USER'S GUIDE TO AUTOPROBE CP

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Part I: Learning to Use AutoProbe CP: Basic Imaging Techniques

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Contents

Preface

Operating Safety

This section includes important information about your AutoProbe CP system. It describes in detail procedures related to the operating safety of AutoProbe CP and therefore must be read thoroughly *before* you operate your AutoProbe CP system.

> ***WARNING!***
>
> The protection provided by the AutoProbe CP system may be impaired if the procedures described in this User's Guide are not followed exactly.

Safety Symbols

Table 0-1 lists symbols that appear throughout this User's Guide and on the AutoProbe CP system. You should become familiar with the symbols and their function. The symbols are used to alert you to matters related to the operating safety of the AutoProbe CP system.

Table 0-1. Safety symbols and their functions.

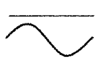
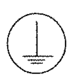
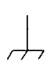
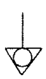
Symbol	Function
	Direct current source.
	Alternating current source.
	Direct and alternating current source.
	Three-phase alternating current.
	Ground (earth) terminal.
	Protective conductor terminal.
	Frame or chassis terminal.
	Equipotentiality.
I	Power on.

Table 0-1 (continued). Safety symbols and their function.

Symbol	Function
○	Power off.
⧈	Equipment protected by double or reinforced insulation.
⚠	Refer to system documentation.
⚡	Electric shock risk.

Definitions: Warning, Caution, and Note

There are three terms that are used in this User's Guide to alert you to matters related to the operating safety of AutoProbe CP—warning, caution, and note. These terms are defined in Table 0-2, below.

Table 0-2. Safety terms and their definitions.

Term	Definition
Warning	Alerts you to possible serious injury unless procedures described in this User's Guide are followed exactly. Do not proceed beyond a warning until conditions are fully understood and met.
Caution	Calls your attention to possible damage to the system or to the impairment of safety unless procedures described in this User's Guide are followed exactly.
Note	Calls your attention to a rule that is to be followed or to an out of the ordinary condition.

It is important that you read all warnings, cautions, and notes in this manual carefully. Warnings, cautions, and notes include information that, when followed, ensures the operating safety of your AutoProbe CP system.

Summary of Warnings and Cautions

This section includes warnings and cautions that must be followed whenever you operate AutoProbe CP.

WARNING!

AutoProbe CP must be properly grounded before you turn on the power to its components. The mains power cord must only be inserted into an outlet with a protective earth ground contact. See the section "Grounding AutoProbe CP" later in this preface for more information.

WARNING!

The line voltage selection must be checked before you turn on the power to AutoProbe CP's system components. The line voltage selector switch is on the rear panel of the AEM. The line voltage selector switch can be set to the following voltages: 100 V, 120 V, 220 V, and 240 V. See the section "Setting the Line Voltage" later in this preface for more information.

WARNING!

Do not open the AutoProbe electronics module (AEM) or the CP base unit. The AEM and the CP base unit use hazardous voltages and therefore present serious electric shock hazards.

WARNING!

PSI requires that you routinely inspect the cables of the AutoProbe CP system to make sure that they are not frayed, loose, or damaged. Cables that are frayed, loose, or damaged must be immediately reported to your local PSI service representative. Do not operate AutoProbe CP when wires are frayed, loose, or damaged.

CAUTION

All AutoProbe CP system components must be handled with care. System components contain delicate electromechanical instrumentation that can easily be damaged by improper handling.

CAUTION

The power to the AEM must be turned OFF before you remove or install the scanner.

CAUTION

The LASER ON/OFF switch of the probe head must be in the OFF position before you remove or install the probe head on the XY translation stage. Otherwise, damage to the light-emitting diodes (LEDs) of the probe head may result.

CAUTION

When removing and installing the scanner, you must be grounded via a grounding strap to ensure that the scanner is not damaged. The scanner is sensitive to electrostatic discharge.

CAUTION

The four screws that connect the scanner to the CP base unit must be securely fastened to ensure proper grounding. When the four screws are securely fastened, maximum instrument performance is ensured since vibrations are reduced.

CAUTION

To preserve safety and EMC compliance, AutoProbe CP must be used with the EMI filter supplied with the AutoProbe CP system.

CAUTION

To preserve EMC immunity, place the metal cover on the CP base unit while imaging.

Grounding AutoProbe CP

AutoProbe CP must be properly grounded *before* you turn on the power to its components The main power cord must be inserted into an outlet with a protective earth ground contact. If you do not have access to an outlet with a protective earth ground contact, you must ground the AutoProbe CP system using the ground connection of the AEM. The location of the ground connection is shown in Figure 0-1, below.

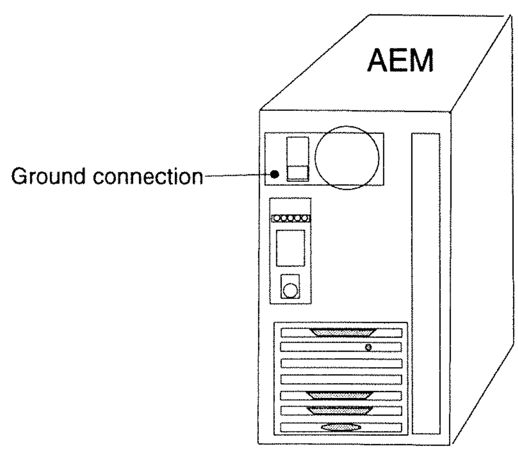


Figure 0-1. Rear panel of the AEM, showing the location of the ground connection.

Setting the Line Voltage

The line voltage selection must correspond to the line voltage of the country where the AutoProbe CP system is operated. The line voltage selection is made using a line voltage selector. The line voltage selector unit is located on the rear panel of the AEM. The line voltage can be set to the following voltages: 100 V, 120 V, 220 V, or 240 V.

To change the line voltage selection, follow these steps:

1. Make sure the power to the AEM is turned off.
2. Unplug the AEM's power cord from the power outlet.
3. Remove the cover of the line voltage selector unit using an appropriately sized screwdriver.
4. Insert an appropriately sized tool into the line voltage selector slot and use the tool to remove the line voltage selector wheel from the unit.
5. Set the line voltage on the line voltage selector wheel to the desired value—100 V, 110 V, 220 V, or 240 V.
6. Put the line voltage selector wheel back into its location in the unit. Make sure that the desired voltage is shown in the window.
7. Install the cover onto the line voltage selector unit.

The line voltage should now be set to the appropriate value.

Laser Safety

Note: Throughout this section, the drawings refer to the AFM probe head for the standard system configuration of AutoProbe CP unless otherwise noted.

AutoProbe CP contains a diode laser powered by a low voltage supply with a maximum output of 0.2 mW CW in the wavelength range 600 to 700 nm. Diode laser power up to 0.2 mW at 600 to 700 nm could be accessible in the interior. AutoProbe CP should always be operated with the probe head properly installed.

> ***WARNING!***
>
> Use of controls or adjustments or performance of procedures other than those specified herein could result in hazardous laser light exposure.

Figure 0-2 shows the two laser warning labels of the probe head. Strict observance of these laser warning labels is required.

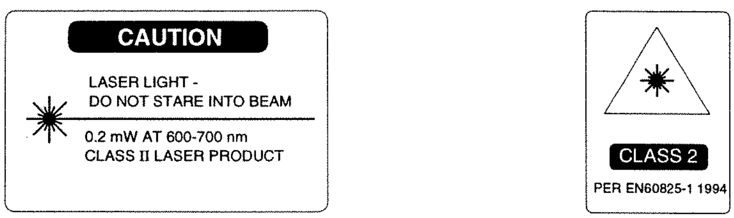


Figure 0-2. Laser warning labels of the probe head.

The left warning label in Figure 0-2, above, specifies that the probe head is a Class II laser product per 21 CFR 1040.10 and 1040.11. The right warning label in Figure 0-2, above, specifies that the scanning head is a Class 2 laser product per EN60825.

Figures 0-3 through 0-7 below show the location of all instrument controls and indicators pertaining to laser operation for AutoProbe CP systems. They also show the locations of all laser safety warning labels, the aperture label, and the compliance label.

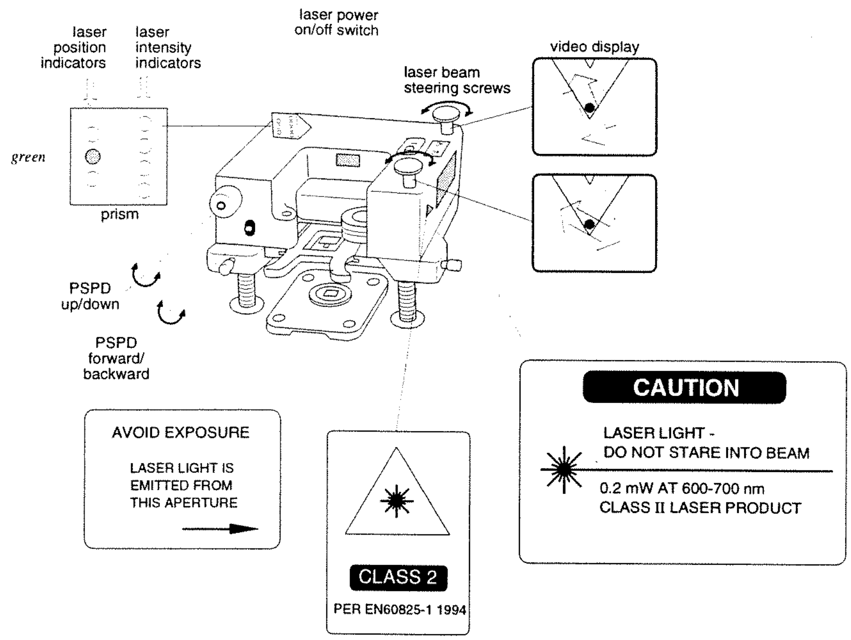


Figure 0-3. Location of laser controls, indicators, and labels on the probe head.

The controls and indicators shown above in Figure 0-3 have the following functions:

Laser power on/off switch: Turns the laser in the probe head on or off. A red light in the switch is lit when the laser power is on.

Laser beam steering screws: The two laser beam steering screws located on the top right side of the probe head are used to adjust the position of the laser beam hitting the cantilever. The screws move the laser spot in two directions, as shown in Figure 0-3, above. If your system includes the optional CP optics, you can monitor these adjustments using the optical view displayed on your video monitor.

PSPD adjustment screws: There are two PSPD (position-sensitive photodetector) screws on the probe head—up/down and forward/backward. These screws adjust the position of the PSPD in the probe head to center the reflected laser light on the photodetector. The forward/backward adjustment screw is useful for PSPD alignment on all probe heads. The up/down adjustment is useful primarily for the AFM/LFM probe head of the standard system configuration.

Laser intensity indicators: Indicates the intensity of reflected laser light hitting the PSPD.

For the standard configuration, there are three probe heads that require laser intensity indicators—AFM, AFM/NC-AFM, and AFM/LFM. There are different indicators for the different probe heads.

Note: The AFM probe head comes with the standard system configuration. The AFM/NC-AFM and AFM/LFM probe heads can be purchased separately for the standard system configuration.

The indicators for the AFM probe head are shown in Figure 0-3, above. For this probe head, the intensity of laser light hitting the PSPD is maximized when the column of four red lights is lit. The indicators for the AFM/NC-AFM and AFM/LFM probe heads are shown in Figure 0-4, below. For these probe heads, when the brightness of the center green light (which has variable brightness) is maximized, the laser intensity hitting the PSPD is maximized.

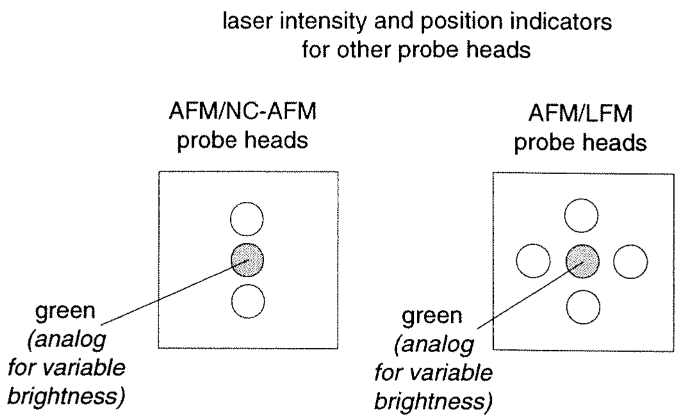


Figure 0-4. Laser intensity and position indicators for the AFM/NC-AFM and AFM/LFM probe heads of the standard system configuration.

For the multitask configuration, when the brightness of the center green light (which has variable brightness) is maximized, the laser intensity hitting the PSPD is maximized. See Figure 0-5, below.

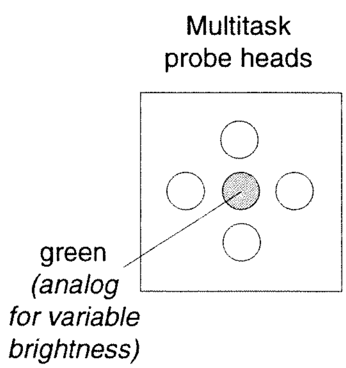


Figure 0-5. Laser intensity and position indicators for the multitask probe head.

Laser position indicators: Indicate the position of the reflected laser light hitting the PSPD. When the laser spot is centered on the photodetector, the center green light is lit, as shown in Figures 0-4 and 0-5, above.

Figure 0-6, below, shows the location of the laser warning labels on the outer housing of AutoProbe CP.

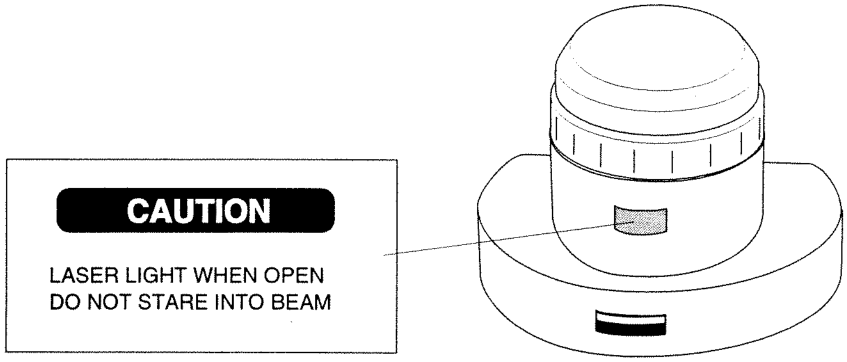


Figure 0-6. Laser warning location on AutoProbe CP housing.

Figure 0-7, below, shows the location of the laser safety compliance label on the rear panel of the AutoProbe electronics module (AEM).

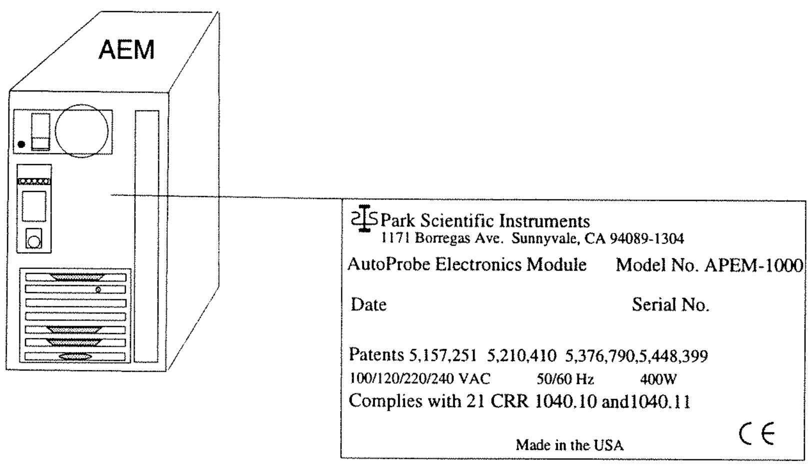


Figure 0-7. Rear panel of the AEM, showing location of laser safety compliance label.

Specifications and Performance for AutoProbe CP

System Configurations:

Standard	Includes an AFM probe head for operation in AFM mode. Optional AFM/NC-AFM probe head can be purchased for operation in AFM, non-contact AFM, intermittent-contact AFM, and MFM modes. Optional AFM/LFM probe head can be purchased for operation in AFM and LFM modes. Optional STM toolkit can be purchased for operation in STM mode.
Multitask	Includes a multitask probe head for operation in the following modes: contact, non-contact, and intermittent-contact AFM, MFM, LFM, and STM.

Measurement Performance:

Standard:	
Scanner	5 μm piezoelectric scanner.
Scan range	Maximum lateral scan range: 5 μm. Maximum vertical scan range: 2.5 μm.
Control resolution	Maximum lateral resolution: 0.0013 Å. Maximum vertical resolution: 0.009 Å.
Multitask:	
Scanner	100 μm piezoelectric scanner.
Scan range	Maximum lateral scan range: 100 μm. Maximum vertical scan range: 7.5 μm.
Control resolution	Maximum lateral resolution: 0.25 Å. Maximum vertical resolution: 0.025 Å.

Microscope Stage:

Translation range	8 mm x 8 mm.
Sample size	50 mm (w) x 50 mm (l) x 25 mm (h) for the standard configuration. 50 mm (w) x 50 mm (l) x 20 mm (h) for the multitask configuration.
Tip-to-sample approach	Automatic with 3 independent stepper motors.
Optical microscope	Optional on-axis microscope with color video monitor for probe tip and sample view. 5:1 zoom, up to 3,500X magnification.
Acoustic isolation	Optional acoustic isolation chamber.

Workstation:

AEM	20-bit DACs for x, y, and z axes. 16-bit DACs for system control.
Computer	100 MHz Pentium processor, 256 Kbyte cache memory, 16 MB RAM.
Mass storage	1 GB hard drive, 3 1/2 in. 1.4 MB floppy disk drive.
Software	ProScan Data Acquisition and Image Processing operates under Windows 95.
Graphics	Windows graphics accelerator, 17 in. high-resolution color monitor.
System power	115/230 V AC, 50/60 Hz, 600 W.

Dimensions and Weights:

CP base unit	10.5 in. (267 mm) x 8 in. (203 mm); 22 lb (10 kg).
AEM	17 in. (432 mm) x 7 1/2 in. (191 mm) x 17 1/2 in. (445 mm); 43 lb (20 kg).
Computer	17 in. (432 mm) x 7 1/2 in. (191 mm) x 17 1/2 in. (445 mm); 27 lb (12 kg).

Operating Environment:

Temperature	0°C to 30°C, 32°F to 112°F.
Humidity	90%; noncondensing.

Cleaning Agents:

CP base unit	Isopropyl alcohol.
Probe head	Isopropyl alcohol.
AEM and computer	Isopropyl alcohol.

WARNING!

To avoid risk of electric shock, do not clean AutoProbe CP system components when power to the components is turned on.

CAUTION

Do not use acetone to clean AutoProbe CP system components. Acetone may damage important safety warning labels.

Park Scientific Instruments Warranty Statement

Warranty on New Systems and Accessories

Park Scientific Instruments (PSI) warrants to the original purchaser of the equipment that the equipment will be free from defects in material and workmanship for a period of one year from date of delivery. PSI agrees as its sole responsibility under this limited warranty that it will replace or repair, at its option, the warranted equipment at no charge to the purchaser and will perform services either at PSI's facility or at the customers facility, at PSI's option. For repairs performed at PSI's facility, the customer must contact PSI in advance for authorization to return the equipment and must follow PSI's shipping instructions. If returned, the equipment must be insured.

PSI will supply replacement parts on loan, whenever possible, to enable field repair by customers with minimum downtime; once the system is operational the defective parts are then returned to PSI.

Specifically excluded from this warranty are all consumable parts including, but not limited to, Microlevers, Ultralevers, and tips. The warranty of equipment sold for use outside the United States depends on the condition of each sale. Equipment which has been subjected to misuse, accident, abuse, disaster, unreasonable use, damage caused by third party systems with which the equipment is used, operational error, neglect, unauthorized repair, alteration or installation is not covered by this warranty.

Warranty on Replacement Parts

PSI warrants all replacement parts to be sold free from defects in materials or workmanship for a period of 90 days from the date received by the customer. PSI will repair or replace, at its discretion, such parts when returned to PSI. Customers must contact PSI in advance to obtain authorization to return parts and follow PSI's shipping instructions.

Except as herein provided, seller makes no warranties, express or implied, and seller expressly excludes and disclaims any warranty of merchantability or fitness for a particular purpose. Under no circumstances shall PSI be liable for any loss or damage, direct, special, indirect or consequential, arising from the use or loss of use of any product, service, part, supplies or equipment. Nor shall PSI be liable under any legal theory, including, but not limited to, lost profits, down-time, goodwill, damage to or replacement of equipment or property, and any cost of recovering, reprogramming, or reproducing any program or data stored in or used with PSI products.

Some states do not allow limitations on the period of time an implied warranty lasts and/or the exclusion or limitation of special, incidental or consequential damages, so the above limitations and/or exclusions may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Manufacturer Information

AutoProbe CP systems contain no user serviceable parts. All service issues should be addressed to your local PSI representative.

PSI, USA
1171 Borregas Avenue
Sunnyvale, CA 94089
T: (408) 747-1600
F: (408) 747-1601

PSI, USA
6 Denny Road, No. 109
Wilmington, DE 19809
T: (302) 762-2245
F: (302) 762-2847

PSI, SA
16 rue Alexandre Gavard
1227 CAROUGE
Geneva, Switzerland
T: 41-22-300-4411
F: 41-22-300-4415

PSI, Korea
Suite 301, Seowon Building
395-13, Seokyo-dong, Mapo-ku
Seoul, Korea
T: 82-2-325-3212
F: 82-2-325-3214

If you return system components to PSI for service that have come into contact with harmful substances you must observe certain regulations. Harmful substances are defined by European Community Countries as "materials and preparations in accordance with the EEC Specification dated 18 September 1979, Article 2." For system components that have come into contact with harmful substances, you must do the following:

- Decontaminate the components in accordance with the radiation protection regulations.
- Construct a notice that reads "free from harmful substances." The notice must be included with the components and the delivery note.

How to Use This User's Guide

The User's Guide to AutoProbe CP is divided into three, easy-to-use parts. The parts include the following:

- Part I: *Learning to Use AutoProbe CP: Basic Imaging Techniques*
- Part II: *Learning to Use AutoProbe CP: Advanced Techniques*
- Part III: *Software Reference*

The contents of the above-listed parts are described in detail in the sections below.

Part I: Learning to Use AutoProbe CP: Basic Imaging Techniques

Part I of this *User's Guide, Learning to Use AutoProbe CP: Basic Imaging Techniques*, contains an introductory chapter and three hands-on tutorials, Chapters 2 through 4. By working through the tutorial chapters, you will learn the basic skills needed to set up the instrument and to take an AFM image.

Start by reading Chapter 1, "AutoProbe CP Basics," for an introduction to the system configurations and the components of AutoProbe CP. Then, work through the tutorial in Chapter 2, "Setting Up to Take an Image" to learn how to set up the system hardware and software for AFM mode. More specifically, you will learn the procedures for connecting cables, removing and installing a probe head and a scanner, and loading a sample and a probe.

Chapter 3, "Taking an AFM Image," guides you through setting up the system software, approaching the sample, and taking an AFM image. Chapter 4, "Taking Better Images," teaches you how to optimize scan and feedback parameters to take higher quality images and how to save and retrieve images.

Part II: Learning to Use AutoProbe CP: Advanced Techniques

Part II of this User's Guide, *Learning to Use AutoProbe CP: Advanced Techniques*, includes hands-on tutorials for operation in the following modes: NC-AFM, IC-AFM, MFM, STM, and LFM. It also includes tutorials that introduce you to advanced capabilities of AutoProbe CP, such as force vs. distance and current vs. voltage data acquisition, and scanner calibration.

Chapter 1, "NC-AFM, IC-AFM, and MFM Imaging," provides step-by-step instructions for taking NC-AFM, IC-AFM, and MFM images. Chapter 1 also describes the principles behind NC-AFM, IC-AFM, and MFM modes of operation.

Chapter 2, "STM Imaging," guides you through taking an STM image. In this chapter, you learn procedures for preparing an STM tip and using a STM cartridge, setting up the hardware and software for operation in STM mode, and taking an STM image.

Chapter 3, "LFM Imaging," leads you through taking simultaneous LFM and AFM images. Chapter 3 also includes information on how LFM images are produced and the usefulness of having both LFM and AFM images available.

Chapter 4, "Force vs. Distance Curves," describes how to use the F vs. D Spectroscopy window of ProScan Data Acquisition to generate force vs. distance curves at x, y locations on the sample surface. A force vs. distance curve is a plot of the vertical force that the tip applies to the cantilever as a function of the tip-to-sample distance. Variations in the shape of force vs. distance curves provide information about the local elastic properties of the sample surface.

Chapter 5, "I-V Spectroscopy," teaches you how to use the I-V Spectroscopy window of ProScan Data Acquisition to generate current vs. voltage (I-V) and dI/dV curves. These curves are used to provide important information about surface electronic properties.

Chapter 6, "Scanner Calibration," describes how the scanner of your AutoProbe CP instrument works and how to calibrate it to maintain its optimal performance.

Part III: Software Reference

Part III of this User's Guide, *Software Reference*, is the reference manual for ProScan Data Acquisition and Image Processing and includes information for the following AutoProbe systems: CP, LS, and M5. The chapters in this part of the User's Guide provide more detailed information about the software features and controls than the information that is provided in the tutorial chapters. The chapters are designed so that you can skip straight to the feature or control that you are interested in learning more about.

Chapter 1, "ProScan Data Acquisition," describes in detail the software features of ProScan Data Acquisition. This chapter discusses each region of the screen, giving special attention to each control and its function. This chapter also discusses the menus, with a description of each menu item and its function.

Chapter 2, "ProScan Image Processing," describes in detail the software features of ProScan Image Processing. This chapter explains how to process images, how to make surface measurements, and how to prepare images for printout in a variety of formats.

Vorwort

Betriebssicherheit

Dieses Kapitel enthält wichtige Informationen über ihr AutoProbe CP System. Es beschreibt im Detail den Arbeitsablauf in Bezug auf die Betriebssicherheit des AutoProbe CP und muss daher vollständig durchgelesen werden *bevor* sie ihr AutoProbe CP System bedienen.

> ***<u>WARNUNG!</u>***
>
> Der durch das AutoProbe CP System versehene Schutz ist beeinträchtigt, falls die in diesem Benutzerhandbuch beschriebenen Arbeitsabläufe nicht genaustens befolgt werden.

Sicherheits Zeichen

In Tabelle 0-1 sind die im Benutzerhandbuch und auf dem AutoProbe CP System vorkommenden Zeichen aufgelistet. Sie sollten mit der Wirkung der Zeichen vertraut werden, in welcher Weise sie mit der Betriebssicherheit des AutoProbe CP in Zusammnehang stehen.

Tabelle 0-1. Sicherheits Zeichen und ihre Wirkung.

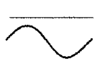
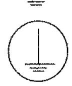
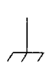
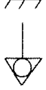
Zeichen	Wirkung
	Gleichstromquelle.
	Wechselstromquelle.
	Wechselstrom- und Gleichstromquelle.
	Dreiphasenstromquelle.
	Erdungsanschluss.
	Schutzerdungsanschluss.
	Gehäuse- oder Rahmenanschluss.
	Äquipotentialanzeige.
I	Schaltet Stromversorgung ein.

Tabelle 0-1(Fortsetzung). Sicherheits Zeichenund ihre Wirkung.

Zeichen	Wirkung
	Schaltet Stromversorgung aus.
	Bezeichnet doppelte oder verstärkte Isolierung des Gerätes.
	Weisst den Benutzer auf eine in der Dokumentation enthaltene Information hin.
	Zeigt eine Berührungsgefahr an.

Definitionen: Warnung, Vorsicht und Beachte

Im Benutzerhandbuch werden drei verschiedene Bezeichnungen, Warnung, Vorsicht und Beachte, benutzt, um auf die Betriebssicherheit des AutoProbe CP hinzuweisen. Diese Bezeichnungen sind in Tabelle 0-2 definiert.

Tabelle 0-2. Sicherheits Bezeichnungen und ihre Definition.

Bezeichnung	Definition
Warnung	Warnt vor möglicher ernsthafter Verletzungsgefahr, falls dem im Benutzerhandbuch beschriebenen Arbeitsablauf nicht unbedingt Folge geleistet wird. Der Arbeitsablauf darf nicht fortgeführt werden, bis nicht alle Voraussetzungen verstanden und erfüllt sind.
Vorsicht	Macht auf mögliche Schädigung des Systems oder Verschlechterung der Sicherheit aufmerksam, falls dem im Benutzerhandbuch beschriebenen Arbeitsablauf nicht unbedingt Folge geleistet wird.
Beachte	Macht auf eine zu beachtende Benutzungsregel oder ungewöhnliche Voraussetzung aufmerksam.

Es ist wichtig, dass alle Warnungen, Vorsichts, und Beachte in diesem Handbuch achtsam gelesen werden, um die Bedienungssicherheit ihres AutoProbe CP Systems zu gewährleisten.

Zusammenfassung der Warnungen und Vorsichts

Dieser Abschnitt beinhaltet die Warnungen und Vorsichts, die unbedingt befolgt werden müssen, wann immer das AutoProbe CP betrieben wird.

WARNUNG!

Das AutoProbe CP muss ordnungsgemäss geerdet werden, bevor Spannung an seine Komponenten angelegt werden darf. Das Versorgungskabel darf nur mit einen Anschluss verbunden werden, der mit einem Erdungspol versehen ist. Für weitere Informationen soll der Teil "Erdung des AutoProbe CP" folgend in diesem Vorwort beachtet werden.

WARNUNG!

Vor dem Einschalten der AutoProbe CP Systemkomponenten muss der Versorgungsspannungsschalter überprüft werden. Der Versorgungsspannungsschalter befindet sich an der Rückwand des AEM und kann folgendermassen eingestellt werden: 110 V, 120 V, 220 V und 240 V. Für weitere Informationen soll der Teil "Einstellen der Versorgungsspannung" folgend in diesem Vorwort beachtet werden.

WARNUNG!

Das AutoProbe Elektronik Modul (AEM) oder die CP Grundeinheit dürfen nicht geöffnet werden. Das AEM und die CP Grundeinheit führen Hochspannung, welche bei Freilegung zu ernsthaften Verletzungen führen kann..

WARNUNG!

PSI verlangt eine routinemässige Überprüfung der Kabel des AutoProbe CP Systems um sicherzustellen, dass sie nicht durchgescheuert, lose oder beschädigt sind.. Kabel welche durchgescheuert, lose oder beschädigt sind, müssen augenblicklich dem örtlichen PSI Servicevertreter gemeldet werden. Das AutoProbe CP soll nicht benutzt werden, falls Kabel durchgescheuert, lose oder beschädigt sind.

VORSICHT!

Alle AutoProbe CP Systemkomponenten müssen mit Vorsicht behandelt werden. In den Systemkomponenten befinden sich empfindliche elektromechanische Messgerätausrüstungen welche bei unsachgemässer Behandlung beschädigt werden können.

VORSICHT!

Um eine Berührungsgefahr zu vermeiden muss beim Entfernen und Installieren des Scanners die Spannung des AEM immer ausgeschaltet sein.

VORSICHT!

