

ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

Artisan Technology Group
(217) 352-9330 | sales@artisantg.com | artisantg.com

Full-service, independent repair center
with experienced engineers and technicians on staff.

We buy your excess, underutilized, and idle equipment
along with credit for buybacks and trade-ins.

Custom engineering
so your equipment works exactly as you specify.

- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

Expert team | Trust guarantee | 100% satisfaction

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

Find the *KLA Tencor P-2* at our website: ***Click HERE***

CLSI 4900 TRACKING
MATHOD

case #
226 569

Password : "P2"

1195-0443

TENCOR® P-2
LONG SCAN PROFILER

KLA 800 600-2829

FAX. 1800 600-9492

TENCOR INSTRUMENTS

Software Version 1.6.1
FOR CLEAN ROOM USE CLASS 100 ONLY

Text Only: # 183369-27 Rev. E 11/93
Text & Binder: # 183377-27

2400 Charleston Road, Mountain View, CA 94043
Phone: (415) 969-6767 FAX: 415-968-9482

650

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

RIGHT NOTICE

ght © 1991, 1992, 1993 by TENCOR INSTRUMENTS. All rights reserved worldwide. No
tion may be reproduced, transmitted, transcribed, stored in retrieval system or translated into
puter language, in any form or by any means, electronic, mechanical, magnetic, chemical,
vise, without the express written permission of TENCOR INSTRUMENTS, 2400 Charles
tain View, California 94043.

RRANTY

pt as otherwise indicated, Tencor Instruments warrants to the Buyer that the items sold by it here
from defects in material and workmanship and meet applicable specifications. In discharge of this
or Instruments agrees either to repair or replace as it may elect, any part or parts which under pr
nal use proves defective in material or workmanship *within twelve months after delivery* to Buye
onal printers for which the warranty terms of the Original Equipment Manufacturers apply. If it is re
some components and accessories fail to give reasonable service for a reasonable period of
rmined solely by Tencor Instruments, Tencor Instruments will at its election replace or repair them.
ruments may at any time discharge its warranty as to any item by refunding the purchase price an
k the item.

less Buyer shall inspect all items and *within thirty days of delivery* notify Tencor Instruments of any a
ects discovered, Tencor Instruments shall have no liability hereunder.

The foregoing warranty and remedy are exclusive and Tencor Instruments shall have no other liability
any other warranty express or implied either in fact or by operation of law, statutory or otherwise.
Instruments shall have no liability for special or consequential damages of any kind and from any cause
out of the installation or use of any item.

TRADEMARKS

386MAX® is a registered trademark of Qualitas, Inc.
Above™ is a trademark of Intel Corporation.
Braycote® is a registered trademark of Castrol, Inc.
dBase™ III is a trademark of Ashton-Tate.
Epson® is a registered trademark of Epson America, Inc.
IBM® PC and AT are registered trademarks of International Business Machines Corporation.
Lotus 1-2-3® is a registered trademark of Lotus Development Corporation.
MS-DOS®, Microsoft®, and Microsoft Windows® are registered trademarks of Microsoft Corporation.
PaintJet® is a registered trademark of Hewlett-Packard Company.
PrintCache™ is a trademark of LaserTools Corporation.
QEMM-386™ is a trademark of Quarterdeck Office Systems.
RAMpage® is a registered trademark of AST Research, Inc.
Tencor® P-2 is a registered trademark of Tencor Instruments.
Tri-Flow™ is a trademark of Thompson & Formby, Inc.
Vibratite™ is a trademark of N.D. Industries Corp.

PATENTS

This instrument is protected under the following patent: 4,752,898.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

REVISION LOG

This publication includes new documentation for version 1.6.1 of the Tencor P-2 software. Read the description below for a brief summary of the changes and improvements from version 1.6.

- The Recipe screens have been reorganized to allow extra space for several new surface analysis parameters. Scan parameters are now all on one screen and grouped logically into two columns. Chapter 5, "Writing a Recipe," has been reordered to reflect this reorganization.
- Five additional surface analysis parameters have been added: MaxHt, MinHt, StpN, StpMn, and StpSD. See Section 5.3.2, "Surface Analysis Fields."
- The Automatic Cursor Positioning feature has been enhanced to allow more flexibility with the ability to distinguish between the beginning and the end of the slope for both falling and rising edges. See Section 7.5, "Automatic Cursor Positioning (Edge Detection)."
- Appendix F, "Release Notes," contains updated information about features that have been added, software problems that have been resolved, and software problems that are known to exist at the time of release of software version 1.6.1.

#183369 Rev. E 11/93

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Table of Contents

1	**Introduction**	**1-1**
1.1	About This Manual	1-1
1.2	Related Manuals	1-2
1.3	How to Use This Manual	1-2
1.4	Conventions Used in This Manual	1-3
1.4.1	Typographic Formatting	1-3
1.4.2	Terminology	1-4
1.5	Instrument Overview	1-7
1.6	Hardware Features and Options	1-8
1.7	Software Features and Options	1-12
2	**Installation**	**2-1**
2.1	Operating Environment	2-1
2.2	Installation	2-2
2.2.1	Shipping Damage	2-3
2.2.2	Shipping Contents	2-4
2.2.3	Pre-power Preparation	2-5
2.2.4	Powering Up	2-6
2.2.5	Setting the Date and Time	2-8
2.2.6	Installing a Precision Locator	2-8
2.2.7	Installing a Custom Fixture	2-11
2.2.8	Configuring the Tencor P-2 for Your Printer	2-12
2.3	Loss of Power	2-14
2.4	Shipping	2-15
3	**Basic Skills**	**3-1**
3.1	Instrument Components	3-1
3.2	Instrument Controls	3-1
3.2.1	Auxiliary Panel	3-2
3.2.2	Built-in Keyboard	3-3
3.2.3	Remote Keyboard	3-5
3.2.4	Miscellaneous Controls	3-6
3.3	Starting Up the System	3-6
3.4	Menus	3-7
3.5	Entering an ID	3-10
3.6	Wafer Handler (Optional)	3-12
3.6.1	Protecting the Wafer Handler	3-12
3.6.2	Resetting the Wafer Handler	3-13
3.7	Protecting the Stylus Arm Assembly	3-14
3.8	Setting the Keylock Position	3-16
3.9	Setting the Door Interlock Switch	3-17
3.10	Setting the Date and Time	3-17

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.11	Restricting Access to the Instrument	3-18
3.12	Setting Screen Colors	3-20
3.13	Exiting to DOS	3-21
3.14	Getting Help	3-21
3.15	Determining Which Options Are Installed	3-21
3.16	Turning Off or Resetting the System	3-21
4	**Getting Started**	**4-1**
4.1	Starting the System	4-1
4.2	Loading the Sample	4-2
4.3	Viewing and Positioning the Sample	4-3
4.3.1	Lowering the Measurement Head	4-4
4.3.2	Positioning in X and Y	4-5
4.3.3	Magnifying the Sample Image	4-7
4.4	Profiling from a Scan Recipe	4-8
4.5	Reading, Printing, and Saving Data	4-11
4.6	Unloading the Sample	4-14
4.7	Tutorial Summary	4-15
5	**Writing A Recipe**	**5-1**
5.1	Measurement Capabilities	5-2
5.2	Scan Modes	5-3
5.3	Setting Scan Parameters	5-3
5.3.1	Recipe Screen Fields	5-5
5.3.2	Surface Analysis Fields	5-12
5.3.3	Additional Surface Roughness Parameters Option	5-17
5.4	Saving Recipes	5-23
5.5	Maintaining Recipes	5-24
5.5.1	Importing Recipes	5-24
5.5.2	Backing Up and Restoring Recipes	5-25
5.5.3	Viewing the Recipe Catalog	5-27
5.5.4	Changing a Stored Recipe	5-28
5.6	Using the SECS Interface Option with Recipes	5-29
5.6.1	Enabling and Configuring the SECS Option	5-29
5.6.2	Uploading a Recipe to the Host	5-31
5.6.3	Downloading a Recipe from the Host	5-32
6	**Profiling A Sample**	**6-1**
6.1	Setting the Lowest Elevator Position	6-2
6.2	Setting X,Y Travel Limits	6-4
6.3	Loading the Sample	6-5
6.3.1	Loading a Sample Manually	6-6
6.3.2	Loading Single Wafers Using the Wafer Handler	6-9
6.4	Viewing and Positioning the Sample	6-18
6.4.1	Lowering the Measurement Head	6-19
6.4.2	Positioning in X and Y	6-21

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

6.4.3 Magnifying the Sample Image 6-24
6.5 Precision Mode 6-24
6.5.1 Die Grid 6-26
6.5.2 Die Grid Example 6-27
6.6 Profiling from a Scan Recipe 6-29
6.7 Unloading the Sample 6-32
6.7.1 Unloading the Sample Manually 6-32
6.7.2 Unloading Single Wafers Using the Wafer Handler 6-32
6.8 Tilting the Stage 6-34
6.9 Rotating the Stage (Optional Theta Mode) 6-34
6.10 Adjusting the Theta Zero Offset (Optional Theta Mode) 6-37
6.11 Setting the Center Offset 6-39
6.12 Leveling the Stage 6-40
6.12.1 Manual Stage Leveling 6-41
6.12.2 Motorized Stage Leveling 6-42
6.13 Setting the Leveling Offset (Optional Theta Mode) 6-43
6.14 Setting the SECS Interface Option to Upload Data 6-44

7 Analyzing the Profile 7-1
7.1 Data Screen 7-2
7.2 Leveling the Profile 7-3
7.3 Measuring Profile Artifacts 7-6
7.3.1 Positioning the Cursors 7-6
7.3.2 Using Delta Average Mode 7-7
7.3.3 Saving Cursor Locations 7-8
7.3.4 Reading the Data 7-8
7.4 Displaying Extra Data 7-10
7.4.1 Data Zoom in the Data Screen 7-10
7.4.2 Summary Window 7-11
7.5 Automatic Cursor Positioning (Edge Detection) 7-11
7.6 Radius Measurement 7-21
7.7 Fit and Level 7-24
7.8 Printing Data 7-26
7.9 Saving Data and Recipes 7-26
7.9.1 Saving Data without the Database Manager Option 7-27
7.9.2 Saving Data with the Database Manager Option 7-28
7.10 Recalling Data 7-29
7.10.1 Recalling Data without the Database Manager Option 7-29
7.10.2 Recalling Data with the Database Manager Option 7-30
7.11 Deleting Data 7-32
7.11.1 Deleting Data without the Database Manager Option 7-32
7.11.2 Deleting Data with the Database Manager Option 7-32
7.12 Exporting Data 7-33
7.12.1 Exporting Data without the Database Manager Option 7-34
7.12.2 Exporting Data with the Database Manager Option 7-34

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

	7.13 Backing Up Data	7-34
8	**Data Analysis: Band Pass Filter**	**8-1**
	8.1 Data Flow	8-2
	8.2 Analog Hardware Filter and Digital Decimation Filter	8-2
	8.3 Digital Software Filters	8-4
	8.3.1 Short Wave Cutoff	8-4
	8.3.2 Long Wave Cutoff	8-7
	8.3.3 Summary of the Effect of Software Filtering on Data	8-8
	8.4 Using Cutoff Filters	8-9
	8.4.1 Setting Short Wave Cutoff Values	8-11
9.	**MicroHead Low Moment Measurement Head Option**	**9-1**
	9.1 Measurements at Low Stylus Force Settings	9-2
	9.1.1 Limitations on Downward Travel	9-2
	9.1.2 Mechanical Leveling and Low Stylus Forces	9-4
	9.1.3 Electrostatic Effects and Low Stylus Forces	9-6
	9.1.4 3-D Scans and Low Stylus Forces	9-6
	9.2 MicroHead Recipe Fields	9-7
	9.3 Installing the MicroHead	9-8
	9.4 Changing the MicroHead Stylus	9-9
	9.5 Changing the Extended Range MicroHead Stylus	9-10
	9.6 Changing the MicroHead Objective Lens	9-11
	9.7 Replacing the MicroHead Sample Illumination Bulb	9-14
	9.8 MicroHead Setup and Diagnostics	9-15
	9.8.1 Measurement Head Setup Window	9-15
	9.8.2 Stylus Force Parameters Window	9-15
	9.8.3 Checking Proper Setup of Stylus Force Coil	9-17
	9.8.4 Troubleshooting Force-Deflection Response Errors	9-19
10	**Automatic (Sequence) Operation**	**10-1**
	10.1 Measurement Capabilities	10-1
	10.2 Sequence Modes	10-2
	10.3 Writing a Sequence Program	10-2
	10.3.1 Procedure	10-2
	10.3.2 Sequence Fields	10-7
	10.4 Setting Up a Sequence Program	10-18
	10.4.1 Procedure	10-18
	10.4.2 Deskew1, Deskew2	10-19
	10.4.3 Recipes	10-21
	10.4.4 X, Y, Theta	10-22
	10.4.5 Multiple Analysis	10-24
	10.5 Running a Sequence Program in Automatic Mode	10-25
	10.5.1 Automatic Naming of Data Files and SECS Transfer Data	10-25
	10.5.2 Preparing for Automatic Loading and Unloading	10-26
	10.5.3 Running the Sequence in Automatic Mode	10-29

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

10.5.4 Stopping and Resuming a Sequence 10-35
10.6 Running a Sequence in Manual Mode 10-35
10.7 Displaying Data 10-41
10.7.1 Accessing Data via the Database Catalog 10-41
10.7.2 Accessing Data after Running a Sequence 10-44
10.8 Printing Data 10-45
10.9 Maintaining Sequence Programs 10-47
10.9.1 Deleting Sequence Programs 10-47
10.9.2 Exporting Sequence Programs 10-48
10.9.3 Importing Sequence Programs 10-48
10.9.4 Backing Up Sequence Programs 10-50
10.9.5 Restoring Sequence Programs 10-51
10.10 Maintaining Sequence Data 10-52
10.10.1 Deleting Sequence Data 10-52
10.10.2 Exporting Sequence Data 10-52
10.11 Using the SECS Interface Option with Sequences 10-52
10.11.1 Enabling and Configuring the SECS Option 10-52
10.11.2 Uploading a Sequence Program to the Host 10-54
10.11.3 Downloading a Sequence Program from the Host 10-55

11 Sort/Combined Statistics Option 11-1
11.1 Combining Statistics 11-2
11.2 Printing Combined Sequence Results 11-6
11.3 Maintaining Combined Sequence Results 11-6

12 Database Manager Option 12-1
12.1 Introduction 12-1
12.1.1 How the Database Works 12-1
12.1.2 Database Structure 12-3
12.2 Configuring the Database 12-4
12.2.1 Setting Major and Minor Data ID Labels 12-4
12.2.2 Adding/Deleting/Renaming Major ID Values 12-6
12.2.3 Restricting Access to Data ID Values 12-9
12.2.4 Setting or Changing the Password 12-10
12.3 Operating the Database 12-12
12.3.1 Saving Data without Assigned Values 12-13
12.3.2 Saving Data with Assigned Values 12-14
12.3.3 Recalling Data 12-15
12.3.4 Exporting Data 12-18
12.3.5 Deleting Data 12-20
12.4 Maintaining the Database 12-20
12.4.1 Database Corruption 12-21
12.4.2 Purging Data 12-21
12.4.3 Importing Data 12-24
12.4.4 Backing Up Data 12-25

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

12.4.5 Restoring Data 12-27

Database Manager Tutorial **T-1**
Introduction T-1
How the Database Works T-1
Setting Up the Practice Session T-2
Lesson 1: Adding and Deleting ID Values T-5
Lesson 2: Saving Data T-7
Lesson 3: Recalling Data T-8
Lesson 4: Exporting Data T-8
Lesson 5: Backing Up Data T-9
Lesson 6: Deleting Data T-10
Lesson 7: Purging Data T-11

13 Wafer Stress Option **13-1**
13.1 Overview 13-1
13.1.1 Using the Wafer Stress Option 13-2
13.1.2 Entering an ID 13-2
13.1.3 Adding an ID Suffix 13-5
13.1.4 Saving Data 13-5
13.2 Taking a Prestress Scan 13-6
13.2.1 Selecting a Scan Recipe 13-6
13.2.2 Loading and Positioning the Sample 13-6
13.2.3 Profiling the Sample 13-7
13.3 Taking a Difference Measurement 13-9
13.3.1 Selecting a Scan Recipe 13-9
13.3.2 Loading and Positioning the Sample 13-10
13.3.3 Entering Stress Parameters 13-11
13.3.4 Taking a Poststress Scan 13-12
13.3.5 Saving Poststress Data 13-14
13.3.6 Displaying Difference Measurements 13-14
13.3.7 Taking Multiple Measurements of the Same Sample 13-16
13.4 Taking a Single, Poststress Measurement 13-17
13.5 Recalculating Stress Measurements 13-18

14 Interactive 3-D Option **14-1**
14.1 Writing a 3-D Recipe 14-1
14.2 Profiling from a 3-D Recipe 14-5
14.2.1 Reading the 3-D Data Screen 14-6
14.3 Analyzing the 3-D Data 14-8
14.3.1 Selecting a Single Trace 14-8
14.3.2 Viewing a Contour Display 14-9
14.3.3 Changing the View Position 14-9
14.4 Leveling 3-D Data 14-10
14.5 Zooming Data in the 3-D Data Screen 14-11
14.5.1 Rescanning a Selected Area 14-12

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

14.6 Saving 3-D Data and Recipes 14-13

15 Offline P-2 Program 15-1
15.1 Shipping Contents 15-1
15.2 Setting Up the Offline Software 15-2
15.2.1 System Requirements 15-2
15.2.2 System Configuration 15-2
15.2.3 Software Installation 15-4
15.3 Running the Offline P-2 Program 15-4
15.4 Offline P-2 Program Directories 15-5

16 Error Messages 16-1
16.1 File System or Hard Disk Problems 16-1
16.1.1 Disk Space Limitations 16-1
16.1.2 Hard Disk Corruption 16-1
16.2 Recipe and Sequence Integrity 16-2
16.3 Error Messages 16-2

17 Hardware Maintenance 17-1
17.1 Troubleshooting 17-1
17.1.1 Service Policy 17-1
17.1.2 Diagnostic Scan 17-1
17.2 Changing the Stylus 17-2
17.2.1 Changing the Stylus Using Tweezers 17-3
17.2.2 Changing the Stylus Using Plastic Forceps 17-5
17.3 Stylus Tip Radius Measurement 17-7
17.4 Focusing the Optics 17-10
17.5 Replacing the Fuse 17-11
17.6 Making a Theta Detent Reference Adjustment 17-11
17.7 Replacing the Sample Illumination Bulb 17-12
17.8 Removing and Installing the Head Assembly 17-13
17.8.1 Removing the Head Assembly 17-13
17.8.2 Installing the Head Assembly 17-16
17.8.3 Setting Up the Measurement Head Software 17-18
17.8.4 Shipping the Damaged Head 17-20
17.9 Calibration 17-20
17.9.1 Calibration Factor (Step Height Method) 17-20
17.9.2 Radius Calibration 17-23
17.9.3 Multipoint Calibration 17-24
17.9.4 Stylus Force Offset 17-26
17.9.5 Scan Position Offset Calibration 17-29
17.10 Lubrication 17-34
17.10.1 Lubricating X-, Y-axis Leadscrews and Reference Flat 17-34
17.10.2 Motorized Level and Rotation Option Stage 17-36
17.10.3 Manual Level Stage 17-38

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

17.11 Printer and Keyboard Diagnostics 17-38
17.12 Shutting Down the Instrument 17-39

18 Software Maintenance 18-1
18.1 Checking Memory Available on the Hard Disk 18-1
18.2 Using Batch Utility Options 18-2
18.2.1 Backing Up Files 18-2
18.2.2 Restoring Files 18-3
18.2.3 Erasing a File 18-4
18.2.4 Removing Data from a Database 18-5
18.2.5 Copying Files to Another Instrument (Database Manager Option Only) 18-5
18.2.6 Database Recovery 18-6
18.2.7 Troubleshooting Database Problems 18-9
18.3 Using Support Programs 18-10
18.3.1 Formatting Diskettes 18-10
18.3.2 Restarting the Main Program 18-10
18.4 Use of INSTALL #1 Diskette as Boot Diskette 18-11
18.5 Hard Disk Replacement or Repartitioning 18-11
18.6 Configuration for Network Drivers 18-12
18.7 Tencor P-2 Directories 18-14
18.7.1 Root Directory 18-15
18.7.2 DOS Directory 18-15
18.7.3 PCACHE Directory 18-15
18.7.4 QEMM Directory 18-15
18.7.5 TENCOR Directory 18-16
18.7.6 SYS Directory 18-17
18.7.7 UTIL Directory 18-18
18.7.8 DB, RECIPE, SEQ, SDATA, and RDATA Directories 18-19
18.7.9 HELP Directory 18-20
18.7.10 EXP Directory 18-21

19 Theory of Operation 19-1
19.1 Introduction 19-1
19.1.1 System Description 19-1
19.1.2 Environmental Effects 19-1
19.2 Application 19-2
19.2.1 Step Height Measurements 19-2
19.2.2 Surface Texture Analysis 19-8
19.3 Conclusion 19-16

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Appendix A—Specifications A-1

Appendix B—Installing Upgraded Tencor P-2 Software B-1

Appendix C—Exporting Data C-1

Appendix D—Precision Locators D-1

Appendix E—Ordering Information E-1

Appendix F—Release Notes F-1

Glossary Glossary-1

Index Index-1

#183369 Rev. E 11/93

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Table of Figures and Tables

Figure 1-1	Tencor P-2 Long Scan Profiler	xxvii
Figure 1-2	Measurement Area of the Tencor P-2 Profiler	xxviii
Figure 1-3	Tencor P-2 Long Scan Profiler–Open Frame Configuration	xxix
Figure 1-4	Tencor P-2 Long Scan Profiler with Wafer Handler	xxx
Figure 2-1	Shockwatch Monitor	2-3
Figure 2-2	Tip-N-Tell Monitor	2-4
Figure 2-3	Removing the Shipping Turnbuckle	2-5
Figure 2-4	Stylus Protection Plate	2-7
Figure 2-5	Reset Date and Time Window	2-8
Figure 2-6	Lightweight Stage Table Top	2-9
Figure 2-7	Precision Locator	2-10
Figure 2-8	Old-Style Precision Locator	2-11
Figure 2-9	Installing the Yoke for Shipping	2-16
Figure 3-1	Auxiliary Panel	3-2
Figure 3-2	Built-In Keyboard	3-3
Figure 3-3	Remote PC/AT Enhanced Keyboard	3-5
Figure 3-4	Menu Bar	3-7
Figure 3-5	Recipe Menu	3-7
Figure 3-6	Sequence Menu	3-7
Figure 3-7	Data Menu	3-8
Figure 3-8	Analysis Menu	3-8
Figure 3-9	Config Menu	3-8
Figure 3-10	Calib Menu	3-9
Figure 3-11	Diag Menu	3-9
Figure 3-12	Exit Menu	3-9
Figure 3-13	Entering an ID in the Alphanumeric Window	3-10
Figure 3-14	Wafer Handler	3-12
Figure 3-15	Protecting the Stylus	3-15
Figure 3-16	Setting the Door Interlock Switch	3-17
Figure 3-17	Restricting Access to the Instrument with a Password	3-18
Figure 3-18	Enabling the Password	3-19
Figure 3-19	Entering a Password	3-19
Figure 3-20	Setting the Screen Colors	3-20
Figure 4-1	Handler Enable Window	4-2
Figure 4-2	Stage Table Controls (Front View)	4-2

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 4-3	Motion Screen	4-4
Figure 4-4	Stylus Lowered to Sample Surface	4-5
Figure 4-5	X, Y Stage Motion Coordinates	4-6
Figure 4-6	Default Recipe	4-8
Figure 4-7	Setting Up to Scan a Step	4-9
Figure 4-8	Scan Screen	4-10
Figure 4-9	Data Screen	4-11
Figure 4-10	Entering an ID for Saving Data	4-12
Figure 4-11	Saving Data with Database Manager Option	4-13
Figure 5-1	Default Recipe	5-3
Figure 5-2	Recipe Catalog	5-4
Figure 5-3	Sample Recipe for Segmented Scan	5-7
Figure 5-4	Surface Analysis Window	5-13
Figure 5-5	Surface Analysis–Additional Roughness Parameters Window	5-17
Figure 5-6	Determination of Bearing Length and Bearing Length Ratio	5-19
Figure 5-7	Fields for Bearing Ratio Parameter	5-19
Figure 5-8	Fields for Cutting Depth Parameter	5-20
Figure 5-9	Determination of Peak Count	5-20
Figure 5-10	Fields for Peak Count Parameter	5-21
Figure 5-11	Determination of High Spot Count	5-21
Figure 5-12	Fields for High Spot Count Parameter	5-22
Figure 5-13	Fields for Mean Peak Spacing Parameter	5-22
Figure 5-14	Save Recipe Window	5-23
Figure 5-15	Disk Storage Path Selection Window	5-24
Figure 5-16	Recipe Maintenance Window	5-25
Figure 5-17	Import Filename Window	5-25
Figure 5-18	Recipe Catalog	5-27
Figure 5-19	SECS Communications Window	5-29
Figure 5-20	SECS Configuration Window	5-29
Figure 5-22	Uploading Recipes to the Host	5-31
Figure 5-22	Alphanumeric ID Window	5-32
Figure 5-23	Downloading a Recipe from the Host	5-32
Figure 6-1	Setting the Lowest Elevator Position	6-3
Figure 6-2	Setting the XY Travel Limits	6-4
Figure 6-3	Handler Enable Window with Handler Disabled	6-6
Figure 6-4	Setting the Load and Measurement Positions	6-6
Figure 6-5	Precision Locator	6-7
Figure 6-6	Detent Disengage Lever	6-8
Figure 6-7	Motion Screen	6-9
Figure 6-8	Enabling the Handler	6-10

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 6-9	Handler Settings Window	6-10
Figure 6-10	Setting the Wafer Size Selector	6-13
Figure 6-11	Placing a Cassette on a Locator	6-13
Figure 6-12	Handler Load Window	6-14
Figure 6-13	Alignment Window	6-14
Figure 6-14	Wafer Orientation	6-15
Figure 6-15	Vacuum Chuck	6-16
Figure 6-16	Valve Position for 100-, 125-, or 150-mm Wafers	6-17
Figure 6-17	Valve Position for 200-mm Wafers	6-17
Figure 6-18	Valve Position for Older Chucks with 200-mm Wafers	6-17
Figure 6-19	Valve Position for Older Chucks with 125- or 150-mm Wafers	6-17
Figure 6-20	Motion Screen	6-18
Figure 6-21	Stylus Lowered to Sample Surface	6-19
Figure 6-22	X,Y Stage Motion Coordinates	6-21
Figure 6-23	Measurement Chamber Internal Dimensions–Standard Configuration	6-22
Figure 6-24	Measurement Chamber Internal Dimensions–Open Frame Configuration	6-22
Figure 6-25	Motion Screen in Precision Mode	6-25
Figure 6-26	Motion Screen with Die Grid Window	6-26
Figure 6-27	Die Locations	6-27
Figure 6-28	Default Recipe	6-29
Figure 6-29	Setting Up to Scan a Step	6-30
Figure 6-30	Scan Screen	6-31
Figure 6-31	Handler Unload Window	6-32
Figure 6-32	Tilting the Stage	6-34
Figure 6-33	Rotating the Stage	6-35
Figure 6-34	Open Frame Configuration Rotation Clearance (Top View)	6-36
Figure 6-35	Adjusting Theta Zero Offset	6-38
Figure 6-36	Setting the Center Offset	6-39
Figure 6-37	Unleveled Trace	6-40
Figure 6-38	Leveling the Stage	6-41
Figure 6-39	Mechanical Level Angle Window	6-42
Figure 6-40	Setting the Leveling Offset	6-43
Figure 6-41	Enabling the SECS Option	6-44
Figure 6-42	Setting SECS to Upload Data	6-44

Figure 7-1	Data Screen	7-2
Figure 7-2	Unleveled Profile Trace	7-4
Figure 7-3	Profile of Fig. 7-2 After Leveling	7-5
Figure 7-4	Measurement Cursors–Delta Average Mode	7-7

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 7-5	Data Zooming in the Data Screen	7-10
Figure 7-6	Summary Window	7-11
Figure 7-7	Edges of a Step	7-12
Figure 7-8	Convex and Concave Arcs	7-12
Figure 7-9	Automatic Cursor Positioning and Minimum Plateau Width	7-14
Figure 7-10	Edge/Arc Detection Setup Window	7-15
Figure 7-11	Enabling Automatic Cursor Positioning from Surface Analysis (1) Window	7-16
Figure 7-12	Step Counting for StpN, StpMn, and StpSD Parameters	7-18
Figure 7-13	Scan 1 with Automatic Cursor Positioning Enabled	7-19
Figure 7-14	Scan 2 with Automatic Cursor Positioning Enabled	7-19
Figure 7-15	Scan 3 with Automatic Cursor Positioning Enabled	7-20
Figure 7-16	Automatic Cursor Positioning Set to Detect the Apex of a Peak	7-20
Figure 7-17	Arc Segment Dimensions	7-21
Figure 7-18	Enabling Fit and Level from the Recipe Screen	7-24
Figure 7-19	Curved Trace Before Fit and Level	7-25
Figure 7-20	Curved Trace After Fit and Level	7-26
Figure 7-21	Selecting the Disk Path	7-27
Figure 7-22	Save Recipe Window	7-27
Figure 7-23	Database Save IDs Window	7-28
Figure 7-24	Data Catalog	7-29
Figure 7-25	Database Recall IDs	7-30
Figure 7-26	Database Catalog	7-31

Figure 8-1	Effect of Filtering on Scan Data	8-1
Figure 8-2	Tencor P-2 Hardware and Software Filters	8-2
Figure 8-3	The Effect of the Analog Filter on Signal Transmission	8-3
Figure 8-4	The Effect of the Short Wave Cutoff on Signal Transmission	8-6
Figure 8-5	The Long Wave Cutoff used as a Short Wave Pass in order to Measure Roughness	8-7
Figure 8-6	The Long Wave Cutoff Used as a Long Wave Pass in order to Measure Waviness	8-7
Figure 8-7	Summary of Signal Transmission Curves and their Corresponding Display Data	8-8
Figure 8-8	Surface Analysis Window	8-9
Figure 8-9	Signal Transmission when the Short Wave Cutoff is Set to a Value Higher than the Analog Filter	8-11

Figure 9-1	Maximum Downward Travel Not Large Enough to Scan Valley	9-3
Figure 9-2	Example Trace—Stylus Force Too Low for Valley Depth	9-3

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 9-3	Scanning an Unleveled Surface at Low Stylus Force	9-4
Figure 9-4	Example Trace—Sample Surface Not Level at Low Stylus Force (Data Leveled Correctly)	9-5
Figure 9-5	Example Trace—Sample Surface Not Level at Low Stylus Force (Data Leveled Incorrectly)	9-6
Figure 9-6	Replacing the MicroHead Stylus	9-9
Figure 9-7	Replacing the Extended Range MicroHead Stylus	9-10
Figure 9-8	Field Lens Installation	9-13
Figure 9-9	Upstop Screw	9-13
Figure 9-10	Measurement Head Setup Window	9-15
Figure 9-11	Stylus Force Test Choices Window	9-16
Figure 9-12	Stylus Force Parameters Window	9-16
Figure 9-13	Stylus Force Test Choices Window	9-17
Figure 9-14	Stylus Force-Deflection Response Window Before Calibration	9-18
Figure 9-15	Stylus Force-Deflection Response Window After Calibration	9-18
Figure 9-16	MicroHead Stylus Force Offset Adjustment	9-19

Figure 10-1	Sequence Program Screen–Left Side Active	10-3
Figure 10-2	Sequence Program Screen–Right Side Active	10-4
Figure 10-3	Saving the Sequence Program	10-4
Figure 10-4	Sequence Catalog	10-6
Figure 10-5	Referencing Deskew Points	10-8
Figure 10-6	Print Options Window	10-10
Figure 10-7	Select Random Slots Window	10-12
Figure 10-8	Selecting Cassette Slots	10-13
Figure 10-9	Sort Options Window	10-15
Figure 10-10	Sort Parameter Values Window	10-16
Figure 10-11	Programming Sequence Locations	10-19
Figure 10-12	X, Y Stage Motion Coordinates	10-22
Figure 10-13	Motion Screen	10-23
Figure 10-14	Data ID Labels Window	10-26
Figure 10-15	Setting the Wafer Size Configuration Dial	10-27
Figure 10-16	Placing a Cassette on the Locator	10-28
Figure 10-17	Database Sequence IDs Window	10-30
Figure 10-18	Uploading Sequence Data	10-31
Figure 10-19	Export Filename Window	10-31
Figure 10-20	Data Screen in Sequence Mode	10-33
Figure 10-21	Data Screen after Sequence Completion	10-34
Figure 10-22	Motion Screen	10-38
Figure 10-23	Sequence IDs Window	10-38
Figure 10-24	Data Screen	10-39
Figure 10-25	Database Save IDs Window	10-40

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 10-26	Database Recall IDs Window	10-41
Figure 10-27	Database Catalog	10-42
Figure 10-28	Sequence Data Screen	10-43
Figure 10-29	Summary Screen	10-44
Figure 10-30	Printing Sequence Data	10-45
Figure 10-31	Sample Printout of Summary Statistics	10-46
Figure 10-32	Sample Printout of Point Data and Statistics	10-46
Figure 10-33	Sequence Catalog	10-47
Figure 10-34	Sequence Maintenance Menu	10-48
Figure 10-35	Entering the Import Filename	10-49
Figure 10-36	Directory of Files Available for Import	10-49
Figure 10-37	Enabling SECS	10-52
Figure 10-38	SECS Configuration Window	10-53
Figure 10-39	Uploading a Sequence Program to Host	10-55
Figure 10-40	Alphanumeric Window	10-56
Figure 10-41	Downloading a Sequence Program	10-56

Figure 11-1	Database Recall IDs	11-2
Figure 11-2	Selection Data Catalog with Selected Sequence Results	11-3
Figure 11-3	Combined Selection Save IDs Window	11-4
Figure 11-4	Combined Sequence Data Screen	11-5
Figure 11-5	Printing Sequence Data	11-6

Figure 12-1	Database Recall IDs Window	12-1
Figure 12-2	Data Branch in Sample Database	12-3
Figure 12-3	Database Password Window	12-4
Figure 12-5	Database Configuration Window	12-5
Figure 12-4	Configuring Database ID Labels	12-5
Figure 12-6	Database Recall IDs Window	12-6
Figure 12-7	ID Value List	12-7
Figure 12-8	Editing ID Values	12-7
Figure 12-9	Create ID Value Window	12-8
Figure 12-10	Renaming a Data ID	12-9
Figure 12-11	Restricting Access to Save ID Values	12-10
Figure 12-12	Entering a New Password	12-11
Figure 12-13	Database Recall IDs Window	12-12
Figure 12-14	Database Save IDs	12-13
Figure 12-15	Database Save IDs Window	12-14
Figure 12-16	ID Value List	12-15
Figure 12-17	Specifying Beginning Time	12-16
Figure 12-18	Specifying Ending Time	12-16
Figure 12-19	Database Catalog	12-17

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 12-20	Selecting the Disk Path	12-19
Figure 12-21	Entering the Export Filename	12-19
Figure 12-22	Data Maintenance Window	12-21
Figure 12-23	Database Purge IDs Window	12-22
Figure 12-24	Specifying Beginning Time	12-23
Figure 12-25	Specifying Ending Time	12-23
Figure 12-26	Entering the Import Filename	12-24
Figure 12-27	Directory of Files Available for Import	12-25
Figure 12-28	Database Backup IDs Window	12-26
Figure 12-29	Database Restore IDs Window	12-28

Figure T-1	Major and Minor IDs	T-1
Figure T-2	Data Maintenance Window	T-3
Figure T-3	Checking if the Training Data is Loaded	T-3
Figure T-4	Sample Database Catalog	T-4
Figure T-5	Database Recall IDs Window	T-5
Figure T-6	ID Values List	T-6
Figure T-7	Editing ID Values	T-6
Figure T-8	Database Save IDs Window	T-7
Figure T-9	Disk Storage Path Selection Window	T-8
Figure T-10	Database Backup IDs Window	T-9
Figure T-11	Deleting Multiple Items of Data	T-11

Figure 13-1	Taking a Difference Measurement	13-3
Figure 13-2	Taking a Poststress-Only Measurement	13-4
Figure 13-3	Handler Wafer Stress Chuck	13-7
Figure 13-4	Saving Prestress Data	13-8
Figure 13-5	Stress Screen	13-11
Figure 13-6	ID Window	13-13
Figure 13-7	Database Recall IDs Window	13-15
Figure 13-8	Difference Trace and Data	13-16
Figure 13-9	Stress Screen: Poststress-Only Measurement	13-17

Figure 14-1	Save Recipe Window	14-2
Figure 14-2	3-D Recipe	14-2
Figure 14-3	3-D Data Screen	14-5
Figure 14-4	Additional 3-D Data Screen Keys	14-7
Figure 14-5	Selecting a Trace	14-8
Figure 14-6	Contour Display	14-9
Figure 14-7	Leveling a Set of 3-D Data	14-10

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 14-8	Zoom Option Screen	14-11
Figure 15-1	Tencor Offline Program Directory Structure	15-5
Figure 17-1	Diagnostic Scan	17-2
Figure 17-2	Replacing the Stylus Using Tweezers	17-3
Figure 17-3	Replacing the Stylus Using Plastic Forceps	17-5
Figure 17-4	Tencor Stylus Radius Measurement Tool	17-7
Figure 17-5	Recipe for Determining Stylus Radius	17-7
Figure 17-6	Positioning to Start Scan	17-8
Figure 17-7	Typical Data from Scanning Stylus Radius Measurement Tool	17-8
Figure 17-8	Cursor Positioning for Radius Determination	17-9
Figure 17-9	Focusing the Optics	17-10
Figure 17-10	Making a Theta Reference Adjustment	17-11
Figure 17-11	Installing the Stylus Protection Plate	17-14
Figure 17-12	Removing the Head Assembly	17-15
Figure 17-13	Installing the Replacement Head Assembly	17-16
Figure 17-14	Measurement Head Setup Window	17-18
Figure 17-15	Sample Calibration Label	17-19
Figure 17-16	Stylus Force Offset Window	17-19
Figure 17-17	Measurement Head Shipping Label	17-20
Figure 17-18	Calibration Window	17-21
Figure 17-19	Step Height Calibration Window	17-22
Figure 17-20	Radius Calibration Window	17-23
Figure 17-21	Multipoint Step Height Calibration Window	17-25
Figure 17-22	Stylus Force Offset Window	17-27
Figure 17-23	Adjusting the Stylus Force Offset	17-28
Figure 17-24	Tencor Stylus Alignment Tool	17-29
Figure 17-25	150X150_CAL Stylus Offset Calibration Recipe	17-30
Figure 17-26	Cross Hair Alignment Pattern	17-30
Figure 17-27	Stage Configuration Window	17-32
Figure 17-28	Stylus Offset Calibration Window	17-32
Figure 17-29	Stage Configuration Window after Position Learn	17-33
Figure 17-30	Right-angle-shaped Feature	17-33
Figure 17-31	Keyboard Diagnostics Window	17-38
Figure 17-32	Printer Diagnostics Window	17-39
Figure 18-1	Disk Storage Path Selection Window	18-1
Figure 18-2	Tencor P-2 Directory Structure	18-13

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 19-1	Step Height Measurement of a Smooth Surface	19-2
Figure 19-2	Delta Averaging	19-2
Figure 19-3	Travel Path of the Stylus	19-3
Figure 19-4	Effect of Stylus Radius and Stylus Tip Angle on a High Step	19-3
Figure 19-5	Effect of Stylus Radius on a Narrow Groove	19-4
Figure 19-6	Stylus Radius and Groove Width Loss Relation	19-5
Figure 19-7	Short Wavelength Cutoff Curves	19-6
Figure 19-8	Trace at 1 mm/s Speed	19-7
Figure 19-9	Trace at 5 mm/s Speed	19-7
Figure 19-10	Trace at 10 mm/s Speed	19-8
Figure 19-11	Three Classes of Surface Texture	19-9
Figure 19-12	Tencor P-2 Separates Surface Texture into Roughness and Waviness	19-9
Figure 19-13	Same R_a for Different Surfaces	19-10
Figure 19-14	Cutoff Wavelength	19-15

Figure D-1	Locator for 4-in. Wafer with Flat or Square Substrate	D-3
Figure D-2	Locator for 4-in. Wafer with Notch	D-3
Figure D-3	Locator for 5-in. Wafer with Flat or Square Substrate	D-3
Figure D-4	Locator for 5-in. Wafer with Notch	D-3
Figure D-5	Locator for 6-in. Wafer with Flat or Square Substrate	D-4
Figure D-6	Locator for 6-in. Wafer with Notch	D-4
Figure D-7	Locator for 8-in. Wafer with Notch	D-4
Figure D-8	Locator for 2-in. Wafer with Flat or Square Substrate	D-5
Figure D-9	Wafer Stress Locator for 2-in. Wafer with Flat or Square Substrate	D-5
Figure D-10	Locator for 3-in. Wafer with Flat or Square Substrate	D-5
Figure D-11	Wafer Stress Locator for 3-in. Wafer with Flat or Square Substrate	D-5
Figure D-12	Locator for 4-in. Wafer with Flat or Square Substrate	D-6
Figure D-13	Wafer Stress Locator for 4-in. Wafer with Flat or Square Substrate	D-6
Figure D-14	Locator for 4-in. Wafer with Notch	D-6
Figure D-15	Wafer Stress Locator for 4-in. Wafer with Notch	D-6
Figure D-16	Locator for 5-in. Wafer with Flat or Square Substrate	D-7
Figure D-17	Wafer Stress Locator for 5-in. Wafer with Flat or Square Substrate	D-7
Figure D-18	Locator for 5-in. Wafer with Notch	D-7
Figure D-19	Wafer Stress Locator for 5-in. Wafer with Notch	D-7
Figure D-20	Locator for 6-in. Wafer with Flat or Square Substrate	D-8
Figure D-21	Wafer Stress Locator for 6-in. Wafer with Flat or Square Substrate	D-8

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure D-22	Locator for 8-in. Wafer with Notch	D-8
Figure D-23	Wafer Stress Locator for 8-in. Wafer with Notch	D-8
Figure D-24	Locator for 8-in. Wafer with Flat or Square Substrate	D-9
Figure D-25	Wafer Stress Locator for 8-in. Wafer with Flat or Square Substrate	D-9
Figure D-26	Locator for 82-mm Wafer with Notch	D-9
Figure D-27	Wafer Stress Locator for 82-mm Wafer with Notch	D-9
Figure D-28	2.5-in. Disc Locator	D-10
Figure D-29	3.5-in. Disc Locator	D-10
Figure D-30	5.25-in. Disc Locator	D-10
Figure D-31	8-in. Disc Locator	D-10
Figure D-32	9-in. Disc Locator	D-11

TABLES

Table 5-1	Recommended Stylus Force Versus Scan Speed	5-8
Table 5-2	Determining the Stylus Radius	5-9
Table 5-3	Full Scale Ranges	5-10
Table 5-4	Long Wave Cutoff Filter Lengths	5-11
Table 8-1	Default Short Wave Cutoff Wavelengths	8-5
Table 8-2	Long Wave Cutoff Filter Lengths	8-10
Table 8-3	Short Wave Cutoff Filter Lengths	8-10
Table 9-1	Maximum Downward Travel for Particular Values of Stylus Force	9-2
Table 9-2	Determining the L-Stylus Radius	9-7
Table 9-3	Minimum Stylus Forces to Cover Full Vertical Ranges Below Null	9-8
Table 9-4	Available Objective Lenses for the MicroHead Option	9-11
Table 10-1	Determining the Back-Scan Distance	10-23
Table 13-1	Elastic Constants for Commonly Used Thin Film Substrates	13-12
Table 17-1	Determining the Stylus Radius	17-2
Table 17-2	Available Dimensions for Figure 17-30	17-34

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Table 18-1	Troubleshooting Files	18-8
Table 18-2	Root Directory Files	18-14
Table 18-3	TENCOR Directory Files	18-15
Table 18-4	SYS Directory Files	18-16
Table 18-5	UTIL Directory Files	18-17
Table 18-6	DB Directory Files	18-18
Table 18-7	RECIPE Directory Files	18-19
Table 18-8	SEQ Directory Files	
Table 18-9	SDATA Directory Files	18-19
Table 18-10	HELP Directory Files	18-20

Table 19-1	Groove Width Loss for Different Radii and Groove Depths	19-4
Table 19-2	Miscellaneous Surface Analysis Parameter Descriptions	19-11
Table 19-3	Roughness Parameter Descriptions	19-12
Table 19-4	Waviness Parameter Descriptions	19-12
Table 19-5	Additional Surface Roughness Parameter Option	19-13
Table 19-6	Additional Intermediate and Extended Long Wave Cutoff Filters	19-14

Table C-1	ASCII and Binary File Extensions and Directories	C-4
Table C-2	Database Seven-Level IDs Format	C-5
Table C-3	Line 1 Format	C-6
Table C-4	Recipe Format	C-6
Table C-5	Summary Data Format	C-9
Table C-6	Raw Data or Raw Trace Format	C-10
Table C-7	Statistics Format	C-11
Table C-8	Database Seven-Level IDs Line Format	C-12
Table C-9	Recipe Format	C-13
Table C-10	Surface Parameter Table	C-16
Table C-11	Summary Data Format	C-18
Table C-12	PARAM_ITEM: Parameter Result Item Format	C-19
Table C-13	Raw Data Format	C-20
Table C-14	Sequence Program Format	C-21
Table C-15	SORT_RCP: Sort Recipe Format	C-23
Table C-16	SORT_PARAM: Sort Parameter Format	C-23
Table C-17	STAGE_POS: Stage Position Format	C-23
Table C-18	SEQ_P: Sequence Location Format	C-24
Table C-19	Sequence Data Component Format	C-24
Table C-20	Statistics Format	C-25
Table C-21	STAT_PARAM: Statistics Parameter Format	C-25
Table C-22	Cutoff Filter Length Codes	C-26

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

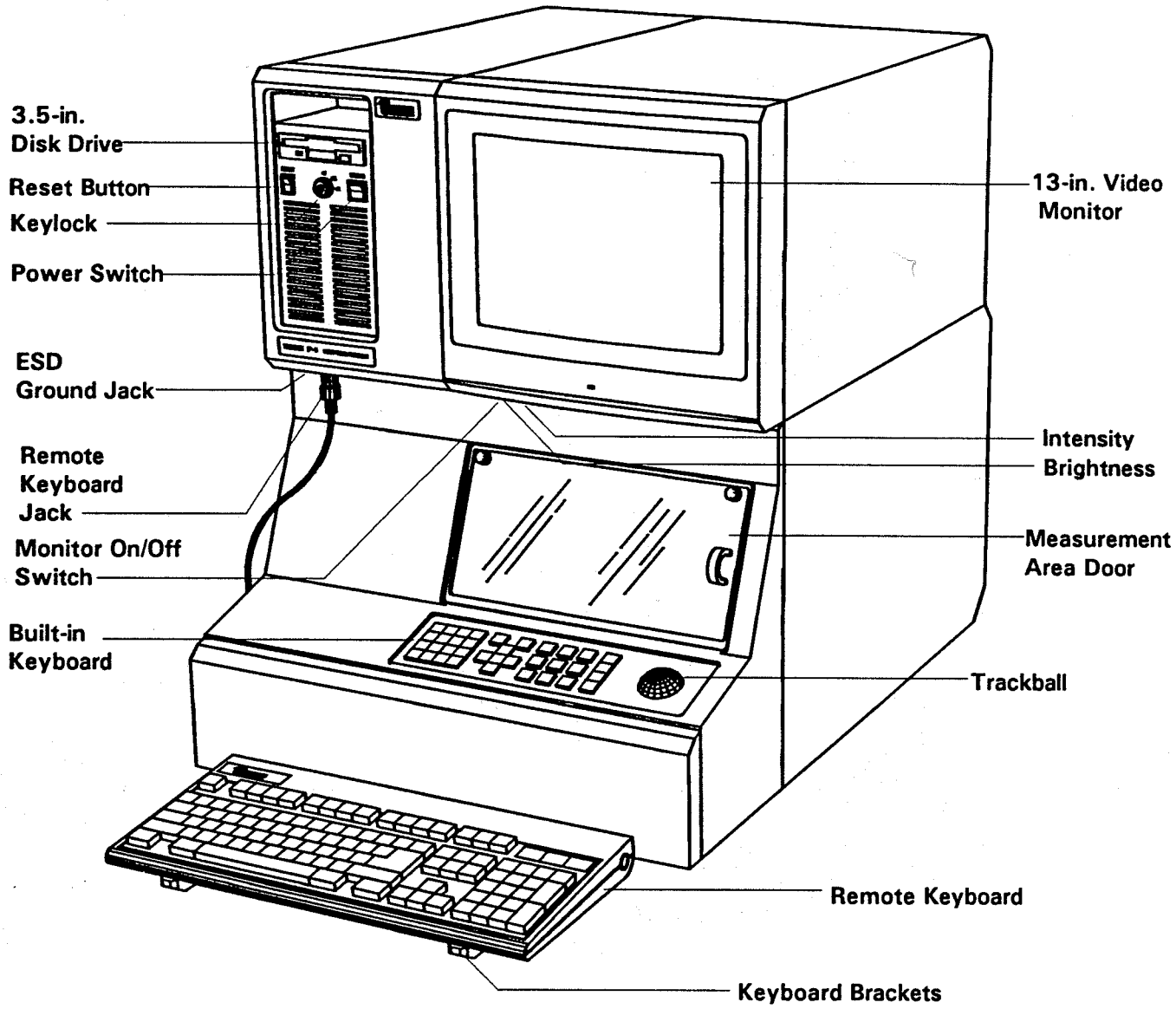


Figure 1-1 Tencor P-2 Long Scan Profiler

#183369 Rev. E 11/93

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

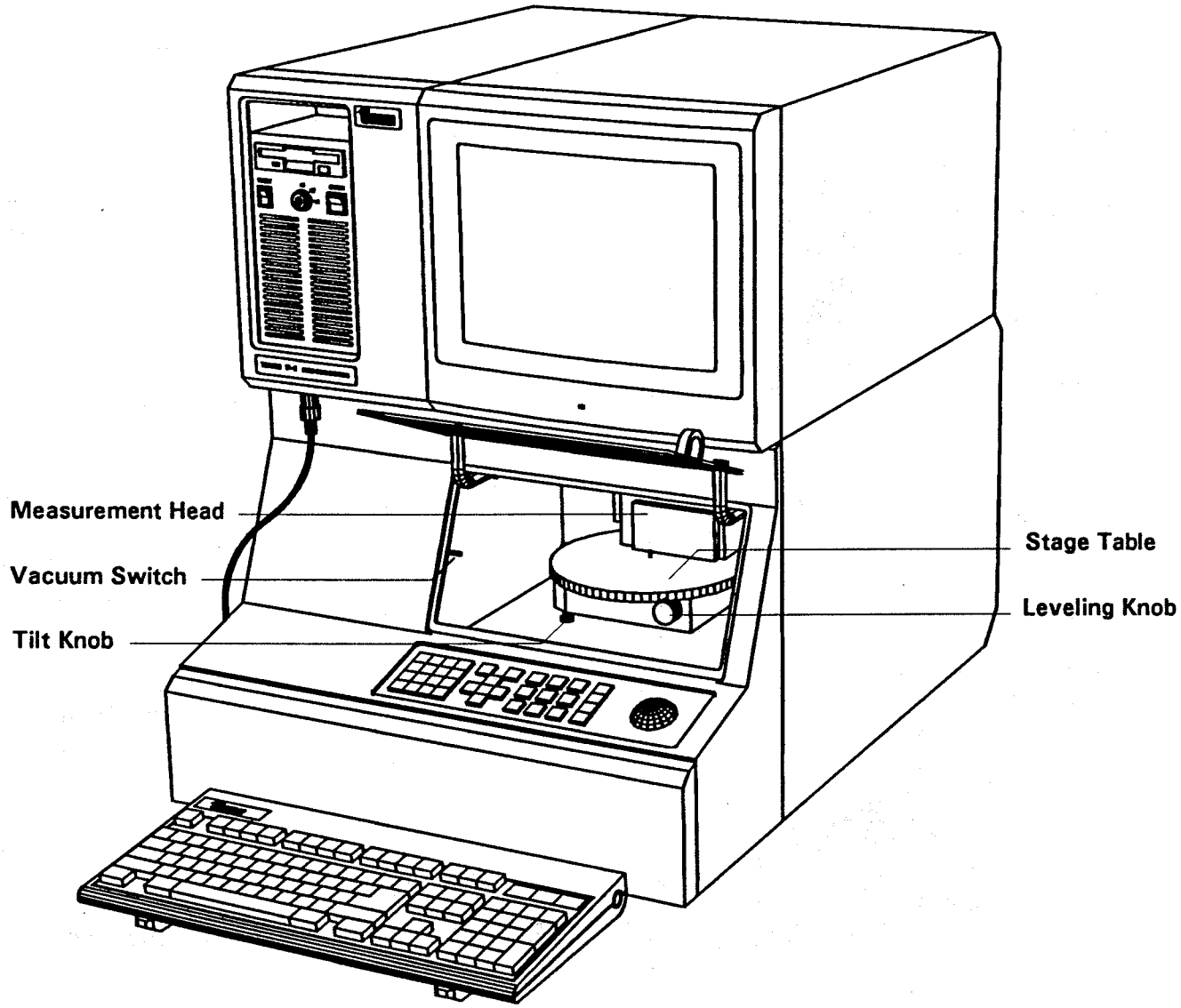


Figure 1-2 Measurement Area of the Tencor P-2 Profiler

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

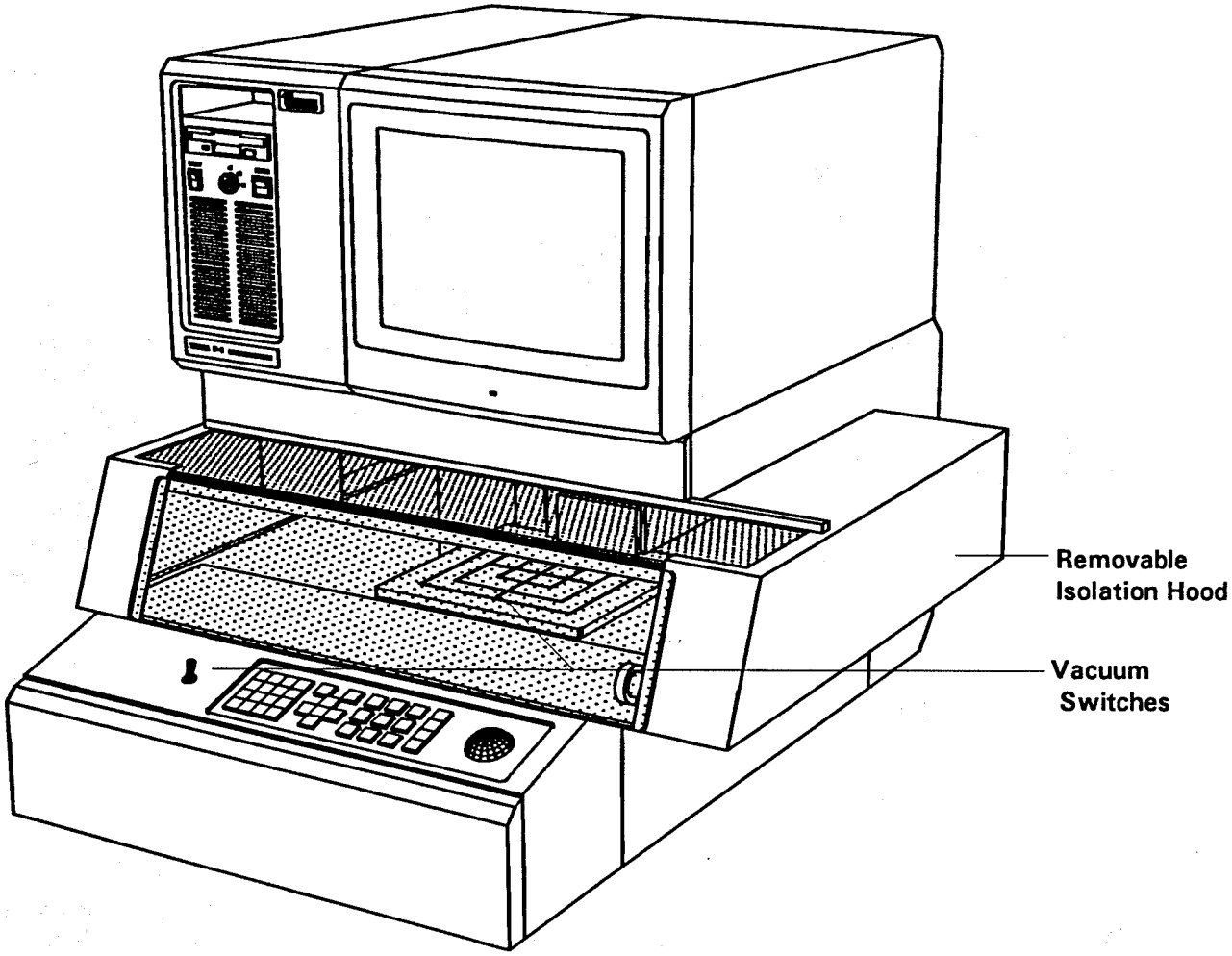


Figure 1-3 Tencor P-2 Long Scan Profiler–Open Frame Configuration

#183369 Rev. E 11/93

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

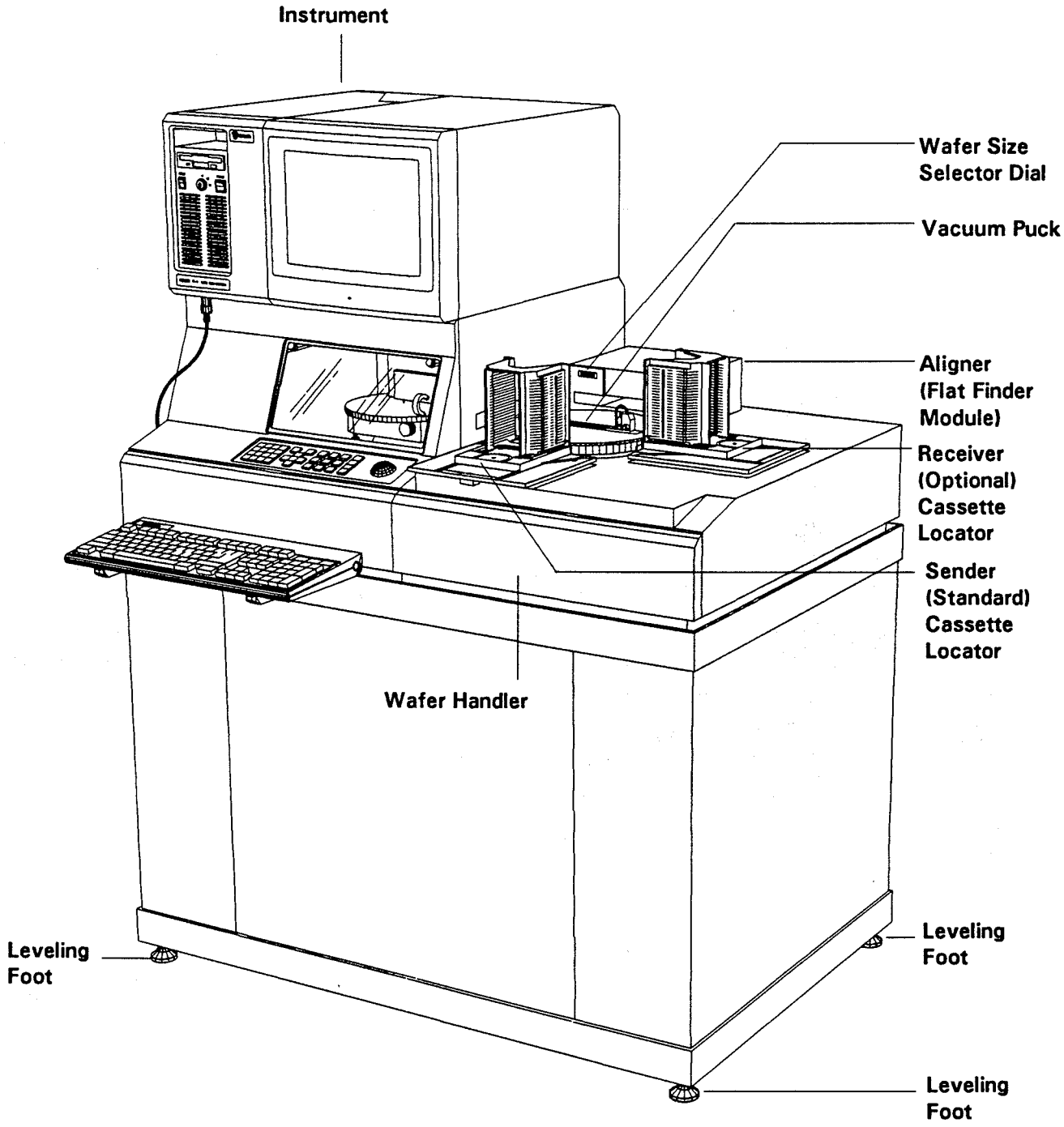


Figure 1-4 Tencor P-2 Long Scan Profiler with Wafer Handler

#183369 Rev. E 11/93

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

1 INTRODUCTION

1.1 ABOUT THIS MANUAL

This manual describes in detail the operation of the Tencor P-2 Long Scan Profiler. This manual is intended as a tutorial and reference for individuals who will use the P-2 to inspect and analyze sample surfaces, and as an general guide to configuration and maintenance of the instrument.

This manual consists of the following chapters:

- Chapter 1, "Introduction," discusses how to use the manual, terminology used, and an overview of the instrument and its features.
- Chapter 2, "Installation," details the procedures necessary for installation of the instrument.
- Chapter 3, "Basic Skills," provides information on starting the instrument and a description and overview of the controls and the measuring software.
- Chapter 4, "Getting Started," is a brief tutorial on how to load and measure a sample.
- Chapter 5, "Writing a Recipe," provides detailed information on creating, editing, copying, and saving profile recipes.
- Chapter 6, "Profiling a Sample," provides detailed information on loading samples, locating sample features, and collecting data from the sample surface.
- Chapter 7, "Analyzing the Profile," discusses analysis of the sample data, as well as editing and saving the data.
- Chapter 8, "Data Analysis: Band Pass Filter," provides information on the use of the Band Pass Filter software for separation of the roughness and waviness components of data.
- Chapter 9, "MicroHead Low Moment Measurement Head Option," describes the use of the optional MicroHead measurement head.
- Chapter 10, "Automatic (Sequence) Operation," covers creating, editing, and saving sequence programs with the Automatic Long Scan Profiler or instruments equipped with the Sequence/Database Manager Option.
- Chapter 11, "Sort/Combined Statistics Option," provides information on the Sort/Combined Statistics software option, which allows statistical analysis of groups of data for statistical process control.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

- Chapter 12, "Database Manager Option," provides information about configuring and using the Database Manager software with the Automatic Long Scan Profiler or instruments equipped with the Sequence/Database Manager Option.
- Chapter 13, "Wafer Stress Option," provides information about the use of the Wafer Stress software option for analysis of thin film stress.
- Chapter 14, "Interactive 3-D Option," provides information on writing 3-D profile recipes, profiling samples, and analyzing the 3-D data with instruments equipped with the Interactive 3-D software option.
- Chapter 15, "Offline P-2 Program," describes the system requirements, software installation, and operation of the optional Offline P-2 Program.
- Chapter 16, "Error Messages," lists and describes error messages that can result when operating the instrument.
- Chapter 17, "Hardware Maintenance," discusses the Tencor Instruments service policy, troubleshooting, changing the stylus, and similar hardware issues.
- Chapter 18, "Software Maintenance," discusses troubleshooting, utility programs, backing up and recovering data, and similar software issues.
- Chapter 19, "Theory of Operation," describes the principles behind the operation of the P-2 Long Scan Profiler and information about the interpretation of data gathered with the instrument.
- Appendixes, a glossary, and an index are also provided at the end of this manual.

1.2 RELATED MANUALS

Tencor Instruments also provides the *Tencor Profiler SECS Interface Manual* detailing the SECS Interface Option.

1.3 HOW TO USE THIS MANUAL

To get the most out of this manual, first-time users should proceed sequentially through the following three chapters to get an overview of the instrument and its operation:

- Chapter 1, "Introduction," on manual conventions, terminology, an overview of the instrument, and a list of hardware and software features.
- Chapter 3, "Basic Skills," on starting and shutting down the instrument, cautionary information, and basic hardware and software operations.
- Chapter 4, "Getting Started," for a guided tutorial example showing basic procedures for measuring samples with the instrument.

