



Lab Manual


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Alpha-Step IQ Surface Profiler

(asiq)

1.0 **Title**

Alpha-Step IQ Surface Profiler

2.0 **Purpose**

The Alpha-step IQ is a mechanical, stylus-based step profiler that can measure step heights up to 2 millimeters, save programs for later use, and provide data analysis and image capture of scans.

3.0 **Scope**

This manual will describe the basic operation of this tool.

4.0 **Applicable Documents**

[Revision History](#)

KLA-Tencor has provided an **on-line** (beta version) manual for this tool. This manual will be available to Users by request only. Please contact Matthew Wasilik to obtain this file.

5.0 **Definitions & Process Terminology**

5.1 **Specifications**

Scanning stylus (standard):	5-micron radius tip, 60° angled stylus
Stylus force:	15 mg (nominal setting)
Profile length (max):	10 mm in the right direction 2 mm in the left direction
Maximum step height:	2 mm (for stepping down conditions only)
Scan Length:	10 mm
Scan Speed:	2 μm/s to 200 μm/s
Sampling Rate:	50, 100, 200, 500 or 1000 Hz
Vertical Range:	± 10 μm (20 μm) at 0.012 Å vertical resolution ± 200 μm (400 μm) at 0.24 Å vertical resolution ± 1000 μm (2000 μm) at 1.2 Å vertical resolution
Horizontal Resolution:	0.01 μm (100 Å) at 2 μm/s scan speed
Scan Method:	Moving stylus, stationary stage
Stylus Control:	Manually adjustable force
Range:	1.0 – 99.9 mg
Resolution:	0.1 mg (~ 0.5mg standard deviation)
Optical Magnification:	1) Standard: 70 – 210 x 2) High Mag. option: 160 – 480 x

Step Height Repeatability:	<ol style="list-style-type: none"> 1) At 20 μm range: 0.0008 μm (8 \AA) typical standard deviation¹ or 0.1% of measured vertical range. 2) At 400 μm range 0.005 μm (4000 \AA) typical standard deviation or 0.2% of the measured vertical range. 3) At 2000 μm range 0.030 μm (2 μm) typical standard deviation or 0.5% of the measured vertical range.
Z control :	interactive control via software
Maximum sample size:	158 mm diameter
Maximum sample thickness:	21 mm
Maximum sample weight:	1 kg
Throat depth:	81 mm
X/Y maximum travel:	151mm x 80 mm
Stage rotation:	360°, unlimited manual rotation
Leveling:	manual and various software leveling of profiles

5.2 Scan Parameters

The main screen displays the scan parameters, the live video image of the sample and stylus, and the scan trace. The different parameters are described here.

- 5.2.1 **Scan Length** - Can be entered in units of μm (10 mm max in right direction, 2 mm max in left direction)
- 5.2.2 **Number of Scans** - A multi-scan mode of up to 10 repeated scans at the position can be selected. The mean and standard deviation of the measurements will be calculated.
- 5.2.3 **Scan Speed** - Speeds between 2 to 200 $\mu\text{m/s}$ can be selected by the user.
- 5.2.4 **Advanced** - This menu gives other options for scan speed, including scan delay. More information on this will be added at a later time.
- 5.2.5 **Sampling Rate** - Rates between 50 to 1000 Hz can be selected by the user.
- 5.2.6 **Scan Time** - This is automatically determined by the Scan Length, Scan Speed, and Number of Scans parameters that are selected by the user.
- 5.2.7 **Scan Direction** - Either the right or left direction arrow can be selected by the user. Note that the maximum scan length differs by direction: 10 mm max in right direction, 2 mm max in the left direction.
- 5.2.8 **Resolution** - This is automatically determined by the Scan Speed, and Sampling Rate parameters that are selected by the user. For example, a slower scan speed and higher sampling rate will yield better resolution.
- 5.2.9 **Sensor Range** - The ASI Q has 3 types of sensors with ranges of 20 μm , 400 μm , and 2 mm, respectively. The user can select which sensor best suits their scan purposes.