Der LASER ON/OFF Schalter des Tastkopfes muss immer ausgeschaltet (OFF Stellung) sein, bevor der Tastkopf entfernt oder an der XY -Bühne installiert wird. Bei Nichtbefolgen des letzteren können die Laserdioden (LEDs) des Tastkopfes beschädigt werden.

VORSICHT!

Um ein beschädigen des Scanners zu vermeiden. müssen sie beim Entfernen und Installieren des Tastkopfesopfes über ein Erdungskabel geerdet sein. Der Tastkopf ist sehr empfindlich gegen elektromagnetische Entladungen.

VORSICHT!

Um eine ordungsgemässe Erdung des CP Scanners zu gewährleisten, müssen die vier Schrauben die den Scanner mit der CP Grundeinheit verbinden, sicher angezogen werden. Wenn die vier Schrauben sicher angezogen sind, ist eine maximale Instrumentenauflösung gewährleistet, da die Vibrationen reduziert sind.

VORSICHT!

Um die EMV Beständigkeit zu gewährleisten, sollte während dem Aufnahmen die CP Grundeinheit mit dem metallenen Deckel geschlossen werden.

Erdung des AutoProbe CP

Das AutoProbe CP muss ordungsgemäss geerdet werden, *bevor* seine Komponenten eigeschaltet werden. Das Versorgungskabel darf nur mit einen Anschluss verbunden werden, der mit einem Erdungspol versehen ist. Falls sie keinen Anschluss mit einem Erdungspol haben müssen sie das AutoProbe CP System über den Erdungspol am AEM mit Erde verbinden. Die Position des Erdungspoles is im folgenden Bild 0-1 eingezeichnet.

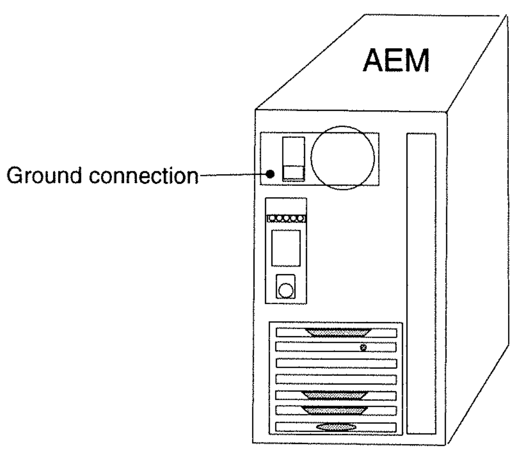


Bild 0-1. Rückwand des AEM, zeigt die Position des Erdungspoles.

Einstellen der Versorgungsspannung

Die Einstellung der Versorgungsspannung muss mit der Versorungsspannung des Landes übereinstimmen, in dem das AutoProbe M5 betrieben wird. Die Einstellung erfolgt über einen Spannungs-Wahl-Schalter, der sich an der Rückseite des AEM befindet. Die Spannung kann folgendermassen eingestellt werden: 100V, 120V, 220V oder 240V.

Um die Einstellung der Versorgungsspannung zu ändern, müssen folgende Schritte befolgt werden:

1. Versichern sie sich, dass die Spannung des AEM ausgeschaltet ist.

2. Stecken sie das Versorgungskabel des AEM aus.

3. Entfernen sie die Abdeckung der Spannung-Wahl-Schalter-Einheit mit Hilfe eines passenden Schraubenziehers.

4. Führen sie ein passendes Werkzeug in den Schlitz des Spannung-Wahl-Schalters und lösen sie mit dessen Hilfe das Spannungs-Wahl-Rad aus der Einheit.

5. Stellen sie das Spannungs-Wahl-Rad in der benötigte Spannung ein; 100V, 120V, 220V oder 240V.

6. Stecken sie das Spannungs-Wahl-Rad zurück in seine Position in der Einheit. Versichern sie sich, dass die gewählte Spannung im Fenster sichtbar ist.

7. Befestigen sie die Abdeckung über der Spannungs-Wahl-Schalter-Einheit.

Die Versorgungsspannung sollte nun ordnungsgemäss eingestellt sein.

Laser Sicherheit

Beachte: In diesem Teil beziehen sich alle Darstellungen auf den AFM Tastkopf der standard system Konfiguration des AutoProbe CP, ansonsten ist es anderwertig bezeichnet.

Das AutoProbe CP enthält eine Laserdiode welche von einer Niederspannungsquelle betrieben wird und eine maximalen Arbeitsleistung von 0.2 mW CW in der Wellenlänge 600-700 nm hat. Im innern des Gerätes könnte eine Diodelaserleistung bis zu 0.2 mW bei 600-700 nm zugänglich sein. Das AutoProbe CP sollte nur bedient werden wenn der Scanner-Kopf ordnungsgemäss montiert ist.

WARNUNG!

Die Benutzung von Steuerungen, Reglern oder das Ausführen von Verfahren anders als bis hierhin beschrieben, kann zu Freisetzung von gefährlichem Laserlicht führen.

Bild 0-2 zeigt die zwei Laserwarnungsmarkierungen des Tastkopfes Strickte Beachtung dieser Warnungsmarkierungen ist erwartet:

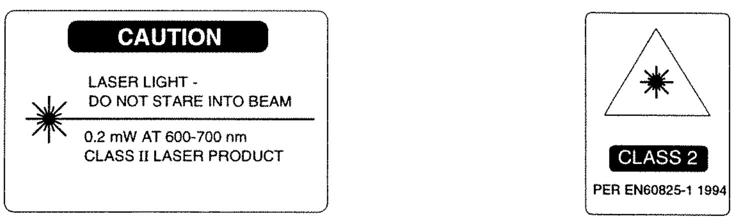


Bild 0-2. Laserwarnungsmarkierungen des Tastkopfes.

Die linke Warnungsmarkierung in Bild 0-2, oben, stuft den Tastkopf als ein Klasse II Laserprodukt nach 21 CFR 1040.10 und 1040.11 ein. Die Warnungsmarkierung in Bild 0-2, oben, , stuft den Tastkopf als ein Klasse 2 Laserprodukt nach EN60825 ein.

Bild 0-3 bis 0-7 unten, bezeichnen die Orte aller Instrumentensteuerungen und Anzeiger im Zusammenhang der Laserbedienung des AutoProbe CP Systems. Weiter werden auch die Orte der Lasersicherheitskennzeichnungen, der Srahlenöffnungskennzeichnungen und der Übereinstimmungskennzeichnungen angezeigt.

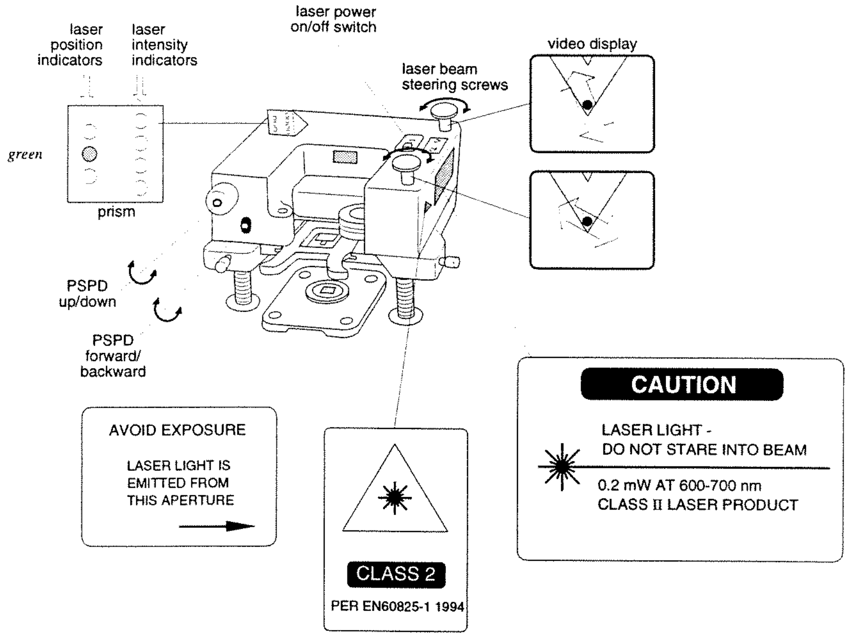


BILD 0-3. Ort der Lasersteuerung des Tastkopfes.

Die Steuerungen und Anzeigen, bezeichnet in Bild 0-3, oben, haben folgende Funktionen:

Laser power on/off switch: Schaltet den Laser des Tastkopfes ein oder aus. Ein rotes Licht im Schalter leuchtet auf, falls der Laser eingescchaltet ist.

Laser beam steering screws: Die zwei Laserstrahl-Steuerungsschrauben, welche sich oben and der rechten Seite des Tastkopfes befinden, dienen zur justierung der Position des Aufteffpunktes des Laserstrahles auf den Balken. Die Schrauben bewegen den Laserpunkt in zwei Richtungen, wie in Bild 0-3, oben, gezeigt wird. Falls ihr System die zusätzliche CP Optics enthält, können sie diese Justierung überwachen indem sie die optische Ansicht auf ihrem Videobildschirm darstellen.

PSPD adjustment screws: Am Tastkopf befinden sich zwei PSPD Schrauben —auf/ab und forwärts/rückwärts. Diese Schrauben justieren die Position des PSPD's im Tastkopf um das reflektierte Laserlicht auf dem Photodetektor zu zentrieren. Die forwärts/rückwärts Justierungsschraube kann an allen Tastköpfen zur PSPD-Einstellung benutzt werden. Die auf/ab Justierung kann hauptsächlich für den AFM/LFM Tastkopf der Standardkonfiguration benutzt werden.

Laser intensity indicators: Zeigt die Intensität des reflektierten Laserlichtes das auf den PSPD (Positions-sensiblen Photodetektor) trifft an.

Es gibt drei Tastköpfe für die Standardkonfiguration, —AFM, AFM/NC-AFM, AFM/LFM. Die verschiedenen Tastköpfe haben verschiedene Indikatoren.

Beachte: Der AFM Tastkopf kommt mit der Standardsystemkonfiguration. Die AFM/NC-AFM und AFM/LFM Tastköpfe sind zusätzlich zur Standardsystemkonfiguration erhältlich.

Die Indikatoren des AFM Tastkopfes sind in Bild 0-3, oben, eingezeichnet. Bei diesem Tastkopf ist die maximale Laserlichtintensität, die die PSPD teffen kann, erreicht, wenn die Reihe der vier roten Lichter erleuchtet ist. Die Indikatoren der AFM/NC-AFM und AFM/LFM Tastköpfe sind in Bild 0-4, unten, eingezeichnet. Bei diesen Tastköpfen ist die maximale Laserlichtintensität, die die PSPD teffen kann, erreicht, wenn die Helligkeit des mittleren grünen Lichtes (welches eine veränderliche Helligkeit aufweisst) maximal ist.

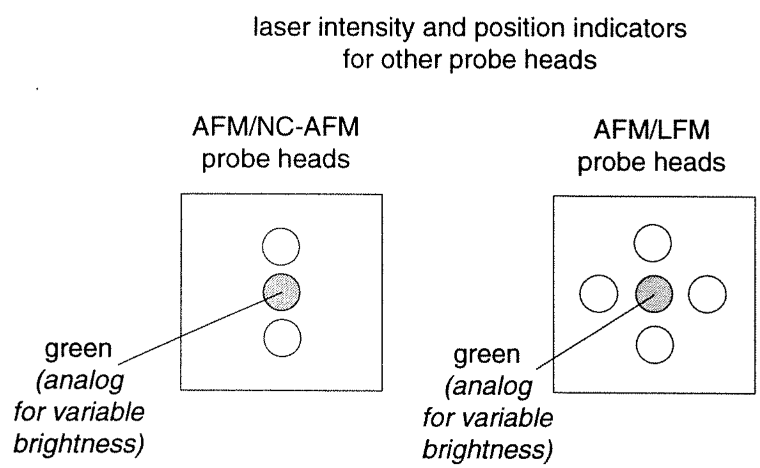


Bild 0-4. Laserintensität und Position des Indikators der AFM/NC-AFM und AFM/LFM Tastköpfe der Standardsystemkonfiguration.

Bei der Multitaskkonfiguration, ist die maximale Laserlichtintensität, die die PSPD teffen kann, erreicht, wenn die Helligkeit des mittleren Lichtes (welches eine veränderliche Helligkeit aufweisst) maximal ist. Eingezeichnet in Bild 0-5, unten.

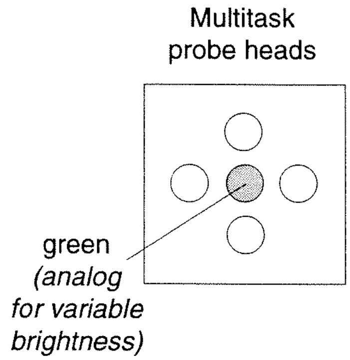


Bild 0-5. Laserintensität und Position des Indikators des Multitasktastkopfes.

Laser position indicators: Zeigen die Position des reflektierten Laserlichtes, das die PSPD trifft, an. Wenn der Laserpunkt auf dem Photodetektor zentriert ist, leuchtet das mittlere grüne Licht auf, wie in Bild 0-4 und 0-5, oben, gezeigt wird.

Bild 0-6, unten, zeigt den Ort der Laserwarnungsmarkierungen auf dem äusseren AutoProbe CP Gehäuse an.

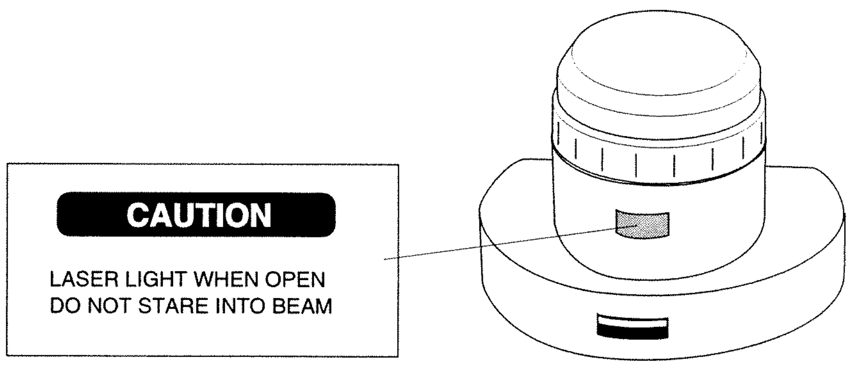


Bild 0-6. Laserwarnungsort des AutoProbe CP Gehäuses.

Bild 0-7, unten, zeigt den Ort der Lasersicherheitsübereinstimmungskennzeichnung auf der Rückseite des AutoProbe Elektronic Modules (AEM) an.

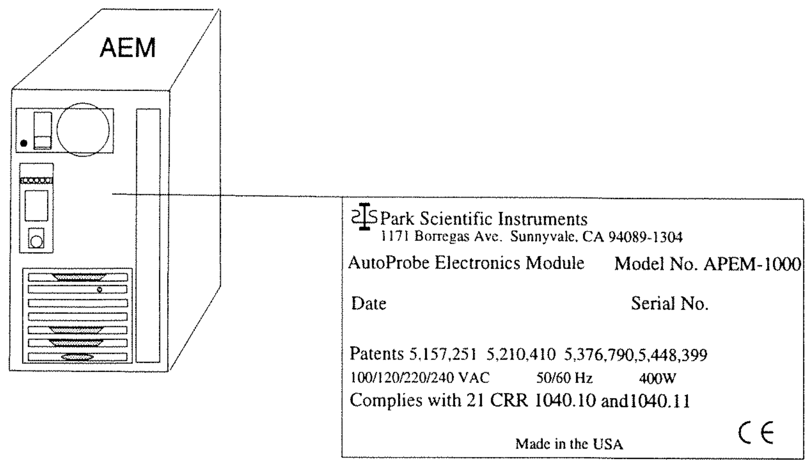


Bild 0-7. Rückseite des AEM,
den Ort der Lasersicherheitsübereinstimmungskennzeichnung anzeigend.

Spezifikationen und Ausführungen des AutoProbe CP's

System Ausführungen:

Standard	Beinhaltet einen AFM Tastkopf für Tätigkeit in der AFM Betriebsart. Ein AFM/NC-AFM Tastkopf für Tätigkeit in AFM, berührungsfreies AFM, periodisch kontaktierendes AFM, und MFM Betriebsarten ist zusätzlich erhältlich. Ein AFM/LFM Tastkopf für Tätigkeit in AFM und LFM Betriebsarten ist zusätzlich erhältlich. Ein STM Werkzeugset für Tätigkeit in STM Betriebsart ist zusätzlich erhältlich.
Multitask	Beinhaltet einen Multitasktastkopf für Tätigkeit in den folgenden Betriebsarten: berührendes, berührungsfreies, und periodisch kontaktierendes AFM, MFM, LFM und STM.

Messleistung:

Standard:	
Scanner	5 μm piezoelektrischer Scanner.
Scannreichweite	Maximale laterale Scannreichweite: 5 μm. Maximale verticale Scannreichweite: 2.5 μm.
Reglerresolution	Maximale Lateralresolution: 0.0013 Å. Maximale Verticalresolution: 0.009 Å.
Multitask:	
Scanner	100 μm piezoelectrischer Scanner.
Scannreichweite	Maximale laterale Scannreichweite: 100 μm. Maximale verticale Scannreichweite: 7.5 μm.
Reglerresolution	Maximale Lateralresolution: 0.25 Å. Maximale Verticalresolution: 0.025 Å.

Mikroscopbühne:

Verschiebbarkeit	8 mm x 8 mm.
Probengrösse	50 mm (w) x 50 mm (l) x 25 mm (h) für die Standardkonfiguration. 50 mm (w) x 50 mm (l) x 20 mm (h) für die Multitaskkonfiguration.
Spitze-zu-Probe Einfahrt	Automatisch mit 3 unabhängigen Schrittmotoren.
Optisches Mikroscop	Zusätzliches axiales Mikroscop mit Farbvideobildschirm zur Ansicht von Messfühlerspitze und Probe. 5:1 Zoom, bis zu 3,500X Vergrösserung.
Akustische Isolation	Zusätzliche akustische Isolationskammer.

Arbeitsplatz:

AEM	20-bit DACs für x, y, und z Achsen.. 16-bit DACs für Systemüberwachung.
Computer	100 MHz Pentium Prozessor, 256 Kbyte Cachespeicher 16 MB RAM.
Massenspeicher	1 GB Hard Drive, 3 1/2 in. 1.4 MB Floppydisk Drive..
Software	ProScan Data Acquisition und Image Processing arbeitets mit Windows 95.
Graphik	Windows Graphikbeschleuniger, 17 in. hochauflösender Farbmonitor.
Systemspannungen	115/230 V AC, 50/60 Hz, 600 W.

Dimensionen und Gewicht:

CP Grundeinheit	10.5 in (267 mm) x 8 in (203 mm); 22 lb (10 kg).
AEM	17 in (432 mm) x 7 1/2 in (191 mm) x 17 1/2 in (445 mm); 43 lb (20 kg).
Computer	17 in (432 mm) x 7 1/2 in (191 mm) x 17 1/2 in (445 mm); 27 lb (12 kg).

Betriebssumgebung:

Temperatur	0°C bis 30°C, 32°F bis 112°F;
Luftfeuchtigkeit	90%; nicht kondensierend.

Reinigungsmittel:

CP Grundeinheit	Isopropylalkohol.
Messkopf	Isopropylalkohol.
AEM und computer	Isopropylalkohol.

WARNUNG!

Um eine Berührungsgefahr zu vermeiden sollen während dem Reinigen der AutoProbe CP Systemkomponenten diese immer ausgeschaltet sein.

VORSICHT

Es sollte kein Aceton verwendet werden um die Komponenten des AutoProbe CP Systems zu reinigen, da dabei wichtige Sicherheits Warnungs Etiketten von den Komponenten losgelöst werden könnten.

Park Scientific Instruments Garantieerklährung

Garantie von neuen Systemen und Zubehörteile

Park Scientific Instruments (PSI) garantiert dem Orginalkäufer des Gerätes, das dieses frei von Material- und Verarbeitungsfehlern ist. Diese Garantie gilt für ein Jahr ab dem Lieferdatum. PSI übernimmt die Verantwortung, das Gerät, welches unter diese begrenzte Garantie fällt, nach eigenem Ermessen zu reparieren oder zu ersetzen, ohne Kosten für den Käufer. Alle Serviceleistungen werden je nach ermessen von PSI in PSI Niederlassungen oder beim Kunden durchgeführt. Bei Reparaturen, welche in PSI Niederlassungen durchgeführt werden, muss PSI vorzeitig kontaktiert werden, um eine Genehmigung für die Rücksendung des Grätes zu erhalten. Für den Transport des Gerätes muss den PSI Transportanleitungen unbedingt Folge geleistet werden. Falls das Gerät zurückgesendet wird, muss es versichert werden.

Wenn immer möglich liefert PSI Ersatzteile als Leihgabe, um eine Reparatur beim Kunden mit möglichst geringer Stillstandzeit zu ermöglichen. Wenn das System wieder betriebsbereit ist, müssen die defekten Teile umgehend zu PSI zurück gesandt werden.

Speziell ausgeschlossen von dieser Garantie sind alle Verbrauchsartikel wie Piezolevers, Microlevers, Ultralevers, Spitzen und ähnliches. Für Geräte, die ausserhalb der Vereinigten Staaten verkauft wurden, gelten die Garantiebedingungen des individuellen Verkaufes. Geräte, welche Gegenstand von falscher Benutzung, Unfall, Missbrauch, Missgeschick, unzumutbarer Benutzung, Beschädigung durch Drittgeräte, mit welchen das Gerät benutzt wurde, Bedienungsfehler, Vernachlässigung, unerlaubtes Reparieren, Verändern oder Installieren sind nicht gedeckt durch diese Garantie.

Garantie von Ersatzteilen

PSI garantiert, das alle verkauften Ersatzteile frei von Material- und Verarbeitungsfehlern sind. Diese Garantie gilt für 90 Tage ab dem Lieferdatum. PSI repariert oder ersetzt solche Teile nach eigenem Ermessen, falls sie zu PSI zurück gesandt werden. Der Kunde muss PSI vorzeitig kontaktieren, um eine Genehmigung für die Rücksendung des Teiles zu erhalten. Für den Transport des Teiles muss den PSI Transportanleitungen unbedingt Folge geleistet werden.

Ausser den bis anhin bestimmten Bedingungen, ob ausgedrückt oder stillschweigend angenommen, übernimmt der Verkäufer keine Garantie. Der Verkäfer schliesst ausserdem ausdrücklich jegliche Garantie für eine Marktgängigkeit oder Tauglichkeit für besondere Zwecke aus. Unter keinen Umständen kann PSI für Verlust oder Schädigung jeglicher Art haftbar gemacht werden, ob direkt, speziell, indirekt oder Folgeschäden, welche durch die Benützung oder Benützungsausfall eines Produktes, einer Serviceleistung, eines Teils, einer Lieferung oder eines Gerätes entstehen. Noch soll PSI unter jeglichem Rechtssystem für Schäden, Einschliesslich aber nicht begrenzt auf, wie Profitverluste, Stillstandzeiten, Firmenansehen, Schädigung oder Auswechslung des Gerätes oder Eigentum und jeglicher Kosten für Rückgewinnung, Umprogrammierung oder Reproduktion jeglicher Programme oder Daten gespeichert oder benützt in PSI Produkten, haftbar gemacht werden.

Gewisse Staten erlauben keine zeitliche Begrenzung einer unausgesprochenen Garantie und/oder der Ausschliessung spezieller, nebensächlicher oder Folgeschäden. In diesem Falle treffen die obenstehenden Einschränkungen und/oder Ausschliessungen für sie nicht zu. Diese Garantie gibt ihnen spezielle juristische Rechte neben den möglichen anderen Rechten die sie haben, welche von Staat zu Staat varieren..

Hersteller Information

Das AutoProbe CP beinhaltet keine Teile, die vom Benutzer selber gewartet werden dürfen. Alle Unterhaltsprobleme sollten unverzüglich den örtlichen PSI Vertretern gemeldet werden.

PSI, USA
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F: (408) 747-1601

PSI, USA
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Wilmington, DE 19809
T: (302) 762-2245
F: (302) 762-2847

PSI, SA
16 rue Alexandre Gavard
1227 CAROUGE
Geneva, Switzerland
T: 41-22-300-4411
F: 41-22-300-4415

PSI, Korea
Suite 301, Seowon Building
395-13, Seokyo-dong, Mapo-ku
Seoul, Korea
T: 82-2-325-3212
F: 82-2-325-3214

Falls sie ihre Systemkomponenten, welche mit Schadstoffen in Berührung kamen, zu Unterhaltszwecken zu PSI zurücksenden, müssen folgende Regeln beachtet werden.

Schadstoffe wurden von den Ländern der Europäischen Gemeinschaft als "Stoffe und Zubereitungen gemäss EG-Richtlinie vom 18.9.1979, Artikel 2." definiert. Mit Systemkomponenten, welche mit Schadstoffen in Kontakt kamen, muss folgendes beachtet werden:

- Kontaminierte Komponenten sind vor der Rücksendung zu PSI entsprechend den Strahlenschutzvorschriften zu dekontaminieren.
- Zur Reparatur oder Wartung eingehende Geräte müssen mit deutlich sichtbarem Vermerk "Frei von Schadstoffen." versehen sein Derselbe Vermerk ist auch auf dem Lieferschein und Anschreiben anzubringen.

Über die Benutzung dieser Bedienungsanleitung

Die Bedienungsanleitung zum AutoProbe M5 ist in drei, einfach zu benützende Abschnitte unterteilt. Die Abschnitte beinhalten das folgende:

- Abschnitt I: *Lernen das AutoProbe CP zu gebrauchen: Grundaufnahmetechniken*
- Abschnitt II: *Lernen das AutoProbe CP zu gebrauchen: Fortgeschrittene Aufnahmetechniken*
- Abschnitt III: *Software Verweis*

Die Inhalte der oben aufgeliesteten Abschnitte sind im Detail in den folgenden Sektionen beschrieben.

Abschnitt I: Lernen das AutoProbe CP zu gebrauchen: Grund Aufnahmetechniken

Abschnitt I dieser Bedienungsanleitung, *Lernen das AutoProbe CP zu gebrauchen: Grund Aufnahmetechniken,* beinhaltet ein Einführungskapitel , und drei praktische Schulungen, Kapitel 2 bis 4. Beim Durcharbeiten der Schulungskapitel, lernen sie die Grundkentnisse, welche benötigt werden, um AFM Bilder aufzunehmen.

Beginnen sie mit lesen des Kapitel 1, "AutoProbe CP Basics," zur Einführung in die Systemkonfigurationen und Komponenten des AutoProbe CP. Arbeiten sie sich dann durch die Schulung in Kapitel 2, "Setting Up to Take an Image" lehrt sie die Systemharware und Software für AFM Mode zu konfigurieren . Genauer gesagt werden sie die folgenden Prozeduren lernen, das Verbinden der Kabel, entfernen und einrichten des Messkopfes und des Scanners sowie das laden einer Probe und eines Messfühlers.

Kapitel 3, "Taking an AFM Image," lehrt sie die Software für AFM Mode zu konfigurieren, ein Auto Approach einzurichten und auszuführen und ein AFM Bild aufzunehmen. Kapitel 4, "Taking Better Images," erklärt wie ein Scan und die Rückkoppelungsparameter für bessere Aufnahmen optimiert werden können sowie das sichern und laden von Bildern.

Abschnitt II: Lernen das AutoProbe CP zu gebrauchen: Fortgeschrittene Aufnahmetechniken

Abschnitt II dieser Bedienungsanleitung, *Lernen das AutoProbe CP zu gebrauchen: Fortgeschrittene Aufnahmetechniken,* beinhaltet praktische Schulungen über die Bedinung des Gerätes mit den folgenden Methoden: STM, LFM, NC-AFM, IC-AFM, und MFM. Er führt sie aussedem in die fortgeschrittenen Fähigkeiten des AutoProbe CP's ein, wie Kraft-Abstand-Kurven, Strom-Spannungs-Kurven und das kalibrieren des Scanners.

Kapitel 1, "STM Imaging," führt sie durch das Aufnehmen eines STM Bildes. In diesem Kapitel werden sie lernen eine STM Spitze zu preparieren, eine STM Kartusche zu benutzen, die Hardware und Sofrware für die Aufnahmen von STM Bildern einzustellen, und ein STM Bild aufzunehmen.

Kapitel 2, "LFM Imaging," führt sie durch das gleichzeitige Aufnehmen von LFM und AFM Bildern. Kapitel 2 enthält des weiteren Informationen darüber wie LFM Bilder entstehen und über den Nutzen beides, LFM und AFM Bilder zur Verfügung zu haben.

Kapitel 3, "NC-AFM, IC-AFM, and MFM Imaging," beschreibt die Grundsätze hinter NC-AFM, IC-AFM, und MFM Betriebsart. Kapitel 3 beinhaltet weiterhin schrittweise Anweisungen zur Aufnahme von NC-AFM, IC-AFM, und MFM Bilder.

Kapitel 4, "Force vs. Distance Curves," beschreibt das Aufnehmen von Kraft-Abstands-Kurven an x,y Orten auf der Probenoberfläche in ProScan Data Acquisition. Eine Kraft-Abstands-Kurve ist die Dartellung der Vertikalkraft die die Spitze auf den Balken überträgt als Funktion des Abstandes zwischen Spitze und Probe. Unterschiede in der Form der Kraft-Abstands-Kurve lassen auf die örtliche Elastizitätskonstante der Probenoberfläche rückschliessen.

Kapitel 5, "I-V Spectroscopy, " lernt ihnen das I-V Spectroscopy Fenster in der ProScan Data Acquisition zu benutzen um eine Strom-Spannungs-Kurve (I-V) und dI/dV-Kurven aufzunehmen. Diese Kurven enthalten wertvolle Informationen über die electrischen Eigenschaften von Oberflächen.

Kapitel 6, "Scanner Calibration, " beschreibt die Arbeitsweise des AutoProbe CP Scanners und die Kalibration des selben um eine optimale Funktion zu erhalten.

Abschnitt III: Software Verweis

Abschnitt III dieser Bedienungsanleitung, *Software Verweis*, ist ein Verweishandbuch für ProScan Data Acquisition and Image Processing und schliesst Informationen über folgenden AutoProbe Systeme ein: CP, LS, and M5. Die Kapitel in diesem Abschnitt der Bedienungsanleitung vermitteln mehr detailierte Informationen über die Softwareeigenschaften und -steuerungen als die in den Schulungskapiteln vermittelten Informationen. Der Aufbau der Kapitel erlaubt ihnen ein direktes Angehen der Eigenschaft oder der Steuerung mit welcher sie sich vertieft befassen möchten.

Kapitel 1, "ProScan Data Acquisition," beschreibt im Detail die Softwareeigenschaften von ProScan Data Acquisition. Dieses Kapitel diskutiert jede Region des Bildschirms, mit spezieller Beachtung jeder Steuerung und seiner Funktion. Dieses Kapitel diskutiert auch die Menus, mit einer Beschreibung jedes Menuelementes und seiner Funktion.

Kapitel 2, "ProScan Image Processing," beschreibt im Detail die Softwareeigenschaften von ProScan Image Processing. Dieses Kapitel erklärt das Bearbeiten der Bilder, wie Oberflächenmessungen gemacht werden und wie Bilder vorbereitet werden um sie in unterschiedlichen Formaten auszudrucken.