The remaining chapters provide detailed reference material about the various aspects of the instrument.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

1.4 CONVENTIONS USED IN THIS MANUAL

This manual uses typographic formatting and symbols to make your learning experience faster and easier. These conventions are introduced in the following sections.

1.4.1 TYPOGRAPHIC FORMATTING

Keep these conventions in mind while reading this manual:

Term	Meaning
abc...xyz	Italics are used to identify information you type using the operator keypad or the computer keyboard.
CD D:\DATA	Messages and examples appear in bold text.
LOAD	The keys or buttons you must press appear in small, capitalized letters.
ALT + S	When you see several keys divided by plus signs, hold down the first key while pressing the remaining keys. For instance, hold down ALT while pressing S.
Config menu	Menus and windows are shown with initial capital letters.
Direction field	The term *field* is used to identify the location of areas on screens where you can type data. The actual field name or description usually appears on the screen next to the location where data is entered. Some fields are for display purposes only and do not accept data.
[←] [→] [↑] [↓]	The arrow keys on the keyboard move the screen cursor around the display. To move the cursor in a specific direction, press the arrow key pointing in the desired direction. Arrow keys can only move the cursor in horizontal or vertical directions. The trackball located on the right side of the keyboard duplicates the actions of the arrow keys and allows diagonal cursor movement.
Enter	The word *enter* is often used in conjunction with data that you type using the keyboard. To enter data means to type the words or data and press the ENTER key.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

NOTE: Notes are boxed when it is vital that you remember the information that follows inside the box.

CAUTION: Boxed information that follows the word *caution* or *warning* means that you can damage the instrument or injure yourself if you do not heed the caution.

1.4.2 TERMINOLOGY

Before continuing, you need to familiarize yourself with several terms used throughout this publication. A more complete listing of words and terms is provided in the glossary at the back of the manual. Since many of the terms are used in conjunction with one another, you might need to read the list twice to understand fully every word or term.

Arrow Keys The four arrow keys found on the operator keypad and computer keyboard. Each arrow key points in a specific direction. When you want to move the selection bar in menus, press [↓] to move the bar downwards and [↑] to move the bar upwards. When editing text or moving within the data entry fields, the cursor moves in the direction of the arrow labeled on the key. When more than one data field appears on a single line, pressing [↓] or [↑] moves the cursor forward or backward through the fields.

Boot A term used to describe the operation of powering up a computer where the computer loads operating system software and sets up its internal software configuration by itself.

Choose The terms *choose* and *select* are used interchangeably to describe the actions you take when selecting options from the screen with the operator keypad or trackball.

Command The action associated with one of the options appearing on a menu and activities performed when keys are pressed on the keyboard or keypad.

Cursor A small rectanglular marker appearing in the alphanumeric fields. The cursor serves as a pointer marking the location where characters appear when you type. When a window first appears on the display, the cursor appears in the first field in the upper left corner of the window or screen.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Database A set of computer files containing information and the software used to maintain and access the information. The Tencor P-2 database contains recipe data describing how to perform scans as well as the associated scan data files themselves.

Directory Computer files are stored on the computer's hard disk in directories. The directory name identifies the location where the files are stored. For instance, the \TENCOR directory contains program and data files necessary to run the Tencor P-2 main program.

Field Reserved area provided on many windows for typing data, displaying data, or selecting options associated with the field. Three types of fields can appear on windows—*data entry fields*, *option fields*, and *display-only fields*. Data entry fields are reserved for typing numeric values or alphanumeric data for recipe parameters. Option fields have associated tables with predefined values. Display-only fields are used by the instrument to display the current status of inspections and values acquired after calculating inspection results.

Highlight A field that has a different background from the other fields indicating that the highlighted field is to be selected or used for data entry.

Keyboard Instrument operation is performed using the built-in computer keyboard or the optional remote keyboard. The keyswitch must be set to position 1 to enable the computer keyboard.

Menu A list of commands that can be selected. Drop-down menus are accessed from the menu bar at the top of the Tencor P-2 screen.

Option One of several items you can select when programming recipe parameters. Many recipe parameter fields have an associated set of options that influence the behavior of the instrument when measurements are performed.

Profile If you intersect a surface with a plane, the line formed is a profile. The Tencor P-2 measures a profile by scanning a surface with a stylus. As the stylus moves up and down, the instrument records the variation along the length measured.

Prompt An indication from the computer that it is waiting for information or instructions from the user.

Reboot A term used to describe the operation of resetting a computer (without necessarily turning off the power) where the computer reloads operating system software and resets its internal software configuration. Usually used when some problem has caused the computer to lock up or crash, and as a final step in many installation procedures for software applications.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Recipe The Tencor P-2 takes a scan based on the settings selected by the user in the recipe. A recipe is a list of scan parameters such as scan length, stylus force, and vertical range/resolution. A recipe also contains instructions for the analysis of the data collected in the scan.

Scan Action performed when the Tencor P-2 measures a sample surface. Also used interchangeably with *profile* to describe the profile trace.

Screen Generic term used to describe the information appearing on the computer display at any given moment. Specific screens (such as the Recipe screen) identify the main displays of the Tencor P-2, as distinguished from smaller subscreens called *windows* that can appear over the main screens.

Select The terms *select* and *choose* are used interchangeably to describe the actions you take when selecting options from the screen with the built-in keyboard, remote keyboard, or the trackball.

Window Small to large rectangular boxes that open on the screen. Windows are displayed when the Tencor P-2 software needs more information about the action being performed. Windows are also used to display a message when an action cannot be performed for some reason.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

2.4 SHIPPING

If you need to return the instrument to the factory, make the following shipping preparations:

- Before powering down the instrument, disconnect the vacuum line (if present) from the rear right corner of the instrument.
- Install the stylus protection plate to protect the stylus; install the yoke, which holds down the stage during transport; hook the turnbuckle, which prevents upward movement of the elevator due to a large shipping shock; and, park the hard disk. All the procedures are described in the following sections.

To install the stylus protection plate (Fig. 2-4):

1. Raise the measurement head door.
2. The red-colored stylus protection plate is stored on the storage screw on the left side of the measurement head. Unscrew the thumb nut holding the stylus protection plate and remove the plate.
3. Hold the stylus protection plate with the guide pins facing up and insert the guide pins into the holes on the left and right sides of the base plate below the stylus.
4. Screw the thumb nut on the screw above the base plate to hold the stylus protection plate in place.

To install the yoke (Fig. 2-9):

1. Center the stage under the measurement head.
2. Place the yoke on the stage such that the ends of the yoke rest on the X-drive assembly and *not on the guide bar.* The guide bar is the raised bar to the rear of the X-drive assembly.

> **CAUTION: If the yoke scratches the guide bar, the guide bar will need to be replaced.**

3. Move the stage back until the stylus protection plate is centered over the yoke in both the X-axis (side to side) and Y-axis (front to back) directions.
4. Lower the head by pressing [↓] and holding, then pressing SEL to shift to maximum speed until the head stops automatically. Note: Make sure the stylus protection plate is centered on the yoke.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

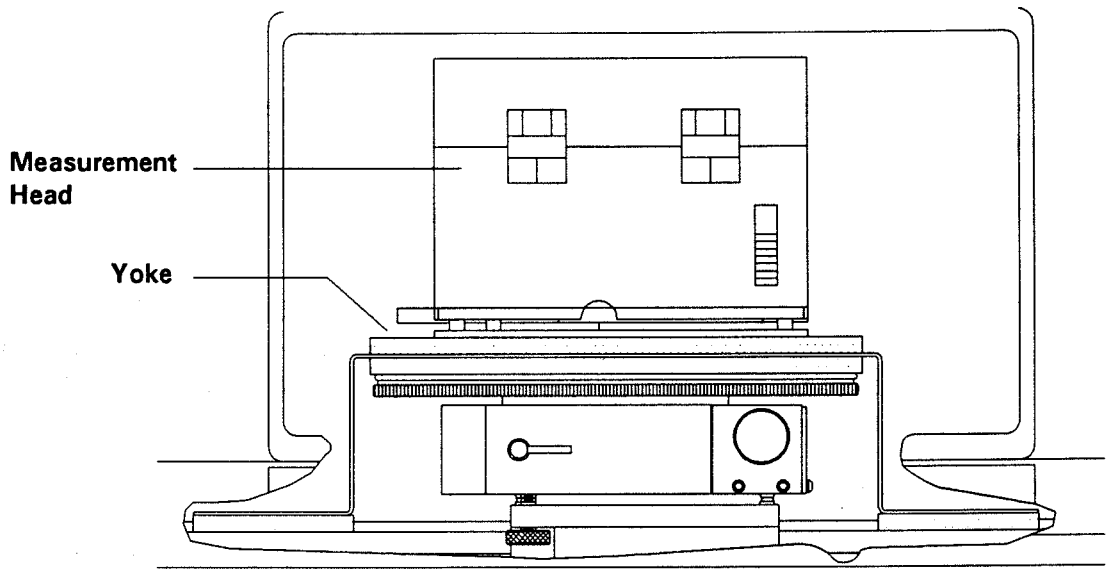


Figure 2-9 Installing the Yoke for Shipping

When the yoke is positioned properly, the head holds the stage firmly in place. The yoke also holds down the X-drive assembly.

To attach the shipping turnbuckle (Fig. 2-3):

1. Remove the left side panel:
   - Each of the side panels is held by two thumb nuts on the inside upper corners. Support the side panel from the outside and unscrew each of the thumb nuts. After removing the thumb nuts, gently lift the side panel away from the instrument.
2. Hook one end of the turnbuckle into the hole on the left side of the measurement head and hook the other end onto the scanner base. See Fig. 2-3.
3. Make sure there is some Vibratite or other thread locker on the turnbuckle screw. Tighten the screw until it just begins to pull the elevator down. *Do not* overtighten. Make sure there is approximately 1/16 in. between the elevator casting and the top of the elevator lead screw post. This gap should be visible from the front of the instrument. If there is an insufficient gap and you have not overtightened the screw, try adjusting the stop sensor on the back of the elevator.
4. Replace the side panels.

CAUTION: You must park the hard disk before moving or shipping the instrument. Failure to do so can result in damage to the hard disk. See the following procedure for details.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To park the hard disk:

1. From the menu bar, choose Shutdown from the Exit menu and press ENTER.
2. At the prompt, turn off power to the instrument. This procedure lifts the head and moves it to an area where there is no data, thereby protecting the disk from damage during shipping.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3 BASIC SKILLS

Chapter 3 describes the Tencor P-2 instrument controls and covers general procedures such as

- Starting, resetting, and shutting down the instrument
- Selecting menus and menu items
- Protecting and resetting the wafer handler and protecting the stylus arm assembly
- Setting the keylock position, door interlock switch, and the date and time; restricting access to the instrument, and changing screen colors
- Getting help

3.1 INSTRUMENT COMPONENTS

Figures 1-1 through 1-4 in Chapter 1, "Introduction," show the major hardware components of the Tencor P-2, including the wafer handler and the open frame configuration.

Figure 1-1 shows the locations of controls and external components. Figure 1-2 shows the main features of the measurement area. Figure 1-3 shows the Tencor P-2 with the Open Frame configuration. Figure 1-4 shows the Tencor P-2 with wafer handler.

3.2 INSTRUMENT CONTROLS

Most of the controls are located on three panels:

- The auxiliary panel (on the front of the instrument, to the left of the computer screen)
- The built-in computer keyboard
- The remote computer keyboard (optional)

Several additional controls are located inside the measurement area.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.2.1 AUXILIARY PANEL

The auxiliary panel is located on the front of the instrument, to the left of the computer screen. It houses the instrument power button, the reset button and keyswitch, and is also the location of the floppy diskette drive door.

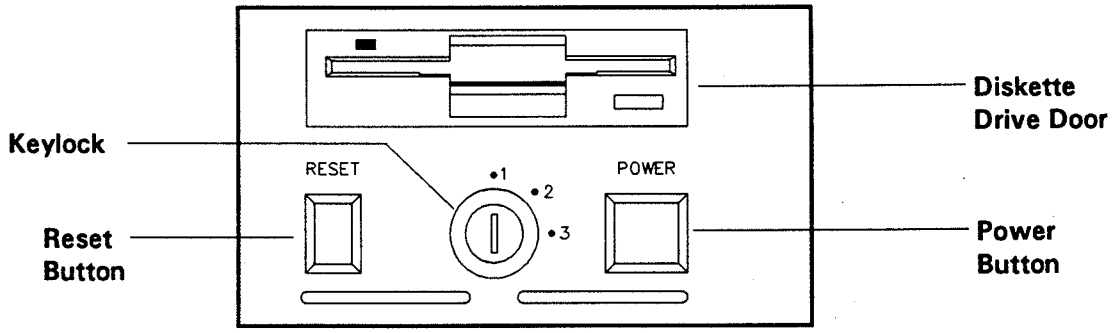


Figure 3-1 Auxiliary Panel

The controls available on the auxiliary panel are described in detail below.

Control	Action
Power Button	Turns system power on or off.
Keylock	Provides three different levels of operator authority. See Section 3.8, "Setting the Keylock Position," for details.
Reset button	Restarts the computer without turning instrument power off.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.2.2 BUILT-IN KEYBOARD

The built-in keyboard is located under the measurement area door on the front of the instrument.

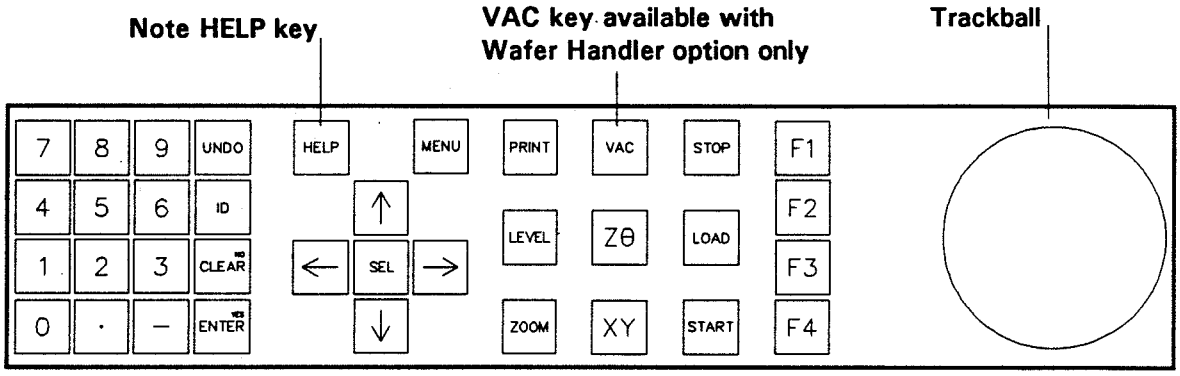


Figure 3-2 Built-In Keyboard

The actions of the keys are described below.

Key	Action
UNDO	Used in data entry to backspace from the end of a character string erasing one character at a time. Reverses zoomed or leveled trace to previous trace when combined with ZOOM or LEVEL key.
ID	Displays Alphanumeric window when saving data.
CLEAR/NO	Deletes an entire data field.
ENTER/YES	Selects menu item from pull-down menu. Completes the entry of any new value or ID.
HELP	Displays help screens for each screen directly accessible from the menu bar.
MENU	Displays pull-down menu. When pressed again, clears pull-down menu. Returns to Data screen from Motion screen and displays pull-down menu.
SEL	Toggles between left and right cursor. SEL pressed twice in quick succession activates both cursors that then move in tandem. [↓] SEL toggles elevator speed to high.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

[↑] [↓]	Raises and lowers the head in Motion screen (ZΘ mode). When tapped quickly, [↑] raises the stylus without raising the head. Activates Delta Average mode cursor operation (see Section 7.2, "Leveling the Profile," and Section 7.3.1, "Positioning the Cursors"). In Motion screen zoom, changes the magnification of the sample image. Selects previous or next field in a pop-up window.
[←] [→]	Moves stage in X-Y direction in Motion screen (XY mode). Rotates stage in ZΘ mode with Motorized Rotary Stage Option. Moves measurement and leveling cursors in Data screen. Selects previous or next value in a pop-up window field.
PRINT	Prints the Data screen when compatible printer is connected.
LEVEL	In Data screen, inserts the leveling cursors.
ZOOM	In Data screen, enlarges a section of a trace. In Motion screen, changes to a higher magnification video image.
VAC	Toggles the vacuum on and off when the handler is disabled in the SECS window under the Config menu. The vacuum status is displayed in the lower right hand corner of the screen. (Available with the handler option only.)
ZΘ	Displays Motion screen and then enables head movement and optional stage rotation.
XY	Displays Motion screen and then enables X,Y stage movement.
START	In Motion screen begins scan. In the Recipe screen, completes entry of a value or ID and then begins scan.
LOAD	Moves stage back and forth between the programmable load/unload position and the measurement position. You can preprogram these two positions (see the Settings window under the Config menu).
STOP	Aborts a scan.
[F1]–[F4]	Function keys. Usage defined at the bottom of each screen or window.
Trackball	An alternative to the arrow keys; used to scroll through menu bar and menu selections. In Motion screen, moves sample stage in the direction the trackball motion indicates.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.2.3 REMOTE KEYBOARD

The remote keyboard is a standard PC/AT enhanced keyboard that allows the use of other software applications (such as spreadsheet or word processing software) on the instrument computer. The remote keyboard is a standard part of the Automatic Long Scan Profiler, as it is easier to use with more complex data entry and database management. It does not replace the built-in keyboard but provides an alternate way of entering commands.

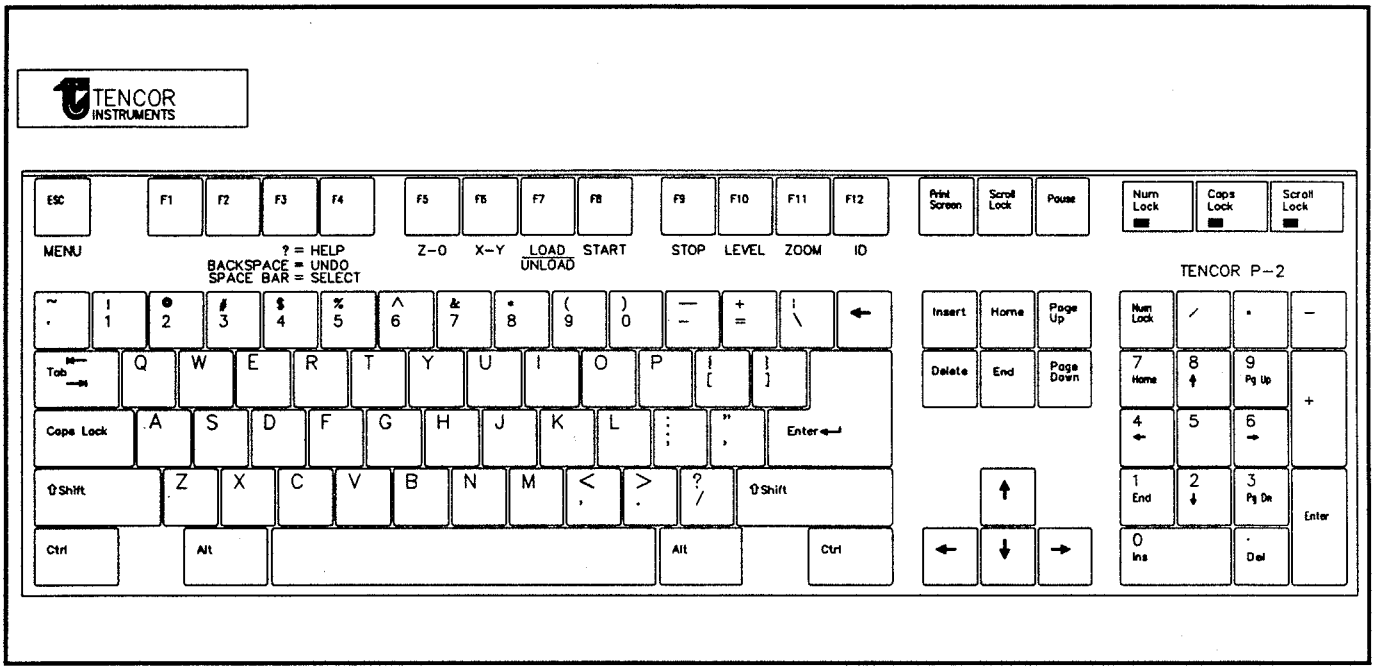


Figure 3-3 Remote PC/AT Enhanced Keyboard

The same key names and functions exist on the remote keyboard as described above in Section 3.2.2, "Built-In Keyboard," with the exception of the trackball. Note that the placement of the keys is not the same as on the built-in keyboard.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.2.4 MISCELLANEOUS CONTROLS

Monitor Controls

The monitor controls are located underneath the left side of the monitor (see Fig. 1-1).

Control	Action
On/Off	Turns the screen on or off
Brightness	Adjusts the level of screen brightness
Intensity	Adjusts the level of screen intensity

Remote Keyboard and ESD Jacks

The remote keyboard and ESD ground jacks are located underneath the computer, to the left of the monitor controls (see Fig. 1-1).

Vacuum Switches

Standard configuration: The vacuum switch is located inside the left side of the measurement area opening (see Fig. 1-2).

Open Frame configuration: The vacuum switch is located on the left side of the built-in keyboard (see Fig. 1-3).

3.3 STARTING UP THE SYSTEM

1. If the power is still on from the installation procedures, the instrument is ready for operation. If not, turn on the power and allow the computer to boot up automatically. Turn on the monitor with the switch located underneath the left front of the screen. See Fig. 1-1.
2. The Tencor logo screen is displayed. If necessary, set the two controls for brightness and intensity. They are also located underneath the monitor to the right of the On/Off switch. See Fig. 1-1.

> **CAUTION:** **Do not leave the display turned up to maximum intensity for longer than 1 hour or damage to the screen can occur.**

3. At the screen prompt, press ENTER. The substrate stage and measurement head move to their home positions. If the wafer handler is installed, the handler is initialized and messages indicating handler initialization are displayed.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

> **NOTE:** If the Password window is displayed when you are getting started, you must enter the correct password to use the instrument. Refer to Section 3.11, "Restricting Access to the Instrument."

3.4 MENUS

After pressing ENTER from the Tencor P-2 title screen, the following menu bar appears at the top of the screen:



Figure 3-4 Menu Bar

Press [←] or [→] or move the trackball sideways to select menus from the menu bar. Press [↑] or [↓] or move the trackball forward or backward to select items from a menu. Press ENTER to display the selected item.

The following menus are available from the menu bar:

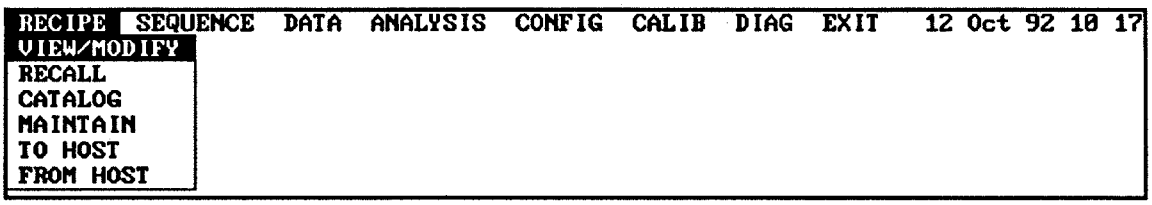


Figure 3-5 Recipe Menu

For details on the Recipe menu items, see Chapter 5, "Writing a Recipe."

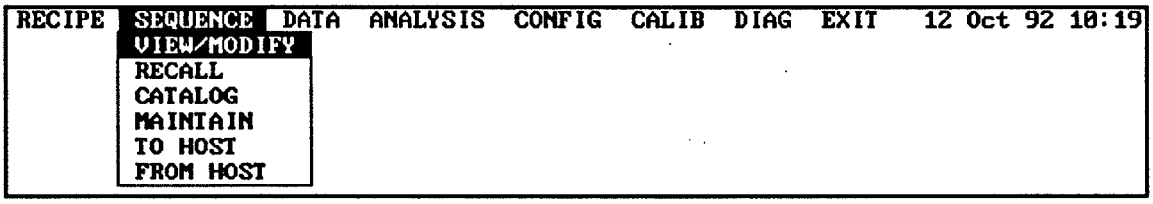


Figure 3-6 Sequence Menu

For details on the Sequence menu items, see Chapter 10, "Automatic (Sequence) Operation."

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

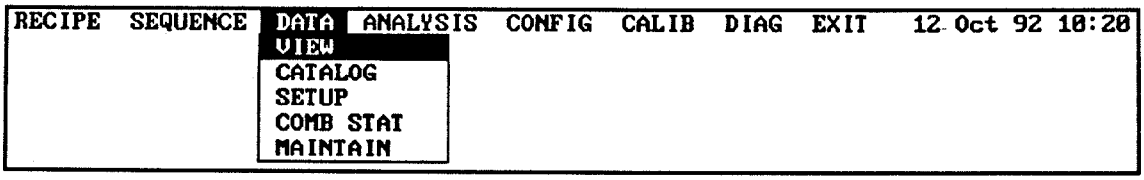


Figure 3-7 Data Menu

See the following sections for details on the Data menu:

- For details on View, Recall, and Catalog, see Chapter 7, "Analyzing the Profile."
- Setup and Maintain are displayed only if the system has the Sequence/Database Manager Option installed. See Chapter 12, "Database Manager Option," for details.
- Comb Stat is displayed only if the system has the Sort/Combined Statistics Option installed. See Chapter 11, "Sort/Combined Statistics Option," for details.

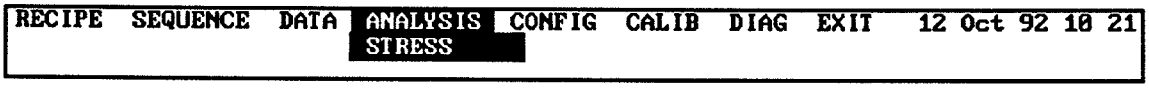


Figure 3-8 Analysis Menu

For details on Stress, see Chapter 13, "Wafer Stress Option."

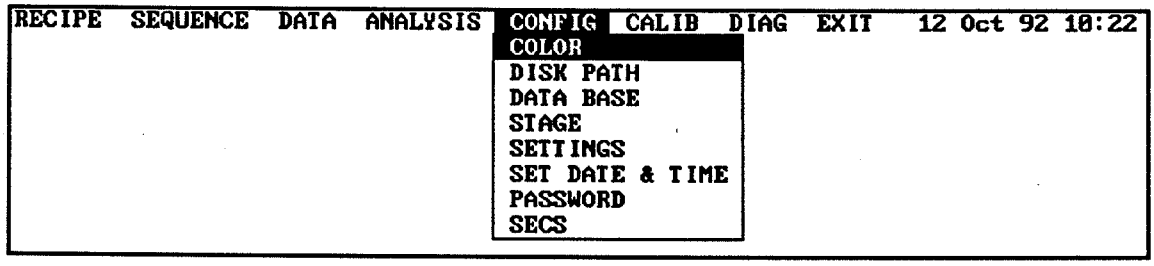


Figure 3-9 Config Menu

For details on the Config (Configuration) menu, see the following sections:

- For details on Disk Path, see Section 7.9, "Saving Data and Recipes."
- Handler is displayed only if your instrument has the wafer handler installed. See Section 6.3.2, "Loading Single Wafers Using the Wafer Handler," for details.
- For details on the Password option, see Section 12.2.4, "Setting or Changing the Password."

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

- For details on SECS, see Section 5.6, "Using the SECS Interface Option with Recipes," Section 6.14, "Setting the SECS Interface Option to Upload Data," Section 10.11, "Using the SECS Interface Option with Sequence Programs," and the *Tencor Profiler SECS Interface Manual*. A small rectangular box labeled SECS is displayed in the lower right hand corner of the video monitor if the SECS option is installed. The color of the box indicates the SECS status: Red–SECS disabled; Yellow–SECS enabled but not communicating; and Green–SECS enabled and communicating.

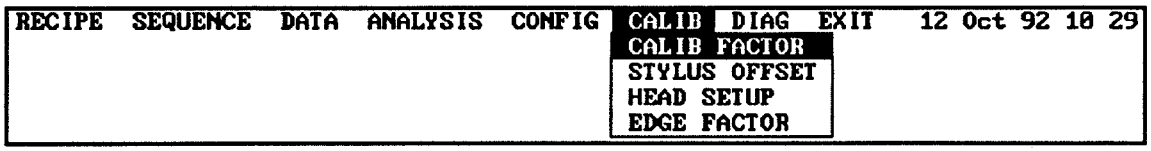


Figure 3-10 Calib Menu

For details on the Calib (Calibration) menu, see the following sections:

- For details on Edge Factor, see Section 7.5, "Automatic Cursor Positioning (Edge Detection)."
- For details on Calib Factor and Stylus Offset, see Section 17.9, "Calibration."
- For details on Head Setup, see Section 17.8.3, "Setting Up the Measurement Head Software."

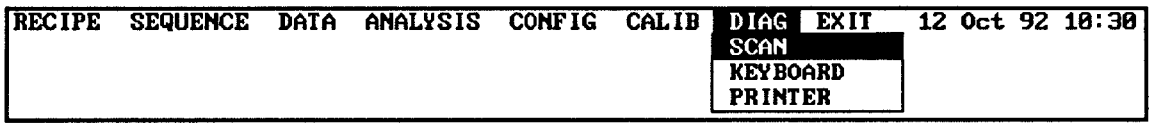


Figure 3-11 Diag Menu

For details on Scan, see Section 17.1.2, "Diagnostic Scan."

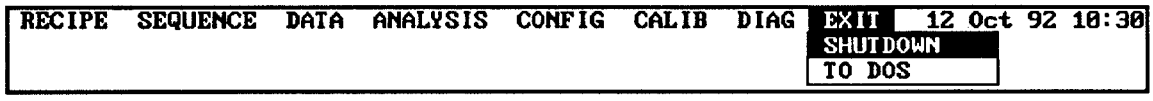


Figure 3-12 Exit Menu

For details on the Exit menu, see the following sections:

- For details on Shutdown, see Section 17.12, "Shutting Down the Instrument."
- For details on To DOS, see Section 3.13, "Exiting to DOS."

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.5 ENTERING AN ID

If you do not have the Database Manager Option, IDs will be used for displaying and storing Scan recipes, Sequence programs, and data. If you have the Database Option, data is saved using seven classes of user-configurable IDs and recalled using seven classes of user-configurable IDs and five data-dependent IDs. See Section 12.3, "Operating the Database," for more information on database IDs.

A Scan recipe ID or Sequence ID can be up to 11 characters, and a Part ID can be up to 17 characters. Whenever you are prompted to enter an ID, an *alphanumeric window* is displayed. The prompt varies depending on the type of ID, but the method of entering the ID is always the same.

To enter an ID from the built-in keyboard:

1. In this example, you will enter a Part ID. Select View from the Data menu and press ENTER.
2. Press ID to display the Alphanumeric window:

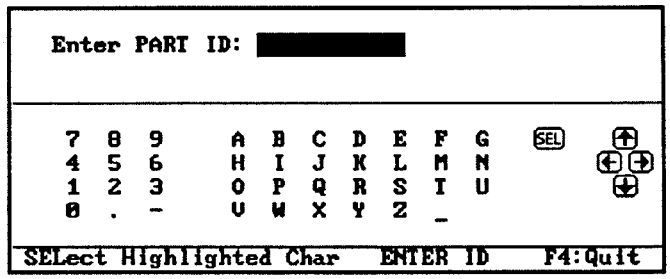


Figure 3-13 Entering an ID in the Alphanumeric Window

3. Use the trackball or arrow keys to highlight a number or character.
4. Press SEL to choose the highlighted number or character, which will then appear at the end of the displayed ID. Press UNDO to erase the last character entered or CLEAR to erase the entire ID. You can enter numbers from the keypad or the Alphanumeric window.
5. Press ENTER to accept the ID or press [F4: Quit] to reject the ID and abort the operation.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To enter an ID from a remote keyboard:

1. In this example you will enter a Part ID. Press ID on the remote keyboard to display the Alphanumeric window (Fig. 3-13).
2. Type the ID as usual. Use the backspace key to erase characters as needed or press CLEAR to erase the entire ID.
3. Press ENTER to accept the ID or press [F4: Quit] to reject the entire ID and abort the operation.

You can enter IDs from the following screens:

- To enter a Recipe ID, press [F1: Save] in the Recipe screen.
- To enter a Sequence ID, press [F1: Save] in the Sequence Program screen or enter it when prompted at the start of a sequence.
- To enter a Part ID, press [F4: Save] in the Data screen. The Alphanumeric window is displayed if you do not have the Database Option. If you do have the Database Option, the Database Save IDs window (Fig. 12-14) is displayed.
- The Alphanumeric window is also displayed whenever recalling a Scan recipe, Sequence program, or data (if you do not have the Database Manager Option).

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.6 WAFER HANDLER (OPTIONAL)

The wafer handler automatically transports wafers in and out of the instrument. The handler consists of a robotic mechanism with a vacuum puck mounted on a turntable, one or two cassette locators (one is standard, the second optional), and an aligner.

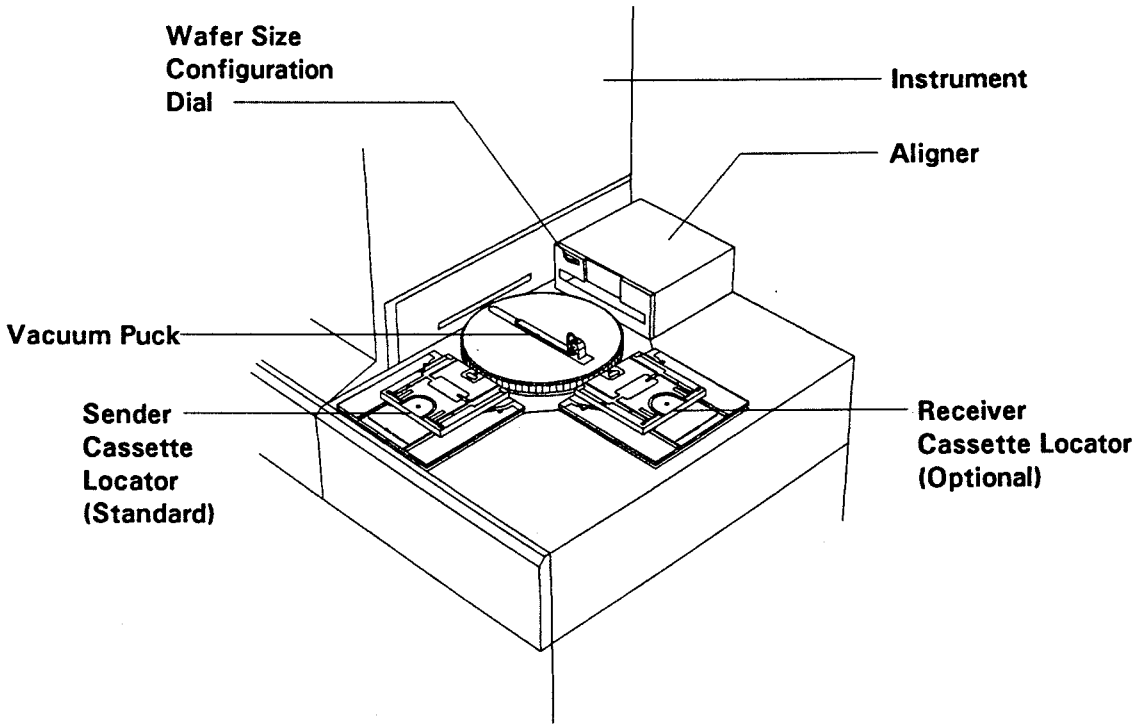


Figure 3-14 Wafer Handler

The vacuum puck picks up and transports the wafers, the cassette locators hold the cassettes of wafers in the proper position, and the aligner orients the wafers in X, Y, and Θ as desired. See Section 6.3.2, "Loading Single Wafers Using the Wafer Handler," and Section 10.5.2, "Preparing for Automatic Loading and Unloading," for details on the operation of the wafer handler with the Tencor P-2.

3.6.1 PROTECTING THE WAFER HANDLER

The following design features protect the wafer handler and its components from damage:

- If the handler does not initialize, the manual vacuum switch could be turned off. Check the switch to make sure that it is on (in the up position). The switch is located inside the instrument below the lower left of the measurement door.
- If the wafer loading or unloading process is interrupted while the handler puck is inside the instrument, the X and Y stages will not move. You need to home the puck by pressing LOAD and then [F3: Home]. If this does not work, try selecting Handler from the Config menu and then press [F3: Initialize].

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

- If a wafer that has been loaded using the handler is unloaded manually, the handler will maintain that there is a wafer in the location until you run the unloading procedure from that location twice. This is a safety mechanism to prevent damage to wafers.
- If you attempt to use the wafer handler to unload a wafer to the cassette after removing the wafer's cassette and replacing it with the same or another cassette, the following prompt is displayed:

  Is the Sender/Receiver cassette slot ## empty? [Y/N]

  Make sure the cassette slot to which you are unloading the wafer is empty; otherwise, the wafer might be damaged.

The following cases illustrate ways in which you could damage the wafer handler, the wafers, or the data:

- The handler is stopped at the exact moment of wafer handoff between the puck and a location.
- Changing a cassette during a scan could result in the loss of scan data.
- The handler is stopped while the handler puck is inside the profiler and the puck is not homed before manually operating the instrument. You must home the puck before using the instrument by pressing LOAD and then [F3: Home]. If this does not work, select Handler from the Config menu and then [F3: Initialize].

3.6.2 RESETTING THE WAFER HANDLER

You can reset the wafer handler by itself or you can reset both the Tencor P-2 and the wafer handler simultaneously. Resetting the handler alone is much faster than resetting both the instrument and the wafer handler.

> **NOTE:** **Before resetting or stopping the wafer handler, see Section 3.6.1, "Protecting the Wafer Handler," for information on protecting the wafer handler, wafers, and data from damage.**

To reset the instrument and the wafer handler:

Press RESET if the instrument is locked up. If the instrument is not locked up, exit to DOS before pressing RESET.

To reset the wafer handler only:

1. Press MENU (several times if necessary) to display the menu bar.
2. Press the button on the rear panel of the wafer handler.
3. Choose Handler from the Config menu to display the Handler Enable window (Fig. 6-3).

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4. Use [←] or [→] to choose Enabled and press [F4: Quit] to exit the Handler Enable window, or
   Press [F3: Initialize].

   The wafer is initialized and messages indicating handler initialization are displayed.

3.7 PROTECTING THE STYLUS ARM ASSEMBLY

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

The Tencor P-2 incorporates several design features to protect the stylus from damage:

- Whenever the stylus is down (that is, near its lowest position) and you press XY or ZΘ and move the stage, the stylus automatically lifts to reduce the risk of hitting the edge of an artifact or a sample fixture. When the stylus is in the near null position (that is, resting on a substrate), it rises only when you select high speed XY movement.
- Whenever the stylus is down for longer than 60 s and a scan is not taking place, the stylus lifts automatically.
- When the stylus reaches its upper limit of travel, that is, the stylus cannot rise any higher while traveling up an incline, the stylus automatically retracts and the scan is terminated. (Note: When the stylus reaches its upper limit, the trace on the Scan screen (Fig. 4-8) ascends and becomes level.)
- As a safety factor, you can program the elevator to lower only to a preset limit. As a further precaution, the keylock must be in position 3 to enable this function to be programmed. Refer to Section 6.1, "Setting the Lowest Elevator Position," and Section 3.8, "Setting the Keylock Position."
- If the measurement head is lowered into contact with a surface, the stylus assembly retracts and thus is protected from damage.
- To prevent use of the instrument by unqualified personnel, you can restrict access to the program via a password. Refer to Section 3.11, "Restricting Access to the Instrument."

Although we have taken these design precautions, there are still cases where damage can occur. Damage occurs whenever the stylus is down and a vertical wall fixed to the stage moves against the stylus shaft.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Specifically, the stylus can be damaged whenever it encounters an obstacle higher than the bevel height of the stylus tip, that is, higher than 880 μm (34 mils) for the standard measurement head stylus, or 440 μm (17 mils) for the MicroHead L-stylus. See Fig. 3-15. In addition, the stylus can be damaged by a shorter object if it has sharp corners or burrs that bite into the stylus tip.

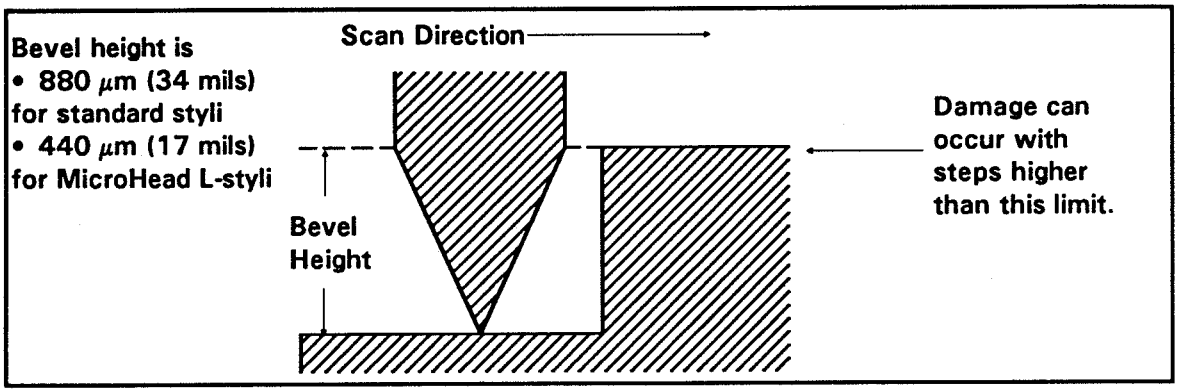


Figure 3-15 Protecting the Stylus

The following cases illustrate ways in which you could damage the stylus arm assembly:

- If you lower the stylus or start a scan when the sample is not directly under the stylus, damage to the stylus can occur. This is most likely to happen when you lower the measurement head such that the stylus drops into the center hole of a disk. Then if you move the stage, you will damage the stylus.

CAUTION: Do not start a scan or move the stage unless you know that the stylus is directly over the sample or you could damage the stylus.

- During a segmented scan (see Fig. 5-4), no scan data is taken between segments and the stylus does not lift in these spaces. If there is an obstruction higher than the stylus tip bevel height (Fig. 3-15), it can damage the sensor assembly.

CAUTION: Because the stylus does not lift in the space where no data is taken in a segmented scan, no major artifact (for example, a fixture) should obstruct its course as it can damage the stylus.

- If the stylus is down and you move the stage in slow motion without monitoring the video image, the stylus can hit the edge of an obstruction or precision locator.

CAUTION: If the stylus is down, do not move the stage without monitoring the video image or you can damage the stylus.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

- If you change the substrate or precision locator without resetting the lowest elevator position, the head can lower onto the locator if the stylus misses the locator. Damage could occur if you press LOAD and cause the substrate or locator to hit the stylus. The measurement head must be at least 6.4 mm (0.25 in.) above the top of the precision locator. Note: The stylus drops about 4 mm (165 mils) below the measurement head.

> **CAUTION:** **If you change the substrate or precision locator to one of a different height, reset the lowest elevator position (see Section 6.1, "Setting the Lowest Elevator Position"). Otherwise, you can damage the stylus and measurement head.**

- When designing custom jigs or fixtures, consider the precautions noted in this section. For instance, when designing a custom disk locator, its center section must be flush with the top of the disk surface. Damage also can occur when there is a hole in a jig, a vacuum hole, or a groove in a surface.

3.8 SETTING THE KEYLOCK POSITION

A three-position keylock limits operator access to Scan recipes for operational security.

To set the keylock position, turn the key to one of the following three positions:

1 You can operate the system only with the current instrument setting.

2 You can select Scan recipes or Sequence programs, but you cannot change their contents.

3 You can access any aspect of operation or setup.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.9 SETTING THE DOOR INTERLOCK SWITCH

The interlock switch prevents motion of the stage table and measurement head when the front door or side panels are open. However, the handler in-process motion does not stop when the front door or side panels are open. You can enable or disable the switch as follows.

To enable or disable the interlock switch:

1. Choose Settings from the Config menu and press ENTER to display the Settings window:

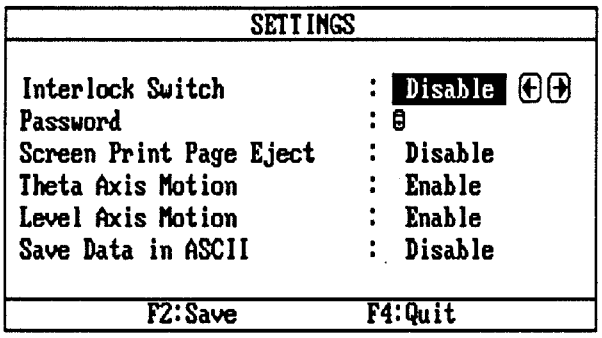


Figure 3-16 Setting the Door Interlock Switch

2. Use the trackball to choose Interlock Switch. Press [←] or [→] to enable or disable the switch.

   When the switch is enabled and the front door or either side panel is open, you will be unable to move the measurement head or stage table. When the switch is disabled and the door or panel is open, the trackball and function keys operate normally.

3. Press [F2: Save] to save the new setting and then press [F4: Quit] to exit.

3.10 SETTING THE DATE AND TIME

You may need to reset the computer clock to adjust for seasonal differences such as Daylight Savings Time, or if the instrument is relocated to a different time zone. See Section 2.2.5, "Setting the Date and Time," for details.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.11 RESTRICTING ACCESS TO THE INSTRUMENT

This section describes how you can use a password to make it difficult for unqualified personnel to use the instrument. For instance, you might want to lock the instrument to protect the stylus from accidental damage in your absence.

NOTE:	Password protection can be defeated by pressing RESET.

To enter or change a password:

1. Choose Settings from the Config menu and press ENTER to display the Settings window:

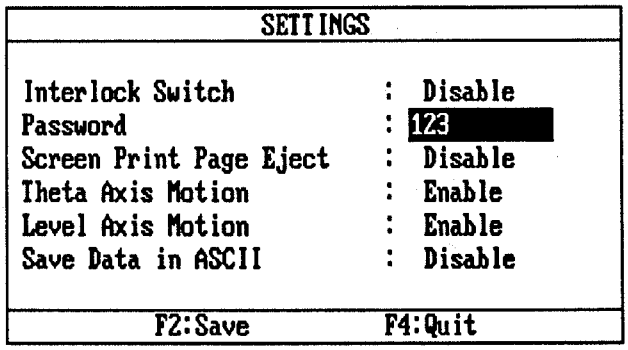


Figure 3-17 Restricting Access to the Instrument with a Password

2. Use the trackball or [↓] to choose Password.
3. **From the built-in (numeric only) keyboard:**

   - Enter a password consisting of numbers only, that is, use the keypad. The password can be up to 12 characters long and must not contain blank spaces. Use UNDO to erase characters as needed.
   - Press ENTER to accept the password or [F4: Quit] to abort the operation.
   - Press [F2: Save] to save the new password and then press [F4: Quit] to exit the Settings window.

From the remote (alphanumeric) keyboard:

- Type the password directly into the Settings window using the alphanumeric keys. Note: If only the built-in keyboard is accessible to the operator, select a password that has numbers only. The reason is that you cannot display the Alphanumeric window once the password has been enabled. The password can be up to 12 characters long and cannot contain blank spaces. Use the backspace key to erase characters as needed.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

- Press [F2: Save] to save the new password and then press [F4: Quit] to exit the Settings window.

To operate the password system:

1. Choose Password from the Config menu and press ENTER to display the Password window:

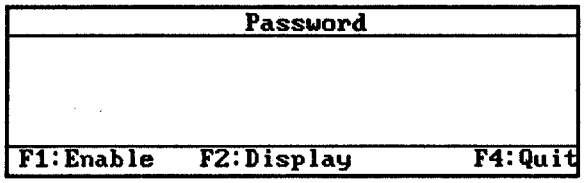


Figure 3-18 Enabling the Password

2. Press [F2: Display] to view the password. Press [F2: Display] again to clear the password.
3. Press [F1: Enable] to activate the password system. The following window (Fig. 3-19) is displayed, and the instrument is inaccessible until the correct password is entered. If there is no password in memory, press ENTER to continue.



Figure 3-19 Entering a Password

To access the instrument when the password has been enabled:

1. Type in the correct password in the Enter Password window (Fig. 3-19) from the built-in keyboard or the remote keyboard. Backspace (or press UNDO) to delete characters if needed.
2. Press ENTER and if the password is correct, the menu bar will be displayed and active. If the password is wrong, the window will remain on the screen.

NOTE:	The password can be defeated by pressing RESET.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.12 SETTING SCREEN COLORS

Although there is a wide range of screen color combinations from which to choose, note the following guidelines when setting the screen colors:

- You can set some but not all colors that appear on the screen.
- *RRWG* stands for raw scan, roughness, waviness, and grid. The rrwg colors represent the individual color options for the graph and grid lines.
- Some printers such as the HP LaserJet allow you to reverse a black background to white or to retain black when printed.

To set the screen colors:

1. Press MENU.
2. Choose Color from the Config menu and press ENTER to display the Color Select window:

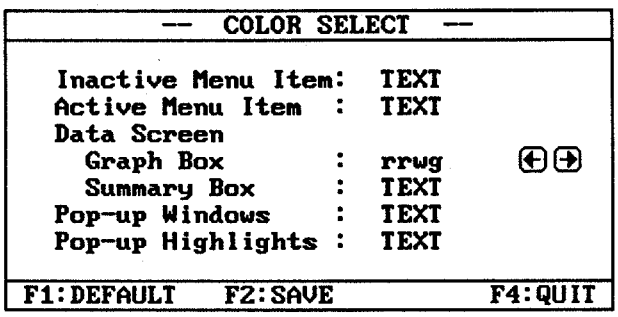


Figure 3-20 Setting the Screen Colors

3. Press [F1: Default] to select the default color scheme; or to change colors, use the trackball to choose an item from the list.
4. Press [←] or [→] to select colors.
5. Press [F2: Save] to save the settings for future use.
6. Press [F4: Quit] to exit.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.13 EXITING TO DOS

To exit to DOS:

1. Press MENU.
2. Choose To DOS from the Exit menu.
3. Press ENTER.
4. When asked to confirm that you wish to return to DOS, press YES. The DOS prompt is displayed.

3.14 GETTING HELP

Press HELP on the keypad on the instrument or press ? on the remote keyboard to display a help screen. Help screens are available for most screens accessible from the top menu bar. In addition, a help screen is available for the Surface Analysis window (accessed from the Recipe screen). Two help screens are also available for the Sequence Program screen. Press [F4: Toggle Field] and HELP to obtain information on the right side of the Sequence Program screen.

3.15 DETERMINING WHICH OPTIONS ARE INSTALLED

At startup, the system displays a title screen and lists the installed software options. Note: The display does not list whether or not the instrument has the Motorized Level and Rotation option installed.

To check on installed software options when running the system:

1. Press MENU.
2. Choose To DOS from the Exit menu.
3. Press ENTER. The installed options are displayed along with a prompt asking for confirmation that you wish to return to DOS. Press NO to return to the system.

3.16 TURNING OFF OR RESETTING THE SYSTEM

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

To power down the Tencor P-2:

1. Press MENU.
2. Choose Shutdown from the Exit menu and press ENTER.
3. When asked to confirm power down, type *Y*.
4. Turn off power to the instrument.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Whenever resetting the system, note the following caution.

> **CAUTION:** ***Never*** **press RESET when the disk is in operation or data, recipe, or program corruption can occur.**

To reset the system:

Press RESET if the instrument accidentally locks up due to a program malfunction, etc. If the instrument is not locked up, exit to DOS before pressing RESET.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4 GETTING STARTED

This chapter is a brief tutorial to guide the operator through a simple sample measurement. It describes

- Loading a sample
- Selecting a profile recipe
- Viewing and positioning the sample
- Profiling the sample
- Examining the sample data
- Unloading the sample

This chapter assumes a basic knowledge of the instrument as described in Chapter 3, "Basic Skills." If you have not done so already, read Chapter 3 before proceeding.

The example used throughout this tutorial follows a continuous sequence of steps. By carefully following the instructions, the screens that appear should be very similar to the example screens reproduced in this chapter.

Since this tutorial is intended to familiarize the operator with the operation of the Tencor P-2, many key aspects of operation are deferred to later chapters. A summary at the end of this chapter refers the reader to the appropriate chapters for more detailed information about each topic.

To work through this chapter, you will need a sample to profile. We recommend a calibration standard for this purpose.

4.1 STARTING THE SYSTEM

1. If the power is still on from the installation procedures, the instrument should be ready for operation. If not, turn on the power and allow the computer to boot up automatically.
2. The Tencor logo screen is displayed. At the screen prompt, press ENTER. The substrate stage and measurement head move to their home positions. If the wafer handler is installed, the handler is initialized and messages indicating handler initialization are displayed.

NOTE:	**If the Password window is displayed when you are getting started, you must enter the correct password to use the instrument. Refer to Section 3.11, "Restricting Access to the Instrument."**

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4.2 LOADING THE SAMPLE

You load samples into the Tencor P-2 either manually or by use of the wafer handler. For this tutorial, however, we will only consider manual loading. See Section 6.3.2, "Loading Single Wafers Using the Wafer Handler," for details on loading wafers with the wafer handler.

Note: If your instrument has the wafer handler installed and you are going to load samples manually, the wafer handler must be set to Disable in the Handler Enable window:

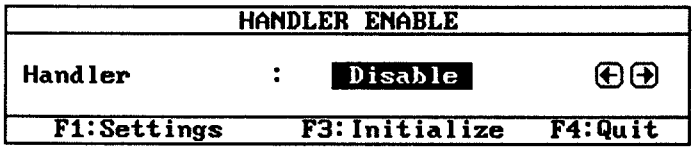


Figure 4-1 Handler Enable Window

To load the sample manually:

1. If the stage is not in the load position, press LOAD to move the stage forward.
2. Open the door and place the substrate on the stage table, disk holder, or precision locator. (Note: If you are using a precision locator, it is normally used in the 0° position as shown in Fig. 2-7.)

   The detent disengage lever below the front of the stage enables the detent to be decoupled if you do not want to use it or if you wish to locate an area close to the detent.

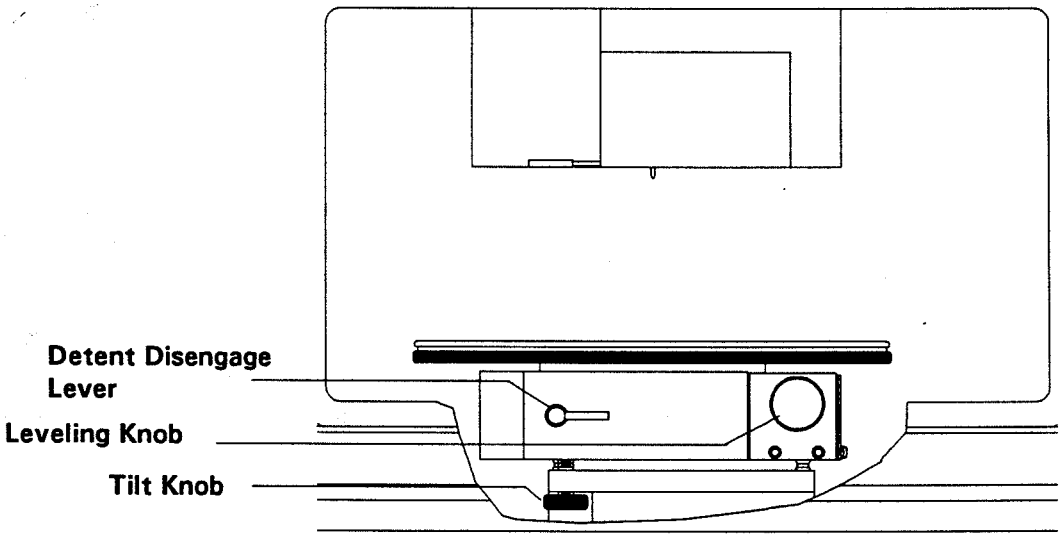


Figure 4-2 Stage Table Controls (Front View)

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

> **NOTE:** ***Open Frame Configuration***–**The stage table has an adjustable vacuum valve to handle wafer sizes of 100 mm (4 in.) to 200 mm (8 in.). The stage table also fits sample precision locators.**

3. Engage the vacuum with the switch found just inside the left side of the measurement door opening.

   Open Frame Configuration only:

   - To open the vacuum valve, use a screwdriver to turn the valve perpendicular to the front of the stage table (see Fig. 1-3).
   - To close the valve, turn it parallel to the front of the stage table.

4. Close the door and press LOAD to center the stage under the measurement head.

4.3 VIEWING AND POSITIONING THE SAMPLE

The Tencor P-2 measurement head contains a high resolution video camera. Once you have loaded the sample and the stage has moved beneath the measurement head, you view the sample in the Motion screen to find an appropriate location to start a scan.

Sample motion consists of two parts:

- ZΘ motion, motion of the measurement head up or down, and rotation of the stage about its central axis
- XY motion, motion of the sample stage left and right, and backward and forward

The Motion screen (Fig. 4-3) provides a video image of the sample with a computer graphic overlay. The overlay includes

- X, Y, Z, and Θ coordinates indicating the position of the stage and head
- A mode status indicator (High speed, Low speed, or Precision mode)
- A box containing function key assignments

A circle represents the 210-mm (8.2-in.) diameter stage table, and a movable cross marker indicates the stylus position over the table as the XY position is changed.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

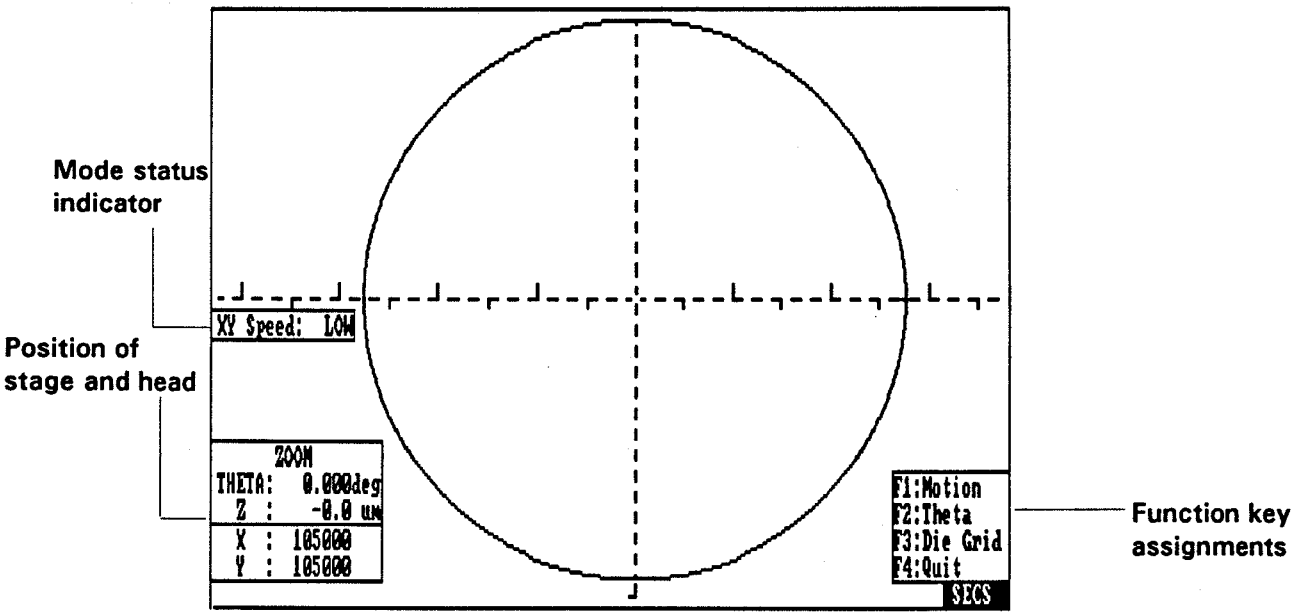


Figure 4-3 Motion Screen

4.3.1 LOWERING THE MEASUREMENT HEAD

1. Press ZΘ to display the Motion screen (Fig. 4-3) and enable downward movement of the head.

2. The keys used to lower the head from the built-in keyboard on the instrument are different from those used from the remote keyboard:

   To lower the head from the built-in keyboard (Fig. 3-2):

   Press [↓] and hold to lower the stylus and begin downward movement of the head. (Motion begins after the stylus is fully down.) Then press SEL for high speed and hold to lower the head to its measurement position.

   Release SEL as the sample comes into view on the screen (Fig. 4-4) for a gentle landing of the stylus.

   To lower the head from the remote keyboard (Fig. 3-3):

   Press [↓] and hold to lower the stylus and begin downward movement of the head. (Motion begins after the stylus is fully down.) Press SPACEBAR and release for high speed. Then hold [↓] to lower the head to its measurement position.

   Release [↓] as the sample comes into view on the screen (Fig. 4-4) and press [↓] again for a low speed, gentle landing of the stylus.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

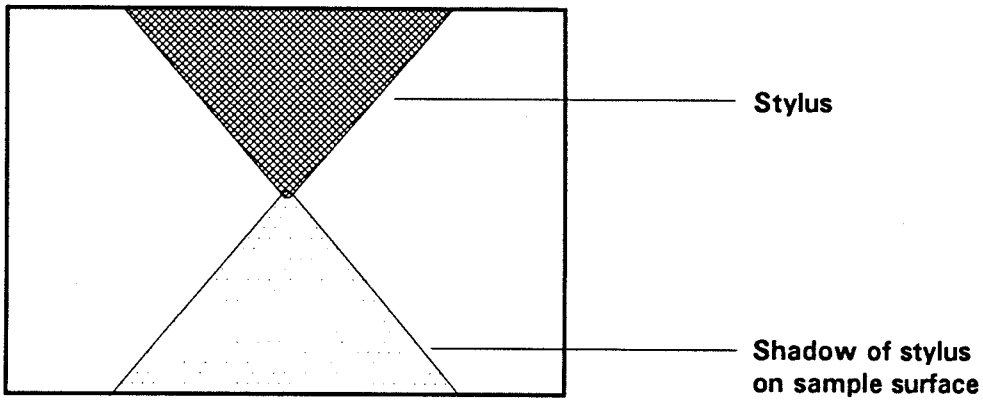


Figure 4-4 Stylus Lowered to Sample Surface

NOTE:	A video image like Fig. 4-4 does *not* guarantee contact between the stylus and the sample surface. Assuming so can result in inaccuracies in the XY position of the start of a scan, which is of particular importance when probing small features. Make sure the stylus is properly nulled as described in Step 3 below.

3. Make sure that the stylus is *nulled*, or in direct contact with the surface, by pressing [↓] momentarily. If the Z coordinate remains unchanged before and after pressing [↓], the stylus is correctly nulled.

4.3.2 POSITIONING IN X AND Y

Figure 4-5 shows the coordinate system used in the Tencor P-2. The X and Y coordinates in the Motion screen represent the lateral position of the stage relative to the right rear corner of the measurement area. The circle in Fig. 4-5 represents the possible travel pattern of the stage, which is limited to a 210-mm (8.2-in.) circle.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

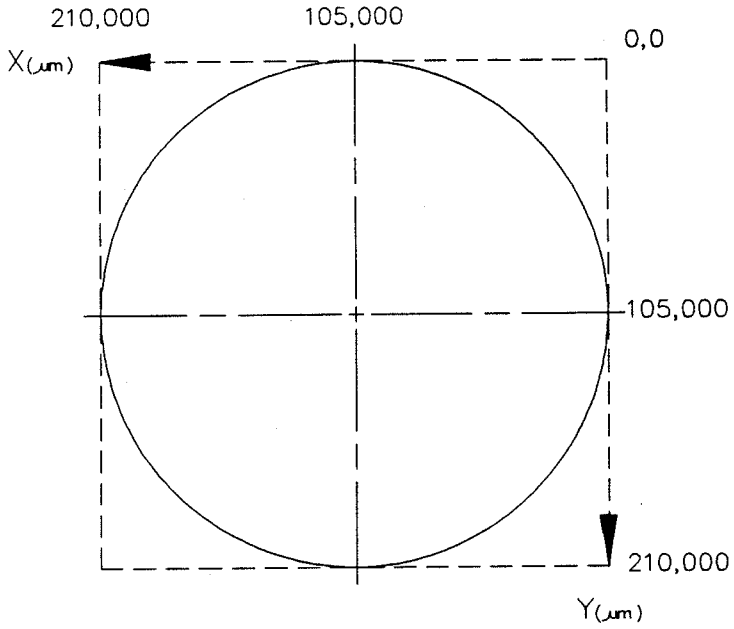


Figure 4-5 X, Y Stage Motion Coordinates

To enable XY motion:

Press XY.

