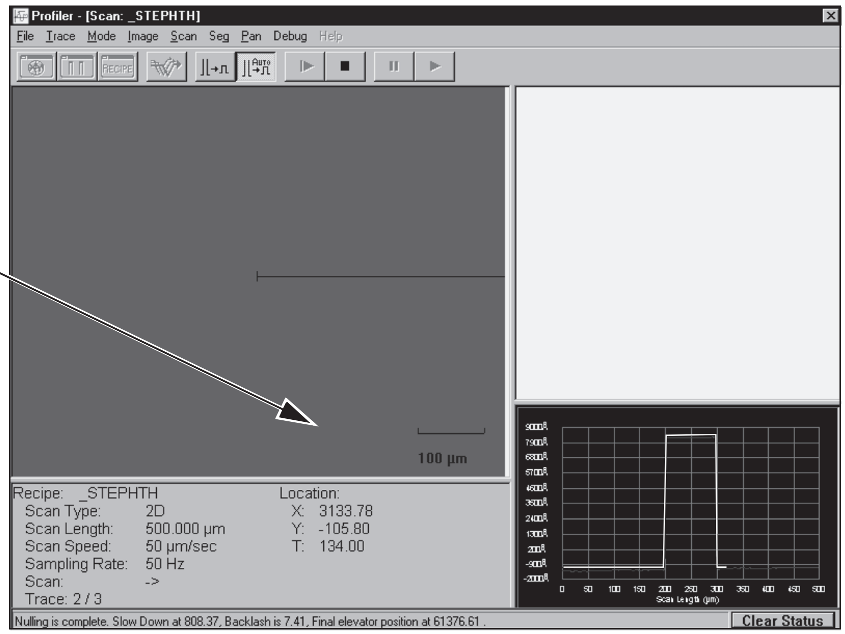


27. Position the crosshair about 200 µm from the left side of the step and click **OK** (at the bottom right of the screen), or click **Start** in the tool bar. The instrument performs the same scan through the exact same location as many times as prescribed in the recipe (the **Multi-Scan Average on** *page 12-32*, set in the **Step Height Calibration Options** dialog box, *Figure 12.44*).
28. 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. (See *Figure 12.56*.)

29. 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 -32.)

Figure 12.56 *Step Height Scan Screen*

Each trace appears in the scan screen, presented in a different color.



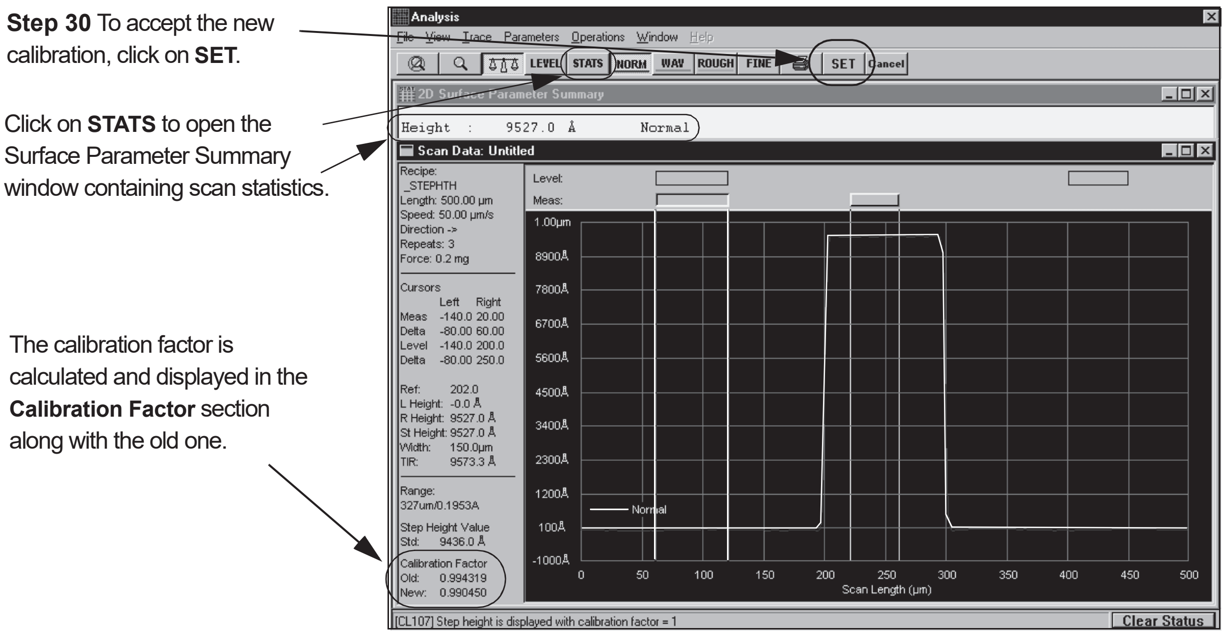
When complete, the calibration factor is automatically calculated and displayed at the end of the information area of the Analysis window. (See the circled area at the bottom left in *Figure 12.57*.)

The calibration factor is displayed with the last calibration factor. Both should be close. See the circled area at the bottom left of *Figure 12.57*.

To compare the step height standard value with the averaged measured height, click on 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 12.57*.

30. Click on 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 12.57*.)

Figure 12.57 *Saving the New Calibration*



31. 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.

LEVEL CALIBRATION

Check the Calibration Matrix on *page 12-51* for possible interaction with other 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 that is difficult to locate. 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-15.

The Level calibration should be performed whenever one of the listed conditions arise:

- Removing and replacing the carriage
- Changing the reference flat
- Replace motorized stage
- Replacing the leveling motor
- System does not complete the initialization procedure.

When performing this calibration, use a Contact Mode stylus, preferably a 2 µm tip, that has been properly installed using the Stylus Replacement procedure. For information on changing the stylus, see Chapter 4 *Stylus Change Procedure* on page 4-1.

CAUTION: Be sure that the system is using a sturdy stylus.

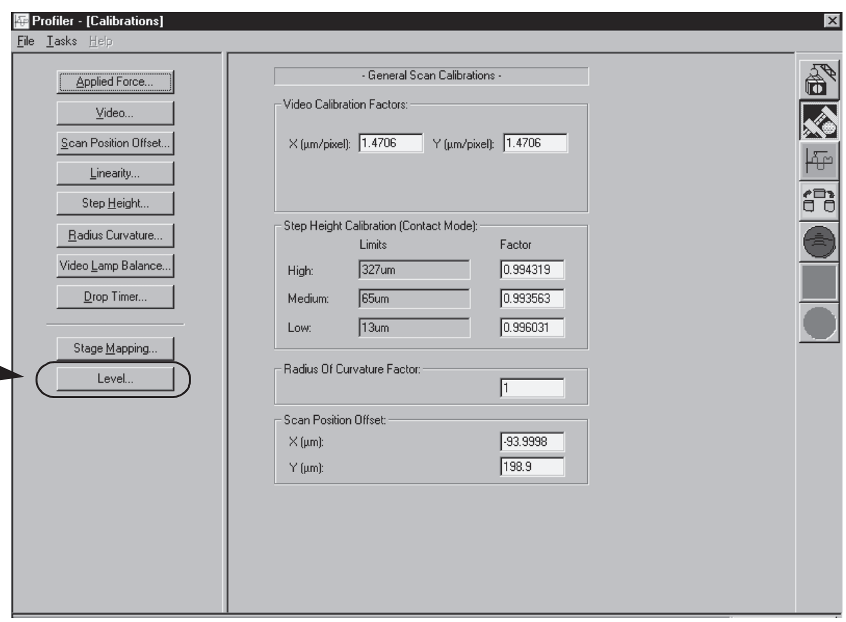
Level Calibration Procedure

Check the Calibration Matrix on *page 12-51* for possible interaction with other calibrations.

1. From from any top level screen, click on the **Calibrations** icon .
2. Click **Level...** to open the Level Calibration screen.

Figure 12.58 *Calibration Screen*

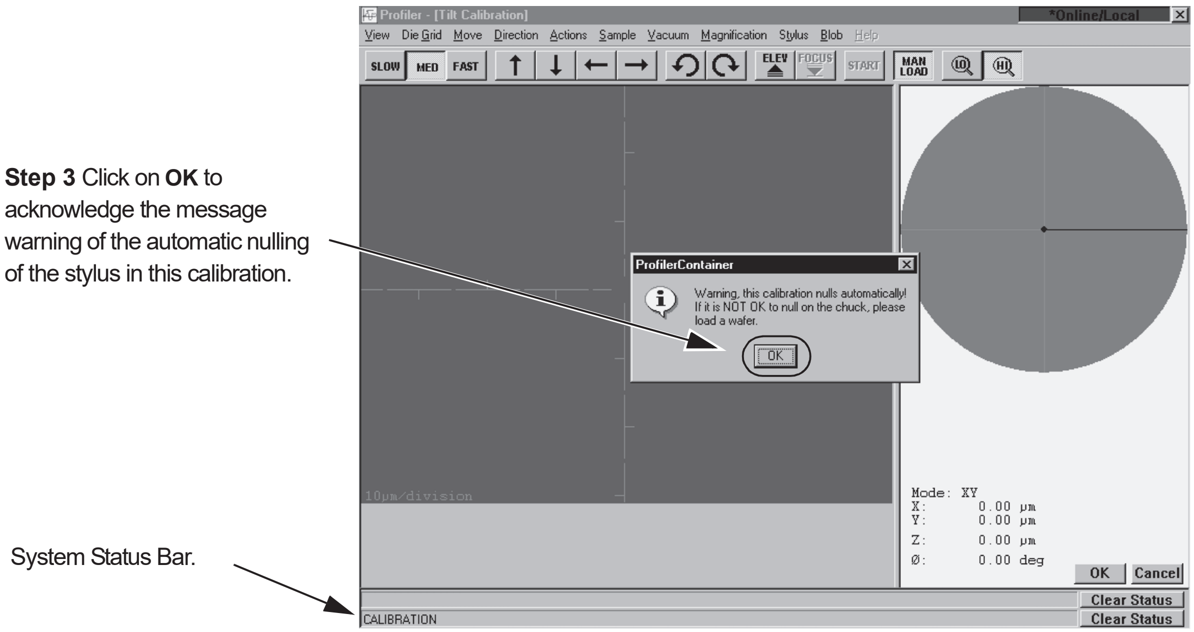
Step 2 Click **Level...** to open the calibration screen.



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 12.59*.)

   Read the message and click **OK** to close the message box. (See *Figure 12.59*.)

Figure 12.59 *Level Calibration Warning*



4. After the warning message is acknowledged, a message is displayed (see *Figure 12.60*) in the system status bar at the bottom left of the screen as pointed out in *Figure 12.59*. The message requests the user to load a 200 mm wafer onto the stage then click the **OK** button. See the following wafer loading procedures.

Figure 12.60 *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.
10. Click **MAN LOAD** to move the stage back under the optics.

End: Load Wafer Manually

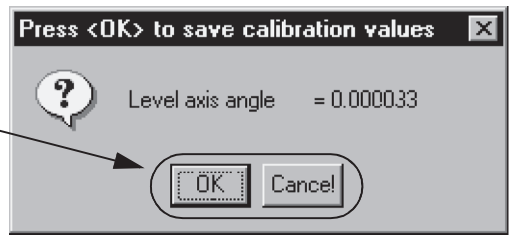
11. Click **OK** to begin the calibration.

    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 12.61*.)

Figure 12.61 *Tilt Axis Angle Calibration Value Dialog Box*

Step 12 Click **OK** to accept the Level calibration value, or **Cancel** to reject it.

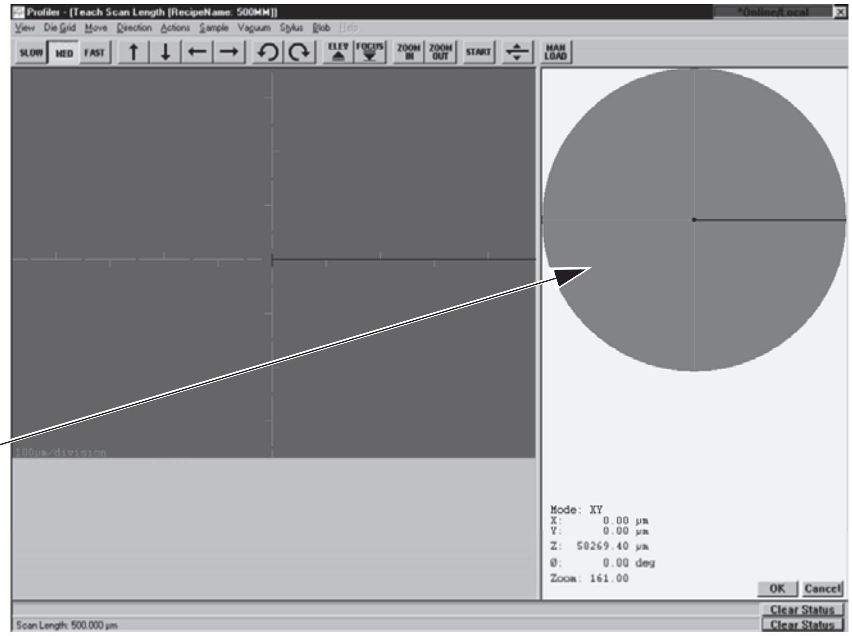


Level Calibration Confirmation

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 12.62*.)

Figure 12.62 *Activating Focus in the XY VIEW Screen*

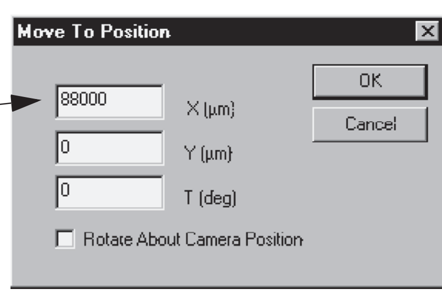


2. Right-click in the navigation window to display the Move Menu. (See *Figure 12.63*.)
3. From the Move Menu choose **Move To…** (See *Figure 12.63*.)

Figure 12.63 *Move To Menu*

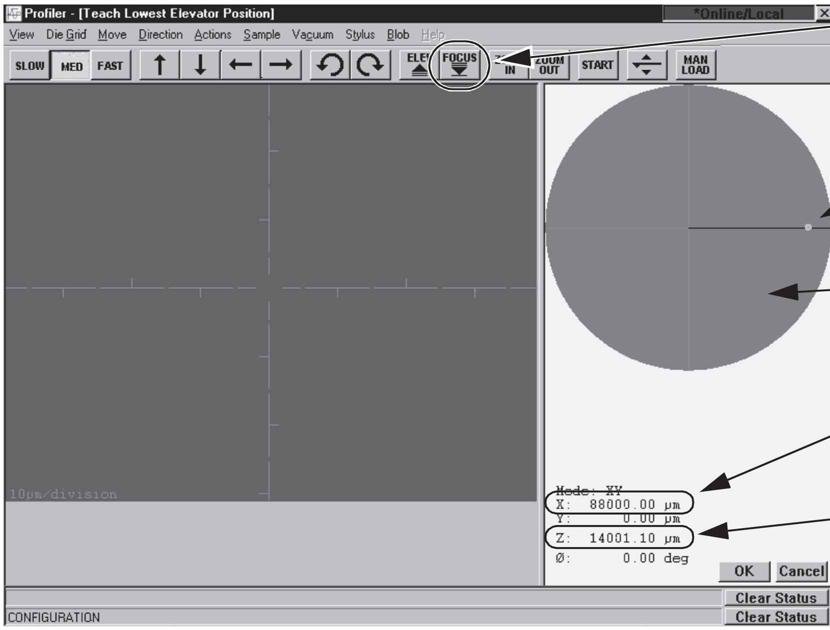
4. The Move To Position dialog box opens. Leave the Y and T fields empty and enter **88000** in the **X** field. (See *Figure 12.64*.) This positions the stylus at the right side of the stage as shown in *Figure 12.65*.

Figure 12.64 *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 12.64*.)

Figure 12.65 *Teach Lowest Elevator Position Screen*



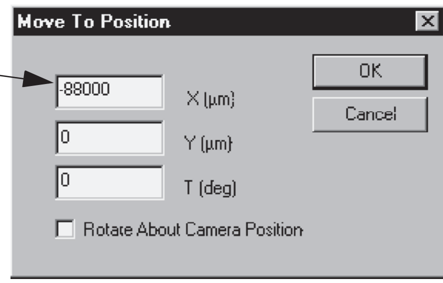
6. After the stylus is in position, click on **FOCUS** to null the stylus near the back of wafer. (See *Figure 12.65*.)
7. When the focus procedure is complete, record the **Z** value as indicated in the lower right corner of the screen. (See *Figure 12.65*.)
8. Right-click in the navigation window to display the Move Menu.
9. From the Move Menu choose **Move To…** (See *Figure 12.66*.)

Figure 12.66 *Move To Menu*

10. The Move To Position dialog box opens. Leave the Y and T fields empty and enter **-88000** in the **X** field. (See *Figure 12.67*.)

Figure 12.67 *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 12.67*.) 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 12.65*.)
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.

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-15 does not use a handler, so this is only effective if the system has a precision locator for wafer alignment.

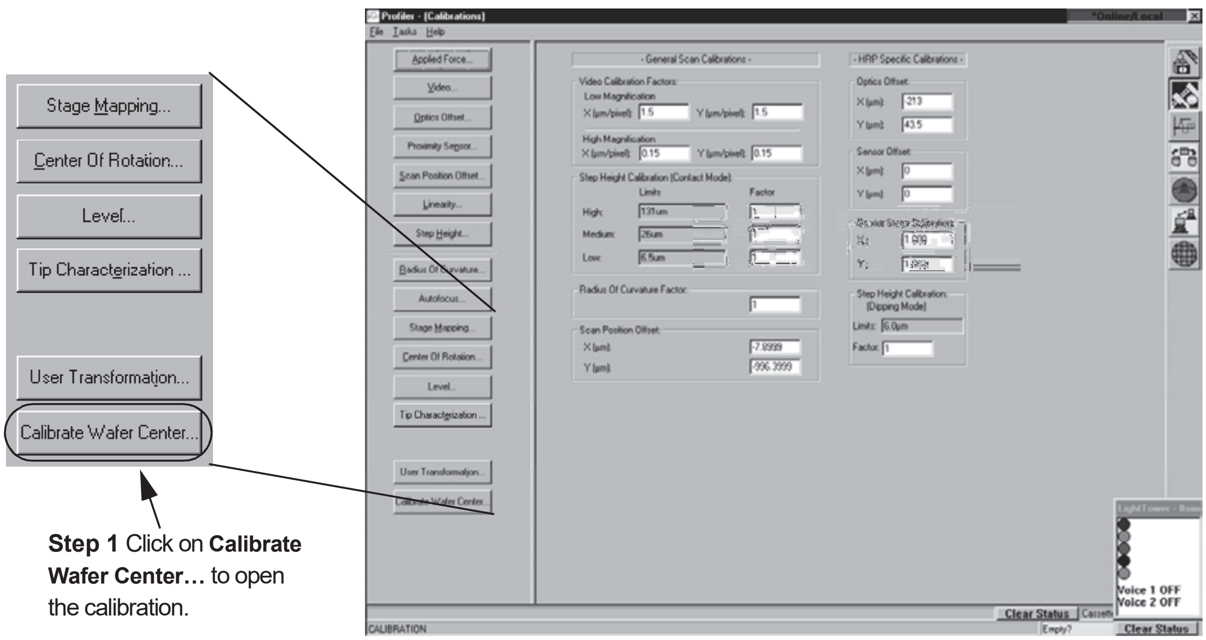
Calibration Procedure

Before performing the Calibrate Wafer Center calibration, all system calibrations must be current, including the Center of Rotation and Stage Mapping calibrations. 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 on Calibrate Wafer Center button.

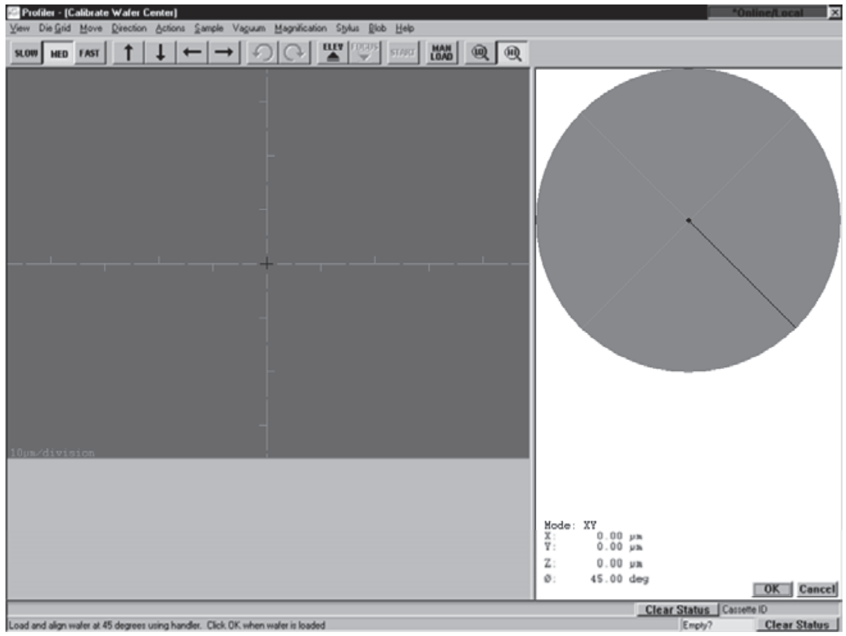
NOTE: The user must be logged in under the proper security level to access the **Calibrate Wafer Center** calibration. Without the correct level, the calibration might be missing from the menu or grayed out.

Figure 12.68 *Calibration Screen*



The user is prompted to load a wafer. The user selects the cassette and slot that the wafer is to be taken from as well as setting the load angle to 45°.

Figure 12.69 *Wafer Center Calibration Screen*



2. Load a wafer on the precision locator.
3. Click **OK** after the wafer is loaded.

   The system moves the wafer to until its edge is under the optics. When the stage stops, the system focuses on a point near the wafer edge.
4. Align the wafer edge with the screen crosshair as prompted by the system. If the edge is not in sight, move the stage to the right using the right arrow button in the toolbar. Align the left wafer edge with the screen crosshairs.
5. Click **OK**.
6. The stage moves to a point near the right wafer edge and the system focuses on the wafer surface. The user is prompted to align the wafer edge with the screen crosshairs.
7. Align the right wafer edge with the screen crosshairs. Use the left-arrow button in the tool bar to move the wafer edge into alignment with the screen crosshairs. (In necessary, use the Slow speed for the arrow button movement to accurately position the edge of the wafer at the screen crosshairs.)
8. Click **OK** to accept the position.
9. Click **OK**.

   The system positions the top of wafer under the optics and focuses. The user is prompted to position the top edge of the wafer at the screen crosshairs.

10. For all tools: Align the top wafer edge with the screen crosshairs. Use the down-arrow button in the tool bar to move the wafer's top edge into alignment with the screen crosshairs. (In necessary, use the Slow speed for the arrow button movement to accurately position the top edge of the wafer at the screen crosshairs.)
11. Click **OK**.

    The system positions the bottom of wafer under the optics and focuses. The user is prompted to position the bottom edge of the wafer at the screen crosshairs.

12. Align the bottom wafer edge with the screen crosshairs. Use the up-arrow button in the tool bar to move the wafer's bottom edge into alignment with the screen crosshairs. (In necessary, use the Slow speed for the arrow button movement to accurately position the bottom edge of the wafer at the screen crosshairs.)