Préface

Sécurité lors de l'utilisation

Ce chapitre comprend des informations importantes à propos de votre système AutoProbe CP. Les procédures relatives à la sécurité lors de l'utilisation de l'AutoProbe CP y sont décrites et par conséquent, doivent être lues scrupuleusement *avant* toute mise en route de votre système AutoProbe CP.

> ***ATTENTION!***
>
> Les protections prévues par le système pourraient être inefficaces si les procédures décrites dans ce manuel ne sont pas suivies scrupuleusement.

Symboles de sécurité

Le tableau 0-1 présente les symboles utilisés tout au long de ce manuel d'utilisation ainsi que sur le système AutoProbe CP. Vous devrez vous familiariser avec leurs symboles et définitions car elles sont utilisées pour vous mettre en garde des problèmes liés à la sécurité lors de l'utilisation de l'AutoProbe CP.

Tableau 0-1. Symboles de sécurité et leur définition.

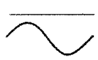
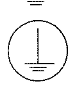
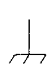
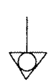
Symbole	Définition
	Source de courant continu.
	Source de courant alternatif.
	Source de courant alternatif avec une composante continue.
3 	Source de courant alternatif triphasé.
	Borne de mise à la masse (terre).
	Borne conductrice isolée.
	Borne connectée au châssis ou à la structure.
	Indique un niveau équipotentiel.
I	Interrupteur enclenché

Table 0-1(suite). Symboles de sécurité et leur définition.

Symbole	Définition
○	Interrupteur déclenché.
⧈	Equipement protégé par une isolation renforcée ou par une double isolation.
⚠	Se référer à la documentation.
⚡	Indique un risque de choc électrique.

Définitions: ATTENTION, AVERTISSEMENT et REMARQUE

Ces trois termes sont utilisés dans ce manuel d'utilisation pour vous mettre en garde des problèmes liés à la sécurité lors de l'utilisation de l'AutoProbe CP—ATTENTION, AVERTISSEMENT ET REMARQUE.

Ces termes sont définis dans le tableau 0-2 suivant.

Tableau 0-2. Description des termes.

Terme	Description
Attention	Vous alerte des blessures sérieuses pouvant survenir dans le cas ou les procédures décrites dans ce manuel ne sont pas suivies correctement. N'outrepassez pas un message de ce type si les conditions ne sont pas comprises et remplies.
Avertissement	Vous met en garde des dommages possibles que le système pourrait subir ou à des altérations de sécurité dans le cas ou les procédures décrites dans ce manuel ne sont pas suivies correctement.
Remarque	Vous met en garde des règles à suivre ou des conditions d'utilisations particulières.

Il est important que vous lisiez attentivement tous les messages "Alerte, Avertissement et Remarque" de ce manuel afin de garantir les mesures de sécurité mises en place pour l'utilisation de votre système AutoProbe CP.

Récapitulatif des messages d'Alerte et d'Avertissement

Cette section comprend les messages d'alerte et d'avertissement auxquels vous devrez être attentifs à chaque fois que vous utiliserez l'AutoProbe CP.

ATTENTION!

L'AutoProbe CP doit être correctement mis à la terre avant l'enclenchement de ses composants. Le cordon d'alimentation principal doit simplement être inséré dans une prise munie d'une fiche de mise à la terre. Pour les instructions, reportez vous à la section "Mise à la masse de l'AutoProbe CP" dans la préface.

ATTENTION!

Le choix et le contrôle de la tension d'alimentation doivent être effectués avant l'enclenchement des composants de l'AutoProbe CP. L' interrupteur pour le choix de la tension d'alimentation est situé sur le panneau arrière de l'AEM. Le sélecteur de tension d'alimentation permet un choix parmi les tensions suivantes : 110 V, 120 V, 220 V, et 240 V. Pour plus d'informations, reportez-vous à la section "Configuration de la tension d'alimentation" dans la préface.

ATTENTION!

Ne pas ouvrir l'AEM ou l'unité de base du CP. L'AEM et l'unité de base du CP utilisent des tensions potentiellement dangereuses et peuvent présenter de sérieux dangers de choc électrique.

AVERTISSEMENT!

PSI vous demande d'inspecter régulièrement les fils conducteurs du système AutoProbe CP afin de vous assurer qu'ils ne soient pas emmêlés, déconnectés ou endommagés. Les fils conducteurs emmêlés, déconnectés ou endommagés doivent immédiatement être signalés à l'équipe de support technique de PSI. Ne pas utiliser l'AutoProbe CP lorsque les fils conducteurs sont emmêlés, déconnectés ou endommagés.

AVERTISSEMENT!

Tous les composants du système AutoProbe M5 doivent être manipulés avec précaution. Les composants du système contiennent une instrumentation électromécanique délicate qui peut facilement être endommagée par de mauvaises manipulations.

AVERTISSEMENT!

Le courant du AEM doit être coupé (position OFF) avant d'enlever ou d'installer le scanner.

AVERTISSEMENT!

L'interrupteur laser ON/OFF de la tête du microscope doit être en position OFF avant de retirer ou d'installer la tête du microscope sur l'étage de translation en XY. Dans le cas contraire, des dommages aux diodes électroluminescentes de la tête du microscope (LEDs) peuvent survenir.

AVERTISSEMENT!

En retirant et en installant le scanner, vous devez être mis à la terre à l'aide d'un bracelet conducteur vous reliant à la terre pour vous assurez que le scanner n'est pas endommagé. Le scanner est sensible aux décharges électrostatiques.

AVERTISSEMENT!

Les quatres vis qui connectent le scanner à l'unité de base du CP doivent être serrées proprement pour assurer une mise à terre correcte. Lorsque les quatres vis sont serrées correctement les performances maximum de l'instruments sont assurées puisque les vibrations sont réduites.

AVERTISSEMENT!

Afin de protéger le EMC, placer le couverde métallique sur la base du CP lors de l'acquisition de l'image.

Mise à la terre de l' AutoProbe CP

L'AutoProbe CP doit être correctement mis à la terre avant l'enclenchement de ses composants. Le câble d'alimentation générale doit être inséré dans une prise munie d'une fiche de mise à la terre. Si vous n'avez pas accès à une prise munie d'une fiche de mise à terre, vous devez mettre l'AutoProbe CP à la terre en utilisant la connection de mise en terre de l'AEM. La Figure 0-1, ci-dessous, montre ou est situé la connection de mise à terre.

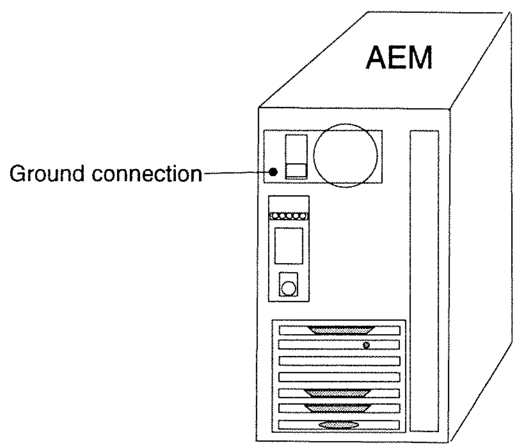


Figure 0-1. Panneau arrière du AEM, montrant l'emplacement du connecteur de mise à la terre

Configuration de la tension d'alimentation

Le choix de la tension d'alimentation doit correspondre à la tension d'alimentation du pays où le sytème AutoProbe CP est utilisé. Le choix de la tension d'alimentation se fait à l'aide d'un sélecteur de tension. Ce sélecteur est situé sur le panneau arrière du AEM. Le sélecteur de la tension d'alimentaion permet un choix parmi les tensions suivantes : 100 V, 120 V, 220 V, or 240 V.

Pour changer la tension d'alimentation, procédez comme suit :

1. Assurez vous que l'interrupteur de l'AEM soit déclenché.

2. Débranchez le cordon secteur de l'AEM de la prise d'alimentation.

3. Enlevez le couvercle du sélecteur de tension d'alimentation en utilisant un tourne-vis de taille appropriée.

4. Insérer un outil de taille appropriée dans la fente du sélecteur d'alimentation et utiliser cet outil pour enlever le disque du sélecteur de tension.

5. Positionner le disque de sélection de tension enlevé précedemment sur la tension de ligne appropriée (100V, 110V, 220V ou 240V).

6. Remettre le disque de sélection de tension en place dans l'unité. Assurez-vous que la tension de ligne désirée apparait dans la fenêtre.

7. Installer le capôt sur le sélecteur de tension de ligne.

La tension d'alimentation devrait à présent être sélectionnée à la valeur appropriée.

Recommandations à l'usage du laser

Note : Tout au long de cette section, les schémas se réfèrent à la tête du microscope AFM pour la configuration standard du système AutoProbe CP, sauf notifications contraires.

L'AutoProbe CP contient une diode laser alimentée par une basse tension avec une puissance maximum de 0.2mW CW d'une longeur d'onde de 600-700nm. La diode laser alimentée jusqu'à 0.2mW à 600-700nm doit être accessible à l'intérieur. L'AutoProbe CP doit toujours fonctionner avec la tête du microscope correctement installée.

> ***ATTENTION!***
>
> Les contrôles, les ajustements et l'exécution de procédures autres que ceux spécifiés ici peuvent provoquer une exposition dangereuse aux rayons laser.

Figure 0-2 Montre les deux étiquettes d'avertissement à propos du laser de la tête du microscope.
Il est recommandé de respecter rigoureusement les étiquettes d'avertissement sur le laser.

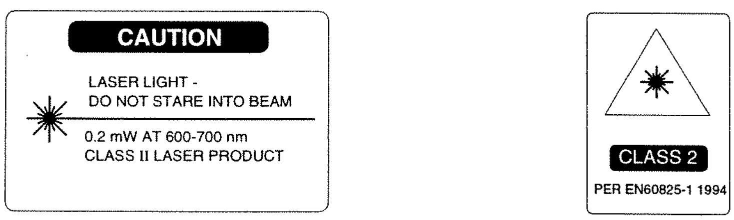


Figure 0-2. Etiquettes d'avertissement à propos du laser de la tête du microscope.

L'étiquette d'avertissement de gauche dans la Figure 0-2, ci-dessus, spécifie que la tête du microscope est un laser de Classe II selon 21 CFR 1040.10 et 1040.11. L'étiquette d'avertissement de gauche dans la Figure 0-2, ci-dessus, spécifie que la tête du microscope est un laser de Classe II selon EN60825.

Les figures 0-3 à 0-7 ci-dessous montrent l'emplacement de tout les instruments de contrôle et indicateurs se rapportant aux opérations effectuées avec le laser du système AutoProbe CP. Ils montrent également l'emplacement de toutes les étiquettes d'avertissements sur le laser, d'orifices et de conformité.

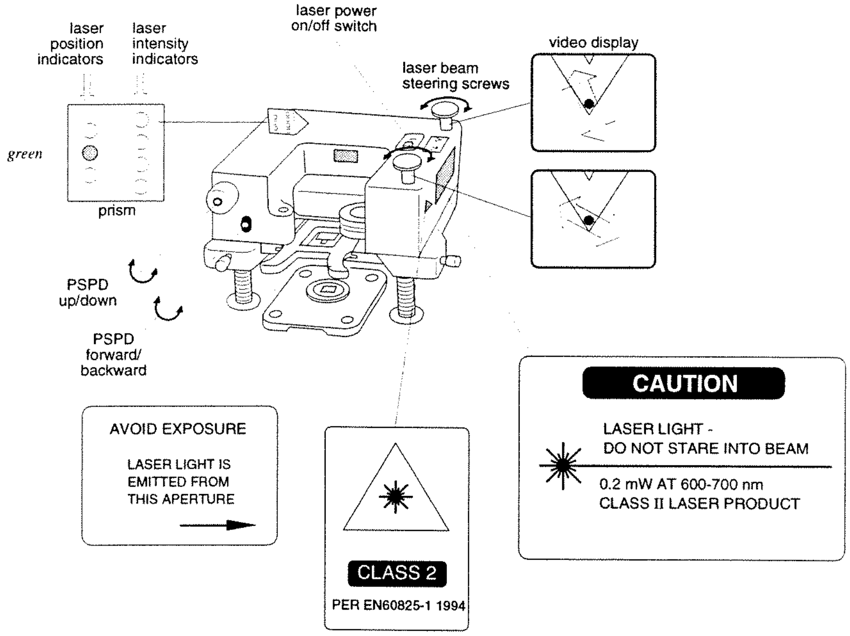


Figure 0-3. Emplacement des contrôles laser sur la tête du microscope.

Les contrôles et indicateurs montrés ci-dessus en figure 0-3 ont les fonctions suivantes :

L'interrupteur on/off du laser : active ou désactive le laser dans la tête du microscope. Une lumière rouge est allumée dans l'interrupteur lorsque le laser est enclenché.

Vis directrices du rayon laser : Les deux vis directrices du rayon laser situées sur le dessus à droite de la tête du microscope sont utilisées pour ajuster la position du rayon laser touchant le cantilever. Les vis bougent le spot du laser dans deux directions, comme montré sur la Figure 0-1, ci-dessus. Si votre système inclus l'option CP optique, vous pouvez contrôler ces ajustements en utilisant la vue optique sur votre moniteur vidéo.

Vis d'ajustement PSPD : Il y a deux vis PSPD sur la tête du microscope-haut/bas et avant/arrière. Ces vis ajustent la position du PSPD dans la tête du microscope pour centrer la lumière du laser refletée sur le photodetecteur. La vis d'ajustement avant/arrière est utile pour l'alignement PSPD sur la tête du microscope. L'ajustement haut/bas est utile principalement pour la tête du microscope AFM/LFM pour un système de configuration standard.

Indicateurs d'intensité du laser : Indique l'intensité avec laquelle la lumière reflétée du laser touche le PSPD (photodétecteur sensible à la position)

Pour une configuration standard, il y a trois têtes de microscope - AFM, AFM/NC - AFM, AFM/LFM. Il y a différents indicateurs pour les différentes têtes de microscope.

Note : La tête de microscope AFM est comprise dans la configuration standard du système. Les têtes de microscope AFM/NC-AFM et AFM/LFM peuvent être achetées séparément.

Les indicateurs de la tête AFM sont montrés dans la Figure 0-3, ci-dessus. Pour cette tête de microscope, l'intensité de la lumière du laser touchant le PSPD est maximisé lorsque la colonne de quatre Leds rouge est allumée. Les indicateurs des têtes de microscope AFM/NC-AFM et AFM/LFM sont montrés dans la Figure 0-4, ci-dessous. Pour ces têtes de microscope, lorsque la brillance du centre de la Led verte (qui a une brillance variable) est maximisée, l'intensité du laser touchant le PSPD est maximisé.

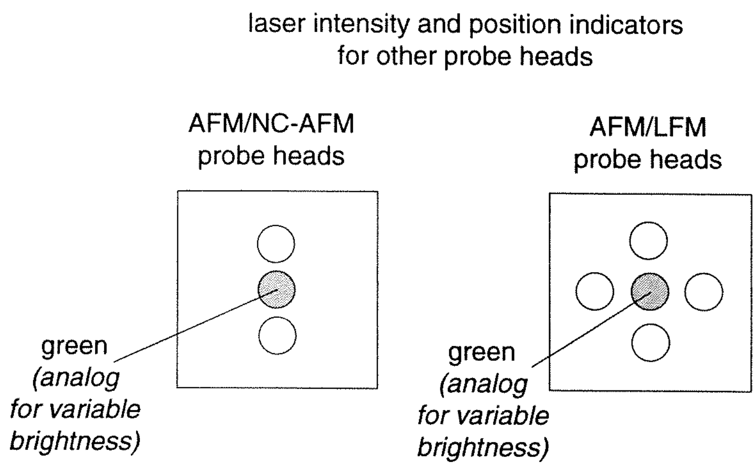


Figure 0-4. Intensité du laser et indicateurs de position de la tête de microscope AFM/NC-AFM et de la tête de microscope AFM/LFM d'une configuration de système standard.

Pour la configuration multitask, lorsque la brillance du centre de la lumière (qui a une brillance variable) est maximisée, l'intensité du laser touchant le PSPD est maximisé. Voir Figure 0-5, ci-dessous.

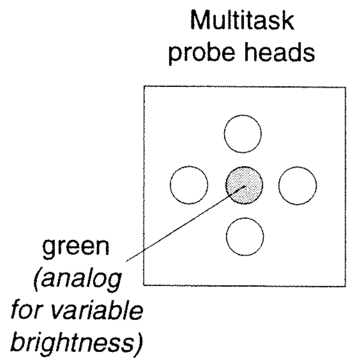


Figure 0-5. Intensité du laser et indicateurs de position pour la tête de microscope multitask.

Indicateurs de position du laser : Indique la position de la lumière du laser réflechi touchant le PSPD. Lorsque le point du laser est centré sur le photodétecteur, la led verte du centre est allumée, comme en figures 0-4 et 0-5, ci-dessus.

La Figure 0-6 ci-dessous, montre la position de l'étiquette d'avertissement du laser à l'extérieur de la coupole de l'AutoProbe CP.

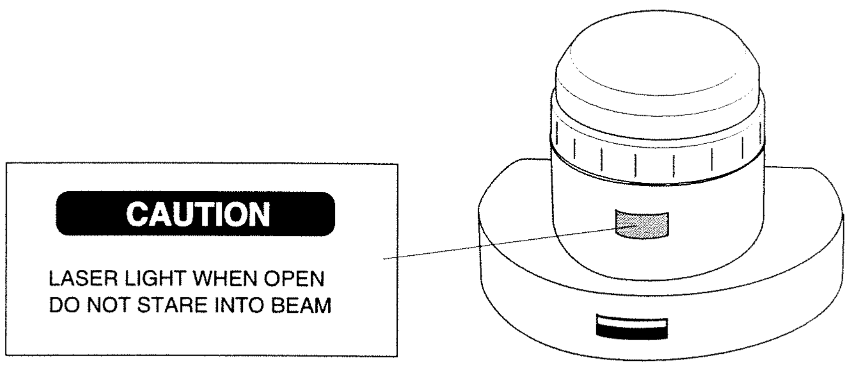


Figure 0-6. Position de l'étiquette d'avertissement du laser sur la base de L'AutoProbe CP

La Figure 0-7, ci-dessous, montre la position de l'étiquette de conformité concernant la sécurité du laser sur le panneau arrière du Module Electronic de l'AutoProbe (AEM)

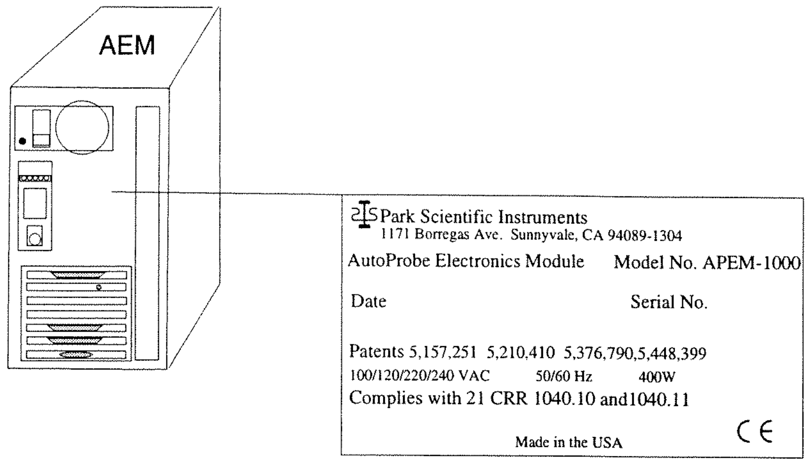


**Figure 0-7. Panneau arrière du AEM,
montrant la position de l'étiquette de conformité concernant la sécurité du laser.**

Caractéristiques et performances pour l'AutoProbe CP

Configuration du Système:

Standard	Inclus une tête de microscope pour des opérations en mode AFM. En option, la tête de microscope AFM/NC-AFM peut-être achetée pour des operations en modes AFM, non-contact, contact intermittent, et MFM. En option, la tête de microscope AFM/LFM peut-être achetée pour des opérations en modes AFM et LFM. En option, le kit d'outils STM peut-être acheté pour des opérations en mode STM.
Multitask	Inclus une tête de microscope multitask pour des opérations dans les modes suivants : AFM contact, non-contact, contact intermittent, MFM, LFM et STM.

Mesures de performance

Scanner	scanner piezoélectrique 5µm
Aire de balayage	Balayage latéral maximum : 5µm
	Balayage vertical maximum : 2.5µm
Résolution de contrôle	Résolution latérale maximum : 0.0013 Å.
	Résolution verticale maximum : 0.009 Å.
Scanner	Scanner piezoélectrique 100 µm
Aire de balayage	Balayage latéral maximum : 100µm
	Balayage vertical maximum : 7.5µm
Résolution de contrôle	Résolution latérale maximum : 0.25 Å.
	Résolution verticale maximum : 0.025 Å.

Etage du microscope :

Course de translation	8 mm x 8 mm
Taille d'échantillon	50 mm (w) x 50 mm (l) x 25 mm (h) pour une configuration standard. 50 mm (w) x 50 mm (l) x 20 mm (h) pour une configuration multitask.
Approche pointe-échantillon	Automatique avec 3 moteurs pas à pas indépendants.
Microscope optique	En option, microscope droit avec moniteur vidéo couleur pour la visualisation de la pointe et de l'échantillon.
Isolation acoustic	En option, chambre d'isolation acoustique.

Station de travail:

AEM	DAC 20-bit pour la commande des axes x, y et z.. DAC 16-bit pour le système de contrôle.
Ordinateur	Processeur Pentium 133 MHz, 256 Kbyte de mémoire cache, 16 MB RAM.
Mass storage	1 GB hard drive, 3 1/2 in. 1.4 MB floppy disk drive.
Mémoire de masse	Disque dur 1 GB, lecteur de disquette 3,5'' 1.4 MB.
Logiciel	"Proscan Data Acquisition" et "Image Processing" fonctionnent sous Windows 95.
Graphiques	Carte graphique accélératrice Windows, moniteur couleur 17'' à haute résolution
Alimentation	115/230 V AC, 50/60 Hz, 600 W.

Dimensions et poids :

Unité de base CP	267 mm (10.5 in) x 203 mm (8 in); 10 kg (22 lb).
AEM	432 mm (17 in) x 191 mm (7 1/2 in) x 445 mm (17 1/2 in); 20 kg (43 lb).
Ordinateur	432 mm (17 in) x 191 mm (7 1/2 in) x 445 mm (17 1/2 in); 12 kg (27 lb).

Conditions d'utilisation :

Temperature	0°C to 30°C, 32°F to 112°F.
Humidité	90%; sans condensation

Entretien :

Unité de base CP	alcool Isopropylique.
Tête de microscope	alcool Isopropylique.
AEM et ordinateur	alcool Isopropylique.

ATTENTION!

Pour éviter tout risques de choc électrique, aucun des composants du système AutoProbe CP ne doit être nettoyé lorsque le système est enclenché.

AVERTISSEMENT!

Ne pas utiliser d'acétone pour nettoyer les composants du système AutoProbe CP. L'acétone peut endommager les étiquettes d'avertissement concernant la sécurité.

Déclaration de Garantie de Park Scientific Instruments

Garantie des Systèmes neufs et des Accessoires

Park Scientific Instruments (PSI) garanti au premier acquéreur que son système est exempt de tout défauts de matériel ou de fabrication et ceci pour une période d'une année à compter de la date de livraison. Pendant cette periode de garantie, PSI est seul responsable du remplacement ou de la réparation, selon son propre choix, du matériel sous garantie et ceci sans charge pour l'acquéreur, autre que des frais d'envois éventuels. PSI se réserve le droit d'exécuter ces services soit sur site, chez le client, soit dans ses propres locaux. Pour les réparations effectuées par PSI, le client doit demander à l'avance une autorisation d'expédition de matériel à PSI (RMA) et suivre la procédure PSI d'expédition. Le matériel renvoyé doit être assuré par l'expéditeur.

PSI fourni en prêt, dans la mesure du possible, des pièces de remplacement pour permettre au client une réparation sur site dans les meilleurs délais. Une fois le système opérationnel, les pièces défectueuses doivent être envoyées chez PSI sans délai.

Sont exclus entre autre de cette garantie tout les consommables, tels que Microlevers, Ultralevers, et les pointes STM. La garantie des équipements vendus pour une utilisation, en dehors des Etats Unis, dépend des conditions de garantie spécifiées lors de la vente. Le matériel qui aurait été soumis à un mauvais traitement, emploi, à un accident, une catastrophe, à une utilisation inappropriée, qui aurait subi des dommages provoqués par un équipement non fournis avec le système, une erreur d'utilisation, une modification, une réparation ou installation non autorisée ne sont pas couverts par la garantie.

Garantie des pièces remplacées

Park Scientific Instruments (PSI) garanti toutes les pièces de remplacement pendant une durée de 90 jours à partir de la date de livraison , contre les défauts de matériel ou de fabrication. PSI remplacera ou réparera, selon sa décision les pièces renvoyées à PSI. Le client doit demander à l'avance une autorisation d'expédition de matériel à PSI (RMA) et suivre la procédure PSI d'expédition

Exception faite aux conditions de garantie précitées, le vendeur ne fourni aucune garantie, de façon formelle ou implicite, et exclu, désavoue expressément toutes formes de garantie se rapportant à la marchandabilité ou l'adaptation à un usage particulier. PSI ne pourra en aucun cas être designé comme responsable des pertes ou dommages, indirects, directs ou consécutifs, survenus lors d'une utilisation ou d'une immobilisation de produits, services, pièces, fournitures ou équipement. PSI sera également dégagé de toutes responsabilités vis-à-vis de la loi, incluant, mais sans s'y limiter, aux pertes de profits, retards, mauvaise volonté, dommage et toutes sortes de coûts de récupération, reprogrammation ou reproduction des programmes ou informations contenues ou utilisées avec les produits PSI.

Certains états n'admettent pas de limitation, dans le temps, de garanties implicites et/ou l'exclusion ou la limitation d'incidents ou de dommages spéciaux. Dans ce cas les limitations et/ou exclusions précitées ne vous concernent pas. Ces garanties vous donnent des droits spéciaux et vous pouvez également être soumis à d'autres droits qui peuvent varier d'un état à l'autre.

Information du fabricant

Toutes les questions relatives au service devront être addressées à votre representant PSI local.

PSI, USA
1171 Borregas Avenue
Sunnyvale, CA 94089
T: (408) 747-1600
F: (408) 747-1601

PSI, USA
6 Denny Road, No. 109
Wilmington, DE 19809
T: (302) 762-2245
F: (302) 762-2847

PSI, SA
16 rue Alexandre Gavard
1227 CAROUGE
Geneva, Switzerland
T: 41-22-300-4411
F: 41-22-300-4415

PSI, Korea
Suite 301, Seowon Building
395-13, Seokyo-dong, Mapo-ku
Seoul, Korea
T: 82-2-325-3212
F: 82-2-325-3214

Si le matériel que vous renvoyez au service technique a été en contact avec des substances toxiques vous devez observer certaines réglementations. Les substances toxiques sont réglementées par les pays de la Communité Européenne par "Materials and Preparations en accord avec les directives EEC du 18 Septembre 1979, Article 2." Pour le matériel qui a été en contact avec des substances toxiques, vous devez procéder comme suit :

- Decontaminate the components in accordance with the radiation protection regulations.
- Le matériel (contaminé) doit être décontaminé en accord avec les directives et réglementations de protection radioactive.

- Construct a notice that reads "free from harmful substances." The notice must be included with the components and the delivery note.
- Le materiel renvoyé doit être accompagné d'un avis "Exempt de substances toxiques". Cet avis doit également apparaître sur le bulletin de livraison.

Comment utiliser ce guide de l'utilisateur

Le guide de l'utilisateur pour l'AutoProbe CP est divisé en trois parties, faciles à utiliser, qui sont les suivantes :

- Partie I: *Apprendre à utiliser l'AutoProbe CP : Techniques d'imagerie de base.*
- Partie II: *Apprendre à utiliser l'AutoProbe CP : Techniques avancées.*
- Partie III: *Réferences du logiciel*

Le contenu des différentes parties listées ci-dessus est décrit en détails dans la section ci-dessous.

Partie I: Apprendre à utiliser l'AutoProbe CP : Techniques d'imagerie de base

La partie I de ce guide de l'utilisateur, *Apprendre à utiliser l'AutoProbe CP : "Techniques d'imagerie de base",* contient un chapitre d'introduction, et trois formations pratiques, les chapitres 2 à 4. En travaillant sur les formations pratiques tout au long de ces chapitres, vous allez apprendre les bases dont vous aurez besoin pour faire fonctionner l'instrument et obtenir des images AFM.

Commencez par lire le Chapitre 1, "Les bases de l'AutoProbe CP," comme introduction aux configurations et composants du système AutoProbe CP. Puis travaillez sur la formation pratique du Chapitre 2, "Faire fonctionner le système pour obtenir une image," afin d'apprendre comment configurer le système logiciel et matériel en mode AFM. De façon précise, vous allez apprendre des procédures pour connecter les câbles, enlever et installer une tête de microscope et un scanner, et charger un échantillon.

Chapter 3, "Acquisition d'un image AFM," vous guide tout au long de la configuration du logiciel, durant l'approche de l'échantillon, et pour prendre une image AFM. Chapter 4, "Obtenir de meilleures images," vous apprend à optimiser les paramètres de balayages et de feedback afin de prendre des images de meilleure qualité et comment les sauvegarder et les recharger.

Partie II: Apprendre à utiliser l'AutoProbe CP : Techniques avancées

La partie II de ce Guide de l'Utilisateur, *Apprendre à utiliser l'AutoProbe CP : "Techniques avancées",* comprend des formations pratiques pour des opérations dans les modes suivants : STM, LFM, NC-AFM, IC-AFM, and MFM. Elle comprend également des travaux pratiques qui vous introduisent aux possibilités avancées de l'AutoProbe CP, tels que les courbes force-distance, les courbes courant/tension, et la calibration du scanner.

Le chapitre 1, “Imager en mode STM”, vous guide afin de prendre une image en mode STM. Dans ce chapitre vous apprendrez des procédures pour préparer des pointes STM et utiliser des cartouches STM, pour configurer l’ordinateur et le programme afin de travailler en mode STM, et prendre une image en mode STM.

Le chapitre 2, “Imager en mode LFM”, vous guide afin de prendre simultanément des images en mode LFM et AFM. Le chapitre 2 vous donne également les informations pour obtenir des images LFM et les avantages d’avoir à disposition les 2 images LFM et AFM.

Le chapitre 3, “Imager en mode NC-AFM, IC-AFM et MFM” décrit les principes des modes d’opération NC-AFM, IC-AFM et MFM. Le chapitre 3 vous donne également les instructions, pas à pas, afin d’obtenir des images NC-AFM, IC-AFM et MFM.

Le chapitre 4, "Courbes Force-Distance," Décrit comment obtenir des courbes force-distance à une position x et y donnée sur la surface de l’échantillon en utilisant le traceur X-Y de “ProScan Data Acquisition”. Une courbe force-distance est un relevé de la force verticale que la pointe applique au levier en fonction de la distance pointe-échantillon. Les variations de la courbe fournissent des informations concernant les proprietés locales d’élasticité à la surface de l’échantillon.

Le chapitre 5, "Spectroscopie I-V," vous apprend à utiliser la fenêtre “Spectroscopie I-V” de “ProScan Data Acquisition” pour générer des courbes courant/tension (I-V) et des courbes dI/dV. Ces courbes fournissent des informations importantes concernant les propriétés électroniques de la surface.

Le chapitre 6. “calibration du scanner”, décrit comment le scanner de votre système AutoProbe CP fonctionne et comment le calibrer afin de maintenir ses performances optimales.

Partie III: Réferences du logiciel

La partie III de ce guide de l’utilisateur, *Réferences du logiciel*, est un manuel de référence pour “ProScan Data Acquisition and Image Processing” et comprend des informations pour les systèmes AutoProbe suivant : CP, LS, et M5. Les chapitres de cette partie du guide de l’utilisateur vous donnent des informations plus détaillées sur certaines caractéristiques et contrôles, les informations qui vous sont données dans les chapitres de formation pratique. Les chapitres sont conçus de telle sorte que vous puissiez allez directement aux caractéristiques et contrôle sur lesquels vous désirez apprendre quelque chose.

Le chapitre 1, "ProScan Data Acquisition," décrit en détail les caractéristiques du logiciel "ProScan Data Acquisition". Ce chapitre traite chaque portion de l'écran, prêtant une attention spéciale à chaque possibilité de contrôle et à ses fonctions. Ce chapitre traite également des menus, avec une description de chaque article du menu et de sa fonction.

Le chapitre 2, "Traitement d'image ProScan," décrit en détail les caractéristiques du logiciel "ProScan Image Processing". Ce chapitre explique comment obtenir des images, comment faire des mesures de surface, et comment préparer les images pour l'impression sous différents formats.

Part I
Learning to Use AutoProbe CP: Basic Imaging Techniques

Part I: Overview

Part I of this User's Guide, *Learning to Use AutoProbe CP: Basic Imaging Techniques*, introduces you to AutoProbe CP. It contains four tutorial chapters that guide you through setting up AutoProbe CP and taking AFM images.

You should start by reading Chapters 1 and 2, which introduce you to the components of AutoProbe CP and describe how to set up the instrument for imaging. Then you should follow the tutorial in Chapter 3 which teaches you how to take AFM images. Chapter 4 explains how to optimize scan and feedback parameters to get the highest quality AFM images.

Chapter 1, "AutoProbe CP Basics": This chapter introduces the system configurations of AutoProbe CP—standard and multitask. It describes the hardware components for each system configuration as well as the system software.

Chapter 2, "Setting Up to Take an Image": This chapter describes how to set up your AutoProbe CP to take images. In this chapter, you will learn the following: how to connect the cables between the system components, how to start the system software, how to install a scanner, how to load a sample, how to move the XY translation stage, and how to load a probe.

Chapter 3, "Taking an AFM Image": This chapter provides you with step-by-step instructions for taking an AFM image. You will learn how to configure the software for AFM mode, how to set up and perform an auto approach, and how to take an AFM image.

Chapter 4, "Taking Better Images": This chapter is designed to help you learn the basics of adjusting scan and feedback parameters to get better AFM images. You will also learn how to take an image at a new location on the sample surface, how to take an image in low-voltage mode, and how to save, load, and delete image files. A special section of this chapter explains how you can operate in low-voltage mode to obtain higher lateral resolution for smaller scan sizes.

Chapter 1
AutoProbe CP Basics

Step-by-Step through AutoProbe CP

Scanning Probe Microscopes (SPMs) are a family of microscopes used to study surface properties of a wide range of materials with high resolution. Since the first real-space images of the surface of silicon in the early 1980's, SPM applications have expanded to cover a wide variety of disciplines, including fundamental surface science, routine surface roughness analysis, and spectacular three-dimensional imaging, from atoms to micron-sized protrusions on the surface of a cell.

Depending on your system configuration, the AutoProbe family of SPMs allow you to take images using many different SPM techniques, including atomic force microscopy (AFM), non-contact atomic force microscopy (NC-AFM), lateral force microscopy (LFM), scanning tunneling microscopy (STM), and magnetic force microscopy (MFM).

Taking an SPM image using AutoProbe typically involves the following steps:

1. Loading a sample.
2. Loading a pre-aligned probe.
3. Performing an auto approach.
4. Navigating over the surface to a region of interest.
5. Adjusting and optimizing scan and feedback parameters.
6. Taking an image, made up of 3-dimensional topographical data.
7. Analyzing the image, to obtain surface measurements and statistics.
8. Printing out plots and tables of data analysis results.
9. Processing the image and printing it out.
10. Saving image files and data analysis results.

The User's Guide to AutoProbe CP will lead you through these steps, beginning with Part I: *Learning to Use AutoProbe CP: Basic Imaging Techniques.*

Note: Throughout this chapter, the drawings refer to the AFM probe head for the standard system configuration of AutoProbe CP.

System Components

AutoProbe CP comes in two system configurations—standard and multitask. The only difference between the components of the two system configurations is the probe head and its imaging capabilities. The principal and optional components are the same.

The AutoProbe CP system consists of three principal components:

- an AutoProbe CP instrument
- an AutoProbe electronics module (AEM)
- a computer, its monitor, and its keyboard

Figure 1-1 shows the above-listed system components.

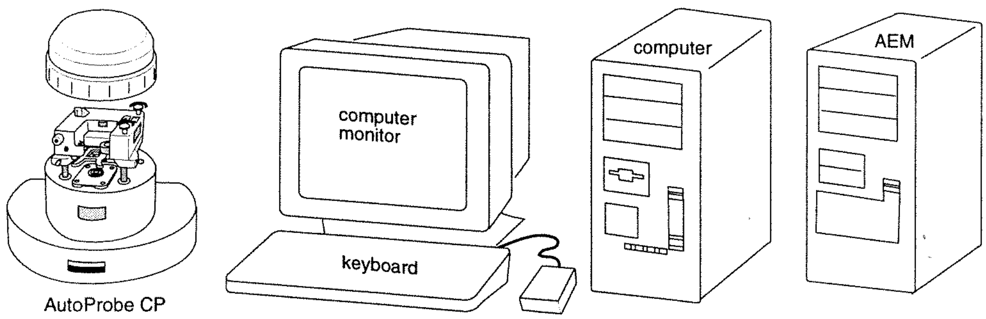


Figure 1-1. AutoProbe CP system components.

The AutoProbe CP system offers three optional components:

- an optical microscope and fiberoptic light source
- an on-axis optical microscope and a color video monitor
- an acoustic isolation chamber

Figure 1-2 depicts the optional components.

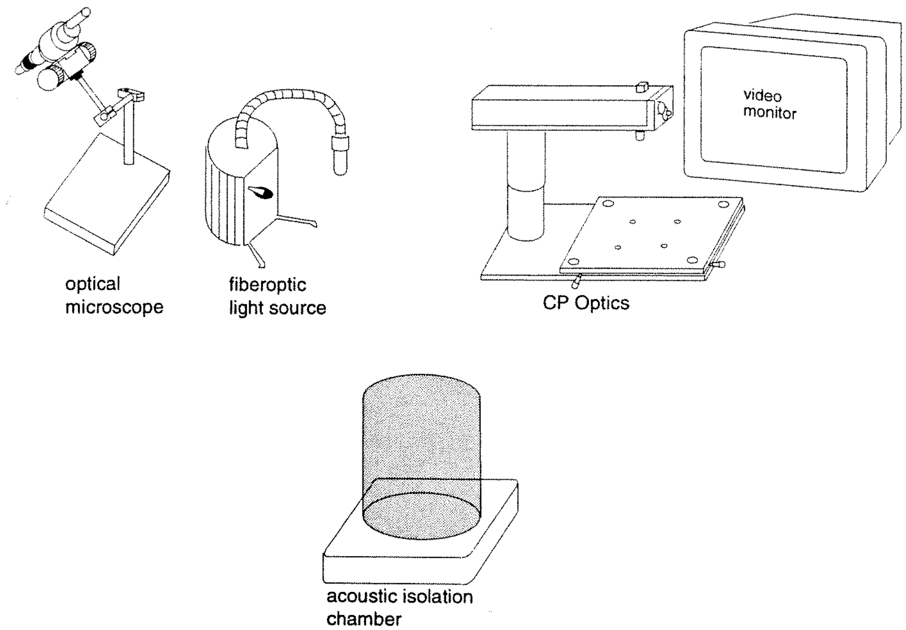


Figure 1-2. Optional components for AutoProbe CP.

The AutoProbe CP Instrument

The **AutoProbe CP instrument** is the central component of the AutoProbe CP system. Its primary components are a probe head, a manual XY stage, a motorized z stage, and a scanner. These components are illustrated in Figure 1-3, below.

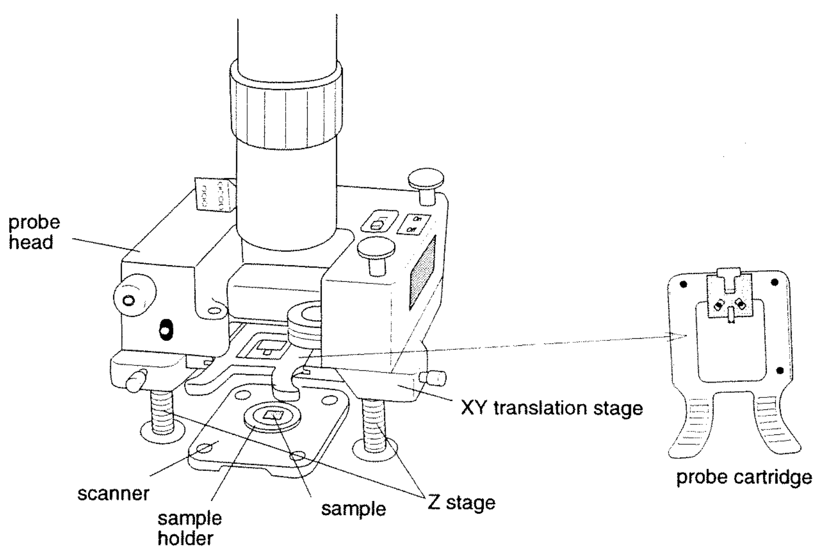


Figure 1-3. Location of AutoProbe CP instrument controls.

The components labeled in Figure 1-3, are described in the sections below. The **probe head** contains a deflection sensor, which consists of a laser diode, a mirror, and a position-sensitive photodetector (PSPD). The probe head type depends on your system configuration. Note the following differences:

For the standard system configuration, there are three probe head types available: AFM, AFM/NC-AFM, and AFM/LFM. The AFM probe head comes with the standard configuration and is for operation in AFM mode. The AFM probe head can be upgraded to include STM mode. The AFM/NC-AFM probe head is optional and is for operation in AFM, NC-AFM, IC-AFM, and MFM modes. The AFM/LFM probe head is also optional and is for operation in AFM and LFM modes.

For the multitask system configuration, there is only one probe head type—multitask. The multitask probe head is used for operation in the following modes: AFM, NC-AFM, IC-AFM, MFM, LFM, and STM. The multitask probe head has two switches: an AFM/STM switch, and a LFM/NC-AFM switch. These switches are used to select the mode of operation.

For both configurations, the probe head holds a **probe cartridge**, which contains a removable chip carrier with a cantilever chip mounted on it. The probe cartridge slides in and out of the probe head on side rails and clicks into place for precise positioning.

The probe head itself slides on and off an **XY translation stage**. An electrical connector on the probe head plugs into a connector mounted on the back of the XY translation stage. The XY translation stage is used to position the probe in x and y over the desired location on the sample. The XY translation stage is moved using two translation screws on the sides of the XY translation stage.

The probe head moves up and down on the **Z stage**. Up and down movement of the probe head moves the probe farther from and closer to the sample surface and is controlled using software tools in ProScan Data Acquisition.

The **scanner** is a piezoelectric ceramic tube. The scanner is installed in an opening below the probe head, with a sample holder attached to the top of the scanner. The sample is set on the sample holder and the scanner rasters the sample holder, and thereby the sample, beneath the probe to generate an image of the sample surface. The size of the scanner depends on your system configuration. The standard configuration comes with a 5 μm scanner. The multitask configuration comes with a 100 μm scanner that includes ScanMaster position detectors that accurately measure the scanner's x, y position.

Note: The 100 μm scanner is available as an option with the standard configuration. The 5 μm scanner is available as an option with the multitask configuration.

The components described above all fit into or onto the AutoProbe CP **base unit**, shown in Figure 1-4 , below. The cover fits over the probe head and scanner to provide isolation from electrical and acoustic noise and EMC immunity.

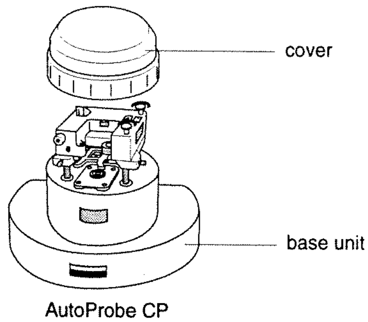


Figure 1-4. The AutoProbe CP base unit and cover.

The CP base unit connects to the AEM. The rear panel of the CP base unit has three large multi-pin connectors, one small multi-pin connector, five BNC connectors, and two buttons as illustrated in Figure 1-5.

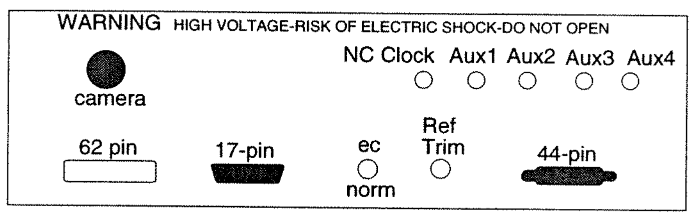


Figure 1-5. The rear panel of the CP base unit.

The Optical Microscope and Fiberoptic Light Source

The controls of the optional optical microscope and fiberoptic light source are illustrated in Figure 1-6, below.

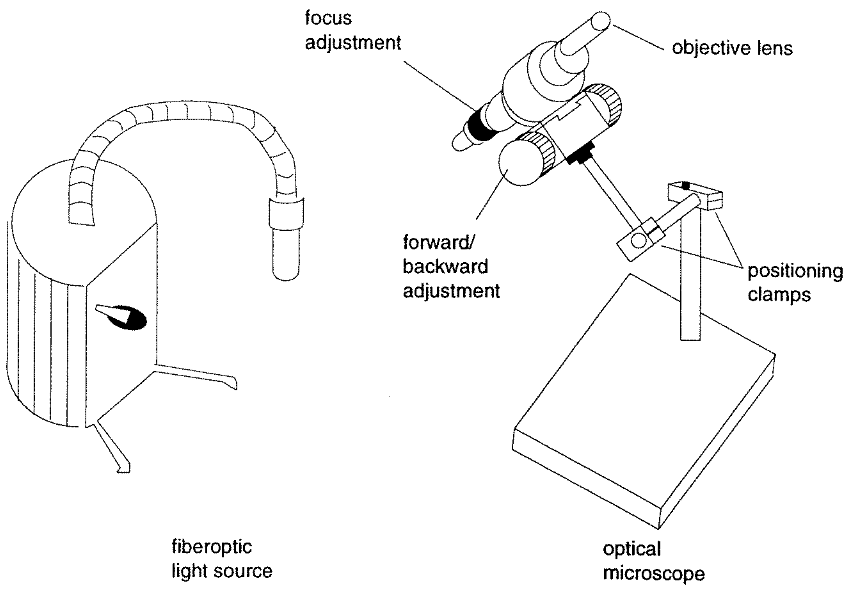


Figure 1-6. Location of instrument controls for AutoProbe CP's fiberoptic light source (left) and optical microscope (right).

The optical microscope is used to view the probe relative to the sample. Its primary components are the objective lens, the focus adjustment knob, and the forward/backward adjustment knobs. The optical microscope has interchangeable 10X, 20X, and 50X objective lenses, which may be focused by turning the focus adjustment knob. The position of the objective lens is adjusted using the four positioning clamps and the forward/backward adjustment knobs. In general, viewing the sample at a 45° angle at a distance of about 2 to 3 inches is recommended.

The fiber optic light source can easily be positioned to illuminate the sample and has one switch for setting the light source intensity. The settings are OFF, LOW, MED, and HIGH.

The CP Optics

The controls of the optional CP Optics are shown in Figure 1-7, below.

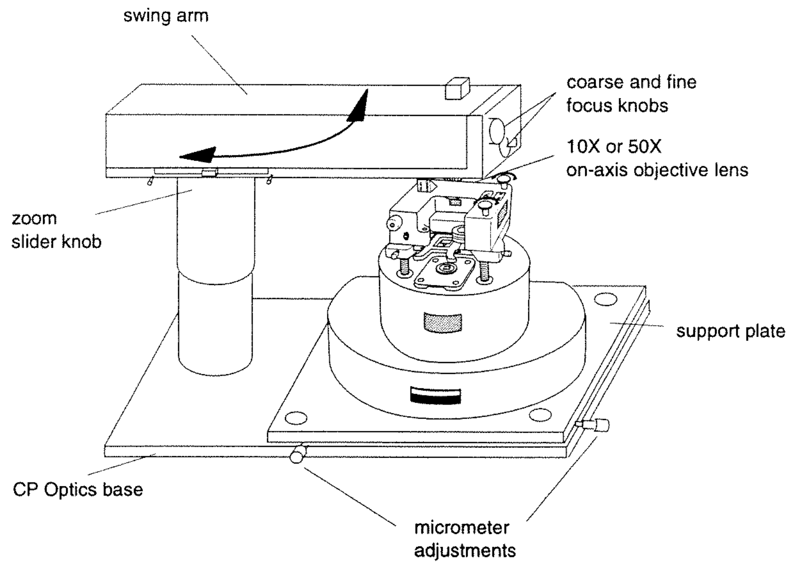


Figure 1-7. Location of the instrument controls for the optional CP Optics.

The primary components of the CP Optics include the following: the microscope swing arm, the zoom slider, the on-axis objective lens, the coarse and fine focusing knobs, the support plate, and the video monitor.

The microscope swing arm is mounted on the CP Optics base and has a 90° range of travel over the base. The zoom slider, located on the swing arm, allows you to zoom the field of view in and out. An objective lens is focused using the coarse and fine focusing knobs at the end of the swing arm. The AutoProbe CP instrument is placed directly onto the support plate of the CP Optics. You can move AutoProbe CP relative to the field of view of the CP Optics using the micrometer adjustments located on the base for up to 5 mm of travel in both the x and y directions.

The Acoustic Isolation Chamber

The components of the optional acoustic isolation chamber are shown in Figure 1-8, below.

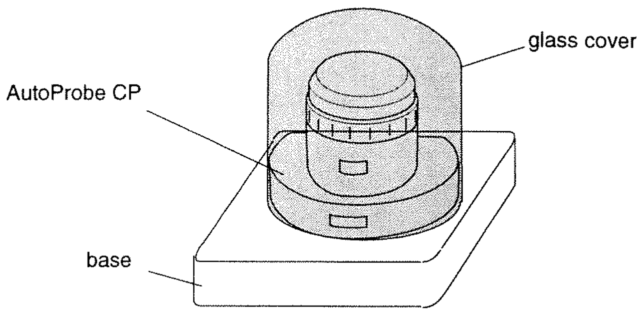


Figure 1-8. Location of the components for AutoProbe CP's optional vibration isolation chamber.

The primary components are the base and the glass cover. The acoustic isolation chamber is recommended for taking atomic-scale images. The base for the acoustic isolation chamber can sit directly on an air table, or it can be placed directly on the CP Optics support plate. AutoProbe CP fits inside the base, and the glass cover fits over the instrument to provide isolation from acoustic vibration.

ProScan Data Acquisition

ProScan Data Acquisition controls AutoProbe CP and collects data. ProScan Data Acquisition consists of two modes: Move mode and Image mode. Move mode controls allow you to move the probe up and down in the z direction and to perform an auto approach. Image mode controls allow you to select a region for scanning on the sample surface, to set scan and feedback parameters, and to take an image. Certain software features, such as the Menu bar, the Toolbar, and the Image Gallery, are shared by both Move mode and Image mode. You will learn more about Move mode and Image mode by working through the tutorials in Chapters 2 through 4. ProScan Data Acquisition is described in detail in Part III of this User's Guide, *Software Reference*.

ProScan Image Processing

ProScan Image Processing provides tools for image processing, data analysis, and presentation of images for printout.

Measurement tools generate useful quantitative data from your images, including the dimensions of surface features, surface roughness statistics, and height distributions. You can analyze individual height profiles (cross sections of an image) or surface regions. Image processing tools allow you to remove imaging artifacts, such as curvature, slope, and noise.

Printing tools allow you to set up a single image or multiple images for printout in a desired format. You can print an image with a title and comments. You can also generate a 3-dimensional rendition of an image.

ProScan Image Processing is described in detail in Part III of this User's Guide, *Software Reference.*

Working in the Windows 95 Environment

This manual assumes that you are already familiar with the Windows 95 operating system. If you are unfamiliar with Windows 95, learning the necessary basic skills does not take long. For a quick tour of Windows 95, read *Introducing Microsoft Windows 95*, included with your Microsoft Windows bundle. You will learn enough to proceed with the AutoProbe CP tutorials.

The following section describes conventions are used throughout this document.

Definitions: Parts of a Screen

To avoid possible confusion, this section defines some of the terms used frequently in this manual to refer to windows and their features.

window An application open on the desktop. The front-most window is the active window. There are two main Data Acquisition windows, and there are several Image Processing windows. To switch between different windows, click buttons on the window representing the various program modes.

image The gray scale display of data, and also a 3-dimensional rendition of data. The data for each image are truly 3-dimensional, containing height information for each x-y location scanned.

scan All of the data associated with an image, including measurement results and scan records. "Scanning" also refers to the back and forth motion of the scanner as an image is acquired.

Figure 1-9 uses a portion of the Image mode window as am example to illustrate different parts of the screen.

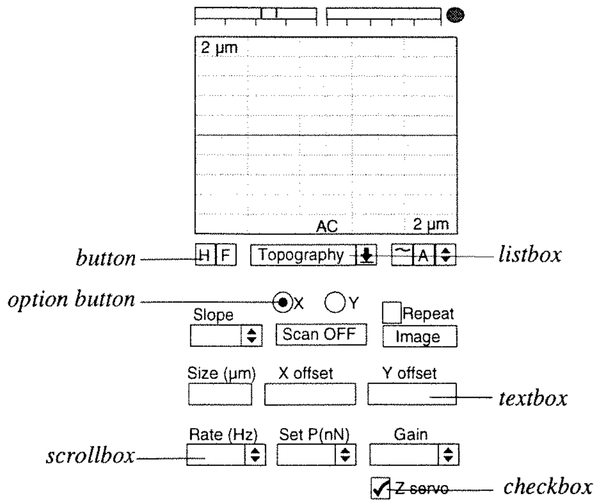


Figure 1-9. Parts of a screen.

dialog box A special window accessed by using an icon or menu. A dialog box allows you to alter values and parameters when using ProScan.

box A section of a dialog box or window, usually with a label, and containing a list of items.

button A labeled area on a computer screen, usually in a window or taskbar. Clicking a button performs the labeled command.

scrollbar A strip alongside a bordered section of a window. The strip is terminated on both ends by arrows that can be used to scroll through items in the bordered section. A slider bar inside the strip can be dragged along the strip to scroll through the items as well.

scrollbox A small box on the screen with an up and a down arrow at one end. You can either type numbers in the box or use the arrows to scroll through numerical values.

listbox A box on the screen with a down arrow at one end. You can click the down arrow to display a list of items, and then you can select an item from the list.

textbox A small box on the screen where you type in text. You can enter a comment, or you can enter a number that represents a new parameter value.

checkbox A small box on the screen that can be either selected (filled with a check mark) or deselected (empty). You click the checkbox to toggle between these two states.

option button A circular button on the screen that can either be selected (filled with a black dot) or deselected (not filled with a black dot). You click the option button to toggle between these two states.

Special to Windows 95

taskbar A bar, usually at the bottom of the screen, containing the Start button and buttons for open applications.

Start button A button on the taskbar. Clicking the Start button opens the Start menu.

Chapter 2
Setting Up to Take an Image

Introduction

This chapter shows you how to set up the hardware of AutoProbe CP to take an AFM image. Specifically, you will learn about the following procedures:

- connecting cables
- starting AutoProbe CP
- removing and installing a probe head
- removing and installing a scanner
- loading a sample
- loading a prealigned chip carrier
- aligning the deflection sensor

This chapter is the first of three tutorial chapters that give you the basic knowledge you need to take an image. Chapter 3 shows you how to take an AFM image, and Chapter 4 introduces you to more features of ProScan Data Acquisition.

If the system has just been installed, perform an initial checkout of the system by following the tutorial of this chapter. For instance, the first section of this chapter shows you the system's cable connections. These connections should be made initially by the authorized PSI representative who installs your system, but you should check the connections to familiarize yourself with the system.

Note: Throughout this chapter, the drawings refer to the AFM probe head for the standard system configuration of AutoProbe CP. The text refers to the standard system configuration of AutoProbe CP. Procedures are similar for the multitask system configuration unless otherwise noted.

Before You Begin

This chapter assumes you have already read Chapter 1, "AutoProbe CP Basics," which introduces you to AutoProbe CP. Chapter 1 describes the standard and optional hardware components of both AutoProbe CP system configurations, standard and multitask. Chapter 1 also includes a brief description of the system software, ProScan Data Acquisition and ProScan Image Processing.

This chapter assumes that you are familiar with working in a Windows environment. You should be familiar with mouse techniques, including pointing and clicking, double-clicking, and holding the left mouse button down while you drag the mouse. You should know how to use the mouse to open up an application, pull down menus, and drag an icon to a different location on the screen.

This chapter also assumes that your AutoProbe CP instrument has been properly installed by a PSI representative. The computer and its components as well as the control electronics have all been set up. Cables are properly connected between system components and the power cords are plugged in.

WARNING!

This instrument contains a laser. Use of controls or adjustments or performance of procedures other than those specified herein could result in hazardous laser light exposure.

Cable Connections

This section illustrates the components of your AutoProbe CP system and shows how they are connected. System components include: the computer, the AutoProbe electronics module (AEM), and the AutoProbe CP instrument. You can refer to this section if you need to disconnect and then reconnect your system components for any reason. All of the cable connections are depicted in Figure 2-1.

1. Make sure that all system components are turned off.

2. Set up the computer components, including the keyboard, the mouse, and the monitor.

   a. Connect the keyboard cable to the keyboard connector on the back panel of the computer unit.

   b. Connect the mouse cable to the mouse connector on the back panel of the computer unit.

   c. Connect the computer monitor cable to the computer monitor connector on the back panel of the computer unit.

3. Connect the 50-pin ISA bus extender cable between the connector labeled 50-pin ISA bus on the back panel of the computer unit and the connector labeled 50-pin ISA bus on the back panel of the AEM. This connects the computer unit to the AEM.

4. Connect the 44-pin I/O cable between the connector labeled 44-pin on the back panel of the AEM to the connector labeled 44-pin I/O Cable on the back panel of the AutoProbe CP instrument. The 44-pin I/O cable carries low-voltage signals, for instance the set point, to the AutoProbe CP instrument.

5. Connect the 17-pin high-voltage cable between the connector labeled 17-pin HV on the back panel of the AEM to the connector labeled 17-pin High Voltage Cable on the back panel of the AutoProbe CP instrument. The 17-pin high-voltage cable carries high-voltage signals that are applied to the piezoelectric scanner.

6. Connect the 62-pin stepper motor cable between the connector labeled 62-pin on the back panel of the AEM to the connector labeled 62-pin Stepmotor Cable on the back panel of the AutoProbe CP instrument. The 62-pin stepper motor cables carries low-voltage signals to the Z stage.

7. If you have the multitask configuration, or the standard configuration with the optional AFM/NC-AFM probe head, connect a BNC cable from the connector labeled NC Synthesizer Card on the back panel of the AEM to the connector labeled NC clock on the back panel of the AutoProbe CP instrument. The BNC cable carries the AC voltage signal to the cantilever that causes the cantilever to oscillate at a constant frequency. All of your system's cables should now be properly connected, and power cords should be plugged in. You are now ready to turn on the components and set up to take an image.

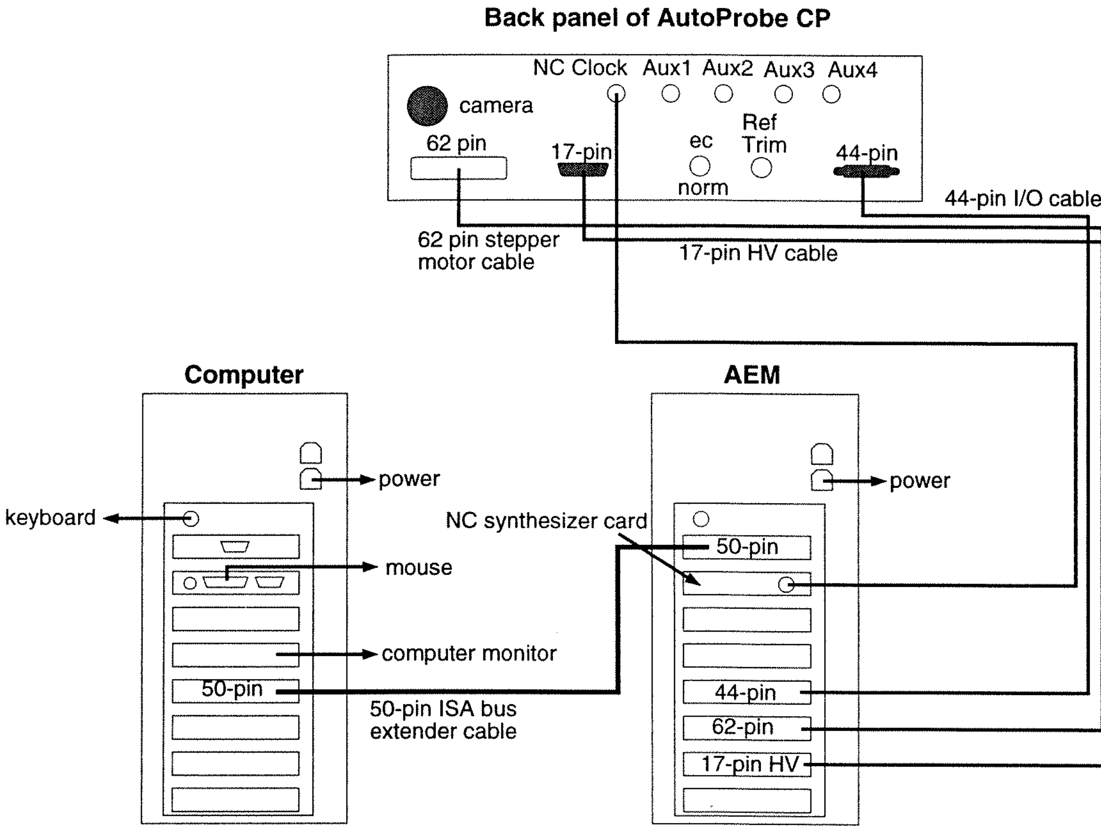


Figure 2-1. Diagram of cable connections for AutoProbe CP system components.

