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SCHMITT MEASUREMENT SYSTEMS, INC.
A DIVISION OF SCHMITT INDUSTRIES, INC.

Texture Measurement System

TMS-2000 Series

TMS-2000W
TMS-2000

User's Manual

085-935-103
Revision 2
Software Version 3.11

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Part 1: Introduction

Welcome to the TMS-2000 Series

Congratulations on your purchase of TMS-2000—the fastest, most accurate, non-contact texture measurement system in the world. This advanced system is ideally suited for quantifying and mapping full surface, interrupted, and zone textures. It is currently being used successfully by major disk and wafer manufacturers. You will discover the ultimate solution to fast, accurate microroughness measurements in disk and wafer manufacturing.

The TMS-2000 series offers several features that provide for easier operation and require minimal operator training.

Feature	Benefit
RA, RMS roughness results from .1Å to 5000Å	Correlates to other measurement instruments
Lower costs than Profilometer, AFM or Interferometers	Lowest cost per measurement of any system
Resolution precision of 0.01Å, reproducibility ±0.5Å or 1%, and repeatability ±0.2Å or 0.5%	Unaffected by outside environmental conditions, including vibration, temperature, humidity, and ambient light
Typically 50 test points per second	Quadruple production throughput
Non-contact measurements cannot harm test surfaces	Increased performance/quality

Liability Limit Notice

⇒ The procedures outlined in this manual are based on the best industrial information available at the time of publication, and if followed, will permit safe operation.

⇒ Schmitt Measurement Systems, Inc. will not be liable for any damage or injury arising out of failure to follow the instructions and cautions contained in this manual.

⇒ SMS will not be liable for failure to exercise due care and caution during the operation of this equipment.

⇒ SMS will not honor our warranty on any device that has been disassembled by anyone other than SMS authorized personnel.

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Inspection and Packing Notice

This instrument has been thoroughly inspected and carefully packed prior to shipment. If the packing container is damaged upon receipt, please notify Schmitt Measurement Systems, Inc. immediately.

Upon receipt and prior to removing the instrument from its shipping container, please verify that the shipping invoice compares with the original purchase order. When removing the instrument from the shipping container, compare the items received with the shipping invoice to ensure that no error was made. If there is any discrepancy in either the order or the shipment, please contact the Schmitt Measurement Systems, Inc. Shipping and Receiving Department immediately.

Comments and Suggestions

Schmitt Measurement Systems, Inc. would be pleased if you would provide us with your comments, corrections, or suggestions relating to this manual or the Texture Measurement System. Please send to:

Texture Measurement System Manual Editor
Schmitt Measurement Systems, Inc.
2765 NW Nicolai St.
Portland, OR 97210
Phone: 503/227-5178 FAX: 503/227-5040

Additional Copies

To order additional copies of this manual, contact Schmitt Measurement Systems, Inc. and request the *Texture Measurement System User's Manual*, Part Number 085-935-103.

About This Manual

This manual is designed to enable you to proceed step-by-step through system setup and operation of the SMS Texture Measurement System. To help you find specific information; the manual has been divided into three parts:

⇒ **Part 1** Introduction

⇒ **Part 2** Scanning Operations

⇒ **Part 3** Technical Appendices

Carefully following the procedures outlined in this manual should answer most questions on how to set up and operate the system. If there are any questions regarding operation, do not hesitate to contact your sales representative or SMS directly.

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Hardware Safety Precautions

Before operating any portion of this instrument, it is important to become familiar with the procedures outlined below.

It is important to understand the dangers of using the Texture Measurement System improperly. Every effort has been made to ensure user safety and the safety of bystanders. The procedures presented here must be followed to obtain the safest possible environment for both the operators and the instrument itself.

Electrical Shock Hazards



WARNING

The voltages and currents used in this equipment are potentially dangerous and normal precautions should be exercised when operating this equipment.

Before using any portion of this equipment, complete these tasks:

⇒ Make sure that none of the components are placed in standing water.

⇒ Ensure that the power supply cord is connected to an AC source of the correct voltage and frequency. Equipment is supplied with a three-wire, grounding-type power cord. Connect only to a properly grounded three-wire receptacle.

⇒ To prevent damage, ensure that any extension cord is sized properly for its load and length.

⇒ Locate power cords and bus cables where they will not become damaged.

⇒ Turn the system power off at the Power Supply to prevent damage to system components before connecting or disconnecting any individual items.

⇒ The Power Supply and Indexer units generate heat in normal operation. When operating, do not restrict the free flow of air around the cases and do not place the cases on or near sources of heat.

⇒ Always disconnect primary AC power from the equipment before performing any service or maintenance work.

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Optical Injury Hazards



WARNING

The laser power source is enclosed in a specially designed housing to provide protection from inadvertent exposure to laser radiation. **DO NOT** attempt to perform any maintenance or disassembly of this optical assembly.

To avoid the risk of any possible exposure to harmful radiation, **DO NOT** stare or look directly into the laser beam.

Use of control or adjustments, or performance of procedures other than those specified herein may result in hazardous radiation exposure.

If the Power Supply light is on, laser power may be **ON** and radiating energy.

⇒ All lasers are classified by the Center for Devices and Radiological Health, (CDRH) of the U.S. Food and Drug Administration and by ANSI Z-136. The classification philosophy is based upon human access and potential hazards.

⇒ This equipment contains a Class II laser. Class II lasers do not have enough output power to accidentally injure a person, unless the viewer continuously stares into the laser beam.

⇒ Class II laser operation does not require any special devices for eye protection.

⇒ This instrument is specifically designed to reduce concerns of using a Class II laser device. The laser source is enclosed in the laser optical assembly to reduce the possibility of stray laser radiation. The exit aperture is clearly marked.

⇒ Maintenance beyond normal operating procedures should be performed only by factory authorized personnel.

Requirements and Installation

System Requirements

The following is a list of minimal requirements needed to use the TMS-2000 system:

⇒ IBM compatible PC with 80386 microprocessor, math coprocessor (DX) (Pentium(R) processor recommended)

⇒ 2 megabytes (MB) free hard disk space (50 MB recommended for extra data storage from files generated by the program)

⇒ 8 MB Random Access Memory (RAM)

⇒ Windows 3.1 and DOS 3.1 or later (DOS 6.0 recommended), or Windows 95

⇒ 2 serial ports, a mouse port, and a mouse

⇒ VGA compatible video resolution or better

⇒ Optional printer (for plot printing)

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Hardware Installation

The installation of the TMS-2000 series hardware is straightforward.

1. Connect each of the two serial cables from the back of the TMS-2000 unit to the back of the host computer. The cables can be connected to either serial port; the software will automatically adjust to accommodate this. See Figure 1.
2. Plug the power cord into an electrical outlet.

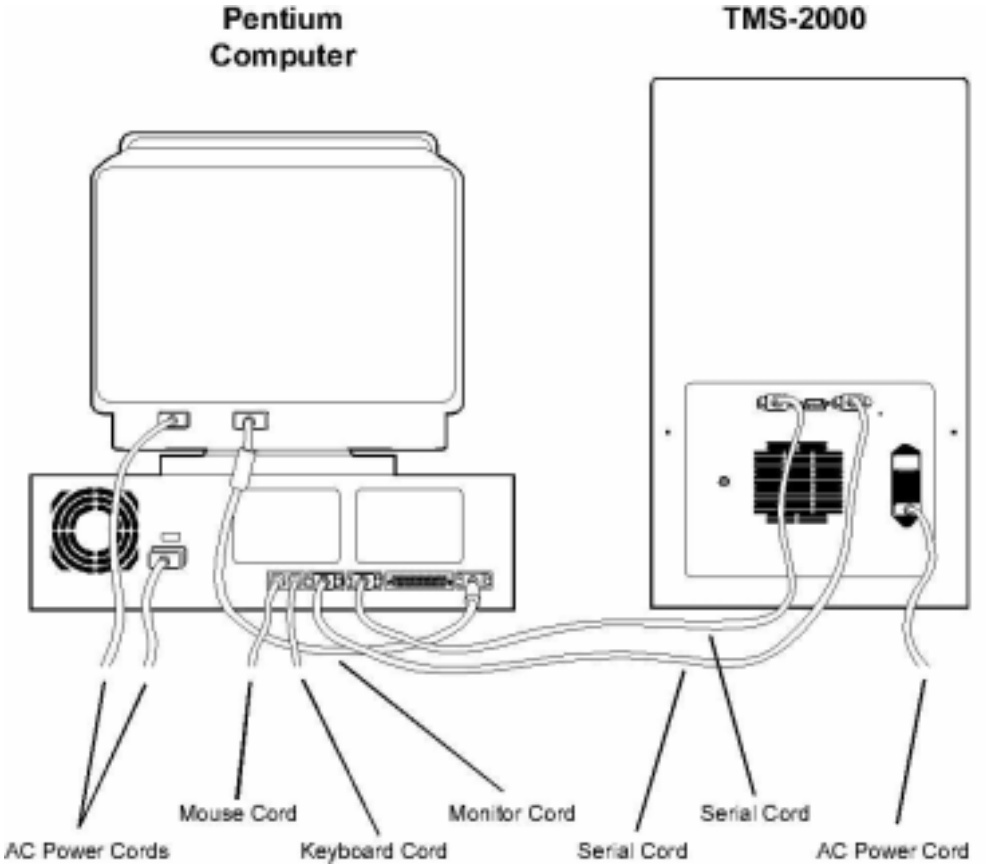


Figure 1. Hardware Installation diagram.

Software Installation

The host computer must be operating Windows 3.1 or Windows 95 to use the Texture Measurement System software.

To install the TMS-2000 system software:

1. Insert the floppy disk into the floppy disk drive.
2. From the **File** menu in the Windows Program Manager, select **Run...**.
3. Type **a:\install.exe** in the Command Line box of the Run window that appears.

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Your Notes

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Part 2: Scanning Operations

Operations Overview

Below is a brief overview of the typical tasks you can perform with the TMS-2000 series. It is important to review these tasks before you begin using the TMS-2000.

1. **Before you load a sample or start the TMS-2000 software**, make sure the power sources for all hardware are turned on. If the hardware is not turned on, you will receive an initialization error and will not be able to scan a surface.
2. Allow the instrument to warm up for at least one hour before starting scans to ensure the most accurate measurements.
3. Load the disc or wafer you wish to scan onto the mount. For more details, refer to "Preparing a Surface to Scan."
4. Specify the data formats for the measurement results. For more details, refer to "Computing Results."
5. Set up a scan definition. For more details, refer to "Editing Scanning Preferences."
6. Specify the default preferences for TZP plots. For more details, refer to "Editing TZP Preferences."
7. Run the scan. For more details, refer to "Running Tests" or "Running Assigned Scan Sequences."
8. Save the data. For more details, refer to "Saving Results."
9. Plot the data or save it to a file (for further analysis using a spreadsheet program). For more details on plotting the data, refer to "Plotting Results."

These procedures can be repeated any number of times on a given sample. Refer to the online help for a walk-through of these steps.

Preparing a Surface to Scan

This section explains how to load a sample and prepare it for scanning.

Loading a Sample

Before running a scan, power on the TMS-2000 and allow it to warm up for one hour, then load the sample in the hardware. The TMS-2000 software needs to communicate with the TMS-2000's Motion Controller and FMS Controller on startup to acquire certain information. If the hardware is not turned on when the program starts, the controllers will not be initialized and the software will not function correctly.

To load or unload a sample in the hardware:

1. Select the proper size sample holder for the sample you are loading.

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2. Place the sample holder onto the TMS mount and secure in place with the four screws that are supplied (requires a 1/8" Allen wrench).
3. Follow the loading procedure for the sample type being used:
   a) **Disk Holder:** Press the sample against the spring loaded lever of the sample holder and lower the sample, making sure it is firmly seated in the sample holder.
   b) **Wafer Holder:** Move the wafer clamp lever to the right. Lower the wafer until firmly seated, then move the lever to the left to secure the sample.

You are now ready to run the software.

Starting the Software

After the hardware and software have been installed (refer to "Requirements and Installation" in *Part 1 Introduction*), you can run the software. The power to the TMS-2000 hardware MUST be turned on before you start the software or you will receive an initialization error and will not be able to run the program.

At the time of installation, a TMS program group containing the TMS program item icons was created in Windows Program Manager.

⇒ Double-click the *TMS Program* icon in the TMS program group window.

The Texture Measurement System window shown in Figure 2 appears.

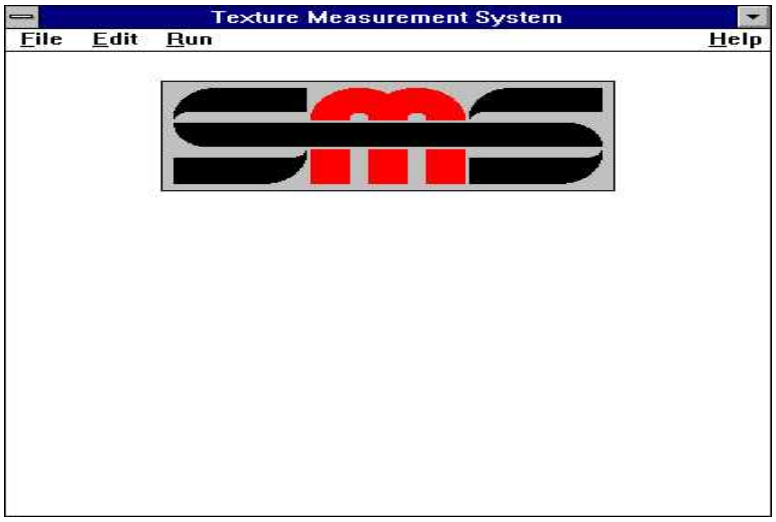


Figure 2. Texture Measurement System window.

You may begin using the TMS-2000 directly, or you may open an existing file for analysis.

To open an existing file:

1. From the **File** menu in the Texture Measurement System window, select **Open…**.
2. Choose the correct drive letter, directory name, and file name.
3. Click **OK**.

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The data for the file that was opened now appears in the Texture Measurement System window.

To close a file:

⇒ From the **File** menu in the Texture Measurement System window, select **New**.

Note *To access online help at any time during execution of the program, press the **F1** key.*

Scanning

After starting the TMS-2000 software (refer to “Starting the Software”) and loading a sample (refer to “Loading a Sample”), you can begin a scan. The following section describes the options for editing the scanning preferences and performing the scan.

Editing Scanning Preferences

It is possible to create, define, or change a measurement scan sequence from the Texture Measurement System window. To do this, you must first log in to the system. The login process ensures that only authorized personnel can change the system configuration. The procedures for logging into the system are given below.

After you log into the system and before you run a test, you may select your data preferences (refer to “Computing Results”) and your TZP preferences (refer to “Editing TZP Preferences”), or you may define a scan sequence (refer to “Creating, Defining, and Changing Scan Sequences”). You may also want to specify SPC assignments for Quality Assurance (QA) purposes (refer to “Customizing the Scan Measurement Process”).

Login Process

To log in to the system:

1. From the **Edit** menu in the Texture Measurement System window, select **Login...**.
2. Type the password and click **OK**. On the initial login, use the default password: **sms**. You can change the default password after a successful login (see instructions below).

   The Texture Measurement System window appears to be the same, but if you click the **Edit** menu now, you will see a list of configuration options that were not there before you logged in to the system.

To change the password:

1. After completing the initial login process, select **Password...** from the **Edit** menu in the Texture Measurement System window.
2. Type the current password and click **OK**.
3. Type the new password in the first box of the Change Password window and press **Enter**.
4. Retype the new password so that the system can verify it and click **OK**.

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If you do not receive an error message, the password was successfully changed.

If you forgot your password, you can log in one of two ways:

1. Use the /LOGIN command line option. (Refer to "Editing the Command Line" for more details.)

OR

1. Exit from the program, open the tms.ini file in any text editor (for example, Notepad in Window 3.1).
2. Delete the Password= line in the [SYSTEM] section of the tms.ini file and save the changes.
3. Restart the TMS-2000 software.

To log off the system: .

⇒ From the **Edit** menu in the Texture Measurement System window, select **Logout**.

Computing Results

Once you are logged into the system (refer to "Login Process") you can specify the data preferences for the scan result.

To change the data preferences:

⇒ From the **Edit** menu in the Texture Measurement System window, select **Data Preferences...**.

The Data Preferences window shown in Figure 3 appears. This window is important because it is where you set up how you view the results, what results are calculated, and what information is sent to your ASCII and SPC data files. You can also specify correlation values for the results.

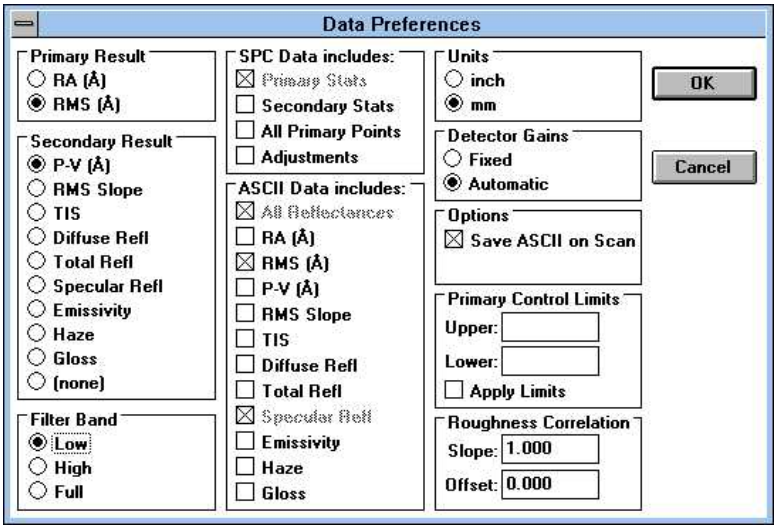


Figure 3. Data Preferences window.

