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INSTALLATION, OPERATION AND MAINTENANCE CLEANROOM MANUAL

Dektak V 200-Si

200MM WAFER SURFACE PROFILER

P/N 333973
Revision 7.XX
Software Version 7.00 and higher

DEKTAK V 200-Si AND MICROSOFT® WINDOWS 3.1

DEKTAK V 200-Si operates in a graphics environment called Microsoft Windows 3.1, created by Microsoft Corporation. An extension of the MS-DOS® operating system, Microsoft Windows gives a standard look and feel to DEKTAK V 200-Si and all other Windows applications.

The DEKTAK V 200-Si package contains all the software necessary to run DEKTAK V 200-Si. You can also run DEKTAK V 200-Si under the full version of Microsoft Windows version 2.1 or higher.

With Microsoft Windows 3.1, you can take advantage of these additional features of the Windows environment:

1. Running multiple applications: You can run several applications under Windows at one time and easily switch between them, creating an integrated work environment.

2. Data exchange between applications: You can transfer data between DEKTAK V 200-Si and other standard DOS applications, files, directories, and disks, and control all DOS-related tasks such as directory or file management and formatting disks.

3. Windows control of the DOS environment: From the Windows environment you can easily access all Windows and non-Windows applications, files, directories, and disks, and control all DOS-related tasks such as directory or file management and formatting disks.

To run DEKTAK V 200-Si under Microsoft Windows, you need to license and install Microsoft Windows Version 2.1 or higher.

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SECTION 1

UNPACKING AND INSTALLATION

ENVIRONMENT REQUIREMENTS (U.S.A. ONLY)

Temperature

Normal operating temperature should be between 18 to 25 degrees Celsius, ±1 degree (64 to 77 degrees Fahrenheit, ±1.8 degrees).

Clean Room

The Dektak Series V system should be operated in a Class 100 or cleaner environment.

Clean Air Flow Rate

Down-blowing laminar flow not to exceed 100ft/min (30m/min).

Relative Humidity

30 to 45% relative humidity (non-condensing).

Electrical Power

Power requirements:	100/120/120 VAC (±5%) at 5 amps, 1 Phase, 50/60Hz 200/230/240 VAC (±5%) at 3 amps, 1 Phase, 50/60Hz
Power demand:	350 VA maximum
Power connection:	A 3 meter, 3 conductor, 16AWG, power cord is supplied with the system. The cord is terminated with a male NEMA L5-15 connector. This connector is rated for 13 amps, 1,625 watts @ 125 VAC.

Vacuum

24" (600mm) Hg minimum constant vacuum for the system with one fitting for 1/4-inch OD tubing. Standard fitting is 1/4-inch slip connect.

Clean Dry Air

100 psi (690 kPa) clean air for the system with one fitting for 1/4-inch OD tubing. Standard fitting is 1/4-inch slip connect.

Venting

The system has one 5-inch OD exhaust port for cooling air fan. The standard configuration has the port at the back of the central lower area of the cabinet. An optional configuration has the air exhaust port through the base of the unit.

If it is not desired to vent the cooling air into the fab environment, then provisions must be made to duct the air into the service chase area or a ducted exhaust system. If venting to an exhaust system, the flow of the exhaust system should not create back pressure at the exhaust fan.

Vibration Interference

The system should not be operated near sources of vibration (such as fans, motors) or in excessive flow of a clean room air duct. Optimum performance will be obtained if placed in an area with little foot traffic and low acoustical noise. Vibration is not to exceed:

70 µg from 1 to 100 Hz on a floor with a flat noise spectrum

Floor

The floor must be level and rigid and capable of supporting the weight 300 lbs. (136kg) of the system.

System Location and Service Access

The system should be located within the work area to provide normal hallway passage in front of the system without interference with the operator. The left and rear sides of the system must have a minimum clearance of 24 inches (610mm) to provide service access.

UNPACKING

Please read the entire installation instructions prior to beginning installation.

The DEKTAK V 200-Si is shipped in two containers: one crate and onecardboard carton containing the monitor. The contents of the shipping crate and the unpacking instructions is provided in the following pages. Check the instrument visually to detect damage in shipment.

NOTE

Save all packing materials, should it be necessary to ship or return the equipment.

The DEKTAK V 200-Si Profiler is shipped in a large wooden crate and is bolted to a pallet. Save all shipping materials should it be necessary to reship the equipment. The procedure for uncrating is described below.

1. Remove the top of the crate by prying off the metal climps which hold the top of the crate in place. A climp hammer, crow bar, or slotted screw driver can be used to remove the climps.

2. Once the top of the crate is off, remove the four sides of the crate.

3. Cut or tear away the plastic wrap around the unit. Remove the sheet metal skins off the sides of the unit. The skins are held in place with industrial grade Velcro. To remove, pull skin firmly out away from the unit and lift up to disengage hooks at the top.

4. Four large bolts secure the unit to the pallet. Remove the nuts from the four bolts located under the pallet. It may be eaier to lift the pallet off the floor witha forklift to access the bolts. Remove the four bolts securing the unit to the pallet.

5. Use a forklift to lift the unit from the pallet. Take care not to snag any cables with the fork blades that may be hanging down below the frame. Make sure the forklift makes solid contact with the front and rear crossbar of the table frame. Attempting to lift the unit from any other direction may damage the machine. With the forklift correctly positioned, lift the system off the pallet. Lower the system to the floor onto a sturdy level surface, casters allows the system to be maneuvered once on the ground. Raise the four feet as far into the frame as they will go, to support the instrument on the four casters.

CAUTION

The DEKTAK V 200-Si is heavy. Attempting to lift the unit without proper equipment may result in personal injury and/or damage to the equipment.

INSTALLATION

Once the DEKTAK V 200-Si is placed on a level surface, the unit is ready to be rolled to its permanent location. Wheel the instrument into its operation position, ensuring adequate service and maintenance clearance (see Figure 1-1).

Leveling

When the unit is moved to its permanent location it must be leveled to insure proper vibration isolation. Place a level on the robot mounting plate as close to the center of the machine as possible. Use a wrench to turn the bolts located on the bottom side of each frame leg clockwise until the wheels lift off the floor. Check the level to see which leg needs more or less adjustment.

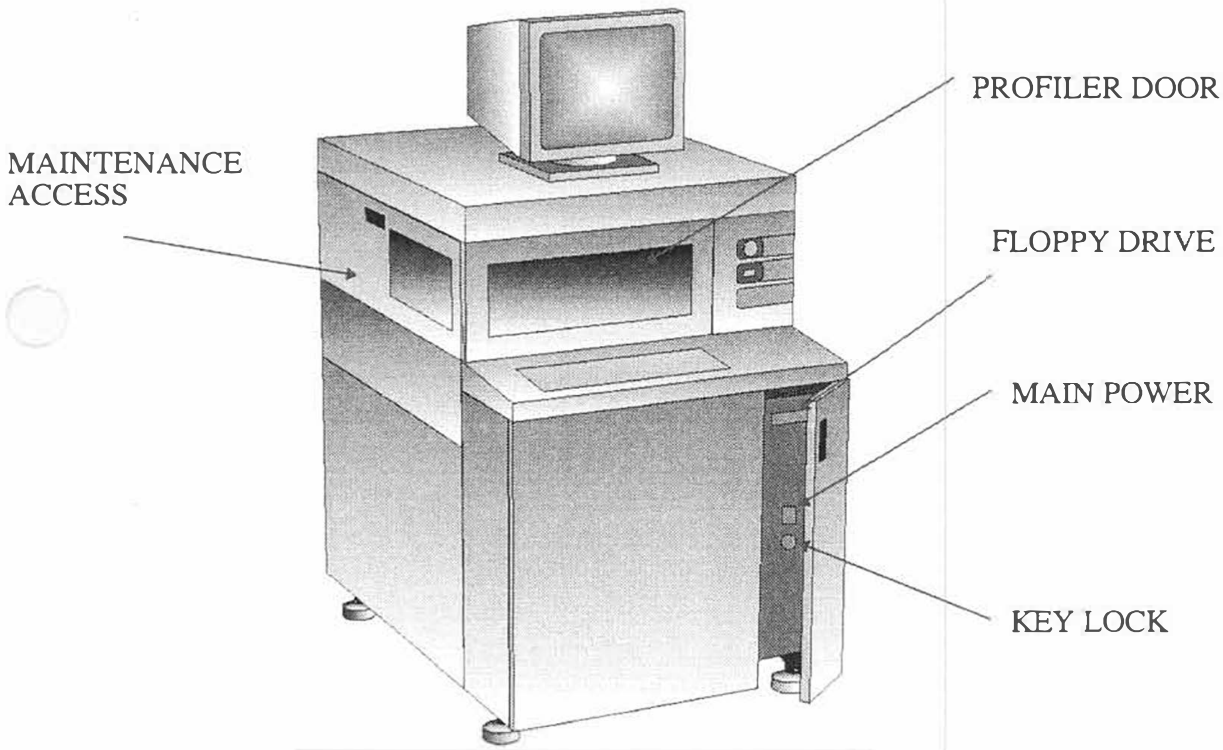


Figure 1-1. Facilities Requirements

- Electricity: 110/220 VAC, 50/60 Hz, 350VA (connect to back)
- Compressed Air: 100 PSI (connect to back)
- Vacuum: 24 inch Hg. (connect to back)
- CE approved
- S2-93 Certified
- Lockable front door for security
- Upgradable to loader system

SHIPPING BRACKETS

To protect the precision sample stage and stylus mechanism during shipment, special fixtures are put in place to restrict their movement within the profiler. The instructions for removing the shipping brackets.

CAUTION

Neglecting to remove any or all of the shipping brackets prior to operation may result in damage to the equipment.

Isolation Table Shipping Brackets

These brackets must be removed before inflating the legs of the isolation table. The shipping brackets connect the isolation table and the table frame during shipping. The brackets must be reinstalled prior to reshipping the unit to prevent damage to the profiler. Remove the side covers and the top cover to access these brackets.

Stage Bracket

Bracket connects the stage to the glass block plate. Remove the four screws holding the bracket.

Surface Block Bracket

An angle bracket secures the surface block plate to the profiler base. To remove the surface block bracket, unscrew the four screws holding down the bracket.

Tower Bracket

A steel bracket is used to restrict the movement of the tower which houses the stylus mechanism. To remove the tower bracket, unscrew the two screws attaching the bracket to the right side of the tower and the tower drive assembly.

CAUTION

The shipping brackets must be reinstalled prior to reshipping the unit or damage to the equipment may result. Save all brackets and screws should it become necessary to return the unit.

AIR, VACUUM, ELECTRICAL CONNECTIONS

Air Pressure Connector

The Dektak V 200-Si is built upon a vibration isolation table and requires no less than 100psi to operate properly. Locate the air pressure connector inside the front right door. Connect the facility air pressure line (1/4" [6.35mm] O.D. tubing) to the "one-touch" fitting attached to the air pressure regulator, marked "**PRESSURE.**" Factory-adjusted to regulate the facilities air pressure to 40 psi, the regulator may need slight adjustments depending upon variations of facility air pressure. After adjusting the pressure regulator to output 40 psi, turn on the air pressure. Allow at least 5 minutes for the isolation table to fully engage. Check each corner of the table by pushing down gently. If the table is not floating freely on each corner, more adjustment may be necessary.

NOTE: The levelling valves are set to approximately 25 psi. The input pressure is not to exceed 10-15 psi above the operating pressure.

Air Vacuum Connectors

The loader robot and vacuum chuck require no less than 24 inches Hg. of vacuum. The air vacuum connector is located on the rear panel. Connect the facilities vacuum line (1/4" [6.35mm] O.D. tubing) to the "one-touch" fitting marked "**VACUUM.**" Connect the air line in a similar fashion. To connect the lines, press them ***firmly*** into the fitting until they fully seat. The air vacuum may now be turned on.

Monitor Cable Connections

The multisync color video monitor can be placed on top of the V 200-Si or on the counter beside the system. The adjustable monitor can be swiveled or tilted for operator comfort. The connectors for the monitor cables are located on the top of the DEKTAK V 200-Si profiler.

Thermal Printer Connections

The DEKTAK V 200-Si comes equipped with an Omni B&W thermal printer. The connectors for the printer cables are located on the top of the DEKTAK V 200-Si profiler.

Exhaust Port

The system has one 5-inch OD exhaust port for cooling air fan. The standard configuration has the port at the back of the central lower area of the cabinet. An optional configuration has the air exhaust port through the base of the unit.

If it is not desired to vent the cooling air into the fab environment, then provisions must be made to duct the air into the service chase area or a ducted exhaust system. If venting to an exhaust sytem, the flow of the exhaust system should not create back pressure at the exhaust fan.

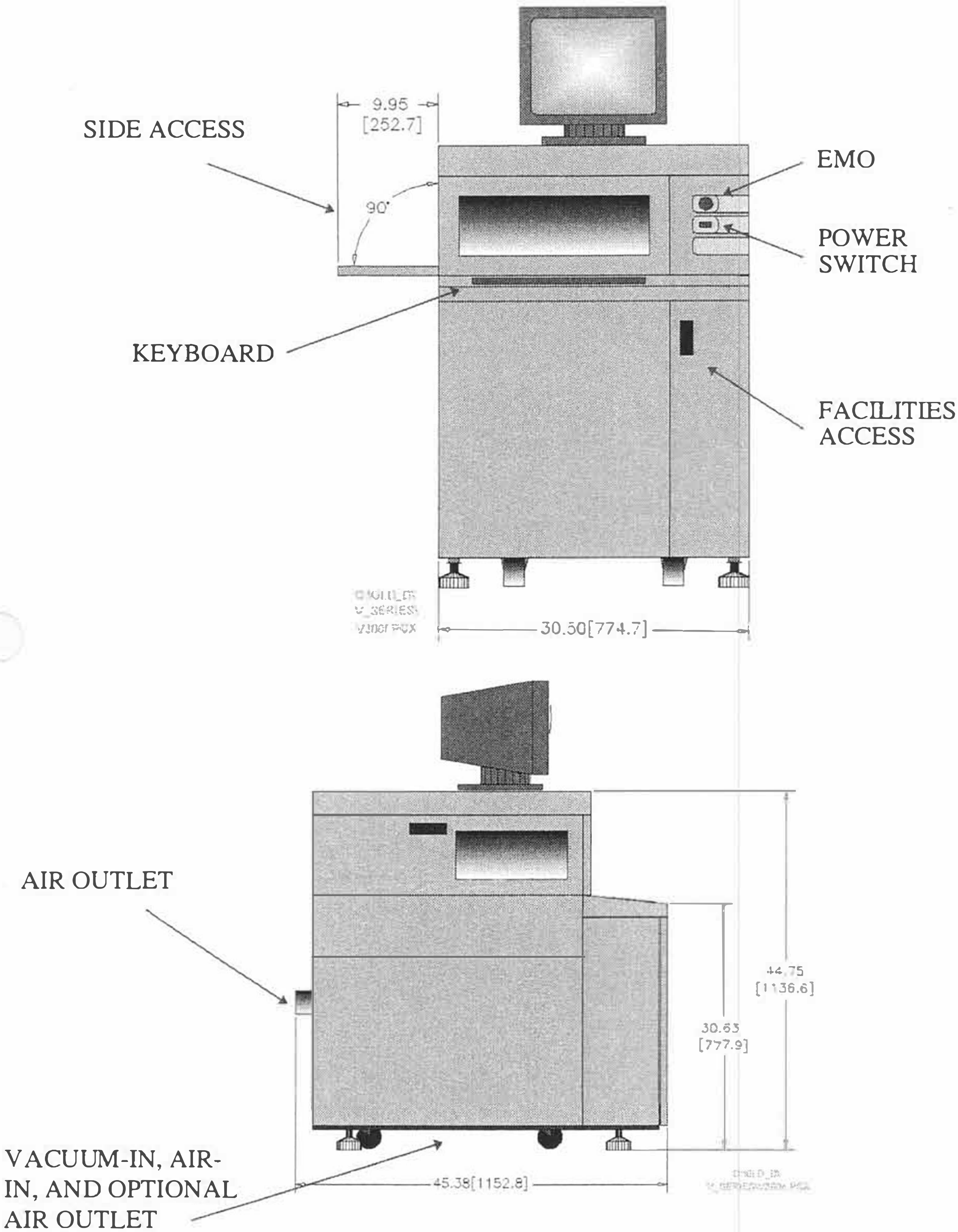


Figure 1-2. Physical Characteristics

POWER SUPPLY SETTING

The power supply has been factory set at the appropriate voltage for the original user facility. If the unit is transferred to a facility where the voltage is different, it will be necessary to change the power supply setting. The procedure to verify or change the power supply setting is as follows:

1. Verify that the main power switch located on the back of the computer console is turned off "O" and the main power cable is disconnected from its primary power source and the computer console.

2. Once the main power cable is disconnected from the Computer Console, slide the clear plastic shield to the left until the fuse is exposed.

3. The voltage select card is located next to the fuse. Verify that the voltage displayed is the correct voltage setting. If it is not, the voltage setting will need to be changed.

4. To change the voltage supply setting, remove the fuse holder and the voltage select card. Firmly but carefully pull the voltage card straight out of the cavity.

5. Four different voltage supply settings are available depending upon how the card is installed (see Figure 1-1). Reinsert the voltage supply card according to the desired voltage setting facing outward.

6. Once the voltage supply card has been reinstalled with the correct voltage setting displayed, reinsert the fuse holder with the voltage setting revealed through the opening of the plastic shield of the fuse holder.

7. Connect the facilities electrical supply to the instrument using an approved IEC-320 power cord, rated at 16 amps or higher.Connect the main power of the Dektak V 200-Si into a power outlet providing the appropriate voltage as shown on the voltage select card.

CAUTION

Never connect the Dektak V 200-Si to a power source which provides a voltage that is different from the power supply setting of the voltage select card.

Verify that the courtesy power switch (located on the front panel) is in the "Off" position, so that the "**O**" is depressed.

Turn on the integral circuit breaker by pressing the circuit breaker switch (located in the facilities interconnect) to the "On" position, so that the "I" is depressed. This activates the emergency off (EMO) circuitry. If the large red EMO switch is depressed, this circuit breaker will be set to the off (open) position, and all power to the instrument disabled. After the power cord has been attached, verify that the emergency off switch (EMO) has been reset. It is reset when it is in the extended position, and activated when it is in the depressed position.

SYSTEM CHECKOUT

Once all of the appropriate cable connections have been completed, The DEKTAK V 200-Si can be powered up to verify that the system is operating properly. The DEKTAK V 200-Si operating software was loaded onto the hard disk at the factory prior to shipment.

1. Turn on the monitor and printer.
2. Power up the DEKTAK V 200-Si by turning on the main power switch located on the front of the profiler.
3. The software will boot up and the DEKTAK V 200-Si sign on screen will be displayed on the monitor (see Figure 1-2).
4. The stage will automatically initialize by first translating to the null position and then centering itself below the stylus.
5. Roll the trackball to verify that the arrow displayed on the monitor responds to the motion of the pointing device.

NOTE

If the DEKTAK V 200-Si does not properly power up and initialize as described above, contact Veeco/Sloan Product Support at (805)963-4431.

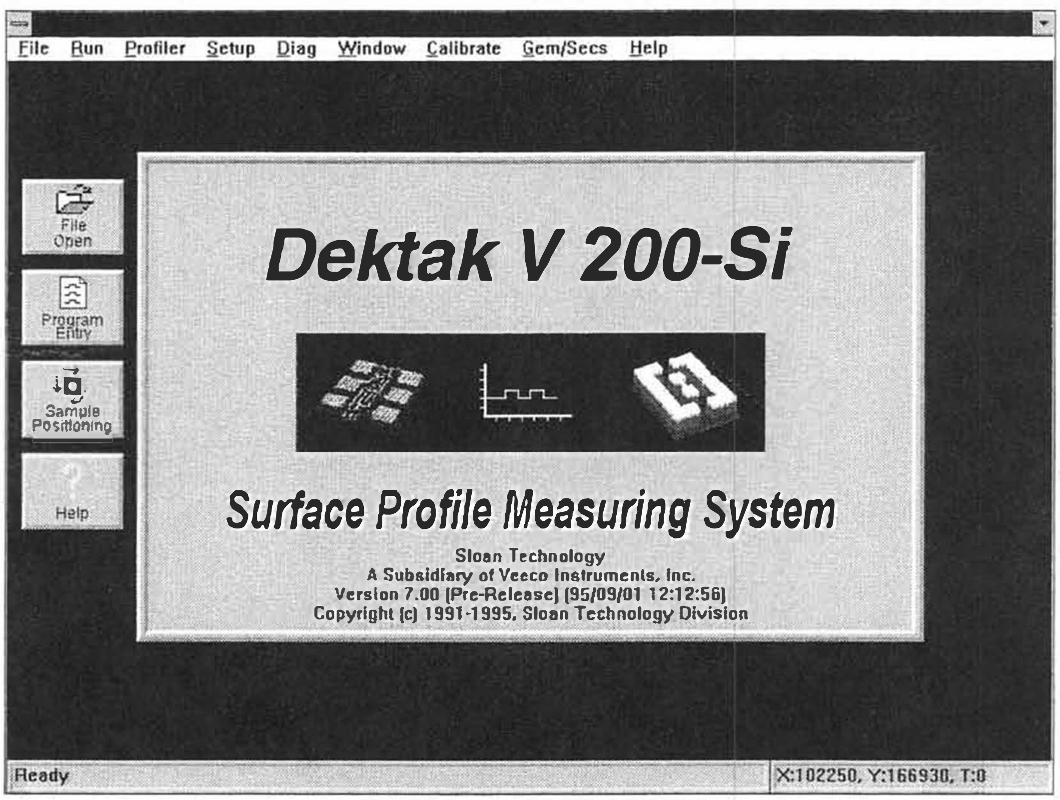


Figure 1-3. Sign on Message

LOADING THERMAL PRINTER PAPER

Before loading paper into the Omni printer provided with the DEKTAK V 200-Si, the end of the paper must be cut squarely without any jagged edges.

1. In most environments, it is acceptable for the standard thermal printer to be installed on the top of the DEKTAK V 200-Si Scan Head. Pull the "Printer Head" lever forward to lift the head.

2. Open the paper roll cover. Place the printer paper in the curve of the paper roll cover, with the paper rolling off the bottom of the roll toward the printer. Insert the paper under the rubber platen until the edge appears on the top of the platen.

3. Pull at least two inches of paper through the printer making sure the paper is centered on the platen. Return the "Printer Head" lever to the back position.

4. Hold the end of the threaded paper so it remains outside when closing the paper roll cover.

5. Turn on the DEKTAK V 200-Si main power switch. Press and hold the "Paper Feed" button and turn on the printer. The printer should begin the "Self Test" mode. The paper should feed out smoothly. Any adjustments can be made by moving the "Printer Head" lever forward and adjusting the paper position.

6. Place the printer cover over the printer. Feed the paper through opening.

NOTE

Change printer paper immediately after the end of roll warning lines are sighted to avoid roll bindup problems.

PRINTER SELECTION

If an external printer is to be used, other than the standard Omni thermal printer, the DEKTAK V 200-Si can transfer the print signal to the external printer port on the rear panel of the computer console. Refer to the Microsoft Windows manual for a listing of compatible printers. The procedure for printer selection is described below.

1. Click-on "Set-Up" from the system menu bar and click-on "Printer Port" from the Set-Up Menu. A dialog box will display "Internal (OmniPrint 426)" and "External Printer."

2. To send print data to the external printer port click-on "External Printer" and click-on "OK".

SECTION 2

GENERAL INFORMATION

INTRODUCTION

The DEKTAK V 200-Si is an advanced surface texture measuring system which accurately measures surface texture below submicro-inch and film thickness to 262 microns.

Principle of Operation

Measurements are made electromechanically by moving the sample beneath a diamond-tipped stylus. The high precision stage moves a sample beneath the stylus according to a user-programmed scan length, speed and stylus force. The stylus is mechanically coupled to the core of an LVDT (Linear Variable Differential Transformer). As the stage moves the sample, the stylus rides over the sample surface. Surface variations cause the stylus to be translated vertically. Electrical signals corresponding to the stylus movement are produced as the core position of the LVDT changes respectively. An analog signal proportional to the position change is produced by the LVDT, which in turn is conditioned and converted to a digital format through a high precision, integrating analog to digital converter. The digitized signals from a single scan are stored in computer memory for display, manipulation, measurement, and print. Stored programs that can be readily changed make the DEKTAK V 200-Si ideal for both production and laboratory use.

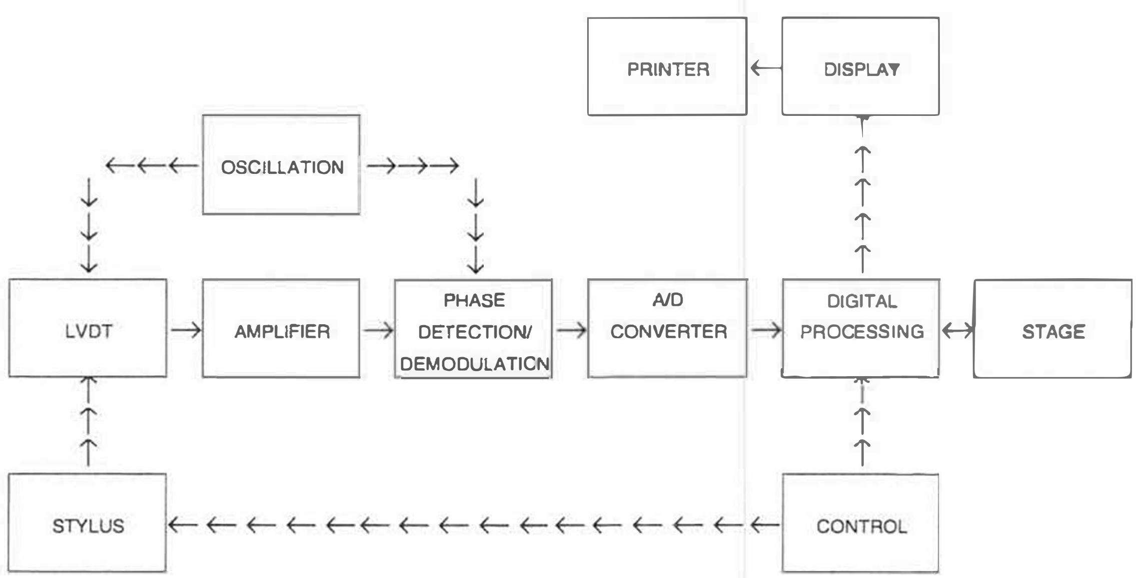


Figure 2-1. Block Diagram of DEKTAK V 200-Si Architecture

CONFIGURATION

Computer Console

The Computer Console incorporates a Pentium computer. The 1.4 MByte, 3-1/2" high density diskette drive permits off line use. Microsoft Windows provides an easy to learn, easy to use interface with pull-down menus and pop-up windows.

Video Monitor

The DEKTAK V 200-Si video monitor is a 15 inch high resolution (720x480 pixels), Super VGA color monitor. It displays programs and graphics in full color, along with a color video image of the substrate surface. It can also be used to view the substrate either alone or with the graphics superimposed.

Precision Scan Head

The DEKTAK V 200-Si precision Scan Head unit contains the mechanical and optical components for sample placement, sample viewing, scanning/measurement and environmental protection. A diamond tipped stylus permits accurate measurements in a wide range of applications. User programmable stylus force from submilligram to 30mg. allow profiling on soft or hard surfaces.

Motorized Video Zoom Camera

A remote controlled 60X to 420X Solid-State Video Zoom optics system and a variable intensity illuminator permits viewing of the sample in the measurement area.

Programmable Sample Stage

A very high precision programmable sample stage performs the scan and permits X-Y positioning to any location of measurement interest in a 200mm x 200mm (8 x 8 inch) area. Theta rotation can be entered in 0.001 degree increments up to 360 degrees. Sample positioning can be controlled via DEKTAK V 200-Si keyboard and trackball.

Thermal Printer

The standard thermal printer produces full-sized printouts in less than 6 seconds. These printouts provide a graphic record of measurement and program data for future reference and/or reproduction. Clean room compatible thermal printer paper is available. Printouts can also be produced on an Epson compatible external printer.

STYLUS SIZE CONSIDERATIONS

A stylus based surface profiler measures the actual physical surface of sample. In certain applications, stylus size and shape should be taken into consideration.

The radius of the standard diamond stylus is 12.5 microns. The standard stylus meets most all requirements for the majority of applications. Some applications, however, may require either a larger or smaller tip radius.

NOTE

Reducing the stylus tip radius increases the point pressure on the sample and may require the stylus force to be reset. Stylus force may be programmed from submilligram to 30mg.

Optional styli with radii of sub-micron, 2.5 micron, 5 microns, 12.5 microns, and 25 microns are available for applications which require very high horizontal resolution or measurement of very soft films.

SCAN SPEED VS. STYLUS FORCE

When using a low stylus force, the stylus may tend to lift off the surface if a large step is encountered at higher scan speeds. In applications where a light stylus force is required, it is recommended that low or medium scan speed be used at the shortest possible scan length.

STYLUS TOWER DESCENT RATE

A programmable stylus tower descent rate gently lowers the stylus onto the sample surface. To increase throughput a proximity sensor allows rapid descent of the stylus tower prior to contacting the sample surface. As the stylus tower is lowered, the proximity sensor automatically slows the stylus descent rate to the selected value prior to the stylus contacting the sample surface.

HORIZONTAL RESOLUTION

The exclusive HyperScan feature provides ultra high horizontal resolution with a maximum of up to 65,400 data points available per scan. The horizontal resolution of the DEKTAK V 200-Si is determined by the scan length and scan duration. The Dektak V 200-Si has a constant sampling rate of 300 data points per second. By slowing down the scan speed, more samples can be taken over a longer period of time. Thus, more samples can be taken over a given scan length. The duration of the scan time can be set from 3 seconds up to 218 seconds. The examples below provide the number of data points per scan at various scan durations for a 2000µm scan length.

Duration	Data Points	Maximum Resolution
218 seconds	64,500	0.031µm/sample
50 seconds	15,000	0.133µm/sample
13 seconds	3,900	0.513µm/sample
3 seconds	900	2.222µm/sample

The following formula may be used to determine the number of data points for any given scan length and speed.

$$\text{\# Data Points/Scan} = \frac{\text{Scan Length (in microns)}}{\text{Horizontal Resolution (in microns)}}$$

The horizontal resolution of the DEKTAK V 200-Si is directly related to the scan length and the number of data points per scan. The scan length is selectable from 50 microns to 200 millimeters. Without altering the number of data points per scan, the horizonatal resolution or the distance between data points can be adjusted by altering the scan length. The scan resolution parameter displays the distance between data points (in microns per sample).

SCAN STORAGE DATA REQUIREMENTS

Scan data can be stored on either the hard disk or on floppy diskettes. The number of data files that can be stored is dependent on the number of data points taken during the scan. It takes five bytes of storage space for each data point plotted. Therefore, a 13 second scan will require approximately 18,750 bytes of disk space.

DEKTAK V 200-SI TECHNICAL SPECIFICATIONS

Vertical Range:	25Å to 2,620 KÅ (0.1 microinch to 10 mils)
Vertical Resolution:	1Å/65KÅ, 10Å/655KÅ, 40Å/2620KÅ,
Scan Length Range:	50 microns to 200mm (2 mils to 8 inches)
Scan Speed Ranges:	3 seconds to 218 seconds
Software Leveling:	Two-point programmable or cursor leveling
Stage Leveling:	Automatic and power leveling
Stylus (standard):	Diamond, 12.5 micron radius
Stylus Tracking Force:	Programmable, submilligram-30mg
Maximum Sample Thickness:	45mm (1.75 inches)
Sample Stage Diameter:	200mm (8 inches)
Sample Stage Translation:	X Axis, 200mm (8 inches) Y Axis, 200mm (8 inches)
Sample Stage Rotation:	Theta, 360°
Maximum Sample Weight:	2.5Kg (5 lbs.)
Power Requirements:	100/115V or 220V, 50/60 Hz
Current:	10A @ 100/115V or 20A @ 220V (±10%)
Phase:	Single Phase
Warm-up Time:	15 min. recommended for maximum stability
Operating Temperature:	21° C ±3°C (70° F ±5°F)
Environmental Humidity:	40%, ±20%
Zoom Magnification:	60X to 420X
Color Camera:	Solid state produces color video image
Sample Illumination:	Variable intensity white light; IR/UV blocked
Dimensions:	30.5W x 45.4D x 60.5H (78 x 111 x 154 cm)
Vacuum Chuck:	Requires external vacuum 24" (600mm) Hg.
Vibration Isolators:	Requires 100 PSI (488 kg/m^2) compressed air.

OPTIONS/ACCESSORIES

See Appendix A in the back of this manual for a complete list of options and accessories for the DEKTAK V 200-Si.

Interactive 3-D Software	Provides 3-D renderings and surface area analysis.
SECS/GEM Software	Allows two-way communications between the Dektak V 200-Si and host computer conforming to the SECS II protocol.
Stress Measurement Software	Can calculate tensile or compressive stress on processed wafers. Includes special fixturing for three-point suspension of wafer.
Step Detection Software	Reference and measurement cursors automatically position before and after steps for automatic computation of analytical functions.
Extended Optics	Provides 115X to 735X zoom magnification of sample surface.
Calibration Standards	A broad line of calibration standards are available to calibrate the system for virtually any application. Both step height and VLSI roughness standards are offered.

OPERATION OVERVIEW

Automation Program

Automation Program files permit a number of Scan Routines to be programmed and stored on the hard disk. Scan Routines along with their X,Y,Theta stage locations are inserted into the Automation Program. Automation Programs can be stored for various applications in DOS file format on the hard disk, giving the DEKTAK V 200-Si virtually unlimited program storage capability.

Scan Routine

The DEKTAK V 200-Si Scan Routine consists of sixteen individual parameters which are selected using the trackball or mouse. Parameters such as scan length and speed, leveling, and stylus force can all be user determined. A total of 200 Scan Routines can be entered into each Automation Program file.

Sample Positioning

The sample is placed on the sample stage and positioned for scanning using the stage translation, rotation, and leveling controls. Sample positioning can be accomplished by using the trackball or mouse. In the fine positioning mode, the sample stage tracks the motion of the trackball or mouse. A crosshair reference is displayed on the monitor during fine positioning. This software reticle is superimposed over the video image of the sample surface.

In the course positioning mode, a template in the shape of a wafer or disk is displayed on the monitor. With the trackball or mouse, simply "point" to the desired location on the template, and the stage automatically translates to that position. The templates can also be rotated to accomplish theta rotation of the sample when the DEKTAK V 200-Si is equipped with the AutoTheta option.

Scanning

When a scan is run, the stylus is lowered onto the sample surface, and the stage moves the sample as the stylus rides over the surface features.. The Video Monitor allows the operator to view both the physical scanning of the sample and the plotting of the data simultaneously. At the end of the scan, the stylus automatically retracts and the system is immediately ready for the next scan. The surface features encountered by the stylus are represented as a two dimensional profile which is plotted, scaled, and displayed on the video monitor.

Profile Manipulation and Measurement

An initial profile may require software leveling, zero referencing and software magnification to zoom-in on an area of interest. Measurement is a continuous process and is facilitated by simple movements of the Reference and Measurement cursors.

Data Plot Display

The plotting screen displays scan data as well as various parameters from the Scan Routine such as the stage X, Y, and theta location, Scan ID#, scan length, scan speed, resolution, and stylus force. Also indicated are both the vertical and horizontal distances between the cursor/trace intercepts as well as the distances from the vertical and horizontal "zero" grid lines. If any analytical functions have been requested, the results from the calculation will also be displayed.

Analytical Functions

The DEKTAK V 200-Si has a wide range of analytical functions available for analysis of roughness, waviness, step height, and geometrical measurements. Up to 30 analytical functions per scan can be performed.

Boundary Magnification

Following a scan, the operator can modify boundary locations to magnify portions of the trace. These new boundary locations can be stored and recalled at any time.

Printing

When the desired profile is displayed and a permanent record is desired, a printout can be made with a single keystroke. A summary of the data only without graphics may also be printed.

Deskew

The DEKTAK V 200-Si system provides a method known as "Deskew" to compensate for sample positioning errors. In each Automation Program a pair of X-Y coordinates, called "Deskew Points", may be programmed/established. These points are defined as two visually identifiable landmarks on the sample which can be located and stored as part of the Automation Program. When like samples are placed on the stage, it is possible to indicate to the DEKTAK V 200-Si the actual location of each like sample relative to the original sample by these visible landmarks using the software reticle. The DEKTAK V 200-Si will compensate for any positional skewing by computing new coordinates to which the stage must move in order to locate the same scan position as the original reference sample.

SECTION 3

OPTICS ADJUSTMENT AND SAMPLE POSITIONING

SECTION 3 OVERVIEW

This section provides a step-by-step exercise for adjusting the optics and positioning the motorized sample stage the to measure the 10KA calibration standard, supplied with the Dektak V 200-Si. This exercise will allow the user to become familiar with the various features of the equipment relating to sample positioning. The skills acquired by performing this exercise can be applied to sample positioning in any application. Items discussed in this section include:

- Stage Control
- A description of Microsoft® Windows 3.1
- Trackball operation
- Power on
- Password protection
- Sample loading
- Coarse positioning
- Zoom lens adjustment
- Camera focus adjustment
- Sample illumination adjustment
- Raising the stylus
- Fine X-Y position adjustments
- Remove Stage Backlash Feature

The calibration standard exercise is continued in Sections 4 and 5 of this manual. Section 4 describes single scan operation and Section 5 describes multiple scan operation. By completing the entire exercise, the user will become well acquainted with the basic operation of the Dektak V 200-Si.

STAGE CONTROL

The Dektak V 200-Si is equipped with a precision sample stage which allows both automatic and semiautomatic sample positioning. Automatic or programmable positioning is described in detail in Section 5. Semiautomatic sample positioning is accomplished by using the trackball or mouse interactively with the various screens of the Microsoft Windows interface. A brief description of Microsoft Windows and trackball/mouse operation is provided on the following page.

MICROSOFT WINDOWS 3.1 USER INTERFACE

The Dektak V 200-Si employs Microsoft® Windows 3.1 as the operating environment. Windows is an extension of the DOS operating system which allows different tasks to be integrated to increase efficiency and ease-of-use.

Windows provides a more practical way of organizing operational tasks of the Dektak V 200-Si into pop-up windows, pull-down menus, and scroll boxes. The operator simply rolls the pointing device (trackball or mouse) and "clicks" on the desired command. Virtually all Window commands are duplicated on the Dektak V 200-Si keyboard allowing either full Windows control, keyboard control, or a combination of both Windows and keyboard operation.

Trackball

A trackball is a pointing device which is used to choose commands. Using a trackball is as easy as pointing and clicking.

The standard Dektak V 200-Si is equipped with a trackball, however it can also be operated via a mouse. Although a trackball usually has multiple buttons, the Dektak V 200-Si uses the left-most button for selecting commands in most applications.

Moving the mouse across a flat surface or spinning the trackball moves the pointer (the arrow on the screen). To select a command move the tip of the pointer until it rests on the desired command and click the left-most button.

The following definitions will be used throughout the rest of this manual:

"Pointing Device"	Trackball.
"Point"	Move the tip of the pointer until it rests on what you want to point to.
"Press"	Hold down the left-most button.
"Click"	Quickly press and release the button.
"Drag"	Hold down the button while moving the pointing device.
"Double Click"	Click the button twice in rapid succession.

POWER ON

1. Verify that the DEKTAK V 200-Si power cable is connected to an external power source. A surge protector is recommended to guard against power surges.

2. Turn the monitor on. The on/off switch for the monitor is located on the lower right of the monitor.

3. Locate the power switch on the front of the DEKTAK V 200-Si profiler. To turn the power switch on, flip the switch to the "I" position.

4. The DEKTAK V 200-Si sample stage will initialize and the sign-on message will be displayed (see Figure 3-1).

NOTE

Be sure to close out the Windows application prior to powering the system down.

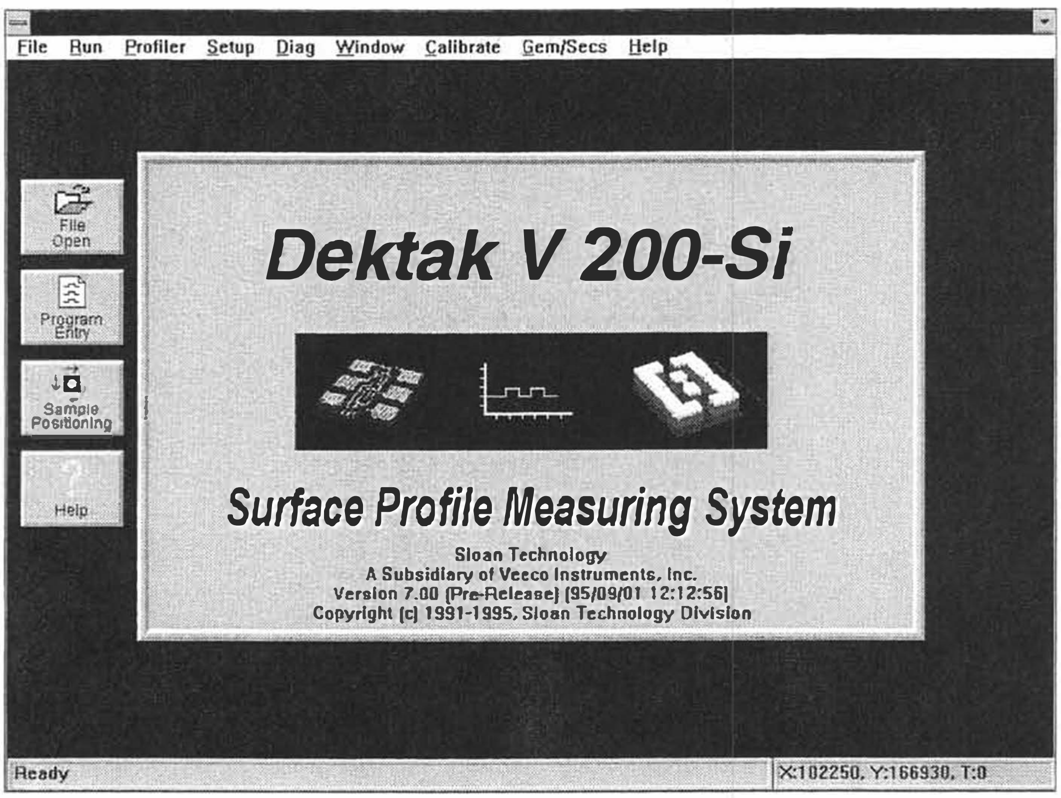


Figure 3-1. Sign-on Message

NOTE

If the DEKTAK V 200-Si does not power up after following the above procedure, contact Veeco/Sloan customer service at (805)963-4431.

PASSWORD PROTECTION

The DEKTAK V 200-Si is equipped with a password protection feature. The password system is initially disabled at the factory. The procedure for enabling the password is described below.

1. Click-on "SET-UP" and click-on "PASSWORD" from the set-up menu. The password submenu will be displayed.
2. Click-on "ENABLE PASSWORD PROTECTION" from the submenu. A dialog box will be displayed listing the three user levels available: operator level, technical level, and engineer level.
3. For the purpose of this exercise the engineer level will be used which permits access to all DEKTAK V 200-Si operations. Click-on "ENGINEER LEVEL".
4. Click-on the box label "PASSWORD" to display the flashing cursor permitting the password to be keyed in. The word "ENGINEER" is the initial password set at the factory. If the initial password is still active, select "ENGINEER" as the password. However, if the password has been changed by the user, key in the new password.
5. Click-on "OK" to activate the password. Once password protection is activated, a dialog will be displayed prompting the user to enter the password whenever the DEKTAK V 200-Si is powered up.

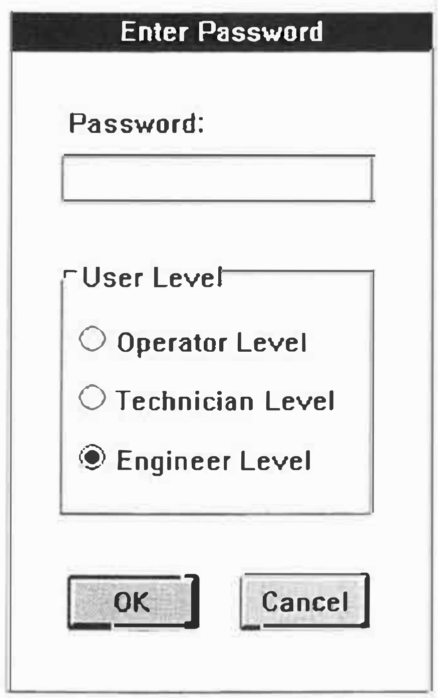


Figure 3-2. Enabling Password Protection

SAMPLE LOADING

The DEKTAK V 200-Si has been preprogrammed to automatically position the sample stage for loading and unloading of samples onto the stage. Directions for loading a sample are described below.

1. Using the trackball, move the pointing device to the system menu bar located at the top of the screen and click-on "PROFILER". The Profiler Menu will be displayed (Figure 3-3).

2. Click-on "Unload" in the Profiler menu. The DEKTAK V 200-Si sample stage will automatically move out to the opening at the front of the scan head to the unload location.

NOTE

The keyboard can be used to position the stage to the load and unload locations. Striking the "W" key when the stage is positioned beneath the stylus moves the stage all the way forward to the scan head door into the unload position. Striking the "LOAD" key when in the unload position, centers the stage below the stylus into the load position.

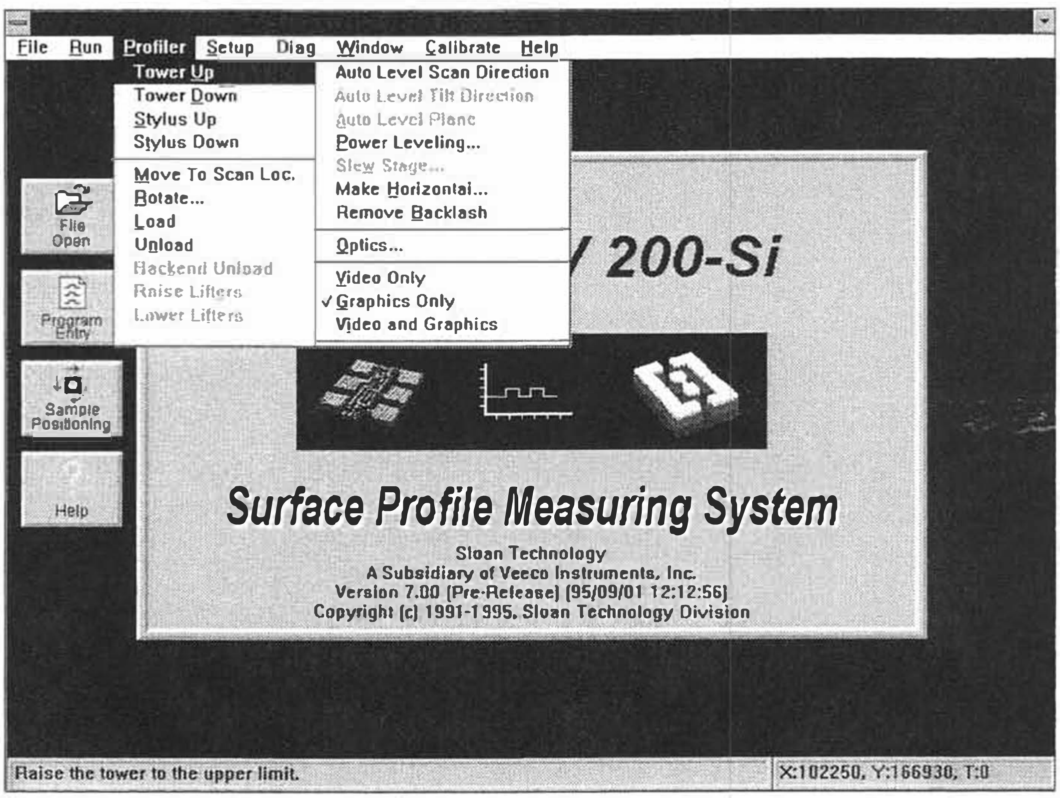


Figure 3-3. Profiler Menu

CALIBRATION STANDARD POSITIONING

1. Open the door to the environmental chamber of the DEKTAK V 200-Si and position the sample in the center of the stage. The calibration standard should be square with the sides of the machine and oriented on the stage as shown in Figure 3-4.

2. Return to the Profiler Menu by clicking-on "PROFILER". When the Profiler Menu appears, click-on "Load". The stage will automatically center the sample stage directly below the stylus.

3. Click-on "PROFILER". When the Profiler Menu appears, click-on "Tower Down". The optics tower will be lowered toward the calibration standard.

CAUTION

As the stylus tower is being lowered, verify that the calibration standard is positioned below the stylus. To stop the tower down motion, press the ABORT key on the DEKTAK V 200-Si keyboard.

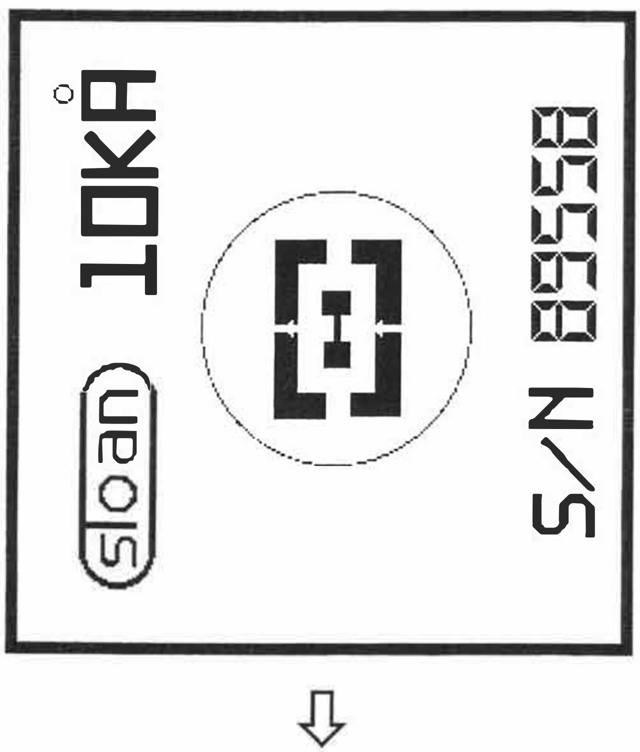


Figure 3-4. Calibration Standard Positioning

SET-UP

Prior to attempting coarse positioning, the appropriate template should be selected. The set-up menu contains a variety of templates for different applications. For this exercise, the template for a 200 mm wafer will be used. The 200 mm wafer template can be used as a template to determine the outer diameter of the sample stage table.

Template Selection

The coarse sample positioning template permits access to any location on the sample stage. The procedure for selecting the desired template is described below.

1. Click-on "SETUP" from the system menu bar. The Setup Menu will be displayed.

2. Click-on "Wafer Template" from the Setup Menu. A dialog box will be displayed allowing selection and editing of various wafer templates (see Figure 3-5).

3. Click-on "200 mm wafer" and click-on "OK". When the sample positioning window is accessed, the selected template will be displayed.

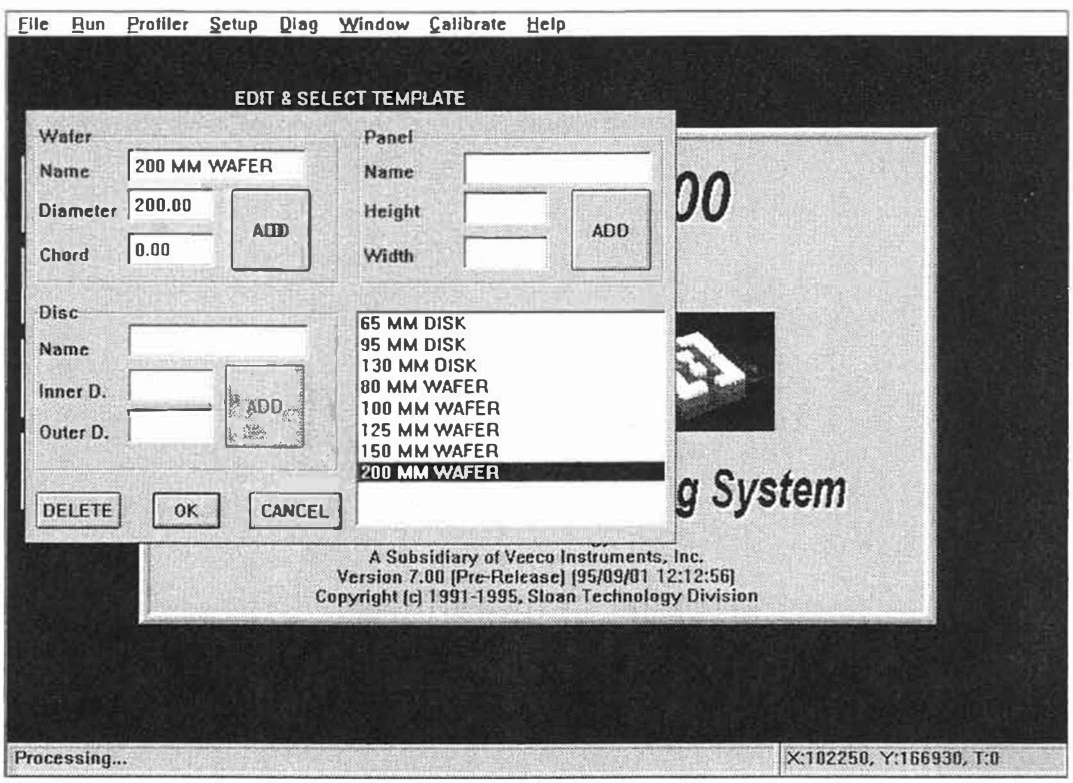


Figure 3-5. Edit & Select Wafer Template Dialog Box

SAMPLE POSITIONING WINDOW

The sample positioning window permits coarse and fine adjustments relative to the X, Y, and Theta positions of the sample stage as well as optics adjustments. To access the sample positioning window, click-on "Sample Positioning" from the Window Menu or click on the "Sample Positioning" icon button. The Sample Positioning screen will be displayed (see Figure 3-6).

Coarse Positioning Template

The sample positioning window displays the predetermined coarse positioning template selected from the set-up menu. The coarse positioning template may be resized by clicking-on and dragging the window border. The window may also be iconned by clicking-on the minimize button. To operate the coarse positioning template, position the crosshair at the desired location on the sample template, double-click the left button on the trackball. The stage will automatically translate to the corresponding location on the sample. The current location of the stylus in relation to the sample stage is indicated by a green dot on the template.

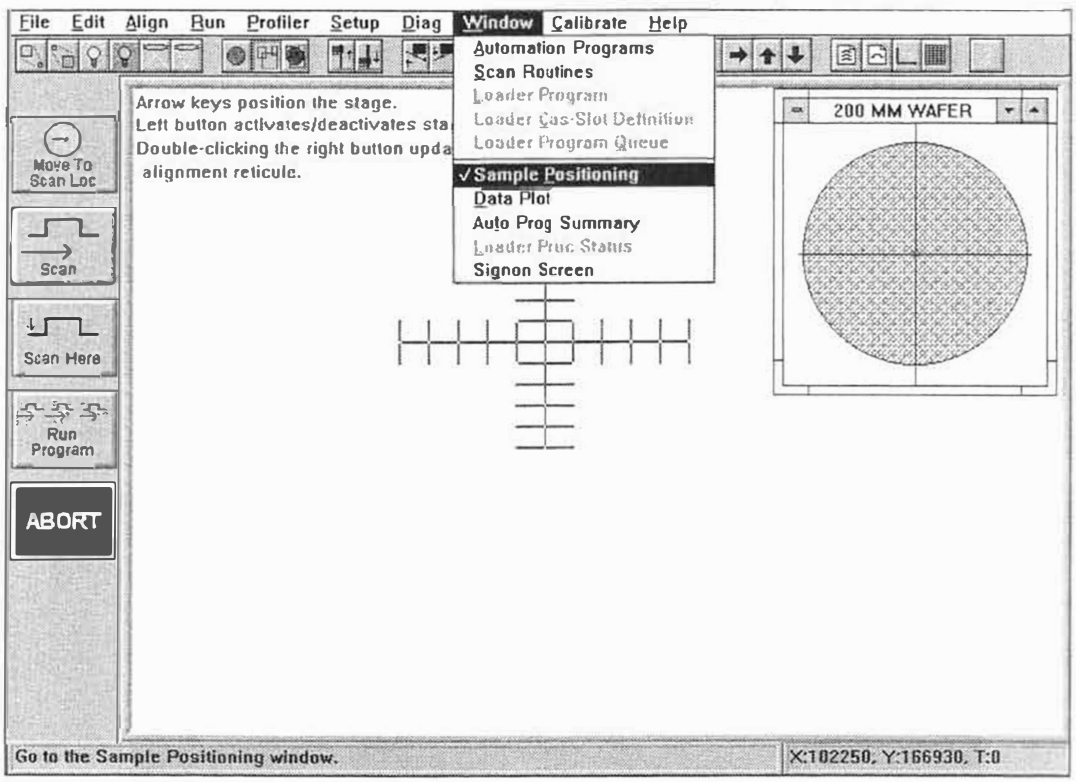
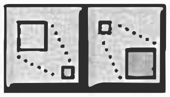


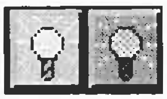
Figure 3-6. Sample Positioning Window

SAMPLE POSITIONING WINDOW TOOLBAR DESCRIPTION

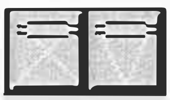
The sample positioning window, located at the top, provides a toolbar containing a series of icons that allow a variety of different functions to be performed with the simple click of a button. These icons and their functions are described below. Additional icons are described in Section 9.



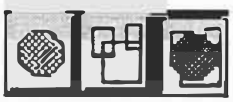
Zoom In/Zoom Out
Click the left button to increase the magnification of the video microscope. Click the right button to decrease magnification.



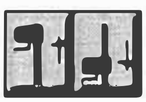
Illumination Adjustment
Click the left button to increase sample illumination. Click the right button to decrease illumination.



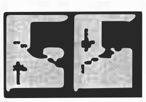
Focus Adjustment (Optional)
When the motorized focus option is installed, the left button raises the focal plan and the right button lower the focal plane.



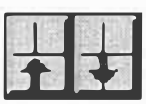
Video/Graphics Overlay Adjustment
Click the left button to display the video image only, the center button for graphics only and the right button for both.



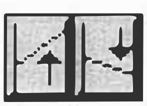
Tower Up/Tower Down
Click the left button to raise the entire optics and stylus assembly all the way up. Click the right button to lower and null the optics tower.



Stylus Up/Stylus Down
Click the left button to raise the stylus arm off the sample surface. Click the right button to lower the stylus onto the sample surface.

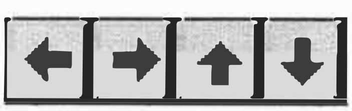


Load/Unload
Click the left button to center the stage below the stylus. Click the right button to translate the stage to the scan head door for loading.



Level Up/Level Down Adjustment
Click the left button to adjust the sample stage leveling upward. Click the right button to adjust the stage leveling downward.

Stage Rotation Adjustment
Click and hold the left button to rotate the stage counter-clockwise. Click and hold the right button to rotate the stage clockwise.
Use the right trackball button to rotate the stage at high speed and the left trackball button to rotate the stage at low speed.



X-Y Stage Position Adjustment
Click the corresponding button to jog the stage right, left, forward, and backwards.

Remove Stage Backlash
Clicking on this button backs the stage up and re-approaches the scan location at an angle to remove backlash in the scan drive mechanism for applications where stylus positioning is critical.

STAGE ROTATION

The sample positioning window permits the user to rotate the stage and make adjustments to the theta sample position. Stage rotation can either be accomplished by clicking on the rotation icon or by using the rotation dialog box. Click-on "Profile" from the system menu bar and click-on "Rotate" to display the Fine Rotation dialog box (see Figure 3-7).

Fine Control

The "Fine Control" section of the rotation window permits the stage to be rotated by clicking-on the clockwise or counterclockwise buttons. The stage will continue to rotate until the button is clicked a second time.

Rotation Speed

A scroll bar is provided to allow adjustments to the fine theta rotation speed. To adjust the speed click-on the high or low arrows or drag the cursor on the scroll bar to the desired speed.

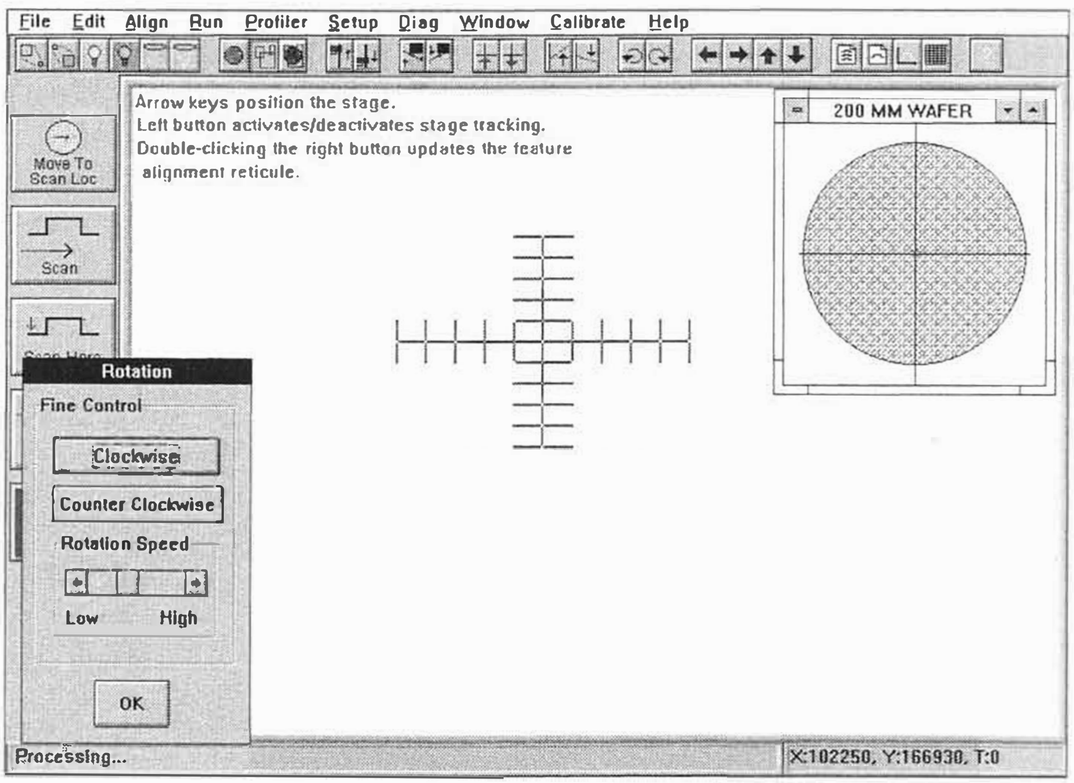


Figure 3-7. Theta Rotation Window

OPTICS ADJUSTMENT DIALOG BOX

The video image displayed on the DEKTAK V 200-Si monitor can be adjusted by using the Optics Dialog Box as well as the toolbar icons. The Profiler menu contains pop-up Optics Dialog Box that allows fine adjustments of focus, illumination, and zoom of the video optics microscope. To adjust the optics, click-on "PROFILER" from the system menu bar and click-on "Optics" to display the Optics Dialog Box (See Figure 3-8).

Zoom Adjustment

Click on the corresponding button to increase or decrease the zoom magnification. Click the button a second time when properly adjusted.

Illumination Adjustment

A scroll bar is used in the Optics dialog box to adjust the sample illumination. The illumination can be adjusted up or down by clicking the corresponding arrow or by dragging the cursor in the scroll bar to the desired illumination.

NOTE

The focus adjustment can only be accomplished with the remote control focus option installed. The focus is automatically adjusted whenever the optics is nulled by lowering the stylus onto the sample surface. The optional remote control focus feature permits fine adjustments of the focal plane.

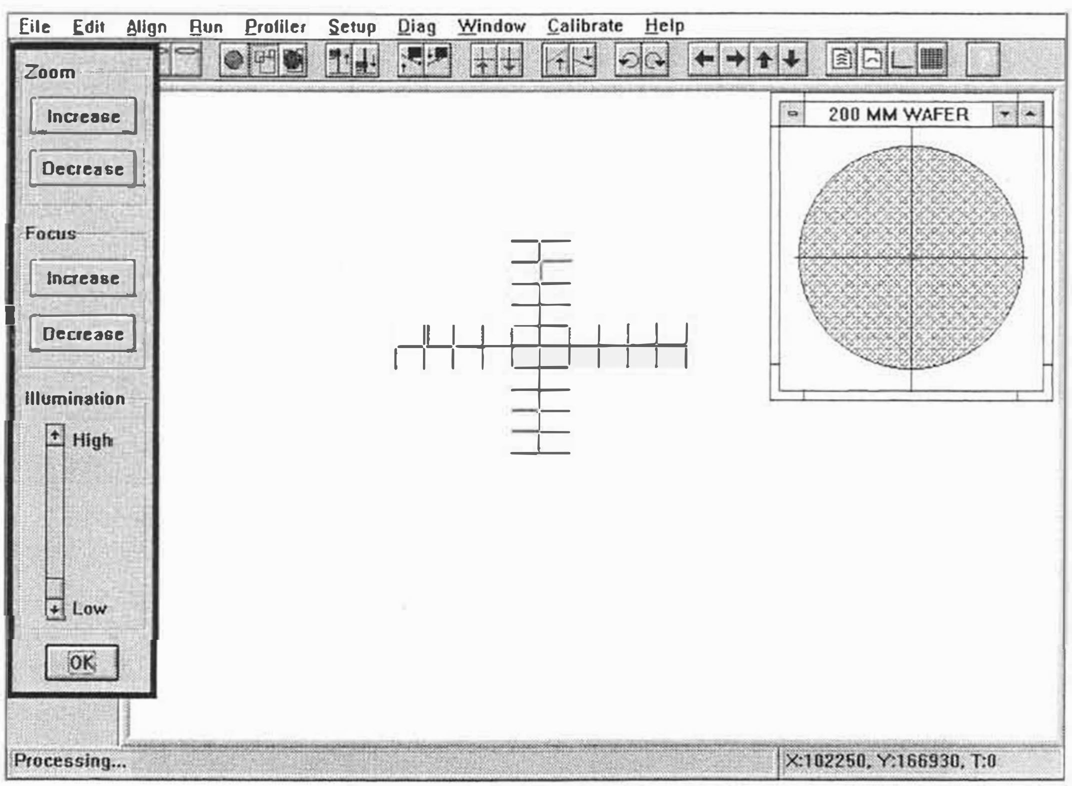
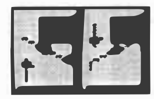


Figure 3-8. Optics Adjustment

LOWERING/RAISING THE STYLUS

The stylus is automatically raised whenever coarse sample stage positioning is initiated. This allows the user to view the sample and position the stage with the stylus lifted off the surface. Lowering the stylus onto the sample surface acts to null the stylus location and adjust the camera focus. With the stylus lowered, the stylus can be properly aligned with the movable reticule.

1. The stylus can be lowered by using either the toolbar icon buttons or the Profiler Menu. To access the Profiler Menu, click-on "Profiler" from the System Menu Bar and the Profiler Menu will be displayed (see Figure 3-9). The "Tower Up" and "Tower Down" options raise and lower the entire tower assembly which includes the video camera, illuminator and stylus mechanism. The "Stylus Up" and "Stylus Down" options raises and lowers the stylus slightly.