> **CAUTION:** **If there is any hardware fixed to the stage and it is above the substrate surface, raise the stylus before moving the stage. Otherwise, head damage can occur.**

There are three modes of XY Motion:

- High speed, for quickly locating a particular area of the sample
- Low speed, for locating appropriate scan locations for most features
- Precision, for precise location of small (≤10 μm wide) features

Press [F1: Motion] to switch between the three modes.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To control the stage motion:

With XY motion enabled

- Press [←] or [→] for corresponding motion along the X-axis.
- Press [↑] or [↓] for corresponding motion along the Y-axis.
- Roll the trackball for corresponding motion in X and Y (High and Low speeds only; in Precision mode, the trackball does not cause precision movement but is used for rough positioning).

As an alternative to pressing [F1: Motion], you can switch speeds as follows:

- While in Slow speed mode, press and hold SEL and then any arrow key to activate high speed XY movement temporarily without switching to High speed mode.
- While in Precision mode, roll the trackball to activate low speed XY movement temporarily without switching to Low speed mode.

NOTE:	**In Precision mode, notice that when the motion ceases, the image appears to do a momentary wiggle (when using the arrow keys only). This is normal and desirable. It is this motion that eliminates the slight mechanical backlash in the stage movement that formerly made tight positioning to small features tedious and difficult. See Section 6.5, "Precision Mode," for details.**

You can move the stage in both Precision and Low speed modes with the stylus in contact with the sample surface. In High speed mode, the stylus raises automatically before the stage moves.

With the sample loaded and the head lowered, experiment with the three modes and the controls. It takes a small amount of time to become accustomed to controlling the motion.

In particular, note that the direction of each arrow key corresponds to the direction that the stage moves. In the video image the sample appears to move in the opposite direction.

4.3.3 MAGNIFYING THE SAMPLE IMAGE

You can magnify (or zoom) the image of the sample to facilitate feature location. Use low magnification to find quickly an area of interest on the sample. Use high magnification to locate accurately an appropriate starting position for a scan.

To control the image magnification:

Press ZOOM when in a Motion screen and [↑] or [↓] to change the magnification of the video image. Press ZΘ or XY to return to motion control.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4.4 PROFILING FROM A SCAN RECIPE

To profile a sample, the instrument moves the stage with the sample beneath the measurement head while the stylus rests on the sample surface. The up and down movement of the stylus provides the profile data.

The Scan recipe specifies how the stage moves and how the data is to be analyzed. The Scan recipe holds the current settings of such parameters as scan length, scan speed, and what kind of surface data are to be calculated and displayed.

Section 5.3, "Setting Scan Parameters," describes the techniques for changing these parameters. Parameters should be changed, if needed, *before* initiating the scan. For this tutorial, it is assumed that they are set correctly already or that the default recipe, titled P2, is to be used (see Fig. 4-6).

To view the current Scan recipe:

1. If in the Motion screen, press [F4: Quit].
2. Do one of the following:
   - If the menu bar appears, use [←] or [→] or the trackball to choose View/Modify from the Recipe menu and press ENTER.
   - If the Data screen appears, press [F1: Recipe].

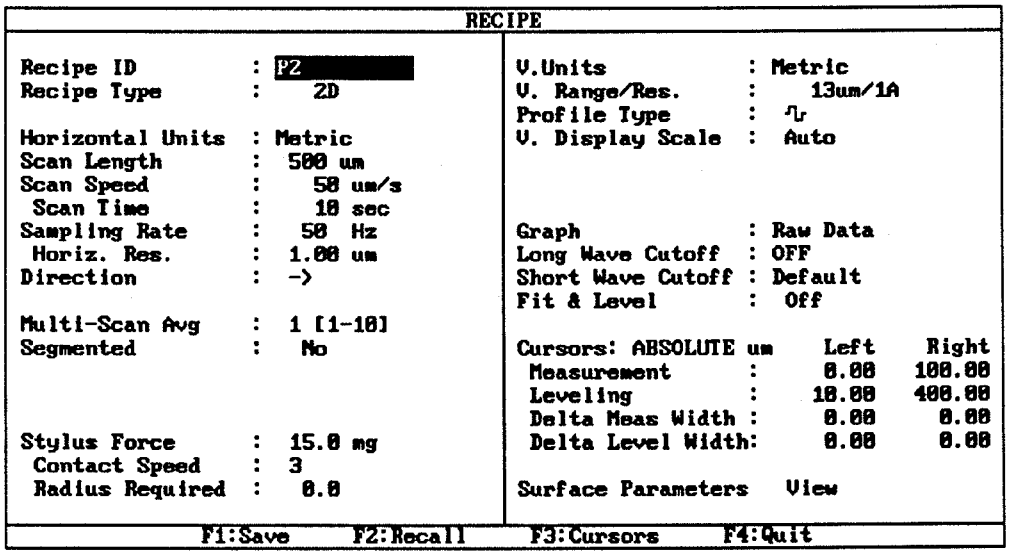


Figure 4-6 Default Recipe

Note: You have the choice of taking a 3-D scan if you have the Interactive 3-D Option installed. See Chapter 14, "Interactive 3-D Option," for more information on taking 3-D scans.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To set up for a scan:

1. Return to the Motion screen by pressing XY.
2. Choose a simple feature to scan. A step is ideal. The width of the step should be small enough that the scan length of 500 μm in the default recipe allows the surface on either side of the step to be sampled. See Fig. 4-7.

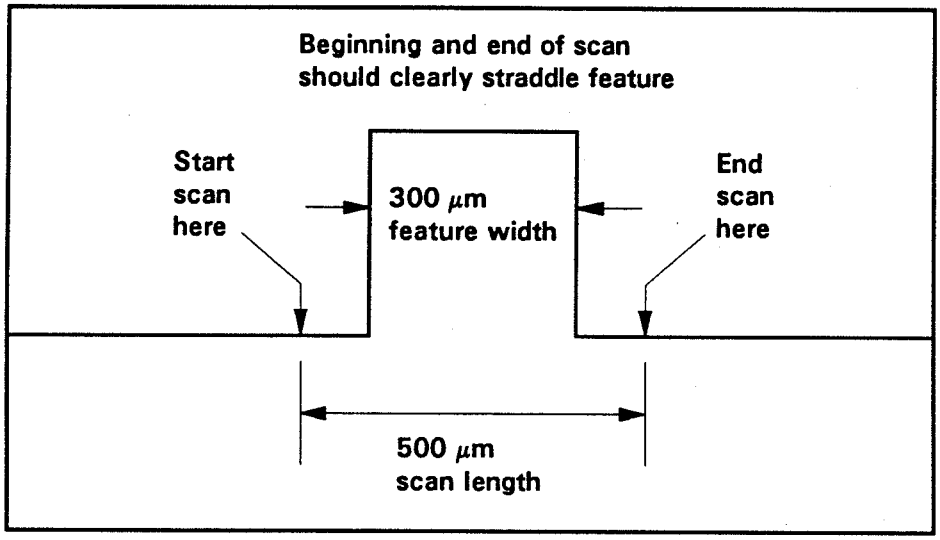


Figure 4-7 Setting Up to Scan a Step

3. Press ZΘ to activate motion in Z. Lower and null the stylus as described in Section 4.3.1, "Lowering the Measurement Head."
4. If necessary, press XY, make sure Precision mode or Low speed mode is active, and move the stage until the tip of the stylus is at an appropriate location to start the data collection (see Fig. 4-7).

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To start a scan:

- Press START regardless of which screen is displayed.

  The stylus descends to the start-of-scan position. Note that it first travels *opposite* to the scan direction for a short distance, then stops and moves in the scan direction. This allows the stage to reach the programmed scan speed before the instrument begins to take data. The Scan screen is displayed during the scan and shows an image of the stylus and the trace as it is generated.

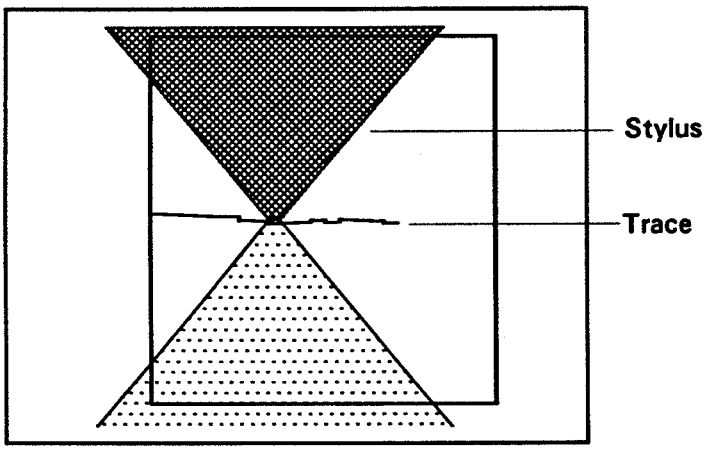


Figure 4-8 Scan Screen

When the scan is completed, the stylus lifts, the stage returns to its original position above the start-of-scan location, and the Data screen is displayed with the profile plotted in dimensioned coordinates. (See Fig. 4-9.) Note: If the trace runs off scale or is not horizontal, refer to Section 6.12, "Leveling the Stage," and Section 7.2, "Leveling the Profile."

To abort a scan:

- You can press STOP to abort a scan at any time.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4.5 READING, PRINTING, AND SAVING DATA

After the scan is taken, the Data screen replaces the Motion screen. The profile trace appears in the Graph box with a summary of the data displayed to the left of it in the Summary box. Figure 4-9 is a sample 2-D scan.

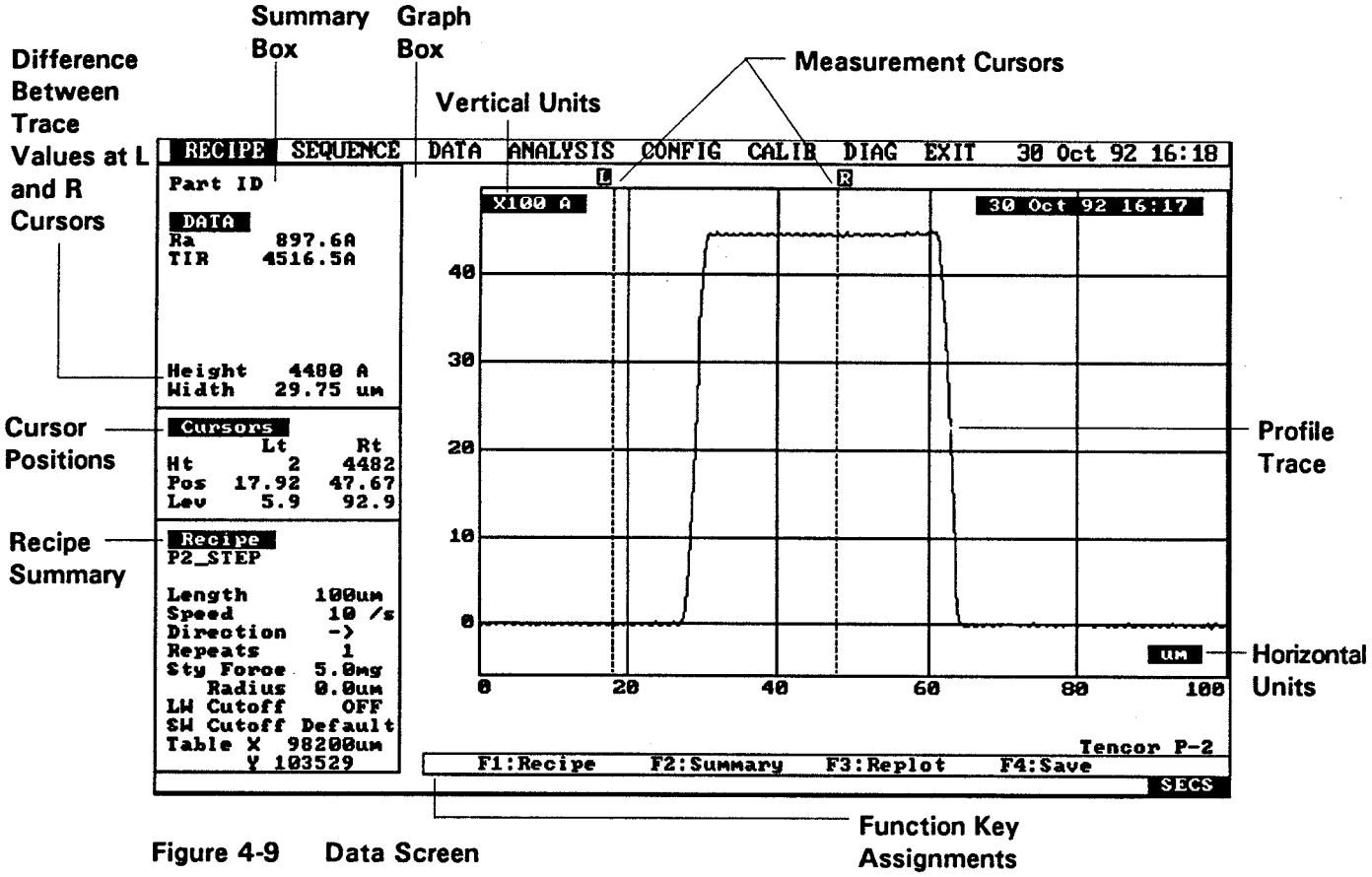


Figure 4-9 Data Screen

To read the data:

When the measurement cursors are positioned for measurement, you read the results directly from the Summary box. To move the cursors, follow the steps below.

When the Data screen is displayed, the measurement cursors (L and R) appear at their preset positions with the right cursor activated.

1. Move R to the desired position with the trackball or direction keys.
2. Press SEL to activate L and adjust its position.
3. Press SEL twice quickly to simultaneously activate both L and R. The cursors will move in tandem.

The Height field displays the vertical distance between the trace intersections of the left and right cursors. The Width field displays the horizontal distance between the cursors.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Each cursor position and the stage position is displayed. (Refer to Section 7.3.4, "Reading the Data," for detailed discussion of items in the Summary Box.) The surface analysis parameters that were selected in the recipe for calculation and display are also shown in the Summary box. (Refer to Section 5.3.2, "Surface Analysis Fields," for definitions of these parameters.)

Note: If you are using a calibration standard for this tutorial and there is an unacceptable discrepancy between your reading and the value for the standard, refer to Section 17.9, "Calibration."

To print data:

Press PRINT on the built-in keyboard or PRINT SCREEN on the remote keyboard to print the entire Data screen on a compatible black and white or color printer. See Section 2.2.8, "Configuring the Tencor P-2 for your Printer," for more information on printer choices.

> **NOTE:** **Press PRINT SCREEN, not SHIFT + PRINT SCREEN. If you perform the following key sequence, all subsequent key presses will be interpreted as though SHIFT were also held down.**
>
> **1. Press SHIFT.**
> **2. Press PRINT SCREEN.**
> **3. Release SHIFT.**
> **4. Release PRINT.**
>
> **If you mistakenly follow this key sequence, press and release SHIFT to correct the problem.**

To save data without the Database Manager Option:

For details refer to Section 3.5, "Entering an ID," and Section 7.9.1, "Saving Data Without the Database Manager Option."

1. Press [F4: Save]. You can save the raw trace data, data summary, and Scan recipe or save the summary only. The following alphanumeric window is displayed:

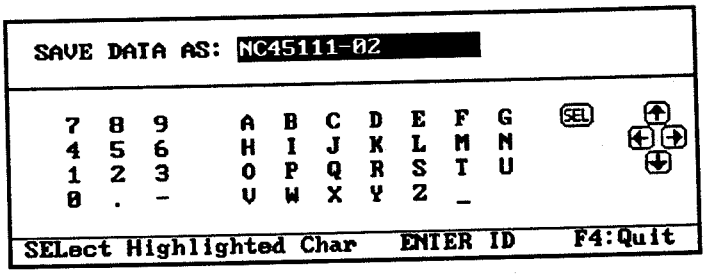


Figure 4-10 Entering an ID for Saving Data

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

2. To enter an ID from the built-in keyboard:

   - Use the trackball or arrow keys to highlight a number or character.
   - Press SEL to choose the highlighted number or character, which will then appear at the end of the displayed ID. (You also can enter numbers from the keypad.) If desired, press UNDO to erase the last character entered or CLEAR to erase the entire ID.
   - Press ENTER to accept the ID or press [F4: Quit] to reject the ID and abort the operation.

   To enter an ID from the remote keyboard:

   - Type the characters and numbers for the ID directly from the keyboard. Use the backspace key to erase characters as needed, or press CLEAR to erase the entire ID.
   - Press ENTER to accept the ID or press [F4: Quit] to reject the ID and abort the operation.

3. The following message appears:

   Save Raw Data + Summary [Y] or Summary Only [N]?

   Enter Y to save both the raw data (trace) and the Summary screen or enter N to save the Summary screen only. If only the Summary screen is saved, the Data screen (displaying the trace) is not saved.

To save data with the Database Manager Option:

For details refer to Section 7.9.2, "Saving Data With the Database Manager Option."

1. Press [F4: Save]. You can save the raw trace data, data summary, and Scan recipe used or the summary only. The following window is displayed:

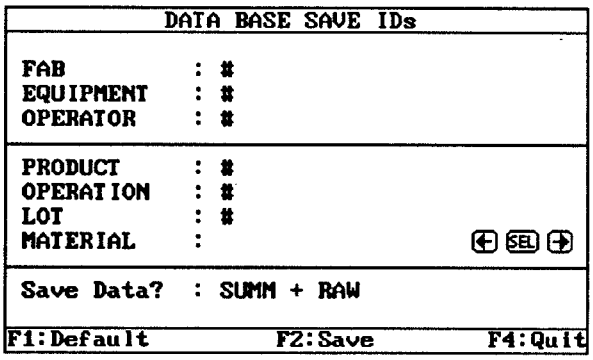


Figure 4-11 Saving Data with Database Manager Option

Data is saved using seven classes of user-configurable IDs.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

> **NOTE:** You can save data quickly without entering values for each ID by pressing [F1: Default] to enter # in the first six IDs. Enter a unique ID only in the seventh ID (Material in the above window) so the data can be easily identified.

2. To enter an ID:
   - Use [↑] or [↓] to move between the IDs and [←] or [→] to select available values for the IDs.
   - You also can type in new values for the IDs. Note: The database should be configured before you start saving data. See Section 12.2, "Configuring the Database," for more information on configuring the database.
   - Press ENTER to accept the ID or press [F4: Quit] to reject the ID and abort the operation.
3. Choose Save Data? and use [←] or [→] to select Summary and Raw Data or Summary Only.
4. When you finish entering values for the IDs, press [F2: Save] or ENTER to save the data.

4.6 UNLOADING THE SAMPLE

To remove the sample from the instrument:

1. Press LOAD. The measurement head rises and the stage moves forward.
2. Open the measurement area door and release the vacuum with the switch found just inside the left side of the measurement door opening.
3. Lift the sample off the stage table.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4.7 TUTORIAL SUMMARY

We recommend that you practice measuring several more features on your sample to become accustomed to the procedures outlined in this chapter.

To summarize this tutorial, the procedures involved in measuring a single sample are:

1. If necessary, turn on the instrument (refer to Chapter 3, "Basic Skills," for details).
2. Load the sample as follows:
   - Press LOAD to bring the stage forward.
   - Open the door, place the sample on the stage, and engage the vacuum to hold it firmly to the stage.
   - Close the door and press LOAD to return the stage to home position

   Refer to Chapter 6, "Profiling a Sample," for details.
3. In the Motion screen, locate the desired feature and position the stylus to scan the feature as follows:
   - Press ZΘ or XY to display the Motion screen and activate motion.
   - Use the arrow keys, trackball, [F1: Motion], ZOOM, and SEL as needed to view and position the sample.

   Refer to Chapter 6, "Profiling a Sample," for details.
4. In the Recipe screen, view the Scan recipe and edit the parameters if necessary (refer to Chapter 5, "Writing a Recipe," for details).
5. Scan the sample by pressing START from any screen (refer to Chapter 6, "Profiling a Sample," for details).
6. From the Data screen, view the displayed data and print or save it as desired (refer to Chapter 7, "Analyzing the Profile," for details).
7. Unload the sample as follows:
   - Press LOAD to bring the stage forward.
   - Open the door, release the vacuum, and remove the sample from the stage.

   Refer to Chapter 6, "Profiling a Sample," for details.

To learn about how the Tencor P-2 collects and analyzes data, read Chapter 19, "Theory of Operation."

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

5 WRITING A RECIPE

A Scan *recipe* is the list of information that tells the instrument how to perform a scan. A recipe contains such parameters as scan speed, scan length, sampling rate, and so on.

The recipe is the logical beginning of the process of profiling a sample with the Tencor P-2. You must have a recipe before you can measure a sample.

Writing a recipe is also a flexible process. You can, for example, first examine a sample surface in the Motion screen, locate an artifact of interest, determine the width of the artifact and therefore an appropriate scan length, and then switch to the Recipe screen to set the scan length.

You can also, upon viewing your data, decide that you want to display more surface analysis data than the recipe calls for, and switch to the Recipe screen to edit your recipe. Upon returning to the Data screen, you will find your changes reflected in the Summary box, without any need to rescan the sample.

Scan recipes form the foundation of both manual and automatic (or sequence) operation of the instrument. In manual operation, you can measure single artifacts from a single recipe, one at a time. Automatic operation allows you to define a sequence of up to 300 different Scan recipes and artifact locations that can be run with or without operator intervention. See Chapter 10, "Automatic (Sequence) Operation," for details.

This chapter discusses

- Measurement capabilities of the Tencor P-2
- Setting scan parameters
- Recipe screen and fields
- Surface Analysis windows and fields
- Saving and maintaining recipes
- Using the SECS Interface option to upload and download recipes to and from a host computer

While this chapter discusses only 2-D recipes, most of the material also applies to 3-D recipes. If you have the Interactive 3-D Option installed, see Section 14.1, "Writing a 3-D Recipe," for details.

If you have the MicroHead Option, see Section 9.2, "MicroHead Recipe Fields."

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

5.1 MEASUREMENT CAPABILITIES

Before discussing recipes directly, it is helpful to consider the following capabilities and features of the Tencor P-2.

- The Tencor P-2 records up to 5000 data points per scan, thereby yielding maximum horizontal resolution (up to 0.01 μm/0.4 μin.).
- It scans at speeds ranging from 1 μm (0.04 mils) per second to 25 mm (1 in.) per second.
- You can use movable cursors to make horizontal and vertical measurements that appear as either surface or step height data. The screen constantly displays these measurements.
- After you take a scan, measurements are made by positioning the cursor lines to intersect the profile. Whenever you reposition the cursors, the program recalculates and displays the surface analysis parameters (selected in the recipe) such as R_a (roughness), TIR, or Average Height. The position of the cursors is set either manually or by program control.
- You can expand each cursor into a band to define a range (Delta Average mode). This enables averaging of step height measurements relative to two ranges rather than two points. You can move the cursors independently or in tandem to any point on the screen.
- The measurement cursors can be set to auto-detect and locate themselves automatically relative to an artifact edge or apex.
- A set of leveling cursors enables you to specify new zero points for releveling. Leveling relative to two ranges is also possible in the Delta Average mode.
- The leveling cursors can be set to Fit and Level in Delta Average mode to remove the curvature in a simple curved trace.
- The ZOOM function enables you to magnify areas of interest to aid analysis. The program displays a zoom box of variable size that can be placed over any portion of the trace by using the trackball. (In the Motion screen, ZOOM operates as an optical zoom.)
- Surface parameter values can be displayed in preprogrammed metric or English units. Units for horizontal measurements are set independently of vertical units.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

5.2 SCAN MODES

The Tencor P-2 offers the following types of manual scans:

- A *continuous scan* collects data continuously across the length of the scan.
- A *segmented scan* divides the scan length into segments of equal length, and collects no data between segments. You can scan across a disk and take no data over the center hole, or measure roughness over several short lengths spaced equally along a straight line (see Fig. 5-3).
- In the *Multi-Scan Average mode,* the Tencor P-2 repeats a scan up to ten times and automatically calculates the average. This feature is especially useful for calibration or for measuring submicron geometries.

5.3 SETTING SCAN PARAMETERS

Parameters such as length, speed, and direction must be set before the scan is taken. The Recipe screen is the means of setting these parameters.

A recipe is independent of the artifact position; therefore, a given recipe can be used at any number of locations.

Figure 5-1 displays the default recipe (P2) for 2-D scans. (If you have the Interactive 3-D option installed, see Section 14.1, "Writing a 3-D Recipe." If you have the MicroHead Option, see Section 9.2, "MicroHead Recipe Fields.")

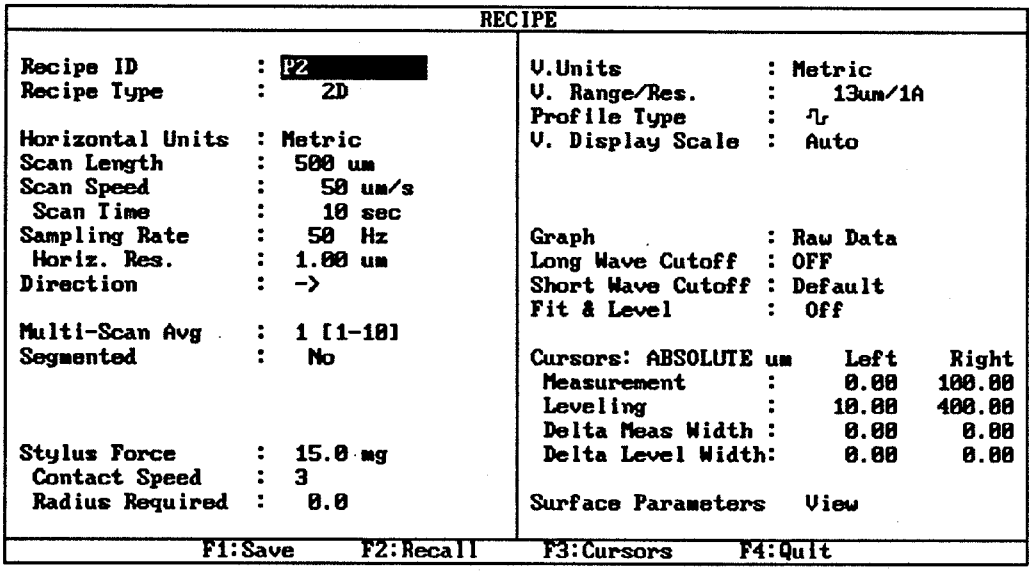


Figure 5-1 Default Recipe

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

The default recipe is a generic recipe that serves as a template for writing new ones. You write a new recipe by changing fields as needed and saving the result to the hard disk with a unique name to identify it.

To access the default Recipe screen:

1. From any screen, press MENU to access the menu bar.
2. Choose Catalog from the Recipe menu and press ENTER to display the Recipe catalog:

RECIPE CATALOG

ID	Type	Length	Speed	V.Range	Dir
ARGON40	3D	900	50	300um	->
BERT3D-2	3D	800	50	13um	->
BERT3D-20	3D	800	50	13um	->
BUMPS-3D	3D	650	100	300um	->
FIT&LEVEL	2D	3000	400	300um	->
LENS2	2D	200	50	300um	->
LNL	2D	150	10	13um	->
P2'"'	3D	937	50	13um	->
P2	2D	500	50	13um	->
P2_3D	3D	1250	100	300um	->
RADIUS	2D	300	10	300um	->
RAD_CONCAVE	2D	3000	100	300um	->
RAD_CONCAV2	2D	3000	100	300um	->
RAD_CONVEX	2D	3000	400	300um	->
RAD_CONVEX2	2D	3000	400	300um	->
RAD_CONVEX3	2D	3000	400	300um	->
RAD_CONVEX4	2D	300	20	300um	->
STEP	2D	120	10	13um	->
STEPAPEX_1	2D	300	10	300um	->
STEP_EDGE	2D	110	10	13um	->

F1:Delete F2:Recall F3:Export F4:Quit

Figure 5-2 Recipe Catalog

3. Press [↑] or [↓] to select P2 from the displayed list of recipes.
4. Press [F2: Recall] to display the recipe.

To edit fields in the Recipe screen and Surface Analysis window:

Toggle through the line items by pressing [↑] or [↓] and change values as needed.

- Some fields have fixed values that can be selected by pressing [←] or [→] to scroll through the allowed values.
- Other fields can accept the displayed values, or you can type in the value from the numeric keypad on the keyboard.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

5.3.1 RECIPE SCREEN FIELDS

Set values for scan parameters in a recipe as follows:

Recipe ID

Scan recipes can be given a name or Recipe ID. When saved on the hard disk for future use, a unique ID must be provided. Recipe IDs can be up to 11 valid characters long. Valid characters are

- Upper case letters
- The digits 0–9
- Most special characters (!, @, #, $, %, &, (,), {, }, and :)

Choose an ID by typing the desired combination of valid characters from the keyboard.

Recipe Type

Press [←] or [→] to toggle between 2-D or 3-D. (If you have the Interactive 3-D option installed, see Section 14.1, "Writing a 3-D Recipe.")

Horizontal Units

Press [←] or [→] to choose metric or English units for all horizontal parameters displayed, that is, scan length, scan speed, cursor positions.

Scan Length

The window automatically displays *Segment Length* if the segmented scan option is chosen. Otherwise, the window displays *Scan Length.* Choose a preferred value by pressing [→] to increase or [←] to decrease the value, or enter a number from the keypad. Press SEL to change the units within a given unit system (for example, μm to mm or μin. to mils).

Scan length must not be greater than 210 mm (8.2 in.). Scan time must not exceed 100 s. If you exceed scan length or time, an error message is displayed. *You will be unable to continue* until you correct the scan length, time, or number of segments. If you get an error message with a segmented scan, check the number of segments entered and make sure that the total length of the segments does not exceed 210 mm.

Scan Speed

Choose scan speed as above except that only preselected values are allowed.

> **NOTE:** **High speeds lose fine detail. Lower scan speeds are required to resolve the full height of a narrow peak, the squareness of a corner, or the presence of a very small artifact.**

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Speeds less than 400 μm/s cannot have a scan length greater than 8 mm (0.31 in.). Available scan speeds (in μm/s) are as follows:

1	50	5000
2	100	10000
5	400	25000
10	1000	
20	2000	

Scan Time

The program automatically displays the value for scan time. You do not enter this value. Note that this time is only for the period that the instrument is collecting the scan data.

Sampling Rate

Sample Rate is the nominal rate at which data is collected. You can set the sample rate to 50 or 100 Hz for scan speed of 1 or 2 μm/s and you can set the sample rate to 50, 100, or 200 Hz for all other scan speeds.

Horizontal Resolution

Horizontal resolution is a computed parameter that depends on the scan speed and sample rate. You do not enter this value.

Direction

Choose the scan direction by pressing [←] or [→]. Note that both the trace in the Scan screen and the data in the Data screen are displayed from right to left, regardless of the scan direction.

Multi-Scan Avg

You can improve the accuracy of a trace by making several scans and averaging the individual point values. Press [←] or [→] to select the number of scans (1–10) to be made and averaged. When you press START to initiate the scans, they will be repeated automatically. The trace displayed looks identical to a single scan trace but is the average of the scans taken.

Segmented

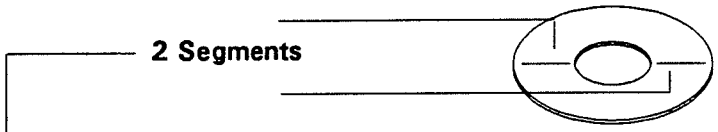
This feature enables data to be taken at specified intervals along a scan line. You can set up to ten data segments with equal spacing between the segments. No scan data is taken between the segments. (For example, use this feature to make an OD-to-OD measurement of a disk by plotting two segments and excluding the center hole.)

1. Press [←] or [→] to switch from No to Yes. Note the addition of the *No. of Segments* and *Spacing Length* fields to the recipe. Also note that the *Scan Length* field has changed to *Segment Length* (compare Fig. 5-1 and Fig. 5-3).
2. Press [←] or [→] to toggle to the number of segments. Press [↓] to choose Spacing Length.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3. Press SEL to change units, μm to mm or μin. to mil.
4. Enter the segment spacing length from the keypad. This is the length between the segments. It corresponds to the interval(s) where scan data is not taken.
5. Press [↓] to select Segment Length field. Select or enter the desired value.

CAUTION: **Because the stylus does not lift in the space where no data is taken, no major artifact (for example, a fixture) should obstruct its course as it can cause damage to the stylus.**




```
                                RECIPE

Recipe ID          : P2-2SEGS          V.Units            : Metric
Recipe Type        :    2D             V. Range/Res.      :    13um/1A
                                       Profile Type       :  ⎍
Horizontal Units   : Metric            V. Display Scale   :  Auto
Segment Length     :  500 um
Scan Speed         :    50 um/s
 Scan Time         :    20 sec
Sampling Rate      :   50  Hz          Graph              : Raw Data
 Horiz. Res.       :  1.00 um          Long Wave Cutoff   : OFF
Direction          :  ->               Short Wave Cutoff  : Default
                                       Fit & Level        :  Off
Multi-Scan Avg     :  1 [1-10]
Segmented          :  Yes              Cursors: ABSOLUTE um     Left     Right
No.of Segments     :  2 [1-10]          Measurement       :     0.00   100.00
 Spacing Length    : 25.0 um            Leveling          :    10.00   400.00
                                        Delta Meas Width  :     0.00     0.00
Stylus Force       :  15.0 mg           Delta Level Width:     0.00     0.00
 Contact Speed     :  3
 Radius Required   :   0.0             Surface Parameters   View

          F1:Save     F2:Recall     F3:Cursors     F4:Quit
```

Figure 5-3 Sample Recipe for Segmented Scan

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Stylus Force

> **NOTE:** If you have the optional MicroHead instead of the standard measurement head, see Section 9.1, "Measurements at Low Stylus Force Settings," and Section 9.2, "MicroHead Recipe Fields," for available settings for the Stylus Force field.

Use the keypad to enter the desired value from 1 to 100 mg. See Table 5-1 for recommended forces for low noise traces at various scan speeds. Higher speeds tend to require higher stylus forces to ensure constant contact between the stylus and substrate. A stylus with a small radius might require a low stylus force on soft substrates. A higher force will minimize the effects of environmental noise.

The stylus force varies slightly as the stylus moves away from the center position. The force decreases approximately 1 mg for every 13 μm below the center. Therefore, use at least 20 mg when in the 300 μm range.

The following table should suffice for polished or ordinarily machined surfaces. Some surfaces have higher slopes and require as much as twice these stylus forces. Brittle materials such as glass and ceramic are worked by microfracturing, and a ground surface can include slopes as high as 40°.

Table 5-1 Recommended Stylus Force Versus Scan Speed

Speed (μm/s)	Recommended Force (mg)	Speed (μm/s)	Recommended Force (mg)
1	1 – 25	100	10 – 35
2	1 – 25	400	15 – 44
5	3 – 25	1000	20 – 50
10	5 – 25	2000	25 – 60
20	7 – 25	5000	30 – 75
50	8 – 30	10000	35 – 85
–	–	25000	40 – 100

Contact Speed

This parameter specifies the stylus drop speed at contact with the substrate. Press [←] or [→] to select a value between 1 and 10, with 1 being the slowest and 10 being the fastest speed. Very soft substrates such as pure aluminum or photoresist can require a setting of 1 or 2. We recommend slower contact speed settings of 1 to 3 for styli with radii below 5 μm.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Radius Required

> **NOTE:** If you have the MicroHead instead of the standard measurement head, see Section 9.2, "MicroHead Recipe Fields," for available MicroHead styli.

Enter the size (μm) of the stylus in use. Standard size is 12.5 μm. Optional sizes are 50 μm, 25 μm, 5 μm, 1.5 to 2.5 μm, and submicrometer supplied with a SEM photograph. Note: This parameter is not used for any calculations but is displayed as a reminder for the user. Verify the stylus radius by the color band on the stylus shank. See Table 5-2.

Table 5-2 Determining the Stylus Radius

Color Code Band	Stylus Radius (μm)	Shank Angle (Deg.)
White	50	60
Blue	25	60
Red	12.5	60
Yellow	5.0	60
Green	1.5 – 2.5	60
Orange	1.5 – 2.5	45
Black	0.1 – 0.8	70

currently on the machine

Vertical Units

Press [←] or [→] to choose metric or English units for all vertical parameters displayed, that is, step height, height of cursors, and vertical scale of trace. (The horizontal units are determined by the units selected in the left window.)

Vertical Range/Resolution

> **NOTE:** If you have the optional MicroHead instead of the standard measurement head, see Section 9.1.1, "Limitations on Downward Travel," and Section 9.2, "MicroHead Recipe Fields," for available values for the Vertical Range/Resolution field.

Choose 13 μm or 300 μm by pressing [←] or [→] depending on the sample artifacts to be profiled. Select 13 μm for feature heights on the order of 6.5 μm, and 300 μm for feature heights on the order of 150 μm. (If the vertical units are English units, choose between the 520 μin. and 12 mil ranges.)

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Profile Type

Displays the scan profile. Press [←] or [→] to choose one of three choices that best represents the profile of the scan to be taken:



Use this mode when you are uncertain of the shape of the scan profile.



Use this mode when measuring a peak greater than 140 μm high.



Use this mode when measuring a valley greater than 140 μm deep.

> **CAUTION:** **Use special caution when profiling samples in the ⌴ mode. The stylus has a 20-μm up range and 280-μm down range. If you exceed the 20-μm up range, the stylus force can increase to as much as 3 g. Such a force could easily damage many materials. If sequencing, it is very important that the substrate is level to prevent exceeding the 20-μm up range.**

Vertical Display Scale

Choose the vertical range of the trace display. Press [←] or [→] to toggle through predefined values or select Auto. Auto is normally a satisfactory and convenient choice, but sometimes it is desirable to fix the scales so that scans are directly comparable.

The Y-axis zero is defined by the data points marked by the leveling cursors, that is, the points where the leveling cursors cross the trace become the zero value on the leveled trace. The full scale ranges are listed in Table 5-3.

Table 5-3 Full Scale Ranges

Å	μin	μm	μin	μm	μin	μm	mil	μm	mil
100	.4	.1	4.0	1.0	40	10	400	100	4.0
160	.65	.16	6.5	1.6	65	16	650	160	6.5
250	1	.25	10	2.5	100	25	1.0	250	10
400	1.6	.40	16	4.0	160	40	1.6	400	16
650	2.5	.65	25	6.5	250	65	2.5	–	–

Graph

Press [←] or [→] to choose the desired trace or traces for display. You can choose either raw data, roughness or waviness only, or any combination of them.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Long Wave Cutoff

Press [←] or [→] to choose a value from the range of cutoff filter lengths provided, or turn off the filter. The scan length should be five times the cutoff length to avoid data distortion. The selectable values are listed in Table 5-4.

Table 5-4 Long Wave Cutoff Filter Lengths

µm	mil	µm	mil	mm	inch	mm	inch
4.5	.18	80[1]	3	1.4	56	25	1
8	.3	140	5.6	2.5[1]	100	–	–
14	.56	250[1]	10	4.5	180	–	–
25	1	450	18	8[1]	300	–	–
45	1.8	800[1]	30	14	560	–	–

[1] These numbers are the ANSI B46.1 - 1985 standard cutoffs.

Roughness is generally regarded as the fine grain texture of a surface. Coarser irregularities, with 30 to more than 100 times the wavelength of the roughness, constitute waviness.

Waviness in a surface often interferes with accurate measurement of the roughness. Waviness can be virtually removed from the trace by processing the trace with a high pass filter (that is, one that will suppress the longer wavelengths in the trace and pass only the short wavelengths of the roughness).

Sixteen filter choices are provided (see Table 5-4). The cutoff length is the wavelength on the filter transmission curve that corresponds to 75% transmission. The ANSI B46.1–1985 standard regards the 800-µm cutoff as preferred for most surfaces.

Conversely, the cutoff lengths act as a low pass filter during waviness measurements to eliminate roughness. Refer to ANSI B46.1–1985 for further information.

Short Wave Cutoff

See Section 8.4, "Using Cutoff Filters," for details.

Fit & Level

Press [←] or [→] to select On or Off. See Section 7.7, "Fit and Level," for details.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Cursors

Two pairs of cursors are used in the Data screen. The *leveling cursors* define two points that establish a level line for the trace (see Section 7.2, "Leveling the Profile"). The *measurement cursors* define the endpoints of the sampling length (see Section 7.3.1, "Positioning the Cursors").

You can enter values either manually or automatically for the left and right cursor positions. You also can use Delta averaging to change the intersection of the cursor and trace from a single point value to the average of the section of the trace defined by the Delta width setting.

1. Press [↑] or [↓] to select the desired cursors.
2. Enter the cursor position value manually from the keypad or to record the positions automatically from the screen, press [F3: Cursors].

You also can set the cursors to position themselves after measurement relative to an artifact edge. Program this Edge Detection setting in the Surface Analysis screen (see Section 5.3.2, "Surface Analysis Fields"). If you set this parameter On, the cursors will be labeled RELATIVE. If set to Off (the default), the cursors will be labeled ABSOLUTE. See Section 7.5, "Automatic Cursor Positioning (Edge Detection)," for details.

Surface Parameters

Press either [←] or [→] to display the Surface Analysis window (Fig. 5-4). Scroll through and edit fields in the Surface Analysis window just as in the main Recipe screen. See Section 5.3.2, "Surface Analysis Fields," for details.

Note: There are two Surface Analysis windows if your instrument has the Additional Surface Roughness Parameters option. See Section 5.3.3, "Additional Surface Roughness Parameters Option," for details.

5.3.2 SURFACE ANALYSIS FIELDS

The following parameters are located in a pop-up window that appears on top of the Recipe screen (see Fig. 5-4). Access this window by pressing [←] or [→] or SEL from the Surface Parameters field in the Recipe screen.

Press [F1: Default] to revert to the default settings for all surface analysis parameters, if desired.

When any desired changes have been made, press [F4: Quit] to return to the Recipe screen and save the current settings.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

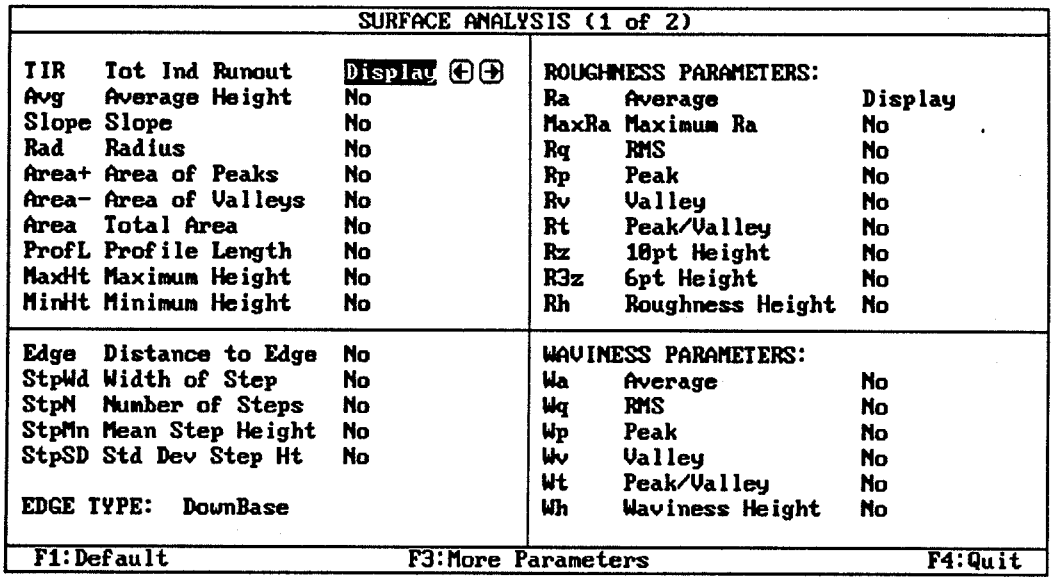


Figure 5-4 Surface Analysis Window

Press [←] or [→] to choose one of the following:

DISPLAY	Displays the calculated value in the Summary box in the Data screen. Up to seven parameter values can be displayed. (More values can be displayed in the Summary window.) Enters the value into memory.
YES	Calculates a parameter and enters it into memory. Displays it in the Summary window but not in the Data screen.
NO	Does not store or display the parameter.

Press [F1: Default] to default to a display of R_a and TIR only.

Parameter definitions that follow are from ANSI B46.1-1985. All values apply to the portion of the profile situated between the two measurement cursors. The distance between the cursors is called the sampling length. Refer to Section 19.2.2, "Surface Texture Analysis," for more information about the surface parameters.

> **NOTE:** **The cutoff filter that you select affects the values of the roughness and waviness parameters.**

The following general purpose parameters are available.

TIR (Total Indicator Runout)

The difference in height between the highest and the lowest points within the sampling length. Note the similarity to the roughness parameters R_t, R_{max}, and R_y described later in this section.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Avg (Average Height)

The average height of all data points between the measurement cursors relative to the leveled baseline.

Slope

The ratio of the difference in vertical positions to the difference in horizontal positions of the measurement cursors. The slope is reported as an angle in degrees. In Delta Average mode, the position of each cursor is taken to be the horizontal midpoint of each delta cursor band, and the data value at this location is the average of the vertical values within these bands.

Rad (Radius)

The distance from the center of curvature of the profile arc (assuming a circular profile within the sampling length) to the profile. The measurement cursors define two points of a circular arc. A least squares fit is performed on the points between the cursors. You should *not* level the raw trace unless definite level reference points exist. In Delta Average mode, the position of each cursor is taken to be the horizontal midpoint of each delta cursor band, and the data value at this location is the average of the vertical values within these bands.

See Section 7.6, "Radius Measurement," for more information.

Area+ (Area of Peaks)

The total area bounded by the leveled baseline and the profile where it rises *above* the baseline within the sampling length. The Delta cursors are not used.

Area- (Area of Valleys)

The total area bounded by the leveled baseline and the profile where it descends *below* the baseline within the sampling length. The Delta cursors are not used.

Area (Total Area)

The sum of Area of Peaks and Area of Valleys within the sampling length. The Delta cursors are not used.

ProfL (Profile Length)

The length that would be obtained from drawing out the profile in a straight line, within the sampling length. The Delta cursors are not used.

MaxHt (Maximum Height)

The maximum height of the trace measured from the zero line within the sampling length.

MinHt (Minimum Height)

The minimum height of the trace measured from the zero line within the sampling length.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

The following group of parameters are associated with Automatic Cursor Positioning. To use them correctly, Automatic Cursor Positioning must be enabled and set up appropriately for the type of artifact to be measured. See Section 7.5, "Automatic Cursor Positioning (Edge Detection)," for details.

Edge (Distance to Edge)

Depending on the setting of two threshold parameters, this distance is either

- The distance between the beginning of the scan and the first rising or falling edge of a profile artifact; or
- The distance between the beginning of the scan and the first concave or convex arc of a profile artifact.

StpWd (Width of Step)

The distance between the first rising edge of an upward step and the falling edge that follows, or the first falling edge of an downward step and the rising edge that follows. This value is meaningless for a concave or convex arc. See Section 7.5, "Automatic Cursor Positioning (Edge Detection)," for details.

StpN (Number of Steps)

The number of steps that occur in the sampling length. These steps are defined as complete pairs of ascending and descending edges. The Type setting in the Edge/Arc Detection Setup window (Fig. 7-10) determines the appropriate order of the edge pairs. For example, if the Type is set for UpEdge, StpN starts counting pairs starting with the first ascending edge encountered. This value is meaningless for a concave or convex arc.

StpMn (Mean Step Height)

The mean value of step height of all the steps that occur in the sampling length. Steps are defined as described for StpN above. This value is meaningless for a concave or convex arc.

StpSD (Std Dev Step Ht)

The standard deviation of the step heights of all the steps that occur in the sampling length. Steps are defined as described for StpN above. This value is meaningless for a concave or convex arc.

NOTE:	**Convex and Concave settings for the Type field in the Edge/Arc Detection Setup window (Fig. 7-10) are for arc measurement and should not be used for any of the step parameters.**

EDGE TYPE

The current setting of the Edge Type field in the Automatic Cursor Positioning configuration is displayed in this field as a reminder to the user. It cannot be changed from this

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

window but must be accessed from the Edge/Arc Detection Setup window. See Section 7.5, "Automatic Cursor Positioning (Edge Detection)," for details on changing this field.

The following roughness parameters are available.

R_a (Average)

The arithmetic average deviation of the absolute values of the roughness profile from the mean line or center line. (Also known as center line average roughness.) The center line divides profiles such that all areas above it are equal to all areas below it.

Max R_a (Maximum R_a)

The trace within the cursors is divided into 19 overlapping sections. Each section is one-tenth of the sampling length. The R_a of each section is calculated, and the maximum is displayed.

R_q (RMS)

The Root-Mean-Square (RMS) or geometric average deviation of the roughness profile from the mean line measured in the sampling length.

R_p (Peak)

The distance between the mean line and the highest peak within the sampling length.

R_v (Valley)

The distance between the mean line and the lowest valley within the sampling length.

R_t (Peak/Valley)

The vertical distance between the highest peak and the lowest valley in the sampling length leveled on the mean line. (Also known as R_{max}, R_y, Maximum Peak-To-Valley Roughness.)

R_z (10pt Height)

The average height difference between the five highest peaks and the five deepest valleys within the cursors measured from a line parallel to the mean line.

R_{3z} (6pt Height)

The average height difference between the three highest peaks and the three deepest valleys in the sampling length measured from a line parallel to the mean line and not crossing the profile.

R_h (Roughness Height)

The difference in height in the roughness profile between the left and right cursor positions (analogous to the Height data that always appears in the Summary box of the Data screen).

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

The following waviness parameters correspond to the roughness parameters listed previously after introducing a low pass filter of selectable cutoff length.

W_a (Average)

W_q (RMS)

W_p (Peak)

W_v (Valley)

W_t (Peak/Valley)

W_h (Waviness Height)

5.3.3 ADDITIONAL SURFACE ROUGHNESS PARAMETERS OPTION

If you have the Additional Surface Roughness Parameters Option, there is a second Surface Analysis window (Fig. 5-5). The standard window is titled Surface Analysis (1 of 2), and the additional window is titled Surface Analysis (2 of 2), Additional Roughness Parameters.

Press [F3: More Parameters] to toggle between the two Surface Analysis windows. Press [F4: Quit] to return to the Recipe screen.

```
SURFACE ANALYSIS (2 of 2), ADDITIONAL ROUGHNESS PARAMETERS

Rpm   Mean Peak Height   No
Dq    RMS Slope          No
Lq    RMS Wavelength     No
SD    Std Dev Heights    No

tp    Bearing Ratio
                DEPTH:    Units
 1  No              0 x 1A
 2  No              0 x 1A
 3  No              0 x 1A

CutDp Cutting Depth
                RATIO:
 1  No             0.0%
 2  No             0.0%
 3  No             0.0%

Pc    Peak Count
                  BAND:    Units
 1  No              0 x 1A
 2  No              0 x 1A
 3  No              0 x 1A

HSC   High Spot Count
                HEIGHT:    Units
 1  No              0 x 1A
 2  No              0 x 1A
 3  No              0 x 1A

Sm    Mean Peak Spacing
                  BAND:    Units
 1  No              0 x 1A
 2  No              0 x 1A
 3  No              0 x 1A

F1:Default          F3:More Parameters          F4:Quit
```

Figure 5-5 Surface Analysis–Additional Roughness Parameters Window

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

> **NOTE:** These parameters only apply to the roughness trace. Attempting to use them on the raw trace or waviness trace will give meaningless results.

To select the first four parameters in the window, press [←] or [→] to choose one of the following:

DISPLAY Displays the calculated value in the Summary box in the Data screen. Up to seven parameter values can be displayed. (More values can be displayed in the Summary window.) Enters the value into memory.

YES Calculates a parameter and enters it into memory. Displays it in the Summary window but not in the Data screen.

NO Does not store or display the parameter.

Press [F1: Default] to default to a display of R_a and TIR only.

The following surface analysis parameters appear in the second Surface Analysis window (Fig. 5-5). Parameter definitions are from ANSI B46.1–1985 or ISO 4287/1–1984 where indicated.

Rpm (Mean Peak Height)

The mean value of the local peak heights within the sampling length. The Delta cursors are not used.

D_q (RMS Slope)

The root mean square (RMS) value of the profile slope. The Delta cursors are not used.

L_q (RMS Wavelength)

2π times the ratio of the root mean square (RMS) deviation of the profile (R_q) to the root mean square slope of the profile (D_q). L_q is a measure of the spacing of local peaks and local valleys, taking into account their relative amplitudes and individual spatial frequencies. (ISO).

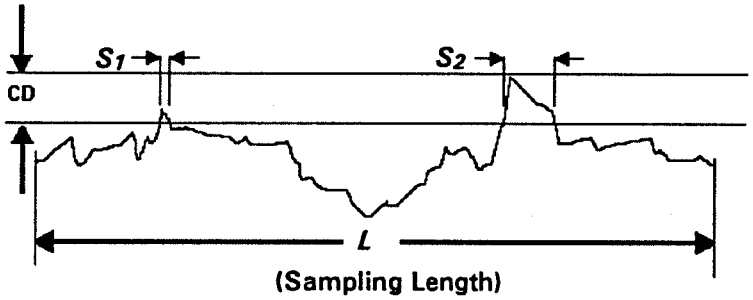
SD (Std Dev Heights)

The standard deviation of the local peak heights about the mean peak height within the sampling length.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

t_p (Bearing Ratio)

See Figure 5-6. A reference line is drawn parallel to the mean line and at a preselected or predetermined distance below the highest peak in the sampling length (called the *cutting depth*) to intersect the profile in one or more subtended lengths. The *bearing length* is the sum of these subtended lengths. The *bearing ratio* is the ratio of the bearing length to the sampling length; it is also called the bearing length ratio. (ANSI).



$$t_p = \frac{S_1 + S_2}{L}$$

Figure 5-6 Determination of Bearing Length and Bearing Length Ratio

Up to three separate calculations can be made for different values of cutting depth. Enter the depth values into two fields—the number and the units. The number field accepts values in the range 1–999; the default value is 1. Press [↓] to move to the units field. Use [←] and [→] to scroll through the allowed values for the units. These are: 1Å, .001 μm, .01 μm, .1 μm, and 1 μm.

```
tp    Bearing Ratio
                DEPTH:    Units
 1  No                 0 x 1Å
 2  No                 0 x 1Å
 3  No                 0 x 1Å
```

Figure 5-7 Fields for Bearing Ratio Parameter

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

CutDp (Cutting Depth)

The value of the cutting depth for a given value of the bearing ratio; that is, the location of a line parallel to the mean line that results in a particular value of bearing ratio for the profile. See Fig. 5-6.

Up to three separate calculations can be made for different values of bearing ratio. Enter the ratio as a percent; any value in the range 0–99.9 is an acceptable entry.

```
CutDp Cutting Depth
                  RATIO:
 1  No                 0.0%
 2  No                 0.0%
 3  No                 0.0%
```

Figure 5-8 Fields for Cutting Depth Parameter

PC (Peak Count)

The number of peak/valley pairs per unit length projecting through a band of width *b* centered about the mean line. See Fig. 5-9. *Projecting through* means that the profile curve climbs above and then falls below the band. Thus, if the profile rises above the band more than once without falling below the band, multiple peaks are not identified. Delta cursors are not used. (ANSI).

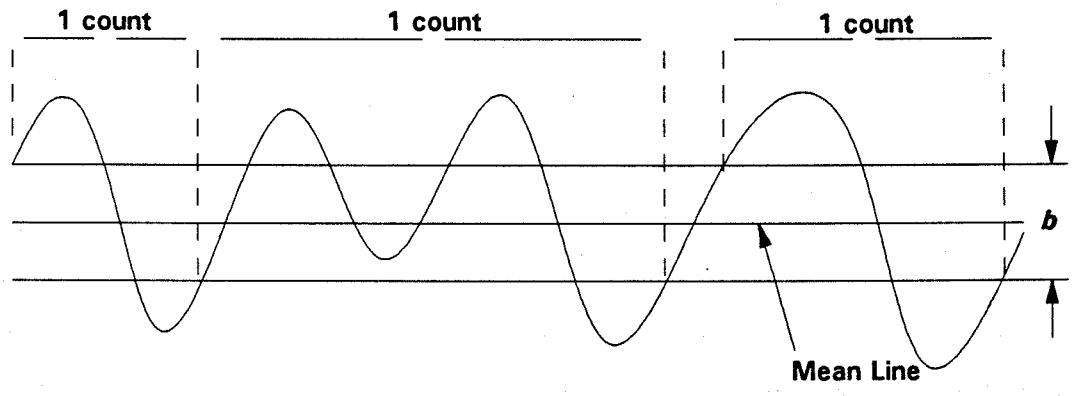


Figure 5-9 Determination of Peak Count

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Up to three separate calculations can be made for different values of the width of the band centered about the mean line. Enter the band values into two fields—the number and the units. The number field accepts values in the range 1–999; the default value is 1. Press [↓] to move to the units field. Use [←] and [→] to scroll through the allowed values for the units. These are: 1Å, .001 μm, .01 μm, .1 μm, and 1 μm.

```
PC    Peak Count
                    BAND:    Units
 1  No                 0 x 1A
 2  No                 0 x 1A
 3  No                 0 x 1A
```

Figure 5-10 Fields for Peak Count Parameter

HSC (High Spot Count)

The number of profile peaks per unit of length projecting through a reference line parallel to and at a given height above a line drawn through the lowest point of the roughness trace, parallel to the mean line. See Fig. 5-11. Note the similarities (and the differences) to Peak Count. Compare Fig. 5-9 and Fig. 5-11.

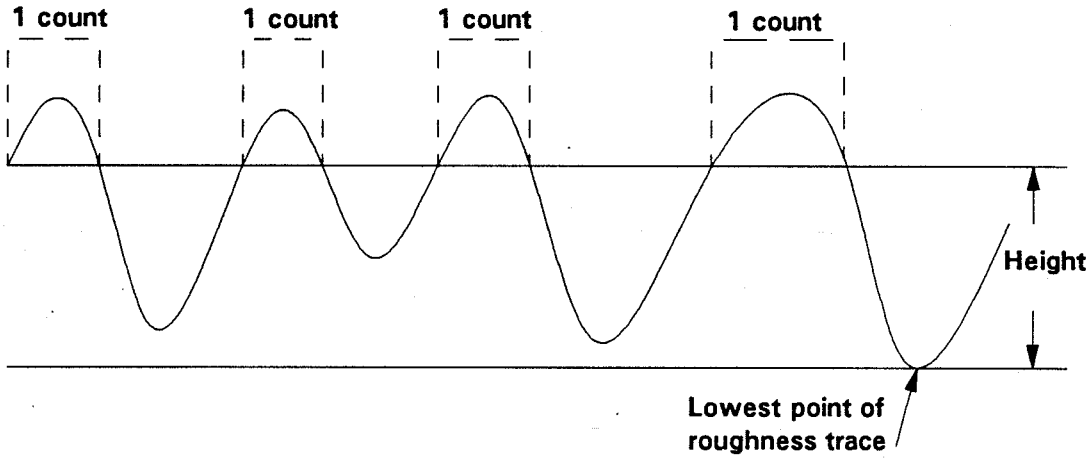


Figure 5-11 Determination of High Spot Count

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Up to three separate calculations can be made for different values of the height of the reference line. Enter the height values into two fields—the number and the units. The number field accepts values in the range 1–999; the default value is 1. Press [↓] to move to the units field. Use [←] and [→] to scroll through the allowed values for the units. These are: 1Å, .001 μm, .01 μm, .1 μm, and 1 μm.

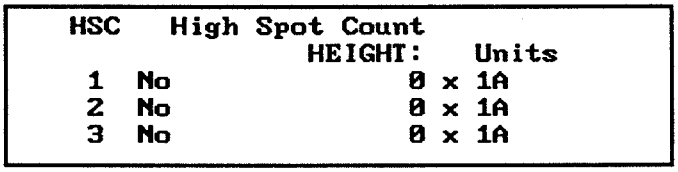


Figure 5-12 Fields for High Spot Count Parameter

S_m (Mean Peak Spacing)

The mean value of the local peak spacing of the profile within the sampling length, where the peaks are defined by the criteria of the Peak Count parameter above.

Up to three separate calculations can be made for different values of the width of the band centered about the mean line. Enter the band values into two fields—the number and the units. The number field accepts values in the range 1–999; the default value is 1. Press [↓] to move to the units field. Use [←] and [→] to scroll through the allowed values for the units. These are: 1Å, .001 μm, .01 μm, .1 μm, and 1 μm.

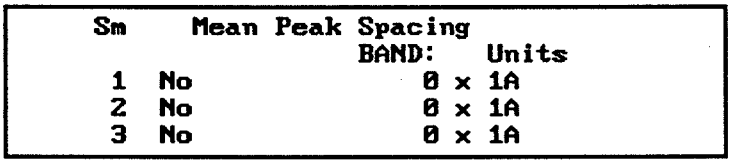


Figure 5-13 Fields for Mean Peak Spacing Parameter

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

5.4 SAVING RECIPES

Once you have written a Scan recipe, you can save it for future use. Ordinarily, you save a recipe to the instrument's hard disk, but you can also export it to floppy diskettes. We recommend that you save important recipes both on the instrument's hard disk and on floppy diskettes, either by individually exporting them to the diskettes as you write them or by periodically backing up the Recipe catalog. See Section 5.5, "Maintaining Recipes," for details.

You can change the Scan recipe name at this time, if desired. Scan recipe names or IDs can be up to 11 characters. Instructions follow for entering Recipe IDs from the built-in keyboard and the optional remote keyboard. See Section 3.5, "Entering an ID," for more information.

To save a recipe using the built-in keyboard:

1. From the Recipe screen, press [F1: Save]. The Save Recipe window is displayed.

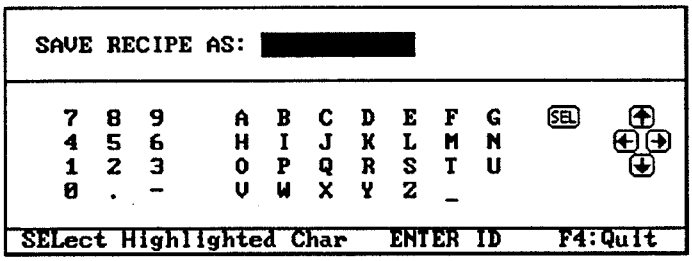


Figure 5-14 Save Recipe Window

2. If you wish to modify or type over the existing recipe ID, go to Step 3. Otherwise, press ENTER to save the recipe with the current ID.
3. Use the trackball or arrow keys to highlight a number or character.
4. Press SEL to choose the highlighted number or character, which appears at the top center of the window. (You also can enter numbers from the numeric keypad.) Repeat as needed to complete the ID.
5. If desired, press UNDO to erase the latest character entered or CLEAR to erase the entire ID.
6. Press ENTER to accept the new ID or press [F4: Quit] to reject the ID and abort the operation.

To save a recipe using the remote keyboard:

1. From the Recipe screen, press [F1: Save]. The Save Recipe window is displayed (Fig. 5-14).

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

2. If you wish to modify or type over the existing recipe ID, go to Step 3. Otherwise, press ENTER to save the recipe with the current ID.
3. Type the desired ID from the keyboard. Use the backspace key to erase characters as needed or press CLEAR to erase the entire ID.
4. Press ENTER to accept or press [F4: Quit] to reject the ID and abort the operation.

5.5 MAINTAINING RECIPES

Recipe maintenance includes such tasks as

- Importing and exporting recipes
- Backing up and restoring recipes
- Deleting recipes
- Editing existing recipes
- Viewing the Recipe catalog

5.5.1 IMPORTING RECIPES

To import recipes:

1. Press MENU one or more times until the menu bar is displayed.
2. Choose Disk Path from the Config menu and press ENTER to display the following window:

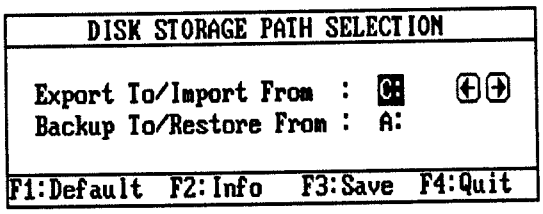


Figure 5-15 Disk Storage Path Selection Window

3. Use [←] or [→] to change the Export To/Import From drive to the drive from which you are going to import data. Note: To import recipes from drive A, insert the diskette into drive A before pressing [F4: Quit].

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4. Press [F4: Quit] to return to the menu bar. Choose Maintain from the Recipe menu and press ENTER to display the following window:

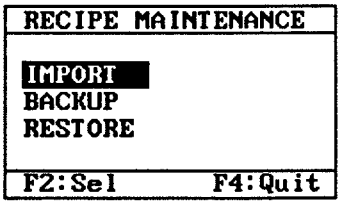


Figure 5-16 Recipe Maintenance Window

5. Choose Import and press ENTER. The following window is displayed:

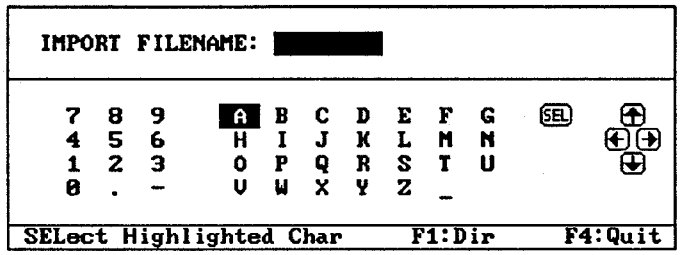


Figure 5-17 Import Filename Window

6. Enter the name of the Scan recipe to be imported and press ENTER. If you do not know the filename to be imported, press [F1: Dir] to display a list of files available for import. Use [↑] or [↓] to select the file to be imported and press ENTER. The following prompt is displayed:

   Save the recipe? [Y/N]

7. To save the recipe, enter Y. The Save Recipe window (Fig. 5-14) is displayed. Type an ID and press ENTER. To open the imported recipe without saving it first, enter N. Note: You can save the recipe later in the Recipe screen. After the recipe is saved, the Recipe Maintenance window is displayed again.