Stage to Wafer Conversion

As a result of the system converting to using the wafer center instead of the stage center as a reference point, all sequence recipes created before the conversion (i.e., before the "Calibrate Wafer Center" calibration) become inaccurate. They must be converted to the wafer center system in order to perform correctly. The Calibrate Wafer Center Calibration adds an offset from the stage coordinate to the wafer coordinates.

The Stage to Wafer calibration should only be performed after the Center of Wafer calibration is performed and prior to any new recipes being created. If only new recipes (recipes created after the Calibrate Wafer Center calibration) are to be used, the conversion is optional.

NOTE: This procedure can only be performed once.

Calibration Procedure

1. From Windows Explorer, run
   <Drive where Eagle is located>:\eagle\exe\StagetoWafer.exe
2. User is warned to back up recipes before proceeding.

   Backup is advised. Use the Pbackup procedure.

3. Click **Proceed**. All sequence recipes are automatically converted.

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 12.2 *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	Fine Scan Position Offset Calibration	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.
Linearity	Applied Force	Step Height	Linearity ensures that a sensor that has been calibrated using only one step height standard can accurately measure other values. For example, a sensor calibrated with a 24 µm standard should accurately measure a 100 µm step.
Step Height	Applied Force, Linearity, 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.
Pulse Ratio	Applied Force, Video, Center of Rotation	none	Calibrates the stage movement distance to match the move distance requested by the user. All previously taught sites in a sequences become invalidated (are slightly off from their original position.)
Stage Mapping	Applied Force, Video, Center of Rotation, Pulse ratio	none	Enhances accuracy of movement between identical positions in a die grid. All previously taught sites in a sequences become invalidated (are slightly off from their original position.)
Level	Applied Force	none	Scans in excess of 1000 µm are more level. 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	

13

GEM/SECS OPTION

INTRODUCTION

The GEM/SECS option is designed for environments in which the system is controlled by, or requires communication with a remote Host computer. GEM/SECS also provides a communication link with the Host for receiving and sending process programs (recipes).

This chapter includes:

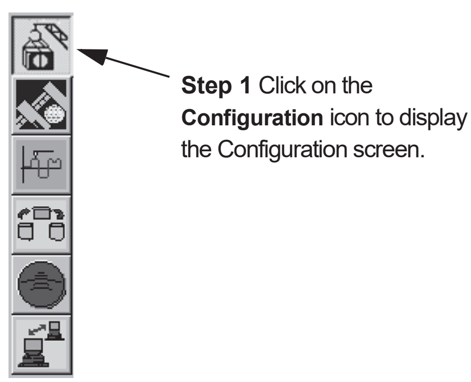
- *Establishing GEM/SECS Communication*
- *Using the GEM/SECS Application*
- *GEM/SECS Configuration Options*
- *GEM Status Window*

ESTABLISHING GEM/SECS COMMUNICATION

Communication between the system and the Host computer is established through the GEM/SECS program. Use the following procedure to open the GEM/SECS link between the system and the Host:

1. From any top level screen, click the **Configuration** icon. (See *Figure 13.1*.)

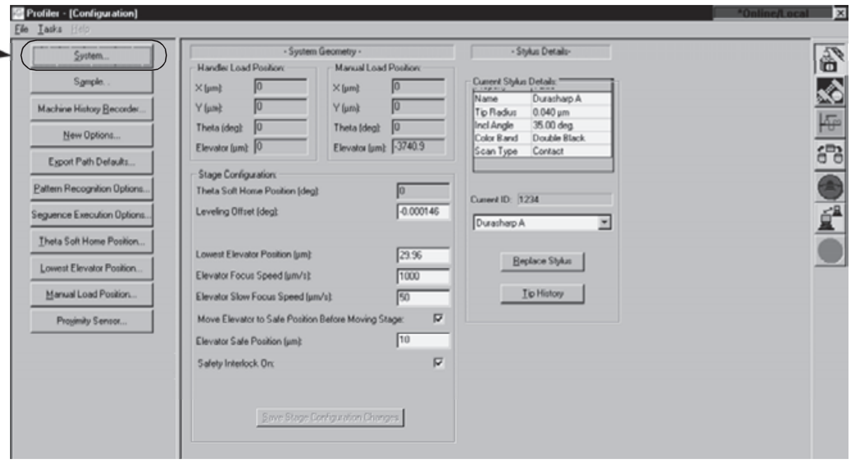
Figure 13.1 *Database File Manager Icon Choice*



2. This brings up the **Configuration** window. To display the **Machine Configuration** dialog box:, click **System…** (circled in *Figure 13.2*).

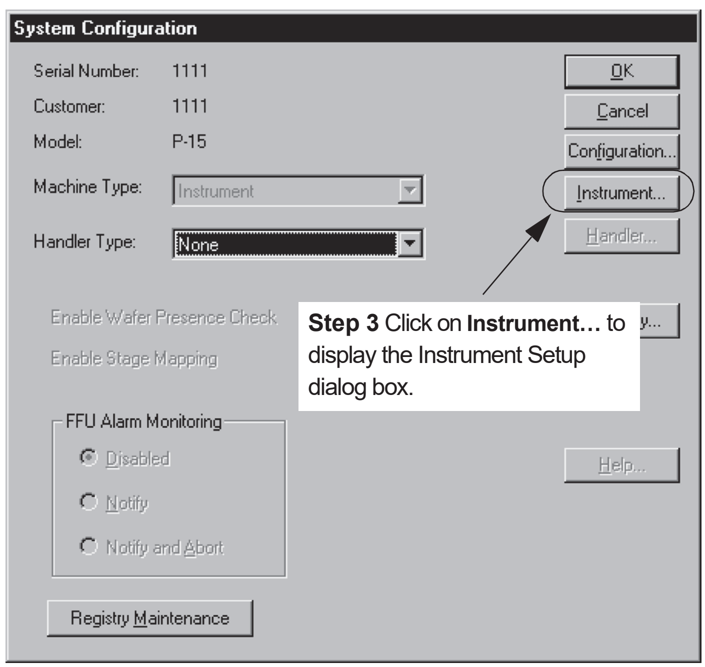
Figure 13.2 *Configuration Screen*

Step 2 Click on the **System…** button to select System Configuration.



3. This brings up the **System Configuration** dialog box. (See *Figure 13.3*.) From the **System Configuration** dialog box, choose **Instrument…** (circled in *Figure 13.3*). This brings up the **Instrument Setup** dialog box. (See *Figure 13.3*.)

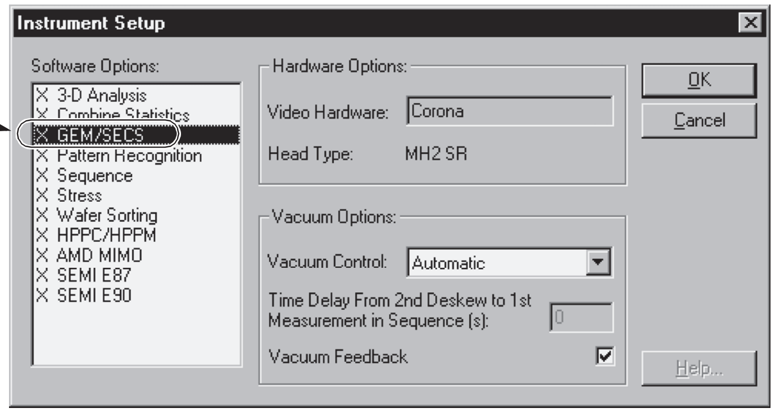
Figure 13.3 *Machine Configuration Dialog box*



4. To activate automatic GEM/SECS connection when the system is booted up: from the **Instrument Setup** dialog box, double-click on the check box next to GEM/SECS (circled in *Figure 13.4*). The Instrument Setup dialog box contains a list of all purchased system options. An **X** next to the option name indicates that it has been chosen to be active. Click in the empty column next to GEM/SECS to put an X next to it. The system is now set up to initiate the GEM/SECS connection every time the system is booted up. (See *Figure 13.4*.)

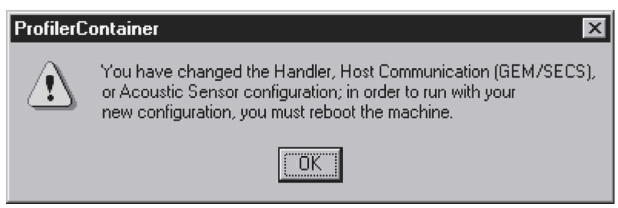
Figure 13.4 *Instrument Setup Dialog Box*

Step 4 Double-click on the box next to GEM/SECS. An X appears when it is chosen.



5. Click on **OK** to set the change and close the dialog box.
6. A message box appears instructing the user to restart the system. GEM/SECS is not activated unless the system is restarted. (See *Figure 13.5*.)

Figure 13.5 *Configuration Warning*



NOTE: A Message Box appears instructing the user to reboot the system. This must be done to ensure proper GEM/SECS connection.

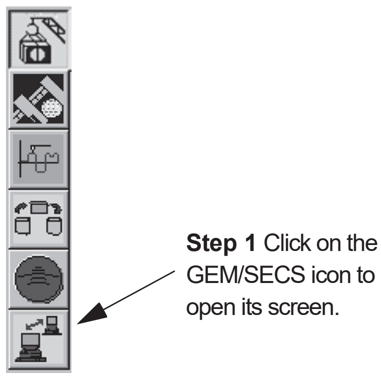
7. Use the same procedure described above (except that the check box should be **empty**), to **deactivate** the automatic connection of GEM/SECS each time the system is booted up.

Enabling GEM/SECS from the GEM User Interface Screen

1. If the GEM+SECS option in the **Instrument Setup** dialog box is enabled, then it is possible to activate GEM/SECS using the **GEM User Interface** screen.

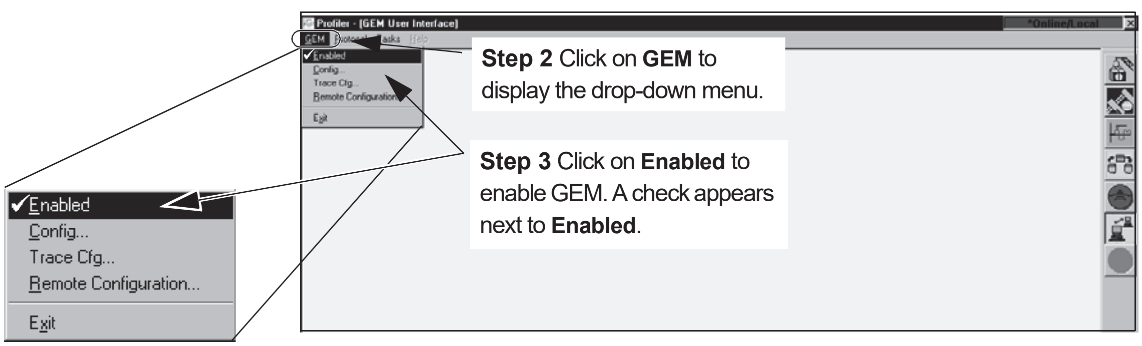
   From any top level screen, click on the **GEM+SECS** icon. (See *Figure 13.6*.)

   Figure 13.6 *Configuration Screen – Opening GEM/SECS Communication*



2. Open the **GEM User Interface** screen. From the **GEM User Interface** dialog box, click on **GEM**, located at the top left of the screen (indicated in *Figure 13.7*).
3. In the drop-down menu, click on **Enabled** to enable GEM/SECS. A check appears next to **Enabled** when GEM is running (illustrated in *Figure 13.7*).

   Figure 13.7 *GEM User Interface Screen (Top of Screen)*



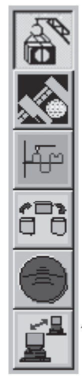
4. **Disabling** GEM/SECS is accomplished by clicking on **Enabled** when the check mark appears next to it. The check mark is absent when GEM/SECS is disabled.

USING THE GEM/SECS APPLICATION

The GEM/SECS application has functions that are accessed in different ways. Establishing the GEM/SECS communication link can be set up through both the **GEM User Interface** and **Configuration** screens. GEM/SECS configuration is accessed through the **GEM** drop-down menu in the **GEM User Interface** screen. Message TTY communication with the Host, using GEM/SECS, is accomplished through the **GEM Status** window.

1. To access the **GEM User Interface** screen from any top level screen, click on the **GEM+SECS** icon. (See *Figure 13.6*.)

Figure 13.8 *Configuration Screen – Opening GEM/SECS Communication*



2. From the GEM User Interface screen, click on GEM at the top left of the screen, to access the drop-down menu (indicated in *Figure 13.9*).

Figure 13.9 *GEM User Interface Screen*

3. Choose the required option.

   Four options are available in the drop-down menu. The first is the Enable/Disable option, and has already been discussed in *Enabling GEM/SECS from the GEM User Interface Screen* on page 13-4. The other three are discussed in the following sections.

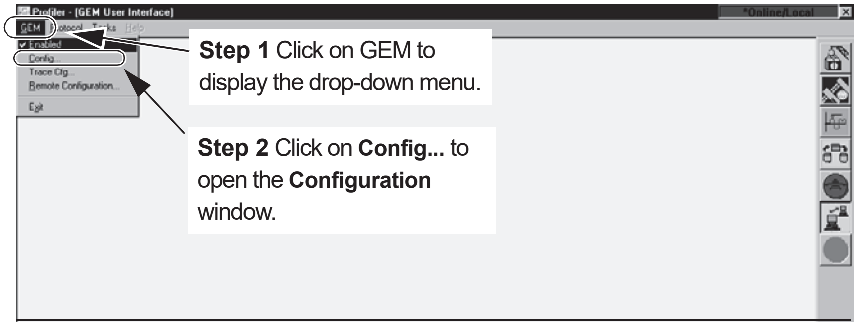
GEM/SECS Configuration Options

These options should only be exercised by those totally familiar with the GEM+SECS operation. The function definition for each of the configurable states is set by **Semi Standard E30**. Refer to that document for any questions regarding GEM+SECS communication. Use the following procedure to configure the GEM/SECS options:

1. From the **GEM User Interface** screen, click on **GEM** to display its menu.

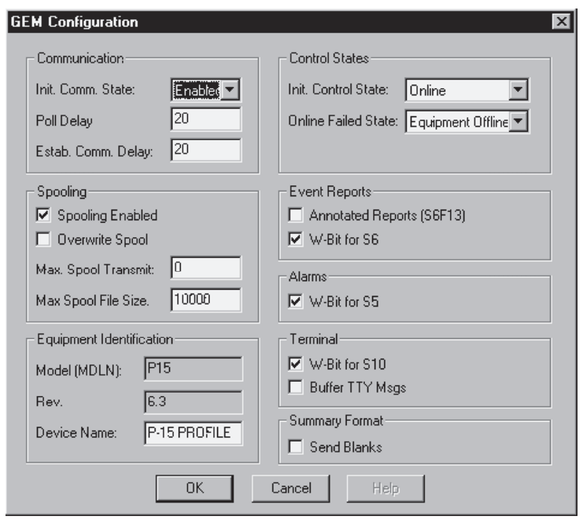
2. From the GEM menu click on **Config...** to display the **Configuration** window.

Figure 13.10 GEM User Interface Screen



The **Configuration** screen is displayed as shown in *Figure 13.11*.

Figure 13.11 Configuration Screen



The GEM Configuration window has seven category boxes containing GEM related options and control information. This section provides user interface information on four of the categories:

- Communication
- Spooling
- Control States
- Equipment Identification.

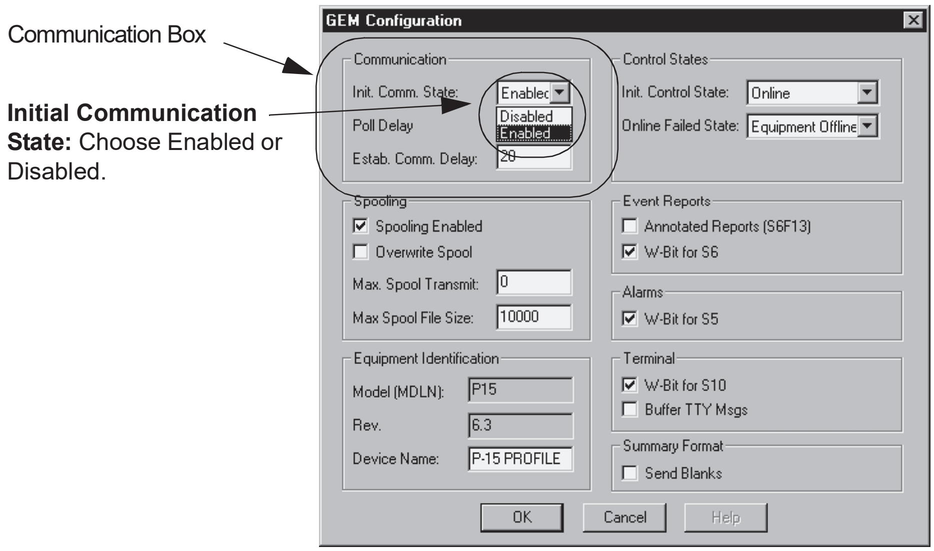
Communication Configuration Options

The Communication box deals with establishing and continuing the communication link between the system and the Host computer. The communication link establishes the ability of the system and Host to send and receive messages.

Initial Communication State

In the **Communication** box, **Init. Comm. State:**, determines the initial communication link status between the system and the Host when the system is booted up. (See *Figure 13.12*.)

Figure 13.12 *Communication Option - Initial Communication States*



From the drop-down menu, choose the desired option. The selected option appears in the field. (See *Figure 13.12*.)

- **Enabled:** This means that when the system is booted up, it attempts to initiate a link between itself and the Host computer.
- **Disabled:** This means that when the system is booted up, it does not attempt to initiate a link between itself and the Host computer.

NOTE: After boot up, once the system initialization is complete, the initial communication state can be overridden using the GEM drop-down menu in the GEM User Interface screen. (See *Enabling GEM/SECS from the GEM User Interface Screen* on page 13-4.)

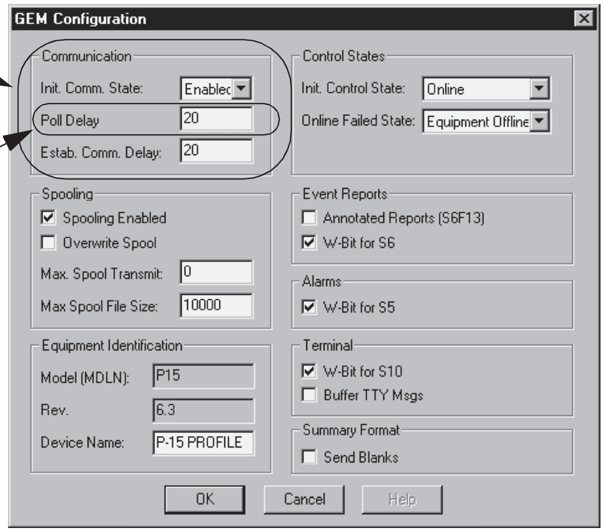
Poll Delay

The system continually checks to determine if the Host computer is still communicating with it. The number of seconds between these "**polls**" of the Host computer is indicated in this box. (See *Figure 13.13*.) This number should only be changed under the supervision of those responsible for GEM/SECS communication between the system and the Host.

Figure 13.13 *Communication Option - Poll Delay*

Communication Box

Poll Delay: To change the number, highlight the box, delete its contents and enter the new number.



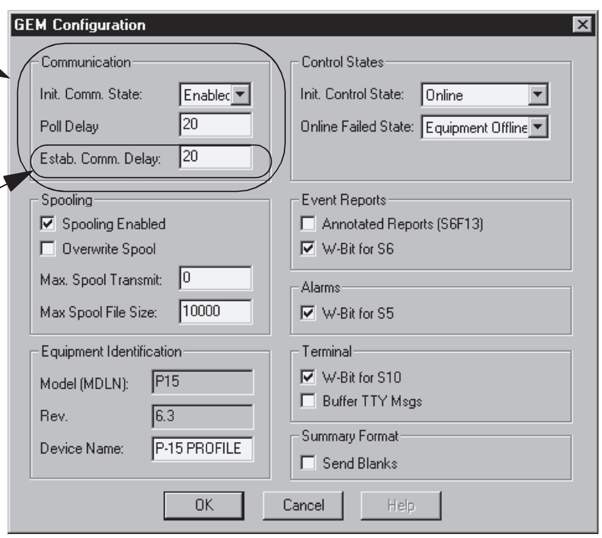
To change the number of seconds between "polling incidents," highlight and delete the current contents of the box. Type in the new "polling interval" in seconds.

Establish Communication Delay

Figure 13.14 *Communication Option - Poll Delay*

Communication Box

Estab. Comm. Delay: To change number, highlight the box, delete contents and enter new time.



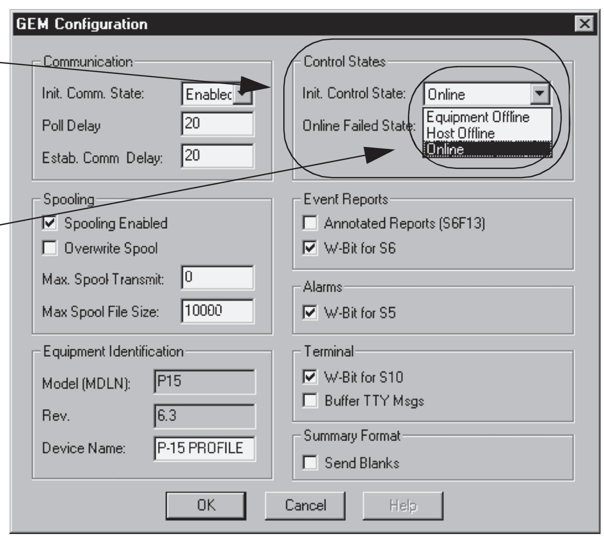
During the system initialization, if the **Init. Comm. State:** is set to **Enable**, the system attempts to establish a communication link between itself and the Host computer. If the link is not established immediately, it continues to attempt the link at intervals set in the **Estab. Comm. Delay**. This number should only be changed under the supervision of those responsible for GEM/SECS communication between the system and the Host.

To change the number of seconds between communication link attempts, highlight and delete the current contents of the box. Type in the new "link attempt interval" in seconds.

Control States

After a communication link is established between the system and the Host, the Online status can take the form of either ONLINE/REMOTE or ONLINE/LOCAL. Control of the system processing can be transferred from the system to the Host or remain with the system.

Figure 13.15 *Control States Option*



Initial Control State

If the Initial Communication State is set to Enabled (see *Initial Communication State* on page 13-7), then the system and the Host are set to be in communication with each other. This does not mean that the Host is controlling the system. For the Host to assume control of the processing at boot up time, **Init. Comm. States** must be set to **Enabled** and the **Control** must be set to **Online**.