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Below is a description of each section of the Data Preferences window. The description includes the section's contents and explains how to select the options available in that section.

The three boxes on the left side of the window describe the calculations that can be performed and displayed by the instrument.

The Primary Result box lets you select one of two methods for calculating surface roughness: RA or RMS (both are measured in angstroms). The statistics calculated for the primary result are always shown in the main Texture Measurement System window, along with the actual result values at each data point.

The Secondary Result box lets you choose from ten different measurement types: PV, RMS Slope, TIS, Diffuse Reflectance, Total Reflectance, Specular Reflectance, Emissivity, Haze, Gloss, or none of the above. The statistics and values of the secondary result are also shown in the main Texture Measurement System window.

The Filter Band selection can be set to either Low, High, or Full. This selection applies to both the primary and the secondary results. Certain secondary results override the Filter Band selection. For instance, total reflectance, emissivity, and RMS slope always use a Full filter band, and specular reflectance leaves the filter band blank. The minimum and maximum filter band values for both the primary and secondary results are shown in the main Texture Measurement System window.

To set the primary result, secondary result, and filter band selections:

⇒ Click the desired selection. A filled in circle indicates the current selection.

The two boxes in the middle of the Data Preferences window allow you to select what to include in the files that store your data results.

The SPC Data section allows you to select the information you would like to include in the Statistical Process Control (SPC) file. The information in this file is used for quality assurance purposes. The SPC file always includes the primary result statistics. You can also choose to include the secondary result statistics, the values at all primary points, and any correlation adjustments (the slope and offset values set in the Roughness Correlation box).

You can also store your data results in an ASCII data file. This is useful if you wish to import the data into a spreadsheet program for further analysis. The ASCII Data section in the Data Preferences window lets you specify which information to include in the ASCII file. As with the SPC data, you can include as many of the results as you like. All reflectance's found are always included in the ASCII data file; therefore the All Reflectance's and Specular Refl fields are grayed out in the ASCII Data section.

Note *Selecting* All Primary Points *in the SPC Data section and all options in the ASCII Data section will result in very large data files. It is recommended that you choose only those measurement options that are necessary for analyzing your scan results.*

To select which data to include in the SPC file or ASCII file:

⇒ Click the items you want to include or not include. A checked box indicates a selected item. (You can choose more than one item, but you cannot deselect items that are grayed out.)

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The five boxes on the right side of the Data Preferences window describe more specifics for the calculations of results.

The Units of measurement can be set to either inches or millimeters (mm) for the radius position.

The Detector Gains can be set to either fixed or automatic. It is recommended that you leave the gains on automatic. Fixed detector gains are generally used for research purposes. The automatic feature sets the gain at the first point of each scan.

To set the units of measurement or detector gains:

⇒ Click the desired selection. A filled in circle indicates the current selection.

You can specify that the ASCII file be saved automatically upon completion of a scan by selecting the Save ASCII on Scan option. If this option is selected, a "Saving ASCII" status bar appears briefly on the screen, immediately after the scan completes.

To select or deselect the save ASCII on scan option:

⇒ Click in the Save ASCII on Scan box in the Options section of the Data Preferences window.

The Roughness Correlation section lets you enter a slope and an offset value so that your results can be correlated to other machines that may use different filter bands. This section appears only if you have added the /correlate or /correlate2 options to the command line. Refer to "Appendix C Command Line Options" for more details on editing the command line.

To change the roughness correlation values:

⇒ Type the desired values in the Slope and Offset fields.

Refer to "Correlation to Other Instruments" in *Appendix B* for more detailed information on how these correlation values are used.

Editing TZP Preferences

In addition to specifying data preferences for scan results you can also specify preferences for TZP plot results.

To edit the TZP preferences:

⇒ From the **Edit** menu in the Texture Measurement System window, select **TZP Preferences...**. The TZP Preferences window will appear (see Figure 4).

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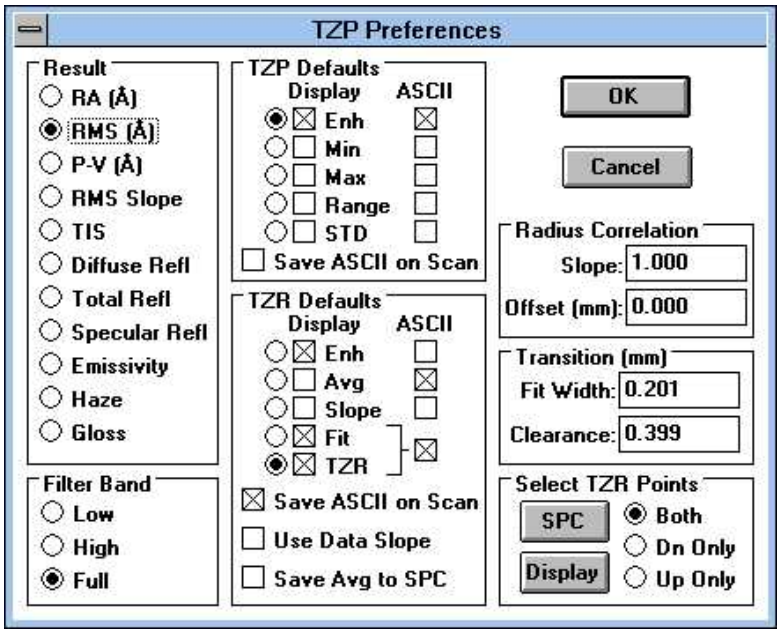


Figure 4. TZP Preferences window.

The TZP Preferences window lets you establish default measurement and display settings for TZP plots. These defaults will apply to all TZP plots but can be changed for individual plots using various menu options in the TZP plot window. (For a detailed explanation of TZP plots see “TZP Plot Option.”)

The Result section of the TZP Preferences window lets you select the default measurement type to be used for TZP plots. There are 11 different measurement options available: RA, RMS, PV, RMS Slope, TIS, Diffuse Reflectance, Total Reflectance, Specular Reflectance, Emissivity, Haze, and Gloss.

The Filter Band section lets you specify the default filter band for TZP plots. The filter band selection is used to control the range of surface structures over which the roughness measurements are calculated. The available filter band options are Low, High, and Full.

To set the results and filter band selections:

⇒ Click the desired selection. A filled in circle indicates the current selection.

The TZP Defaults section of the TZP Preferences window lets you specify which data result you want displayed in the TZP plot window. The TZP data available for display are: enhanced average, minimum, maximum, range, and standard deviation.

To select or deselect the TZP data result to display:

⇒ Click in the box to the left of the desired data. A checked box indicates the current selection. Any or all of the available statistics may be selected for display.

The TZP Defaults section also lets you specify the data type of the active cursor when a TZP plot is first displayed.

To specify the data type of the active cursor:

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⇒ Click in the circle to the left of the desired data type. A filled in circle indicates the current selection. Make sure the selected result for the cursor is also selected to be displayed.

You can choose any or all of the available TZP data for inclusion in an ASCII TZP file.

To select the TZP data to include in the ASCII file:

⇒ Click in the box to the right of the desired data. A checked box indicates the current selection. Any or all of the available data may be selected for inclusion in the ASCII file.

You can also specify that an ASCII data file be saved upon completion of a scan by clicking in the Save ASCII on Scan box.

The TZR Defaults section of the TZP Preferences window is similar to the TZP Defaults section. In the TZR Defaults section you can specify the data result to display, the data type of the active cursor, and the TZR data to include in the ASCII file. The process for setting these options is identical to the process for setting TZP Defaults described above. The TZR data available for display are: enhanced average, average, slope, fit and TZR.

Two additional default options can be selected in the TZR Defaults section: Use Data Slope and Save Avg to SPC. Selecting Use Data Slope causes the TZR plot to use a line fit instead of an average fit for the data adjacent to the transition zone. Selecting the Save Avg to SPC default option saves all of the average values to the SPC file (but only after a scan is run). To select Use Data Slope or Save Avg to SPC, click in the box next to the desired selection.

The Radius Correlation variables allow you to establish correlation of the radius data from machine to machine. This may be necessary if you are using different machines for locating surface roughness and need to correlate the outputs from the different machines so they match. The Radius Correlation Slope variable lets you specify the scaling factor of TZR radii you want to correlate. The Radius Correlation Offset variable gives you the ability to offset the dimensional positioning of the TZR radius point

To specify the slope and offset values:

1. Click in the box of the value you want to change.
2. Type the new value.

The Transition Fit Width and Clearance variables let you customize the transition zone measurement process. Transition width indicates the width of the transition zone from beginning to end. Change this variable to adjust the width of the transition over which the transition slope and line fit are to be computed. The Transition Clearance variable lets you specify the distance from the center of the transition zone to the point where the fly zone line fit starts.

Note *The Fit Width and Clearance variables are set to predetermined values, which are based on experimental data. You only need to change these values if the default settings are not appropriate for your sample.*

To specify the fit width and clearance values:

1. Click in the box of the value you want to change.
2. Type the new value.

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Finally, the Select TZR Points section of the TZP Preferences window gives you access to additional customization options for TZR plots. These options are described in detail in "TZR Preferences".

After you have finished editing the TZP preferences, click **OK** to close the TZP Preferences window. Remember that the TZP preferences define default settings for all TZP plots. These defaults can be changed for individual TZP scans using the options described in "TZR Preferences."

Creating, Defining, and Changing Scan Sequences

This section is very important because this is where you customize the individual scans you will run. To edit a scan sequence, you must be successfully logged in to the system (refer to "Login Process"). The basic operations you can perform from the Edit Scan Sequence window are described below.

To edit a scan sequence:

⇒ From the **Edit** menu in the Texture Measurement System window, select **Scan Sequence...**.

The Edit Scan Sequence window shown in Figure 5 appears. You can now open, create, rename, save, or delete a scan sequence, as well as change its properties.

To create a new scan sequence:

⇒ From the **File** menu in the Edit Scan Sequence window, select **New...**.

The word [default] now appears in the Scan Sequence field. After entering the information for the new scan sequence, you can save it under a new name by selecting **File...Save... or Save As...**.

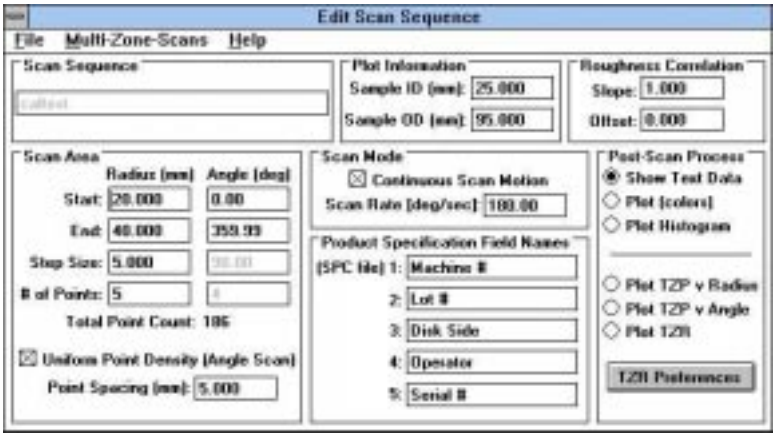


Figure 5. Edit Scan Sequence window.

To save a new scan sequence:

1. From the **File** menu in the Edit Scan Sequence window, select **Save** or **Save As...**. Both options prompt you to type a new scan sequence name.
2. Type the new scan sequence name and click **OK**.

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To save a current scan sequence under the same name

⇒ From the **File** menu in the Edit Scan Sequence window, select **Save**.

To save a current scan sequence under a different name:

1. From the **File** menu in the Edit Scan Sequence window, select **Save As...**.
2. Type the new scan sequence name and click **OK**.

To open an existing scan sequence:

1. From the **File** menu in the Edit Scan Sequence window, select **Open...**.
2. Select the scan sequence to open from the list and click **OK**.

To rename a scan sequence:

1. From the **File** menu in the Edit Scan Sequence window, select **Rename...**.
2. Type the new name and click **OK**.

To delete a scan sequence:

1. From the **File** menu in the Edit Scan Sequence window, select **Delete...**.
2. Select the scan sequence to delete from the list and click **OK**.

You can password protect a scan sequence using the **Write Protect...** option under the **File** menu in the Edit Scan Sequence window. A protected scan will have "(Password Protected)" displayed under the sequence name. The correct password is required to save any changes.

To write protect a scan sequence:

1. From the **File** menu in the Edit Scan Sequence window, select **Write Protect...**.
2. The Change Scan Sequence Password window will appear. Enter a password for the currently selected scan sequence.
3. Reenter the password and click **OK**.

To change the password of a scan sequence:

1. From the **File** menu in the Edit Scan Sequence window, select **Write Protect...**.
2. The Write Protected Scan Sequence window will appear. Enter the password for the currently selected scan sequence and click **OK**.
3. The Change Scan Sequence Password window will appear. Enter a new password for the currently selected scan sequence.
4. Reenter the new password and click **OK**.

Note *To remove password protection, enter a "blank" password.*

The properties of the Edit Scan Sequence window are Scan Sequence, Scan Area, Plot Information, Roughness Correlation, Scan Mode, Product Specification Field Names, and Post-Scan Process. These properties are described below and can be edited to suit each particular scan.

The name of the current scan sequence is displayed in the upper-left corner of the window. If there is no scan sequence opened or it is new, [default] is displayed instead.

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The Scan Area section is where you define the scanning boundaries. The start radius is the radius location where the scan will begin. The end radius is where the scan will stop. These radii are measured from the center of the scanning area. The radius step size describes how far to step from each radius measurement to the next. This value is directly dependent on the radius number of points, so that if one of these values is changed, the other is recalculated. The radius number of points tells the system how many radii to measure values on.

The start angle defines the beginning angle position for the scan. The end angle describes where the scan stops. To scan a complete circle these values should be 0.00 and 359.99, respectively. The angle step size and angle number of points are dependent on each other. They describe the number of angles to measure points on, and if one of these values is changed, the other is recalculated.

To change the radius and angle parameters:

1. Click in the box of the parameter you want to change.
2. Type in the new value.

The total point count is calculated by the system and cannot be changed manually. It depends on the number of points for both the angle and the radius, as well as whether or not the uniform point density box is checked. If you change any of these values, the system automatically recalculates the total point count.

The uniform point density allows you to specify the distance between the points scanned on each radius. It therefore affects the angle step size and angle number of points. If the box is checked, the angle step size and angle number of points values will be grayed out and you will not be able to change them. This means that the points will be the same distance apart on each radius, and that distance will be specified in the point spacing box. This option gives a more uniform coverage of the surface because more points will be scanned on the outer radii than on the inner.

If the uniform point density is not checked, you can change the values of the angle step size and angle number of points, but not the point spacing. This option means that the same number of points are checked on each radius and therefore will be further apart on the outer radii than on the inner. Further out on the disk or wafer the surface coverage will be less.

To toggle the uniform point density on or off:

⇒ Click the Uniform Point Density box. A checked box indicates it is selected. Type the value for the point spacing in the box below.

The Plot Information section lets you specify information for the graphic that appears in the Run window when you begin a scan and when you plot the data. This graphic gives a perspective on the sample being scanned. The Sample ID field is for the inner diameter of the sample. If there is no hole in the center of the sample, this value should be set to 0.00. The Sample OD specifies the outer diameter of the sample.

To edit the plot information:

1. Click in the box of the parameter you want to change.
2. Type the new value.

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The Roughness Correlation section gives you the capability to customize the instrument correlation for each different scan sequence you define. This section appears only if you have added the /correlate2 option to the command line. Refer to "Appendix C Command Line Options" for information on editing the command line and how the correlation values are used.

To specify the slope and offset values:

1. Click in the box of the value you want to change.
2. Type the new value.

The Scan Mode section allows you to choose to continuously scan the surface without stopping, at the scan rate specified. If you do not select this option, the scan stops at every point it scans from the start to the end radii and angles.

To choose the continuous scan option:

1. Click the Continuous Scan Motion box. A checked box indicates it is selected.
2. Type the value for the speed to scan the surface in the Scan Rate field.

   If the uniform point density box is not checked, this value is measured in either millimeters (mm) per second (sec) or inches (in) per second, depending on the units you specified in the Data Preferences window. Otherwise it is measured in degrees (deg) per second.

The Product Specification Field Names section is used for the user entered file information. You can customize the information you want saved in the file. The first item is also used for naming the files when SPC runs are performed using this scan sequence.

To edit the product specification field names:

1. Click in the box of the field you want to change.
2. Type the new field name.

The Post-Scan Process section of the Edit Scan Sequence window lets you specify the type of display you want to see after a scan is performed. This selection will determine what is automatically displayed after a scan completes.

There are six post-scan process preferences to choose from: Show Text Data, Plot (colors), Plot Histogram, Plot TZP v Radius, Plot TZP v Angle, and Plot TZR. Show Text Data is the default selection and will display the data results for the scan in the main window. Choosing any of the Plot options will cause that particular plot type to be displayed immediately after the scan completes.

Note *If TZR or TZP plots are chosen, then an ASCII TZR or TZP file can be automatically saved. If TZR is chosen, then an SPC scan will cause the TZR SPC file to be generated.*

To choose a post-scan process option:

⇒ Click the desired selection. A filled in circle indicates the current selection.

The TZR Preferences window (see Figure 6) allows you to specify a Transition Fit Width and Clearance and a Radius Correlation Slope and Offset. You can set defaults for the TZR Plot and you can also specify which TZR Points you want to focus on in the TZR display and the SPC file.