Starting AutoProbe CP

To start AutoProbe CP, complete the following steps:

1. Turn on the AutoProbe electronics module (AEM). The on/off button is located on the front panel of the module.

2. If you purchased CP optics, turn on the color video monitor. The on/off button is located on the front of the monitor, below the screen.

3. Turn the computer and the monitor on. The computer on/off switch is located on the front panel of the computer unit. The computer monitor on/off button is located on the front of the monitor, below the screen.

When you start the computer, you automatically enter the Windows desktop.

4. Open ProScan Data Acquisition. From Start, point to the Program folder and select PSI ProScan. Then, click the Data Acquisition icon. Alternatively, double-click the Data Acquisition icon in the desktop.

When ProScan Data Acquisition first opens, you will see Move mode as shown in Figure 2-2, below. The controls unique to Move mode are located on the left side of the window, and the other controls are shared with Image mode.

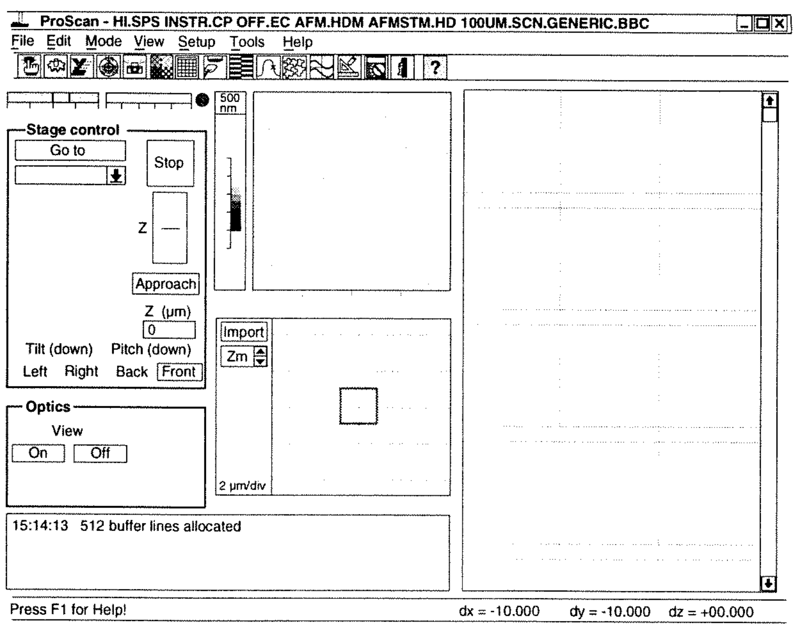


Figure 2-2. The Move mode window of the ProScan Data Acquisition screen.

The different sections of the ProScan Data Acquisition screen are labeled in Figure 2-3.

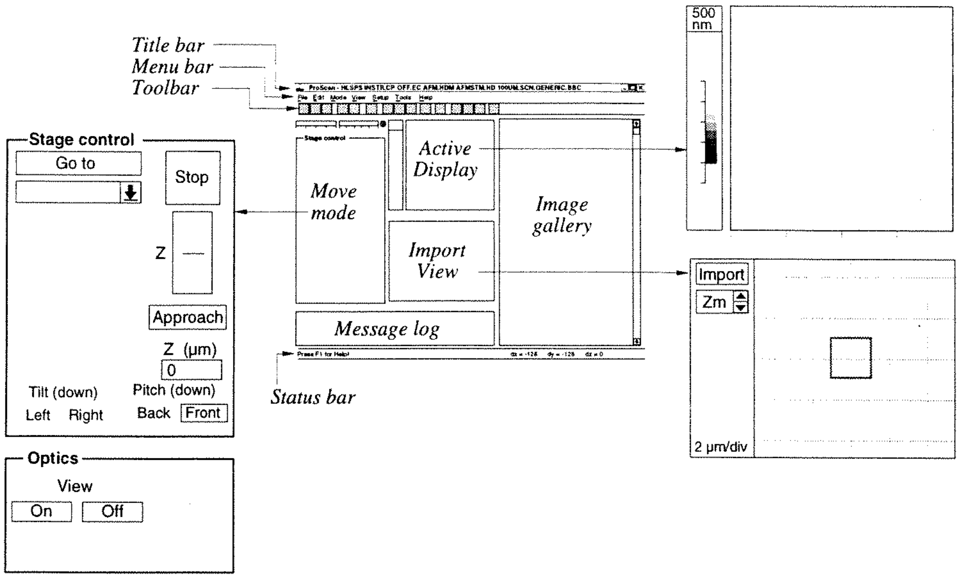


Figure 2-3. Sections of the ProScan Data Acquisition screen.

Move mode controls allow you to turn on and off the optics light, move the Z stage, which moves the probe up and down in the z direction, and perform an auto approach.

> ***CAUTION***
>
> Improper use of the controls in Move mode can result in severe damage to your instrument. For instance you can ruin the probe tip, damage the sample, and break the scanner tube. Before you use these controls, complete the tutorials in Part I of this User's Guide. In these tutorials, you learn how to use Move mode controls. You can also refer to Part III, *Software Reference*, of this User's Guide if you want information about a specific control in Move mode.

Controlling the XY and Z Stages

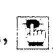
This section shows you how to control the manual XY stage and the motorized Z stage for moving the probe in x, y, and z, respectively. You will need to know how to move these stages to perform the procedures described in the remainder of this chapter.

The probe head is placed on the manual XY stage and is used to move the probe in the x and y directions to select a location on the sample for imaging. The XY stage is controlled using the two translation screws on the sides of the XY stage. The motorized Z stage is essentially the three threaded posts that extend from the XY stage. The Z stage is used to move the probe head, and therefore the probe, up and down relative to the sample in the z direction. The Z stage is controlled using the z direction pad in Move mode. The sections that follow describe in detail how to move the XY and Z stages.

Before you can move the XY stage, you must be sure that there is ample distance between the probe and the sample. If the probe and the sample are too close to one and other, the probe can be dragged across the sample, thereby damaging both the probe and the sample. Therefore, you will first learn how to control the Z stage to move the probe a safe distance away from the sample.

Before you can move the Z stage, you must first check if the Z stage needs to be reset. If the Z stage needs to be reset, there will be dashed lines (---) instead of coordinates in the Z(μm) textbox in Move mode. Resetting the Z stage synchronizes its position with the coordinate system of the software. After you reset the Z stage, the dashes should be replaced by a number that represents the z position of the stage, in microns. In general, the Z stage only needs to be reset when you first enter Data Acquisition.

To reset the Z stage:

1. When the ProScan program opens, the probe head is turned on. This means that the power to the probe head is turned on. Turn off the power to the probe head by deselecting the Head ON menu item of the Mode menu. Alternatively, you can turn the probe head off or on by clicking the Head ON icon, , of the Toolbar. The Menu bar and the Toolbar are indicated in Figure 2-3, above. Turning off the power to the probe head enables the Reset Stage menu item of the Setup menu.

2. From the Setup menu, select Reset Stage to open the Reset Stage dialog box.

Note: A window appears warning you to move the optics or any other obstacle to stage motion out of the way of the Z stage. If you are using CP optics, move the objective lens out of the way of the probe head by rotating the swing arm towards you. Then, click the [OK] button.

3. Click the Z Head checkbox, if it is not already selected.

4. Click the [Reset] button. The probe head should move to its upper limit in the z direction. A green indicator light near the top of the window flashes while the Z stage is moving. When the system has finished the reset stage process, the green light will stop flashing and the [Done] button will be enabled.

5. Click the [Done] button when the reset stage process is complete. A number representing the z coordinate of the stage should appear in the Z(µm) textbox in Move mode.

Once the Z stage has been reset, you can practice moving the probe head up and down using the z direction pad in Move mode. The z direction pad controls both the speed and the direction of the probe head.

To move the probe using the z direction pad, do the following:

1. Practice moving the probe toward the sample.

   The direction the probe moves in z is set by the position of the cursor on the z direction pad. The upper portion of the z direction pad moves the probe in the positive z direction, or away from the sample. The lower portion of the z direction pad moves the probe in the negative z direction, or toward the sample.

   Improper use of the controls in Move mode can result in severe damage to your instrument. For instance you can ruin the probe tip, damage the sample, and break the scanner tube. Before you use these controls, complete the tutorials in Part I of this User's Guide. In these tutorials, you learn how to use Move mode controls. You can also refer to Part III, *Software Reference*, of this User's Guide if you want information about a specific control in Move mode.

> ***CAUTION***
>
> *Be extremely careful* when you use the z direction pad to move the probe toward the sample. If you move the probe too close to the sample, you can crash and ruin the probe and the sample and break the scanner tube.

To do this, place the cursor on the lower portion of the z direction pad and then click and hold the mouse button. When the probe is a few millimeters away from the sample, release the mouse button to stop movement of the probe.

2. Try varying the speed of the probe.

   The speed of the probe is set by the position of the cursor relative to the center (0) of the z direction pad. The probe has zero velocity when the cursor is at the center of the pad. The farther the cursor is from the center of z direction pad, the faster the probe motion will be.

   Click and hold the cursor farther from and closer to the center line of the z direction pad.

3. Move the probe away from the sample.

   To move the probe away from the sample, place the cursor on the upper portion of the z direction pad and then click and hold the mouse button. Release the mouse button to stop movement of the probe.

Now that the probe is a safe distance away from the sample, you can move the XY stage to position the probe over the location on the sample surface you wish to image. The XY stage has a range of motion of 8 mm in both the x and y directions.

To move the probe in x and y, do the following:

1. Practice moving the probe in x.

   The direction the probe moves in x is set by the direction you turn the x translation screw of the XY stage. The x translation screw is the knob located on the right side of the XY stage. When you turn the x translation screw away from you, the probe moves to the right as you face the sample, which is defined as the positive x direction. When you turn the x translation stage screw toward you, the probe moves to the left as you face the sample, which is defined as the negative x direction.

2. Practice moving the probe in y.

The direction the probe moves in y is set by the direction you turn the y translation screw of the XY stage. The y translation screw is the knob located on the front of the XY stage. When you turn the y translation screw counterclockwise, the probe moves away from you as you face the sample, which is defined as the positive y direction. When you turn the y translation stage screw clockwise, the probe moves towards you as you face the sample, which is defined as the negative y direction. Now you are ready to learn how to remove and install the probe head.

Removing and Installing the Probe Head

The probe head is installed on a manual XY stage, shown in Figure 2-4.

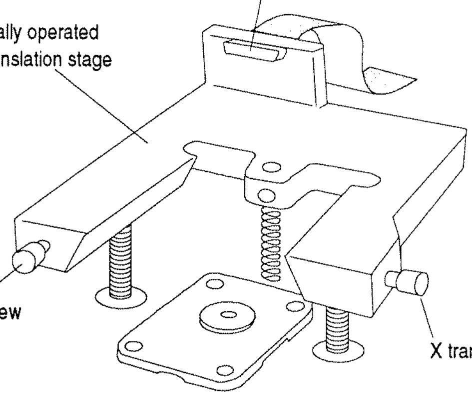


Figure 2-4. The XY stage, with no probe head installed.

The probe head slides onto the two support arms of the XY stage. An electrical connector on the rear of the head plugs into a connector mounted on the rear of the translation stage.

To remove the probe head, do the following:

1. Before you can remove the probe head, the power to the probe head and the power to the laser inside the probe head must be turned off. To turn the power to the probe head and the laser off, do the following: 1) deselect Head ON from the Mode menu or click the Head ON icon, ; and 2) turn the LASER ON/OFF switch of the probe head to the OFF position.

2. Use the z direction pad to raise the Z stage, providing ample clearance between the probe and the sample for removing the probe head.

   Note: If you are using AutoProbe CP with CP Optics, move the objective lens out of the way of the probe head by rotating the swing arm towards you before you raise the Z stage.

3. If there is a probe cartridge installed in the probe head, remove it now by grabbing the two prongs (using one or two hands) and sliding the cartridge out towards you, as shown in Figure 2-5.

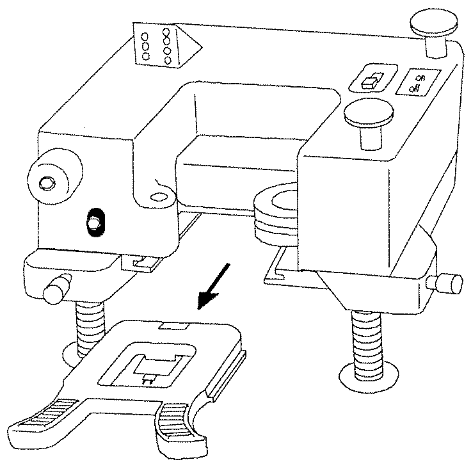


Figure 2-5. Removing the cartridge from the probe head.

Set the probe cartridge on a flat surface with the cantilever facing upwards.

4. Remove the probe head by sliding it off the support arms of the XY stage, as shown in Figure 2-6. As you slide the head off the XY stage, the electrical connector on the back of the probe head will become disengaged.

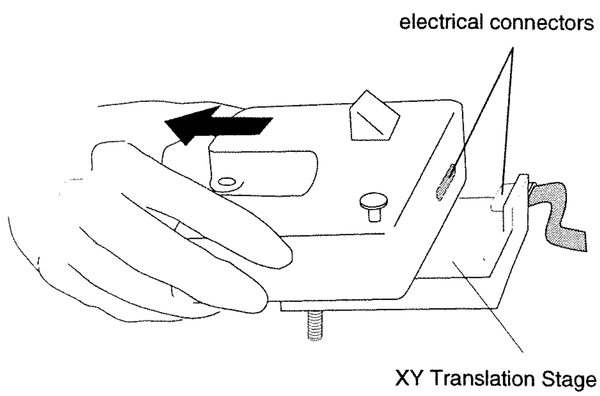


Figure 2-6. Removing the probe head from the XY stage.

Set the probe head on a flat surface or back into its original box.

To reinstall the probe head, do the following:

1. Before you can remove the probe head, the power to the probe head and the power to the laser inside the probe head must be turned off. To turn the power to the probe head and the laser off, do the following: 1) deselect Head ON from the Mode menu or click the Head ON icon, ; and 2) turn the LASER ON/OFF switch of the probe head to the OFF position.

2. Slide the probe head onto the support arms of the XY stage. The electrical connector on the head plugs into a connector mounted on the back of the support arms, as shown in Figure 2-7, below.

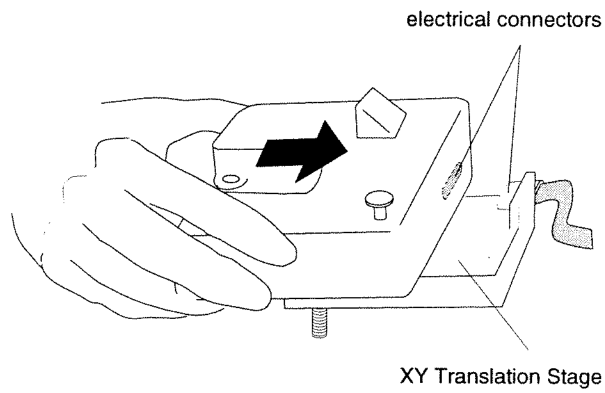


Figure 2-7. Installing the probe head by sliding it onto the support arms of the XY stage.

The probe head is now installed.

Note: If you have the standard configuration and install a different probe head, you need to reconfigure the system software so that it is consistent with the new probe head. This procedure is described in Chapter 3.

Removing and Installing the Scanner

This section describes how to remove and install the scanner. The scanner is the component that rasters your sample beneath the probe tip during a scan and is depicted in Figure 2-8, below.

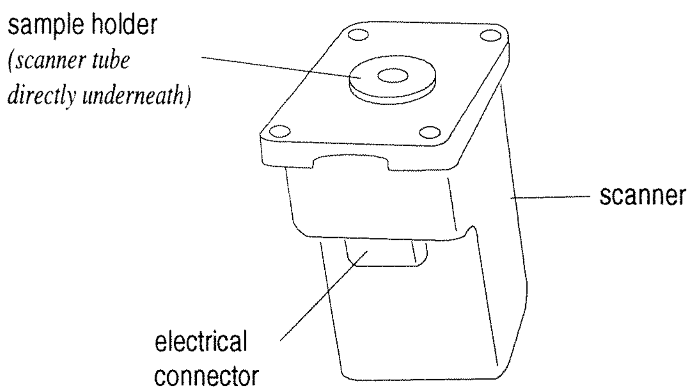


Figure 2-8. The scanner.

The size of the scanner depends on your system configuration. Note the following differences:

- A 5 µm scanner is standard with the standard configuration.
- A 100 µm scanner is standard with the multitask configuration.

The scanner fits into the hole in the center of the stage beneath the probe head. The electrical connector on one side of the scanner plugs into a hole in the stage. Inside the scanner housing is a piezoelectric ceramic tube. The sample holder is attached to the top of this tube. Voltages applied to the piezoelectric tube cause it to bend, and the back and forth bending motion moves the sample in a raster pattern under the probe tip.

CAUTION

The scanner is extremely fragile! The piezoelectric ceramic tube inside can easily break under mechanical shock. Use extreme care when handling the scanner. Do *not* apply any pressure to the sample holder on the top surface of the scanner, or the scanner tube may break.

To remove the scanner, do the following:

1. Remove the probe head, as described in the previous section, "Removing and Installing the Probe Head." Be sure to turn off the power to the probe head before removing it.

2. If a sample is already loaded, remove it from the sample holder.

3. The scanner fits into a hole in the center of the CP stage. The scanner is secured with four hex-head screws. Using the appropriately sized allen wrench (3/32"), loosen the four hex-head screws at the corners of the scanner.

   Turn the screws counterclockwise until they become loose. When they are loose, you will be able to lift the screws into a raised position, as illustrated in Figure 2-9, below. It is not necessary to remove the screws completely.

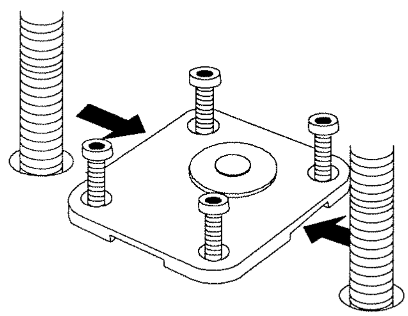


Figure 2-9. The scanner, with four hex-head screws loosened and in raised position. Side fingerholds on scanner are indicated.

4. The electrical connector on the front of the scanner plugs directly into the CP stage. Carefully pry the scanner up using the fingerholds on the left and right sides of the scanner to disconnect the electrical connector from the CP stage. You can also pry the scanner up *very gently* using a flathead screwdriver. As a third alternative, you can remove the scanner by carefully pulling the screws (use two diagonally opposite screws).

CAUTION

Do not allow the top of the scanner—especially the sample holder—to come into contact with another surface. If the scanner hits another surface, the scanner tube may break.

The electrical connector may fit snugly. In this case, pry the scanner up a little at a time.

5. When the electrical connector inside the hole has been disengaged, lift the scanner up and tilt it towards you to remove it from the CP stage.

6. Store the scanner on its side in the padded wooden box originally supplied.

To install the scanner (with no probe head currently installed) do the following:

1. If the four hex head screws supplied with the scanner are not already inserted and in the raised position, insert the four screws now.

2. Orient the scanner so that the electrical connector and the label face towards you and insert it into the hole of the CP stage. There is only one correct fit. The scanner should fit snugly.

3. Tighten the four hex-head screws supplied with the scanner using the 3/32" allen wrench supplied until the scanner fits securely into the hole.

4. Install the probe head as described in the previous section "Removing and Installing the Probe Head."

The scanner is now installed.

Note: If you have changed any of the following items, make sure to reconfigure the system software so that it is consistent with the new hardware:

- the probe head (for the standard configuration)
- the position of the AFM/STM or LFM/NC-AFM switches (for the multitask configuration)
- the scanner (for all configurations)

This procedure is described in Chapter 3.

Loading a Sample

This section explains how to load a sample. The assumption here is that you are starting from scratch, with no sample loaded. These step-by-step instructions also apply when you want to change a sample that is already loaded.

To load a sample, you must first move the probe head to provide access to the sample holder.

1. If you are using AutoProbe CP Optics, move the objective lens out of the way of the probe head by rotating the swing arm towards you.

> ***CAUTION***
>
> You must move the objective lens out of the way before loading a sample. Otherwise, when you raise the probe head, it will hit the objective lens, damaging both the probe head and the lens.

2. Use the z direction pad to raise the probe head. The z direction pad is described in the section "Moving the XY and Z Stages" earlier in this chapter. Raise the probe head to provide ample clearance for loading a sample.

3. For a sample, use the calibration gratings provided with your instrument. The standard configuration comes with a 1 µm grating. The multitask configuration comes with a 10 µm grating. The grating size refers to the spacing between the calibration lines.

4. Secure the sample to one of the sample mounting disks supplied with the instrument. A piece of double-stick (double-sided) tape can be used to attach the sample to the disk.

Next, you will slide the sample mounting disk onto the sample holder, as shown in Figure 2-10. The sample holder is a small round stub attached to the top of the scanner. The magnet of the sample holder holds the sample mounting disk securely in place. The scanner (located underneath the sample holder, where you can't see it) is the element that rasters your sample back and forth under the probe head while an image is being taken.

> ***CAUTION***
>
> Don't let the metal disk snap down hard on the magnetic sample stub. The piezoelectric scanner (mounted underneath the sample holder) is a ceramic material that can easily break under mechanical shock.

5. Gently *slide* the disk onto the sample holder, as illustrated in Figure 2-10. Position the disk so that the *sample* is centered on the sample holder.

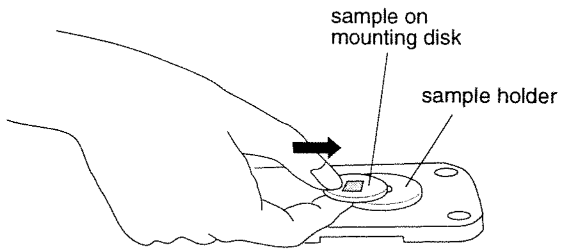


Figure 2-10. Sliding the sample mounting disk onto the sample holder.

6. Use the z direction pad to lower the Z stage to within several millimeters of the sample surface.

7. Move the CP optics back into position after lowering the Z stage.

Now you are ready to load a prealigned AFM chip carrier in the probe head.

Loading a Probe

The step-by-step instructions in this section show you how to load a contact Ultralever probe in the probe head. Each contact Ultralever probe comes pre-mounted on a ceramic chip carrier. These carriers come in a box of 25 and are disposable. The probe is a microfabricated cantilever chip, shown in Figure 2-11 below. (The size of the cantilevers in Figure 2-11 is greatly exaggerated.)

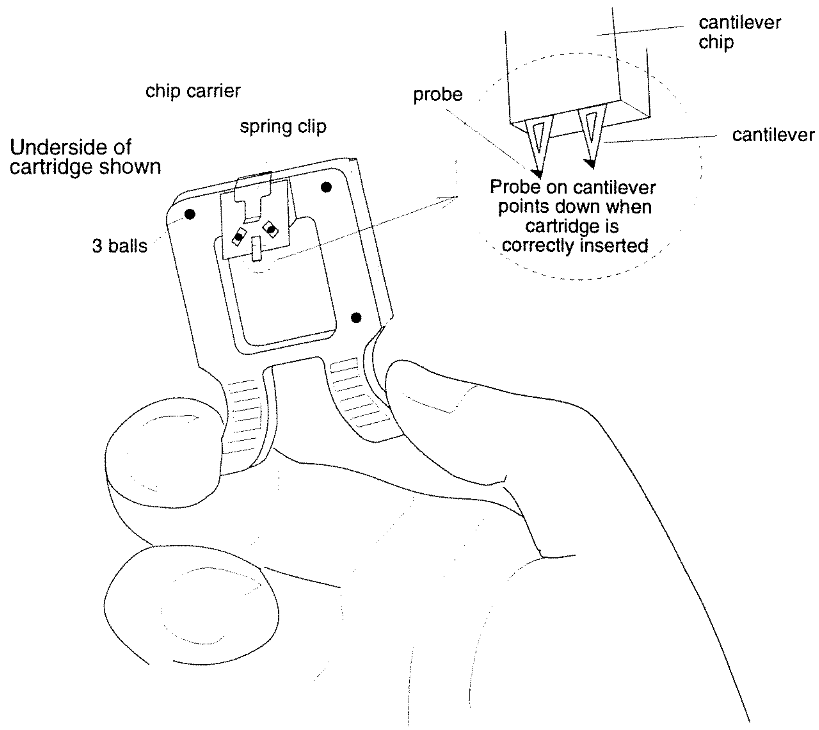


Figure 2-11. Microfabricated cantilever chip mounted on probe cartridge.

At the end of the chip are two cantilevers, probably too small for you to see by eye. At the end of each cantilever is a sharp tip. One of these tips will be brought into contact with your sample, and your sample will be raster-scanned beneath it.

In order to load the small chip carrier onto the probe head, you must first mount the chip carrier on a probe cartridge. You can then easily insert the cartridge in the probe head. The chip carrier is designed to fit snugly and securely in the cartridge mount. The cartridge also is designed to slide securely in place in the probe head.

How Does AFM Work?

Atomic force microscopy in contact mode measures the repulsive forces between atoms in the probe tip and atoms in the sample surface. The tip is located at the end of a flexible cantilever. As the tip responds to the peaks and valleys of the sample surface, the cantilever bends.

A deflection sensor in the probe head monitors this bending, or deflection, of the cantilever. The scanner then moves the sample up or down in order to keep the deflection constant. This up and down motion of the scanner matches the surface topography and is used to generate an image of the surface.

If the probe cartridge is already installed in the probe head, you will first need to remove it. To remove the probe cartridge, complete Steps 1 and 2. If no probe cartridge is installed, skip to Step 3.

CAUTION

Any time that you load a cartridge or remove a cartridge, it is very important to raise the probe head first. If you don't raise the head, the cantilever tip will scrape across the surface of the sample. The sample *and* the tip will be damaged.

1. Remove the probe cartridge from the probe head by grabbing the two prongs (using one or two hands) and sliding the cartridge out towards you, as shown in Figure 2-12.

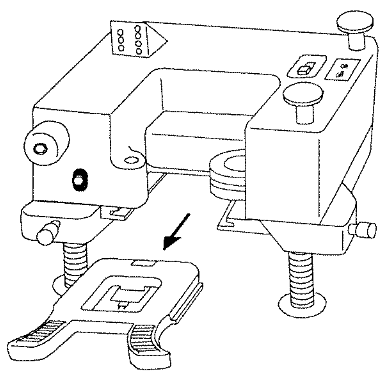


Figure 2-12. Removing the cartridge from the probe head.

2. To remove the old chip carrier, grab the ceramic plate by the edges and slide it (wiggle it) from under the spring clip. You can place a chip carrier on a flat surface with the chip facing up.

   Note: To prevent the chip carrier from sliding around in a container, secure the chip carrier to the container using a small piece of tape over a corner of the ceramic plate. Or, you can store a chip carrier in the original chip carrier box.

3. To mount a new chip carrier on the cartridge, using either your fingers or a pair of tweezers take out a new chip carrier from the box containing contact Ultralevers.

> ***CAUTION***
>
> Hold the chip carrier by the ceramic plate. Don't let your fingers or the tweezers touch the microfabricated cantilever chip, which is very fragile. Touching the cantilever chip can damage or break off the tips.

4. Take hold of the chip carrier using two fingers as shown in Figure 2-13. Orient the chip carrier with the cantilever chip facing up and the chip pointing towards you, as shown. Be careful not to touch the chip!

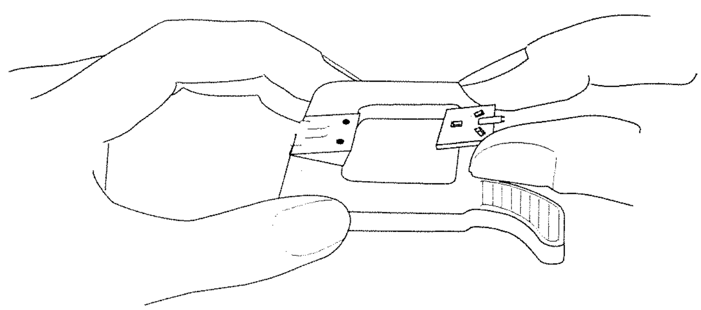
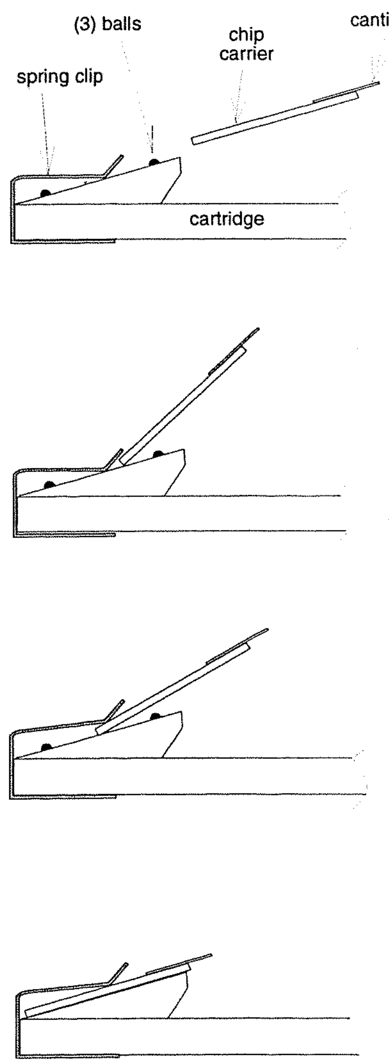


Figure 2-13. One hand holding the cartridge and the other holding a chip carrier.

The chip carrier has three slots in it, arranged in a triangle. These three slots fit over three balls on the cartridge mount. A spring clip on the cartridge will hold the slots securely against the balls.

5. Pick up the cartridge with your other hand and hold it as shown in Figure 2-13.

6. Using the procedure illustrated in Figure 2-14, insert the chip carrier under the lip of the spring clip. Use either a flat edge or a corner of the ceramic plate to force the spring clip open. Then slide the chip carrier under the spring clip until you feel the balls engage the slots. Wiggle the chip carrier from side to side to ensure that *all three balls* fit snugly.



1 Chip carrier in position to install.

2 Insert the chip carrier under the lip of the spring clip.

3 Push the chip carrier further, opening the clip.

4 Insert the chip carrier until you feel the balls engage all three slots.

Figure 2-14. Procedure for inserting the chip carrier under the spring clip.

A correctly installed chip carrier is shown in Figure 2-15, below.

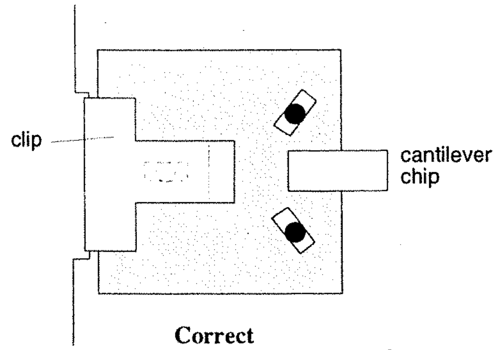


Figure 2-15. The chip carrier, correctly inserted under the spring clip.