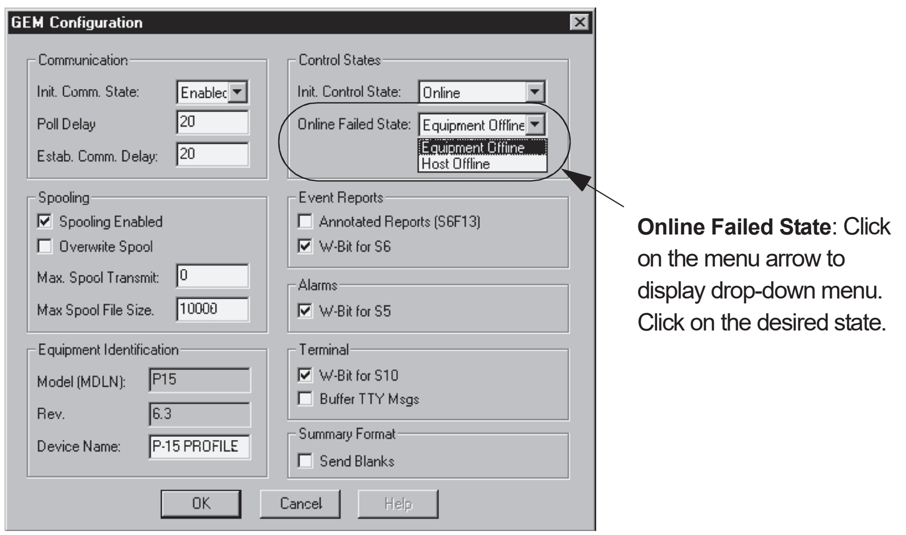
- **Online:** In this state, when the system is fully initilized, its activity is controlled by either the Host (ONLINE/REMOTE) or the system (ONLINE/LOCAL) according to preprogrammed parameters. To set this option, click the menu arrow next to the **Init. Control State:** interaction box. Click **Online**. (See *Figure 13.15*.)

- **Equipment Offline:** In this state, the system is being operated by the operator and not the Host. For allowable communication between Host and system while in this state, see Semi Standard E30. While in this state, the operator must initiate Online status. (See *Figure 13.15*.)
- **Host Offline:** In this state, the system is ready to accept Host interaction whenever the Host is responding. This state allows the system to continue operation while waiting for Host interaction. (See *Figure 13.15*.)

Online Failed State:

This setting establishes a default state in the event that Initial Communication was set to Online, and the Online status fails. If Online fails, the system automatically resets to the state chosen in the **Online Failed State** selection. (See *Figure 13.16*.)

Figure 13.16 *GEM Configuration - Online Failed State:*



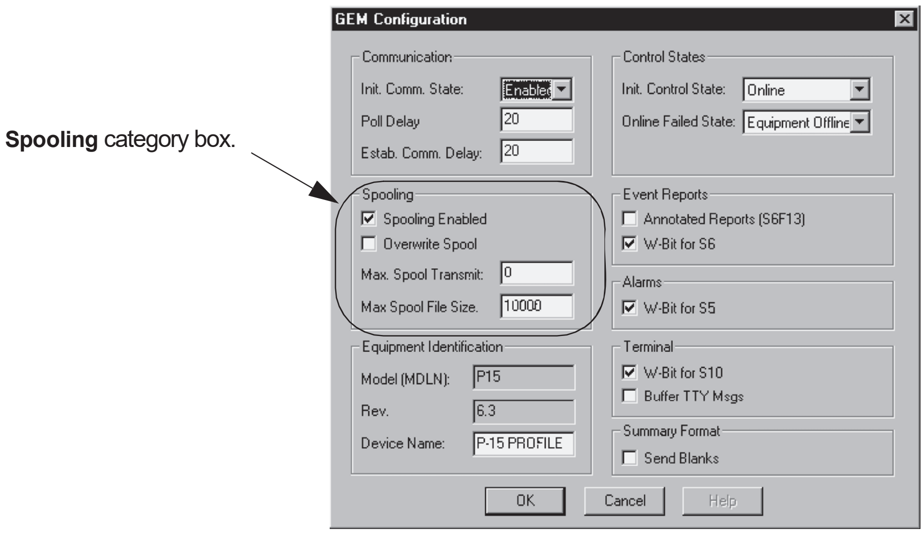
- **Equipment Offline**: With this setting, if the Online status fails, the system resets to Equipment Offline. In this state, the operator must initiate generation of the Online status.
- **Host Offline**: With this setting, if the Online status fails, the system resets to Host Offline. In this state, the system is open to initiation of the Online status from the Host.

Spooling

When enabled, spooling is activated during communication failure between the Host and the system. In the event of communication failure between the host and the system, the system no longer sends events to the host. When spooling is enabled, the events are written to a file. When the system is in this spooling mode, an asterisk (*) appears in the status bar. When communication is restored, the host must send an S6F23 (RSD) message to the system requesting that queued messages be purged or requesting that they be transmitted. After the host message is received, the asterisk is removed from the status bar.

When activated, this allows the system to queue messages intended for the host so they can be delivered when the communication is restored. (See *Figure 13.17*.)

Figure 13.17 *GEM Configuration - Spooling*



- **Spooling Enabled:**

  This option enables the spooling activity during periods of communication laps between the system and the Host. Click on the empty checkbox next to **Spooling Enabled** to enable this option. The **X** in the box enables the option. (See *Figure 13.17*.)

- **Overwrite Spool:**

  This option requires that **Spooling Enabled** is active (**X** in the checkbox). When activated, this option allows a full spool file to have its oldest messages overwritten with new messages. Click on the empty checkbox next to **Overwrite Spool** to enable this option. The **X** in the box indicates that the option is active. (See *Figure 13.17*.)

- **Max. Spool Transmit:**

  This is the maximum number of messages that can be sent in response to a S6F23 message from the Host. (See *Figure 13.17*.)

- **Max. Spool File Size:**

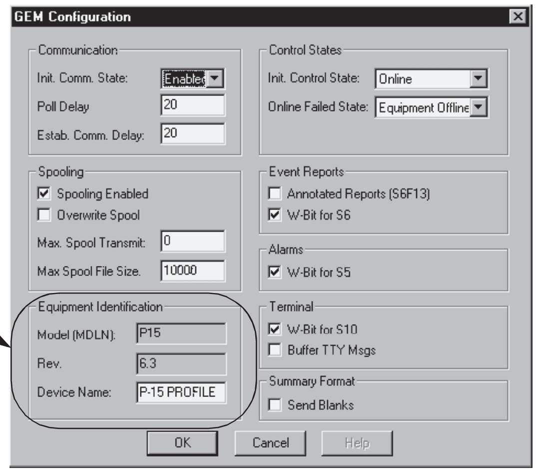
  This specifies the maximum size, in bytes, of the disk file that is used for the spool area. (See *Figure 13.17*.)

Equipment Identification

This information identifies the system, and the software being used to operate it. These fields are generated by the system when the software is loaded.

Figure 13.18 *GEM Configuration - Equipment Identification*

Equipment Identification category box.



- **Model (MDLN):**

  This field contains the model number (e.g., P-15). (See *Figure 13.18*.)

- **Rev.:**

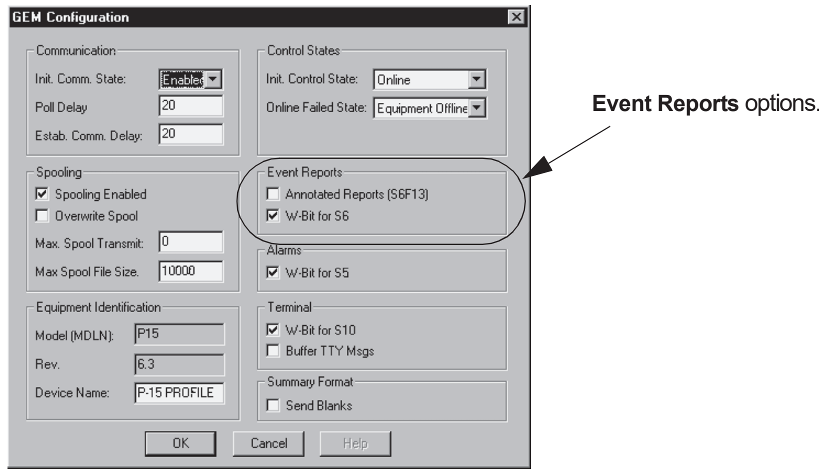
  This field contains the version number of the software operating the system. (See *Figure 13.18*.)

- **Device Name:**

  A default name is applied to the system by the system software when it is installed. The name can be changed by the host, at host discretion. (See *Figure 13.18*.)

Event Reports

Figure 13.19 *GEM Configuration - Event Reports*



- **Annotated Reports (S6F13):**

  This option provides annotation with the S6F13 event reports sent to the Host. (See *Figure 13.19*.)

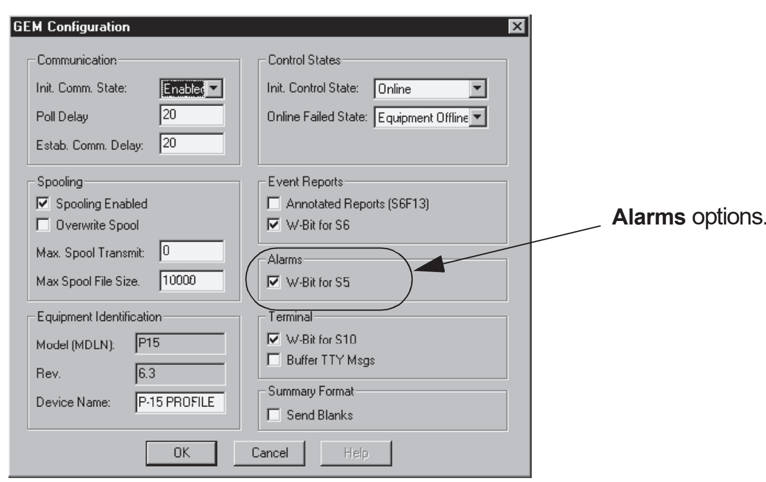
- **W-Bit for S6:**

  This option specifies whether S6 messages are to be sent to the Host with the **Wait Bit** set to **0** or **1**. If the check box contains an **X**, the Wait Bit is set to **1**. (See *Figure 13.19*.)

Alarms

This option sets the S5 Alarm message **Wait Bit** to either **0** or **1** for transmission to the Host. If the check box contains an **X**, the Wait Bit is set to **1**.

Figure 13.20 *GEM Configuration - Alarms*

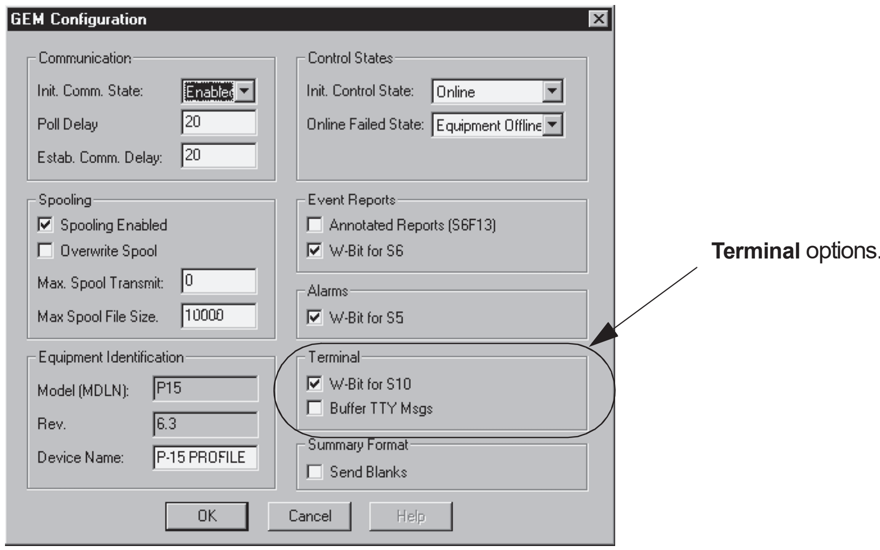


- **W-Bit for S6:**

  This option specifies whether S5 Alarm messages are to be sent to the Host with the **Wait Bit** set to **0** or **1**. (See *Figure 13.20*.)

Terminal Options

Figure 13.21 *GEM Configuration - Terminal*



- **W-Bit for S10:**

  This option specifies whether S10 messages are to be sent to the Host with the Wait Bit set to 0 or 1. An **X** in the check box indicates that the wait bit is set to **1**. (See *Figure 13.21*.)

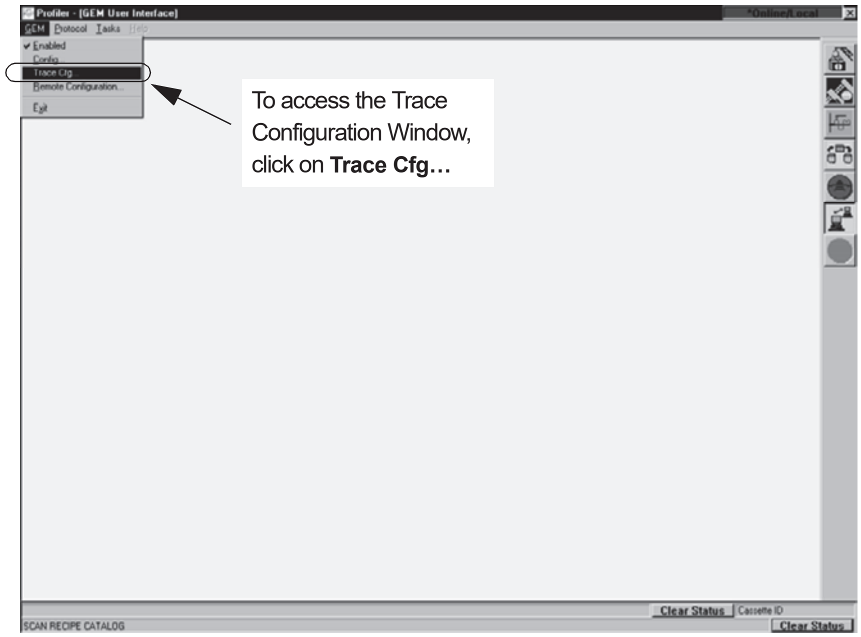
- **Buffer TTY Msgs:**

  With this option enabled, the system does not display the messages. (See *Figure 13.21*.)

Trace Configuration

This option is designed to limit which messages are stored in the Status (Log) File on the disk. The divisions are set by message priority. Each message generated by the system carries with it a priority rating. By choosing one of the options, only the desired messages are saved to the Status (Log) File.

Figure 13.22 *GEM User Interface Screen - Trace Configuration*

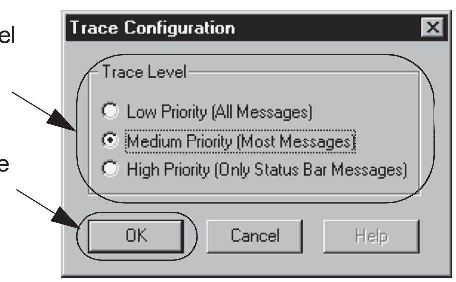


1. To access the Trace Configuration dialog box from the GEM/SECS window, click on **Trace Cfg…** from the **GEM** drop-down menu. (See *Figure 13.22*.)

Figure 13.23 *Trace Configuration Dialog Box*

Step 2 Choose the priority level of the messages to be stored.

Step 3 Click on **OK** to save the configuration.



2. Choose the priority level of the messages to be stored by clicking in the radio button of the selection. (See *Figure 13.23*.)

- **Low Priority (All Messages)**

  This option prescribes saving all messages to the Status (log) file.

- **Medium Priority (Most Messages)**

  This option prescribes saving to the Status (log) file, most generated messages, generally omitting those messages used only for communication.

- **High Priority (Only Status Bar Messages)**

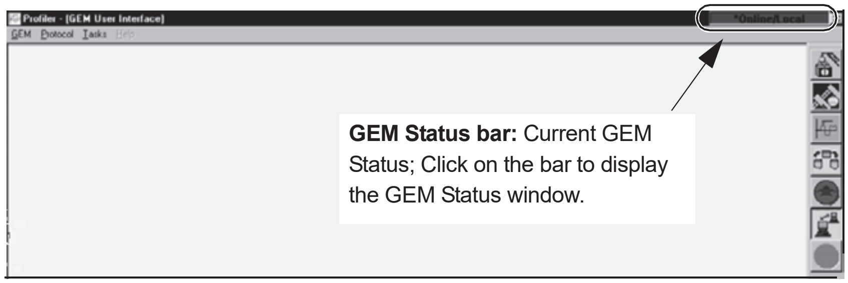
  This option prescribes saving only the most important messages, those that are typically displayed in the Status Bar Messages box.

3. Click on **OK** in the Trace Configuration dialog box to save the configuration.

GEM STATUS WINDOW

When the GEM option is installed in a system, the GEM status window can be accessed through the Status Bar at the top right of all screens operating in the system environment.

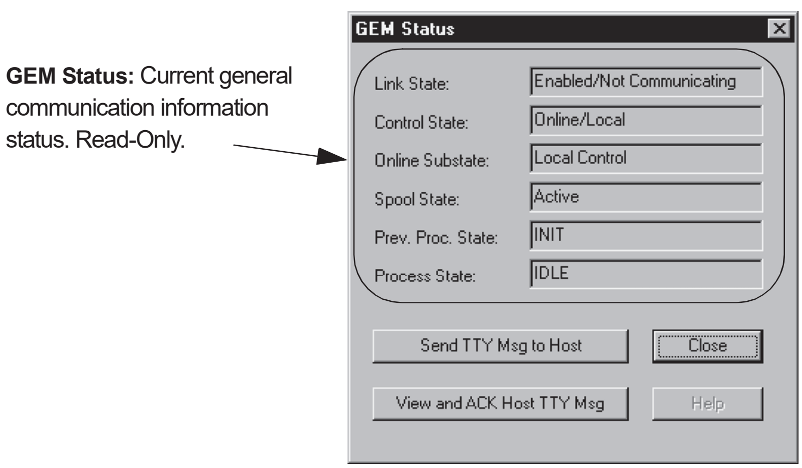
Figure 13.24 *GEM User Interface Screen - GEM Status*



Current GEM Status Information

1. To access the **GEM Status** window, click on the **Status Bar** at the top right of the screen (circled in *Figure 13.24*, where it appears in every screen.)

Figure 13.25 *GEM Status Window*



2. The GEM Status window displays the **current** GEM communication status in the system. This window can be helpful for troubleshooting purposes.
   - **Link State:** The Link State has two possibilities:

     Enabled: This means that the communication link between the system and the Host is established. In this mode, the system and Host might be either Communicating or Not Communicating. Note: Not Communicating can also mean that it is "active until communications are formally established" (S1F13 and S1F14).

     Disabled: This means that the communication link between the system and the Host has been disabled so no link is possible in this state.
   - **Control State:** The Control State has two possibilities:

     Online: This means that the system is in operating mode. In this state, control of the system can be from: **Host** (Host computer controlling the processing); or **Local** (the system controlling its own activity).

     Host Offline: This means that the Host is not sending or responding to messages from the system. In this case, if the control state is set to Local, the system continues to process wafers. If the system is set to Host control, the system has limited functionality.

     Offline: This means the system is not sending or responding to messages from the Host. In this case, the system can only operate under Local control.
   - **Online Substrate:** This is the status of the communication link. The Online status could either be **Online/Remote** (Host control) or **Online/Local** (system control).
   - **Spool State:** This is the status of the spooling activity between the system and the Host if the system is set to spool and the communication link is active. If the system is set to spool information, then the spooling activity is either **Active** or **Inactive**. During a communication interruption, the system spools messages to a queue. When communication is restored, the Host can send an S6F23 message requesting that the stored messages be sent to the Host.
   - **Prev. Proc. State:** This indicates which processing state the system was last in, immediately prior to the current processing status. For more information on the process states see the **KLA-Tencor Profiler SECS Interface** manual.
   - **Process State:** This indicates which processing state the system is currently operating in. For more information on the process states see the **KLA-Tencor Profiler GEM/SECS Interface** manual.

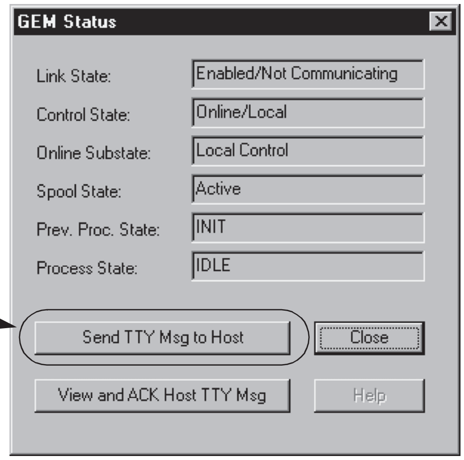
GEM TTY Messages: Sending and Receiving

It is possible to send and receive TTY messages using GEM. The messages dealt with in this screen are strictly text communications between the system and the Host. These are not commands that the Host computer can respond to.

Sending TTY Messages to the Host

Figure 13.26 GEM Status Window

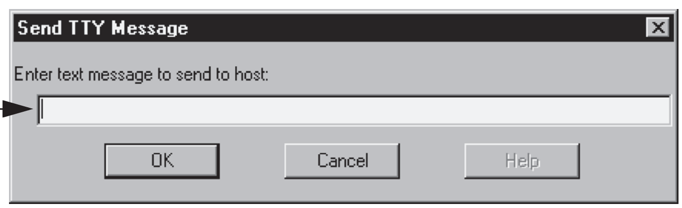
Step 1 To open the interactive window for sending TTY messages, click here.



1. To open the dialog box for sending TTY messages, click on the **Send TTY Msg to Host** button. (See *Figure 13.26*.)

Figure 13.27 Send TTY Message Window

Step 2 Click in the message box to activate cursor, then type the message.

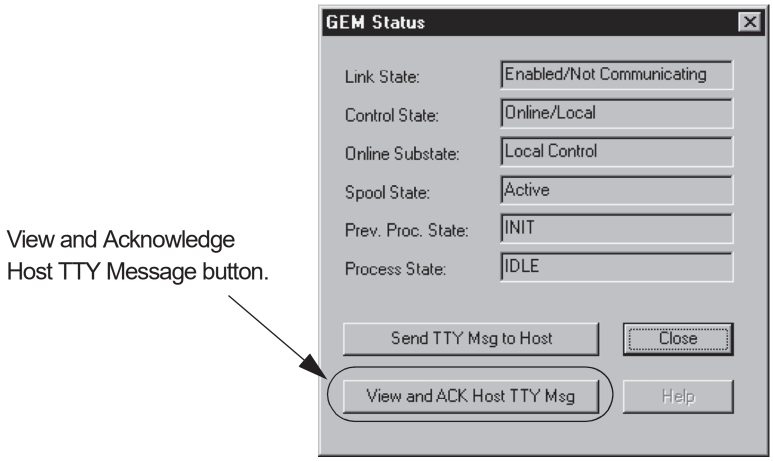


2. Type in the message that is to be sent to the Host screen. When satisfied with the message content, click on the **OK** button to send it to the Host. (See *Figure 13.27*.)

View and Acknowledge TTY Message From the Host

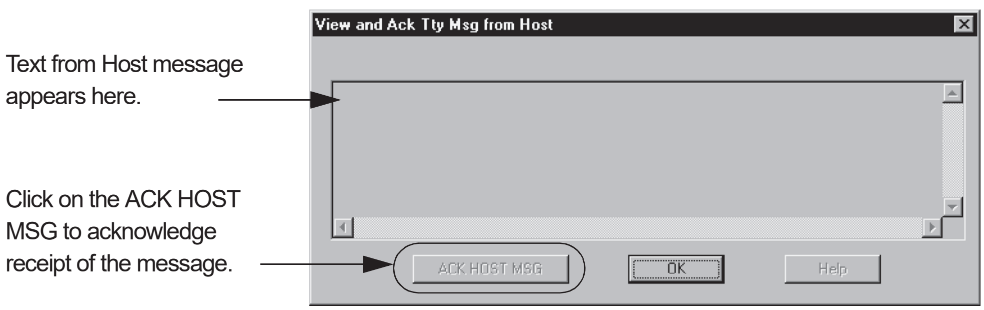
When a message comes from the Host, it can be viewed in the **View and Ack Tty Msg from Host** window. To enter the window, click on the **View and ACK Host TTY Msg** button (circled in *Figure 13.28* below). If a message arrives from the Host during normal processing, an indicator appears (the letters **TTY**) at the upper right corner of the screen, in the status bar. Click on the Status Bar to display the **GEM Status** box.