5.5.2 BACKING UP AND RESTORING RECIPES

To back up recipes:

1. Change the disk path (see Steps 1 through 3 of Section 5.5.1, "Importing Recipes").
2. Choose Maintain from the Recipe menu and press ENTER to display the Recipe Maintenance window (Fig. 5-16).

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3. Choose Backup and press ENTER. The following prompt is displayed:

   Backup All Sequences Also? [Y/N]:

4. Enter Y to back up the sequences with the recipes or N to back up recipes only. The following prompt is displayed:

   Please insert backup volume 1
   Press any key to continue

5. Insert the first backup diskette and press ENTER. When the backup diskette is full, the following prompt is displayed:

   Continue with volume 1 [Y] or suspend the session [N]?

6. Insert another backup diskette or enter N to suspend the backup session if you do not have a backup diskette ready.

   Note: If you select the backup function again, after the function was suspended, the system displays a prompt asking you if you want to resume the backup function. Enter Y to resume the backup function.

7. When all the specified data is backed up, the system will display a message that the backup is complete.

To restore recipes:

1. Change the disk path (see Steps 1 through 3 of Section 5.5.1, "Importing Recipes").
2. Choose Maintain from the Recipe menu and press ENTER to display the Recipe Maintenance window (Fig. 5-16).
3. Choose Restore and press ENTER. The following prompt is displayed:

   Approximate restoration capacity is 5.0
   high-density diskettes. OK to Restore? [Y/N]:

4. Enter Y to continue and the following prompt is displayed:

   Restore all Sequence Programs found also? [Y/N]:

5. Enter Y to restore Scan recipes and Sequence programs or enter N to restore the recipes only.
6. The system prompts you to insert the first backup diskette. Insert the first backup diskette and press any key to continue.

NOTE:	**Insert the diskettes in the same order as you did during the backup procedure. If the diskette numbers are not recorded, see Section 18.2.6, "Database Recovery," for procedures on displaying the diskette sequence numbers.**

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

7. The system prompts for each succeeding backup diskette. When the backup is complete, the following prompt is displayed:

   Restoration is complete
   Press any key to continue

8. Press any key to return to the Recipe Maintenance window (Fig. 5-16).

5.5.3 VIEWING THE RECIPE CATALOG

From the Recipe catalog, the user can

- Delete a recipe
- Export a recipe
- Recall a recipe

To view the Recipe catalog:

1. Press MENU (several times if necessary) to display the main menu bar.
2. Choose Catalog from the Recipe menu and press ENTER. The Recipe Catalog window (Fig. 5-18) is displayed listing recipe IDs and various parameters:

RECIPE CATALOG

ID	Type	Length	Speed	V.Range	Dir
ARGON40	3D	900	50	300um	->
BERT3D-2	3D	800	50	13um	->
BERT3D-20	3D	800	50	13um	->
BUMPS-3D	3D	650	100	300um	->
FIT&LEVEL	2D	3000	400	300um	->
LENS2	2D	200	50	300um	->
LNL	2D	150	10	13um	->
P2'"'	3D	937	50	13um	->
P2	2D	500	50	13um	->
P2_3D	3D	1250	100	300um	->
RADIUS	2D	300	10	300um	->
RAD_CONCAVE	2D	3000	100	300um	->
RAD_CONCAV2	2D	3000	100	300um	->
RAD_CONVEX	2D	3000	400	300um	->
RAD_CONVEX2	2D	3000	400	300um	->
RAD_CONVEX3	2D	3000	400	300um	->
RAD_CONVEX4	2D	300	20	300um	->
STEP	2D	120	10	13um	->
STEPAPEX_1	2D	300	10	300um	->
STEP_EDGE	2D	110	10	13um	->

F1:Delete F2:Recall F3:Export F4:Quit

Figure 5-18 Recipe Catalog

3. Press [↑] or [↓] to select a recipe.
4. Press [←] or [→] or use the trackball to scroll additional recipe parameters into view.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

5. Press [F1: Delete] to delete the currently highlighted recipe; or
   Press [F3: Export] to export the currently highlighted recipe; or
   Press [F2: Recall] to recall the currently highlighted recipe.
6. Press [F4: Quit] to quit the catalog.

5.5.4 CHANGING A STORED RECIPE

Often a new recipe is a slight variation of one that you have already written. Rather than always using the default recipe (P2) as a template, any other recipe can serve the same purpose.

To change a stored recipe when the Recipe ID is known:

1. Press MENU.
2. Choose Catalog from the Recipe menu and press ENTER to display the Recipe catalog (Fig. 5-18).
3. Press [↑] or [↓] to select a recipe. Note: To change the default recipe, choose P2 from the list.
4. Press [F2: Recall] to recall the selected recipe.
5. Scroll through the recipe fields using [↑] or [↓] and change values as needed.
6. Press [F1: Save] to save the new recipe. The Save Recipe window is displayed (Fig. 5-14).
7. Enter a new ID and press ENTER, or press ENTER to keep the current ID and overwrite the former recipe.
8. In the latter case, you are prompted:

   Recipe already exists, overwrite? [Y/N]

   Press YES to overwrite the former recipe and if data has been saved with that recipe, you will be prompted again:

   Existing recipe has data, rename? [Y/N]

   Press YES to display the Alphanumeric window again and enter a new ID for the new recipe.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

5.6 USING THE SECS INTERFACE OPTION WITH RECIPES

You can use the SECS Interface Option to upload and download recipes to and from a host. Procedures for enabling and configuring the SECS Option, and uploading and downloading recipes are described in the following sections. For more information, refer to the *Tencor Profiler SECS Interface Manual*.

5.6.1 ENABLING AND CONFIGURING THE SECS OPTION

You must enable and configure the SECS Option before uploading or downloading recipes. You do not need to configure the SECS interface each time that you upload or download a recipe.

To enable and configure the SECS Option:

1. Choose SECS from the Config menu and press ENTER. The SECS Communications window is displayed:

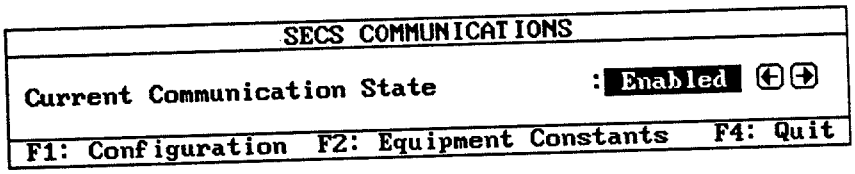


Figure 5-19 SECS Communications Window

2. Use [←] or [→] to select Enabled.
3. Press [F1: Configuration] to configure the SECS Option. The SECS Configuration window is displayed:

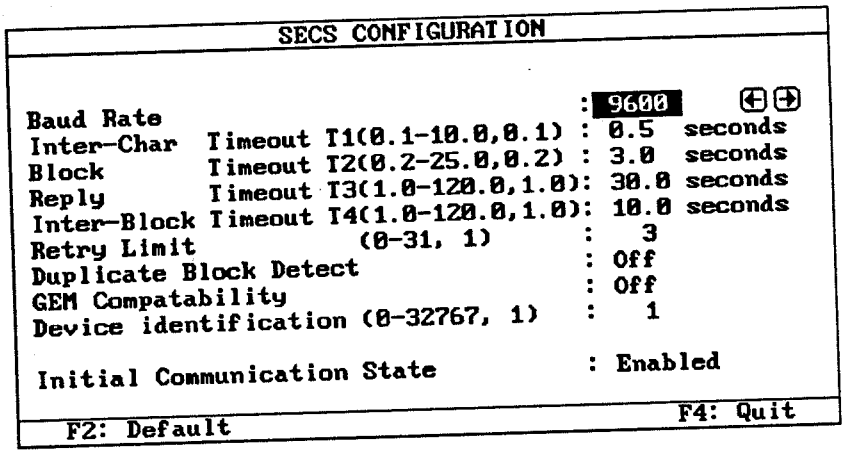


Figure 5-20 SECS Configuration Window

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4. To set the SECS configuration to default values, press [F2: Default] or set the values as desired using the following list:

Option	Description
Baud Rate	Available speeds are 300, 600, 1200, 2400, 4800, and 9600. The default speed is 9600.
Inter-Char Timeout	The range allowed is 0.1 to 10 s at increments of .1 s. The default value is 0.5 s.
Block Timeout	Also called the Protocol Timeout. The range allowed is 0.2 to 25 s at increments of 0.2 s. The default value is 3 s.
Reply Timeout	Also called the Transaction Timeout. The range allowed is 1 to 120 s at increments of 1 s. The default value is 30 s.
Inter-Block Timeout	The range allowed is 0 to 120 s at increments of 1 s. The default value is 10 s.
Retry Limit	Also called the Transmit Failure Retry Limit. The range allowed is 0 to 31 at increments of 1. The default value is 3.
Duplicate Block Detect	Can be enabled (On) or disabled (Off). The default value is Off.
GEM Compatibility	Uses S1F65 or S1F1 to establish the connection. Can be On or Off. The default value is On.
Device Identification	Specified as a value from 0 to 32,767 (15 bits). The default value is 0.
Initial Communication State	Can be Enabled or Disabled. The default value is Enabled.

5. Press [F4: Quit] to save the values and exit the window. The SECS Communication window is displayed with the following message below it:

   Restart P-2 program to enable new parameters!
   Press any key to continue.

6. Press any key to exit the message. Restart the program by pressing RESET.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

5.6.2 UPLOADING A RECIPE TO THE HOST

You must enable and configure the SECS Option before uploading recipes to the host.

To upload a recipe to the host:

1. If necessary, enable and configure the SECS Option. See Section 5.6.1, "Enabling and Configuring the SECS Option," for details. Note: You do not have to enable or configure the SECS Option each time that you upload or download a recipe. The saved values remain unchanged even through power off.
2. Choose To Host from the Recipe menu and press ENTER. The following window is displayed:

UPLOAD RECIPE TO HOST CATALOG

ID	Type	Length	Speed	V.Range	Dir
100/100/14	2D	100	5	13um	->
100/200/14	2D	100	5	13um	->
100/50/14	2D	100	5	13um	->
100/50/14/1	2D	100	1	13um	->
100SEC	2D	500	5	13um	->
100SECONDS	2D	500	5	13um	->
10MM	2D	10	5	13um	->
10MM-3D	3D	10	5	13um	->
200/2	2D	200	2	13um	->
200B	2D	200	20	13um	->
200B-MM	2D	200	50	13um	->
200L	2D	200	20	13um	->
200M	2D	200	20	13um	->
200R	2D	200	20	13um	->
200T	2D	200	20	13um	->
3-D/FABRIC	3D	4000	400	300um	->
3-D/LOGO	3D	700	50	13um	->
3-D/PAPER	3D	1000	50	300um	->
3-D/STYLUS	3D	925	50	13um	->
3-D/TPATCH	3D	410	50	13um	->

F2:Upload F4:Quit

Figure 5-21 Uploading Recipes to the Host

3. Use [↑] or [↓] to select the recipe to be uploaded.
4. Press [F2: Upload]. The following message is displayed:

   SECS Upload of XXXX. Please wait...
   <STOP>: Abort Transmission

   You can press STOP or ESC to abort the transmission at any time.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

5.6.3 DOWNLOADING A RECIPE FROM THE HOST

You must enable and configure the SECS Option before downloading recipes from the host.

To download a recipe:

1. If necessary, enable and configure the SECS Option. See Section 5.6.1, "Enabling and Configuring the SECS Option," for details. You do not have to enable or configure the SECS Option each time that you upload or download a recipe. The saved values remain unchanged even through power off.
2. Choose From Host from the Recipe menu and press ENTER. The Alphanumeric ID window is displayed:

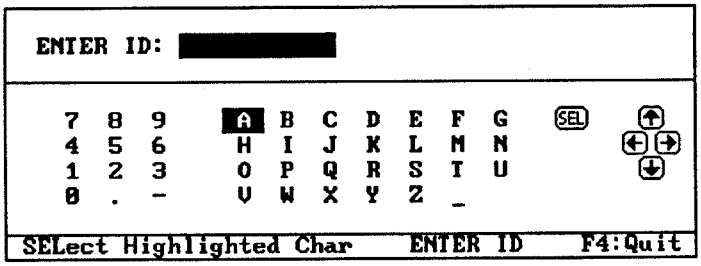


Figure 5-22 Alphanumeric ID Window

3. Enter the name of the recipe to be downloaded from the host computer and press ENTER (see Section 3.5, "Entering an ID"). Note: You cannot download a recipe that already exists as the current recipe or is saved in the database. To download a recipe with the same name, either rename or delete the recipe in the database.

   The Recipe Download From Host window is displayed:

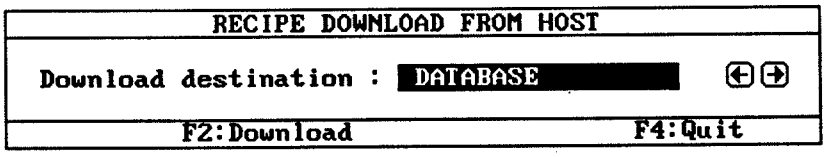


Figure 5-23 Downloading a Recipe From the Host

4. Use [←] or [→] to select one of the following destinations for the download destination: Database, Current Recipe, or DB + Current Rcp.
5. Press [F2: Download] to download the selected recipe.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

6 PROFILING A SAMPLE

This chapter discusses profiling a sample in detail. Once you have written a recipe (Chapter 5), take a scan using the procedures documented in this chapter. The next chapter, Chapter 7, "Analyzing the Profile," explains in detail how to analyze the profile data.

While the focus is on manual operation of the instrument, the information in this chapter is also a prerequisite for automatic operation. Automatic operation is described in detail in Chapter 10, "Automatic (Sequence) Operation."

This chapter describes

- Setting the lowest elevator position and XY travel limits
- Loading samples with and without the wafer handler
- Viewing and positioning the sample for scanning
- Scanning the sample
- Unloading samples with and without the wafer handler
- Tilting and leveling the stage and setting the center offset and leveling offset
- Rotating the stage and adjusting the Theta Zero offset (Motorized Level and Rotation option only)
- Setting the SECS Interface option to upload data

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

6.1 SETTING THE LOWEST ELEVATOR POSITION

The lowest elevator position is set at the factory to allow the stylus to be nulled on the stage surface for both the standard stage and the wafer handler locator. As a safety factor, you can program the elevator to lower only to a preset limit. The keylock must be in position 3 to enable you to program this function. See Section 3.8, "Setting the Keylock Position," for details.

If a wafer locator is installed, a new lowest position must be determined, and that position entered into the stage configuration file. The handler has a separate configuration table that is effective only when the handler is enabled.

> **CAUTION:** **It is very important to determine the correct lowest position for the elevator when a precision locator is installed. The stylus can be damaged if you leave the stage configuration with the factory settings.**

To determine the lowest elevator position:

1. Lower the stylus and position the stylus onto the locator surface as described in Section 6.4, "Viewing and Positioning the Sample." Make sure that the stylus is in an area that is free of obstructions or vacuum grooves.
2. Scan the surface of the tool using the default P-2 recipe as decribed in Section 6.6, "Profiling From a Scan Recipe."
3. Level the stage as described in Section 6.12, "Leveling the Stage."
4. Null the stylus again on the surface of the tool and make a note of the value of the Z coordinate in the left-hand corner of the Motion screen (see Fig. 6-20).

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To set the lowest elevator position:

1. Press MENU.
2. Choose Stage from the Config menu and press ENTER to display the Stage Configuration window:

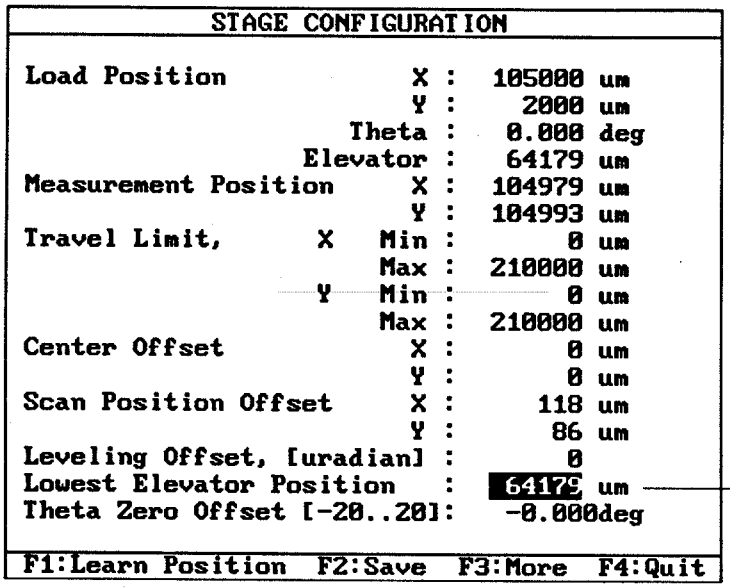


Figure 6-1 Setting the Lowest Elevator Position

3. Choose Lowest Elevator Position and enter the value (in microns) determined in Step 4 above.
4. Press [F1: Learn Position] and the following prompt is displayed:

   Rehoming elevator to set new limit [Y/N]:

5. Press YES to home the elevator and set the Z limit. This message is displayed:

   Homing stage, please wait.

   If the value entered is too high, it will automatically default to the factory setting.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

6.2 SETTING X,Y TRAVEL LIMITS

X,Y limits are set to prevent the stylus from moving off a sample smaller than 210 mm (8.2 in.) and to prevent the stage table from hitting the edges of the housing when the sample is larger than 210 mm (8.2 in.).

To set the Travel Limits:

1. Press MENU.
2. Choose Stage from the Config menu and press ENTER to display the Stage Configuration window:

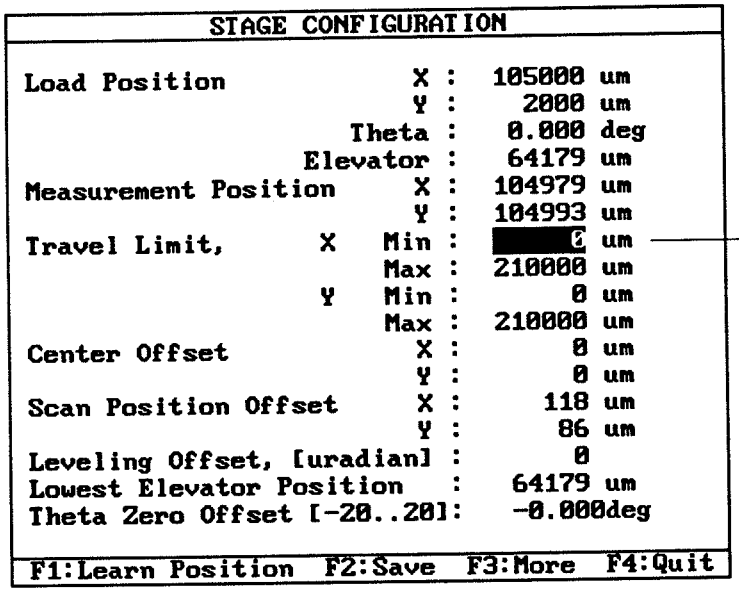


Figure 6-2 Setting the XY Travel Limits

3. Use [↓] to choose Travel Limit and enter maximum and minimum values for X and Y, or set the values for X and Y at a desired location using the Learn Position function described below. Note: The minimum limit for X and Y is 0 μm and the maximum limit for X and Y is 210,000 μm.
4. Press [F2: Save] and then [F4: Quit] to return to the menu bar.

To learn values for the Travel Limits:

1. Choose Travel Limit and press [F1: Learn Position].
2. Press MENU, then XY on the built-in keyboard or [F6: X-Y] on the remote keyboard to display the Motion screen.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3. Use the trackball to move to the maximum or minimum position.

> **CAUTION:** **Do not use [↑], [↓], [←], and [→] to select the limits. Using these keys can cause the instrument software limits to be exceeded and the instrument to lock up. If the instrument locks up, use the trackball to free the instrument. If necessary, press RESET to reboot.**

4. Press MENU and then ENTER to return to the Settings window.
5. Scroll to each appropriate Travel Limit field (minimum or maximum X and Y) and press [F1: Learn Position]. The coordinates of the selected position will be entered and saved.
6. Repeat Steps 2 through 5 for the remaining Travel Limit (maximum or minimum).
7. Press [F2: Save] and then [F4: Quit] to return to the menu bar.

6.3 LOADING THE SAMPLE

You can load samples manually or use the wafer handler if installed.

Load the sample manually if

- the instrument does not have the wafer handler installed
- the sample is other than a wafer

Use the wafer handler to load wafers (sizes 4-, 5-, 6- or 8-in.) if

- the instrument has the wafer handler installed

The wafer handler is of particular use when running in Automatic mode. The handler can be set to load and unload a cassette of wafers without operator intervention when running a sequence. See Section 10.5.2, "Preparing for Automatic Loading and Unloading," for details.

> **NOTE:** **Only wafers can be loaded and unloaded with the wafer handler.**

The following sections describe how to load samples manually and with the wafer handler.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

6.3.1 LOADING A SAMPLE MANUALLY

Load the sample manually if your instrument does not have the wafer handler installed, or if you are loading odd-sized wafers or other sample types such as compact disks or magnetic storage media.

Note: If your instrument has the wafer handler installed and you are going to load samples manually, the wafer handler must be set to Disable in the Handler Enable window (see Fig. 6-3).

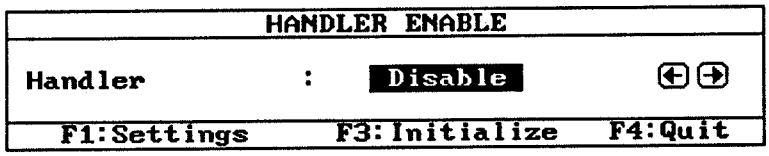


Figure 6-3 Handler Enable Window With Handler Disabled

The load and measurement positions can be preprogrammed so that the stage will shuttle between two set positions when you press LOAD.

To program the load and measurement positions:

1. Press LOAD to move the stage to the load or measurement position.
2. Press MENU.
3. Choose Stage from the Config menu and press ENTER.

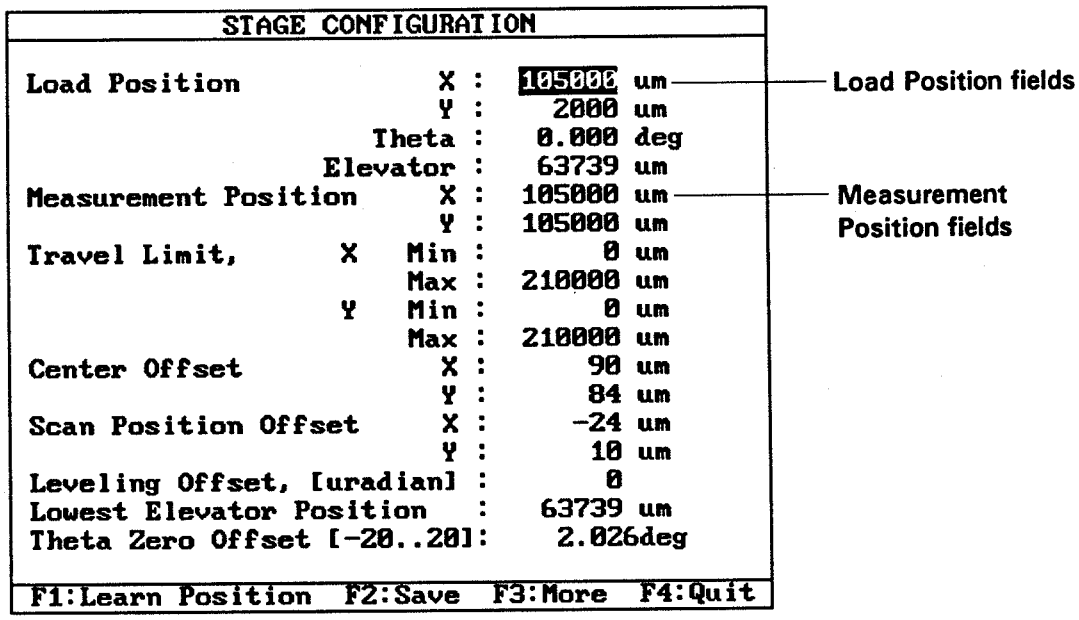


Figure 6-4 Setting the Load and Measurement Positions

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4. Use the arrow keys or the trackball to choose the X or Y Load Position or Measurement Position field and press [F2: Learn Position]. The X or Y coordinate of the current stage position will be inserted in the field. You also can type in the appropriate coordinate positions. Load Position for the Tencor P-2 without handler is typically X=105000, Y=2000 μm; for the P-2 equipped with the wafer handler, X=206000, Y=105000 μm. Measurement Position is always X=105000, Y=105000 μm.

> **CAUTION:** **For instruments equipped with the wafer handler, the Load Position is set to match the Tencor P-2 to the handler and *must not* be changed. Any changes can cause handler and/or wafer damage.**

5. Press [↑] or [↓] to move to another field and repeat.
6. Press [F2: Save] to save the learned or entered coordinates, then [F4: Quit] to exit.

To load the sample manually:

1. If the stage is not in the load position, press LOAD to move the stage forward.
2. Open the door to the measurement area and place the substrate on the stage table, disk holder, or precision locator.

   If you are using a precision locator, note the four detents at 90° and the two intermediate detents at 45°. (See Appendix D, "Precision Locators," for graphic representations of the available locators.) When the precision locator is aligned as in Fig. 6-5, it is in the 0 theta position (theta = 0°).

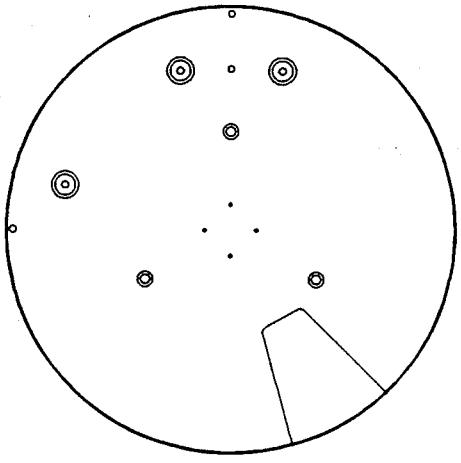


Figure 6-5 Precision Locator

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

The detent disengage lever below the left front of the stage allows the detent to be disengaged if you do not want to use it, or if you need to locate an area close to the detent.

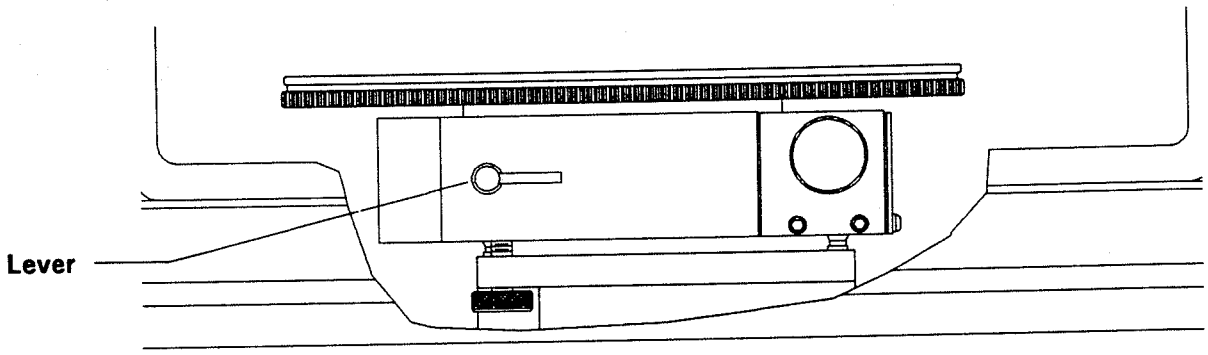


Figure 6-6 Detent Disengage Lever

> **NOTE:** ***Open Frame Configuration*–The stage table has an adjustable vacuum valve to handle wafer sizes of 100 mm (4 in.) to 200 mm (8 in.). The stage table also accommodates sample precision locators.**

3. Engage the stage vacuum with the switch found just inside the left side of the measurement door opening (see Fig. 1-2). Press the switch down to engage the vacuum.

   Open Frame Configuration only:

   - The vacuum valve is located to the left of the built-in keyboard. In addition, there is a wafer size valve on the stage similar to the old style size selector on the handler stage. See Section 6.3.2, "Loading Single Wafers Using the Wafer Handler," and Figs. 6-18 and 6-19. To open the vacuum valve, use a screwdriver to turn the valve perpendicular to the front of the stage table.

4. Close the door and press LOAD to locate the sample under the stylus, or press XY and use the trackball to position the sample. In the latter case, the Motion screen will be displayed (Fig. 6-7). Press [F1: Speed] for high-speed movement of the stage with the trackball.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

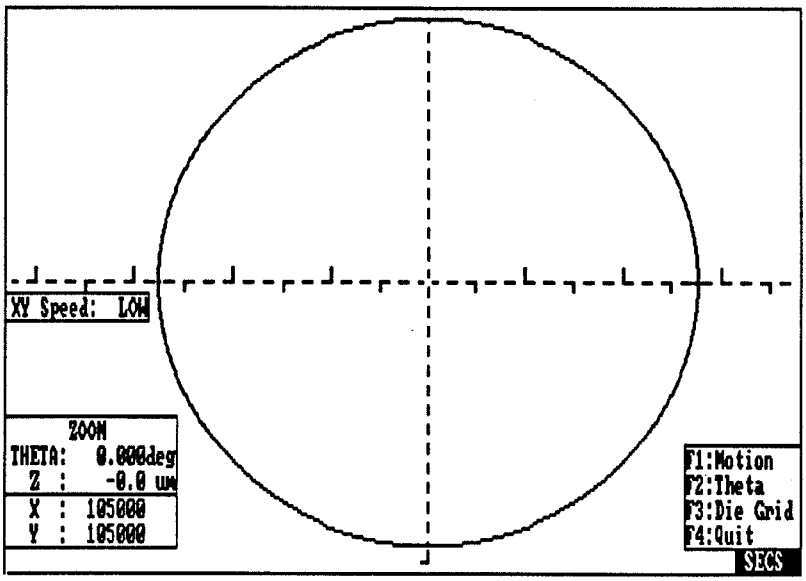


Figure 6-7 Motion Screen

6.3.2 LOADING SINGLE WAFERS USING THE WAFER HANDLER

The wafer handler can be configured to load wafers of four different sizes:

- 100 mm (4 in.)
- 125 mm (5 in.)
- 150 mm (6 in.)
- 200 mm (8 in.)

The standard system configuration includes one cassette locator for 200-mm wafers. A second locator is available as an option. For 100-, 125-, or 150-mm wafers, an additional locator plate for each size attaches by thumbscrew on top of the 200-mm locator.

You cannot use this method of loading and unloading for samples other than wafers; use the procedures described in Section 6.3.1, "Loading a Sample Manually." For satisfactory operation the handler chuck must be removed (see Section 2.2.6, "Installing a Precision Locator") and the elevator limit reset (see Section 6.1, "Setting the Lowest Elevator Position").

Before operating the wafer handler for the first time, read Section 3.6.1, "Protecting the Wafer Handler," for important information on protecting the wafer handler and wafers from damage.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

> **NOTE:** Cassettes should be the same size and type that Tencor Instruments Field Service taught the wafer handler. Cassettes that have been used in chemical processing, which causes distortion, can make it difficult for the handler to center the wafers on the vacuum puck and stage. Dedicated machine cassettes are best.

To enable the handler and set handler parameters:

1. From the menu bar, choose Handler from the Config menu and press ENTER to display the Handler Enable window:

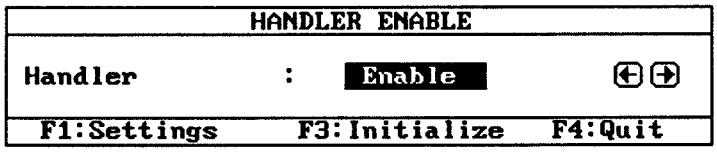


Figure 6-8 Enabling the Handler

2. Use [←] or [→] to choose Enable. Press [F4: Quit] to exit the Handler Enable window or to configure the handler settings, go to step 3.

> **NOTE:** If the handler does not initialize, the manual vacuum switch could be turned off. Check the switch to make sure that it is On (in the up position). The switch is located inside the instrument below the lower left of the measurement door.

3. In the Handler Enable window, press [F1: Settings] to display the Handler Settings window:

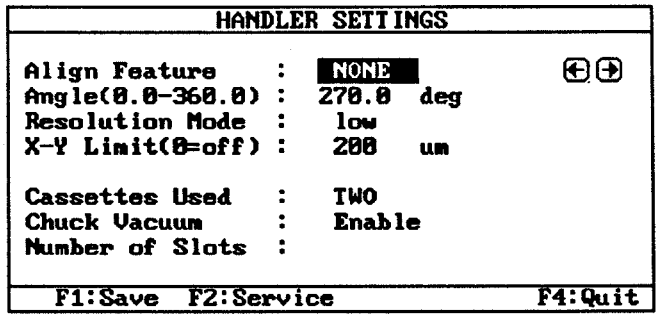


Figure 6-9 Handler Settings Window

Note: Only Tencor Instruments service personnel can access [F2: Service].

4. Press [↑] or [↓] to move between the fields and press [←] or [→] to choose available values for each field. The fields are explained below.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

5. To save the values entered, press [F1: Save] and then [F4: Quit]. To exit the window without saving the entered values, press [F4: Quit].

Values for the handler parameters are set as follows:

Align Feature

The aligner has two functions: wafer angular orientation according to flat or notch, and alignment in X-Y. The available choices are

Flat	Orients the wafer by its major flat.
Notch	Orients the wafer by its alignment notch.
None	Turns wafer orientation off. The handler bypasses the aligner when it loads wafers. Bypassing the aligner increases the throughput but it also can reduce the accuracy of centering the wafer on the stage.

Angle (0.0–360.0)

If you choose Flat or Notch in the Align Feature field, enter the degrees of arc to orient the wafer. You can enter any number from 0 to 360. The Angle Feature specifies the position, in degrees, of the flat or notch when it is placed on the puck. A value of 0^{o} causes the wafer to be placed on the instrument chuck with the flat or notch at the back of the instrument, that is, the 12 o'clock position. When a wafer is unloaded into a cassette, the flat or notch is rotated 90 degrees and in this example, the flat will be at the 3 o'clock position. See Fig. 6-14.

Resolution Mode

The available choices are Low or High. The Low Resolution Mode specifies that 512 data points will be taken during a 360^{o}-wafer revolution (takes approximately 1.2 s to complete). The High Resolution Mode specifies that 2048 data points will be taken during one wafer revolution (takes approximately 5.0 s to complete).

X-Y Limit

This is the limit of acceptable eccentricity for the wafer alignment. Note that throughput is affected since the handler will make as many attempts as necessary to align the wafer within the X-Y limit specified. If you enter zero for the X-Y limit, the aligner will not perform alignment. The handler specification for the accuracy of this eccentricity is 200 μm.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Cassettes Used

This field specifies the number of cassettes used by the handler. The available choices are One or Two. If you select One, a single cassette will serve both as the Sender and Receiver cassette. If you select Two, the standard cassette serves as the Sender and the optional cassette serves as the Receiver.

Chuck Vacuum

The available choices are Enable and Disable. The chuck vacuum should be disabled when taking stress measurements because the chuck vacuum could cause bending of the wafer and result in incorrect measurements. For all other types of measurements leave the chuck vacuum enabled.

To load a single wafer using the handler:

1. Make sure the vacuum chuck is installed on the stage table. (The instrument is shipped with the vacuum chuck installed if your instrument comes with the wafer handler.) If a vacuum chuck has to be installed, a new lowest elevator position must be set (see Section 6.1, "Setting the Lowest Elevator Position").

> **CAUTION: Do not use a precision locator when using the handler to load wafers; you could damage the instrument.**

   If you are taking stress measurements, make sure the wafer stress chuck (see Fig. 13-3) is installed on the stage table. To replace the vacuum chuck with the wafer stress chuck, see Section 2.2.6, "Installing a Precision Locator." Note: If a stress chuck has to be installed, a new lowest elevator position must be set (see Section 6.1, "Setting the Lowest Elevator Position").

2. Enable the handler and set the handler parameters if necessary (see previous section). You do not need to set handler parameters each time you load a wafer.
3. To align the wafer, turn the wafer size selector dial on the aligner (Fig. 6-10) until it displays the appropriate wafer diameter. Set the alignment in the Handler

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Settings window (Fig. 6-9) or the Handler Load window (Fig. 6-12).

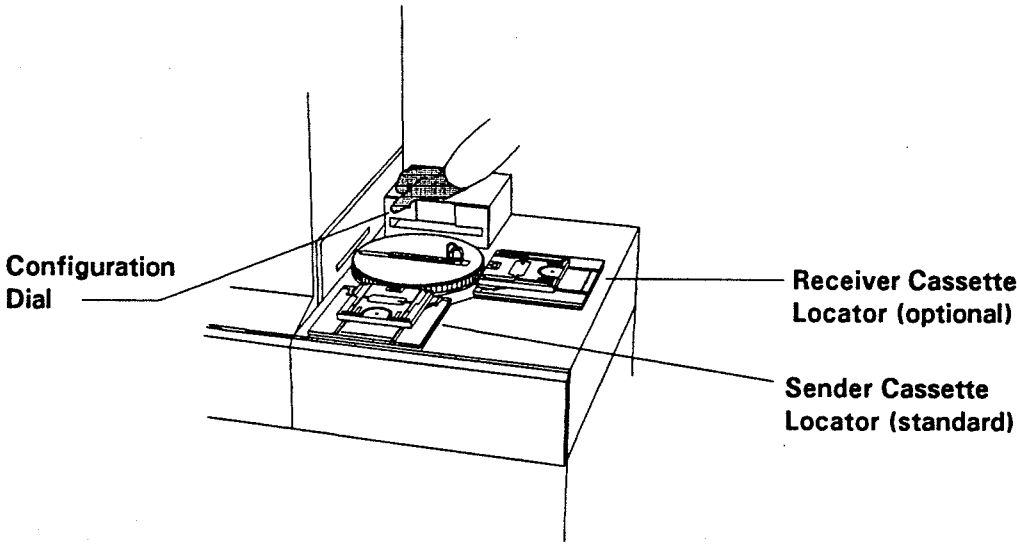


Figure 6-10 Setting the Wafer Size Selector

4. Place the wafer in a slot of a cassette of the appropriate size. Note the number of the cassette slot. Load the wafer right side up. The bottom slot of the cassette is number 1.
5. Place the cassette on the sender cassette locator (Fig. 6-11) as follows:
   - Tilt the cassette back slightly and place the bottom rear corners of the cassette in the grooves on the locator. The grooves are marked with wafer sizes (100 mm, 125 mm, 150 mm, and 200 mm).
   - Tilt the cassette forward until it fits securely in the grooves of the cassette locator. The H-bar across the bottom of the cassette must trip the limit switch in the slot on the locator.

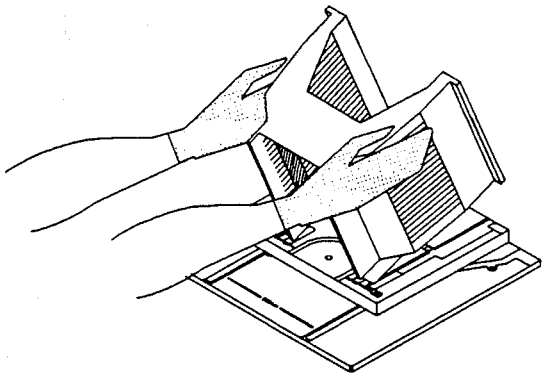


Figure 6-11 Placing a Cassette on a Locator

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

> **NOTE:** Cassettes placed on both locators must be the same size, otherwise wafers could be damaged and handler performance could be affected. Reinitialize the handler each time the cassette size is changed.

6. Press LOAD. The Handler Load window is displayed in the lower right corner of the Motion screen (Fig. 6-12). No motions will be actuated.

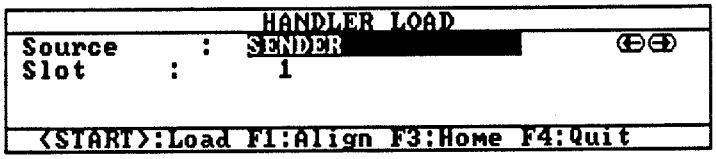


Figure 6-12 Handler Load Window

If a wafer is already in the instrument, the program displays the Handler Unload window. Unload the wafer that is already in the instrument (see Section 6.7.2, "Unloading Single Wafers Using the Wafer Handler," for more information) and press LOAD to display the Handler Load window.

7. The Handler Load window should indicate Sender in the Source field. If it does not, press [→] to display Sender. Available choices for Source are Sender, Puck, Measurement Stage, Aligner, and Receiver.

8. Press [↓] to select the Slot field in the window. Type the number of the cassette slot in which you placed the wafer. Note: The Slot field is only displayed if you select Sender or Receiver in the Source field.

9. Press [F1: Align] to change the alignment, or press START to load the wafer, or press [F4: Quit] to exit the window without loading the wafer.

   If you pressed [F1: Align], the Alignment window is displayed:

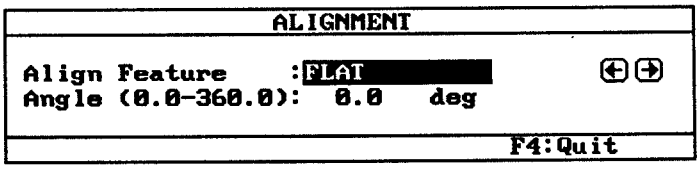


Figure 6-13 Alignment Window

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

The following options are available in the Align Feature field:

Flat	Orients the wafer by its major flat.
Notch	Orients the wafer by its alignment notch.
None	Turns wafer orientation off. The handler bypasses the aligner when it loads wafers. Bypassing the aligner reduces the accuracy of centering the wafer on the stage by the location error of the wafer in the cassette, typically about 3000 μm.

10. If you choose Flat or Notch in Step 9, press [↓] to select the Angle field. Type the degrees of arc to orient the wafer. You can type any number from 0 to 360.

    Figure 6-14 shows the angular orientation scheme. The top of the drawing represents the back of the instrument and the top of the computer screen. Entering 0 or 360 orients the flat or the notch to the back of the Tencor P-2 console and the top of the computer screen. When a wafer is unloaded into a cassette, the flat or notch is rotated 90 degrees and in this example, the flat will be at the 3 o'clock position.

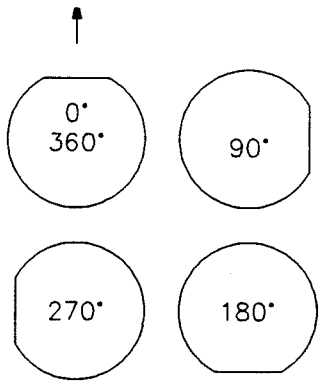


Figure 6-14 Wafer Orientation

Note: A change in the Alignment window will also be reflected in the Handler Settings window (Fig. 6-9).

11. Press START to load the wafer. Note: If the wafer loading or unloading process is interrupted while the handler puck is inside the instrument, the X, Y stages will not move. You can home the puck by pressing LOAD and then [F3: Home]. If this does not work, choose Handler from the Config menu and then press [F3: Initialize].

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

TENCOR P-2 HANDLER VACUUM CHUCK

The vacuum chuck (Fig. 6-15) is specifically designed to accept the handler vacuum puck and to allow a quick vacuum release. The instrument is equipped with the vacuum chuck if your instrument comes with the wafer handler. If you need to replace the vacuum chuck, use the instructions provided in Section 2.2.6, "Installing a Precision Locator."

The lowest elevator position is set at the factory to allow the stylus to be nulled on the stage surface for both the standard stage and the wafer handler locator. If a wafer locator is installed, a new lowest position must be determined, and that position entered into the stage configuration file. The handler has a separate configuration table that is effective only when the handler is enabled.

> **CAUTION:** **It is very important to determine the correct lowest position for the elevator when a precision locator is installed. The stylus can be damaged if you leave the stage configuration with the factory settings. See Section 6.1, "Setting the Lowest Elevator Position," for details.**

The vacuum chuck is equipped with a rotary valve so that 100-, 125-, 150-, or 200-mm wafers can be vacuum clamped on the wafer locator.

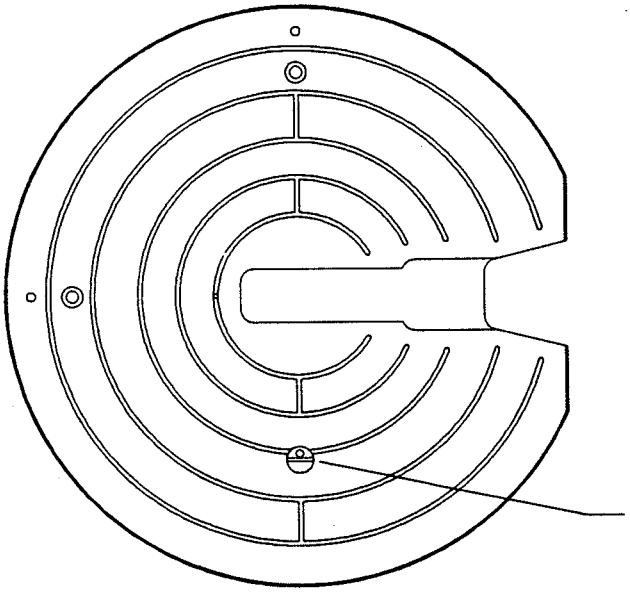


Figure 6-15 Vacuum Chuck

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To set the vacuum valve for 100-, 125-, or 150-mm wafers:

Rotate the valve so that the hole in the value is farthest away from the center of the chuck. The slot is perpendicular to a radial line.



Figure 6-16 Valve Position for 100-, 125-, or 150-mm Wafers

To set the vacuum valve for 200-mm wafers:

Rotate the valve 180° so that the hole in the value is closest to the center of the chuck. The slot is perpendicular to the radial line.

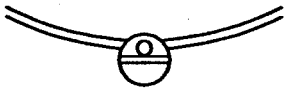


Figure 6-17 Valve Position for 200-mm Wafers

In some older chucks, the valve design is different. The valve has no hole in the top.

To set the vacuum valve on older chucks:

To enable a 200-mm wafer, the slot should point toward the center.

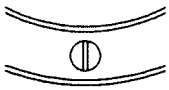


Figure 6-18 Valve Position for Older Chucks with 200-mm Wafers

For 125- or 150-mm wafers, the slot is rotated 90° so that the slot is perpendicular to a radial line. The older chuck does not accommodate 100-mm wafers.

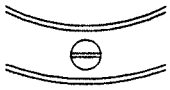


Figure 6-19 Valve Position for Older Chucks with 125- or 150-mm Wafers

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

6.4 VIEWING AND POSITIONING THE SAMPLE

The Tencor P-2 measurement head contains a high resolution video camera. Once you have loaded a sample and the stage has moved beneath the measurement head, you view the sample in the Motion screen to find an appropriate location to start a scan.

Sample motion consists of two parts:

- ZΘ motion, motion of the measurement head up or down, and rotation of the stage about its central axis
- XY motion, motion of the sample stage left and right, and backward and forward

The Motion screen (Fig. 6-20) provides a video image of the sample with a computer graphic overlay. The overlay includes

- X, Y, Z, and Θ coordinates indicating the position of the stage and head
- A mode status indicator (High speed, Low speed, or Precision mode)
- A box containing function key assignments

A circle represents the 210-mm (8.2-in.) diameter stage table, and a movable cross marker shows the stylus position over the table as the XY position changes.

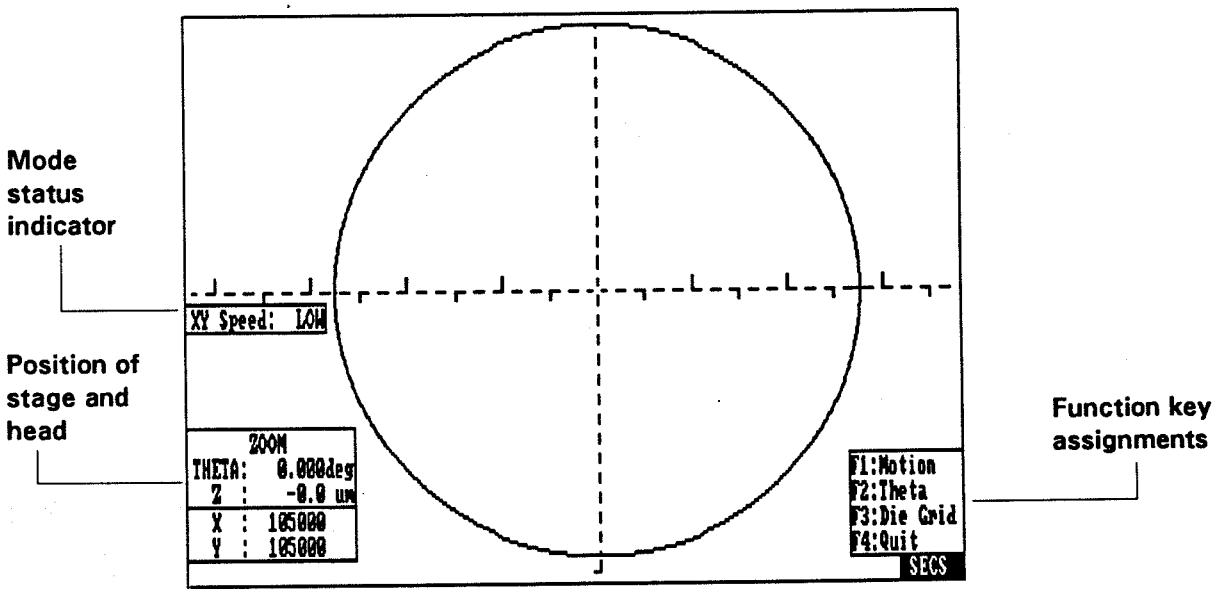


Figure 6-20 Motion Screen

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

6.4.1 LOWERING THE MEASUREMENT HEAD

1. Press Z⊖ to display the Motion screen (Fig. 6-20) and enable downward movement of the head.

2. The keys used to lower the head from the built-in keyboard on the instrument are different from those used from the remote keyboard:

   To lower the head from the built-in keyboard (Fig. 3-2):

   Press [↓] and hold to lower the stylus and initiate downward movement of the head. (Motion begins after the stylus is fully down.) Then press SEL for high speed and hold to lower the head to its measurement position.

   Release SEL as the sample comes into view on the screen (Fig. 6-21) for a low speed, gentle landing of the stylus.

   To lower the head from the remote keyboard (Fig. 3-3):

   Press [↓] and hold to lower the stylus and initiate downward movement of the head. (Motion begins after the stylus is fully down.) Press SPACEBAR and release for high speed. Then hold [↓] to lower the head to its measurement position.

   Release [↓] as the sample comes into view on the screen (Fig. 6-21) and press [↓] again for a low speed, gentle landing of the stylus.

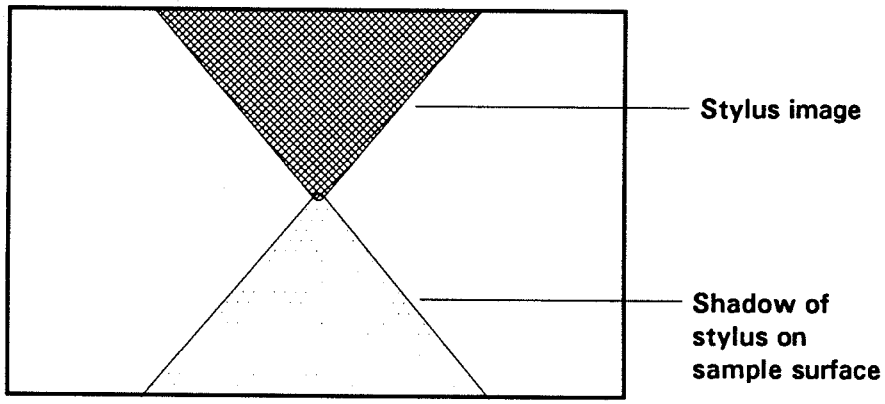


Figure 6-21 Stylus Lowered to Sample Surface

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

NOTE: **A video image like Fig. 6-21 does not guarantee contact between the stylus and the sample surface. Assuming so can result in inaccuracies in the XY position of the start of a scan, which is of particular importance when probing small features. Make sure the stylus is properly nulled as described.**

3. Make sure that the stylus is *nulled*, or in direct contact with the surface, by pressing [↓] momentarily. If the Z coordinate remains unchanged before and after pressing [↓], the stylus is correctly nulled.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

6.4.2 POSITIONING IN X AND Y

Figure 6-22 shows the coordinate system used in the Tencor P-2. The X and Y coordinates in the Motion screen represent the lateral position of the stage relative to the right rear corner of the measurement area. The circle in Fig. 6-22 represents the possible travel pattern of the stage, which is limited to a 210-mm (8.2-in) circle.

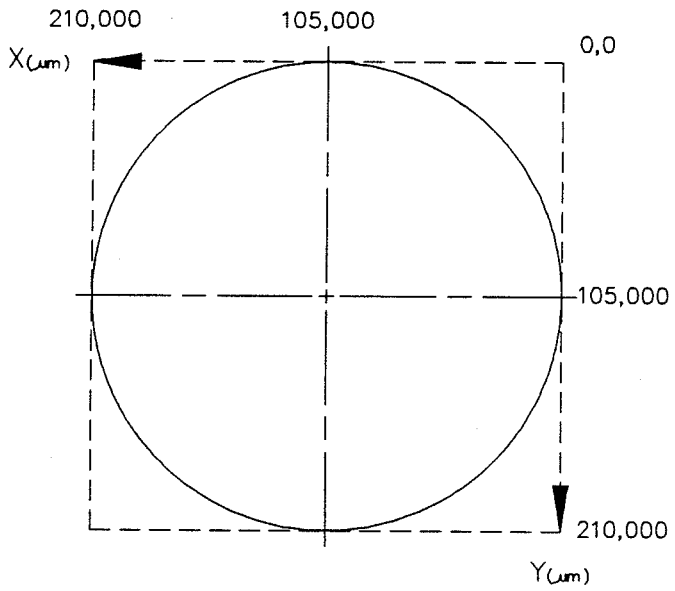


Figure 6-22 X,Y Stage Motion Coordinates

There are three modes of XY Motion:

- High speed, for quickly locating a particular area of the sample
- Low speed, for locating appropriate scan locations for most features
- Precision, for precise location of small (≤10 μm wide) features

NOTE:	**When programming X, Y stage coordinates near the edge of the measuring zone in Fig. 6-22, allow for the back-scan distance, which varies with scan speed (see Table 10-1). The back-scan distance and the scan length together must be within the 210-mm (8.2-in.) circular limits. The center is located approximately at 105000, 105000 μm.**

Refer to the following figures for assistance in determining the space requirements of particular samples. Dimensions given are internal dimensions at table level.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

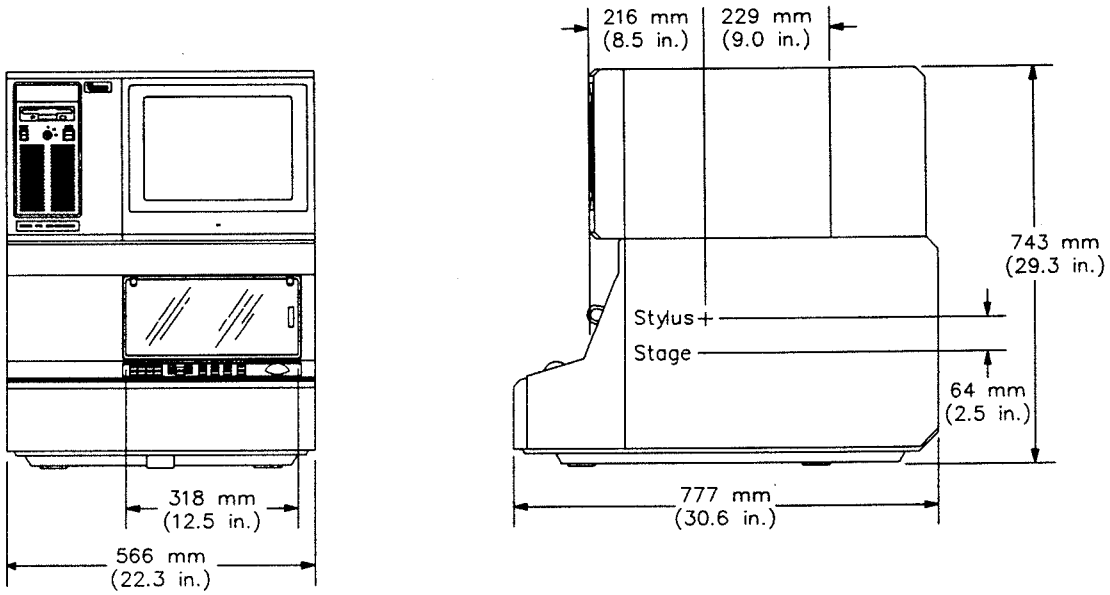


Figure 6-23 Measurement Chamber Internal Dimensions–Standard Configuration

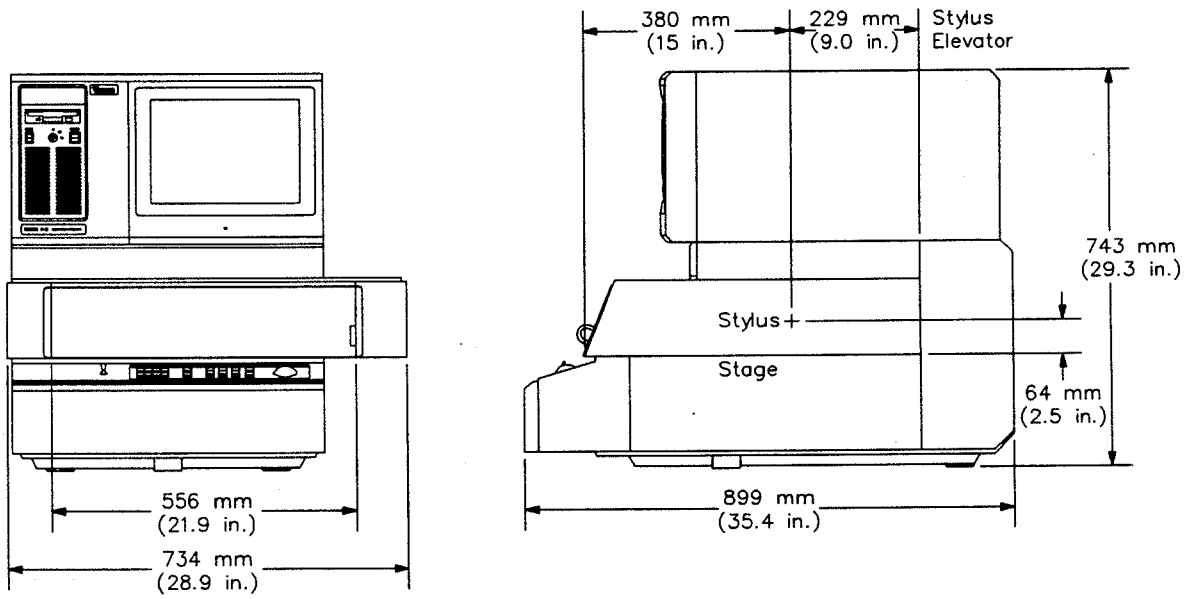


Figure 6-24 Measurement Chamber Internal Dimensions–Open Frame Configuration

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To enable XY motion:

Press XY. Press [F1: Motion] to switch between the three modes.

> **CAUTION:** **If there is any hardware fixed to the stage and it is above the substrate surface, raise the stylus *before* moving the stage. Otherwise, head damage can occur.**

To control the stage motion:

With XY motion enabled

- Press [←] or [→] for corresponding motion along the X-axis.
- Press [↑] or [↓] for corresponding motion along the Y-axis.
- Roll the trackball for corresponding motion in X and Y (High speed and Low speed modes only; the trackball does not cause precision movement).

For ease of use, the three modes also can be accessed in other ways, as described below.

- While in Low speed mode, press and hold SEL and then any arrow key to activate high speed XY movement temporarily without switching to High speed mode.
- While in Precision mode, roll the trackball to activate slow XY movement temporarily without switching to Low speed mode.

> **NOTE:** **In Precision mode, notice that when the motion ceases, the image appears to do a momentary wiggle (when using the arrow keys only). This is normal and desirable. It is this motion that eliminates the slight mechanical backlash in the stage movement that formerly made tight positioning to small features tedious and difficult. See Section 6.5, "Precision Mode," for details.**

You can move the stage in both Precision and Low speed modes with the stylus in contact with the sample surface. In High speed mode, the stylus raises automatically before the stage moves.

In particular, note that the direction of each arrow key corresponds to the direction that the stage moves. In the video image, the sample appears to move in the opposite direction.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

6.4.3 MAGNIFYING THE SAMPLE IMAGE

You can magnify (or *zoom*) the image of the sample to facilitate feature location. Use low magnification to find quickly an area of interest on the sample. Use high magnification to locate accurately an appropriate starting position for a scan.

To control the Zoom magnification:

Press ZOOM when in a Motion screen and [↑] or [↓] to change the magnification of the video image. Press ZΘ or XY to return to motion control.

6.5 PRECISION MODE

Precision mode virtually eliminates the mechanical backlash present in the stage motion and effectively allows precise locating of the stylus for scanning small features. This mode features

- Precision alignment for the scanning of small features (≤10 μm wide).
- On-screen cross hairs that simplify accurate alignment of small features for scanning.
- Stylus offset calibration. Using a stylus-to-cross hairs alignment tool, the operator can perform straightforward alignment of a feature with cross hairs and does not need to worry about the true stylus position. The system automatically aligns the feature with the true stylus position prior to a scan.
- Ability to step across a small feature in accurate 1–2 μm increments to optimize the location of a scan.
- Ability to program up to seven different Die Grid spacings (delta X, delta Y) and to use arrow keys to move to the same feature on adjacent dies.
- Ability to use Die Grid spacings to move an arbitrary number of dies to the same feature on any die of the sample.
- Simplified sequence setup. This eliminates the need to step through a sequence and readjust coordinates.
- Improved accuracy of deskew operation. Deskew is easy to use and less dependent on operator skill.

Mechanical backlash is all but eliminated by introducing an extra motion after an operator-initiated move. This "wiggle" physically releases any backlash that has built up in the stage assembly.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

> **NOTE:** The trackball is active in Precision mode but does not activate precision motion. Notice that there is no wiggle when motion stops. The trackball is useful for rough positioning of the stage. Only the arrow keys activate precision motion.

You can use the Precision mode cross hairs, when properly calibrated, to locate scan locations accurately without worrying about the stylus offset. See Section 17.9.5, "Scan Position Offset Calibration," for details.

> **NOTE:** You should perform the automated stylus offset calibration described in Section 17.9.4, "Stylus Offset Calibration," whenever you change the stylus.

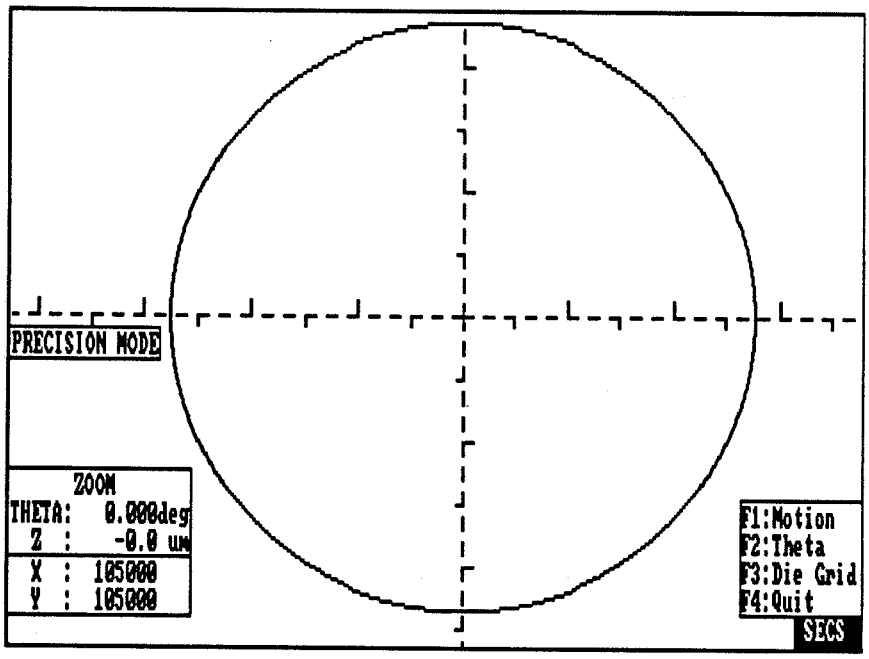


Figure 6-25 Motion Screen in Precision Mode

In Precision mode, there are three types of XY movement possible:

- Rough positioning (no "wiggle") using the trackball, equivalent to motion in Slow mode
- Fine positioning using the arrow keys
- Stepping in small (1–2 μm) increments

To step the stage:

Press and immediately release the appropriate arrow key.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

6.5.1 DIE GRID

The Die Grid window allows simple entry of target coordinates for repeating features and greatly simplifies setting up sequences on such samples.