2. To lower the stylus, click-on "Stylus Down" from the Profiler Menu or use the stylus down icon. The Profiler Menu will disappear and the stylus will be lowered onto the sample surface.

NOTE

The stylus reticule should be aligned with the stylus tip with the camera magnification set at maximum zoom.

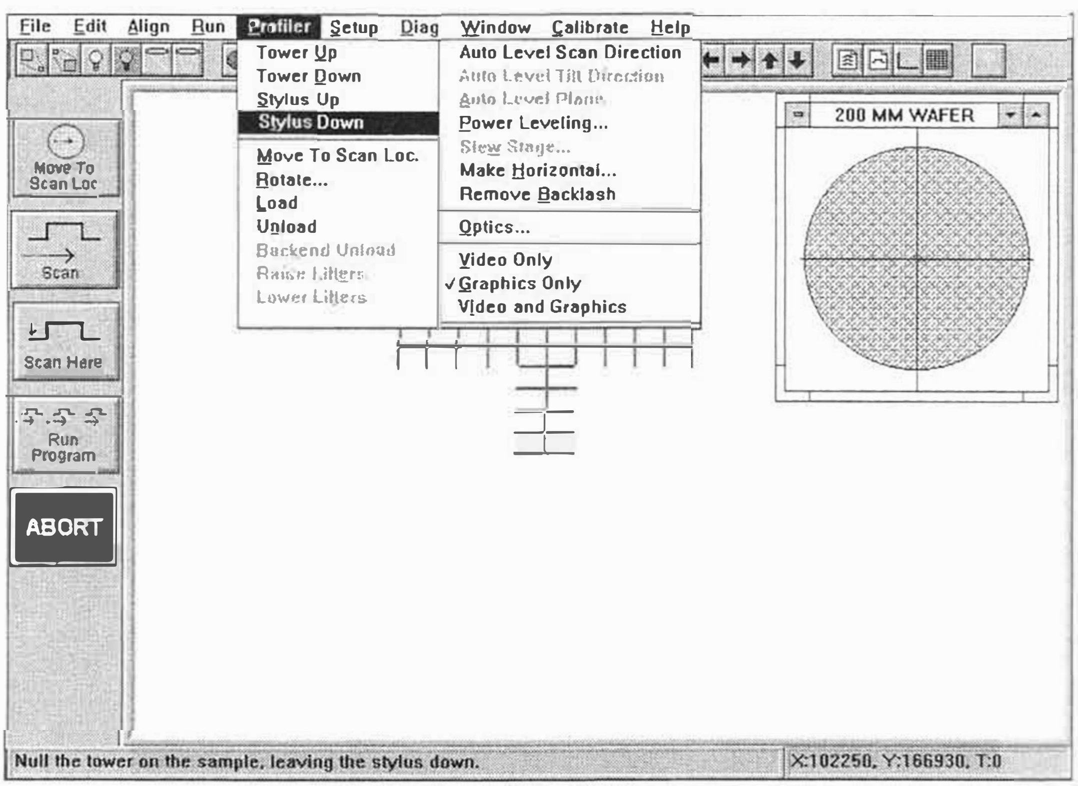


Figure 3-9. Stylus Down Mode

STYLUS RETICULE ALIGNMENT

The stylus reticule can be aligned to a newly installed stylus, or to allow for tolerances in the stylus head. If the stylus tip is not properly aligned with the reticule on the Sample Positioning window, the position of the reticule can be adjusted. The reticule provides a reference point when positioning the sample stage. Because the stylus is raised off the surface during stage positioning, the reticule indicates where the stylus will touch down on the surface.

1. To align the reticule with the stylus tip click-on "Setup" from the system menu bar. The set up menu will be displayed.

2. Click-on "Stylus Reticule" and three options will appear: Align, Reset, and Style. (The "Reset" selection repositions the reticule to the original default location in the center of the screen. The "Style" selection allows the reticule style to be altered by entering a larger number to make the reticule lines bolder or a smaller number for a fine line reticule.) Click-on "ALIGN" to manually reposition the reticule.

3. When "ALIGN" is clicked-on a dialog box is displayed with instructions to ensure a substrate is located under the stylus. Click-on "OK" to proceed.

4. A crosshair contained within a box will be displayed. Align the crosshair with the stylus tip and double-click.

5. A dialog box will be displayed, click-on "YES" to update the stylus reticule location.

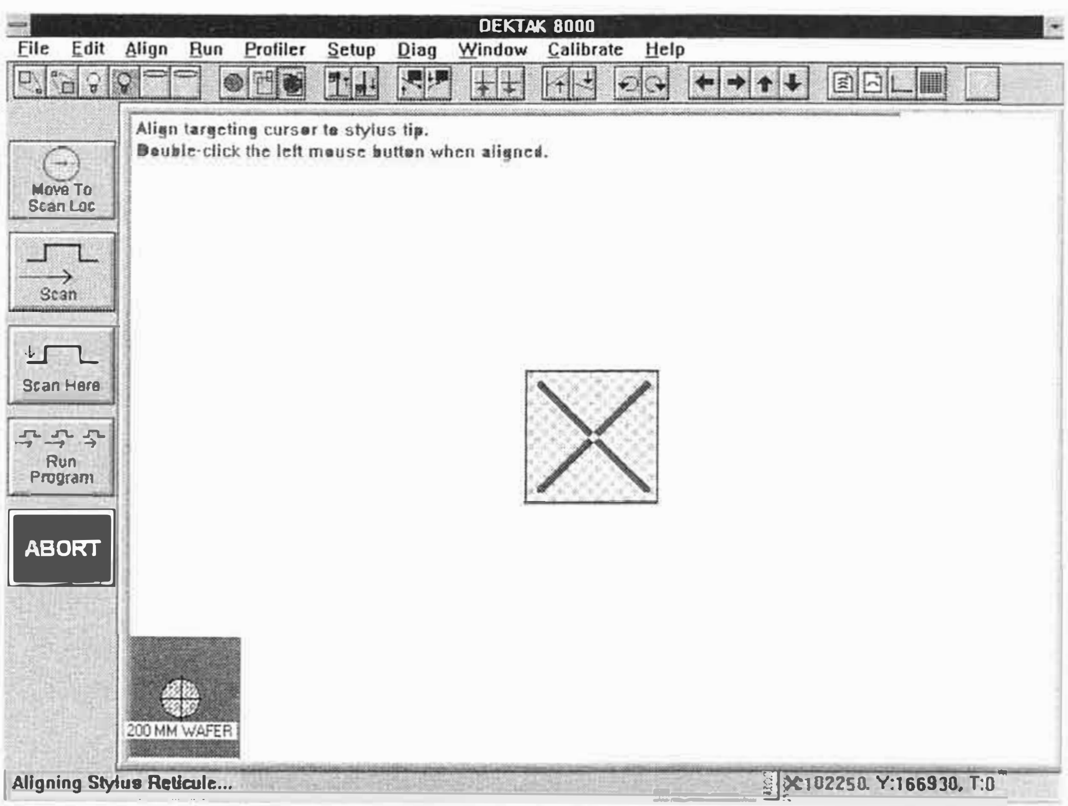


Figure 3-10. Stylus Reticule Alignment

FEATURE RETICULE ALIGNMENT

The Feature Reticule is the smaller green reticule displayed on the fine positioning screen. The feature reticule can be aligned with surface features away from the stylus to more accurately position the stylus for a scan. The procedure for realigning the Feature Reticule is described below.

1. The Feature Reticule can be realigned when the Sample Positioning Window is displayed. To reposition the Feature Reticule, roll the pointing device to the desired location on the Sample Positioning Window. It is best to align the Feature Reticule with an easily recognizable surface feature.

2. Once the cursor is properly aligned with the desired feature, double-click the right button on the trackball.

3. A dialog box will be displayed, click-on "YES" to update the Feature Reticule alignment. The Feature Reticule will automatically be repositioned to the new location.

NOTE

The stylus location in relation to the reticule may change slightly when zooming the video camera in or out. In order to maintain proper stylus/reticule alignment, it is recommended that the desired zoom magnification be adjusted prior to aligning the reticule.

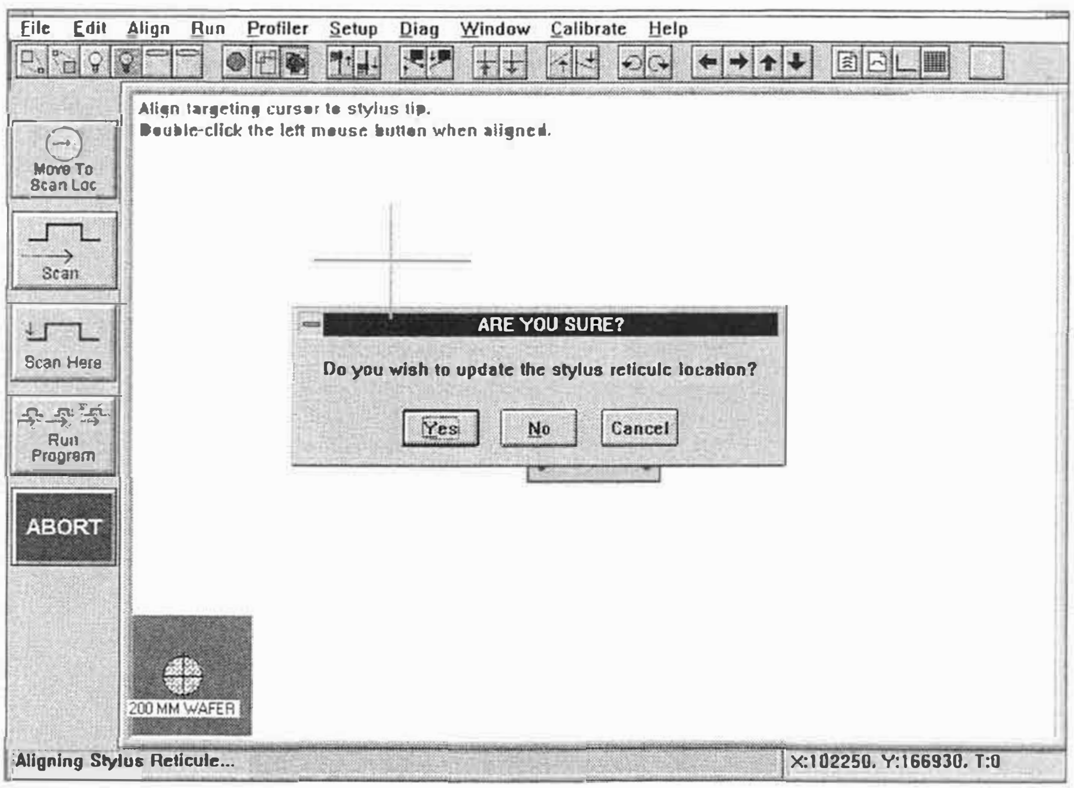


Figure 3-11. Feature Reticule Alignment

X-Y AND FINE STAGE POSITION ADJUSTMENTS

Once the optics are properly adjusted, X-Y and fine stage positioning can be accomplished. The sample positioning can be accomplished by using the toolbar arrow keys at the top of the Sample Positioning Window as described earlier in this section. Fine adjustments can also be accomplished by maneuvering the stage with the trackball as described below.

1. The Sample Positioning Window permits fine adjustments to the X-Y position of the sample stage. Simply use the trackball to point to any portion of the video image displayed on the screen and click to activate the stage.

2. Once the stage is activated, the stage will track the motion of the mouse or trackball along the X-Y axis.

3. When the stage is properly positioned, click-on any portion of the video display a second time and the stage will be deactivated. The current X-Y-Theta stage location will be displayed in the lower right corner of the screen.

NOTE

Rolling the trackball too fast during fine positioning can cause oscillation in the lead screws. To stop the oscillation, push the small "TURBO" button on the trackball.

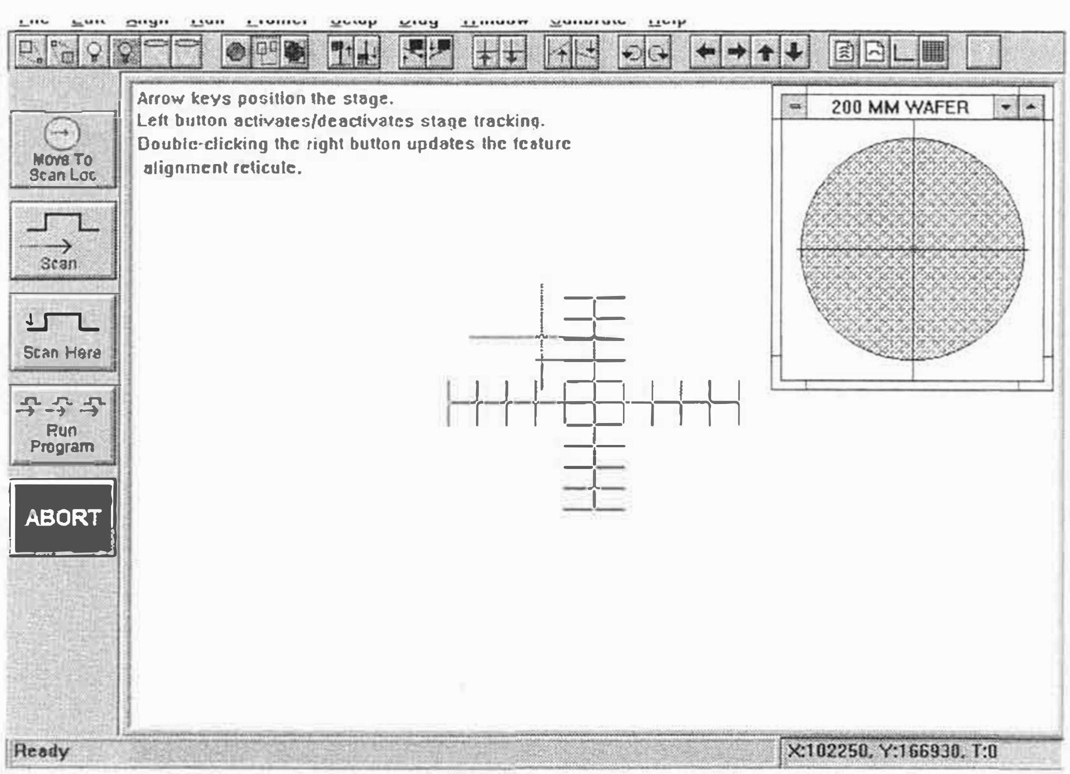


Figure 3-12. X-Y Stage Positioning Window

REMOVE STAGE BACKLASH

For applications where X-Y stage repeatability must be maintained at the highest level possible, a remove backlash feature is available. This feature removes any backlash in the sample positioning and scan drive mechanism to assure excellent sample positioning repeatability.

When this feature is activated, the sample stage backs up and re-approaches the selected site at a diagonal to remove any backlash that may be present in the motors. For applications where positional repeatability is an issue, the remove backlash function should be used when prior to entering a scan location or a deskew point location.

To activate the remove backlash feature, click-on the remove backlash icon button from the toolbar.

It may also be activated from the "Profiler" menu by clicking on the "Remove Backlash" selection (see Figure 3-13).

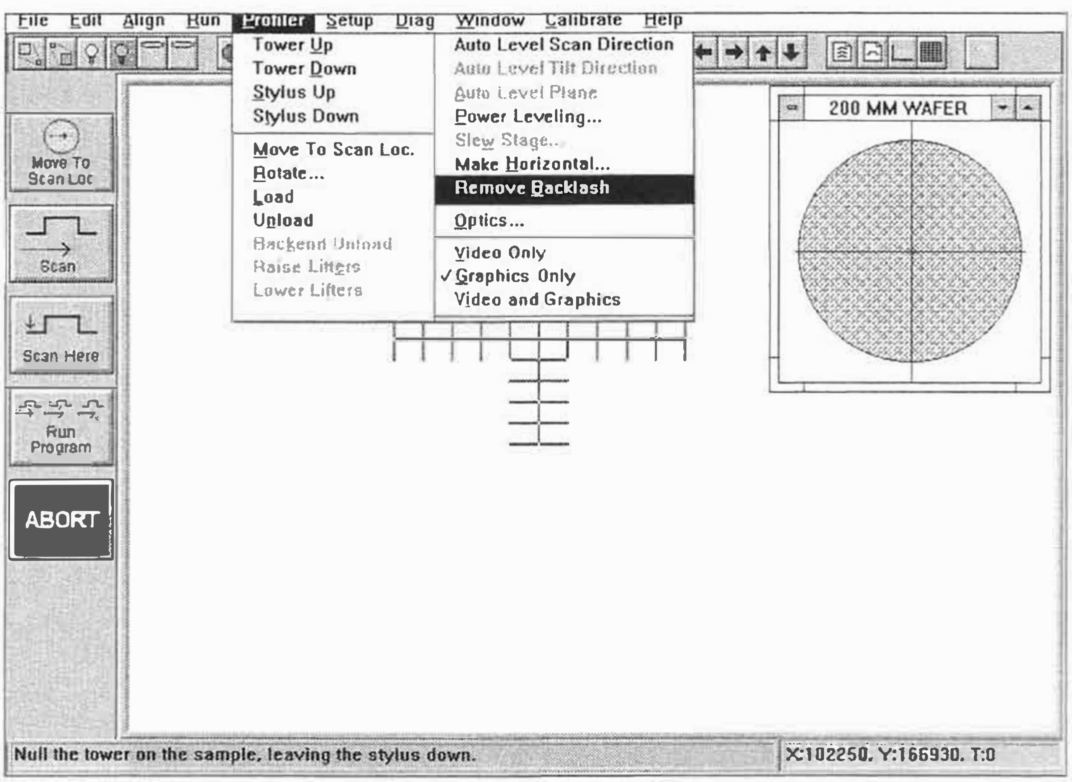


Figure 3-13. Remove Backlash

SECTION 4

SINGLE SCAN OPERATION

SECTION 4 OVERVIEW

This section will provide a step-by-step exercise for performing routine step height measurements on the 10KA calibration standard supplied with the DEKTAK V 200-Si. It is a continuation of the exercise begun in Section 3 of this manual. The exercise is designed to teach the user the basic operational skills required to program and run simple scan routines. The items discussed in this section include:

- Creating an automation program
- Scan routine programming
- Running a scan routine
- Reference/measurement cursor positioning
- Stage leveling
- Making a step height measurement
- Plot magnification
- Print out

In the exercise described in this section, the DEKTAK V 200-Si is operated via a trackball, as well as the keyboard. The user interface screens work in conjunction with the trackball and the keyboard. The user may want to become familiar with the DEKTAK V 200-Si user interface by reading section three prior to attempting this exercise.

CREATING AN AUTOMATION PROGRAM

Prior to running a scan routine, an automation program must first be created. Automation programs are files which contain all the necessary information for performing single or multiple scan routine sequences. The procedure for creating a new automation program is described below.

1. Click-on "Window" from the system menu bar and click-on "Automation Programs" from the Window Menu. The Automation Programs screen will be displayed (see Figure 4-1).

2. Click-on "File" from the screen specific menu bar and click-on "New" from the file menu. A dialog box will be displayed asking if current Automation Program is to be saved. Clicking-on "Yes" allows the current Automation Program to be saved. Clicking-on "No" deletes any changes to the current Automation Program and enters the default Automation Program.

3. A second dialog box will be displayed for the 3-D mapping option. For this application select "Standard" and click-on "OK".

4. The automation program control header dialog box will be displayed allowing automation programs to be saved under user defined index headings. This feature is described in more detail in Section 5. For this application, click-on "OK". A new automation program will be created containing the default scan routine parameters.

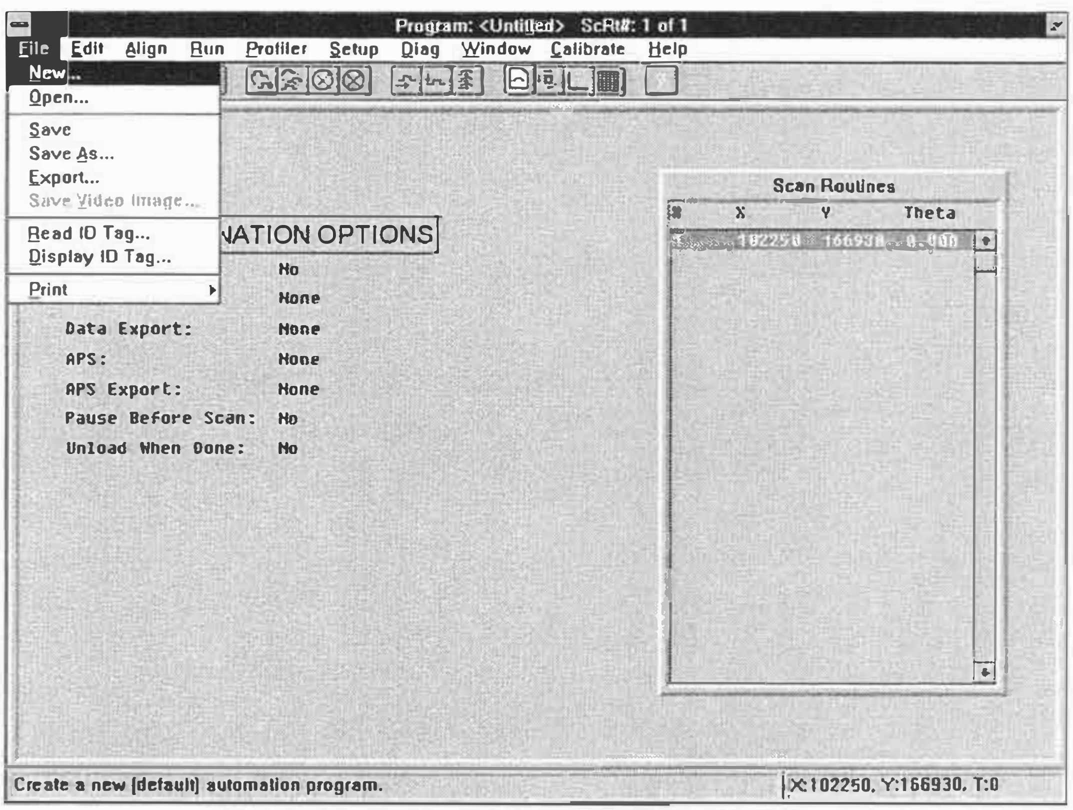


Figure 4-1. Creating A New Automation Program

ENTERING THE SCAN LENGTH

This page describes entering the appropriate scan length for measuring the calibration standard supplied with the Dektak V 200-Si. The scan length and scan location can be entered from the sample positioning screen as described below.

1. Click-on "Window" and click-on "Sample Positioning" from the stage menu. The sample positioning screen will be displayed.

2. With the stylus tower down, activate fine sample positioning by clicking-on the video image of the sample positioning screen. The stage should now track the motion of the trackball. Position the stylus reticule to the left of the "dog-bone" step of the calibration standards shown below (the image in Figure 4-2 is shown at minimum magnification). With the stylus reticule properly positioned, click the track ball a second time to deactivate the stage.

3. Click-on "Edit" and click-on "Enter Scan Length...". The stage will now track the left and right motion of the track ball to allow the scan length to be entered. Roll the track ball until the stylus reticule is positioned to the right of the "dog-bone" step, and click-on the track ball button.

4. The "Enter Scan Length" window will be displayed (Figure 4-2) allowing the scan length to be altered. For this exercise, click-on the "Scan Length" box and enter a scan length of 1000 microns. The "Enter Scan Location" box should be activated, indicated by an "X" in the box. Click-on "OK" to enter the scan length and scan location into the Scan Routine Program.

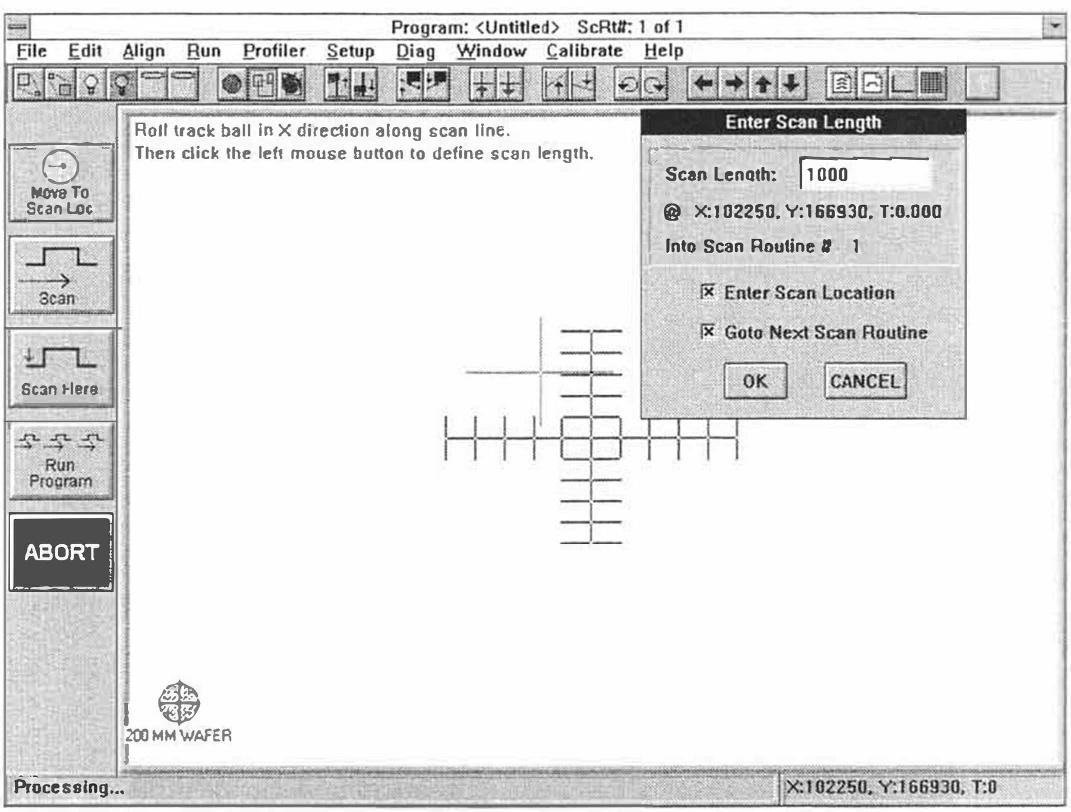


Figure 4-2. Entering 1000 Micron Scan Length into a Scan Routine

RUNNING A SCAN ROUTINE

When running a scan routine, it is often beneficial to view the video image of the stylus and sample with the graphic representation of the surface profile superimposed. To accomplish this, pull-down the "DISPLAY" menu and click-on "Video and Graphics".

To run a scan routine, click on the "Scan" icon button or pull-down the "RUN" menu, and click-on "Run Scan Routine." To run the scan routine at the stage's current X-Y location rather than at the default location listed in the scan routine parameters, the following sequence of events will occur when a scan is initiated:

1. The data plot screen will be displayed with the graphic display of the scaled grid superimposed over the video image of the stylus and calibration standard.

2. The stylus will be lowered onto the surface. After a brief pause, the scan will commence. As the stylus scans across the calibration standard, the initial profile trace is plotted on the scaled grid.

3. Once the scan is complete, the stylus will lift off the surface and the stage will return to the X-Y location where the scan originated. The profile is then automatically replotted and rescaled. The image displayed on the monitor should resemble Figure 4-3.

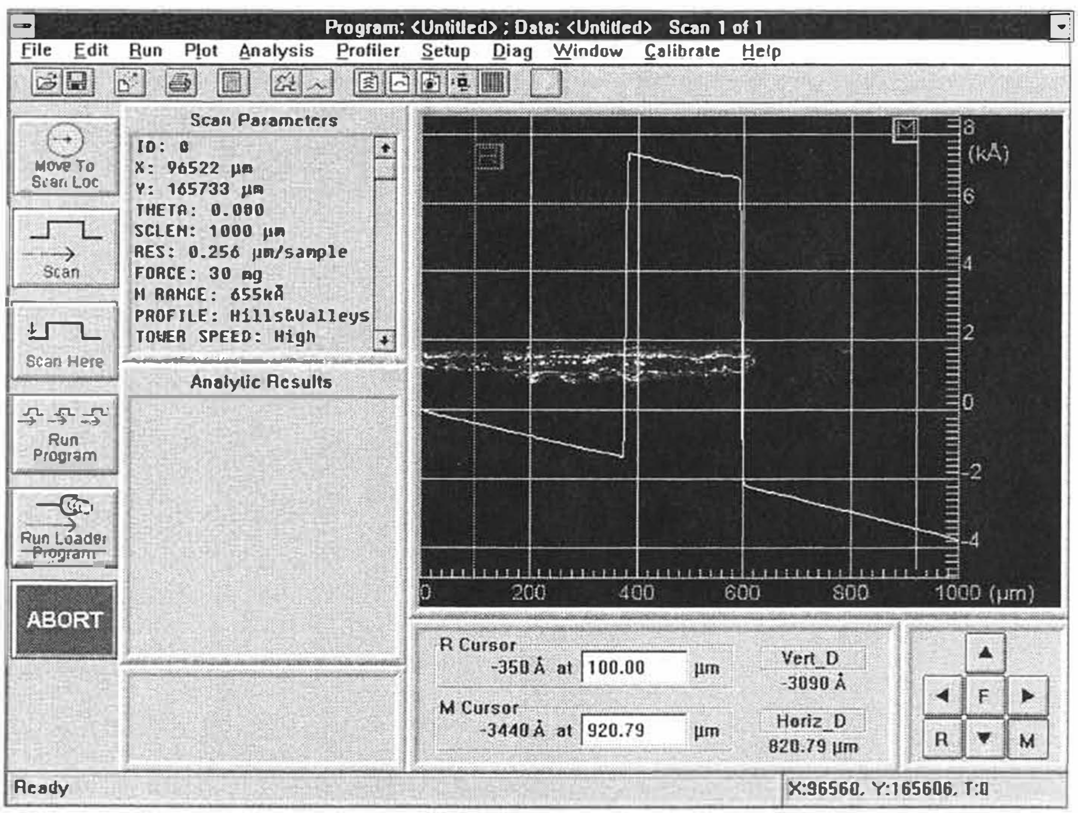


Figure 4-3. Calibration Standard Profile

REFERENCE/MEASUREMENT CURSOR POSITIONING

The reference (R) cursor and measurement (M) cursor are used to define the portion of the profile trace for leveling or performing analytical functions. Cursor positioning is critical for obtaining accurate results. Cursors can be positioned by using either the trackball method or the numeric entry method.

It is recommended that the default cursor band widths be used for leveling and measuring. To activate the default cursor bands click-on "Plot" and click-on "Default Bands" (See Figure 4-4).

Trackball Cursor Positioning

Special arrow buttons are provided at the bottom right of the Data Plot screen for positioning the cursors (see Figure 4-4). Cursors can be repositioned by clicking and holding the left and right arrow buttons. Click-on the "R" button to reposition the reference cursor and click-on the "M" button to reposition the measurement cursor. Clicking-on the "F" button moves the cursors at high speed. You can also reposition the cursors by dragging the “R” and “M” flags at the top of the cursors.

The boxes to the far left of the cursor positioning arrows indicate the location of the cursors. The top box refers to the R cursor location and the bottom box refers to the M cursor. The number contained in the box indicates the point at which the cursor intercepts the profile trace in relation to the vertical scale.

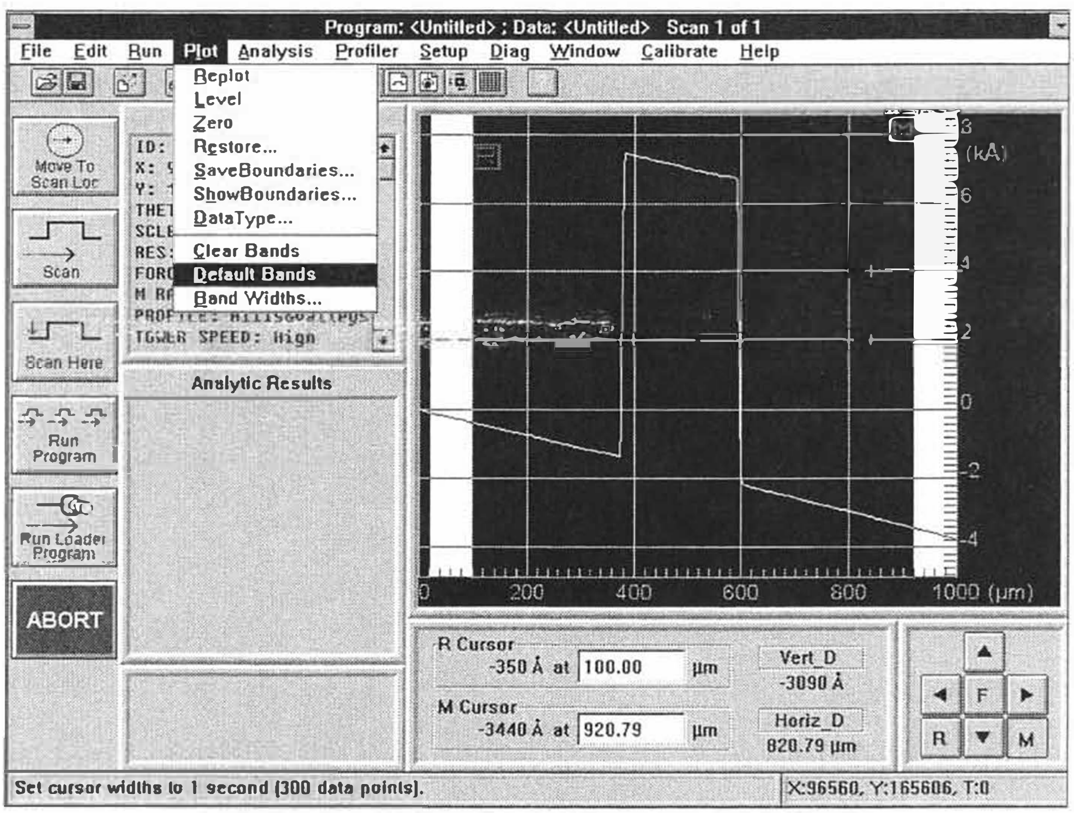


Figure 4-4. Setting the Default Cursor Band Widths

Cursor Positioning - Numeric Entry

The grey boxes to the left of the cursor positioning arrows display the cursor position in relation to the horizontal scale. Cursor locations can also be altered by using the DEKTAK V 200-Si keyboard to numerically enter new cursor positions. For this exercise the R cursor should be set at 100 microns with the M cursor at 900 microns. Keyboard cursor positioning is described below.

1. Click-on the upper grey box indicating the R cursor horizontal position. A flashing prompt will appear in the box.

2. Key-in 100 on the DEKTAK V 200-Si keyboard and press enter. The R cursor will be repositioned at 100 microns.

3. Click-on the lower grey box indicating the M cursor horizontal position. A flashing red prompt will appear in the box.

4. Key-in 900 and press enter. The M cursor will be repositioned at 900 microns.

The box labeled "Vert Delta:" displays the vertical difference between the points at which the R and M cursors intercept the profile trace. The box below it labeled "Horiz Delta:" provides the horizontal distance between the cursors.

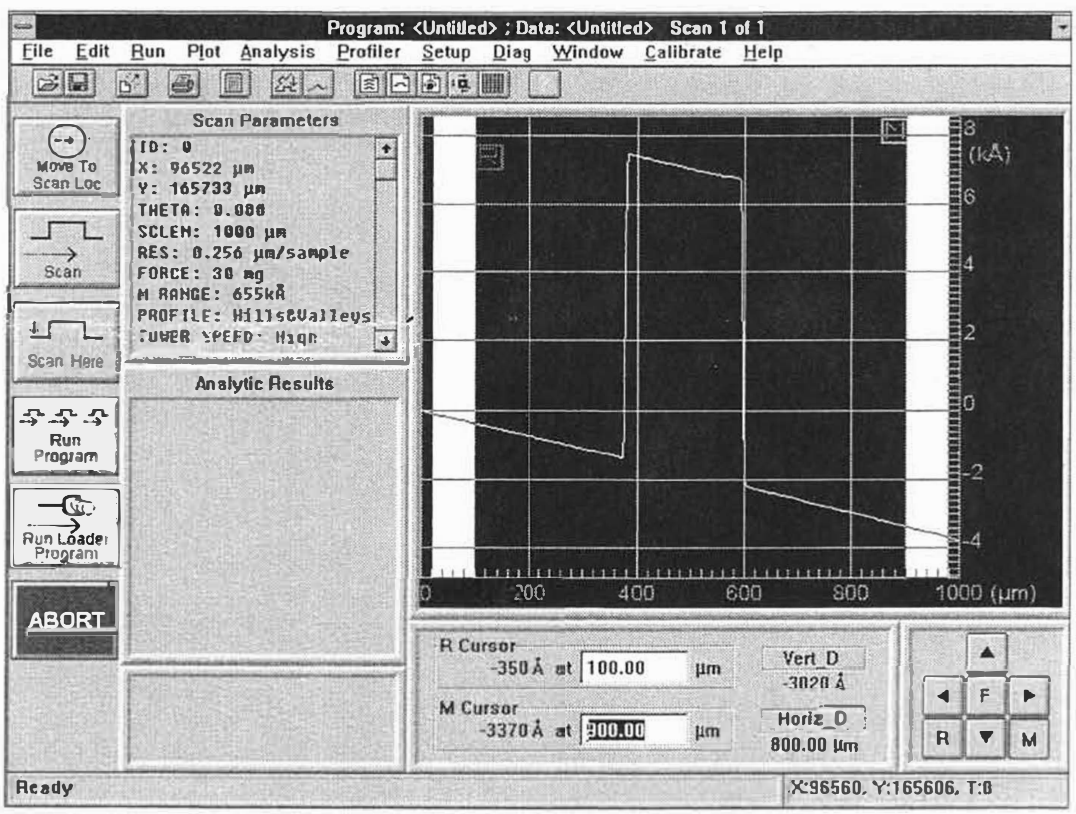


Figure 4-5. Setting the M Cursor at 900 µm

AUTOMATIC STAGE LEVELING IN THE SCAN DIRECTION

It is not necessary to autolevel the stage, unless it is severely out of level. The auto leveling feature can only be accessed when the data plot screen is displayed. It is used interactively with the reference and measurement cursors. When Auto Leveling is activated, the stage is automatically leveled in relation to the points at which the profile trace intercepts the cursors. The R and M cursors must be positioned on the same horizontal plane along the profile trace. For the best result, the R and M cursors should be positioned as far apart as possible.

1. To use auto leveling, click-on "Profiler" from the system menu bar, click-on "Auto Level Scan Direction" (see Figure 4-6).

2. If the stylus is resting on the sample surface when auto leveling is clicked-on, the stylus will first be raised. The stage will then be automatically leveled according to the vertical difference between the cursors.

3. When a second scan is performed, the profile trace should be adequately leveled to make a measurement. Additional leveling of the trace can be accomplished in software.

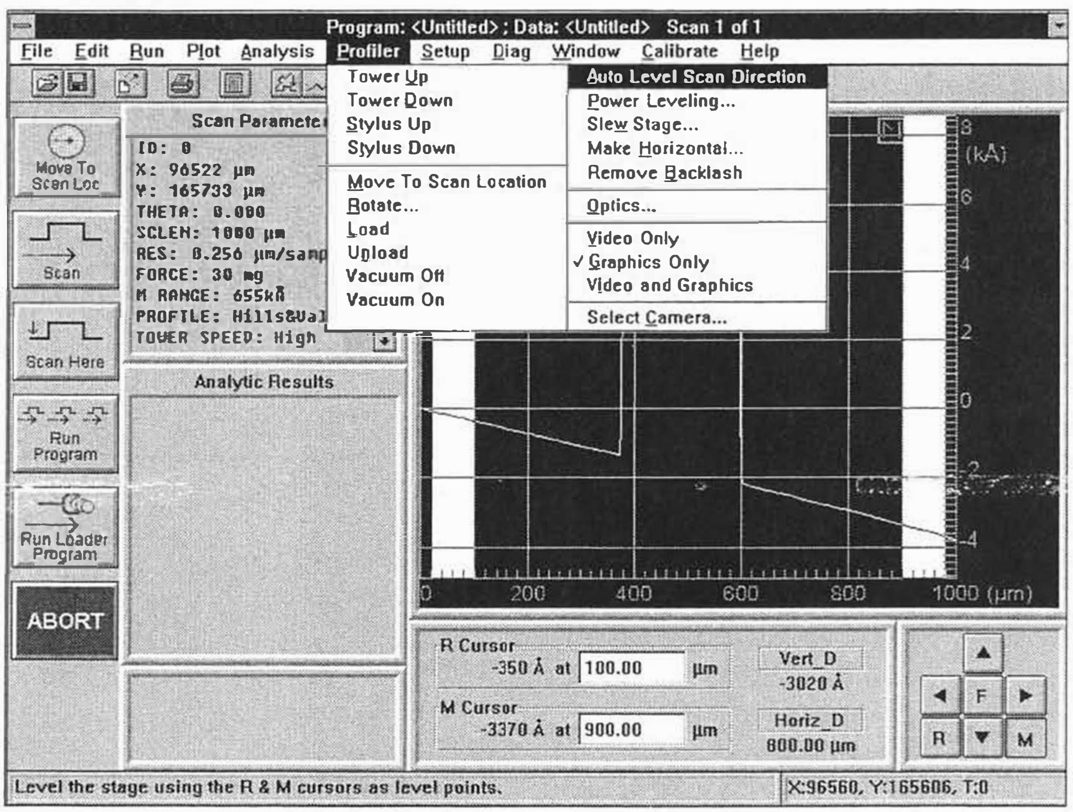


Figure 4-6. Auto Leveling of the Stage

POWER STAGE LEVELING

The power leveling method allows the stage to be mechanically leveled. It is usually used in applications where the stage or sample is extremely out of level, to the point where the scan line runs off the scale.

1. To use the power leveling, click-on "Profiler" from the system menu bar and click-on "Power Leveling". The stage leveling window will be displayed (see Figure 4-7). This window allows the stage to be raised or lowered at one end to adjust the level.

2. If the scan trace has a positive slope or runs off the top of the screen, click-on "Lower". The stage will continue to level until "Lower" is clicked-on a second time.

3. If the scan trace has a negative slope or it runs off the bottom of the screen click-on "Raise". The stage will continue to level until "Raise" is clicked-on a second time.

4. When the desired stage leveling adjustments have been accomplished, click-on "OK". The stage leveling window will disappear.

5. Run another scan to verify if the stage level has been adjusted satisfactorily. The power leveling method uses a trial and error technique that may have to be repeated several times to level the stage.

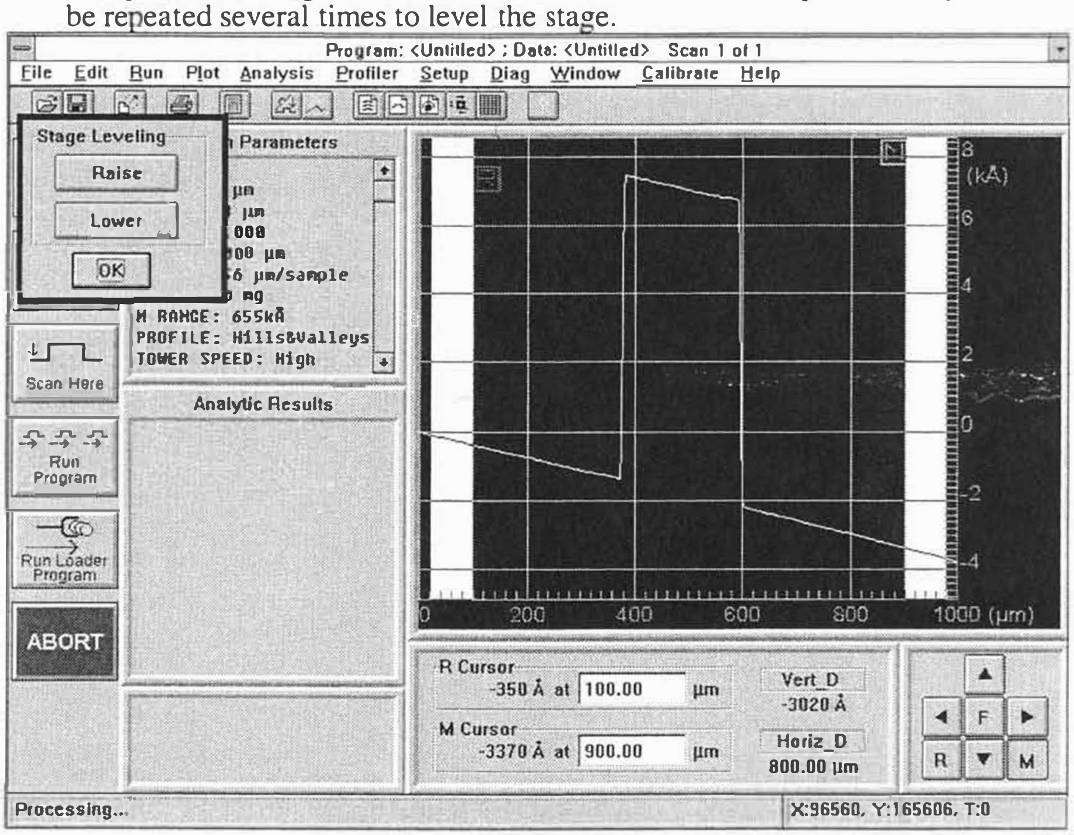


Figure 4-7. Stage Leveling Window

SOFTWARE LEVELING

Even after the stage has been power leveled or auto leveled, ensuing scans may show the profile trace slightly out of level. Software leveling allows the system to quickly level the profile trace, without actually having to completely level the stage. The stage must be software leveled in order to obtain accurate step height measurements or accurate readings from analytical functions. Software leveling sets the reference and measurement cursors at zero to establish reference for measurements.

1. To software level a trace, position the R and M cursors along the baseline of the step (see Figure 4-8).

2. Click-on "PLOT" from the system menu bar. The Plot Menu will be displayed.

3. Click-on "Level". The profile trace will be replotted and leveled with the R and M cursor intercepts at zero.

Software leveling can also be programmed into the scan routine to automatically level the trace at the conclusion of the scan. For more information see Section 8 on software leveling.

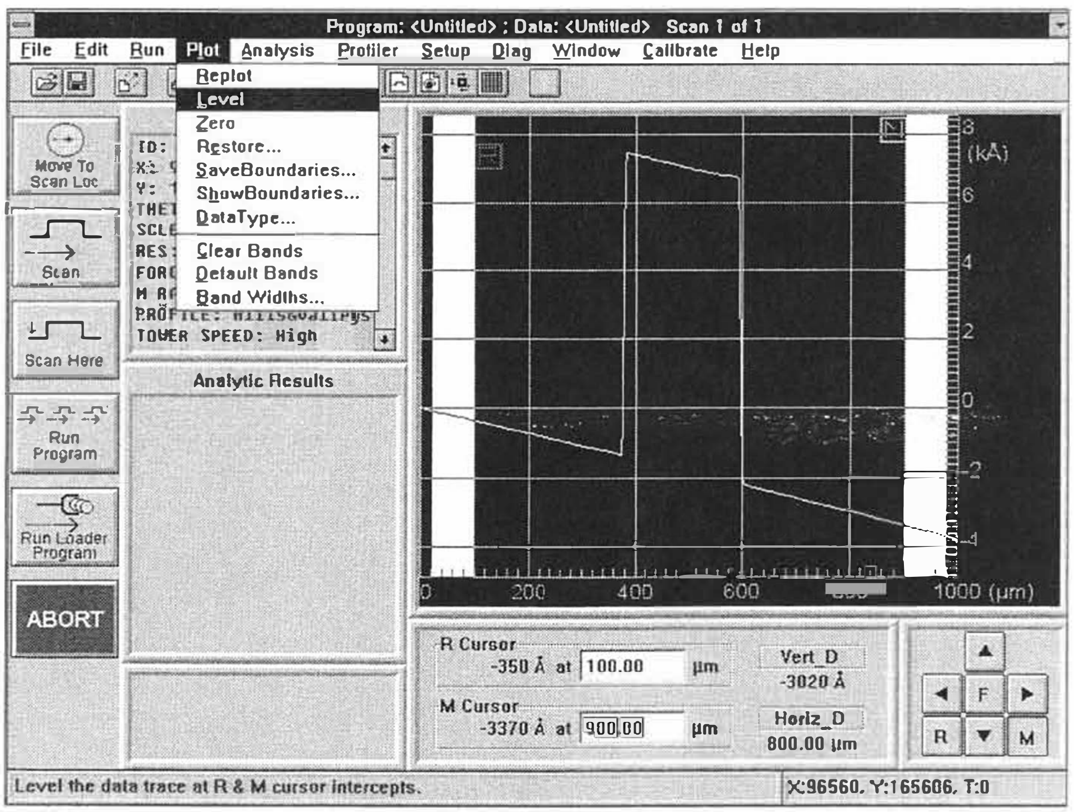


Figure 4-8. Cursor Positioning for Software Leveling

SETTING THE ZERO POINT

Any point on the profile trace may be selected as the zero point. The zero point is the point of reference from which all measurements are taken. Software leveling sets both the R and M cursor intercepts at Zero. When the "Zero" function is activated, it sets the zero point only at the R cursor intercept. It is important when measuring step heights that the M cursor is positioned at the top of the step. For optimum results, the zero point should be set as close to the base of the step, prior to step height measurements.

1. Position the reference or "R" cursor at the desired zero location, just to the left of the base of the step as shown in the figure below.

2. Click-on "Plot". The plot menu will be displayed.

3. Click-on "Zero" from the Plot Menu. The profile trace will automatically be replotted and the zero point will be established at the R cursor intercept (see Figure 4-9).

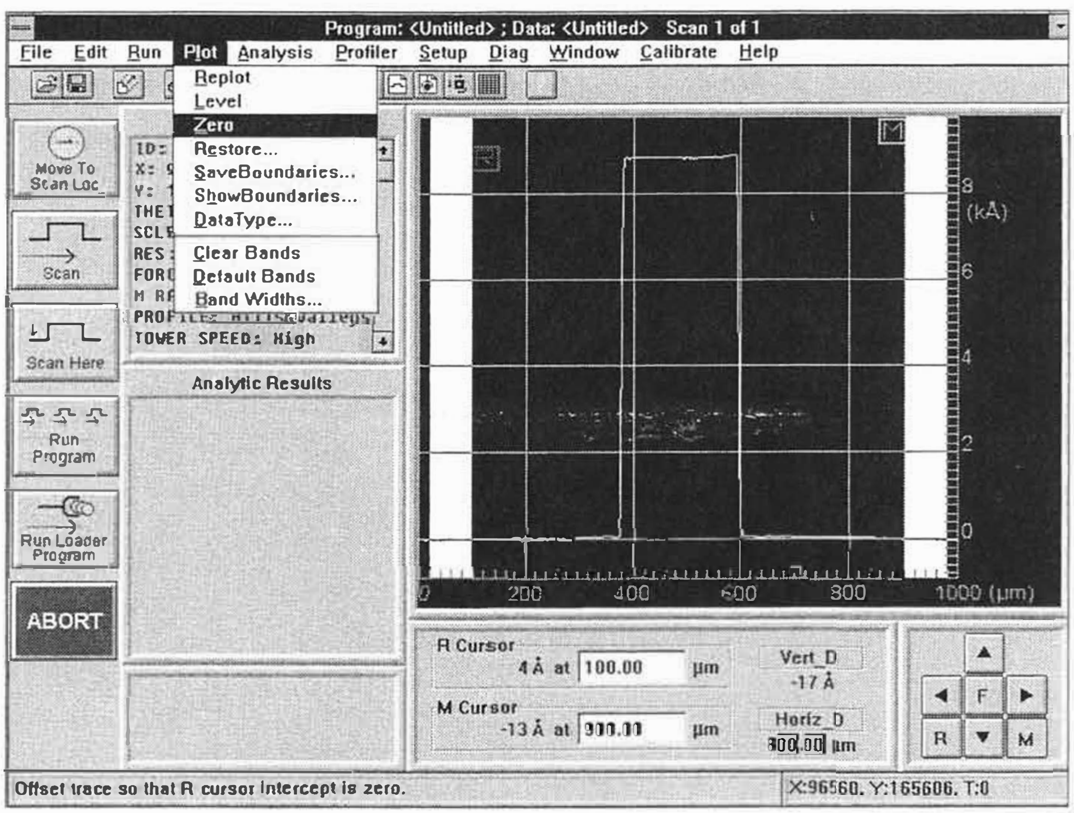


Figure 4-9. Setting the Zero Point

DELTA AVERAGE STEP HEIGHT MEASUREMENT

Once the scan routine has been run and the profile is properly leveled and zeroed, an accurate step height measurement of the calibration standard can be obtained using the Delta Average step height analytical function.

1. Analytical functions are calculated using the R and M cursors. The cursor positions shown in Figure 4-8 are correct for the Delta average step height calculation, with the R cursor at the base of the step and the M cursor at the top of the step.

2. To calculate the average step height function, click-on "Analysis" and click-on "Analytical Functions". The analytical functions menu will be displayed. To activate the Delta average step height function, click-on the box labeled "ASH" from the "Height" selections.

3. Click-on the "Measure" selection located at the bottom of the analytical functions window. (The "Measure and Program" selection enters the ASH function into the current scan routine to be automatically performed when the current scan routine is run again.) Click-on the "COMPUTE" button and the average step height will be calculated with the result displayed in the area to the left of the data plot screen.

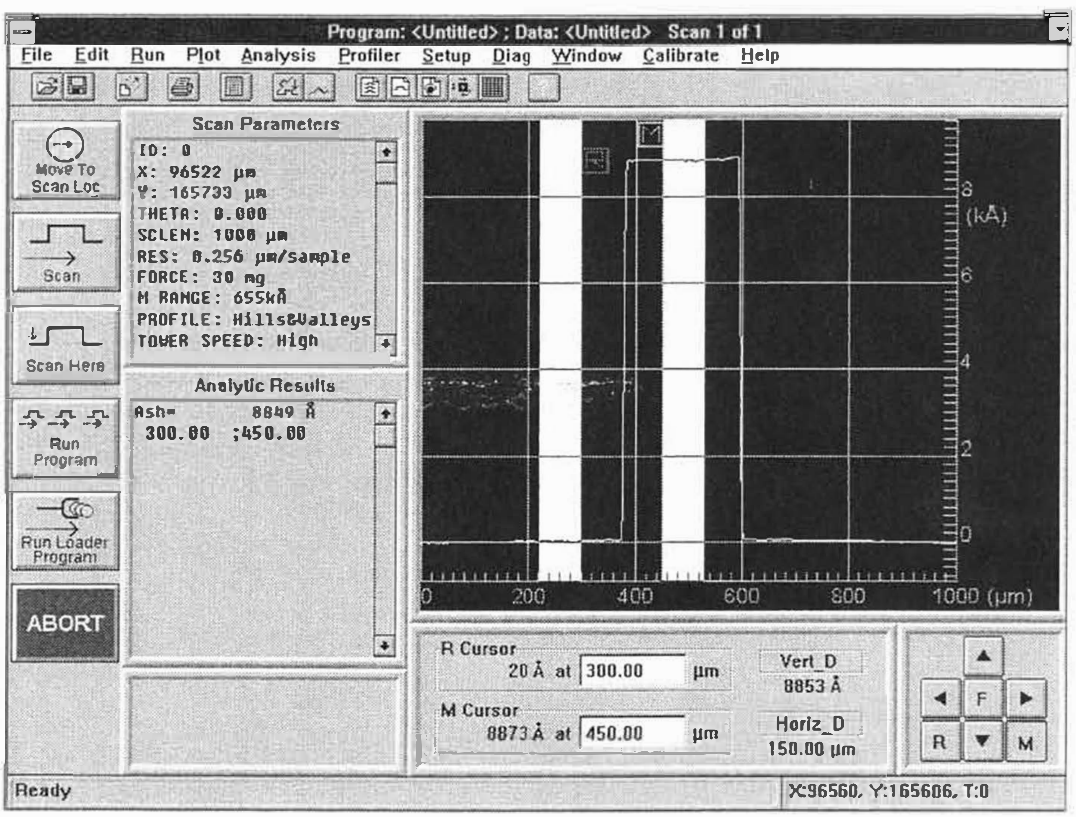


Figure 4-10. Step Height Measurement

PLOT MAGNIFICATION

Once a scan has been run and the profile trace is plotted, a portion of the data plot display can be isolated and magnified for more detailed analysis of the profile trace.

1. To magnify an area of interest, roll the pointing device to the data plot grid. The location of the pointing device on the grid will be displayed as a crosshair. Roll the crosshair to the corner of the area of the data plot screen that is to be magnified and click-on that location.

2. The blue crosshair will now be displayed as a small red box. Drag the pointing device away from the first corner at a diagonal to expand the box. Once the box has turned green, it contains enough data to allow the trace to be replotted. When the desired boundaries are set, click-on the trackball button a second time. For this exercise the boundaries should look similar to those shown in Figure 4-11.

3. Click-on "PLOT" from the menu bar. When the plot menu is displayed, click-on "REPLOT". The system will automatically replot the profile trace with the new boundaries similar to Figure 4-12.

4. To redisplay the original profile trace, pull-down the "PLOT" menu once again and click-on "REPLOT" a second time. The original trace will be replotted.

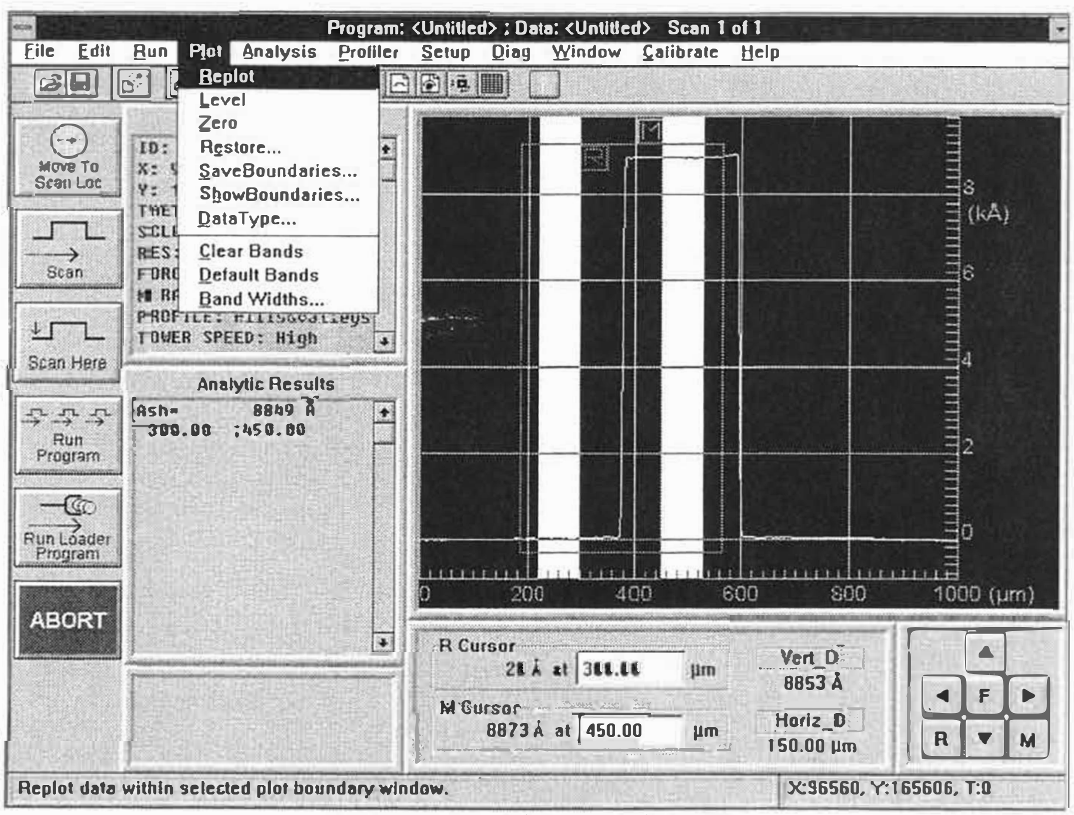


Figure 4-11. Plot Magnification

SAVING BOUNDARIES

1. To save the new set of boundaries, click-on "Plot" and click-on "Save Boundaries". A dialog box will pop-up requesting an identification number under which to save the boundaries (see Figure 4-12). Any number between 1 and 9 may be used.

2. Use the numeric keypad to key-in I.D. number for the plot boundaries. For this exercise select Number 1. Once the number has been entered click-on "OK". The dialog box will disappear and the current boundaries will be saved in memory under I.D. number 1. If previous boundaries had already been saved under I.D. number 1, the new boundaries will replace the old.

SHOWING SAVED BOUNDARIES

1. To show the saved boundaries, click-on "Plot" and click-on "Show Boundaries".

2 All boundaries currently saved in memory will be displayed on the Data Plot Screen along with the I.D. number.

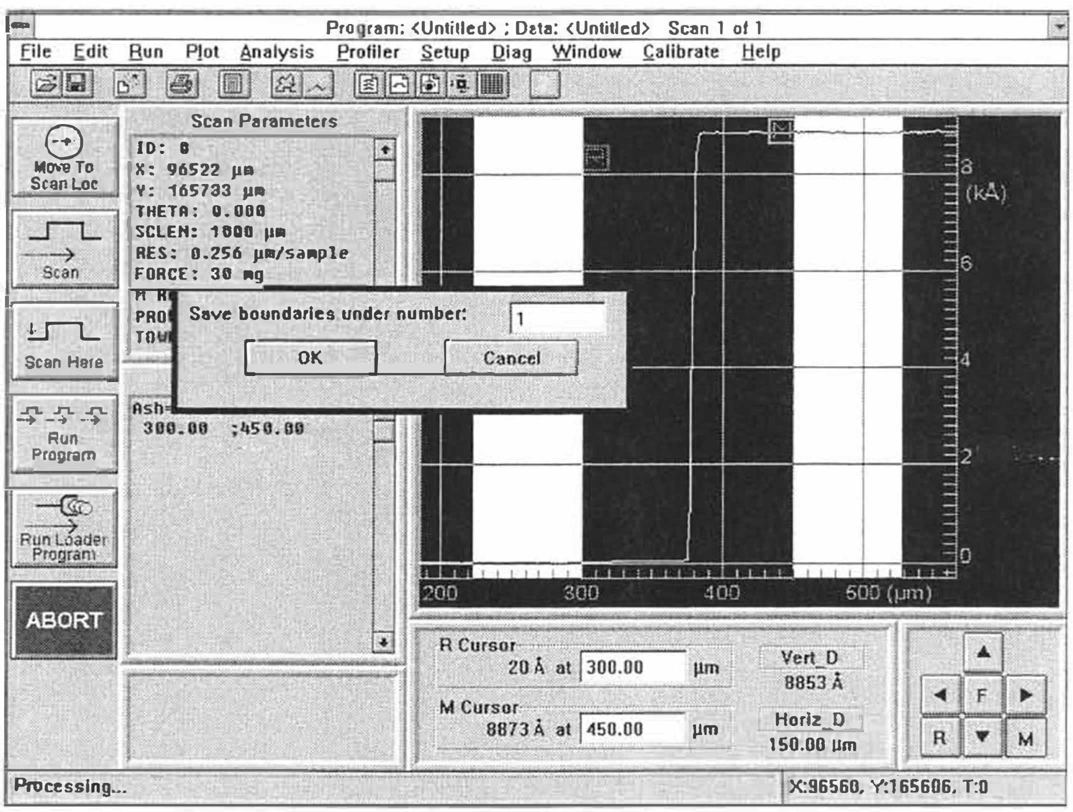


Figure 4-12. Saving Boundaries

RESTORING SAVED BOUNDARIES

The restore function allows the profile trace displayed on the data plot screen to be replotted using a set of boundaries saved in memory.

1. Click-on "Plot" from the menu bar.

2. Click-on "Restore" from the Plot Menu. A dialog box will be displayed requesting the I.D. number under which the desired boundaries to be restored were saved (see Figure 4-13).

3. Key-in the I.D. number "1" and click-on "OK". The current scan trace will then be replotted using the saved boundaries.

4. The original profile trace may also be restored by following the above procedure for restoring a saved boundary and entering restore boundaries under number "0". The original trace will be restored.

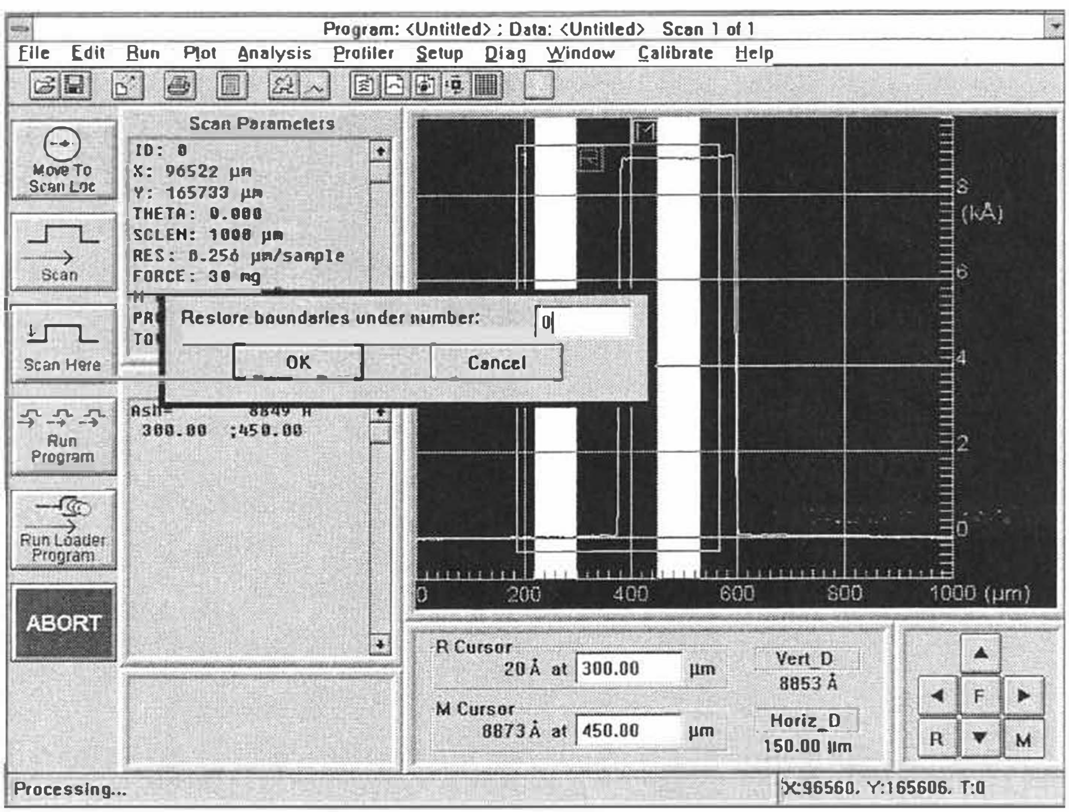


Figure 4-13. Restoring Saved Boundaries

PRINTOUT

A printout may be requested on the DEKTAK V 200-Si thermal printer or on a Windows compatible printer. A printout can be obtained of all the scan data with the plotted profile, a summary of the scan data, the scan routine form, the automation program form and the automation program summary. A printout of the entire active screen can be printed when using a Window compatible printer.