Figure 13.28 *GEM Status - View and Ack Host TTY Msg Window*



The Host might require a response from the system signalling that the message delivered to the system was read. To acknowledge receipt of the message click on the **ACK HOST MSG** (Acknowledge Host Message) button (circled in *Figure 13.29*).

Figure 13.29 *View and Ack TTY Msg from Host Window*

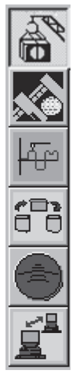


Uploading Recipes to the Host

Using GEM/SECS, process recipes can be uploaded (exported) to the Host computer. If the information has been stored in one of the files in the Database File Manager, it can be uploaded using the following procedure. (Note: the Host can also initiate the upload.)

1. From any top level screen, click on the **Database File Manager** icon.

Figure 13.30   Database File Manager Icon Choice

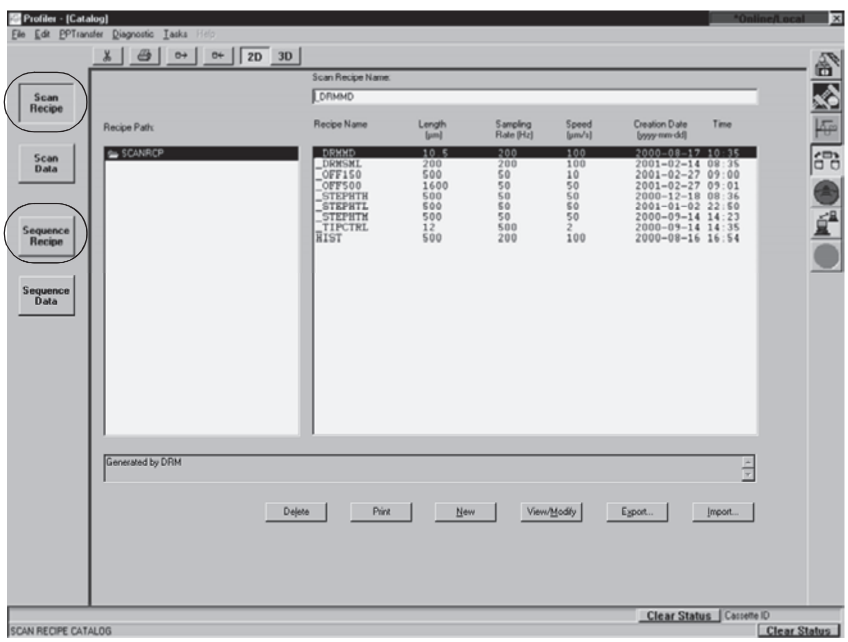


Step 1 Double-click on the **Database File Manager** icon to display the Catalog screen.

2. The **Database Catalog** screen is displayed. This screen provides access to: **Scan Recipes**; **Scan Data**; **Sequence Recipes**; **Sequence Data**. (See the access buttons, circled in *Figure 13.31*. Only the **Recipe** screens are used in this procedure.)

Figure 13.31   Database Catalog Screen.

Step 3 Only the Scan Recipe and the Sequence Recipe catalogs are used in this procedure.

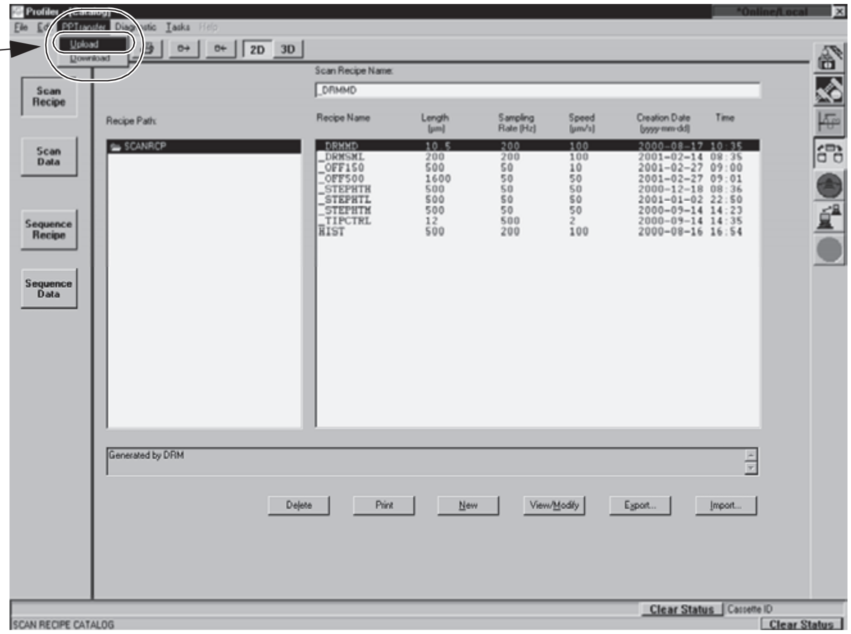


3. Either **Scan Recipe** or **Sequence Recipe** can be chosen. The window then displays a list of related recipes. (See *Figure 13.31*.)
4. In the chosen window, move the cursor over the desired item in the list and click on it. This highlights the specific file/recipe that is to be uploaded. (The screens are presented below.)

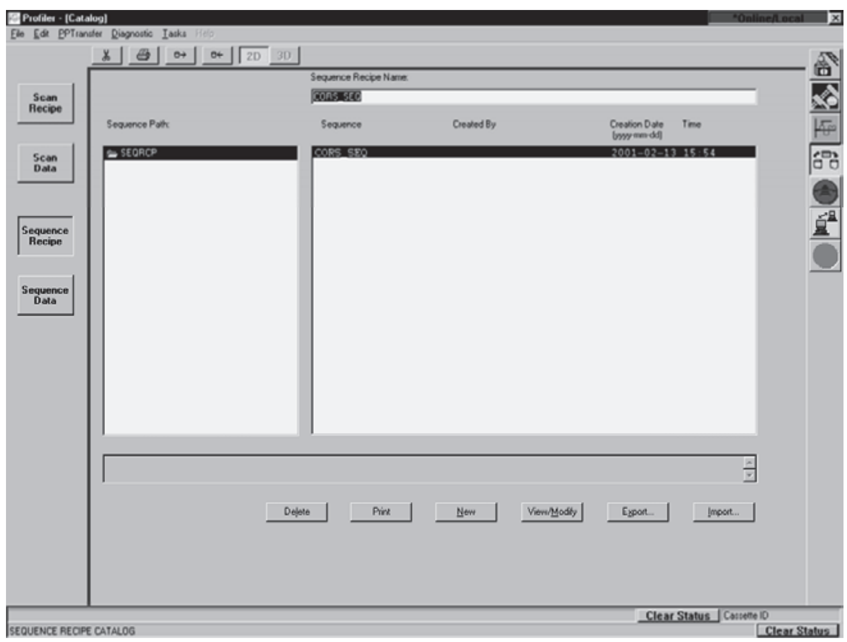
***Figure 13.32** Scan and Sequence Recipe Windows*

Scan Recipe Window

Step 5 To upload (export) a recipe, click on **PPTransfer** then on **Upload**.



Sequence Recipe Window

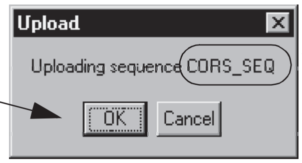


5. In the **Screen Menu** bar, click on **PPTransfer** to display the PPT drop-down menu. Click on **Upload**. (It is available in all four screens. See circled display in the **Scan Recipe Window** in *Figure 13.32*.)

6. This displays the **Upload** dialog box. (See *Figure 13.33*.) Check the file name presented in the dialog box and compare it against the file highlighted in the database catalog window. They should be the same.
7. If they are the same, click on **OK**. It is then transferred to the Host.

Figure 13.33 *Upload Window*

Step 7 If the correct recipe for upload is named in this box, click on OK to send it.



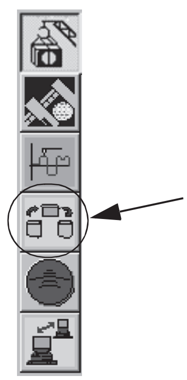
Step 6 Check the file name against the recipe name from the catalog. They should be the same.

Downloading Recipes from the Host

Using GEM/SECS, process recipes can be downloaded (imported) from the Host computer. To download a recipe from the Host, use the following procedure.

1. From any top level screen, double-click on the **Database File Manager** icon.(See *Figure 13.34*.)

Figure 13.34 *Database File Manager Icon Choice*

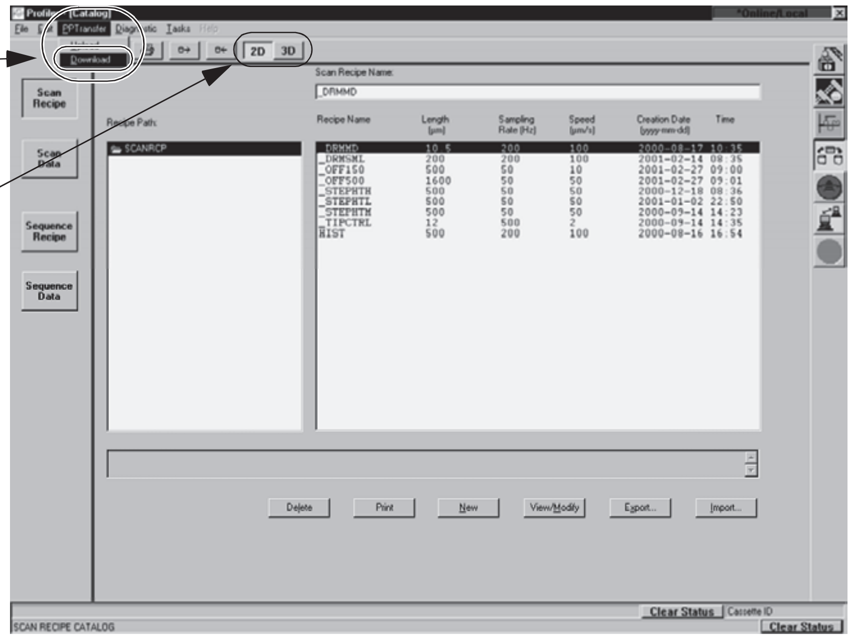


Step 1 Click on the **Database File Manager** icon to display the Catalog screen.

2. When the Database File Manager opens, click on the 2D or 3D icons in the tool bar so the system displays the required recipe type. (See *Figure 13.35*.)

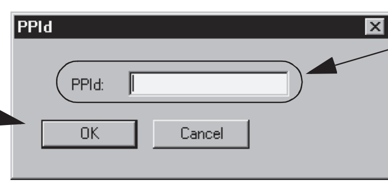
3. From the **Catalog** (database) screen click on **PPTransfer** (Process Program Transfer) in the Screen menu bar to display the PPT menu. Click on **Download** to display the **PPid** (Process Program identification) window. (Download is circled in *Figure 13.35*.)

Figure 13.35 *Database Screen - PPTransfer Menu*



4. In the **PPid**: box, type in the exact name of the recipe that is to be downloaded. (See *Figure 13.36*.)
5. Click **OK** to begin the Download process. (See *Figure 13.36*.)

Figure 13.36 *PPid Window*



6. When the download is complete, the recipe appears in either the **Scan Recipe** file (2D or 3D) or the **Sequence Recipe** file (2D or 3D), depending on which type of recipe it is. GEM/SECS directs the recipe to the proper file. The downloaded recipe can now be accessed.

14

WAFER STRESS APPLICATION OPTION

INTRODUCTION

Stress can be generated in the film and wafer as a result of thin film deposition. The deformation of the thin film can create bending and compressing, or expansion of the substrate surface. The result is a slight concave or convex curvature of the wafer. Careful monitoring of the thin 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.

The KLA-Tencor Profiler software calibrates the following stress values:

- Average Stress — derived from a polynomial fit of the entire profile, excluding 5% of the fit data on either end.
- Maximum Stress — the maximum absolute stress value.
- Center Stress — stress at the midpoint of the profile data.

Chapter Contents

This chapter describes:

- *Data Collection* on page 14-4
- *Loading Wafers* on page 14-5
- *The Stress Application Window* on page 14-7
- *Selecting, Creating, and Modifying a Stress Recipe* on page 14-12
- *Saving a Stress Recipe* on page 14-20
- *Printing a Stress Recipe* on page 14-22
- *Creating Stress Data* on page 14-22
- *Analyzing Stress Scan Results* on page 14-26

Stoney Equation

The Stoney equation for stress in a thin-film layer deposited on a substrate is as follows:

$$\sigma = \frac{1}{6R} \frac{E}{(1-\nu)} \frac{t_s^2}{t_f}$$

where

$$\frac{E}{(1-\nu)} = \text{wafer elastic constant}$$

σ = stress

t_s = wafer thickness

t_f = film thickness

R = radius of curvature

E = Young's Modulus for the wafer (substrate)

ν = Poisson's Ratio

As a profile is taken, the height of the wafer is being measured as a function of position:

$$y = f(x)$$

where

$$R(x) = \frac{[1 + (dy/dx)^2]^{3/2}}{d^2y/dx^2}$$

with y = Z-axis.

Two methods are available to obtain **y** (which relates to the Z-axis) from the profile. These are the two methods of calculation that exist for determining the stress: the least square fit (13 Point Least Square Fit), and the polynomial fit (Polynomial Fit). The recommended algorithm is the Polynomial Fit. It is chosen in the Stress recipe editor, at the bottom of the screen. This algorithm produces the best repeatability of the two available methods. The calculation provides three polynomial order options, 5th, 6th, and 7th order. For the best repeatable results, use the 5th order polynomial fit (see *Choosing the Stress Calculation Method* on page 14-19).

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 [3] [4] [5],

$$y = c_0 + c_1x + c_2x^2 + \ldots + c_nx^n$$

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:

$$y = c_0 + c_1x + c_2x^2 + c_3x^3$$

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 c_3, c_2, c_1, **and** c_0.

$$x^3y = c_0x^3 + c_1x^4 + c_2x^5 + c_3x^6$$

$$x^2y = c_0x^2 + c_1x^3 + c_2x^4 + c_3x^5$$

$$xy = c_0x + c_1x^2 + c_2x^3 + c_3x^4$$

$$y = c_0 + c_1x + c_2x^2 + c_3x^3$$

The next step is to solve this set of simultaneous equations to find the values of c_3, c_2, c_1, **and** c_0. Crout's method [3] [4] 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:

$$R(x) = \frac{[1 + (dy/dx)^2]^{3/2}}{d^2y/dx^2}$$

where,

$dy/dx = 3c_3x^2 + 2c_2x + c_1$ and $d^2y/dx^2 = 6c_3x = 2c_2$

The results are then used to calculate stress using the stress formula presented at the beginning of this section.

Least Square Fit

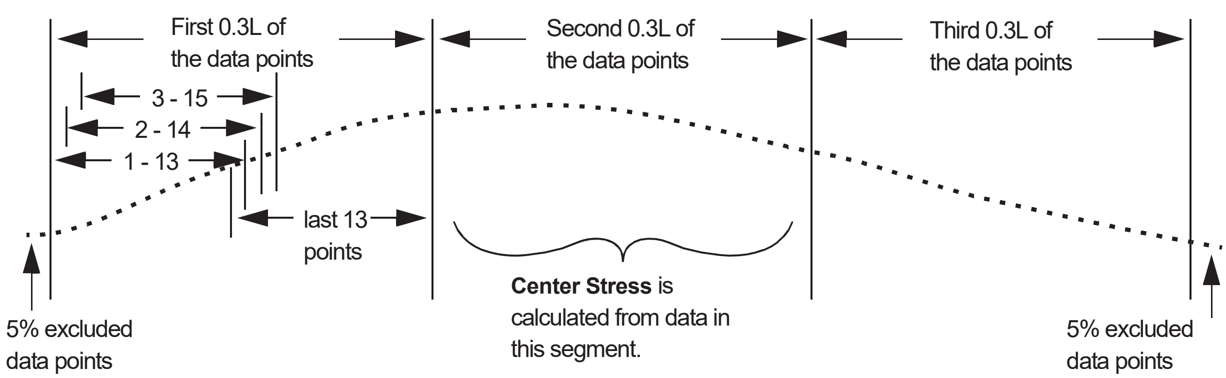
The Least Square Fit method is more complicated than the Polynomial Fit method. It consists of fitting local sections of data to circular arcs and computing the mean radius from the local radius of curvature. This is more susceptible to noise variations and fine surface geometries, making it less robust.

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.

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 14.1*.)

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 14.1*.) This continues until data point N-12 of the section where it calculates the last point (N = total data points in the section).

Figure 14.1 *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 14.1*.)

Data Collection

Use the Wafer Stress application to compare pre- and post-processing traces. This comparison calculates the curvature caused solely by the process-induced stress.

Only the pre- and post-deposition traces, along with their summaries, are saved. Stress values are not saved but are recalculated each time for the raw traces. To calculate the stress values, both the pre- and post-deposition traces must be present in the Scan Data catalog.

Scan Data Identification

To compute and display a difference measurement, both pre- and post-deposition raw data must be saved. Saving the raw and summary data allows for the recalculation of stress values using different parameters.

In order to save and store data for retrieval and use in the stress application, each data set must be given a name. The name must contain 79 characters or less and should be designed to help the user identify it as a pre- or post-processing scan. Ideally the scan name also includes other information such as a reference to the substrate composition. However, it is up to the user to come up with a suitable name. The name is entered in the dialog box shown in *Figure 14.2*.

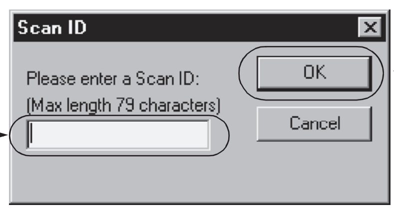
Naming Scan Data Procedure

When a scan is initiated in the Stress application, this dialog box appears.

1. Enter the scan data name in the variable box.
2. Click **OK** to accept the name. This initiates the scan.

Figure 14.2 *Stress Recipe Name Assignment Dialog Box*

Click in the Scan ID variable box and enter the name to be used to identify the scan data.



Click **OK** when the name has be entered.

LOADING WAFERS

In the P-15 system, the manual load procedure is used. For general information on installing a precision locator, see *Installing the Precision Locator:* on page 11-47. See *Optional Stress Precision Locators* on page 11-55 for graphic representations of some of the stress locators.

The system might come with a stress locators. Use the manual load procedure. (See also *Figure 14.4*.)

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. Use the following procedure to create the first scan.

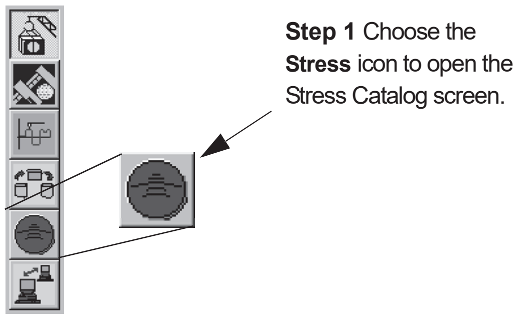
This procedure assumes that the precision locator is in place on the sample stage.

Load Wafer - Manual Procedure

Begin: (Manual) Load Wafer Procedure

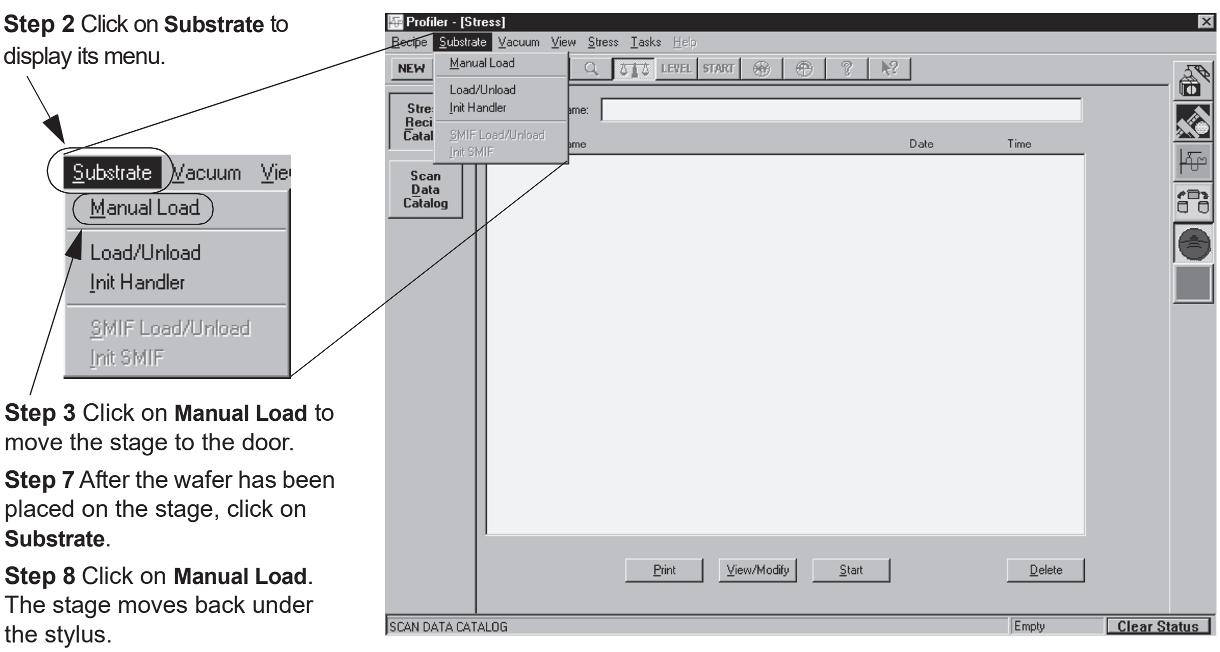
1. From the **Catalog** screen, click on the **Stress** icon. This opens the Stress catalog screen displaying the Stress Recipe list. (See *Figure 14.3*.)

Figure 14.3 *Catalog Screen – Choosing the Stress Application*



2. In the **Stress** screen, click **Substrate** to display its menu. (See *Figure 14.4*.)

Figure 14.4 *Stress Screen with Substrate Menu*



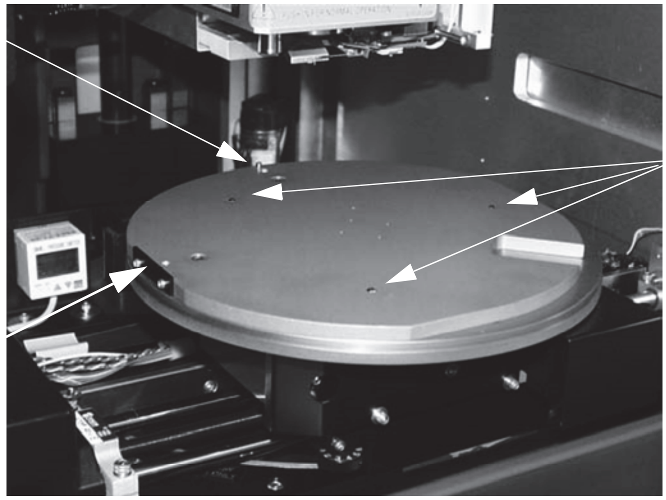
3. From the **Substrate** menu choose **Manual Load**. (See *Figure 14.4*.) This moves the sample stage to the stage door. Do not open the stage door until the stage stops.

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.

---

4. Open the stage door.

Figure 14.5 *Precision Locator on the Stage*



5. 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. (See *Figure 14.5*.)