To set up the Die Grid spacing:

1. Press [F3: Die Grid] and you will see the Die Grid window appear to the left of the sample image. Use [↑] and [↓] to step through the fields.

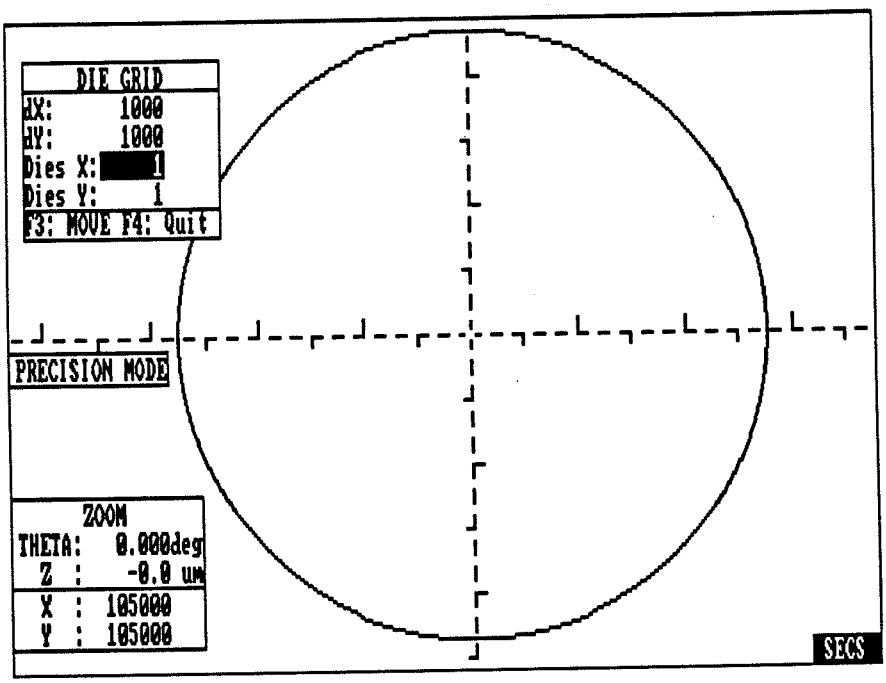


Figure 6-26 Motion Screen with Die Grid Window

2. For the dX and dY fields, use [←] and [→] to scroll through the seven settings for spacing (1000-, 500-, 200-, 100-, 50-, 20-, and 10-μm) and select one, or type a desired value from the keyboard. This value, once entered, overrides the original setting in that field. In this way, up to seven custom spacings can be entered and saved. (Note: The settings will revert to the default values upon exiting the software).
3. Press [F4: Quit] to return to the normal Precision Mode Motion screen.

Repeated stepping using the Die Grid spacing:

1. If the Die Grid window is still displayed, press [F4: Quit] to return to the normal Precision Mode Motion screen.
2. From any position, hold down SEL on the built-in keyboard, or the space bar on the remote keyboard, then press and release the desired arrow key. The stage will reposition in the appropriate direction by the distance stored in the Die Grid dX or dY field.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Moving by a given number of dies:

1. Press [F3: Die Grid] to access the Die Grid window.
2. Use [↑] and [↓] to position the cursor in the Dies X field. Enter an integer value with a minus (-) sign for movement toward the left of the instrument (the -X direction).
3. Use [↑] and [↓] to position the cursor in the Dies Y field. Enter an integer value with a minus (-) sign for movement toward the front of the instrument (the -Y direction).
4. Press [F3: Move] and the stage will reposition to the location that you have entered.
5. Press [F4: Quit] to leave the Die Grid screen.

NOTE:	If the sample is not precisely square to the stage motion, repositioning as described might require manual fine adjustment, especially when the number of dies is large. This is of particular importance when setting deskew coordinates, as they tend to be far apart.

6.5.2 DIE GRID EXAMPLE

The following example illustrates the use of the Die Grid in Precision mode.

Consider a sample with a rectangular die pattern such that the distance from a given feature on one die to the same feature on the surrounding die is 1000 μm in both X and in Y, as in Fig. 6-27.

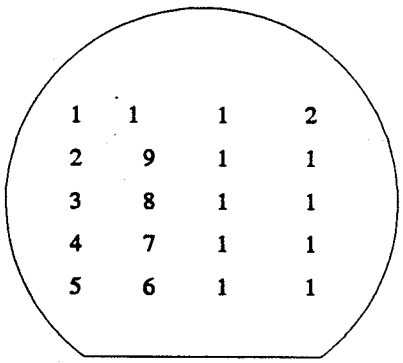


Figure 6-27 Die Locations

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To measure the example:

1. Press XY to display the Motion screen, then press [F3: Die Grid] (Fig. 6-26).
2. In the dX and dY fields, select or enter 1000 μm. The Dies X and Dies Y fields can be left unchanged.
3. Press [F4: Quit] to return to the Motion screen.
4. Press [F1: Motion] until Precision mode is selected. Locate the desired feature of Die 1 and position the cross hair appropriately. Press START to take the scan.
5. From the Data screen, press XY to display the Motion screen. Hold down the space bar and press and release [↓]. The stage will reposition to the appropriate location on Die 2, ready to scan the desired feature. Press START to take the scan.
6. Repeat Step 5 until you have scanned Die 5. From the Data screen, press XY to display the Motion screen. Hold down the space bar and press and release [→]. Now the stage will reposition to the appropriate location on Die 6, ready to scan the desired feature. Press START to take the scan.
7. From the Data screen, press XY to display the Motion screen. Hold down the space bar and press and release [↑]. The stage will reposition to the appropriate location on Die 7, ready to scan the desired feature. Press START to take the scan.
8. Proceed in like manner, using [↑], [→], and [↓] as appropriate, until all of the desired dies have been scanned.

NOTE: **When setting precise locations, especially in a sequence, it is important that the camera is at maximum zoom, and the stylus is nulled on the surface of the sample.**

Press zθ until the stylus has clearly come into contact with the surface. Do not rely on the appearance of the image, but use the Z coordinate reading to verify that the stylus is in contact with the surface. Press and release the [↓] key until the displayed Z coordinate does not change.

Setting locations while at intermediate zoom settings and/or with the stylus not in contact with the sample surface can introduce imprecision in the true stylus location on subsequent scans.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

6.6 PROFILING FROM A SCAN RECIPE

To profile a sample, the Tencor P-2 moves the stage with the sample beneath the measurement head while the stylus rests on the sample surface. The up and down movement of the stylus provides the profile data.

The Scan recipe specifies how the stage moves, and how the data is to be analyzed. The Scan recipe holds the current settings of parameters such as scan length, scan speed, and type of surface data to be calculated and displayed.

Section 5.3, "Setting Scan Parameters," describes the techniques for changing these parameters. Parameters should be changed, if needed, before initiating the scan.

To view the current Scan recipe:

1. If in the Motion screen, press [F4: Quit].
2. Do one of the following:
   - If the menu bar appears, use [←] or [→] or the trackball to choose View/Modify from the Recipe menu and press ENTER.
   - If the Data screen appears, press [F1: Recipe].

```
                                RECIPE

Recipe ID          : P2                 V.Units            : Metric
Recipe Type        :   2D               V. Range/Res.      :   13um/1A
                                        Profile Type       :  ⎍
Horizontal Units   : Metric             V. Display Scale   :  Auto
Scan Length        :  500 um
Scan Speed         :   50 um/s
 Scan Time         :   10 sec
Sampling Rate      :   50  Hz           Graph              : Raw Data
 Horiz. Res.       : 1.00 um            Long Wave Cutoff   : OFF
Direction          :  ->                Short Wave Cutoff  : Default
                                        Fit & Level        :  Off
Multi-Scan Avg     :  1 [1-10]          Cursors: ABSOLUTE um     Left     Right
Segmented          :   No                Measurement       :     0.00   100.00
                                         Leveling          :    10.00   400.00
                                         Delta Meas Width  :     0.00     0.00
Stylus Force       :  15.0 mg            Delta Level Width:     0.00     0.00
 Contact Speed     :  3
 Radius Required   :   0.0              Surface Parameters   View

          F1:Save     F2:Recall     F3:Cursors     F4:Quit
```

Figure 6-28 Default Recipe

Note: You have the choice of taking a 3-D scan if you have the Interactive 3-D Option installed. See Chapter 14, "Interactive 3-D Option," for more information on taking 3-D scans.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To set up for a scan:

1. Return to the Motion screen by pressing XY.
2. Move the stage and choose a feature for scanning.
3. Press ZΘ to activate motion in Z. Lower and null the stylus as described in Section 6.4.1, "Lowering the Measurement Head."
4. If necessary, press XY, make sure Precision mode or Slow mode is active, and move the stage until the tip of the stylus is at an appropriate location to start the data collection.

Figure 6-29 shows an example using a simple step artifact.

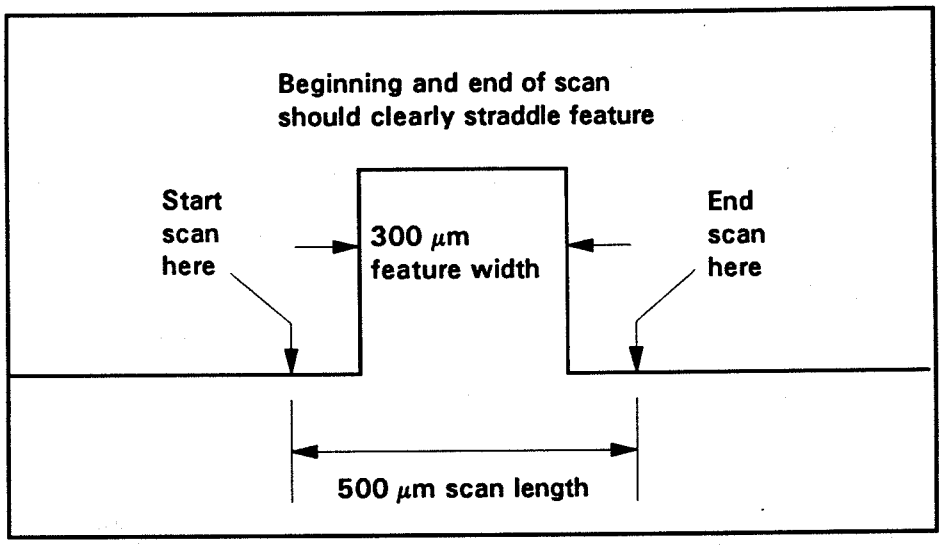


Figure 6-29 Setting Up to Scan a Step

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To start a scan:

- Press START regardless of which screen is displayed.

The stylus descends to the start-of-scan position. Note that the stage first travels opposite to the scan direction for a short distance, then stops and moves in the scan direction. This allows the stage to reach the programmed scan speed before the instrument begins to take data. The Scan screen is displayed during the scan and shows an image of the stylus and the trace as it is generated.

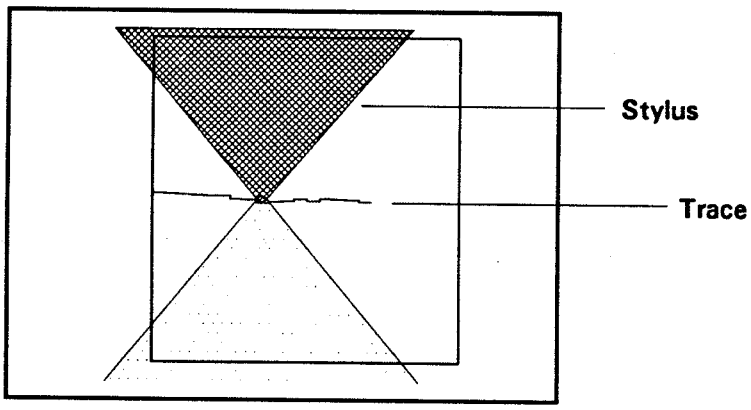


Figure 6-30 Scan Screen

When the scan is completed, the stylus lifts, the stage returns to its original position above the start-of-scan location, and the Data screen is displayed with the profile plotted in dimensioned coordinates. Note: If the trace runs off scale or is not horizontal, refer to Section 6.12, "Leveling the Stage," and Section 7.2, "Leveling the Profile."

To abort a scan:

- Press STOP to abort a scan at any time.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

6.7 UNLOADING THE SAMPLE

6.7.1 UNLOADING THE SAMPLE MANUALLY

Use this procedure if the instrument does not have a wafer handler or if you are unloading a sample that is other than a wafer.

To unload the sample manually:

1. Press LOAD to move the stage forward.
2. Open the measurement door and turn off the stage vacuum with the switch found just inside the left side of the measurement door opening (see Fig. 1-2). The switch is spring-loaded and its enabled position is down. Press the switch up to disable the vacuum.

   Open Frame Configuration only:

   - The vacuum valve is located to the left of the built-in keyboard. In addition, there is a wafer size valve on the stage similar to the old style size selector on the handler stage. See Section 6.3.2, "Loading Single Wafers Using the Wafer Handler," and Figs. 6-18 and 6-19. To open the vacuum valve, use a screwdriver to turn the valve parallel to the front of the stage table.
3. Remove the sample.

6.7.2 UNLOADING SINGLE WAFERS USING THE WAFER HANDLER

This unloading procedure applies to instruments with the wafer handler installed.

To unload a single wafer using the wafer handler:

1. Choose an empty slot in the cassette and note the slot number.
2. Press LOAD to display the Handler Unload window (Fig. 6-31). Note: If the Handler Load window appears first, press LOAD again.

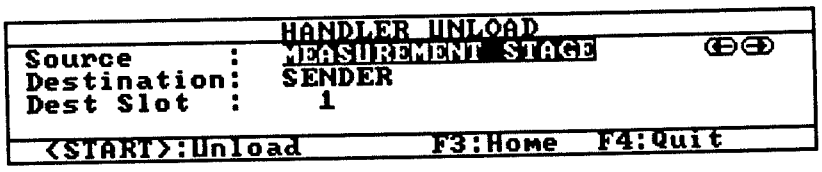


Figure 6-31 Handler Unload Window

3. Press [→] to select Measurement Stage as the location of the wafer in the Source field. (The possible wafer locations are Sender, Puck, Measurement Stage, Aligner, and Receiver.)
4. Press [↓] to scroll to the Destination field and press [←] or [→] to select Sender or Receiver as the destination.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

> **NOTE:** You can unload wafers to the slots of the Sender cassette in any order. With the Receiver cassette, you must unload to slot 25 first, then to slot 24, slot 23, and so on down to slot 1. The handler will not unload to a slot if there is a wafer below that slot.

5. Press [↓] to scroll to the Source Slot field and type in the number of the empty cassette slot.
6. Press START to unload the wafer. The following prompt is displayed if you are unloading a wafer from the instrument or handler after removing its cassette from the locator:

   Is the Sender/Receiver cassette slot ## empty? [Y/N]

   Make sure the cassette slot to which you are unloading the wafer is empty, otherwise the wafer might be damaged.
7. After the wafer has been unloaded into the cassette, press [F3: Home] to return the puck to its home position.

> **CAUTION:** You must home the puck because it is susceptible to damage in its raised position after unloading the wafer to the cassette.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

6.8 TILTING THE STAGE

When scanning areas toward the front or back of the sample, you may notice that the stage table may have a slight tilt so that the stylus null position is higher or lower than it was when you first nulled the stylus on the sample. This can be adjusted with tilt adjustment. The sample stage may be tilted about the X-axis (toward and away from the measurement door).

- To tilt the stage from front to back or back to front, turn the tilt knob located at the lower left side of the stage. Note: make sure that there is sufficient clearance between the level motor and the x home switch if you turn the tilt knob more than one full revolution.

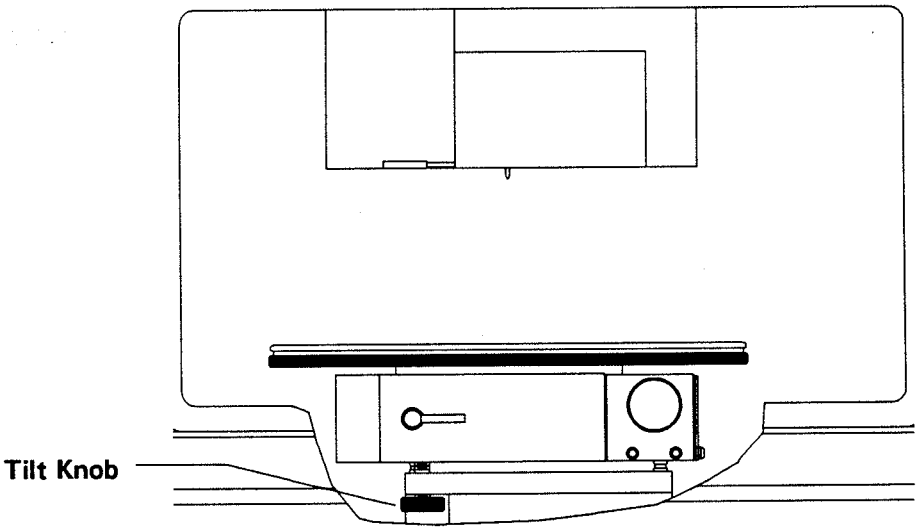


Figure 6-32 Tilting the Stage

6.9 ROTATING THE STAGE (Optional Theta Mode)

You can rotate the sample stage with the Motorized Level and Rotation Option only.

> **CAUTION:** ***Open Frame Configuration only*–Before rotation, check that there is sufficient clearance between the larger of the stage table and/or sample and the elevator. See the following section "Rotating the Stage–Open Frame Configuration," for details.**

To rotate the stage from the Motion screen:

1. Press ZΘ to display the Motion screen.
2. Press [←] or [→] for clockwise or counterclockwise manual rotation. Press SEL and an arrow key for high speed rotation.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To rotate the stage from the Stage Rotation window:

1. Press ZΘ to display the Motion screen.
2. Press [F2: Theta]. The Stage Rotation window is displayed:

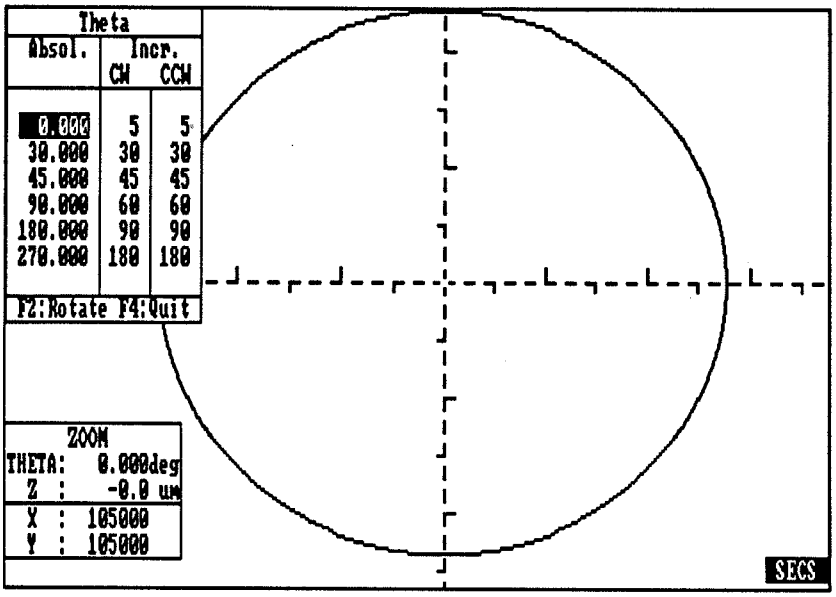


Figure 6-33 Rotating the Stage

3. Press [↑] or [↓] to select the desired rotation position in the fixed instrument coordinates listed under the Absolute column, or enter a value. Note: Any value can be altered; or

   In the columns labeled Incr. (Increment), use the arrow keys to select the degrees of rotation desired, clockwise or counterclockwise, from the current position, or enter a value.

NOTE:	Only the first row can be altered.

4. Press [F2: Rotate] to rotate the stage. Note: If the theta value displayed in the Motion screen does not equal 0 degrees for a sample in the zero theta position, refer to Section 6.10, "Adjusting the Theta Zero Offset (Optional Theta Mode)."

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

ROTATING THE STAGE–OPEN FRAME CONFIGURATION

> **CAUTION:** ***Open Frame Configuration only*–Before rotation, check that there is sufficient clearance between the larger of the stage table and/or sample and the elevator.**

You can rotate large rectangular panels in the housing if the corners will not collide with the elevator or the door of the Isolation Hood. See Fig. 6-34 for the innermost and outermost rotation positions that are the physical limits of travel. Values marked with an asterisk indicate Y coordinate stage positions as displayed in the Motion screen.

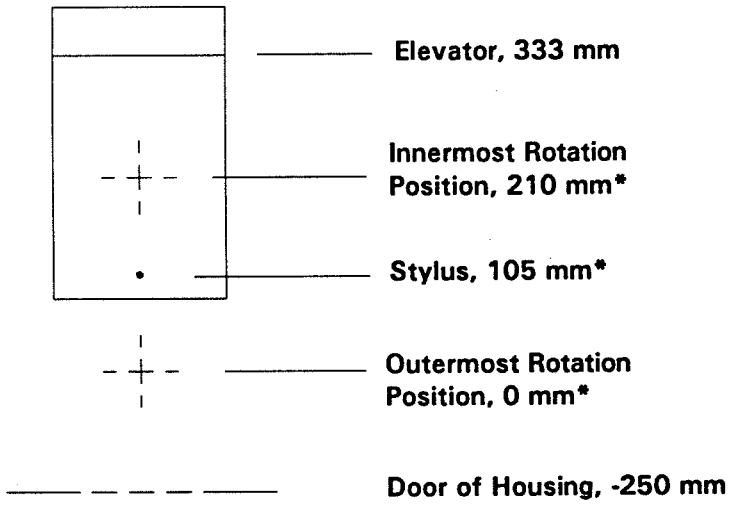


Figure 6-34 Open Frame Configuration Rotation Clearance (Top View)

If the sample extends farther than the stage table, the sample can hit the elevator when rotated. Following are the maximum values of the Y coordinate stage position that allow you to rotate the sample without hitting the elevator, if the sample is centered on the stage table:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Sample Size	Maximum Y Coordinate Value
244 x 244 mm (9.6 in.) (stage table)	160 mm (16.3 in.)
350 x 350 mm (13.7 in.)	85 mm (3.3 in.)
412 x 412 mm (16.2 in.)	41 mm (1.6 in.) (maximum size with hood)
470 x 470 mm (18.5 in.)	0 mm (0.0 in.) (maximum size with hood removed)

6.10 ADJUSTING THE THETA ZERO OFFSET (Optional Theta Mode)

The Theta Zero Offset adjustment enables you to make a software correction to align a particular precision locator precisely with the instrument's coordinate system.

To determine the theta zero offset:

1. Load a sample containing a feature that runs parallel to the X-axis of the stage.
2. Press [←] or [→] to move the stage in the X direction and check the alignment.
3. If you detect a theta error, calculate the angle or do the following:
   - Press ZΘ to enable stage rotation, and then press [←] or [→] to manually rotate the sample until the feature appears parallel to the X-axis of the stage.
   - Record the angle of rotation. Press MENU.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

- Choose Stage from the Config menu and press ENTER to display the Stage Configuration window:

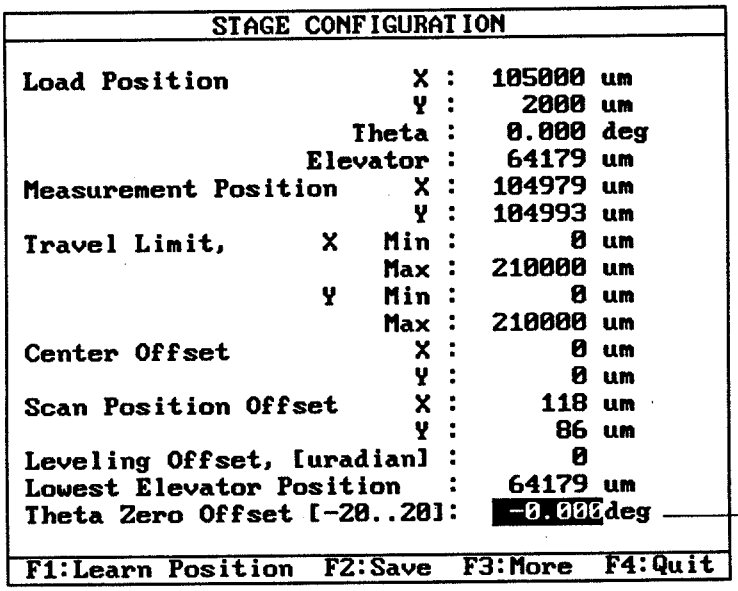


Figure 6-35 Adjusting Theta Zero Offset

- Choose Theta Zero Offset. Subtract the angle value that you recorded from the Theta Zero Offset value already in the window.
- Type this new value in the Theta Zero Offset field. For example, if the current value in the window is 7.0 and the angle is 0.5, the new Theta Zero Offset value is 6.5.
- Press [F2: Save] to save the new setting and then [F4: Quit] to exit.

4. The Theta Zero Offset adjustment changes the theta display coordinates in the Motion screen but does not physically move the stage. Therefore, to position the stage in the zero theta position, you must:
   - Press ZΘ to display the Motion screen.
   - Press [F2: Theta].
   - Press [F2: Rotate] to rotate the stage to 0 degrees. (After rotation, the theta value displayed in the Motion screen should equal 0 degrees.)

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

6.11 SETTING THE CENTER OFFSET

The instrument comes with the center of rotation aligned with the stylus tip. If it becomes necessary to readjust the centering, use the following procedures. Note: If you change the Center Offset, you also should change the X,Y travel limits by the same amount. See Section 6.2, "Setting X,Y Travel Limits," for more information.

To set the Center Offset:

1. Press MENU.
2. Choose Stage from the Config menu and press ENTER to display the Stage Configuration window.

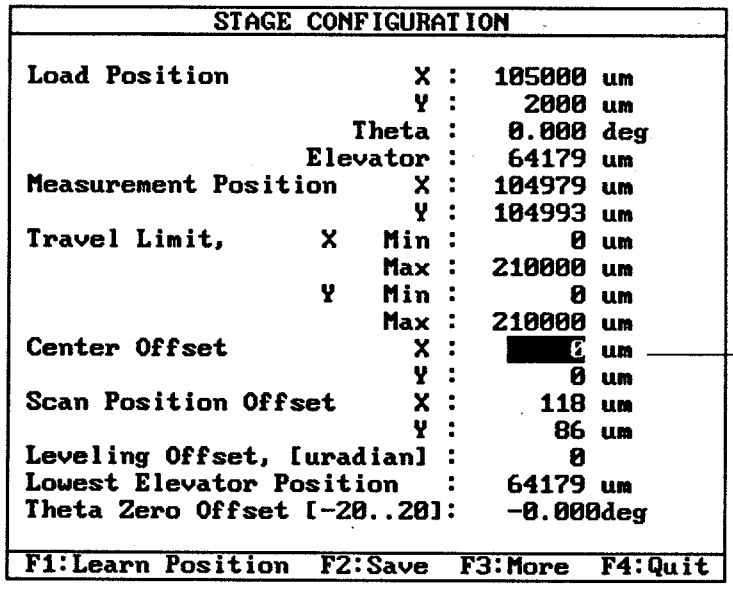


Figure 6-36 Setting the Center Offset

3. Choose Center Offset in the Stage Configuration window and enter the desired value or use the Motion screen to enter the value using the following steps. Note: The maximum limit for the Center Offset is 9000 μm. Also, you can only enter negative values from the Motion screen.

To enter values for the Center Offset in the Motion screen:

- Choose Center Offset and press [F1: Learn Position].
- Press MENU and then XY on the built-in keyboard or [F6: X-Y] on the remote keyboard to display the Motion screen (Fig. 6-20).
- Use [↑] or [↓] and [←] or [→] to select the desired center.
- Press MENU and then ENTER to return to the Stage Configuration window.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

- Use [↑] or [↓] to move to X and Y for the Center Offset and press [F1: Learn Position]. The selected values will be entered.

4. Press [F2: Save] to save the new values and then [F4: Quit] to exit.
5. Change X,Y limits by the same amount entered for the Center Offset. In other words, if the Center Offset changes by a negative amount, subtract the amount from the X,Y limits. If the Center Offset changes by a positive amount, increase the X,Y limits by that amount. See Section 6.2, "Setting X,Y Travel Limits," for details on changing the X,Y travel limits.

6.12 LEVELING THE STAGE

If the measured surface is not parallel to the scanning motion, the resulting trace in the Data screen will not be level (Fig. 6-37), causing inaccuracies in the data analysis. Other problems can arise in 3-D and automatic measurements if the surface is not level.

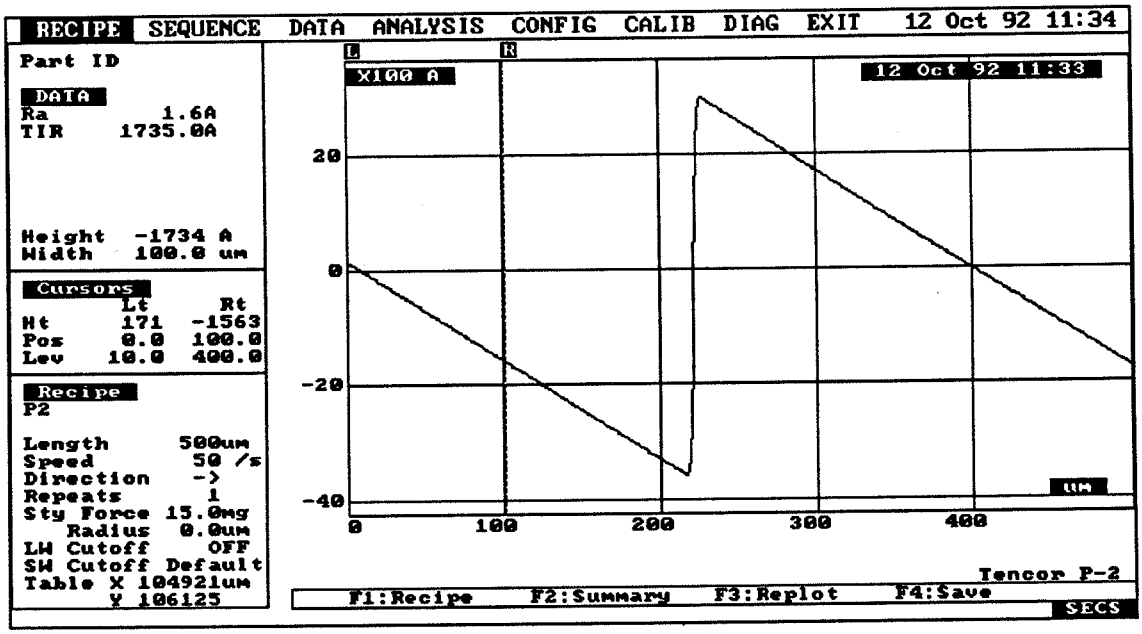


Figure 6-37 Unleveled Trace

The Tencor P-2 provides two ways of correcting for this condition:

- Mechanical adjustment of the stage so that the sample surface becomes level
- Software leveling of the profile data

Software leveling is discussed in Chapter 7, "Analyzing the Profile."

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

6.12.1 MANUAL STAGE LEVELING

You can use the following leveling procedure only if your instrument has a manual stage.

To level the stage manually using the software:

1. With the Data screen displayed (Fig. 6-37), press LEVEL. Note the addition of [F3: Mechanical Level]. Adjust the leveling cursors.
2. Press [F3: Mechanical Level] and the following prompt is displayed:

   Turn x counts (+ or -)

   where *x* is a number calculated by the system.
3. Open the measurement area door. Turn the leveling knob (Fig. 6-38) by the number of counts prompted in Step 2, clockwise for + and counterclockwise for -. Note: One turn equals 10 counts.

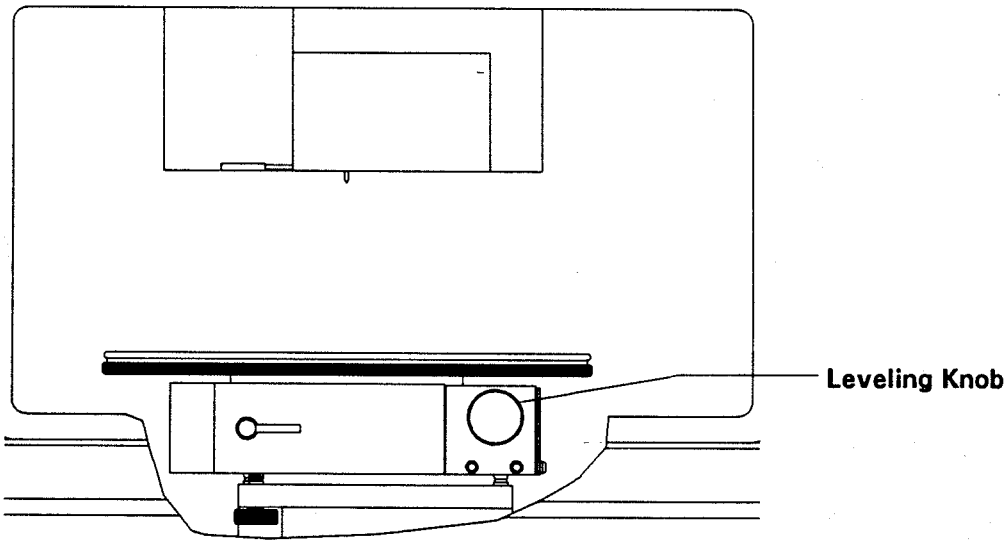


Figure 6-38 Leveling the Stage

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

6.12.2 MOTORIZED STAGE LEVELING

If your instrument has the optional Motorized X-Y Stage, you can use the following methods to level a trace.

To level the stage manually:

1. With the Motion screen displayed, press LEVEL to display the following window:

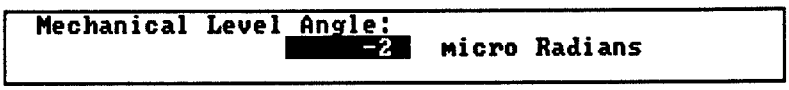


Figure 6-39 Mechanical Level Angle Window

When you initially turn on power to the instrument, this reference value is 0. Note: The value 0 does not indicate that the sample is level but is a reference number only.

2. Press [↑] or [↓] to level the sample. Press [↑] to raise the right side of the stage and [↓] to lower the right side of the stage:

   - *From the built-in keyboard,* press SEL and [↑] or [↓] for fast leveling movement.
   - *From the remote keyboard,* press SPACEBAR once and then [↑] or [↓] for fast leveling motion.

To level the stage auto-mechanically:

1. Press UNDO + LEVEL to unlevel the trace, if necessary, and to see the slope of the original trace.
2. Press LEVEL to display the Data screen. Note the addition of [F3: Auto Mechanical].
3. Position the left leveling cursor at one end of the slope and the right cursor at the other end.
4. Press [F3: Auto Mechanical] to display the following prompt:

   MECHANICAL Auto-Leveling. Please Confirm: [Y/N]

5. Press YES to initiate the auto-leveling.
6. Rescan and check that the trace appears level.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

6.13 SETTING THE LEVELING OFFSET (Optional Theta Mode)

This feature is only available if you have the Motorized Level and Rotation Option. The instrument comes with the Leveling Offset set for the stage table. If the trace in the Scan screen (Fig. 6-30) is not horizontal, set the Leveling Offset using the following procedure.

To set the Leveling Offset:

1. Press MENU.
2. Choose Stage from the Config menu and press ENTER. The Stage Configuration window is displayed:

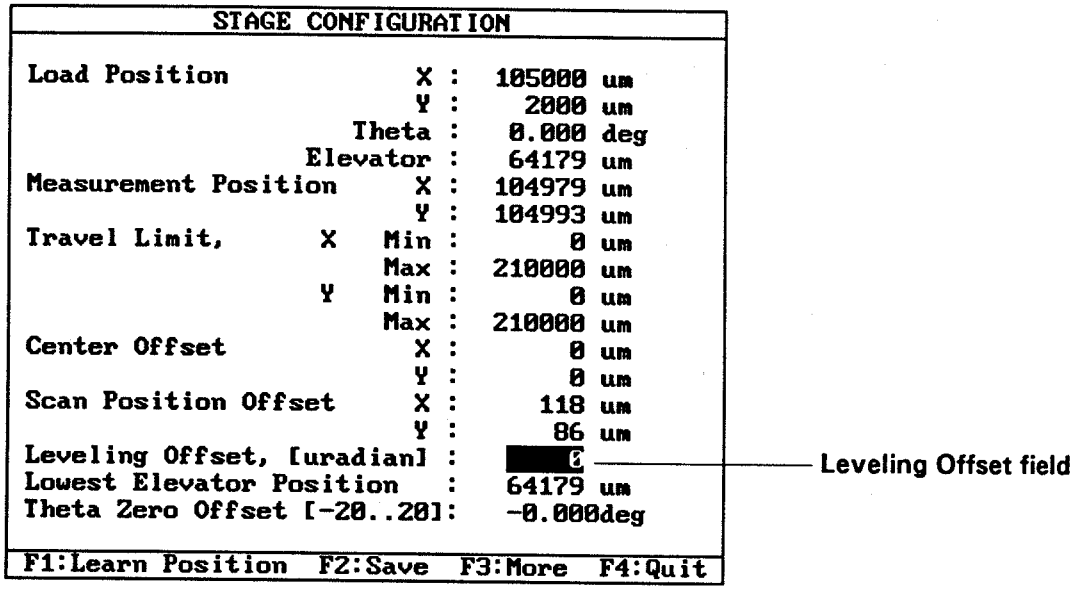


Figure 6-40 Setting the Leveling Offset

3. Choose Leveling Offset and enter the desired value or enter the current position as the Leveling Offset value using the following steps:
   - Verify that the stage is level by pressing START. The resulting trace should be horizontal (Fig. 6-30). If the stage is not level, level the stage as described in the next step.
   - Press MENU and then LEVEL on the built-in keyboard or [F10: Level] on the remote keyboard to display the Motion screen. Level the stage (see Section 6.12.2, "Motorized Stage Leveling," for details).
   - Press MENU, choose Stage from the Config menu and press ENTER to return to the Stage Configuration window. Press [F1: Learn Position]. The current position will be entered and saved.
4. Press [F2: Save] to save the new values and then [F4: Quit] to exit.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

6.14 SETTING THE SECS INTERFACE OPTION TO UPLOAD DATA

> **NOTE:** If you want to upload single scan or sequence data to the host computer, you must enable and set the SECS Option to upload data before scanning wafers.

You can use the SECS Option to upload single-scan or sequence data automatically or manually to the host computer. To upload recipes, see Section 5.6, "Using the SECS Interface Option with Recipes," for details.

To set the SECS Option to upload data:

1. If necessary, enable and configure the SECS Option. See Section 5.6.1, "Enabling and Configuring the SECS Option," for details. Note: You do not have to enable or configure the SECS Option each time that you upload data. The saved values remain unchanged even through power off.
2. Choose SECS from the Config menu and press ENTER. The SECS Communication window is displayed:

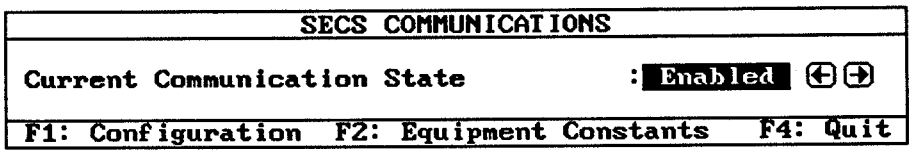


Figure 6-41 Enabling the SECS Option

3. To set the SECS interface to upload data to the host, press [F2: Equipment Constants] to display the SECS Equipment Constants window:

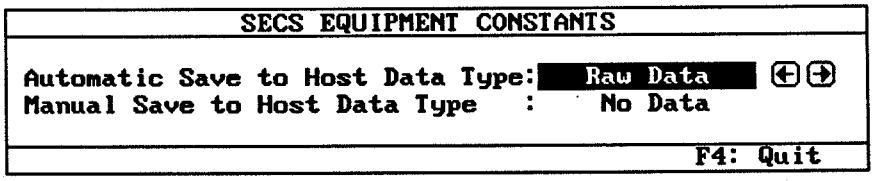


Figure 6-42 Setting SECS to Upload Data

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4. You can set the following options:

Option	Description
Automatic save to host data type	Set this option to Raw data or Summary data to upload data automatically each time a wafer is scanned. You have three options: No data, Raw data, and Summary data.
Manual save to host data type	Set this option to Raw data or Summary data to upload data manually. Each time you display scanned data and press [F4: Save] you will be prompted to upload the displayed data to the host. You have three options: No data, Raw data, and Summary data.

5. Press [F4: Quit] to exit the window and return to the SECS Communication window. Press [F4: Quit] to return to the menu bar.
6. If your instrument has the wafer handler installed, you must reset the instrument to activate the new settings. From the main menu bar, choose To DOS from the Exit menu and press ENTER. Type *y* when asked to confirm that you wish to return to DOS. The DOS prompt is displayed. Press RESET.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

7 ANALYZING THE PROFILE

Once you have written a recipe (Chapter 5) and taken a scan (Chapter 6), the computer makes its calculations from the scan data. The results are displayed moments later in the Data screen.

This chapter discusses how the information is presented in the Data screen and how to analyze and manipulate the data.

This chapter describes

- The parts of the Data screen
- Leveling the profile
- Using the measurement cursors to measure profile artifacts
- Using the Zoom function to enlarge a portion of the profile
- Accessing extra information from the Data Summary window
- Using Fit and Level to measure profile artifacts on curved surfaces
- Using Automatic Cursor Positioning (Edge Detection) to position the data cursors relative to an artifact edge or apex

This chapter describes the 2-D Data screen. For information on the 3-D Data screen, refer to Chapter 14, "Interactive 3-D Option."

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

7.1 DATA SCREEN

A representative Data screen display is shown in Fig. 7-1.

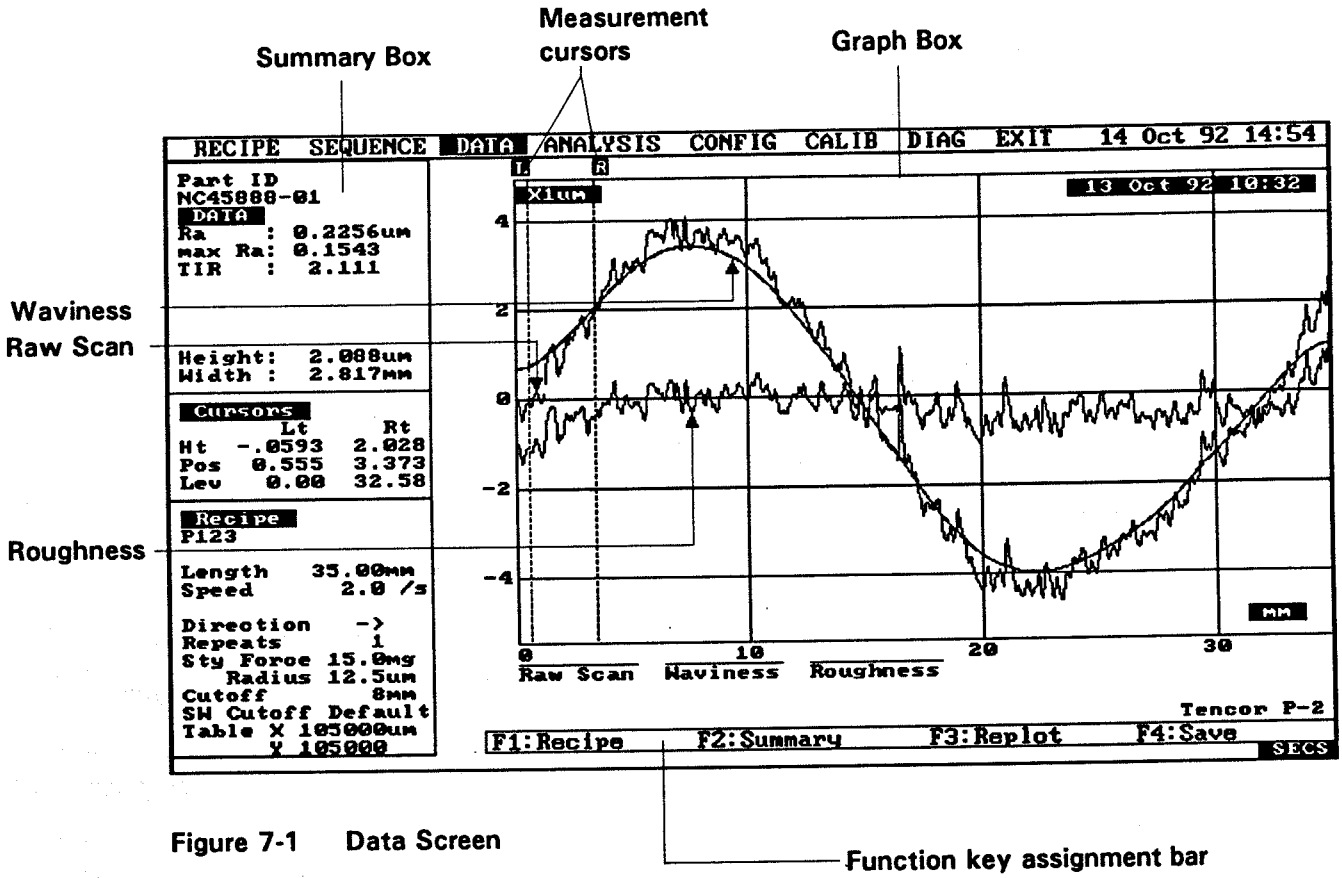


Figure 7-1 Data Screen

(Note: Raw scan, waviness, and roughness traces appear in different colors on the screen.)

The exact form that the Data screen takes depends on the settings that were established in the Scan recipe and on the nature of the sample surface.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

The Data screen has the following parts:

- The *Summary box* contains a summary of the calculated data from the profile, as well as a summary of the Scan recipe settings that were used to take the scan. The values that appear in the sections labeled DATA and Cursors are continually updated to reflect the current setting of the *measurement cursors* and the *leveling cursors*. The leveling cursors are described in Section 7.2, "Leveling the Profile," and the measurement cursors in Section 7.3, "Measuring Profile Artifacts."
- The *Graph box* contains a graphic plot of the profile height (the vertical axis) at each horizontal location within the scan (the horizontal axis). The graph can display the raw data or the filtered roughness or waviness data, or any combination, as determined in the recipe (see Section 5.3.2, "Surface Analysis Fields"). The graph's axes are scaled and labeled as determined by the Scan recipe and the magnitude of the vertical data. The measurement cursors appear in this screen and are manipulated as described in Section 7.3, "Measuring Profile Artifacts."
- The *Function key assignment bar* displays the current functions assigned to the F1–F4 keys. These functions will change depending on what operation is being performed. The functions are described in the following sections.

The screen colors can be changed if desired. See Section 3.12, "Setting Screen Colors," for details.

7.2 LEVELING THE PROFILE

If a surface to be measured is not parallel to the scan motion, the resulting trace will not be level, causing inaccuracies in the analysis of the data. Other problems can arise in sequential and 3-D measurements if the surface is not level. Note: This discussion refers to flat surface profiles; for a discussion of curved surface profiles, see Section 7.7, "Fit and Level."

The Tencor P-2 provides two methods of leveling a trace:

- *Software Leveling:* The software mathematically fine-tunes the leveling at the points of intersection between the *leveling cursors* and the trace. This leveling happens automatically immediately after the scan. Use this method for a fine leveling adjustment. Software leveling does not physically level the stage.
- *Mechanical Leveling:* You can use two methods to adjust the stage so that the test surface is physically leveled. Use this method for a coarse leveling adjustment. Mechanical leveling is discussed in Section 6.12, "Leveling the Stage."

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

The leveling cursors are used to define the endpoints for the leveling operation. The current positions of the leveling cursors are determined by the Scan recipe. Often the appropriate positions are unknown until a scan has been performed. Therefore, when the Data screen first appears after a scan, the leveling cursors will not necessarily be set appropriately, and the data can look something like Fig. 7-2.

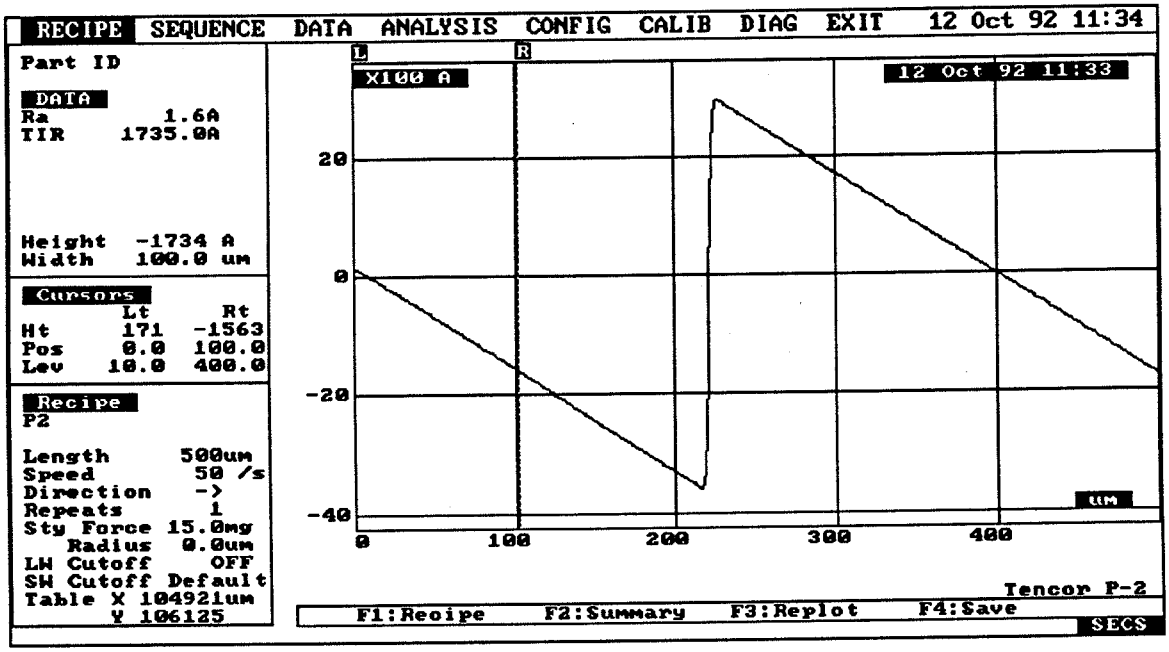


Figure 7-2 Unleveled Profile Trace

Before data analysis is attempted, then, it is often necessary to perform the leveling operation described in this section.

> **NOTE:** Users upgrading to Version 1.6.1 from a pre-Version 1.5 release might notice differences between Version 1.6.1 and the previous version in calculated parameter values (especially roughness parameters) when not using Delta Average leveling cursors. This is due to improvements in the leveling operation. Results with Version 1.6.1 are more reliable than with earlier versions.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

> **NOTE:** When measuring a radius, do not level the raw data unless there are obvious level reference points on which to set the leveling cursors. See Section 7.6, "Radius Measurement," for more information.

To level the trace:

1. Press LEVEL if the trace is not horizontal. The leveling cursors, which are two vertical dotted lines labeled L (left) and R (right), will appear at their preset positions with the left cursor activated.
2. Move L to the desired position with the trackball or arrow keys.
3. Press SEL to activate R and adjust its position with the trackball or arrow keys. The cursors also can be set to move in tandem:
   - Press SEL twice quickly to activate both L and R simultaneously. Use the trackball or arrow keys to move both cursors together.
4. Press [F3: Replot] or LEVEL to level the trace (Fig. 7-3).

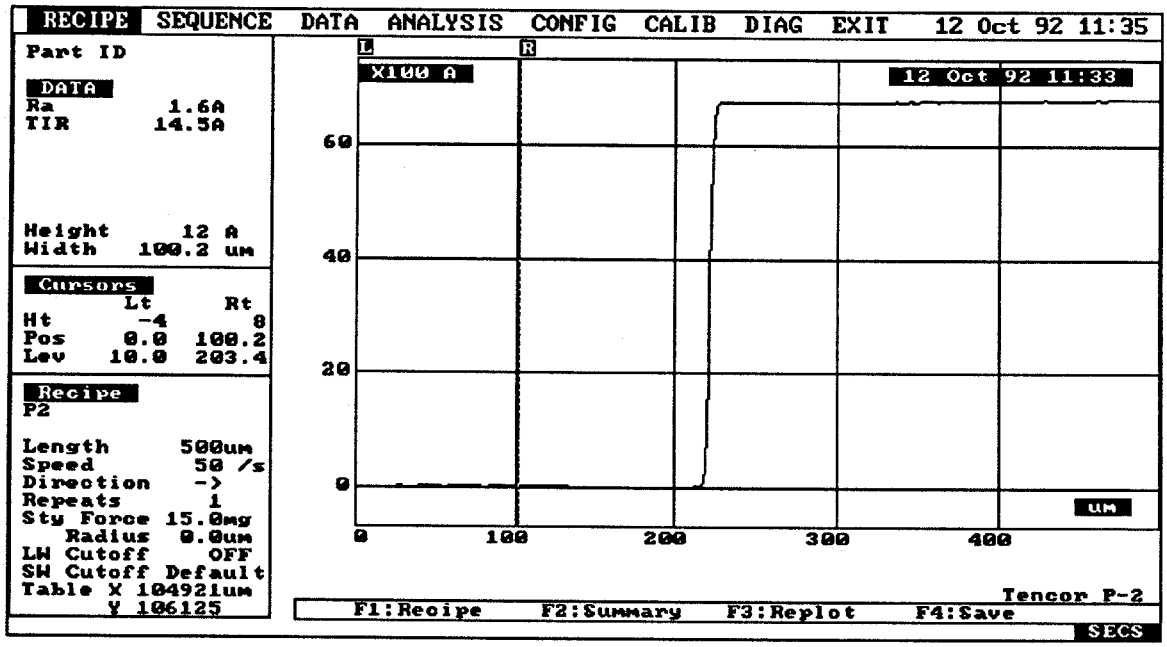


Figure 7-3 Profile of Fig. 7-2 After Leveling

5. If desired, press UNDO + LEVEL to unlevel the trace and return to the previous trace, and repeat.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

The leveling cursors also can be used in Delta Average mode. Instead of a single vertical line, the cursors can be expanded to define a band of a desired width. The values within this band are then averaged before the leveling calculation is performed.

To level the trace (Delta Average mode):

1. Press LEVEL if the trace is not horizontal. The leveling cursors, which are two vertical dotted lines labeled L (left) and R (right), will appear at their preset positions with the left cursor activated.
2. Press [↑] for Delta Average cursor operation. A second vertical line (also labeled L) appears to the right of the original cursor, defining the width of the delta range.
   - Hold down [↑] to expand the delta width and release when the width is satisfactory.
   - Press and hold down [↓] to reduce or eliminate the delta width.
   - Press SEL twice rapidly to adjust the delta widths of both cursors simultaneously.
3. Move L to the desired position with the trackball or arrow keys.
4. Press SEL to activate R. Set the delta width as in Step 2 and adjust its position with the trackball or arrow keys. The cursors also can be set to move in tandem:
   - Press SEL twice quickly to activate both L and R simultaneously. Use the trackball or arrow keys to move both cursors together.
5. Press [F3: Replot] or LEVEL to level the trace. Press UNDO + LEVEL to unlevel the trace and to return to the previous trace.

7.3 MEASURING PROFILE ARTIFACTS

Once the profile has been leveled, if necessary, the data is ready for critical examination.

7.3.1 POSITIONING THE CURSORS

Both horizontal and vertical measurements are made simultaneously from the two measurement cursors. The measurement cursors look exactly like the leveling cursors. They are normally active.

To position the measurement cursors:

1. Move L to the desired position with the trackball or arrow keys.
2. Press SEL to activate R and adjust its position with the trackball or arrow keys. The cursors also can be set to move in tandem:
   - Press SEL twice quickly to activate both L and R simultaneously. Use the trackball or arrow keys to move both cursors together.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

NOTE: In a noisy environment, scans taken to measure surface roughness might display a small spike at the beginning and at the end of the scan. This is a mathematical artifact due to the way that the software filtering algorithm works at the scan boundaries.

To exclude these data points from any parameter calculations, do not set the measurement cursors directly at the boundaries of the scan. That is, avoid setting L flush with the left side of the graph, and avoid setting R flush with the right side of the graph. Moving them inward toward the center of the graph just a small amount (5 data points) will suffice.

7.3.2 USING DELTA AVERAGE MODE

Delta Average mode enables you to expand each measurement cursor into a region, independently or in tandem.

To use the Delta Average Mode:

1. The measuring cursors, which are two vertical dotted lines labeled L (left) and R (right), will appear at their preset positions with the left cursor activated.

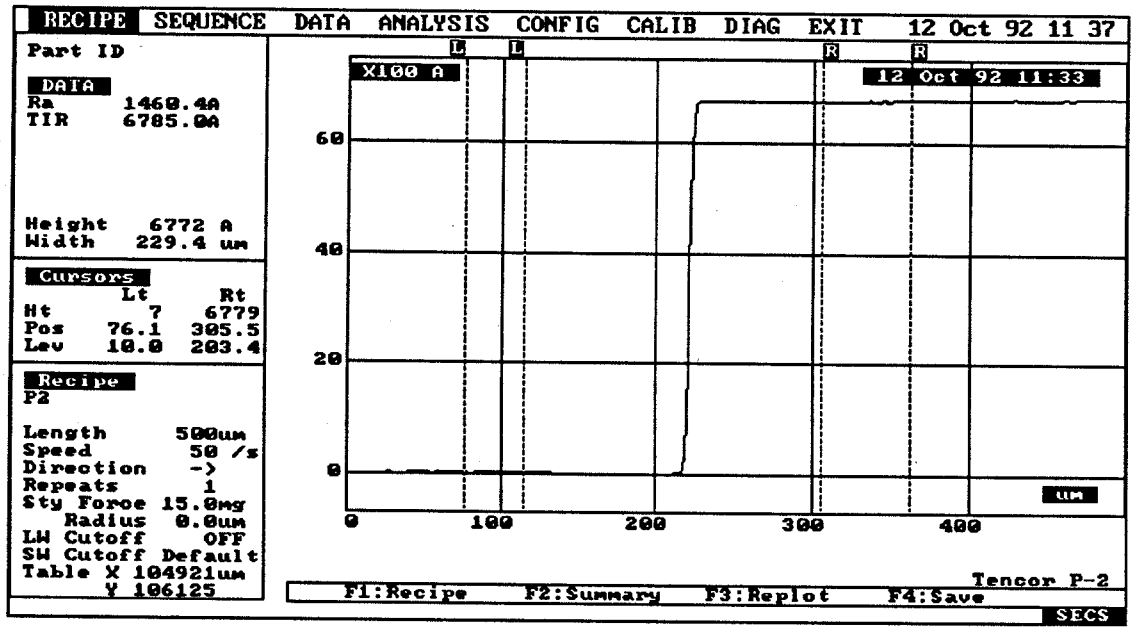


Figure 7-4 Measurement Cursors–Delta Average Mode

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

2. Press [↑] for Delta Average cursor operation. A second vertical line (also labeled L) appears to the right of the original cursor, defining the width of the delta range.
   - Hold down [↑] to expand the delta width and release when the width is satisfactory.
   - Press and hold down [↓] to reduce or eliminate the delta width.
   - Press SEL twice rapidly to adjust the delta widths of both cursors simultaneously.
3. Move L to the desired position with the trackball or arrow keys.
4. Press SEL to activate R. Set the delta width as in Step 2 and adjust its position with the trackball or arrow keys. The cursors also can be set to move in tandem:
   - Press SEL twice quickly to activate both L and R simultaneously. Use the trackball or arrow keys to move both cursors together.

7.3.3 SAVING CURSOR LOCATIONS

To save the selected cursor locations:

1. Press [F1: Recipe] to display the Recipe window.
2. Press [F3: Cursors] to enter the current leveling and measurement cursor positions, including delta widths, into the current recipe. This is the most convenient and precise way to record cursor positions for subsequent scans.
3. Press [F1: Save] if you want to save the recipe with these cursor positions.

7.3.4 READING THE DATA

> **NOTE:** **The trace can appear distorted by a much more sensitive scale on the vertical axis than on the horizontal axis. Do not try to estimate angles from the screen because angles that appear to be significant on the screen might not be.**

The positions of the measurement cursors define the sampling length used in the calculations for all parameters. The intersection of the leveling cursors and the trace defines the zero height line.

As you move the cursors, measurement data is continuously updated in the Summary box to the left of the profile graph. The Summary box also displays the calculated values of the surface parameters that you selected in the recipe for display (up to seven different parameters can be displayed here). Those selected to be saved are displayed in the Summary window (see Fig. 7-6), accessed by pressing [F2: Summary].

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

The following values always appear in the Summary box:

Data:

Height	Vertical distance between trace intersections of left and right cursors (in Delta Average mode, the vertical distance between the average values of height within the two delta width regions)
Width	Horizontal distance between the cursors (in Delta Average mode, the horizontal distance between the midpoints of the two delta width regions)

Cursors:

Ht	Height of trace intersection of left and right cursors
Pos	Position of measurement cursors
Lev	Position of leveling cursors

Recipe:

Table X/Y	Position of stage shown in terms of X,Y coordinates (μm)

For a description of any of the other values, see Section 5.3.2, "Surface Analysis Fields."

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

7.4 DISPLAYING EXTRA DATA

7.4.1 DATA ZOOM IN THE DATA SCREEN

1. Press ZOOM to magnify a feature of the trace for closer scrutiny. A small zoom box appears in the center of the screen.

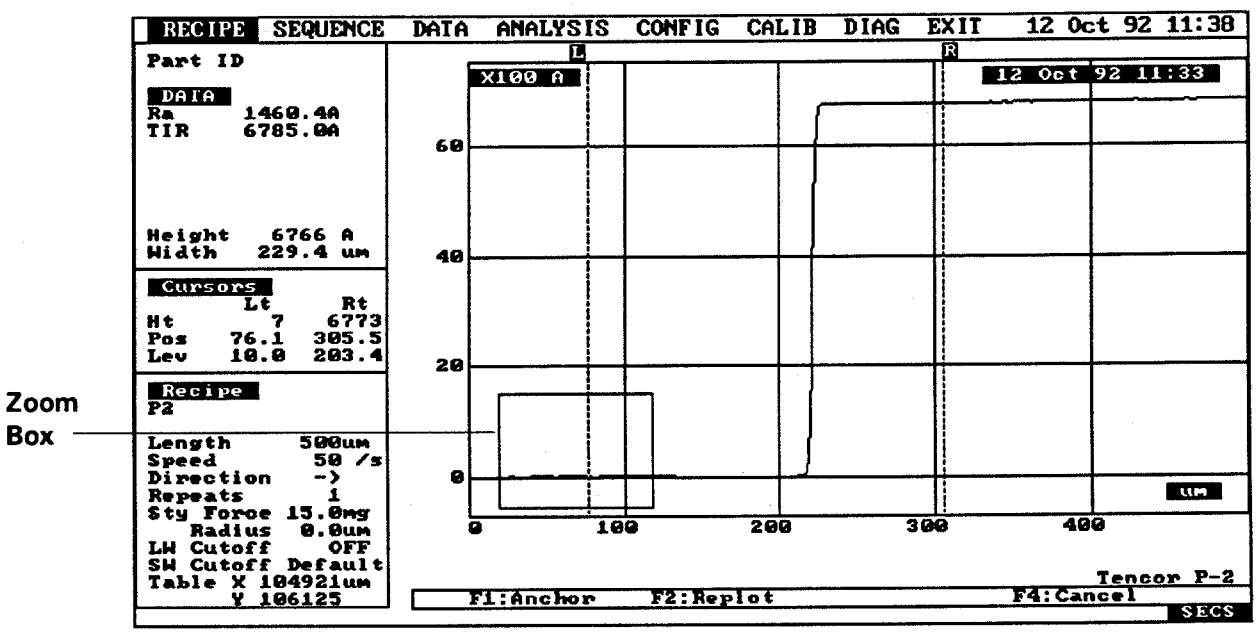


Figure 7-5 Data Zooming in the Data Screen

2. Use the trackball or arrow keys to place the lower left corner of the zoom box in the desired location.
3. Press [F1: Anchor] to anchor the corner and use the trackball to adjust the horizontal and vertical size of the box.
4. Press [F2: Replot] or ZOOM to plot the magnified trace or press [F1: Move] again to move the zoom box to a new position. Note that zooming results in higher resolution in the data readout. Press UNDO + ZOOM to return to the previous trace. Press [F3: Replot] to return to the original trace.
5. Press [F4: Cancel] to remove the zoom box if necessary.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

7.4.2 SUMMARY WINDOW

The Summary box contains only some of the information about the scan. A full display of the scan information is available in the Summary window.