1. To request a printout, click-on "FILE" from the menu bar.

2. From the File Menu, click-on "Print". A submenu will be displayed, listing the various print options (see Figure 4-14).

3. Click-on "Scan Data" from the print submenu. A printout will be produced on the current active printer.

NOTE

The printer port is selected from the SET-UP menu. When using an external printer, the drivers for the Windows compatible printer must be installed prior to use.

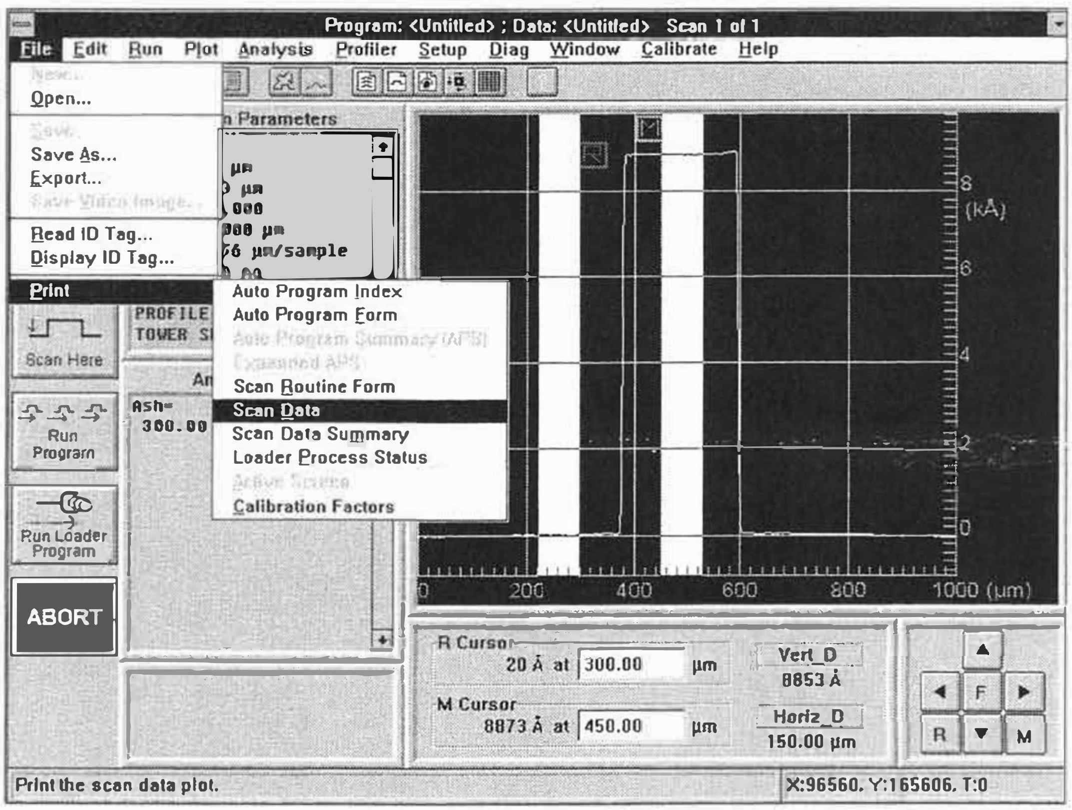


Figure 4-14. Print Menu Selections

SAVING AN AUTOMATION PROGRAM

An automation program can be stored on the DEKTAK V 200-Si hard disk or on a diskette. The automation can then be opened at a later time to be rerun or altered. For the purpose of this exercise, follow the procedure described below to save the automation program created in this section onto the C drive.

1. Click-on "WINDOW" from the system menu bar and click-on "Automation Programs" from the programs menu. The Automation Programs screen will be displayed (Figure 4-15).

2. Click-on "File" from the Automation Program's screen specific menu bar. The file menu will be displayed.

3. Click-on "Save As. . ." from the File Menu. A pop-up window is displayed requesting file name under which the Automation Program is to be saved (see Figure 4-15).

4. A filename up to eight characters long may be entered. For this exercise key-in the file name "exercise" and click-on "OK." The window will disappear and the Automation Program is now saved on the hard disk under file name "exercise".

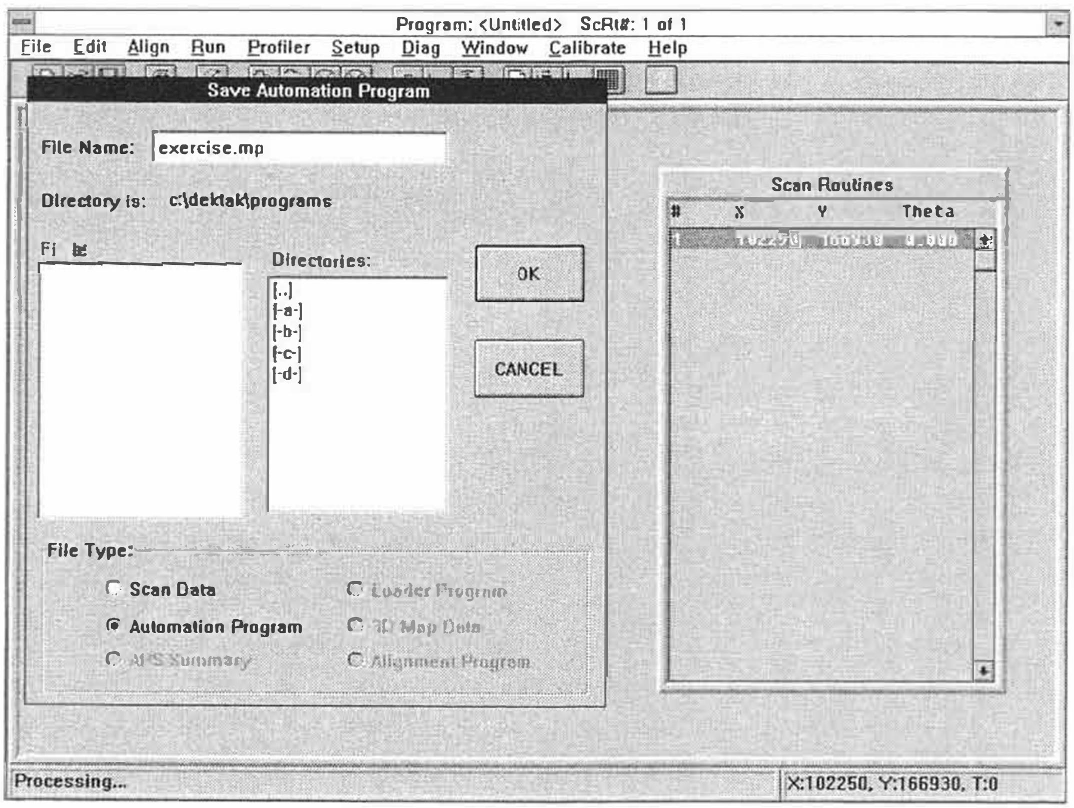


Figure 4-15. Automation Program File Name

SECTION 5

MULTIPLE SCAN OPERATION

AUTOMATION PROGRAMS EXERCISE

This section is a continuation of the exercise begun in Sections 3 and 4 using the 10KA calibration standard. By building on the experience gained in creating and performing a single scan operation, the DEKTAK V 200-Si can be used to produce complex multi-scan sequences. Items discussed in this chapter include:

- Automation Program Description
- Copying Scan Routines
- Triplet Entry
- Running an Automation Program
- Selecting Deskew Points
- Data Destination Options
- Requesting a Printout
- Data File
- Pause After Scan
- Saving an Automation Program
- Reopening a Saved Automation Program

AUTOMATION PROGRAM DESCRIPTION

The Automation Program is the basis for all operations performed on the DEKTAK V 200-Si. Automation programs are stored in DOS file format on the hard disk, giving the DEKTAK V 200-Si virtually unlimited program storage capability. A basic knowledge of MS-DOS commands will be very helpful in understanding and creating automation programs. For more information, see the Microsoft MS-DOS operating system user's guide and user's reference.

The Automation Programs Screen displays the current scan routine along with their X,Y,Theta locations, deskew points, and data destination options. This screen allows the DEKTAK V 200-Si to be programmed for performing multi-scan operations at various locations on a sample.

The Screen Specific menu bar located just above the automation program screen contains a File menu, Edit menu and Deskew menu. These three menus are described in the following pages.

OPENING A NEW AUTOMATION PROGRAM

For the purpose of this exercise, a new Automation Program will be opened to create a multi-scan automation program.

1. Click-on "Window" from the System Menu bar and click-on "Automation Programs" from the Window Menu. The Automation Programs screen will be displayed.

2. Click-on "File" from the menu bar and click-on "New" from the File menu. A dialogue will be displayed requesting if you want to save changes to the current Automation Program.

3. A second dialogue box will ask whether you want to create a standard automation program or one using mapping, for this exercise select "Standard".

4. A third dialogue box will then be displayed permitting an automation program control header to be created which allows additional information pertinent to the samples under test to be entered into the automation program control header. Click-on "OK" when finished and the default scan routine will be entered into the current automation program.

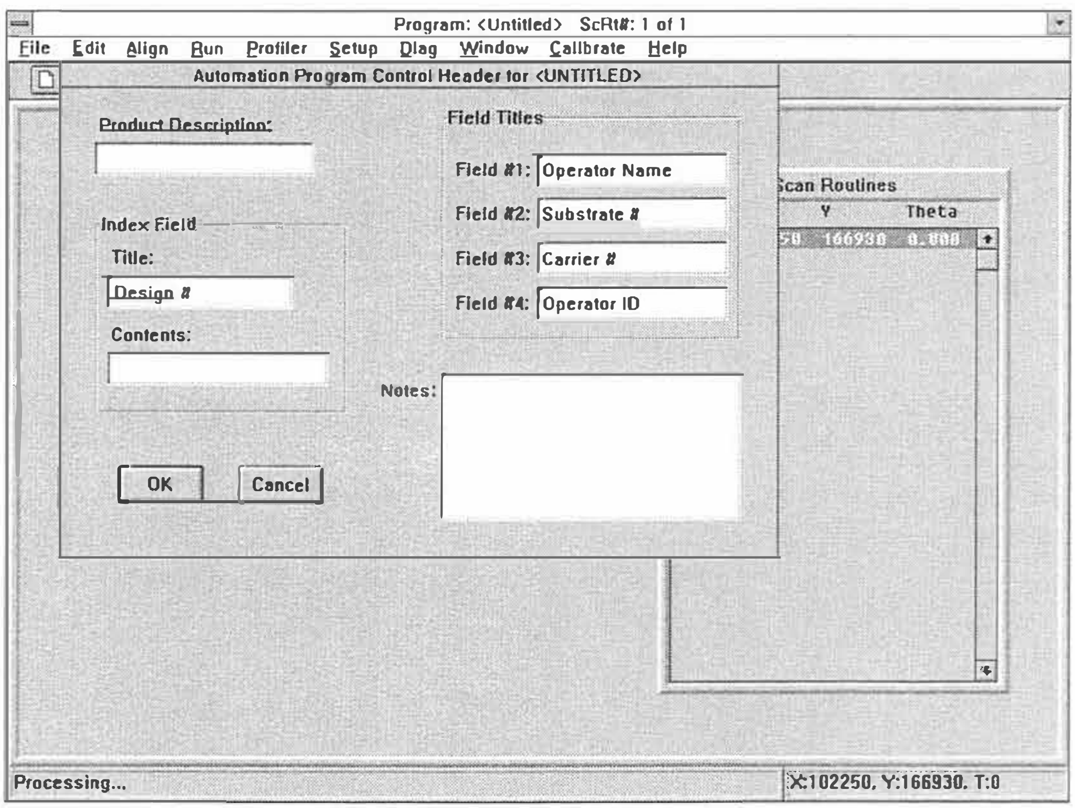


Figure 5-1. Automation Program Control Header

EDITING AN AUTOMATING PROGRAM

The procedure below describes how to copy the current Scan Routine to create an Automation Program containing multiple Scan Routines. An Automation Program can contain up to 200 Scan Routines, however, for the purpose of this exercise, an Automation Program will be created containing three Scan Routines.

1. Click-on "Edit" from the Automation Program window menu bar and click-on "Copy to Range..." from the Edit Menu. A pop-up window will be displayed requesting the copy to range (see Figure 5-2).

2. A flashing cursor will appear in the box labeled "Copy current scan routine to scan routine #", key in number "2" in the box.

3. Click-on the box below it labeled "Through Scan Routine #." The flashing cursor will appear in the second box. Key-in number "3".

4. Click-on "OK". The window will disappear and the current Scan Routine 1 will be copied to scan routines 2 and 3 where the Scan Routines are listed on the right half of the Automation Programs screen. Scan Routine 2 is now the current Scan Routine.

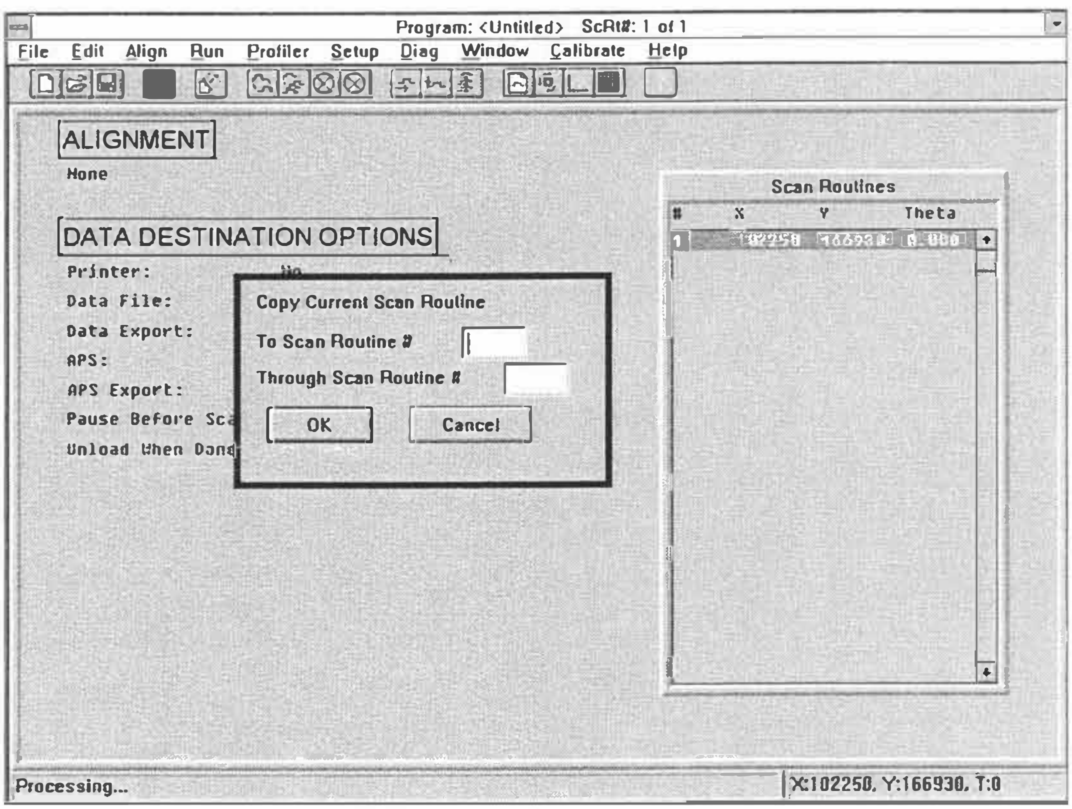


Figure 5-2. Copy to Range Window

GLOBAL EDITING OF SCAN ROUTINE PARAMETERS

The individual scan parameters within each scan routine of an Automation Program can be changed at any time. For the purpose of this exercise, the Global Edit Mode will be used to allow the parameters of all the scan routines within the Automation Program to be edited.

1. Click-on "Window" and click-on "Scan Routines" from the Window Menu. The Scan Routines screen will be displayed. Click-on "Edit" and click-on "Global Edit Mode" (Figure 5-3).

2. Click-on the "Display Parameters" window. The Display parameters options will be displayed. Click on the "Automatic Leveling" checkbox. Enter 150 into each band width box (Figure 5-3). Click on "OK" to close.

3. To enter the ASH analytical function, click-on "Edit" from the menu bar and click-on "Append Analytical Functions". The Analytical Functions will be displayed.

4. Click-on the M cursor box and enter "1000". Click-on "ASH" from the Height Parameters and click-on "ADD". The ASH Band Widths dialog box will be displayed. Enter the default ASH band widths for the R and M cursor by clicking-on "OK". Click-on "Done" when finished.

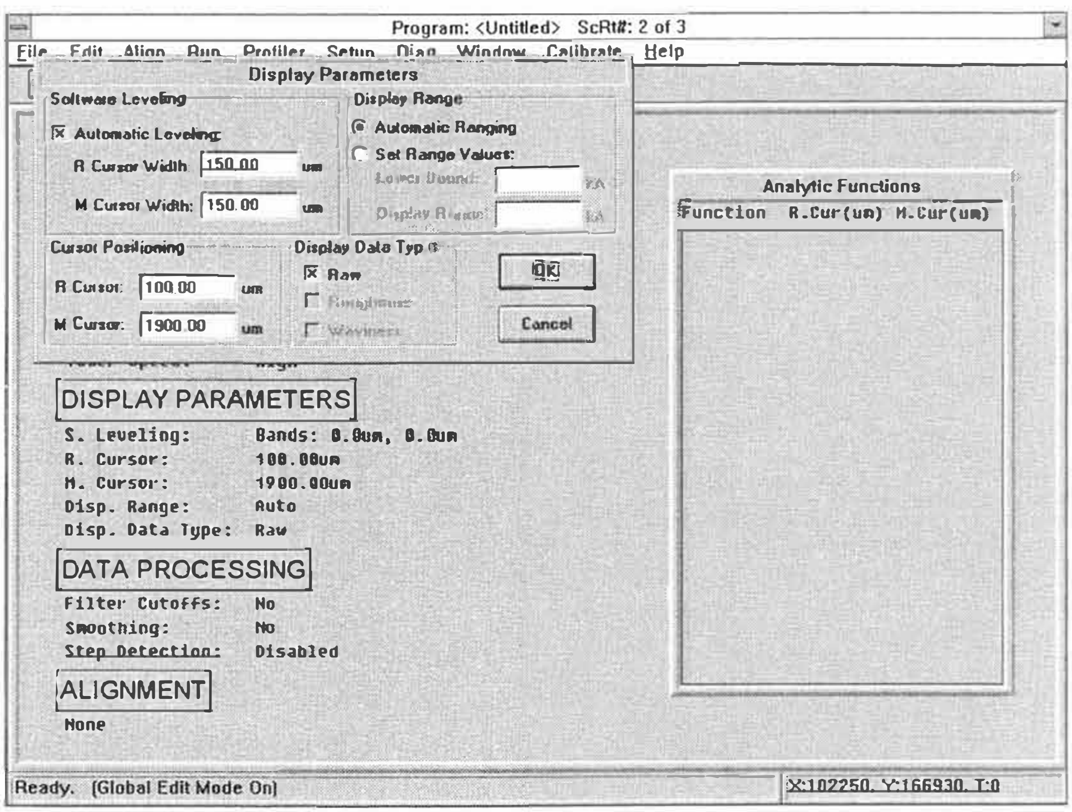


Figure 5-3. Global Edit Mode

PROGRAM ENTRY

The location of a scan routine is identified by a set of three numbers which represent the X,Y, and theta positions of the stage where the scan routine is to be performed. Because all three scan routines in the current automation program have the same values, it will be necessary to enter new values for each scan routine.

1. Click-on "Window" from the menu bar and click-on "Sample Positioning". The sample positioning screen will be displayed.

2. Click-on "Edit" from the screen specific menu bar. The Edit Menu will be displayed listing several options (see Figure 5-4). Selecting "Enter Scan Location" from the Edit Menu enters the current stage location into the current scan routine. Selecting "Enter Scan Length" allows the scan length to be adjusted. And selecting "Go to Scan Routine" goes to the selected scan routine, making it the current scan routine. The number of the current scan routine is displayed at the very top of the screen.

3. Click-on "Go To Scan Routine" and enter scan routine number "1" into the dialog box and click-on "OK".

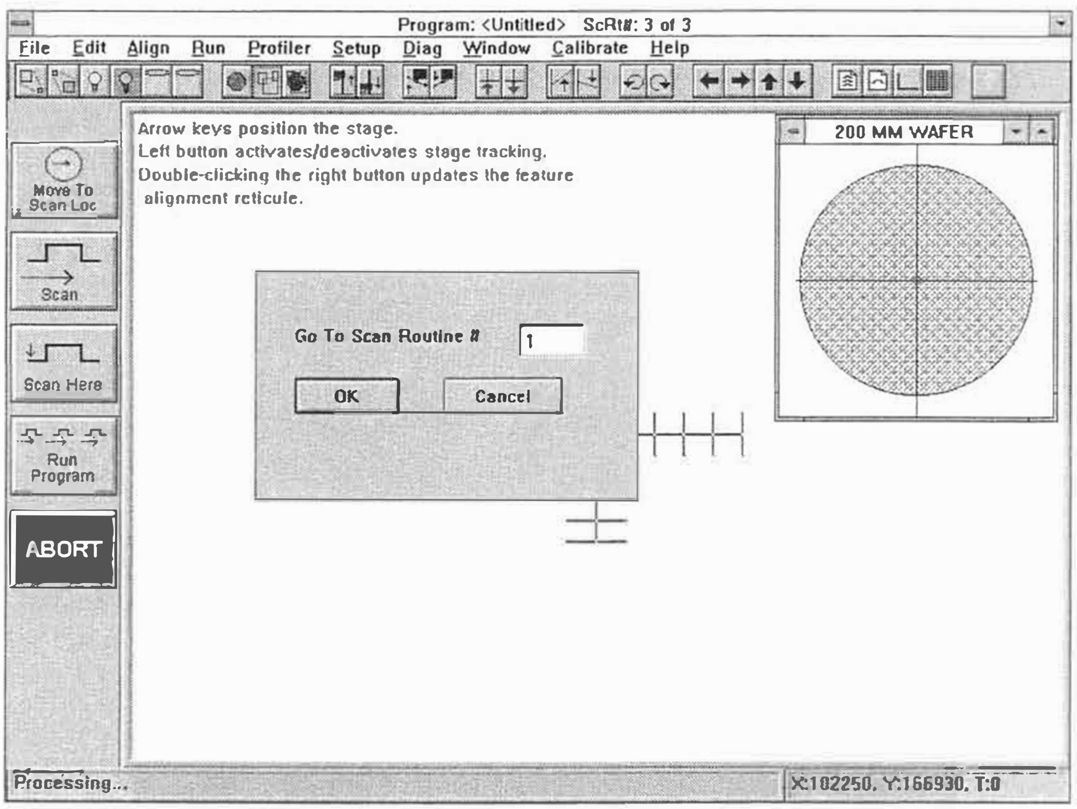


Figure 5-4. Program Entry Menu

Scan Location Entry - Scan Routine #1

Prior to entering the location for Scan Routine #1, verify that Scan Routine #1 is displayed at the top of the screen as the current Scan Routine.

1. Click-on the video image of the sample positioning screen. The stage will now track the motion of the mouse or trackball. When the calibration standard is properly positioned, as shown in Figure 5-5, click-on the mouse or trackball a second time to deactivate the stage.

2. Click-on "Edit". The Edit Menu will be displayed.

3. Click-on "Enter Scan Location" from the Edit Menu.

4. A dialog box will be displayed verifying the Scan Location for Scan Routine #1. Click-on "OK" to enter the location. Scan Routine #2 is now the current Scan Routine.

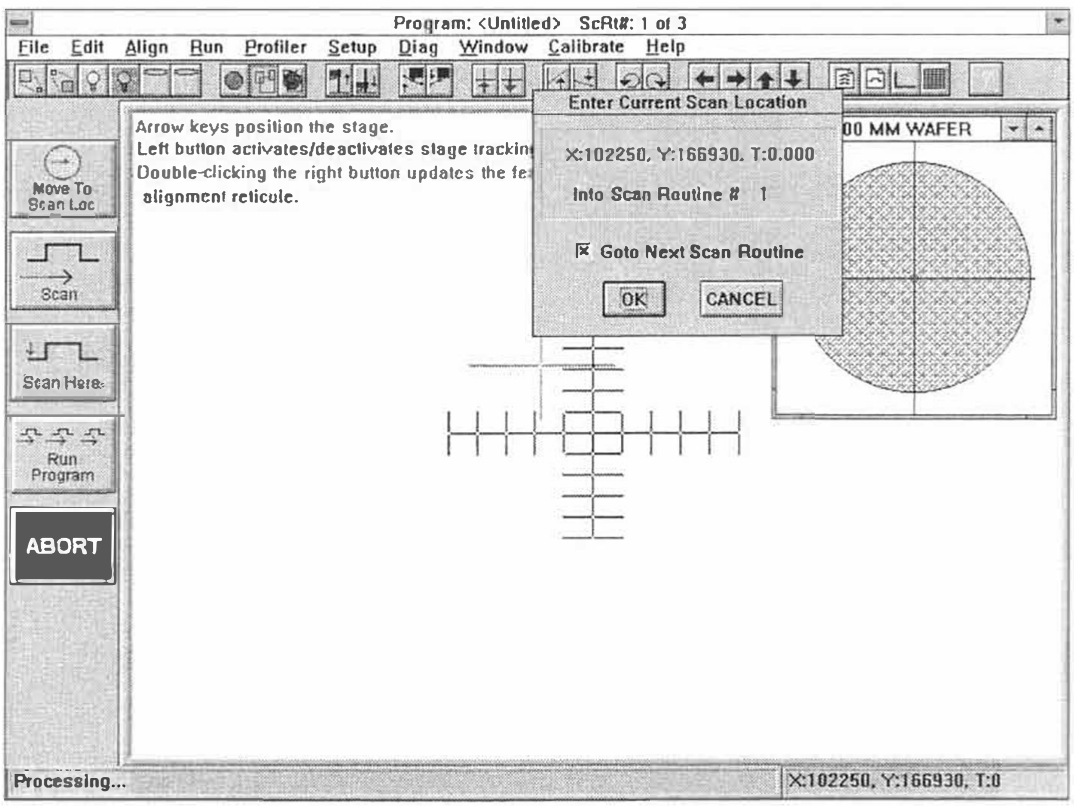


Figure 5-5. Stylus Position for Scan Routine #1

Scan Location Entry - Scan Routine #2

Prior to entering the location for Scan Routine #2, verify that Scan Routine #2 is displayed at the top of the screen as the current scan routine.

1. Click-on the video image of the Sample Positioning screen. The stage will now track the motion of the mouse or trackball.

2. Roll the pointing device to position the calibration standard as shown in Figure 5-6. Once the calibration standard is properly aligned with the software reticule, click the mouse or trackball a second time to deactivate the stage.

3. Click-on "Edit". The Edit Menu will be displayed.

4. Click-on "Enter Scan Location" and click-on "OK". The current X,Y stage position will be entered into Scan Routine #2 and Scan Routine #3 will become the current Scan Routine.

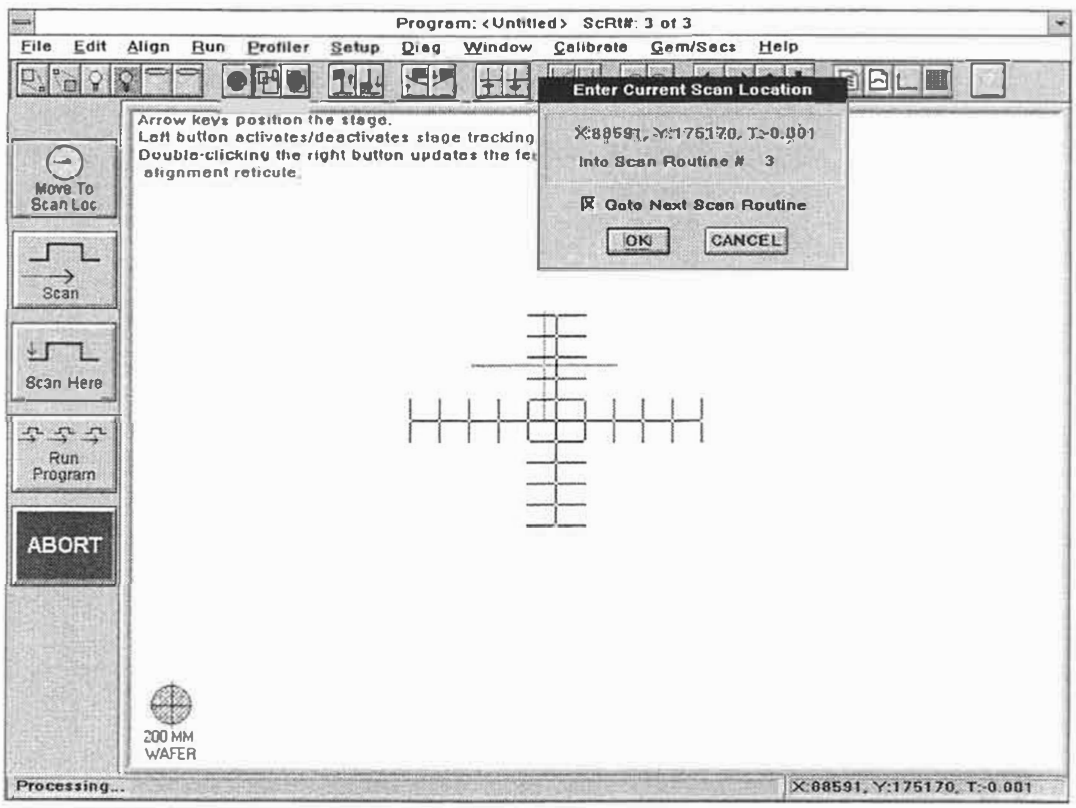


Figure 5-6. Stylus Position for Scan Routine #2

Scan Location Entry - Scan Routine #3

Prior to entering the location for Scan Routine #3, verify that Scan Routine #3 is displayed at the top of the screen as the current Scan Routine.

1. Click-on the Video image of the Sample Positioning screen. The stage will now track the motion of the mouse or trackball.

2. Roll the pointing device to position the calibration standard as shown in Figure 5-6. Click a second time to deactivate the stage.

3. Click-on "Edit". The Edit Menu will be displayed.

4. Click-on "Enter Scan Location" from the Edit Menu and click-on "OK". The current X,Y stage position will be entered into Scan Routine #3.

5. Once all of the triplets are entered an Automation Program can be run. Click-on "RUN" and click-on "Run Auto Program". The Automation program will be run, performing a scan at each programmed location.

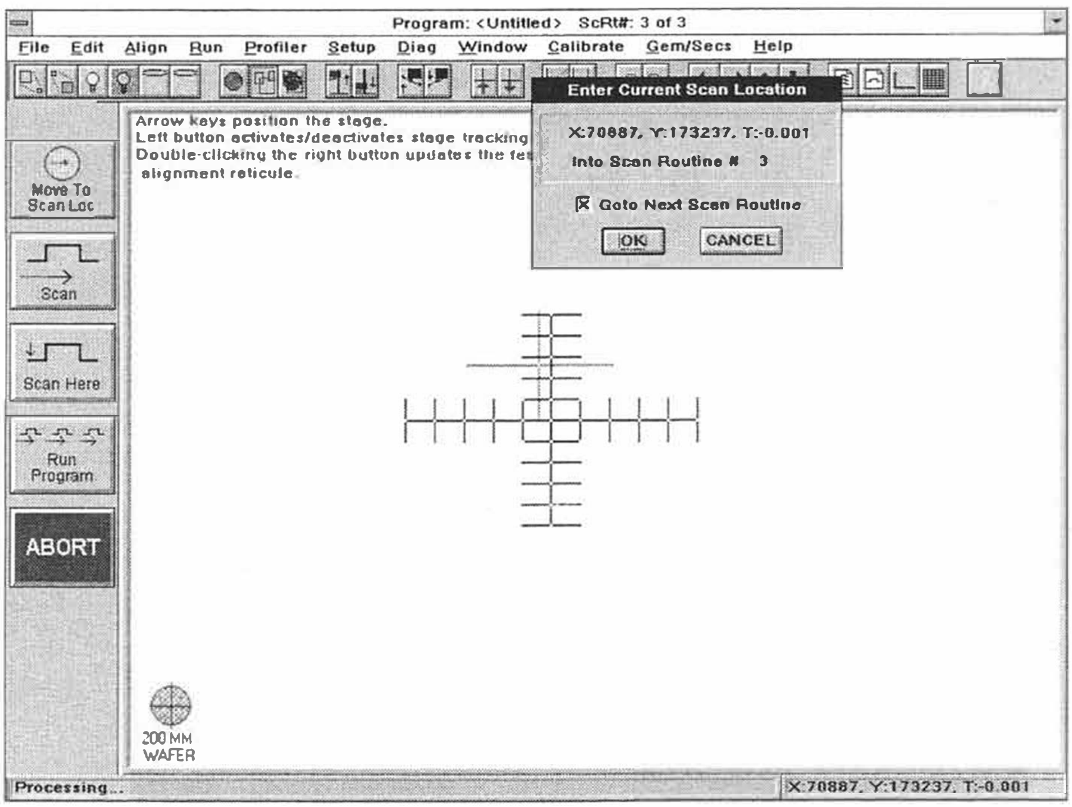


Figure 5-7. Stylus Position for Scan Routine #3

DATA DESTINATION OPTIONS

Data destination options can be entered into the Automation Program to automatically perform a selected function at the conclusion of each scan routine. Several data destination options are available on the DEKTAK V 200-Si for selecting the printer, data file, APS, and pause after scan. The procedure to program these options for the purpose of this exercise is described on the following pages.

Printer

1. Click-on the printer data destination option and three printer options will be displayed: no, print plot, and print plot summary (see Figure 5-8). If "No" is selected, a printout will not be produced. If "Print Plot" is selected, the plotted profile trace along with the profile data will be printed out on the DEKTAK V 200-Si thermal printer. If "Print Plot Summary" is selected, a printout will be produced of a summary of the scan data only.

2. For this exercise, click-on "Print Plot". With "Print Plot" selected, a printout of the plotted profile will be produced after each scan routine is completed, whenever the Automation Program used in this exercise is run.

NOTE

In addition to the Plot or Scan Data Summary printout, the Automation Program Summary (APS) can be printed at the conclusion of the Automation Program.

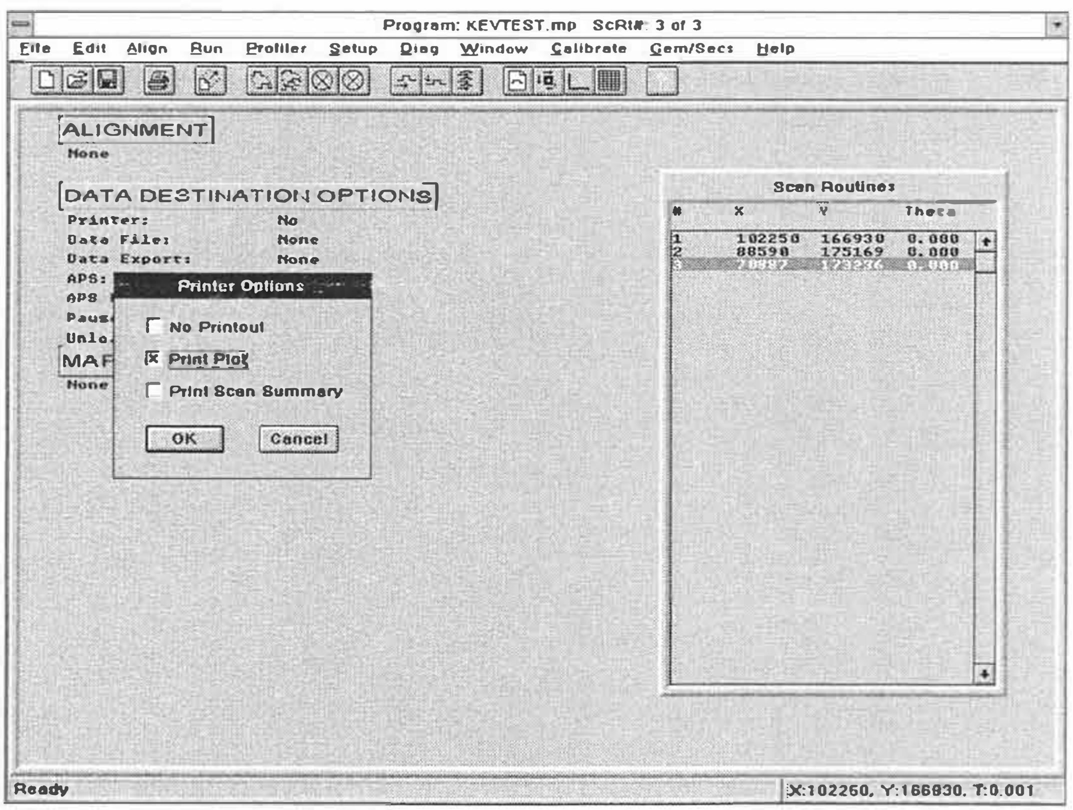


Figure 5-8. Printer Data Destination Option

Data File/Data Export

The data file and data export options permit the data plot screen from the just concluded scan routine to be filed either as binary data or ASCII data on the DEKTAK V 200-Si hard disk or for back-up on a diskette. The plotted profile can then be redisplayed at a later date for further analysis. Two data file options are available "No" and "Yes". For this exercise the data will be filed to the C drive.

1. Click-on the "Data File" option in the Automation Programs screen. A dialogue box will be displayed permitting the data to be saved either at binary data or ASCII data (see Figure 5-9). Click-on "Select File" under binary data. A dialogue box will be displayed containing a directory listing of the Data Plot screen previously saved in the "V 200-Si" file.

2. Unless otherwise specified, data will automatically be loaded to the default DEKTAK V 200-Si file on the "C" drive. Click-on the box labeled "File Name:" just to the right of "*.*" and a flashing cursor will be displayed in the box.

3. A file name up to eight characters may be entered under which to file data. Push the back-space key to delete the "*.*" and key in the filename "EXERCISE" and click-on "OK".

4. The filename "EXERCISE" will be entered into the data file option. When the current automation program is run, the data plot screens produced from the performed scan routines will be filed under "EXERCISE".

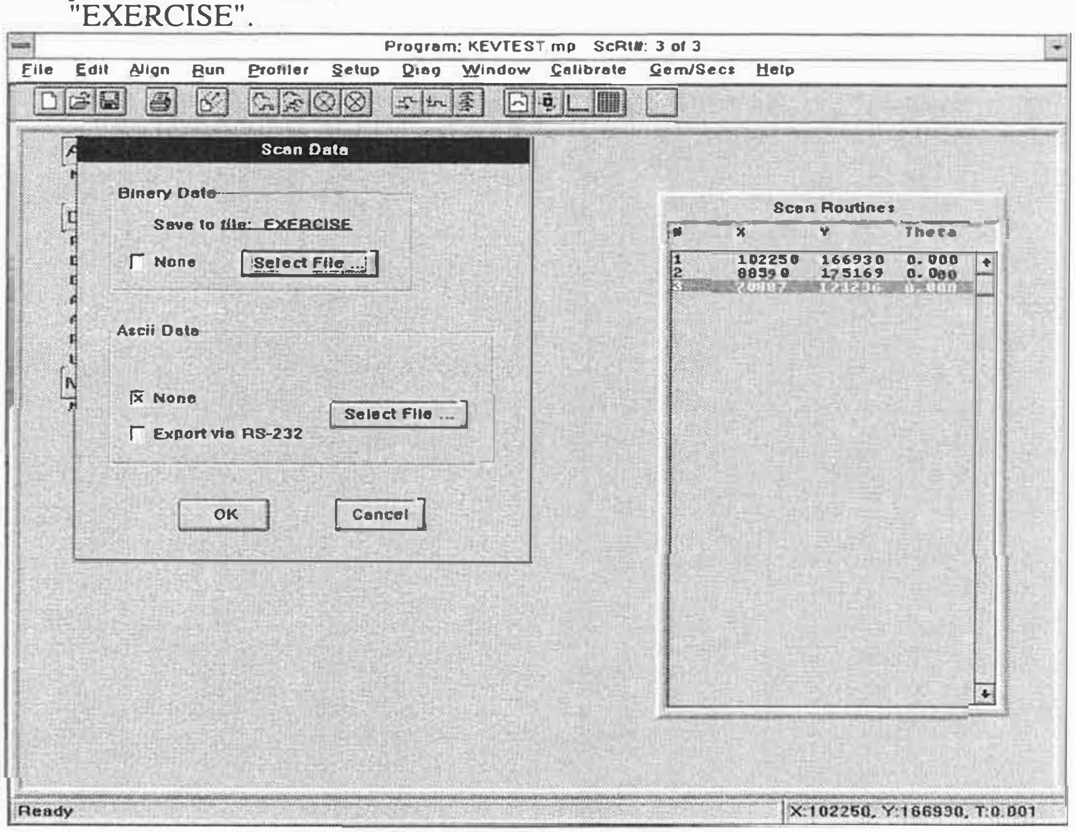


Figure 5-9. Data File Directory

Opening Saved Scan Data Plot

For the purpose of this exercise, the current Automation Program will be run to demonstrate how the data destination option files data plot screens under the selected filename.

1. Click-on "RUN" and click-on "Run Auto Program". The Automation Program will be run and the data plot screens will be filed.

2. At the conclusion of the Automation Program, the Data Plot screens can be retrieved by clicking-on "File" located above the Data Plot Screen.

3. Click-on "Open" from the File Menu and click-on "Single Scan" from the sub-menu. A directory listing will be displayed of the saved data plot screens. The data plot screen from scan routines 1, 2, and 3 are filed under "EXERCISE.001", "EXERCISE.002" and "EXERCISE.003" respectively (see Figure 5-10).

4. To redisplay the Data Plot Screen from Scan Routine #1, click-on "EXERCISE.1" and click-on "OK". The Data Plot Screen from Scan Routine #1 will be replotted and redisplayed.

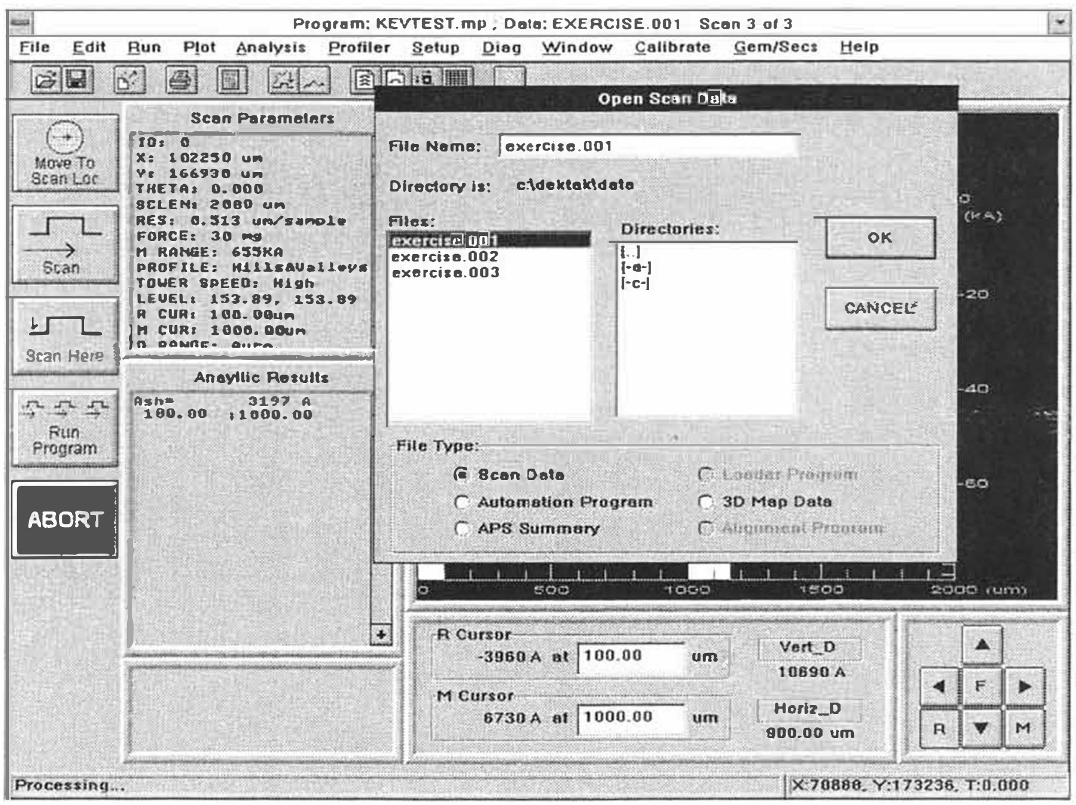


Figure 5-10. Load Data File Directory

Enabling Automation Program Summary (APS)

The Automation Program Summary data destination option provides a summary and listing of the analytical function results for an Automation Program. All scan routines within the automation program must have identical scan routine parameters (excluding X,Y,Theta location) for the Automation Program Summary to be computed.

1. Click-on "Window" and click-on "Automation Programs" to return to the Automation Program Screen.

2. Click-on the line labeled "APS" from the Data Destination Options to display the Automation Program Summary dialog box (see Figure 5-11).

3. Click-on the box labeled "Print APS" to produce a printout of the Automation Program Summary.

4. Click-on the "Select File" button under "Binary APS" to save the Automation Program Summary as a binary file.

5. Click-on the box labeled "Summary File Name" and key-in the filename "EXERCISE.APS" (by convention, these filenames should be given an .APS Dos file extension) and click-on "OK".

6. Click-on "RUN" and click-on "Run Auto Program" from the Run menu. The current Automation Program will be run, and the Automation Program summary will be computed, displayed, printed, and saved.

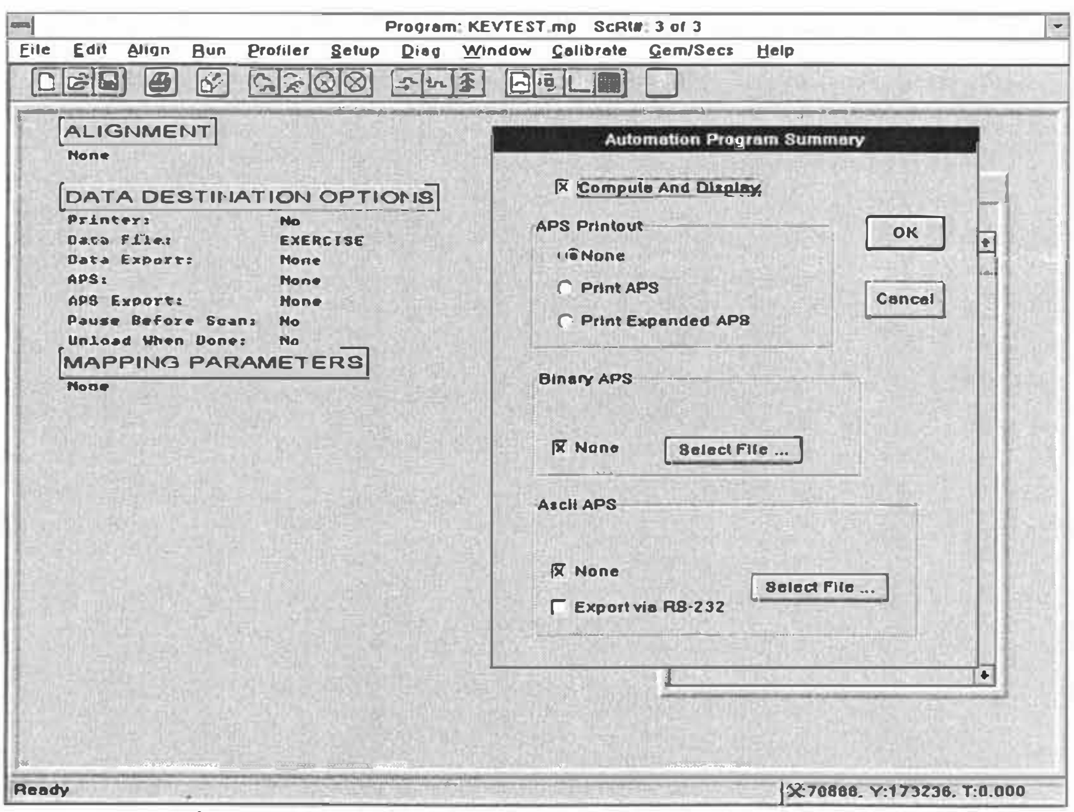


Figure 5-11. Automation Program Summary Dialog Box

Automation Program Summary Screen

The Automation Program Summary Screen (see Figure 5-12) provides data on the just concluded Automation Program. The items highlighted in yellow include: The Automation Program filename, number of Scan Routines, Sample ID, Automation Program start time and date. The items highlighted in green display the locations of the reference and measurement cursors for each analytical function. The items highlighted in blue provide the mean, standard deviation, minimum, maximum, and range of the analytical function from all the scan routines. The items highlighted in red provide the individual analytical function results for each scan routine.

1. To redisplay the Automation Program Summary after exiting the APS screen, click-on "Window" and click-on "Auto Prog Summary".

2. To print an Automation Program Summary, click-on "File" and click-on "Print" and click-on "Auto Prog Summary (APS)" from the File Menu.

3. To redisplay an Automation Program Summary saved to file, click-on "File" from the APS screen menu bar and click-on "Open" from the File Menu. A listing of the files saved under the ".APS" DOS file extension will be displayed. Click-on the desired filename and click-on "OK".

4. To save an Automation Program Summary to file from the APS screen, click-on "File" and click-on "Save" from the APS File Menu. Enter the desired filename with the ".APS" DOS file extension and click-on "OK".

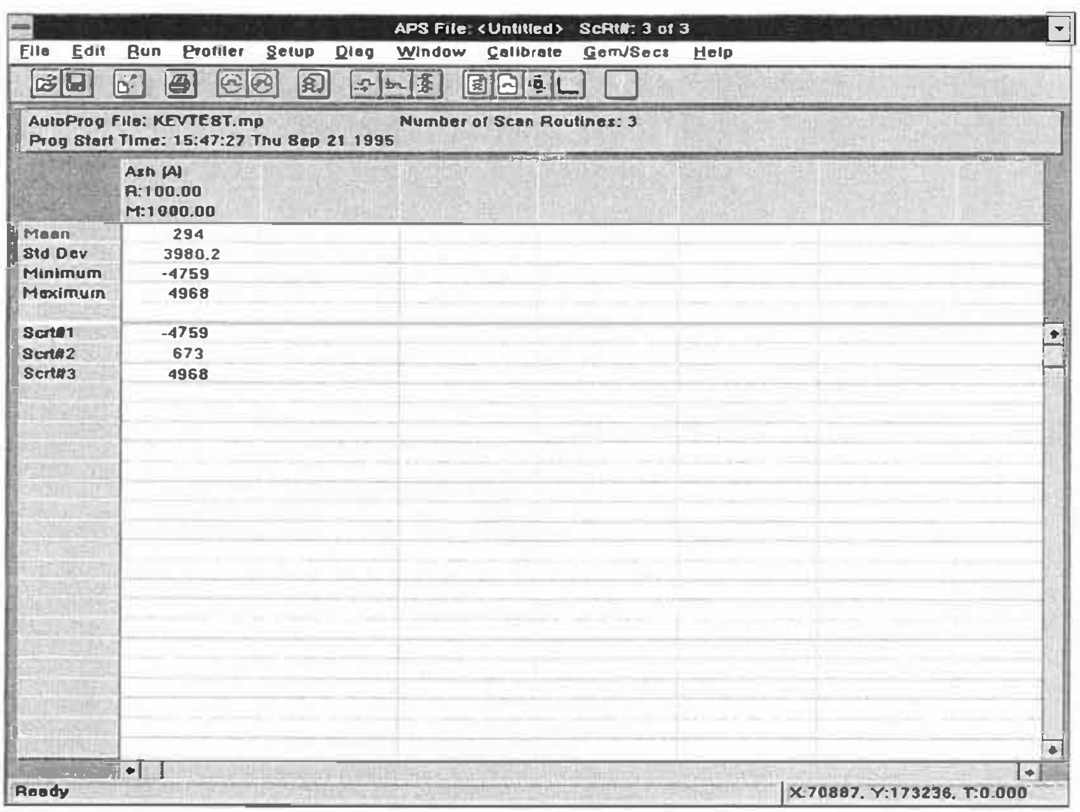


Figure 5-12. Automation Program Summary Screen

Pause Before Scan

The Before After Scan data destination option allows a pause or a time delay to be entered between each scan routine to permit the operator time to visually inspect or record scan data. Three pause before scan options are available: "No Pause", "Adjust", and "Time Delay". When "No Pause" is selected, all scan routines within the Automation Program will be run one right after another. When "Adjust" is selected, the system will stop after each scan routine to allow any necessary adjustments to be made to the sample position. It will wait until the operator clicks-on "Continue" from the Run menu before continuing to the next scan routine in sequence, contained in the Automation Program. Finally, the "Time Delay" selection permits a time delay to be entered between scans. The procedure for entering a time delay into the Automation Program is described below.

1. Click-on "Pause Before Scan" and a dialogue box will be displayed permitting a time delay to be entered in seconds (see Figure 5-13).

2. For the purpose of this exercise, click-on "Time Delay" and key in "10" seconds and press "Enter". A ten second delay will be entered between each scan routine when the current Automation Program is run.

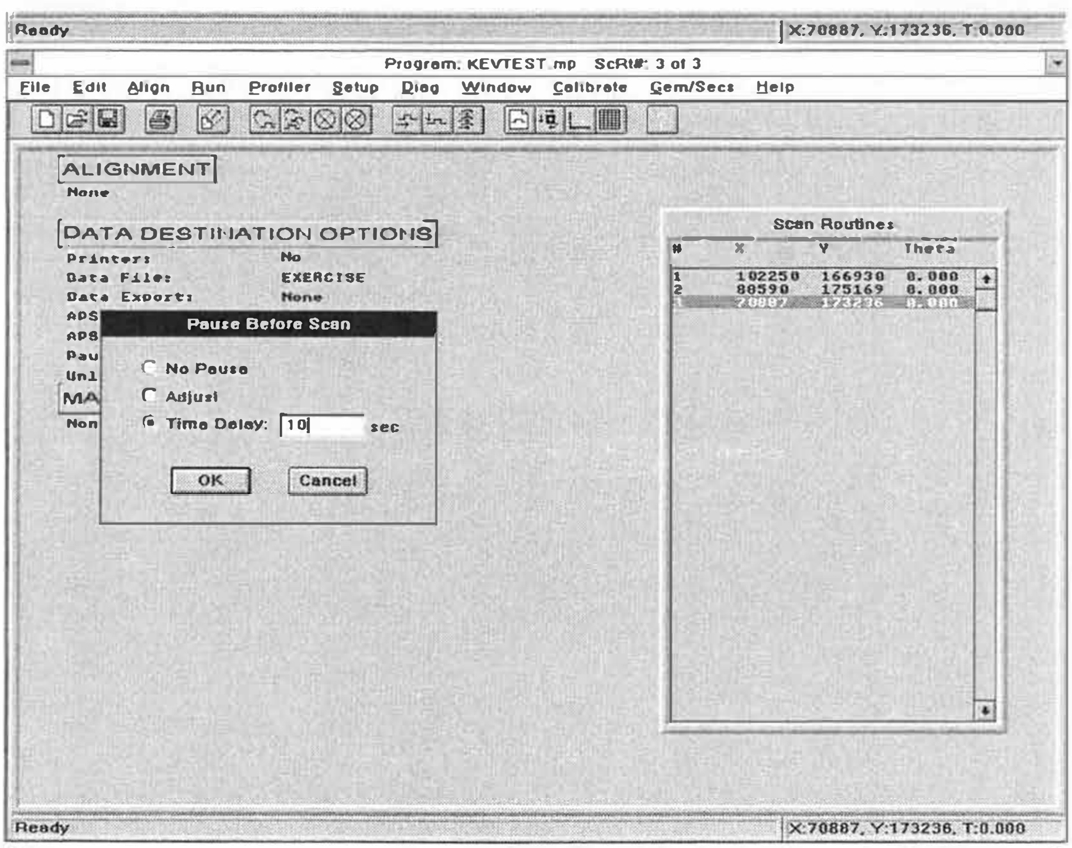


Figure 5-13. Delay Before Scan

UNLOAD AFTER AUTOMATION PROGRAM

When an Automation Program is complete the "Unload When Done" feature may be selected to automatically translate the sample stage to the scan head door at the conclusion of an automation program to allow easy loading and unloading of samples.

1. Click-on "Unload When Done" from the automation program data destination options. The Unload After Program dialogue box will be displayed (see Figure 5-14).

2. Click-on "Go to Unload Position" and click-on "OK".

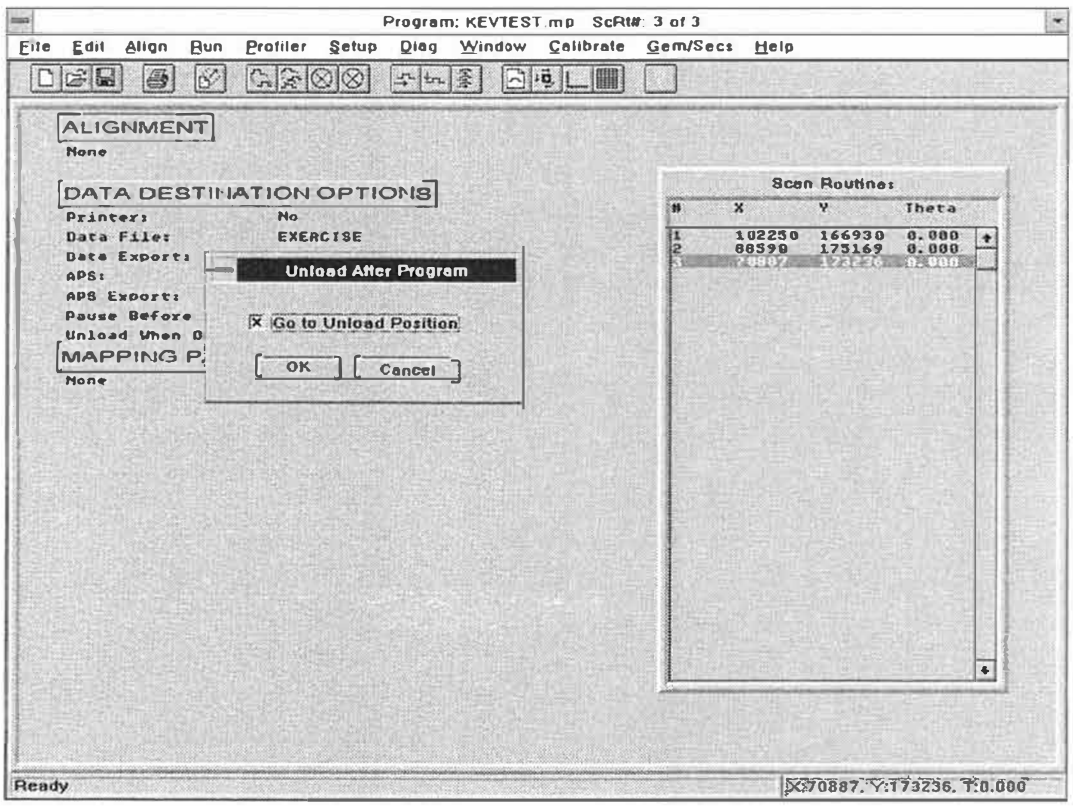


Figure 5-14. Unload After Program Dialogue Box

SELECTING DESKEW POINTS

Each Automation Program contains two Deskew Points. The Deskew feature allows the system to compensate for slight sample to sample positioning errors.

When an Automation Program is being developed on a production reference sample, all programmed X-Y coordinates relate to the position of that particular sample as it rests on the sample stage. It is highly unlikely that like samples can be loaded at the exact physical location of the reference sample used to define the Automation Program. Tooling or fixturing pins are extremely helpful and highly recommended if fast, accurate sample positioning is to be achieved, however slight sample and/or physical positioning variances will throw off or "skew" the programmed X-Y coordinates.

To compensate for this "skewing", Deskew Points can be established on the reference sample when the Automation Program is defined. Any easily identifiable landmarks on the reference sample may be selected as Deskew Points, such as test pads on a silicon wafer or the corner of the substrate.

To assure deskew accuracy, the following steps must be taken when establishing or verifying Deskew Points:

1. Always verify Deskew Points at the same video magnification as the points were established.

2. Prior to establishing reference or actual Deskew Points, always lower the stylus by activating the "Tower Down" function from the "STYLUS" menu, to ensure the tower is nulled over the feature. Always raise the stylus prior to repositioning the sample.

3. For critical measurements it is recommended that Deskew Points be set prior to entering the triplets for the scan routines within an Automation Program.

4. For the greatest deskew accuracy, establish the two Deskew Points at the greatest diagonal position possible (see Figure 5-15).

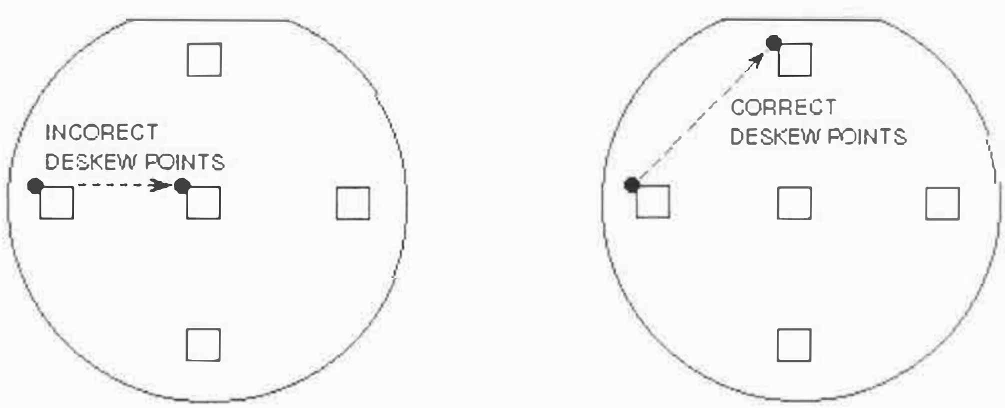


Figure 5-15. Establishing Deskew Points at a Diagonal

ESTABLISHING REFERENCE DESKEW POINTS

In the upper left field of the Automation Programs screen the coordinates for the Deskew Points are displayed. If no deskew points have been entered, then "none" will appear below "Deskew Points". Two deskew points are required. The procedure for setting reference deskew points for this exercise is described below.

To Set 1st Reference Deskew Point

1. Click-on "Align" from the menu bar displayed in either the automation programs window or the fine positioning window and click-on "Set AutoProg Deskew Points". The fine positioning screen will be displayed along with the dialog box for setting the first Deskew point.

2. Click-on the software reticule to activate the stage. Roll the pointing device until the software reticule is lined up with the upper right corner of the calibration standard pattern as shown in Figure 5-16.

3. When the reticule and standard are properly aligned, click the pointing device a second time to deactivate the stage.

4. Click-on "Profiler" and click-on "Tower Down" to lower the stylus and null the tower. Then click-on "Profiler" and click-on "Stylus Up" to raise the stylus. Readjust the reticule/standard positioning if necessary.

5. Click-on "OK" in the dialog box. The current X,Y,Theta location will be entered as the first reference deskew point.

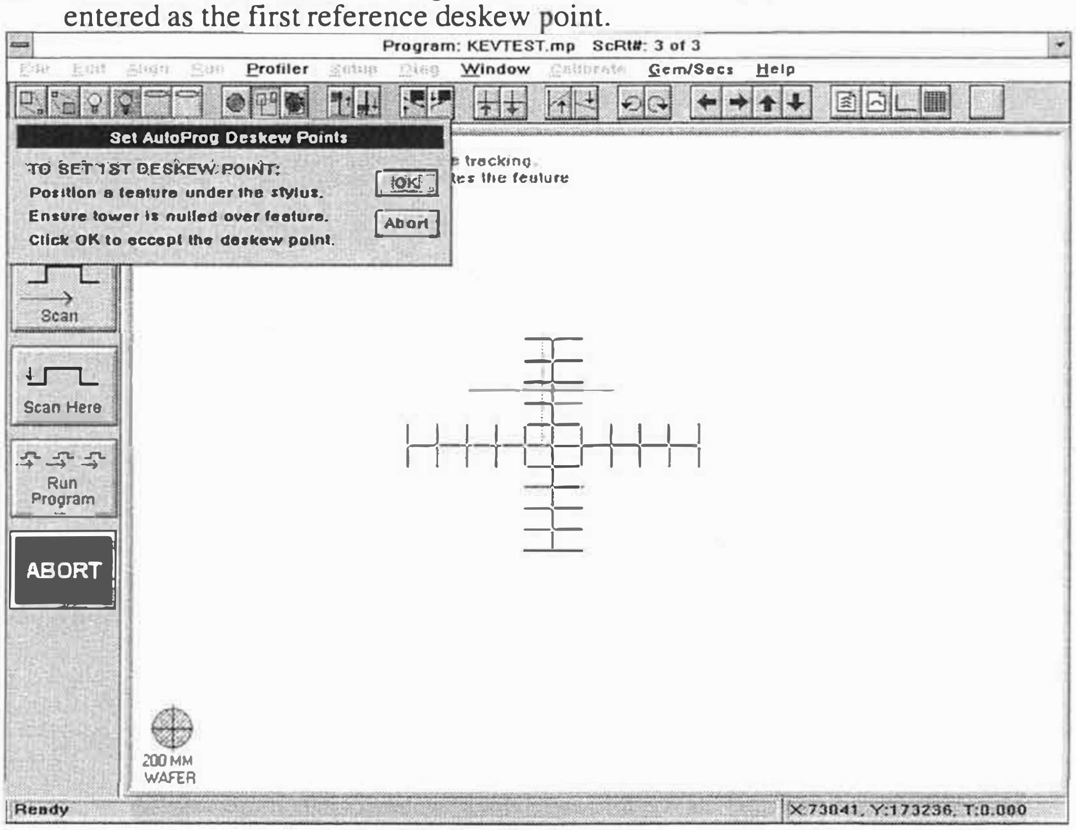


Figure 5-16. Setting the First Reference Deskew Point

To Set 2nd Reference Deskew Point

Once the first reference Deskew Point has been set, a second dialog box will be displayed providing instructions for setting the second reference Deskew Point (see Figure 5-17). The second deskew point must be selected at a point which is located at a diagonal from the first reference deskew point.

1. Roll the pointing device to the software reticule and click. The arrow will disappear and the stage will track the motion of the pointing device.

2. Position the sample stage so that the lower left corner of the calibration standard pattern is lined up with the software reticule as shown below. Once the standard and reticule are properly aligned, click the pointing device a second time to deactivate the stage.

3. Click-on "OK" in the dialog box. The current X,Y,theta location will be entered as the second reference deskew points.

4. Click-on "Profiler" and click-on "Tower Down" to lower the stylus and null the tower. Then click-on "Profiler" and click-on "Stylus Up" to raise the stylus. Readjust the reticule/standard positioning if necessary.

5. To verify that the deskew points have been entered, return to the Automation Programs screen. The X,Y,theta triplet values of the deskew point locations will be displayed.