   The wafer rests on three precision points. (See *Figure 14.5*.)
6. Close the stage door.
7. Click **Substrate**, in the menu bar, to display its menu.

End: (Manual) Load Wafer Procedure

8. From the menu, choose **Manual Load**. This moves the sample stage back under the stylus. (See *Figure 14.4*.)
9. Leave the Stress screen open for the next procedure.

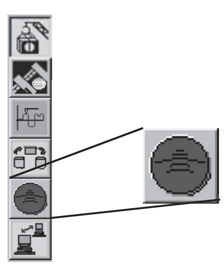
THE STRESS APPLICATION WINDOW

Stress Recipe Catalog

This section describes the various parts of the Stress Recipe Catalog screen and the function of the stress recipe related buttons.

1. Click the **Stress** icon in the **Catalog** screen. (See *Figure 14.6*.)

Figure 14.6 *Catalog Screen – Choosing the Stress Application*



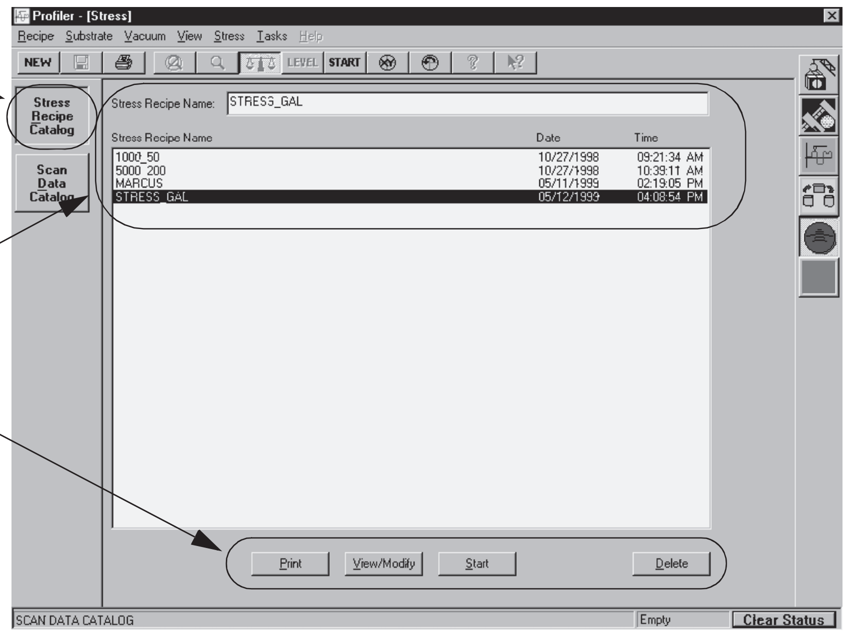
2. This displays the **Stress** application screen. If the Recipe catalog is not displayed, click on **Stress Recipe Catalog** to view the currently saved and available stress recipes. (See *Figure 14.7*.)

Figure 14.7 *Stress Application Screen*

Step 2 If not already highlighted, click on **Stress Recipe Catalog** to display the current list of stress related scan recipes.

Recipe list area. See *Figure 14.8*.

Recipe functions. See *Figure 14.9*.



3. Choose a Recipe to use for a stress scan by clicking on the recipe to highlight it. If the name is long, it might be truncated in the list area, making it difficult to distinguish between similar names. When highlighted, the recipe names appear in its entirety in the **Stress Recipe Name** box. (See *Figure 14.8*.)

Figure 14.8 *Stress Recipe List Area*

The Stress Recipe Name. When a recipe is selected, its name appears in full in the Stress Recipe Name box.

List of currently available Stress Recipes.

Dates and times that the corresponding recipes were created.

The **Stress Recipe Name** list contains all the currently defined and saved Stress Recipes. Each recipe is presented with its creation date and time. (See *Figure 14.8*.)

4. Four function buttons are positioned at the bottom of the recipe list area. (See *Figure 14.7*.) These are all duplicated functions, residing originally in the menu bar menus for use in conjunction with the listed recipes. (See descriptions in *Figure 14.9*.)

Figure 14.9 *Function Buttons in the Stress Recipe Screen*

This prints the currently highlighted recipe contents.

This opens the Stress Recipe Editor for the currently highlighted recipe.

This initiates a stress scan using the currently highlighted recipe.

This deletes the currently highlighted recipe.

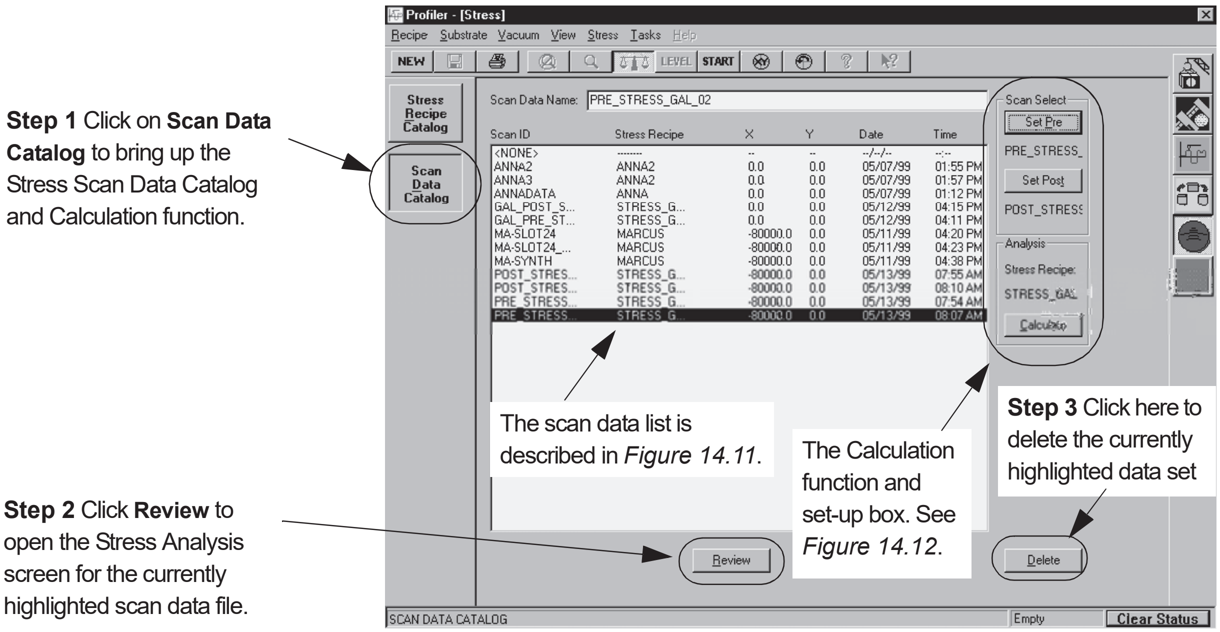
- Click **Print** to print the currently highlighted recipe.
- Click **View/Modify** to open the Stress Recipe Editor for the currently highlighted recipe.
- Click **Start** to initiate a stress scan using the currently highlighted recipe.
- Click **Delete** to delete the currently highlighted recipe 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.

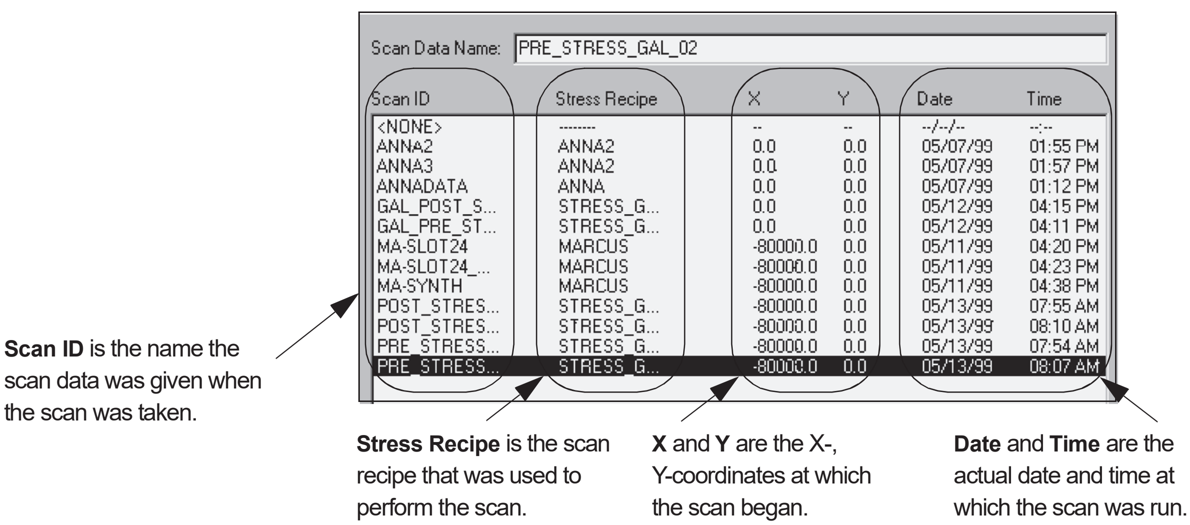
1. To access the available stress data files, click on **Scan Data Catalog**. This displays the list of data files from scans that have been performed using a Stress Recipe for use with the Calculation function. (See *Figure 14.10*.)

Figure 14.10 *Stress Screen with the Scan Data Catalog Displayed*



The **Scan Data Catalog** contains the scan data files that were collected from scans that used stress recipes. Each data file listing contains six items. See *Figure 14.11* for details.

Figure 14.11 *Scan Data Information in the Stress Data Catalog*

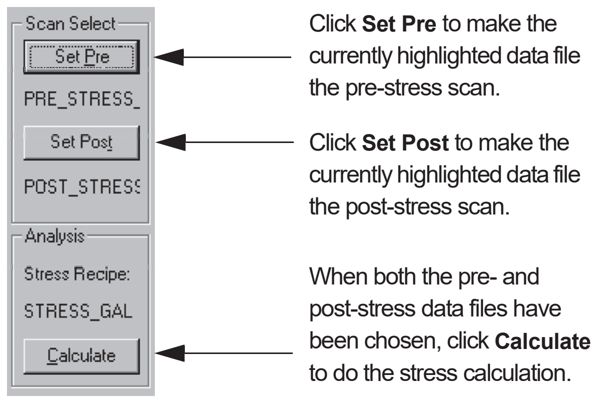


- **Scan ID** is the name given the data file when a scan was performed.
- **Stress Recipe** is the name of the recipe that was used to create the scan.

- **X** and **Y** are the actual coordinates on the wafer where the scan began.
- **Date** and **Time** are the actual date and time that the scan was created.

2. Click **Review** to open the Stress Analysis screen to view the data in the highlighted data file.
3. Click **Delete** to delete the currently highlighted stress data set.
4. The Calculation function and setup is configured and executed in this screen. (See *Figure 14.12*.)

Figure 14.12 *Stress Calculation Function and Set-Up*



- Click **Set Pre** to make the currently highlighted data file the pre-stress scan.
- Click **Set Post** to make the currently highlighted data file the post-stress scan.
- With both pre- and post-stress data files chosen, click **Calculation** to perform the stress calculation.

NOTE: This step requires that the appropriate recipe has already been chosen in the Stress Recipe Catalog. (See *Stress Scan Analysis Procedure*, Step *2. on page 14-28*.)

The Stress Screen Tool Bar

The Stress Screen has a tool bar that contains six active icons. These icons present quick access to six functions that also reside in the individual menu bar items.

Table 14.1 *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.

Table 14.1 *Tool Bar Icons*

Button	Action
	Displays the Print dialog box for printing data on the current screen.
	Starts a scan using the current stress recipe.
	Toggles to the XY View screen.
	Switches to the Theta view window.

SELECTING, CREATING, AND MODIFYING A STRESS RECIPE

Select and Open a Stress Recipe

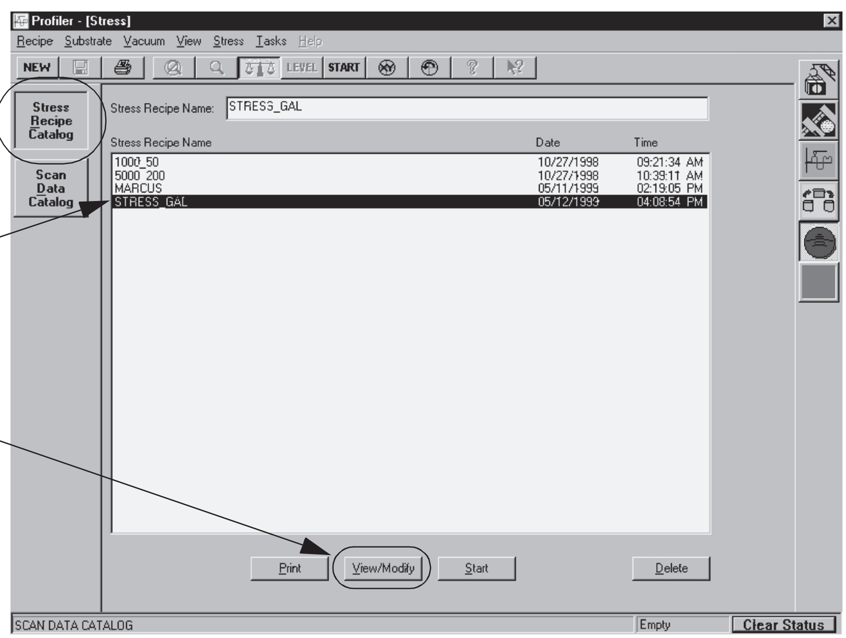
1. From any top level screen, click the **Stress** icon in the process icon bar. This opens the Stress application screen. 
2. This displays the **Stress** application screen. Click on **Stress Recipe Catalog** to view the currently saved and available stress recipes. (See *Figure 14.13*.)

Figure 14.13 *Stress Application Screen*

Step 2 If not already highlighted, click on **Stress Recipe Catalog** to display the current list of stress related scan recipes.

Step 3 Click to highlight the recipe that is to be modified.

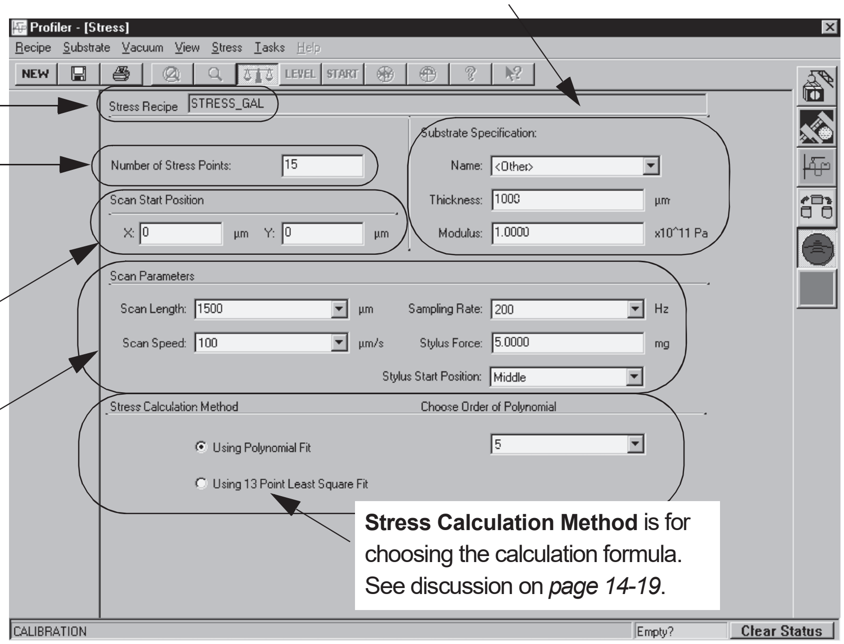
Step 4 To open the Stress recipe screen, click on **View/Modify**.



3. Click on the recipe that is to be viewed or modified. (See *Figure 14.13*.)

4. Click **View/Modify** (see *Figure 14.13*.) to open the **Stress** recipe editor.

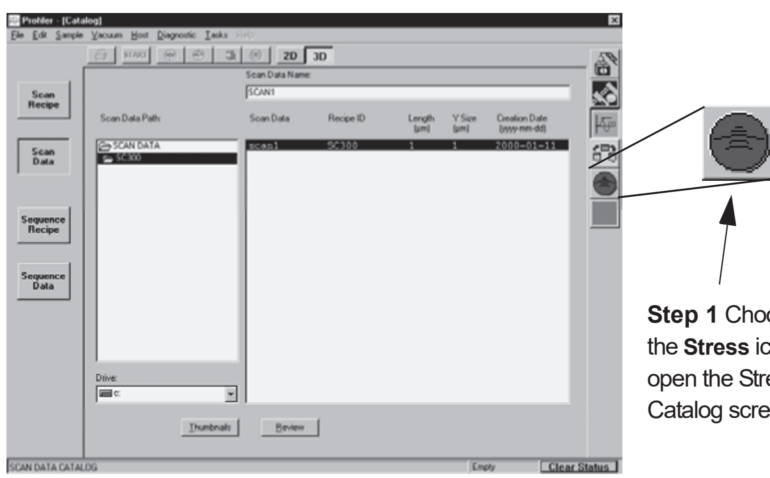
Figure 14.14 *Stress Recipe Editor Window*



Creating a New Stress Recipe

1. To open the Stress application, double-click the **Stress** icon in the **Catalog** screen. (See *Figure 14.15*.) This opens the Stress Catalog screen.

Figure 14.15 *Catalog Screen – Choosing the Stress Application*



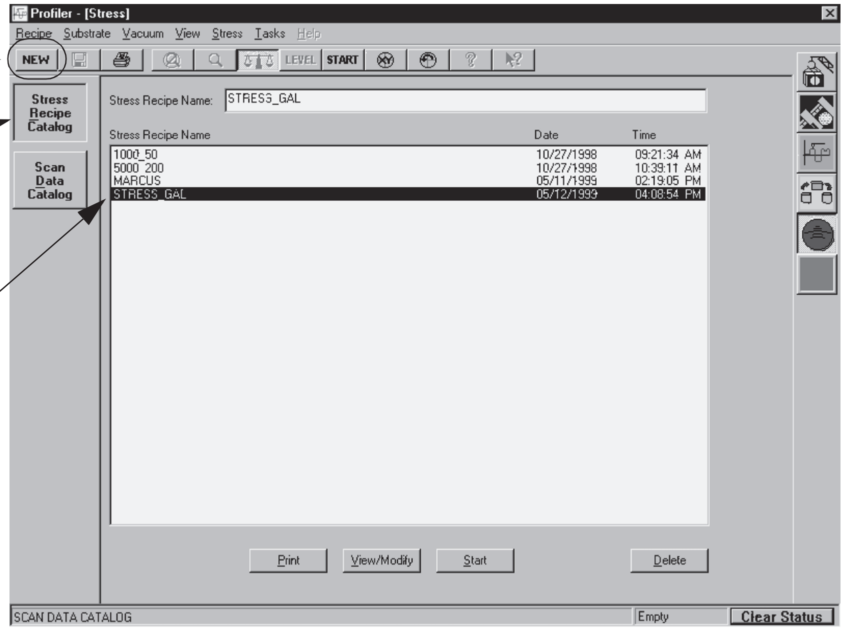
2. This displays the **Stress** application screen. If it is not currently active, click on **Stress Recipe Catalog** to view the available stress recipes. (See *Figure 14.16*.)

Figure 14.16 *Stress Application Screen*

Step 4 Click **NEW** to open the recipe editor for creating a new recipe.

Step 2 If not already chosen, click on **Stress Recipe Catalog** to display the current list of stress related scan recipes.

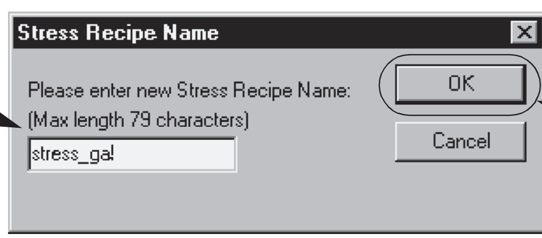
Step 3 Click to highlight the recipe that is to be used to create the new recipe.



3. If there is a recipe that has parameters closest to those required in the new recipe, highlight it.
4. Click **NEW.** This brings up a dialog box for naming the new recipe.
5. Enter the name of new stress recipe.

Figure 14.17 *Stress Recipe Name Dialog Box.*

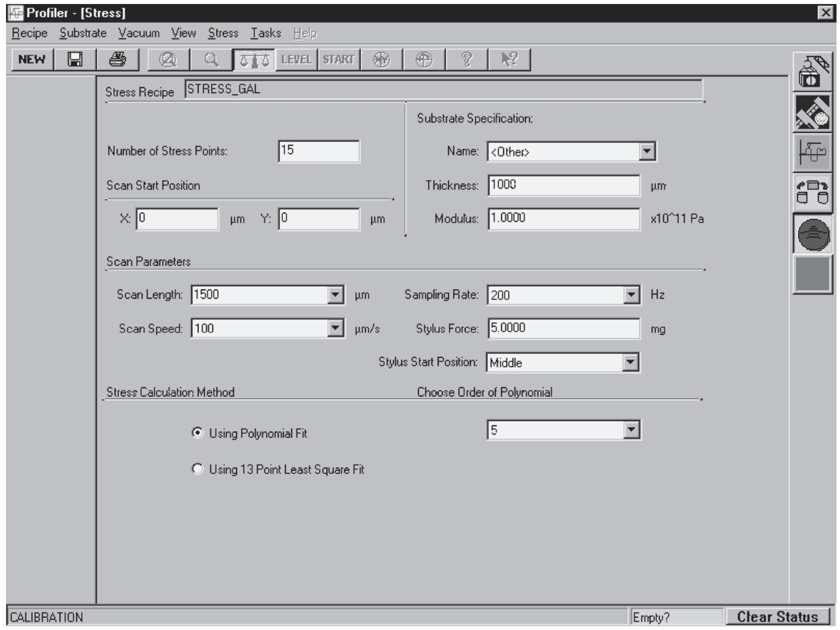
Step 5 Enter the recipe name in the box provided.



Step 6 When the name is correctly entered, click **OK**.

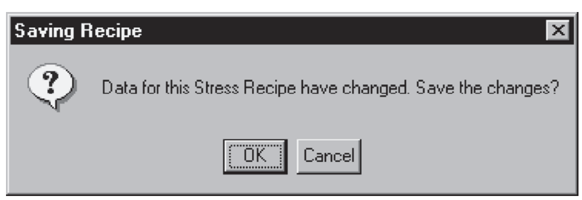
6. Click **OK** to accept the name, and the Stress Recipe Editor opens, ready for entering new parameters to form a new stress recipe. (See *Figure 14.17*.)

Figure 14.18 *Stress Screen with Stress Recipe Editor Open*



7. Make the necessary changes to the parameters. (See *Modifying a Stress Recipe* on page 14-15.)
8. If the user attempts to start a scan using this recipe before saving the new parameters, a dialog box appears stating that the recipe parameters have changed and request a decision as to whether to save the new parameters or not. It is important to save the new parameters if the recipe is to be used again to run comparative scans.

Figure 14.19 *Saving Recipe Parameters Dialog Box*



Click **OK** to save the new parameters.

Modifying a Stress Recipe

Once a recipe has been chosen and the Stress recipe editor opened, the recipe parameters can be modified.

Recipe Name

This part of the recipe cannot be modified. The current recipe name is listed at the top left of the screen. (See *Figure 14.14* and *Figure 14.20*.) (If a new recipe is required with parameters like those of the current recipe, click **NEW** at the left end of the tool bar. This creates a new recipe with the same attributes at the original recipe.)