Note: ***If the user is not sure of the dimensions of the features to be scanned, a sensor with the largest range should be used first for measurements. Choosing a sensor with a smaller range than the actual feature size can result in damage to the sensor and to the sample. Also, when stepping up from bottom to the top of a feature (peak bias), it is preferred that the maximum distance not exceeds the dimension of 875 microns. This will prevent potential damage to the stylus.***

5.2.10 Adjustment

The user can choose from 3 different biases: Center, Valley, and Peak bias.

Note: ***When using the 20- μm sensor, only the center bias can be used. For the 400- μm and 2-mm sensor ranges, any of the 3 biases can be used.***

5.2.10.1 **Center Bias** – Divides the range into equal \pm halves, i.e., for the 400- μm range, $\pm 200 \mu\text{m}$ can be measured. The center bias setting is optimized for a randomly distributed surface measurement.

5.2.10.2 **Valley Bias** – The full range is measured below the starting point (for the 400 μm range, 0 to $- 400 \mu\text{m}$ can be measured). The valley bias setting is optimized for a hole or trench measurement.

5.2.10.3 **Peak Bias** – The full range is measured above the starting point (for the 400 μm range, 0 to $+ 400 \mu\text{m}$ can be measured). The peak bias setting is optimized for measuring “bumps” on a surface.

Note: ***When using peak bias, it is preferred that the maximum distance not exceeds the dimension shown in [Figure 2](#). This will prevent potential damage to the stylus.***

5.2.11 Required Stylus Force

This parameter box should be colored green, which indicates that the value is within 10% of the set point. If the color is yellow or red, report on FAULTS.

Note: ***Deep trench measurements may require adjustment to the stylus force. Users may be trained to do this. Send email to ASIQ@silicon with specific request if you wish to be trained for this.***

5.2.12 Contact Speed

The speed at which the stylus approaches the sample, on a scale from 1 to 10. The default value for silicon is 5. For softer materials (gold, photoresist, etc.) a lower setting should be used (1-3). In order to prolong the life of the stylus tip, it is not recommended that a contact speed value higher than 5 be used.

5.2.13 **Required Radius** - Set at 5 μm . Only one stylus is available for the ASIQ, so this value is not to be changed.

5.2.14 **Elevator Position** - Records the position of the stage.

5.2.15 Analysis

Three types of data analysis can be selected. Measured Profile shows the original scan profile. Step Height Analysis allows the user to perform various types of data analysis, including leveling, zooming in on a particular part of the data, etc. Roughness/Waviness mode – information on this type of analysis will be added at a later date.

5.3 Video Image

A live image of the sample and the stylus (when it is in the lowered position) is shown on the right side of the screen.

5.3.1 Capture Video

One still image can be captured and saved with the current recipe. It will also be included in the data analysis report that is automatically generated.

5.3.2 Delete Video

The captured image can be deleted and a new image captured at any time.

5.4 Stylus Control

The up and down arrows next to the live image box controls the stylus and the elevator. Clicking on the up or down arrows once will raise or lower the stylus from its housing, respectively. Clicking and holding down the up arrow will lower the stage, and the stylus will be left raised above the sample. Clicking and holding down the down arrow will bring the stylus into contact with the sample on the stage.

5.5 Scan Trace and Analysis

The main screen displays the scan trace and the main features of data analysis.

The parameters of the scan trace that are displayed can be chosen by clicking the **Parameters** menu.

Some of the main scan trace parameters include:

Pos (L), (R)	Profile height at intersection with left/right cursor. (When the 2-zone option is chosen, the height at the midpoint of the zone is given.)
Height (L), (R)	Calculated difference between heights at 2 bars/zones.
TIR	Total Indicator Run out - difference between maximum and minimum profile heights for section of plot between measurement cursors.
Width	Width between the 2 bars/zones.

There are several other parameters available for data analysis, including Ave, Slope, Radius, Area+, Area-, MaxHt, MinHt, etc.

6.0 Safety

7.0 Statistical/Process Data

8.0 Available Process, Gases, Process Notes

8.1 Surface Roughness Measurements

The standard stylus at ASIQ has a 5 micron radius tip. This radius can affect roughness data. If the wavelengths on the substrate surface are short relative to the stylus radius, they will not register on the trace or will be attenuated in height. The minimum wave on the substrate should be large enough to accommodate the stylus in order to receive accurate roughness data.

9.0 Equipment Operation

9.1 Setting Scan Parameters

- 9.1.2 Scan parameters can be saved as a recipe in a user's personal folder.
- 9.1.3 Enable the system (asiq) using the Wand.
- 9.1.4 Log in.
- 9.1.5 When the default screen appears, the user can choose New to start a new recipe, or Load to load a previously saved recipe.
- 9.1.6 Choose and enter various scan parameters, as described in Section 5.2.

9.2 Scanning a Sample

9.2.1 Bring the stage out towards the front using the controls to the left of the box.

Note: ***Never manually move the stage, except to rotate it.***

Make sure that the stylus is safely recessed back, and that it is not visible on the screen image. If not, press the UP arrow once to move the stylus back up. Open the door to the stage and place your wafer on the stage.

9.2.2 The stage must be manually rotated to find your desired position. Adjust the zoom knob to the right of the stage if necessary.

Note: ***The zoom should not be adjusted while the stylus is down, as it is easy to knock the stage or stylus when accessing the zoom control.***

9.2.3 Close the door. Use the stage control knobs to position your sample under the stylus housing.

Click on the down arrow once to bring the stylus out from its shield. The message box will indicate **Dropping Sensor**. Then click and hold down the down arrow to bring the stage up and the stylus into contact with the sample, and wait until the stylus adjusts to the center of the crosshairs on the screen. The message box will indicate **Adjusting sensor**. Click the up arrow once to bring the stylus out of contact with the sample.

Note: ***Always retract the stylus before moving the stage or adjusting the zoom. Do not attempt to use the zoom function when the stylus is in contact with the sample. In other words always lift the stylus from the sample (up key) when a measurement scan will not immediately follow.***

9.2.4 With the sample in position and the desired Scan parameters set, click on START to initiate the scan. If you need to stop the scan at any point, you can click on STOP.

Note: ***The preferred direction of a scan is shown in [Figure 1](#).***

9.2.5 The stylus will first make a 400- μm back scan in order to have constant speed during one scan. Then, at the starting point, it will begin data collection.

9.2.6 If you wish to save the current recipe, click the **Save As** button and save it to your own folder. Do not create any new folders on the computer.

9.3 Data Analysis

After the scan, the profile is plotted on the screen with the summary of the data displayed next to it. The program automatically generates a report template, which can be viewed by clicking **Data Review**. There are various options for data analysis under the **Operators** menu, including digital noise filtering, erasing defects, and creating charts for presentations.

9.3.1 Measuring Profile Features

There are two options for measuring profile features: **2 Bars** and **2 Zones**. The 2 Bars option displays two vertical lines that can be clicked on and dragged to any point on the profile to apply any of the data analysis features to these points. Similarly, the 2 zones can be manipulated by the user and moved to any point.

9.3.2 Leveling

In order to level a plot, two points on the profile whose heights are equal are chosen. The program re-computes the measurement data to make these heights equal on the display, and the rest of the profile is displayed relative to these points.

Click on the leveling button to open the leveling window. There are different types of leveling operations: Leveling using least Square Line, Min Zone Method, Using 2 Zones

(Data Averaging), No Leveling, and Leveling using a polynomial of an order chosen by the user.

The most common method is the 2 Zone Leveling Method, where the two zones are placed at points where the heights are equal, and the profile is reoriented relative to these points.

The leveling window shows both the original scan trace and the plot that results after leveling is applied.