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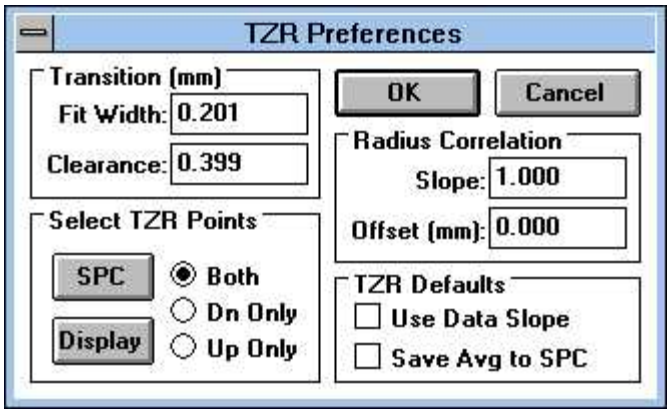


Figure 6. TZR Preferences window.

The Transition Fit Width and Clearance variables let you customize the transition zone measurement process. Transition width indicates the width of the transition zone from beginning to end. Change this variable to adjust the width of the transition over which the transition slope and line fit are computed.

The Transition Clearance variable lets you specify the distance from the center of the transition zone to the point where the fly zone line fit starts.

Note *The Fit Width and Clearance variables are set to predetermined values, which are based on experimental data. You only need to change these values if the default settings are not appropriate for your sample.*

To specify the fit width and clearance values:

1. Click in the box of the value you want to change.
2. Type the new value.

The Radius Correlation variables allow you to establish correlation of the data from machine to machine. This may be necessary if you are using different machines for locating surface roughness and need to correlate the outputs from the different machines so they match. The Radius Correlation Slope variable lets you specify the scaling factor of TZR radii you want to correlate. The Radius Correlation Offset variable gives you the ability to offset the dimensional positioning of the TZR radius point.

To specify the slope and offset values:

1. Click in the box of the value you want to change.
2. Type the new value.

The TZR Defaults section of the TZR Preferences window lets you specify two default options for TZR Plots: Use Data Slope and Save Avg to SPC. Selecting Use Data Slope causes the TZR plot to use a line fit instead of an average fit for the data adjacent to the transition zone. Selecting the Save Avg to SPC default option saves all of the average values to the SPC file.

To select the TZR defaults:

⇒ Click the desired selection. A checked box indicates the item is selected.

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The Select TZR Points section of the TZR Preferences Window gives you the ability to isolate certain parts of the TZR plot for further analysis. You can choose the type of the transition you want, as well as specific items of interest along the transition area.

You can choose the transition to consider in one of three ways:

1. Select **Both** to choose Up and Down transition areas. This is the default setting.
2. Select **Dn Only** to choose the Down transition.
3. Select **Up Only** to choose the Up transition.

To choose the desired transitions:

⇒ Click the desired selection: **Both, Dn Only**, or **Up Only**. A filled in circle indicates the item is selected.

You can select individual transition items to display or save to an SPC file.

To select the individual transition items to save to an SPC file:

1. Click the SPC button on the TZR Preferences window. The TZR Selection for SPC window will appear (see Figure 7).
2. Individual transition items are identified as slope, value or radius *and* by their location along the transition area. The alphanumeric code US2 (Up Slope 2), for example, signifies the value of the Up transition slope.

   Click the desired selection. A checked box indicates the item is selected. You can select any or all of the individual transition points shown in the TZR Selection for SPC window.
3. Click **OK** to return to the TZR Preferences window.

Note *The individual transition points selected in the TZR Selection for SPC window will only be saved to the SPC file if the corresponding transition area was also selected in the TZR Preferences window. If not, then a blank field will be contained in the SPC file..*

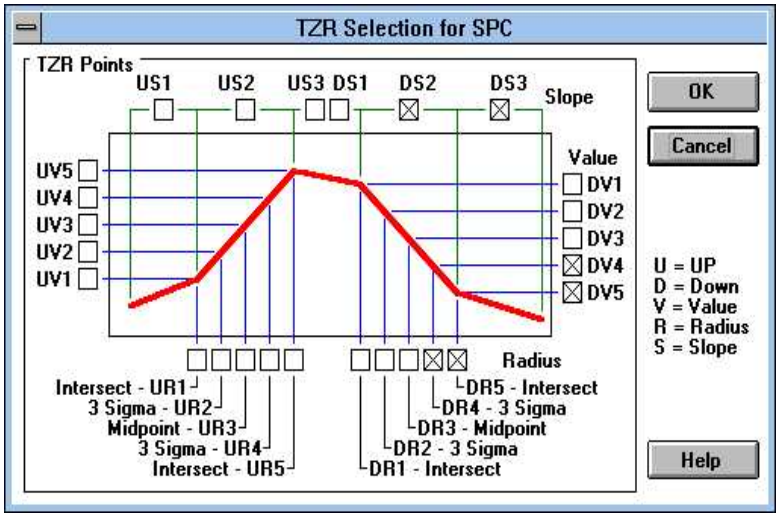


Figure 7. TZR SPC Item Selection window.

To select individual transition items to display on the TZR plot:

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1. Click the Display button on the TZR Preferences window. The TZR Display Selection window will appear (see Figure 8).
2. Individual transition items are identified as slope, value or radius *and* by their location along the transition area. The alphanumeric code US2 (Up Slope 2), for example, signifies the value of the Up transition slope.

   Click the desired selection. A filled in circle indicates the item is selected.

   You can select only one slope item, one transition value, and one transition radius in the TZR Display Selection window.
3. Click **OK** to return to the TZR Preferences window.

Note *The individual transition points selected in the TZR Selection for Display window will only be displayed on the TZR plot if the corresponding transition area was also selected in the TZR Preferences window. If not, then "-----" will be displayed in its place.*

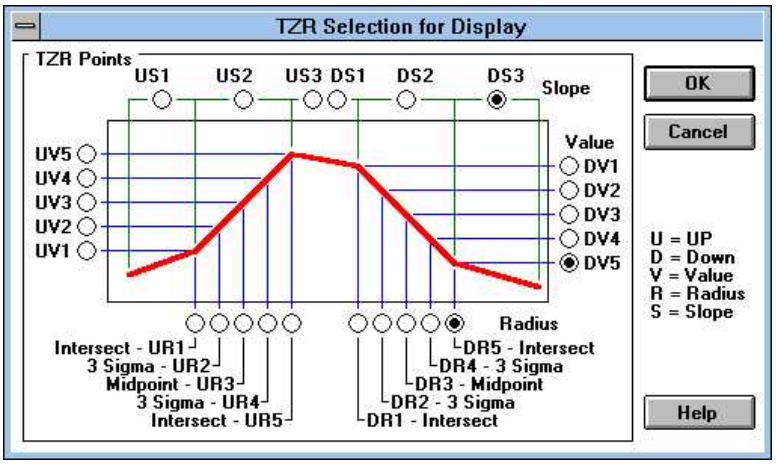


Figure 8. TZR Display Selection window.

After you have finished editing all desired selections in the TZR Preferences window, click **OK** to close the window and return to the Edit Scan Sequence window. (For more information on TZR plot options refer to "TZR Plot Option.")

To save all scan sequence settings:

⇒ From the **File** menu in the Edit Scan Sequence window select **File Save...** or **Save As...**.

To exit from the Edit Scan Sequence window:

⇒ From the **File** menu in the Edit Scan Sequence window, select **Close**.

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Zone Scanning Options

A useful feature in the TMS-2000 series is the capability to divide a surface into zones and then define a unique scan sequence for each zone. You can specify up to nine zones. To specify a scan sequence for each zone, perform the procedures described in the *Creating, Defining, and Changing Scan Sequences* section. When you have created the scan you want for the zone, name the scan sequence in the format NAME:#, where NAME is whatever scan sequence name is appropriate and # is a single-digit number in the range 1-9 of the scan zone. The numbers do not have to be consecutive, nor do they have to start with 1. The NAME must be the same for different zones of the same scan sequence.

When you have defined a multi-zone scan sequence, a sequence name of the format NAME: is automatically created for the combination of all the zones. Now when you run a scan and select a name from the given list, the option of running a combined scan of all the zones or running each individual zone scan is available to you. If you select the name of a multi-zoned scan, the words *Multi Zone Scan* appears in red at the right side of the Choose the Name of the Scan Sequence to Run window. This also appears if you are selecting a multi-zone scan when you are assigning SPC scans to functions keys (refer to "Customizing the Scan Measurement Process").

For example, suppose you want to run a scan with three different sequences for three different zones. You could name these zone sequences MyScan:1, MyScan:2, and MyScan:8. The scan sequence named MyScan: would also be created as a combination of the zones 1, 2, and 8.

Now suppose you have chosen to run MyScan: from the **Select Test…** option from the **Run** menu in the Texture Measurement System window. When the scan is finished and the data displayed, Zone:128 appears in red in the Texture Measurement System window above the Scan Sequence box (see Figure 9). This means the combined data of zones 1, 2, and 8 are displayed in the window.

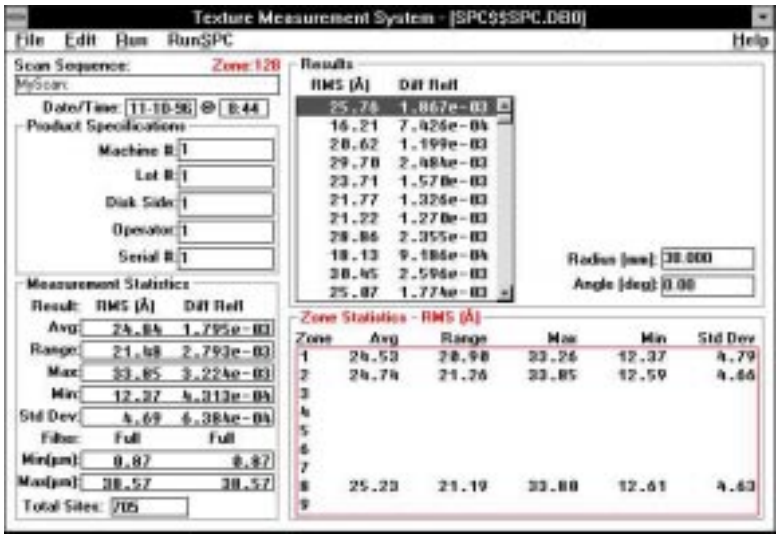


Figure 9. Multi-zone Scan Results.

If you wanted to plot the data, Zone:128 would also appear in red in the plot window above the Filter Band statistics. Refer to "Plotting Results" for more details on plotting data.

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To plot the data from a multi-zone scan:

⇒ From the **File** menu in the Texture Measurement System window, select **Plot**.

You may choose to display all the zones or only a subset of them. You must always select at least one zone.

To select the zones to display:

1. From the **Edit** menu in the Texture Measurement System window or a plot window, select **Zones**. The Select Zones window shown in Figure 10 appears.
2. Select the zones you want to display. Checked boxes indicate selected zones.

Note *This menu option appears only when you have plotted or run a multi-zone scan.*

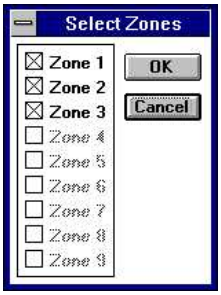


Figure 10. Select Zones window.

A Multi-Zone-Scans menu option appears in the Edit Scan Sequence window (refer to “Customizing the Scan Measurement Process”). When you select this menu option, it takes you directly to the help file that explains multi-zone scans. The **Help** button in the Enter Name of New Scan Sequence window also goes directly to this help screen.

Specifying Movement Parameters

To change the linear and rotation movement parameters (for example, the home switch), you must be successfully logged in to the system (refer to “Login Process”). Some of the parameters are factory set and cannot be changed (they will appear grayed out).

Once you change the parameters in these windows they are saved. You cannot cancel the changes. These windows are useful for positioning the sample before reconfiguring the Detector Setup parameters

Note *It is not recommended that you change the factory set default calibration parameters because system performance may decrease. Please contact a factory-authorized representative if you feel any changes are needed.*

To change the movement parameters:

1. From the **Edit** menu in the Texture Measurement System window, select **Motion Parameters...**.
2. While holding down the left mouse button, select either **Radius Stage** or **Angle Stage**.

   Figure 11 shows the Radius Stage Setup window; Figure 12 shows the Angle Stage Setup window.

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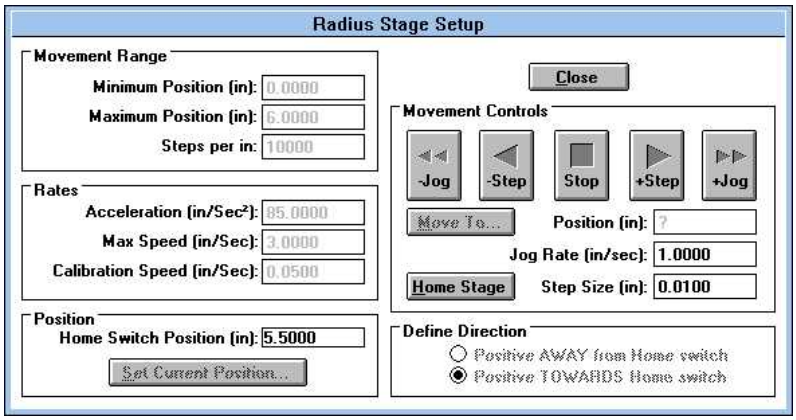


Figure 11. Radius Stage Setup window.

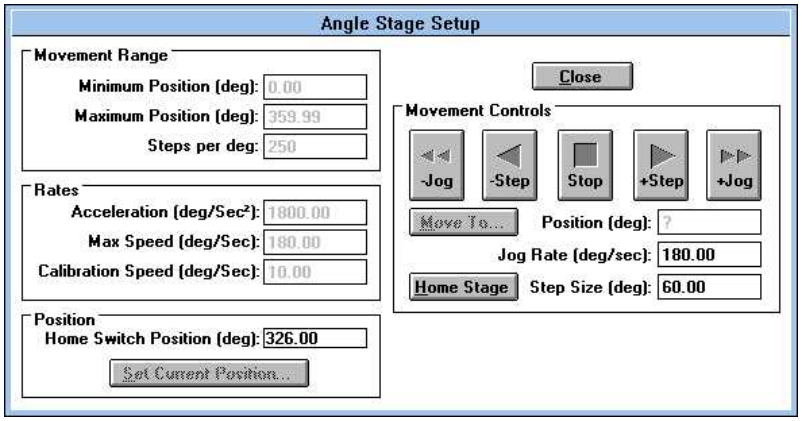


Figure 12. Angle Stage Setup window.

The Movement Range box of each window describes the range and resolution of the motion stage. The Minimum Position and Maximum Position fields of each window set the range in which the stage can be programmed to move. The Radius Stage is measured in inches (in) and the Angle Stage is measured in degrees (deg). The Steps per deg/in field sets the number of motor steps required to make the stage move the programmed distance.

The Rates box of each window shows the performance parameters for the mechanical properties of the stage. The Acceleration field is the fastest rate the motor can change speed under all load conditions. The Max Speed describes the fastest rate the motor can run the stage. The Calibration Speed is the fastest speed the motor can stop and detect the home switch without moving beyond it.

The Position box of each window gives the current home switch location. The home switch is positioned relative to the center of the sample. The value is set at the factory and is different for disks than for wafers. All location references for the instrument are in reference to this position.

The parameters in the movement range, rates, and position boxes are factory set and can only be changed by contacting a factory authorized representative.

The movement controls box allows you to position the sample under the source optics manually. It functions the same as the manual control. Refer to "Manually Controlling the Instrument" for more details on these movement controls.

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The Define Direction section appears only in the Radius Stage Setup window and defines the direction of the motion of the stage relative to where the home switch is located. The Positive AWAY from Home Switch is used when the home switch is at the end of the stage away from the source optics, and the TOWARDS option is used when the home switch is at the end of the stage under the source optics.

To exit from the radius or angle stage setup window:

⇒ Click **Close**.

Detector Setup

To set the gains of the specular, low band, and high band detectors you must be logged into the system (refer to “Login Process”). You also have to position a sample under the source optics using manual control (refer to “Manually Controlling the Instrument”), or using the Angle Stage and Radius Stage setup windows (refer to “Specifying Movement Parameters”).

Note *The calibration parameters of the detectors are factory set and cannot be changed (they will appear grayed out).Please contact a factory authorized representative if you feel the detectors need recalibrating.*

To change the detector setup:

⇒ From the **Edit** menu in the Texture Measurement System window, select **Detector Setup...**.

The Detector Setup window shown in Figure 13 appears. Most of the values in this window are factory set and appear grayed out. If the FMS Controller is not successfully initialized, you will not be able to edit any values. The changes you make in this window will not be saved until you click **OK**.

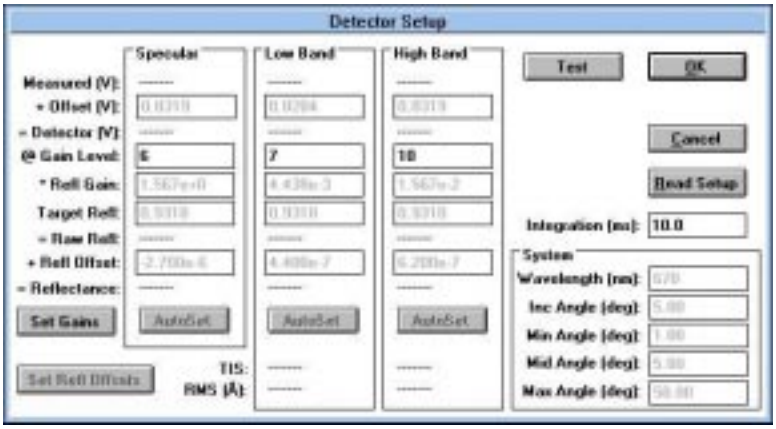


Figure 13. Detector Setup window.

A description of each of the fields is given below. Please refer to the online help for more details.

The integration field in the Detector Setup window specifies the duration of the measurement at a particular point.

To specify the integration time:

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1. Click in the Integration field box.
2. Type the value.

The system configuration parameters are displayed in this window. They generate the boundaries used for the Filter Band. These parameters are the wavelength of the laser source, the incident angle at which the light strikes the sample, and the angles representing the source optics. Refer to the online help for more details on these angles.