Figure 14.20 *Stress Recipe Name*

Number of Stress Points

This number was used with the **Least Square Fit** calculation procedure. (See *Choosing the Stress Calculation Method* on page 14-19.) The calculations related to this procedure are described in the introduction to this chapter. (See *Figure 14.14* and *Figure 14.21*.) This number belongs to legacy software and has no effect on any calculation. Ignore this number.

Figure 14.21 *Number of Stress Points*

This number is only active with the **13 Point Least Square Fit**.

Scan Start Position

This is the start position on the wafer for each comparative scan, described in X-, Y-coordinates. If the proper procedure was used for wafer placement on the stress locator, this setting should ensure that the pre- and post-processing scans are performed at the same location on the wafer. (See *Figure 14.14* and *Figure 14.22*.)

For general purposes, the longer the scan, the more accurate are the results. The amount of time required to complete the scan must be balanced against the need for accurate data. KLA-Tencor recommends scanning 80% of the wafer diameter to determine the stress.

> **EXAMPLE:**
>
> When scanning across the diameter of an eight inch wafer (200000 µm), the scan should be 160000 µm long. This means that the scan should begin at X = -80000, Y = 0. It should end at X = 80000, Y = 0. (See *Figure 14.22*.)

To change the coordinates:

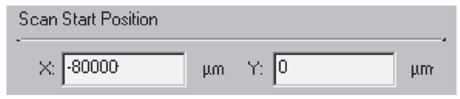
1. Highlight the current X-coordinate number and enter the new one.
2. Highlight the current Y-coordinate number and enter the new one.

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.

OR

1. ALTERNATIVE Step 1: An alternative is to click on the XY icon in the tool bar to open the XY View screen.
2. ALTERNATIVE Step 2: Move the video image until finding the target area, then click on the desired start position. (In scans of specific attributes this can prove to provide easier positioning of the scan start, but in general, it is repeatability is less accurate.)
3. ALTERNATIVE Step 3: Click **OK** to accept the start position.

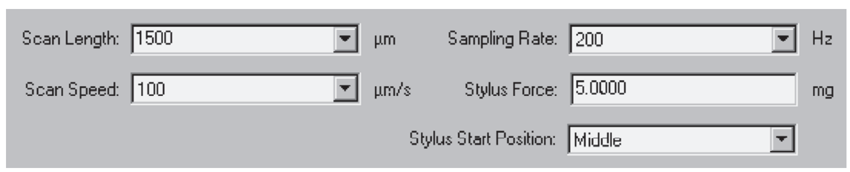
Figure 14.22 *Scan Start Position*



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. (See *Figure 14.14* and *Figure 14.23*.)

Figure 14.23 *Scan Parameters*



Scan Length: For best results, the scan length should be 80% of the diameter of the wafer being measured for stress. The longer the scan, the more accurate the results.

Scan Speed: Scan speed often works in concert with Applied Force. If the speed is too high with a very light Applied Force, the results could be inaccurate. (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 become further apart.

Stylus Force (Applied Force): Applied Force is the force exerted on the sample surface by the stylus tip. As the force goes up on a smaller tip, the greater the potential for damage to the sample surface and the to the tip itself. For this reason, it is recommended that at least a 2 µm tip be used for this type of scan over a long distance (12.5 µm or even 25 µm is acceptable). 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 5 mg.

Stylus Start Position: This allows the user to choose which profile type is used in the scan. Three choices are presented: Middle, Top, and Bottom. These profile types correspond to the stylus movement limits as described in *Profile Type: Available choices for each range and the resultant scan traces* on page 3-42.

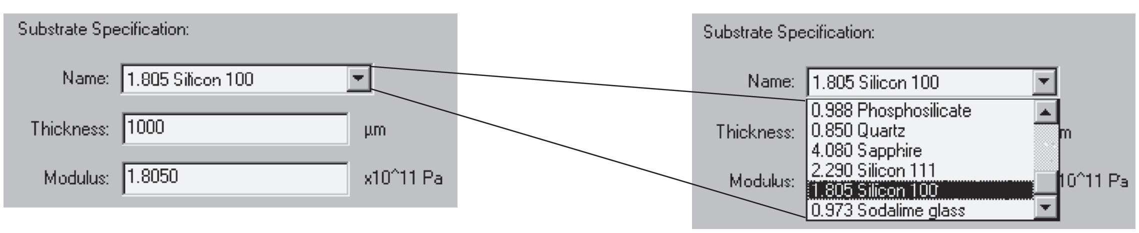
KLA-Tencor recommends using the **Middle** option first. If the Middle option limits out, observe the direction of the limit and choose the corresponding profile type.

Substrate Specification

The Substrate settings refer to the wafer composition and thickness. Each type of substrate has an elasticity constant that is important in the calculation. The software is programmed to provide the constant (**Modulus**) for each listed substrate type. (See *Figure 14.14* and *Figure 14.24*.) Click on the menu-arrow next to the substrate **Name** variable box and scroll through the list and choose the substrate being used. Choosing the substrate automatically sets the **Modulus**. The operator must set the substrate **Thickness** by double-clicking in the variable box and entering the new thickness in microns (µm). (See *Figure 14.24*.) It is important to note that the user is given another chance to enter the thickness each time the scan is started. This way, a sample can be tested numerous times using the same material in different thicknesses without having to go into the recipe each time to change this parameter.

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. Like the other substrates, the user is given the opportunity to change the thickness each time a scan is run using this recipe.

Figure 14.24 *Substrate Specification*



The following is a list of common substrates and their corresponding elastic constants. The Orientation is the crystalline orientation of the substrate being tested.

Table 14.2 *Elastic Constant of Substrates*

Substrate Material	Orientation	Elastic Constants (10^{11} Pa)
Aluminum	*	1.030
Aluminum Oxide (Al_2O_3)	+	3.835
Aluminum Oxide (Al_2O_3)	+	4.895
Aluminum Nitride (AlN)	+	4.367
Beryllium Oxide (BeO)	+	4.367
Borophosphosilicate (BPSG) Glass	+	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	+	0.988
Quartz	+	0.850
Sapphire	+	4.080
Silicon	111	2.290
Silicon	100	1.805
Sodalime glass (Corning microsheet 0211)	+	0.973

(+ = amorphous structure)

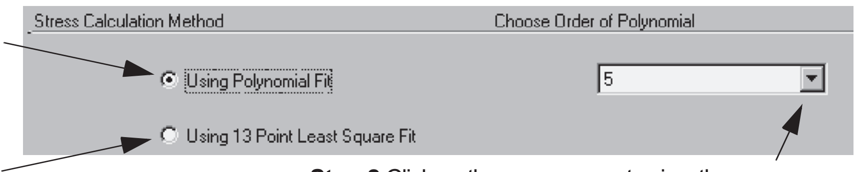
Choosing the Stress Calculation Method

1. The stress can be calculated using either of two methods. The first, Polynomial Fit, is the recommended method. This method gives the best repeatability. The **Using Polynomial Fit** option gives the opportunity to choose from three polynomial orders, 5th, 6th, and 7th. The best results come from the 5th order polynomial. The higher the order, the higher the possibility that smaller sample surface features could be included in the calculation.

   To choose the order, click on the menu-arrow next to the variable box and click on the order to be used. (See *Figure 14.25*.)

2. The second method is the **13 Point Least Square Fit** method, described in the introduction to this chapter. **13 Point Least Square Fit** calibration is a legacy formula that does not provide the best calculation results for stress. Its repeatability is not as good as the Polynomial Fit procedure. It is still present in the software for use by those who wish to compare the results of current scans with older scans that used the **13 Point Least Square Fit** calibration for stress calculations before the new Polynomial Fit formula was available. This method should not be used unless it is well understood and conducted for specifically defined results. (See *Figure 14.25*.)

Figure 14.25 *Stress Calculation Method*



Step 1 Click in the empty radio button to choose it. The dot indicates that it is chosen.

The **13 Point Least Square Fit** option (does not provide the best reproducible results).

Step 2 Click on the menu-arrow to view the menu. Choose the desired polynomial order. 5 is generally acceptable for most stress applications.

SAVING A STRESS RECIPE

It is necessary to save a current recipe if any of the following circumstances occur:

- If any of the parameters in a current recipe have been changed and the changes need to be preserved.
- If any of the parameters in a current recipe have been changed and the changes need to be preserved, but the old recipe also needs to be saved. In this case it is necessary to perform a **Save As** procedure.
- If a new recipe has been created and used but not saved, and there is a need to preserve the recipe for future use.

Saving Recipe Parameters

When the parameters in a current recipe have changed and those changes need to preserved in the current recipe, use the following procedure.

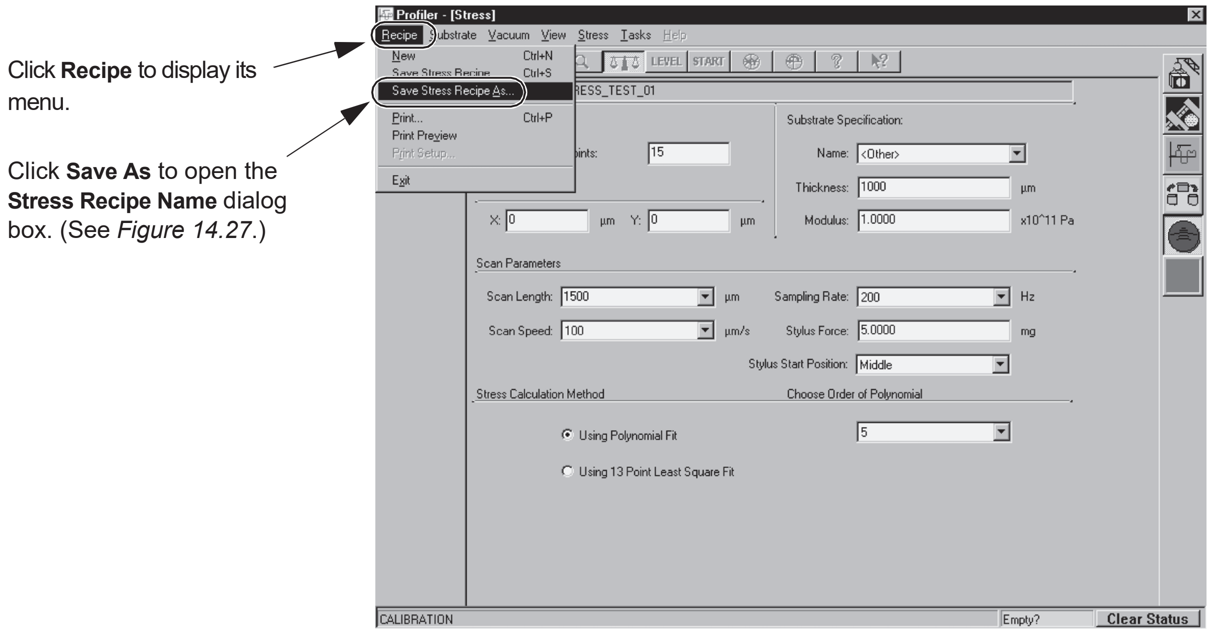
1. From the Stress Recipe screen, click **Recipe** in the Menu Bar. This displays its **menu**.
2. Click **Save**.

Saving Recipe Parameters as a New Recipe

If the user changes parameters in a recipe and needs to keep the old recipe in tact while preserving the changes, a new recipe can be created from the original.

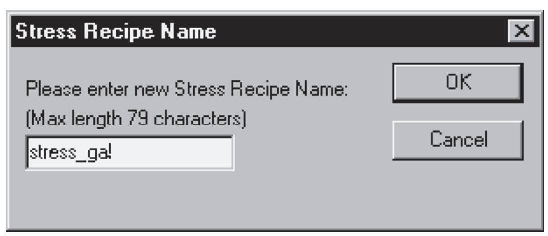
1. When the parameters have been changed in a recipe, and before the changes have been saved as part of the original recipe, click Recipe at the far left end of the Menu Bar to display its menu.

Figure 14.26   Stress Screen With Recipe Menu



2. Choose **Save As** to display the Stress Recipe Name dialog box.

Figure 14.27   Stress Recipe Name Dialog Box.

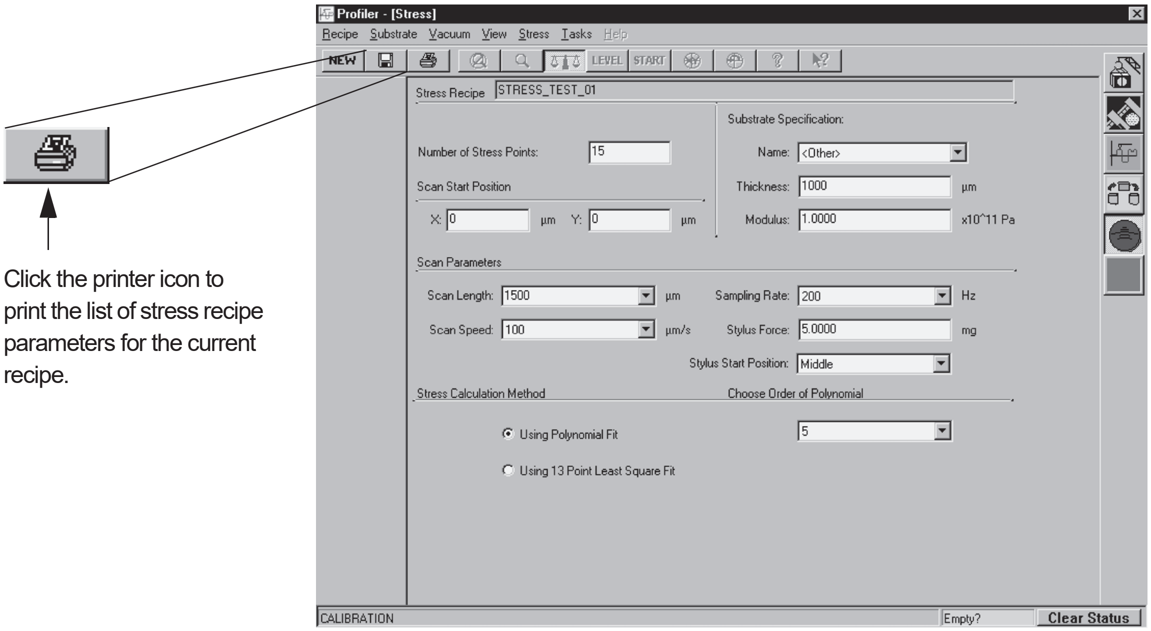


3. Enter the name of the new recipe name in the provided space. The name should help the user quickly identify the specific use for the recipe.
4. Click **OK** to establish the new recipe using the parameters displayed in the original one.

PRINTING A STRESS RECIPE

With the Stress Recipe Editor open, click on the printer icon. This prints the currently displayed stress recipe.

Figure 14.28 *Printer Icon in Tool Bar*



CREATING STRESS DATA

Taking a Single 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.

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.

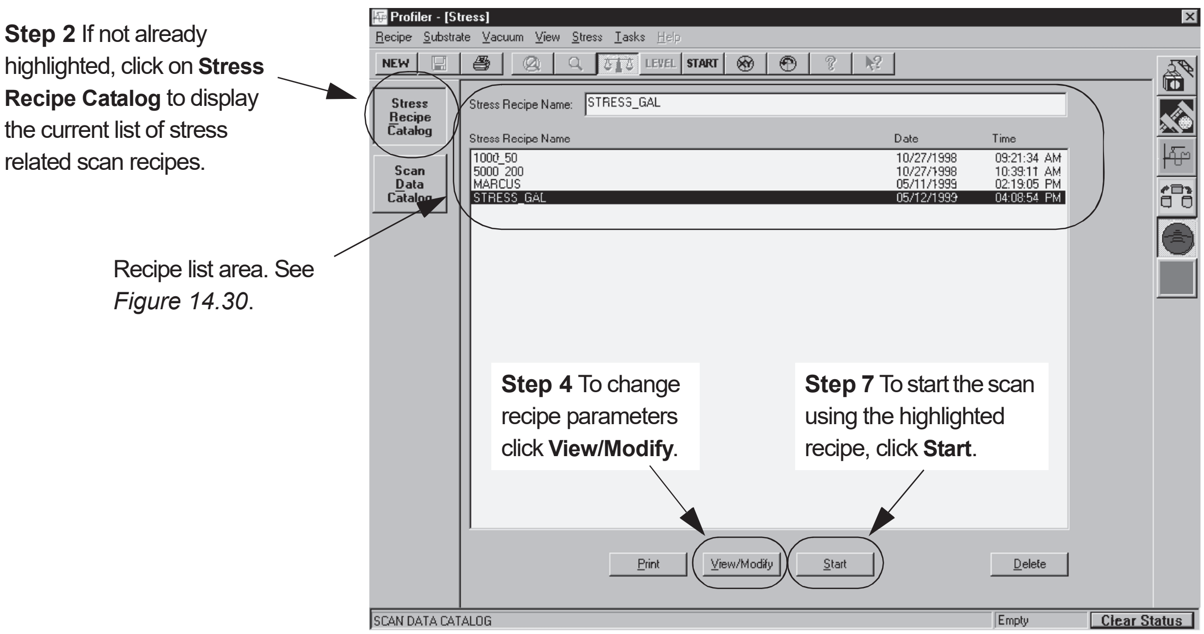
1. If the stress precision locator is not in place on the stage, attach it using the procedure described in *Installing a Precision Locator* on page 11-47, with additional reference to *Optional Precision Locators* on page 11-58.
2. Load the wafer using the *Load Wafer - Manual Procedure* on page 14-6.

Choosing a Stress Recipe

Choose the stress recipe that is to be used for both the pre- and post-stress scans using the following procedure.

1. To open the Stress application, click the **Stress** icon . This opens the Stress Catalog screen.
2. This displays the **Stress** application screen. If the Recipe catalog is not displayed, click on **Stress Recipe Catalog** to view the currently saved and available stress recipes. (See *Figure 14.29*.)

Figure 14.29 *Stress Application Screen*



3. Choose a Recipe to use for a pre-stress scan by clicking on the recipe to highlight it. When highlighted, the recipe name appears in its entirety in the **Stress Recipe Name** box. (See *Figure 14.30*.)

   If no changes are required to the current recipe before it is run, skip to Step *7*.

   If recipe parameter modifications are required before running the scan, continue.

Figure 14.30 *Stress Recipe List Area*

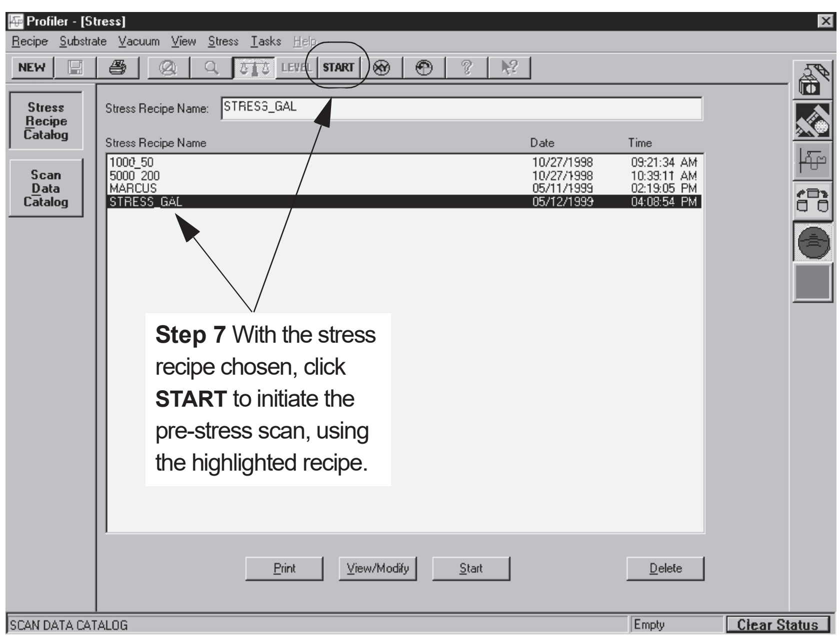
If the Stress Recipe must be Modified:

4. **If the recipe requires modification** of parameters before the scans can be run, click **View/Modify** at the bottom center of the screen. (See *Figure 14.29*.)
5. The Stress Recipe window opens. Change the parameters requiring adjustment. (For information of parameters see *Modifying a Stress Recipe* on page 14-15.)
6. To save the recipe changes either directly to the recipe or create a new recipe, see *Saving Recipe Parameters* on page 14-20 or *Saving Recipe Parameters as a New Recipe* on page 14-20.

Starting the Pre-stress Scan

7. From either the Stress catalog screen or the Stress recipe editor, click the **START** button to initiate the pre-stress scan.

Figure 14.31 *Stress Recipe Catalog Screen*

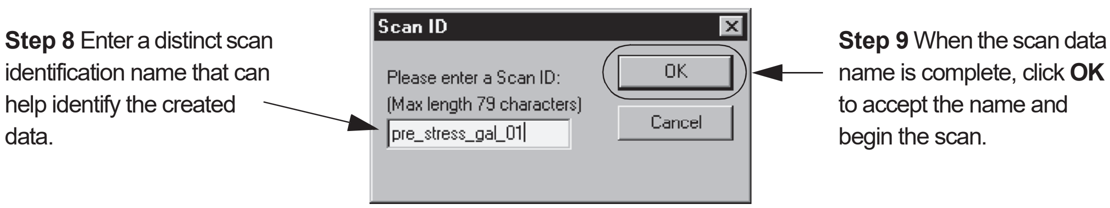


8. This displays the **Scan ID** dialog box. Enter a scan data identification name that allows the user to clearly isolate it from other data.

   EXAMPLE:

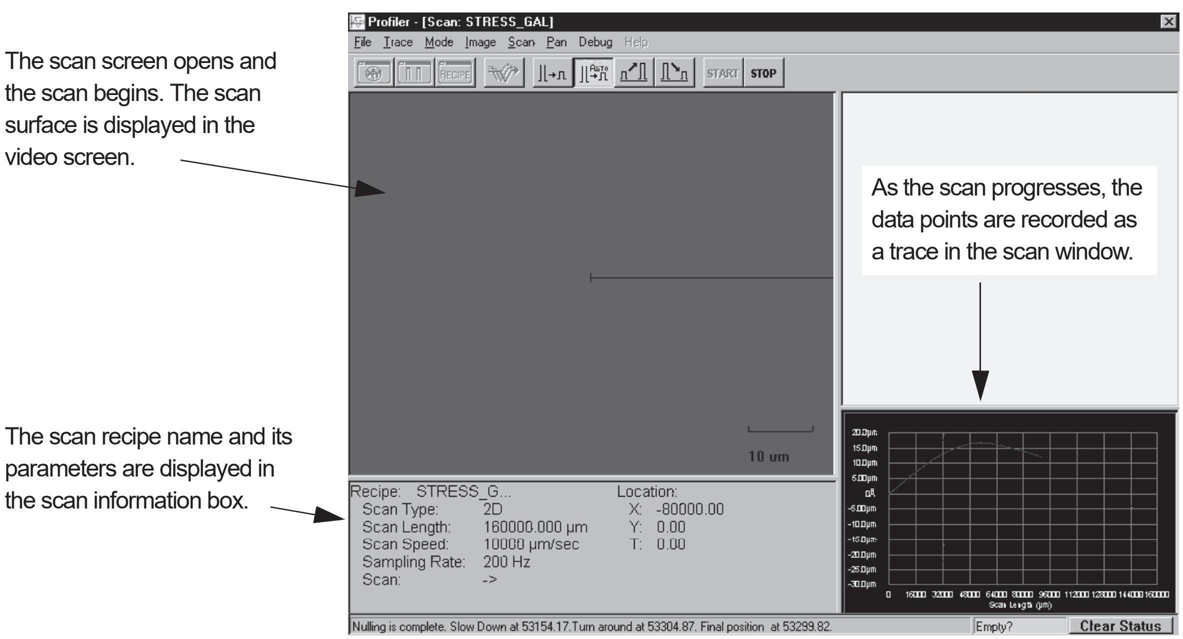
   In *Figure 14.32*, **pre_** refers to pre-stress, **stress_** identifies the scan as stress related, **gal_** indicates that it is a gallium arsenide substrate, and **01** is the scan number.