Now you are ready to load the cartridge in the probe head.

<u>*CAUTION*</u>
Any time that you load a cartridge or remove a cartridge, it is very important to raise the probe head first. If you don't raise the head, the cantilever tip will scrape across the surface of your sample. Your sample *and* the tip will be damaged.

7. Move the Z stage up using the z direction pad in the Move mode window.

When the probe head has been raised, you are ready to load the probe cartridge.

8. To insert the probe cartridge in the head, hold the cartridge by the two prongs. Make sure you hold it with the cantilever chip facing down, so that the tip can contact the sample.

The probe cartridge slides along a ledge in the probe head. The ledge of the probe head has three contact zones: two conical depressions and a flat region. The underside of the cartridge has three balls embedded in it. These three balls fit over the three contact zones in the probe head. The cartridge slides along the ledge, until all three balls are engaged by the contact zones.

9. Insert the cartridge into the head by sliding it along the ledge.

CAUTION
Make sure the cantilever chip faces down.

You can use one hand or two, whichever works best for you. The cartridge should fit snugly inside the probe head. Wiggle the cartridge in and out a bit to make sure that *all three balls* are engaged.

Next you will learn how to use the optical view to focus on the cantilevers at the end of the cantilever chip.

Using the Optical View

This set of instructions shows you how to use either the CP Optics or the separate optical microscope to focus on the cantilever and the sample. The optical view allows you to view the cantilever as you align the deflection sensor. It also allows you to monitor the cantilever as it approaches the sample. Later in this chapter, you will align the deflection sensor.

If you are using the AutoProbe CP Optics, read the next section, "Using the CP Optics." If you are using the separate optical microscope and fiberoptic light source instead, skip to the section, "Using the Separate Optical Microscope."

Using the AutoProbe CP Optics

These procedures assume that the CP Optics and the video monitor are properly installed and that a probe head, a chip carrier, and a sample are already loaded.

AutoProbe CP is shown mounted on the base of the CP Optics in Figure 2-16. The principal components are the microscope swing arm, the zoom slider, the on-axis objective lens, the coarse and fine focusing knobs, and the support plate.

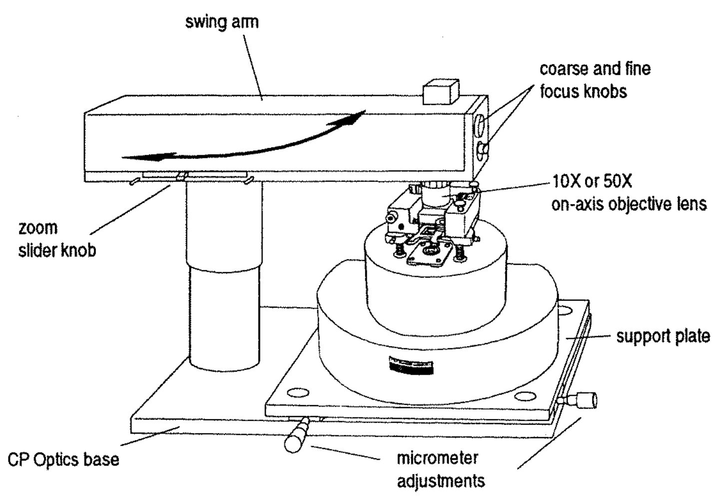


Figure 2-16. Location of the instrument controls for the optional CP Optics.

The microscope swing arm is mounted on the CP Optics base and has a 90° range of travel over the base. The zoom slider, located on the swing arm, allows you to zoom the field of view in and out. An objective lens is focused using the coarse and fine focusing knobs at the end of the swing arm. The AutoProbe CP instrument is placed directly onto the support plate of the CP Optics. You can move AutoProbe CP relative to the field of view of the CP Optics using the micrometer adjustments located on the base. These adjustments give you 5 mm of travel in the x and y directions.

To activate the CP Optics and focus on the probe tip, complete the following steps:

1. Slowly rotate the swing arm counterclockwise until the objective lens fits between the two arms of the probe head. The lens should then be positioned over the cantilever and the sample.

> ***CAUTION***
>
> A built-in stop inside the swing arm should ensure that the objective lens will stop before it hits the probe head. However, you should rotate the swing arm slowly in case the XY positioning of the probe head needs slight adjustment.

2. Click the View [On] button in the Optics section of the Move mode window.

   The sample will be illuminated with light from the CP Optics. The video monitor will brighten, displaying a blurry image.

3. Zoom out to the widest field of view by moving the zoom slider knob all the way to the right. To move the zoom slider knob, place your thumb on the slider knob and place your forefinger on the peg attached to the left side of the slider. Then squeeze your thumb and forefinger together to move the slider knob all the way to the right.

4. Adjust the coarse focus to move the objective lens up or down using the large focusing knob on the end of the swing arm. Monitor the focus adjustment by looking at the video monitor. You should see the end of the cantilever chip with a triangularly-shaped cantilever in the center of the optical view, as shown in Figure 2-17.

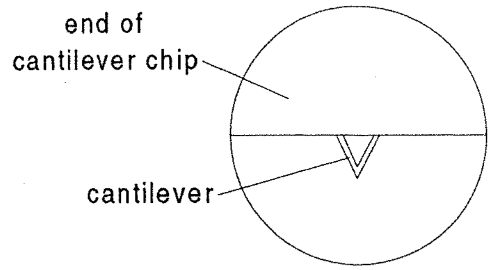


Figure 2-17. End of a cantilever chip showing the cantilever, as seen through the optical view.

> ***CAUTION***
>
> When you adjust the coarse focus of the optical view, the objective lens moves up and down. Do not drive the objective lens all the way down into the probe head! Driving the objective lens into the probe head can damage the probe head *and* the lens.

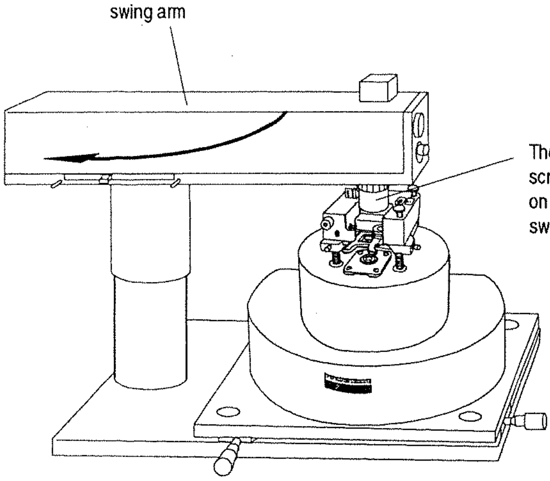
5. If the cantilever you will be using is not in the center of the field of view, you can adjust the position of the cantilever until you can see it on the video monitor. Move the cantilever chip relative to the optics' field of view by using the two micrometer adjustments attached to the CP Optics support plate. These micrometers move the entire AutoProbe CP instrument base relative to the CP Optics.

   Note: You may notice that using the micrometers causes the optical view to wobble. Because the AutoProbe CP instrument has built-in vibration isolation, moving the instrument using the micrometers creates damping effects. These effects stop when you stop moving the micrometers.

6. When you have moved the cantilever to the center of the field of view, adjust the fine focus using the small focusing knob on the end of the swing arm. Adjust the focus until the cantilever is clearly visible.

   Note: If you have a 20X or 50X objective lens in addition to a 10X objective lens, follow the instructions of Figure 2-18 to change the lens.

You are now ready to align the deflection sensor. Skip to the section "Aligning the Deflection Sensor," which describes this procedure.



1. Lift the tip off the sample using the z direction pad.
2. Rotate the swing arm towards you.
3. Unscrew the objective lens from the hole underneath the swing arm.

Figure 2-18. Instructions for changing the objective lens for the CP Optics.

Using the Separate Optical Microscope

These procedures assume that the separate optical microscope is properly assembled and that you are using the fiberoptic light source supplied with it. This section also assumes that a probe head, a chip carrier, and a sample are already loaded.

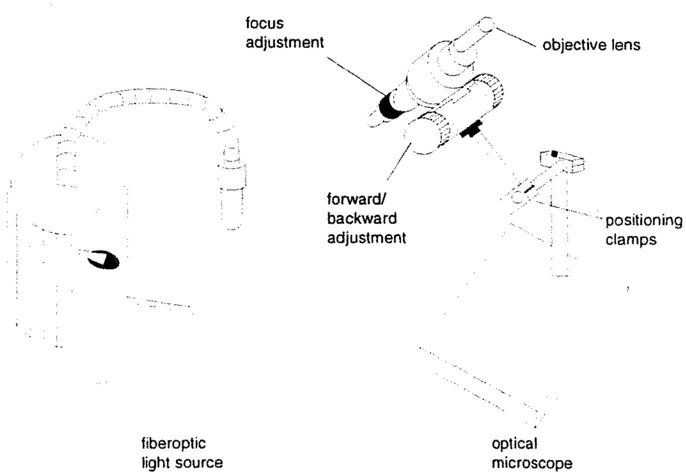


Figure 2-19. Separate optical microscope and fiberoptic light source standard with AutoProbe CP.

To focus the optical microscope on the probe tip, complete the following steps:

1. Position the fiberoptic light source so that it shines directly down on the sample, about 2 to 3 inches above the sample surface.

2. If your AutoProbe CP is in an acoustic isolation chamber, you may need to set the optical microscope on top of a book or two to compensate for the additional height of the acoustic isolation chamber.

3. Position the optical microscope so that the lens points at approximately 45° relative to the sample by adjusting the four positioning clamps.

4. Move the objective lens forward or backward along its length of travel using the two large adjustment knobs on either side of the microscope body. You should see the cantilever chip and two triangularly shaped cantilevers near the center of the field of view.

5. If necessary, shift the base of the microscope so that the cantilever chip is near the center of the field of view. Figure 2-20 below shows a 45° view of the cantilever chip, with the cantilever chip reflected off the sample surface.

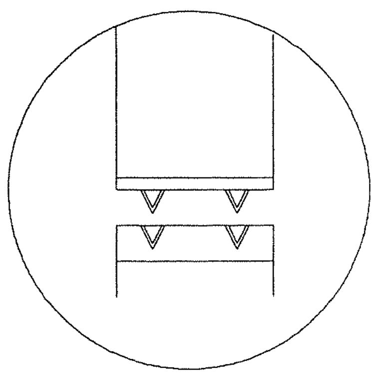


Figure 2-20. 45° view of cantilever chip, and reflection of the chip in the sample surface.

6. When the cantilever chip is in the center of the field of view, adjust the focus up or down by rotating the housing of the objective lens. Adjust the focus so that the cantilever is clearly visible.

You are now ready to align the deflection sensor. The next section, "Aligning the Deflection Sensor," describes this procedure.

Aligning the Deflection Sensor

Aligning the deflection sensor means first steering the laser beam so that it reflects off of the back of the cantilever, and then moving the position-sensitive photodetector (PSPD) so that it is aligned with the laser spot. This section describes how to align the deflection sensor. It includes two subsections, "The AFM Probe Head" and "The Multitask Probe Head." "The AFM Probe Head" describes how to align deflection sensor for AFM probe head for the standard configuration. "The Multitask Probe Head" describes how to align the deflection sensor for the multitask configuration.

Note: For the standard configuration, procedures are similar for an AFM/NC-AFM or an AFM/LFM probe head. However, the laser position and intensity indicators for all three types of probe heads are different. The procedures for aligning the deflection sensor for an AFM/NC-AFM or an AFM/LFM probe head are included in Part II of this User's Guide, *Learning to Use AutoProbe CP: Advanced Techniques.*

WARNING!

Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous laser light exposure.

How does the deflection sensor work?

The deflection sensor works by reflecting a laser beam off the back of the cantilever onto a position-sensitive photodetector (PSPD). This technique is known as "beam bounce" detection. As the cantilever bends, the position of the laser spot on the PSPD shifts. The shift in position gives a measure of how much the cantilever has been deflected.

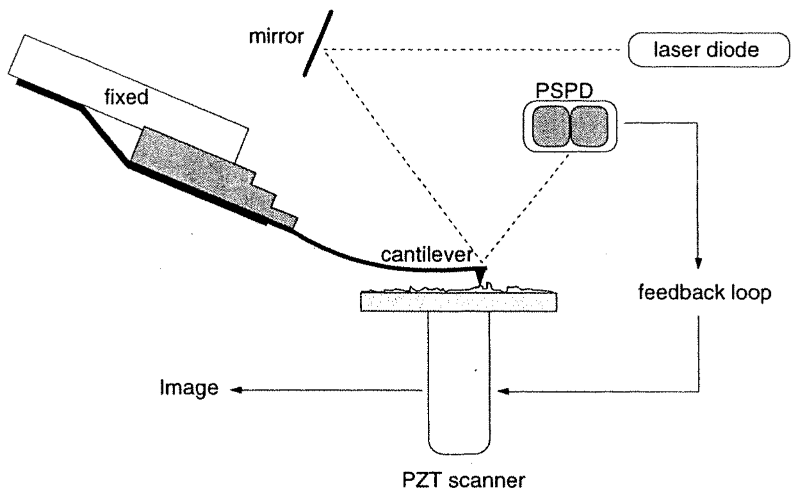


Figure 2-21. The components of the deflection sensor in the probe head.

For proper alignment of the sensor, two conditions must be met:

1. The intensity of the reflected laser beam hitting the PSPD must be above a certain level. For maximum intensity, the laser beam must hit the correct spot on the back of the cantilever tip.

2. The reflected laser beam must be centered on the PSPD. To center the laser spot, the PSPD must be correctly positioned.

The AFM Probe Head

To align the deflection sensor for the AFM probe head, follow these steps:

1. Make sure that the power to the probe head is on. If the power to the probe head is turned off, turn it on by clicking the Head ON icon, . If the LASER ON/OFF switch is in the OFF position, turn it to the ON position.

2. Focus on the cantilever using the optical view as described in the section "Using the Optical View" earlier in this chapter.

3. If the laser beam is not reflecting off the back of the cantilever tip, then you need to adjust the position of the laser beam. The controls for adjusting the laser beam position are pictured in Figure 2-22.

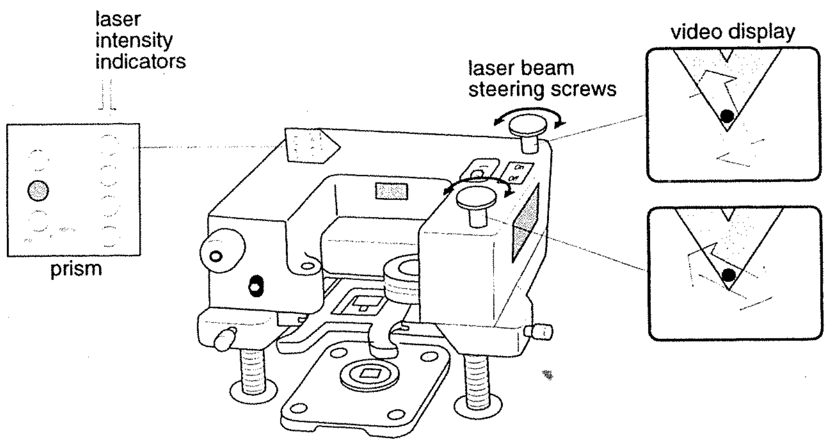


Figure 2-22. Adjusting laser intensity using the laser beam steering screws.

4. Using the two laser beam steering screws, move the laser until you can see a red reflected spot on the back of the cantilever tip.

   Note: Don't try to maximize the brightness of the laser spot you see in the optical view. Your goal is to produce the maximum amount of reflected light hitting the PSPD. When the spot is positioned so that most of the laser beam is reflected onto the PSPD, the laser spot on the back of the cantilever is not necessarily bright.

The laser intensity incident on the PSPD can be monitored by viewing the laser intensity indicator, which is the right-hand column of four lights. All four lights are red. The lights turn on from the bottom up with increasing incident laser intensity. If fewer than three red lights are lit, you must use the laser beam steering screws to adjust the position of the laser beam hitting the cantilever.

5. While watching the column of red lights, make *small* adjustments to the laser position by turning first one and then the other steering screw. Adjust both screws so that 3 or 4 red lights are lit. Only small adjustments to the beam steering should be needed, since the system is very sensitive.

The position of the laser spot on the PSPD can be monitored by viewing the laser position indicator, which is the left-hand column of three lights pictured in Figure 2-23. The center light is green, and the upper and lower lights are red. All three lights are digital. If the laser is correctly positioned on the PSPD, then the center green light will be on. The upper and lower red lights indicate the adjustment direction for the PSPD.

6. Look at the laser position indicator to see if the green light is lit. If the green light is not lit, then you need to adjust the position of the PSPD.

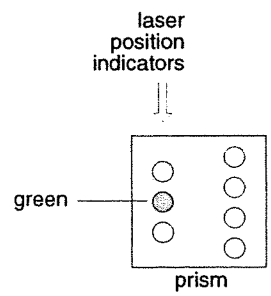


Figure 2-23. Laser position indicator.

7. The controls for adjusting the position of the PSPD are pictured in Figure 2-24. Using the small allen wrench supplied with AutoProbe CP, adjust the position of the PSPD forward/backward adjustment screw until you see the green light. You may also turn the PSPD forward/backward adjustment screw by hand if you prefer.

   - When the *lower* red light is on, turn *clockwise.*
   - When the *upper* red light is on, turn *counterclockwise.*

Turn the screws until the green light is lit. At the optimum position, only the green light should be on.

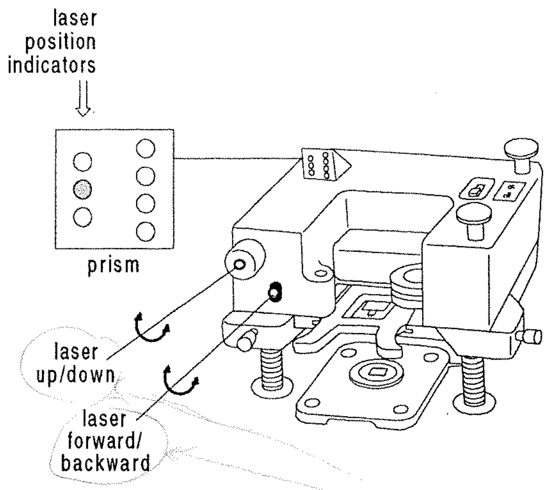


Figure 2-24. Adjusting the PSPD position using the PSPD adjustment screws.

Again, only small adjustments should be needed, since the system is very sensitive to these adjustments.

8. After adjusting the forward/backward position of the PSPD to obtain a green light, check the laser intensity indicator again. If you see only one red light or no red light, turn the PSPD up/down adjustment screw until you see 3 or 4 red lights.

When the green light is on and 3 or 4 red lights are lit, the deflection sensor is properly aligned.

You are now ready to move on to Chapter 3, which describes how to configure the system software, perform an approach, and take an image. The last section of this chapter explains how to end your AutoProbe session if you would like to stop for now and continue with the tutorials at a later time.

The Multitask Probe Head

The following steps describe how to align the deflection sensor for the multitask probe head. To align the deflection sensor, you must first steer the laser beam so that it reflects off of the back of the cantilever. Then, you move the position-sensitive photodetector (PSPD) so that it is aligned with the laser spot. To align the deflection sensor for the multitask probe head, follow these steps:

1. Make sure that the power to the probe head is on. If the power to the probe head is turned off, turn it on by clicking the Head ON icon, . If the LASER ON/OFF switch is in the OFF position, turn it to the ON position.

2. Set the AFM/STM switch of the multitask probe head to the AFM position. This configures the probe head for operation in contact-AFM mode. For contact-AFM mode, the LFM/NC-AFM switch must be set to the LFM position.

3. Focus on the cantilever using the optical view as described in the section "Using the Optical View" earlier in this chapter.

4. If the laser beam is not reflecting off the back of the cantilever tip, then you need to adjust the position of the laser beam. The controls for adjusting the laser beam position are pictured in Figure 2-25.

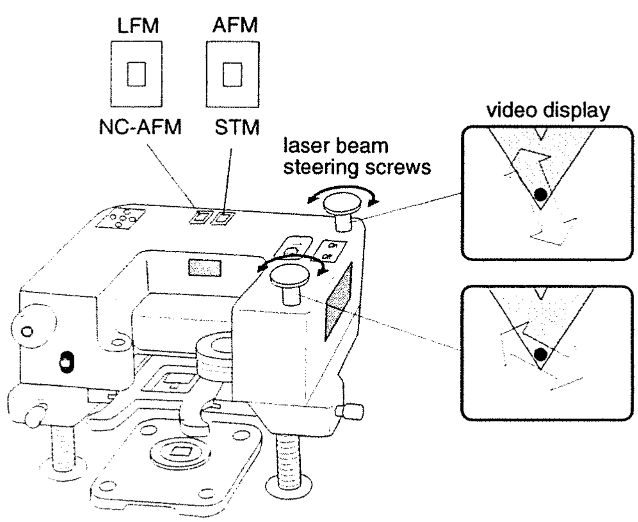


Figure 2-25. Aligning the laser spot on the end of the cantilever.

To steer the laser spot, adjust the laser beam steering screws. Figure 2-25 shows the direction the laser spot moves when you turn the laser beam steering screws. You may need to turn both screws at the same time. Move the laser until you can see a red reflected spot on the back of the cantilever tip.

After you have aligned the laser spot on the end of the cantilever, you no longer need to move the laser beam. Now, you are ready to move the PSPD so that its center is aligned with the laser spot.

5. Adjust the position of the PSPD to align the laser spot with the center of the PSPD. The laser position indicator has five lights. Four lights are red and one light is green. The green light is at the center of the indicator. When the PSPD is correctly positioned, the center green light is on. When the PSPD is *not* correctly positioned, one or more red lights will be on. Figure 2-26 shows how the PSPD adjustment screws move the PSPD.

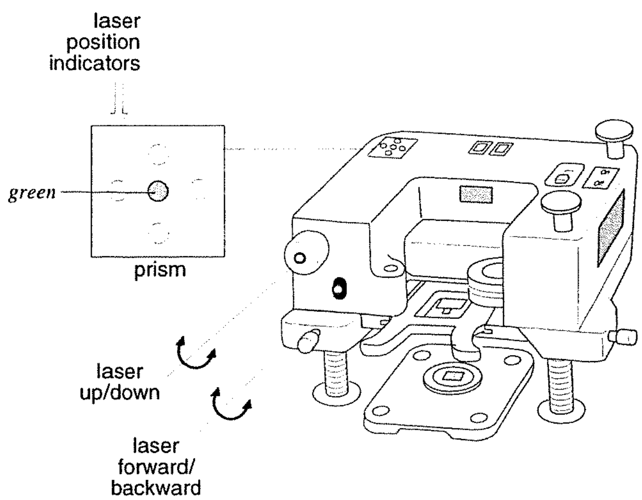


Figure 2-26. Adjusting the PSPD position up/down and forward/backward.

When the back or front red light is on, adjust the PSPD forward/backward screw. For the back red light, rotate the screw counterclockwise (CCW). For the front red light, rotate the screw clockwise (CW).

When the left or right red light is on, adjust the PSPD up/down screw. For the left red light, rotate the screw clockwise (CW). For the right red light, rotate the screw counterclockwise (CCW).

After making adjustments to the up/down position, you may need to readjust the forward/backward position, and vice versa. Near the correct position, the red lights are very sensitive and you may find it difficult to position the PSPD so that all of the red lights stay off.

You are now ready to move on to Chapter 3, which describes how to configure the system software, perform an approach, and take an image, If you'd like to stop for now and continue your AutoProbe session at a later time, go to the next section, "Ending Your AutoProbe Session."

Ending Your AutoProbe Session

To end your AutoProbe session, complete these steps:

1. Exit ProScan by selecting Exit from the File menu. The Exit menu item is only enabled when the power to the probe head is turned off.

   If the power to the probe head is turned on, turn it off now by clicking the Head ON icon, , and setting the Laser On/Off switch to the Off position.

   > *CAUTION*
   >
   > Be sure to move the sample away from the probe using the z direction pad before turning off the power to the probe head.

2. A message box will appear reminding you to close any open PSI DVMs (PSI Digital Voltmeter windows). Since you have not opened any DVM windows in this working session, just click the OK button. A DVM window is a software tool that is described in Part III, Chapter 1 or this User's Guide.

3. On the taskbar, you should see the AutoProbe SPM Controller button. Right-click this button once to view its pop-up menu, then select Close from the menu.

   Note: If you do not see the AutoProbe SPM Controller button, hold down the `[Alt]` key on your keyboard. While holding down the `[Alt]` key, press and release the `[Tab]` key until the AutoProbe SPM Controller window is displayed on the screen. Click the Close button, ☒, at the top right of the window.

4. A message box appears asking you if you would like to Abort, Retry, or Ignore. Click the Abort button to close the AutoProbe SPM Controller.

You may need to reboot your computer after an abnormal termination of ProScan Data Acquisition.

To reboot the computer, you can do one of the following:

- Press `[Ctrl] [Alt] [Delete]` simultaneously on your keyboard to restart the system.
- Press the "Reset" button on the front of your computer.
- Turn the computer off and then on using the OFF/ON switch on the front of the computer unit.

Where to Go from Here

Now you should be familiar with the procedures for setting up the instrument to take an image:

- You can move the probe in x, y, and z.
- You can install a probe head and a scanner.
- You can load a sample on the sample holder.
- You can load a chip carrier and probe cartridge on the probe head.
- You can use the instrument's optics.
- You know how to align the deflection sensor.

At this point, you can continue on with the next tutorial, or you can end your session and come back to the instrument later. You don't need to remove the probe cartridge. If you like, you may also leave your sample loaded on the sample holder.

The tutorial in the next chapter will show you how to configure the system software, approach the sample, and take an AFM image. In Chapter 4, you will learn more about the controls of ProScan Data Acquisition software.

Chapter 3
Taking an AFM Image

Introduction

In Chapter 2, you learned how to set up your system for taking an AFM image. This chapter guides you through configuring the system software, approaching the sample, and taking an image.

In Chapter 4, you will learn how to set and optimize scan and feedback parameters, explore different areas on the sample surface, and save, delete, and retrieve image files.

Note: Throughout this chapter, the text refers to the standard system configuration of AutoProbe CP. Procedures are similar for the multitask system configuration unless otherwise noted.

Before You Begin

This chapter assumes you have already read Chapter 1, "AutoProbe CP Basics," and Chapter 2, "Setting Up to Take an Image." Chapter 1 introduces you to AutoProbe CP. Chapter 2 includes information on how to start AutoProbe CP and how to load a probe head, a scanner, a sample, and a probe.

This chapter also assumes that the probe is positioned over the sample, ready for an auto approach, and the deflection sensor is aligned. It also assumes that your sample is the calibration grating provided with your system. Using a calibration grating is recommended because the features of a grating are relatively easy to identify. For the multitask head, the AFM/STM switch should be in the AFM position and the LFM/NC-AFM switch should be in the LFM position. If this is not the case, follow the instructions in Chapter 2 to set up the instrument for taking an image.

WARNING!

This instrument contains a laser. Use of controls or adjustments or performance of procedures other than those specified herein could result in hazardous laser light exposure.

Configuring the Software

The procedures for configuring the system software prompt the instrument to load files that correspond to the installed hardware. For example, files containing information about the probe head, the scanner, the probe, and the mode of operation are loaded. When you configure the system software, you are selecting the files that will be loaded.

This section describes how to configure the system software for operation in contact-AFM mode.

1. If the power to the probe head is turned on, turn it off now by clicking the Head ON icon, , and setting the LASER ON/OFF switch to the OFF position.

2. Select the Configure Parts menu item of the Setup menu. Alternatively, click the Configure Parts icon, . The ProScan Database Configuration dialog box will open.

   Note: The Configure Parts menu item (or, alternatively, the Configure Parts icon) is only enabled if the probe head is turned off. When the probe head is turned back on, the system is prompted to load files pertaining to the installed hardware and mode of operation. Therefore, enabling the Configure Parts menu item only when the probe head is turned off ensures that files are updated before an image is taken.

3. Configure the system software for taking an AFM image. To do this, make the following selections in the ProScan Database Configuration dialog box:

   For the standard configuration:

   - Head type: Select the file that names the type of probe head you are using. For the AFM probe head, you select AFMSTM.
   - Scanner: Select the file that has the scanner calibration values for the scanner you are using.
   - Head mode: AFM (selects AFM mode).
   - Beam bounce cantilever: Select the file that corresponds to the cantilever you are using. For example, you would select "UL06B" if you are using the B cantilever of a contact AFM Ultralever.
   - Electrochemistry ON/OFF: OFF.
   - Voltage mode: HI (selects a high-voltage mode of scanning).

   Note: AFMSTM is selected because the AFM probe head can be upgraded to include STM mode, thereby making the probe head an AFMSTM probe head.

For the multitask configuration:

- Head type: Select the file that corresponds to the positions of the switches on top of the multitask probe head. For this tutorial, the AFM/STM switch should be set to the AFM position, and the LFM/NC-AFM switch should be set to the LFM position for operation in contact-AFM mode. Select the file that reads AFMLFM in the software.
- Scanner: Select the file that has the scanner calibration values for the scanner that you are using.
- Head mode: AFM (selects AFM mode).
- Beam bounce cantilever: Select the file that corresponds to the cantilever you are using. For example, you would select "UL06B" if you are using the B cantilever of a contact AFM Ultralever.
- Electrochemistry ON/OFF: OFF.
- Voltage mode: HI (selects a high-voltage mode of scanning).

After you finish entering these selections, click the OK button to return to the Move mode window.

The software is now configured for taking an AFM image.

Approaching the Sample

This section teaches you how to perform a tip-to-sample approach to lower the probe tip and bring it into contact with the sample. Once contact has been made, you will be ready to take an image.

Setting Up for an Auto Approach

To set up for an auto approach, follow these steps:

1. Before you can set up for an auto approach, the power to the probe head and the power to the laser inside the probe head must be turned on. To turn on the power to the probe head and the laser, do the following: 1) select Head ON from the Mode menu or click the Head ON icon, ; and 2) turn the LASER ON/OFF switch of the probe head to the ON position.

2. Bring the cantilever into the optics' field of view.

3. Focus on the sample.

4. Use the z direction pad to lower the probe until it is within a few millimeters of the sample surface. The farther the probe tip is from the sample, the longer the auto approach process will take.

   Note: If you are using CP Optics and the optics are focused on the sample, you can lower the probe head until the cantilever is almost in focus, but not in focus. At this point the cantilever will be close to, but not touching, the sample surface.

> ***CAUTION***
>
> Be careful not to lower the probe head too far. If the probe tip hits the sample surface, both the probe tip and the sample will be damaged.

Performing an Auto Approach

To perform an auto approach, follow these steps:

1. Check the alignment of the deflection sensor by looking at the laser position and intensity indicator on the probe head. If realignment is necessary, follow the procedures of the section "Aligning the Deflection Sensor" in Chapter 2.

2. Click the [Approach] button in Move mode to initiate an auto approach.

The first noise you hear is the system lifting the tip before the approach. Then, the system decreases the tip-to-sample spacing. The auto approach stops when the force on the cantilever matches that represented by the set point value displayed in Image mode.

Note: The set point parameter is described in Chapter 4. For now, there is no need to change the set point parameter—its default value can be used. In Chapter 4, you will learn more about how to select a value for the set point parameter.

If the sample surface is in focus on the video monitor, then you will see the cantilever come into focus as the probe is brought into contact with the sample during the auto approach. A green indicator light at the top of the screen in Move mode flashes during the auto approach process. When the approach is complete, the green light stops flashing.

When the tip has made contact with the sample surface, you are ready to take an image. If you have difficulty performing an auto approach, the next section provides troubleshooting tips.

> ***CAUTION***
>
> If you plan to turn off the probe head after the tip and sample are in contact, remember to raise the probe head first. When the probe head is turned off, the z feedback loop is disabled. Both the probe and the sample can be damaged if the probe head is turned off while the tip and sample are in contact.

Troubleshooting Tips

This section lists some common problems that can make it difficult to align the deflection sensor, or that can cause the sensor to become misaligned. The deflection sensor must be properly aligned before an auto approach can be performed successfully. Here are some common problems that can cause misalignment of the deflection sensor and their solutions.

The cartridge is not properly inserted in the probe head. Wiggle the cartridge in and out to make sure that all three contact zones are engaged by the three balls on the cartridge. You should be able to feel when the cartridge is correctly positioned over the contact zones.

The chip carrier is not properly inserted in the cartridge mount. Remove the cartridge from the head. Then wiggle the chip carrier from side-to-side to make sure that all three balls on the cartridge mount are engaged by the three slots on the chip carrier. You should be able to feel the chip carrier click into place.

The cantilever tips are broken. You should be able to see if the cantilever tips have broken off by using the optical view. If the tips are broken, replace the chip carrier.

The laser power is not on. Check that the LASER ON/OFF switch of the probe head is in the ON position. The switch is lit red when in the ON position. If the laser is not switched on, switch it on now.

If none of these problems is causing the misalignment, and you still cannot perform an auto approach, you need to realign the laser beam to maximize the intensity of the reflected beam and to center the laser spot on the PSPD. Refer to the section "Aligning the Deflection Sensor" in Chapter 2.

The software generates an A-B or A+B nulling range error message. If the "nulling range" error message appears in the Message log at the bottom of the window after you align the deflection sensor and attempt an auto approach, then the PSPD may have become misaligned during the approach. If you are using a highly reflective sample such as the gold grating, this misalignment during the approach may be caused by extraneous reflections of laser light hitting the PSPD.

A+B signal

First, try rotating the sample. This changes the angle of reflection of the laser light off of the sample. After rotating the sample, make sure that the deflection sensor is aligned and try the auto approach again.

If you are still having problems, you can use a Digital Volt Meter window (a DVM window) to optimize the position of the PSPD. DVM windows can be used to check instrument signals, such as the signal representing the difference between voltages from the two halves of the bi-cell PSPD. This signal, called "A-B," should be small (on the order of tens to hundreds of millivolts) when the PSPD is properly aligned with the laser spot.

A-B Signal

To check the A-B signal, follow these steps:

1. Open a DVM by clicking the DVM icon, .

2. Click the CH button on the DVM to see a selecti select "A-B." The display of the DVM will show given in volts or millivolts depending on the value.

3. Adjust the PSPD forward/backward screw to move the PSPD until the absolute value of the A-B signal is less than 300 mV. The laser spot should now be centered between the A and B halves of the PSPD.

4. Once you have minimized the A-B signal, close the DVM and click the Approach button. The approach should work.

You can also use a DVM to check the intensity of the reflected laser beam on the PSPD. This signal, called "A+B," should have a value greater than 1 V when the intensity of the laser is optimized. After optimizing the A+B signal, you may again check that the A-B signal, representing the position of the PSPD, is optimized. The position of the PSPD is optimized when the A-B signal is less than 300 mV.

To check the A+B signal, follow these steps:

1. Open a DVM by clicking the DVM icon, .

2. Click the CH button on the DVM to see a selection of channels, or signals, and select "A+B." The display of the DVM will show the value of the A+B signal, given in volts or millivolts depending on the value.

3. Adjust the PSPD forward/backward screw and/or laser beam steering screws to move the laser until the value of the A+B signal is greater than 1 V.

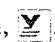
4. Close the DVM and click the Approach button. The approach should work.

Taking an AFM Image

You are ready to take an AFM image using AutoProbe CP.

1. If you have not already done so, place the cover over the instrument. Covering or closing the instrument helps block acoustic and electrical noise.

> ***CAUTION***
>
> It is recommended that you place the metal cover on the CP base unit while imaging, as this preserves EMC immunity,

2. Switch to Image mode now by clicking the Image Mode icon, . The Image mode window is shown in Figure 3-1, below.

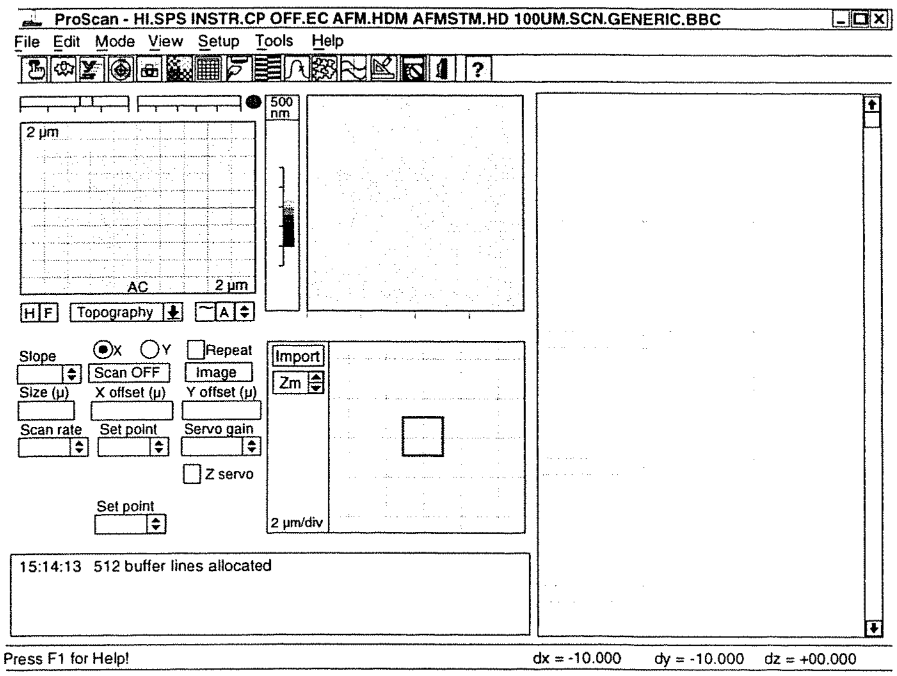


Figure 3-1. The Image mode window.

3. The Topography signal (i.e. the signal representing surface topography) should be displayed on the Oscilloscope Display. The Signal Name listbox underneath the Oscilloscope Display lists the signal that is currently being monitored. Topography should appear by default. If you do not see the signal trace on the Oscilloscope Display, click the [A] (Auto Rescale) button to rescale the signal trace to fit the display.

4. To take an image, click the [Image] button.

AutoProbe will generate an image for you which will be displayed in the Active Display. Images are displayed in gray scale format. In a gray scale image, brightness corresponds to vertical height on the surface. Higher points are brighter, and lower points are darker.

When the scan is finished, the image is automatically loaded into the Image Gallery. You can see how linear the scan is by observing how perpendicular the lines of the grating are in your image.

Starting and Stopping a Scan

When a scan is in progress, the [Image] button is replaced by a [Cancel] button. At any time, you can cancel a scan that is in progress by clicking the [Cancel] button. You can save time by canceling a scan that doesn't interest you.

1. Start a scan by clicking the [Image] button. Before the scan is finished, click the [Cancel] button.

   The scan stops immediately, and the incomplete image remains frozen in the Active Display until you start a new scan.

   Note: The incomplete image will be displayed in the Image Gallery and saved on your hard disk. You can delete an image you do not wish to keep when it is displayed in the Image Gallery. For details, see Chapter 4, "Taking Better Images."

You can also start a continuous scan, one that repeats continuously, by starting a single scan and then enabling the Repeat checkbox, located above the [Image] button. Continuous scans can be useful while you are adjusting parameters.

2. Start a continuous scan now. First click the [Image] button. Before the scan is finished, click the Repeat checkbox so that it is selected.

   A continuous series of images is built up, one after the other. After each scan is finished, the image is automatically saved on your hard disk in the default directory **c:\spmdata** and displayed in the Image Gallery.

Where to Go from Here

Now you should be familiar with the procedures for taking a contact-AFM image:

- You can configure the software.
- You can perform an auto approach.
- You can take an AFM image.

At this point, you can practice lifting the tip, performing an auto approach, and taking an image. Or, you can go to Chapter 4 to learn how to optimize scan and feedback parameters, move to a new location on the sample surface, and save, delete, and retrieve images. If you'd like, you can end your AutoProbe session now and continue with the tutorials at another time.

To end your AutoProbe session, follow these steps:

1. Exit ProScan by selecting Exit from the File menu.

   If the power to the probe head is turned on, turn it off now by clicking the Head ON icon, , and setting the LASER ON/OFF switch to the OFF position.

CAUTION
Be sure to move the probe away from the sample using the z direction pad before exiting ProScan.

2. A message box will appear reminding you to close any open PSI DVM windows (digital voltmeter windows). Close any open DVMs and then click the OK button.

3. On the taskbar, you should see the AutoProbe SPM Controller button. Right-click this button once to view its pop-up menu, then select Close from the menu.

   Note: If you do not see the AutoProbe SPM Controller icon, hold down the `[Alt]` key on your keyboard. While holding down the `[Alt]` key, press and release the `[Tab]` key until the AutoProbe SPM Controller window is displayed on the screen. Click the Close button, ☒, at the top right of the window.

4. When you close the AutoProbe SPM controller window, a message box appears asking you if you would like to Abort, Retry, or Ignore. Click the Abort button to close the AutoProbe SPM Controller.

Chapter 4
Taking Better Images

Introduction

In Chapter 3, you learned how to configure the software, how to perform an auto approach, and how to take AFM images. This chapter takes you several steps further. It is designed to answer some of the questions you may have after taking an image:

- What are the scan and feedback parameters and how do I optimize them to get the best image?
- How do I take an image at a new location on the sample surface?
- How do I save, delete, and retrieve images?

After completing this tutorial, you will know techniques for taking a better image, including the following:

- how to set scan parameters and choose a reasonable range of values
- how to set feedback parameters and optimize the operation of the z feedback loop
- how to select an image size
- how to take an image at a new location on the sample surface
- how to position a follow-up scan using an image you just took
- how to use low-voltage mode and the Topo x 16 signal channel to take higher-resolution images
- how to save, delete, and retrieve images

Note: Throughout this chapter, the text refers to the standard system configuration of AutoProbe CP. Procedures are similar for the multitask system configuration unless otherwise noted.

Before You Begin

This chapter assumes you have already read Chapter 2, "Setting Up to Take an Image," and Chapter 3, "Taking an AFM Image." In Chapter 2, you learned how to start AutoProbe CP, how to load a probe head, a scanner, a sample, and a probe, and how to move the probe. Chapter 3 showed you how to configure the software, how to set up and perform an auto approach, and how to take an AFM image.

The beginning of this chapter assumes that your sample is a calibration grating. Using a calibration grating is recommended, because a grating is flat and has periodic features that make it easier to see the effects of adjusting scan and feedback parameters.

This chapter assumes that both a sample and a probe are already loaded and that you are ready to perform an auto approach. If this is not the case, follow the instructions in Chapter 2 to load a sample and a probe.

A Brief Tour of Image Mode

Image mode includes controls for setting scan and feedback parameters and taking an image. Image mode also includes an Oscilloscope Display for monitoring instrument signals. Enter Image mode by either selecting Image Mode from the Mode menu or clicking the Image Mode icon, . The Image mode window is shown in Figure 4-1, below.

Note: The Image Mode menu item, or alternatively the Image Mode icon, , is enabled only when the probe head is on. If the probe head is off, you can turn it on by either deselecting Head ON from the Mode menu or clicking the Head ON icon, .

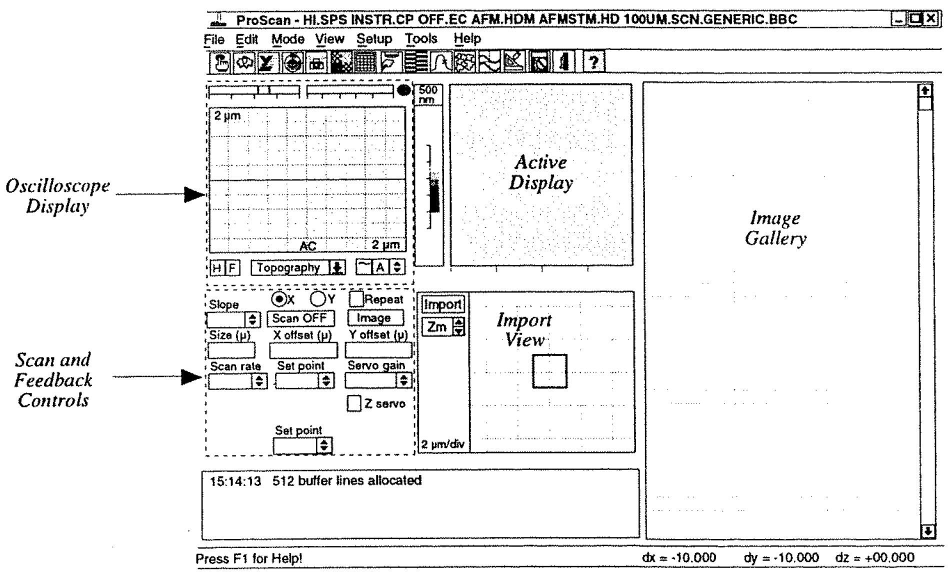


Figure 4-1. The Image mode window.

Below is a brief description of the controls on the screen and their functions.

Title Bar: The Title bar displays the file names of the files currently loaded in the software. These file names should represent the hardware components you have installed. If this is not the case, then you should reconfigure the software as described in the section "Configuring the Software" of Chapter 3.

Menu Bar: The Menu bar contains drop-down menus that contain menu items. These menu items give you access to instrument controls.

Toolbar: The Toolbar contains icons that represent the most frequently used menu items in the Menu bar.

Oscilloscope Display: The Oscilloscope Display displays in real time the signal trace as an image is built up in the Active Display. Monitoring the signal trace helps you to optimize scan and feedback parameters.

Scan and Feedback Controls: Scan controls allow you to adjust scan parameters such as the scan size and scan rate. Feedback controls allow you to adjust feedback parameters such as the set point and gain to optimize the operation of the z feedback loop. In this tutorial, you will learn how to choose reasonable values for these and other parameters.

Active Display: The Active Display is where an image is built up during a scan.

Import View: The Import View allows you to view an image imported from the Image Gallery, and then to select a scan size and scanner coordinates (scan location) for a follow-up scan. In this tutorial, you will learn how to import an image from the Image Gallery into the Import View and how to select a scan size and scanner coordinates using a green cursor box in the Import View.

Image Gallery: The Image Gallery displays newly acquired images. By default those images are saved on your hard disk. Previously saved images can also be loaded to the Image Gallery for comparison with new images. In this tutorial, you will learn how to save, delete, and retrieve image files. Saving only the most useful images will save disk space, since each image contains a large amount of data.

This tutorial is meant to give you an overview of these screen controls. It introduces the most important features and shows you how to use them. For more detailed information about specific screen controls, consult Part III, *Software Reference*, of this User's Guide. The first chapter of the *Software Reference* manual, "ProScan Data Acquisition," describes each feature of the screen individually and gives you a more detailed description of how each feature works.

Adjusting Scan Parameters

In this section, you will learn how to adjust scan parameters, such as scan size and scan rate. You will also learn how to change the scan direction and how to compensate for a slightly tilted sample by adjusting the slope in the x and y directions. The controls for scan parameters are located in the Scan and Feedback Control sections of Image mode, as illustrated in Figure 4-1. Before adjusting these scan parameters, you need to perform an auto approach and take an image.

1. Switch to Move mode by either selecting Move Mode from the Mode menu or clicking the Move Mode icon, .

2. Perform an auto approach as described in Chapter 3.

3. Switch to Image mode by either selecting Image Mode from the Mode menu or clicking the Image Mode icon, .

4. Click the Image button to take an image.

You are now ready to practice adjusting scan parameters.

Adjusting the Scan Size

The scan size refers to the scan width. Since all scans are square, you only need to enter the scan width to set the scan size for a scan.

The scan size you choose depends entirely on what features you want to see in an image and of course, on the size of your scanner. Note the following differences between the standard and the multitask configurations:

For the standard configuration's 5 μm scanner, the maximum scan size is 5 μm. When you use a 1 μm grating, a scan size of around 5 μm will allow you to see about 5 lines of grating. With a scan size of 1 μm, you may only see one line of grating.

For the multitask configuration's 100 μm scanner, the maximum scan size is 100 μm. When you use the 10 μm grating, a scan size of around 30 μm will allow you to see about three lines of the grating. With a scan size of 10 μm, you may only see one line of the grating.

To adjust the scan size, do the following:

1. Position the cursor over the number in the Size textbox and double-click to highlight that number. (Or, click and drag the cursor to select the number.)

2. Type in a new scan size in microns, and then press the `[Enter]` key on your keyboard. Alternatively, use the scrollbox arrows to scroll through a range of values. You don't need to type the "µm" units.

3. Start a new scan with this scan size by clicking the Image button.

4. Now try a smaller scan, about half as wide.

You should be able to see the change in your image. By choosing successively smaller scans, you can "zoom in" on a region of interest.

An alternative way to change the scan size involves varying the dimensions of the green cursor box in the Import View. This method is described in a later section, "Taking an Image at a New Location."

Adjusting the Scan Rate

The scan rate sets the frequency of the back and forth rastering of the sample beneath the probe and can be adjusted while you are acquiring an image. A general rule of thumb is that slower scan rates give you better resolution because the feedback system has time to respond, while faster scan rates save you time. On the other hand, if the scan rate is too fast, the feedback loop may not have time to respond to changes in topography and can result in an image that appears smeared.

The scan rate you use depends on the type of image you are taking. For AFM images of the Topography signal acquired using a scan size from 1 to 10 µm and with feedback enabled, typical scan rates are from 1 to 4 Hz.

To determine which scan rate is best to use for a particular set of scan conditions, take a scan at several scan rates. If you see no discernible difference in image quality until you reach a certain scan rate, use a scan rate that lies below the point where image quality begins to degrade.

To adjust the scan rate, do the following:

1. Position the cursor over the number in the Rate textbox and double-click to highlight the old text. (Or, click and drag the cursor to select the number.)

2. Type in a new scan rate in Hertz, and then press the [Enter] key. Alternatively, use the scrollbox arrows to scroll through a range of values. You don't need to type in the "Hz" units.

3. Start a new scan by clicking the [Image] button.

You can practice adjusting the scan rate while an image is being acquired. As you adjust the scan rate, you can monitor differences in image quality. After you determine which scan rate is best, take a new image using that scan rate.

Did you notice the gray scale of the image change immediately after the scan finished?

A feature called "Keep Level" can be turned on to prevent the gray scale from saturating while an image is being collected. It works by keeping the average gray level of each line constant. Keep Level is a menu item of the View menu and is turned on by default. You can turn Keep Level off by deselecting it from the View menu. Without leveling, if the contrast range of the gray scale is set to match the initial height range of the data, the gray scale may saturate if a taller or deeper feature is encountered later in the scan.

Keep Level only affects how the image is displayed *during a scan.* When the scan is finished, the original contrast range of the gray scale is restored.

Additionally, when a scan is finished, the computer can make various adjustments to optimize the gray scale image. To see your options for image display modes, select the Input Configuration menu item of the Setup menu. (Alternatively, click the Input Configuration icon, .) The Input Configuration dialog box will open, showing checkboxes and controls that you can use to select the image display mode.

To learn more about the Input Configuration dialog box, see Part III, *Software Reference*, of this User's Guide. The section "Input Config: The Input Configuration Dialog Box," describes what image display modes are available, when to use them, and how to turn them on or off. In Chapter 1 of the *Software Reference* manual, you will also learn how to manually adjust the gray scale using the gray scale bar.

Changing the Scan Direction

The sample is rastered under the probe in the x and y directions while an image is being acquired. In the fast scan direction, the computer collects a line of data made up of individual data points. Movement in the slow scan direction positions the probe for the next line of data.

The X and Y option buttons set the fast scan direction. When the X option button is selected, the x direction is the fast scan direction. Each line of data that builds up an image is collected horizontally and the slow scan direction is displayed vertically. When the Y option button is selected, the y direction is the fast scan direction.

Each line of data that builds up an image is collected vertically and the slow scan direction is displayed horizontally. The X option button is selected by default.

Note: When x is the fast scan direction, data are collected from left-to-right by default. When y is the fast scan direction, data are collected from bottom-to-top by default. You can reverse the direction in which data are collected, for example from left-to-right to right-to-left when x is the fast scan direction, using controls in the Input Configuration dialog box. For details, see Part III, *Software Reference*, of this User's Guide.

To change the scan direction, do the following:

1. Click the Y option button to set y as the fast scan direction.

2. To start a new scan with y as the fast scan direction, click the [Image] button.

In general, when you switch between the x and y scan directions you will not see a significant difference in your image. In some cases, though, you may be able to distinguish effects due to tip anisotropy. (Anisotropy is the condition of having different properties along different axes or directions.)

Adjusting the X and Y Slope

Slope occurs when the sample is not flat relative to the scanning plane. For instance, slope can be due to a slightly wedge-shaped sample or a crooked sample mount. By adjusting the slope in the x and y directions, you can compensate for a slight tilt, or slope, of the sample surface.

You can tell if any slope adjustment is needed by looking at the signal trace on the Oscilloscope Display. If the signal trace is tilted on the display, adjusting the slope in the x and y directions can usually remove most of this tilt.

To adjust the slope in the x and y directions, do the following:

1. Click the X option button in Image mode. This sets x to be the fast scan direction.

2. To adjust the x slope, enter a new value from -1 to 1 (arbitrary units scaled with the x, y, and z ranges of scanner motion) in the Slope scrollbox.
   Or, use the scrollbox arrows to scroll through a range of values.

   Watch the signal trace on the Oscilloscope Display while you adjust the value of the slope parameter. Continue adjusting the value of the slope parameter until the signal trace is no longer tilted.

3. Now change the fast scan direction by clicking the Y option button. When the Y option button is selected, the y direction is the fast scan direction.

4. To adjust the slope in the y direction, enter a new value from -1 to 1 (arbitrary units scaled with the x, y, and z ranges of scanner motion) in the Slope scrollbox. Or, use the scrollbox arrows to scroll through a range of values. Watch the signal trace on the Oscilloscope Display and continue adjusting until the signal trace is no longer tilted.

   Note: In order to adjust the slope in either the x or y direction, you must first make that direction the fast scan direction. You can compensate for a diagonally slanted sample by adjusting the slope parameter for both the x and y fast scan directions.

5. If desired, switch the fast scan direction back to the x direction by clicking the X option button.

6. To start a new scan, click the Image button.

If you saw a lot of slope in the "before" image, your "after" image should now look better (less tilted).

Note: There are several ways to compensate for sample slope. Adjusting the slope value can remove slight tilt before a scan is started. Another way to remove tilt is to turn on Auto Flat in the Input Configuration dialog box. In general, Auto Flat should be turned on, unless the actual slope of the surface is important in your results analysis. For more information about the Auto Flat feature, see the section "Input Config: The Input Configuration Dialog Box" in Chapter 1 of the *Software Reference* manual. Chapter 2 of the *Software Reference* manual describes ProScan Image Processing, which includes computer fitting routines that also allow you to remove slope from an image. See Chapter 2, "ProScan Image Processing," of the *Software Reference* manual for details.

Adjusting Feedback Parameters

This section introduces the z feedback loop. You will learn about controlling the gain parameter and adjusting the set point parameter (i.e., the reference cantilever deflection for AFM imaging). The controls for feedback parameters are located in the Scan and Feedback Controls section of Image mode, as illustrated in Figure 4-1.

Optimizing the Gain

To get the best images, the gain parameter needs to be optimized for each set of scan conditions. If the gain is set too low, fine topographical features do not show clearly in an image. On the other hand, if it is set too high, the system oscillates.

The procedure for checking that the gain is set to an optimal value is simple. First, you start with the gain set to a low value. Then, you gradually increase the value until the system is on the brink of oscillation.

> ***CAUTION***
>
> If you allow the system to oscillate too severely, the probe and the sample may be damaged.

Figure 4-2 below shows the signal trace on the Oscilloscope Display. The first panel shows oscillation superimposed on the signal trace. The second panel represents surface topography of a calibration grating with feedback optimized.

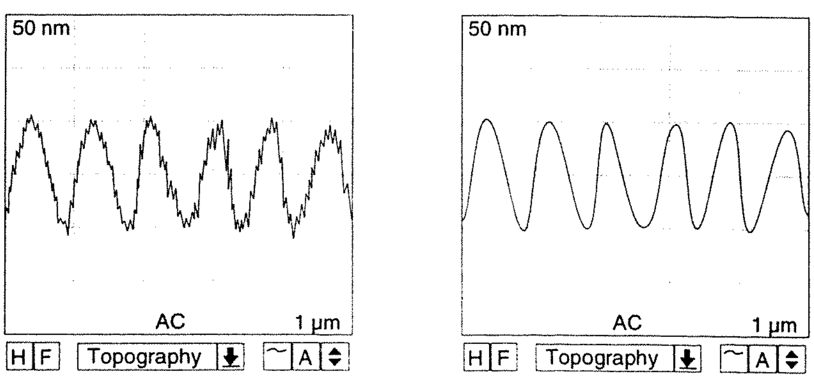


Figure 4-2. The signal trace on the Oscilloscope Display.

z filter 153
signal set up required

To see the effect of lowering the gain:

1. In Image mode, lower the gain incrementally by clicking the down scrollbox arrow of the Gain scrollbox. The gain value will decrease in 0.001 increments.

As you lower the gain, watch the signal trace on the Oscilloscope Display. You should see the contours of the calibration lines on the grating become gradually blurred, or less defined.

CAUTION

Do not lower the gain value all the way to zero. When the gain is set to zero, the feedback loop is disabled, and the system will not track changes in surface features. If the feedback is completely disabled, the tip can be damaged if the sample surface is very rough. For STM operation, some finite feedback response is needed to prevent the tip from crashing into the sample.

When the gain is set to a low value, the feedback loop is disabled and therefore cannot track surface topography. In Chapter 1 of the *Software Reference* manual, you will learn how to take an image in constant-height mode, with feedback minimized. For constant-height mode, an image is generated from the Error signal, which represents the cantilever deflection (for AFM imaging) as it changes in response to the surface topography.

2. Now raise the gain until the system begins to oscillate. Increase the gain value incrementally by clicking the up scrollbox arrow of the Gain scrollbox. Stop when you begin to see oscillations appearing on the Oscilloscope Display, superimposed on the signal trace of the grating.

As you increase the gain from a low value, first you will see the contours of the grating lines reestablished on the Oscilloscope Display. As the gain is increased further, oscillations appear superimposed on the signal trace of the grating. See Figure 4-2.

3. Lower the gain until the oscillations disappear. The gain value is now optimized.

When you optimize the gain parameter for a scan, you will find that a range of acceptable values exists, rather than a specific, fixed value.

When the scan conditions change, you should check that the gain parameter is still optimized. If you start to see oscillations, lower the gain until the system is just below the oscillation point. You should also check that the gain is set high enough to track the sample topography.

How does z feedback work?

When the feedback loop is optimized, the scanner's motion matches surface topography. The z feedback loop operates to keep the cantilever deflection constant by adjusting the z position of the probe. The hardware components and signal pathways for AFM operation are shown in Figure 4-3.

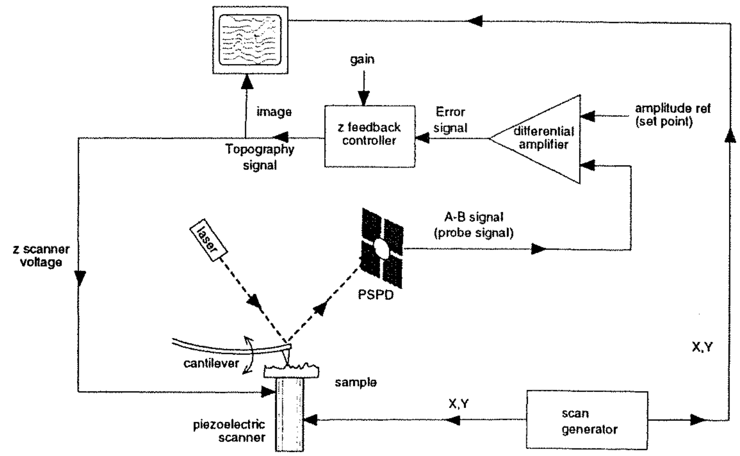


Figure 4-3. Hardware components and signal pathways for AFM operation.

The cantilever deflection is compared to the set point value in the Set Point scrollbox (the reference value for the z feedback loop) and an Error signal is generated. The Error signal is sent to the feedback electronics, which generate a feedback voltage. This feedback voltage controls the scanner tube, causing it to extend or retract. The probe is moved toward or away from the sample and a constant cantilever deflection is maintained. For AFM, the feedback signal can be used to generate an image of sample topography.

The gain parameter controls how much the Error signal is amplified before being used to generate the feedback signal. Higher gain values mean that the feedback loop is more sensitive to changes in cantilever deflection. Surface features can then be tracked more closely. However, if the gain is set too high, the feedback signal will fluctuate too strongly in response to small changes. As a result, the system will oscillate. You will be able to see these oscillations in the signal trace displayed on the Oscilloscope Display.

The optimal value of the gain parameter depends on a number of factors, including the scan rate, scan size, and the sample topography. You should check that the gain parameter is optimized for each scan, and adjust it as needed. To learn more about the z feedback loop, see Chapter 1 of the *Software Reference* manual, "ProScan Data Acquisition."

In addition to adjusting the gain, you should also adjust the set point. Adjusting the set point is described in the following section.

Adjusting the Set Point

The set point sets the amount of cantilever bending, or deflection, during a scan. When the z feedback loop is enabled, the system operates to keep the set point constant by either extending or retracting the scanner a short distance toward or away from the sample.

The optimal value of the set point parameter depends on a number of factors, including what sample you are looking at. If you notice horizontal streaking in an image, the set point is too high and you are dragging "dirt" (unidentified particles, material, etc.) around on the sample. If you still see streaking after reducing the set point value, your sample is probably too soft to examine using contact AFM. You can adjust the set point while a scan is in progress so that you can immediately see its effect.

Note: Controls in the Scan Configuration dialog box allow you to take images simultaneously with different set points. For details see Chapter 1 of the *Software Reference* manual, "ProScan Data Acquisition."

To adjust the set point, do the following:

1. Position the cursor over the number in the Set Point scrollbox and double-click to highlight the old value. (Or, click and drag the cursor to select the number.)

2. Type in a new set point value and then press the `[Enter]` key. Alternatively, use the scrollbox arrows to scroll through the range of values. The units used to display the set point depend on how your system is calibrated. Typically, the set point is displayed in units of µm (microns).

   Note: You can change the units used to display the set point in the Servo Unit dialog box. For more information, refer to Chapter 1 of the *Software Reference* manual, "ProScan Data Acquisition."

3. Start a new scan by clicking the Image button. Try adjusting the set point while a scan is in progress, so you can immediately see its effect.

Selecting a Number of Data Points

When you take an image, you can choose the number of data points contained in an image. You can choose amongst 64 x 64, 128 x 128, 256 x 256, or 512 x 512. You select a number of data points in the Scan Configuration dialog box, which is displayed when you select Scan Config (Configuration) from the Setup menu. Alternatively, you can click the Scan Config icon, ☰, to open the dialog box. A 256 x 256 image is selected by default.

In general, a larger number of data points gives you higher lateral resolution than a smaller number of data points. For example, for the same scan size, a 512 x 512 image contains 64 times the number of data points as a 64 x 64 image and therefore has a higher lateral resolution. However, collecting a 512 x 512 image takes more time.

Note: An efficient way to increase the lateral resolution of an image is to zoom in on a smaller region and then take a scan. This increases the number of data points per scan size. See the section "Taking an Image at a New Location" in this chapter for details.

To select a number of data points, do the following:

1. From the Setup menu, select Scan Config. Alternatively, click the Scan Config icon, ☰. The Scan Configuration dialog box will open.

2. Select a new number of data points by clicking the option button that corresponds to the number you want to use, and then click the [OK] button to close the dialog box. For example, if you want to take a 512 x 512 image, click the 512 x 512 option button.

3. To start a scan using the selected number of data points, click the [Image] button.

Try taking images using several different numbers of data points to see what results.

Taking an Image at a New Location

This section shows you how to take an image at a new location on the sample surface. There are two ways to take an image at a new location on the sample:

- coarse positioning of the probe using the x and y translation screws of the XY stage
- fine positioning of the scanner using the green cursor box in the Import View

When you move the probe using the screws of the XY stage, the range of motion can be on the order of millimeters. When you move the scanner using the green cursor box in the Import View, the range of motion is on the order of micrometers or angstroms.

The section "Controlling the XY and Z Stages" in Chapter 2 describes how to coarsely position the probe to select a location on the sample for imaging. This section describes how to select a scan size and scanner coordinates (scan location) for a follow-up scan using the green cursor box in the Import View.

The Import View allows you to position a follow-up scan using an image you recently took. First you transfer a recent image from the Image Gallery into the Import View. Then you resize and move the green cursor box around in the image to select a new scan size and a new scan location.

To use the Import View to position a follow-up scan, do the following:

1. Take an AFM image as you normally do.

2. Transfer the current image from the Image Gallery into the Import View by selecting the image in the Image Gallery and then clicking the Import button in the Import View.

The green cursor box at the center of the Import View will enclose the imported image. The imported image won't completely fill the display. The labeled components of the Import View are shown in Figure 4-4, below.

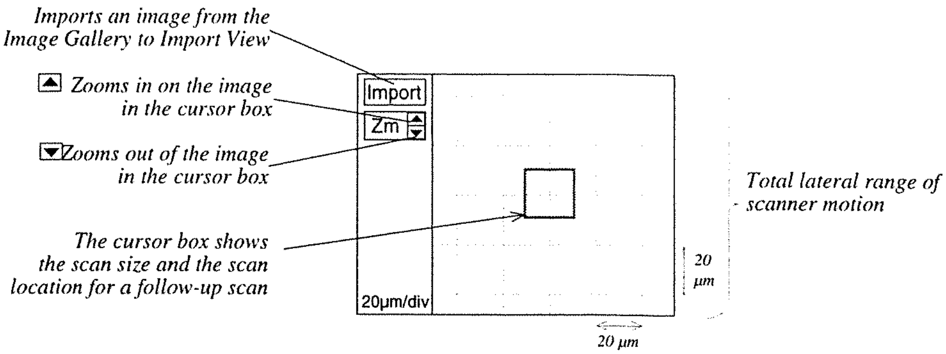


Figure 4-4. The Import View.

The Import View can show up to a 5 µm range of motion (for the standard configuration's 5 µm scanner) or a 100 µm range of motion (for the multitask configuration's 100 µm scanner). The units per division of the Import View are indicated in the lower-left corner of the display. The size of a displayed image is proportional to its scan size, and the position of a displayed image corresponds to its scanner coordinates, which represent scan location. The scanner coordinates are referenced to the scanner's undeflected, or home, position.

You can zoom in or out on the image in the Import View by clicking the Zm [△] or Zm [▽] button to the left of the display, respectively.

3. Zoom in on the scanner's range now by first clicking the [Zm] button, and then successively clicking the Zm [△] button.

As you zoom in, the units per division of the display panel change.

4. Zoom back out again by successively clicking the Zm [▽] button.

Next you will select a region in the image for a follow-up scan. To select a region for the next scan, you vary the dimensions of the green cursor box and then drag it to a new location in the image, as shown in Figure 4-5.

5. To change the size of the green cursor box, position the cursor near any corner of the green cursor box. The cursor will change to a bi-directional arrow, ↘ or ↗. Click and drag the corner until you reach the desired scan size. Select a scan size that lies within the displayed image.

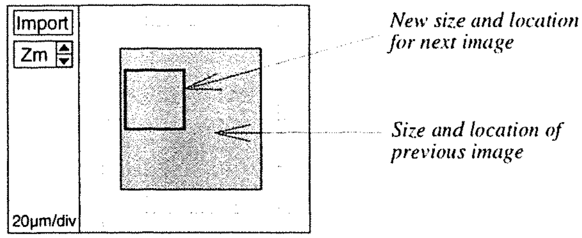


Figure 4-5. Changing the size and location of the green cursor box.

After you resize the green cursor box, the new scan size is displayed in the Size textbox.

6. To drag the green cursor box to a new location, position the cursor near the center of the green cursor box. The cursor will change to a four-way arrow, ✥. Click and drag the green cursor box until you reach the desired scan location. Position the green cursor box within the displayed image.

After you reposition the green cursor box, the scanner coordinates displayed in X Offset and Y Offset textboxes are updated.

7. Now start a new scan by clicking the [Image] button.

The new image will be built up in the Active Display. Using the cursor box in the Import View, you can successively decrease the scan size to zoom in on a feature of interest.

Note: You can also select a wider region than the previous scan. To learn more about the Import View, see the section "Import View" in Chapter 1 of the *Software Reference* manual.

Taking Images in Low-Voltage Mode

Both a high-voltage mode and a low-voltage mode are available when you use AutoProbe CP. High-voltage mode allows you to image micron-size features on the sample surface. Low-voltage mode allows you to take scans with smaller scan sizes, and to image smaller features, such as atoms, without losing lateral resolution.

High-voltage mode applies the full voltage range to the scanner to produce xy and z motion and is most often used for scan sizes in the micron range. The maximum scan size in high-voltage mode represents a scanner's available range of motion. For example, the maximum xy range of a 100 µm scanner is about 100 µm. The maximum z range of a 100 µm scanner is about 8 µm, which is the maximum height variation the scanner can respond to.

Low-voltage mode uses only a portion of the scanner's full xy, and z range and is generally used for smaller scans on the order of tens to hundreds of angstroms. The range of xy motion is reduced to approximately one fourth of its full range, and the range of z motion is reduced to approximately one third of its full range. For example, the xy range of a 100 µm scanner is reduced to about 25 µm, and the z range is reduced to about 2.5 µm.

This section explains why low-voltage mode is important for obtaining improved lateral resolution with smaller scan sizes and gives step-by-step instructions for switching from high to low-voltage mode.

CAUTION

The z scanner ranges in high and low-voltage modes do not overlap (the scanner's z range in low-voltage mode is more extended). To avoid damage to the probe tip and sample when you select low-voltage mode, you must raise the Z stage a short distance using the z direction pad to keep the probe tip clear of the sample surface.

For CP systems, be sure to move the optics out of the way to protect the objective lens before you raise the Z stage. Move the optics by rotating the swing arm away from the probe head.

Why You Need Low-Voltage Mode: Lateral Resolution

Low-voltage mode can be useful when you want to look at smaller features on your sample. Without low-voltage mode, you would not be able to obtain the highest lateral resolution for small scan sizes, below about 500 Å.

The main factors limiting the lateral resolution of your images are the following:

- the scan size divided by the number of data points per scan line
- the effective tip radius
- the x-y detector resolution (if ScanMaster is enabled)
- the digitized step size of the scanner in the fast scan direction

The scan size divided by the number of data points per scan line is one factor that limits the lateral resolution. If a 10 µm image is taken with 256 x 256 data points, then one data point is taken every 10 µm/256, or 391 Å, which represents the limit of the lateral resolution. Lateral resolution will be a factor of 2 better for a 10 µm image taken with 512 x 512 data points. However, it will take twice as long to collect the data, since there are twice as many lines of data.

In order to improve the lateral resolution as limited by the scan size without increasing the time it takes to take an image, you can use a smaller scan size. For example, for a 256 x 256 image and a scan size of 500 Å (0.05 µm), the lateral resolution limit improves to 500 Å/256, or 1.95 Å.

However, the lateral resolution can only be as good as the largest limiting factor. If you are using small scan sizes (below about 5 µm), the largest limiting factor is not likely to be the scan size divided by the number of data points per scan line. As a rule of thumb, *do not select a scan size that is smaller than the lateral resolution (as limited by any of the factors described here) multiplied by the number of data points per scan line.* Selecting a smaller scan size will only result in adjacent data points containing repeated information.

In most cases, the largest limiting factor to the lateral resolution is the interaction area between the tip and the sample, or the effective tip radius. This interaction area is affected by both the physical radius of curvature of the tip, or the tip sharpness, as well as the range and rate of change of the quantity being measured for the mode you are operating in. Specific conditions, such as a water layer on the tip, can affect the lateral resolution as well.

For example, in STM mode the exponential relationship between tunneling current and tip-to-sample spacing isolates the interaction between the tip and the sample to atoms at the very end of the tip. Thus, even a very blunt tip with a radius on the order of 1000 Å can be used in STM mode to achieve atomic resolution, as long as it has a single atom that protrudes more than its neighbors. This same tip, however, may not be able to resolve features that are wide if those features are also very deep (high aspect ratio features).

For other modes, however, the lateral resolution as limited by the effective tip radius is on the order of nanometers to tens of nanometers. Factors such as tip wear and deformation increase the interaction area for contact-AFM operation. The response of the measured signal to changes in tip-to-sample spacing affects the lateral resolution for non-contact AFM modes. The only real way to determine the smallest features you can image using a particular tip in a particular operating mode is to optimize all of the other factors that limit the lateral resolution and then try to image small features on a sample.

Assuming a small scan size and good tip conditions, the next factor most likely to limit the lateral resolution of your images is the resolution of the x-y detector, which is on the order of 20 nm. This limit only applies if ScanMaster is on. Thus, if you are trying to achieve the highest lateral resolution for small scan sizes, you may want to turn ScanMaster off.

Note: ScanMaster is not available with 5 µm scanners.

Finally, the digitized step size of the scanner in the fast scan direction also limits the lateral resolution of your images. The voltage applied to the scanner is digitized, and the number of possible voltage values depends on the number of bits of the digital-to-analog converter (the DAC) used to send the voltage signal to the scanner. AutoProbe CP uses 20-bit DACs for sending the voltage signal to the scanner, so the voltage can be expressed as a 20-bit number, which has 2^{20} possible values. The total range of motion of the scanner can therefore be divided into 2^{20} digitized steps. If you are in high-voltage mode with a 100 µm scanner, the minimum step size of the scanner is 100 µm/2^{20} steps = 1.0 Å/step. For a 100 µm scanner and a 20-bit digital-to-analog converter, the resolution as limited by the step size of the scanner is always 1.0 Å.

Since 1.0 Å is much smaller than the typical interaction area between the tip and the sample for modes other than STM mode, the digitized step size of the scanner is not likely to be the factor limiting the lateral resolution of your images. However, low-voltage mode prevents the step size of the scanner from limiting the lateral resolution of your images, STM or other, by reducing the maximum scan width from 100 µm to 25 µm. Since the same number of digitized voltage steps is used to produce a smaller range of motion, the resolution due to the scanner step size improves to 25 $\mu m/2^{20}$, or 0.24 Å. Using low-voltage mode, you are guaranteed that the step size of the scanner will not limit the lateral resolution of your images.

Switching to Low-Voltage Mode

Now that you understand how low-voltage mode works to improve lateral resolution for small scan sizes, you are ready to switch to low-voltage mode and take an image.

> ***CAUTION***
>
> The z scanner ranges in high and low-voltage modes do not overlap (the scanner's z range in low-voltage mode is more extended). To avoid damage to the probe tip and sample when you select low-voltage mode, you must raise the Z stage a short distance using the z direction pad to keep the probe tip clear of the sample surface.
>
> For CP systems, be sure to move the optics out of the way to protect the objective lens before you raise the Z stage. Move the optics by rotating the swing arm away from the probe head.

When you switch between voltage modes, the z position of the scanner changes in response to a change in the voltages applied to the scanner. In some cases, the change in voltages may cause the probe to crash into the sample surface. Therefore, you must move the probe away from the sample at least 5 µm before switching between voltage modes.

To switch from high to low-voltage mode, follow these steps:

1. Make sure you are in Image mode.

2. Enter 0 in both the X and Y Offset textboxes to set the scanner coordinates to (0, 0).

3. Switch to Move mode.

4. Move the probe about 5 µm away from the sample using the z direction pad to keep the probe clear of the sample surface.

5. Turn off the power to the probe head by deselecting Head ON under the Mode menu or by clicking the Head ON icon, .

6. Select the voltage mode you are switching to, High Voltage or Low Voltage, from the Mode menu.

   Note: You can also change the voltage mode by using the ProScan Database Configuration dialog box. Refer to the section "Configuring the System Software" in Chapter 3 of this manual for more information on using the ProScan Database Configuration dialog box.

7. Turn on the power to the probe head by selecting Head ON from the Mode menu or by clicking the Head ON icon, .

8. Click the Approach button to perform an auto approach.

9. Take an image.

When the scan is finished, the image is automatically saved on your hard disk and displayed in the Image Gallery.

Taking High-Resolution Topography Images

The Topography signal, referred to in Chapter 3 of this manual, "Taking an AFM Image," is actually the output of the feedback loop. When the gain parameter is set to a moderate or high value, the output of the feedback loop varies in order to minimize the Error signal. The Topography signal is thus an approximation of sample topography.

AutoProbe CP uses 20-bit DACs for sending the output of the feedback loop to the scanner, so the voltage can be expressed as a 20-bit number, which has 2^{20} possible values. The total range of motion of the scanner in the z direction can therefore be divided into 2^{20} digitized steps.

However, the image file format used by ProScan software can only accommodate 16-bit numbers to represent height data. Therefore, the total contrast range of the image produced using the Topography signal has only 2^{16} possible values. This means that ProScan cannot save the Topography signal data in its original form, with 2^{20} possible values.

When the Topography signal is used, the system drops the four least significant bits of data from the output of the Z feedback . This process is roughly analogous to recording measurements taken in millimeters as lengths in centimeters to avoid writing out more digits for each reading. When you are taking an image of a sample with a wide variation in topography, the loss of precision does not affect the value of each data point significantly.

However, when you are imaging an extremely flat sample, especially one with fine detail, the loss of resolution can cause quantization of the data. Because the Topography signal can only be displayed in limited increments, an area that varies smoothly with height over a small range is displayed as a series of flat areas on the image. The Topography signal on the Oscilloscope display will appear to have steps, as shown in Figure 4-6.

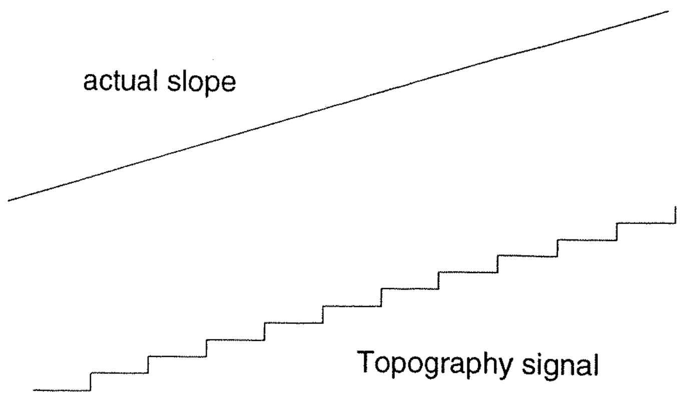


Figure 4-6. Quantization of Topography signal data.

For imaging the smallest variations in sample topography with the highest Z resolution, you can take an image using the Topo x 16 signal, available from the Input Configuration dialog box. The Topo x 16 signal uses the 16 least significant bits of the 20-bit DAC output to produce an image. This allows you to regain the precision lost when using the Topography signal. However, the cost of added precision is a loss in the overall height range that can be imaged. Specifically, the height range covered by the Topo x 16 signal is 1/16th of the scanners Z range.

As long as you are imaging a region where the variation in topography is within 1/16th of the scanner's z range, it can be represented by the 16 least significant bits of the DAC output. In this case, the Topo x 16 image represents the variations in topography accurately. However, if the DAC output crosses either the high or low limit of the 16-bit range, the signal abruptly changes to the opposite limit. If you cross this wrap-around point at the high limit, the Topo x 16 data point representing a higher region will be represented by a low number. Conversely, if you cross the wrap-around point at the low limit, the Topo x 16 signal representing a lower region is represented by a higher number. Figure 4-7 illustrates the high-end wrap-around point.

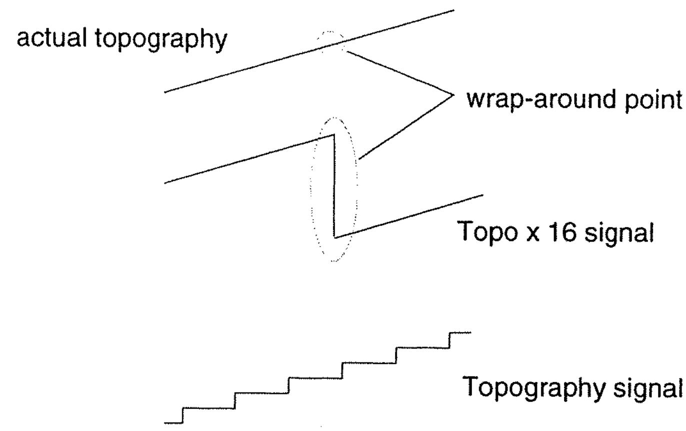


Figure 4-7. Representation of sample topography by the Topo x 16 signal and the Topography signal.

Wrap-around points show up on a Topo x 16 image as sudden changes in contrast. If the probe frequently crosses a wrap-around point, the resulting sudden shifts in contrast make the image difficult to interpret. When you are using the Topo x 16 signal channel, you may need to use the Z stage to back the tip away from the sample. This forces the scanner into a shifted range of voltages where it will not cross a wrap-around point.

You can collect image files using the Topography signal and the Topo x 16 signal simultaneously. This capability allows you to compare results with both methods.

To use the Topo x 16 signal, do the following:

1. If the power to the probe head is turned off, turn it on now by clicking the Head ON icon, ; and setting the LASER ON/OFF switch to the ON position.

2. Select the Input Config menu item of the Setup menu. Alternatively, click the Input Configuration icon, . The Input Configuration dialog box will open.

   Note: The Input Config menu item (or, alternatively, the Input Configuration icon) is only enabled if the probe head is turned on.

The Input Configuration dialog box, shown in Figure 4-8, allows you to select various signals for viewing on the Oscilloscope Display and for producing images. The list of available signals is displayed in the Available listbox. The list of selected signals is displayed in the Selected box.

The [Add —>] and [<— Remove] buttons allow you to add or remove signals from the Selected box. The other buttons and checkboxes allow you to select additional options for selected signals. Refer to the section "Input Config: The Input Configuration Dialog Box" in Chapter 1 of the *Software Reference* manual for more information about the Input Configuration dialog box.

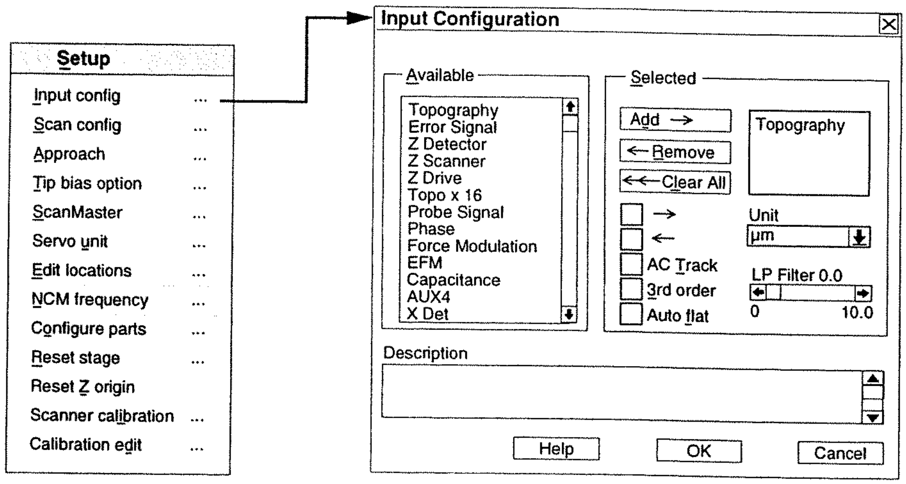


Figure 4-8: The Input Configuration dialog box.

3. Select Topo x 16 from the Available scrollbox.

4. Click the [Add —>] button.

   Topo x 16 appears in the Selected box.

5. Click the [OK] button to register your selection and close the dialog box.

Next, configure ProScan to monitor both the Topography and Topo x 16 signals.

6. Switch to Image mode by either selecting Image Mode from the Mode menu or clicking the Image Mode icon, Y.

7. In Image mode, click the arrow on the Signal Name listbox under the Oscilloscope Display. Make sure that the Topography and Topo x 16 signals are available to be viewed on the Oscilloscope Display. You will monitor these signals to adjust parameters for taking simultaneous Topography and Topo x 16 images.

Next, you will set up the Active Display so that you can view the Topography image and the Topo x 16 image at the same time:

8. From the View menu, select Layout. Alternatively, click the Layout icon, . The Image Layout dialog box will open. Click the Dual option button and then click the OK button.

There should now be two images in the Active Display of the Image mode window so that you can view the Topography and Topo x 16 images simultaneously.

9. Click the Image button to take an image.

If the system is operating at a wrap-around point the Topo x 16 signal trace on the Oscilloscope Display will show sudden shifts in level and the Topo x 16 image will show sudden shifts in contrast. To move the system away from the wrap-around point, do the following:

10. Click the Cancel button to cancel the scan in progress.

    Note: You cannot use Move mode while a scan is in progress.

11. Switch to Move mode by either selecting Move Mode from the Mode menu or clicking the Move Mode icon, .

12. Click once on the upper portion of the z direction pad, near the center line.

    This should raise the Z stage by a fraction of a micron.

13. Return to Image mode and take more images of the sample.

Try comparing the Topography and Topo x 16 images for large and small scan areas, and for areas with large and small variations in height.

Saving, Loading, and Deleting Images

This section gives you a brief overview of how to save, load, and delete image files. For a more detailed description of working with image files, refer to the section "The Image Gallery" in Chapter 1 of the *Software Reference* manual.

By default, all newly acquired images are displayed in the Image Gallery, and these images are automatically saved on your hard disk. You can load images that have been previously saved on your hard disk or a diskette, to compare them with new images. The Image Gallery, along with the Active Display and the Import View, are shown in Figure 4-9 below.

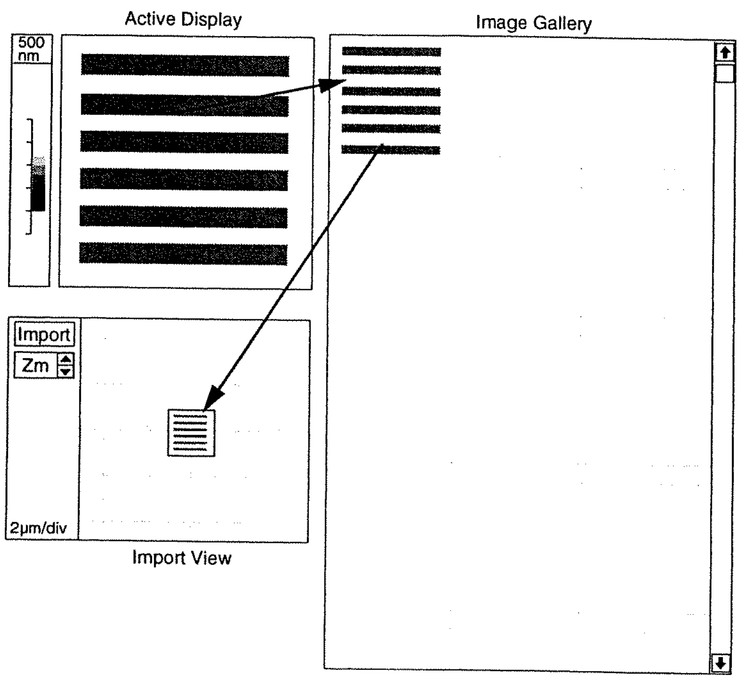


Figure 4-9. The Image Gallery.

The number of images that can be displayed in the Image Gallery is only limited by the amount of space available on your hard disk. Up to 28 images can be displayed on the screen at one time, and scrollbars allow you to scroll through all of the stored images. You can display the Image Gallery using a partial or full-screen display.

To scroll through the images displayed in the Image Gallery, do the following:

1. Click and drag the scrollbar up or down to scroll through images displayed in the Image Gallery.

The Save to Buffer menu item under the Mode menu sets the status of newly acquired images. When the Save to Buffer menu item is selected, new images are displayed in the Image Gallery and saved on your hard disk. When the Save to Buffer menu item is not selected, new images are not displayed in the Image Gallery or saved on your hard disk. The Save to Buffer menu item is selected by default.

Note: You can also toggle the Save to Buffer icon, , to set the status of new images. When the Save to Buffer icon is on, new images are displayed in the Image Gallery and saved on your hard disk. When the Save to Buffer icon is off, new images are *not* displayed in the Image Gallery or saved on your hard disk.

Newly acquired images are stored in the directory **c:\spmdata**, which is set up on your hard disk during installation. You can save images to a directory other than **c:\spmdata** using the New Session dialog box. To learn more about the New Session dialog box, see Chapter 1 of the *Software Reference* manual, "ProScan Data Acquisition."

An image file name is generated automatically for each new image you acquire and is displayed beneath the image in the Image Gallery. The file name consists of the date the image was taken and a sequence number, which is displayed in hexadecimal format. The file extension **hdf** shows that the image was saved using the **hdf** file format (hierarchical data format). For example, the first image taken on August 15 will have the file name **08150001.hdf**. An icon next to the file name of an image displayed in the Image Gallery sets the save/delete status of the image.

Practice setting the status of a new image:

2. First, take an image with the Save to Buffer menu item selected. The Save to Buffer menu item should be selected under the Mode menu by default. If it is not selected, select it now. Then, click the [Image] button to take an image.

When the scan is finished, the image is automatically displayed in the Image Gallery and stored on your hard disk. The file name should include the date and a sequence number. A folder icon should be displayed before the file name, indicating that the image was saved on your hard disk.

3. Now, deselect Save to Buffer from the Mode menu and then click the [Image] button to see what results.

When the scan is finished, the image will not be displayed in the Image Gallery or saved on your hard disk.

You can also load images that have been previously saved to your hard disk or a diskette. For previously saved images, a diskette icon appears next to the file name of the image in the Image Gallery, indicating that the image was loaded from your hard disk or a diskette to the Image Gallery.

Try loading a previously saved image to the Image Gallery:

4. From the File menu, select Load. The Load to Buffer dialog box will open, allowing you to select an image file from any drive or directory.

5. Select the image file you want to load to the Image Gallery in the File Name listbox and then click the [OK] button.

The image will be loaded in the Image Gallery. A diskette icon will appear next to the image file name, indicating that the image was loaded from your hard disk or a diskette.

You can delete a new image or a previously saved image when the image is displayed in the Image Gallery.

Try deleting an unwanted image now:

6. First, click either the folder icon (for new images) or the diskette icon (for previously saved images) that is displayed next to the image file name. The folder or diskette icon will change to a gray wastebasket icon, indicating that the image is tagged to be deleted.

7. Select Delete Files from the File menu. The image will be deleted from your hard disk. A white wastebasket icon should replace the gray wastebasket icon, indicating that the file has been deleted.

8. Clear the deleted image from the Image Gallery by selecting Clean Buffers from the File menu.

Any images displayed in the Image Gallery can be shared between Data Acquisition and Image Processing. This sharing of the images allows you to analyze images before deciding whether to save or delete them. Saving only the most useful images makes more efficient use of your hard disk space.

Try importing an image from Data Acquisition to Image Processing:

9. Select an image in the Image Gallery. A green box will enclose the selected image.

10. Switch to Image Processing by either selecting Image Processing from the Tools menu or clicking the Image Processing icon, . The Image Processing program will open, and the selected image will appear in the Active Display.

11. Exit Image Processing by clicking the Exit button at the top right of the window. To learn more about ProScan Image Processing, refer to Chapter 2 of the *Software Reference* manual, "ProScan Image Processing."

You can view a list of scan parameters associated with an image, and you can read or add comments to an image displayed in the Image Gallery using the View dialog box. You can also change the contrast level of an image in the View dialog box. The View dialog box is displayed when you double-click an image in the Image Gallery.

Open the View dialog box for an image now:

12. Double-click an image in the Image Gallery. The View dialog box will open.

13. Review the scan parameters listed in the Parameters listbox.

14. Practice entering comments in the Comments textbox. You can either overwrite the comments in the original image file or create a duplicate image file with the new comments.

    To overwrite the comments in the original image file, click the [OK] button after you add to or change the text and then click the [Overwrite] button.

    To create a duplicate copy of the image file with the new comments, click the [OK] button after you add to or change the text and then click the [Save As New] button. The Save As dialog box will open, allowing you to save the image file to any pre-existing directory. Enter a name for the image file in the File Name textbox and then click the [OK] button to close the dialog box.

15. Expand the display of the image by clicking the [Z] (zoom) button above the image. Reduce the display of the image by clicking the [Z] button again.

16. Increase the contrast of the image by clicking the [+] button. Decrease the contrast by clicking the [-] button. Changes you make to the contrast will be saved if you click the [OK] button to exit the View dialog box. They will not be saved if you click the [Cancel] button to exit.

17. Click either [OK] or [Cancel] to exit the View dialog box.

Where to Go from Here

Now you should be familiar with the main features of ProScan Data Acquisition and how to use them.

- You are familiar with the scan parameters and know how to adjust them.
- You know the basics of how the z feedback loop operates and can optimize feedback parameters.
- You can select an image size.
- You can use the Import View to position a follow-up scan.
- You know how to use low-voltage mode and the Topo x 16 signal channel to take higher-resolution images.
- You know how to save, delete, and retrieve images.

At this point, you can practice exploring the sample and taking images under different scan conditions. Or, you can go to Part II of this User's Guide and learn about advanced techniques. If you are interested in learning about a specific software control, refer to Chapter 1 of the *Software Reference* manual, "ProScan Data Acquisition." If you'd like, you can end your AutoProbe session now as you normally do and return to the tutorials at another time.