9.3.3 Zoom

The zoom window allows the user to zoom in on part of the scan profile, or to view the entire profile.

9.4 Logging Off

To log off, click on **User**, which will return to the login screen for the next user. Do not click on Exit, which will shut down the whole system.

9.5 Saving a file to the CD/RW

Press the windows key on the keyboard. A windows menu will open. Then simply drag your file over the CD drive.

10.0 Troubleshooting Guidelines

- 10.1 Occasionally the ASIQ computer software is known to “freeze”. Rebooting the computer typically solves this problem. To reboot, if possible press the Windows key on the keyboard and select RESTART. If Windows key not functional simply press the restart key on the CPU. When the Windows software has rebooted click on the ASIQ icon.
- 10.2 Occasionally the ASIQ stage is known to freeze. Rebooting the computer typically solves this problem. To reboot press the Windows key on the keyboard and select RESTART. If Windows key not functional simply press the restart key on the CPU. When the Windows software has rebooted click on the ASIQ icon.

11.0 Figures & Schematics

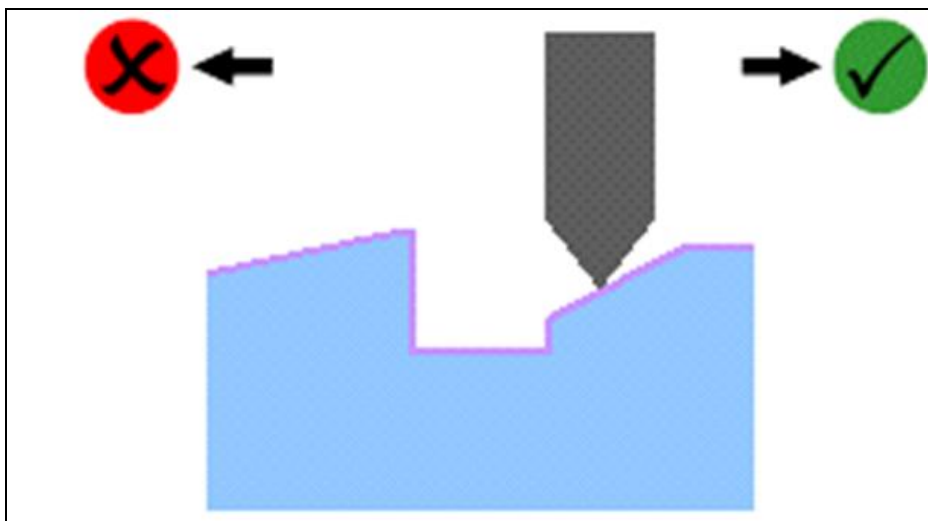


Figure 1

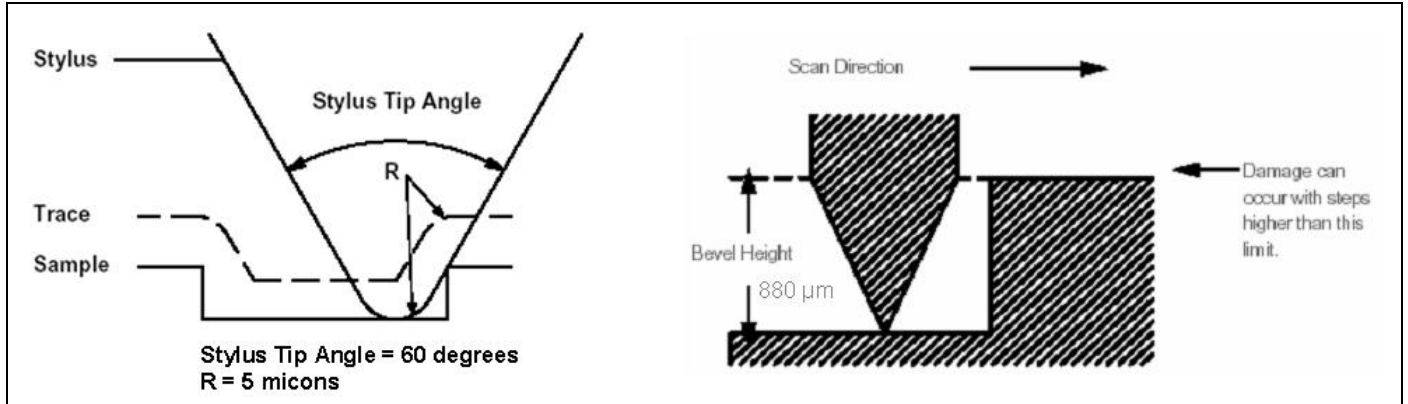


Figure 2

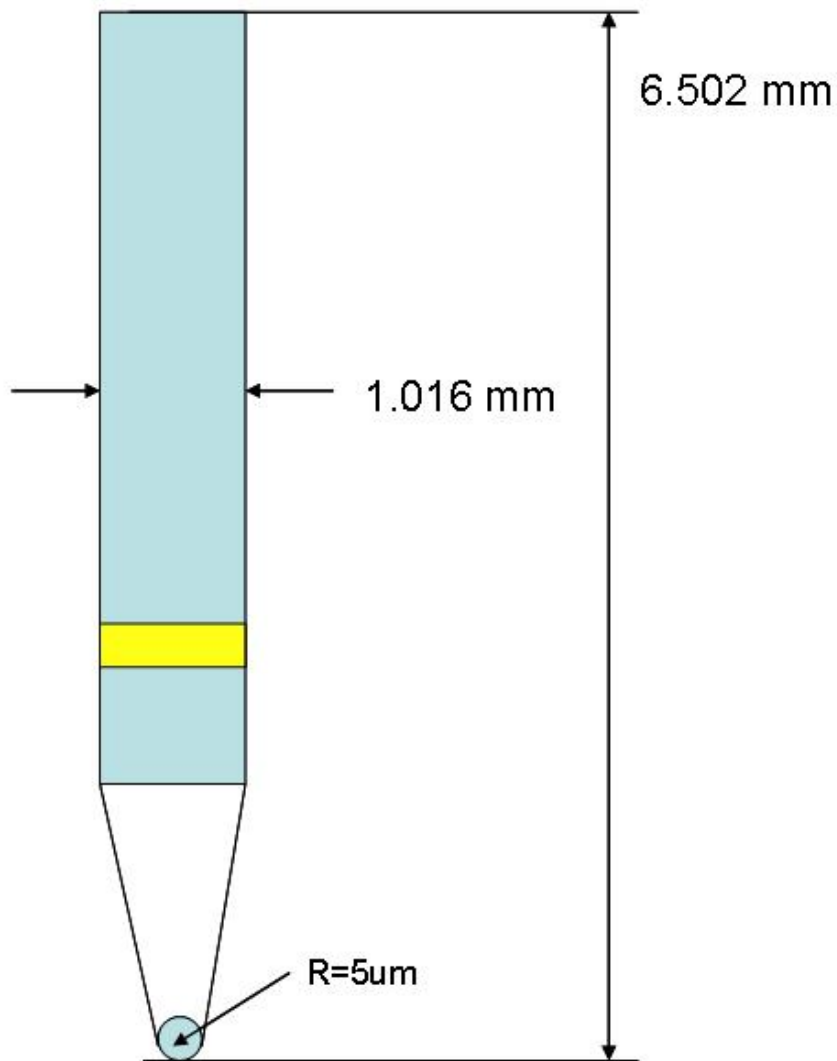


Figure 3

AS200 Study Guide

Be sure to know...

1. Changing parameters from default menu.
2. What part of the machine moves during a scan.
3. Moving stylus from home position towards the sample.
4. Measuring step height.
5. Leveling a profile.
6. Zooming in on a profile segment.
7. Returning to viewing the entire profile.
8. Zooming in on the sample image.
9. Returning to previous magnification.
10. How to logout.