***Figure 14.32** Scan ID Dialog Box*



9. When the name has been entered, click **OK** to accept the scan data name and begin the scan. (See *Figure 14.33*.)

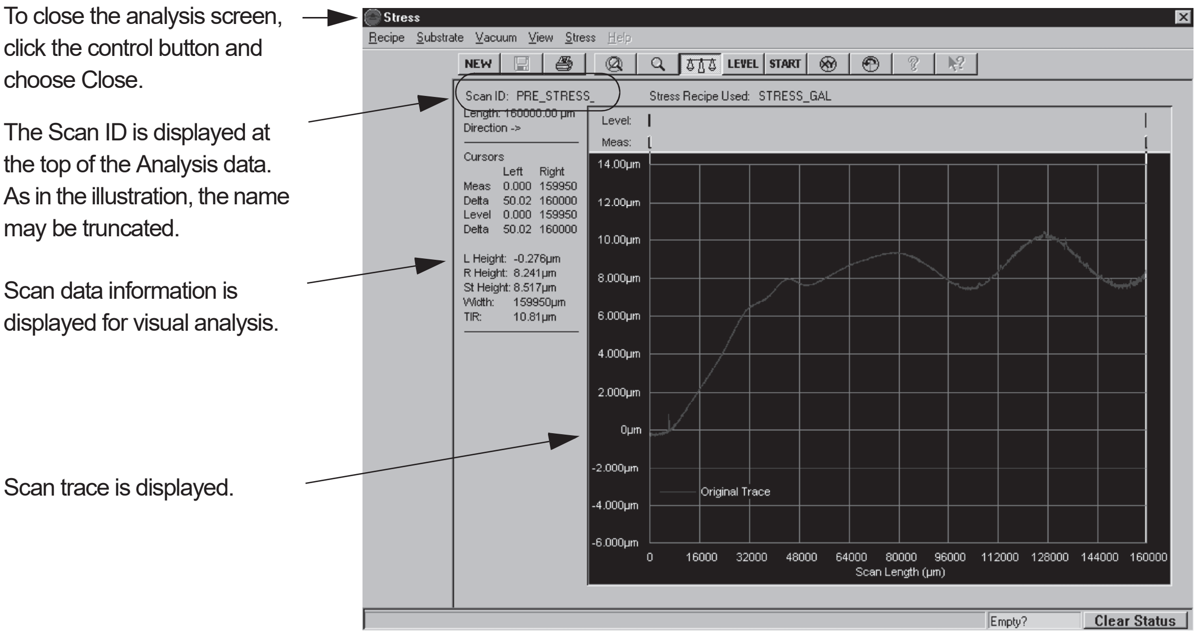
***Figure 14.33** Scan Screen with Real Time Scan Trace*



10. When the scan is complete, the data is automatically saved and the Scan Analysis screen opens. (See *Figure 14.34*.)

    To close the analysis screen, click on the control button at the top left corner of the screen and choose **Close** from its menu. (See *Figure 14.34*.)

Figure 14.34 Stress Scan Analysis Screen



To close the analysis screen, click on the control button at the top left corner of the screen and choose **Close** from its menu. (See *Figure 14.34*.)

Taking a Single 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

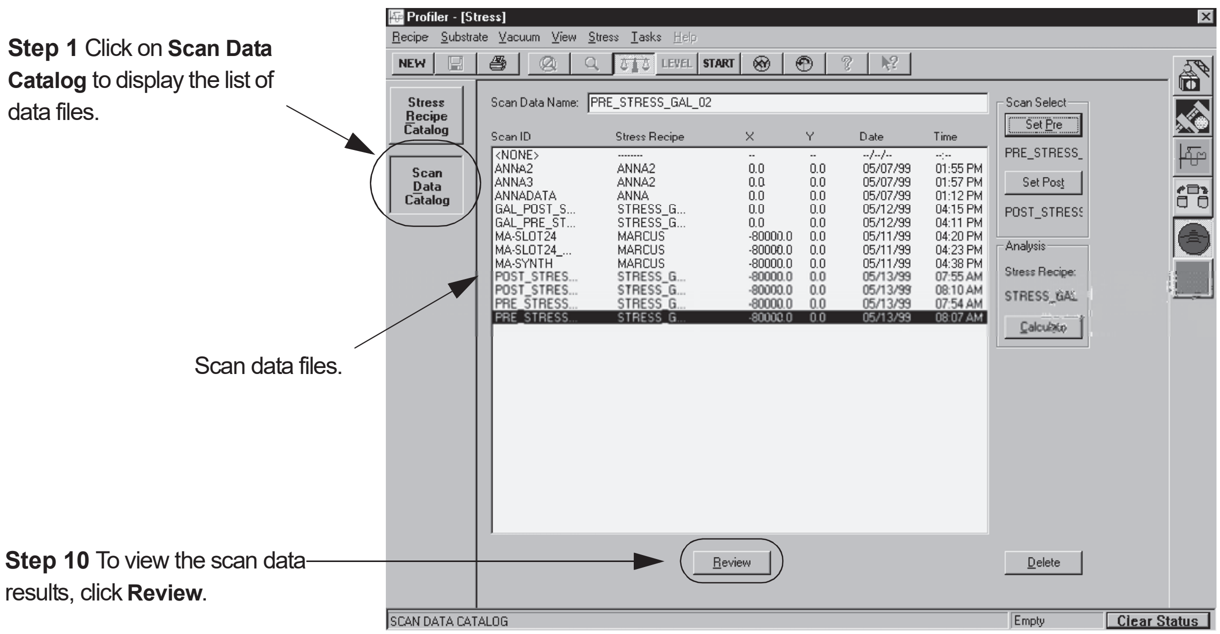
Stress analysis is accomplished through the comparison of a pre-stress scan and a post-stress scan. The analysis is not saved, but is instead generated each time the calculations are performed.

Viewing Stress Scan Results

1. From the Stress screen, click on **Scan Data Catalog**. This displays the names of the scan data files. (See *Figure 14.35*.)

   Notice that the catalog list has information regarding the ID (name) of the data file, the stress recipe used to collect the data, the X- and Y-coordinates at which the scan started, the date the data was collected, and the time it was collected.

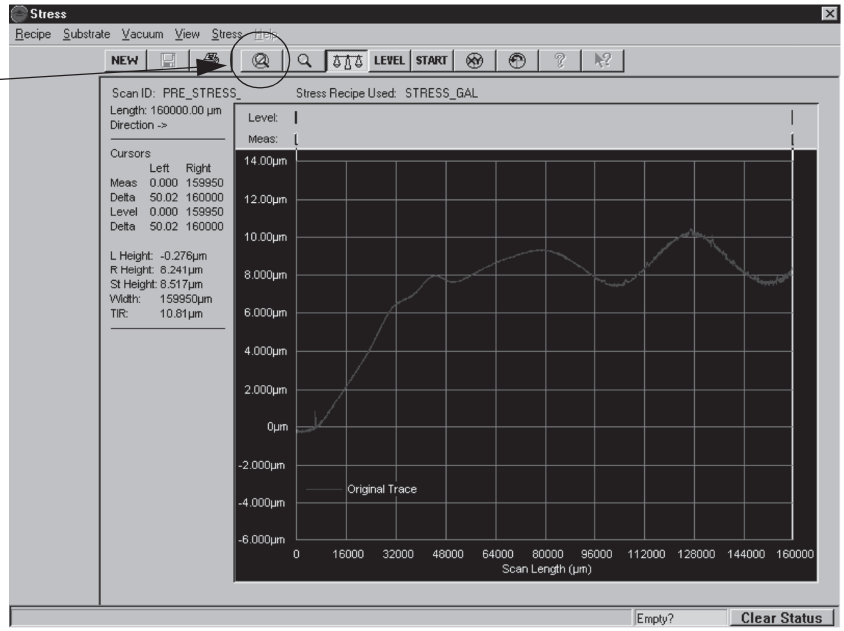
Figure 14.35 *Stress Screen with Scan Data Catalog Displayed*



2. Click to highlight the data file that is to be viewed. Click **Review** at the bottom center of the screen to open the data file. (See *Figure 14.35*.)

Figure 14.36 *Stress Screen with Stress Data File*

If only partial scan data is visible, click on the **cancel zoom** icon to display the entire graphic.



3. If the data is not fully displayed, click the **cancel zoom** icon. (See *Figure 14.36*.)
4. To return to the Stress catalog screen, press the **ESC** key.

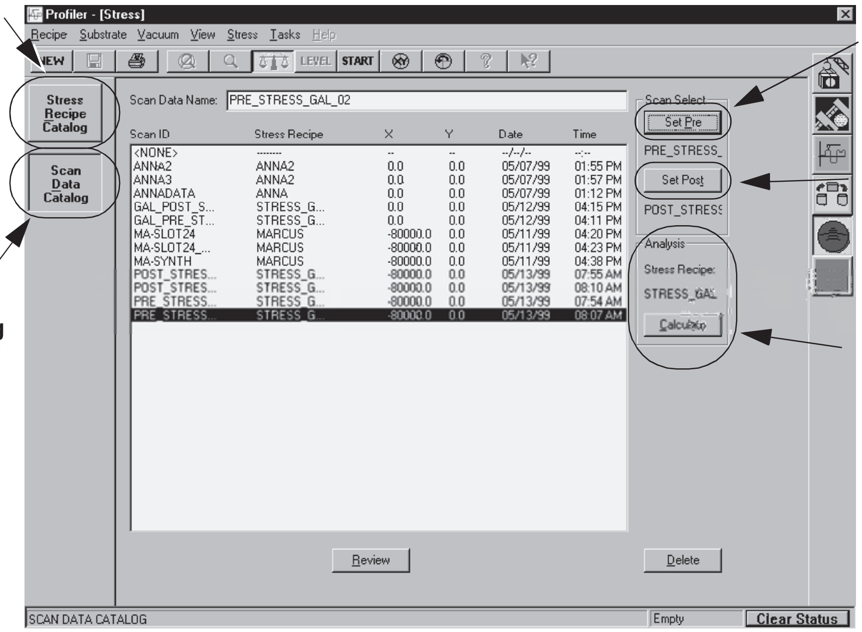
Stress Scan Analysis Procedure

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. To open the Stress application, click the **Stress** icon . This opens the Stress Catalog screen.
2. With the **Stress Recipe Catalog** chosen, click on the recipe that is to be used for the calculation. A chosen recipe is highlighted. (See *Figure 14.37*.)

3. After the recipe is chosen, click **Scan Data Catalog**. (See *Figure 14.37*.)

Figure 14.37 *Stress Screen with Scan Data Catalog Displayed*



Step 2 Click on **Stress Recipe Catalog** to display the list of recipes. Choose a recipe.

Step 3 Click on **Scan Data Catalog** to display the list of data files.

Step 5 Click on **Set Pre** to set the pre-stress recipe.

Step 7 Click on **Set Post** to set the post-stress recipe.

Step 8 Check the Stress recipe to ensure that it the same as that in the chosen data files. If it is, click **Calculate**.

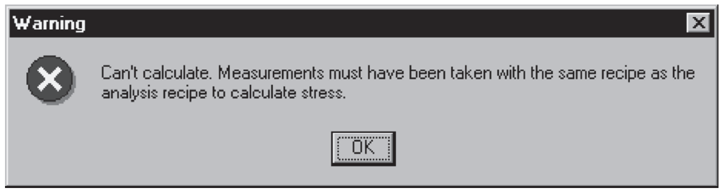
4. Highlight the data file that is to be used as the pre-stress scan.

   The Scan ID names might be difficult to tell apart if they are truncated. However, when a data file is highlighted, its entire name is displayed above the scan data file list, in the box titled **Scan Data Name**.

5. With the data file highlighted in the Stress Scan Data Catalog, click **Set Pre** to choose the highlighted file for use as the pre-stress scan data file in the calculation. (See *Figure 14.37*.)
6. Highlight the data file that is to be used as the post-stress scan.
7. Click **Set Post** to choose the highlighted file for use as the post-stress scan data file in the calculation. (See *Figure 14.37*.)
8. When both pre- and post-stress data files are chosen, the **Calculate** button is enabled. Check the recipe in the Analysis box and if correct for the pre- and post-stress data files, click on **Calculate** to perform the stress analysis. (See *Figure 14.37*.)

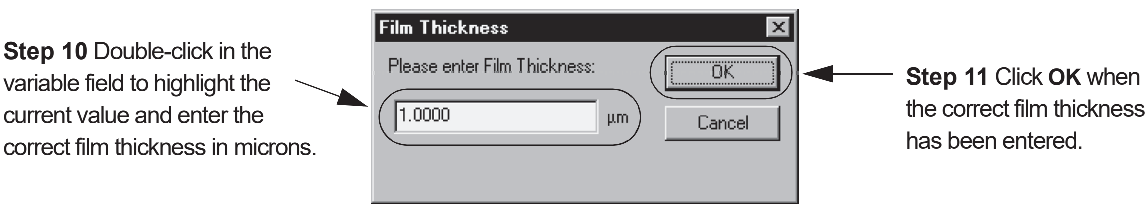
9. If an incorrect match is made of recipes between the pre- and post-stress data files, and the chosen recipe, a warning box appears. (See *Figure 14.38*.) Click **OK** to abort the calculation. Start again by choosing the stress recipe in the recipe catalog and again choose the pre- and post-stress scan data files.

Figure 14.38 *Calculation Warning for Mismatched Recipes*



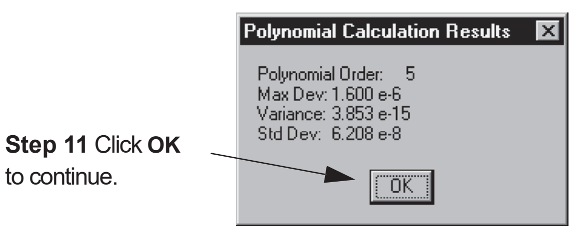
10. If the data files are accepted for calculation, the **Film Thickness** dialog box appears. (See *Figure 14.39*.) Enter the film thickness, in microns (µm) in the variable box.
11. Click **OK** when the thickness has been entered. (See *Figure 14.39*.)

Figure 14.39 *Film Thickness Dialog Box*



12. The calculation is performed by the system and the calculation results message box titled, **Polynomial Calculation Results**, appears. (See *Figure 14.40*.) Click **OK** to continue.

Figure 14.40 *Polynomial Calculation Results*



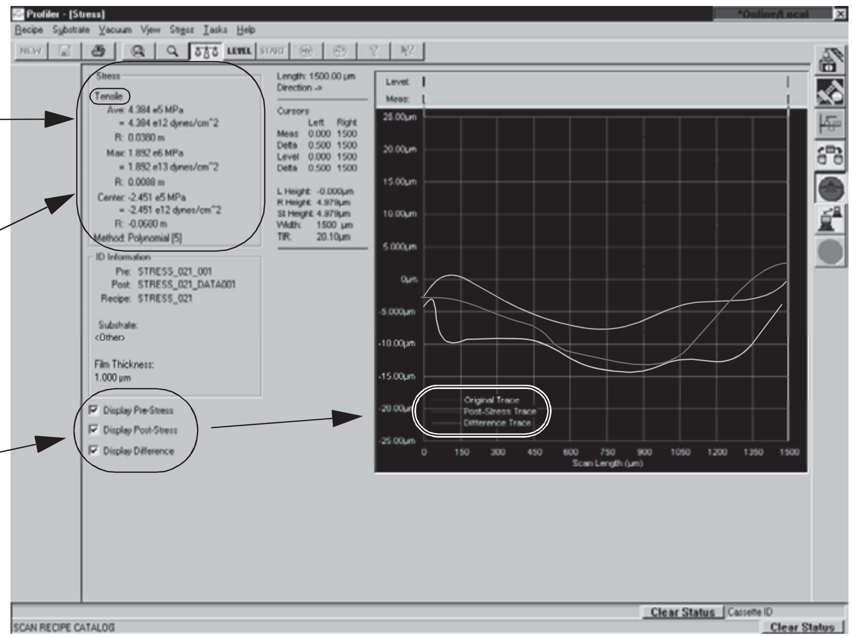
13. The Stress calculation analysis screen opens for reviewing the result of the calculation. (See *Figure 14.41* and *Choosing the Stress Calculation Method* on page 14-19.)

Figure 14.41 *Stress Calculation Analysis Screen*

A general result is posted at the top of the Stress analysis box. In this case the results show the stress to be **Tensile**. (See *Figure 14.43*.)

The **Stress** analysis box contains the stress calculation results. (See *Introduction on page 14-1*.)

Put a check in the check box of each trace that is to be displayed on the screen.



NOTE: The data and traces are fictitious and created only to show the position of data reports.

Analyzing the Results

The calculation results are displayed in the Polynomial Calculation Results message box immediately after the scan is complete. See *Table 14.3* for an explanation of the individual results. Click **OK** to continue with the analysis display.

Figure 14.42 *Polynomial Calculation Results*

Click **OK** to continue.

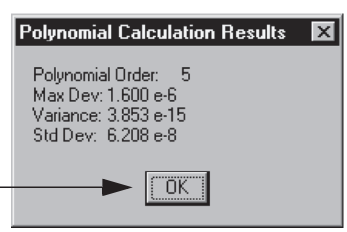
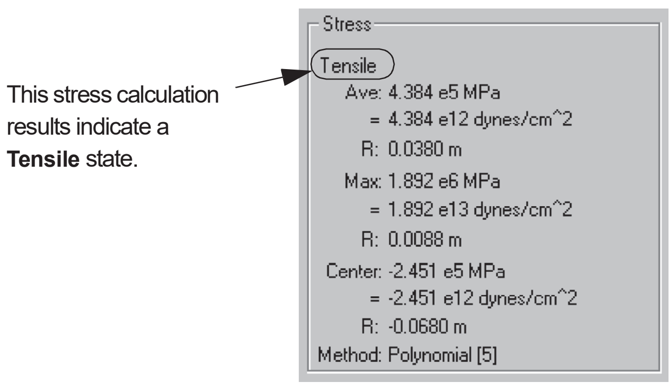


Table 14.3 *Polynomial Calculation Results Message Box*

Result	Explanation
Polynomial Order	Chosen as part of the Recipe. (See *Choosing the Stress Calculation Method* on page 14-19.)
Max. Dev.	Maximum Deviation of the fit polynomial from the original profile
Variance	Variance = (Standard Deviation)^2
Std. Dev.	Standard Deviation from the Mean

After the Polynomial Calculation Results message box is closed, the Stress Analysis screen is displayed. The Stress box in the upper left portion of the screen (see *Figure 14.43*) displays the results of the calculation. The computative analysis is characterized at the top of the box as either compressive or tensile. (See *Table 14.4* for an explanation of the box contents.)

Figure 14.43 *Stress Calculation Results Box*



The results in each category are displayed in MPa and dynes/cm^2. In addition, the **`R:`** in each set of data represents the Radius of Curvature. The Radius of Curvature is the average radius used in calculating stress per the definitions in the Introduction.

Table 14.4 *Stress Calculation Results Box Contents*

Result	Explanation
Stress Designation	**Compressive**  Positive value average stress (Ave.) Positive value polynomial Tensile  Negative value average stress (Ave.) Negative value polynomial
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
Method	Polynomial Fit or 13 Point Least Square Fit

15

CMP ANALYSIS ALGORITHMS

INTRODUCTION

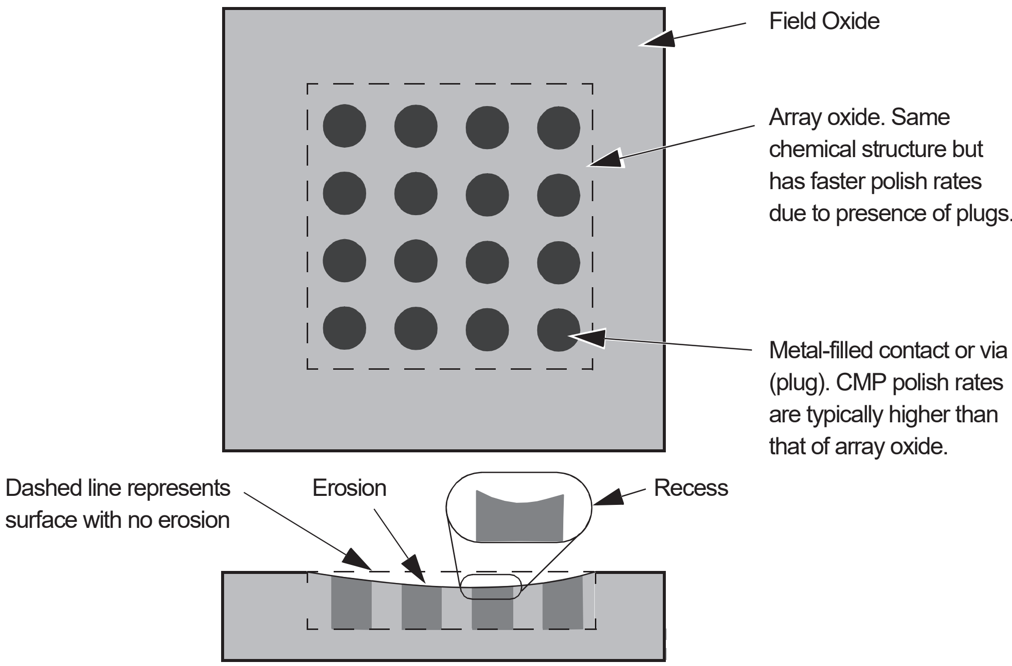
CMP (Chemical Mechanical Polishing) processes are used on a variety of different surface compositions. In general, the analysis of CMP surface scans centers around three structures: arrays, lines, and pads. Each of these structures requires its own unique method of analysis. The analysis can be performed on scans in 2D or 3D scans. In the P-15 systems, the analysis is integrated into the system software. Each basic structure is discussed in its own section. The CMP Analysis chapter contains the following sections:

- *Arrays* on page 15-2
- *Lines* on page 15-3
- *Pads* on page 15-5
- *Setup for Analysis* on page 15-6
- *Analysis Application* on page 15-8

ARRAYS

For the purposes of this analysis, "array" is defined as an array of circular contacts or vias (plug). 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 15.1*.

Figure 15.1 *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 calculates both erosion and recession.