The values for the specular, low, and high band detectors are displayed when you request a measurement by clicking the **Test** button with the sample in place. The Measured field shows the raw measured voltage of each detector. The Offset is added to the Measured voltage to calculate the value for the detector. The @Gain Level field defines the gain level at which the detector amplifier operates. This is a whole number between zero and seventeen.

To change the gain level:

1. Click the **Set Gains** button

   OR

2. Type the new values.

The gain levels set here are the gain levels used when Fixed Detector Gains are selected under Data Preferences (see Figure 3: Data Preferences window).

Note *If the gain level is set too high, the Measured voltage will be limited to about 4.5 volts. The amplifiers might also overload so that the Measured voltage is almost zero.*

The Refl Offset compensates for optical noise in the system. The Reflectance is calculated by adding the Refl Offset to the Raw Refl. This is the final value that computes all the filter band results for the instrument.

The TIS is the ratio of the reflectance of the particular band (Low or High) to the specular reflectance. The RMS is computed from the TIS and is not adjusted by the correlation slope and offset parameters.

The serial number is the serial number of the TMS-2000 that is hooked up to your computer.

When you are satisfied with the changes you have made to the gain level and/or the integration time, click **OK**. This will save your changes. If you want to test the setup, click the **Test** button. The **Read Setup** button reinitializes the FMS Controller and reads the Detector Setup parameters. When you click this, any changes made are lost.

Customizing the Scan Measurement Process

If you are interested in running Statistical Process Control (SPC) scans to process information to conform to the ISO-9001 standard or other Quality Assurance programs, this window will be important to you. It allows you to assign function keys and function/control/shift key combinations to scan sequences so that you can run quick tests to generate SPC files by simply pressing those function keys. From this window (see Figure 14) you also specify the location where the SPC files are sent, and the names for those files. You are allowed to specify up to 1,000 SPC file names.

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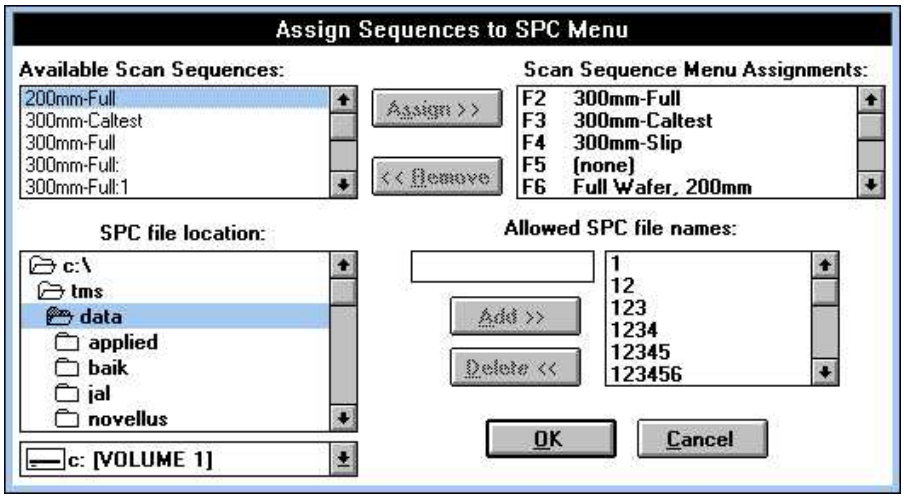


Figure 14. Assign Sequences to SPC Menu.

To assign or unassign function keys to or from available scan sequences:

1. From the **Edit** menu in the Texture Measurement System window, select **QA (SPC) Assignments...**.
2. Select a scan sequence to assign from the Available Scan Sequences list.

   If you select a multi-zone scan, the words Multi Zone Scan appear in red above the list box.
3. Select a function key (or function/control/shift key combination) from the Scan Sequences Menu Assignments list.
4. Click either the **Assign>>** button to assign a scan sequence to a function key or the **<<Remove** button to unassign a scan sequence from a function key.
5. Select the path in the SPC file location box where you want all of your SPC files to be stored.
6. Make sure at least one name appears in the Allowed SPC file names list box. If no name appears, the software will not accept the SPC changes you have made. Delete an existing name by highlighting it and clicking **Delete<<**, or enter a new name by typing it in the box above the **Add>>** button and then clicking **Add>>**.

Note *If each of these procedures are done, a new menu will appear in the Texture Measurement System window with the title Run SPC. Refer to "Running Assigned Scan Sequences" for more details.*

Now when you are in the Texture Measurement System window and need to generate an SPC file, just press the function key or function/control/shift key combination for the scan you want to run.

Running Tests

After you have specified your scan sequence and data preferences, you are ready to test your sample.

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To run an initial scan:

1. From the **Run** menu in the Texture Measurement System window, select **Select Test...**.
2. Select the scan sequence name and click **OK**.

   When you select a scan that is multi-zone, the words Multi Zone Scan appear in red to the right of the list box.
3. Type the specifications and click **OK**.
4. Type a file name and click **OK**.

   A Run window appears (see Figure 15) that shows the Scan Sequence Name, status, sequence number, location, measurement result of the current scan, and a graphical display of the actual scan. The sequence number shows the current zone being measured when running a multi-zone scan.
5. To begin the scan, click the Start button in the Run window.
6. If you would like to stop the scan at any time, click **Stop**.
7. If you would like to exit from the Run window without finishing the scan, click **Abort**.

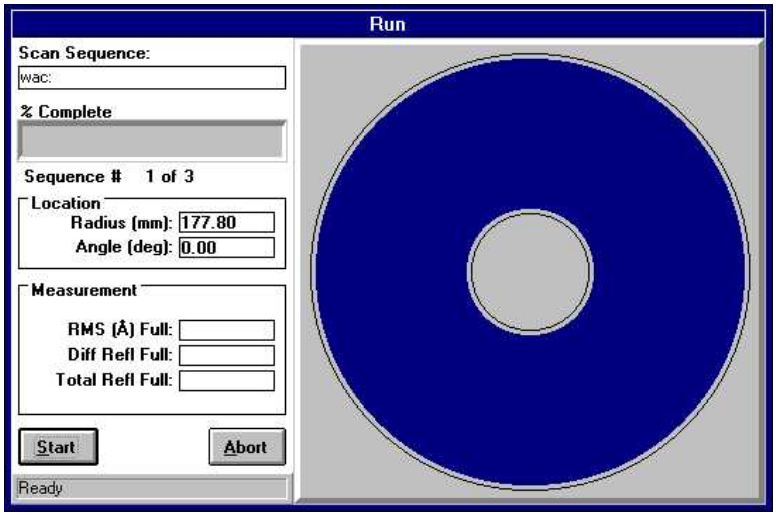


Figure 15. Run window.

Immediately after the scan completes, the post-scan process (e.g., TZR plot) specified in the Edit Scan Sequence window will run and the results will be displayed (see "Creating, Defining, and Changing Scan Sequences"). All of the appropriate data files will be saved.

After the initial scan is performed, two other menu options are available for running a test. These choices both repeat the previous scan using the same product specifications.

To repeat a scan and save the data to a new file:

1. From the **Run** menu in the Texture Measurement System window, select **Quick Test**.
2. Click the **Start** button in the Run window.

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3. When the scan is finished, type the new data file name when prompted and click **OK**.

To repeat a scan and have the data automatically saved to a default file:

⇒ From the **Run** menu in the Texture Measurement System window, select **Quick Run**.

This option automatically starts the scan and saves the data to a file called SPC$$SPC.DB0 when the scan is completed.

Running Assigned Scan Sequences

If scan sequences have been properly assigned (refer to "Customizing the Scan Measurement Process"), it is possible to run scan sequences using function keys on the keyboard and save those results in an SPC file.

To run customized scan sequences:

1. From the **Run SPC** menu in the Texture Measurement System window, select the scan sequence to run.

   Scan Sequences are assigned to this menu using the Assign Sequences to SPC menu window (see Figure 13).

   The function key associated with the scan sequence is to the right of the scan sequence name in the menu. Once you are familiar with these function keys, you can press the key on the keyboard for the scan sequence you want and bypass the menu.
2. Type the specifications in the next window and click **OK**.

   The first item specified also identifies the destination file name. The list of names for this field is entered in Allowed SPC Filenames in the Assign Sequences to SPC menu window.
3. Click **Start**.
4. When the scan is finished the data results are automatically saved in the file SPC$$SPC.DB0. The SPC data is saved in the SPC file you specified in step 2 above.

Note *An SPC file will be saved as SPC$$SPC.DB0, a TZP SPC file will be saved as SPC$$SPC.DP0, and a TZR SPC file will be saved as SPC$$SPC.DR0.*

Viewing Results

After a test has been run, the results appear in the selected display window. The particular Scan Sequence name is given at the top of the window, along with the date and time the scan was performed, and the zone status in red (if the scan was multi-zoned).

Note *When the zones are shown, they appear as a sequence of single-digit numbers not separated by commas. For example, in the window below, Zone:123 means that zones 1, 2, and 3 have their results displayed in the window. When more than one zone is selected for display, the result displayed is a compilation of all the zones chosen.*

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The Measurement Statistics box shows the result format, average, range, maximum, minimum, and standard deviation of the data. These statistics are shown for both the primary result and the secondary result you specified in the Data Preferences window (refer to "Computing Results"). It also shows the minimum and maximum filter values for the filter band that was selected. The filter bands are shown for both the primary and secondary results. The last value in this box gives the number of test measurements that were taken. You can also determine at what radius and angle a specific value was taken.

Note *If a post-scan process option other than Show Text Data was selected in the Edit Scan Sequences window, you will not see the Texture Measurement System window after the scan completes. Instead you will see the display for whichever post-scan process you selected (refer to "Creating, Defining, and Changing Scan Sequences").*

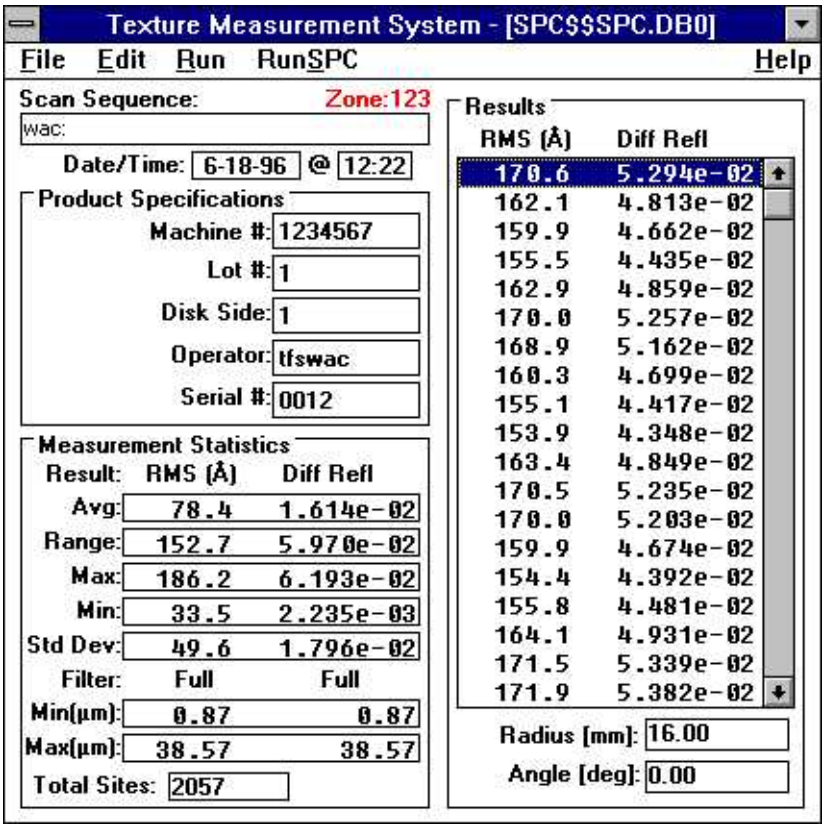


Figure 16. Texture Measurement System window.

To view the radius and angle of a given result:

⇒ In the Results box of the Texture Measurement System window, select the result you want to view.

The Radius and Angle boxes below the result box list the specific information for that data spot.

The Product Specifications section gives the particular information for the scan performed and can be edited only after a successful login (refer to "Login Process"). These specifications are used for all data files.

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Saving Results

While you are logged in, you can save your data files. There are two ways to do this.

To save a data file under the current file name:

1. From the **File** menu in the Texture Measurement System window, select **Save**. This saves the current data information.

To save a data file under a different file name:

1. From the **File** menu in the Texture Measurement System window, select **Save As...**.
2. Type the new file name and click **OK**.

   These procedures save the data in files that can be read by the TMS program. If you want to save the results in ASCII format, select **Save as ASCII**.

Plotting Results

After a scan has been performed, you can plot the data from the resulting measurements. A plot allows you to visualize the roughness distribution in the surface you scanned.

There are three viewing options for plots: Plot, TZP Plot, and Histogram. The **Plot** option allows you to view the whole surface as a two-dimensional color map. The **TZP Plot** option plots the selected item as a function of radius. TZP stands for Transition Zone Positioning and is a very useful mapping tool. The **Histogram** plot option shows the frequency of data value occurrences as a function of data value. A detailed explanation of each plot type is given in the following sections.

To select a plot option:

⇒ From the **File** menu in the Texture Measurement System window, select **Plot, TZP Plot, or Histogram** (see Figure 17).



Figure 17. Plot options pull down menu.

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Plot Option

The **Plot** viewing option lets you view the whole surface as a two-dimensional color map.

To start a plot:

⇒ From the **File** menu in the Texture Measurement System window, select **Plot**

The TMS Plot (shown in Figure 18 and Figure 19) window appears.

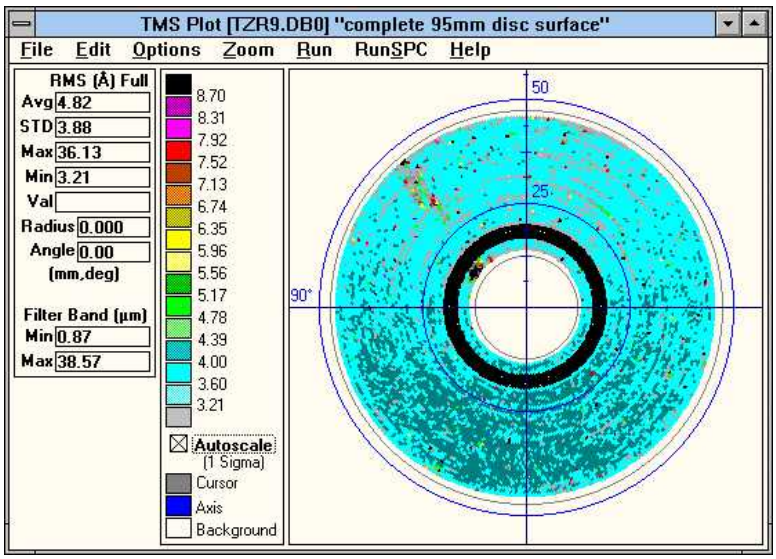


Figure 18. Plot window (disk).

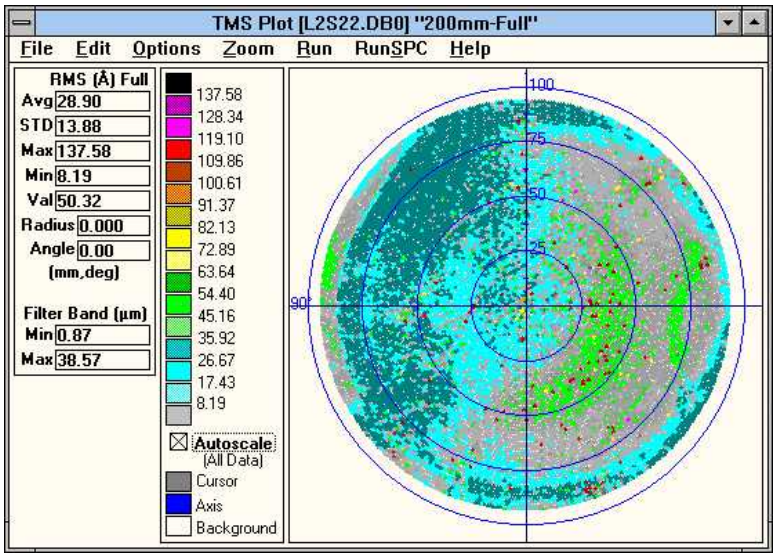


Figure 19. Plot window (wafer).

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If a data file was open when the Plot option was selected, a graphical plot of that data appears in the Plot window. You can also open a file from within the Plot window.

To open a data file from within a plot window:

1. From the **File** menu in the TMS Plot window, select **Open…**.
2. Type or select the file name and click **OK**.

Controlling the Plot Display

The Plot window is divided into three distinct sections: the numerical display area, the color key area, and the plot area.

The numerical display area is located on the left side of the Plot window and shows the average, standard deviation, maximum, and minimum values of the computed result for the entire data file. If the Crosshairs option in the Plot Options Menu is selected (see "Changing the Plot Options"), the Val, Radius, and Angle fields appear below the plot statistics. The Radius and Angle fields show the current location of the cursor, which is set by clicking the mouse anywhere in the plot area. If the cursor is near a plotted data point, the cursor will 'snap' to the center of the plotted point and the computed result value of the point will be displayed in the Val field. If the cursor is not near a plotted data point the Val field will be blank. The Filter Band wavelength limit values are displayed in the Min and Max fields.

When you are displaying a multi-zone plot, the words Zone: ### appear in red above the Filter Band values in the numerical display area. The ### is a series of single-digit numbers (not separated by commas) and represents the zones you have selected for display. You can choose which zones to display on the plot. For example, if you have run a multi-zone scan with five different zones and you decide to display zones 1 and 2 on the plot, Zone:12 appears in the window.