To view the Summary window, press [F2: Summary] in the Data screen. The Summary window displays all scan parameters, the measurement and leveling cursor positions, and all surface analysis parameters selected in the recipe.

```
SCAN SUMMARY DATA      Part ID:  123                15 Oct 92  17:05

RECIPE                 CURSORS                      DATA
ID:        P2-S                                     Ra [Average]   :    955A
                       Height    :   -868A          max Ra         :     884
Length  :   500um       Left     :  -1829          Rq[RMS]        :    1187
Speed   :    10um/s     Right    :  -2697          Rp [Peak]      :    2128
Time    :     50s                                  Rv [Valley]    :   -3105
Horiz.Res :   0.2um    Width     :  99.77um        Rt [P/V]       :    5233
Sty Force :  15.0mg     Left     :   0.00          Rz[10pt height]:    4276
Sty Drop  :     3       Right    :  99.77          R3z[6pt height]:    4945
Sty Radius:  12.5um     L.delta  :      0          Wa [Average]   :      94
Direction :     ->      R.delta  :      0          TIR            :    5397
V.Range: 13um/520uin
Repeats   :     1      Leveling :
Cutoff : 0.08mm/3mil    Left     :    10um
                        Right    :   400
                        L.delta  :      0
                        R.delta  :      0          Cursors
                                                   Height  :   -868A
                                                   Width   :  99.77um
                                                              F4: Quit
```

Figure 7-6 Summary Window

Press [F4: Quit] to return the display to the Data screen.

7.5 AUTOMATIC CURSOR POSITIONING (EDGE DETECTION)

Consider a situation where you wish to compare the step heights from ten different instances of an artifact on a sample. It is difficult without taking extra care to start each of the ten scans at precisely the same location relative to the artifacts. Typically, the measurement cursor settings from the first scan will not precisely compare to the same locations relative to the feature on the subsequent scans. Therefore, you need to manually adjust the measurement cursors for each scan. This can be tedious and introduces some imprecision into the comparison, since it is difficult to locate the cursors manually in exactly the same way for all the scans.

Automatic Cursor Positioning (Edge Detection) makes it possible to automatically and reliably set the position of the measurement cursors relative to the rising or falling edge of a steplike feature, or the apex of an arclike feature. For each instance, then, you need not worry that you are starting the scan at precisely the same distance in front of each of

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

the artifacts. This eliminates the need to manually adjust the cursors for each scan, facilitating comparison between two or more instances of an artifact.

Both the location of the edge (or the apex of an arc) and the step width can be calculated and displayed in the Summary box in the Data screen and/or the Summary screen.

For steplike features, Automatic Cursor Positioning distinguishes between rising or falling edges. Since steps are rarely perfectly vertical, Automatic Cursor Positioning also distinguished between two types of edges. The following convention is used: the location at the *top* of the slope is called the edge, and the location at the *bottom* of the slope is called the base. When the slope levels out again, this location is called the edge. The following figure shows this convention for a plateau and a valley.

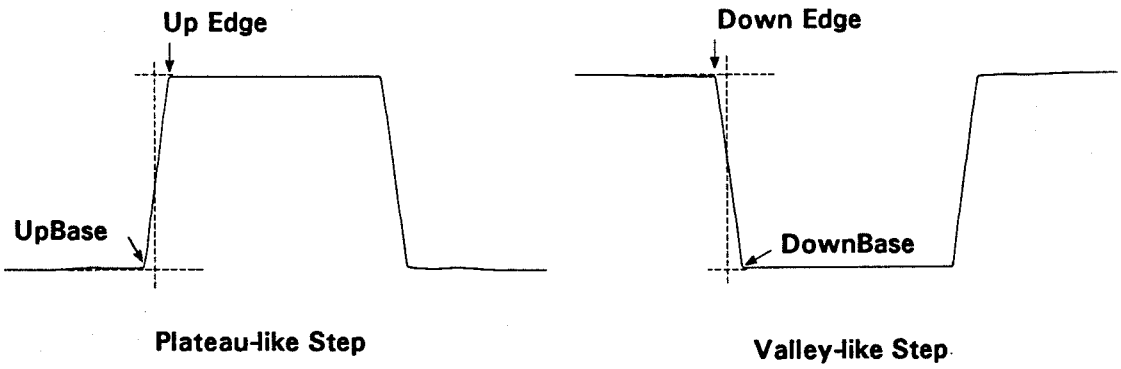


Figure 7-7 Edges of a Step

Automatic Cursor Positioning also distinguishes between convex (hill-like) and concave (valley-like) arcs.

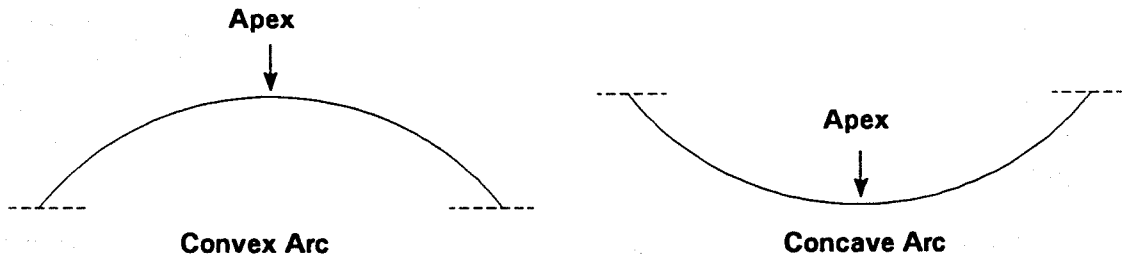


Figure 7-8 Convex and Concave Arcs

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

There are several values that you must set to specify the nature of the step edge or apex feature that you are measuring. These are described below.

Type

There are six choices that specify the type of edge or apex that we want to detect:

- UpEdge (rising edge)
- DownEdge (falling edge)
- UpBase (rising base)
- DownBase (falling base)
- Convex (hill-like arc)
- Concave (valley-like arc)

Slope Threshold

This factor sets the value at which an upward slope in the trace is considered to be preceding the step height edge or apex; that is, when an upward slope appears that rises significantly above the general roughness of the surface.

Valid values range between 0–50.000. When the artifact is much larger in comparison to the surrounding roughness of the surface, set the value higher. If the artifact is only a little larger than the surrounding roughness, set this value lower. Note that in this case, you might also need to set the Minimum Plateau Width (described below) to avoid any ambiguity.

The concept of the Slope Threshold is very similar to a signal-to-noise ratio. The best value for a given sample will depend on the relative scales of the artifacts you are examining and the surrounding surface roughness, as well as parameters such as scan speed, sampling rate, and so on. You might need to experiment to find appropriate values for Slope Threshold. The default values of 5.000 (for a step) and 1.000 (for an arc) are sufficient for most scans above 200Å.

Plateau/Apex Threshold

This factor affects the precise horizontal location calculated for the edge or arc. Since the edge of a step is rarely a perfectly defined location, this factor allows you to adjust the value slightly to the left or right.

For an edge, set this value to about the same value as the Slope Threshold. Valid values range between 0–50.000. Setting this threshold slightly greater than the Slope Threshold will move the exact location of the edge slightly to the left for an UpEdge or to the right for a DownEdge. Setting this threshold slightly smaller than the Slope Threshold will move the precise location of the edge slightly to the right for an UpEdge, or to the left for a DownEdge. For UpBase and DownBase, the adjustment is the reverse. For a Convex or Concave arc, set this value to a very small number, between 0–1.000. You might need

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

to experiment to find appropriate values for Plateau/Apex Threshold depending upon the relative scales of the artifact that you are examining and the surrounding surface roughness. The default values of 5.000 (for a step) and 0.000 (for an apex) are sufficient for most scans above 200Å.

> **NOTE:** **The Slope Threshold determines whether or not an edge will be detected; the Plateau/Apex Threshold determines only the precise reported location of a detected edge.**

Minimum Plateau Width

This value specifies the minimum horizontal length between a rising and falling edge, used in the edge detection calculation to determine the correct edge. This is useful in cases when the roughness of a surface might be large enough that it becomes difficult to adjust the Slope Threshold to find the correct feature without ambiguity. In such cases, narrow roughness peaks can extend above the height determined by the Slope threshold without causing the algorithm to identify them as the edge.

For steplike features, Minimum Plateau Width specifies a plateau as follows:

- For ascending features (UpEdge, UpBase,), the plateau is the one following the detected edge.
- For descending features (DownEdge, DownBase), the plateau is the one preceding the detected edge.

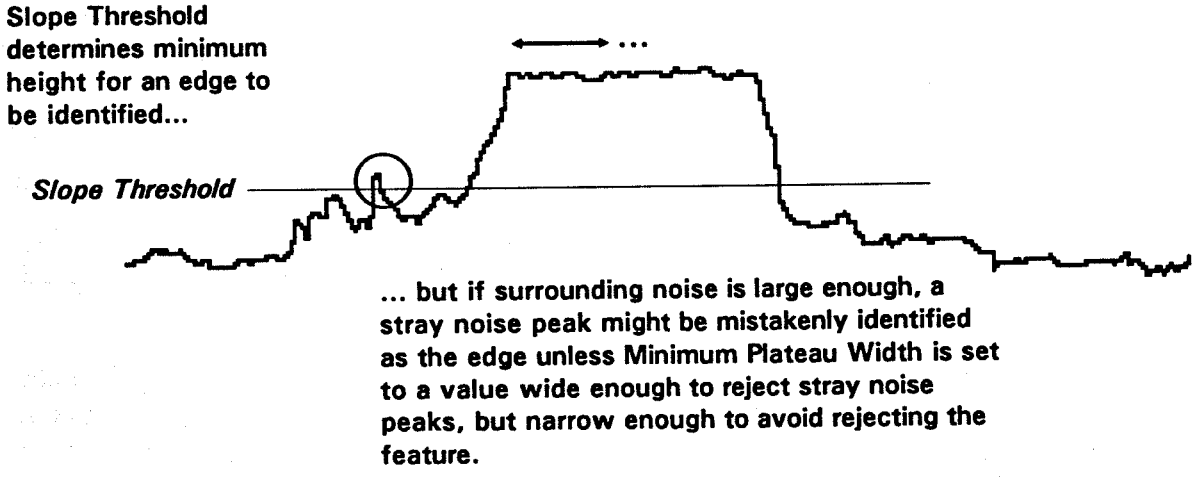


Figure 7-9 Automatic Cursor Positioning and Minimum Plateau Width

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

The Minimum Plateau Width can be used to reject such peaks that may otherwise cause failure to detect the correct edge. For UpEdge, DownEdge, UpBase, and DownBase features, set this value to be greater than the width of stray peaks, but always slightly less than the width of the step to be detected. Setting it too high will result in no edge being found. Valid values are in the range 0.005–1000.00 μm (0.0002–39.3701 mil.).

> **NOTE:** **Minimum Plateau Width is not intended for use with Concave or Convex features. In cases of rough sample surfaces, though, it might be useful. For a Convex arc, the Minimum Plateau Width specifies a minimum width for the feature, and so can be used to reject narrow roughness peaks in the vicinity of the arc. For the Concave arc, the Minimum Plateau Width is used to specify a minimum size for a level section following a detected arc.**

To set the Edge/Arc Detection Thresholds:

1. Press MENU to display the Menu bar.
2. Choose Edge Factor from the Calib menu and press ENTER to display the following window:

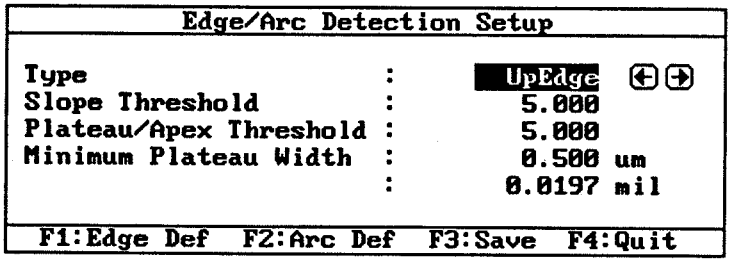


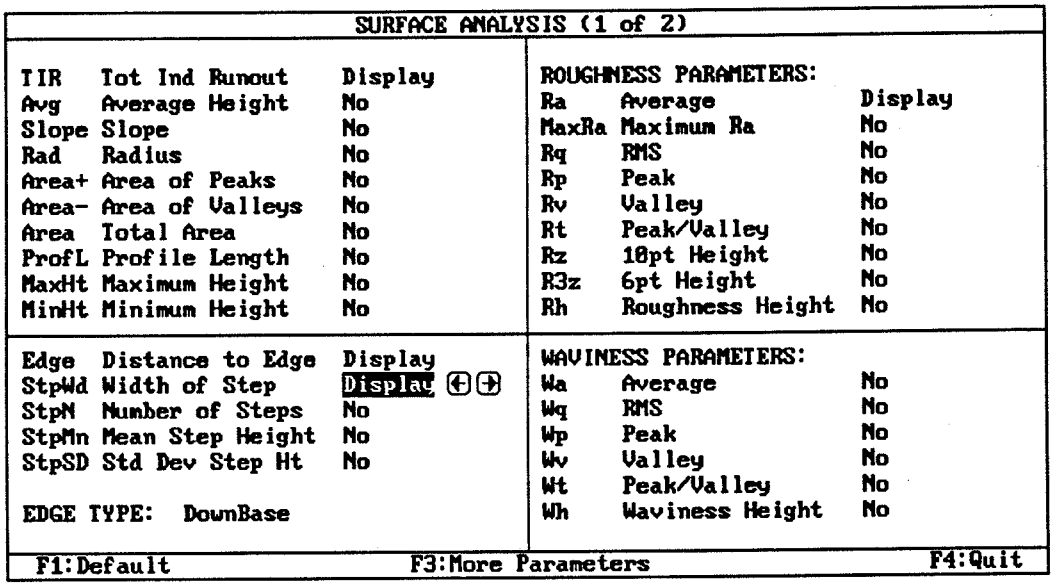
Figure 7-10 Edge/Arc Detection Setup Window

3. Use [↑] or [↓] to select the Type field. Use [←] or [→] to select UpEdge, DownEdge, UpBase, DownBase, Convex, or Concave.
4. Use [↑] or [↓] to select the Slope Threshold field. Type in an appropriate value as described above. Then use [↓] to select the Plateau/Apex Threshold field. Type in an appropriate value as described above; or
   Press [F1: Step Def] for the default step settings, or [F2: Apex Def] for the default apex settings.
5. If Type has been set to UpEdge, UpBase, DownEdge, or DownBase, use [↑] or [↓] to select the Minimum Plateau Width field. Type in an appropriate value as described above. Note: Pressing [F1: Step Default] does *not* put a default value in this field; you must set it yourself.
6. Press [F3: Save] to save the threshold values, or press [F4: Quit] to leave them unchanged and exit the Edge/Arc Detection Setup window.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To activate Automatic Cursor Positioning:

1. From the Recipe screen, press [↑] or [↓] to get to the Surface Parameters field, and press [→] or [←] to access the Surface Analysis (1) window.



SURFACE ANALYSIS (1 of 2)

TIR	Tot Ind Runout	Display
Avg	Average Height	No
Slope	Slope	No
Rad	Radius	No
Area+	Area of Peaks	No
Area-	Area of Valleys	No
Area	Total Area	No
ProfL	Profile Length	No
MaxHt	Maximum Height	No
MinHt	Minimum Height	No

Edge	Distance to Edge	Display
StpWd	Width of Step	Displau
StpN	Number of Steps	No
StpMn	Mean Step Height	No
StpSD	Std Dev Step Ht	No

EDGE TYPE: DownBase

ROUGHNESS PARAMETERS:

Ra	Average	Display
MaxRa	Maximum Ra	No
Rq	RMS	No
Rp	Peak	No
Rv	Valley	No
Rt	Peak/Valley	No
Rz	10pt Height	No
R3z	6pt Height	No
Rh	Roughness Height	No

WAVINESS PARAMETERS:

Wa	Average	No
Wq	RMS	No
Wp	Peak	No
Wv	Valley	No
Wt	Peak/Valley	No
Wh	Waviness Height	No

F1:Default F3:More Parameters F4:Quit

Figure 7-11 Enabling Automatic Cursor Positioning from Surface Analysis (1) Window

2. Press [↑] or [↓] to get to the Edge field. Press [←] or [→] to choose one of the following:

DISPLAY Calculates a parameter and enters it into memory. Displays the calculated value in the Summary box in the Data screen. Up to seven parameters can be displayed there. The calculated value is also displayed in the Summary screen. Up to 20 parameters can be calculated for a given scan and displayed in the Summary screen. Labels cursor data in Recipe screen as RELATIVE.

YES Calculates a parameter and enters it into memory. Displays it in the Summary screen but not in the Summary box in the Data screen. Up to 20 parameters can be calculated for a given scan and displayed in the Summary screen. Labels cursor data in Recipe screen as RELATIVE.

NO Does not store or display the parameter. Labels cursor data in Recipe screen as ABSOLUTE.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3. Repeat Step 2 for the Step Width field if you want to calculate and display the Step Width parameter.
4. Scan the sample. When the Data screen appears, set the L and R cursors (in normal or Delta Average mode) on opposite sides of the edge of the artifact, as in Fig. 7-11. Level the scan if necessary (see Section 7.2, "Leveling the Profile").
5. When you have set the cursors as desired, press [F1: Recipe].
6. In the Recipe screen, press [F3: Cursors] to record the current leveling and measurement cursor positions, including delta widths, into the current recipe. Notice that the Cursors data in the Recipe is labeled with the word RELATIVE. This indicates that Automatic Cursor Positioning has been enabled in this recipe.

The calculated parameters are interpreted as follows:

Edge (Distance to Edge)

Depending on the setting of the Slope Threshold and the Plateau/Apex Threshold, this distance is either

- The distance between the beginning of the scan and the first rising or falling edge or base of a step; or
- The distance between the beginning of the scan and the apex of the first convex or concave arc.

StpWd (Width of Step)

The width of a step plateau; that is, the distance between the leading and trailing edges of the plateau. The StpWd value does not apply in the case of an arc.

StpN (Number of Steps)

The number of steps that occur in the sampling length. These steps are defined as complete pairs of ascending and descending edges. The Type setting in the Edge/Arc Detection Setup window (Fig. 7-10) determines the appropriate order of the edge pairs. For example, if the Type is set to UpEdge, StpN starts counting pairs starting with the first ascending edge encountered. See Fig. 7-12. StpN is meaningless for a concave or convex arc.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

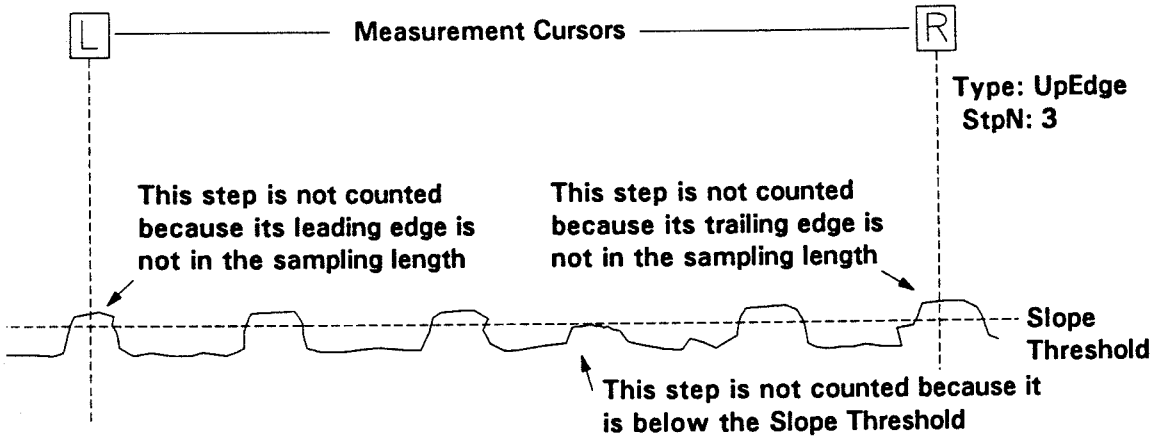


Figure 7-12 Step Counting for StpN, StpMn, and StpSD Parameters

StpMn (Mean Step Height)

The mean value of step height of all the steps that occur in the sampling length. Steps are defined as described for StpN above. StpMn is meaningless for a concave or convex arc.

StpSD (Std Dev Step Ht)

The standard deviation of the step heights of all the steps that occur in the sampling length. Steps are defined as described for StpN above. StpSD is meaningless for a concave or convex arc.

NOTE: **It is important to note that the Automatic Cursor Positioning calculation can only be used reliably if you have set the Edge Factor thresholds appropriately for the particular type of feature you are scanning. Also note that the profile scan length must be long enough that the artifact is completely included, and that there is enough scan data on either side for the leveling cursors to be set reliably.**

When measuring an arc with Radius as one of the calculated parameters, do *not* level the trace after the scan. Leveling can introduce errors into the radius calculation. Note that the measurement cursors will automatically set themselves about the apex such that the height difference between the left and right cursor/trace intersections is a minimum. See Section 7.6, "Radius Measurement," for more information.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

The following figures (Fig. 7-13, 7-14, and 7-15) demonstrate the usefulness of Automatic Cursor Positioning. The three scans were taken across the same section of the artifact, but the scans began and ended at different points along the profile. Delta Average cursors are used.

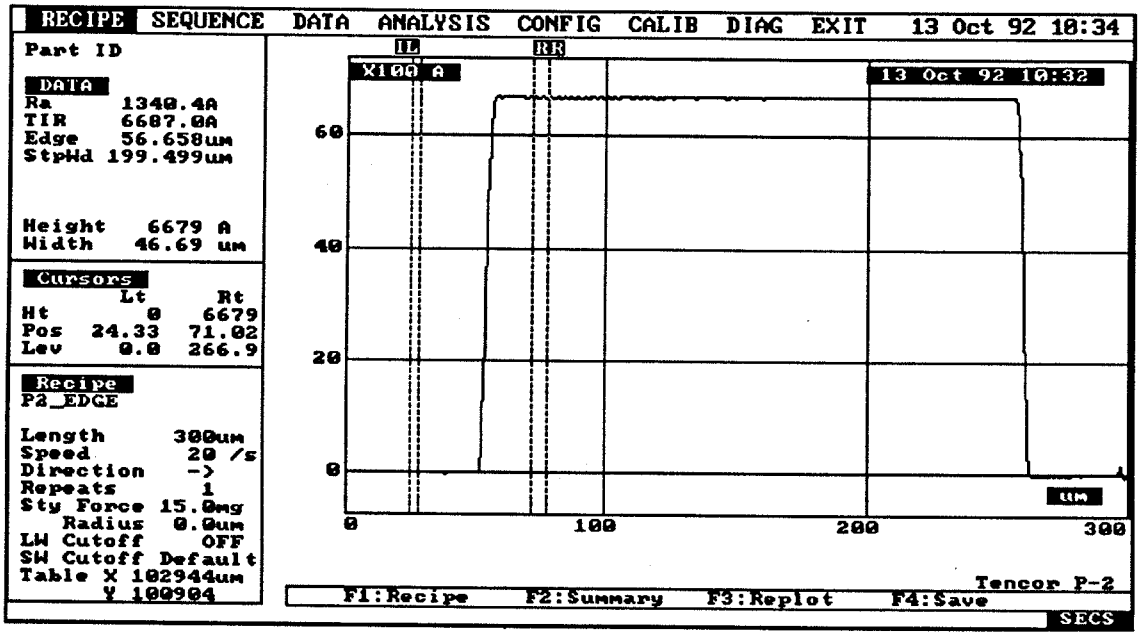


Figure 7-13 Scan 1 with Automatic Cursor Positioning Enabled

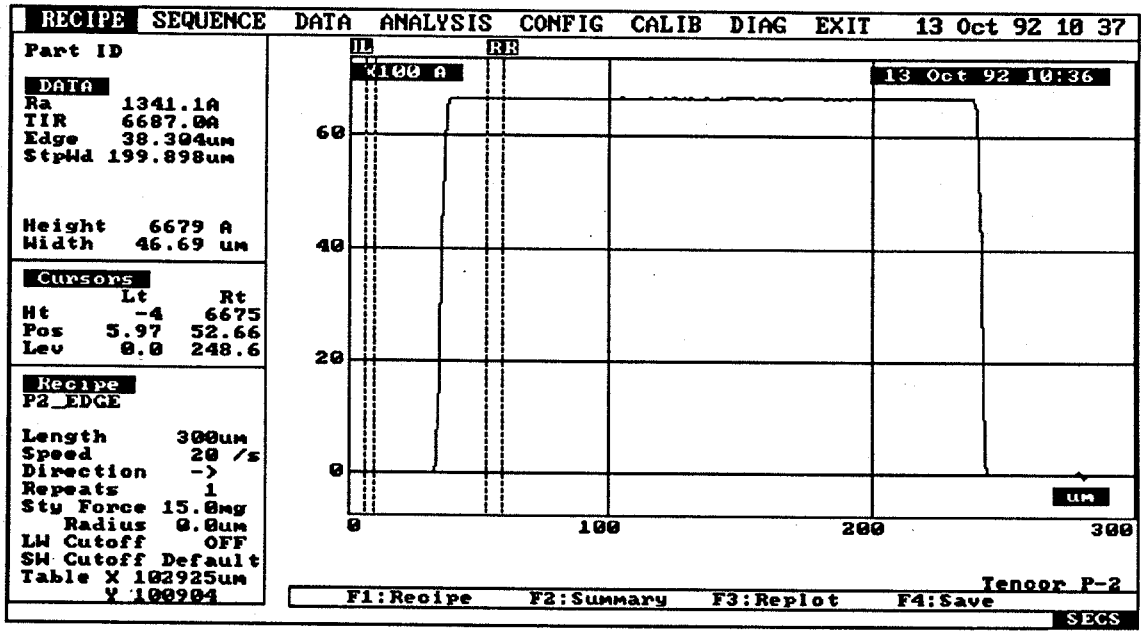


Figure 7-14 Scan 2 with Automatic Cursor Positioning Enabled

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Notice how the L and R cursors are located relative to the edge of the step in each plot.

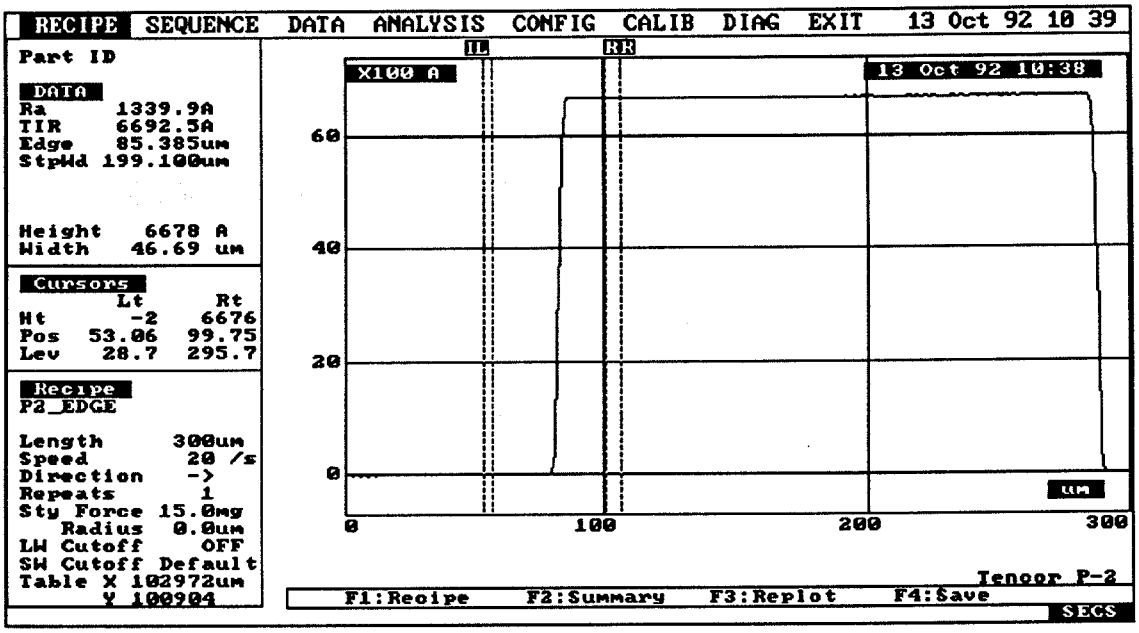


Figure 7-15 Scan 3 with Automatic Cursor Positioning Enabled

The following figure shows a sample where the apex of a peak is the feature of interest.

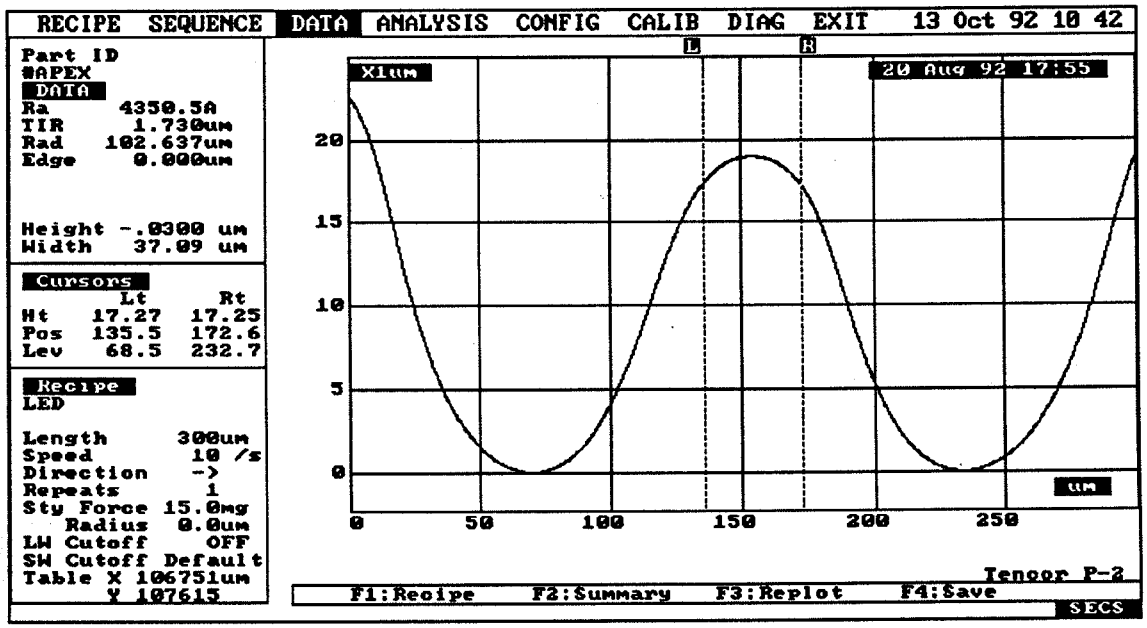


Figure 7-16 Automatic Cursor Positioning Set to Detect the Apex of a Peak

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

7.6 RADIUS MEASUREMENT

The average radius of a circular segment defined by the measurement cursors is calculated from a data set using a least squares fit method. This method is capable of high precision and can be employed manually or in a programmed sequence. It is useful over a range from 0.5 μm (20 μin.) to 200 mm (7.9 in.), provided that the sample will fit into the instrument.

You should keep in mind that the radius of the measurement stylus is added to the sample radius in the measurement. While the radius of a 2-μm stylus added to a 20-mm radius sample might be considered negligible (0.01%), that of a 5-μm stylus added to a 1-mm radius is a 0.5% error, which is probably not acceptable.

This consideration disappears if the instrument is calibrated with a high precision cylindrical standard whose radius is within a factor of 5 of the sample to be measured. For the highest accuracy, we recommend that you perform this calibration. After reading this section, see Section 17.9.2, "Radius Calibration," for instructions.

Note that this calibration is only effective when radius measurement is enabled by setting the Radius parameter to Display or Yes in the Scan recipe. This means also that the radius measurement should be disabled by setting the Radius parameter to No in the Scan recipe when the instrument is used for other types of measurements.

For maximum precision, the height of the measured arc and the size of the included angle must be within certain limits. These limits depend on the type of measurement head you are using. The height of the measured arc should be limited to 77% of the vertical range of the measurement head, and the included angle to 90°. Measurements can be made up to 90% of the vertical range of the measurement head in arc height and 110° in included angle with a small loss of precision.

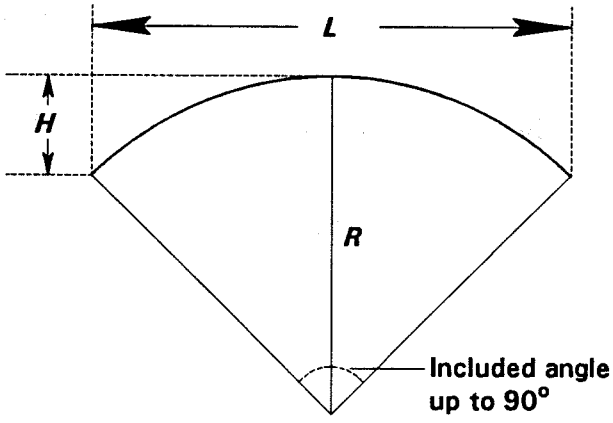


Figure 7-17 Arc Segment Dimensions

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Precise measurement is also restricted to arc segments that are symmetric to the radial axis of the measured artifact. To measure another portion of the radius, the sample must be physically rotated about the radial axis.

Scan length and scan speed are dependent on the radius of the sample and the arc height allowed by the measurement head and its vertical range. For a given radius R and optimum arc height H, the optimum scan length L can be determined by the following formula:

$$L = 2\sqrt{2RH - H^2}$$

See Figure 7-15.

Scans taken at the lowest possible horizontal resolution for the optimal scan length generally yield the most repeatable and precise radius measurements. To achieve the lowest horizontal resolution, you might have to try various combinations of scan speed and sampling rate. Start with a 200 Hz sampling rate, then set the scan speed to get a scan time that is a close as possible to 25 seconds without exceeding it. If the longest scan time possible under these restrictions is 12 seconds or less, set the sampling rate to 100 Hz, and then set the scan speed so that the the scan time is as close as posible to 50 seconds without exceeding it.

When there is a choice, use the center bias profile type ⌐¬ if the arc height H is less than about 40–45% of the range available with your measurement head. Otherwise, use either the peak bias ⊓ (for convex or hill-like radii) or the valley bias ⊔ (for concave or valley-like radii), as appropriate.

The stylus force needed depends on the arc height H and on the profile type (peak, valley, or center bias). Stylus force must be set high enough for the stylus to reach the lowest points of the scan. If, while measuring a radius, the trace flattens out and no "data out of range" message is displayed, try a higher stylus force setting.

A 1-σ repeatability (precision) of 0.002% of the radius is routinely obtained when you follow a few simple rules:

- Do not use software leveling on the scan data (that is, set both leveling cursors to zero)
- Preset the position of the measurement cursors

These rules are followed when the scan recipe is set up as follows:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Recipe Field	Setting
Scan Length	See formula earlier in this section
Scan Speed	See discussion earlier in this section
Sample Rate	200 Hz if possible (see discussion earlier in this section)
Surface Parameters	Set Radius and Distance to Edge to "Display"
Stylus Force	See discussion earlier in this section
Profile Type	See discussion earlier in this section
Vertical Range	To range necessary to accommodate sample

Cursors (RELATIVE):	Left	Right
Measurement	$-\frac{scan\ length}{2}$	$\frac{scan\ length}{2}$
Leveling	0	0
Delta Meas	0	0
Delta Lev	0	0

For convex radii, the cursors will be automatically adjusted whenever the Edge and Radius parameters are selected in the Scan recipe and Automatic Cursor Positioning (set for Apex) is enabled.

For 0.002% repeatability, adjust the measurement cursors in the Data screen so that the height values for the cursors are equal within 0.5 μm (20 μin.) for radii larger than 2.5 mm (0.1 in).

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

7.7 FIT AND LEVEL

The Tencor P-2 software has the capability to allow for accurate step height measurement on curved surfaces (such as lenses or glass optical fibers), or in the case of a bow in a profile that has been leveled in the normal manner. This capability is enabled or disabled in the Scan recipe.

> **NOTE:** The software can remove a simple convex or concave curve from the data, but not more complex curves like waves. On such profiles, however, the trace can usually be zoomed such that the data within the Zoom box forms a locally simple curve. Then a Fit and Level can be performed on the zoomed data as described below.

To activate Fit and Level:

1. From the Recipe screen, press [↑] or [↓] to get to the Fit and Level field. Toggle Fit and Level On with [←] or [→].

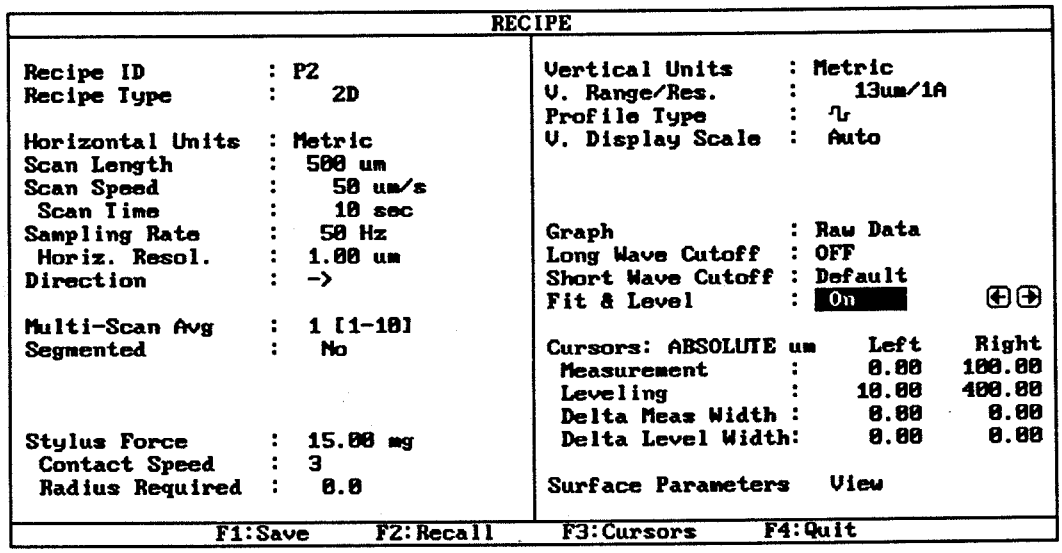


Figure 7-18 Enabling Fit and Level from the Recipe Screen

2. Press [F1: Save] to save the recipe, or [F4: Quit] to leave the Recipe screen without saving the recipe.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To level a curved trace:

> **NOTE:** **The Fit and Level software uses the Delta Average mode to determine the curvature of the profile. At least one, preferably both, of the cursors must be set in Delta Average mode for the determination of the curvature to be accurate.**

1. From the Data screen, press LEVEL.
2. Move L to the desired position, then press [↑] to activate Delta Average cursor operation. Adjust the width of the cursor so that it covers a section of the left side of the profile that is as wide as practical depending on the width of the artifact relative to the sampling length (see Fig. 7-19).
3. Press SEL to activate R and press [↑] to activate Delta Average cursor operation. Adjust the width of the cursor so that it covers a section of the right side of the profile that is as wide as practical depending on the width of the artifact relative to the sampling length (see Fig. 7-19).

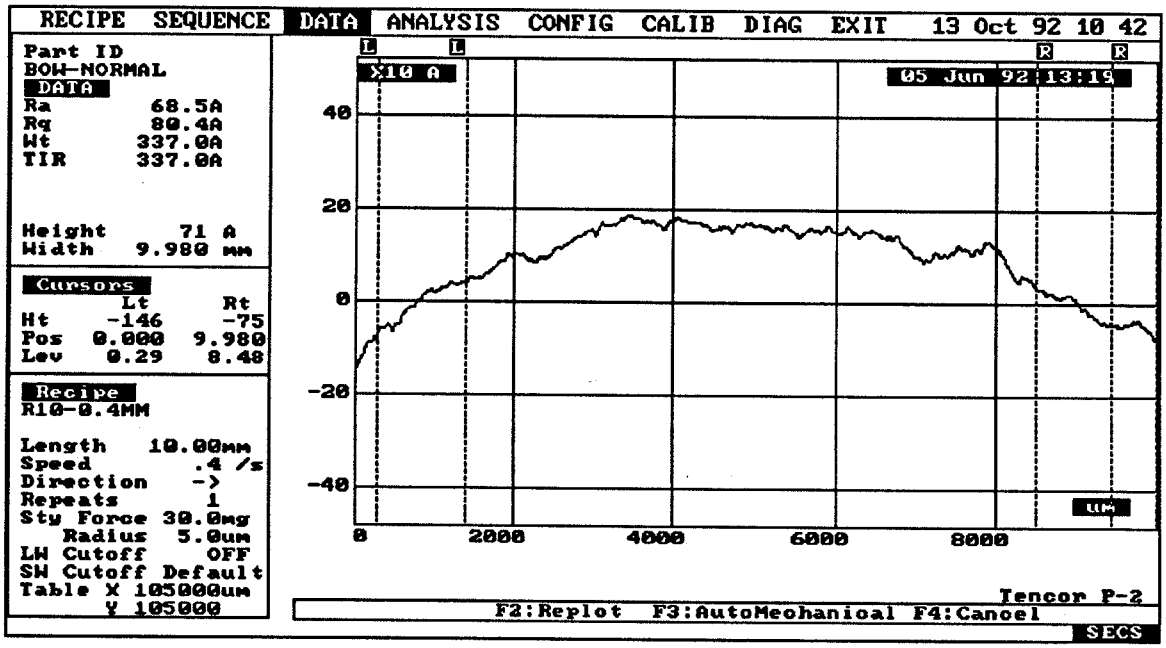


Figure 7-19 Curved Trace Before Fit and Level

4. When you have set the cursors as described, press [F2: Replot]. The profile will be replotted with the curvature subtracted out of the displayed trace (see Fig. 7-20).

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

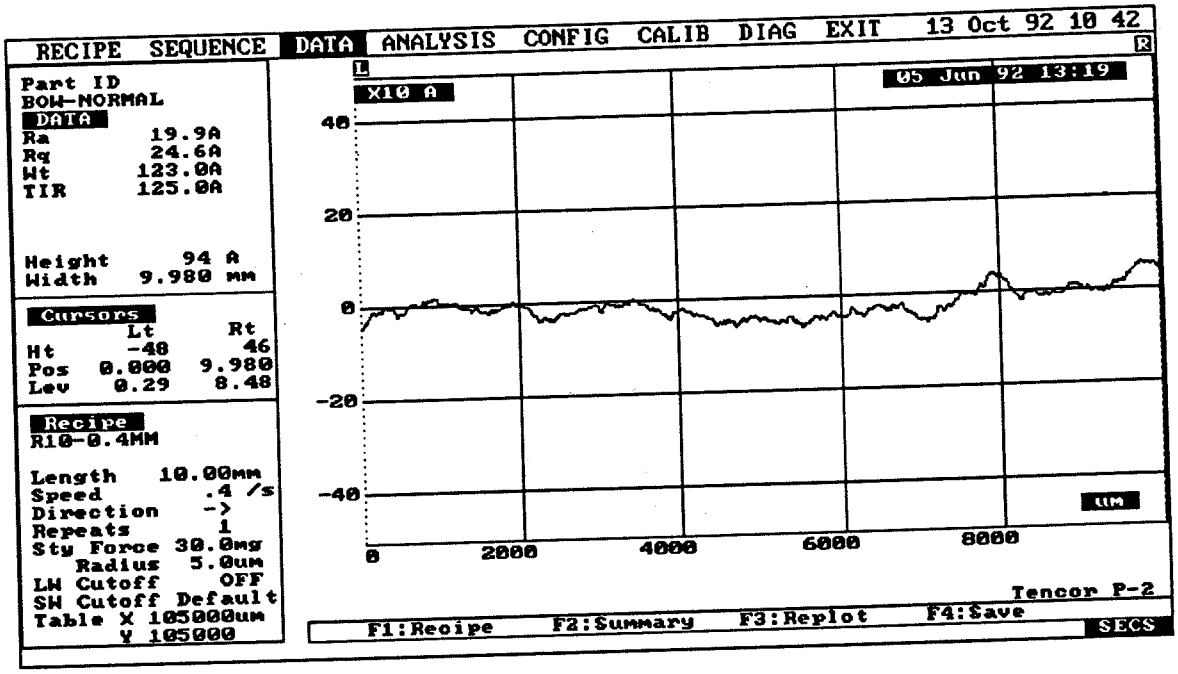


Figure 7-20 Curved Trace After Fit and Level

> **NOTE:** Fit and Level does *not* work for 3-D scans.

7.8 PRINTING DATA

Press PRINT on the built-in keyboard or PRINT SCREEN (*not* SHIFT + PRINT SCREEN) on the remote keyboard to print the entire Data screen on a compatible black-and-white or color printer.

> **NOTE:** If the color printer is not connected to the instrument and you press PRINT, the instrument will lock up. Press RESET to reboot the instrument.

7.9 SAVING DATA AND RECIPES

Data and recipes are saved internally to the hard disk. The default path for data saved or exported is the hard disk. To save data to a diskette, change the disk path and insert a blank, formatted diskette in drive A.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To change the disk path:

1. Choose Disk Path from the Config menu to display the following window:

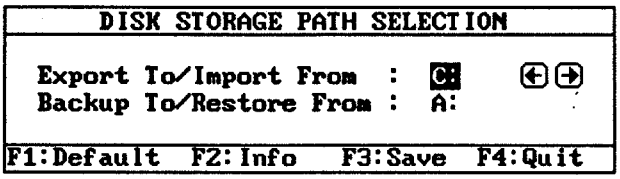


Figure 7-21 Selecting the Disk Path

2. Select Export To/Import From and press [←] or [→] to select the drive. Note: If you do not have the Database Option, only Export To/Import From will work in the Disk Path window. In this case, you can only perform backups in DOS.

   Press [F1: Default] to select the default disk path that directs recipes and data to be saved and exported to hard disk during a save operation.

   Note: If you are going to save the data to drive A, insert a blank formatted diskette into drive A before pressing [F4: Quit].

7.9.1 SAVING DATA WITHOUT THE DATABASE MANAGER OPTION

To save to the hard disk:

1. If the Data screen is displayed, press [F4: Save] to save the raw data for the trace, the data summary, and the Scan recipe used to the hard disk. (This recipe is stored for reference only.) The Save Recipe window is displayed (Fig. 7-22). If the Recipe window is displayed, press [F1: Save] to save the Scan recipe to hard disk. The Save Recipe window is displayed (Fig. 7-22):

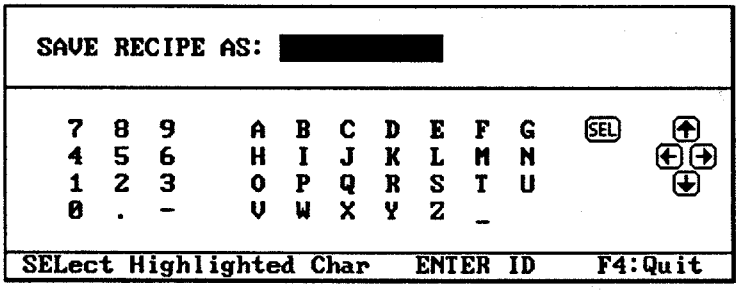


Figure 7-22 Save Recipe Window

2. Enter an ID (11 characters maximum *with no spaces*) in order to label the recipe or data file. Note: When exporting data, the ID will automatically be truncated to the first eight characters.

3. Press ENTER.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

7.9.2 SAVING DATA WITH THE DATABASE MANAGER OPTION

To save to the hard disk:

1. If the Data screen is displayed, press [F4: Save] to save the raw data for the trace, the data summary, and the Scan recipe used to hard disk. (This recipe is stored for reference only.)

   If the Recipe window is displayed, press [F1: Save] to save the Scan recipe to hard disk.

   The Database Save IDs window is displayed:

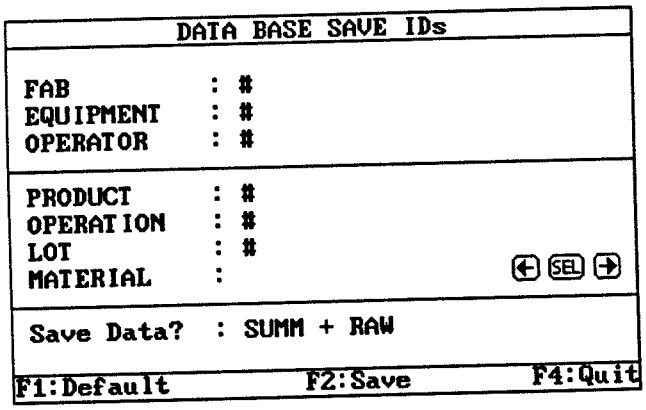


Figure 7-23 Database Save IDs Window

Data is saved using seven user-configurable IDs and five data-dependent IDs (not visible at the time of saving data). See Section 12.3.2, "Saving Data with Assigned Values," for more information.

> **NOTE:** **You can save data quickly without entering values for each ID by pressing [F1: Default] to enter # in the first six IDs. Enter a unique ID only in the seventh ID (Material in the above window) so the data can be easily identified.**

2. **To enter values for the IDs:**

   - Use [↑] or [↓] to move between the IDs. Use [←] or [→] to select assigned values for the IDs.
   - You also can enter new values for the IDs. Each ID value can be a combination of up to a maximum of 17 characters and numbers (*no spaces allowed*). See Section 3.5, "Entering an ID," for details. Note: When exporting data, the ID will automatically be truncated to the first 8 characters. (The database should be configured before you start saving data. See Section 12.2, "Configuring the Database," for more information.)

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3. Choose Save Data? and use [←] or [→] to select Summary and Raw Data or Summary only.
4. When you finish entering values for the IDs, press ENTER to save the data.

7.10 RECALLING DATA

7.10.1 RECALLING DATA WITHOUT THE DATABASE MANAGER OPTION

To view a trace that has been saved, access the Data catalog:

1. Press MENU.
2. Choose Catalog from the Data menu and press ENTER to display the Data catalog:

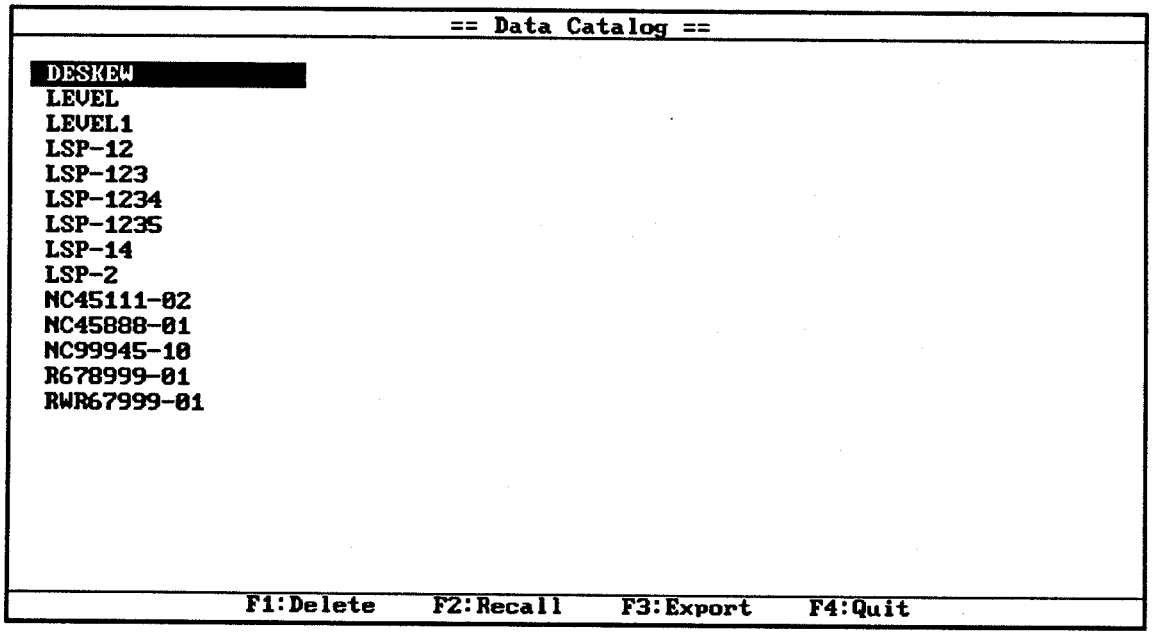


Figure 7-24 Data Catalog

3. Choose the appropriate ID.
4. Press [F2: Recall] to display the trace.

To view a trace when the Data ID is known:

1. Press MENU.
2. Choose Recall from the Data menu and press ENTER.
3. Enter the Data ID of the desired data at the prompt.
4. Press ENTER. The selected data is displayed in the Data screen.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

7.10.2 RECALLING DATA WITH THE DATABASE MANAGER OPTION

To view a trace that has been saved, access the Database catalog:

1. Press MENU.
2. Choose Catalog from the Data menu and press ENTER. The Database Recall IDs window is displayed:

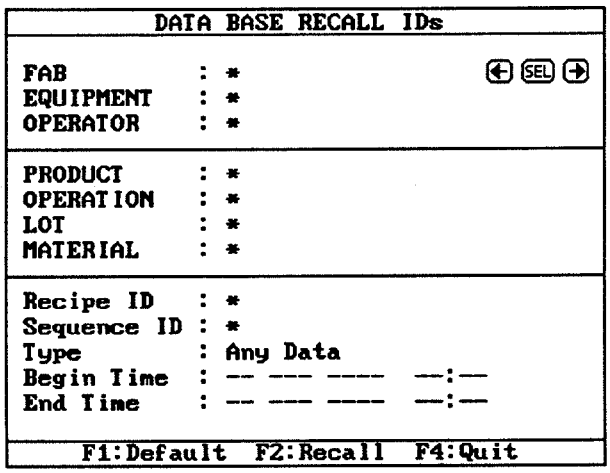


Figure 7-25 Database Recall IDs

Data is saved using seven user-configurable IDs and five data-dependent IDs (the last five IDs in the above figure). See Section 12.3.2, "Saving Data with Assigned Values," for more information on saving data.

3. To select Data IDs:
   - Use [↑] or [↓] to move between the IDs.
   - Use [←] or [→] to select available values for the IDs.
   - If the data was saved using the default value (#), press [F1: Default] to enter # as an identifier in the first seven IDs (Fab, Equipment, Operator, Product, Operation, Lot, and Material in Fig. 7-25). See Section 12.3, "Operating the Database," for more information on default values.
   - Entering values for Type, Begin Time, and End Time is optional. These three categories are useful if you have a very large amount of data in the database and if you know the time frame during which the data was saved.
   - To display the entire database, enter * in all the IDs, except Type, Begin Time, and End Time.

   See Section 12.3.3, "Recalling Data," for more information on recalling data using assigned values and default values.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4. When you are done entering values for the IDs, press ENTER to display the Database catalog:

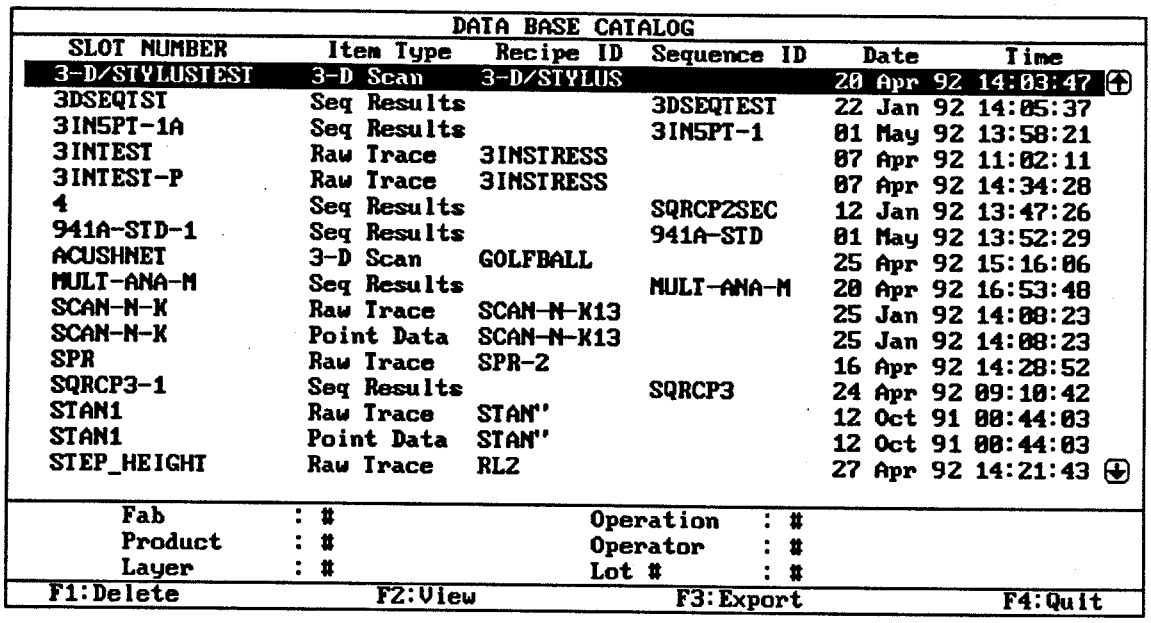


Figure 7-26 Database Catalog

The Database catalog lists all the files in alphabetical order.

5. Use [↑] or [↓], PAGE DOWN, PAGE UP, HOME, or END to scroll up and down the Database catalog. Choose the desired data item and press ENTER or [F2: View] to display the trace.

To view a trace when the Data ID is known:

1. Press MENU.
2. Choose Recall from the Data menu and press ENTER. The Database Recall IDs window is displayed (Fig. 7-25).
3. Enter * in the first six IDs (Fab, Equipment, Operator, Product, Operation, and Lot in Fig. 7-23). Then enter the Data ID of the desired data in the seventh ID (Material in Fig. 7-25). If you do not know the Recipe ID or Sequence ID, enter * in Recipe and Sequence IDs.
4. Press ENTER to display the Database catalog (Fig. 7-26). The data listed in the catalog will match the specifications entered in the Recall IDs window.
5. Choose the desired item and press ENTER to display the trace.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

7.11 DELETING DATA

You can delete data, one item at a time, from the Data catalog (if you do not have the Database Manager Option) or from the Database catalog (if you have the Database Manager Option).

You have the option of deleting either the trace or the summary or both. If you are deleting sequence data, you must delete all of it. See Chapter 10, "Automatic (Sequence) Operation," for details.

7.11.1 DELETING DATA WITHOUT THE DATABASE MANAGER OPTION

This section documents deleting data one item at a time using the Data catalog.

> **NOTE:** **To delete *all* the data from the database, see Section 18.2.4, "Removing Data from a Database."**

To delete data from the Data catalog:

1. Press MENU.
2. Choose Catalog from the Data menu and press ENTER. The Data catalog is displayed (Fig. 7-24).
3. Choose the appropriate ID.
4. Press [F1: Delete]. The following prompt appears:

   Deleting f . Please confirm. [Y/N]:

5. Press YES. The following prompt is displayed:

   Delete Entire Item [Y] or Raw Data Only [N]?

6. Press YES to delete the raw data and summary or press NO to delete the raw data and retain the summary.

7.11.2 DELETING DATA WITH THE DATABASE MANAGER OPTION

This section documents deleting data one item at a time from the Database catalog.

> **NOTE:** **To delete *all* data from the database, see Section 12.4.2, "Purging Data."**

To delete data from the Database catalog:

1. Press MENU.
2. Choose Catalog from the Data menu and press ENTER. The Database Recall IDs window is displayed (Fig. 7-25).

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3. To select Data IDs:
   - Use [↑] or [↓] to move between the IDs.
   - Use [←] or [→] to select available values for the IDs.
   - If the data to be deleted was saved using the default value (#), press [F1: Default] to enter # as an identifier in the first seven IDs (Fab, Equipment, Operator, Product, Operation, Lot, and Material in Fig. 7-25). See Section 12.3, "Operating the Database," for more information on default values.
   - Entering values for Type, Begin Time, and End Time is optional. These three categories are useful if you have a very large amount of data in the database and if you know the time frame during which the data was saved.
   - To display the entire database, enter * in all the IDs, except Type, Begin Time, and End Time.
4. When you finish entering values for the IDs, press ENTER to display the Database catalog (Fig. 7-26).
5. Select the item to be deleted and press [F1: Delete]. The system prompts you to confirm the deletion.
6. Enter Y to confirm deletion or N to return to the Database catalog without deleting the item. If you enter Y, the following prompt is displayed:

   Delete Entire Item [Y] or Raw Data Only [N]?
7. Enter Y to delete the entire item or N to delete the raw data only.

See Section 12.3.5, "Deleting Data," for more information on deleting data.

7.12 EXPORTING DATA

You can format data for use by standard spreadsheet and database manager programs. This capability is called *Export* and works by converting data from the Tencor P-2 internal binary representation to ASCII representation. (For details, refer to Appendix C, "Exporting Data.")

> **NOTE:** **Data exported in ASCII format cannot be directly manipulated in another program. You will need to write macros that can manipulate ASCII data in the receiving programs.**

With the Database Manager Option, you also can export data in binary format when exporting to another Tencor P-2 instrument or the Offline P-2 Program (see Section 12.3.4, "Exporting Data").

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To export to a diskette, you must change the disk path and use a formatted diskette. (See Section 18.3.1, "Formatting Diskettes.")

The Tencor P-2 software can be run in a Microsoft Windows 3.1 full-screen DOS window. A special format ASCII file can be generated for quick and easy data exchange with Windows-based spreadsheets or database managers. See Appendix C, "Exporting Data," for details.

7.12.1 EXPORTING DATA WITHOUT THE DATABASE MANAGER OPTION

You can export data from the Data catalog to hard disk or diskette. (Note: Sequence data can be exported automatically during a sequence run in Automatic Sequence mode. Refer to Section 10.10.2, "Exporting Sequence Data," for details.)

To export to the hard disk or diskette:

1. Change the disk path to the drive to which the data is to be exported. See Section 7.9, "Saving Data and Recipes," earlier in this chapter for procedures to change the disk path.
2. Press MENU.
3. Choose Catalog from the Data menu and press ENTER.
4. With the trackball or [↑] or [↓], select the ID of the data to be exported.
5. Press [F3: Export] to display the Alphanumeric window.
6. Enter the export filename (a maximum of eight characters) and press ENTER.

7.12.2 EXPORTING DATA WITH THE DATABASE MANAGER OPTION

See Section 12.3.4, "Exporting Data," for details on exporting data using the Database catalog.

7.13 BACKING UP DATA

> **NOTE:** **It is very important to back up data regularly to guard against database corruption. If your database does get corrupted, see Section 18.2.6, "Database Recovery," for procedures on recovering the database.**

To back up data if you do not have the Database Manager Option, see Section 18.2.1, "Backing Up Files," for details.

To back up data if you have the Database Manager Option, see Section 12.4.4, "Backing Up Data," for details.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

8 DATA ANALYSIS: BAND PASS FILTER

The Tencor P-2 software enables you to separate the waviness and roughness components of your data by selecting a long wave cutoff filter in the Scan recipe. The Band Pass Filter provides an adjustable short wave cutoff filter allowing you to isolate band passes for wavelengths.

Figure 8-1 illustrates how an adjustable short wave cutoff can be used to isolate a second waviness component from roughness. This waviness (Roughness 1 below) is sometimes known as microwaviness or microcorrugation.