Analysis Process

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

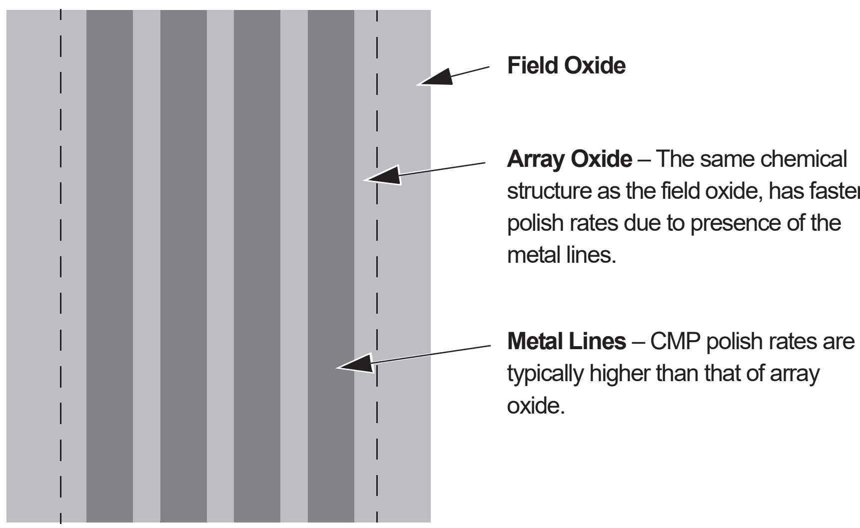
1. The data is smoothed using a median filter with a kernel (smoothing window) of five data points.
2. The "erosion region" (ER) is found by determining the minimum and maximum slopes in the profile. The slope of each point is defined to be the average slope with respect to the ten nearest neighbors.

3. The "calculations region" (CR) is defined as some fraction of the ER. By default this fraction is set to 1/2 (50%).
4. Determine the local maxima within the CR using a window of 5 data points.
5. Determine the local minima within the CR using a window of 5 data points.
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.

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 line is illustrated in *Figure 15.2*.

Figure 15.2 *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.

Analysis Process

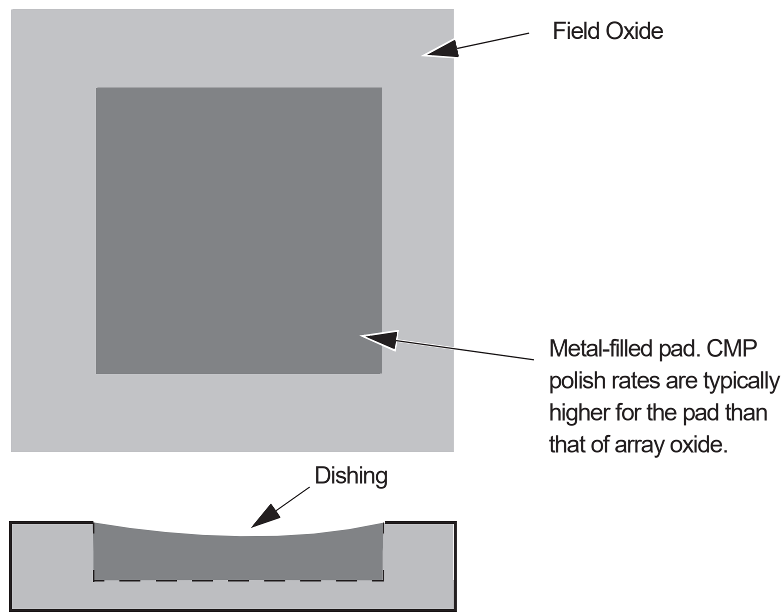
The analysis is performed on Normal data as described in the following sequence:

1. The data is smoothed using a median filter with a kernel (smoothing window) of five data points.
2. The "erosion region" (ER) is found by determining the minimum and maximum slopes in the profile. The slope at each point is defined to be the average slope with respect to the ten nearest neighbors.
3. The "calculations region" (CR) is defined as some fraction of the ER. By default, this fraction is set to 1/2 (50%).
4. Determine the vertical range of data within the CR. Define Tolerance to be 1/2 of the vertical range.
5. 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.
6. 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.
7. Using the local maxima, interpolate to obtain a curve that fits those points (curve A).
8. Using the local minima, interpolate to obtain a curve that fits those points (curve B).
9. Calculate the average of curve A. This is the erosion value.
10. 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 which typically has a polish rate higher than that of the surrounding oxide. The basic composition of a sample pad is illustrated in *Figure 15.3*.

Figure 15.3 *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

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

1. The data is smoothed using a median filter with a kernel (smoothing window) of five data points.
2. Find the "erosion region" ER by finding the minimum and maximum slopes in the profile. The slope at each point is defined to be the average slope with respect to the ten nearest neighbors.
3. The "calculations region" (CR) is defined as some fraction of the ER. By default, this fraction is set to 1/2 (50%).
4. Calculate the average of all data points within the calculation region. This will be the dishing value.

Setup for Analysis

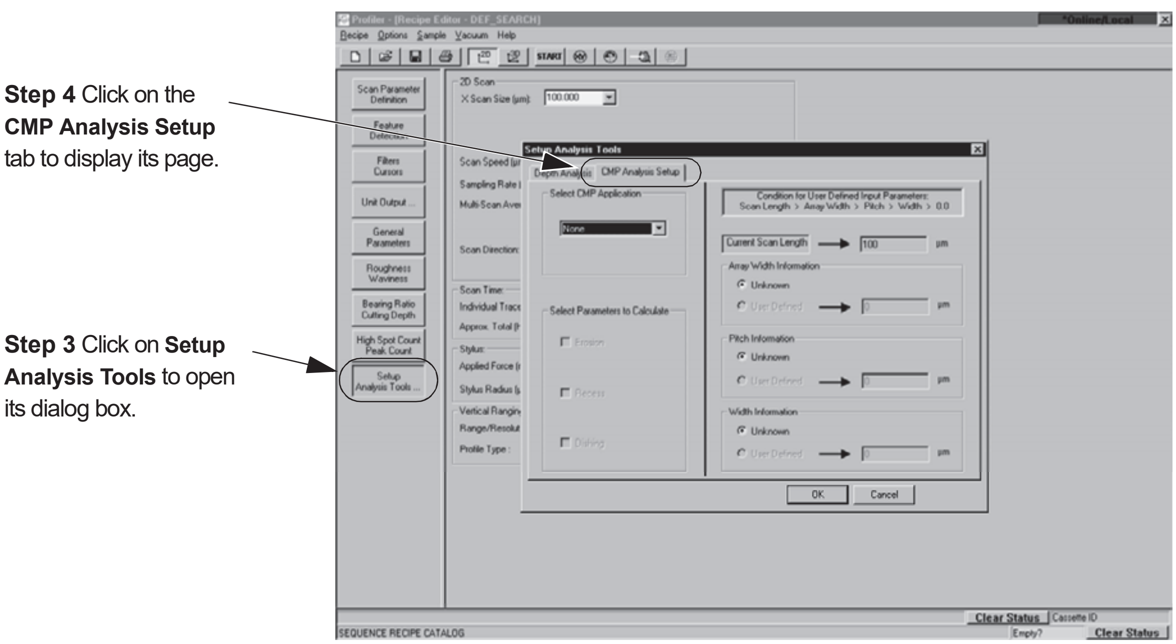
Introduction

A scan can be programmed to include any of the three types of analysis, erosion, recess, and dishing, using the scan recipe. The scan data is processed to present erosion and recess, or dishing values to the Analysis screen. In addition, the 6.x software saves the data from each scan so that the erosion, recess, or dishing values can be calculated later by changing the recipe parameters used to create the original scan.

Setup for Erosion and Recess Analysis

1. From the Catalog screen choose **Scan Recipe**.
2. Double-click on the required recipe to open the Recipe Editor for that recipe. (Or click to highlight the required recipe, then click on **View/Modify** at the bottom of the screen.)
3. From the Recipe Editor screen choose **Setup Analysis Tools**. This displays the Setup Analysis Tools dialog box. (See *Figure 15.4*.)
4. Click on the **CMP Analysis Setup** tab to display its page. (See *Figure 15.4*.)

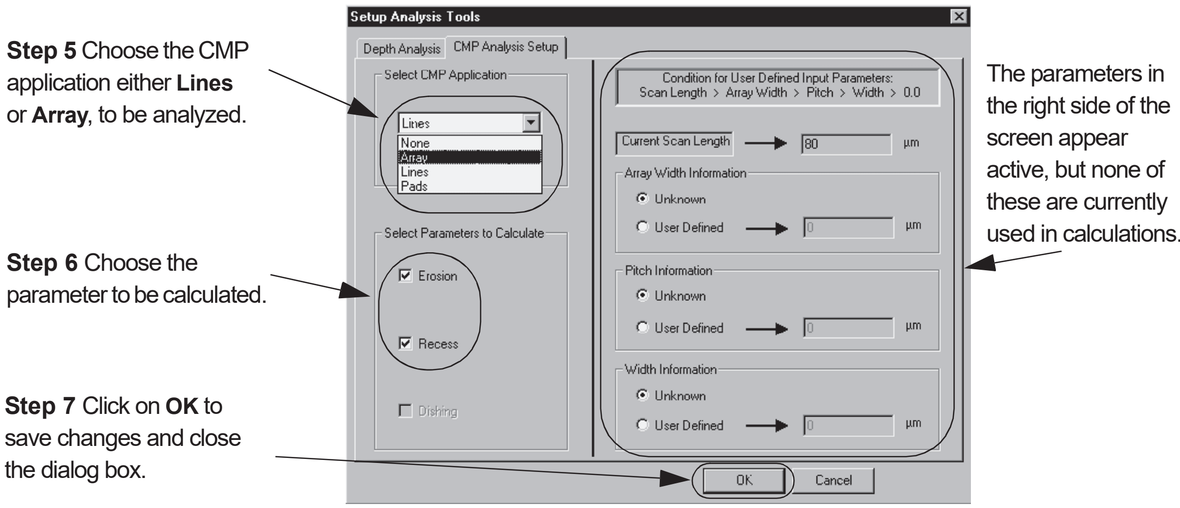
Figure 15.4 *Setup Analysis Tools Dialog Box*



5. From the **Select CMP Application** drop-down menu select either **Array** or **Lines.**

   Both of these selection enable the Erosion and Recess analysis checkboxes in the **Select Parameters to Calculate** field. Both choices open with a check in their checkbox. (See *Figure 15.5*.) This indicates that they are enabled and will be calculated, with the results displayed in the Analysis screen's Statistics window.

Figure 15.5 *CMP Analysis Setup Page*



6. With either Lines or Arrays chosen, with the selected application displayed in the Setup CMP Application drop-down menu field, choose the parameters (Erosion, or Recess) to be calculated. The default is, both Erosion and Recess are enabled. (See *Figure 15.5*.) To enable or disable a parameter, click in the checkbox to toggle the check in and out of the field.

   Notice the parameters on the right side of the screen appear to be active. Values can be entered in the User Defined fields, but they are not currently used in the calculations. These parameters are part of an upcoming capability enhancement to the current algorithm.

7. Click **OK** when all the changes are complete. This closes the Setup analysis Tools dialog box.
8. The recipe must be saved after the recipe changes are complete if they are to be preserved in the recipe. (See *Figure 15.5*.)

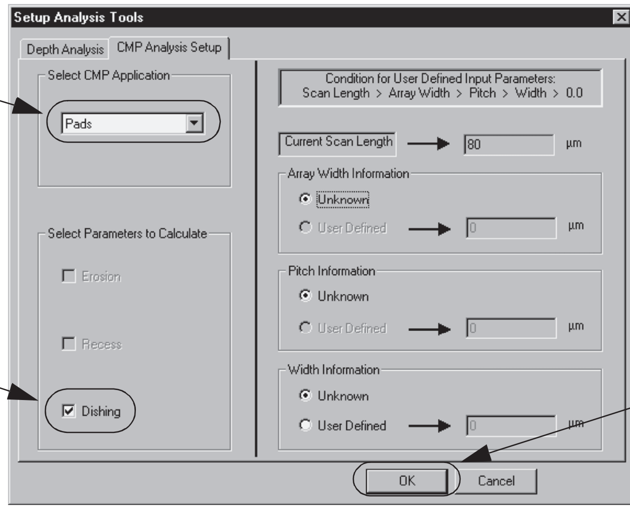
Setup for Dishing Analysis

The dishing analysis is performed on Pads. When the Pads application is chosen, the only parameter that is active is Dishing. Erosion and Recess are inactive.

1. In the CMP Analysis Setup page, choose **Pads** from the **Select CMP Application** drop-down menu.

   The **Select Parameters to Calculate** field changes to reflect the **Dishing** parameter active and enabled. If left as it is, the Dishing analysis takes place and the results are displayed in the Analysis screen's Statistics window.

Figure 15.6 CMP Analysis Setup for Pads Analysis



2. The Dishing parameter should be active and have a check in the checkbox (enabled). Leave it that way. If no check is present, click in the checkbox to place the check in the box. (See *Figure 15.6*.)
3. After all changes are complete, click on **OK** to save the changes and close the dialog box. (See *Figure 15.6*.)

Analysis Application

During the analysis of data following a scan, the chosen parameters are calculated and displayed in the Statistics window of the Analysis screen. For data gathered from scans that used recipes from previous software versions, the data can be recalculated by changing parameters in the recipe originally used to create that data. this means that data which was originally processed without the erosion, recess, or dishing calculations can be recalculated by activating these applications and parameters in the original recipe.

Analysis of New Data

When a scan or sequence of scans are run using one or more recipes containing the CMP Analysis Algorithm, the results are displayed in the Analysis screen immediately following the scan.

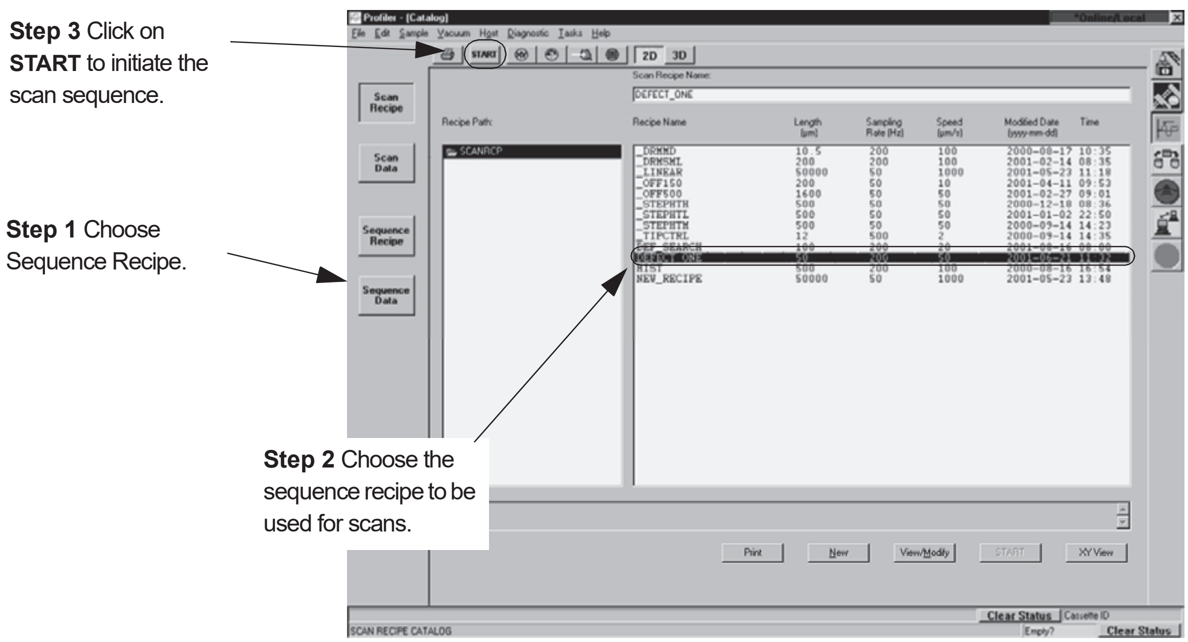
1. Set up the recipe to be used according to the procedures described in the section titled *Setup for Analysis* on page 15-6.
2. If the recipe, or a series of related recipes, is to be used in a sequence, follow the procedure for establishing a sequence described in *Creating a Sequence Recipe* on page 7-13.

Starting a Sequence Containing CMP Analysis

The following procedure assumes that the recipes used in the sequence have already been set up to perform the CMP analysis.

1. In the Catalog screen, choose **Sequence Recipe**. This displays the available sequence recipes in the List window. (See *Figure 15.7*.)
2. In the Sequence Scan List window, click on to highlight the sequence recipe to be used. (See *Figure 15.7*.)
3. Click **START** to initiate the scan sequence. (See *Figure 15.7*.)

Figure 15.7 *Sequence Recipe Catalog Screen*



4. Click on **START** in the tool bar to initiate the scan sequence. (See *Figure 15.7*.) The screen changes to the View Scan screen and scan sequence begins. The procedure continues until all the scans at all the designated sites are complete. When the sequence ends the system performs all the required calculations. The Analysis screen is then displayed.

Analysis Screen for Sequences Running the CMP Analysis

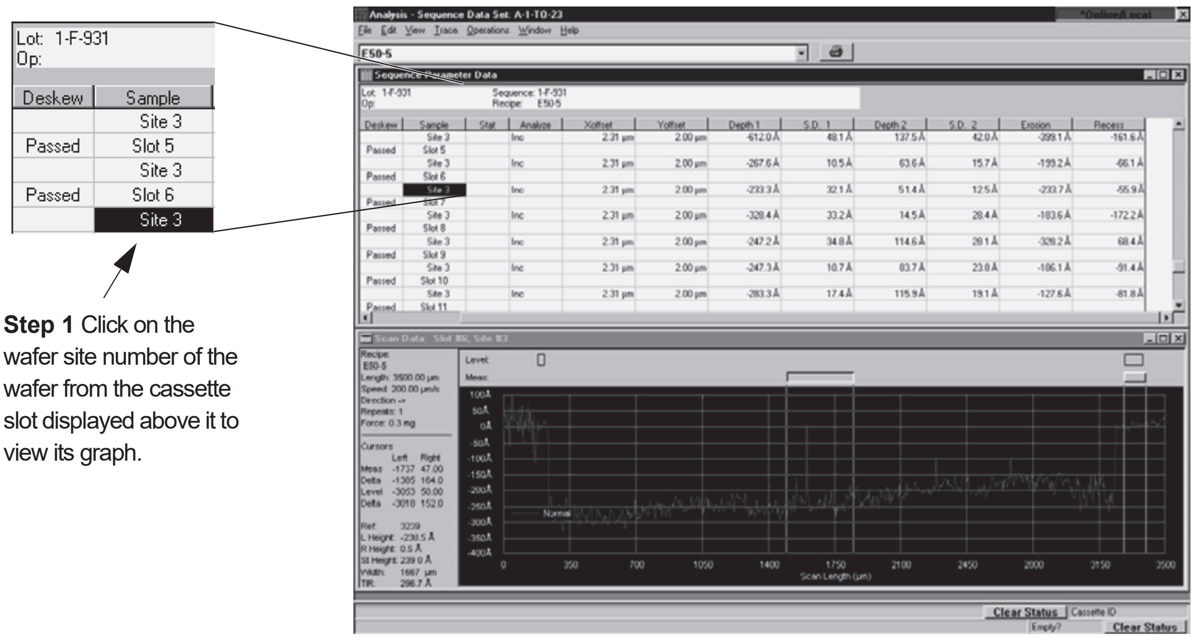
The Analysis screen is composed of two major windows, the Analysis Trace and the Statistics. For more information on 3D the Analysis screen functions see *3D Analysis Screen Features* on page 9-3, and for 2D see *2D Analysis Window Features* on page 8-5.

Once the screen is open, the results of the CMP Analysis calculations are visible in the Statistics window. (See *Figure 15.8*.)

The sequence in *Figure 15.8* contains scans from each wafer in a cassette. The same sites were scanned on each wafer. One scan is performed on each different site on the wafer. Each site scan is performed using a different recipe. Each identical scan site on all the wafers is processed using the same recipe. E.g., all #3 scan sites use the same recipe. This makes it possible to correlate the results and view them all together in one place.

1. To view the trace of the statistics set in the Statistics window, click on the site number below the cassette wafer slot. (See *Figure 15.8*.)

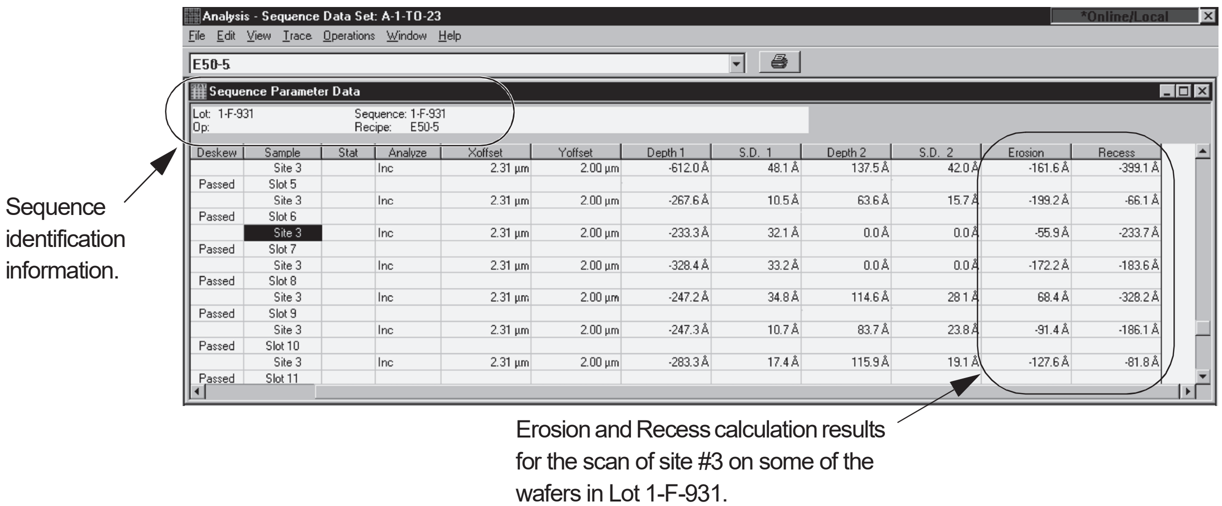
Figure 15.8 *Analysis Screen for Sequence with CMP Analysis*



Step 1 Click on the wafer site number of the wafer from the cassette slot displayed above it to view its graph.

The Erosion and Recess calculation results are displayed in their respective columns in the Statistics window. (See *Figure 15.9*.) If one of the calculations shows a result that is questionable, the trace can be viewed and the data recalculated after adjusting parameters, like applying a filter or cursor placement.

Figure 15.9 *Sequence Erosion and Recess Results*



Deskew	Sample	Stat	Analyze	Xoffset	Yoffset	Depth 1	S.D. 1	Depth 2	S.D. 2	Erosion	Recess
	Site 3		Inc	2.31 µm	2.00 µm	-612.0 Å	48.1 Å	137.5 Å	42.0 Å	-161.6 Å	-399.1 Å
Passed	Slot 5										
	Site 3		Inc	2.31 µm	2.00 µm	-267.6 Å	10.5 Å	63.6 Å	15.7 Å	-199.2 Å	-66.1 Å
Passed	Slot 6										
	Site 3		Inc	2.31 µm	2.00 µm	-233.3 Å	32.1 Å	0.0 Å	0.0 Å	-55.9 Å	-233.7 Å
Passed	Slot 7										
	Site 3		Inc	2.31 µm	2.00 µm	-328.4 Å	33.2 Å	0.0 Å	0.0 Å	-172.2 Å	-183.6 Å
Passed	Slot 8										
	Site 3		Inc	2.31 µm	2.00 µm	-247.2 Å	34.8 Å	114.6 Å	28 1 Å	68.4 Å	-328.2 Å
Passed	Slot 9										
	Site 3		Inc	2.31 µm	2.00 µm	-247.3 Å	10.7 Å	83.7 Å	23.8 Å	-91.4 Å	-186.1 Å
Passed	Slot 10										
	Site 3		Inc	2.31 µm	2.00 µm	-283.3 Å	17.4 Å	115.9 Å	19.1 Å	-127.6 Å	-81.8 Å
Passed	Slot 11										

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