To select which zones to display on the plot:

1. From the **Edit** menu in the TMS Plot window, select **Zones**.
2. Select, which zones you, want to include in the plot. A checked box indicates the zone is selected.

Note *The Zones option appears in the Edit menu only when you have plotted data from a multi-zone scan.*

The second or middle area of the Plot window is the color key area. This area defines the colors used to represent the various measured result values in the plot. It also defines the colors of the Cursor, Axis, and Background of the plot area. All colors in the color key can be customized.

To change the colors:

1. Click the color box you want to change.
2. Select the new color from the palette that appears.
3. Click **OK**.

A **Redraw** button may appear to the left of the color key in the TMS Plot window. This will probably appear only if the plot takes more than three seconds to draw. To view the plot using your new color key, click this button and the plot window will be updated with the new colors.

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The Autoscale check box appears below the color key area. If you select the Autoscale button (it will be indicated by a checked box), the maximum and minimum data values will automatically be assigned to the top and bottom of the color key, respectively. If Autoscale is not selected, you can click in the boxes next to the minimum and maximum colors and enter your own values.

The third area of the Plot window is the plot area. This is the primary display area in the Plot window and it shows the plotted data in graphical form.

To change the view of the plot:

There are five different view variables you can specify: Data Type, Filter Band, Data Limits, Spot Size, and Roughness Correlation.

1. From the **Options** menu in the TMS Plot window, select **Data Type**. While holding down the left mouse button, choose the desired plot result. A check mark indicates the current selection. The available data types are RA, RMS, P-V, RMS Slope, TIS, Diffuse Reflectance, Total Reflectance, Specular Reflectance, Emissivity, Haze, and Gloss.
2. From the **Options** menu in the TMS Plot window, select **Filter Band**. While holding down the left mouse button, choose the desired filter band. A check mark indicates the current selection. The filter band selection is used to control the range of surface structures over which the roughness measurements are calculated. The available filter band options are Low, High, and Full.
3. From the **Options** menu in the TMS Plot window, select **Data Limits**. While holding down the left mouse button, choose the data limit. A check mark indicates the current selection. Select the desired Autoscale data limit using this menu option. The available selections are All Data, 1 Sigma, 2 Sigma, and 3 Sigma. All Data forces the plot limits to be set to the maximum and minimum data values of the data type displayed. The Sigma settings use the data mean plus and minus the indicated number of standard deviation values as plot limits.
4. From the **Options** menu in the TMS Plot window, select **Spot Size…**. Type the new value and click **OK**.
5. From the **Options** menu in the TMS Plot window, select **Roughness Correlation**. This will allow you to change the values *for display only.*

You can hide the axes and cross hairs in the TMS Plot window or make the screen monochrome instead of color by selecting or deselecting these options in the TMS Options menu. A check mark next to the option indicates it is selected.

If the plot is large in the TMS Plot window, a **Redraw** button may appear. This allows you to make several changes in the window without having to wait for the graph to redraw. Click this button and the current plot will be redrawn without the axes. If you turn axes back on, the plot will be automatically redrawn.

If the cross hairs are turned on in the TMS Plot window, two lines appear on the plot. The intersection of these lines indicate the current cross hair position. The values of the measurement, radius, and angle of this position are indicated on the left side of the plot below the statistical values. If you turn the cross hairs off, these boxes are not present.

You might need to view an area of the plot in more detail. There are two ways to do this. One is to select a cornered zoom and the other is a centered zoom.

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To zoom in on a corner of the plot:

1. From the **Zoom** menu in the TMS Plot window, select **Corner**.
2. Place the mouse on the graph in a corner of the area you want to enlarge.
3. While holding down the left mouse button, drag it to the opposite corner of the zoom area.
4. Release the mouse button and the graph will redraw the square that you highlighted so that it fills the plot area.

To zoom in on a centered area:

1. From the **Zoom** menu in the TMS Plot window, select **Middle**.
2. Place the mouse on the graph in the center of the area you wish to enlarge.
3. While holding down the left mouse button, drag it to the outer edge of the zoom area.
4. Release the mouse button and the graph will redraw the square you highlighted so that it fills the plot area.

To return to the original plot size:

From the **Zoom** menu in the TMS Plot window, select **Out**.

You can rerun the same scan or select a different scan to run from within the Plot window.

To rerun the same scan from within the TMS Plot window:

⇒ From the **Run** menu in the TMS Plot window, choose **Quick Test** or **Quick Run**.

To select and run a different scan from within the TMS Plot window:

⇒ From the **Run** menu in the TMS Plot window, choose **Select Test**. A dialog box will appear giving you the option to choose a new test to run. (Refer to "Running Tests.")

To select and run an SPC scan from within the TMS Plot window

⇒ From the **Run SPC** menu, select the scan you want to run.

If you need to copy and paste the plot into another document, you can do so from the TMS Plot window.

To copy and paste the plot into a document:

⇒ From the **Edit** menu in the TMS Plot window, select **Copy to Clipboard**.

The graph is now in the clipboard and can be pasted into a document.

Saving and Printing Plots

Plots can be saved separately from the scan results, and can also be printed.

To save a plot to a file:

1. From the **File** menu in the TMS Plot window, select **Save Bitmap...**.
2. Type the file name and click **OK**.

The file will be saved as a bitmap with a file extension of .bmp.

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To view a plot in the form it will be printed:

⇒ From the **File** menu in the TMS Plot window, select **Print Preview**.

To print a plot:

⇒ From the **File** menu in the TMS Plot window, select **Print**.

Exiting from the Plot window

To close the plot window:

⇒ From the **File** menu in the TMS Plot window, select **Exit**.

You should now be back in the Texture Measurement System window.

TZP Plot Option

The **TZP Plot** option gives a cross-sectional view of the scanned surface. The values displayed at the cross section in this type of plot are an average of the values calculated at each radius on the surface. You can isolate sections of the plot using the zoom menu and cursor control in conjunction. From this isolated section, it is possible to find the exact spot of the transition from a heavy microroughness area to a smoother one. Usually the park zone of a disk near the inner diameter is rougher than the fly zone towards the outer edge, and with the transition plot it is easy to find the spot where that roughness changes.

To start a TZP Plot:

⇒ From the **File** menu in the Texture Measurement System window, select **TZP Plot**

The TZP Plot window appears (see Figure 20). If a data file was open when the TZP Plot option was selected, a graphical plot of that data appears in the TZP Plot window. You can also open a file from within the TZP Plot window.

To open a data file from within the TZP Plot window:

1. From the **File** menu in the TZP Plot window, select **Open…**.
2. Type or select the file name and click **OK**.

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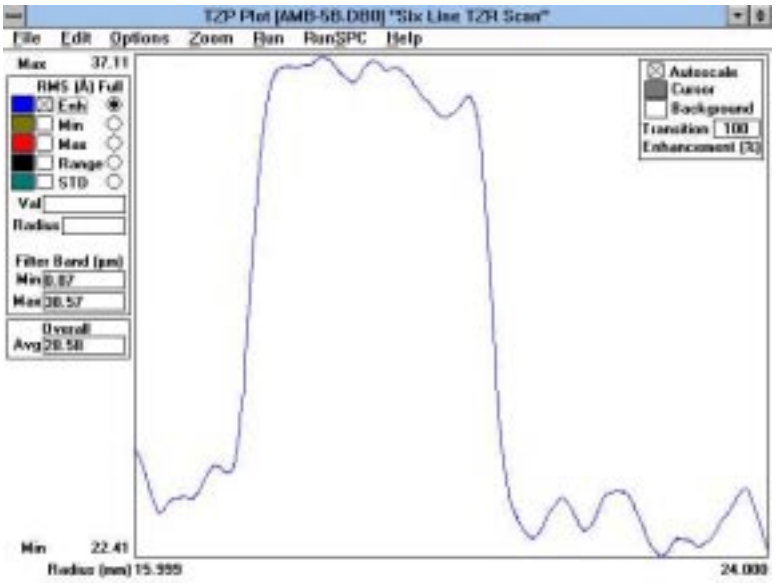


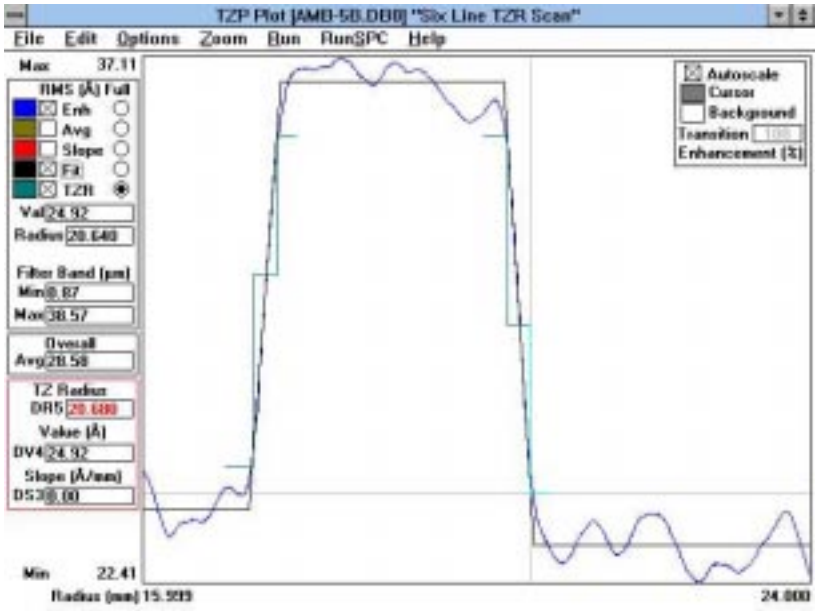
Figure 20. TZP Plot window.

In the TZP Plot window you can specify one of three different plot modes:

1. TZP v Radius: When this plot mode is selected the TZP Plot window will display the results as a function of radius.
2. TZP v Angle: When this plot mode is selected the TZP Plot window will display the results as a function of angle.
3. Show TZR: When this plot mode is selected the TZP Plot window will display the Transition Zone Radius (TZR) as a function of radius (see figure 21).

To select one of the above plot modes:

⇒ From the **Options** menu in the TZP Plot window, select the desired mode. A check mark indicates the mode is currently selected.



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Figure 21. TZP Plot window with TZR mode selected.

Controlling the TZP Plot Display

The TZP Plot window is divided into two distinct sections: the numerical display area and the plot area.

The numerical display area is located on the left side of the TZP Plot window. In TZP v Radius and TZP v Angle plot modes, the statistics that can be viewed are: the enhanced average, minimum, maximum, range, and standard deviation values of the computed result for each radius (or angle) of the entire data file. In the TZR plot mode, the statistics that can be viewed are: the enhanced average, raw average, slope, fit curve, and TZR types of the computed result for each radius of the entire data (see Figure 21).

To select which values to include in the TZP plot:

⇒ In the upper-left corner of the TZP Plot window, click the desired statistic to view. A checked box indicates the current selections.

It is possible to turn all the values on, but you cannot turn them all off. At least one will always be selected.

The colors used to represent the various statistics in the TZP plot area can be changed.

To change the colors:

1. Click the color box you want to change.
2. Select the new color from the palette that appears.
3. Click **OK**.

If the Cursor option in the TZP Plot Options Menu is enabled, the Val and Radius (or Angle) fields will be displayed below the statistics. The Radius (or Angle) field will show the current location of the cursor, which is set by clicking the mouse at any horizontal location in the plot area. The vertical cursor line will be drawn at that radius (or angle) with the horizontal line drawn to represent the data value at that radius (or angle). The Val field will display the value of the plotted data at the cursor location. The Filter Band wavelength limit values are displayed in the Min and Max fields. The Overall Area displays the average value of all measured data in the file.

If the Show TZR Plot mode is active, a box outlined in red will appear below the Overall Area. This section contains data on the individual transition points that were selected in the TZR Selection for Display window (see Figure 23). The radius, value and slope for the specific points of interest appear in this box. If you click anywhere inside the red box, the TZR Selection for Display window will appear, allowing you to change the individual TZR points you want to display. See "Editing TZR Preferences" for details on selecting individual transition points for display.

When you are displaying a multi-zone plot, the words Zone: ### appear in red above the Filter Band values in the numerical display area. The ### is a series of single-digit numbers (not separated by commas) and represents the zones you have selected for display. You can choose which zones to display on the plot. For example, if you have run a multi-zone scan with five different zones and you decide to display zones 1 and 2 on the plot, Zone:12 appears in the window.

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To select which zones to display on the TZP plot:

1. From the **Edit** menu in the TZP Plot window, select **Zones**.
2. Select which zones you want to include in the plot. A checked box indicates the zone is selected.

Note *The Zones option appears in the Edit menu only when you have plotted data from a multi-zone scan.*

The second area of the TZP Plot window is the plot area. This is the primary display area in the TZP Plot window and it shows the plotted data in graphical form.

To change the view of the TZP plot:

There are three view variables you can specify: Data Type, Filter Band, and Roughness Correlation.

1. From the **Options** menu in the TZP Plot window, select **Data Type**. While holding down the left mouse button, choose the desired plot result. A check mark indicates the current selection. The available data types are RA, RMS, P-V, RMS Slope, TIS, Diffuse Reflectance, Total Reflectance, Specular Reflectance, Emissivity, Haze, and Gloss.
2. From the **Options** menu in the TZP Plot window, select **Filter Band**. While holding down the left mouse button, choose the desired filter band. A check mark indicates the current selection. The filter band selection is used to control the range of surface structures over which the roughness measurements are calculated. The available filter band options are Low, High, and Full.
3. From the **Options** menu in the TZP Plot window, select **Roughness Correlation** to change the value used *for display only*.

You can make the screen monochrome instead of color and toggle the cursor on and off in the TZP Plot Options window. A check mark next to the option indicates it is selected.

The TZP Plot window allows you to turn a cursor on and off to track the radius and value at certain points on the plot. This is a hot cursor, implying that it will follow the line you are tracking if you hold the left mouse button down and drag it across the screen. If the cursor is turned on, two axes appear that track the current position of the cursor on the screen. It is possible to select which line on the graph you want to follow with the cursor to view specific values.

To choose the line to place the cursor on:

⇒ Click the circle next to the value that you want to follow.

When the cursor is turned on it will be on that particular line on the graph, and *val* and *radius* boxes will appear to give you specific data at the point where the cursor is located. You can drag the cursor along the line to view the values at each radius, or you can click on a specific spot on the line that you want to view.

You can specify that the TZP plot uses a line fit instead of an average fit for the data adjacent to the transition zone by selecting **Use Data Slope** in the TZP Plot **Options** menu. A check mark next to Use Data Slope indicates it is selected. The Use Data Slope option can also be set in the TZR Preferences window (see Figure 22).

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The Radius value at the bottom left corner of the TZP Plot window is the inner diameter of the surface, and the bottom right corner is the outer diameter. The *min* value at the bottom left of the plot is the minimum data value to display on the plot, and the *max* value at the top left is the maximum data value to display. The minimum and maximum values can be set automatically or manually. This is controlled by the Autoscale selection in the upper-right corner. If this box is selected, the values will be set automatically; otherwise you can enter them manually in the boxes next to min and max.

The transition enhancement in the TZP Plot window is a percentage that indicates how much processing is done on the average values at each radius. This processing is done to remove the smearing caused by measuring small features with a large laser spot. The range of this percentage is 0-200%.

At the 100% setting the TZP plot will closely represent the actual roughness transition on the sample. The 200% setting enhances the transition edges and exaggerates the extremes. The zero setting is the raw data from the plot.

To change the transition enhancement percentage:

1. Click in the transition enhancement box in the upper-right corner of the TZP Plot window.

   A dialog box appears asking for the new value.
2. Type the new value and click **OK**.

The cursor and background color blocks in the upper-right corner of the TZP Plot window specify the colors for these items. When the screen is in color, you can change the colors of these values to whatever you like.

To change the colors:

1. Click the color box you want to change.
2. Select the new color from the palette that appears.
3. Click **OK**.

The lines in the TZP Plot window are automatically redrawn when you change the colors.

Editing TZR Options

You can edit the TZR options for an individual TZR plot from within the TZP Plot window.

To edit the TZR options from within the TZP Plot window:

⇒ Select **Edit**...**TZR Options** from the TZP Plot window.

The TZR Options window (see Figure 22) appears. This window lets you customize the TZR plot options for display, as well as set the Transition Fit Width and Clearance and the Radius Correlation Slope and Offset. These settings will apply to the current TZR plot and will not affect the default settings for TZP Plots that were specified in the TZP Preferences window (see "Editing TZP Preferences")

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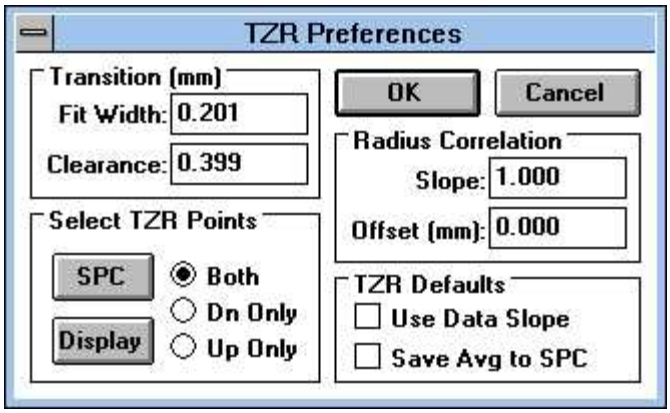


Figure 22. TZR Options window.

The Transition Fit Width and Clearance variables let you customize the transition zone measurement process. Transition width indicates the width of the transition zone from beginning to end. Change this variable to adjust the width of the transition over which the transition slope and line fit are to be computed. The Transition Clearance variable lets you specify the distance from the center of the transition zone to the point where the fly zone line fit starts.