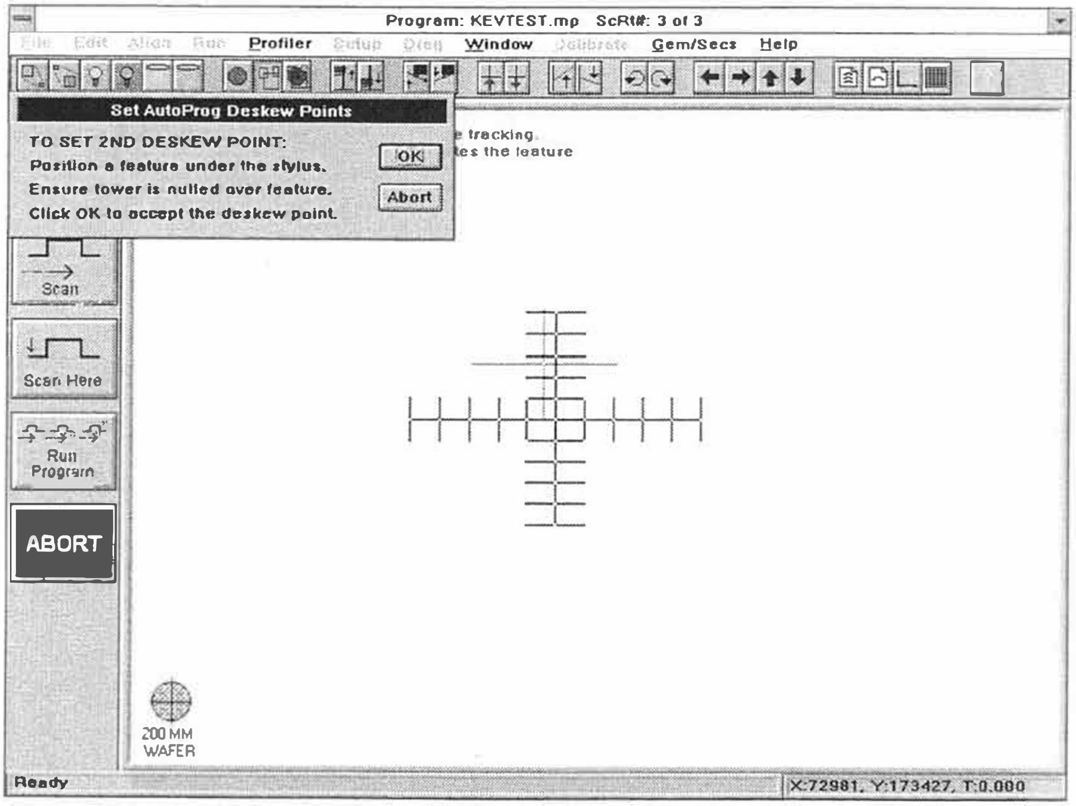


Figure 5-17. Setting the Second Reference Deskew Point

RUNNING AN AUTOMATION PROGRAM ON A SKEWED SAMPLE

The exercise below describes the procedure for setting the actual deskew points on the skewed calibration standard. Prior to running the Automation Program, reposition the calibration standard on the stage, approximately 1 mm to 2 mm from its original position.

1. Click-on "RUN" and click-on "Run Auto Program" from the Run menu. The stage will translate to the X,Y,theta location of the reference deskew points. A dialog box will be displayed providing instructions for checking the first actual deskew point (see Figure 5-18).

2. Click-on "Profiler" and click-on "Tower Down" to lower the stylus and null the tower. Click-on "Profiler" and click-on "Stylus Up" to raise the stylus.

3. Click-on the software reticule to activate the stage. Roll the pointing device to relocate the visually identifiable landmark selected as the 1st reference deskew point. Line up the software reticule with the upper right corner of the calibration standard pattern as shown in Figure 5-18.

4. Once the reticule is properly aligned with the calibration standard, click the pointing device a second time to deactivate the stage.

5. Click-on "OK" in the dialog box. The dialog box will disappear and the current X,Y,theta stage location will be entered as the first actual deskew point. The stage will then translate to the X,Y,theta location entered as the second reference deskew point.

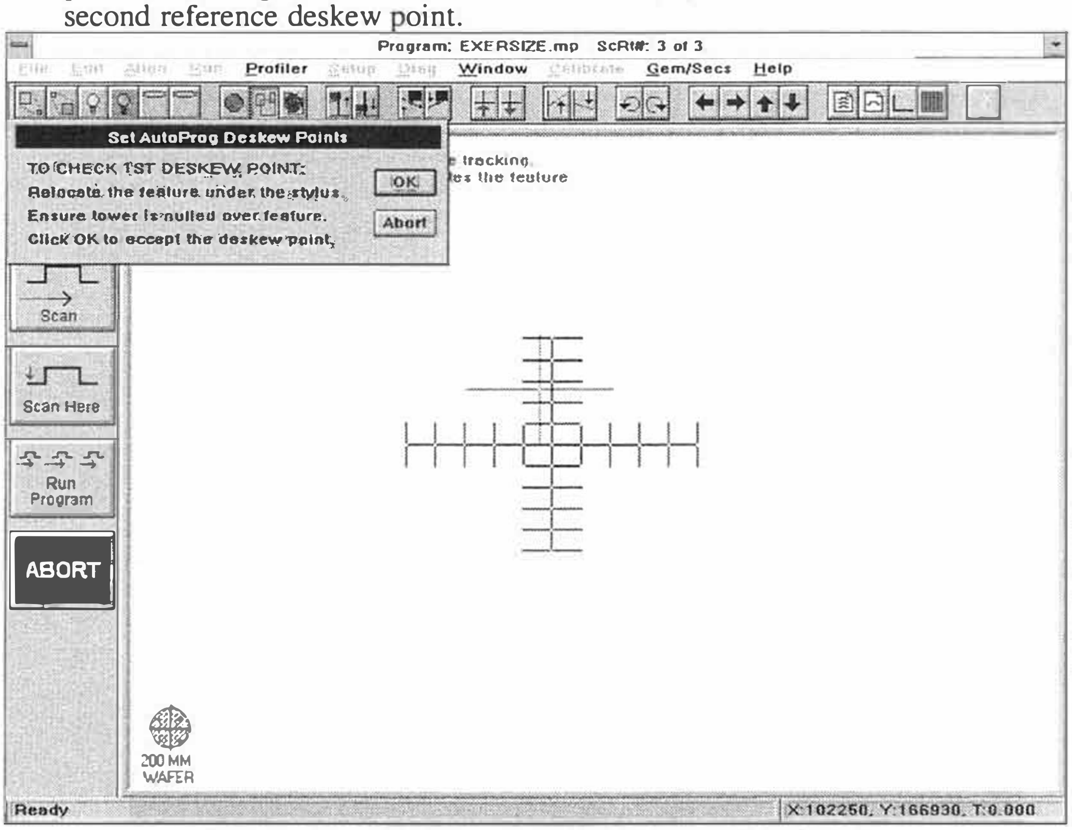


Figure 5-18. Checking the 1st Actual Deskew Point

6. Click-on "Profiler" and click-on "Tower Down" to lower the stylus and null the tower. Click-on "Profiler" and click-on "Stylus Up" to raise the stylus.

7. Click-on the software reticule to activate the stage. Roll the pointing device to relocate the visually identifiable landmark selected as the second reference deskew point. Line up the software reticule with the lower left corner of the calibration standard as shown in Figure 5-19.

8. Once the reticule is properly aligned with the calibration standard, click the pointing device a second time to deactivate the stage.

9. Click-on "OK" in the dialog box. The dialog box will disappear and the DEKTAK V 200-Si is now ready to run the Automation Program. The stage will translate to the first scan routine location and begin the Automation Program.

NOTE

If the DEKTAK V 200-SI is equipped with the AutoTheta Option, a third dialog box will be displayed requesting that the 2nd Deskew Point be relocated to adjust for any rotational offset. Repeat the above procedure (steps 6-9) to relocate the 2nd actual Deskew Point.

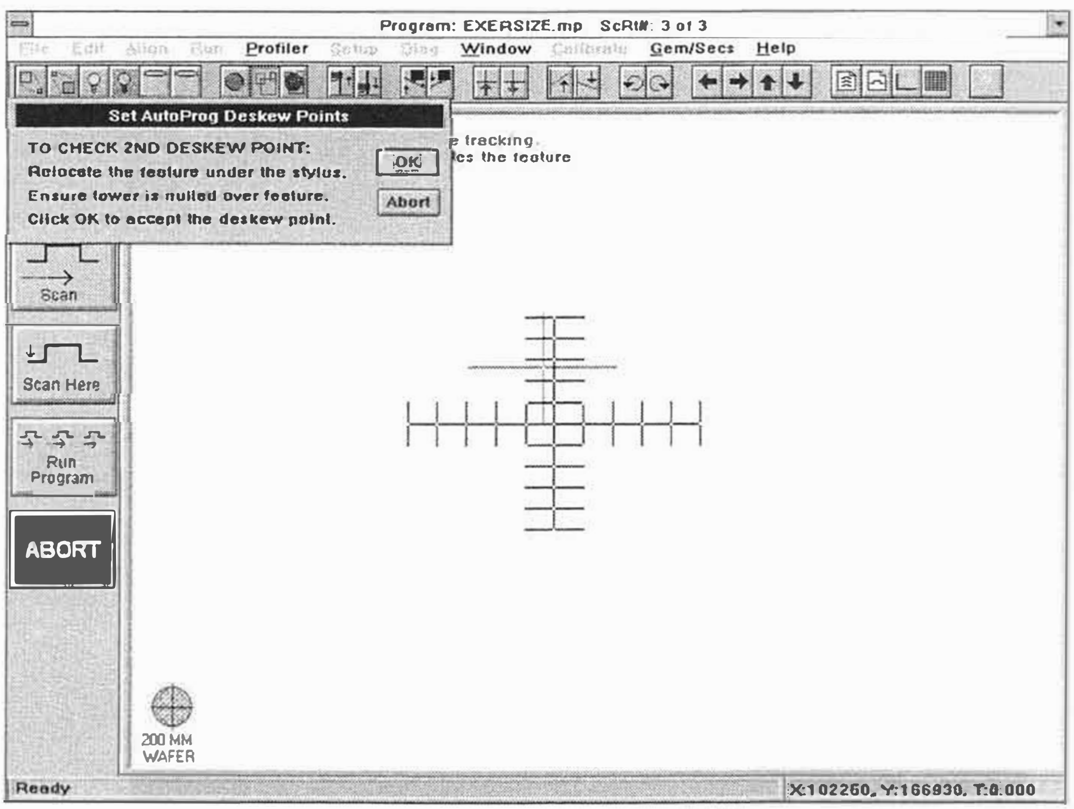


Figure 5-19. Checking the 2nd Actual Deskew Point

REPLACING AN EXISTING AUTOMATION PROGRAM

By participating in the exercise described in this section, many changes and alterations have been made to the Automation Program. The procedure for saving an existing Automation Program with changes is described below.

1. Click-on "Window" and click-on "Automation Programs" to return to the Automation Programs screen.

2. Click-on "File" and the file menu will be displayed.

3. Click-on "Save As" from the File Menu.

4. Click-on "OK". A second pop-up window will be displayed with a warning asking if it is OK to replace the existing "EXERCISE.MP".

5. Click-on "Yes". Both windows will disappear and the new automation program "EXERCISE" will replace the existing program.

NOTE

To save the Automation Program to the A Drive, click-on "Save" from the File menu and save the filename as: "A:\EXERCISE.MP". Be sure to return the system to the C Drive prior to removing the diskette from the A Drive.

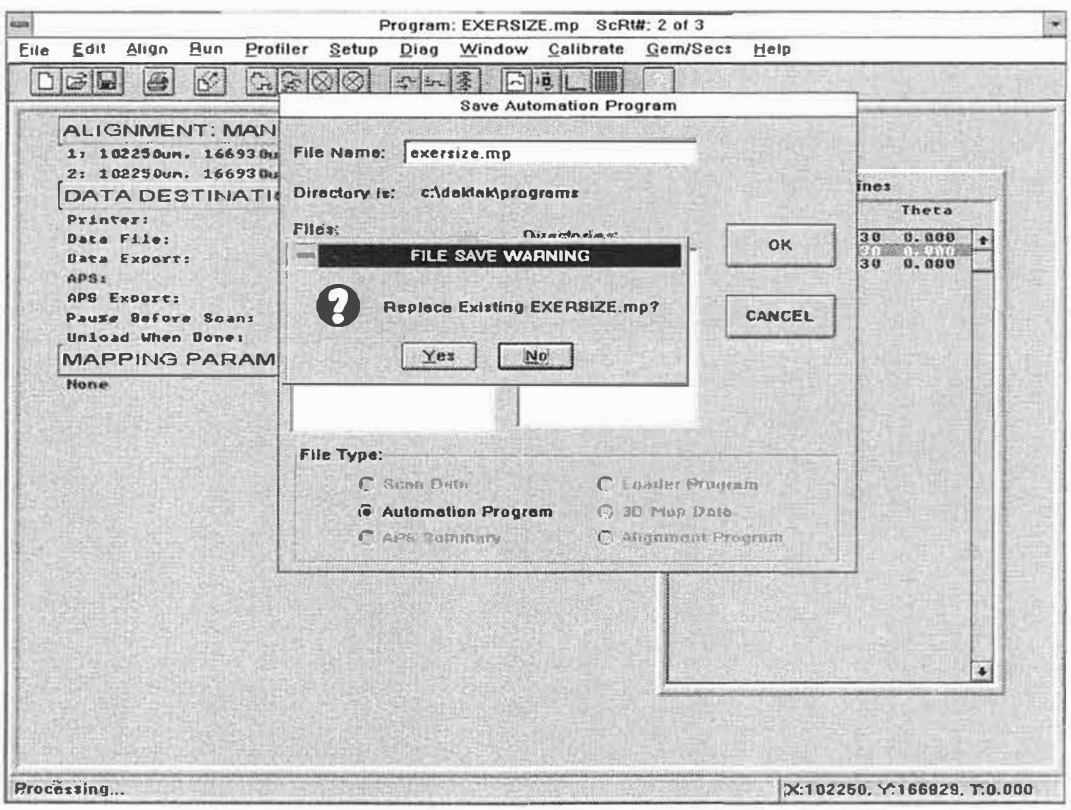


Figure 5-20. Replacing an Existing Automation Program

SECTION 6

ANALYTICAL FUNCTIONS

SECTION OVERVIEW

This section provides a description of the analytical functions included as part of the standard DEKTAK V 200-Si software. These special functions allow the user to perform complex analytical computations on the profile data quickly and easily. Multiple analytical functions can be entered into a scan routine to automatically calculate surface texture parameters on like samples. The operator can also perform analytical functions at the conclusion of a scan by selecting the desired parameters one-by-one.

By using these functions to analyze the profile data, valuable information can be obtained for controlling and monitoring the production process. To assist the operator, analytical functions are grouped by applications: roughness, waviness, step height, and geometry parameters. The items included in this section are listed below.

- Analytical Functions Description
- Roughness Parameters
- Waviness Parameters
- Step Height Parameters
- Geometry Parameters
- Analytical Function Exercise
- Entering Analytical Functions into the Scan Routine
- Cutoff Wavelength Filters
- Smoothing

ANALYTICAL FUNCTIONS DESCRIPTION

The DEKTAK V 200-Si is equipped with 25 different analytical functions for measuring surface texture. The following pages provide the abbreviation for each function as it appears on the screen, along with a brief description of the parameter.

If extensive surface texture analysis is planned, it is recommended that the ANSI B46.1 specification on surface texture be studied. A copy of this specification can be obtained from the American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017.

ROUGHNESS PARAMETERS

Max Dev Maximum Deviation: Calculates the furthest data point above or below the mean line.

Max Ra Maximum Ra: Identifies that portion of the assessment length which has the highest Ra. The assessment length, defined by the cursors, is divided into nineteen overlapping segments. Each segment is equal to one-tenth of the assessment length distance. The Ra is calculated for each segment. The R cursor will be positioned in the center of the segment with the highest Ra. Only one MRa is allowed to be programmed into a scan program.

Ra Arithmetic Average Roughness: Formerly known as AA and CLA. Ra is the universally recognized, and most used, international parameter of roughness. It is the arithmetic average deviation from the mean line.

Rp Maximum Peak: The maximum height or the highest peak of the profile roughness above the mean line, within the assessment length.

Rq Root-mean-square (RMS): Determines the root-mean-square value of roughness corresponding to Ra.

Rt Maximum Peak to Valley: The sum total of the Maximum Peak and Maximum Valley measurements of roughness within the assessment length (Rt = Rp + Rv).

Rv Maximum Valley: The lowest point, or the maximum depth of the profile roughness below the mean line, within the assessment length.

Rz din Ten Point Height Average: The average height difference between the five highest peaks and the five lowest valleys in accordance with DIN 4768/1 specification published by the Deutsche Institut fuer Normung c.v.

Skew Skewness: The symmetry of the profile about the mean line. It will distinguish between asymmetrical profiles of the same Ra or Rq.

NOTE

For the best results, the scan trace should be software leveled prior to calculating any analytical functions.

WAVINESS PARAMETERS

Wa Arithmetic Average of Waviness: The average deviation of waviness from the mean line (corresponds to Ra).

Wmaxdev Maximum Deviation of Waviness: Measures the distance of the furthest data point above or below the mean line from the waviness profile (corresponds to Maximum Deviation of roughness).

Wp Maximum Peak of Waviness: Measures the maximum height of the highest peak of the waviness profile, above the mean line (corresponds to Rp).

Wq Root-Mean-Square of Waviness: Determines the root-mean-square (RMS) value of waviness (corresponds to Wa).

Wt Maximum Peak to Valley of Waviness: The sum total of the maximum peak and maximum valley measurements of waviness (Wt=Wp+Wv).

Wv Maximum Valley of Waviness: The lowest point, or the maximum depth of the waviness profile below the mean line (corresponds to Rv).

NOTE

The waviness analytical functions can only be accessed if the DEKTAK V 200-Si is equipped with Software Version 1.12 or higher. Waviness calculations will be performed on raw profile data unless the low pass waviness filter has been activated.

STEP HEIGHT PARAMETERS

ASH	Delta Average Step Height: Used to obtain a step height measurement in applications where roughness or noise is present on the profile trace. It computes the difference between two average height measurements.
AVG HT	Average Height: Calculates the average height of a step, with respect to the zero line, using the R and M cursors to define the area of measurement.
HSC	High Spot Count: The number of peaks that project above a line that is parallel to the mean line.
PC	Peak Count: The number of peaks that project through a selectable band centered about the mean line of the assessment length
PEAK	Maximum Peak: Calculates the maximum height above the baseline, as determined by the cursor/trace intercepts.
PV	Maximum Peak to Valley: Calculates the vertical distance between the maximum peak and maximum valley.
TIR	Total Indicated Reading: Calculates the vertical distance between the highest and lowest data points between the cursors.
VALLEY	Maximum Valley: Calculates the maximum depth below the baseline, determined by the cursor/trace intercepts.

GEOMETRY PARAMETERS

Area — Area-Under-The-Curve: Computes the area of a profile between the R and M cursors with respect to the horizontal zero grid line. The profile **must be leveled** for accurate results. If the profile is above the zero line, area is expressed as a positive value in square microns. If the profile is below the zero line, the result will be a negative value.

Perim — Perimeter: Calculates the outside perimeter of a profile between the R and M cursors. A horizontal reference line is created using the R and M cursor intercepts. The profile must be leveled for accurate results.

Radius — Radius: A least-squares-arc is fitted to the data points and the radius is calculated from the equation of a circle. The algorithm does not distinguish between concave and convex shapes. To maximize the accuracy of the results, the following factors must be considered: (1) the sample shape must approximate a sector of a circle: (2) the stylus tip must traverse the apex of the sample if it is a sphere. Using the largest radius stylus possible will help minimize the error; (3) Repeatability errors may dominate the measurement if the chord rise is less than 100Å for scans longer than 1 mm.

Slope — Slope: Calculates the arc tangent of the ratio of the vertical distance to the horizontal distance between the R and M cursor/trace intercepts. The result is expressed in degrees. Slope is useful only for relatively shallow slopes. If the stylus radius is too large or the step too steep, the stylus will contact the upper edge of the step before the lower edge and the slope measurement will be inaccurate.

TP — Bearing Ratio: The percentage of points along the assessment length that project above a line that is parallel to the mean line.

Volume — Volume: The integration-by-shells technique is used to find the volume of a solid. This is accomplished by rotating the lamina delineated by the scan trace and a line segment connecting the cursor intercepts through 180 degrees about a vertical axis which is located half way between the cursors.

ANALYTICAL FUNCTION EXERCISE

This exercise will demonstrate how to perform an average roughness measurement at the conclusion of a scan. For the purpose of this exercise, the optically flat glass of the calibration standard provided with the system can be used. The calibration standard should be positioned so that a 2 mm scan will traverse across the glass portion of the standard without encountering a step (see Figure 6-2).

1. Click-on "Windows" and click-on "Automation Programs". The Automation Programs screen will be displayed.

2. Click-on "File" from the menu bar, and click-on "new" from the menu. The default scan routine will be entered into the current Automation Program.

3. With the stage positioned as shown in Figure 6-2, click-on "RUN". From the main menu bar and click-on "Run ScRt Here" from the menu. The current Scan Routine will be run.

4. Once the scan routine has been run with the profile plotted, the trace must be leveled. Click-on "Plot" and click-on "Level" from the menu. The trace will be replotted and leveled.

NOTE

Prior to initiating any analytical function, the trace must first be software leveled to obtain accurate results.

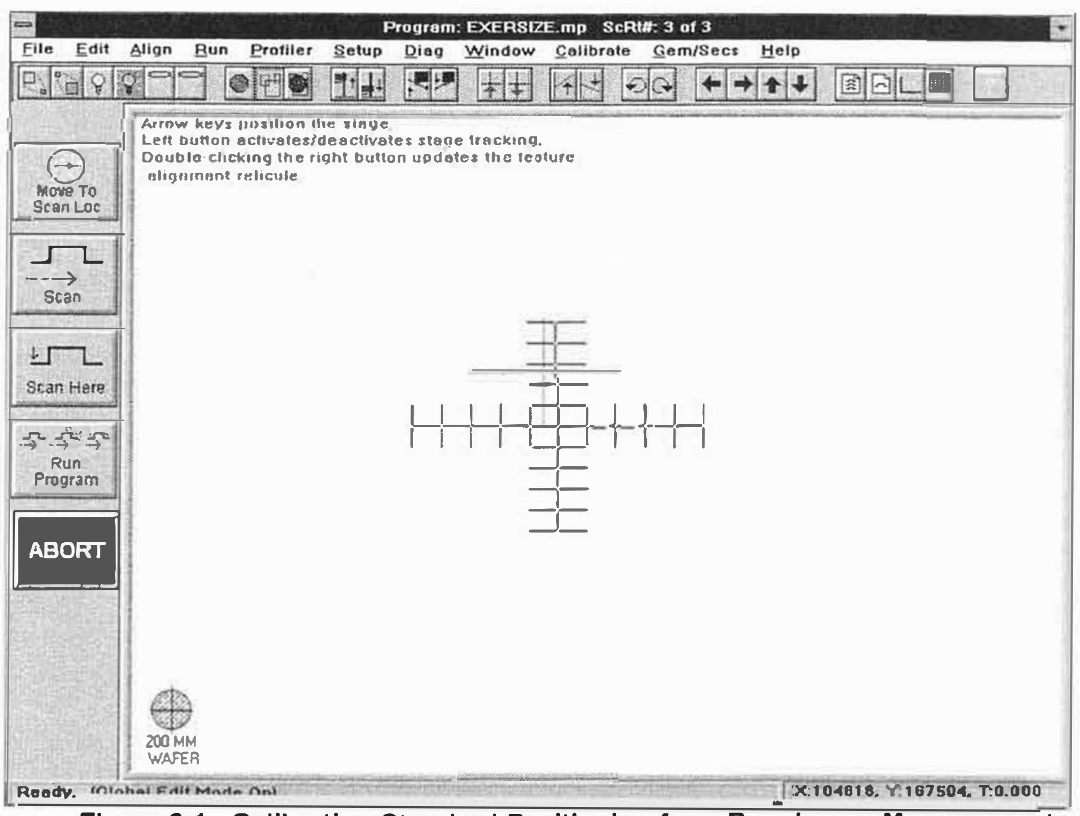


Figure 6-1. Calibration Standard Positioning for a Roughness Measurement

AVERAGE ROUGHNESS MEASUREMENT

Once the scan is run and the profile trace is leveled, an analytical function may be performed from the Data Plot screen. The procedure for executing the Average Roughness (Ra) analytical function on the raw profile data is described below. The analytical function will only be calculated on the data between the R and M cursors. The cursors can be relocated if desired, but for this exercise, the default cursor setting of 100 and 1900 microns should be appropriate for a 2 mm scan.

1. Click-on "Analysis" from the menu bar and click-on "Analytical Functions" to display the dialogue box below (see Figure 6-3).

2. The Analytical Functions Menu contains selections for setting roughness, waviness, heights, and geometry parameters. The roughness functions menu lists nine different parameters, click-on "RA". The RA parameter will be highlighted.

3. Click-on the "measure" button provided in the roughness functions window (selecting "measure and program" automatically enters the analytical function into the Scan Routine program).

4. Click-on "Compute" and the window will disappear and the average roughness will be calculated. The result from the RA function will be displayed in the area of the left of the Data Plot screen along with the cursor locations. Note that an asterisk appears next to the Ra, this indicates that the analytical function was calculated on the raw, unfiltered data.

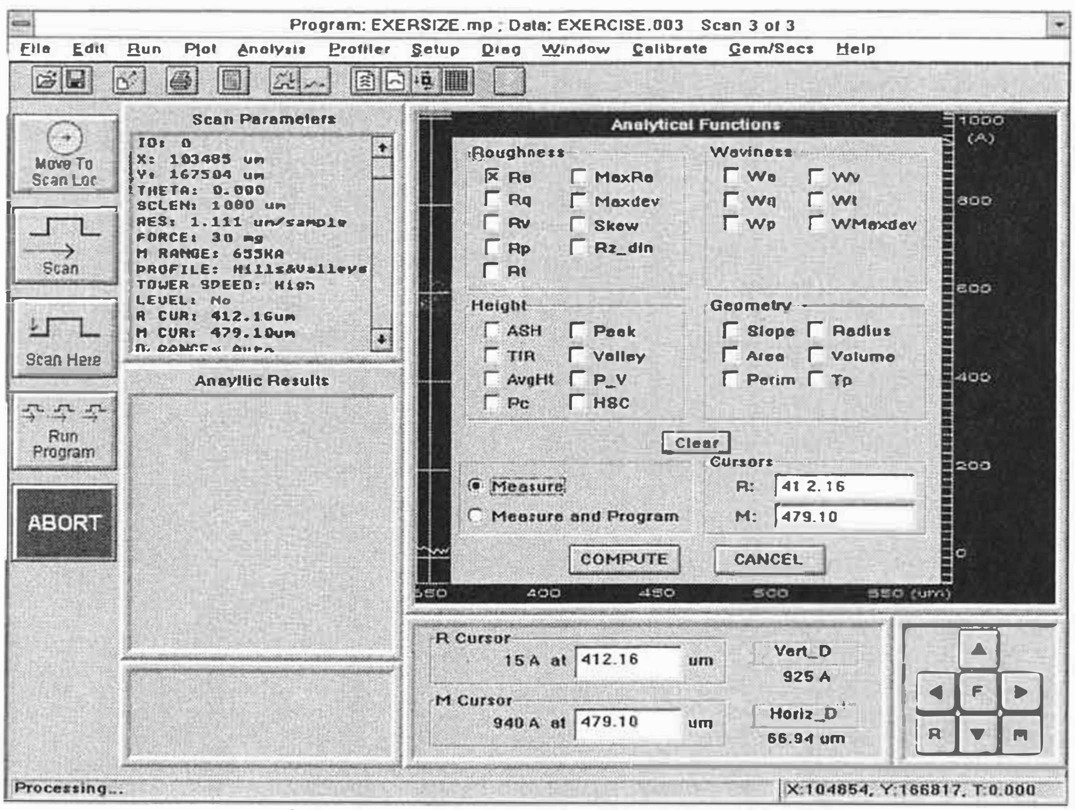


Figure 6-2. Roughness Functions Window

DETERMINING THE CUTOFF WAVELENGTH

The DEKTAK V 200-Si is equipped with short pass, and long pass digital filters for filtering out high and low frequency signals. In effect, the cutoff frequencies defines the intended difference between roughness and waviness. The filters are designed in accordance with the ANSI B46.1 specification on surface texture. The wavelengths are user selectable from 1 to 200,000 microns.

The appropriate cutoff wavelength will vary from application to application. However, it is recommended that the scan length be at least 5-10 times longer than the cut-off wavelength. The cutoff value will not be accepted if fewer than 8 data points are available per cutoff wavelength. The "scan Resolution" parameter displayed on the Scan Routine Screen provides the number of microns per sample for a given scan length and speed. The minimum acceptable cut-off wavelength must be at least eight times longer than the value listed as the scan resolution. This can be otherwise defined as: microns per sample x 8 = minimum acceptable cut-off wavelength.

For example, the default scan routine used for the purpose of this exercise has a scan length of 2000 microns, a scan speed of medium, and a scan resolution of 0.513 microns per sample. Multiplying 0.513 by 8 equals 4.10, so the minimum acceptable cut-off wavelength is 5 microns. The scan length must be at least 5 times greater than the cut-off wavelength. Dividing the 2000 micron scan length by 5 equals 400. Therefore, a cut-off value must be selected between 5 and 400 microns.

Three separate cut-off filters are provided for selecting the wavelength by pass frequency. The three filters are described below.

Short (High) Pass Filter

This filter is used for calculating roughness data. It filters out low frequency waviness signals and allows high frequency roughness data to pass through.

Long (Low) Pass Filters

This filter is used for calculating waviness data. It filters out high frequency roughness signals and allows low frequency waviness data to pass through.

Band Pass Filter

When the band pass filter is selected, both the short pass and long pass filters will be enabled to calculate the roughness data. It creates a band which filters out high frequency signals above the band and low frequency signals below the band.

ACTIVATING THE CUTOFF FILTERS

To obtain accurate roughness measurements, it is recommended that the short pass filter be activated. The procedure for activating the short pass and long pass filters is described below.

1. Click-on "Analysis" from the Data Plot Screen menu bar, and click-on "Cutoff Filters" from the Analysis Menu. A dialog box will be displayed for setting the roughness and waviness filters (see Figure 6-4).

2. Click-on the box labeled "Short Pass Filter Cutoff" and enter a value of 20.

3. Click-on the box labeled "Long Pass Filter Cutoff" and enter a value of 200.

4. Click-on "OK" and the profile trace will be replotted with three separate scan traces: The white trace represents the raw profile data, the yellow trace represents the roughness profile as determined with the short pass filter, and the red trace represents the waviness profile as determined by the long pass filter.

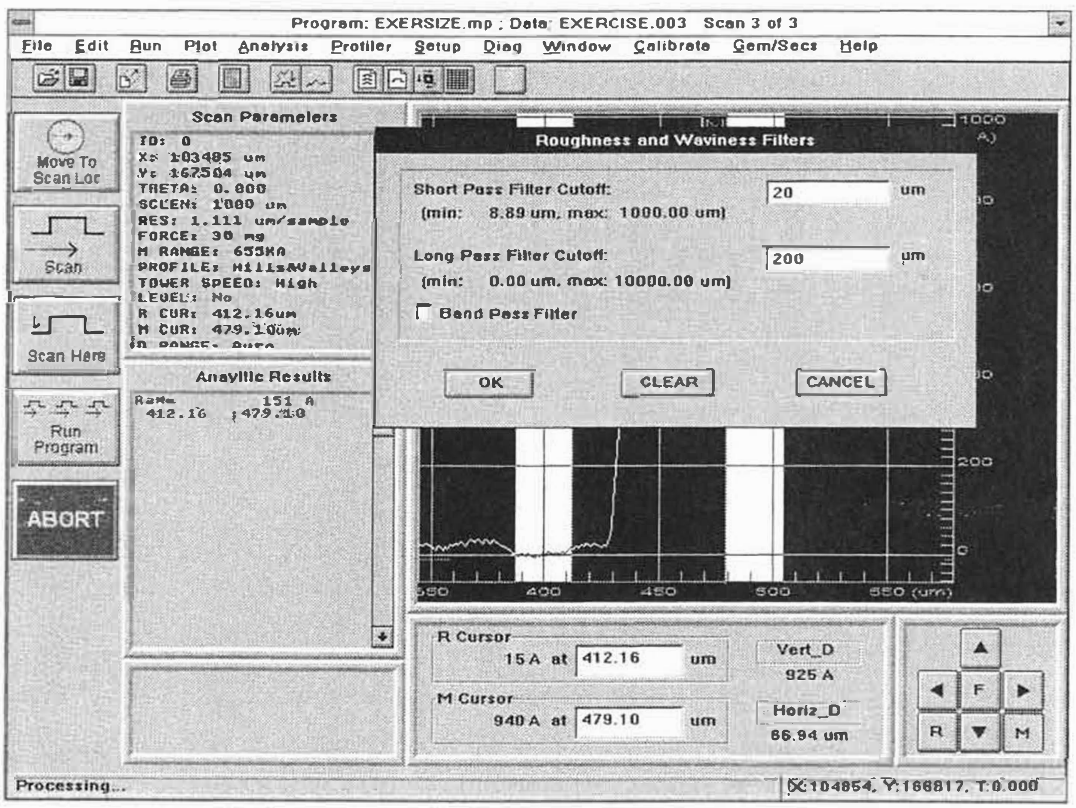


Figure 6-3. Roughness and Waviness Filter Dialog Box

DATA TYPE SELECTION

The operator may select the type of data to be displayed on the data plot screen. The raw, roughness, and waviness profile data can be displayed either individually or simultaneously. The procedure for selecting the data type is described below.

1. Click-on "Plot" from the Data Plot Screen menu bar. The Plot Menu will be displayed.

2. Click-on "DataType" from the Plot menu. A window will be displayed permitting the selection of raw, roughness, or waviness data type display. All three selections should be activated as indicated by an "X" in their respective boxes (see Figure 6-5).

3. Click-on the box labeled "waviness" to delete the "X" from the box. (The box acts as a toggle to switch the data type on and off.)

4. Click-on "OK". The Data Plot screen will be replotted with the roughness and raw data profiles displayed and the waviness profile deleted.

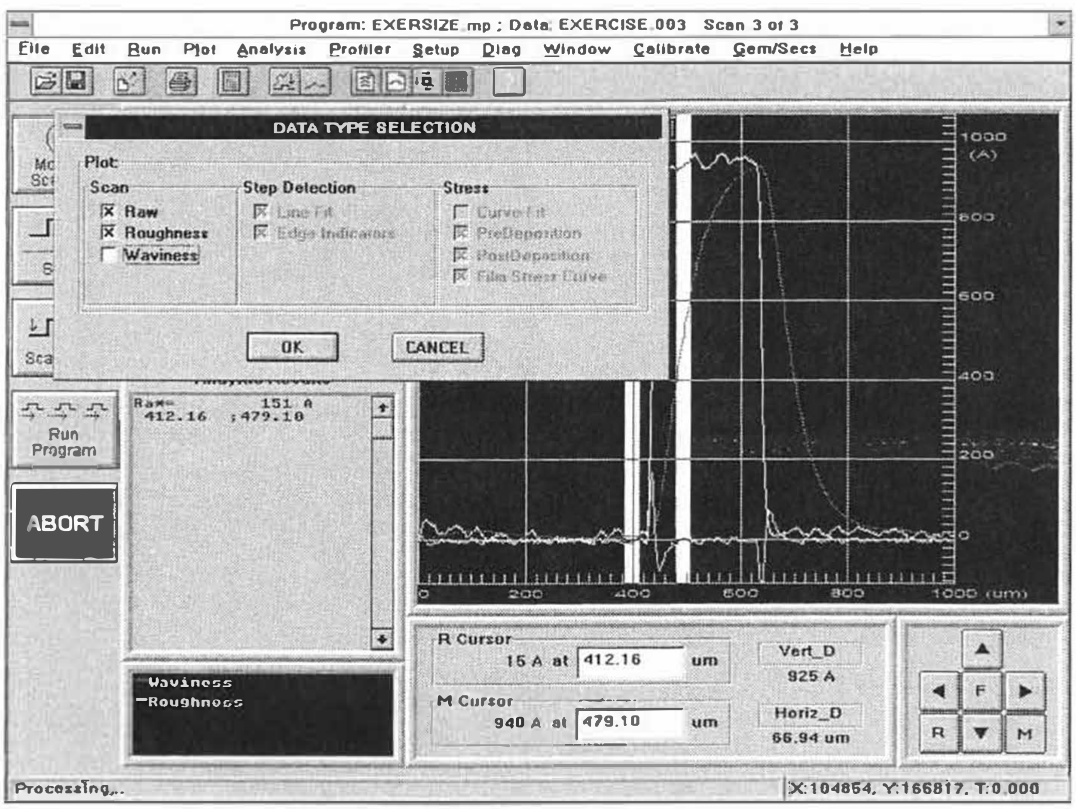


Figure 6-4. Data Type Window

MEASURING AND ENTERING ANALYTICAL FUNCTIONS

Once the short pass roughness filter is activated, perform the average roughness analytical function a second time. Analytical functions can be entered into the current scan routine from the Data Plot Screen to be automatically calculated whenever the current scan routine is performed. The procedure for measuring the Ra function and entering it into the scan routine is described below.

1. Click-on "Analysis" from the Data Plot Screen menu bar and click-on "Analytical Functions". The Analytical Functions menu will be displayed.

2. Click-on "RA" from the roughness functions menu. The RA parameter will be highlighted.

3. Click-on the "Measure and Program" button provided in the Roughness Functions window (see Figure 6-6).

4. Click-on "Compute". The Roughness Functions menu will disappear and the average roughness will be measured and entered into the current scan routine. The result from the Ra function will be displayed in the area to the left of the data plot screen. Note the different results from the first Ra calculated on the unfiltered raw profile data and the second Ra calculated on the filtered roughness data.

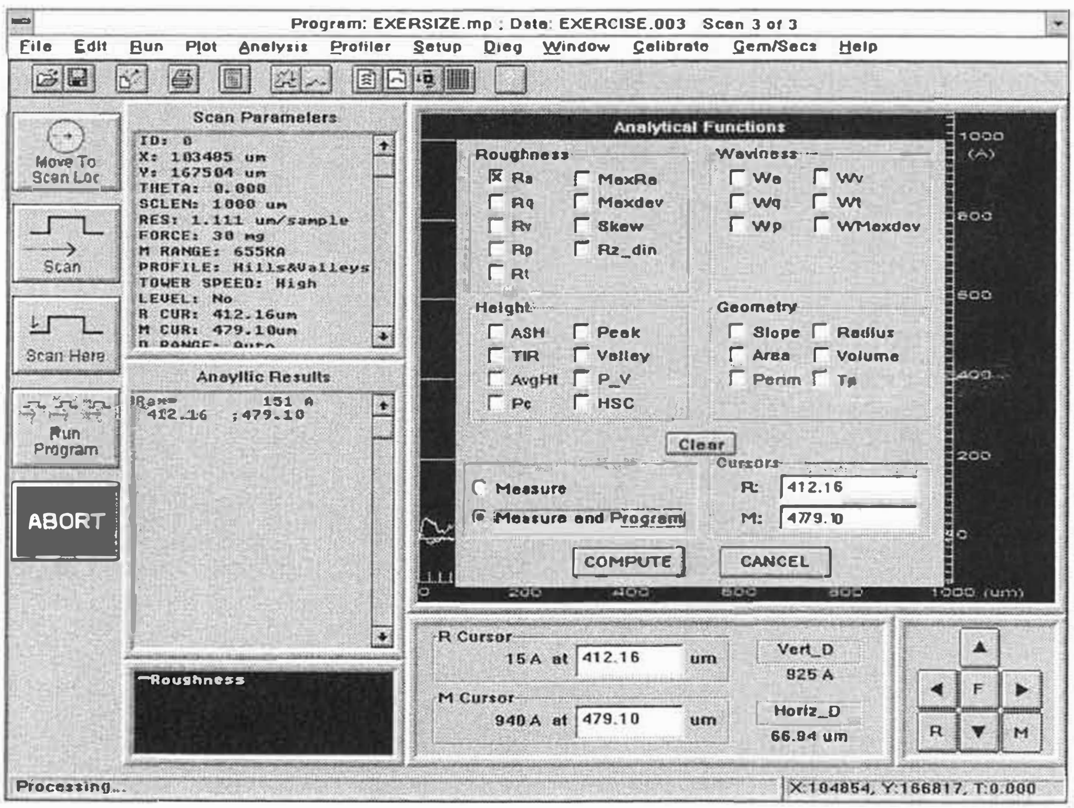


Figure 6-5. Analytical Functions/Data Plot Screen Entry

ENTERING ANALYTICAL FUNCTIONS INTO A SCAN ROUTINE

Multiple analytical functions can be entered into the Scan Routine screen, to be automatically calculated at the conclusion of the scan. The procedure for entering analytical functions into the scan routine is described below.

1. Click-on "Window" from the system menu bar, and click-on "Scan Routines" from the Programs menu. The Scan Routine screen will be displayed.

2. Click-on "Edit" from the Scan Routine screen menu bar, and click-on "Append Analytical Functions". The Analytical Functions menu window will be displayed.

3. Click-on "WA" from the Waviness Functions Window. "WA" will be highlighted.

4. The cursors can be set at different locations for each individual analytical function. To adjust the cursor positioning, click-on the box labeled "R. Cursor", delete the current value, and key-in 0. Then click-on the box labeled "M. Cursor", delete the current value, and key-in 2000.

5. Click-on "ADD". The WA function will be entered into the area on the right of the Scan Routines screen labeled "Analytic Functions" (see Figure 6-7). Click-on "DONE" when complete.

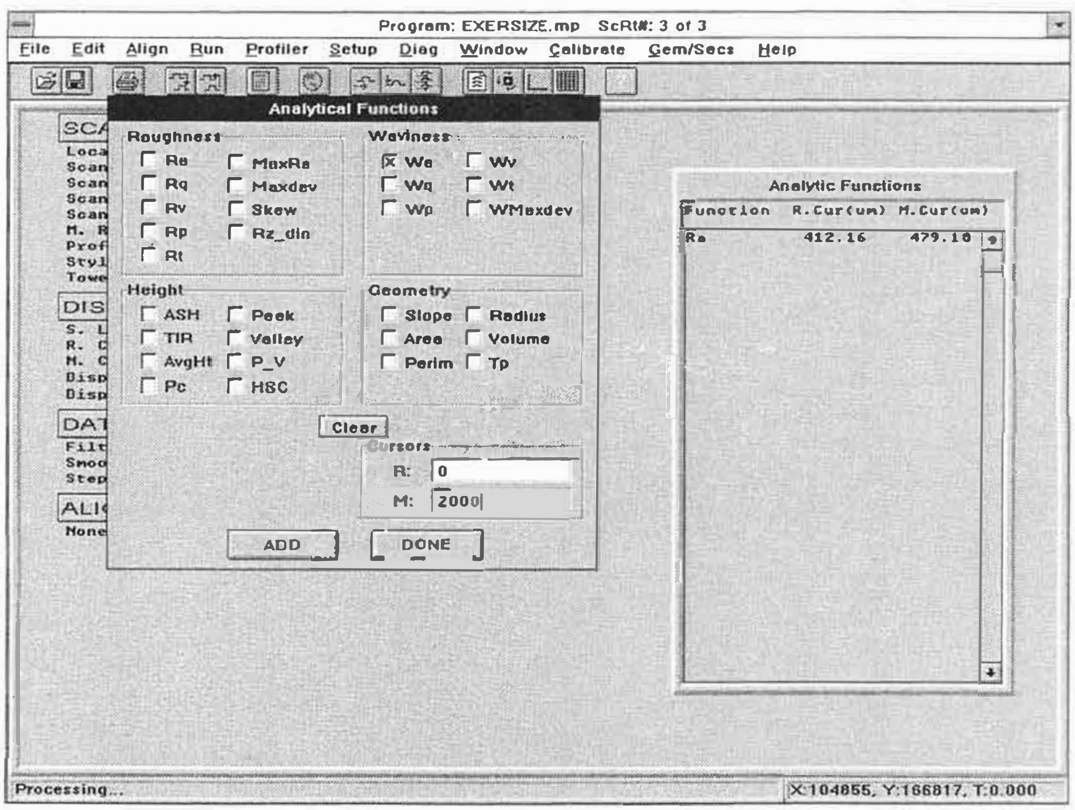


Figure 6-6. Analytical Functions/Scan Routine Screen Entry

ENTERING FILTER CUTOFFS INTO A SCAN ROUTINE

The short pass and long pass filters can be entered into the scan routine to automatically be activated for calculating roughness and waviness analytical functions. The procedure for entering filter cutoffs into a scan routine is described below.

1. Click-on the data processing parameter labeled "Filter Cutoffs" from the Scan Routine Screen. The filter cutoffs parameter will be highlighted.

2. Click-on the box labeled "Short Pass Filter Cutoff" and key-in a cutoff value of 20 microns for calculating roughness.

3. Click-on the box labeled "Long Pass Filter Cutoff" and key-in a cutoff value of 200 microns for calculating waviness.

4. Click-on "OK" and the dialog box will disappear and the cutoff values will be entered into the scan routine.

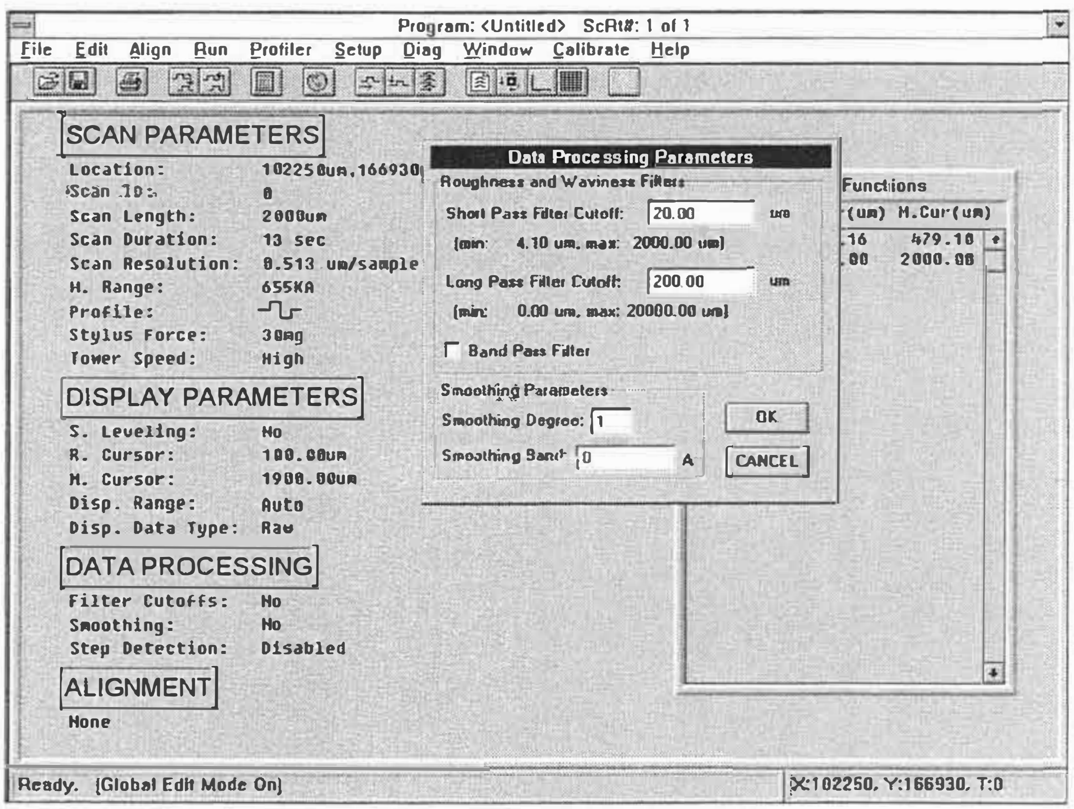


Figure 6-7. Filter Cutoffs Parameter

ENTERING DATA TYPE INTO A SCAN ROUTINE

The type of profile data to be displayed at the conclusion of a scan can also be predetermined by entering the selected data types into the scan routine. The procedure for entering the data type into a scan routine is described below.

1. Click-on the "Disp. Data Type" parameter from the Scan Routine Screen. The Disp. Data Type parameter provides three options: raw, roughness, and waviness.

2. When the default Scan Routine is used, the raw profile data is entered as the Display Data Type parameter. For the purpose of this exercise all three data types will be displayed. The boxes containing the data type selections act as a toggle for entering and deleting the selections. Click-on the boxes labeled "Roughness" and "Waviness" to enter all three data types into the scan routine (see Figure 6-9).

NOTE

The roughness data type cannot be selected unless the short pass filter is first activated. Likewise, the waviness data type cannot be selected unless the long pass filter is activated.

Once the Analytical Functions, cutoff filters, and display data types have been entered into the current scan routine, they will automatically be executed whenever the current scan routine is run.

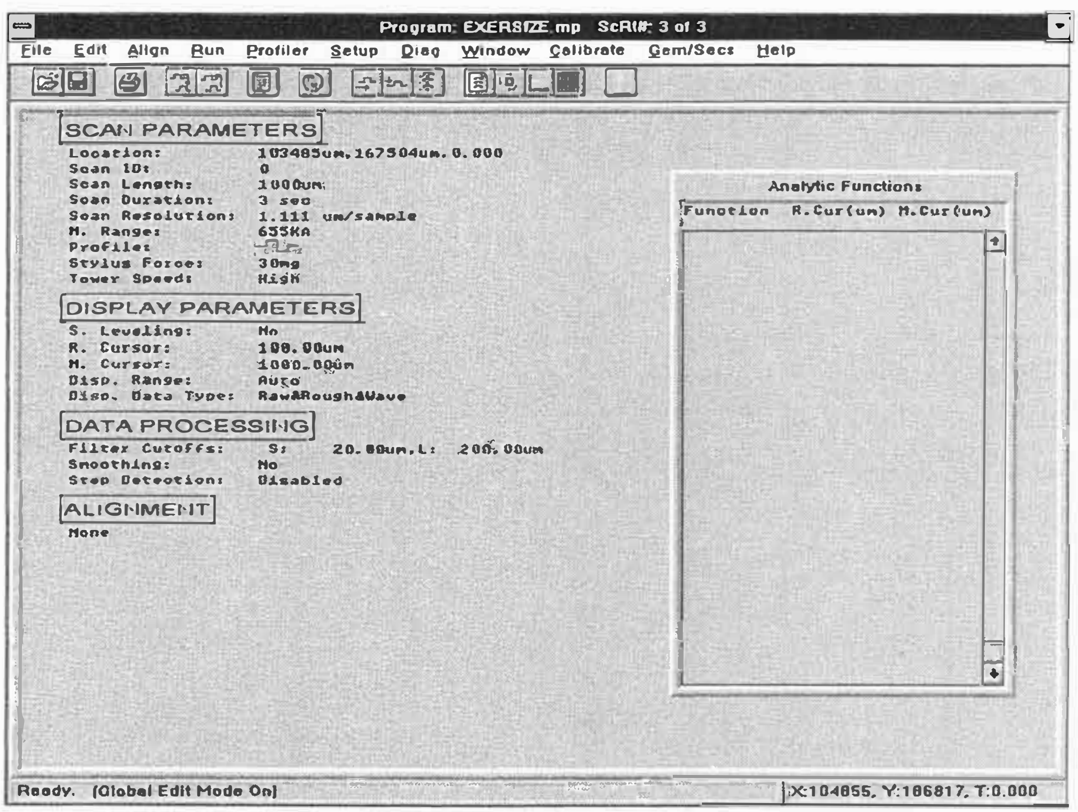


Figure 6-8. Display Data Type Parameter

DELETING ANALYTICAL FUNCTIONS FROM A SCAN ROUTINE

When the Scan Routine Screen is displayed and an analytical function is entered, the delete function can be accessed from the Analytical Functions Menu. The procedure for deleting an analytical function from the scan routine is described below.

1. Roll the pointing device to the right hand portion of the Scan Routines screen where the entered Analytical Functions are stored. Click-on the desired analytical function to be deleted. For the purpose of this exercise, click-on "WA". The function to be deleted will be highlighted.

2. Click-on "Edit" from the Scan Routine Screen menu bar and click-on "Delete Analytical Functions". The Delete Analytical Functions window will be displayed.

3. Click-on "OK" from the Delete Analytical Functions Window. The highlighted analytical function will be deleted from the Scan Routine.

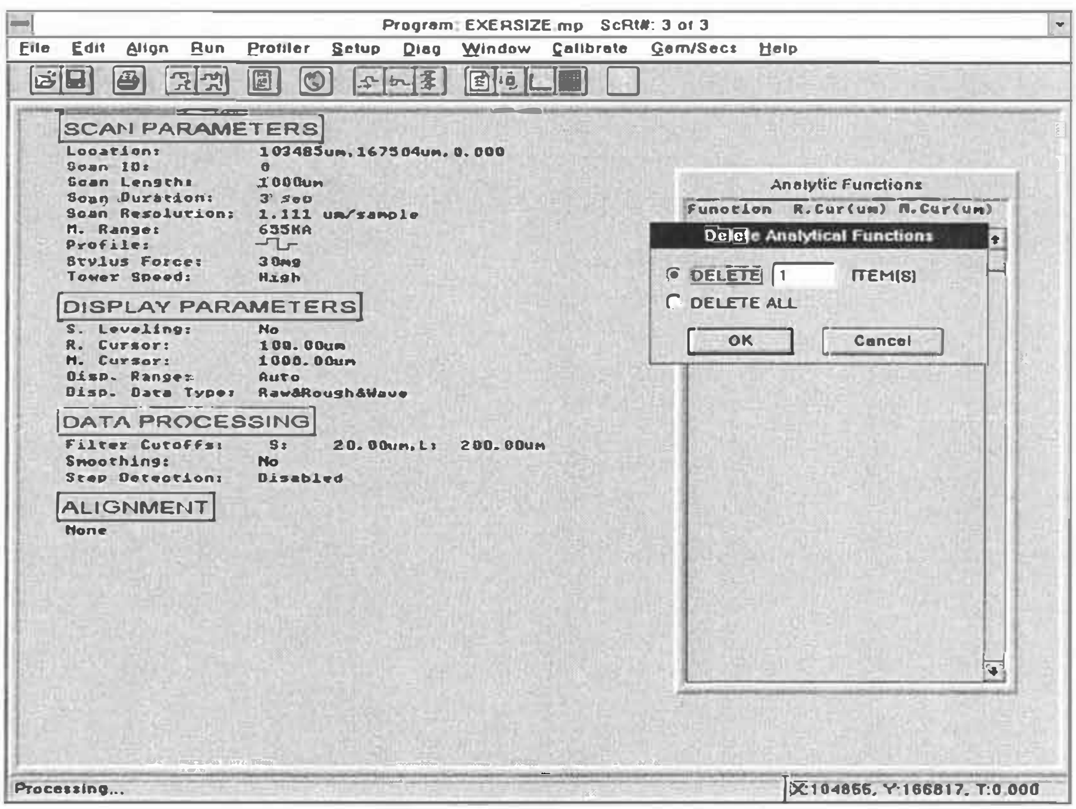


Figure 6-9. Deleting Analytical Functions

DESCRIPTION OF SMOOTHING FUNCTION

Whenever the smoothing function is activated, the roughness, waviness, or raw profiles will be calculated using the smoothed data. The smoothing function is used to reduce high frequency, low amplitude noise on a trace. Some applications involve films deposited over rough substrates. This substrate roughness "transfers" to the film surface, which can make measurements difficult or questionable.

The DEKTAK V 200-SI offers three degrees of smoothing. The higher the degree, the more smoothing will be realized.

Degree 1: 5-point smoothing.

Degree 2: 11-point smoothing.

Degree 3: 23-point smoothing.

After the degree of smoothing is selected, a prompt asks for the value of the vertical distance between the maximum peak to valley roughness.

Determine the maximum peak to valley distance of the high frequency low amplitude noise, and then enter this or a greater value (the TIR analytical function can easily be used to determine the noise band to be entered).

The smoothing function smoothes all data within the specified noise band by examining each data point in turn and comparing it with the previous and following points.

If Degree 1 is selected, five consecutive data points are used in the smoothing calculation and if they lie within the specified noise band, a running calculation is started. A first-order curve is fitted to all consecutive points lying within the noise band. As new points are examined, the routine calculates the new value of each point by looking at the four closest points that lie within the band.

When the algorithm encounters a point that lies outside the band, the calculation is interrupted. The new point is left "as is" and becomes a center point of a new noise band. If the next five points are within the new band, the calculation is restarted. If subsequent points lie outside the band, they will be plotted "as is," and each becomes a new reference point. This technique is desirable to straight filtering as the slope of the profile is maintained.

The smoothing function may be used in one of two ways. In applications where rough samples will be run on a regular basis, smoothing may be entered into the Scan Routine. In this way, the smoothing function will be performed on each scan profile automatically. The smoothing function may also be selected after a scan has been completed. Both methods for smoothing will be discussed on the following pages.

ACTIVATING THE SMOOTHING FUNCTION

Smoothing may be performed on profile data at the conclusion of a scan. The procedure for activating the smoothing function from the Data Plot Screen is described below.

1. Click-on "Window" from the system menu bar, and click-on "Data Plot" from the Window Menu. The Data Plot Screen will be displayed with the profile data replotted.

2. Click-on "Analysis" from the Data Plot Screen menu bar, and click-on "Analytical Functions" to display the Analytical Functions menu.

3. Click-on "TIR" from the Height functions and click-on "Compute". The total indicated reading peak to valley distance will be calculated.

4. Click-on "Analysis" from the Data Plot Screen menu bar, and click-on "Smoothing" from the Analysis Menu. A dialog box will be displayed for entering smoothing parameters (see Figure 6-11).

5. Three degrees of smoothing are available. For the purpose of this exercise, enter "2" into the box labeled "smoothing degree".

6. Click-on the box labeled "Smoothing Band" and enter a value equal to or greater than the value displayed as the TIR result. Click-on "OK" and the raw profile data will be smoothed and replotted.

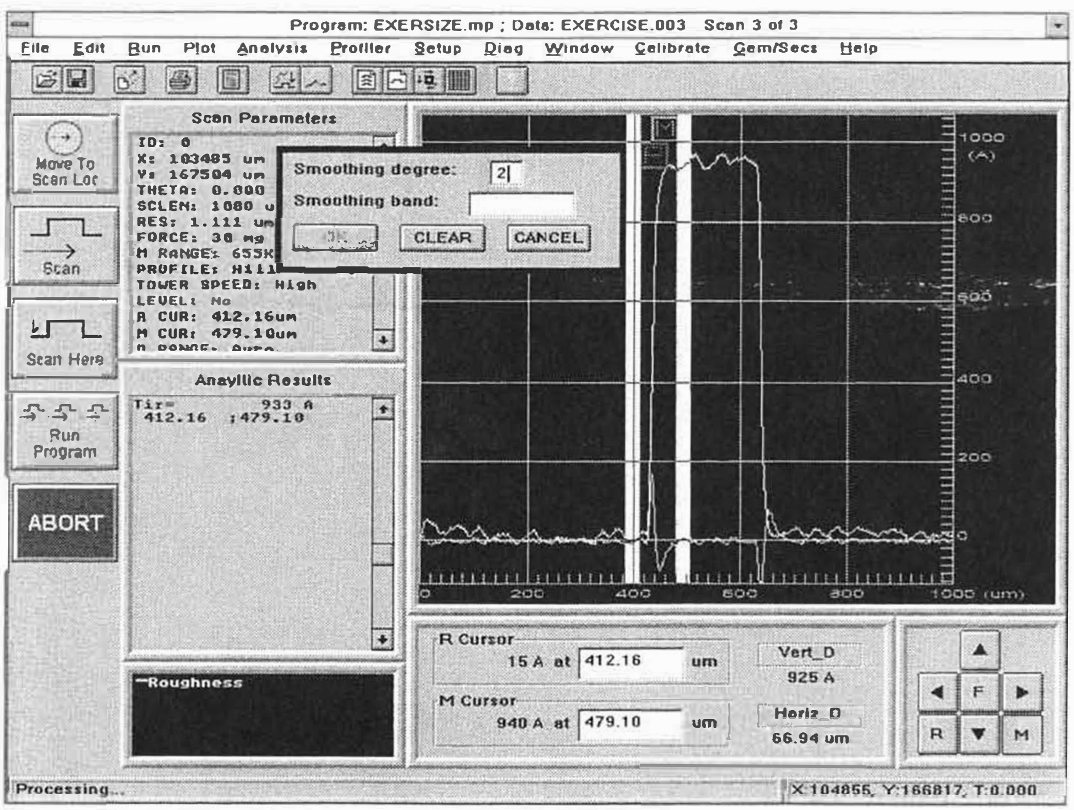


Figure 6-10. Smoothing Dialog Box

ENTERING SMOOTHING INTO A SCAN ROUTINE

Smoothing may be entered into the current scan routine to automatically be executed at the conclusion of the scan. The procedure for entering smoothing into the scan routine is described below.

1. Click-on "Window" from the system menu bar, and click-on "Scan Routines" from the Window Menu. The Scan Routines screen will be displayed.

2. Click-on the "Smoothing" parameter from the Scan Routines screen.

3. The Smoothing Parameter window will be displayed permitting smoothing parameter to be entered. Three degrees of smoothing are available. Enter the desired degree either 1, 2, or 3.

4. The smoothing band value can be determined by performing the Total Indicated Reading (TIR) analytical function on the scan to be smoothed. Enter a value equal to or greater than the TIR value. The smoothing function will now automatically smooth the profile data whenever the current scan routine is executed. To clear smoothing, click-on the smoothing parameter and click-on "NO".

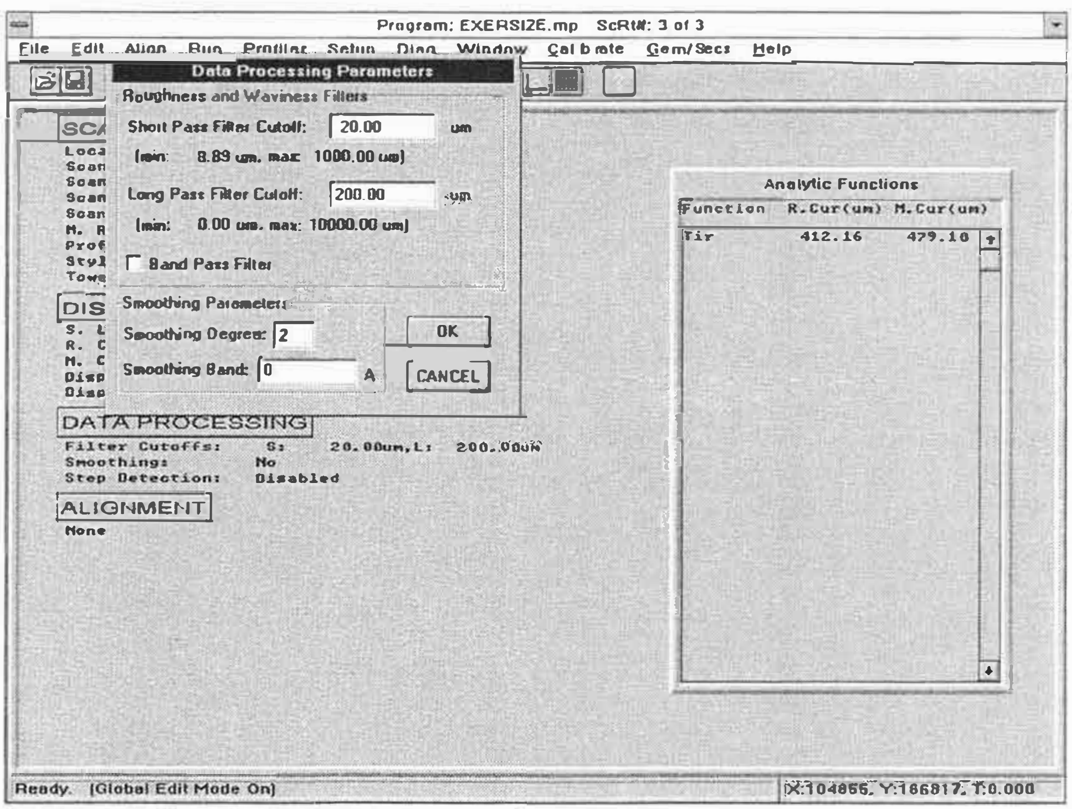


Figure 6-11. Smoothing Parameter

SECTION 7

SYSTEM MENU DESCRIPTIONS

SECTION 7 OVERVIEW

This section provides a brief description of the various menus and menu selections available in the DEKTAK V 200-Si software. This section is included to provide additional information on the various menu items which may or may not have been discussed in the previous sections of this manual. Items discussed in this section include:

- System Menu
- File Menu
- Run Menu
- Profiler Menu
- Setup Menu
- Diagnostics Menu
- Window Menu
- Calibration Menu
- Automation Programs Menu Selections
- Scan Routine Menu Selections

The DEKTAK V 200-Si uses Microsoft Windows as the user interface. Microsoft Windows is an extension of the DOS operating systems. Whenever the DEKTAK V 200-Si file is accessed, the DEKTAK V 200-Si screen is displayed (see Figure 7-1). Continually displayed at the top of the DEKTAK V 200-Si screen is the system menu bar. The various menus included in the system menu bar are described in the following pages. Individual screens such as the Automation Programs screen and the Scan Routines screen, have a second, screen specific, menu bar in addition to the system menu bar. These additional menus will also be described later in this section.

SYSTEM MENU

The DEKTAK V 200-Si user interface consists of a variety of screens. The system menu box, status line and system menu bar are continually displayed at the top of each screen (see Figure 7-1).

System Menu Box

The small box in the upper left corner of the screen displays a pop-up window when clicked on (See Figure 7-1). The window permits the user to exit the DEKTAK V 200-Si software and enter MS-DOS commands.

Status Line

A status line is visible at all times, located at the bottom of the screen. It constantly displays screen specific status information and the current X, Y, theta stage position.

System Menu Bar

The system menu bar provides access to the different types of operations available. The various menus contained within the system menu bar come under the headings: File, Run, Profiler, Setup, Diagnostics, Window, and Calibration. A description of the contents of each menu and instructions for accessing them are provided in the following pages of this section.