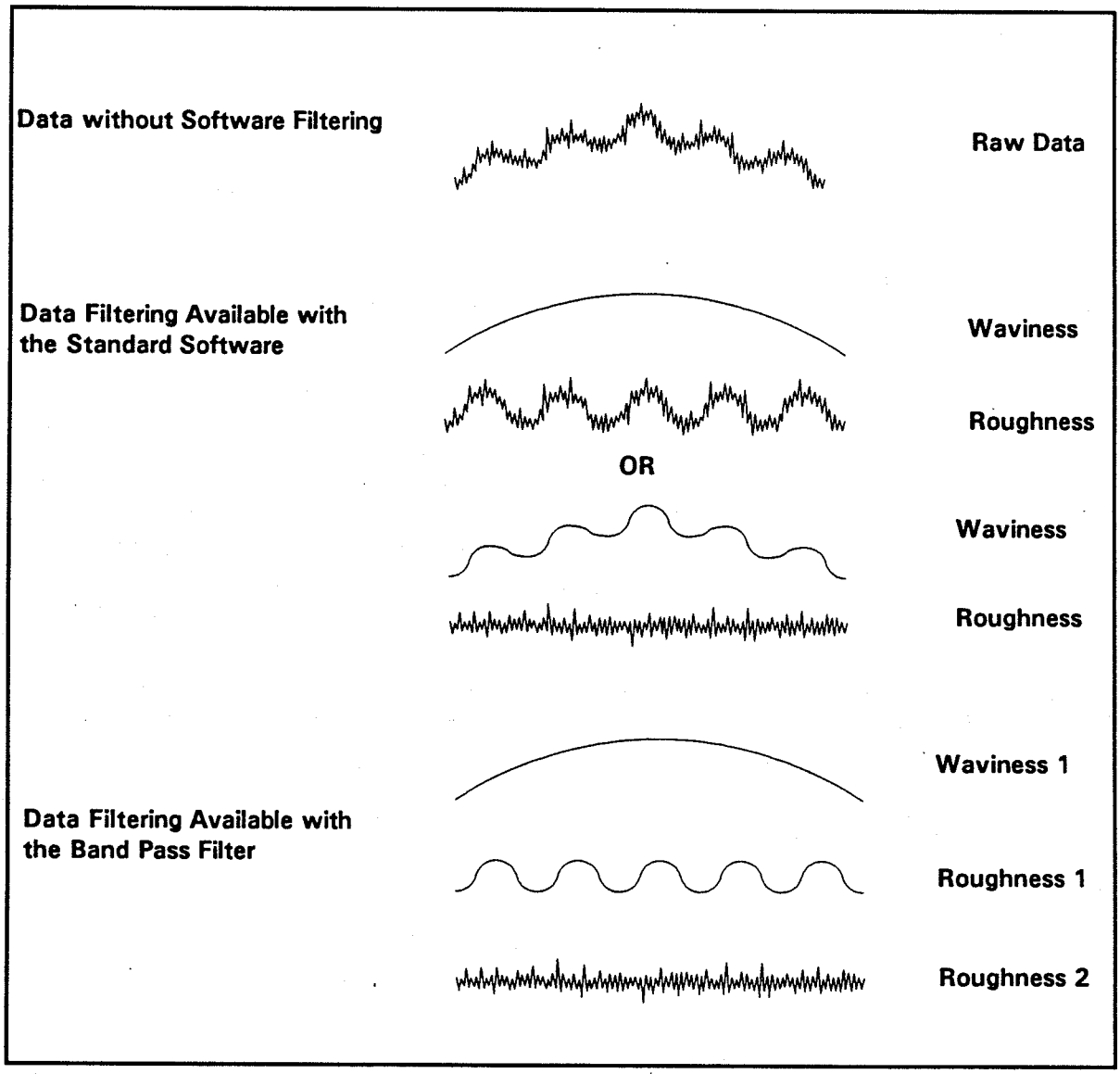


Figure 8-1 Effect of Filtering on Scan Data

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

8.1 DATA FLOW

The Tencor P-2 trace data does not come from the sensor directly but instead passes through three filters before being displayed as a raw trace (Fig. 8-2). The three filters are

- Analog hardware filter
- Digital decimation filter
- Digital software filter

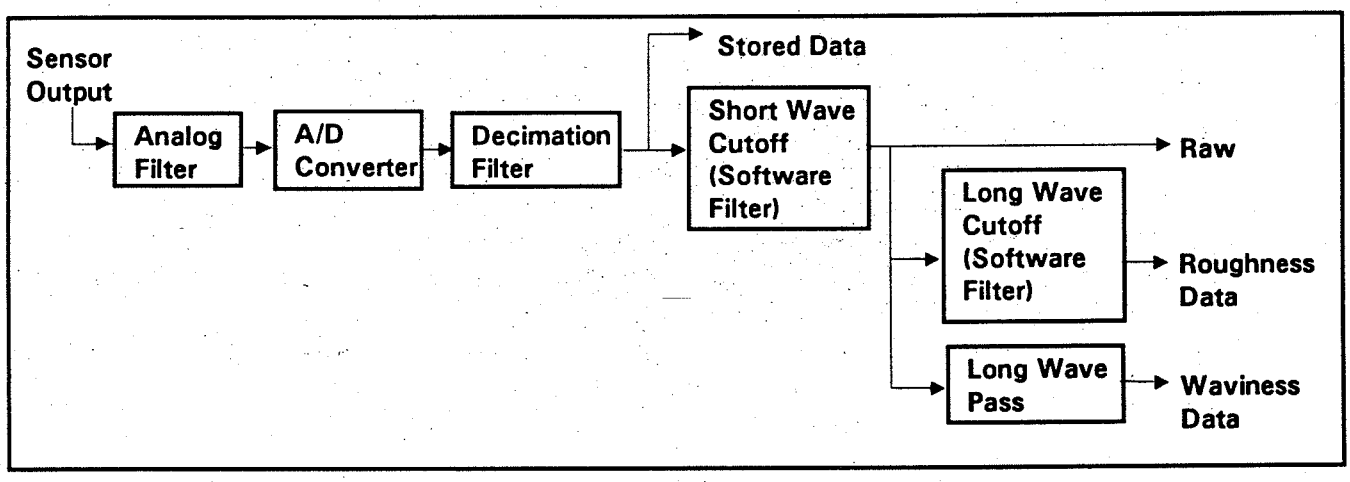


Figure 8-2 Tencor P-2 Hardware and Software Filters

NOTE: **Raw data displayed in the Data screen is data that has been filtered by the short wave cutoff (if activated). Stored raw data, however, is data that has been filtered only by the analog and the decimation filters.**

8.2 ANALOG HARDWARE FILTER AND DIGITAL DECIMATION FILTER

Each profiler has a built-in input filter, which we call an analog hardware filter. There is also a digital decimation filter that depends on the sampling rate selected. The two functions of the analog filter are as follows:

- *Minimize frequency folding effects*: The Tencor P-2 uses an Analog-to-Digital (A/D) Converter, which operates nominally at 200 Hz (100 Hz at 1 μm/s and 2 μm/s scan speed). Frequencies of its input signal are restricted to one half this frequency (100 or 50 Hz) because frequencies above that level are folded and distorted as noise and can cause aliasing. A filter is needed to provide at least 50:1 attenuation at 25 Hz. The Tencor P-2 uses the analog filter to minimize these effects.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

- *Reduction of noise*: The analog filter reduces noise by attenuating higher frequencies.

The Tencor P-2 analog filter has a fixed cutoff frequency of 18 Hz.

After traveling through the analog hardware filter and the A/D converter, the input signal is processed by the digital decimation filter. The purpose of this filter is to reduce the signal sampling rate from the original 100 or 200 Hz down to the sampling rate selected in the recipe by the user. If you select a 200-Hz sampling rate in the recipe, then no decimation is done.

In the process of reducing the sampling rate, the decimation filter also affects the cutoff frequency of the scan data. At 100 Hz, the decimation filter does not significantly reduce the signal cutoff frequency (18 Hz). At 50 Hz, the combination of the hardware analog filter and the decimation filter has a cutoff frequency of 14 Hz.

The combined filter's cutoff value, expressed in wavelength, depends on the scan speed. The wavelength is directly proportional to the scan speed and is given by the following equation:

$$\textit{Cutoff Wavelength} = \frac{\textit{Scan Speed}}{\textit{Cutoff Frequency of Combined Filters}}$$

For example, the cutoff is 5.6 μm for a speed of 100 μm/s, given a frequency of 18 Hz. This applies for recipe sampling rates of 100 or 200 Hz. At a sampling rate of 50 Hz, the cutoff is 7.1 μm for a speed of 100 μm/s, given the cutoff frequency of 14 Hz.

NOTE: **If you set the scan speed too high, the analog and decimation filters will filter away the surface profile, thus greatly distorting it.**

The analog and decimation filters have a broad transmission curve as shown in Fig. 8-3. For every decade in scan speed, the curve moves a decade in wavelength.

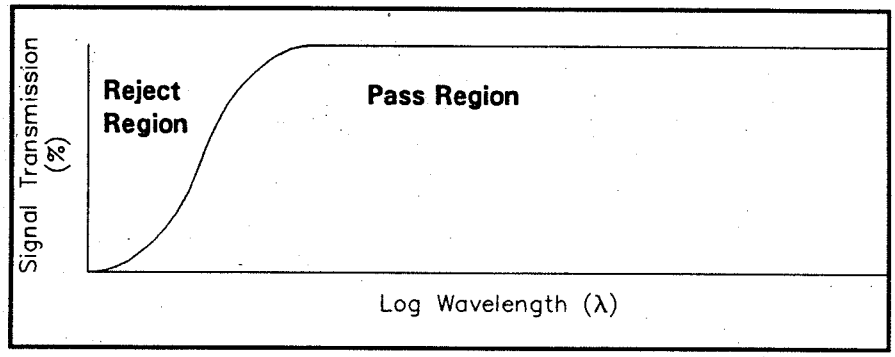


Figure 8-3 The Effect of the Analog Filter on Signal Transmission

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

8.3 DIGITAL SOFTWARE FILTERS

After passing through the analog hardware filter, A/D Converter and digital decimation filter, the signal is processed by two digital software filters (see Fig. 8-2). The software filters are

- Short wavelength filter cutoff, known as the Short Wave Cutoff
- Long wavelength filter cutoff, known as the Long Wave Cutoff

> **NOTE:** **Users who operate both a Tencor P-1 and P-2 might notice a small, systematic difference in roughness measurements between the two instruments when the default short wave cutoff is chosen. The Tencor P-2 is a second-generation P-1 with improved hardware for better sensitivity. This improvement allows an increase in the cutoff filter frequency, enabling the P-2 to collect more detailed data. Consequently, the roughness data obtained on the P-2 is expected to be slightly higher than obtained by measurements of the same sample on a Tencor P-1.**

8.3.1 SHORT WAVE CUTOFF

Filtering Capabilities

The short wave cutoff is applied to data after a scan is taken in order to provide you with more flexibility in analyzing your data. This is done by giving you additional control of the short wave cutoff and the band width. (The band width is the distance between the short wave cutoff wavelength and the long wave cutoff wavelength.) You might desire additional short wave filtering beyond that of the analog filter, because the analog filter is ineffective in reducing noise below 40 Hz at sampling rates of 100 or 200 Hz, and 25 Hz at a sampling rate of 50 Hz. The short wave cutoff eliminates this noise while preserving the signal.

In previous software versions that do not include the Band Pass Filter (which formerly was an option), the Tencor P-2 uses a digital filter with a fixed cutoff. In combination with the analog and decimation filters, the digital filter gives overall cutoff frequencies of 4.0 Hz at 50 Hz sampling rate, 7.5 Hz at 100 Hz sampling rate, and 12 Hz at 200 Hz sampling rate. This is used with the analog filter as a compromise between noise filtering and signal preservation. You can select different cutoffs by changing the sampling rate.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Table 8-1 Default Short Wave Cutoff Wavelengths

Speed (μm/sec)	Sampling Rate (Hz)	Cutoff Frequency (Hz)	Short Wave Cutoff Wavelength (μm)
2	50	4	0.50
	100	7.5	0.27
	200	12	N/A
5	50	4	1.25
	100	7.5	0.67
	200	12	0.42
10	50	4	2.50
	100	7.5	1.33
	200	12	.83
20	50	4	5.00
	100	7.5	2.67
	200	12	1.67
50	50	4	12.50
	100	7.5	6.67
	200	12	4.17
100	50	4	25.00
	100	7.5	13.33
	200	12	8.33
400	50	4	100.00
	100	7.5	53.33
	200	12	33.33

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Effect on Signal Transmission

The short wave cutoff is defined as the wavelength on the filter transmission curve that corresponds to 75% signal transmission (see Fig. 8-4). This means that at the 75% point on the curve, the filter passes 75% of the signal at that wavelength and attenuates 25%. At the 90% point, it passes 90% of the signal.

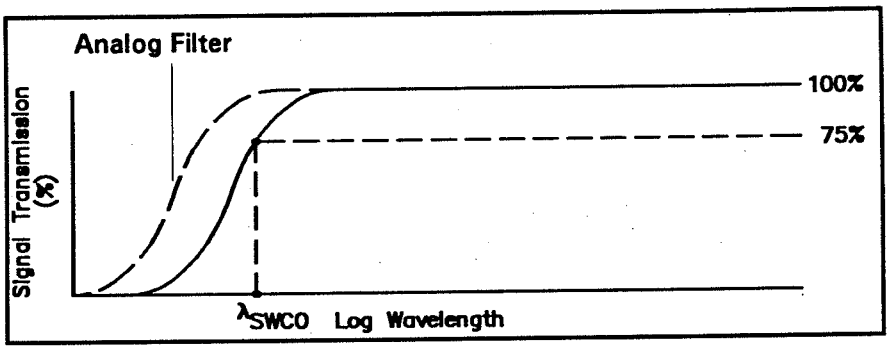


Figure 8-4 The Effect of the Short Wave Cutoff on Signal Transmission

The data processed by the input analog filter and the software noise filter is displayed in the Data screen as raw data. The data is stored as raw data and the variations made by the software filters are not stored. To display the variations you will need to recall the raw data with the recipe.

Like the long wave cutoff, the short wave cutoff can be used to view or measure specific surface properties. The long wave cutoff is used to eliminate waviness and form error so that roughness can be evaluated unambiguously. The short wave cutoff is used to eliminate surface detail so as to make step measurement easier.

Using the short wave cutoff, we also can eliminate the effect of excessive environmental noise. The pass band can be set so that only ranges of wavelengths of interest to the user will be measured. (See Section 8.4, "Using Cutoff Filters," for details.) You can also select Default, which is the equivalent of the fixed frequency filter.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

8.3.2 LONG WAVE CUTOFF

Like the short wave cutoff, the long wave cutoff is applied to data after a scan is taken. The following figure (Fig. 8-5) shows the signal transmission curve after the addition of the long wave cutoff.

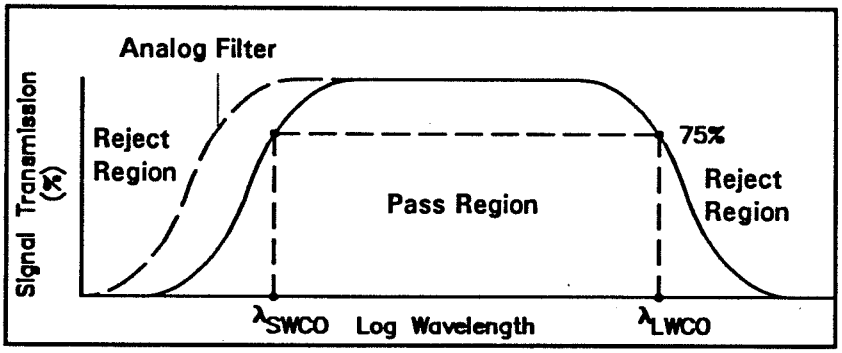


Figure 8-5 The Long Wave Cutoff used as a Short Wave Pass in order to Measure Roughness

Similar to the short wave cutoff, the long wave cutoff is the wavelength on the filter transmission curve that corresponds to 75% signal transmission. This filter suppresses the longer wavelengths (or waviness) so that you can see the roughness component.

The Tencor P-2 provides 16 filter choices (see Table 8-2 later in this chapter). The ANSI/ASME B46.1-1985 standard regards the 800 μm cutoff as preferred for most surfaces. Refer to ANSI/ASME B46.1-1985 for further information.

Waviness

To separate and view the waviness component of your data, you can set the digital filter as a long wave pass. (See Section 8.4, "Using Cutoff Filters," for more information on setting the filter.) In other words, wavelengths longer than the long wave cutoff value are passed and displayed as waviness data (see Fig. 8-6).

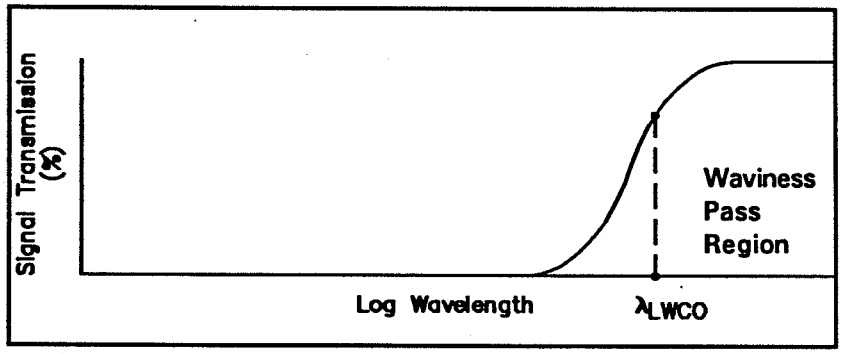


Figure 8-6 The Long Wave Cutoff Used as a Long Wave Pass in order to Measure Waviness

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

8.3.3 SUMMARY OF THE EFFECT OF SOFTWARE FILTERING ON DATA

Figure 8-7 provides a sample of various signal transmission curves along with their corresponding display data. The microwaviness data is the waviness component isolated by the short wave cutoff made available with the Band Pass Filter.

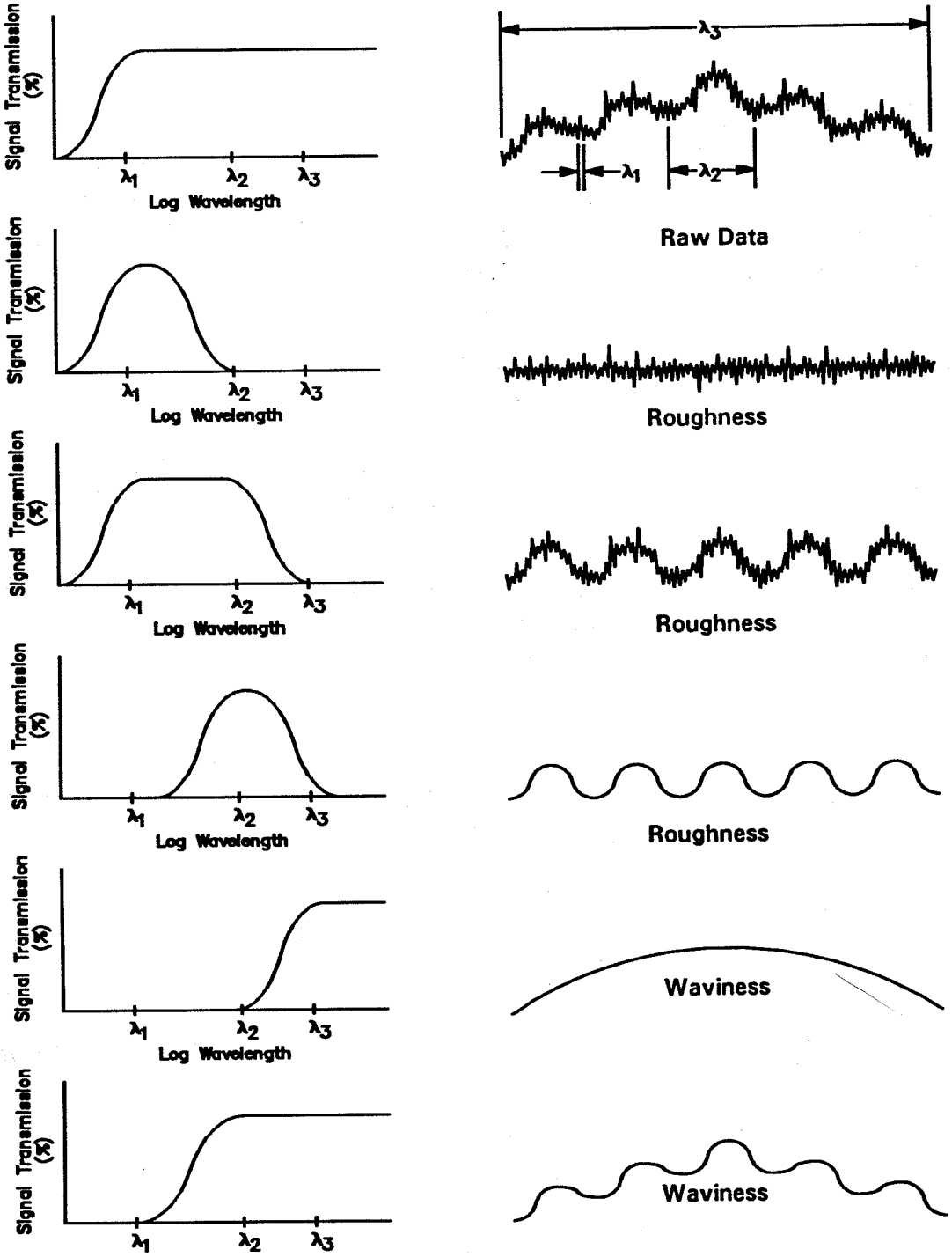


Figure 8-7 Summary of Signal Transmission Curves and their Corresponding Display

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

8.4 USING CUTOFF FILTERS

To select a cutoff filter:

1. Display a Scan recipe as follows:
   - From the Data screen, press [F1: Recipe] to display the current Scan recipe.
   - Choose Catalog from the Recipe menu and press ENTER. Select the desired recipe and press [F2: Recall] to display the recipe.
2. Use [↓] or use the trackball to select the Long Wave Cutoff field.

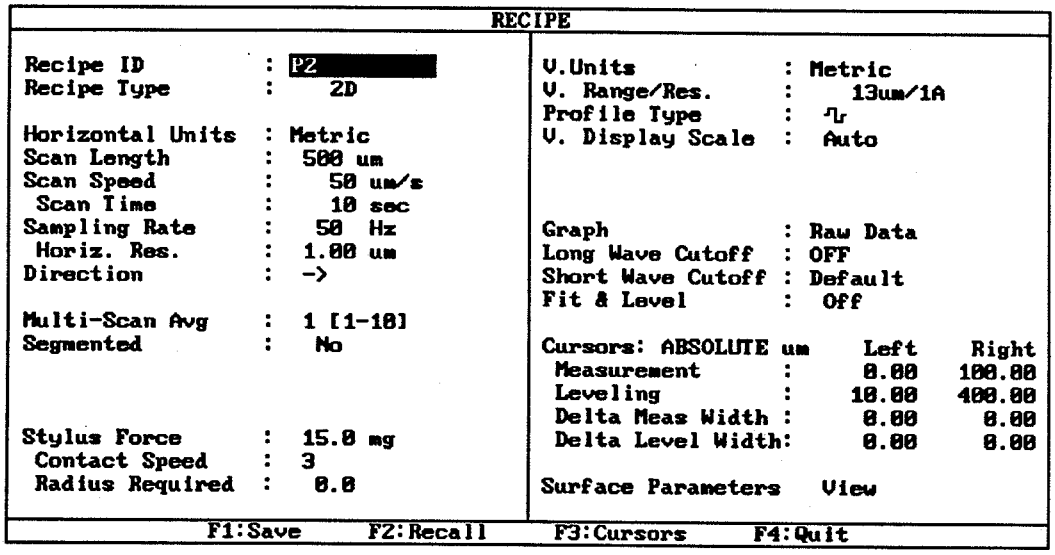


Figure 8-8 Recipe Screen

3. Use [←] or [→] to select a value from the range of cutoff filter lengths provided, or turn off the filter. The scan length should be three or more times the cutoff length to avoid data distortion. The recommended starting value is five times the cutoff length. The selectable values are listed in Table 8-2. The values are listed both in metric and English units.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Table 8-2 Long Wave Cutoff Filter Lengths

Long Wave Cutoff Filter Lengths					
µm	mil	µm	mil	mm	mil
4.5	.18	80[1]	3.0[1]	1.4	56
8.0	.30	140	5.6	2.5	100[1]
14	.56	250[1]	10.0[1]	4.5	180
25	1.0	450	18.0	8.0[1]	300[1]
45	1.8	800[1]	30.0[1]	14.0	560
–	–	–	–	25.0	1 in.

[1] Cutoffs specified in B46.1-1985

6. Use [↓] to select the Short Wave Cutoff field.
7. Use [←] or [→] to select a value from the short wave cutoff filter lengths provided, or turn off the filter. The range of values displayed varies according to the scan speed selected. See Table 8-3 for the full range of values available.

Table 8-3 Short Wave Cutoff Filter Lengths

Short Wave Cutoff Filter Lengths					
µm	mil	µm	mil	mm	mil
Default[1]	–	14	.56	1.4	56
.25	.01	25	1.0	2.5	100
.45	.02	45	1.8	4.5	180
.80	.03	80	3.0	8.0	300
1.4	.06	140	5.6	14.0	560
2.5	.10	250	10.0	25.0	1 in.
4.5	.18	450	18.0	–	–
8.0	.30	800	30.0	–	–

[1] Refer to Table 8-1 for default short wave cutoff wavelengths

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

For the short wave cutoff to be effective, set its value higher than that of the hardware filter as shown in the figure below. In this example, the short wave cutoff, set at 45 μm, is effective in that additional short wavelengths are attenuated.

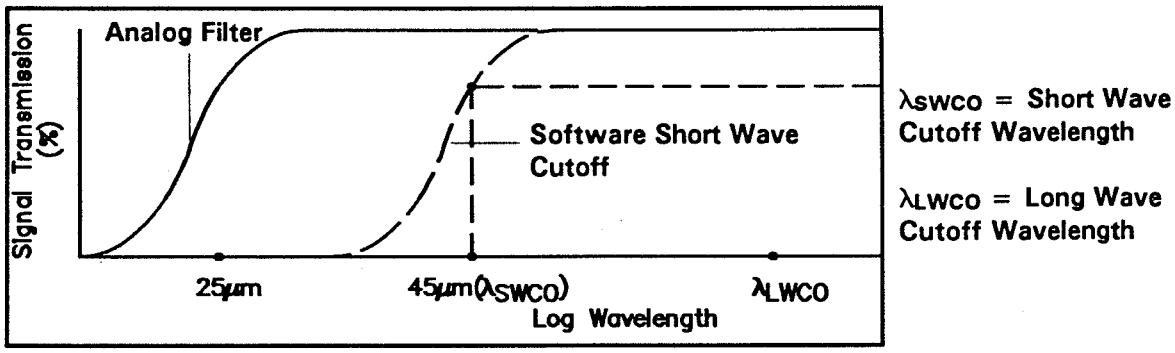


Figure 8-9 Signal Transmission when the Short Wave Cutoff is Set to a Value Higher than the Analog Filter

The short wave cutoff default value is a 4.0 Hz filter at 50 Hz sampling rate, 7.5 Hz at 100 Hz sampling rate, and 12 Hz at 200 Hz sampling rate. When you select the default value, the scan speed determines the short wave cutoff wavelength.

The values listed are in the same series as the long wave cutoff filter. The values are the result of combining the analog and software filters.

8.4.1 SETTING SHORT WAVE CUTOFF VALUES

Before setting the short wave cutoff value, set the scan speed in the Scan recipe. As you change the scan speed, the range of short wave cutoff values that can be displayed changes. This protects you from setting a cutoff too short for the scan speed.

The software will not allow the selection of a short wave filter that is longer than the current long wave filter cutoff, or a long wave filter cutoff that is shorter than the current short wave filter cutoff.

The shortest long wave or short wave cutoff available depends on the scan speed. The software will prevent selection of any cutoff values that are shorter than the analog cutoff. For scan speeds greater than 5 μm/s, the shortest short wave cutoff selection turns the short wave filter off entirely.

If changing the scan speed or scan length in the recipe causes either filter setting to become invalid, the cutoff is automatically changed to the nearest valid value (possibly the default).

In the Tencor P-2, the lowest available short wave cutoff at a particular scan speed can vary from one instrument (or measurement head) to another due to variations in scan hardware.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

9. MICROHEAD LOW MOMENT MEASUREMENT HEAD OPTION

The MicroHead Option for the Tencor P-2 Long Scan Profiler permits highly accurate profiling of surface topography with minimal stylus contact force. The MicroHead is ideal for applications such as

- Profiling aluminum step heights
- Characterizing surface roughness of uncoated disks
- Profiling pole tip recession depths on thin film heads
- Surface characterization of soft films or substrate
- Scanning at higher speeds for a given stylus force than is possible with the standard head

The MicroHead's innovative stylus arm design has a very low moment of inertia, so measurements are much less susceptible to environmental noise. This allows the Tencor P-2 to operate effectively at stylus forces up to 200x lower than achievable by the standard measurement head. At higher force settings, the MicroHead can either take scans at higher speeds for a given stylus force or take scans with greatly reduced noise. The MicroHead also allows greater precision in identifying peaks and valleys on the surface with vertical repeatability typically at 6Å (1σ) with 0.5Å resolution.

The Microhead also features a new optical design that enhances the sample viewing capabilities of the Tencor P-2. The top-down view of the sample is undistorted, facilitating precise stylus alignment. User-interchangeable lenses provide magnification from 65 to 1800x in two ranges. Features as small as 10 x 10 μm are easily positioned and scanned.

An extended range model that offers most of these capabilities with an extended vertical range is also available.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

9.1 MEASUREMENTS AT LOW STYLUS FORCE SETTINGS

Once the MicroHead is installed and set up, the Tencor P-2 Long Scan Profiler works in the same way as with the standard head. There are, however, some special considerations when using very low forces. These issues are discussed below.

9.1.1 LIMITATIONS ON DOWNWARD TRAVEL

Because the stylus force varies as the stylus moves away from the center position, the depth of valleys that can be effectively profiled with low stylus force settings is limited (the full range is available for upward travel). The downward travel available at various stylus force settings is shown in Table 9-1.

Table 9-1 Maximum Downward Travel for Particular Values of Stylus Force

Stylus Force (mg)	Approx. Maximum Downward Travel (μm)	
	MicroHead	Extended Range MicroHead
0.05	0.4	N/A
0.1	0.8	N/A
0.2	1.6	N/A
0.5	4.0	6.0
1.0	8.0	12
2.0	16.0	25
5.0	40	65
10.0	full range	130
15.0	full range	195
20.0	N/A	260
25.0	N/A	full range
30.0	N/A	full range
35.0	N/A	full range
40.0	N/A	full range
45.0	N/A	full range

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

If you exceed these values during the scan of a step or ramp, the stylus becomes suspended in air (see Fig. 9-1). The resulting trace displays a random wander (see Fig. 9-2).

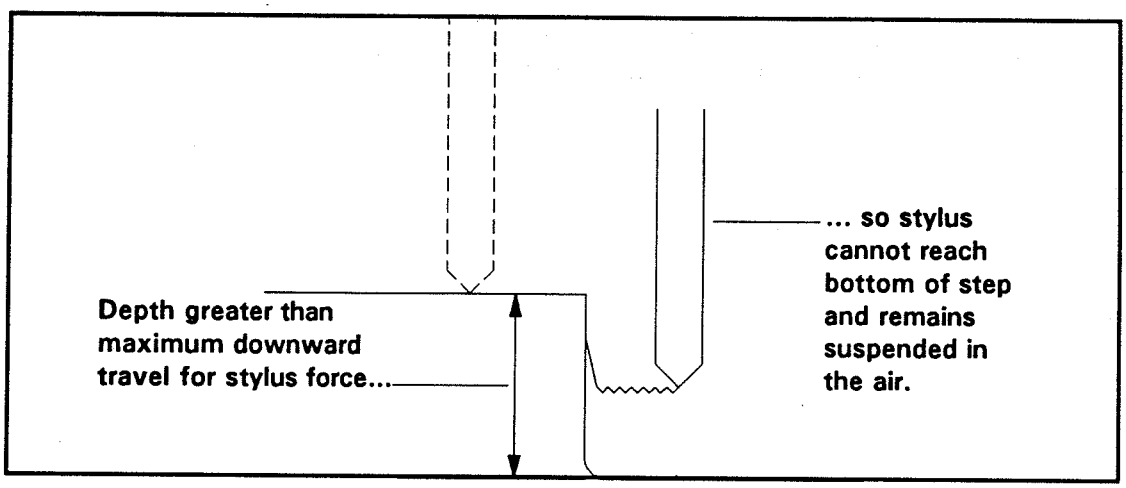


Figure 9-1 Maximum Downward Travel Not Large Enough to Scan Valley

Actual depth should be 8.3 µm

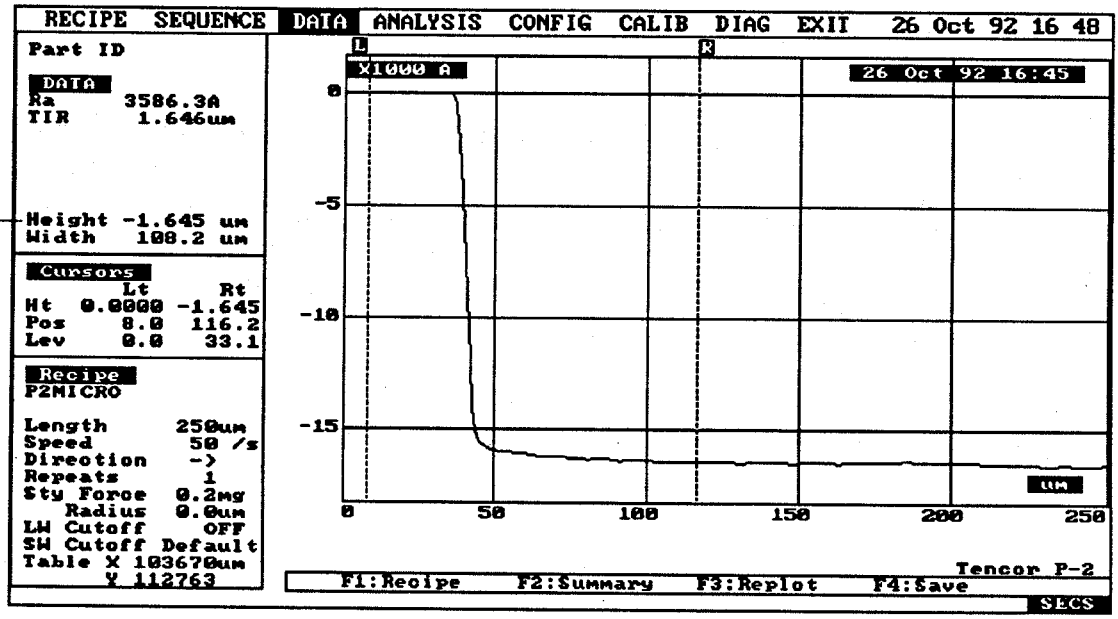


Figure 9-2 Example Trace—Stylus Force Too Low for Valley Depth

In order to reach the bottom of the step, increase the stylus force in the Scan recipe (see Section 9.2, "MicroHead Recipe Fields").

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

9.1.2 MECHANICAL LEVELING AND LOW STYLUS FORCES

The limit on downward travel discussed above also means that mechanical leveling becomes particularly important at low stylus forces. A small amount of tilt in the orientation of the sample surface can result in a situation where the maximum travel limit of the stylus is exceeded. Figure 9-3 shows what can happen if you set the stylus force as low as possible for a given artifact size, but the sample surface is not level.

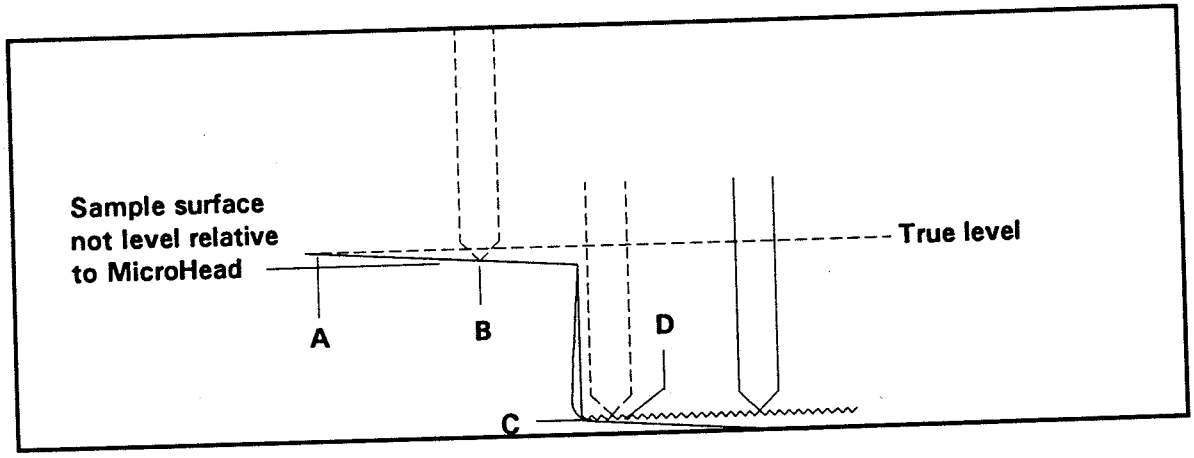


Figure 9-3 Scanning an Unleveled Surface at Low Stylus Force

The stylus is nulled at position A. As the stylus comes near the edge of the step (position B), it has already used up some of its range of vertical motion because of the tilt of the surface relative to the scan motion. At the bottom of the step (position C), the stylus begins to trace the surface, but it has come close to its limit of downward travel. As the stylus continues to move to the right while the sample surface slants away beneath it, it leaves the sample surface and hangs suspended in the air (position D).

Figure 9-4 shows a sample trace taken with low stylus force with a sample that is not level. The stage was purposefully tilted by about 1/2 degree of arc.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

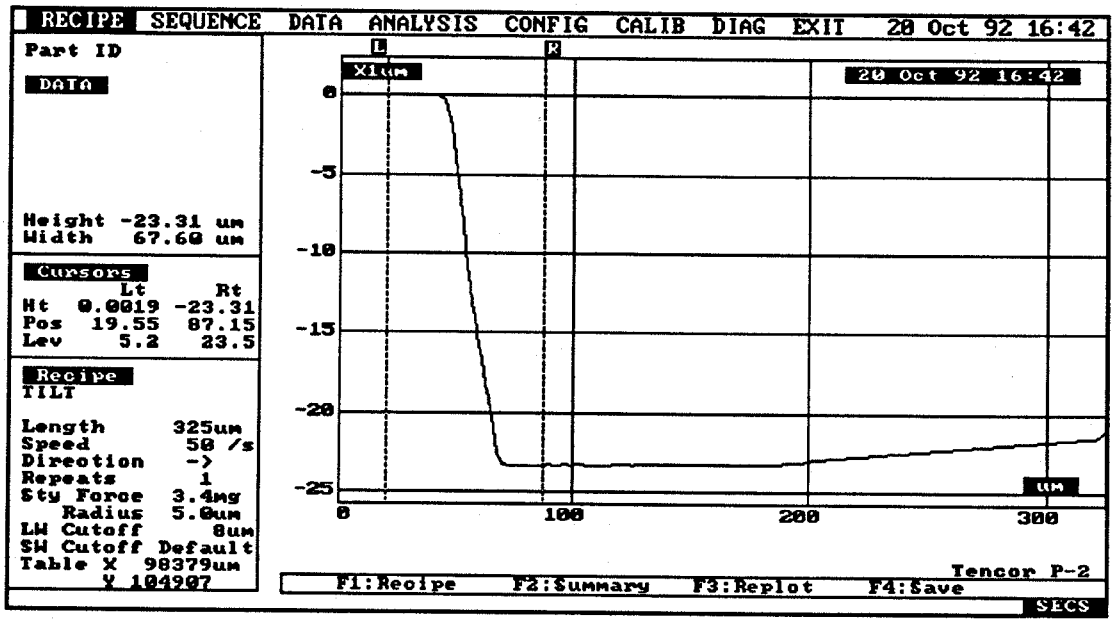


Figure 9-4 Example Trace—Sample Surface Not Level at Low Stylus Force (Data Leveled Correctly)

Good results are possible in such a situation if the stylus traces enough of a flat section of the sample surface so that the data can be leveled. In Fig. 9-4, the height recorded in the Summary window is accurate because the data was leveled on the top of the step on the left side of the screen.

It is bad practice, however, to take scans when the sample is not mechanically leveled. Figure 9-5 shows the same data as in Fig. 9-4 but leveled on the portion of the trace where the stylus was not in contact with the surface. It might not be obvious on examining the data screen that the stylus was suspended above the sample surface. Ordinarily, there would be no reason to avoid setting the leveling cursors on the bottom of the valley. In fact, you might think it was preferable because you can more widely separate the L and R leveling cursors.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Note that while it is not obvious that the leveling cursors were set on the wrong section of the trace, the measured valley depth is inaccurate.

Note difference between this value and the height in Fig. 9-4

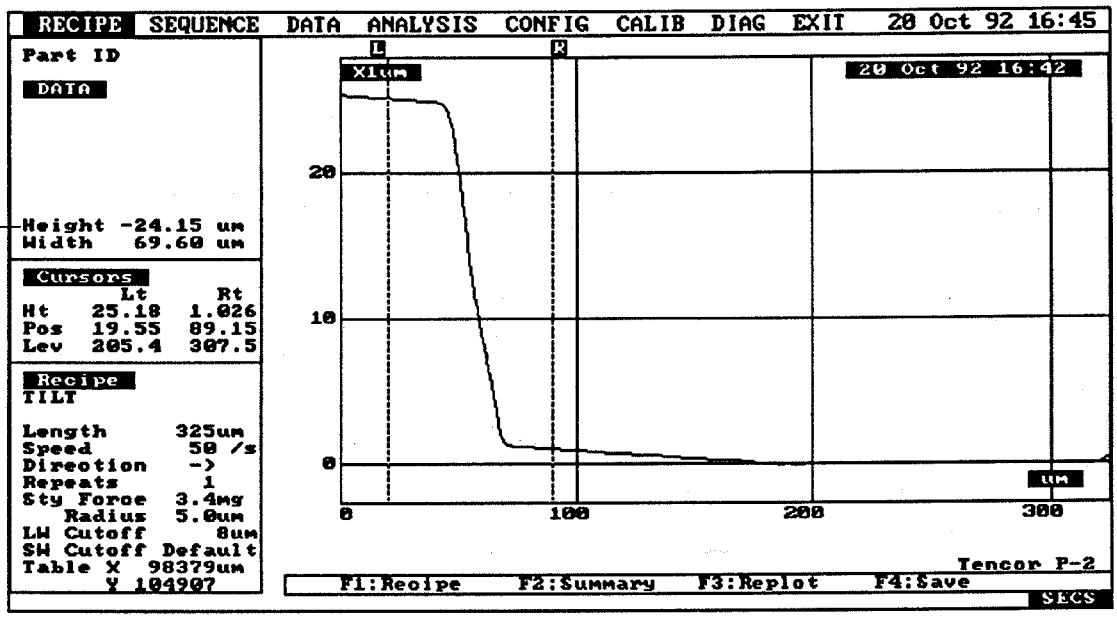


Figure 9-5 Example Trace—Sample Surface Not Level at Low Stylus Force (Data Leveled Incorrectly)

To avoid such effects, there are two things you can do:

- Make certain that the sample surface is mechanically level.
- Use a larger stylus force.

9.1.3 ELECTROSTATIC EFFECTS AND LOW STYLUS FORCES

It is possible for a large electrostatic force to develop between a highly charged sample surface and the MicroHead stylus. This can make calibration and operation at low stylus forces impossible. If you need to profile a non-conductive substrate such as a glass flat, remove any electrostatic buildup prior to taking a measurement.

9.1.4 3-D SCANS AND LOW STYLUS FORCES

The method of performing 3-D scans might result in a gradual reduction in the actual stylus force with each successive trace. To avoid anomalous results, use a higher force setting for 3-D scans than would normally be required to reach the lowest position in the scanned region. Since the magnitude of the total force reduction depends on the number of traces, test any 3-D recipes on several full scans before saving data using the current force settings.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

9.2 MICROHEAD RECIPE FIELDS

The Recipe parameters discussed in this section require special attention for low force operation.

Stylus Force

NOTE:	Low force settings are best for microroughness measurements. The sample surface must be flat and mechanically leveled as precisely as possible for optimum results. See Section 9.1, "Measurements at Low Stylus Force Settings," for details.

Use the keypad or remote keyboard to enter the desired value, from .05 to 15.0 mg, or, for the Extended Range MocroHead, .5 to 45 mg.

Radius Required

Enter the size (in μm) of the stylus in use. Table 9-2 lists the available L-styli.

Note: This parameter is not used for any calculations but is displayed as a reminder for the user. Verify the stylus radius by the color band on the stylus arm.

Table 9-2 Determining the L-Stylus Radius

Color Code Band	Stylus Radius (μm)	Shank Angle (Deg.)
Red	12.5	60
Yellow	5.0	60
Green	2.0	60
Black	0.3–0.8	70
Black	0.1–0.2	70

Vertical Range

The vertical ranges of the Microhead are:

- ± 3.25 μm at 0.5Å resolution
- ± 13 μm at 2Å resolution
- ± 63 μm at 10Å resolution

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

The vertical ranges of the Extended Range Microhead are:

- ± 6.55 μm at 1Å resolution
- ± 65.5 μm at 10Å resolution
- ± 325 μm at 50Å resolution

Press [←] or [→] to select the choice that best represents the size of the sample artifacts to be profiled.

Table 9-3 shows the minimum stylus force required to cover the full downward range of the stylus at each of the vertical range settings.

Table 9-3 Minimum Stylus Forces to Cover Full Vertical Ranges Below Null

MicroHead		Extended Range MicroHead	
Range (μm)	Minimum Stylus Force (mg)	Range (μm)	Minimum Stylus Force (mg)
± 3.25	0.4	± 6.55	0.6
± 13	1.6	± 65.5	6
± 65	8.2	± 325	24

9.3 INSTALLING THE MICROHEAD

The procedures for installation of the MicroHead are almost identical to those for the standard Tencor P-2 measurement head. See Section 17.8, "Removing and Installing the Head Assembly," for details. Note: The MicroHead requires software Version 1.6 or above to operate. If you have not already done so, perform the software upgrade as described in Appendix B, "Installing Upgraded Tencor P-2 Software."

To install the MicroHead:

1. Remove the measurement head that is currently installed in the instrument as described in Section 17.8.1, "Removing the Head Assembly."
2. Unpack the MicroHead carefully from its boxes and packaging.
3. Install the appropriate microscope objective lens by screwing it into place. If you do not know which optics will be required for your applications, we suggest the 4.0x objective with a magnification range of 185–750x and a field width of 1.2–0.3 mm.
4. Install the MicroHead assembly into the instrument as described in Section 17.8.2, "Installing the Head Assembly."

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

5. Power up the instrument and perform the measurement head setup as described in Section 9.8.1, "Measurement Head Setup Window."
6. Enter the Scan Position Offset value from the label on the stylus protection plate and save. You may wish to recheck these constants by following the procedure for the Scan Position offset calibration as described in Section 17.9.5, "Scan Position Offset Calibration."

> **CAUTION:** **Be sure to reset the Lowest Elevator Position before using a newly-installed measurement, or you might crash the head. See Section 6.1, "Setting the Lowest Elevator Position," for instructions.**

9.4 CHANGING THE MICROHEAD STYLUS

A stylus wrench is provided with the MicroHead; it is located on the inside surface of the measurement head door. To avoid losing the stylus should you accidentally drop it, place a sheet of cardboard or paper or a small container on the stage beneath the stylus before proceeding.

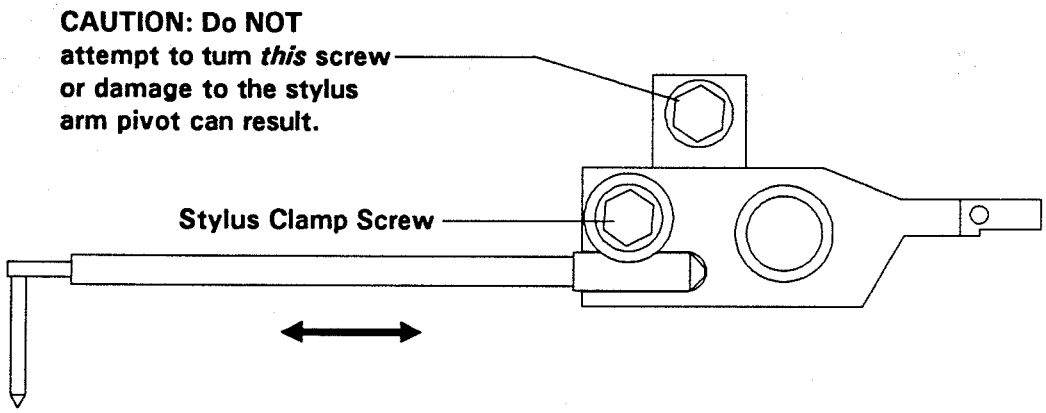


Figure 9-6 Replacing the MicroHead Stylus

To remove the stylus:

1. Raise the measurement head to the top and open the door.
2. Loosen the thumb screw holding the stylus wrench to the inside of the door and slide the wrench from its holder.
3. The head of the stylus clamp screw is visible when you face the instrument. *Be careful to avoid the other screw shown in Fig. 9-6.* Loosen it by inserting the stylus wrench and turning the wrench counterclockwise 1/2 turn. Be careful to apply turning torque only and do not press inward any harder than necessary to seat the wrench. Do not remove the screw.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4. Pull the stylus gently to the left and remove it from the stylus arm.

To replace the stylus:

1. Insert the long side of the L-stylus (see Fig. 9-6) into the groove in the stylus arm with the tip pointing downward toward the stage. Gently maneuver it until it is fully inserted into its slot.
2. Gently tighten the clamp screw so as to just hold the stylus in place. Do not tighten it too much because the stylus arm pivot can be damaged.
3. Remove the stylus wrench from the stylus clamp screw, return it to its storage clip, and tighten the retaining thumbscrew.
4. Close the measurement head door.

NOTE:	**After changing the stylus, be sure to perform the Scan Position Offset calibration as described in Section 17.9.5, "Scan Position Offset Calibration."**

9.5 CHANGING THE EXTENDED RANGE MICROHEAD STYLUS

The Extended Range MicroHead stylus uses a spring clip to secure the stylus in place and simplify replacement. To avoid losing the stylus should you accidentally drop it, place a sheet of cardboard or paper or a small container on the stage beneath the stylus before proceeding.

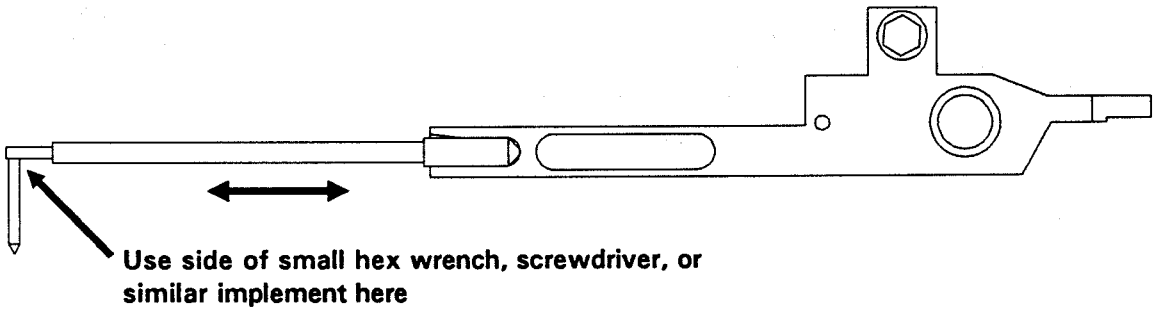


Figure 9-7 Replacing the Extended Range MicroHead Stylus

To remove the stylus:

1. Raise the measurement head to the top and open the door.
2. Locate the stylus. With the side of a small hex wrench or similar implement, reach behind the bend in the L and press gently towards the left. Be careful to apply force only to the left along the line of the stylus arm. The stylus will slide out of its slot and drop.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To replace the stylus:

1. Using your fingers, gently insert the long side of the L-stylus (see Fig. 9-7) into the groove in the stylus arm with the tip pointing downward toward the stage. Be careful to align the flattened back side of the stylus to the rear wall of the groove.
2. Gently slide the stylus into the groove until it is fully inserted.
3. Close the measurement head door.

> **NOTE:** **After changing the stylus, be sure to perform the Scan Position Offset calibration as described in Section 17.9.5, "Scan Position Offset Calibration."**

9.6 CHANGING THE MICROHEAD OBJECTIVE LENS

Four lenses (two standard and two optional) are available for the Tencor MicroHead, offering a range of magnifications. Table 9-4 lists the magnification ranges and field widths for the available lenses.

Table 9-4 Available Objective Lenses for the MicroHead Option

Lens	Magnification Range	Field Width (mm)
Low Power	62–250x	3.6–.90
4.0x	185–750x	1.20–.30
6.3x	300–1200x	.74–.18
10x	440–1800x	.49–.12

The 4.0x and the 6.3x lenses are standard. The low power lens provides a larger field of view than provided by the 4.0x lens, and requires a second field lens to be mounted in front of the zoom. The 10x lens requires some special care in installation, as the stylus tip is not protected, and it is only recommended for users who need magnifications higher than 1190x.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

> **NOTE:** You might wish to remove the stylus before changing the lens to eliminate the possibility of damaging the stylus by dropping the lens. See Section 9.4, "Changing the MicroHead Stylus," or Section 9.5, "Changing the Extended Range MicroHead Stylus," for details.

To change the objective lens to the 4.0x, 6.3x, or low power lens:

1. Press ZΘ, then [↑] to raise the head so that the stylus tip cannot contact any surface.
2. Raise the measurement head door.
3. Reach in and unscrew the objective lens. Slide it forward toward you to remove it, being very careful not to hit the stylus arm.

> **CAUTION:** Be careful not to drop the objective lens while you are removing it from the measurement head or damage to the instrument might result.

4. Screw in the replacement lens in the same manner.
5. Close the measurement head door.

Note: The low power lens requires installation of a field lens in front of the camera zoom lens. See the procedures that follow.

To install or remove the field lens (low power objective):

1. Lower the measurement head to its lowest position.
2. Remove the instrument left side panel as follows:
   - Each side panel is held by two large thumbwheel knobs on the inside upper corners. Support the left side panel from the outside and unscrew each of the thumbwheel knobs, then gently lift the left side panel away from the instrument.
3. The measurement head cover is held on by 4 thumbscrews. Remove the thumbscrews, then lift and pull forward gently on the measurement head cover.
4. The field lens is installed in a mounting tube. The tube then fits over the zoom lens, as shown in Fig. 9-8. Press the tube against the end of the zoom lens to align it, then tighten the 2 set screws with a 5/64-in. hex wrench to hold it in place.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

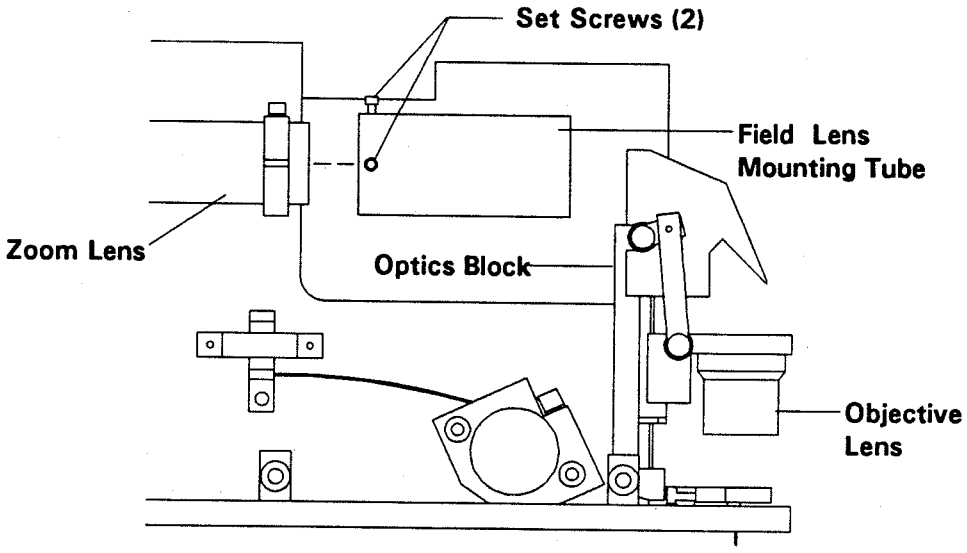


Figure 9-8 Field Lens Installation

5. Replace the measurement head cover and the side panel.

To change the objective lens to the 10x lens:

1. Press ZΘ, then [↑] to raise the head so that the stylus tip cannot contact any surface.
2. Raise the measurement head door.
3. Tighten the upstop screw (Fig. 9-9) until the stylus comes down to almost its full down position. Note: In some later models, the upstop screw is found just behind the stylus.

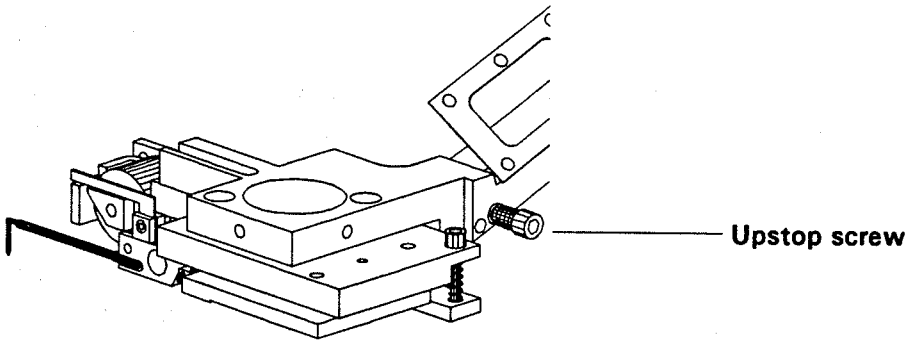


Figure 9-9 Upstop Screw

4. Remove the stylus as described in Section 9.4, "Changing the MicroHead Stylus," or, if you have an Extended Range head, Section 9.5, "Changing the Extended Range MicroHead Stylus."
5. Back off the focusing screw until the lens mount is in its highest position.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

6. Reach in and unscrew the objective lens. Slide it forward toward you to remove it, being very careful not to hit the stylus arm.
7. Screw in the replacement 10x lens in the same manner.
8. Reinstall the stylus as described in Section 9.4, "Changing the MicroHead Stylus," or, if you have an Extended Range head, Section 9.5, "Changing the Extended Range MicroHead Stylus."
9. Back off the upstop screw until the stylus rises to within 0.2 in. of the end of the lens.
10. Close the measurement head door.

> **CAUTION:** **With the 10x objective lens installed, the stylus arm cannot retract fully, and the stylus will be below the base of the head at all times. Extra care must be taken when moving the stage around high features.**

9.7 REPLACING THE MICROHEAD SAMPLE ILLUMINATION BULB

The illumination bulb for the optic lens is located in the back of the optics block (Fig. 9-8).

To replace the illumination bulb:

1. Remove the instrument left side panel as follows:
   - Each side panel is held by two large thumbwheel knobs on the inside upper corners. Support the left side panel from the outside and unscrew each of the thumbwheel knobs, then gently lift the left side panel away from the instrument.
2. Lower the measurement head and null the stylus on a patterned substrate.
3. Raise the stylus. Loosen the 4 thumbscrews on the side of the measurement head cover, then lift the front of the head cover and pull forward gently.
4. Locate the pair of intertwined wires from the illumination bulb at the back of the optics block.
5. Follow the wires to where they are plugged into a socket on the head electronics board. Note the position of the socket and carefully unplug the wires.
6. Follow the wires to the optics block. The illumination bulb is mounted on a collet that is held down by a collet clamp plate with two Number 2 cap head screws.
7. Use a hex wrench (size 5/64 in.) to loosen carefully the two cap head screws on the collet clamp plate, just enough to slide the lamp out of the collet. Hold the lamp by the side of the collet — do *not* pull on the wires!
8. Insert a new illumination bulb. Try not to touch the bulb with your fingers. Do not tighten the cap head screws yet.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

9.8 MICROHEAD SETUP AND DIAGNOSTICS

This section describes the head setup and the stylus force diagnostic windows. The MicroHead is ordinarily set up at the factory, and it should not be necessary for you to do anything unless you are installing a new MicroHead yourself.

9.8.1 MEASUREMENT HEAD SETUP WINDOW

The Measurement Head Setup window is used to maintain the file containing physical parameters of the MicroHead. Each head comes with its own set of calibration numbers. These numbers are recorded on the back of the stylus protection plate.

To access the Measurement Head Setup window:

1. Choose Head Setup from the Calib menu and press ENTER. The following window is displayed:

```
MEASUREMENT HEAD SETUP

Enter numbers from stylus protection plate.

 Stylus Force Calibration:
      Spring Constant      :  8.00 um/mg
      Initial Drop Force   :  5.0 mg
      Min Contact Force    :  2.0 mg
      Contact Sense Delay  :   .2 sec
 Factory 300um Range Calc  : 0.9966
 Stylus Drop Timer[12-50]  :  22
 Linearity Calibration:
      'A' Coefficient      :   675
      'B' Coefficient      :  -625

          F2:Save                    F4:Quit
```

Figure 9-10 Measurement Head Setup Window

2. Check the values displayed with the values on the back of the stylus protection plate and edit if necessary.
3. Press [F2: Save] to retain the edited values, or [F4: Quit] to leave the values unchanged and exit from the Measurement Head Setup window.

9.8.2 STYLUS FORCE PARAMETERS WINDOW

The Stylus Force Parameters window is provided as a diagnostic tool for the MicroHead. If you experience any problems or have any questions about the performance of the MicroHead, write down or print out these values and have them at hand before contacting Tencor Instruments.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To check Stylus Force Parameters:

1. Choose Stylus Force from the Calib menu. The following window appears:

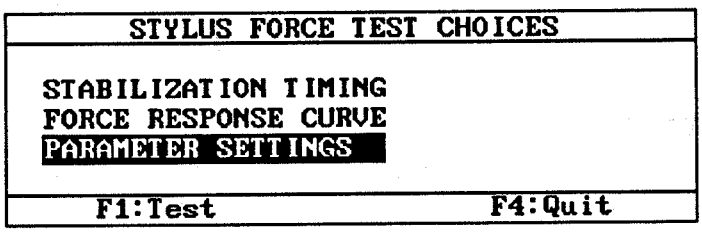


Figure 9-11 Stylus Force Test Choices Window

2. Select Parameter Settings and press ENTER. The following window appears:

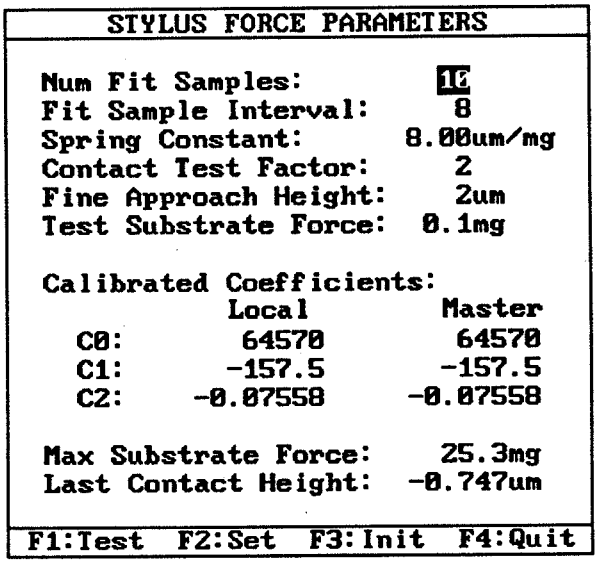


Figure 9-12 Stylus Force Parameters Window

3. Press [F4: Quit] to leave the values unchanged and exit from the Stylus Force Parameters window.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

9.8.3 CHECKING PROPER SETUP OF STYLUS FORCE COIL

The Stylus Force-Deflection Response window is provided as a diagnostic tool for the MicroHead. The window displays a graph of the vertical displacement of the stylus as a function of the stylus force control DAC (Digital to Analog Converter) setting (in white); also plotted are the first and second derivatives (in red and green, respectively). The curve should have a certain appearance, neither too steep nor too shallow. With the DAC setting at 0, the curve should intersect the graph's Y-axis near the top of the range. At maximum downward displacement, the curve should fall within a DAC setting of 500–650.

If you experience any problems, or have any questions about the performance of the MicroHead, check the stylus force response by following the procedures described below. A simple adjustment can be made if the curve crosses the Y-axis above or below the recommended value. Adjusting the point where the curve crosses the X-axis can only be performed by authorized Tencor Instruments service personnel.

After you perform the response calculation, print out the graph that results and have it at hand before contacting Tencor Instruments.