Note *The Fit Width and Clearance variables are set to predetermined values, which are based on experimental data. You only need to change these values if the default settings are not appropriate for your sample.*

To specify the fit width and clearance values:

1. Click in the box of the value you want to change.
2. Type the new value.

The Radius Correlation variables allow you to establish correlation of the radius data from machine to machine. This may be necessary if you are using different machines for locating surface roughness and need to correlate the outputs from the different machines so they match. The Radius Correlation Slope variable lets you specify the scaling factor of TZR radii you want to correlate. The Radius Correlation Offset variable gives you the ability to offset the dimensional positioning of the TZR radius point.

To specify the slope and offset values:

1. Click in the box of the value you want to change.
2. Type the new value.

The Select TZR Points section of the TZR Options Window gives you the ability to isolate certain parts of the TZR plot for further analysis. You can choose the type of the transition you want, as well as specific items of interest along the transition area.

You can choose the transition to consider in one of three ways:

1. Select **Both** to choose Up and Down transition areas. This is the default setting.
2. Select **Dn Only** to choose the Down transition.
3. Select **Up Only** to choose the Up transition.

To choose the desired transitions:

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⇒ Click the desired selection: **Both, Dn Only**, or **Up Only**. A filled in circle indicates the item is selected.

You can select individual items to display.

To select individual transition items to display on the TZR plot:

1. Click the Display button on the TZR Preferences window. The TZR Display Selection window will appear (see Figure 23).
2. Individual transition items are identified as slope, value or radius *and* by their location along the transition area. The alphanumeric code US2 (Up Slope 2), for example, signifies the value of the Up transition slope.

   Click the desired selection. A filled in circle indicates the item is selected.

   You can select only one slope transition point, one value transition point, and one radius transition point in the TZR Display Selection window.
3. Click **OK** to return to the TZR Preferences window.

Note *The individual transition points selected in the TZR Display Selection window will only be displayed on the TZR plot if the corresponding transition area was also selected in the TZR Preferences window . If not, then "-----" will be displayed.*

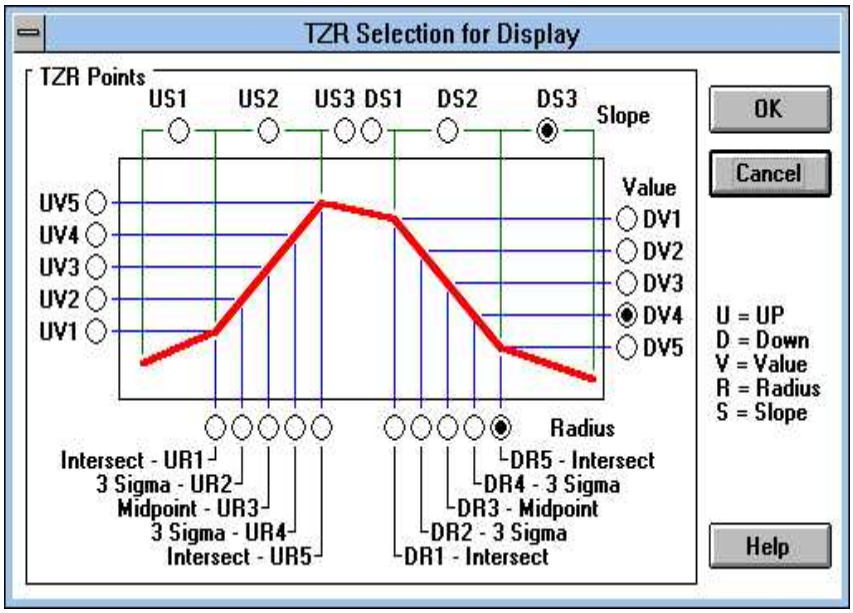


Figure 23. TZR Display Selection window.

You might need to view an area of the TZP plot in more detail.

To zoom in on a corner of the TZP Plot:

1. From the **Zoom** menu in the TZP Plot window, select **Corner**.
2. Place the mouse on the graph in a corner of the area you want to enlarge.
3. While holding down the left mouse button, drag it to the opposite corner of the zoom area.

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4. Release the mouse button and the graph will redraw the square that you highlighted so that it fills the plot area.

To return to the original TZP plot size:

From the **Zoom** menu in the TZP Plot window, select **Out**.

You can rerun the same scan or select a different scan to run from within the Plot window.

To rerun the same scan from within the TZP Plot window:

⇒ From the **Run** menu in the TZP Plot window, choose **Quick Test** or **Quick Run**.

To select and run a different scan from within the TZP Plot window:

⇒ From the **Run** menu in the TZP Plot window, choose **Select Test**. A dialog box will appear giving you the option to choose a new test to run. (See "Running Tests.")

To select or run an SPC scan from within the TZP Plot window:

⇒ From the **Run SPC** menu, choose the scan you want to run.

If you need to copy and paste the plot into another document, you can do so from the TZP Plot window.

To copy and paste the plot into a document:

⇒ From the **Edit** menu in the TZP Plot window, select **Copy to Clipboard**.

The graph is now in the clipboard and can be pasted into a document.

Saving and Printing TZP Plots

Plots can be saved separately from the scan results, and can also be printed.

To save a TZP plot to a file:

1. From the **File** menu in the TZP Plot window, select **Save Bitmap...**.
2. Type the file name and click **OK**.

The file will be saved as a bitmap with a file extension of .bmp.

You can also save the TZP plot data to an ASCII file for further analysis.

To save TZP plot data to an ASCII file:

1. From the **File** menu in the TZP Plot window, select **Save ASCII...**.
2. Type the file name and click **OK**.

To view a TZP plot in the form it will be printed:

⇒ From the **File** menu in the TZP Plot window, select **Print Preview**.

To print a TZP plot:

⇒ Form the **File** menu in the TZP Plot window, select **Print**.

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Exiting from the TZP Plot window

To close the TZP plot window:

⇒ From the **File** menu in the TZP Plot window, select **Exit**.

You should now be back in the Texture Measurement System window.

Histogram Option

The **Histogram** option is used to display and analyze measurement data in histogram form. It displays the frequency of data value occurrences as a function of data value.

To plot a histogram:

⇒ From the **File** menu in the Texture Measurement System window, select **Histogram**.

The Histogram window (shown in Figure 24) will appear. If a data file was open when the histogram option was selected, a bar chart will appear in the display area of the histogram window. If no data file was open before selecting **Histogram**, you can open one from within the Histogram window.

To open a data file from within the Histogram window:

1. From the **File** menu in the Histogram window, select **Open…**.
2. Type or select the file name and click **OK**.

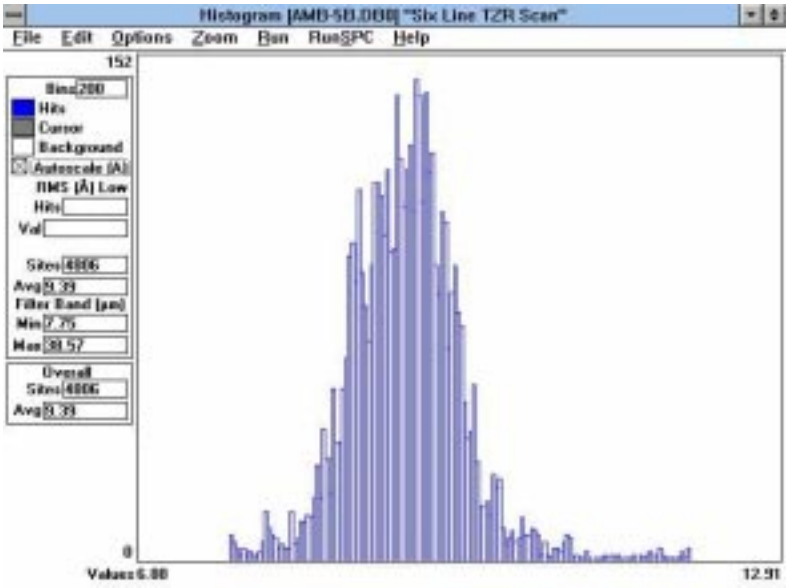


Figure 24. Histogram plot window.

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Controlling the Histogram Display

The Histogram window is divided into two distinct sections: the display control area and the histogram bar chart. The display control area displays and controls information about the plotted data, such as number of bins, color key for the plot, autoscale indicator, and various statistics of the scan results. Each of the fields in the histogram display control area is described below.

When you run a histogram plot, the data values in the data file are divided into a fixed number of ranges or bins. Bins are represented as bars on the histogram bar chart.

To change the number of bins:

1. Click in the Bins box.
2. Type the new value and click **OK**.

The Y value of each bar in the histogram represents the number of sites (referred to as hits) measured within the specified range for the corresponding bin. If you are using a color monitor, you can change the color of the hits, as well as the cursor and background colors.

To change the colors:

1. Click in the color box you want to change.
2. Select the new color from the palette that appears and click **OK**.

The Autoscale setting effects how the plot limits are set. If the Autoscale box is checked, the plot limits are set based on the values found in the data file and the setting of the Data Limits item in the Histogram Options menu. If Autoscale is not checked, the plot limits are set manually.

To set the plot limits manually:

1. Make sure the Autoscale box is **not** checked.
2. Click in the box of the value you want to change. The Values boxes are located at the left (minimum value) and right (maximum value) of the X axis and at the top of the Y axis (maximum hits).
3. Enter the value for the setting and click **OK**.

Note *If Autoscale is checked, you will be unable to click in the Values boxes.*

The next line in the histogram display control area indicates the data type and filter band for the current histogram view. There are four different view settings you can specify in the Histogram Options menu: Data Type, Filter Band, Data Limits, and Rougness Correlation.

To change the view of the histogram:

1. From the **Options** menu in the Histogram window, select **Data Type**. While holding down the left mouse button, choose the result. A check mark indicates the current selection.
2. Select **Filter Band**. While holding down the left mouse button, choose the band. A check mark indicates the current selection.
3. Select **Data Limits**. While holding down the left mouse button, choose the data limit. A check mark indicates the current selection.
4. Select **Roughness Correlation** to change the value used *for display only*.

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You can also turn the cursor on or off and make the screen monochrome instead of color by selecting the appropriate option in the Histogram Options menu. A check mark indicates the item is selected.

If the cursor option is enabled, the Hits and Val fields will be displayed in the display controls area. The Hits and Val boxes show the number of hits at the value represented by the horizontal position of the cursor. Set the cursor location by clicking the mouse anywhere in the bar chart area. The Hits and Val fields will change as you move the cursor to different locations in the bar chart.

If the histogram displayed is a multi-zoned plot, the words Zone:### appear in red above the Sites field.

To select which zones to display on the histogram:

1. From the **Edit** menu in the Histogram window, select **Zones**.
2. Select which zones you want to include. A checked box indicates selected zones.

Note *The Zones option appears in the Edit menu only when you have plotted data from a multi-zone scan.*

The next section of the display control area shows the histogram statistics. The number of measurement sites and the average value of all data in the histogram bins is shown. The minimum and maximum Filter Band wavelength limit values are also displayed. The Overall area of the Histogram window displays the number of measurement sites and the average value of all data in the selected zones. These may be different from the histogram statistics if **Fit Bins to Plot** was selected from the Histogram Zoom menu.

There are four ways to zoom in on an area of the histogram: Corner, Out, Fit Bins to Plot.

To zoom in on a corner of the histogram:

1. This selection lets you start a zoom from the corner of the histogram plot area. From the **Zoom** menu in the Histogram window, select **Corner**.
2. Click the mouse in the plot area at one corner of the area you want to expand.
3. While holding down the left mouse button, drag the cursor to the opposite corner of the zoom area.
4. Release the mouse button and the graph and the plot will redraw with the zoom area filling the entire plot area.

To redraw the original histogram choose the **Out** option from the **Zoom** menu in the Histogram window.

To cause the data in the histogram display to be redistributed into the total number of bins, choose the **Fit Bins to Plot** option from the **Zoom** menu in the Histogram window. Data not displayed will be removed from the available histogram data until **All Data** is selected or a new file is opened.

To cause all data in the selected zones to be redistributed into the total number of bins, choose the **All Data** option from the **Zoom** menu in the Histogram window.

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You can rerun the same scan or select a different scan to run from within the Plot window.

To rerun the same scan from within the Histogram window:

⇒ From the **Run** menu in the Histogram window, choose **Quick Test** or **Quick Run**.

To select and run a different scan from within the Histogram window:

⇒ From the **Run** menu in the Histogram window, choose **Select Test**. A dialog box will appear giving you the option to choose a new test to run. (See "Running Tests.")

To select or run an SPC scan from within the Histogram window:

⇒ From the **Run SPC** menu, choose the scan you want to run.

If you need to copy and paste the plot into another document, you can do so from the Histogram window.

To copy and paste a histogram into a document:

⇒ From the **Edit** menu in the Histogram window, select **Copy to Clipboard**.

The graph is now in the clipboard and can be pasted into a document.

Saving and Printing Histograms

Histograms can be saved separately from the scan results, and can also be printed.

To save a histogram to a file:

1. From the **File** menu in the Histogram window, select **Save Bitmap...**.
2. Type the file name and click **OK**.

The file will be saved as a bitmap with a file extension of .bmp.

To view a histogram in the form it will be printed:

⇒ From the **File** menu in the Histogram window, select **Print Preview**.

To print a histogram:

⇒ From the **File** menu in the Histogram window, select **Print**.

Exiting from the Histogram window

To close the histogram window:

⇒ From the **File** menu in the Histogram window, select **Exit**.

You should now be back in the Texture Measurement System window.

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Manually Controlling the Instrument

Manual control of the instrument allows you to move the stages to any position and measure the sample at any location. Time trend tests at one spot may also be monitored using this control. You can use this window to position the sample before reconfiguring the Detector Setup parameters.

To access manual control:

⇒ From the **Run** menu in the Texture Measurement Window, select **Manual Mode**.

The Manual window shown in Figure 25 appears. Several options are now available to control the instrument settings. The spot on the sample to be measured has to be identified. The two stages of the machine, radius and angle, each have their own home switches which are set at factory defaults. To select the position to measure, use the movement controls.

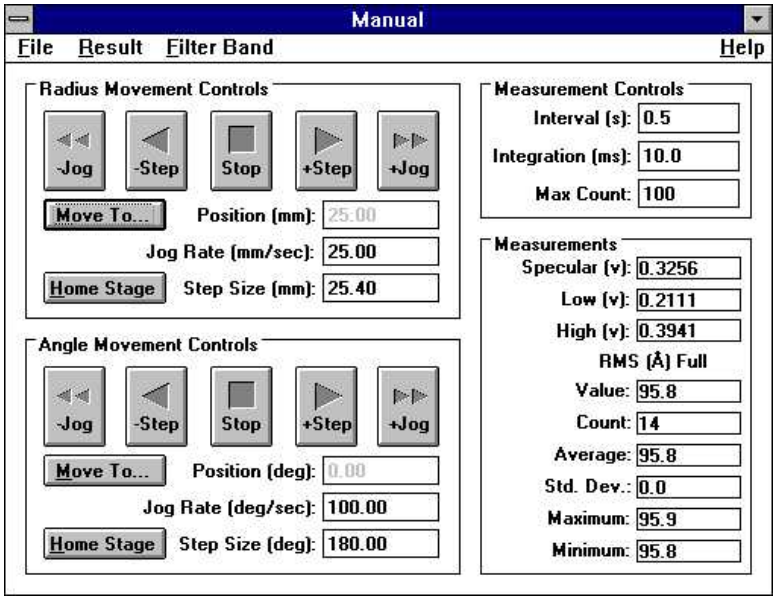


Figure 25. Manual mode window.

Movement Controls

The motion of the stage can be controlled from the Manual window. There are two types of motion: linear and rotary. The linear motion (measured in millimeters (mm) or inches (in)) is controlled from the Radius Movement Controls box. The rotary motion (measured in degrees (deg)) is controlled from the Angle Movement Controls box. It may be necessary to move the sample to the home switch before positioning it for a scan.

To find the home switch of the linear or rotary stage:

⇒ In the Radius Movement Controls or Angle Movement Controls box, click the **Home Stage** button.

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The current stage position is displayed in the Position field of the control box. The current stage position can be changed after the home switch is found.

To change the stage position:

1. In the Radius Movement Controls or Angle Movement Controls box, click the **Move To...** button.
2. Type the new value in the entry field and press Enter.

   The new position is displayed in the Position field of the control box, and the sample is moved to that position.

The jog rate and step size distance the stage moves can be changed inside these control boxes as well.

To change the jog rate the stage moves:

1. In the Radius Movement Controls or Angle Movement Controls box, click inside the Jog Rate field.
2. Type the new value.

   When you hold down the ± J**og** buttons, the stage moves at this rate.

To change the step size distance the stage moves:

1. In the Radius Movement Controls or Angle Movement Controls box, click inside the Step Size field.
2. Type the new value.

   When you click the ± S**tep** buttons, the stage moves by this increment.

Clicking the **Stop** button stops the stage movement.

Setting the Gain

You can automatically set the gain for all detectors when Manual Mode is activated. The settings will be correct for the current sample spot in the source optics.

Note *The settings are not permanent and will return to the original settings when the Manual window is closed. To make the changes permanent, refer to "Detector Setup."*

To set the gain:

⇒ From the **File** menu in the Manual window, select **Auto Set Gain**.

Selecting the Trend Measurement Result

Eleven different options are available for the result of the trend measurement. They are RA, RMS, PV, RMS Slope, TIS, Diffuse Refl, Total Refl, Spec Refl, Emissivity, Haze and Gloss. These options can be selected from the Manual window.

To choose the result:

⇒ From the **Result** menu in the Manual window, select the desired result.

A check mark beside the result indicates the current selection.

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Filter Band Adjustment

It is possible the change the filter band for the result from the Manual window. There are three options available (Low, High, or Full), and the current selection is indicated by a check mark.

To change the filter band:

⇒ From the **Filter Band** menu in the Manual window, select **Low**, **High**, or **Full**.

Measurement Controls

The Measurement Controls box controls the rate and amount of data to gather. The rate is measured in seconds (s).

To change the speed the data is gathered:

1. In the Measurement Controls box, click inside the Interval field.
2. Type the new value.

To select the duration of each measurement:

1. In the Measurement Controls box, click inside the Integration field.
2. Type the new value. The range of possible values is from 0.2 milliseconds (ms) to 2000 ms (10 ms or 15 ms is recommended).

To enter the number of measurements to make:

1. In the Measurement Controls box, click inside the Max Count field.
2. Type the new value.

Taking Measurements

After you are satisfied with the manual control options you have specified, you can take measurements.

To take measurements:

1. From the **File** menu in the Manual window, select **Start**.
2. If you want to stop the trend cycle before it collects all of the data you specified, select **Stop** from the **File** menu.

   The results will be displayed in the Measurements box of the Manual window. The statistics from these measurements can be saved for later analysis.

To save the statistical results:

1. From the **File** menu in the Manual window, select **Save** or **Save As...**.
2. Type the file name to save the data in and click **OK**.

   The data is now saved in Trend format in the file you specified. Refer to the *Trend* subsection of the "Data File Format" appendix for more details.

If you try to start a new trend cycle in this window without saving the data, you will be asked if you want to save the data. If you click no, the data from the previous cycle will be lost.

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Measurements

The Measurements box in the Manual window displays the statistics of the current measurement being taken. The values in the fields of this box cannot be changed. They are continuously updated once the measurement run is started. Details on starting the measurement run are in the “Taking Measurements” section.

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The specular, low, and high boxes display the voltages of the bands measured at the current location. The line below these boxes lists the current result format and which band is selected for the result. The value is the measurement at the current location, the count tallies the number of measurements taken, and the average, standard deviation, maximum, and minimum values are continuously calculated and updated when new measurements are taken. After the required number of measurements have been taken (or if you select **Stop** from the **File** menu), these results will display the trend for that particular point that was under the source optics. This is useful if you want to compare the trends at the same data point during different stages of manufacturing to see the changes. You can save this data to a file then move to another point on the sample and repeat the process.

Note *In the Manual window, the system is continuously measuring the sample under the source optics. That is the reason the numbers in the Specular, Low, and High boxes are constantly changing. The other values in this box will show results only when you select **Start** from the **File** menu. These are the data results that get saved.*

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Part 3: Technical Appendices

Appendix A: Specifications

Appendix B: Details of TMS-2000 Series

Appendix C: Command Line Options

Appendix D: Menu Command Reference

Appendix E: Error Messages

Appendix F: Data File Format

Appendix G: Glossary

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Your Notes

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Appendix A: Specifications

Measurements	
Source:	Class II Laser, 670 nm
Spot Size:	~1mm diameter
Number of Spots:	Programmable (full sample to single test point)
Primary Results:	RA or RMS (Rq) Microroughness
Secondary Results:	PV, RMS Slope, TIS, Diffuse Reflectance, Specular Reflectance, Emissivity, Haze and Gloss
Speed:	50 Measurements per second (varies with Scan and User Setup)
Range:	From .1Å to 5000Å (RMS or RA)
Resolution:	0.01Å
Repeatability:	±0.2Å or 0.5%, whichever is greater (same sample, same machine)
Reproducibility:	±0.5Å or 1%, whichever is greater (same sample, different machine)
Spatial Filtering Frequency (wavelength):	Low Band: 0.026 to 0.129 µm-1 (7.8 to 38 µm) High Band: 0.129 to 1.14 µm-1 (0.88 to 7.8 µm) Full Band: 0.026 to 1.14 µm-1 (0.88 to 38 µm)

Stages	**Rotary**	**Linear**
Repeatability	±0.01º	±0.0005 inches (±0.01 mm)
Accuracy	±0.05º	±0.0010 inches (±0.03 mm)

Miscellaneous	
Data File Generation	ASCII (Detailed), SPC (Production Statistics), Color Plots, Sample Statistics
Sample Holders	TMS-2000 Standard Disks: 65mm, 95mm, 130mm TMS-2000W Standard Wafers: 125mm, 150mm, 200mm
Materials	Aluminum, Nickel, Silicon, and other reflective materials
Installation	Electrical Requirements: 90-135 VAC, 180-270 VAC—50/60 Hz (automatically selected by the instrument)
Shipping Weights	TMS-2000/2000W: 70 lbs/32 kg Computer: 75 lbs/34 kg

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Appendix B: Details of TMS-2000 Series

Correlation to Other Instruments

Surface roughness measurement is done using different approaches. For example, a profilometer looks at a “slice” of the surface and gets a one-dimensional measurement. Some technologies measure in two dimensions. All systems use different spatial wavelengths on the surfaces they measure. These factors imply that using two different machines can give two different roughness results for the same surface. Different instruments can be correlated to make their outputs match.

The TMS-2000 system uses Slope (m) and Offset (b) to perform this correlation. The operator determines these constants based on the types of instruments in use and the type of surface being measured. The RMS value (x) is calculated and multiplied by the slope, and the offset is added to this result to give the correlated value (y). In equation notation, y = m*x + b.

Note *The instrument specifications for no correlation factors are Slope=1 and Offset=0. This is considered to be the most accurate setup for the TMS-2000 system.*

Positioning correlation is also possible using the TZR correlation. This yields a radius based on slope and offset parameters. In equation notation, r = mx + b.

Filter Band

The filter band controls the range of surface structures over which the roughness measurements are calculated. Each band has a range specified in terms of spatial frequencies or spatial wavelengths. This program generates spatial wavelengths as the boundaries. Lower configuration angles generate higher wavelength boundaries.

The TMS-2000 system has three bands that can measure scattered light: Specular, Low, and High. The Low and High bands are the only ones that are selectable as independent bands, and they are combined if the Full band is selected.

The Specular band is used in the calculation of the Specular Reflectance. The Low, High, and Full bands are *not* used in the calculation of Specular Reflection; only the Specular band is used. The Full band is *always* used in calculations of RMS Slope, Total Reflectance, Emissivity, Haze and Gloss.

TMS Instrument

This document describes the operation of the SMS Texture Measurement System (TMS). The basic TMS-2000 series system consists of the TMS instrument, an IBM compatible PC, the TMS software, and a printer (optional). The TMS instrument contains sample motion stages (linear and rotary), the motion controller and motor drives, the optics assembly, the FMS controller, and the TMS interface electronics. Most of this manual deals with the operation of the software for the Texture Measurement System. This software is designed to run on an IBM or compatible personal computer under the Microsoft(R) Windows™ Operating System. The computer uses serial RS-232 communications ports to communicate with the Measurement system hardware.

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Sample Motion Stages

The sample to be measured is placed on a mount which is custom made for each sample type (disk or wafer). This is bolted onto a rotary stage which can orient the sample to any angular position relative to its center. The rotary stage is fastened to a linear stage which adds front-to-back motion to the sample. The two stages combined provide the means for any part of the sample surface to be positioned at the measurement location under the optics assembly. Both stages use DC stepping motors for actuation. The linear stage has sensors to determine the ends of travel, one of which locates the home position. The rotary stage also has a sensor to locate the home position.

Motion Controller and Motor Drives

The motion controller receives control commands from the computer through a serial cable which communicates at 9600 baud rate. It converts the commands into motion signals which it sends to the motor drives. The drives cause the motors to move in response to these signals, positioning the sample for measurement at the desired location. The motion controller also interprets the signals from the limit and home sensors on the stages.

Optical Assembly

The optics assembly consists of a laser diode, several detectors, and other passive optical components. The laser operates at a wavelength of 670 nm and an average power of less than 1 mW (class II). Its light is guided through several lenses and apertures to the sample at the bottom of the optics assembly. The light reflects and scatters from the sample back into the optics assembly. Other optics separate the reflected/scattered light into discrete regions which define each filter band and gather the light into a separate detector for each region. The detectors measure these levels and transmit them to the FMS.

FMS Controller

The FMS controller is the heart of the detector electronics. The FMS Controller controls the laser and receives the signals from the detectors. It provides amplification of the detector signals and measures each of them about 5000 times per second. These measurements are averaged over the requested integration time and the results are transmitted to the computer through a serial cable at 19200 baud. When the controller is initialized, the calibration constants are sent from the controller to the software and used in the calculations.

Interface Electronics

Interface electronics in the TMS instrument provide power, power distribution, various interconnections, and other functions. One of the major functions is to coordinate the Motion Controller and the FMS Controller. The Motion Controller provides position information to trigger the FMS Controller to take measurements, allowing high-speed detector signal acquisition at known sample locations.

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Appendix C: Command Line Options

The TMS program can be invoked with several different command line options. These allow the program to run in different operating modes. The command line options listed below can be used in any combination. Refer to “Editing the Command Line” for a command line example.

Option	Description
/correlate	superseded by /correlate2. Uses Slope and Offset values defined in the Data Preferences window.
/correlate2	supersedes /correlate. Uses slope and offset values stored in the scan sequence to measure the data, providing for different adjustment values to be used for each scan sequence. These slope and offset values are defined in the Edit Scan Sequence window. The default values for these fields are copied from the slope and offset fields in the Data Preferences window.
/demo	Software Demonstration mode. Runs without the instrument hardware. The most useful reason for using this option is to demonstrate the operation of a measurement scan. The Run window operates and simulated data is generated. This data can be saved, plotted, or converted to ASCII. In this mode the software will not give access to certain features which communicate with the hardware.
/login	Log In Shortcut mode. Logs in the software, bypassing the requirement for the login password, when the program starts. This allows direct access to the protected features and is most useful for an instrument used in a laboratory environment rather than a production environment.
/noneg	Limit Negative Numbers mode. Limits the power levels measured from the low and high band scatter detectors so that negative numbers are not computed for the displayed results.
/production	Production mode. Prevents the display of the Main Run Menu when the software is not logged in. This option has no effect when the software is logged in.
/promo	Promotional Demonstration mode. Prints the SMS company name, address, and phone numbers when it prints a plot or histogram to the printer. This is useful as an identification tool.

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Editing the Command Line

To change the command line options (in Windows 3.1 only):

1. Exit from the TMS program if it is running.
2. Click the TMS Program icon once so that it is highlighted.
3. From the **File** menu, select **Properties...**.
4. Edit the Command Line field. The command line options must follow a space after the ...\tms.exe portion of the command. For example,

   \tms.exe /demo /correlate

   is a valid command line. These commands *are not* case sensitive.
5. Click **OK**.
6. Double-click the TMS Program icon to start the TMS program.

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Appendix D: Menu Command Reference

This section provides a quick reference for the menu commands available from the TMS-2000 system. The commands are arranged by the menu item under which they appear.

Texture Measurement System Window

This is a list of the commands available in the Texture Measurement System window. This window appears when you start the TMS-2000 program.

File Menu

Command	Description
New	Create a new data file
Open...	Open an existing data file
Save	Save the data under the current file name
Save As..	Save the data under a different file name
Save ASCII…	Save the data as an ASCII file
Plot	Graph the data using a color map
TZP Plot	Plot data vs. Radius
Histogram	Plot frequency of data value occurrences
Exit	Close TMS-2000

Edit Menu

Command	Description
Login...	Type a password to gain access to editing features

After you have logged in correctly (refer to “Login Process”), the following choices are available from the Edit menu in the Texture Measurement System window.

Command	Description
Zones	Select the zones to display results for (appears only for multi-zone scans)
Roughness Correlation	Change the values used *for display only*
Logout	Logs out of editing capabilities
Password...	Lets you change the current password
Data Preferences...	Edit the data result computation preferences
TZP Preferences	Edit the TZP plot result preferences
Detector Setup...	Change the detector electronics settings
Motion Parameters...	Reposition the sample under the source
Scan Sequence...	Edit the scan sequences
QA (SPC) Assignments...	Assign SPC scan sequences to function keys

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Run Menu

Command	Description
Select Test...	Choose a new test to run
Quick Test	Repeat the previous test, specify file name to save
Quick Run	Repeat the previous test, save to file name SPC$$SPC.DB0
Manual Mode	Measure data trends at individual points

Run SPC Menu

This menu item appears only if you have correctly logged in to the system (refer to “Login Process”) and made SPC assignments (refer to “Customizing the Scan Measurement Process”).

Command	Description
[Variable]	Each menu item corresponds to an assigned scan sequence. Select the menu item or press the funtion key to activate the scan. The number of menu items is the number of assigned scan sequences.

Help Menu

Command	Description
Contents	Lists the contents of the help file
Search for Help On...	Type a subject to search for in help
How to Use Help	Tips on how to use the help facility
About TMS...	Information on TMS-2000 software program

Plot Window

This is a list of commands available from the TMS Plot window. You can reach these commands by selecting **Plot** from the **File** menu in the Texture Measurement System Window.

File Menu

Command	Description
Open...	Open an existing data plot file
Save Bitmap...	Save the current plot as a bitmap
Print	Print the plot
Print Preview	View the plot as it will look when it is printed
Exit	Close the TMS Plot window

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Edit Menu

Command	Description
Zones	Select the zones to display (available only for multi-zoned scans)
Roughness Correlation	Change the values used *for display only*
Copy to Clipboard	Copy the plot for use in another document window

Options Menu

Command	Description
Data Type	Select the result type. A submenu appears with the options RA, RMS, PV, RMS Slope, TIS, Diffuse Refl, Total Refl, Spec Refl, Emissivity, Haze, and Gloss.
Filter Band	Select the filter band. A submenu appears with the options Low, High, or Full.
Data Limits	Select the Autoscale data limits. A submenu appears with the options All Data, 1 Sigma, 2 Sigma, and 3 Sigma.
Spot Size...	Change the size of the spots on the plot
Axes	Toggle the axes of the plot on and off
Crosshairs	Toggle the crosshairs on and off
Monochrome	Toggle the color on and off

Zoom Menu

Command	Description
Corner	Zoom in on a section with one corner of the enlargement where you place the mouse initially
Middle	Zoom in on a section with the center of the enlargement where you place the mouse initially
Out	Return to the original plot size

Run Menu

Command	Description
Select Test...	Choose a new test to run
Quick Test	Repeat the previous test, specify file name to save
Quick Run	Repeat the previous test, save to file name SPC$$SPC.DB0
Run SPC Menu	Select or run an SPC scan

Help Menu

Command	Description
Contents	List the contents of the help file
Search for Help On...	Search for help on a particular topic

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TZP Plot Window

This is a list of commands that are available from the TZP Plot window. You can reach these commands by selecting **TZP Plot** from the **File** menu in the Texture Measurement System window.

File Menu

Command	Description
Open...	Open an existing plot file
Save ASCII...	Save the current data for the plot to an ASCII file
Save Bitmap...	Save the current data plot as a bitmap
Print	Print the plot
Print Preview	View the plot as it will look when it is printed
Exit	Close the TZP Plot window

Edit Menu

Command	Description
Zones	Select the zones to display (available only for multi-zoned scans)
Roughness Correlation	Change the values used *for display only*
TZR Options	Edit TZR calculation and display options
Copy to Clipboard	Copy the plot for use in another document window

Options Menu

Command	Description
Data Type	Select the result type. A submenu appears with the options RA, RMS, PV, RMS Slope, TIS, Diffuse Refl, Total Refl, Spec Refl, Emissivity, Haze and Gloss.
Filter Band	Select the filter band. A submenu appears with the options Low, High, or Full.
Cursor	Toggle the cursor on and off
Monochrome	Toggle the color on and off
Use Data Slope	Plot data using a line fit
TZP v Radius	Display the data as a function of radius
TZP v Angle	Display the data as a function of angle
Show TZR	Display the TZR as a function of radius

Zoom Menu

Command	Description
Corner	Zoom in on a section with one corner of the enlargement where you place the mouse initially

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Out	Return to the original plot size

Run Menu

Command	Description
Select Test...	Choose a new test to run
Quick Test	Repeat the previous test, specify file name to save
Quick Run	Repeat the previous test, save to file name SPC$$SPC.DB0
Run SPC Menu	Select or run an SPC scan

Help Menu

Command	Description
Contents	List the contents of the help file
Search for Help On...	Search for help on a particular topic

Histogram Window

This is a list of commands available from the Histogram window. You can reach these commands by selecting **Histogram** from the **File** menu in the Texture Measurement System Window.

File Menu

Command	Description
Open...	Open an existing histogram file
Save Bitmap...	Save the current histogram as a bitmap
Print	Print the histogram
Print Preview	View the histogram as it will look when it is printed
Exit	Close the Histogram window

Edit Menu

Command	Description
Zones	Select the zones to display (available only for multi-zoned scans)
Roughness Correlation	Change the values used *for display only*

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Copy to Clipboard	Copy the histogram for use in another document window

Options Menu

Command	Description
Data Type	Select the result type. A submenu appears with the options RA, RMS, PV, RMS Slope, TIS, Diffuse Refl, Total Refl, Spec Refl, Emissivity, Haze, and Gloss.
Filter Band	Select the filter band. A submenu appears with the options Low, High, or Full.
Data Limits	Select the Autoscale data limits. A submenu appears with the options All Data, 1 Sigma, 2 Sigma, and 3 Sigma.
Crosshairs	Toggle the crosshairs on and off
Monochrome	Toggle the color on and off

Zoom Menu

Command	Description
Corner	Zoom in on a section with one corner of the enlargement where you place the mouse initially
Out	Return to the original histogram size
Fit Bins to Plot	Redistributes the data included in the displayed plot area into the total number of bins
All Data	Redistributes ALL data in the selected zones into the total number of bins

Run Menu

Command	Description
Select Test...	Choose a new test to run
Quick Test	Repeat the previous test, specify file name to save
Quick Run	Repeat the previous test, save to file name SPC$$SPC.DB0
Run SPC Menu	Select or run an SPC scan

Help Menu

Command	Description
Contents	List the contents of the help file
Search for Help On...	Search for help on a particular topic

Edit Scan Sequence Window

This is a list of commands that are available from the Edit Scan Sequence window. You can reach these commands by selecting **Scan Sequence...** from the **Edit** menu in the Texture Measurement System window.

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File Menu

Command	Description
New...	Create a new scan sequence
Open...	Open an existing scan sequence
Save	Save the current scan sequence under the current name
Save As...	Save the current scan sequence under a different name
Rename...	Rename the current scan sequence
Delete...	Delete a scan sequence
Write Protect...	Indicates the scan sequence is write protected; a password is required to edit the scan sequence
Close	Close the Edit Scan Sequence window

Multi-Zone-Scans

This menu has no options. When it is selected, the help file for creating multiple zone scans is opened.

Help Menu

Command	Description
Contents	List the contents of the help file
Search for Help On...	Search for help on a particular topic

Manual Window

This is a list of commands that appear in the manual window. You can reach these commands by selecting **Manual Mode** from the **Run** menu in the Texture Measurement System window.

File Menu

Command	Description
Start	Begin a trend measurement cycle (measures at one point only)
Stop	Stop the trend measurement cycle
Save...	Save the data from the previous trend cycle
Auto Set Gain	Reset the detector gains automatically
Close	Return to the Texture Measurement System window

Result Menu

The current item selected in this menu is indicated by a check mark.

Command	Description
RA	Display average roughness of surface
RMS	Display root mean square of surface deviation

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PV	Display amplitude difference between peak and valley
RMS Slope	Display measure of amplitudes on a PSD curve
TIS	Display total integrated scatter
Diffuse Refl	Display diffuse reflectance
Total Refl	Display total reflectance
Spec Refl	Display specular reflectance
Emissivity	Display emissivity
Haze	Display haze
Gloss	Display gloss

Filter Band Menu

The current item selected in this menu is indicated by a check mark.

Command	Description
Low	Display result from low filter band
High	Display result from high filter band
Full	Display result from low and high filter bands combined

Help Menu

Command	Description
Contents	List the contents of the help file
Search for Help On...	Search for help on a particular topic

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Appendix E: Error Messages

Below are some common errors that may occur when using the TMS-2000.

Initialization Failures

The following errors occur when either the FMS Controller or the Motion Controller are not initialized properly. The FMS Controller is initialized when the program is started, the Detector Setup window is opened, the Manual Mode is entered, or a scan is run. The Motion Controller is initialized when the program is started, movement parameters are edited, or a scan is run.

Error	Occurs When...	How to fix it
FMS controller initialization failed	You try to run the software and the TMS-2000 hardware is not powered on or connected correctly.	Check the serial connections and make sure all power is on. Restart the TMS-2000 software.
Motion controller initialization failed	Same as above.	Same as above.

Data Error

Error	Occurs When...	How to fix it
Data Error	Points are measured which are not on the sample, or gain levels are not set properly.	Set the gains in the Detector Setup window, reset the area to scan.

Login Failures

Error	Occurs When...	How to fix it
Invalid Password!	You typed the wrong password.	Retype the correct password OR use the /LOGIN command line option OR delete the “password=“ line in the tms.ini file and restart the program.
Passwords do not match!	You typed two different passwords when you tried to change the current password.	Try again, make sure you type the same new password in both the Enter and Re-enter new password boxes.

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Appendix F: Data File Format

ASCII

This format requires roughly 3 times the disk space of binary files, but is readable by other programs (such as a spreadsheet), and can even be imported into a word processing program. Data in an ASCII format file is stored as text characters and numbers, with commas separating fields and quotes surrounding strings. This is sometimes referred to as CSV, or Comma Separated Values format.

This program assumes that ASCII files end with a ".DA#" extension, where # = 0 to 9. TZP ASCII files end with a ".DP0" extension and TZR ASCII files end with a ".DR0" extension. Refer to the online help for examples of ASCII data files.

Note *The TMS software program is not capable of reading ASCII files.*

Binary Data Files

Binary data files are the more compact file format. In general this format will be unreadable by other programs since the data is stored as binary values with no separators between fields. This program assumes that binary data files end with a ".DB#" extension, where # = 0 to 9.

SPC

The SPC file format is used for Quality Assurance (QA) purposes. It is a process of data collection and storage. It allows you to collect information and send it to a central location. The accumulated data represents the performance of a given production process. Changes in the product or process over a span of time can be monitored and this information can then be presented for conformance to the ISO-9001 standard or other Quality Assurance programs.

SPC files have a file name specified when the scan sequences are assigned to function keys (refer to "Customizing the Scan Measurement Process"). An SPC file will be saved as SPC$$SPC.DB0, a TZP SPC file will be saved as SPC$$SPC.DP0, and a TZR SPC file will be saved as SPC$$SPC.DR0.

The data included in the files is determined when data preferences are made (refer to "Computing Results"). Refer to the online help for examples of SPC data files.

Note *The TMS software program is not capable of reading SPC files.*

Trend

Trend data file format is ASCII, stored as text characters and numbers. The TMS program can write to Trend data files but not read them. These files are generated in Manual Mode. Refer to the online help for an example of a Trend data file.

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Appendix G: Glossary

acceleration

Parameter in the Radius Stage Setup and Angle Stage Setup windows. It sets the fastest rate the motor can reliably change speed under all load conditions.

angle of incidence

Angle that a line (as a ray of light) falling on a surface makes with a perpendicular to the surface at the point of incidence.

angle of reflection

Angle between a reflected ray and the normal drawn at the point of incidence to a reflecting surface.

angle stage

See *rotary stage*.

angstrom (Å)

Unit of length used especially for microroughness on surfaces. Examples: 1 Å=1x10^{-10} meters, 1 µm=10,000 Å, 1 nm=10 Å

ASCII

American Standard Code for Information Interchange. It is a file format used by the TMS-2000 series. This format typically requires substantially more disk space than binary files, but is readable by other programs (such as spreadsheet), and can even be imported into a word processing program. Data in an ASCII format file is stored as text characters and numbers with commas separating fields and quotes surrounding strings. This is sometimes referred to as CSV, or Comma Separated Values format. The TMS program can write ASCII files, but cannot read them. Trend data files are stored as ASCII files. You can specify the data to include in the ASCII file from the Data Preferences menu option.

bins

The ranges into which data values in a data file are divided to create histograms. Bins are represented as bars on the histogram bar chart.

binary

A file format used by the TMS-2000 series. This format is generally more compact than ASCII, however, in general this format will be unreadable by other programs (or humans!) as the data is stored as binary values with no separators between fields. The TMS program will write and read binary TMS data files. They have a .DB0 extension.

calibration speed

Parameter in the Radius Stage Setup and Angle Stage Setup windows. It sets the fastest speed the motor can stop instantly upon the controller and detect (without sliding past) the home switch.

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correlation factors

Make the outputs of one instrument match those of another that possibly uses different filter bands or measurement techniques. The factors in the TMS-2000 system are Slope and Offset.

cross hairs

Locate particular points and the data values at those points. They are represented by axes, and the point of intersection of these axes stands for the data point.

data error

Error message that is displayed if no sample is in the source optics or the gain levels are not set properly, or points are measured which are not on the sample. The points where data errors occur are not plotted in the plot window and are shown in a different color than the acceptable points in the Run window. The reason for this error is the Specular Reflectance detector reading was not greater than zero at these bad points. The result will be displayed as -999.9 at the point, and it will not be included in the statistical calculations for the scan.

detector gain

See *gain*.

diffuse reflectance

Measure of the light broken up and distributed by reflecting off of a surface roughness, where the range of collection angles of diffuse light need to be specified. It is the ratio of scattered power to incident power.

emissivity

Relative power of a surface to emit heat by radiation. An emissivity of 1.0 implies perfect absorption or emission. The Filter Band is always 'Full' for this calculation.

filter band

Controls the range of surface structures over which the roughness measurements are calculated. It is the basis for roughness computations. The filter band can be Low, High, Full (a combination of Low and High), or Specular. The Full filter band is always used for calculations of total reflectance, emissivity, and RMS slope. The specular reflectance uses the Specular filter band and none of the others.

FMS

Finish Measurement System.

FMS Controller

Electronic hardware of the TMS instrument. It controls the laser and receives the signals from the detectors. When it is initialized, the calibration constants are sent from the controller to the software and used in the calculations. The FMS Controller is initialized when the program is started, the Detector Setup window is opened, the Manual Mode is entered, or a scan is run.

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gain

Number used in detector calculations. It is calculated from the detector gain level specified in the Detector Setup window. The gain is proportional to two raised to the power of the gain level.

gain level

Parameter in the Detector Setup window. It can be set as a whole number between zero and seventeen. At each gain level, the corresponding gain value is two raised to a power equal to the level value. For example, at gain level 6, the value of the gain is 2^6, or 64. If it set too high, the Measured value in this window will be limited to about 4.5 volts, or reduced to nearly zero if the amplifiers overload.

gloss

Measure of the amount of light reflected in the specular direction from a sample proportional to all of the light reflected and scattered from the sample.

haze

Measure, in parts per million, of the diffuse reflectance of a surface.

histogram

A chart of the number of occurrences of data values plotted over the range of values in the data.

home switch

A hardware switch used to reference the stage locations. Its position is calculated in both the linear and rotary stages. It s determined at factory setup and is different for disks and wafers. It is recommended that you do not change this value. All locations are in reference to this position.

incident angle

See *angle of incidence*.

integration

Duration of a measurement at a single point measured in milliseconds (ms). The value can be in the range from 0.2 ms to 2000.0 ms. Recommended values are between 4 ms and 10 ms. The time to complete a scan increases proportionally with the integration time at each point. Increasing this number decreases the noise at each point. Any integration time longer than 4 ms may cause the scan to run slower.

interface electronics

Hardware of the TMS instrument. They provide power, power distribution, various interconnections, and other functions. It coordinates the Motion and FMS Controllers.

interval

Time to wait between measurements during a trend cycle measurement.

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jog

Moves either the linear (radius) or the rotary (angle) stage at a pace specified by the jog rate, and either the (+) or (-) direction.

jog rate

Speed to move the stage when in manual control when the ±jog button is clicked.

linear stage

Hardware platform that gives the TMS-2000 its back and forth scanning motion

login password

Default is sms. This is required to edit the configuration of the system.

machined surfaces

Tend to be formed in a regular or periodic manner due to tool marks

max speed

Parameter in the Radius Stage Setup and Angle Stage Setup windows. It sets the fastest speed the motor can reliably run the stage.

microroughness

Measure of surface at very detailed level to determine roughness

motion controller

Electronic hardware of the TMS instrument. It receives control commands from the computer through a serial cable at 9600 baud and converts those commands into motion signals which it sends to the motor drives. The motion controller also interprets the signals from the limit and home sensors on the stages. It is initialized when you start the software and before movement parameters (angle stage and radius stage) can be changed. The Motion Controller is initialized when the program is started, movement parameters are edited, or a scan is run.

motor drives

Electronic hardware of the TMS instrument. These cause the motors to move in response from the Motion Controller signals it receives. The sample is positioned according to these signals.

negative numbers

For large negative numbers, see Data Error. Small negative numbers usually appear while measuring very small values when too much noise is present. Noise is the cause of measurements which have different values when repeated at the same point on the sample. This effect can be reduced by increasing the Integration using the Detector Setup Window, but there is a tradeoff between operation speed and integration time. Using the /NoNeg command line option limits numbers so that they will not go negative, and statistical results may be incorrect as a result.

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noise

Cause of measurements which have different values when repeated at the same point on the sample. This effect can be reduced by the square root of the integration time; therefore, increasing the integration decreases the noise (but it also increases the total scan time).

normal

Perpendicular to the surface

offset

Correlation factor to make the outputs of one machine match those of another. This is added to the result of the RMS value multiplied by the Slope to yield the new correlated value. For no correlation, this value should be set to zero.

optical assembly

Hardware of the TMS instrument. It consists of a laser diode, detectors, and passive optical components.

password

Required to edit the configuration parameters of the system. The default password for editing the configuration is sms. If you change the password, the new one must be between three and ten characters long.

point of incidence

Place where light rays fall on a surface.

primary result

Primary computed result from the data measured. The selection is made in the Data Preferences window. It can be either RA or RMS. This is the result that is compared to the Primary Control Limits and used in the SPC file generation.

PV

Measure of the amplitude difference for the surface between the peak and valley. Other terms used for PV are Rt and TIR.

RA

average roughness of the surface as measured from the mean level of the surface. Other terms used for RA are Ra, ra, AA, and CLA.

radius stage

See *linear stage.*

Ra roughness

Arithmetic average roughness of the absolute deviations from the mean surface level. This term is used more for machined surfaces than polished optics.

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raw refl

Raw reflectance. Parameter in the Detector Setup window. It is the product of the Detector voltage and the Refl Gain, and represents the ratio of the amount of light gathered by the detector to the amount of light incident on the sample. The Auto Set button is used to calibrate the instrument and is not used by the operator.

Rdiffuse

See *diffuse reflectance*.

reflectance

Fraction of the total radiant flux incident upon a surface that is reflected and that varies according to the wavelength distribution of the incident radiation. In the Detector Setup window this parameter is the Raw Refl corrected by adding the Refl Offset. This value is used to compute all other results provided by the instrument.

refl gain

Reflectance gain. Parameter in the Detector Setup window. It is set so that when it is multiplied by the Detector value the product (Raw Refl) is equal to the known specular reflectance of the sample. If the gain level is changed, this displayed value is compensated for that change.

refl offset

Reflectance offset. Parameter in the Detector Setup window. It defines the offset for the Raw Refl to compensate for the noise of the optics assembly.

RMS

Root Mean Square of the surface deviation from the mean level of the surface. Other terms used for RMS are Rq and rms. In the Detector Setup window, it is computed from the TIS value specifically for each band, and is not adjusted by the correlation factors.

RMS Correlation

Ensures the results of the TMS-2000 series are compatible with the results of other machines that possibly use different filter bands. The correlation factors are Slope and Offset. For no correlation, the Slope should be set to one and the Offset set to zero.

RMS roughness

Assuming a surface in the horizontal plane, this is the root mean squared value of all vertical deviations from the mean surface level.

RMS Slope

Measure of how the amplitudes of the surface spatial frequencies (or wavelengths) fall off on a log-log plot (This is analogous to the slope of a PSD curve). The Filter Band is always 'Full' for this calculation.

rotary stage

Hardware of the TMS instrument. Provides the rotational (circular) scanning motion.

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Rspecular

See *specular reflectance.*

sample motion stages

Hardware of the TMS instrument. Comprised of two stages, linear and rotary.

scan sequence

Set of parameters that define which points on a sample are to be measured. All measured points will be on evenly spaced radii from the sample center. You choose the radii and the spacing between them. At each radius you choose whether the number of points measured around the center will be constant or evenly distributed. If constant, then the measurements will be arrayed as spokes radiating from the center at angle spacing of your choosing. If distributed, then the measurements will appear as rings of measurements with the points in each ring at a distance spacing of your choice. You can specify that the stages stop moving in order to measure each point or you can specify the rate to scan while measuring each point while it is moving.

secondary result

Secondary computed result from the data measured. The selection is made in the Data Preferences window. It can be one of the following choices: PV, RMS Slope, TIS, Diffuse Reflectance, Total Reflectance, Specular Reflectance, or Emissivity. Statistics from this result can be included in the SPC data file.

slope

Correlation factor to make the output of one machine match those of another. The RMS value is multiplied by this and the Offset is then added to the product to yield the new correlated result. For no correlation, this value should be set to one.

SMS

Schmitt Measurement System. The company that produces the TMS-2000 series.

source optics

Part of the instrument that contains the laser and the light gathering optics, including the detectors.

spatial bandwidth

Limits of maximum and minimum bandwidth an instrument can measure of surface features.

spatial frequency

Inverse of the minimum and maximum spatial bandwidths.

SPC

See *Statistical Process Control*.

specular band

Filter band used in some calculations during a scan.

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specular reflectance

Measure of the reflectance of the surface looking only at the reflected laser beam (specular). The Filter Band is always blank for this calculation.

stage

Hardware platform. The TMS-2000 has a rotary (angle) stage and a linear (radius) stage for movement control.

Statistical Process Control

Used for conformance to ISO-9001 standard or other Quality Assurance programs. Data files in this format have a .PRN extension. These files can be specified from the QA (SPC) Assignment menu option. The data included in these files is determined in the Data Preferences window. You can choose to monitor overall trends or detailed trends at each point.

target refl

Target reflectance. Calibration parameter in the Detector Setup window set to the known reflectance of the sample. Using the Auto Set button computes this value and finds the Refl Gain so that the Raw Refl value matches this value.

TIS

See Total Integrated Scatter.

Total Integrated Scatter (TIS)

Ratio between the diffuse reflectance and the specular reflectance.

TMS

Texture Measurement System.

TMS instrument

Hardware of the TMS-2000 series. It consists of several components. These are the sample motion stages (linear and rotary), motion controller, motor drives, optics assembly, FMS controller, and TMS interface electronics.

total refl

See *total reflectance*.

total reflectance

Measure of the total sample reflection. The Filter Bandwidth is always Full and Specular for this calculation.

transition enhancement percentage

Parameter in the TZP Plot window that controls the amount of processing performed on the average value of the radius. The processing tries to remove the smearing effect introduced by trying to measure small features with a large laser spot. The acceptable range is from 0% to 200%.

TZP

Transition Zone Plot

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TZR

Transition Zone Radius. The radius computed by the software which identifies the edge of a transition.

uniform point density

Parameter in the Edit Scan Sequence window. It determines the spacing of measurements along the radii. If it is selected, the points are evenly spaced on each radii scanned. If it is not selected, the same number of points on each radii is scanned.

wavelength

System configuration parameter in the Detector Setup window. It indicates the wavelength of the laser source, measured in nanometers (nm).

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Your Notes

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