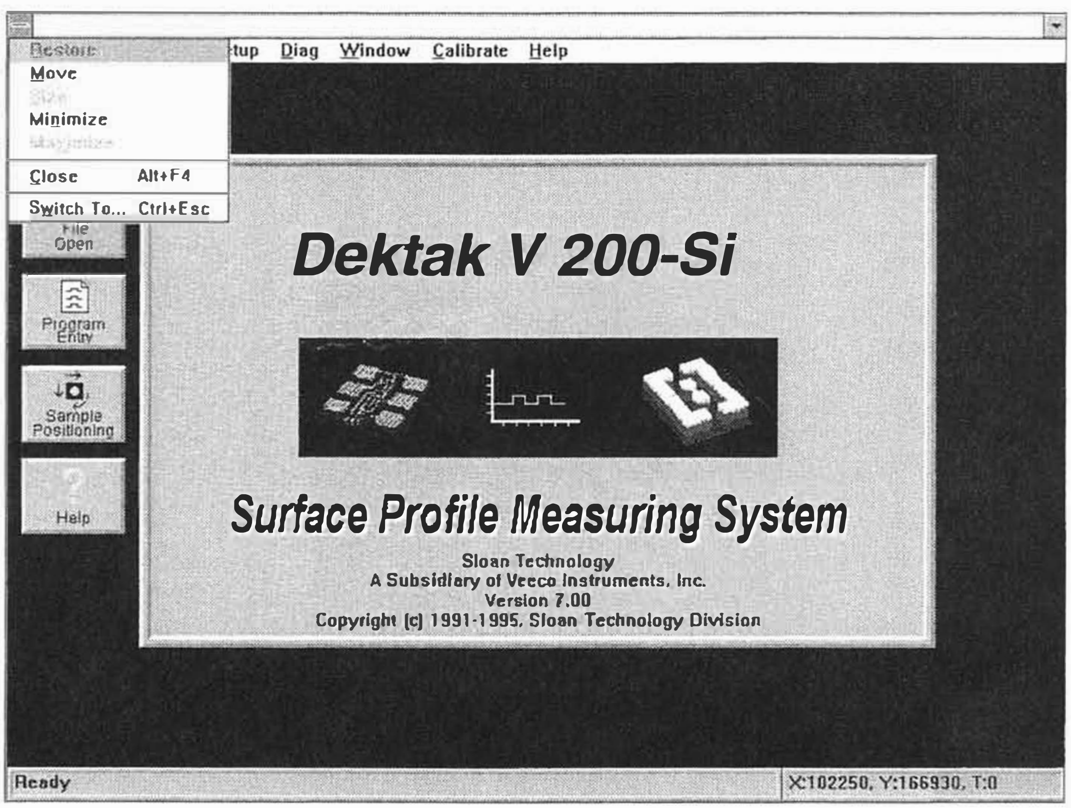


Figure 7-1. System Menu Box

FILE MENU

The File Menu allows Automation Programs and other files to opened, saved or printed. To access the File Menu, click-on "File" (see Figure 7-2).

New

The "New" selection replaces the existing automation program with a new single scan automation program containing the default scan parameters.

Open

The "Open" selection allows an automation program or other previously saved files to be opened. Clicking-on "Open" displays a list of available files.

Save

The "Save" selection saves any recent changes to the current automation program.

Save As

The "Save As" selection allows an automation program to be saved under a different file name. Clicking-on "Save As" displays a list of current file names.

Export

The "Export" selection allows an automation program to be exported as a TXT file. Clicking-on "Export" displays a list of current TXT files.

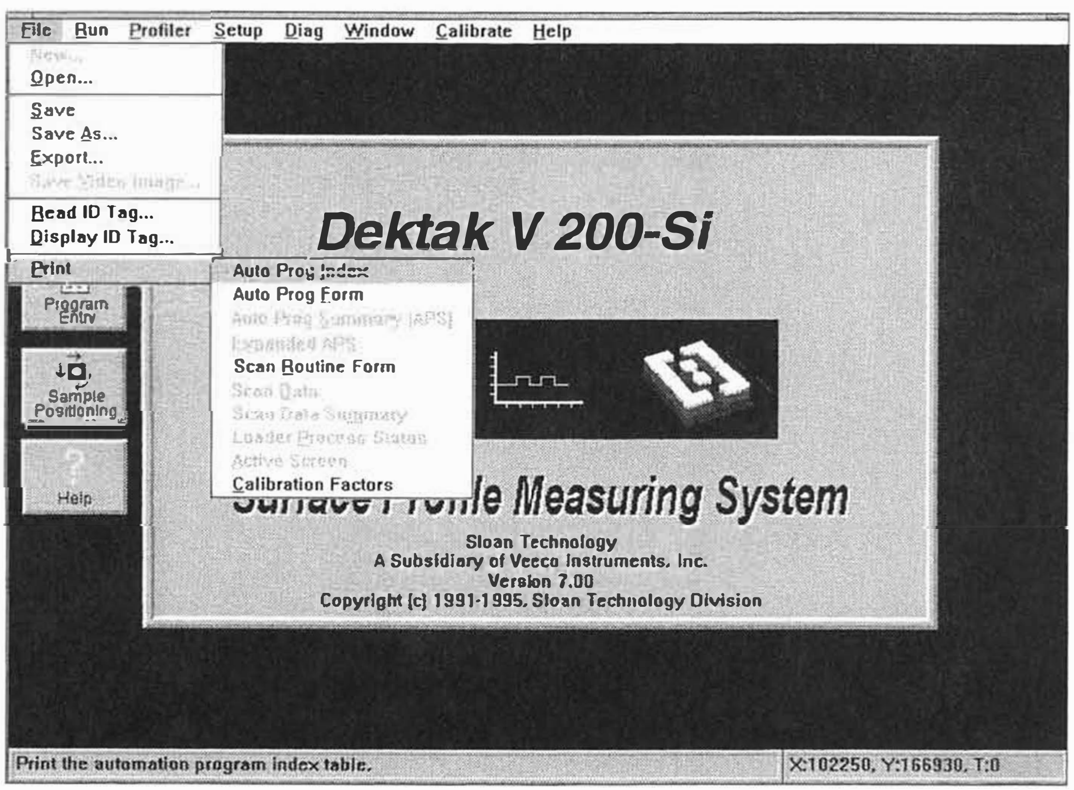


Figure 7-2. File Menu

FILE MENU (CONTINUED)

Print
Clicking-on "Print" displays a sub-menu providing access to a variety of print functions described below.

Automation Program Index
Clicking-on "Auto Prog Index" produces a printout of an index of the current Automation Programs saved on the hard disk.

Automation Program Form
Clicking-on "Auto Prog Form" produces a printout of the file name, deskew points, data destination options, and scan routines entered into the current Automation Program.

Automation Program Summary (APS)
This print function provides a summary of the analytical results from a multiscan Automation Program. The "Auto Prog Summary (APS)" selection can only be accessed when the APS function is activated in the Automation Program.

Expanded APS
This print function provides a more detailed printout of the results from a multiscan Automation Program Summary. The "Expanded APS" selection can only be accessed when the APS function is activated in the Automation Program.

Scan Routine Form
Clicking-on "Scan Routine Form" produces a printout of the scan parameters and analytical functions entered into the current Scan Routine.

Scan Data
Clicking-on "Scan Data" produces a printout of the plotted profile trace along with the scan data summary.

Scan Data Summary
Clicking-on "Scan Data Summary" produces a printout of the parameters and the analytical function results from the just completed Scan Routine. It provides a summary of the scan data only.

Loader Process Status
This selection can only be accessed if the DEKTAK V 200-Si is equipped with the cassette loader. Clicking-on "Loader Process Status" produces a printout of the parameters from the loader process status screen.

Print Active Screen
This print function acts as a Print Screen command. It prints the entire current active screen to an external printer. This operation will work with any raster-type, Windows compatible printer, including all dot matrix, LaserJet, Postscript and even color printers.

Calibration Factors
Clicking-on "Calibration Factors" produces a printout of the current calibration factors for the DEKTAK V 200-Si.

RUN MENU

This pull-down menu is used to run a Scan Routine or an Automation Program. To access the Run Menu, click-on "Run" (see Figure 7-3).

Scan

When "Scan" is clicked-on, the stage moves the X,Y,Theta location of the current Scan Routine, and runs a scan.

Scan Here

When "Scan Here" is clicked-on, the current Scan Routine is run at the current X,Y,Theta stage position.

Auto Program

When "Auto Program" is clicked-on, all of the Scan Routines in the current Automation Program are run, beginning with Scan Routine #1.

Auto Program From

When "Auto Program From" is clicked-on, the current Automation Program is run beginning at the selected scan routine.

Auto Program By Index

This selection provides a printout of the Automation Program Header.

Continue

This command is used to continue the current Automation Program when the wait between scan routine function has been activated.

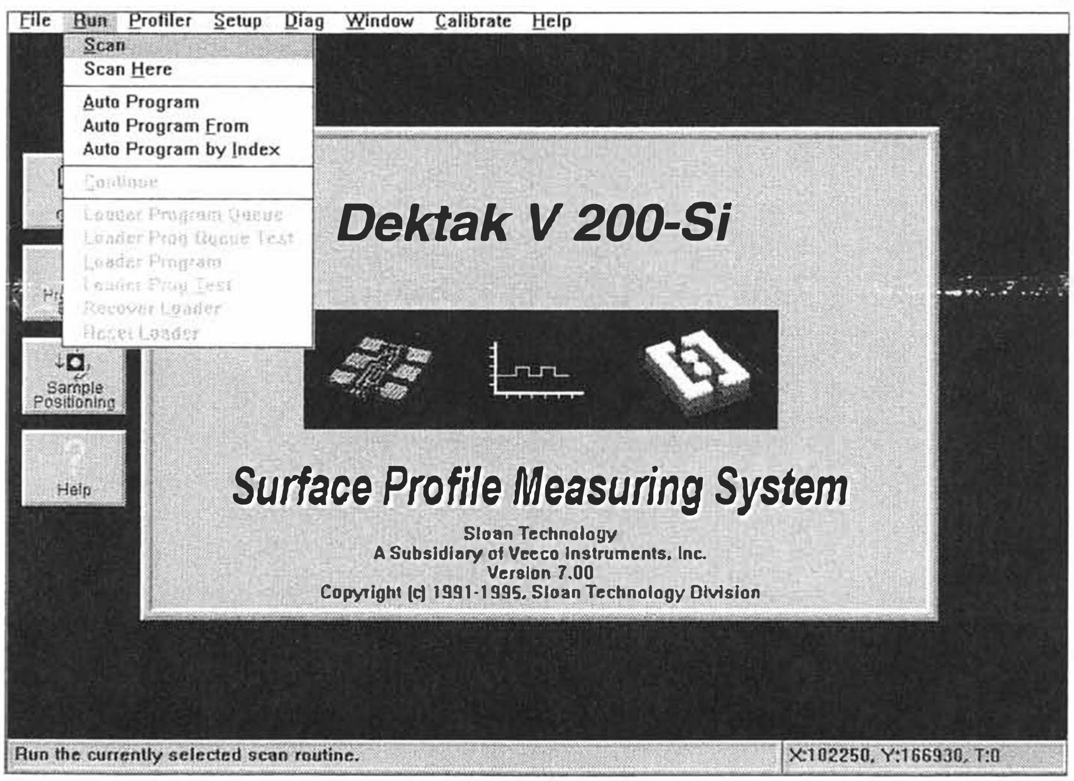


Figure 7-3. Run Menu

PROFILER MENU

This pull-down menu is used for controlling profiler functions. To access the Profiler Menu, click-on "Profile" (see Figure 7-4).

Tower Up
When "Tower Up" is clicked-on, the system tower will be raised all the way up.

Tower Down
When "Tower Down" is clicked-on, the stylus will be lowered all the way down until it makes contact with the sample surface and then the stylus will be lifted off the surface. The tower speed may be set in the Scan Routines screen at high, medium, or low speed.

Stylus Up
When "Stylus Up" is clicked-on, the system raises the stylus off the surface of substrate without raising the stylus tower. This allows the user to view the video image of the stage surface while positioning the stage, without contact between the stylus and sample.

Stylus Down
When "Stylus Down" is clicked-on, the stylus will be lowered onto the sample surface. The stylus is automatically raised off the sample surface whenever the sample stage is repositioned.

Sample Positioning
Displays the sample positioning screen providing a video image of the sample surface with a repositionable stylus reticule and feature alignment reticule superimposed. It permits fine sample positioning, theta rotation, and a sample template for coarse positioning.

Move to Scan Location
Moves the stage to the X,Y,Theta location of the current Scan Routine.

Rotate
Displays a dialogue box which allows adjustments in the theta rotation of the sample stage.

Load
Translates the stage to the load position, centered directly below the stylus.

Unload
Translates the stage to the front of the scan head, permitting convenient loading and unloading of samples.

Auto Leveling
The auto leveling feature can only be accessed when the data plot screen is displayed. It is used interactively at the conclusion of a scan to automatically level the sample stage.

Power Leveling
Displays a dialogue box which permits motorized adjustments the level or tilt of the sample stage up or down.

Make Horizontal
This feature is useful to correct rotational offsets in the positioning of skewed samples on the sample stage.

Remove Backlash
This feature removes any backlash in the scan stage to assure sample positioning repeatability.

Optics
Clicking-on "Optics" displays a window which allows adjustments to the zoom optics, sample illumination and camera focus (The optional remote control focus must be installed to adjust the focus using the optics window).

Video Only
When this selection is clicked-on, the video image of the sample surface from the DEKTAK V 200-Si's 35-200X video zoom microscope is projected on the monitor.

Graphics Only
When "Graphics Only" is clicked-on the graphic screen is displayed on the monitor, without the video image.

Video and Graphics
When "Video and Graphics" is clicked-on the graphic screen is superimposed over the video image of the sample surface.

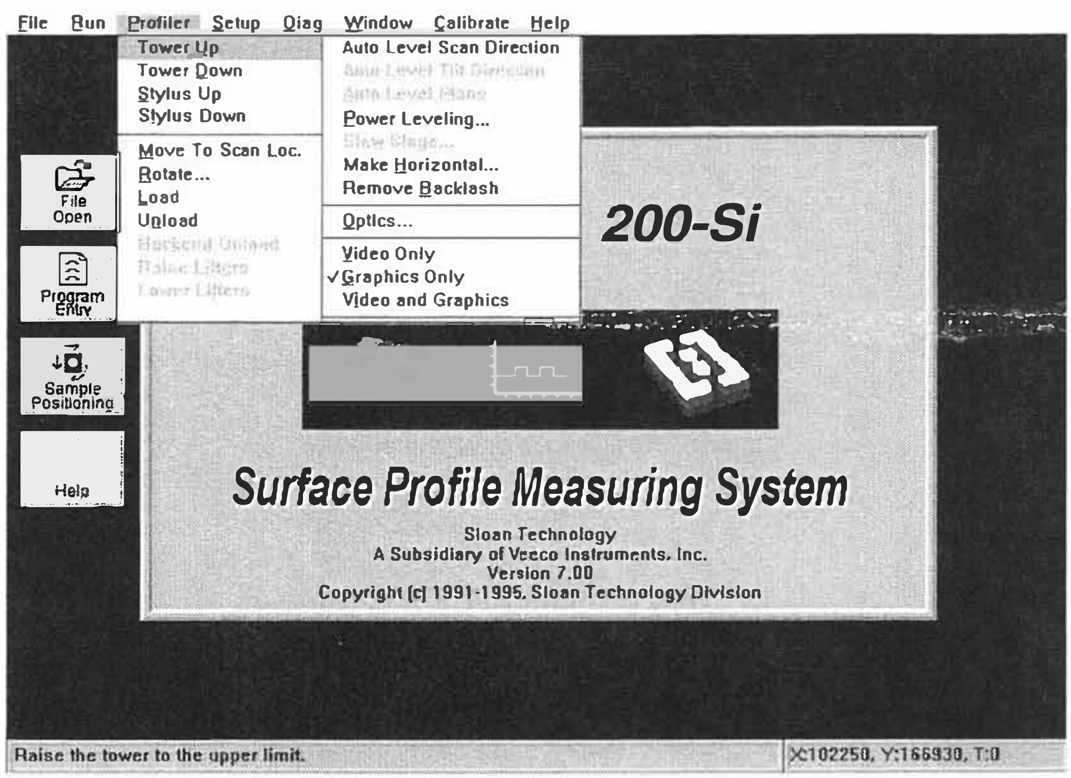


Figure 7-4. Profiler Menu

SETUP MENU

This pull-down menu is used for setting up the DEKTAK V 200-Si (see Figure 7-5).

Printer Port
Allows the print signal to be transferred to the standard thermal printer port or to the external printer port.

Wafer Template
Displays a listing of the various size wafer and disk template selections available for the coarse positioning screen.

Working Directories
Allows the working directories to be altered.

Stylus Reticule
Displays a dialog box for adjusting the stylus reticule position on the screen.

Default Theta Alignment
This selection can only be accessed with optional programmable theta installed. It displays a dialogue box which permits the default theta alignment to be changed.

Theta Resolution
This selection can only be accessed with optional programmable theta installed. I displays a dialogue box which permits the theta resolution to be adjusted.

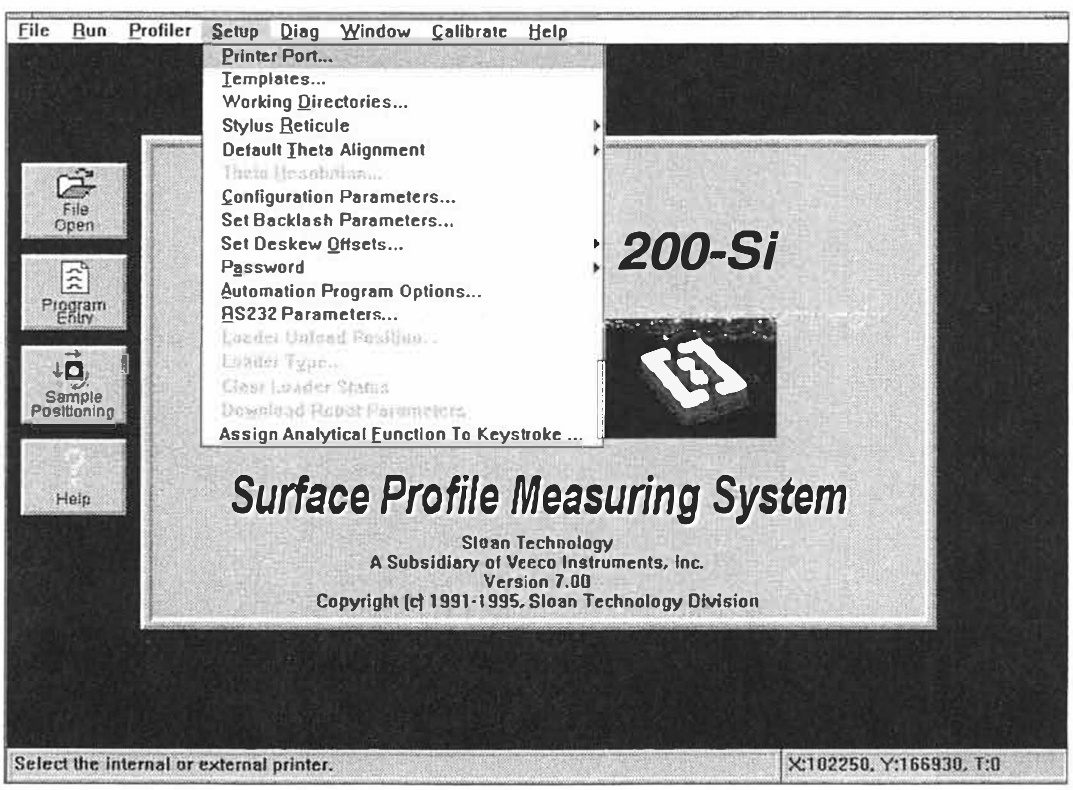


Figure 7-5. Setup Menu

SETUP MENU (Continued)

Configuration Parameters

Displays the factory set up parameters for software and hardware options.

Set X Backlash Parameter

For optimal repeatability in stage positioning, stage locations should always be selected for the left, i.e., move the stage to the left of the position desired and the approach the position from that side before selecting it. When the stage is automatically positioned for scanning, if the anti-backlash algorithm is enabled, the location will also be approached from the left. This eliminates repeatability errors due to backlash in the gears. To enable the backlash algorithm, enter a backlash distance in the "Distance" field. A value of 1000 is suggested. Enter 0 to disable the algorithm. The speed and acceleration values should not require adjustments.

Set Deskew Offsets

This selection allows the user to correct for offsets in the deskew positioning or reset the deskew points.

Password

This selection allows password protection to be enabled at various levels on the DEKTAK V 200-Si. The password security level is displayed in the "About" dialogue box, accessible from the system menu.

Automation Program Options

This selection allows the Automation Program options of including a header or executing options after an APS edit.

SECS Parameters

Semiconductor Equipment Communications Standard (SECS) cannot be accessed without optional software installed. This selection displays a dialog box which permits the setting of band rates, time outs, device I.D., retry limit, and maximum SECS blocks. It allows the DEKTAK V 200-Si to be placed on-line.

DIAGNOSTICS MENU

This pull-down menu is used for diagnostic testing and analysis of the DEKTAK V 200-Si. To access the Diagnostics Menu, click-on "Diag" (see Figure 7-6).

Toggle ON/OFF Debug Boxes
This selection acts as a toggle to turn the automatic display of debug boxes on and off.

View Diagnostics Messages
This selection displays the diagnostics messages on the screen.

Select Hardware Diagnostics
This selection allows the selected hardware diagnostics to be saved to file.

Initialize and Home Stage
This selection initializes and homes the sample stage.

Reinitialize Stage
This selection reinitializes the sample stage.

Initialize SP<->RTC Communications
This selection initializes the SP to RTC communications.

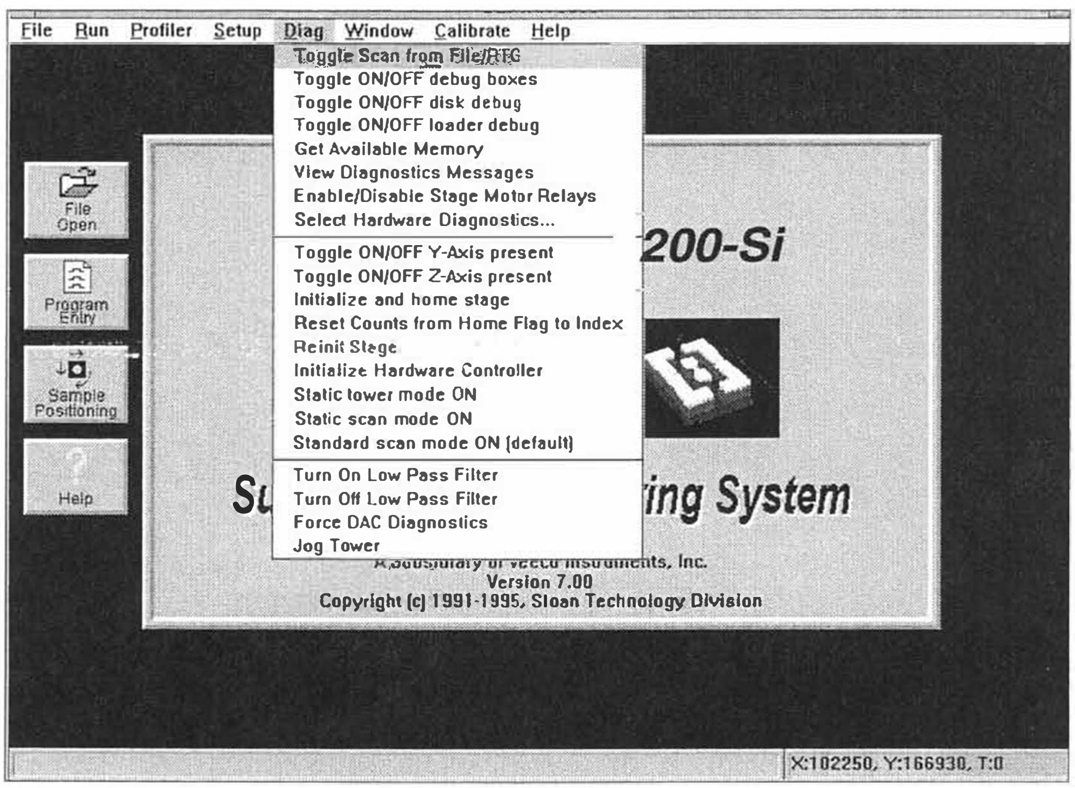


Figure 7-6. Diagnostics Menu

WINDOW MENU

This pull-down menu provides access to the various DEKTAK V 200-Si screens (see Figure 7-7).

Automation Programs
When "Automation Programs" is clicked-on, the Automation Program screen is displayed which permits alterations to the Automation Programs.

Scan Routines
When "Scan Routines" is clicked-on, the Scan Routine program screen is displayed. The Scan Routines screen is used to enter all scan parameters.

Sample Positioning
This selection provides access to the sample positioning screen where adjustments to the X-Y-Theta stage position and the optics can be made.

Data Plot
The Data Plot selection can only be accessed once a Scan Routine has been run and plotted. The data plot screen displays the scale profile trace.

Automation Program Summary
The "Auto Prog Summary" can be selected when APS has been enabled, in the Automation Program Screen, and the Automation Program has been run.

Signon Screen
This selection displays the Signon Screen shown below.

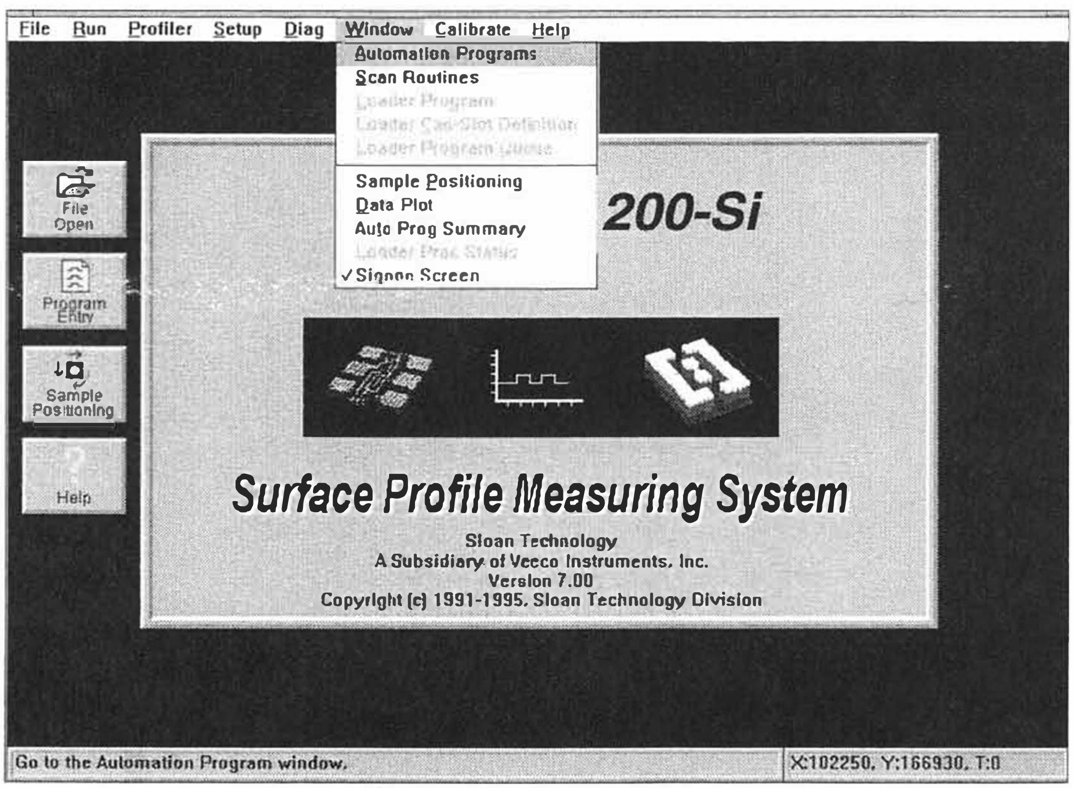


Figure 7-7. Window Menu

CALIBRATION MENU

Calibrate Theta

Displays a dialog box for setting theta calibration. The programmable theta option must be installed to access this selection.

Calibrate X,Y Axes

Displays a dialog box for setting the X,Y calibration of the DEKTAK V 200-Si.

Find Center of Rotation of Stage

Displays a dialog box for finding the center of a skewed sample on the stage.

Vertical Calibration

Displays a dialog box for setting and clearing the vertical calibration of the DEKTAK V 200-Si (see Section 10 of this manual).

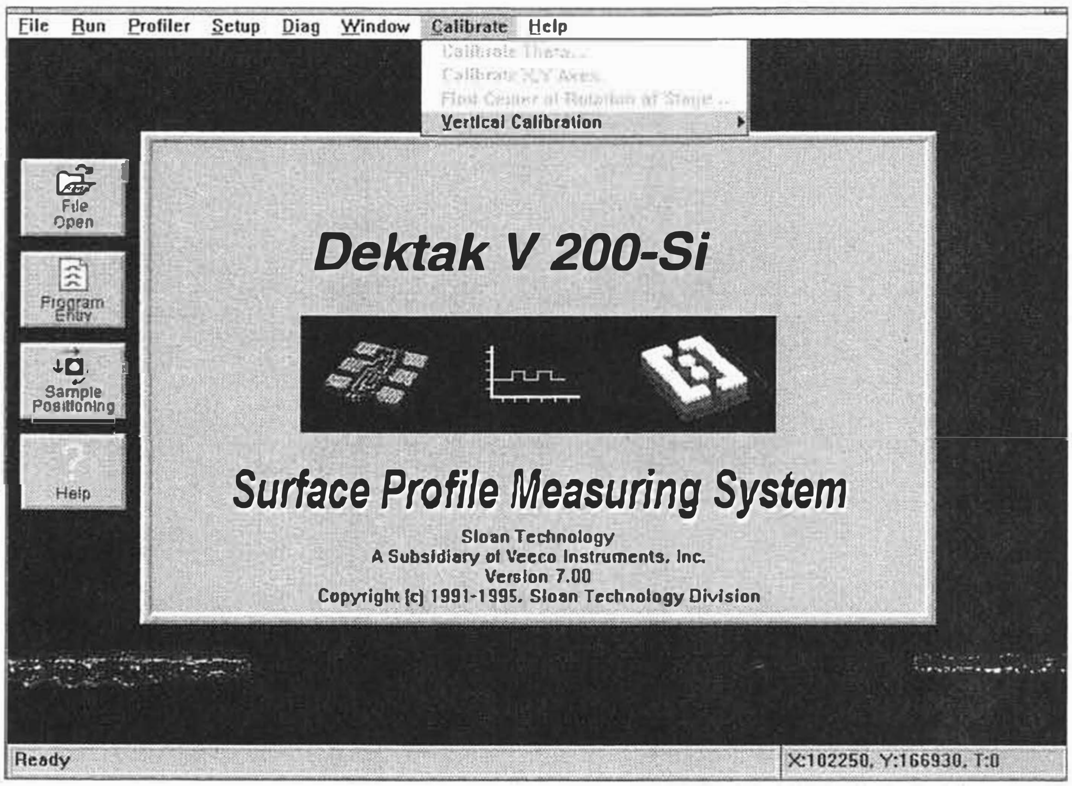


Figure 7-8. Calibration Menu

AUTOMATION PROGRAMS MENU SELECTIONS

When the Automation Programs screen is displayed, additional menu selections are provided (see Figure 7-9). These menus are briefly described below. A more detailed description of the use and functions of the menu items is provided in Section 5 of this manual.

Edit Menu

Selecting "Insert Default Scan Rt" establishes the current Scan Routine as the default Scan Routine. Selecting "Delete Scan Rt" deletes the current Scan Routine from the Automation Program. "Delete ScRt Range" allows a range of scan routines to be deleted. Selecting "Copy To" allows the current Scan Routine to be copied to a requested scan routine number. Selecting "Copy To Range" allows the current Scan Routine to be copied to a range of Scan Routine numbers. Selecting "Auto Prog Header" displays a dialogue box for creating an automation program header. Selecting "Build AutoProg Index" displays a dialogue box for building an automation program index.

Align Menu

Selecting "Clear Auto Prog Deskew Points" clears the current deskew points from the Automation Program. Selecting "Set Auto Prog Deskew Points" provides instructions for entering new reference deskew points into the Automation Program. The "Auto Alignment" selection can only be accessed if the unit is equipped with automatic alignment.

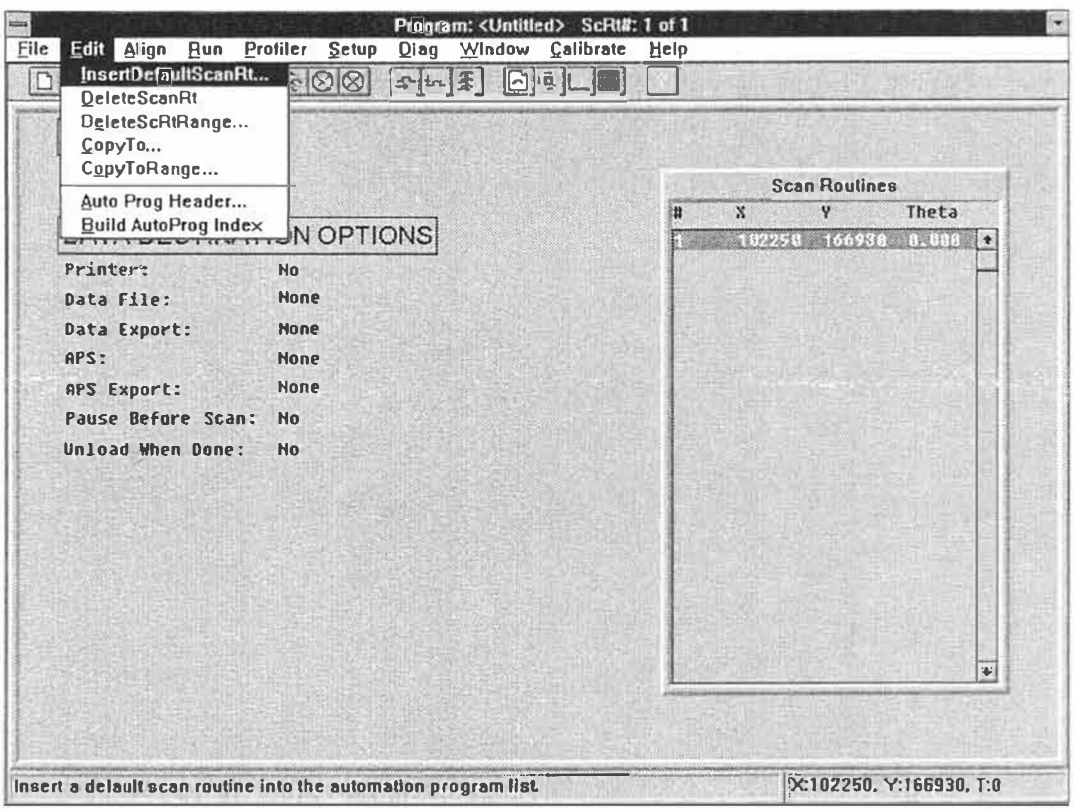


Figure 7-9 Automation Program Menus

SCAN ROUTINE MENU SELECTIONS

When the Scan Routines screen is displayed, additional menu selections are provided (see Figure 7-10). These menus are briefly described below.

Edit Menu

The Edit Menu permits editing of individual scan routines or global editing of all the scan routines within a multiscan Automation Program. Selecting "Next" displays the next scan routine in sequence of the current Automation Program. Selecting "Previous" displays the previous scan routine of the current Automation Program. The "Go To" function allows a selected scan routine to be displayed.

The "Append Analytical Functions" selection permits analytical functions to be entered into the scan routine. The "Delete Analytical Functions" selection permits highlighted analytical functions to be deleted from the scan routine.

The Global Edit selection acts as a toggle to activate and deactivate the Global Edit Mode. When the Global Edit Mode is activated any changes to the parameters of the displayed scan routine will effect all the scan routines within the Automation Program.

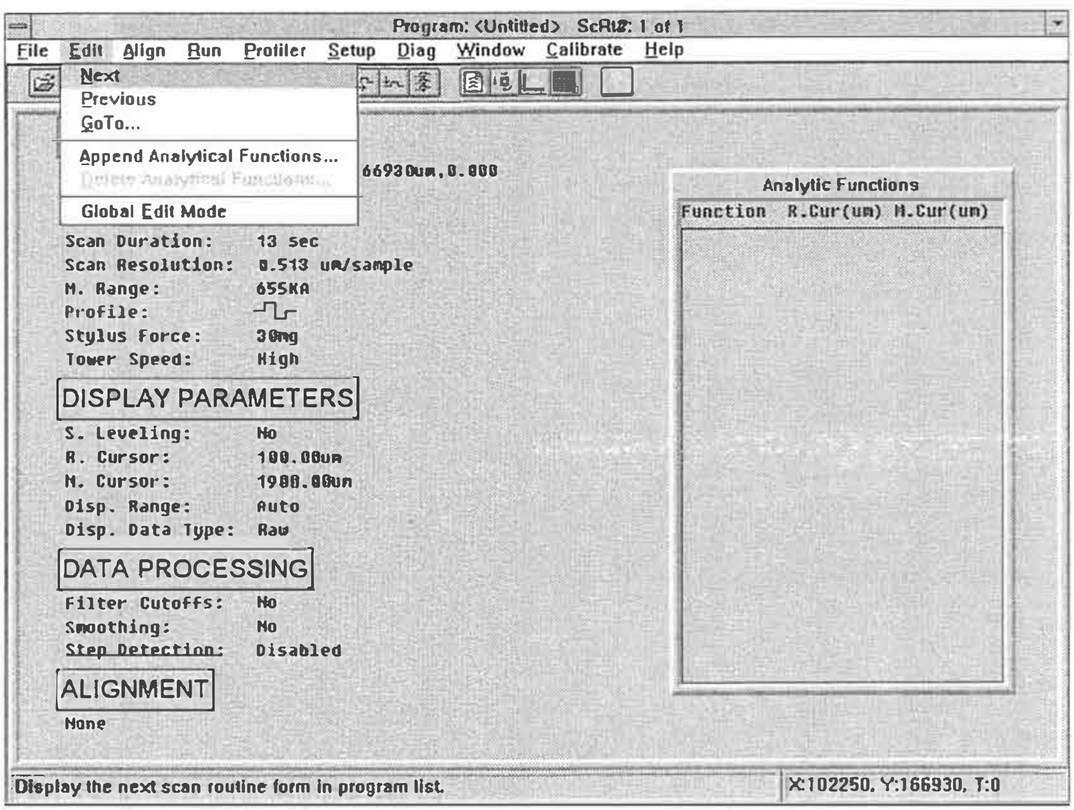


Figure 7-10. Scan Routine Menus

SECTION 8

SCAN ROUTINE PARAMETER DESCRIPTIONS

SECTION 8 OVERVIEW

This section describes the various scan parameters and display parameters of the Scan Routine Screen (see Figure 7-10). Up to 200 different Scan Routines can be entered into a single Automation Program File. Each Scan Routine within an Automation Program contains all the necessary parameters for performing a specified scan. These individual parameters are user selectable, providing extraordinary flexibility to adopt the DEKTAK V 200-Si for a wide range of applications. The Scan Routine parameters discussed in this section include:

- Location
- Scan ID
- Scan Length
- Scan Speed
- Scan Resolution
- Measurement Range
- Profile
- Stylus Force
- Tower Speed
- Software Leveling
- Reference Cursor
- Measurement Cursor
- Display Range
- Display Data Type
- Filter Cutoffs
- Smoothing

SCAN ROUTINE PARAMETERS WINDOW

All of the above parameters are user selectable and can be accessed from the Scan Routine window. To display the Scan Routine window, click-on the "Window" selection from the menu bar and click-on "Scan Routine" from the Window Menu. The Scan Routine window will be displayed (see Figure 8-1).

SCAN PARAMETERS

The procedure for setting the various scan parameters is described below.

Location

This parameter displays the X,Y,Theta stage location at which the current scan routine will be performed. The first number in the triplet represents the X location, the second number is the Y location, and the third is the Theta location expressed in degrees.

The stage location can be altered by clicking-on the "Location" parameter. When the "Location" parameter is highlighted, a box for entering each triplet is displayed (see Figure 8-1). Simply click-on one of the boxes labeled X, Y, or T and enter the desired coordinates using the DEKTAK V 200-Si numeric keypad. Press the enter key to set the new location.

Because the numeric value of the X,Y,Theta location is often not known, in most cases the stage location will be entered by using the Sample Positioning Screen.

Scan ID

This parameter permits a four digit scan identification filename or number to be assigned. To enter the Scan I.D. click-on the "Scan ID" parameter. When the "Scan ID" parameter is highlighted, a box for entering the number is displayed. Key-in the desired filename or number using the keyboard and press enter.

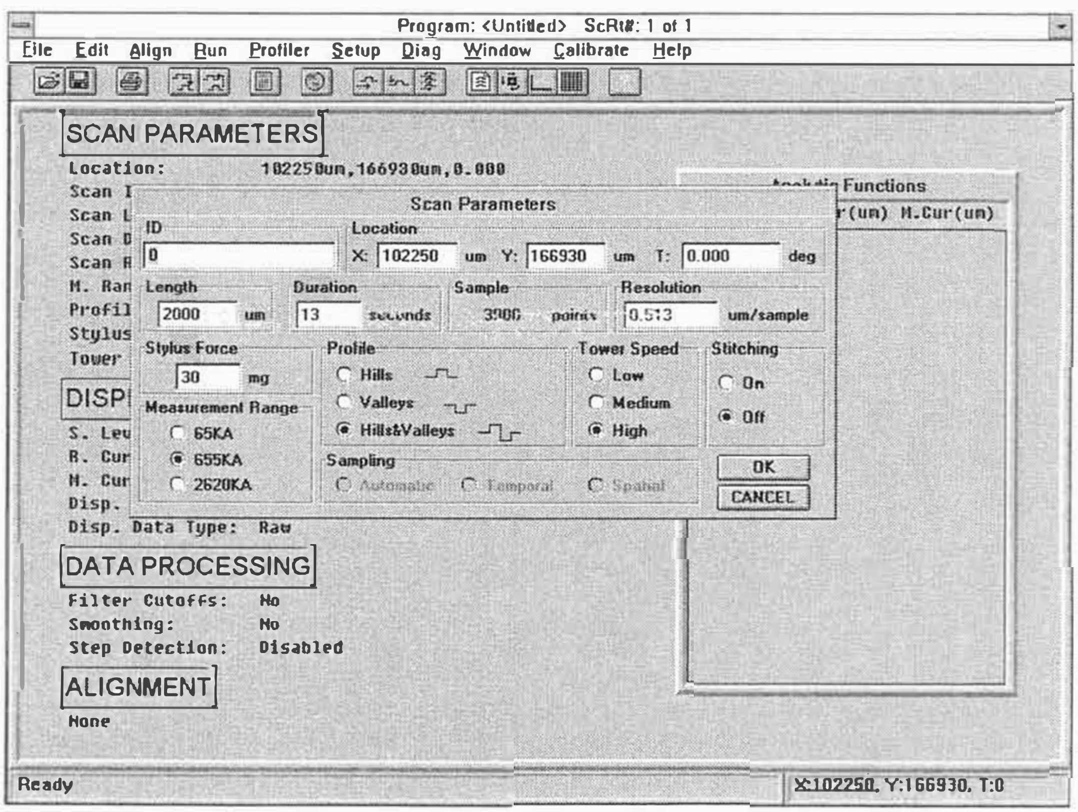


Figure 8-1. Location Parameter

Scan Length

The exclusive ScanStitching feature enables Scan Lengths from 50 microns to 300,000 microns (300mm). To enter a scan length over 100mm the ScanStitching feature must first be activated by selecting "ON" in the box labeled "Stitching". To set the scan length, click-on the "Scan Length" parameter. When the "Scan Length" parameter is highlighted, a box for entering the length is displayed. Enter the desired scan length using the DEKTAK V 200-Si numeric keypad, and press the enter key. The scan length is expressed in microns.

Scan Speed

The scan duration setting displays the amount of time it takes to complete a given scan. The horizontal resolution of a scan is determined by the scan duration in conjunction with the scan length. The scan speed is directly related to the data sampling rate. For example, a 50 second scan provides 15,000 data points. The scan duration can be set from 3 seconds to 218 seconds for a maximum of 65,400 data points per scan. A longer scan duration should be selected for long scan applications and measurements of very fine surface roughness which require the highest horizontal resolution obtainable. When high throughput is the primary consideration, the a shorter scan duration can be used. For most applications, a 10-20 second scan provides adequate resolution and throughput.

To set the scan duration, click-on the "Scan Duration" parameter. Key in the desired duration in seconds. The resolution and sample points will automatically be adjusted in accordance with the new duration value.

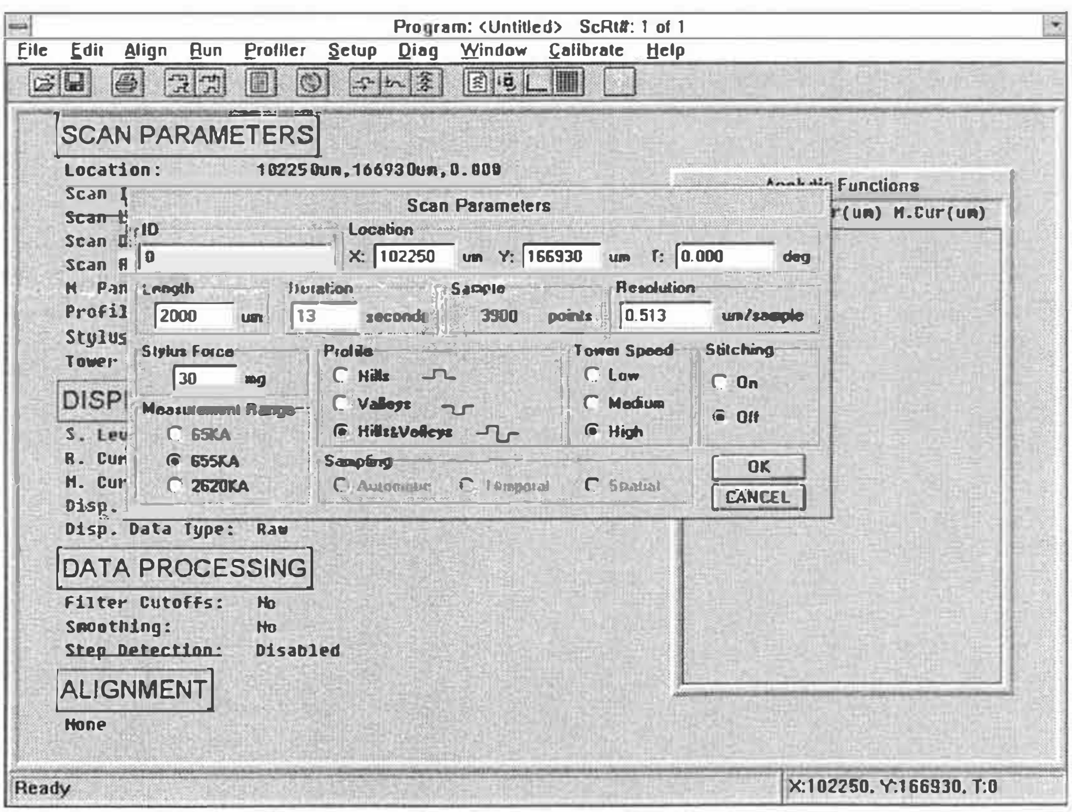


Figure 8-2. Scan Speed Parameter

Scan Resolution

The Scan Resolution parameter displays the horizontal resolution for the scan length and scan speed entered into the Scan Routine. The scan resolution is expressed in microns per sample. In other words, it provides the horizontal distance between data points. Data points are the points along the scan path at which data samples are taken. The more data points taken during a given scan length, the shorter the distance between samples. Therefore, a scan routine with the lowest number of microns per sample will provide the best possible horizontal resolution.

Measurement Range

The available vertical resolution depends upon the measurement range selected. When measuring extremely fine geometries, the 65KA range provides a vertical bit resolution of 1A. For general applications, the 10A vertical resolution of the 655KA range is usually adequate. When measuring thick films or very rough or curved samples, the 2620KA range with 20A resolution should be selected.

To set the measurement range, click-on the "M. Range" parameter. When the "M. Range" parameter is highlighted, three boxes will be displayed offering the three measurement range selections: 65KA, 655KA and 2620KA. Click-on the desired measurement range to enter the selection.

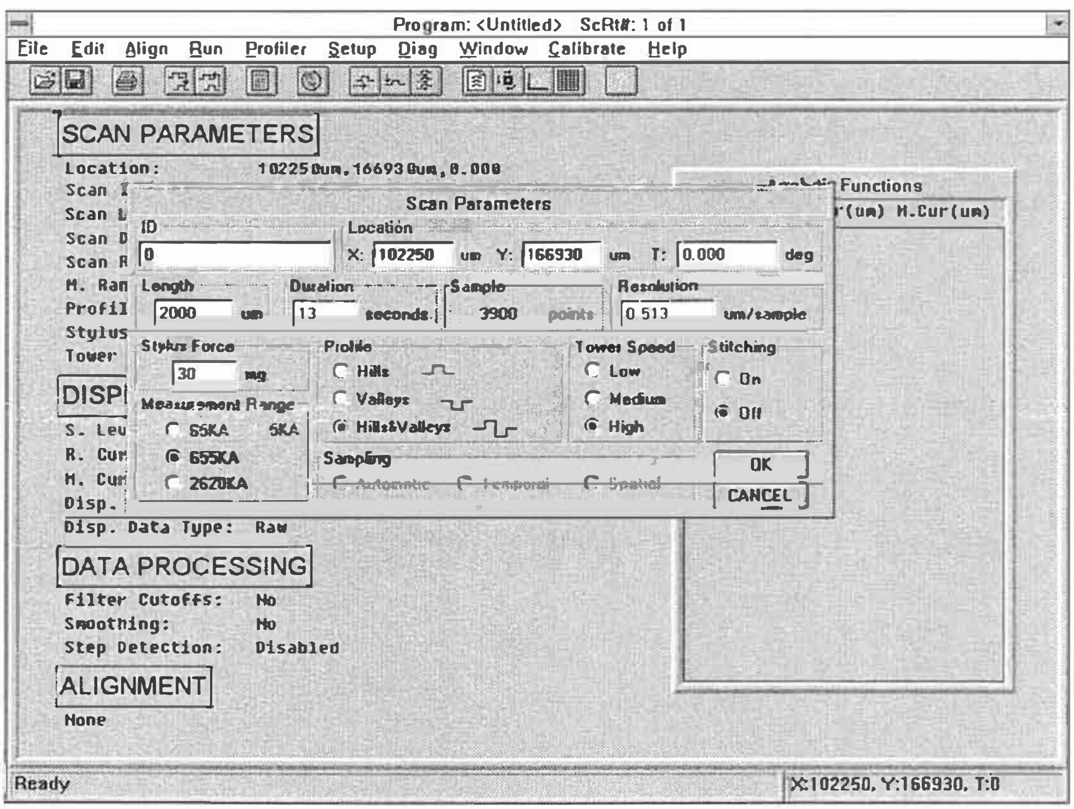
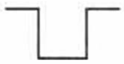


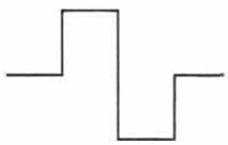
Figure 8-3. Measurement Range Parameter

Profile

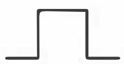
The profile setting scales the measurement range according to the profile selected. Three different profiles are available for a variety of sample surface characteristics.



(Valleys) Provides 90% of the measurement range below the zero horizontal grid line. Used primarily for measuring etched depths.



(Hills and Valleys) Provides 50% of the measurement range above the zero horizontal grid line and 50% below. Used in most applications, especially if the surface characteristics of the sample are not well known, or if the sample is out of level.



(Hills) Provides 90% of the measurement range above the horizontal grid line. Used primarily for measuring step heights.

To set the profile, click-on the "Profile" parameter. When the "Profile" parameter is highlighted, three boxes will be displayed containing the various profile options. Move the pointing device to the desired profile and click-on the mouse or trackball button. The selected profile will be entered into the Scan Routine Program.

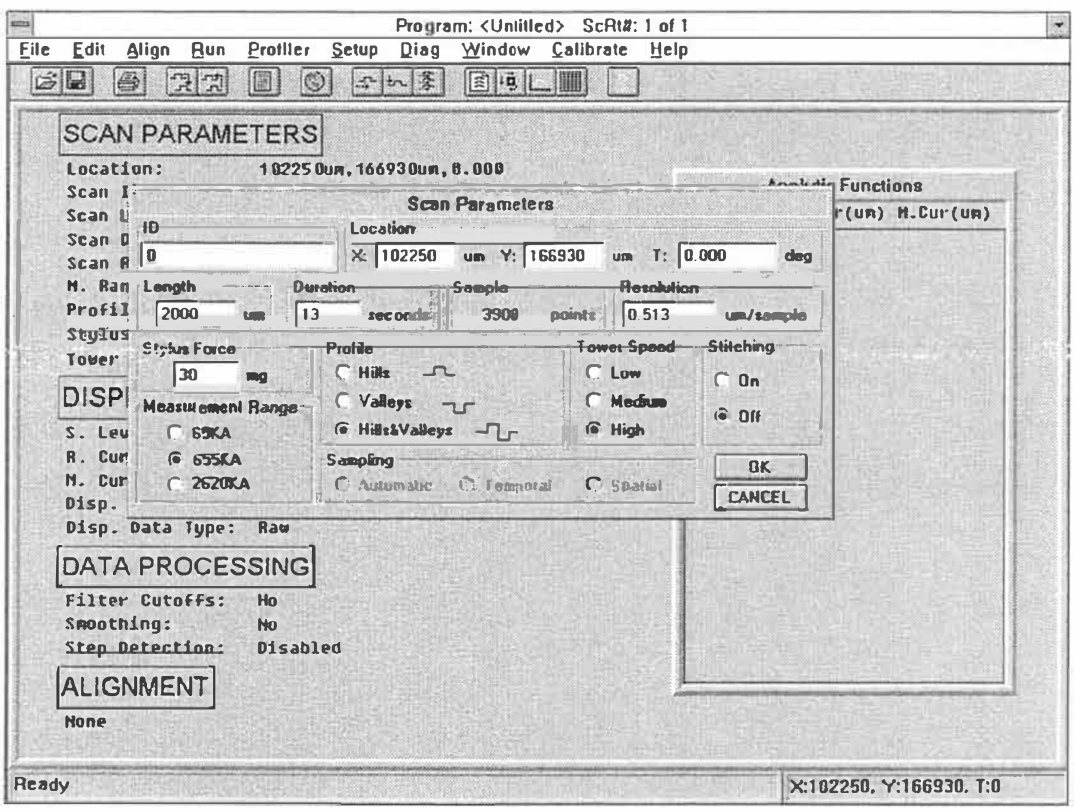


Figure 8-4. Profile Parameter

Stylus Force

The stylus force can be set from 30mg. down to 0.5mg. force. The Scan Parameters Dialogue Box enables the stylus force to be adjusted. To adjust the force click-on either the up arrow or down arrow within the "Stylus Force" selection of the dialogue box. When the desired stylus force is displayed click-on the "OK" button to enter the stylus force into the scan routine.

Minimum Inertia Force Adjustment

The inertia force can also be set below 0.5mg by selecting the Minimum Inertia Force selection. To set the inertia force at minimum, click-on the box labeled "Minimum Inertia Force". An "X" will appear in the box when Minimum Inertia Force is selected. Click-on the "OK" button to enter the minimum inertia force into the scan routine parameters.

Tower Speed

The tower speed determines at what velocity the stylus tower is lowered onto the sample surface. When measuring soft surfaces, the lower tower speed should be selected to eliminate stylus impact damage to the sample. To increase throughput a high tower speed can be selected when measuring hard surfaces.

To set the tower speed, click-on the "Tower Speed" parameter. When the "Tower Speed" parameter is highlighted, three boxes will be displayed with the selections of Low, Medium, and High tower speed. Click-on the desired tower speed to enter the selection.

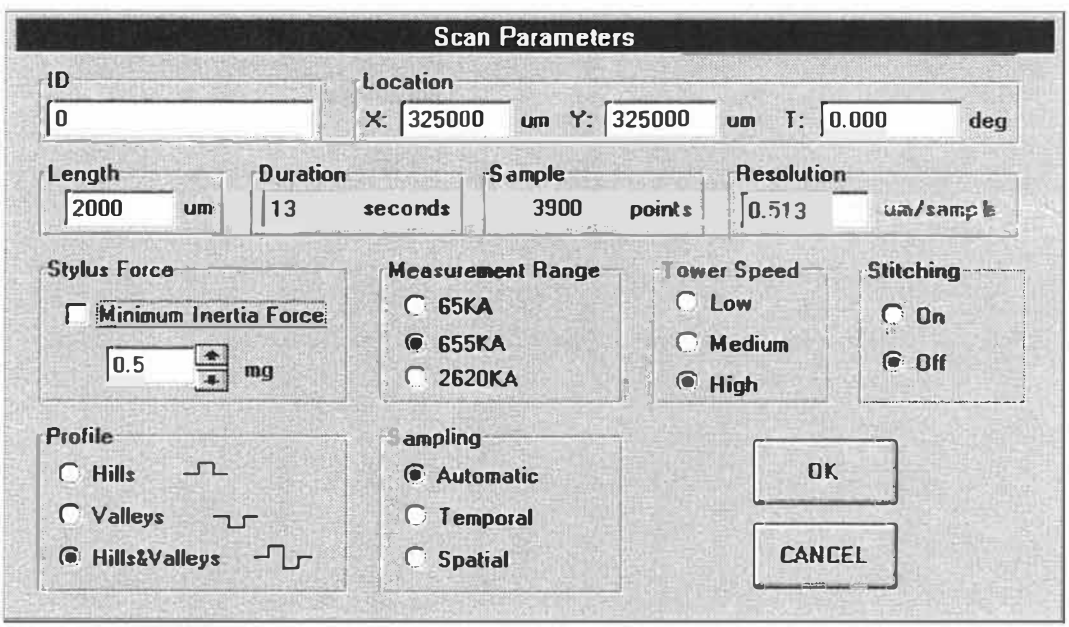


Figure 8-5. Tower Speed Parameter

DISPLAY PARAMETERS

The Scan Routines screen contains additional parameters under the heading "Display Parameters" which allow automatic manipulation of the graphic display of the profile trace. The Display Parameters are described below.

Software Leveling

The DEKTAK V 200-Si can be programmed to automatically software level the profile trace at the conclusion of a scan in relation to the cursor/trace intercepts. In order to obtain accurate step height readings and analytical calculations, the trace must be software leveled. Software leveling can be programmed into the scan routine. Cursor band widths can also be entered to perform 4-cursor delta leveling.

To enter software leveling, click-on the "S. Leveling" parameter. If software leveling is desired, click-on the Automatic Leveling checkbox.

When Automatic Leveling is selected, two additional boxes will be displayed (Figure 8-6). These boxes permit the cursor band widths to be adjusted and entered into the software leveling parameter. If no bands are required, enter 0, and the default fine line cursors will be used to level the trace. If the desired cursor widths are known, they can be entered into the scan routine. The first box represents the width of the reference cursor and the second box is for setting the measurement cursor width.

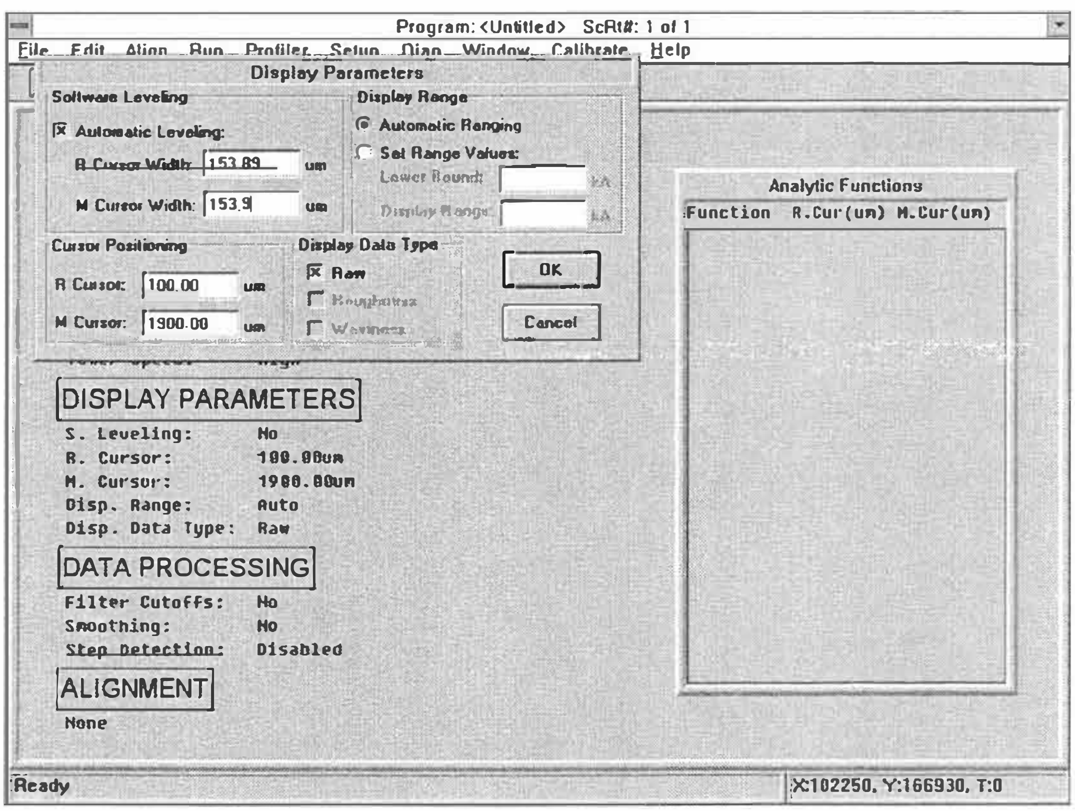


Figure 8-6. Software Leveling Parameter

Band Width Setting

Cursor band widths can also be entered from the Data Plot screen. Delta averaging technique is used to provide a roughness average reading of the section of the profile trace within the bands. The profile trace will then be automatically leveled according to the two average readings.

When setting the cursor band widths and cursor locations, it is often helpful to first run a sample scan of the scan routine to be leveled. Once the scan has been completed and the unleveled trace is displayed, position the cursors at two points on the trace that run along the same horizontal plane.

To set the cursor width click-on the "Plot" menu from the Data Plot screen menu bar. Click-on "Band Width" and a window will be displayed permitting the cursor band widths to be adjusted (see Figure 8-7). Once the desired band widths are set, click-on "OK."

To enter the new band widths into the software leveling parameter of the Scan Routine screen, pull down the Bands menu again and click-on "Enter Software Leveling." The selected band width value will automatically be entered into the software leveling parameter.

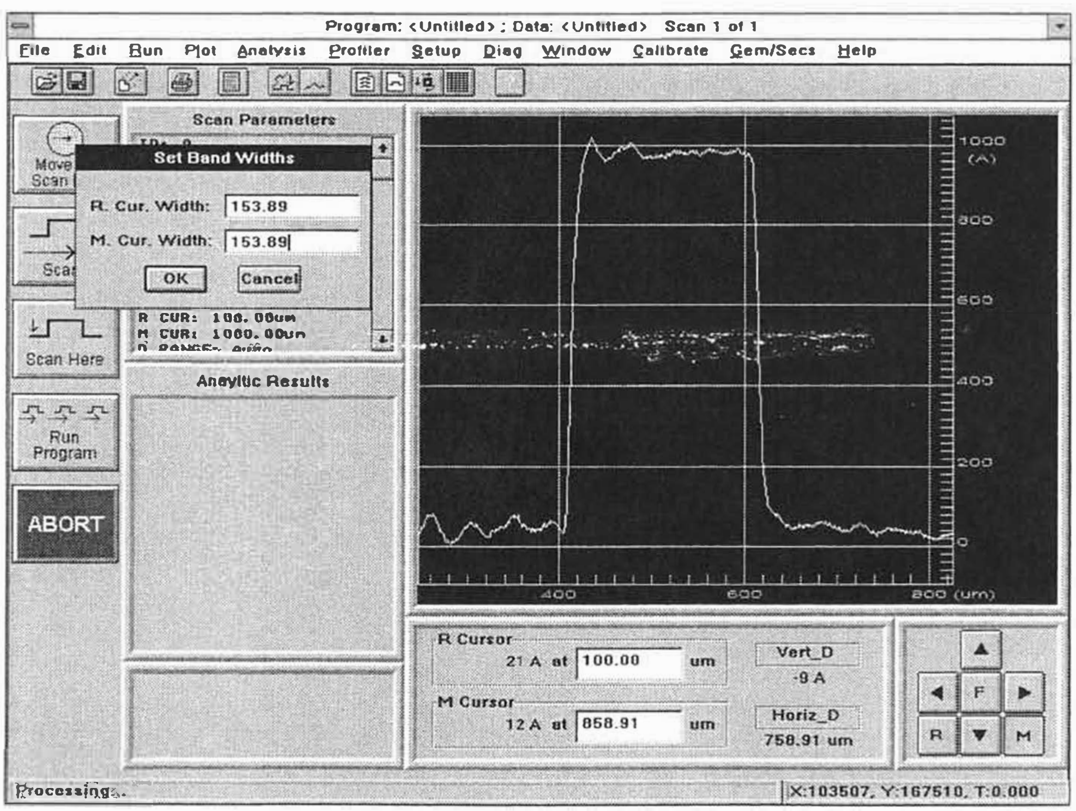


Figure 8-7. Software Leveling Band Width

Reference/Measurement Cursors

The R. Cursor and M. Cursor parameters permit the reference and measurement cursor locations in relation to the horizontal scale of the Data Plot screen to be entered into a scan routine. Once entered, whenever the scan routine is executed, the cursors will automatically be positioned to the programmed locations. The cursor settings are used to automatically software level the profile trace.

If the desired cursor settings are known, they can be numerically entered directly into the Scan Routine, when the Scan Routine screen is displayed. This can be accomplished by simply clicking-on the "R. Cursor" or "M. Cursor" parameter, and entering the desired cursor location.

Cursor locations can also be entered into the current scan routine from the Data Plot screen. To set the cursor locations for leveling, it is recommended that a sample scan be run of the feature to be measured. Once the scan is complete, position the reference cursor at a location along the reference plane (i.e., the base of a step or the lip of an etched depth). To accurately level the trace, the measurement cursor should be positioned away from the reference cursor, yet along the same horizontal plane.

Once the cursors have been properly positioned, click-on "Edit" from the Data Plot screen menu bar. Click-on "Enter Software Leveling" from the Bands menu and the new cursor locations will be entered into the scan routine. The software leveling function will now be performed at the specified cursor locations whenever the current scan routine is executed.

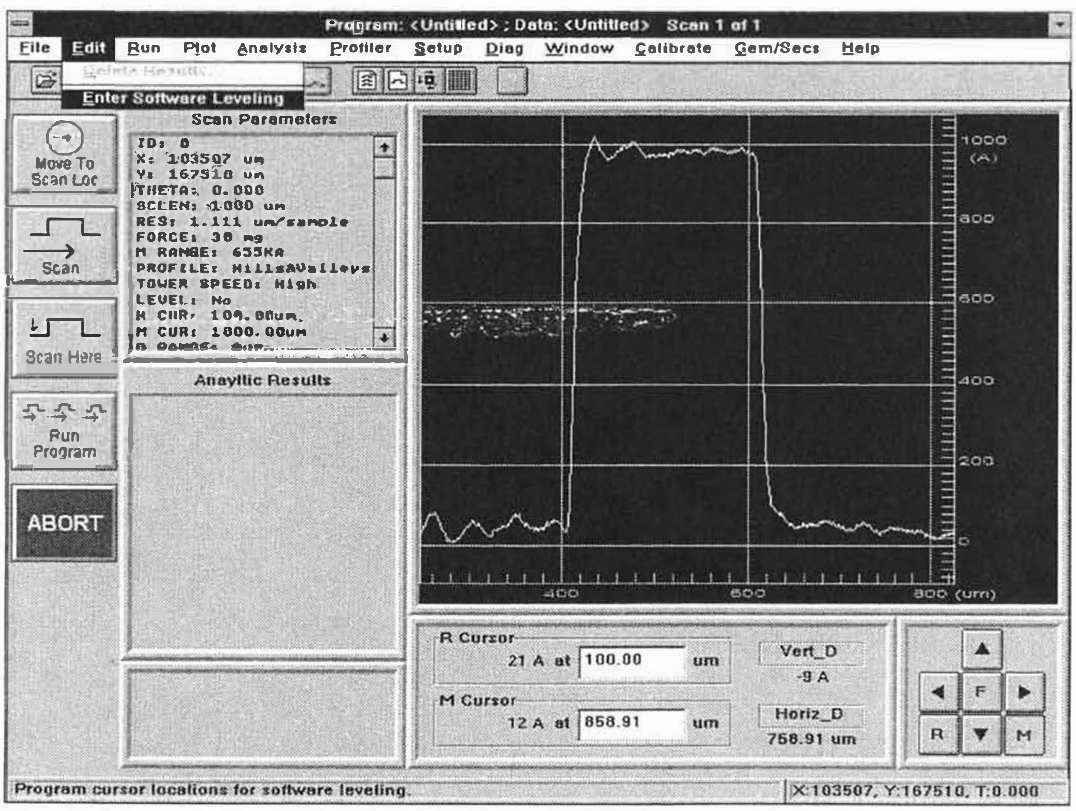


Figure 8-8. Cursor Parameters

Display Range

The Auto Ranging feature automatically scales and ranges the profile trace to fill 80% of the data plot display. However, in some applications where repetitive or like scans are being compared, it may be advantageous to preset the graphic scale by numeric entry.

To set the display range, click-on the "Disp. Range" parameter. When the "Disp. Range" parameter is highlighted, two options are displayed: Auto and Select. To select automatic ranging, click-on "Auto." To set the display range at a specified value, click-on "Select." The "Select" option provides two additional boxes for entering the upper and lower boundaries of the graphic scale (see Figure 8-9). Enter the desired setting for the upper boundary in the first box and press enter. Repeat the procedure to enter the lower boundary in the second box.

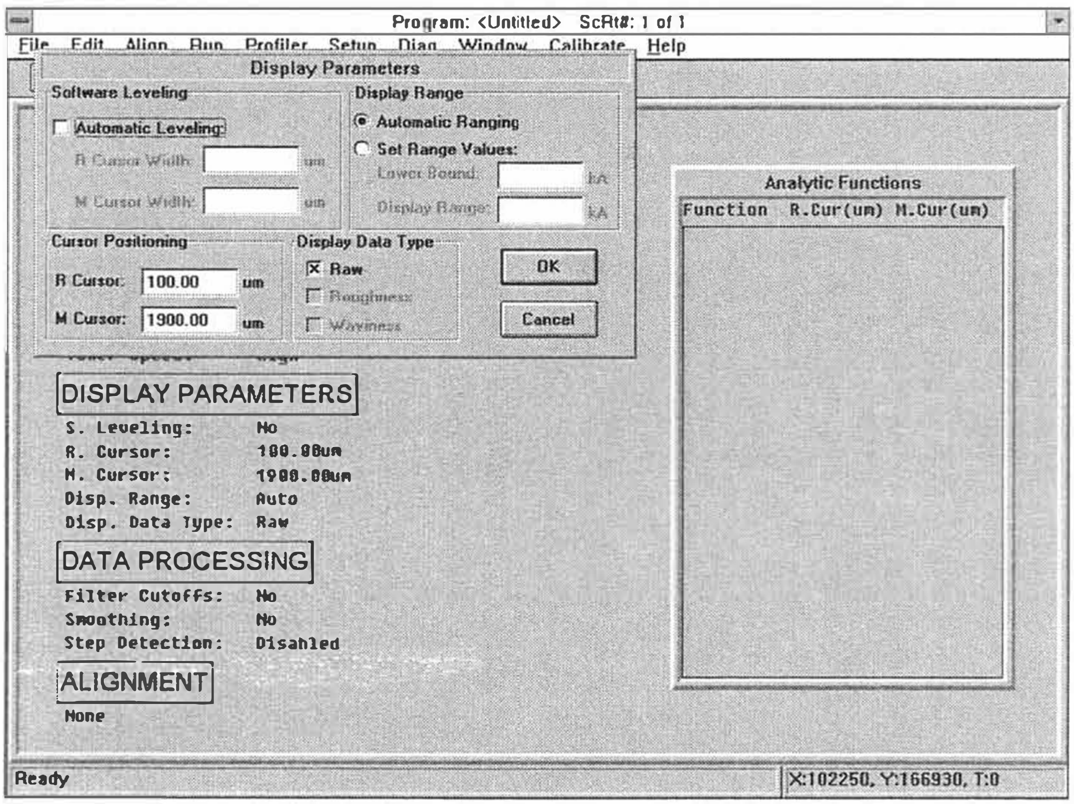


Figure 8-9. Display Range Parameter

Display Data Type

This parameter permits raw profile data as well as the roughness and waviness profile to be displayed. The raw profile and roughness or waviness profiles can be displayed individually or simultaneously, to easily correlate the profiles. A detailed description of the function and use of the Display Data Type parameter is provided in Section 6 of this manual.

DATA PROCESSING

The DEKTAK V 200-Si provides parameters for processing profile data for specific applications. Within the field of the Scan Routines screen are two parameters listed under the heading "Data Processing." These parameters permit filter cutoffs and smoothing filters to be activated. Their use and function is described in detail in Section 6 of this manual.

Filter Cutoffs

Roughness and waviness filter cutoffs can be entered from the Scan Routine screen or the Data Plot screen. This parameter permits user selected cutoff values to be entered into the current Scan Routine. A short pass filter is available for calculating roughness analytical functions. A long pass filter is available for calculating roughness analytical functions.

Smoothing

The smoothing parameter permits a smoothing filter to be activated. When the smoothing function is used, raw, roughness and waviness profiles are calculated using the smoothed data. Three degrees of smoothing are available. The higher the degree, the more smoothing will be realized.

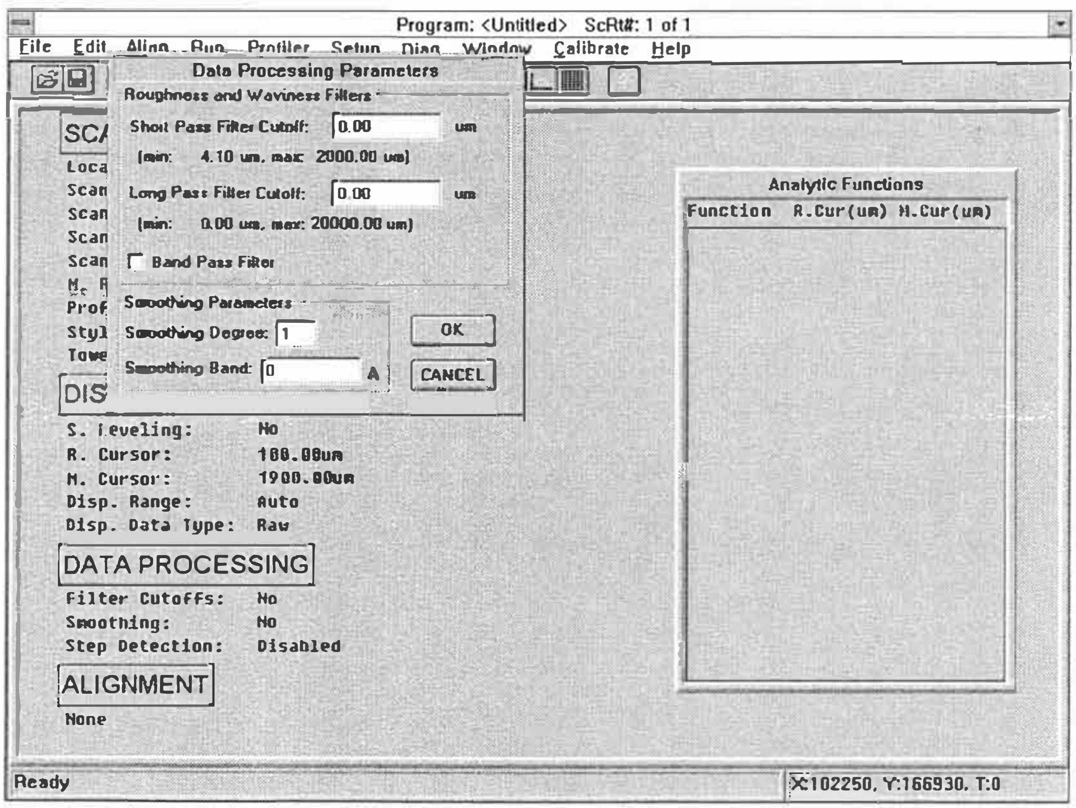


Figure 8-10. Smoothing Parameter

STEP DETECTION / AUTOMATIC ALIGNMENT OPTIONS

The DEKTAK V 200-Si provides optional features for Step Detection and Automatic Alignment. The instructions for opening these features is provided in the appendix in the back of this manual.

SECTION 9

KEYBOARD AND ICON FUNCTIONS

KEYBOARD FUNCTIONS

The DEKTAK V 200-Si keyboard can be used for performing nearly all Windows fuctions typically performed using the trackball. The corresponding key functions are described in this section.

An external computer keyboard can also be connected to the DEKTAK V 200-Si for entering alpha-numeric commands. See Section 1 of this manual for external keyboard installation instructions.

NUMERIC ENTRY KEYBOARD FUNCTIONS

Key	*Function*
0-9	(NUMERIC KEYPAD) Used in specifying numeric values for programming parameters, cursors, boundaries and smoothing functions.
-	(MINUS SIGN KEY) Used for specifying negative values.
CLR	(BACKSPACE KEY) Erases any alpha-numeric data keyed in but not yet entered. The Clear Key also acts as a backspace key when making alpha-numeric keyboard entries.
ABORT	("A" KEY) Interrupts a scan or automation program and progress. Also used to stop tower motion or stage translation.
ENTER	(ENTER) Enters specified numeric data or filenames.
REPLOT	("C" KEY) Will replot the desired boundaries (1 through 9) according to the boundaries saved. **RPLT,0** will display the original boundaries.
ZERO	("D" KEY) Places the R cursor/trace intercept on the zero horizontal grid line.
LEVEL	("E" KEY) Levels a trace according to the R and M cursor/trace intercepts. The R cursor/trace intercept will automatically be zeroed.

STAGE POSITIONING KEYBOARD FUNCTIONS

Key	*Function*
DATAPLOT BOUNDARIES	("F", "G", "H", "N" KEYS) When one of these keys is pressed, it activates the corresponding boundary on the data plot display, allowing the boundary to be repositioned by pressing the arrow keys or entering numeric value.
LEFT BOUNDARY	("F" KEY) Activates the LEFT boundary on the data plot display, allowing the boundary to be repositioned by pressing the arrow keys or entering numeric value.
TOP BOUNDARY	("G" KEY) Activates the TOP boundary on the data plot display, allowing the boundary to be repositioned by pressing the arrow keys or entering numeric value.
RIGHT BOUNDARY	("H" KEY) Activates the RIGHT boundary on the data plot display, allowing the boundary to be repositioned by pressing the arrow keys or entering numeric value.
BOTTOM BOUNDARY	("N" KEY) Activates the BOTTOM boundary on the data plot display, allowing the boundary to be repositioned by pressing the arrow keys or entering numeric value.
ARROW KEYS	For cursor, boundary, and stage positioning. Select the desired cursor keys, boundary keys or stage key to reposition using the keys described below.
UP	("I" KEY) For repositioning the top and bottom boundaries ("G" and "N" keys) upward and positioning the stage ("Q" key) so that the video image of the sample on the screen moves upward.
LEFT	("J" KEY) For repositioning the left and right boundaries ("F" and "H" keys) to the left and positioning the stage ("Q" key) so that the video image of the sample on the screen moves to the left. Can also be used for moving the Refernce Cursor ("M" key) and Measurement Cursor ("O" key) to the left.
RIGHT	("K" KEY) For repositioning the left and right boundaries ("F" and "H" keys) to the right and positioning the stage ("Q" key) so that the video image of the sample on the screen moves to the right. Can also be used for moving the Refernce Cursor ("M" key) and Measurement Cursor ("O" key) to the right.
DOWN	("L" KEY) For repositioning the top and bottom boundaries ("G" and "N" keys) downward and positioning the stage ("Q" key) so that the video image of the sample on the screen moves downward.

FAST KEY ("SHIFT" KEY) Speeds up stage, stylus tower, boundary or cursor movement. The Fast key also acts as the shift key when making alpha-numeric keyboard entries.

NOTE

To move sample stage, cursors, boundaries, or stylus tower in the fast mode, press and hold the appropriate arrow key and then the FAST key ("SHIFT" KEY).

R CURSOR ("M" KEY) Press to adjust the reference cursor location or width. Use in conjunction with the right and left arrow keys to position the cursor. Use in conjunction with the up and down arrow keys to adjust the cursor width.

M CURSOR ("O" KEY) Press to adjust the measurement cursor location or width. Use in conjunction with the right and left arrow keys to position the cursor. Use in conjunction with the up and down arrow keys to adjust the cursor width.

TILT STAGE ("P" KEY) When this key is pressed, the stage can be mechanically leveled by pressing the up and down arrow keys ("I" and "L" keys).

STAGE (STAGE POSITIONING) When this key is pressed, the sample can be positioned along the X-Y axis by pressing the arrow keys ("I", "J", "K", and "L" keys).

THETA (THETA ROTATION) Permits the sample stage to be rotated by using the left and right arrow keys ("J" and "K" keys).

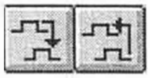
DISPLAY KEYBOARD FUNCTIONS

Key	*Function*
VIDEO	("S" KEY) Controls three video display modes: Video only, graphics only, or video/graphics overlay.
STYLUS	("T" KEY) Raises and lowers the stylus tower. Pressing the "T" key and the Fast key simultaneously raises and lowers the stylus tower at high speed.
PRINT	("U" KEY) Initiates a printout on the printer of the scan data and plotted profile trace.
AUTO PROG	("V" KEY) Initiates the current automation program.
LOAD	("W" KEY) This key acts as a toggle for loading and unloading samples. Striking the "W" key with the stage positioned below the stylus raises the stylus tower and moves the stage all the way forward to the unload position at the Scan Head door opening. Striking this key when the stage is in the unload position centers the stage under the stylus in the load position.
SCAN	("X" KEY) Runs the current Scan Routine at the current X,Y,Theta location.
FOCUS	("Y" and ":" KEYS) Adjusts the video camera lens focus. The optional remote control focus feature must be installed to activate these keys.
LIGHTING	("Z" and "," KEYS) Adjusts the sample illumination. The "Z" key increases the illumination and the "," key decreases the illumination.
ZOOM	("\" and "." KEYS) Adjusts the video camera zoom lens from 85-550X. The "\" key increases magnification and the "." key decreases the magnification.

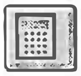
ICON FUNCTIONS

The Dektak V 200-Si Microsoft Windows user interface provides a series of easy to use on screen icon buttons for performing repetitive functions quickly with simple point and click ease. The description for these icons is provided below.

Icon	*Function*
	Displays the Automation Program Window.
	Displays the Sample Positioning Window.
	Displays the Data Plot Window.
	Displays the Automation Program Sumary Window
	Displays the Scan Routine Window
	Runs the current scan routine.
	Runs the current scan routine at the current stage location.
	Runs the current automation program.
	Opens a new Automation Program.
	Opens a saved file such as Automation Program or scan data.
	Saves the current Automation Program or scan data.
	Prints the current scan data and profile trace.
	Displays the Help menus.



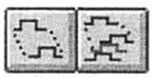
(Only available on Scan Routine Window) Displays the next and previous scan routines of a multiscan Automation Progam.



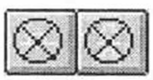
Displays the analytical funtions dialog box.

Enables and disables scan routine Global Edit Mode.

(Available in Automation Program Window only) Displays dialog box for exporting scan data.



(Available in Automation Program Window only) Displays dialog box for copying a single scan routine or a range of scan routines into the current Automation Program.



(Available in Automation Program Window only) Displays dialog box for deleting a single scan routine or a range of scan routines from the current Automation Program.

(Available in the Data Plot Window only) Performs the software leveling function on the scan trace.

(Available in the Data Plot Window only) Performs the replot function on the scan trace used to enlarge a portion of the trace.

Displays the Loader Program Window.

(Available in the Sample Positioning Window only) Removes stage backlash prior to entering scan sites and deskew sites into an automation program.

SECTION 10

CALIBRATION, MAINTENANCE AND WARRANTY

SECTION 10 OVERVIEW

Items discussed in this section include:

- Care and Handling
- Vertical Calibration
- Theta Calibration
- X,Y Calibration
- Find Center of Rotation of Stage
- Changing the Time and Date
- Formatting a Data Disk
- Stylus Replacement
- Illuminator Lamp Replacement
- Warranty

CARE AND HANDLING

Like any precision instrument, the DEKTAK V 200-Si requires care in handling and operation. The following recommendations should be followed.

1. Allow the DEKTAK V 200-Si to warm up for approximately 15 minutes prior to use, to stabilize the electronics.

2. Do not use any leadscrew lubricants other than Veeco authorized leadscrew lubricant P/N 085280.

3. Always position the sample so that the stylus is the only part of the stylus arm that touches the sample.

4. Always keep the Scan Head door closed when the DEKTAK V 200-Si is not in use.

5. Never connect or disconnect any cables when power is on.

6. Do not lower the stylus tower without the stage assembly in place.

7. Do not move a sample during a scan.

8. Avoid vibration and shock during measurements. (A common source of this is an operator or observer touching or bumping a surface close to the instrument or the instrument itself during a scan.)

9. Always raise stylus tower and optics assembly to the full up position when the system is not in use, even when power is left on.

VERTICAL CALIBRATION

The DEKTAK V 200-Si should be software calibrated regularly (at least once a month) to ensure vertical measurement accuracy. The 10KA calibration standard supplied with the DEKTAK V 200-Si can be used for this purpose. Additional calibration standards are also available to calibrate the instrument for a wide variety of applications. Step height calibration standards range in thickness from 200 angstroms to 100,000 angstroms. All calibration standards are traceable to the National Institute of Standards and Technology and include a certificate of calibration.

Vertical Calibration Help Window

The DEKTAK V 200-Si provides user instructions for setting the vertical calibration. This window can be displayed from any screen but the Data Plot screen. The procedure to display the Vertical Calibration Help window is described below.

1. Click-on "Calibrate" from the system menu bar. The set-up menu will be displayed.

2. Click-on "Vertical Calibration" and click-on "Set". The vertical calibration help window will be displayed (see Figure 10-1).

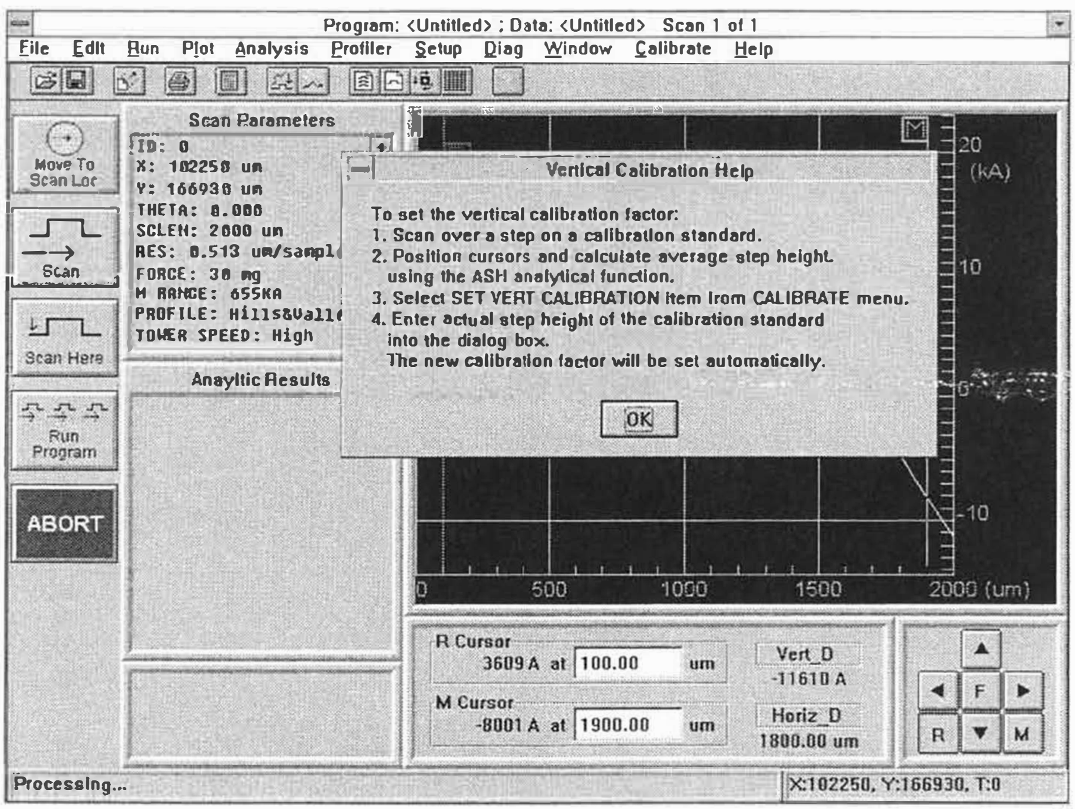


Figure 10-1. Vertical Calibration Help Window

SCANNING A CALIBRATION STANDARD

To set the vertical calibration, a scan must first be run using a calibration standard and the average step height function must be calculated on the scan data. The detailed instructions for sample positioning, and running a scan are provided in Section 3 and 4 of this manual. For the purpose of discussion, the calibration procedure described below will use the 10KA calibration standard supplied with the DEKTAK V 200-Si.

1. Open a new Automation Program and enter a scan length of 500 microns into the default scan routine.

2. Position the calibration standard to run a 500 micron scan over the center of the "dog bone" shaped step of the 10KA calibration standard.

3. Click-on "Scan Here" from the Run menu. The 500 micron scan will be run and the profile will be plotted.

4. Auto level the stage, as described in Section 4 of this manual.

5. Click-on "Scan Here" a second time, and software level the trace as described in Section 4. The resulting profile should resemble Figure 10-2 below.

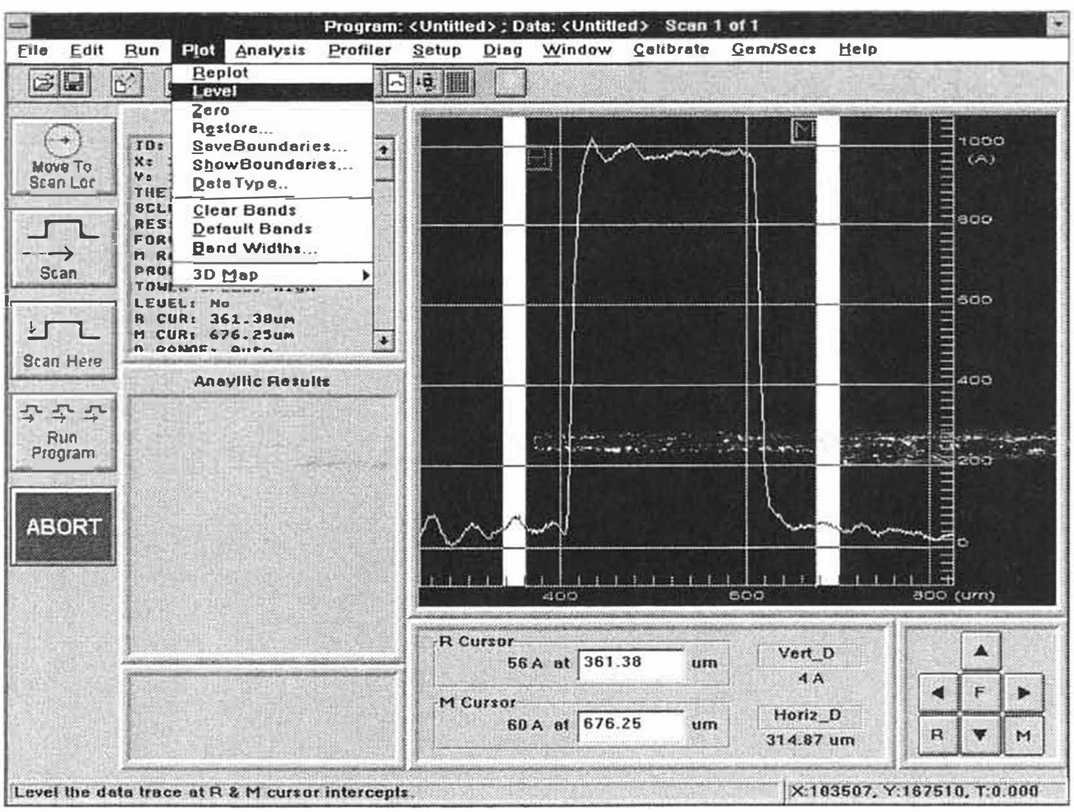


Figure 10-2. Calibration Standard Step Height

CALCULATING AVERAGE STEP HEIGHT

It is recommended that the cursor band widths be set at approximately 100 microns for calculating the average step height analytical function. The cursor bands can also be used for software leveling the trace. A detailed description of the procedure for setting the width of the bands is provided in Section 8 of this manual.

1. To set the cursor bands, click-on "Set Bands" from the bands menu and enter band widths of 100 microns for each cursor.

2. With the reference cursor positioned along the base of the step, reposition the measurement cursor to the center of the step (see Figure 10-3).

3. Click-on "Analysis" and click-on "Append Analytical Functions". The Analytical Functions window will be displayed.

4. Click-on "ASH" to activate the average step height parameter and click-on "Compute". The average step height will be calculated and the result will be displayed to the left of the Data Plot screen. Click-on "Done".

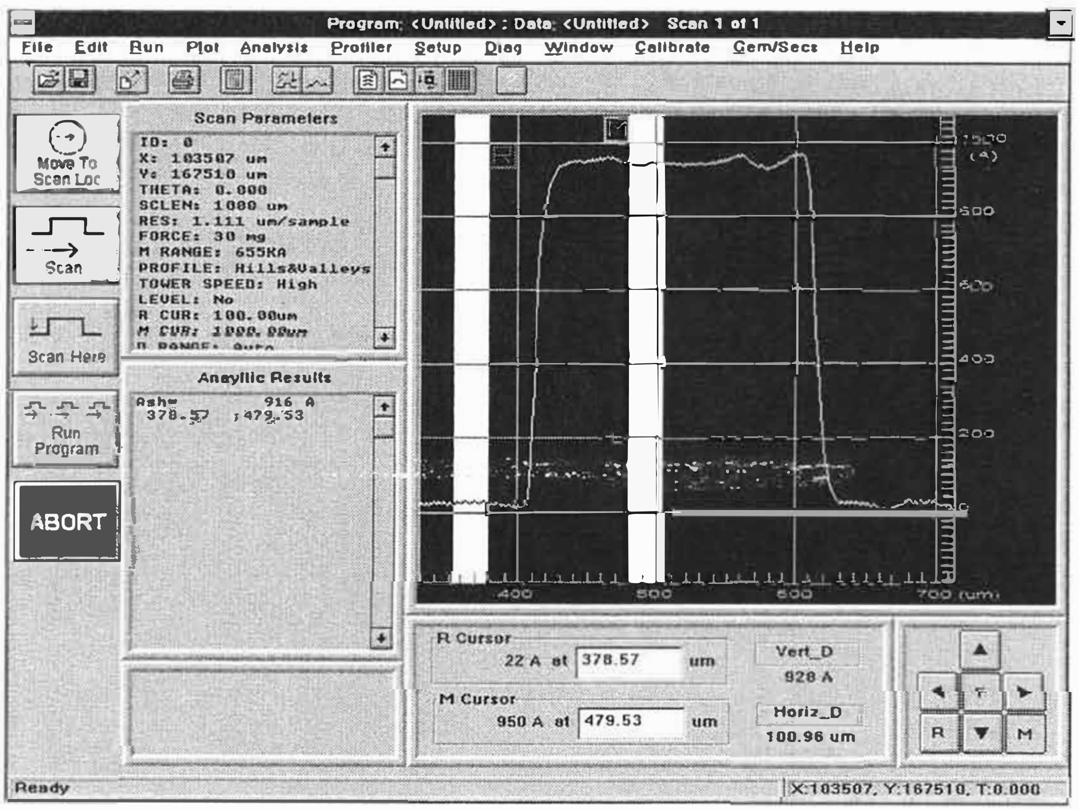


Figure 10-3. Calculating Average Step Height

SETTING THE VERTICAL CALIBRATION

Once the average step height has been calculated, the vertical calibration can be set.

1. Click-on "Calibrate" from the system menu bar located above the Data Plot screen. The calibration menu will be displayed.

2. Click-on "Set Vert. Calibration" from the menu. A dialog box will be displayed permitting the vertical calibration to be set (see Figure 10-4).

3. The dialog box displays the measurement range of the current Scan Routine. The "Set Options" selections permit the vertical calibration to either be set for the current measurement range, or for all three ranges: 65KA, 655KA and 2620 KA. This feature allows the various ranges to be set using different size step height calibration standards. For the purpose of this exercise, click-on "Set for All Ranges."

4. The "Measured Step Height" value is actually the average step height value calculated on the just concluded scan. In the box labeled "Actual Step Height," enter the certified step height value printed on the certificate of calibration and on the back of the case provided with the 10KA calibration standard.

5. Click-on "OK" to set the vertical calibration. When the scan routine is rerun and the average step height function is once again calculated, the ASH result should equal that of certified value.

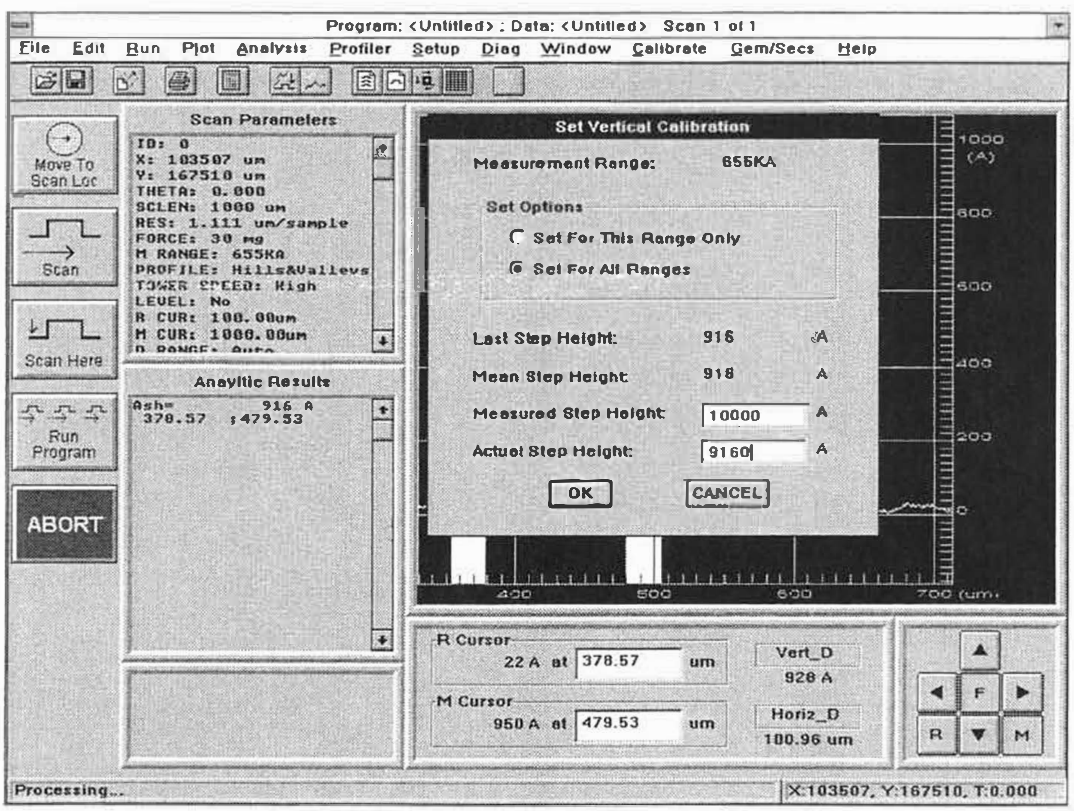


Figure 10-4. Set Vertical Calibration Dialog Box

CLEARING VERTICAL CALIBRATION

Whenever the vertical calibration is set, the old values are automatically cleared and replaced by the new parameters. However, in some cases, it may be desirable to clear individual ranges or all ranges. This procedure is described below.

1. Click-on "Calibrate" and click-on "Clear Vert. Calibration" from the menu, the clear vertical calibration dialog box will be displayed (see Figure 10-5).

2. The dialog box permits the vertical calibration to be cleared from the various display ranges either individually or from all the ranges. Click-on the range or ranges to be cleared and click-on "CLEAR" and click-on "OK". The vertical calibration will be cleared from the selected range or ranges.

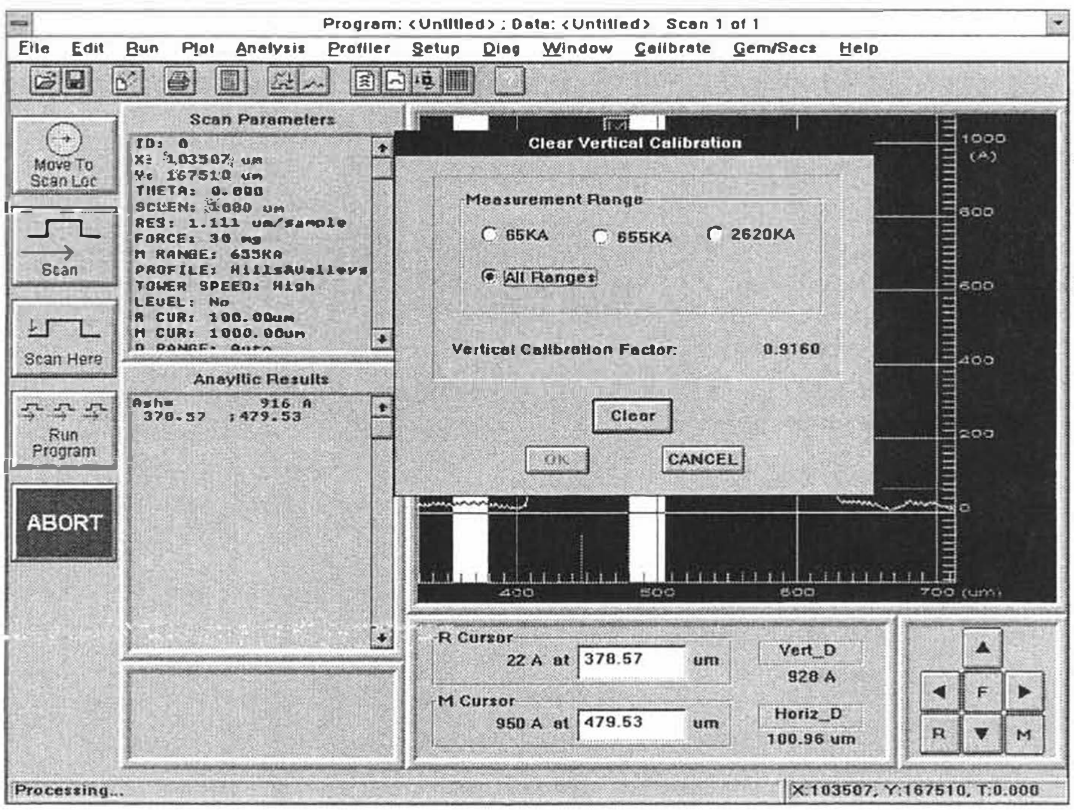


Figure 10-5. Clear Vertical Calibration Dialog Box

THETA CALIBRATION

The calibration procedures described in the next few pages calibrate the DEKTAK V 200-Si for Deskew and machine-to-machine compatibility. The theta and X,Y calibration selections are as well as the find center of the stage rotation procedure can all be accessed from the Calibration Menu.

Select "Calibrate Theta" to set Encoder Counts per degree of theta stage. The default value is 1000 and can be reset by selecting the "Reset" button. The procedure is described below.

1. Select "JOG TO X0,Y0" then jog to a point. The tower will null when you click to stop jogging. Repeat this process until the point is accurately selected.

2. Select "Rotate 360". The stage will rotate approximately 360 degrees. If it rotated exactly 360 degrees we would be back to the start point. Most likely we will be off.

3. Select "Rotate -" or "Rotate +", dependent on having gone to far or not far enough, respectively, until the reticule is again aligned with the start point. The degrees off and encoder counts/degree will be displayed.

4. Select "OK" to accept the new value or cancel to keep the old. In either case the stage will rotate back to 0.

5. The accuracy of the calibration can be checked by again selecting the "Calibrate Theta" menu, and the selecting "Rotate 360", this time the stage should wind up exactly back at the start point after the rotation.

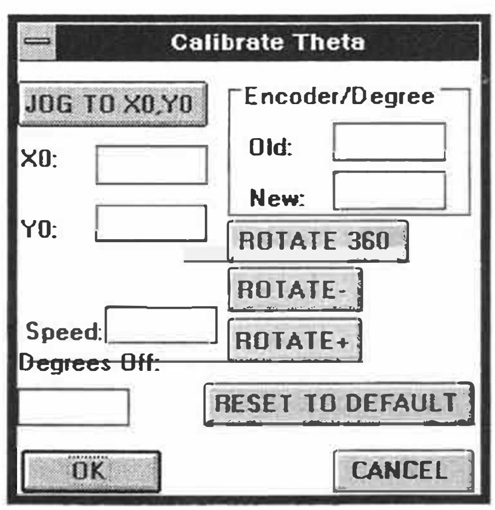


Figure 10-6. Theta Calibration Dialogue Box

SET AXIS CORRECTION FACTOR

Select this menu to calibrate the angle between the X and Y axes. The default is 90 degrees and can be set by selecting "Reset to Default". The calibration procedure is described below for both motorized and programmable theta.

1. If using the programmable AutoTheta, select "Jog to X0,Y0" to position to the intersection of a pair of straight lines known to be at 90 degrees to each other (orthogonal). The tower will null when you click to stop jogging. Repeat until the point is accurately selected.

2. Select "Jog to X1,Y1" to position to the end point of the horizontal line.

3. Select "Rotate". This will rotate the stage so that the selected line is horizontal. The stage will move back close to X0,Y0.

If using motorized theta, the line can be made horizontal by using the "Slew Stage" operation under the "Profiler Menu".

Now that a horizontal line has been established.

1. Select "Jog to X0,Y0" to move back to the intersection. Again the tower will null when you click to stop jogging. Repeat until the point is again accurately selected.

2. Select "Jog to X2,Y2" to position to the end of the vertical line. The tower will null when you stop jogging. Repeat until the point is accurately selected. The angle between the axes will be displayed.

3. Select "OK" to accept the value, "CANCEL" to quit without changing the correction factor.

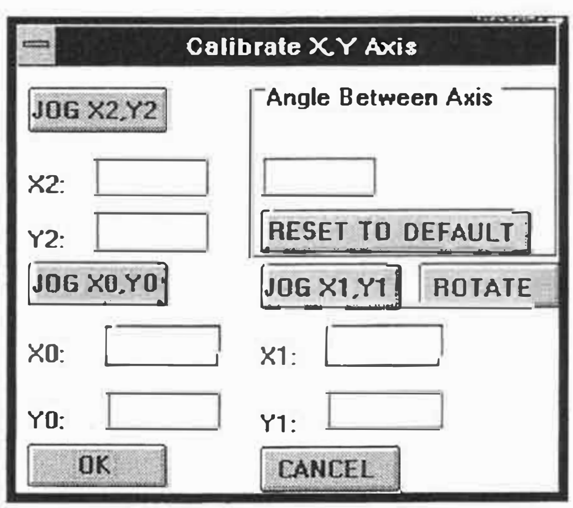


Figure 10-7. Calibrate X,Y Axis Dialogue Box

FIND CENTER OF ROTATION OF STAGE

1. Select "Jog to X0,Y0" to select a point which you will be able to easily re-identify once the stage is rotated 180 degrees. The tower will null when you stop jogging. Repeat until the point is accurately selected.

2. Select "Rotate 180".

3. Select "Jog to X1,Y1" and find the same point as in step 1. Again, repeat until the point is accurately selected. The center of rotation of the stage will be the mid point of the line segment connecting X0,Y0 with X1,Y1.

4. Select "New center" to use this value as the center.

5. Select "Go to Center" to move to the center.

6. Adjust the sample under the stylus so that an easily identifiable point comes into the field of view.

7. Repeat steps 1 through 5. This time the selected point should stay within the field of view because it is close to the center. If it is not, pick a point closer to the center or adjust the sample so that the point is closer to the center.

8. Visually identify a point close to the center. Select "Rotate 180" and watch the point as it moves around the supposed center. It should maintain a constant distance from the center as it rotates. If it does not, repeat from step 7, except selecting "Average Center" instead of "New Center", until you are satisfied that the point you pick is maintaining a constant distance from the center as it rotates.

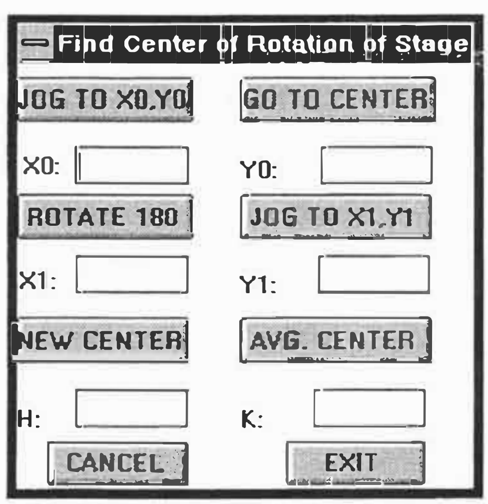


Figure 10-8. Find Center of Rotation of Stage Dialogue Box

ANTI-BACKLASH ALGORITHM

For optimal repeatability in stage positioning, stage locations should always be selected from the left. I.e, move the stage to the left of the position desired and then approach the position from that side before selecting it. When the stage is automatically positioned for scanning, if the anti-backlash algorithm is enabled, the location will be approached from the left also. This eliminates repeatability errors due to backlash in the gears.

1. To enable the anti-backlash algorithm, select "Setup" from the menu bar. The DEKTAK V 200-Si Setup Menu will be displayed.
2. Select "Set X Backlash Parameter" from the Setup Menu. The X Stage Backlash Parameter dialogue box will be displayed (see Figure 10-9).
3. Enter a backlash distance in the "Distance" field. A value of 1000 is suggested. (Enter 0 to disable the algorithm.)
4. The speed and acceleration values should be left alone. Select "OK" to enter the backlash parameters.

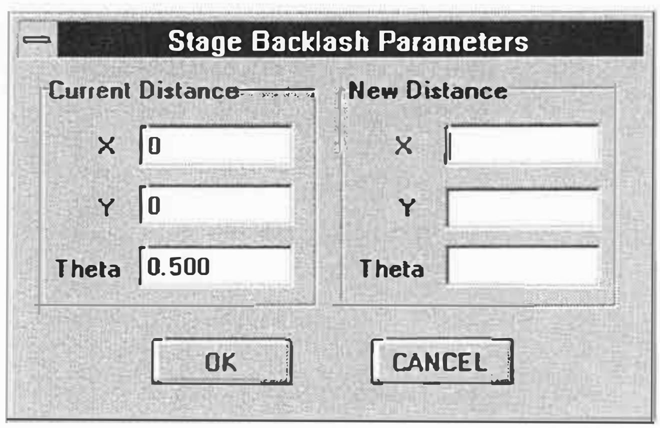


Figure 10-9. Stage Backlash Parameters Dialogue Box

CHANGING THE TIME AND DATE

The DEKTAK V 200-Si has an internal clock which keeps the time and date. Whenever a printout is produced of the scan data or the scan data summary, the time and date are recorded on the printout. Resetting the clock is accomplished in the MS-DOS executive window. The procedure for setting the time and date is described below.

1. Exit the DEKTAK V 200-Si application by clicking-on the System Menu Box located in the uppermost left corner of the screen. Click-on "Switch To" from the system menu and double click-on "Program Manager". The program manager will be displayed.

2. If the main menu is not displayed, double click-on the "Main" menu icon.

3. Double click-on the "Control Panel" icon from the Main Menu and the control panel will be displayed (see Figure 10-10).

4. Double click-on on the "Time/Date" icon. To change the time or date, click-on the item to be changed (for example, minutes). The item will be highlighted and arrows will be displayed to increase or decrease the number.

5. Once the desired time and date is set, click-on "OK" and click-on the control panel menu box and click-on "Close."

6. To return to the DEKTAK V 200-Si application, click-on the System Menu Box and click-on "Switch To" and double click-on the DEKTAK V 200-Si application.

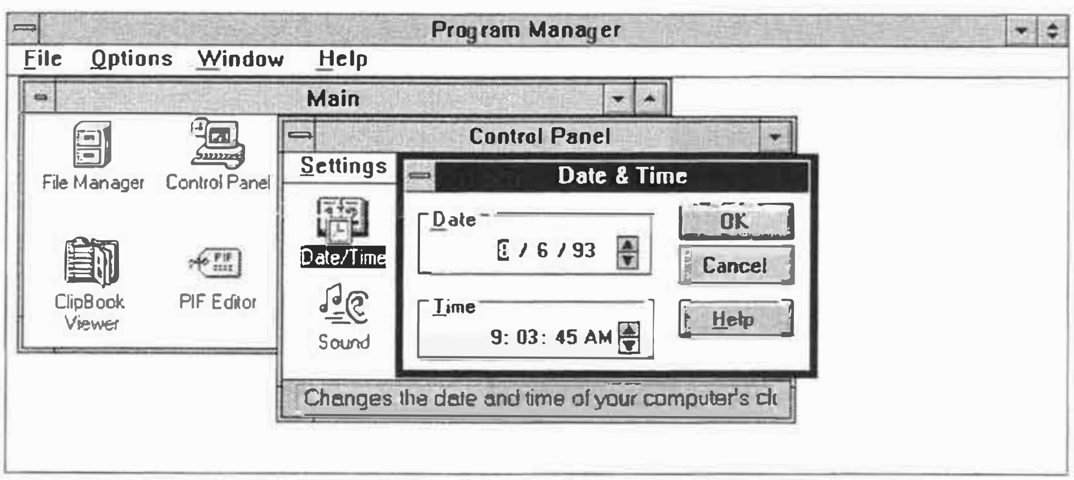


Figure 10-10. Time and Date Control Panel

FORMATTING A DATA DISK

DEKTAK V 200-Si Automation Programs and Scan Data Files can be stored on external micro disks rather than on the hard disk drive. The DEKTAK V 200-Si "A" drive is a 3½ inch diskette drive. An optional 5¼ inch floppy disk drive is available, which can be used as the external or "E" drive. Before a diskette can be used, it must be formatted. The procedure for formatting a 3½ inch diskette in the DEKTAK V 200-Si "A" drive is described below.

1. Exit the DEKTAK V 200-Si application by clicking-on the System Menu Box, and clicking on "Switch To" and double click-on "Program Manager".
2. If the main menu is not displayed, double click-on the "Main" menu icon.
3. Double click-on the "File Manager" icon from the Main Menu. The File Manager will be displayed.
4. Click-on "Disk" from the File Manager menu bar and click-on "Format Disk" from the disk menu. A dialog box will be displayed for selecting the disk drive. Insert a new 3½ inch diskette into drive "A" located in the upper left corner of the DEKTAK V 200-Si computer console.
5. Select disk drive "A" and click-on "OK." The diskette inserted into drive "A" will be formatted.

CAUTION

Formatting a disk erases any data that currently exists on the disk.

DELETING FILES

Automation Program Files and Scan Data Files can be deleted from the hard disk from the File Manager.

1. Switch to the File Manager from the Dektak V 200-Si application by following the procedure described above in steps 1-3. File Manager will be displayed with a listing of the saved files. Click-on the desired file to open it.
2. Click-on the file to be deleted, the selected file will be highlighted.
3. Click-on "File" from the menu bar, and click-on "Delete" from the File Menu. A dialog box will display the file to be deleted. Click-on "OK" to delete the file.
4. Once the desired files have been deleted, return to the Dektak V 200-Si application clicking-on the System Menu Box and clicking-on "Switch To" and double clicking-on the DEKTAK V 200-Si application.

STYLUS REPLACEMENT

All DEKTAK V 200-Si styli have the same shank size. They differ only in the radius of the diamond tip. The procedure to remove and/or replace a stylus is described below.

CAUTION

The stylus suspension system is delicate.

1. Click-on "Stylus" and click-on "Tower Up" to raise the stylus and optics tower to the full up position.
2. The "Quick Release" stylus mechanism enables fast and easy stylus replacement. To remove the stylus, simply pull down on the stylus shaft (see Figure 10-11). The stylus is held in place magnetically.
3. To install a new stylus, position the stylus within the groove at the bottom of the sensor until the magnet locks it into position. Slide stylus all the back.
4. Use the stylus position adjustment knobs to align the video image of the stylus tip with the on screen reticule.

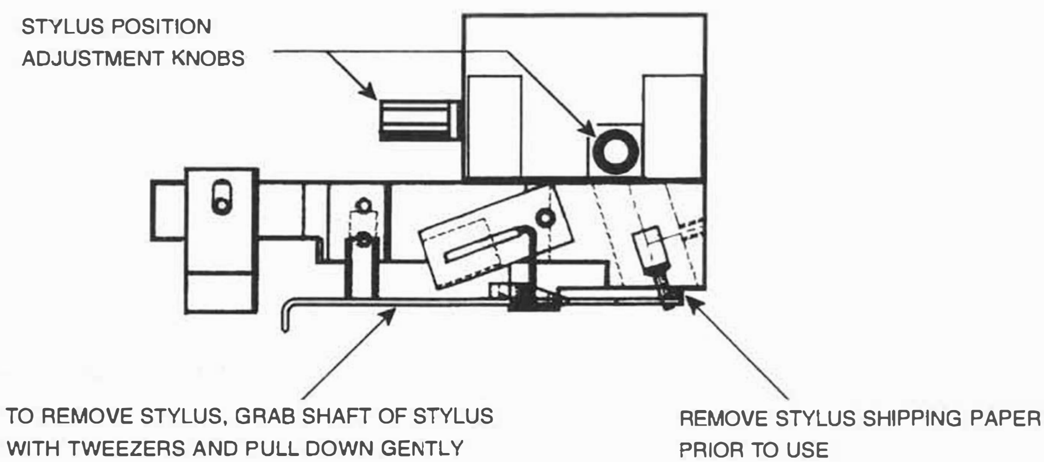


Figure 10-11. Low Inertia Sensor Head

ILLUMINATOR LAMP REPLACEMENT

CAUTION

Do not touch lamp while power is on. The bulb is extremely hot.

1. Click-on "Profiler" and click-on "Tower Up" to optics tower to the full up position.

2. Turn off the DEKTAK V 200-Si.

3. Remove the screw attaching the cover plate to side of the illuminator and remove the cover plate.

4. Pull the lamp straight out.

5. Place a new bulb in the socket and check the reference dimension. For optimum illumination, set the bulb filament parallel to the filter (see Figure 10-12). If the new lamp does not light, check the lamp wire connection at the rear of the optics bridge.

6. Replace the illuminator cover plate.

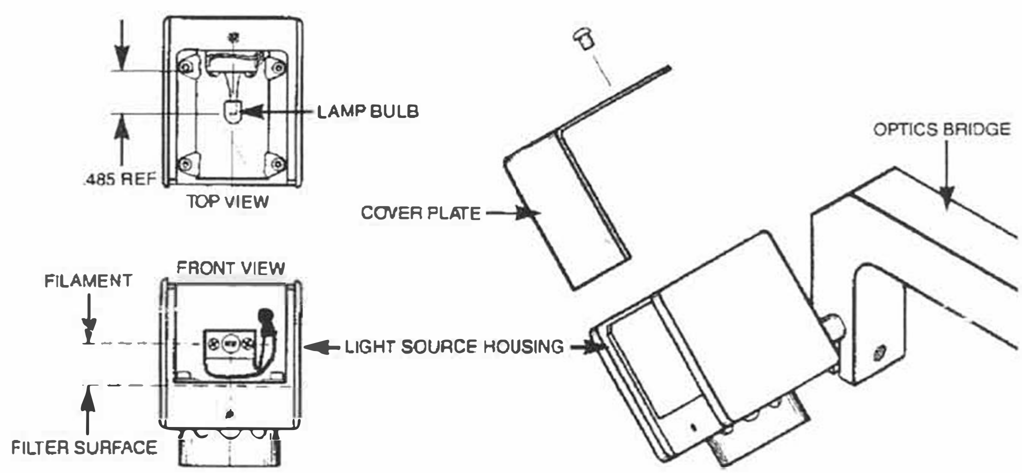


Figure 10-12. Illuminator Lamp Replacement

LEADSCREW LUBRICATION

Scandrives that are in clean rooms and being used many hours per day require fresh lubrication often. The maintenance personnel must determine the frequency of lubrication depending upon the amount of use. A little too much oil will not hurt as it can be cleaned up after it falls off the scandrive. This will not contaminate samples since this area is under the chuck.

On the other hand, if a leadscrew runs dry, the machine will hang up during homing or sample positioning; also, the leadscrew can be ruined and must then be replaced.

Grease on the scandrive rods is all right but, DO NOT get it on the leadscrew. Universal Leadscrew Oil (Sloan Part Number is 085280) is the only approved oil that can be used on the scandrive leadscrew. This oil can also be used on the Y and X drive leadscrews. Leadscrews that have been coated with teflon, will require periodic cleaning of the anti-backlash nut to remove the teflon residue (once a year).The scandrive rods require a light grease. DO NOT apply this grease to any leadscrew.

Suggested frequency for fresh lubrication based upon heavy use of a machine:

1. Scandrive leadscrew...............monthly
2. Scandrive rods.........................bi-monthly
3. X or Y leadscrews..................every 3 months

SERVICE CONTRACTS

To maximize equipment uptime and avoid major repairs, Veeco offers customized service contracts to meet customer needs. These contracts can be used to extend the one-year factory warranty. Service contracts include routine maintenance to keep the equipment up to factory spec.

For more information on service contracts, call the Veeco Service Center near you:

Santa Barbara, CA:	(805)963-4431
Plainview, NY:	(516)349-8300
Milpitas, CA:	(408)263-0700
Santa Ana, CA:	(714)631-6484

MAJOR REPAIRS

WARNING

The computer console and/or Video Monitor should NEVER be opened when connected to the primary power source. Major service should only be performed by qualified, factory trained, Veeco Service Engineers.

The DEKTAK V 200-Si cannot be readily repaired after major component failures without the assistance of specialized test equipment and software routines. In the event of equipment failure, please call the Veeco Service Center near you for assistance.

Before calling the Veeco Service Center, check the following:

1. Reboot the DEKTAK V 200-Si by first closing the Windows application and turning the system off, and then turning the power back on.
2. Are all cables properly connected and free of obvious damage?
3. Is the power cord connected properly?
4. Is the sample illumination properly adjusted?
5. Does the stylus tower move up and down when "Tower Up" or "Tower Down" is clicked-on?

WARRANTY

All new catalog-listed standard equipment sold and/or manufactured under Veeco's labels, is warranted by Veeco to be free of defects in material and workmanship if properly operated and maintained. This warranty covers the cost of necessary parts and labor (including, where applicable, field service labor and field service engineer transportation) during the warranty period.

The warranty period is one (1) year.

Warranty period takes effect upon date of shipment. Except as excluded below, these warranties extend to parts which are manufactured by persons other than Veeco which are components of standard catalog items. Purchased equipment incorporated into any item supplied by Veeco will be covered by manufacturer's warranty.

Expendable items, including but not limited to styli, lamps, and fuses, are specifically excluded from the foregoing warranties and are not warranted. All used Equipment is sold on an "as is, where is" basis without warranty, express or implied.

Equipment made or modified to Purchaser's specifications on special order shall carry the above warranties with respect to material and workmanship, but shall be specifically excluded from any other warranties, express or implied, including those related to performance specifications, and any special components shall only carry the original manufacturer's warranties.

Warranty Claims

Veeco's obligation under these warranties is limited to repairing or replacing at Veeco's option defective non-expendable parts. Veeco's obligation shall not extend to defects that do not impair service. No claim will be allowed for any defect unless Veeco has received notice of the defect within thirty days following its discovery by Purchaser.

Claims for Shipment Damage

No claim will be allowed for Equipment damaged in shipment sold under standard terms of F.O.B. Factory. Within thirty days of Purchaser's receipt of Equipment, Veeco must receive notice of any defect which Purchaser could have discovered by prompt inspection of Equipment. In any event, Veeco shall have the option of inspection at Purchaser's premises or at Veeco's plant, before allowing or rejecting the claim.

Warranty Eligibility

To be eligible for the above warranties, Purchaser must perform preventative maintenance in accordance with the schedule set forth in the Operation and Maintenance Manual provided. Veeco assumes no liability under the above warranties for Equipment or system failures resulting from improper operation, improper preventative maintenance, abuse or modifications of the equipment or system from the original configuration.

NOTE

This warranty is in lieu of all other warranties, expressed or implied and constitutes fulfillment of all of Veeco's liabilities to the purchaser. Veeco does not warrant that the system can be used for any particular purpose other than that covered by the applicable specifications. Veeco assumes no liability in any event, for consequential damages, for anticipated or lost profits, incidental damages or loss of time or other losses incurred by the purchaser or any third party in connection with systems covered by this warranty or otherwise.

Service

Field Service is available nationwide. Service and installations are performed by factory trained Veeco service engineers.

Contact the Veeco Surface Metrology sales/service office, for prompt service.

WESTERN REGION

Veeco Surface Metrology
602 East Montecito St.
Santa Barbara CA 93103
Attn.: Service Center
Phone: (805)963-4431
Fax: (805)965-0522

EASTERN REGION

Veeco Instruments Inc.
Terminal Drive
Plainview, NY 11803
Attn.: Service Center
Phone: (516)349-8300
Fax: (516)349-8321

APPENDIX A

DEKTAK V 200-Si OPTIONS, ACCESSORIES AND REPLACEMENT PARTS

OPTIONS

Item	*Description*	*Part No.*
Stress Measurement Software	Can calculate tensile or compressive stress on processed wafers. Includes special fixturing for three-point suspension of wafer.	508908
Extended Optics	85X to 550X.	044230
Remote Keyboard	Standard PC/AT 101 keyboard used in place of integral keyboard.	010074
SECS/GEM	Allows two-way communication between the DEKTAK V 200-SI and a host computer.	508869
Motorized Focus	Motorized variable focus for high magnification applications.	516906
DekMap 2	3-D image rendering software.	508941
DekMap 2 Workstation	Includes Pentium computer with DekMap 2 software and 17" monitor.	508948
Pattern Recognition	Cognex automatic alignment system.	563150

ACCESSORIES

Item	*Description*		*Part No.*
	Color Code	Size	
Styli	Black	25 micron radius	665105
	Red	12.5 micron radius	665104
	Orange	5 micron radius	665103
	Gray	2.5 micron radius	665102
	Green	Sub-micron radius	665101

Item	*Description*	*Part No.*
Calibration Standards Set	Five Calibration Standards. Sloan certified nominal 200A and 500A, and NBS traceable nominal 1KA, 5KA, and 50KA measurements. May be used with all Stylus Profilers. Includes a Certificate of Calibration and Hardwood Case.	138375
Individual Calibration Standards	Nominal 200A measurement	138365
	Nominal 500A measurement	138366
	Nominal 1KA measurement	138367
	Nominal 5KA measurement	138368
	Nominal 10KA measurement	138369
	Nominal 50KA measurement	138370
	Nominal 100KA measurement	138371

Factory Recertification of Sloan Calibration Standard(s) available.

Item	*Description*	*Part No.*
VLSI Calibration Standards	Nominal 180A measurement	085350
	Nominal 440A measurement	085351
	Nominal 880A measurement	085352
	Nominal 4500A measurement	085353
	Nominal 9400A measurement	085354
VLSI Roughness Standards	90A (0.354um)	085370
	220A (0.866um)	085371
	440A (1.732um)	085372
	2250A (8.858um)	085373
	4700A (18.504um)	085374
	Complete set (90A, 220A, 440A, 2250A, 4700A)	085360
Printer Paper	OmniPrint 426 Model	085542
	All other Omni Models	085549
Clean Room Paper	All Omni Models	085556
Sample Illuminator Lamp	Replacement Bulb	140229
Leadscrew Lubricant	1/3 Fluid Oz.	085280

APPENDIX B

STRESS MEASUREMENT

DESCRIPTION OF STRESS

The stress algorithm creates a *stress curve*, made up of stress values for every data point on the scan trace. If a pre-stress scan data file was saved, then the calculation proceeds (on all the scan data points) as follows:

1. The pre-stress scan data is loaded and smoothed using a running average with a window size of 1/10 the scan length.
2. The smoothed data is further smoothed using a piece wise third order polynomial interpolation technique.
3. The curvature trace is derived from the first and second derivatives of the smoothed data trace.
4. Steps 1-3 are then applied to the post stress scan data, producing a curvature trace for the post stress scan data.
5. The stress curve is then computed from the curvature traces.
6. The maximum and average compressive and tensile stresses are calculated from the stress curve, and displayed in the Stress Results dialog box. Only those values of the stress curve between the cursors are considered.

Three-Point Substrate Suspension

To compensate for substrate deflection created by gravity or by a vacuum hold stage, the stress option kit provides three-point substrate suspension. Three .25 inch diameter steel ball bearings are used to suspend the substrate above the stage surface. These ball bearings are inserted into the tap holes on top of the stage. A magnet is also provided for removing the ball bearings from the stage.

Stress Reference

Prior to calculating stress, a reference must be established. Stress can either be calculated using a straight line as the reference, or by producing a preliminary reference scan on the sample prior to processing. In order to accurately measure stress, the reference scan and the scan produced after thin film deposition, must have identical scan parameters, including cursor locations (stress is computed on the data between the reference and measurement cursors). For this reason, it is recommended that the scan parameters used to produce the original reference scan be saved in an Automation Program file to be used after deposition.

Once the reference scan is produced, it must be saved in a data file. The data file is then used as the reference for comparison and stress calculation.

IDENTIFYING SUBSTRATE CHARACTERISTICS

To program stress, first, position the R and M cursors to enclose that part of the scan trace over which to collect stress statistics. If a reference scan is being used to compute stress, then the same scan parameters used to produce the reference scan must be used to produce the scan on the substrate after deposition. Whether the default straight line reference or a reference scan is being used to calculate stress, the substrate must also be scanned after thin film deposition. Once the scan has been produced on the substrate after deposition, the characteristics of the substrate being measured for stress must be entered into the stress calculation.

1. Run the scan on substrate after deposition. The scan will be plotted.
2. Click-on "Analysis" from the Data Plot screen menu bar.
3. Click-on "Compute Stress" from the Analysis Menu. The stress dialog box will be displayed (see Figure B-2).
4. The "Thin Film Substrate" portion of the stress dialog box displays the material, orientation, and elasticity of the thin film substrate. Several options are stored in memory to compute stress in a variety of applications. To view the preprogrammed thin film substrate selections click-on "Options." The Options menu will be displayed (see Figure B-1).
5. Click-on the thin film substrate to be measured for stress and click-on "OK."

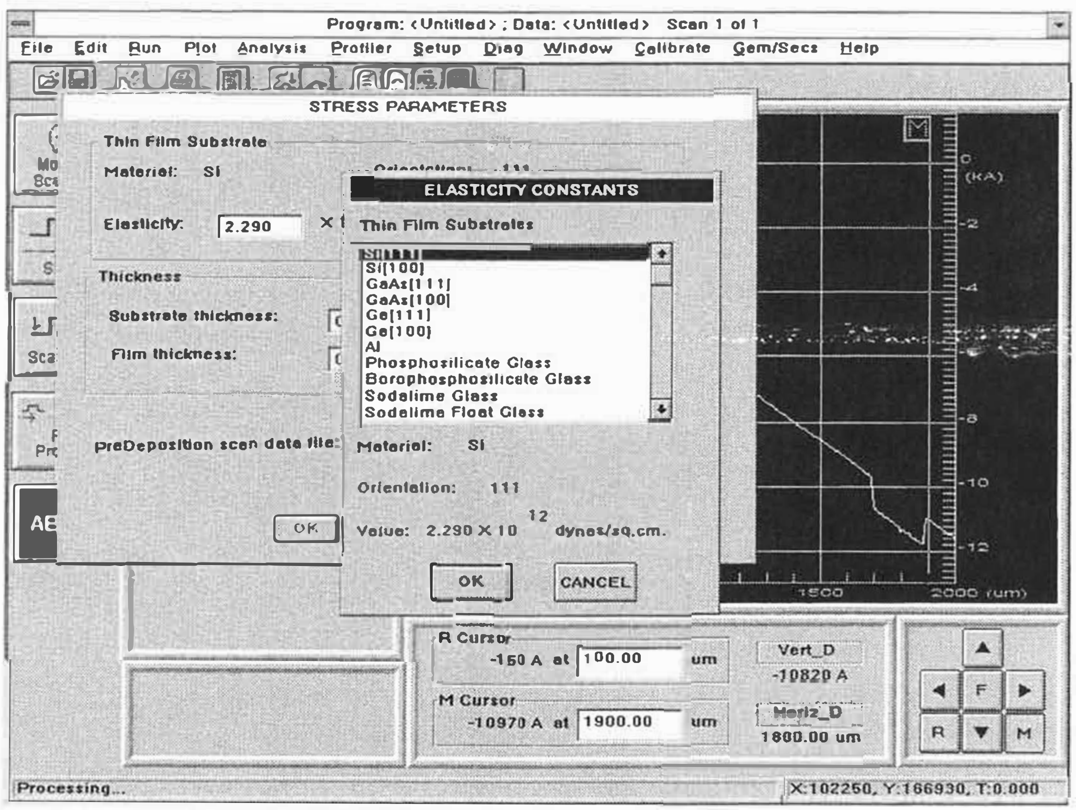


Figure B-1. Stress Options Menu

ENTERING STRESS PARAMETERS

Once the substrate material and orientation has been identified, the other stress parameters can be entered.

1. If the elasticity of the substrate is known to be different than the value displayed in the box labeled "Elasticity," click on the box and enter the correct value.

2. Click-on the box labeled "Substrate Thickness" and enter that value in microns.

3. Click-on the box labeled "Film Thickness" and enter that value in microns.

4. If the stress is to be measured against the default straight line reference click-on "OK" and the stress result will be displayed.

5. If the stress is to be measured against a reference scan produced earlier and saved in a data file, click-on the box labeled "Stress Data File." Enter the file name under which the reference scan profile data was saved and click-on "OK." Stress will be computed and the stress result window will be displayed (see Figure B-3).

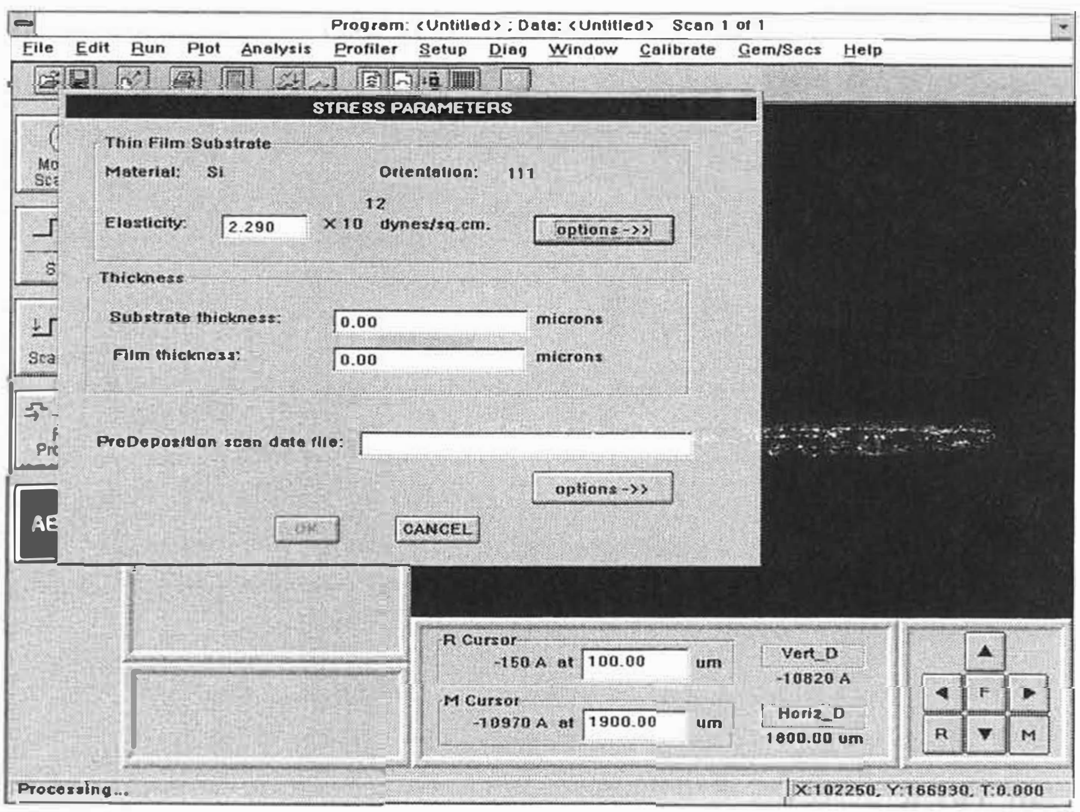


Figure B-2. Stress Measurement Dialog Box

STRESS RESULTS

The statistical results are displayed in the Stress Results dialog box. These results can be viewed at any time after stress has been computed by selecting the Analysis menu from the DataPlot window and selecting "Stress Results" item.

A print out of stress results can be obtained by either selecting the PRINT button from the Stress Results dialog box or as part of the Scan Data Summary print out.

Upon the completion of the stress computation, the stress and smoothed scan data traces are shown. Whenever a stress curve is displayed, the vertical scale changes from Angstroms to Dynes/cm^2. The following types of stress plots can be selected from the Stress Curves dialog box obtained from the Plot Menu in the Data Plot screen by selecting the "Stress Curves" menu item:

1. *Pre stress scan data, curve fit, and stress.*
   Scan data curve plotted in white, curve fit in cyan, stress curve in green.

2. *Post stress scan data, curve fit and stress.*
   Scan data curve plotted in white, curve fit in cyan, stress curve in green.

3. *Pre and Post stress curves, and stress difference curve.*
   Post stress scan data curve in white, pre stress curve in cyan, post stress curve in green, and stress difference curve in orange.

4. *Remove all stress curves.*
   Removes all stress and curve fit curves, and restores the vertical scale to Angstroms.

Constraints and Limitations

1. The stage should be hardware leveled, and in the same leveled position for both the pre and post stress scans.

2. Both pre and post stress scans must have the same number of data points. That is, don't abort either scan before completion.

3. The algorithm will work best on a flat wafers. Surface features will throw off the curve fitting algorithm, and produce invalid maximum stress values.

APPENDIX C

DEKTAK V 200-Si AUTOLOADER INSTALLATION AND OPERATION INSTRUCTIONS

The DEKTAK V 200-Si cassette to cassette AutoLoader provides automatic transfer and orientation of wafers up to 200mm (8"). Single cassette and dual cassette configurations are available.

INSTALLATION

Once the loader is unpacked and connected to the Dektak V 200-Si, the air and vacuum lines must be connected and the system leveled.

Air Pressure and Vacuum

If the AutoLoader is to be located in front of a wall, be sure to leave enough room (about two feet) between the wall and loader for easy access to the air pressure and vacuum connectors before moving the loader to its permanent location.

Air Pressure

The Dektak V 200-Si with AutoLoader is built upon a vibration isolation table and requires no less than 100 psi. to operate properly. The air pressure connector is located on the back side of the loader. Connect the external air pressure using a 1/4" dia. hose by simply pushing it straight in and then pulling back to make sure the hose is secure. The air pressure may now be turned on. Allow at least 5 minutes for the isolation table to fully engage.

Air Vacuum

The loader robot and vacuum chuck require no less than 24 inches Hg. of vacuum. The air vacuum connector is located on the back side of the loader. Connect the external air vacuum using a 1/4" dia. hose by simply pushing it straight in and then pulling back to make sure the hose is secure. The air vacuum may now be turned on.

Leveling

When the unit is moved to its permanent location it must be leveled to insure proper vibration isolation. Place the level on the robot mounting plate as close to the center of the machine a possible. Use a wrench to turn the blots located on the bottom side of each frame leg clockwise until the wheels lift off the floor. Check the level to see witch leg needs more or less adjustment. When the table appears level, check each corner of the table by pushing down gently. If the table is not floating freely on each corner, more adjustment may be necessary.

OPERATION OVERVIEW

Loader Program files permit a number of cassette configurations to be programmed and stored on the hard disk. The user can create a program to use a single cassette to transfer up to 25 samples, a double cassette to transfer up to 50 samples, or cassette to cassette to get substrates from the first cassette and put back in the second cassette.

The Dektak V 200-Si Scan head can be used with or without the AutoLoader. When the machine is first powered up, the Programmable Sample Stage moves to the robot load position. The user can ignore the loader and use the Scan head by itself by picking "Unload" from the menu. This will move the Programmable Sample Stage to the front for manual loading.

NOTE

The stage should be as level as possible before using the AutoLoader. If a mistake is made in the leveling process, every attempt should be made to level the stage before using the AutoLoader. Run a Loader Test program before running an automation program with the AutoLoader. Do not attempt to run a loader program until the scan stage is properly leveled.

CREATING A LOADER PROGRAM

Before running the AutoLoader, a loader program must be created to reflect the current conditions. An Auto Load program can be set up in three different configurations:

Single Cassette

The standard Auto Loader is set up with a single cassette. Substrates are taken from the cassette and placed on the Prealigner. After the substrate is aligned, it is placed on the profiler scan stage. when the automation routine is finished, the substrate is placed back in the cassette.

Double Cassette

The double cassette configuration is identical to the single cassette configuration, but allows you to process up to 50 substrates at a time. the loader routine starts on cassette #1 and finishes on cassette #2.

Cassette to Cassette

The Cassette to Cassette routine takes the substrates from cassette 1, lower most position, prealigns the substrate and puts the substrate on the profiler scan stage. When the automation program is done, the robot removes the substrate from the scan stage and puts the substrate in cassette 2 in the highest most position. This routine is ideal for clean operations.

SETTING UP A SINGLE CASSETTE LOAD PROGRAM

Using the track ball, click on "Window" in the menu bar and select "Program Loader". The Loader Program dialogue box will be displayed (see Figure E-1). This window provides several selections for setting up the system. The Loader Program window is described below.

Cassette 1

This selection controls the activity of cassette 1. Clicking on the slot numbers will activate or deactivate those slots.

Cassette 2

This selection controls the activity of cassette 2. Clicking on the slot numbers will activate or deactivate those slots.

Cassette Config

Select: SINGLE CASSETTE, DOUBLE CASSETTE or CASSETTE TO CASSETTE for desired loader routine.

Substrate Size

The sample size is set at the factory and can not be changed by the user at this time. Call Veeco/Sloan Technology customer service for assistance.

Substrate Shape

This selection does not apply to flat panels and therefore can not be accessed.

Print Final Process Status

When this item is selected, the printer will print a report of the loader status at the end of a loader routine, or after the program has been aborted.

Display Process Status

Display Process Status provides a graphic representation of the loader status during a loader program: **NO** - Status will not be shown at any time. **ALWAYS** - shows the status during loader operation and turns off during the scanning process. **AFTER EACH SUBSTRATE PROCESSED** - shows the status only after a substrate has been processed and for a specific amount of time. **AFTER FINAL SUBSTRATE PROCESSED** - shows the status only after the last substrate is processed and for a specific amount of time. **DISPLAY DURATION** - allows the user to specify the amount of time to display the status when "AFTER EACH SUBSTRATE PROCESSED" or "AFTER FINAL SUBSTRATE PROCESSED" are activated.

TUTORIAL

The default setup shows cassette 1 fully loaded with 25 samples and cassette 2 with none. "Cassette Configuration" is set at 1 cassette, and "Display Process Status" is set to always. For learning purpose we will create a program to process five substrates. Go to the "CASSETTE 1" column and click on the "CHECK NONE" bar. This will make it easier to check on only five positions instead of checking off 20 positions. Now click on positions 1 through 5. All the other parameters are preset to the configuration we need. Now you can save this program.

Saving a Program

To save a new or modified loader program, click-on the "SAVE PROGRAM" button. A new window will appear with a list of existing programs. You can choose one of these or save as a new program by typing in a new name. When finished, click on "OK" The new program is now saved to the hard disk. The "LOADER PROGRAMS" window will reappear. When you are finished, click on "DONE". The loader is now ready to run a loader program with your current scan automation program.

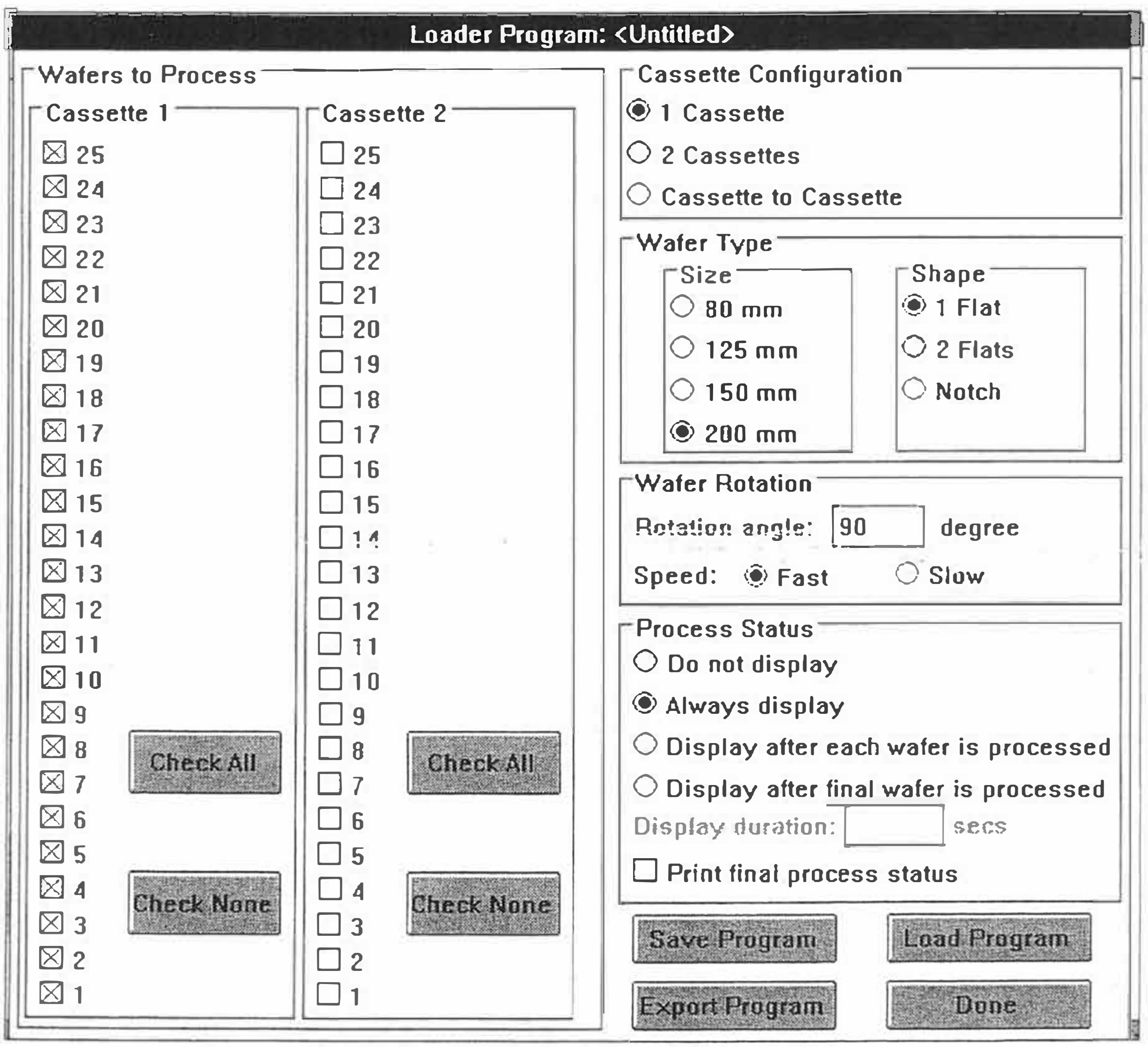


Figure C-1. Loader Program Dialogue Box

LOADER PROCESS STATUS

To view a graphic representation of the current loader program, click on "Window" in the menu bar and Select "LOADER PROC. STATUS". A window will appear showing the current loader setup. This window can be made smaller and moved around to make a resized "DISPLAY PROC. STATUS" window by using standard Windows techniques.

Setting Up a Double Cassette Load Program

Setting up a double cassette load program is identical to setting up a single cassette program with the exception of clicking on "DOUBLE CASSETTE" in the "CASSETTE CONFIG" menu and adding substrates to the Cassette 2 column.

Setting Up a Cassette To Cassette Load Program

Setting up a cassette to cassette program is similar to setting up a double cassette program. For example, to setup a five substrates cassette to cassette program, you must click on the five slots to be processed in the cassette 1 column and then click on any five slots in the cassette 2 column. It is not necessary to click on the same five slots for cassette 2, but you must have at least 5 slots selected.

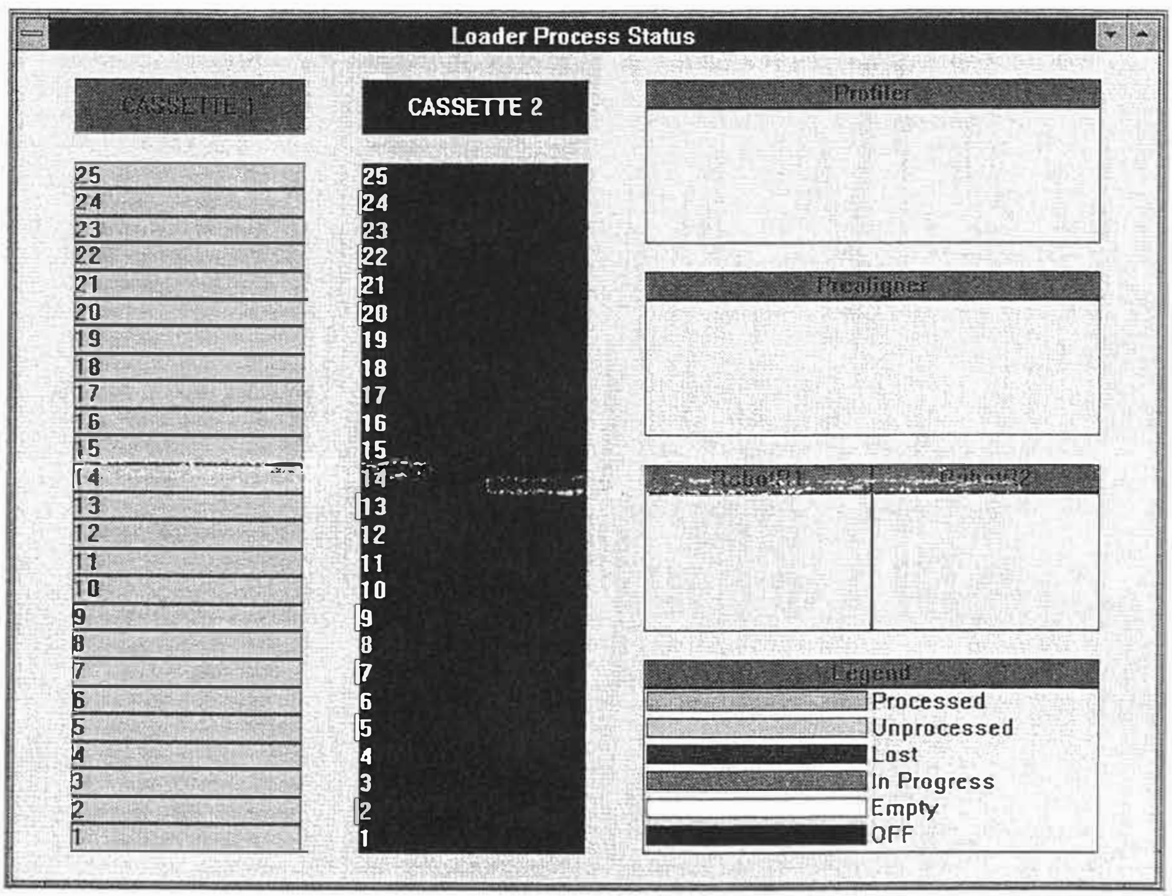


Figure C-2. Loader Process Status Window

RUNNING A LOADER PROGRAM

Run Loader Program Test

The user can run the current loader program without running a scan routine by clicking on "RUN" in the menu bar and picking "RUN LOADER PROGRAM TEST". This allows the program to be check without waiting for a scan.

Run Loader Program

To start a loader program with the current scan automation program, click on "RUN" in the menu bar and pick "RUN LOADER PROGRAM". The loader program will immediately start.

Aborting a Loader Program

A loader program can be aborted at any time by hitting the "ABORT" key on the profiler key panel, or by hitting the "A" key on the external keyboard. All process will stop and the robot will go to it's home position. The user can use this time for several things;

1. Modify the scan automation program, check the magazine tray, etc., then resume with the program. To resume a program, click on "RUN" in the menu bar and pick "CONTINUE". The program will continue from the same point it was aborted at.

2. Completely abort the scan and loader programs. After clicking on the "LOADER PROGRAM ABORTED" message, click on "RUN" in the menu bar and pick "RECOVER LOADER". This tells the machine to find all substrates still left in the loader process and to put them back in the cassette.

Running the Last Loader Program

To run the last loader program, click on "PROGRAMS" in the menu bar and pick "LOADER PROGRAM". The last program will be displayed. Click on "DONE" to reset the last program and start the program as before.

RECOVER LOADER

After picking "RECOVER LOADER", the scan stage will move to the robot load position and the "LOADER OPERATION" window will appear.

This window will show the current status of the loader program. Check to make sure the information in the window reflects the true current status. If all information is correct, click on "GO" and the robot will put the substrates back in the cassette, starting with the last substrate to enter the load process. Keep clicking on "GO" until the last substrate is back in the cassette. When all substrates are back in the cassette, click on "DONE" to exit "RECOVER LOADER".

Incorrect Status

The "RECOVER LOADER" program will no allow you to move a substrate to a location it believes is already occupied by another substrate, and it also will not pick up a substrate if it believes there is no substrate present. The user can override the program by using "GO OVERRIDE". For example, if the substrate is on the Pre-aligner but the loader status shows the substrate on the loader arm 1, the user must click on "GO OVERRIDE" to force the robot to carry out the command. Always make a visual check of the situation before using "GO OVERRIDE". Attempting to move a substrate to a location that is already occupied will result in damage to the substrate and robot.

WARNING

Never turn off the machine and/or vacuum when the robot still has a substrate on the arms. This may result in damage to the substrate. Use "ABORT" sparingly to avoid creating difficult or confusing situations.

Recover Loader Used as a Utility

Recover loader can be used as a utility to move substrates manually. This is helpful when checking to see if the profiler scan stage is level enough to work well with the loader.

For example, if the user wants to move the third substrate from cassette 1 to the profiler scan stage, click on "RUN" in the menu bar and select "RECOVER LOADER". When the Loader Operation window appears, click on "CASSETTE 1" and type in slot "3" in the "GET SUBSTRATE FROM" box. Next, click on "PROFILER" in the "PUT SUBSTRATE TO" box and click on "GO" to start the process.

When the substrate has been put on the profiler stage, click on "DONE". The profiler can be used to move the stage, start a scan, etc. When finished, click on "RECOVER LOADER" in the "RUN" menu again and click on "GO" to return the substrate to it's original location.

APPENDIX D

3-D RENDERING OPTION

DEK-MAP II, the Dektak Rendering Option is an add-on software package that allows Dektak surface profiler customers to view and analyze data in 3 dimensions (X, Y, and Z), instead of only 2 dimensions (X and Z) that the current products provide. Dektak surface profilers collect 3D data through the use of mapped scans. The mapped scan data is then converted into data files that are usable to both the standard Dektak analysis routines, and the 3D rendering package.

Overview

DekMap II, the Dektak Rendering Option will run as a stand-alone analysis tool on any computer that meets the system configuration specifications. As a stand alone application the program is called up by the user through one of the standard Microsoft Windows application starting mechanisms (double-clicking an icon, using a shortcut, etc.).

Recommended System Configuration to Run *DekMap II* Software

Hardware

486DX-66MHz to Pentium based IBM compatible PC with:

8 Megabytes of RAM (minimum)

100 Megabytes hard drive capacity

Microsoft compatible mouse or trackball pointing device

VGA Color subsystem capable of 800x600 pixels and 256 colors

VGA Color Monitor capable of 800x600 pixels

Software

Microsoft Windows 3.1 or Windows for Workgroups 3.11 under DOS 6.2 or greater or Microsoft Windows 95

The package will be network compatible based on the network compatibility of the underlying operating system. This typically includes remote file system storage and retrieval, along with remote printing.

SETTING UP A 3D MAPPING PROGRAM

In order to set-up a 3D mapping automation program, the area on the sample surface to be mapped must first be defined. This is accomplished by physically moving the sample stage to define the corners of the area to be mapped. The procedure for entering the mapping area from the sample positioning screen is described below.

1. From the sample positioning screen, position the sample so that the software reticule is located at one of the four corners of the area to be mapped.

2. Click-on "Edit" from the menu bar and click-on "Enter Map Area".

3. Using the software reticule as a reference, roll the trackball along the scan direction to determine the length of the scans used in the map, and click-on the left button of the trackball. Next, roll the trackball perpendicular to the scan direction and click-on the desired location to define the Y extent of the map. The Enter Scan Map Region dialog box will be displayed (Figure D-1).

4. To accept the scan length and Y extent, click-on "OK" from the Enter Scan Map Region dialog box. The Map Program dialog box shown in Figure D-2 will display detailed map parameters.

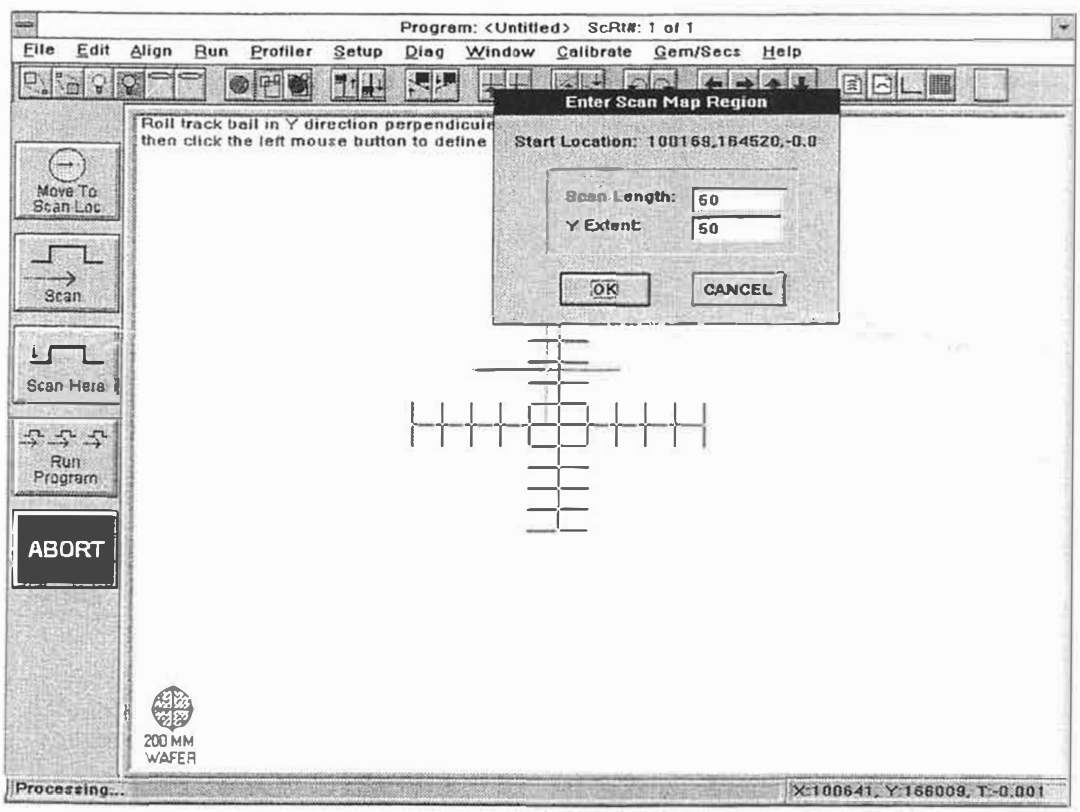


Figure D-1. Enter Scan Map Region Dialogue Box

ENTERING MAPPING PARAMETERS INTO AN AUTO PROGRAM

The Map Program dialog box shown in Figure D-2 contains the parameters for a 3-D map set-up in the previous step. Prior to running a 3D mapping program it is recommended that a mapping data filename be selected. Click-on the Mapping Data Filename "select..." button from the map program dialog box to enter the desired filename. To enter the filename and accept the map program parameters, click-on "OK".

The mapping parameters can also be changed via the dialog box to allow individual parameters to be altered as desired. In most instances the mapping parameters should be entered through the Sample Positioning Screen. Click-on the "Map Entry" button to go back to the Sample Positioning Screen.

The Map Program dialog box can be accessed at any time by clicking-on "Mapping Parameters" from the Automation Program screen field.

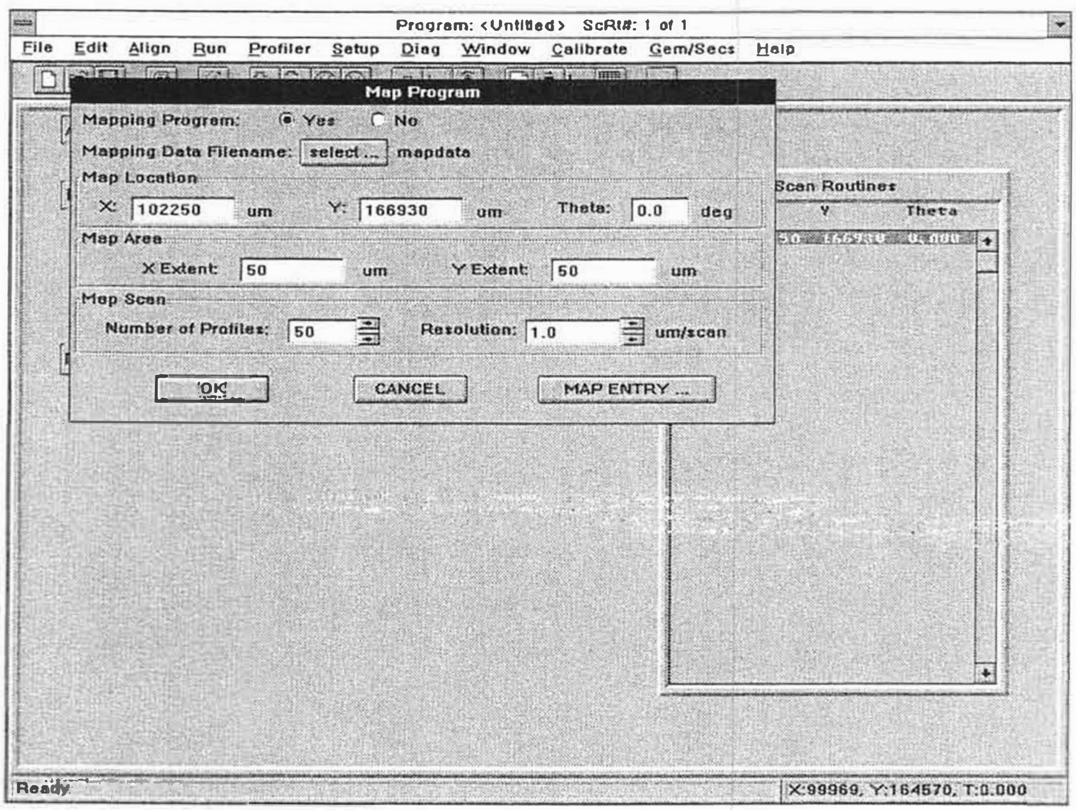


Figure D-2. Map Program Dialog Box

RUNNING A MAP PROGRAM

To execute a mapping program, simply run an automation program containing the desired mapping parameters.

1. To run the current automation mapping program, select the Run Menu and selecting the "Auto Program" menu item.
2. The current automation mapping program will be run. The Data Plot screen will be displayed and plot each scan in real time.
3. Once all the scans in the automation mapping program are complete, the 3D Projection Screen will be displayed with the three dimensional rendered image generated from the multi-scan mapping program.

The user can also select to have the image displayed as either a wire frame or scan line image, with Z color rendering. In this window the user is able to either scroll the Phi and Theta angles with a slide bar, or by directly entering in values for these angles. The image is instantly updated to reflect the users' selections.

At anytime, from the small screen, the user can enlarge the image with the standard MS-Windows Maximize button or command. When maximized the Z color rendered image fills the entire display. All previously selected user options, viewing angles, axis display options, are used when displaying the maximized image. The user is still provided with the Phi and Theta sliders on this screen.

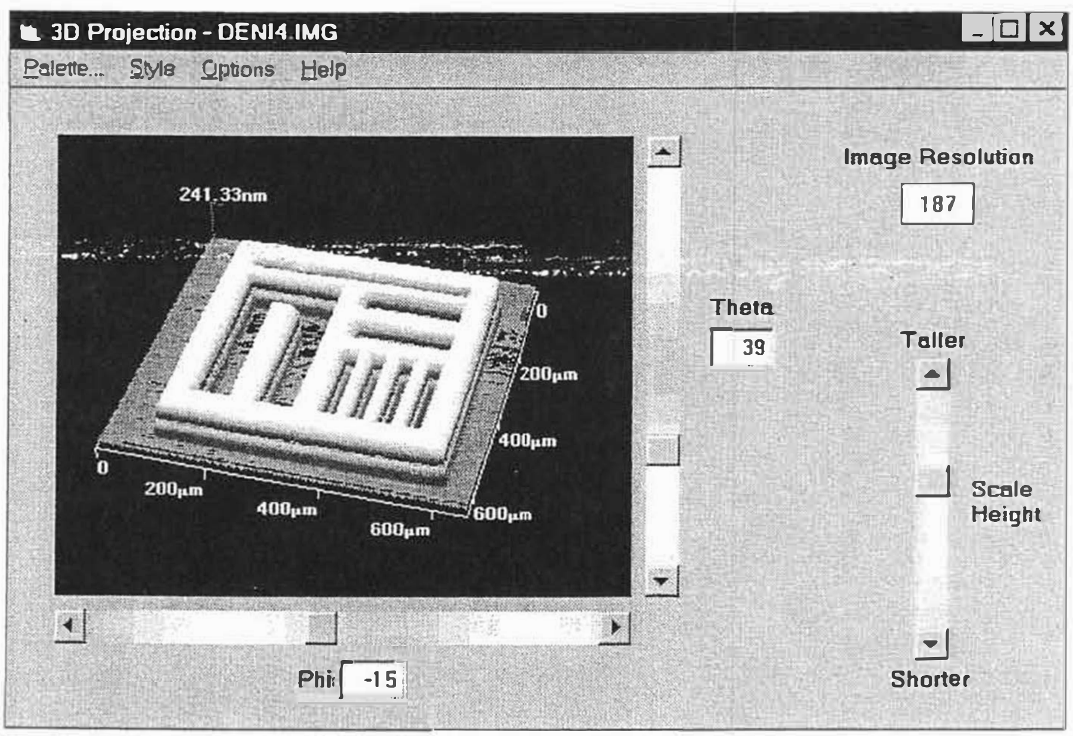


Figure D-3. 3D Projection Window

DEKTAK RENDERING OPTION SOFTWARE

The DekMap II icon is displayed in the lower left of the Data Plot screen once a mapping automation program has been run and the rendered image is displayed. Double clicking on the icon opens the Dektak Rendering Option software which permits additional data analysis.

Title Screen

Once started, the package will display a title screen that incorporates both a menu bar and a toolbar for command selection. The title screen will display the version number of the Dektak Rendering Option software that is currently running. The user then uses the title screen as a home base for performing data analysis, transformations, and image presentation.

File Open

The **File**, **Open** command opens a scanned image file, and transfers the data into a working data buffer (current data set) for use by the package. All data analysis, transformations, and image presentations are then performed from the current data set.

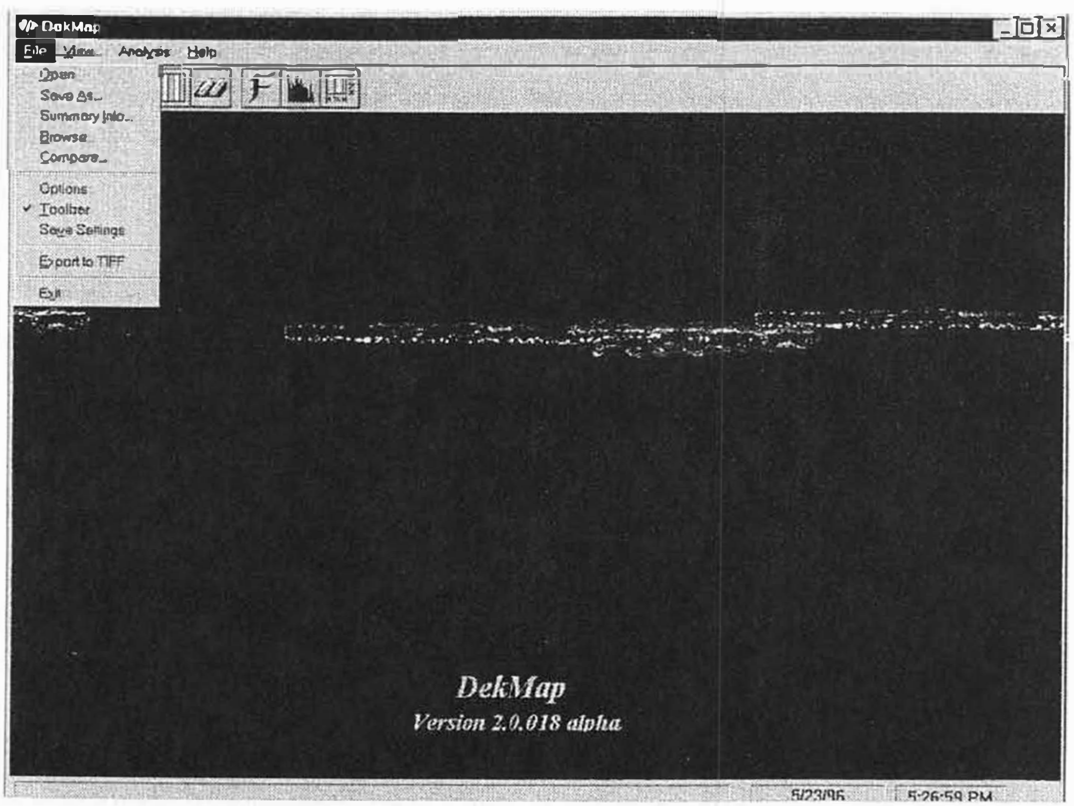


Figure D-4. Dektak Rendering Option Main Title Window

File Browse

The **File, Browse** command allows the user to visually browse through directories of images. When this command is invoked the user is prompted with a standard file dialog box (see Figure D-5). The file name that the user selects becomes the starting point for that directory. Eighteen (18) image files starting with the file name selected are then displayed in a top down Z color rendering on the screen simultaneously in adjacent locations within the browse window. Below each image is listed the file name of the image and the text from the comment field when the image was saved (see section Summary Information). The user can then click the mouse on any image that is displayed, and that image will loaded into the current data set.

The browse window contains two menu commands, **Next** and **Previous**. The commands display either the next or previous eighteen (18) images respectively. If there are fewer than eighteen images left then if the command is 'Previous' the first image is the first file listed in the directory, and then the next seventeen (17) image files from there. If the command is 'Next' all unused images will be shown as blank.

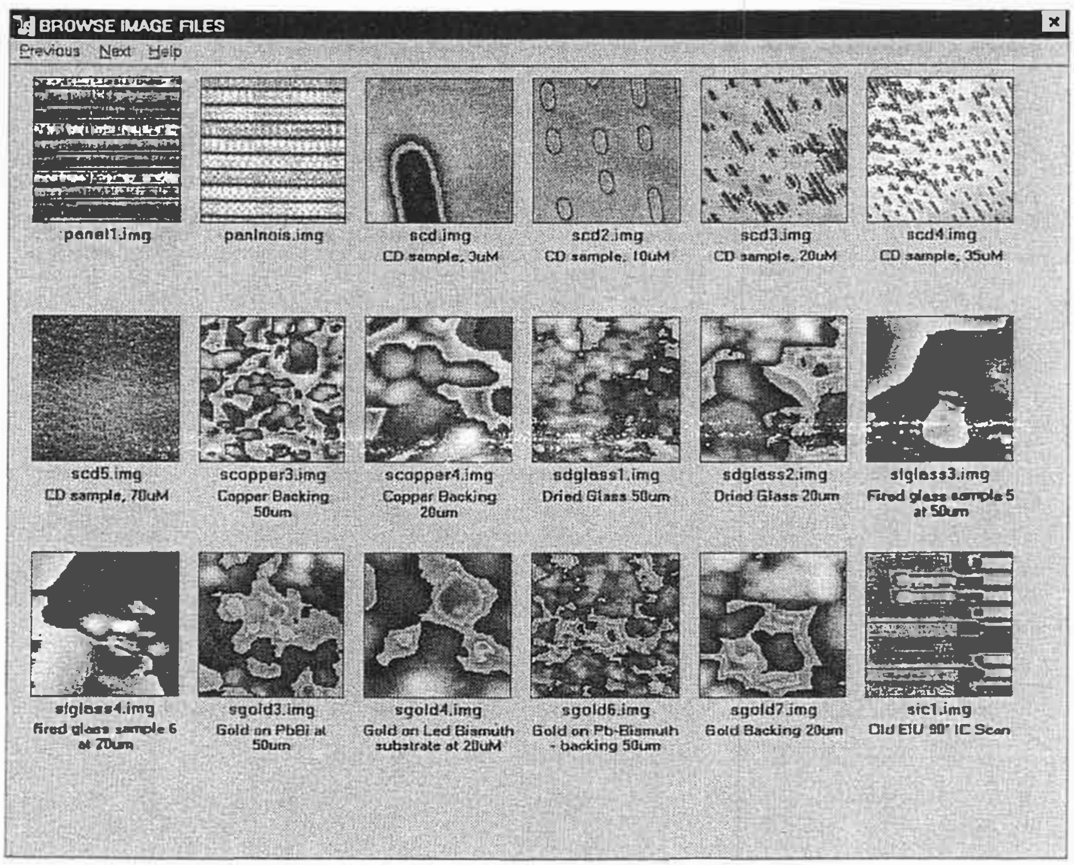


Figure D-5. Image Browse Window

File Save

The **File, Save As** command allows the user to save an image. This command is typically used when the user has transformed the data set and wishes to save the results of the transformation independent of the raw data set.

Summary Information

The **File, Summary Info** command allows the user to either add or edit the data set summary information. The summary information consists of a three user editable fields. These are a 'Comment', 'Keywords', and 'Description' fields. The comment field is a forty (40) character text field that is displayed in the browse window along with the image. The keywords field is a forty (40) character text field that is a hook for a yet to be developed feature whereby the user will be able to limit the browse or a find screen to only image files that contain certain keywords. The description field is a free form, multi-line text field of unlimited length. This field allows the user to enter a lengthy description of the contents of this image file. The summary information window also displays the file name of the image, the date that it was scanned, and the scan line resolution of the current data set in display only fields.

File Export

The **File, Export to TIFF** command transfers the current data set into a TIFF version 6.0 file. The user is prompted with a standard file dialog box, to enter the name and location of the TIFF file to be created. Once the user enters this information and presses the OK button, the current data set is translated into a top down rendered image using a 128 color gray scale, and stored into the file the user specified.

Printing

Anywhere within the package the user is capable of printing the current window on an attached printer. There are three print options available; the entire display contents, the current window, or the client area of the current window. The entire display means exactly that, every pixel shown on the monitor is sent to the printer. The current window is defined as the current active MS-Windows window, this includes the window border, sizing handles, title bar, menu bar, and window client area (contents). The client area is the portion of a window that excludes the title bar, menu bar, and window border, if any.

To print the current window press **Ctrl+P**, to print the entire screen press **Ctrl+S,** to print the current client area press **Ctrl+Shift+P** keys together. The requested portion of the screen is then sent to the current default printer as defined by MS-Windows and the user. The page orientation of the output is automatically changed so the largest possible image is printed on a page.

Two Dimensional (Top Down) View

Throughout the package, when the data set is presented to the user it is always presented in a Z height color rendering with a viewing angle of straight down, looking from directly overhead of the image plane. This image rendering is called a top down view. A number of the top down displays include the X and Y scales shown alongside the image. The top down image is shown whenever the user transforms that data set so there is a visual indication of how the transform effected the image, such as changing the color palette.

Intensity and Contrast Control

The user has the capability of adjusting the intensity and contrast of an image. This is accomplished by altering the range, and color increments within a palette. Slider controls are provided to the user to adjust the intensity or contrast of the image (see Figure D-6). Adjusting image intensity and contrast is equivalent to adjust the color palette. Increasing the intensity has the effect of pushing the color band up towards the top (or higher Z heights); decreasing lowers the band. Increasing the contrast has the effect of narrowing the color band with the palette; decreasing widens the band.

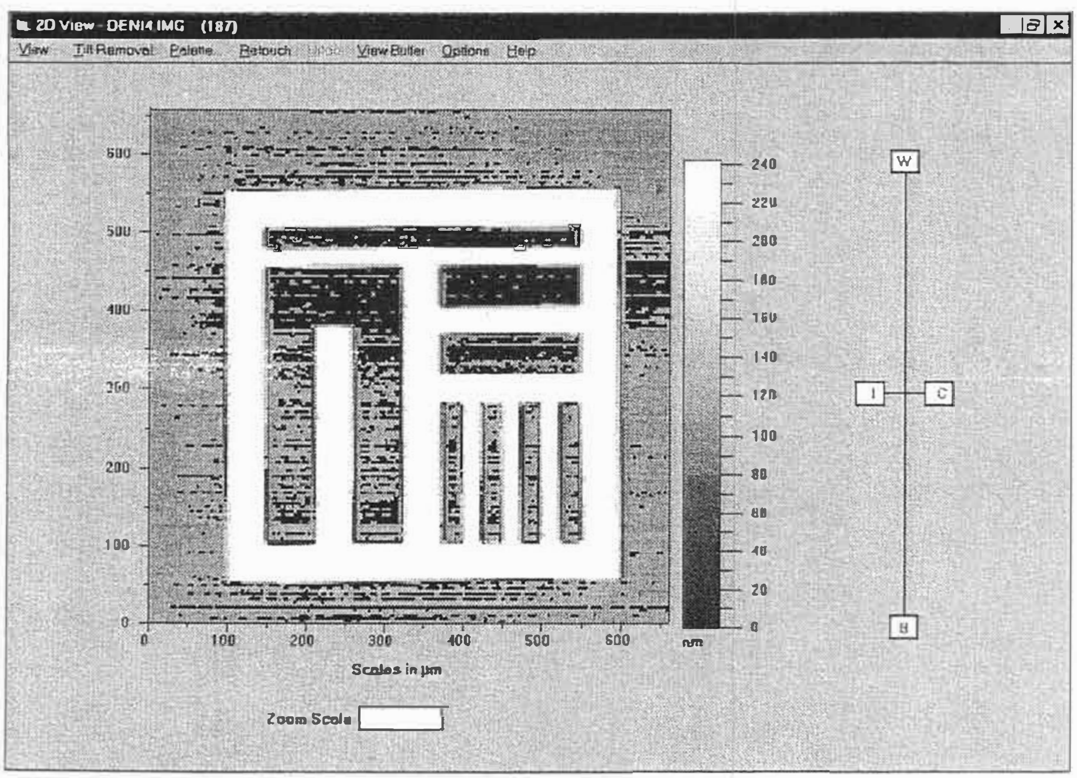


Figure D-6. Two Dimension View Window

User Definable Z Color Palettes

Available from both the 2D and 3D viewing windows is a command that allows the user to alter the Z height color definitions or Z color palette.

The Z color palette design window is displayed whenever the user executes the **Palette** command from one of the view windows. The screen is organized into two areas, and design and preview. The design area contains several elements. The first is a plot of the RGB colors as a function of intensity against the Z height. The next element is a palette of the current Z height colors, displayed along with a scale. The last set of elements are RGB color selection buttons that allow the user to change the current RGB pen, and a "Smooth" command button. These buttons work in conjunction with the RGB plot. When the user has selected a color pen they are able to click or drag the mouse through the plot object. The currently selected color then traces the users movement, and is re-plotted, and displayed in the z color palette. The smooth command "smoothes" the RGB plot with a data smoothing algorithm.

The preview area is provided so the user can get an instant feel for how the palette will look with their image, without having to return to a view window. The preview area consists of a top down image, along with a command button that allows the user to preview or view the current palette.

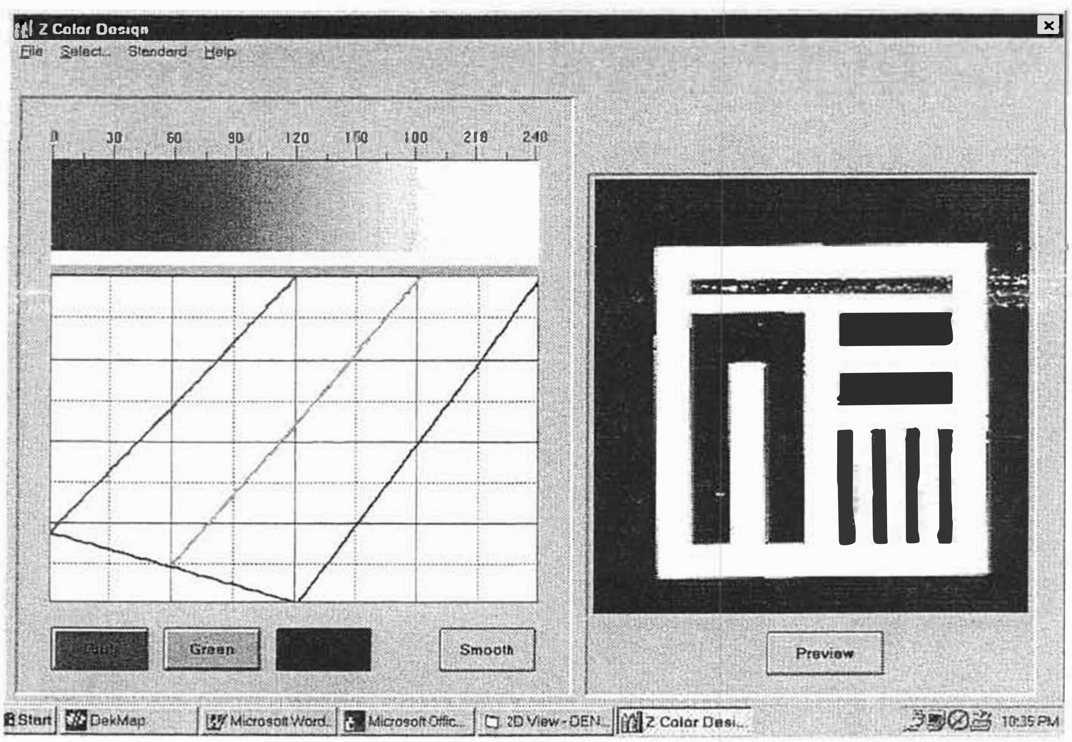


Figure D-7. Z Height Color Palette Design Window

Predefined Color Palettes

The user can select a Z color palette from a number of predefined palettes in the system. The user is presented with a predefined palette selection window when the **Select** menu command is executed. A selection window then displays a selection of six (6) different primary colors, each with the option of full range or saturated color, and two (2) rainbow color palettes. The primary colors are defined as red, green, blue, yellow, cyan, and magenta. The full range and saturation options for each of these colors refers to whether the color palette becomes fully saturated with the primary color at the end or in the middle on the way to white (all color saturation). If the color palettes finishes with the primary color being fully saturated this is called "saturated". If the color palette finishes with white, then this is called "full range".

The two rainbow palettes are labeled Spectrum for full color spectrum, and luminance for distinct bands of black, blue, red, magenta, green, cyan, yellow, and white.

Closing this window automatically selects the currently selected predefined color palette.

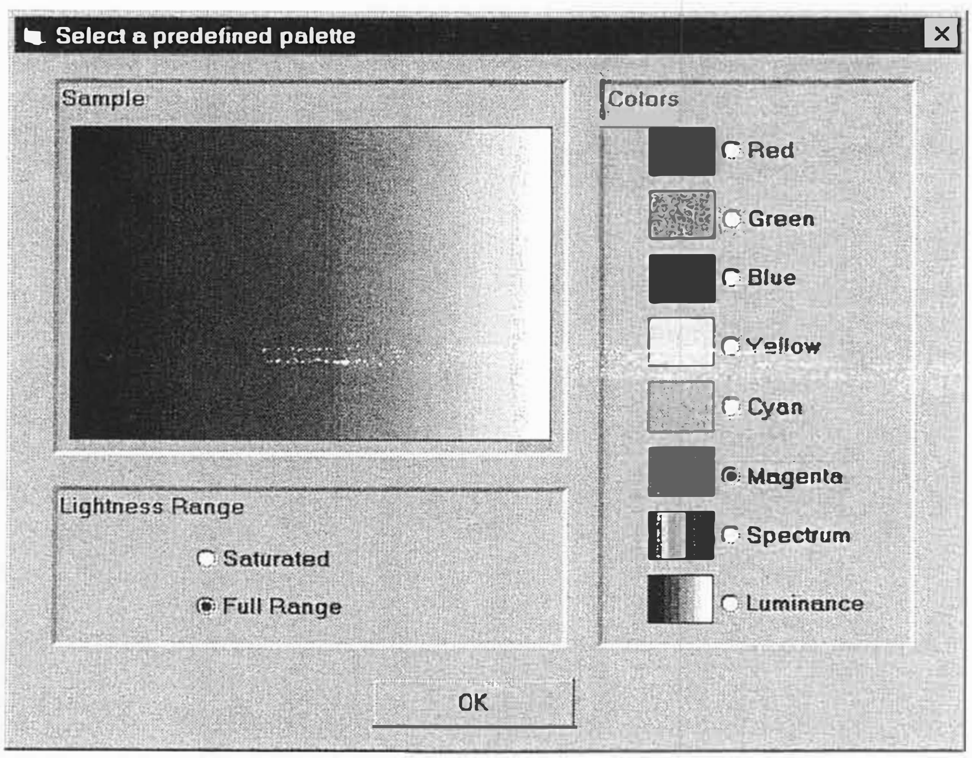


Figure D-8 - Predefined Z Height Color Palette Selection Window

Storage and Retrieval of User Defined Palettes

The Z color design window also allows the users to record and retrieve palettes through the File menu command. The user selects either the **File, Save Palette As,** or **File, Open Palette** menu commands to save or open a palette file, respectively. The user is then presented with a standard file dialog box where the palette file name is specified. The palette file is then either loaded and displayed on the Z color design window, or saved into the file specified.

Default Palette

The package utilizes a default palette. This palette is used whenever a new image is loaded into the package. It is also used by the Browse, and Fast Fourier Transform windows. In these windows multiple top view images are presented. With the color limitation of 236 colors (due to Microsoft Windows, and the hardware specifications), only a single 128 color palette can be utilized, and this is the default palette.

The default palette is typically the "Fire" palette. This palette starts at black and extends through to white with intensity of red increasing first, then green, and finally blue. The total effect is a palette that starts at black, goes to red, orange, yellow, and finishes at white. The fire palette is also known as the standard palette and can be instantly recalled by executing the **Standard** menu command.

The user has the ability to change the default palette through the **File, Change Default** menu command. This command takes the current palette and saves it as the default. The user can then load the current default palette with the **File, Load Default** menu command.

2 Dimensional Light Shaded Imaging

The user is able to light shade the image. Light shaded images are shown in the top down format with adjustable light source coordinates, and contrast.

To light shade an image the user brings up a maximized 3D view window. Menu commands to either **Slope Shade**[1] or light shade the image. When the **Light Shading** menu command is invoked it presents the user with a window that shows a top down view of sphere (see Figure D-9). The user the drags the mouse pointer to a position on the sphere (a fudicial mark follows the mouse pointer). The position on the sphere then becomes the position of the light source. The closer to the outside edge of the sphere the light source is the lower to the horizon it is.

The user can then click on the View Lighted Image area of the screen and be presented with a top down view of their image with light shading. A scroll bar also appears that allows the user to adjust the contrast of the image.

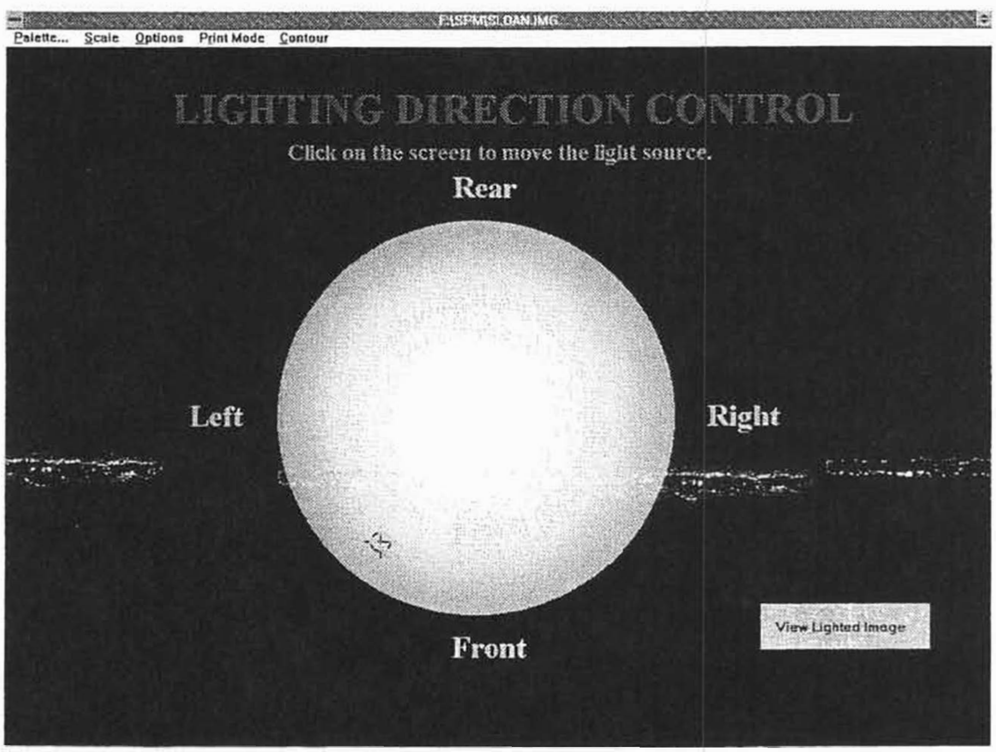


Figure D-9. - Light source positioning window

[1] Slope shading is a special case of light shading. In a slope shaded image the surface is shaded according to it's slope from the horizon. A steep area appears dark, while a flat area appears light. This is the same as have the light source position directly above the center point of the image plane.

ANALYTICAL FUNCTIONS

A number of data analysis functions are provided through two sets of interfaces. One interface provides analysis of area and 3D roughness. The other interface provides analysis of distances, heights, angles, and 2D roughness.

Area Analysis

The area analysis or histogram window provides the user with the ability to perform roughness analysis on the data set. The roughness related analysis features include reporting of the Average Height, RMS Deviation, R_a, Maximum Deviation, R_p, R_t, R_v, R_z, Skewness, and Kurtosis of the entire scanned area.

A number of plotting features are also available through this window. These include Z height histogram, Z height histogram integral, roughness frequency, bearing ratio, autocorrelation and contour line (14) plots. The user is also able to retrieve and record both roughness frequency and autocorrelation plots. These two types of plots can then be simultaneously compared against other plots of the same type.

The histogram window also allows the user to manipulate the data via selected tilt corrections, data smoothing and Z height truncations.

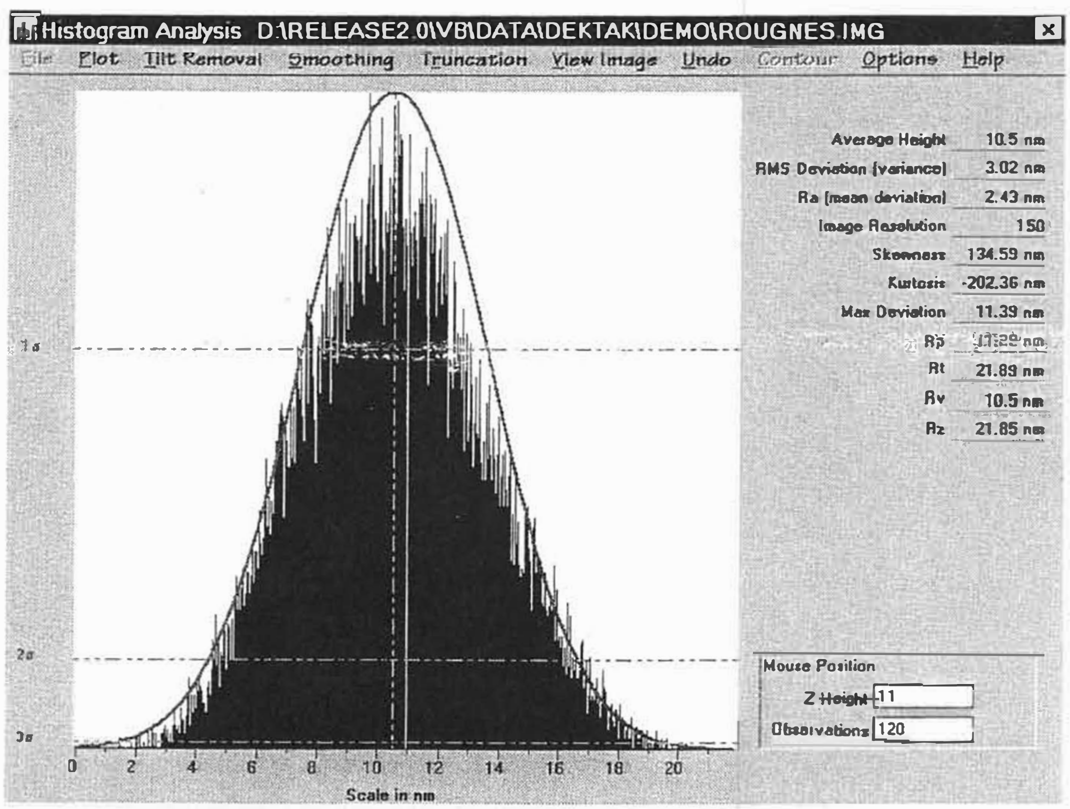


Figure D-10. - Histogram Analysis Window, Showing the Z Height Histogram Plot

Z Height Histogram Plot

The Height Histogram command displays a histogram plot of the observed Z heights, shown with the number of observations as the Y axis and the Z height as the X axis (see Figure D-10). When the mouse pointer is positioned within the plot, the current location of the pointer, expressed in the X and Y coordinate system values, is displayed on the screen.

Z Height Histogram Integral Plot

The Histogram Integral command displays a plot of the Z height histogram integral, shown with the integral result range of 0 to 1 as the Y axis and the Z height as the X axis. When the mouse pointer is positioned within the plot, the current location of the pointer, expressed in the X and Y coordinate system values, is displayed on the screen.

Z Height Gaussian Fit Plot

The Z height gaussian fit command is only available immediately after the Z height histogram command has been executed. Executing this command will superimpose a gaussian function plot over the histogram plot. The Y axis continues to be defined as the number of observations, but will be displayed with the 1, 2, and 3 sigma divisions. The X axis will continue to be defined as the Z height. When the mouse pointer is positioned within the plot, the current location of the pointer, expressed in the X and sigma coordinate system values, is displayed on the screen.

Bearing Ratio Plot

The Bearing Ratio command displays a plot of the bearing ratio, shown with the ratio (expressed as a percentage from 0% to 100%) as the Y axis, and the Z height as the X axis. When the mouse pointer is positioned within the plot, the current location of the pointer, expressed in the X and Y coordinate system values, is displayed on the screen.

Autocorrelation Plot

The Autocorrelation command displays a plot of the autocorrelation function for the data set. Autocorrelation is the reverse Fourier transform of the roughness frequency. The Y axis is defined as the amplitude, and the X axis is the displacement. When the mouse pointer is positioned within the plot, the current location of the pointer, expressed in the X and Y coordinate system values, is displayed on the screen. When the autocorrelation plot is on the screen, the user can choose to display another previously saved autocorrelation plot. This is done by selecting the **Load** command from the menu. The autocorrelation plot can also be saved so that it can be re-displayed at a later time with the **Save** menu command.

Roughness Frequency Plot

The Roughness Frequency command displays a plot of the spatial frequencies vs. the log of the power amplitude. This is calculated by taking the power spectral density from the Fourier transform of each scan line. The Y axis is defined as the log of the power amplitude, and the X axis is the spatial frequency shown in μm^{-1} (or the appropriate inverse distance units).

When a roughness frequency plot is being displayed the user has the ability to load another roughness frequency plot and overlay on top of the current plot. This is done with the **Load** command from the menu. The user is presented with a standard file dialog box and the selected file is then shown on the current plot with a legend, and using a different line color. The user can select up to five other roughness plots to be shown against the current plot at any one time.

The current data sets' roughness frequency plot can be saved so that it can be re-displayed at a later time with the **Save** menu command. This command presents the user with a standard file dialog box, and allows the user to enter the name of the file to save the current plot into.

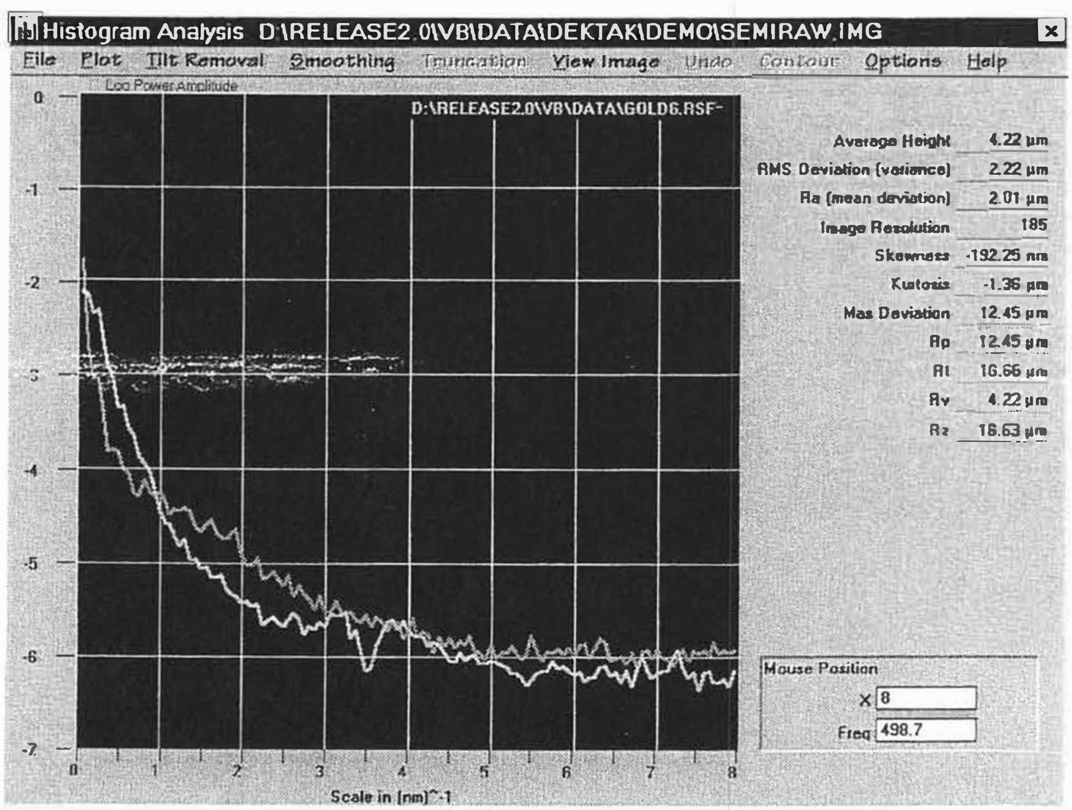


Figure D-11. Roughness Frequency Plot with Additional Roughness Parameters

Average Z Height

When the histogram window is displayed the observed R_a will be displayed. The average Z height is the Z coordinate of the center plane, that extends outward in X and Y to infinity.

R_a

When the histogram window is displayed the observed R_a will be displayed. The R_a, or Mean Deviation, is calculated as the average deviation from the center plane

RMS Deviation

When the histogram window is displayed the observed RMS deviation will be displayed. The RMS deviation or root-mean-square roughness is calculated as the RMS deviation from the center plane.

Skewness

When the histogram window is displayed the observed skewness will be displayed. "Skewness is a measure of symmetry of the surface about a mean plane."[2] In the 2D sense skewness is defined as:

$$Skewness = \frac{1}{R_q^{\,3}} \frac{1}{N} \sum_{1}^{N} Y_i^3$$

where:

R_q = RMS deviation

N = number of data points

Y_i = Z height of a data point

Kurtosis

When the histogram window is displayed the observed kurtosis will be displayed. "Kurtosis is a measure of the amplitude density function sharpness. It quantitatively describes the randomness of a profile's shape relative to that of a perfectly random surface which has a kurtosis of 3."[3]

$$Kurtosis = \frac{1}{R_q^3} \frac{1}{N} \sum_{1}^{N} Y_i^4$$

where:

R_q = RMS deviation

N = number of data points

Y_i = Z height of a data point

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[2] ANSI/ASME B46.1-1985 Surface Texture (Surface Roughness, Waviness and Lay), para. C3.2.3

[3] ANSI/ASME B46.1-1985 Surface Texture (Surface Roughness, Waviness and Lay), para. C3.2.4

Maximum Deviation

When the histogram window is displayed the observed maximum deviation will be displayed. The Max Dev or Maximum Deviation, is the furthest data point above or below the mean image plane.

R_p

When the histogram window is displayed the observed R_p value will be calculated and displayed on the screen. The R_p or Roughness Peak, is the maximum height or highest peak of the profile roughness above the mean plane.

R_t

When the histogram window is displayed the observed R_t value will be calculated and displayed on the screen. The R_t or Ten Point Height, is the average distance between the five maximum peaks and the five maximum valley measurements.

R_v

When the histogram window is displayed the observed R_v value will be calculated and displayed on the screen. The R_v or Maximum Valley, is the lowest point below the mean image plane.

R_z

When the histogram window is displayed the observed R_z value will be calculated and displayed on the screen. The R_z or Average Height Difference, is the average difference in height between the five highest peaks and five lowest valleys relative to the mean plane.

IMAGE ANALYSIS

The data point analysis or "image analysis" window provides the users with the ability to cross section the data, and then select two points and review the locations, distances, angles, and vector distances for these two points.

The data point analysis window also serves as a gateway to standard Dektak 2D analysis functions once the user has selected a cross section of the 3D data resulting in a 2D data set.

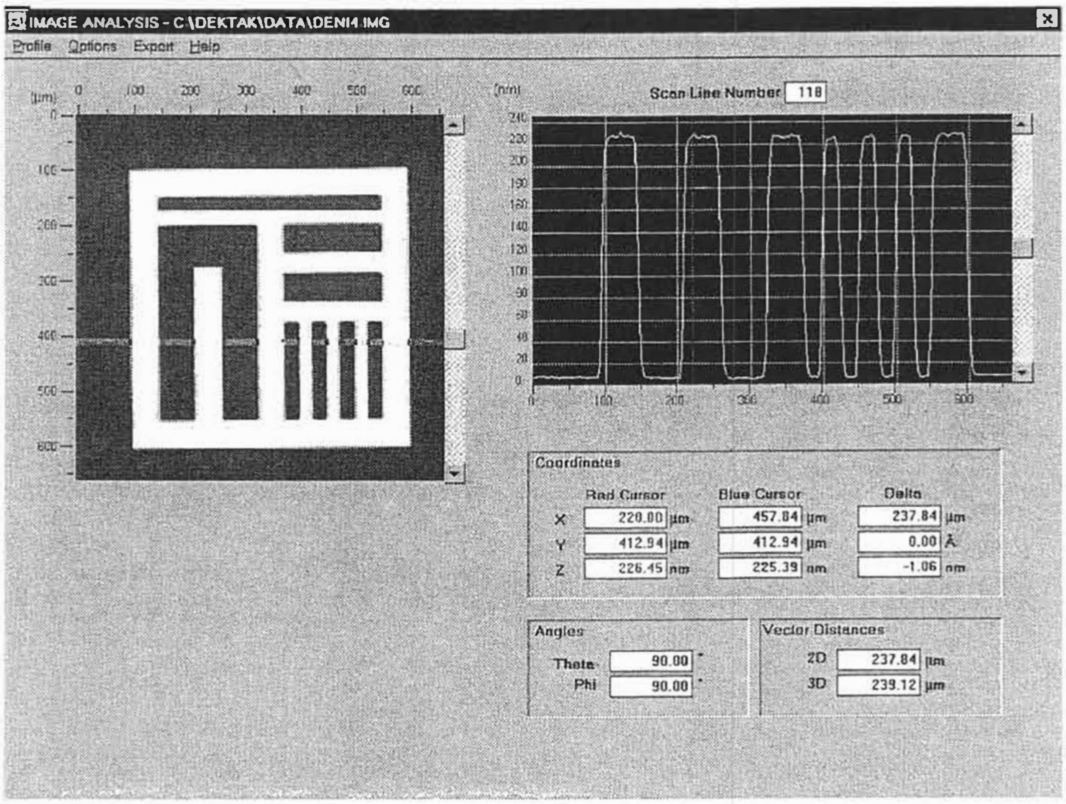

Figure D-12. Image Analysis Window

Cross-Sectioning of Data

The image analysis window allows the user to cross section the 3D data set in three different ways, "horizontal", "vertical", and "diagonal". These terms make sense if you view the data set as a top down image, but their real definitions are:

Horizontal - a cross sectioning of the data along the Y axis (y is kept constant) for X equal to 0 to the scan length.

Vertical - a cross sectioning of the data along the X axis (x is kept constant) for Y equal to 0 to the scan width.

Diagonal - a cross sectioning of the data between two user defined points within the scan. This means the cross section is of variable XY slope, and variable length.

In all cross sectioning methods the X, Y, or XY coordinates are translated to the X axis (or length), and the Z heights are translated to the Y axis, resulting in a 2D representation of the data. This resultant data is then plotted in a separate plot object (herein referred to as the cross section plot) on the window with the correct scales placed along the axis. The aspect ratio of plot defaults to the length by the maximum observed Z height. A scroll bar positioned to the right of the plot allows the user to adjust the aspect ratio by a variable, yet unknown amount.
When the data point analysis window is displayed it defaults to taking a horizontal cross section, at the Y mid-point or scan width / 2.

Data Point Selection

In the cross section plot there are two vertical lines, one red, the other blue. Their default positions at 1/3 the X range from the start, and 1/3 the X range from the end. These two lines denote the two measurement points that are used for all subsequent calculations. The actual data points are located where these vertical indicators intersect the plotted line.

To move either vertical indicator the user drags the mouse near one of the lines and moves it either to the left or right. All up, down motion is ignored. The user does not have to position precisely on top of one of the indicator lines to select it, just near it. The red (left hand) indicator is prevented from moving to the right side of the blue (right hand) indicator, and vice versa. Due to the preceding rule clicking with the mouse to the left of the red indicator always selects the red indicator and vice versa. In the situation where both indicators are equidistant from where the user clicks the mouse, the blue indicator will be selected. Once any indicator is moved the coordinates, distances, angles, and vector distances displays will be updated based on the selected points.

Selected Point Coordinates

At all times the current X, Y, and Z coordinates of the two selected points are displayed with appropriate titles.

Delta X,Y, and Z

At all times the distances between the two selected points are displayed, expressed as the delta for each X, Y, and Z axis.

2D and 3D Vector Distance

At all times the two dimensional and three dimensional vector distances between the two selected points is displayed. The two dimensional vector distance is calculated as the XY vector distance points. The three dimensional vector distance is calculated as the XYZ vector distance between points.

Theta Angle

At all times, the Theta angle defined by the two selected points are displayed. These are labeled Theta. Theta is defined as the angle from the XY plane for the 3D vector between the two points. This can also be considered the angle defined by the two points as shown on the cross section plot, since the X axis is always parallel to either X or Y plane. Theta is expressed in degrees. If the two cursors intercept the cross section plot at the same vertical height, then Theta would be defined as 0°.

Phi Angle

Phi is defined as the 2D vector angle (X and Y) of the two points in 3D space. This can also be considered the angle defined by the cross section line as shown on the top view image. Horizontal is 90°, and vertical is 0°.

Side by Side Image Comparison

The user can compare the top down view images of two data sets side by side on the display. A cursor is then shown in both images at the same relative coordinates to assist the user in determining feature differentiation. The user is also has the ability to subtract, add or divide one image from/by the other. To use this feature the use selects the **File, Compare** menu command. This command displays a window can show two images side by side, horizontally on the screen. The user is then selects the data set to be displayed in the left hand image with the **Select Left** menu command. The user then selects the data set to be displayed in the right hand image with the **Select Right** menu command. Once both images are displayed the user can then choose to add, subtract, or divide the data sets and display the resultant image with the **Sum Images, Subtract Images, or Divide Images** menu commands. These commands use the following algorithms for their operation:

Sum: $left(x,y) = left(x,y) + right(x,y)$

Subtract: $left(x,y) = left(x,y) - right(x,y)$

Divide: $left(x,y) = \frac{left(x,y)}{right(x,y)}$

Contour Plotting

The user is able to have the system overlay a contour plot on top of a top view image at two locations within the package. In the 3D view window, when the screen is maximized, the user has the option of dividing the Z height range into 4, 6, 10, or 16 equal height increments, and contour lines are then super imposed over a top view image using the color green. In the histogram window the user can select the **Contour** menu command to divide the Z height range into 14 equal height increments, and contour lines are then super imposed over a top view image using the color green.

Data Transformations

A number of data transformations are offered through the functions such as tilt correction, filtering, smoothing, convolution, scaling, image touch up and magnification. Once manipulated the data can then be transformed and saved as a new and separate image file.

Edge Fit

The user is able to remove planar tilt from an image using an algorithm known as 'Edge Fit'. Edge fit tilt removal calculates the X and Y tilt by finding the average height on all four sides of the image. From these averages the X and Y slopes are calculated and then subtracted from the data set.

Three Point

The user is able to remove planar tilt from an image using an algorithm known as 'Three Point'. Three point tilt removal allows the user to select three points within a data set. A plane is then defined that contains these three points and is subtracted from the data set.

Parabolic

The user is able to remove parabolic dishing from an image using an algorithm called 'Parabolic'. With parabolic tilt removal a third order polynomial function for a parabola is calculated based on the data set. This polynomial is then subtracted from the data set.

Parabolic in Y Only

The user is able to remove parabolic dishing in each individual scan line, on a line by line basis with an algorithm called 'Parabolic Line by Line'. With this tilt removal a third order polynomial function for a parabola is computed for each line. The polynomial for each line is then subtracted from that line. The overall effect is to remove a curvature that resembles a slice taken out of a can, if you cut the can from top to bottom.

Line by Line Averaging in X Only

The user is able to remove the DC offset in the X direction from each scan line, on a line by line basis with an algorithm called 'Line by Line H'. This tilt removal algorithm effectively flattens the image along the Y axis by removing the DC component from each scan line. This is accomplished by finding the average height of each scan line and then subtracting that height from each point in that line. This type of tilt removal is only recommended for surfaces that are known to be flat.

Line by Line Averaging in Y Only

The user is able to remove the DC offset in the Y direction from each line, on a line by line basis with an algorithm called 'Line by Line V'. This tilt removal algorithm effectively flattens the image along the X axis by removing the DC component from each line in Y. This is accomplished by finding the average height of each line and then subtracting that height from each point in that line. This type of tilt removal is only recommended for surfaces that are known to be flat.

Line by Line Averaging in X Only with Data Rejection

The user is able to remove a portion of the DC offset in the X direction from each scan line, on a line by line basis with an algorithm called Histogram H. The user additionally selects one of three options from Hills, Hills and Valleys, and Valleys. This option determines how the average height of a scan line is computed. For Valleys, the average height is calculated by taking the average height of lowest 33% of the data set. For Hills and Valleys, the average height is calculated by taking the average height of the lowest 50% of the data set. For Hills it is 66% of the data set. Once the average height is calculated the algorithm works the same as Line by Line H. This type of tilt removal is only recommended for surfaces that are known to be flat.

Line by Line Averaging in Y Only with Data Rejection

The user is able to remove a portion of the DC offset in the Y direction from each Line, on a line by line basis with an algorithm called Histogram V. This works in the same manner as Histogram V, except in the Y direction instead of X. This type of tilt removal is only recommended for surfaces that are known to be flat.

Streak Removal

The user can remove horizontal or vertical streaks from the image with a **Retouch, Streak Removal** menu command. Streak removal allows the user to select a rectangular area from a top view image. Once selected the data points above and below the X edges (top and bottom) are interpolated through the Y range of scan lines, eliminating the actual data bound by the rectangle, and replacing it with the interpolated data. The top view image is then updated with the transformed data.

Spot Removal

The user can remove horizontal or vertical streaks and unwanted particles with the **Retouch, Spot Removal** menu command. Spot removal allows the user to select a rectangular area from a top view image. Once the area has been selected the data points with the rectangle are interpolated in both the X and Y directions between all edges of the rectangle, eliminating the actual data bound by the rectangle, and replacing it with the interpolated data. The top view image is then updated with the transformed data set.

Smoothing

The user can smooth the data with the **Retouch, Smoothing** menu command. Smoothing is the same as applying a low pass filter to the data. This command allows the user to select either 3, 5, or 9 point averaging for the smoothing transform. The higher the point number the higher the frequency of the filter is. The entire data set is then transformed and displayed in a top view image.

Convolution

The user can convolve the data set with either predefined or user defined transforms, and display the results with a series of commands. Data convolution can be explained as the process of converting a data set to the frequency domain, applying a filter, and then re-transforming the data back into the X,Y domain.

To convolve the data the user first selects the Retouch, Select Filter menu command to bring up a dialog box that allows them to select from matrix sizes of 3x3, 5x5, 7x7, 9x9, 11x11, or 13x13; select from a predefined transform from either a rectangular low pass filter, a gaussian low pass filter, an edge enhancement transform, an edge detection transform, a band pass filter, or a allows the user to create their own matrix or transform values. The size of the matrix determines the frequencies that will be involved in the convolution; the larger the matrix, the lower the frequency.

To convolve the data using the selected transform matrix, the user then selects the Apply Filter command. This command then applies the transform to the data set, replacing the original data set with the transformed data. Next the transformed image is displayed as a top down image.

Data Zoom

The user is able to select a square portion of the data set that is magnified and becomes the new data set, with the Zoom command. The user selects a square area of the data set from a top view image. Once selected the portion of the data set is reproduced at the original resolution original data set. For example, if the original data set is defined as 100 elements by 100 elements, and the user selects a 20 by 20 region, the 20 by 20 data is re-scaled to 100 by 100 elements. The missing data points are interpolated so the image does not appear pixelated. The requirement that a square are be selected is enforced by the package as the user clicks and drags the mouse during the zoom command.

While the user is dragging the mouse to select the area to magnify, the current size of the selected area is displayed on the screen.

Z Height Truncation

On the Z height histogram plot the user is able to select a command that truncates the Z height information down to a specified range. Z height data above or below this range is truncated to the new minimum or maximum heights respectively. To use truncation the user first selects the menu command **Truncation, Cursors**. This displays two vertical cursor lines within the histogram plot. The cursor on the right serves as the cut off point for the maximum height, and the left cursor as the minimum. The user then selects the menu command **Truncation, Action** to transform the data set.

2 Dimensional Fast Fourier Transform

The user is able to analyze and filter frequencies from an image, through the fourier transform analysis feature. This feature is provided by a separate window that can transform the data set from its spatial XY domain into a frequency domain. The real and imaginary components are then plotted along with the power spectral density (or sum of the squares of the real and imaginary components). The user is then allowed to erase components from the frequency content of the data, and then re-transform the data back into the XY domain, resulting in a transformed image.

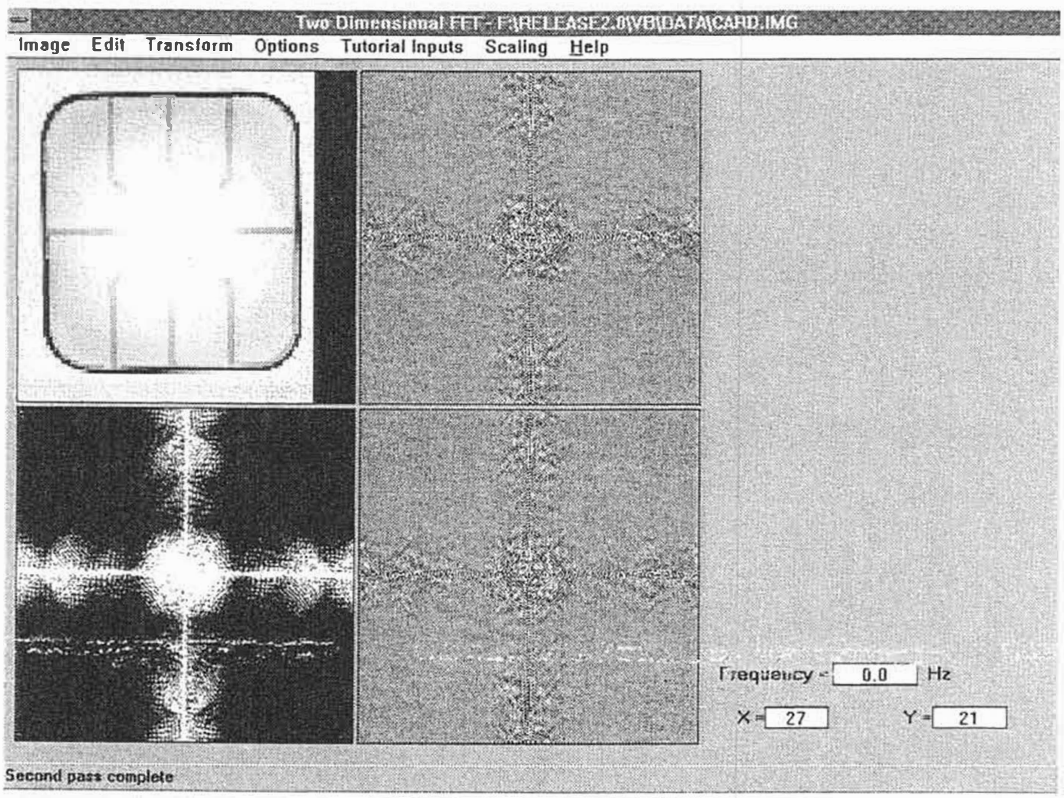

Figure D-13. Fast Fourier Analysis Window

Excluding Frequency Data

To transform the XY domain data into its frequency domain the user imports the into the FFT analysis window with the "Import Data" command button. From there the data can be transformed into the frequency domain with the "Transform" command button. The real and imaginary components of the FFT are plotted on XY charts with the color (or intensity) of each data point determined by its scale. A power spectral density (PSD) plot is shown with the color of each data point determined by the amplitude of the frequency component.

The user is now able to select either an ellipsoidal or rectangular area on the PSD graph. The center of either type of object is the exact center of the graph or 0Hz. To select either type of shape the user presses either the "Ellipse Zone" or "Rect Zone" command buttons, and then clicks and drags the mouse with the PSD graph to draw the shape. The user now has the option of either excluding the frequency data within or outside of the area selected. To exclude frequencies outside of the selected area, the user selects the Exclude Outer command button. To exclude frequencies inside of the selected area, the user selects the Exclude Inner command button. Both command buttons then erase, or zero, the frequencies to be excluded from the data set. The cutoff is a sharp distinct cutoff filter. If the user instead wants a gradual filtering a Gaussian Cut command button can be used to implement a gaussian roll-off of the amplitudes starting at the frequency (or frequencies) defined by the edge of the selected area, before using either the exclude inner or outer commands.

The user can exclude a specific frequency and orientation (with respect to X or Y) with an eraser. Two sizes of erasers are available; small, and large. To erase a frequency component the user selects the appropriately sized eraser from the **Erase** menu command, and then clicks and drags the eraser over the PSD graph. Whenever the mouse button is depressed all information under the eraser will be erased.

To convert the frequency domain data back into the XY domain, and resulting in a recovered image, then user selects the Retransform command button. The real and imaginary component data, along with the frequency information removed by the user, is re-transformed into an image which is shown along side the original image. The user then has the option of exporting the re-transformed image into the current working data set for the rest of the program with the Export Image command button.

Amplitude Scaling

To assist the user in determining the frequency components of an image, menu commands to scale the amplitudes up or down are available. When the amplitude is scaled down, the mode dominant frequencies will remain brighter on the PSD graph, while the less dominant will dim from existence. The effect can be reversed by either scaling up or using the **Scaling, Restore** menu command to restore the original scale. The scale must be restored if a comparable image to the original is desired, otherwise the Z heights of the re-transformed image will be scaled according to the difference between the selected scale factor and the original.

Tutorial or Experimental Mode

The FFT analysis window also allows the user the experiment with using FFT transforms and filtering frequencies. The user is able to generate a number of sample image patterns and noise patterns of both random and fixed frequency. The user can then perform the transforms and data filtering as normal with these generated images. This then give the user a better feel for the meaning of the PSD graph, and what factors should be consider when filtering information for achieving specific results.

On-line Help

The package offers on-line help to the user through the standard MS-Windows help system. The package includes the recommended MS-Windows help menu that allows the user to select the help file contents, search the help file index, and help on how to use the help system.

The on-line help describes how each command is used, and outlines the general procedures and principals involved in using the package.

APPENDIX E

STEP DETECTION SOFTWARE OPTION

The DEKTAK V 200-Si Step Detection Option enables the automatic computation of analytic functions on scanned features. This is accomplished in a two step process. First, the Step Detection algorithm will locate the leading and trailing edge of each scanned feature. Dektaks' Reference and Measurement Cursors can then be automatically positioned at a relative distance from each detected edge, where chosen analytic functions (ie. Average Step Height, Slope, Peak,Valley, Peak to Valley, etc.) will be computed. The Step Finder can be thought of as a filter that accentuates the edges of a scanned feature where a high variation (high frequency) between data points exist.

NOTE

Step Detection is an optional feature that must be installed in the DEKTAK V 200-Si prior to use.

How does it work?

A least squares fit algorithm has been employed to accomplish the location of feature edges. The following variables will be used by the least squares fit algorithm to determine the fitting criteria of a line to scanned data points.

Detection Method

First Step Will position the R and M cursors for selected Analytical Functions relative to the beginning of the first step that matches the Step Description parameters. If a matching step is found, the ASH of the left edge and the right edge will be the first two entries in the Analytic Results window.

Every Step Will position the R and M cursors for selected Analytical Functions relative to every step that matches the Step Description parameters.

Feature edges are determined by the relative change in slope of each line segment and the proximity (minimum width) from other line segments.

The operation procedure for Step Detection is described in the following pages.

EVERY STEP PARAMETERS WINDOW DESCRIPTION

The Step Parameters Window displays all the necessary parameters for performing the Step Detection function. When the window is first displayed it will contain the default values for the "Every Step" detection method (see Figure E-1). The step parameter values may need to be changed depending on the steps being measured. A description of the parameters contained in the "Every Step" Parameters windows is provided below.

Min. Step Height (A): Indicates the minimum height (in angstroms) of features to be measured. Decimal values can be entered to indicate any portion of angstroms.

Max. Step Height (A): Indicates the maximum height (in angstroms) of the features to be measured. The default value indicates the

Smoothing Factor: The minimum edge height used to search for potential steps, in angstroms.

+ Step: When selected, Step Detection will search for the first positive step matching Step Description parameters.

- Step: When selected, Step Detection will search for the first negative step matching Step Description parameters.

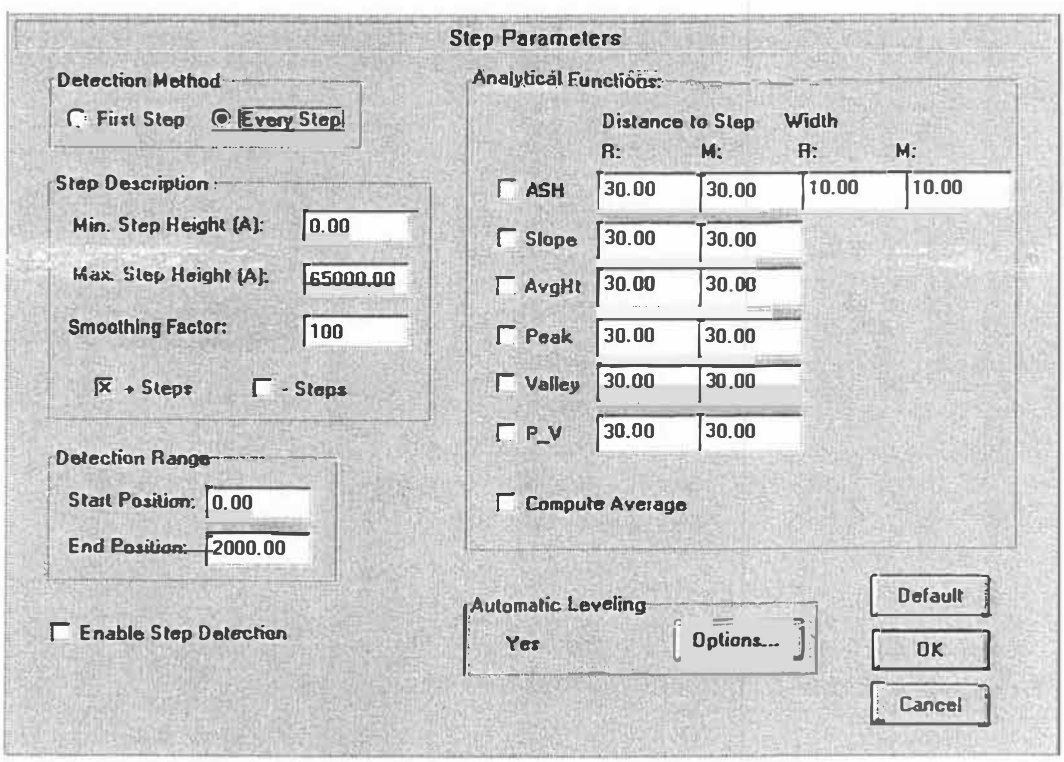

Figure E-1. Every Step Parameters Window

EVERY STEP PARAMETERS WINDOW DESCRIPTION (Cont.)

Detection Range

Start Position: The position, in microns, to start searching for a step.

End Position: The position, in microns, to end searching for a step.

Enable Step Detection: When checked, will perform Step Detection as specified on a completed scan. This check box is only available in program mode.

Analytical Functions

ASH	Compute Average Step Height function.
Slope	Compute Slope function.
AvgHt	Compute Average Height function.
Peak	Compute Maximum Peak function.
Valley	Compute Maximum Valley function.
P_V	Compute Maximum Peak to Valley function.
Compute Average	Compute the average of all results of an Analytical Function.

Automatic Leveling - When selected will cause leveling to occur automatically with the R cursor placed at a relative distance before the first detected step and the M cursor placed at a relative distance from last detected step. Relative distance will be determined from the first selected analytical functions' **Distance to Step** value or 30µm if no analytic functions are chosen.

FIRST STEP PARAMETERS WINDOW DESCRIPTION

A description of the parameters contained in the "First Step" Parameters windows is provided below (see Figure E-2).

Step Description

Height (A): The desired height of the step to detect, in Angstroms.

Distance to Step

R: The relative position of the R Cursor to the left of potential step being detected.

M: The relative position of the M Cursor to the right of potential step being detected.

Band Width

R: Width of R Cursor positioned to the left of potential step being detected.

M: Width of M Cursor positioned to the right of potential step being detected.

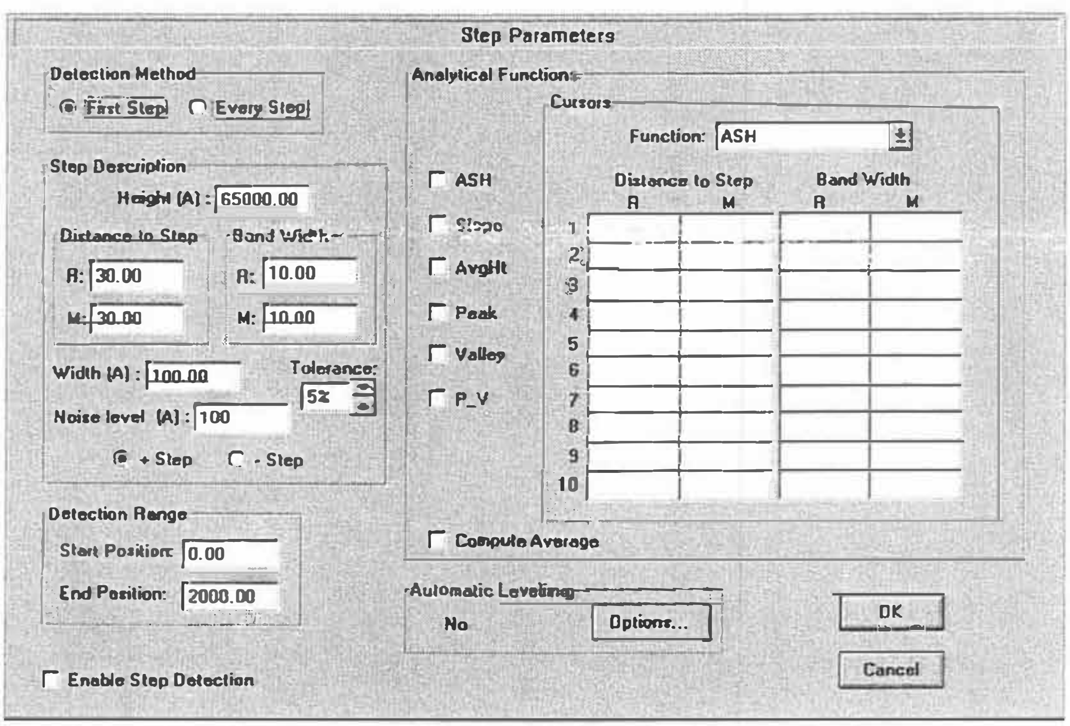

Figure E-2. Dialog Box For First Step Parameters

FIRST STEP PARAMETERS WINDOW DESCRIPTION (Cont.)

Width(A): The desired width of the step to detect, in Angstroms.

Noise Level: The minimum edge height used to search for potential steps, in Angstroms.

Tolerance: Error factor used for calculating the height and width of the matching step.

+ Step: When selected, Step Detection will search for the first positive step matching Step Description parameters.

- Step When selected, Step Detection will search for the first negative step matching Step Description parameters.

Detection Range

Start Position The position, in microns, to start searching for a step.

End Position The position, in microns, to end searching for a step.

Enable Step Detection

When checked, will perform Step Detection as specified on a completed scan. This check box is only available in program mode.

Save Changes To Scan Routine

When checked, all entered Step Detection parameters will be saved to the current scan routine. This check box is only available in compute mode, when step detect has been initiated from the Data Plot screen.

Analytical Functions

ASH Compute Average Step Height function.

Slope Compute Slope function.

AvgHt Compute Average Height function.

Peak Compute Maximum Peak function.

Valley Compute Maximum Valley function.

P_V Compute Maximum Peak to Valley function.

Compute Average Compute the average of all results of an Analytical Function.

FIRST STEP PARAMETERS WINDOW DESCRIPTION (Cont.)

Cursors

Function: Selects an Analytical Function and displays the corresponding cursor values in the grid below it.

Distance To Step (R)

The relative distance from the beginning of the detected step at which to place the R Cursor prior to performing the corresponding Analytical Function. Negative values fall to the left of the beginning of the step, positive values to the right. Up to 10 distances may be entered for each Analytical Function.

Distance To Step (M)

The relative distance from the beginning of the

Band Width (R)

M Cursor Band Width used when performing corresponding Analytical Function. Up to 10 widths may be entered for each Analytical Function.

Band Width (M)

M Cursor Band Width used when performing corresponding Analytical Function. Up to 10 widths may be entered for each Analytical Function.

Automatic Leveling

Options Display the Automatic Leveling Dialog Box.

STEP DETECTION SET-UP

Step Detection is typically used for finding and measuring steps when performing multi-scan operations. It enables like features at multiple locations on multiple samples to be scanned with the step height measured automatically. Prior to using Step Detection in a multi-scan operation, it is recomended that a sample scan be created of the feature to be measured to aid in setting up the Step Detection parameters. Using the scan shown in Figure E-3 as an example of a sample scan, the following pages will demonstrate how to set-up and perform Step Detection on a scan data file.

Figure G-3 shows a scan across a feature with steps located at approximately 300um and 1400um. The procedure to invoke Step Detection on an existing scan data file is provided below.

1. With a scanned profile of multiple steps displayed on the data plot screen, click-on the Analysis Menu from the menu bar (see Figure E-3).

2. Select "Step Detection..." from the analysis menu and the Step Parameters window will be displayed (see Figure E-2).

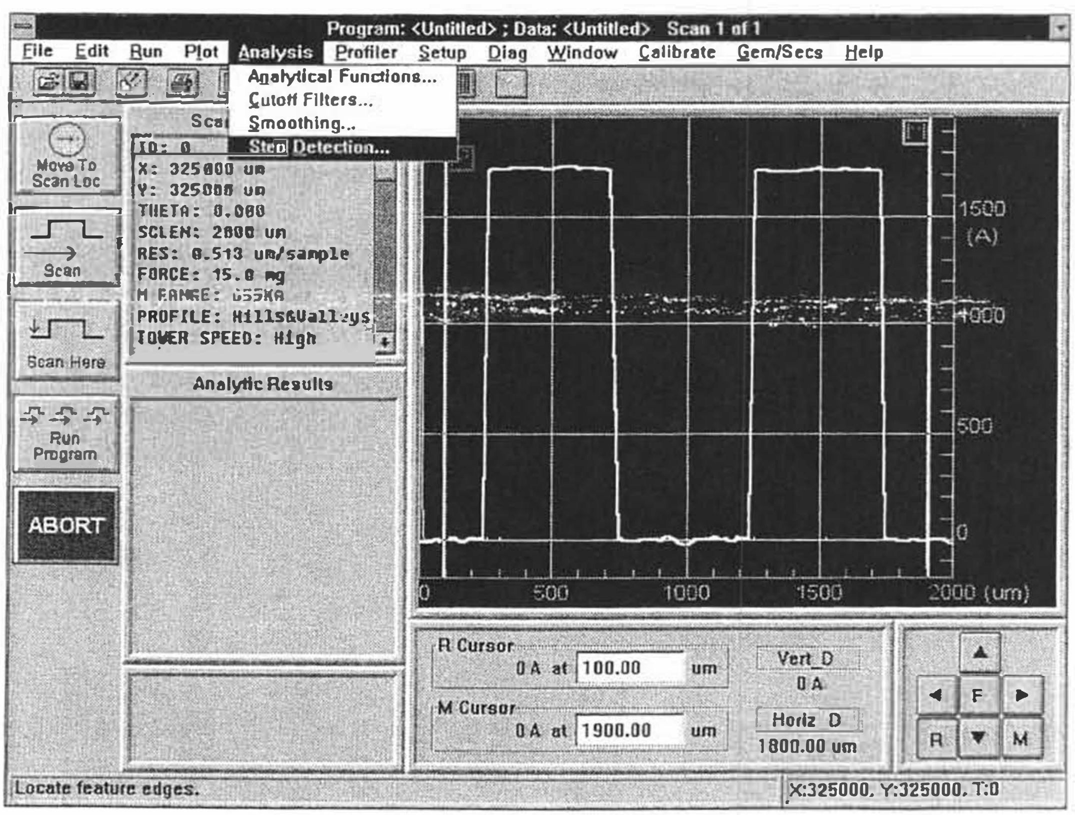

Figure E-3. Typical Scan of a Step

PERFORMING STEP DETECTION ON A SINGLE SCAN

With the Step Parameters Window displayed, select the Step Detection method (First Step or Every Step) from the Step Parameter Window. Select the desired parameters for the scan to measure the scanned step or steps. Click on "Enable Step Detection" and click on "OK".

The resulting scan after Step Detection has been enabled will perform redisplay the plotted profile and detect and measure the steps which apply to selected Step Detection parameters.

The selected analytical funtions such as the ASH measurement will be performed on the detected steps. The steps will be detected causing the ASH measurement to be computed with R and M cursors positioned on either side of the step and displayed to the left of the plotted profile.

You can now automatically locate the cursors to their corresponding position by highlighting the desired **Analytic Result**.

The result of selecting both cursors (both R and M cursor buttons indented) will allow simultaneous movement of cursors and simultaneous modification of cursor band widths. To select both cursors hold the control key (**<Ctrl>**) down while clicking with the left mouse button on the R or M cursor button that is not indented. Clicking on either the right arrow or left arrow will then cause both cursors to move simultaneously. Clicking on the up arrow or down arrow will cause both cursor bands to simultaneously expand or contract.

PROGRAMMING STEP DETECTION INTO A SCAN ROUTINE

Now that an acceptable step detection criteria for locating feature edges on a single scan data file has been determined, the same criteria can be used for performing step detection on similar features during subsequent scans.

To enable Step Detection during a scan, select the **Window->Scan Routines** menu item to display the Scan Routines Window.

From the Scan Routines Window, invoke the Step Detection dialog box by clicking the left mouse button on the **Data Processing->Step Detection...** item.

This displays the **Data Processing->Step Detection...** dialog box with default values displayed.

Step Detection Enabled - must be selected (X in box) to enable Step Detection while scanning.

PROGRAMMING STEP DETECTION ON MULTIPLE SCANS

The Automation Program Summary (APS) can be used with step detection to automatically compute standard deviation and mean values of chosen analytic functions at each detected step for a series of scans.

To program a series of scans with Step Detection select **Automation Programs** from the **Window** menu.

First, invoke the APS dialog box in order to enable the computation of Automation Program Summary information. To do this, click with the left mouse button on the **DATA DESTINATION OPTIONS->APS** screen item.

Then, click with the left mouse button on **Compute And Display** to cause the check box to display an X.

Then, create a copy of the previously developed scan routine by selecting **Copy To...** from the **Edit** menu item.

Enter scan routine location where copy will be created.

Double-click the left mouse button on the newly created scan routine to allow modification of the new scan routine location.

Click, with the left mouse button, on the **SCAN PARAMETERS->Location** item.

Change the **Location X:** and **Y:** values appropriately and then click on the OK button.

Return to the Automation Program Window by selecting the **Window->Automation Program** menu item so that we can run the automation programs.

Select the **Run->Auto Program From...** menu item after highlighting the first Auto Program to be executed.

The resulting **Automation Program Summary** with Mean, Standard Deviation, Minimum, Maximum and Range values for ASH measurements at each detected step.

APPENDIX E - STEP DETECTION OPTION

APPENDIX F

PATTERN RECOGNITION OPTION

The DEKTAK V 200-Si Pattern Recognition Option allows a multi-scan automation program to be run on multiple samples by automatically deskewing substrates prior to measurement. The procedure for Auto Alignment is described in the following pages.

NOTE

Pattern Recognition is an optional feature that must be installed in the DEKTAK V 200-Si prior to use.

Auto-Align Program Entry Sequence

1. **Load the Reference substrate.** Using the DEKTAK V 200-Si cassette loader with the prealigner is recommended. This assures continuity with subsequent program execution operation.

2. **"Square-Up" the substrate.** Rotate stage to orthogonally align features using the "Make Horizontal" function in the DEKTAK V 200-Si sample positioning screen.

3. **Set Alignment targets**. Locate, train and test alignment targets. Illumination source is user selectable.

4. **Name and save the program and its elements.**

5. **Assign to a DEKTAK Automation Program**.

Reference Substrate Orthogonal Pre-Alignment

1. Load reference substrate onto chuck. Using the DEKTAK V 200-Si auto loader for the placement of the initial substrate onto the chuck is recommended.

2. Position the stage in the "Load" position so the center of the stage is located in the center of the Low magnification optical field of view.

3. Using the "Make Horizontal" function, locate two points in the image that are to be aligned to the same orthogonal axis.

4. Angle is calculated, and the stage is rotated as required.

5. Use the default theta alignment to set the correct stage rotation.

ALIGNMENT TARGET MODELS FLOW CHART

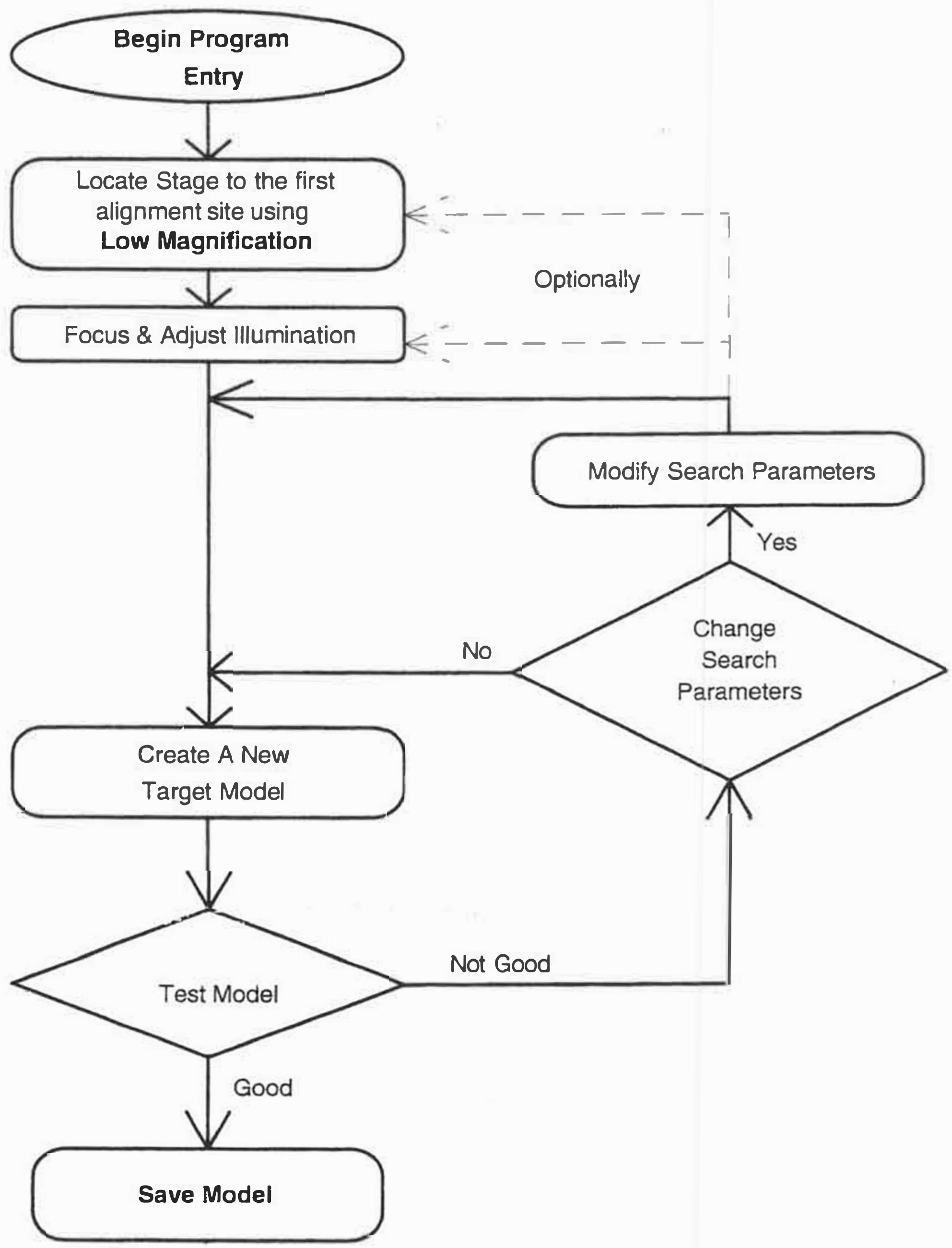

Figure F-1. First Alignment Location Flow Chart

ALIGNMENT TARGET MODELS FLOW-CHART

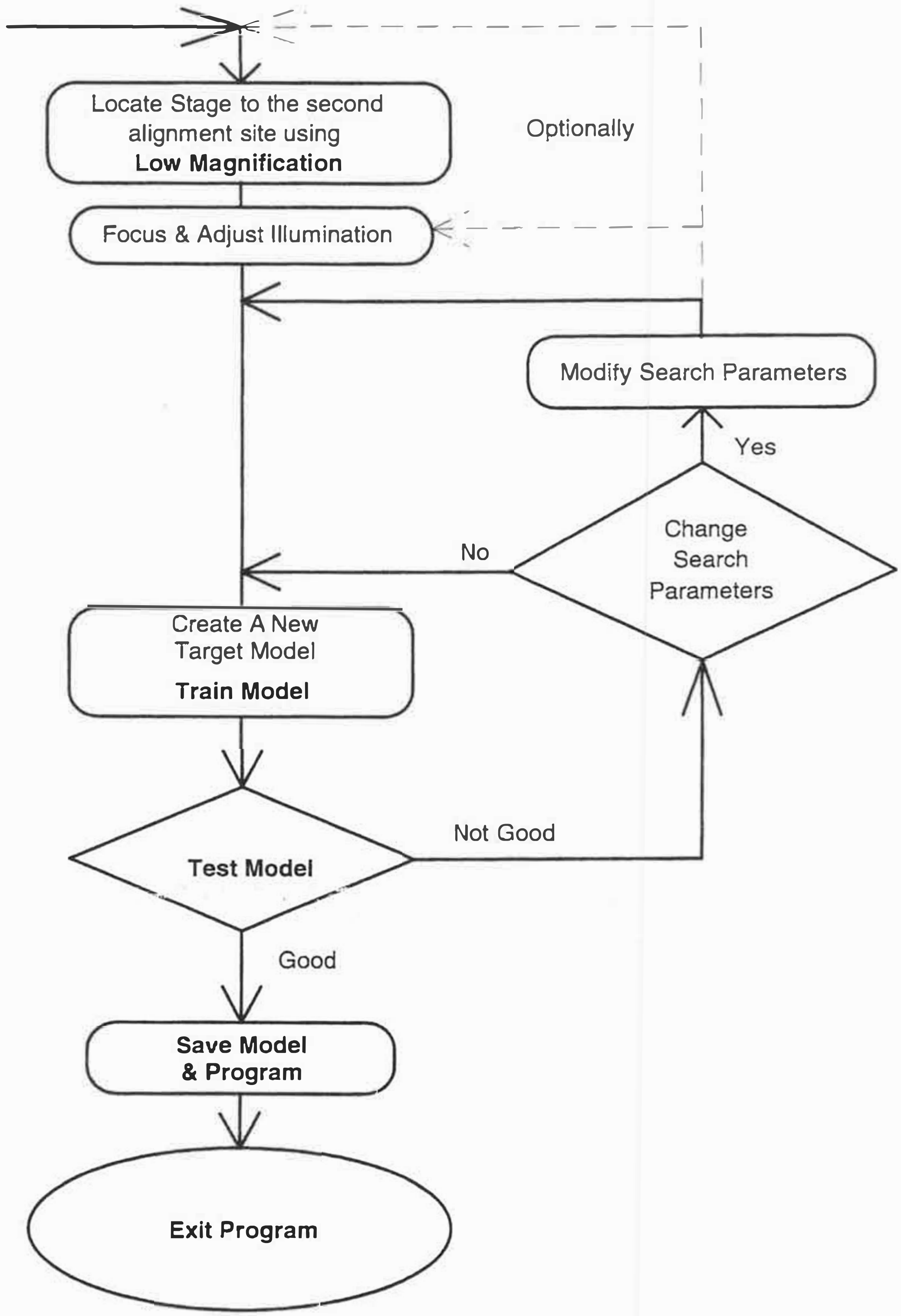

Figure F-2. Second Alignment Location Flow Chart

OVERVIEW

The DEKTAK Automatic Alignment option enables operator-free substrate alignment for execution of automation programs. When combined with automated substrate handling, fully automated operation is possible.

Substrate alignment is useful for replicating a programmed measurement sequence (Automation Program) on many substrates which may be placed on the DEKTAK stage in slightly varying orientations.

The DEKTAK Automatic Alignment option provides the DEKTAK surface profilers the ability to use a hardware pattern recognition system to align a test substrate to a predefined reference. It replaces the manual deskew operation traditionally used for substrate alignment. The advantages of the hardware system over the human operator is better consistency (read repeatability), and faster through-put. Different alignment techniques are available with the hardware pattern recognition system that optimize the performance for both alignment speed and repeatability.

Automatic alignment can be performed on a global level, where common alignment offsets are applied to all scan sites in the automation program, or on a local level where prior to a scan an alignment operation can be performed to provide offsets to be applied to that particular scan.

The DEKTAK Automatic Alignment option uses a vision processor manufactured by COGNEX to perform the image pattern recognition. An optics unit is attached to the DEKTAK sensor head which provides two fixed magnifications and both dark and bright field illumination for each magnification.

Basically, a set of reference video images and other properties are learned (trained) for a given alignment program. The operator specifies alignment locations and is guided through the alignment model creation and test process. This setup is performed at the same time the automation program scan sites are programmed. The alignment program is then attached to the automation program so when the automation program is executed, the alignment program is executed at the proper time. When the automation program instructs the alignment program to execute, the stage is sent to the first alignment site, and the programmed alignment methods are executed. The stage is optionally corrected, and if another alignment site is programmed, then the stage is traversed and the alignment process continues until completed. The balance of the automation program is then executed. If enabled, a local alignment program would be selected and executed just prior to scanning.

SUBSTRATE ALIGNMENT

The DEKTAK Automatic Alignment option allows the user to specify both the alignment targets and their locations on the substrate. This flexibility is required to accommodate the various shapes and sizes of wafers, flat panels, and other substrates. In general, alignment targets that are separated as far as possible, and at roughly 45 degrees from one another work the best since the corrections for rotation are optimized. Substrate alignment can be accomplished using both global alignment and local alignment. In most cases, the global alignment is adequate, however for applications where small features are to be measured, the application of a local alignment to that feature may be desired.
The global alignment operation is a composed of a two point coarse alignment (using a low magnification), which removes the rotational offset of the substrate and determines the X and Y offsets to be applied to all scan sites within the Automation Program. To further refine the alignment, the DEKTAK Automatic Alignment option provides the choice of either a single or two point fine alignment which uses a higher magnification. The coarse alignment optics provide a field of view (FOV) of roughly 10mm horizontal and 8mm vertical -- pixel resolutions of about 18-19 microns. The fine alignment optics provide a FOV of roughly 750 microns horizontal and 625 microns vertical -- pixel resolutions of about 1.3 microns.

The DEKTAK Automatic Alignment option uses image pattern recognition techniques to find alignment targets (models) on the user's substrates to determine the substrate's alignment relative to a stored reference. The stored reference is trained from a real part. The alignment program and the measurement programs are created at the same time to establish the reference.

PATTERN RECOGNITION CONCEPTS

The alignment reference is composed of two or more pattern recognition models that are extracted from the reference substrate. Pattern recognition models are of two classes: grayscale (linear) and intensity gradients or edge (non-linear) models. The choice of which to use is determined by the application.

Grayscale models or linear models, use a normalized cross-correlation technique that provides robust search operation for applications that may be subject to linear changes in the image. If we consider the model to be an object on a background with some contrast between them, then linear changes would encompass varying illumination and process changes that affect the contrast linearly.

Image intensity gradients or edge based models are best utilized when either non-linear contrast changes are expected, or less than 100% of the model is expected to be in the test image. Non-linear contrast changes can occur in manufacturing processes. Varying etches of material that change reflectivity as a function of thickness for example, cause non-linear changes to contrast -- sometimes this can include contrast reversals.

In either case, all pattern recognition models require some contrast in the image of the alignment feature to its background. If there is too little contrast, than neither pattern recognition scheme will work. In general, it is recommended to use the grayscale models unless there is compelling need to use edge based models. Grayscale model searches are faster and more robust than edge based model searches. They are more tolerant of rotational shifts.

Along with feature contrast, the alignment feature chosen must be unique within the entire image field of view. This includes the bordering area surrounding the image. If the alignment model is not unique, then the alignment system will fail due to the ambiguity.

Ideal Alignment Setup

The ideal alignment setup would have the alignment models placed on a diagonal (about 45 degrees) and spread as far apart as possible. The alignment features chosen to be the target model would have high contrast (use your eyes as a gauge, if it looks good to you, it will be great for the vision system), and be unique to both the immediate image and to the surrounding area as well. Furthermore, the selected feature will be present in good quality on all substrates to be tested. In some cases, a manufacturer may want to design their masks with pattern recognition in mind -- placing alignment features in locations that are not subjected to changes as layers are processed.

ALIGNMENT PROGRAM CREATION

The creation of an Automatic Alignment program is performed through the DEKTAK Alignment Program Entry application. This application guides the user through the steps required to locate, train and test alignment models. It is recommended that you first create a measurement program (Automation Program), then while the substrate is still on the stage, create an alignment program.

This application is launched from within the main DEKTAK application by selecting the ***Create Alignment Program*** menu item under the ***Align*** menu. The ***Align*** menu is found in either the Automation Program Setup window, or the Sample Positioning window to display the Automatic Alignment Window.

To create an alignment program, select the ***New Alignment Program*** menu item under the ***File*** menu in the Alignment Program Entry application (see Figure F-3) -- or key press F2 (function key F2). This begins the program creation. A dialog box will appear asking you to select the alignment program options (see Figure F-4). These include coarse and/or fine alignment, and selection of grayscale (default) or edge based model creation. Then based upon your selections, the program guides you through the operations of model location, training, and testing.

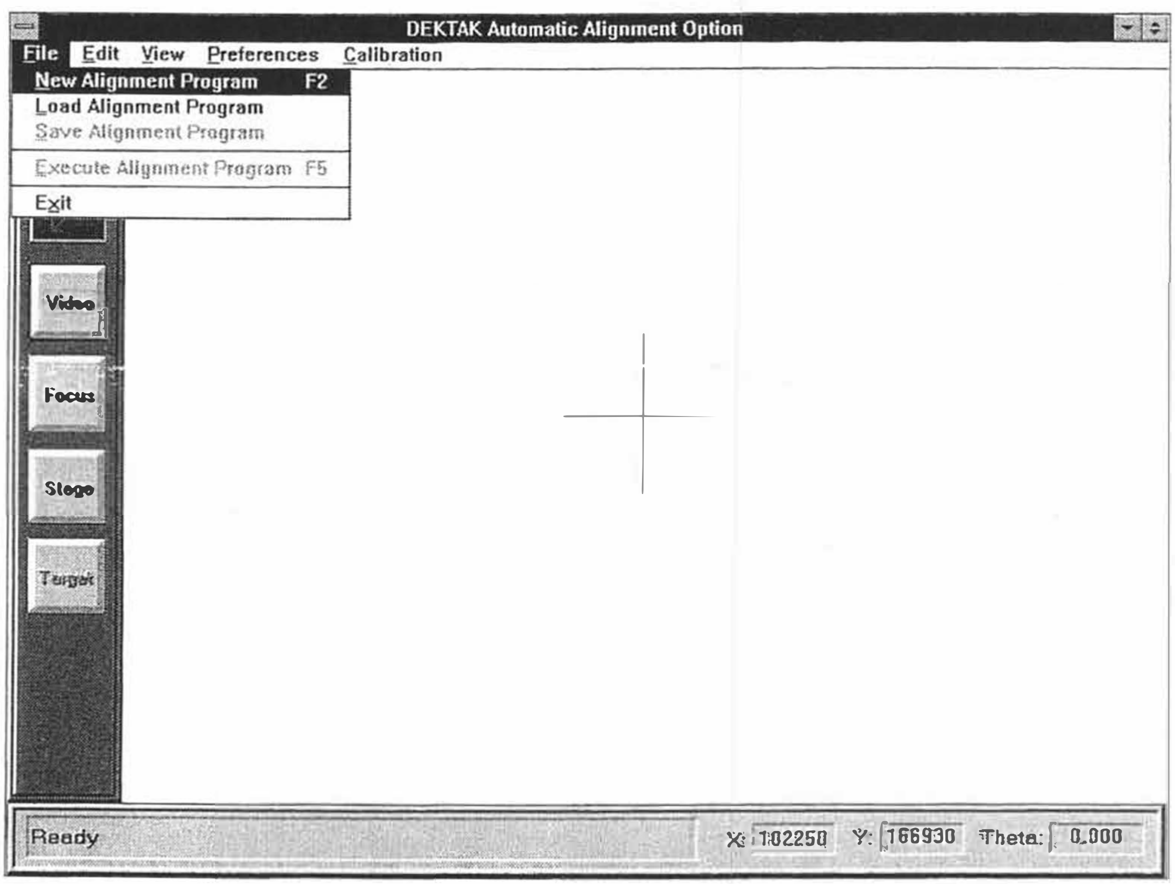

Figure F-3. Creating A New Alignment Program

COARSE ALIGNMENT

The steps to create a coarse alignment program are as follows:

1. Select coarse alignment from the Alignment Program Options dialog box (see Figure F-4).

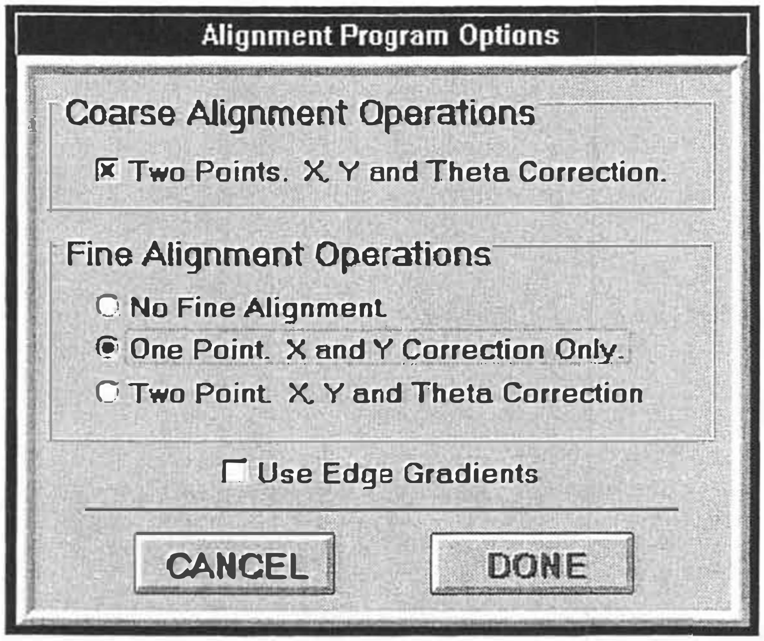

Figure F-4. Alignment Program Options Dialog Box.

2. When Coarse Alignment Operations is selected from the Alignment Program Options dialog box the Coarse Alignment Entry #1 dialog box will be displayed (see Figure F-5). Click on "Locate Alignment Feature" and "Continue".

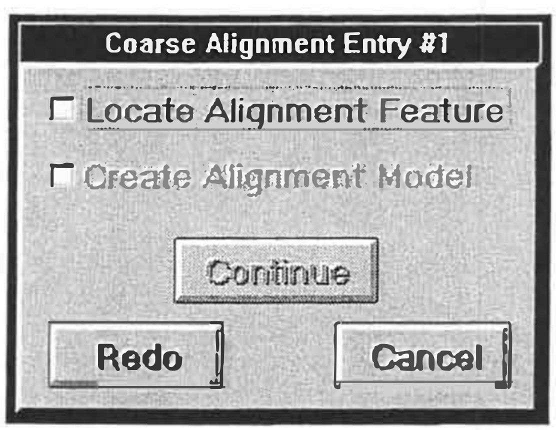

Figure F-5. Coarse Alignment Entry #1 Dialog Box

LOCATING COARSE ALIGNMENT FEATURES

Locate the alignment feature on the substrate. This is accomplished by using the positioning controls in the stage control window which automatically comes up after you make you program options. You can jog to position by using the arrow buttons. You can also position by double clicking on the stage template, or manually entering the location into the stage location boxes and press the **Move Stage** button. From within this window, you can also adjust the illumination to optimize the image contrast. Pressing **DONE** will complete this step. The "Coarse Alignment Entry #1" dialog box will be redisplayed. Click on "Create Alignment Model" and "Continue" (see Figure F-7).

> **Note:** It is recommended that the stage be positioned such that the desired feature is located directly under the crosshair on the display. This allows the system to tolerate the maximum variations in substrate placement.

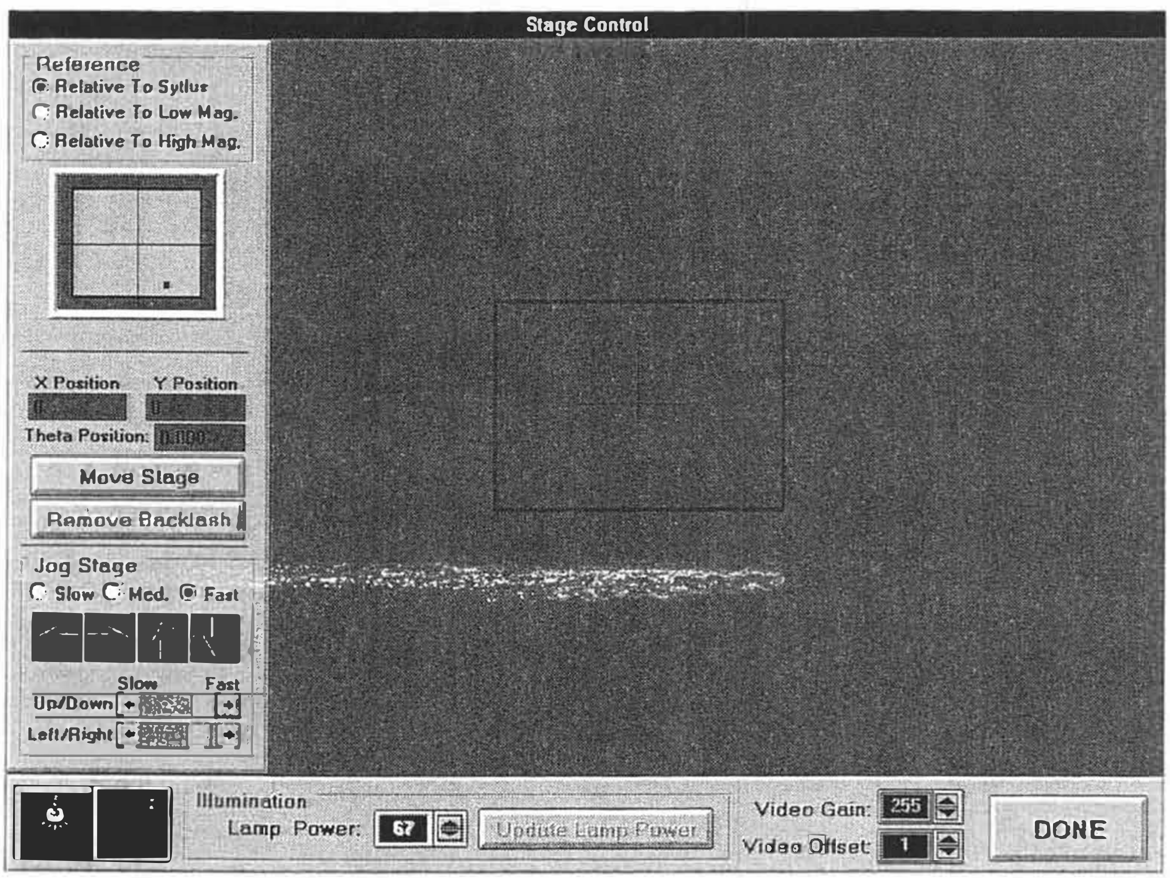

Figure F-6. Stage Control Window

CREATING THE ALIGNMENT MODEL

Create the alignment model by using the COGNEX Trackball to move a box on the screen until it completely covers the desired feature(s). To change the shape of the box, press the MIDDLE BUTTON on the COGNEX Trackball -- it anchors the upper left corner and allows changes to the bottom and right boundaries. Press the LEFT BUTTON to accept the location and shape of the box.

> **Note:** The dimensions of the box must be kept small (less than 2 x 2 inches on the video display) or the vision system will error.

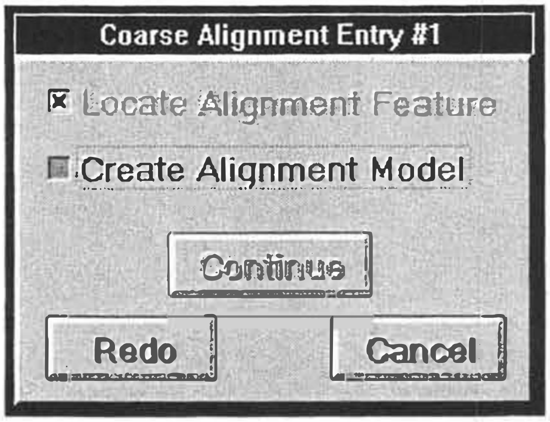

Figure F-7. Create Alignment Model Selection

After you have accepted the box location and shape, the application automatically trains and tests the model for both contrast and uniqueness. The test results are displayed in the next dialog box to appear (see Figure F-8). If the score difference between the chosen model and the next closest is large enough, then you should choose to accept it and continue on. If not, in the message window, suggestions will be displayed to accommodate usage of the selected model.

> **Note**: It is recommended that unless it is absolutely necessary, if more than one occurrence of the model is found, you should choose to create a new model. Complete uniqueness is the best solution, and will provide the most robust operation.

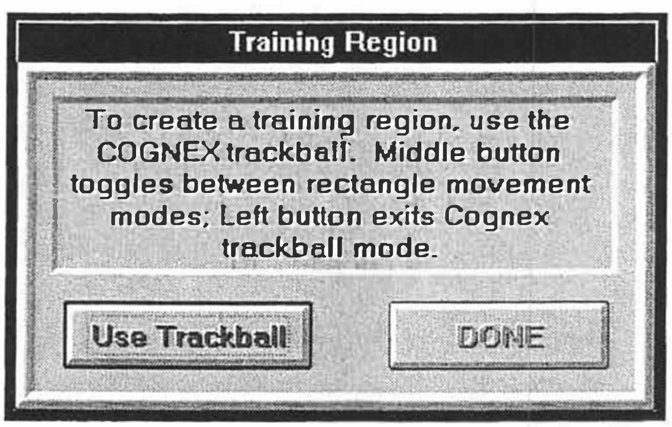

Figure F-8. Training Region Dialog Box

FINE ALIGNMENT

The steps to create a fine alignment program are as follows:

1. Select fine alignment from the program option dialog box. If coarse alignment is also selected, follow the directions for coarse alignment first. After acceptance of both coarse alignment models, the application automatically starts guiding you throughout the steps to create fine alignment models.

   Note: The steps to create fine alignment models are exactly the same as with coarse alignment, accept the addition of locating the alignment feature first through the coarse optics.

2. Locate the alignment feature on the substrate using coarse optics. This is accomplished by using the positioning controls in the stage control window which automatically comes up after you make you program options. You can jog to position by using the arrow button, double click on the stage template, or manually enter the location into the stage location boxes. From within this window, you can adjust the illumination to optimize the image contrast. Pressing **DONE** will complete this step.

   Note: It is recommended that the stage be positioned such that the desired feature is located directly under the crosshair on the display. This allows the system to tolerate the maximum variations in substrate placement.

3. Locate the alignment feature on the substrate using fine optics. This is accomplished by using the positioning controls in the stage control window which automatically comes up after you make you program options. You can jog to position by using the arrow button, double click on the stage template, or manually enter the location into the stage location boxes. From within this window, you can adjust the illumination to optimize the image contrast. Pressing **DONE** will complete this step.

   Note: It is recommended that the stage be positioned such that the desired feature is located directly under the crosshair on the display. This allows the system to tolerate the maximum variations in substrate placement.

4. Create the alignment model. This is done by using the COGNEX Trackball to move a box on the screen until it completely covers the desired feature(s). To change the shape of the box, press the MIDDLE BUTTON on the COGNEX Trackball -- it anchors the upper left corner and allows changes to the bottom and right boundaries. Press the LEFT BUTTON to accept the location and shape of the box.

   Note: The dimensions of the box must be kept small (less than 2 x 2 inches on the video display) or the vision system will error.

AUTOMATIC ALIGNMENT MODEL ACCEPTANCE

After you have accepted the box location and shape, the application automatically trains and tests the model for both contrast and uniqueness. The test results are displayed in the next dialog box to appear. If the score difference between the chosen model and the next closest is large enough, then you should choose to accept it and continue on. If not, in the message window, suggestions will be displayed to accommodate usage of the selected model.

> **Note**: It is recommended that unless it is absolutely necessary, if more than one occurrence of the model is found, you should choose to create a new model. Complete uniqueness is the best solution, and will provide the most robust operation.

AUTOMATIC ALIGNMENT PROGRAM ENTRY

After the alignment program is completed, you will close DEKTAK Automatic Alignment Program Entry application (***File/Exit***) and return to the main DEKTAK application. The final step would then be to assign the alignment program to the automation program you created previously. Save the Automation Program and return the substrate to the carrier. Now you are ready to perform automated measurement programs with alignment.

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