To check the stylus force setup:

1. Press Z0 to display the motion screen.
2. Lower the stylus by pressing Z0. The message "Lowering sensor" will appear in a small box in the center of the screen. Hold down Z0 until the stylus has fully descended. Note: the stylus will lift automatically after 60 s. The force-deflection response calculation described below must be performed while the stylus is fully lowered.
3. Choose Stylus Force from the Calib menu. The following window appears:

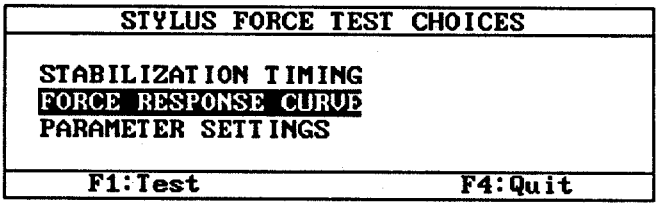


Figure 9-13 Stylus Force Test Choices Window

4. Select Force Response Curve and press ENTER. The following window appears (Fig. 9-14):

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

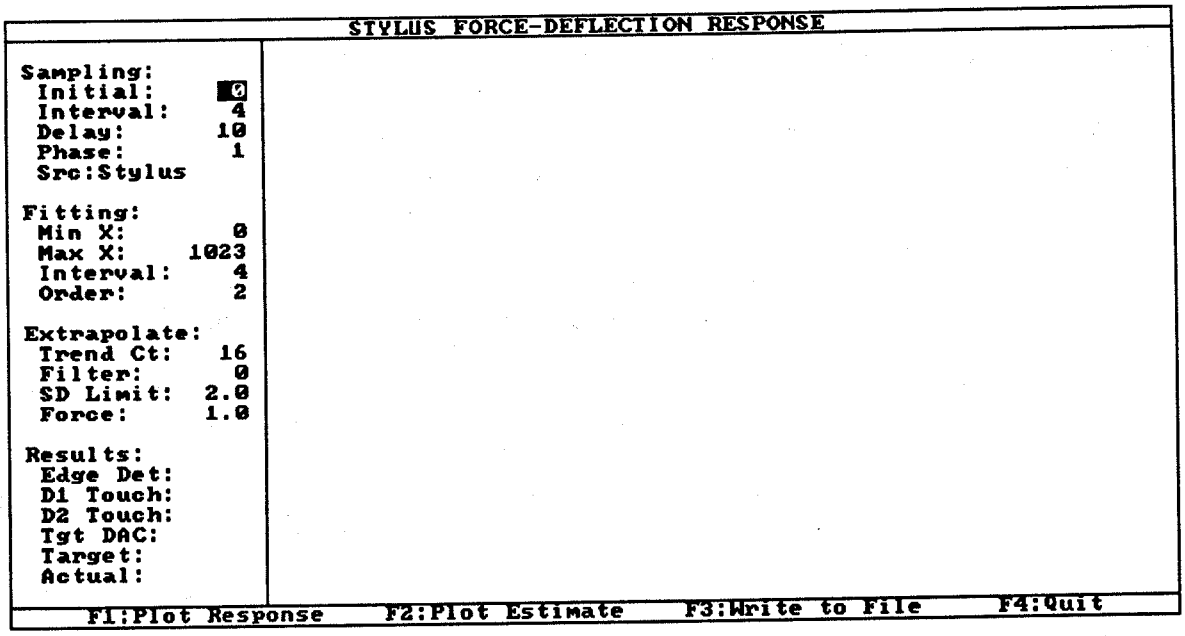


Figure 9-14 Stylus Force-Deflection Response Window Before Calibration

5. Press [F1: Plot Response] to start the force-deflection response calculation. A message appears on the screen that says

   Measuring Stylus Response

   After a brief time, a graph similar to Fig. 9-15 appears in the right side of the window:

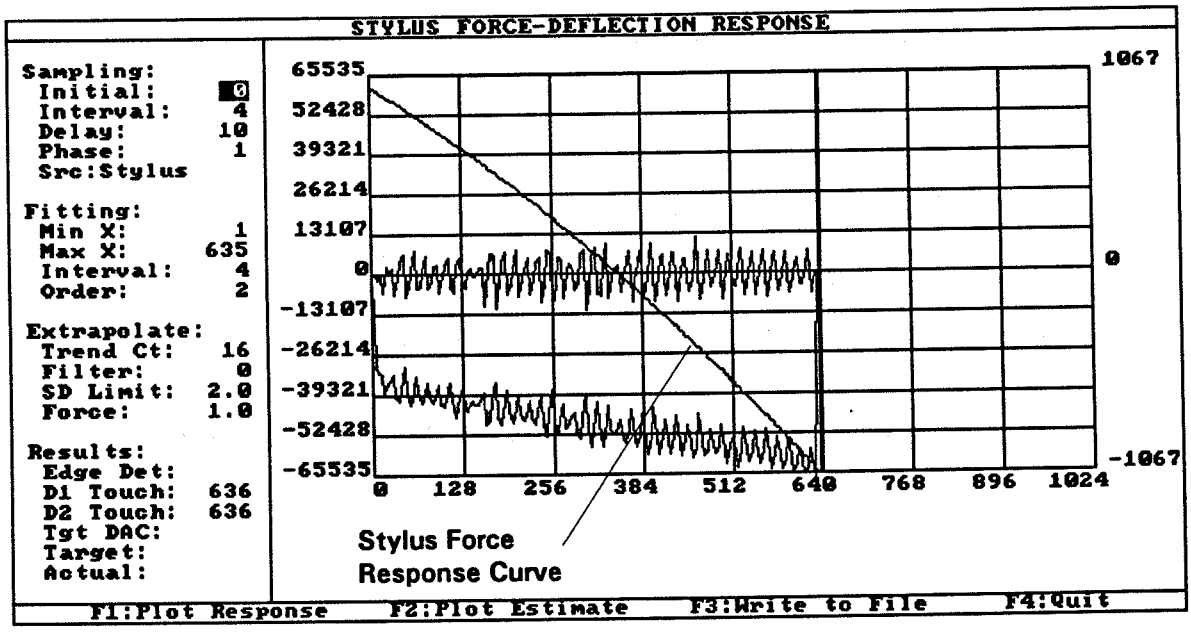


Figure 9-15 Stylus Force-Deflection Response Window After Calibration

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

5. The stylus force response curve should have an appearance like Fig. 9-15. The curve should begin near the top left corner of the graph and should intersect the DAC setting axis between 500 and 650 for optimum response of the MicroHead.

   - If the value at a DAC setting of 0 is too low (below about 52,000 counts), adjust the stylus force offset screw by turning it counterclockwise carefully about 1/20th turn. See Fig. 9-16 for the location of the stylus force offset screw. Repeat Steps 1–5 until the curve crosses the Y-axis of the graph within the two topmost grid divisions.

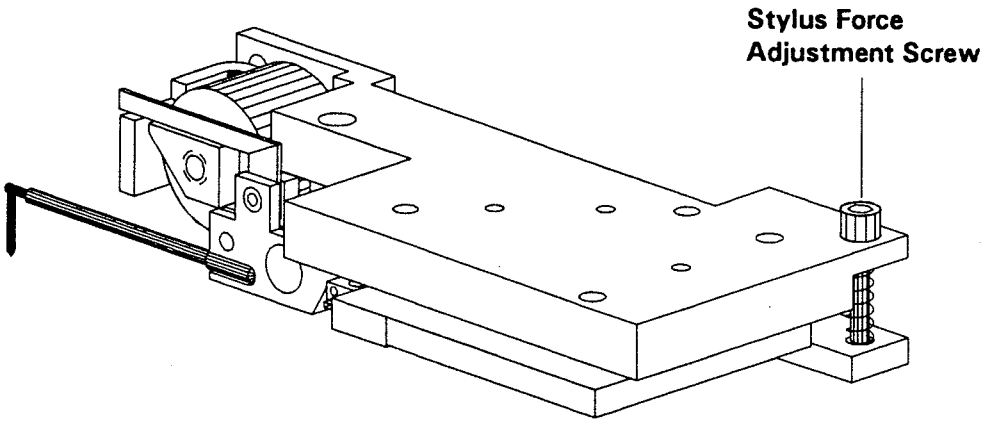


Figure 9-16 MicroHead Stylus Force Offset Adjustment

9.8.4 TROUBLESHOOTING FORCE-DEFLECTION RESPONSE ERRORS

The MicroHead performs a force test each time the stylus drops. If this test fails, a red box will appear on the screen containing a message like

STYLUS FORCE CALIBRATION FAILED

If this happens, review the Stylus Force Parameters window (Fig. 9-12). The coefficient C2 should be negative. If it is not, a new force-deflection response curve can be established by pressing [F3: Init]. To complete reinitialization, the elevator must be raised high enough that the stylus does not contact the sample surface when the sensor is down (in the measurement position). Also, a strong electrostatic charge on the sample or the stage can prevent calculation or cause erroneous results. If the coefficient C0 is less than 50000, electrostatic force might be the cause. To verify this, raise the elevator some distance above the sample surface, then perform the stylus force-deflection response calculation. If the C0 value is significantly higher, the substrate or stage is probably charged.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

10 AUTOMATIC (SEQUENCE) OPERATION

The Sequence Option allows you to write a *sequence program* and program the instrument so that up to 300 scans can be taken on a single substrate by pressing one key. A sequence program links scan recipes with stage locations so that repetitive measurements can be automated, greatly enhancing the productivity of the instrument. The Sequence program can consist of a maximum of 300 2-D and 3-D recipes and artifact locations. The sequence operation is available with the Automatic Long Scan Profiler or as a software option.

Sequence operation is different from manual operation. In manual operation (see Chapters 4, 5, and 6, "Writing a Recipe," "Profiling a Sample," and "Analyzing the Profile") you program parameters into a single recipe for a single scan. You cannot take multiple scans by pressing one key as in automatic operation.

This chapter covers

- Writing a Sequence program
- Setting up a Sequence program
- Running a Sequence program in automatic and manual modes
- Displaying, printing, saving, and exporting Sequence program data

10.1 MEASUREMENT CAPABILITIES

The Sequence Option provides the following measurement capabilities:

- Combine up to 300 artifact locations and Scan recipes (2-D and 3-D) into a sequence and run with or without operator intervention.
- In Automatic mode, set the wafer handler to load, scan, and unload up to 25 wafers without operator intervention.
- Set up tolerances for recipe parameters, such as R_a, R_v, and TIR, to pass and fail samples. You also can set the wafer handler to sort passed and failed wafers into separate cassettes if you are using the handler to load and unload wafers.
- In Multiple Analysis mode, take full advantage of the long-scan capability of the Tencor P-2 by applying different measurement recipes to a single scan.
- Automatically display, print, or save statistics or raw data for all locations.
- Automatically insert X, Y, and Θ coordinates from the Motion screen in the Setup mode.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

10.2 SEQUENCE MODES

The following three modes are available during automatic operation:

- In *Setup mode*, you define or edit a Sequence program by specifying Scan recipes (2-D and 3-D), positioning the sample, taking the scan, entering the stage position, and repeating as often as needed. The Sequence program can be changed only in this mode. You can manually load samples or use the wafer handler to load single wafers only.
- In *Automatic mode*, the entire sequence can be run without operator intervention. Once a sequence is started, it will run until completed unless a specified recipe is not found or you press STOP. STOP aborts the sequence and returns the stage to the first location. You can load samples manually, use the wafer handler to load single wafers, or set the handler to load and unload up to a maximum of 26 wafers automatically without operator intervention. You also can set up tolerances for recipe parameters to pass and fail samples. If you are using the handler, passed and failed wafers also can be sorted into separate cassettes. The Sequence program cannot be changed in this mode.
- In *Manual mode*, you can intervene and control the running of the Sequence program. The sequence stops at each location and allows you to adjust the X,Y location for fine positioning before the measurement is taken. The sequence also stops after each scan, enabling you to analyze the data. You can manually load samples or use the wafer handler to load single wafers only. You also can set up tolerances for recipe parameters to pass and fail samples.

10.3 WRITING A SEQUENCE PROGRAM

10.3.1 PROCEDURE

This section provides instructions on writing a new Sequence program by changing the current Sequence program, by starting with a blank Sequence program, or by changing a saved Sequence program.

You need to set parameters such as sequence mode, deskew, print and save options in the Sequence Program screen before running a sequence. You also need to enter Scan recipes and X,Y coordinate positions for the start of each scan.

NOTE:	**When in the Sequence mode, press MENU at any time to exit from any sequence window or screen and return to the Sequence Program screen.**

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To write a new Sequence program by changing the current one:

1. From any screen, press MENU one or more times until the menu bar is displayed and active.
2. Choose View/Modify from the Sequence menu and press ENTER to display the Sequence Program screen similar to Fig. 10-1.

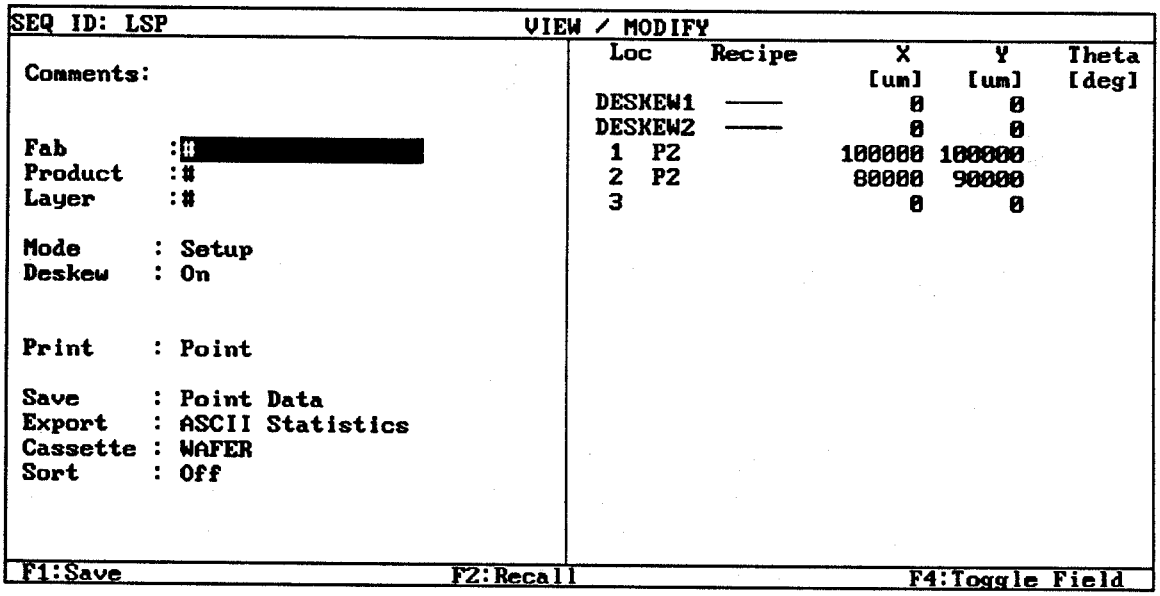


Figure 10-1 Sequence Program Screen–Left Side Active

3. Toggle through the line items by pressing [↑] or [↓] or by using the trackball and change values as needed. See Section 10.3.2, "Sequence Fields," later in this chapter for descriptions of the fields.
4. Press [F4: Toggle Field] to activate the fields on the right (Fig. 10-2). (See Section 10.3.2, "Sequence Fields," and Section 10.4, "Setting Up a Sequence Program," for details.)

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

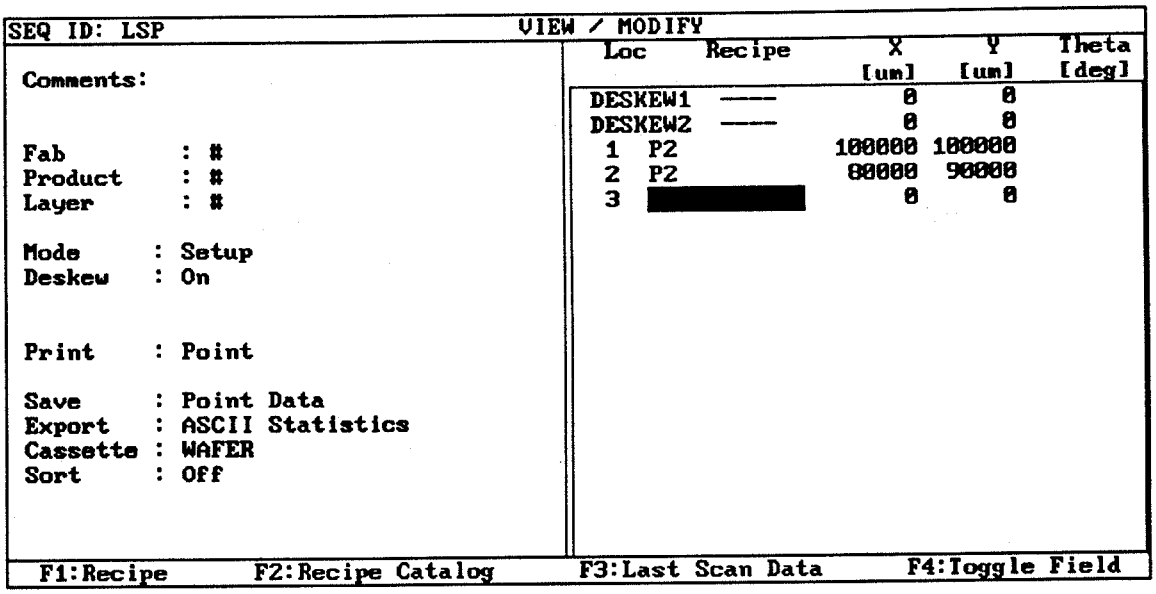


Figure 10-2 Sequence Program Screen–Right Side Active

5. From the right side of the Sequence Program screen, press [F3: Last Scan Data] to view the Data screen (trace) for the last scan taken. If you highlight a different location and press [F3: Last Scan Data], the trace taken at that location will not be displayed unless it was the last scan taken.

6. Press [F4: Toggle Field] to activate the fields on the left. Then press [F1: Save] to save the Sequence program. The Sequence Alphanumeric window is displayed:

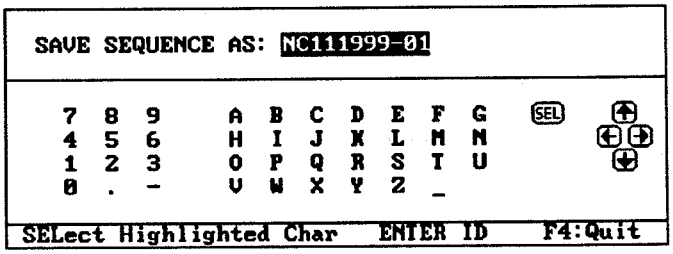


Figure 10-3 Saving the Sequence Program

7. To enter a new ID:

   - Use [↑] or [↓] to move between the ID fields and [←] or [→] to select available values for the IDs.
   - You also can type in new values for the IDs. See Section 3.5, "Entering an ID," for details. Note: The database should be configured before you start saving data or sequences. See Section 12.2, "Configuring the Database," for details.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

- Press ENTER when ready.

8. When you enter the ID, the Sequence program is saved in the Sequence catalog. If the ID already exists, the following prompt appears:

   Sequence already exists, overwrite? [Y/N]

   - Press YES to overwrite the old Sequence program, or
   - To retain the old Sequence program, press NO. Then press [F1: Save] to enter a different ID. Press ENTER to save the new Sequence program under the new ID.

To start with a blank Sequence program:

1. From any screen, press MENU one or more times until the menu bar is displayed and active.
2. Choose View/Modify from the Sequence menu and press ENTER to display the current Sequence Program screen (Fig. 10-1).
3. Toggle through the line items by pressing [↑] or [↓] or by using the trackball. To erase the entry in the Comments field, use [←]. Use [←] or [→] to select new values for the other fields.
4. Press [F1: Save] to save the Sequence program. The Sequence Alphanumeric window (Fig. 10-3) is displayed. Save the Sequence Program under a name that will easily identify the Sequence program to be blank.
5. Each time you want to begin with a blank Sequence Program screen, recall the blank Sequence program, enter the desired attributes, and save under a different name.

To view the Sequence catalog:

1. Press MENU.
2. Choose Catalog from the Sequence menu and press ENTER to display the Sequence catalog (Fig. 10-4):

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

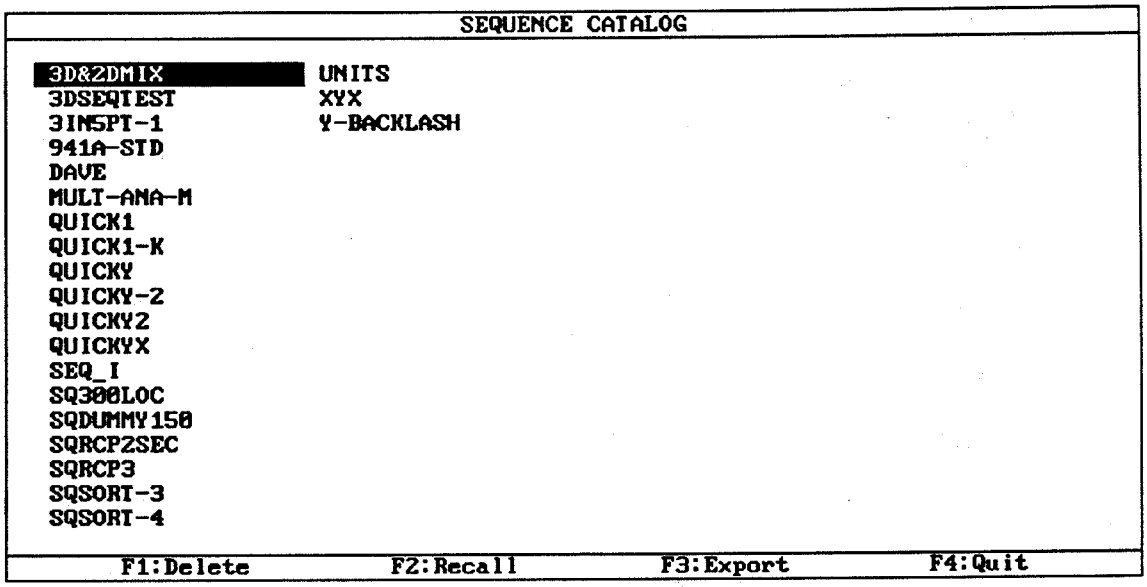


Figure 10-4 Sequence Catalog

3. Press [↑] or [↓] to select a Sequence program.
4. Press [F1: Delete] to delete the selected Sequence program.
5. Press [F2: Recall] to recall the selected Sequence program.
6. Press [F3: Export] to export the selected Sequence program. Note: Before you export the selected Sequence program, make sure the disk path is set correctly. Also check that there is a blank formatted diskette in drive A if you plan to export the Sequence program to drive A. See Section 7.9, "Saving Data and Recipes," for details on setting the disk path.
7. Press [F4: Quit] to exit the catalog.

To change a stored Sequence program:

1. Access the Sequence catalog (Fig. 10-4). See "To view the Sequence catalog," above for details.
2. Press [F2: Recall] to display the sequence of your choice.
3. Toggle through the line items by pressing [↑] or [↓] and change values as needed.
4. Press [F1: Save] to save the new Sequence program. The Alphanumeric window (Fig. 10-3) is displayed. Enter a new ID (see Section 3.5, "Entering an ID," for details) and press ENTER, or press ENTER to keep the current ID and overwrite the old Sequence program.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

10.3.2 SEQUENCE FIELDS

Set sequence fields as follows:

Comments

Enter up to two lines of comments such as instructions for an operator or a description of the Sequence program. The first line can be up to 26 characters long, and the second line can contain 36 characters. You can use any character.

Mode

Three modes available when running a sequence are setup, automatic, and manual.

In *Setup mode,* you define or edit a Sequence program by specifying Scan recipes (2-D and 3-D), positioning the sample, taking the scan, entering the stage position, and repeating as often as needed. You can change the Sequence program only in this mode.

In *Automatic mode,* the entire sequence is run without your intervention. Once a sequence starts, it will run until completed unless a specified recipe is not found. To stop a Sequence program, press STOP. STOP aborts the sequence and returns it to the first location.

In *Manual mode,* the sequence stops at each location and allows you to adjust the X,Y location for fine positioning before the measurement is taken. The sequence also stops after each scan, enabling you to analyze the data. For example, you can collect statistics and repeat a scan if desired. You cannot edit a Sequence program in this mode.

Press [←] or [→] to select a mode.

Deskew

In most cases, artifacts on a surface are not precisely located relative to the periphery of the substrate. Therefore, when the stage moves to the X, Y, and theta coordinate positions specified in the Sequence program, the same artifacts on other samples will be positioned slightly differently. Using deskew enables the scanning of precisely the same location on different samples.

Deskew enables you to manually set two deskew reference points and enter their stage coordinate values prior to the start of each sequence. See Fig. 10-5 for help in locating the reference points.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

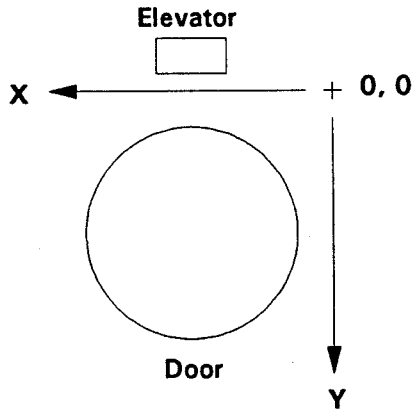


Figure 10-5 Referencing Deskew Points

After that, all stage coordinate values in that sequence are recalculated based on these reference points. Thus, deskew compensates for any translational or rotational errors between different substrates.

Off disables the deskew feature.

On requires manually matching two reference points at the beginning of each sequence. These points are used to correct mathematically for translational (X,Y) and rotational (theta) error, but no physical theta correction is made.

With Theta is available for those occasions when it is desirable to have a physical theta correction. Theta deskew can only be accomplished with the Motorized Theta/Level Option. See Section 6.9, "Rotating the Stage (Optional Theta Mode)," for details. Theta deskew requires manually matching three reference points. Two points are used for determining and correcting the rotational error. One of the same two points is then used to compensate for translational error.

Use [←] or [→] to select On, Off, or With Theta.

NOTE:	**When you have performed a deskew operation, the coordinates that appear in the Motion screen are coordinates computed to correct for the rotational and translational errors. When you operate the instrument outside Sequence mode, deskew is automatically off and the Motion screen coordinates represent the real (physical) coordinates.**

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

When you place a sample on the stage table and the sample is greatly off center, the following problems can arise:

1. The stage has a travel limit of 210 mm (8.2 in.), that is, the scan length can be a maximum of 210 mm. The maximum sample size (with side panels intact) is 254 x 254 mm (10 x 10 in.). Therefore, when you greatly misplace the sample and perform the deskew operation, the stylus will be unable to access certain areas of the sample due to the travel limit.
2. When you have performed the deskew operation, the computed coordinates displayed in the Motion screen will be very different from the real coordinates of the artifact.

Print

The printing options displayed in this field depend on the print options selected in the Print Options window (Fig. 10-6). For example, if you selected to print Point and Trace data, the Print field lists two options: Off and Trace + Point. Use the Off option in the Print field to disable printing temporarily.

Summary Statistics calculates and prints the mean, standard deviation, minimum, maximum, and range for each parameter selected in the sequence. Statistics are calculated for scans taken with the same Scan recipe and are calculated only if two or more locations are profiled with a given recipe. See Section 10.8, "Printing Data," for sample printouts.

Point Data prints statistics and the results for each parameter at each measurement site for each Scan Recipe ID. This option also prints the X, Y, and theta coordinates of the highlighted location. The default values are those of the first location of first recipe. See Section 10.8, "Printing Data," for sample printouts.

Trace Data prints the profile plotted in dimensioned coordinates. The recipe information and measurement data are also printed with the profile. Note: 3-D traces cannot be printed automatically from a sequence.

Note: If the printing option has been selected, the printer must be online before the sequence ends or an error message is displayed that the printer is not online and data will not be printed. Also note that the Sort Cassette Results will be printed only if the Sort field is set to On. See Sort later in this section for details on enabling Sort. See Section 2.2.8, "Configuring the Tencor P-2 for your Printer," for more information about your printer output.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To set print options:

1. Press SEL to display the Print Options window:

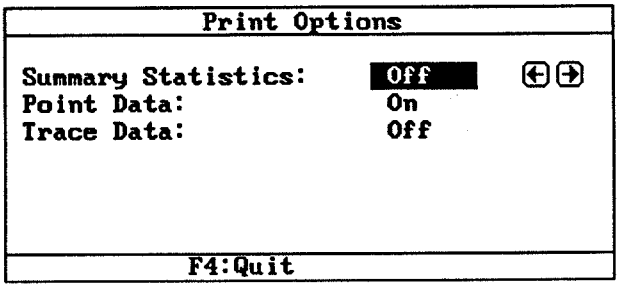


Figure 10-6 Print Options Window

2. Press [←] or [→] to toggle between Off and On. Press [↑] or [↓] to select another print feature.
3. Press [F4: Quit] to return to the Sequence Program screen. Use [←] or [→] to toggle between print options displayed in the Print field in the Sequence Program screen.

Save

When running an Automatic sequence, you must set Export, Save, or SECS to On if you want to save sequence data. If all these three options are Off, you will lose all sequence data except the last Data screen.

> **CAUTION:** **Avoid overloading the hard disk. See Section 18.1, "Checking Memory Available on the Hard Disk."**

When running a Manual or Setup sequence, if Save and SECS are set to Off, you can save the individual traces when the Data screen is displayed after each scan.

> **NOTE:** **If this is the first time you are saving data in software version 1.5, refer to Section 12.2, "Configuring the Database," for a detailed discussion on configuring your database before taking scans.**

Use [←] or [→] to select the desired option. The following options are available:

Off does not save any scan data. Note: In Automatic Sequence mode, if Save is set to Off, you will lose all the sequence scans. You will be able to save only the sequence summary at the end of the sequence run.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Statistics saves only the statistics for the specified parameters, the Scan Recipe ID, Part ID, and Sequence ID. The results for each parameter at each measurement site are not saved. Note: Statistics are calculated for scans taken with the same Scan recipe and are saved only if two or more locations are profiled with a given recipe. To save data when only a single scan is made with a given recipe, select Point Data. In this case, results are saved for the single scan and statistics saved for multiple scans taken with other recipes in the sequence.

Point Data saves the results for each parameter, the Scan Recipe ID, Part ID, Sequence ID, and X, Y, and theta coordinates at each measurement site. This option also saves statistics automatically.

Trace Data saves everything, including the Scan recipe used, the raw data points (graph), and the statistics.

> **NOTE:** **You can edit the following fields in Setup mode only. See Section 10.4, "Setting Up a Sequence Program," later in this chapter for details.**

Export

Export formats data for use with other programs and is available only in Automatic mode. You can export the data in unformatted ASCII or binary format. Use [←] or [→] to select an option. The following options are available:

Off does not export any scan data.

ASCII or Binary Statistics exports only the statistics for the specified parameters, the Scan Recipe ID, Part ID, and Sequence ID. This option does not export the results for each parameter at each measurement site.

ASCII or Binary Point Data exports the results for each parameter, the Scan Recipe ID, Part ID, Sequence ID, and X, Y, and theta coordinates at each measurement site. Statistics are also exported automatically.

ASCII or Binary Trace Data exports everything, including the Scan recipe used, the raw data points (graph), and the statistics.

> **NOTE:** **Data exported in ASCII format normally cannot be manipulated in another program directly. You will need to write macros that can manipulate ASCII data in the receiving program. See Appendix C, "Exporting Data."**

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Cassette

The Cassette function is only available for instruments with the wafer handler. Use [←] or [→] to toggle between the three wafer handler loading options.

Wafer allows you to load and unload single wafers either manually or using the wafer handler. You can use this method of loading and unloading wafers for all three sequence modes, that is, Setup, Manual, and Automatic. This mode of operation has not changed from the previous software releases.

To set the wafer option:

Use [←] or [→] to select Wafer.

Random can be only used in Automatic mode. This option allows you to set the number of wafers to be randomly selected from the cassette for scanning. The wafers will be loaded and unloaded without operator intervention. Random can only be used with a full cassette of wafers.

To set the Random option:

1. Use [←] or [→] to select Random.
2. Press SEL or SPACEBAR to display the Select Random Slots window:

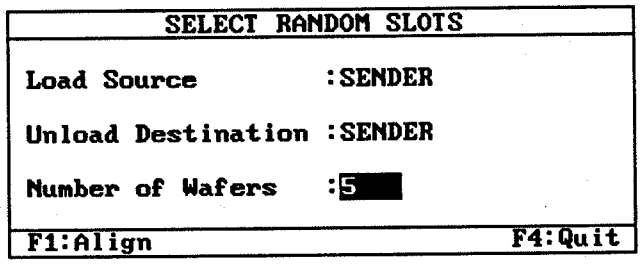


Figure 10-7 Select Random Slots Window

3. Use the arrow keys to select each field and use [←] or [→] to select available values. Enter a number in the Number of Wafers field.
4. To set the alignment, press [F1: Align]. The Alignment window (Fig. 6-13) is displayed. You can set the align feature to None, Notch, or Angle. If you select Angle, enter a value for the Angle. (See Section 6.3.2, "Loading Single Wafers Using the Wafer Handler," for details on the alignment feature.)

   Press [F4: Quit] to exit the Alignment window and return to the Select Random Slots window.
5. Press [F4: Quit] to exit the Select Random Slots window. The settings are saved with the Sequence program.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Select can be only used in Automatic mode. This option allows you to select some or all the wafers in a cassette for automatic loading, measurement, and unloading. You also can select the source and destination cassettes and display the Alignment window to set wafer alignment. After the Sequence program has been completed, you can display the Cassette Slots window again to see the status of each wafer.

To set the select option:

1. Use [←] or [→] to select Select.
2. Press SEL or SPACEBAR to display the Select Cassette Slots window:

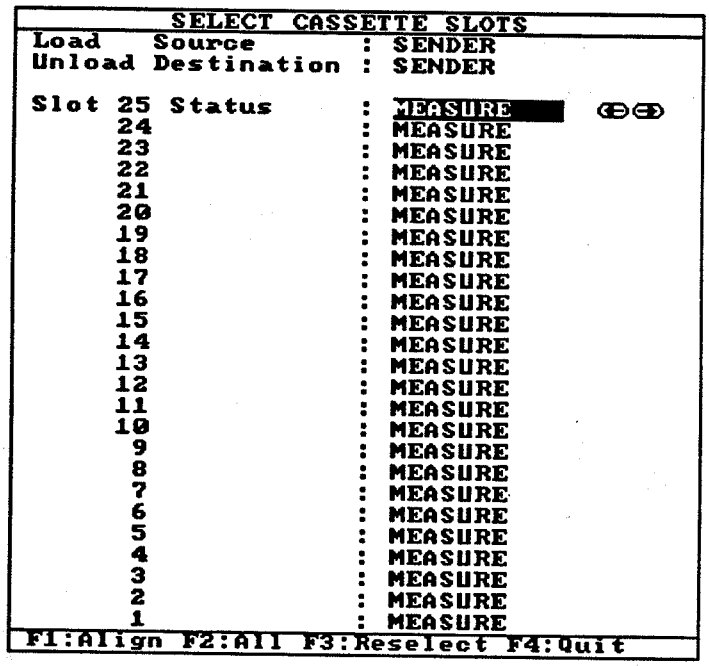


Figure 10-8 Selecting Cassette Slots

3. To select slots:
   - Use [↑] or [↓] to move up and down the list of wafer slots and use [←] or [→] to set the selected slot to Measure or Skip.
   - To select all the slots, press [F2: All].
   - To clear the current cassette results and reselect all the cassette slots for a new sequence, press [F3: Reselect].
4. To set the alignment, press [F1: Align]. The Alignment window (Fig. 6-13) is displayed. You can set the align feature to None, Notch, or Angle. If you select Angle, enter a value for the Angle. (See Section 6.3.2, "Loading Single Wafers Using the Wafer Handler," for details on the alignment feature.)

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

5. Press [F4: Quit] to exit the Select Cassette Slots window. The settings are saved with the Sequence program.

   After all the wafers in the cassette have been scanned, you can display the Cassette Slots window again to see the status of each wafer:

Status	Description
Skipped	The wafer was not scanned.
Done	The wafer has been scanned.
Unmeasured	The wafer was stopped from being loaded into the instrument during the loading process.
Passed	The wafer was within the tolerances set up using the Sort option. Displayed only if the Sort option is enabled.
Failed	The wafer was outside the tolerances set up using the Sort option. Displayed only if the Sort option is enabled.

Sort

Use the Sort Option to set up tolerances for parameters such as R_a, R_v, and TIR to pass and fail samples, and sort the passed and failed samples. Note: The Sort Option does not come with the Sequence/Database Manager Option and must be purchased separately with the Combined Statistics software package.

- If your instrument does not have the handler, a status message indicating the pass or fail status is displayed after each sample is scanned. You can manually separate the samples into passed and failed lots when unloading the samples.
- If your instrument has the wafer handler installed, you can set up the Sort Option so that passed and failed wafers are unloaded into separate cassettes.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To set up the Sort Option:

1. Use [←] or [→] to set Sort to On and press SEL or the space bar to display the Sort Options window (Fig. 10-9):

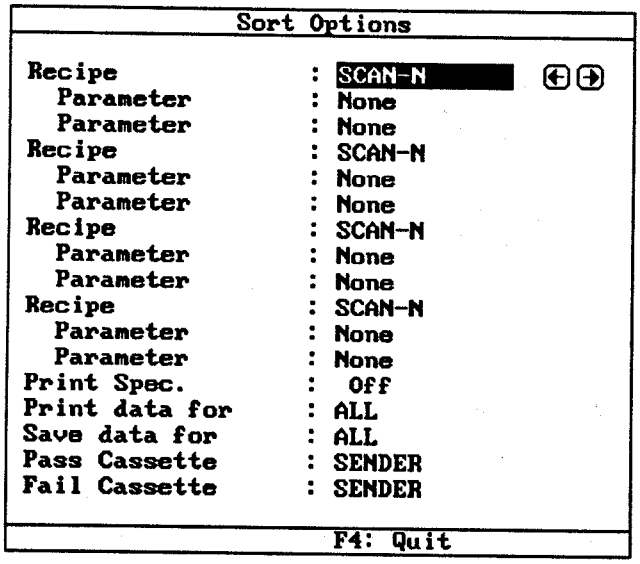


Figure 10-9 Sort Options Window

The Sort Options window lists four recipe fields with two parameters each. Each recipe field lets you select the desired recipe from the recipes used in the Sequence program. You can select up a maximum of four different recipes and eight parameters.

2. Use [←] or [→] to select a recipe for the first Recipe field. Note: To use all eight parameters for the same recipe, select the same recipe name for the four Recipe fields.
3. Select the first Parameter field and select the desired parameter by using[←] or [→]. Only parameters selected in the recipe are available.
4. Press SEL to display the Sort Parameter Values window (Fig. 10-10):

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

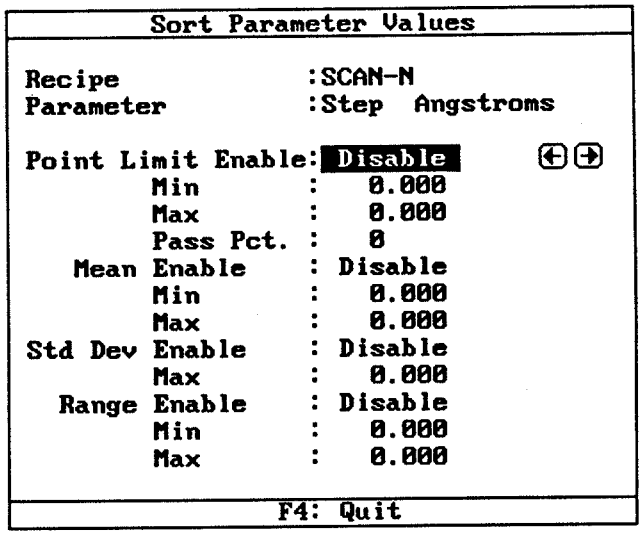


Figure 10-10 Sort Parameter Values Window

5. Enter minimum and maximum values for Point Limit, Mean, Std Dev (Standard Deviation), and Range. To disable any sort parameter, select Disable.

   The Mean, Std Dev, and Range are based on the data results. Wafers with values outside the minimum and maximum values will fail.

   Unlike the other sort tolerances, the Point Limit tests each scan parameter individually. It is a hard limit that each scan must pass in order for the sample to pass. The Pass Pct. (see next step) allows loosening of this tolerance so that only a percentage of the scans must pass for the sample to pass. Since two or more scans are required to calculate scan statistics, the Point Limit is the only tolerance that will work for a single scan type in a sequence.

6. You can specify a percentage of acceptance for each parameter by entering a value in the Pass Pct. field. For example, if you enter 50, then all wafers with 50% of their points within the range are passed for that recipe and parameter.

7. Press [F4: Quit] to exit the Sort Parameters Values window and redisplay the Sort Options window (Fig. 10-9). The values entered are saved with the Sequence program.

8. Use [↓] to select the next recipe field and use [→] to select a parameter. Follow Steps 4, 5, 6, and 7 above to enter minimum and maximum values for the Point Limit, Mean, Std Dev (Standard Deviation), and Range.

9. After entering minimum and maximum values for the desired recipe parameters in the Sort Parameters Values window (Fig. 10-10), press [F4: Quit] return to the Sort Options window (Fig. 10-9).

10. Use [↓] to select the Print Spec. field and set it to On if you want to print the specifications entered for each parameter, or Off if you do not want to not print

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

the specifications. The specifications will be printed out each time the sequence is started.

11. Set the Print Data for field to print data for passed samples only, failed samples only, or all samples. Note: The Print option in the Sequence program (Fig. 10-1) must be set to Statistics, Point, or Trace data for the data to be printed.
12. Select the Save Data For field and set it to save data for passed samples only, failed samples only, or all samples. Note: The Save option in the Sequence program (Fig. 10-1) must be set to Statistics, Point, or Trace data for the data to be saved.
13. If you are using the wafer handler, specify the Pass and Fail cassettes. By selecting different cassettes for Pass and Fail cassettes, you can separate passed and failed wafers. You can specify different Pass and Fail cassettes only if both the standard (sender) and the optional (receiver) cassettes are installed on the handler. Also note that the settings in the Pass Cassette and Fail Cassette fields in this window supersede the settings for the Load Source and Unload Destination fields in the Select Cassette Slots window (Fig. 10-8).
14. Press [F4: Quit] when you are done setting all the options to save the values and exit the window.

Deskew1, Deskew2

These are the X,Y coordinates used as reference points for the deskew operation. Deskew1 and Deskew2 are only displayed if deskew is enabled.

Location

The location number identifies the site in a sequence.

Recipe

Enter the Scan Recipe ID of the recipe to be used at each location. Each location can have a different recipe. You also can use 2-D and 3-D recipes in the same sequence.

X, Y, Theta

Enter the X, Y, and theta stage coordinates for each measurement site. See Section 10.4.4, "X,Y, Theta," for more information on entering values using *location learn*. X and Y are in microns and theta is in degrees. Note: Theta positioning is available only in instruments with the Motorized Theta/Level Option.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

10.4 SETTING UP A SEQUENCE PROGRAM

10.4.1 PROCEDURE

The Setup mode allows you to test various Scan recipes and scan locations to be used in writing a Sequence program. In this mode, you can define or edit a Sequence program by specifying the Scan recipe, positioning the sample, taking the scan, entering the stage position and repeating as often as needed.

You can change Sequence programs and recipes in this mode (when the keylock is set to 3), but *you must save them to retain them*. The automatic print feature is also available in this mode. The automatic save feature is inactive, but you can save data by pressing [F3: Data] to display the Data screen and then pressing [F4: Save].

> **NOTE:** **For critical X,Y positioning accuracy of the artifacts in relationship to the measurement cursors: first define all the X,Y locations using Precision motion, then run the sequence in Manual mode (see Section 10.6, "Running a Sequence in Manual Mode," for details), and define or verify the cursor positions. Enabling Automatic Cursor Positioning in the recipe allows you to set the cursor positions relative to the edge of the artifact instead of the beginning of the scan. See Section 7.5, "Automatic Cursor Positioning (Edge Detection)," for details.**

To set up a sequence:

1. Press MENU.
2. Choose either View/Modify, Recall, or Catalog from the Sequence menu to display the desired Sequence program (Fig. 10-1). To start with a blank Sequence program, see Section 10.3, "Writing a Sequence Program."
3. In the Sequence screen use [↓] to select the mode field and then use [←] or [→] to toggle to Setup.
4. Press [F4: Toggle Field].
5. Use [↑] or [↓] to highlight a program field (for example, Deskew, Recipe or X, Y, Theta) and edit or set up the field as described in the corresponding sections below.
6. **To add or delete scan locations:**
   - *To add* a new location and copy a Scan recipe, press INS on the remote keyboard and enter new X,Y coordinate positions.
   - *To delete* a location, change the Mode to Setup. Then select the location to be deleted and press DEL from the remote keyboard. The subsequent location numbers will be deleted.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Note: When programming locations, choose a logical progression to reduce the distance traveled and to save scan time (see Fig. 10-11).

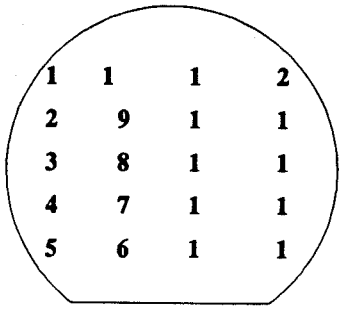


Figure 10-11 Programming Sequence Locations

7. **To initiate a scan:**

   - Highlight the coordinates of the measurement site and press START. (Press STOP to abort the scan and return to the Sequence Program screen at the first location.) When the sequence starts, the screen will display the Scan screen followed by the Data screen showing the Sequence ID and the location number.
   - If the Print option is On, the results will be printed automatically.
   - Press MENU from the Data screen to return to the Sequence Program screen.

10.4.2 DESKEW1, DESKEW2

These are the X,Y coordinates used as reference points for the deskew operation. If the deskew option is turned off, the deskew points will not be displayed in the Sequence program.

NOTE:	To reduce measurement error, set the deskew points as far apart as possible. Do not set the deskew points on the same X- or Y-axis position, but instead use two points on a diagonal line. If the deskew points are identical, the sequence will abort.

To enter the deskew values:

Set Deskew to On or With Theta and type the X and Y coordinate values in microns directly into the Sequence program, or enter the values from the Motion screen as follows:

1. Set Deskew to On or With Theta.
2. Highlight Deskew2 and press XY to display the Motion screen with the following message:

   Press [ENTER] to record coordinates to Deskew2.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3. Press [F1: Motion] until Precision motion is active.
4. Press ZΘ and lower the stylus. When in contact with the substrate, the stylus should be in the null position. (The stylus is in the null position when pressing and releasing [↓] does not change the Z position displayed in the lower-left corner of the Motion screen.) Use the trackball for rough positioning and use [←] or [→] for fine positioning of the nulled stylus tip at the desired deskew location.
5. Press ENTER to record the coordinates in the Sequence program. The Sequence Program screen is displayed with the new coordinates.
6. Press [↑] to select Deskew1 and repeat Steps 2 and 3 for other deskew locations.

To select deskew coordinates after pressing START:

Use the following steps to select new deskew coordinates in Setup mode after pressing START.

1. Display the Sequence Program screen and select the deskew coordinates to be changed.
2. Press XY or ZΘ to display the Motion screen.
3. Press [F1: Motion] until Precision motion is active.
3. Use the trackball for rough positioning and use [←] or [→] for fine positioning of the stage at the desired deskew location, and press ENTER to record the coordinates in the Sequence program. The Sequence Program screen is displayed with the new coordinates.
4. Repeat Steps 1, 2, and 3 for other deskew coordinates to be changed.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

10.4.3 RECIPES

Enter the Scan Recipe ID of the recipe to be used at each location. Each location can have a different recipe.

To enter a Scan Recipe ID:

Type in the Recipe ID directly, or insert it from the Recipe catalog as follows:

1. Press [F2: Recipe Catalog].
2. When the Recipe catalog is displayed, use [↑] or [↓] to highlight the recipe you wish to insert into the sequence.
3. Press ENTER and the Sequence Program screen is displayed with the desired recipe ID inserted.

To view or edit a Scan recipe:

You can edit a Scan recipe in Setup mode only. Also note that the keylock must be set to 3. See Section 3.8, "Setting the Keylock Position."

1. Highlight the Scan recipe and press [F1: Recipe] to display it. If you highlight a blank recipe field, the last recipe displayed appears.

   If you highlight a Scan Recipe ID that cannot be found, an error message is displayed. If you press [F1: Recipe] again, the last recipe displayed appears.
2. Change the recipe as desired; see Chapter 5, "Writing a Recipe," for details.
3. After changing a recipe, press [F1: Save] and enter a new Scan Recipe ID to save as a new recipe.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

10.4.4 X, Y, THETA

Enter the X, Y, and theta stage coordinates for each measurement site (X and Y in microns and theta in degrees). Type in the values directly or learn them from the Motion screen (Fig. 10-13). See below for procedures on entering values by learning them. Note: Theta is available only in instruments with the Motorized Theta/Level Option.

NOTE: **Refer to Fig. 10-12 for valid coordinates. When programming the X, Y stage coordinates close to the edge of the circle, allow for the back-scan distance that varies with the scan speed. (See Table 10-1.) The total scan (including the back-scan) must be within the 210-mm (8.2-in.) circular limits. The center is approximately 105000, 105000 μm.**

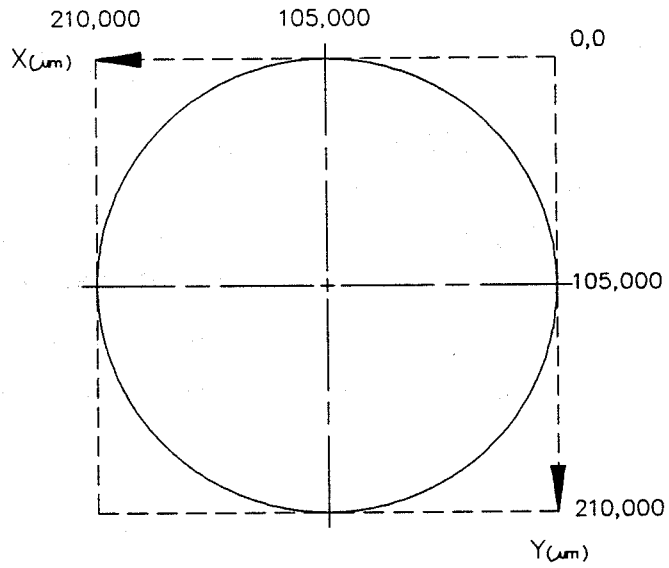


Figure 10-12 X, Y Stage Motion Coordinates

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Table 10-1 Determining the Back-Scan Distance

Scan Speed	Back-Scan Distance
1 – 100 μm/s	0.20 mm
400	0.30
1 mm/s	0.75
2	1.50
5	3.75
10	7.50

X,Y Location Learn

Use the following steps to enter X,Y values by *location learning* them in the Motion screen (Fig. 10-13).

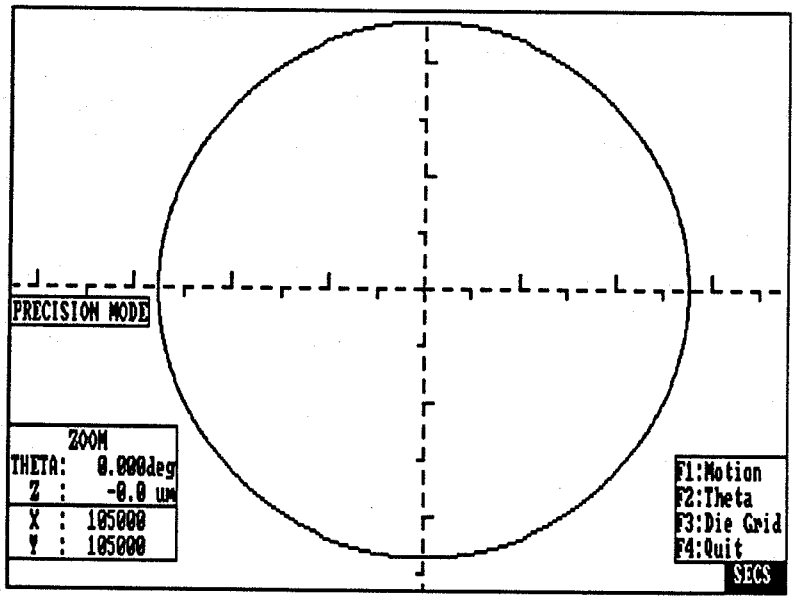


Figure 10-13 Motion Screen

1. If you start from existing X,Y coordinates, highlight the coordinates to be entered or edited and press XY. The Motion screen is displayed with the following message:

   Press ENTER to Record Coordinates to Loc X.

2. Press [F1: Motion] until Slow motion or Precision motion (for precise location of small features) is active.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3. If you start from scratch, position the sample in the desired location. *To locate the sample precisely, you must null the stylus before fine-positioning the sample.* Press Zθ and lower the stylus to the desired start-of-scan position. When in contact with the substrate, the stylus should be in the null position. (The stylus is in the null position when repeatedly pressing and releasing [↓] does not change the Z position displayed in the lower-left corner of the Motion screen.)
4. Use the trackball to approach the measurement point. If in Precision mode, use [←] or [→] on the final approach to the measurement point.

NOTE:	***For optimum XY positioning accuracy (minimal backlash),*** **it is very important to be operating in Precision mode.**

5. Press ENTER to record the coordinates in the Sequence program. The Sequence Program screen is displayed with the new coordinates inserted. Use [↓] to select the next set of coordinates to be entered or edited and repeat the procedure.

NOTE:	**For optimum X,Y positioning accuracy, take a scan at each location and verify that the resulting scan corresponds to what you desire.**

6. To add a new location, move the cursor to the end of the last line and press ENTER. A new location number is displayed with the X and Y default values of 0.

10.4.5 MULTIPLE ANALYSIS

To reanalyze a section of a trace using a different Scan recipe and without rescanning, enter 0, 0 as stage coordinates. Instead of a new scan being taken, raw data from the previous scan is used, thereby saving time and enhancing throughput. Examples of multiple analysis include

- Measurements that require more than one cursor setting, e.g., two different step heights on a single scan
- Measurements with different filter settings
- Measurements with different surface parameters enabled in the recipe

NOTE:	**When selecting or creating a Scan recipe for reanalysis, you can change analysis parameters (cursor positions and filter lengths, for example) but not scan parameters (such as scan length, speed, stylus pressure). Also note that in this case you cannot use a combination of 2-D and 3-D recipes in the same Sequence program.**

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

10.5 RUNNING A SEQUENCE PROGRAM IN AUTOMATIC MODE

When you initiate a sequence in Automatic mode, the entire sequence on each sample runs without your intervention. Once it starts, the sequence will run until completed unless a specified Scan recipe is not found or you press STOP to abort the sequence. Additionally, you also can automate

- Entering seven-level IDs for each sample
- Uploading sequence data via the SECS interface
- Exporting data
- Loading and unloading of wafers (if the instrument is equipped with a wafer handler)

The following sections cover all the options available for automating the sequence operation so that you can run Sequence programs with minimum operator intervention.

10.5.1 AUTOMATIC NAMING OF DATA FILES AND SECS TRANSFER DATA

Each time a sequence is run, the data files and the SECS transfer data can be named automatically. For example, when the first wafer in the cassette is loaded the data is saved under the filename 01; when the second wafer is loaded, the data is saved under the filename 02, and so forth. To name the data files and the SECS transfer data automatically, configure one of the ID labels in the Save Sequence IDs window as described below.

When you process a cassette of wafers, you are prompted for the seven-level IDs for the Save and SECS options only when the first wafer is loaded. For all subsequent wafers, the filenames are assigned automatically. Note that you will always be prompted for the export filename if the Export option is enabled.

This option is only available in Automatic mode and with the Random or Select Cassette options listed in the Sequence program. For details on the Random and Select Cassette options, see Section 10.3.2, "Sequence Fields."

To name the sequence data files and the SECS transfer data automatically:

1. Select Database from the Config menu and press ENTER. The Database Password window is displayed.
2. Type the password and press ENTER to display the Database Configuration window.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3. Choose Config Labels in the Configuration window and press [F1: Select] to display the Data ID Labels window:

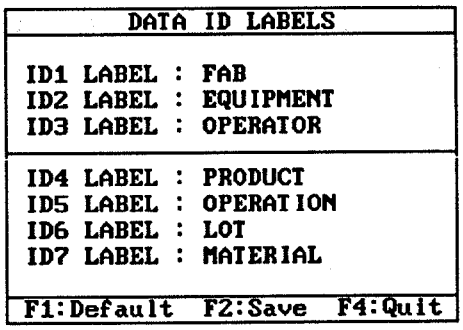


Figure 10-14 Data ID Labels Window

4. To set the program to name the sequence data files and the SECS transfer data automatically, type *SLOT NUMBER* for any of the last four ID labels. Note: The label must be in upper-case letters and there must be a space between the two words SLOT and NUMBER.
5. Press [F2: Save] to save your changes and then [F4: Quit] to exit the window.

10.5.2 PREPARING FOR AUTOMATIC LOADING AND UNLOADING

You can set the wafer handler and program software to load, unload, and sort passed and failed wafers without operator intervention. This option is only available in the Automatic mode and with the Select and Random Cassette options in the Sequence program. For details on the Random and Select Cassette options, see Section 10.3.2, "Sequence Fields."

Before operating the wafer handler, be sure to read Section 3.6, "Wafer Handler," for information on protecting the wafer handler and wafers from damage.

The wafer handler can load wafers in four sizes: 100 mm (4 in.), 125 mm (5 in.), 150 mm (6 in.), and 200 mm (8 in.). You cannot use this method of loading for samples other than wafers.

NOTE: **The cassettes used should be the same size and type that Tencor Instruments Field Service taught the wafer handler. Cassettes that have been used in chemical processing, which causes distortion, can make it difficult for the handler to center the wafers on the vacuum puck and stage. Dedicated machine cassettes are best.**

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To prepare for automatic loading and unloading:

1. Enable the wafer handler and set the handler parameters if necessary. You do not need to enable the handler and set the parameters each time the handler is used. See Section 6.3.2, "Loading Single Wafers Using the Wafer Handler," for details.
2. Make sure the vacuum chuck is installed on the stage table. (The instrument is shipped with the vacuum chuck installed if your instrument comes with the wafer handler.) Do not use a precision locator when using the handler to load wafers; you could damage the instrument.
3. To align the wafers, turn the wafer size configuration dial on the aligner (Fig. 10-15) until it displays the wafer diameter. Note: Set wafer alignment in the Handler Settings window (Fig. 6-9). See Section 6.3.2, "Loading Single Wafers Using the Wafer Handler," for details.

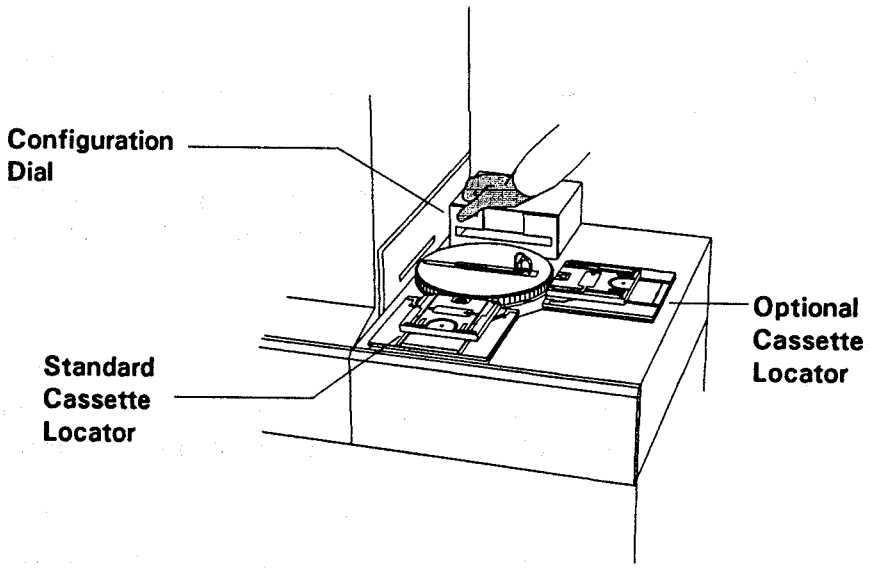


Figure 10-15 Setting the Wafer Size Configuration Dial

4. Prepare a cassette by filling all the slots with wafers. Load the wafers right side up. The bottom slot of the cassette is number 1.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

5. Place the cassette on the standard cassette locator:

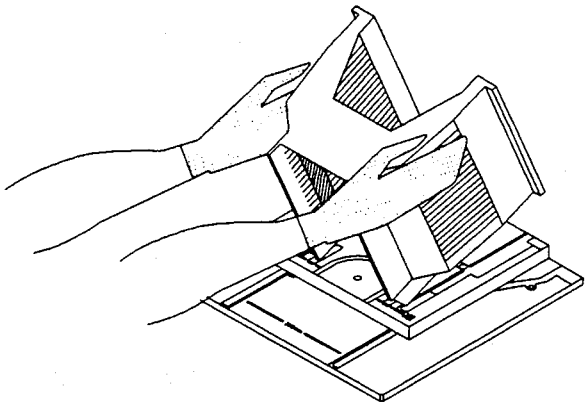


Figure 10-16 Placing a Cassette on the Locator

- Tilt the cassette back slightly and place the bottom rear corners of the cassette in the grooves on the locator. The grooves are marked with wafer sizes (100 mm, 125 mm, 150 mm, and 200 mm).
- Tilt the cassette forward until it fits securely in the grooves of the cassette locator. The H-bar across the bottom of the cassette must trip the limit switch in the slot on the locator.

NOTE:	**Cassettes placed on both locators must be the same size, otherwise wafers could be damaged and handler performance could be affected. Reinitialize the handler each time the cassette size is changed.**

6. To sort passed and failed wafers into two cassettes, place another cassette on the optional cassette locator (Fig. 10-15). The optional cassette locator functions as the receiver cassette locator.
7. Display the Sequence program to be run in Automatic mode and set the Cassette option to Select or Random. See Section 10.3, "Writing a Sequence Program," and Section 10.3.2, "Sequence Fields," for details.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

10.5.3 RUNNING THE SEQUENCE IN AUTOMATIC MODE

To run a Sequence program in Automatic mode:

1. Enable and set the SECS Option to upload data if you want to upload sequence data to the host computer. See Section 6.14, "Setting the SECS Interface Option to Upload Data," for details.
2. Set the Database Sequence IDs so that the files will be automatically named if the Select or Random Cassette option is selected in the Sequence program. See Section 10.5.1, "Automatic Naming of Data Files and SECS Transfer Data," for details.
3. Press MENU.
4. Choose either View/Modify, Recall, or Catalog from the Sequence menu to display the desired Sequence program (Fig. 10-1).
   - If the sequence has not yet been set to Automatic, in the Sequence Program screen use [↓] to select the Mode field. Then use [←] or [→] to toggle to Automatic.
   - If you do not want to start the sequence at location #1, press [F4: Toggle Field] and use [↑] or [↓] to highlight the location at which you want to begin.
   - To view a Scan recipe, highlight the name and press [F1: Recipe]. You can change the recipe contents in Setup mode only and the keylock must be set to position 3. See Section 10.4, "Setting Up a Sequence Program," for details.
5. Load the sample(s):
   - If you are manually loading a sample, see Section 6.3.1, "Loading a Sample Manually," for details.
   - If you are using the wafer handler to load a single wafer, see Section 6.3.2, "Loading Single Wafers Using the Wafer Handler," for details.
   - If you are using the Cassette Select or Random to load selected, all, or random wafers, see Section 10.5.2, "Preparing for Automatic Loading and Unloading," for details.
6. Press START.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

7. If the Save option is On, the Database Sequence IDs window is displayed:

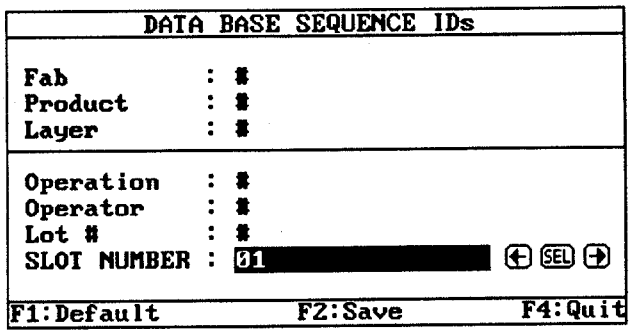


Figure 10-17 Database Sequence IDs Window

- The first three IDs have the same values entered in the Sequence program. Do not change these values.
- If you are *not* naming the files automatically, enter a filename for the data in the last ID (Slot Number in the above window). You also can enter values for the fourth, fifth, and sixth IDs if desired. Press [F2: Save] and then [F4: Quit] to save the values and continue.
- If you are naming the files automatically, press [F2: Save] and then [F4: Quit]. You do not need to enter values for any of the IDs. The filename in Slot Number will be automatically assigned for each wafer. See Section 10.5.1, "Automatic Naming of Data Files and SECS Transfer Data," for details.

NOTE:	**If Save is set to Off, you will lose all sequence scan data. You will be able to save only the sequence summary at the end of the sequence run.**

8. If the Save is set to On and the SECS option is set to automatically upload data, you will not be prompted to upload data. Data will be automatically uploaded using the IDs entered in the Database Sequence IDs window (Fig. 10-17).

   If the Save is set to Off and the SECS option is set to upload data automatically, the following window is displayed (Fig. 10-18):

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Artisan Technology Group is an independent supplier of quality pre-owned equipment

Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP